2006 Urban Air Toxics Monitoring Program (UATMP) Final Report
Volume I: Main Content

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2006 Urban Air Toxics Monitoring Program (UATMP)

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LIST OF ACRONYMS

AGL	Above ground level
AIRS	Aerometric Information and Retrieval System
AQS	Air Quality Subsystem (of the Aerometric Information and Retrieval System)
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, and xylenes (*o*-, *m*-, and *p*-xylene)
CALEPA	California EPA
CBSA	Core-based statistical area(s)
CFR	Code of Federal Regulations
CV	coefficient of variation
DNPH	2,4-dinitrophenylhydrazine
DQO	Data Quality Objective(s)
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group
GC	gas chromatography
GC/MS-FID	gas chromatography/mass spectrometry and flame ionization detection
HAP	hazardous air pollutant
HPLC	high-performance liquid chromatography
HQ	Hazard Quotient
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IC	Ion Chromatography
L	liter
m^3	Cubic meter
MDL	method detection limit
MRL	Minimal risk level
MSA	metropolitan statistical area(s)
MTBE	methyl *tert*-butyl ether
NATA	National Air Toxics Assessment
NATTS	National Air Toxics Trends Site
NA	not applicable
ND	Non-detect
NEI	National Emissions Inventory
ng/m^3	Nanograms per cubic meter
NOAA	National Oceanic and Atmospheric Administration
ppbC	parts per billion carbon
ppbv	parts per billion (by volume)
pg/m^3	Picograms per cubic meter
PM	particulate matter
PUF	Polyurethane foam
QAPP	Quality Assurance Project Plan

LIST OF ACRONYMS (Continued)

REL	Reference exposure limit
RfC	Reference Concentration
RFG	Reformulated gasoline
RPD	relative percent difference
SIP	State Implementation Plan(s)
SNMOC	Speciated Nonmethane Organic Compound
SVOC	Semivolatile Organic Compounds
UATMP	Urban Air Toxics Monitoring Program
VOC	Volatile Organic Compound(s)
TAD	Technical Assistance Document
TNMOC	Total Nonmethane Organic Compound(s)
tpy	tons per year
TSP	Total Suspended Particulate
$\mu g/m^3$	Micrograms per cubic meter
URE	Unit Risk Estimate
WBAN	Weather Bureau/Army/Navy ID

Abstract

This report presents the results and conclusions from the ambient air monitoring conducted as part of the 2006 Urban Air Toxics Monitoring Program (UATMP)—a program designed to characterize the magnitude and composition of potentially toxic air pollution in, or near, urban locations. The 2006 UATMP included 59 monitoring sites that collected 24-hour air samples, typically on a 6- or 12-day schedule. Forty-five sites sampled for 60 volatile organic compounds (VOC) and/or 15 carbonyl compounds. Five sites sampled for 80 speciated nonmethane organic compounds (SNMOC) and an additional five sites sampled for total NMOC (TNMOC). Six sites sampled for semivolatile compounds (SVOC). Twenty sites sampled for 11 metals and 23 sites sampled for hexavalent chromium. Overall, over 180,000 ambient air concentrations were measured during the 2006 UATMP. This report uses various graphical, numerical, and statistical analyses to put the vast amount of ambient air monitoring data collected into perspective. Not surprisingly, the ambient air concentrations measured during the program varied significantly from city to city and from season to season.

The ambient air monitoring data collected during the 2006 UATMP serve a wide range of purposes. Not only do these data characterize the nature and extent of urban air pollution close to the 59 monitoring sites participating in this study, but they also indicate some trends and patterns that may be common to all urban environments. Therefore, this report presents some results that are specific to particular monitoring locations and presents other results that are apparently common to urban environments. The results should ultimately provide additional insight into the complex nature of urban air pollution. The final data are also included in the appendices to this report.

1.0 Introduction

Air pollution in urban locations incorporates many components that originate from a wide range of stationary, mobile, area, and natural emissions sources. Because some of these components include toxic compounds known or suspected to have the potential for negative human health impacts, the U.S. Environmental Protection Agency (EPA) continues to encourage state, local, and tribal agencies to understand and appreciate the nature and extent of toxic air pollution in urban locations. To achieve this goal, EPA sponsors the Urban Air Toxics Monitoring Program (UATMP) to characterize the composition and magnitude of urban air pollution through extensive ambient air monitoring. Since the inception of the UATMP in 1987, many environmental and health agencies have participated in the program to assess the sources and effects of air pollution within their jurisdictions. This report summarizes and interprets the 2006 UATMP monitoring effort, which includes up to twelve months of 1-in-6 and 1-in-12 day measurements of ambient air quality at 59 monitoring sites in or near 38 urban/rural locations in 28 states, including 29 metropolitan statistical areas (MSA). Much of the data analyses and interpretation in this report focuses on pollutant-specific risk potential.

The contents of this report provide both a qualitative overview of air toxics pollution at selected urban and rural locations and a quantitative analysis of the factors that appear to affect urban and rural air quality most significantly. This report also focuses on data characterization at each of the 59 different air sampling locations, a site-specific approach that allows for much more detailed analyses of the factors (e.g., stationary sources, mobile sources, natural sources, meteorological influences) that affect air quality differently from one location to the next. While the analyses presented in this report are extensive, they are by no means comprehensive. Each state section highlights the more definitive results and trends; however, a more detailed look at the results provides further insight.

The contents of this report offer participating agencies useful insights into important air quality issues. For example, participating agencies can use trends and patterns in the UATMP monitoring data to determine whether levels of air pollution present public health concerns, to identify which emission sources contribute most to air pollution, or to forecast whether proposed pollution control initiatives might significantly improve air quality. Since 2001, EPA has been

actively conducting the National Air Toxics Assessment (NATA), which uses air toxics emissions data to model ambient monitoring concentrations across the nation. UATMP monitoring data may be used to compare modeling results, such as NATA. Policy-relevant questions that the UATMP may help answer include the following:

- Which anthropogenic sources substantially degrade air quality?
- Have pollutant concentrations decreased as a result of regulations?
- Which pollutants contribute the greatest health risk on a short-term, intermediate-term, and long-term basis?

The data analyses in this report are applied at every participating UATMP monitoring site, depending upon pollutants sampled for, and present a comprehensive account of urban air pollution. However, state and local environmental agencies are encouraged to perform additional analyses on the monitoring data so that the many factors that affect their specific ambient air quality can be understood fully. While each state section is designed to be a stand-alone section to allow those interested in a particular site or state to understand the analyses without having to read the entire report, it is recommended that Sections 1 through 3 and 32 be read as complements to the state sections.

To facilitate examination of the 2006 UATMP monitoring data, the complete set of measured concentrations is presented in the appendices of this report. In addition, these data are publicly available in electronic format from the Air Quality Subsystem (AQS) of EPA's Aerometric Information Retrieval System (AIRS) at http://www.epa.gov/ttn/airs/airsaqs/.

The report is organized into 34 sections and 12 appendices. Table 1-1 highlights the contents of each section.

Table 1-1. Organization of the 2006 UATMP Report

Report Section	Section Title	Overview of Contents
1	Introduction	Introduction to the background and scope of the UATMP.
2	The 2006 UATMP	This section provides background information on the scope of the 2006 UATMP and includes information about the following: • Monitoring locations • Pollutants selected for monitoring • Sampling and analytical methods • Sampling schedules • Completeness of the air monitoring program.
3	Summary of the 2006 UATMP	This section, which presents and discusses significant trends and relationships in the UATMP data, characterizes how ambient air concentrations varied with monitoring location and with time, presents an interpretation of the significance of the observed spatial and temporal variations, and evaluates risk.
4	Sites in Alabama	Monitoring results for Birmingham-Hoover, AL MSA (ETAL, NBAL, PVAL, and SIAL)
5	Site in Arizona	Monitoring results for Phoenix-Mesa-Scottsdale, AZ MSA (PXSS)
6	Site in Colorado	Monitoring results for Grand Junction, CO MSA (GPCO)
7	Site in Washington, D.C.	Monitoring results for Washington, DC MSA (WADC)
8	Sites in Florida	Monitoring results for Orlando-Kissimmee, FL MSA (ORFL), Miami-Ft. Lauderdale-Pompano Beach, FL MSA (FLFL), and Tampa-St. Petersburg-Clearwater, FL MSA (AZFL, GAFL, SKFL, SMFL, and SYFL)
9	Site in Georgia	Monitoring results for Atlanta-Sandy Springs-Marietta, GA MSA (SDGA)
10	Sites in Illinois	Monitoring results for Chicago-Naperville-Joliet, IL-IN-WI MSA (NBIL and SPIL)
11	Sites in Indiana	Monitoring results for Chicago-Naperville-Joliet, IL-IN-WI MSA (INDEM), and Indianapolis-Carmel, IN MSA (IDIN, ININ, and WPIN)
12	Site in Kentucky	Monitoring results for Hazard, KY (HAKY)
13	Site in Massachusetts	Monitoring results for Boston-Cambridge-Quincy, MA-NH MSA (BOMA)
14	Sites in Michigan	Monitoring results for Detroit-Warren-Livonia, MI MSA (DEMI) and Sault Sainte Marie, MI (ITCMI)
15	Site in Minnesota	Monitoring results for Minneapolis-St.Paul-Bloomington, MN MSA (MIMN)

Table 1-1. Organization of the 2006 UATMP Report (Continued)

Report Section	Section Title	Overview of Contents
16	Sites in Mississippi	Monitoring results for Tupelo, MS (TUMS) and Post-Katrina monitoring results for Gulfport-Biloxi, MS MSA (GPMS)
17	Site in Missouri	Monitoring results for St. Louis, MO-IL MSA (S4MO)
18	Sites in New Jersey	Monitoring results for New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (CHNJ, ELNJ, and NBNJ) and Philadelphia-Camden-Wilmington, PA-NJ-DE-ND MSA (CANJ)
19	Sites in North Carolina	Monitoring results for Durham, NC MSA (RTPNC) and Candor, NC (CANC)
20	Sites in Oklahoma	Monitoring results for Tulsa, OK MSA (TOOK, TSOK, and TUOK) and Pryor, OK (CNEP)
21	Site in Oregon	Monitoring results for La Grande, OR (LAOR)
22	Sites in Puerto Rico	Monitoring results for San Juan-Caguas-Guaynabo, PR MSA (BAPR and SJPR)
23	Site in Rhode Island	Monitoring results for Providence-New Bedford-Fall River, RI-MA MSA (PRRI)
24	Site in South Carolina	Monitoring results for Chesterfield, SC (CHSC)
25	Sites in South Dakota	Monitoring results for Custer, SD (CUSD) and Sioux Falls, SD MSA (SFSD)
26	Sites in Tennessee	Monitoring results for Knoxville, TN MSA (LDTN and MSTN)
27	Sites in Texas	Monitoring results for Austin-Round Rock, TX MSA (MUTX, PITX, RRTX, TRTX, and WETX) and El Paso, TX MSA (YDSP)
28	Site in Utah	Monitoring results for Ogden-Clearfield, UT MSA (BTUT)
29	Site in Vermont	Monitoring results for Burlington-South Burlington, VT MSA (UNVT)
30	Site in Washington	Monitoring results for Seattle-Tacoma-Bellevue, WA MSA (SEWA)
31	Sites in Wisconsin	Monitoring results for Madison, WI MSA (MAWI) and Mayville, WI (MVWI)
32	Data Quality	This section defines and discusses the concepts of precision and accuracy. Based on quantitative and qualitative analyses, this section comments on the precision and accuracy of the 2006 UATMP ambient air monitoring data.

Table 1-1. Organization of the 2006 UATMP Report (Continued)

Report Section	Section Title	Overview of Contents
33	Conclusions and Recommendations	This section summarizes the most significant findings of the report and makes several recommendations for future projects that involve ambient air monitoring in urban locations.
34	References	This section lists the references cited throughout the report.

2.0 The 2006 UATMP

The 2006 UATMP included 59 monitoring sites that collected 24-hour integrated ambient air samples for up to 12 months, at 1-in-6 or 1-in-12 day sampling intervals. Section 2.5 provides further details on each of the sampling methodologies used to collect samples. All UATMP samples were analyzed in the Eastern Research Group (ERG) laboratory in Morrisville, NC. Samples were analyzed for concentrations of selected hydrocarbons, halogenated hydrocarbons, and polar compounds from canister samples (TO-15 and SNMOC), carbonyl compounds from sorbent cartridge samples (TO-11A), semivolatile organic compounds (SVOC) from polyurethane foam (PUF) samples (TO-13) or XAD-2® resin samples (SW846 Method 8270), hexavalent chromium from the EPA-approved method, and trace metals from filters (IO-3.5). The following discussion reviews the monitoring locations, pollutants selected for monitoring, collection schedules, sampling and analytical methods, and completeness of the 2006 UATMP dataset.

2.1 Monitoring Locations

Although EPA sponsors the UATMP, EPA does not dictate the location of its monitoring sites. Rather, representatives from the state, local, and tribal agencies that voluntarily participate in the program and contribute to the overall monitoring costs select the monitoring locations based on specific siting criteria and study needs. Some monitors were placed in urban areas near the centers of heavily populated cities (e.g., Chicago, IL and Phoenix, AZ), while others were placed in moderately populated rural areas (e.g., Candor, NC and Custer, SD).

In the wake of Hurricane Katrina's devastation to the Gulf Coast in late August 2005, EPA, state, and local agencies in Mississippi and Louisiana developed and implemented an intensive sampling initiative to evaluate air, water, and sediment quality during the clean-up and recovery process. To evaluate air quality, a network of nearly 30 ambient monitoring sites was instituted in Louisiana and Mississippi. One of those sites sampled year-round in 2006. At the request of the State of Mississippi, part of the post-Katrina data from the Gulfport, MS site are included in this report. The site serving as the background site for post-Katrina data analysis (Tupelo, MS) is also a UATMP site, and its results are also presented in this report.

Figure 2-1 shows the locations of the 59 monitoring sites, which encompass 38 different urban and rural areas, participating in the 2006 program. Outlined in Figure 2-1 are the associated core-based statistical areas (CBSA), as designated by the U.S. Census Bureau, where each site is located. A CBSA refers to either a micropolitan or metropolitan statistical area (US Census Bureau, 2007). The site-specific descriptions in Tables 2-1 and 2-2 and in Appendix A provide detailed information on the surroundings near the 2006 UATMP monitoring locations. Monitoring sites that are designated as part of EPA's National Air Toxic Trend Station (NATTS) network are indicated by bold type in Table 2-1. The NATTS network, consisting of 23 monitoring sites located in different geographical areas with varying population densities, was designed to "provide long-term monitoring data for certain priority air toxics across representative areas of the country in order to establish overall trends for these pollutants" (EPA, 2005a).

Eight new sites participated in the 2006 UATMP program. The 51 monitoring sites participating in previous UATMP are listed in Table 2-3. These 51 sites are discussed further in Section 3.3.4, Site Trends Analysis, and the individual state sections. Sections 4 through 31 are state-specific breakdowns of the data analysis, and contain topographic maps for each of the sites. Stationary source facilities within 10 miles of the monitoring sites are provided in these sections as well. The location and category descriptions of these emissions sources were retrieved from the 2002 National Emission Inventory (NEI) (EPA, 2006a).

As Figure 2-1 shows, the 2006 UATMP monitoring sites are widely distributed across the country. The monitoring data from these sites may indicate certain air quality trends that are common to all urban environments, but may also show distinct geographic trends. The data analyses in this report differentiate those trends that appear to be site-specific from those that appear to be common to most urban environments.

Figure 2-1. Monitoring Site Locations for the 2006 UATMP

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
AZFL	Azalea Park, St. Petersburg, FL	Residential	Suburban	51,000	Unknown	A neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay pilot project. This monitor is sited in an area of high population density with uniform mixed land use, consisting of residential, commercial, and industrial properties. Major point sources are located approximately 2 to 10 miles from the monitoring site. In addition, this site is at least 150 meters from major roadways. However, given the proximity of motor vehicle traffic it is expected that mobile sources will contribute appreciably to the measured samples.
BAPR	Barceloneta, PR	Residential	Rural	10	1994	The Barceloneta site is a residential area surrounded by 5 pharmaceutical plants. The greater area outside the city is rural in character and the city itself is within 2 miles of the Atlantic Ocean.
BOMA	**Boston, MA**	Commercial	Urban	27,287	2000	The Boston site is located in a residential neighborhood on Harrison Avenue in Dudley Square. Its purpose is to measure population exposure for a city bus terminal which is located across the street from the monitor and other urban sources.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
BTUT	**Bountiful, UT**	Residential	Suburban	33,310	2002	The Bountiful Viewmont site is located in a suburban area of the Ogden-Clearfield MSA, at 171 West 1370 North in Bountiful, Utah. This site is a relocation of the BOUT site, which was about 1.1 miles south of the new site. The site is located on the grounds of Viewmont High School, adjacent to a parking lot, tennis courts, and a football field. The surrounding neighborhood is made up of residential properties. BTUT is a SLAMS neighborhood-scale site for monitoring population exposure to SO_2, CO, NO_2, and $PM_{2.5}$; and a NAMS neighborhood-scale site for monitoring maximum ozone concentrations. Speciated $PM_{2.5}$ sampling, meteorological monitoring, and NATTS air toxics sampling are also done at the Bountiful Viewmont site. Several petroleum refineries are located two to five miles away from the site, as are several sand and gravel mining operations.
CANC	Candor, NC	Forest	Rural	100	1999	The Candor, NC, site is in rural Montgomery Co., at the end of a private dead end road named Perry Dr. The site sits approximately 1.5 miles off a main road (McCallum Road.). There is not a pollution source within 5 miles of the site. EPA also monitors next to this site.
CANJ	Camden, NJ	Residential	Suburban	62,000	1986	Although this monitoring site in Camden, NJ, is in a residential area, numerous industrial facilities and busy roadways are located within a 10 mile radius. The monitors are situated in a parking lot of a business complex.
CHNJ	Chester, NJ	Agricultural	Rural	12,623	1995	The Chester, NJ, site is located in a rural-agricultural, residential section and is topographically rolling. The site is located near Lucent Laboratory Building #1. There is potential population exposure to ozone, NO_2, and SO_2.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
CHSC	**Chesterfield, SC**	Forest	Rural	550	2000	The site was chosen as a background site. It is very rural and in the middle of Carolina Sandhills Wildlife Refuge. The site is located on secondary road SC 145 between McBee and Chesterfield. Traffic on 145 is light. The nearest industry (AO Smith Water Heaters) is approximately 9 miles away. Elevation is ~450'.
CNEP	Pryor, OK	Agricultural	Rural	5	2003	The Cherokee Nation's Environmental Program (CNEP) established this ambient air monitoring site on tribal trust land at the Cherokee Heights community in 2004. The purpose of this sampling project is to obtain additional data about the concentrations of VOCs in ambient air at the Pryor site and in the adjacent Cherokee Heights tribal community. This site is approximately 3.8 miles from the coal-fired power plant, 1.5 miles from the gas-fired power plant, and 0.75 mile from the sewage lagoon of the industrial park. Current instrumentation at the site includes the following: R & P TEOM for continuous PM10 measurement (Federal Equivalent Method), R & P TEOM with FDMS for continuous $PM_{2.5}$ measurement (the FDMS includes reference flow to account for volatile loss), R & P 2025 sequential sampler for $PM_{2.5}$ (Federal Reference Method), API gaseous monitors for NO_x, NOy, ozone, and SO_2, and MetOne meteorological instruments for wind speed, wind direction, ambient temperature, and relative humidity.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
CUSD	Custer, SD	Residential	Suburban	1,940	2002	The site is located on the edge of an urban area, in a pasture across the road from the last housing development on the east side of the City of Custer. The city has a population of 1,860 and is the largest city in the county. The city is located in a river valley in the Black Hills with pine covered hills on the north and south sides of the valley. The site is located in the center of the valley on the east side of the city. Major sources near the site include vehicles (highest traffic counts from May through September), forest fires (mainly during July through September), wood burning for heat, and wildland heath fires (during the winter months). The main industries in the area include tourism, logging, and mining of feldspar/quartz.
DEMI	**Dearborn, MI**	Industrial	Suburban	12,791	1990	The Dearborn, MI site is located in a residential neighborhood with industrial impacts. An auto and steel manufacturing plant is located in close proximity to the monitoring site. Previous violations of the PM_{10} standard have also occurred at this site. The site lies between I-75 and I-94. This site is expected to show some of the highest levels of air toxics in the Detroit Pilot program area. The SO_2 and PM_{10} measurements are also made there.
ELNJ	Elizabeth, NJ	Industrial	Suburban	170,000	Unknown	The Elizabeth site is located in Union County, NJ, at an urban-industrial site where the topography is relatively smooth. The monitoring site is located 75 yards away from the Toll Plaza and about one mile from Bayway Refinery. The neighborhood scale is at maximum concentration. The location has a PM_{10} filter analyzer for sulfates and nitrates as well as the UATMP site.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
ETAL	East Thomas, Birmingham, AL	Residential	Suburban	30,000	Unknown	This SLAMS microscale roadway site (located at the intersection of Finley Avenue and Arkadelphia Road) has a thirty-five year history of ambient air monitoring. This site is used mainly to monitor vehicle emissions. It is also an environmental justice site in that most of the residences in the area are owned and occupied by minorities. It is also located in a valley that is heavily industrialized. This site has also yielded some of the county's highest reported particulate levels. There have been several special roadway emission studies performed at this site over the past few years, the latest of which was pertaining to the contribution of $PM_{2.5}$ particles from roadway emissions.
FLFL	Davie, FL	Commercial	Suburban	8000	Unknown	The site is located on the campus of the University of Florida, Agricultural Research Center in Davie, Florida. It is located in a generally residential area that is surrounded by 4 major thoroughfares in the county (~1 mile from I-595, ~2 miles from the Florida Turnpike, ~6 miles from I-95, and ~6 miles from I-75). It is located ~ 6 miles from the Ft. Lauderdale-Hollywood International Airport and ~9 miles from Port Everglades. It is in an area generally representative of the ambient air conditions experienced throughout the county. It is expected that this site will become an NCORE type II site in the near future.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
GAFL	Gandy, Tampa, FL	Commercial	Suburban	81,460	Unknown	A neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay Region Air Toxics Study Monitoring Stations (TBRATS) pilot project. This monitor is sited in an area of high population density with uniform mixed land use, consisting of residential, commercial, and industrial properties. Major point sources are located greater than one mile from the monitoring site. Since the emission points from these sources are elevated and not proximate to the monitor, concentrations measured during this study should not be dominated by a single source. In addition, this site is at least 150 meters from major roadways. However, given the proximity of motor vehicle traffic, mobile sources are expected to contribute appreciably to the measured samples.
GPCO	**Grand Junction, CO**	Commercial	Urban	19,572	2000-2002	This site is a small 1-story shelter that houses the VOC/carbonyl sampler. The inlet for this sampler is 13' above the ground and 35' south of Pitkin Avenue. This site also has meteorological sensors (WS, WD, T, RH) on a 10 meter tower, a carbon monoxide sampler and a continuous PM_{10} sampler. Monitoring is being conducted on the southeast side of the downtown area. The area is very mixed usage, with commercial business to the west, northwest and north, residential to the northeast and east, and industrial to the southeast, south and southwest. The location is next to one of the major east-west roads in Grand Junction.
GPMS	Gulfport, MS	Commercial	Rural	17,000	1995	The Gulfport site is in a light commercial and residential area. This site was selected because this area is believed to have high ambient air toxic concentrations based upon information from the NATA study and Mississippi's major source emission inventories.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
HAKY	**Hazard, KY**	Residential	Suburban	500	1999	The Perry County Horse Park monitoring station was established in April 2000 and is designated as a SLAMS site for PM_{10} and a Special Purpose Monitoring site for ozone and $PM_{2.5}$. In October 2001, $PM_{2.5}$ Speciation sampling was added as part of the national speciation program. The site is located on the grounds of the Perry County Horse Park and is approximately 2.5 miles north/northeast of Hazard. The monitoring station is an 8' x 10' aluminum clad shelter with a wooden deck covering the roof. The closest structure to the site is Perry Central High School, which is about 600 feet northwest of the site. The elevation is at 912 feet.
IDIN	Stout Field in Indianapolis, IN	Military Reservation	Urban	30,916	1996	This site is located at Stout Field National Guard Armory. This monitor is strategically located based on an evaluation of U.S. EPA's 1996 and 1999 NATA; its proximity to major sources for HAP emissions; its proximity to areas where the public lives and congregates; and its history of housing operating monitors. This site monitors for metals, carbonyls, and VOC.
INDEM	Gary, IN	Industrial	Urban	42,950	1990	This site is located on property now owned by the Dunes National Lakeshore. It is approximately one-half to three-quarters of a mile south west of the USX coking battery for their mill. The site is part of the Chicago PAMS network. It is considered a Type 2 or source site. Monitoring for ozone, NO/NO_x, ozone precursors, and carbonyls began in 1995 as the network was deployed in Wisconsin, Illinois, Indiana, and Michigan. Other parameters monitored at this location are SO_2, PM_{10}, $PM_{2.5}$, speciated $PM_{2.5}$, and several meteorological parameters.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
ININ	South Harding St., Indianapolis, IN	Residential	Urban	97,780	2002	This site is located on South Harding Street. This monitor is strategically located based on an evaluation of U.S. EPA's 1996 and 1999 NATA; its proximity to major sources for HAP emissions; its proximity to areas where the public lives and congregates; and its history of housing operating monitors. This site monitors for metals, carbonyls, VOC, and hexavalent chromium.
ITCMI	Sault Sainte Marie, MI	Residential	Rural	100,000	1990	Tribal members had issued complaints arising from the smell and clouds being produced from a steel plant and paper mill located on the other side of the Saint Mary's River. The site is located on Lake Superior State University campus, which is a residential area. This site includes two sequential $PM_{2.5}$ filter based FRM monitors (primary and a collocated), a $PM_{2.5}$ speciation monitor, a $PM_{2.5}$ TEOM monitor, an AVOCS monitor, a PAH monitor, a meteorological station, and a large particulate matter collector (dustfall monitor).
LAOR	**La Grande, OR**	Residential	Urban	55	2003	The La Grande site is a neighborhood-scale site surrounded by single-family housing with some commercial activities near by. Schools, a community college, a hospital, businesses, and some light manufacturing, typical of a rural community, can be found in fairly close proximity. A variety of sources impact this site. Forest and agricultural lands surrounding La Grande are subject to seasonal burning. No major point sources are located in close proximity to the site; although a large wood products manufacturing complex is located within the airshed. Interstate 84, a major trucking route, passes on the edge of town and a large rail yard is located near the town center.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
LDTN	Loudon, TN	Residential	Suburban	13,360	2003	The site was set up due to public concern about air emissions from several sources in an industrial park. Among these sources is a very large facility that processes corn to make corn syrup, A.E. Staley, a sausage casing manufacturer, boat manufacturer, paper products manufacturer, waste metal reclamation, waste paper reclamation, and others.
MAWI	Madison, WI	Residential	Urban	23,750	1993	The Madison monitoring site is located on the East High School's Killiher Athletic field, near the corner of Hoard and Fifth Street. The monitoring site was originally established in 1992 as an ozone monitoring site. Air toxics monitoring was added in 2002 as part of the Region 5 State and Local Regional Air Toxics Monitoring Strategy. The site was selected to provide new monitoring data for a midsize city experiencing urban growth.
MIMN	Minneapolis, MN	Commercial	Urban	10,000	2000	This site is used to characterize urban air mass in Minneapolis. The site resides in an urban business district, primarily offices and retail shops, city government and warehouses. Nearby sources (less than 1.5 miles from) include Hennepin Energy Recovery Center (HERC) (which uses mass burn technology to convert 365,000 tons of garbage a year into electricity), NRG Energy Center Minneapolis LLC Steam and Air-Conditioning Supply, and Hennepin County Medical Center. There is also a high density of mobile sources and some light manufacturing industries.
MSTN	Loudon Middle School, Loudon, TN	Residential	Suburban	7,287	2006	The second site at Loudon Middle School in Loudon, TN, was set up due to public concern about air emissions from several sources in an industrial park. This site is SW of the LDTN site and upwind of the industrial sources.
MUTX	Murchison Middle School, Austin, TX	Residential	Suburban	4,374	2002	This site is located between a parking lot and the athletic fields at Murchison Middle School. The site is also located fairly close to the roadway running in front of the school.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
MVWI	**Mayville, WI**	Agricultural	Rural	5,990	1989/1994	Mayville is a designated rural NATTS site. The Mayville air monitoring station is a multi-parameter site located in rural southeast Wisconsin. The site is located approximately 45 miles northwest of Milwaukee. The Mayville site is located directly to the east of the Horicon National Wildlife Refuge. The monitoring station provides an excellent location for a rural background air toxics monitoring station. The site is rural but is located within an area affected by a major urban area. The site also shows impact on an important wildlife sanctuary. Current sampling at the site compliments and supports the air toxics monitoring effort at the site. It will in some cases allow for comparison of the monitoring methodologies ($PM_{2.5}$ metals vs. PM_{10} metals). The station was originally established for the study of ozone, fine particulate matter and regional haze. Sampling for hexavalent chromium began in March 2005 and has continued into 2006.
NBAL	North Birmingham, AL	Commercial	Urban	2,000	1994	This NAMS neighborhood scale site (located in North Birmingham) is a super site with a thirty-five year history of ambient air monitoring. It is an environmental justice site in that most of the residences in the area are owned and occupied by minorities. It is located in a valley that is heavily industrialized. This site yields the one of county's highest reported particulate levels.
NBIL	**Northbrook, IL**	Residential	Suburban	29,600	2001	The village of Northbrook is located in northeast Cook County. This monitoring site is located at the Northbrook Water Filtration Station at 750 Dundee Road. A forest preserve is located immediately south with residential areas farther south (southeast to southwest). Residential areas are also immediately to the west. Commercial areas are located along Dundee Road and to the east. A major expressway (I-94) is located 1 km to the east and north. O'Hare Airport is located 18 km to the southwest and the Chicago Loop is located 32 km to the southeast.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
NBNJ	New Brunswick, NJ	Agricultural	Rural	63,000	Unknown	The New Brunswick site is located in a suburban-agricultural, residential area and is topographically smooth. The actual site location is in Rutgers University's Horticultural Farm.
ORFL	Winter Park, FL	Commercial	Urban	59,000	Unknown	The site is an Urban/Neighborhood spatial scale site to determine the concentrations of the EPA Criteria pollutants (and now Air Toxics) to which the area population may be exposed. The primary emission source is motor vehicles with some commercial businesses also in the area.
PITX	Pickle Research Center, Austin, TX	Residential	Suburban	33,936	2005	The Pickle Research Center is located in close proximity to MOPAC (Loop 1), a major Austin-specific north-south thoroughfare. It is also bounded on one side by Braker Lane, a four to six lane east-west road in Austin.
PRRI	**Providence, RI**	Residential	Urban	5,500	1996	The site is on the roof of a rather spread-out, 1-story building in a fairly low-income neighborhood of south-Providence. It's approximately a half-mile from I-95 where it makes a sharp curve as it enters the city, where traffic congestion is common. Narragansett Bay and the Port of Providence are just a few tenths of a mile further to the east, on the other side of the highway. There is some industry along the Bay, including an asphalt plant right next to the curve in the highway. There is also a highway relocation project that's been under way for a couple of years.
PVAL	Providence, AL	Residential	Rural	Unknown	Unknown	This SLAMS urban scale general background site (located in the western-most corner of Jefferson County) was established in the fall of 1999 to monitor background levels of ozone and $PM_{2.5}$ in the county, to get a better idea of what concentrations were entering the county, and to give better resolution at that time for the ozone mapping program. It is a rural site in that there are not many residences in the area and most of the land use is agricultural. It is located on a rural mountaintop on the edge of a field used for horse grazing. It is an excellent site for a background air toxics monitor.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
PXSS	**Phoenix, AZ**	Residential	Urban	250	1993	The supersite is intended to represent the central core of the Phoenix metropolitan area in a high emissions area, and is a PAMS Type 2 site. The site houses a variety of air monitoring equipment including criteria pollutant samplers and analyzers, PAMS and air toxics, total NMHC, meteorology, visibility/urban haze, and has been selected for several state and national air monitoring studies. The area surrounding the site is primarily residential neighborhoods. There is an interstate highway approximately 1 mile west of the site, as well as commercial and industrial areas within five miles of the site.
RRTX	Round Rock, TX	Commercial	Suburban	20,900	2004	The RRTX site is located in Round Rock, TX, north of Austin. The site is located south of FM 3406 and east of the I-35 corridor, at the dead end of Commerce Boulevard. It was selected for an emphasis on a variety of factors: upwind of industrial facilities, population density (weighed heavily), and mobile source traffic (this location is fairly close to I-35, the north-south corridor through Austin into Round Rock).
RTPNC	Research Triangle Park, NC	Commercial	Suburban	12,000	2003	This site is located on the north side of the EPA campus. It is approximately 600 meters south of interstate I-40. There are trees to the east of the site, sloping down from the site to the trees. The height of the tallest tress (relative to the sampling port) to the east is less than 2 times the distance to the trees. The site has at least 270° clearance around the site.
S4MO	**St. Louis, MO**	Residential	Urban	22,840	1995	Blair Street has some industry around it and a fair amount of industry to the east. The site is also only about 250 meters from I-70 (at its closest point).

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
SDGA	**Decatur, GA**	Residential	Suburban	98,510	1995/1997	Northwesterly winds predominate making this site a short-range downwind location from Atlanta's urban core. Undeveloped land surrounds the site but within 1/8 of a mile there is a residential subdivision, a greenhouse/horse barn and an athletic field and a high school. Traffic on Wildcat Road (a dead end, 2-lane blacktop) has considerable vehicular and diesel traffic during school hours. Three shelters comprise the dry structures at the site. One houses the PAMS GC, carbonyls and VOC equipment, another the continuous monitors, and the third one belongs to Georgia Tech. Particulate matter, IMPROVE and PM_{10} metals reside on exposed structures.
SEWA	**Seattle, WA**	Industrial	Suburban	20,000	Unknown	The Beacon Hill site is centrally located within the Seattle urban area. The site is isolated within the confines of the city's water reservoir. The neatest roads are at least 1 km away. It is surrounded by residential neighborhoods, Jefferson Park and a middle school. It is about 100 meters above sea level. The hill is part of a larger ridge defining the eastern edge of an area of light industry including a major seaport, an airport and warehousing and trucking activity about 4 km west of the site. Interstate freeways and arterial roads carrying large amounts of traffic are closely situated 2 to 4 km northwest of the site. The site is considered to be representative of 24 hour average $PM_{2.5}$ levels within a 20 km radius.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
SFSD	Sioux Falls, SD	Residential	Urban	4,320	1999	The SFSD monitoring site is located in Sioux Falls, SD, the largest city in the state, near two grade schools north of the site and residential areas on the west, east, and south. The area within 1 mile of the site is mostly residential with a few retail businesses. The main industrial area of the city is about 3 miles northwest and 2 miles to the west of the site. The site was selected because it represents population exposure to chemical and particulate emissions from the industrial parts of the city. The predominant wind direction is northwest for most of the year with southeast winds during the summer months.
SIAL	Sloss Industries, Birmingham, AL	Residential	Urban	2,700	1993	This SPM neighborhood scale site (located between North Birmingham and Tarrant) has been in operation since 1994. It was established as an environmental justice site to monitor the emissions of a slag wool plant and a coke plant and is located next door to several residences in a residential area directly across the street from the plants.
SJPR	San Juan, PR	Industrial	Suburban	250	1992	The San Juan site is located at Bayamón Municipio, in the Regional Jail. The San Juan Metropolitan Area (SJMA) is affected by the emissions from stationary sources and by the heavy daily traffic. This geographical area is one of the Island's most polluted areas. The selected location is an open area representing a neighborhood scale in which the industrial area merges with the residential areas. The incidence of respiratory diseases is one of the general concerns (for the community and for the government). In general, the concentrations for the criteria pollutants are under the standards. But air toxics were not sampled for previously.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
SKFL	**Skyview Elementary School, Pinellas Park, FL**	Residential	Suburban	50,500	2003	This air monitoring site is located in south central Pinellas County at Skyview Elementary School, 8601 60th St. N., Pinellas Park, Florida. This site is a NATTS and samples for all pollutants/parameters required by NATTS, including VOCs, carbonyls, metals, $PM_{2.5}$ speciation, and black carbon. In addition, measurements are made for wind speed, wind direction, ambient pressure, and ambient temperature. Site spatial scale is neighborhood. This is a population-oriented site.
SMFL	Simmons Park, Tampa, FL	Unknown	Unknown	18,700	Unknown	Neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay pilot project. The East Lake monitor is in an area of low population density and it is representative of urban background concentrations for the Tampa Bay metro area. Major point sources are located approximately 8 to 15 km and at 150 m from major roadways.
SPIL	Schiller Park, IL	Mobile	Suburban	214,900	2001	This monitoring site is located on a trailer at 4743 Mannheim Road just south of Lawrence Ave. and between Mannheim Road and I-294. The closest runway at O'Hare Airport is 0.5 km to the northwest. The immediate vicinity is mostly commercial. Residential areas are located east across I-294.
SYFL	**Sydney, Plant City, FL**	Residential	Rural	5,142	2002	The site in Sydney is a NATTS neighborhood/rural site. Monitoring has been occurring at Sydney for 5 years as a background site. Current development in the area warranted it becoming a NATTS site. The Sydney site is also being used for an intercomparison of the port of Tampa as compared to a neighbor/rural site.
TOOK	Site #1, Tulsa, OK	Industrial	Urban	500	1995	This site is located approximately ¾ mile east of I-244. It is primarily located in an industrial area with Sun Refinery approximately 2 miles NW and Sinclair Refinery approximately ¼ mile South of site. It contains SO_2, H_2S, TSP Metals, and Toxics (VOC and Carbonyl).

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
TRTX	Travis High School, Austin, TX	Residential	Suburban	27,114	2004	This site is wedged between a parking lot, tennis courts, and the baseball field at Travis High School. The site was selected for an emphasis on a variety of factors: upwind of industrial facilities, population density (weighed heavily), and mobile source traffic (this location is fairly close to I-35 north-south corridor through Austin into Round Rock). The Travis High School site is approximately two miles south of Town Lake/the Colorado River.
TSOK	Site #2, Tulsa, OK	Residential	Suburban	62,500	2005	The Greenwood site is located approximately 200 yards N-NE of I-244 on the Oklahoma State University at Tulsa Campus. It is primarily neighborhood scale with no major industry nearby. A railroad track switching site is located approximately 50 ft. SE of the site. It contains TSP Metals and Toxics (VOC and Carbonyl).
TUMS	Tupelo, MS	Commercial	Suburban	4,900	1995/1997	The Tupelo site is in a light commercial and residential area. This site was selected because this area is believed to have high ambient air toxic concentrations based upon information from the NATA study and Mississippi's major source emission inventories.
TUOK	Site #3, Tulsa, OK	Residential	Urban	82,600	Unknown	This site is located approximately 50 ft. south of Highway 51, a major crosstown expressway. It is primarily neighborhood scale with no major industry nearby and influenced primarily by downtown traffic. It contains CO, PM_{10}, TSP Metals, and Toxics (VOC and Carbonyl).
UNVT	**Underhill, VT**	Forest	Rural	1,200	2005	The Underhill monitoring site is in a rural area, about 20 miles east of Burlington, VT. The site is at the base of Mount Mansfield, a remote field surrounded by forest.
WADC	**Washington, D.C.**	Commercial	Urban	75,800	1991	WADC is located in an open field at the southeast of end of the McMillian Water Reservoir in Washington, D.C. It is also located near several heavily traveled roadways. The site is surrounded by a hospital, a cemetery, and a university. WADC is a PAMS site.

Table 2-1. Descriptions of the 2006 UATMP Monitoring Sites (Continued)

Site Code	Location	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
WETX	Webberville Road, Austin, TX	Residential	Urban	5,733	2003	The WETX site is located in a parking lot near the intersections of Webberville Road and Northwestern Avenue and Webberville Road and Pedermales Street. Railroad tracks run parallel with Northwestern Avenue. The site was selected for an emphasis on a variety of factors: upwind of industrial facilities, population density (weighed heavily), and mobile source traffic (this location is fairly close to I-35 north-south corridor through Austin into Round Rock).
WPIN	Washington Park, Indianapolis, IN	Residential	Suburban	11,514	1984	The Washington Park Monitoring Site is located approximately 3.75 miles from the center of the city in the northeast part of Indianapolis. The nearest main roads are 30th St. (40 meters to the south) and Keystone Ave. (600 meters to the west). The site is located on the south end of Washington Park in a mostly residential neighborhood. No significant industry is located near the site. Washington Park was established in 1999 as a $PM_{2.5}$ and toxics monitoring location. It collects $PM_{2.5}$ mass for compliance purposes, along with $PM_{2.5}$ speciation and continuous $PM_{2.5}$. Air toxics monitoring began as one of the sites in the four-city Children's Health Initiative. Currently, samples collected at the site are analyzed for sixty-two VOC/HAPS. Carbonyl compounds and metals are also monitored. It is considered a long term trends site for Indianapolis. Future plans include possible designation as an NCore Site.
YDSP	El Paso, TX	Residential	Suburban	12,400	2003	This site is located in a vacant lot adjacent to the YDSP Tribal Courthouse. According to a 2003 traffic count conducted by TxDOT, this portion of Socorro Road averages 10,200 vehicles per work day. The site is approximately 50 meters northwest of the Old Reservation subdivision.

BOLD = EPA-designated National Air Toxics Trend System (NATTS) site.

Table 2-2. Site Information for the 2006 UATMP Monitoring Sites

Site Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI [c] (tpy)	Closest National Weather Service Station
AZFL	12-103-0018	Azalea Park, St. Petersburg, FL	574,226	2,721	St. Petersburg/Whitted Airport
BAPR	72-017-0003	Barceloneta, PR	23,028[b]	406	San Juan, PR, Luis Munoz Marin Int'l Airport
BOMA	25-025-0042	Boston, MA	1,562,639	1,436	General Logan Int'l. Airport
BTUT	49-011-0004	Bountiful, UT	246,163	851	Salt Lake City International
CANC	37-123-0001	Candor, NC	11,369	171	Moore County Airport
CANJ	34-007-0003	Camden, NJ	2,017,289	1,267	Philadelphia International Airport
CHNJ	34-027-3001	Chester, NJ	241,918	1,143	Somerville, NJ, Somerset Airport
CHSC	45-025-0001	Chesterfield, SC	37,525	463	Monroe Airport
CNEP	40-097-9014	Pryor, OK	31,107	331	Claremore Regional Airport
CUSD	46-033-0003	Custer, SD	5,492	23	Custer County Airport
DEMI	26-163-0033	Dearborn, MI	1,167,257	8,785	Detroit Metropolitan Airport
ELNJ	34-039-0004	Elizabeth, NJ	2,187,129	1,903	Newark Int'l Airport

Table 2-2. Site Information for the 2006 UATMP Monitoring Sites (Continued)

Site Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI [c] (tpy)	Closest National Weather Service Station
ETAL	01-073-0028	East Thomas, Birmingham, AL	394,178	4,562	Birmingham Int'l Airport
FLFL	12-011-1002	Davie, FL	1,333,555	117,376	Ft Lauderdale, FL, Hollywood Int'l Airport
GAFL	12-057-1065	Gandy, Tampa, FL	473,022	7,004	Tampa, FL Int'l Airport
GPCO	08-077-0018	Grand Junction, CO	111,141	536	Walker Field Airport
GPMS	28-047-0008	Gulfport, MS	173,435	3,231	Gulfport/Biloxi Regional Airport
HAKY	21-193-0003	Hazard, KY	32,103	108	Julian Carroll Airport
IDIN	18-097-0085	Stout Field, Indianapolis, IN	591,305	3,982	Indianapolis International Airport
INDEM	18-089-0022	Gary, IN	404,985	3,125	Lancing Municipal Airport
ININ	18-097-0057	South Harding, Indianapolis, IN	660,891	3,982	Indianapolis International Airport
ITCMI	26-033-0901	Sault Sainte Marie, MI	21,916	184	Sault Ste. Marie Municipal Airport
LDTN	47-105-0108	Loudon, TN	48,670	1,545	McGhee Tyson Airport
MAWI	55-025-0041	Madison, WI	364,645	2,677	Dane County Regional-Traux Field Airport
MIMN	27-053-0966	Minneapolis, MN	1,131,912	3,352	Minneapolis-St. Paul Int'l Airport

Table 2-2. Site Information for the 2006 UATMP Monitoring Sites (Continued)

Site Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI [c] (tpy)	Closest National Weather Service Station
MSTN	47-105-0109	Loudon Middle School, Loudon, TN	48,670	1,545	McGhee Tyson Airport
MUTX	48-453-7001	Murchison Middle School, Austin, TX	696,128	2,207	Camp Mabry Army National Guard
MVWI	55-027-0007	Mayville, WI	24,688	539	West Bend Municipal Airport
NBAL	01-073-0023	North Birmingham, AL	389,196	4,562	Birmingham Int'l Airport
NBIL	17-031-4201	Northbrook, IL	879,379	21,071	Palwaukee Municipal Airport
NBNJ	34-023-0006	New Brunswick, NJ	796,347	2,427	Somerville, NJ, Somerset Airport
ORFL	12-095-2002	Winter Park, FL	993,441	4,580	Orlando Executive Airport
PITX	48-453-703	Pickle Research Center, Austin, TX	672,699	2,207	Camp Mabry Army National Guard
PRRI	44-007-0022	Providence, RI	685,230	1,251	Theodore F Green State Airport
PVAL	01-073-1009	Providence, AL	28,587	4,562	Tuscaloosa Municipal Airport
PXSS	04-013-9997	Phoenix, AZ	1,471,887	8,905	Phoenix Sky Harbor International Airport
RRTX	48-491-7004	Round Rock, TX	387,701	713	Georgetown Municipal Airport

Table 2-2. Site Information for the 2006 UATMP Monitoring Sites (Continued)

Site Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI [c] (tpy)	Closest National Weather Service Station
RTPNC	37-063-0014	Research Triangle Park, NC	399,239	795	Raleigh-Durham Int'l Airport
S4MO	29-510-0085	St. Louis, MO	821,898	1,975	St. Louis Downtown Airport
SDGA	13-089-0002	Decatur, GA	728,937	10,418	WB Hartsfield/Atlanta International Airport
SEWA	53-033-0080	Seattle, WA	887,100	4,872	Boeing Field/King County International Airport
SFSD	46-099-0007	Sioux Falls, SD	161,598	500	Joe Foss Field Airport
SIAL	01-073-6004	Sloss Industries, Birmingham, AL	389,196	4,562	Birmingham Int'l Airport
SJPR	72-021-0006	San Juan, PR	221,546[b]	227	San Juan, PR, Luis Munoz Marin Int'l Airport
SKFL	12-103-0026	Skyview Elementary School, Tampa, FL	699,265	2,721	St. Petersburg-Clearwater International Airport
SMFL	12-057-0081	Simmons Park, Tampa, FL	61,186	7,004	Tampa Int'l Airport
SPIL	17-031-3103	Schiller Park, IL	2,074,707	21,071	O'Hare Int'l Airport
SYFL	12-057-3002	Sydney, Plant City, FL	124,967	7,004	Winter Haven's Gilbert Airport
TOOK	40-143-0235	Site #1, Tulsa, OK	459,346	1,733	Richard Lloyd Jones Jr. Airport

Table 2-2. Site Information for the 2006 UATMP Monitoring Sites (Continued)

Site Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI [c] (tpy)	Closest National Weather Service Station
TRTX	48-453-7002	Travis High School, Austin, TX	560,699	2,207	Austin-Bergstrom Int'l Airport
TSOK	40-143-0172	Site #2, Tulsa, OK	337,360	1,733	Tulsa International Airport
TUMS	28-081-0005	Tupelo, MS	71,184	916	Tupelo Municipal Airport
TUOK	40-143-0191	Site #3, Tulsa, OK	460,577	1,733	Richard Lloyd Jones Jr. Airport
UNVT	50-007-0007	Underhill, VT	33,622	555	Morrisville-Stowe State Airport
WADC	11-001-0043	Washington, D.C.	1,835,924	681	Ronald Reagan Washington National Airport
WETX	48-453-7000	Webberville Road, Austin, TX	677,505	2,207	Austin-Bergstrom Int'l Airport
WPIN	18-097-0078	Washington Park, Indianapolis, IN	792,104	3,982	Indianapolis International Airport
YDSP	48-141-9001	El Paso, TX	443,463	2,278	El Paso Int'l Airport

[a] Reference: http://zipnet.htm
[b] County population used as surrogate.
[c] Reference: EPA, 2006a.

Table 2-3. Current UATMP Monitoring Sites with Past Participation

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005
Azalea Park, St. Petersburg, FL (AZFL)				✓								✓	✓	✓	✓	✓
Barceloneta, PR (BAPR)												✓	✓	✓		
Boston, MA (BOMA)														✓	✓	✓
Bountiful, UT (BTUT)														✓	✓	✓
Camden, NJ (CANJ)	✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Candor, NC (CANC)														✓	✓	✓
Chester, NJ (CHNJ)	✓											✓	✓	✓	✓	✓
Chesterfield, SC (CHSC)																✓[b]
Custer, SD (CUSD)													✓	✓	✓	✓
Davie, FL (FLFL)																✓
Dearborn, MI (DEMI)												✓	✓	✓	✓	✓
Decatur, GA (SDGA)																✓[b]
East Thomas, Birmingham, AL (ETAL)																✓
El Paso, TX (YDSP)																✓
Elizabeth, NJ (ELNJ)											✓	✓	✓	✓	✓	✓

Table 2-3. Current UATMP Monitoring Sites with Past Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005
Gandy, Tampa, FL (GAFL)												✓	✓	✓	✓	✓
Gary, IN (INDEM)																✓
Grand Junction, CO (GPCO)														✓		✓
Gulfport, MS (GPMS)														✓	✓	✓[c]
Hazard, KY (HAKY)																✓[b]
Sault Ste. Marie, MI (ITCMI)														✓	✓	✓
La Grande, OR (LAOR)																✓[b]
Loudon, TN (LDTN)														✓	✓	✓
Madison, WI (MAWI)																✓
Mayville, WI (MVWI)														✓		✓[b]
Minneapolis, MN (MIMN)																✓
Murchison Middle School, Austin, TX (MUTX)																✓
New Brunswick, NJ (NBNJ)												✓	✓	✓	✓	✓

Table 2-3. Current UATMP Monitoring Sites with Past Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005
North Birmingham, AL (NBAL)																✓
Northbrook, IL (NBIL)														✓	✓	✓
Phoenix, AZ (PXSS)												✓	✓	✓	✓	
Pickle Research Center, Austin, TX (PITX)																
Providence, RI (PRRI)															✓	✓[b]
Providence, AL (PVAL)																✓
Research Triangle Park, NC (RTPNC)															✓	✓
Round Rock, TX (RRTX)																✓
San Juan, PR (SJPR)																✓
Schiller Park, IL (SPIL)														✓	✓	✓
Seattle, WA (SEWA)																✓[b]
Simmons Park, Tampa, FL (SMFL)												✓				✓
Sioux Falls, SD (SFSD)											✓	✓	✓	✓	✓	✓
Skyview Elementary School, Tampa, FL (SKFL)															✓	✓

Table 2-3. Current UATMP Monitoring Sites with Past Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004	2005
Sloss Industries, Birmingham, AL (SIAL)																✓
St. Louis, MO (S4MO)													✓	✓	✓	✓
Sydney, Plant City, FL (SYFL)															✓	✓
Travis High School, Austin, TX (TRTX)																✓
Tupelo, MS (TUMS)												✓	✓	✓	✓	✓
Underhill, VT (UNVT)																✓[b]
Washington, D.C. (WADC)												✓				✓[b]
Webberville Rd, Austin, TX (WETX)																✓
Winter Park, FL (ORFL)			✓											✓	✓	✓

[a] The time period for the 1999/2000 UATMP covers October 1999 to December 2000.

[b] These sites sampled for hexavalent chromium only, and their analysis was presented in a separate report.

[c] This site sampled as part of the Katrina Monitoring Effort beginning in October 2005.

Target pollutant concentrations measured during the 2006 UATMP varied significantly from monitoring site to monitoring site. As discussed throughout this report, the proximity of the monitoring locations to different emissions sources, especially industrial facilities and heavily traveled roadways, often explains the observed spatial variations in ambient air quality. To provide a first approximation of the contributions of stationary source emissions on ambient air quality at each site, Table 2-2 lists the stationary source hazardous air pollutant (HAP) emissions in the monitoring site's residing county, according to the 2002 NEI, as well as the number of people living within 10 miles of each monitoring location.

At every UATMP monitoring site, the sample collection equipment was installed either in a temperature-controlled enclosure (usually a trailer or a shed) with the sampling probe inlet exposed to the ambient air or as a stand alone sampler. With this common setup, every UATMP monitoring site sampled ambient air at heights approximately 5 to 20 feet above local ground level.

For record keeping and reporting purposes, each of these sites was assigned:

- A unique four- or five-letter UATMP site code – used to track samples from the monitoring sites to the ERG laboratory; and
- A unique nine-digit AQS site code – used to index monitoring results in the AQS database.

This report cites the UATMP site code when presenting selected monitoring results.

2.2 Methods Used and Pollutants Targeted for Monitoring

Urban air pollution typically contains hundreds of components, including, but not limited to, volatile organic compounds (VOC), carbonyl compounds, metals, and particulate matter. Because the sampling and analysis required to monitor for every component of air pollution has been prohibitively expensive, the UATMP instead focuses on specific pollutants, as listed below:

- *Compendium Method TO-15* was used to measure ambient air concentrations of 61 VOC and used in conjunction with the Technical Assistance Document (TAD) for

sampling and analysis of ozone precursors to measure 80 Speciated Nonmethane Organic Compounds (SNMOC);

- *Compendium Method TO-11A* was used to measure ambient air concentrations of 15 carbonyl compounds;

- *Compendium Method TO-13A* was used to measure ambient air concentrations of 19 SVOC, or *SW846 Method 8270* was used to measure ambient air concentrations of 106 SVOC at GPMS;

- *Compendium Method IO-3.5* was used to measure ambient concentration of 11 metals; and

- *EPA-approved hexavalent chromium method* was used to measure ambient concentrations of hexavalent chromium.

Carbon disulfide was added to the VOC list beginning in January 2006. Tables 2-4 through 2-9 identify the specific target pollutants and their corresponding experimentally-determined range of and average method detection limits (MDL).

All detection limits of the analytical methods must be considered carefully when interpreting the corresponding ambient air monitoring data. By definition, detection limits represent the lowest concentrations at which laboratory equipment have been experimentally determined to reliably quantify concentrations of selected pollutants to a specific confidence level. If a chemical concentration in ambient air does not exceed the method sensitivity (as gauged by the detection limit), the analytical method might not differentiate the pollutant from other pollutants in the sample or from the random "noise" inherent in laboratory analyses. While quantification below the MDL is possible, the measurement reliability is lower. Therefore, when samples contain concentrations at levels below their respective detection limits, multiple analyses of the same sample may lead to a wide range of results, including highly variable concentrations or "non-detect" observations. Data analysts must exercise caution when interpreting monitoring data with many reported concentrations at levels near or below the corresponding detection limits.

MDLs are determined at the ERG laboratory using 40 CFR, Part 136 Appendix B procedures (EPA, 2005b) in accordance with the specifications presented in the NATTS TAD

(EPA, 2007a). This procedure involves analyzing at least seven replicate standards prepared on/in the appropriate sampling media (per analytical method). Instrument detection limits are not determined (replicates of standards only) because sample contamination and preparation variability would not be considered.

Because non-detect results significantly limit the range of data interpretations for ambient air monitoring programs, participating agencies should note that the approach for treating non-detects may slightly affect the magnitude of the calculated central tendency concentrations, especially for pollutants with a low detection rate. The non-detects were treated as valid data points. For purposes of risk analysis, non-detects were substituted with one-half of the MDL on a target pollutant basis to calculate seasonal and annual averages.

The following discussion presents an overview of the sampling and analytical methods. For detailed descriptions of the methods, readers should refer to EPA's original documentation of the Compendium Methods (EPA, 1996; EPA, 1998; EPA, 1999a; EPA, 1999b; EPA, 1999c; EPA, 1999d; EPA, 2006b).

2.2.1 VOC and SNMOC Sampling and Analytical Method

VOC and SNMOC sampling and analysis was performed in accordance with a combination of EPA Compendium Method TO-15 and the procedure presented in EPA's "Technical Assistance Document for Sampling and Analysis of Ozone Precursors" (EPA, 1998). Ambient air samples for VOC analysis were collected in passivated stainless steel canisters. The central laboratory distributed the prepared canisters (i.e., cleaned and evacuated) to the UATMP monitoring sites before each scheduled sample collection event, and site operators connected the canisters to air sampling equipment prior to each sampling day. Before use in the field, the passivated canisters had internal pressures much lower than atmospheric pressure. Using this pressure differential, ambient air naturally flowed into the canisters once they were opened. A mass flow controller on the sampling device inlet ensured that ambient air entered the canister at an integrated constant rate across the collection period. At the end of the 24-hour sampling

period, a solenoid valve automatically stopped ambient air from flowing into the canister. Site operators recovered and returned the canisters to the central laboratory for analysis.

By analyzing each sample with gas chromatography incorporating mass spectrometry and flame ionization detection (GC/MS-FID), laboratory staff determined ambient air concentrations of 61 VOC, 80 SNMOC, and total nonmethane organic compounds (TNMOC). TNMOC is the sum of all hydrocarbon concentrations within the sample. Because isobutene and 1-butene elute from the gas chromatography (GC) column at the same time, the SNMOC analytical method reports only the sum of the concentrations for these compounds, and not the separate concentrations for each compound. The same measurement applies to *m*-xylene and *p*-xylene for both the VOC and SNMOC methods. These raw data are presented in Appendices I and J.

Regarding samples of acetonitrile, laboratory analysts have indicated that the values may be artificially high (or nonexistent) due to site conditions and potential cross-contamination with concurrent sampling of carbonyl compounds using Method TO-11A. The inclusion of acetonitrile in data analysis calculations needs to be determined on a site-specific basis by the agency responsible for the site. As such, acetonitrile results are excluded from the program-wide and site-specific pollutant of interest designation and corresponding risk analysis.

Table 2-4 summarizes the MDLs for the laboratory analysis of the VOC samples and Table 2-5 summarizes the MDLs for the SNMOC samples. Although the sensitivity of the analytical method varies from pollutant-to-pollutant and site-to-site, the MDL for VOC

Table 2-4. VOC Method Detection Limits

Pollutant	MDL (ppbv)
Acetonitrile	0.0987
Acetylene	0.0235
Acrolein	0.1066
Acrylonitrile	0.0572
tert-Amyl Methyl Ether	0.0128
Benzene	0.0053

Table 2-4. VOC Method Detection Limits (Continued)

Pollutant	MDL (ppbv)
Bromochloromethane	0.0192
Bromodichloromethane	0.0075
Bromoform	0.0172
Bromomethane	0.0108
1,3-Butadiene	0.0069
Carbon Tetrachloride	0.0097
Carbon Disulfide	0.0091
Chlorobenzene	0.0053
Chloroethane	0.0089
Chloroform	0.0045
Chloromethane	0.0150
Chloromethylbenzene	0.0055
Chloroprene	0.0224
Dibromochloromethane	0.0103
1,2-Dibromoethane	0.0184
m-Dichlorobenzene	0.0047
o-Dichlorobenzene	0.0061
p-Dichlorobenzene	0.0071
Dichlorodifluoromethane	0.0051
1,1-Dichloroethane	0.0063
1,2-Dichloroethane	0.0154
1,1-Dichloroethene	0.0146
cis-1,2-Dichloroethylene	0.0162
trans-1,2-Dichloroethylene	0.0186
Dichloromethane	0.0176
1,2-Dichloropropane	0.0333
cis-1,3-Dichloropropene	0.0142
trans-1,3-Dichloropropene	0.0097
Dichlorotetrafluoroethane	0.0032
Ethyl Acrylate	0.0118
Ethyl *tert*-Butyl Ether	0.0077
Ethylbenzene	0.0053
Hexachloro-1,3-butadiene	0.0191
Methyl Ethyl Ketone	0.0442
Methyl Isobutyl Ketone	0.0079
Methyl Methacrylate	0.0067
Methyl *tert*-Butyl Ether	0.0031
n-Octane	0.0065
Propylene	0.0097
Styrene	0.0105
1,1,2,2-Tetrachloroethane	0.0136
Tetrachloroethylene	0.0113
Toluene	0.0053

Table 2-4. VOC Method Detection Limits (Continued)

Pollutant	MDL (ppbv)
1,2,4-Trichlorobenzene	0.0175
1,1,1-Trichloroethane	0.0033
1,1,2-Trichloroethane	0.0063
Trichloroethylene	0.0107
Trichlorofluoromethane	0.0073
Trichlorotrifluoroethane	0.0124
1,2,4-Trimethylbenzene	0.0041
1,3,5-Trimethylbenzene	0.0045
Vinyl Chloride	0.0087
m,*p*-Xylene[1]	0.0095
o-Xylene	0.0045

[1] Because *m*-xylene and *p*-xylene elute from the GC column at the same time, the VOC analytical method can report only the sum of *m*-xylene and *p*-xylene concentrations and not concentrations of the individual compounds.

Table 2-5. SNMOC Method Detection Limits[1]

Pollutant	MDL (ppbC)
Acetylene	0.0978
Benzene	0.2600
1,3-Butadiene	0.2367
n-Butane	0.1989
cis-2-Butene	0.2150
trans-2-Butene	0.1839
Cyclohexane	0.2617
Cyclopentane	0.1955
Cyclopentene	0.3200
n-Decane	0.3889
1-Decene	0.4772
m-Diethylbenzene	0.4772
p-Diethylbenzene	0.4716
2,2-Dimethylbutane	0.1578
2,3-Dimethylbutane	0.2511
2,3-Dimethylpentane	0.3828
2,4-Dimethylpentane	0.2989
n-Dodecane	0.7133
1-Dodecene	0.7133
Ethane	0.0867
2-Ethyl-1-butene	0.4505
Ethylbenzene	0.2467

Table 2-5. SNMOC Method Detection Limits[1] (Continued)

Pollutant	MDL (ppbC)
Ethylene	0.0794
m-Ethyltoluene	0.3572
o-Ethyltoluene	0.3389
p-Ethyltoluene	0.4177
n-Heptane	0.2411
1-Heptene	0.3828
n-Hexane	0.2033
1-Hexene	0.4489
cis-2-Hexene	0.4505
trans-2-Hexene	0.4505
Isobutane	0.0983
Isobutene/1-Butene[3]	0.1867
Isopentane	0.1878
Isoprene	0.2644
Isopropylbenzene	0.3411
2-Methyl-1-butene	0.3200
3-Methyl-1-butene	0.3200
2-Methyl-1-pentene	0.4505
4-Methyl-1-pentene	0.4505
2-Methyl-2-butene	0.3200
Methylcyclohexane	0.1867
Methylcyclopentane	0.2144
2-Methylheptane	0.2389
3-Methylheptane	0.1761
2-Methylhexane	0.2933
3-Methylhexane	0.2300
2-Methylpentane	0.1761
3-Methylpentane	0.2489
n-Nonane	0.3766
1-Nonene	0.4733
n-Octane	0.2122
1-Octene	0.4889
n-Pentane	0.1655
1-Pentene	0.2194
cis-2-Pentene	0.3089
trans-2-Pentene	0.1433
a-Pinene	0.4772
b-Pinene	0.4772
Propane	0.1139
n-Propylbenzene	0.3777
Propylene	0.1200

Table 2-5. SNMOC Method Detection Limits[1] (Continued)

Pollutant	MDL (ppbC)
Propyne	0.1233
Styrene	0.4889
Toluene	0.2839
n-Tridecane	0.7133
1-Tridecene	0.7133
1,2,3-Trimethylbenzene	0.3377
1,2,4-Trimethylbenzene	0.4650
1,3,5-Trimethylbenzene	0.3011
2,2,3-Trimethylpentane	0.4889
2,2,4-Trimethylpentane	0.2317
2,3,4-Trimethylpentane	0.2184
n-Undecane	0.3350
1-Undecene	0.3350
m-Xylene/*p*-Xylene[2]	0.3900
o-Xylene	0.2655

[1] Concentration in ppbC = concentration in ppbv x number of carbon atoms in compound.
[2] Because isobutene and 1-butene elute from the GC column at the same time, the SNMOC analytical method can report only the sum of concentrations for these two compounds and not concentrations of the individual compounds. For the same reason, the *m*-xylene and *p*-xylene concentrations are reported as a sum.

reported for every pollutant is lower than 0.11 parts per billion by volume (ppbv). SNMOC detection limits are expressed in parts per billion-carbon (ppbC). All of the SNMOC MDLs are less than 0.72 ppbC.

2.2.2 Carbonyl Sampling and Analytical Method

Following the specifications of EPA Compendium Method TO-11A, ambient air samples for carbonyl analysis were collected by passing ambient air through cartridges containing silica gel coated with 2,4-dinitrophenylhydrazine (DNPH), a compound known to react selectively and reversibly with many aldehydes and ketones. Carbonyl compounds in ambient air are retained in the sampling cartridge, while other compounds pass through the cartridge without reacting with the DNPH-coated matrix. As with the VOC sampling, the ERG laboratory distributed the DNPH cartridges to the monitoring sites, and site operators connected the cartridges to the air sampling equipment. After each 24-hour sampling period, site operators recovered and returned the cartridges to the central laboratory for chemical analysis.

To quantify concentrations of carbonyls in the sampled ambient air, laboratory analysts eluted the exposed DNPH cartridges with acetonitrile. This solvent elution liberated a solution of DNPH derivatives of the aldehydes and ketones for analysis. High-performance liquid chromatography (HPLC) analysis and ultraviolet detection of these solutions determined the relative amounts of individual carbonyls present in the original air sample. Because butyraldehyde/isobutyraldehyde elute from the HPLC column at the same time, the carbonyl analytical method can report only the sum of the concentrations for these compounds, and not the separate concentrations for each compound. For the same reason, the analytical method reports only the sum of the concentrations for the three tolualdehydes isomers, as opposed to reporting separate concentrations for the three individual compounds. These raw data are presented in Appendix K.

Table 2-6 lists the MDLs reported by the ERG laboratory for measuring concentrations of 15 carbonyl compounds. Although the sensitivity of the analytical method varies from pollutant-to-pollutant and from site-to-site, the detection limit reported by the ERG laboratory for every pollutant is less than 0.01 ppbv for a 1000 liter (L) sample volume.

2.2.3 Semivolatile Sampling and Analytical Method

Semivolatile sampling was performed in accordance with EPA Compendium Method TO-13A or SW846/Method 8270C. Most sites that sampled SVOC did so according to Method TO-13A. ERG supplied prepared sampling media and received the samples from the sites for these analyses. Sample collection modules containing PUF, petri dishes containing filters, and Chain of Custody forms and all associated documentation, were shipped to ERG. Upon receipt of the collection modules at the ERG laboratory, sample preparation and analysis procedures are based on Compendium Method TO-13A. SVOC raw data are presented in Appendix L.

Table 2-6. Carbonyl Method Detection Limits[1]

Pollutant	Minimum MDL (ppbv)	Maximum MDL (ppbv)	Average MDL (ppbv)[2]
Acetaldehyde	0.0020	0.0490	0.0054
Acetone	0.0030	0.0790	0.0082
Benzaldehyde	0.0007	0.0220	0.0023
Butyraldehyde[3]	0.0005	0.0160	0.0018
Crotonaldehyde	0.0005	0.0150	0.0016
2,5-Dimethylbenzaldehyde	0.0003	0.0100	0.0011
Formaldehyde	0.0020	0.1560	0.0065
Hexaldehyde	0.0006	0.0180	0.0020
Isovaleraldehyde	0.0005	0.0140	0.0014
Propionaldehyde	0.0006	0.0180	0.0021
Tolualdehydes[3]	0.0009	0.0280	0.0030
Valeraldehyde	0.0004	0.0130	0.0013

[1] Assumes a 1000 L sample volume.
[2] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.
[3] Because butyraldehyde/isobutyraldehyde elute from the HPLC column at the same time, the carbonyl analytical method can report only the sum of concentrations for these two compounds and not concentrations of the individual compounds. For the same reason, the analytical method also reports only the sum of concentrations for the three tolualdehydes isomers, as opposed to reporting separate concentrations for the three individual compounds.

GPMS, the post-Katrina monitoring site, also sampled SVOC during 2006. However, this site used a different collection media in order to expand the number of pollutants monitored (19 for Method TO-13A vs. 106 for Method 8270C). Similar to TO-13A, ERG supplied prepared sampling media and received the collected samples from the sites for analysis. Semivolatile sampling modules containing prepared XAD-2® resin, petri dishes containing filters, and Chain of Custody forms and all associated documentation, were shipped to ERG. Upon receipt of the collection modules at the ERG laboratory, sample preparation and analysis procedures were conducted based on SW846 Method 8270. GPMS SVOC raw data are also presented in Appendix L.

Table 2-7a lists the MDLs for SVOC target pollutants for Method TO-13A. MDLs for SVOC ranged from 0.06 to 0.52 picograms per cubic meters (pg/m^3), based on an average sample volume of 200 cubic meters (m^3). Table 2-7b lists the MDLs for the laboratory analysis

Table 2-7a. SVOC (TO-13A) Method Detection Limits[1]

Pollutant	Minimum MDL (pg/m^3)	Maximum MDL (pg/m^3)	Average MDL (pg/m^3)[2]
Acenaphthene	0.078	0.298	0.143
Acenaphthylene	0.085	0.326	0.157
Anthracene	0.054	0.205	0.099
Benzo (a) anthracene	0.047	0.181	0.087
Benzo (a) pyrene	0.067	0.254	0.122
Benzo (b) fluoranthene	0.051	0.196	0.094
Benzo (e) pyrene	0.034	0.128	0.062
Benzo (g,h,i) perylene	0.032	0.122	0.059
Benzo (k) fluoranthene	0.037	0.141	0.068
Chrysene	0.045	0.173	0.083
Coronene	0.031	0.117	0.056
Dibenz (a,h) anthracene	0.033	0.124	0.060
Fluoranthene	0.055	0.209	0.101
Fluorene	0.132	0.503	0.242
Indeno(1,2,3-cd)pyrene	0.047	0.179	0.086
Naphthalene	0.283	1.080	0.520
Perylene	0.044	0.170	0.082
Phenanthrene	0.051	0.196	0.094
Pyrene	0.067	0.254	0.122

[1] Assumes a 200 m^3 sample volume.
[2] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

Table 2-7b. SVOC (SW846/8270C) Method Detection Limits[1]

Pollutant	Minimum MDL ($\mu g/m^3$)	Maximum MDL ($\mu g/m^3$)	Average MDL ($\mu g/m^3$)[2]
Acenaphthene	0.0002	0.1040	0.0327
Acenaphthylene	0.0002	0.0906	0.0279
Acetophenone	0.0003	0.1420	0.0379
2-Acetylaminofluorene	0.0002	0.0776	0.0323
4-Aminobiphenyl	0.0011	0.5560	0.1122
Aniline	0.0005	0.2720	0.0609
Anthracene	0.0003	0.1290	0.0423
Azobenzene	0.0003	0.1290	0.0280
Benzidine	0.0021	1.4900	0.8677
Benzo (a) anthracene	0.0002	0.0776	0.0272
Benzo (a) pyrene	0.0002	0.0776	0.0188
Benzo (b) fluoranthene	0.0003	0.1420	0.0354
Benzo (g,h,i) perylene	0.0002	0.1160	0.0425

Table 2-7b. SVOC (SW846/8270C) Method Detection Limits[1] (Continued)

Pollutant	Minimum MDL ($\mu g/m^3$)	Maximum MDL ($\mu g/m^3$)	Average MDL ($\mu g/m^3$)[2]
Benzo (k) fluoranthene	0.0002	0.1160	0.0375
Benzyl alcohol	0.0004	0.1810	0.0465
Bis(2-chloroethoxy)methane	0.0003	0.1420	0.0362
Bis(2-chloroethyl)ether	0.0003	0.1420	0.0362
Bis(2-chloroisopropyl)ether	0.0002	0.1160	0.0333
Bis(2-ethylhexyl)phthalate	0.0002	0.1040	0.0344
4-Bromophenyl phenyl ether	0.0003	0.1290	0.0457
Butyl benzyl phthalate	0.0002	0.1160	0.0358
Carbazole	0.0002	0.1160	0.0400
4-Chloro-3-methylphenol	0.0003	0.1420	0.0396
4-Chloroaniline	0.0004	0.1940	0.0479
Chlorobenzilate	0.0001	0.0647	0.0233
2-Chloronaphthalene	0.0002	0.0906	0.0295
2-Chlorophenol	0.0003	0.1550	0.0410
4-Chlorophenyl phenyl ether	0.0002	0.1040	0.0361
Chrysene	0.0003	0.1290	0.0347
Diallate	0.0002	0.1040	0.0302
Dibenz (a,h) anthracene	0.0002	0.1040	0.0344
Dibenzofuran	0.0001	0.0647	0.0249
1,2-Dichlorobenzene	0.0003	0.1290	0.0347
1,3-Dichlorobenzene	0.0002	0.1040	0.0293
1,4-Dichlorobenzene	0.0002	0.1160	0.0341
3,3´-Dichlorobenzidine	0.0003	0.1550	0.0385
2,4-Dichlorophenol	0.0002	0.1160	0.0350
2,6-Dichlorophenol	0.0002	0.1160	0.0350
Diethyl phthalate	0.0002	0.0906	0.0354
Dimethyl phthalate	0.0002	0.0906	0.0287
4-Dimethylaminoazobenzene	0.0002	0.0906	0.0228
7,12-Dimethylbenz (a) anthracene	0.0002	0.1160	0.0375
3,3´-Dimethylbenzidine	0.0021	1.0500	0.2643
2,4-Dimethylphenol	0.0014	0.6860	0.1318
Di-n-butyl phthalate	0.0002	0.1040	0.0327
4,6-Dinitro-2-methylphenol	0.0003	0.1420	0.0370
1,3-Dinitrobenzene	0.0003	0.1550	0.0444
2,4-Dinitrophenol	0.0003	0.1680	0.0778
2,4-Dinitrotoluene	0.0003	0.1420	0.0412
2,6-Dinitrotoluene	0.0003	0.1420	0.0362
Di-n-octyl phthalate	0.0002	0.0906	0.0262
Dinoseb	0.0003	0.1290	0.0406
Diphenylamine	0.0011	0.5560	0.1122
Ethyl Methanesulfonate	0.0003	0.1550	0.0452
Fluoranthene	0.0002	0.0776	0.0289

Table 2-7b. SVOC (SW846/8270C) Method Detection Limits[1] (Continued)

Pollutant	Minimum MDL ($\mu g/m^3$)	Maximum MDL ($\mu g/m^3$)	Average MDL ($\mu g/m^3$)[2]
Fluorene	0.0002	0.0906	0.0287
Hexachlorobenzene	0.0002	0.1040	0.0310
Hexachlorobutadiene	0.0003	0.1550	0.0418
Hexachlorocyclopentadiene	0.0004	0.2200	0.0550
Hexachloroethane	0.0002	0.1040	0.0344
Hexachloropropene	0.0003	0.1420	0.0387
Indeno(1,2,3-cd)pyrene	0.0000	0.0313	0.0173
Isodrin	0.0002	0.0906	0.0304
Isophorone	0.0002	0.1160	0.0316
Isosafrole	0.0002	0.1160	0.0350
Methyl Methanesulfonate	0.0003	0.2390	0.1393
3-Methylcholanthrene	0.0003	0.1290	0.0423
2-Methylnaphthalene	0.0003	0.1290	0.0390
2-Methylphenol	0.0004	0.1940	0.0521
3 & 4-Methylphenol	0.0004	0.1810	0.0490
Naphthalene	0.0003	0.1420	0.0412
1,4-Naphthoquinone	0.0002	0.1160	0.0442
1-Naphthylamine	0.0010	0.5180	0.1121
2-Naphthylamine	0.0010	0.5050	0.1022
2-Nitroaniline	0.0003	0.1290	0.0381
3-Nitroaniline	0.0002	0.1040	0.0276
4-Nitroaniline	0.0003	0.1290	0.0356
Nitrobenzene	0.0002	0.1160	0.0324
5-Nitro-o-toluidine	0.0002	0.1160	0.0316
2-Nitrophenol	0.0004	0.1940	0.0471
4-Nitrophenol	0.0003	0.1420	0.0513
N-Nitrosodiethylamine	0.0003	0.2210	0.1285
N-Nitrosodimethylamine	0.0003	0.2020	0.1181
N-Nitrosodi-n-butylamine	0.0002	0.1040	0.0344
N-Nitrosodi-n-propylamine	0.0002	0.1160	0.0417
N-Nitrosomethylethylamine	0.0003	0.1420	0.0430
N-Nitrosopiperidine	0.0002	0.1040	0.0335
N-Nitrosopyrrolidine	0.0003	0.1550	0.0494
Pentachlorobenzene	0.0002	0.1040	0.0335
Pentachloroethane	0.0004	0.1810	0.0490
Pentachloronitrobenzene	0.0003	0.1550	0.0469
Pentachlorophenol	0.0003	0.1550	0.0452
Phenacetin	0.0002	0.1040	0.0344
Phenanthrene	0.0002	0.1160	0.0358
Phenol	0.0003	0.1680	0.0425
2-Picoline	0.0014	0.6730	0.1421
Pronamide	0.0003	0.1290	0.0381

Table 2-7b. SVOC (SW846/8270C) Method Detection Limits[1] (Continued)

Pollutant	Minimum MDL (µg/m^3)	Maximum MDL (µg/m^3)	Average MDL (µg/m^3)[2]
Pyrene	0.0002	0.1160	0.0341
Pyridine	0.0005	0.3500	0.2035
Safrole	0.0003	0.1290	0.0373
1,2,4,5-Tetrachlorobenzene	0.0003	0.1290	0.0398
2,3,4,6-Tetrachlorophenol	0.0003	0.1420	0.0379
o-Toluidine	0.0003	0.1550	0.0427
1,2,4-Trichlorobenzene	0.0002	0.1160	0.0341
2,4,5-Trichlorophenol	0.0003	0.1420	0.0396
2,4,6-Trichlorophenol	0.0002	0.1040	0.0302

[1] Assumes a 200 m^3 sample volume.
[2] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

of the SVOC Method 8270 samples. MDLs for SVOC ranged from 0.02 to 0.87 micrograms per cubic meter (µg/m^3), in an average sample volume of 300 m^3.

2.2.4 Metals Sampling and Analytical Method

Sampling for the determination of metals in particulate matter was performed by the sites in accordance with EPA Compendium Method IO-3.5. Filters with Chain of Custody forms and all associated documentation were shipped to the ERG laboratory from the field. Upon receipt, the filters were analyzed by the ERG laboratory. Metals raw data are presented in Appendix M.

Table 2-8 lists the MDLs for the analysis of the metal samples. Two types of filters were utilized. Sites sampled for PM_{10} or Total Suspended Particulate (TSP) on either 47 mm Teflon® or 8 × 10" Quartz filters. Therefore, because of the difference in the filter collection media, there are two sets of MDLs listed in Table 2-8. The MDLs ranged from 0.02 to 0.60 nanograms per cubic meter (ng/m^3) for the PM_{10} filters and from 0.02 to 0.48 ng/m^3 for the TSP filters.

Table 2-8. Metals Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)[1]
8 X 10" Quartz Filters			
Antimony	0.0030	0.2100	0.0350
Arsenic	0.0030	0.2600	0.0329
Beryllium	0.0020	0.2800	0.0361
Cadmium	0.0020	0.1800	0.0255
Chromium	0.0200	3.6400	0.5981
Cobalt	0.0030	0.2400	0.0315
Lead	0.0040	0.4100	0.0755
Manganese	0.0040	0.2400	0.1072
Mercury	0.0090	0.2800	0.1748
Nickel	0.0090	0.8300	0.1876
Selenium	0.0040	0.1800	0.0316
47mm Teflon® Filters			
Antimony	0.0100	0.0400	0.0274
Arsenic	0.0090	0.0300	0.0209
Beryllium	0.0200	0.0300	0.0247
Cadmium	0.0080	0.0200	0.0180
Chromium	0.1420	0.6300	0.4780
Cobalt	0.0100	0.0300	0.0210
Lead	0.0180	0.0800	0.0638
Manganese	0.0160	0.1600	0.1157
Mercury	0.0090	0.2600	0.1945
Nickel	0.0880	0.2300	0.1761
Selenium	0.0180	0.0300	0.0263

[1] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

2.2.5 Hexavalent Chromium Sampling and Analytical Method

Hexavalent chromium was measured using an EPA-approved approach. For a detailed description of the EPA-approved approach, refer to the *Standard Operating Procedure for the Determination of Hexavalent Chromium in Ambient Air Analyzed by Ion Chromatography (IC)* (EPA, 2006b). The MDL is experimentally determined for each site at the ERG analytical laboratory; the average MDL for the program, which is presented in Table 2-9, was 0.013 ng/m^3. Raw data are presented in Appendix N.

Table 2-9. Hexavalent Chromium Method Detection Limit

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)[1]
Hexavalent Chromium	0.0056	0.0317	0.0129

[1] The MDL in the table above represents the average MDL for this pollutant, as the MDL varies slightly based on sample volume.

2.3 Sample Collection Schedules

Table 2-10 presents the first and last date on which sample collection occurred for each monitoring location. The UATMP monitoring sites started sampling in January 2006 and stopped sampling in December 2006, with a few exceptions. Six sites began sampling after January 2006:

- Loudon, TN site (MSTN) started in February 2006;
- Tulsa, OK site (TSOK) started sampling carbonyls and VOC in June 2006;
- Indianapolis, IN site (WPIN) started in June 2006;
- Cherokee Nation site (CNEP) started in September 2006; and
- Indianapolis, IN sites (IDIN and ININ) started in October 2006.
- Tulsa, OK sites (TOOK, TSOK, and TUOK) began sampling metals in October 2006.

Sixteen sites ended sampling before December 2006:

- La Grande, OR and Madison, WI sites (LAOR and MAWI) ended in February 2006;
- El Paso, TX site (YDSP) ended in March 2006;
- Minneapolis, MN site (MIMN) ended metals sampling in March 2006, and VOC and carbonyl sampling in April 2006;
- North Carolina sites (CANC and RTPNC) ended in June 2006;
- The Birmingham, AL sites (ETAL, NBAL, PVAL, and SIAL) and Austin, TX sites (MUTX, PITX, RRTX, TRTX, and WETX) ended in late June or early July 2006; and
- The Ft. Lauderdale, FL site (FLFL) ended in October 2006.

Table 2-10. Sampling Schedules and Completeness

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
AZFL	1/5/06	12/31/06	61	61	100															
BAPR	1/5/06	12/31/06	59	59	100	57	59	97												
BOMA	1/5/06	12/31/06							61	61	100	56	56	100						
BTUT	1/5/06	12/31/06	60	60	100	59	60	98	59	61	97	58	58	100	59	60	98			
CANC	1/11/06	6/28/06	9	9	100															
CANJ	1/5/06	12/31/06	57	59	97	53	58	91												
CHNJ	1/5/06	12/31/06	58	60	97	58	60	97												
CHSC	1/5/06	12/31/06							59	61	97									
CNEP	9/26/06	12/26/06				14	16	88												
CUSD	1/5/06	12/31/06	62	62	100	61	62	98							61	62	98			
DEMI	1/5/06	12/31/06	60	60	100	58	61	95	59	61	97									
ELNJ	1/5/06	12/31/06	59	60	98	58	60	97												
ETAL	1/11/06	6/28/06	15	15	100	15	15	100	16	17	94	15	15	100				16	17	94
GAFL	1/5/06	12/31/06	61	61	100															

[a] Begins with 1st valid sample and may include all six analyses.
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-10. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
GAFL	1/5/06	12/31/06	61	61	100															
GPCO	1/5/06	12/31/06	61	61	100	61	61	100	60	61	98									
GPMS	1/2/06	12/31/06	71	74	96	68	72	94	2	2	100	42	48	88	62	66	94	61	63	97
HAKY	1/5/06	12/31/06							59	61	97									
IDIN	10/2/06	12/31/06	16	16	100							13	16	81						
INDEM	1/5/06	12/31/06	54	55	98															
ININ	10/2/06	12/31/06	14	15	93				16	16	100	16	16	100						
ITCMI	1/5/06	12/31/06																60	62	97
LAOR	1/5/06	2/4/06							6	6	100									
LDTN	1/5/06	12/31/06	56	57	98	55	57	96												
MAWI	1/5/06	2/22/06	8	8	100	8	8	100												
MIMN	1/5/06	4/23/06	17	17	100	16	17	94				12	13	92						
MSTN	2/22/06	12/31/06	51	54	94	49	54	91												
MUTX	1/5/06	6/28/06	17	17	100	15	17	88					13	100	15	17	88			

[a] Begins with 1st valid sample and may include all six analyses.
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-10. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
MVWI	1/5/06	12/31/06							60	61	98									
NBAL	1/11/06	7/10/06	17	19	89	17	20	85	15	16	94	30	30	100				15	16	94
NBIL	1/5/06	12/31/06	61	61	100	60	61	98	59	61	97	62	62	100	57	58	98			
NBNJ	1/5/06	12/31/06	53	60	88	51	60	85												
ORFL	1/5/06	12/31/06	61	61	100															
PITX	1/5/06	6/28/06	16	17	94	16	18	89				17	17	100	16	18	89			
PRRI	1/5/06	12/31/06							61	61	100									
PVAL	1/11/06	6/28/06	16	17	94	16	17	94	17	18	94	15	15	100				15	18	83
PXSS	1/5/06	12/31/06							59	61	97	59	63	94						
RRTX	1/5/06	7/1/06	16	17	94	15	18	83				15	15	100	15	18	83			
RTPNC	1/11/06	6/28/06	9	9	100															
S4MO	1/5/06	12/31/06	61	62	98	59	62	95	61	61	100	59	60	98						
SDGA	1/5/06	12/31/06							57	61	93									
SEWA	1/5/06	12/31/06							13	17	76									

[a] Begins with 1st valid sample and may include all six analyses.
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-10. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
SFSD	1/5/06	12/31/06	60	61	98	59	61	97							59	61	97			
SIAL	1/11/06	7/4/06	16	16	100	18	18	100	16	16	100	15	15	100				16	18	89
SJPR	1/5/06	12/31/06	40	52	77	40	52	77												
SKFL	1/5/06	12/31/06	60	60	100															
SMFL	1/5/06	12/31/06	61	61	100															
SPIL	1/5/06	12/31/06	60	62	97	61	61	100												
SYFL	1/5/06	12/31/06	61	61	100				57	59	97									
TOOK	1/23/06	12/31/06	44	52	85	44	53	83				14	14	100						
TRTX	1/5/06	6/28/06	16	18	89	16	18	89				15	16	94	16	18	89			
TSOK	6/10/06	12/31/06	28	32	88	29	32	91				15	15	100						
TUMS	1/5/06	12/31/06	61	61	100	60	61	98												
TUOK	1/23/06	12/31/06	30	54	56	31	55	56				13	13	100						
UNVT	1/5/06	12/31/06							59	61	97									

[a] Begins with 1st valid sample and may include all six analyses.

A = Valid Samples

B = Total Number of Samples

C = Completeness (%)

Table 2-10. Sampling Schedules and Completeness (Continued)

Site	Monitoring Period[a]		Carbonyl			VOC			Hexavalent Chromium			Metals			SNMOC			SVOC		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
WADC	1/5/06	12/31/06							59	61	97									
WETX	1/5/06	6/28/06	14	17	82	15	18	83	12	16	75	17	17	100	15	17	88			
WPIN	6/28/06	12/31/06	5	6	83															
YDSP	1/5/06	3/14/06				17	19	89												
Overall			1,839	1,923	96	1,329	1,441	92	1,000	1,035	97	529	539	98	375	395	95	183	194	94

[a] Begins with 1st valid sample and may include all six analyses.

A = Valid Samples

B = Total Number of Samples

C = Completeness (%)

According to the UATMP schedule, 24-hour integrated samples were to be collected at every monitoring site approximately 1-in-6 or 1-in-12 days (dependent upon location) and each sample collection began and ended at midnight, local standard time. Table 2-10 shows the following:

- At most sites, VOC and carbonyl samples were collected concurrently.
- Of the 59 sites, 12 did not sample for VOC and/or carbonyls.
- Six sites sampled SVOCs.
- 10 sites collected SNMOC or TNMOC samples.
- 20 sites collected metal samples.
- Finally, 23 sites collected hexavalent chromium samples.

As part of the sampling schedule, site operators were instructed to collect duplicate samples on roughly 10 percent of the sampling days for select methods when duplicate samplers were available. Sampling calendars were distributed to help site operators schedule the collection of samples, duplicates, and field blanks. Field blanks were collected once a month for carbonyl compounds, hexavalent chromium, metals, and SVOC. In cases where monitors failed to collect valid samples on a scheduled sampling day, site operators were instructed to reschedule samples for other days. This practice explains why some monitoring locations periodically strayed from the 1-in-6 or 1-in-12 day sampling schedule. The State of Michigan prepared a schedule that allowed Michigan's Department of Environmental Quality's laboratory to share samples with ERG's laboratory.

The 1-in-6 or 1-in-12 day sampling schedule provides cost-effective approaches to data collection for trends characterization (annual average concentrations) of toxic pollutants in ambient air and ensures that sampling days are evenly distributed among the seven days of the week to allow weekday/weekend comparison of air quality. Because the 1-in-6 day schedule yields twice the number of measurements, data characterization based on this schedule tends to be more robust.

The post-Katrina monitoring site in Gulfport, MS (GPMS) followed a sampling schedule that was different from other UATMP sites. GPMS followed a 1-in-3 day sampling schedule from January through March, and then decreased its sampling frequency to a 1-in-6 day frequency for the remainder of the year.

2.4 Completeness

Completeness refers to the number of valid samples collected and analyzed compared to the number of total samples attempted. Monitoring programs that consistently generate valid results have higher completeness than programs that consistently invalidate samples. The completeness of an air monitoring program, therefore, can be a qualitative measure of the reliability of air sampling equipment and laboratory analytical equipment and a measure of the efficiency with which the program was managed. Appendix B identifies samples that were invalidated and lists the specific reasons why the samples were invalidated.

Table 2-10 summarizes the completeness of the monitoring data sets collected during the 2006 UATMP:

- For VOC sampling, the completeness ranged from 56 to 100 percent, with an overall completeness of 92 percent;
- For carbonyl sampling, the completeness ranged from 56 to 100 percent with an overall completeness of 96 percent;
- For SNMOC sampling, the completeness ranged from 83 to 98 percent with an overall completeness of 95 percent;
- For SVOC sampling, the completeness ranged from 83 to 97 percent with an overall completeness of 94 percent;
- For metals sampling, the completeness ranged from 81 to 100 percent with an overall completeness was 98 percent; and
- For hexavalent chromium sampling, the completeness ranged from 75 to 100 percent, with an overall completeness was 97 percent.

The UATMP data quality objective for completeness based on the EPA-approved Quality Assurance Project Plan (QAPP), specifies that 85-100 percent of samples collected at a given monitoring site must be analyzed successfully to be considered sufficient for data trends analysis (ERG, 2006/2007). The data in Table 2-10 shows that 14 data sets (from a total of 139 data sets) for the 2006 UATMP monitoring sites did not meet this data quality objective. These data sets were lower than the 85 percent criteria for a number of reasons. A few sites did not meet the objective because there were complications at the onset of sampling (TOOK, TSOK, TUOK, and IDIN). Other sites were having sampling issues that would not allow make-up samples to be performed (PVAL, SEWA, RRTX, WETX and SJPR). One hundred percent completeness was achieved for 22 carbonyl monitoring sites, five VOC monitoring sites, seven hexavalent chromium monitoring sites, and 17 metals monitoring sites.

3.0 Summary of the 2006 UATMP Data

This section summarizes the data gathered during the 2006 UATMP reporting year. A total of 182,974 valid urban air toxics concentrations (including non-detect, duplicate analyses, replicate analyses, and analyses for collocated samples) were collected at 59 sites for the 2006 UATMP reporting year. These data were analyzed on a site-specific basis and results are presented in the individual state sections, Sections 4.0 through 31.0. A tabular presentation of the summary and raw data is found in Appendices C through O, as follows:

Pollutant	# Sites	Appendix	
		Summary Data	Raw Data
VOC	34	C	I
SNMOC	5	D	J
Carbonyl	45	E	K
SVOC	6	F	L
Metals	20	G	M
Hexavalent Chromium	23	H	N
TNMOC	5	D	J
Range of Detection Limits	--	O	--

Sites sampling in Texas and Alabama were commissioned to sample for one year, beginning in the summer of 2005 and continuing through the summer of 2006, though the start and end dates vary slightly from site to site. In order to facilitate data analysis, the entire dataset for the one year sampling duration for sites in Texas and Alabama is included in the individual state sections' analyses (Section 4.0 for Alabama; Section 27.0 for Texas). However, for the data analyses presented in Section 3.0 and Section 32.0 (Quality Assurance), only 2006 data were considered.

3.1 Data Summary Parameters

The raw data tables in Appendices I through N were uploaded into a database for air quality statistical analysis. This section examines six different data summary parameters and reviews the basic findings determined from the statistical analysis: 1) number of measured detections, 2) concentration ranges, 3) central tendency statistics, 4) risk screening, 5) non-chronic risk, and 6) correlation. The six analyses described in Section 3.1 were completed on the program-level UATMP data set and the data set for each state. Results of the program-level data

set analyses are described here in Section 3.1. Results for analyses completed as the site-specific data set are presented in the state-specific sections.

To better understand the following sections, it is important to know how the concentration data were treated. First, all duplicate and replicate (or collocated) measurements were averaged in order to calculate a single concentration for each pollutant for each sampling day at each site. Second, *m,p*-xylene and *o*-xylene concentrations were summed together and are henceforth referred to as "total xylenes," "xylenes (total)," or simply "xylenes" throughout the remainder of this report, with the exception of Table 3-1 and Table 3-4, as well as Section 32.0, where results are broken into *m,p*-xylene and *o*-xylene species. This is referred to as the preprocessed daily measurement.

In order to compare concentrations across multiple sampling methods, all concentrations have been converted to a common unit of measure: $\mu g/m^3$. However, whenever a particular sampling method is isolated from others, such as in Tables 3-1 through 3-6, the statistical parameters are presented in the units of measure associated with the particular sampling method. It is important to pay very close attention to the unit of measure associated with each analysis discussed in this section of the report.

3.1.1 Target Pollutant Detections

Tables 3-1 through 3-6 summarize the number of times the target pollutants were detected out of the number of valid samples taken. Approximately 51 percent of the pollutants sampled were measured above the MDLs. The percentages listed below represent the percent of measurements that were above the MDLs:

- 44.3 percent of VOC;
- 85.7 percent of carbonyl compounds;
- 45.7 percent of SNMOC;

Table 3-1. Statistical Summaries of the VOC Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Acetonitrile	896	0.06	502.25	6.14	0.43	0.95	1.20	0.37	3.19	25.53	4.16
Acetylene	1,326	0.01	39.70	0.94	0.45	0.61	0.65	0.39	1.04	1.50	1.60
Acrolein	1,048	0.05	5.37	0.41	0.16	0.27	0.30	0.18	0.47	0.45	1.11
Acrylonitrile	70	0.02	2.06	0.21	0.05	0.13	0.14	0.09	0.27	0.26	1.25
tert-Amyl Methyl Ether	12	0.01	0.22	0.04	0.01	0.03	0.02	0.01	0.03	0.06	1.37
Benzene	1,329	0.05	9.87	0.37	0.20	0.27	0.28	0.18	0.42	0.45	1.21
Bromochloromethane	0	NA									
Bromodichloromethane	42	0.01	0.09	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.59
Bromoform	3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01
Bromomethane	1,208	0.01	31.10	0.04	0.01	0.01	0.01	0.01	0.02	0.89	20.66
1,3-Butadiene	1,132	0.01	1.36	0.05	0.02	0.04	0.04	0.02	0.07	0.06	1.16
Carbon Tetrachloride	1,326	0.01	0.22	0.10	0.10	0.10	0.10	0.08	0.12	0.03	0.31
Carbon Disulfide	1,018	0.01	78.80	2.09	0.02	0.73	0.48	0.07	2.34	4.33	2.07
Chlorobenzene	65	0.01	0.10	0.03	0.02	0.03	0.03	0.02	0.04	0.02	0.61
Chloroethane	842	0.01	0.48	0.02	0.01	0.02	0.02	0.01	0.02	0.03	1.38
Chloroform	934	0.01	2.40	0.05	0.02	0.02	0.03	0.02	0.04	0.11	2.18
Chloromethane	1,329	0.15	4.72	0.62	0.58	0.59	0.59	0.51	0.67	0.22	0.35
Chloromethylbenzene	8	0.01	0.07	0.03	0.01	0.02	0.02	0.01	0.03	0.02	0.70
Chloroprene	17	0.01	0.12	0.03	0.03	0.03	0.03	0.02	0.04	0.03	0.77
Dibromochloromethane	39	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.34
1,2-Dibromoethane	1	NA									
m-Dichlorobenzene	29	0.01	0.09	0.02	0.01	0.01	0.02	0.01	0.02	0.02	0.95
o-Dichlorobenzene	15	0.01	0.06	0.02	0.01	0.01	0.01	0.01	0.03	0.01	0.78
p-Dichlorobenzene	987	0.01	3.75	0.05	0.01	0.02	0.02	0.01	0.04	0.20	4.24
Dichlorodifluoromethane	1,329	0.11	1.17	0.54	0.54	0.54	0.53	0.49	0.58	0.09	0.17
1,1-Dichloroethane	0	NA									
1,2-Dichloroethane	30	0.01	0.85	0.05	0.01	0.02	0.02	0.01	0.02	0.15	3.25
1,1-Dichloroethene	8	0.03	0.17	0.09	0.11	0.10	0.08	0.05	0.12	0.05	0.51
cis-1,2-Dichloroethylene	34	0.04	0.34	0.13	0.08	0.11	0.12	0.08	0.17	0.07	0.50
trans-1,2-Dichloroethylene	8	0.01	0.08	0.02	0.01	0.01	0.02	0.01	0.02	0.02	1.08

[a] Number of measured detections out of 1,329 valid samples.

Table 3-1. Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Dichloromethane	1,288	0.02	44.33	0.29	0.06	0.09	0.11	0.06	0.14	1.62	5.49
1,2-Dichloropropane	3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01
cis-1,3-Dichloropropene	0	NA									
trans-1,3-Dichloropropene	0	NA									
Dichlorotetrafluoroethane	1,324	0.01	0.07	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	0.26
Ethyl Acrylate	4	0.01	0.19	0.06	NA	0.03	0.03	0.02	0.07	0.07	1.18
Ethyl *tert*-Butyl Ether	16	0.01	0.27	0.06	0.01	0.03	0.03	0.01	0.06	0.07	1.32
Ethylbenzene	1,326	0.01	9.60	0.12	0.04	0.07	0.07	0.04	0.12	0.36	2.97
Hexachloro-1,3-butadiene	86	0.01	0.07	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.51
Methyl Ethyl Ketone	1,274	0.04	19.10	0.57	0.28	0.40	0.40	0.25	0.62	0.80	1.40
Methyl Isobutyl Ketone	989	0.01	3.63	0.09	0.04	0.05	0.06	0.03	0.09	0.20	2.11
Methyl Methacrylate	26	0.01	5.20	0.49	0.01	0.14	0.14	0.04	0.48	1.05	2.13
Methyl tert-Butyl Ether	275	0.01	4.20	0.19	0.04	0.07	0.08	0.04	0.14	0.43	2.32
n-Octane	1,130	0.01	4.08	0.06	0.02	0.03	0.04	0.02	0.05	0.17	2.85
Propylene	1,329	0.04	13.50	0.55	0.17	0.35	0.37	0.21	0.57	0.92	1.66
Styrene	1,149	0.01	6.70	0.09	0.02	0.03	0.04	0.02	0.06	0.33	3.77
1,1,2,2-Tetrachloroethane	16	0.01	0.19	0.03	0.01	0.01	0.02	0.01	0.02	0.04	1.58
Tetrachloroethylene	947	0.01	1.94	0.05	0.02	0.03	0.03	0.02	0.05	0.10	1.91
Toluene	1,329	0.04	45.00	0.81	0.21	0.47	0.48	0.25	0.86	1.73	2.14
1,2,4-Trichlorobenzene	43	0.01	0.36	0.03	0.01	0.02	0.02	0.01	0.03	0.05	1.68
1,1,1-Trichloroethane	1,313	0.01	0.23	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.48
1,1,2-Trichloroethane	4	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.35
Trichloroethylene	407	0.01	0.76	0.05	0.02	0.03	0.03	0.02	0.04	0.08	1.73
Trichlorofluoromethane	1,327	0.01	1.57	0.27	0.26	0.26	0.27	0.24	0.29	0.07	0.27
Trichlorotrifluoroethane	1,329	0.03	0.47	0.11	0.10	0.10	0.10	0.09	0.11	0.03	0.32
1,2,4-Trimethylbenzene	1,265	0.01	6.99	0.11	0.03	0.06	0.06	0.03	0.12	0.23	2.20
1,3,5-Trimethylbenzene	1,186	0.01	1.76	0.03	0.01	0.02	0.02	0.01	0.04	0.06	1.79
Vinyl chloride	145	0.01	0.63	0.02	0.01	0.01	0.01	0.01	0.01	0.05	3.32
m,p-Xylene	1,329	0.01	6.60	0.29	0.09	0.16	0.17	0.09	0.31	0.44	1.54
o-Xylene	1,321	0.01	2.60	0.11	0.03	0.06	0.07	0.04	0.12	0.15	1.41

[a] Number of measured detections out of 1,329 valid samples.

Table 3-2. Statistical Summaries of the Carbonyl Compound Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Acetaldehyde	1,839	0.05	15.40	1.20	1.18	0.92	0.96	0.63	1.45	0.98	0.82
Acetone	1,839	0.02	7.20	0.82	1.10	0.63	0.60	0.32	1.10	0.72	0.88
Benzaldehyde	1,825	0.01	1.10	0.05	0.02	0.03	0.03	0.02	0.05	0.06	1.33
Butyraldehyde	1,838	0.01	3.57	0.10	0.05	0.07	0.07	0.05	0.11	0.13	1.30
Crotonaldehyde	1,771	0.01	2.77	0.10	0.03	0.05	0.05	0.03	0.10	0.15	1.57
2,5-Dimethylbenzaldehyde	0	NA									
Formaldehyde	1,828	0.02	205.00	4.07	1.33	1.94	2.03	1.21	3.07	12.96	3.18
Hexaldehyde	1,803	0.01	1.51	0.05	0.02	0.03	0.03	0.02	0.04	0.11	2.04
Isovaleraldehyde	810	<0.01	0.23	0.02	0.01	0.01	0.01	0.01	0.02	0.02	1.14
Propionaldehyde	1,834	0.01	2.15	0.12	0.08	0.09	0.09	0.06	0.14	0.11	0.94
Tolualdehydes	1,752	<0.01	1.78	0.04	0.02	0.03	0.03	0.02	0.04	0.05	1.33
Valeraldehyde	1,796	0.01	0.94	0.05	0.02	0.03	0.03	0.02	0.05	0.09	1.59

[a] Number of measured detections out of 1,839 valid samples.

Table 3-3a. Statistical Summaries of the SVOC (Method TO-13A) Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Acenaphthene	121	0.04	32.50	4.51	0.27	0.58	1.06	0.24	6.57	7.15	1.59
Acenaphthylene	107	0.02	30.10	3.15	1.37	0.50	0.64	0.14	3.51	5.65	1.79
Anthracene	96	0.04	87.20	3.16	0.20	0.66	0.74	0.20	2.99	9.62	3.04
Benzo (a) anthracene	110	0.02	21.90	1.12	0.02	0.12	0.18	0.04	0.39	2.90	2.59
Benzo (a) pyrene	93	0.02	15.30	0.91	0.40	0.17	0.23	0.07	0.63	2.05	2.25
Benzo (b) fluoranthene	114	0.04	22.10	1.07	0.08	0.17	0.24	0.07	0.51	2.69	2.50
Benzo (e) pyrene	99	0.02	13.70	0.85	0.12	0.14	0.21	0.07	0.46	1.90	2.23
Benzo (g,h,i) perylene	107	0.02	9.21	0.57	0.09	0.14	0.18	0.06	0.41	1.22	2.13
Benzo (k) fluoranthene	113	0.02	16.00	0.83	0.11	0.12	0.17	0.04	0.39	2.03	2.45
Chrysene	117	0.03	25.00	1.56	0.13	0.25	0.36	0.13	0.82	3.54	2.27
Coronene	81	0.02	1.90	0.23	0.17	0.08	0.11	0.05	0.27	0.33	1.42
Dibenz (a,h) anthracene	47	0.02	2.45	0.34	0.02	0.08	0.12	0.04	0.54	0.51	1.50
Fluoranthene	122	0.08	73.10	4.87	1.61	1.79	1.99	0.80	4.68	8.76	1.80
Fluorene	122	0.17	45.60	5.66	21.50	1.63	2.28	0.81	7.15	8.09	1.43
Indeno(1,2,3-cd)pyrene	102	0.02	13.10	0.73	0.08	0.16	0.20	0.07	0.39	1.68	2.29
Naphthalene	122	0.13	1,220.00	146.46	2.69	7.73	9.42	0.59	131.00	276.06	1.88
Perylene	54	0.02	3.98	0.41	0.02	0.09	0.13	0.04	0.57	0.67	1.62
Phenanthrene	122	0.33	157.00	15.39	13.40	5.79	6.40	2.59	13.63	23.63	1.54
Pyrene	122	0.04	46.40	2.86	2.39	1.00	1.14	0.44	2.99	5.40	1.89

[a] Number of measured detections out of 122 valid samples.

Table 3-3b. Statistical Summaries of the SVOC (Method 8270C) Concentrations

Pollutant	# of Measured Detections[a]	Minimum (µg/m^3)	Maximum (µg/m^3)	Arithmetic Mean (µg/m^3)	Mode (µg/m^3)	Median (µg/m^3)	Geometric Mean (µg/m^3)	First Quartile (µg/m^3)	Third Quartile (µg/m^3)	Standard Deviation (µg/m^3)	Coefficient of Variation
Acenaphthene	59	0.001	0.025	0.007	NA	0.006	0.006	0.003	0.009	0.006	0.795
Acenaphthylene	7	0.001	0.004	0.002	NA	0.002	0.002	0.001	0.002	0.001	0.506
Acetophenone	56	0.004	0.044	0.011	0.013	0.009	0.010	0.006	0.012	0.008	0.694
2-Acetylaminofluorene	0	NA									
4-Aminobiphenyl	0	NA									
Aniline	0	NA									
Anthracene	9	<0.001	0.021	0.008	NA	0.005	0.003	0.001	0.011	0.008	1.028
Azobenzene	0	NA									
Benzidine	0	NA									
Benzo (a) anthracene	7	<0.001	0.001	0.001	NA	<0.001	0.001	<0.001	0.001	<0.001	0.314
Benzo (a) pyrene	0	NA									
Benzo (b) fluoranthene	0	NA									
Benzo (g,h,i) perylene	0	NA									
Benzo (k) fluoranthene	0	NA									
Benzyl alcohol	0	NA									
Bis(2-chloroethoxy)methane	0	NA									
Bis(2-chloroethyl)ether	0	NA									
Bis(2-chloroisopropyl)ether	0	NA									
Bis(2-ethylhexyl)phthalate	56	0.002	0.037	0.007	0.002	0.005	0.006	0.004	0.009	0.007	0.878
4-Bromophenyl phenyl ether	0	NA									
Butyl benzyl phthalate	17	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.484
Carbazole	0	NA									
4-Chloro-3-methylphenol	0	NA									
4-Chloroaniline	0	NA									
Chlorobenzilate	0	NA									
2-Chloronaphthalene	0	NA									
2-Chlorophenol	0	NA									
4-Chlorophenyl phenyl ether	0	NA									

[a] Number of measured detections out of 60 valid samples.

Table 3-3b. Statistical Summaries of the SVOC (Method 8270C) Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (µg/m^3)	Maximum (µg/m^3)	Arithmetic Mean (µg/m^3)	Mode (µg/m^3)	Median (µg/m^3)	Geometric Mean (µg/m^3)	First Quartile (µg/m^3)	Third Quartile (µg/m^3)	Standard Deviation (µg/m^3)	Coefficient of Variation
Chrysene	7	<0.001	0.001	<0.001	NA	<0.001	<0.001	<0.001	0.001	<0.001	0.720
Diallate	0	NA									
Dibenz (a,h) anthracene	0	NA									
Dibenzofuran	61	0.002	0.021	0.008	0.002	0.006	0.007	0.005	0.010	0.004	0.563
1,2-Dichlorobenzene	0	NA									
1,3-Dichlorobenzene	0	NA									
1,4-Dichlorobenzene	56	0.002	0.118	0.028	0.022	0.016	0.017	0.009	0.039	0.027	0.989
3,3´-Dichlorobenzidine	0	NA									
2,4-Dichlorophenol	0	NA									
2,6-Dichlorophenol	0	NA									
Diethyl phthalate	58	0.001	0.017	0.004	0.003	0.003	0.003	0.002	0.004	0.002	0.613
Dimethyl phthalate	0	NA									
4-Dimethylaminoazobenzene	0	NA									
7,12-Dimethylbenz (a) anthracene	0	NA									
3,3´-Dimethylbenzidine	0	NA									
2,4-Dimethylphenol	0	NA									
Di-n-butyl phthalate	43	0.001	0.050	0.004	0.002	0.002	0.003	0.002	0.003	0.008	1.878
4,6-Dinitro-2-methylphenol	0	NA									
1,3-Dinitrobenzene	0	NA									
2,4-Dinitrophenol	0	NA									
2,4-Dinitrotoluene	0	NA									
2,6-Dinitrotoluene	0	NA									
Di-n-octyl phthalate	4	0.009	0.011	0.009	NA	0.009	0.009	0.009	0.009	0.001	0.083
Dinoseb	0	NA									
Diphenylamine	0	NA									
Ethyl Methanesulfonate	0	NA									
Fluoranthene	56	0.001	0.004	0.002	0.003	0.002	0.002	0.001	0.002	0.001	0.420
Fluorene	60	0.002	0.017	0.006	0.011	0.005	0.005	0.003	0.008	0.003	0.581

[a] Number of measured detections out of 60 valid samples.

Table 3-3b. Statistical Summaries of the SVOC (Method 8270C) Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (µg/m^3)	Maximum (µg/m^3)	Arithmetic Mean (µg/m^3)	Mode (µg/m^3)	Median (µg/m^3)	Geometric Mean (µg/m^3)	First Quartile (µg/m^3)	Third Quartile (µg/m^3)	Standard Deviation (µg/m^3)	Coefficient of Variation
Hexachlorobenzene	0	NA									
Hexachlorobutadiene	0	NA									
Hexachlorocyclopentadiene	0	NA									
Hexachloroethane	0	NA									
Hexachloropropene	0	NA									
Indeno(1,2,3-cd)pyrene	0	NA									
Isodrin	0	NA									
Isophorone	0	NA									
Isosafrole	0	NA									
Methyl Methanesulfonate	0	NA									
3-Methylcholanthrene	0	NA									
2-Methylnaphthalene	61	0.006	0.070	0.027	0.018	0.024	0.023	0.016	0.035	0.013	0.499
2-Methylphenol	4	0.001	0.005	0.003	NA	0.004	0.003	0.002	0.005	0.001	0.405
3 & 4-Methylphenol	8	0.003	0.016	0.008	NA	0.006	0.007	0.004	0.012	0.004	0.546
Naphthalene	60	0.008	0.125	0.049	0.064	0.044	0.042	0.028	0.061	0.027	0.546
1,4-Naphthoquinone	0	NA									
1-Naphthylamine	0	NA									
2-Naphthylamine	0	NA									
2-Nitroaniline	0	NA									
3-Nitroaniline	0	NA									
4-Nitroaniline	0	NA									
Nitrobenzene	0	NA									
5-Nitro-o-toluidine	0	NA									
2-Nitrophenol	10	0.003	0.018	0.010	NA	0.010	0.009	0.007	0.011	0.004	0.418
4-Nitrophenol	0	NA									
N-Nitrosodiethylamine	0	NA									
N-Nitrosodimethylamine	0	NA									
N-Nitrosodi-n-butylamine	0	NA									
N-Nitrosodi-n-propylamine	0	NA									

[a] Number of measured detections out of 60 valid samples.

Table 3-3b. Statistical Summaries of the SVOC (Method 8270C) Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (µg/m^3)	Maximum (µg/m^3)	Arithmetic Mean (µg/m^3)	Mode (µg/m^3)	Median (µg/m^3)	Geometric Mean (µg/m^3)	First Quartile (µg/m^3)	Third Quartile (µg/m^3)	Standard Deviation (µg/m^3)	Coefficient of Variation
N-Nitrosomethylethylamine	0	NA									
N-Nitrosopiperidine	0	NA									
N-Nitrosopyrrolidine	0	NA									
Pentachlorobenzene	0	NA									
Pentachloroethane	0	NA									
Pentachloronitrobenzene	0	NA									
Pentachlorophenol	5	0.001	0.004	0.003	NA	0.002	0.002	0.001	0.004	0.001	0.566
Phenacetin	0	NA									
Phenanthrene	61	0.003	0.028	0.011	0.014	0.010	0.010	0.006	0.014	0.006	0.509
Phenol	18	0.003	0.013	0.007	NA	0.005	0.006	0.004	0.009	0.003	0.494
2-Picoline	0	NA									
Pronamide	0	NA									
Pyrene	48	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	<0.001	0.351
Pyridine	0	NA									
Safrole	0	NA									
1,2,4,5-Tetrachlorobenzene	0	NA									
2,3,4,6-Tetrachlorophenol	0	NA									
o-Toluidine	0	NA									
1,2,4-Trichlorobenzene	0	NA									
2,4,5-Trichlorophenol	0	NA									
2,4,6-Trichlorophenol	0	NA									

[a] Number of measured detections out of 60 valid samples.

Table 3-4. Statistical Summaries of the SNMOC Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
Acetylene	298	0.29	43.35	2.35	1.09	1.64	1.76	1.10	2.62	3.08	1.31
Benzene	298	0.20	19.40	1.43	1.03	1.13	1.19	0.78	1.69	1.34	0.94
1,3-Butadiene	117	0.03	7.70	0.24	0.12	0.14	0.15	0.10	0.24	0.70	2.96
n-Butane	298	0.54	98.00	6.09	1.33	3.85	4.07	2.26	7.31	7.90	1.30
cis-2-Butene	237	0.03	2.34	0.27	0.10	0.22	0.21	0.13	0.32	0.23	0.89
trans-2-Butene	233	0.03	5.67	0.31	0.32	0.21	0.23	0.14	0.36	0.42	1.35
Cyclohexane	275	0.03	5.72	0.50	0.16	0.33	0.33	0.19	0.58	0.61	1.22
Cyclopentane	281	0.05	325.25	1.53	0.11	0.27	0.28	0.16	0.45	19.35	12.64
Cyclopentene	54	0.05	1.47	0.29	0.13	0.22	0.23	0.14	0.35	0.24	0.82
n-Decane	246	0.06	16.30	0.68	0.25	0.34	0.38	0.24	0.54	1.53	2.26
1-Decene	0	NA									
m-Diethylbenzene	142	0.05	4.34	0.60	0.15	0.36	0.37	0.18	0.72	0.70	1.16
p-Diethylbenzene	142	0.04	2.37	0.35	0.07	0.21	0.23	0.12	0.42	0.37	1.05
2,2-Dimethylbutane	285	0.07	8.40	0.41	0.38	0.34	0.32	0.21	0.49	0.60	1.46
2,3-Dimethylbutane	289	0.04	6.92	0.51	0.26	0.39	0.38	0.23	0.60	0.54	1.06
2,3-Dimethylpentane	278	0.10	4.74	0.60	0.58	0.41	0.44	0.26	0.73	0.58	0.97
2,4-Dimethylpentane	274	0.05	3.00	0.39	0.44	0.30	0.30	0.17	0.44	0.36	0.92
n-Dodecane	165	0.02	14.50	0.52	0.20	0.22	0.25	0.15	0.35	1.45	2.80
1-Dodecene	111	0.04	2.66	0.49	0.14	0.33	0.33	0.17	0.61	0.47	0.96
Ethane	298	1.04	52.80	8.38	4.08	6.39	6.84	4.71	9.34	6.66	0.79
2-Ethyl-1-butene	0	NA									
Ethylbenzene	297	0.04	8.54	0.74	0.53	0.54	0.53	0.30	0.90	0.79	1.06
Ethylene	296	0.25	50.20	3.01	1.24	2.11	2.32	1.56	3.63	3.57	1.18
m-Ethyltoluene	281	0.03	24.40	0.60	0.44	0.44	0.41	0.24	0.66	1.49	2.50
o-Ethyltoluene	198	0.05	10.70	0.40	0.21	0.25	0.26	0.16	0.35	0.88	2.21
p-Ethyltoluene	271	0.03	11.70	0.34	0.16	0.24	0.25	0.16	0.36	0.74	2.17
n-Heptane	297	0.07	4.22	0.59	1.21	0.40	0.44	0.25	0.71	0.53	0.90
1-Heptene	218	0.05	1.44	0.22	0.11	0.16	0.18	0.13	0.25	0.17	0.79

[a] Number of measured detections out of 298 valid samples.

Table 3-4. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
n-Hexane	297	0.14	49.80	1.48	2.56	0.80	0.92	0.48	1.66	3.11	2.11
1-Hexene	258	0.05	1.83	0.28	0.11	0.24	0.23	0.14	0.35	0.21	0.75
cis-2-Hexene	13	0.03	2.20	0.32	NA	0.13	0.15	0.06	0.23	0.56	1.74
trans-2-Hexene	24	0.05	1.47	0.19	0.13	0.12	0.13	0.09	0.15	0.28	1.47
Isobutane	297	0.19	115.75	4.35	1.26	1.94	2.34	1.18	4.12	8.40	1.93
Isobutene/1-Butene	294	0.15	24.20	1.33	1.22	0.91	0.96	0.67	1.26	1.95	1.46
Isopentane	285	0.23	672.00	8.40	12.70	3.86	4.22	2.31	7.73	39.84	4.74
Isoprene	254	0.02	13.60	0.89	0.29	0.39	0.46	0.21	0.96	1.39	1.56
Isopropylbenzene	136	0.03	1.24	0.15	0.10	0.13	0.13	0.10	0.16	0.14	0.90
2-Methyl-1-butene	233	0.05	8.54	0.63	0.14	0.44	0.39	0.16	0.89	0.79	1.25
3-Methyl-1-butene	11	0.10	0.77	0.28	0.10	0.16	0.21	0.11	0.43	0.22	0.79
2-Methyl-1-pentene	32	0.03	1.29	0.12	0.03	0.07	0.07	0.05	0.10	0.22	1.87
4-Methyl-1-pentene	10	0.18	0.59	0.33	NA	0.29	0.31	0.22	0.39	0.14	0.41
2-Methyl-2-butene	222	0.04	1.74	0.30	0.12	0.22	0.23	0.14	0.40	0.23	0.78
Methylcyclohexane	296	0.07	5.19	0.67	0.23	0.43	0.47	0.29	0.77	0.69	1.04
Methylcyclopentane	296	0.06	21.95	0.84	1.28	0.57	0.57	0.32	0.96	1.40	1.68
2-Methylheptane	271	0.03	2.31	0.32	0.13	0.26	0.26	0.16	0.39	0.26	0.81
3-Methylheptane	232	0.04	2.11	0.24	0.15	0.19	0.19	0.13	0.29	0.20	0.85
2-Methylhexane	262	0.05	6.25	0.69	1.05	0.54	0.48	0.26	0.84	0.70	1.02
3-Methylhexane	297	0.11	13.70	1.48	1.20	1.22	1.12	0.71	1.80	1.36	0.92
2-Methylpentane	286	0.12	30.90	2.71	1.50	1.93	1.81	0.97	3.46	3.32	1.22
3-Methylpentane	297	0.12	25.08	1.06	1.48	0.73	0.77	0.52	1.17	1.68	1.58
n-Nonane	280	0.08	6.32	0.35	0.25	0.25	0.27	0.17	0.40	0.48	1.37
1-Nonene	168	0.04	2.53	0.26	0.11	0.19	0.19	0.12	0.28	0.30	1.16
n-Octane	295	0.07	5.77	0.41	0.19	0.31	0.32	0.20	0.47	0.45	1.08
1-Octene	132	0.05	1.33	0.28	0.10	0.20	0.21	0.13	0.34	0.24	0.85
n-Pentane	298	0.34	3,042.50	15.81	2.38	2.73	2.94	1.52	5.22	177.04	11.20
1-Pentene	275	0.09	78.90	0.92	1.02	0.34	0.38	0.20	0.59	4.85	5.26
cis-2-Pentene	202	0.03	2.30	0.20	0.21	0.18	0.17	0.12	0.24	0.18	0.89

[a] Number of measured detections out of 298 valid samples.

Table 3-4. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Measured Detections[a]	Minimum (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
trans-2-Pentene	249	0.05	5.13	0.30	0.15	0.24	0.24	0.17	0.35	0.35	1.18
a-Pinene	230	0.05	14.85	1.35	0.20	0.60	0.68	0.28	1.62	1.98	1.47
b-Pinene	29	0.03	2.90	0.82	NA	0.58	0.49	0.17	1.56	0.72	0.87
Propane	298	1.04	637.00	15.27	17.90	8.75	9.14	5.09	15.02	40.24	2.64
n-Propylbenzene	231	0.04	6.88	0.27	0.13	0.21	0.21	0.14	0.29	0.47	1.73
Propylene	298	0.27	19.30	1.39	1.29	1.00	1.10	0.69	1.64	1.48	1.06
Propyne	0	NA									
Styrene	176	0.03	9.57	0.79	0.15	0.33	0.41	0.17	0.90	1.32	1.66
Toluene	298	0.30	60.25	3.34	1.80	2.36	2.37	1.35	4.22	4.34	1.30
n-Tridecane	39	0.05	6.92	0.48	0.09	0.16	0.21	0.10	0.29	1.12	2.32
1-Tridecene	0	NA									
1,2,3-Trimethylbenzene	224	0.04	6.04	0.34	0.14	0.23	0.24	0.14	0.39	0.50	1.46
1,2,4-Trimethylbenzene	279	0.09	41.10	0.95	0.11	0.62	0.58	0.34	0.95	2.61	2.76
1,3,5-Trimethylbenzene	230	0.04	12.80	0.37	0.10	0.21	0.23	0.14	0.35	0.92	2.49
2,2,3-Trimethylpentane	141	0.06	2.84	0.30	0.12	0.23	0.23	0.13	0.38	0.29	0.97
2,2,4-Trimethylpentane	298	0.11	11.03	0.94	1.01	0.65	0.65	0.34	1.04	1.05	1.13
2,3,4-Trimethylpentane	267	0.04	4.42	0.41	0.11	0.32	0.31	0.19	0.49	0.40	0.97
n-Undecane	220	0.03	26.50	0.91	0.19	0.39	0.44	0.24	0.70	2.46	2.70
1-Undecene	118	0.03	1.64	0.31	0.08	0.21	0.22	0.12	0.43	0.29	0.93
m-Xylene/*p*-Xylene	296	0.14	25.23	1.65	1.96	1.32	NA	0.73	2.02	1.98	1.20
o-Xylene	296	0.04	10.57	0.60	0.30	0.46	NA	0.28	0.71	0.73	1.22
SNMOC (Sum of Knowns)	298	14.20	5,002.50	100.85	103.00	64.90	69.33	44.43	100.73	294.64	2.92
Sum of Unknowns	298	4.50	858.00	72.34	119.00	52.55	52.37	30.80	91.80	74.51	1.03
TNMOC	298	27.40	5,275.00	172.44	118.00	136.00	132.08	90.93	186.00	317.17	1.84

[a] Number of measured detections out of 298 valid samples.

Table 3-5. Statistical Summaries of the Metals Concentrations

Pollutant	# of Measured Detections[a,b]	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Antimony (PM_{10})	415	0.02	11.50	1.36	1.14	0.95	0.99	0.64	1.50	1.36	1.00
Arsenic (PM_{10})	415	0.03	6.83	0.82	0.39	0.59	0.61	0.39	0.96	0.79	0.96
Beryllium (PM_{10})	370	0.00	0.07	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.95
Cadmium (PM_{10})	415	0.00	15.30	0.35	0.05	0.16	0.17	0.09	0.35	0.96	2.70
Chromium (PM_{10})	415	0.83	6.50	2.48	2.00	2.25	2.34	1.85	2.90	0.92	0.37
Cobalt (PM_{10})	415	0.01	29.20	0.30	0.09	0.13	0.14	0.09	0.22	1.65	5.52
Lead (PM_{10})	415	0.08	60.25	5.98	3.36	3.81	4.06	2.28	6.42	6.94	1.16
Manganese (PM_{10})	415	0.24	89.10	10.13	10.60	6.29	6.68	3.47	11.80	12.01	1.19
Mercury (PM_{10})	362	0.00	2.94	0.07	0.05	0.03	0.03	0.01	0.07	0.19	2.73
Nickel (PM_{10})	415	0.26	7.42	1.34	1.04	1.17	1.19	0.89	1.50	0.78	0.58
Selenium (PM_{10})	413	0.01	3.95	0.69	0.20	0.49	0.47	0.24	0.87	0.64	0.93
Antimony (TSP)	114	0.07	5.32	1.19	1.47	0.95	0.90	0.59	1.50	0.89	0.75
Arsenic (TSP)	114	0.08	21.90	1.67	2.36	0.81	0.93	0.51	1.50	2.82	1.69
Beryllium (TSP)	114	0.00	1.23	0.06	0.01	0.01	0.02	0.01	0.03	0.17	2.98
Cadmium (TSP)	114	0.04	1.48	0.31	0.16	0.23	0.22	0.12	0.37	0.30	0.95
Chromium (TSP)	114	1.20	13.30	3.73	2.33	3.13	3.29	2.38	4.70	2.06	0.55
Cobalt (TSP)	114	0.01	2.36	0.36	0.20	0.26	0.23	0.13	0.42	0.39	1.11
Lead (TSP)	114	1.16	61.30	12.49	12.50	6.41	7.51	3.49	13.90	14.04	1.12
Manganese (TSP)	114	0.85	614.00	47.89	22.20	23.98	22.39	9.10	46.90	82.49	1.72
Mercury (TSP)	98	0.00	0.69	0.07	0.01	0.03	0.03	0.01	0.07	0.11	1.56
Nickel (TSP)	114	0.44	13.50	1.73	1.73	1.45	1.41	0.93	1.96	1.59	0.92
Selenium (TSP)	114	0.08	7.31	1.06	0.26	0.73	0.73	0.40	1.30	1.09	1.03

[a] For PM_{10} number of measured detections out of 415 valid samples.
[b] For TSP number of measured detections out of 114 valid samples.

Table 3-6. Statistical Summaries of the Hexavalent Chromium Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Hexavalent Chromium	775	0.001	0.989	0.049	0.022	0.030	0.032	0.018	0.055	0.072	1.466

[a] Number of measured detections out of 1,000 valid samples.

- 83.4 percent of metals;
- 6.0 percent of SVOC; and
- 66.6 percent of hexavalent chromium.

Similar to previous years, acetaldehyde and acetone had the greatest number of measured detections (1,839) reported in samples taken (1,839). If SVOC measured with Method 8270C are excluded, nine pollutants (bromochloromethane; 1,1-dichloroethane; *cis*-1,3-dichloropropene; *trans*-1,3-dichloropropene; 2,5-dimethylbenzaldehyde; l-decene; 2-ethyl-1-butene; l-tridecene; and propyne) had zero measured detections (see Tables 3-1 through 3-6). The number of pollutants with no measured detections increases dramatically if Method 8270C pollutants are included (91).

3.1.2 Concentration Range

The concentrations measured during the 2006 UATMP show a wide range of variability, and the following observations were made in regards to the measured detections.

- Approximately 78 percent of the measured detections had concentration values less than 1 $\mu g/m^3$, while less than 3 percent had concentrations greater than 5 $\mu g/m^3$.
- VOC had the highest number of samples with concentrations greater than 5 $\mu g/m^3$ (1,153); carbonyl compounds had the least (508); and SVOC, metals, and hexavalent chromium had no concentrations greater than 5 $\mu g/m^3$.
- At least one target pollutant had a measurement greater than 5 $\mu g/m^3$ on 92 of 134 total sampling days.
- Concentrations of 71 target pollutants never exceeded 1 $\mu g/m^3$.
- Thirteen sites had maximum concentration values over 100 $\mu g/m^3$.

Excluding GPMS, which was part of the post-Katrina monitoring network and sampled at a higher frequency compared to other sites, BTUT had the greatest number of measured detections (6,132, out of a possible 6,437 valid data points), as well as the greatest number of samples with concentrations greater than 5 $\mu g/m^3$ (331, out of a possible 6,437 valid data points). The minimum and maximum concentration measured for each target pollutant is presented in Tables 3-1 through 3-6 (in respective pollutant group units).

Eight of the sites that sampled for hexavalent chromium (BTUT, DEMI, HAKY, MVWI, PRRI, S4MO, SYFL, and WADC) measured their highest concentration on July 4, 2006. The July 4th hexavalent chromium concentration was one of the five highest concentrations measured at an additional five sites (BOMA, DHSC, NBIL, SDGA, and UNVT). Hexavalent chromium is a component in fireworks (NLMa) and it is possible that Independence Day fireworks celebrations may be leading to this increased concentration level. Additional studies are recommended (refer to Section 34.0).

3.1.3 Statistics

In addition to the number of measured detections and the concentration ranges, Tables 3-1 through 3-6 also present a number of central tendency and data distribution statistics (arithmetic mean, geometric mean, median, mode, first and third quartiles, standard deviation, and coefficient of variation) for each of the pollutants sampled during the 2006 UATMP by respective pollutant group units.

The top three VOCs by average mass concentration, as presented in Table 3-1, are acetonitrile (6.14 ppbv), carbon disulfide (2.09 ppbv), and acetylene (0.94 ppbv). The top three carbonyl compounds by mass concentration, as presented in Table 3-2, are formaldehyde (4.07 ppbv), acetaldehyde (1.20 ppbv), and acetone (0.82 ppbv). The top three SVOC by mass concentration, as presented in Tables 3-3a and 3-3b, are naphthalene (146.46 ng/m^3), phenanthrene (15.39 ng/m^3), and fluorene (5.66 ng/m^3) as measured with TO-13A method, and naphthalene (0.049 µg/m^3), 1,4-dichlorobenzene (0.028 µg/m^3), and 2-methylnaphthalene (0.027 µg/m^3) as measured with SW8270/8270C method.

The top three SNMOC by mass concentration, as presented in Table 3-4, are *n*-pentane (15.81 ppbC), propane (15.27 ppbC), and isopentane (8.40 ppbC). Among the metals, the top three pollutants for both PM_{10} and TSP fractions, as presented in Table 3-5, are manganese (TSP = 47.89 ng/m^3, PM_{10} = 10.13 ng/m^3), lead (TSP= 12.49 ng/m^3, PM_{10} = 5.89 ng/m^3), and total chromium (TSP = 3.73 ng/m^3, PM_{10} = 2.48 ng/m^3). The average mass concentration of hexavalent chromium, as presented in Table 3-6, is 0.049 ng/m^3.

3.1.4 Risk Screening and Pollutants of Interest

Each year, a subset of pollutants is selected for further analyses. Reviewing a subset of pollutants is a practical approach if there is a large number of measurements contained in the dataset. In UATMPs prior to 2003, this subset was based on frequency and magnitude of concentrations (previously called "prevalent compounds"). Since the 2003 UATMP, risk-based calculations were used to determine the "pollutants of interest". EPA defines risk as "the probability that damage to life, health, and/or the environment will occur as a result of a given hazard (such as exposure to a toxic chemical)" (EPA, 2006c). For the 2006 UATMP, the pollutants of interest are also based on risk potential.

EPA has published a guidance document outlining a risk screening approach that utilizes a risk-based methodology for performing an initial screen of ambient air toxics monitoring data sets (EPA, 2006d). This screening process provides a risk-based methodology for analysts and interested parties to identify which pollutants may pose a risk in their area. Not all UATMP pollutants have screening values; those that do are also typically referred to as Hazardous Air Pollutants (HAPs), as they are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. EPA is required to control 188 HAPs (EPA, 2007b). Preprocessed daily measurements of the target pollutants were compared to risk screening values in order to identify pollutants of interest across the program. The following risk screening process was completed to identify these pollutants:

1. If a pollutant was measured by two separate methods at the same site and that yield similar results, such as measuring benzene with VOC and SNMOC methods, then the two concentrations were averaged together. The purpose was to have one concentration per pollutant per day per site. The two SVOC methods do not measure the same suite of pollutants and do not necessarily yield similar results when they do measure the same pollutants. Therefore, the results were not averaged together in these instances. Metals were sampled with different filters, which can also produce dissimilar results. Similar to SVOC, metals sampled with different filters were not averaged together.

2. Each 24-hour speciated measurement was compared against the screening value. Concentrations that were greater than the screening value are described as "failing the screen."

3. The number of failed screens was summed for each applicable pollutant. The number of failures for each metal or SVOC was summed together to determine the total number of failed screens for each applicable pollutant.

4. A total of 10,901 of 23,933 applicable concentrations (45.55%) failed screens. The percent contribution of the number of failed screens was calculated for each applicable pollutant.

5. The pollutants contributing to the top 95 percent of the total failed screens were identified as pollutants of interest.

Table 3-7 identifies the pollutants that failed screens at least once, and summarizes the total number of measured detections, percentage failed, and cumulative percentage of failed screens. Following the steps above, the program-level pollutants of interest, as indicated by the shading in Table 3-7, were identified as follows:

- Acetaldehyde
- Acrolein
- Arsenic
- Benzene
- 1,3-Butadiene
- Carbon Tetrachloride
- *p*-Dichlorobenzene
- Formaldehyde
- Hexachloro-1,3-butadiene
- Hexavalent chromium
- Manganese
- Naphthalene
- Tetrachloroethylene

The 2006 list of pollutants of interest is very similar to the 2005 list. Hexavalent chromium and naphthalene are new for 2006, while nickel and total xylenes did not make the list. A couple of items to note in regards to the 2006 pollutants of interest include the following:

- Hexavalent chromium measurements were analyzed in a separate report for the 2005 program year (EPA, 2007c) and therefore were excluded from the risk screening process in 2005**.**

Table 3-7. Program–Level Risk Screening Summary

Pollutant	# of Failed Screens	# of Measured Detections	% of Failed Screens	% of Total Failures	Cumulative % Contribution
Acetaldehyde	1,814	1,839	98.64	16.64	16.64
Formaldehyde	1,599	1,828	87.47	14.67	31.31
Benzene	1,329	1,329	100.00	12.19	43.50
Carbon Tetrachloride	1,323	1,326	99.77	12.14	55.64
Acrolein	1,048	1,048	100.00	9.61	65.25
1,3-Butadiene	1,011	1,141	88.61	9.27	74.53
p-Dichlorobenzene	644	1,043	61.74	5.91	80.43
Tetrachloroethylene	535	947	56.49	4.91	85.34
Arsenic	485	529	91.68	4.45	89.79
Manganese	349	529	65.97	3.20	92.99
Hexavalent Chromium	96	775	12.39	0.88	93.87
Naphthalene	90	182	49.45	0.83	94.70
Hexachloro-1,3-butadiene	86	86	100.00	0.79	95.49
Cadmium	74	529	13.99	0.68	96.17
Acrylonitrile	70	70	100.00	0.64	96.81
Nickel	66	529	12.48	0.61	98.50
Dichloromethane	64	1,288	4.97	0.59	98.00
Xylenes	55	1,329	4.14	0.50	98.50
Trichloroethylene	36	407	8.85	0.33	98.83
1,2-Dichloroethane	30	30	100.00	0.28	99.11
Benzo (a) pyrene	19	93	20.43	0.17	99.28
1,1,2,2-Tetrachloroethane	16	16	100.00	0.15	99.43
Bromomethane	16	1,208	1.32	0.15	99.58
Methyl *tert*-Butyl Ether	9	275	3.27	0.08	99.66
Chloromethylbenzene	8	8	100.00	0.07	99.73
Dibenz (a,h) anthracene	5	47	10.64	0.05	99.78
Beryllium	3	484	0.62	0.03	99.81
Benzo (a) anthracene	3	117	2.56	0.03	99.83
Ethyl Acrylate	3	4	75.00	0.03	99.86
Toluene	3	1,329	0.23	0.03	99.89
Benzo (b) fluoranthene	2	114	1.75	0.02	99.91
Cobalt	2	529	0.38	0.02	99.93
1,2-Dibromoethane	1	1	100.00	0.01	99.94
1,1,2-Trichloroethane	1	4	25.00	0.01	99.94

Table 3-7. Program–Level Risk Screening Summary (Continued)

Pollutant	# of Failed Screens	# of Measured Detections	% of Failed Screens	% of Total Failures	Cumulative % Contribution
Benzo (k) fluoranthene	1	113	0.88	0.01	99.95
Chloromethane	1	1,329	0.08	0.01	99.96
Indeno(1,2,3-cd)pyrene	1	102	0.98	0.01	99.97
n-Hexane	1	297	0.34	0.01	99.98
Vinyl chloride	1	145	0.69	0.01	99.99
Chloroform	1	934	0.11	0.01	100.00
Total	10,901	23,933	45.55		

- As mentioned in Section 2.5.1, there is currently some question about the reliability of the acetonitrile data. Therefore, acetonitrile results were excluded from the risk screening process and "pollutants of interest" designation.

- *p*-Dichlorobenzene is analyzed with the TO-15 method, while 1,4-dichlorobenzene is analyzed with Method 8270. This is the same pollutant reported with two separate names. Because these two analytical methods have vastly different characteristics (i.e., MDL, collection media, etc.), heir concentrations were not averaged together. However, the total number of failed screens has been added together in Table 3-7 and is listed under *p*-dichlorobenzene.

Refer to the summary tables in Appendices C through H and the raw monitoring data in Appendices I through N for a closer examination of data trends for the other pollutants measured by the program.

3.1.5 Non-Chronic Risk

In addition to the risk screening described above, non-chronic (short-term) risk was also evaluated using the Agency for Toxic Substances and Disease Registry (ATSDR) acute and intermediate minimal risk level (MRL) factors and California EPA (CALEPA) acute reference exposure limit (REL) factors (ATSDR, 2006; CARB, 2006). Acute risk is defined as resulting from exposures of 1 to 14 days while intermediate risk is defined as resulting from exposures of 15 to 364 days. For the non-chronic risk determination, the preprocessed daily measurements were compared to the acute MRL and REL factors, and seasonal averages were compared to the intermediate-term MRL.

The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDL substitutions for all non-detects. The substitution of 1/2 MDL for non-detects may have a significant impact on pollutants that are rarely measured at or above the associated detection limit and/or have a relatively high MDL. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. The spring season included concentrations from March, April, and May; summer includes June, July, and August; autumn includes September, October, and November; and winter includes January, February, and December. This analysis was based on site-specific concentrations, but the number of exceedances has been summed to the program-level.

Table 3-8 presents a summary of the program-level short-term risk analysis. Acrolein, formaldehyde, and benzene were the only pollutants with least one concentration exceeding the ATSDR and/or CALEPA risk factors. Out of 1,828 measured detections of formaldehyde, 26 exceeded the ATSDR MRL, but only 12 exceeded the CALEPA REL. The ATSDR MRL is nearly half the CALEPA REL for formaldehyde (49 $\mu g/m^3$ vs. 94 $\mu g/m^3$, respectively). Out of 1,048 measured detections of acrolein, 1,048 exceeded the ATSDR MRL, and 1,019 exceeded the CALEPA REL. Every measured detection of acrolein during the 2006 UATMP was greater than 0.11 $\mu g/m^3$. However, the MRL and REL risk factors are very low for this pollutant, which indicates that even very low concentrations of acrolein may present some health risk. With the MDL for acrolein similar to, or slightly higher than these risk factors, most, if not all, of the concentrations will likely exceed these risk factors. Only one concentration of benzene, out of over 1,300 measured detections, exceeded the ATSDR MRL. Benzene does not have a CALEPA acute risk factor. Exceedances of the acute risk factors are discussed in further detail in Sections 4.0 through 31.0 on a site-specific basis.

Also presented in Table 3-8 is a summary of the program-level intermediate-term risk analysis. Out of 125 seasonal averages of formaldehyde, only three seasonal averages of formaldehyde, one occurring during the spring season, one occurring during summer, and one in

Table 3-8. Program-Level Non-Chronic Risk Summary

Sampling Method	Pollutant	Acute Risk				Intermediate Risk				
		ATSDR MRL ($\mu g/m^3$)	# of Exceedances/ # of Measured Detections	CAL EPA REL ($\mu g/m^3$)	# of Exceedances/ # of Measured Detections	ATSDR MRL ($\mu g/m^3$)	# of Winter Exceedances/ # of Seasonal Averages	# of Spring Exceedances/ # of Seasonal Averages	# of Summer Exceedances/ # of Seasonal Averages	# of Autumn Exceedances/ # of Seasonal Averages
TO-11A	Formaldehyde	49	26/1,828	94	12/1,828	40	0/29	1/36	1/29	1/31
TO-15	Acrolein	0.11	1,048/1,048	0.19	1,019/1,048	0.09	20/20	13/13	21/21	22/22
TO-15	Benzene[1]	28.75	1/1,329	NA	--	NA	--	--	--	--

[1] Indicates the use of the ATSDR re-calculated acute risk factor

autumn, exceeded the ATSDR intermediate MRL (40 $\mu g/m^3$). Out of 76 seasonal acrolein averages, 76 exceeded the ATSDR intermediate MRL (0.09 $\mu g/m^3$). Note that 2006 is the first year that acrolein was sampled for a complete year. Benzene does not have an intermediate risk factor, therefore, intermediate risk cannot be evaluated. Exceedances of the intermediate risk factors are also discussed in further detail in Sections 4.0 through 31.0 on a site-specific basis. Site-specific graphical displays of seasonal averages for the program-level pollutants of interest are also presented and discussed in Section 3.2.2.2.

3.1.6 Pearson Correlations

This report uses Pearson correlation coefficients to measure the degree of correlation between two variables. By definition, Pearson correlation coefficients always lie between -1 and +1. Three qualification statements apply:

- A correlation coefficient of -1 indicates a perfectly "negative" relationship, indicating that increases in the magnitude of one variable are associated with proportionate decreases in the magnitude of the other variable, and vice versa.
- A correlation coefficient of +1 indicates a perfectly "positive" relationship, indicating that the magnitudes of two variables both increase and both decrease proportionately.
- Data that are completely uncorrelated have Pearson correlation coefficients of 0.

Therefore, the sign (positive or negative) and magnitude of the Pearson correlation coefficient indicate the direction and strength, respectively, of data correlations. Generally, correlations greater than 0.50 or less than -0.50 are classified as strong. Correlations less than 0.50 and greater than -0.50 are classified as weak.

When calculating correlations among the UATMP data, several measures were taken to identify spurious correlations and to avoid introducing bias to the correlations:

- Data correlations were calculated only for the program-level pollutants of interest identified in Section 3.1.4.

- Correlations were calculated from the processed UATMP monitoring database in which each pollutant has just one numerical concentration for each successful sampling date, or the preprocessed daily measurements. Non-detects (and their substituted value) were not included in this analysis.

Ambient air concentration tendencies often correlate with ambient meteorological observations. The following three sections summarize how the pollutants of interest's concentrations correlated with seven meteorological parameters: average maximum daily temperature; average daily temperature; average daily dew point temperature; average daily wet bulb temperature; average daily relative humidity; average daily sea level pressure; and average wind speed.

3.1.6.1 Maximum and Average Temperature

Temperature is often a factor associated with high ambient air concentrations for some pollutants, such as ozone. Higher temperature helps speed up the kinetic process as pollutants react with each other. According to Table 3-9, the program-level pollutants of interest had mostly weak correlations with maximum temperature and average temperature. Although the correlations shown in Table 3-9 are generally low, they are nearly all positive, which indicates that an increase in temperature is generally associated with a proportionate increase in concentration.

The poor correlations exhibited at the program-level are not surprising due to the complex and diverse local meteorology associated with the monitoring sites. For this report, 59 sites are spread across 28 states. As discussed in Sections 4.0 through 31.0, the temperature parameters correlate better at select individual sites.

3.1.6.2 Moisture

Three moisture parameters were used in this study for correlation with the pollutants of interest. The *dew point temperature* is the temperature to which moist air must be cooled to reach saturation with respect to water. The *wetbulb temperature* is the temperature to which moist air must be cooled by evaporating water into it at constant pressure until saturation is

Table 3-9. Summary of Pearson Correlations between the Pollutants of Interest and Selected Meteorological Parameters

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Acetaldehyde	1839	0.10	0.06	0.00	0.02	-0.15	-0.16	-0.11
Acrolein	1048	0.24	0.23	0.19	0.21	-0.08	-0.20	0.00
Arsenic (PM_{10})	415	0.04	<0.01	0.09	0.05	0.12	0.07	-0.35
Arsenic (TSP)	114	0.15	0.14	0.10	0.13	-0.08	-0.05	-0.07
Benzene	1329	0.01	-0.01	-0.04	-0.03	-0.07	0.05	-0.08
1,3-Butadiene	1141	-0.12	-0.14	-0.17	-0.15	-0.09	0.07	-0.04
Carbon Tetrachloride	1326	0.40	0.41	0.40	0.41	0.05	-0.05	-0.10
1,4-Dichlorobenzene	56	-0.41	-0.52	-0.58	-0.57	-0.37	0.36	-0.09
p-Dichlorobenzene	987	0.08	0.11	0.12	0.12	0.05	0.02	0.00
Formaldehyde	1828	0.03	0.02	0.02	0.02	0.02	-0.51	-0.01
Hexachloro-1,3-butadiene	86	0.34	0.37	0.35	0.38	0.00	0.00	-0.08
Hexavalent Chromium	775	0.17	0.16	0.03	0.10	-0.18	0.09	-0.07
Manganese (PM_{10})	415	0.23	0.20	-0.01	0.11	-0.32	0.08	-0.22
Manganese (TSP)	114	0.30	0.31	0.21	0.26	-0.27	0.04	-0.13
Naphthalene	182	0.20	0.18	0.09	0.14	-0.23	0.03	-0.17
Tetrachloroethylene	947	0.01	0.00	-0.01	0.00	-0.04	0.01	0.07

reached. The *relative humidity* is the ratio of the mixing ratio to its saturation value at the same temperature and pressure (Rogers and Yau, 1989). All three of these parameters provide an indication of how much moisture is presently in the air. Higher dew point and wet bulb temperatures indicate increasing amounts of moisture in the air, while relative humidity is expressed as a percentage with 100 percent indicating saturation. It should be noted that a high dew point and wet bulb temperature do not necessarily equate to a relative humidity near 100 percent, nor does a relative humidity near 100 percent equate to a relatively high dew point or wet bulb temperature.

As illustrated in Table 3-9, the three moisture parameters had mostly weak correlations with the pollutants of interest. The sites participating in the 2006 program year were located in different climatic zones ranging from a desert climate (west Texas) to a very moist climate (Florida and Puerto Rico). As discussed in Sections 4.0 through 31.0, the moisture parameters correlate better at select individual sites.

3.1.6.3 Wind and Pressure

Wind is an important component affecting air quality. Surface wind observations include two primary components: wind speed and wind direction. *Wind speed*, by itself, is a scalar value and is usually measured in nautical miles or knots (1 knot = 0.5 meters per second = 1.15 miles per hour). *Wind direction* describes where the wind is coming from, and is measured in degrees where 0/360° is from the north, 90° is from the east, 180° is from the south, and 270° is from the west. Wind speed and direction together represent a vector quantity, but in some cases wind speed can be quantified separately (the scalar value). Pearson correlations were calculated for the average scalar wind speed and are presented in Table 3-9. Wind direction is evaluated later in this report.

As shown in Table 3-9, the scalar wind speed has weak correlations with the pollutants of interest at the program level, which is consistent with the temperature and moisture parameter observations. Geographical features such as mountains or valleys influence both wind speed and wind direction. The sites used for sampling in the 2006 program year are located in different geographic zones ranging from a mountainous region (Colorado) to a plains region (South

Dakota). Additionally, sites located downwind may correlate better with the measured concentrations than sites upwind. Nearly all of the correlations with wind speed are negative, however, indicating that as wind speed decreases, concentrations of the pollutants of interest tend to increase. As discussed in Sections 4.0 through 31.0, the scalar wind speed correlates better at select individual sites.

Wind is created through changes in pressure. The magnitude of the pressure difference (or pressure gradient) over an area is directly proportional to the magnitude of the wind speed. The direction of the wind flow is governed by the direction of the pressure gradient. Sea level pressure is the local station pressure corrected for elevation, in effect bringing all geographic locations down to sea-level, thus making different topographical areas comparable. Overall, sea level pressure correlated weakly with ambient concentrations. However, a strong correlation was calculated for formaldehyde (-0.51).

3.2 Additional Program-Level Analyses of the 2006 UATMP Dataset

This section provides a summary of additional analyses performed on the 2006 UATMP dataset at the program level and discusses the results. Additional program-level analyses include an examination of the potential impact of motor vehicles and a review of how concentrations vary among the sites themselves and from season-to-season. The results of some of these analyses are further discussed in the state sections (4.0 through 32.0).

3.2.1 The Impact of Mobile Source Emissions on Spatial Variations

Mobile source emissions from motor vehicles contribute significantly to air pollution in urban environments. Pollutants found in motor vehicle exhaust generally result from incomplete combustion of vehicle fuels. Although modern vehicles and, more recently, vehicle fuels have been engineered to minimize air emissions, all motor vehicles with internal combustion engines emit a wide range of chemical pollutants. The magnitude of these emissions in urban areas primarily depends on the volume of traffic, while the chemical profile of these emissions depends more on vehicle design and fuel formulation. This report uses four parameters to evaluate the impact of motor vehicle emissions on ambient air quality:

- Estimated motor vehicle ownership data;

- BTEX concentration profiles;
- Estimated daily traffic volumes; and
- Mobile source tracer analysis.

3.2.1.1 Motor Vehicle Ownership Data

As an indicator of motor vehicle emissions near the UATMP monitoring sites, Table 3-10 presents estimates of the number of vehicles owned by residents in the county in which the monitoring site is located. Where possible, actual county-level vehicle registration data were obtained from the state or local agency. If data were not available, vehicle registration data are available at the state-level (EIA, 2006). The county proportion of the state population was then applied to the state registration count. For each UATMP county, a vehicle registration to population ratio was developed. Each ratio was then applied to the 10-mile population surrounding the monitors (from Table 2-3). These estimated values are discussed in the individual state sections.

For purposes of comparison, the county-level motor vehicle ownership data and the arithmetic mean of hydrocarbons are presented in Table 3-10. Figure 3-1 compares 10-mile vehicle ownership to the hydrocarbon mean graphically. The trendline in the figure indicates a very slight positive linear correlation between motor vehicle ownership and ambient air concentrations of hydrocarbons. A Pearson correlation calculation from this data yields a weak positive correlation (0.15). However, other factors might impact the reliability of motor vehicle ownership data as an indicator of ambient air monitoring data results:

- Estimates of higher car ownership surrounding a monitoring site do not necessarily imply increased motor vehicle use in the immediate vicinity of a monitoring site. Conversely, sparsely populated regions often contain heavily traveled roadways.
- Emission sources in the area other than motor vehicles may significantly affect levels of hydrocarbons in the ambient air.

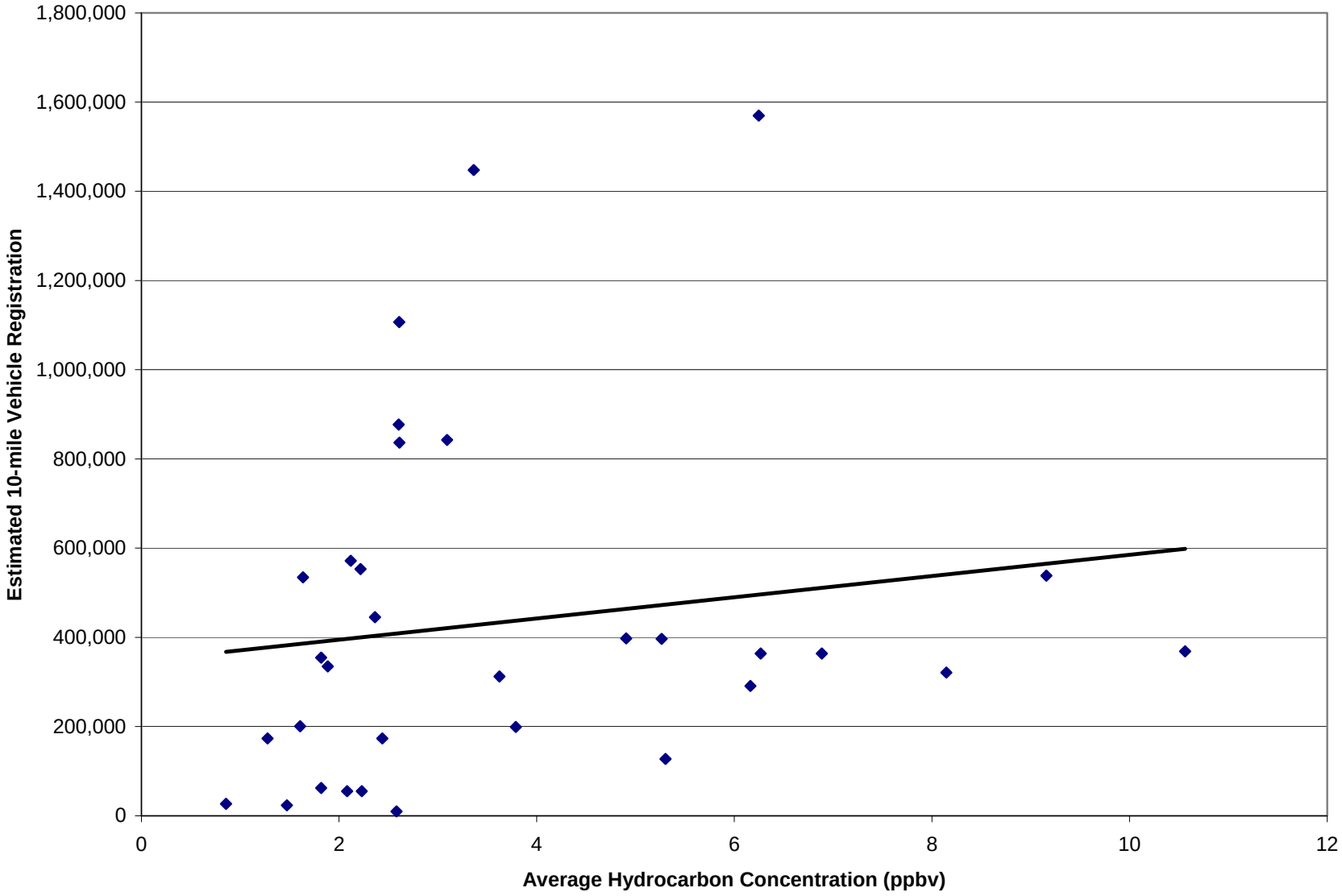
Table 3-10. Summary of Mobile Source Information by Monitoring Site

Site	County Motor Vehicle Registration	2006 Estimated County Population	Traffic Data Near Site (Daily Average)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Arithmetic Mean (ppbv)	Acetylene Arithmetic Mean (ppbv)
AZFL	1,461,505	924,413	51,000	4,829.76	2,072.04	NA	NA
BAPR	13,912	23,028	10	8.77	108.79	5.01	0.90
BOMA	424,907	687,610	27,287	1,140.61	1,962.38	NA	NA
BTUT	223,379	276,259	33,310	1,116.69	428.66	3.79	1.16
CANC	28,333	27,638	100	164.10	37.39	NA	NA
CANJ	371,045	517,001	62,000	1,294.50	704.57	3.36	1.05
CHNJ	353,934	493,160	12,623	1,718.49	1,396.98	1.28	0.52
CHSC	42,726	43,191	550	217.35	48.21	NA	NA
CNEP	29,815	39,774	5	271.83	107.68	1.47	0.46
CUSD	14,191	7,944	1,940	43.15	37.87	2.58	0.76
DEMI	1,423,637	1,971,853	12,791	9,892.20	1,902.04	3.09	0.97
ELNJ	381,155	531,088	170,000	1,327.73	664.49	6.25	1.45
ETAL	614,075	656,700	30,000	4,009.60	839.02	10.56	6.37
FLFL	1,637,132	1,787,636	8,000	7,627.16	2,681.07	NA	NA
GAFL	1,189,885	1,157,738	81,400	5,580.45	2,140.55	NA	NA
GPCO	154,175	134,189	19,572	557.45	223.19	5.31	1.69
GPMS	171,674	171,875	17,000	862.14	1,392.60	2.44	0.56
HAKY	22,704	29,753	500	145.19	17.63	NA	NA
IDIN	897,388	865,504	30,916	4,096.68	1,195.63	NA	NA
INDEM	453,146	494,202	42,950	1,518.45	956.59	NA	NA
ININ	897,388	865,504	97,780	4,096.68	1,195.63	NA	NA
ITCMI	33,580	38,674	100,000	180.93	605.64	NA	NA
LAOR	33,263	24,345	55	304.94	114.20	NA	NA
LDTN	50,519	44,566	12,945	365.94	181.80	2.23	0.62
MAWI	425,763	463,826	23,750	1,761.58	1,040.38	1.89	0.76
MIMN	1,097,109	1,122,093	10,000	4,147.23	1,418.38	2.61	1.07
MSTN	50,519	44,566	7,287	365.94	181.80	2.08	0.48
MUTX	731,956	921,006	4,374	2,956.09	1,337.08	2.22	0.82
MVWI	95,112	88,983	5,990	353.76	273.93	NA	NA
NBAL	614,075	656,700	2,000	4,009.60	839.02	6.89	1.92

Table 3-10. Summary of Mobile Source Information by Monitoring Site (continued)

Site	County Motor Vehicle Registration	2006 Estimated County Population	Traffic Data Near Site (Daily Average)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Arithmetic Mean (ppbv)	Acetylene Arithmetic Mean (ppbv)
NBIL	2,133,068	5,288,655	29,600	8,766.59	5,441.27	1.82	0.72
NBNJ	564,799	786,971	63,000	2,360.85	1,329.95	2.12	0.73
ORFL	1,043,571	1,043,500	59,000	5,584.04	2,305.52	NA	NA
PITX	731,956	921,006	33,936	2,956.09	1,337.08	1.64	0.60
PRRI	142,334	635,596	5,500	1,996.79	704.39	NA	NA
PVAL	614,075	656,700	NA	4,009.60	839.02	0.86	0.34
PXSS	3,682,234	3,768,123	250	10,069.61	5,455.91	NA	NA
RRTX	285,183	353,830	20,900	840.49	324.92	3.62	0.68
RTPNC	188,168	246,896	12,000	1,263.01	337.11	NA	NA
S4MO	1,438,244	1,347,691	22,840	1,376.92	481.95	2.60	0.80
SDGA	458,290	723,602	98,510	3,173.30	1,110.37	NA	NA
SEWA	1,726,115	1,826,732	20,000	11,754.01	4,088.72	NA	NA
SFSD	202,696	163,281	4,320	547.35	198.34	1.61	0.51
SIAL	614,075	656,700	2,700	4,009.60	839.02	6.27	1.45
SJPR	145,642	221,546	250	493.18	1,091.92	6.65	1.24
SKFL	1,461,505	924,413	50,500	4,829.76	2,072.04	NA	NA
SMFL	1,189,885	1,157,738	18,700	5,580.45	2,140.55	NA	NA
SPIL	2,133,068	5,288,655	214,900	8,766.59	5,441.27	2.61	0.89
SYFL	1,189,885	1,157,738	5,142	5,580.45	2,140.55	NA	NA
TOOK	498,898	577,795	500	3,482.32	890.73	5.27	0.66
TRTX	731,956	921,006	27,114	2,956.09	1,337.08	2.36	0.55
TSOK	498,898	577,795	62,500	3,482.32	890.73	6.16	0.61
TUMS	69,888	79,714	4,900	438.24	178.81	1.82	0.56
TUOK	498,898	577,795	82,600	3,482.32	890.73	4.91	0.61
UNVT	122,119	150,069	1,200	896.16	358.75	NA	NA
WADC	236,789	581,530	75,800	1,277.49	390.59	NA	NA
WETX	731,956	921,006	5,733	2,956.09	1,337.08	9.16	1.56
WPIN	897,388	865,504	11,514	4,096.68	1,195.63	NA	NA
YDSP	533,438	736,310	2,200	2,208.64	529.75	8.15	2.71

Figure 3-1. Comparison of Average Hydrocarbon Concentration vs. 10-Mile Vehicle Registration



3.2.1.2 Estimated Traffic Volume Data

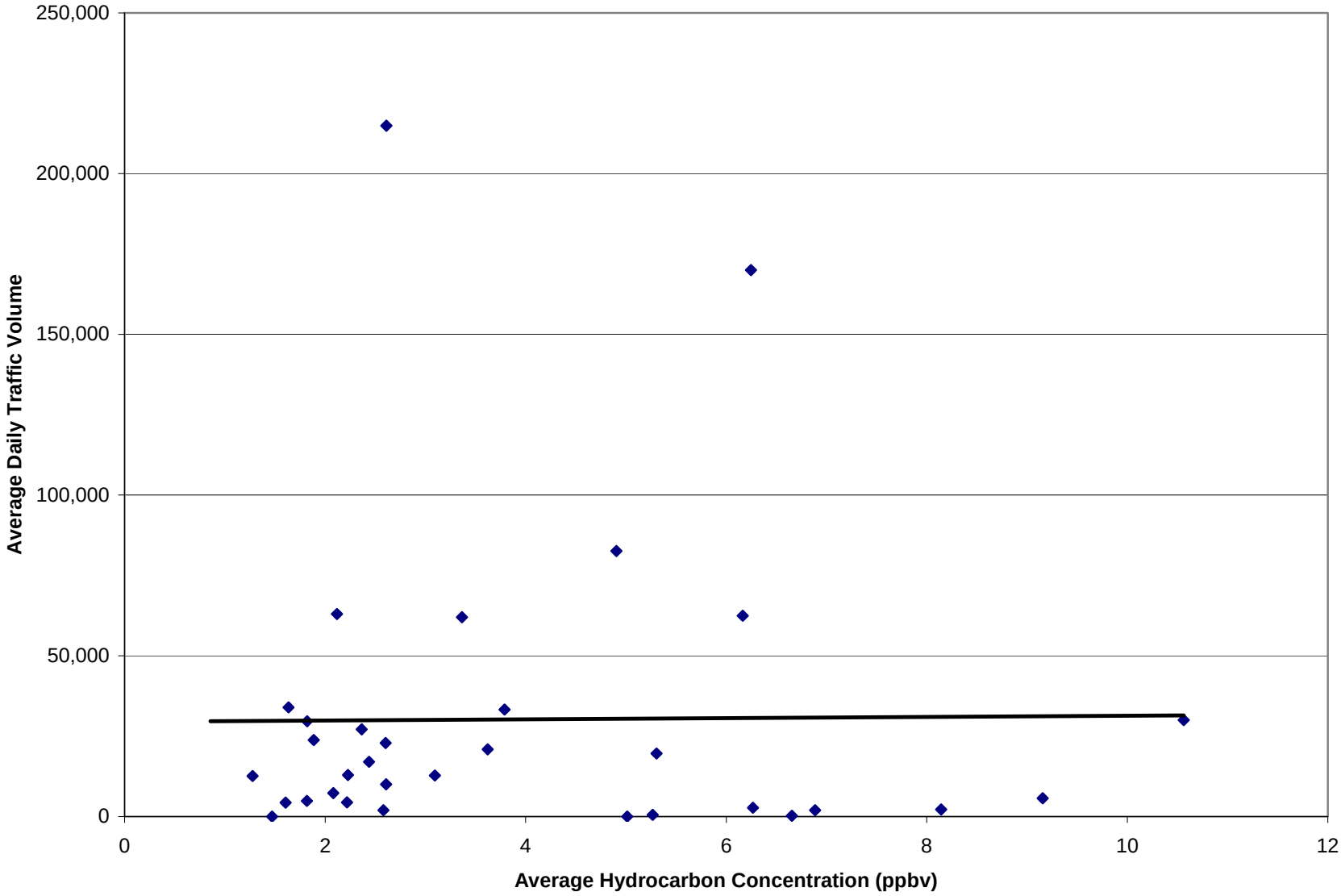
When a monitoring site is being characterized, a parameter often recorded is the number of vehicles that pass the monitoring site on a daily basis. Traffic data were obtained from the site information provided on EPA's AQS database or by contacting state and local agencies. Table 3-10 contains the estimated daily traffic values, as well as county-level on-road and non-road HAP emissions.

The highest daily traffic volume occurred at the SPIL and ELNJ sites, with over 214,900 and 170,000 vehicles passing by these monitoring sites, respectively. SPIL is located near Interstate 294 near the Chicago-O'Hare International Airport, and ELNJ is located near Exit 13 on Interstate 95. The average hydrocarbon (total) value of the preprocessed daily measurements at ELNJ was 6.25 ppbv, which is ranked 7th among sites that measured hydrocarbons. ETAL, WETX, YDSP, NBAL, SJPR, and SIAL each had average hydrocarbon concentrations greater than ELNJ, yet their traffic counts are ranked 9th, 22nd, 26th, 27th, 28th, and 31st highest, respectively. At SPIL, the average hydrocarbon (total) value was only 2.61 ppbv, which ranked 17th.

Specific characterizations for these sites appear in the separate state sections. As shown in Figure 3-2, there does not appear to be a direct correlation between traffic counts and average hydrocarbon concentrations. The calculated Pearson correlation was only 0.01, indicating hardly any relationship between the two at all. This observation might suggest that the site traffic counts may need to be updated, as many were recorded ten or more years ago.

Estimated on-road county emissions were highest in Wayne County, MI, which is where DEMI is located. The hydrocarbon average for DEMI ranked 16th highest. Estimated non-road county emissions were highest in Cook County, IL. Non-road emission sources include, but are not limited to, activities from airplanes, construction vehicles, and lawn and garden equipment. Refer to Table 3-10 and Figure 3-2 for a more detailed look at mobile source emissions and average hydrocarbon concentrations.

Figure 3-2. Comparison of Average Hydrocarbon Concentration vs. Daily Traffic Volume



3.2.1.3 Mobile Source Tracer Analysis

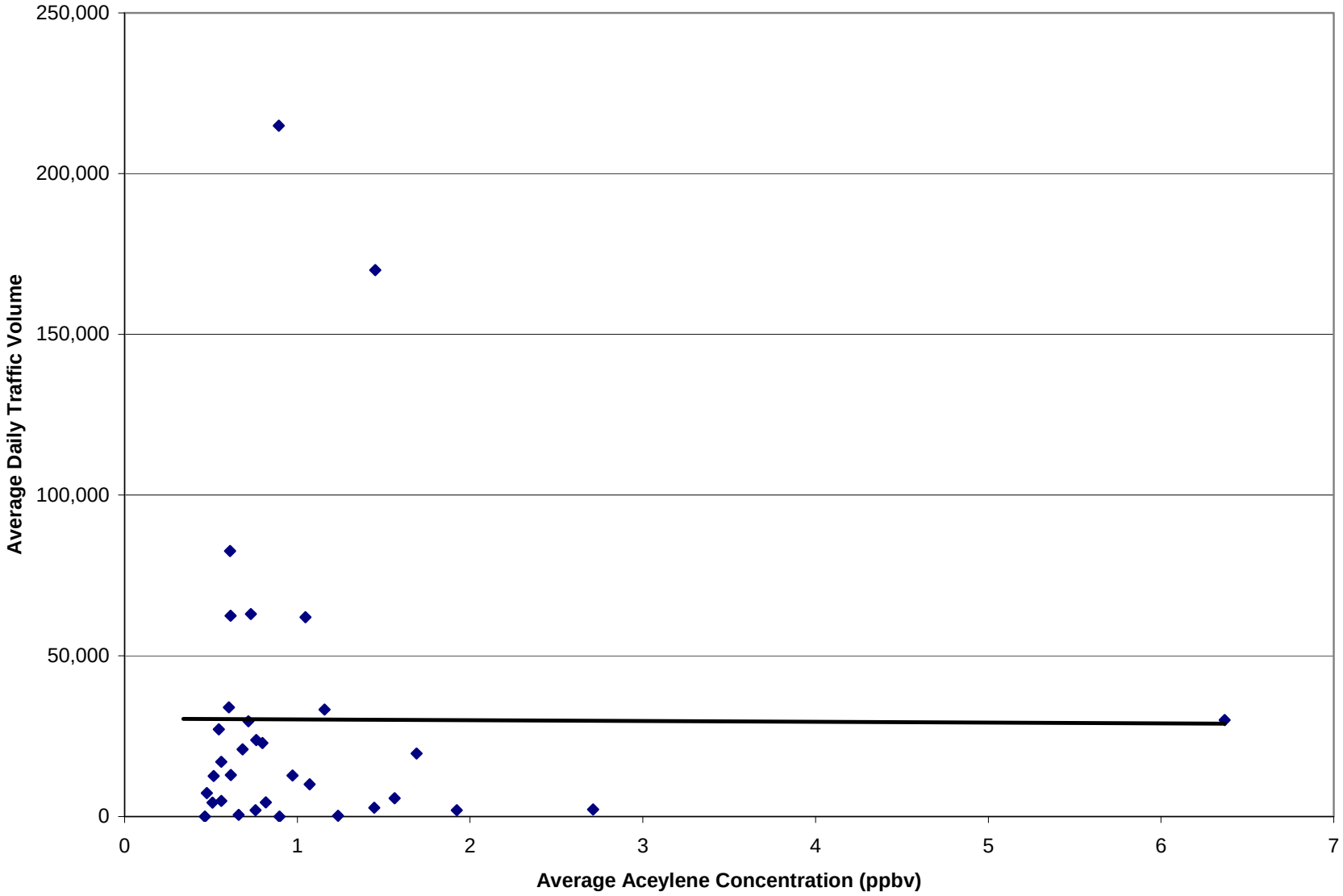
Research has shown that acetylene can be used as a signature compound for automotive emissions (Warneck, 1988; NRC, 1991) because this VOC is not typically emitted from biogenic or stationary sources. As summarized in Table 3-10, many UATMP sites are located in high traffic areas (e.g., ELNJ and SPIL). The average preprocessed acetylene concentration for each site is also summarized in Table 3-10. As presented in Figure 3-3, there does not appear to be a direct correlation between daily traffic and acetylene concentrations. The calculated Pearson correlation was -0.01, indicating a very weak relationship. Similar to the comparison between hydrocarbons and traffic volume, this observation might suggest that the site traffic counts may need to be updated, as many were recorded ten or more years ago.

Nearly all emissions of ethylene are due to automotive sources, with the exception of activities related to natural gas production and transmission. Ethylene is not detected as a VOC by the TO-15 sampling method, but is detected using the SNMOC method. For the five sites that chose the SNMOC option, ethylene to acetylene concentration ratios were computed and compared to a ratio developed in numerous tunnel studies, and are presented in Table 3-11. An ethylene to acetylene ratio of 1.7 to 1 is indicative of mobile sources (TCEQ, 2002). Of the sites that sampled SNMOC, NBIL's ethylene to acetylene ratio was the closest to the expected 1.7 to 1 ratio (1.74 to 1). These results are discussed further in the individual state sections.

Table 3-11. Average Ethylene to Acetylene Ratios for Sites that Measured SNMOC

Site	Average Ethylene to Acetylene Ratio	% Difference from 1.70 Ratio
BTUT	1.30	-23.34
CUSD	1.43	-16.05
GPMS	1.47	-13.76
NBIL	1.74	2.59
SFSD	1.22	-28.43

Figure 3-3. Comparison of Average Acetylene Concentration vs. Daily Traffic Volume



3.2.1.4 BTEX Concentration Profiles

The *magnitude* of emissions from motor vehicles generally depends on the volume of traffic in urban areas, but the *composition* of these emissions depends more on vehicle design. Because the distribution of vehicle designs (i.e., the relative number of motor vehicles of different styles) is probably quite similar from one urban area to the next, the composition of air pollution resulting from motor vehicle emissions is not expected to exhibit significant spatial variations. In support of this hypothesis, previous air monitoring studies have observed relatively constant composition of ambient air samples collected along heavily traveled urban roadways (Conner et al., 1995). Roadside studies have found particularly consistent proportions of four hydrocarbons (benzene, toluene, ethylbenzene, and the xylene isomers - the "BTEX" compounds) both in motor vehicle exhaust and in ambient air near roadways.

To examine the impact of motor vehicle emissions on air quality at the 2006 UATMP monitoring sites, Table 3-12 and Figure 3-4 compare concentration ratios for the BTEX compounds measured during the 2006 UATMP to the ratios reported in a roadside study (Conner et al., 1995). This comparison provides a qualitative depiction of how greatly motor vehicle emissions affect air quality at the UATMP monitoring sites: the more similar the concentration ratios at a particular monitoring site are to those of the roadside study, the more likely that motor vehicle emissions impact ambient levels of hydrocarbons at that location.

As presented in Figure 3-4, the concentration ratios for BTEX compounds measured at most UATMP monitoring sites bear some resemblance to the ratios reported in the roadside study. The BTEX ratios at the BAPR and SJPR monitoring sites appear to be the most similar to the roadside study profile. For all monitoring sites, the toluene-ethylbenzene ratio is the largest of the three ratios, with the exceptions of CNEP, CUSD, PVAL, and SIAL. The benzene-ethylbenzene ratio is the smallest of the three ratios at eight sites, while the xylenes-ethylbenzene ratio is the smallest at 26 sites. These observations suggest, though certainly do not prove, that emissions from motor vehicles have an impact on the levels of hydrocarbons in urban ambient air, although are not necessarily the only contributing factor.

Table 3-12. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study

Site	Benzene-Ethylbenzene Ratio	Toluene-Ethylbenzene Ratio	Xylenes-Ethylbenzene Ratio
Roadside Study	2.85	5.85	4.55
BAPR	3.11 ± 0.26	9.42 ± 2.09	4.22 ± 0.18
BTUT	4.86 ± 0.34	8.49 ± 0.44	4.52 ± 0.19
CANJ	4.67 ± 0.38	7.41 ± 0.66	3.60 ± 0.22
CHNJ	5.60 ± 0.50	5.71 ± 0.42	3.04 ± 0.20
CNEP	7.61 ± 1.65	6.50 ± 1.59	3.31 ± 0.26
CUSD	6.42 ± 0.66	6.00 ± 0.51	3.49 ± 0.25
DEMI	4.92 ± 0.52	6.67 ± 0.69	3.77 ± 0.20
ELNJ	3.69 ± 0.33	6.73 ± 0.34	3.84 ± 0.24
ETAL[1]	3.64 ± 0.43	5.25 ± 0.30	3.78 ± 0.18
GPCO	4.04 ± 0.34	7.20 ± 0.40	4.61 ± 0.15
GPMS	4.16 ± 0.79	6.89 ± 0.55	3.36 ± 0.17
LDTN	7.02 ± 0.68	9.89 ± 0.85	3.44 ± 0.13
MAWI	5.83 ± 0.89	5.95 ± 0.65	3.42 ± 0.37
MIMN	4.71 ± 0.33	5.90 ± 0.42	3.75 ± 0.12
MSTN	5.88 ± 0.60	12.48 ± 1.46	3.64 ± 0.17
MUTX[1]	1.95 ± 0.34	3.08 ± 0.39	1.49 ± 0.17
NBAL[1]	3.12 ± 0.80	4.38 ± 0.88	3.84 ± 0.55
NBIL	5.74 ± 0.58	6.87 ± 0.74	3.40 ± 0.19
NBNJ	3.94 ± 0.45	5.70 ± 0.34	3.79 ± 0.20
PITX[1]	2.00 ± 0.45	3.06 ± 0.61	1.48 ± 0.17
PVAL[1]	6.77 ± 2.99	9.56 ± 1.17	3.43 ± 0.21
RRTX[1]	1.91 ± 0.39	11.87 ± 1.77	1.43 ± 0.23
S4MO	3.55 ± 0.43	5.73 ± 0.58	2.80 ± 0.20
SFSD	5.74 ± 0.51	10.70 ± 2.32	3.31 ± 0.18
SIAL[1]	11.38 ± 6.08	6.24 ± 1.08	4.01 ± 0.31
SJPR	2.48 ± 0.23	8.05 ± 0.99	4.18 ± 0.16
SPIL	5.30 ± 0.64	7.09 ± 0.51	3.54 ± 0.16
TOOK	5.33 ± 0.62	12.22 ± 1.24	4.60 ± 0.19
TRTX[1]	2.00 ± 0.33	4.19 ± 0.80	1.71 ± 0.20
TSOK	1.36 ± 0.33	6.34 ± 2.10	2.65 ± 0.21
TUMS	6.10 ± 1.89	9.47 ± 0.95	3.51 ± 0.16
TUOK	4.10 ± 1.02	11.68 ± 1.08	3.73 ± 0.21
WETX[1]	1.93 ± 0.37	3.46 ± 0.59	2.22 ± 0.30
YDSP[1]	3.02 ± 0.27	5.93 ± 0.42	3.59 ± 0.08

[1] The ratios for these sites include data from both 2005 and 2006.

Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study

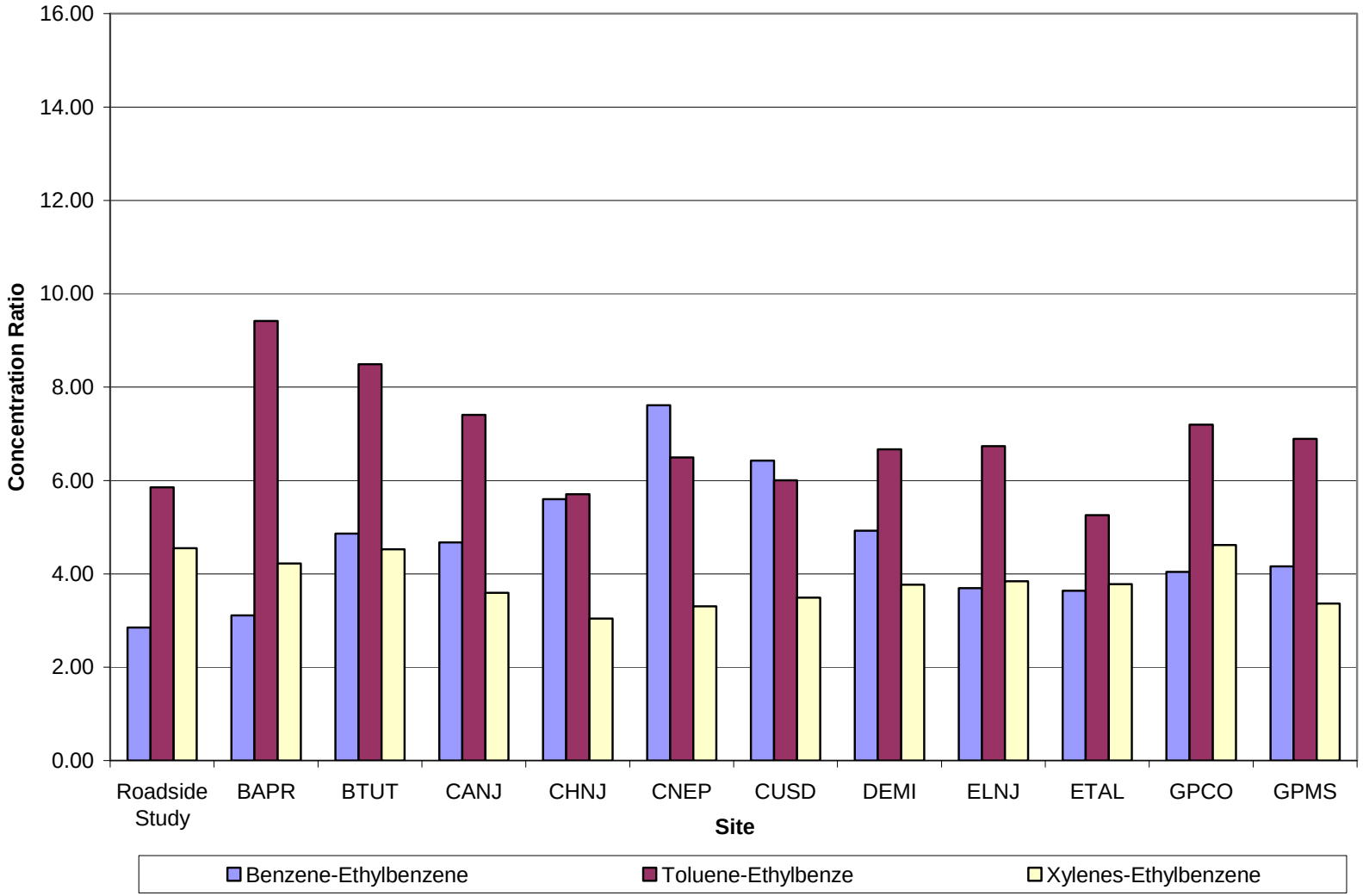


Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)

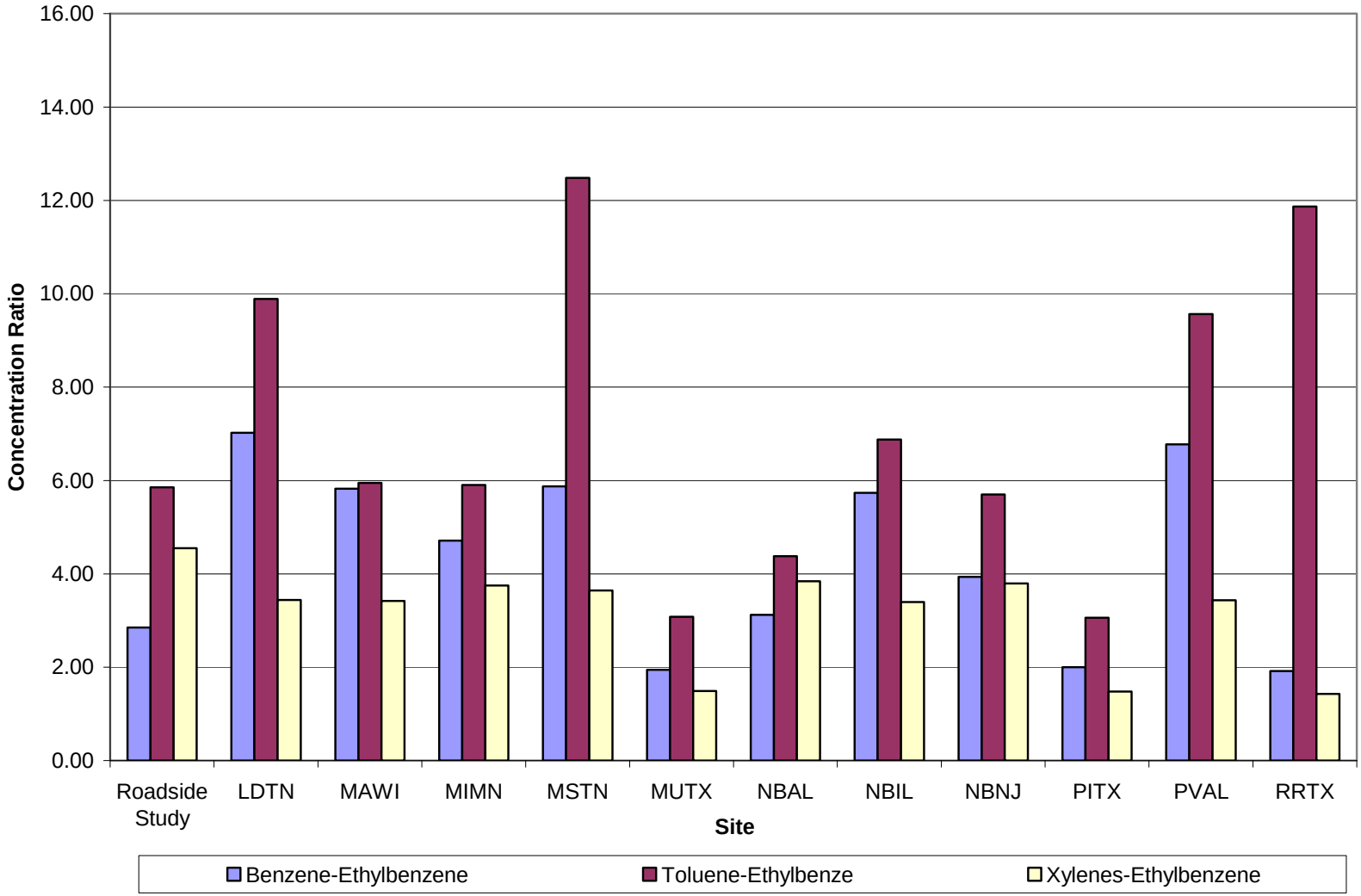
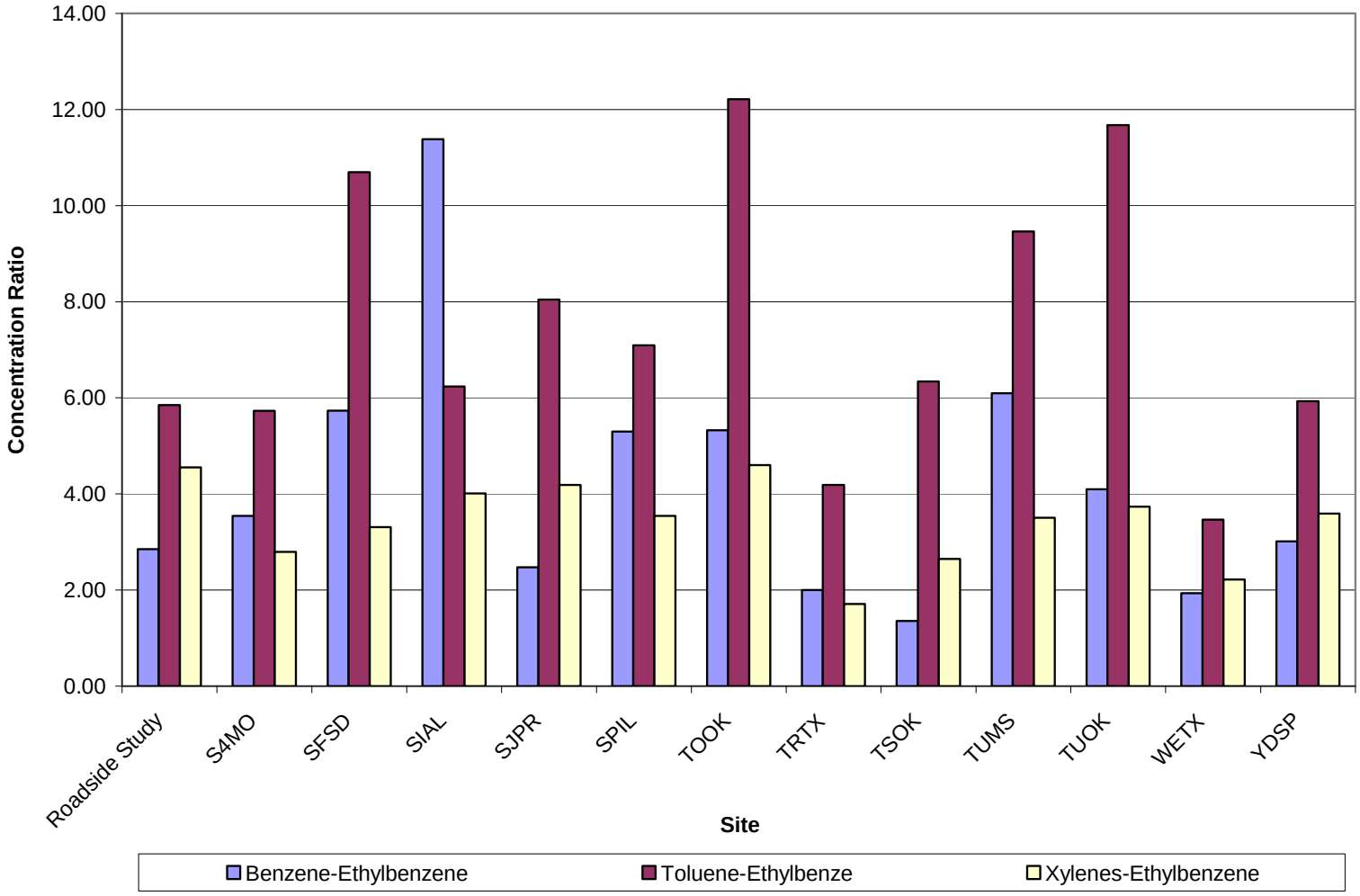


Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)



3.2.2 Variability Analysis

Two types of variability are analyzed for this report. The first type examines the coefficient of variation for each of the pollutants of interest across the UATMP sites. Seasonal variability is the second type of variability analyzed in this report. The UATMP concentration data were divided into the four seasons, as described in Section 3.1.5.

3.2.2.1 Coefficient of Variation

The coefficient of variation provides a relative measure of variability by expressing standard deviations to the magnitude of the arithmetic mean. Figures 3-5 to 3-17 are graphical displays of site-specific standard deviation versus average concentration. This analysis is best suited for comparing variability across data distributions for different sites and pollutants. Pollutants of interest whose data points are clustered together indicate uniformity in how the concentrations are dispersed among the sites. This suggests that concentrations are affected by typical and consistent sources (e.g., mobile sources). Data points that are not clustered suggest the likelihood of a stationary source not typically found in most urban areas (e.g., coke manufacturing facility).

Figure 3-10 for formaldehyde and Figure 3-14 for *p*-dichlorobenzene show that these compounds exhibit this "clustering" while Figure 3-5 for 1,3-butadiene and Figure 3-6 for acetaldehyde do not. The data point in the far right of Figure 3-10 is not clustered with most of the other points. This value belongs to INDEM, which tends to have a much higher formaldehyde average than other UATMP sites. INDEM resides in a heavily industrialized area, and this may be the result of emissions from nearby petroleum refinery and steel manufacturing facilities.

3.2.2.2 Seasonal Variability Analysis

Figures 3-18 to 3-29 provide a graphical display of the average concentrations by season for the program-level pollutants of interest. Seasonal averages are calculated based on criteria specified in Section 3.1.5. If the pollutant of interest has a corresponding ATSDR Intermediate MRL, then this value is indicated on the graph and is plotted where applicable.

Figure 3-5. Coefficient of Variation Analysis of 1,3-Butadiene Across 34 Sites

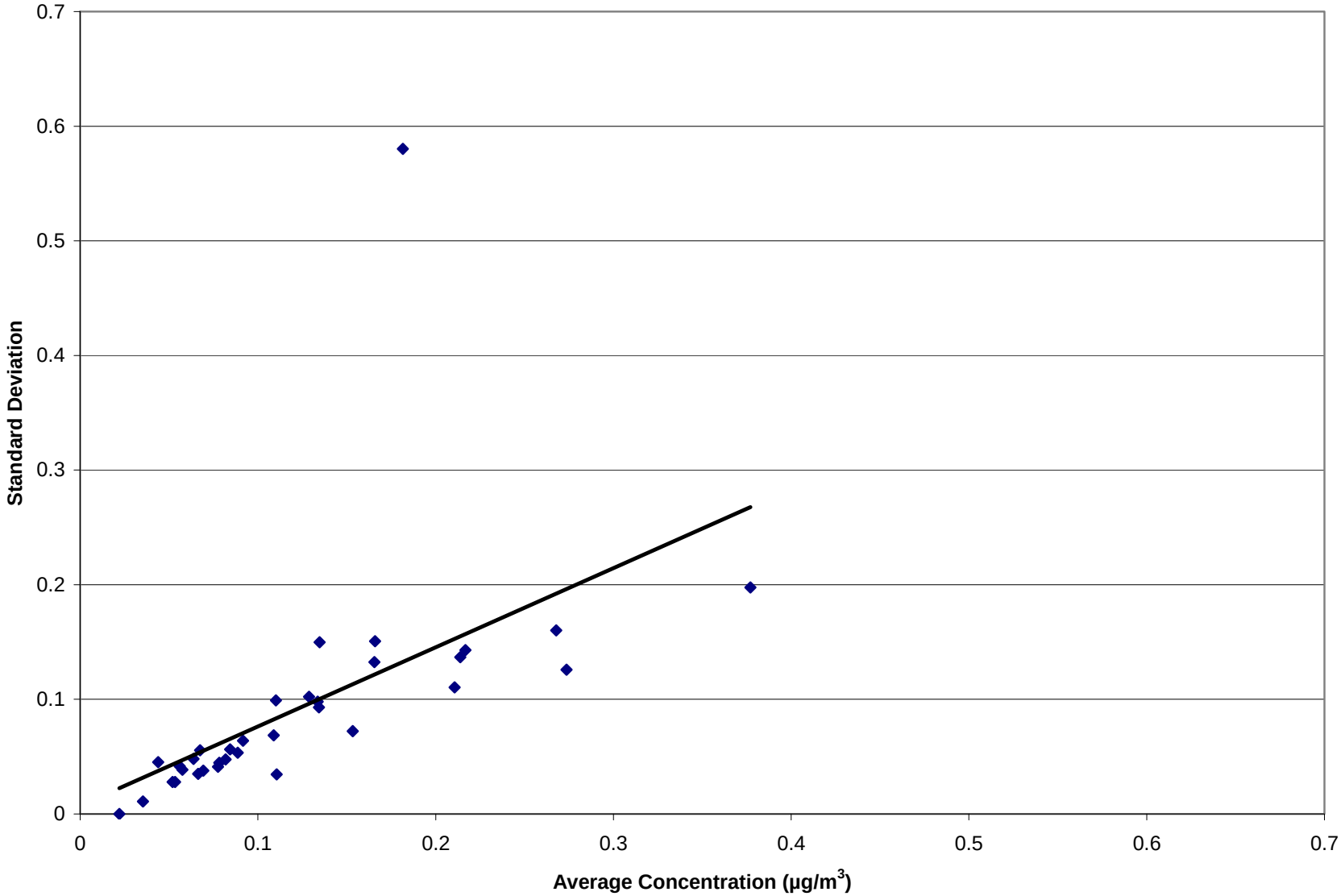


Figure 3-6. Coefficient of Variation Analysis of Acetaldehyde Across 45 Sites

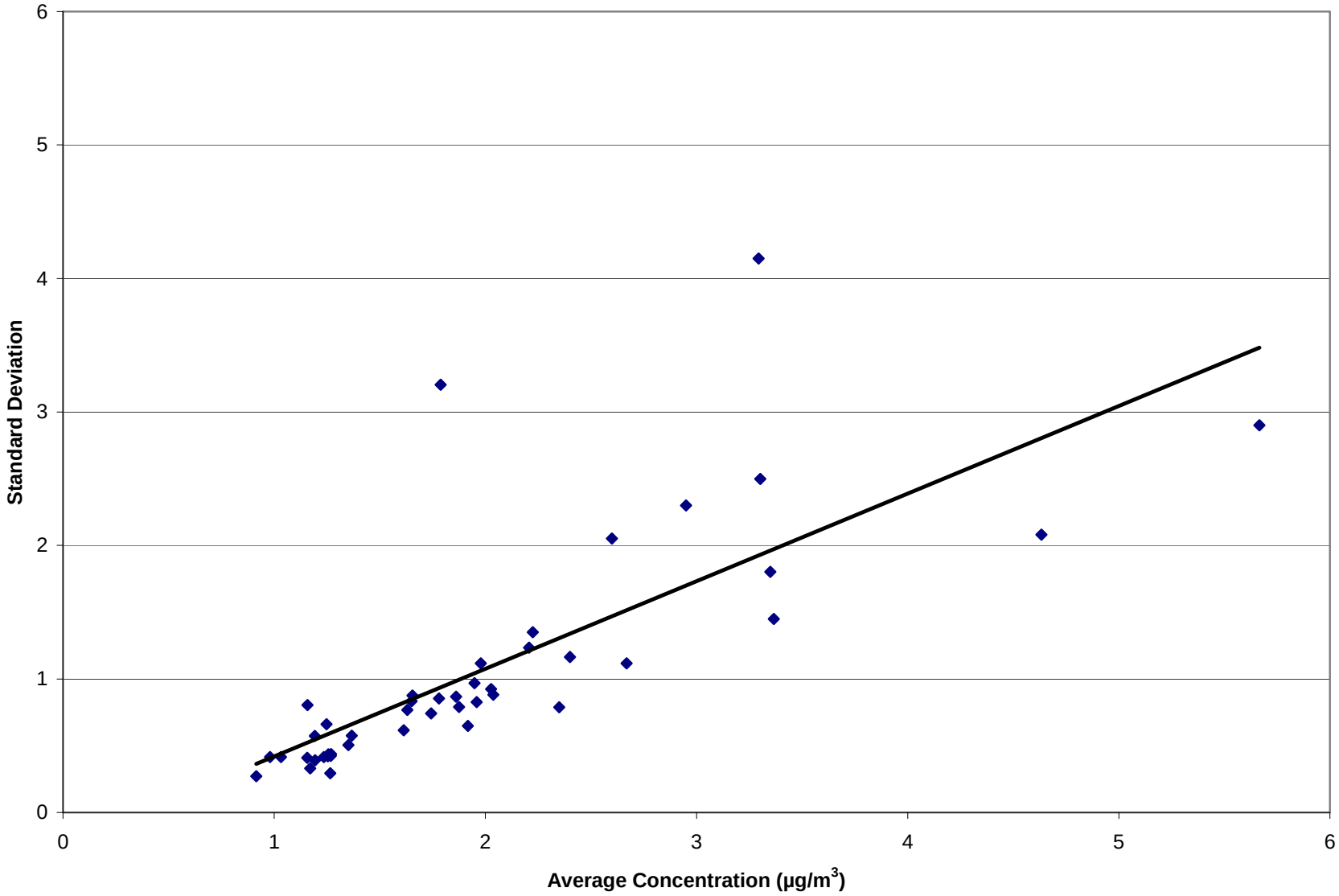


Figure 3-7. Coefficient of Variation Analysis of Acrolein Across 33 Sites

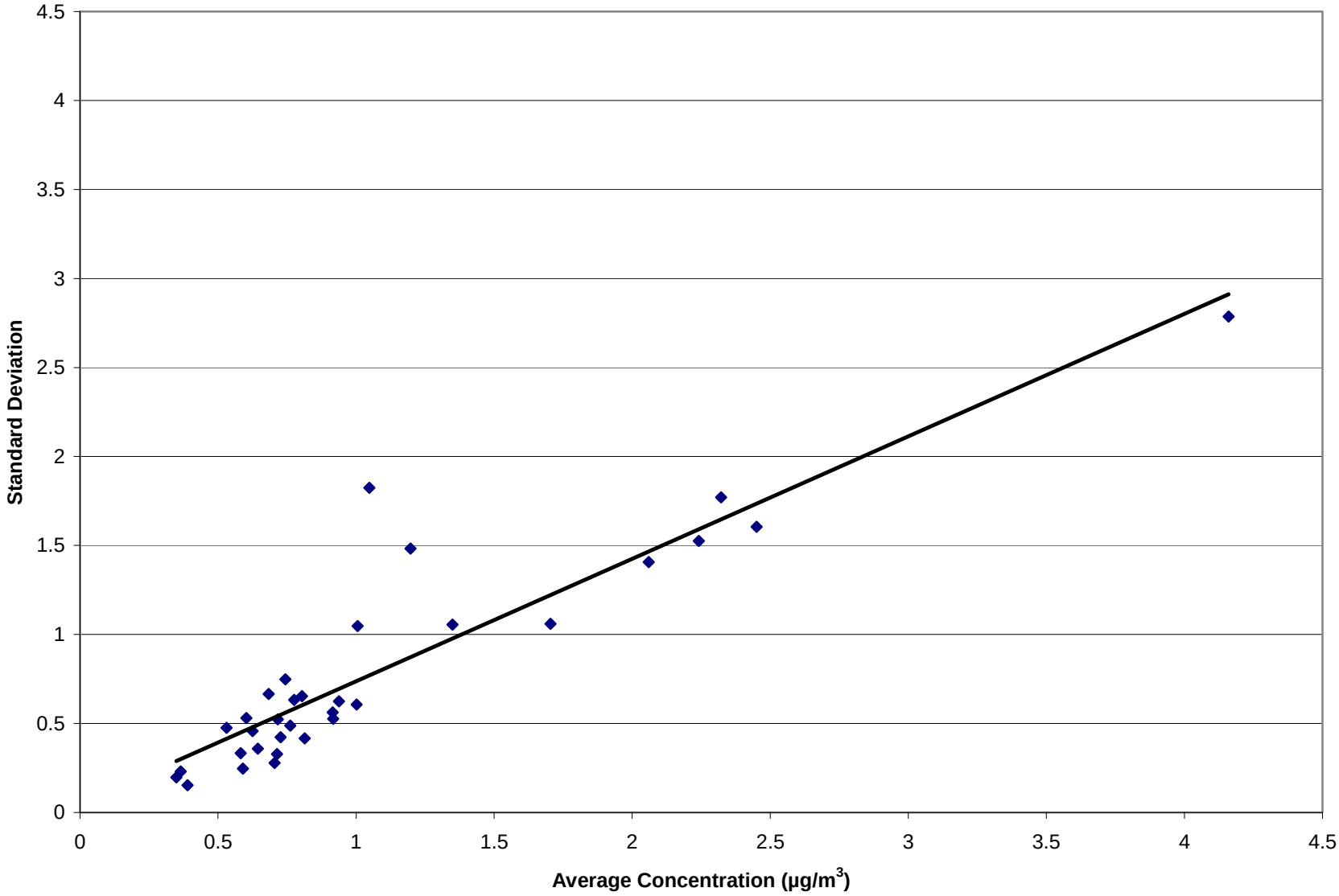


Figure 3-8. Coefficient of Variation Analysis of Benzene Across 34 Sites

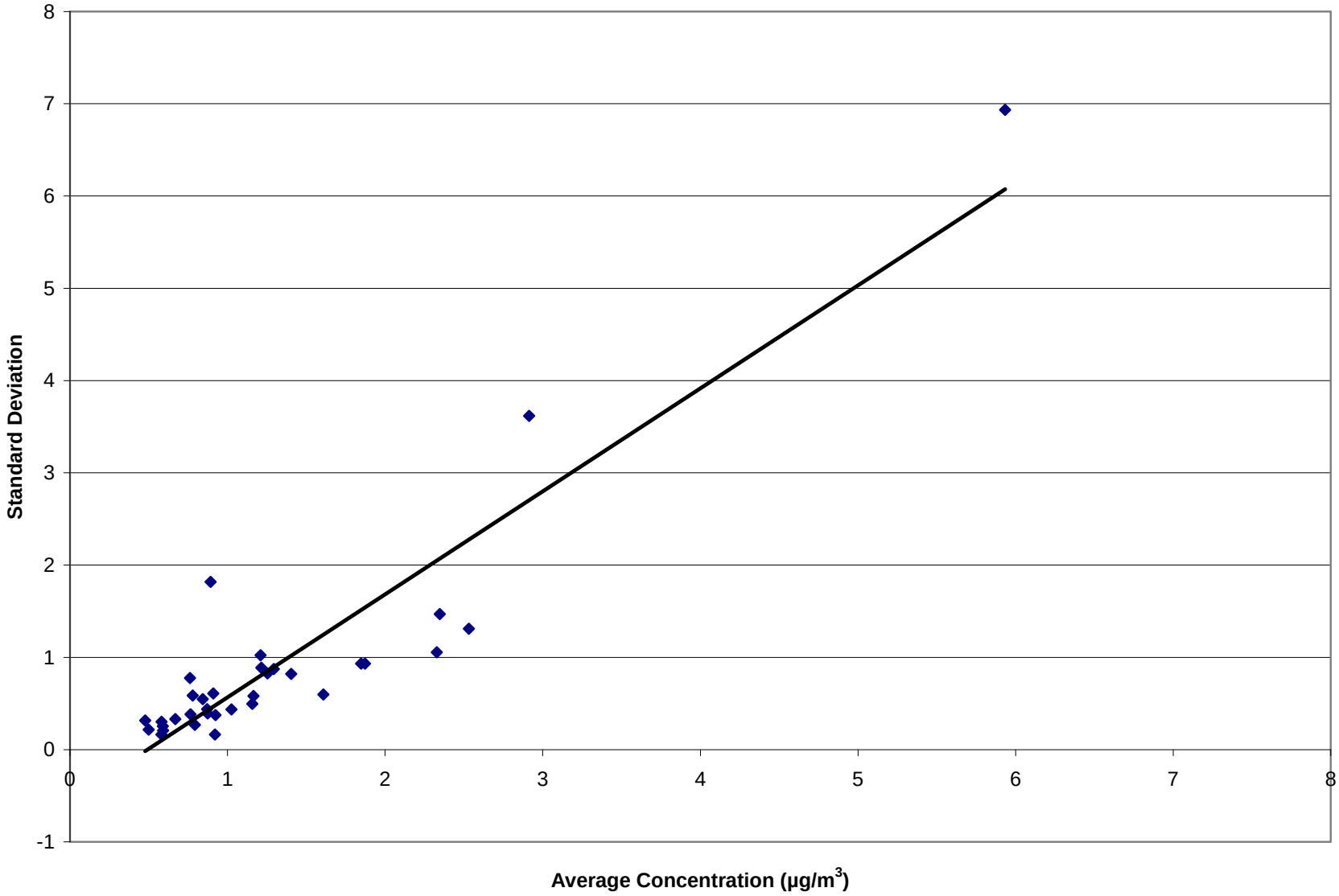


Figure 3-9. Coefficient of Variation Analysis of Carbon Tetrachloride Across 34 Sites

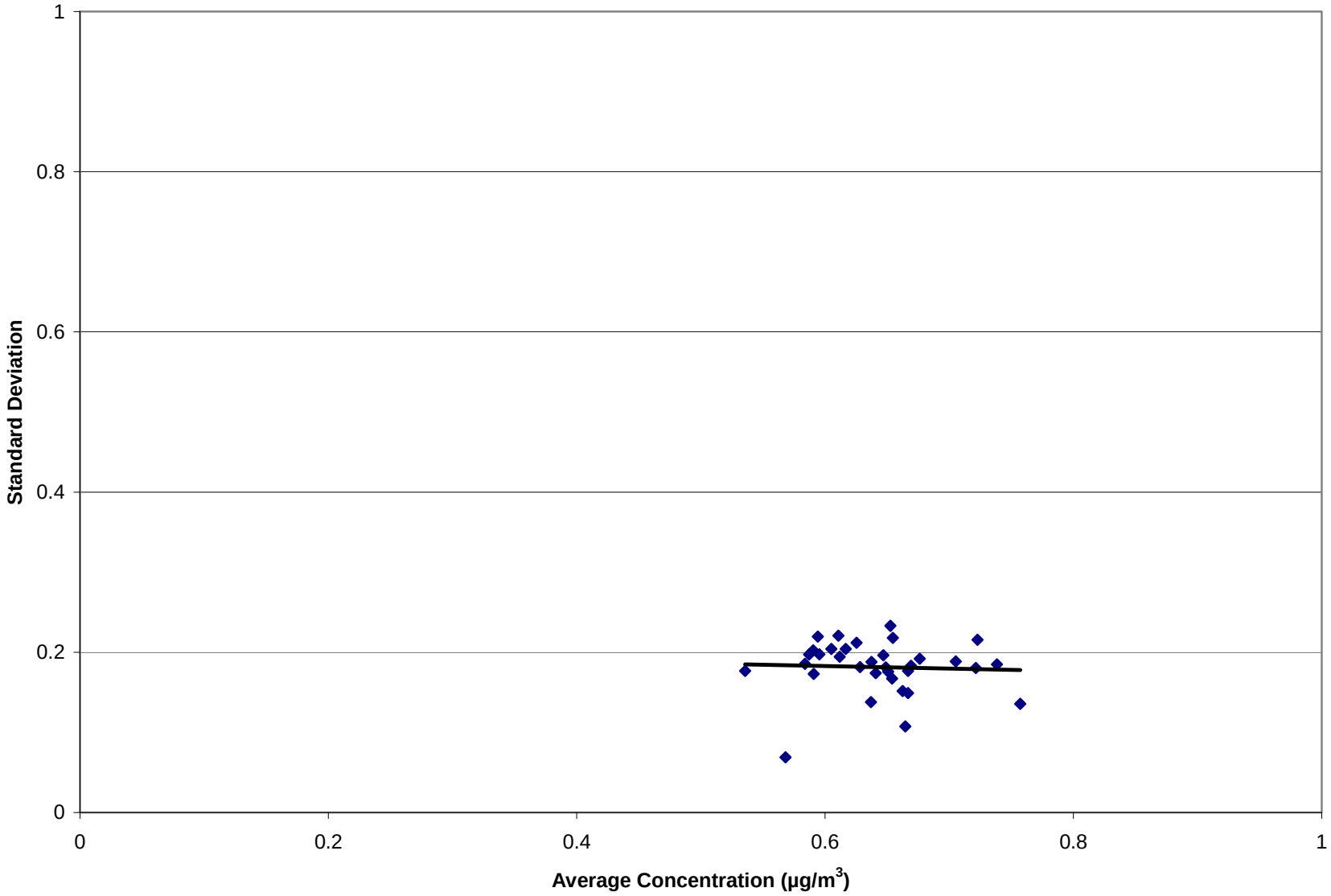


Figure 3-10. Coefficient of Variation Analysis of Formaldehyde Across 45 Sites

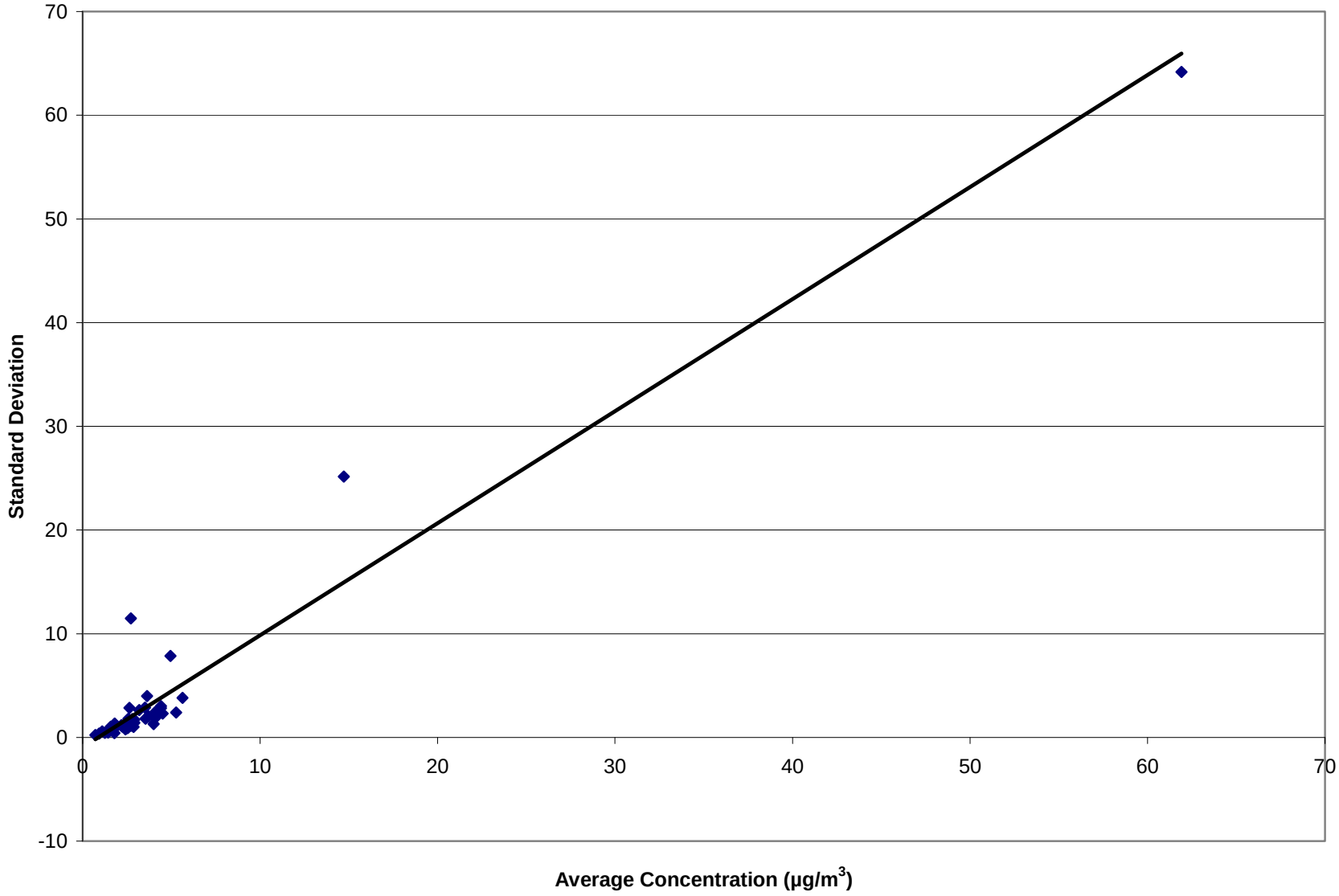


Figure 3-11. Coefficient of Variation Analysis of Hexachloro-1,3-Butadiene Across 29 Sites

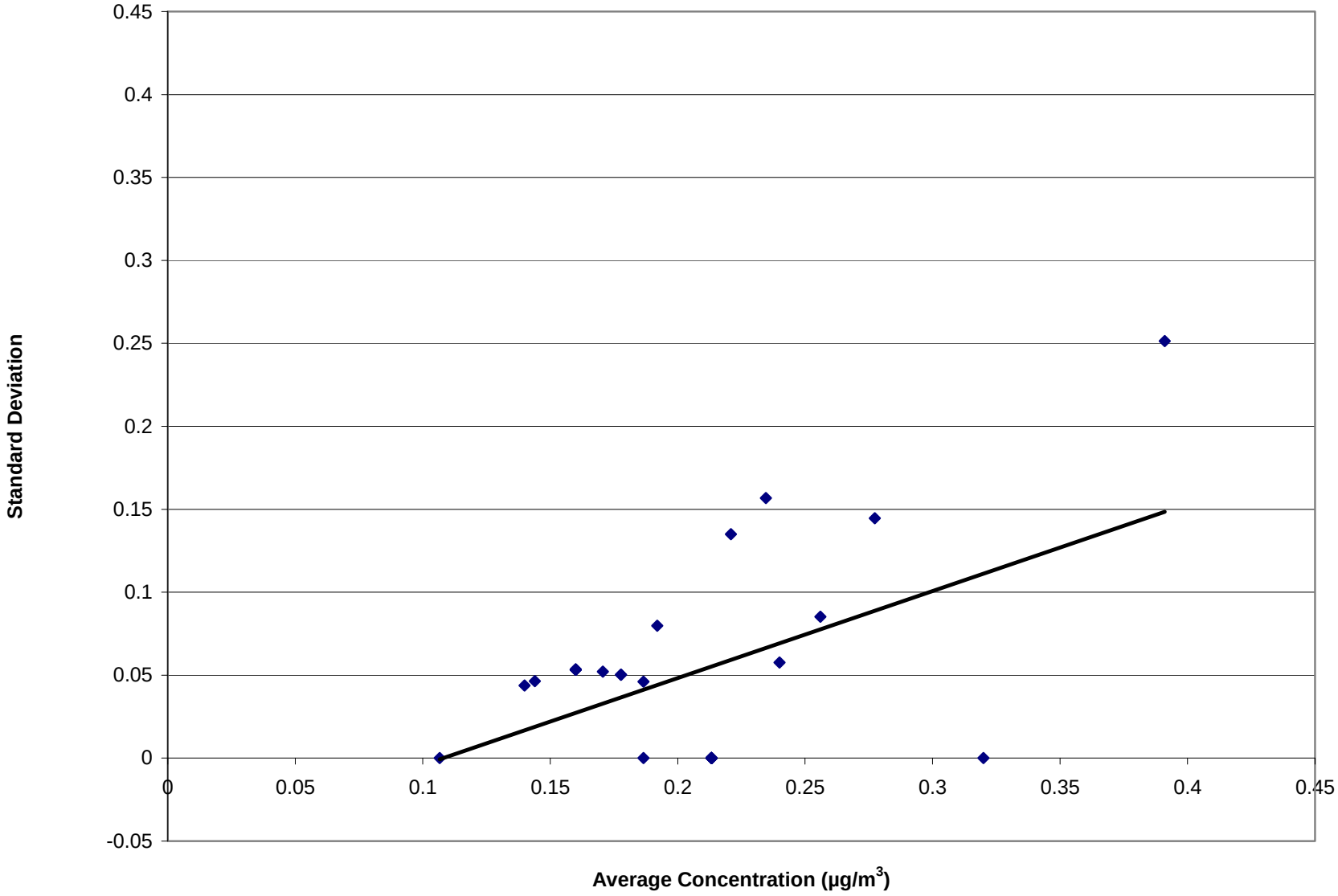


Figure 3-12. Coefficient of Variation Analysis of Hexavalent Chromium Across 23 Sites

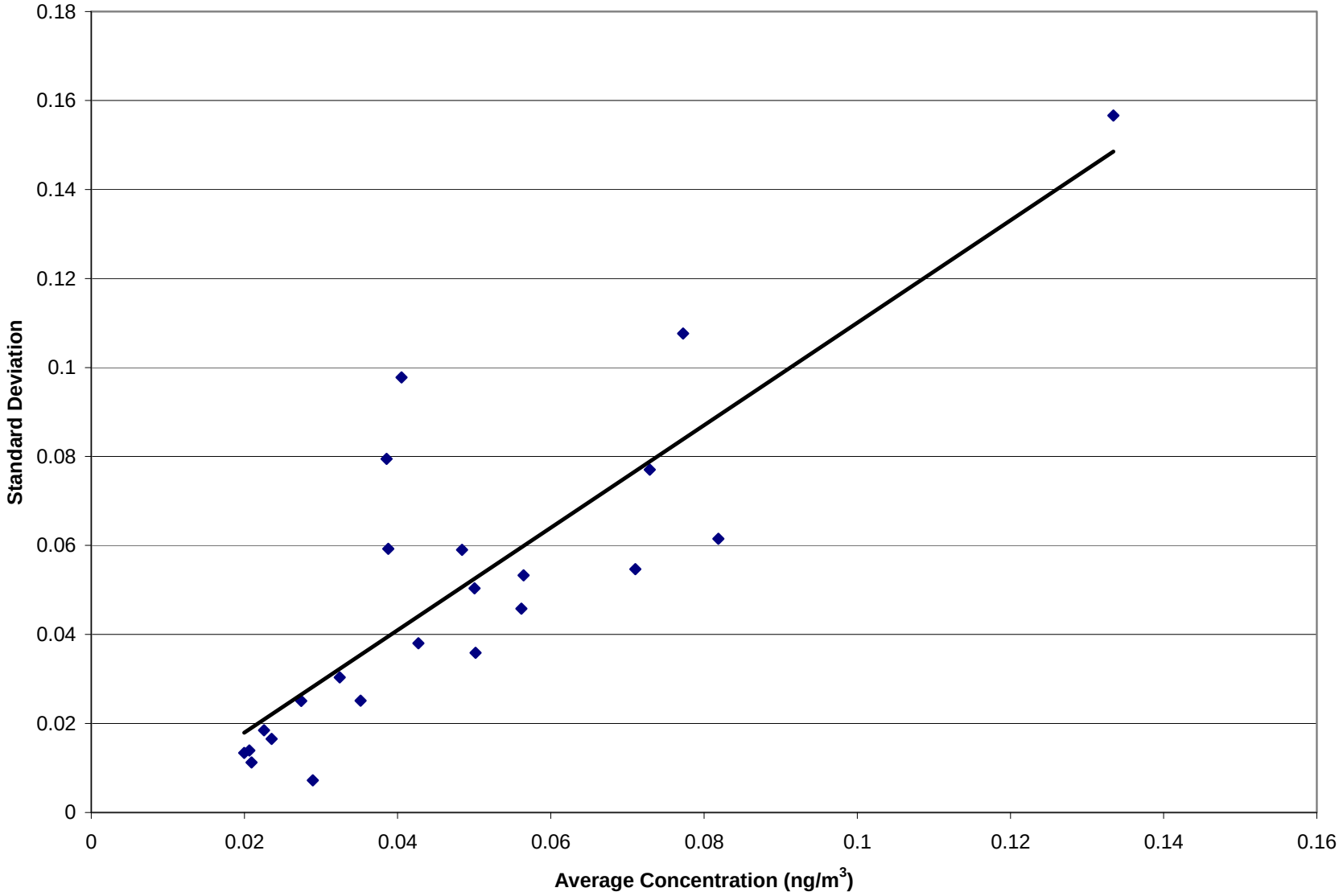


Figure 3-13. Coefficient of Variation Analysis of Naphthalene Across 6 Sites

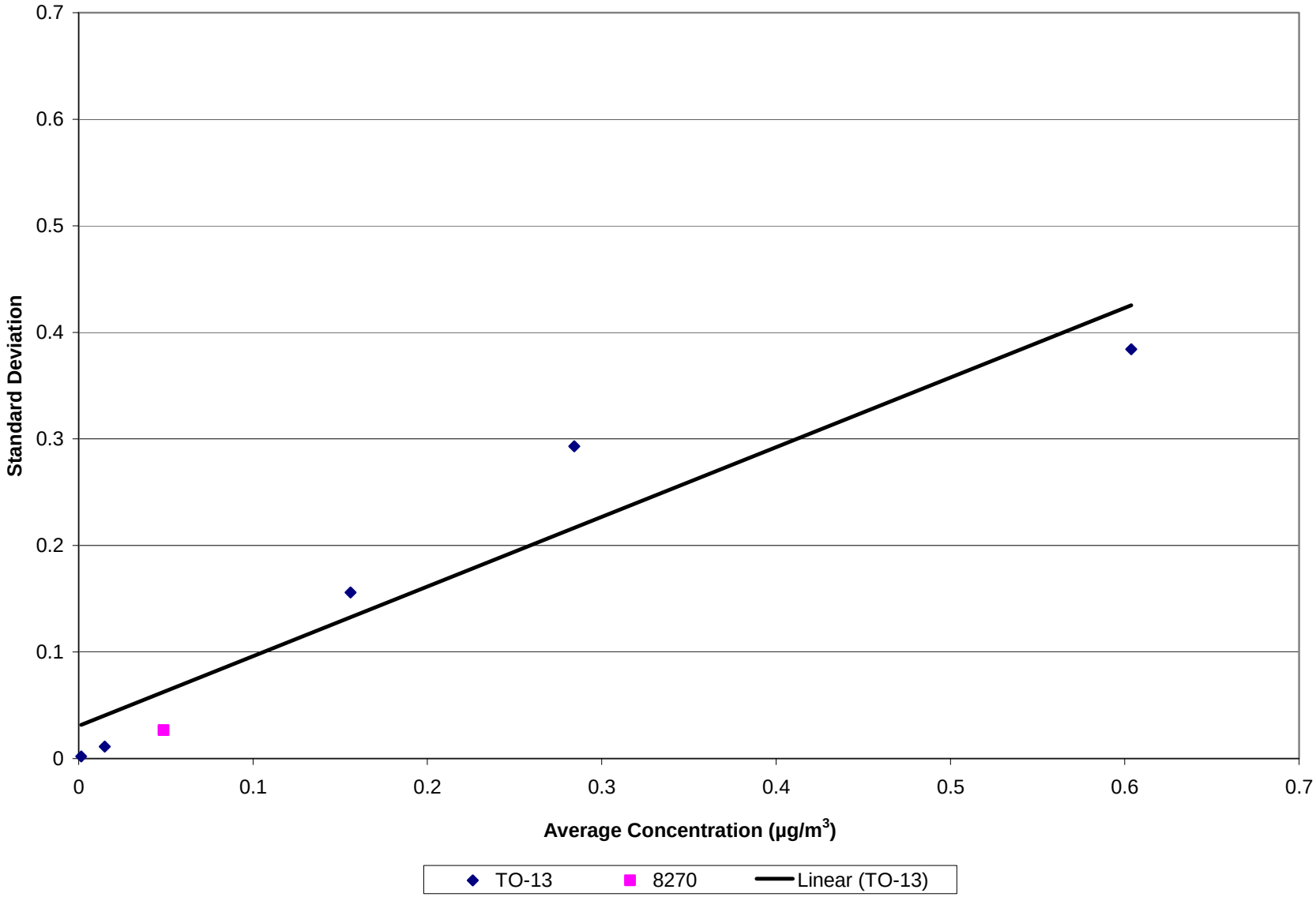


Figure 3-14. Coefficient of Variation Analysis of *p*-Dichlorobenzene/1,4-Dichlorobenzene Across 35 Sites

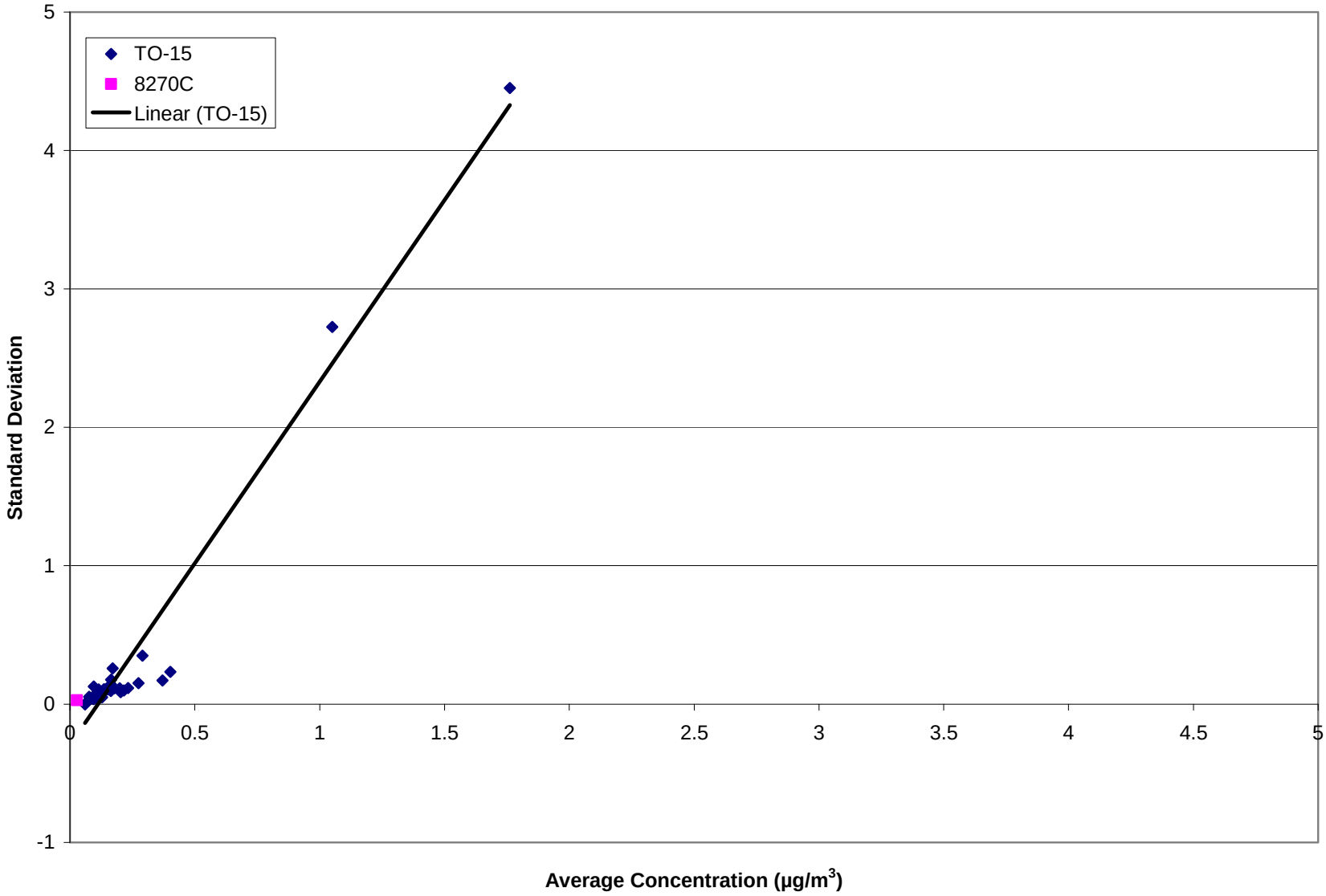


Figure 3-15. Coefficient of Variation Analysis of Tetrachloroethylene Across 34 Sites

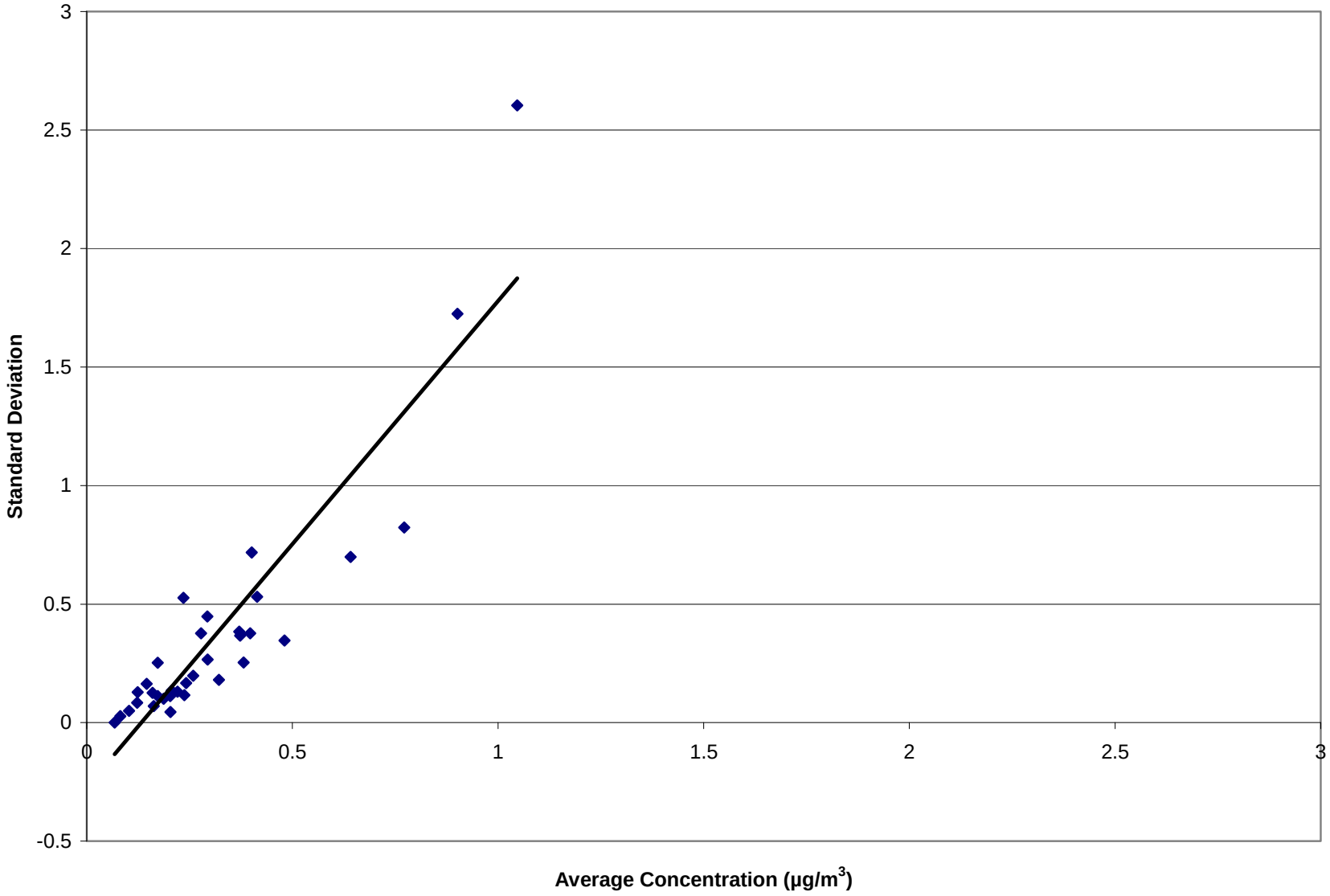


Figure 3-16. Coefficient of Variation Analysis of Arsenic Across 21 Sites

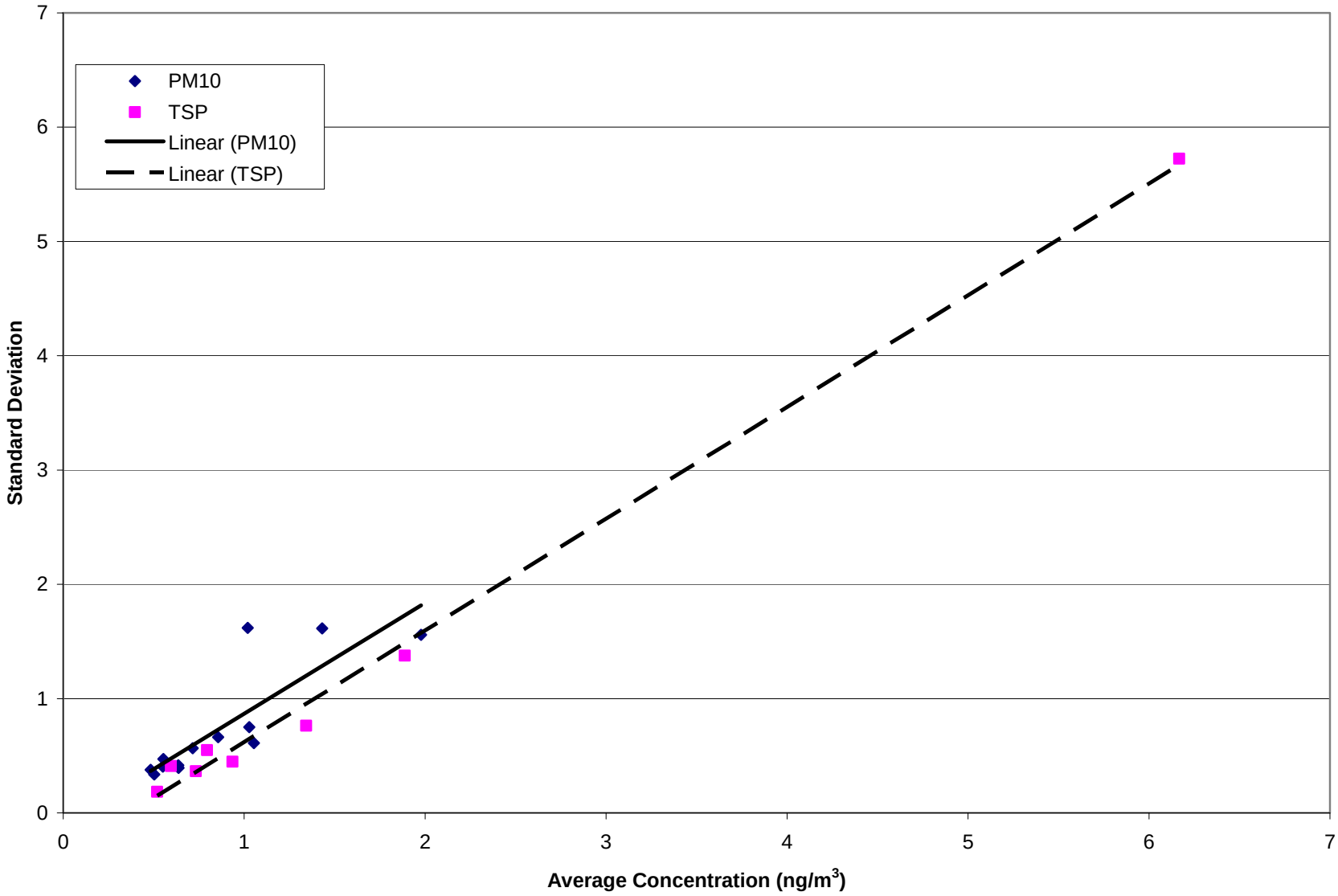


Figure 3-17. Coefficient of Variation Analysis of Manganese Across 21 Sites

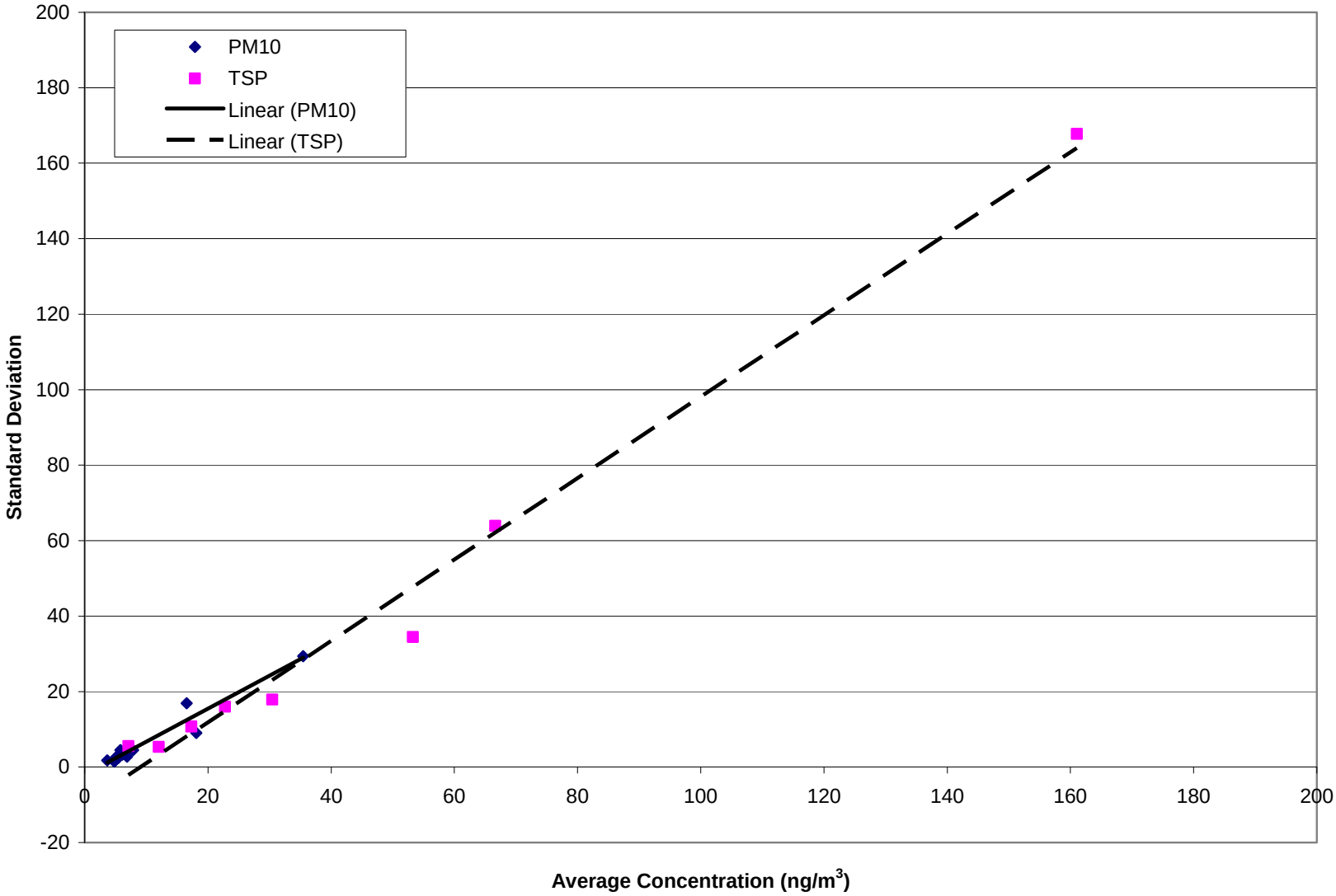


Figure 3-18a. Comparison of Average Seasonal 1,3-Butadiene Concentration by Season

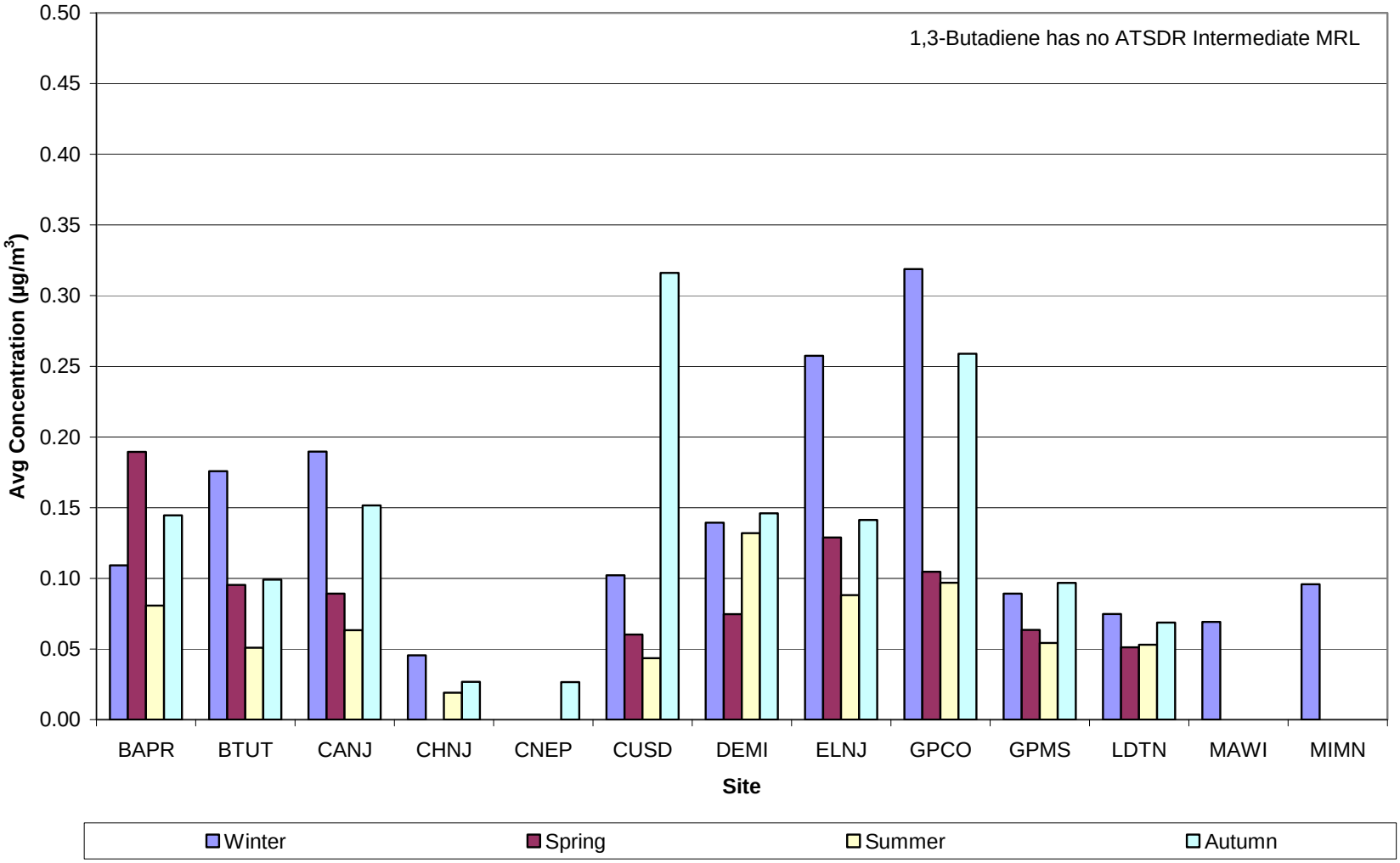


Figure 3-18b. Comparison of Average Seasonal 1,3-Butadiene Concentration by Season (Continued)

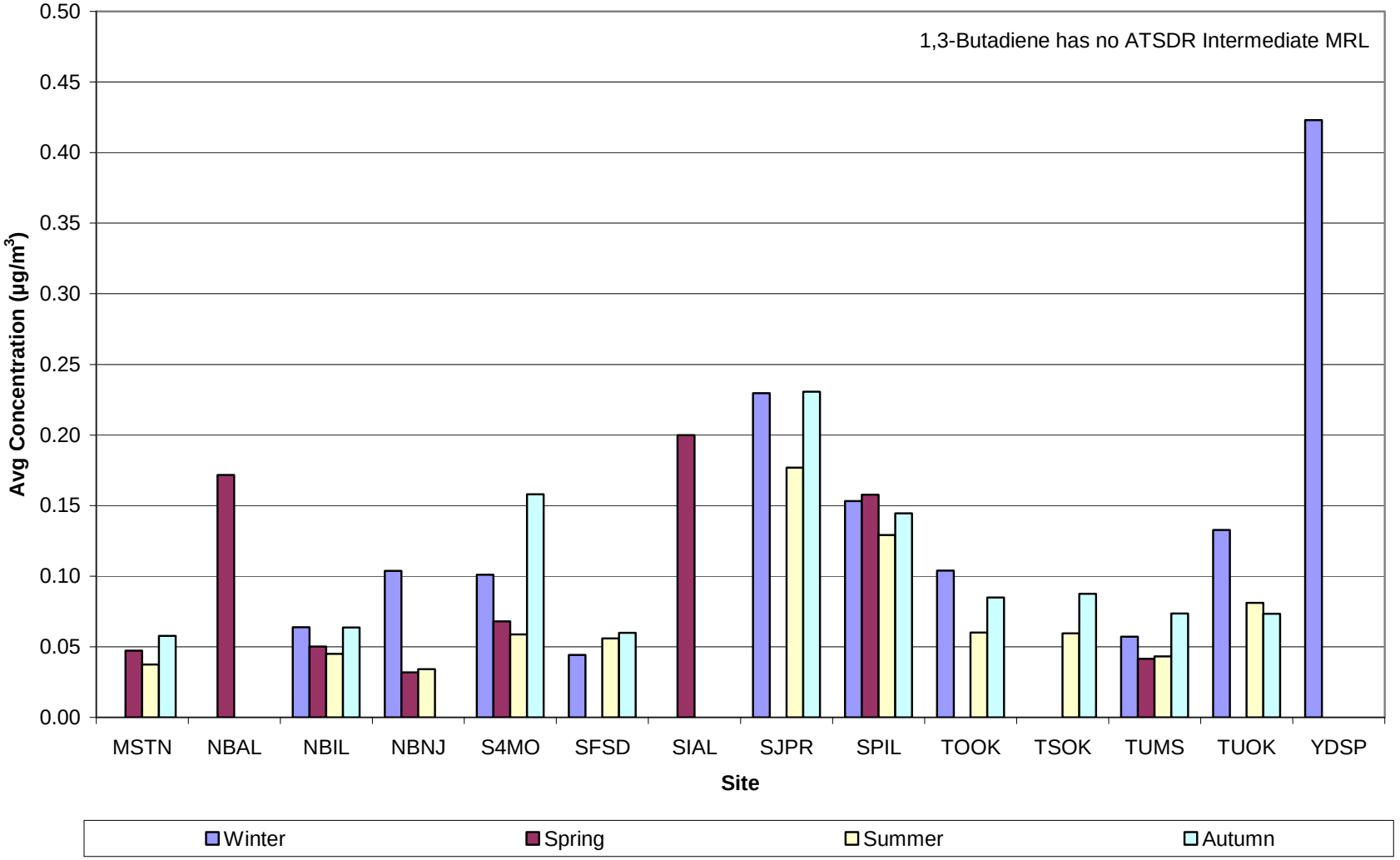


Figure 3-19a. Comparison of Average Seasonal Acetaldehyde Concentration by Season

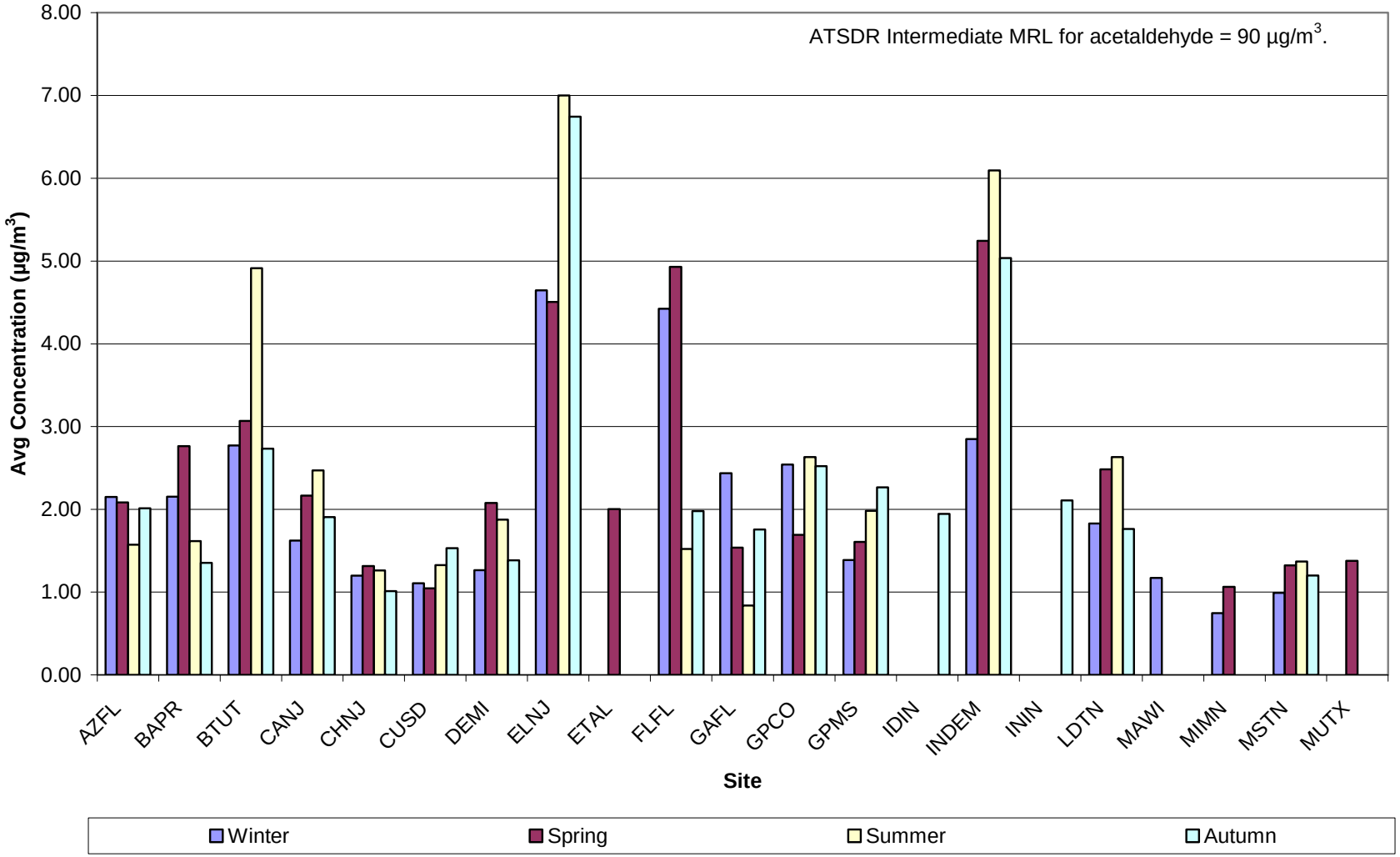


Figure 3-19b. Comparison of Average Seasonal Acetaldehyde Concentration by Season (Continued)

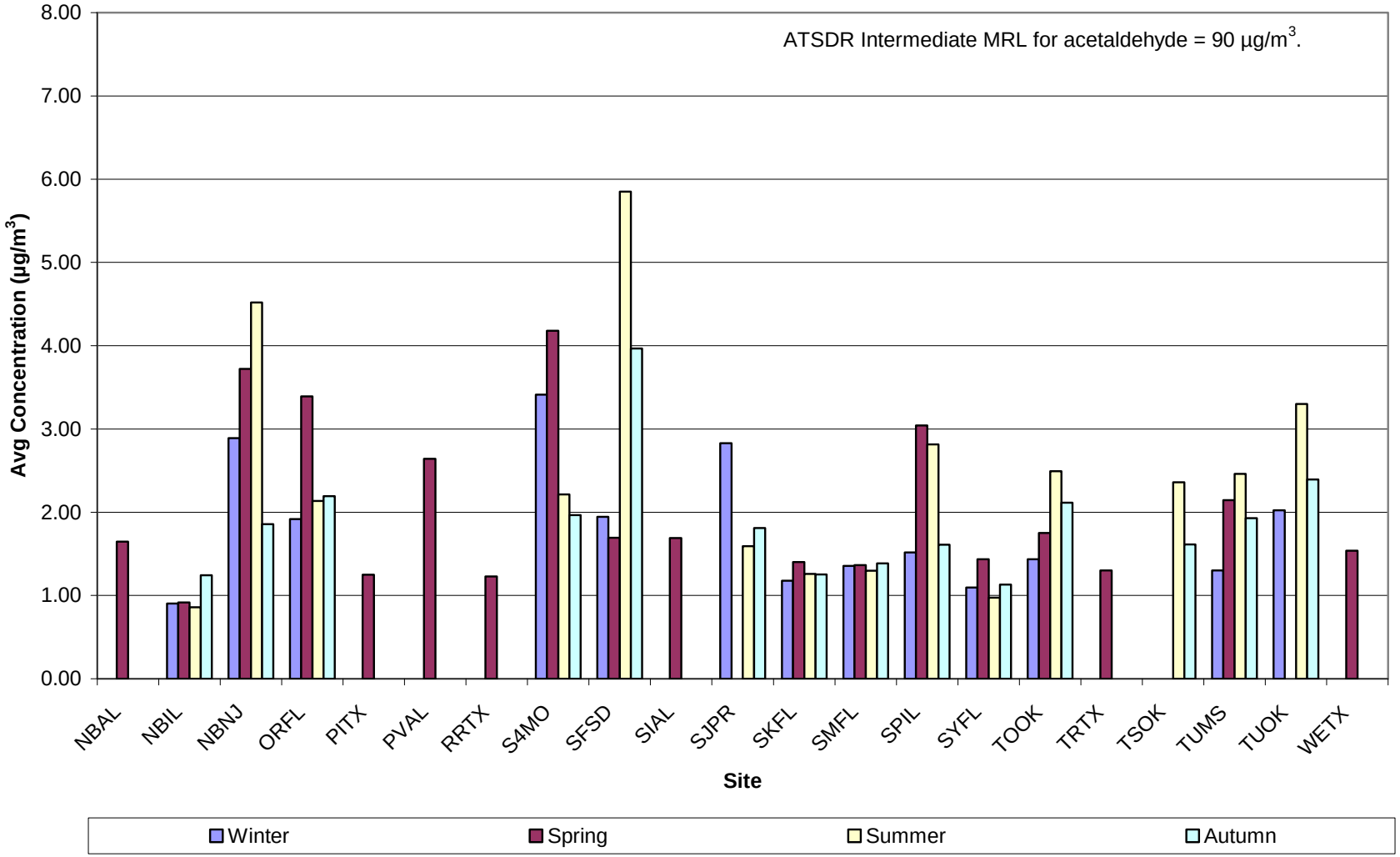


Figure 3-20a. Comparison of Average Seasonal Acrolein Concentration by Season

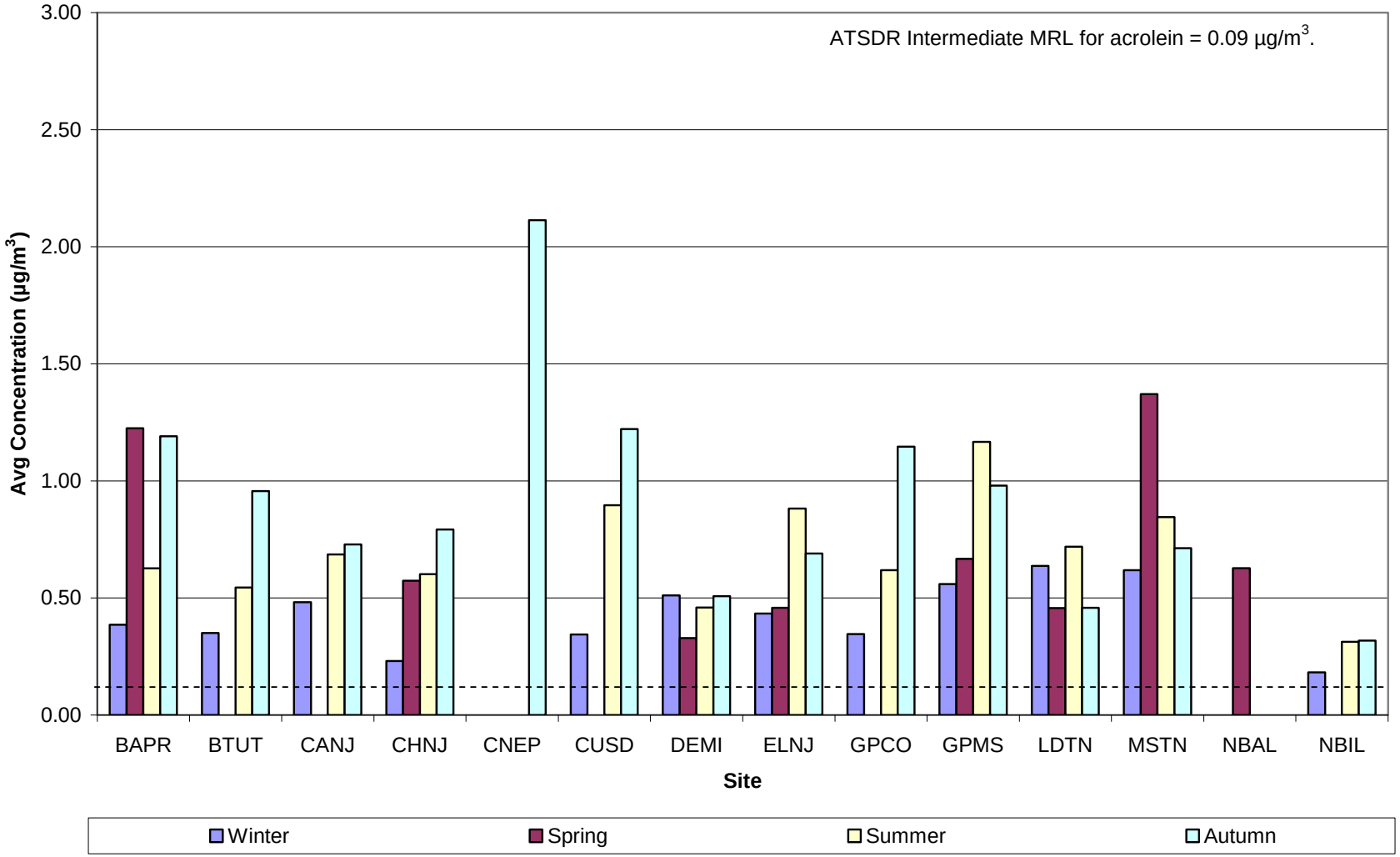


Figure 3-20b. Comparison of Average Seasonal Acrolein Concentration by Season (Continued)

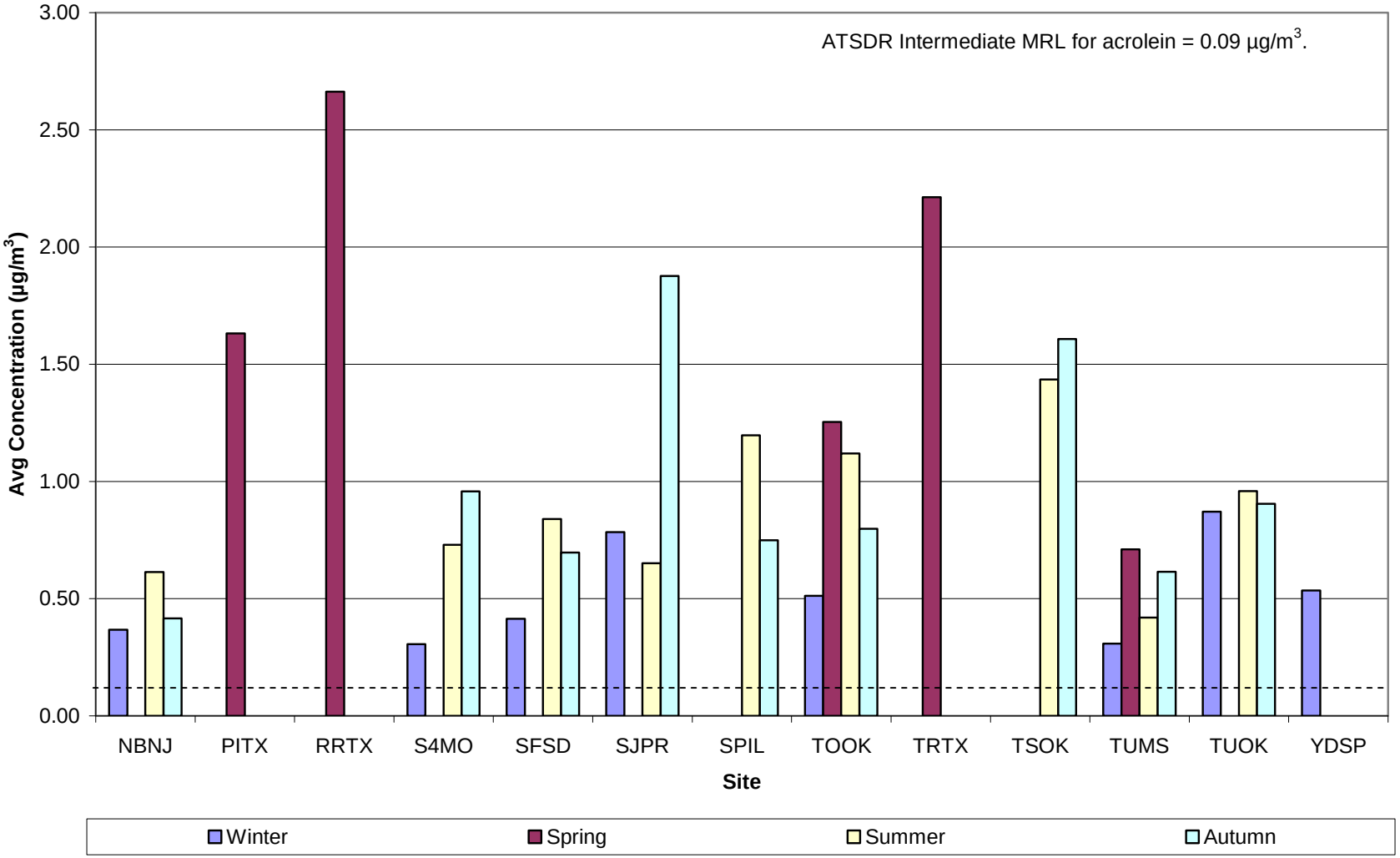


Figure 3-21a. Comparison of Average Seasonal Arsenic PM_{10} Concentration by Season

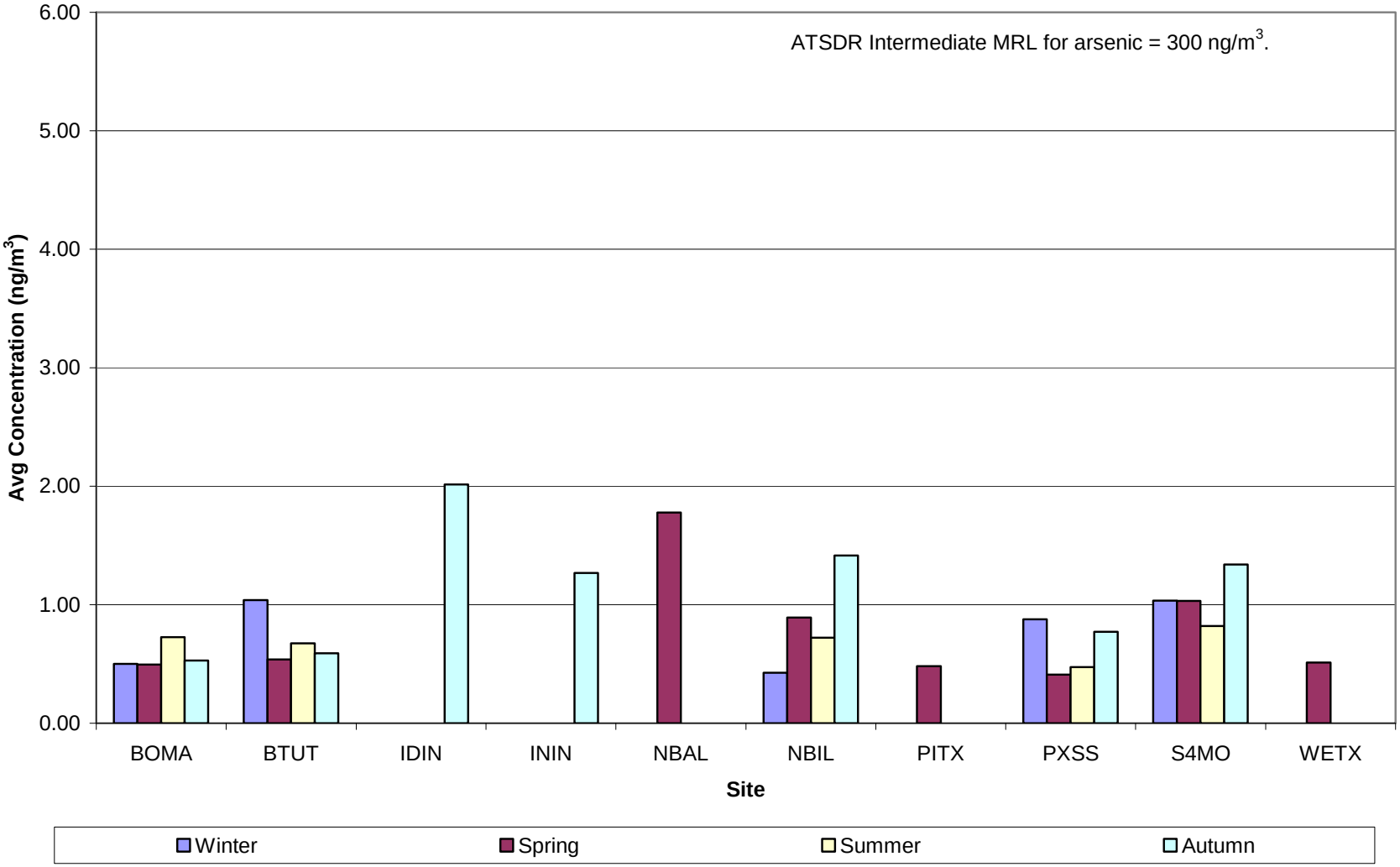


Figure 3-21b. Comparison of Average Seasonal Arsenic TSP Concentration by Season

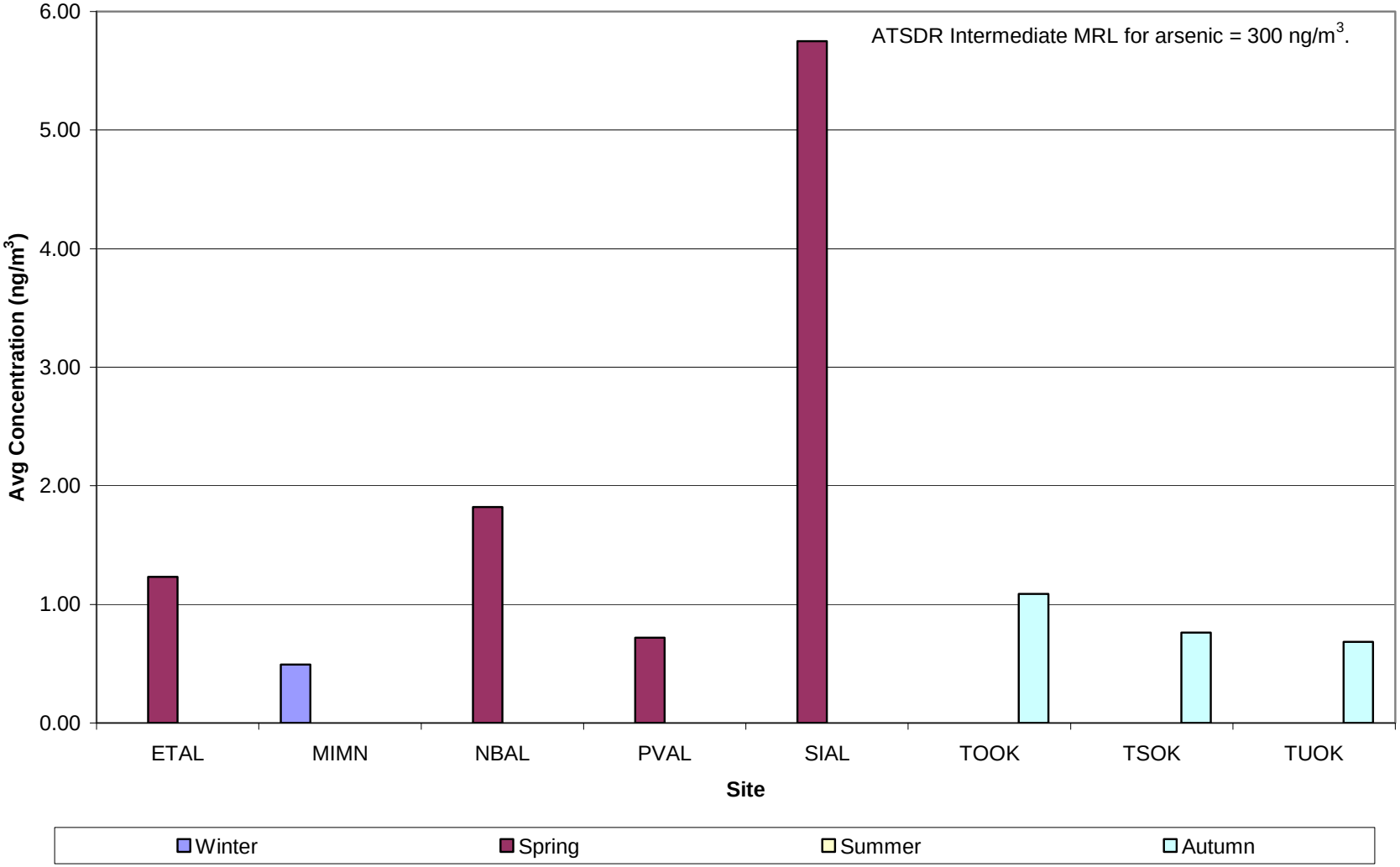


Figure 3-22a. Comparison of Average Seasonal Benzene Concentration by Season

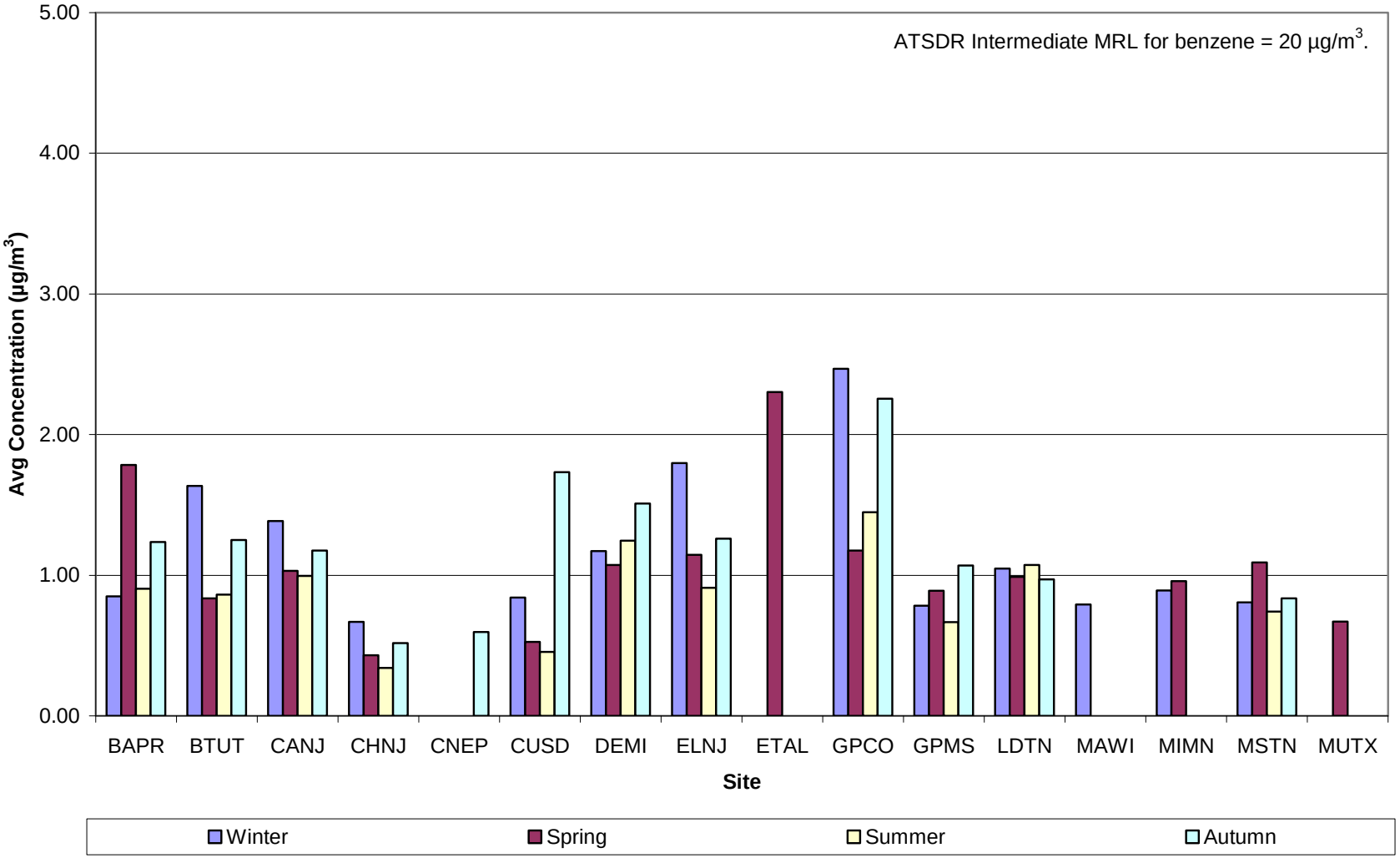


Figure 3-22b. Comparison of Average Seasonal Benzene Concentration by Season (Continued)

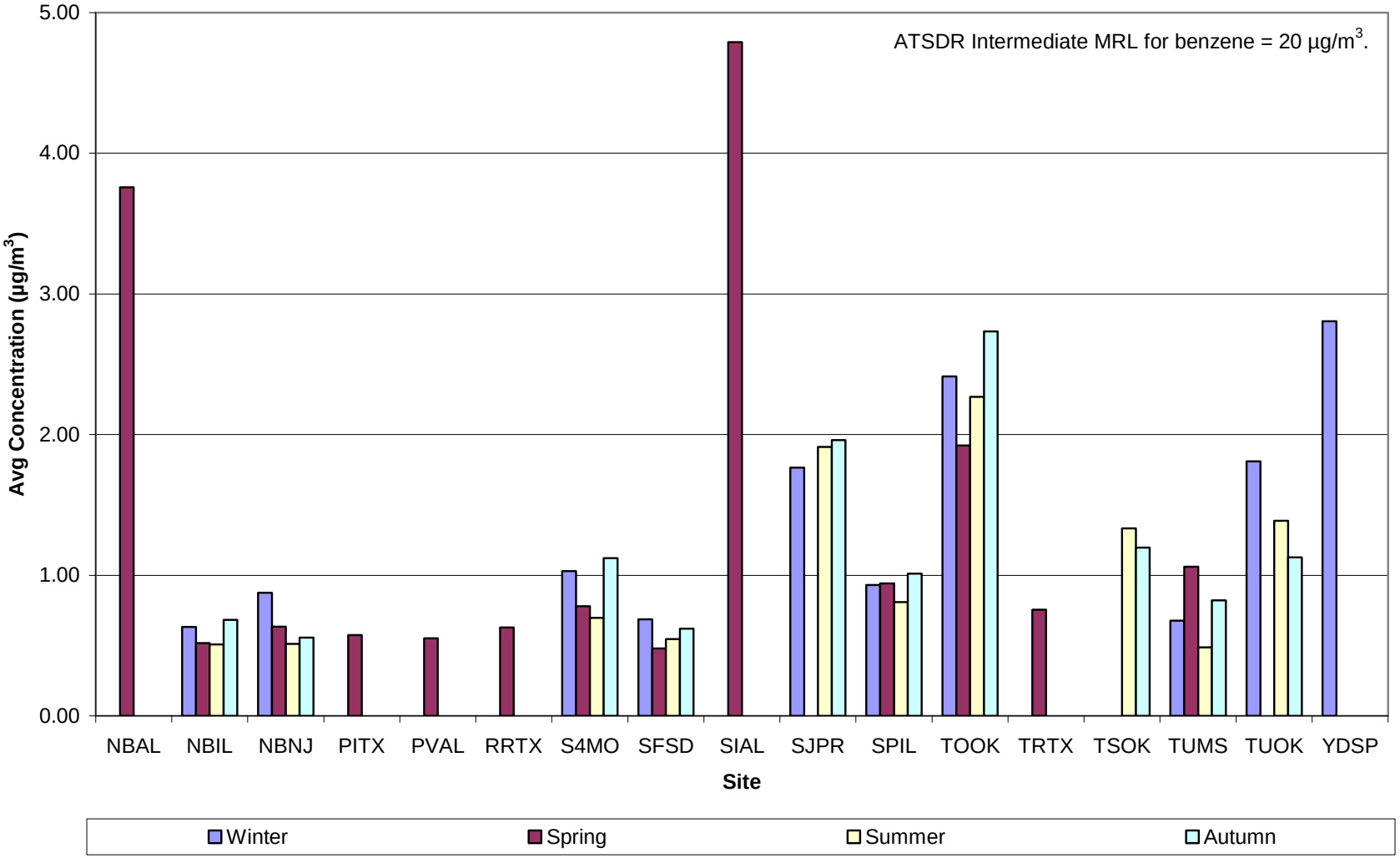


Figure 3-23a. Comparison of Average Seasonal Carbon Tetrachloride Concentration by Season

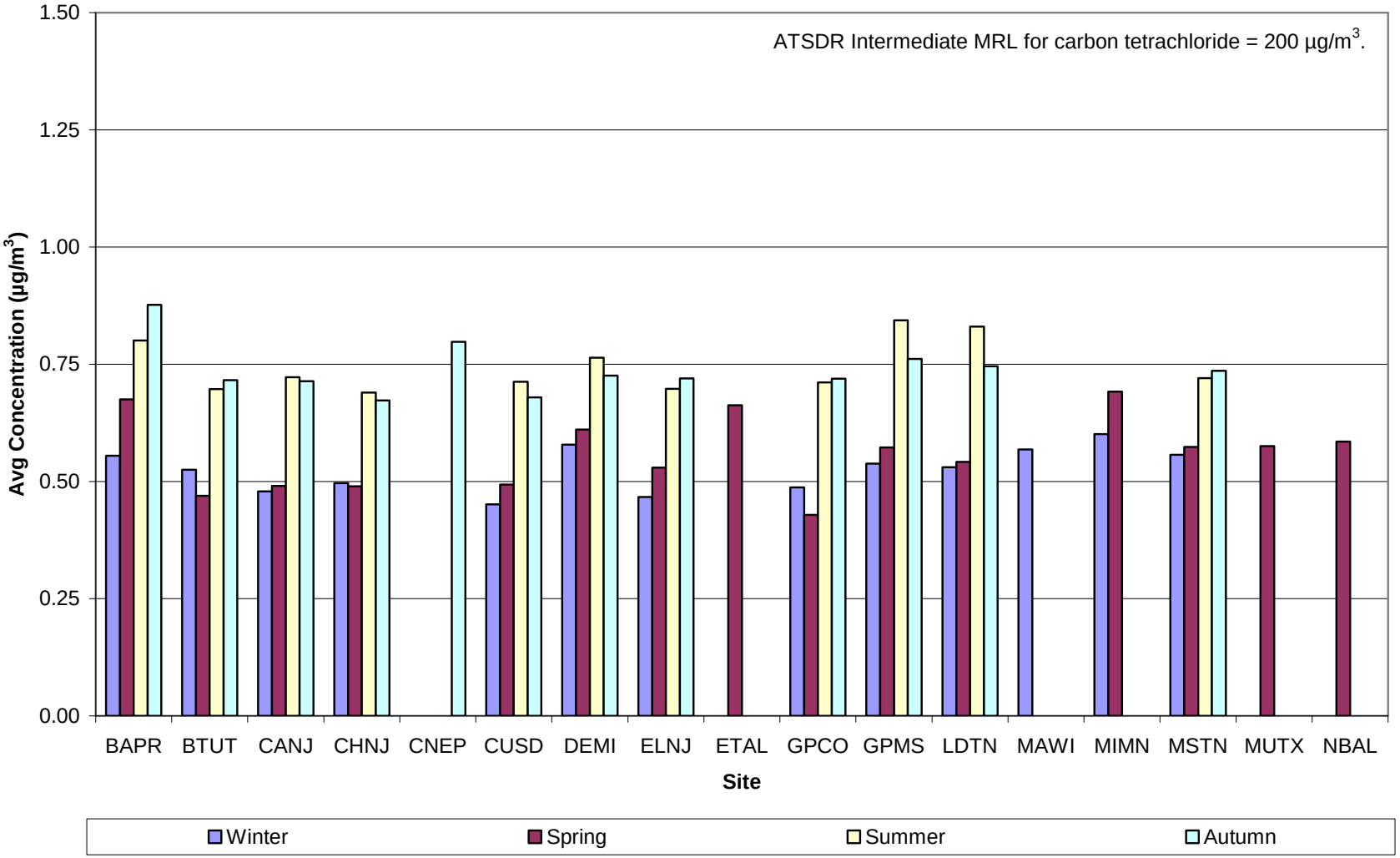


Figure 3-23b. Comparison of Average Seasonal Carbon Tetrachloride Concentration by Season (Continued)

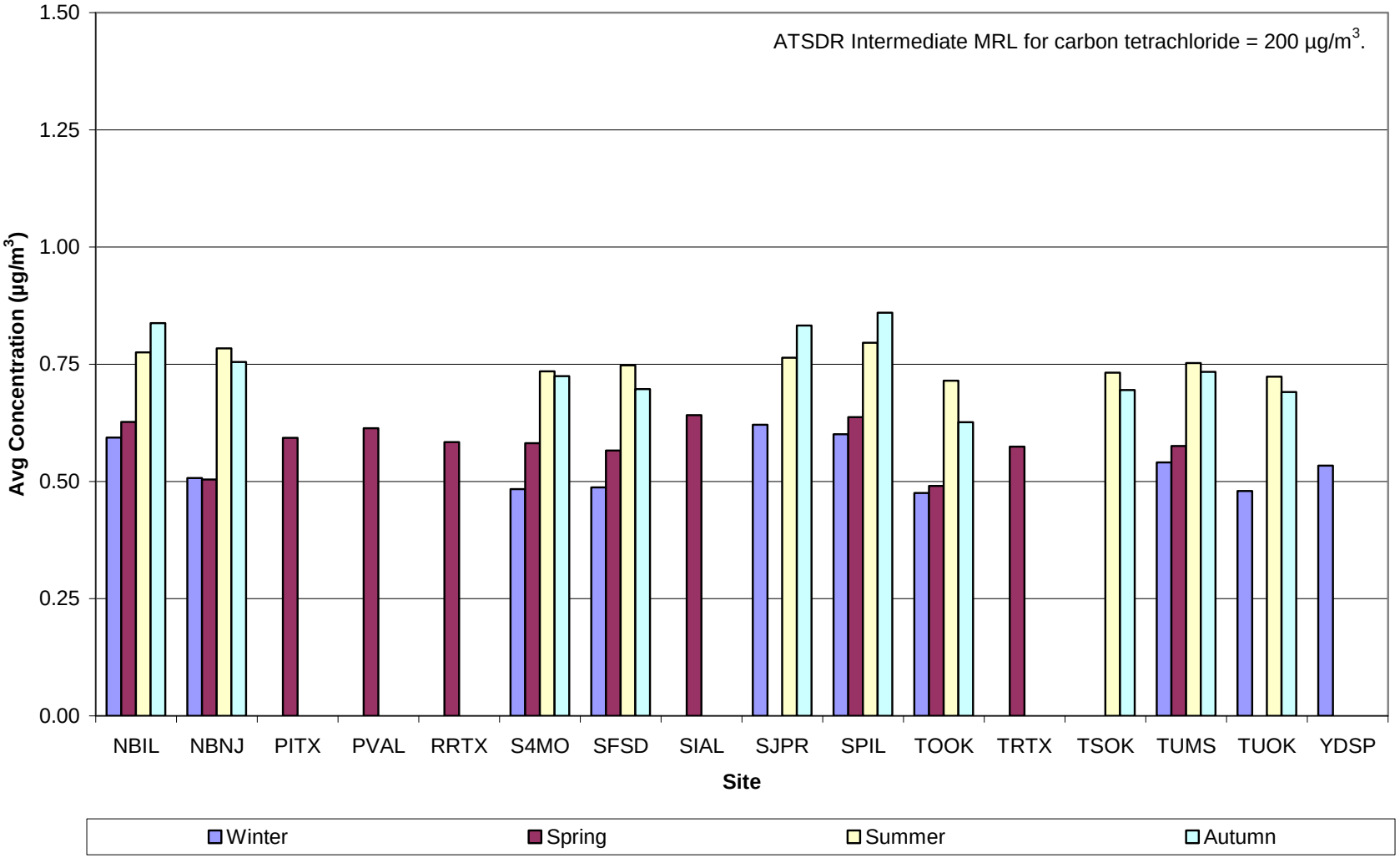


Figure 3-24a. Comparison of Average Seasonal Formaldehyde Concentration by Season

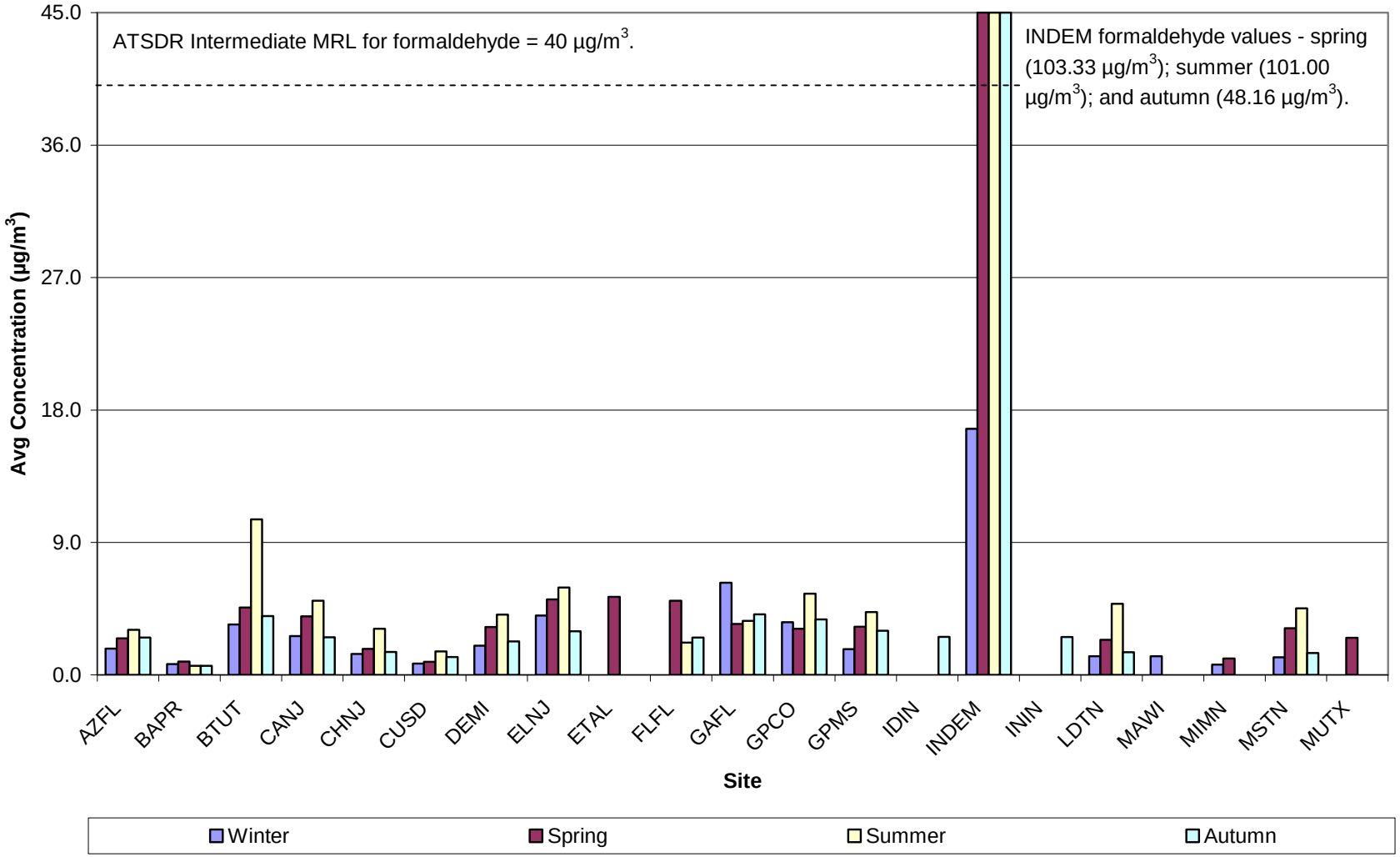


Figure 3-24b. Comparison of Average Seasonal Formaldehyde Concentration by Season (Continued)

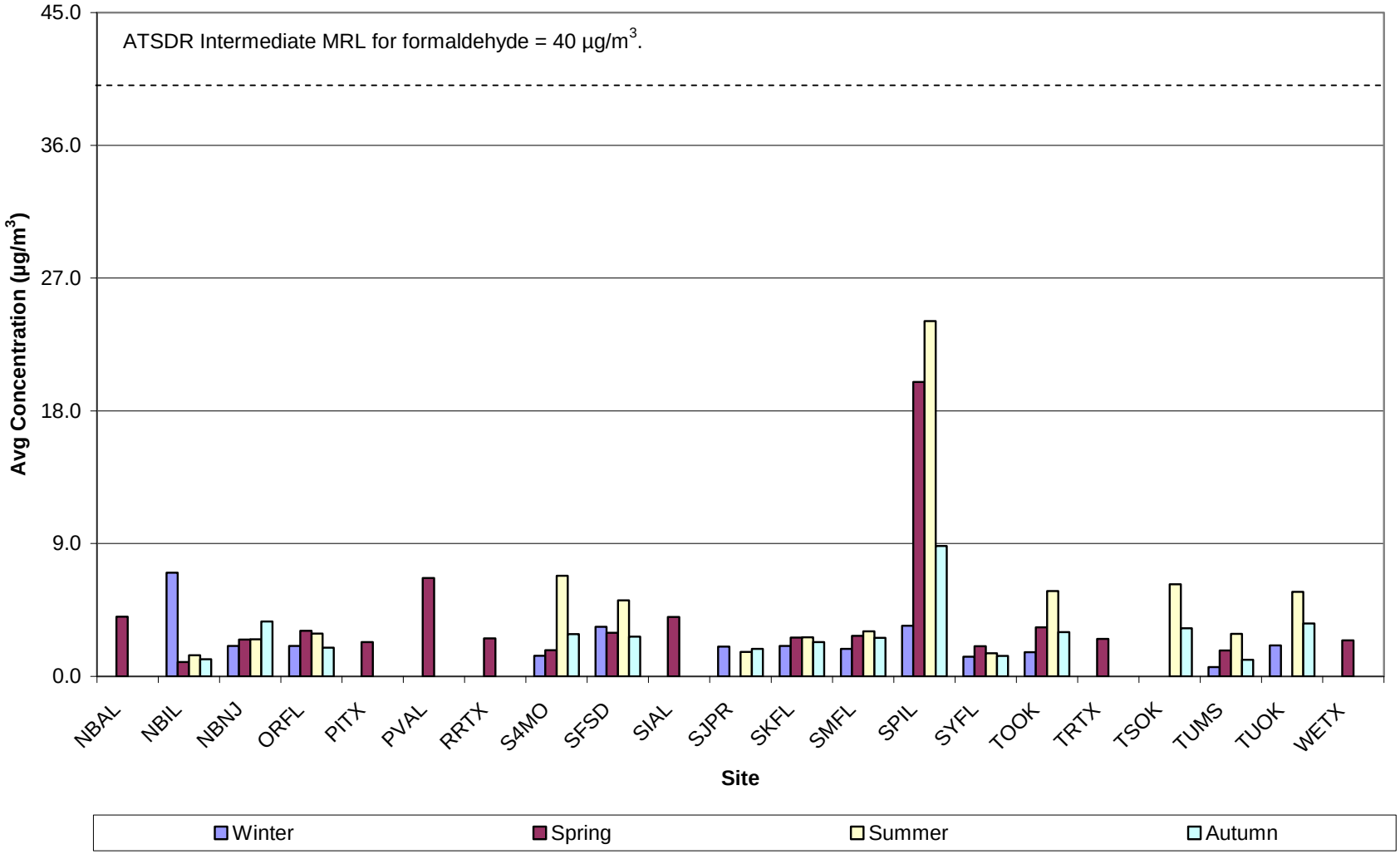


Figure 3-25. Comparison of Average Seasonal Hexavalent Chromium Concentration by Season

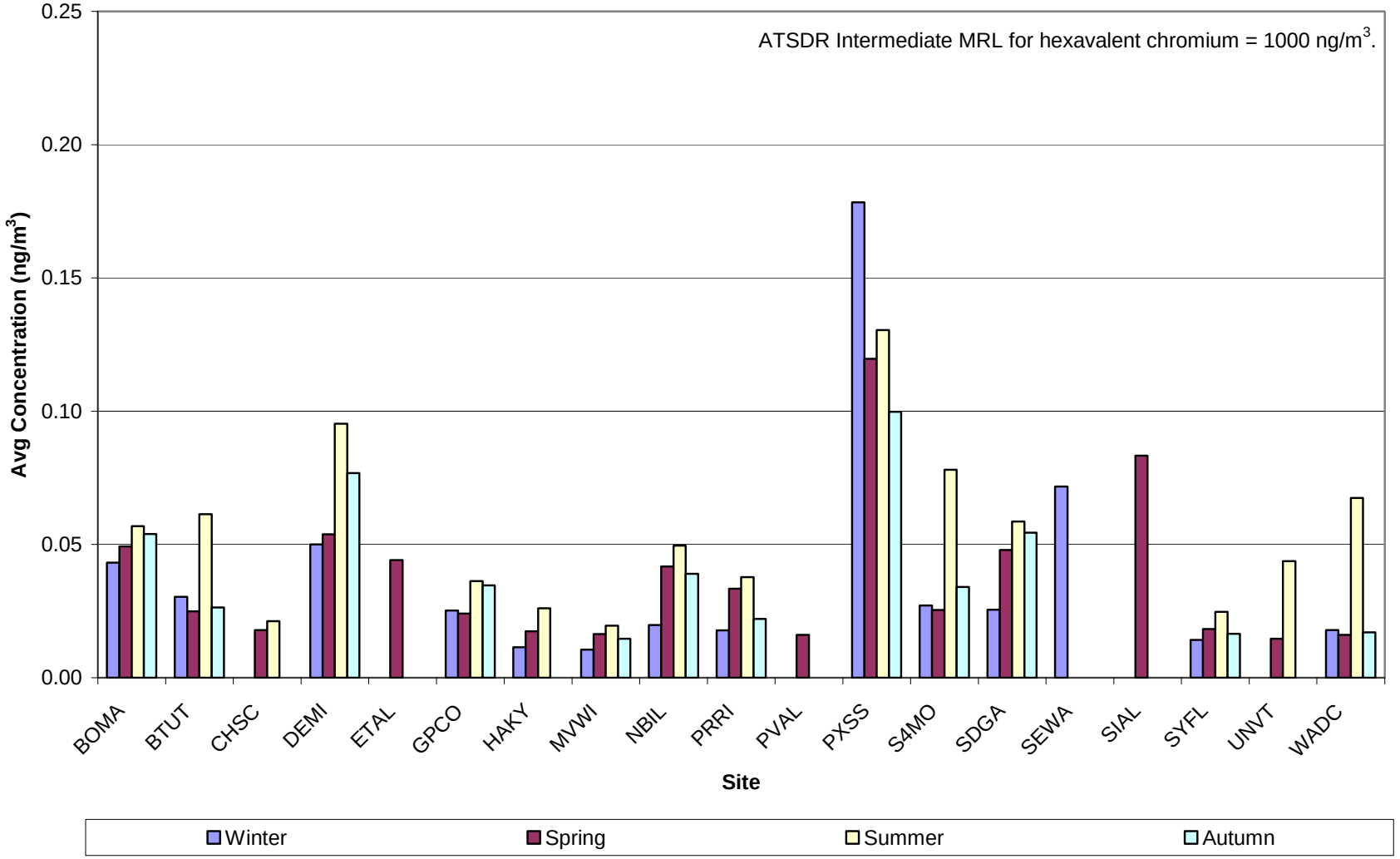


Figure 3-26a. Comparison of Average Seasonal Manganese PM_{10} Concentration by Season

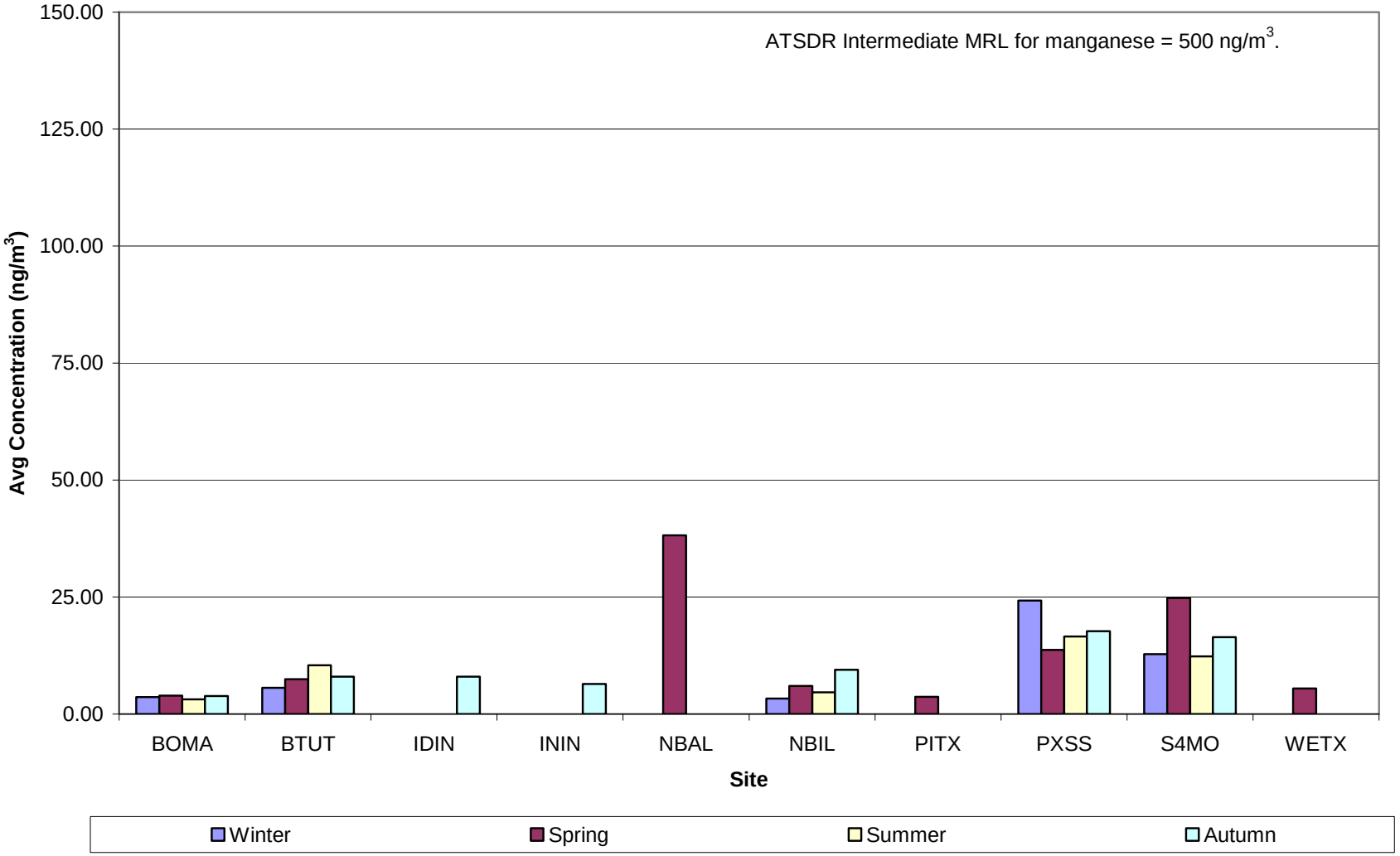


Figure 3-26b. Comparison of Average Seasonal Manganese TSP Concentration by Season

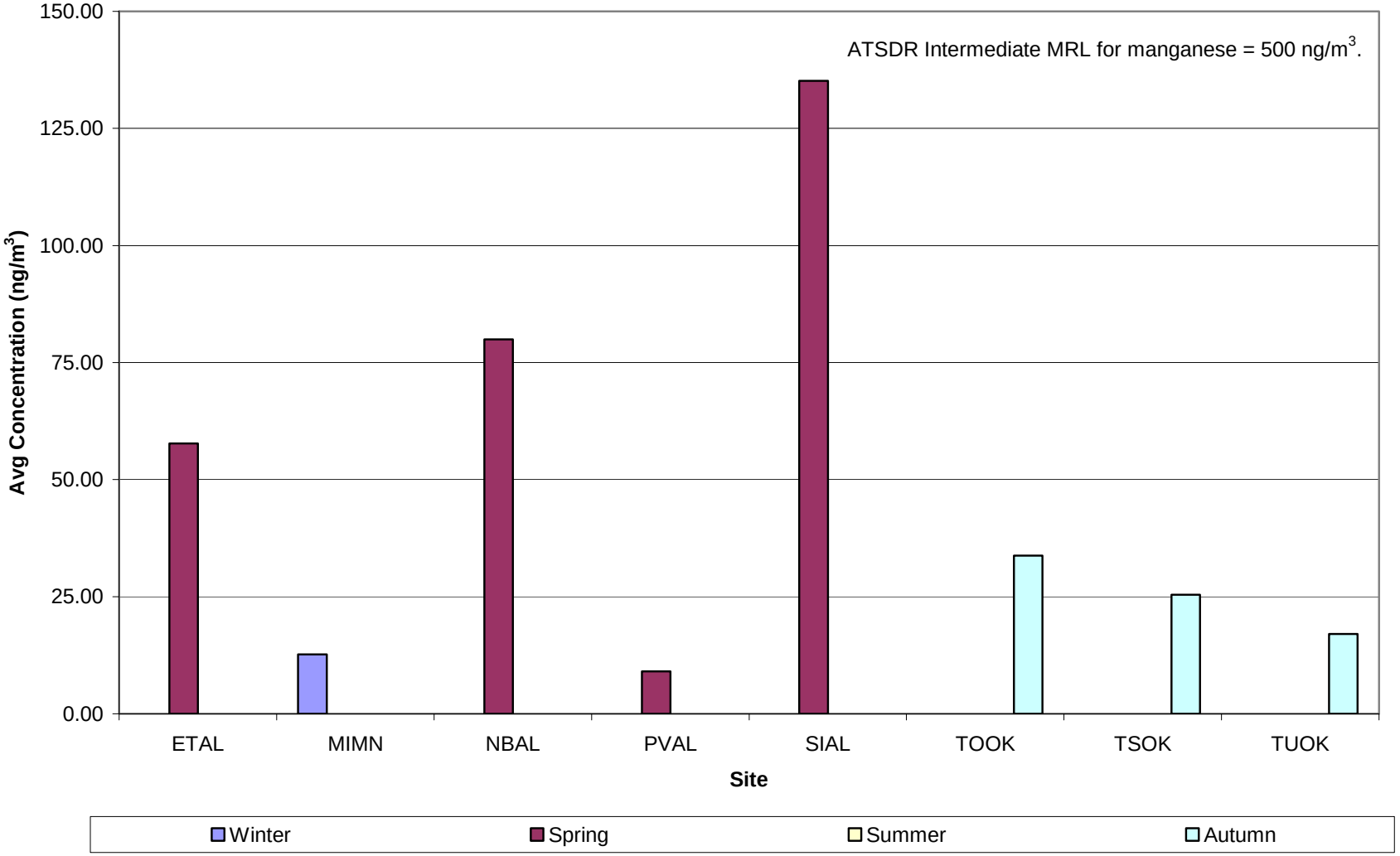


Figure 3-27. Comparison of Average Seasonal Naphthalene Concentration by Season

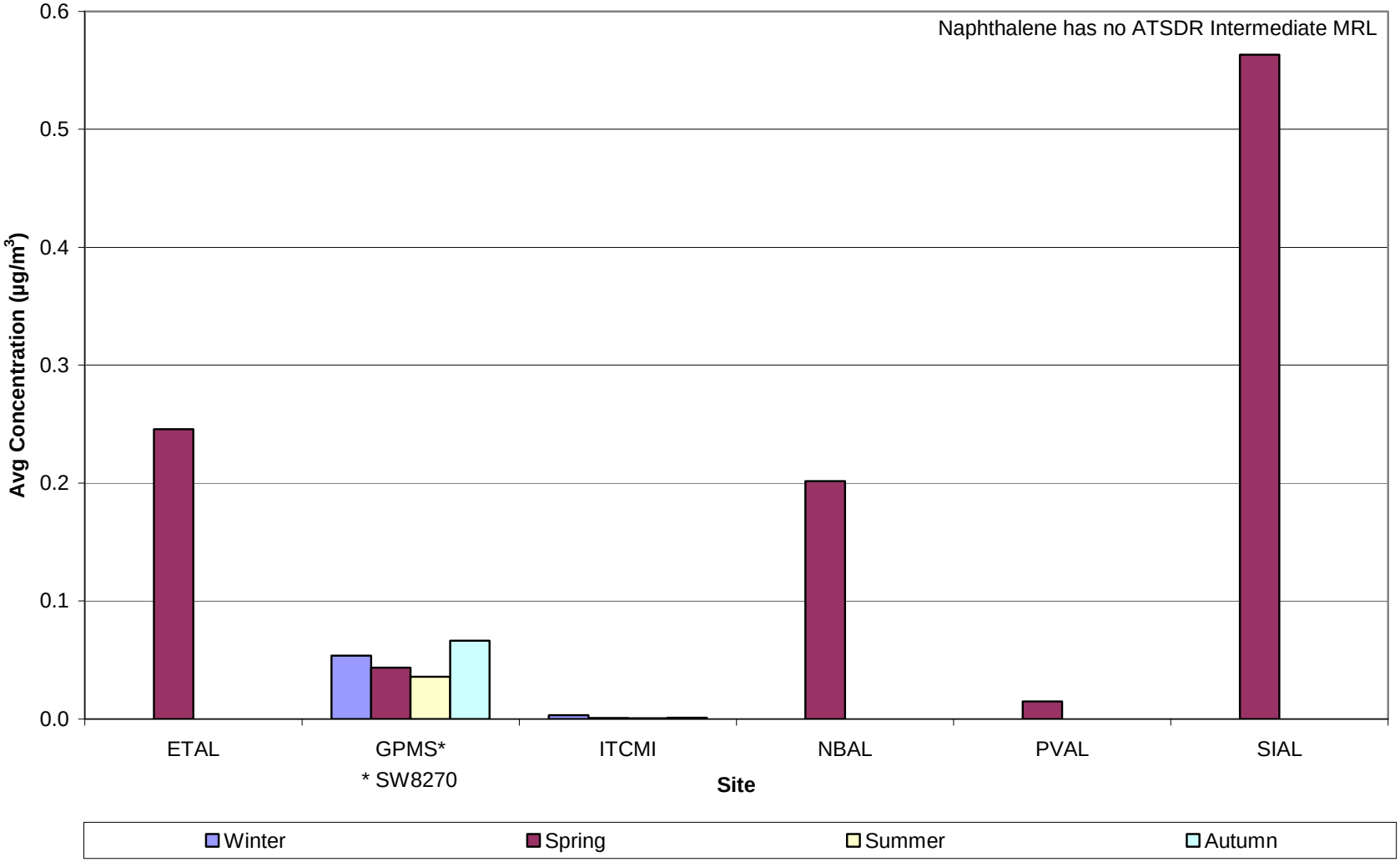


Figure 3-28a. Comparison of Average Seasonal *p*-Dichlorobenzene by Compendium Method TO-15 Concentration by Season

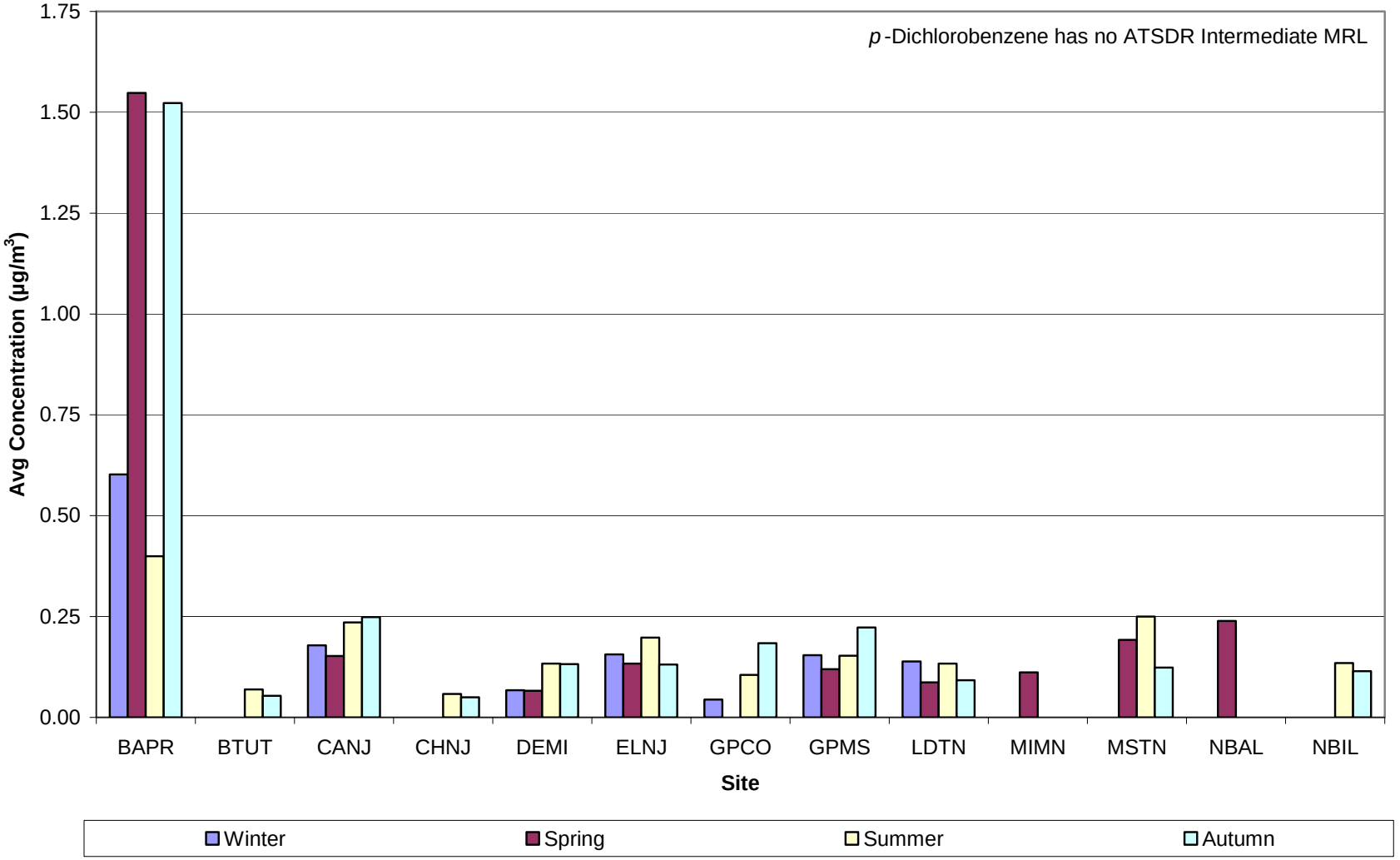


Figure 3-28b. Comparison of Average Seasonal *p*-Dichlorobenzene by Compendium Method TO-15 Concentration by Season (Continued)

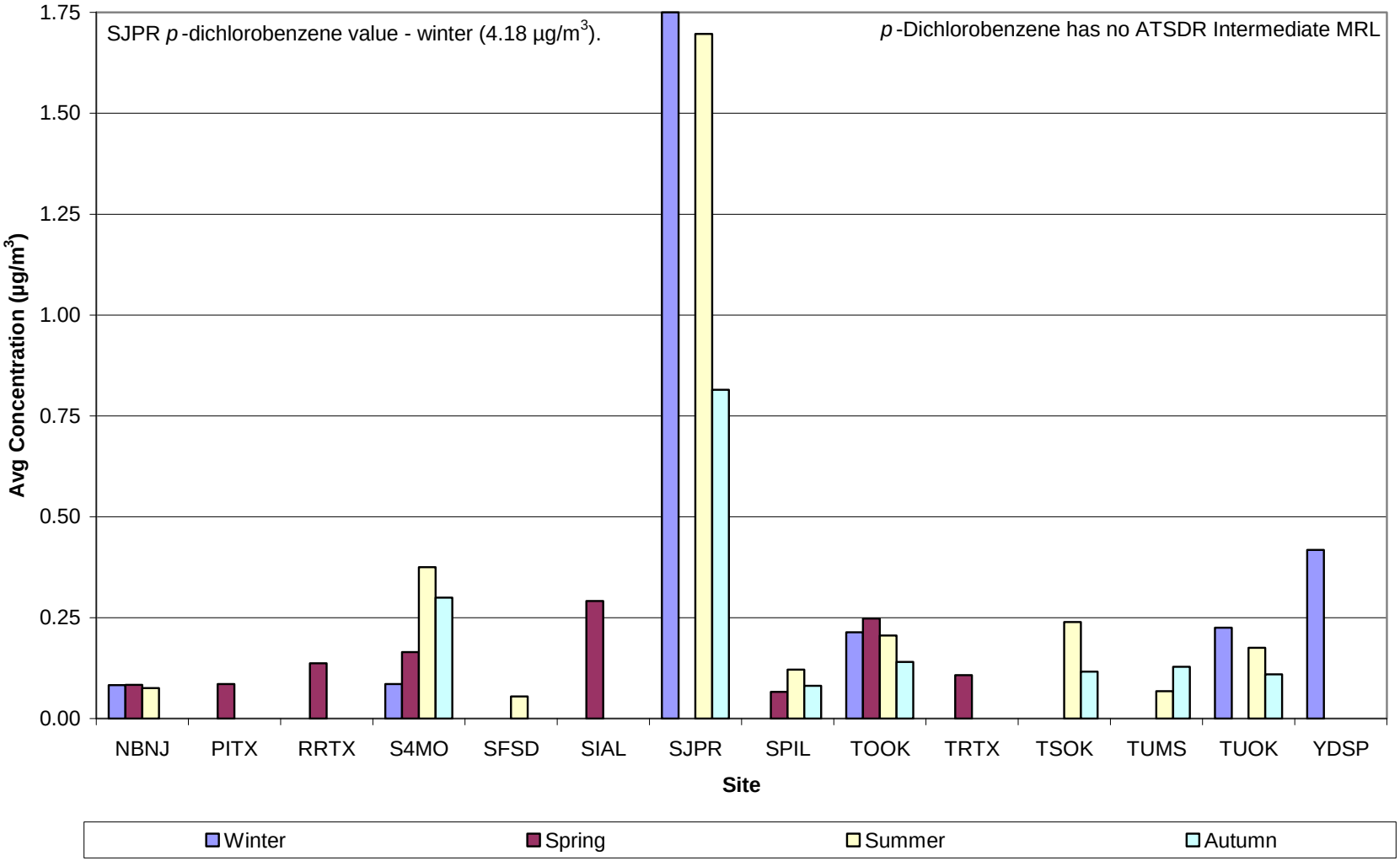


Figure 3-28c. Comparison of Average Seasonal 1,4-Dichlorobenzene (*p*-Dichlorobenzene) by Compendium Method TO-13A Concentration by Season

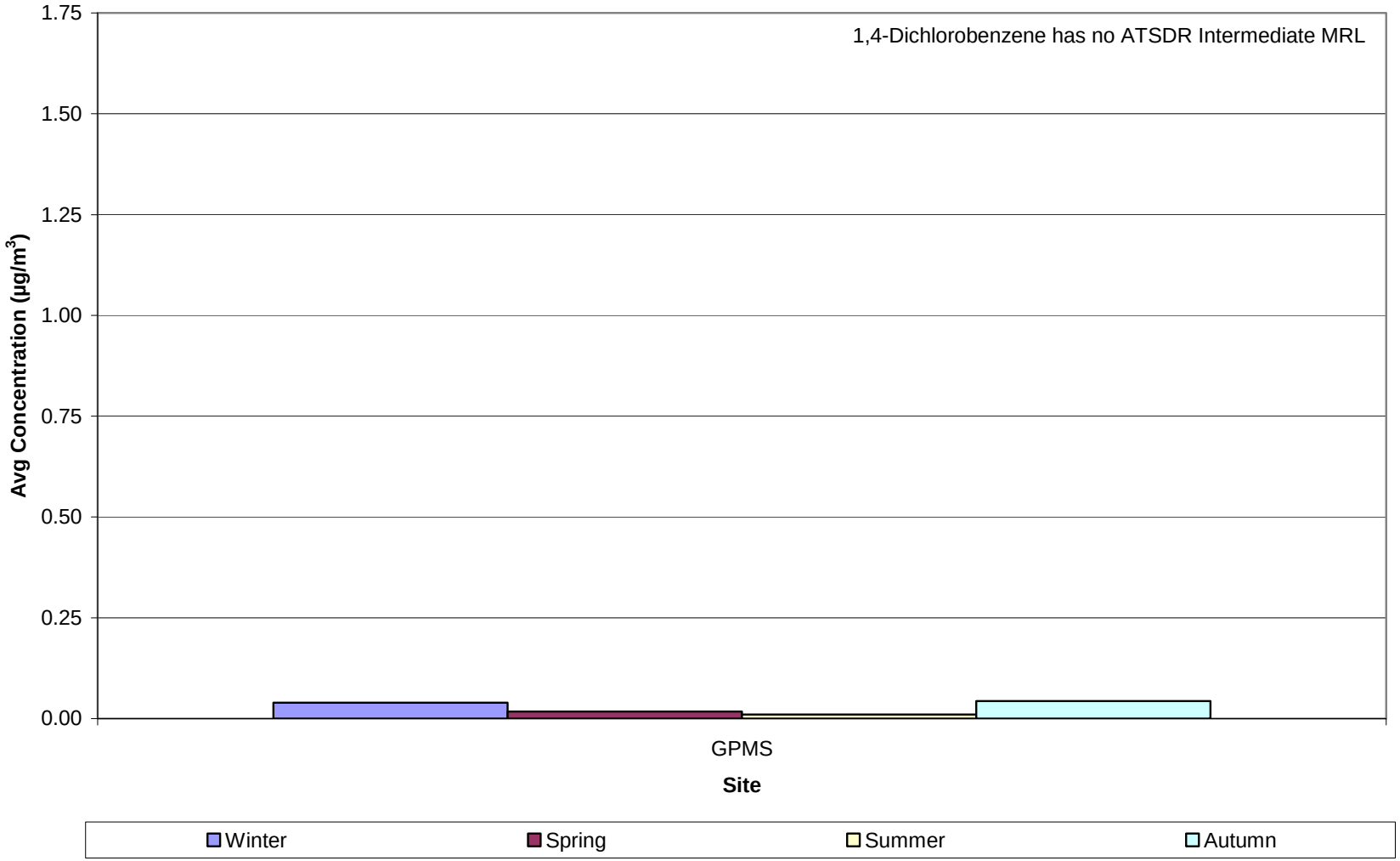


Figure 3-29a. Comparison of Average Seasonal Tetrachloroethylene Concentration by Season

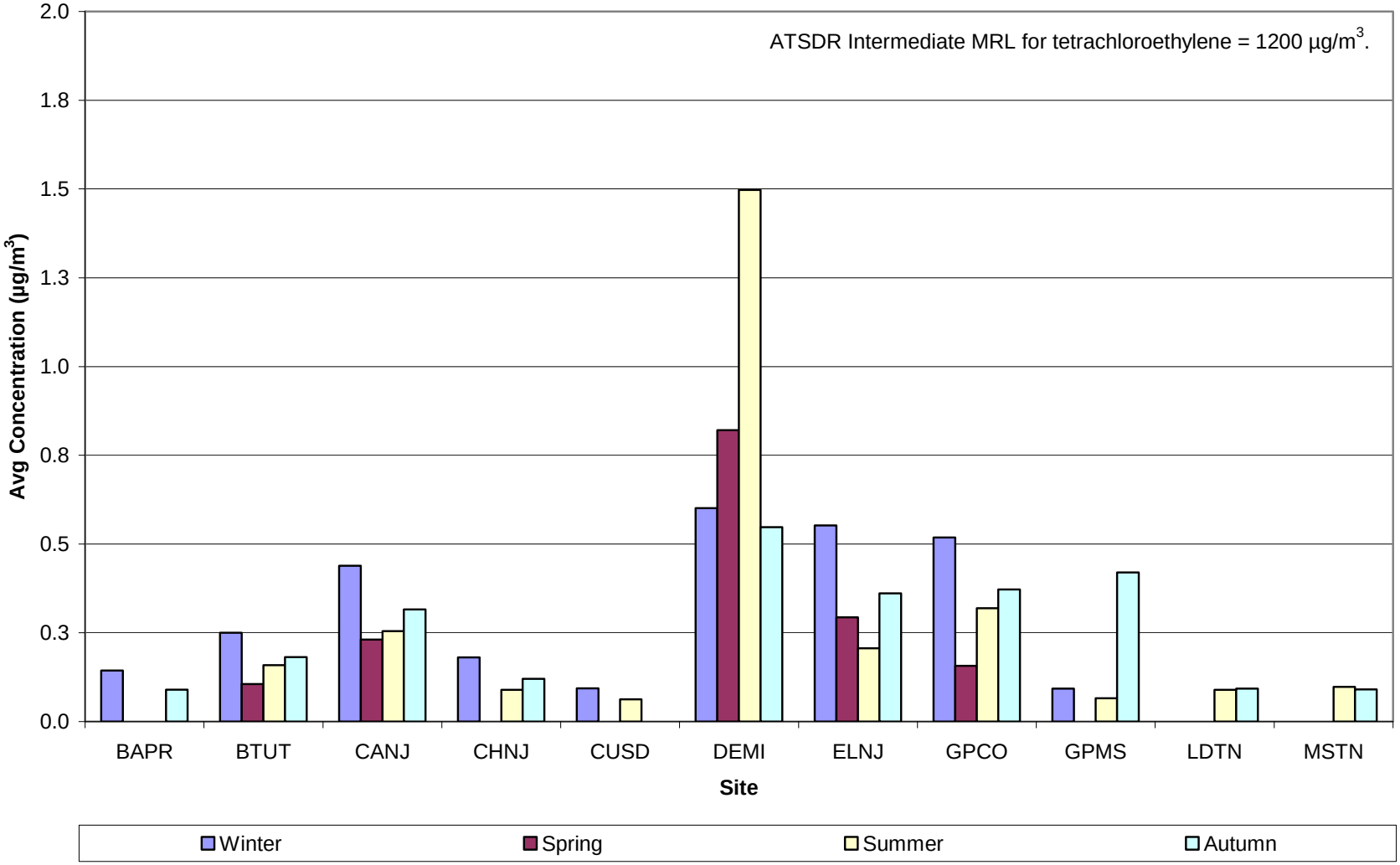
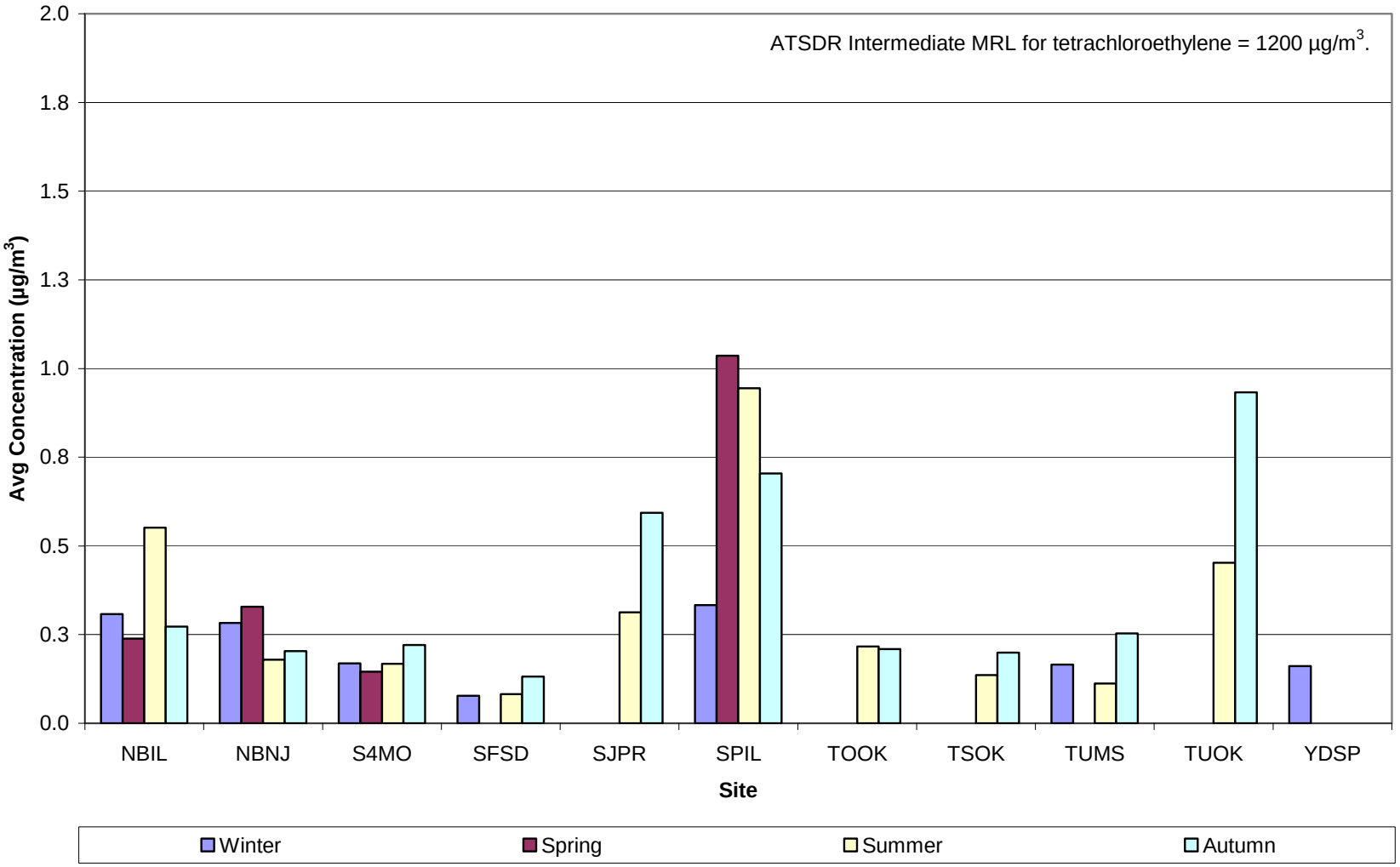


Figure 3-29b. Comparison of Average Seasonal Tetrachloroethylene Concentration by Season (Continued)



Many of the pollutants of interest, such as acrolein and tetrachloroethylene, were measured frequently in some seasons but not in others. As a result of the seasonal average criteria, there are gaps in the figures for these pollutants for certain seasons. For example, Figure 3-29 shows that tetrachloroethylene had few spring averages, even though many of the sites sampled year-round.

Other pollutants of interest, such as formaldehyde, benzene, and acetaldehyde, were detected year-round. Comparing the seasonal averages for the sites with four valid seasonal averages often reveals a trend for these pollutants. For example, formaldehyde averages tended to be higher in the summer, as shown in Figure 3-24, while benzene averages tended to be higher in the autumn and winter, as shown in Figure 3-22. The seasonal behavior of these two pollutants suggests the influence of reformulated gasoline (RFG), as the benzene content is typically lowered during the warmer periods (i.e., summer and spring). Refineries often begin production of RFG during the spring and end in the autumn. Additionally, methyl-*tert*-butyl ether (MTBE) was used as an RFG additive in fuels to replace the lowered benzene content. Research has shown that the combustion of fuels containing MTBE lead to the secondary production of formaldehyde. Thus, while benzene may experience a reduction in concentrations during the summer months, formaldehyde concentrations may increase if MTBE is used in the gasoline blend. Other pollutants, such as carbon tetrachloride, may not exhibit such a trend.

Of the sites that sampled metals, most are located in Alabama, Texas, Oklahoma, and Indiana. Unfortunately, the Texas and Alabama sites sampled through early summer, so only one or two seasonal averages are available. The Oklahoma and Indiana sites began sampling during the fall, so only autumn averages are available. Therefore, seasonal trends are available for only a small sample of sites, which makes a seasonal pattern difficult to discern at this time.

The first program-year with a full year's worth of acrolein measurements is 2006. For sites with at least three valid seasonal averages, it appears that summer and autumn more commonly exhibited the highest averages, while winter exhibited the least. Every valid seasonal average of acrolein exceeded the ATSDR intermediate MRL, which is indicated by the dashed line.

3.3 Additional Site-Specific Analyses

In addition to many of the analyses described in the preceding sections, the state-specific sections (4.0 through 31.0) contain additional analyses that are applicable at a local level. This section provides an overview of these analyses but does not discuss their results. Results of these site-specific analyses are presented in the state-specific sections.

3.3.1 Emission Tracer Analysis

In this analysis, pollution roses for each of the site-specific pollutants of interest that exceeded the acute risk factors were created to help identify the geographical area where the emission sources of these pollutants may have originated. A pollution rose is a plot of the ambient concentration versus the unit vector of the wind direction; high concentrations are shown in relation to the direction of potential emissions sources.

3.3.2 Back Trajectory Analysis

A back trajectory analysis traces the origin of an air parcel in relation to the location where it is currently being measured. The method of constructing a back trajectory uses the Lagrangian frame of reference. In simplest terms, an air parcel can be traced back one hour to a new point of reference based on the current measured wind speed and direction. At this new point of reference (that is now one hour prior to the current observation), the wind speed and direction are used again to determine where the air was one hour before. Each time segment is referred to as a "time step." Typical back trajectories go 24 to 48 hours prior using surface and upper air meteorological observations. Back trajectory calculations are also governed by other meteorological parameters, such as pressure and temperature.

Gridded meteorological data and the model used for back trajectory analyses were prepared and developed by the National Oceanic and Atmospheric Administration (NOAA) using data from the National Weather Service (NWS) and other cooperative agencies. The model used is the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) (Draxler, R.R. and Rolph, G.D., 2003). The meteorological data represented the 2006 sampling year. Back trajectories were computed 24 hours prior to the sampling day (to match the 24-hour

sample), and composite back trajectory maps were constructed for sampling days using GIS software. Trajectories are modeled with an initial height of 250 meters above ground level (AGL). The value of the composite back trajectory map is the determination of a 24-hour airshed domain for each site. An airshed domain is the geographical area surrounding a site from which an air parcel may typically travel within the 24-hour time frame. Agencies can use the airshed domain to evaluate regions where long-range transport may affect their monitoring site.

3.3.3 Wind Rose Analysis

In this analysis, wind roses were constructed for each site to help identify the predominant direction from which the wind blows. A wind rose shows the frequency of wind directions about a 16-point compass, and uses color or shading to represent wind speeds. Wind roses are constructed by uploading hourly surface wind data from the nearest weather station into a wind rose software program, WRPLOT (Lakes, 2006). A wind rose is often used in determining where to put an ambient monitoring site when trying to capture emissions from an upwind source. A wind rose may also be useful in determining whether high concentrations correlate with a specific wind direction. While the composite back trajectory maps show where a parcel of air originated from on a number of days, the wind rose shows the frequency at which wind speed and direction are measured near the monitoring site. In other words, the back trajectory map focuses on long range transport, while the wind rose captures day-to-day fluctuations at the surface. Both are used to identify potential meteorological influences on the monitoring sites.

3.3.4 Site Trends Analysis

Table 2-3 presented past UATMP participation for sites participating in this year's program. For sites that participated prior to 2005 and were still participating through the 2006 program year, a trends analysis was conducted. The determination of trends are based on daily average concentrations (refer to the definitions in Section 3.1.5) at each site for three pollutants: 1,3-butadiene, benzene, and formaldehyde. These daily average concentrations are presented in the form of bar graphs with confidence intervals, represented by error bars extending from the top of each bar graph. The purpose of the confidence interval is to show the statistical significance of the relative increases or decreases shown over the years of participation.

Although the average concentration for a particular year may appear to be much lower (or higher) than another year, if the confidence intervals overlap, the difference is not statistically significant. A large confidence interval correlates to a low confidence in a specific statistical parameter, in this case the daily average concentrations, and may indicate the presence of outliers driving the daily average in one direction or another. Not all sites sample the same pollutant types, therefore all three pollutants may not be represented for all years of participation.

At sites where the pollutants were sampled for at least three consecutive years, formaldehyde consistently measured the highest daily average concentration, while 1,3-butadiene consistently measured the lowest. The site with the most years of participation is CANJ, having sampled continuously since 1994.

3.3.5 Chronic Risk Assessment

A chronic risk assessment was completed for the pollutants that failed at least one risk screen at each site, and where the *annual average* concentrations were available. An *annual* average includes all measured detections and 1/2 MDL substituted values for non-detects. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Exceptions to this include the Texas and Alabama sites, for which the sampling period for these sites has been adjusted to account for their mid-calendar year start and stop dates. Therefore, the start and stop date criteria for a valid annual average has also been adjusted accordingly.

Theoretical cancer and noncancer risks are calculated by applying the applicable cancer unit risk estimates (URE) and/or noncancer reference concentrations (RfC) to the annual average concentration. Cancer risk is defined as the likelihood of developing cancer as a result of exposure over a 70-year period, and is presented as the number of people at risk for cancer per million people (EPA, 2006c). The cancer risks presented in this report predict the cancer risk due to exposure at the annual average level over a 70-year period, not the risk resulting from exposure over the time period covered in this report. Noncancer risk is presented as the Noncancer Hazard Quotient (HQ). Noncancer health effects include conditions such as asthma.

An HQ less than one indicates no chance of developing noncancer effects through lifetime exposure, while an HQ greater than one indicates that developing a noncancerous health effect is possible (EPA, 2006c). Annual averages and theoretical risk calculations are presented in each of the following subsections, where applicable.

In February 2006, the EPA released the results of its national-scale air toxics assessment, NATA, for base year 1999 (EPA, 2006c). NATA uses the NEI for HAP as its starting point, but also incorporates ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These concentrations are then applied to cancer URE and noncancer RfC factors to yield census tract-level cancer and noncancer risk. The NATA is a useful resource in helping federal and state/local/tribal agencies identify potential areas of air quality concern.

Several of the program-level pollutants of interest are HAP that have been identified as NATA risk driver pollutants (EPA, 2006c):

- acrolein (national noncancer);
- arsenic (regional cancer and noncancer);
- benzene (national cancer);
- 1,3-butadiene (regional cancer and noncancer);
- carbon tetrachloride (regional cancer);
- formaldehyde (regional noncancer);
- manganese (regional noncancer);
- nickel (regional noncancer); and
- tetrachloroethylene (regional cancer).

Data from EPA's 1999 NATA were retrieved and are also presented in this data analysis. First, each site's respective census tract is identified and the percent of the home county population that resides in said census tract is calculated. Then the NATA-modeled cancer and

noncancer risk and modeled concentration associated with the pollutants that failed screens at each site is presented and discussed. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Although EPA does not recommend comparing concentrations from different base years, it is useful to see if the concentration profile is similar.

3.3.6 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk assessment discussed above, each state section also contains a summary of toxicity-weighted, county-level emissions based on an EPA-approved approach (EPA, 2007d)**.** A pollutant emitted in high quantities does not necessarily present a higher risk to human health than a pollutant emitted in very low quantities. The more toxic the pollutant, the more risk associated with its emissions in ambient air. In order to assign weight to the emissions based on the toxicity of a given pollutant rather than quantity emitted, the cancer URE and noncancer RfC discussed above are applied to pollutant-specific emissions at the county-level. The ten pollutants with the highest emissions in each site's home county will be presented in each state section, and will be compared to the ten highest toxicity-weighted emissions. While the absolute magnitude of the toxicity-weighted emissions is not meaningful, the relevant magnitude of toxicity-weighted emissions to one another is very meaningful in identifying potential pollutants of interest. In addition, those pollutants exhibiting the ten highest cancer risks based on the 2006 sampling year's concentrations will also be presented. The pollutants sampled at each site varied based on the purpose behind the monitoring. This data analysis may help state, local, and tribal agencies better understand which pollutants emitted, from a toxicity basis, are of the greatest concern.

4.0 Sites in Alabama

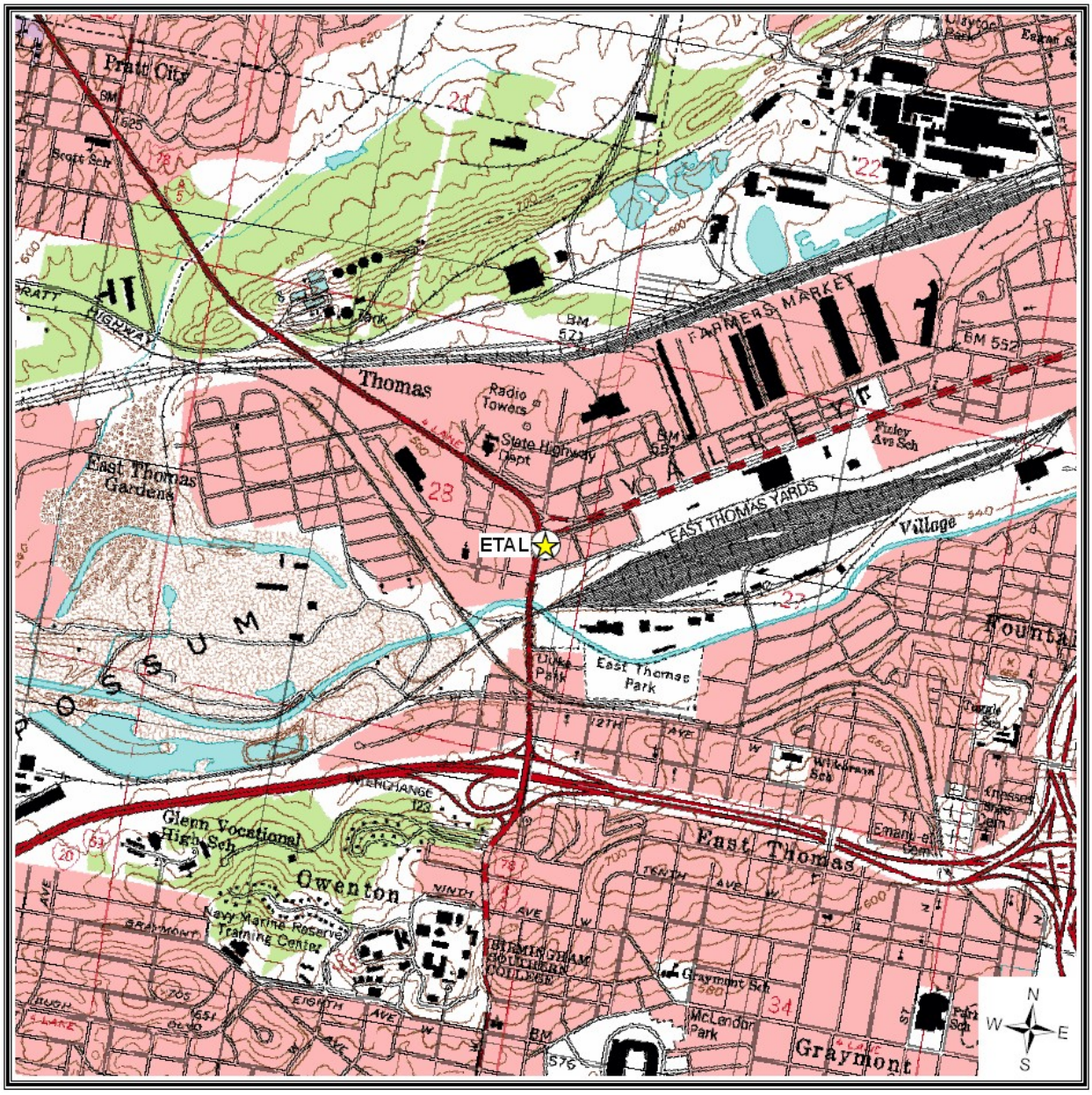
This section presents meteorological, concentration, and spatial trends for the UATMP sites in Alabama (ETAL, NBAL, PVAL, and SIAL), located in or near the Birmingham area. Figures 4-1 thru 4-4 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 4-5 thru 4-6 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 4-5 shows, the three monitoring sites located within the city of Birmingham (ETAL, NBAL, and SIAL) are located relatively close to each other. Both the sites and nearby facilities are oriented along a diagonal line extending from northeast to southwest Birmingham. Surface coating processes, waste treatment and disposal operations, and fuel combustion facilities are the most prevalent industries near these monitoring sites. The PVAL monitoring site is located on the western edge of Jefferson County, with relatively few industrial sources nearby.

Sites sampling in the Birmingham, Alabama area were funded to sample for one year, beginning in the summer of 2005 and continuing through the summer of 2006, though the start and end dates vary slightly from site-to-site. In order to facilitate data analysis, the entire dataset for the one year of sampling for these sites is included.

Birmingham, Alabama is about 300 miles inland from the Gulf of Mexico. This proximity allows the Gulf of Mexico to be a major influence in the city's climate. Winters are tempered and wet while summers are warm and humid. The area enjoys fairly ample precipitation (Ruffner and Bair, 1987).

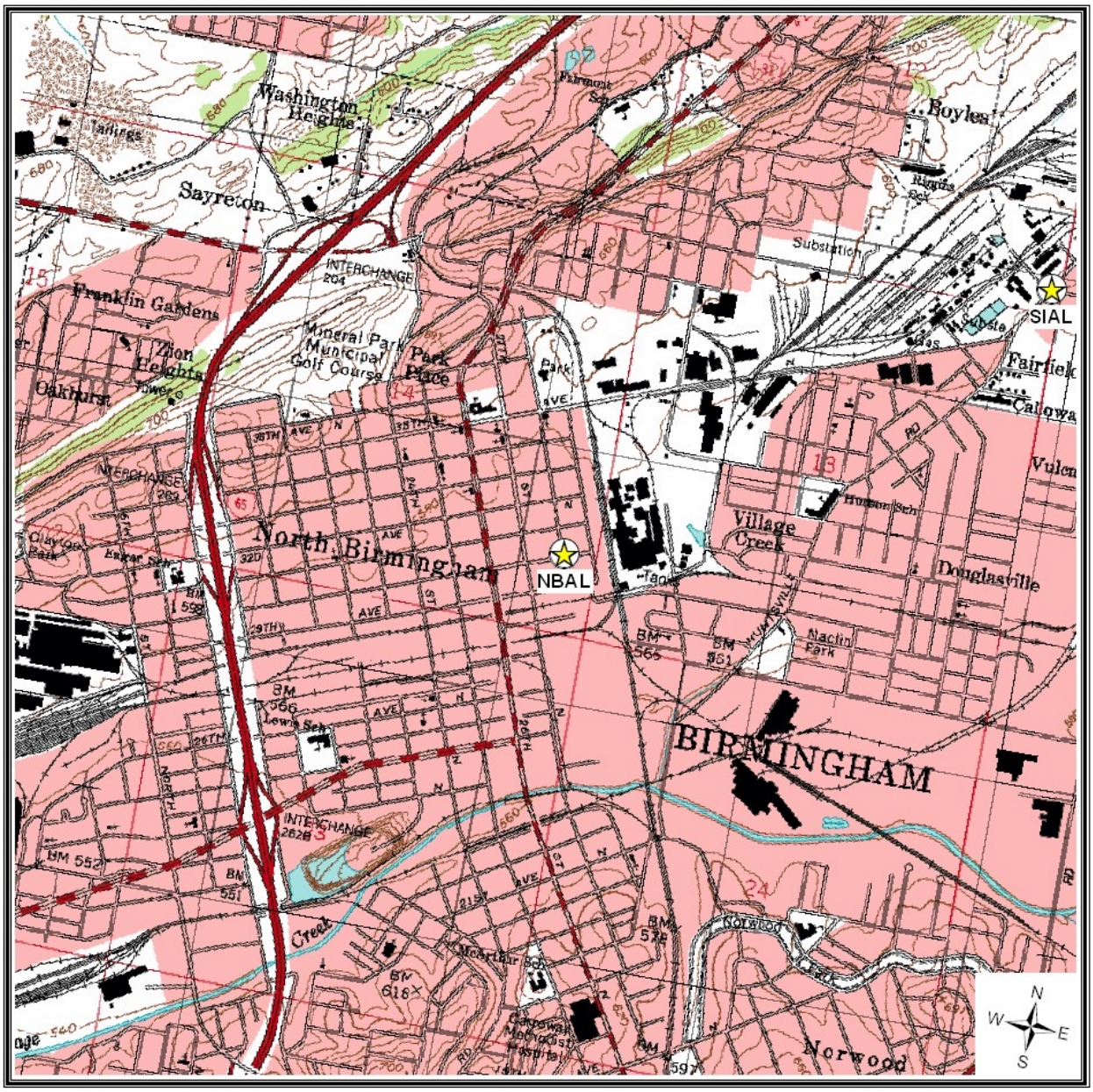
Hourly meteorological data at weather stations near these sites were retrieved for all of 2005 and 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the ETAL, NBAL, and SIAL monitoring sites is Birmingham International Airport (WBAN 13876), while the closest weather station to PVAL is Tuscaloosa Municipal Airport (WBAN 93806). Table 4-1 presents average meteorological conditions of temperature

Figure 4-1. Birmingham, Alabama (ETAL) Monitoring Site



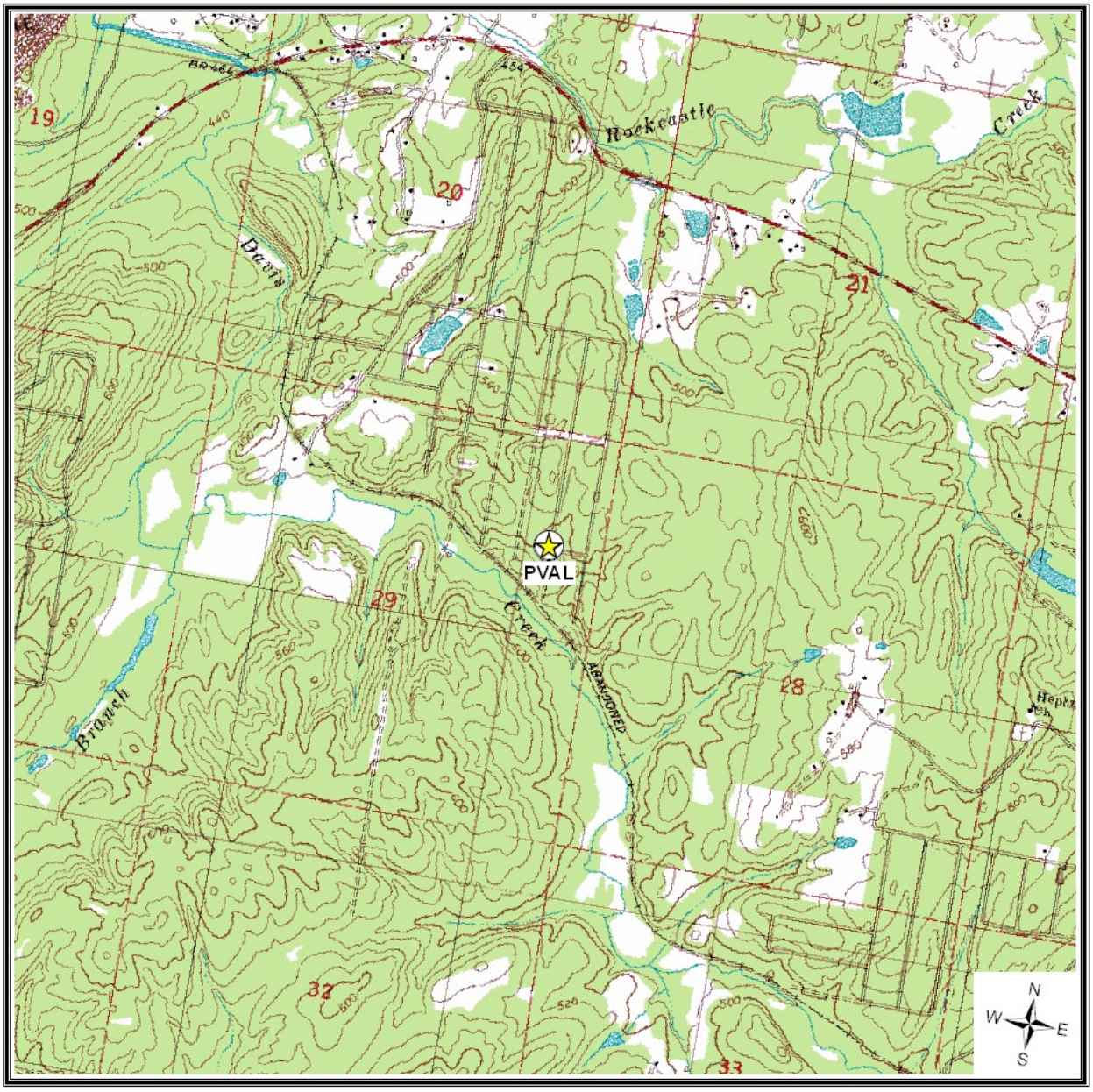
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-2. Birmingham, Alabama (NBAL) Monitoring Site



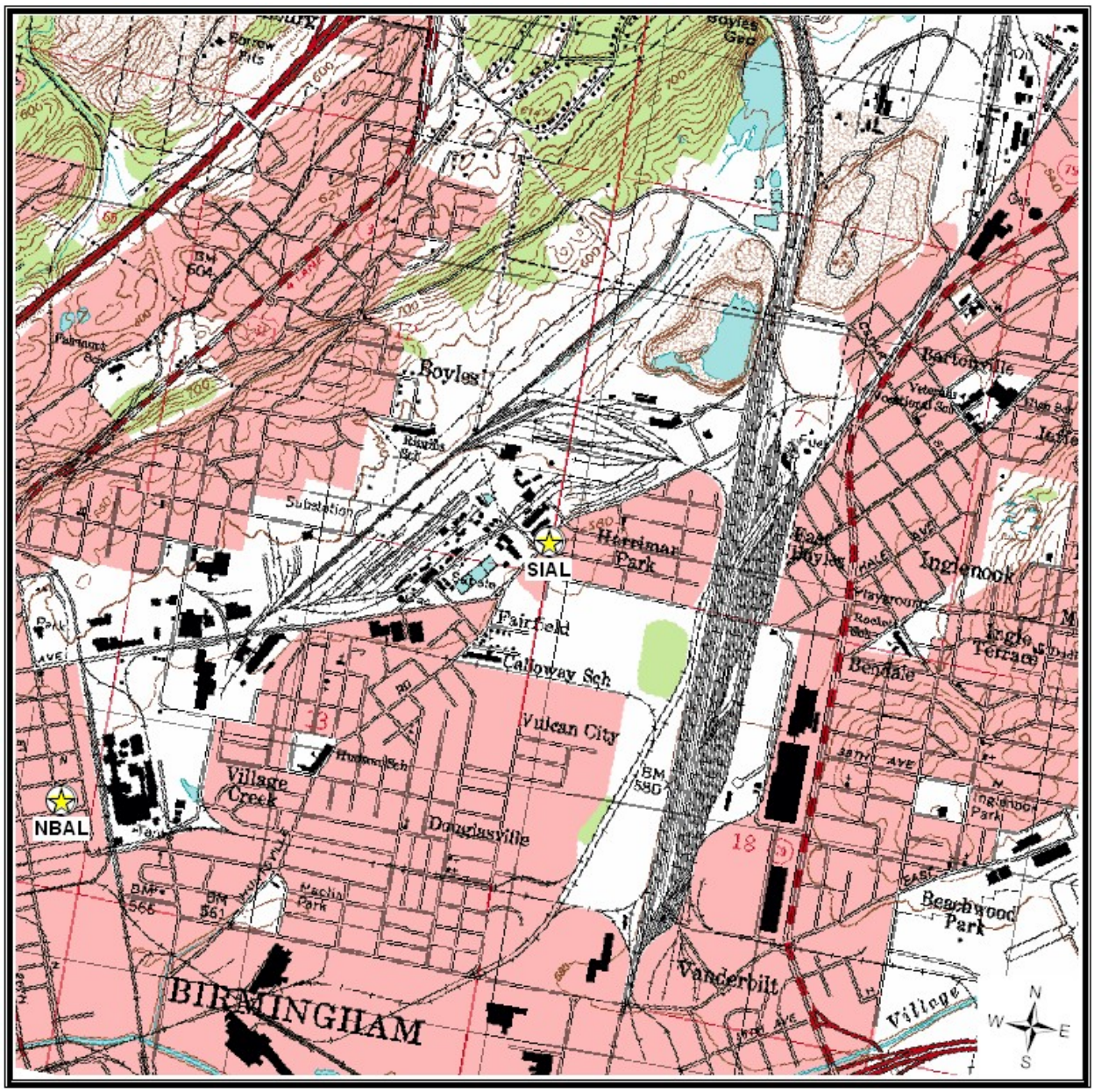
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-3. Birmingham, Alabama (PVAL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-4. Birmingham, Alabama (SIAL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-5. Facilities Located Within 10 Miles of ETAL, NBAL, and SIAL

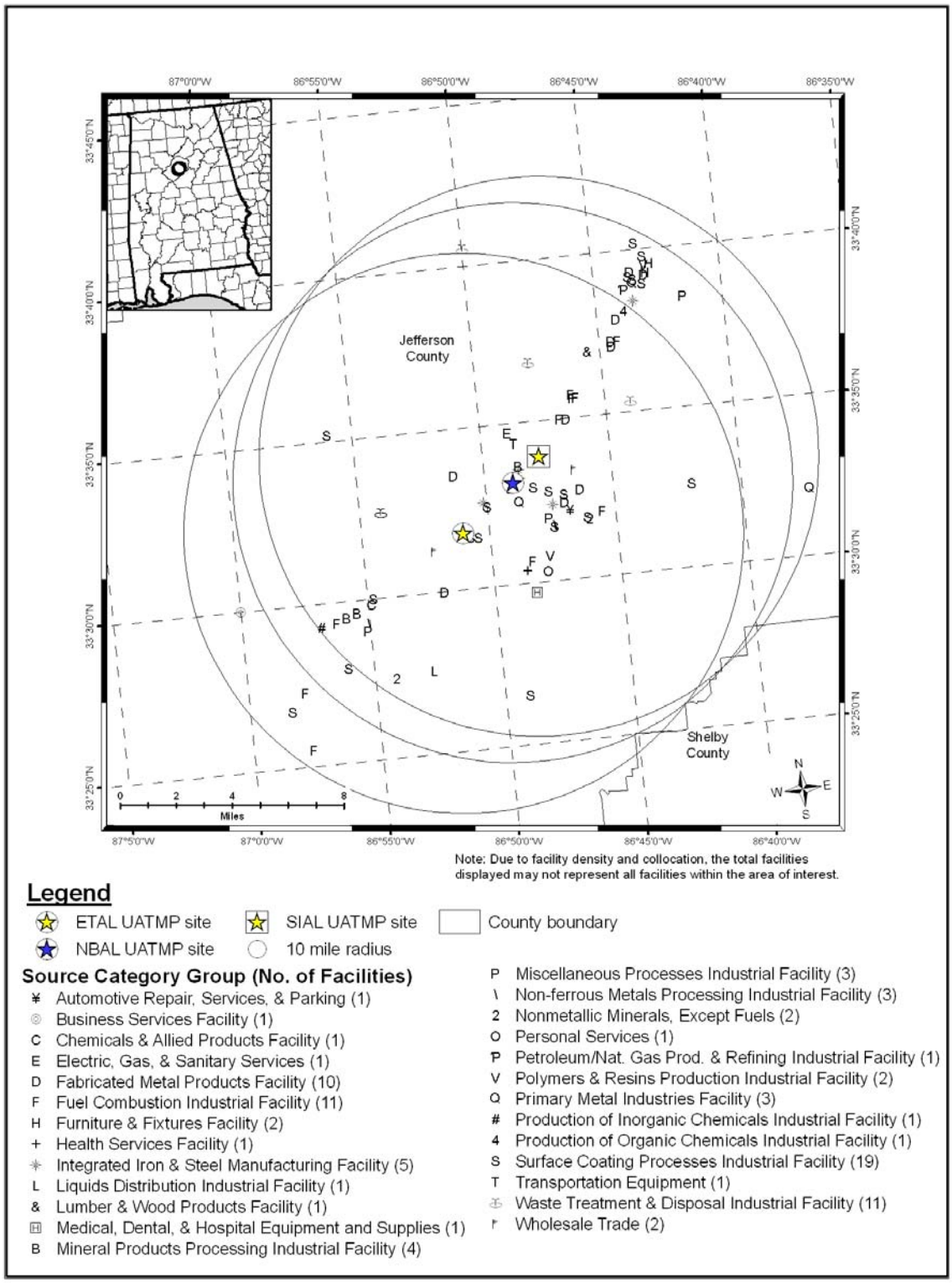


Figure 4-6. Facilities Located Within 10 Miles of PVAL

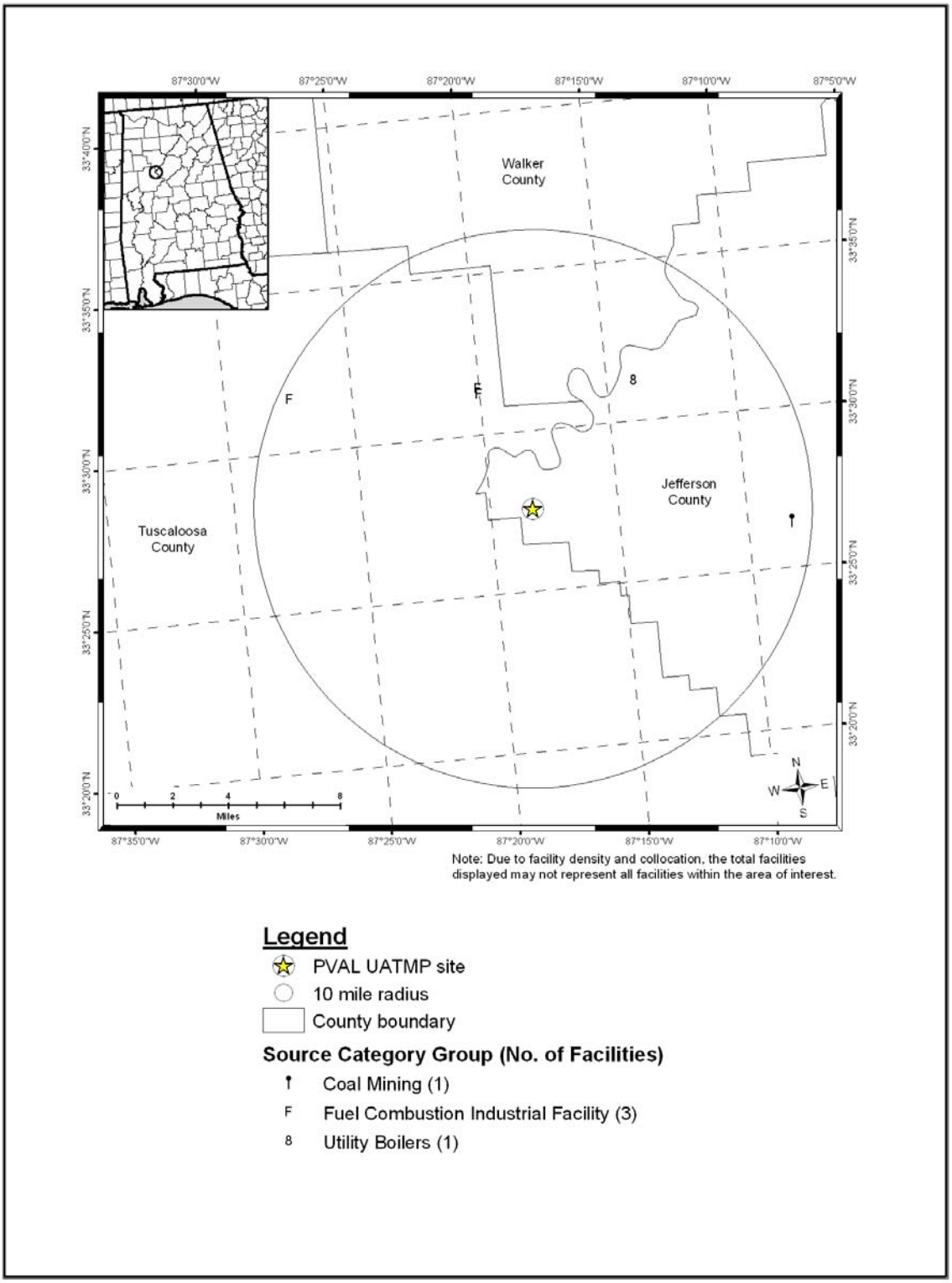


Table 4-1. Average Meteorological Conditions near the Monitoring Sites in Alabama

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
ETAL	13876	2005-2006	74.31 ± 1.55	64.18 ± 1.52	51.24 ± 1.70	57.16 ± 1.45	66.47 ± 1.30	1017.79 ± 0.53	5.32 ± 0.28
		Sampling Day	75.26 ± 4.24	64.85 ± 4.36	51.00 ± 4.89	57.32 ± 4.16	64.83 ± 4.28	1017.70 ± 1.53	5.31 ± 0.91
NBAL	13876	2005-2006	74.31 ± 1.55	64.18 ± 1.52	51.24 ± 1.70	57.16 ± 1.45	66.47 ± 1.30	1017.79 ± 0.53	5.32 ± 0.28
		Sampling Day	76.90 ± 4.25	66.33 ± 4.31	51.92 ± 4.66	58.32 ± 4.02	63.74 ± 4.01	1017.70 ± 1.41	5.29 ± 0.85
PVAL	93806	2005-2006	76.38 ± 1.52	64.65 ± 1.49	53.29 ± 1.67	58.39 ± 1.45	70.23 ± 1.08	1017.48 ± 0.53	4.53 ± 0.25
		Sampling Day	79.24 ± 4.06	66.92 ± 4.08	54.95 ± 4.56	60.12 ± 3.96	69.39 ± 3.07	1017.26 ± 1.45	4.39 ± 0.85
SIAL	13876	2005-2006	74.31 ± 1.55	64.18 ± 1.52	51.24 ± 1.70	57.16 ± 1.45	66.47 ± 1.30	1017.79 ± 0.53	5.32 ± 0.28
		Sampling Day	76.76 ± 4.09	66.24 ± 4.19	52.28 ± 4.71	58.51 ± 3.98	64.81 ± 4.43	1017.27 ± 1.62	5.47 ± 0.95

(average maximum and average), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the July 2005 to June 2006 time frame (to capture an entire year closely corresponding to the sampling duration for the Alabama sites) and on days samples were collected. Also included in Table 4-1 is the 95 percent confidence interval for each parameter. As shown in Table 4-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

4.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Alabama monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 4-2 presents the pollutants that failed at least one screen at the Alabama monitoring sites. The Alabama sites sampled for carbonyls, VOCs, SVOCs, and metals (NBAL sampled for TSP and PM_{10} while the other Alabama sites sampled TSP only).

The following observations are shown in Table 4-2:

- The number of pollutants failing the screen varies by site.
- 19 pollutants with a total of 360 measured concentrations failed the screen at ETAL.
- 29 pollutants with a total of 458 measured concentrations failed the screen at NBAL.
- 12 pollutants with a total of 208 measured concentrations failed the screen at PVAL.
- 25 pollutants with a total of 376 measured concentrations failed the screen at SIAL.
- The pollutants of interest also varied by site, yet the following 10 pollutants contributed to the top 95 percent of the total failed screens at each Alabama monitoring site: arsenic (TSP), acrolein, formaldehyde, carbon tetrachloride,

Table 4-2. Comparison of Measured Concentrations and EPA Screening Values for the Alabama Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
East Thomas, Birmingham, Alabama – ETAL					
Arsenic (TSP)	31	31	100.00	8.61	8.61
Manganese (TSP)	31	31	100.00	8.61	17.22
Naphthalene	31	31	100.00	8.61	25.83
Formaldehyde	31	31	100.00	8.61	34.44
Carbon Tetrachloride	31	31	100.00	8.61	43.06
Benzene	31	31	100.00	8.61	51.67
Acetaldehyde	31	31	100.00	8.61	60.28
1,3-Butadiene	29	30	96.67	8.06	68.33
p-Dichlorobenzene	29	29	100.00	8.06	76.39
Tetrachloroethylene	20	25	80.00	5.56	81.94
Acrolein	17	17	100.00	4.72	86.67
Nickel (TSP)	11	31	35.48	3.06	89.72
Hexachloro-1,3-butadiene	10	10	100.00	2.78	92.50
Cadmium (TSP)	9	31	29.03	2.50	95.00
Xylenes	9	31	29.03	2.50	97.50
Benzo (a) pyrene	4	26	15.38	1.11	98.61
Hexavalent Chromium	3	26	11.54	0.83	99.44
Acrylonitrile	1	1	100.00	0.28	99.72
Ethyl Acrylate	1	1	100.00	0.28	100.00
Total	360	475	75.79		
North Birmingham, Alabama – NBAL					
Carbon Tetrachloride	31	31	100.00	6.77	6.77
Arsenic (PM_{10})	31	31	100.00	6.77	13.54
Benzene	31	31	100.00	6.77	20.31
p-Dichlorobenzene	31	31	100.00	6.77	27.07
Acetaldehyde	31	31	100.00	6.77	33.84
Manganese (TSP)	31	31	100.00	6.77	40.61
Arsenic (TSP)	31	31	100.00	6.77	47.38
Naphthalene	30	31	96.77	6.55	53.93
Formaldehyde	29	31	93.55	6.33	60.26
Manganese (PM_{10})	27	31	87.10	5.90	66.16
1,3-Butadiene	25	25	100.00	5.46	71.62
Acrolein	22	22	100.00	4.80	76.42
Tetrachloroethylene	17	23	73.91	3.71	80.13
Cadmium (TSP)	16	31	51.61	3.49	83.62
Cadmium (PM_{10})	14	31	45.16	3.06	86.68
Xylenes	11	31	35.48	2.40	89.08
Nickel (TSP)	9	31	29.03	1.97	91.05
Benzo (a) pyrene	9	23	39.13	1.97	93.01
Hexachloro-1,3-butadiene	6	6	100.00	1.31	94.32

Table 4-2. Comparison of Measured Concentrations and EPA Screening Values for the Alabama Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Benzo (a) anthracene	5	30	16.67	1.09	95.41
Hexavalent Chromium	5	24	20.83	1.09	96.51
Dibenz (a,h) anthracene	4	13	30.77	0.87	97.38
Nickel (PM_{10})	3	31	9.68	0.66	98.03
Benzo (b) fluoranthene	3	28	10.71	0.66	98.69
Benzo (k) fluoranthene	2	29	6.90	0.44	99.13
Trichloroethylene	1	14	7.14	0.22	99.34
1,2-Dichloroethane	1	1	100.00	0.22	99.56
Indeno(1,2,3-cd)pyrene	1	22	4.55	0.22	99.78
Acrylonitrile	1	1	100.00	0.22	100.00
Total	458	726	63.09		
Providence, Alabama – PVAL					
Benzene	31	31	100.00	14.90	14.90
Carbon Tetrachloride	31	31	100.00	14.90	29.81
Acetaldehyde	29	31	93.55	13.94	43.75
Arsenic (TSP)	29	31	93.55	13.94	57.69
Formaldehyde	27	31	87.10	12.98	70.67
Manganese (TSP)	19	31	61.29	9.13	79.81
p-Dichlorobenzene	19	27	70.37	9.13	88.94
Acrolein	10	10	100.00	4.81	93.75
Hexachloro-1,3-butadiene	5	5	100.00	2.40	96.15
Naphthalene	5	31	16.13	2.40	98.56
1,3-Butadiene	2	9	22.22	0.96	99.52
Acrylonitrile	1	1	100.00	0.48	100.00
Total	208	269	77.32		
Sloss Industries, Birmingham, Alabama – SIAL					
Carbon Tetrachloride	31	31	100.00	8.24	8.24
Acetaldehyde	31	31	100.00	8.24	16.49
Arsenic (TSP)	31	31	100.00	8.24	24.73
Manganese (TSP)	31	31	100.00	8.24	32.98
Benzene	31	31	100.00	8.24	41.22
Formaldehyde	31	31	100.00	8.24	49.47
p-Dichlorobenzene	30	31	96.77	7.98	57.45
Naphthalene	30	31	96.77	7.98	65.43
1,3-Butadiene	28	28	100.00	7.45	72.87
Acrolein	19	19	100.00	5.05	77.93
Benzo (a) pyrene	16	27	59.26	4.26	82.18
Tetrachloroethylene	15	22	68.18	3.99	86.17
Nickel (TSP)	11	31	35.48	2.93	89.10
Hexavalent Chromium	7	23	30.43	1.86	90.96
Dibenz (a,h) anthracene	6	21	28.57	1.60	92.55
Hexachloro-1,3-butadiene	6	6	100.00	1.60	94.15

Table 4-2. Comparison of Measured Concentrations and EPA Screening Values for the Alabama Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Beryllium (TSP)	6	31	19.35	1.60	95.74
Cadmium (TSP)	4	31	12.90	1.06	96.81
Xylenes	4	31	12.90	1.06	97.87
Chloromethylbenzene	3	3	100.00	0.80	98.67
Benzo (k) fluoranthene	1	30	3.33	0.27	98.94
Benzo (a) anthracene	1	31	3.23	0.27	99.20
Indeno(1,2,3-cd)pyrene	1	25	4.00	0.27	99.47
Benzo (b) fluoranthene	1	29	3.45	0.27	99.73
Acrylonitrile	1	1	100.00	0.27	100.00
Total	376	637	59.03		

manganese (TSP), acetaldehyde, benzene, naphthalene, hexachloro-1,3-butadiene,and *p*-dichlorobenzene. If PVAL is not included, the list of pollutants of interest is even longer.

- Of the 10 pollutants that were the same among all four sites, four pollutants of interest (acrolein, benzene, carbon tetrachloride, and hexachloro-1,3-butadiene) had 100 percent of their measured detections fail screens.

4.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven measured detections in a respective season. The seasons presented for Alabama will be autumn 2005 through spring 2006 rather than winter through autumn in order to accommodate their summer to summer sampling schedule (a summer 2005 and summer 2006 seasonal average will not be possible due to the low number of samples compared to the detection criteria). Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where

sampling began no later than February and ended no earlier than November for most sites. However, this time period was adjusted for the Alabama sites to accommodate their summer to summer sampling schedule. The daily and seasonal averages are presented in Table 4-3. Because a full summer of sampling was not conducted at the sites, summer averages (both 2005 and 2006) could not be calculated and are therefore not shown in Table 4-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for ETAL are shown in Table 4-3:

- Among the daily averages, total xylenes had the highest concentration by mass (7.57 ± 1.89 μg/m^3), followed by formaldehyde (4.90 ± 0.76 μg/m^3) and benzene (2.90 ± 0.65 μg/m^3).

- Most of the seasonal averages of the pollutants of interest did not vary much from season-to-season, when the confidence interval is considered. One exception to this was *p*-dichlorobenzene. The autumn average (0.44 ± 0.15 μg/m^3) was more than twice the winter average (0.19 ± 0.05 μg/m^3). Unfortunately, this site did not have a valid spring *p*-dichlorobenzene concentration for comparison.

The following observations for NBAL are shown in Table 4-3:

- Similar to ETAL, the pollutants with the highest daily averages for NBAL were total xylenes (9.66 ± 2.88 μg/m^3), formaldehyde (4.17 ± 0.89 μg/m^3), and benzene (3.17 ± 1.17 μg/m^3).

- No autumn averages could be calculated for NBAL for VOC and carbonyl compounds due to a brief gap in sampling.

- Most of the seasonal averages of the pollutants of interest did not vary much from season-to-season, when the confidence interval was considered. One exception to this was formaldehyde. The spring average (4.04 ± 1.25 μg/m^3) was more than twice the winter average (2.06 ± 0.66 μg/m^3).

The following observations for PVAL are shown in Table 4-3:

- The pollutants with the highest daily averages were formaldehyde (4.14 ± 2.06 μg/m^3), acetaldehyde (1.49 ± 0.82 μg/m^3), and acrolein (0.68 ± 0.46 μg/m^3).

- Most of the seasonal averages of the pollutants of interest did not vary much from season-to-season, when the confidence interval was considered.

Table 4-3. Daily and Seasonal Averages for the Pollutants of Interest for the Alabama Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Autumn 2005		Winter 2005/2006		Spring 2006	
			Average ($\mu g/m^3$)	Confidence Int.	Average ($\mu g/m^3$)	Confidence Int.	Average ($\mu g/m^3$)	Confidence Int.	Average ($\mu g/m^3$)	Confidence Int.
East Thomas, Birmingham, Alabama – ETAL										
1,3-Butadiene	30	31	0.26	0.06	0.25	0.13	0.28	0.10	NR	NR
Acetaldehyde	31	31	1.99	0.27	2.28	0.71	1.60	0.27	2.00	0.53
Acrolein	17	30	0.95	0.31	NR	NR	NR	NR	NR	NR
Arsenic	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	31	31	2.90	0.65	4.03	1.86	2.74	0.88	2.30	0.91
Cadmium (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Carbon Tetrachloride	31	31	0.68	0.04	0.68	0.07	0.62	0.08	0.66	0.05
Formaldehyde	31	31	4.90	0.76	4.42	1.21	3.33	0.58	5.30	1.27
Hexachloro-1,3-butadiene	10	31	0.17	0.03	NR	NR	NR	NR	NR	NR
Manganese (TSP)	31	31	0.05	0.01	0.06	0.02	0.04	0.02	0.06	0.03
Naphthalene	31	31	0.27	0.09	0.37	0.25	NR	NR	0.25	0.13
Nickel (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
p-Dichlorobenzene	29	31	0.29	0.06	0.44	0.15	0.19	0.05	NR	NR
Tetrachloroethylene	25	31	0.45	0.12	0.45	0.23	NR	NR	NR	NR
Xylenes	31	31	7.57	1.89	10.33	4.51	7.09	2.56	6.81	4.35
North Birmingham, Alabama – NBAL										
1,3-Butadiene	25	31	0.17	0.05	NR	NR	NR	NR	0.17	0.11
Acetaldehyde	31	31	1.65	0.25	NR	NR	1.17	0.26	1.65	0.51
Acrolein	22	31	0.90	0.20	NR	NR	0.79	0.33	0.63	0.16
Arsenic (PM_{10})	31	31	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (TSP)	31	31	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	31	31	3.17	1.17	NR	NR	2.08	0.91	3.76	2.79
Benzo (a) anthracene	30	31	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (a) pyrene	23	31	<0.01	<0.01	NR	NR	NR	NR	NR	NR
Cadmium (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (PM_{10})	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Carbon Tetrachloride	31	31	0.67	0.05	NR	NR	0.66	0.11	0.59	0.04
Formaldehyde	31	31	4.17	0.89	NR	NR	2.06	0.66	4.04	1.25
Hexachloro-1,3-butadiene	6	31	0.19	0.03	NR	NR	NR	NR	NR	NR

Table 4-3. Daily and Seasonal Averages for Pollutants of Interest for the Alabama Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily		Autumn 2005		Winter 2005/2006		Spring 2006	
			Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval
Hexavalent Chromium	24	31	<0.01	<0.01	NR	NR	NR	NR	NR	NR
Manganese (PM_{10})	31	31	0.04	0.01	0.05	0.02	0.02	0.01	0.04	0.02
Manganese (TSP)	31	31	0.07	0.02	0.10	0.05	0.05	0.03	0.08	0.05
Naphthalene	31	31	0.29	0.09	0.30	0.16	0.24	0.12	0.20	0.15
Nickel (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
p-Dichlorobenzene	31	31	0.32	0.06	NR	NR	0.26	0.06	0.24	0.08
Tetrachloroethylene	23	31	0.31	0.09	NR	NR	NR	NR	NR	NR
Xylenes	31	31	9.66	2.88	NR	NR	7.74	6.05	9.95	5.84
Providence, Alabama – PVAL										
Acetaldehyde	31	31	1.49	0.82	1.29	0.26	0.74	0.24	2.64	3.00
Acrolein	10	30	0.68	0.46	NR	NR	NR	NR	NR	NR
Arsenic (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	31	31	0.57	0.10	0.61	0.12	0.62	0.20	0.55	0.29
Carbon Tetrachloride	31	31	0.65	0.05	0.71	0.08	0.56	0.12	0.61	0.08
Formaldehyde	31	31	4.14	2.06	3.14	1.07	1.11	0.42	6.67	7.21
Hexachloro-1,3-butadiene	5	31	0.19	0.04	NR	NR	NR	NR	NR	NR
Manganese (TSP)	31	31	0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01
Naphthalene	31	31	0.02	<0.01	0.01	<0.01	0.02	0.01	0.01	0.01
p-Dichlorobenzene	27	31	0.25	0.08	0.27	0.04	0.15	0.03	NR	NR
Sloss Industries, Birmingham, Alabama – SIAL										
1,3-Butadiene	28	31	0.23	0.05	NR	NR	0.26	0.12	0.20	0.08
Acetaldehyde	31	31	1.55	0.19	1.61	0.33	1.24	0.26	1.69	0.39
Acrolein	19	31	1.15	0.43	NR	NR	NR	NR	NR	NR
Arsenic (TSP)	31	31	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01	0.01
Benzene	31	31	6.17	2.07	NR	NR	7.55	7.45	4.79	2.13
Benzo (a) pyrene	27	31	<0.01	<0.01	NR	NR	NR	NR	<0.01	<0.01
Beryllium (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Carbon Tetrachloride	31	31	0.65	0.04	NR	NR	0.56	0.07	0.64	0.07
Dibenz (a,h) anthracene	21	31	<0.01	<0.01	NR	NR	NR	NR	NR	NR
Formaldehyde	31	31	3.70	0.71	3.09	0.64	2.31	0.72	4.03	1.17

Table 4-3. Daily and Seasonal Averages for Pollutants of Interest for the Alabama Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily		Autumn 2005		Winter 2005/2006		Spring 2006	
			Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval
Hexachloro-1,3-butadiene	6	31	0.18	0.04	NR	NR	NR	NR	NR	NR
Hexavalent Chromium	23	32	<0.01	<0.01	NR	NR	NR	NR	<0.01	<0.01
Manganese (TSP)	31	31	0.14	0.05	0.15	0.13	0.07	0.02	0.14	0.09
Naphthalene	31	31	0.50	0.12	0.44	0.23	NR	NR	0.56	0.27
Nickel (TSP)	31	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
p-Dichlorobenzene	31	31	0.40	0.11	NR	NR	0.27	0.05	0.29	0.12
Tetrachloroethylene	22	31	0.32	0.09	NR	NR	NR	NR	NR	NR

NA = Not Available due to short sampling duration.
NR = Not Reportable due to low number of measured detections.

- One exception to this was *p*-dichlorobenzene. The autumn average (0.27 ± 0.04 μg/m^3) was more than the winter average (0.15 ± 0.03 μg/m^3). Unfortunately, this site did not have a valid spring *p*-dichlorobenzene concentration for comparison.

- The spring formaldehyde and acetaldehyde averages were significantly higher than the other seasons. However, the confidence intervals were also very large, indicating that these averages may be impacted by outliers. Relatively high concentrations of these pollutants were measured on April 17, 2006.

The following observations for SIAL are shown in Table 4-3:

- The pollutants with the highest daily averages were benzene (6.17 ± 2.07 μg/m^3), formaldehyde (3.70 ± 0.71 μg/m^3), and acetaldehyde (1.55 ± 0.19 μg/m^3).

- No autumn averages could be calculated for SIAL for VOC and carbonyl compounds due to a few invalid samples.

- Most of the seasonal averages of the pollutants of interest did not vary much from season-to-season, when the confidence interval was considered.

The winter benzene average was significantly higher than the spring average. However, the confidence intervals were also very large, indicating that this average may be impacted by outliers. A relatively high concentration of benzene was measured on February 4, 2006.

4.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for Alabama monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen at the Alabama sites, only acrolein and benzene exceeded either the acute or intermediate risk values, and each site's non-chronic risk is summarized in Table 4-4.

The following observations about acrolein are shown in Table 4-4:

- All acrolein measured detections at the Alabama sites were greater than the ATSDR acute MRL (0.11 μg/m^3) and most were greater than the California REL (0.19 μg/m^3).

Table 4-4. Non-Chronic Risk Summary for the Alabama Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Autumn 2005 Average (µg/m^3)	Winter 2006 Average (µg/m^3)	Spring 2006 Average (µg/m^3)
ETAL	TO-15	Acrolein	0.95 ± 0.31	0.11	17	0.19	16	0.09	NR	NR	NR
NBAL	TO-15	Acrolein	0.90 ± 0.20	0.11	22	0.19	22	0.09	NR	0.79 ± 0.33	0.63 ± 0.16
PVAL	TO-15	Acrolein	0.68 ± 0.46	0.11	10	0.19	8	0.09	NR	NR	NR
SIAL	TO-15	Acrolein	1.15 ± 0.43	0.11	19	0.19	19	0.09	NR	NR	NR
SIAL	TO-15	Benzene	6.17 ± 2.07	28.75	1	--	--	20	NR	7.55 ± 7.45	4.79 ± 2.13

NA = Not Available due to short sampling duration.
NR = Not Reportable due to low number of measured detections.

- The average daily concentration ranged from 0.68 ± 0.46 μg/m^3 (for PVAL) to 1.15 ± 0.43 μg/m^3 (for SIAL).

- Few seasonal averages of acrolein could be calculated, due to the low number of measured detections in each season.

- NBAL had both a winter and spring acrolein average. Both were an order of magnitude greater than the ATSDR intermediate MRL (0.09 μg/m^3).

The following observations about benzene are shown in Table 4-4:

- One benzene measured detection at the SIAL site was greater than the ATSDR acute risk value of 28.75 μg/m^3.

- The average daily benzene concentration was 6.17 ± 2.07 μg/m^3, and none of the valid seasonal averages exceeded the ATSDR intermediate MRL of 20 μg/m^3.

- As previously mentioned, autumn seasonal averages could not be calculated for the SIAL site.

- The exceedance of the ATSDR acute value occurred on February 4, 2006. The winter 2006 benzene average had a large confidence interval, indicating that the average may be impacted by outliers.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. Acrolein concentrations exceeded the acute risk factors at all four Alabama monitoring sites, and benzene exceeded the acute risk factor at SIAL. Figures 4-7 through 4-11 are pollution roses for acrolein and/or benzene for the Alabama sites. As shown in Figures 4-7 through 4-10, and discussed in Section 4.3, most, if not all, acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CALEPA REL) and solid line (ATSDR MRL). Only one benzene concentration exceeded the ATSDR acute MRL, as shown in Figure 4-11.

Figure 4-7 is the acrolein pollution rose for the ETAL monitoring site and the following observations can be made:

- Concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is characteristic of mobile sources.

Figure 4-7. Acrolein Pollution Rose for ETAL

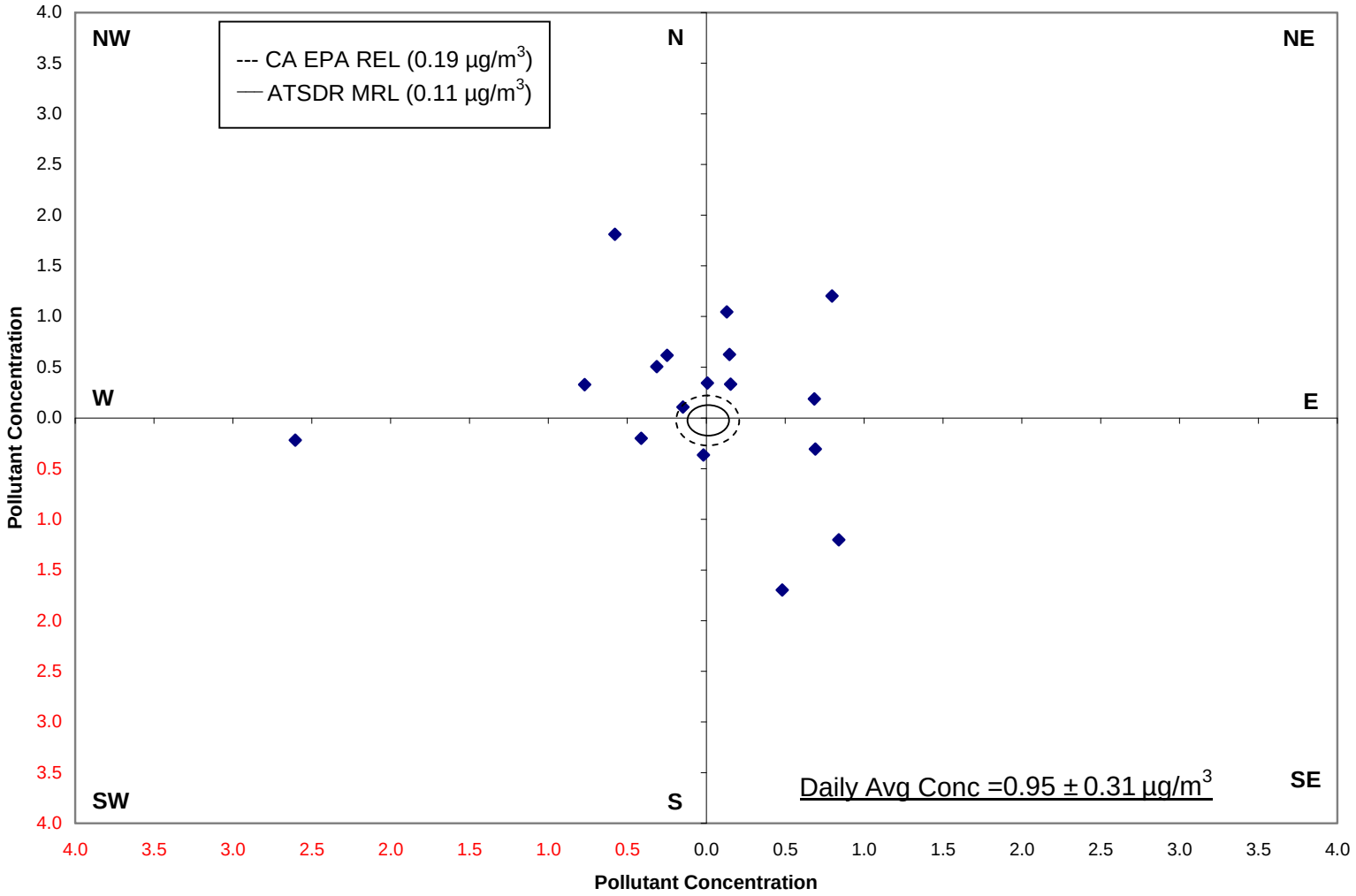


Figure 4-8. Acrolein Pollution Rose for NBAL

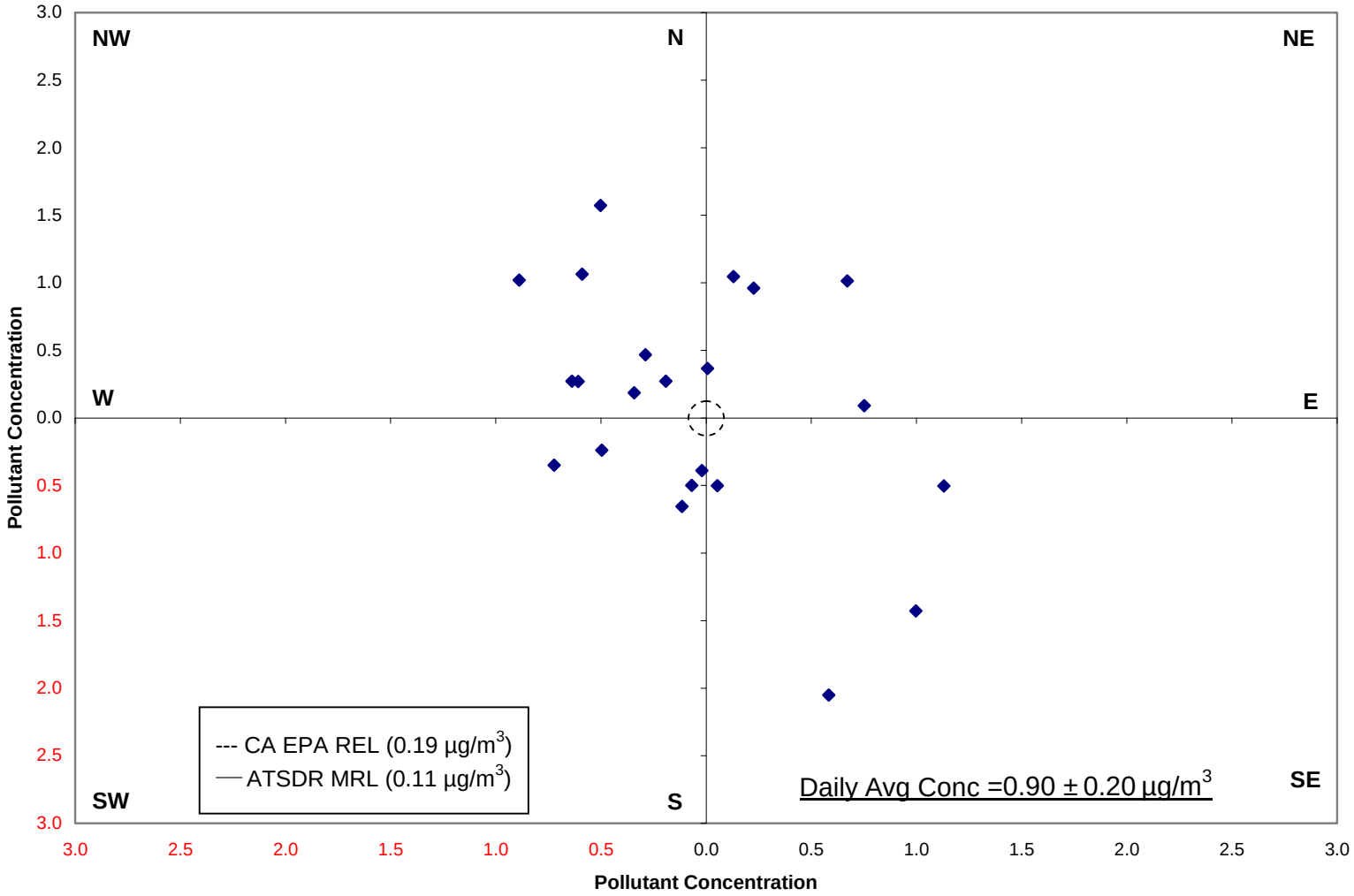


Figure 4-9. Acrolein Pollution Rose for PVAL

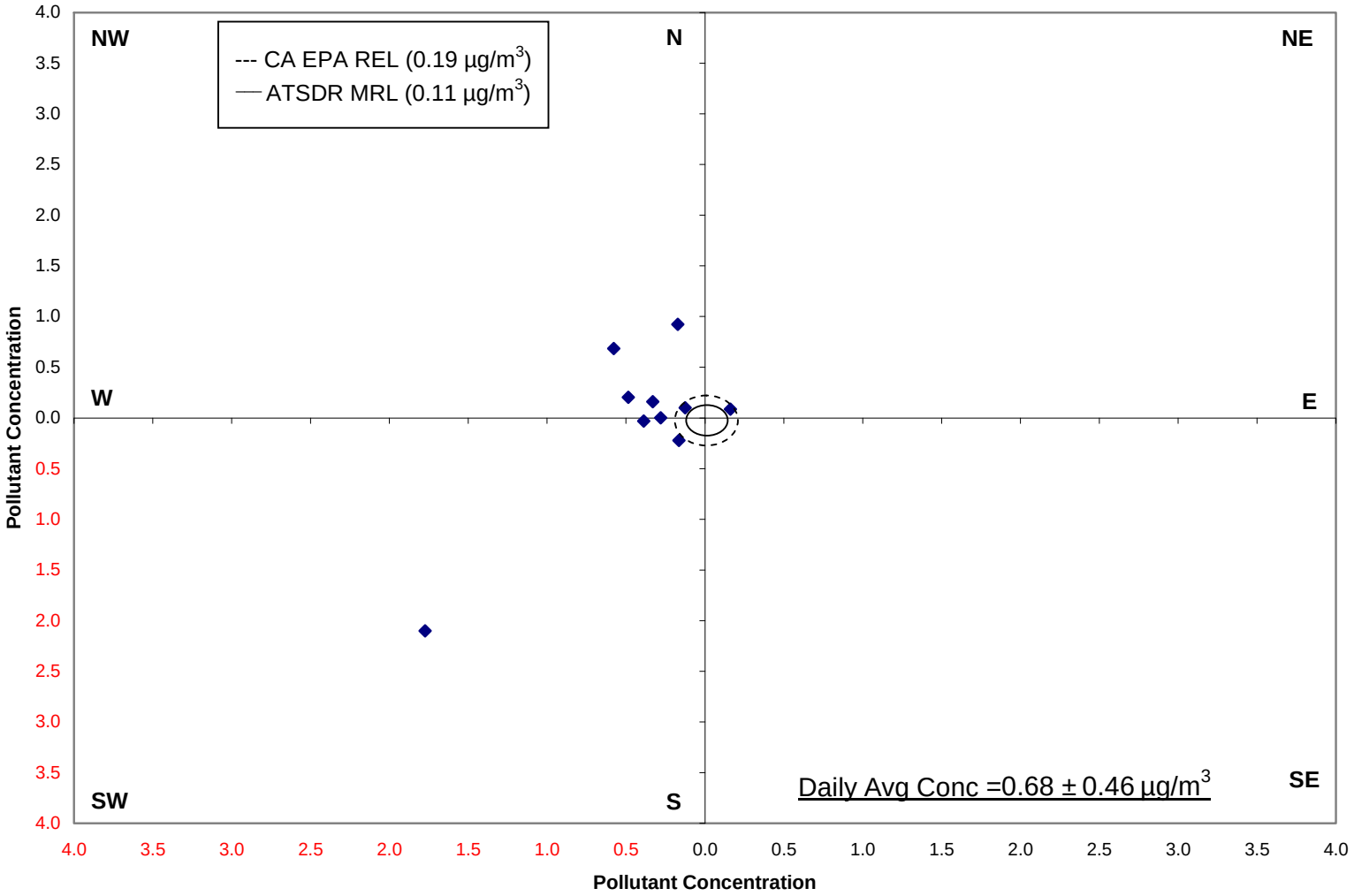


Figure 4-10. Acrolein Pollution Rose for SIAL

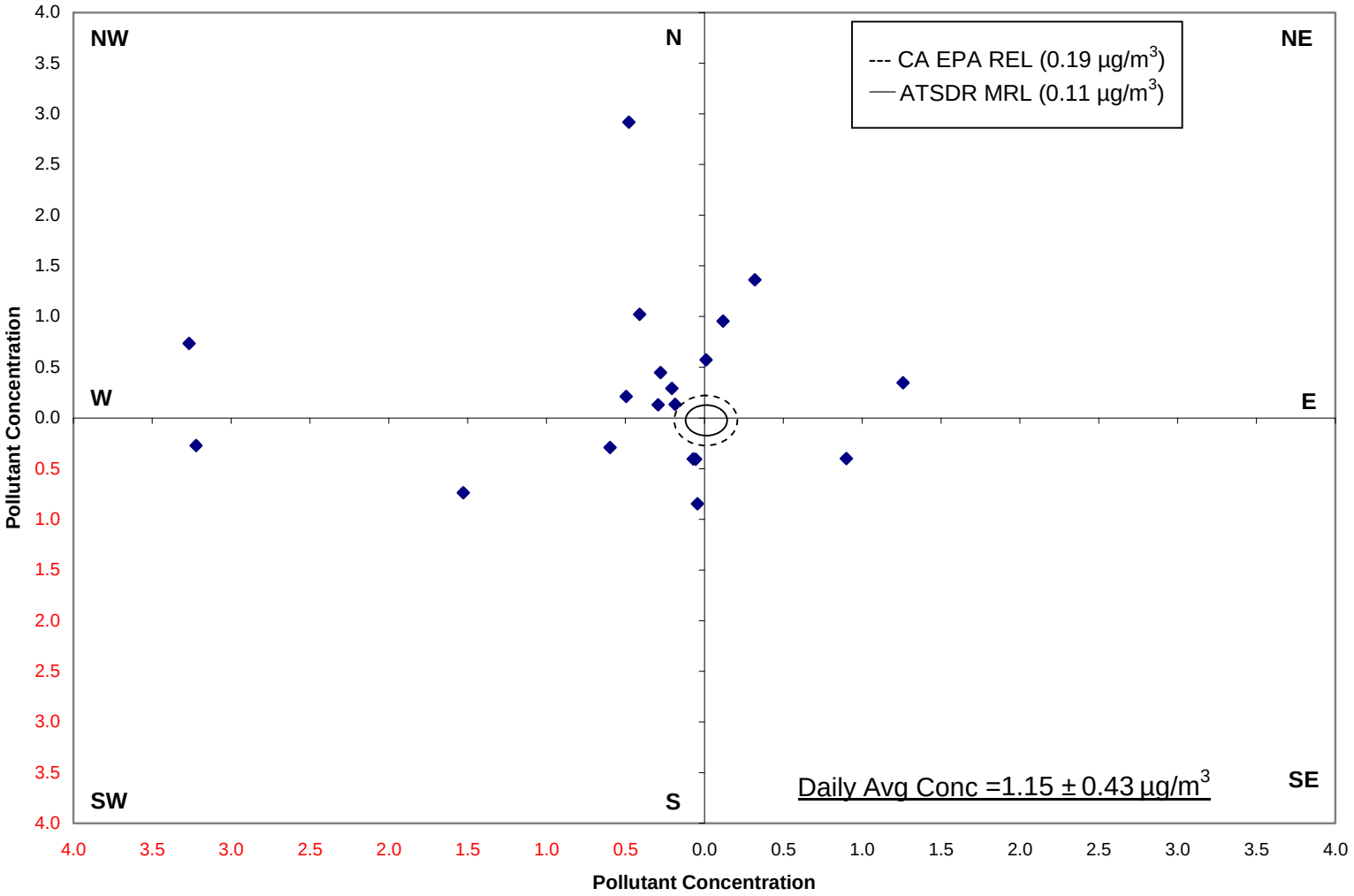
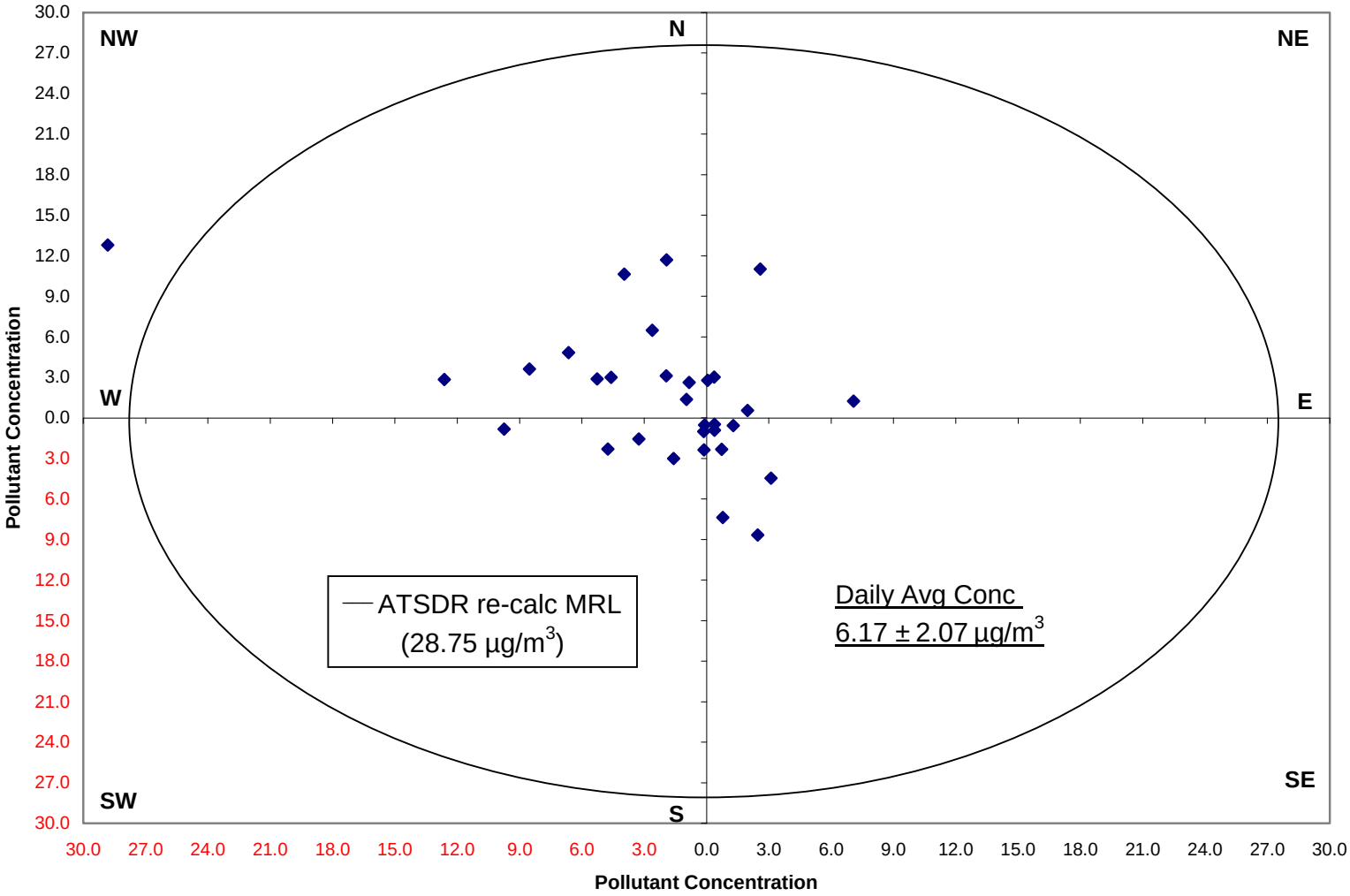


Figure 4-11. Benzene Pollution Rose for SIAL



- The highest concentration of acrolein occurred on July 27, 2005 with a westerly wind.

- The ETAL site is located near several heavily traveled roadways, including I-20, which runs east to west and lies to the south of the monitoring site. Railroads are also located to the north and south of the site. A number of industrial facilities are located within a 10-mile radius of this site.

Figure 4-8 is the acrolein pollution rose for the NBAL monitoring site and the following observations can be made:

- The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is characteristic of mobile sources.

- The highest concentration of acrolein occurred on October 31, 2005 with a south-southeasterly wind.

- NBAL is located in a commercial, urban part of Birmingham, just east of I-65, where several railways transverse the area near the monitoring site. A number of industrial facilities are located within a few miles of this site.

Figure 4-9 is the acrolein pollution rose for the PVAL monitoring site and the following observations can be made:

- The few detected concentrations of acrolein were measured on days with winds originating primarily from a westerly and northwesterly direction.

- The highest concentration of acrolein occurred on October 19, 2005 with a southwesterly wind.

- The PVAL site is located in a rural area beyond the Birmingham city limits, with few industrial sources nearby.

Figure 4-10 is the acrolein pollution rose for the SIAL monitoring site and the following observations can be made:

- Concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, characteristic of mobile sources.

- The highest concentrations of acrolein occurred on October 19, 2005 and July 27, 2005, both with a westerly wind.

- These dates correspond with ETAL and PVAL.

- SIAL is located just east of NBAL, near several heavily traveled roadways. A number of railways also transverse the area near SIAL. This site is in an urban area and a number of industrial facilities are located within a few miles of the site.

Figure 4-11 is the benzene pollution rose for the SIAL monitoring site and the following observations can be made:

- Most concentrations measured at SIAL are well below the ATSDR MRL. Only the concentration measured on February 4, 2006, which occurred with northwesterly winds, exceeded the acute risk factor.

- Figure 4-5 shows that there are a few industrial facilities located to the northwest of the monitoring site.

4.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following three meteorological data analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and the concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

4.4.1 Pearson Correlation Analysis

Table 4-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Alabama monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for ETAL from Table 4-5:

- Most of the correlations between the temperature and moisture variables and the pollutants of interest were positive, indicating that concentrations tend to increase as temperature and humidity increase.

- Relative humidity generally did not follow the same trend as the dew point and wet bulb temperatures.

- Formaldehyde exhibited strong correlations with the temperature variables, which indicates that concentrations of this pollutant tend to increase as temperature increases.

Table 4-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Alabama Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
East Thomas, Birmingham, Alabama – ETAL								
1,3-Butadiene	30	-0.09	-0.16	-0.16	-0.16	-0.02	0.12	-0.48
Acetaldehyde	31	0.42	0.29	0.12	0.19	-0.26	0.13	-0.63
Acrolein	17	0.06	0.04	0.14	0.11	0.27	0.25	-0.16
Arsenic (TSP)	31	0.34	0.24	0.21	0.21	0.07	0.28	-0.84
Benzene	31	0.13	0.00	0.01	0.00	0.07	0.28	-0.65
Cadmium (TSP)	31	0.27	0.16	0.14	0.14	0.05	0.26	-0.64
Carbon Tetrachloride	31	0.27	0.29	0.17	0.22	-0.20	-0.06	0.10
Formaldehyde	31	0.62	0.58	0.34	0.44	-0.32	0.02	-0.38
Hexachloro-1,3-butadiene	10	-0.37	-0.49	-0.53	-0.53	-0.23	0.83	-0.32
Manganese (TSP)	31	0.35	0.27	0.19	0.21	-0.05	0.15	-0.58
Naphthalene	31	0.07	-0.05	-0.10	-0.09	-0.10	0.41	-0.50
Nickel (TSP)	31	0.19	0.13	0.20	0.18	0.28	-0.10	-0.29
p-Dichlorobenzene	29	0.47	0.38	0.38	0.38	0.19	-0.03	-0.53
Tetrachloroethylene	25	-0.15	-0.22	-0.16	-0.19	0.05	0.22	-0.29
Xylenes	31	0.18	0.09	0.16	0.12	0.21	0.11	-0.62
North Birmingham, Alabama – NBAL								
1,3-Butadiene	25	0.15	0.04	-0.01	0.01	-0.06	0.35	-0.58
Acetaldehyde	31	0.63	0.52	0.34	0.42	-0.22	0.05	-0.61
Acrolein	22	-0.08	-0.15	-0.28	-0.23	-0.29	0.52	-0.35
Arsenic (PM_{10})	31	0.32	0.20	0.15	0.16	0.03	0.17	-0.78
Arsenic (TSP)	31	0.32	0.21	0.17	0.18	0.05	0.15	-0.73
Benzene	31	0.10	-0.03	-0.12	-0.08	-0.17	0.32	-0.51
Benzo (a) anthracene	30	0.07	-0.03	-0.07	-0.06	-0.05	0.20	-0.48
Benzo (a) pyrene	23	0.13	0.06	0.03	0.04	0.01	0.08	-0.36
Cadmium (PM_{10})	31	0.37	0.30	0.33	0.32	0.20	0.03	-0.52
Cadmium (TSP)	31	0.36	0.30	0.29	0.30	0.13	0.03	-0.45
Carbon Tetrachloride	31	0.14	0.15	0.03	0.07	-0.23	0.02	-0.01
Formaldehyde	31	0.81	0.77	0.61	0.68	-0.12	-0.07	-0.43

Table 4-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Alabama Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Hexachloro-1,3-butadiene	6	0.32	0.05	-0.18	-0.07	-0.27	0.71	-0.60
Hexavalent Chromium	24	0.22	0.21	0.03	0.12	-0.29	0.04	-0.15
Manganese (PM_{10})	31	0.40	0.36	0.17	0.25	-0.29	0.18	-0.23
Manganese (TSP)	31	0.24	0.24	0.09	0.15	-0.27	0.19	0.05
Naphthalene	31	0.27	0.13	0.08	0.09	-0.04	0.15	-0.65
Nickel (TSP)	31	0.16	0.18	0.21	0.20	0.18	-0.18	0.02
p-Dichlorobenzene	31	0.23	0.16	0.19	0.19	0.16	0.21	-0.55
Tetrachloroethylene	23	0.08	-0.03	-0.08	-0.05	-0.06	0.13	-0.54
Xylenes	31	0.20	0.12	0.16	0.15	0.15	0.29	-0.65
Providence, Alabama – PVAL								
Acetaldehyde	31	0.17	0.16	0.17	0.17	0.12	-0.33	-0.06
Acrolein	10	0.21	0.12	0.21	0.16	0.46	-0.01	-0.56
Arsenic (TSP)	31	0.31	0.23	0.18	0.21	0.00	0.21	-0.59
Benzene	31	-0.10	-0.13	-0.05	-0.08	0.17	0.06	-0.23
Carbon Tetrachloride	31	0.17	0.16	0.12	0.14	0.00	-0.32	-0.04
Formaldehyde	31	0.37	0.34	0.33	0.34	0.15	-0.36	-0.16
Hexachloro-1,3-butadiene	5	0.43	0.40	0.36	0.39	-0.13	0.06	0.45
Manganese (TSP)	31	0.44	0.39	0.22	0.28	-0.33	-0.11	-0.37
Naphthalene	31	0.02	0.03	0.05	0.03	0.02	0.22	-0.11
p-Dichlorobenzene	27	0.34	0.45	0.55	0.53	0.59	-0.22	-0.10
Sloss Industries, Birmingham, Alabama – SIAL								
1,3-Butadiene	28	-0.30	-0.33	-0.24	-0.28	0.11	-0.11	-0.25
Acetaldehyde	31	0.51	0.40	0.14	0.24	-0.44	0.03	-0.47
Acrolein	19	0.55	0.49	0.53	0.54	0.24	-0.23	-0.49
Arsenic (TSP)	31	-0.28	-0.27	-0.14	-0.20	0.21	-0.13	0.07
Benzene	31	-0.24	-0.22	-0.16	-0.18	0.06	-0.29	-0.01
Benzo (a) pyrene	27	-0.34	-0.30	-0.27	-0.28	-0.04	-0.33	0.35
Beryllium (TSP)	31	0.11	0.08	0.07	0.07	0.05	-0.01	-0.18
Carbon Tetrachloride	31	0.20	0.16	0.01	0.08	-0.28	-0.27	0.12

Table 4-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Alabama Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Dibenz (a,h) anthracene	21	-0.41	-0.35	-0.24	-0.28	0.19	-0.28	0.38
Formaldehyde	31	0.68	0.67	0.46	0.54	-0.22	-0.11	-0.23
Hexachloro-1,3-butadiene	6	-0.69	-0.63	-0.38	-0.52	0.21	-0.25	0.56
Hexavalent Chromium	23	0.07	0.09	-0.13	-0.04	-0.47	0.28	-0.12
Manganese (TSP)	31	0.12	0.09	0.06	0.07	0.00	0.00	-0.17
Naphthalene	31	-0.13	-0.17	-0.19	-0.19	-0.07	-0.08	-0.32
Nickel (TSP)	31	0.05	0.02	0.10	0.07	0.22	-0.09	-0.08
p-Dichlorobenzene	31	0.28	0.17	0.18	0.18	0.11	0.13	-0.50
Tetrachloroethylene	22	0.02	-0.10	-0.02	-0.05	0.20	0.31	-0.58

- Most of the pollutants also exhibited a positive correlation with sea level pressure, indicating that concentrations tend to increase as pressure increases.

- Nearly all of the pollutants of interest exhibited a negative correlation with wind speed, many of which were strong, indicating that concentrations increase as wind speeds decrease.

- Although some of the correlations for hexachloro-1,3-butadiene were strong, the low detection rate of this pollutant may skew the correlations.

The following observations are gathered for NBAL from Table 4-5:

- Correlations between the pollutants of interest for NBAL and the selected meteorological parameters were similar to those calculated for ETAL.

- Most of the correlations between the temperature and moisture variables and the pollutants of interest were positive, indicating that concentrations tend to increase as temperature and humidity increase.

- Formaldehyde exhibited even stronger correlations with the temperature and moisture variables for NBAL.

- Most of the pollutants also exhibited a positive correlation with sea level pressure, indicating that concentrations tend to increase as pressure increases.

- Nearly all of the pollutants of interest exhibited a strong negative correlation with wind speed, indicating that concentrations increase as wind speeds decrease.

The following observations are gathered for PVAL from Table 4-5:

- Correlations tended to be weaker for PVAL, although the temperature and moisture trend of mostly positive correlations continues, indicating that concentrations tend to increase as temperature and humidity increase.

- Most of the negative correlations were calculated for scalar wind speed, indicating that concentrations increase as wind speeds decrease.

The following observations are gathered for SIAL from Table 4-5:

- The correlations for SIAL were somewhat different from the other sites.

- More pollutants exhibited negative correlations with the temperature and moisture variables. However, pollutants such as formaldehyde, acetaldehyde, and acrolein still exhibited strong positive correlations with these parameters.

- Most of the correlations with sea level pressure were negative, indicating that concentrations tend to increase as pressure decreases.

- Like all of the other Alabama sites, correlations with wind speed were mostly negative, indicating that concentrations increase as wind speeds decrease.

4.4.2 Composite Back Trajectory Analysis

Figures 4-12 through 4-15 are composite back trajectory maps for the Alabama monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day and each concentric circle represents 100 miles.

The following observations can be made from Figures 4-12 through 4-15.

- The back trajectory maps look very similar to each other.

- Back trajectories originated from a variety of directions at the Alabama sites.

- The 24-hour airshed domain is somewhat large for these sites, with trajectories originating as far away as southern Iowa, or greater than 600 miles away.

- Nearly 90 percent of the trajectories originated within 400 miles of the Alabama sites.

4.4.3 Wind Rose Analysis

Hourly wind data from the Birmingham International Airport and Tuscaloosa Municipal Airport stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 4-16 through 4-19 are the wind roses for the Alabama monitoring sites on days that sampling occurred.

As shown in Figures 4-16, 4-17, and 4-19 (for ETAL, NBAL, and SIAL):

- The wind roses for the three sites within the Birmingham city limits resembled each other.

- Hourly winds were predominantly out of the north, south, and south-southeast on days that samples were collected.

Figure 4-12. Composite Back Trajectory Map for ETAL

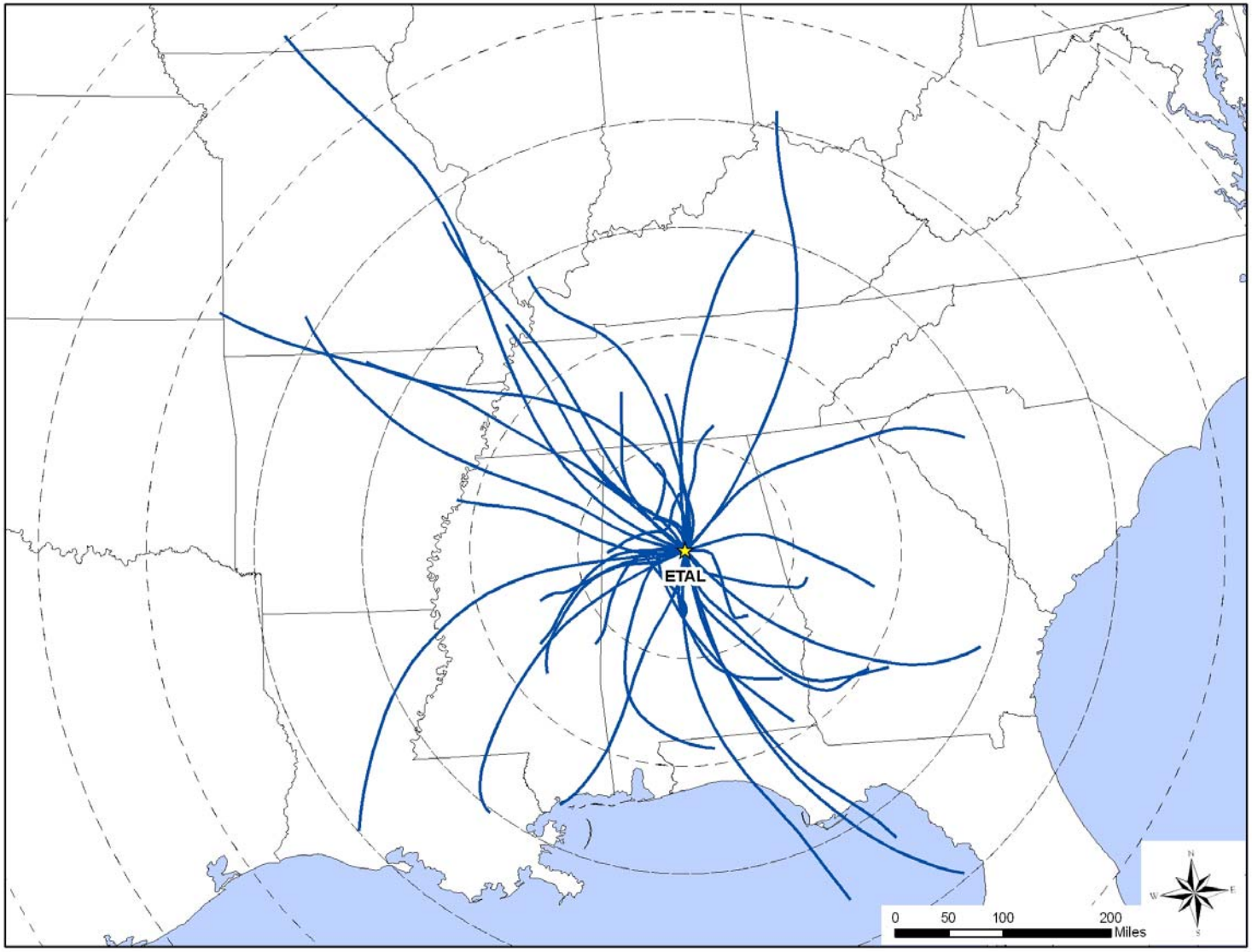


Figure 4-13. Composite Back Trajectory Map for NBAL

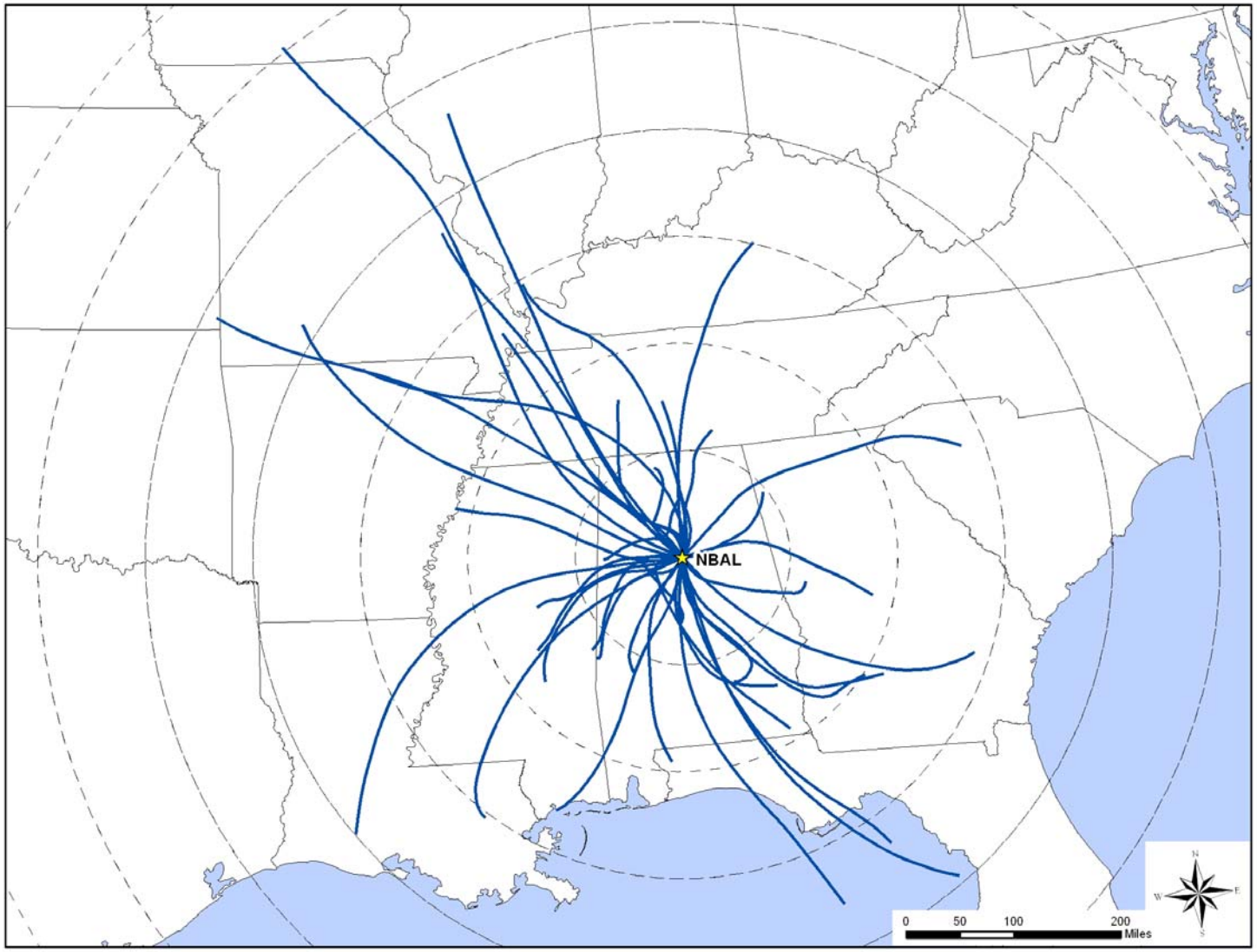


Figure 4-14. Composite Back Trajectory Map for PVAL

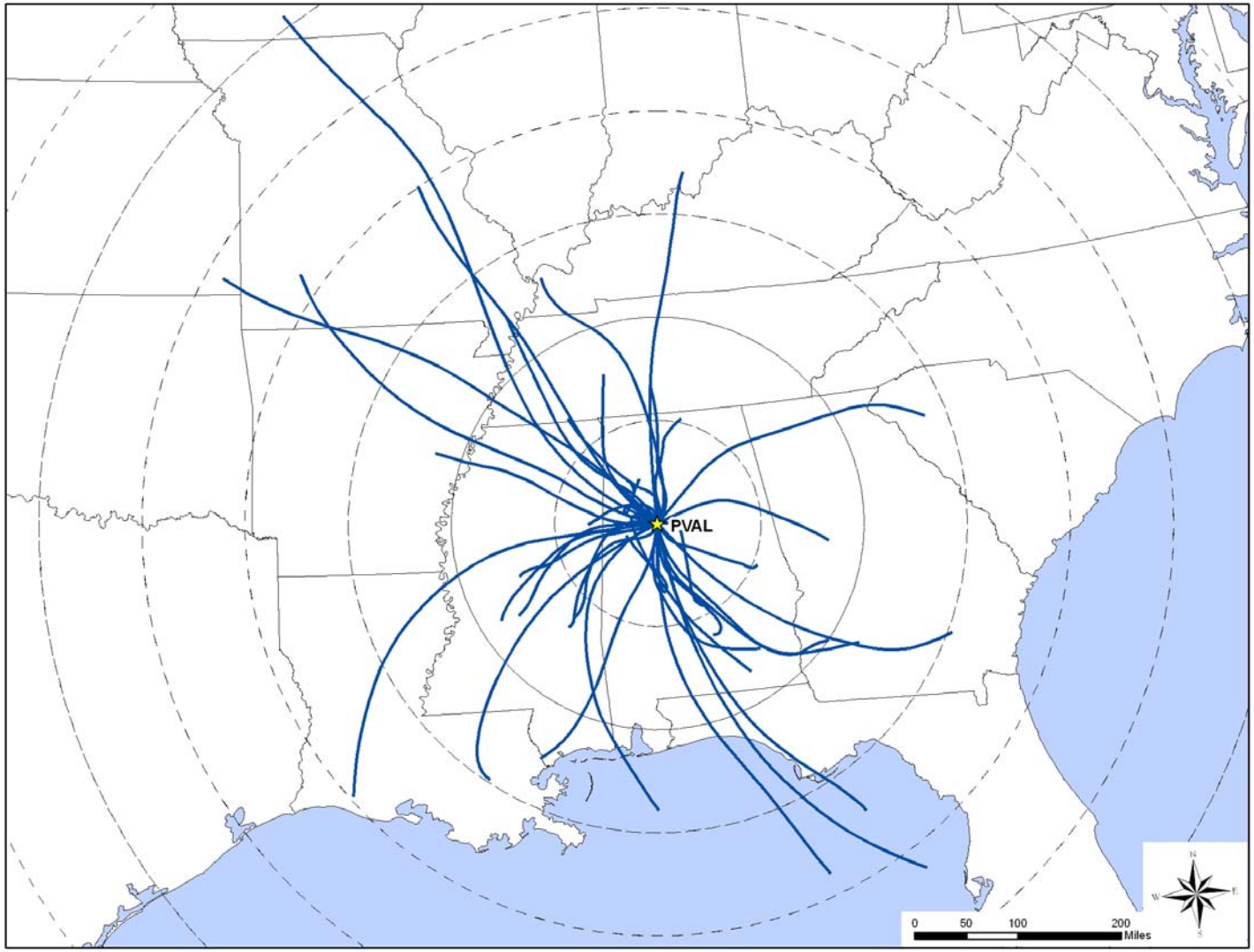


Figure 4-15. Composite Back Trajectory Map for SIAL

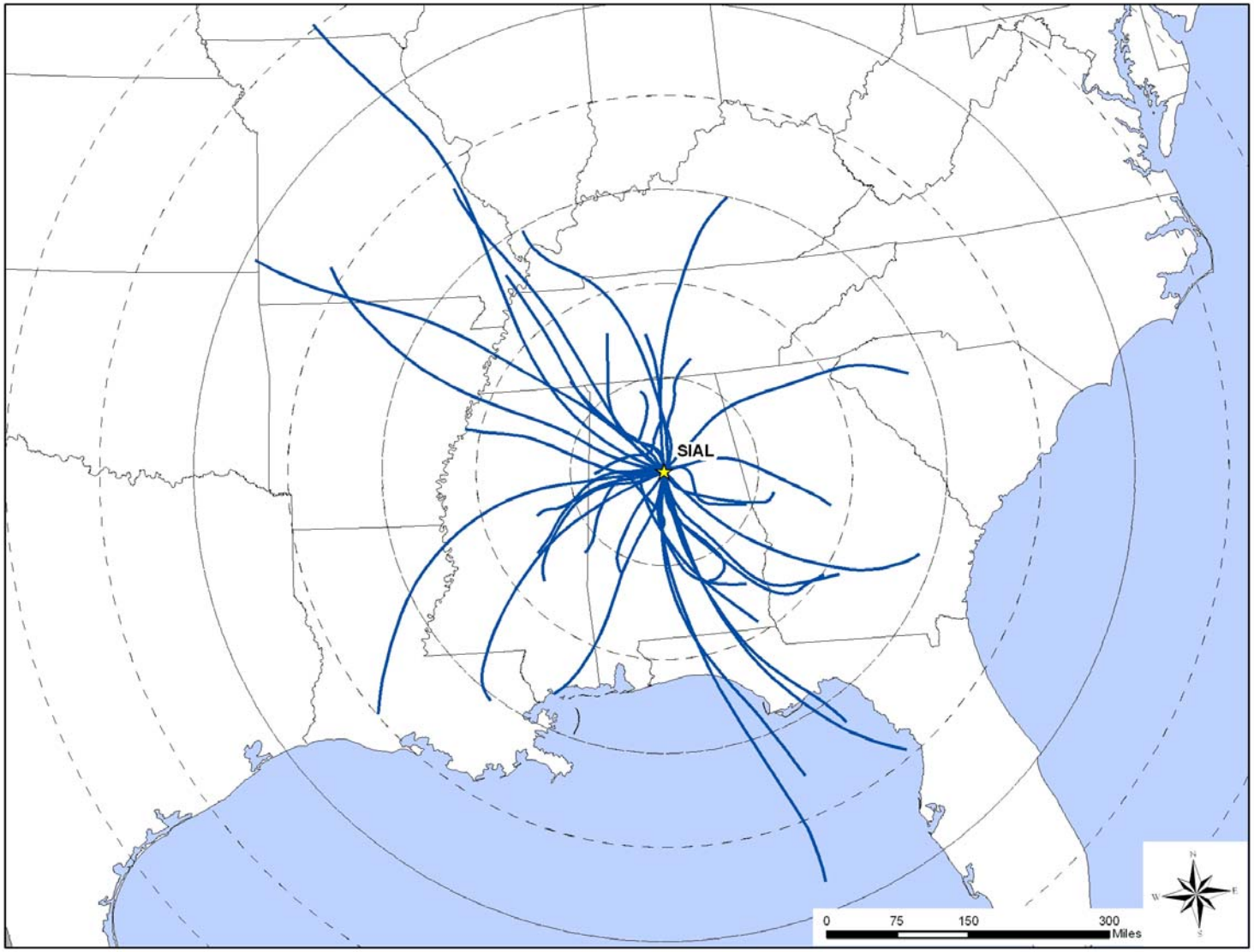


Figure 4-16. Wind Rose for ETAL Sampling Days

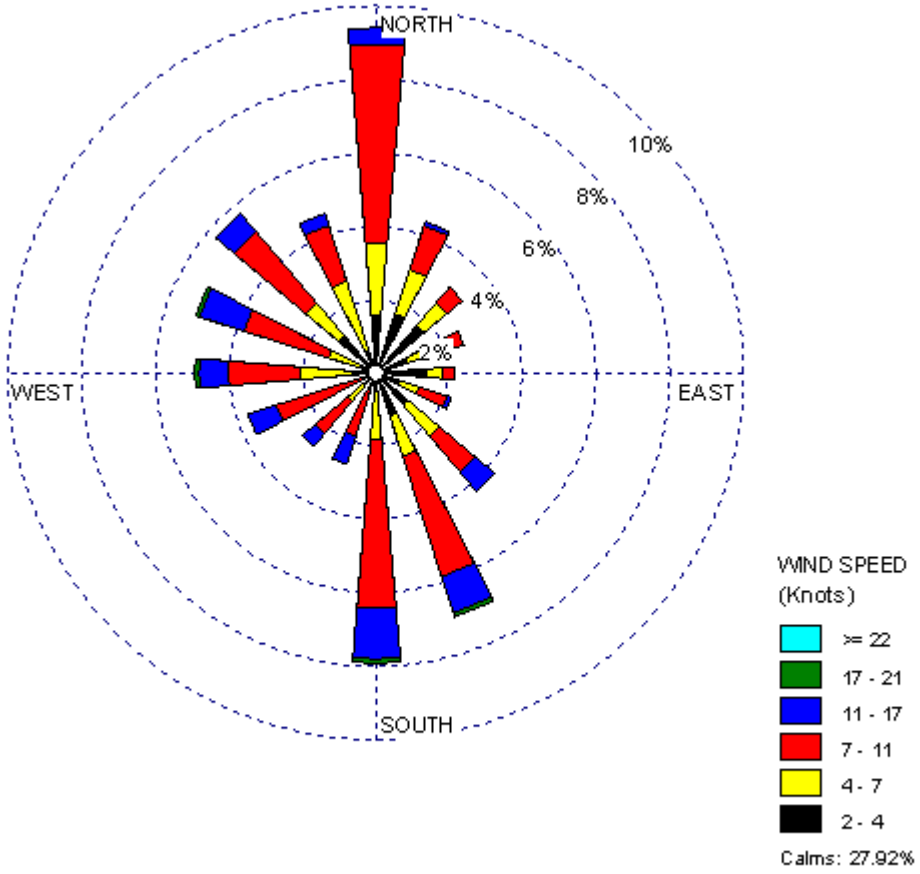


Figure 4-17. Wind Rose for NBAL Sampling Days

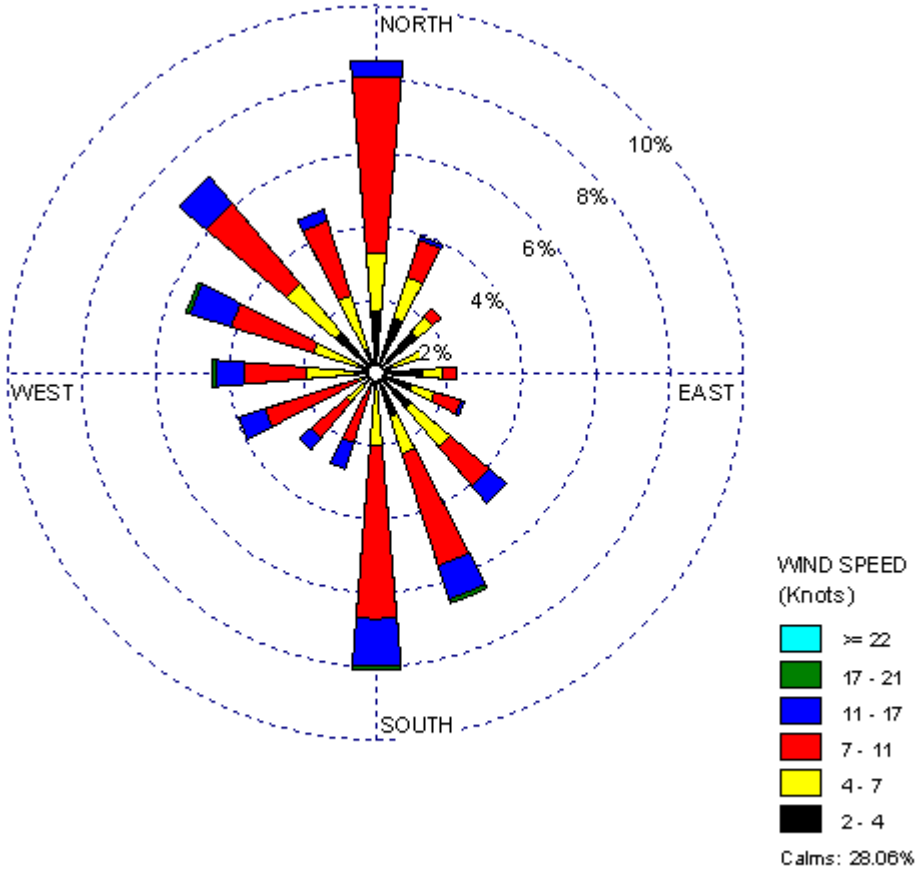


Figure 4-18. Wind Rose for PVAL Sampling Days

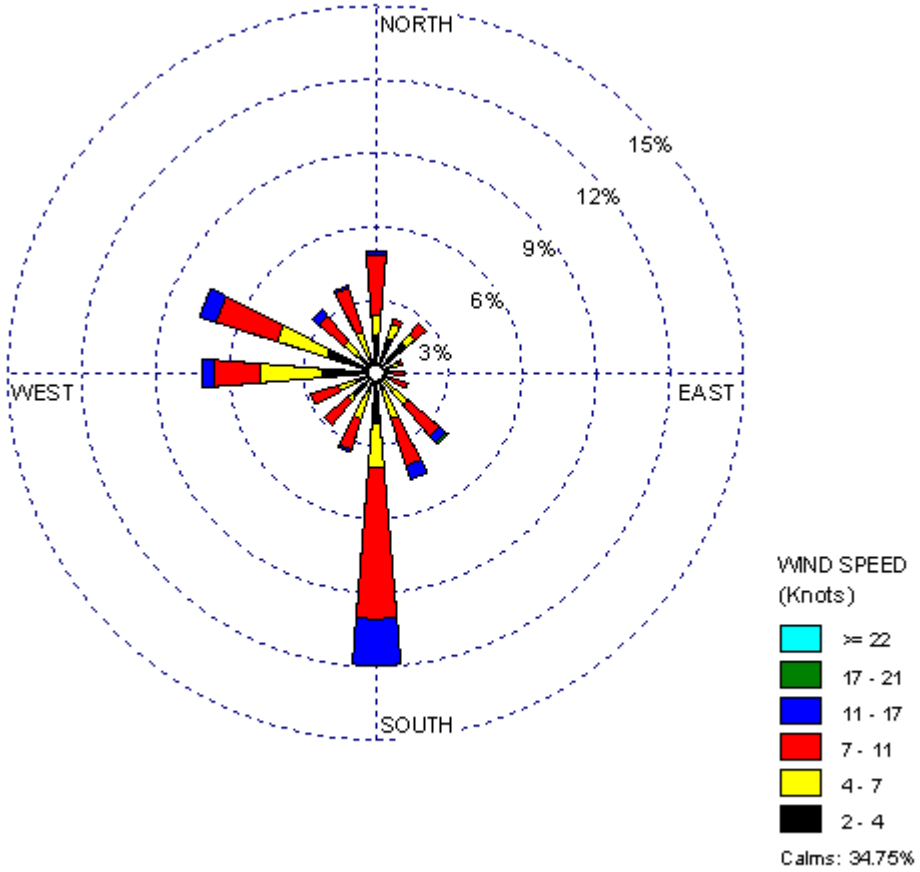
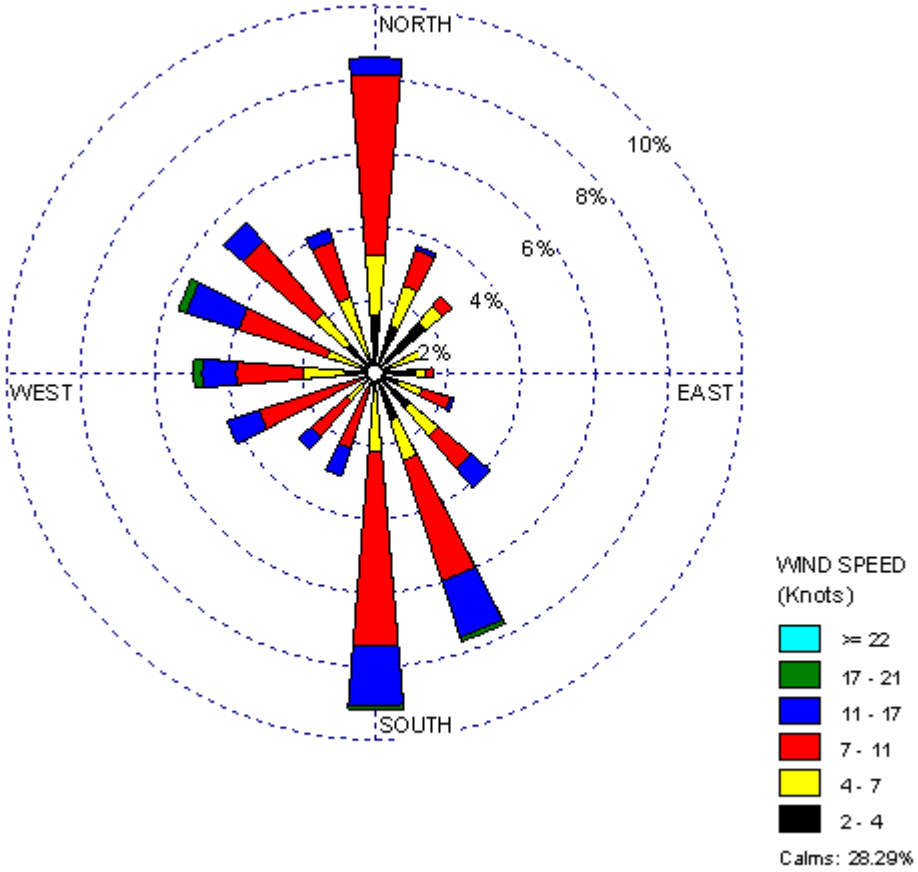


Figure 4-19. Wind Rose for SIAL Sampling Days



- Calm winds (<2 knots) were recorded for nearly thirty percent of the hourly measurements at these sites.

- For wind speeds greater than 2 knots, most of the observations ranged from 7 to 11 knots.

As shown in Figure 4-18 (for PVAL)

- Southerly (12 percent), west-northwesterly (8 percent), and westerly (7 percent), winds were predominant near PVAL on days that samples were collected.

- Nearly 35 percent of hourly wind speed observations were calm, or less than 2 knots.

- Wind speeds in the 7 to 11 knot range were the most often recorded.

4.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic volume comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

4.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Jefferson County, Alabama were obtained from the Alabama Department of Revenue and the U.S. Census Bureau, and are summarized in Table 4-6. Table 4-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 4-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 4-6 include:

- PVAL has a significantly lower population residing within 10 miles of it than the other sites, and therefore a significantly lower estimated 10 mile vehicle ownership.

- Traffic data for three Birmingham sites was obtained from the Alabama Department of Transportation, but no traffic data was available for PVAL.

Table 4-6. Motor Vehicle Information for the Alabama Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
ETAL	656,700	614,075	0.94	394,178	368,593	30,000
NBAL	656,700	614,075	0.94	389,196	363,934	2,000
PVAL	656,700	614,075	0.94	28,587	26,731	NA
SIAL	656,700	614,075	0.94	389,196	363,934	2,700

NA = Not available.

- The ETAL site experiences a significantly higher daily traffic volume than NBAL and SIAL. According to Figure 4-1, ETAL resides next to a major interstate.

- Compared to other UATMP locations, Jefferson County's population and vehicle registration are in the middle of the range.

4.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information of this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- Of the four Alabama sites, the NBAL monitoring site's ratios most resemble those of the roadside study, although its ratios were lower than those of the roadside study's. This suggests that mobile source emissions are influencing concentrations at this site.

- For ETAL, the benzene-ethylbenzene and xylenes-ethylbenzene ratios were very similar to each other, while the toluene-ethylbenzene ratio was the highest of the three.

- For PVAL, the benzene-ethylbenzene and toluene ethylbenzene ratios were significantly higher than those of the roadside study. In addition, the benzene-ethylbenzene ratio was much higher than the xylenes-ethylbenzene ratio.

- For SIAL, the benzene-ethylbenzene ratio was the highest of the three ratios, which was different from the roadside study, where the toluene-ethylbenzene ratio was the highest.

- These observations suggests that sources other than mobile sources are influencing concentrations at these sites.

4.6 Trends Analysis

A trends analysis could not be performed as these sites have not participated in the UATMP for three consecutive years.

4.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Alabama sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 4-7. NATA data is presented for the census tract where the monitoring site is located. Additionally, the pollutants of interest are bolded.

The following observations based on annual averages for the Birmingham sites can be seen in Table 4-7:

- The pollutants with the top 3 annual averages by mass concentration for ETAL, NBAL, and SIAL were xylenes, formaldehyde, and benzene, although not necessarily in that order. Xylenes consistently had the highest annual average among these three sites.

- The pollutants with the highest cancer risks were not necessarily these pollutants.

- Theoretical cancer risk for benzene was the highest for all three sites, ranging from 22.65 in-a-million (for NBAL) to 48.15 in-a-million (for ETAL).

- Cancer risks resulting from hexachloro-1,3-butadiene were also high, ranging from 10.90 in-a-million (for NBAL) to 12.04 (for SIAL).

- Other pollutants with cancer risks greater than 10 in-a-million included carbon tetrachloride (for ETAL and NBAL), arsenic (for SIAL), and naphthalene (for SIAL).

- Acrolein and manganese exhibited noncancer HQs greater than 1 for all three sites. However, the acrolein HQ for each site was significantly higher than the manganese HQ.

- All other noncancer risks were less than 1.0.

The following observations based on annual averages for PVAL can be seen in Table 4-7:

- Formaldehyde, acetaldehyde, and hexachloro-1,3-butadiene exhibited the highest annual averages.

- Like the other three Birmingham sites, hexachloro-1,3-butadiene had the highest theoretical cancer risk (15.61 in-a-million).

Table 4-7. Chronic Risk Summary for the Monitoring Sites in Alabama

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005-2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
East Thomas, Birmingham, Alabama (ETAL) – Census Tract ID 01073001200								
Acetaldehyde	0.0000022	0.009	2.04	4.48	0.23	1.99 ± 0.27	4.37	0.22
Acrolein	NR	0.00002	0.14	NR	6.81	0.57 ± 0.23	NR	28.47
Acrylonitrile	0.000068	0.002	<0.01	0.13	<0.01	0.06 ± 0.01	4.24	0.03
Arsenic*	0.0043	0.00003	0.03	0.14	<0.01	<0.01 ± <0.01	6.69	0.05
Benzene	0.0000078	0.03	2.06	16.03	0.07	2.90 ± 0.65	22.65	0.1
Benzo (a) pyrene	0.001	NR	<0.01	0.07	NR	<0.01 ± <0.01	0.41	NR
1,3-Butadiene	0.00003	0.002	0.16	4.81	0.08	0.25 ± 0.06	7.41	0.12
Cadmium*	0.0018	0.00002	0.18	0.32	0.01	<0.01 ± <0.01	0.82	0.02
Carbon Tetrachloride	0.000015	0.04	0.22	3.24	0.01	0.68 ± 0.04	10.27	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.37	<0.01	0.28 ± 0.06	3.05	<0.01
Ethyl Acrylate	0.000014	NR	<0.01	<0.01	NR	0.07 ± 0.02	0.99	NR
Formaldehyde	5.5E-09	0.0098	1.81	0.01	0.18	4.90 ± 0.76	0.03	0.5
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.50 ± 0.23	11.1	0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.91	<0.01	<0.01 ± <0.01	0.55	<0.01
Manganese*	NR	0.00005	5.94	NR	0.12	0.05 ± 0.01	NR	1.09
Naphthalene	0.000034	0.003	0.09	2.98	0.03	0.27 ± 0.09	9.03	0.09
Nickel*	0.00016	0.000065	0.42	0.07	0.01	<0.01 ± <0.01	0.33	0.03
Tetrachloroethylene	0.0000059	0.27	0.17	1.03	<0.01	0.37 ± 0.11	2.21	<0.01
Xylenes	NR	0.1	3.32	NR	0.03	7.57 ± 1.89	NR	0.08
North Birmingham, Alabama (NBAL) - Census Tract ID 01073000800								
Acetaldehyde	0.0000022	0.009	2.22	4.89	0.25	1.65 ± 0.25	3.62	0.18
Acrolein	NR	0.00002	0.15	NR	7.71	0.65 ± 0.20	NR	32.62
Acrylonitrile	0.000068	0.002	<0.01	0.16	<0.01	0.06 ± 0.01	4.42	0.03
Arsenic*	0.0043	0.00003	0.03	0.11	<0.01	<0.01 ± <0.01	8.94	0.07
Arsenic (PM_{10})	0.0043	0.00003	0.03	0.11	<0.01	<0.01 ± <0.01	9.03	0.07
Benzene	0.0000078	0.03	2.53	19.77	0.08	3.17 ± 1.17	24.72	0.11

Table 4-7. Chronic Risk Summary for the Monitoring Sites in Alabama (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005-2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Benzo (a) anthracene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.32	NR
Benzo (a) pyrene	0.001	NR	<0.01	0.08	NR	<0.01 ± <0.01	1.77	NR
Benzo (b) fluoranthene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.23	NR
Benzo (k) fluoranthene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.21	NR
1,3-Butadiene	0.00003	0.002	0.21	6.17	0.1	0.15 ± 0.05	4.39	0.07
Cadmium*	0.0018	0.00002	0.9	1.61	0.04	<0.01 ± <0.01	1.48	0.04
Cadmium (PM_{10})	0.0018	0.00002	0.9	1.61	0.04	<0.01 ± <0.01	1.27	0.04
Carbon Tetrachloride	0.000015	0.04	0.21	3.19	0.01	0.67 ± 0.05	10.02	0.02
Dibenz (a,h) anthracene	0.001		<0.01	0.08	NA	<0.01 ± <0.01	0.39	NA
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.38	<0.01	0.32 ± 0.06	3.51	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.83	<0.01	0.05 ± 0.01	1.31	<0.01
Formaldehyde	5.5E-09	0.0098	1.95	0.01	0.2	4.17 ± 0.89	0.02	0.43
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.50 ± 0.23	10.9	0.01
Hexavalent Chromium	0.012	0.0001	<0.01	1.08	<0.01	<0.01 ± <0.01	0.6	<0.01
Indeno(1,2,3-cd)pyrene	0.0001		<0.01	0.05	NA	<0.01 ± <0.01	0.14	NA
Manganese (PM_{10})		0.00005	10.74	NA	0.21	0.04 ± 0.01	NA	0.71
Manganese*		0.00005	10.74	NA	0.21	0.07 ± 0.02	NA	1.39
Naphthalene	0.000034	0.003	0.11	3.85	0.04	0.29 ± 0.09	9.74	0.1
Nickel*	0.00016	0.000065	0.75	0.12	0.01	<0.01 ± <0.01	0.29	0.03
Nickel (PM_{10})	0.00016	0.000065	0.75	0.12	0.01	<0.01 ± <0.01	0.22	0.02
Tetrachloroethylene	0.0000059	0.27	0.18	1.04	<0.01	0.24 ± 0.08	1.44	<0.01
Trichloroethylene	0.000002	0.6	0.12	0.25	<0.01	0.11 ± 0.05	0.22	<0.01
Xylenes		0.1	6.31	NA	0.06	9.66 ± 2.88	NA	0.1

Table 4-7. Chronic Risk Summary for the Monitoring Sites in Alabama (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005-2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Providence, Alabama (PVAL) – Census Tract ID 01073014102								
Acetaldehyde	0.0000022	0.009	1.27	2.79	0.14	1.49 ± 0.82	3.28	0.17
Acrolein	NR	0.00002	0.07	NR	3.40	0.28 ± 0.18	NR	13.77
Acrylonitrile	0.000068	0.002	<0.01	0.04	<0.01	0.06 ± 0.01	4.00	0.03
Arsenic*	0.0043	0.00003	0.04	0.18	<0.01	<0.01 ± <0.01	3.46	0.03
Benzene	0.0000078	0.03	0.96	7.47	0.03	0.57 ± 0.10	4.47	0.02
1,3-Butadiene	0.00003	0.002	0.07	2.18	0.04	0.03 ± 0.02	0.91	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.65 ± 0.05	9.82	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.01	0.12	<0.01	0.22 ± 0.08	2.42	<0.01
Formaldehyde	5.5E-09	0.0098	1.31	0.01	0.13	4.14 ± 2.06	0.02	0.42
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.71 ± 0.27	15.61	0.01
Manganese*	NR	0.00005	2.74	NR	0.05	0.01 ± <0.01	NR	0.13
Naphthalene	0.000034	0.003	0.03	1.05	0.01	0.02 ± <0.01	0.58	0.01
Sloss Industries, Birmingham, Alabama (SIAL) – Census Tract ID 01073005500								
Acetaldehyde	0.0000022	0.009	2.05	4.52	0.23	1.55 ± 0.19	3.41	0.17
Acrolein	NR	0.00002	0.14	NA	6.90	0.73 ± 0.32	NA	36.57
Acrylonitrile	0.000068	0.002	<0.01	0.23	<0.01	0.07 ± 0.02	4.61	0.03
Arsenic*	0.0043	0.00003	0.03	0.13	<0.01	0.01 ± <0.01	24.79	0.19
Benzene	0.0000078	0.03	2.49	19.41	0.08	6.17 ± 2.07	48.15	0.21
Benzo (a) anthracene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.31	NR
Benzo (a) pyrene	0.001	NR	<0.01	0.08	NR	<0.01 ± <0.01	1.95	NR
Benzo (b) fluoranthene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.31	NR
Benzo (k) fluoranthene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.25	NR
Beryllium*	0.0024	0.00002	0.01	0.01	<0.01	<0.01 ± <0.01	0.73	0.02
1,3-Butadiene	0.00003	0.002	0.17	5.01	0.08	0.21 ± 0.05	6.36	0.11
Cadmium*	0.0018	0.00002	0.42	0.75	0.02	<0.01 ± <0.01	0.66	0.02

Table 4-7. Chronic Risk Summary for the Monitoring Sites in Alabama (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005-2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Carbon Tetrachloride	0.000015	0.04	0.21	3.15	0.01	0.65 ± 0.04	9.73	0.02
Chloromethylbenzene	0.000049	NR	<0.01	<0.01	NR	0.05 ± 0.01	2.34	NR
Dibenz (a,h) anthracene	0.001	NR	<0.01	0.08	NR	<0.01 ± <0.01	0.44	NR
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.31	<0.01	0.40 ± 0.11	4.39	<0.01
Formaldehyde	5.5E-09	0.0098	1.84	0.01	0.19	3.70 ± 0.71	0.02	0.38
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.55 ± 0.24	12.04	0.01
Hexavalent Chromium	0.012	0.0001	<0.01	1.00	<0.01	<0.01 ± <0.01	0.63	<0.01
Indeno(1,2,3-cd)pyrene	0.0001	NR	<0.01	0.05	NR	<0.01 ± <0.01	0.19	NR
Manganese*	NR	0.00005	10.65	NR	0.21	0.14 ± 0.05	NR	2.79
Naphthalene	0.000034	0.003	0.09	3.12	0.03	0.50 ± 0.12	16.85	0.17
Nickel*	0.00016	0.000065	0.74	0.12	0.01	<0.01 ± <0.01	0.34	0.03
Tetrachloroethylene	0.0000059	0.27	0.17	1.00	<0.01	0.24 ± 0.07	1.43	<0.01
Xylenes	NR	0.1	5.80	NR	0.06	6.24 ± 1.40	NR	0.06

*Metals sampled were sampled with TSP filters, except where indicated otherwise.
BOLD indicates a pollutant of interest
NR = a risk factor is not available and therefore, no risk calculation can be made.
NA = Not available due to the short sampling duration.

- The noncancer HQ from acrolein was also greater than 1.0 (13.77), but was about half as high as those calculated for the other sites.

- No other pollutant had a noncancer HQ greater than 1.0 for PVAL.

In addition to the annual averages and risks based on 2005-2006 monitoring data, data from EPA's 1999 NATA were retrieved and are also presented in Table 4-7. The census tract for each Alabama site is presented in Table 4-7. Populations from the 2000 Census for each census tracts ranged from 2,689 (or 0.4 percent of the 2000 county total) for SIAL to 5,387 (or 0.8 percent of the 2000 county total) for NBAL.

The following observations can be garnered for the three Birmingham sites (ETAL, NBAL, and SIAL) from Table 4-7:

- Manganese, xylenes, benzene, and acetaldehyde (in that order) exhibited the highest NATA-modeled concentrations.

- While actual measured concentrations of manganese were much lower than the modeled concentrations, the annual averages of xylenes and benzene did have some of the highest annual averages at these sties.

- Manganese and xylenes do not have cancer risk factors.

- Benzene exhibited the highest modeled cancer risks at all three sites, ranging from 16.03 in-a-million (at ETAL) to 19.77 in-a-million (at NBAL). These risk were similar to those calculated for ETAL and NBAL, but the calculated risk for benzene for SIAL (48.15 in-a-million) was more than twice the modeled cancer risk (19.41 in-a-million).

- Acrolein was the only pollutant with a noncancer HQ greater than 1.0 at all three sites, although the modeled noncancer risks were much lower than the calculated noncancer risks for each site.

The following observations can be garnered for PVAL from Table 4-7:

- Manganese, formaldehyde, and acetaldehyde had the highest modeled concentrations.

- The highest modeled cancer risks were attributable to benzene, carbon tetrachloride, and acetaldehyde.

- Acrolein was the only pollutant with a noncancer HQ greater than 1.0, although the modeled noncancer risk (3.40) was much lower than the calculated noncancer risk (13.77).

4.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 4-8 and 4-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 4-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 4-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average concentration is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 4-8:

- Benzene, formaldehyde, and acetaldehyde were the top three emitted pollutants with cancer risk factors in Jefferson County, while benzene, lead, and 1,3-butadiene had the top three toxicity-weighted emissions.

- Benzene also had the highest cancer risk based on the annual average concentration for NBAL, ETAL, and SIAL, ranging from 22.65 in-a-million (for ETAL) to 48.15 in-a-million (for SIAL).

- Benzene's cancer risk for PVAL ranked third, and was considerably lower than the Birmingham sites (4.47 in-a-million).

- While hexachloro-1,3-butadiene had the second highest cancer risk based on the annual average for ETAL and NBAL, this pollutant's cancer risk ranked first for PVAL and fifth for SIAL, yet the cancer risks were all relatively similar.

Table 4-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Alabama

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (Jefferson County)		Top 10 Cancer Toxicity-Weighted Emissions (Jefferson County)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
East Thomas, Birmingham, Alabama – ETAL					
Benzene	1,914.42	Benzene	1.49E-02	Benzene	22.65
Formaldehyde	1,040.74	Lead	1.13E-02	Hexachloro-1,3-butadiene	11.10
Acetaldehyde	373.93	1,3-Butadiene	7.13E-03	Carbon Tetrachloride	10.27
Tetrachloroethylene	280.30	Naphthalene	4.71E-03	Naphthalene	9.03
1,3-Dichloropropene	238.49	Arsenic	1.69E-03	1,3-Butadiene	7.41
1,3-Butadiene	237.53	Tetrachloroethylene	1.65E-03	Arsenic	6.69
Dichloromethane	162.04	*p*-Dichlorobenzene	1.36E-03	Acetaldehyde	4.37
Naphthalene	138.65	1,3-Dichloropropene	9.54E-04	Acrylonitrile	4.24
p-Dichlorobenzene	123.56	Hexavalent Chromium	8.61E-04	*p*-Dichlorobenzene	3.05
Polycyclic Organic Matter as 15-PAH	14.67	Acetaldehyde	8.23E-04	Tetrachloroethylene	2.21
North Birmingham, Alabama – NBAL					
Benzene	1,914.42	Benzene	1.49E-02	Benzene	24.72
Formaldehyde	1,040.74	Lead	1.13E-02	Hexachloro-1,3-butadiene	10.90
Acetaldehyde	373.93	1,3-Butadiene	7.13E-03	Carbon Tetrachloride	10.02
Tetrachloroethylene	280.30	Naphthalene	4.71E-03	Naphthalene	9.74
1,3-Dichloropropene	238.49	Arsenic	1.69E-03	Arsenic (PM10)	9.03
1,3-Butadiene	237.53	Tetrachloroethylene	1.65E-03	Arsenic (TSP)	8.94
Dichloromethane	162.04	*p*-Dichlorobenzene	1.36E-03	Acrylonitrile	4.42
Naphthalene	138.65	1,3-Dichloropropene	9.54E-04	1,3-Butadiene	4.39
p-Dichlorobenzene	123.56	Hexavalent Chromium	8.61E-04	Acetaldehyde	3.62
Polycyclic Organic Matter as 15-PAH	14.67	Acetaldehyde	8.23E-04	*p*-Dichlorobenzene	3.51

Table 4-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Alabama (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (Jefferson County)		Top 10 Cancer Toxicity-Weighted Emissions (Jefferson County)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Providence, Alabama – PVAL					
Benzene	1,914.42	Benzene	1.49E-02	Hexachloro-1,3-butadiene	15.61
Formaldehyde	1,040.74	Lead	1.13E-02	Carbon Tetrachloride	9.82
Acetaldehyde	373.93	1,3-Butadiene	7.13E-03	Benzene	4.47
Tetrachloroethylene	280.30	Naphthalene	4.71E-03	Acrylonitrile	4.00
1,3-Dichloropropene	238.49	Arsenic	1.69E-03	Arsenic	3.46
1,3-Butadiene	237.53	Tetrachloroethylene	1.65E-03	Acetaldehyde	3.28
Dichloromethane	162.04	*p*-Dichlorobenzene	1.36E-03	*p*-Dichlorobenzene	2.42
Naphthalene	138.65	1,3-Dichloropropene	9.54E-04	1,3-Butadiene	0.91
p-Dichlorobenzene	123.56	Hexavalent Chromium	8.61E-04	Naphthalene	0.58
Polycyclic Organic Matter as 15-PAH	14.67	Acetaldehyde	8.23E-04	Formaldehyde	0.02
Sloss Industries, Birmingham, Alabama – SIAL					
Benzene	1,914.42	Benzene	1.49E-02	Benzene	48.15
Formaldehyde	1,040.74	Lead	1.13E-02	Arsenic	24.79
Acetaldehyde	373.93	1,3-Butadiene	7.13E-03	Naphthalene	16.85
Tetrachloroethylene	280.30	Naphthalene	4.71E-03	Hexachloro-1,3-butadiene	12.04
1,3-Dichloropropene	238.49	Arsenic	1.69E-03	Carbon Tetrachloride	9.73
1,3-Butadiene	237.53	Tetrachloroethylene	1.65E-03	1,3-Butadiene	6.36
Dichloromethane	162.04	*p*-Dichlorobenzene	1.36E-03	Acrylonitrile	4.61
Naphthalene	138.65	1,3-Dichloropropene	9.54E-04	*p*-Dichlorobenzene	4.39
p-Dichlorobenzene	123.56	Hexavalent Chromium	8.61E-04	Acetaldehyde	3.41
Polycyclic Organic Matter as 15-PAH	14.67	Acetaldehyde	8.23E-04	Chloromethylbenzene	2.34

Table 4-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Alabama

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (Jefferson County)		Top 10 Noncancer Toxicity-Weighted Emissions (Jefferson County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
East Thomas, Birmingham, Alabama – ETAL					
Toluene	5,862.72	Acrolein	2,930,122.29	Acrolein	28.47
Xylenes	4,195.84	1,3-Butadiene	118,762.60	Manganese	1.09
Benzene	1,914.42	Formaldehyde	106,198.46	Formaldehyde	0.50
Methyl Tert-Butyl Ether	1,700.77	Bromomethane	66,526.05	Acetaldehyde	0.22
Methanol	1,263.87	Benzene	63,814.03	1,3-Butadiene	0.12
Hexane	1,100.16	Naphthalene	46,217.08	Benzene	0.10
Formaldehyde	1,040.74	Xylenes	41,958.37	Naphthalene	0.09
Ethylbenzene	925.98	Acetaldehyde	41,547.57	Xylenes	0.08
Methyl Ethyl Ketone	781.84	Cyanide	38,836.22	Arsenic	0.05
1,1,1-Trichloroethane	634.12	Cadmium	21,408.23	Nickel	0.03
North Birmingham, Alabama – NBAL					
Toluene	5,862.72	Acrolein	2,930,122.29	Acrolein	32.62
Xylenes	4,195.84	1,3-Butadiene	118,762.60	Manganese (TSP)	1.39
Benzene	1,914.42	Formaldehyde	106,198.46	Manganese (PM10)	0.71
Methyl Tert-Butyl Ether	1,700.77	Bromomethane	66,526.05	Formaldehyde	0.43
Methanol	1,263.87	Benzene	63,814.03	Acetaldehyde	0.18
Hexane	1,100.16	Naphthalene	46,217.08	Benzene	0.11
Formaldehyde	1,040.74	Xylenes	41,958.37	Xylenes	0.10
Ethylbenzene	925.98	Acetaldehyde	41,547.57	Naphthalene	0.10
Methyl Ethyl Ketone	781.84	Cyanide	38,836.22	1,3-Butadiene	0.07
1,1,1-Trichloroethane	634.12	Cadmium	21,408.23	Arsenic (PM10)	0.07

Table 4-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk for Pollutants with Noncancer RfCs for the Monitoring Sites in Alabama

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (Jefferson County)		Top 10 Noncancer Toxicity-Weighted Emissions (Jefferson County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Providence, Alabama – PVAL					
Toluene	5,862.72	Acrolein	2,930,122.29	Acrolein	13.77
Xylenes	4,195.84	1,3-Butadiene	118,762.60	Formaldehyde	0.42
Benzene	1,914.42	Formaldehyde	106,198.46	Acetaldehyde	0.17
Methyl Tert-Butyl Ether	1,700.77	Bromomethane	66,526.05	Manganese	0.13
Methanol	1,263.87	Benzene	63,814.03	Acrylonitrile	0.03
Hexane	1,100.16	Naphthalene	46,217.08	Arsenic	0.03
Formaldehyde	1,040.74	Xylenes	41,958.37	Benzene	0.02
Ethylbenzene	925.98	Acetaldehyde	41,547.57	Carbon Tetrachloride	0.02
Methyl Ethyl Ketone	781.84	Cyanide	38,836.22	1,3-Butadiene	0.02
1,1,1-Trichloroethane	634.12	Cadmium	21,408.23	Hexachloro-1,3-butadiene	0.01
Sloss Industries, Birmingham, Alabama – SIAL					
Toluene	5,862.72	Acrolein	2,930,122.29	Acrolein	36.57
Xylenes	4,195.84	1,3-Butadiene	118,762.60	Manganese	2.79
Benzene	1,914.42	Formaldehyde	106,198.46	Formaldehyde	0.38
Methyl Tert-Butyl Ether	1,700.77	Bromomethane	66,526.05	Benzene	0.21
Methanol	1,263.87	Benzene	63,814.03	Arsenic	0.19
Hexane	1,100.16	Naphthalene	46,217.08	Acetaldehyde	0.17
Formaldehyde	1,040.74	Xylenes	41,958.37	Naphthalene	0.17
Ethylbenzene	925.98	Acetaldehyde	41,547.57	1,3-Butadiene	0.11
Methyl Ethyl Ketone	781.84	Cyanide	38,836.22	Xylenes	0.06
1,1,1-Trichloroethane	634.12	Cadmium	21,408.23	Acrylonitrile	0.03

- While arsenic had one of the 10 highest cancer risks for all of the sites, the risk for SIAL was significantly higher than at the remaining sites.

- Although naphthalene also had one of the 10 highest cancer risks for all of the sites, the risk for PVAL was significantly lower than for the remaining sites.

The following observations can be made from Table 4-9:

- Toluene, xylenes, and benzene were the top three emitted pollutants with noncancer risk factors in Jefferson County, while acrolein, 1,3-butadiene, and formaldehyde had the top three toxicity-weighted emissions.

- Acrolein also had the highest noncancer risk based on the annual average concentration for all four Alabama sites, ranging from 13.77 for PVAL to 36.57 for SIAL.

- Although acrolein was the only pollutant with a noncancer risk greater than 1.0 for most UATMP sites, manganese had noncancer HQs greater than 1.0 for the three Birmingham sites, ranging from 1.09 for ETAL to 2.79 for SIAL. Manganese, however, did not have one of 10 highest toxicity-weighted emissions, and neither acrolein nor manganese was one of the most emitted pollutants in Jefferson County.

Alabama Pollutant Summary

- *The pollutants of interest common to each Alabama site were acetaldehyde, arsenic (TSP), acrolein, benzene, carbon tetrachloride, p-dichlorobenzene, formaldehyde, hexachloro-1,3-butadiene, manganese (TSP), and naphthalene.*

- *Among each sites pollutants of interest, total xylenes had the highest daily average for ETAL and NBAL, while formaldehyde had the highest daily average for PVAL, and benzene had the highest daily average for SIAL.*

- *Acrolein exceeded both of the short-term risk factors at each Alabama site and benzene exceeded the ATSDR MRL at SIAL.*

5.0 Site in Arizona

This section presents meteorological, concentration, and spatial trends for the UATMP site in Phoenix, Arizona (PXSS). Figure 5-1 is a topographical map showing the monitoring site in its urban location. Figure 5-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The Phoenix site is surrounded by numerous point sources, mostly located to the southeast, south, and southwest of the site. A large number of point sources near PXSS fall into the fuel combustion source category.

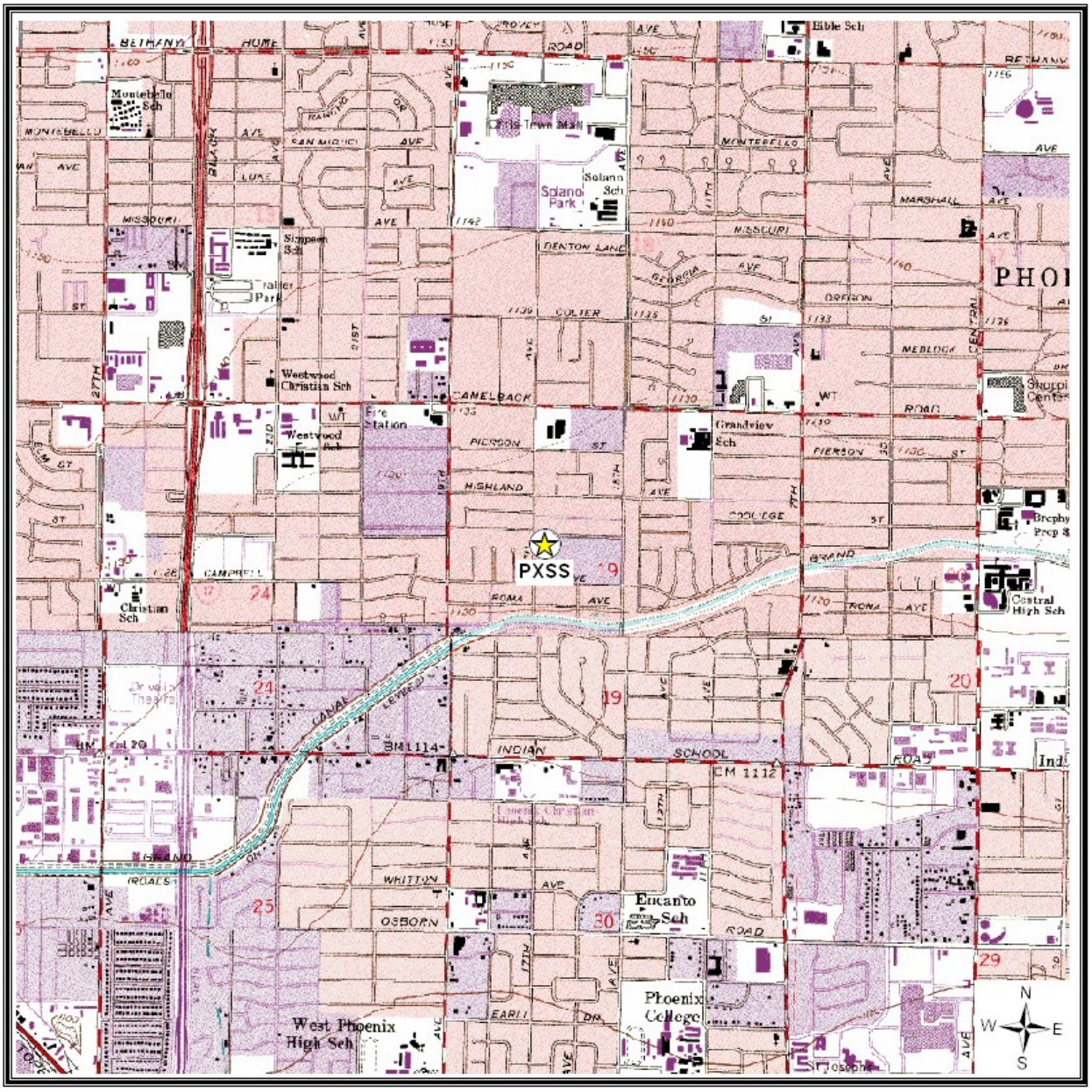
The Phoenix area is located in the Salt River Valley, which is part of the Sonora Desert. The area experiences mild winters and extremely hot and dry summers. Differences between the daytime maximum temperature and overnight minimum temperature can be as high as 50 degrees. A summer "monsoon" period brings precipitation to the area for part of the summer, while storms originating off the Pacific Coast bring rain in the winter and early spring. Winds are generally light. (Ruffner and Bair, 1987 and WRCC, 2006).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the PXSS monitoring site is Sky Harbor International Airport (WBAN 23183). Table 5-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 5-1 is the 95 percent confidence interval. As shown in Table 5-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

5.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Arizona monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 5-1. Phoenix, Arizona (PXSS) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 5-2. Facilities Located Within 10 Miles of PXSS

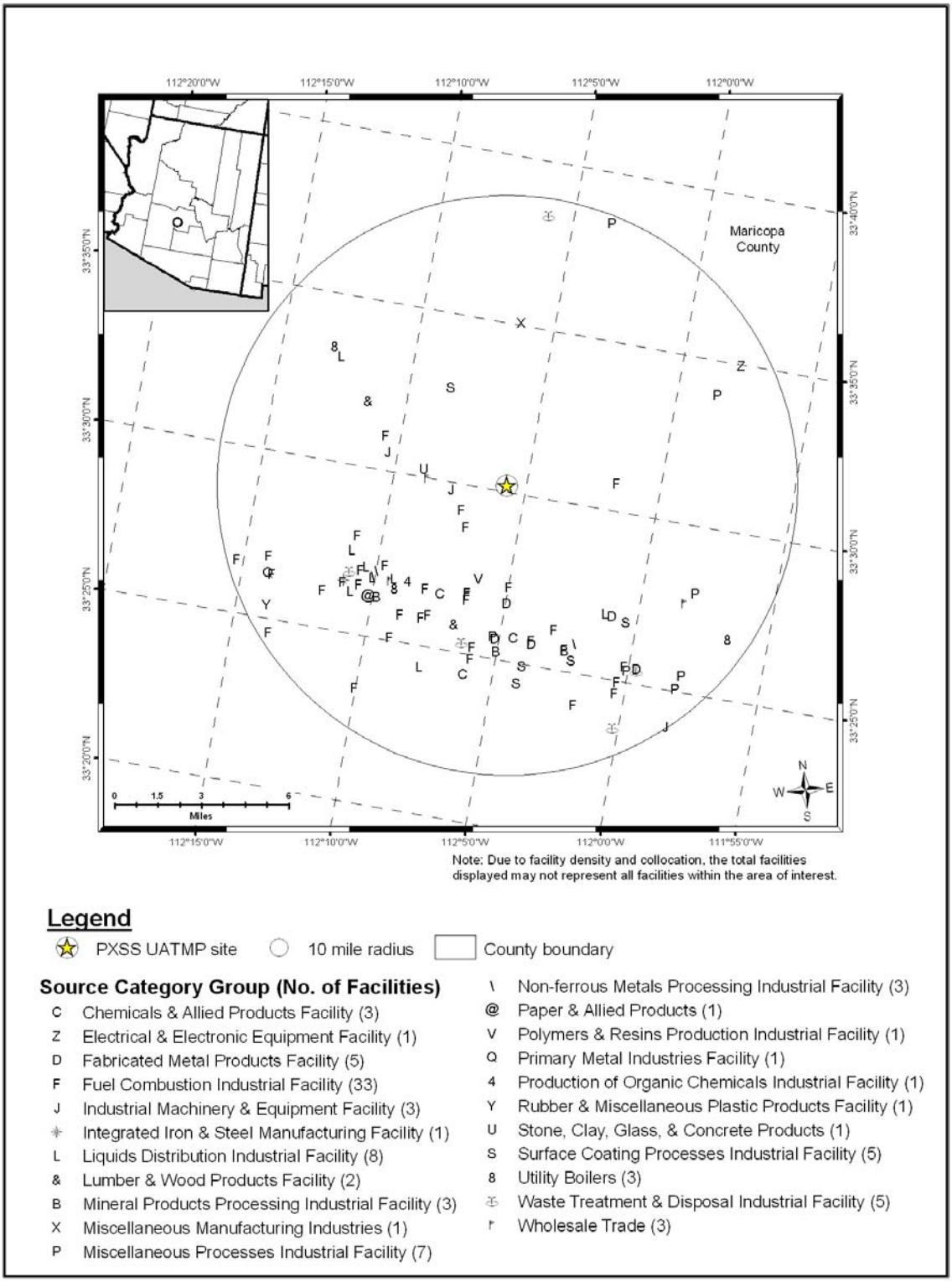


Table 5-1. Average Meteorological Conditions near the Monitoring Site in Arizona

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
PXSS	23183	All 2006	86.22 ± 1.58	75.49 ± 1.59	36.13 ± 1.55	55.33 ± 1.10	28.32 ± 1.33	1012.09 ± 0.52	5.79 ± 0.20
		Sampling Day	85.37 ± 3.63	74.61 ± 3.70	36.63 ± 3.52	54.59 ± 2.56	28.93 ± 2.90	1012.70 ± 1.24	5.84 ± 0.48

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. PXSS sampled hexavalent chromium and metals (PM_{10}). Table 5-2 presents the five pollutants that failed at least one screen at PXSS.

The following observations are shown in Table 5-2:

- A total of 155 measured concentrations (over 50 percent) failed screens.
- The screening process at PXSS resulted in three pollutants of interest: manganese (57 failed screens), arsenic (56), and hexavalent chromium (35).
- More than 90 percent of the measured detections of manganese and arsenic exceeded the screening values.

Table 5-2. Comparison of Measured Concentrations and EPA Screening Values for the Arizona Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Phoenix, Arizona – PXSS					
Manganese (PM_{10})	57	59	96.61	36.77	36.77
Arsenic (PM_{10})	56	59	94.92	36.13	72.90
Hexavalent Chromium	35	58	60.34	22.58	95.48
Nickel (PM_{10})	6	59	10.17	3.87	99.35
Cadmium (PM_{10})	1	59	1.69	0.65	100.00
Total	155	294	52.72		

5.2 Concentration Averages

Three types of concentration averages were calculated for the following subsections: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within a season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less

than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects were incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 5-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 5-3:

- Manganese had the highest daily average concentration by mass at PXSS (18.08 ± 2.31 ng/m^3).
- The seasonal averages for hexavalent chromium and manganese did not vary significantly.
- The autumn and winter arsenic averages were slightly higher than the spring and summer averages.
- Arsenic and manganese were detected in every sample collected at PXSS, and hexavalent chromium was detected in all but one measurement.

5.3 Non-Chronic Risk Evaluation

Non-chronic risk based on the concentration data for PXSS was evaluated using ATSDR acute and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the five pollutants with at least one failed screen, none exceeded either of the acute and intermediate risk values.

5.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

Table 5-3. Daily and Seasonal Averages for the Pollutants of Interest for the Arizona Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Phoenix, Arizona – PXSS												
Arsenic (PM_{10})	59	59	0.64	0.11	0.88	0.28	0.41	0.05	0.47	0.08	0.77	0.22
Hexavalent Chromium	58	59	0.13	0.04	0.18	0.10	0.12	0.03	0.13	0.12	0.10	0.02
Manganese (PM_{10})	59	59	18.08	2.31	24.22	4.27	13.70	2.23	16.59	5.19	17.72	4.54

5.4.1 Pearson Correlation Analysis

Table 5-4 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the PXSS monitoring site. (Refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 5-4:

- The pollutants of interest for PXSS exhibited weak correlations with the selected meteorological parameters, indicating that these variables have little effect on concentrations of the pollutants of interest.

5.4.2 Composite Back Trajectory Analysis

Figure 5-3 is a composite back trajectory map for the PXSS monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 5-3 represents 100 miles.

The following observations can be made from Figure 5-3:

- The back trajectories originated from a variety of directions at PXSS.
- The 24-hour airshed domain was somewhat smaller at PXSS than other UATMP sites;
- 72 percent of the trajectories originated within 200 miles of the site and 90 percent within 300 miles from the PXSS monitoring site.
- One trajectory originated as far away as northern Nevada, greater than 500 miles away.

5.4.3 Wind Rose Analysis

Hourly wind data from the Sky Harbor International Airport near the PXSS monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 5-4 is the wind rose for the PXSS monitoring site on days sampling occurred.

Table 5-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Arizona Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Phoenix, Arizona – PXSS								
Arsenic (PM_{10})	59	-0.22	-0.27	-0.08	-0.21	0.26	0.31	-0.31
Hexavalent Chromium	58	-0.03	-0.04	-0.10	-0.08	-0.13	-0.03	-0.16
Manganese (PM_{10})	59	-0.13	-0.21	-0.30	-0.27	-0.26	0.34	-0.30

Figure 5-3. Composite Back Trajectory Map for PXSS

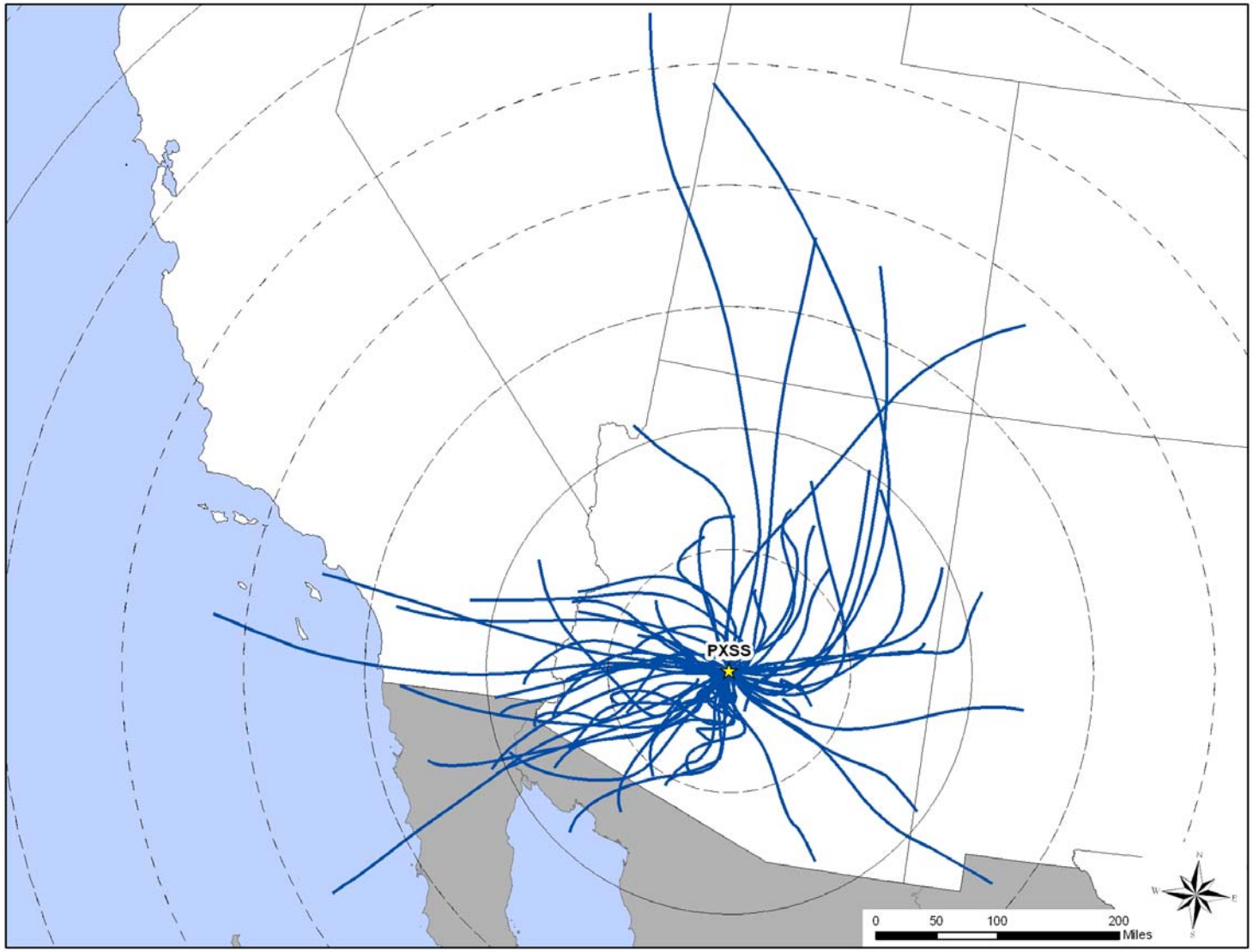
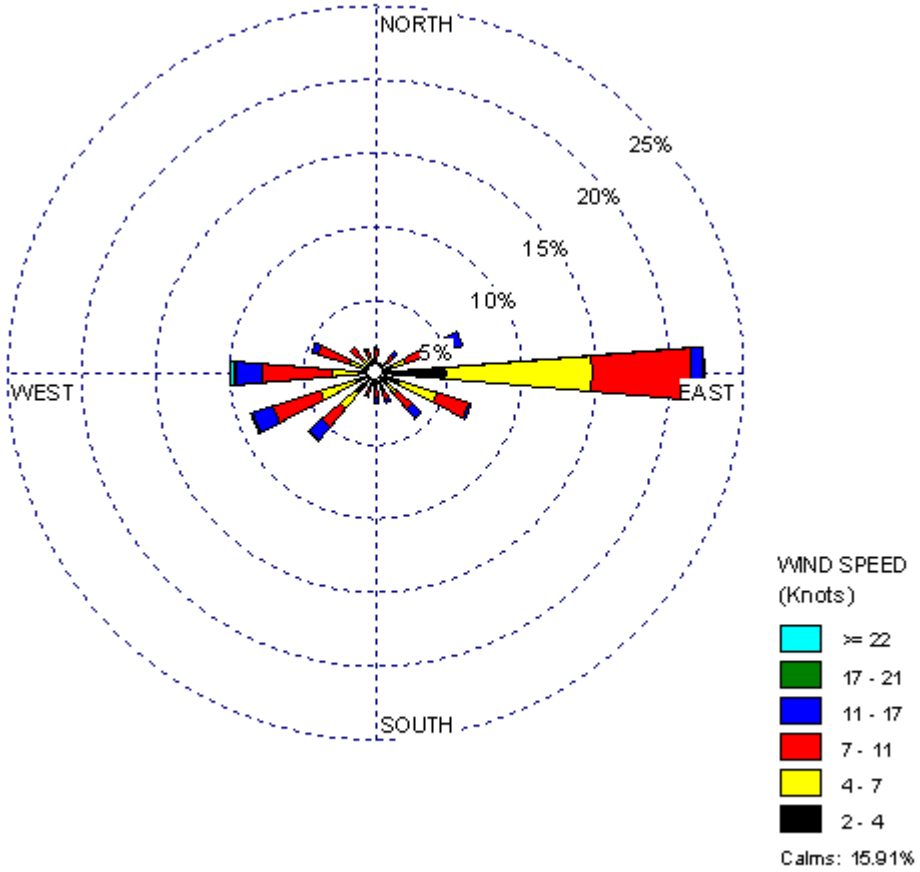


Figure 5-4. Wind Rose for PXSS Sampling Days



Observations from Figure 5-4 include:

- Hourly winds were predominantly out of the east (22 percent of observations) and west (10 percent) on sampling days.

- Wind speeds tended to range from 7 to 11 knots on days that samples were collected (30 percent of observations).

- Calm winds (<2 knots) were observed for 16 percent of the observations.

5.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as this site did not sample for VOC. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

5.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Maricopa County, AZ were obtained from the Arizona Department of Transportation and the U.S. Census Bureau, and are summarized in Table 5-5. Table 5-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 5-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 5-5 include:

- Compared to other UATMP sites, the county population in and around PXSS is near the top, second only to the Chicago area.

- PXSS also has the highest county-level vehicle registration of any UATMP site.

- Although the Phoenix area is one of several large metropolitan areas included in the UATMP, the average daily traffic count is very low compared to other UATMP sites. Most of the other sites with low traffic counts are in fairly rural areas. Given that the PXSS monitoring site is considered a residential area and is located in an urban-city center setting, it is possible this number is underestimated.

Table 5-5. Motor Vehicle Information for the Arizona Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
PXSS	3,768,123	3,682,234	0.98	1,471,887	1,438,337	250

5.6 Trends Analysis

A trends analysis could not be performed for PXSS as this site has not participated in the UATMP for three consecutive years.

5.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at PXSS and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 5-6. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA for the pollutants that failed at least one screen at PXSS were retrieved and are also presented in Table 5-6. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for the PXSS site is as follows:

- The PXSS monitoring site is located in census tract 04013108902.
- The census tract population for the census tract where the PXSS monitoring site is located was 5,222, which represents less than 1 percent of the county population in 2000.

The following observations can be made from Table 5-6:

- With the exception of manganese, all of the annual averages were less than 0.01 $\mu g/m^3$.
- Based on these annual average concentrations, arsenic and hexavalent chromium exhibited cancer risks greater than 1 in a million (2.74 and 1.58 in-a-million, respectively).
- Manganese exhibited the highest noncancer HQ (0.36).
- Each of the NATA-modeled concentrations for pollutants that failed at least one screen was less than 0.01 $\mu g/m^3$,which was similar to the annual averages.

Table 5-6. Chronic Risk Summary for the Monitoring Site in Arizona

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Phoenix, Arizona (PXSS) – Census Tract ID 04013108902								
Arsenic*	0.0043	0.00003	<0.01	0.05	<0.01	<0.01 ±0.01	2.74	0.02
Cadmium*	0.0018	0.00002	<0.01	0.02	<0.01	<0.01 ±0.01	0.24	0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.37	<0.01	<0.01 ±0.01	1.58	<0.01
Manganese*	NR	0.00005	<0.01	NR	<0.01	0.02 ±0.01	NR	0.36
Nickel*	0.00016	0.000065	<0.01	0.02	<0.01	<0.01 ±0.01	0.22	0.02

*Metals sampled at PXSS were sampled with PM_{10} filters.
BOLD indicates a pollutant of interest
NR = a risk factor is not available and therefore, no risk calculation can be made.

- In terms of cancer risk, the highest risk for a pollutant that failed at least one screen was calculated for hexavalent chromium (0.37 in-a-million). All the rest were less than 0.10 in-a-million.

- The NATA-modeled cancer risks tended to be an order of magnitude less than the cancer risks calculated from the annual averages.

- All of the NATA noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects.

5.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 5-7 and 5-8 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 5-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 5-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 5-7:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and the highest cancer toxicity-weighted emissions for Maricopa County.

- Seven of the top 10 pollutants (benzene, acetaldehyde, tetrachloroethylene, 1,3-dichloropropene, 1,3-butadiene, naphthalene, and *p*-dichlorobenzene) appeared on both the highest emitted list and the highest toxicity-weighted emissions list, indicating that most of the highest emitted pollutants are also the most toxic.

- PXSS did not sample for VOC, carbonyls, or SVOC and therefore, cancer risks based on annual averages for most of these pollutants cannot be assessed at this time. However, lead, arsenic, and hexavalent chromium, which were sampled for at PXSS, were listed in the top 10 toxicity-weighted emissions.

Table 5-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for PXSS

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Maricopa County)		Top 10 Cancer Toxicity-Weighted Emissions (for Maricopa County)		Top 10 Cancer Risks Based on Annual Average Concentration (for PXSS)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Phoenix, Arizona – PXSS					
Benzene	1,914.42	Benzene	1.49E-02	Arsenic	2.74
Formaldehyde	1,040.74	Lead	1.13E-02	Hexavalent Chromium	1.58
Acetaldehyde	373.93	1,3-Butadiene	7.13E-03	Cadmium	0.24
Tetrachloroethylene	280.30	Naphthalene	4.71E-03	Nickel	0.22
1,3-Dichloropropene	238.49	Arsenic	1.69E-03		
1,3-Butadiene	237.53	Tetrachloroethylene	1.65E-03		
Dichloromethane	162.04	*p*-Dichlorobenzene	1.36E-03		
Naphthalene	138.65	1,3-Dichloropropene	9.54E-04		
p-Dichlorobenzene	123.56	Hexavalent Chromium	8.61E-04		
Polycyclic Organic Matter as 15-PAH	14.67	Acetaldehyde	8.23E-04		

Table 5-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for PXSS

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Maricopa County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Maricopa County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for PXSS)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Phoenix, Arizona – PXSS					
Toluene	5,862.72	Acrolein	2,930,122.29	Manganese	0.36
Xylenes	4,195.84	1,3-Butadiene	118,762.60	Arsenic	0.02
Benzene	1,914.42	Formaldehyde	106,198.46	Nickel	0.02
Methyl Tert-Butyl Ether	1,700.77	Bromomethane	66,526.05	Cadmium	0.01
Methanol	1,263.87	Benzene	63,814.03	Hexavalent Chromium	<0.01
Hexane	1,100.16	Naphthalene	46,217.08		
Formaldehyde	1,040.74	Xylenes	41,958.37		
Ethylbenzene	925.98	Acetaldehyde	41,547.57		
Methyl Ethyl Ketone	781.84	Cyanide	38,836.22		
1,1,1-Trichloroethane	634.12	Cadmium	21,408.23		

- Arsenic and hexavalent chromium were listed first and second for highest cancer risk based on the annual average for PXSS (2.74 and 1.58 in-a-million, respectively).

- Because lead did not fail any screens at PXSS it was excluded from this analysis.

The following observations can be made from Table 5-8:

- Although toluene was the highest emitted pollutant (by mass) with a noncancer risk factor, it does not rank in the top 10 pollutants based on toxicity-weighted emissions.

- Acrolein has the highest noncancer toxicity- weighted emissions, but does not appear in the list of highest emitted pollutants.

- Only three pollutants (xylenes, benzene, and formaldehyde) appear on both the top 10 emitted pollutants and top 10 toxicity-weighted emissions lists.

- Because PXSS did not sample for VOC, carbonyls, or SVOC and therefore, a comparison of noncancer risks based on annual averages for these pollutants cannot be assessed at this time.

- Cadmium was the only pollutant that failed screens at PXSS and has one of the top 10 highest noncancer toxicity-weighted emissions. The noncancer HQ for cadmium based on the annual average at PXSS was very low (0.01).

Arizona Pollutant Summary

- *The pollutants of interest for the Arizona site were manganese, arsenic, and hexavalent chromium.*

- *Manganese had the highest daily average at PXSS.*

- *No pollutants exceeded either of the short-term risk factors.*

6.0 Site in Colorado

This section presents meteorological, concentration, and spatial trends for the UATMP site in Grand Junction, Colorado (GPCO). Figure 6-1 is a topographical map showing the monitoring site in its urban location. Figure 6-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The Grand Junction site is surrounded by numerous point sources, mostly located to the northwest, north, and northeast of the site. A large number of point sources near GPCO fall into the liquids distribution source category.

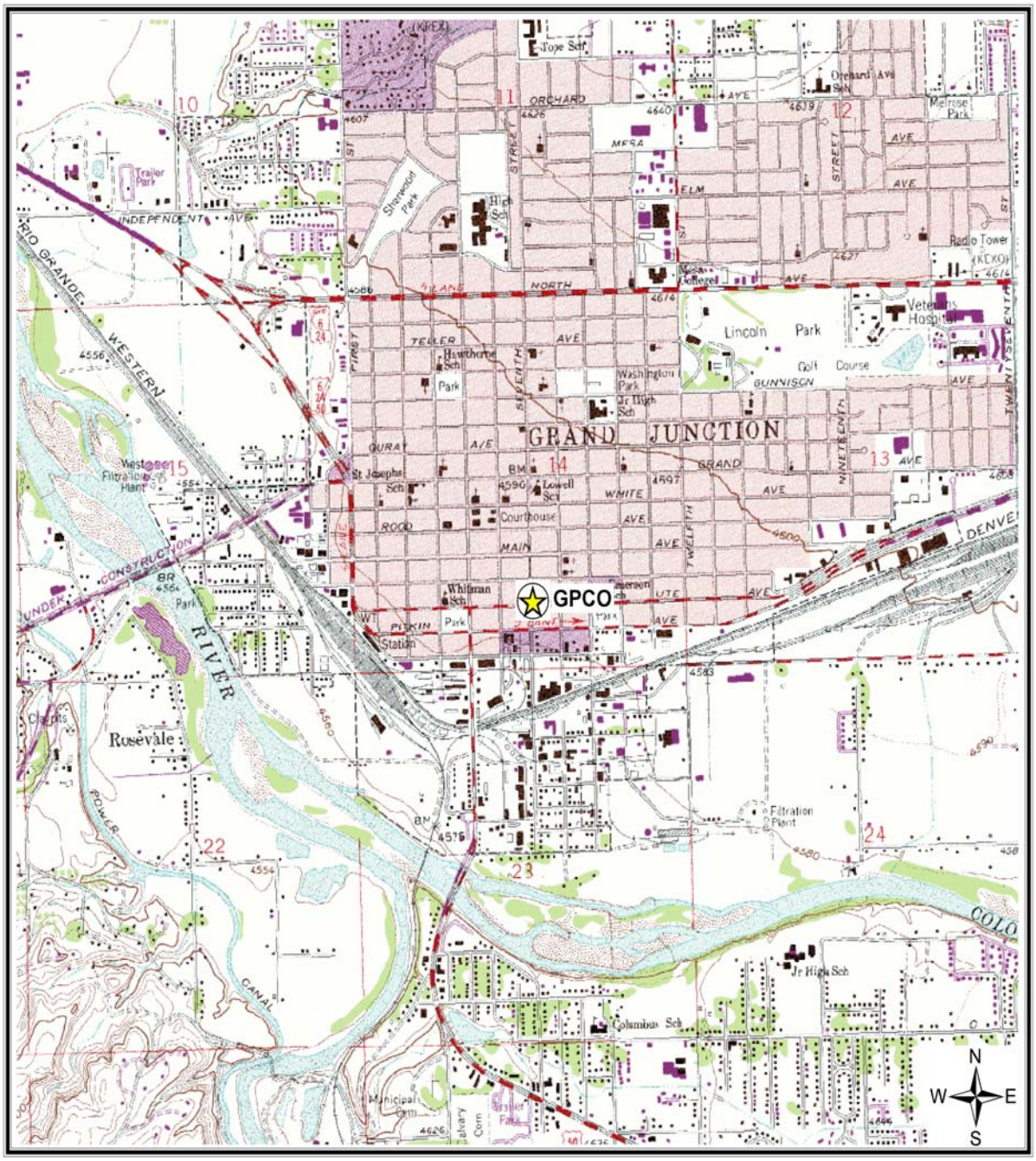
Grand Junction is located in a mountain valley on the west side of the Rockies. This location can help protect the area from dramatic weather changes. The area tends to be rather dry and winds tend to flow out of the east-southeast on average, due to the valley breeze effect. Valley breezes occur as the sun heats up the side of a mountain. The warm air rises, creating a current that will move up the valley walls (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the GPCO monitoring site is Walker Field Airport (WBAN 23066). Table 6-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 6-1 is the 95 percent confidence interval for each parameter. As shown in Table 6-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

6.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Colorado monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 6-1. Grand Junction, Colorado (GPCO) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 6-2. Facilities Located Within 10 Miles of GPCO

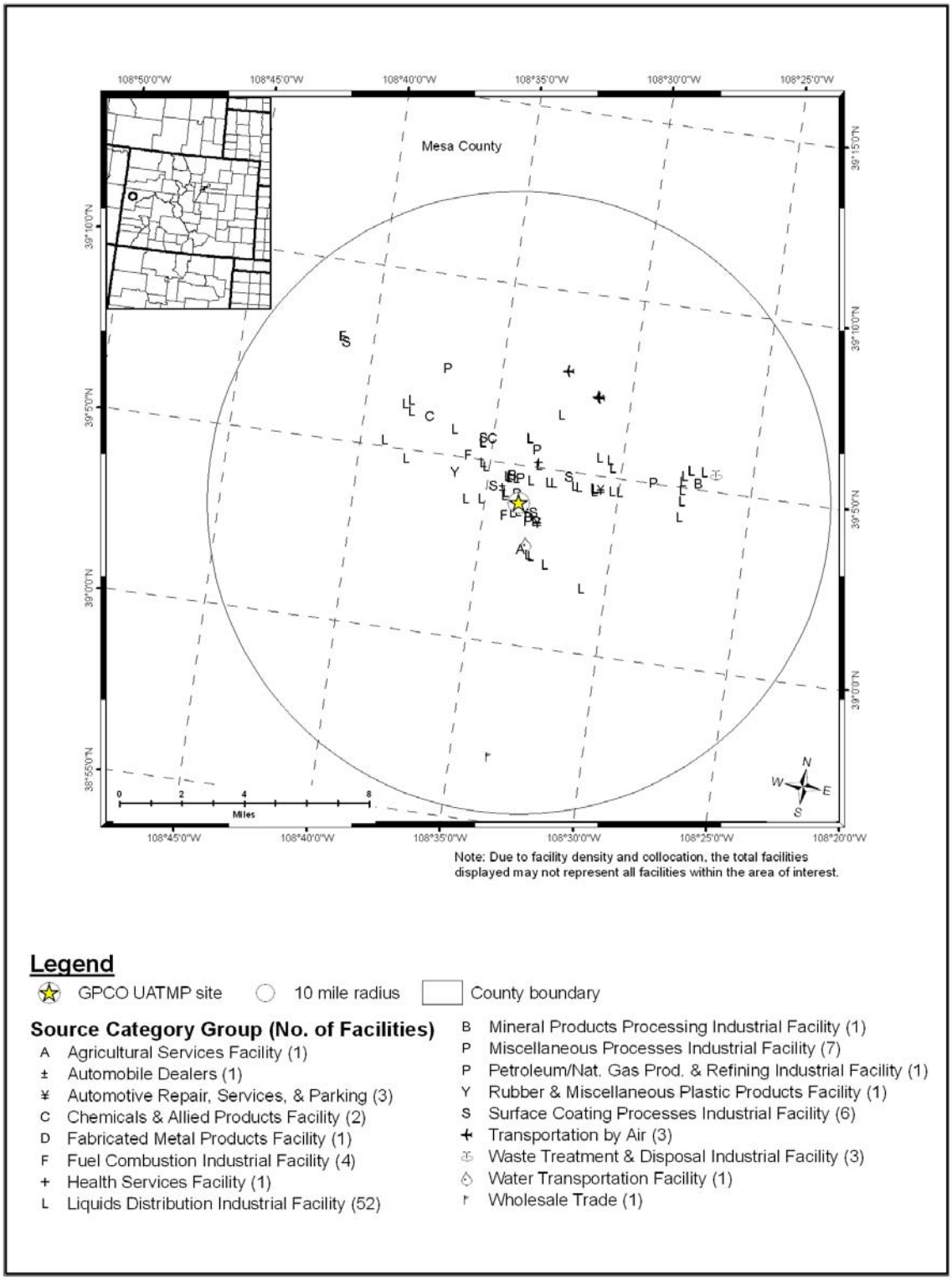


Table 6-1. Average Meteorological Conditions near the Monitoring Site in Colorado

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
GPCO	23066	All 2006	65.40 ± 2.12	53.29 ± 1.94	27.92 ± 1.32	41.31 ± 1.30	46.02 ± 2.11	1015.49 ± 0.82	6.86 ± 0.27
		Sampling Day	64.15 ± 5.17	52.34 ± 4.66	27.14 ± 3.22	40.60 ± 3.13	45.95 ± 5.08	1016.08 ± 2.07	6.97 ± 0.70

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. The GPCO site sampled for carbonyls and VOCs only. Table 6-2 presents the pollutants that failed at least one screen at GPCO.

The following observations are shown in Table 6-2:

- A total of 412 measured concentrations and thirteen pollutants failed screens.
- The screening process at GPCO resulted in eight pollutants of interest: formaldehyde (61 failed screens), acetaldehyde (61), benzene (61), carbon tetrachloride (59), 1,3-butadiene (56), acrolein (45), tetrachloroethylene (37), and *p*-dichlorobenzene (17).
- Of the eight pollutants of interest, 100 percent of the measured detections of acetaldehyde, benzene, formaldehyde, acrolein, and 1,3-butadiene exceeded the screening values.
- Of pollutants failing at least one screen, sixty-eight percent of the measured concentrations failed screens.

Table 6-2. Comparison of Measured Concentrations and EPA Screening Values for the Colorado Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Grand Junction, Colorado – GPCO					
Formaldehyde	61	61	100.00	14.81	14.81
Acetaldehyde	61	61	100.00	14.81	29.61
Benzene	61	61	100.00	14.81	44.42
Carbon Tetrachloride	59	60	98.33	14.32	58.74
1,3-Butadiene	56	56	100.00	13.59	72.33
Acrolein	45	45	100.00	10.92	83.25
Tetrachloroethylene	37	52	71.15	8.98	92.23
p-Dichlorobenzene	17	37	45.95	4.13	96.36
Xylenes	5	61	8.20	1.21	97.57
Hexavalent Chromium	4	49	8.16	0.97	98.54
Acrylonitrile	3	3	100.00	0.73	99.27
Hexachloro-1,3-butadiene	2	2	100.00	0.49	99.76
Dichloromethane	1	57	1.75	0.24	100.00
Total	412	605	68.10		

6.2 Concentration Averages

Three types of concentration averages were calculated for the following subsections: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within a season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 6-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 6-3:

- Formaldehyde had the highest daily average concentration by mass at GPCO (4.00 ± 0.32 μg/m^3), followed by acetaldehyde (2.35 ± 0.20 μg/m^3) and benzene (1.85 ± 0.23 μg/m^3).

- Formaldehyde concentrations were also the highest among each season, ranging from 3.14 ± 0.52 μg/m^3 in spring to 5.22 ± 0.49 μg/m^3 in summer.

- While formaldehyde was highest in the summer, carbon tetrachloride was highest in the summer and autumn, and benzene and 1,3-butadiene were highest in autumn and winter.

- Acetaldehyde, benzene, and formaldehyde were detected in every sample collected at GPCO, while acrolein and *p*-dichlorobenzene were detected in less than two-thirds of the samples collected.

6.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for GPCO was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the thirteen

Table 6-3. Daily and Seasonal Averages for the Pollutants of Interest for the Colorado Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Acetaldehyde	61	61	2.35	0.20	2.54	0.38	1.69	0.35	2.63	0.28	2.52	0.37
Acrolein	45	61	0.80	0.19	0.35	0.10	NR	NR	0.62	0.30	1.15	0.41
Benzene	61	61	1.85	0.23	2.47	0.48	1.18	0.25	1.45	0.33	2.26	0.41
1,3-Butadiene	56	61	0.21	0.04	0.32	0.07	0.10	0.04	0.10	0.02	0.26	0.07
Carbon Tetrachloride	60	61	0.59	0.06	0.49	0.08	0.43	0.09	0.71	0.10	0.72	0.11
p-Dichlorobenzene	37	61	0.14	0.03	0.04	0.02	NR	NR	0.11	0.05	0.18	0.06
Formaldehyde	61	61	4.00	0.32	3.58	0.43	3.14	0.52	5.52	0.49	3.77	0.41
Tetrachloroethylene	52	61	0.40	0.10	0.52	0.16	0.16	0.09	0.32	0.27	0.37	0.10

NR = Not reportable due to low number of measured detections.

pollutants with at least one failed screen, only acrolein exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 6-4.

The following observations about acrolein are shown in Table 6-4:

- All forty-five acrolein measured detections were greater than the ATSDR acute risk value of 0.11 μg/m^3 and the California REL risk value of 0.19 μg/m^3.

- The average daily acrolein concentration was 0.80 ± 0.19 μg/m^3, which is almost four times the California REL value.

- For the intermediate acrolein risk, seasonal averages were compared to the ATSDR intermediate value of 0.09 μg/m^3. The winter, summer, and autumn seasonal averages were each greater than the ATSDR intermediate risk level. Acrolein had fewer than seven measured detections during the spring at GPCO (6), therefore, no spring average was calculated.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of daily concentration and daily average wind direction. Figure 6-3 is a pollution rose for acrolein for GPCO.

Observations gleaned from the acrolein pollution rose include:

- All acrolein concentrations exceeded the acute risk factors, indicated by a dashed (CALEPA REL) and solid line (ATSDR MRL).

- The acrolein concentrations on the pollution rose were predominantly associated with southeast and easterly winds, which may indicate that sources of acrolein are located in these directions from the site.

- The highest concentration of acrolein occurred on September 2, 2006 with a westerly wind.

- GPCO is situated near several roadways and a railroad that runs east-northeast to west-southwest in relation to the monitoring site, and then curves northwestward just south of the site (Figure 6-1). Additionally, a number of point sources are located both to the west and the east of the monitoring site (Figure 6-2).

6.4 Meteorological and Concentration Analysis

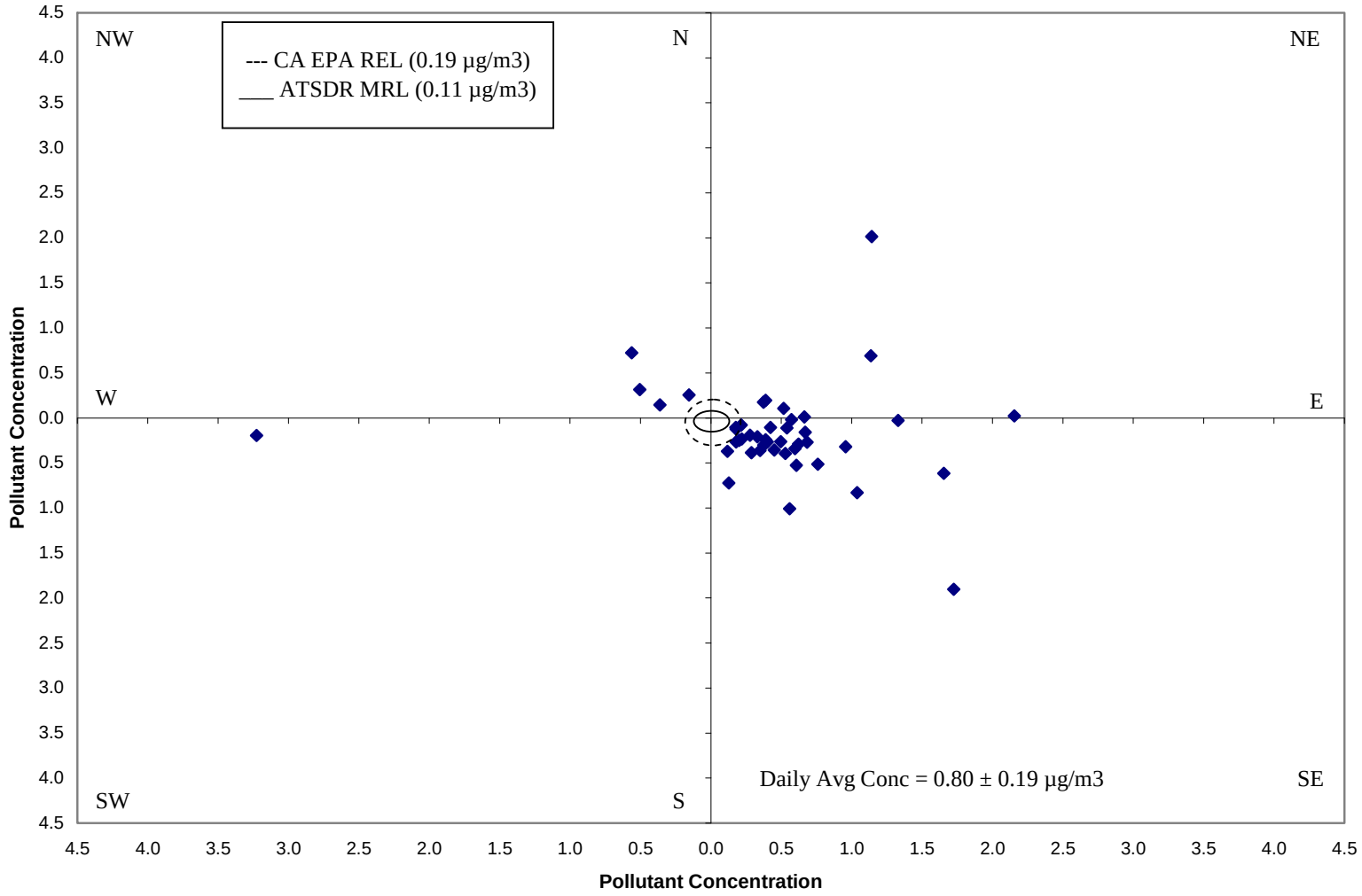
The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson correlation coefficients between meteorological parameters

Table 6-4. Non-Chronic Risk Summary for the Colorado Monitoring Site

Site	Method	Pollutant	Daily Avg (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Avg (µg/m^3)	Spring Avg (µg/m^3)	Summer Avg (µg/m^3)	Autumn Avg (µg/m^3)
GPCO	TO-15	Acrolein	0.80 ± 0.19	0.11	45	0.19	45	0.09	0.35 ± 0.10	NR	0.62 ± 0.30	1.15 ± 0.41

NR = Not reportable due to low number of measured detections.

Figure 6-3. Acrolein Pollution Rose for GPCO



(such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

6.4.1 Pearson Correlation Analysis

Table 6-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters at the GPCO monitoring site. (Refer to Section 3.1.6 for more information on Pearson Correlations.)

The following observations are gathered from Table 6-5:

- Formaldehyde exhibited strong correlations with maximum, average, and wet bulb temperatures, indicating that concentrations of formaldehyde tend to increase with increasing temperature and moisture content.

- 1,3-Butadiene exhibited strong negative correlations with these same parameters, which indicates that concentrations of 1,3-butadiene tend to increase with decreasing temperature and moisture content.

- While most of the wind speed correlations were weak, all were negative. This indicates that decreasing winds speeds correlate to increasing concentrations of the pollutants of interest.

6.4.2 Composite Back Trajectory Analysis

Figure 6-4 is a composite back trajectory map for the GPCO monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 6-4 represents 100 miles.

The following observation can be made from Figure 6-4:

- The back trajectories originated from a variety of directions at GPCO, although less frequently from the northeast, east, and southeast.

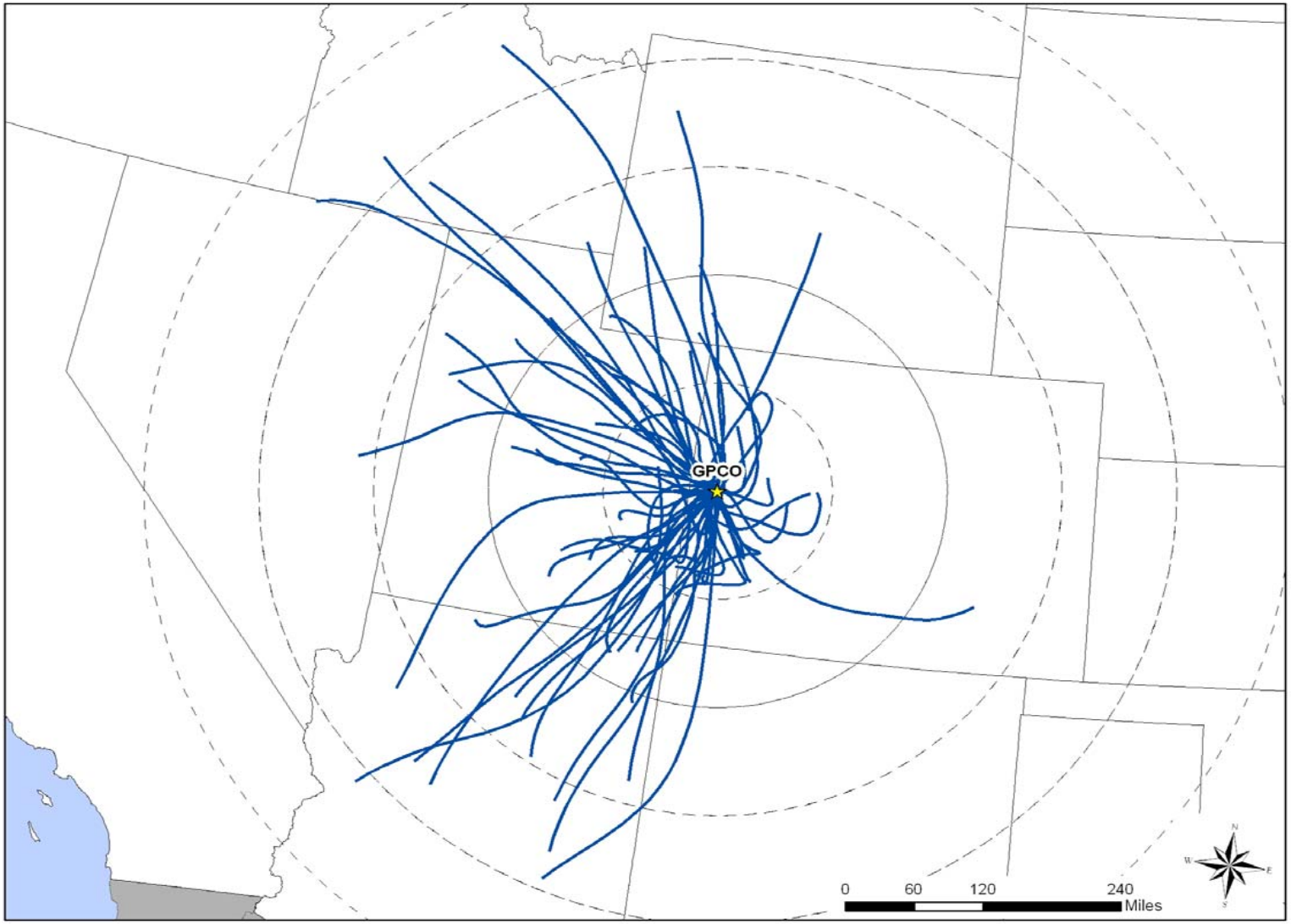
- The 24-hour airshed domain was somewhat smaller at GPCO than other UATMP sites.

- 53 percent of the trajectories originated within 200 miles of the site, and 79 percent within 300 miles from the GPCO monitoring site.

Table 6-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Colorado Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Grand Junction, Colorado – GPCO								
Acetaldehyde	61	0.18	0.16	0.12	0.14	-0.08	0.19	-0.37
Acrolein	45	0.10	0.10	0.19	0.15	0.07	-0.17	-0.02
Benzene	61	-0.37	-0.40	-0.11	-0.34	0.36	0.42	-0.46
1,3-Butadiene	56	-0.52	-0.55	-0.38	-0.53	0.32	0.43	-0.48
Carbon Tetrachloride	60	0.39	0.41	0.48	0.46	-0.03	-0.16	0.02
p-Dichlorobenzene	37	0.11	0.10	0.29	0.19	0.11	-0.03	-0.07
Formaldehyde	61	0.63	0.63	0.46	0.60	-0.33	-0.14	-0.07
Tetrachloroethylene	52	-0.14	-0.16	-0.03	-0.12	0.13	0.25	-0.12

Figure 6-4. Composite Back Trajectory Map for GPCO



- Trajectories originated as far away as central Idaho, greater than 400 miles.

6.4.3 Wind Rose Analysis

Hourly wind data from the Walker Field Airport near the GPCO monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 6-5 is the wind rose for the GPCO monitoring site on days that sampling occurred.

Observations from Figure 6-5 include:

- Hourly winds were predominantly out of the east-southeast (15 percent of observations), east (13 percent), and southeast (11 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on sampling days (36 percent of observations).
- Calm winds (<2 knots) were recorded for 11 percent of the observations.

6.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

6.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Mesa County, CO were obtained from the Colorado Department of Revenue and the U.S. Census Bureau, and are summarized in Table 6-6. Table 6-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 6-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Figure 6-5. Wind Rose for GPCO Sampling Days

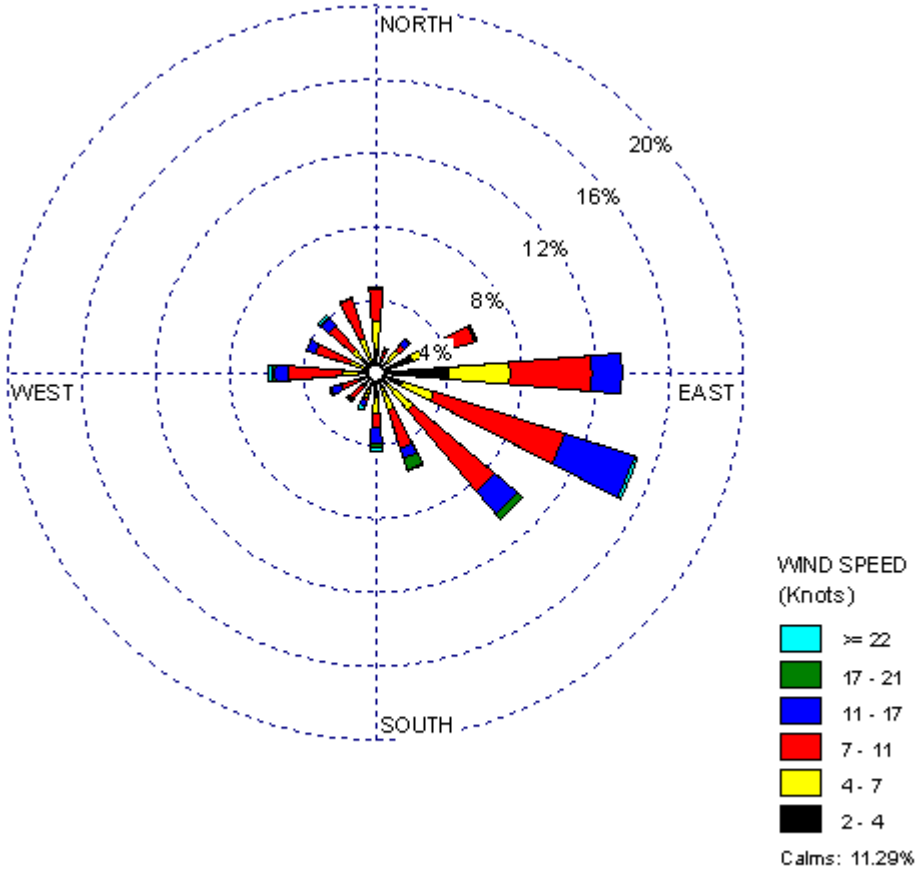


Table 6-6. Motor Vehicle Information for the Colorado Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
GPCO	134,189	154,175	1.15	111,141	127,694	19,572

Observations gleaned from Table 6-6 include:

- Compared to other UATMP sites, the population and vehicle registration count near GPCO is low to mid-range; however, GPCO has one of the highest estimated vehicle registration-to-population ratios (1.15).

- The average daily traffic count falls in the middle of the range compared to other UATMP sites.

- The GPCO monitoring site is located in a commercial area and is located in an urban-city center setting.

6.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road or motor vehicle emissions.

The BTEX table and figure show the following:

- The BTEX ratios generally resemble those of the roadside study.

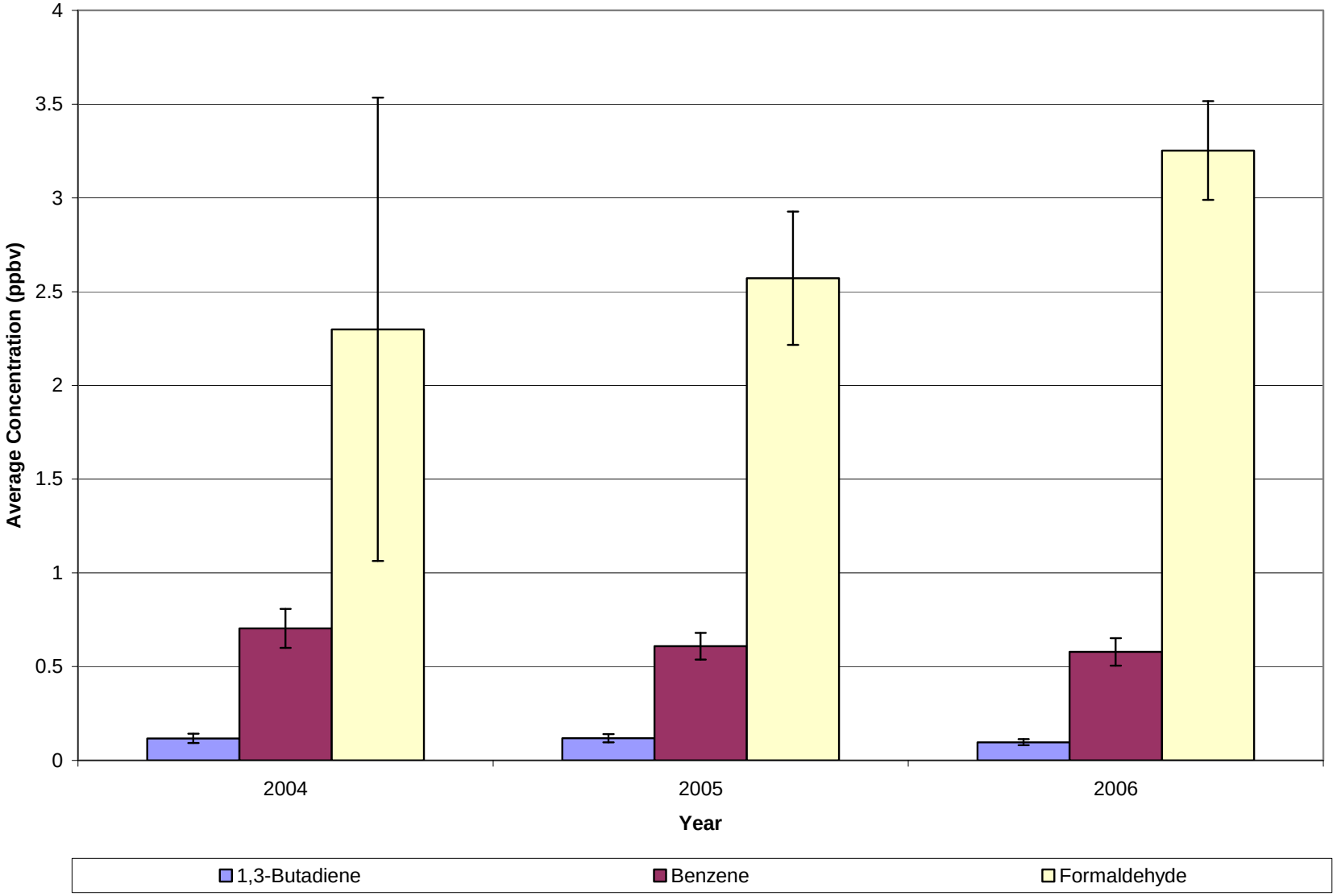
- The benzene-ethylbenzene ratio (4.04 ± 0.34) and the xylenes-ethylbenzene ratio (4.61 ± 0.15) were closer together than the roadside study ratios (2.85 and 4.55, respectively).

- The toluene-ethylbenzene ratio for GPCO (7.20 ± 0.40) was higher than that of the roadside study (5.85).

6.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The GPCO site has participated in the UATMP since 2004. Figure 6-6 presents the trends analysis for formaldehyde, benzene, and 1,3-butadiene for GPCO.

Figure 6-6. Comparison of Yearly Averages for the GPCO Monitoring Site



The following observations can be made from Figure 6-6:

- Concentrations of 1,3-butadiene at GPCO have changed little over the last three years.

- Concentrations of benzene have decreased slightly since 2004, although the overlapping confidence intervals indicate the decrease was not significant.

- The formaldehyde concentration has been steadily increasing since 2004. However, the large confidence interval in 2004 makes it difficult to determine if the increase was significant. This average concentration contained several outliers.

6.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at GPCO and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 6-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 6-7. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for GPCO is as follows:

- The GPCO monitoring site is located in census tract 08077000800.

- The census tract population for the census tract where the GPCO monitoring site is located was 5,845, which represents about 5 percent of the county population in 2000.

The following observations can be made from Table 6-7:

- The pollutants with the top four annual averages by mass concentration at GPCO were xylenes (5.40 ± 0.81 µg/m^3), formaldehyde (4.00 ± 0.32 µg/m^3), acetaldehyde (2.35 ± 0.20 µg/m^3), and benzene (1.85 ± 0.23 µg/m^3).

- Yet the pollutants with the highest cancer risk were benzene, carbon tetrachloride, and acrylonitrile (14.41, 8.77, and 5.96 in-a-million, respectively).

- Only acrolein exhibited a noncancer HQ greater than 1 (31.26). All other noncancer risks were less than 0.50.

- Formaldehyde, acetaldehyde, benzene, and xylenes exhibited the highest NATA-modeled concentrations.

Table 6-7. Chronic Risk Summary for the Monitoring Site in Colorado

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Grand Junction, Colorado (GPCO) – Census Tract 08077000800								
Acetaldehyde	0.0000022	0.009	0.58	1.28	0.06	2.35 ± 0.20	5.17	0.26
Acrolein	NR	0.00002	0.02	NR	1.04	0.63 ± 0.16	NR	31.26
Acrylonitrile	0.000068	0.002	<0.01	0.15	<0.01	0.09 ± 0.03	5.96	0.04
Benzene	0.0000078	0.03	0.56	4.39	0.02	1.85 ± 0.23	14.41	0.06
1,3-Butadiene	0.00003	0.002	0.04	1.25	0.02	0.20 ± 0.04	5.91	0.1
Carbon Tetrachloride	0.000015	0.04	0.21	3.19	0.01	0.58 ± 0.06	8.77	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.01	0.14	<0.01	0.09 ± 0.03	0.99	<0.01
Dichloromethane	0.00000047	1	0.21	0.10	<0.01	0.41 ± 0.09	0.19	<0.01
Formaldehyde	5.5E-09	0.0098	0.73	<0.01	0.07	4.00 ± 0.32	0.02	0.41
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± <0.01	1.59	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.03	<0.01	<0.01	0.36	<0.01
Tetrachloroethylene	0.0000059	0.27	0.07	0.42	<0.01	0.34 ± 0.09	2.03	<0.01
Xylenes	NR	0.1	0.53	NR	0.01	5.40 ± 0.81	NR	0.05

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made

- Although these four pollutants were the same as the ones exhibited the highest annual averages, the NATA-modeled concentrations tended to be lower by an order of magnitude.

- In terms of cancer risk, the top three pollutants identified by NATA in the GPCO census tract were benzene (4.39 in-a-million risk), carbon tetrachloride (3.19), and acetaldehyde (1.28).

- Acrolein was the only pollutant in the GPCO census tract to have a noncancer hazard quotient greater than 1.0 (1.04). Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

6.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 6-8 and 6-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 6-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 6-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 6-8:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and the highest cancer toxicity-weighted emissions for Mesa County.

- Benzene had the highest cancer risk based on annual averages at GPCO.

- Although formaldehyde was the second highest emitted pollutant in Mesa County, the cancer risk factor is low; this pollutant was not listed on either the highest toxicity-weighted emissions or the cancer risks based on annual averages.

Table 6-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for GPCO

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Mesa County)		Top 10 Cancer Toxicity-Weighted Emissions (for Mesa County)		Top 10 Cancer Risks Based on Annual Average Concentration (for GPCO)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Grand Junction, Colorado – GPCO					
Benzene	156.46	Benzene	1.22E-03	Benzene	14.41
Formaldehyde	59.48	Lead	5.01E-04	Carbon Tetrachloride	8.77
Dichloromethane	20.67	1,3-Butadiene	4.74E-04	Acrylonitrile	5.96
Acetaldehyde	19.49	Arsenic	1.89E-04	1,3-Butadiene	5.91
1,3-Butadiene	15.79	Polycyclic Organic Matter as 15-PAH	1.67E-04	Acetaldehyde	5.17
Naphthalene	4.23	Naphthalene	1.44E-04	Tetrachloroethylene	2.03
Polycyclic Organic Matter as 15-PAH	3.03	Hexavalent Chromium	9.64E-05	Hexachloro-1,3-butadiene	1.59
Tetrachloroethylene	2.92	Polycyclic Organic Matter as 7-PAH	6.09E-05	*p*-Dichlorobenzene	0.99
Trichloroethylene	1.50	Acrylonitrile	5.94E-05	Hexavalent Chromium	0.36
Vinyl Chloride	1.19	Acetaldehyde	4.29E-05	Dichloromethane	0.19

Table 6-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for GPCO

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Mesa County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Mesa County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for GPCO)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Grand Junction, Colorado – GPCO					
Toluene	388.94	Acrolein	153,654.69	Acrolein	31.26
Xylenes	232.09	1,3-Butadiene	7,896.97	Formaldehyde	0.41
Benzene	156.46	Manganese	6,135.14	Acetaldehyde	0.26
Formaldehyde	59.48	Formaldehyde	6,069.34	1,3-Butadiene	0.10
Hexane	57.09	Benzene	5,215.18	Benzene	0.06
Methanol	55.39	Xylenes	2,320.91	Xylenes	0.05
Ethylbenzene	53.46	Acetaldehyde	2,165.68	Acrylonitrile	0.04
Hydrogen Fluoride	36.34	Cyanide	1,554.17	Carbon Tetrachloride	0.01
Methyl Ethyl Ketone	29.47	Arsenic	1,461.84	Tetrachloroethylene	0.00
Dichloromethane	20.67	Naphthalene	1,410.73	Hexachloro-1,3-butadiene	0.00

- Lead, which followed benzene based on toxicity-weighted emissions, was not sampled for at the GPCO monitoring site.

- In addition to benzene, two additional pollutants (acetaldehyde and 1,3-butadiene) appeared on all three lists.

- Dichloromethane, which ranked third highest for total emissions in Mesa County, had the tenth highest cancer risk based on annual averages at GPCO (0.19 in-a-million), but does not have one of the 10 highest toxicity-weighted emissions.

The following observations can be made from Table 6-9:

- Although toluene was the highest emitted pollutant (by mass) with a noncancer risk factor, it did not rank in the top 10 pollutants based on toxicity-weighted emissions.

- Acrolein had the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants.

- Acrolein had the only noncancer HQ greater than 1 based on annual averages for GPCO.

- Three pollutants (xylenes, benzene, and formaldehyde) appeared on all three "Top 10" lists.

Colorado Pollutant Summary

- *The pollutants of interest at the Colorado site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, p-dichlorobenzene, and tetrachloroethylene.*

- *Formaldehyde had the highest daily average for GPCO.*

- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

7.0 Site in Washington, D.C.

This section presents meteorological, concentration, and spatial trends for the UATMP site in Washington, D.C. (WADC). Figure 7-1 is a topographical map showing the monitoring site in its urban location. Figure 7-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The Washington, D.C. site is surrounded by a handful of industrial point sources, with very few actually residing in the District itself. Several of these sources fall into the fuel combustion or utility boiler source category, although an electric, gas, and sanitary service facility resides fairly close to the WADC site.

Located on the Potomac River that divides Virginia and Maryland, the capital enjoys all four seasons, although its weather is somewhat variable. Summers are warm and often humid, as southerly winds prevail, which can be accentuated by the urban heat island effect. Winters are typical of the Mid-Atlantic region, where cool, blustery air masses are common followed by a fairly quick return to mild temperatures (Ruffner and Bair, 1987 and http://en.wikipedia.org/wiki/Washington,_D.C.).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the WADC monitoring site is Reagan National Airport (WBAN 13743). Table 7-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 7-1 is the 95 percent confidence interval for each parameter. As shown in Table 7-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

Figure 7-1. Washington, D.C. (WADC) Monitoring Site

Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 7-2. Facilities Located Within 10 Miles of WADC

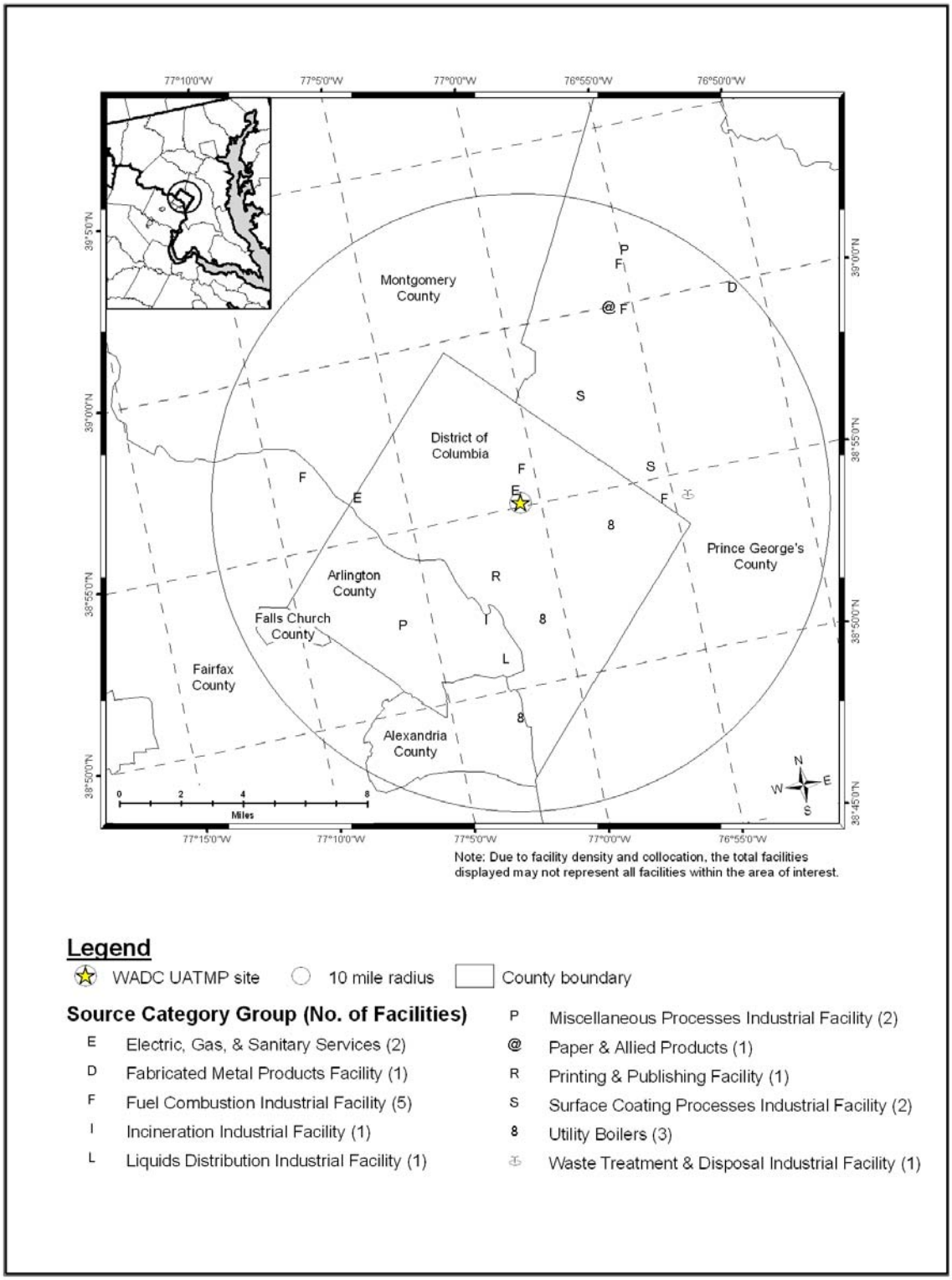


Table 7-1. Average Meteorological Conditions near the Monitoring Site in Washington, D.C.

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
WADC	13743	All 2006	67.18 ± 1.65	58.97 ± 1.57	45.69 ± 1.77	52.38 ± 1.48	64.52 ± 1.53	1016.64 ± 0.70	7.53 ± 0.31
		Sampling Day	67.23 ± 3.90	59.19 ± 3.67	46.82 ± 3.86	52.87 ± 3.31	66.89 ± 3.86	1016.34 ± 1.61	7.26 ± 0.64

7.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Washington, D.C. monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 9-2 presents the pollutants that failed at least one screen at WADC. The WADC site only sampled for hexavalent chromium.

The following observations are shown in Table 7-2:

- One of 40 hexavalent chromium concentrations failed screens. This is a 2.50 percent failure rate.

Table 7-2. Comparison of Measured Concentrations and EPA Screening Values for the Washington, D.C. Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Washington, D.C. – WADC					
Hexavalent Chromium	1	40	2.50	100.00	100.00
Total	1	40	2.50		

7.2 Concentration Averages

Three types of concentration averages were calculated for the following subsections: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within a season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average.

Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 7-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 7-3:

- The daily average concentration of hexavalent chromium for WADC was 0.041 ± 0.030 ng/m^3.
- Seasonal hexavalent chromium averages wee available for each season.
- The winter, spring, and autumn seasonal averages were very similar to each other, while the summer average was more than three times the other averages. However, the confidence interval for the summer average indicates that this average was likely influenced by outliers.
- The highest concentration recorded at WADC (0.645 ng/m^3) was measured on July 4, 2006 and was an order of magnitude higher than any of the other concentrations measured at WADC. This concentration was also the only one to exceed the risk screening value (0.083 ng/m^3).

7.3 Non-Chronic Risk Evaluation

Non-chronic risk based on the concentration data for WADC was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Hexavalent chromium does not have acute risk factors, therefore, acute risk could not be evaluated. This pollutant did not exceed its intermediate risk value at WADC.

7.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

Table 7-3. Daily and Seasonal Averages for the Pollutants of Interest for the Washington, D.C. Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Washington, D.C. – WADC												
Hexavalent Chromium	40	59	0.041	0.030	0.018	0.007	0.016	0.006	0.067	0.078	0.017	0.007

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

7.4.1 Pearson Correlation Analysis

Table 7-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters for the WADC monitoring site. (Refer to Section 3.1.6 for more information on Pearson correlations.) The calculated Pearson correlations were weak.

7.4.2 Composite Back Trajectory Analysis

Figure 7-3 is a composite back trajectory map for the WADC monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 7-3 represents 100 miles.

The following observations can be made from Figure 7-3:

- The back trajectories originated from a variety of directions at WADC, although most frequently from the northwest.
- The 24-hour airshed domain is somewhat large at WADC, with trajectories originating as far away Lake Michigan, greater than 600 miles away.
- However, 46 percent of the trajectories originated within 300 miles of the site; and 72 percent within 400 miles from the WADC monitoring site.

7.4.3 Wind Rose Analysis

Hourly wind data from the Reagan National Airport near the WADC monitoring site was uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 7-4 is the wind rose for the WADC monitoring site on days sampling occurred.

Observations from Figure 7-4 include:

- Hourly winds were predominantly out of the south (20 percent of observations) on sampling days.
- Calm winds (<2 knots) were less frequently observed at WADC than many other UATMP sites (less than 8 percent of the measurements).

Table 7-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Washington, D.C. Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Washington, D.C. – WADC								
Hexavalent Chromium	40	0.24	0.22	0.26	0.25	0.10	-0.02	0.06

Figure 7-3. Composite Back Trajectory Map for WADC

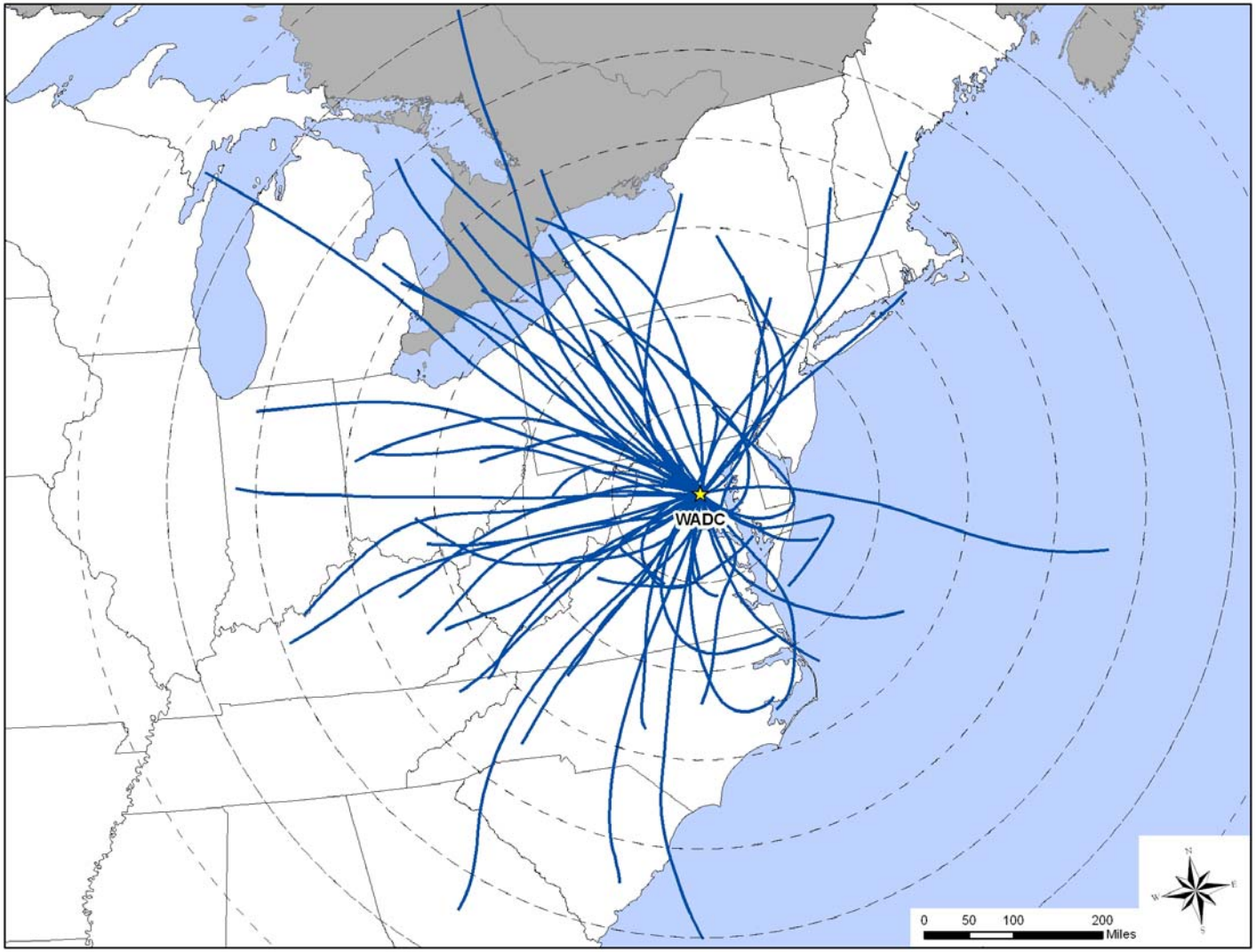
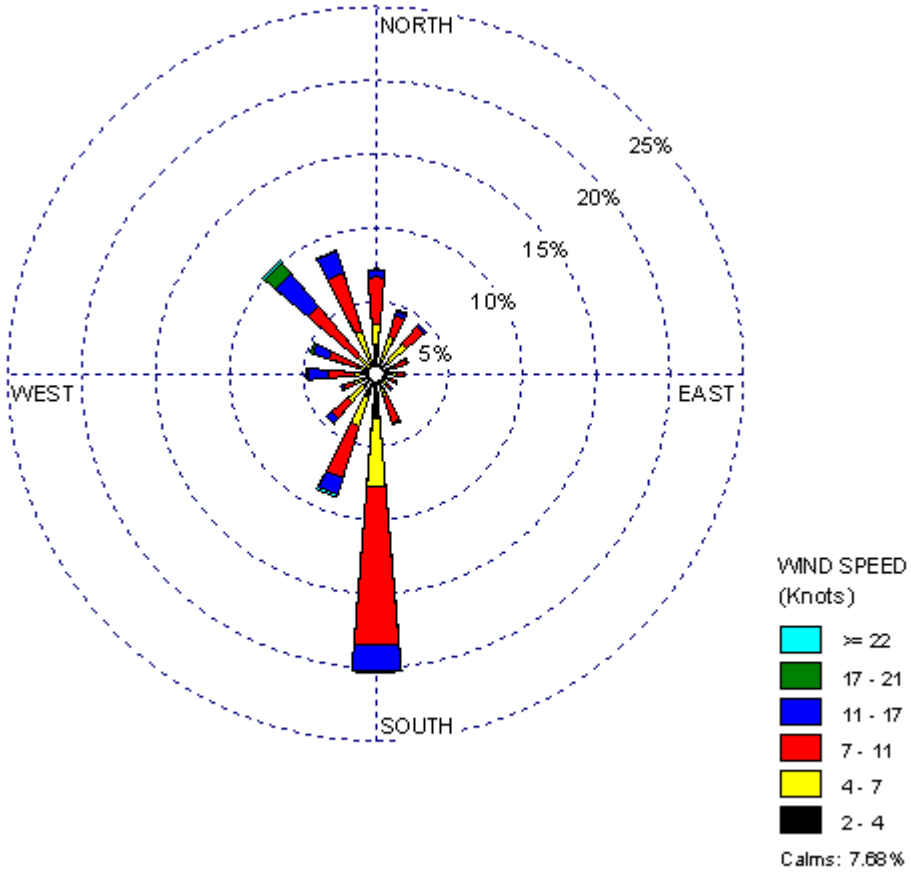


Figure 7-4. Wind Rose for WADC Sampling Days



- Wind speeds ranged from 7 to 11 knots on days that samples were collected (40 percent of observations).

7.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze VOCs for this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

7.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Washington, D.C. was obtained from the District of Columbia Department of Motor Vehicles and the U.S. Census Bureau, and are summarized in Table 7-5. Table 7-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of the site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 7-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 7-5 include:

- Compared to other UATMP sites, the District population near WADC is near the middle of the range.
- WADC's 10-mile population is fourth highest of all UATMP sites, behind only ELNJ, SPIL, and CANJ.
- WADC's vehicle registration is mid-to-low compared to other UATMP sites, but its estimated 10-mile ownership estimate ranks 15th highest compared to other UATMP sites.
- WADC's estimated vehicle per person ratio is one of the lowest of all the UATMP sites.
- The average daily traffic count is also fairly high, ranking 8th compared to other UATMP sites.

Table 7-5. Motor Vehicle Information for the Washington, D.C. Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
WADC	581,530	230,000	0.40	1,835,924	726,123	75,800

7.6 Trends Analysis

A trends analysis could not be performed for WADC as this site has not participated in the UATMP for three consecutive years.

7.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at WADC and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 7-6. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for the WADC monitoring site is as follows:

- The WADC monitoring site is located in census tract 11001003301.

The population for the census tract where the WADC monitoring site is located was 2,707, which represents less than one percent of the District population in 2000.

The following observations can be made from Table 7-6:

- Both the NATA-modeled and annual average concentrations for hexavalent chromium were less than 0.01 $\mu g/m^3$.
- In terms of cancer risk, the NATA-modeled and calculated cancer risks were very similar (0.38 and 0.36 in-a-million, respectively).
- Both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

7.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 7-7 and 7-8 present a risk-based assessment of the District-level emissions based on cancer and noncancer toxicity, respectively. Table 7-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the

Table 7-6. Chronic Risk Summary for the Monitoring Site in Washington, D.C.

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Washington, D.C. (WADC) – Census Tract ID 11001003301								
Hexavalent Chromium	0.012	0.0001	<0.01	0.38	<0.01	<0.01 ± <0.01	0.36	<0.01

Table 7-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for WADC

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Washington, D.C.)		Top 10 Cancer Toxicity-Weighted Emissions (for Washington, D.C.)		Top 10 Cancer Risks Based on Annual Average Concentration (for WADC)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Washington, D.C. – WADC					
Benzene	205.68	Benzene	1.60E-03	Hexavalent Chromium	0.36
Formaldehyde	111.05	1,3-Butadiene	7.44E-04		
Acetaldehyde	38.27	Tetrachloroethylene	2.08E-04		
Tetrachloroethylene	35.18	Naphthalene	1.98E-04		
1,3-Butadiene	24.78	*p*-Dichlorobenzene	1.34E-04		
Trichloroethylene	16.05	Polycyclic Organic Matter as 7-PAH	8.95E-05		
p-Dichlorobenzene	12.18	Acetaldehyde	8.42E-05		
Dichloromethane	8.86	Polycyclic Organic Matter as 15-PAH	8.23E-05		
Naphthalene	5.81	Arsenic	6.19E-05		
Polycyclic Organic Matter as 15-PAH	1.50	Ethylene Oxide	4.90E-05		

Table 7-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for WADC

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Washington, D.C.)		Top 10 Noncancer Toxicity-Weighted Emissions (for Washington, D.C.)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for WADC)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Washington, D.C. – WADC					
Toluene	462.57	Acrolein	323,975.52	Hexavalent Chromium	2.98E-04
Methyl *Tert*-Butyl Ether	362.58	1,3-Butadiene	12,392.33		
Xylenes	311.31	Formaldehyde	11,331.58		
Benzene	205.68	Chlorine	8,575.00		
Methanol	198.99	Cyanide	7,315.67		
Formaldehyde	111.05	Benzene	6,856.00		
Ethylbenzene	69.19	Acetaldehyde	4,252.49		
1,1,1-Trichloroethane	60.49	Xylenes	3,113.14		
Hexane	57.94	Naphthalene	1,936.65		
Methyl Ethyl Ketone	52.73	2,4-Toluene Diisocyanate	1,206.11		

highest cancer risk (in-a-million) as calculated from the annual average. Table 7-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 7-7:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and has the highest cancer toxicity-weighted emissions for Washington, D.C.

- Seven of the top 10 pollutants (benzene, acetaldehyde, tetrachloroethylene, 1,3-butadiene, naphthalene, POM as 15-PAH, and *p*-dichlorobenzene) appeared on both the highest emitted list and the highest toxicity-weighted emissions list, indicating that most of the highest emitted pollutants were also the most toxic.

- Hexavalent chromium, the only pollutant sampled at WADC, had a low cancer risk based its annual average (0.36 in-a-million). This is confirmed by the toxicity-weighted emissions, which does not show hexavalent chromium among the top 10 pollutants based on toxicity-weighted emissions.

The following observations can be made from Table 7-8:

- Although toluene was the highest emitted pollutant (by mass) with a noncancer risk factor, it did not rank in the top 10 based on toxicity-weighted emissions.

- Conversely, acrolein has the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants.

- Only two pollutants (xylenes and benzene) appeared on both the top 10 emitted pollutants and top 10 toxicity-weighted emissions lists.

- Hexavalent chromium had a low noncancer HQ based its annual average (less than 0.01). This is confirmed by the toxicity-weighted emissions, which does not show hexavalent chromium among the top 10 pollutants based on toxicity-weighted emissions.

Washington, D.C. Pollutant Summary

- *WADC sampled only for hexavalent chromium. This pollutant failed one screen and did not exceed the intermediate risk factor (no acute risk factors are available).*

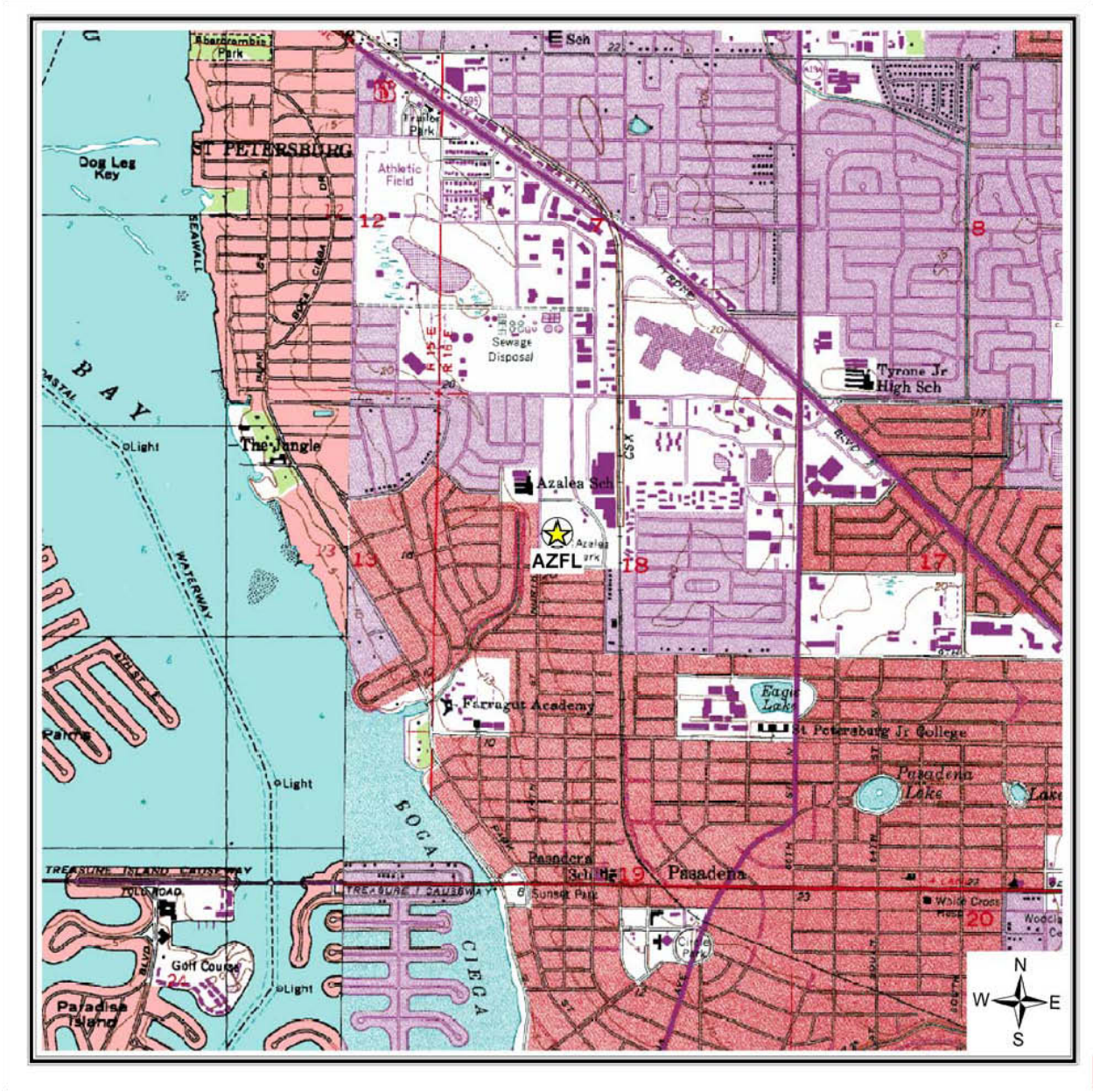
8.0 Sites in Florida

This section presents meteorological, concentration, and spatial trends for the five UATMP sites in and near the Tampa/St. Petersburg, FL area (AZFL, GAFL, SKFL, SMFL, and SYFL), one site in the Ft. Lauderdale, FK area (FLFL), and one site near Orlando, FL (ORFL). Figures 8-1 through 8-7 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 8-8 through 8-10 identify point source emission sources within 10 miles of the sites and that reported to the 2002 NEI. In the Tampa/St. Petersburg area, three of these sites are located in Hillsborough County and two are located in Pinellas County. SKFL and AZFL are located on the Peninsula, with the bulk of the facilities to the north of the sites, and closest to SKFL. GAFL is located near the Gandy Bridge on Highway 92. A cluster of facilities is located near GAFL, but most are to the east of this site. SYFL is farther inland in Plant City. Most of the facilities within 10 miles are to the west or east of this site. SMFL is located in the southwest portion of Hillsborough County, with relatively few facilities nearby. A wide range of industries have facilities near these sites, of which surface coating and fuel combustion processes are the most numerous. FLFL (Figure 8-9) is located on Florida's east coast near Ft. Lauderdale and nearby facilities are located mostly to the northeast and east of the monitoring site. Surface coating and liquids distribution industries are the major source types within the 10 mile radius. Several facilities surround ORFL (Figure 8-10), most of which are involved in waste treatment and disposal or fuel combustion processes.

Florida's climate is subtropical, with very mild winters and warm, humid summers. The annual average maximum temperature is around 80°F for all locations and average relative humidity is near 70 percent. Although land and sea breezes affect each of the locations, wind generally blows from an easterly direction due to high pressure offshore (Ruffner and Bair, 1987).

Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the GAFL and SMFL monitoring sites is Tampa International Airport (WBAN 12842); closest

Figure 8-1. Tampa/St. Petersburg, Florida (AZFL) Monitoring Site

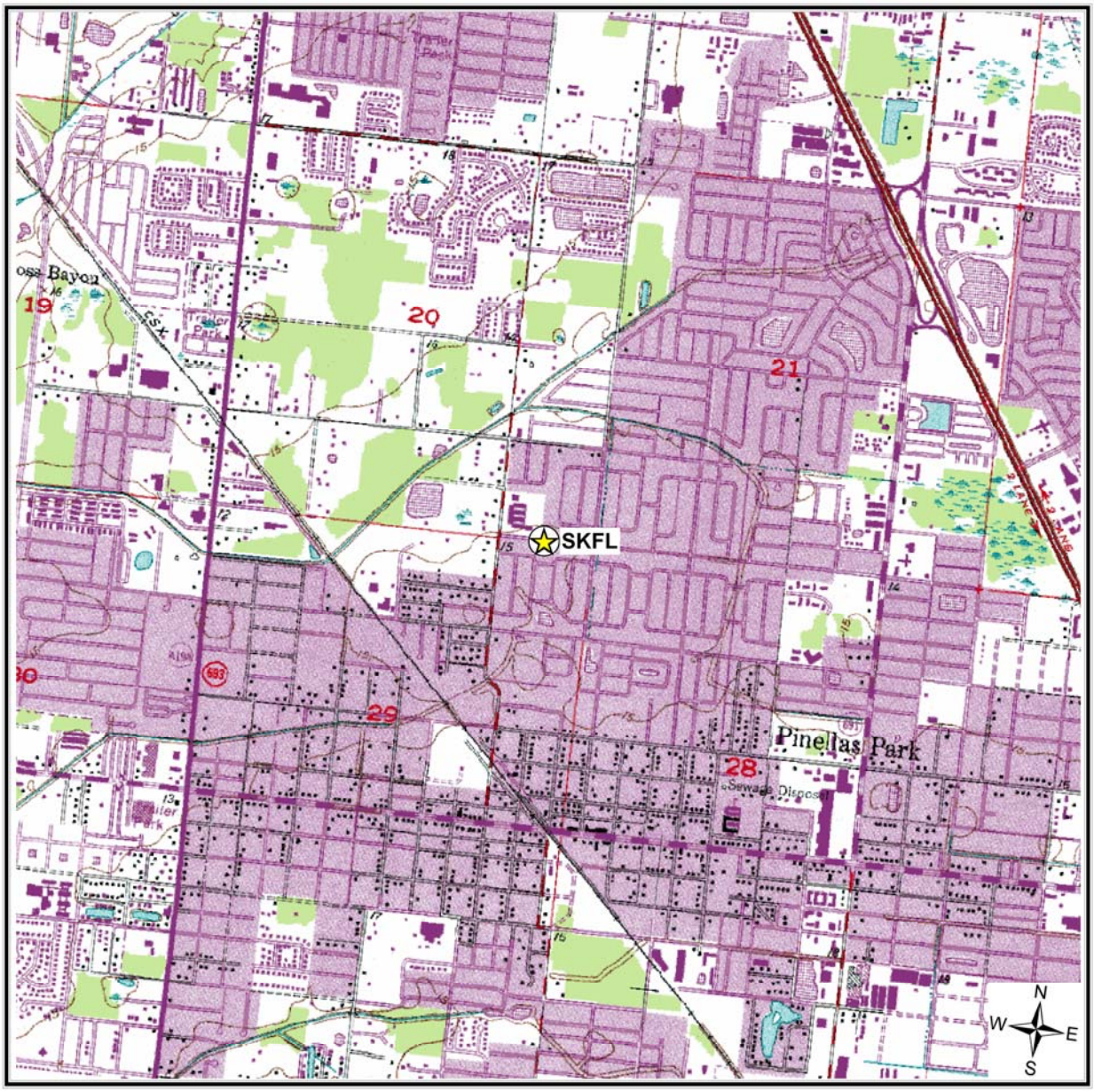


Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-2. Tampa/St. Petersburg, Florida (GAFL) Monitoring Site

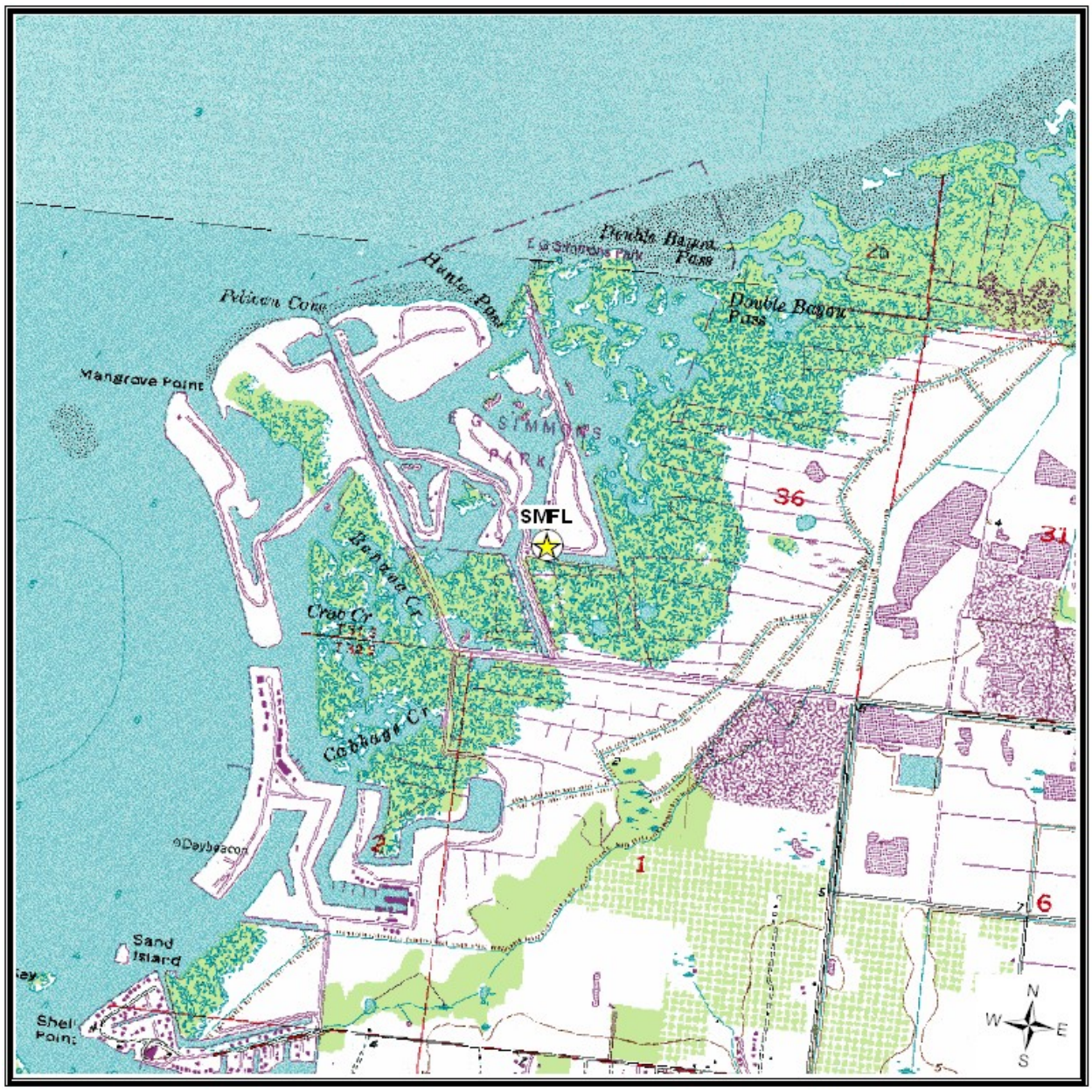
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-3. Tampa/St. Petersburg, Florida (SKFL) Monitoring Site



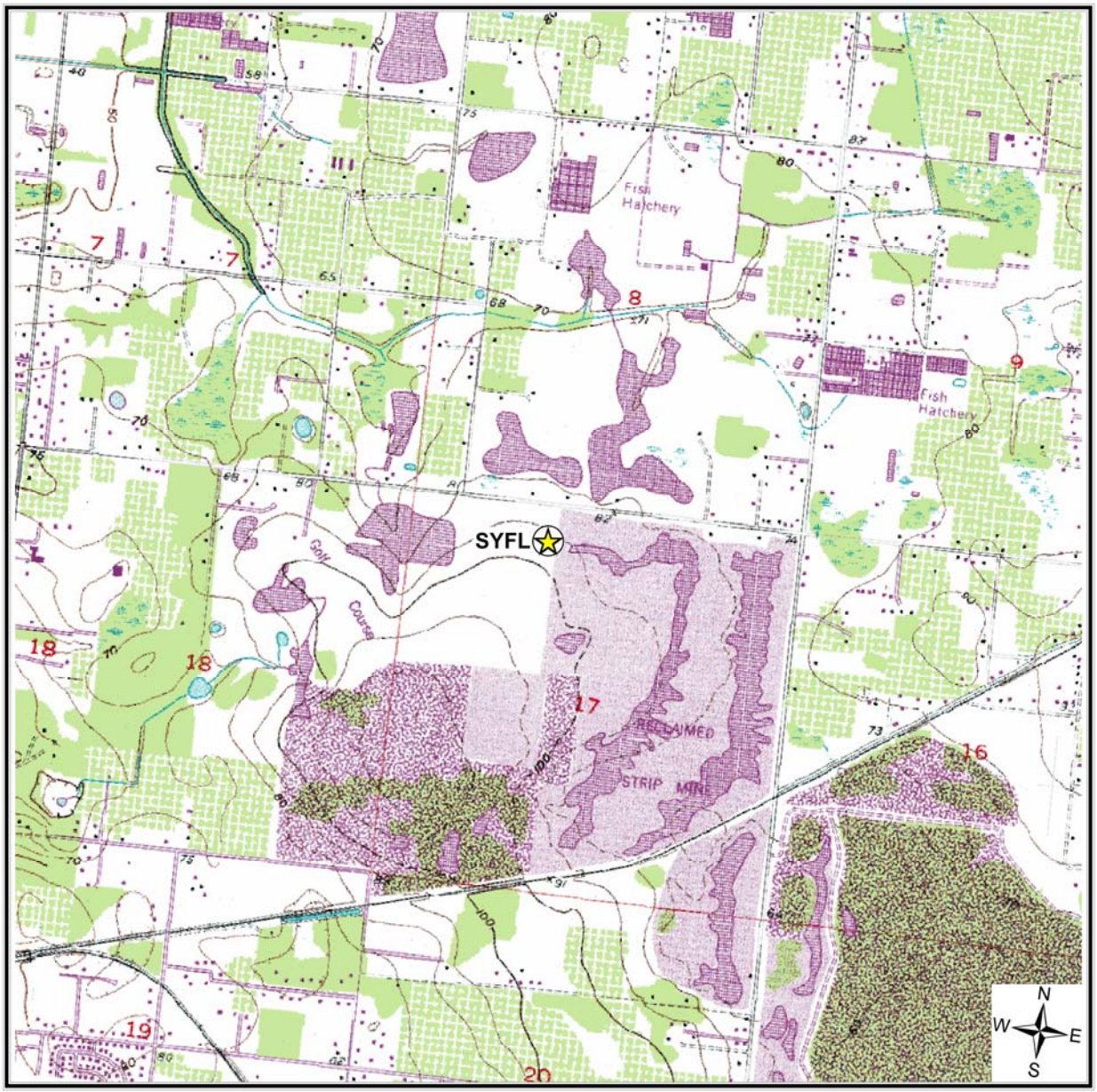
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-4. Tampa/St. Petersburg, Florida (SMFL) Monitoring Site



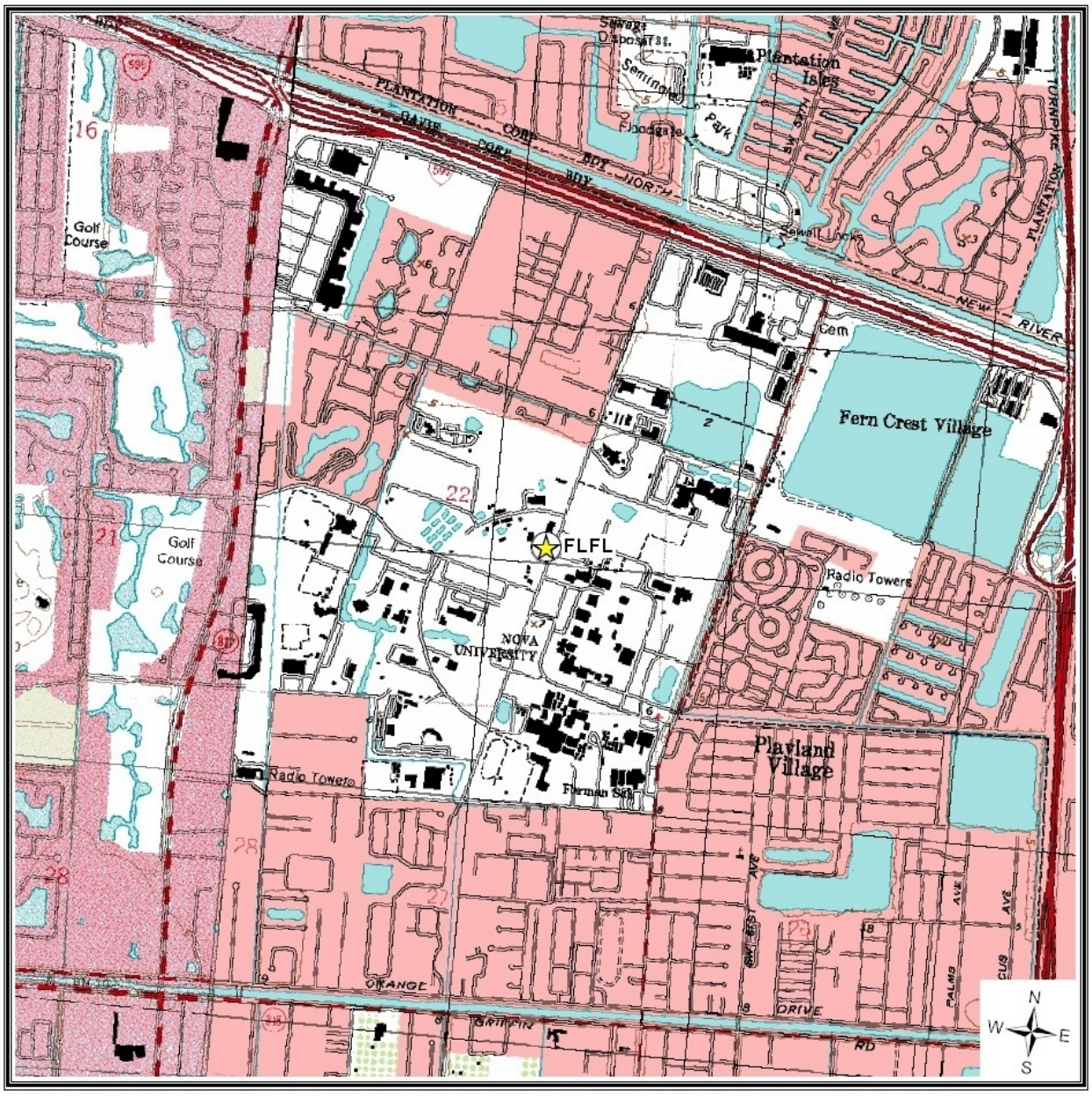
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-5. Tampa/St. Petersburg, Florida (SYFL) Monitoring Site



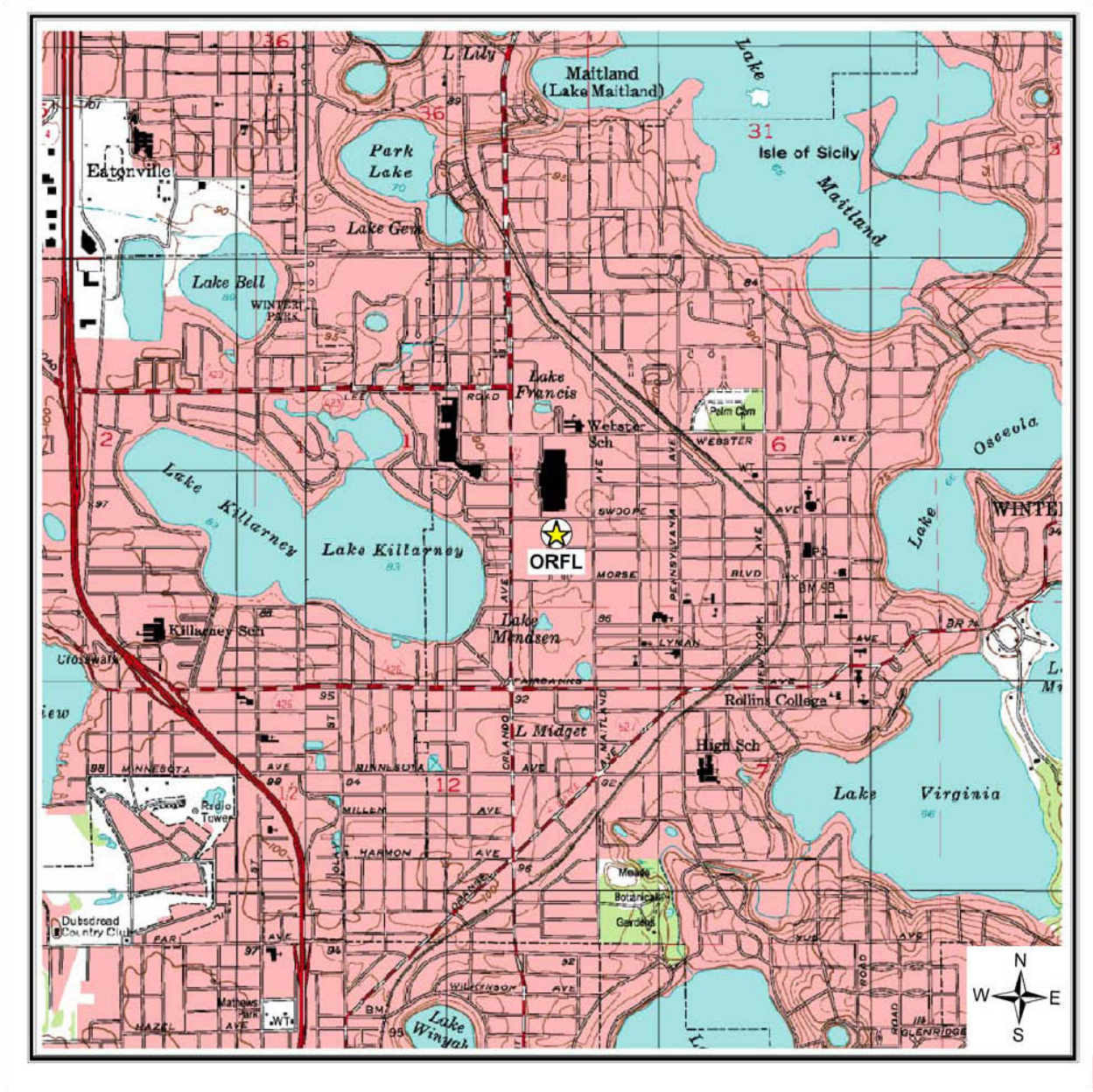
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-6. Ft. Lauderdale, Florida (FLFL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-7. Orlando, Florida (ORFL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-8. Facilities Located Within 10 Miles of the Tampa/ St. Petersburg, Florida Monitoring Sites

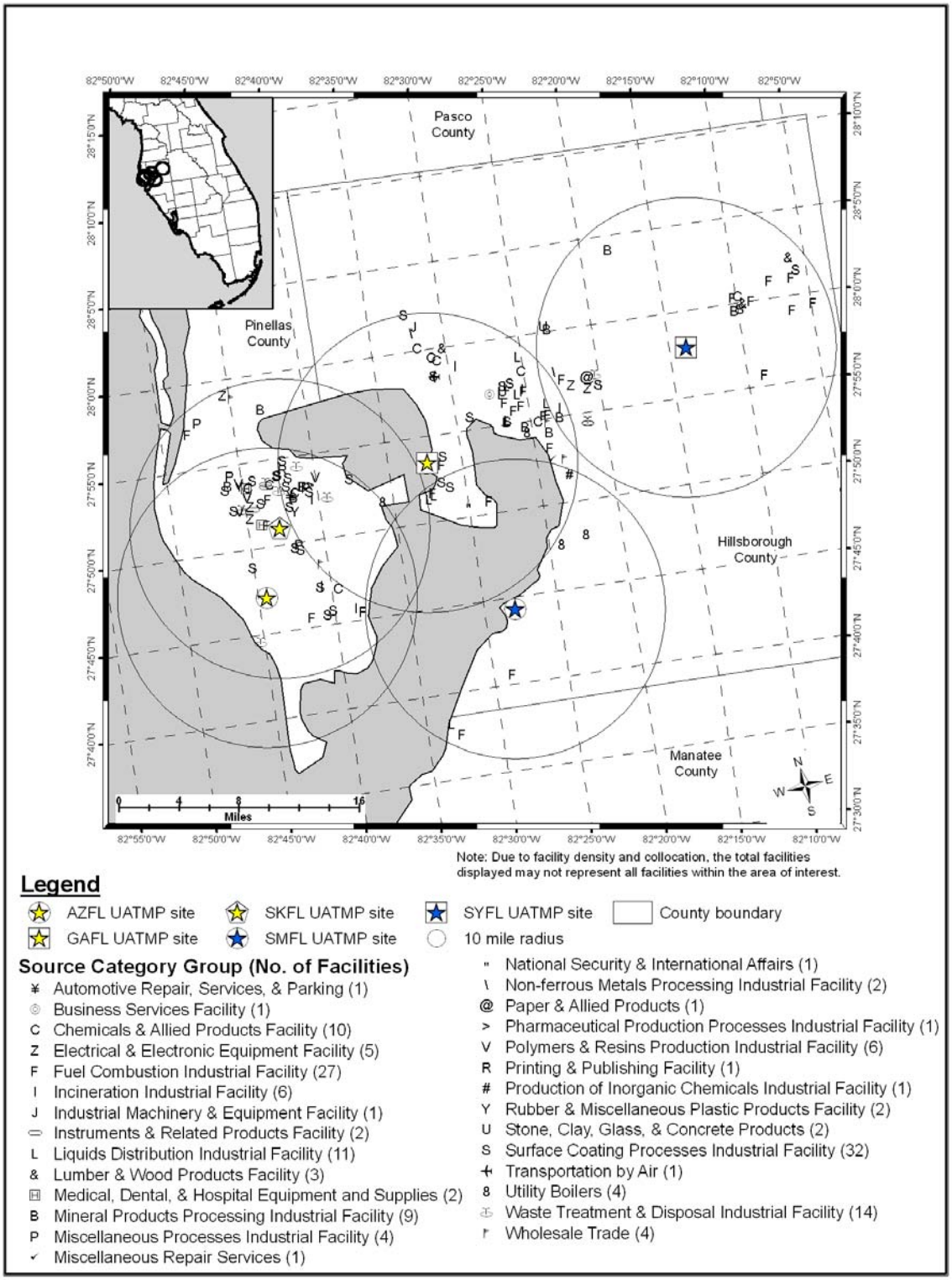


Figure 8-9. Facilities Located Within 10 Miles of FLFL

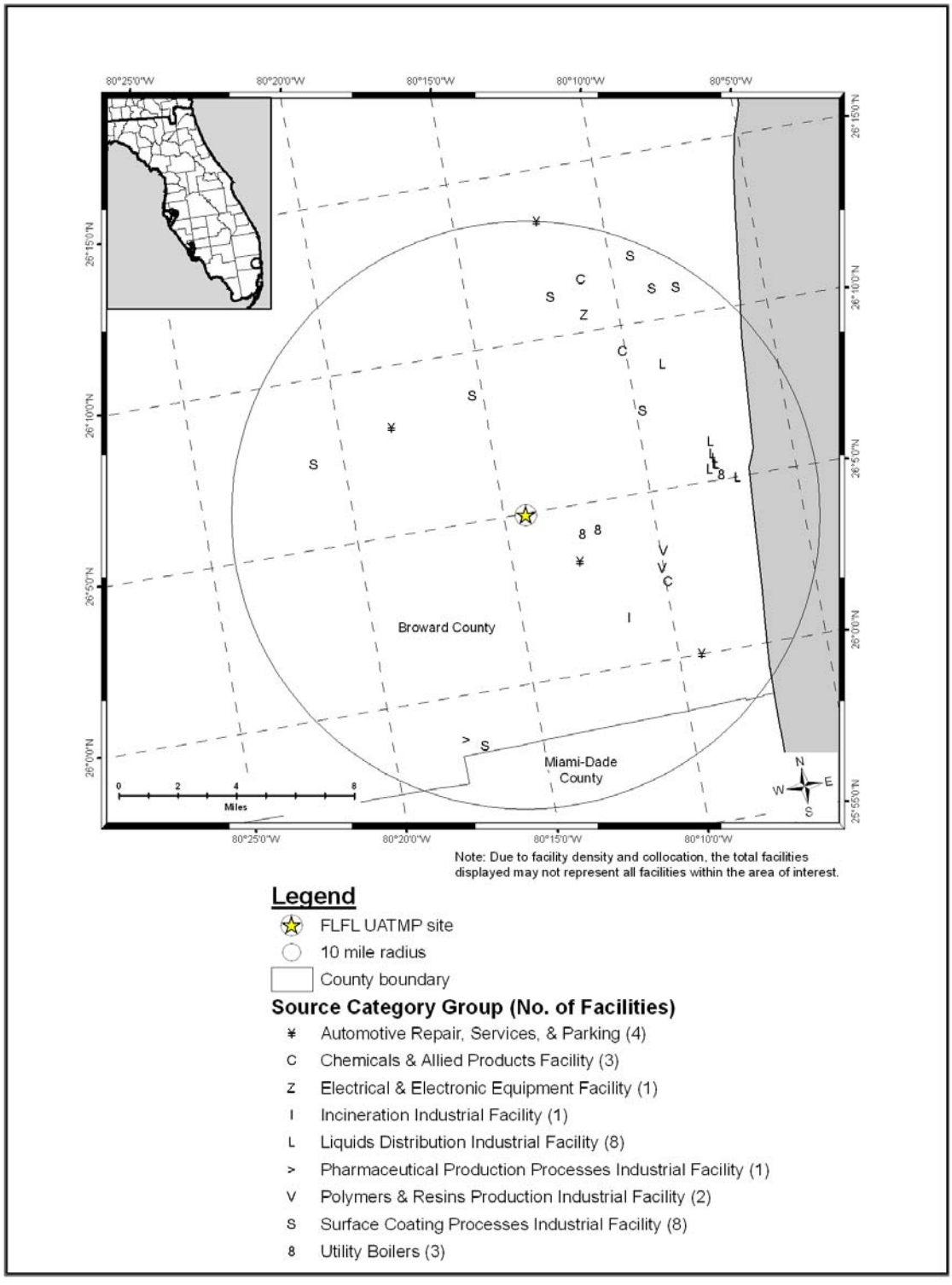
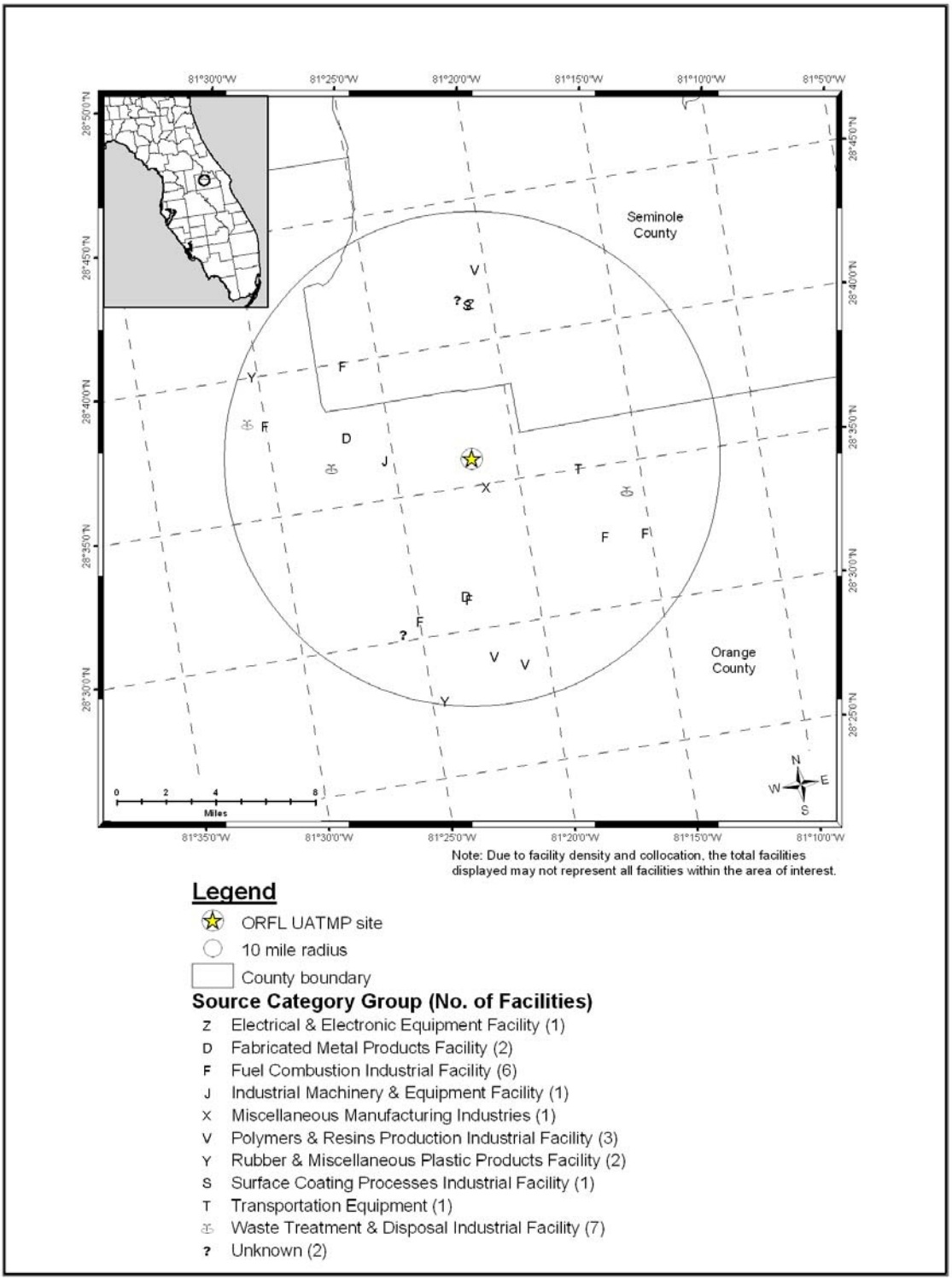


Figure 8-10. Facilities Located Within 10 Miles of ORFL



to AZFL is St. Petersburg/Whitted Airport (WBAN 92806); closest to SKFL is St. Petersburg/Clearwater International Airport (WBAN 12873); closest to SYFL is Winter Haven's Gilbert Airport (WBAN 12876); closest to FLFL is Ft. Lauderdale/Hollywood International Airport (WBAN 12849); and closest to ORFL is Orlando Executive Airport (WBAN 12841). Table 8-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were taken. Also included in Table 8-1 is the 95 percent confidence interval. As shown in Table 8-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

8.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Florida monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contributed to the top 95 percent of the site's total failed screens. Table 8-2 presents the pollutants that failed at least one screen at each of the Florida monitoring sites. With exception of SYFL (which also sampled hexavalent chromium), these sites sampled for carbonyl compounds only. Only two carbonyls have risk screening values, acetaldehyde and formaldehyde.

The following observations are shown in Table 8-2:

- Both acetaldehyde and formaldehyde failed the screen at least once at each site, and contributed almost equally to the number of failures. Therefore, acetaldehyde and formaldehyde were the two pollutants of interest at each Florida site.

- While hexavalent chromium failed screens at SYFL, it contributed to less than one percent of the total failed screens.

Table 8-1. Average Meteorological Conditions near the Monitoring Sites in Florida

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
AZFL	92806	All 2006	81.02 ± 0.83	74.32 ± 0.84	63.09 ± 1.00	67.38 ± 0.83	69.45 ± 0.94	1017.08 ± 0.39	7.35 ± 0.28
		Sampling Day	81.61 ± 1.76	75.05 ± 1.79	64.05 ± 2.10	68.17 ± 1.76	70.03 ± 2.20	1016.63 ± 0.88	7.05 ± 0.66
FLFL	12849	All 2006	82.88 ± 0.67	76.94 ± 0.72	64.25 ± 0.90	68.92 ± 0.73	66.20 ± 0.84	1016.84 ± 0.35	7.88 ± 0.32
		Sampling Day	84.32 ± 1.68	78.08 ± 1.78	65.48 ± 2.10	69.99 ± 1.74	66.62 ± 2.19	1016.51 ± 0.90	7.55 ± 0.88
GAFL	12842	All 2006	81.48 ± 0.85	73.05 ± 0.91	61.61 ± 1.11	66.10 ± 0.92	69.40 ± 0.98	1017.57 ± 0.39	6.04 ± 0.21
		Sampling Day	82.07 ± 1.81	74.00 ± 1.92	62.90 ± 2.34	67.14 ± 1.95	70.30 ± 2.28	1017.03 ± 0.87	6.02 ± 0.51
ORFL	12841	All 2006	82.50 ± 0.91	72.95 ± 0.92	59.95 ± 1.13	65.17 ± 0.91	66.63 ± 1.02	1018.23 ± 0.42	6.40 ± 0.24
		Sampling Day	83.07 ± 1.84	73.88 ± 1.89	61.58 ± 2.29	66.36 ± 1.88	68.29 ± 2.29	1017.73 ± .97	6.34 ± 0.56
SKFL	12873	All 2006	82.22 ± 0.86	73.89 ± 0.89	62.23 ± 1.07	66.75 ± 0.89	69.84 ± 2.20	1017.54 ± 0.39	7.09 ± 0.28
		Sampling Day	83.25 ± 1.77	74.92 ± 1.88	63.62 ± 2.22	67.87 ± 1.87	70.14 ± 2.08	1017.09 ± 0.89	6.85 ± 0.64
SMFL	12842	All 2006	81.48 ± 0.85	73.05 ± 0.91	61.61 ± 1.11	66.10 ± 0.92	69.40 ± 0.98	1017.57 ± 0.39	6.04 ± 0.21
		Sampling Day	82.21 ± 1.79	74.02 ± 1.91	62.85 ± 2.30	67.11 ± 1.92	70.17 ± 2.26	1017.07 ± 0.89	5.98 ± 0.51
SYFL	12876	All 2006	82.52 ± 0.87	72.10 ± 0.88	60.57 ± 1.09	65.17 ± 0.89	70.32 ± 1.05	1017.88 ± 0.40	5.95 ± 0.24
		Sampling Day	83.10 ± 1.75	72.98 ± 1.78	62.14 ± 2.30	66.36 ± 1.86	71.98 ± 2.48	1017.29 ± 0.93	6.01 ± 0.57

Table 8-2. Comparison of Measured Concentrations and EPA Screening Values for the Florida Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Petersburg, Florida – AZFL					
Acetaldehyde	61	61	100.0	50.83	50.83
Formaldehyde	59	61	96.72	49.17	100.0
Total	120	122	98.36		
Davie, Florida – FLFL					
Formaldehyde	47	47	100.0	53.41	53.41
Acetaldehyde	41	41	100.0	46.59	100.0
Total	88	88	100.0		
Gandy in Tampa, Florida – GAFL					
Acetaldehyde	61	61	100.0	50.41	50.41
Formaldehyde	60	61	98.36	49.59	100.0
Total	121	122	99.18		
Winter Park, Florida – ORFL					
Acetaldehyde	61	61	100.0	51.26	51.26
Formaldehyde	58	61	95.08	48.74	100.0
Total	119	122	97.54		
Pinellas Park, Florida – SKFL					
Acetaldehyde	59	60	98.33	50.00	50.00
Formaldehyde	59	60	98.33	49.00	100.0
Total	118	120	98.33		
Simmons Park in Tampa, Florida – SMFL					
Acetaldehyde	61	61	100.0	50.0	50.00
Formaldehyde	61	61	100.0	50.0	100.0
Total	122	122	100.0		
Plant City, Florida – SYFL					
Acetaldehyde	59	61	96.72	53.64	53.64
Formaldehyde	50	61	81.97	45.45	99.09
Hexavalent Chromium	1	41	2.44	0.91	100.00
Total	110	163	67.48		

- Acetaldehyde failed 100 percent of the screens at nearly all the Florida sites (one measured detection at SKFL and two at SYFL did not fail the screen) and formaldehyde failed 100 percent of the screens at FLFL and SMFL.

8.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no later than November. Daily and seasonal averages are presented in Table 8-3. With the exception of FLFL, all the Florida monitoring sites sampled year round. Annual averages are presented and discussed in further detail in later sections.

The following observations for acetaldehyde are shown in Table 8-3:

- Daily averages of acetaldehyde did not vary much among the sites, ranging from 1.16 ± 0.10 $\mu g/m^3$ for SYFL to 3.29 ± 1.19 $\mu g/m^3$ for FLFL.
- Seasonal acetaldehyde averages could be calculated for each season for each site.
- Most of the seasonal averages of acetaldehyde did not differ statistically. Only ORFL's spring acetaldehyde average was significantly higher than the other seasonal averages.

The following observations for formaldehyde are shown in Table 8-3:

- The daily average concentration of formaldehyde for FLFL and GAFL were somewhat higher than for the other sites (3.63 ± 1.22 $\mu g/m^3$ and 4.41 ± 0.76 $\mu g/m^3$, respectively), but not statistically significant.
- With the exception of a winter average for FLFL, seasonal averages for formaldehyde were available for each season for each site. The seasonal averages for formaldehyde for each site show little statistical variation.
- The large confidence intervals for the spring FLFL formaldehyde average and the winter GAFL formaldehyde average indicate that a few outliers may be influencing those seasonal formaldehyde averages upward.

Table 8-3. Daily and Seasonal Averages for the Pollutants of Interest for the Florida Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval	Average ($\mu g/m^3$)	Confidence Interval
Azalea Park, St. Petersburg, Florida – AZFL												
Acetaldehyde	61	61	1.96	0.21	2.15	0.47	2.08	0.43	1.57	0.17	2.01	0.44
Formaldehyde	61	61	2.46	0.23	1.78	0.33	2.49	0.43	3.07	0.30	2.53	0.53
Davie, Florida – FLFL												
Acetaldehyde	47	47	3.29	1.19	4.42	1.22	4.93	3.34	1.52	0.18	1.98	0.44
Formaldehyde	41	47	3.63	1.22	NR	NR	5.05	2.61	2.19	0.20	2.53	0.36
Gandy, Tampa, Florida – GAFL												
Acetaldehyde	61	61	1.66	0.22	2.44	0.41	1.54	0.34	0.84	0.11	1.76	0.37
Formaldehyde	61	61	4.41	0.76	6.26	2.52	3.47	0.65	3.67	0.36	4.12	0.63
Winter Park, Florida – ORFL												
Acetaldehyde	61	61	2.40	0.29	1.92	0.28	3.39	0.91	2.13	0.28	2.19	0.25
Formaldehyde	61	61	2.49	0.23	2.06	0.41	3.09	0.39	2.91	0.43	1.95	0.31
Skyview, Florida – SKFL												
Acetaldehyde	60	60	1.27	0.11	1.18	0.24	1.40	0.30	1.26	0.13	1.25	0.16
Formaldehyde	60	60	2.41	0.20	2.07	0.25	2.62	0.52	2.65	0.25	2.32	0.44
Simmons Park, Florida – SMFL												
Acetaldehyde	61	61	1.35	0.13	1.36	0.26	1.37	0.27	1.30	0.17	1.39	0.29
Formaldehyde	61	61	2.56	0.23	1.86	0.31	2.75	0.56	3.05	0.31	2.61	0.37
Plant City, Florida – SYFL												
Acetaldehyde	61	61	1.16	0.10	1.09	0.20	1.44	0.23	0.97	0.16	1.13	0.13
Formaldehyde	61	61	1.58	0.18	1.34	0.24	2.04	0.32	1.57	0.45	1.39	0.32

NR = not reportable due to low number of measured detections.

8.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for Florida monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. No concentrations exceeded the acute or intermediate risk value for the Florida monitoring sites.

8.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

8.4.1 Pearson Correlation Analysis

Table 8-4 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Florida monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for acetaldehyde from Table 8-4:

- Acetaldehyde exhibited negative correlations with all three moisture variables at nearly all sites. This indicates that as moisture content increases, concentrations of acetaldehyde tend to decrease.

- In addition, strong negative correlations were calculated between acetaldehyde and the temperature variables for GAFL, indicating that temperature increases correlated with decreases in acetaldehyde concentrations at this site.

- Strong positive correlations were also calculated between acetaldehyde and the sea level pressure for AZFL and GAFL, indicating that pressure increases corresponded to increases in acetaldehyde concentrations at these sites.

Table 8-4. Pollutant of Interest Concentration Correlations with Selected Meteorological Parameters for the Florida Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Azalea Park, St. Petersburg, Florida – AZFL								
Acetaldehyde	61	-0.41	-0.49	-0.61	-0.58	-0.44	0.62	-0.11
Formaldehyde	61	0.55	0.49	0.22	0.32	-0.41	0.20	-0.06
Davie, Florida – FLFL								
Acetaldehyde	47	-0.40	-0.45	-0.41	-0.43	-0.07	0.07	-0.02
Formaldehyde	41	-0.38	-0.40	-0.32	-0.36	-0.01	0.02	0.10
Gandy, Tampa, Florida – GAFL								
Acetaldehyde	61	-0.54	-0.59	-0.61	-0.62	-0.31	0.50	0.04
Formaldehyde	61	0.04	0.07	0.11	0.10	0.12	0.22	-0.03
Winter Park, Florida – ORFL								
Acetaldehyde	61	0.02	-0.06	-0.24	-0.18	-0.37	0.13	-0.04
Formaldehyde	61	0.43	0.29	-0.01	0.10	-0.50	-0.11	-0.18
Pinellas Park, Florida – SKFL								
Acetaldehyde	60	-0.08	-0.19	-0.34	-0.30	-0.41	0.49	-0.45
Formaldehyde	60	0.26	0.17	-0.14	-0.04	-0.62	0.31	-0.16
Simmons Park, Tampa, Florida – SMFL								
Acetaldehyde	61	0.00	-0.13	-0.34	-0.28	-0.51	0.27	-0.07
Formaldehyde	61	0.54	0.44	0.14	0.25	-0.44	-0.06	-0.04
Plant City, Florida – SYFL								
Acetaldehyde	61	-0.13	-0.29	-0.55	-0.48	-0.66	0.36	-0.14
Formaldehyde	61	0.09	-0.05	-0.35	-0.25	-0.60	0.23	-0.12

The following observations are gathered for formaldehyde from Table 8-4:

- Formaldehyde exhibited strong negative correlations with relative humidity at ORFL, SKFL, and SYFL. This indicates that as moisture content increases, concentrations of formaldehyde tended to decrease.

- Strong positive correlations were calculated between formaldehyde and maximum temperature for AZFL and SMFL, indicating that temperature increases correlated with increases in formaldehyde concentrations at these sites.

8.4.2 Composite Back Trajectory Analysis

Figures 8-11 through 8-17 are composite back trajectory maps for the Florida monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sampling day. Each concentric circle around the sites shown in these figures represents 100 miles.

The following observations can be made from Figures 8-11 through 8-15 and 8-17:

- The composite back trajectories at the Tampa/St. Petersburg and Orlando monitoring sites resemble each other.

- Back trajectories originated from a variety of directions from the sites.

- The 24-hour airshed domains were moderately large, with trajectories originating nearly 600 miles away. However, 64 percent of the trajectories originated within 300 miles of the sites and 83 percent within 400 miles from the monitoring sites.

The following observations can be made from Figures 8-16:

- The 24-hour airshed domain for FLFL was also moderately large, with trajectories originating from nearly 600 miles away.

- The back trajectories originated from a smaller variety of directions at FLFL, less frequently from the north or west.

- 62 percent of the trajectories originated within 300 miles of the site; and 77 percent within 400 miles from the FLFL monitoring site.

- The FLFL monitoring site did not sample in November or December. The composite back trajectory map might look different with addition of sampling during these months.

Figure 8-11. Composite Back Trajectory Map for AZFL

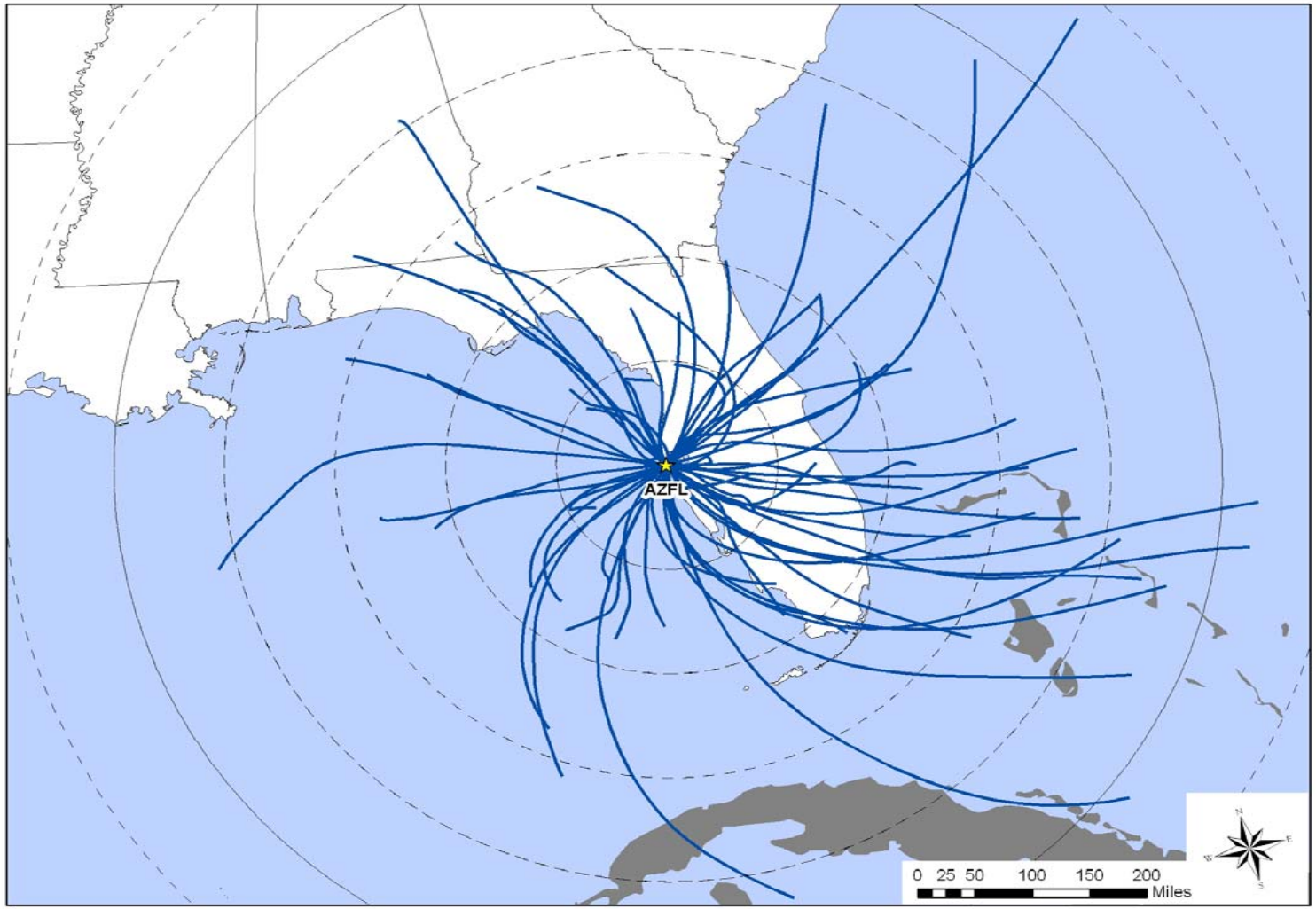


Figure 8-12. Composite Back Trajectory Map for GAFL

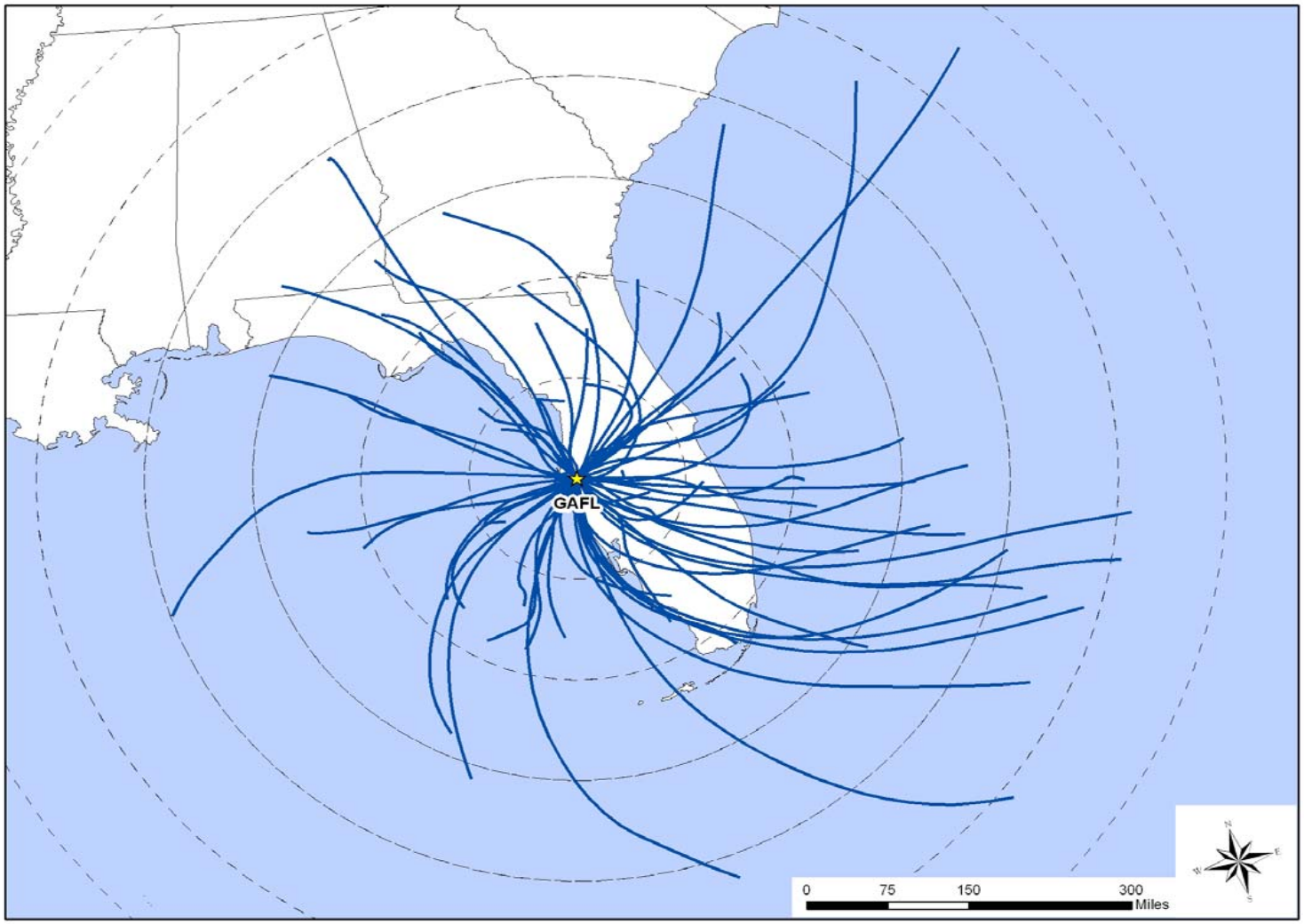


Figure 8-13. Composite Back Trajectory Map for SKFL

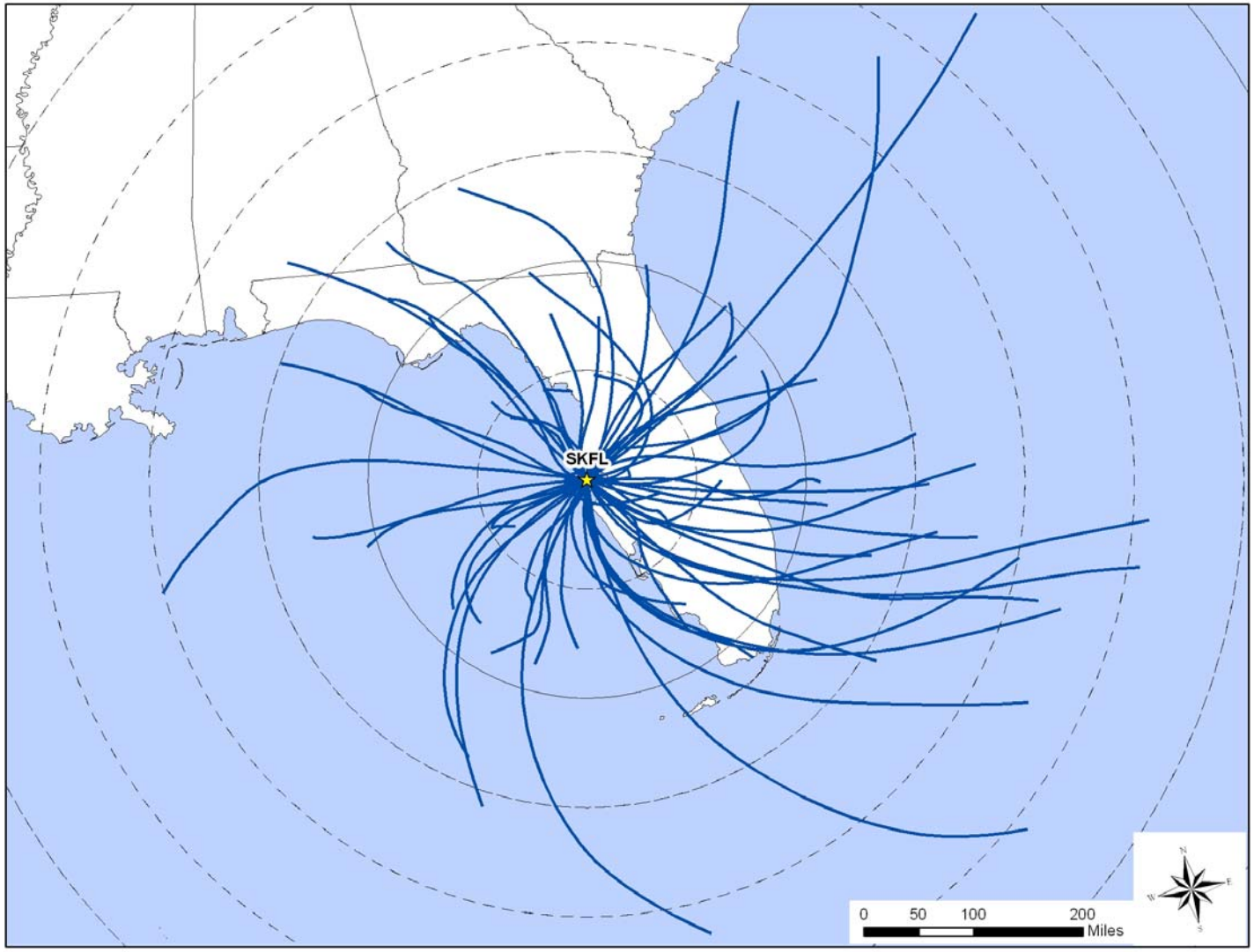


Figure 8-14. Composite Back Trajectory Map for SMFL

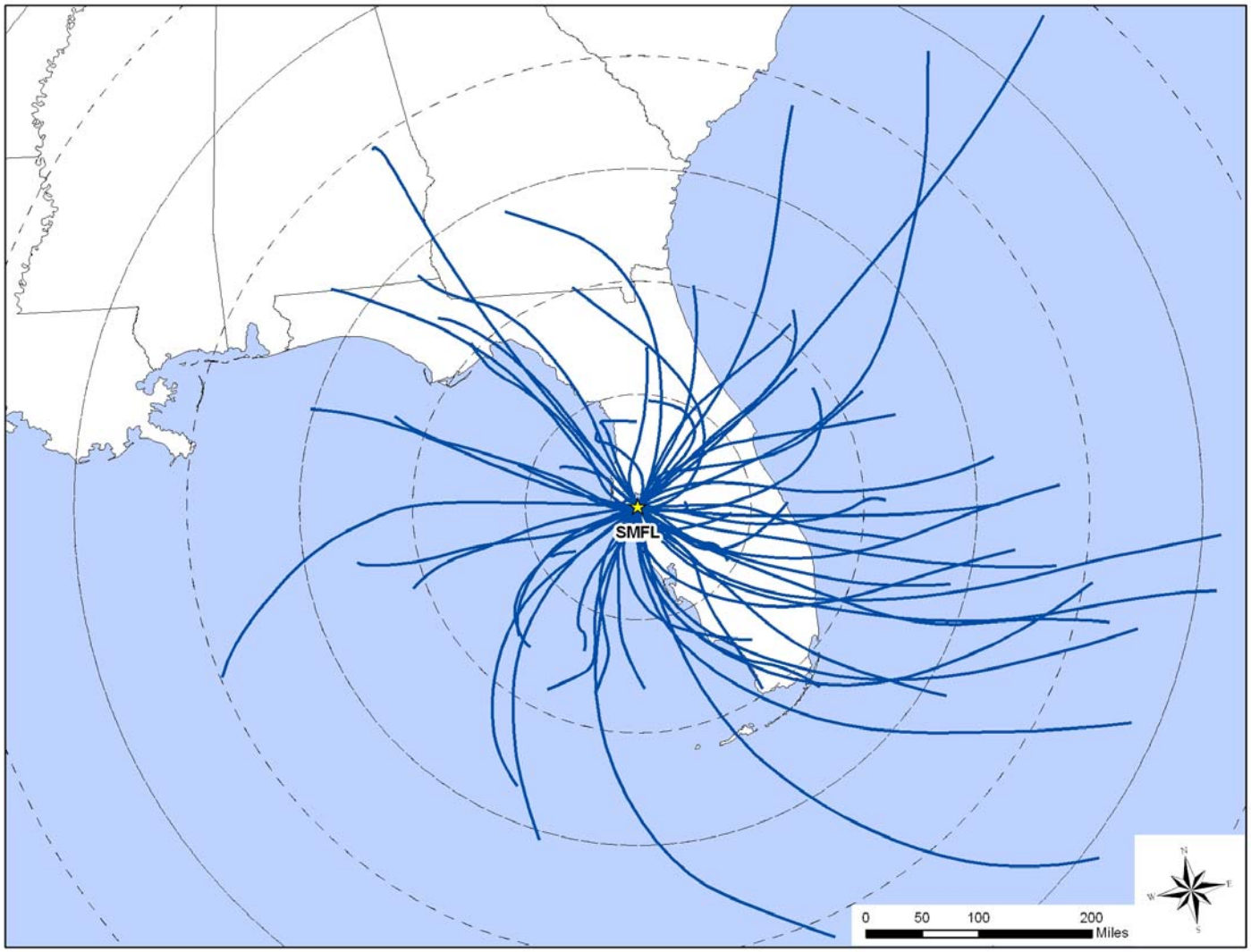


Figure 8-15. Composite Back Trajectory Map for SYFL

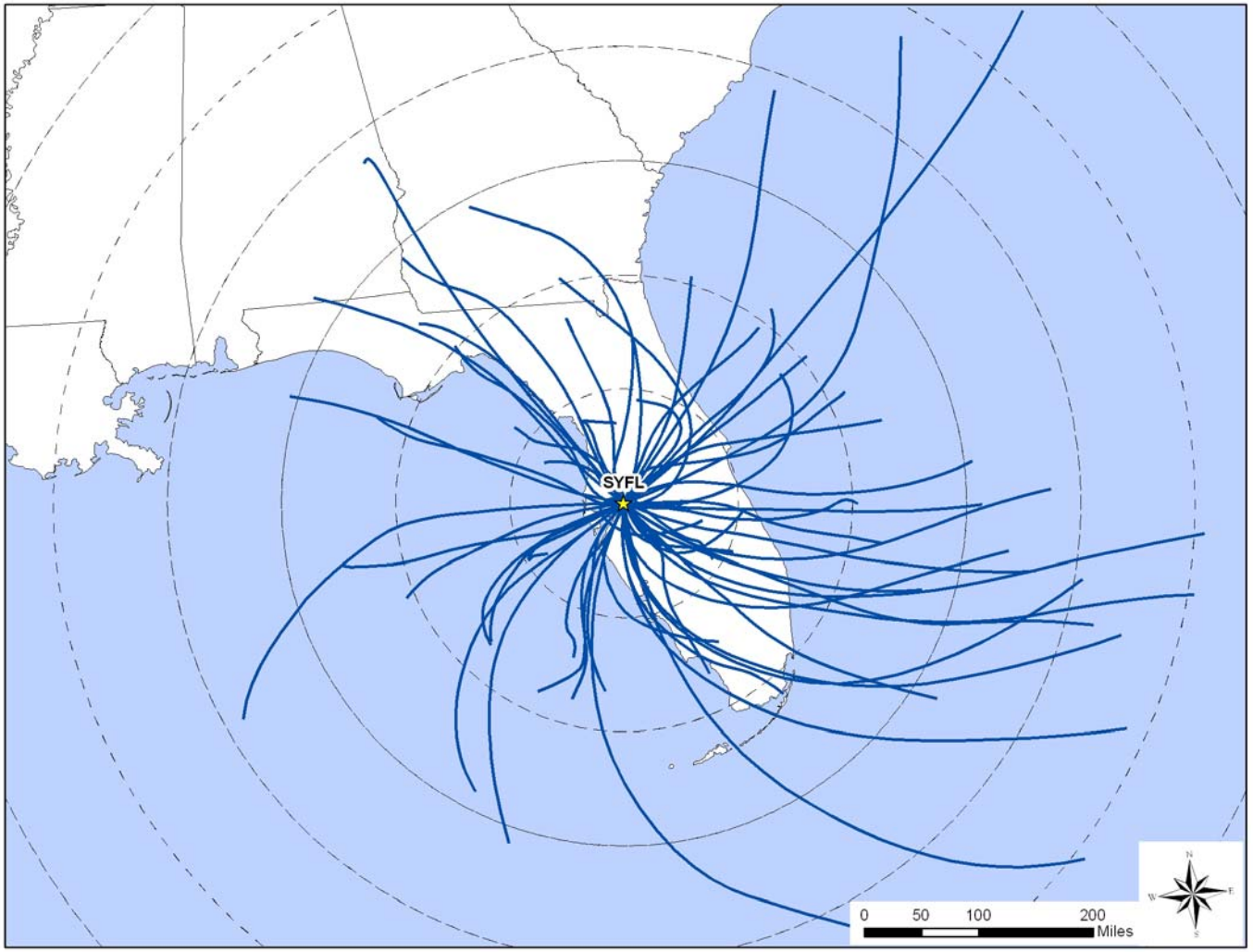


Figure 8-16. Composite Back Trajectory Map for FLFL

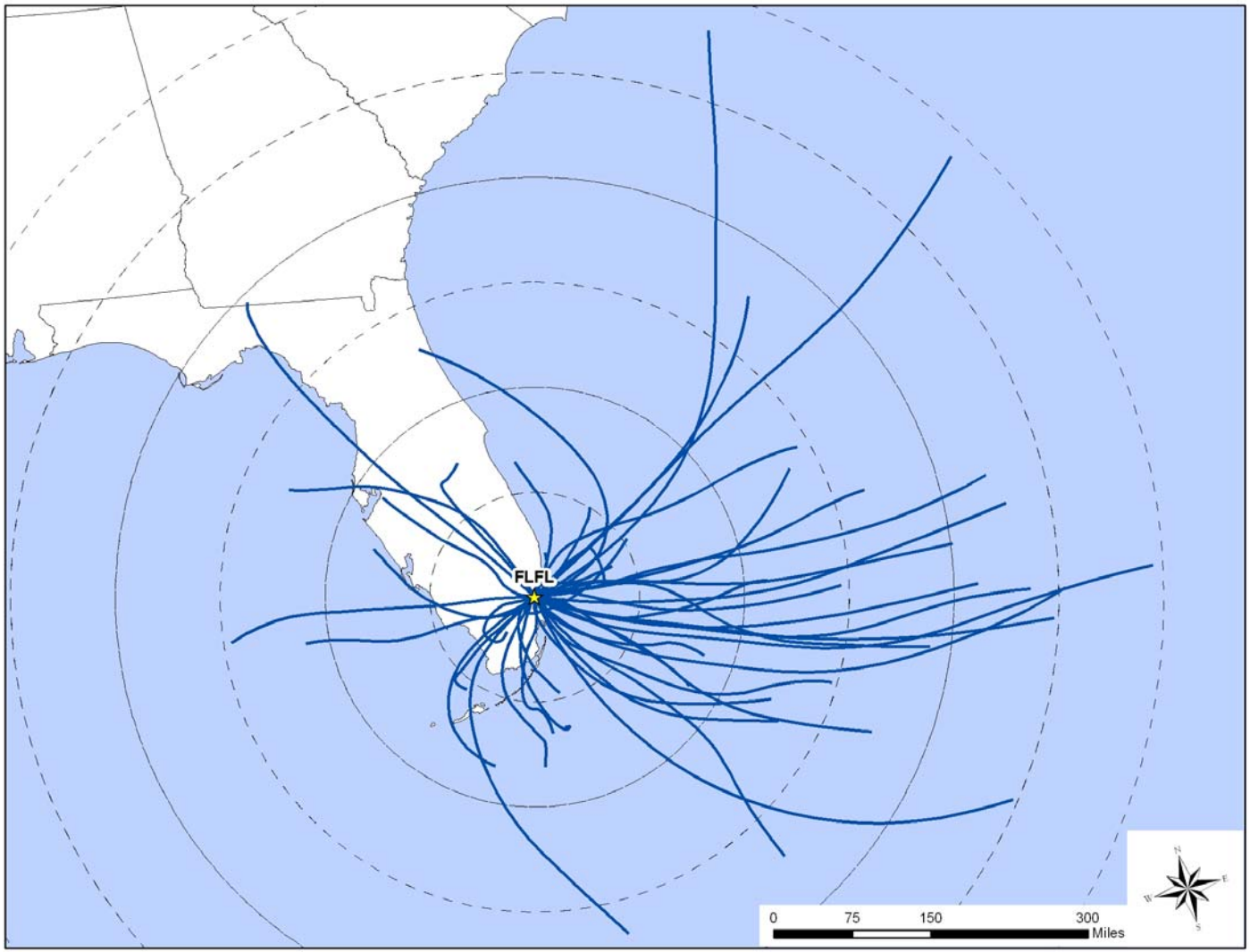
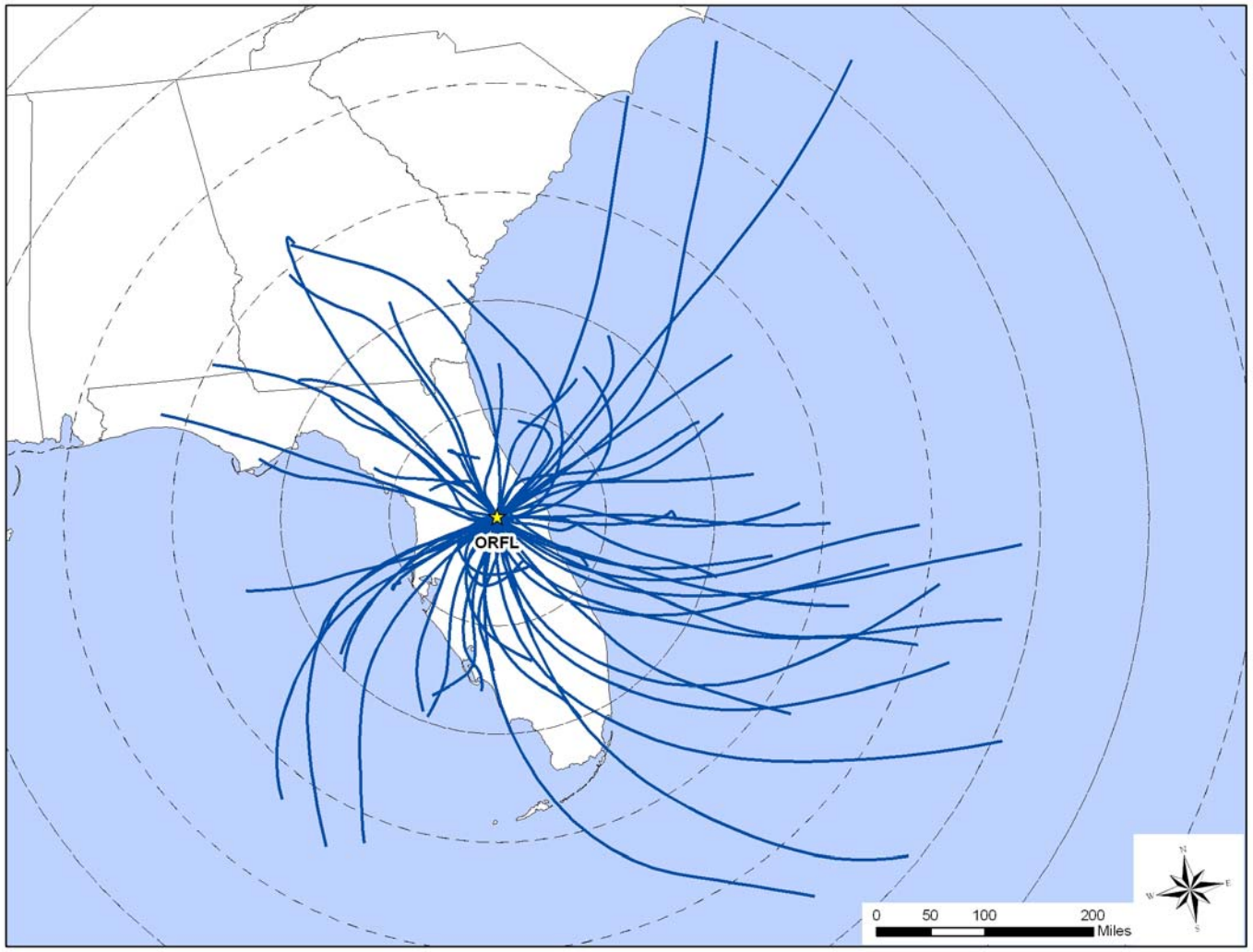


Figure 8-17. Composite Back Trajectory Map for ORFL



8.4.3 Wind Rose Analysis

Hourly wind data from weather stations at Tampa International, Whitted, St. Petersburg/Clearwater International, Gilbert, Orland Executive, and Ft. Lauderdale/Hollywood International Airports were uploaded into a wind rose software program WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 8-18 thru 8-24 are wind roses for the Florida monitoring sites on days samples were taken.

Observations from Figure 8-18 for AZFL include:

- Hourly winds near AZFL varied greatly, but originated more frequently out of the east (9 percent of observations), and north (8 percent of observations).
- Wind speeds ranged from 7 to 11 knots on days that samples were taken (38 percent of observations).
- Calm winds (<2 knots) were observed for 7 percent of observations.

Observations from Figure 8-19 for GAFL include:

- Hourly winds near GAFL were predominantly out of the west (9 percent of observations) and east, east-northeast and west-southwest (each 7 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on days that samples were taken (39 percent of observations), with calm winds observed for 12 percent of measurements.

Observations from Figure 8-20 for SKFL include:

- Hourly winds near SKFL were predominantly out of the east, east-northeast, or west (each accounting for approximately 8 percent of observations) on sampling days.
- Wind speeds ranged from 7 to 11 knots on days that samples were taken. However, winds from the south had the highest frequency of winds greater than 11 knots.
- Calm winds were observed for 9 percent of observations.

Observations from Figure 8-21 for SMFL include:

- Similar to GAFL, hourly winds near SMFL were predominantly out of the west (10 percent of observations), east (7 percent), and east-northeast (7 percent on sampling

Figure 8-18. Wind Rose for AZFL Sampling Days

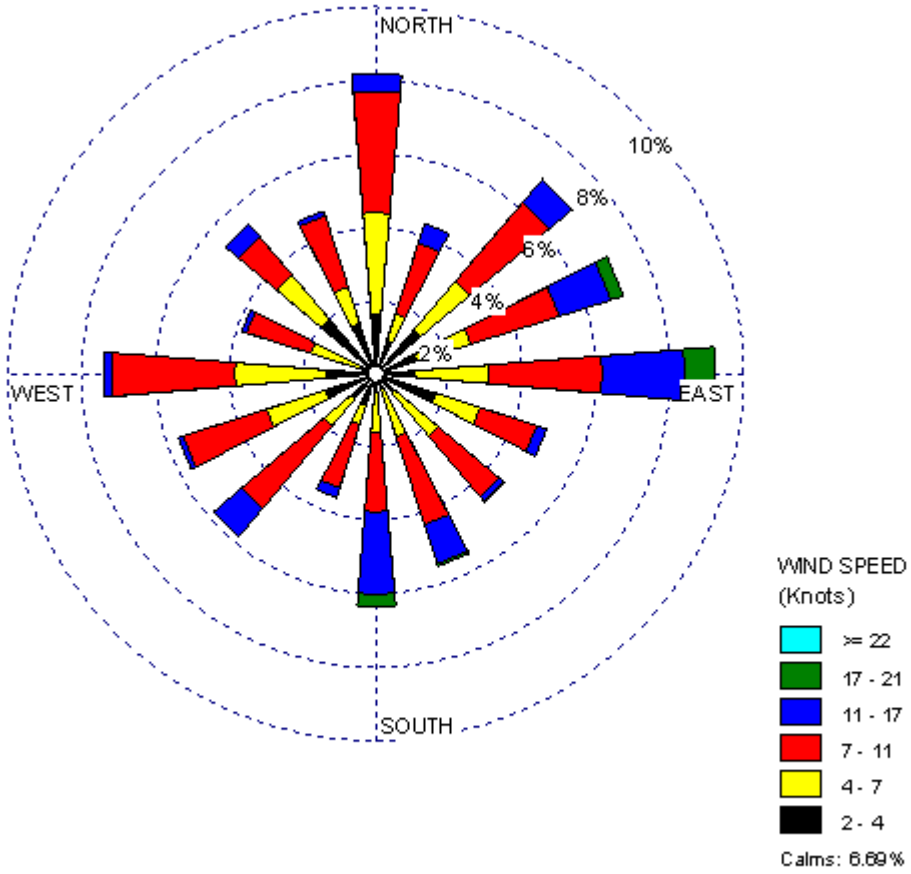


Figure 8-19. Wind Rose for GAFL Sampling Days

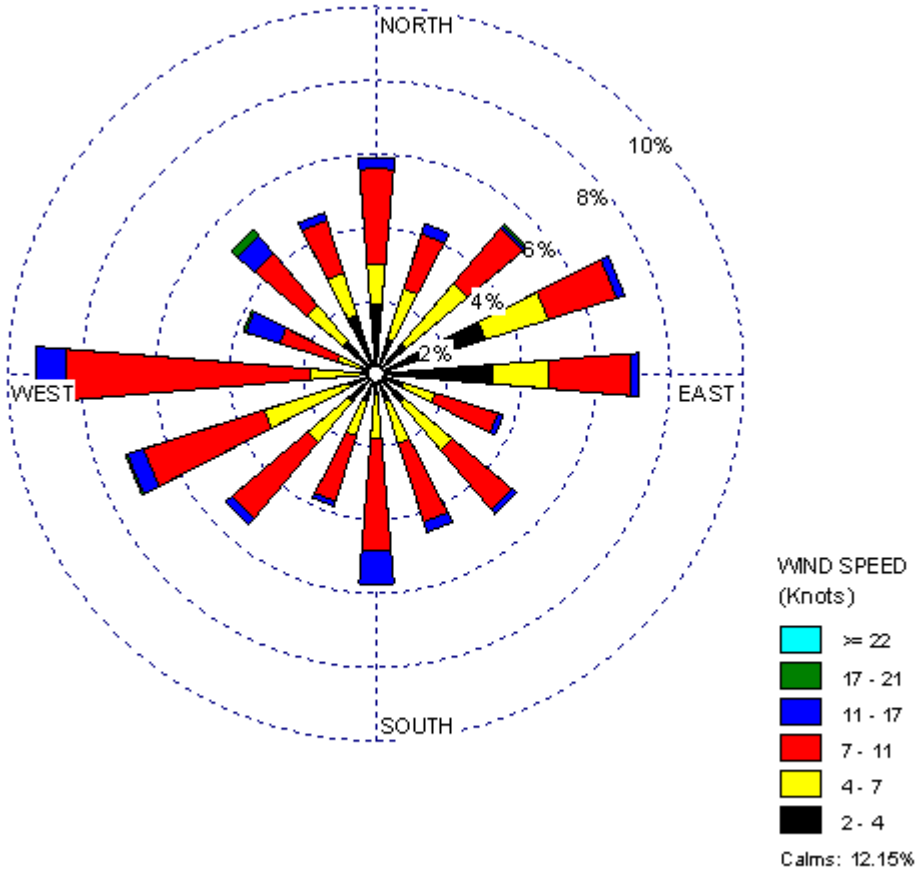


Figure 8-20. Wind Rose for SKFL Sampling Days

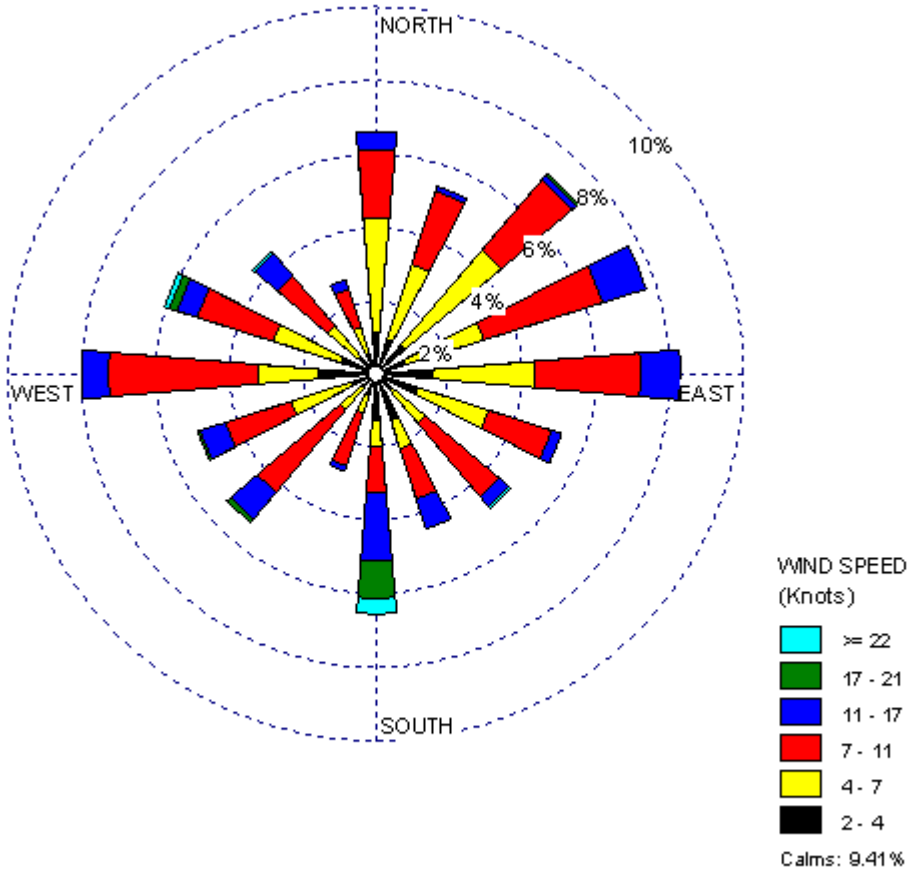


Figure 8-21. Wind Rose for SMFL Sampling Days

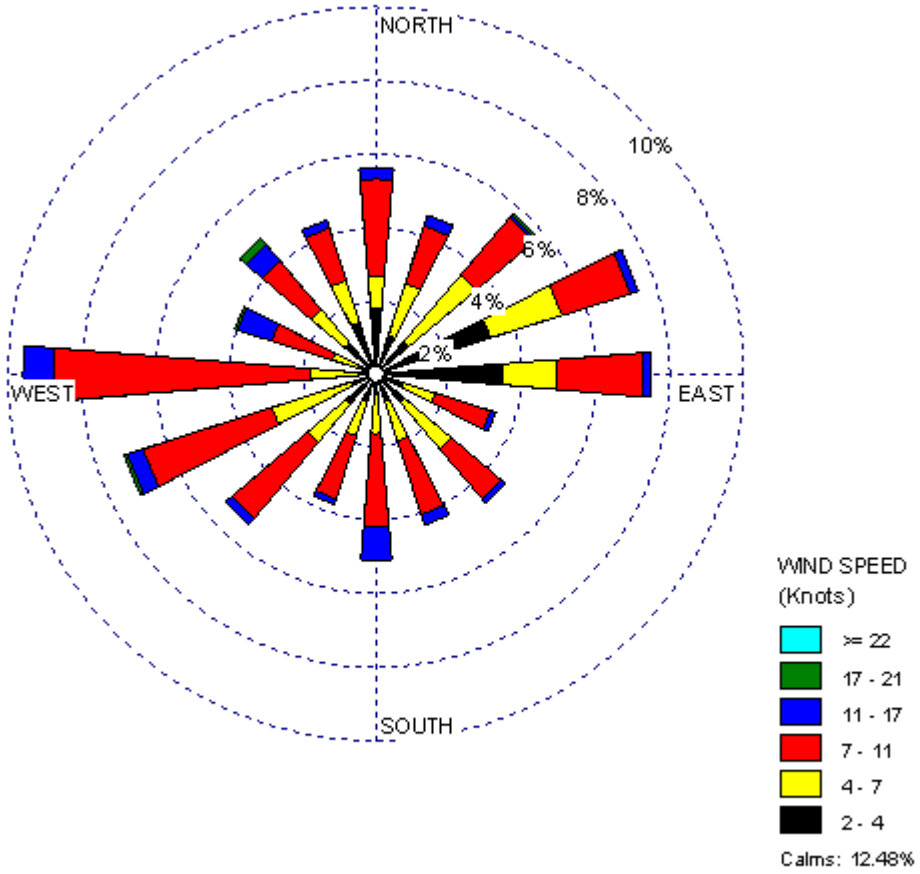


Figure 8-22. Wind Rose for SYFL Sampling Days

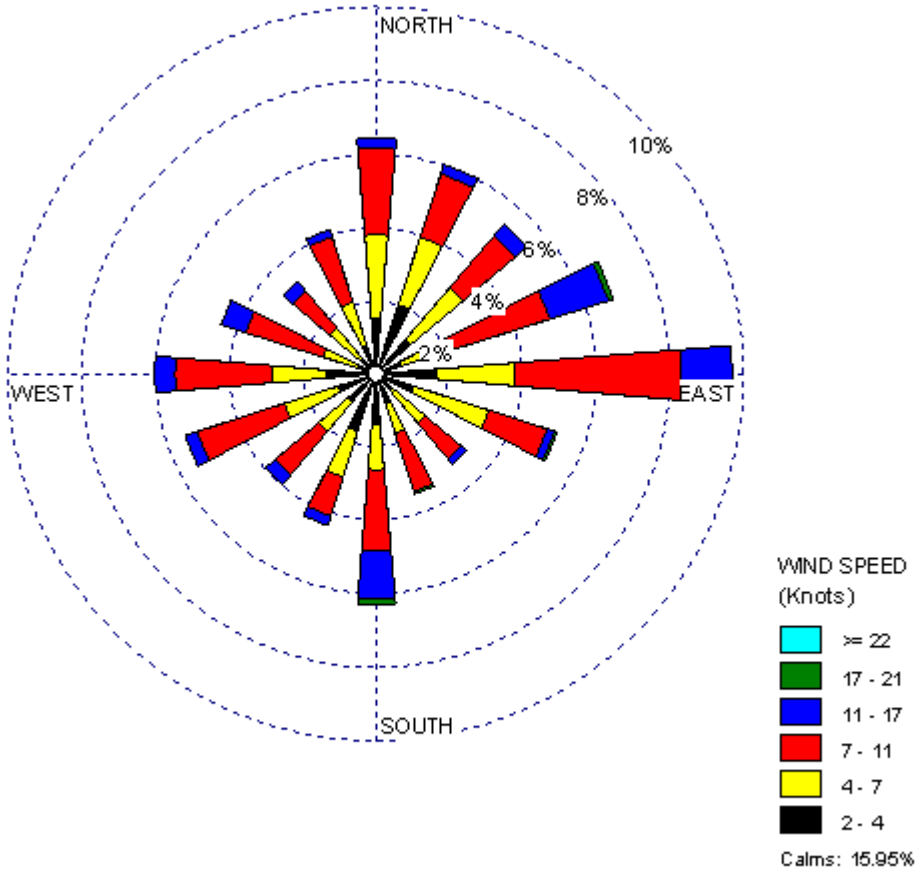


Figure 8-23. Wind Rose for FLFL Sampling Days

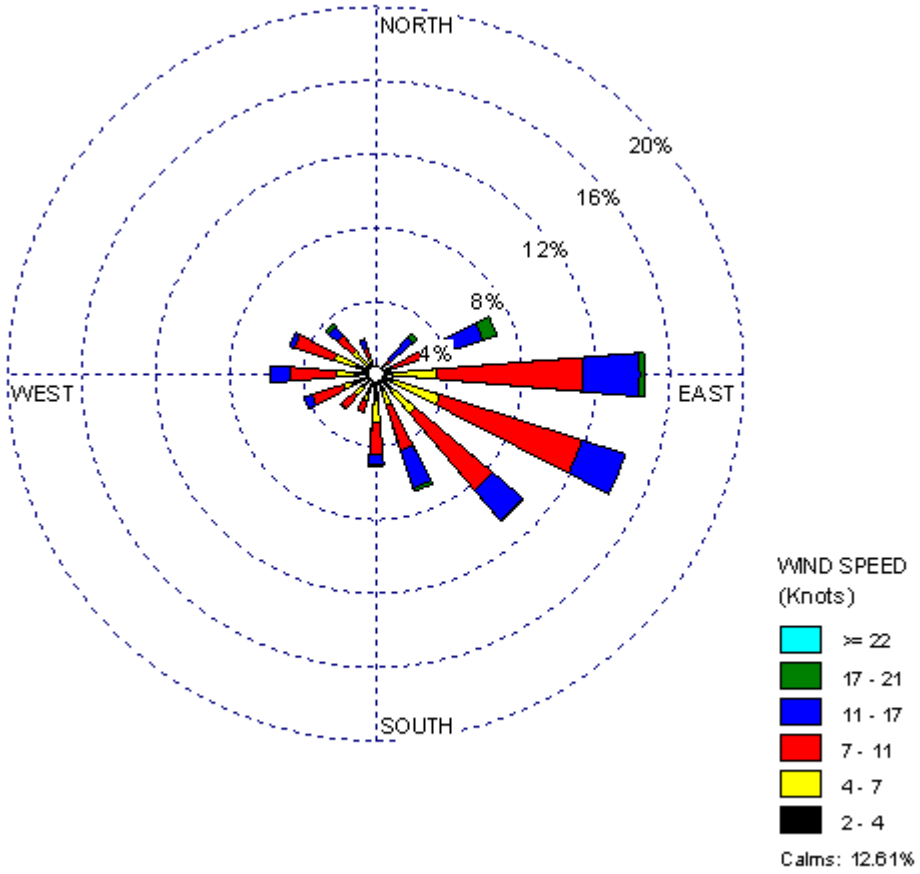
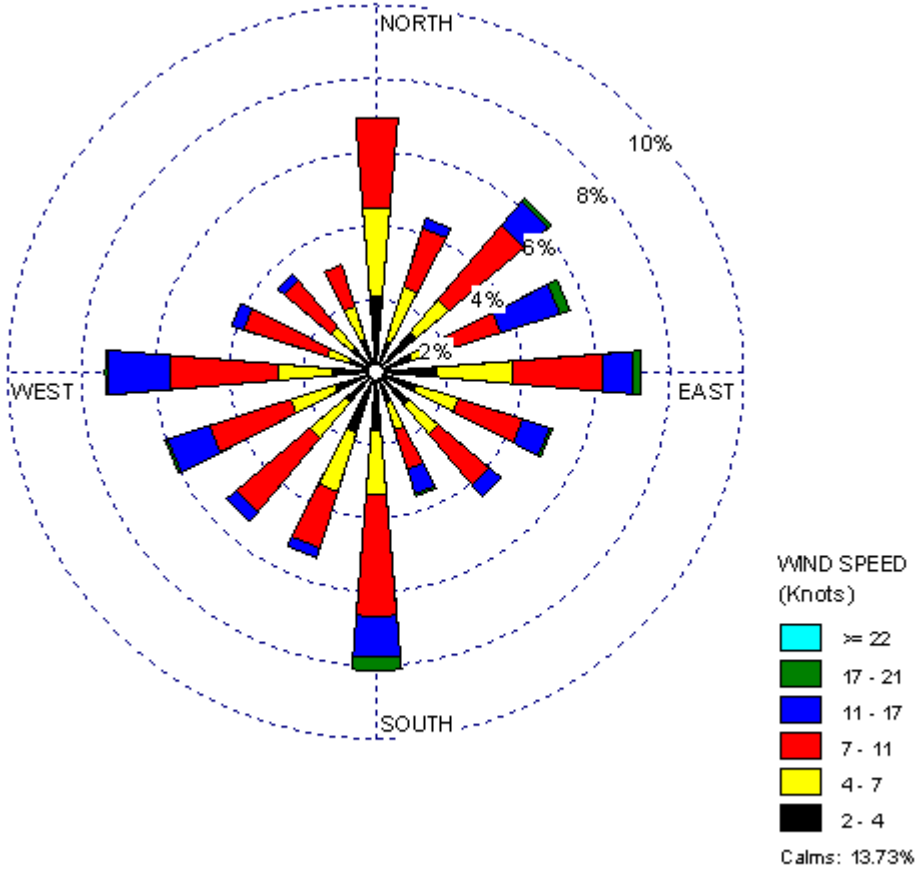


Figure 8-24. Wind Rose for ORFL Sampling Days



days). Both of these sites are located in close proximity to Tampa Bay, which lies to the west of the monitoring locations.

- Wind speeds ranged from 7 to 11 knots on days that samples were taken (39 percent of observations). Calm winds were observed for 12 percent of observations.

Observations from Figure 8-22 for SYFL include:

- Hourly winds near SYFL were predominantly out of the east (10 percent of observations), with north, east-northeast, and southerly winds each making up another 6 percent of observations on sampling days.
- Wind speeds ranged from 7 to 11 knots on most days that samples were taken.
- Calm winds were observed for 16 percent of observations.

Each of the previous five sites reside in the Tampa/St. Petersburg area on Florida's Gulf Coast. While there are differences, their wind roses were similar to each other. In contrast, the FLFL site is the only Florida site residing on Florida's Atlantic Coast, and its wind rose was much different than the other sites. Observations from Figure 8-23 for FLFL include:

- Hourly winds near FLFL were predominantly out of the east (15 percent of observations), east-southeast (14 percent) and southeast (11 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on days that samples were taken, although winds out of the east were recorded at higher speeds more frequently than other directions.
- Calm winds were recorded for 13 percent of observations.

Observations from Figure 8-24 for ORFL include:

- Hourly winds near ORFL were predominantly out of the south (8 percent of observations), with the east, north, and west each making up 7 percent of observations on sampling days.
- Wind speeds ranged from 7 to 11 knots on days that samples were taken.
- Calm winds were recorded for 14 percent of observations.

8.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not

be performed as ERG did not analyze VOCs for this site. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

8.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Pinellas, Hillsborough, Orange, and Broward Counties in Florida were obtained from the Florida Department of Highway Safety and Motor Vehicles and the U.S. Census Bureau, and are summarized in Table 8-5. Table 8-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 8-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 8-5 include:

- Of the four Florida counties with monitoring sites, Broward County, where FLFL is located, is the most populous, while Pinellas County, where AZFL and SKFL are located, are the least populated.

- Broward County has the lowest estimated vehicles per person and Pinellas County has the highest.

- While FLFL has the highest number of people living within a 10 mile radius of the site, SMFL has the least. SMFL is located within a wildlife sanctuary at E.G. Simmons Park.

- The GAFL monitoring site, located near the Gandy Bridge between Tampa and St. Petersburg, experiences the highest daily traffic volume, while SYFL, located in the more rural outskirts of the Tampa area, experiences the lowest.

8.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted.

Table 8-5. Motor Vehicle Information for the Florida Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
AZFL	924,413	1,461,506	1.58	574,226	907,856	51,000
FLFL	1,787,636	1,637,132	0.91	1,333,555	1,221,281	8,000
GAFL	1,157,738	1,189,885	1.03	437,022	486,156	81,400
ORFL	1,043,500	1,043,571	1.00	993,441	993,509	59,000
SKFL	924,413	1,461,505	1.58	699,265	1,105,544	50,500
SMFL	1,157,738	1,189,885	1.03	61,186	62,885	18,700
SYFL	1,157,738	1,189,885	1.03	124,967	128,437	5,142

Details on how this analysis was conducted can be found in Section 3.3.4. The Florida sites with enough data for a trends analysis are AZFL, GAFL, ORFL, SKFL and SYFL. Figures 8-25 through 8-29 present the trends analysis for formaldehyde for these sites.

The following observations can be made from Figures 8-25 through 8-29:

- After a three year downward trend, concentrations of formaldehyde at the AZFL site have generally been increasing slightly over the last three years.

- While concentrations of formaldehyde at the GAFL site appear to have increased significantly from 2004 to 2005, the confidence interval for the 2005 formaldehyde average indicates that the average was influenced by outliers. The 2006 formaldehyde average concentration is much closer to those from previous years. However, the 2006 average concentration is an increase from the 2003 and 2004 averages.

- The formaldehyde average at the ORFL monitoring site has decreased slightly since holding steady in 2005.

- Although the formaldehyde average at the SKFL monitoring site appears to have decreased each year, the very large confidence intervals in 2004 and 2005 make it difficult to make an accurate assessment.

- The 2006 formaldehyde average at SYFL appears to have decreased from 2005 levels. However, given the confidence level shown for 2005, it is difficult to discern if this is an actual decreasing trend.

8.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at each Florida site and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 8-6. The NATA data is presented for the census tract where the monitoring site is located. Additionally, the pollutants of interest are bolded.

The following observations can be made from Table 8-6:

- Formaldehyde had higher daily averages than acetaldehyde at each Florida site, which was also true for the annual averages.

Figure 8-25. Comparison of Yearly Averages for the AZFL Monitoring Site

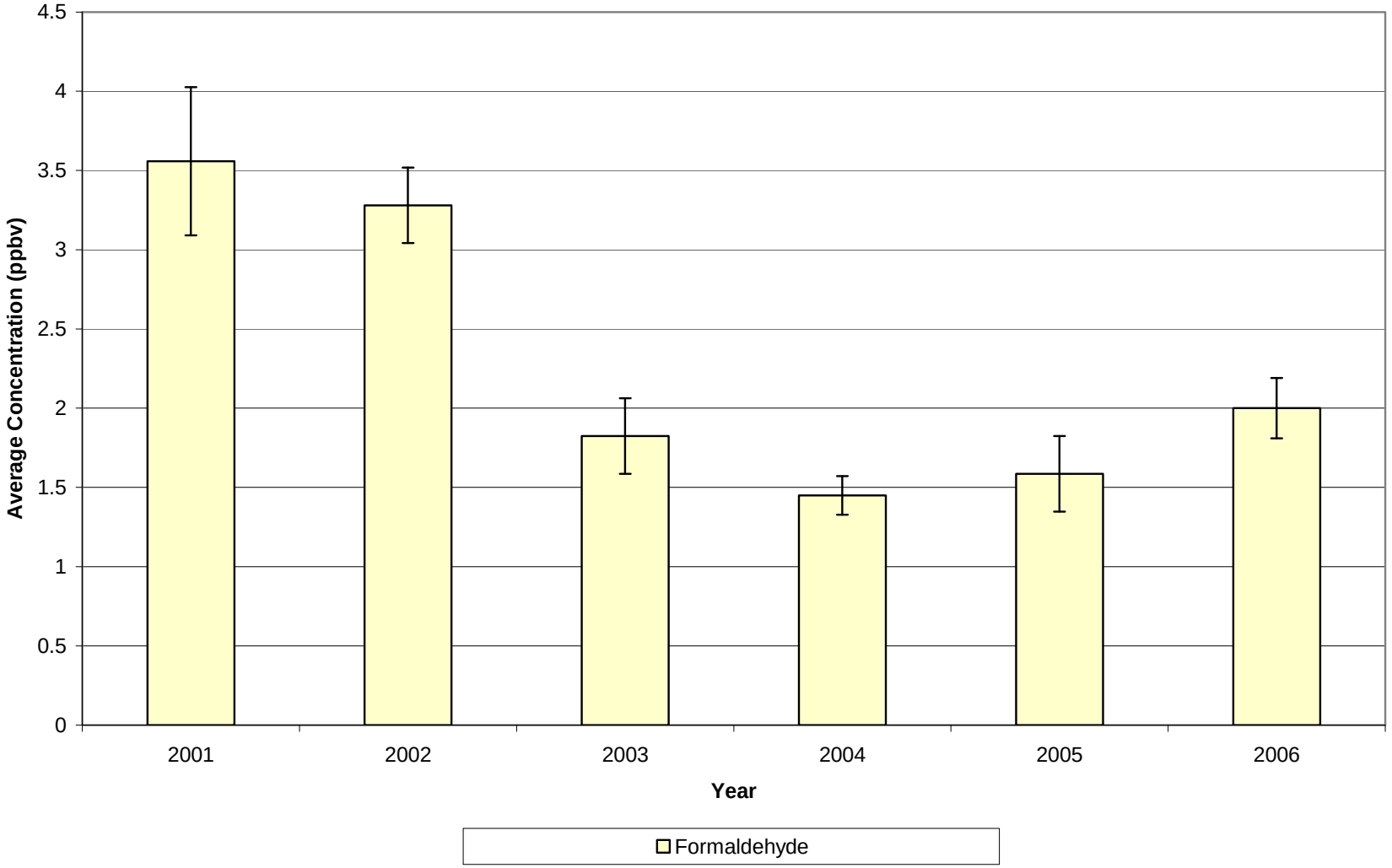


Figure 8-26. Comparison of Yearly Averages for the GAFL Monitoring Site

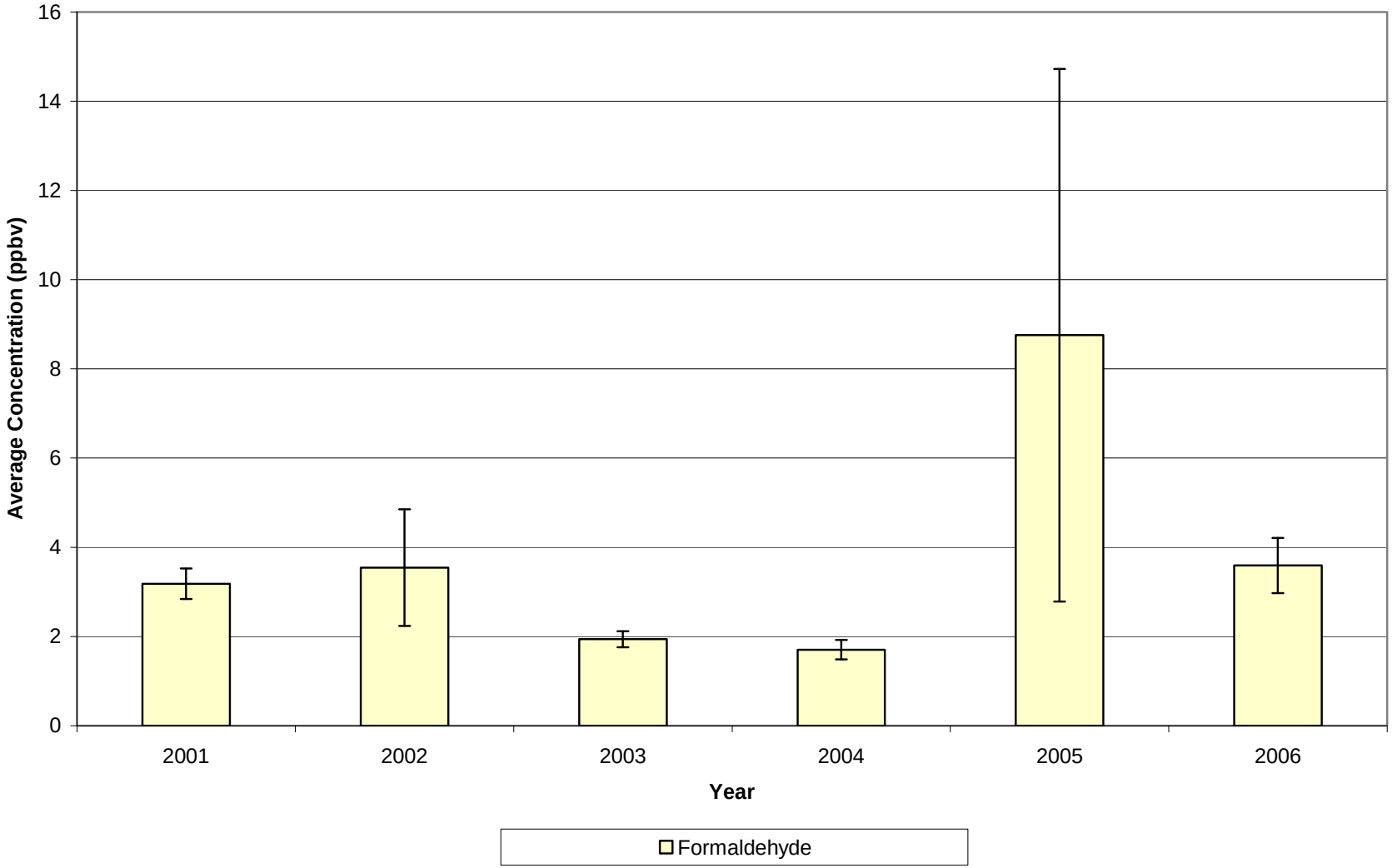


Figure 8-27. Comparison of Yearly Averages for the ORFL Monitoring Site

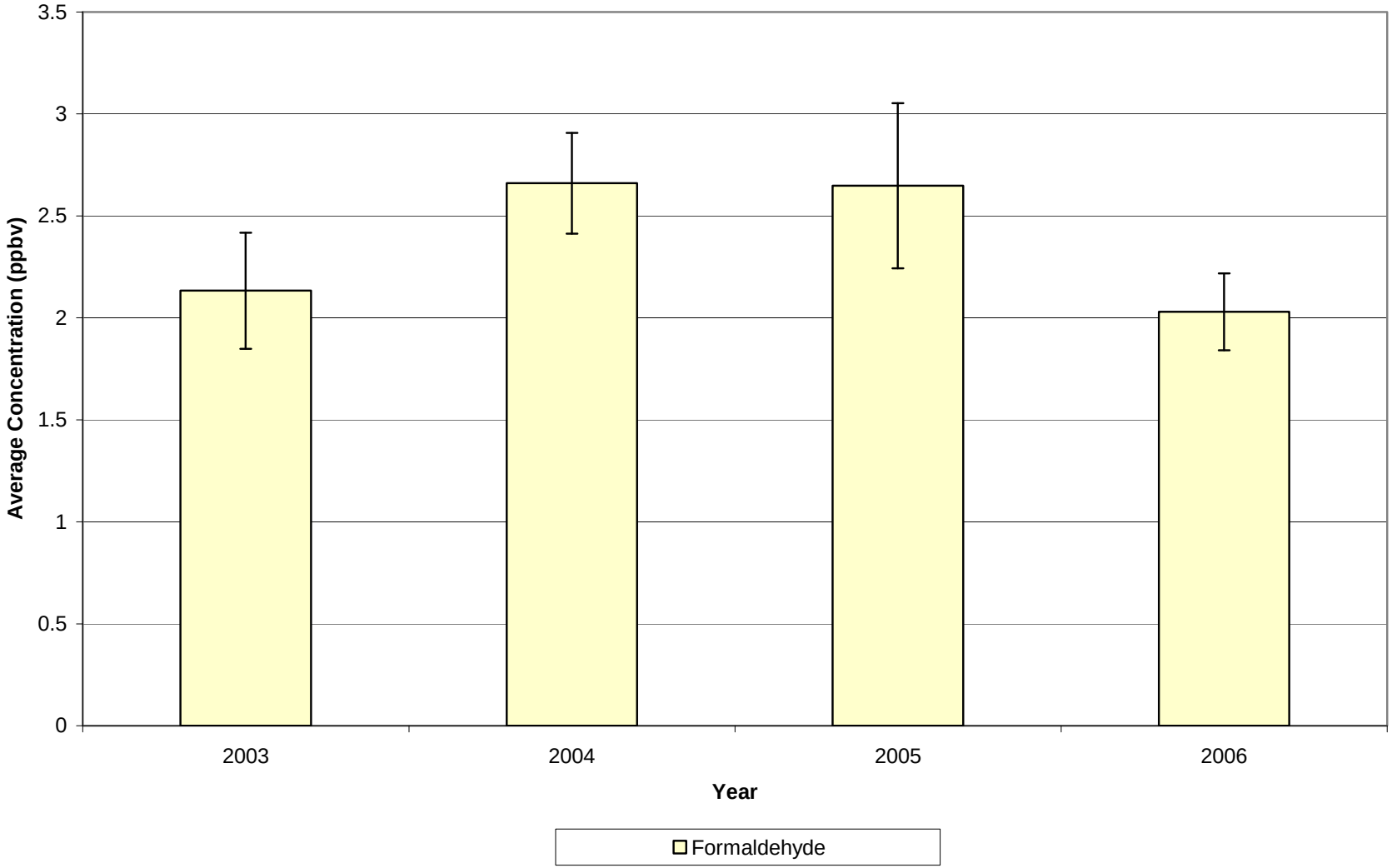


Figure 8-28. Comparison of Yearly Averages for the SKFL Monitoring Site

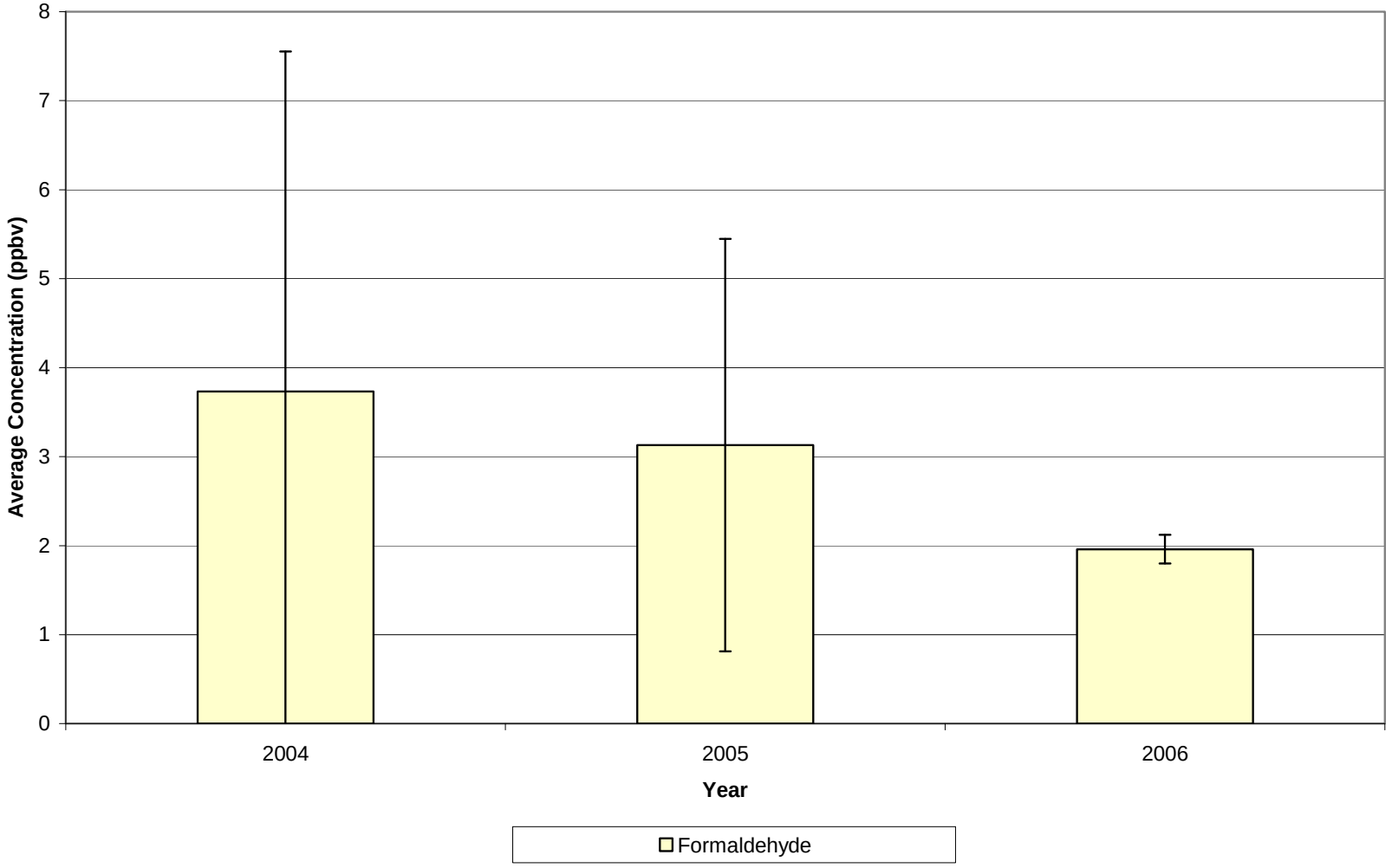
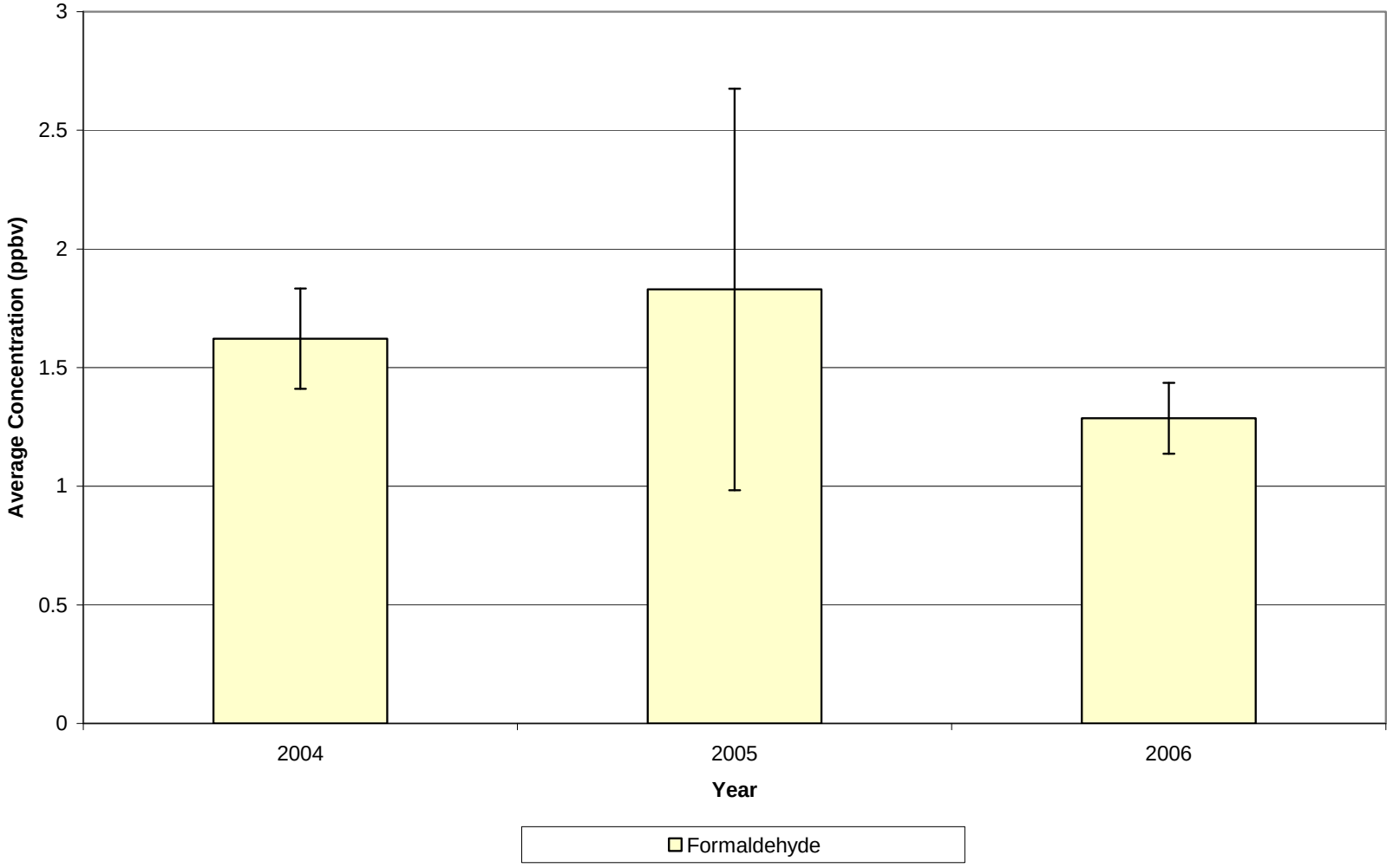


Figure 8-29. Comparison of Yearly Averages for the SYFL Monitoring Site



- For each site, acetaldehyde had a higher cancer risk than formaldehyde, ranging from 2.55 in-a-million for SYFL to 5.28 in-a-million for ORFL.

- Cancer risk due to formaldehyde was less than 0.05 in-a-million for all of the Florida sites.

- Noncancer HQs were less than 0.5 for the pollutants that failed screens at the Florida sites.

- Annual averages could not be calculated at FLFL because the site stopped sampling in October.

In addition to the annual averages and risks based on 2006 monitoring data, data from EPA's 1999 NATA were retrieved and are also presented in Table 8-6. Data from NATA is presented by the census tract where each site resides.

The census tract information for the Florida sites follows, grouped by county:

- 12103022402 for AZFL and12103024905 for SKFL; the 5,456 people residing in the AZFL census tract represent 0.6 percent of the 2000 Pinellas County population, while the 6,522 residents of the SKFL census tract represent 0.7 percent of the 2000 Pinellas County population.

- 12011070204 for FLFL; the 4,301 residents of the FLFL census tract represent 0.3 percent of the 2000 Broward County population.

- 12057006500 for GAFL, 12057012204 for SYFL, and 12057014107 for SMFL; the 5,913 people residing in the GAFL census tract represent 0.6 percent of the 2000 Hillsborough County population; the 4,362 residents of the SYFL census tract represent 0.4 percent of the 2000 Hillsborough County population; and the 1,803 residents of the more rural SMFL census tract represent just less than 0.2 percent of the Hillsborough County population.

- 12095015901 for ORFL; the 2,083 people residing in the ORFL census tract represent 0.2 percent of the 2000 Orange County population.

The following observation can be made from the NATA data in Table 8-6:

- NATA-modeled concentrations for formaldehyde and acetaldehyde were very similar to those measured in 2006.

- NATA-modeled cancer and noncancer risks for formaldehyde and acetaldehyde were very similar to those calculated from the annual averages.

Table 8-6. Chronic Risk Summary for the Monitoring Sites in Florida

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Azalea Park, St. Petersburg (AZFL) – Census Tract ID 12103022402								
Acetaldehyde	0.0000022	0.009	1.21	2.67	0.13	1.96 ± 0.21	4.31	0.22
Formaldehyde	5.5E-09	0.0098	1.31	0.01	0.13	2.46 ± 0.23	0.01	0.25
Davie, Florida (FLFL) – Census Tract ID 12011070204								
Acetaldehyde	0.0000022	0.009	1.68	3.71	0.19	3.29 ± 1.19	NA	NA
Formaldehyde	5.5E-09	0.0098	2.30	0.01	0.23	3.17 ± 1.12	NA	NA
Gandy, Tampa, Florida (GAFL) – Census Tract ID 12057006500								
Acetaldehyde	0.0000022	0.009	1.73	3.81	0.19	1.66 ± 0.22	3.64	0.18
Formaldehyde	5.5E-09	0.0098	1.72	0.01	0.18	4.41 ± 0.76	0.02	0.45
Winter Park, Florida (ORFL) – Census Tract ID 12095015901								
Acetaldehyde	0.0000022	0.009	1.99	4.38	0.22	2.40 ± 0.29	5.28	0.27
Formaldehyde	5.5E-09	0.0098	1.98	0.01	0.20	2.49 ± 0.23	0.01	0.25
Skyview, Florida (SKFL) – Census Tract ID 12103024905								
Acetaldehyde	0.0000022	0.009	1.65	3.63	0.18	1.27 ± 0.11	2.79	0.14
Formaldehyde	5.5E-09	0.0098	1.73	0.01	0.18	2.41 ± 0.20	0.01	0.25
Simmons Park, Tampa, Florida (SMFL) – Census Tract ID 12057014107								
Acetaldehyde	0.0000022	0.009	1.06	2.33	0.12	1.35 ± 0.13	2.97	0.15
Formaldehyde	5.5E-09	0.0098	1.26	0.01	0.13	2.56 ± 0.23	0.01	0.26
Plant City, Florida (SYFL) – Census Tract ID 12057012204								
Acetaldehyde	0.0000022	0.009	1.25	2.75	0.14	1.16 ± 0.10	2.55	0.13
Formaldehyde	5.5E-09	0.0098	1.42	0.01	0.14	1.58 ± 0.18	0.01	0.16
Hexavalent Chromium	0.012	0.0001	<0.01	1.00	<0.01	<0.01 ± <0.01	0.22	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

8.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 8-7 and 8-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 8-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 8-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made for FLFL in Broward County from Table 8-7:

- Like many other counties with UATMP sites, benzene was the highest emitted pollutant (by mass) with a cancer risk factor in Broward County, where FLFL is located.
- Unlike most counties, naphthalene had the highest cancer toxicity-weighted emissions.
- Benzene did have the second highest cancer toxicity-weighted emissions, while naphthalene had the second highest total emissions.
- Formaldehyde and acetaldehyde were the only pollutants with failed screens at FLFL, but annual averages (and therefore, cancer risks) could not be calculated.
- These two pollutants had the fourth and fifth highest total emissions according to the NEI, but neither pollutant appeared in the list of 10 highest cancer toxicity-weighted emissions.

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Florida Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Davie, Florida (FLFL) – Broward County					
Benzene	1,357.39	Naphthalene	2.80E-02		
Naphthalene	823.24	Benzene	1.06E-02		
Dichloromethane	530.09	1,3-Butadiene	4.78E-03		
Formaldehyde	523.41	Lead	4.46E-03		
Acetaldehyde	192.21	Nickel	1.83E-03		
1,3-Butadiene	159.40	Arsenic	9.06E-04		
1,3-Dichloropropene	116.00	*p*-Dichlorobenzene	6.54E-04		
Tetrachloroethylene	92.71	Tetrachloroethylene	5.47E-04		
p-Dichlorobenzene	59.42	1,3-Dichloropropene	4.64E-04		
Trichloroethylene	34.84	Polycyclic Organic Matter as 7-PAH	4.52E-04		
Gandy, Tampa, Florida (GAFL) – Hillsborough County					
Benzene	1,078.20	Benzene	8.41E-03	Acetaldehyde	3.64
Formaldehyde	441.37	1,3-Butadiene	3.49E-03	Formaldehyde	0.02
Acetaldehyde	168.60	Lead	1.60E-03		
1,3-Butadiene	116.37	Hexavalent Chromium	1.22E-03		
Tetrachloroethylene	58.96	Naphthalene	1.08E-03		
Dichloromethane	32.75	Cadmium	7.24E-04		
Naphthalene	31.70	Nickel	4.08E-04		
Trichloroethylene	21.19	Arsenic	3.90E-04		
Polycyclic Organic Matter as 15-PAH	5.29	Acetaldehyde	3.71E-04		
Lead	3.60	Tetrachloroethylene	3.48E-04		

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Simmons Park, Tampa, Florida (SMFL) – Hillsborough County					
Benzene	1,078.20	Benzene	8.41E-03	Acetaldehyde	2.97
Formaldehyde	441.37	1,3-Butadiene	3.49E-03	Formaldehyde	0.01
Acetaldehyde	168.60	Lead	1.60E-03		
1,3-Butadiene	116.37	Hexavalent Chromium	1.22E-03		
Tetrachloroethylene	58.96	Naphthalene	1.08E-03		
Dichloromethane	32.75	Cadmium	7.24E-04		
Naphthalene	31.70	Nickel	4.08E-04		
Trichloroethylene	21.19	Arsenic	3.90E-04		
Polycyclic Organic Matter as 15-PAH	5.29	Acetaldehyde	3.71E-04		
Lead	3.60	Tetrachloroethylene	3.48E-04		
Plant City, Florida (SYFL) – Hillsborough County					
Benzene	1,078.20	Benzene	8.41E-03	Acetaldehyde	2.55
Formaldehyde	441.37	1,3-Butadiene	3.49E-03	Hexavalent Chromium	0.22
Acetaldehyde	168.60	Lead	1.60E-03	Formaldehyde	0.01
1,3-Butadiene	116.37	Hexavalent Chromium	1.22E-03		
Tetrachloroethylene	58.96	Naphthalene	1.08E-03		
Dichloromethane	32.75	Cadmium	7.24E-04		
Naphthalene	31.70	Nickel	4.08E-04		
Trichloroethylene	21.19	Arsenic	3.90E-04		
Polycyclic Organic Matter as 15-PAH	5.29	Acetaldehyde	3.71E-04		
Lead	3.60	Tetrachloroethylene	3.48E-04		

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Winter Park, Florida (ORFL) – Orange County					
Benzene	1,068.60	Benzene	8.34E-03	Acetaldehyde	5.28
Formaldehyde	379.84	1,3-Butadiene	3.68E-03	Formaldehyde	0.01
Dichloromethane	157.31	Arsenic	2.14E-03		
Acetaldehyde	134.32	Lead	1.47E-03		
1,3-Butadiene	122.78	Naphthalene	9.66E-04		
Tetrachloroethylene	61.88	Tetrachloroethylene	3.65E-04		
Naphthalene	28.42	Acetaldehyde	2.96E-04		
Trichloroethylene	24.25	Polycyclic Organic Matter as 15-PAH	2.69E-04		
Polycyclic Organic Matter as 15-PAH	4.89	Polycyclic Organic Matter as 7-PAH	2.61E-04		
Polycyclic Organic Matter as 7-PAH	1.22	Hexavalent Chromium	2.50E-04		
Azalea Park, St. Petersburg, Florida (AZFL) – Pinellas County					
Benzene	886.09	Benzene	6.91E-03	Acetaldehyde	4.31
Formaldehyde	299.22	1,3-Butadiene	3.02E-03	Formaldehyde	0.01
Acetaldehyde	107.60	Nickel	2.32E-03		
1,3-Butadiene	100.78	Lead	2.12E-03		
Dichloromethane	64.63	Arsenic	8.22E-04		
Naphthalene	22.64	Naphthalene	7.70E-04		
Trichloroethylene	20.71	Hexavalent Chromium	3.28E-04		
Nickel	14.50	Acetaldehyde	2.37E-04		
Tetrachloroethylene	10.28	Polycyclic Organic Matter as 7-PAH	2.17E-04		
Polycyclic Organic Matter as 15-PAH	3.14	Polycyclic Organic Matter as 15-PAH	1.73E-04		

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Pinellas Park, Florida (SKFL) – Pinellas County					
Benzene	886.09	Benzene	6.91E-03	Acetaldehyde	2.79
Formaldehyde	299.22	1,3-Butadiene	3.02E-03	Formaldehyde	0.01
Acetaldehyde	107.60	Nickel	2.32E-03		
1,3-Butadiene	100.78	Lead	2.12E-03		
Dichloromethane	64.63	Arsenic	8.22E-04		
Naphthalene	22.64	Naphthalene	7.70E-04		
Trichloroethylene	20.71	Hexavalent Chromium	3.28E-04		
Nickel	14.50	Acetaldehyde	2.37E-04		
Tetrachloroethylene	10.28	Polycyclic Organic Matter as 7-PAH	2.17E-04		
Polycyclic Organic Matter as 15-PAH	3.14	Polycyclic Organic Matter as 15-PAH	1.73E-04		

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Florida Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Davie, Florida (FLFL) – Broward County					
Xylenes	56,151.18	Acrolein	1,583,912.55		
Toluene	31,886.49	Xylenes	561,511.76		
Ethylbenzene	13,718.43	Naphthalene	274,414.51		
Chloroform	9,751.74	Nickel	176,214.27		
Methanol	7,845.13	Chloroform	99,507.59		
Benzene	1,357.39	Toluene	79,716.21		
Naphthalene	823.24	1,3-Butadiene	79,700.70		
Hexane	647.07	Formaldehyde	53,409.33		
Dichloromethane	530.09	Benzene	45,246.30		
Formaldehyde	523.41	Bromomethane	32,400.00		
Gandy, Tampa, Florida (GAFL) – Hillsborough County					
Hydrochloric Acid	3,106.48	Acrolein	1,259,274.30	Formaldehyde	0.45
Toluene	2,859.57	Hydrochloric Acid	155,323.87	Acetaldehyde	0.18
Xylenes	2,002.05	1,3-Butadiene	58,187.34		
Methanol	1,171.89	Formaldehyde	45,037.84		
Benzene	1,078.20	Manganese	44,152.15		
Hexane	554.19	Nickel	39,275.93		
Ethylbenzene	466.12	Benzene	35,939.93		
Formaldehyde	441.37	Cadmium	20,105.24		
Hydrogen Fluoride	403.65	Xylenes	20,020.54		
Methyl Isobutyl Ketone	367.10	Acetaldehyde	18,733.64		

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Simmons Park, Tampa, Florida (SMFL) – Hillsborough County					
Hydrochloric Acid	3,106.48	Acrolein	1,259,274.30	Formaldehyde	0.26
Toluene	2,859.57	Hydrochloric Acid	155,323.87	Acetaldehyde	0.15
Xylenes	2,002.05	1,3-Butadiene	58,187.34		
Methanol	1,171.89	Formaldehyde	45,037.84		
Benzene	1,078.20	Manganese	44,152.15		
Hexane	554.19	Nickel	39,275.93		
Ethylbenzene	466.12	Benzene	35,939.93		
Formaldehyde	441.37	Cadmium	20,105.24		
Hydrogen Fluoride	403.65	Xylenes	20,020.54		
Methyl Isobutyl Ketone	367.10	Acetaldehyde	18,733.64		
Plant City, Florida (SYFL) – Hillsborough County					
Hydrochloric Acid	3,106.48	Acrolein	1,259,274.30	Formaldehyde	0.16
Toluene	2,859.57	Hydrochloric Acid	155,323.87	Acetaldehyde	0.13
Xylenes	2,002.05	1,3-Butadiene	58,187.34	Hexavalent Chromium	0.00
Methanol	1,171.89	Formaldehyde	45,037.84		
Benzene	1,078.20	Manganese	44,152.15		
Hexane	554.19	Nickel	39,275.93		
Ethylbenzene	466.12	Benzene	35,939.93		
Formaldehyde	441.37	Cadmium	20,105.24		
Hydrogen Fluoride	403.65	Xylenes	20,020.54		
Methyl Isobutyl Ketone	367.10	Acetaldehyde	18,733.64		

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Winter Park, Florida (ORFL) – Orange County					
Toluene	2,883.18	Acrolein	1,129,242.73	Acetaldehyde	0.27
Xylenes	1,958.88	Hydrochloric Acid	71,713.76	Formaldehyde	0.25
Hydrochloric Acid	1,434.28	1,3-Butadiene	61,391.20		
Benzene	1,068.60	Formaldehyde	38,758.87		
Methanol	979.23	Benzene	35,619.97		
Hexane	511.76	Xylenes	19,588.83		
Ethylbenzene	471.37	Arsenic	16,603.66		
Formaldehyde	379.84	Acetaldehyde	14,924.42		
Methyl Isobutyl Ketone	340.63	Cyanide	12,315.62		
Methyl Ethyl Ketone	264.60	Nickel	10,037.02		
Azalea Park, St. Petersburg, Florida (AZFL) – Pinellas County					
Toluene	2,450.18	Acrolein	725,871.26	Formaldehyde	0.25
Xylenes	1,614.36	Nickel	223,056.24	Acetaldehyde	0.22
Methanol	1,169.66	1,3-Butadiene	50,388.30		
Benzene	886.09	Formaldehyde	30,533.10		
Hexane	451.60	Benzene	29,536.39		
Hydrochloric Acid	435.32	Manganese	22,160.13		
Ethylbenzene	410.00	Hydrochloric Acid	21,766.06		
Formaldehyde	299.22	Xylenes	16,143.60		
Styrene	295.25	Acetaldehyde	11,955.94		
Methyl *Tert*-Butyl Ether	185.76	Naphthalene	7,547.45		

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Pinellas Park, Florida (SKFL) – Pinellas County					
Toluene	2,450.18	Acrolein	725,871.26	Formaldehyde	0.25
Xylenes	1,614.36	Nickel	223,056.24	Acetaldehyde	0.14
Methanol	1,169.66	1,3-Butadiene	50,388.30		
Benzene	886.09	Formaldehyde	30,533.10		
Hexane	451.60	Benzene	29,536.39		
Hydrochloric Acid	435.32	Manganese	22,160.13		
Ethylbenzene	410.00	Hydrochloric Acid	21,766.06		
Formaldehyde	299.22	Xylenes	16,143.60		
Styrene	295.25	Acetaldehyde	11,955.94		
Methyl *Tert*-Butyl Ether	185.76	Naphthalene	7,547.45		

The following observations can be made for GAFL, SMFL, and SYFL in Hillsborough County from Table 8-7:

- Benzene was the highest emitted pollutant with a cancer risk factor and had the highest cancer toxicity-weighted emissions for Hillsborough County.

- Five other pollutants (acetaldehyde, 1,3-butadiene, tetrachloroethylene, naphthalene, and lead) appeared on both the highest emissions and highest cancer toxicity-weighted emissions lists.

- Only acetaldehyde, which had the highest cancer risks of the pollutants of interest at GAFL, SMFL, and SYFL, appeared on all three lists.

- SYFL also measured hexavalent chromium during the 2006 UATMP. Hexavalent chromium was the pollutant with the fourth highest toxicity-weighted emissions in Hillsborough County.

The following observations can be made for ORFL in Orange County from Table 8-7:

- Benzene was the highest emitted pollutant with a cancer risk factor and had the highest cancer toxicity-weighted emissions for Orange County.

- Formaldehyde and acetaldehyde had the second and fourth highest emissions in Orange County, respectively.

- Acetaldehyde ranked 7th in highest toxicity-weighted emissions while formaldehyde did not make the list.

The following observations can be made for AZFL and SKFL in Pinellas County from Table 8-7:

- Benzene was also the highest emitted pollutant and had the highest cancer toxicity-weighted emissions for Pinellas County.

- Formaldehyde and acetaldehyde had the second and third highest emissions in Pinellas County, respectively.

- Similar to Orange County, acetaldehyde ranked 8th in highest toxicity-weighted emissions while formaldehyde did not make the list.

The following observations can be made for FLFL in Broward County from Table 8-8:

- Total xylenes were the highest emitted pollutant (by mass) with a noncancer risk factor in Broward County, but had the second highest toxicity-weighted emissions.

- Acrolein, which did not appear on the list of 10 highest emitted pollutants, had the highest toxicity-weighted emissions.

- In addition to xylenes, five other pollutants (toluene, chloroform, benzene, naphthalene, and formaldehyde) appeared in both "top 10" lists.

The following observations can be made for GAFL, SMFL, and SYFL in Hillsborough County from Table 8-8:

- Hydrochloric acid was the highest emitted pollutant with a noncancer risk factor in Hillsborough County, it had the second highest toxicity-weighted emissions.

- Similar to Broward County, acrolein had the highest toxicity-weighted emissions, but did not appear on the list often highest emitted pollutants.

- Only formaldehyde appeared on all three top 10 lists.

- While acetaldehyde was not one of the highest emitted pollutants in Hillsborough County, it ranked 10^{th} for highest noncancer toxicity-weighted emissions.

- Noncancer HQs for acetaldehyde and formaldehyde were all less than 0.50.

The following observations can be made for ORFL in Orange County and for AZFL and SKFL in Pinellas County from Table 8-8:

- Although toluene was the highest emitted pollutant, acrolein had the highest noncancer toxicity-weighted emissions.

- Similar to the other Florida counties, acrolein was not one of the 10 highest emitted pollutants.

- Again, only formaldehyde appeared on all three top 10 lists.

- While acetaldehyde was not one of the highest emitted pollutants in either Orange or Pinellas Counties, it ranked 8^{th} and 9^{th}, respectively, for the highest noncancer toxicity-weighted emissions.

- Noncancer HQs for acetaldehyde and formaldehyde were all less than 0.30 for ORFL, AZFL, and SKFL.

Florida Pollutant Summary

- *The pollutants of interest at all seven Florida sites were acetaldehyde and formaldehyde.*
- *The pollutant of interest with the highest daily average at all the monitoring sites was formaldehyde.*
- *Acetaldehyde failed 100 percent of the screens at nearly all the Florida sites (one measured detection at SKFL and two at SYFL did not fail. Formaldehyde failed 100 percent of the screens at FLFL and SMFL.*
- *A comparison of formaldehyde average concentrations for all years of UATMP participation showed that 2006 formaldehyde concentrations increased slightly at AZFL and decreased slightly at ORFL. Due to the presence of outliers, the appearance of a trend cannot be determined for GAFL, SKFL, and SYFL.*

9.0 Site in Georgia

This section presents meteorological, concentration, and spatial trends for the UATMP site in Georgia (SDGA). This site is located in the Atlanta-Sandy Springs-Marietta MSA. Figure 9-1 is a topographical map showing the monitoring site in its urban location. Figure 9-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. SDGA is located near a number of point sources, most of which are located to the west of the site. These sources represent a wide variety of industries, including fuel combustion and waste treatment and disposal processes.

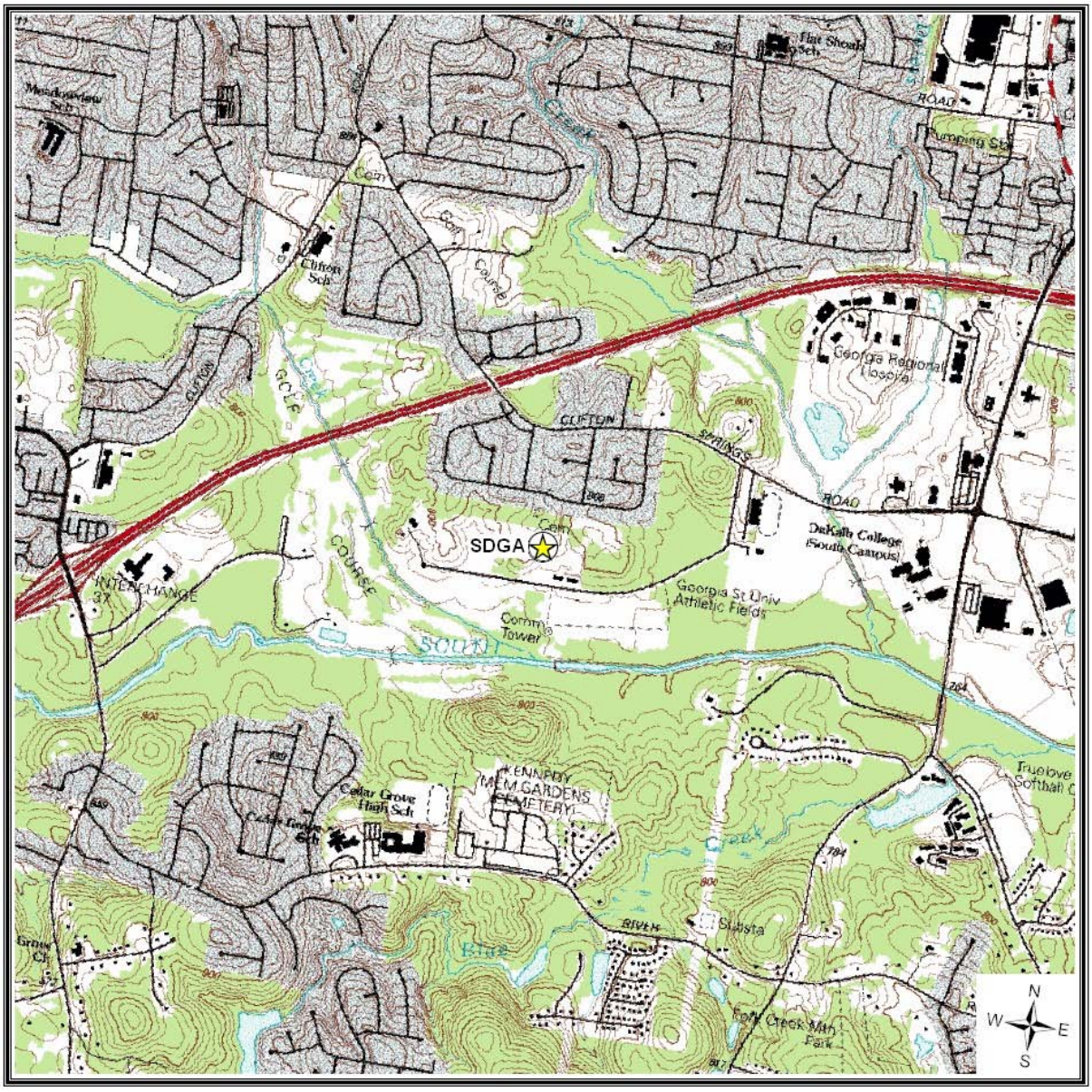
Atlanta is the largest city in Georgia, and is located at the base of the Blue Ridge Mountains. The Gulf of Mexico to the south is the major moisture source for weather systems that move across the region. Both topographical features, in addition to the Atlantic Ocean to the east, exert moderating influences on the area's climate (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the SDGA monitoring site is at WB Hartsfield/Atlanta International Airport (WBAN 13874). Table 9-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 9-1 is the 95 percent confidence interval. As shown in Table 9-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

9.1 Risk Screening and Pollutants of Interest

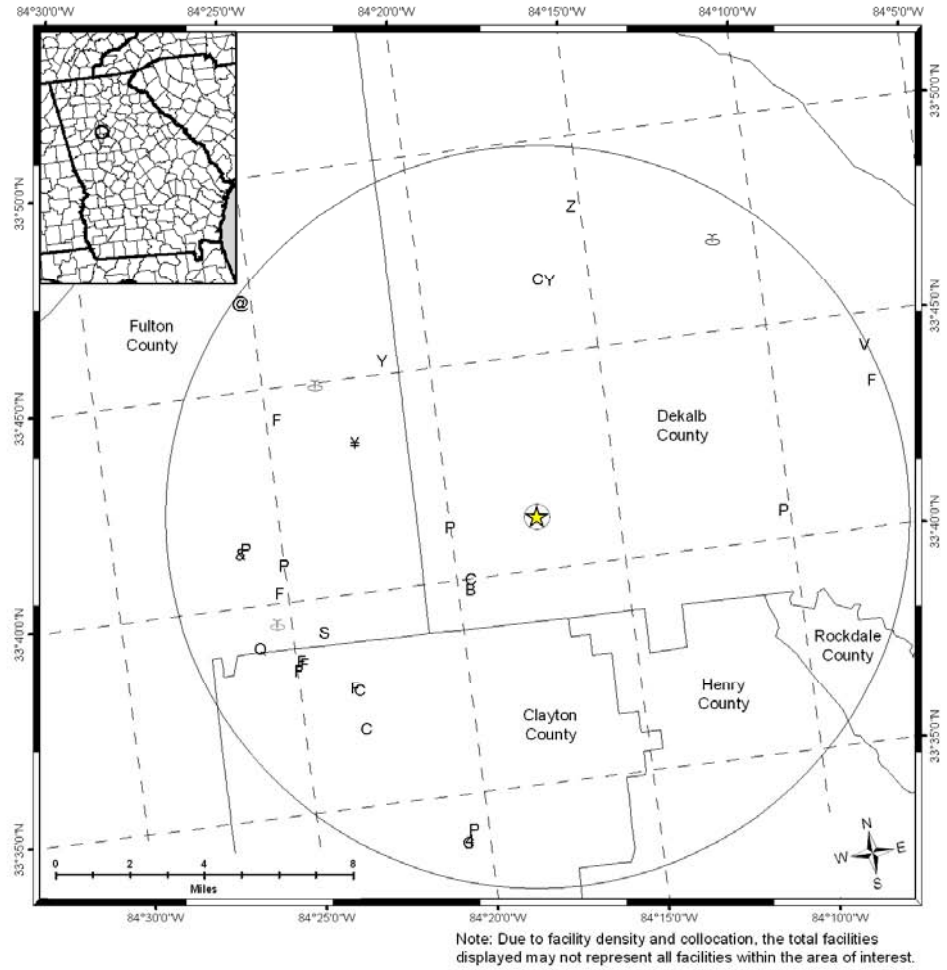
Risk screening was completed to identify the pollutants of interest for the Georgia monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs

Figure 9-1. Decatur, Georgia (SDGA) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 9-2. Facilities Located Within 10 Miles of SDGA



Legend

SDGA UATMP site | 10 mile radius | County boundary

Source Category Group (No. of Facilities)

- ¥ Automotive Repair, Services, & Parking (1)
- C Chemicals & Allied Products Facility (5)
- Z Electrical & Electronic Equipment Facility (1)
- F Fuel Combustion Industrial Facility (7)
- & Lumber & Wood Products Facility (1)
- B Mineral Products Processing Industrial Facility (1)
- P Miscellaneous Processes Industrial Facility (5)
- @ Paper & Allied Products (1)
- V Polymers & Resins Production Industrial Facility (1)
- Q Primary Metal Industries Facility (1)
- 4 Production of Organic Chemicals Industrial Facility (1)
- Y Rubber & Miscellaneous Plastic Products Facility (2)
- S Surface Coating Processes Industrial Facility (1)
- Waste Treatment & Disposal Industrial Facility (7)

Table 9-1. Average Meteorological Conditions near the Monitoring Site in Georgia

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
SDGA	13874	All 2006	72.41 ± 1.45	63.16 ± 1.42	49.14 ± 1.57	55.65 ± 1.31	63.43 ± 1.36	1017.66 ± 0.55	7.10 ± 0.27
		Sampling Day	73.48 ± 3.28	64.13 ± 3.12	50.80 ± 3.23	56.76 ± 2.78	65.03 ± 3.28	1016.88 ± 1.22	7.29 ± 0.68

are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 9-2 presents the pollutants that failed at least one screen at SDGA. At SDGA, only hexavalent chromium was sampled.

The following observations are shown in Table 9-2:

- Five of 52 hexavalent chromium concentrations failed screens. This is less than 10 percent of all measured detections.

Table 9-2. Comparison of Measured Concentrations and EPA Screening Values for the Georgia Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Decatur, Georgia – SDGA					
Hexavalent Chromium	5	52	9.52	9.52	100

9.2 Concentration Averages

Three types of concentration averages were calculated for hexavalent chromium: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 9-3. Annual averages are presented and discussed in further detail in later sections.

Table 9-3. Daily and Seasonal Averages for Pollutants of Interest for the Georgia Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Decatur, Georgia – SDGA												
Hexavalent Chromium	52	57	0.05	0.01	0.03	0.01	0.05	0.02	0.06	0.01	0.05	0.04

The following observations are shown in Table 9-3:

- The daily average of hexavalent chromium at SDGA was 0.05 ± 0.01 ng/m^3.
- The highest seasonal average occurred in summer (0.06 ± 0.01 ng/m^3). However, the seasonal averages varied little, with winter exhibiting the lowest seasonal average (0.03 ± 0.01 ng/m^3).

9.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for SDGA was evaluated using ATSDR acute and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. Hexavalent chromium has no acute risk factors; therefore, acute risk could not be evaluated. The intermediate risk value was not exceeded at SDGA.

9.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

9.4.1 Pearson Correlation Analysis

Table 9-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters at the SDGA monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.) Correlations calculated for SDGA between hexavalent chromium and the meteorological parameters were weak.

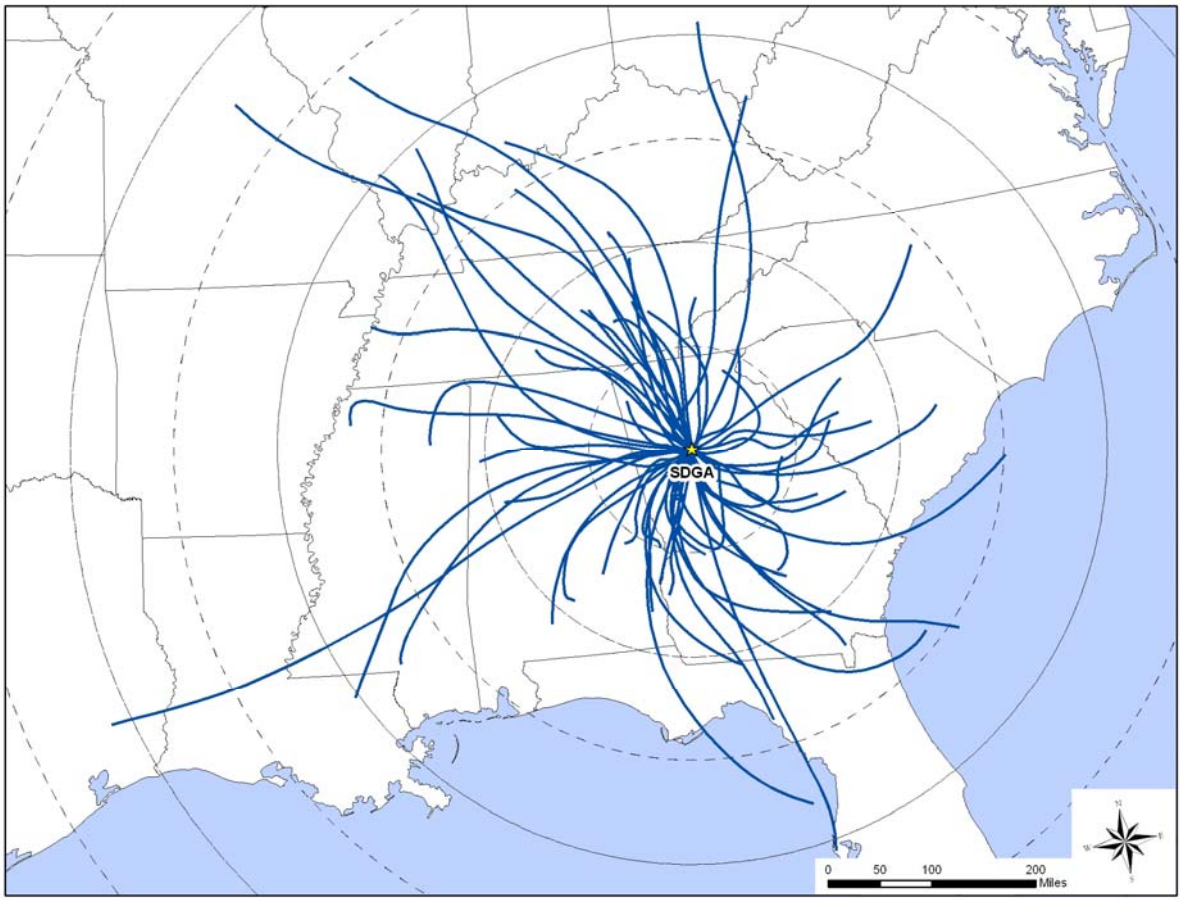
9.4.2 Composite Back Trajectory Analysis

Figure 9-3 is a composite back trajectory map for the SDGA monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of

Table 9-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Georgia Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Decatur, Georgia – SDGA								
Hexavalent Chromium	52	0.19	0.18	0.13	0.16	-0.08	0.10	-0.30

Figure 9-3. Composite Back Trajectory Map for SDGA



air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 9-3 represents 100 miles.

The following observations can be made from Figure 9-3:

- The back trajectories originated from a variety of directions at SDGA.
- The 24-hour airshed domain was somewhat large at SDGA, with trajectories originating as far away as Texas, or greater than 600 miles away.
- The majority of the trajectories originated from within 300 miles of the site.

9.4.3 Wind Rose Analysis

Hourly wind data from the WB Hartsfield/Atlanta International Airport near the SDGA monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 9-4 is the wind rose for the SDGA monitoring site on days that sampling occurred.

Observations from Figure 9-4 include:

- Hourly winds were predominantly out of the northwest (15 percent of observations), west-northwest (12 percent), and west (10 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on most sampling days.
- Calm winds (<2 knots) were recorded for only seven percent of the observations.

9.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed because ERG did not analyze VOCs at this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

Figure 9-4. Wind Rose for SDGA Sampling Days

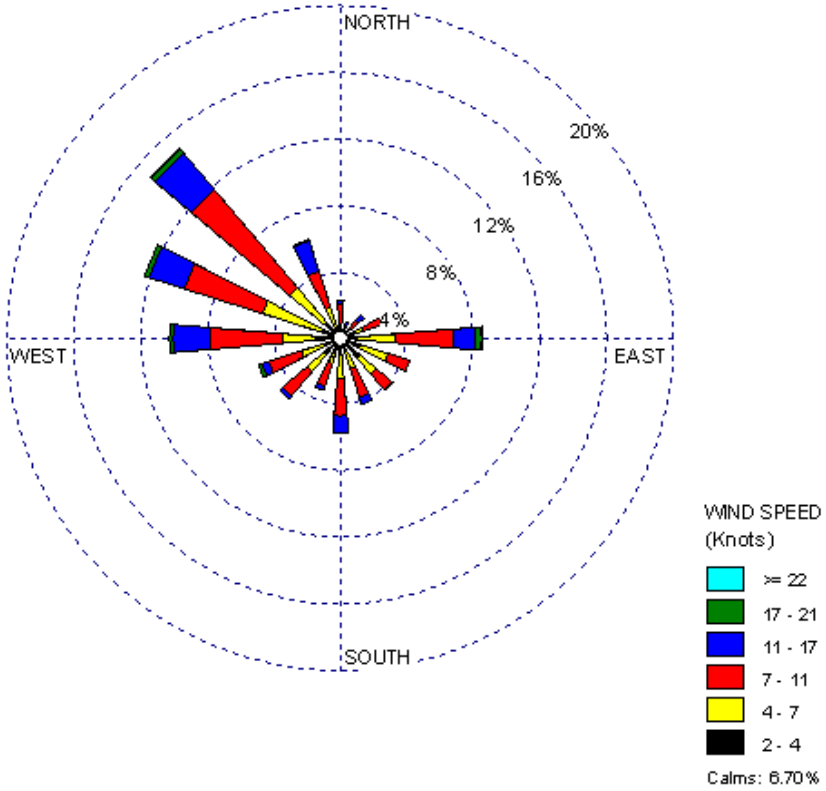


Table 9-5. Motor Vehicle Information for the Georgia Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
SDGA	723,602	458,290	0.63	728,937	461,669	98,510

9.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population were obtained from the Georgia Department of Revenue and Regulation and the U.S. Census Bureau, as shown in Table 9-5 in DeKalb, GA. Table 9-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 9-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 9-5 include:

- Compared to other UATMP sites, SDGA's county population and 10-mile radius population were relatively high, falling roughly in the top 1/3 of sites.
- Vehicle registration and estimated vehicles per person were in the middle of the range.
- Despite having only six sites with a lower population-to-vehicle ownership ratio, the SDGA traffic count is the fourth highest of all UATMP sites.

9.6 Trends Analysis

A trends analysis could not be performed for SDGA as this site has not participated in the UATMP for three consecutive years.

9.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at SDGA and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 9-6. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA for the pollutants that failed at least one screen at SDGA were retrieved and are presented in Table 9-6. The NATA data is presented for the census tract where the monitoring site is located.

Table 9-6. Chronic Risk Summary for the Monitoring Site in Georgia

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Decatur, Georgia (SDGA) – Census Tract ID 13089023404								
Hexavalent Chromium	0.012	0.0001	<0.01	0.48	<0.01	<0.01 ± <0.01	0.55	<0.01

The census tract information for SDGA is as follows:

- The SDGA monitoring site is located in census tract 13089023404.
- The population for the census tract where the SDGA monitoring site is located was 9,033, which represents less than two percent of De Kalb County's population in 2000.

The following observations can be made from Table 9-6:

- Both the NATA-modeled and annual average concentration for hexavalent chromium were less than 0.01 $\mu g/m^3$.
- In terms of cancer risk, the NATA-modeled and calculated cancer risks were very similar (0.48 and 0.55 in-a-million, respectively).

Both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

9.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 9-7 and 9-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 9-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 9-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

Table 9-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for SDGA

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for De Kalb County)		Top 10 Cancer Toxicity-Weighted Emissions (for De Kalb County)		Top 10 Cancer Risks Based on Annual Average Concentration (for SDGA)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Decatur, Georgia – SDGA					
Benzene	721.36	Benzene	5.63E-03	Hexavalent Chromium	0.55
Formaldehyde	228.22	Arsenic	2.61E-03		
Dichloromethane	118.50	1,3-Butadiene	2.14E-03		
Acetaldehyde	81.24	Lead	1.37E-03		
1,3-Butadiene	71.24	Naphthalene	6.06E-04		
Tetrachloroethylene	52.62	Hexavalent Chromium	5.87E-04		
Naphthalene	17.83	Tetrachloroethylene	3.10E-04		
Trichloroethylene	11.99	Polycyclic Organic Matter as 15-PAH	2.24E-04		
Polycyclic Organic Matter as 15-PAH	4.07	Polycyclic Organic Matter as 7-PAH	1.95E-04		
Bis(2-Ethylhexyl)Phthalate	1.58	Acetaldehyde	1.79E-04		

Table 9-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for SDGA

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for De Kalb County)		Top 10 Noncancer Toxicity-Weighted Emissions (for De Kalb County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for SDGA)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Decatur, Georgia – SDGA					
Methyl Isobutyl Ketone	3,454.11	Acrolein	727,132.35	Hexavalent Chromium	<0.01
Toluene	2,841.94	Hydrochloric Acid	81,488.19		
Xylenes	2,326.61	1,3-Butadiene	35,618.84		
Methyl Ethyl Ketone	1,700.92	Glycol Ethers	34,330.15		
Hydrochloric Acid	1,629.76	Benzene	24,045.18		
Benzene	721.36	Formaldehyde	23,287.32		
Glycol Ethers	686.60	Xylenes	23,266.13		
Ethylene Glycol	360.89	Arsenic	20,258.05		
1,1,1-Trichloroethane	357.86	Acetaldehyde	9,026.98		
Ethylbenzene	311.57	Cyanide	8,419.85		

The following observations can be made from Table 9-7:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and the highest cancer toxicity-weighted emissions for De Kalb County, Georgia.

- Six of the top 10 pollutants (benzene, acetaldehyde, tetrachloroethylene, 1,3-butadiene, naphthalene, and POM as 15-PAH) appeared on both the highest emitted list and the highest toxicity-weighted emissions list, indicating that most of the highest emitted pollutants were also the most toxic.

- Hexavalent chromium, the only pollutant sampled at SDGA, had a low cancer risk based its annual average (0.55 in-a-million). However, this pollutant has the 6th highest toxicity-weighted emissions in De Kalb County.

The following observations can be made from Table 9-8:

- Although methyl isobutyl ketone and toluene were the highest emitted pollutants with noncancer risk factors, neither pollutant ranked in the top 10 based on toxicity-weighted emissions.

- Acrolein had the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants.

- Hexavalent chromium did not rank in the top 10 highest emitted pollutants with noncancer risk factors or the 10 highest noncancer toxicity-weighted emissions in De Kalb County.

Georgia Pollutant Summary

- *The only pollutant sampled at the Georgia site was hexavalent chromium.*

- *Hexavalent chromium failed 10 percent of screens and did not exceed its intermediate risk factor.*

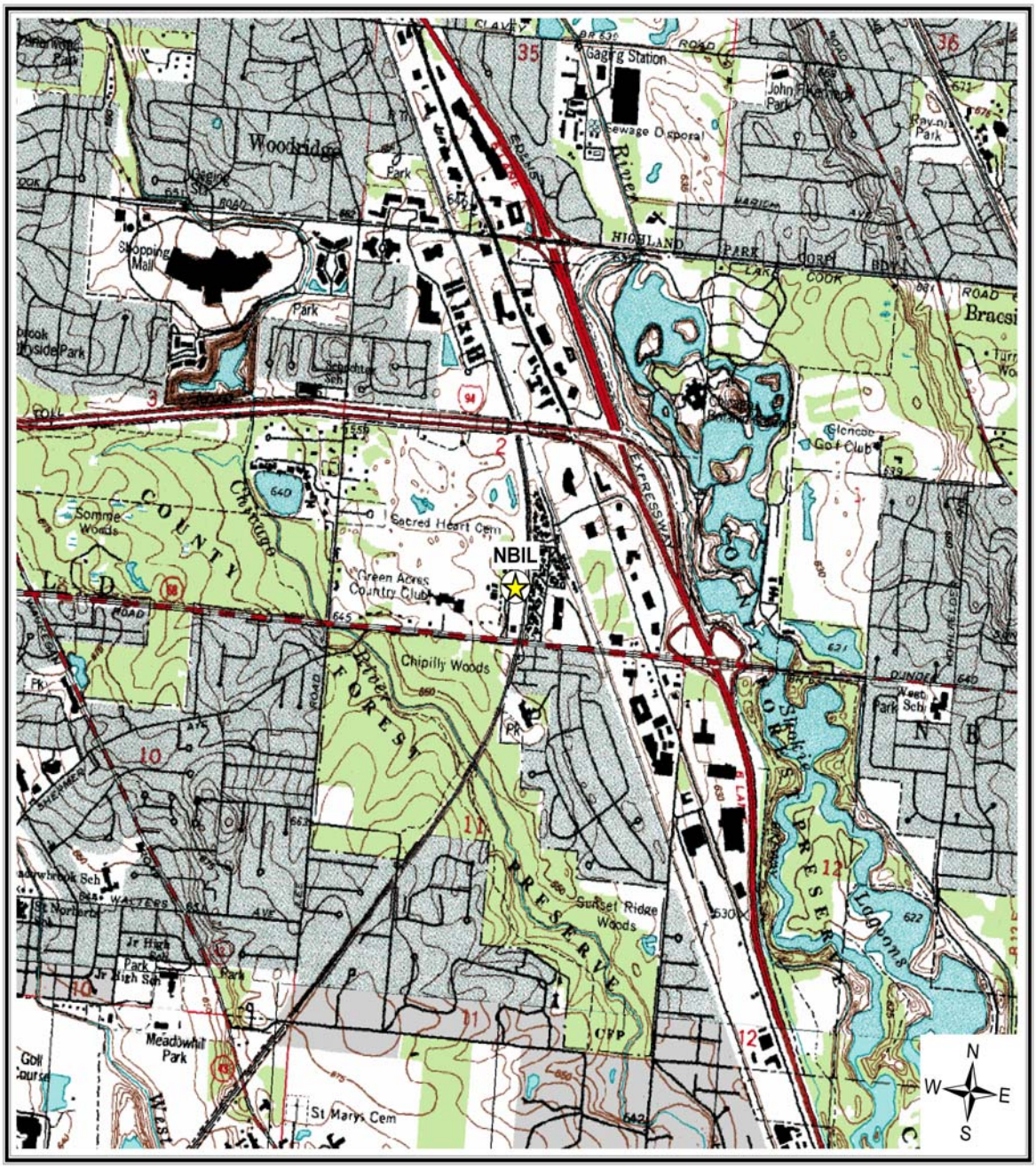
10.0 Sites in Illinois

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Illinois (NBIL and SPIL), located in the Chicago-Naperville-Joliet, IL-IN-WI MSA. More specifically, NBIL is located in Northbrook, Illinois and SPIL is located in Schiller Park, which are both suburbs of Chicago. Figures 10-1 and 10-2 are topographical maps showing the monitoring sites in their urban locations. Figure 10-3 identifies point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 10-3 shows, the NBIL and SPIL sites are within several miles of each other, and are surrounded by numerous point sources. Fuel combustion and surface coating processes are the most numerous source category groups surrounding these sites.

Daily weather fluctuations are common for the Chicago area. The proximity of Chicago to Lake Michigan offers moderating effects from the continental climate of the region. In the summertime, afternoon lake breezes can cool the city when winds from the south and southwest push temperatures upward. The origin of the air mass determines the amount and type of winter precipitation. The largest snowfalls tend to occur when cold air masses flow southward over Lake Michigan. Wind speeds average around 10 mph, but can be greater due to the winds channeling between tall buildings downtown (Ruffner and Bair, 1987).

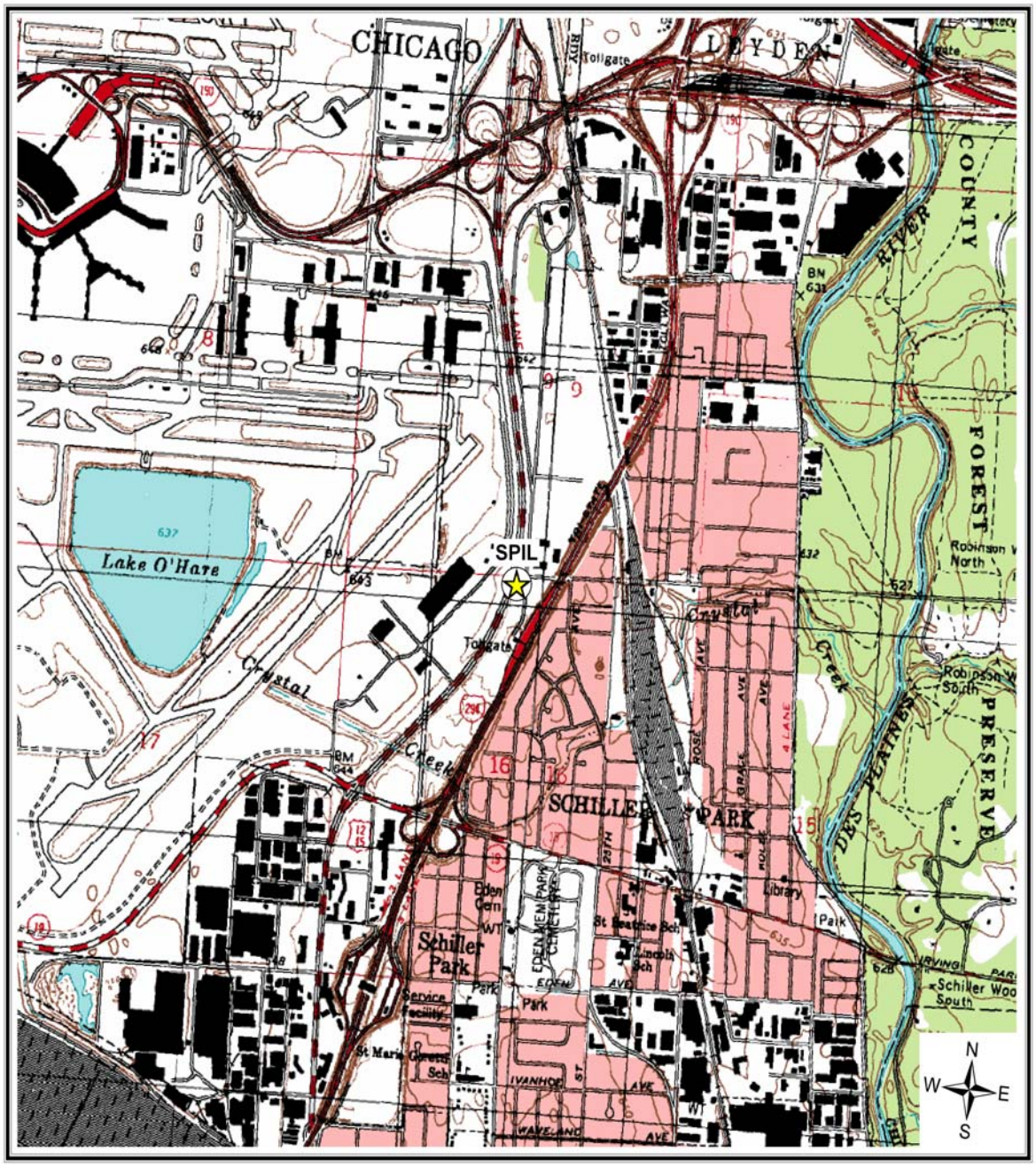
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The two weather stations are Palwaukee Municipal Airport and O'Hare International Airport (WBAN 4838 and 94846, respectively). Table 10-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were taken. Also included in Table 10-1 is the 95 percent confidence interval for each parameter. As shown

Figure 10-1. Chicago, Illinois (NBIL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 10-2. Chicago, Illinois (SPIL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 10-3. Facilities Located Within 10 Miles of NBIL and SPIL

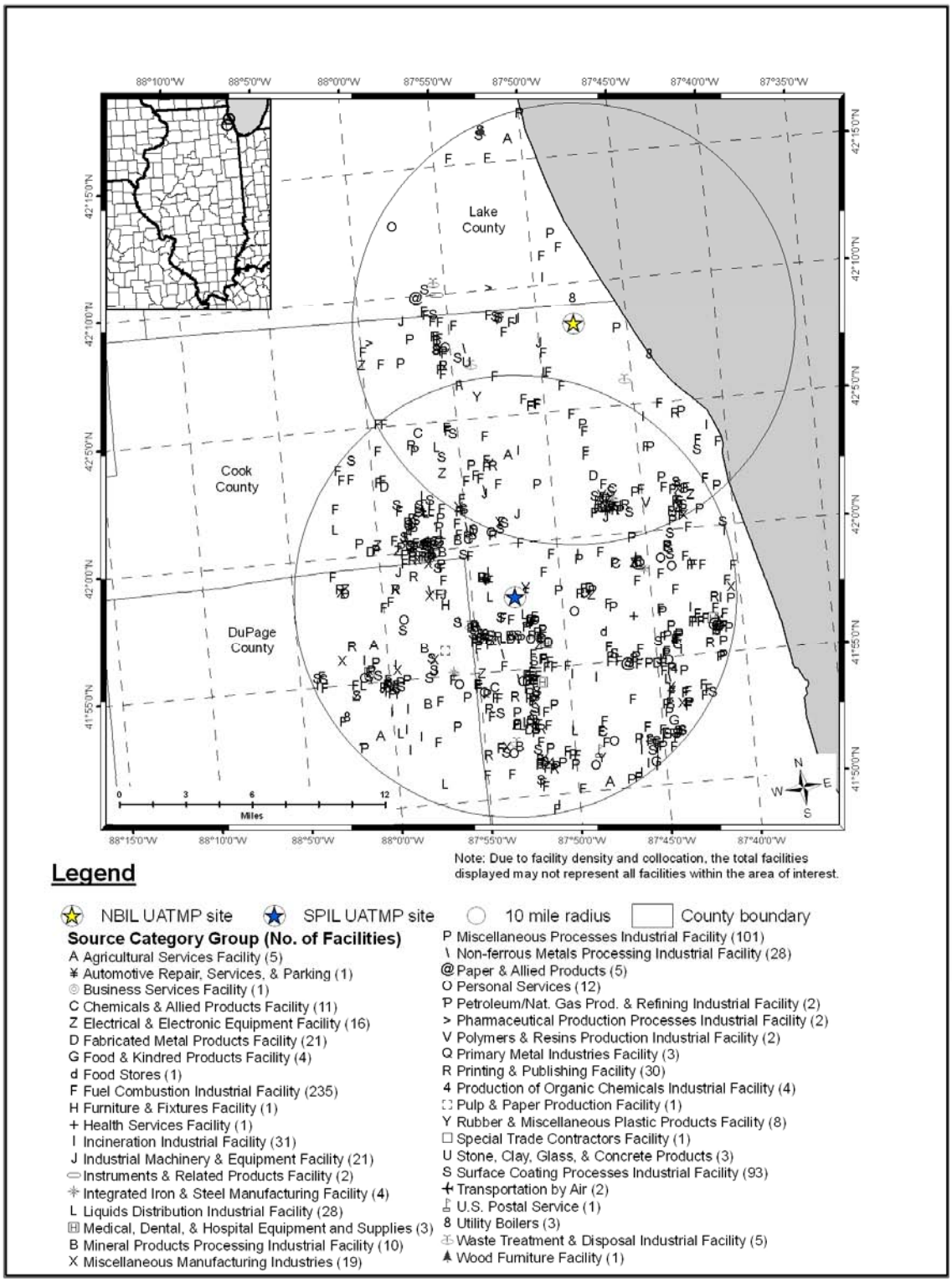


Table 10-1. Average Meteorological Conditions near the Monitoring Sites in Illinois

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
NBIL	04838	All 2006	59.02 ± 1.88	51.43 ± 1.77	41.09 ± 1.75	46.42 ± 1.61	70.39 ± 1.22	1016.34 ± 0.74	7.01 ± 0.29
		Sampling Day	57.60 ± 4.56	50.09 ± 4.14	39.89 ± 3.99	45.19 ± 3.71	70.88 ± 3.01	1016.14 ± 1.70	7.06 ± 0.72
SPIL	94846	All 2006	60.02 ± 1.91	52.32 ± 1.80	40.99 ± 1.75	46.78 ± 1.61	68.07 ± 1.24	1015.75 ± 0.74	8.01 ± 0.30
		Sampling Day	59.47 ± 4.69	51.61 ± 4.27	40.48 ± 3.94	46.14 ± 3.78	68.92 ± 3.16	1015.72 ± 1.68	8.00 ±0.76

in Table 10-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

10.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Illinois monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Table 10-2 presents the pollutants that failed at least one screen at the Illinois monitoring sites. NBIL sampled for VOC, carbonyls, SNMOC, metals (PM_{10}), and hexavalent chromium; SPIL sampled for VOC and carbonyls only.

The following observations are shown in Table 10-2:

- The number of pollutants failing the screen varied by site.
- Nineteen pollutants with a total of 432 measured concentrations failed screens at NBIL.
- Thirteen pollutants with a total of 426 measured concentrations failed screens at SPIL.
- The pollutants of interest, which are highlighted in gray, also varied by site, yet the following nine pollutants of interest were common to both sites: benzene, acrolein, formaldehyde, carbon tetrachloride, 1,3-butadiene, acetaldehyde, tetrachloroethylene, *p*-dichlorobenzene, and trichloroethylene.
- Of the nine pollutants that were common between the two sites, three pollutants of interest (benzene, carbon tetrachloride, and acrolein) had 100 percent of their measured detections fail screens.
- Of the pollutants with at least one failed screen, 54 percent of concentrations failed screens at NBIL, while 78 percent failed screens at SPIL.

Table 10-2. Comparison of Measured Concentrations and EPA Screening Values for the Illinois Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Northbrook, Illinois – NBIL					
Benzene	60	60	100.00	13.89	13.89
Carbon Tetrachloride	60	60	100.00	13.89	27.78
Acetaldehyde	58	61	95.08	13.43	41.20
Arsenic (PM_{10})	53	62	85.48	12.27	53.47
1,3-Butadiene	37	44	84.09	8.56	62.04
Formaldehyde	35	61	57.38	8.10	70.14
Acrolein	34	34	100.00	7.87	78.10
Tetrachloroethylene	33	48	68.75	7.64	85.65
Manganese (PM_{10})	25	62	40.32	5.79	91.44
p-Dichlorobenzene	14	35	40.00	3.24	94.68
Trichloroethylene	4	35	11.43	0.93	95.60
Cadmium (PM_{10})	4	62	6.45	0.93	96.53
Hexavalent Chromium	4	50	8.00	0.93	97.45
Acrylonitrile	3	3	100.00	0.69	98.15
Bromomethane	2	55	3.64	0.46	98.61
Hexachloro-1,3-butadiene	2	2	100.00	0.46	99.07
Nickel (PM_{10})	2	62	3.23	0.46	99.54
1,2-Dichloroethane	1	1	100.00	0.23	99.77
1,1,2,2-Tetrachloroethane	1	1	100.00	0.23	100.00
Total	432	798	54.14		
Schiller Park, Illinois – SPIL					
Benzene	61	61	100.00	14.32	14.32
Carbon Tetrachloride	61	61	100.00	14.32	28.64
Acetaldehyde	59	60	98.33	13.85	42.49
1,3-Butadiene	58	58	100.00	13.62	56.10
Formaldehyde	55	56	98.21	12.91	69.01
Tetrachloroethylene	49	59	83.05	11.50	80.52
Acrolein	41	41	100.00	9.62	90.14
p-Dichlorobenzene	18	39	46.15	4.23	94.37
Trichloroethylene	16	47	34.04	3.76	98.12
Hexachloro-1,3-butadiene	4	4	100.00	0.94	99.06
Acrylonitrile	2	2	100.00	0.47	99.53
Ethyl Acrylate	1	1	100.00	0.23	99.77
Dichloromethane	1	59	1.69	0.23	100.00
Total	426	548	77.74		

10.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 10-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for NBIL are shown in Table 10-3:

- Formaldehyde had the highest average concentration by mass (2.72 ± 2.88 μg/m^3), followed by acetaldehyde (0.98 ± 0.10 μg/m^3) and carbon tetrachloride (0.71 ± 0.05 μg/m^3).

- Seasonal averages for formaldehyde showed a wide variation of results with a large confidence interval for the highest average (winter, 7.03 ± 10.69 μg/m^3).

- Most of the pollutants of interest's seasonal averages varied little from their daily averages.

The following observations for SPIL are shown in Table 10-3:

- The pollutant with the highest daily average was formaldehyde (14.71 ± 6.59 μg/m^3). Formaldehyde's daily average concentration was significantly higher than any of the other pollutants of interest. The highest seasonal averages of formaldehyde occurred in the summer (24.09 ± 13.52 μg/m^3) and spring (19.96 ± 19.33 μg/m^3). However, the large confidence intervals indicate that outliers may be affecting these averages.

- The other seasonal averages did not vary much from season to season, if the confidence interval was considered.

Table 10-3. Daily and Seasonal Averages for the Pollutants of Interest for the Illinois Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Northbrook, Illinois – NBIL												
Acetaldehyde	61	61	0.98	0.10	0.91	0.16	0.92	0.15	0.86	0.21	1.24	0.24
Acrolein	34	60	0.35	0.07	0.18	0.07	NR	NR	0.31	0.14	0.32	0.08
Arsenic (PM_{10})	62	62	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	60	60	0.59	0.07	0.63	0.12	0.52	0.13	0.51	0.15	0.68	0.17
1,3-Butadiene	44	60	0.07	0.01	0.06	0.02	0.05	0.01	0.04	0.01	0.06	0.01
Cadmium (PM_{10})	62	62	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Carbon Tetrachloride	60	60	0.71	0.05	0.59	0.06	0.63	0.08	0.78	0.12	0.84	0.05
p-Dichlorobenzene	35	60	0.17	0.09	NR	NR	NR	NR	0.13	0.11	0.11	0.06
Formaldehyde	61	61	2.72	2.88	7.03	10.69	0.97	0.24	1.43	0.53	1.15	0.33
Hexavalent Chromium	50	59	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese (PM_{10})	62	62	0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tetrachloroethylene	48	60	0.41	0.15	0.31	0.27	0.24	0.12	0.55	0.39	0.27	0.08
Trichloroethylene	35	60	0.23	0.08	0.12	0.07	NR	NR	0.13	0.07	0.19	0.16
Schiller Park, Illinois – SPIL												
Acetaldehyde	60	60	2.22	0.34	1.52	0.27	3.04	0.77	2.82	0.74	1.61	0.48
Acrolein	41	61	1.01	0.32	NR	NR	NR	NR	1.20	0.41	0.75	0.52
Benzene	61	61	0.92	0.09	0.93	0.15	0.94	0.23	0.81	0.20	1.01	0.15
1,3-Butadiene	58	61	0.15	0.02	0.15	0.04	0.16	0.06	0.13	0.03	0.14	0.02
Carbon Tetrachloride	61	61	0.72	0.05	0.60	0.05	0.64	0.05	0.80	0.08	0.86	0.10
p-Dichlorobenzene	39	61	0.11	0.02	NR	NR	0.07	0.02	0.12	0.06	0.08	0.03
Formaldehyde	56	60	14.71	6.59	3.44	0.88	19.96	19.33	24.09	13.52	8.83	3.86
Tetrachloroethylene	59	61	0.77	0.21	0.33	0.13	1.04	0.60	0.94	0.30	0.70	0.39
Trichloroethylene	47	61	0.53	0.17	0.22	0.09	0.20	0.15	0.71	0.41	0.55	0.28

NR = Not reportable due to low number of detections.
NA = Not available due to short sampling duration.

10.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for the Illinois monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein and formaldehyde exceeded either the acute and/or intermediate risk values. Non-chronic risk is summarized in Table 10-4.

The following observations about acrolein are shown in Table 10-4:

- All acrolein measured detections at the Illinois sites were greater than the ATSDR acute MRL value of 0.11 $\mu g/m^3$ and all but one were greater than the California REL value of 0.19 $\mu g/m^3$.

- The average daily concentrations for NBIL and SPIL were 0.35 ± 0.07 $\mu g/m^3$ and 1.01 ± 0.32 $\mu g/m^3$, respectively. The SPIL average is an order of magnitude higher than either acute risk factor.

- The NBIL seasonal averages for acrolein (ranging from 0.18 ± 0.07 $\mu g/m^3$ in winter to 0.32 ± 0.08 $\mu g/m^3$ in autumn) were greater than the intermediate risk factor of 0.09 $\mu g/m^3$.

- The two seasonal acrolein averages calculated for SPIL, 0.75 ± 0.52 $\mu g/m^3$ in autumn and 1.20 ± 0.41 $\mu g/m^3$ in summer, were also greater than the intermediate risk factor.

The following observations about formaldehyde are shown in Table 10-3:

- One formaldehyde measured detection at NBIL exceeded the ATSDR acute MRL value of 49 $\mu g/m^3$. However, the seasonal averages were all less than the intermediate MRL.

- Four formaldehyde measured detections at the SPIL site were greater than the ATSDR acute MRL and one measured detection was greater than the California REL value of 94 $\mu g/m^3$. While no valid seasonal formaldehyde averages exceeded the intermediate MRL, the seasons where the highest concentrations were measured are easily discernable.

Table 10-4. Non-Chronic Risk Summary for the Illinois Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
NBIL	TO-15	Acrolein	0.35 ± 0.07	0.11	34	0.19	28	0.09	0.18 ±0.07	NR	0.31 ± 0.14	0.32 ± 0.08
NBIL	TO-11A	Formaldehyde	2.72 ±2.88	49	1	94	0	49.13	7.03 ±10.69	0.97 ±0.24	1.43 ±0.53	1.15 ± 0.33
SPIL	TO-15	Acrolein	1.01 ± 0.32	0.11	41	0.19	40	0.09	NR	NR	1.20 ±0.41	0.75 ± 0.52
SPIL	TO-11A	Formaldehyde	14.71 ± 6.59	49	4	94	1	49.13	3.44 ±0.88	19.96 ±19.33	24.09 ±13.52	8.83 ±3.86

NR = Not reportable due to low number of detections.
NA = Not available due to short sampling duration.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. Acrolein concentrations exceeded the acute risk factors at both NBIL and SPIL, and the acute risk factor for formaldehyde was exceeded at SPIL. Figures 10-4 and 10-5 are pollution roses for acrolein, and Figures 10-6 and 10-7 are pollution roses for formaldehyde.

Observations gleaned from the acrolein pollution roses include:

- Nearly all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

- Figure 10-4 shows that high acrolein concentrations at NBIL occurred with winds originating from a variety of directions. However, more of these high concentrations occurred with winds having a westerly component. Major roadways and expressways surround the NBIL monitoring site, although the area is primarily residential.

- Figure 10-5 shows that high acrolein concentrations at SPIL also occurred with winds originating from a variety of directions. The highest acrolein concentration at SPIL was recorded with northeasterly winds. Major roadways and highways are situated to the north, east, and south of the SPIL monitoring site, and Chicago O'Hare International Airport is located to the west.

Observations gleaned from the formaldehyde pollution roses include:

- Figure 10-6 shows that only one formaldehyde concentration exceeded the ATSDR MRL at NBIL. This concentration was measured on January 5, 2006, on a day with northwesterly winds. Figure 10-3 shows that there are several industrial sites located to the northwest of NBIL.

- Figure 10-7 shows that four measured detections of formaldehyde at SPIL exceeded the ATSDR acute risk factor, and one exceeded the CalEPA REL value. Figure 10-7 shows that the highest formaldehyde concentrations occurred with westerly or southerly winds. Figure 10-3 shows that a very large number of industrial sources are located to the west and south of SPIL.

Figure 10-4. Acrolein Pollution Rose for NBIL

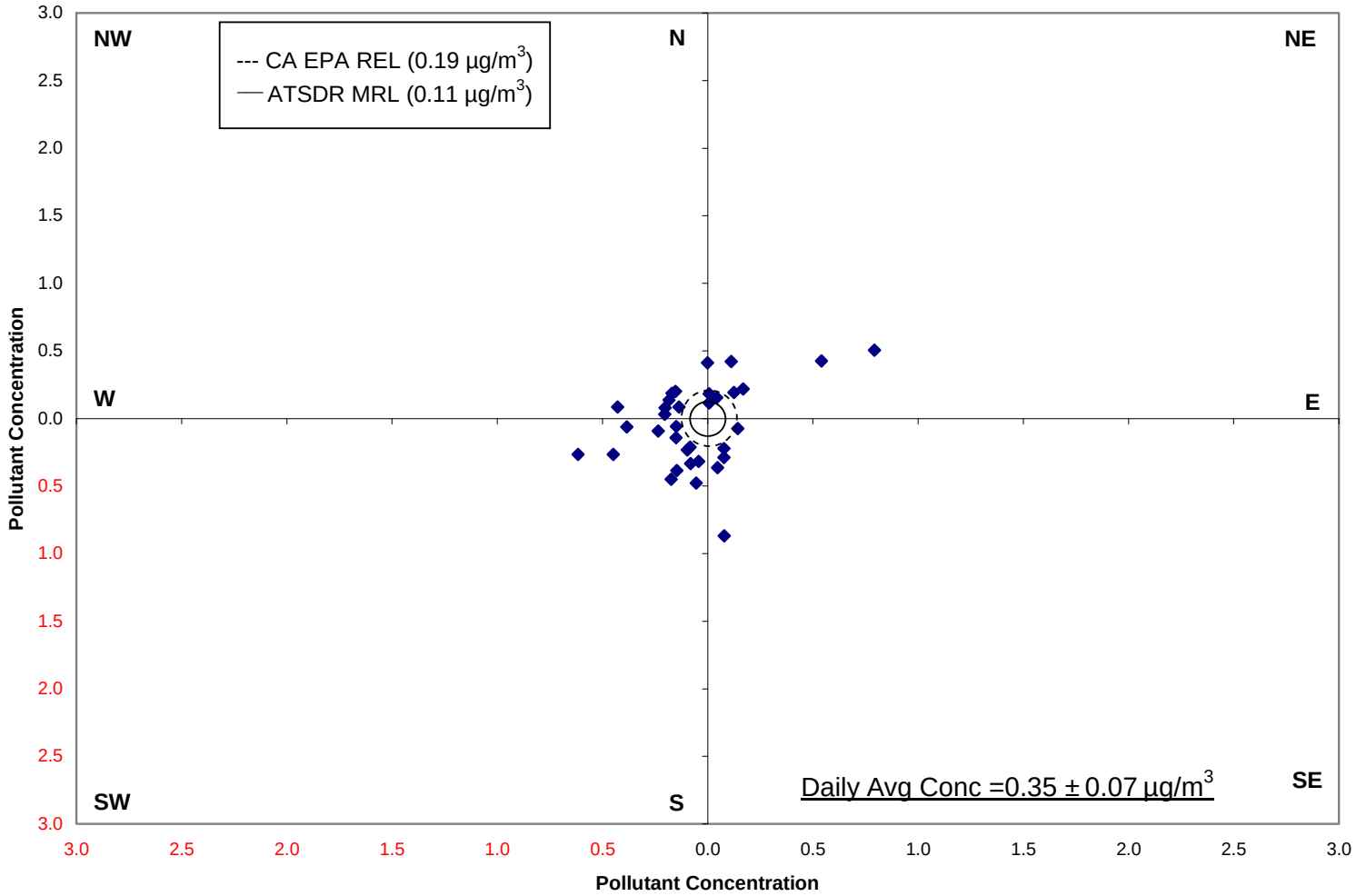


Figure 10-5. Acrolein Pollution Rose for SPIL

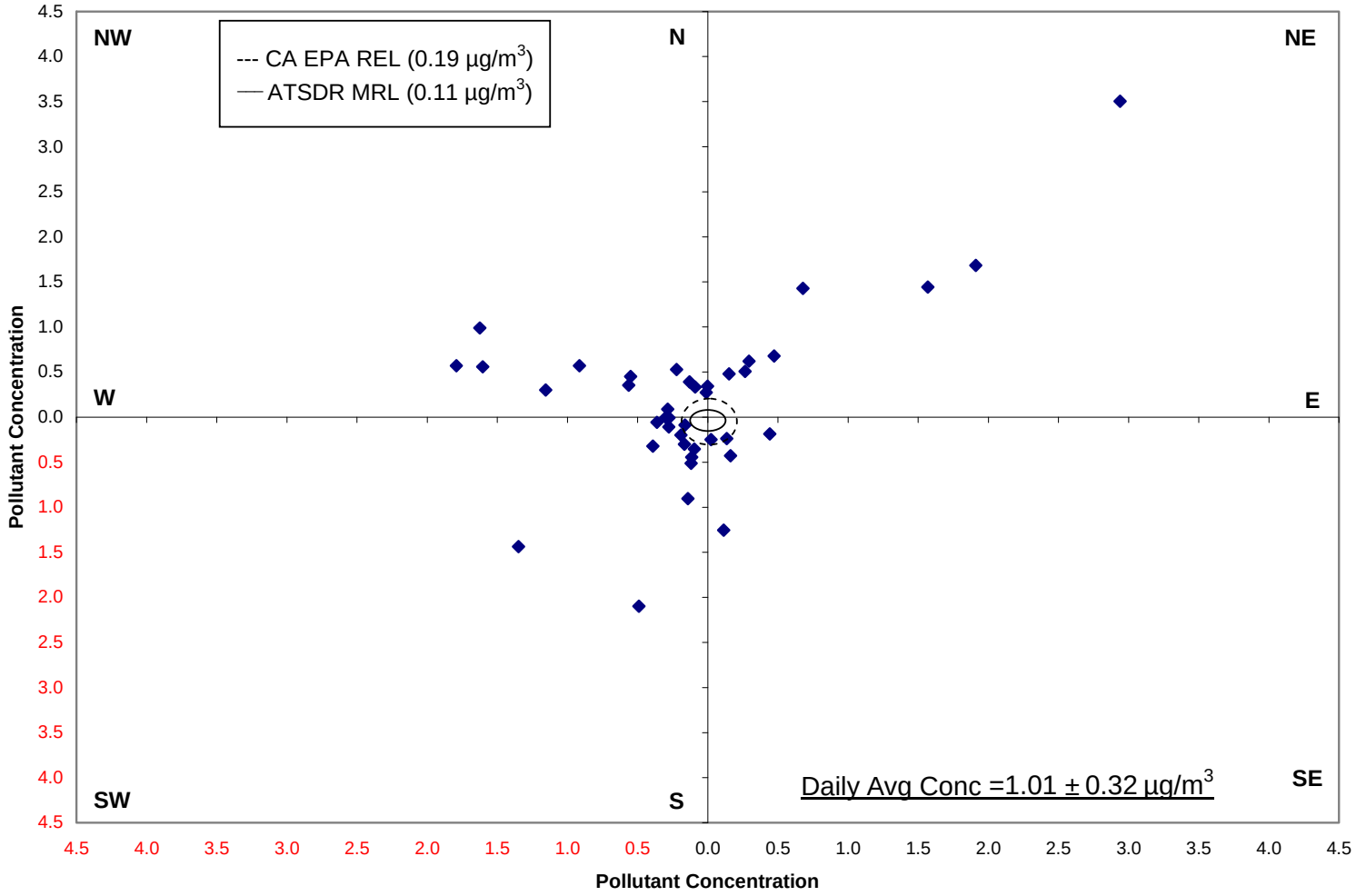


Figure 10-6. Formaldehyde Pollution Rose for NBIL

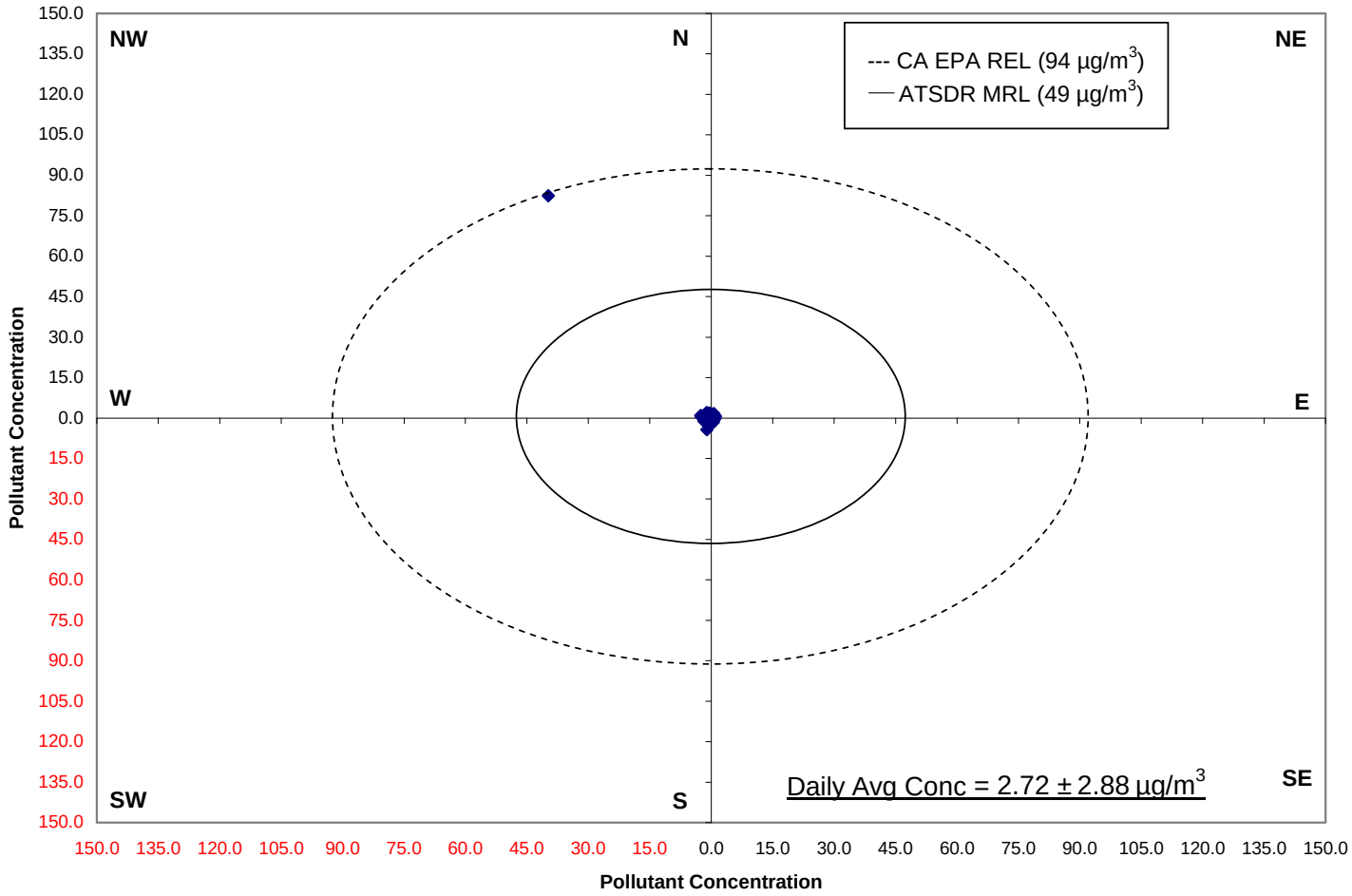
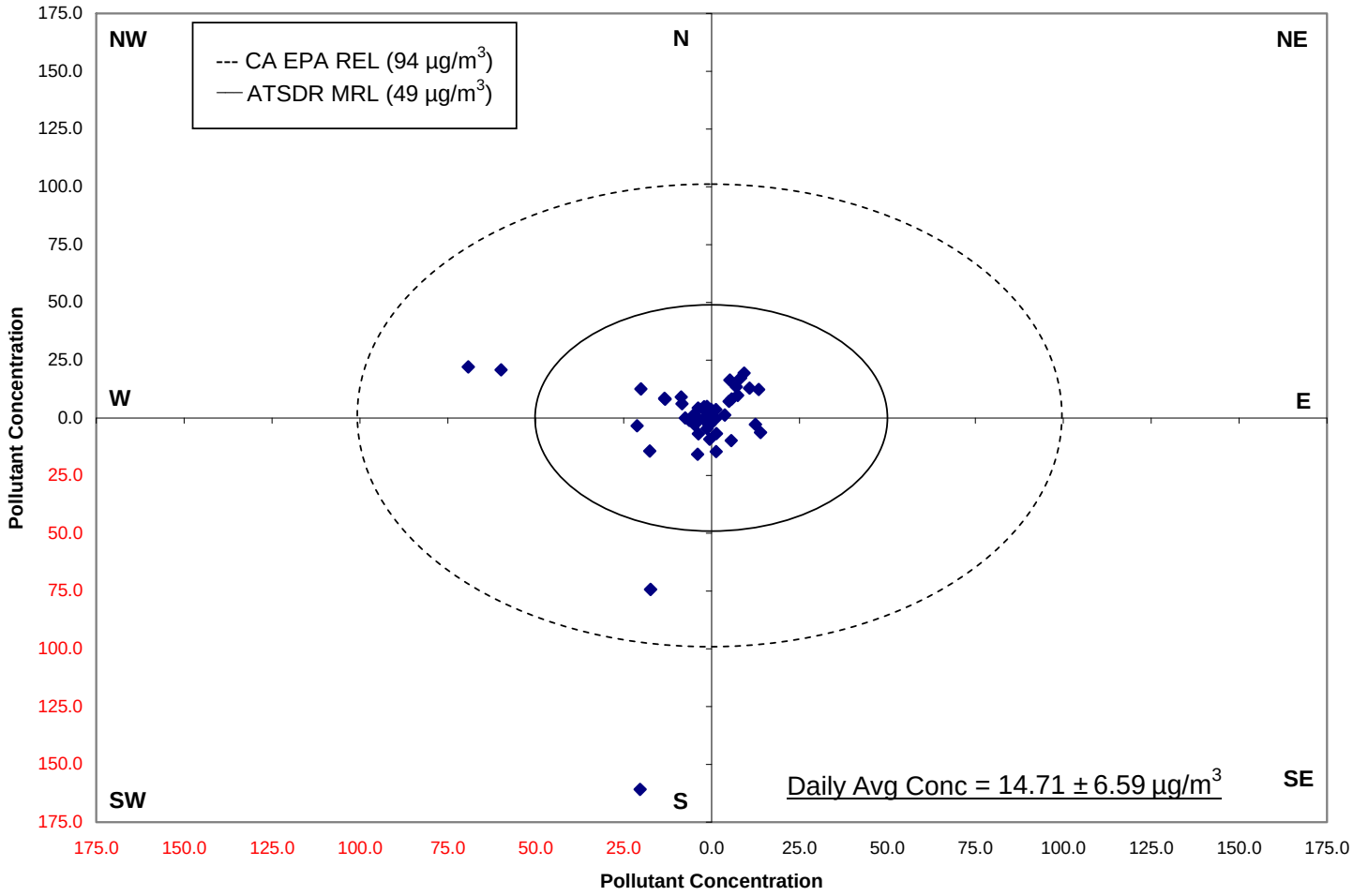


Figure 10-7. Formaldehyde Pollution Rose for SPIL



10.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

10.4.1 Pearson Correlation Analysis

Table 10-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Illinois monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for NBIL from Table 10-5:

- Most of the correlations between the pollutants of interest and the meteorological parameters were less than 0.50 or greater than -0.50, which indicates that meteorological conditions have little influence on the concentrations of these pollutants.

- Nearly all of the correlations with scalar wind speed were moderately strong and negative, indicating that as wind speed decreases, concentrations of the pollutants of interest increase at NBIL.

The following observations are gathered for SPIL from Table 10-5:

- Strong positive correlations were calculated between formaldehyde and maximum, average, dew point, and wet bulb temperatures, ranging from 0.55 to 0.59. This indicates that concentrations of formaldehyde tend to increase as temperatures and moisture content increase.

- The remainder of the Pearson correlations were generally weak.

- All the correlations with the scalar wind speed were negative, indicating that concentrations tend to decrease as winds increase in magnitude.

Table 10-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Illinois Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Northbrook, Illinois – NBIL								
1,3-Butadiene	44	-0.05	-0.12	-0.14	-0.13	-0.01	-0.08	-0.38
Acetaldehyde	61	0.12	0.05	-0.05	0.00	-0.28	0.08	-0.30
Acrolein	34	0.39	0.38	0.34	0.36	-0.12	0.00	-0.33
Arsenic (PM_{10})	62	0.29	0.26	0.22	0.24	-0.10	0.12	-0.38
Benzene	60	0.08	0.02	0.04	0.03	0.09	-0.03	-0.32
Cadmium (PM_{10})	62	-0.09	-0.11	-0.11	-0.11	-0.02	0.09	-0.13
Carbon Tetrachloride	60	0.38	0.38	0.35	0.37	-0.13	0.01	-0.27
Formaldehyde	61	-0.15	-0.12	-0.11	-0.12	0.04	0.03	0.13
Hexavalent Chromium	50	0.34	0.32	0.25	0.29	-0.15	0.13	-0.41
Manganese (PM_{10})	62	0.33	0.27	0.11	0.21	-0.46	0.19	-0.34
p-Dichlorobenzene	35	-0.06	-0.03	-0.09	-0.05	-0.21	0.23	0.14
Tetrachloroethylene	48	0.24	0.21	0.17	0.20	-0.17	-0.04	-0.27
Trichloroethylene	35	0.21	0.16	0.03	0.10	-0.36	0.03	-0.07
Schiller Park, Illinois – SPIL								
1,3-Butadiene	58	-0.15	-0.18	-0.19	-0.19	0.00	-0.09	-0.28
Acetaldehyde	60	0.43	0.42	0.31	0.38	-0.33	0.00	-0.27
Acrolein	41	0.44	0.45	0.41	0.44	-0.19	-0.03	-0.02
Benzene	61	-0.14	-0.14	-0.13	-0.14	0.08	0.12	-0.32
Carbon Tetrachloride	61	0.32	0.36	0.35	0.35	-0.07	0.06	-0.21
Formaldehyde	56	0.58	0.59	0.55	0.58	-0.19	0.03	-0.17
p-Dichlorobenzene	39	0.23	0.27	0.21	0.24	-0.18	0.05	-0.15
Tetrachloroethylene	59	0.41	0.40	0.37	0.40	-0.17	0.01	-0.16
Trichloroethylene	47	0.29	0.31	0.29	0.30	-0.12	-0.05	-0.25

10.4.2 Composite Back Trajectory Analysis

Figures 10-8 and 10-9 are composite back trajectory maps for the Illinois monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites in Figures 10-8 and 10-9 represents 100 miles.

The following observations can be made from Figures 10-8 and 10-9:

- The back trajectories originated from a variety of directions at NBIL and SPIL, although less frequently from the east.
- The 24-hour airshed domain for these sites is rather large, with trajectories originating as far away as Manitoba, Canada, or over 800 miles away.
- Roughly 72 percent of the trajectories originated within 400 miles of the sites; and nearly 90 percent within 500 miles from the Illinois monitoring sites.

10.4.3 Wind Rose Analysis

Hourly wind data from the weather station at Paulwakee Municipal Airport near NBIL and Chicago O'Hare International Airport near SPIL were uploaded in a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 10-10 and 10-11 are the wind roses for the NBIL and SPIL monitoring sites on days that sampling occurred.

Observations from Figure 10-10 for NBIL include:

- Hourly winds near NBIL were predominantly out of the west (10 percent of observations) and south (9 percent) on sampling days.
- Wind speeds frequently ranged from 7 to 11 knots on days samples were taken. Calm winds (< 2 knots) were recorded for 14 percent of observations.

Figure 10-8. Composite Back Trajectory Map for NBIL

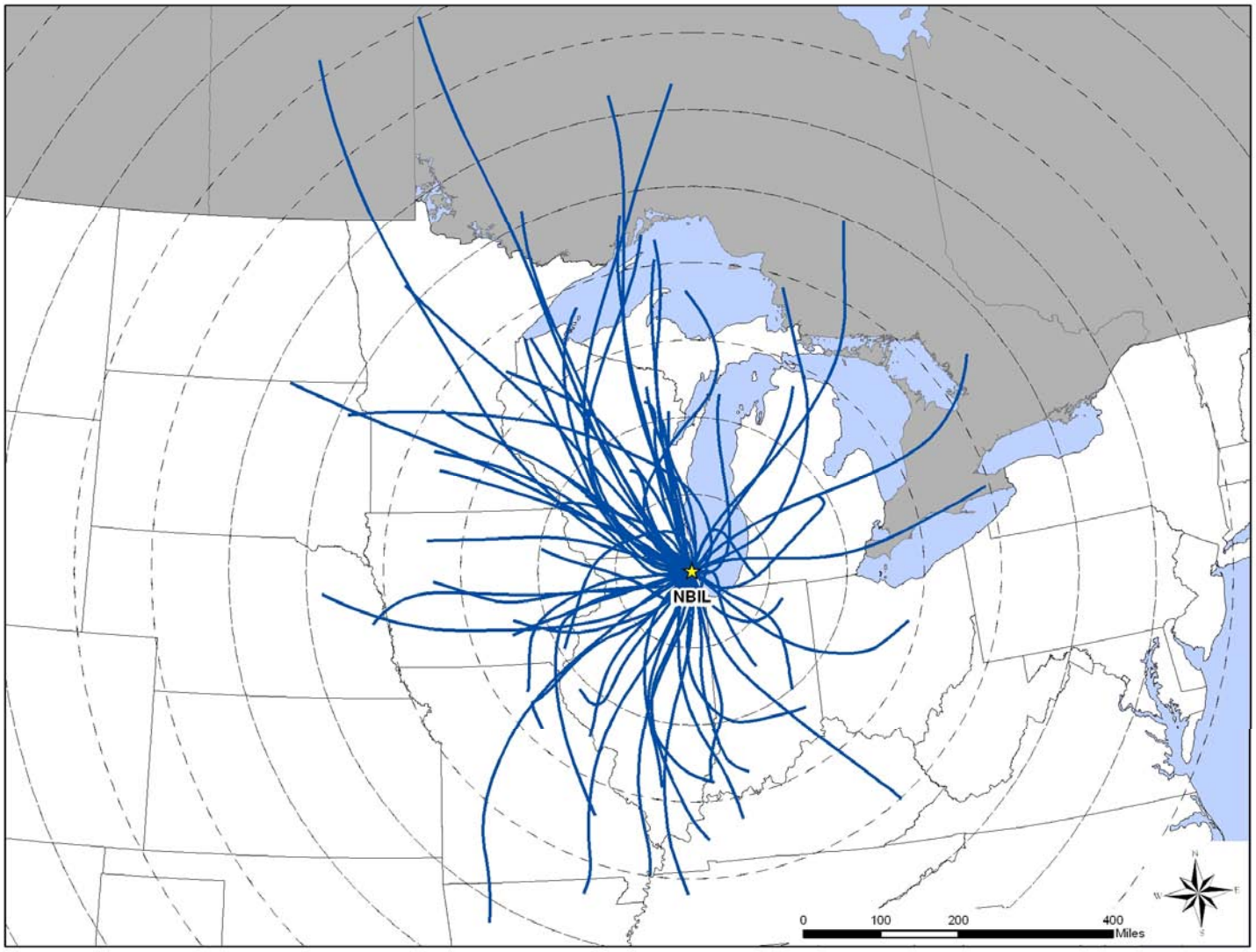


Figure 10-9. Composite Back Trajectory Map for SPIL

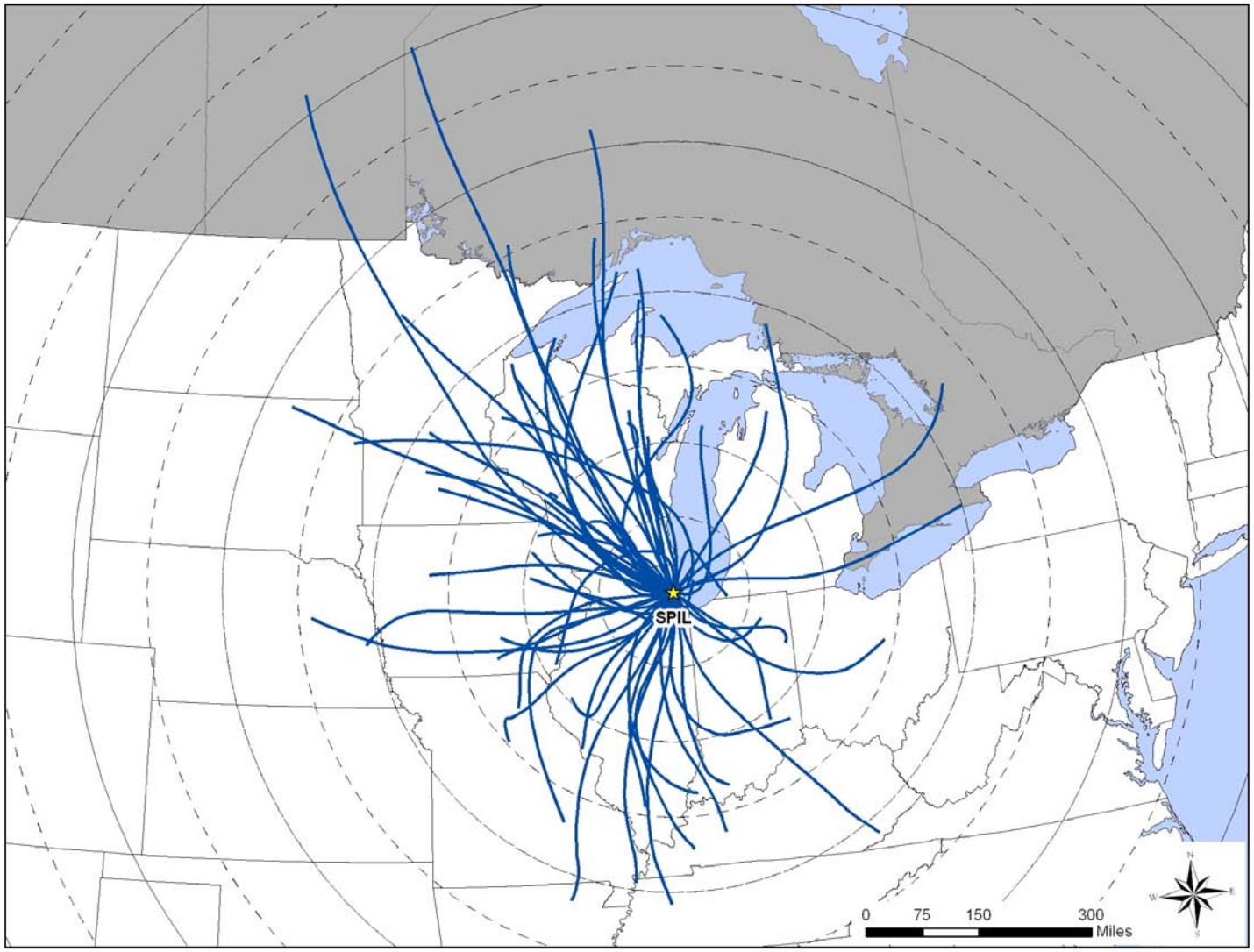


Figure 10-10. Wind Rose for NBIL Sampling Days

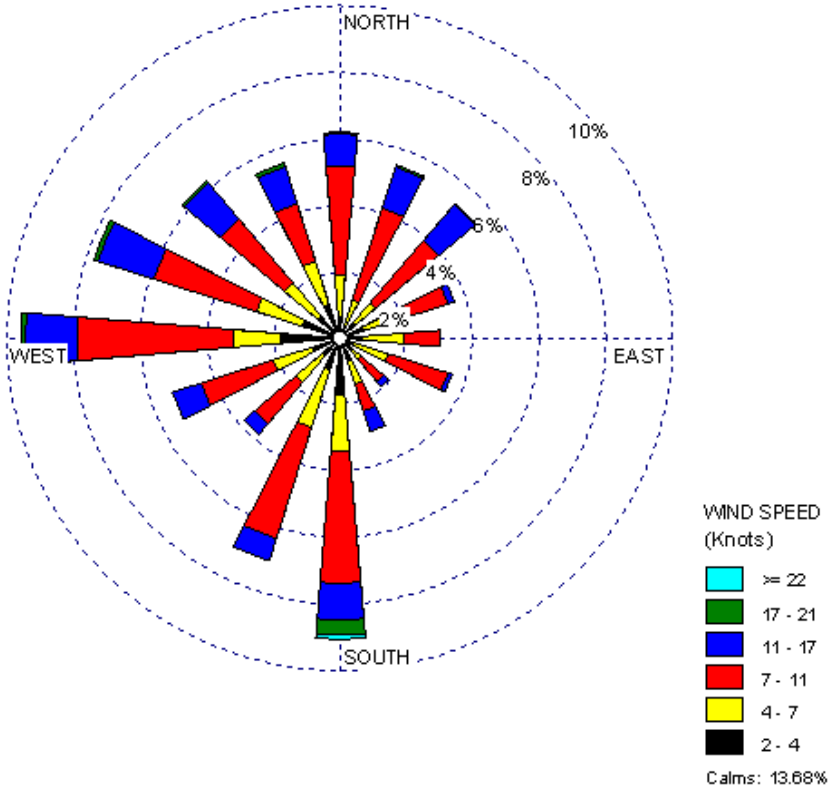
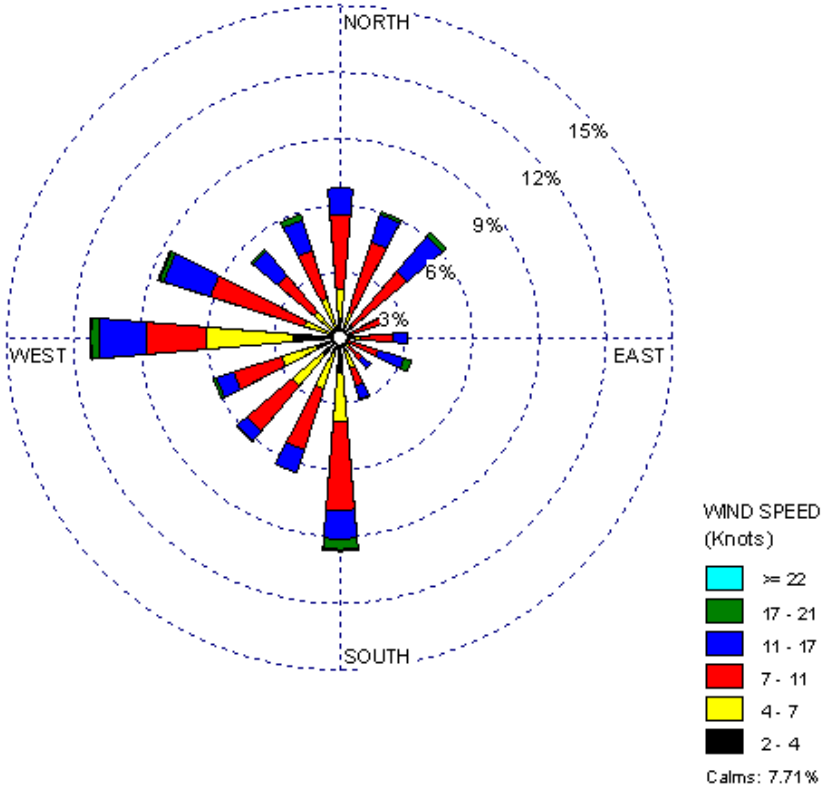


Figure 10-11. Wind Rose for SPIL Sampling Days



Observations from Figure 10-11 for SPIL include:

- Hourly winds near SPIL were similar to NBIL, although they were measured at two different weather stations.

- Winds were predominantly out of the west (11 percent of observations) and south (10 percent) on sampling days.

- Wind speeds frequently ranged from 7 to 11 knots on sampling days. Calm winds were recorded for 8 percent of observations.

10.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and acetylene-ethylene mobile tracer analysis.

10.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Cook County, IL were obtained from the Illinois Secretary of State and the U.S. Census Bureau, and are summarized in Table 10-6. Table 10-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 10-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 10-6 include:

- The SPIL monitoring site has more than twice the population residing within 10 miles than NBIL, and therefore a significantly higher estimated 10-mile vehicle ownership.

- The SPIL site experiences a significantly higher daily traffic volume than NBIL, as well as the highest traffic volume among all UATMP sites.

- Figure 10-2 shows that SPIL resides near a major interstate close to Chicago's O'Hare International Airport.

Table 10-6. Motor Vehicle Information for the Illinois Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
NBIL	5,288,655	2,133,068	0.40	879,379	354,679	29,600
SPIL	5,288,655	2,133,068	0.40	2,074,707	836,790	214,900

10.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- Like the roadside study, the toluene-ethylbenzene is the highest ratio for both NBIL and SPIL (6.78 ± 0.74 and 7.09 ± 0.51, respectively).

- The benzene-ethylbenzene ratios (5.74 ± 0.58 and 3.30 ± 0.64) are greater than the xylenes-ethylbenzene ratios (3.40 ± 0.19 and 3.54 ± 0.16) for these sites, which is inconsistent with those of the roadside study.

10.5.3 Mobile Tracer Analysis

As previously stated, NBIL sampled for SNMOC in addition to VOC. Acetylene is a compound that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile source emissions have found that ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3)

Table 3-11 shows:

- NBIL's ethylene-acetylene ratio, 1.74, is slightly higher than the 1.7 ratio. The similarities in these ratios suggest that mobile sources are influencing the air quality at the NBIL monitoring site.

- But because this ratio is slightly higher than the tunnel study, there may be other sources of ethylene contributing to this area's air quality.

10.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was

conducted. Details on how this analysis was conducted can be found in Section 3.3.4. Both Illinois sites have participated in the UATMP since 2003. Figures 10-12 and 10-13 present the trends analysis for formaldehyde, benzene, and 1,3-butadiene for NBIL and SPIL, respectively. The following observations can be made from Figures 10-12 and 10-13:

- Prior to 2005, the Illinois sites sampled only VOCs, therefore no formaldehyde trend can be evaluated at this time since only two years of formaldehyde data are available.

- For NBIL, the average 1,3-butadiene concentration has been decreasing since 2004. Although the large confidence interval for the 2004 average benzene concentration makes it difficult to discern an overall trend, the average benzene concentration decreased between 2005 and 2006.

- As illustrated in Figure 10-13, the average concentrations of benzene and 1,3-butadiene for SPIL have changed little over the last three years.

10.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Illinois sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 10-7. Additionally, the pollutants of interest are bolded. In addition to the annual averages and risks based on 2006 monitoring data, data from EPA's 1999 NATA were retrieved and are also presented in Table 10-7. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for the Illinois sites is as follows:

- The census tract for NBIL is 17031801500, which had a population of 6,227, which represents approximately 0.1 percent of the Cook County population in 2000.

- The census tract for SPIL is 17031811600, which had a population of 6,372, which also represents approximately 0.1 percent of the county population in 2000.

Figure 10-12. Comparison of Yearly Averages for the NBIL Monitoring Site

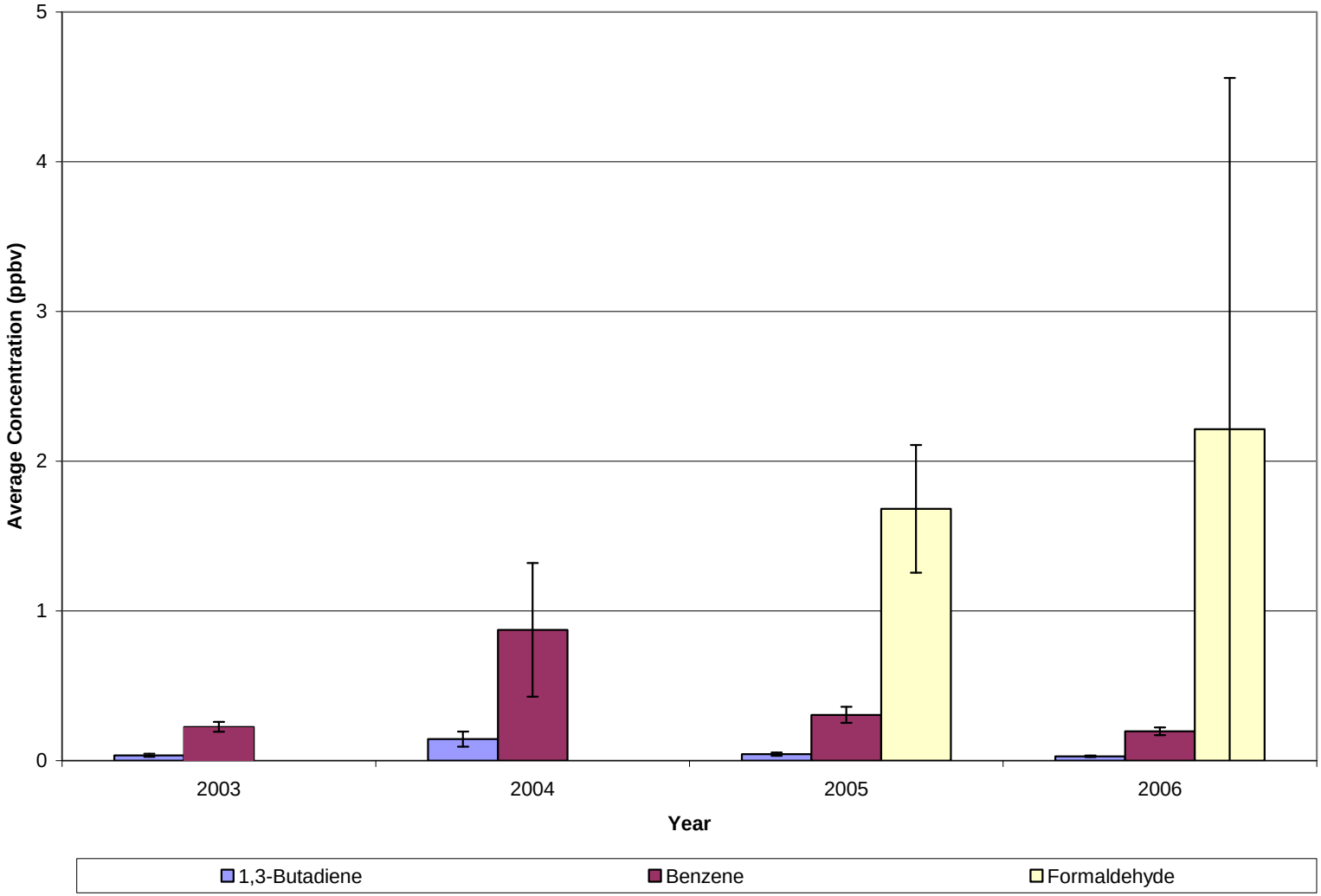


Figure 10-13. Comparison of Yearly Averages for the SPIL Monitoring Site

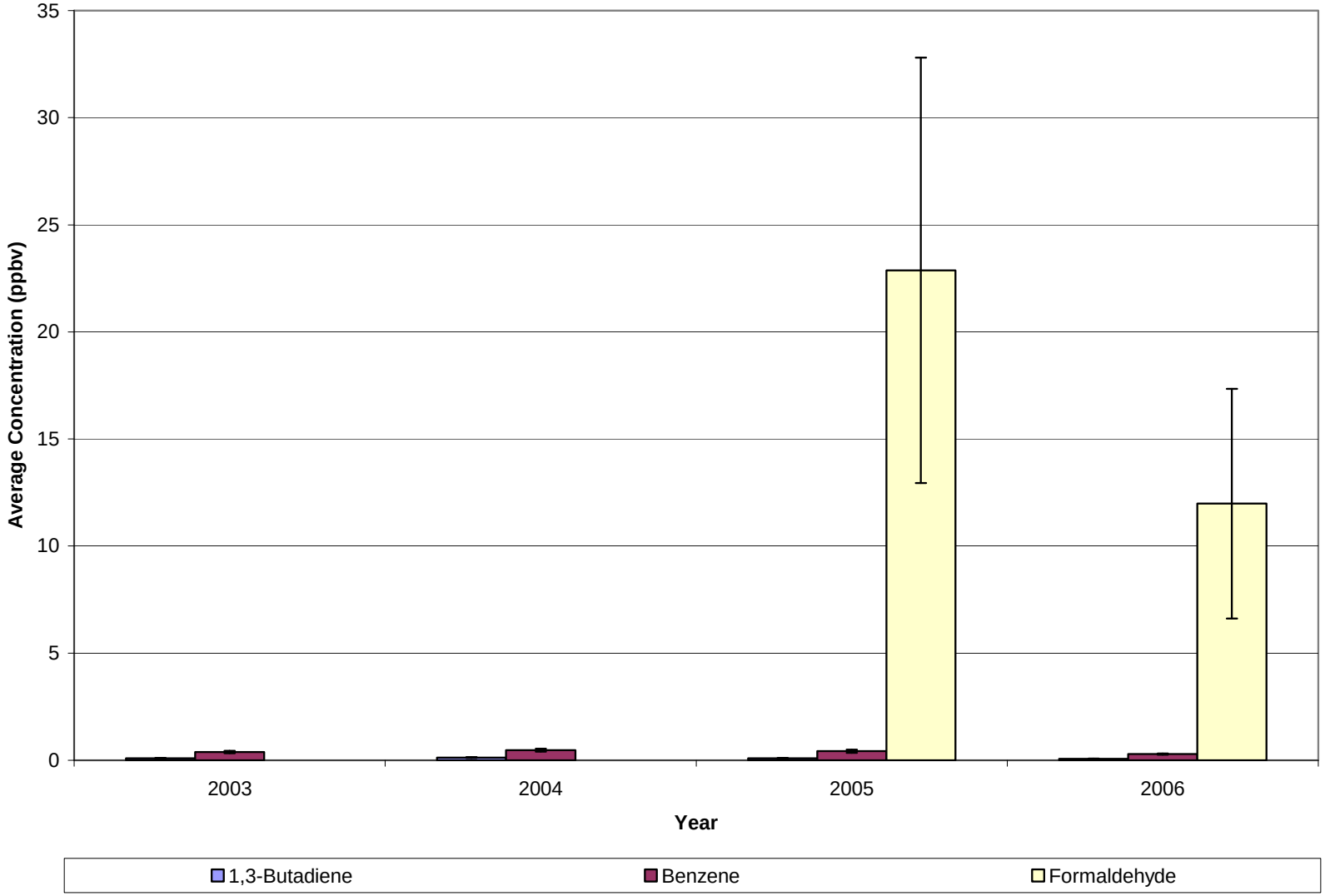


Table 10-7. Chronic Risk Summary for the Monitoring Sites in Illinois

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Northbrook, Illinois (NBIL) – Census Tract ID 17031801500								
Acetaldehyde	0.0000022	0.009	2.72	5.99	0.30	0.98 ± 0.10	2.16	0.11
Acrolein	NR	0.00002	0.18	NR	8.98	0.25 ± 0.05	NR	12.46
Acrylonitrile	0.000068	0.002	<0.01	0.06	<0.01	0.06 ± <0.01	4.39	0.03
Arsenic*	0.0043	0.00003	0.01	0.06	<0.01	<0.01 ± <0.01	3.68	0.03
Benzene	0.0000078	0.03	2.64	20.55	0.09	0.59 ± 0.07	4.58	0.02
Bromomethane	NR	0.005	0.14	NR	0.03	2.07 ± 3.91	NR	0.41
1,3-Butadiene	0.00003	0.002	0.32	9.59	0.16	0.06 ± 0.01	1.68	0.03
Cadmium*	0.0018	0.00002	0.24	0.44	0.01	<0.01 ± <0.01	0.37	0.01
Carbon Tetrachloride	0.000015	0.04	0.22	3.23	0.01	0.71 ± 0.05	10.58	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.44	<0.01	0.11 ± 0.05	1.20	<0.01
1,2-Dichloroethane	0.000026	2.4	0.05	1.25	<0.01	0.03 ± <0.01	0.82	<0.01
Formaldehyde	5.5E-09	0.0098	2.73	0.02	0.28	2.72 ± 2.88	0.01	0.28
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.10 ± 0.05	2.21	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.74	<0.01	<0.01 ± <0.01	0.45	<0.01
Manganese*		0.00005	0.67	NR	0.01	0.01 ± <0.01	NR	0.12
Nickel*	0.00016	0.000065	0.36	0.06	0.01	<0.01 ± <0.01	0.19	0.02
1,1,2,2-Tetrachloroethane	0.000058	NR	0.08	4.44	NR	0.05 ± <0.01	2.69	NR
Tetrachloroethylene	0.0000059	0.27	0.24	1.44	<0.01	0.34 ± 0.13	2.00	<0.01
Trichloroethylene	0.000002	0.6	0.26	0.52	<0.01	0.15 ± 0.05	0.30	<0.01

Table 10-7. Chronic Risk Summary for the Monitoring Sites in Illinois (Continued)

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Schiller Park, Illinois (SPIL) – Census Tract ID 17031811600								
Acetaldehyde	0.0000022	0.009	3.33	7.32	0.37	2.22 ± 0.34	4.89	0.25
Acrolein	NR	0.00002	0.22	NR	11.08	0.72 ± 0.24	NR	35.81
Acrylonitrile	0.000068	0.002	<0.01	0.05	<0.01	0.06 ± <0.01	4.24	0.03
Benzene	0.0000078	0.03	2.79	21.79	0.09	0.92 ± 0.09	7.20	0.03
1,3-Butadiene	0.00003	0.002	0.31	9.22	0.15	0.15 ± 0.02	4.39	0.07
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.72 ± 0.05	10.82	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.06	0.64	<0.01	0.07 ± 0.02	0.82	<0.01
Dichloromethane	0.00000047	1	1.15	0.54	<0.01	0.50 ± 0.12	0.24	<0.01
Ethyl Acrylate	0.000014	NR	<0.01	<0.01	NR	0.02 ± <0.01	0.33	NR
Formaldehyde	5.5E-09	0.0098	2.99	0.02	0.30	13.73 ± 6.22	0.08	1.40
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.08 ± 0.01	1.66	<0.01
Tetrachloroethylene	0.0000059	0.27	0.41	2.42	<0.01	0.75 ± 0.21	4.41	<0.01
Trichloroethylene	0.000002	0.6	1.72	3.45	<0.01	0.42 ± 0.14	0.83	<0.01

*Metals sampled were sampled with PM_{10} filters

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

The following observations can be made for NBIL from Table 10-7:

- The pollutants with the top 3 annual averages by mass concentration were formaldehyde (2.72 ± 2.88 µg/m^3), bromomethane (2.07 ± 3.91 µg/m^3), and acetaldehyde (3.02 ± 0.78 µg/m^3).

- The pollutants with the highest cancer risks were not these pollutants. The highest theoretical cancer risks were calculated for carbon tetrachloride (10.58 in-a-million), benzene (4.58), and acrylonitrile (4.39).

- According to the 1999 NATA, benzene (20.55 in-a-million), 1,3-butadiene (9.59), and acetaldehyde (5.99) had the highest cancer risk for pollutants that failed screens at NBIL.

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1, according to both the 2006 annual average and the 1999 NATA. All other noncancer HQs were less than 0.50.

The following observations can be made for SPIL from Table 10-7:

- Although formaldehyde had the highest annual averages by mass concentration (13.73 ± 6.22 µg/m^3), the highest theoretical cancer risks were calculated for carbon tetrachloride (10.82 in-a-million), benzene (7.20), and acetaldehyde (4.89).

- According to the 1999 NATA, benzene (21.79 in-a-million), 1,3-butadiene (9.22), and acetaldehyde (7.32) had the highest cancer risk for pollutants that failed screens at SPIL. These risk values were very similar to those for NBIL.

- Acrolein and formaldehyde exhibited theoretical noncancer HQ greater than 1 (35.81 and 1.40, respectively). SPIL has the second highest noncancer HQ for formaldehyde of all UATMP sites, second only to INDEM (6.32). All other noncancer HQs were less than 0.30.

- According to the 1999 NATA, only acrolein had a noncancer HQ greater than 1.0 (11.08).

10.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 10-8 and 10-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 10-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with

Table 10-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Illinois

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Northbrook, Illinois (NBIL) – Cook County					
Benzene	1923.92	Benzene	1.50E-02	Carbon Tetrachloride	10.58
Formaldehyde	1311.52	Arsenic	1.25E-02	Benzene	4.58
Tetrachloroethylene	1167.21	Coke Oven Emissions	1.04E-02	Acrylonitrile	4.39
Acetaldehyde	634.98	Naphthalene	7.45E-03	Arsenic	3.68
p-Dichlorobenzene	523.44	1,3-Butadiene	7.10E-03	1,1,2,2-Tetrachloroethane	2.69
Trichloroethylene	420.87	Tetrachloroethylene	6.89E-03	Hexachloro-1,3-butadiene	2.21
Dichloromethane	316.79	*p*-Dichlorobenzene	5.76E-03	Acetaldehyde	2.16
1,3-Butadiene	236.69	Hexavalent Chromium	5.66E-03	Tetrachloroethylene	2.00
Naphthalene	219.02	Cadmium	2.51E-03	1,3-Butadiene	1.68
1,3-Dichloropropene	89.84	Lead	2.15E-03	*p*-Dichlorobenzene	1.20
Schiller Park, Illinois (SPIL) – Cook County					
Benzene	1923.92	Benzene	1.50E-02	Carbon Tetrachloride	10.82
Formaldehyde	1311.52	Arsenic	1.25E-02	Benzene	7.20
Tetrachloroethylene	1167.21	Coke Oven Emissions	1.04E-02	Acetaldehyde	4.89
Acetaldehyde	634.98	Naphthalene	7.45E-03	Tetrachloroethylene	4.41
p-Dichlorobenzene	523.44	1,3-Butadiene	7.10E-03	1,3-Butadiene	4.39
Trichloroethylene	420.87	Tetrachloroethylene	6.89E-03	Acrylonitrile	4.24
Dichloromethane	316.79	*p*-Dichlorobenzene	5.76E-03	Hexachloro-1,3-butadiene	1.66
1,3-Butadiene	236.69	Hexavalent Chromium	5.66E-03	Trichloroethylene	0.83
Naphthalene	219.02	Cadmium	2.51E-03	*p*-Dichlorobenzene	0.82
1,3-Dichloropropene	89.84	Lead	2.15E-03	Ethyl Acrylate	0.33

Table 10-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Illinois

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Northbrook, Illinois (NBIL) – Cook County					
Toluene	7,837.72	Acrolein	3,193,594.06	Acrolein	12.46
Xylenes	5,082.62	Manganese	153,628.02	Bromomethane	0.41
Methanol	3,404.01	Formaldehyde	133,828.14	Formaldehyde	0.28
Methyl Ethyl Ketone	3,215.93	1,3-Butadiene	118,344.25	Manganese	0.12
Benzene	1,923.92	Bromomethane	113,356.00	Acetaldehyde	0.11
Methyl Isobutyl Ketone	1,483.77	Nickel	100,856.60	Acrylonitrile	0.03
Hexane	1,332.45	Arsenic	96,523.58	Arsenic	0.03
Formaldehyde	1,311.52	Naphthalene	73,005.50	1,3-Butadiene	0.03
Tetrachloroethylene	1,167.21	Acetaldehyde	70,553.24	Benzene	0.02
1,1,1-Trichloroethane	1,137.26	Cadmium	69,789.79	Nickel	0.02
Schiller Park, Illinois (SPIL) – Cook County					
Toluene	7,837.72	Acrolein	3,193,594.06	Acrolein	35.81
Xylenes	5,082.62	Manganese	153,628.02	Formaldehyde	1.40
Methanol	3,404.01	Formaldehyde	133,828.14	Acetaldehyde	0.25
Methyl Ethyl Ketone	3,215.93	1,3-Butadiene	118,344.25	1,3-Butadiene	0.07
Benzene	1,923.92	Bromomethane	113,356.00	Acrylonitrile	0.03
Methyl Isobutyl Ketone	1,483.77	Nickel	100,856.60	Benzene	0.03
Hexane	1,332.45	Arsenic	96,523.58	Carbon Tetrachloride	0.02
Formaldehyde	1,311.52	Naphthalene	73,005.50	Tetrachloroethylene	<0.01
Tetrachloroethylene	1,167.21	Acetaldehyde	70,553.24	Hexachloro-1,3-butadiene	<0.01
1,1,1-Trichloroethane	1,137.26	Cadmium	69,789.79	Trichloroethylene	<0.01

the highest cancer risk (in-a-million) as calculated from the annual average. Table 10-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. In addition, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average are limited to those pollutants for which each respective site sampled. SPIL sampled for VOC and carbonyl compounds. NBIL sampled for these pollutants as well, but also sampled for SNMOC, metals, and hexavalent chromium.

The following observations can be made from Table 10-8:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the second highest cancer risk based on the 2006 annual average for both Illinois sites.

- Carbon tetrachloride had the highest cancer risk based on the 2006 annual average for both NBIL and SPIL, yet this pollutant was neither one of the highest emitted nor one of the most toxic based on the 2002 NEI emission inventory.

The following observations can be made from Table 10-9:

- Although toluene and xylenes were the highest emitted pollutants with noncancer risk factors in Cook County, they did not rank in the top 10 based on toxicity-weighted emissions or the annual average-based noncancer risk.

- Acrolein had the highest noncancer toxicity-weighted emissions in Cook County and has the highest noncancer risks based on the 2006 annual average at both sites, but does not appear in the list of highest emitted pollutants.

- Formaldehyde, which had the highest daily and annual averages at both sites, is one of the 10 highest emitted pollutants in Cook County and is ranked third for noncancer toxicity-weighted emissions.

Illinois Pollutant Summary

- *The pollutants of interest common to each Illinois site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, p-dichlorobenzene, formaldehyde, tetrachloroethylene, and trichloroethylene.*

- *Formaldehyde had the highest daily average for each of the two Chicago sites (NBIL and SPIL).*

- *Acrolein and formaldehyde exceeded the short-term risk factors at both Chicago sites.*

- *A comparison of benzene, 1,3-butadiene and formaldehyde concentrations for all years of UATMP participation shows that concentrations of benzene decreased at NBIL between 2005 and 2006 and that concentrations of benzene and 1,3-butadiene have varied little at SPIL.*

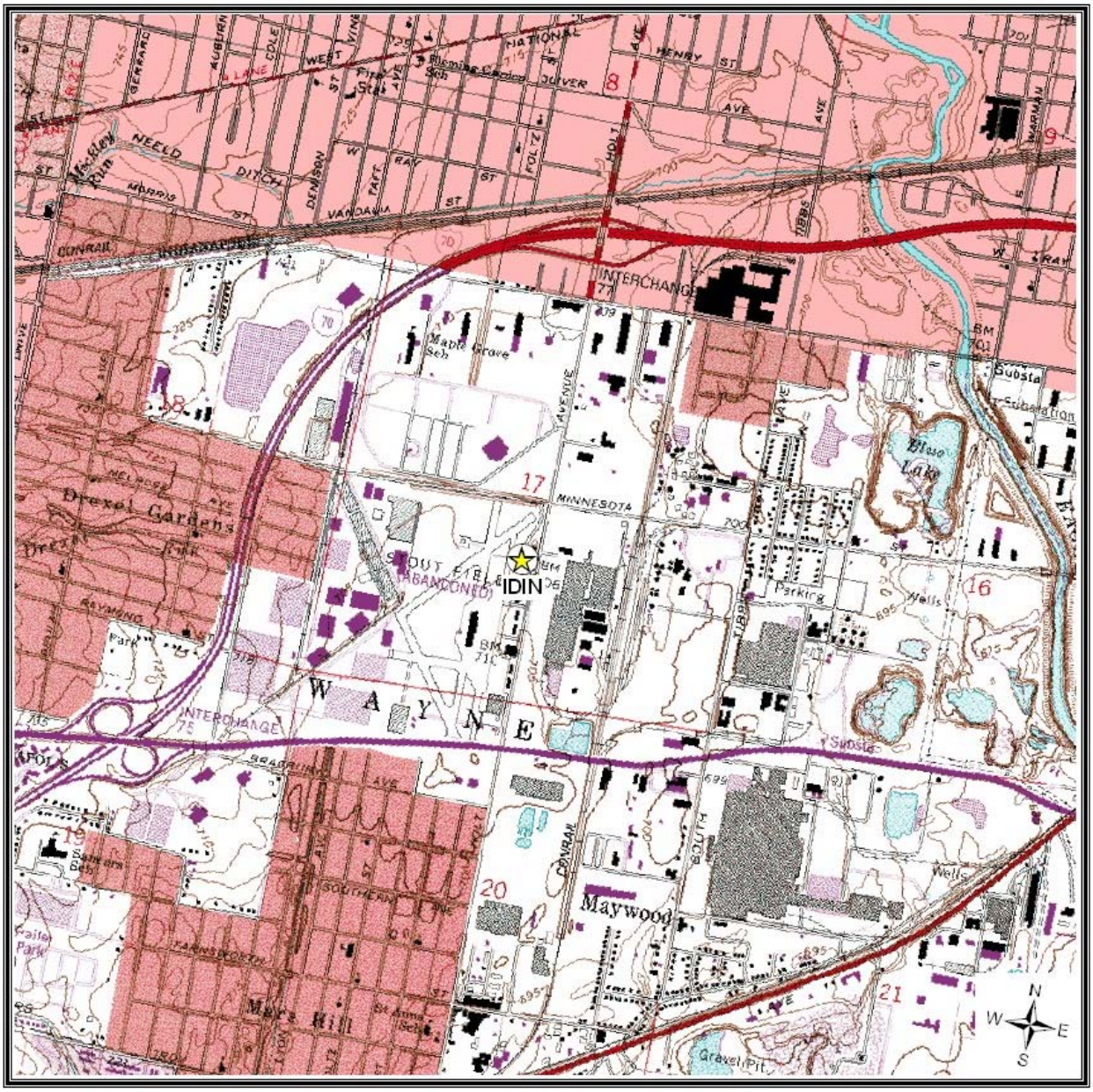
11.0 Sites in Indiana

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Indiana (IDIN, INDEM, ININ and WPIN). Three sites, IDIN, ININ and WPIN, are located in Indianapolis. INDEM is located in Gary in the Chicago-Naperville-Joliet, IL-IN-WI MSA. Figures 11-1 to 11-4 show topographical maps of the monitoring sites. Figures 11-5 and 11-6 identify point source emission locations within 10 miles of these sites that reported to the 2002 NEI for point sources. Figure 11-5 shows that IDIN and ININ are relatively close to each other, and that WPIN is further northeast. The bulk of the industrial sources are located between the three sites, and are predominately involved in fuel combustion industries. Due in part to INDEM's proximity to Lake Michigan, most of the facilities near INDEM are located to the east or west of the monitoring site. The bulk of these facilities are involved in fuel combustion processes, mineral products processing, or liquids distribution, as shown in Figure 11-6.

The city of Indianapolis is located in the center of Indiana, and experiences a temperate continental climate. Summers are warm and often humid, winters are chilly with occasional Arctic outbreaks, and precipitation is spread rather evenly throughout the year. The prevailing wind direction is southwesterly. Gary is located to the southeast of Chicago, and at the southern-most tip of Lake Michigan. Gary's proximity to Lake Michigan is an important factor controlling the weather of the area. In the summer, warm temperatures can be suppressed, while cold winter temperatures are often moderated. Winds that blow across Lake Michigan and over Gary in the winter can provide abundant amounts of lake-effect snow (Ruffner and Bair, 1987 and http://www.garychamber.com/geoclimate.asp).

Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The closest weather station to the Indianapolis locations is the Indianapolis International Airport (WBAN 93819) and the closest weather station to INDEM is located at Lancing Municipal Airport (WBAN 04879). Table 11-1 presents average meteorological conditions of temperature (average maximum and

Figure 11-1. Indianapolis, Indiana (IDIN) Monitoring Site

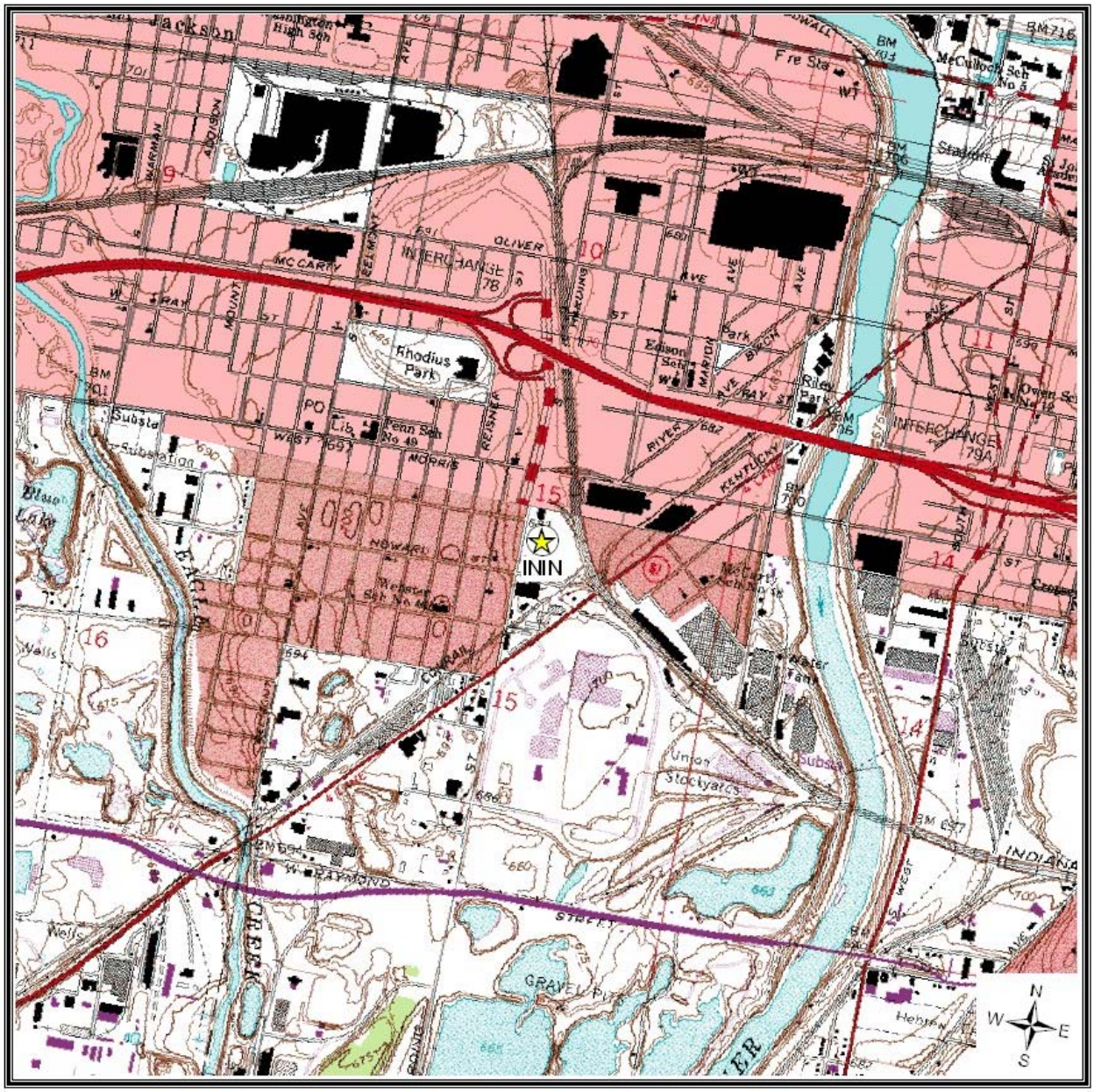


Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 11-2. Gary, Indiana (INDEM) Monitoring Site

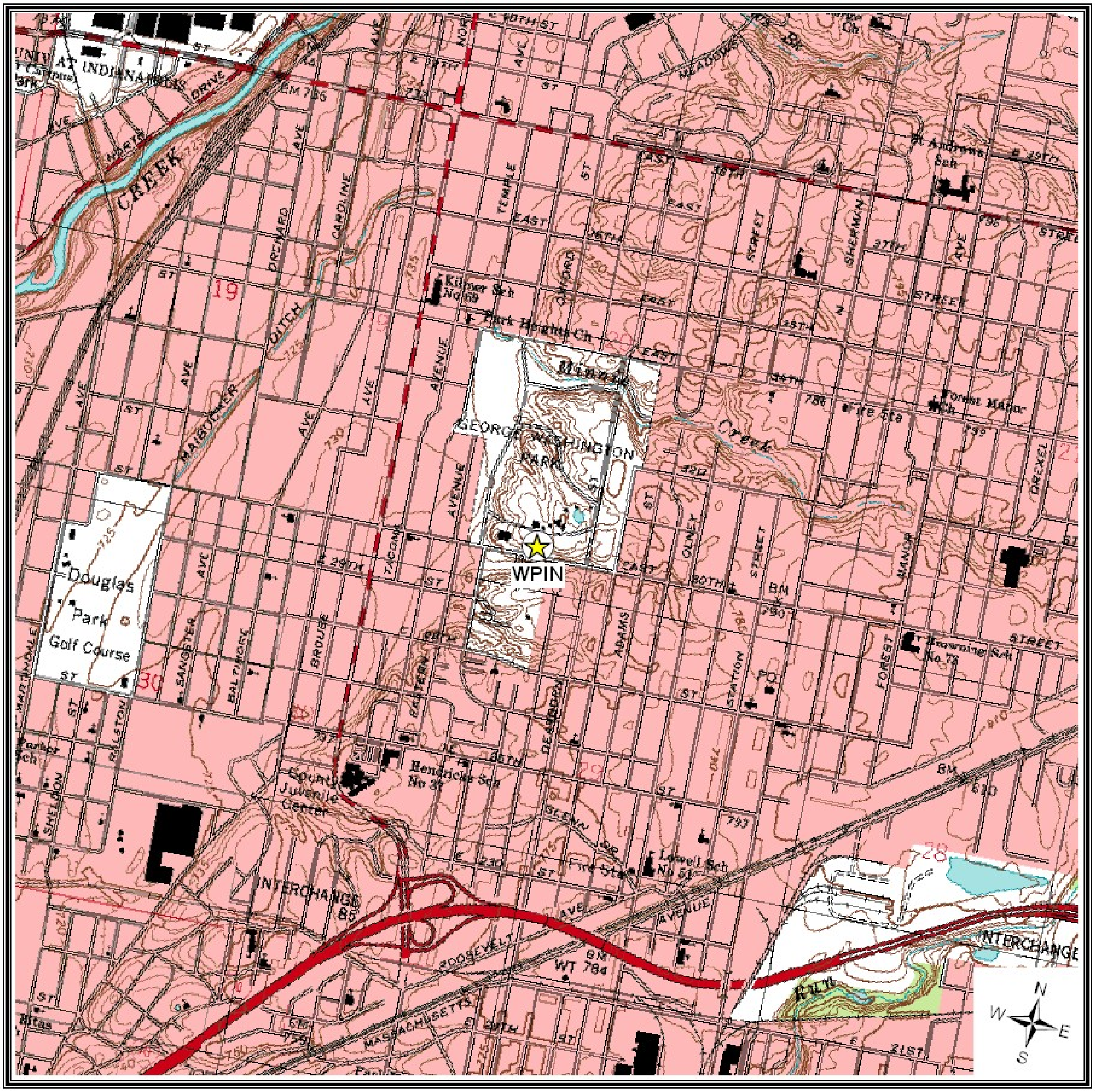
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 11-3. Indianapolis, Indiana (ININ) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 11-4. Indianapolis, Indiana (WPIN) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 11-5. Facilities Located within 10 Miles of IDIN, ININ, and WPIN

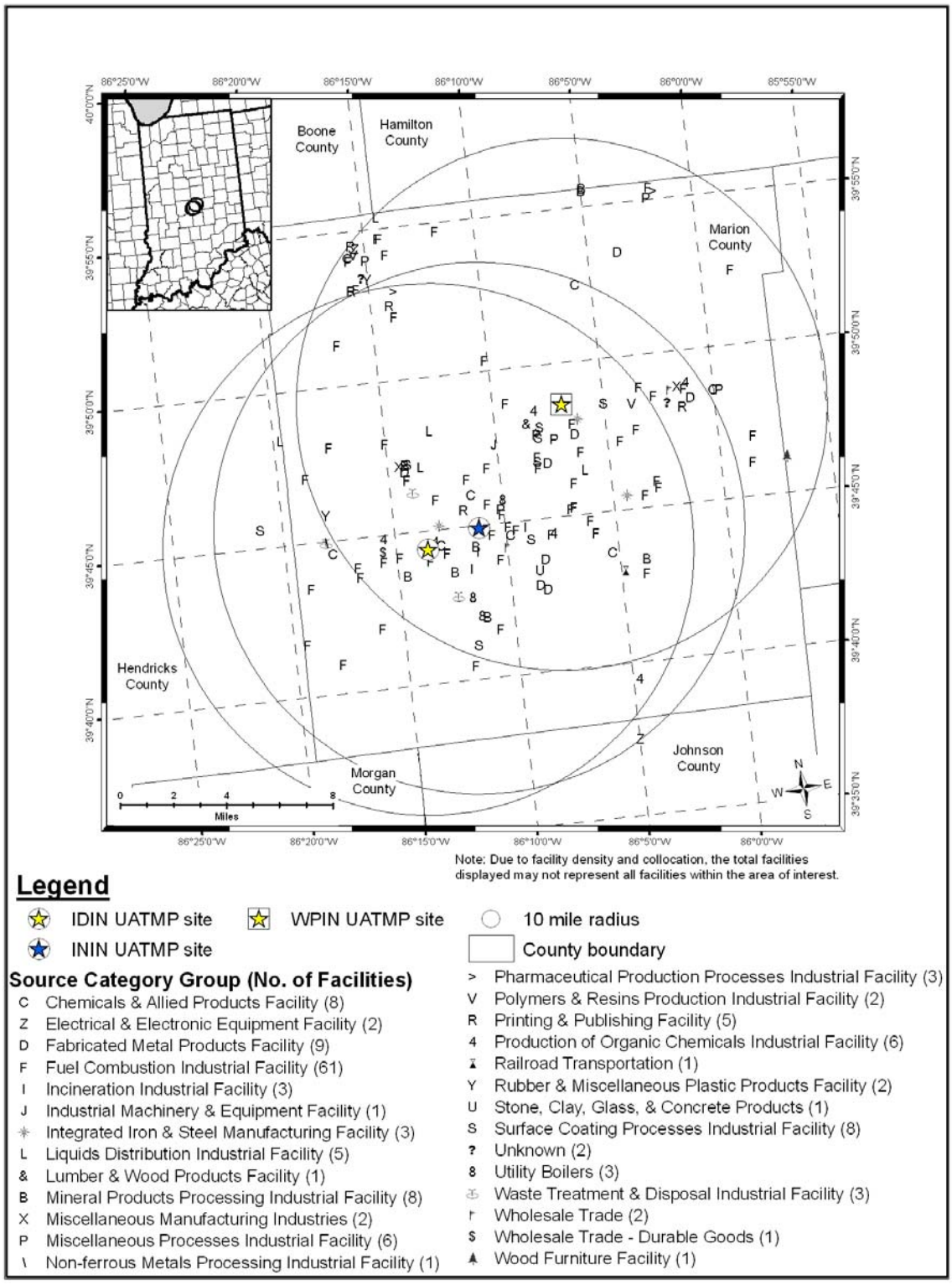


Figure 11-6. Facilities Located within 10 Miles of INDEM

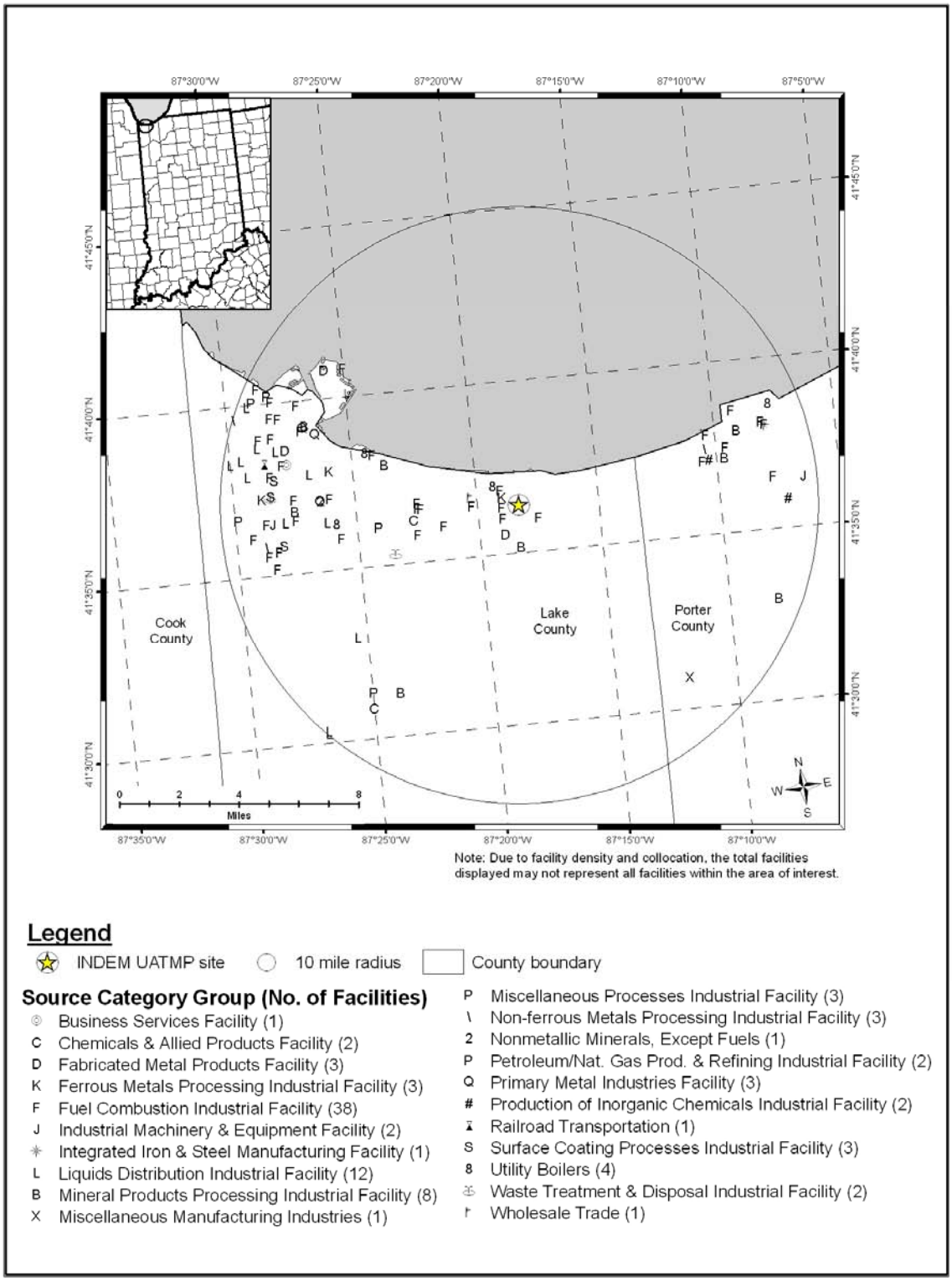


Table 11-1. Average Meteorological Conditions near the Monitoring Sites in Indiana

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
IDIN	93819	All 2006	62.91 ± 1.74	54.54 ± 1.69	44.26 ± 1.69	49.34 ± 1.55	70.93 ± 1.25	1016.37 ± 0.69	8.33 ± 0.32
		Sampling Day	51.06 ± 5.83	43.44 ± 5.03	35.89 ± 4.93	40.11 ±4.52	76.76 ± 5.92	1017.17 ± 3.72	9.35 ± 2.09
INDEM	04879	All 2006	60.43 ± 1.83	52.43 ± 1.72	43.13 ± 1.72	47.88 ± 1.59	73.12 ± 1.20	NA[1]	6.62 ± 0.36
		Sampling Day	58.65 ± 4.68	50.36 ± 4.13	41.42 ± 3.97	46.03 ±3.72	74.36 ± 3.46	NA[1]	6.54 ± 0.94
ININ	93819	All 2006	62.91 ± 1.74	54.54 ± 1.69	44.26 ± 1.69	49.34 ± 1.55	70.93 ± 1.25	1016.37 ± 0.69	8.33 ± 0.32
		Sampling Day	50.88 ± 5.89	42.86 ± 5.18	34.60 ± 5.30	39.30 ±4.74	74.71 ± 6.04	1018.84 ± 3.12	9.12 ± 2.02
WPIN	93819	All 2006	62.91 ± 1.74	54.54 ± 1.69	44.26 ± 1.69	49.34 ± 1.55	70.93 ± 1.25	1016.37 ± 0.69	8.33 ± 0.32
		Sampling Day	70.33 ± 13.47	64.18 ± 11.85	59.05 ± 11.45	61.06 ±11.24	84.60 ± 4.40	1013.03 ± 1.89	7.92 ± 2.21

[1] Sea level pressure was not recorded at the Lancing Municipal Airport weather station.

average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 10-1 is the 95 percent confidence interval for each parameter. As shown in Table 11-1, average meteorological conditions on sampling days at INDEM were fairly representative of average weather conditions throughout the year. Table 11-1 shows that temperatures on sampling days at ININ and IDIN appear colder than for temperatures for the entire year. This is due to these two sites not beginning sampling until October. The temperatures on sampling days at WPIN appear warmer than for the entire year; however, this site did not begin sampling until late June. Temperatures for an entire year's worth of sampling days would likely look more similar to those for the entire year.

11.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Indiana monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. The Indiana sites all sampled for carbonyl compounds, but ININ and IDIN also sampled for metals, and ININ also sampled for hexavalent chromium. Table 11-2 presents the pollutants that failed at least one screen at the Indiana monitoring sites.

The following observations are shown in Table 11-2:

- While the pollutants of interest varied by location, two pollutants were identified as pollutants of interest at all the sites. Formaldehyde failed 88 total screens and acetaldehyde failed 89 total screens at all four sites.

- IDIN had seven pollutants with a total of 55 measured concentrations fail the screen.

Table 11-2. Comparison of Measured Concentrations and EPA Screening Values for the Indiana Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Stout Field, Indianapolis, Indiana – IDIN					
Formaldehyde	16	16	100.00	29.09	29.09
Acetaldehyde	16	16	100.00	29.09	58.18
Arsenic (PM_{10})	12	13	92.31	21.82	80.00
Manganese (PM_{10})	7	13	53.85	12.73	92.73
Nickel (PM_{10})	2	13	15.38	3.64	96.36
Cadmium (PM_{10})	1	13	7.69	1.82	98.18
Cobalt (PM_{10})	1	13	7.69	1.82	100.00
Total	55	97	56.70		
Gary, Indiana – INDEM					
Acetaldehyde	54	54	100.00	50.00	50.00
Formaldehyde	54	54	100.00	50.00	100.00
Total	108	108	100.00		
South Harding, Indianapolis, Indiana – ININ					
Arsenic (PM_{10})	16	16	100.00	27.12	27.12
Acetaldehyde	14	14	100.00	23.73	50.85
Formaldehyde	14	14	100.00	23.73	74.58
Manganese (PM_{10})	9	16	56.25	15.25	89.83
Cadmium (PM_{10})	3	16	18.75	5.08	94.92
Hexavalent Chromium	2	11	18.18	3.39	98.31
Cobalt (PM_{10})	1	16	6.25	1.69	100.00
Total	59	103	57.28		
Washington Park, Indianapolis, Indiana – WPIN					
Acetaldehyde	5	5	100.00	55.56	55.56
Formaldehyde	4	5	80.00	44.44	100.00
Total	9	10	90.00		

- INDEM had two pollutants fail a total of 108 screens.
- Seven pollutants with a total of 59 measured concentrations failed the screen at ININ.
- Two pollutants with a total of 9 measured concentrations failed the screen at WPIN.

11.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2

MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 11-3. Annual averages are presented and discussed in further detail in later sections.

Table 11-3 shows the following:

- With the exception of hexavalent chromium, the pollutants of interest were detected in 100 percent of the samples collected at all four Indiana monitoring sites.
- The daily average concentration of formaldehyde at INDEM was significantly higher than any other pollutant concentration measured (61.91 ± 17.11 μg/m^3).
- The INDEM formaldehyde seasonal averages show that the spring and summer formaldehyde averages (103.33 ± 41.60 μg/m^3 and 101.00 ± 42.64 μg/m^3, respectively) were an order of magnitude higher than the other seasons, and two orders of magnitude higher than any concentration measured at the other sites.
- INDEM had the highest daily formaldehyde average compared to all UATMP sites, which is consistent with the 2005 measurements. Formaldehyde also had the highest daily average at ININ, IDIN, and WPIN, although significantly lower in magnitude than INDEM.
- Due to the sampling start dates of the Indianapolis sites, few seasonal averages could be calculated.

11.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for the Indiana monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the two pollutants with at least one failed screen, only formaldehyde at INDEM

Table 11-3. Daily and Seasonal Averages for the Pollutants of Interest for the Indiana Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Indianapolis, Indiana – IDIN												
Acetaldehyde	16	16	1.78	0.42	NA	NA	NA	NA	NA	NA	1.94	0.59
Arsenic (PM_{10})	13	13	<0.01	<0.01	NA	NA	NA	NA	NA	NA	<0.01	<0.01
Formaldehyde	16	16	2.21	0.57	NA	NA	NA	NA	NA	NA	2.59	0.76
Manganese (PM_{10})	13	13	0.01	<0.01	NA	NA	NA	NA	NA	NA	0.01	<0.01
Nickel (PM_{10})	13	13	<0.01	<0.01	NA	NA	NA	NA	NA	NA	<0.01	<0.01
Gary, Indiana – INDEM												
Acetaldehyde	54	54	4.63	0.56	2.85	0.30	5.24	0.74	6.09	1.13	5.03	1.24
Formaldehyde	54	54	61.91	17.11	16.73	2.70	103.33	41.60	101.00	42.64	48.16	20.78
Indianapolis, Indiana – ININ												
Acetaldehyde	14	14	1.86	0.45	NA	NA	NA	NA	NA	NA	2.11	0.63
Arsenic (PM_{10})	16	16	<0.01	<0.01	NA	NA	NA	NA	NA	NA	<0.01	<0.01
Cadmium (PM_{10})	16	16	<0.01	<0.01	NA	NA	NA	NA	NA	NA	<0.01	<0.01
Formaldehyde	14	14	2.24	0.55	NA	NA	NA	NA	NA	NA	2.57	0.73
Hexavalent Chromium	11	16	<0.01	<0.01	NA	NA	NA	NA	NA	NA	NR	NR
Manganese (PM_{10})	16	16	0.01	<0.01	NA	NA	NA	NA	NA	NA	0.01	<0.01
Washington Park, Indiana – WPIN												
Acetaldehyde	5	5	1.27	0.26	NA	NA	NA	NA	NR	NR	NR	NR
Formaldehyde	5	5	1.43	0.42	NA	NA	NA	NA	NR	NR	NR	NR

NR = Not reportable due to low number of measured detections.
NA = Not available due to short sampling duration.

Table 11-4. Non-Chronic Risk Summary for the Indiana Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
INDEM	TO-11A	Formaldehyde	61.91 ± 17.11	49	21	94	11	40	16.73 ± 2.70	103.33 ± 41.60	101.00 ± 42.64	48.16 ± 20.78

exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 11-4.

The following observations about formaldehyde at INDEM are shown in Table 11-4.

- Twenty-one formaldehyde measured detections exceeded the ATSDR MRL acute risk value of 49 $\mu g/m^3$ and eleven exceeded the California EPA REL value of 94 $\mu g/m^3$.

- The daily average formaldehyde concentration was 61.91 ± 17.11 $\mu g/m^3$, which is more than the ATSDR MRL value, but less than the California EPA REL value.

- For the intermediate formaldehyde risk, seasonal averages were compared to the ATSDR intermediate value of 40 $\mu g/m^3$. Three seasonal averages exceeded the ATSDR Intermediate MRL. The spring and summer averages were more than two times the ATSDR Intermediate MRL.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of daily concentration and daily average wind direction. Formaldehyde concentrations at INDEM exceeded the short-term risk factors. Figure 11-7 is a pollution rose for formaldehyde for INDEM.

Observations gleaned from the formaldehyde pollution rose for INDEM include:

- Many concentrations exceeded the acute risk factors, indicated by a dashed (CALEPA REL) and solid line (ATSDR MRL).

- The concentrations on the pollution rose are scattered around the center, a pattern consistent with mobile source attribution. However, the highest concentrations of formaldehyde occurred with southwesterly, northwesterly, or northeasterly winds.

- INDEM is located in a very industrialized area, and major interstates are located just south of the monitoring site. In addition, several railway lines criss-cross the area surrounding the monitoring site (refer to Figure 11-2).

11.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters

Figure 11-7. Formaldehyde Pollution Rose for INDEM

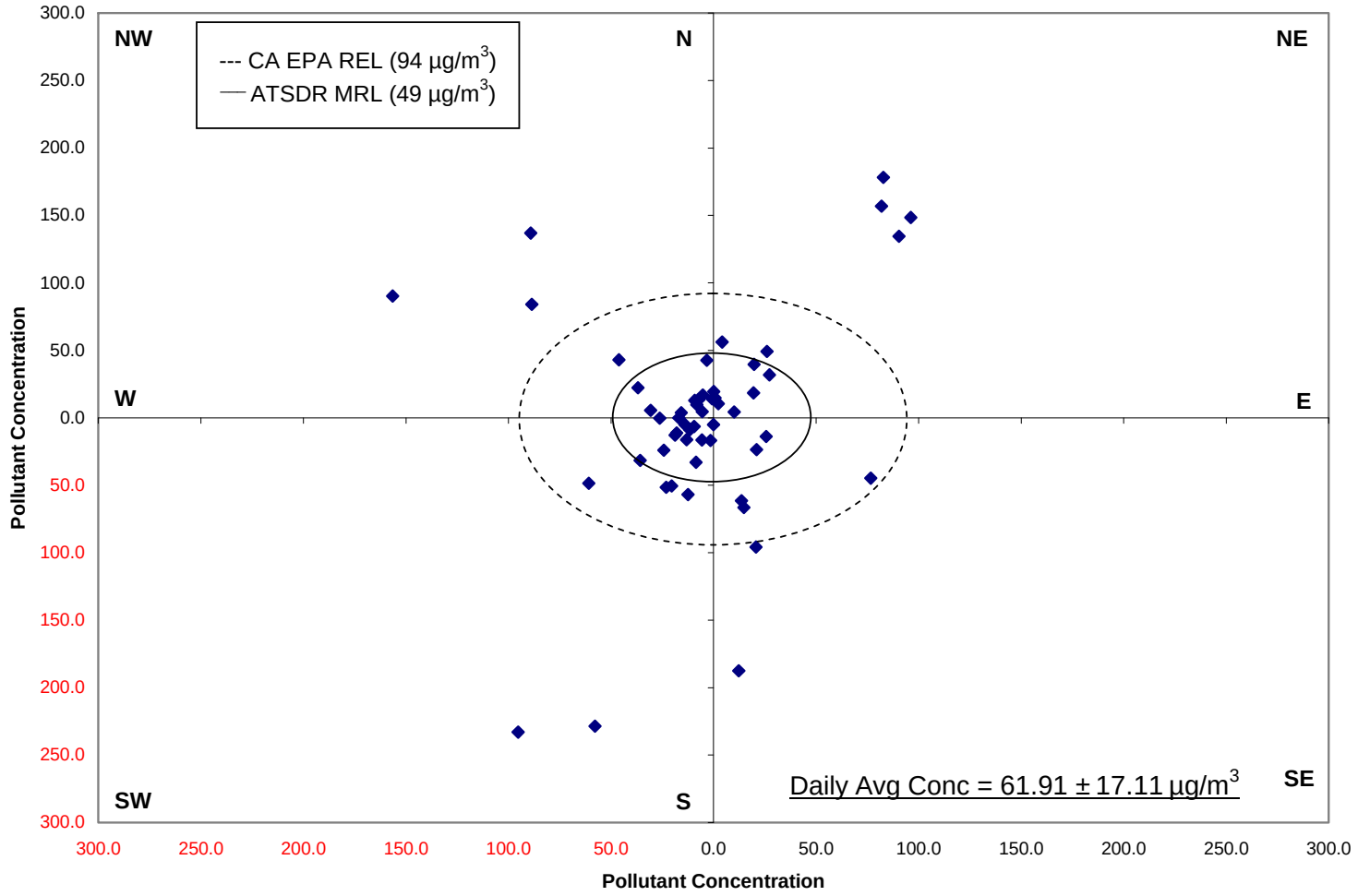


Table 11-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Indiana Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Stout Field, Indianapolis, Indiana – IDIN								
Acetaldehyde	16	0.58	0.57	0.45	0.53	-0.23	0.23	-0.70
Arsenic (PM_{10})	13	0.55	0.51	0.42	0.48	-0.22	0.14	-0.44
Formaldehyde	16	0.79	0.75	0.54	0.67	-0.41	0.35	-0.67
Manganese (PM_{10})	13	0.17	0.25	0.11	0.20	-0.30	0.28	-0.37
Nickel (PM_{10})	13	0.41	0.47	0.47	0.48	0.04	0.16	-0.15
Gary, Indiana – INDEM								
Acetaldehyde	54	0.61	0.58	0.55	0.57	-0.10	NA[1]	-0.24
Formaldehyde	54	0.50	0.47	0.46	0.46	-0.04	NA[1]	-0.07
South Harding, Indianapolis, Indiana – ININ								
Acetaldehyde	14	0.74	0.68	0.52	0.62	-0.37	0.26	-0.51
Arsenic (PM_{10})	16	0.58	0.55	0.45	0.51	-0.21	0.25	-0.64
Cadmium (PM_{10})	16	0.66	0.59	0.44	0.53	-0.34	0.27	-0.38
Formaldehyde	14	0.85	0.77	0.56	0.69	-0.48	0.24	-0.42
Hexavalent Chromium	11	-0.49	-0.59	-0.66	-0.63	-0.29	0.52	0.03
Manganese (PM_{10})	16	0.40	0.27	-0.06	0.12	-0.75	0.58	-0.41
Washington Park, Indianapolis, Indiana – WPIN								
Acetaldehyde	5	0.65	0.59	0.50	0.54	-0.94	0.85	-0.15
Formaldehyde	5	0.74	0.78	0.78	0.78	-0.37	0.24	-0.24

[1] Sea level pressure was not recorded at the Lancing Municipal Airport weather station.

(such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

11.4.1 Pearson Correlation Analysis

Table 11-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and selected meteorological parameters for the Indiana monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered about Pearson correlations for the Indiana sites:

- Some of the strongest correlations were exhibited at the Indiana monitoring sites, indicating that meteorological conditions influence concentrations of the pollutants of interest.

- The Indianapolis sites sampled for a limited duration during the 2006 program year. A low number of measured detections, such as at WPIN, can skew the correlations in one direction or another. A full year of sampling would provide a better indication of correlations between concentrations and meteorological parameters.

- Correlations between formaldehyde and the temperature parameters were particularly strong, indicating that as temperature increases, formaldehyde concentrations also increase.

- The correlations with sea level pressure tended to be positive, correlations with scalar wind speed were negative. This indicates that increasing pressure and decreasing wind speeds correspond to increasing concentrations of the pollutants of interest.

11.4.2 Composite Back Trajectory Analysis

Figures 11-8 to 11-11 are composite back trajectory maps for the Indiana monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figures 11-8 to 11-11 represents 100 miles.

The following observations can be made from Figures 11-8 through 11-11:

- Figure 11-8 shows that the 24-hour airshed domain is somewhat large at IDIN, with trajectories originating greater than 700 miles away. Most of the trajectories originated more than 300 miles from the site.

Figure 11-8. Composite Back Trajectory Map for IDIN

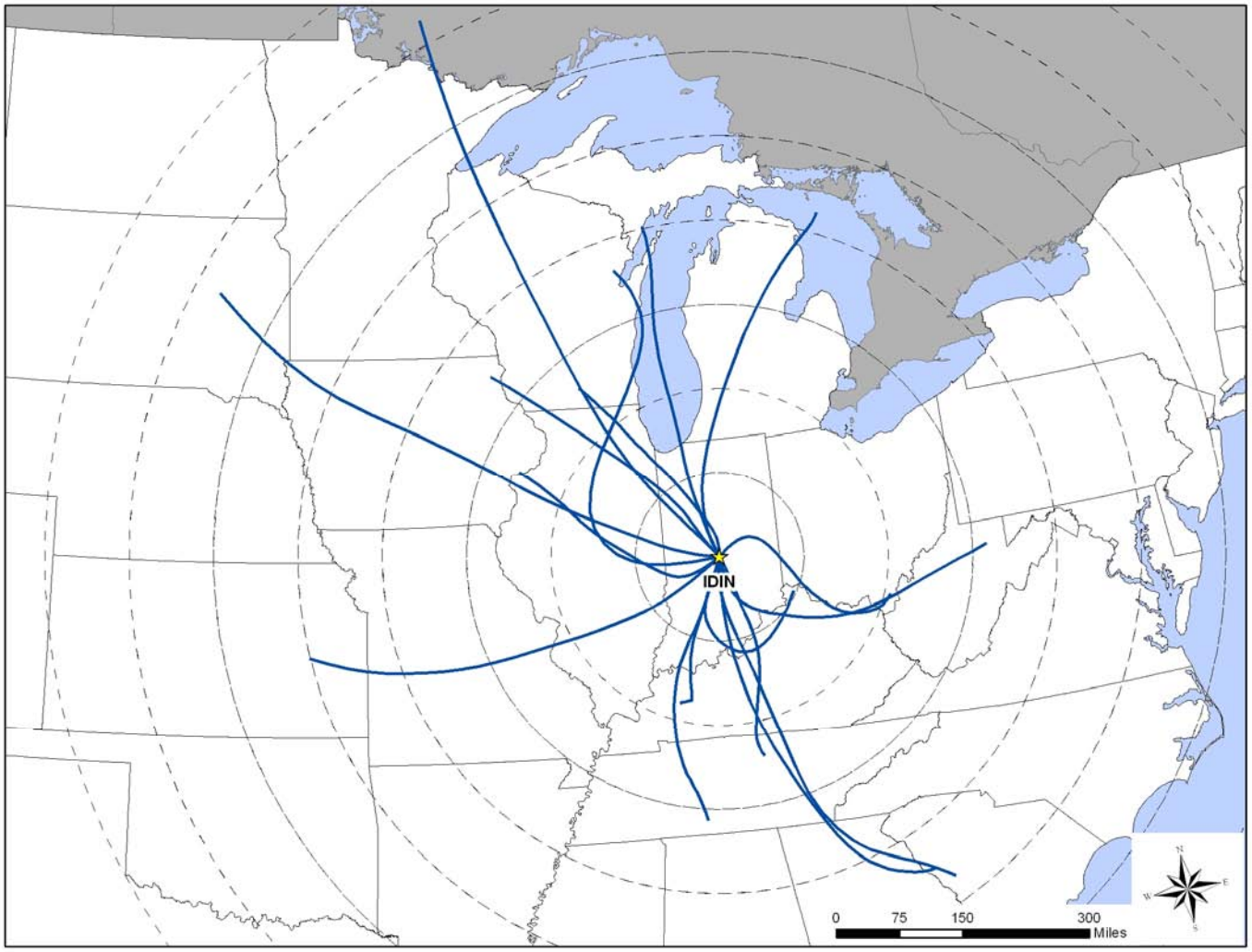


Figure 11-9. Composite Back Trajectory Map for INDEM

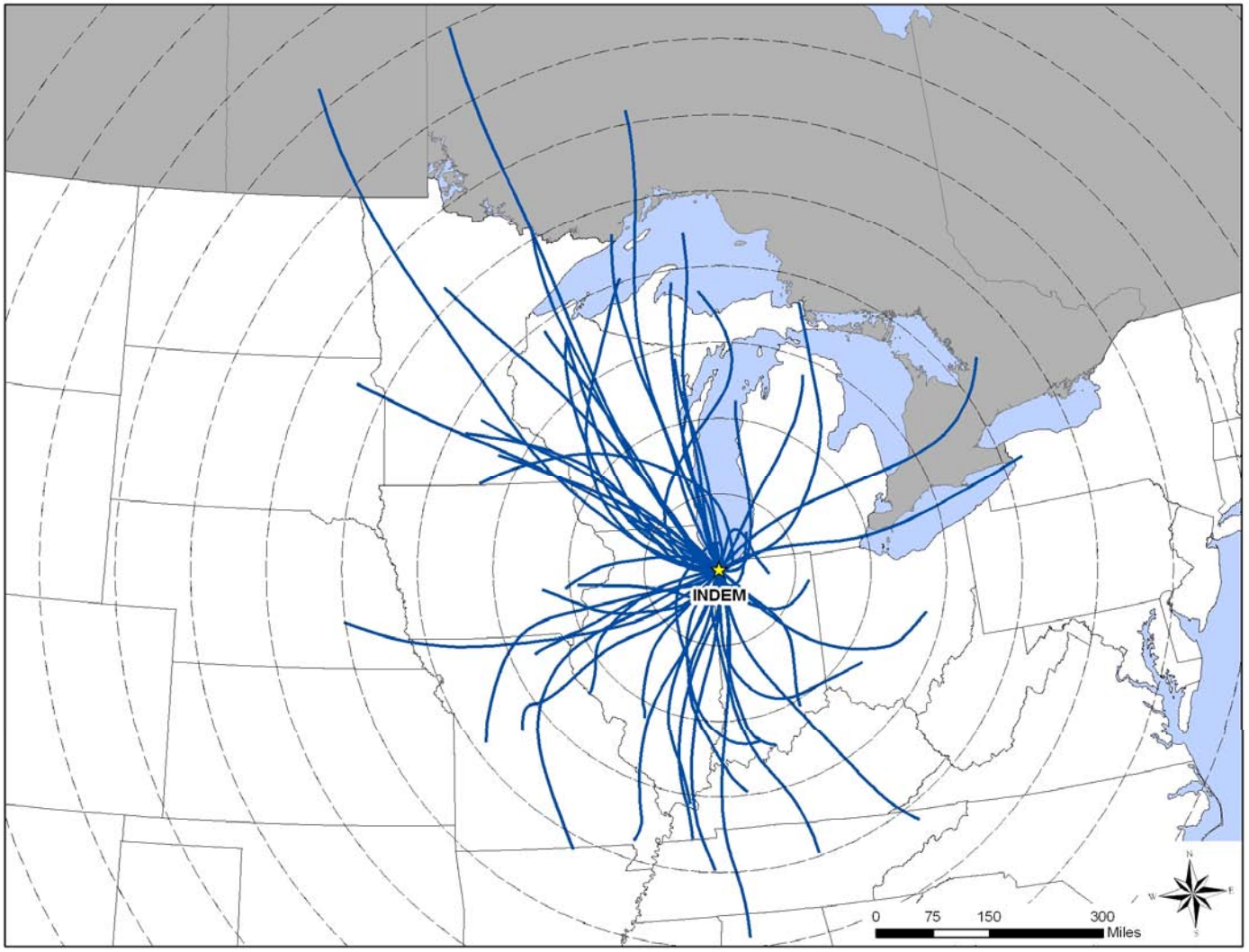


Figure 11-10. Composite Back Trajectory Map for ININ

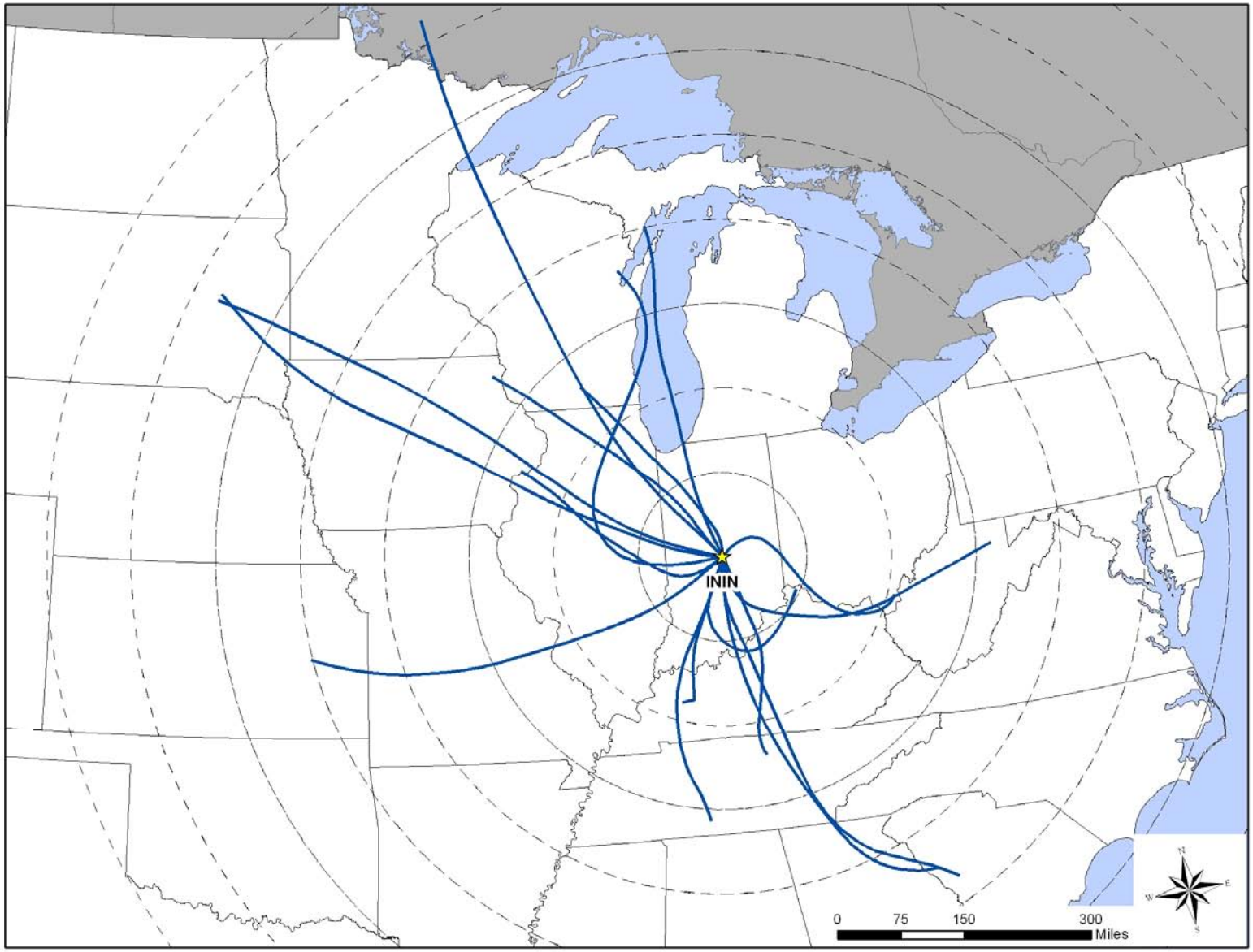
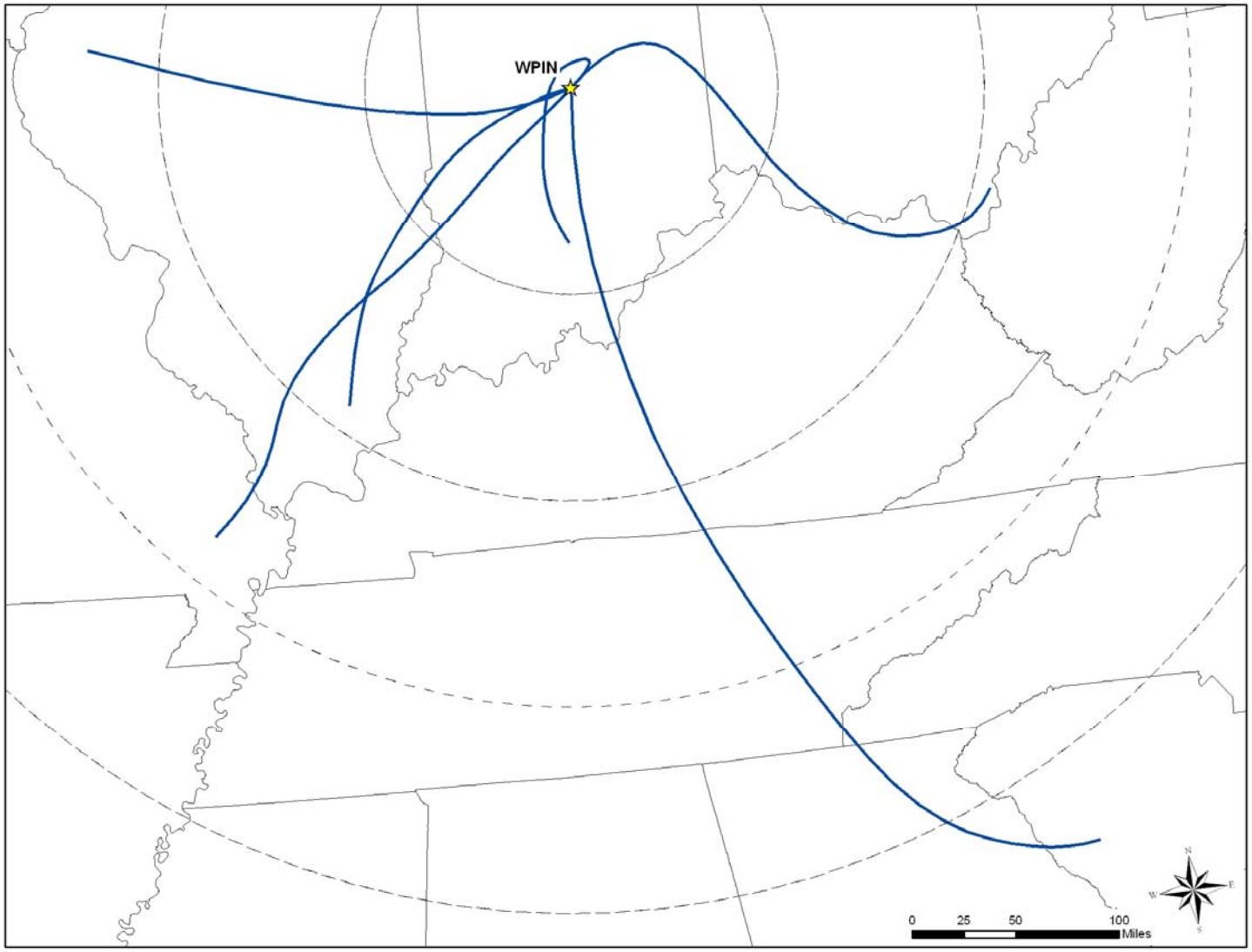


Figure 11-11. Composite Back Trajectory for WPIN



- Figure 11-9 shows that the 24-hour airshed domain is larger at the INDEM monitoring site, with trajectories originating more than 800 miles away, although most of the trajectories originate within 400 miles of the site.

- Figure 11-10 shows that none of the back trajectories for ININ originated to the northeast, and very few to the southwest. The longest trajectory originated over 700 miles to the north-northwest, with most of the trajectories originating within 400 miles of the monitoring site.

- Figure 11-11 shows that no trajectories for the WPIN site originated to the north and all the trajectories originated within 500 miles. However, sampling occurred on only six days at WPIN. The composite back trajectory map for WPIN might look different with a full year's worth of sampling.

11.4.3 Wind Rose Analysis

Hourly wind data from the Indianapolis International Airport near the IDIN, ININ and WPIN monitoring sites and the Lancing Municipal Airport near the INDEM monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 11-12 through 11-15 are the wind roses for the Indiana monitoring sites on days that sampling occurred.

Observations from Figure 11-12 for IDIN include:

- Hourly winds were predominantly out of the southeast and northwest (each 9 percent of observations), closely followed by westerly winds (8 percent of observations.)

- Winds with a westerly component were more likely to reach speeds greater than 17 knots.

- Five percent of observations were calm (<2 knots).

Observations from Figure 11-13 for INDEM include:

- Hourly winds were predominantly out of the south (10 percent of observations) and west (10 percent).

- Wind speeds frequently ranged from 7 to 11 knots on day samples were collected.

- Calm winds were observed for 21 percent of the measurements.

Figure 11-12. Wind Rose for IDIN Sampling Days

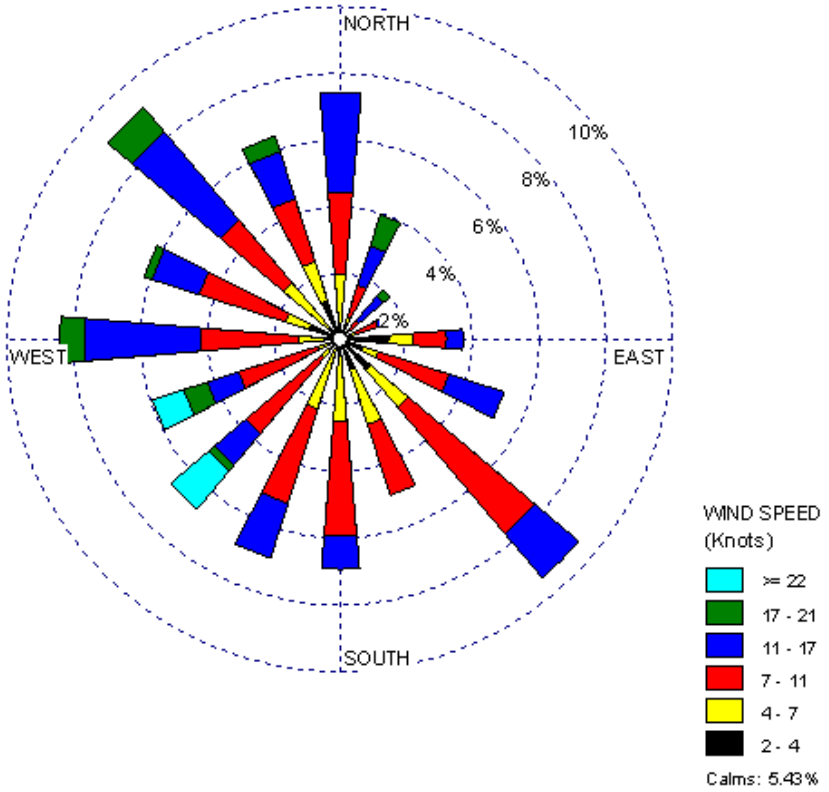


Figure 11-13. Wind Rose for INDEM Sampling Days

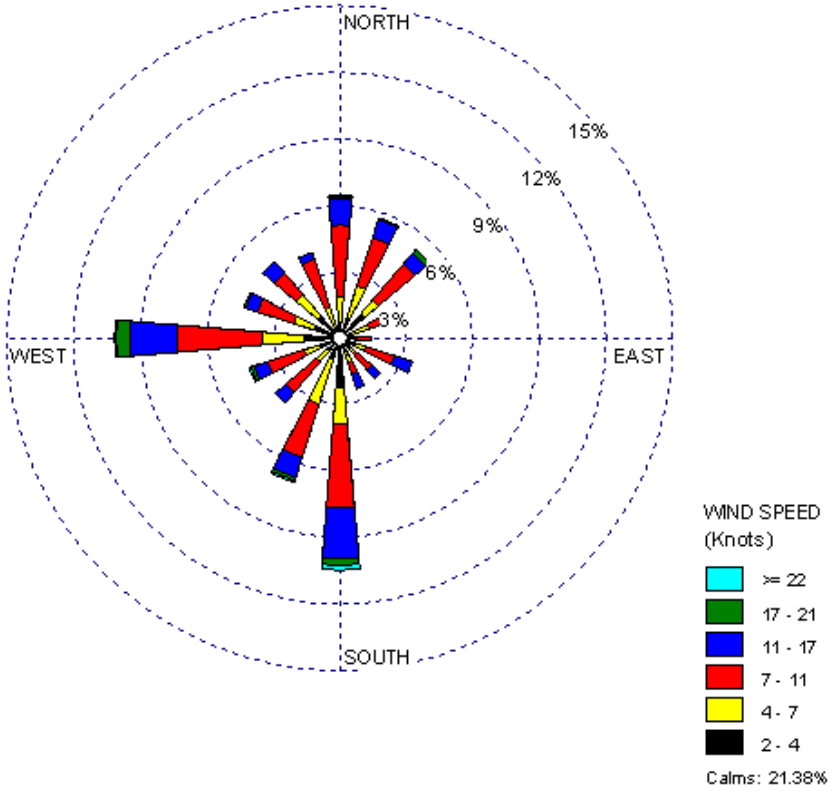


Figure 11-14. Wind Rose for ININ Sampling Days

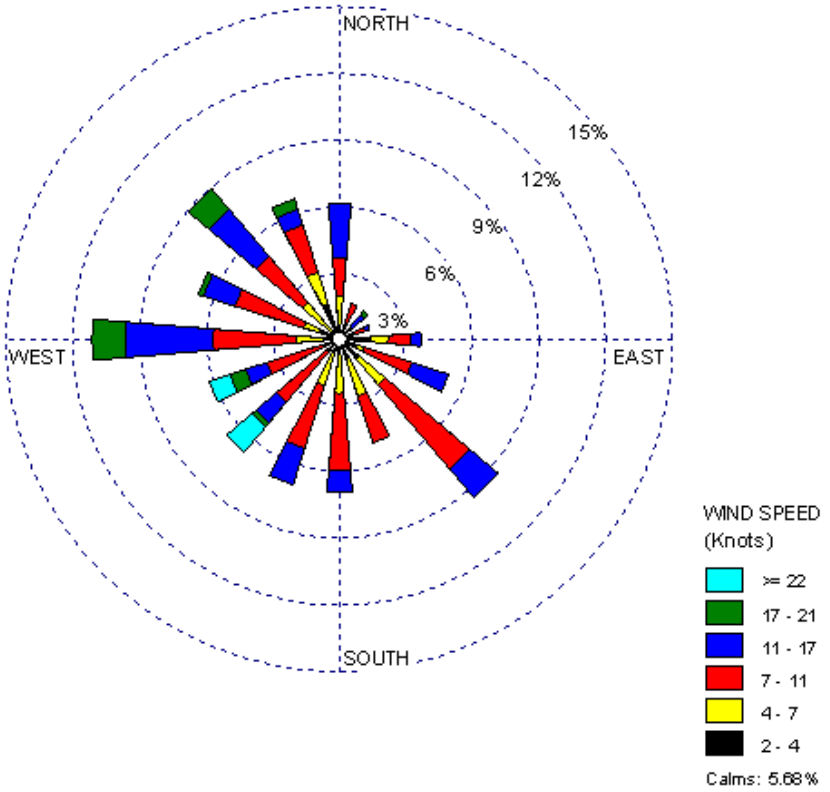
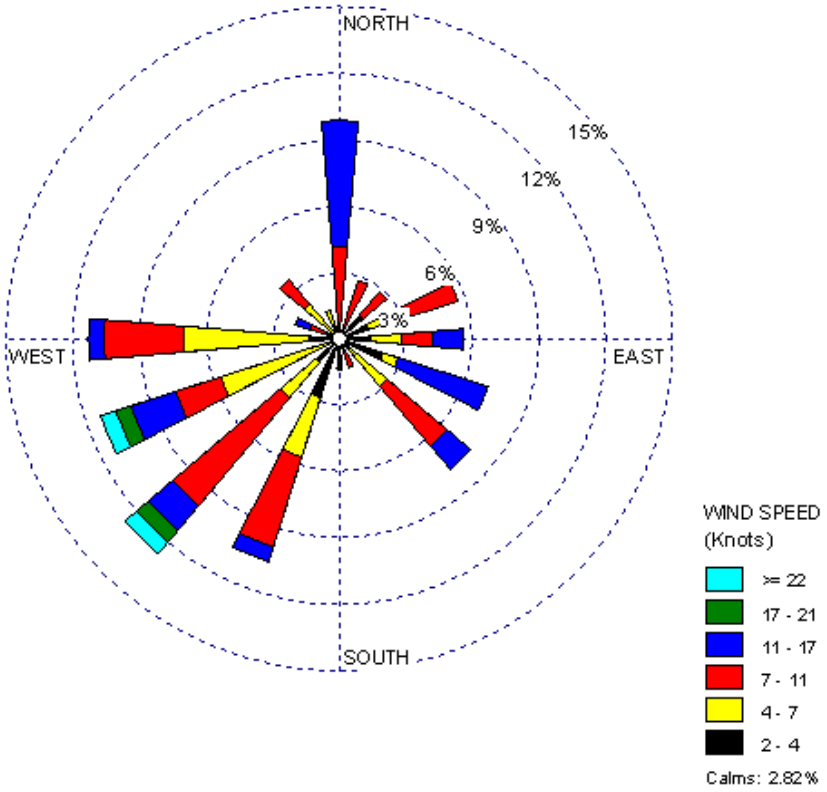


Figure 11-15. Wind Rose for WPIN Sampling Days



Observations from Figure 11-14 for ININ include:

- Hourly winds were predominantly out of the west (11 percent of observations), southeast (9 percent), and northwest (9 percent).
- Winds with a westerly component were more likely to reach speeds greater than 17 knots.
- Calm winds were recorded for 6 percent of observations.

Observations from Figure 11-15 for WPIN include:

- South-southwesterly to westerly winds were observed most frequently, accounting for approximately 45 percent of observations. Northerly winds accounted for another 10 percent of observations.
- The most commonly observed wind speeds were in the range of 7-11 knots.

11.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze for VOCs for these sites. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

11.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Lake and Marion Counties, Indiana were obtained from the Indiana Bureau of Motor Vehicles and the U.S. Census Bureau, and are summarized in Table 11-6. Table 11-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 11-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Table 11-6. Motor Vehicle Information for the Indiana Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
IDIN	865,504	897,388	1.03	591,305	613,088	30,916
INDEM	494,202	453,146	0.92	404,985	371,341	42,950
ININ	865,504	897,388	1.03	660,891	685,237	97,780
WPIN	865,504	897,388	1.03	792,104	821,284	11,514

Observations gleaned from Table 11-6 include:

- Lake County, where INDEM is located, has roughly half the population and vehicle registration of Marion County, but their vehicles per person ratios are similar.

- INDEM has the lowest 10-mile population and estimated vehicle ownership, while WPIN has the most.

- WPIN has the lowest traffic volume, while ININ experiences the most.

- Compared to other UATMP sites, the sites located in Marion County are in the top third of all sites for county population and vehicle registration, as well as 10 mile population and vehicle ownership.

- ININ has the fifth largest daily traffic volume of all UATMP sites, yet INDEM falls in the middle of the range in regards to population and vehicle registration.

11.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. Only INDEM participated in the UATMP prior to 2005 and Figure 11-16 presents the trends analysis for formaldehyde for INDEM.

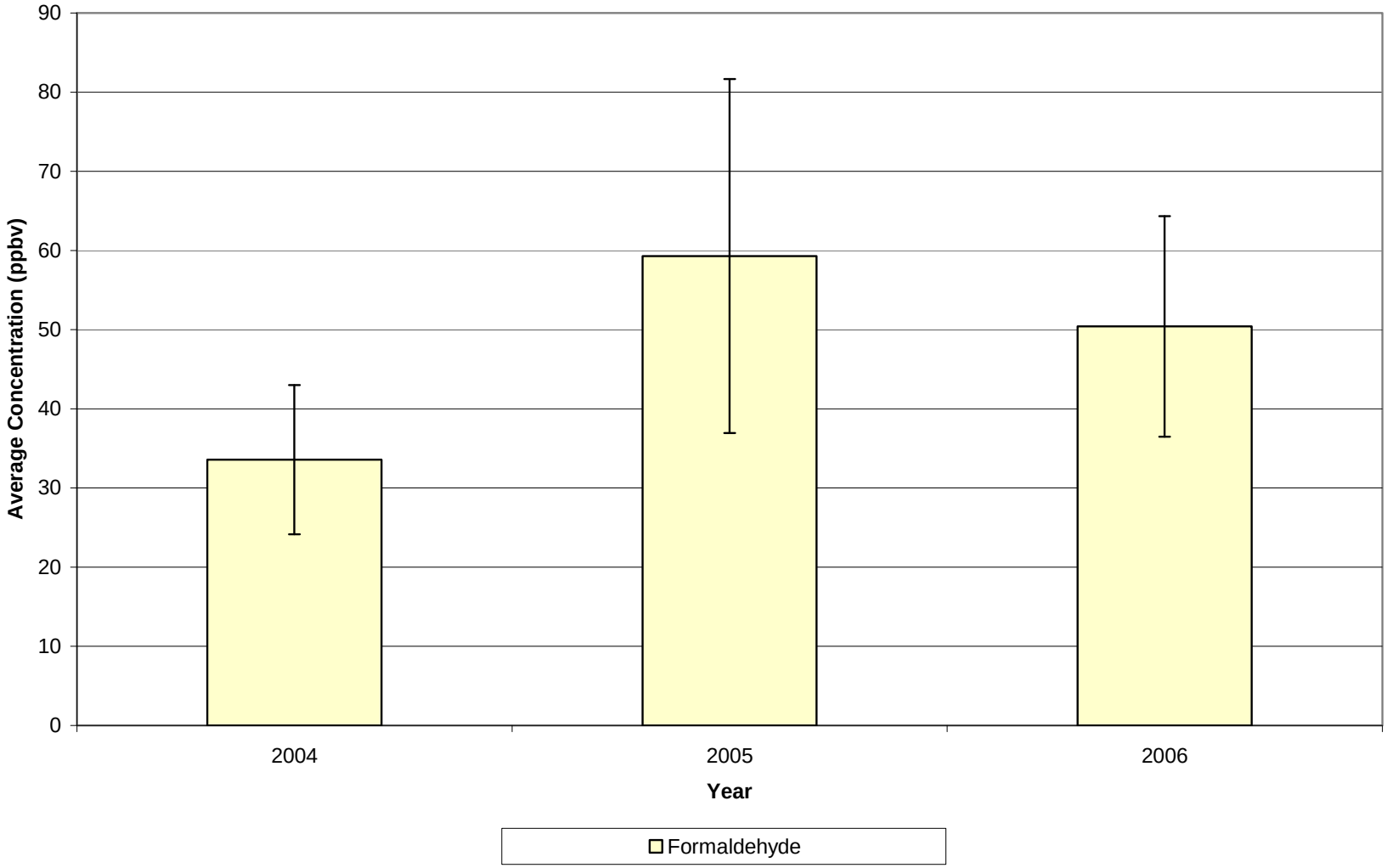
Figure 11-16 shows that:

- Formaldehyde appears to have decreased slightly since 2005, but is still higher than in 2004. However, when considering the confidence interval, as shown by error bars in Figure 11-16, the values have not changed considerably.

11.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Indiana sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 11-7. Additionally, the pollutants of interest are bolded. The Indianapolis sites did not sample long enough to calculate annual averages for the pollutants of interest. In addition to the annual averages and risks based on 2006 monitoring data, where available, data from EPA's 1999

Figure 11-16. Comparison of Yearly Averages for the INDEM Monitoring Site



NATA were retrieved and are also presented in Table 11-7. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for the Indiana sites is as follows:

- The census tract for IDIN is 18097342300, which had a population of 6,536 and represents approximately 0.8 percent of the Marion County population in 2000.
- The census tract for ININ is 18097358100, which had a population of 3,374 and represents approximately 0.4 percent of the Marion County population in 2000.
- The census tract for WPIN is 18097350700, which had a population of 2,058 and represents approximately 0.2 percent of the Marion County population in 2000.
- The census tract for INDEM is 18089010202, which had a population of 1,689 and represents approximately 0.3 percent of the Lake County population in 2000.

The following observations can be made from Table 11-7:

- Formaldehyde and acetaldehyde had the highest NATA-modeled concentrations of all the pollutants of interest at the Indiana monitoring sites.
- Due to the short sampling duration of the Indianapolis sites, only INDEM has annual averages.
- While the acetaldehyde annual average was somewhat similar to the NATA-modeled concentration, the formaldehyde annual average was significantly higher than the NATA-modeled concentration at INDEM. However, because formaldehyde has such a low cancer risk, the annual average-based cancer risk was still less than 1 in-a-million. The same was not true of noncancer risk. The annual average-based noncancer HQ was 6.32 for INDEM, while the NATA-modeled noncancer HQ for formaldehyde was 0.19.
- The highest NATA-modeled cancer risk at a UATMP site, based on census tract location, was calculated for arsenic at ININ (208.16 in-a-million). This was more than twice the next highest NATA-modeled cancer risk for a UATMP site (dichloromethane, 71 in-a-million at MIMN). This risk near IDIN for arsenic is much lower.

11.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 11-8 and 11-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity,

Table 11-7. Chronic Risk Summary for the Monitoring Sites in Indiana

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Indianapolis, Indiana (IDIN) – Census Tract ID 18097342300								
Acetaldehyde	0.0000022	0.009	1.41	3.10	0.16	NA	NA	NA
Arsenic*	0.0043	0.00003	<0.01	4.74	0.04	NA	NA	NA
Cadmium*	0.0018	0.00002	<0.01	0.05	<0.01	NA	NA	NA
Cobalt*	NR	0.0001	<0.01	NR	<0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.74	0.01	0.18	NA	NA	NA
Manganese*	NR	0.00005	<0.01	NR	0.08	NA	NA	NA
Nickel*	0.00016	0.000065	<0.01	0.06	0.01	NA	NA	NA
Gary, Indiana (INDEM) – Census Tract ID 18089010202								
Acetaldehyde	0.0000022	0.009	1.96	4.32	0.22	4.63 ± 0.56	10.19	0.51
Formaldehyde	5.5E-09	0.0098	1.86	0.01	0.19	61.91 ± 17.11	0.34	6.32
Indianapolis, Indiana (ININ) – Census Tract ID 18097358100								
Acetaldehyde	0.0000022	0.009	1.64	3.60	0.18	NA	NA	NA
Arsenic*	0.0043	0.00003	0.05	208.16	1.61	NA	NA	NA
Cadmium*	0.0018	0.00002	<0.01	0.08	<0.01	NA	NA	NA
Cobalt*	NR	0.0001	<0.01	NR	<0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.92	0.01	0.20	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	<0.01	3.19	<0.01	NA	NA	NA
Manganese*	NR	0.00005	0.01	NR	0.13	NA	NA	NA
Washington Park, Indianapolis, Indiana (WPIN) – Census Tract ID 18097350700								
Acetaldehyde	0.0000022	0.009	1.48	3.25	0.16	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.47	0.01	0.15	NA	NA	NA

* Metals sampled with PM_{10} filters
BOLD indicates a pollutant of interest
NR = a risk factor is not available and therefore, no risk calculation can be made
NA = annual average not available

respectively. Table 11-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 11-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. Because the Indianapolis sites have no annual averages and therefore no site-specific cancer and noncancer risk calculations, the emissions for Marion County in Tables 11-8 and 11-9 have been consolidated into one entry.

The following observations can be made from Table 11-8:

- Nine of the 10 highest emitted pollutants (by mass) with cancer risk factors were the same for both Marion and Lake Counties.

- Benzene, formaldehyde, and acetaldehyde were the top three emitted pollutants in both counties.

- The pollutants with the 10 highest cancer toxicity-weighted emissions were the same in both counties. Coke oven emissions have the highest toxicity-weighted emissions in both counties. Acetaldehyde was identified in all three "top 10" lists for Lake County/INDEM.

The following observations can be made from Table 11-8:

- Nine of the 10 highest emitted pollutants with noncancer risk factors were the same for both Marion and Lake Counties.

- Hydrochloric acid, toluene, xylenes, benzene, and methanol were the top five emitted pollutants in both counties, although not necessarily in that order.

- Acrolein has the highest noncancer toxicity-weighted emissions in Marion County, followed by manganese and hydrochloric acid.

- Unlike most other UATMP counties, manganese has the highest noncancer toxicity-weighted emissions in Lake County.

Table 11-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Indiana

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Indianapolis, Indiana (IDIN, ININ, and WPIN) – Marion County					
Benzene	762.79	Coke Oven Emissions	1.89E-02		
Formaldehyde	312.54	Benzene	5.95E-03		
Acetaldehyde	129.03	1,3-Butadiene	3.06E-03		
Dichloromethane	123.14	Arsenic	2.75E-03		
1,3-Butadiene	102.02	Hexavalent Chromium	1.71E-03		
1,3-Dichloropropene	62.42	Naphthalene	1.57E-03		
Naphthalene	46.08	Cadmium	6.55E-04		
Coke Oven Emissions	30.48	Lead	5.50E-04		
Trichloroethylene	21.28	Polycyclic Organic Matter as 15-PAH	3.07E-04		
p-Dichlorobenzene	13.81	Acetaldehyde	2.84E-04		
Gary, Indiana (INDEM) – Lake County					
Benzene	410.05	Coke Oven Emissions	6.45E-02	Acetaldehyde	10.19
Formaldehyde	195.91	Arsenic	3.96E-03	Formaldehyde	0.34
Acetaldehyde	147.88	Benzene	3.20E-03		
Coke Oven Emissions	104.05	Naphthalene	1.74E-03		
Naphthalene	51.13	1,3-Butadiene	1.24E-03		
Dichloromethane	47.36	Hexavalent Chromium	1.15E-03		
1,3-Butadiene	41.45	Lead	6.12E-04		
1,3-Dichloropropene	35.16	Polycyclic Organic Matter as 15-PAH	3.88E-04		
Lead	22.20	Acetaldehyde	3.25E-04		
p-Dichlorobenzene	7.78	Cadmium	2.67E-04		

Table 11-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Indiana

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Indianapolis, Indiana (IDIN, ININ, and WPIN) – Marion County					
Toluene	2,162.01	Acrolein	1,047,145.40		
Xylenes	1,373.12	Manganese	112,123.36		
Hydrochloric Acid	1,062.57	Hydrochloric Acid	53,128.59		
Benzene	762.79	1,3-Butadiene	51,009.39		
Methanol	403.50	Formaldehyde	31,891.65		
Methyl Ethyl Ketone	362.07	Benzene	25,426.35		
Hexane	334.41	Arsenic	21,325.21		
Formaldehyde	312.54	Bromomethane	18,967.01		
Ethylbenzene	301.76	Cadmium	18,188.33		
Methyl Isobutyl Ketone	254.05	Nickel	16,949.04		
Gary, Indiana (INDEM) – Lake County					
Hydrochloric Acid	1,133.24	Manganese	813,675.39	Formaldehyde	6.32
Toluene	1,000.22	Acrolein	492,627.56	Acetaldehyde	0.51
Xylenes	703.65	Hydrochloric Acid	56,662.03		
Benzene	410.05	Arsenic	30,703.29		
Methanol	243.60	Nickel	25,638.09		
Hexane	232.53	1,3-Butadiene	20,724.19		
Formaldehyde	195.91	Formaldehyde	19,990.77		
Methyl Ethyl Ketone	184.87	Chlorine	19,571.26		
Acetaldehyde	147.88	Naphthalene	17,042.50		
Ethylbenzene	125.17	Acetaldehyde	16,431.15		

Formaldehyde has an annual average-based noncancer HQ greater than 1 in Lake County (6.32), and was one of only two UATMP site-formaldehyde noncancer risks to be greater than 1 (the other was SPIL, 1.40).

Indiana Pollutant Summary

- *The pollutants of interest vary by location at the Indiana sites, but acetaldehyde and formaldehyde were pollutants of interest at each site.*
- *Formaldehyde had the highest daily average concentration at each site and was particularly high at INDEM.*
- *Formaldehyde exceeded both of the acute risk factors and the intermediate risk factor at INDEM.*

12.0 Site in Kentucky

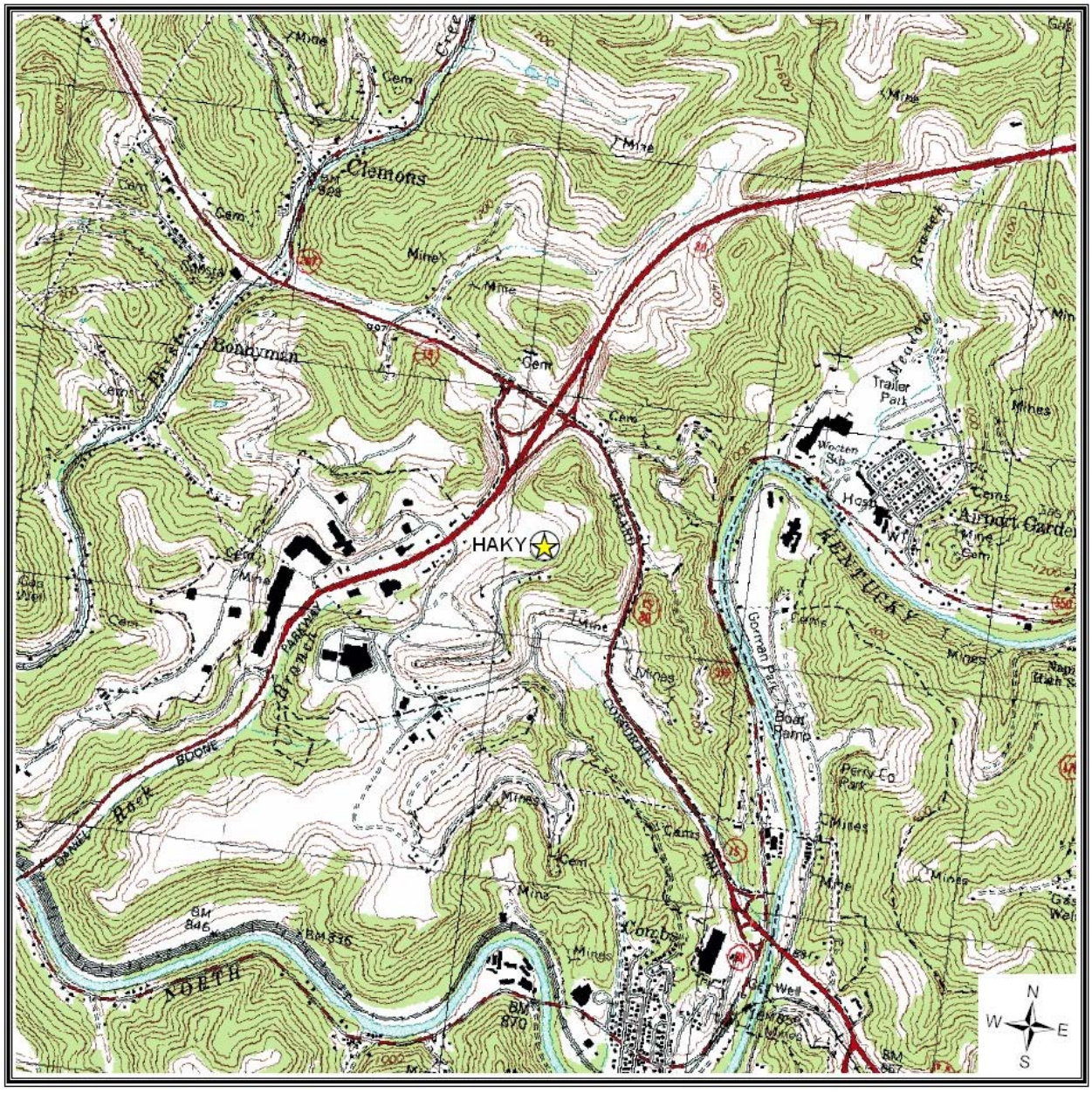
This section presents meteorological, concentration, and spatial trends for the UATMP site located in Hazard, Kentucky (HAKY). Figure 12-1 is a topographical map showing the monitoring site in its rural location. Figure 12-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. HAKY is located near a very small number of point sources, located mainly to the north and southeast of the site. The town of Hazard is located in southeast Kentucky, just on the outskirts of Daniel Boone National Forest. The area experiences all four seasons, and precipitation is fairly evenly distributed throughout the year (http://www.wildernet.com/pages/area.cfm?areaID=0802&CU_ID-1).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the HAKY monitoring site is at Julian Carroll Airport in Jackson, Kentucky (WBAN 03889). Table 12-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 12-1 is the 95 percent confidence interval. As shown in Table 12-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

12.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Kentucky monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute

Figure 12-1. Hazard, Kentucky (HAKY) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 12-2. Facilities Located Within 10 Miles of HAKY

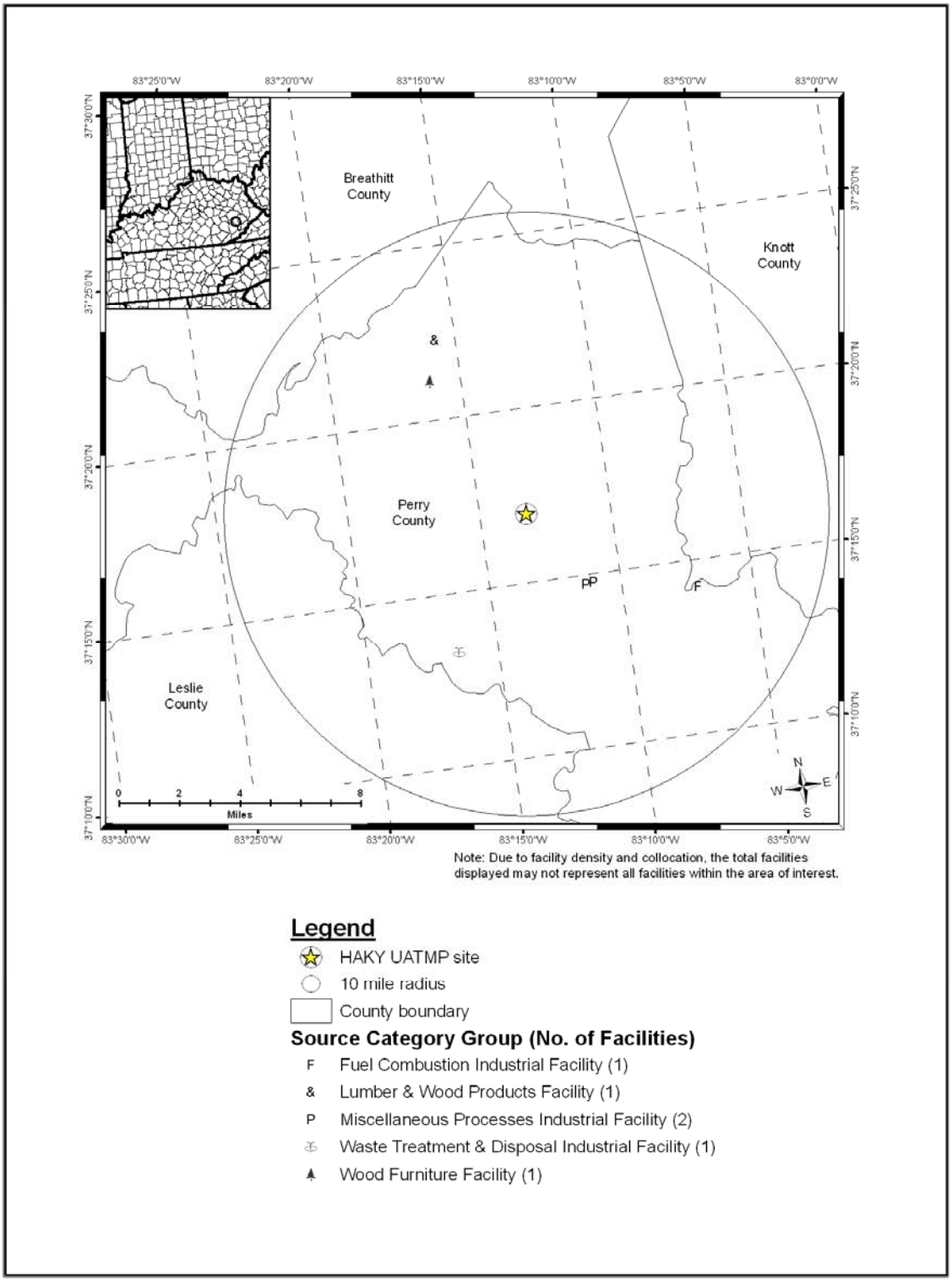


Table 12-1. Average Meteorological Conditions near the Monitoring Site in Kentucky

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
HAKY	03889	All 2006	66.48 ± 1.61	57.36 ± 1.53	44.36 ± 1.72	50.89 ± 1.45	65.34 ± 1.58	1017.23 ± 0.63	2.76 ± 0.20
		Sampling Day	67.38 ± 3.61	58.14 ± 3.39	45.93 ± 3.48	51.83 ± 3.03	67.53 ± 3.99	1016.39 ± 1.42	2.89 ± 0.52

to the top 95 percent of the site's total failed screens. Only hexavalent chromium was sampled at HAKY, and it did not fail any screens as shown in Table 12-2. In order to facilitate analysis, this pollutant will be considered HAKY's only pollutant of interest.

Table 12-2. Comparison of Measured Concentrations and EPA Screening Values for the Kentucky Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Hazard, Kentucky – HAKY					
Hexavalent Chromium	0	44	0	0	0

12.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 12-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 12-3:

- The daily average concentration for hexavalent chromium at HAKY was 0.020 ± 0.004 ng/m^3.
- The seasonal averages varied little across the seasons.
- The autumn average concentration was not calculated due to the low number of measured detections.

Table 12-3. Daily and Seasonal Averages for the Pollutants of Interest for the Kentucky Monitoring Site

Pollutant	# of Measured Detections	# of Samples			Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Hazard, Kentucky – HAKY												
Hexavalent Chromium	44	59	0.020	0.004	0.011	0.004	0.017	0.004	0.026	0.009	NR	NR

NR = Not reportable due to low number of measured detections.

Daily

12.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for HAKY was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. Acute risk factors are not available for hexavalent chromium; therefore, acute risk cannot be evaluated. The intermediate risk value was not exceeded in the samples collected at HAKY.

12.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

12.4.1 Pearson Correlation Analysis

Table 12-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters at the HAKY monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.) The correlations calculated between hexavalent chromium and the meteorological parameters at HAKY were weak.

12.4.2 Composite Back Trajectory Analysis

Figure 12-3 is a composite back trajectory map for the HAKY monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 12-3 represents 100 miles.

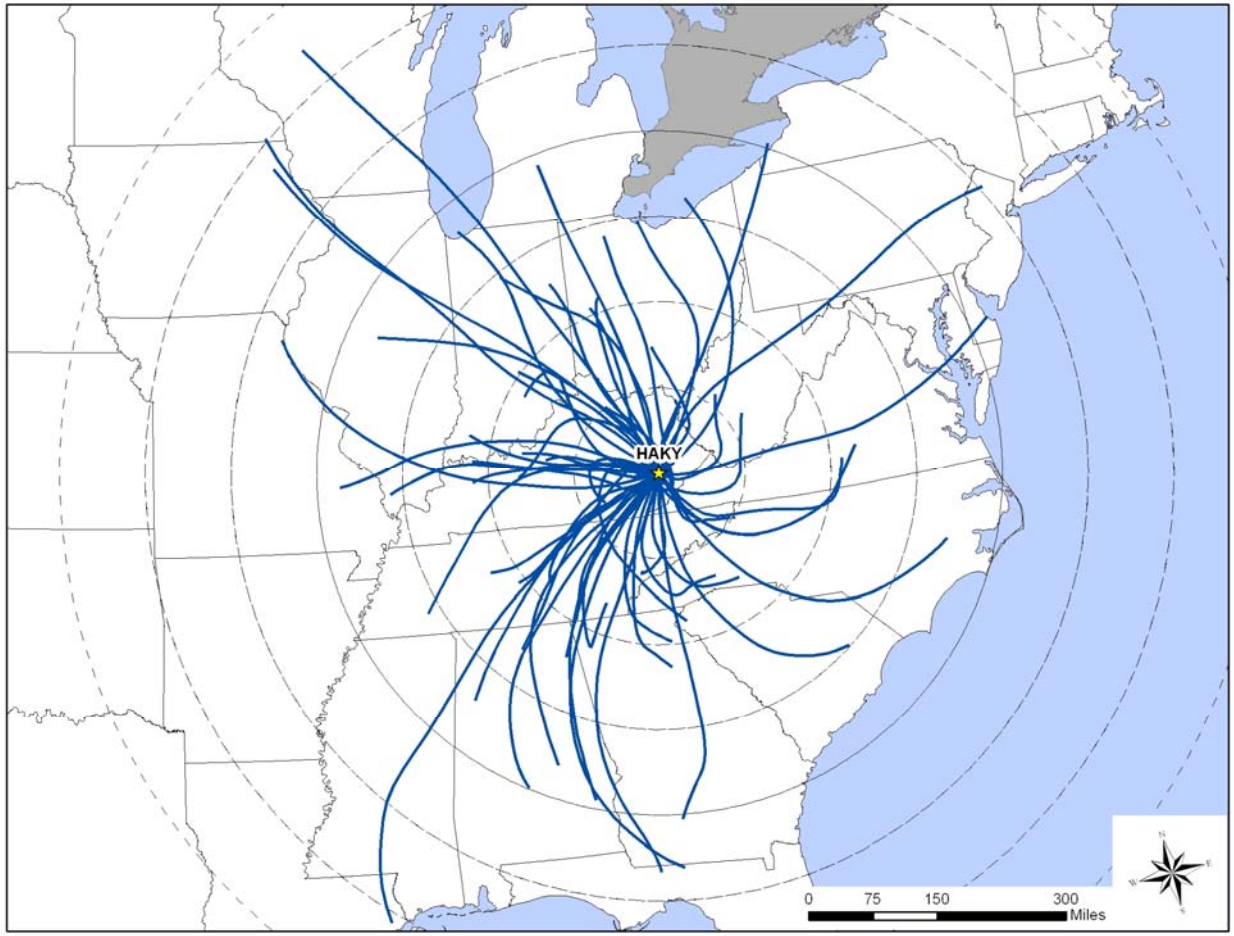
The following observations can be made from Figure 12-3:

- Back trajectories originated from a variety of directions at HAKY.

Table 12-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Kentucky Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Hazard, Kentucky – HAKY								
Hexavalent Chromium	44	0.36	0.32	0.35	0.36	0.07	0.14	-0.23

Figure 12-3. Composite Back Trajectory Map for HAKY



- The 24-hour airshed domain was moderately large at HAKY, with trajectories originating as far away as Louisiana and Wisconsin (> 600 miles).

- However, the majority of the trajectories originated from within 300 miles of the site.

12.4.3 Wind Rose Analysis

Hourly wind data from the Julian Carroll Airport near the HAKY monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 12-4 is the wind rose for the HAKY monitoring site on days that sampling occurred.

Observations from Figure 12-4 include:

- Hourly winds were predominantly out of the west (7 percent of observations), south (6 percent), and south-southwest (6 percent) on sampling days.

- Winds near HAKY were light, as calm winds (<2 knots) were the most frequently observed wind speed (54 percent of observations).

12.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze for VOCs at this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

12.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population were obtained from the Kentucky Department of Revenue and Regulation and the U.S. Census Bureau, as shown in Table 12-5. Table 12-5 also includes a vehicle registration to county population ratio (vehicles per person) for Perry County. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 12-5 contains the average daily

Figure 12-4. Wind Rose for HAKY Sampling Days

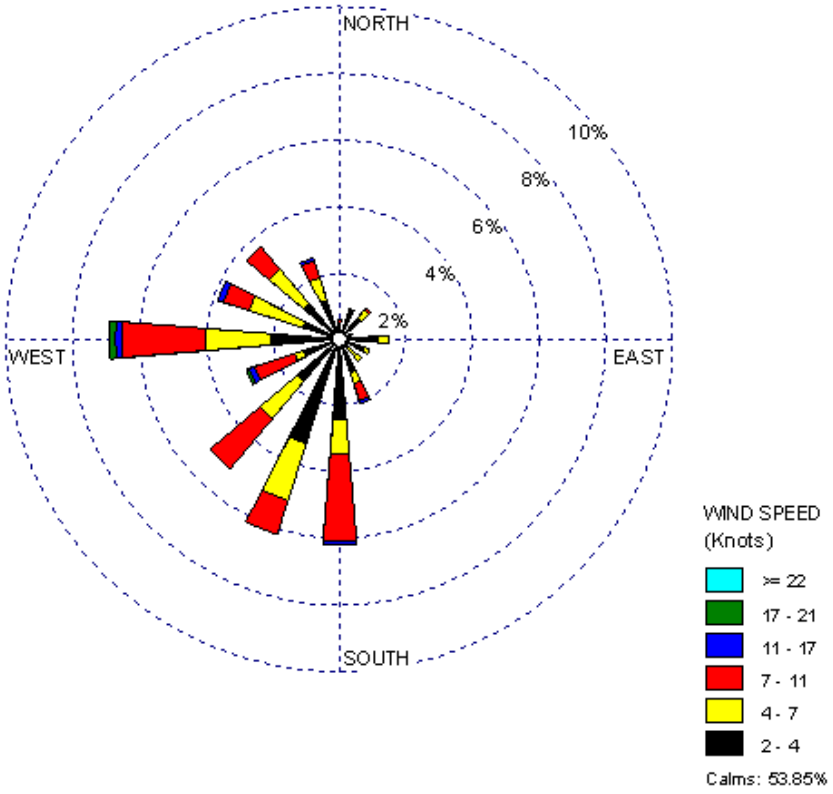


Table 12-5. Motor Vehicle Information for the Kentucky Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
HAKY	29,753	22,704	0.76	32,103	24,497	500

traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 12-5 include:

- HAKY's county population, vehicle registration, population and vehicle ownership within 10 miles, and daily traffic volume are some of the lowest compared to other UATMP sites.

- HAKY is located in a rural area.

12.6 Trends Analysis

A trends analysis could not be performed for HAKY as this site has not participated in the UATMP for three consecutive years.

12.7 Chronic Risk Analysis

A chronic risk analysis was completed hexavalent chromium at HAKY. Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 12-6. Finally, data from EPA's 1999 NATA for hexavalent chromium were retrieved and are presented in Table 12-6. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for HAKY is as follows:

- The HAKY monitoring site is located in census tract 21193970400.

- The population for the census tract where the HAKY monitoring site is located was 4,359, which represents fifteen percent of Perry County's population in 2000.

The following observations can be made from Table 12-6:

- Both the NATA-modeled and annual average concentration for hexavalent chromium were less than 0.01 $\mu g/m^3$.

- In terms of cancer risk, the NATA-modeled and calculated cancer risks were both less than 1 in-a-million, although the annual average-based cancer risk (0.20 in-a-million) was an order of magnitude greater than the NATA-modeled cancer risk (0.03 in-a-million).

Table 12-6. Chronic Risk Summary for the Monitoring Site in Kentucky

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Hazard, Kentucky (HAKY) – Census Tract ID 21193970400								
Hexavalent Chromium	0.012	0.0001	<0.01	0.03	<0.01	<0.01 ± <0.01	0.20	<0.01

- Both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

12.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 12-7 and 12-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 12-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the hexavalent chromium cancer risk (in-a-million) as calculated from the annual average. Table 12-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be.

The following observations can be made from Table 12-7:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and had the highest cancer toxicity-weighted emissions for Perry County, Kentucky.

- Eight of 10 pollutants (benzene, acetaldehyde, tetrachloroethylene, 1,3-butadiene, naphthalene, *p*-dichlorobenzene, POM as 15-PAH, and POM as 7-PAH) appeared on both the highest emitted list and the highest cancer toxicity-weighted emissions list, indicating that most of the highest emitted pollutants were also the most toxic.

- Perry County has low HAP emissions among the UATMP counties.

- Hexavalent chromium, the only pollutant sampled at HAKY, had a low cancer risk based its annual average (0.20 in-a-million). This pollutant does not appear on either the highest emissions list or the highest cancer toxicity-weighted emissions list.

The following observations can be made from Table 12-8:

- Toluene was the highest emitted pollutant with noncancer risk factor in Perry County.

- Unlike most other UATMP counties, toluene did rank in the top 10 pollutants based on toxicity-weighted emissions (tenth highest).

- Acrolein had the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants.

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for HAKY

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Perry County)		Top 10 Cancer Toxicity-Weighted Emissions (for Perry County)		Top 10 Cancer Risks Based on Annual Average Concentration (for HAKY)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Hazard, Kentucky – HAKY					
Benzene	38.73	Benzene	3.02E-04	Hexavalent Chromium	0.20
Formaldehyde	11.03	1,3-Butadiene	7.51E-05		
Tetrachloroethylene	3.87	Lead	5.70E-05		
Acetaldehyde	3.67	Polycyclic Organic Matter as 15-PAH	4.68E-05		
1,3-Butadiene	2.50	Naphthalene	4.19E-05		
Dichloromethane	2.40	Polycyclic Organic Matter as 7-PAH	3.02E-05		
Naphthalene	1.23	Polycyclic Organic Matter as non-15-PAH	2.64E-05		
Polycyclic Organic Matter as 15-PAH	0.85	Tetrachloroethylene	2.29E-05		
p-Dichlorobenzene	0.63	Acetaldehyde	8.08E-06		
Polycyclic Organic Matter as 7-PAH	0.15	*p*-Dichlorobenzene	6.92E-06		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for HAKY

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Perry County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Perry County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for HAKY)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Hazard, Kentucky – HAKY					
Toluene	68.21	Acrolein	43,070.00	Hexavalent Chromium	<0.01
Xylenes	45.74	Benzene	1,290.98		
Benzene	38.73	4,4'-Methylenediphenyl Diisocyanate	1,255.09		
Methanol	14.82	1,3-Butadiene	1,252.34		
Methyl *Tert*-Butyl Ether	11.56	Formaldehyde	1,125.93		
Formaldehyde	11.03	Cyanide	986.23		
Ethylbenzene	10.51	Xylenes	457.40		
Hexane	10.42	Naphthalene	410.44		
Methyl Ethyl Ketone	8.20	Acetaldehyde	407.88		
Methyl Isobutyl Ketone	5.10	Toluene	170.52		

- Hexavalent chromium did not rank in the top 10 highest emitted pollutants with noncancer risk factors or the 10 highest noncancer toxicity-weighted emissions in Perry County.

Kentucky Pollutant Summary

- *While hexavalent chromium, the only pollutant sampled for at HAKY, did not fail any screens, it was treated as a pollutant of interest in order to facilitate analysis.*

13.0 Site in Massachusetts

This section presents meteorological, concentration, and spatial trends for the UATMP site in Massachusetts (BOMA). This site is located in the Boston-Lawrence-Worcester MSA. Figure 13-1 is a topographical map showing the monitoring site in its urban location. Figure 13-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. BOMA is located near a number of sources, of which a majority of the facilities employ fuel combustion processes.

Boston's location on the East Coast ensures that the city experiences a fairly active weather pattern. Most storm systems track across the Northeast, bringing ample precipitation to the area. The proximity to the Atlantic Ocean helps moderate temperature, both in the summer and the winter, while at the same time allowing winds to gust higher than they would farther inland. Winds generally flow from the northwest in the winter and southwest in the summer (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the BOMA monitoring site is at Logan International Airport (WBAN 14739). Table 13-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind speed information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 13-1 is the 95 percent confidence interval. As shown in Table 13-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

13.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Massachusetts monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 13-1. Boston, Massachusetts (BOMA) Monitoring Site

Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 13-2. Facilities Located Within 10 Miles of BOMA

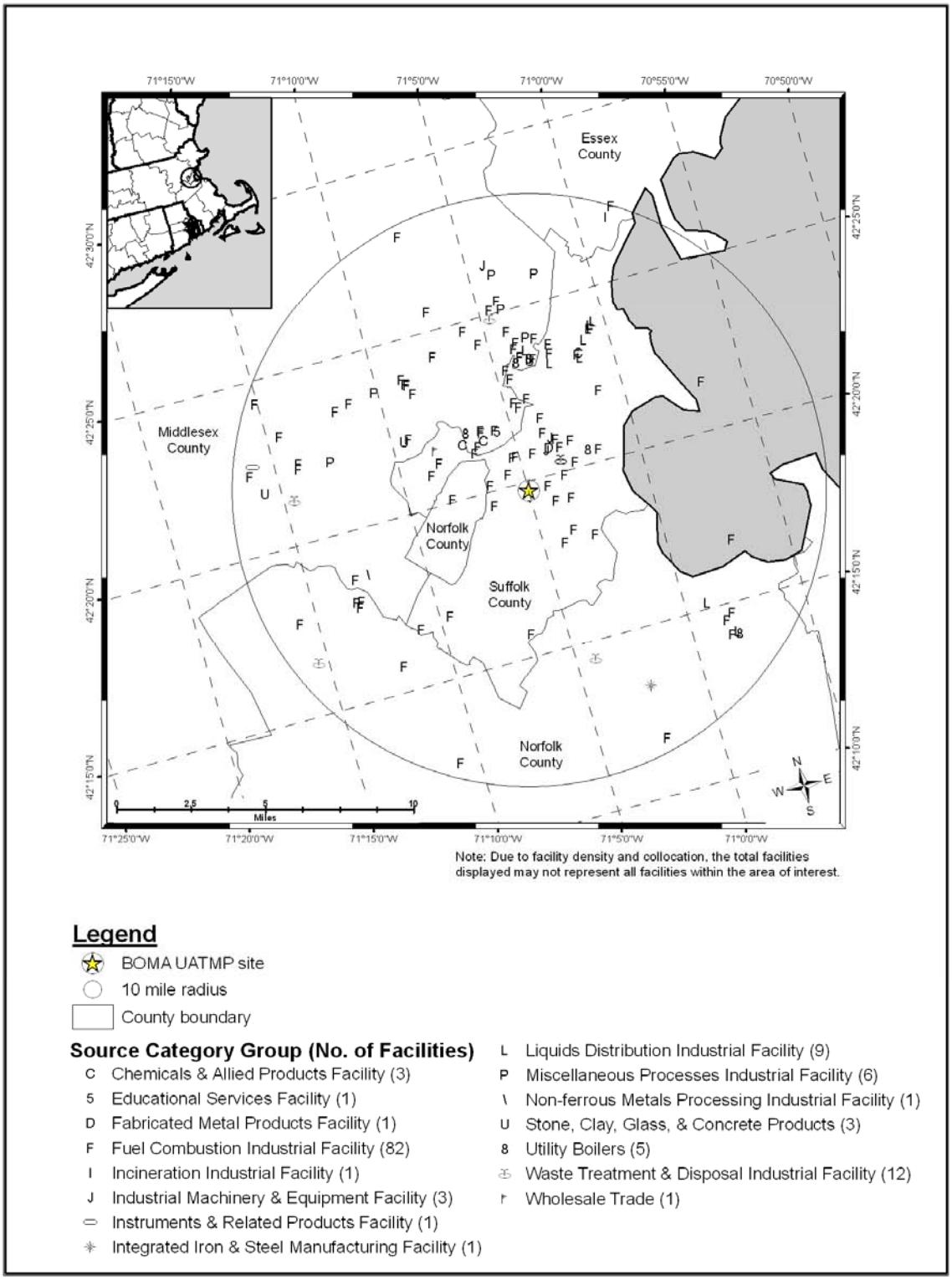


Table 13-1. Average Meteorological Conditions near the Monitoring Site in Massachusetts

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BOMA	14739	All 2006	59.96 ± 1.69	53.03 ± 1.59	41.07 ± 1.80	47.55 ± 1.50	66.49 ± 1.58	1014.72 ± 0.80	9.60 ± 0.32
		Sampling Day	59.49 ± 4.04	52.92 ± 3.71	41.68 ± 4.15	47.70 ± 3.51	67.98 ± 3.53	1015.44 ± 1.92	9.13 ± 0.72

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. BOMA sampled for metals and hexavalent chromium only. Table 13-2 presents the pollutants that failed at least one screen at BOMA

The following observations are shown in Table 13-2:

- A total of 93 measured concentrations failed screens.
- The screening process for BOMA resulted in five pollutants of interest: arsenic (48), nickel (25), manganese (9), and hexavalent chromium (8).
- The percent of measured detections failing screens ranged from five percent (cadmium) to 86 percent (arsenic).

Table 13-2. Comparison of Measured Concentrations and EPA Screening Values for the Massachusetts Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Boston, Massachusetts – BOMA					
Arsenic (PM_{10})	48	56	85.71	51.61	51.61
Nickel (PM_{10})	25	56	44.64	26.88	78.49
Manganese (PM_{10})	9	56	16.07	9.68	88.17
Hexavalent Chromium	8	54	14.81	8.60	96.77
Cadmium (PM_{10})	3	56	5.36	3.23	100.00
Total	93	278	33.45		

13.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there are at least seven measured detections within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the

average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 13-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 13-3:

- Among the daily averages for BOMA, manganese had the highest concentration by mass (3.67 ± 0.46 ng/m^3), followed by nickel (2.39 ± 0.35 ng/m^3).
- The other two pollutants were at least an order of magnitude less than these two pollutants.
- The seasonal averages of nickel appeared to vary the most, but the difference was not statistically significant.

13.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for BOMA was evaluated using ATSDR acute and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. Of the five pollutants with at least one failed screen, none exceeded either the acute or intermediate risk values.

13.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

Table 13-3. Daily and Seasonal Averages for the Pollutants of Interest for the Massachusetts Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Boston, Massachusetts – BOMA												
Arsenic (PM_{10})	56	56	0.55	0.11	0.50	0.16	0.49	0.17	0.73	0.37	0.53	0.15
Hexavalent Chromium	54	61	0.06	0.01	0.04	0.02	0.05	0.02	0.06	0.02	0.05	0.04
Manganese (PM_{10})	56	56	3.67	0.46	3.63	0.85	3.93	1.06	3.12	0.77	3.86	0.79
Nickel (PM_{10})	56	56	2.39	0.35	3.43	0.82	2.38	0.59	1.49	0.21	1.89	0.32

13.4.1 Pearson Correlation Analysis

Table 13-4 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the BOMA monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 13-4:

- Most of the correlations were weak.
- Nickel exhibited a strong negative correlation with average temperature, indicating that nickel concentrations tend to decrease with increasing temperature.
- Arsenic exhibited a strong negative correlation with scalar wind speed, which indicates that increasing wind speeds result in decreasing arsenic concentrations.
- All of the correlations with scalar wind speed were negative, which indicates that increasing wind speeds result in decreasing concentrations of the pollutants of interest.

13.4.2 Composite Back Trajectory Analysis

Figure 13-3 is a composite back trajectory map for the BOMA monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 13-3 represents 100 miles.

The following observations can be made from Figure 13-3:

- Back trajectories originated from a variety of directions at BOMA.
- The 24-hour airshed domain was large at BOMA, with trajectories originating as far away as the Northern Quebec, Canada (> 700 miles).
- 63 percent of the trajectories originated within 400 miles of the site.

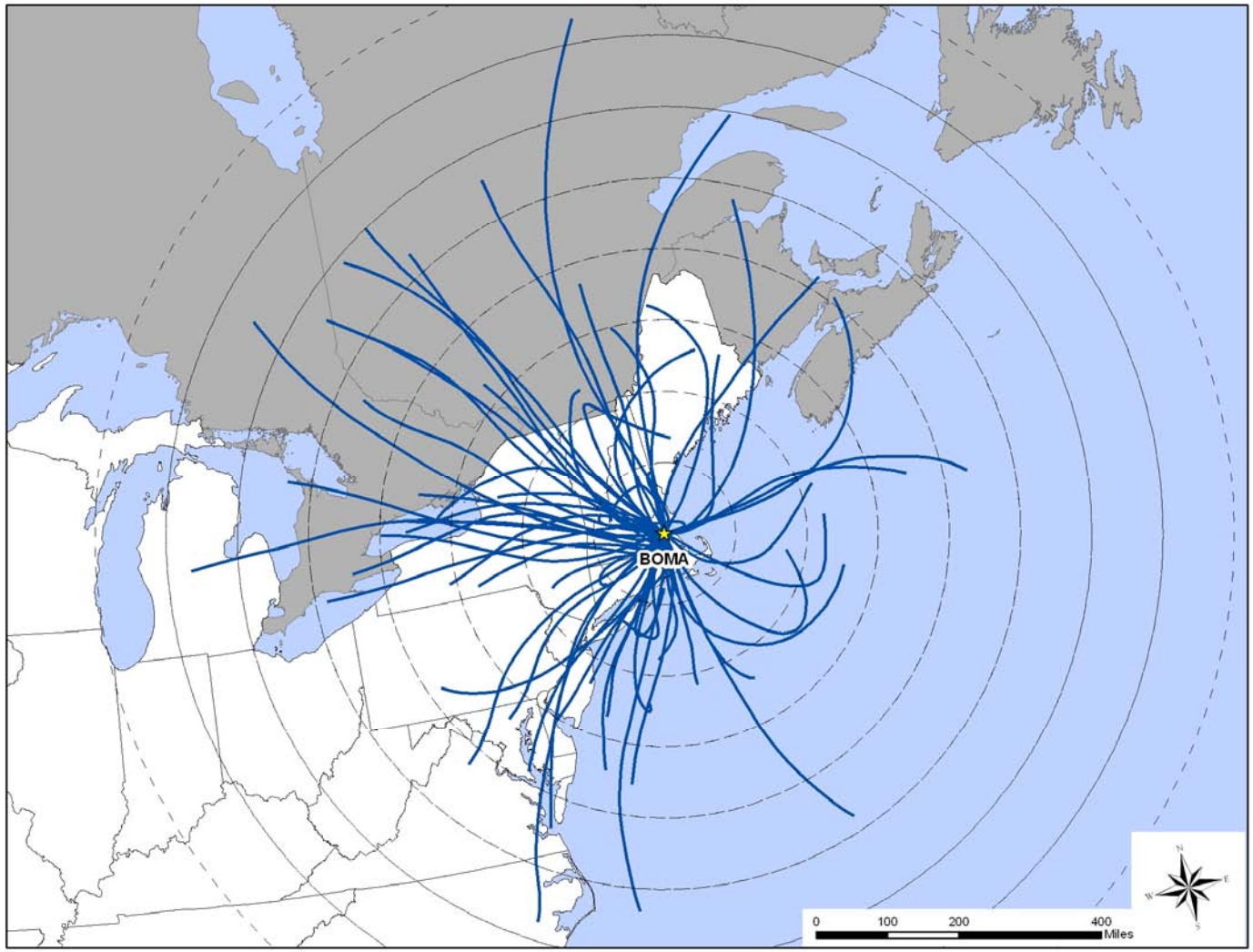
13.4.3 Wind Rose Analysis

Hourly wind data from the Logan International Airport near the BOMA monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions

Table 13-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Massachusetts Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Boston, Massachusetts – BOMA								
Arsenic (PM_{10})	56	0.34	0.27	0.28	0.28	0.10	0.11	-0.50
Hexavalent Chromium	54	0.06	0.09	0.18	0.14	0.29	0.02	-0.16
Manganese (PM_{10})	56	0.12	0.03	-0.10	-0.04	-0.33	0.26	-0.34
Nickel (PM_{10})	56	-0.47	-0.51	-0.43	-0.49	0.04	0.33	-0.38

Figure 13-3. Composite Back Trajectory Map for BOMA



about a 16-point compass, and uses different shading to represent wind speeds. Figure 13-4 is the wind rose for the BOMA monitoring site on days that sampling occurred.

Observations from Figure 13-4 include:

- Hourly winds were predominantly out of the west (12 percent of observations), south-southwest (12 percent), and southwest (11 percent) on sampling days.
- Winds tended to be breezier at BOMA than other UATMP sites.
- Wind speeds ranged from 7 to 11 knots for 47 percent of observations, and ranged from 11 to 17 knots for 23 percent of observations.
- Calm winds (<2 knots) were recorded for only 3 percent of the observations.

13.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as this site did not sample for VOC. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

13.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration was not available in Suffolk County, MA. Thus, state-level vehicle registration from the Energy Information Administration (EIA) was allocated to the county-level using the county-level population proportion. County-level population information was obtained from the U.S. Census Bureau, and is summarized in Table 13-5. Table 13-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 13-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Figure 13-4. Wind Rose for BOMA Sampling Days

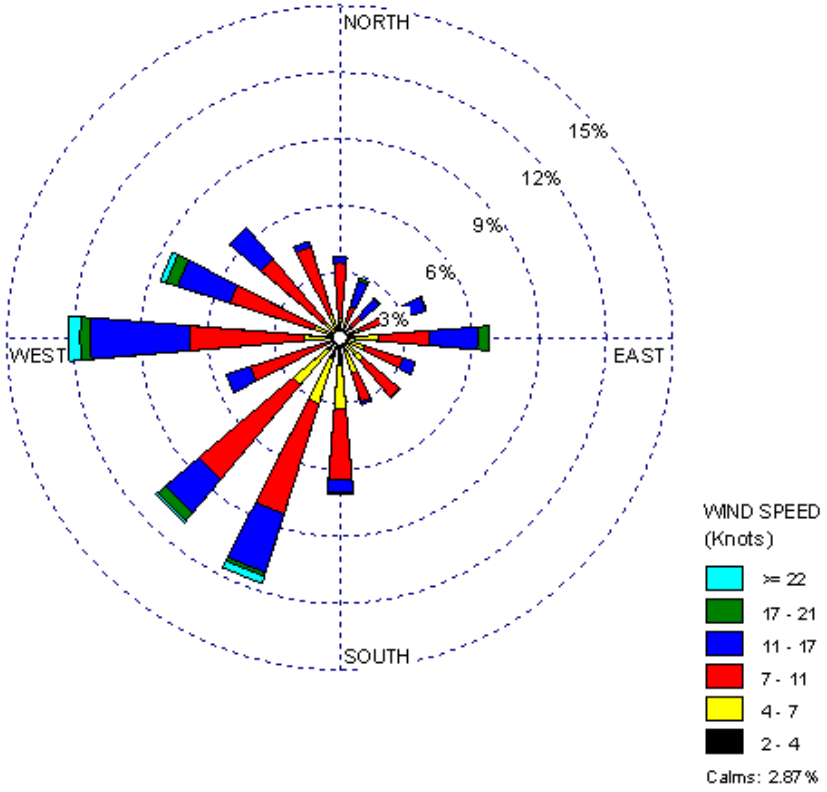


Table 13-5. Motor Vehicle Information for the Massachusetts Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
BOMA	687,610	424,907	0.62	1,562,639	965,629	27,287

Observations gleaned from Table 13-5 include:

- Compared to other UATMP sites, BOMA's county population is in the middle of the range.

- BOMA's 10-mile population is comparatively high, behind only sites in the New York City, Philadelphia, Washington, D.C., and Chicago areas. As a result, its estimated 10-mile vehicle ownership is also on the high end compared to other UATMP sites, even though the estimated county-level vehicle ownership is in the middle of the range for UATMP sites.

13.6 Trends Analysis

A trends analysis could not be performed for BOMA because this site does not sample VOC or carbonyl compounds.

13.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at BOMA and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 13-6. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA for the pollutants that failed at least one screen at BOMA were retrieved and are presented in Table 13-6. The NATA data is presented for the census tract where the monitoring site is located.

The census tract information for BOMA is as follows:

- The BOMA monitoring site is located in census tract 25025080400.

- The population for the census tract where the BOMA monitoring site is located was 723, which represents 0.1 percent of Suffolk County's population in 2000.

The following observations can be made for hexavalent chromium from Table 13-6:

- Both the NATA-modeled and annual average concentration for hexavalent chromium were less than 0.01 $\mu g/m^3$.

- In terms of cancer risk, the NATA-modeled and calculated cancer risks were very similar (0.54 and 0.61 in-a-million, respectively).

Table 13-6. Chronic Risk Summary for the Monitoring Site in Massachusetts

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Boston, Massachusetts (BOMA) – Census Tract ID 25025080400								
Arsenic*	0.0043	0.00003	0.07	0.28	<0.01	<0.01 ± <0.01	2.37	0.02
Cadmium*	0.0018	0.00002	0.03	0.05	<0.01	<0.01 ± <0.01	0.44	0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.54	<0.01	<0.01 ± <0.01	0.61	<0.01
Manganese*	NR	0.00005	0.11	NR	<0.01	<0.01 ± <0.01	NR	0.07
Nickel*	0.00016	0.000065	0.61	0.10	0.01	<0.01 ± <0.01	0.38	0.04

* Metals sampled with PM_{10} filters

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made

- Both noncancer hazard quotients for hexavalent chromium were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

The following observations can be made for metals from Table 13-6:

- The annual averages tended to be lower than the NATA-modeled concentrations, especially for nickel.
- The cancer risks based on the 2006 annual average were higher than the NATA-modeled cancer risks.
- Manganese has no cancer risk factor, so cancer risk cannot be assessed at this time.
- Noncancer risk for all of the metal pollutants of interest was very low for both the NATA and 2006 annual average based noncancer risks.

13.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 13-7 and 13-8 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 13-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 13-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 13-7:

- Unlike most UATMP counties, benzene was not the highest emitted pollutant (by mass) with a cancer risk factor in Suffolk County; formaldehyde was the most emitted pollutant.

Table 13-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for BOMA

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Suffolk County)		Top 10 Cancer Toxicity-Weighted Emissions (for Suffolk County)		Top 10 Cancer Risks Based on Annual Average Concentration (for BOMA)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Boston, Massachusetts – BOMA					
Formaldehyde	493.41	Benzene	2.44E-03	Arsenic	2.37
Benzene	312.92	1,3-Butadiene	1.24E-03	Hexavalent Chromium	0.61
Acetaldehyde	209.31	Polycyclic Organic Matter as 7-PAH	7.43E-04	Cadmium	0.44
Dichloromethane	57.44	Acetaldehyde	4.60E-04	Nickel	0.38
1,3-Butadiene	41.34	Naphthalene	4.39E-04		
Tetrachloroethylene	24.91	Polycyclic Organic Matter as 15-PAH	3.58E-04		
Naphthalene	12.90	Lead	1.83E-04		
Polycyclic Organic Matter as 7-PAH	8.62	Arsenic	1.52E-04		
Trichloroethylene	6.94	Tetrachloroethylene	1.47E-04		
Polycyclic Organic Matter as 15-PAH	6.51	Nickel	1.47E-04		

Table 13-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for BOMA

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Suffolk County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Suffolk County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for BOMA)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Boston, Massachusetts – BOMA					
Toluene	750.68	Acrolein	940,325.73	Manganese	0.07
Methyl *Tert*-Butyl Ether	620.16	Formaldehyde	50,347.56	Nickel	0.04
Xylenes	586.59	Acetaldehyde	23,257.08	Arsenic	0.02
Formaldehyde	493.41	1,3-Butadiene	20,668.04	Cadmium	0.01
Methanol	401.06	Nickel	14,092.82	Hexavalent Chromium	<0.01
Benzene	312.92	Benzene	10,430.69		
Methyl Ethyl Ketone	210.80	Cyanide	8,719.15		
Acetaldehyde	209.31	Xylenes	5,865.88		
Methyl Isobutyl Ketone	146.16	Naphthalene	4,299.58		
Ethylene Glycol	123.10	Glycol Ethers	2,624.15		

- Benzene did have the highest cancer toxicity-weighted emissions.

- Neither hexavalent chromium nor metals were among the highest emitted pollutants in Suffolk County.

- Lead, arsenic, and nickel had some of the highest cancer toxicity-weighted emissions.

- Only arsenic had an annual average-based cancer risk greater than 1 in-a-million (2.37).

The following observations can be made from Table 13-8:

- Although toluene was the highest emitted pollutant with a noncancer risk factor, it did not rank in the top 10 pollutants based on toxicity-weighted emissions.

- Acrolein had the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants.

- Nickel was the only pollutant that failed screens at BOMA and had one of the top 10 highest noncancer toxicity-weighted emissions.

- The noncancer HQ for nickel based on the annual average at BOMA was very low (0.04).

Massachusetts Pollutant Summary

- *The pollutants of interest at the Massachusetts site were arsenic, manganese, nickel, and hexavalent chromium.*

- *Manganese had the highest daily average at BOMA.*

- *None of the pollutants of interest exceeded the acute or intermediate risk factors.*

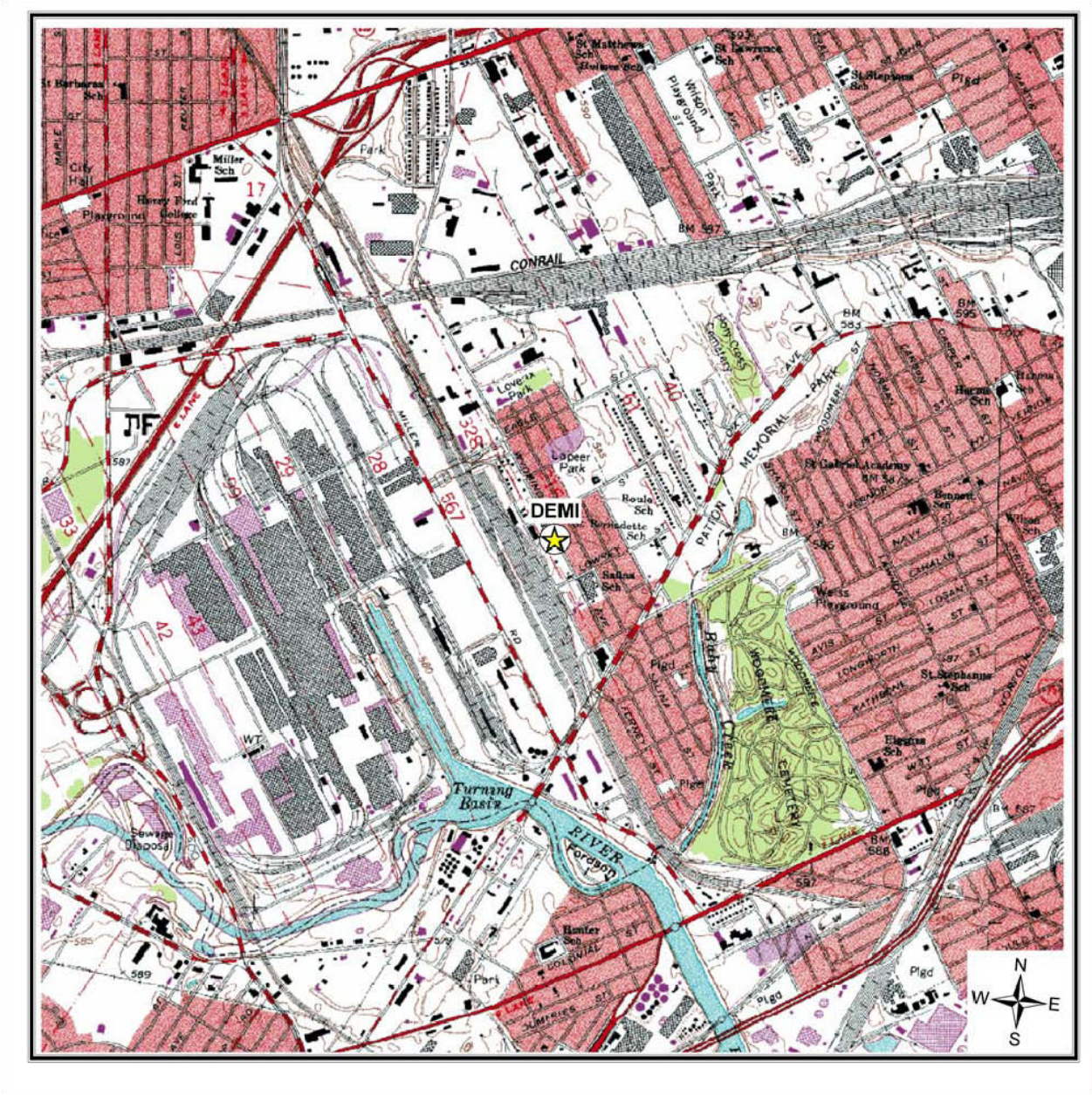
14.0 Sites in Michigan

This section presents meteorological, concentration, and spatial trends for the two UATMP sites in Michigan. The DEMI site is located in the Detroit area, while the ITCMI site is in Sault Saint Marie on the Upper Peninsula. Figures 14-1 and 14-2 are topographical maps showing the monitoring sites in their urban locations. Figures 14-3 and 14-4 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. A number of point sources surround DEMI, several of which are located just south of the site. Most of these point sources are involved in fuel combustion or waste treatment and disposal processes. All of the industrial facilities within 10 miles of ITCMI are involved in waste treatment and disposal.

The Detroit area is located in the Great Lakes region, where storm systems frequently track across the region. Winters tend to be cold and wet, while summers are generally mild. The urbanization of the area along with Lake St. Clair to the east are two major influences on the city's weather. The lake tends to keep Detroit warmer in the winter and cooler in the summer than more inland areas. The urban heat island keeps the city warmer than outlying areas. Winds are often breezy and generally flow from the southwest on average. Sault Saint Marie is located on the northeast edge of Michigan's Upper Peninsula. While this area also experiences an active weather pattern, its climate is somewhat tempered by the surrounding waters of Lakes Superior and Huron, as the city resides on the channel between the two lakes. This location experiences ample precipitation, especially during lake-effect snow events (Ruffner and Bair, 1987).

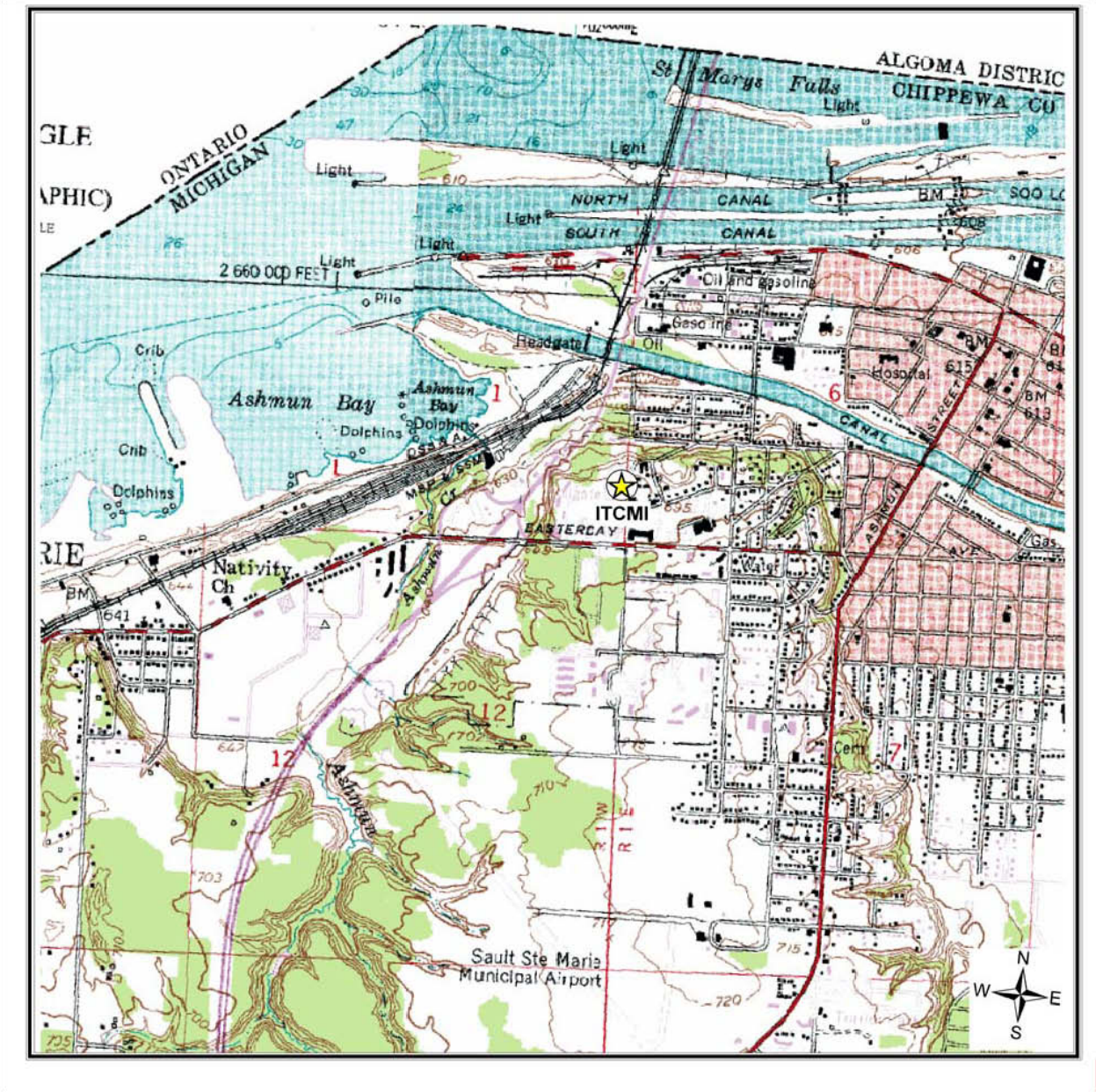
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather stations closest to the Michigan monitoring sites are Detroit-Metropolitan Airport and Sault Ste. Marie International Airport, WBAN 94847 and 14847, respectively.

Figure 14-1. Detroit, Michigan (DEMI) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 14-2. Sault Saint Marie, Michigan (ITCMI) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 14-3. Facilities Located Within 10 Miles of DEMI

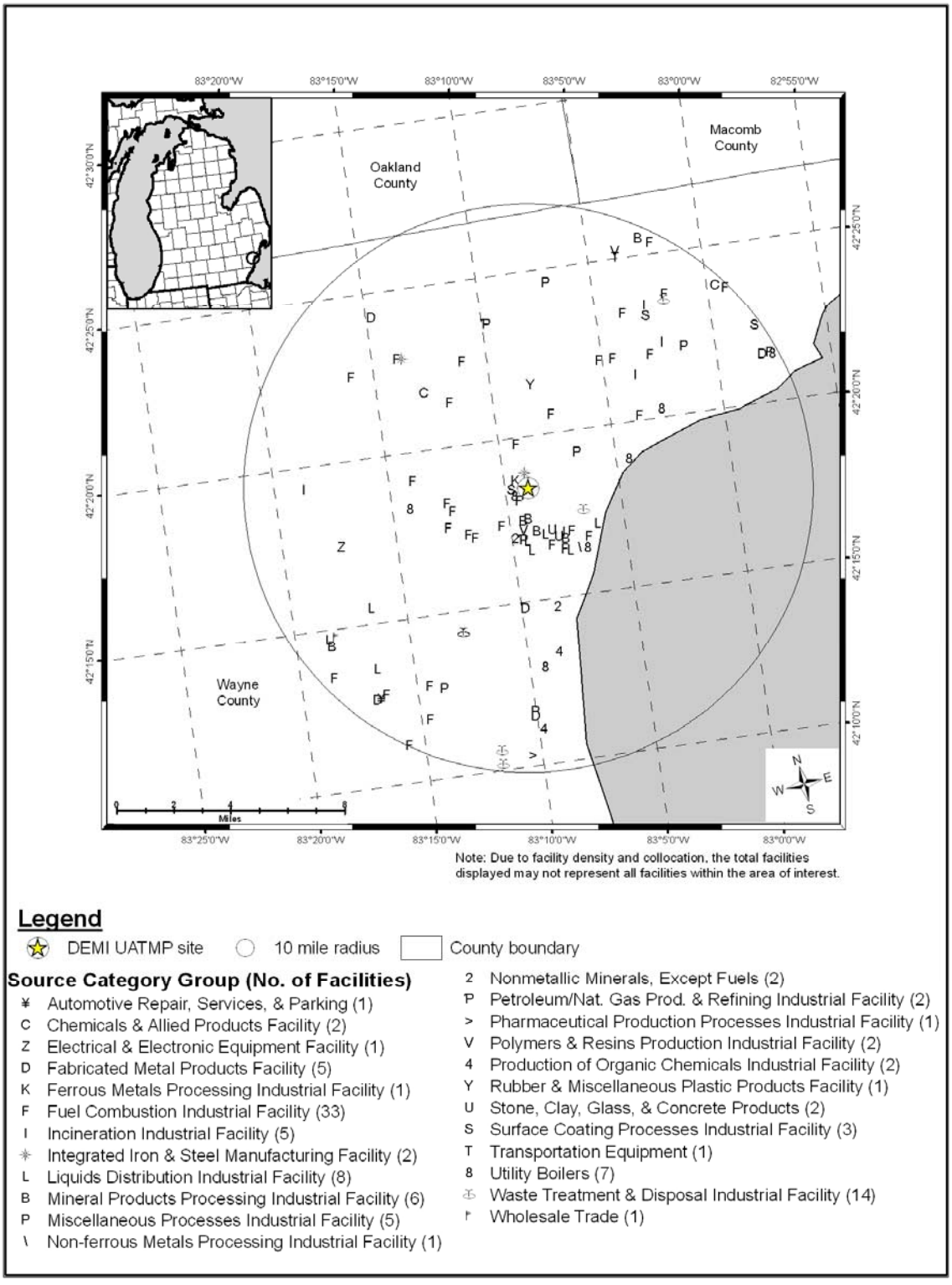


Figure 14-4. Facilities Located Within 10 Miles of ITCMI

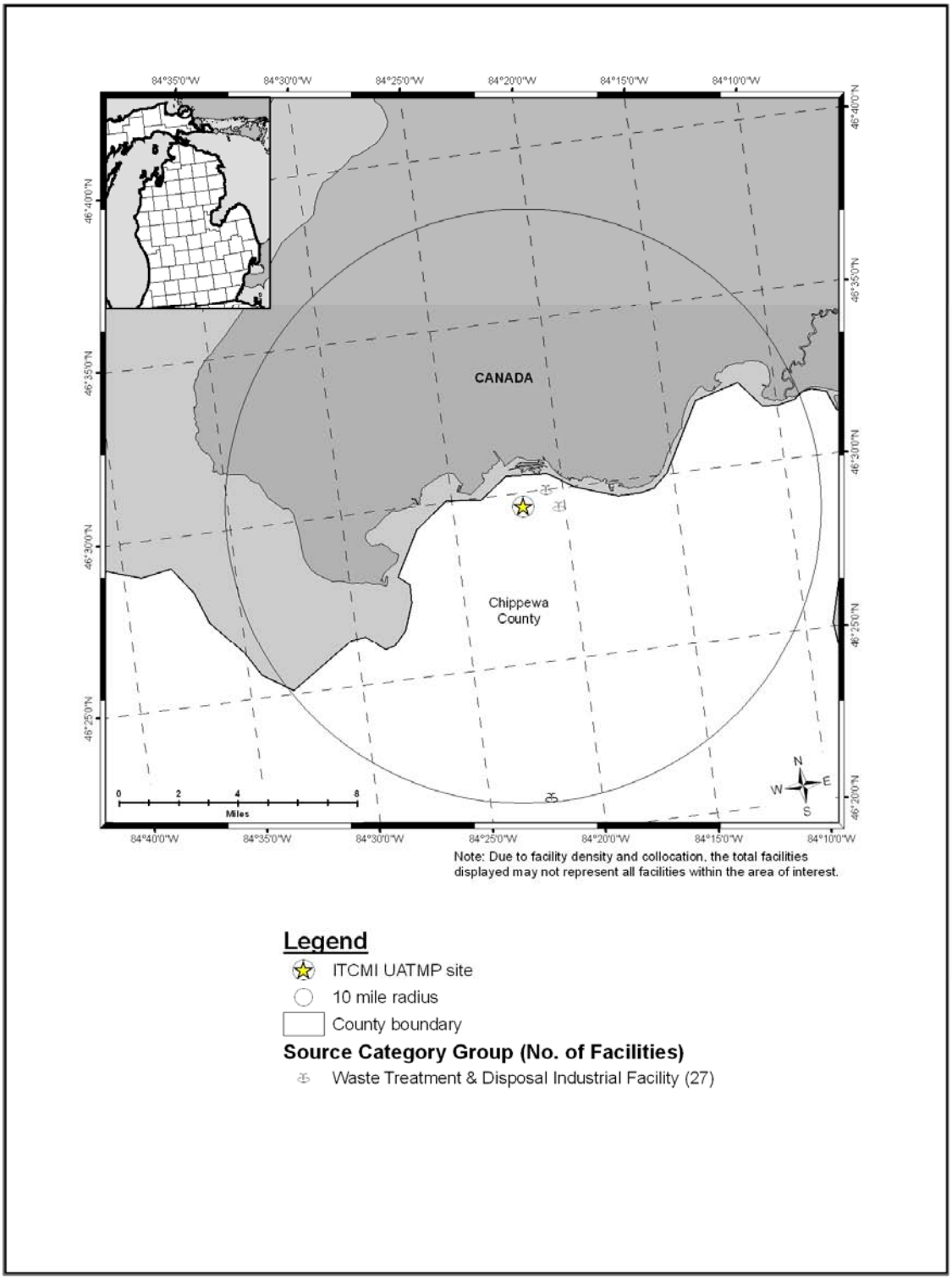


Table 14-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average seal level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 14-1 is the 95 percent confidence interval for each parameter. As shown in Table 14-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year at both DEMI and ITCMI.

14.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. DEMI sampled for carbonyl compounds, hexavalent chromium, and VOC, while ITCMI sampled only for SVOC. Table 14-2 presents the pollutants that failed at least one screen at the Michigan monitoring sites.

The following observations are shown in Table 14-2:

- Sixteen pollutants with a total of 431 measured concentrations failed screens at DEMI; 1 pollutant with one measured concentration failed screens at ITCMI.
- Carbon tetrachloride, benzene, formaldehyde, acetaldehyde, 1-3 butadiene, tetrachloroethylene, acrolein, *p*-dichlorobenzene, and hexavalent chromium contributed to the top 95 percent of the total failed screens at the DEMI monitoring site.
- Only benzo(a)pyrene failed screens at ITCMI.
- Of the nine pollutants of interest for DEMI, acrolein, 1,3-butadiene, benzene, and carbon tetrachloride had 100 percent of their measured detections fail the screening values.

Table 14-1. Average Meteorological Conditions near the Monitoring Sites in Michigan

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
DEMI	94847	All 2006	59.95 ± 1.84	52.16 ± 1.70	41.01 ± 1.67	46.73 ± 1.54	68.35 ± 1.23	1016.00 ± 0.74	7.65 ± 0.32
		Sampling Day	61.05 ± 4.31	52.63 ± 3.96	41.57 ± 3.75	47.15 ± 3.50	69.12 ± 3.22	1015.41 ± 1.69	7.39 ± 0.72
ITCMI	14847	All 2006	51.68 ± 2.03	43.92 ± 1.78	35.87 ± 1.66	40.23 ± 1.61	75.99 ± 1.21	1014.46 ± 0.80	6.46 ± 0.28
		Sampling Day	52.23 ± 4.84	44.65 ±4.19	36.32 ± 3.96	40.83 ± 3.81	75.19 ± 3.09	1014.62 ± 1.47	6.44 ± 0.69

Table 14-2. Comparison of Measured Concentrations and EPA Screening Values for the Michigan Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Dearborn in Detroit, Michigan – DEMI					
Carbon Tetrachloride	58	58	100.00	13.46	13.46
Benzene	58	58	100.00	13.46	26.91
Formaldehyde	58	60	96.67	13.46	40.37
Acetaldehyde	58	60	96.67	13.46	53.83
1,3-Butadiene	53	53	100.00	12.30	66.13
Tetrachloroethylene	51	55	92.73	11.83	77.96
Acrolein	47	47	100.00	10.90	88.86
p-Dichlorobenzene	18	49	36.73	4.18	93.04
Hexavalent Chromium	13	55	23.64	3.02	96.06
Hexachloro-1,3-butadiene	5	5	100.00	1.16	97.22
Dichloromethane	4	57	7.02	0.93	98.14
1,2-Dichloroethane	3	3	100.00	0.70	98.84
Acrylonitrile	2	2	100.00	0.46	99.30
Vinyl chloride	1	5	20.00	0.23	99.54
Xylenes	1	58	1.72	0.23	99.77
Trichloroethylene	1	23	4.35	0.23	100.00
Total	431	648	66.51		
Intertribal Council, Sault Sainte Marie, Michigan – ITCMI					
Benzo (a) pyrene	1	51	1.96	100.00	100.00
Total	1	51	1.96		

14.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there are at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are

presented in Table 14-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 14-3:

- Formaldehyde had the highest concentration by mass (2.91 ± 0.36 μg/m^3), followed by acetaldehyde (1.65 ± 0.21 μg/m^3), and benzene (1.25 ± 0.21 μg/m^3).
- Most of the seasonal averages did not vary significantly, although formaldehyde's summer average was significantly higher than any other summer average.
- Trichloroethylene's summer average had a very large confidence interval, indicating that this average was likely influenced by outliers.
- At ITCMI, the daily average for benzo(a)pyrene was 1.555 ± 0.053 ng/m^3.

14.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for Michigan monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short term MRL and REL factors, as well as to compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein, which was sampled at DEMI, exceeded either the acute and intermediate risk values. DEMI's non-chronic risk is summarized in Table 14-4.

The following observations about acrolein are shown in Table 14-4:

- All 47 acrolein measured detections at the DEMI site were greater than the ATSDR acute value of 0.11 μg/m^3 and 43 were greater than the California REL value of 0.19 μg/m^3.
- All four seasonal averages of acrolein exceeded the intermediate MRL (0.09 μg/m^3).

Table 14-3. Daily and Seasonal Averages for the Pollutants of Interest for the Michigan Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Dearborn in Detroit, Michigan – DEMI												
Acetaldehyde	60	60	1.65	0.21	1.26	0.19	2.08	0.60	1.88	0.22	1.38	0.40
Acrolein	47	58	0.53	0.14	0.51	0.40	0.33	0.10	0.46	0.13	0.51	0.14
Benzene	58	58	1.25	0.21	1.17	0.32	1.07	0.21	1.25	0.45	1.51	0.58
1,3-Butadiene	53	58	0.13	0.04	0.14	0.04	0.07	0.03	0.13	0.13	0.15	0.07
Carbon Tetrachloride	58	58	0.67	0.05	0.58	0.07	0.61	0.06	0.76	0.13	0.73	0.08
p-Dichlorobenzene	49	58	0.11	0.03	0.07	0.03	0.07	0.02	0.13	0.08	0.13	0.04
Formaldehyde	60	60	2.91	0.36	1.99	0.37	3.26	0.74	4.10	0.58	2.29	0.57
Hexavalent Chromium	55	59	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tetrachloroethylene	55	58	0.90	0.46	0.60	0.21	0.82	0.31	1.50	1.71	0.55	0.15
Sault Sainte Marie, Michigan – ITCMI												
Benzo (a) pyrene	51	60	1.55E-04	5.30E-05	1.94E-04	1.39E-04	1.10E-04	4.63E-05	6.72E-05	4.56E-05	1.51E-04	9.06E-05

Table 14-4. Non-Chronic Risk Summary for the Michigan Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate -term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
DEMI	TO-15	Acrolein	0.53 ± 0.14	0.11	47	0.19	43	0.09	0.51 ± 0.40	0.33 ± 0.10	0.46 ± 0.13	0.51 ± 0.14

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. Figure 14-5 presents the pollution rose for acrolein for DEMI.

Observations gleaned from the acrolein pollution rose include:

- All of the acrolein concentrations exceeded the ATSDR MRL acute risk factor, which is indicated by a solid line.
- All but four acrolein concentrations exceeded the California EPA REL acute risk factor, indicated by the dashed line.
- The concentrations exceeding acute risk factors occurred with winds originating from a variety of directions, a pattern characteristic of mobile sources.
- The DEMI site is located in a suburban, yet industrial area, and is surrounded by many railways and major interstates. I-94 is located to the west and north and I-75 is located to the south and east of the site. Major auto and steel manufacturers are located in close proximity to the site.

14.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

14.4.1 Pearson Correlation Analysis

Table 14-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Michigan monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for DEMI from Table 14-5:

- Formaldehyde exhibited strong correlations with maximum, average, dew point, and wet bulb temperatures. This indicates that as temperature and moisture content increase, formaldehyde concentrations also increase.

Figure 14-5. Acrolein Pollution Rose for DEMI

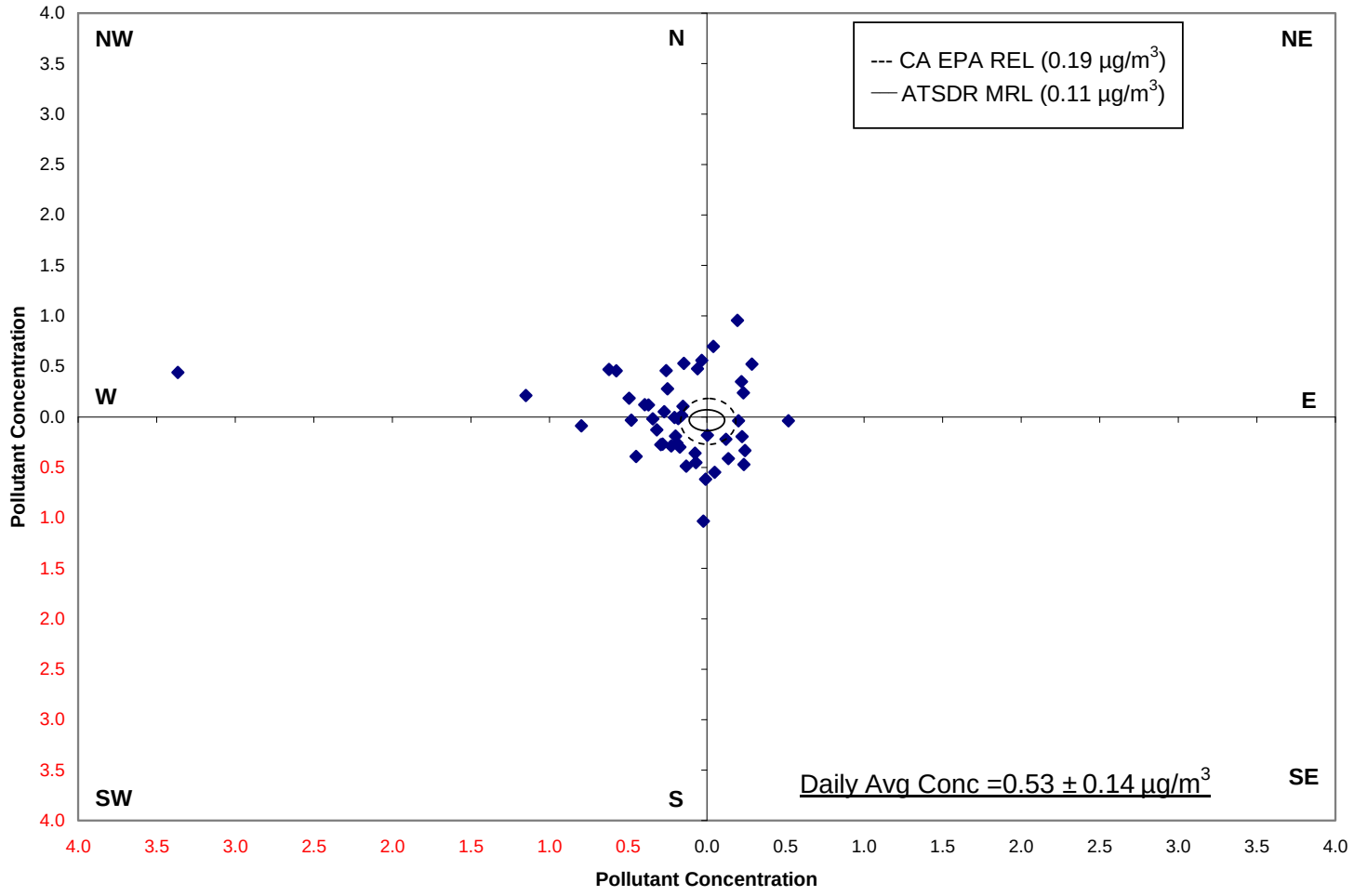


Table 14-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Michigan Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Dearborn in Detroit, Michigan – DEMI								
1,3-Butadiene	53	0.04	0.00	0.00	-0.01	0.02	0.11	-0.23
Acetaldehyde	60	0.43	0.37	0.29	0.33	-0.24	0.11	-0.37
Acrolein	47	-0.15	-0.13	-0.14	-0.14	-0.01	0.11	-0.06
Benzene	58	0.04	0.00	0.04	0.01	0.12	0.16	-0.38
Carbon Tetrachloride	58	0.29	0.35	0.38	0.37	0.04	-0.07	0.00
p-Dichlorobenzene	49	0.06	0.01	0.04	0.02	0.06	0.21	-0.31
Formaldehyde	60	0.69	0.65	0.52	0.59	-0.38	0.12	-0.30
Hexavalent Chromium	55	0.18	0.19	0.22	0.20	0.10	0.01	-0.22
Tetrachloroethylene	55	0.23	0.22	0.17	0.19	-0.16	0.05	-0.06
Sault St. Marie, Michigan – ITCMI								
Benzo (a) pyrene	51	-0.25	-0.30	-0.31	-0.31	-0.06	0.20	-0.02

- Though generally weak, all of the correlations with the scalar wind speed were negative, indicating that as wind speeds decrease, concentrations of the pollutants of interest at DEMI increase.

The following observations are gathered for ITCMI from Table 14-5:

- The correlations with benzo(a)pyrene were weak.

14.4.2 Composite Back Trajectory Analysis

Figures 14-6 and 14-7 are composite back trajectory maps for the Michigan monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

The following observations can be made from Figure 14-6 for DEMI:

- Back trajectories originated from a variety of directions at DEMI.
- The 24-hour airshed domain was large, with trajectories originating as far away as North Dakota, or over 700 miles away.
- 61 percent of the trajectories originated within 300 miles of the site; and 71 percent within 400 miles from the DEMI monitoring site.

The following observations can be made from Figure 14-7 for ITCMI:

- Back trajectories originated from a variety of directions at ITCMI, although less frequently from the east and southeast.
- The 24-hour airshed domain was large, with trajectories originating as far away as North Dakota, over 700 miles away.
- The majority of the trajectories originated over 300 miles away from the site.

Figure 14-6. Composite Back Trajectory Map for DEMI

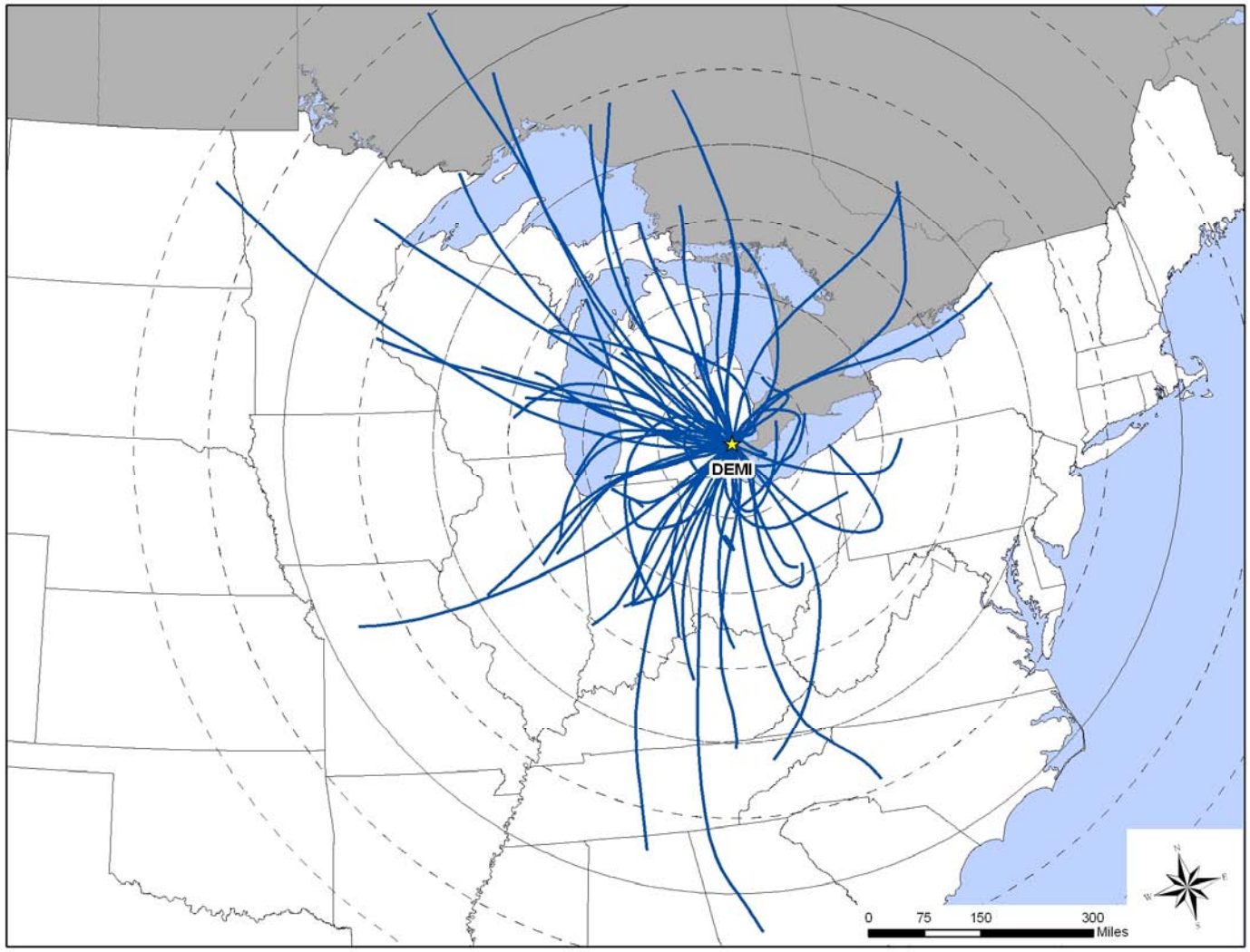
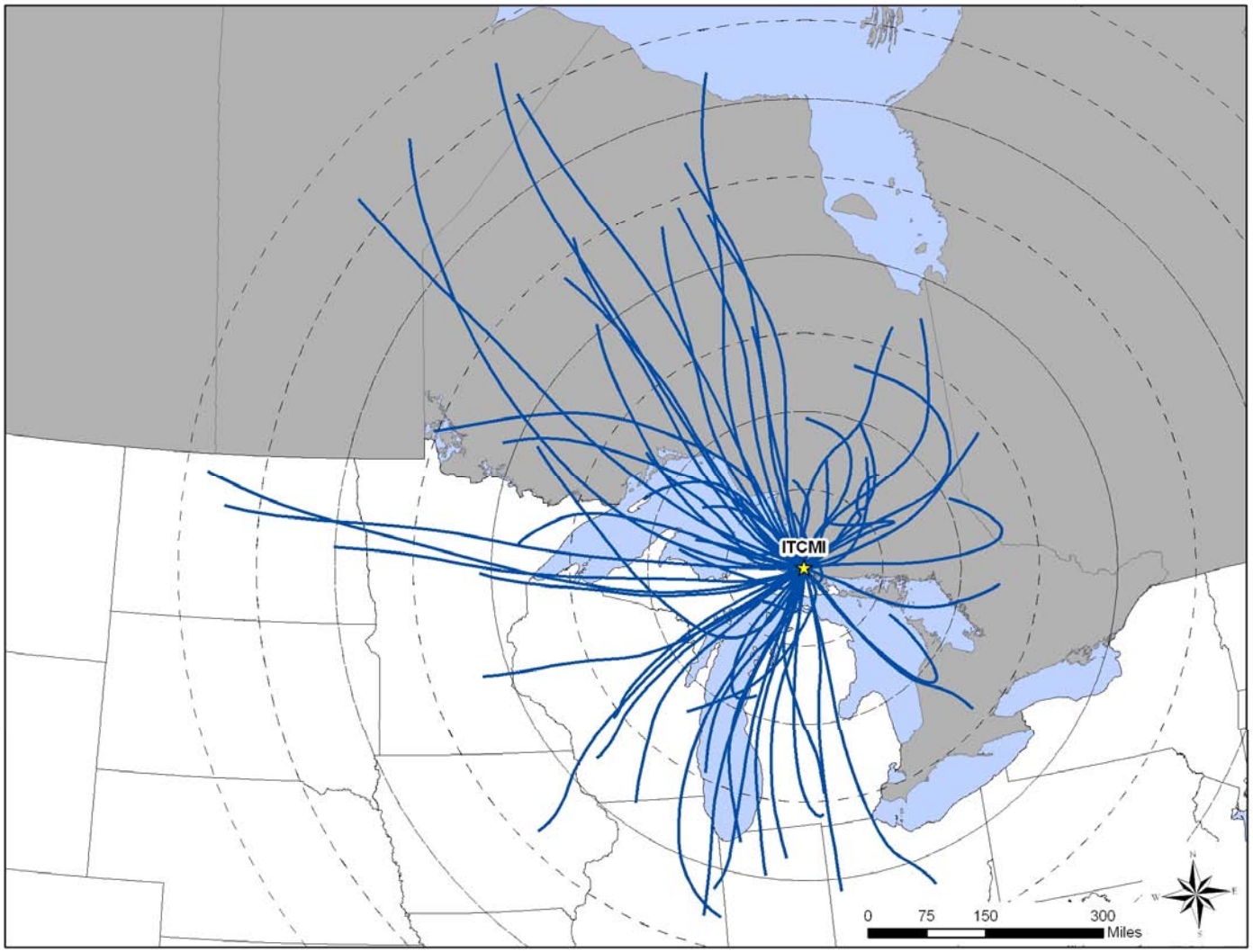


Figure 14-7. Composite Back Trajectory Map for ITCMI



14.4.3 Wind Rose Analysis

Hourly wind data from the weather stations nearest DEMI and ITCMI were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 14-8 through 14-9 are the wind roses for the Michigan monitoring sites on days that sampling occurred

Observations from Figure 14-8 for DEMI include:

- Hourly winds near DEMI originated from all directions.
- The most frequently measured wind directions were southerly, westerly, and west-north westerly (9 percent, 8 percent, and 8 percent, respectively).
- Calm winds were recorded for 10 percent of the hourly observations.
- For wind speeds greater than 2 knots, observations most often ranged from 7 to 11 knots.
- Wind speeds greater than 22 knots were most frequently recorded with southerly to westerly wind directions.

Observations from Figure 14-9 for ITCMI include:

- Hourly winds near ITCMI originated predominantly from the west-northwest (13 percent of the hourly observations), northwest (10 percent), west (8 percent), and east (8 percent).
- Calm winds were recorded for 14 percent of the hourly measurements.
- For wind speeds greater than 2 knots, observations most often ranged from 7 to 11 knots.
- Stronger winds (11-17 knots) were most frequently observed from the west-northwest and northwest.

Figure 14-8. Wind Rose for DEMI Sampling Days

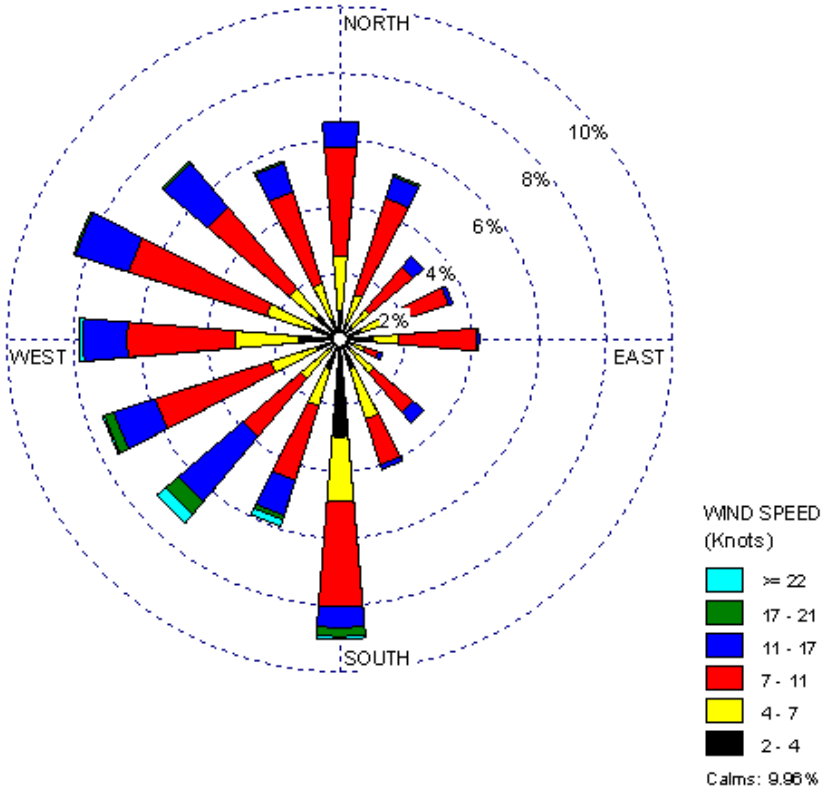
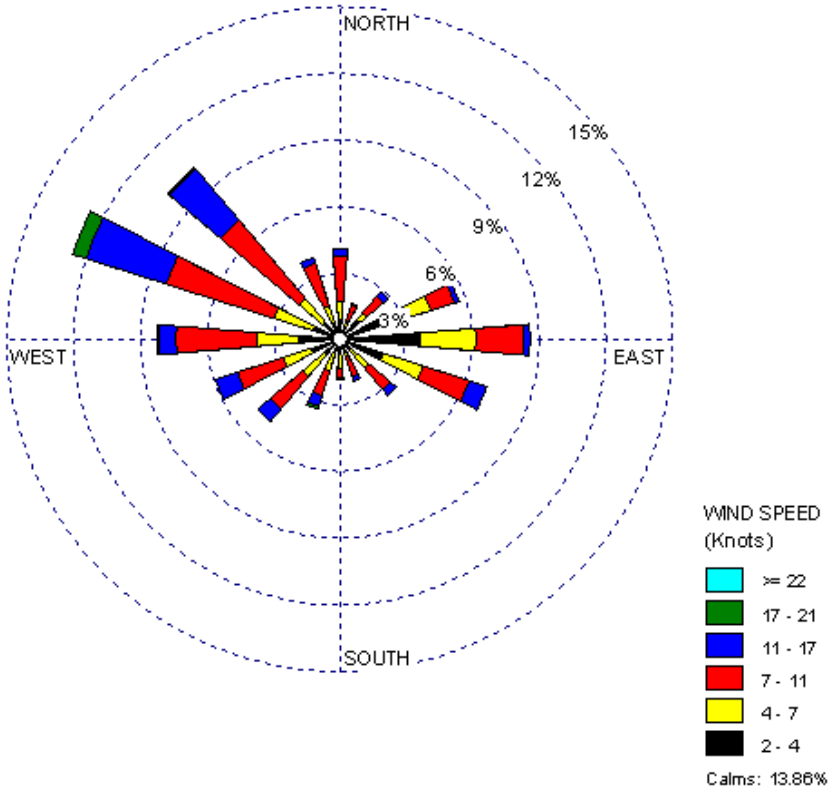


Figure 14-9. Wind Rose for ITCMI Sampling Days



14.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

14.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Chippewa County and Wayne County, Michigan, were obtained from the Michigan Department of State and the U.S. Census Bureau, and are summarized in Table 14-6. Table 14-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 14-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 14-6 include:

- The DEMI site is located in Wayne County, and ITCMI is located in Chippewa County.
- Wayne County has significantly more residents and registered vehicles than Chippewa County.
- Wayne County has the fourth highest population and ninth highest vehicle registration of all the UATMP sites.
- Although DEMI has a higher estimated vehicle ownership within a 10-mile radius than ITCMI, the ITCMI site has a higher daily traffic volume.
- The ITCMI monitoring site has the third highest traffic volume of all the UATMP sites.

14.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-

Table 14-6. Motor Vehicle Information for the Michigan Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
DEMI	1,971,853	1,423,637	0.72	1,167,257	842,735	12,791
ITCMI	38,674	33,580	0.87	21,916	19,029	100,000

urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle emissions.

The BTEX figure and table show the following:

- Similar to the roadside study, the toluene-ethylbenzene ratio was the highest ratio for DEMI.
- But unlike the roadside study, the benzene-ethylbenzene ratio (4.92 ± 0.52) was higher than the xylenes-ethylbenzene ratio (3.77 ± 0.20).
- ITCMI did not sample VOC.

14.6 Trends Analysis

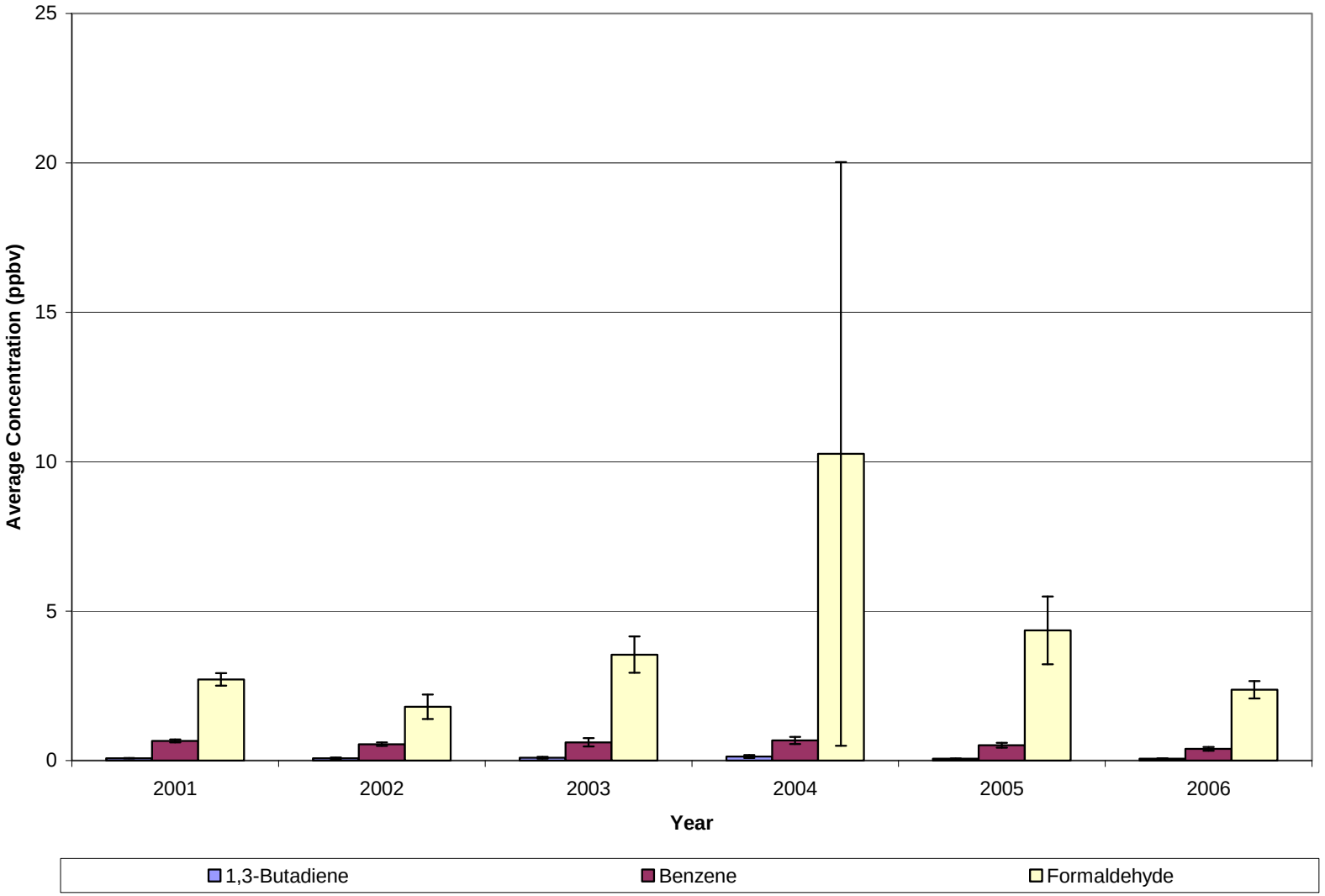
For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. DEMI is the only site with sufficient data to conduct a trends analysis. The DEMI monitoring site has consistently sampled VOC and carbonyls since 2001, as shown in Figure 14-10.

- After an initial decrease in formaldehyde concentrations in 2002, formaldehyde concentrations increased in 2003. The high 2004 formaldehyde concentration was probably influenced by outliers, as indicated by the confidence interval represented by error bars. The average formaldehyde concentration decreased in 2006 from 2005.
- Concentrations of 1,3-butadiene and benzene have been fairly consistent throughout the period.

14.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Michigan sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer

Figure 14-10. Comparison of Yearly Averages for the DEMI Monitoring Site



and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 14-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 14-7. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the Michigan sites is as follows:

- The census tract for DEMI is 26163573500, which had a population of 5,214 and represents approximately 0.3 percent of the Wayne County population in 2000.

- The census tract for ITCMI is 26033970300, which had a population of 3,744, and represents approximately 10 percent of the county population in 2000.

The following observations can be made for DEMI from Table 14-7:

- The pollutants with the top 3 annual averages by mass concentration at DEMI were formaldehyde (2.91 ± 0.36 μg/m^3), xylenes (2.65 ± 0.53 μg/m^3), and acetaldehyde (1.65 ± 0.21 μg/m^3).

- The pollutants with the highest cancer risks were not these pollutants. The highest theoretical cancer risks for DEMI were calculated for carbon tetrachloride (10.04 in-a-million), benzene (9.77), and tetrachloroethylene (5.05).

- According to the 1999 NATA, benzene (29.55 in-a-million), 1,3-butadiene (10.06), and acetaldehyde (5.72) had the highest cancer risk for pollutants that failed screens at DEMI.

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1, according to both the 2006 annual average for DEMI (22.68) and the 1999 NATA (9.52). All other noncancer HQs were less than 0.40

The following observations can be made for ITCMI from Table 14-7:

- Benzo(a)pyrene was the only pollutant to fail screens at ITCMI. This pollutant has no noncancer risk factor; therefore, noncancer risk cannot be assessed.

- The NATA-modeled concentration and the annual average for benzo(a)pyrene were both less than 0.01 μg/m^3.

- Cancer risk was low for both the NATA-modeled and the annual average-based risk.

Table 14-7. Chronic Risk Summary for the Monitoring Sites in Michigan

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Dearborn, Michigan (DEMI) – Census Tract ID 26163573500								
Acetaldehyde	0.0000022	0.009	2.60	5.72	0.29	1.65 ± 0.21	3.63	0.18
Acrolein	NR	0.00002	0.19	NR	9.52	0.45 ± 0.12	NR	22.68
Acrylonitrile	0.000068	0.002	<0.01	0.26	<0.01	0.07 ± 0.01	4.80	0.04
Benzene	0.0000078	0.03	3.79	29.55	0.13	1.25 ± 0.21	9.77	0.04
1,3-Butadiene	0.00003	0.002	0.34	10.06	0.17	0.12 ± 0.04	3.71	0.06
Carbon Tetrachloride	0.000015	0.04	0.21	3.14	0.01	0.67 ± 0.05	10.04	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.08	0.92	<0.01	0.10 ± 0.03	1.10	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	1.07	<0.01	0.09 ± 0.11	2.40	<0.01
Dichloromethane	0.00000047	1	0.69	0.33	<0.01	0.55 ± 0.19	0.26	<0.01
Formaldehyde	5.5E-09	0.0098	2.58	0.01	0.26	2.91 ± 0.36	0.02	0.30
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.09 ± 0.02	1.92	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	1.65	<0.01	<0.01 ± <0.01	0.82	<0.01
Tetrachloroethylene	0.0000059	0.27	0.37	2.16	<0.01	0.86 ± 0.43	5.05	<0.01
Trichloroethylene	0.000002	0.6	0.11	0.21	<0.01	0.13 ± 0.14	0.26	<0.01
Vinyl chloride	0.0000088	0.1	0.07	0.62	<0.01	0.04 ± 0.05	0.34	<0.01
Xylenes		0.1	6.69	NR	0.07	2.65 ± 0.53	NR	0.03
Sault Ste. Marie, Michigan (ITCMI) – Census Tract ID 26033970300								
Benzo (a) pyrene	0.001	NR	<0.01	0.07	NR	<0.01 ± <0.01	0.13	NR

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

14.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 14-8 and 14-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 14-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 14-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. DEMI sampled for VOC, hexavalent chromium, and carbonyl compounds; ITCMI sampled for SVOC only. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made for DEMI from Table 14-8:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor, had second highest cancer toxicity-weighted emissions, and had the second highest cancer risk based on the 2006 annual average for DEMI.

- Coke oven emissions had the highest cancer toxicity-weighted emissions in Wayne County, but its total emissions were not in the top 10.

- Carbon tetrachloride had the highest cancer risk based on the 2006 annual average for this site, yet this pollutant was neither one of the highest emitted nor one of the most toxic based on the 2002 NEI emission inventory.

- Benzene, tetrachloroethylene, and 1,3-butadiene were shown on all three "top 10" lists.

The following observations can be made for ITCMI from Table 14-8:

- Similar to Wayne County, benzene was the highest emitted pollutant with a cancer risk factor in Chippewa County.

Table 14-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Michigan

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Detroit, Michigan (DEMI) – Wayne County					
Benzene	1,901.76	Coke Oven Emissions	2.50E-02	Carbon Tetrachloride	10.04
Formaldehyde	740.64	Benzene	1.48E-02	Benzene	9.77
Tetrachloroethylene	388.05	1,3-Butadiene	5.76E-03	Tetrachloroethylene	5.05
Dichloromethane	290.39	Quinoline	4.83E-03	Acrylonitrile	4.80
Acetaldehyde	272.58	Polycyclic Organic Matter as 7-PAH	4.25E-03	1,3-Butadiene	3.71
1,3-Butadiene	192.12	Naphthalene	3.85E-03	Acetaldehyde	3.63
1,3-Dichloropropene	147.66	Cadmium	3.16E-03	1,2-Dichloroethane	2.40
Naphthalene	113.19	Tetrachloroethylene	2.29E-03	Hexachloro-1,3-butadiene	1.92
p-Dichlorobenzene	76.63	Lead	2.15E-03	*p*-Dichlorobenzene	1.10
Trichloroethylene	47.80	Polycyclic Organic Matter as 15-PAH	1.04E-03	Hexavalent Chromium	0.82
Sault Sainte Marie, Michigan (ITCMI) – Chippewa County					
Benzene	81.74	Benzene	6.38E-04	Benzo (a) pyrene	0.13
Formaldehyde	23.56	1,3-Butadiene	2.18E-04		
Tetrachloroethylene	18.23	Lead	1.63E-04		
Acetaldehyde	9.84	Tetrachloroethylene	1.08E-04		
1,3-Butadiene	7.28	Naphthalene	9.88E-05		
Dichloromethane	6.13	Polycyclic Organic Matter as 15-PAH	8.03E-05		
Naphthalene	2.90	Polycyclic Organic Matter as 7-PAH	5.40E-05		
1,3-Dichloropropene	2.81	Arsenic	5.30E-05		
p-Dichlorobenzene	1.50	Polycyclic Organic Matter as non-15 PAH	4.80E-05		
Polycyclic Organic Matter as 15-PAH	1.46	Acrylonitrile	4.51E-05		

Table 14-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Michigan

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Detroit, Michigan (DEMI) – Wayne County					
Toluene	4,966.63	Acrolein	2,046,078.60	Acrolein	22.68
Xylenes	3,339.72	Manganese		Formaldehyde	0.30
Benzene	1,901.76	1,3-Butadiene	96,059.90	Acetaldehyde	0.18
Hydrochloric Acid	1,627.79	Cadmium	87,737.35	1,3-Butadiene	0.06
Methanol	907.55	Hydrochloric Acid	81,389.73	Benzene	0.04
Ethylbenzene	748.25	Formaldehyde	75,575.59	Acrylonitrile	0.04
Formaldehyde	740.64	Benzene	63,391.91	Xylenes	0.03
Hexane	720.40	Bromomethane	41,215.89	Carbon Tetrachloride	0.02
Methyl Ethyl Ketone	575.03	Nickel	40,571.14	Tetrachloroethylene	<0.01
Glycol Ethers	476.52	Naphthalene	37,730.55	Hexachloro-1,3-butadiene	<0.01
Sault Sainte Marie, Michigan (ITCMI) – Chippewa County					
Toluene	324.83	Acrolein 330,598.26	70,535.51	Benzo (a) pyrene	NR
Xylenes	208.66	1,3-Butadiene	3,640.69		
Benzene	81.74	Benzene	2,724.67		
Ethylbenzene	46.52	Formaldehyde	2,404.12		
Hexane	35.65	Xylenes	2,086.61		
Formaldehyde	23.56	Acetaldehyde	1,093.23		
Tetrachloroethylene	18.23	Naphthalene	968.19		
Methanol	15.69	Cyanide	953.02		
Methyl Ethyl Ketone	11.55	Toluene	812.07		
Acetaldehyde	9.84	Bromomethane	783.24		

- Benzene also had the highest cancer toxicity-weighted emissions.

- The only SVOC to make either emissions-based top 10 list was naphthalene; however, this pollutant did not fail any screens and was not included in this analysis.

- Benzo(a)pyrene, which did fail screens at ITCMI, was not one of the highest emitted pollutants in Chippewa County and did not have one of the highest cancer toxicity-weighted emissions according to the 2002 NEI.

The following observations can be made for DEMI from Table 14-9:

- Although toluene and xylenes were the highest emitted pollutants with noncancer risk factors in Wayne County, they did not rank in the top 10 based on toxicity-weighted emissions.

- Xylenes ranked seventh for DEMI for annual average-based noncancer risk; however, the translated HQ was very low (0.03).

- Acrolein had the highest noncancer toxicity-weighted emissions in Wayne County and the highest noncancer risk based on the 2006 annual average for DEMI, but did not appear in the list of highest emitted pollutants.

- Formaldehyde, which had the highest daily and annual averages for DEMI, was one of the 10 highest emitted pollutants in Wayne County. Its noncancer toxicity-weighted emissions ranked sixth, and the noncancer risk based on the 2006 annual average ranked second.

The following observations can be made for ITCMI from Table 14-9:

- Similar to Wayne County, toluene and xylenes were the highest emitted (by mass) pollutants with noncancer risk factors in Chippewa County; however unlike Wayne County, these two pollutants also ranked in the top 10 for the highest noncancer toxicity-weighted emissions.

- Acrolein also had the highest noncancer toxicity-weighted emissions in Chippewa County.

- As mentioned in previously, benzo(a)pyrene does not have a noncancer risk factor.

Michigan Pollutant Summary

- *The pollutants of interest for DEMI included carbon tetrachloride, benzene, formaldehyde, acetaldehyde, 1,3-butadiene, tetrachloroethylene, acrolein, p-dichlorobenzene, and hexavalent chromium. Benzo(a)pyrene was the only pollutant of interest for ITCMI.*

- *Formaldehyde had the highest daily average for DEMI.*

- *Acrolein exceeded the short-term risk factors at DEMI.*

- *Formaldehyde decreased at DEMI from 2005 to 2006.*

15.0 Site in Minnesota

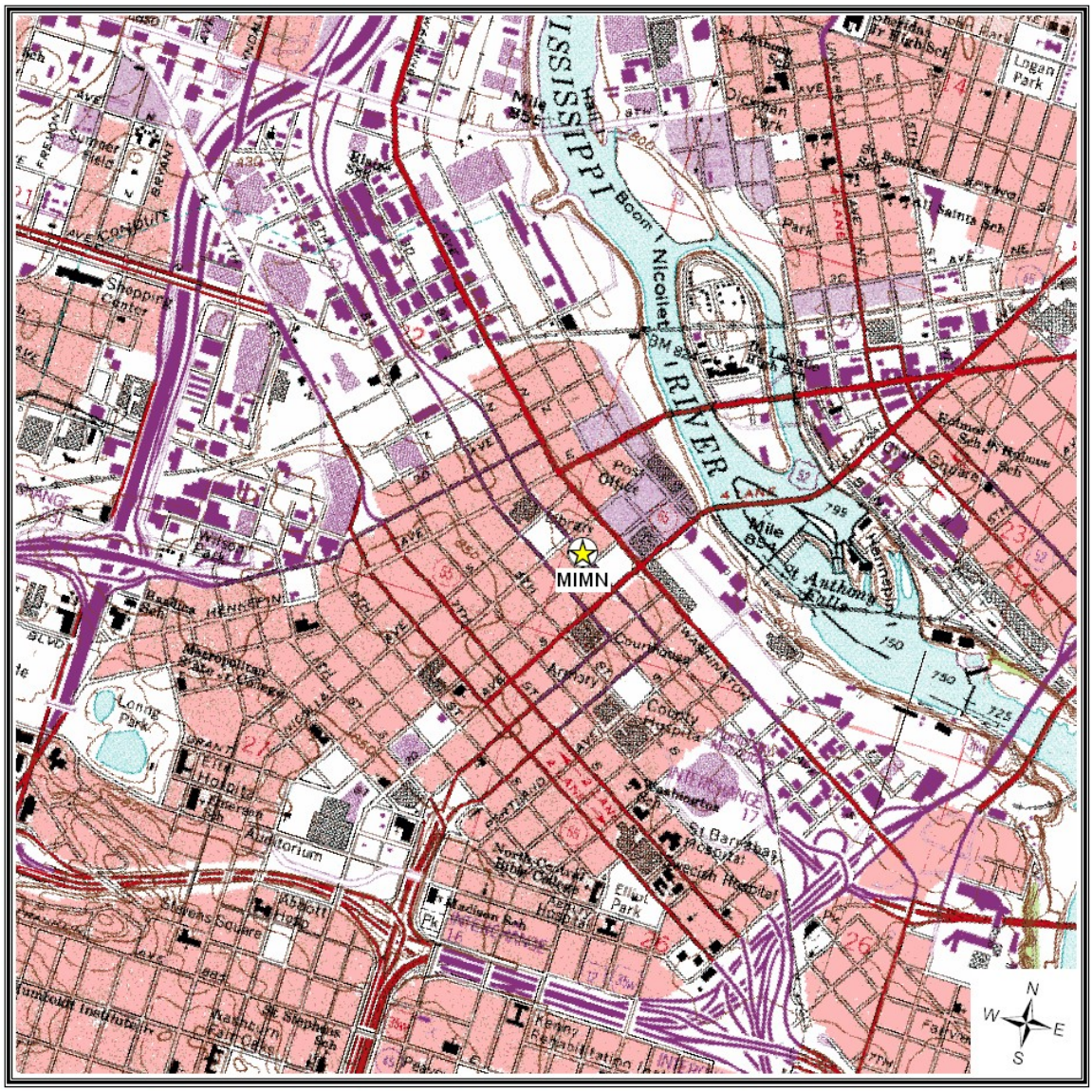
This section presents meteorological, concentration, and spatial trends for the UATMP site in Minneapolis, Minnesota (MIMN). Figure 15-1 is a topographical map showing the monitoring site in its urban location. Figure 15-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The Minneapolis site is surrounded by numerous point sources, of which a majority are involved in fuel combustion processes.

The Mississippi River runs through the center of Minneapolis and connects with the Minnesota River in southwest St. Paul. The city has many small lakes, which freeze in the winter. The city experiences a continental climate, generally cold in the winter and warm in the summer. Winds fluctuate seasonally, and tend to be out of the southeast in the summer and fall, and out of the northwest in the winter and spring. Although precipitation in the area isn't great, the spring thaw in conjunction with the river system can lead to flooding in the spring. (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the MIMN monitoring site is at Minneapolis-St. Paul International Airport (WBAN 14922).

Table 15-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 15-1 is the 95 percent confidence interval for each parameter. As shown in Table 15-1, average meteorological conditions on sampling days were somewhat cooler and slightly windier than average weather conditions throughout the year. The site sampled only until the end of April, missing nearly all the warmer months; this shorter sampling period probably attributed to this difference.

Figure 15-1. Minneapolis, Minnesota (MIMN) Monitoring Site



Source: USGS 7.5 Minutes Series. Map Scale: 1:24,000

Figure 15-2. Facilities Located Within 10 Miles of MIMN

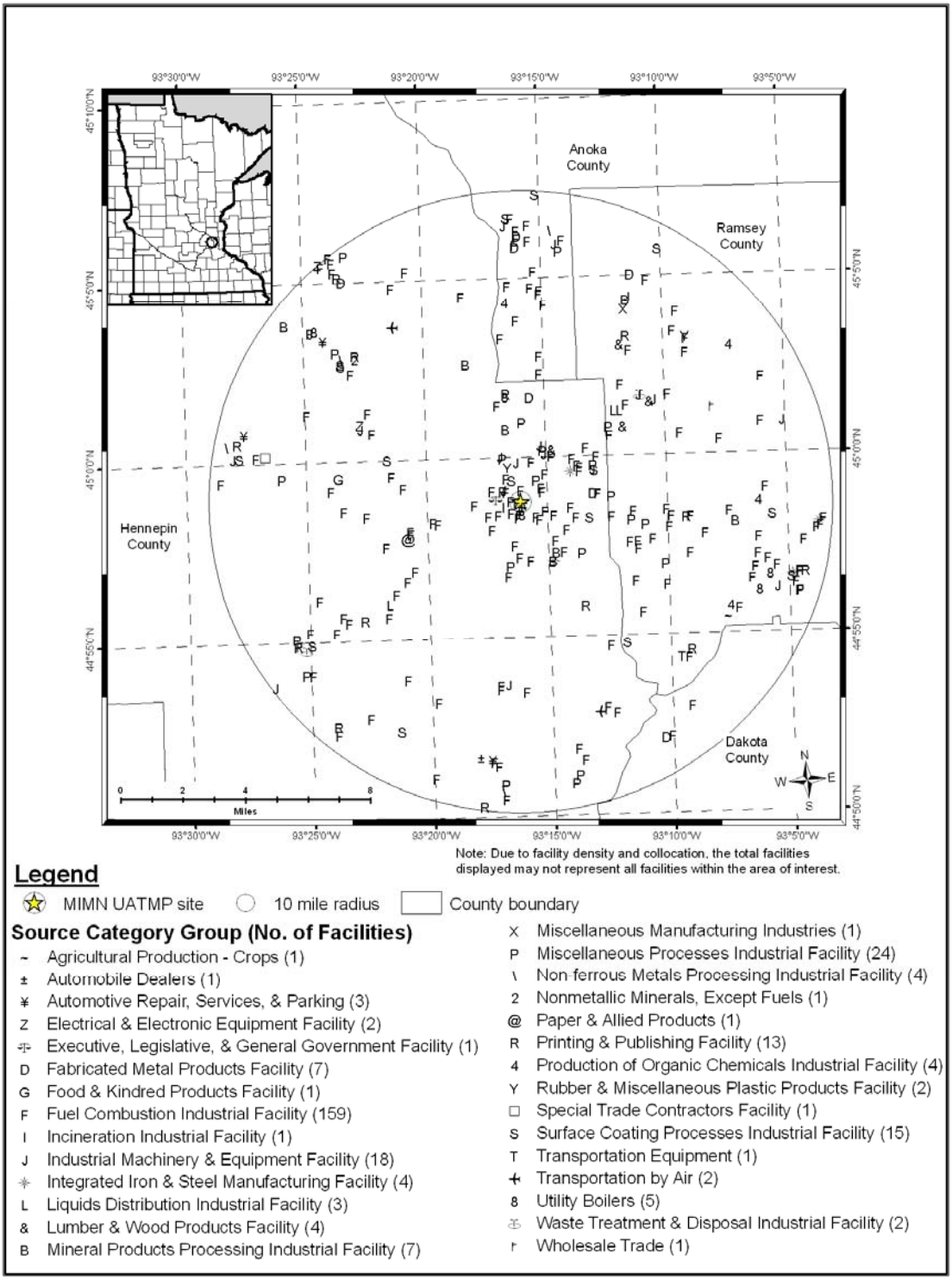


Table 15-1. Average Meteorological Conditions near the Monitoring Site in Minnesota

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
MIMN	14922	All 2006	57.42 ± 2.22	49.63 ± 2.10	36.56 ± 1.87	43.35 ± 1.79	64.06 ± 1.39	1015.45 ± 0.79	7.92 ± 0.29
		Sampling Day	41.32 ± 7.40	34.29 ± 6.81	21.90 ± 5.45	29.61 ± 5.48	64.58 ± 7.55	1015.15 ± 3.78	8.38 ± 1.14

15.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. The MIMN site sampled for carbonyls, VOC, and metals. Table 15-2 presents the fourteen pollutants that failed at least one screen at MIMN.

Table 15-2. Comparison of Measured Concentrations and EPA Screening Values for the Minnesota Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Minneapolis, Minnesota – MIMN					
Acetaldehyde	17	17	100.00	15.04	15.04
Benzene	16	16	100.00	14.16	29.20
Carbon Tetrachloride	16	16	100.00	14.16	43.36
1,3-Butadiene	14	14	100.00	12.39	55.75
Manganese (TSP)	11	12	91.67	9.73	65.49
Arsenic (TSP)	11	12	91.67	9.73	75.22
Tetrachloroethylene	7	9	77.78	6.19	81.42
Formaldehyde	6	17	35.29	5.31	86.73
Acrolein	5	5	100.00	4.42	91.15
p-Dichlorobenzene	4	9	44.44	3.54	94.69
Nickel (TSP)	3	12	25.00	2.65	97.35
Cadmium (TSP)	1	12	8.33	0.88	98.23
Hexachloro-1,3-butadiene	1	1	100.00	0.88	99.12
Trichloroethylene	1	6	16.67	0.88	100.00
Total	113	158	71.52		

The following observations are shown in Table 15-2:

- A total of 125 measured concentrations failed screens.
- The risk screening process for MIMN resulted in eleven pollutants of interest: acetaldehyde (17 failed screens), benzene (16), carbon tetrachloride (16), arsenic (11),

manganese (11), 1,3-butadiene (14), formaldehyde (6), tetrachloroethylene (7), acrolein (5), *p*-dichlorobenzene (4), and nickel (3).

- Of the eleven pollutants of interest, acetaldehyde, benzene, carbon tetrachloride, acrolein, and 1,3-butadiene had 100 percent of their measured detections fail the screening values.

15.2 Concentration Averages

Three types of concentration averages were calculated for the twelve pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there are at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 15-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 15-3:

- Acetaldehyde, arsenic, benzene, carbon tetrachloride, formaldehyde, and manganese were detected in every sample collected at MIMN, while acrolein, *p*-dichlorobenzene, tetrachloroethylene, nickel, and 1,3-butadiene were detected in one-half or less of the samples collected.

- Among the daily averages for MIMN, formaldehyde, acetaldehyde, and benzene had the highest concentrations by mass (0.93 ± 0.17 µg/m^3, 0.92 ± 0.13 µg/m^3, and 0.92 ± 0.08 µg/m^3, respectively).

- Both formaldehyde and acetaldehyde were higher in spring than winter.

- MIMN sampled metals until mid-March, and therefore has only winter seasonal averages for these pollutants. Carbonyls and VOC were sampled from January through April, so no summer or autumn seasonal averages could be calculated.

Table 15-3. Daily and Seasonal Averages for the Pollutants of Interest for the Minnesota Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Minneapolis, Minnesota – MIMN												
Acetaldehyde	17	17	0.92	0.13	0.75	0.15	1.06	0.14	NA	NA	NA	NA
Acrolein	5	16	0.39	0.13	NR	NR	NR	NR	NA	NA	NA	NA
Arsenic (TSP)	12	12	0.0005	0.0001	0.0005	0.0001	NA	NA	NA	NA	NA	NA
Benzene	16	16	0.92	0.08	0.89	0.09	0.96	0.14	NA	NA	NA	NA
1,3-Butadiene	14	16	0.11	0.02	0.10	0.01	NR	NR	NA	NA	NA	NA
Carbon Tetrachloride	16	16	0.64	0.09	0.60	0.10	0.69	0.13	NA	NA	NA	NA
p-Dichlorobenzene	9	16	0.10	0.04	NR	NR	0.11	0.04	NA	NA	NA	NA
Formaldehyde	17	17	0.93	0.17	0.71	0.11	1.12	0.25	NA	NA	NA	NA
Manganese (TSP)	12	12	0.0120	0.0030	0.0127	0.0039	NR	NR	NA	NA	NA	NA
Nickel (TSP)	12	12	0.0031	0.0022	0.0036	0.0029	NR	NR	NA	NA	NA	NA
Tetrachloroethylene	9	16	0.20	0.03	NR	NR	NR	NR	NA	NA	NA	NA

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

15.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for MIMN was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the fourteen pollutants with at least one failed screen, only acrolein exceeded both short-term risk values, and its non-chronic risk is summarized in Table 15-4.

The following observations about acrolein are shown in Table 15-4:

- Five acrolein measured detections were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$.
- The average detected concentration was 0.39 ± 0.13 $\mu g/m^3$, which was nearly twice the California REL value.
- Due to the low number of measured detections, seasonal averages could not be calculated for comparison to the ATSDR intermediate risk level.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of daily concentration and daily average wind direction. Figure 15-3 is a pollution rose for acrolein for MIMN.

Observations gleaned from the acrolein pollution rose include:

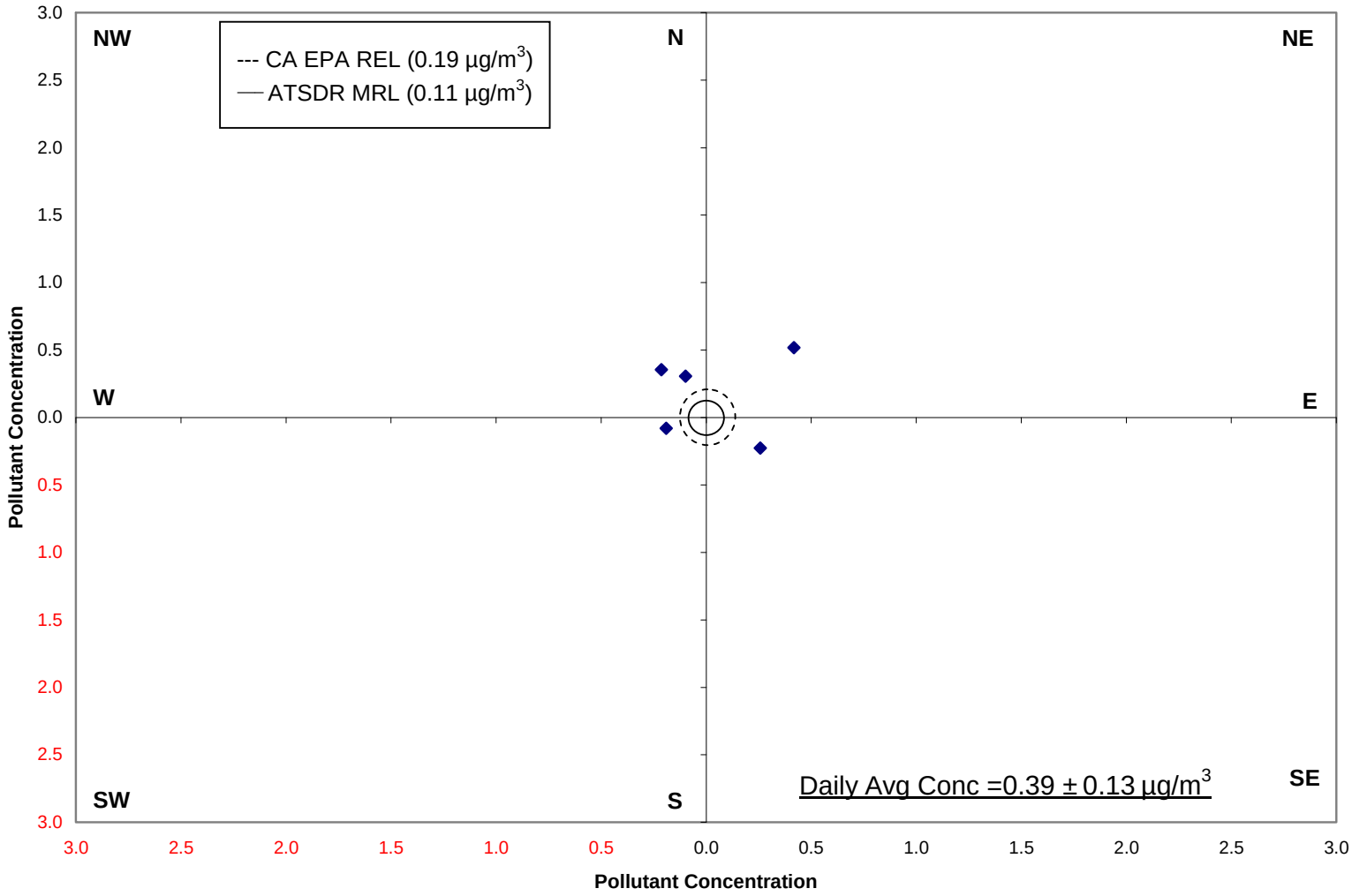
- All acrolein concentrations exceeded the ATDSR MRL acute risk factor, indicated by a solid line, and the CalEPA REL acute risk factor, indicated by a dashed line.
- The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources.
- MIMN is located in downtown Minneapolis and is situated near several major roadways (Figure 15-1). The immediate vicinity is mostly shops and offices, although industrial sources are located within a mile of the monitoring site.

Table 15-4. Non-Chronic Risk Summary for the Minnesota Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
MIMN	TO-15	Acrolein	0.39 ± 0.13	0.11	5	0.19	5	0.09	NR	NR	NA	NA

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

Figure 15-3. Acrolein Pollution Rose for MIMN



15.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

15.4.1 Pearson Correlation Analysis

Table 15-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the MIMN monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 15-5:

- Formaldehyde, acetaldehyde, and *p*-dichlorobenzene exhibited strong positive correlations with maximum and average temperatures, indicating that as temperatures increase, concentrations of these pollutants also increase.

- Several pollutants exhibited strong correlations with the individual moisture parameters, although not consistently across all the moisture parameters.

- Acrolein exhibited strong correlation with several parameters, although the low number of measured detections may skew the correlations.

15.4.2 Composite Back Trajectory Analysis

Figure 15-4 is a composite back trajectory map for the MIMN monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 15-4 represents 100 miles.

The following observations can be made from Figure 15-4:

- Back trajectories originated from a variety of directions at MIMN, although less frequently from the southeast.

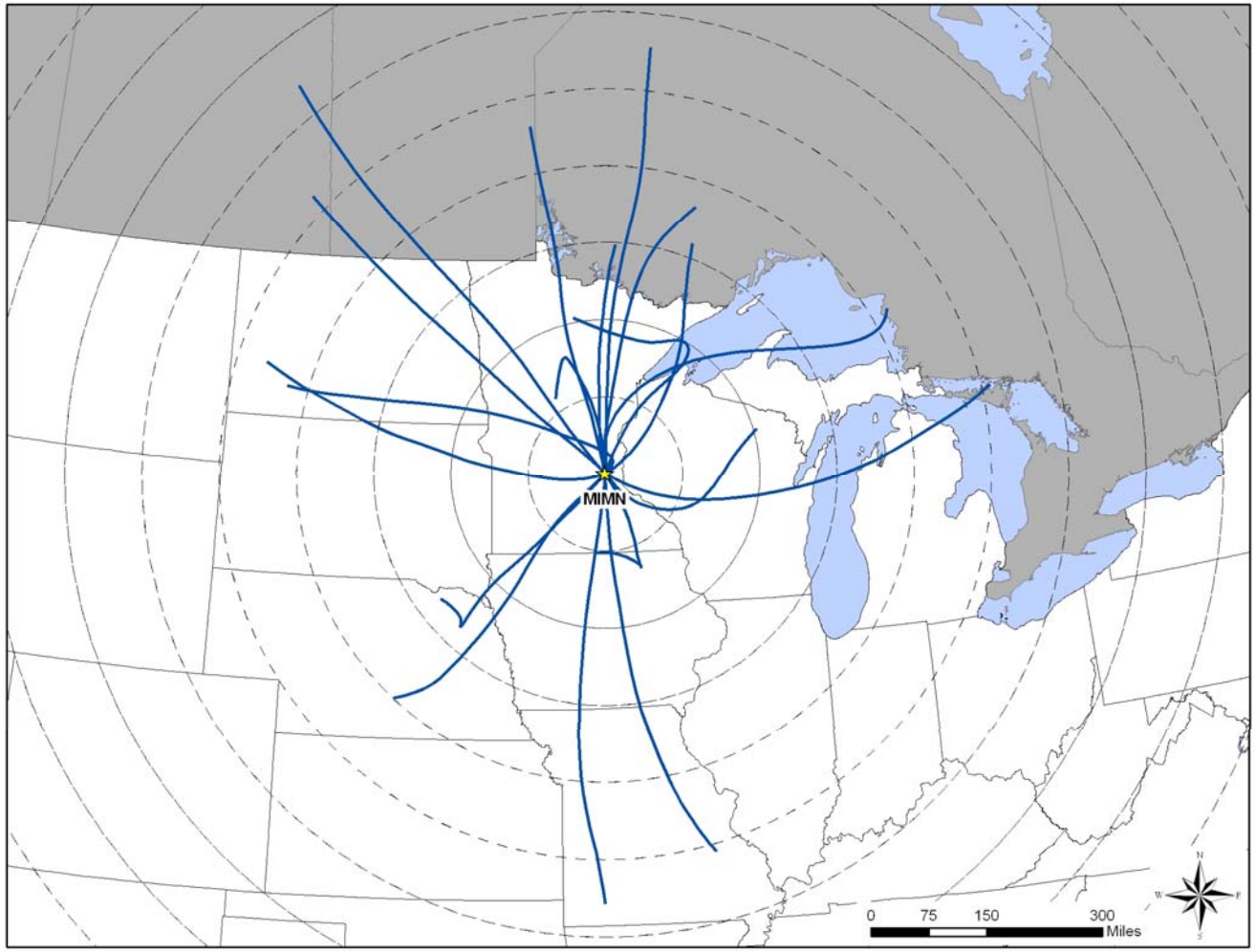
- The 24-hour airshed domain was somewhat large, with trajectories originating as far away as Saskatchewan Canada (> 600 miles).

- Over half of the trajectories originated more than 400 miles away from of the site.

Table 15-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Minnesota Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Minneapolis, Minnesota – MIMN								
Acetaldehyde	17	0.75	0.69	0.39	0.61	-0.63	-0.19	-0.27
Acrolein	5	-0.20	-0.27	-0.56	-0.38	-0.72	0.82	-0.51
Arsenic (TSP)	12	0.06	0.09	-0.21	-0.02	-0.47	-0.05	0.10
Benzene	16	-0.21	-0.24	-0.25	-0.24	-0.07	0.46	-0.42
1,3-Butadiene	14	0.12	-0.01	-0.14	-0.07	-0.28	0.47	-0.60
Carbon Tetrachloride	16	0.15	0.28	0.52	0.38	0.41	0.05	-0.21
Formaldehyde	17	0.64	0.62	0.48	0.60	-0.38	-0.32	0.04
Manganese (TSP)	12	0.04	-0.25	-0.49	-0.36	-0.61	0.25	0.19
Nickel (TSP)	12	0.37	0.07	0.14	0.08	0.14	-0.31	-0.22
p-Dichlorobenzene	9	0.64	0.61	0.24	0.49	-0.44	-0.16	0.23
Tetrachloroethylene	9	-0.42	-0.35	0.45	-0.15	0.77	-0.13	-0.08

Figure 15-4. Composite Back Trajectory Map for MIMN



15.4.3 Wind Rose Analysis

Hourly wind data from the Minneapolis-St. Paul International Airport near the MIMN monitoring site was uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 15-5 is the wind rose for the MIMN monitoring site on days that sampling occurred.

Observations from Figure 15-5 include:

- Hourly winds were predominantly out of the northwest (13 percent observations), north-northwest (13 percent), and east-southeast (11 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on sampling days.
- Calm winds (<2 knots) were observed for five percent of the observations.

15.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

15.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Hennepin County, Minnesota were obtained from the Minnesota Department of Public Safety – Driver and Vehicle Services and the U.S. Census Bureau, and are summarized in Table 15-6. Table 15-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 15-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Figure 15-5. Wind Rose for MIMN Sampling Days

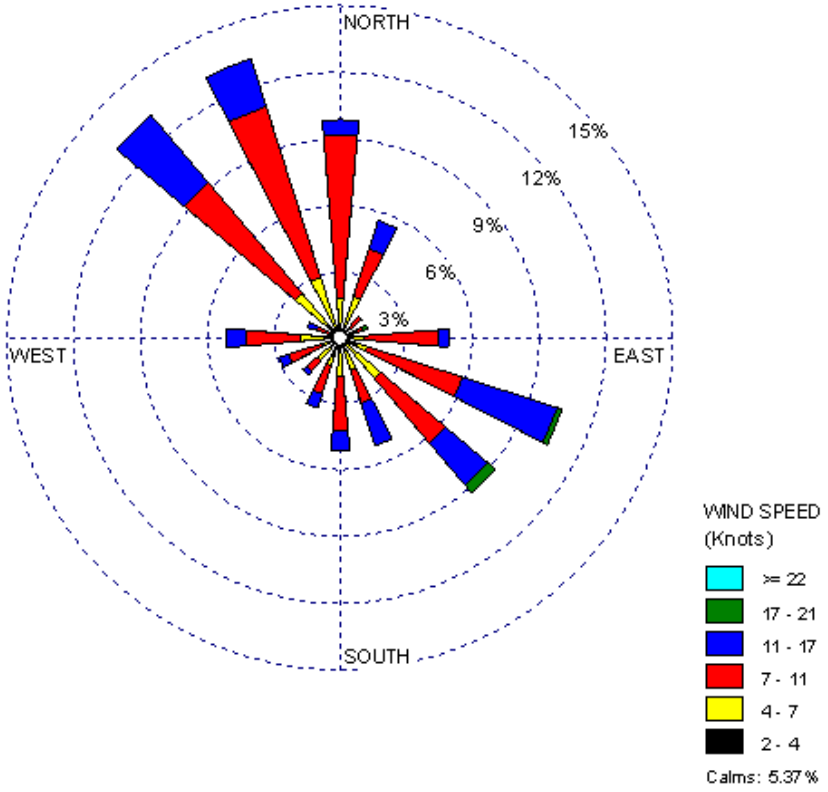


Table 15-6. Motor Vehicle Information for the Minnesota Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
MIMN	1,122,093	1,097,109	0.98	1,131,912	1,106,709	10,000

Observations gleaned from Table 15-6 include:

- Hennepin County is one of the twelve counties in the UATMP with a population over 1 million.
- Vehicle registration count is also high compared to other UATMP sites.
- MIMN's estimated 10 mile vehicle ownership is fifth behind sites from the northern New Jersey, Phoenix, Arizona and Ft. Lauderdale, Florida.
- The average daily traffic count falls in the middle of the range compared to other UATMP sites.
- The MIMN monitoring site is located in a commercial area and is in an urban-city center setting.

15.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area. For more information on this study, refer to Section 3.2.1.4. Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- For MIMN, the benzene-ethylbenzene ratio (4.71 ± 0.33) was higher than the xylenes-ethylbenzene ratio (3.75 ± 0.12), which is the opposite of the roadside study (3.75 and 4.55, respectively).
- The toluene-ethylbenzene ratio (5.90 ± 0.42) was the highest ratio for MIMN, which is similar to the roadside study (5.85).

15.6 Trends Analysis

A trends analysis could not be performed for MIMN as this site has not participated in the UATMP for three consecutive years.

15.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at MIMN and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Because MIMN completed sampling in April 2006, annual averages could not be calculated. As a result, no chronic risk analyses could be performed. However, data from EPA's 1999 NATA for the pollutants that failed at least one screen at MIMN were retrieved and are presented in Table 15-7. The NATA data are presented for the census tract where the monitoring site is located. The pollutants of interest are bolded in Table 15-7.

The census tract information for MIMN is as follows:

- The MIMN monitoring site is located in census tract 27053104600.
- The population for the census tract where the SDGA monitoring site is located was 3,082, which represents approximately 0.3 percent of Hennepin County's population in 2000.

The following observations can be made from Table 15-7:

- According to NATA, benzene, acetaldehyde, and formaldehyde had the highest modeled-concentrations, while benzene, 1,3-butadiene, and acetaldehyde had the highest cancer risks.
- The MIMN census tract's benzene cancer risk (39 in-a-million) was one of the highest risks for any UATMP sites, behind only ININ's arsenic (208 in-a-million) and BAPR's dichloromethane (71 in-a-million) cancer risks.
- Acrolein had the only NATA-modeled noncancer HQ greater than 1 (10.81). The remaining noncancer HQs were less than 0.40.

15.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 15-7 and 15-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 15-8 presents the 10 pollutants with the highest emissions from the 2002 NEI and the 10 pollutants with the highest cancer toxicity-weighted emissions. Table 15-9 presents similar information, but is based noncancer risk factors. The pollutants in these tables

Table 15-7. Chronic Risk Summary for the Monitoring Site in Minnesota

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Minneapolis, Minnesota (MIMN) – Census Tract ID 27053104600								
Acetaldehyde	0.0000022	0.009	3.22	7.08	0.36	NA	NA	NA
Acrolein	NR	0.00002	0.22	NR	10.81	NA	NA	NA
Arsenic*	0.0043	0.00003	0.15	0.64	<0.01	NA	NA	NA
Benzene	0.0000078	0.03	5.06	39.5	0.17	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.47	14.18	0.24	NA	NA	NA
Cadmium*	0.0018	0.00002	0.14	0.25	0.01	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.21	3.18	0.01	NA	NA	NA
***p*-Dichlorobenzene**	0.000011	0.8	0.06	0.69	<0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	3.12	0.02	0.32	NA	NA	NA
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	NA	NA	NA
Manganese*	NR	0.00005	0.36	NR	0.01	NA	NA	NA
Nickel*	0.00016	0.000065	1.1	0.18	0.02	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	0.35	2.04	<0.01	NA	NA	NA
Trichloroethylene	0.000002	0.6	0.57	1.13	<0.01	NA	NA	NA

* Metals sampled for TSP
BOLD = pollutants of interest
NA = no annual averages available
NR = no risk factor available.

Table 15-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for MIMN

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Hennepin County)		Top 10 Cancer Toxicity-Weighted Emissions (for Hennepin County)		Top 10 Cancer Risks Based on Annual Average Concentration (for MIMN)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Minneapolis, Minnesota – MIMN					
Benzene	952.91	Benzene	7.43E-03		
Formaldehyde	471.14	Arsenic	4.69E-03		
Acetaldehyde	239.57	1,3-Butadiene	3.15E-03		
1,3-Butadiene	104.84	Lead	2.53E-03		
Trichloroethylene	88.85	Cadmium	2.48E-03		
1,3-Dichloropropene	81.63	Naphthalene	2.09E-03		
Naphthalene	61.60	Hexavalent Chromium	1.57E-03		
Tetrachloroethylene	49.95	Polycyclic Organic Matter as non-15-PAH	1.34E-03		
p-Dichlorobenzene	42.13	Polycyclic Organic Matter as 15-PAH	7.20E-04		
Dichloromethane	34.81	Polycyclic Organic Matter as 7-PAH	5.76E-04		

Table 15-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for MIMN

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Hennepin County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Hennepin County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for MIMN)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Minneapolis, Minnesota – MIMN					
Toluene	2,180.15	Acrolein	1,517,588.62		
Xylenes	1,413.29	Cadmium	68,812.07		
Benzene	952.91	1,3-Butadiene	52,421.07		
Hexane	594.14	Formaldehyde	48,075.66		
Formaldehyde	471.14	Arsenic	36,354.75		
Ethylbenzene	315.77	Nickel	34,602.06		
Hydrochloric Acid	302.71	Benzene	31,763.64		
Acetaldehyde	239.57	Acetaldehyde	26,618.50		
1,1,1-Trichloroethane	222.58	Bromomethane	22,778.27		
Methanol	211.66	4,4'-Methylenediphenyl Diisocyanate	21,406.70		

are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. The pollutants with the highest cancer and noncancer risks could not be calculated because annual averages could not be determined for MIMN.

The following observations can be made from Table 15-8:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor in Hennepin County.
- Benzene also had the highest cancer toxicity-weighted emissions.
- Benzene, 1,3-butadiene, and naphthalene were the only three pollutants that were on both the highest emitted and the highest toxicity-weighted emissions "top 10" lists.
- While VOCs and carbonyls tended to be emitted most, metals and PAHs tended to be the most toxic.

The following observations can be made from Table 15-9:

- Although toluene and xylenes were the highest emitted pollutants (by mass) with noncancer risk factors in Hennepin County, only benzene ranked in the top 10 based on toxicity-weighted emissions.
- Acrolein had the highest noncancer toxicity-weighted emissions even though this pollutant did not appear in the list of highest emitted pollutants.
- Benzene, formaldehyde, and acetaldehyde were the only three pollutants that were on both the highest emitted and the highest noncancer toxicity-weighted emissions "top 10" lists.

Minnesota Pollutant Summary

- *The pollutants of interest for the Minnesota site were acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, manganese, nickel p-dichlorobenzene, and tetrachloroethylene.*
- *Formaldehyde had the highest daily average for MIMN. Concentrations of formaldehyde were highest in spring.*
- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

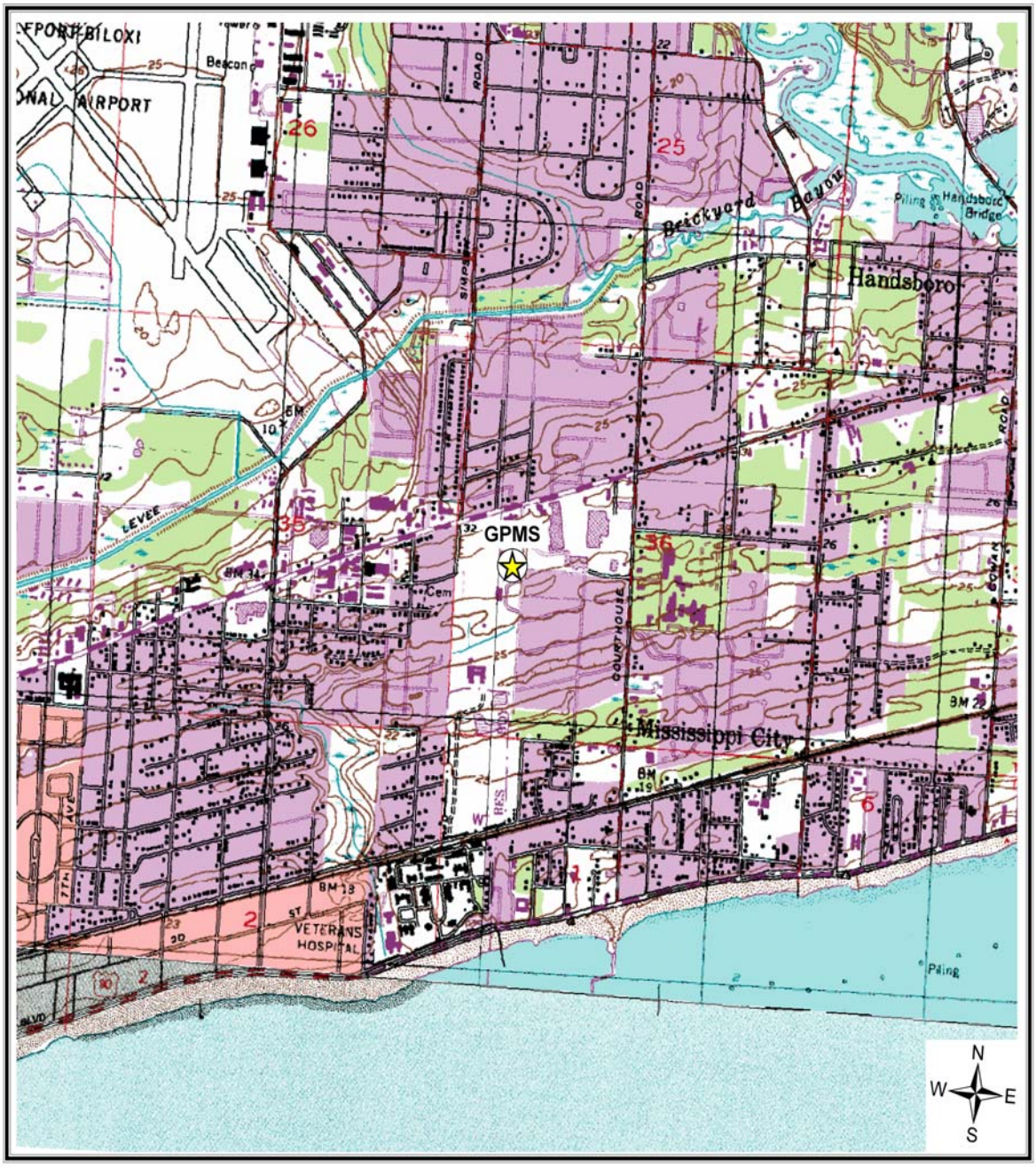
16.0 Sites in Mississippi

This section presents meteorological, concentration, and spatial trends for the two UATMP sites in Mississippi (GPMS, TUMS). These sites are located in two cities in Mississippi: Gulfport and Tupelo, respectively. Figures 16-1 and 16-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 16-3 through 16-4 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. Few point sources are located near the GPMS site, which is located on the Gulf Coast. Most of the sources are located to the north of the site and the majority are involved in surface coating processes. The point sources within a 10 mile radius of TUMS, which is located in northeast Mississippi, are mainly to the east and southeast of the site. A number of the sources near the TUMS site are involved in surface coating processes, polymer and resin production, and chemical and allied products production.

Climatologically, both of the Mississippi cities are warm and humid, especially Gulfport, the site nearest the coast. High temperatures and humidity, due to proximity to the Gulf of Mexico, can make this region feel uncomfortable. Precipitation is distributed fairly evenly throughout the year, and thunderstorms are fairly common, especially in the summer and nearer to the coast (Ruffner and Bair, 1987).

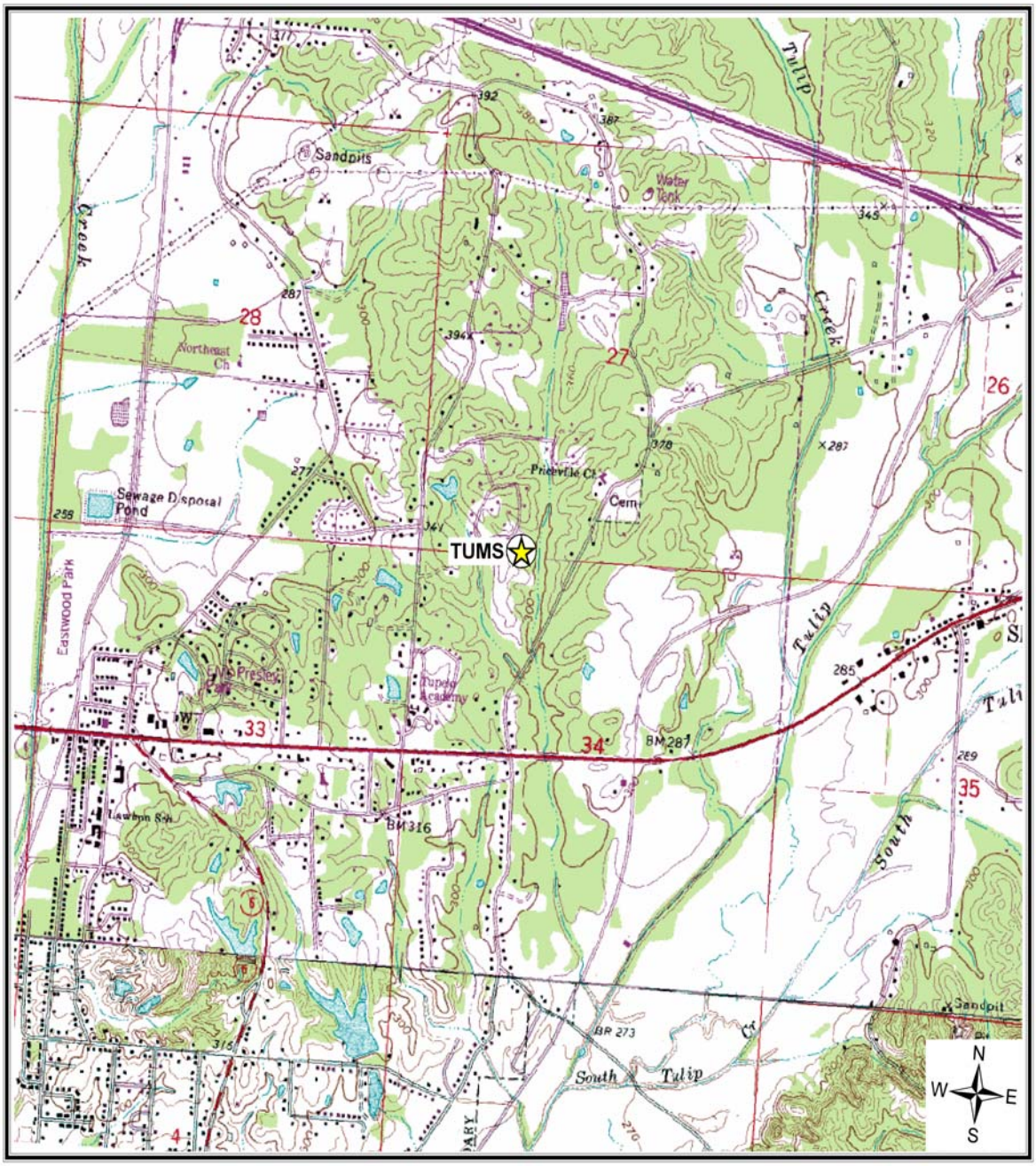
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the GPMS monitoring site is Gulfport-Biloxi Regional Airport (WBAN 93878); and the closest weather station to TUMS site is Tupelo Municipal Airport (WBAN 93862). Table 16-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed wind) for the entire year and on days samples were collected. Also included in Table 16-1 is the 95 percent confidence interval for each parameter. As shown in Table 16-1,

Figure 16-1. Gulfport, Mississippi (GPMS) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 16-2. Tupelo, Mississippi (TUMS) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 16-3. Facilities Located Within 10 Miles of GPMS

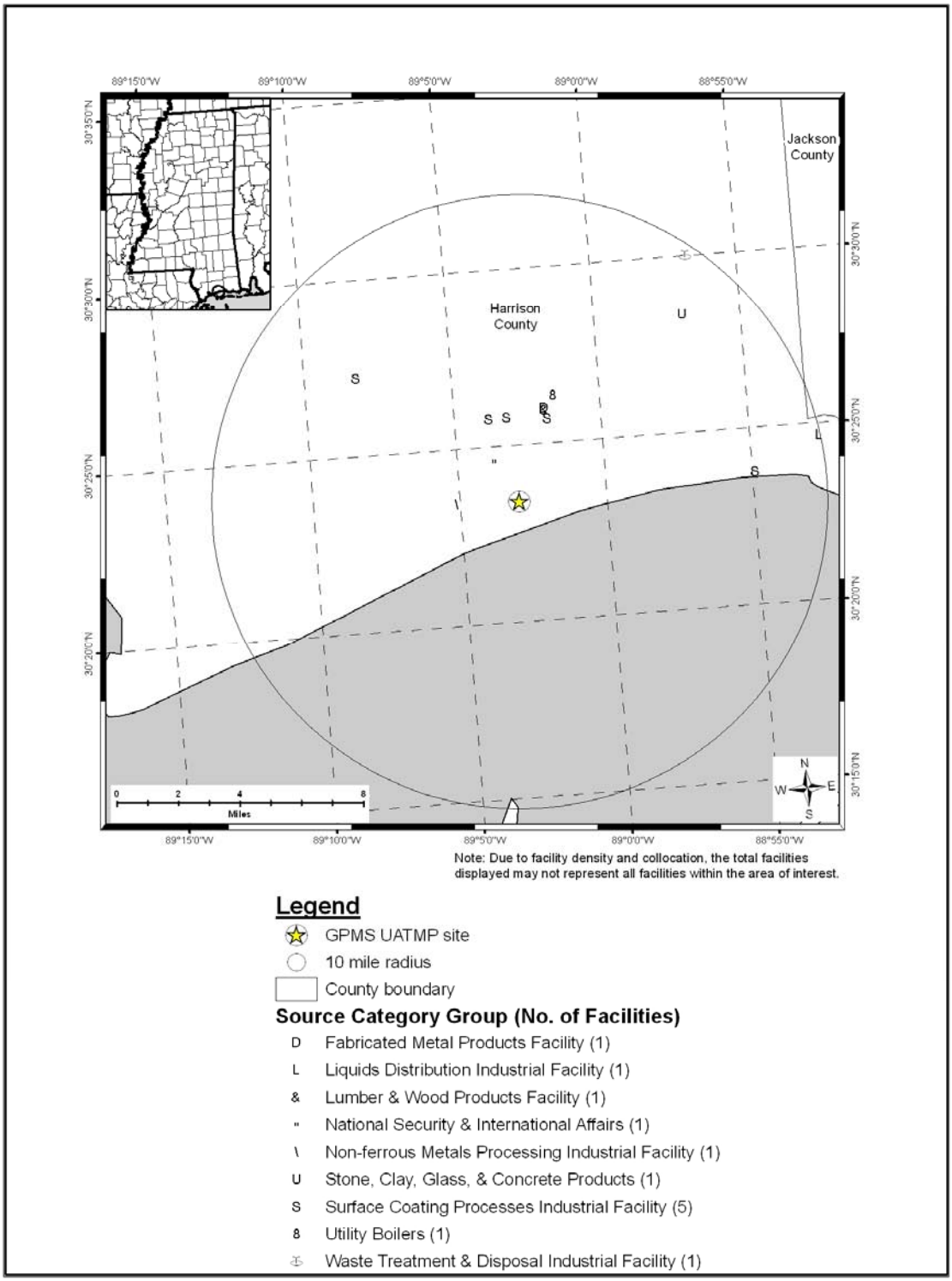


Figure 16-4. Facilities Located Within 10 Miles of TUMS

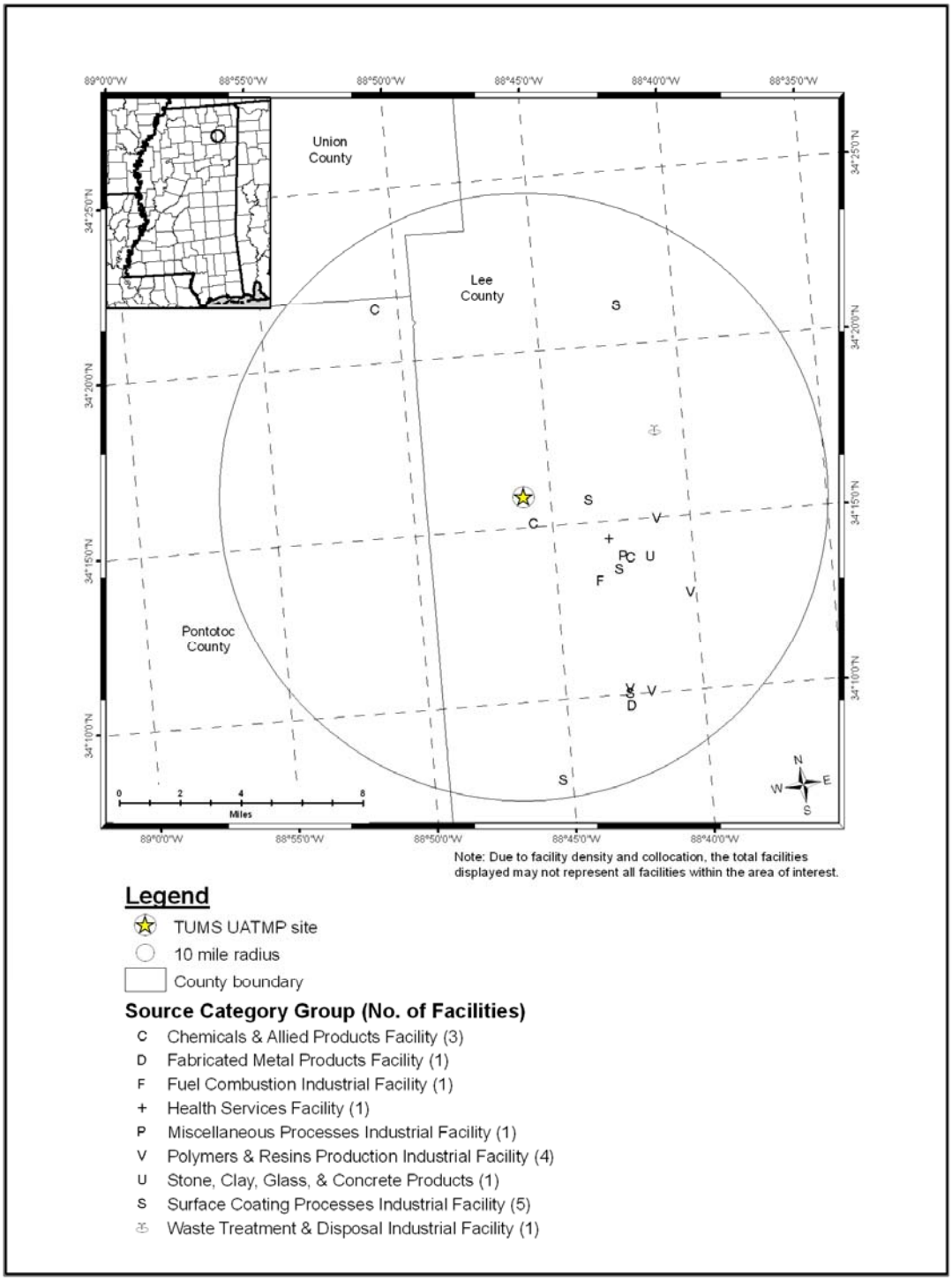


Table 16-1. Average Meteorological Conditions near the Monitoring Sites in Mississippi

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
GPMS	93874	All 2006	77.72 ± 1.18	68.82 ± 1.26	57.98 ± 1.47	62.60 ± 1.23	71.21 ± 1.19	1017.35 ± 0.50	5.78 ± 0.29
		Sampling Day	76.21 ± 2.65	66.67 ± 2.67	55.10 ± 3.14	60.22 ± 2.60	69.77 ± 2.84	1017.69 ± 1.03	6.13 ± 0.69
TUMS	93862	All 2006	79.15 ± 1.17	67.59 ± 1.22	57.37 ± 1.45	61.74 ± 1.22	72.92 ± 1.00	1017.72 ± 0.49	4.15 ± 0.26
		Sampling Day	74.93 ± 4.08	64.37 ± 3.78	51.21 ± 3.37	56.92 ± 3.16	65.96 ± 2.79	1017.06 ± 1.19	5.73 ±0.67

average meteorological conditions on sampling days at GPMS and TUMS were fairly representative of average weather conditions throughout the year.

16.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. TUMS sampled for carbonyls and VOC, while GPMS sampled for SVOC and SNMOC in addition to carbonyls and VOC. GPMS initially sampled at a 1-in-3 day schedule as part of the post-Katrina monitoring effort. As a result, this site has more samples than most UATMP sites. Table 16-2 presents the pollutants that failed at least one screen at the Mississippi monitoring sites.

The following observations are shown in Table 16-2:

- 14 pollutants with a total of 505 measured concentrations failed screens at GPMS; 11 pollutants with a total of 338 measured concentrations failed the screen at TUMS.

- The pollutants of interest also varied by site, yet the following seven pollutants contributed to the top 95 percent of the total failed screens at both Mississippi monitoring sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, *p*-dichlorobenzene, formaldehyde, carbon tetrachloride.

- Of the seven pollutants of interest that were the same at both sites, three pollutants of interest, acrolein, benzene and carbon tetrachloride, had all 100 percent of their measured detections fail screens.

- GPMS sampled for SVOC through October. While *p*-dichlorobenzene and 1,4-dichlorobenzene are the same pollutant with different names, they are sampled with different methods (as a VOC and an SVOC, respectively). Because resulting data were obtained using two separate methods, they will be kept separate in this and subsequent analyses. "*p*-Dichlorobenzene" refers to the pollutant measured with the

Table 16-2. Comparison of Measured Concentrations and EPA Screening Values for the Mississippi Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Gulfport, Mississippi – GPMS					
Formaldehyde	71	71	100.00	14.06	14.06
Acetaldehyde	71	71	100.00	14.06	28.12
Benzene	68	68	100.00	13.47	41.58
Carbon Tetrachloride	68	68	100.00	13.47	55.05
Acrolein	65	65	100.00	12.87	67.92
1,3-Butadiene	56	61	91.80	11.09	79.01
p-Dichlorobenzene	46	60	76.67	9.11	88.12
Naphthalene	42	60	70.00	8.32	96.44
Tetrachloroethylene	8	37	21.62	1.58	98.02
Hexachloro-1,3-butadiene	5	5	100.00	0.99	99.01
1,4-Dichlorobenzene	2	56	3.57	0.40	99.41
Acrylonitrile	1	1	100.00	0.20	99.60
Xylenes	1	68	1.47	0.20	99.80
Dichloromethane	1	66	1.52	0.20	100.00
Total	505	757	66.71		
Tupelo, Mississippi – TUMS					
Carbon Tetrachloride	60	60	100.00	17.75	17.75
Acetaldehyde	60	61	98.36	17.75	35.50
Benzene	60	60	100.00	17.75	53.25
Acrolein	47	47	100.00	13.91	67.16
Formaldehyde	40	61	65.57	11.83	78.99
1,3-Butadiene	37	47	78.72	10.95	89.94
p-Dichlorobenzene	15	36	41.67	4.44	94.38
Tetrachloroethylene	13	33	39.39	3.85	98.22
Hexachloro-1,3-butadiene	3	3	100.00	0.89	99.11
Acrylonitrile	2	2	100.00	0.59	99.70
1,2-Dichloroethane	1	1	100.00	0.30	100.00
Total	338	411	82.24		

TO-15 (VOC) method and "1,4-dichlorobenzene" refers to the pollutant measured with the 8270C (SVOC) method.

16.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within

each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 16-3. Annual average concentrations are presented and discussed in further detail in later sections.

The following observations are shown in Table 16-3:

- Formaldehyde had the highest concentration by mass (2.91 ± 0.40 μg/m^3) for GPMS, followed by acetaldehyde (1.74 ± 0.17 μg/m^3).
- Seasonal averages of the pollutants of interest for GPMS peaked in the summer or autumn.
- For TUMS, the pollutants with the highest daily averages were acetaldehyde (1.95 ± 0.24 μg/m^3) and formaldehyde (1.58 ± 0.26 μg/m^3).
- Most of the seasonal averages for TUMS did not vary much from season-to-season, when the confidence interval was considered.
- Acetaldehyde concentrations tended to be lower in winter; carbon tetrachloride was highest in summer and autumn; and formaldehyde was highest in the summer.

16.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for the Mississippi monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute CALEPA REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded

Table 16-3. Daily and Seasonal Averages for the Pollutants of Interest for the Mississippi Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Gulfport, Mississippi – GPMS												
Acetaldehyde	71	71	1.74	0.17	1.39	0.27	1.61	0.30	1.98	0.37	2.26	0.30
Acrolein	65	68	0.81	0.10	0.56	0.15	0.67	0.15	1.17	0.24	0.98	0.20
Benzene	68	68	0.86	0.13	0.78	0.11	0.89	0.35	0.67	0.11	1.07	0.26
1,3-Butadiene	61	68	0.08	0.02	0.09	0.01	0.06	0.02	0.05	0.01	0.10	0.05
Carbon Tetrachloride	68	68	0.65	0.05	0.54	0.05	0.57	0.06	0.84	0.13	0.76	0.08
p-Dichlorobenzene	60	68	0.16	0.02	0.15	0.03	0.12	0.03	0.15	0.07	0.22	0.06
Formaldehyde	71	71	2.91	0.40	1.76	0.24	3.28	0.93	4.26	0.94	3.01	0.50
Naphthalene	60	61	0.05	0.01	0.05	0.01	0.04	0.01	0.04	0.01	0.07	0.02
Tupelo, Mississippi – TUMS												
Acetaldehyde	61	61	1.95	0.24	1.30	0.49	2.15	0.44	2.46	0.36	1.93	0.43
Acrolein	47	60	0.62	0.13	0.31	0.11	0.71	0.35	0.42	0.10	0.61	0.20
Benzene	60	60	0.76	0.20	0.68	0.12	1.06	0.68	0.49	0.08	0.82	0.30
1,3-Butadiene	47	60	0.06	0.01	0.06	0.01	0.04	0.02	0.04	0.01	0.07	0.04
Carbon Tetrachloride	60	60	0.65	0.04	0.54	0.04	0.58	0.04	0.75	0.12	0.73	0.07
p-Dichlorobenzene	36	60	0.10	0.02	NR	NR	NR	NR	0.07	0.02	0.13	0.04
Formaldehyde	61	61	1.58	0.26	0.63	0.14	1.76	0.37	2.88	0.41	1.13	0.23
Tetrachloroethylene	33	60	0.29	0.15	0.17	0.18	NR	NR	0.11	0.06	0.25	0.19

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 16-4.

The following observations about acrolein are shown in Table 16-4:

- All of the acrolein measured detections at GPMS and TUMS exceeded the ATSDR MRL acute value, and all but two acrolein measured detections at each site exceeded the CALEPA REL value.

- All the seasonal averages for both sites were greater than the ATSDR intermediate value (0.09 $\mu g/m^3$).

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. Acrolein exceeded the acute risk factors at both GPMS and TUMS. Figures 16-5 through 16-6 are acrolein pollution roses for GPMS and TUMS. As shown in Figures 16-5 through 16-6, and discussed above, all acrolein concentrations exceeded at least one of the acute risk factors, which are indicated by a dashed line (CALEPA REL) and solid line (ATSDR MRL).

Observations gleaned from the acrolein pollution rose for GPMS include:

- The pollution rose shows that acrolein concentrations exceeded the acute risk factors on days with winds from a variety of directions. This tends to be a characteristic of mobile sources.

- Several major thoroughfares through Gulfport are located near the monitoring site. In addition, GPMS is located near the Gulfport-Biloxi Regional Airport.

Observations gleaned from the acrolein pollution rose for TUMS include:

- The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is characteristic of mobile sources.

- The highest concentration of acrolein occurred with a north-northeasterly wind.

- TUMS is located on the Tupelo Airport property on the west side of town. Several major roadways, such as Natchez Trace Parkway and Highway 278, border the airport property.

Table 16-4. Non-Chronic Risk Summary for the Mississippi Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
GPMS	TO-15	Acrolein	0.81 ± 0.10	0.11	65	0.19	62	0.09	0.56 ± 0.15	0.67 ± 0.15	1.17 ± 0.24	0.98 ± 0.20
TUMS	TO-15	Acrolein	0.62 ± 0.13	0.11	47	0.19	45	0.09	0.31 ± 0.11	0.71 ± 0.35	0.42 ± 0.10	0.61 ± 0.20

Figure 16-5. Acrolein Pollution Rose for GPMS

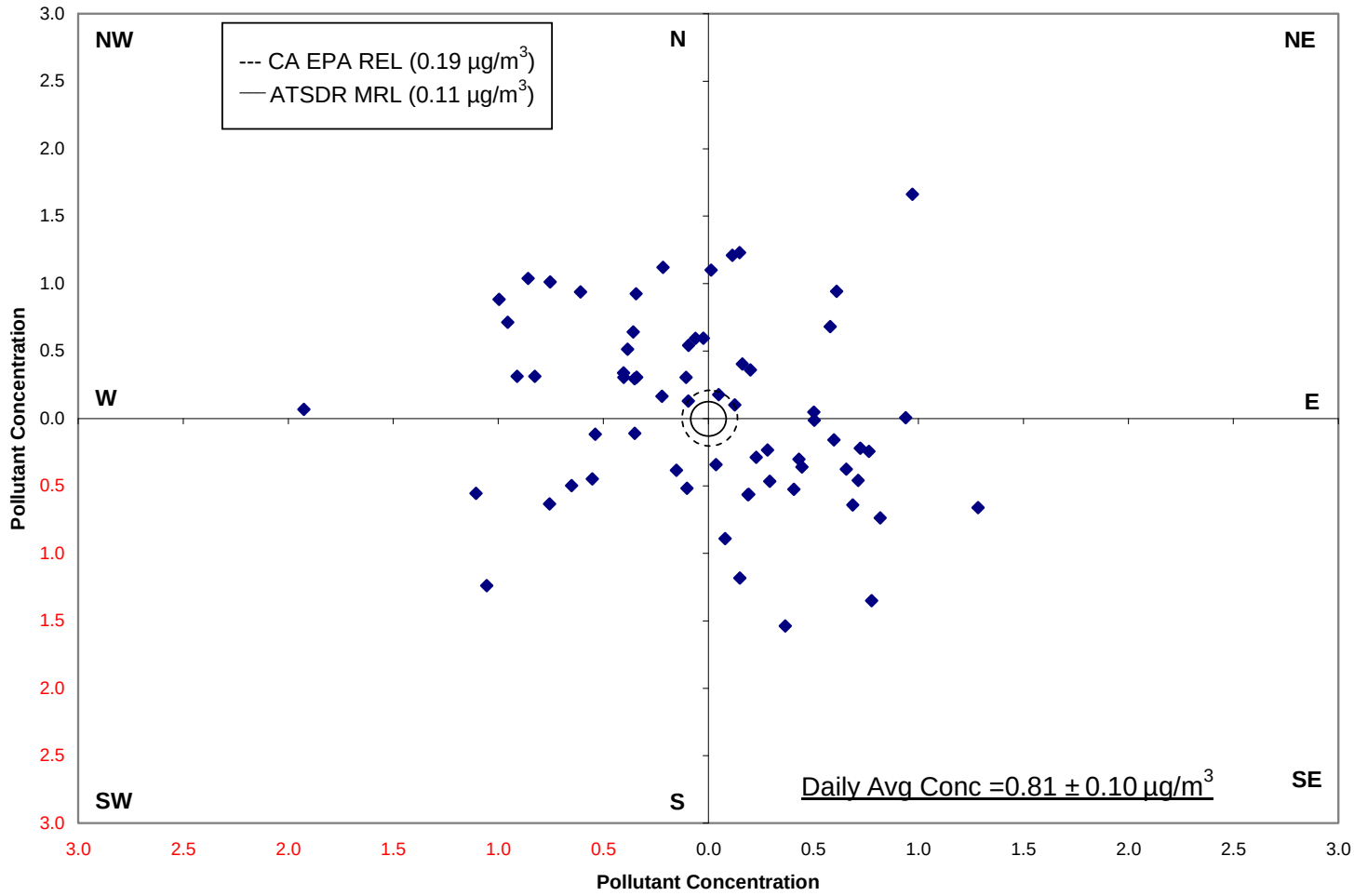
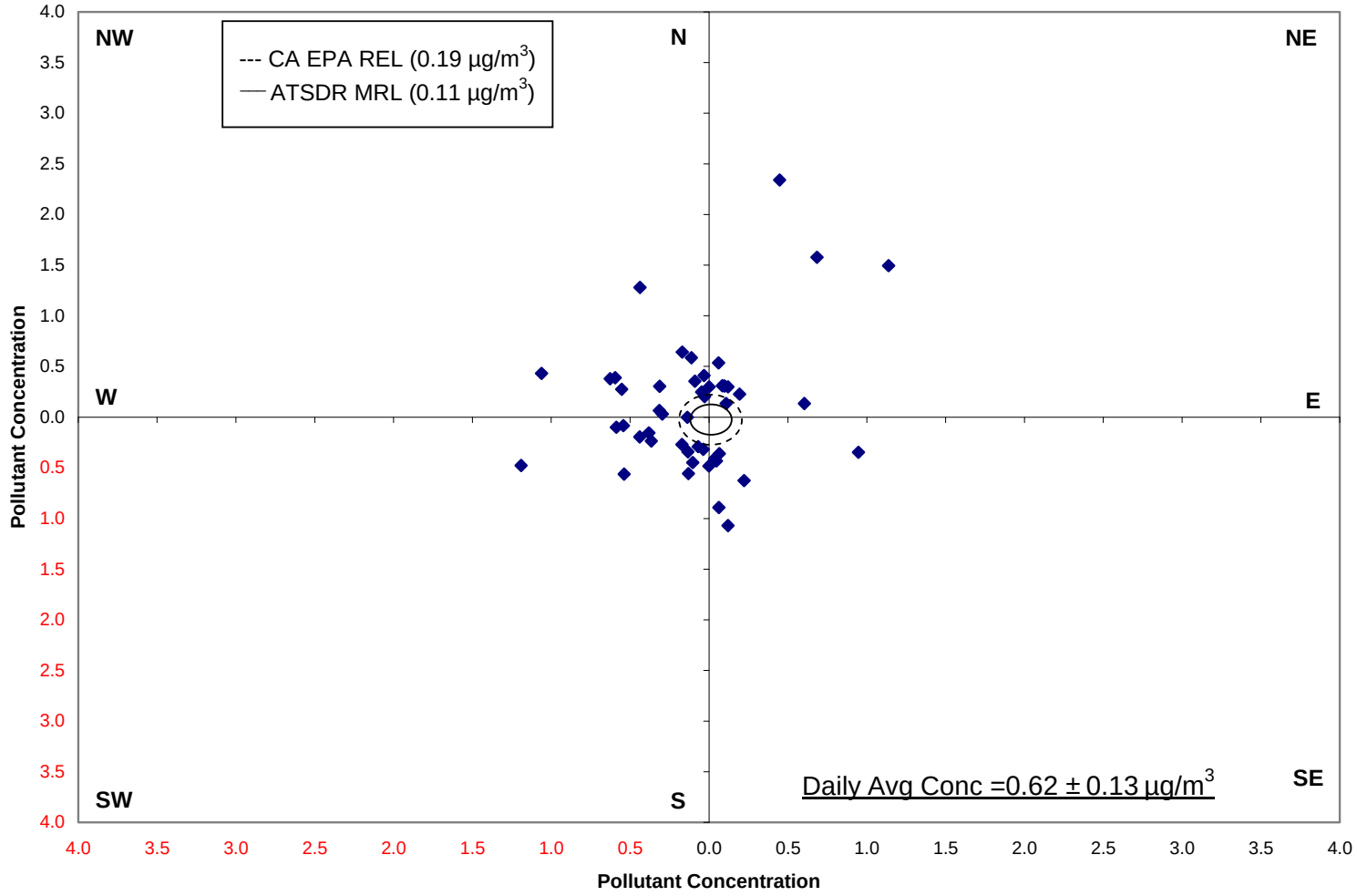


Figure 16-6. Acrolein Pollution Rose for TUMS



16.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and the concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

16.4.1 Pearson Correlation Analysis

Table 16-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Mississippi monitoring sites. (Please refer to Section 3.1.6 for more information on understanding Pearson correlations.)

The following observations are gathered for GPMS from Table 16-5:

- Strong positive correlations were calculated between acrolein and carbon tetrachloride and formaldehyde and maximum and average temperatures, indicating that concentrations of these pollutants increase as temperatures increase.

- With the exception of benzene, the pollutants of interest exhibited negative correlations with scalar wind speed. This indicates that concentrations tend to increase as wind speeds decrease.

The following observations are gathered for TUMS from Table 16-5:

- Strong positive correlations were calculated for formaldehyde and maximum, average, dew point, and wet bulb temperatures. This indicates that as temperatures and moisture content increase, formaldehyde concentrations at TUMS also increase.

- A strong positive correlation was also calculated between acetaldehyde and relative humidity, although this trend was not consistent across all three moisture variables.

16.4.2 Composite Back Trajectory Analysis

Figures 16-7 and 16-8 are composite back trajectory maps for the Mississippi monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figures 16-7 and 16-8 represents 100 miles.

Table 16-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Mississippi Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Gulfport, Mississippi – GPMS								
1,3-Butadiene	61	-0.10	-0.17	-0.09	-0.14	0.12	0.06	-0.03
Acetaldehyde	71	0.39	0.27	0.13	0.18	-0.21	-0.02	-0.49
Acrolein	65	0.52	0.46	0.41	0.44	0.06	-0.05	-0.42
Benzene	68	-0.01	-0.04	-0.03	-0.04	-0.01	0.03	0.26
Carbon Tetrachloride	68	0.51	0.46	0.32	0.39	-0.14	-0.16	-0.28
Formaldehyde	71	0.47	0.44	0.25	0.33	-0.26	-0.11	-0.33
Naphthalene	60	-0.10	-0.23	-0.28	-0.27	-0.20	0.01	-0.29
p-Dichlorobenzene	60	0.00	-0.11	-0.13	-0.13	-0.08	0.12	-0.27
Tupelo, Mississippi – TUMS								
1,3-Butadiene	47	-0.18	-0.28	-0.31	-0.30	0.02	0.12	-0.36
Acetaldehyde	61	0.34	0.24	0.05	0.15	-0.53	0.41	-0.37
Acrolein	47	0.17	0.21	0.28	0.26	0.14	-0.22	-0.09
Benzene	60	0.00	-0.06	-0.07	-0.07	-0.01	0.10	-0.20
Carbon Tetrachloride	60	0.32	0.34	0.35	0.35	-0.03	-0.04	-0.28
Formaldehyde	61	0.82	0.80	0.66	0.74	-0.51	-0.04	-0.37
p-Dichlorobenzene	36	-0.12	-0.22	-0.19	-0.22	0.12	0.13	-0.21
Tetrachloroethylene	33	-0.05	-0.06	-0.11	-0.09	-0.14	-0.19	0.20

Figure 16-7. Composite Back Trajectory Map for GPMS

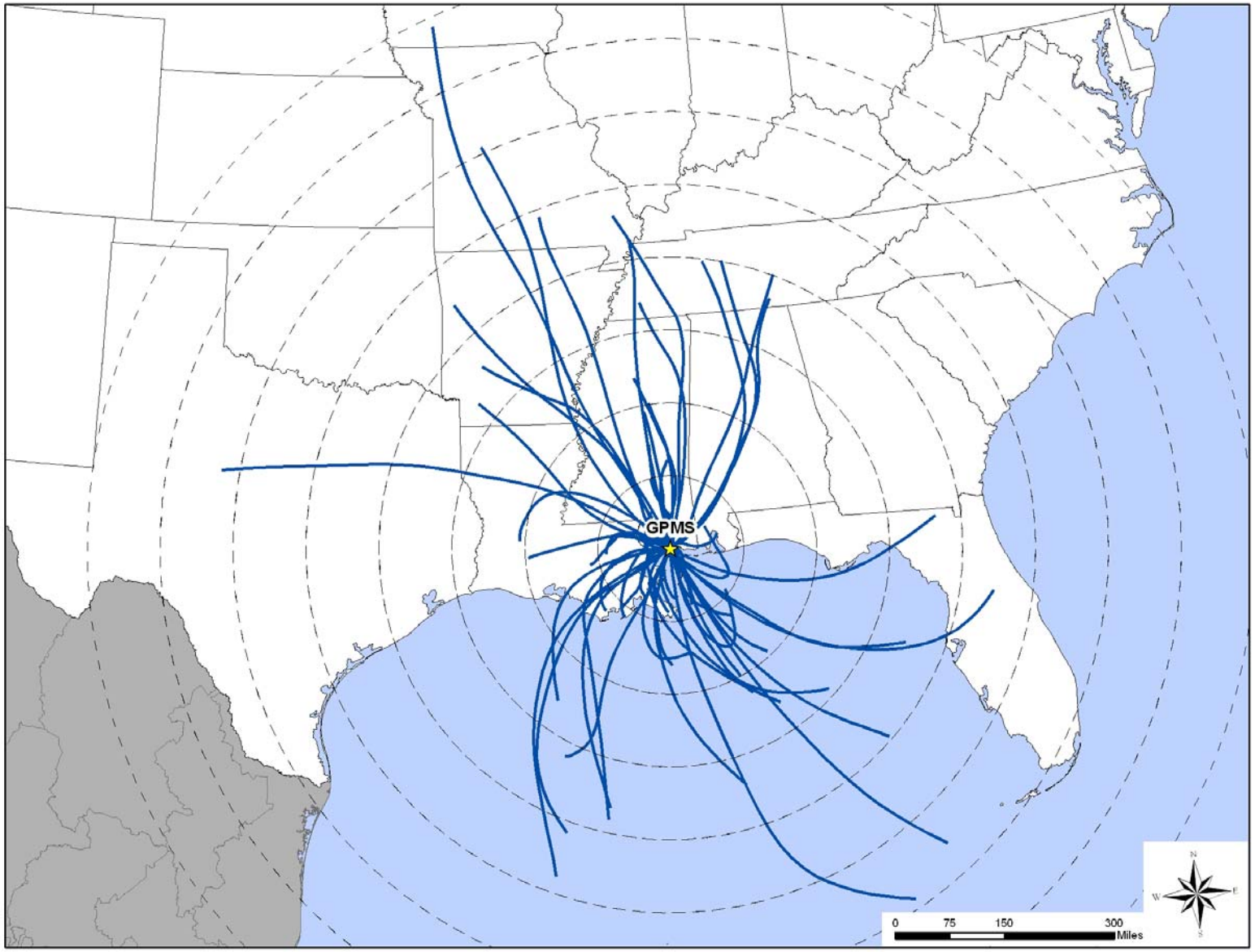
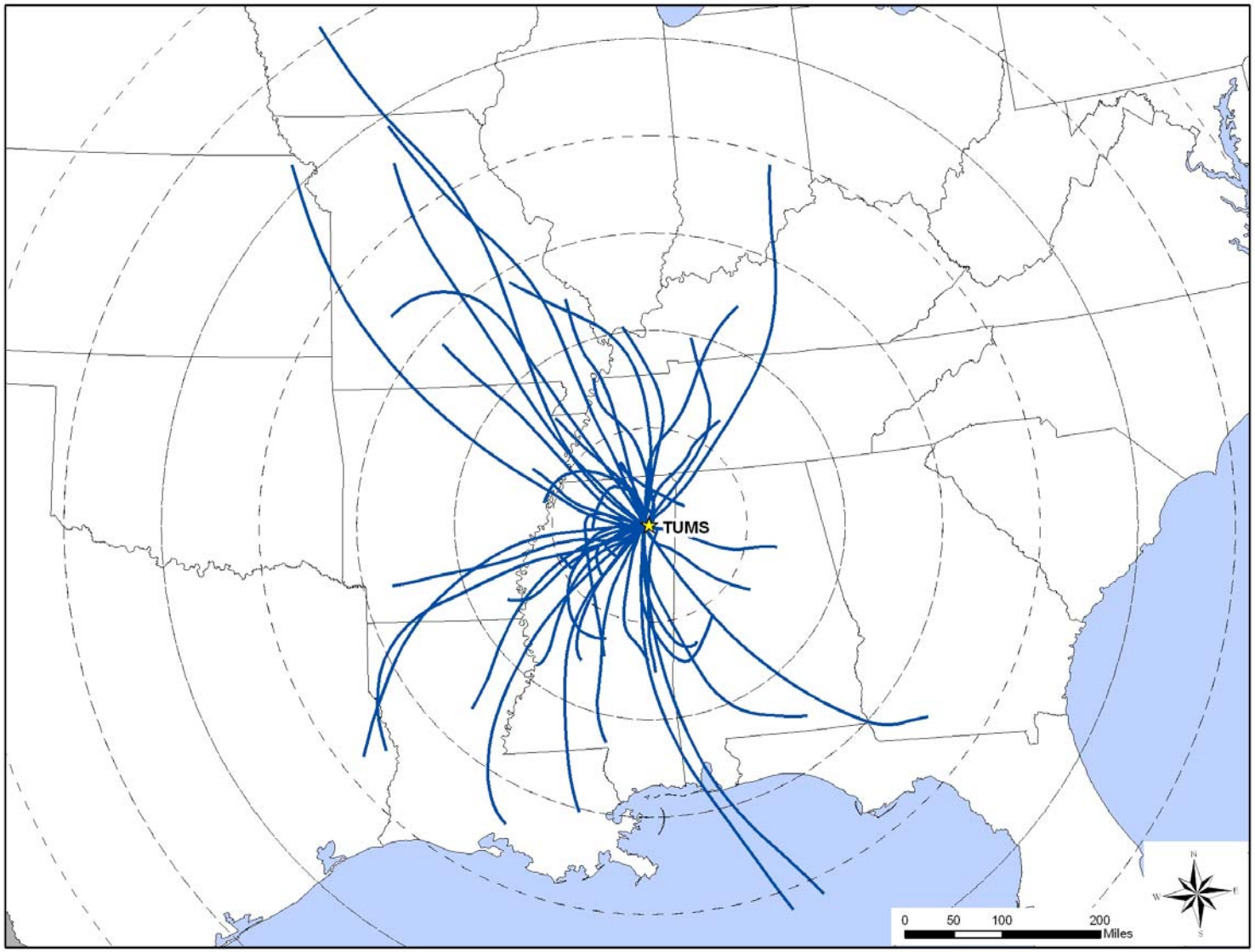


Figure 16-8. Composite Back Trajectory Map for TUMS



The following observations can be made from Figures 16-7:

- Back trajectories originated from a variety of directions at GPMS.
- The 24-hour airshed domain was somewhat larger at GPMS than at TUMS, with trajectories originating as far away as Iowa (> 800 miles). However, nearly all of the trajectories originated within 400 miles of GPMS.

The following observations can be made from Figures 16-8:

- Back trajectories also originated from a variety of directions at TUMS.
- The 24-hour airshed domain was slightly smaller at TUMS than GPMS, with the longest trajectory originating just over 600 miles away. However, most of the trajectories originated within 300 miles of the site.

16.4.3 Wind Rose Analysis

Hourly wind data from weather stations near these sites were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from submitted wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 16-9 and 16-10 are the wind roses for the Mississippi monitoring sites on days that sampling occurred.

Observations from Figure 16-9 include:

- Hourly winds were predominantly out of the north (11 percent of observations) and south (9 percent) on sampling days near GPMS.
- Calm winds (<2 knots) were recorded for 23 percent of the hourly measurements.
- Most of the observations ranged from 7 to 11 knots, although winds greater than 17 knots occurred most frequently with east-southeasterly or southeasterly winds.

Observations from Figure 16-10 include:

- Similar to GPMS, hourly winds were predominantly out of the north (15 percent of observations) and south (13 percent) on sampling days near TUMS.
- Calm winds (<2 knots) were recorded for 21 percent of the hourly measurements.

Figure 16-9. Wind Rose for GPMS Sampling Days

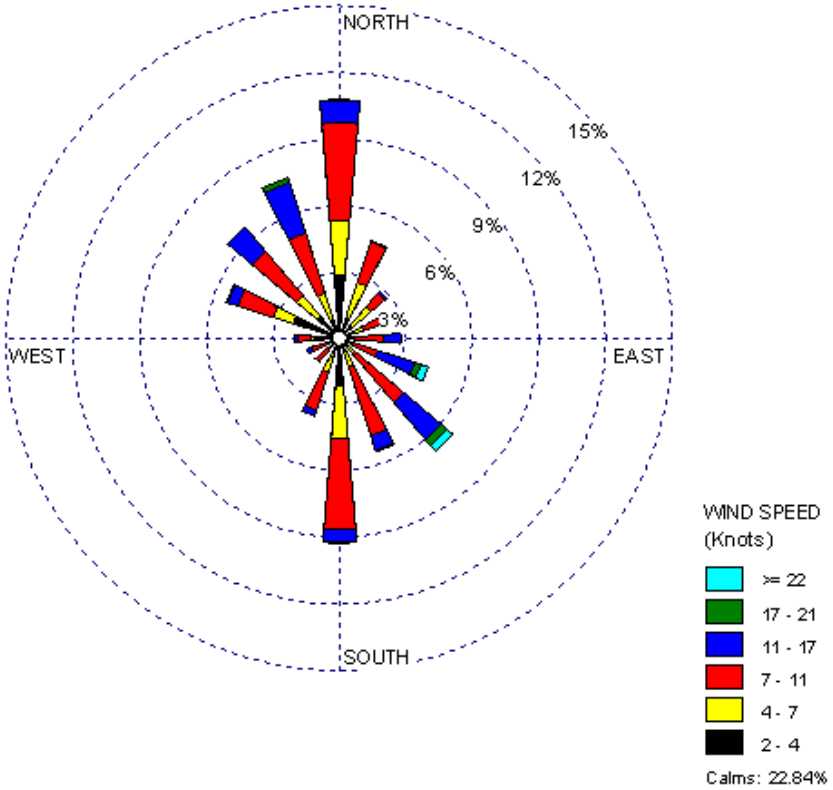
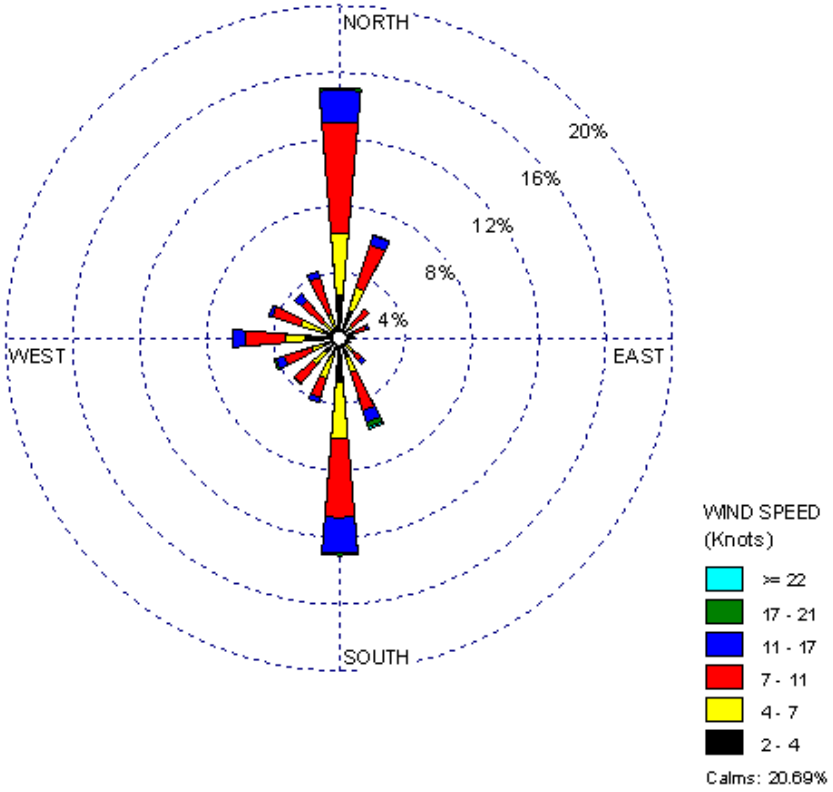


Figure 16-10. Wind Rose for TUMS Sampling Days



- Wind speeds ranging from 7 to 11 knots were the most frequently observed wind speed (32 percent of observations).

16.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and ethylene-acetylene ratio analysis.

16.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population information for Harrison and Lee County, Mississippi, were obtained from the Mississippi State Tax Commission and the U.S. Census Bureau, and are summarized in Table 16-6. Table 16-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 16-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 16-6 include:

- Population, vehicle registration, and traffic volume are higher near GPMS then TUMS.
- Both sites are in the lowest third for population and vehicle ownership compared to other UATMP sites.
- The GPMS vehicles per person estimate ranks thirteenth for all UATMP sites.

16.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the

Table 16-6. Motor Vehicle Information for the Mississippi Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
GPMS	171,875	171,674	1.00	173,435	173,232	17,000
TUMS	79,714	69,888	0.88	71,184	62,409	4,900

concentration ratios at each of the monitoring sites in an effort characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- The toluene-ethylbenzene ratio was the highest ratio for both GPMS and TUMS (6.89 ± 0.55 and 9.47 ± 0.95, respectively), and both were significantly higher than the toluene-ethylbenzene ratio for the roadside study (5.85).

- For both GPMS and TUMS, the benzene-ethylbenzene ratio was higher than the xylene-ethylbenzene ratio, which is the opposite of the roadside study.

16.5.3 Mobile Tracer Analysis

As previously stated, GPMS sampled for SNMOC in addition to VOC. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.) The ethylene to acetylene ratio for GPMS is provided in Table 3-11.

Table 3-11 shows:

- GPMS's ethylene-acetylene ratio (1.47) was somewhat lower than the 1.7 ratio.

- This ratio suggests that while mobile sources may be influencing the air quality at the GPMS monitoring site, there may also be atmospheric chemical processes affecting the quantities of ethylene in this area's air quality.

- Known sinks of ethylene include reactions with ozone, as well as soil (NLMb).

16.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. Figures 16-11 and 16-12 present the trends graphs for formaldehyde, benzene, and 1,3-butadiene for GPMS and TUMS, respectively.

The following observations can be made from Figures 16-11 and 16-12:

- The GPMS monitoring site has participated in the UATMP since 2001. After several years of decreasing, formaldehyde concentrations increased in 2005 which continued in 2006. Hurricane Katrina devastated the Gulf Coast on August 29, 2005, which could account for this increase. Benzene's average concentration also increased in 2005, but returned to 2004 levels in 2006. 1,3-Butadiene's 2006 average was the lowest of all sampling years at GPMS.

- TUMS' formaldehyde concentrations have been decreasing since 2001, as depicted in Figure 16-12. The 1,3-butadiene and benzene concentrations have not changed significantly since 2001 at TUMS.

16.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Mississippi sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 16-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 16-7. The NATA data are presented for the census tract where each monitoring site is located.

The census tract information for the Mississippi sites is as follows:

- The census tract for GPMS is 28047001700, which had a population of 6,200 and represents approximately 3.3 percent of the Harrison County population in 2000.

- The census tract for TUMS is 280081950600, which had a population of 7,862, and represents approximately 10 percent of the Lee County population in 2000.

The following observations can be made for GPMS from Table 16-7:

- The pollutants with the top three annual averages by mass concentration at GPMS were formaldehyde (2.91 ± 0.40 µg/m^3), xylenes (2.05 ± 0.45 µg/m^3), and acetaldehyde (1.74 ± 0.17 µg/m^3).

Figure 16-11. Comparison of Yearly Averages for the GPMS Monitoring Site

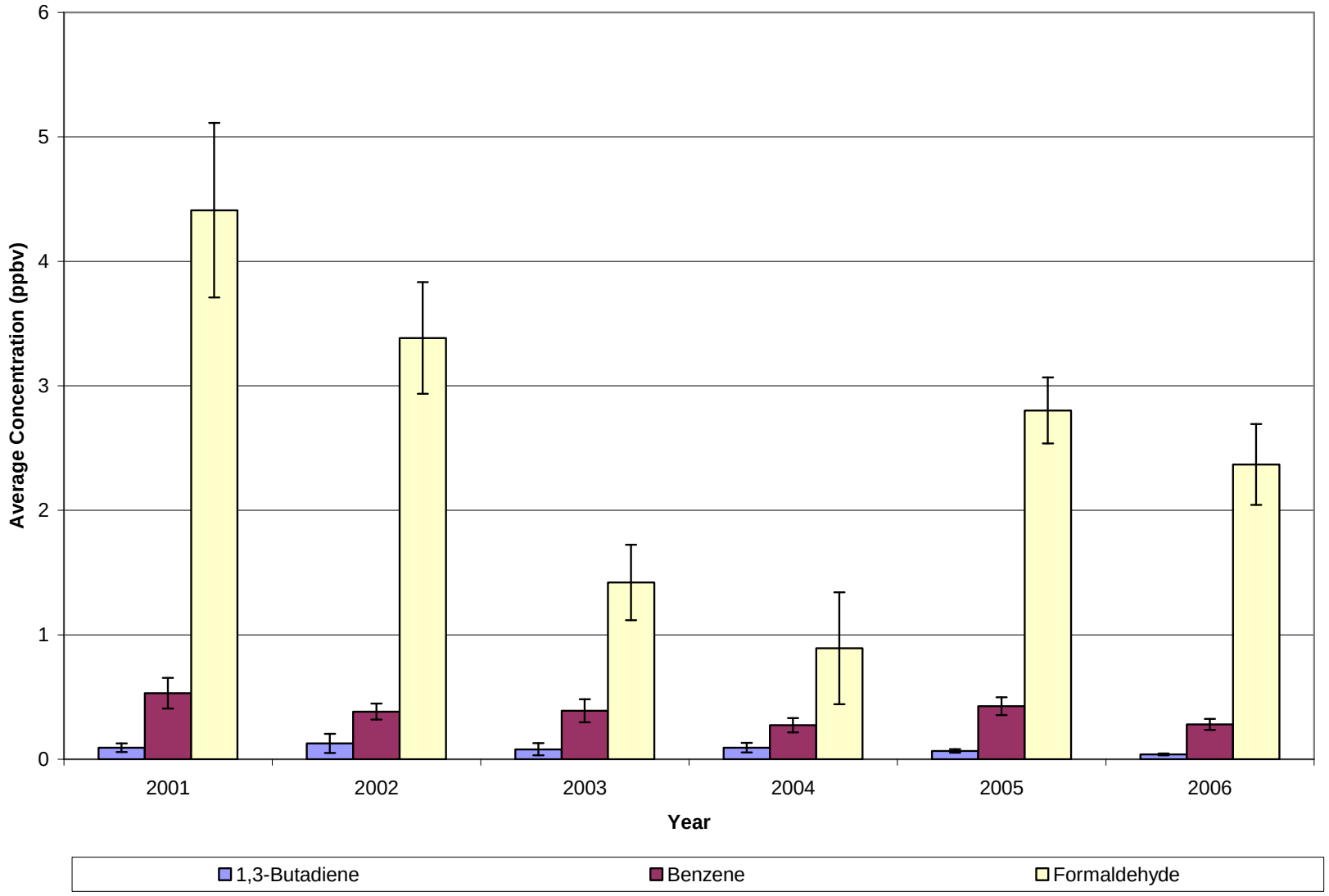


Figure 16-12. Comparison of Yearly Averages for the TUMS Monitoring Site

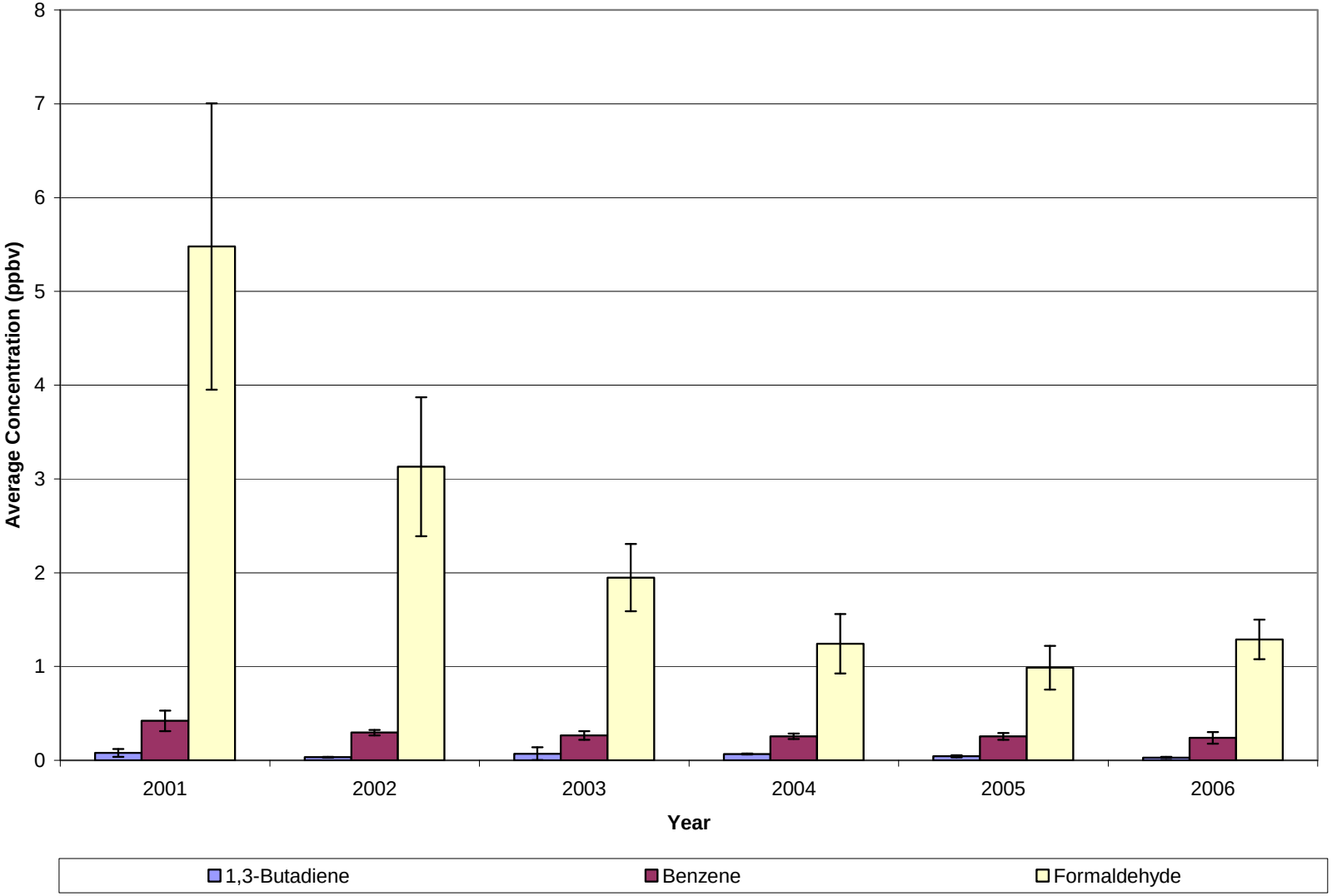


Table 16-7. Chronic Risk Summary for the Monitoring Sites in Mississippi

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Gulfport, Mississippi (GPMS) – Census Tract ID 28047001700								
Acetaldehyde	0.0000022	0.009	0.98	2.17	0.11	1.74 ± 0.17	3.84	0.19
Acrolein	NR	0.00002	0.06	NR	2.97	0.78 ± 0.10	NR	39.13
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	0.07 ± 0.02	4.46	0.03
Benzene	0.0000078	0.03	0.90	7.02	0.03	0.86 ± 0.13	6.70	0.03
1,3-Butadiene	0.00003	0.002	0.07	2.00	0.03	0.08 ± 0.01	2.33	0.04
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.65 ± 0.05	9.70	0.02
1,4-Dichlorobenzene	0.000011	0.8	0.02	0.23	<0.01	0.03 ± 0.01	0.29	<0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.02	0.23	<0.01	0.16 ± 0.02	1.75	<0.01
Dichloromethane	0.00000047	1	0.29	0.14	<0.01	0.43 ± 0.09	0.20	<0.01
Formaldehyde	5.5E-09	0.0098	0.97	0.01	0.10	2.91 ± 0.40	0.02	0.30
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.33 ± 0.14	7.15	<0.01
Naphthalene	0.000034	0.003	0.03	0.86	0.01	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	0.12	0.70	<0.01	0.15 ± 0.09	0.88	<0.01
Xylenes	NR	0.1	1.72	NR	0.02	2.05 ± 0.45	NR	0.02
Tupelo, Mississippi (TUMS) – Census Tract ID 28081950600								
Acetaldehyde	0.0000022	0.009	0.82	1.81	0.09	1.95 ± 0.24	4.29	0.22
Acrolein	NR	0.00002	0.04	NR	2.06	0.51 ± 0.12	NR	25.67
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.07 ± 0.01	4.54	0.03
Benzene	0.0000078	0.03	0.9	7.06	0.03	0.76 ± 0.20	5.94	0.03
1,3-Butadiene	0.00003	0.002	0.05	1.55	0.03	0.05 ± 0.01	1.61	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.14	0.01	0.65 ± 0.04	9.76	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.02	0.22	<0.01	0.08 ± 0.02	0.90	<0.01
1,2-Dichloroethane	0.000026	2.4	0.02	0.41	<0.01	0.03 ± <0.01	0.90	<0.01
Formaldehyde	5.5E-09	0.0098	0.76	<0.01	0.08	1.58 ± 0.26	0.01	0.16
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.22 ± 0.12	4.80	<0.01
Tetrachloroethylene	0.0000059	0.27	0.07	0.39	<0.01	0.18 ± 0.09	1.07	<0.01

BOLD indicates a pollutant of interest
NR = a risk factor is not available and therefore, no risk calculation can be made
NA = no annual average available

- The pollutants with the highest cancer risks were not these pollutants. The highest theoretical cancer risks for GPMS were calculated for carbon tetrachloride (9.70 in-a-million), hexachloro-1,3-butadiene (7.15), and benzene (6.70).

- According to the 1999 NATA, formaldehyde, xylenes, and acetaldehyde also had the highest modeled concentrations, but benzene, carbon tetrachloride, and acetaldehyde had the highest cancer risk for pollutants that failed screens at GPMS.

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1, according to both the 2006 annual average-based noncancer risk and the 1999 NATA. But the 2006 annual average-based noncancer risk for acrolein (39.13) was significantly higher than the NATA modeled noncancer risk (2.97).

- All other noncancer HQs were less than 0.35.

- No annual average, and therefore no theoretical cancer and noncancer risks, are available for naphthalene because GPMS stopped sampling SVOC in October.

The following observations can be made for TUMS from Table 16-7:

- The pollutants with the top three annual averages by mass concentration at TUMS were acetaldehyde (1.95 ± 0.24 µg/m^3), formaldehyde (1.58 ± 0.26 µg/m^3), and benzene (0.76 ± 0.20 µg/m^3), which also had the highest NATA-modeled concentrations.

- The highest theoretical cancer risks calculated from the annual averages for TUMS were carbon tetrachloride (9.76 in-a-million), benzene (5.94), and acrylonitrile (4.54), while the highest NATA cancer risks were modeled for benzene (7.06), carbon tetrachloride (3.14), and acetaldehyde (1.81).

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1, according to both the 2006 annual average-based noncancer risk and the 1999 NATA. But, similar to GPMS, the 2006 annual average-based noncancer risk for acrolein (25.67) was significantly higher than the NATA modeled noncancer risk (2.06).

- All other noncancer HQs were less than 0.30.

16.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 16-8 and 16-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 16-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with

Table 16-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Mississippi

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Gulfport, Mississippi (GPMS) – Harrison County					
Benzene	259.68	Benzene	2.03E-03	Carbon Tetrachloride	9.70
Formaldehyde	72.47	1,3-Butadiene	7.28E-04	Hexachloro-1,3-butadiene	7.15
Acetaldehyde	29.74	Lead	4.26E-04	Benzene	6.70
1,3-Butadiene	24.27	Naphthalene	1.76E-04	Acrylonitrile	4.46
Dichloromethane	16.46	Polycyclic Organic Matter as 7-PAH	1.00E-04	Acetaldehyde	3.84
Tetrachloroethylene	16.06	Arsenic	9.50E-05	1,3-Butadiene	2.33
Naphthalene	5.19	Tetrachloroethylene	9.47E-05	*p*-Dichlorobenzene	1.75
1,4-Dichlorobenzene/ *p*-Dichlorobenzene	4.09	Polycyclic Organic Matter as 15-PAH	7.92E-05	Tetrachloroethylene	0.88
Polycyclic Organic Matter as 15-PAH	1.44	Acetaldehyde	6.54E-05	1,4-Dichlorobenzene	0.29
Trichloroethylene	1.28	Hexavalent Chromium	5.94E-05	Dichloromethane	0.20
Tupelo, Mississippi (TUMS) – Lee County					
Dichloromethane	213.37	Hexavalent Chromium	2.42E-03	Carbon Tetrachloride	9.76
Benzene	125.72	Benzene	9.81E-04	Benzene	5.94
Formaldehyde	31.69	Lead	3.85E-04	Hexachloro-1,3-butadiene	4.80
Acetaldehyde	11.52	Naphthalene	3.49E-04	Acrylonitrile	4.54
Naphthalene	10.27	1,3-Butadiene	2.81E-04	Acetaldehyde	4.29
1,3-Butadiene	9.35	Nickel	1.41E-04	1,3-Butadiene	1.61
Tetrachloroethylene	6.30	Arsenic	1.13E-04	Tetrachloroethylene	1.07
Trichloroethylene	2.45	Dichloromethane	1.00E-04	1,2-Dichloroethane	0.90
1,4-Dichlorobenzene	1.66	Cadmium	9.86E-05	*p*-Dichlorobenzene	0.90
Nickel	0.88	Polycyclic Organic Matter as 7-PAH	5.37E-05	Formaldehyde	0.01

the highest cancer risk (in-a-million) as calculated from the annual average. Table 16-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. GPMS sampled for VOC, SNMOC, SVOC, and carbonyl compounds. However, GPMS stopped sampling for SVOC prior to November, so no annual average, and thus cancer and noncancer risk values, could be calculated. TUMS sampled for VOC and carbonyl compounds only. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made for GPMS from Table 16-8:

- Benzene was the highest emitted pollutant with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the third highest cancer risk based on the 2006 annual average for GPMS.

- Carbon tetrachloride and hexachloro-1,3-butadiene had the highest cancer risks based on the 2006 annual average; however, these pollutants were neither emitted in high quantities nor toxic based on the 2002 NEI emission inventory.

- Benzene, tetrachloroethylene, acetaldehyde, and 1,3-butadiene were shown on all three "top 10" lists.

The following observations can be made for TUMS from Table 16-8:

- While benzene was most commonly the highest emitted pollutant (by mass) with a cancer risk factor and had the highest cancer toxicity-weighted emissions in many UATMP counties, this was not the case for Lee County, Mississippi.

- Dichloromethane was the highest emitted pollutant, and this pollutant had the eighth highest cancer toxicity-weighted emissions. Hexavalent chromium, which did not have one of the 10 highest emissions in Lee County, had the highest cancer toxicity-weighted emissions. This indicates that hexavalent chromium has a relatively high toxicity.

Table 16-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Mississippi

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Gulfport, Mississippi (GPMS) – Harrison County					
Xylenes	1,074.93	Acrolein	257,453.61	Acrolein	39.13
Hydrochloric Acid	1,034.43	Hydrochloric Acid	51,721.52	Formaldehyde	0.30
Toluene	827.86	Chlorine	16,950.00	Acetaldehyde	0.19
Benzene	259.68	1,3-Butadiene	12,135.88	1,3-Butadiene	0.04
Ethylbenzene	231.08	Xylenes	10,749.27	Acrylonitrile	0.03
Hexane	194.60	Manganese	10,155.93	Benzene	0.03
Methanol	123.37	Benzene	8,655.88	Xylenes	0.02
Methyl Ethyl Ketone	98.22	Formaldehyde	7,394.69	Carbon Tetrachloride	0.02
Hydrogen Fluoride	78.09	Nickel	4,358.15	Hexachloro-1,3-butadiene	0.00
Formaldehyde	72.47	Cyanide	4,251.04	Tetrachloroethylene	0.00
Tupelo, Mississippi (TUMS) – Lee County					
Toluene	308.12	Acrolein	94,615.93	Acrolein	25.67
Xylenes	216.58	Nickel	13,509.96	Acetaldehyde	0.22
Dichloromethane	213.37	1,3-Butadiene	4,676.76	Formaldehyde	0.16
Methyl Isobutyl Ketone	199.44	Benzene	4,190.76	Acrylonitrile	0.03
Benzene	125.72	2,4-Toluene Diisocyanate	4,091.84	1,3-Butadiene	0.03
Methyl Ethyl Ketone	104.00	Naphthalene	3,424.92	Benzene	0.03
Glycol Ethers	63.81	Formaldehyde	3,233.42	Carbon Tetrachloride	0.02
Methanol	55.61	Manganese	3,193.98	Hexachloro-1,3-butadiene	0.00
Hexane	48.66	Glycol Ethers	3,190.27	Tetrachloroethylene	0.00
Ethylbenzene	39.37	Cadmium	2,739.45	*p*-Dichlorobenzene	0.00

- Like GPMS, carbon tetrachloride had the highest cancer risk based on the 2006 annual average for TUMS, yet this pollutant was neither one of the highest emitted nor one of the most toxic based on the 2002 NEI emission inventory.

The following observations can be made for GPMS from Table 16-9:

- Xylenes, hydrochloric acid, and toluene were the highest emitted pollutants (by mass) with noncancer risk factors in Harrison County.

- Both xylenes and hydrochloric acid were among the top 10 based on toxicity-weighted emissions.

- Although xylenes ranked seventh for GPMS for annual average-based noncancer risk, the HQ was very low (0.02). Hydrochloric acid was not sampled for at GPMS.

- Acrolein had the highest noncancer toxicity-weighted emissions in Harrison County and had the highest noncancer risk based on the 2006 annual average for GPMS, but did not appear in the list of highest emitted pollutants.

- Benzene, xylenes, and formaldehyde appeared on all three top 10 lists.

The following observations can be made for TUMS from Table 16-9:

- Although toluene and xylenes were the highest emitted pollutants with noncancer risk factors in Lee County, they did not rank in the top 10 based on toxicity-weighted emissions.

- Both of these pollutants were sampled for at TUMS, yet neither was listed as having one of the top 10 noncancer risks.

- Acrolein had the highest noncancer toxicity-weighted emissions in Lee County and had the highest noncancer risk based on the 2006 annual average for TUMS, but did not appear in the list of highest emitted pollutants.

Mississippi Pollutant Summary

- *The pollutants of interest common to each Mississippi site were acetaldehyde, benzene, carbon tetrachloride, formaldehyde, acrolein, 1,3-butadiene and p-dichlorobenzene.*

- *Acetaldehyde had the highest daily average at TUMS, while formaldehyde was highest at GPMS.*

- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of formaldehyde and benzene increased in 2005 from previous level at GPMS. Formaldehyde concentrations at TUMS have remained constant over the last few years after steadily decreasing from 2001 through 2003.*

17.0 Site in Missouri

This section presents meteorological, concentration, and spatial trends for the UATMP site in Missouri (S4MO). This site is located in the St. Louis MSA. Figure 17-1 is a topographical map showing the monitoring site in its urban location. Figure 17-2 identifies point source emission locations within 10 miles of the site that reported to the 2002 NEI for point sources. Numerous sources are located near the St. Louis site, most of which are involved in fuel combustion industries.

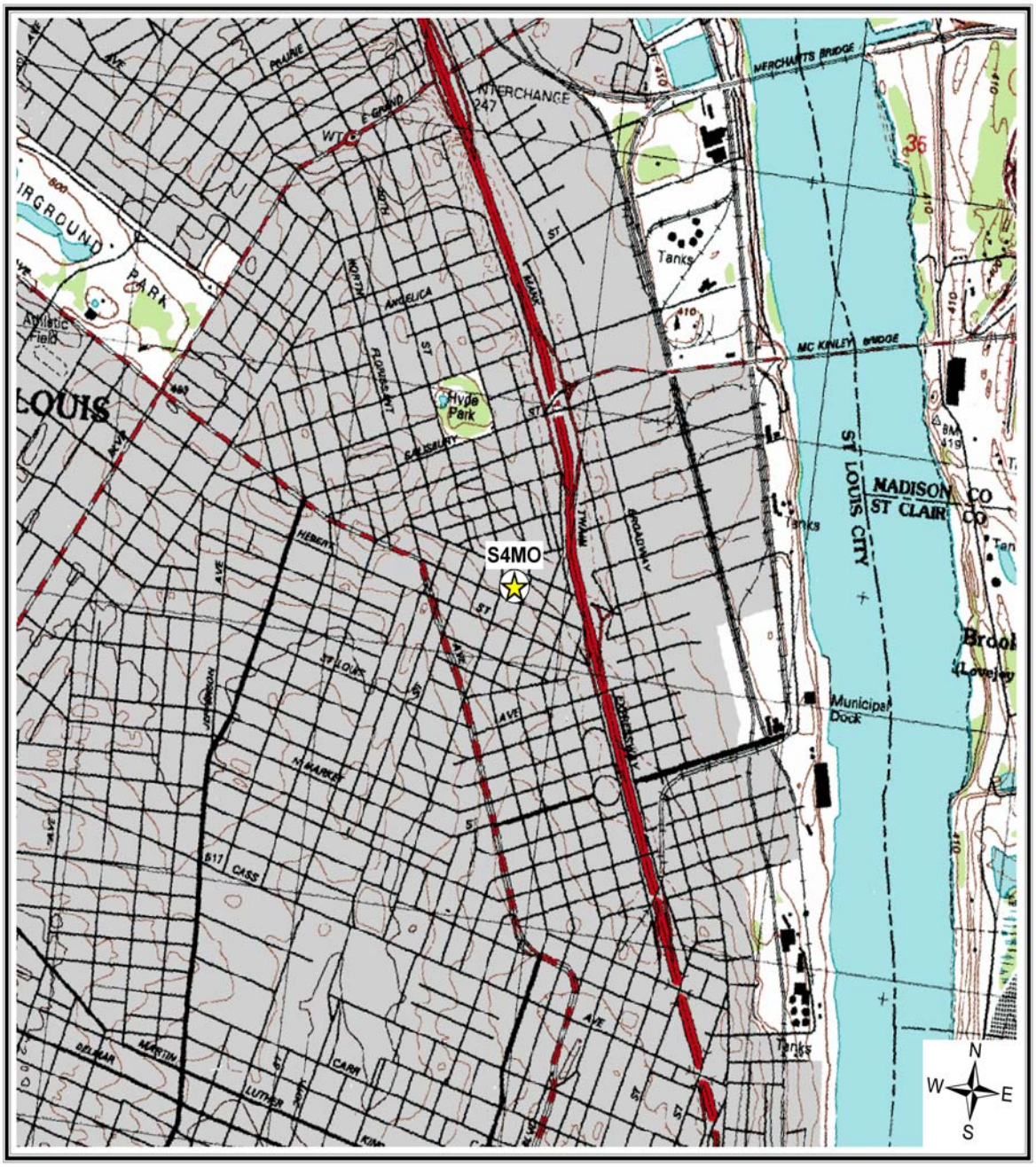
St. Louis has a climate that is continental in nature, with cold, dry winters, warm, somewhat wetter summers, and significant seasonal variability. Wind speeds are generally light and wind flows from the southeast on average (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the S4MO monitoring site is at St. Louis Downtown Airport (WBAN 03960). Table 17-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 17-1 is the 95 percent confidence interval for each parameter. As shown in Table 17-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

17.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each

Figure 17-1. St. Louis, Missouri (S4MO) Monitoring Site



Source : USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 17-2. Facilities Located Within 10 Miles of S4MO

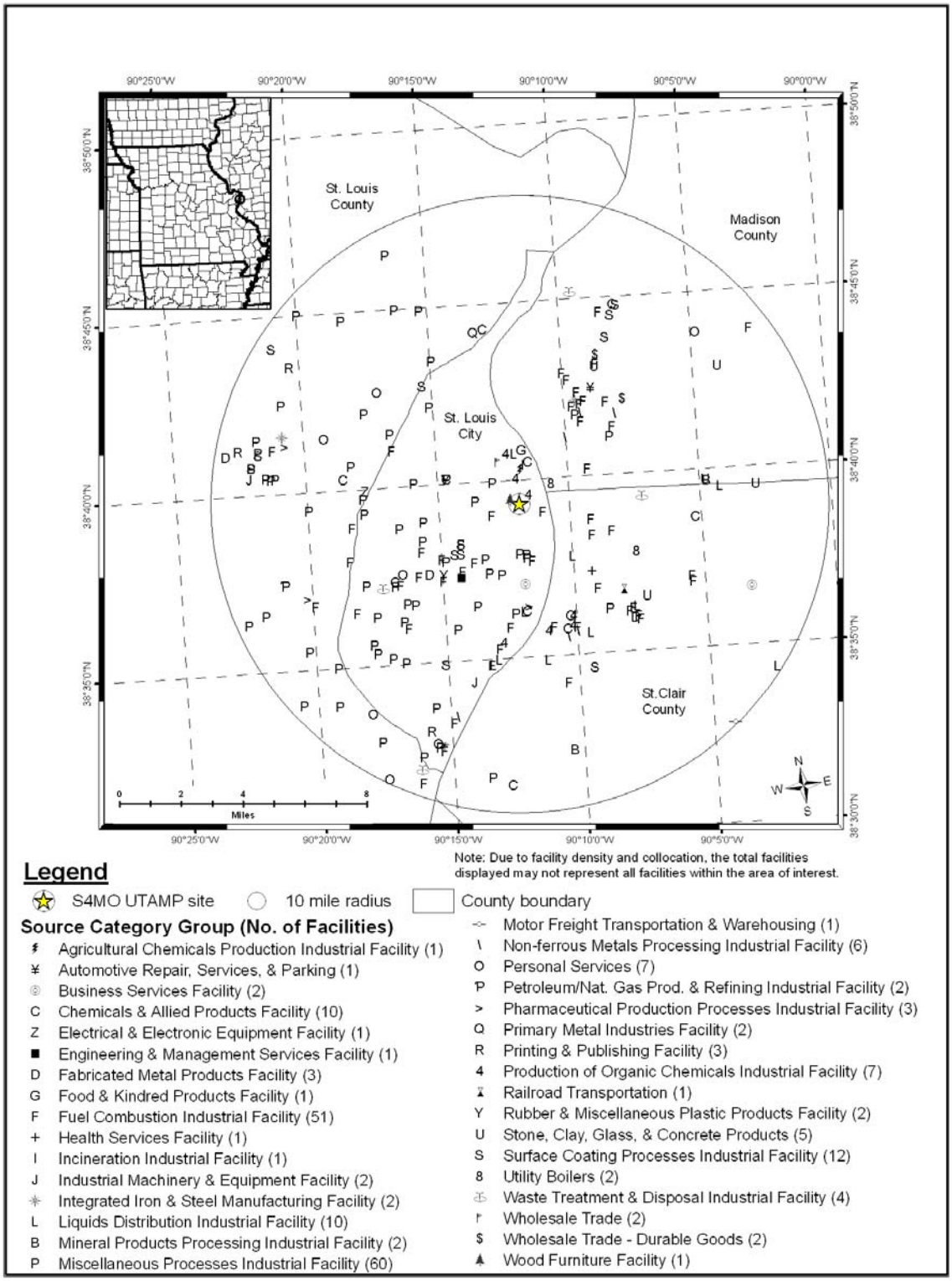


Table 17-1. Average Meteorological Conditions near the Monitoring Site in Missouri

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
S4MO	03960	All 2006	67.50 ± 1.86	57.25 ± 1.72	45.63 ± 1.74	51.23 ± 1.57	68.36 ± 1.18	1016.79 ± 0.73	6.28 ± 0.29
		Sampling Day	68.14 ± 4.23	57.91 ± 3.88	46.63 ± 3.75	51.92 ± 3.48	69.27 ± 2.57	1016.75 ± 1.33	6.08 ± 0.71

measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. S4MO sampled for carbonyls, VOC, hexavalent chromium, and metals Table 17-2 presents the nineteen pollutants that failed at least one screen at S4MO.

Table 17-2. Comparison of Measured Concentrations and EPA Screening Values for the Missouri Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Louis, Missouri – S4MO					
Acetaldehyde	61	61	100.00	11.55	11.55
Carbon Tetrachloride	59	59	100.00	11.17	22.73
Benzene	59	59	100.00	11.17	33.90
Arsenic (PM_{10})	59	59	100.00	11.17	45.08
Manganese (PM_{10})	50	59	84.75	9.47	54.55
1,3-Butadiene	49	51	96.08	9.28	63.83
Formaldehyde	49	61	80.33	9.28	73.11
Acrolein	41	41	100.00	7.77	80.87
Cadmium (PM_{10})	29	59	49.15	5.49	86.36
Tetrachloroethylene	26	49	53.06	4.92	91.29
p-Dichlorobenzene	25	45	55.56	4.73	96.02
Hexachloro-1,3-butadiene	7	7	100.00	1.33	97.35
Hexavalent Chromium	4	50	8.00	0.76	98.11
Nickel (PM_{10})	3	59	5.08	0.57	98.67
Acrylonitrile	2	2	100.00	0.38	99.05
1,2-Dichloroethane	2	2	100.00	0.38	99.43
Chloromethylbenzene	1	1	100.00	0.19	99.62
1,1,2,2-Tetrachloroethane	1	1	100.00	0.19	99.81
Trichloroethylene	1	26	3.85	0.19	100.00
Total	528	751	70.31		

The following observations are shown in Table 17-2:

- A total of 528 measured concentrations failed screens.
- The screening process at S4MO resulted in eleven pollutants of interest: acetaldehyde (61 failed screens), arsenic (59), benzene (59), carbon tetrachloride (59),

manganese (50), formaldehyde (49), 1,3-butadiene (49), acrolein (41), cadmium (29), tetrachloroethylene (26), and *p*-dichlorobenzene (25).

- Of the eleven pollutants of interest, acetaldehyde, acrolein, arsenic, benzene, and carbon tetrachloride had 100 percent of their measured detections fail the screening values.

17.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 17-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 17-3:

- Formaldehyde had the highest concentration by mass (3.19 ± 0.66 μg/m^3), followed by acetaldehyde (2.95 ± 0.58 μg/m^3) and benzene (0.91 ± 0.16 μg/m^3).

- Formaldehyde concentrations were significantly higher in summer, while acetaldehyde concentrations were highest in the spring. The remaining concentrations did not vary much by season.

- Acetaldehyde, arsenic, benzene, cadmium, carbon tetrachloride, formaldehyde, and manganese were detected in every sample collected at S4MO.

Table 17-3. Daily and Seasonal Averages for the Pollutants of Interest for the Missouri Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
St. Louis, Missouri – S4MO												
Acetaldehyde	61	61	2.95	0.58	3.41	1.28	4.18	1.64	2.21	0.22	1.97	0.26
Acrolein	41	59	0.78	0.19	0.31	0.12	NR	NR	0.73	0.26	0.96	0.47
Arsenic (PM_{10})	59	59	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	59	59	0.91	0.16	1.03	0.46	0.78	0.18	0.70	0.10	1.12	0.27
1,3-Butadiene	51	59	0.11	0.03	0.10	0.05	0.07	0.04	0.06	0.01	0.16	0.07
Cadmium (PM_{10})	59	59	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Carbon Tetrachloride	59	59	0.63	0.05	0.48	0.06	0.58	0.10	0.73	0.12	0.72	0.10
p-Dichlorobenzene	45	59	0.29	0.10	0.09	0.08	0.17	0.17	0.37	0.21	0.30	0.14
Formaldehyde	61	61	3.19	0.66	1.41	0.51	1.77	0.71	6.82	1.11	2.86	0.62
Manganese (PM_{10})	59	59	0.02	<0.01	0.01	0.01	0.02	0.01	0.01	<0.01	0.02	0.01
Tetrachloroethylene	49	59	0.20	0.03	0.17	0.06	0.15	0.06	0.17	0.03	0.22	0.08

NR = Not reportable due to the low number of measured detections.

17.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for S4MO was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the nineteen pollutants with at least one failed screen, only acrolein exceeded the acute risk values, and its non-chronic risk is summarized in Table 17-4.

The following observations about acrolein are shown in Table 17-4:

- All forty-one acrolein measured detections were greater than the ATSDR MRL acute risk value of 0.11 $\mu g/m^3$ and 39 were greater than the California EPA REL value of 0.19 $\mu g/m^3$.
- The average measured concentration was 0.78 ± 0.19 $\mu g/m^3$, which is more than four times the California REL value.
- A valid seasonal average could not be calculated for spring due to the low number of measured detections.
- The remaining seasonal averages ranged from more than three to over 10 times the ATSDR intermediate risk MRL.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of daily concentration and daily average wind direction. Figure 17-3 is a pollution rose for acrolein at S4MO.

Observations gleaned from the acrolein pollution rose include:

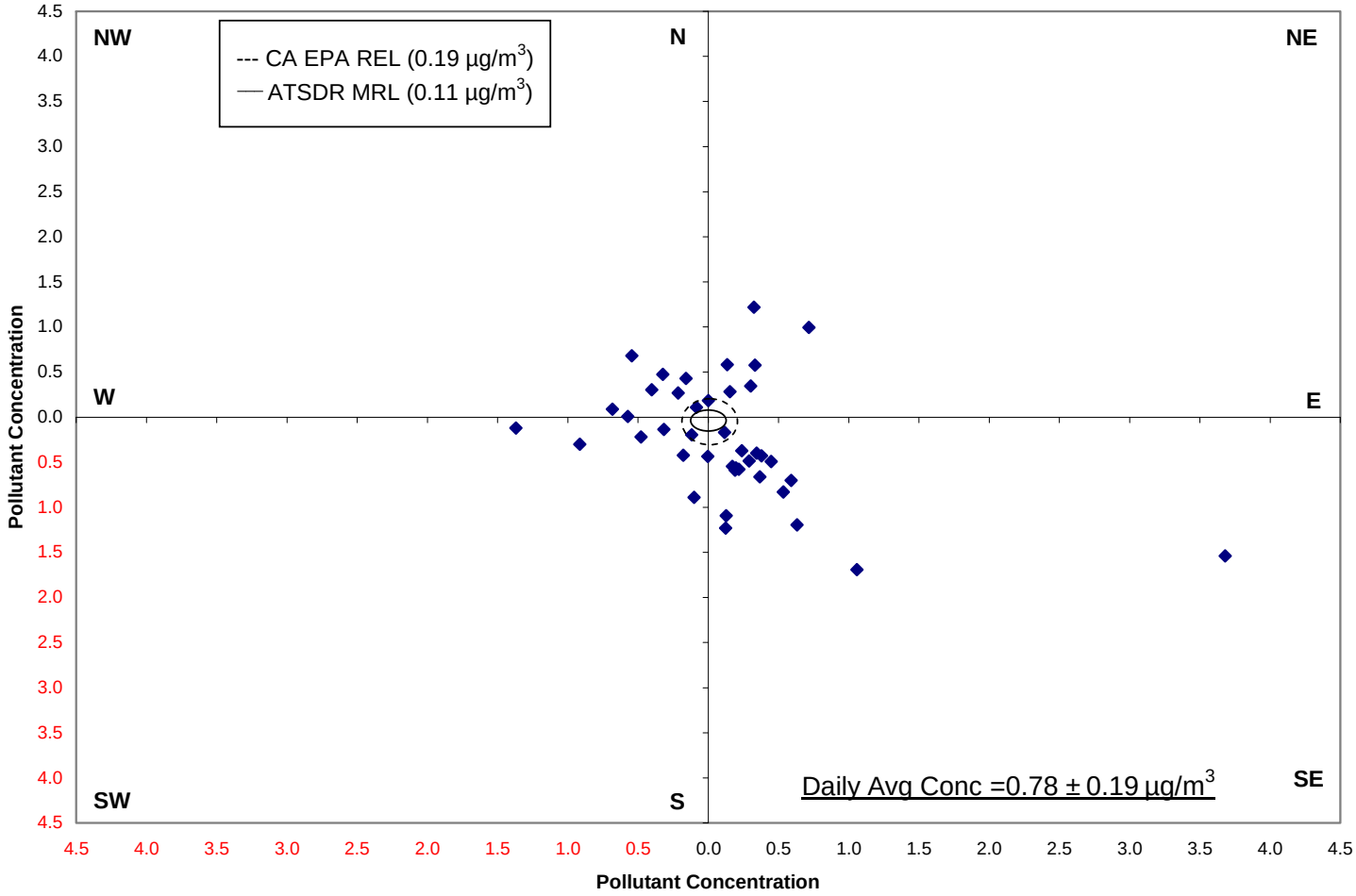
- All of the acrolein concentrations exceeded the ATSDR MRL acute risk factor, indicated by a solid line, and all but two exceeded the CalEPA REL, indicated by a dashed line.
- The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources.

Table 17-4. Non-Chronic Risk Summary for the Missouri Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
S4MO	TO-15	Acrolein	0.78 ± 0.19	0.11	41	0.19	39	0.09	0.31 ± 0.12	NR	0.73 ± 0.26	0.96 ± 0.47

NR = Not reportable due to the low number of measured detections.

Figure 17-3. Acrolein Pollution Rose for S4MO



- The highest concentration of acrolein was measured on a day with an east-southeasterly wind. A number of fuel combustion emission sources are located in the same general direction.

- S4MO is located in downtown St. Louis, between I-70 and another major roadway.

17.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

17.4.1 Pearson Correlation Analysis

Table 17-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters at the S4MO monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 17-5:

- Formaldehyde exhibited strong positive correlations with maximum, average, dew point and wet bulb temperatures, which indicates that formaldehyde concentrations increase as temperature and moisture content increase.

- Carbon tetrachloride also exhibited strong positive correlations with maximum and average temperature.

- All of the correlations between the pollutants of interest and scalar wind speed were negative, indicating that as wind speeds decrease, concentrations increase.

- The remaining correlations were generally weak.

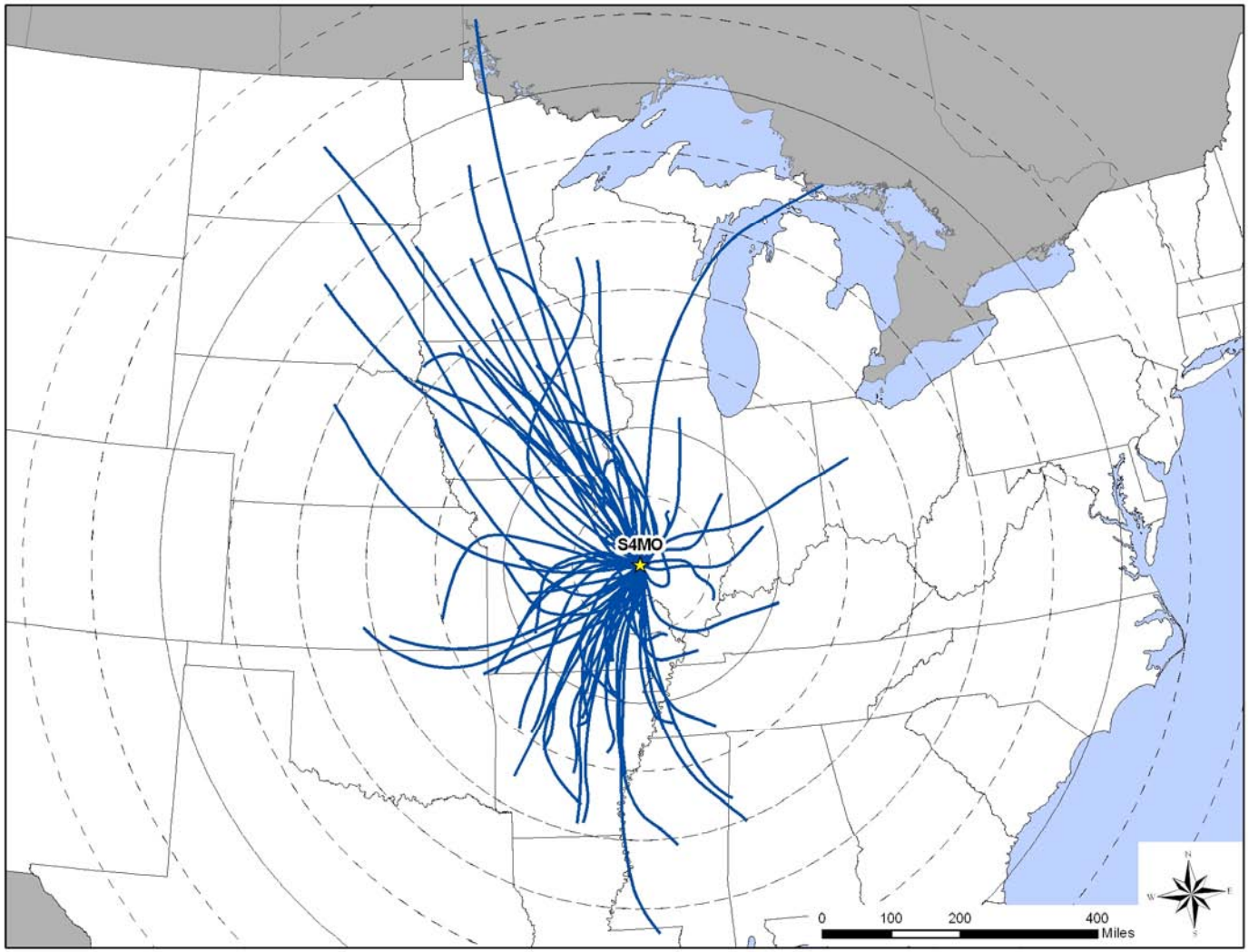
17.4.2 Composite Back Trajectory Analysis

Figure 17-4 is a composite back trajectory map for the S4MO monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 17-4 represents 100 miles.

Table 17-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Missouri Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
St. Louis, Missouri – S4MO								
Acetaldehyde	61	0.03	-0.07	-0.13	-0.10	-0.18	-0.09	-0.19
Acrolein	41	0.22	0.18	0.21	0.20	0.12	-0.16	-0.34
Arsenic (PM_{10})	59	-0.03	-0.13	-0.13	-0.13	0.05	0.14	-0.36
Benzene	59	-0.04	-0.17	-0.18	-0.18	0.02	-0.07	-0.37
1,3-Butadiene	51	-0.12	-0.24	-0.26	-0.24	-0.01	-0.08	-0.31
Cadmium (PM_{10})	59	0.28	0.22	0.18	0.21	-0.11	0.00	-0.44
Carbon Tetrachloride	59	0.52	0.50	0.47	0.48	-0.07	-0.06	-0.37
p-Dichlorobenzene	45	0.20	0.18	0.18	0.18	0.05	-0.08	-0.30
Formaldehyde	61	0.76	0.75	0.70	0.73	-0.14	0.02	-0.49
Manganese (PM_{10})	59	0.07	0.04	-0.05	-0.01	-0.30	-0.01	-0.10
Tetrachloroethylene	49	0.25	0.09	0.04	0.07	-0.09	-0.02	-0.50

Figure 17-4. Composite Back Trajectory Map for S4MO



The following observations can be made from Figure 17-4:

- Back trajectories originated from a variety of directions at S4MO, although there was an apparent lack of trajectories from the east.
- The 24-hour airshed domain was very large at S4MO, with trajectories originating as far away as western Ontario, Canada (> 800 miles).
- The majority of the trajectories originated within 400 miles of the site.

17.4.3 Wind Rose Analysis

Hourly wind data from the St. Louis Downtown Airport near the S4MO monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 17-5 is the wind rose for the S4MO monitoring site on days that sampling occurred.

Observations from Figure 17-5 include:

- Hourly winds were predominantly out of the southeast (12 percent), south-southeast (11 percent of observations), and south (10 percent), on sampling days.
- Wind speeds commonly ranged from 7 to 11 knots on sampling days.
- Calm winds (<2 knots) were observed for 19 percent of the measurements.

17.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

17.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in St. Louis City and St. Louis County, Missouri were obtained from the Missouri Department of Revenue and the U.S. Census Bureau, and are summarized in Table 17-6. Table 17-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is

Figure 17-5. Wind Rose for S4MO Sampling Days

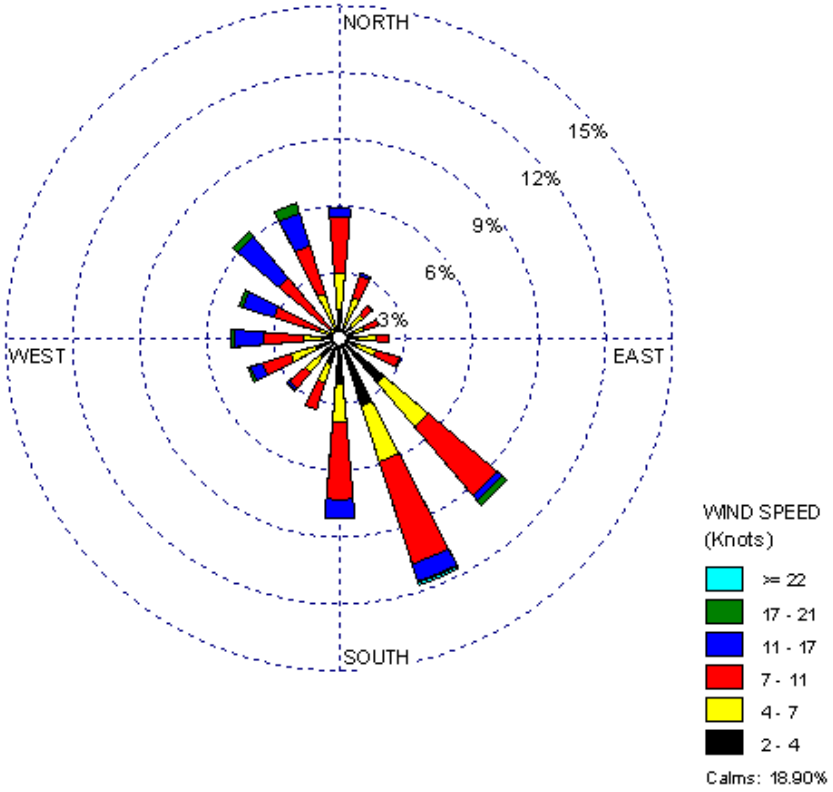


Table 17-6. Motor Vehicle Information for the Missouri Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
S4MO	1,347,691	1,438,244	1.07	821,898	877,122	22,840

presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 17-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis

Observations gleaned from Table 17-6 include:

- Compared to other UATMP sites, S4MO has the 7th highest county population and the 8th highest county-level vehicle registration count.
- S4MO also has the 10th highest estimated vehicle registration-to-population ratio.
- The average daily traffic count falls in the middle of the range compared to other UATMP sites.
- The S4MO monitoring site is in a residential area and is located in an urban-city center setting.

17.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- The toluene-ethylbenzene ratio (5.73 ± 0.58, respectively) was very similar to that of the roadside study (5.85).
- But unlike the roadside study, the benzene-ethylbenzene ratio (3.55 ± 0.43) was higher than the xylenes-ethylbenzene ratio (2.80 ± 0.20).

17.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was

conducted. Details on how this analysis was conducted can be found in Section 3.3.4. S4MO has been a participant in the UATMP since 2002. Figure 17-6 presents the trends analysis for formaldehyde, benzene, and 1,3-butadiene for S4MO. Based on Figure 17-6, the following observations were made:

- The average benzene concentration decreased slightly in 2006.
- S4MO's 1,3-butadiene concentrations have been decreasing since 2004, although difficult to discern in Figure 17-6.
- When the confidence intervals, represented by the error bars, are taken into account, formaldehyde concentrations have changed little over the period, although a slight downward trend seems likely.

17.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at S4MO and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 17-7. Additionally, the pollutants of interest are bolded. In addition to the annual averages and risks based on 2006 monitoring data, data from EPA's 1999 NATA were retrieved and are also presented in Table 17-7. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the Missouri monitoring site is as follows:

- The census tract for S4MO is 29510109700.
- The population for this census tract was 4,016, which represents approximately 0.3 percent of the St. Louis County population in 2000.

The following observations, based on the annual averages, can be made from Table 17-7:

- The pollutants with the top 3 annual averages by mass concentration at S4MO were formaldehyde (3.19 ± 0.66 µg/m^3), acetaldehyde (2.95 ± 0.58 µg/m^3), and benzene (0.91 ± 0.16 µg/m^3).

Figure 17-6. Comparison of Yearly Averages for the S4MO Monitoring Site

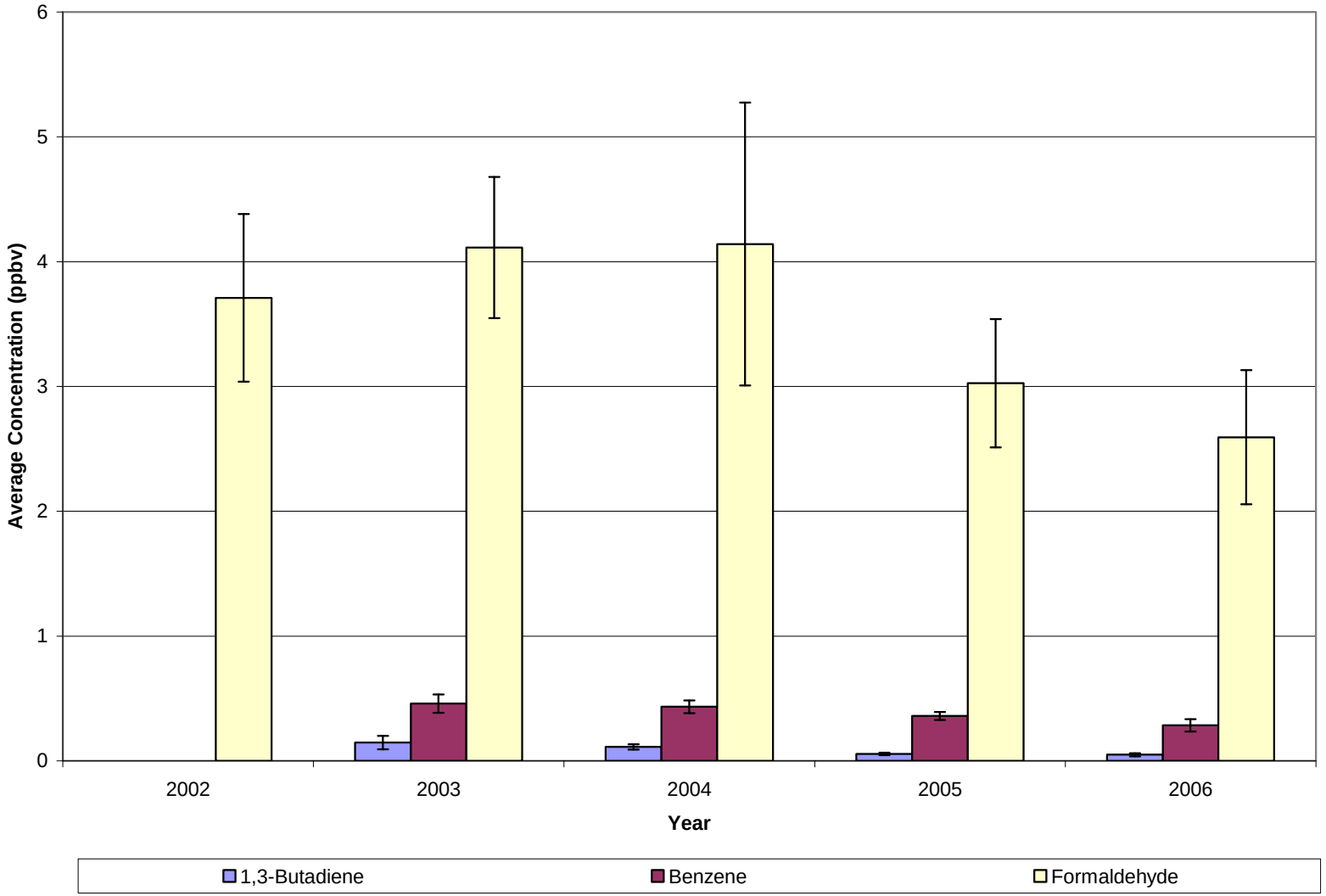


Table 17-7. Chronic Risk Summary for the Monitoring Site in Missouri

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
St. Louis, Missouri (S4MO) – Census Tract ID 29510109700								
Acetaldehyde	0.0000022	0.009	2.36	5.18	0.26	2.95 ± 0.58	6.49	0.33
Acrolein	NR	0.00002	0.24	NR	11.89	0.58 ± 0.150	NR	28.83
Acrylonitrile	0.000068	0.002	<0.01	0.31	<0.01	0.07 ± 0.01	4.48	0.03
Arsenic*	0.0043	0.00003	0.10	0.42	<0.01	<0.01 ± <0.01	4.53	0.04
Benzene	0.0000078	0.03	2.47	19.27	0.08	0.91 ± 0.16	7.09	0.03
1,3-Butadiene	0.00003	0.002	0.23	6.86	0.11	0.10 ± 0.03	2.88	0.05
Cadmium*	0.0018	0.00002	1.54	2.77	0.08	<0.01 ± <0.01	1.18	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.63 ± 0.05	9.38	0.02
Chloromethylbenzene	0.000049	NR	<0.01	<0.01	NR	0.01 ± <0.01	0.68	NR
***p*-Dichlorobenzene**	0.000011	0.8	0.25	2.77	<0.01	0.23 ± 0.08	2.48	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.91	<0.01	0.03 ± <0.01	0.81	<0.01
Formaldehyde	5.5E-09	0.0098	2.18	0.01	0.22	3.19 ± 0.66	0.02	0.33
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.09 ± 0.02	1.92	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	2.34	<0.01	<0.01 ± <0.01	0.49	<0.01
Manganese*	NR	0.00005	12.02	NR	0.24	0.02 ± <0.01	NR	0.33
Nickel*	0.00016	0.000065	1.29	0.21	0.02	<0.01 ± <0.01	0.19	0.02
1,1,2,2-Tetrachloroethane	0.000058	NR	0.05	3.15	NR	0.05 ± <0.01	2.66	NR
Tetrachloroethylene	0.0000059	0.27	0.23	1.37	<0.01	0.17 ± 0.03	1.03	<0.01
Trichloroethylene	0.000002	0.6	0.30	0.61	<0.01	0.10 ± 0.04	0.20	<0.01

*Metals sampled were sampled with PM_{10} filters

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

- Carbon tetrachloride had the highest theoretical cancer risk for S4MO (9.38 in-a-million).

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1 (28.83), based on the 2006 annual average at S4MO. All other noncancer HQs were less than 0.40.

- According to the 1999 NATA, manganese had the highest modeled concentration (12.02 $\mu g/m^3$).

- Benzene (19.27 in-a-million), 1,3-butadiene (6.86), and acetaldehyde (5.18) have the highest NATA-modeled cancer risks for pollutants that failed screens at S4MO.

- Like the noncancer risks based on the 2006 annual average, the only NATA-modeled noncancer risk greater than 1 was for acrolein (11.89).

17.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 17-8 and 17-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 17-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest cancer toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 17-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. S4MO sampled for VOC, metals, hexavalent chromium, and carbonyl compounds. In addition, the highest cancer and noncancer risk based on annual averages are limited to those pollutants failing at least one screen.

Table 17-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Site in Missouri

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for St. Louis)		Top 10 Noncancer Toxicity-Weighted Emissions (for St. Louis)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for S4MO)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
St. Louis, Missouri – S4MO					
Benzene	252.44	Benzene	1.97E-03	Carbon Tetrachloride	9.38
Formaldehyde	160.07	1,3-Butadiene	9.00E-04	Benzene	7.09
Acetaldehyde	62.89	Arsenic	3.76E-04	Acetaldehyde	6.49
1,3-Butadiene	29.99	Hydrazine	3.19E-04	Arsenic	4.53
Trichloroethylene	27.61	Naphthalene	2.64E-04	Acrylonitrile	4.48
Tetrachloroethylene	18.28	Acetaldehyde	1.38E-04	1,3-Butadiene	2.88
Dichloromethane	13.23	Nickel	1.12E-04	1,1,2,2-Tetrachloroethane	2.66
Naphthalene	7.76	Tetrachloroethylene	1.08E-04	*p*-Dichlorobenzene	2.48
Polycyclic Organic Matter as 15-PAH	1.15	Polycyclic Organic Matter as 7-PAH	9.38E-05	Hexachloro-1,3-butadiene	1.92
Nickel	0.70	Hexavalent Chromium	9.34E-05	Cadmium	1.18

Table 17-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Site in Missouri

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for St. Louis)		Top 10 Noncancer Toxicity-Weighted Emissions (for St. Louis)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for S4MO)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
St. Louis, Missouri – S4MO					
Toluene	688.46	Acrolein	386,409.41	Acrolein	28.83
Xylenes	453.77	Chlorine	23,771.26	Manganese	0.33
Methanol	445.40	Hydrochloric Acid	17,433.37	Acetaldehyde	0.33
Hydrochloric Acid	348.67	Formaldehyde	16,333.56	Formaldehyde	0.33
Methyl *Tert*-Butyl Ether	307.77	1,3-Butadiene	14,995.08	1,3-Butadiene	0.05
Methyl Ethyl Ketone	278.82	Nickel	10,815.37	Arsenic	0.04
Ethylene Glycol	254.91	Maleic Anhydride	9,645.64	Acrylonitrile	0.03
Benzene	252.44	Benzene	8,414.77	Cadmium	0.03
Formaldehyde	160.07	Acetaldehyde	6,987.50	Benzene	0.03
Methyl Isobutyl Ketone	142.97	Manganese	5,315.48	Nickel	0.02

The following observations can be made from Table 17-8:

- Benzene was the highest emitted pollutant with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the second highest cancer risk based on the 2006 annual average for S4MO.

- Carbon tetrachloride had the highest cancer risk based on the 2006 annual average, yet this pollutant was neither one of the highest emitted nor one of the most toxic based on the 2002 NEI emission inventory.

- Benzene, acetaldehyde, and 1,3-butadiene appeared on all three "top 10" lists.

The following observations can be made from Table 17-9:

- Although toluene and xylenes were the highest emitted pollutants with noncancer risk factors in St. Louis City, they did not rank in the top 10 based on toxicity-weighted emissions or the annual average-based noncancer risk.

- Acrolein had the highest noncancer toxicity-weighted emissions in St. Louis City and had the highest noncancer risks based on the 2006 annual average at both sites, but did not appear in the list of highest emitted pollutants.

- Formaldehyde, acetaldehyde, and manganese tied for second highest noncancer risk based on the 2006 annual averages and had some of the highest toxicity-weighted emissions, but only formaldehyde had one of the highest total emissions near S4MO.

Missouri Pollutant Summary

- *The pollutants of interest at the Missouri site were acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, formaldehyde, manganese, p-dichlorobenzene, and tetrachloroethylene.*

- *Formaldehyde had the highest daily average for S4MO. Formaldehyde was highest in summer, and acetaldehyde was highest in spring.*

- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

- *A comparison of formaldehyde, benzene, and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of all three pollutants appear to have decreased from 2005 to 2006. However, the formaldehyde confidence intervals indicate that this decrease in formaldehyde was not statistically significant.*

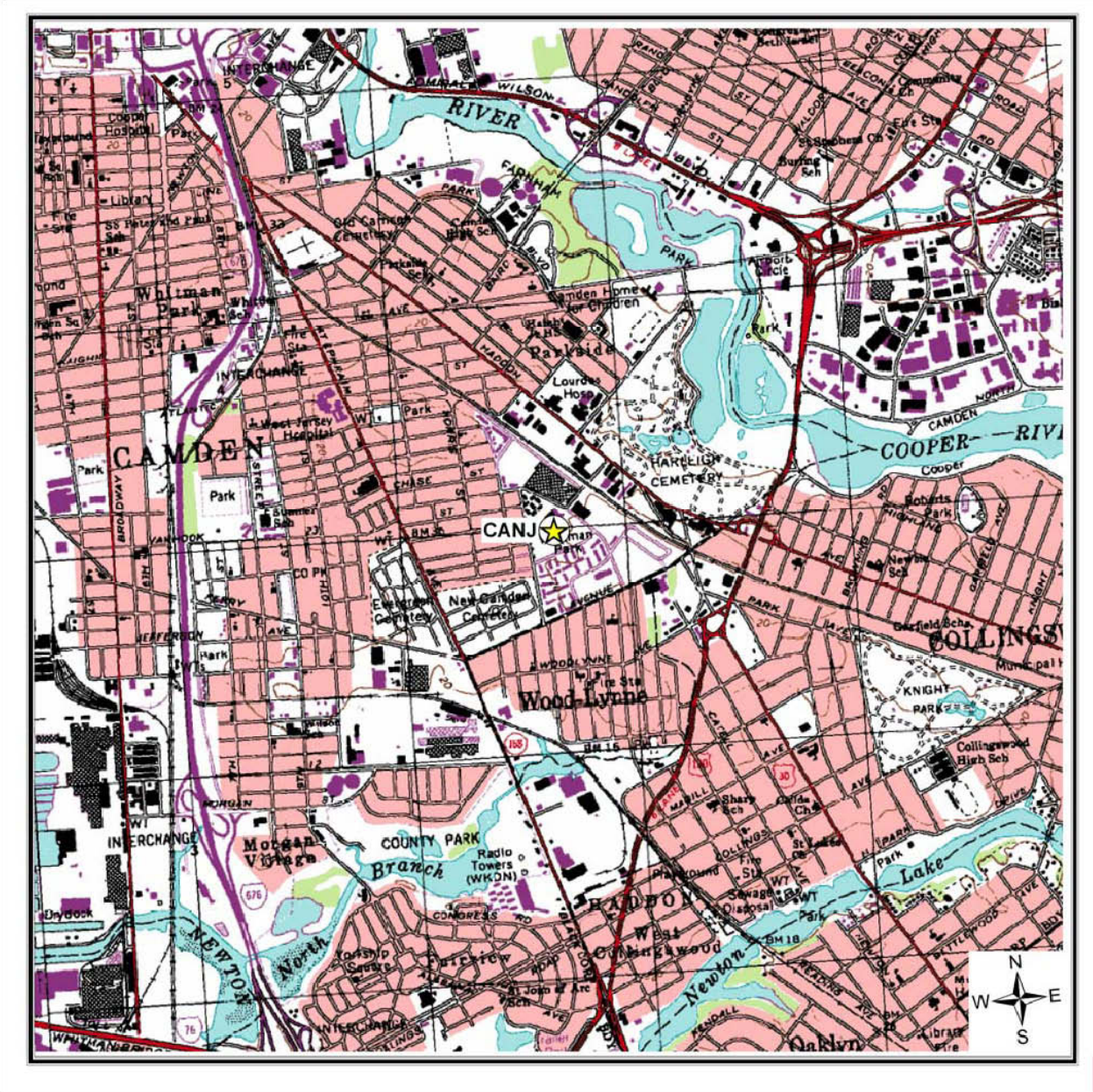
18.0 Sites in New Jersey

This section presents meteorological, concentration, and spatial trends for the four UATMP sites in New Jersey (CANJ, CHNJ, ELNJ, and NBNJ). The four sites are located in Camden, Chester, Elizabeth, and New Brunswick, New Jersey, respectively. Figures 18-1 through 18-4 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 18-5 through 18-7 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. CANJ is located on the southwest side of the state, near the PA/NJ border and east of Philadelphia. A number of point sources are located mainly to its north and west, most of which are involved in fuel combustion processes. CHNJ is located in the north-central part of New Jersey and has only eight industrial sources nearby, most of which lie just within the 10 mile radius from the site. ELNJ and NBNJ are close to each other, with the outer portions of their 10 mile radii intersecting. These two sites are near the New Jersey/New York border, just west of Staten Island, and have a number of sources in the vicinity, most of which are fuel combustion processes, chemical and allied products production, and liquid distribution processes.

Storm systems frequently track across New Jersey, producing fairly variable weather. However, its proximity to the Atlantic Ocean has a moderating effect on temperature. Summers along the coast tend to be cooler than areas farther inland, while winters tend to be warmer. New Jersey's location also allows for ample annual precipitation and high humidity. A southwesterly wind is most common in the summer and a northwesterly wind is typical in the winter (Ruffner and Bair, 1987).

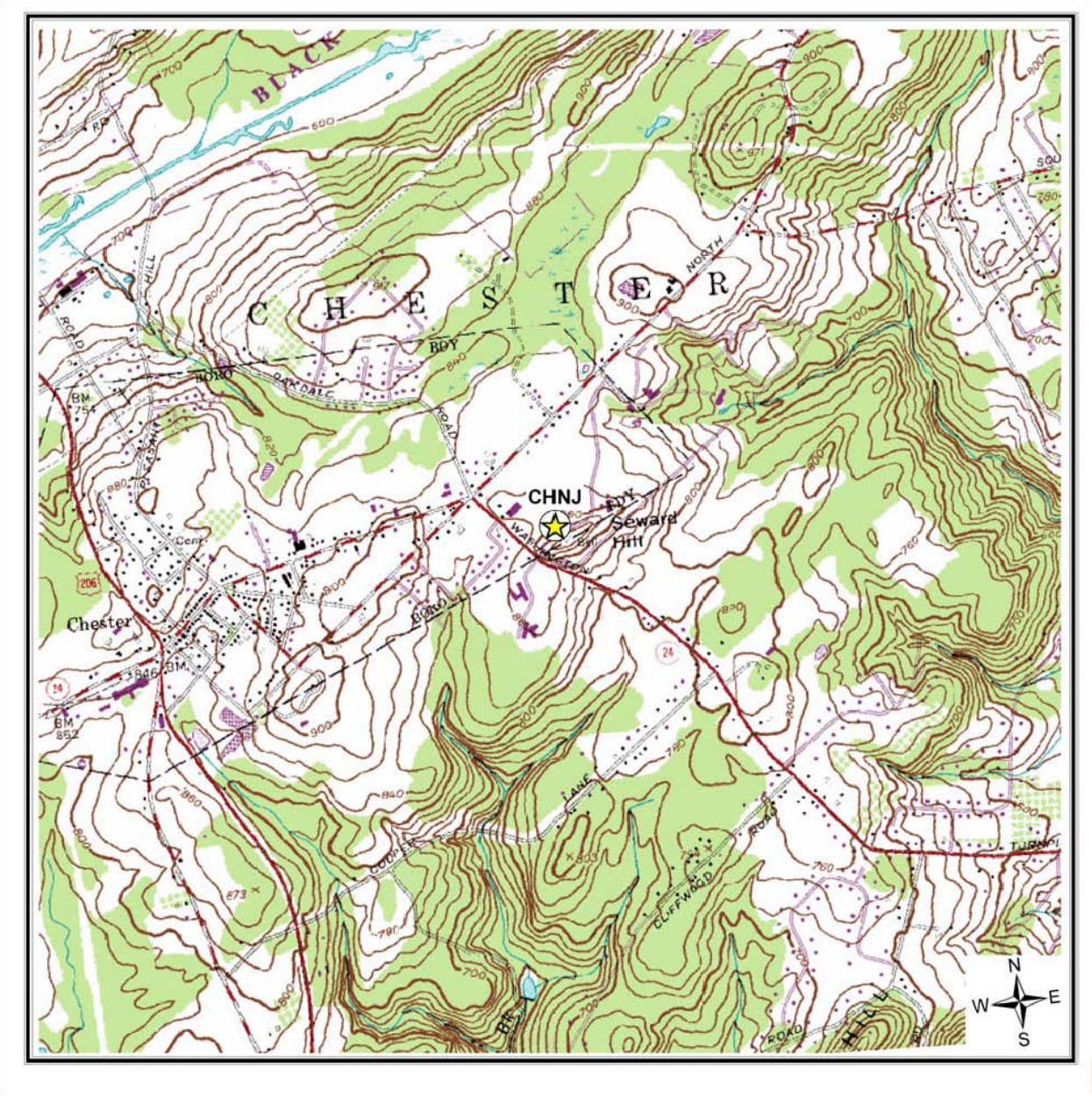
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to CANJ is Philadelphia International (WBAN 13739); the closest station to CHNJ and NBNJ is Somerville-Somerset Airport (WBAN 54785); and Newark International Airport (WBAN 14734)

Figure 18-1. Camden, New Jersey (CANJ) Monitoring Site



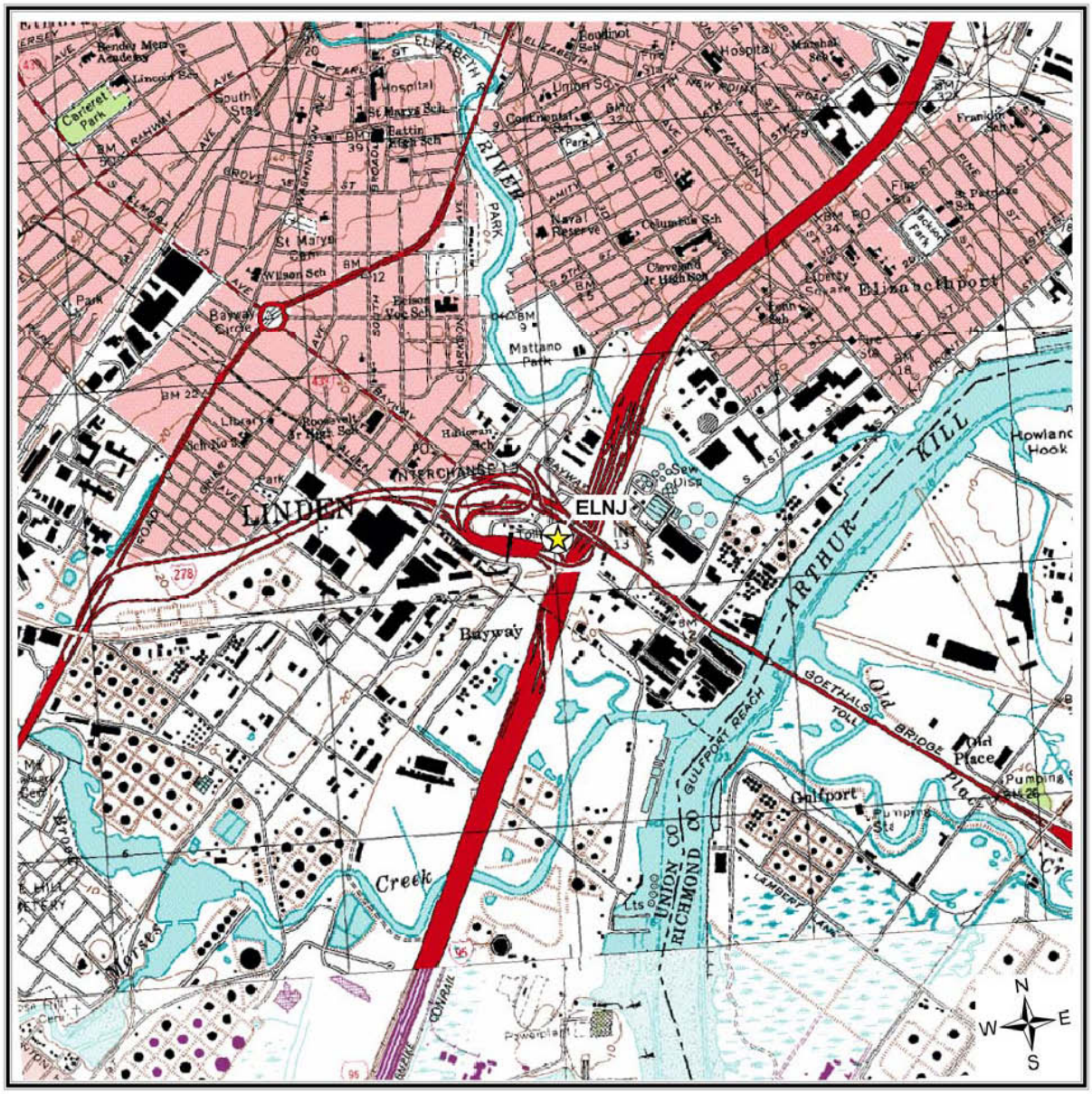
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 18-2. Chester, New Jersey (CHNJ) Monitoring Site



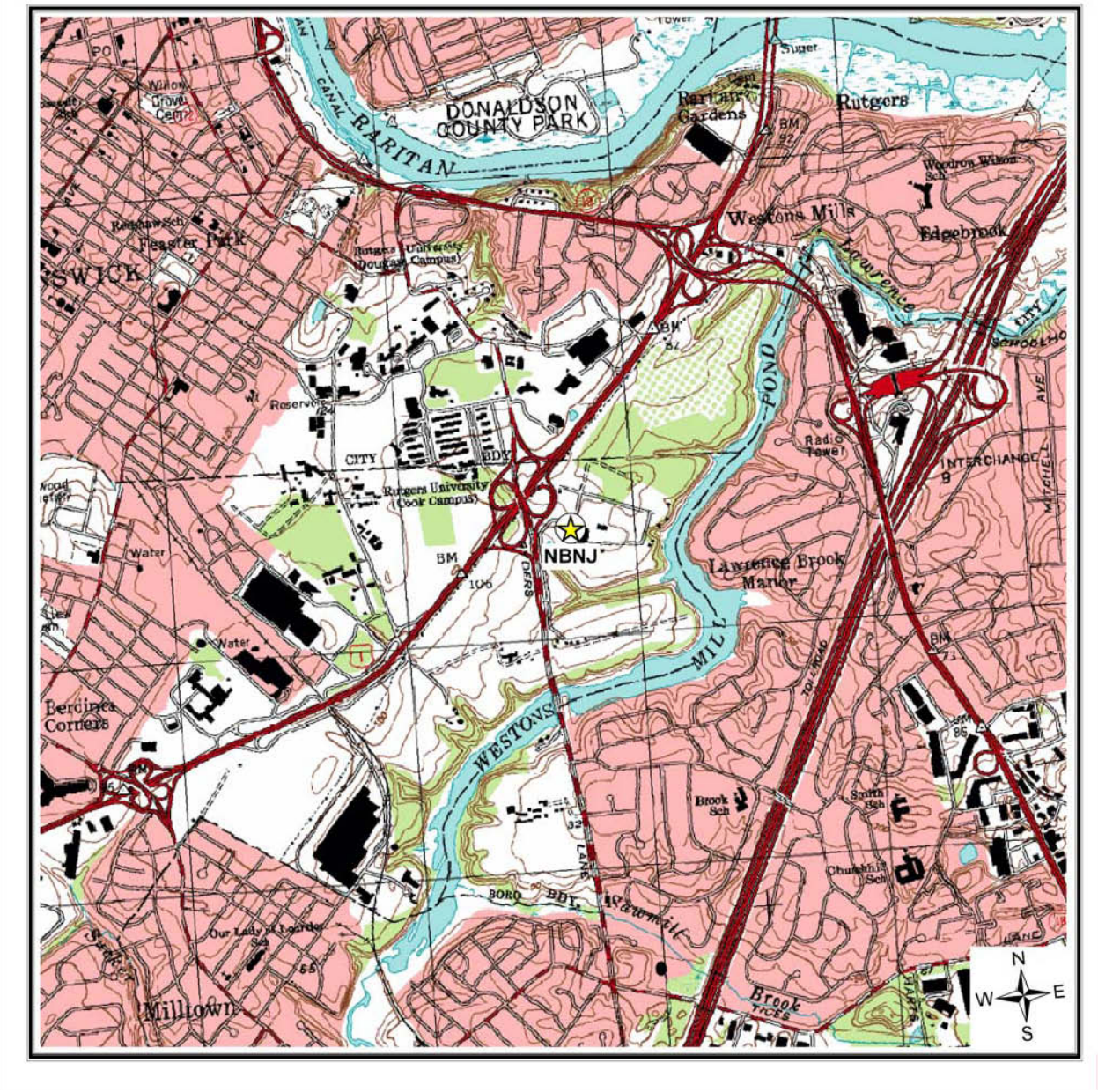
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 18-3. Elizabeth, New Jersey (ELNJ) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 18-4. New Brunswick, New Jersey (NBNJ) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 18-5. Facilities Located Within 10 Miles of CANJ

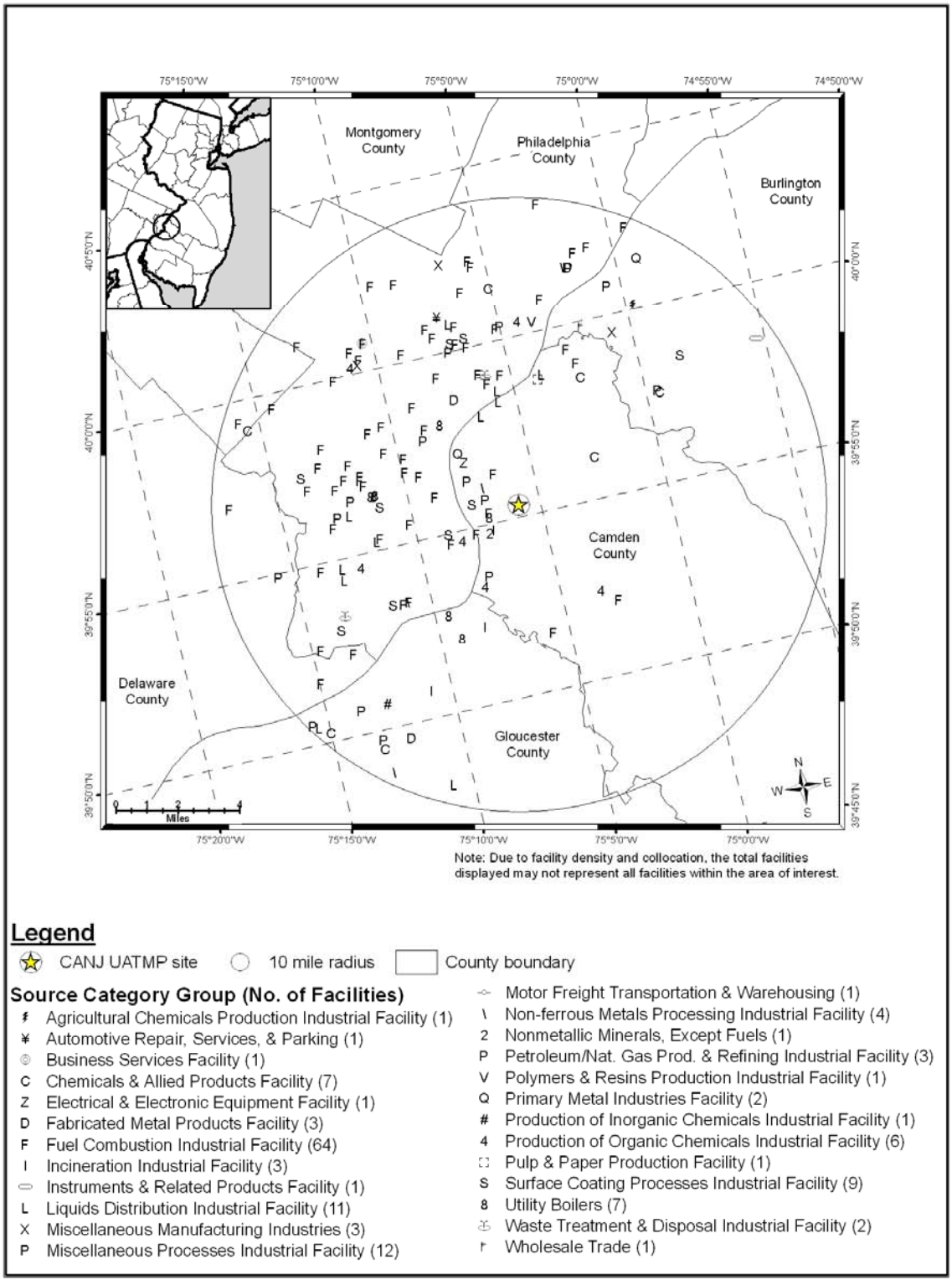


Figure 18-6. Facilities Located Within 10 Miles of CHNJ

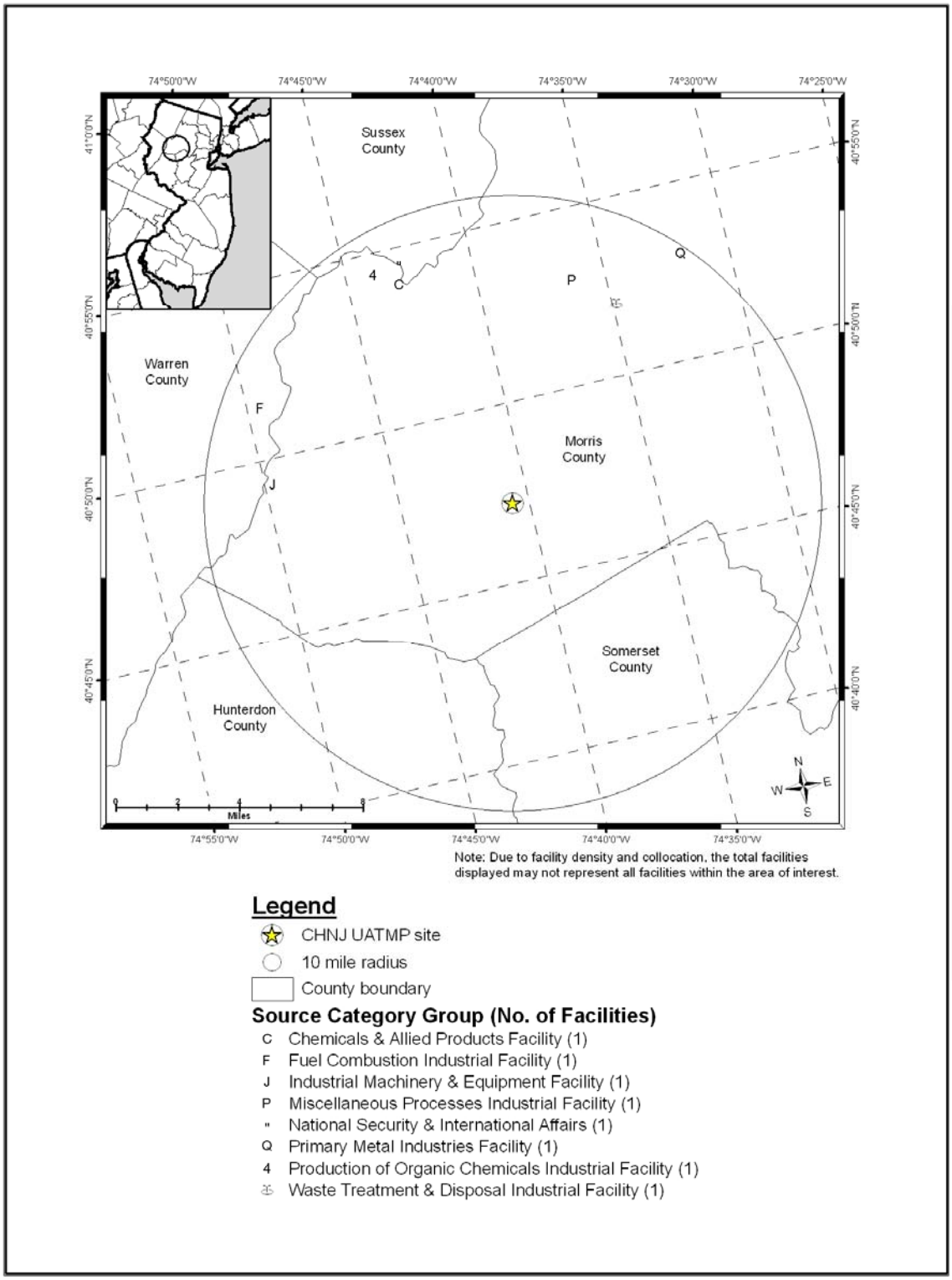
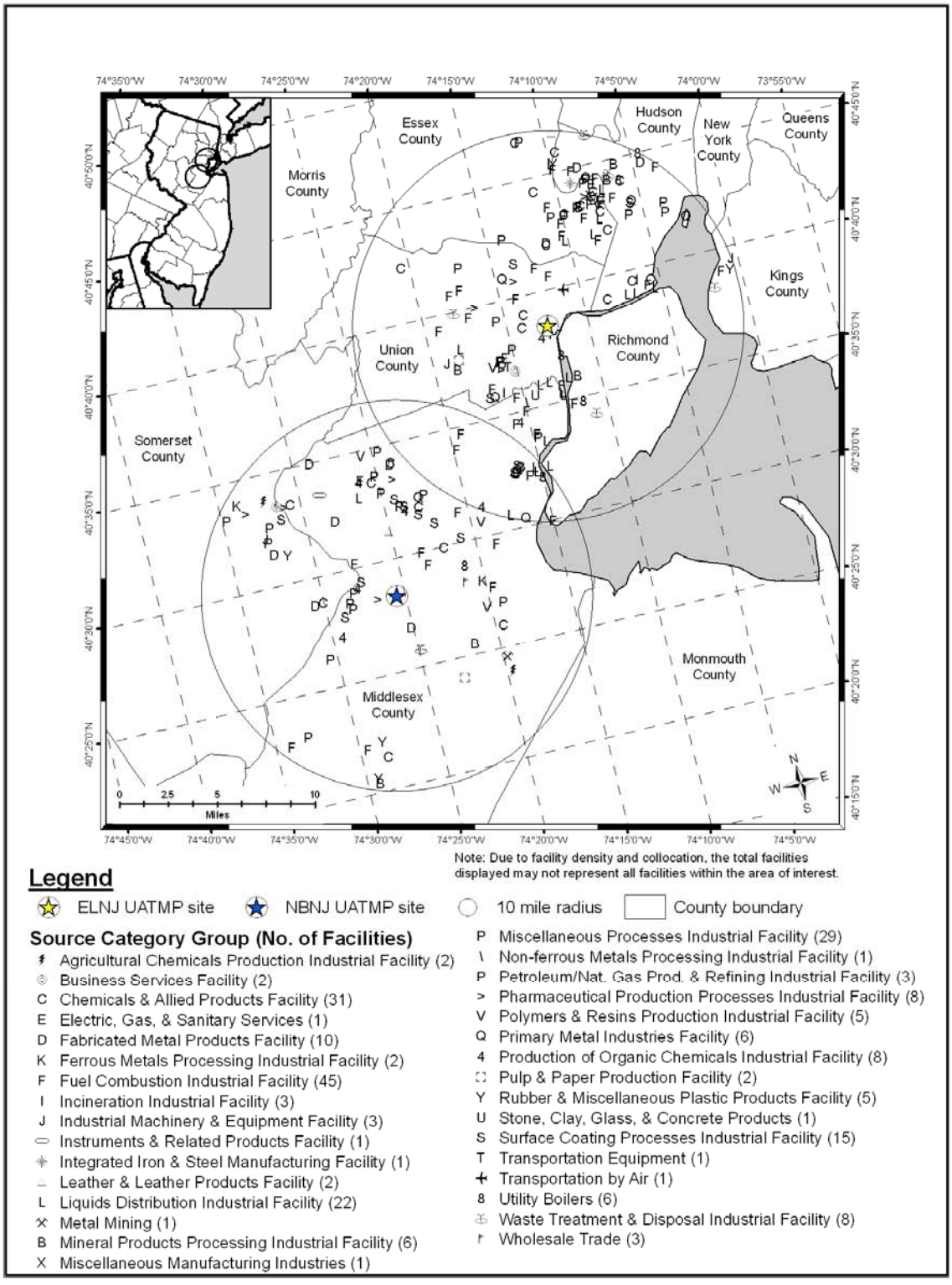


Figure 18-7. Facilities Located Within 10 Miles of ELNJ and NBNJ



is the closest weather station to ELNJ. Table 18-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 18-1 is the 95 percent confidence interval for each parameter. As shown in Table 18-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

18.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. The New Jersey sites sampled for carbonyl compounds and VOC only. Table 18-2 presents the pollutants that failed at least one screen at the New Jersey monitoring sites.

The following observations are shown in Table 18-2:

- Fifteen pollutants with a total of 446 measured concentrations failed the screen at CANJ; twelve pollutants with a total of 299 measured concentrations failed the screen at CHNJ; seventeen pollutants with a total of 451 measured concentrations failed the screen at ELNJ; and twelve pollutants with a total of 326 measured concentrations failed the screen at NBNJ.

- The pollutants of interest also varied by site, yet the following seven pollutants contributed to the top 95 percent of the total failed screens at each New Jersey monitoring site: acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, carbon tetrachloride, and tetrachloroethylene.

- One hundred percent of the acrolein, carbon tetrachloride, and benzene measured detections failed the screen at each New Jersey site.

Table 18-1. Average Meteorological Conditions near the Monitoring Sites in New Jersey

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CANJ	13739	All 2006	65.58 ± 1.68	57.51 ± 1.59	42.76 ± 1.83	50.46 ± 1.49	61.17 ± 1.56	1016.11 ± 0.73	8.18 ± 0.34
		Sampling Day	65.53 ± 4.06	57.50 ± 3.83	43.55 ± 4.26	50.73 ± 3.53	63.21 ± 4.08	1016.07 ± 1.70	7.53 ± 0.72
CHNJ	54785	All 2006	64.83 ± 1.69	54.30 ± 1.59	42.45 ± 1.85	48.74 ± 1.55	67.90 ± 1.43	1015.30 ± 0.74	3.65 ± 0.26
		Sampling Day	64.70 ± 3.99	54.06 ± 3.82	43.48 ± 4.25	48.96 ± 3.66	71.20 ± 3.41	1015.16 ± 1.69	3.30 ± 0.60
ELNJ	14734	All 2006	64.82 ± 1.71	57.09 ± 1.62	41.83 ± 1.82	48.82 ± 1.50	59.75 ± 1.50	1015.51 ± 0.74	8.71 ± 0.33
		Sampling Day	64.68 ± 4.15	57.16 ± 3.89	42.79 ± 4.12	50.15 ± 3.49	61.81 ± 3.73	1015.55 ± 1.73	8.13 ± 0.78
NBNJ	54785	All 2006	64.83 ± 1.69	54.30 ± 1.59	42.45 ± 1.85	48.74 ± 1.55	67.90 ± 1.43	1015.30 ± 0.74	3.65 ± 0.26
		Sampling Day	64.47 ± 4.03	53.91 ± 3.84	43.22 ± 4.30	48.79 ± 3.70	70.91 ± 3.45	1015.27 ± 1.71	3.33 ± 0.60

18-10

Table 18-2. Comparison of Measured Concentrations and EPA Screening Values for the New Jersey Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Camden, New Jersey – CANJ					
Formaldehyde	57	57	100.00	12.78	12.78
Acetaldehyde	57	57	100.00	12.78	25.56
Benzene	53	53	100.00	11.88	37.44
Carbon Tetrachloride	53	53	100.00	11.88	49.33
1,3-Butadiene	51	52	98.08	11.43	60.76
p-Dichlorobenzene	49	51	96.08	10.99	71.75
Tetrachloroethylene	49	52	94.23	10.99	82.74
Acrolein	42	42	100.00	9.42	92.15
Bromomethane	14	53	26.42	3.14	95.29
Trichloroethylene	9	42	21.43	2.02	97.31
Acrylonitrile	4	4	100.00	0.90	98.21
Dichloromethane	3	53	5.66	0.67	98.88
Methyl *tert*-Butyl Ether	3	49	6.12	0.67	99.55
1,2-Dichloroethane	1	1	100.00	0.22	99.78
Hexachloro-1,3-butadiene	1	1	100.00	0.22	100.00
Total	446	620	71.94		
Chester, New Jersey – CHNJ					
Benzene	58	58	100.00	19.40	19.40
Carbon Tetrachloride	58	58	100.00	19.40	38.80
Acetaldehyde	57	58	98.28	19.06	57.86
Formaldehyde	49	58	84.48	16.39	74.25
Acrolein	41	41	100.00	13.71	87.96
1,3-Butadiene	14	37	37.84	4.68	92.64
Tetrachloroethylene	12	45	26.67	4.01	96.66
Hexachloro-1,3-butadiene	4	4	100.00	1.34	97.99
1,2-Dichloroethane	2	2	100.00	0.67	98.66
p-Dichlorobenzene	2	22	9.09	0.67	99.33
Chloromethylbenzene	1	1	100.00	0.33	99.67
Acrylonitrile	1	1	100.00	0.33	100.00
Total	299	385	77.66		
Elizabeth, New Jersey – ELNJ					
Formaldehyde	59	59	100.00	13.08	13.08
Acetaldehyde	59	59	100.00	13.08	26.16
Carbon Tetrachloride	58	58	100.00	12.86	39.02
Benzene	58	58	100.00	12.86	51.88
1,3-Butadiene	55	55	100.00	12.20	64.08
Acrolein	50	50	100.00	11.09	75.17
Tetrachloroethylene	44	56	78.57	9.76	84.92
p-Dichlorobenzene	40	55	72.73	8.87	93.79
Methyl *tert*-Butyl Ether	6	48	12.50	1.33	95.12

Table 18-2. Comparison of Measured Concentrations and EPA Screening Values for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Hexachloro-1,3-butadiene	5	5	100.00	1.11	96.23
Xylenes	4	58	6.90	0.89	97.12
Acrylonitrile	4	4	100.00	0.89	98.00
1,2-Dichloroethane	3	3	100.00	0.67	98.67
Dichloromethane	2	58	3.45	0.44	99.11
1,1,2,2-Tetrachloroethane	2	2	100.00	0.44	99.56
1,1,2-Trichloroethane	1	1	100.00	0.22	99.78
Trichloroethylene	1	33	3.03	0.22	100.00
Total	451	662	68.13		
New Brunswick, New Jersey – NBNJ					
Acetaldehyde	53	53	100.00	16.26	16.26
Carbon Tetrachloride	51	51	100.00	15.64	31.90
Benzene	51	51	100.00	15.64	47.55
Formaldehyde	47	52	90.38	14.42	61.96
Acrolein	33	33	100.00	10.12	72.09
1,3-Butadiene	30	42	71.43	9.20	81.29
Tetrachloroethylene	28	47	59.57	8.59	89.88
p-Dichlorobenzene	17	44	38.64	5.21	95.09
Acrylonitrile	7	7	100.00	2.15	97.24
Hexachloro-1,3-butadiene	5	5	100.00	1.53	98.77
1,2-Dichloroethane	3	3	100.00	0.92	99.69
1,1,2,2-Tetrachloroethane	1	1	100.00	0.31	100.00
Total	326	389	83.80		

18.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average.

Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal average concentrations are presented in Table 18-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for CANJ are shown in Table 18-3:

- Among the daily averages for CANJ, formaldehyde had the highest concentration by mass (3.54 ± 0.47 µg/m^3), followed by acetaldehyde (2.04 ± 0.23 µg/m^3) and benzene (1.16 ± 0.13 µg/m^3).

- Most of the seasonal averages of the pollutants of interest for CANJ did not vary much statistically from season-to-season.

- Carbon tetrachloride was higher in summer and autumn (0.72 ± 0.09 µg/m^3 and 0.71 ± 0.08 µg/m^3, respectively) than winter and spring (0.48 ± 0.07 µg/m^3 and 0.49 ± 0.09 µg/m^3, respectively).

- The summer formaldehyde average (5.05 ± 1.09 µg/m^3) was the highest seasonal formaldehyde average.

The following observations for CHNJ are shown in Table 18-3:

- The pollutants with the highest daily averages for CHNJ were formaldehyde (1.93 ± 0.28 µg/m^3) and acetaldehyde (1.19 ± 0.15 µg/m^3).

- Some of the CHNJ pollutants of interest do not have seasonal averages listed in Table 18-3 because there were so few measured detections. For the pollutants with valid seasonal averages, most of them did not vary much among the seasons.

- Formaldehyde was the one exception. The summer formaldehyde average (3.15 ± 0.66 µg/m^3) was higher than the winter, spring, and fall averages (1.43 ± 0.28 µg/m^3, 1.77 ± 0.42 µg/m^3, and 1.57 ± 0.39 µg/m^3, respectively).

The following observations for ELNJ are shown in Table 18-3:

- The pollutants with the highest daily averages for ELNJ were acetaldehyde (5.67 ± 0.74 µg/m^3), formaldehyde (4.51 ± 0.59 µg/m^3), and methyl *tert*-butyl ether (1.74 ± 0.90 µg/m^3).

- The acetaldehyde average for ELNJ was significantly higher than the acetaldehyde averages for the other New Jersey sites.

Table 18-3. Daily and Seasonal Averages for the Pollutants of Interest for the New Jersey Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Camden, New Jersey – CANJ												
Acetaldehyde	57	57	2.04	0.23	1.62	0.28	2.16	0.51	2.47	0.46	1.90	0.43
Acrolein	42	53	0.76	0.15	0.48	0.30	NR	NR	0.69	0.17	0.73	0.20
Benzene	53	53	1.16	0.13	1.39	0.35	1.03	0.19	1.00	0.17	1.18	0.23
Bromomethane	53	53	0.43	0.16	0.39	0.24	0.70	0.53	0.51	0.32	0.20	0.10
1,3-Butadiene	52	53	0.13	0.03	0.19	0.07	0.09	0.03	0.06	0.01	0.15	0.05
Carbon Tetrachloride	53	53	0.61	0.05	0.48	0.07	0.49	0.09	0.72	0.09	0.71	0.08
p-Dichlorobenzene	51	53	0.22	0.03	0.18	0.05	0.15	0.04	0.24	0.05	0.25	0.06
Formaldehyde	57	57	3.54	0.47	2.64	0.43	3.98	0.91	5.05	1.09	2.56	0.54
Tetrachloroethylene	52	53	0.32	0.05	0.44	0.14	0.23	0.06	0.25	0.06	0.32	0.05
Chester, New Jersey – CHNJ												
Acetaldehyde	58	58	1.19	0.15	1.20	0.29	1.32	0.24	1.26	0.33	1.01	0.30
Acrolein	41	58	0.72	0.16	0.23	0.08	0.57	0.38	0.60	0.23	0.79	0.23
Benzene	58	58	0.50	0.06	0.67	0.11	0.43	0.06	0.34	0.06	0.52	0.11
1,3-Butadiene	37	58	0.04	0.01	0.05	0.02	NR	NR	0.02	0.01	0.03	0.01
Carbon Tetrachloride	58	58	0.58	0.05	0.50	0.06	0.49	0.08	0.69	0.09	0.67	0.10
Formaldehyde	58	58	1.93	0.28	1.43	0.28	1.77	0.42	3.15	0.66	1.57	0.39
Tetrachloroethylene	45	58	0.16	0.04	0.18	0.06	NR	NR	0.09	0.02	0.12	0.03
Elizabeth, New Jersey – ELNJ												
Acetaldehyde	59	59	5.67	0.74	4.65	1.22	4.51	1.20	7.00	1.23	6.74	1.76
Acrolein	50	58	0.68	0.18	0.43	0.19	0.46	0.18	0.88	0.56	0.69	0.20
Benzene	58	58	1.29	0.23	1.80	0.67	1.15	0.21	0.91	0.15	1.26	0.32
1,3-Butadiene	55	58	0.17	0.04	0.26	0.09	0.13	0.05	0.09	0.02	0.14	0.03
Carbon Tetrachloride	58	58	0.60	0.05	0.47	0.08	0.53	0.08	0.70	0.11	0.72	0.06
p-Dichlorobenzene	55	58	0.16	0.03	0.16	0.07	0.13	0.04	0.20	0.08	0.13	0.03
Formaldehyde	59	59	4.51	0.59	4.04	1.11	5.14	1.26	5.93	0.94	2.96	0.66
Methyl tert-Butyl Ether	48	58	1.74	0.90	2.72	1.83	2.24	1.87	0.29	0.23	0.16	0.05
Tetrachloroethylene	56	58	0.37	0.10	0.55	0.32	0.29	0.07	0.21	0.05	0.36	0.09

Table 18-3. Daily and Seasonal Averages for the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
New Brunswick, New Jersey – NBNJ												
Acetaldehyde	53	53	3.35	0.49	2.89	0.84	3.72	0.81	4.52	0.87	1.85	0.68
Acrolein	33	51	0.60	0.18	0.37	0.25	NR	NR	0.61	0.22	0.42	0.09
Benzene	51	51	0.67	0.09	0.88	0.23	0.63	0.08	0.51	0.08	0.56	0.14
1,3-Butadiene	42	51	0.07	0.02	0.10	0.04	0.03	0.01	0.03	0.01	NR	NR
Carbon Tetrachloride	51	51	0.61	0.06	0.51	0.08	0.50	0.09	0.78	0.11	0.75	0.13
p-Dichlorobenzene	44	51	0.09	0.01	0.08	0.03	0.08	0.03	0.08	0.02	NR	NR
Formaldehyde	52	53	2.63	0.77	2.07	0.51	2.50	0.41	2.51	0.58	3.72	4.18
Tetrachloroethylene	47	51	0.28	0.11	0.28	0.10	0.33	0.32	0.18	0.04	0.20	0.09

NA = Not available due to short sampling duration.
NR = Not reportable due to the low number of measured detections.

- With the exception of carbon tetrachloride, the pollutants of interest were highest in the summer or winter. However, the seasonal averages for ELNJ did not vary much statistically.

- The one exception was methyl *tert*-butyl ether. This pollutant's winter and spring averages (2.72 ± 1.83 μg/m^3 and 2.24 ± 1.87 μg/m^3, respectively) were much higher than the other seasons. However, the confidence intervals indicate that these averages were probably influenced by outliers.

The following observations for ELNJ are shown in Table 18-3:

- The pollutants with the highest daily averages for NBNJ were acetaldehyde (3.35 ± 0.49 μg/m^3), and formaldehyde (2.63 ± 0.77 μg/m^3).

- The summer and autumn carbon tetrachloride average concentrations were higher than the other seasonal averages.

- 1,3-Butadiene was highest in winter.

- The very high confidence interval for formaldehyde's autumn average indicates the likely presence of outliers.

18.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for New Jersey monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 18-4.

The following observations about acrolein are shown in Table 18-4:

- All of the acrolein measured detections at the New Jersey sites were greater than the ATSDR acute MRL value of 0.11 μg/m^3 and all but four of the acrolein measured detections exceeded the California REL value of 0.19 μg/m^3.

Table 18-4. Non-Chronic Risk Summary for the New Jersey Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
CANJ	TO-15	Acrolein	0.76 ± 0.15	0.11	42	0.19	42	0.09	0.48 ± 0.30	NR	0.69 ± 0.17	0.73 ± 0.20
CHNJ	TO-15	Acrolein	0.72 ± 0.16	0.11	41	0.19	39	0.09	0.23 ± 0.08	0.57 ± 0.38	0.60 ± 0.23	0.79 ±0.23
ELNJ	TO-15	Acrolein	0.68 ± 0.18	0.11	50	0.19	50	0.09	0.43 ± 0.19	0.46 ± 0.18	0.88 ±0.56	0.69 ± 0.20
NBNJ	TO-15	Acrolein	0.60 ± 0.18	0.11	33	0.19	31	0.09	0.37 ± 0.25	NR	0.61 ±0.22	0.42 ±0.09

NA = Not available due to short sampling duration.
NR = No reportable due to the low number of measured detections.

- The average detected concentration varied only slightly from 0.60 ± 0.18 μg/m^3 (for NBNJ) to 0.76 ± 0.15 μg/m^3 (for CANJ), which were all significantly higher than either acute risk factor.

- All seasonal averages for acrolein exceeded the ATSDR intermediate risk value (0.09 μg/m^3).

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. For all four New Jersey monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 18-8 through 18-11 are pollution roses for acrolein at the New Jersey sites.

Observations gleaned from the acrolein pollution roses include:

- Only 4 of the 166 acrolein concentrations did not exceed the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

- Figure 18-8 shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions at CANJ, which is a pattern consistent with mobile sources. However, they were most frequently measured on days with westerly winds. CANJ is located between several major thoroughfares, including I-676. Although located in a predominantly residential area, many industrial sources are located fairly close to the monitoring site.

- Figure 18-9 shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions at CHNJ, a pattern consistent with mobile sources. Only two concentrations were less than the CalEPA REL risk factor. The highest concentration of acrolein occurred with an easterly wind. Although located in a rural area, the CHNJ monitoring site is located near a main road through town.

- Figure 18-10 shows that acrolein concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions at ELNJ. The highest concentration of acrolein occurred with a west-southwesterly wind. ELNJ is located near exit 13 of I-95, which is also where I-278 to Staten Island intersects I-95. The area is also very industrial with a major refinery located just south of the site.

- Figure 18-11 shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions at NBNJ. Two concentrations were less than the CalEPA REL risk factor. The highest concentrations of acrolein

Figure 18-8. Acrolein Pollution Rose for CANJ

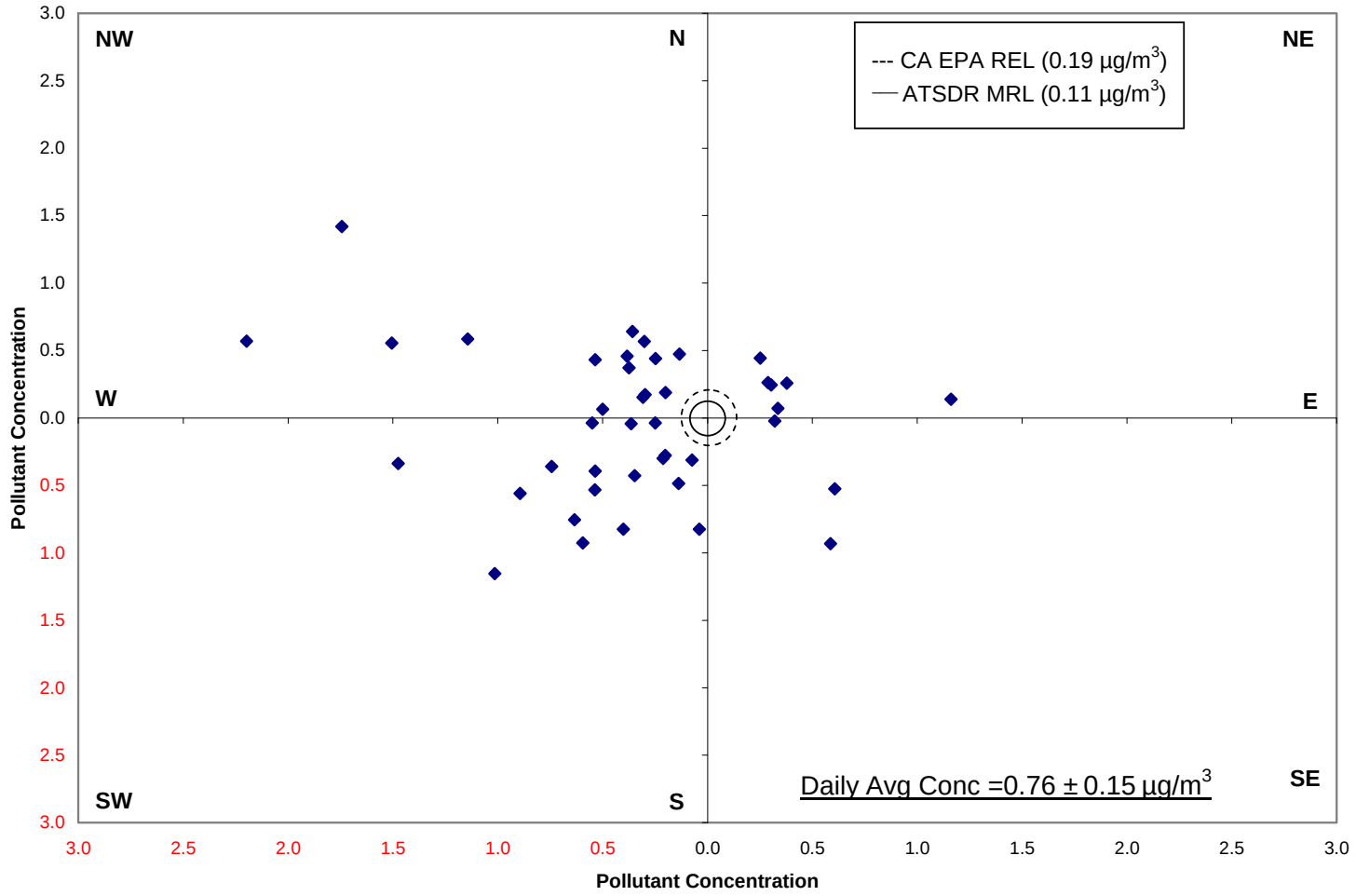


Figure 18-9. Acrolein Pollution Rose for CHNJ

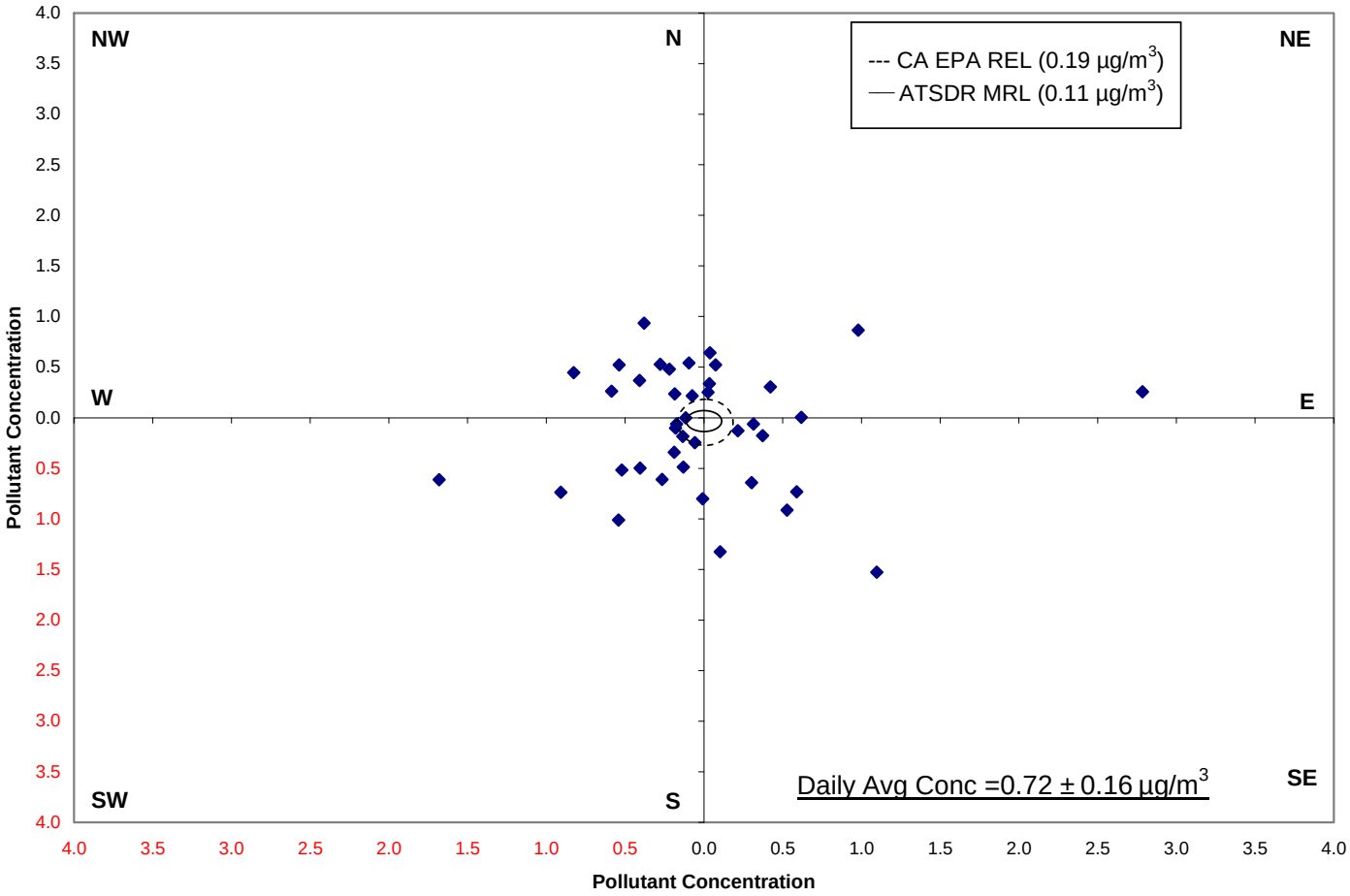


Figure 18-10. Acrolein Pollution Rose for ELNJ

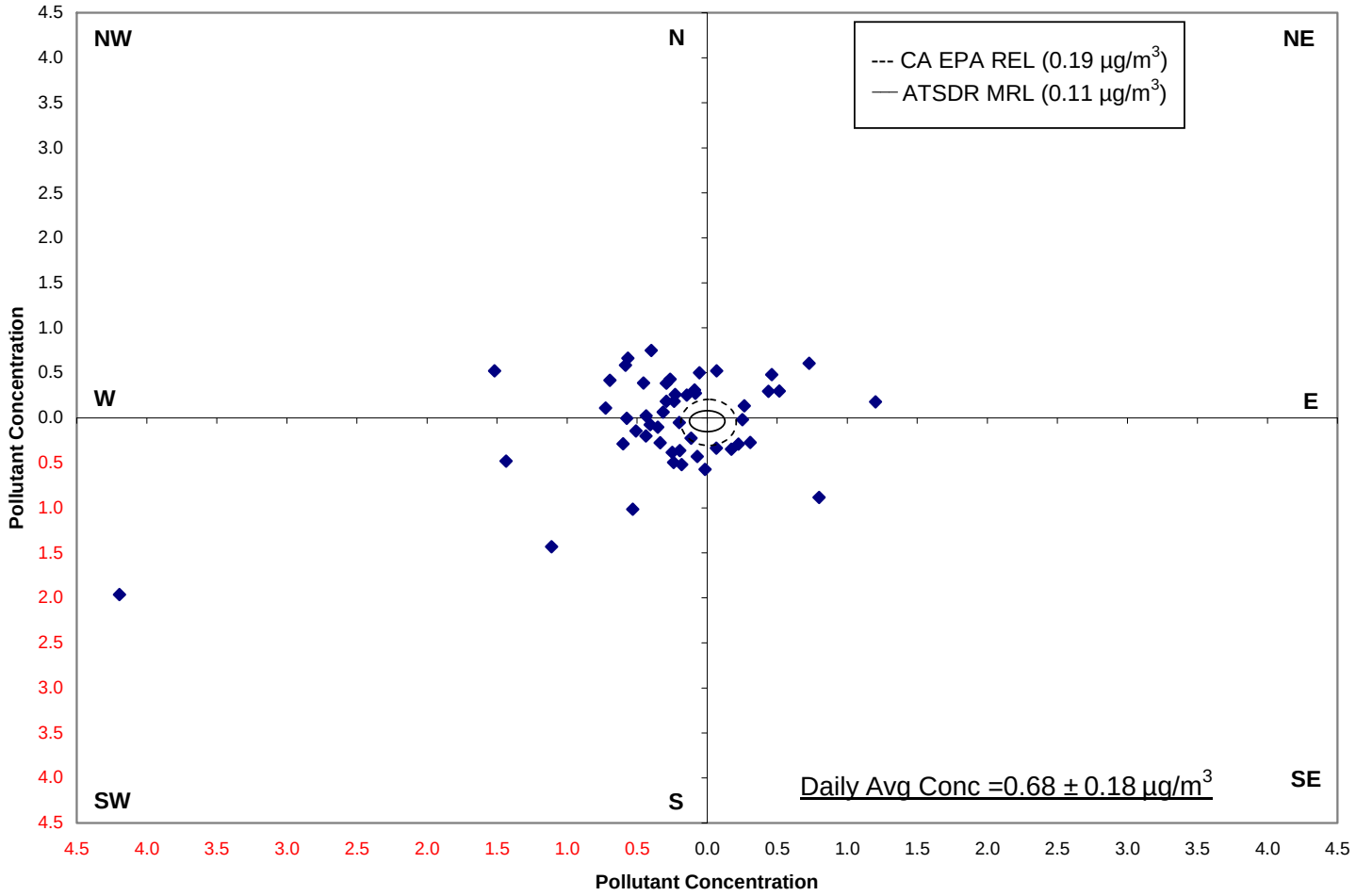
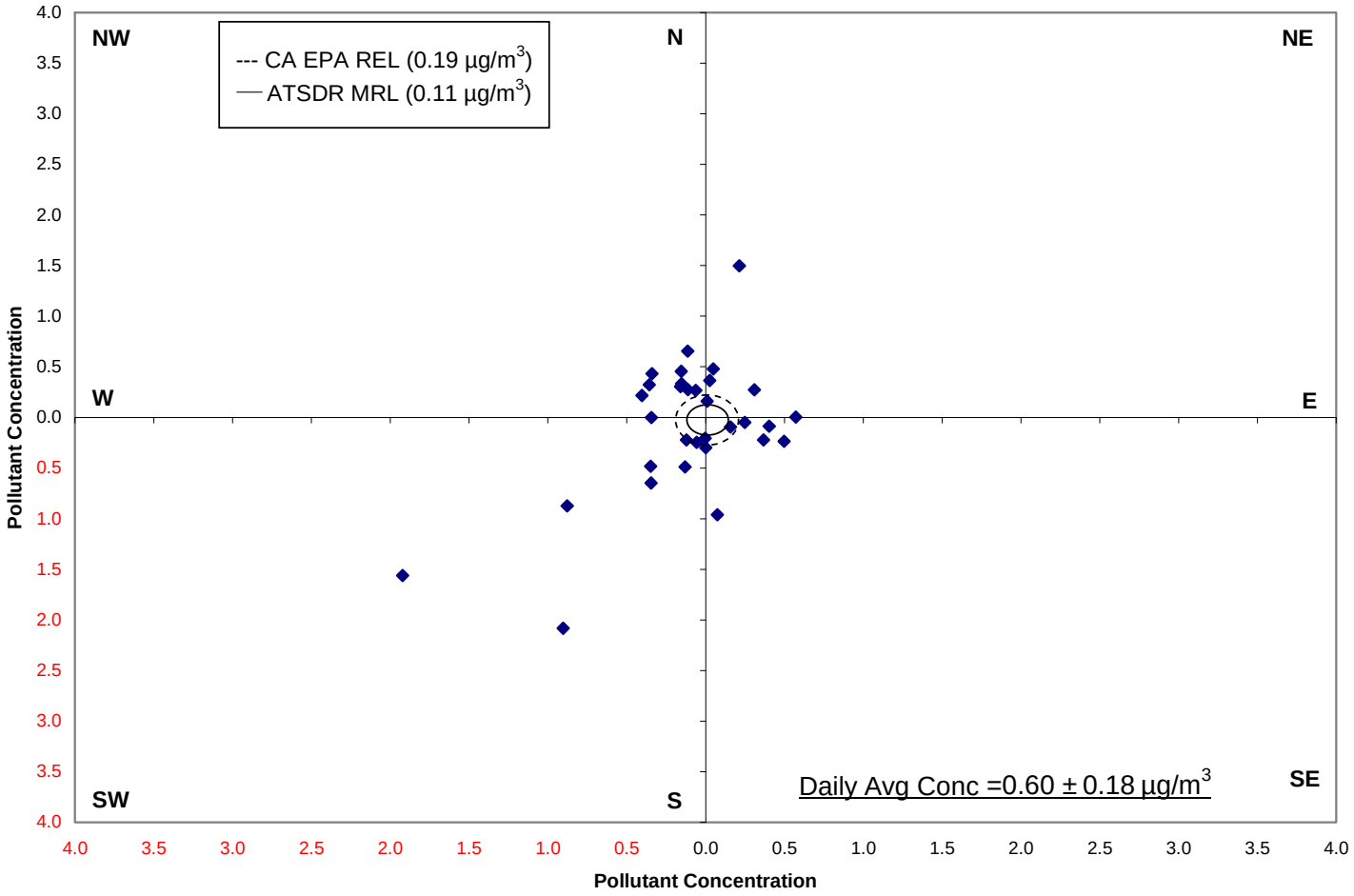


Figure 18-11. Acrolein Pollution Rose for NBNJ



occurred with southwesterly winds. Although the NBNJ monitoring site is located in a rural area, it is also wedged between several major roadways. The site is positioned just off a US-1 exit and is just west of the New Jersey Turnpike (I-95).

18.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

18.4.1 Pearson Correlation Analysis

Table 18-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the New Jersey monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for CANJ from Table 18-5:

- Strong positive correlations were calculated for formaldehyde, acetaldehyde, and carbon tetrachloride and maximum and average temperatures. This indicates that concentrations of these pollutants increase as temperature increases.

- Carbon tetrachloride and formaldehyde also exhibited strong positive correlations with one or more moisture variables, indicating that moisture content also plays a role in the concentrations of these pollutants.

The following observations are gathered for CHNJ from Table 18-5:

- Carbon tetrachloride and formaldehyde also exhibited moderately strong positive correlations with the temperature and moisture variables at this site. This indicates that concentrations of these pollutants increase as temperature and moisture content increase.

- Benzene exhibited strong negative correlations with the temperature and moisture variables. This indicates that concentrations of benzene decrease as temperature and moisture content increase.

- Strong negative correlations were also calculated between 1,3-butadiene and relative humidity.

The following observations are gathered for ELNJ from Table 18-5:

Table 18-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the New Jersey Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Camden, New Jersey – CANJ								
1,3-Butadiene	52	-0.29	-0.35	-0.29	-0.34	0.06	0.18	-0.35
Acetaldehyde	57	0.58	0.51	0.40	0.45	-0.09	0.16	-0.43
Acrolein	42	0.15	0.15	0.12	0.14	-0.03	-0.18	0.27
Benzene	53	-0.05	-0.11	-0.03	-0.08	0.15	0.10	-0.37
Bromomethane	53	0.13	0.08	-0.03	0.01	-0.18	0.10	-0.24
Carbon Tetrachloride	53	0.53	0.54	0.56	0.56	0.19	-0.14	0.12
Formaldehyde	57	0.68	0.63	0.45	0.54	-0.19	0.03	-0.26
p-Dichlorobenzene	51	0.36	0.33	0.31	0.32	0.06	0.10	-0.32
Tetrachloroethylene	52	-0.29	-0.30	-0.13	-0.24	0.33	0.12	-0.36
Chester, New Jersey – CHNJ								
1,3-Butadiene	37	-0.40	-0.42	-0.50	-0.45	-0.43	-0.01	0.40
Acetaldehyde	58	0.13	0.03	0.01	0.01	-0.02	0.24	-0.37
Acrolein	41	0.08	0.07	0.02	0.05	-0.11	0.15	-0.06
Benzene	58	-0.51	-0.55	-0.42	-0.50	0.13	0.03	-0.08
Carbon Tetrachloride	58	0.48	0.52	0.54	0.54	0.28	-0.17	0.06
Formaldehyde	58	0.68	0.60	0.54	0.57	0.05	-0.01	-0.39
Tetrachloroethylene	45	-0.31	-0.37	-0.34	-0.36	-0.04	0.05	-0.04

Table 18-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Elizabeth, New Jersey – ELNJ								
1,3-Butadiene	55	-0.29	-0.32	-0.21	-0.28	0.22	0.11	-0.51
Acetaldehyde	59	0.53	0.47	0.37	0.42	-0.11	0.17	-0.48
Acrolein	50	0.28	0.31	0.33	0.33	0.13	-0.12	0.12
Benzene	58	-0.17	-0.21	-0.11	-0.17	0.20	0.16	-0.56
Carbon Tetrachloride	58	0.41	0.44	0.51	0.50	0.28	-0.13	-0.07
Formaldehyde	59	0.52	0.45	0.29	0.36	-0.25	0.11	-0.37
Methyl *tert*-Butyl Ether	48	-0.07	-0.12	-0.10	-0.13	0.02	0.15	-0.48
p-Dichlorobenzene	55	0.21	0.18	0.15	0.15	-0.01	-0.08	-0.32
Tetrachloroethylene	56	-0.20	-0.23	-0.11	-0.18	0.25	0.08	-0.41
New Brunswick, New Jersey – NBNJ								
1,3-Butadiene	42	-0.42	-0.49	-0.39	-0.45	0.21	0.00	-0.18
Acetaldehyde	53	0.40	0.30	0.22	0.25	-0.04	0.06	-0.34
Acrolein	33	0.46	0.46	0.43	0.45	0.02	-0.11	0.20
Benzene	51	-0.28	-0.38	-0.25	-0.33	0.27	0.01	-0.36
Carbon Tetrachloride	51	0.54	0.55	0.58	0.58	0.32	-0.15	-0.14
Formaldehyde	52	0.18	0.10	0.09	0.09	0.02	0.23	-0.32
p-Dichlorobenzene	44	0.15	0.03	0.06	0.03	0.13	0.04	-0.24
Tetrachloroethylene	47	0.00	-0.06	-0.10	-0.09	-0.12	-0.15	-0.04

- Correlations calculated between acetaldehyde and formaldehyde and maximum temperature were strong and positive, indicating that concentrations of these pollutants increase as temperature increases

- Carbon tetrachloride exhibited strong positive correlations with the moisture variables, indicating the increased moisture content correlates to increased concentrations of carbon tetrachloride.

- Benzene and 1,3-butadiene exhibited strong negative correlations with the scalar wind speed. This indicates that as wind speed decreases, the concentrations of these pollutants increase.

The following observations are gathered for NBNJ from Table 18-5:

- Strong positive correlations were calculated between carbon tetrachloride and the maximum, average, dew point, and wet bulb temperatures. This indicates that concentrations of this pollutant increases as temperature and moisture content increase.

- The remaining correlations were weak.

18.4.2 Composite Back Trajectory Analysis

Figures 18-12 through 18-15 are composite back trajectory maps for the New Jersey monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 18-12 through Figure 18-15 represents 100 miles.

The following observations can be made from Figures 18-12 through 18-15:

- Back trajectories originated from a variety of directions at the New Jersey sites.

- The back trajectories originated less frequently from the east at these sites.

- The 24-hour airshed domains were somewhat large, with trajectories originating as far away as western Quebec, Canada (> 600 miles).

- Most of the trajectories originated within 400 miles of the monitoring sites.

Figure 18-12. Composite Back Trajectory Map for CANJ

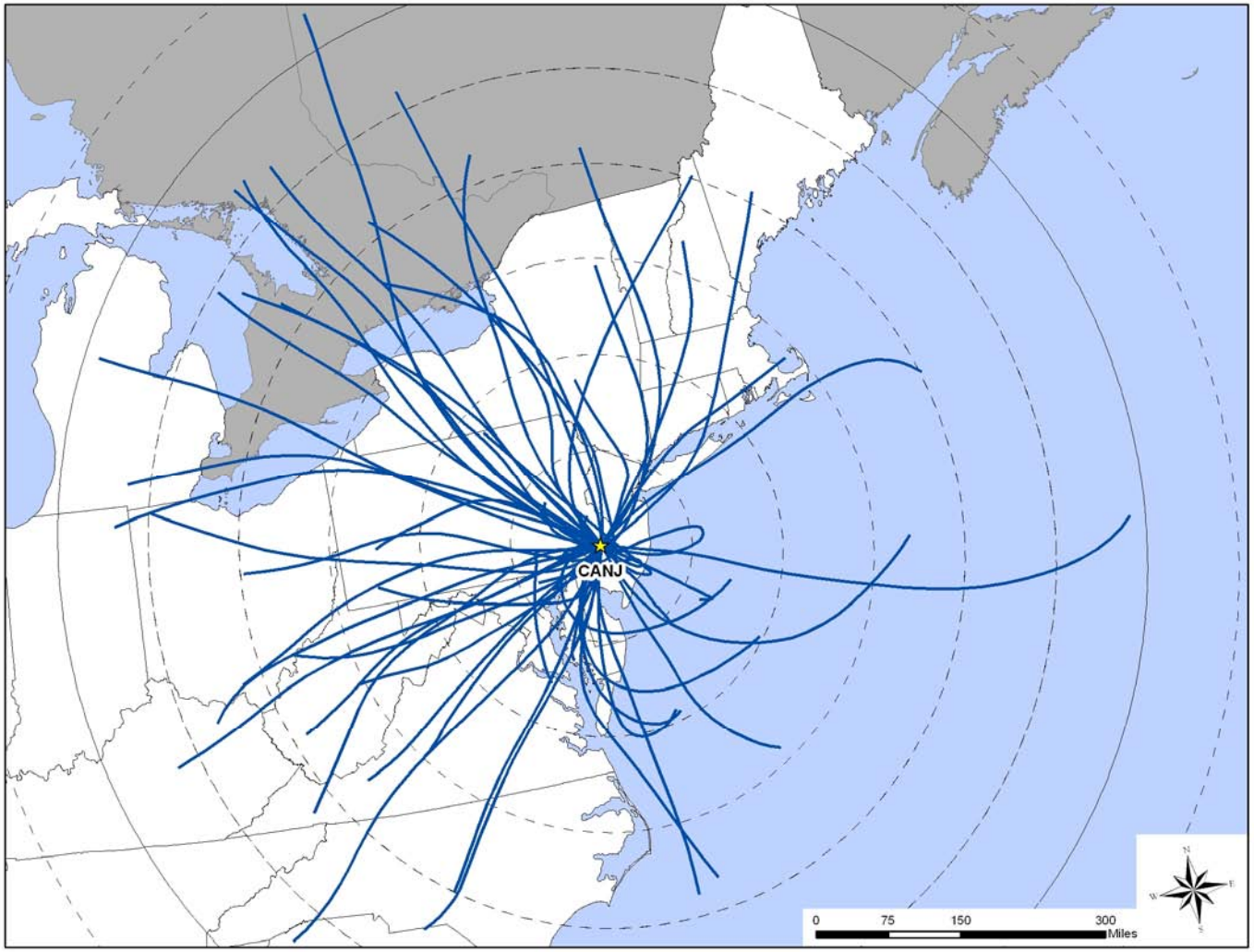


Figure 18-13. Composite Back Trajectory Map for CHNJ

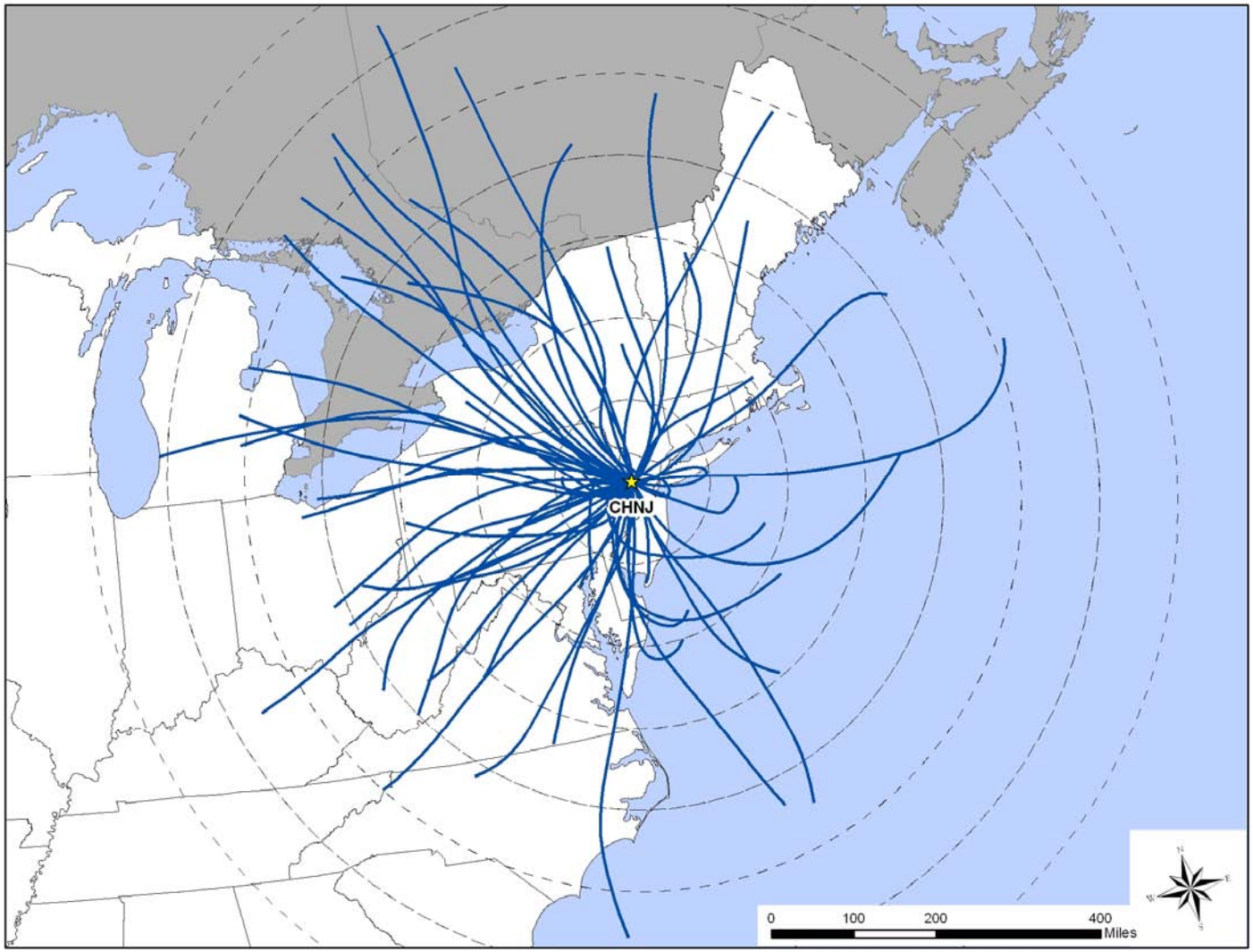


Figure 18-14. Composite Back Trajectory Map for ELNJ

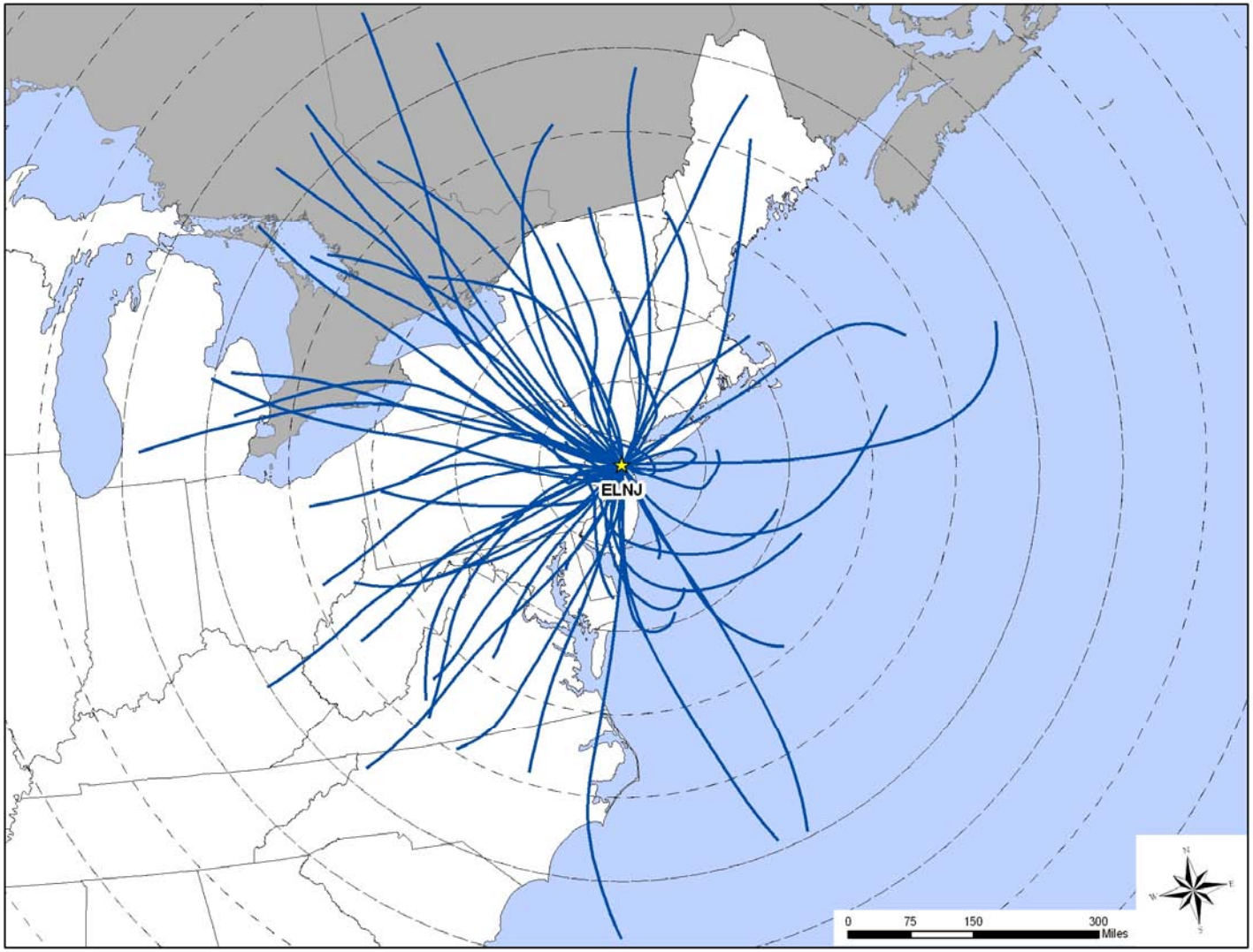
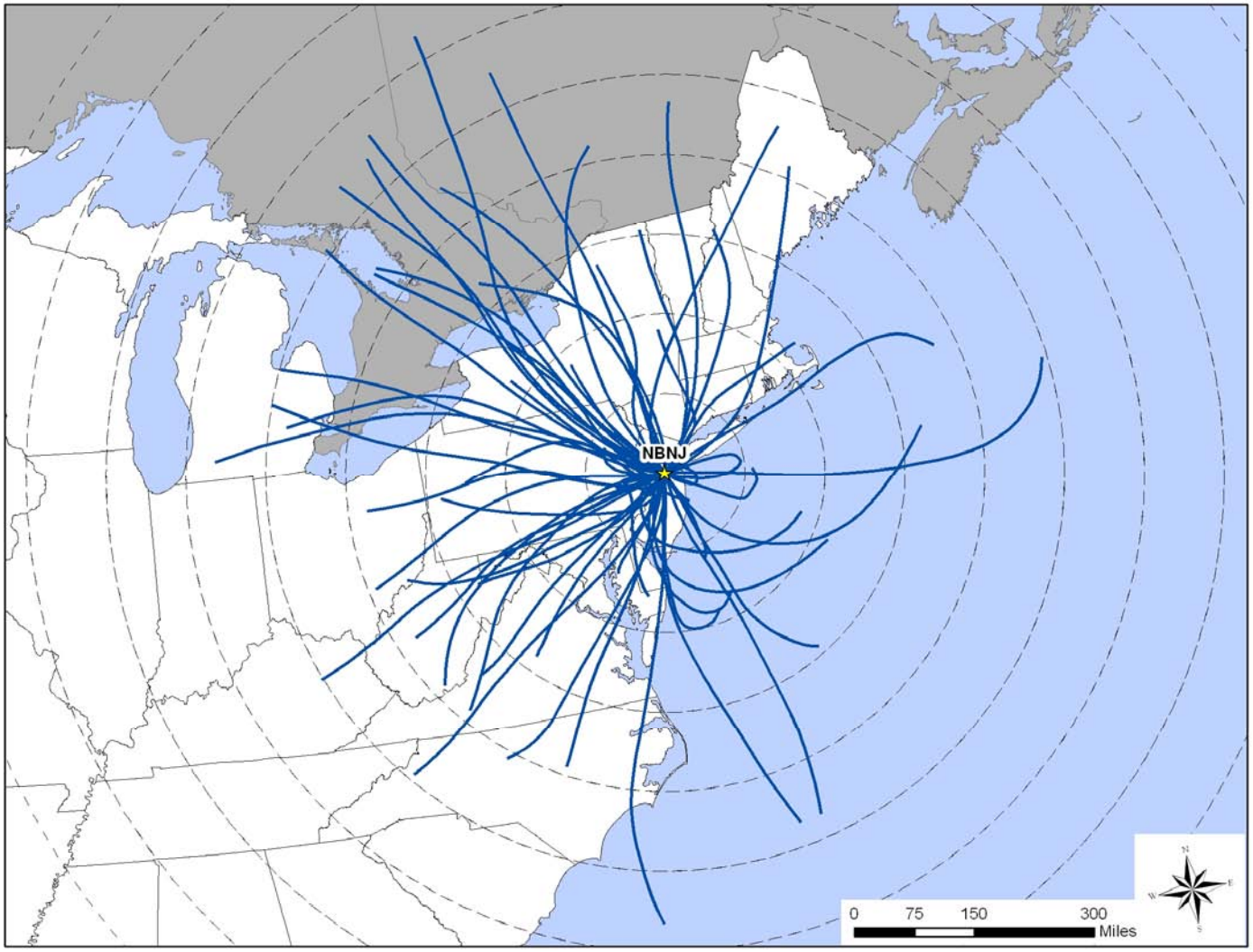


Figure 18-15. Composite Back Trajectory Map for NBNJ



18.4.3 Wind Rose Analysis

Hourly wind data from the weather stations closest to the sites were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 18-16 through 18-19 are the wind roses for the New Jersey monitoring sites on days sampling occurred.

Observations from Figure 18-16 for CANJ include:

- Hourly winds originated from a variety of directions on days samples were collected near CANJ.
- However, an apparent lack of winds originating from the northeast and southeast is evident in Figure 18-16.
- Wind observations were recorded most frequently from southwest and west-northwest (9 percent each of observations).
- In regards to wind speed, most of observations (40 percent) ranged from 7 to 11 knots.
- Calm winds (<2 knots) were recorded for 10 percent of the hourly observations.

Observations from Figure 18-17 for CHNJ include:

- Fifty-five percent of wind observations were calm (<2 knots) near CHNJ, for which there is no associated direction.
- For winds speeds greater than 2 knots, hourly winds originated primarily from the north (9 percent of observations) and south (6 percent) on days samples were collected near CHNJ.

Observations from Figure 18-18 for ELNJ include:

- Hourly winds originated primarily from the west (10 percent of observations) and west-southwest (10 percent) near ELNJ.
- Similar to CANJ, an apparent lack of winds originating from the east and southeast is evident in Figure 18-18.

Figure 18-16. Wind Rose for CANJ Sampling Days

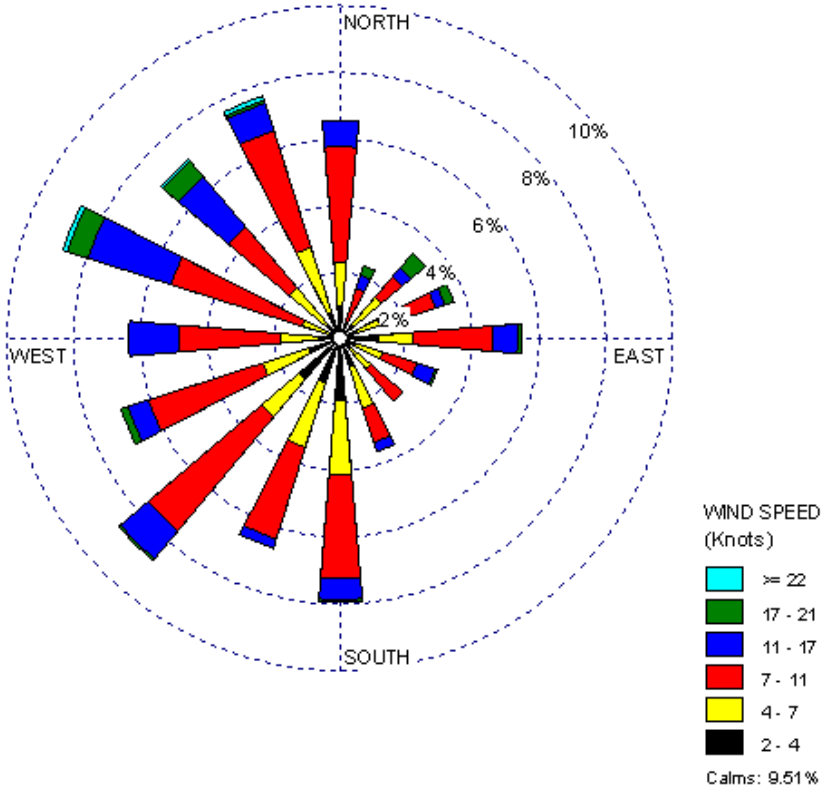


Figure 18-17. Wind Rose for CHNJ Sampling Days

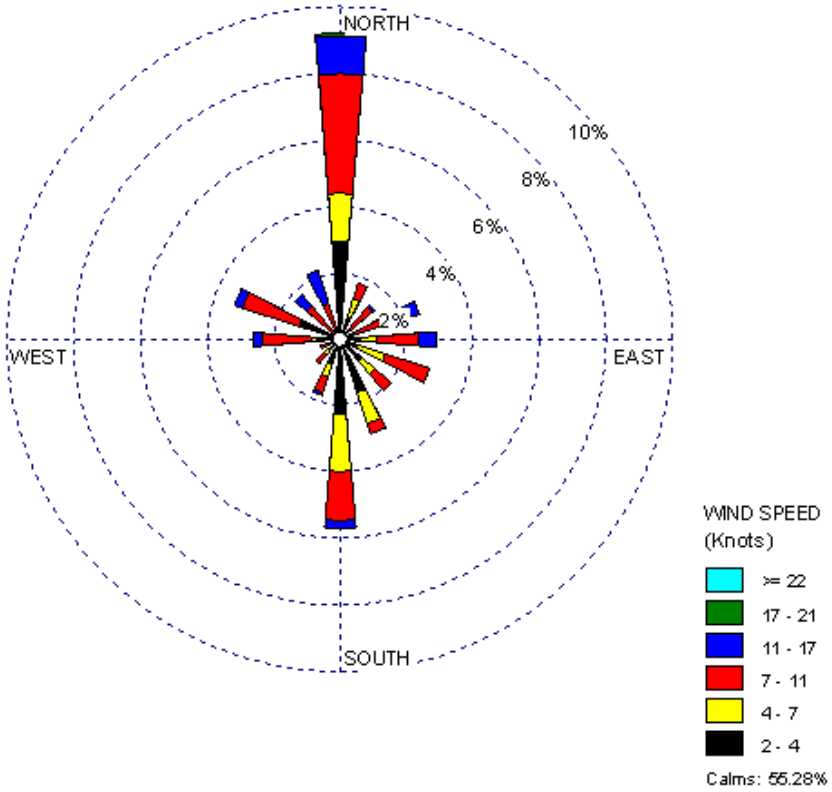


Figure 18-18. Wind Rose for ELNJ Sampling Days

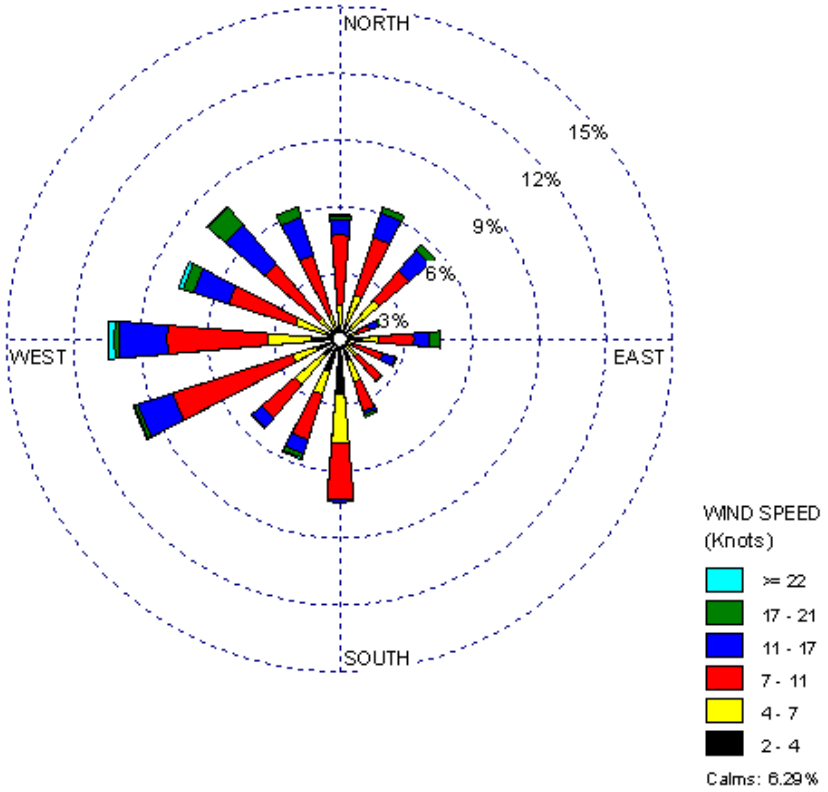
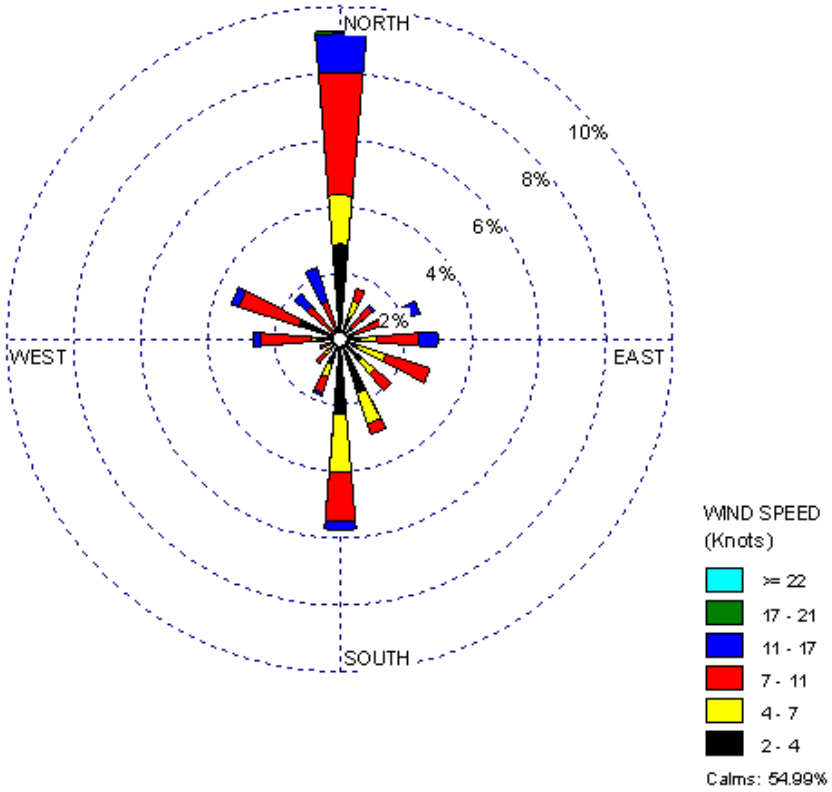


Figure 18-19. Wind Rose for NBNJ Sampling Days



- In regards to wind speed, most of observations (40 percent) ranged from 7 to 11 knots. Calm winds (<2 knots) were recorded for 6 percent of the hourly observations.

Observations from Figure 18-19 for NBNJ include:

- The wind rose for NBNJ is similar to CHNJ's wind rose. This is reasonable as the weather stations for the CHNJ and NBNJ are both from the Somerville-Somerset Airport.

- Fifty-five percent of wind observations were also calm (<2 knots).

- Hourly winds near NBNJ originated primarily from the north (9 percent of observations) on days samples were collected.

18.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

18.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County level vehicle registration information was not available for Camden, Middlesex, Morris, and Union Counties. Thus, state-level vehicle registration, from the Energy Information Administration (EIA), was allocated to the county level using the county-level population proportion. County-level population information in these counties was obtained from the U.S. Census Bureau, and is summarized in Table 18-6. Table 18-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 18-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 18-6 include:

- County population is highest in Middlesex County, where NBNJ is located.

- The estimated number of vehicles registered near each site is similar.

Table 18-6. Motor Vehicle Information for the New Jersey Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
CANJ	517,001	371,045	0.72	2,017,289	1,447,782	62,000
CHNJ	493,160	353,934	0.72	241,918	173,621	12,623
ELNJ	531,088	381,155	0.72	2,187,129	1,569,674	170,000
NBNJ	786,971	353,934	0.72	796,347	571,528	63,000

- Not surprisingly, the 10-mile population is lowest near CHNJ, the most rural site, and highest near ELNJ, the site closest to Newark and New York City. Ten mile population and estimated vehicle registration is second highest near CANJ, which is located near Philadelphia.

- The CHNJ and ELNJ sites also have the least and most daily traffic volume passing the sites, respectively.

- In relation to the other UATMP sites, the county-level populations are mid-range; however, ELNJ and CANJ have the highest and third highest 10-mile radius populations, and highest two estimated 10-mile vehicle registrations.

- The ELNJ site's daily traffic count is second only to one of the Chicago sites (SPIL)

18.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- Of the four New Jersey sites, the ELNJ monitoring site's ratios most resembled those of the roadside study, although the benzene-ethylbenzene and xylenes-ethylbenzene ratios were closer together at this site than they were for the roadside study. This suggests that mobile source emissions are major influences at this site.

- For NBNJ, the benzene-ethylbenzene and xylenes-ethylbenzene ratios were also very similar (3.94 ± 0.45 and 3.79 ± 0.20, respectively), but the benzene-ethylbenzene ratio was higher while the toluene-ethylbenzene ratio was relatively close to that of the roadside study (5.70 ± 0.34 vs. 5.85).

- For CANJ and CHNJ, the benzene-ethylbenzene ratio was higher than the xylenes-ethylbenzene ratio (4.67 ± 0.38 and 3.60 ± 0.22, and 5.60 ± 0.50 and 3.04 ± 0.20, respectively), which is the opposite of the roadside study. The CANJ toluene-ethylbenzene ratio was somewhat higher than that of the roadside study (7.41 ± 0.66 vs. 5.85), while that of CHNJ (5.71 ± 0.42) was very close to that of the roadside

study. The benzene-ethylbenzene and toluene-ethylbenzene ratios for CHNJ were very similar.

18.6 Trends Analysis

For sites that participated in the UATMP prior to 2005 and are still participating in the 2006 program year (i.e., minimum 3 consecutive years); a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. CANJ has participated in the UATMP since 1994; ELNJ since 1999; and CHNJ and NBNJ since 2001. Figures 18-20 through 18-23 are trends figures for formaldehyde, benzene, and 1,3-butaidene for CANJ, CHNJ, ELNJ, and NBNJ, respectively.

The following observations can be made from Figures 18-20 through 18-23:

- Figure 18-20 shows that there has been a lot of variation over the last 10 years. The addition of confidence intervals shows that while the average concentrations have changed over the years, the difference has generally not be statistically significant. High formaldehyde concentrations in 1996, 1997, and 2004 may have been influenced by outliers, as indicated by the large confidence intervals. However, the overall trend, though slight, has been a decrease in all pollutants shown over the last three years.

- Figure 18-21 shows that formaldehyde concentrations at CHNJ have been decreasing since 2001. The slight increase in 2004 may have been influenced by outliers, as indicated by the large confidence interval. Concentrations of 1,3-butadiene have not changed significantly since 2001. Benzene decreased from 2003 to 2006.

- As indicated in Figure 18-22, after two years of decreasing, formaldehyde concentrations began to increase somewhat in the years 2003 to 2005 at the ELNJ monitoring site. The 2006 formaldehyde concentration decreased slightly, but this decrease was not statistically significant. Benzene and 1,3-butadiene concentrations have decreased slightly since the onset of sampling.

- As indicated in Figure 18-23, formaldehyde levels at NBNJ decreased after 2001, but increased in later years. The 2004 increase may have been influenced by outliers, as indicated by the large confidence interval. The 2006 formaldehyde concentration was a significant decrease from 2005. Benzene also decreased in 2006. 1,3-Butadiene concentrations have not changed significantly since 2001.

Figure 18-20. Comparison of Yearly Averages for the CANJ Monitoring Site

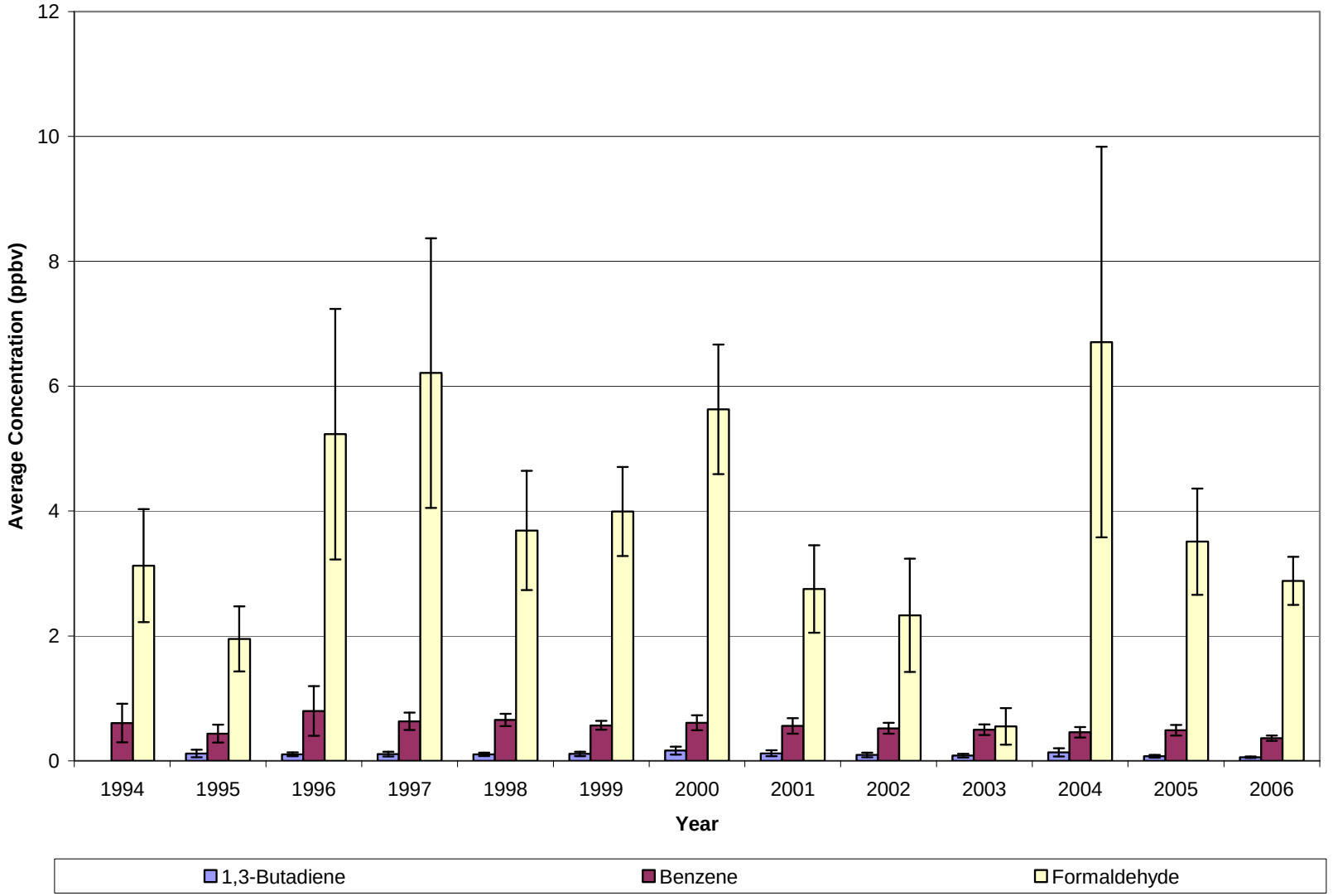


Figure 18-21. Comparison of Yearly Averages for the CHNJ Monitoring Site

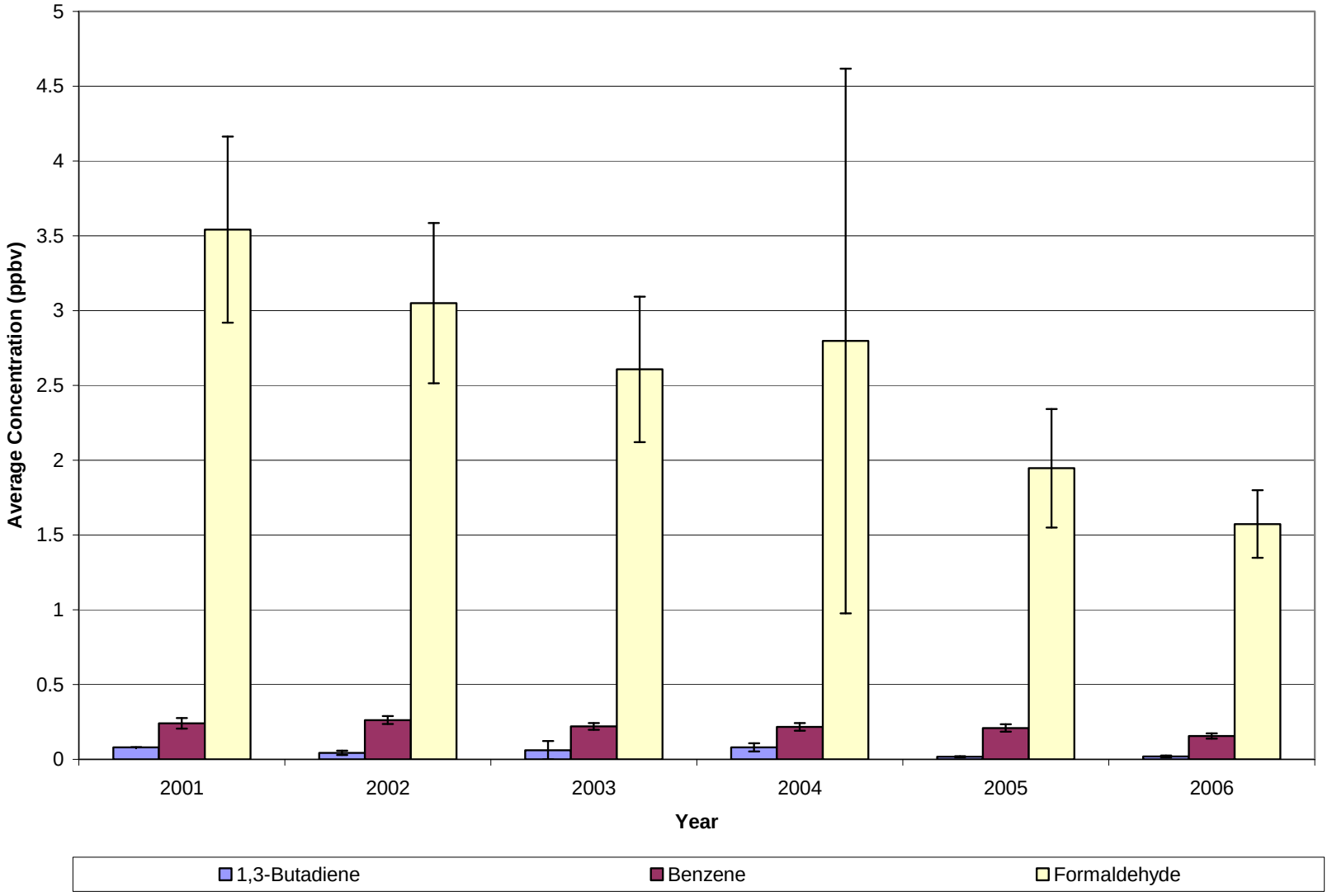


Figure 18-22. Comparison of Yearly Averages for the ELNJ Monitoring Site

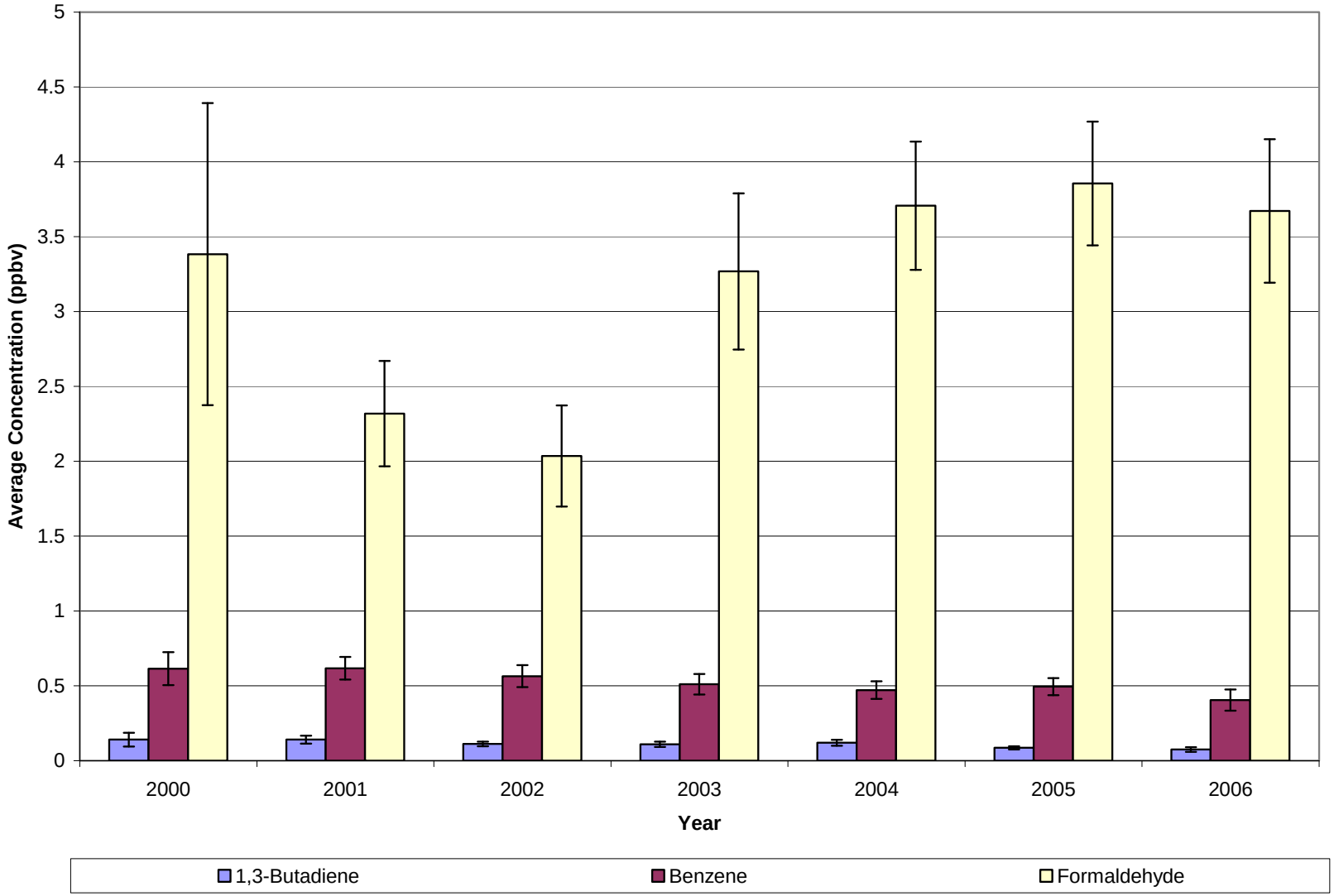
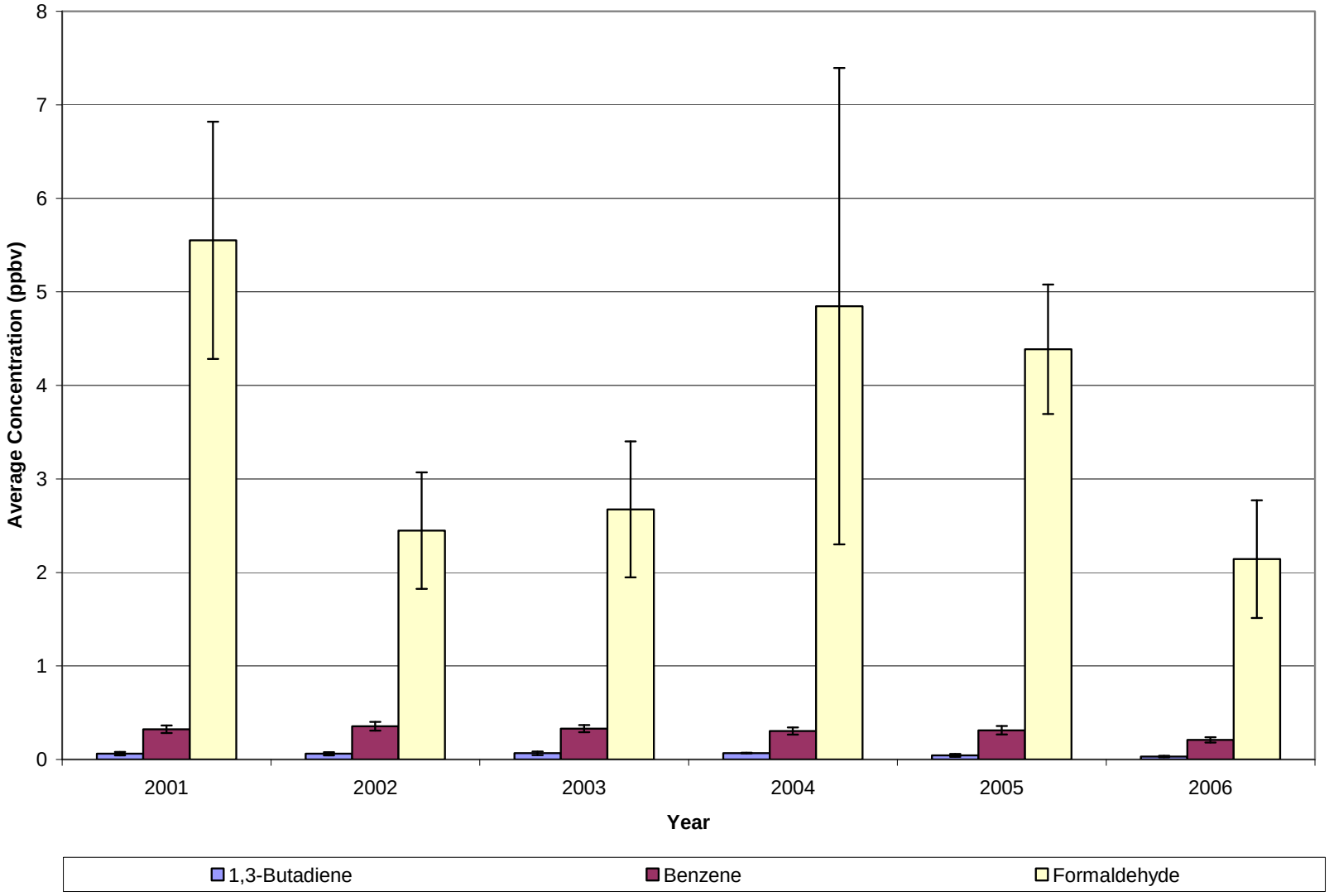


Figure 18-23. Comparison of Yearly Averages for the NBNJ Monitoring Site



18.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the New Jersey sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 18-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 18-7. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the New Jersey sites is as follows:

- CANJ is located in census tract 34007601500 with a population of 6,424, which represents 1.3 percent of the Camden County population in 2000.
- CHNJ is located in census tract 34027045901, with a population of 1,635, which represents 0.3 percent of Morris County's 2000 population.
- ELNJ is located in census tract 34039030100. The population in that census tract in 2000 was 334, or less than 0.1 percent of Union County's population.
- NBNJ is located in census tract 34023006206. In 2000, the population in this census tract was 1,794 or 0.2 percent of the Middlesex County population.

The following observations can be made about the concentrations from Table 18-7:

- Formaldehyde and acetaldehyde were the pollutants with the highest annual averages by mass concentration for all four New Jersey sites.
- NATA-modeled concentrations of formaldehyde and acetaldehyde were fairly similar to the annual averages, but were not necessarily the highest modeled concentrations.
- For ELNJ, xylenes had the highest NATA-modeled concentration. While formaldehyde had the highest concentration for NBNJ, benzene was a close second.

The following observations can be made about risk from Table 18-7:

- Carbon tetrachloride had the highest theoretical cancer risk for CANJ, CHNJ, and NBNJ, generally around 9 in-a-million; acetaldehyde had the highest theoretical cancer risk for ELNJ (12.47 in-a-million).

Table 18-7. Chronic Risk Summary for the Monitoring Sites in New Jersey

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Camden, New Jersey (CANJ) – Census Tract ID 34007601500								
Acetaldehyde	0.0000022	0.009	2.50	5.50	0.28	2.04 ± 0.23	4.48	0.23
Acrolein	NR	0.00002	0.19	NR	9.63	0.63 ± 0.14	NR	31.44
Acrylonitrile	0.000068	0.002	<0.01	0.07	<0.01	0.09 ± 0.04	6.23	0.05
Benzene	0.0000078	0.03	1.91	14.87	0.06	1.16 ± 0.13	9.02	0.04
Bromomethane	NR	0.005	0.29	NR	0.06	0.43 ± 0.16	NR	0.09
1,3-Butadiene	0.00003	0.002	0.18	5.37	0.09	0.13 ± 0.03	3.79	0.06
Carbon Tetrachloride	0.000015	0.04	0.22	3.30	0.01	0.61 ± 0.05	9.18	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.09	1.00	<0.01	0.21 ± 0.03	2.29	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	1.05	<0.01	0.03 ± <0.01	0.79	<0.01
Dichloromethane	0.00000047	1	0.79	0.37	<0.01	0.97 ± 0.7	0.46	<0.01
Formaldehyde	5.5E-09	0.0098	2.45	0.01	0.25	3.54 ± 0.47	0.02	0.36
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± 0.01	1.58	<0.01
Methyl-*Tert*-Butyl Ether	NR	3	2.30	NR	<0.01	0.82 ± 0.34	NR	<0.01
Tetrachloroethylene	0.0000059	0.27	0.23	1.38	<0.01	0.32 ± 0.05	1.86	<0.01
Trichloroethylene	0.000002	0.6	0.15	0.31	<0.01	0.42 ± 0.2	0.84	<0.01
Chester, New Jersey (CHNJ) – Census Tract ID 34027045901								
Acetaldehyde	0.0000022	0.009	1.10	2.43	0.12	1.19 ± 0.15	2.62	0.13
Acrolein	NR	0.00002	0.07	NR	3.34	0.54 ± 0.13	NR	27.1
Acrylonitrile	0.000068	0.002	<0.01	0.03	<0.01	0.06 ± <0.01	4.29	0.03
Benzene	0.0000078	0.03	1.04	8.08	0.03	0.5 ± 0.06	3.89	0.02
1,3-Butadiene	0.00003	0.002	0.11	3.43	0.06	0.03 ± 0.01	0.91	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.12	0.01	0.58 ± 0.05	8.76	0.01
Chloromethylbenzene	0.000049	NR	<0.01	<0.01	NR	0.02 ± 0.01	0.8	NR
p-Dichlorobenzene	0.000011	0.8	0.02	0.24	<0.01	0.04 ± 0.01	0.44	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.77	<0.01	0.03 ± <0.01	0.8	<0.01
Formaldehyde	5.5E-09	0.0098	1.29	0.01	0.13	1.93 ± 0.28	0.01	0.20
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± 0.01	1.63	<0.01

Table 18-7. Chronic Risk Summary for the Monitoring Sites in New Jersey (Continued)

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Tetrachloroethylene	0.0000059	0.27	0.12	0.72	<0.01	0.13 ± 0.03	0.78	<0.01
Elizabeth, New Jersey (ELNJ) – Census Tract ID 34039030100								
Acetaldehyde	0.0000022	0.009	4.36	9.59	0.48	5.67 ± 0.74	12.47	0.63
Acrolein	NR	0.00002	0.71	NR	35.46	0.61 ± 0.17	NR	30.29
Acrylonitrile	0.000068	0.002	<0.01	0.07	<0.01	0.09 ± 0.03	6.00	0.04
Benzene	0.0000078	0.03	3.38	26.33	0.11	1.29 ± 0.23	10.10	0.04
1,3-Butadiene	0.00003	0.002	0.54	16.09	0.27	0.16 ± 0.03	4.72	0.08
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.6 ± 0.05	8.93	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.07	0.73	<0.01	0.15 ± 0.03	1.70	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	0.92	<0.01	0.04 ± 0.01	0.91	<0.01
Dichloromethane	0.00000047	1	0.71	0.33	<0.01	0.78 ± 0.16	0.37	<0.01
Formaldehyde	5.5E-09	0.0098	5.60	0.03	0.57	4.51 ± 0.59	0.02	0.46
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.04	<0.01	0.08 ± 0.02	1.84	<0.01
Methyl *Tert*-Butyl Ether	NR	3	3.45	NR	<0.01	1.44 ± 0.76	NR	<0.01
1,1,2,2-Tetrachloroethane	0.000058	NR	0.06	3.26	NR	0.07 ± 0.04	3.87	NR
Tetrachloroethylene	0.0000059	0.27	0.31	1.82	<0.01	0.36 ± 0.1	2.12	<0.01
1,1,2-Trichloroethane	0.000016	0.4	<0.01	<0.01	<0.01	0.02 ± <0.01	0.29	<0.01
Trichloroethylene	0.000002	0.6	0.12	0.24	<0.01	0.09 ± 0.02	0.19	<0.01
Xylenes	NR	0.1	6.20	NR	0.06	3.58 ± 0.78	NR	0.04
New Brunswick, New Jersey (NBNJ) – Census Tract ID 34023006206								
Acetaldehyde	0.0000022	0.009	1.98	4.36	0.22	3.35 ± 0.49	7.37	0.37
Acrolein	NR	0.00002	0.15	NR	7.61	0.43 ± 0.13	NR	21.67
Acrylonitrile	0.000068	0.002	<0.01	0.07	<0.01	0.12 ± 0.05	8.03	0.06
Benzene	0.0000078	0.03	2.26	17.62	0.08	0.67 ± 0.09	5.21	0.02
1,3-Butadiene	0.00003	0.002	0.28	8.33	0.14	0.06 ± 0.02	1.7	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.61 ± 0.06	9.16	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.44	<0.01	0.08 ± 0.01	0.90	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	0.93	<0.01	0.03 ± <0.01	0.84	<0.01

Table 18-7. Chronic Risk Summary for the Monitoring Sites in New Jersey (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Formaldehyde	5.5E-09	0.0098	2.28	0.01	0.23	2.58 ± 0.76	0.01	0.26
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.11 ± 0.06	2.41	<0.01
1,1,2,2-Tetrachloroethane	0.000058	NR	0.06	3.20	NR	0.05 ± <0.01	2.71	NR
Tetrachloroethylene	0.0000059	0.27	0.20	1.21	<0.01	0.26 ± 0.10	1.53	<0.01

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

- According to NATA, the benzene cancer risk was highest near each of the sites, ranging from 8.08 in-a-million for CHNJ to 26.33 in-a-million near ELNJ.

- The cancer risk due to carbon tetrachloride was comparatively lower (roughly 3 in-a-million near each site), according to NATA.

- Acrolein exhibited the highest noncancer risk HQ (based on annual averages) at all four sites, ranging from 21.67 for NBNJ to 31.44 for CANJ. All other noncancer HQs were less than 1.00.

- Acrolein also had the highest noncancer risk HQ according to NATA, although the range was much broader (3.34 for CHNJ to 35.46 for ELNJ). Similar to the annual average-based HQs, all other NATA-modeled noncancer HQs were less than 1.00.

18.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 18-8 and 18-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 18-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 18-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 18-8:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants (by mass) with cancer risk factors in each of the New Jersey counties.

- Benzene, 1,3-butadiene, and naphthalene had the highest cancer toxicity-weighted emissions in Camden, Union, and Middlesex Counties; benzene, lead, and 1,3-butadine had the highest cancer toxicity-weighted emissions in Morris County.

Table 18-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in New Jersey

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Camden, New Jersey (CANJ) – Camden County					
Benzene	216.15	Benzene	1.69E-03	Carbon Tetrachloride	9.18
Formaldehyde	151.44	1,3-Butadiene	8.59E-04	Benzene	9.02
Dichloromethane	54.85	Naphthalene	6.59E-04	Acrylonitrile	6.23
Acetaldehyde	40.92	Tetrachloroethylene	2.28E-04	Acetaldehyde	4.48
Tetrachloroethylene	38.60	*p*-Dichlorobenzene	2.10E-04	1,3-Butadiene	3.79
1,3-Dichloropropene	36.96	Lead	1.68E-04	*p*-Dichlorobenzene	2.29
1,3-Butadiene	28.64	Polycyclic Organic Matter as 15-PAH	1.65E-04	Tetrachloroethylene	1.86
Naphthalene	19.40	1,3-Dichloropropene	1.48E-04	Hexachloro-1,3-butadiene	1.58
p-Dichlorobenzene	19.09	Polycyclic Organic Matter as 7-PAH	1.10E-04	Trichloroethylene	0.84
Polycyclic Organic Matter as 15-PAH	2.99	Polycyclic Organic Matter as non-15 PAH	9.79E-05	1,2-Dichloroethane	0.79
Chester, New Jersey (CHNJ) – Morris County					
Benzene	315.27	Benzene	2.46E-03	Carbon Tetrachloride	8.76
Formaldehyde	152.06	Lead	1.82E-03	Acrylonitrile	4.29
Dichloromethane	55.40	1,3-Butadiene	1.37E-03	Benzene	3.89
Acetaldehyde	48.39	Naphthalene	7.10E-04	Acetaldehyde	2.62
1,3-Butadiene	45.64	Nickel	2.54E-04	Hexachloro-1,3-butadiene	1.63
1,3-Dichloropropene	34.56	*p*-Dichlorobenzene	1.96E-04	1,3-Butadiene	0.91
Tetrachloroethylene	30.16	Tetrachloroethylene	1.78E-04	1,2-Dichloroethane	0.80
Naphthalene	20.88	Polycyclic Organic Matter as 15-PAH	1.49E-04	Chloromethylbenzene	0.80
p-Dichlorobenzene	17.86	1,3-Dichloropropene	1.38E-04	Tetrachloroethylene	0.78
Trichloroethylene	17.30	Hexavalent Chromium	1.32E-04	*p*-Dichlorobenzene	0.44

Table 18-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in New Jersey (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Elizabeth, New Jersey (ELNJ) – Union County					
Benzene	237.32	Benzene	1.85E-03	Acetaldehyde	12.47
Formaldehyde	123.12	1,3-Butadiene	9.26E-04	Benzene	10.10
Dichloromethane	76.45	Naphthalene	7.14E-04	Carbon Tetrachloride	8.93
Tetrachloroethylene	42.46	Nickel	3.47E-04	Acrylonitrile	6.00
Acetaldehyde	41.67	Lead	2.86E-04	1,3-Butadiene	4.72
1,3-Dichloropropene	38.31	Tetrachloroethylene	2.51E-04	1,1,2,2-Tetrachloroethane	3.87
1,3-Butadiene	30.88	*p*-Dichlorobenzene	2.18E-04	Tetrachloroethylene	2.12
Naphthalene	20.99	Arsenic	1.74E-04	Hexachloro-1,3-butadiene	1.84
p-Dichlorobenzene	19.81	Polycyclic Organic Matter as 15-PAH	1.55E-04	*p*-Dichlorobenzene	1.70
Trichloroethylene	4.57	1,3-Dichloropropene	1.53E-04	1,2-Dichloroethane	0.91
New Brunswick, New Jersey (NBNJ) – Middlesex County					
Benzene	397.48	Benzene	3.10E-03	Carbon Tetrachloride	9.16
Formaldehyde	209.33	1,3-Butadiene	1.69E-03	Acrylonitrile	8.03
Dichloromethane	108.94	Naphthalene	1.10E-03	Acetaldehyde	7.37
Acetaldehyde	68.23	Tetrachloroethylene	3.54E-04	Benzene	5.21
Tetrachloroethylene	59.97	*p*-Dichlorobenzene	3.18E-04	1,1,2,2-Tetrachloroethane	2.71
1,3-Butadiene	56.40	Polycyclic Organic Matter as 15-PAH	2.34E-04	Hexachloro-1,3-butadiene	2.41
1,3-Dichloropropene	55.98	1,3-Dichloropropene	2.24E-04	1,3-Butadiene	1.70
Naphthalene	32.48	Polycyclic Organic Matter as 7-PAH	1.71E-04	Tetrachloroethylene	1.53
p-Dichlorobenzene	28.95	Lead	1.65E-04	*p*-Dichlorobenzene	0.90
Trichloroethylene	7.55	Acetaldehyde	1.50E-04	1,2-Dichloroethane	0.84

Table 18-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in New Jersey

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Camden, New Jersey (CANJ) – Camden County					
Toluene	688.19	Acrolein	361,545.39	Acrolein	31.44
Methyl *Tert*-Butyl Ether	525.70	Formaldehyde	15,452.86	Formaldehyde	0.36
Xylenes	465.64	1,3-Butadiene	14,318.98	Acetaldehyde	0.23
Benzene	216.15	Bromomethane	10,308.65	Bromomethane	0.09
Formaldehyde	151.44	Manganese		1,3-Butadiene	0.06
Methyl Isobutyl Ketone	135.73	Benzene	7,204.85	Acrylonitrile	0.05
Methyl Ethyl Ketone	132.62	Naphthalene	6,465.67	Benzene	0.04
1,1,1-Trichloroethane	120.76	Cyanide		Carbon Tetrachloride	0.02
Hexane	94.41	Xylenes	4,656.44	Tetrachloroethylene	0.00
Ethylbenzene	90.29	Acetaldehyde	4,546.24	Dichloromethane	0.00
Chester, New Jersey (CHNJ) – Morris County					
Toluene	922.39	Acrolein	413,407.46	Acrolein	27.10
Methyl *Tert*-Butyl Ether	793.79	Nickel	24,375.66	Formaldehyde	0.20
Xylenes	666.41	1,3-Butadiene	22,819.77	Acetaldehyde	0.13
Benzene	315.27	Formaldehyde	15,516.30	Acrylonitrile	0.03
Formaldehyde	152.06	Benzene	10,509.00	Benzene	0.02
Ethylbenzene	140.78	Bromomethane	9,639.60	1,3-Butadiene	0.02
Methyl Ethyl Ketone	132.19	Naphthalene	6,961.21	Carbon Tetrachloride	0.01
Hexane	131.51	Xylenes	6,664.10	Hexachloro-1,3-butadiene	0.00
Methyl Isobutyl Ketone	115.88	Cyanide	5,943.86	Tetrachloroethylene	0.00
1,1,1-Trichloroethane	109.17	Acetaldehyde	5,376.71	*p*-Dichlorobenzene	0.00

Table 18-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in New Jersey (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Elizabeth, New Jersey (ELNJ) – Union County					
Toluene	781.12	Acrolein	349,882.79	Acrolein	30.29
Xylenes	554.95	Nickel	33,390.25	Acetaldehyde	0.63
Methyl *Tert*-Butyl Ether	517.91	1,3-Butadiene	15,440.19	Formaldehyde	0.46
Hexane	320.83	Formaldehyde	12,563.54	1,3-Butadiene	0.08
Benzene	237.32	Bromomethane	10,687.32	Acrylonitrile	0.04
Methyl Ethyl Ketone	200.58	Benzene	7,910.75	Benzene	0.04
Methyl Isobutyl Ketone	182.99	Naphthalene	6,996.30	Xylenes	0.04
Formaldehyde	123.12	Cyanide	6,605.69	Carbon Tetrachloride	0.01
1,1,1-Trichloroethane	122.57	Chlorine	5,812.50	Tetrachloroethylene	0.00
Ethylbenzene	107.78	Xylenes	5,549.51	Hexachloro-1,3-butadiene	0.00
New Brunswick, New Jersey (NBNJ) – Middlesex County					
Toluene	1,301.53	Acrolein	589,734.26	Acrolein	21.67
Methyl *Tert*-Butyl Ether	966.10	1,3-Butadiene	28,201.19	Acetaldehyde	0.37
Xylenes	907.17	Formaldehyde	21,360.14	Formaldehyde	0.26
Benzene	397.48	Manganese	18,284.10	Acrylonitrile	0.06
Methyl Ethyl Ketone	267.14	Bromomethane	15,616.28	1,3-Butadiene	0.03
Methyl Isobutyl Ketone	255.93	Benzene	13,249.34	Benzene	0.02
Hexane	223.35	Naphthalene	10,828.14	Carbon Tetrachloride	0.02
Formaldehyde	209.33	Cyanide	9,484.14	Hexachloro-1,3-butadiene	0.00
Ethylbenzene	181.85	Xylenes	9,071.74	Tetrachloroethylene	0.00
1,1,1-Trichloroethane	177.19	Acetaldehyde	7,580.81	*p*-Dichlorobenzene	0.00

- Neither formaldehyde nor dichloromethane appeared on the highest cancer toxicity-weighted emissions list, and none of these pollutants had the highest cancer risks based on the 2006 annual averages for any of the New Jersey monitoring sites.

- Instead, carbon tetrachloride (for CANJ, CHNJ, and NBNJ) and acetaldehyde (for ELNJ) have the highest cancer risks based on the 2006 annual averages. While carbon tetrachloride was neither one of the highest emitted nor one of the most toxic based on the 2002 NEI emission inventory, acetaldehyde was one of the top five highest emitted pollutants in the New Jersey counties.

The following observations can be made from Table 18-9:

- Although toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants (by mass) with noncancer risk factors in each New Jersey county, only total xylenes appeared on the top 10 noncancer toxicity-weighted emissions lists.

- With the exception of xylenes for ELNJ, none of these pollutants ranked on any of the highest annual average-based noncancer risks lists.

- Acrolein had the highest noncancer toxicity-weighted emissions in each New Jersey County and had the highest noncancer risks based on the 2006 annual average for all four sites, but did not appear in the list of highest emitted pollutants.

New Jersey Pollutant Summary

- *The pollutants of interest common to each of the New Jersey sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.*

- *Formaldehyde and acetaldehyde had the highest daily averages for all four sites.*

- *Acrolein exceeded the short-term risk factors at all four New Jersey sites.*

- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of benzene and 1,3-butadiene have generally changed little at these sites. Formaldehyde concentrations seem to vary more from year to year, although an overall decreasing trend is evident at CHNJ.*

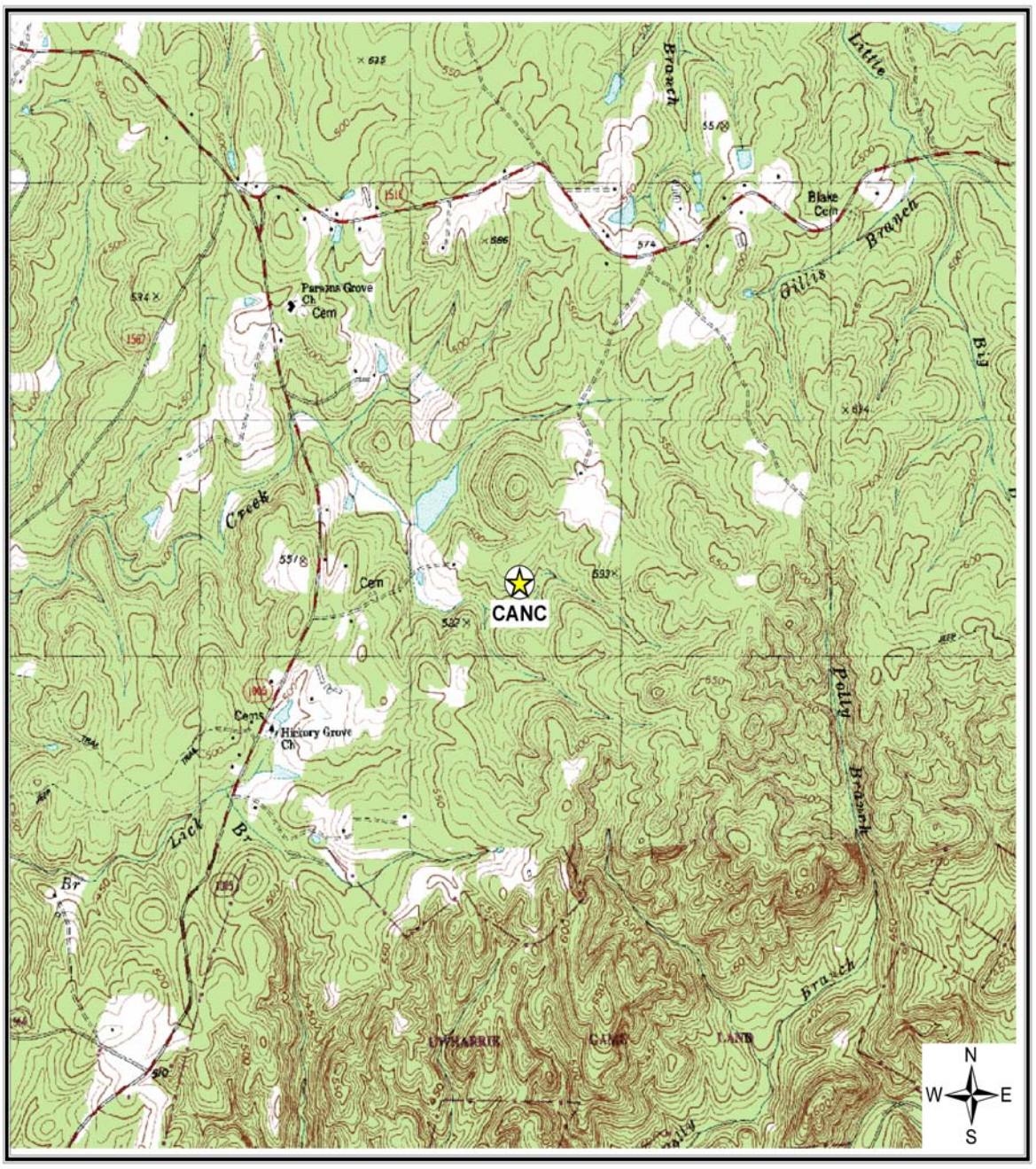
19.0 Sites in North Carolina

This section presents meteorological, concentration, and spatial trends for the UATMP sites in North Carolina (CANC and RTPNC). CANC is a rural site located in Candor near the Uwharrie National Forest. RTPNC is an urban site located in the Research Triangle Park area near Durham, North Carolina. Figures 19-1 and 19-2 are topographical maps showing the monitoring sites in their rural and urban locations. Figures 19-3 and 19-4 identify point source emission locations within 10 miles of these sites as reported to the 2002 NEI for point sources. The CANC site has few sources nearby, most of which are located to the north or west of the site. The majority of sources are involved in lumber and wood products production and fuel combustion processes. The RTPNC site has a few more nearby sources, mostly to the north and east, and the majority are involved in fuel combustion processes and industrial machinery and equipment operations.

Candor is located in south-central North Carolina, about halfway between Charlotte and Fayetteville, near the Uwharrie National Forest. This area is considered the Sandhills region, where the sandy soil allows for rapid drainage, as well as rapid warming during the day and cooling during the night. As a result, daytime temperatures rise quickly, while nighttime temperatures cool quickly. Research Triangle Park is located between Raleigh and Durham in central North Carolina. Its Southeastern location allows for warm, usually humid summers and mild winters. The Mid-Atlantic location of these sites allows for fairly ample rainfall. Afternoon thunderstorms are typical during the summer, although rainfall is distributed rather equally throughout the year (Ruffner and Bair, 1987).

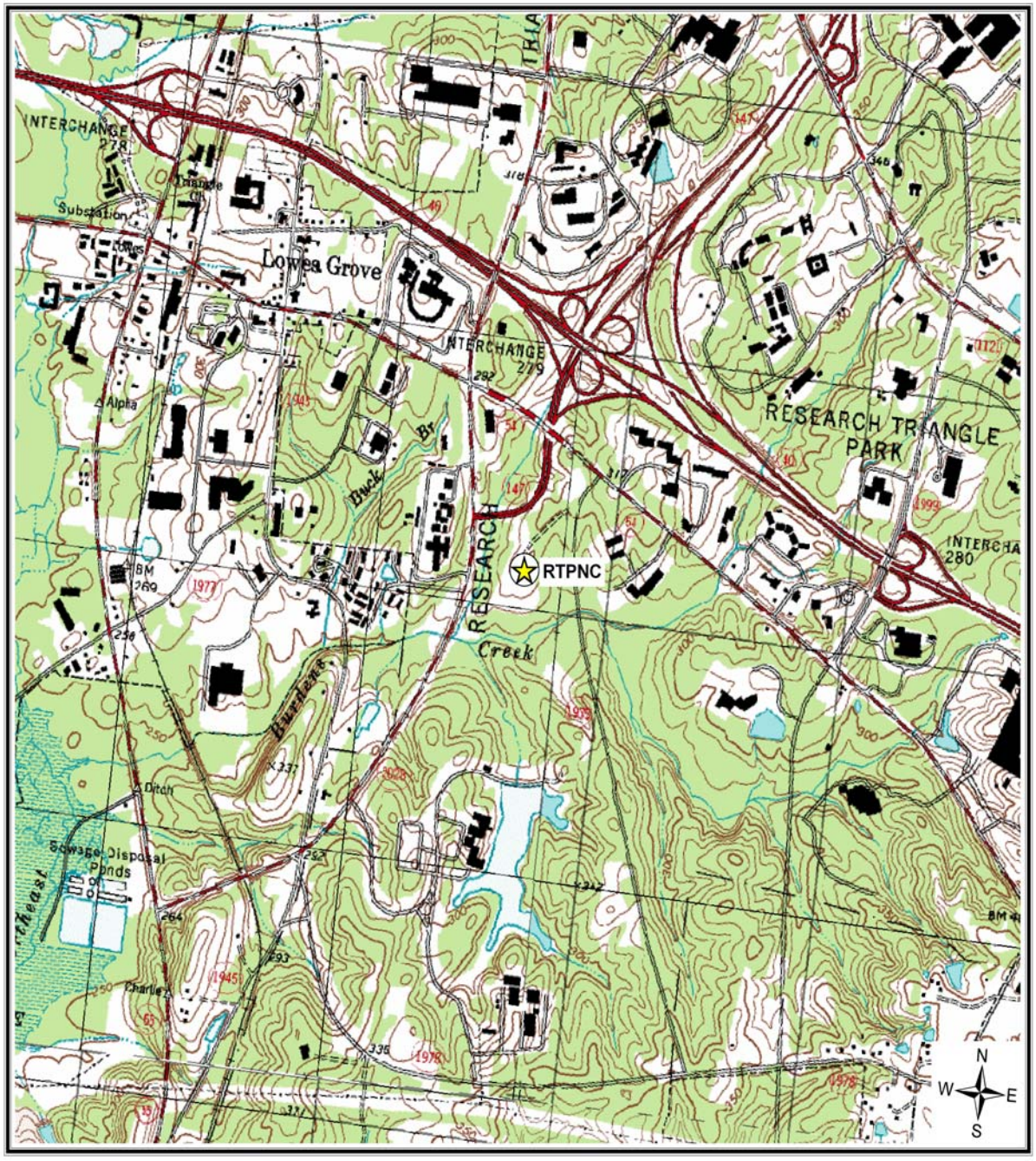
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the CANC and RTPNC monitoring sites are the Moore County Airport and Raleigh-Durham International Airport (WBAN 3720 and 13722, respectively). Table 19-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity),

Figure 19-1. Candor, North Carolina (CANC) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 19-2. Research Triangle Park, North Carolina (RTPNC) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24, 000.

Figure 19-3. Facilities Located Within 10 Miles of CANC

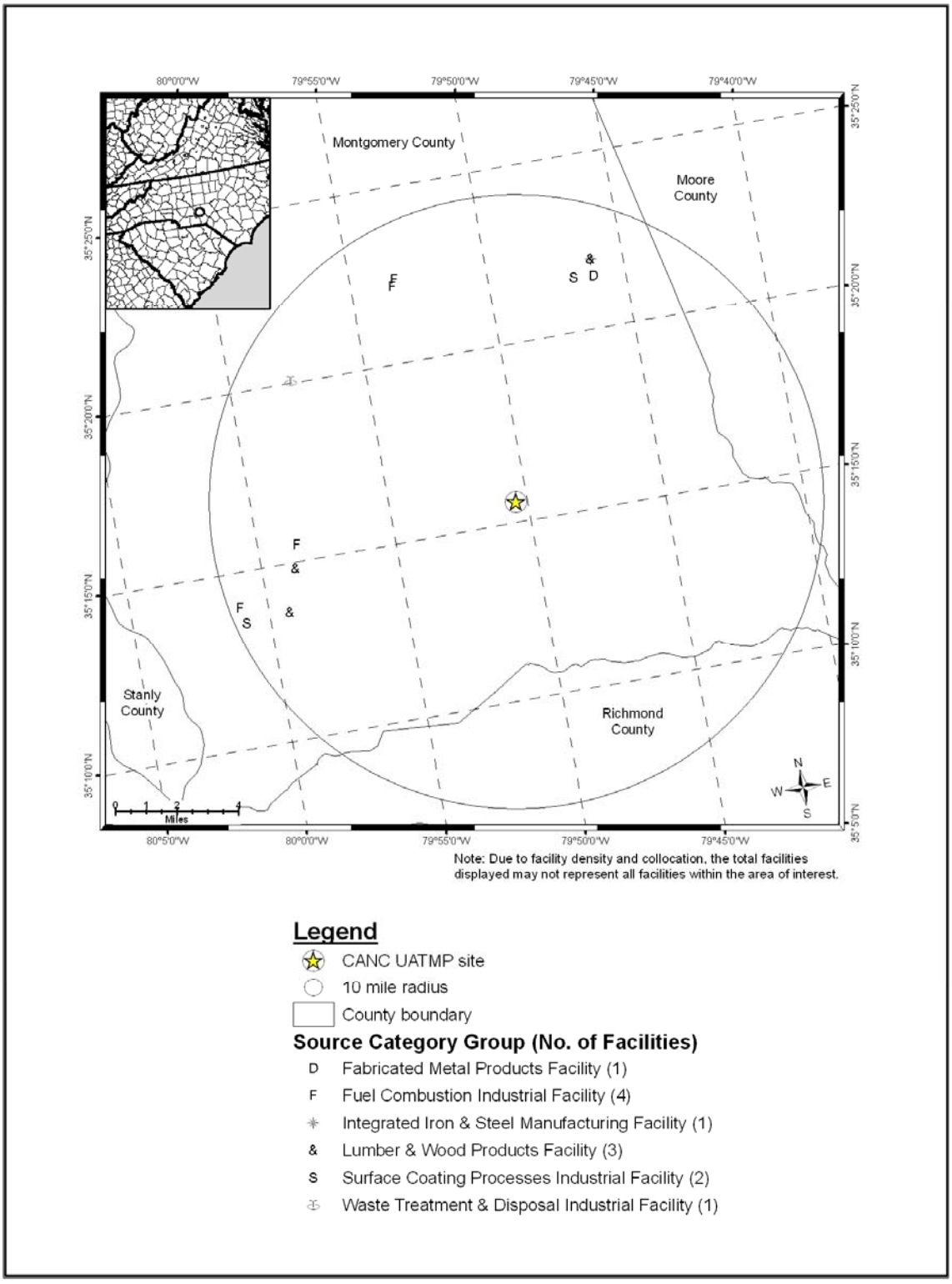


Figure 19-4. Facilities Located Within 10 Miles of RTPNC

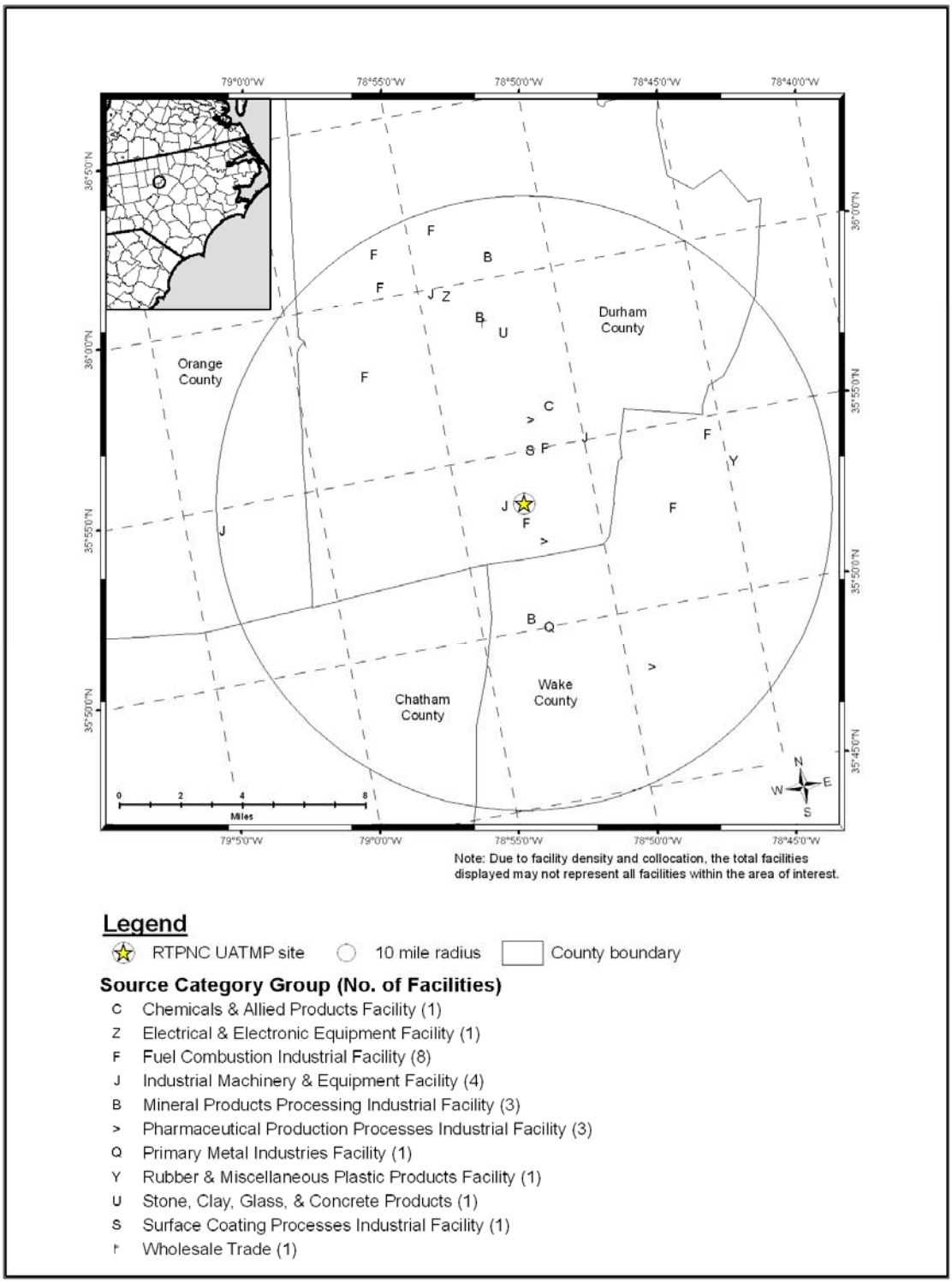


Table 19-1. Average Meteorological Conditions near the Monitoring Sites in North Carolina

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CANC	03720	All 2006	72.05 ± 1.47	60.90 ± 1.47	47.85 ± 1.70	54.17 ± 1.41	65.74 ± 1.34	NA[1]	4.86 ± 0.28
		Sampling Day	67.00 ± 8.59	58.20 ± 6.91	44.42 ± 9.83	51.55 ± 7.06	65.92 ± 14.83	NA[1]	6.06 ± 1.77
RTPNC	13722	All 2006	71.92 ± 1.46	61.11 ± 1.43	48.51 ± 1.70	54.61 ± 1.39	66.97 ± 1.35	1017.19 ± 0.66	5.19 ± 0.28
		Sampling Day	67.89 ± 7.98	57.56 ± 6.89	43.81 ± 9.18	50.91 ± 6.77	65.27 ± 4.92	1016.47 ± 4.43	6.86 ± 1.31

NA[1] = Sea level pressure was not recorded at this station.

pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 19-1 is the 95 percent confidence interval for each parameter. As shown in Table 19-1, temperatures on sampling days appeared cooler than temperatures experienced throughout the year. This difference is probably attributable to the sampling duration of these sites. Both CANC and RTPNC stopped sampling in June, thereby missing the warmest months of the year. The weather station at Moore County Airport did not record sea level pressure; therefore it is not presented in Table 19-1.

19.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. The North Carolina sites sampled for carbonyl compounds only. Table 19-2 presents the pollutants that failed at least one screen at the North Carolina monitoring sites.

Table 19-2. Comparison of Measured Concentrations and EPA Screening Values for the North Carolina Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Candor, North Carolina – CANC					
Acetaldehyde	8	9	88.89	57.14	57.14
Formaldehyde	6	9	66.67	42.86	100.00
Total	14	18	77.78		
Durham, North Carolina – RTPNC					
Acetaldehyde	9	9	100.00	60.00	60.00
Formaldehyde	6	9	66.67	40.00	100.00
Total	15	18	83.33		

The following observations are shown in Table 19-2:

- Acetaldehyde and formaldehyde failed screens at the CANC and RTPNC monitoring sites.
- These two pollutants failed a total of 14 screens at CANC and 15 screens at RTPNC.
- Acetaldehyde contributed to over 50 percent of the total failed screens for both sites.
- Acetaldehyde concentrations failed more than 85 percent of its screens at CANC and 100 percent at RTPNC. Formaldehyde concentrations failed nearly 70 percent of its screens at RTPNC and CANC.

19.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal average concentrations are presented in Table 19-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 19-3:

- Acetaldehyde and formaldehyde were detected in every sample collected at the North Carolina monitoring sites.
- The daily average of formaldehyde was higher than acetaldehyde for both sites, but if the confidence interval was considered, the concentrations were not significantly different.
- Winter and spring seasonal averages for these two pollutants could not be calculated due to the low number of measured detections (these sites sampled a 1-in-12 schedule). Summer and autumn averages could not be calculated because the sites stopped sampling in June.

Table 19-3. Daily and Seasonal Averages for the Pollutants of Interest for the North Carolina Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Candor, North Carolina – CANC												
Acetaldehyde	9	9	1.03	0.27	NR	NR	NR	NR	NA	NA	NA	NA
Formaldehyde	9	9	1.66	0.61	NR	NR	NR	NR	NA	NA	NA	NA
Durham, North Carolina – RTPNC												
Acetaldehyde	9	9	1.19	0.26	NR	NR	NR	NR	NA	NA	NA	NA
Formaldehyde	9	9	2.17	0.77	NR	NR	NR	NR	NA	NA	NA	NA

NA = Not available due to short sampling duration.

NR = Not reportable due to low number of measured detections.

19.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for the North Carolina monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the two pollutants with at least one failed screen at either site, none of the concentrations exceeded the acute risk values. Intermediate risk could not be assessed because seasonal averages could not be calculated.

19.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

19.4.1 Pearson Correlation Analysis

Table 19-4 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the North Carolina monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 19-4:

- Strong negative correlations were calculated between formaldehyde and acetaldehyde and relative humidity for both sites. This indicates that these pollutant's concentrations tend to increase as moisture content decreases.

- Strong positive correlations were exhibited between formaldehyde and maximum and average temperature for both sites, indicating that formaldehyde concentrations tend to increase as temperature increases.

- The low number of measured detections at these sites may make the correlations appear stronger than they would otherwise.

Table 19-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the North Carolina Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Candor, North Carolina – CANC								
Acetaldehyde	9	0.35	0.04	-0.49	-0.27	-0.81	NA	0.46
Formaldehyde	9	0.81	0.56	-0.02	0.26	-0.64	NA	0.21
Durham, North Carolina – RTPNC								
Acetaldehyde	9	0.39	0.29	-0.32	-0.04	-0.83	0.16	0.19
Formaldehyde	9	0.66	0.62	0.05	0.35	-0.62	0.09	-0.17

NA = This station did not record sea level pressure.

19.4.2 Composite Back Trajectory Analysis

Figures 19-5 and 19-6 are composite back trajectory maps for the North Carolina monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

The following observations can be made from Figure 19-5:

- Back trajectories originated from a variety of directions at CANC, although there was an absence of trajectories from the east.
- The 24-hour airshed domain was large, with trajectories originating as far away as northern Illinois (> 700 miles).
- Over 70 percent of the trajectories originated within 400 miles of the CANC monitoring site.
- The back trajectory map might look much different with a full year's worth of sampling day trajectories.

The following observations can be made from Figure 19-6:

- Back trajectories originated from a variety of directions at RTPNC, although there was an absence of trajectories from the east.
- The 24-hour airshed domain was large, with trajectories originating as far away as Wisconsin (>700 miles).
- Nearly 70 percent of the trajectories originated within 400 miles of the site.
- Figure 19-6 might look much different with a full year's worth of sampling day trajectories.

19.4.3 Wind Rose Analysis

Hourly wind data from the Moore County Airport and Raleigh-Durham International Airport weather stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds.

Figure 19-5. Composite Back Trajectory Map for CANC

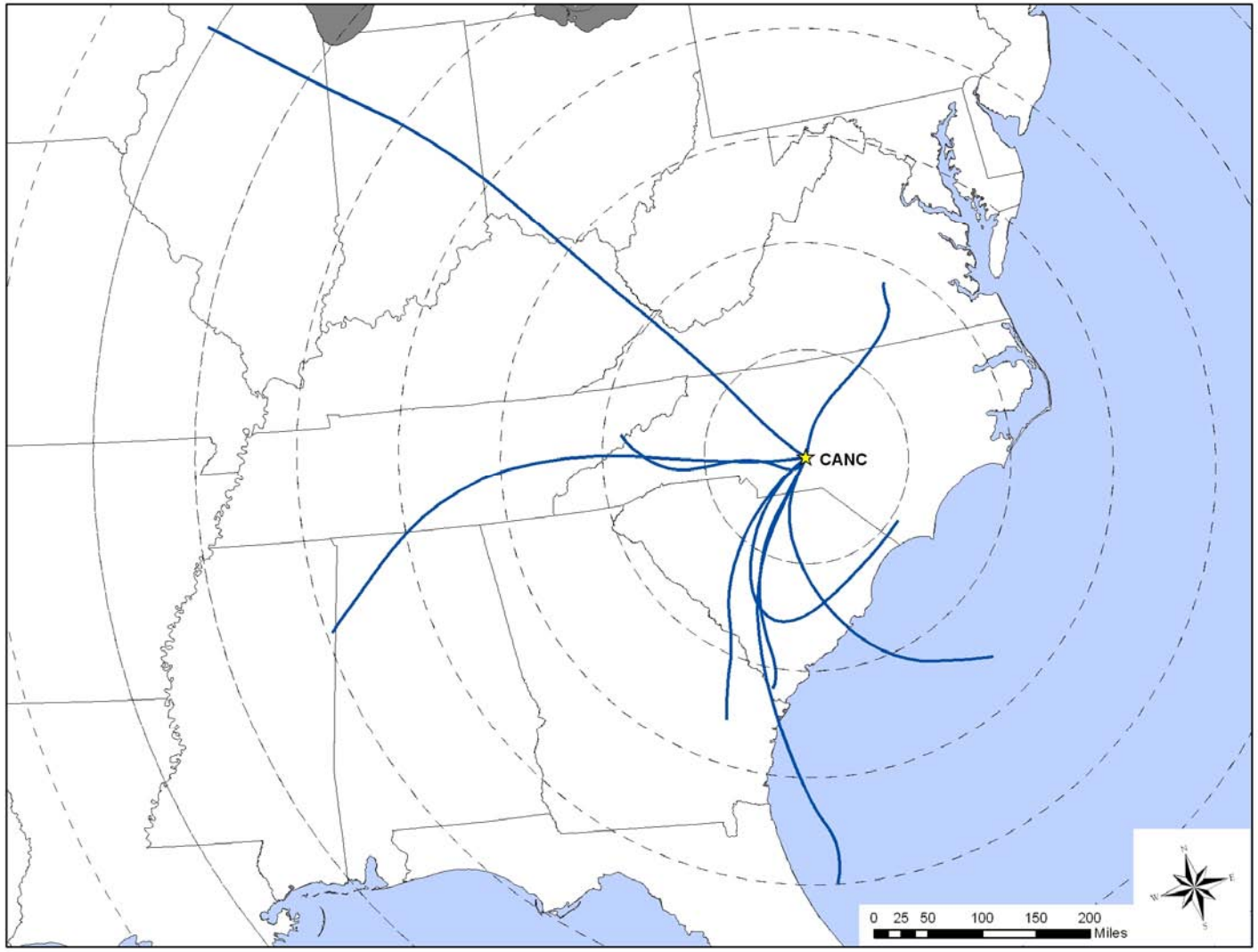
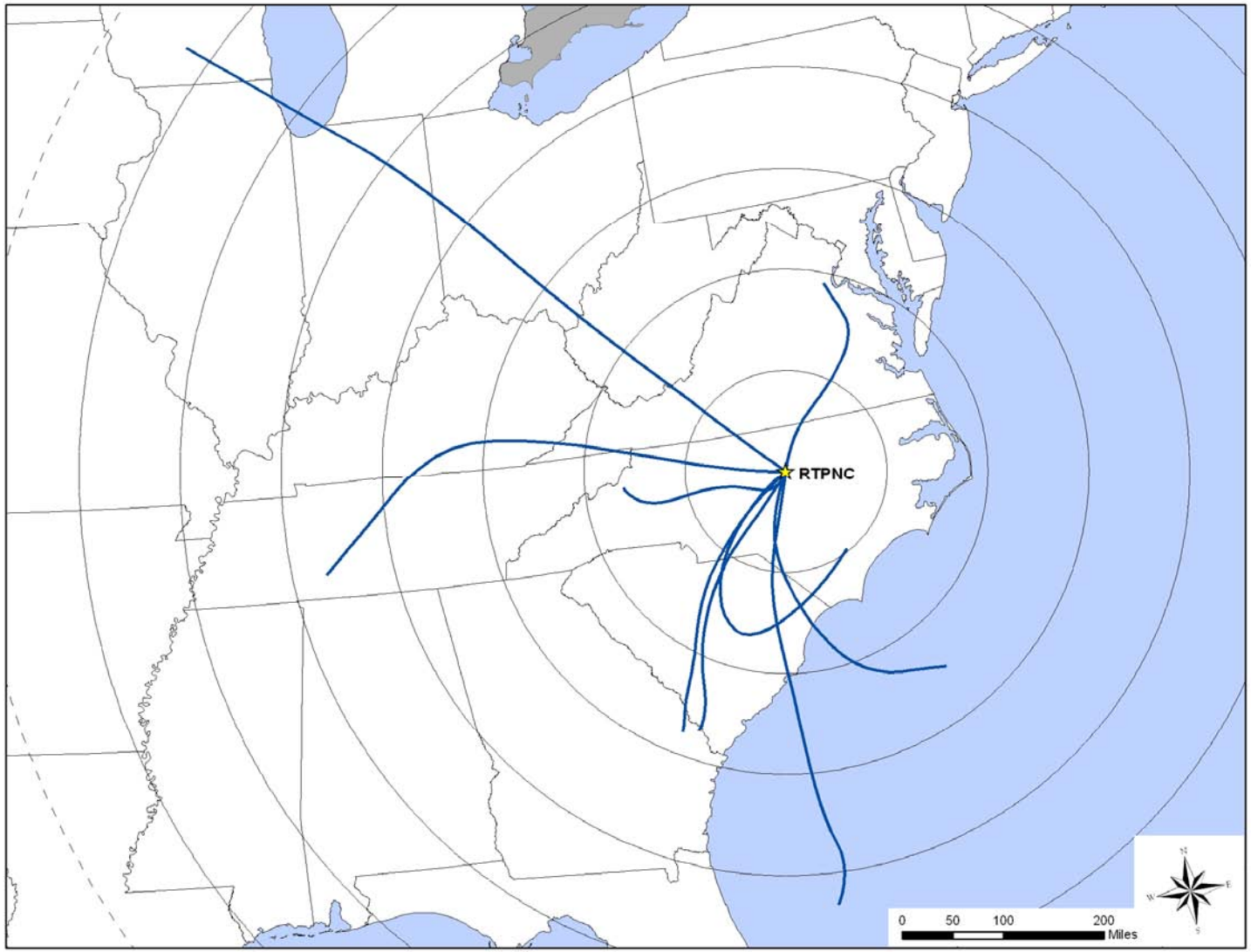


Figure 19-6. Composite Back Trajectory Map for RTPNC



Figures 19-7 and 19-8 are the wind roses for the North Carolina monitoring sites on days that sampling occurred.

Observations from Figure 19-7 for CANC include:

- Hourly winds were predominantly out of the west-southwest (16 percent of observations), southwest (15 percent), and west (15 percent) on days samples were collected near CANC.
- Calm winds (<2 knots) were recorded for 14 percent of the hourly observations.
- For wind speeds greater than two knots, most of the observations ranged from 7 to 11 knots.

Observations from Figure 19-8 for RTPNC include:

- Hourly winds were predominantly out of southwest (16 percent), south-southwest (14 percent), and west-southwest (13 percent) on days samples were collected near RTPNC.
- Calm winds (<2 knots) were recorded for 12 percent of the hourly observations.
- For wind speeds greater than two knots, most of observations ranged from 7 to 11 knots.

19.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze VOCs for this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

19.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Montgomery County and Durham County, North Carolina were obtained from the North Carolina Department of Transportation and the U.S. Census Bureau, and are summarized in Table 19-5. Table 19-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally,

Figure 19-7. Wind Rose for CANC Sampling Days

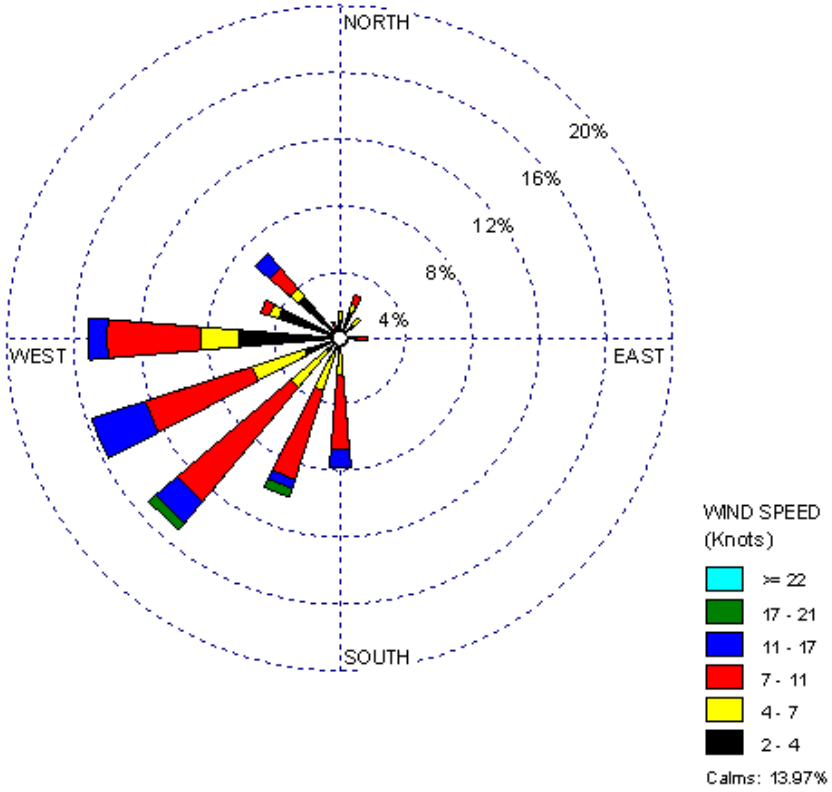


Figure 19-8. Wind Rose for RTPNC Sampling Days

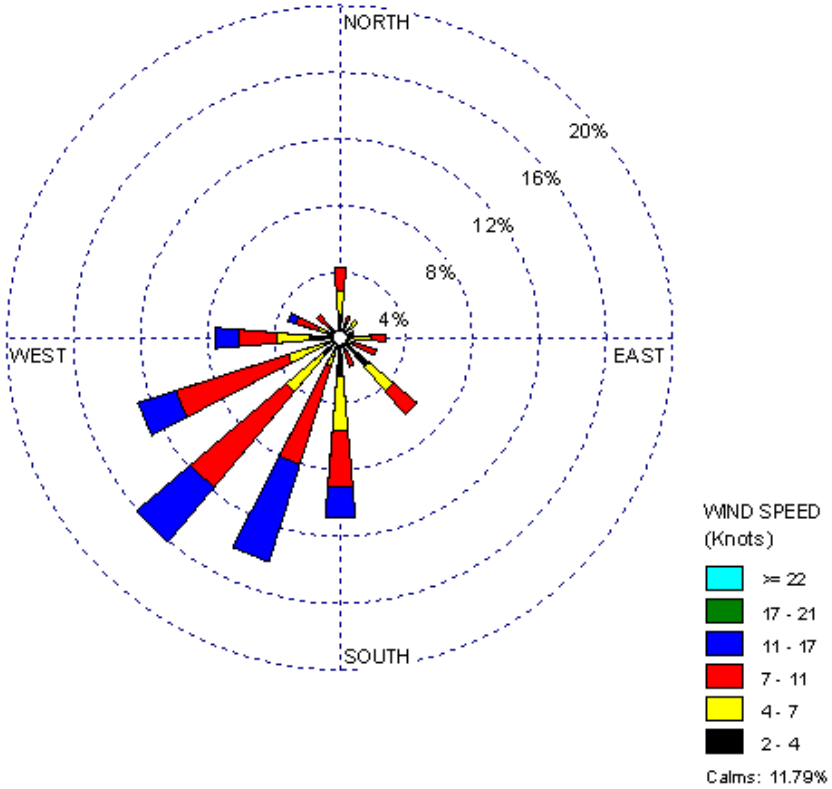


Table 19-5. Motor Vehicle Information for the North Carolina Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
CANC	27,638	28,333	1.03	11,369	11,655	100
RTPNC	246,896	188,168	0.76	399,239	304,274	12,000

Table 19-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 19-5 include:

- The CANC monitoring site has a significantly lower county-level and 10-mile population and vehicle ownership than RTPNC. CANC also has a significantly lower daily traffic volume than RTPNC. This is expected as the CANC site is located within the boundaries of a National Forest, while RTPNC is located in a business park near a major interstate, as shown in Figures 19-1 and 19-2.

- The CANC site's vehicles per person ratio is higher than the RTPNC ratio, and is over 1.0.

- Compared to other UATMP locations, CANC has one of the lowest daily traffic volumes, with only three monitoring sites reporting a smaller daily traffic volume, while RTPNC's daily traffic volume falls in the middle of the range.

19.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The CANC monitoring site has participated in the UATMP since 2003 and the RTPNC site has participated in the UATMP since 2004. As previously mentioned, these sites sampled for only carbonyl compounds. Figures 19-9 and 19-10 present the trends analysis for formaldehyde.

The following observations can be made from Figures 19-9 and 19-10:

- Formaldehyde concentrations have changed little over the last four years for CANC.

- The RTPNC monitoring site also appears to have a fairly consistent formaldehyde concentration.

19.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the North Carolina sites. The North Carolina sites did not sample long enough to allow calculation of annual averages for the pollutants of interest (refer to Section 3.3.5 regarding the definition of an

Figure 19-9. Comparison of Yearly Averages for the CANC Monitoring Site

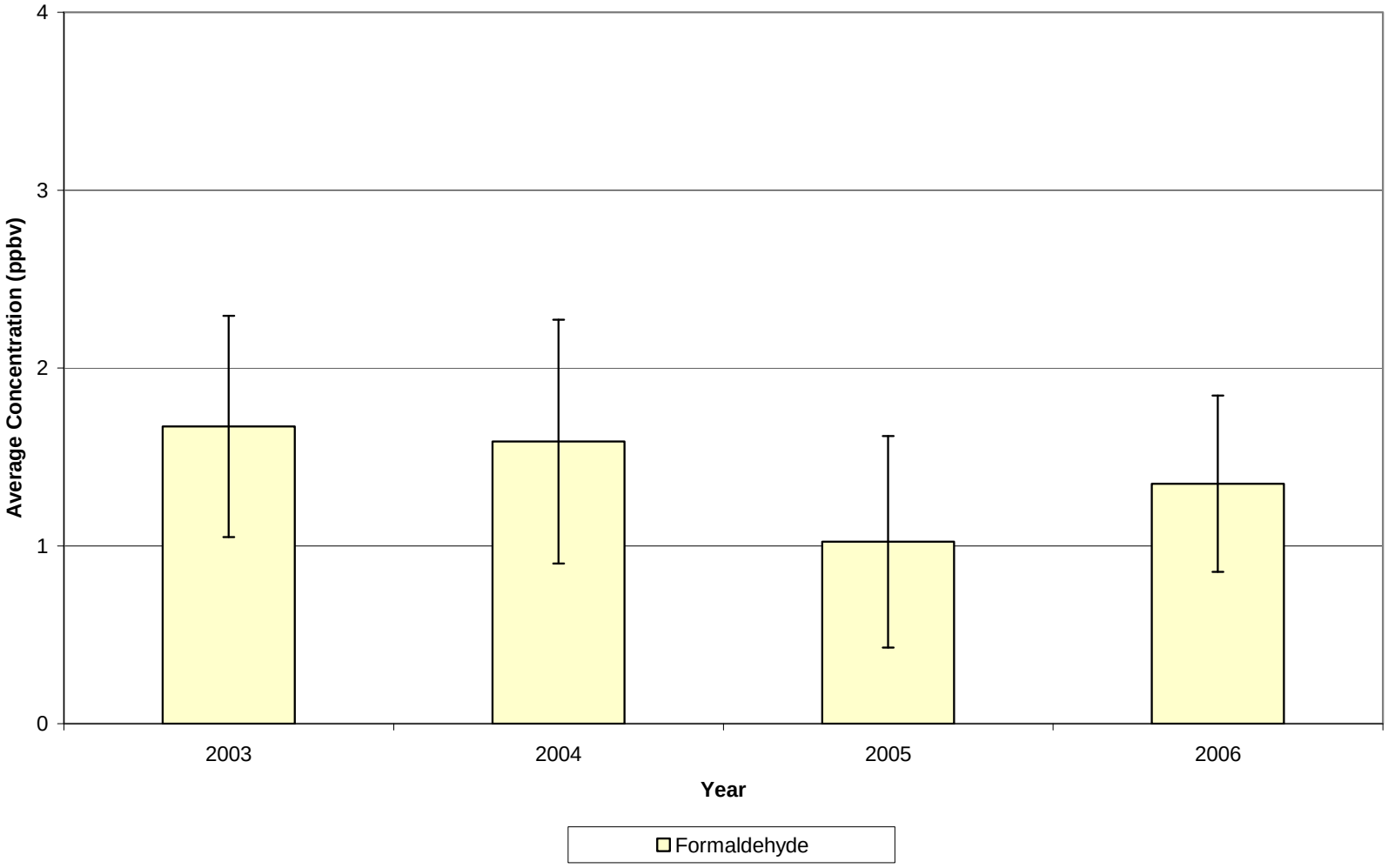
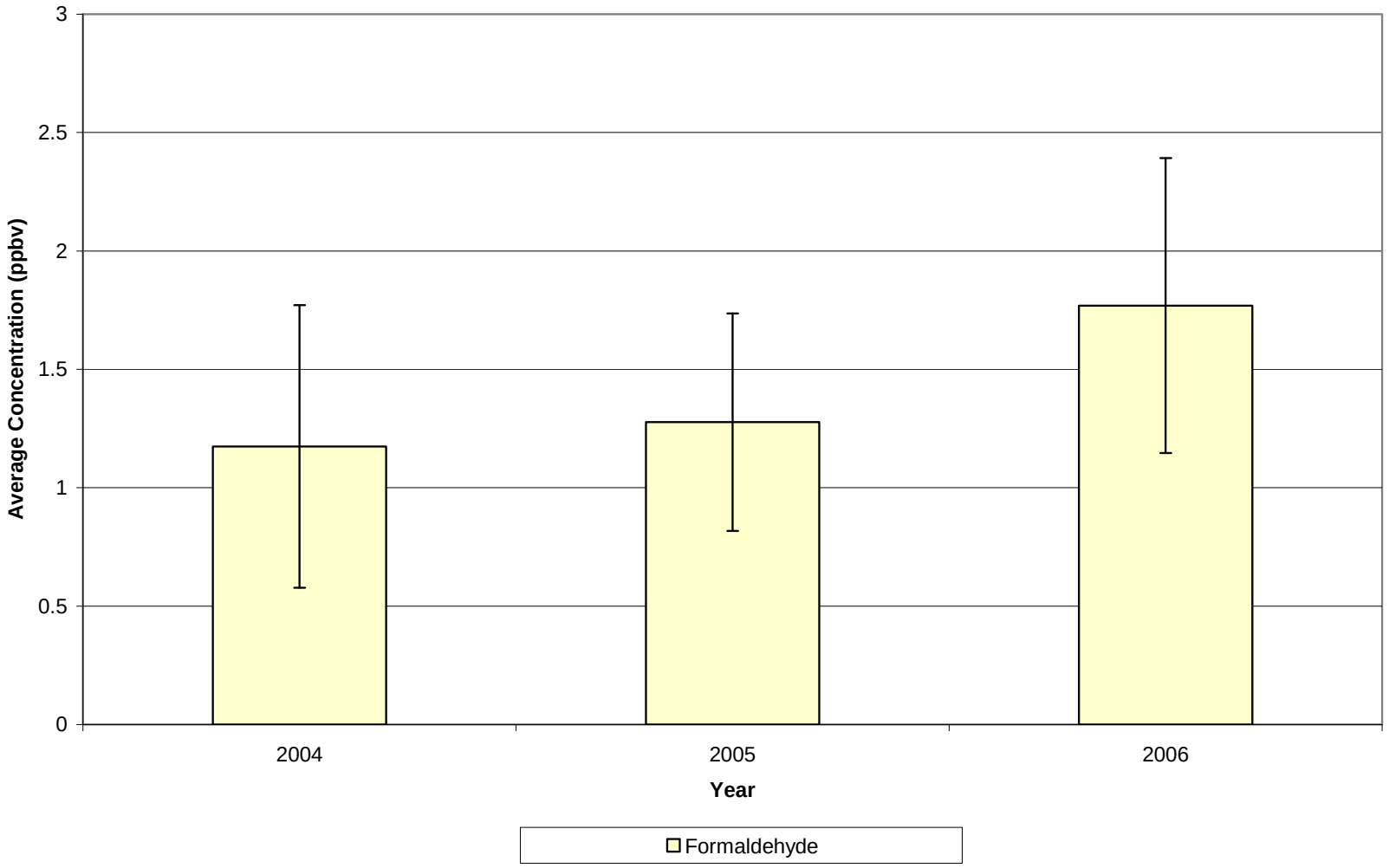


Figure 19-10. Comparison of Yearly Averages for the RTPNC Monitoring Site



annual average), and therefore annual average-based cancer and not cancer risks cannot be assessed. However, data from EPA's 1999 NATA were retrieved and are presented in Table 19-6. The NATA data are presented for the census tract where the monitoring sites are located.

The census tract information for the North Carolina sites is as follows:

- The census tract for CANC is 37123960500, which had a population of 6,424 and represents approximately 24 percent of the Montgomery County population in 2000.
- The census tract for RTPNC is 37063002014, which had a population of 5,034, and represents approximately 2.3 percent

The following observations can be made from Table 19-6:

- The NATA-modeled concentrations of acetaldehyde and formaldehyde were higher for RTPNC than for CANC, although both were relatively low.
- Cancer risks attributable to acetaldehyde were significantly higher than those of formaldehyde for both North Carolina sites.
- NATA-modeled noncancer risks of formaldehyde and acetaldehyde were very low for both sites.

19.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 19-7 and 19-8 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 19-7 presents the 10 pollutants with the highest emissions from the 2002 NEI and the 10 pollutants with the highest toxicity-weighted emissions. The 10 pollutants with the highest cancer risk could not be calculated because there are no annual averages. Table 19-8 presents similar information, but is based on noncancer risk factors. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be.

Table 19-6. Chronic Risk Summary for the Monitoring Sites in North Carolina

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Candor, North Carolina (CANC) – Census Tract ID 37123960500								
Acetaldehyde	0.0000022	0.009	0.57	1.25	0.06	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	0.39	<0.01	0.04	NA	NA	NA
Durham, North Carolina (RTPNC) – Census Tract ID 37063002014								
Acetaldehyde	0.0000022	0.009	1.21	2.65	0.13	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.24	0.01	0.13	NA	NA	NA

BOLD indicates a pollutant of interest
NA = annual average not available

Table 19-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in North Carolina

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Candor, North Carolina (CANC) – Montgomery County					
Formaldehyde	55.44	Benzene	3.91E-04		
Benzene	50.17	Polycyclic Organic Matter as 7-PAH	1.39E-04		
Acetaldehyde	7.96	1,3-Butadiene	9.04E-05		
1,3-Butadiene	3.01	Hexavalent Chromium	5.36E-05		
Dichloromethane	2.24	Polycyclic Organic Matter as 15-PAH	4.41E-05		
Polycyclic Organic Matter as 7-PAH	2.11	Naphthalene	4.01E-05		
Tetrachloroethylene	1.66	Arsenic	3.83E-05		
Naphthalene	1.18	Polycyclic Organic Matter as non-15 PAH	2.32E-05		
Polycyclic Organic Matter as 15-PAH	0.80	Lead	2.22E-05		
p-Dichlorobenzene	0.64	Acetaldehyde	1.75E-05		
Durham, North Carolina (RTPNC) – Durham County					
Benzene	248.26	Benzene	1.94E-03		
Formaldehyde	91.93	1,3-Butadiene	7.44E-04		
Acetaldehyde	34.10	Naphthalene	2.01E-04		
1,3-Butadiene	24.81	Tetrachloroethylene	1.44E-04		
Tetrachloroethylene	24.37	Ethylene Oxide	1.12E-04		
Dichloromethane	23.89	Beryllium	1.04E-04		
Trichloroethylene	7.04	Hexavalent Chromium	8.43E-05		
Naphthalene	5.92	Polycyclic Organic Matter as 15-PAH	7.75E-05		
p-Dichlorobenzene	5.01	Acetaldehyde	7.50E-05		
Polycyclic Organic Matter as 15-PAH	1.41	Polycyclic Organic Matter as 7-PAH	6.81E-05		

Table 19-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in North Carolina

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Candor, North Carolina - CANC - Montgomery County					
Toluene	77.23	Acrolein	68,961.80		
Formaldehyde	55.44	Manganese	19,022.29		
Benzene	50.17	Formaldehyde	5,657.29		
Xylenes	49.49	Benzene	1,672.47		
Methanol	21.91	Chlorine	1,544.23		
Ethylbenzene	11.89	1,3-Butadiene	1,505.90		
Hexane	11.63	Cyanide	982.21		
Methyl Ethyl Ketone	9.77	Acetaldehyde	884.62		
Methyl Isobutyl Ketone	9.36	Xylenes	494.92		
Hydrochloric Acid	9.19	Hydrochloric Acid	459.64		
Durham, North Carolina - RTPNC - Durham County					
Toluene	606.64	Acrolein	261,196.28		
Xylenes	392.76	1,3-Butadiene	12,406.99		
Methanol	253.60	Formaldehyde	9,380.86		
Benzene	248.26	Benzene	8,275.48		
Ethylene Glycol	106.35	Xylenes	3,927.60		
Hexane	98.65	Acetaldehyde	3,788.53		
Methyl Ethyl Ketone	94.65	Cyanide	2,839.13		
Ethylbenzene	93.30	Beryllium	2,169.50		
Formaldehyde	91.93	Naphthalene	1,974.04		
Hydrochloric Acid	36.43	Hydrochloric Acid	1,821.62		

The following observations can be made from Table 19-7

- Unlike most UATMP counties, formaldehyde was the highest emitted pollutant (by mass) with a cancer risk factor in Montgomery County, where CANC is located, while benzene followed with the second highest emissions. However, the emissions for these pollutants were very similar and rather low.

- Benzene had the highest emissions in Durham County, where RTPNC is located, followed by formaldehyde. The emissions of these pollutants in Durham County were higher than those of Montgomery County.

- Benzene had the highest cancer toxicity-weighted emissions in both counties, while formaldehyde did not appear on either top 10 toxicity-weighted emissions lists.

- Benzene, acetaldehyde, 1,3-butadiene, POM as 7-PAH, naphthalene, and POM as 15-PAH were shown on both "top 10" lists for Montgomery County, while benzene, acetaldehyde, 1,3-butadiene, tetrachloroethylene, naphthalene, and POM as 15-PAH were shown on both "top 10" lists for Durham County.

The following observations can be made from Table 19-8:

- Although toluene was the highest emitted pollutant (by mass) with a noncancer risk factor in both Durham and Montgomery Counties, it did not rank in the top 10 based on toxicity-weighted emissions.

- The toluene emissions in Durham County were much higher than those in Montgomery County.

- Like most counties, acrolein had the highest noncancer toxicity-weighted emissions in both counties, but was significantly higher in Durham County.

- Formaldehyde, benzene, and xylenes were the only pollutants that appear on both lists for the two North Carolina counties.

North Carolina Pollutant Summary

- *The pollutants of interest common to both North Carolina sites were acetaldehyde and formaldehyde.*

- *Formaldehyde had the highest daily average for both sites.*

- *A comparison of formaldehyde concentrations for all years of UATMP participation shows that formaldehyde concentrations at CANC and RTPNC have changed little over the years.*

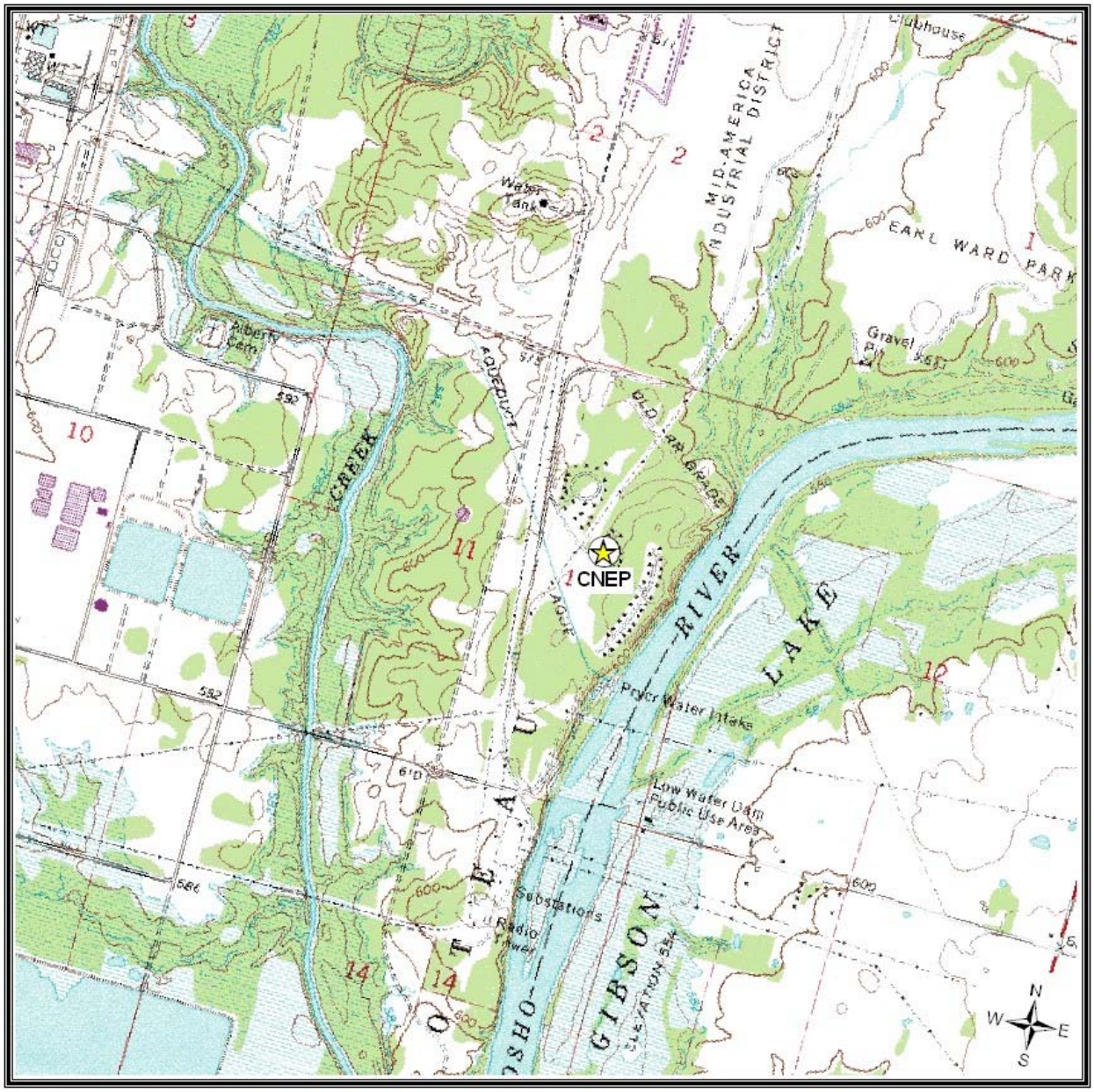
20.0 Sites in Oklahoma

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Oklahoma (CNEP, TOOK, TSOK and TUOK). TOOK, TSOK, and TUOK are located in Tulsa, in northeast Oklahoma, while CNEP is located in Pryor, OK, approximately 30 miles east of the other sites. Figures 20-1 through 20-4 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 20-5 and 20-6 identify point source emission locations within 10 miles of these sites as reported to the 2002 NEI for point sources. Only a small number of sources are located within a 10 mile radius of CNEP, as shown in Figure 20-5. The sources near this site are located mainly to the west and consist of mostly fuel combustion processes. As shown in Figure 20-6, the three Tulsa sites reside within a mile or two of each other. There are many sources located within 10 miles of the Tulsa sites, most of which are located to the northeast and southwest of the sites. Fabricated metal products production account for more than a dozen of the local processes.

Tulsa is located in northeast Oklahoma, just southeast of the Osage Indian Reservation, and along the Arkansas River. The area is characterized by a continental climate, with warm and humid summers and cool winters. The region experiences ample rainfall, with spring as the wettest season. A southerly wind prevails, bringing warm, moist air northward from the Gulf of Mexico. Pryor is also in northeast Oklahoma, approximately 30 miles east of Tulsa, so the climate is much like that of Tulsa. Oklahoma is in “Tornado Alley”, where severe thunderstorms are capable of producing strong winds and hail, and tornadoes are more prevalent than in other regions in the U.S. (Ruffner and Bair, 1987).

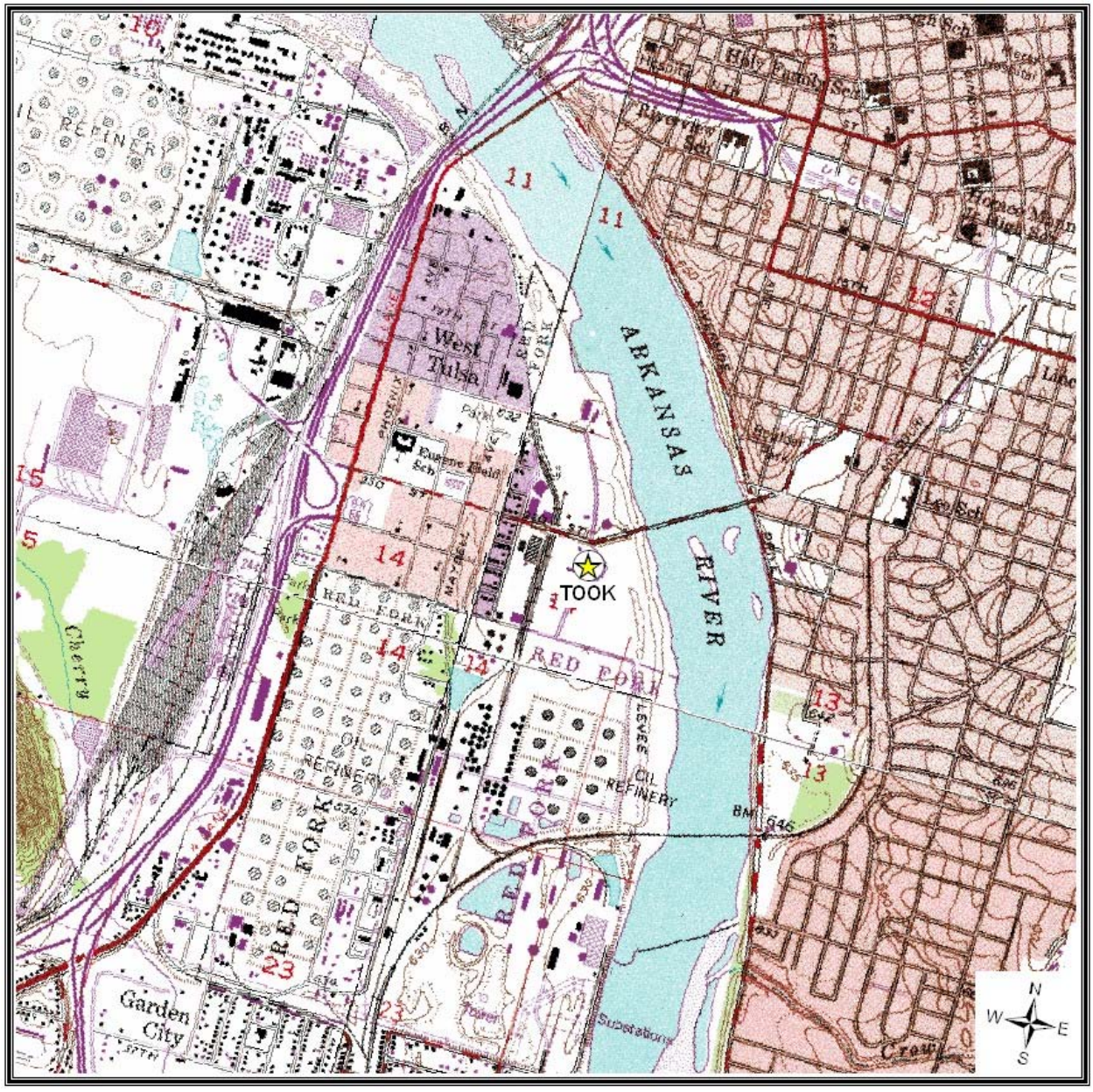
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the CNEP monitoring site is the Claremore Regional Airport; TOOK and TUOK are closest to the Richard Lloyd Jones Jr. Airport; and TSOK is near the Tulsa International Airport (WBAN 53940, 53908, and 13968, respectively.) Table 20-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point

Figure 20-1. Cherokee Nation, Oklahoma (CNEP) Monitoring Site



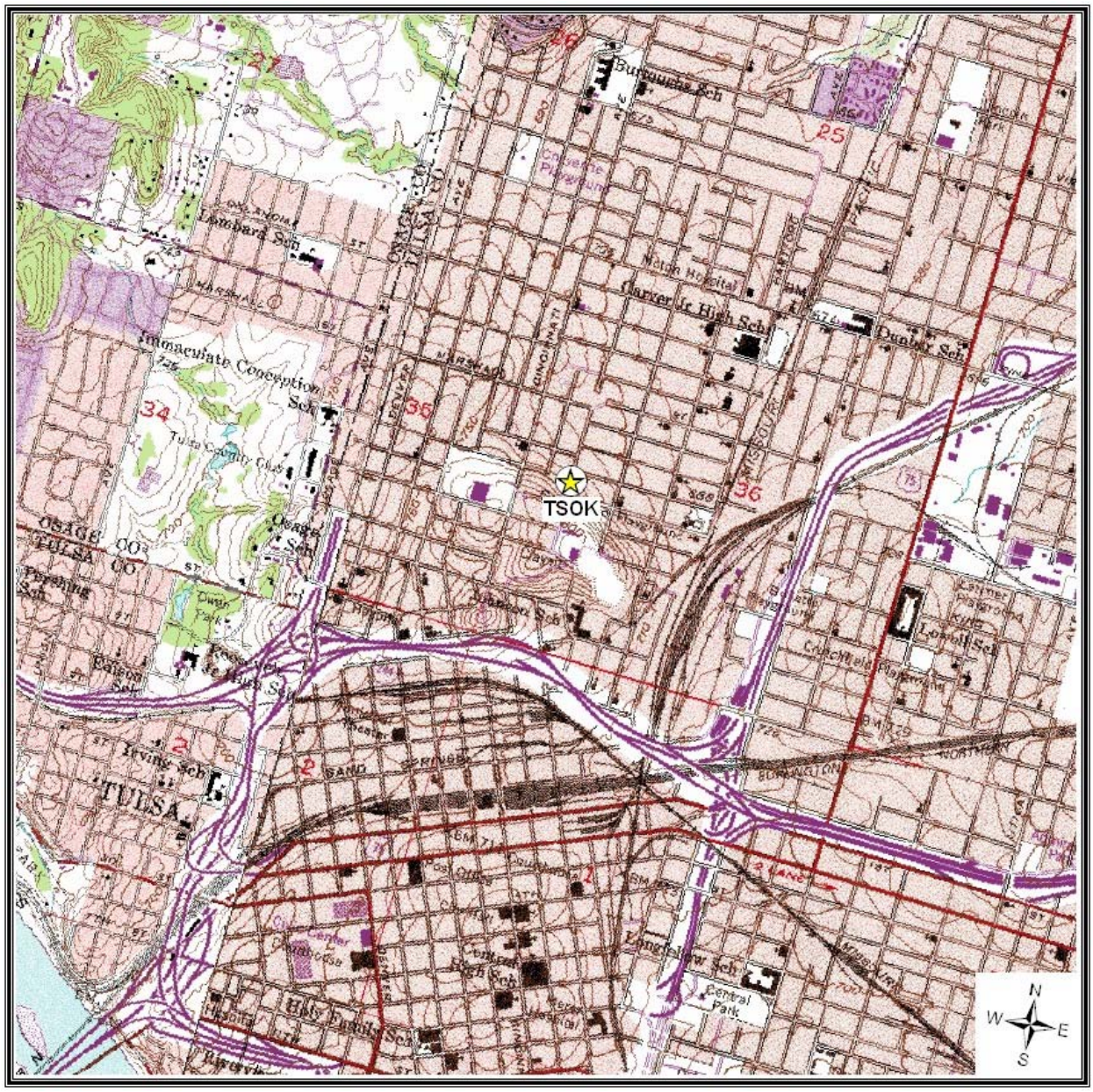
Sources: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 20-2. Tulsa, Oklahoma (TOOK) Monitoring Site



Sources: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 20-3. Tulsa, Oklahoma (TSOK) Monitoring Site



Sources: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 20-4. Tulsa, Oklahoma (TUOK) Monitoring Site

Sources: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 20-5. Facilities Located Within 10 Miles of CNEP

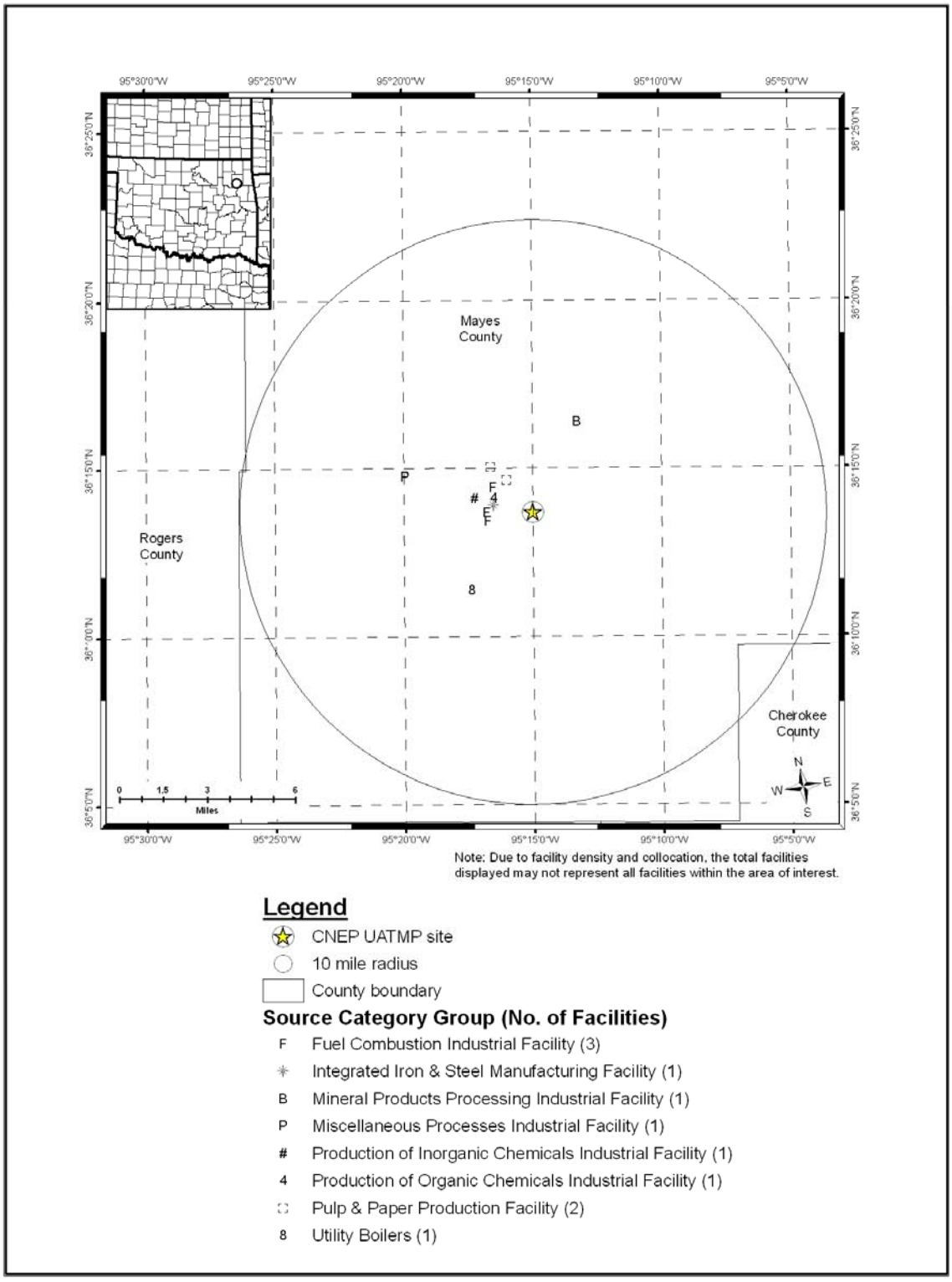


Figure 20-6. Facilities Located Within 10 Miles of TOOK, TSOK and TUOK

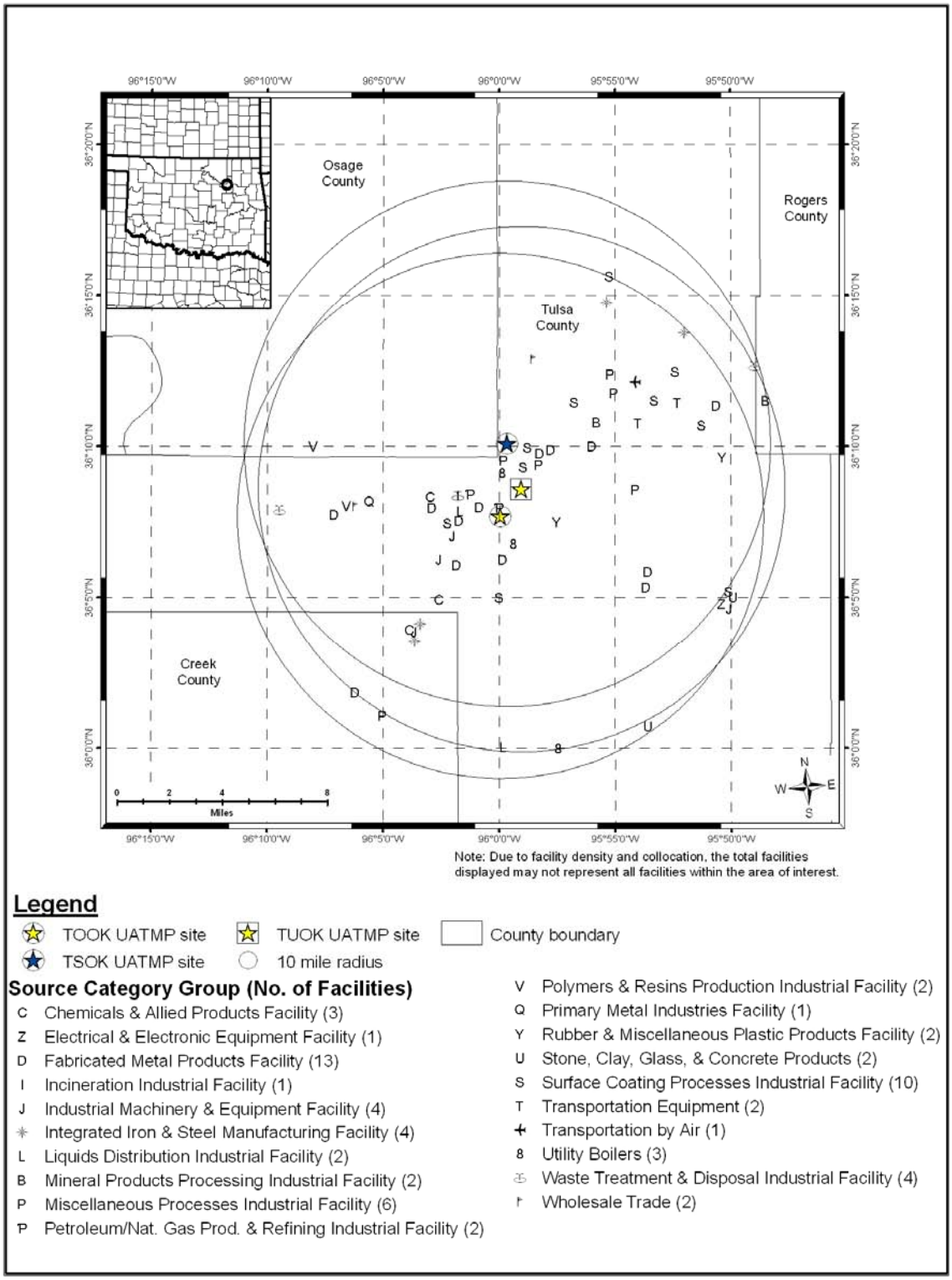


Table 20-1. Average Meteorological Conditions near the Monitoring Sites in Oklahoma

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CNEP	53940	All 2006	72.83 ± 1.81	61.17 ± 1.71	47.40 ± 1.74	53.87 ± 1.54	64.51 ± 1.31	NA[1]	6.94 ± 0.33
		Sampling Day	60.31 ± 7.53	49.23 ± 7.22	37.79 ± 8.02	44.08 ± 6.88	67.71 ± 6.40	NA[1]	5.88 ± 1.18
TOOK	53908	All 2006	74.67 ± 1.80	62.51 ± 1.74	46.93 ± 1.73	54.15 ± 1.52	61.31 ± 1.33	1016.63 ± 0.71	5.79 ± 0.28
		Sampling Day	76.32 ± 4.57	63.91 ± 4.41	49.70 ± 4.14	55.96 ± 3.80	64.13 ± 3.07	1016.50 ± 1.60	5.71 ± 0.78
TSOK	13968	All 2006	74.27 ± 1.80	63.45 ± 1.75	46.47 ± 1.72	54.34 ± 1.50	58.05 ± 1.41	1015.41 ± 0.73	8.18 ± 0.34
		Sampling Day	77.26 ± 6.30	66.62 ± 6.11	50.90 ± 5.64	57.63 ± 5.20	60.84 ± 4.27	1016.61 ± 2.11	7.22 ± 0.95
TUOK	53908	All 2006	74.67 ± 1.80	62.51 ± 1.74	46.93 ± 1.73	54.15 ± 1.52	61.31 ± 1.33	1016.63 ± 0.71	5.79 ± 0.28
		Sampling Day	75.52 ± 4.62	63.17 ± 4.46	48.69 ± 4.30	55.22 ± 3.88	63.50 ± 3.14	1016.74 ± 1.63	5.79 ± 0.76

[1]Sea level pressure was not recorded at the Claremore Regional Airport.

temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 20-1 is the 95 percent confidence interval for each parameter. Table 20-1 shows a large difference for CNEP between annual weather conditions and those observed on sampling days. This site sampled only from September through December, which can explain the wide disparity between the two sets of averages. Table 20-1 shows little difference for the Tulsa sites between annual weather conditions and those observed on sampling days.

20.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. The CNEP site sampled for VOC only, while TOOK, TSOK and TUOK sampled for VOC, carbonyl compounds, and metals. Table 20-2 presents the pollutants that failed at least one screen at the Oklahoma monitoring sites.

The following observations are shown in table 20-2:

- Five pollutants with a total of 49 measured concentrations failed screens at CNEP; 18 pollutants with a total of 354 measured concentrations failed screens at TOOK; fourteen pollutants with a total of 242 measured concentrations failed screens at TSOK; and 15 pollutants with a total of 252 measured concentrations failed screens at TUOK.

- The pollutants of interest varied by site, yet the following four pollutants contributed to the top 95 percent of the total failed screens at each Oklahoma monitoring site: acrolein, benzene, 1,3-butadiene, and carbon tetrachloride.

- Acrolein, benzene, and carbon tetrachloride had 100 percent of their measured detections fail screens at all of the sites.

Table 20-2. Comparison of Measured Concentrations and EPA Screening Values for the Oklahoma Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Cherokee Nation, Oklahoma – CNEP					
Acrolein	14	14	100.00	28.57	28.57
Benzene	14	14	100.00	28.57	57.14
Carbon Tetrachloride	14	14	100.00	28.57	85.71
1,3-Butadiene	6	10	60.00	12.24	97.96
1,2-Dichloroethane	1	1	100.00	2.04	100.00
Total	49	53	92.45		
Tulsa, Oklahoma – Site 1 – TOOK					
Acetaldehyde	44	44	100.00	12.43	12.43
Acrolein	44	44	100.00	12.43	24.86
Carbon Tetrachloride	44	44	100.00	12.43	37.29
Benzene	44	44	100.00	12.43	49.72
Formaldehyde	43	44	97.73	12.15	61.86
p-Dichlorobenzene	38	44	86.36	10.73	72.60
1,3-Butadiene	33	38	86.84	9.32	81.92
Tetrachloroethylene	16	34	47.06	4.52	86.44
Manganese (TSP)	14	14	100.00	3.95	90.40
Arsenic (TSP)	14	14	100.00	3.95	94.35
Xylenes	6	44	13.64	1.69	96.05
Nickel (TSP)	6	14	42.86	1.69	97.74
Cadmium (TSP)	2	14	14.29	0.56	98.31
Hexachloro-1,3-butadiene	2	2	100.00	0.56	98.87
1,2-Dichloroethane	1	1	100.00	0.28	99.15
Dichloromethane	1	41	2.44	0.28	99.44
Acrylonitrile	1	1	100.00	0.28	99.72
Chloromethane	1	44	2.27	0.28	100.00
Total	354	525	67.43		
Tulsa, Oklahoma – Site 2 – TSOK					
Acrolein	29	29	100.00	11.98	11.98
Benzene	29	29	100.00	11.98	23.97
Carbon Tetrachloride	28	28	100.00	11.57	35.54
Acetaldehyde	28	28	100.00	11.57	47.11
Formaldehyde	26	28	92.86	10.74	57.85
1,3-Butadiene	24	28	85.71	9.92	67.77
p-Dichlorobenzene	21	29	72.41	8.68	76.45
Arsenic (TSP)	14	15	93.33	5.79	82.23
Manganese (TSP)	14	15	93.33	5.79	88.02
Tetrachloroethylene	12	27	44.44	4.96	92.98
Xylenes	8	29	27.59	3.31	96.28

Table 20-2. Comparison of Measured Concentrations and EPA Screening Values for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Nickel (TSP)	5	15	33.33	2.07	98.35
Acrylonitrile	3	3	100.00	1.24	99.59
Cadmium (TSP)	1	15	6.67	0.41	100.00
Total	242	318	76.10		
Tulsa, Oklahoma – Site 3 – TUOK					
Acrolein	31	31	100.00	12.30	12.30
Carbon Tetrachloride	31	31	100.00	12.30	24.60
Benzene	31	31	100.00	12.30	36.90
Acetaldehyde	30	30	100.00	11.90	48.81
Formaldehyde	29	30	96.67	11.51	60.32
1,3-Butadiene	28	31	90.32	11.11	71.43
Tetrachloroethylene	22	29	75.86	8.73	80.16
p-Dichlorobenzene	19	31	61.29	7.54	87.70
Arsenic (TSP)	12	13	92.31	4.76	92.46
Manganese (TSP)	12	13	92.31	4.76	97.22
Hexachloro-1,3-butadiene	2	2	100.00	0.79	98.02
Xylenes	2	31	6.45	0.79	98.81
Acrylonitrile	1	1	100.00	0.40	99.21
Nickel (TSP)	1	13	7.69	0.40	99.60
1,2-Dichloroethane	1	1	100.00	0.40	100.00
Total	252	318	79.25		

20.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects were incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal average

concentrations are presented in Table 20-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for CNEP are shown in Table 20-3:

- Acrolein exhibited the highest daily average for CNEP.
- Spring and summer averages could not be calculated for CNEP because this site began sampling in September; winter averages could not be calculated because there were not enough measured detections in conjunction with the onset of sampling.

The following observations for the Tulsa sites are shown in Table 20-3:

- Xylenes had the highest daily averages for TOOK and TSOK, but this pollutant was not a pollutant of interest for TUOK.
- Formaldehyde had similar daily averages across the Tulsa sites, as did 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene.
- The Tulsa sites had equipment problems at the onset of sampling. Additionally, the original location of the TSOK site was problematic. The monitoring equipment was moved to a new location and sampling resumed in June. As a result, seasonal averages could not be calculated for many of the pollutants for winter and spring. In addition, metals sampling did not begin until October, which would only allow for autumn averages to be calculated. However, a few seasonal trends can still be identified.
- Formaldehyde was highest in the summer for all three Tulsa sites.
- Acetaldehyde was also highest in the summer for TSOK and TUOK.
- Xylenes were significantly higher during the summer for TSOK.

20.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for the Oklahoma monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded

Table 20-3. Daily and Seasonal Averages for the Pollutants of Interest for the Oklahoma Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Cherokee Nation, Oklahoma – CNEP												
Acrolein	14	14	2.06	0.74	NR	NR	NA	NA	NA	NA	2.11	0.92
Benzene	14	14	0.58	0.09	NR	NR	NA	NA	NA	NA	0.60	0.10
1,3-Butadiene	10	14	0.04	0.01	NR	NR	NA	NA	NA	NA	0.03	0.01
Carbon Tetrachloride	14	14	0.76	0.07	NR	NR	NA	NA	NA	NA	0.80	0.07
Tulsa, Oklahoma – Site 1 – TOOK												
Acetaldehyde	44	44	2.03	0.27	1.44	0.54	1.75	0.44	2.49	0.48	2.11	0.50
Acrolein	44	44	0.94	0.18	0.51	0.14	1.25	0.31	1.12	0.47	0.80	0.18
Arsenic (TSP)	14	14	<0.01	<0.01	NR	NR	NA	NA	NA	NA	<0.01	<0.01
Benzene	44	44	2.35	0.43	2.41	1.02	1.92	0.89	2.27	0.59	2.73	0.94
1,3-Butadiene	38	44	0.09	0.02	0.10	0.04	NR	NR	0.06	0.02	0.08	0.03
Carbon Tetrachloride	44	44	0.59	0.05	0.48	0.10	0.49	0.07	0.72	0.09	0.63	0.07
p-Dichlorobenzene	44	44	0.20	0.03	0.21	0.13	0.25	0.05	0.21	0.03	0.14	0.04
Formaldehyde	44	44	3.72	0.60	1.63	0.46	3.33	0.91	5.79	0.85	3.01	0.64
Manganese (TSP)	14	14	0.03	0.01	NR	NR	NA	NA	NA	NA	0.03	0.01
Nickel (TSP)	14	14	<0.01	<0.01	NR	NR	NA	NA	NA	NA	<0.01	<0.01
Tetrachloroethylene	34	44	0.24	0.06	NR	NR	NR	NR	0.22	0.11	0.21	0.07
Xylenes	44	44	5.38	1.09	5.38	2.64	5.22	2.10	5.55	1.70	5.33	2.36
Tulsa, Oklahoma – Site 2 – TSOK												
Acetaldehyde	28	28	1.88	0.29	NR	NR	NA	NA	2.36	0.46	1.61	0.25
Acrolein	29	29	1.35	0.38	NR	NR	NA	NA	1.44	0.38	1.61	0.83
Arsenic (TSP)	15	15	<0.01	<0.01	NR	NR	NA	NA	NA	NA	<0.01	<0.01
Benzene	29	29	1.21	0.32	NR	NR	NA	NA	1.33	0.65	1.20	0.30
1,3-Butadiene	28	29	0.08	0.02	NR	NR	NA	NA	0.06	0.02	0.09	0.02
Carbon Tetrachloride	28	29	0.67	0.07	NR	NR	NA	NA	0.73	0.08	0.69	0.07
p-Dichlorobenzene	29	29	0.16	0.05	NR	NR	NA	NA	0.24	0.10	0.12	0.03
Formaldehyde	28	28	4.24	0.88	NR	NR	NA	NA	6.25	1.08	3.27	0.70
Manganese (TSP)	15	15	0.02	0.01	NR	NR	NA	NA	NA	NA	0.03	0.01

Table 20-3. Daily and Seasonal Averages for the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Tetrachloroethylene	27	29	0.17	0.04	NR	NR	NA	NA	0.14	0.04	0.20	0.09
Xylenes	29	29	9.18	3.19	NR	NR	NA	NA	14.66	5.57	5.83	1.85
Tulsa, Oklahoma – Site 3 – TUOK												
Acetaldehyde	30	30	2.67	0.40	2.02	1.13	NR	NR	3.30	0.47	2.39	0.37
Acrolein	31	31	0.92	0.19	0.87	0.49	NR	NR	0.96	0.25	0.90	0.26
Arsenic (TSP)	13	13	<0.01	<0.01	NR	NR	NA	NA	NA	NA	<0.01	<0.01
Benzene	31	31	1.40	0.29	1.81	0.90	NR	NR	1.39	0.26	1.13	0.29
1,3-Butadiene	31	31	0.09	0.02	0.13	0.07	NR	NR	0.08	0.02	0.07	0.02
Carbon Tetrachloride	31	31	0.65	0.06	0.48	0.11	NR	NR	0.72	0.08	0.69	0.09
p-Dichlorobenzene	31	31	0.16	0.06	0.23	0.22	NR	NR	0.18	0.04	0.11	0.04
Formaldehyde	30	30	4.10	0.68	2.09	0.75	NR	NR	5.74	0.82	3.59	0.61
Manganese (TSP)	13	13	0.02	0.01	NR	NR	NA	NA	NA	NA	0.02	0.01
Tetrachloroethylene	29	31	0.64	0.25	NR	NR	NR	NR	0.45	0.19	0.93	0.58

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 20-4.

The following observations about acrolein are shown in Table 20-4:

- All of the acrolein measured detections at the Oklahoma sites were greater than the ATSDR acute value of 0.11 μg/m^3 and all but two were greater than the California REL value of 0.19 μg/m^3.

- The average detected concentration of acrolein was 2.06 ± 0.74 μg/m^3 for CNEP; 0.94 ± 0.18 μg/m^3 for TOOK; 1.35 ± 0.38 μg/m^3 for TSOK; and 0.92 ± 0.19 μg/m^3 for TUOK.

- CNEP and TSOK's acrolein averages were an order of magnitude higher than either acute risk factor.

- Only some of the seasonal averages for acrolein could be calculated, therefore intermediate risk could not be evaluated in several cases. But where seasonal averages could be calculated, the intermediate risk factor was exceeded.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. Only acrolein concentrations exceeded the acute risk factors. Figures 20-7 through 20-10 are pollution roses for acrolein at the CNEP, TOOK, TSOK, and TUOK sites, respectively. As shown in Figures 20-7 and 20-10, all acrolein concentrations exceeded the ATSDR acute risk factor, which is indicated by a solid line, and all except one acrolein concentration at CNEP and one at TUOK exceeded the CALEPA REL, which is indicated by a dashed line.

Observations gleaned from the acrolein pollution roses include:

- High concentrations of acrolein were measured on days with winds from a variety of directions.

- No acrolein measured detections at CNEP occurred with southeasterly, westerly or northwesterly winds.

- The TOOK pollution rose shows a more random scattering of concentrations, although more frequently measured with southerly winds. The highest concentration was measured on a day with northeasterly winds.

Table 20-4. Non-Chronic Risk Summary for the Oklahoma Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
CNEP	TO-15	Acrolein	2.06 ± 0.74	0.11	14	0.19	13	0.09	NA	NA	NA	2.11 ± 0.92
TOOK	TO-15	Acrolein	0.94 ± 0.18	0.11	44	0.19	44	0.09	0.51 ± 0.14	1.25 ± 0.31	1.12 ± 0.47	0.80 ± 0.18
TSOK	TO-15	Acrolein	1.35 ± 0.38	0.11	29	0.19	29	0.09	NR	NA	1.44 ± 0.38	1.61 ± 0.83
TUOK	TO-15	Acrolein	0.92 ± 0.19	0.11	31	0.19	30	0.09	0.87± 0.49	NR	0.96 ± 0.25	0.90 ± 0.26

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

Figure 20-7. Acrolein Pollution Rose for CNEP

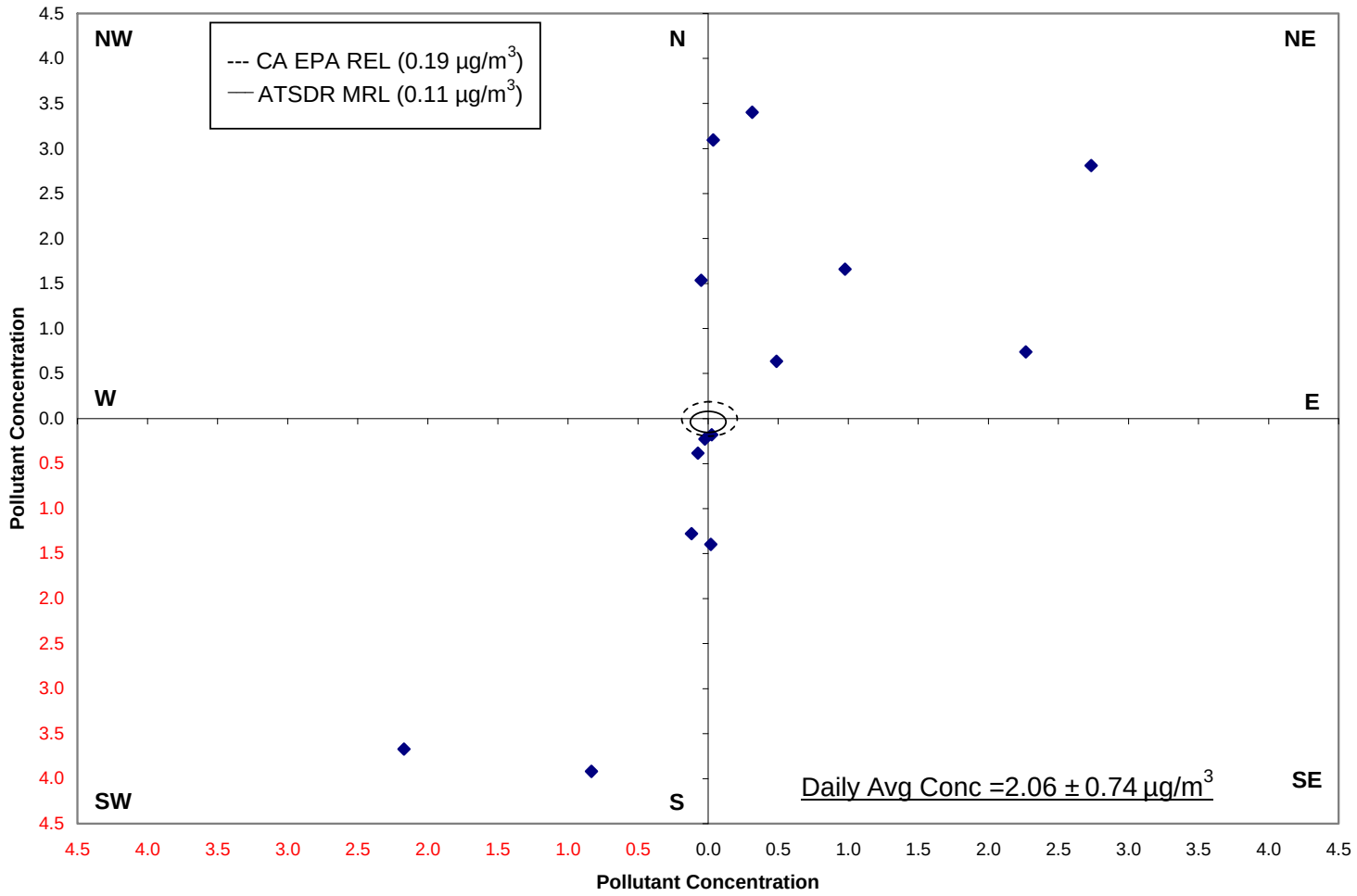


Figure 20-8. Acrolein Pollution Rose for TOOK

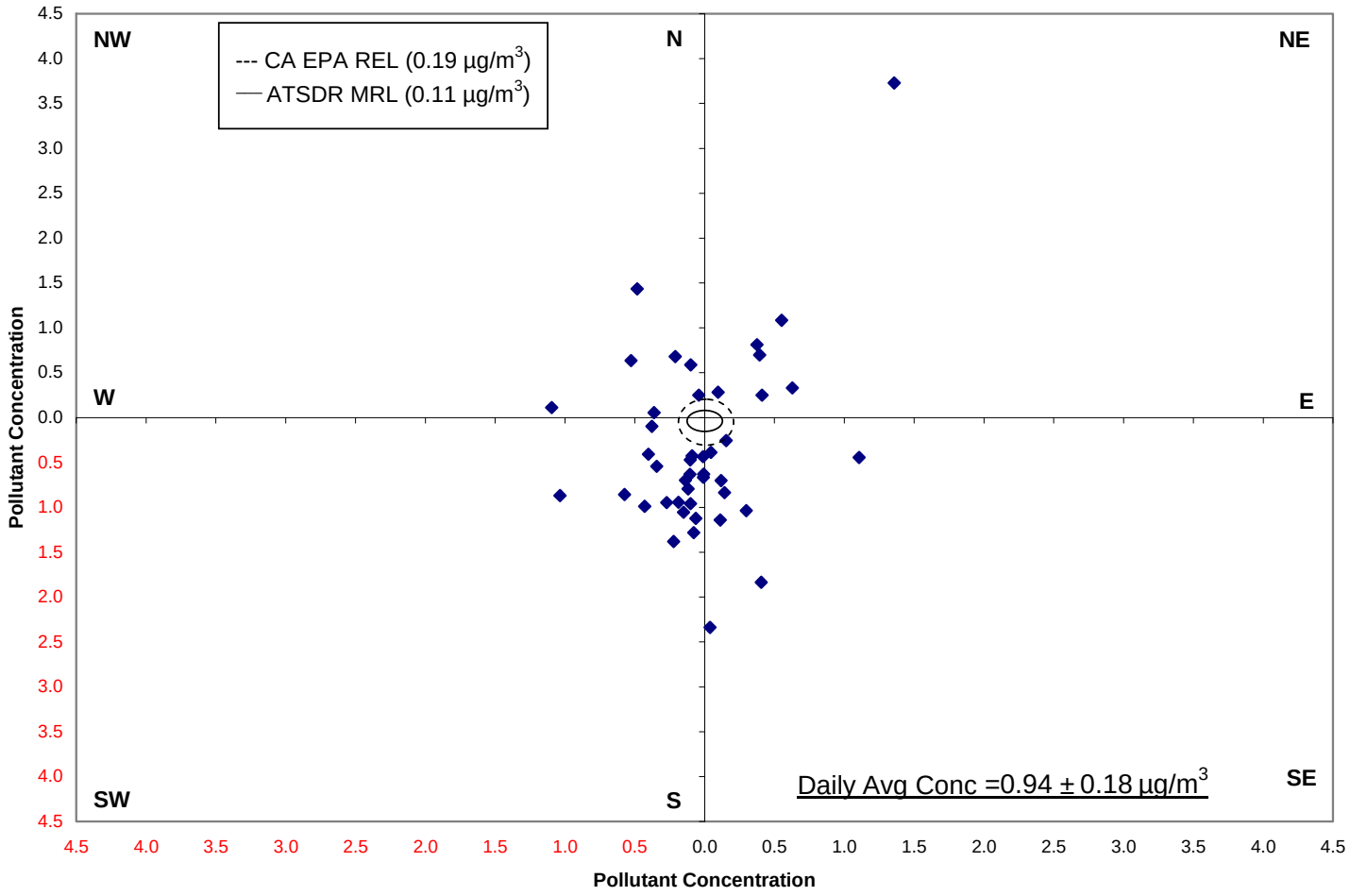


Figure 20-9. Acrolein Pollution Rose for TSOK

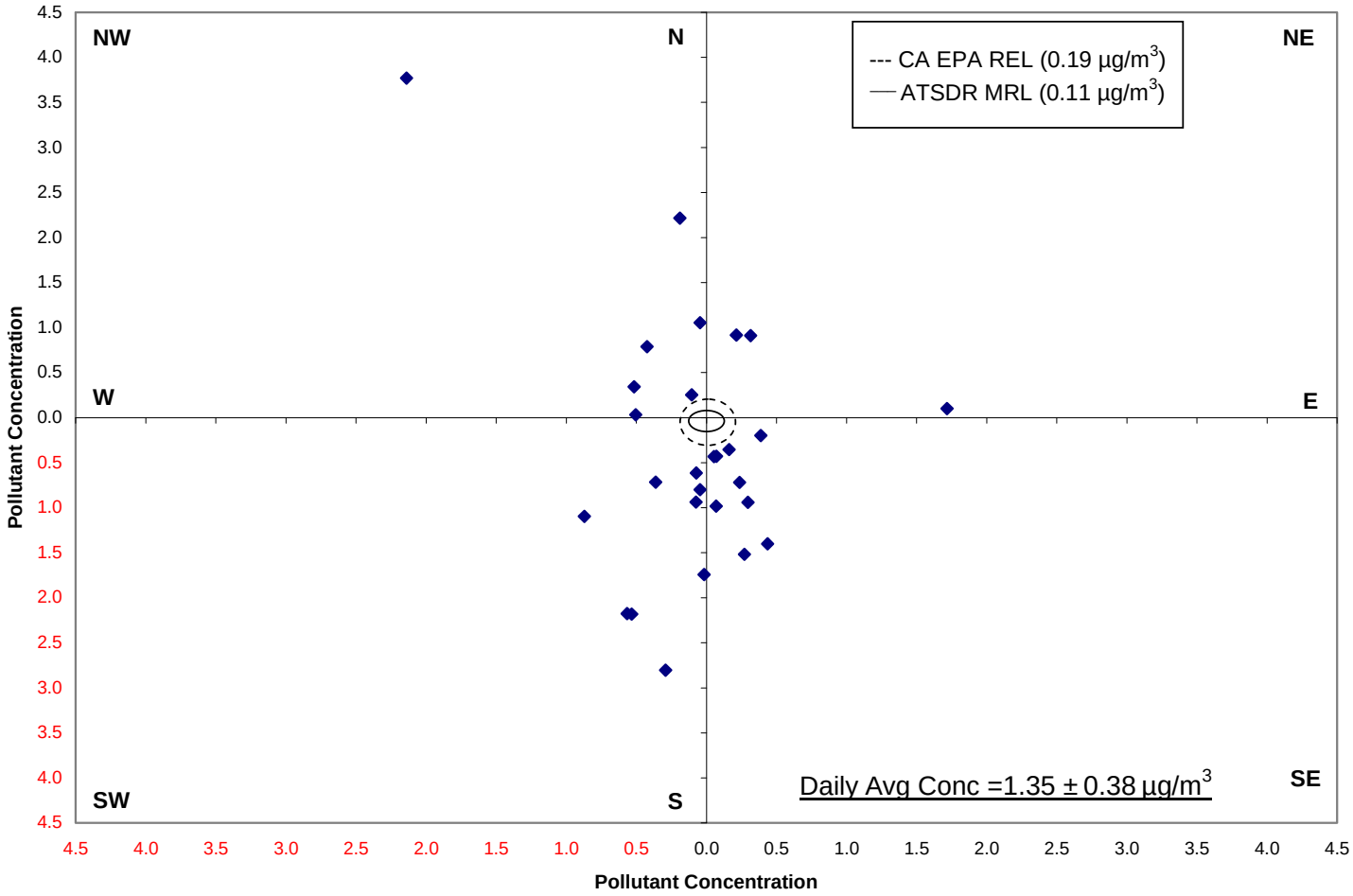
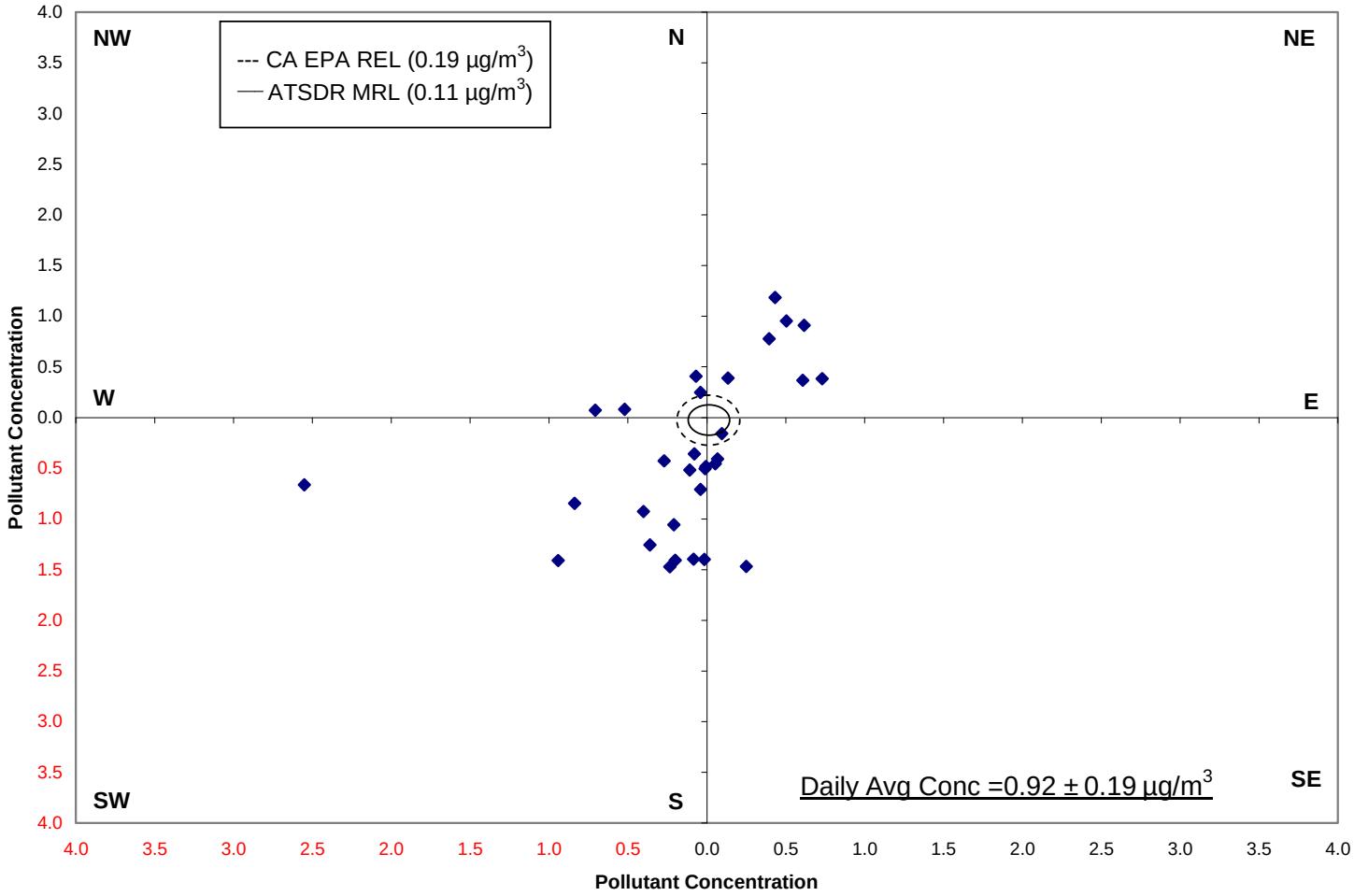


Figure 20-10. Acrolein Pollution Rose for TUOK



- The TSOK pollution rose shows that acrolein was detected mostly on days with winds from the north and south, while the highest concentration detected was measured on a day with a northwesterly wind.

- The TUOK pollution rose shows a northeast/southwest wind pattern similar to that of CNEP, while the highest concentration was measured on a day with winds from the west.

20.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

20.4.1 Pearson Correlation Analysis

Table 20-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Oklahoma monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for CNEP from Table 20-5:

- The correlations calculated for the pollutants of interest were weak.

- A correlation for sea level pressure could not be calculated because this parameter was not recorded at this station.

The following observations are gathered for TOOK from Table 20-5:

- Formaldehyde and carbon tetrachloride exhibited strong positive correlations with maximum, average, dew point, and wet bulb temperatures. This indicates that concentrations of these pollutants increase as temperature and moisture content increase.

- Arsenic and acetaldehyde also exhibited strong positive correlations with maximum temperatures, indicating that concentrations of these pollutants increase as temperatures increase.

- Several pollutants exhibited strong negative correlations with the scalar wind speed, and all of the correlations with this variable were negative. This indicates the concentrations increase as wind speeds decrease.

Table 20-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Oklahoma Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Cherokee Nation, Oklahoma – CNEP								
1,3-Butadiene	10	-0.29	-0.23	0.02	-0.09	0.43	NA	-0.34
Acrolein	14	0.20	0.25	0.17	0.20	-0.10	NA	-0.31
Benzene	14	-0.35	-0.32	-0.11	-0.20	0.33	NA	-0.39
Carbon Tetrachloride	14	0.46	0.43	0.43	0.44	0.24	NA	0.23
Tulsa, Oklahoma – Site #1 – TOOK								
1,3-Butadiene	38	-0.29	-0.43	-0.46	-0.45	-0.07	0.15	-0.50
Acetaldehyde	44	0.58	0.46	0.33	0.38	-0.32	-0.22	-0.37
Acrolein	44	0.33	0.37	0.46	0.43	0.26	-0.18	-0.07
Arsenic (TSP)	14	0.58	0.42	0.45	0.43	0.29	-0.05	-0.60
Benzene	44	0.11	-0.04	-0.07	-0.06	-0.01	-0.03	-0.51
Carbon Tetrachloride	44	0.54	0.50	0.49	0.51	-0.06	-0.25	-0.06
Formaldehyde	44	0.82	0.80	0.70	0.74	-0.33	-0.34	-0.01
Manganese (TSP)	14	0.36	0.13	-0.02	0.04	-0.24	0.17	-0.58
Nickel (TSP)	14	0.24	0.24	0.37	0.32	0.45	-0.06	-0.20
p-Dichlorobenzene	44	0.21	0.16	0.12	0.15	-0.15	-0.40	-0.12
Tetrachloroethylene	34	0.15	0.10	0.02	0.06	-0.17	-0.11	-0.12
Xylenes	44	0.22	0.10	0.04	0.06	-0.13	-0.19	-0.44
Tulsa, Oklahoma – Site #2 – TSOK								
1,3-Butadiene	28	-0.29	-0.36	-0.40	-0.38	-0.09	0.42	-0.45
Acetaldehyde	28	0.57	0.57	0.42	0.48	-0.44	-0.25	-0.23
Acrolein	29	0.14	0.14	0.15	0.15	0.01	0.03	0.05
Arsenic (TSP)	15	0.33	0.22	0.22	0.21	0.05	0.15	-0.50
Benzene	29	0.06	0.08	0.15	0.13	0.24	-0.07	-0.47
Carbon Tetrachloride	28	0.69	0.65	0.59	0.63	-0.28	-0.39	0.08

Table 20-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Formaldehyde	28	0.82	0.82	0.70	0.75	-0.42	-0.44	-0.05
Manganese (TSP)	15	0.26	0.19	-0.05	0.08	-0.48	0.31	-0.54
p-Dichlorobenzene	29	0.44	0.40	0.44	0.43	0.07	-0.14	-0.24
Tetrachloroethylene	27	-0.11	-0.16	-0.18	-0.17	-0.01	-0.03	-0.19
Xylenes	29	0.46	0.49	0.59	0.56	0.23	-0.29	-0.30
Tulsa, Oklahoma – Site #3 – TUOK								
1,3-Butadiene	31	-0.35	-0.40	-0.37	-0.39	0.18	0.41	-0.42
Acetaldehyde	30	0.55	0.47	0.40	0.41	-0.26	-0.17	-0.45
Acrolein	31	0.22	0.18	0.17	0.18	0.00	-0.34	-0.29
Arsenic (TSP)	13	-0.29	-0.43	-0.24	-0.37	0.35	0.08	-0.41
Benzene	31	-0.13	-0.17	-0.15	-0.17	0.10	0.04	-0.41
Carbon Tetrachloride	31	0.65	0.64	0.60	0.62	-0.19	-0.55	-0.04
Formaldehyde	30	0.83	0.79	0.71	0.74	-0.39	-0.38	-0.19
Manganese (TSP)	13	-0.14	-0.23	-0.39	-0.27	-0.46	0.62	0.04
p-Dichlorobenzene	31	0.03	-0.01	-0.04	-0.03	-0.11	-0.21	-0.30
Tetrachloroethylene	29	0.14	0.05	-0.02	0.00	-0.17	-0.21	-0.11

NA = Not available due to short sampling duration.

The following observations are gathered for TSOK from Table 20-5:

- Similar to TOOK, formaldehyde and carbon tetrachloride exhibited strong positive correlations with maximum, average, dew point, and wet bulb temperatures. This indicates that concentrations of these pollutants increase as temperature and moisture content increase.

- Acetaldehyde exhibited strong positive correlations with maximum and average temperatures, indicating that concentrations of this pollutant increase as temperatures increase.

- Xylenes exhibited strong positive correlations with dew point and wet bulb temperatures, which indicates the increasing moisture content leads to increasing concentrations of xylenes.

- Most of the correlations with scalar wind speed were negative. This indicates the concentrations increase as wind speeds decrease.

The following observations are gathered for TUOK from Table 20-5:

- Similar to TOOK and TSOK, formaldehyde and carbon tetrachloride exhibited strong positive correlations with maximum, average, dew point, and wet bulb temperatures. This indicates that concentrations of these pollutants increase as temperature and moisture content increase.

- Like TOOK, acetaldehyde exhibited a strong positive correlation with maximum temperature, indicating that concentrations of this pollutant increase as temperatures increase.

- Carbon tetrachloride and manganese exhibited strong correlations with sea level pressure, which indicates changes in pressure lead to changes in concentrations of the pollutants.

- Most of the correlations with scalar wind speed were negative. This indicates the concentrations increase as wind speeds decrease.

20.4.2 Composite Back Trajectory Analysis

Figures 20-11 through 20-14 are composite back trajectory maps for the Oklahoma monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

Figure 20-11. Composite Back Trajectory Map for CNEP

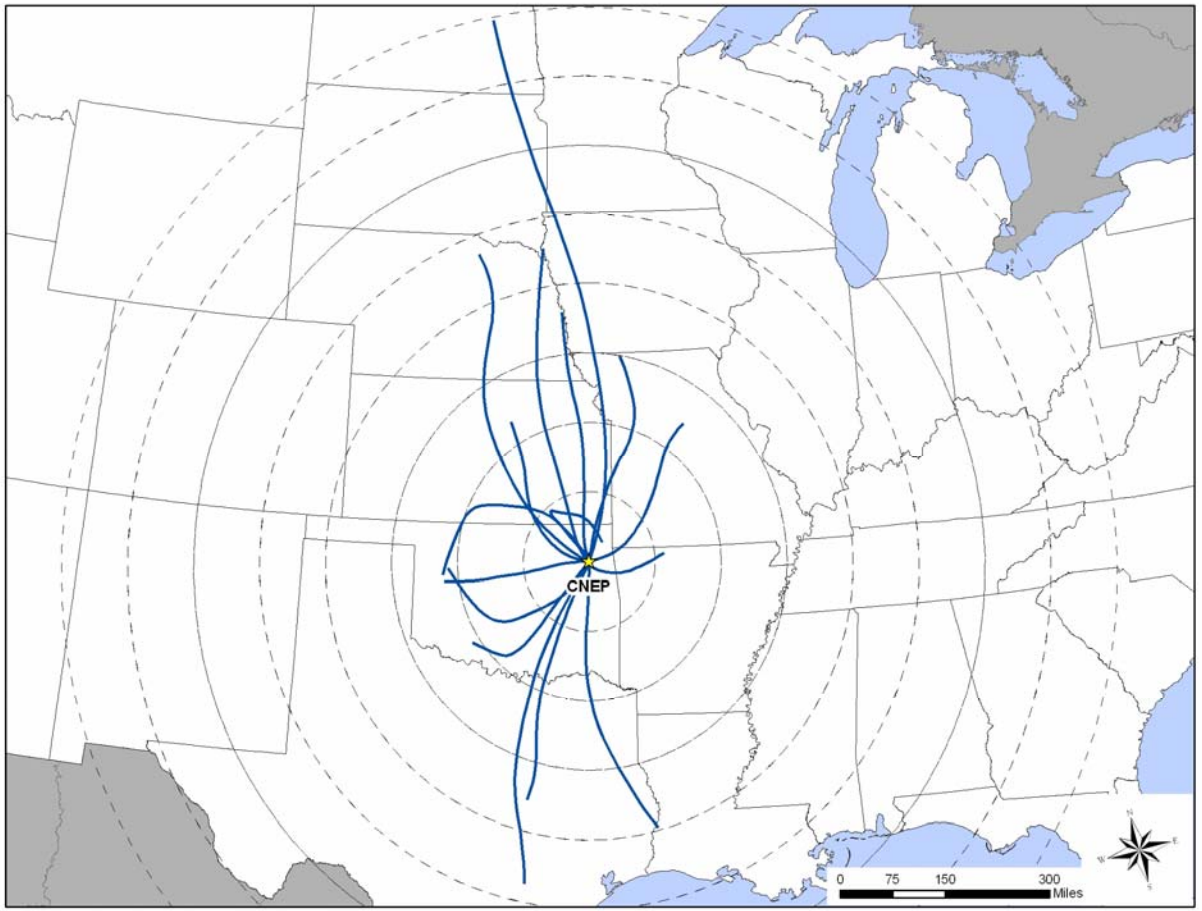


Figure 20-12. Composite Back Trajectory Map for TOOK

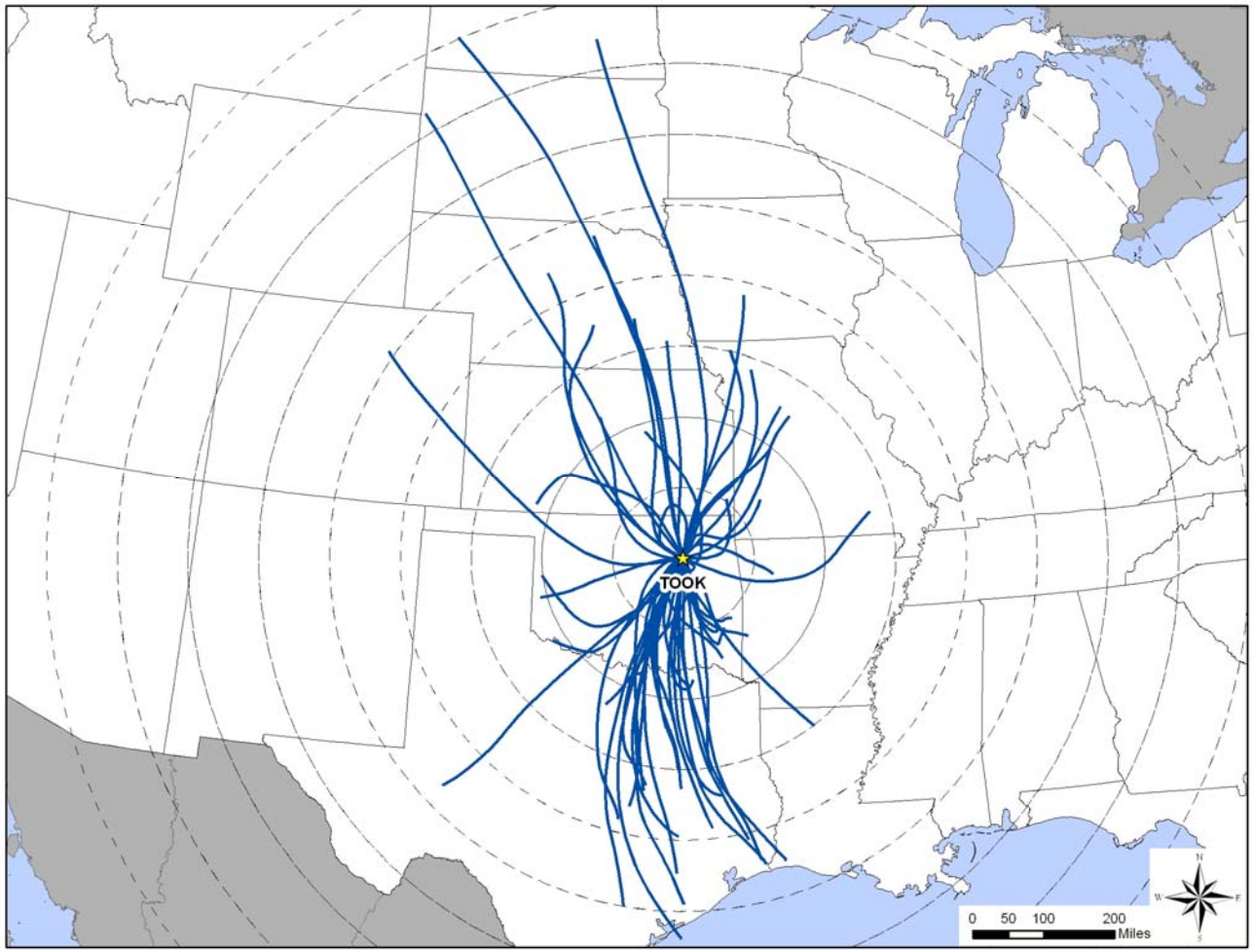


Figure 20-13. Composite Back Trajectory Map for TSOK

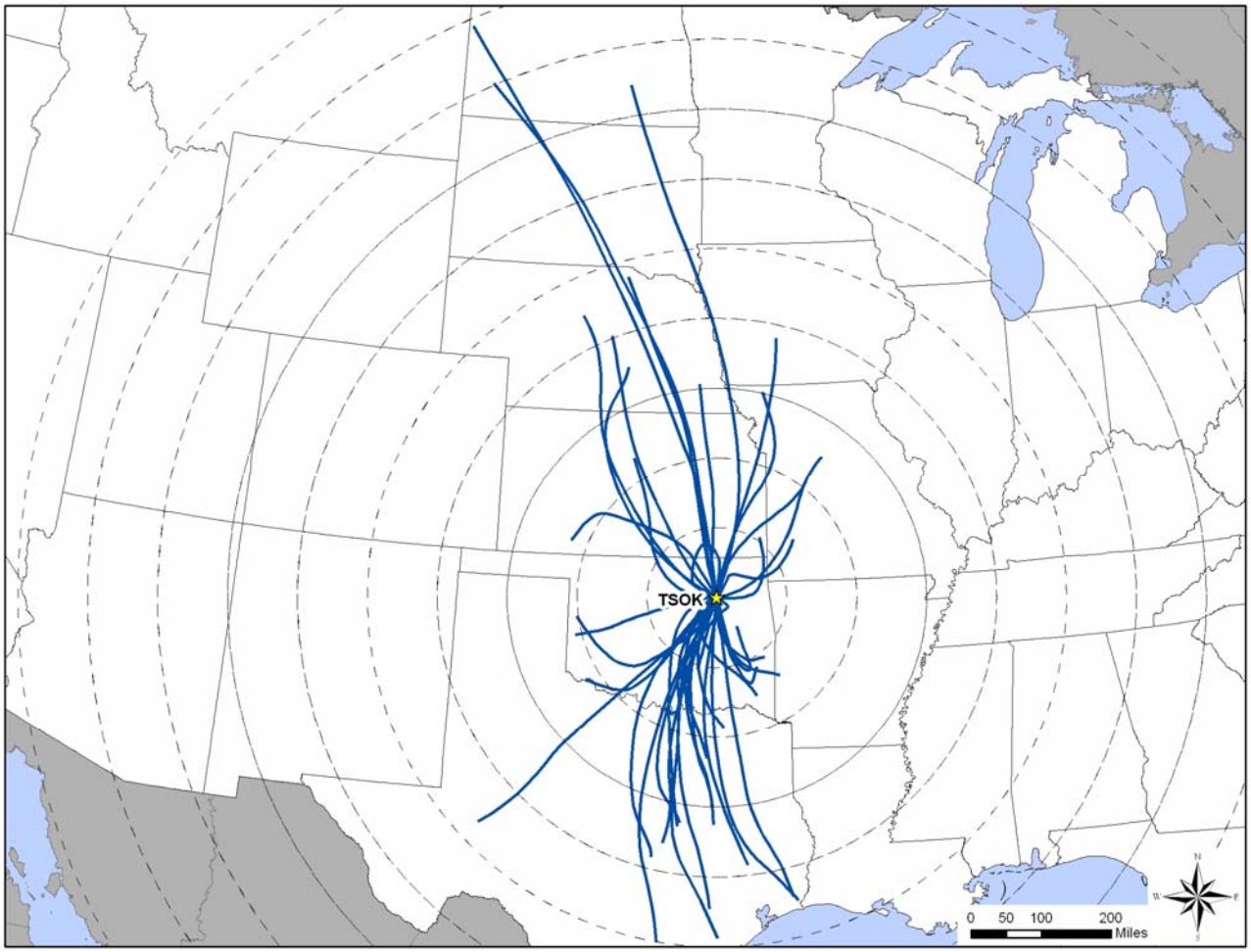
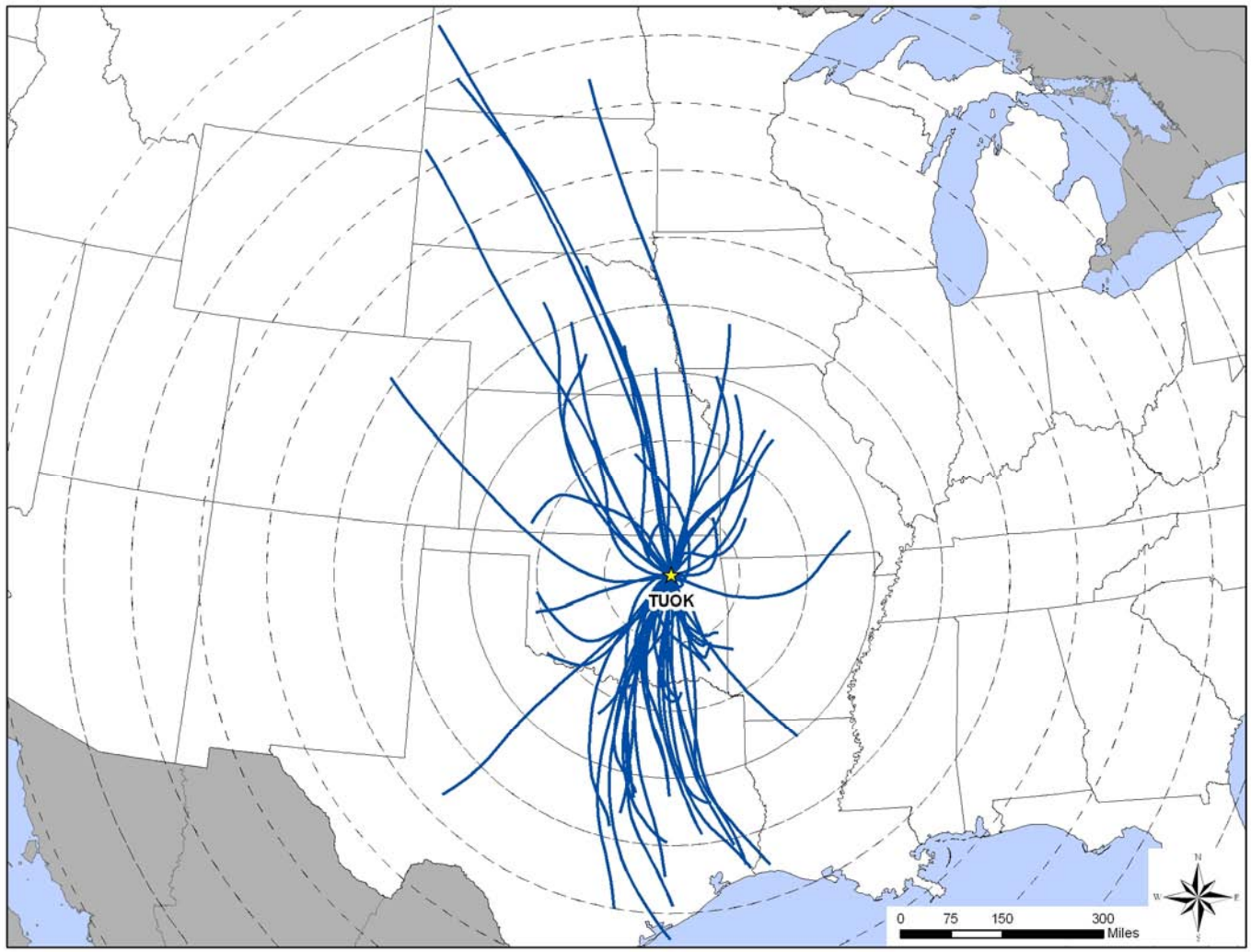


Figure 20-14. Composite Back Trajectory Map for TUOK



The following observations can be made from Figure 20-11 for CNEP:

- Back trajectories originated predominantly from the north and south at CNEP.
- The 24-hour airshed domain was large, with trajectories originating as far away as North Dakota (~ 800 miles).
- Over 50 percent of the trajectories originated within 300 miles of the site and 75 percent within 400 miles from CNEP.
- The composite back trajectory map might look much different with a full year's worth of sampling days.

The following observations can be made for the Tulsa sites from Figures 20-12 through 20-14:

- Back trajectories for the Tulsa sites originated predominately from the north and south, similar to CNEP.
- The longest trajectories originated nearly 900 miles to the north of the sites, indicating that the 24-hour airshed domain was large for Tulsa.
- The majority of the back trajectories originated with 400 miles from the sites.

20.4.3 Wind Rose Analysis

Hourly wind data from the Claremore Regional Airport, Richard Lloyd Jones, Jr. Airport, and Tulsa International Airport weather station were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 20-15 through 20-18 present the wind roses for the Oklahoma monitoring sites on days that sampling occurred.

Observations from Figures 20-15 through 20-18 include:

- Hourly winds near the Oklahoma sites were predominantly out of the south (over 20 percent of observations for each site).
- The frequency of calm winds (<2 knots) varied by site, ranging from 10 percent near TSOK to 27 percent near TOOK.

Figure 20-15. Wind Rose for CNEP Sampling Days

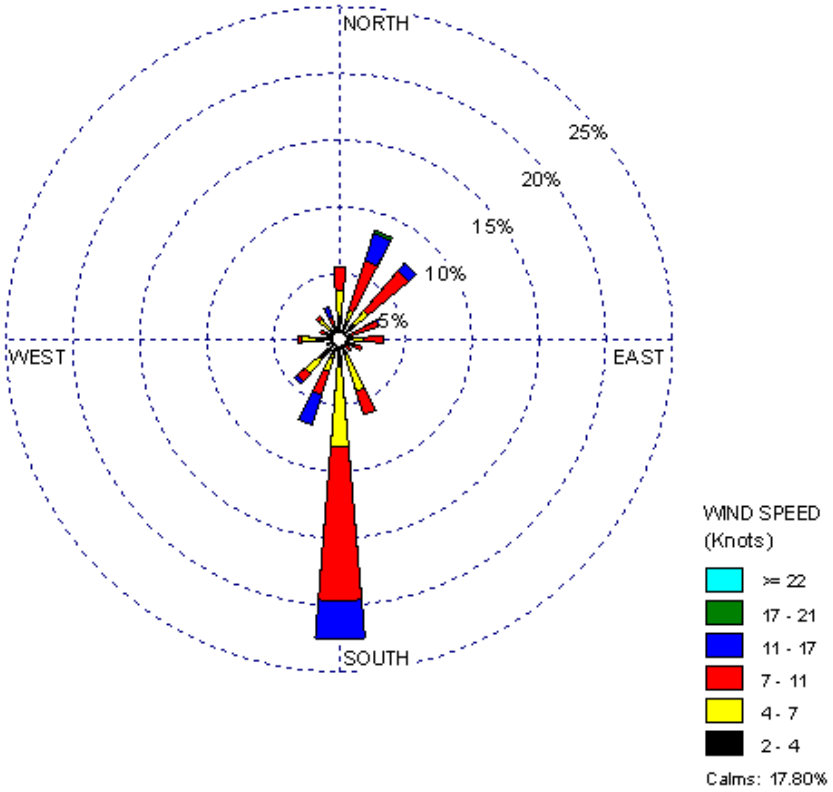


Figure 20-16. Wind Rose for TOOK Sampling Days

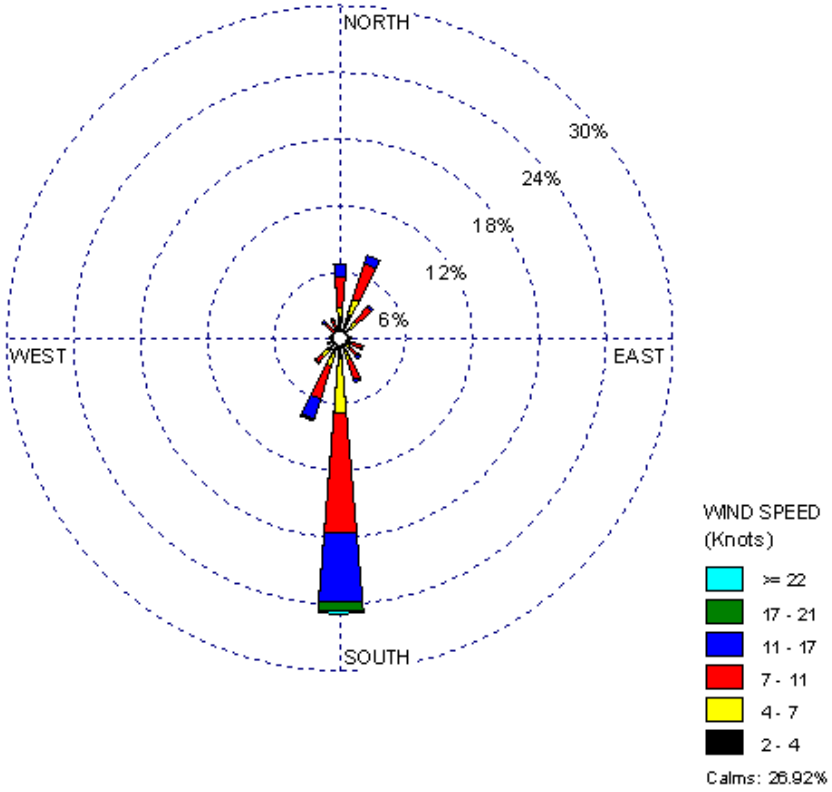


Figure 20-17. Wind Rose for TSOK Sampling Days

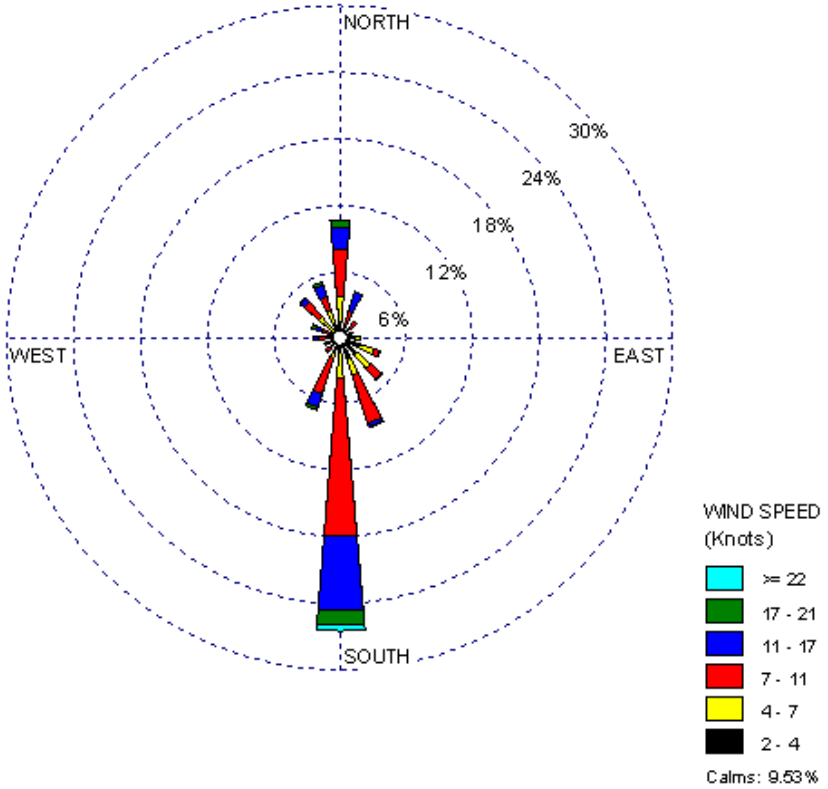
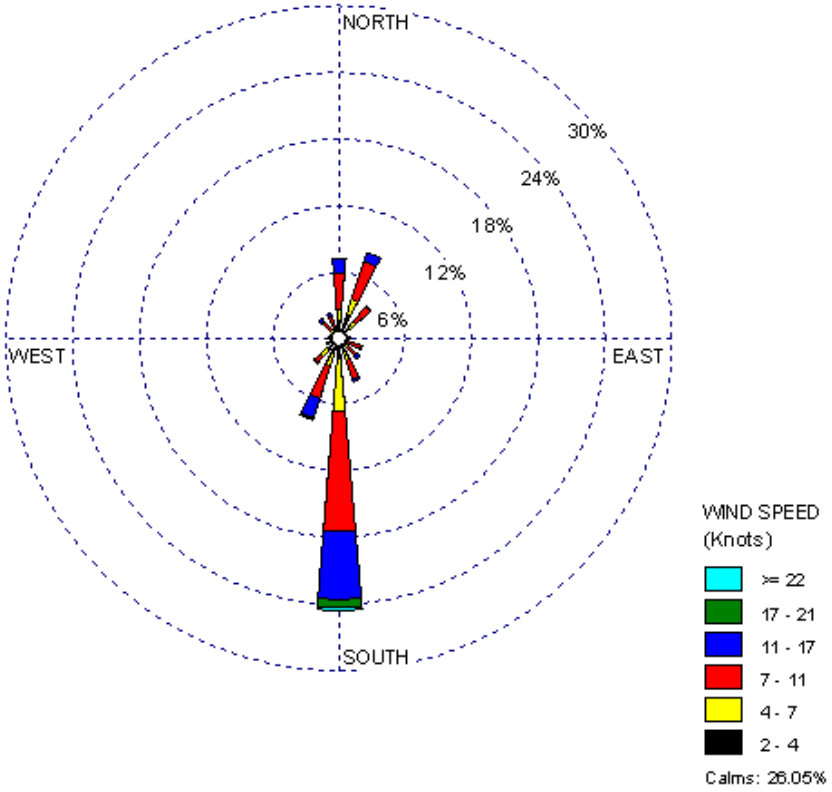


Figure 20-18. Wind Rose for TUOK Sampling Days



20.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

20.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Tulsa and Chippewa Counties were obtained from the Oklahoma Tax Commission and the U.S. Census Bureau, and are summarized in Table 20-6. Table 20-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 20-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 20-6 include:

- The population and vehicle registration near the Tulsa sites is significantly higher than the CNEP site.
- Of the three Tulsa sites, TUOK has the highest 10 mile population and vehicle ownership, although the TOOK population and vehicle ownership data is very similar.
- TUOK and TSOK experience a significantly higher traffic volume than the TOOK site.
- Compared to other UATMP sites, TOOK, TSOK, and TUOK's population and vehicle ownership is in the middle of the range.
- TSOK and TUOK's daily traffic volume is in the top 10 highest traffic volumes of all UATMP sites.
- CNEP has one of the lowest county population and vehicle registrations compared to other sites.
- The traffic volume for CNEP is the lowest recorded for all UATMP sites. TOOK also has a relatively low daily traffic volume.

Table 20-6. Motor Vehicle Information for the Oklahoma Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
CNEP	39,774	29,815	0.75	31,107	23,318	5
TOOK	577,795	498,898	0.86	459,346	396,623	500
TSOK	577,795	498,898	0.86	377,360	291,294	62,500
TUOK	577,795	498,898	0.86	460,577	397,686	82,600

20.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- Of the Oklahoma sites, TSOK's ratios most resemble the ratios of the roadside study.
- TSOK had the lowest ratios of the Oklahoma sites.
- For CNEP, the benzene-ethylbenzene ratio was the highest of the three ratios; for the three Tulsa sites, toluene-ethylbenzene ratios were the highest, similar to the roadside study.
- For TOOK, all three ratios were higher than those in the roadside study, with TOOK's toluene-ethylbenzene ratio being significantly higher than the roadside study. A similar trend is shown for TUOK.
- For both TOOK and TUOK, the benzene-ethylbenzene ratio was higher than the xylenes-ethylbenzene ratio.

20.6 Trends Analysis

A trends analysis could not be performed because the Oklahoma sites have not participated in the UATMP for three consecutive years.

20.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Oklahoma sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 20-7. Additionally, the pollutants of interest are bolded. CNEP and TSOK did not collect enough samples for annual averages for the pollutants of interest to be calculated. Similarly, the Tulsa sites did not begin sampling metals until October, so annual averages for metals could not be

Table 20-7. Chronic Risk Summary for the Monitoring Sites in Oklahoma

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Cherokee Nation, Pryor, Oklahoma (CNEP) – Census Tract ID 40097040400								
Acrolein	NR	0.00002	0.02	NR	0.95	NA	NA	NA
Benzene	0.0000078	0.03	0.43	3.36	0.01	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.01	0.30	0.01	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.21	3.20	0.01	NA	NA	NA
1,2-Dichloroethane	0.000026	2.4	0.01	0.32	<0.01	NA	NA	NA
Site #1, Tulsa, Oklahoma (TOOK) – Census Tract ID 40143004600								
Acetaldehyde	0.0000022	0.009	1.91	4.20	0.21	2.03 ± 0.27	4.46	0.23
Acrolein	NR	0.00002	0.13	NR	6.59	0.94 ± 0.18	NR	46.90
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	0.07 ± 0.02	4.78	0.04
Arsenic*	0.0043	0.00003	<0.01	0.13	<0.01	NA	NA	NA
Benzene	0.0000078	0.03	3.89	30.35	0.13	2.35 ± 0.43	18.30	0.08
1,3-Butadiene	0.00003	0.002	0.24	7.35	0.12	0.08 ± 0.02	2.32	0.04
Cadmium*	0.0018	0.00002	<0.01	0.15	<0.01	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.21	3.21	0.01	0.59 ± 0.05	8.86	0.01
Chloromethane	NR	0.09	0.95	NR	0.01	1.36 ± 0.39	NR	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.36	<0.01	0.20 ± 0.03	2.19	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.87	<0.01	0.03 ± <0.01	0.82	<0.01
Dichloromethane	0.00000047	1	0.33	0.15	<0.01	0.46 ± 0.27	0.22	<0.01
Formaldehyde	5.5E-09	0.0098	1.74	0.01	0.18	3.72 ± 0.60	0.02	0.38
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± 0.01	1.62	<0.01
Manganese*	NR	0.00005	<0.01	NR	0.03	NA	NA	NA
Nickel*	0.00016	0.000065	<0.01	0.44	0.04	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	0.17	1.00	<0.01	0.20 ± 0.05	1.15	<0.01
Xylenes	NR	0.1	6.76	NR	0.07	5.38 ± 1.09	NR	0.05
Site #2, Tulsa, Oklahoma (TSOK) – Census Tract ID 40143000900								
Acetaldehyde	0.0000022	0.009	1.74	3.83	0.19	NA	NA	NA
Acrolein	NR	0.00002	0.11	NR	5.73	NA	NA	NA
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	NA	NA	NA

Table 20-7. Chronic Risk Summary for the Monitoring Sites in Oklahoma (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Arsenic*	0.0043	0.00003	<0.01	0.08	<0.01	NA	NA	NA
Benzene	0.0000078	0.03	1.93	15.09	0.06	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.18	5.33	0.09	NA	NA	NA
Cadmium*	0.0018	0.00002	<0.01	0.09	<0.01	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.21	3.18	0.01	NA	NA	NA
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.41	<0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.51	0.01	0.15	NA	NA	NA
Manganese*	NR	0.00005	<0.01	NR	0.02	NA	NA	NA
Nickel*	0.00016	0.000065	<0.01	0.20	0.02	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	0.23	1.33	<0.01	NA	NA	NA
Xylenes	NR	0.1	2.88	NR	0.03	NA	NA	NA
Site #3, Tulsa, Oklahoma (TUOK) – Census Tract ID 40143003200								
Acetaldehyde	0.0000022	0.009	1.59	3.51	0.18	2.67 ± 0.4	5.87	0.30
Acrolein	NR	0.00002	0.11	NR	5.44	0.92 ± 0.19	NR	45.86
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	0.06 ± 0.01	4.40	0.03
Arsenic*	0.0043	0.00003	<0.01	0.08	<0.01	NA	NA	NA
Benzene	0.0000078	0.03	1.79	13.95	0.06	1.4 ± 0.29	10.95	0.05
1,3-Butadiene	0.00003	0.002	0.18	5.28	0.09	0.09 ± 0.02	2.75	0.05
Carbon Tetrachloride	0.000015	0.04	0.21	3.14	0.01	0.65 ± 0.06	9.73	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.32	<0.01	0.16 ± 0.06	1.81	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.85	<0.01	0.03 ± <0.01	0.8	<0.01
Formaldehyde	5.5E-09	0.0098	1.47	0.01	0.15	4.1 ± 0.68	0.02	0.42
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.08 ± 0.01	1.65	<0.01
Manganese*	NR	0.00005	<0.01	NR	0.02	NA	NA	NA
Nickel*	0.00016	0.000065	<0.01	0.19	0.02	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	0.21	1.27	<0.01	0.6 ± 0.24	3.55	<0.01
Xylenes	NR	0.1	2.79	NR	0.03	4.14 ± 1.32	NR	0.04

* Metals sampled with TSP filters
BOLD indicates a pollutant of interest
NR = a risk factor is not available and therefore, no risk calculation can be made.
NA = annual average not available

calculated. In addition to the annual averages and risks based on 2006 monitoring data, where available, data from EPA's 1999 NATA were retrieved and are also presented in Table 20-7. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the Oklahoma sites is as follows:

- The census tract for CNEP is 40097040400, which had a population of 5,307 and represents approximately 14 percent of the Mayes County population in 2000.
- The census tract for TOOK is 40143004600, which had a population of 3,147 and represents approximately 0.6 percent of the Tulsa County population in 2000.
- The census tract for TSOK is 40143000900, which had a population of 1,590 and represents approximately 0.3 percent of the Tulsa County population in 2000.
- The census tract for TUOK is 40143003200, which had a population of 1,677, and represents approximately 0.3 percent of the Tulsa County population in 2000.

The following observations can be made for CNEP from Table 20-7:

- Benzene had the highest NATA-modeled concentration of all the pollutants of interest for CNEP.
- The NATA-modeled cancer risks for benzene and carbon tetrachloride were both greater than 1 in-a-million (3.36 and 3.20 in-a-million, respectively).
- None of the NATA-modeled noncancer risks were greater than 1.0.
- Acrolein's noncancer risk was the highest (0.95).

The following observations can be made for the Tulsa sites from Table 20-7:

- Xylenes and formaldehyde had the highest annual averages for TOOK and TUOK, while xylenes and benzene had the highest NATA-modeled concentrations for all three Tulsa sites.
- Benzene and carbon tetrachloride had the highest cancer risks based on annual average for TOOK and TUOK.
- Benzene and 1,3-butadiene had the highest cancer risks for the Tulsa sites according to NATA.

- Like most sites, acrolein was the only pollutant with a noncancer HQ greater than 1, although the annual average based risk is significantly higher than the NATA modeled risk.

20.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 20-8 and 20-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 20-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 20-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on the annual average are limited to those pollutants failing at least one screen.

The following observations for CNEP can be made from Table 20-8:

- Benzene was the highest emitted pollutant with cancer risk factor in Mayes County, Oklahoma and had the third highest toxicity-weighted emissions.
- Arsenic and hexavalent chromium had the highest toxicity-weighted emissions in Mayes County.
- Annual averages could not be calculated for CNEP, so no cancer risk calculations could be made.

The following observations for the Tulsa sites can be made from Table 20-8:

- In Tulsa County, benzene had both the highest emissions and the highest toxicity-weighted emissions, which is similar to most UATMP counties.
- Benzene also had the highest cancer risk based on annual averages for TOOK and TUOK.

Table 20-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Oklahoma

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Cherokee Nation, Oklahoma (CNEP) – Mayes County					
Benzene	70.47	Arsenic	3.87E-03		
Formaldehyde	59.29	Hexavalent Chromium	7.45E-04		
Acetaldehyde	10.22	Benzene	5.50E-04		
1,3-Butadiene	5.69	Cadmium	1.94E-04		
Naphthalene	5.36	Naphthalene	1.82E-04		
Dichloromethane	3.47	1,3-Butadiene	1.71E-04		
Polycyclic Organic Matter as 7-PAH	2.17	Polycyclic Organic Matter as 7-PAH	1.53E-04		
Trichloroethylene	1.86	Lead	1.07E-04		
Benzyl Chloride	1.40	Nickel	9.65E-05		
Tetrachloroethylene	1.24	Benzyl Chloride	6.86E-05		
Tulsa, Oklahoma, Site #1 (TOOK) – Tulsa County					
Benzene	656.52	Benzene	5.12E-03	Benzene	18.30
Formaldehyde	230.68	Lead	2.71E-03	Carbon Tetrachloride	8.86
Tetrachloroethylene	95.57	1,3-Butadiene	2.24E-03	Acrylonitrile	4.78
Acetaldehyde	81.21	Hexavalent Chromium	1.45E-03	Acetaldehyde	4.46
1,3-Butadiene	74.76	Naphthalene	6.67E-04	1,3-Butadiene	2.32
Dichloromethane	24.20	Tetrachloroethylene	5.64E-04	*p*-Dichlorobenzene	2.19
Trichloroethylene	22.32	Polycyclic Organic Matter as 15-PAH	1.83E-04	Hexachloro-1,3-butadiene	1.62
Naphthalene	19.63	Acetaldehyde	1.79E-04	Tetrachloroethylene	1.15
p-Dichlorobenzene	12.22	Polycyclic Organic Matter as 7-PAH	1.68E-04	1,2-Dichloroethane	0.82
Polycyclic Organic Matter as 15-PAH	3.33	*p*-Dichlorobenzene	1.34E-04	Dichloromethane	0.22

Table 20-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Oklahoma (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Tulsa, Oklahoma, Site #2 – (TSOK) – Tulsa County					
Benzene	656.52	Benzene	5.12E-03		
Formaldehyde	230.68	Lead	2.71E-03		
Tetrachloroethylene	95.57	1,3-Butadiene	2.24E-03		
Acetaldehyde	81.21	Hexavalent Chromium	1.45E-03		
1,3-Butadiene	74.76	Naphthalene	6.67E-04		
Dichloromethane	24.20	Tetrachloroethylene	5.64E-04		
Trichloroethylene	22.32	Polycyclic Organic Matter as 15-PAH	1.83E-04		
Naphthalene	19.63	Acetaldehyde	1.79E-04		
p-Dichlorobenzene	12.22	Polycyclic Organic Matter as 7-PAH	1.68E-04		
Polycyclic Organic Matter as 15-PAH	3.33	*p*-Dichlorobenzene	1.34E-04		
Tulsa, Oklahoma, Site #3 (TUOK) – Tulsa County					
Benzene	656.52	Benzene	5.12E-03	Benzene	10.95
Formaldehyde	230.68	Lead	2.71E-03	Carbon Tetrachloride	9.73
Tetrachloroethylene	95.57	1,3-Butadiene	2.24E-03	Acetaldehyde	5.87
Acetaldehyde	81.21	Hexavalent Chromium	1.45E-03	Acrylonitrile	4.40
1,3-Butadiene	74.76	Naphthalene	6.67E-04	Tetrachloroethylene	3.55
Dichloromethane	24.20	Tetrachloroethylene	5.64E-04	1,3-Butadiene	2.75
Trichloroethylene	22.32	Polycyclic Organic Matter as 15-PAH	1.83E-04	*p*-Dichlorobenzene	1.81
Naphthalene	19.63	Acetaldehyde	1.79E-04	Hexachloro-1,3-butadiene	1.65
p-Dichlorobenzene	12.22	Polycyclic Organic Matter as 7-PAH	1.68E-04	1,2-Dichloroethane	0.80
Polycyclic Organic Matter as 15-PAH	3.33	*p*-Dichlorobenzene	1.34E-04	Formaldehyde	0.02

Table 20-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Oklahoma

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Cherokee Nation, Oklahoma (CNEP) – Mayes County					
Toluene	140.89	Acrolein	88,332.62		
Xylenes	91.15	Arsenic	30,003.79		
Benzene	70.47	Manganese	20,653.19		
Hydrochloric Acid	61.46	Nickel	9,274.52		
Formaldehyde	59.29	Formaldehyde	6,050.05		
Methanol	58.86	Cadmium	5,391.68		
Ethylene Glycol	25.78	Cyanide	3,097.21		
Methyl Ethyl Ketone	24.77	Hydrochloric Acid	3,072.88		
Hexane	22.47	1,3-Butadiene	2,845.14		
Ethylbenzene	21.85	Mercury	2,650.60		
Tulsa, Oklahoma, Site #1 (TOOK) – Tulsa County					
Toluene	1,693.16	Acrolein	666,521.43	Acrolein	46.90
Xylenes	1,071.67	Manganese	44,619.69	Formaldehyde	0.38
Benzene	656.52	1,3-Butadiene	37,378.71	Acetaldehyde	0.23
Methanol	315.45	Formaldehyde	23,538.94	Benzene	0.08
Hexane	285.46	Benzene	21,883.97	Xylenes	0.05
Ethylbenzene	259.65	Xylenes	10,716.70	1,3-Butadiene	0.04
Methyl Ethyl Ketone	237.23	Nickel	10,459.51	Acrylonitrile	0.04
Formaldehyde	230.68	Acetaldehyde	9,023.31	Chloromethane	0.02
Methyl Isobutyl Ketone	132.45	Cyanide	7,120.19	Carbon Tetrachloride	0.01
Tetrachloroethylene	95.57	Naphthalene	6,543.01	Hexachloro-1,3-butadiene	<0.01

Table 20-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Oklahoma (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Tulsa, Oklahoma, Site #2 (TSOK) – Tulsa County					
Toluene	1,693.16	Acrolein	666,521.43		
Xylenes	1,071.67	Manganese	44,619.69		
Benzene	656.52	1,3-Butadiene	37,378.71		
Methanol	315.45	Formaldehyde	23,538.94		
Hexane	285.46	Benzene	21,883.97		
Ethylbenzene	259.65	Xylenes	10,716.70		
Methyl Ethyl Ketone	237.23	Nickel	10,459.51		
Formaldehyde	230.68	Acetaldehyde	9,023.31		
Methyl Isobutyl Ketone	132.45	Cyanide	7,120.19		
Tetrachloroethylene	95.57	Naphthalene	6,543.01		
Tulsa, Oklahoma, Site #3 (TUOK) – Tulsa County					
Toluene	1,693.16	Acrolein	666,521.43	Acrolein	45.86
Xylenes	1,071.67	Manganese	44,619.69	Formaldehyde	0.42
Benzene	656.52	1,3-Butadiene	37,378.71	Acetaldehyde	0.30
Methanol	315.45	Formaldehyde	23,538.94	Benzene	0.05
Hexane	285.46	Benzene	21,883.97	1,3-Butadiene	0.05
Ethylbenzene	259.65	Xylenes	10,716.70	Xylenes	0.04
Methyl Ethyl Ketone	237.23	Nickel	10,459.51	Acrylonitrile	0.03
Formaldehyde	230.68	Acetaldehyde	9,023.31	Carbon Tetrachloride	0.02
Methyl Isobutyl Ketone	132.45	Cyanide	7,120.19	Tetrachloroethylene	<0.01
Tetrachloroethylene	95.57	Naphthalene	6,543.01	Hexachloro-1,3-butadiene	<0.01

- Lead had the second highest toxicity-weighted emissions.

- Annual averages could not be calculated for TSOK, so no cancer risk calculations could be made. In addition, annual averages for metals could not be calculated for the Tulsa sites, so no cancer risk calculations for metals could be made.

The following observations can be made from Table 20-9:

- Like many UATMP counties, toluene and xylenes had the highest emissions in both Tulsa and Mayes Counties for pollutants with noncancer risk factors.

- Acrolein had the highest toxicity-weighted emissions for both counties, but did not appear on the list of highest emitted pollutants.

- Acrolein also had the highest noncancer risk for the TOOK and TUOK sites (no annual average could be calculated for acrolein for TSOK and CNEP).

Oklahoma Pollutant Summary

- *The pollutants of interest common to all Oklahoma sites were acrolein, benzene, 1,3-butadiene, and carbon tetrachloride.*

- *Formaldehyde concentrations tended to be higher during the summer at the Tulsa sites.*

- *Acrolein exceeded the short-term risk factors at all four sites.*

21.0 Site in Oregon

This section presents meteorological, concentration, and spatial trends for the UATMP site in La Grande, Oregon (LAOR). Figure 21-1 is a topographical map showing the monitoring site in its rural location. Figure 21-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. LAOR is located near a small number of sources, all of which are located to the west of the site. The sources represent in a variety of industries, including automotive repair services, fuel combustion processes, and polymer and resin production.

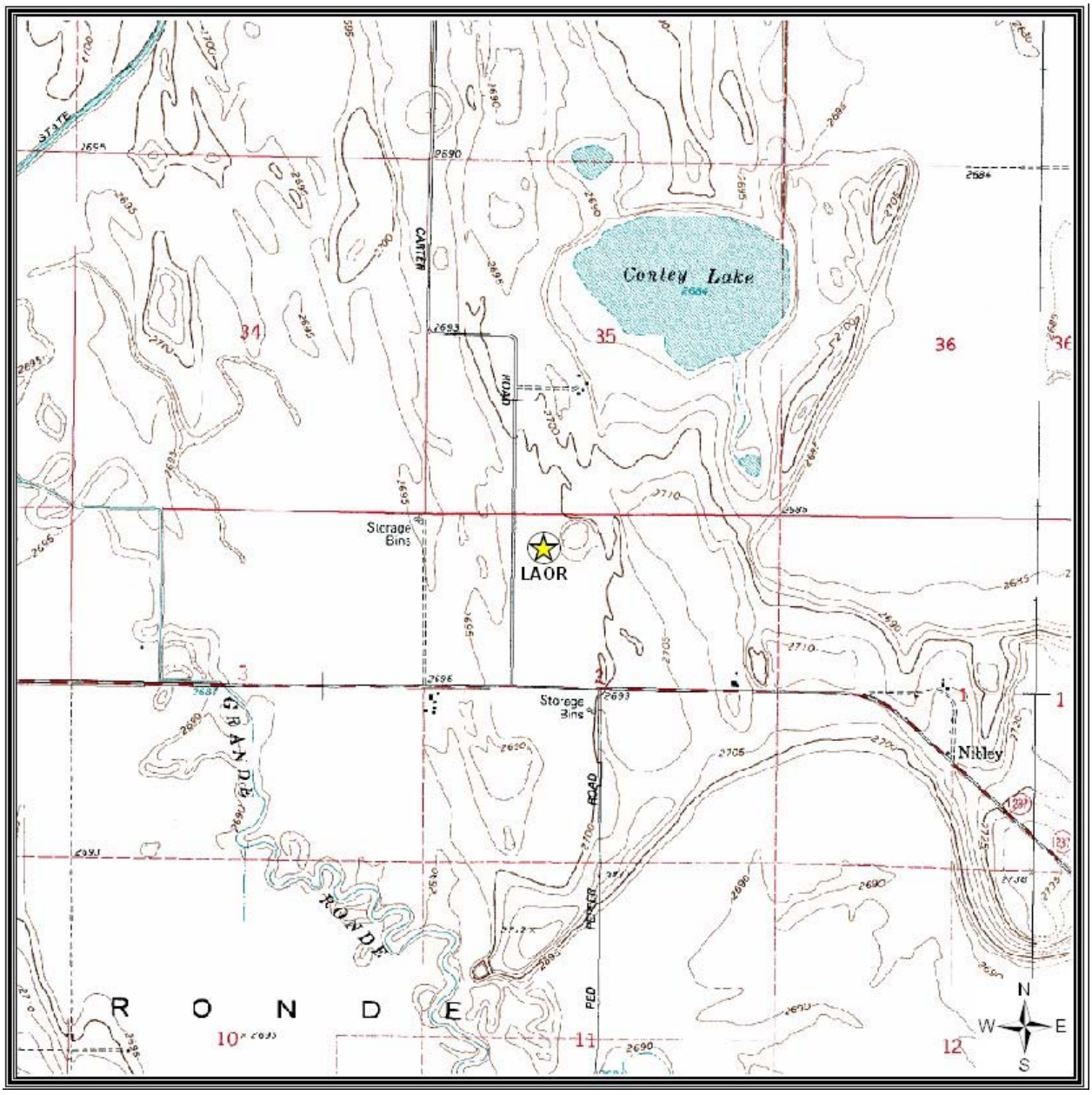
La Grande is located in a mountain valley in northeast Oregon, between the Wallowa Mountains to the east and Blue Mountains to the west. The city experiences a somewhat dry continental climate. The mountains can block storm systems moving across the region that are still intact after moving across the Cascades (WRCC).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the LAOR monitoring site is at La Grande/Union County Airport (WBAN 24148). Table 21-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 21-1 is the 95 percent confidence interval for each parameter. As shown in Table 21-1, average meteorological conditions on sampling days were much cooler than average weather conditions throughout the year. This is expected because samples were collected only in January and February.

21.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the North Carolina monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 21-1. La Grande, Oregon (LAOR) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 21-2. Facilities Located Within 10 Miles of LAOR

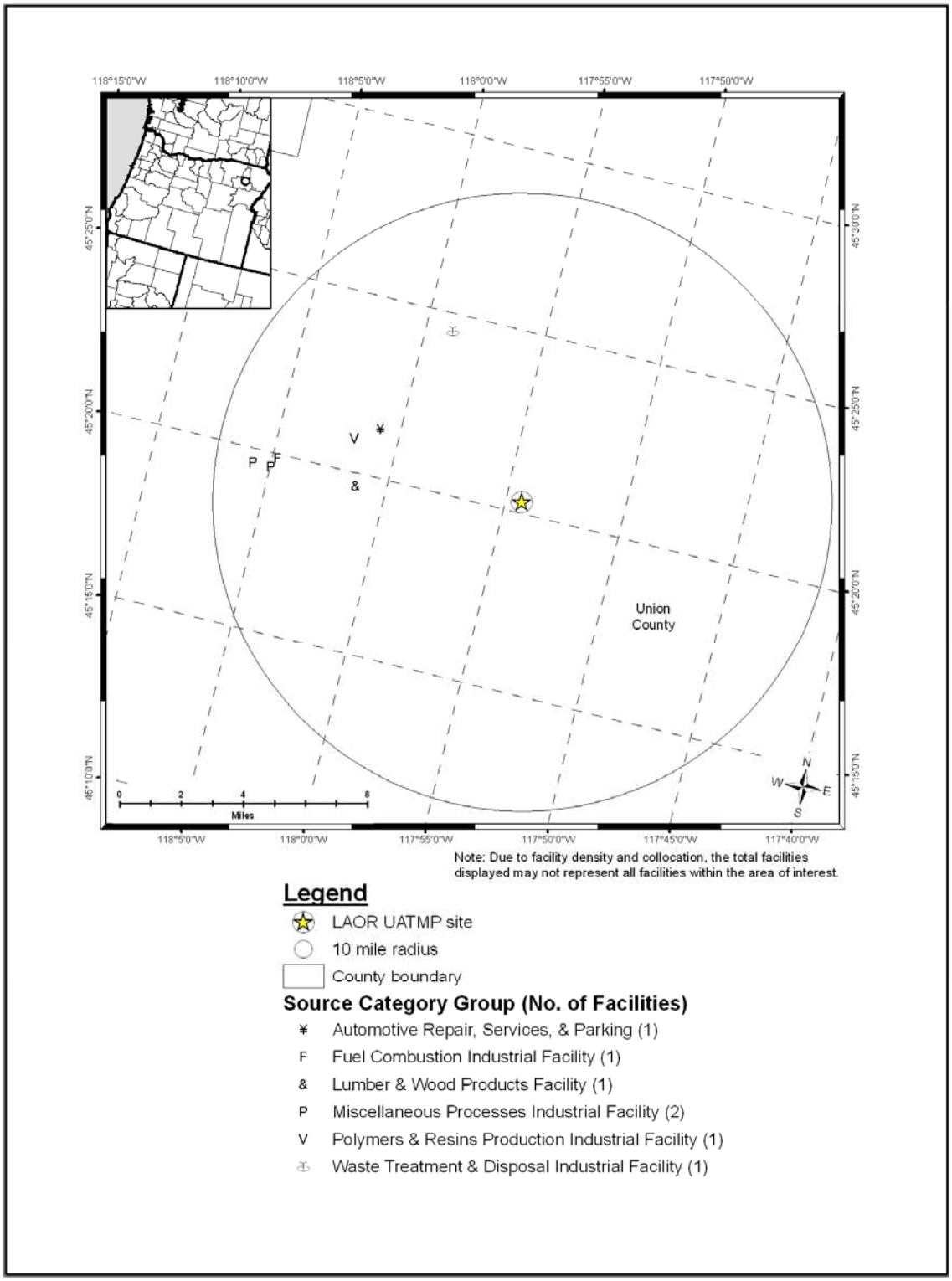


Table 21-1. Average Meteorological Conditions near the Monitoring Site in Oregon

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
LAOR	24148	All 2006	61.23 ± 1.98	49.76 ± 1.52	33.02 ± 1.04	42.01 ± 1.12	57.67 ± 1.47	NA[1]	7.41 ± 0.44
		Sampling Day	41.00 ± 3.61	37.23 ± 3.57	26.64 ± 2.07	33.33 ± 2.53	66.54 ± 6.02	NA[1]	11.80 ± 3.80

[1]Sea level pressure was not recorded at the LaGrande/Union County Airport.

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. LAOR sampled only hexavalent chromium. Though detected four times, hexavalent chromium did not fail the screen on any occasion, as shown in Table 21-2. In order to facilitate analyses, this pollutant will be considered LAOR's only pollutant of interest.

Table 21-2. Comparison of Measured Concentrations and EPA Screening Values for the Oregon Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
La Grande, Oregon – LAOR					
Hexavalent Chromium	0	4	0	0.00	0.00

21.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 21-3. Annual averages will be presented and discussed in further detail in later sections.

Table 21-3. Daily and Seasonal Averages for the Pollutants of Interest for the Oregon Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
La Grande, Oregon – LAOR												
Hexavalent Chromium	4	6	0.027	0.025	NR	NR	NA	NA	NA	NA	NA	NA

NR = Not reportable due to low number of measured detections.
NA = Not available due to short sampling duration.

The following observations are shown in Table 21-3:

- The daily average for hexavalent chromium for LAOR was 0.027 ± 0.025 ng/m^3.
- No winter average could be calculated because of the low number of measured detections; spring, summer, or autumn averages could not be calculated because this site stopped sampling in February.

21.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for LAOR was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. Hexavalent chromium did not exceed the ATSDR intermediate MRL. Hexavalent chromium has no acute risk factors; therefore acute risk could not be assessed.

21.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

21.4.1 Pearson Correlation Analysis

Table 21-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters for the LAOR monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 21-4:

- Hexavalent chromium exhibited a strong negative correlation with maximum temperature, indicating that as temperatures increase, concentrations decrease.
- A strong positive correlation was calculated for relative humidity, indicating that as relative humidity increases, concentrations of hexavalent chromium decrease.

Table 21-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Oregon Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
La Grande, Oregon – LAOR								
Hexavalent Chromium	4	-0.54	-0.32	0.36	-0.12	0.74	NA[1]	-0.31

[1]Sea level pressure was not recorded at the LaGrande/Union County Airport.

- The low number of measured detections likely skewed the correlations.

21.4.2 Composite Back Trajectory Analysis

Figure 21-3 is a composite back trajectory map for the LAOR monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 21-3 represents 100 miles.

The following observations can be made from Figure 21-3:

- Back trajectories originated from the south and southwest of LAOR.
- The 24-hour airshed domain was smaller at LAOR than most other UATMP sites, with its furthest trajectory originating 500 miles away, off the California Coast.
- The composite back trajectory for LAOR might look much different with a full year's worth of sampling day trajectories.

21.4.3 Wind Rose Analysis

Hourly wind data from the La Grande/Union County Airport near the LAOR monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 21-4 is the wind rose for the LAOR monitoring site on days that sampling occurred.

Observations from Figure 21-4 include:

- Hourly winds were predominantly out of the south (31 percent of observations) and south-southeast (22 percent) on sampling days.
- Winds tended to be slightly breezier near LAOR than other UATMP sites.
- Wind speeds ranged most frequently from 11 to 17 knots on sampling days (28 percent of observations).
- Calm winds (<2 knots) were recorded for only 6 percent of the observations.

Figure 21-3. Composite Back Trajectory Map for LAOR

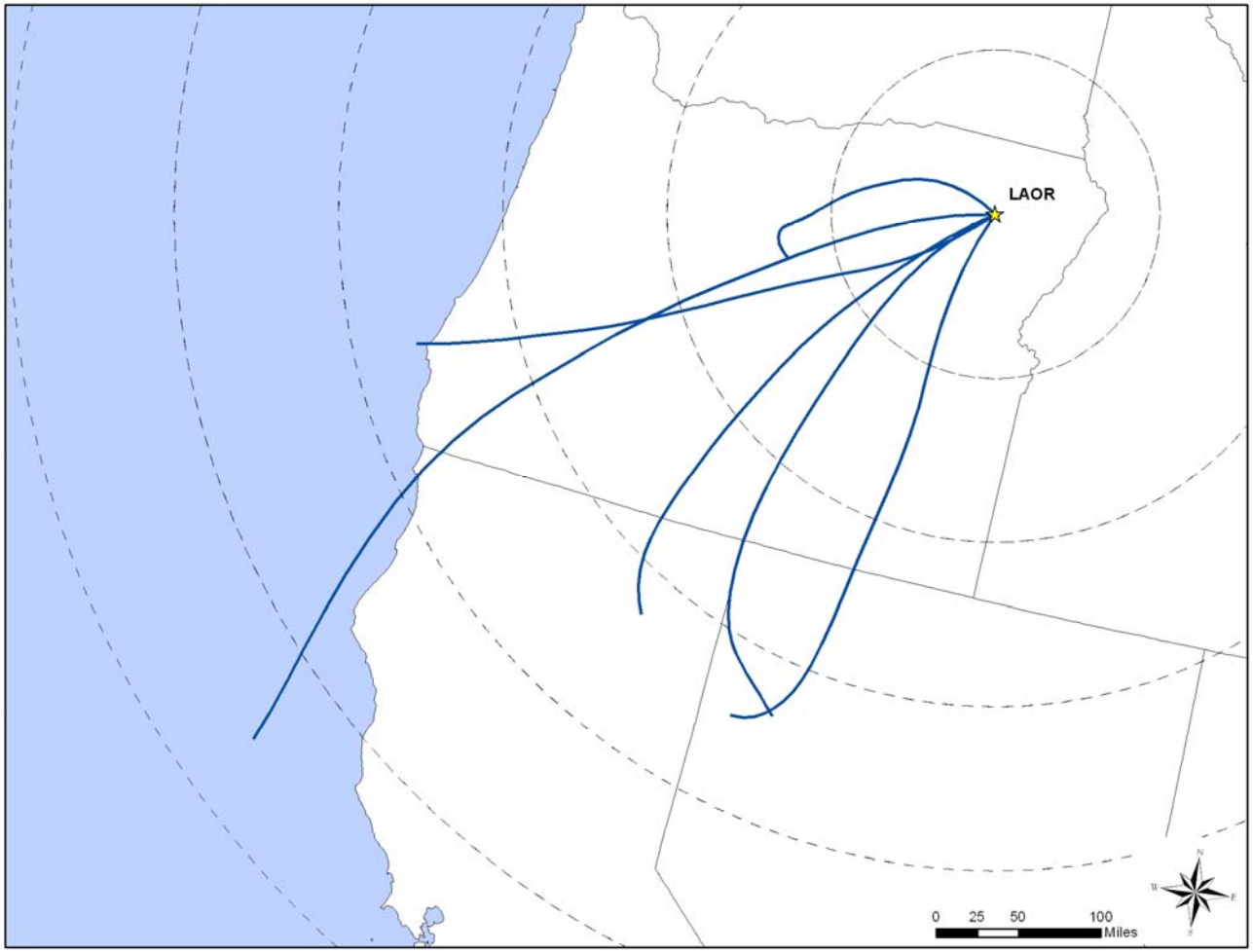
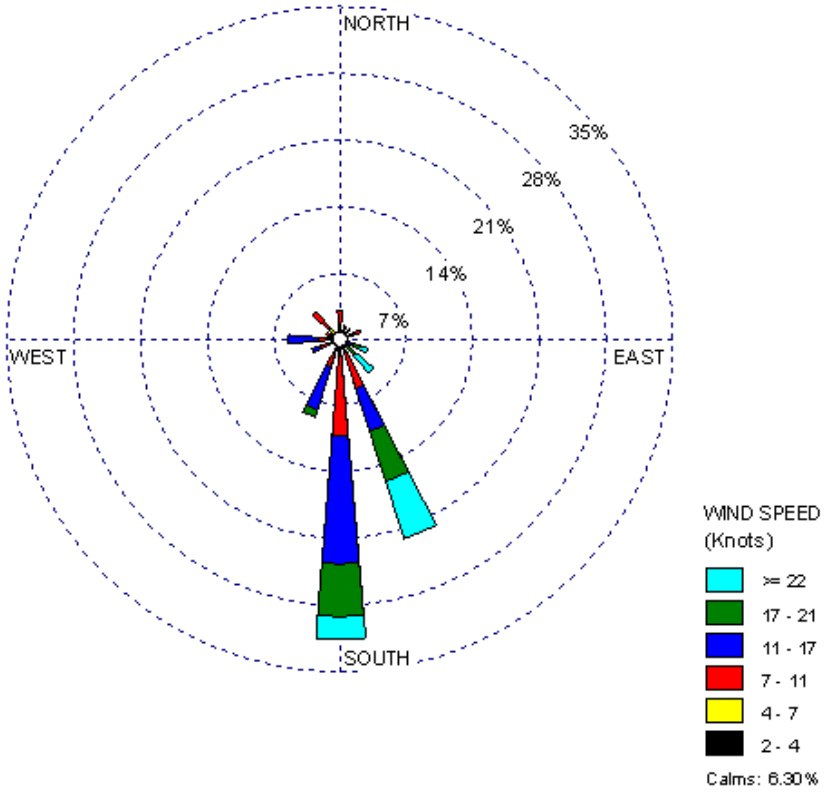


Figure 21-4. Wind Rose for LAOR Sampling Days



21.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as this site did not sample for VOC. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

21.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population information was obtained from the Oregon Department of Transportation and U.S. Census Bureau, and is summarized in Table 21-5. Table 21-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 21-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 21-5 include:

- Compared to other UATMP sites, LAOR's county population, vehicle registration, 10-mile population and vehicle ownership, and daily traffic volume are in the bottom five for each statistic.

- LAOR's estimated vehicles per person ratio is the third highest, behind only sites in Florida and South Dakota.

21.6 Trends Analysis

A trends analysis could not be performed for LAOR as this site has not participated in the UATMP for three consecutive years.

21.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutant of interest for LAOR. LAOR did not sample long enough for annual averages to be calculated (refer to Section 3.3.5 regarding the definition of an annual average), and therefore annual average-based cancer and not cancer risks

Table 21-5. Motor Vehicle Information for the Oregon Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
LAOR	24,345	33,263	1.37	15,964	21,812	55

Table 21-6. Chronic Risk Summary for the Monitoring Site in Oregon

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
La Grande, Oregon (LAOR) – Census Tract ID 41061970500								
Hexavalent Chromium	0.012	0.0001	<0.01	0.09	<0.01	NA	NA	NA

NA = Not available due to short sampling duration.

cannot be assessed. However, data from EPA's 1999 NATA were retrieved and are presented in Table 21-6. The NATA data are presented for the census tract where the monitoring site is located.

The following observations can be made for LAOR from Table 21-6:

- The census tract for LAOR is 41061970500, which had a population of 3,352 and represents approximately 13 percent of the Union County population in 2000.

- Cancer and noncancer risk due to hexavalent chromium at LAOR was very low according to the NATA.

21.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 21-7 and 21-8 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 21-7 presents the 10 pollutants with the highest emissions from the 2002 NEI and the 10 pollutants with the highest toxicity-weighted emissions. The 10 pollutants with the highest cancer risk based on annual averages could not be calculated because there are no annual averages. Table 21-8 presents similar information, but is based on noncancer risk factors. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be.

The following observations can be made from Table 21-7:

- Benzene, formaldehyde, and acetaldehyde had the highest emissions (by mass) in Union County for pollutants with cancer risk factors, but only benzene (which ranked second) and acetaldehyde (which ranked ninth) were among the top 10 highest cancer toxicity-weighted emissions.

- POM as non-15 PAH had the highest toxicity-weighted emissions for Union County, but this pollutant group ranked tenth for total emissions.

The following observations can be made from Table 21-8:

- Like many UATMP counties, toluene and xylenes had the highest emissions in Union County. However, neither of these pollutants was among those with the top 10 highest noncancer toxicity-weighted emissions.

Table 21-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for LAOR

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Union County)		Top 10 Cancer Toxicity-Weighted Emissions (for Union County)		Top 10 Cancer Risks Based on Annual Average Concentration (for LAOR)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
La Grande, Oregon – LAOR					
Benzene	103.09	Polycyclic Organic Matter as non-15 PAH	9.19E-04		
Formaldehyde	56.80	Benzene	8.04E-04		
Acetaldehyde	17.77	Polycyclic Organic Matter as 7-PAH	7.60E-04		
Polycyclic Organic Matter as 7-PAH	11.30	Polycyclic Organic Matter as 15-PAH	3.26E-04		
Dichloromethane	9.97	1,3-Butadiene	1.80E-04		
1,3-Butadiene	6.00	Naphthalene	1.43E-04		
Tetrachloroethylene	5.99	Lead	1.23E-04		
Polycyclic Organic Matter as 15-PAH	5.93	Arsenic	4.98E-05		
Naphthalene	4.22	Acetaldehyde	3.91E-05		
Polycyclic Organic Matter as non-15 PAH	2.83	Tetrachloroethylene	3.53E-05		

Table 21-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for LAOR

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Union County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Union County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for LAOR)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
La Grande, Oregon – LAOR					
Toluene	175.86	Acrolein	217,747.26		
Xylenes	113.14	Manganese	16,119.69		
Benzene	103.09	Hexamethylene Diisocyanate	15,194.00		
Methanol	98.82	Formaldehyde	5,796.03		
Formaldehyde	56.80	Benzene	3,436.27		
Ethylbenzene	27.15	1,3-Butadiene	3,000.00		
Methyl Ethyl Ketone	25.55	4,4'-Methylenediphenyl Diisocyanate	2,941.68		
1,1,1-Trichloroethane	24.86	Acetaldehyde	1,974.40		
Hexane	22.64	Naphthalene	1,406.40		
Methyl Isobutyl Ketone	19.35	Cyanide	1,162.11		

- Acrolein, which did not have one of the highest total emissions, had the highest noncancer toxicity-weighted emissions.

- Only benzene and formaldehyde appeared on both lists.

Oregon Pollutant Summary

- *Oregon sampled for only hexavalent chromium and none of its measured detections failed screens.*

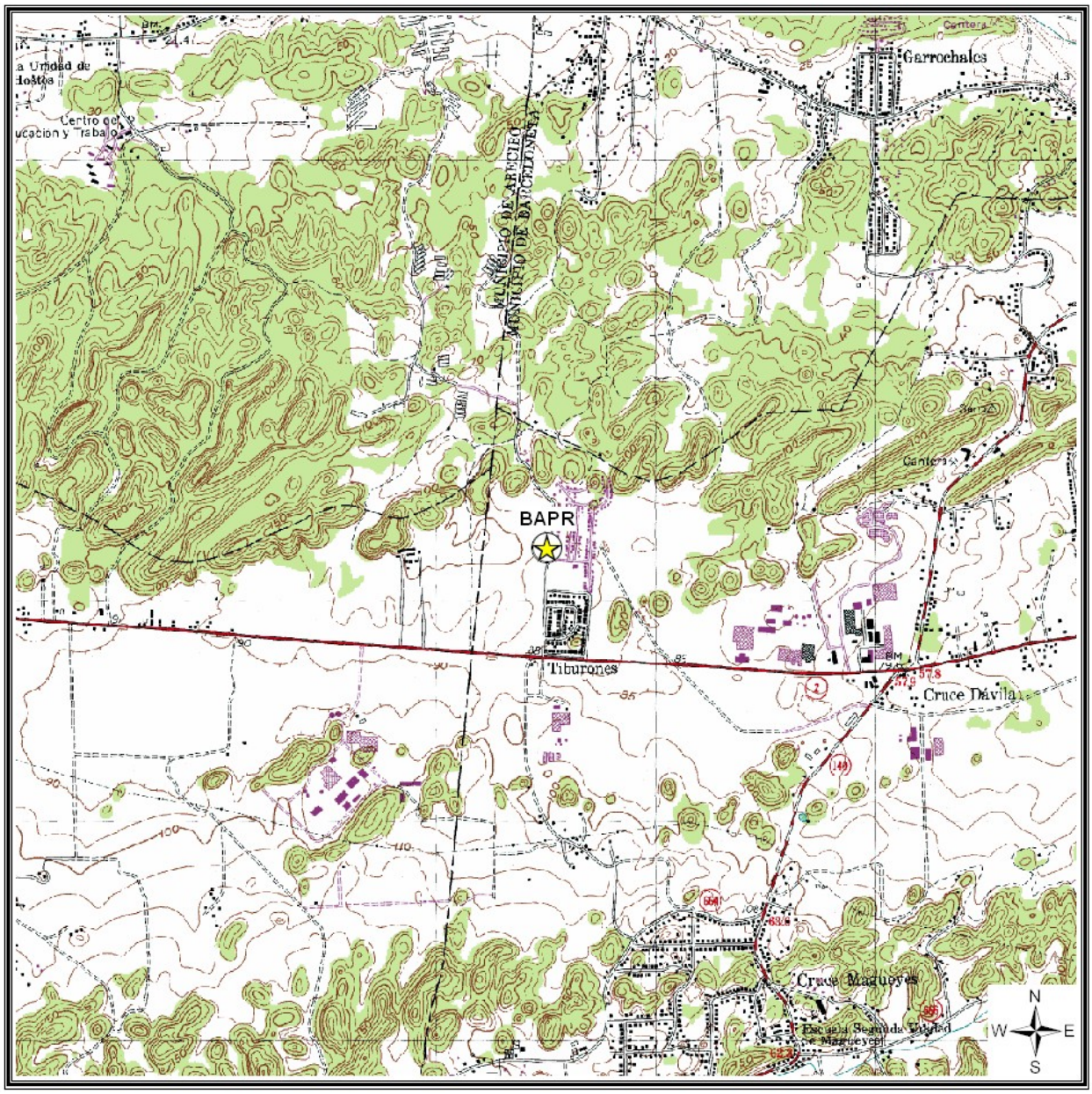
22.0 Sites in Puerto Rico

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Puerto Rico (BAPR and SJPR). SJPR is located in San Juan, and BAPR is located further west in Barceloneta. Both sites lie on the northern coast of Puerto Rico and are part of the San Juan, PR MSA. Figures 22-1 and 22-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 22-3 and 22-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 22-3 shows, many of the emission sources near BAPR are located just east of the monitoring site and are involved in pharmaceutical production. Many of the emission sources near SJPR are also located just east of the monitoring site and are involved in liquids distribution and fabricated metal product production.

The island of Puerto Rico is located in the northern Caribbean and experiences a tropical climate, where the air is warm and humid year-round and rainfall is abundant. Breezy winds flow from the northeast to east on average with the aid of the sub-tropical high pressure that resides over the tropical Atlantic Ocean. However, the sea-breeze is a daily occurrence (Ruffner and Bair, 1987).

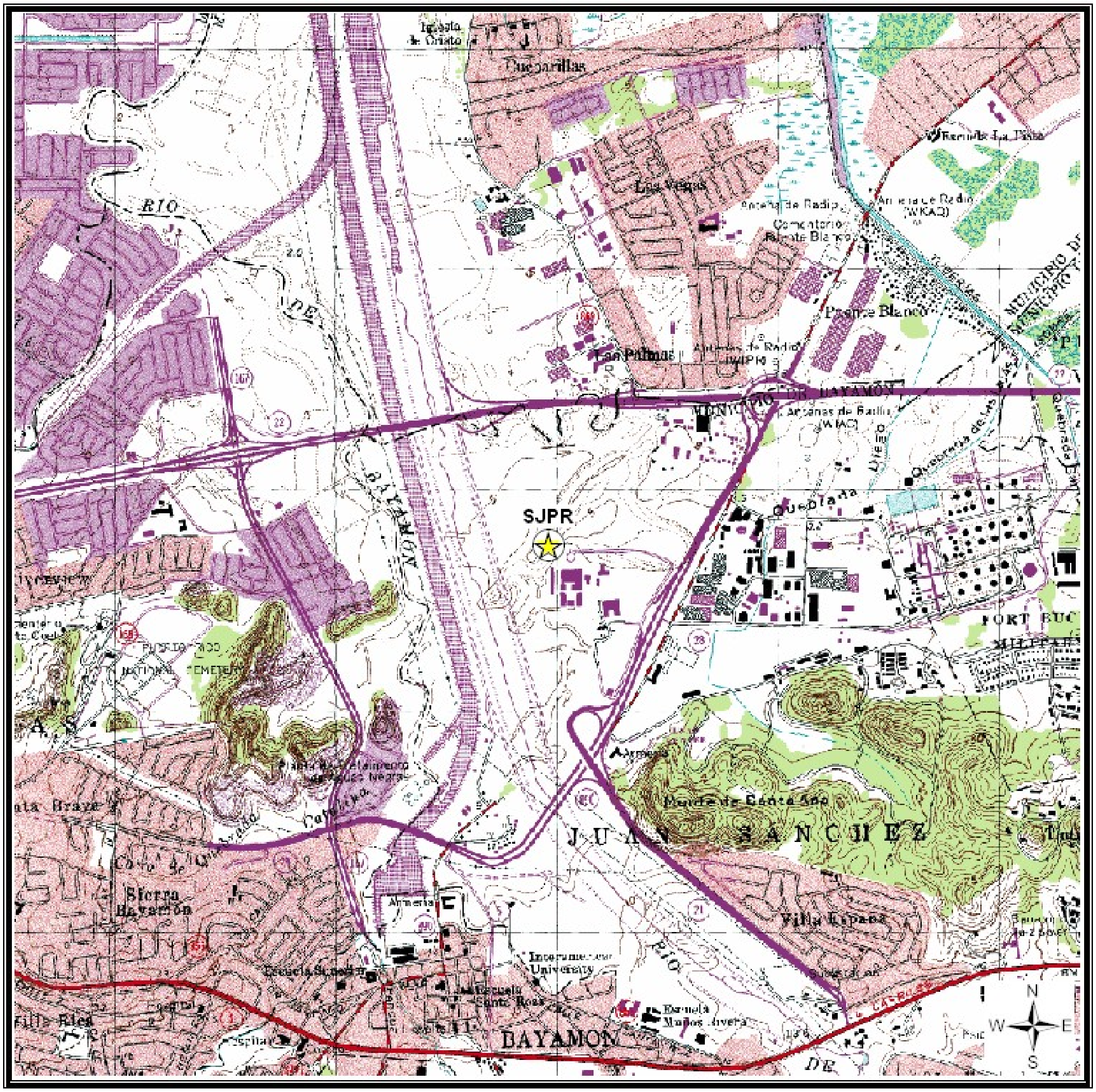
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the Puerto Rico monitoring sites is Luis Munoz Marin International Airport (WBAN 11641). Table 22-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 22-1 is the 95 percent confidence interval for each parameter. As shown in Table 22-1, average meteorological conditions on sampling days were fairly representative of average weather conditions throughout the year.

Figure 22-1. Barceloneta, Puerto Rico (BAPR) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 22-2. San Juan, Puerto Rico (SJPR) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 22-3. Facilities Located Within 10 Miles of BAPR

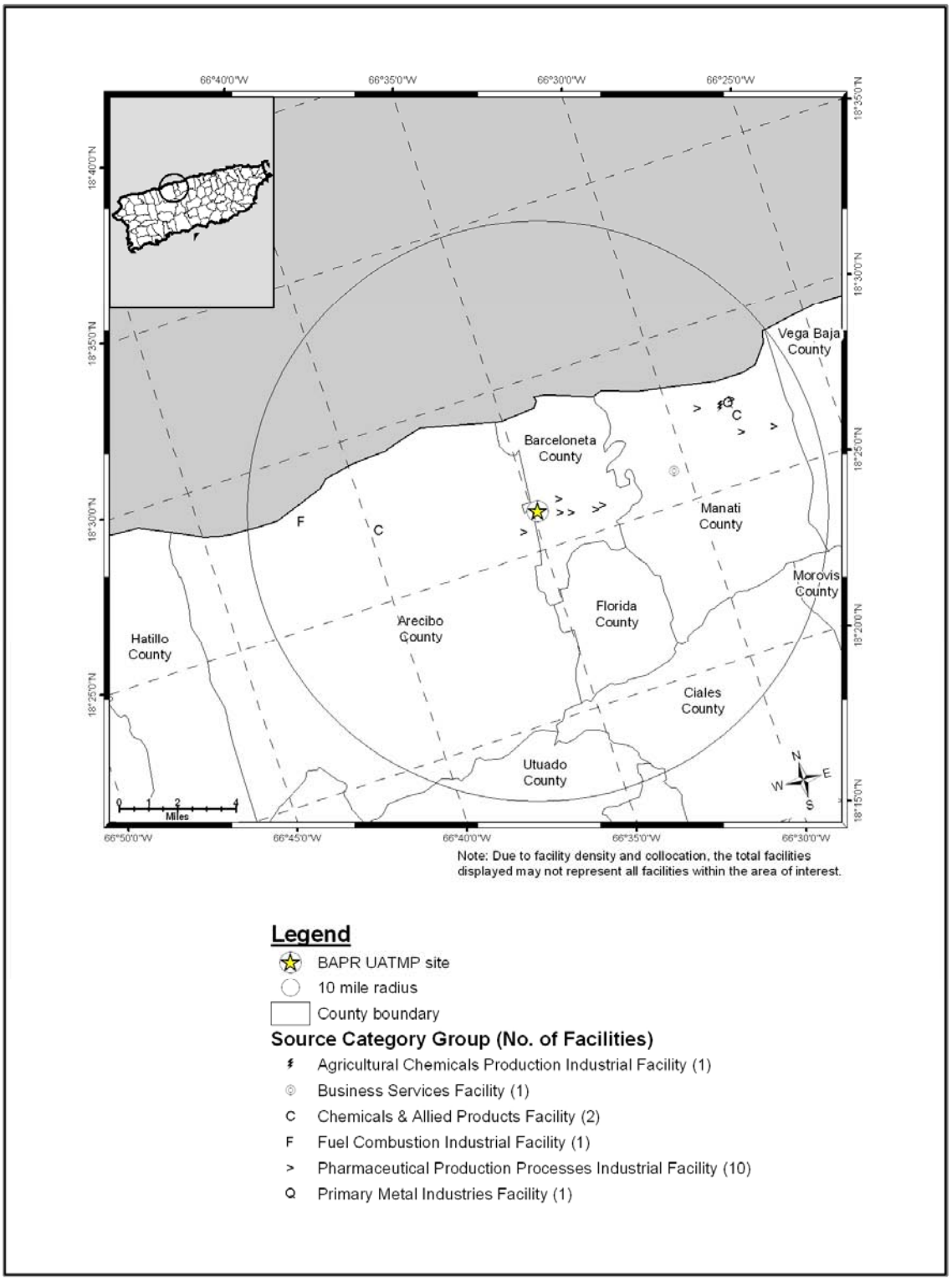


Figure 22-4. Facilities Located Within 10 Miles of SJPR

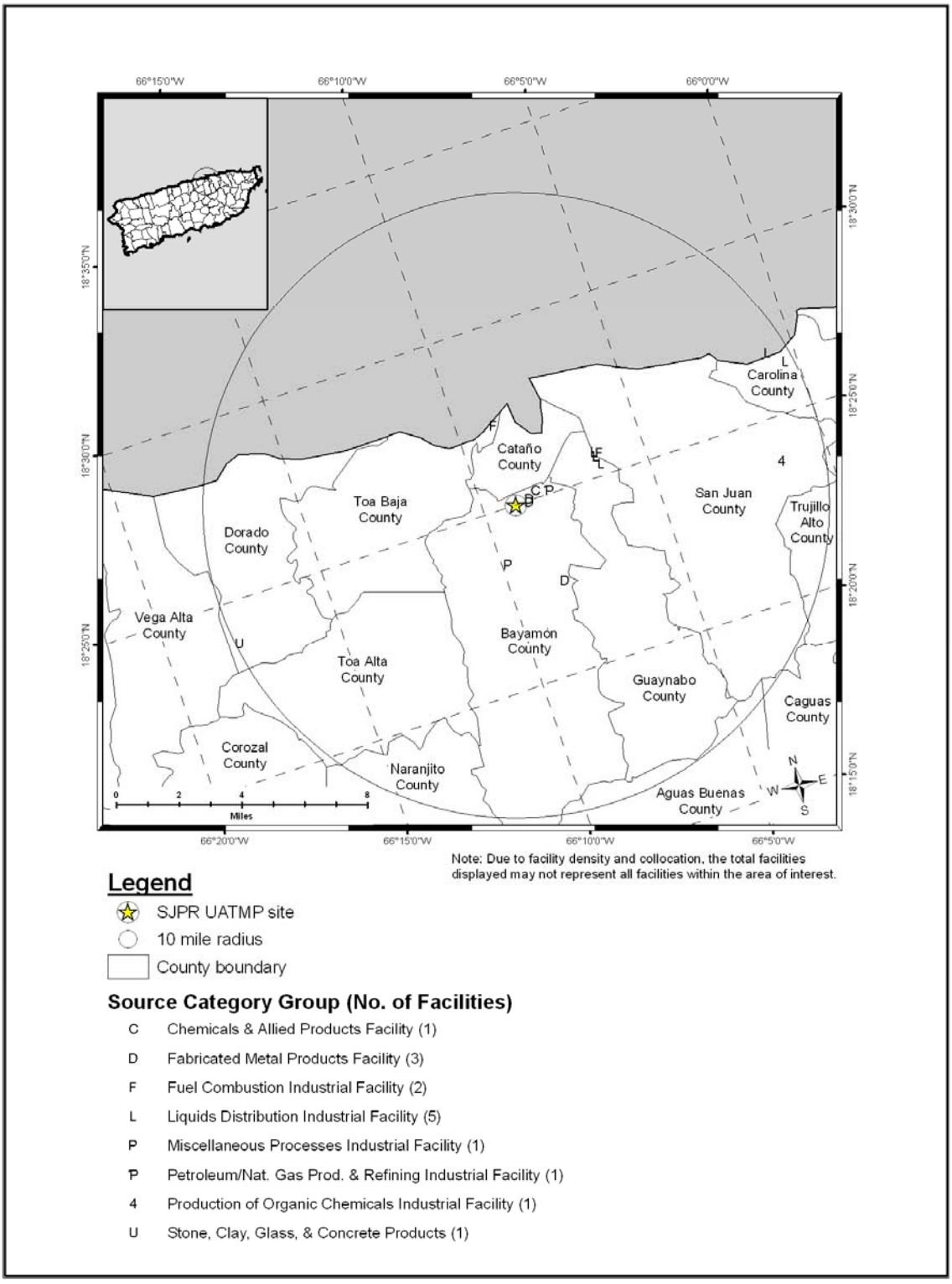


Table 22-1. Average Meteorological Conditions near the Monitoring Sites in Puerto Rico

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BAPR	11641	All 2006	85.70 ± 0.36	79.81 ± 0.30	71.34 ± 0.32	74.04 ± 0.28	76.14 ± 0.55	1015.26 ± 0.22	6.15 ± 0.24
		Sampling Day	85.37 ± 0.91	79.60 ± 0.75	71.01 ± 0.85	73.77 ± 0.73	75.74 ± 1.30	1015.34 ± 0.57	6.30 ± 0.65
SJPR	11641	All 2006	85.70 ± 0.36	79.81 ± 0.30	71.34 ± 0.32	74.04 ± 0.28	76.14 ± 0.55	1015.26 ± 0.22	6.15 ± 0.24
		Sampling Day	85.27 ± 0.94	79.48 ± 0.79	71.04 ± 0.96	73.76 ± 0.81	76.06 ± 1.34	1015.44 ± 0.62	6.50 ± 0.72

22.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Puerto Rico monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. The Puerto Rico sites sampled for carbonyl compounds and VOC only. Table 22-2 presents the pollutants that failed at least one screen at the Puerto Rico monitoring sites.

Table 22-2. Comparison of Measured Concentrations and EPA Screening Values for the Puerto Rico Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Barceloneta, Puerto Rico – BAPR					
Acetaldehyde	59	59	100.00	14.53	14.53
Benzene	57	57	100.00	14.04	28.57
1,3-Butadiene	57	57	100.00	14.04	42.61
Carbon Tetrachloride	57	57	100.00	14.04	56.65
p-Dichlorobenzene	56	57	98.25	13.79	70.44
Acrolein	46	46	100.00	11.33	81.77
Dichloromethane	44	57	77.19	10.84	92.61
Formaldehyde	8	59	13.56	1.97	94.58
Xylenes	5	57	8.77	1.23	95.81
Tetrachloroethylene	4	24	16.67	0.99	96.80
Acrylonitrile	4	4	100.00	0.99	97.78
Hexachloro-1,3-butadiene	3	3	100.00	0.74	98.52
Toluene	2	57	3.51	0.49	99.01
Trichloroethylene	1	6	16.67	0.25	99.26
Chloroform	1	53	1.89	0.25	99.51
1,1,2,2-Tetrachloroethane	1	1	100.00	0.25	99.75
Ethyl Acrylate	1	1	100.00	0.25	100.00
Total	406	655	61.98		

Table 22-2. Comparison of Measured Concentrations and EPA Screening Values for the Puerto Rico Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
San Juan, Puerto Rico – SJPR					
Formaldehyde	40	40	100.00	12.31	12.31
1,3-Butadiene	40	40	100.00	12.31	24.62
Acetaldehyde	40	40	100.00	12.31	36.92
Benzene	40	40	100.00	12.31	49.23
Carbon Tetrachloride	40	40	100.00	12.31	61.54
p-Dichlorobenzene	39	40	97.50	12.00	73.54
Acrolein	36	36	100.00	11.08	84.62
Tetrachloroethylene	29	37	78.38	8.92	93.54
Xylenes	9	40	22.50	2.77	96.31
Dichloromethane	7	40	17.50	2.15	98.46
Acrylonitrile	2	2	100.00	0.62	99.08
Chloromethylbenzene	1	1	100.00	0.31	99.38
1,2-Dichloroethane	1	1	100.00	0.31	99.69
Hexachloro-1,3-butadiene	1	1	100.00	0.31	100.00
Total	325	398	81.66		

The following observations are shown in Table 22-2:

- Seventeen pollutants with a total of 406 measured concentrations failed the screen at BAPR and 14 pollutants with a total of 325 measured concentrations failed the screen at SJPR.

- While the pollutants of interest varied by site, the following eight pollutants contributed to the top 95 percent of the total failed screens at each Puerto Rico monitoring site: benzene, acetaldehyde, carbon tetrachloride, formaldehyde, 1,3-butudiene, xylenes, *p*-dichlorobenzene, and acrolein.

- Of the eight pollutants that were the same for both sites, five pollutants of interest (acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and acrolein) had 100 percent of their measured detections fail the screening values at both sites.

- Formaldehyde failed 100 percent of screens at SJPR, but failed only 8 of 59 screens at BAPR.

22.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average

concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal average concentrations are presented in Table 22-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for BAPR are shown in Table 22-3:

- Acetaldehyde, benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, formaldehyde, xylenes, and dichloromethane were detected in every sample collected at BAPR.

- Among the daily averages for BAPR, dichloromethane had the highest concentration by mass (10.05 ± 3.55 μg/m^3), followed by xylenes (4.68 ± 1.41 μg/m^3) and acetaldehyde (1.98 ± 0.28 μg/m^3).

- The seasonal averages of dichloromethane had large confidence intervals, which may indicate that the averages are influenced by outliers. This was also true of the spring xylenes average, the spring acrolein average, and the spring and autumn *p*-dichlorobenzene averages.

The following observations for SJPR are shown in Table 22-3:

- Among the daily averages, total xylenes had the highest concentration by mass (8.46 ± 2.16 μg/m^3), followed by acetaldehyde (2.60 ± 0.64 μg/m^3) and benzene (1.87 ± 0.29 μg/m^3).

- The winter and summer averages of *p*-dichlorobenzene also had large confidence intervals, suggesting averages influenced by outliers.

- No seasonal average was available for spring because samples were not collected in May.

- Acetaldehyde, benzene, carbon tetrachloride, formaldehyde, 1,3-butadiene, *p*-dichlorobenzene, and total xylenes were detected in every sample collected at SJPR.

Table 22-3. Daily and Seasonal Averages for the Pollutants of Interest for the Puerto Rico Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Barceloneta, Puerto, Rico – BAPR												
Acetaldehyde	59	59	1.98	0.28	2.15	0.42	2.76	0.52	1.62	0.55	1.36	0.50
Acrolein	46	57	1.05	0.53	0.39	0.15	1.23	1.51	0.63	0.17	1.19	0.53
Benzene	57	57	1.21	0.27	0.85	0.18	1.78	0.90	0.90	0.15	1.24	0.18
1,3-Butadiene	57	57	0.13	0.03	0.11	0.02	0.19	0.08	0.08	0.02	0.14	0.02
Carbon Tetrachloride	57	57	0.72	0.06	0.55	0.07	0.68	0.07	0.80	0.12	0.88	0.10
p-Dichlorobenzene	57	57	1.05	0.71	0.60	0.54	1.55	2.12	0.40	0.18	1.52	1.48
Dichloromethane	57	57	10.05	3.55	15.39	8.90	9.54	8.15	6.75	4.59	7.87	3.49
Formaldehyde	59	59	0.72	0.06	0.73	0.08	0.90	0.11	0.62	0.07	0.62	0.14
Xylenes	57	57	4.68	1.41	2.96	1.18	7.38	4.53	3.30	0.87	4.80	1.86
San Juan, Puerto, Rico – SJPR												
Acetaldehyde	40	40	2.60	0.64	2.83	1.38	NR	NR	1.59	0.38	1.81	0.22
Acrolein	36	40	1.20	0.48	0.78	0.49	NR	NR	0.65	0.20	1.88	1.21
Benzene	40	40	1.87	0.29	1.77	0.50	NR	NR	1.91	0.65	1.96	0.39
1,3-Butadiene	40	40	0.21	0.03	0.23	0.08	NR	NR	0.18	0.05	0.23	0.07
Carbon Tetrachloride	40	40	0.74	0.06	0.62	0.09	NR	NR	0.76	0.09	0.83	0.08
p-Dichlorobenzene	40	40	1.76	1.38	4.19	5.12	NR	NR	1.70	2.37	0.82	0.31
Formaldehyde	40	40	1.80	0.13	2.01	0.41	NR	NR	1.66	0.18	1.85	0.20
Tetrachloroethylene	37	40	0.40	0.23	NA	NA	NR	NR	0.31	0.14	0.59	0.62
Xylenes	40	40	8.46	2.16	6.48	2.25	NR	NR	10.82	5.44	8.05	2.11

NA = Not available due to short sampling duration.
NR = No reportable due to the low number of measured detections.

22.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for Puerto Rico monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute or the intermediate risk values, and each site's non-chronic risk is summarized in Table 22-4.

The following observations about acrolein are shown in Table 22-4:

- All of the acrolein measured detections at the Puerto Rico monitoring sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$, and all but one exceeded the California REL value of 0.19 $\mu g/m^3$.

- The average measured concentration was 1.05 ± 0.53 $\mu g/m^3$ for BAPR and 1.20 ± 0.48 $\mu g/m^3$ for SJPR, which were an order of magnitude higher than either acute risk factor.

- All seasonal averages for acrolein were at least one order of magnitude higher than the intermediate risk factor.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. For both Puerto Rico monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 22-5 and 22-6 are pollution roses for acrolein for the Puerto Rico sites. As shown in Figures 22-5 and 22-6, and discussed above, nearly all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CALEPA REL) and solid line (ATSDR MRL).

Observations gleaned from the acrolein pollution rose for BAPR include:

- Figure 22-5 for BAPR shows that concentrations exceeding the acute risk factors occurred with winds generally originating from the east. But, winds originated out of the east at BAPR on a majority of the sampling days.

Table 22-4. Non-Chronic Risk Summary for the Puerto Rico Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
BAPR	TO-15	Acrolein	1.05 ± 0.53	0.11	46	0.19	45	0.09	0.39 ± 0.15	1.23 ± 1.51	0.63 ± 0.17	1.19 ± 0.53
SJPR	TO-15	Acrolein	1.20 ± 0.48	0.11	36	0.19	36	0.09	0.78 ± 0.49	NR	0.65 ± 0.20	1.88 ± 1.21

NA = Not available due to short sampling duration.
NR = No reportable due to the low number of measured detections.

Figure 22-5. Acrolein Pollution Rose for BAPR

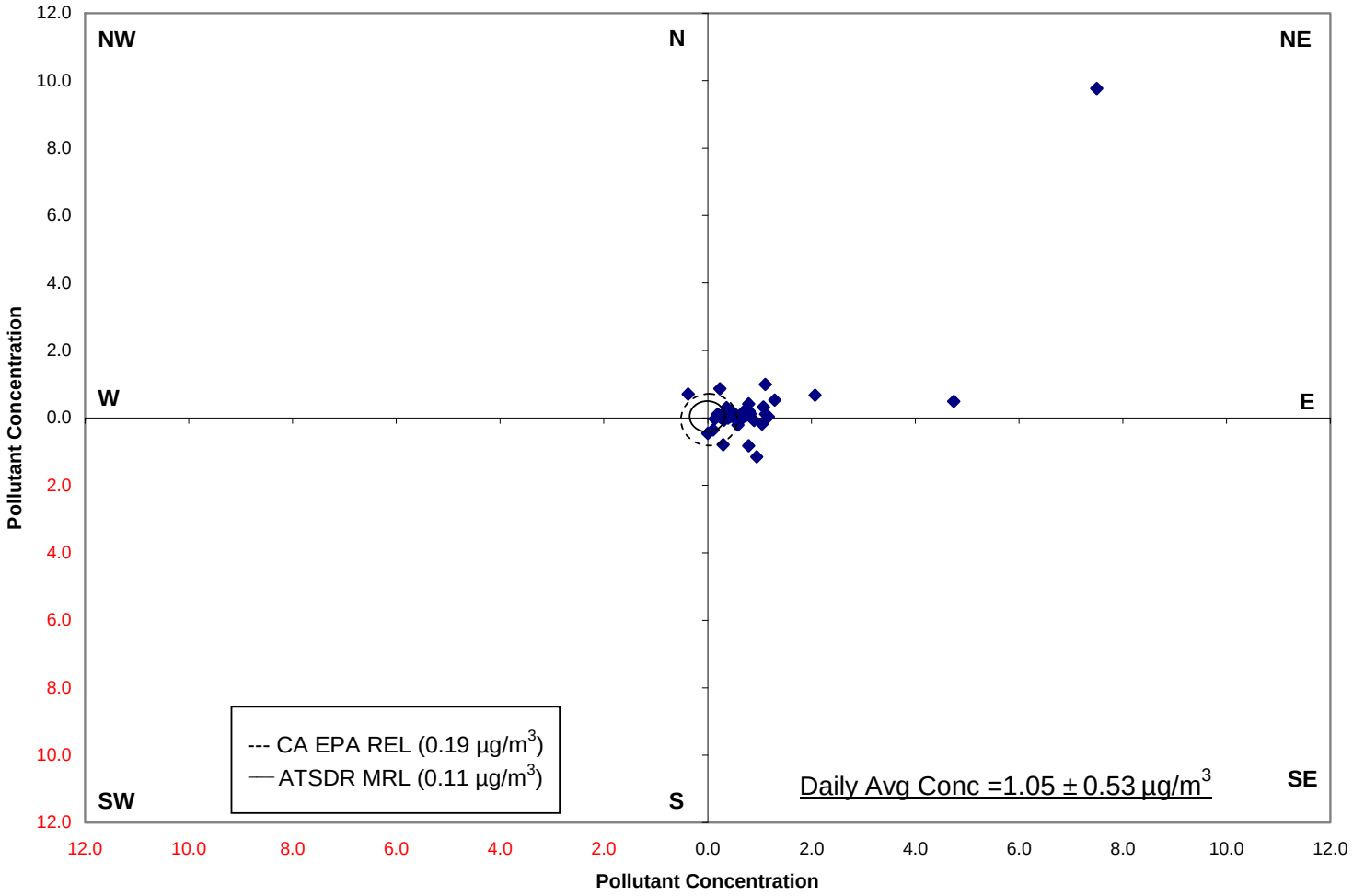
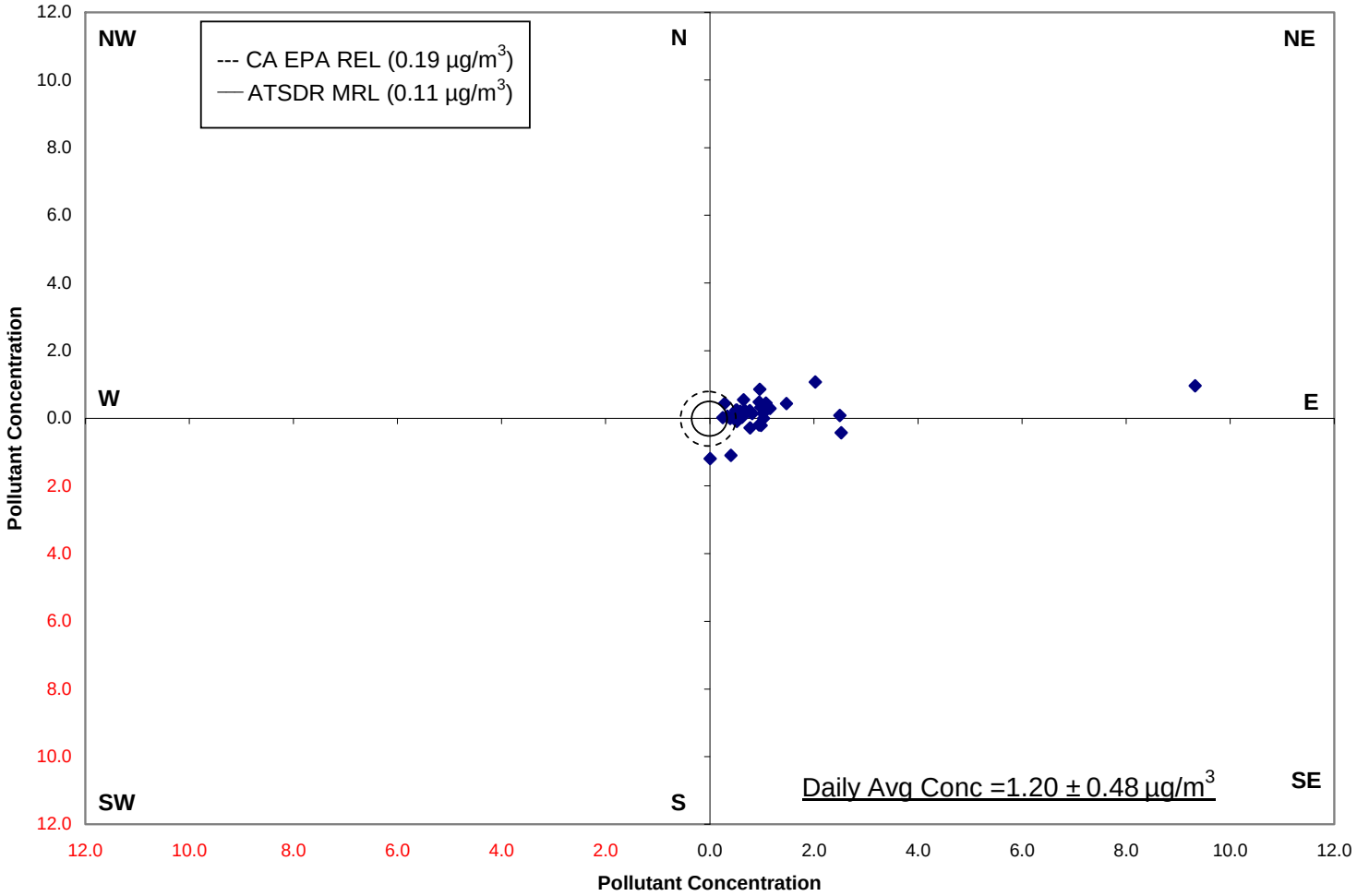


Figure 22-6. Acrolein Pollution Rose for SJPR



- The highest concentration of acrolein was measured on May 5, 2006, a day with a northeasterly wind.

- BAPR is located just north of a major road through Barceloneta, a town that lies to the west of San Juan. The immediate vicinity is classified as residential and rural. Several pharmaceutical production sources are located east of the monitoring site.

Observations gleaned from the acrolein pollution rose for SJPR include:

- Figure 22-6 for SJPR shows that most of the concentrations exceeding the acute risk factors occurred with winds originating from the east. But, winds originated out of the east at SJPR on a majority of the sampling days.

- The highest concentration of acrolein was measured on November 7, 2006, a day with an easterly wind.

- SJPR is located between several major roadways, including Highway 22, 5, and 167, just west of Fort Buchanan and Luchetti Industrial Park

22.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

22.4.1 Pearson Correlation Analysis

Table 22-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Puerto Rico monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for BAPR from Table 22-5:

- Most of the correlations for BAPR were weak.

- Carbon tetrachloride exhibited strong positive correlations with maximum, average, and wet bulb temperatures, indicating that as temperature and moisture content increase, concentrations of carbon tetrachloride also increase.

The following observations are gathered for SJPR from Table 22-5:

Table 22-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Puerto Rico Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Barceloneta, Puerto Rico – BAPR								
1,3-Butadiene	57	-0.13	-0.06	-0.17	-0.13	-0.19	-0.20	0.05
Acetaldehyde	59	-0.26	-0.34	-0.48	-0.46	-0.33	0.12	-0.01
Acrolein	46	-0.07	0.03	-0.27	-0.19	-0.48	-0.14	0.01
Benzene	57	-0.02	0.02	-0.18	-0.12	-0.31	-0.16	-0.04
Carbon Tetrachloride	57	0.59	0.58	0.45	0.52	-0.07	-0.15	-0.08
Dichloromethane	57	0.03	-0.01	-0.01	-0.02	0.01	0.06	-0.01
Formaldehyde	59	-0.18	-0.20	-0.27	-0.26	-0.18	0.00	-0.14
p-Dichlorobenzene	57	-0.05	0.05	-0.09	-0.04	-0.22	-0.15	-0.04
Xylenes	57	-0.10	0.00	-0.18	-0.13	-0.29	-0.16	0.04
San Juan, Puerto Rico – SJPR								
1,3-Butadiene	40	-0.29	-0.39	-0.25	-0.29	0.09	-0.18	-0.37
Acetaldehyde	40	-0.44	-0.55	-0.70	-0.68	-0.45	0.22	-0.02
Acrolein	36	0.01	-0.04	-0.09	-0.08	-0.10	-0.30	-0.11
Benzene	40	0.02	-0.03	0.10	0.07	0.22	-0.09	-0.37
Carbon Tetrachloride	40	0.37	0.39	0.42	0.43	0.19	-0.23	-0.33
Formaldehyde	40	-0.04	-0.21	-0.41	-0.37	-0.40	-0.02	-0.21
p-Dichlorobenzene	40	-0.28	-0.30	-0.24	-0.27	-0.01	0.11	0.04
Tetrachloroethylene	37	-0.23	-0.15	0.05	0.00	0.26	-0.27	-0.12
Xylenes	40	0.17	0.13	0.17	0.17	0.11	0.02	-0.19

- Similar to BAPR, most of the correlations for SJPR were weak.

- Acetaldehyde exhibited strong negative correlations with average, dew point, and wet bulb temperatures, indicating that as temperature and moisture content increase, concentrations of acetaldehyde tend to decrease.

22.4.2 Composite Back Trajectory Analysis

Figures 22-7 and 22-8 are composite back trajectory maps for the Puerto Rico monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

The following observations can be made from Figures 22-7 and 22-8:

- Back trajectories predominantly originated from the east at BAPR and SJPR.

- The 24-hour airshed domains are somewhat smaller for the Puerto Rico monitoring sites than other UATMP sites, both in size and directional variation.

- Few back trajectories originated over 600 miles away, with most of the trajectories originating within 400 miles of the sites.

22.4.3 Wind Rose Analysis

Hourly wind data from the Luis Munoz Marin International Airport were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 22-9 and 22-10 are the wind roses for the Puerto Rico monitoring sites on days that sampling occurred.

The following observations can be made from Figures 22-9 and 22-10:

- The wind roses for these sites look very similar.

- Hourly winds were predominantly out of the east (approximately 30 percent of observations) and east-northeast (approximately 20 percent) near BAPR and SJPR on days samples were collected.

Figure 22-7. Composite Back Trajectory Map for BAPR

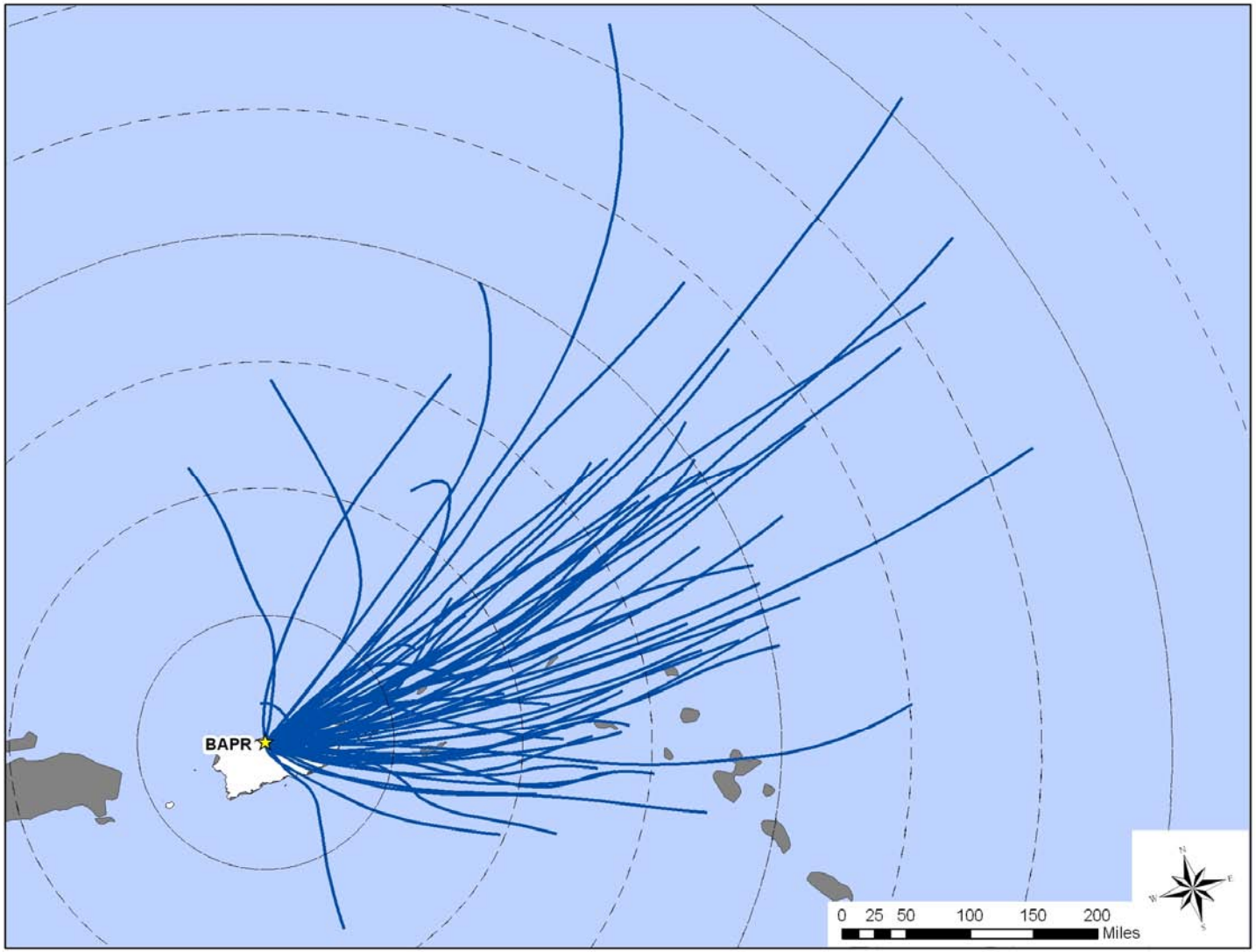


Figure 22-8. Composite Back Trajectory Map for SJPR

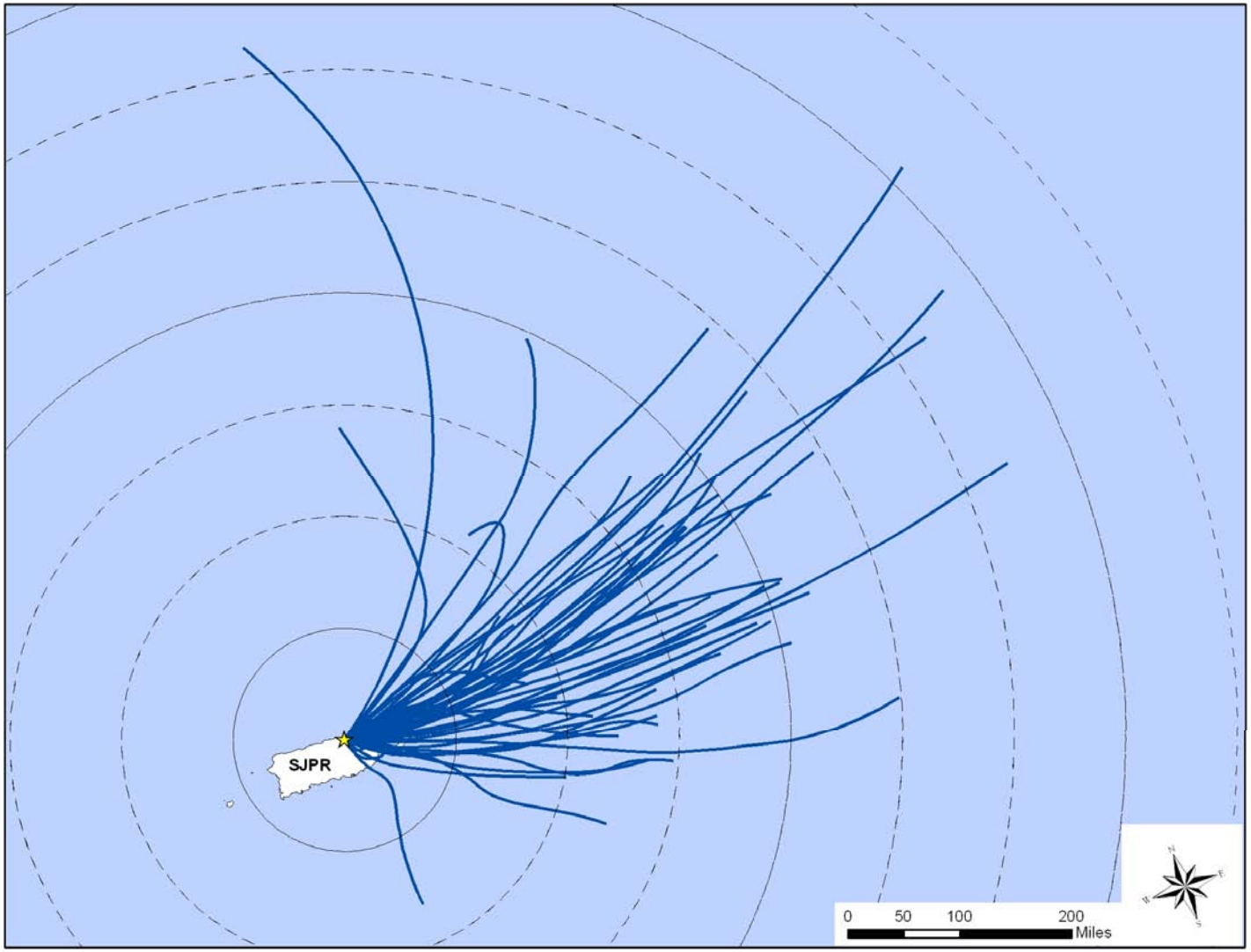


Figure 22-9. Wind Rose for BAPR Sampling Days

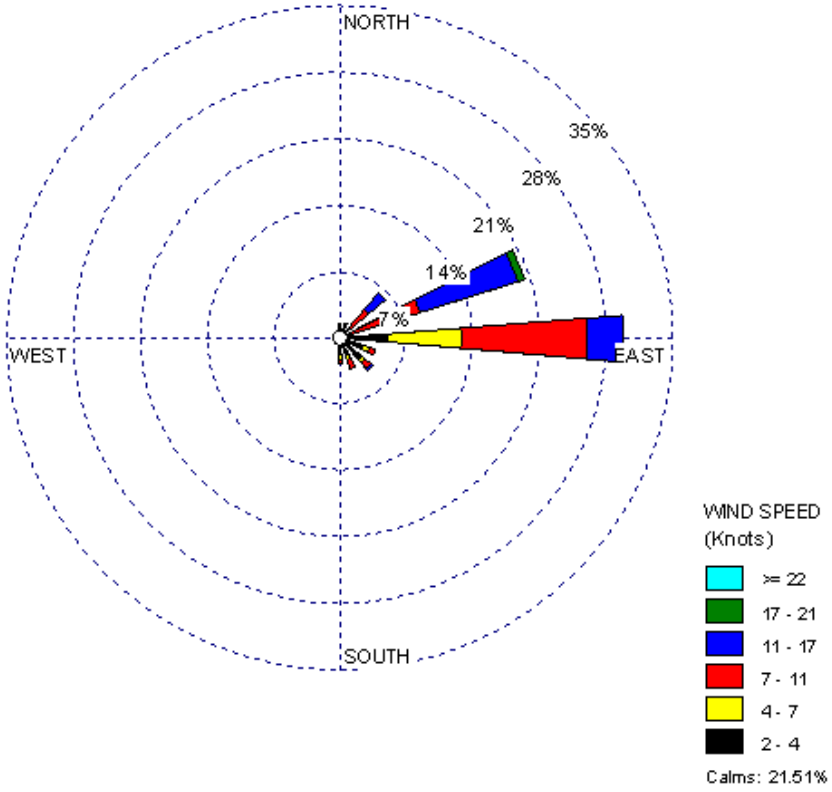
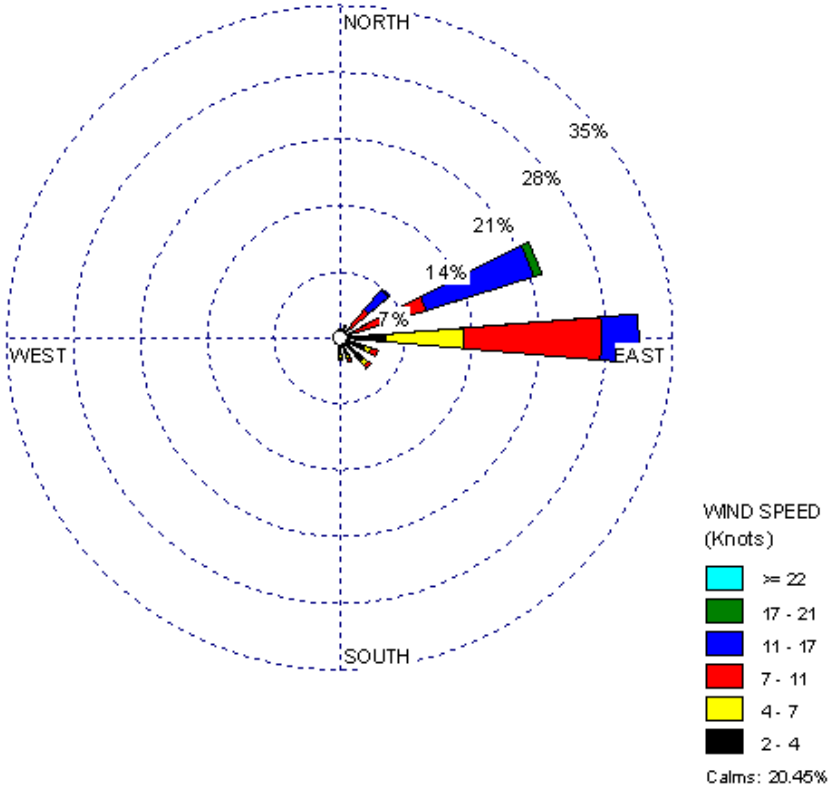


Figure 22-10. Wind Rose for SJPR Sampling Days



- Calm winds were observed for about 20 percent of the observations near each site, although wind speeds of 7 to 11 knots were recorded most frequently.

- Winds were stronger when originating out of the east-northeast.

22.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

22.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Bayamon and Barceloneta Municipios were obtained from the Air Monitoring Division of Puerto Rico's Air Quality Program and the U.S. Census Bureau, and are summarized in Table 22-6. Table 22-6 also includes a vehicle registration to county population ratio (vehicles per person). Finally, Table 22-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis. Ten mile population data was not available for the Puerto Rico sites.

Observations gleaned from Table 22-6 include:

- The BAPR monitoring site has a significantly lower county population than the SJPR site, as well as a lower county vehicle ownership.

- Compared to other UATMP sites, Barceloneta County has the second lowest county population and the lowest vehicle registration.

- Both sites have comparatively low registration-populations ratios.

- While the daily traffic flow near BAPR is significantly lower than at SJPR, these two sites experience the second and fifth lowest traffic volumes (respectively) compared to other UATMP locations.

22.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4.). Table 3-12 and Figure

Table 22-6. Motor Vehicle Information for the Puerto Rico Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
BAPR	23,028	13,912	0.60	NA	NA	10
SJPR	221,546	145,642	0.66	NA	NA	250

3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- The benzene-ethylbenzene and xylenes-ethylbenzene ratios for BAPR and SJPR closely resemble those of the roadside study.

- This indicates that mobile sources may contribute appreciably to concentrations measured at the Puerto Rico sites.

22.6 Trends Analysis

A trends analysis could not be performed for the Puerto Rico sites as they have not participated in the UATMP for three consecutive years.

22.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Puerto Rico sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 22-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 22-7. The NATA data are presented for the census tracts where the monitoring sites are located.

The census tract information for the Puerto Rico sites is as follows:

- The census tract for BAPR is 72017590300, which had a population of 6,625, which represents approximately 30 percent of the Barceloneta Municipio population in 2000.

- The census tract for SJPR is 72021030103, which had a population of 4,814, which represents approximately 2 percent of the Bayamon Municipio population in 2000.

The following observations can be made for BAPR from Table 22-7:

- Dichloromethane, toluene, and total xylenes had the highest annual averages by mass concentration for BAPR as well as the highest NATA-modeled concentrations.

Table 22-7. Chronic Risk Summary for the Monitoring Sites in Puerto Rico

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Barceloneta, Puerto Rico (BAPR) – Census Tract ID 72017590300								
Acetaldehyde	0.0000022	0.009	0.27	0.59	0.03	1.98 ± 0.28	4.35	0.22
Acrolein	NR	0.00002	0.13	NR	6.42	0.87 ± 0.44	NR	43.47
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.08 ± 0.02	5.43	0.04
Benzene	0.0000078	0.03	2.10	16.41	0.07	1.21 ± 0.27	9.43	0.04
1,3-Butadiene	0.00003	0.002	0.13	3.79	0.06	0.13 ± 0.03	4.01	0.07
Carbon Tetrachloride	0.000015	0.04	0.69	10.35	0.02	0.72 ± 0.06	10.84	0.02
Chloroform	NR	0.098	0.42	NR	<0.01	0.46 ± 0.41	NR	<0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.06	0.62	<0.01	1.05 ± 0.71	11.56	<0.01
Dichloromethane	0.00000047	1	151.06	71.00	0.15	10.05 ± 3.55	4.73	0.01
Ethyl Acrylate	0.000014	NR	<0.01	<0.01	NR	0.04 ± 0.03	0.50	NR
Formaldehyde	5.5E-09	0.0098	1.01	0.01	0.10	0.72 ± 0.06	<0.01	0.07
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.09 ± 0.02	1.90	<0.01
1,1,2,2-Tetrachloroethane	0.000058	NR	<0.01	<0.01	NR	0.05 ± 0.01	2.89	NR
Tetrachloroethylene	0.0000059	0.27	0.25	1.45	<0.01	0.09 ± 0.05	0.56	<0.01
Toluene	NR	0.4	14.72	NR	0.04	8.07 ± 6.32	NR	0.02
Trichloroethylene	0.000002	0.6	0.12	0.23	<0.01	0.07 ± 0.06	0.14	<0.01
Xylenes	NR	0.1	3.91	NR	0.04	4.68 ± 1.41	NR	0.05
San Juan, Puerto Rico (SJPR) – Census Tract ID 72021030103								
Acetaldehyde	0.0000022	0.009	0.22	0.49	0.02	2.60 ± 0.64	5.72	0.29
Acrolein	NR	0.00002	0.14	NR	7.15	1.09 ± 0.45	NR	54.66
Acrylonitrile	0.000068	0.002	<0.01	0.16	<0.01	0.08 ± 0.03	5.69	0.04
Benzene	0.0000078	0.03	2.19	17.06	0.07	1.87 ± 0.29	14.6	0.06
1,3-Butadiene	0.00003	0.002	0.08	2.44	0.04	0.21 ± 0.03	6.32	0.11
Carbon Tetrachloride	0.000015	0.04	0.70	10.48	0.02	0.74 ± 0.06	11.08	0.02
Chloromethylbenzene	0.000049	NR	<0.01	<0.01	NR	0.02 ± 0.01	0.82	NR
***p*-Dichlorobenzene**	0.000011	0.8	0.18	1.98	<0.01	1.76 ± 1.38	19.37	<0.01
1,2-Dichloroethane	0.000026	2.4	0.05	1.25	<0.01	0.03 ± <0.01	0.84	<0.01
Dichloromethane	0.00000047	1	1.48	0.69	<0.01	5.88 ± 7.49	2.76	0.01

Table 22-7. Chronic Risk Summary for the Monitoring Sites in Puerto Rico (Continued)

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Formaldehyde	5.5E-09	0.0098	0.83	<0.01	0.08	1.80 ± 0.13	0.01	0.18
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.08 ± 0.01	1.70	<0.01
Tetrachloroethylene	0.0000059	0.27	3.06	18.04	0.01	0.37 ± 0.22	2.21	<0.01
Xylenes	NR	0.1	4.20	NR	0.04	8.46 ± 2.16	NR	0.08

* **BOLD** indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

- The NATA-modeled dichloromethane concentration was an order of magnitude higher than the annual average.

- *p*-Dichlorobenzene, carbon tetrachloride, and benzene had the three highest cancer risks based on annual averages, while dichloromethane, benzene, and carbon tetrachloride had the three highest cancer risks based on NATA.

- The NATA-based and annual average-based cancer risks for some pollutants, such as carbon tetrachloride, were very similar, while others were very different, such as dichloromethane.

- The dichloromethane NATA cancer risk was the second highest cancer risk for a pollutant of interest for any UATMP site (behind only arsenic for ININ).

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1, according to both the 2006 annual average and the 1999 NATA, although the annual average-based noncancer risk was much higher.

- All other noncancer HQs were less than 0.25.

The following observations can be made for SJPR from Table 22-7:

- Xylenes, dichloromethane, and acetaldehyde had the highest annual averages by mass concentration for SJPR, while xylenes, tetrachloroethylene, and benzene had the highest NATA-modeled concentrations.

- *p*-Dichlorobenzene, benzene, and carbon tetrachloride had the three highest cancer risks based on annual averages, while tetrachloroethylene, benzene, and carbon tetrachloride had the three highest cancer risks based on NATA.

- The NATA-based and annual average-based cancer risks for some pollutants, such as carbon tetrachloride, were very similar, while others were very different, such as acrylonitrile.

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1, according to both the 2006 annual average and the 1999 NATA, although the annual average-based noncancer risk was much higher.

- SJPR had one of the highest acrolein annual averaged-based noncancer risk among UATMP sites, behind only two sites in Oklahoma.

- All other noncancer HQs, both NATA-modeled and annual average-based, were less than 0.30.

22.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 22-8 and 22-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 22-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 22-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 22-8:

- Dichloromethane was the highest emitted pollutant with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the fifth highest cancer risk based on the 2006 annual average for BAPR. The emissions, toxicity-weighted emissions, and cancer risk for this pollutant for SJPR were lower.

- Benzene was the highest emitted pollutant with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the second highest cancer risk based on the 2006 annual average for SJPR.

- *p*-Dichlorobenzene had the highest cancer risk based on the 2006 annual average for both BAPR and SJPR, yet this pollutant was neither one of the highest emitted nor one of the most toxic based on the 2002 NEI emission inventory.

The following observations can be made from Table 22-9:

- Dichloromethane was the highest emitted pollutant with a noncancer risk factor, had the seventh highest noncancer toxicity-weighted emissions, and had the tenth highest noncancer risk based on the 2006 annual average for BAPR.

- Acrolein had the highest noncancer toxicity-weighted emissions in Barceloneta County and had the highest noncancer risks based on the 2006 annual average for BAPR. The same was true for Bayamon County and SJPR.

Table 22-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Puerto Rico

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Barceloneta, Puerto Rico (BAPR) – Barceloneta Municipio					
Dichloromethane	346.71	Dichloromethane	1.63E-04	*p*-Dichlorobenzene	11.56
Benzene	12.11	Hexavalent Chromium	1.15E-04	Carbon Tetrachloride	10.84
Formaldehyde	4.02	Benzene	9.44E-05	Benzene	9.43
Tetrachloroethylene	1.87	Arsenic	4.15E-05	Acrylonitrile	5.43
Acetaldehyde	1.69	1,3-Butadiene	4.03E-05	Dichloromethane	4.73
1,3-Butadiene	1.34	Tetrachloroethylene	1.10E-05	Acetaldehyde	4.35
Naphthalene	0.14	Naphthalene	4.62E-06	1,3-Butadiene	4.01
Polycyclic Organic Matter as 15-PAH	0.04	Acetaldehyde	3.72E-06	1,1,2,2-Tetrachloroethane	2.89
Ethylene Oxide	0.03	Polycyclic Organic Matter as 7-PAH	2.82E-06	Hexachloro-1,3-butadiene	1.90
Hexavalent Chromium	0.03	Ethylene Oxide	2.75E-06	Tetrachloroethylene	0.56
San Juan, Puerto Rico (SJPR) – Bayamon Municipio					
Benzene	179.30	Benzene	1.40E-03	*p*-Dichlorobenzene	19.37
Formaldehyde	56.89	Hexavalent Chromium	1.05E-03	Benzene	14.60
Acetaldehyde	22.64	1,3-Butadiene	5.84E-04	Carbon Tetrachloride	11.08
Tetrachloroethylene	22.10	Arsenic	3.33E-04	1,3-Butadiene	6.32
1,3-Butadiene	19.48	Tetrachloroethylene	1.30E-04	Acetaldehyde	5.72
Dichloromethane	16.99	Naphthalene	9.43E-05	Acrylonitrile	5.69
Naphthalene	2.77	Acetaldehyde	4.98E-05	Dichloromethane	2.76
Polycyclic Organic Matter as 15-PAH	0.55	Polycyclic Organic Matter as 7-PAH	3.69E-05	Tetrachloroethylene	2.21
Chromium III	0.30	Polycyclic Organic Matter as 15-PAH	3.02E-05	Hexachloro-1,3-butadiene	1.70
Hexavalent Chromium	0.30	Ethylene Oxide	2.42E-05	1,2-Dichloroethane	0.84

Table 22-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Puerto Rico

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Barceloneta, Puerto Rico (BAPR) – Barceloneta Municipio					
Dichloromethane	346.71	Acrolein	9,987.03	Acrolein	43.47
Toluene	41.31	Chlorine	2,150.02	Acetaldehyde	0.22
Xylenes	34.62	1,3-Butadiene	672.05	Formaldehyde	0.07
Acetonitrile	29.95	Acetonitrile	499.09	1,3-Butadiene	0.07
Methanol	12.29	Formaldehyde	410.06	Xylenes	0.05
Benzene	12.11	Benzene	403.60	Benzene	0.04
Ethylbenzene	8.39	Dichloromethane	346.71	Acrylonitrile	0.04
Hexane	6.96	Xylenes	346.23	Toluene	0.02
Formaldehyde	4.02	Arsenic	321.32	Carbon Tetrachloride	0.02
Hydrochloric Acid	2.01	Acetaldehyde	187.85	Dichloromethane	0.01
San Juan, Puerto Rico (SJPR) – Bayamon Municipio					
Toluene	545.64	Acrolein	142,465.88	Acrolein	54.66
Xylenes	428.41	1,3-Butadiene	9,740.29	Acetaldehyde	0.29
Benzene	179.30	Benzene	5,976.57	Formaldehyde	0.18
Hexane	132.60	Formaldehyde	5,805.58	1,3-Butadiene	0.11
Ethylbenzene	105.81	Xylenes	4,284.09	Xylenes	0.08
Formaldehyde	56.89	Arsenic	2,582.58	Benzene	0.06
Methyl *Tert*-Butyl Ether	30.38	Acetaldehyde	2,516.00	Acrylonitrile	0.04
Acetaldehyde	22.64	Toluene	1,364.11	Carbon Tetrachloride	0.02
Tetrachloroethylene	22.10	Nickel	1,050.58	Dichloromethane	0.01
1,3-Butadiene	19.48	Naphthalene	924.56	*p*-Dichlorobenzene	<0.01

- While *p*-dichlorobenzene had the highest annual average-based cancer risk for both sites, the noncancer risk attributable to *p*-dichlorobenzene was very low.

Puerto Rico Pollutant Summary

- *The pollutants of interest common to each Puerto Rico site were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, p-dichlorobenzene, formaldehyde, and xylenes.*

- *Dichloromethane had the highest daily average for BAPR, while total xylenes had highest average for SJPR.*

- *Acrolein exceeded the short-term risk factors at both Puerto Rico sites.*

23.0 Site in Rhode Island

This section presents meteorological, concentration, and spatial trends for the UATMP site in Rhode Island (PRRI). This site is located in the Providence MSA. Figure 23-1 is a topographical map showing the monitoring site in its urban location. Figure 23-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. PRRI is surrounded by a very large number of industrial sources. A majority of the sources are involved in fuel combustion and surface coating processes.

Providence is a coastal city on the Narragansett Bay, which opens to the Rhode Island Sound and the Atlantic Ocean. Its proximity to the Sound and the Atlantic temper cold air outbreaks and breezes off the ocean moderate summertime heat. On average, southerly and southwesterly winds in the summer become northwesterly in the winter. Weather is fairly variable in the region as frequent storm systems affect New England (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the PRRI monitoring site is at Theodore F. Green State Airport (WBAN 14739).

Table 23-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 23-1 is the 95 percent confidence interval for each parameter. As shown in Table 23-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

23.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Rhode Island monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 23-1. Providence, Rhode Island (PRRI) Monitoring Site

Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 23-2. Facilities Located Within 10 Miles of PRRI

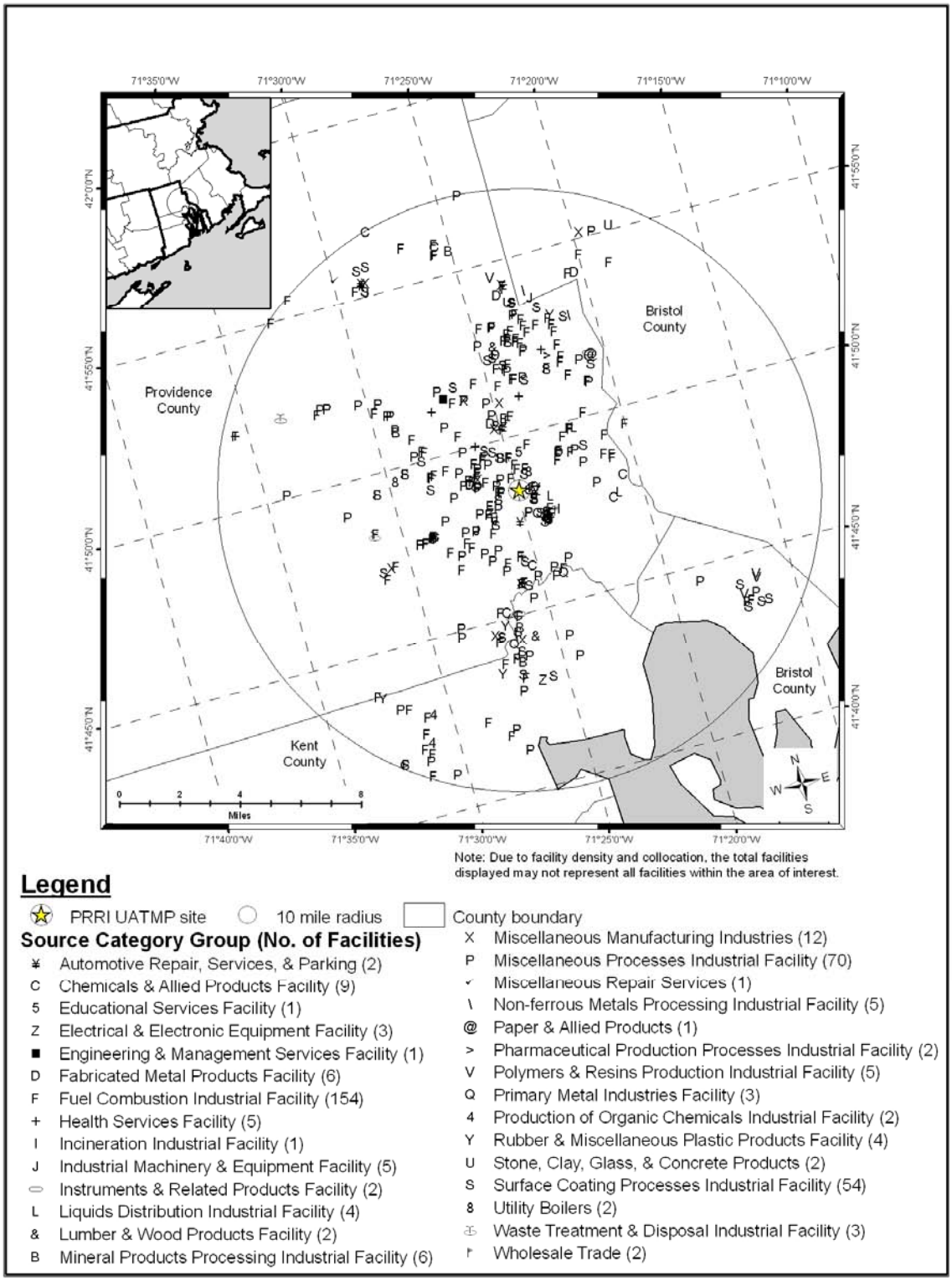


Table 23-1. Average Meteorological Conditions near the Monitoring Site in Rhode Island

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Speed Wind (kt)
PRRI	14765	All 2006	61.68 ± 1.64	53.56 ± 1.57	41.63 ± 1.85	48.11 ± 1.52	66.93 ± 1.56	1015.09 ± 0.78	7.74 ± 0.30
		Sampling Day	61.59 ± 3.92	53.82 ± 3.76	42.42 ± 4.39	48.52 ± 3.63	68.05 ± 3.64	1015.63 ± 1.86	7.13 ± 0.62

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. The PRRI site sampled for hexavalent chromium only. Table 23-2 presents risk screening results at PRRI.

The following observations are shown in Table 23-2:

- A total of three measured concentrations failed screens.
- Six percent of the 50 measured detections failed screens.

Table 23-2. Comparison of Measured Concentrations and EPA Screening Values for the Rhode Island Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Providence, Rhode Island – PRRI					
Hexavalent Chromium	3	50	6.00	100.00	100.00

23.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than

February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 23-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for PRRI are shown in Table 23-3:

- The daily average concentration for hexavalent chromium for PRRI was 0.032 ± 0.008 ng/m^3.

- The highest seasonal average of hexavalent chromium was calculated for summer (0.038 ± 0.022 ng/m^3), while the lowest seasonal average was calculated for winter (0.018 ± 0.009 ng/m^3). However, these differences were not statistically significant, as indicated by the confidence intervals.

23.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for PRRI was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. No hexavalent chromium seasonal average exceeded the intermediate risk value. Acute risk could not be assessed because hexavalent chromium has no acute risk factors.

23.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

23.4.1 Pearson Correlation Analysis

Table 23-4 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the PRRI monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.) All the correlations

Table 23-3. Daily and Seasonal Averages for the Pollutants of Interest for the Rhode Island Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Providence, Rhode Island – PRRI												
Hexavalent Chromium	50	61	0.032	0.008	0.018	0.009	0.033	0.011	0.038	0.022	0.022	0.012

Table 23-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Rhode Island Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Providence, Rhode Island – PRRI								
Hexavalent Chromium	50	0.11	0.12	0.18	0.16	0.19	0.05	-0.05

between hexavalent chromium and the meteorological parameters were weak, indicating that meteorology has little influence on concentrations of hexavalent chromium.

23.4.2 Composite Back Trajectory Analysis

Figure 23-3 is a composite back trajectory map for the PRRI monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 23-3 represents 100 miles.

The following observations can be made from Figure 23-3:

- Back trajectories originated from a variety of directions at PRRI.
- The 24-hour airshed domain was large at PRRI, with trajectories originating as far away as northern Quebec, Canada (~ 700 miles).
- The majority of the trajectories originated within 500 miles of the site.

23.4.3 Wind Rose Analysis

Hourly wind data from the Theodore F. Green State Airport near the PRRI monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 23-4 is the wind rose for the PRRI monitoring site on days that sampling occurred.

Observations from Figure 23-4 for PRRI include:

- Hourly winds were predominantly out of the west (11 percent of observations), south (11 percent), and west-northwest (9 percent) on sampling days.
- Wind speeds most frequently ranged from 7 to 11 knots on days samples were collected.
- Calm winds (<2 knots) were recorded for 10 percent of the observations.

Figure 23-3. Composite Back Trajectory Map for PRRI

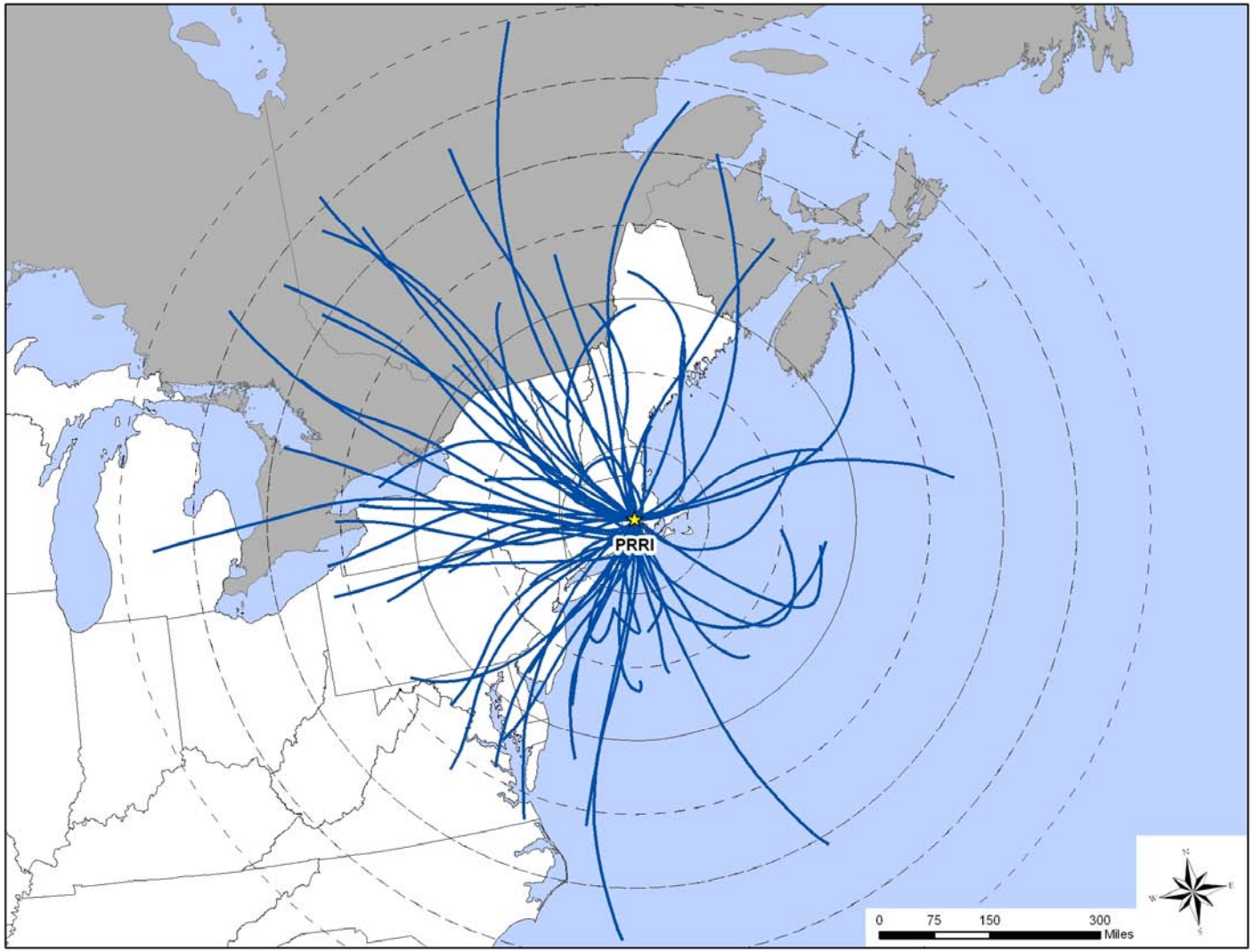
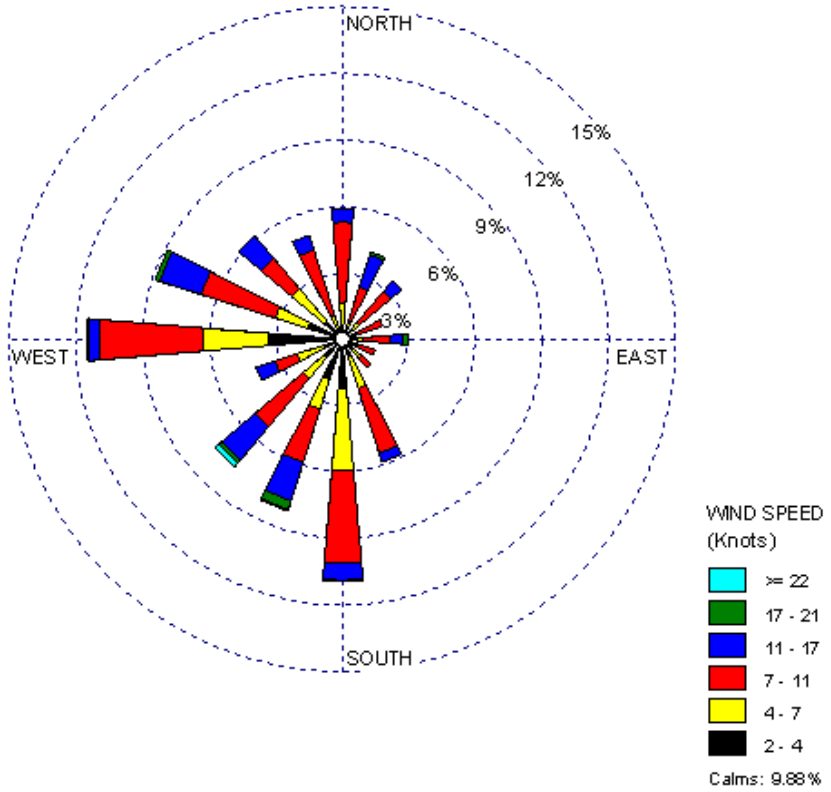


Figure 23-4. Wind Rose for PRRI Sampling Days



23.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze VOCs at this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

23.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population were obtained from Rhode Island Data Control and the U.S. Census Bureau, and is summarized in Table 23-5. Table 23-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 23-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 23-5 include:

- Compared to other UATMP sites, PRRI's county population is in the middle of the range, while its 10-mile population is in the highest third.
- Due to the low number of registered vehicles, the vehicle per person ratio is very low. Consequently, the number of estimated vehicles within 10 miles is in the lower third among UATMP sites.
- Daily traffic volume is also in the lower third of UATMP sites.

23.6 Trends Analysis

A trends analysis could not be performed for PRRI as this site has not participated in the UATMP for three consecutive years.

23.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at PRRI and where the *annual average* concentrations could be calculated (refer to Section 3.3.5

Table 23-5. Motor Vehicle Information for the Rhode Island Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
PRRI	635,596	142,334	0.22	685,230	153,449	5,500

regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 23-6. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA for the pollutants that failed at least one screen at PRRI were retrieved and are presented in Table 23-6. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the Rhode Island monitoring site is as follows:

- PRRI is located in census tract 44007000400.
- The population for the census tract where the PRRI monitoring site is located was 3,660, which represents about 0.5 percent of Providence County's population in 2000.

The following observations can be made from Table 23-6:

- Both the NATA-modeled and annual average concentration for hexavalent chromium was less than 0.01 $\mu g/m^3$.
- The NATA-modeled cancer risk (1.41 in-a-million) was greater than the annual average-based cancer risk (0.33 in-a-million, respectively).
- Both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

23.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 23-7 and 23-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 23-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the hexavalent chromium cancer risk (in-a-million) as calculated from the annual average. Table 23-8 identifies the 10 pollutants with the highest emissions, noncancer toxicity-weighted emissions, and the hexavalent chromium noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for

Table 23-6. Chronic Risk Summary for the Monitoring Site in Rhode Island

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Providence, Rhode Island (PRRI) – Census Tract ID 44007000400								
Hexavalent Chromium	0.012	0.0001	<0.01	1.41	<0.01	<0.01 ± <0.01	0.33	<0.01

Table 23-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for PRRI

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Providence County)		Top 10 Cancer Toxicity-Weighted Emissions (for Providence County)		Top 10 Cancer Risks Based on Annual Average Concentration (for PRRI)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Providence, Rhode Island – PRRI					
Benzene	310.24	Benzene	2.42E-03	Hexavalent Chromium	0.33
Formaldehyde	178.17	1,3-Butadiene	1.27E-03		
Tetrachloroethylene	93.14	Nickel	7.33E-04		
Acetaldehyde	52.50	Hexavalent Chromium	5.86E-04		
1,3-Butadiene	42.18	Tetrachloroethylene	5.50E-04		
Trichloroethylene	41.73	Lead	4.03E-04		
Dichloromethane	30.23	Cadmium	2.98E-04		
p-Dichlorobenzene	13.64	Naphthalene	2.93E-04		
Naphthalene	8.60	Arsenic	1.81E-04		
Nickel	4.58	*p*-Dichlorobenzene	1.50E-04		

Table 23-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for PRRI

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Providence County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Providence County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for PRRI)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Providence, Rhode Island - PRRI					
Toluene	815.33	Acrolein	427,471.34	Hexavalent Chromium	<0.01
Methyl *Tert*-Butyl Ether	600.89	Nickel	70,466.67		
Xylenes	551.52	1,3-Butadiene	21,091.64		
Methanol	328.64	Formaldehyde	18,180.44		
Benzene	310.24	Benzene	10,341.31		
Formaldehyde	178.17	Cadmium	8,282.30		
Ethylbenzene	130.72	Cyanide	7,872.55		
Hexane	110.63	Acetaldehyde	5,833.75		
Tetrachloroethylene	93.14	Xylenes	5,515.18		
Methyl Ethyl Ketone	76.85	Chlorine	4,567.50	.	

specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 23-7:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and also had the highest cancer toxicity-weighted emissions for Providence County, Rhode Island.

- Six of the top 10 pollutants (benzene, tetrachloroethylene, 1,3-butadiene, *p*-dichlorobenzene, naphthalene, and nickel) appeared on both the highest emitted list and the highest toxicity-weighted emissions list, indicating that most of the highest emitted pollutants were also the most toxic.

- Hexavalent chromium, the only pollutant sampled at PRRI, had a low cancer risk based on its annual average (0.33 in-a- million), but was identified as having the fourth highest toxicity-weighted emissions in Providence County.

The following observations can be made from Table 23-8:

- Although toluene and methyl *tert*-butyl ether were the highest emitted pollutants with noncancer risk factors, neither pollutant ranked in the top 10 based on toxicity-weighted emissions.

- Instead, acrolein had the highest noncancer toxicity-weighted emissions; this pollutant did not appear in the list of highest emitted pollutants.

- Hexavalent chromium did not rank among the top 10 highest emitted pollutants with noncancer risk factors or the 10 highest noncancer toxicity-weighted emissions in Providence County, and had a very low noncancer risk, based on the annual average for PRRI.

Rhode Island Pollutant Summary

- *Hexavalent chromium was the only pollutant sampled for at PRRI. The pollutant failed six percent of screens.*

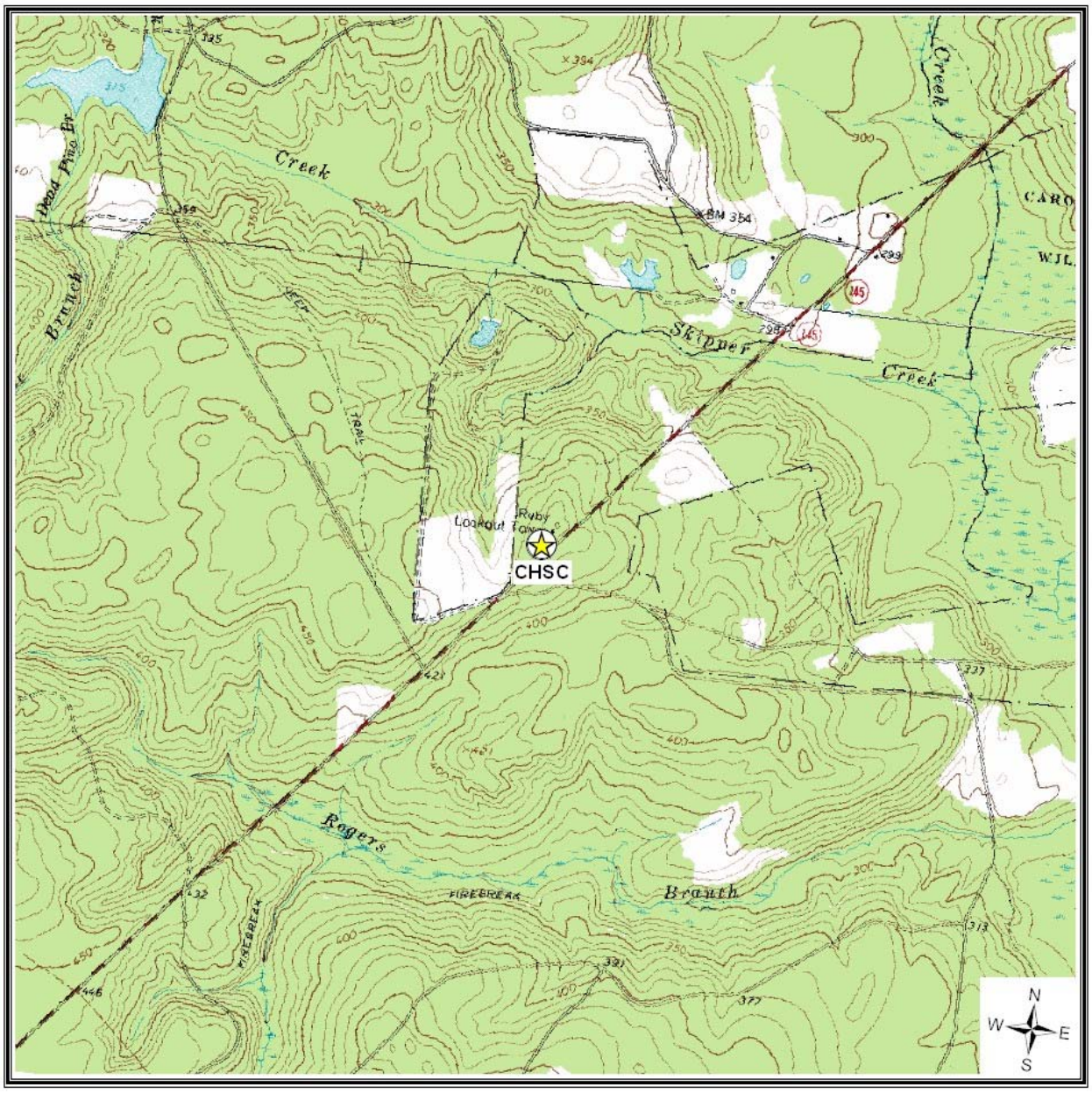
24.0 Site in South Carolina

This section presents meteorological, concentration, and spatial trends for the UATMP site in South Carolina (CHSC). This site is located in the Chesterfield area. Figure 24-1 is a topographical map showing the monitoring site in its rural location. Figure 24-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. CHSC is located near only two sources, located to the northeast and east of the site. One of the facilities is involved in fuel combustion processes and the other is involved in surface coating processes.

The town of Chesterfield is located in the NC/SC border, north of Florence. The area boasts a temperate climate, typical of its southeast location. Winters tend to be mild and snowfall is rare, while summers can be hot and humid, due in part to its proximity to the Atlantic (http://wkbwradio.com/site/localitems.htm).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the CHSC monitoring site is at Monroe Airport, Monroe, North Carolina (WBAN 53872). Table 24-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 24-1 is the 95 percent confidence interval for each parameter. As shown in Table 24-1, average meteorological conditions on sampling days were representative of the average weather conditions throughout the year.

Figure 24-1. Chesterfield, South Carolina (CHSC) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 24-2. Facilities Located Within 10 Miles of CHSC

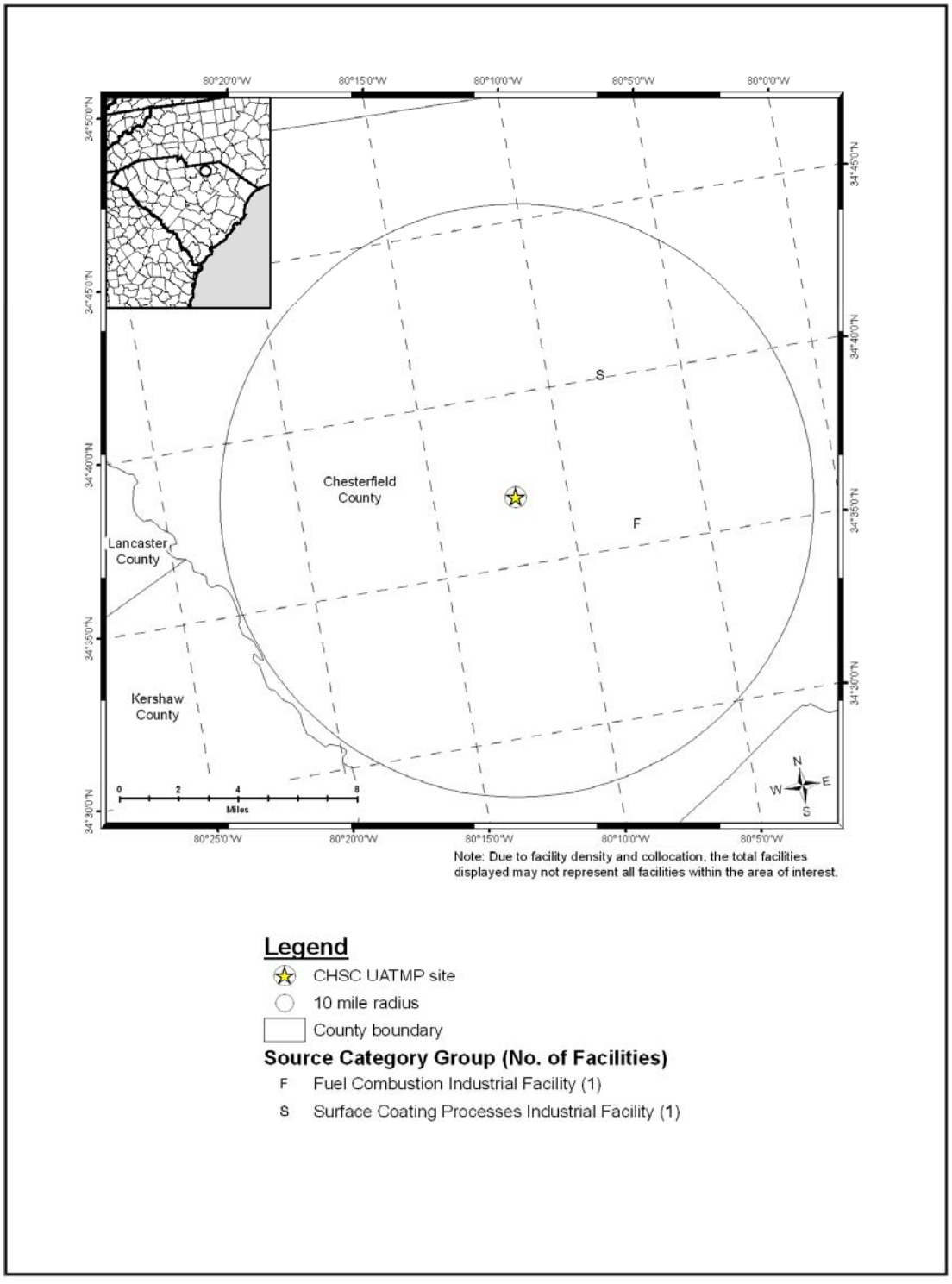


Table 24-1. Average Meteorological Conditions near the Monitoring Site in South Carolina

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CHSC	53872	All 2006	72.02 ± 1.44	61.32 ± 1.39	47.72 ± 1.66	54.31 ± 1.32	64.76 ± 1.36	1018.05 ± 0.64	4.58 ± 0.29
		Sampling Day	73.90 ± 3.27	63.12 ± 3.01	49.69 ± 3.40	55.91 ± 2.80	65.59 ± 3.33	1017.26 ± 1.48	4.68 ± 0.70

24.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the South Carolina monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Hexavalent chromium was the only pollutant sampled for at CHSC.

The following observations are shown in Table 24-2

- None of the hexavalent chromium measured detections failed the screen.
- Hexavalent chromium will be considered a pollutant of interest for CHSC in order to facilitate analysis.

Table 24-2. Comparison of Measured Concentrations and EPA Screening Values for the South Carolina Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Chesterfield, South Carolina – CHSC					
Hexavalent Chromium	0	27	0.00	0.00	0.00

24.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual

average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 24-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 24-3:

- The daily average for CHSC for hexavalent chromium was 0.024 ± 0.006 ng/m^3.
- Only spring and summer averages could be calculated due to the low number of measured detections in winter and autumn. The spring and summer averages were similar.

24.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for CHSC was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. None of the seasonal hexavalent chromium averages exceeded intermediate risk value. Acute risk could not be assessed because hexavalent chromium has no acute risk factors.

24.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

24.4.1 Pearson Correlation Analysis

Table 24-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters for the CHSC monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.) All of the correlations between

Table 24-3. Daily and Seasonal Averages for the Pollutants of Interest for the South Carolina Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Chesterfield, South Carolina – CHSC												
Hexavalent Chromium	27	59	0.024	0.006	NR	NR	0.018	0.006	0.021	0.011	NR	NR

NR = Not reportable due to low number of measured detections.

Table 24-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the South Carolina Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Chesterfield, South Carolina – CHSC								
Hexavalent Chromium	27	0.15	0.16	0.10	0.15	-0.08	0.15	-0.20

hexavalent chromium and the pollutants of interest for CHSC were weak, indicating that meteorology has little influence on concentrations of hexavalent chromium.

24.4.2 Composite Back Trajectory Analysis

Figure 24-3 is a composite back trajectory map for the CHSC monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 24-3 represents 100 miles.

The following observations can be made from Figure 24-3:

- Back trajectories originated from a variety of directions at CHSC.
- The 24-hour airshed domain was somewhat large at CHSC, with trajectories originating as far away as central Illinois (> 600 miles).
- Nearly 70 percent of the trajectories originated within 300 miles of the site; and 85 percent within 400 miles from the CHSC monitoring site.

24.4.3 Wind Rose Analysis

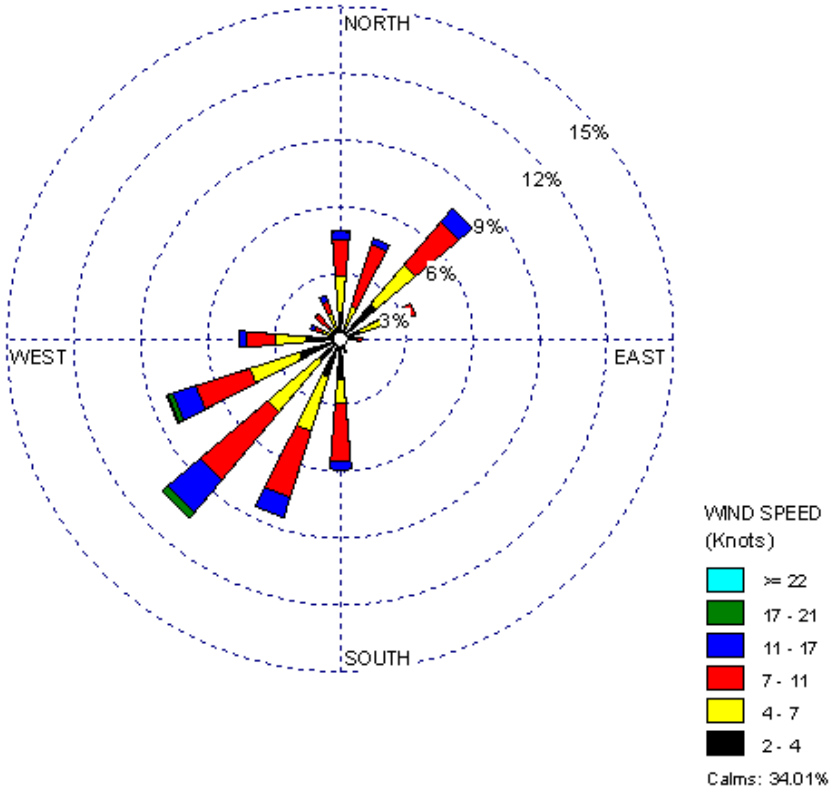
Hourly wind data from the Monroe Airport near the CHSC monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 24-4 is the wind rose for the CHSC monitoring site on days that sampling occurred.

Observations from Figure 24-4 include:

- South-southwesterly to west-southwesterly winds account for over 27 percent of the hourly wind observations near CHSC.
- Calm winds (<2 knots) were recorded for 34 percent of the observations. For wind speeds greater than 2 knots, wind speeds in the 7 to 11 knot range were most prevalent on sampling days.

Figure 24-3. Composite Back Trajectory Map for CHSC

Figure 24-4. Wind Rose for CHSC Sampling Days



24.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze for VOCs at this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

24.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level population and vehicle registration information were obtained from the South Carolina Department of Motor Vehicles and the U.S. Census Bureau, and is summarized in Table 24-5. Table 24-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 24-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 24-5 include:

- Compared to other UATMP sites, CHSC's county population, vehicle registration, 10-mile population, 10-mile ownership, and traffic count are in the bottom third of the statistics.
- CHSC's person to vehicle ratio is in the top third.
- CHSC is located in a rural forested area.

24.6 Trends Analysis

A trends analysis could not be performed for CHSC as this site has not participated in the UATMP for three consecutive years.

24.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at CHSC and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer

Table 24-5. Motor Vehicle Information for the South Carolina Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
CHSC	43,191	42,726	0.99	37,525	37,121	550

risk, cancer UREs and/or noncancer RfCs are presented in Table 24-6. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA for the pollutants that failed at least one screen at CHSC were retrieved and are presented in Table 24-6. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for CHSC is as follows:

- The CHSC monitoring site is located in census tract 45025950800.
- The population for the census tract where the CHSC monitoring site is located was 2,492, which represents about 5 percent of Chesterfield County's population in 2000.

The following observations can be made from Table 24-6:

- Both the NATA-modeled and annual average concentration for hexavalent chromium were less than 0.01 $\mu g/m^3$.
- The NATA-modeled cancer risk (0.23 in-a-million) and the annual average-based cancer risk (0.17 in-a-million) were very low. Additionally, both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

24.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 23-7 and 23-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 23-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the hexavalent chromium cancer risk (in-a-million) as calculated from the annual average. Table 23-8 identifies the 10 pollutants with the highest emissions, noncancer toxicity-weighted emissions, and the hexavalent chromium noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

Table 24-6. Chronic Risk Summary for the Monitoring Site in South Carolina

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Chesterfield, South Carolina (CHSC) – Census Tract ID 45025950800								
Hexavalent Chromium	0.012	0.0001	<0.01	0.23	<0.01	<0.01 ± <0.01	0.17	<0.01

Table 24-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for CHSC

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Chesterfield County)		Top 10 Cancer Toxicity-Weighted Emissions (for Chesterfield County)		Top 10 Cancer Risks Based on Annual Average Concentration (for CHSC)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Chesterfield, South Carolina – CHSC					
Benzene	50.95	Benzene	3.97E-04	Hexavalent Chromium	0.23
Formaldehyde	13.67	Lead	1.52E-04		
Dichloromethane	7.24	1,3-Butadiene	1.21E-04		
Acetaldehyde	4.99	Naphthalene	6.66E-05		
1,3-Butadiene	4.02	Polycyclic Organic Matter as 15-PAH	5.76E-05		
Trichloroethylene	2.90	Polycyclic Organic Matter as 7-PAH	4.01E-05		
Naphthalene	1.96	Polycyclic Organic Matter as non-15 PAH	3.04E-05		
Tetrachloroethylene	1.68	Arsenic	1.61E-05		
Polycyclic Organic Matter as 15-PAH	1.05	Nickel	1.31E-05		
p-Dichlorobenzene	0.93	Acetaldehyde	1.10E-05		

Table 24-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for CHSC

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Chesterfield County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Chesterfield County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for CHSC)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Chesterfield, South Carolina – CHSC					
Toluene	133.62	Acrolein	41,997.99	Hexavalent Chromium	<0.01
Methyl Ethyl Ketone	130.71	Glycol Ethers	4,043.10		
Xylenes	114.21	1,3-Butadiene	2,010.56		
Glycol Ethers	80.86	Benzene	1,698.30		
Benzene	50.95	Formaldehyde	1,395.09		
Methanol	33.95	Cyanide	1,390.34		
Ethylene Glycol	32.03	Nickel	1,255.70		
Ethylbenzene	23.74	Xylenes	1,142.14		
Methyl Isobutyl Ketone	20.05	Naphthalene	653.02		
Hexane	18.85	Acetaldehyde	554.60		

The following observations can be made from Table 24-7:

- Benzene was the highest emitted pollutant with a cancer risk factor and had the highest cancer toxicity-weighted emissions for Chesterfield County, South Carolina.

- Five of the top 10 pollutants (benzene, acetaldehyde, 1,3-butadiene, naphthalene, and POM as 15-PAH) appeared on both the highest emitted list and the highest toxicity-weighted emissions list, indicating that most of the highest emitted pollutants also tend to be the most toxic.

- Hexavalent chromium, the only pollutant sampled for at CHSC, had a low cancer risk based its annual average (0.23 in-a-million). This pollutant did not appear on either highest emitted pollutant list or the highest toxicity-weighted emissions list.

The following observations can be made from Table 24-7:

- Toluene and methyl ethyl ketone were the highest emitted pollutants with noncancer risk factors; however, neither pollutant ranked in the top 10 based on toxicity-weighted emissions.

- Acrolein had the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants.

- Hexavalent chromium did not rank in the top 10 highest emitted pollutants with noncancer risk factors or the 10 highest noncancer toxicity-weighted emissions in Chesterfield County, and had a very low noncancer risk, based on the annual average for CHSC.

South Carolina Pollutant Summary

- *South Carolina sampled for hexavalent chromium only and no hexavalent chromium measured detections failed screens.*

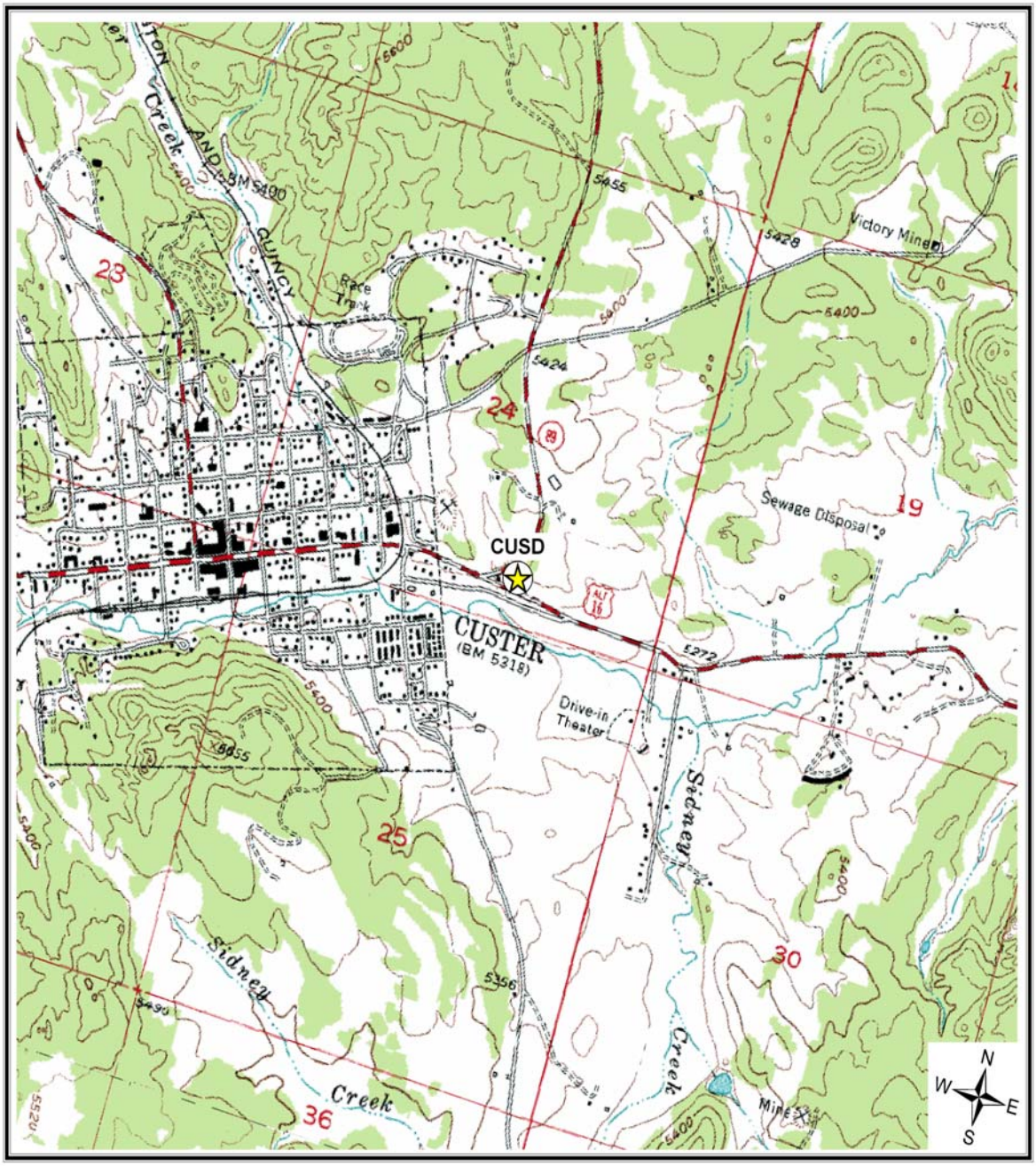
25.0 Sites in South Dakota

This section presents meteorological, concentration, and spatial trends for the UATMP sites in South Dakota (CUSD and SFSD). One site is located in Custer, in western South Dakota, south of Rapid City, and the other is located in Sioux Falls, in southeastern South Dakota, respectively. Figures 25-1 and 25-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 25-3 and 25-4 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. Figure 25-3 shows no point source emission sources located within 10 miles of the CUSD monitoring site. Figure 25-4 shows that there are a few point sources located to the northwest of SFSD.

The Sioux Falls area has a continental climate, with cold winters, warm summers, and often drastic day to day variations. Precipitation varies throughout the year, but is typically sufficient for the springtime growing season. On average, a south wind blows in the summer and a northwesterly wind blows in the winter. The weather in Custer is considered semi-arid continental; annual precipitation is light. Warm summers and relatively mild winters are characteristic of this area, thanks to the Black Hills to the west, allowing winters to be milder in comparison to the rest of the state (Ruffner and Bair, 1987).

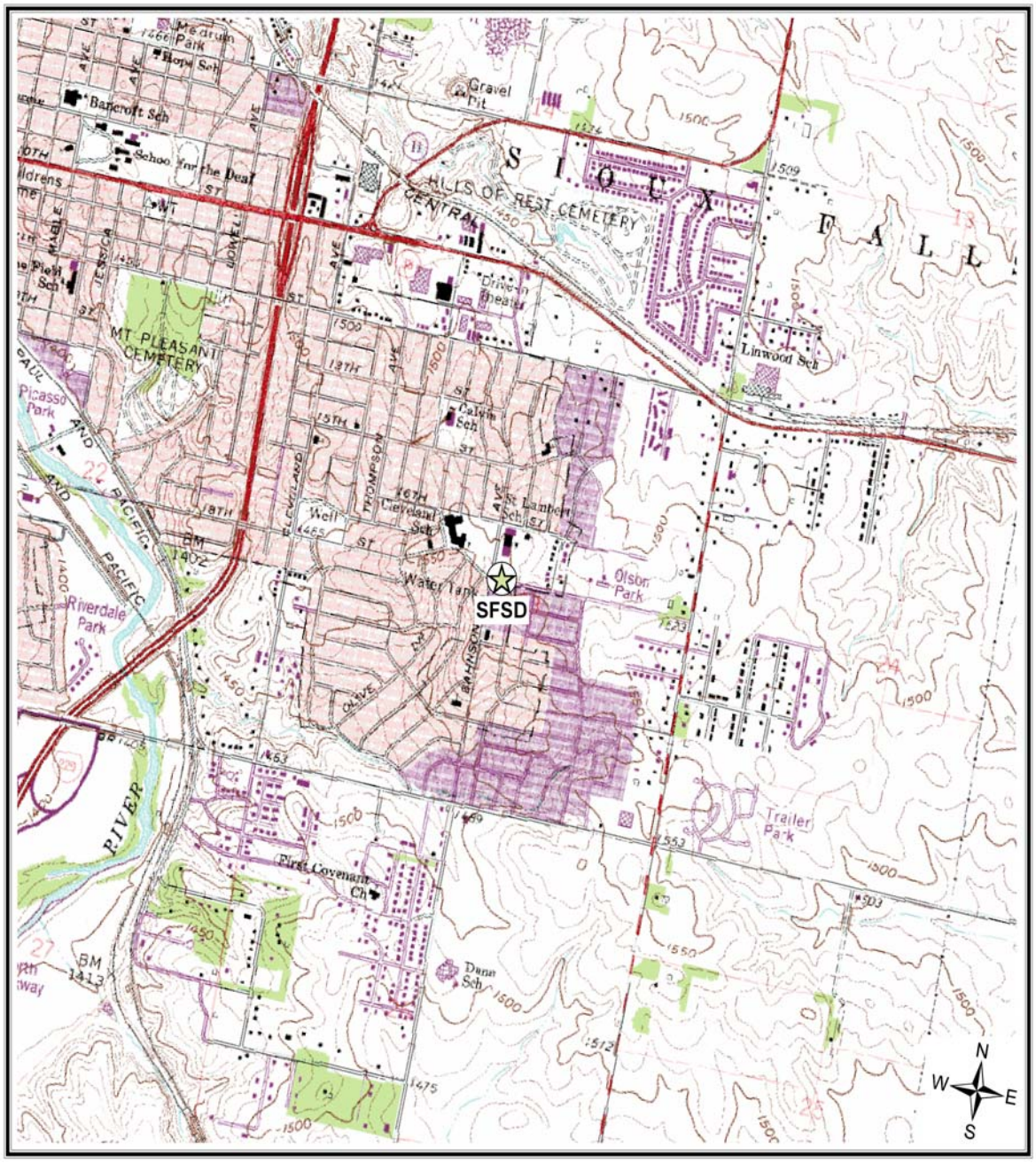
Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the CUSD monitoring site is Custer County Airport (WBAN 94032); the closest weather station to SFSD is Sioux Falls Joe Foss Field Airport (WBAN 14944). Table 25-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 25-1 is the 95 percent confidence interval for each parameter. As shown in Table 25-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

Figure 25-1. Custer, South Dakota (CUSD) Monitoring Site



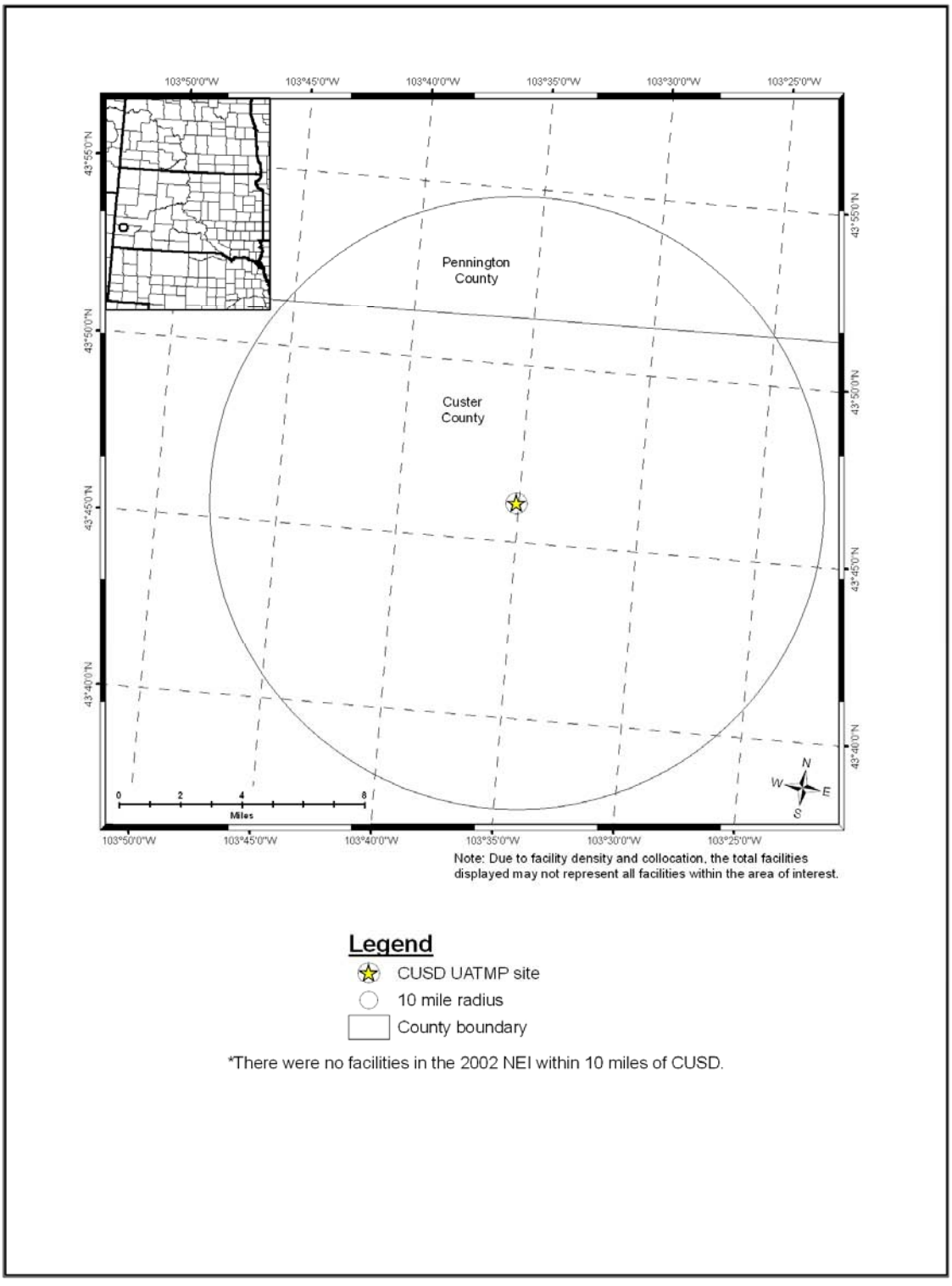
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 25-2. Sioux Falls, South Dakota (SFSD) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 25-3. Facilities Located Within 10 Miles of CUSD



*There were no facilities in the 2002 NEI within 10 miles of CUSD.

Figure 25-4. Facilities Located Within 10 Miles of SFSD

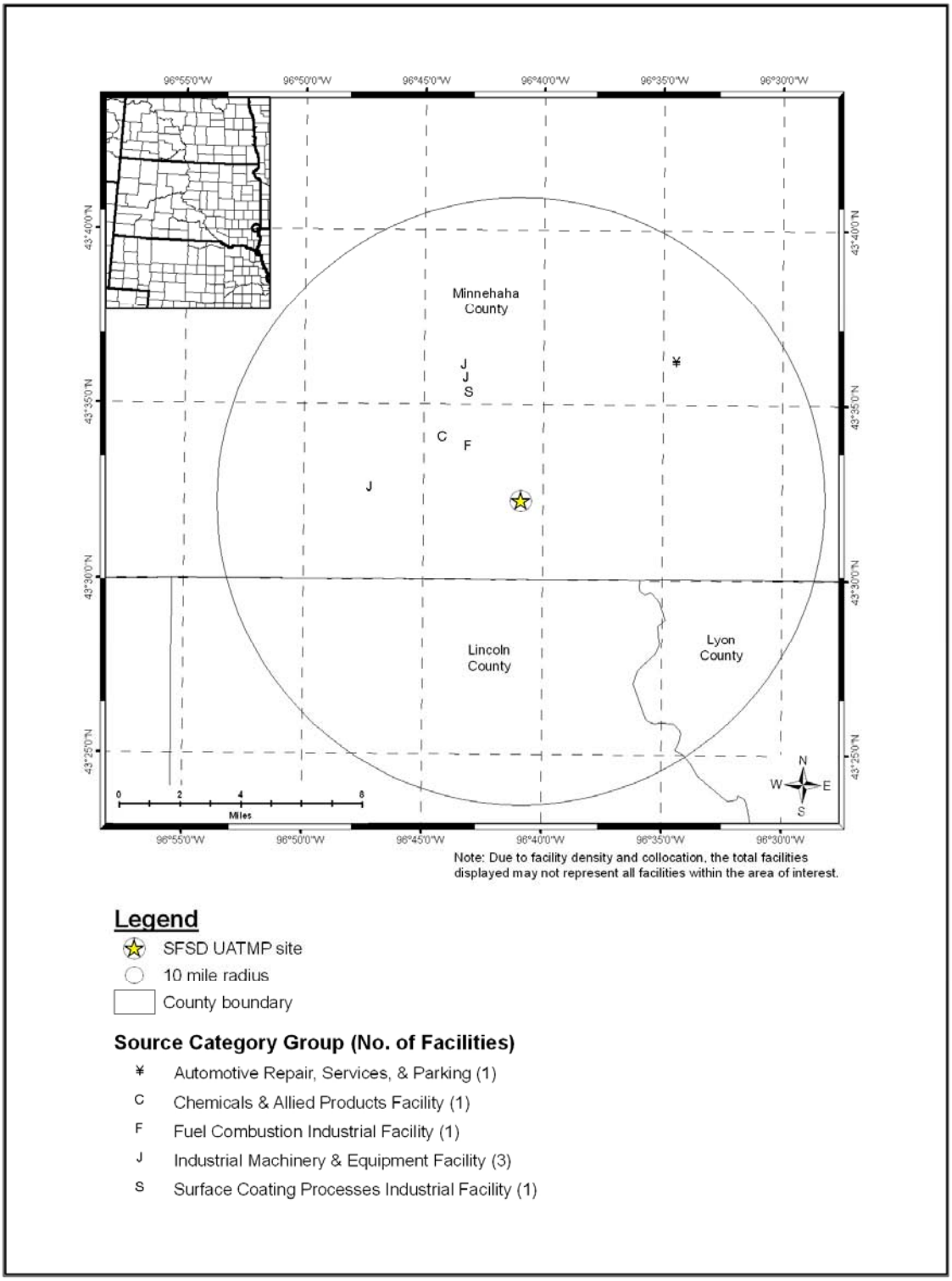


Table 25-1. Average Meteorological Conditions near the Monitoring Sites in South Dakota

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
CUSD	94032	All 2006	54.76 ± 2.02	44.27 ± 1.82	26.97 ± 1.51	36.43 ± 1.45	56.01 ± 1.56	1014.58 ± 0.79	5.68 ± 0.23
		Sampling Day	54.18 ± 4.91	43.96 ± 4.36	26.67 ± 3.59	36.16 ± 3.45	55.91 ± 3.98	1014.90 ± 1.95	5.82 ± 0.60
SFSD	14944	All 2006	58.83 ± 2.14	48.97 ± 2.00	38.07 ± 1.83	43.61 ± 1.76	69.18 ± 1.18	1015.44 ± 0.82	8.52 ± 0.39
		Sampling Day	59.87 ± 5.33	49.28 4.96	38.16 ± 4.48	43.71 ± 4.36	68.69 ± 2.44	1015.89 ± 1.88	8.00 ± 0.90

25.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the South Dakota monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. The South Dakota sites sampled for carbonyl compounds, SNMOC, and VOC. Table 25-2 presents the pollutants that failed at least one screen at the South Dakota monitoring sites.

Table 25-2. Comparison of Measured Concentration and EPA Screening Values for the South Dakota Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Custer, South Dakota – CUSD					
Benzene	61	61	100.00	18.83	18.83
Carbon Tetrachloride	60	60	100.00	18.52	37.35
Acetaldehyde	60	62	96.77	18.52	55.86
Acrolein	47	47	100.00	14.51	70.37
1,3-Butadiene	42	52	80.77	12.96	83.33
Formaldehyde	31	62	50.00	9.57	92.90
1,1,2,2-Tetrachloroethane	7	7	100.00	2.16	95.06
Tetrachloroethylene	4	22	18.18	1.23	96.30
Acrylonitrile	3	3	100.00	0.93	97.22
p-Dichlorobenzene	3	9	33.33	0.93	98.15
Hexachloro-1,3-butadiene	1	1	100.00	0.31	98.46
n-Hexane	1	61	1.64	0.31	98.77
Toluene	1	61	1.64	0.31	99.07
Trichloroethylene	1	2	50.00	0.31	99.38
Xylenes	1	61	1.64	0.31	99.69
1,2-Dichloroethane	1	1	100.00	0.31	100.00
Total	324	572	56.64		

Table 25-2. Comparison of Measured Concentration and EPA Screening Values for the South Dakota Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Sioux Falls, South Dakota – SFSD					
Benzene	59	59	100.00	17.82	17.82
Acetaldehyde	59	60	98.33	17.82	35.65
Carbon Tetrachloride	58	59	98.31	17.52	53.17
Formaldehyde	54	60	90.00	16.31	69.49
Acrolein	42	42	100.00	12.69	82.18
1,3-Butadiene	35	45	77.78	10.57	92.75
Acrylonitrile	10	10	100.00	3.02	95.77
Tetrachloroethylene	7	33	21.21	2.11	97.89
p-Dichlorobenzene	3	13	23.08	0.91	98.79
1,2-Dichloroethane	2	2	100.00	0.60	99.40
Hexachloro-1,3-butadiene	2	2	100.00	0.60	100.00
Total	331	385	85.97		

The following observations are shown in Table 25-2:

- Sixteen pollutants with a total of 324 measured concentrations failed the screen at CUSD and 11 pollutants with a total of 331 measured concentrations failed the screen at SFSD.

- The pollutants of interest varied by site, yet the following six pollutants contributed to the top 95 percent of the total failed screens at each South Dakota monitoring site: benzene, acetaldehyde, carbon tetrachloride, formaldehyde, 1,3-butadiene, and acrolein.

- Of the six pollutants that were the same for both sites, two pollutants of interest (benzene and acrolein) had 100 percent of their measured detections fail screens.

25.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The

resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal average concentrations are presented in Table 25-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for CUSD are shown in Table 25-3:

- Acetaldehyde had the highest daily average concentration by mass (1.25 ± 0.16 $\mu g/m^3$), followed by formaldehyde (1.11 ± 0.15 $\mu g/m^3$) and acrolein (0.91 ± 0.16 $\mu g/m^3$).

- Acetaldehyde, formaldehyde, and benzene were detected in every sample collected at CUSD.

- Seasonal averages for some of the pollutants of interest could not be calculated due to the low number of measured detections.

- Benzene and 1,3-butadiene had high autumn averages for CUSD, but the relatively high confidence intervals indicate that these averages were influenced by outliers.

- Formaldehyde tended to be higher in summer for CUSD.

The following observations for SFSD are shown in Table 25-3:

- Formaldehyde and acetaldehyde had the highest daily average concentrations by mass (3.52 ± 0.73 $\mu g/m^3$ and 3.30 ± 0.63 $\mu g/m^3$, respectively). Additionally, these pollutants' daily averages were an order of magnitude higher than the daily averages for other pollutants of interest.

- Acetaldehyde, benzene, carbon tetrachloride, and formaldehyde were detected in every sample collected at SFSD.

- Seasonal averages for some of the pollutants of interest could not be calculated due to the low number of measured detections at SFSD.

- Seasonal averages of many of the pollutants of interest at SFSD did not vary much, although the summer seasonal average of formaldehyde was higher than its other seasonal averages. Additionally, acetaldehyde was higher in summer and autumn.

Table 25-3. Daily and Seasonal Averages for the Pollutants of Interest for the South Dakota Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Custer, South Dakota – CUSD												
Acetaldehyde	62	62	1.25	0.16	1.11	0.24	1.05	0.20	1.33	0.30	1.53	0.47
Acrolein	47	61	0.91	0.16	0.34	0.09	NR	NR	0.90	0.20	1.22	0.37
Benzene	61	61	0.89	0.44	0.84	0.16	0.53	0.12	0.46	0.07	1.73	1.69
1,3-Butadiene	52	61	0.15	0.13	0.10	0.03	0.06	0.02	0.04	0.01	0.32	0.45
Carbon Tetrachloride	60	61	0.59	0.05	0.45	0.05	0.49	0.08	0.71	0.10	0.68	0.12
Formaldehyde	62	62	1.11	0.15	0.77	0.15	0.89	0.17	1.60	0.31	1.21	0.33
1,1,2,2-Tetrachloroethane	7	61	0.13	0.04	NR	NR	NR	NR	NR	NR	NR	NR
Sioux Falls, South Dakota – SFSD												
Acetaldehyde	60	60	3.30	0.63	1.94	0.43	1.69	0.46	5.85	1.47	3.97	1.12
Acrolein	42	59	0.71	0.10	0.41	0.16	NR	NR	0.84	0.21	0.70	0.14
Acrylonitrile	10	59	0.55	0.20	NR	NR	NR	NR	NR	NR	NR	NR
Benzene	59	59	0.59	0.05	0.69	0.09	0.48	0.04	0.55	0.12	0.62	0.11
1,3-Butadiene	45	59	0.05	0.01	0.04	0.01	NR	NR	0.06	0.01	0.06	0.01
Carbon Tetrachloride	59	59	0.62	0.05	0.49	0.09	0.57	0.07	0.75	0.10	0.70	0.10
Formaldehyde	60	60	3.52	0.73	3.36	2.12	2.95	0.96	5.15	0.91	2.69	0.54

NR = Not reportable due to low number of measured detections.

25.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for the South Dakota monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 25-4.

The following observations about acrolein are shown in Table 25-4:

- All of the acrolein measured detections at the South Dakota monitoring sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$.
- The average detected concentration was 0.71 ± 0.10 $\mu g/m^3$ for SFSD and 0.91 ± 0.16 $\mu g/m^3$ for CUSD, which were both several times larger than either acute risk factor.
- With the exception of spring, the seasonal averages for acrolein could be calculated for both sites. Winter averages of acrolein tended to be lower than other seasons for the South Dakota sites.
- All the seasonal averages were significantly higher than the ATSDR intermediate risk value.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. For both South Dakota monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 25-5 and 25-6 are pollution roses for acrolein at the South Dakota sites. As shown in Figures 25-5 and 25-6, and discussed above,

Observations gleaned from acrolein pollution roses include:

- All acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CALEPA REL) and solid line (ATSDR MRL).

Table 25-4. Non-Chronic Risk Summary for the South Dakota Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
CUSD	TO-15	Acrolein	0.91 ± 0.16	0.11	47	0.19	47	0.09	0.34 ± 0.09	NR	0.90 ± 0.20	1.22 ± 0.37
SFSD	TO-15	Acrolein	0.71 ± 0.10	0.11	42	0.19	42	0.09	0.41 ± 0.16	NR	0.84 ± 0.21	0.70 ± 0.14

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

Figure 25-5. Acrolein Pollution Rose for CUSD

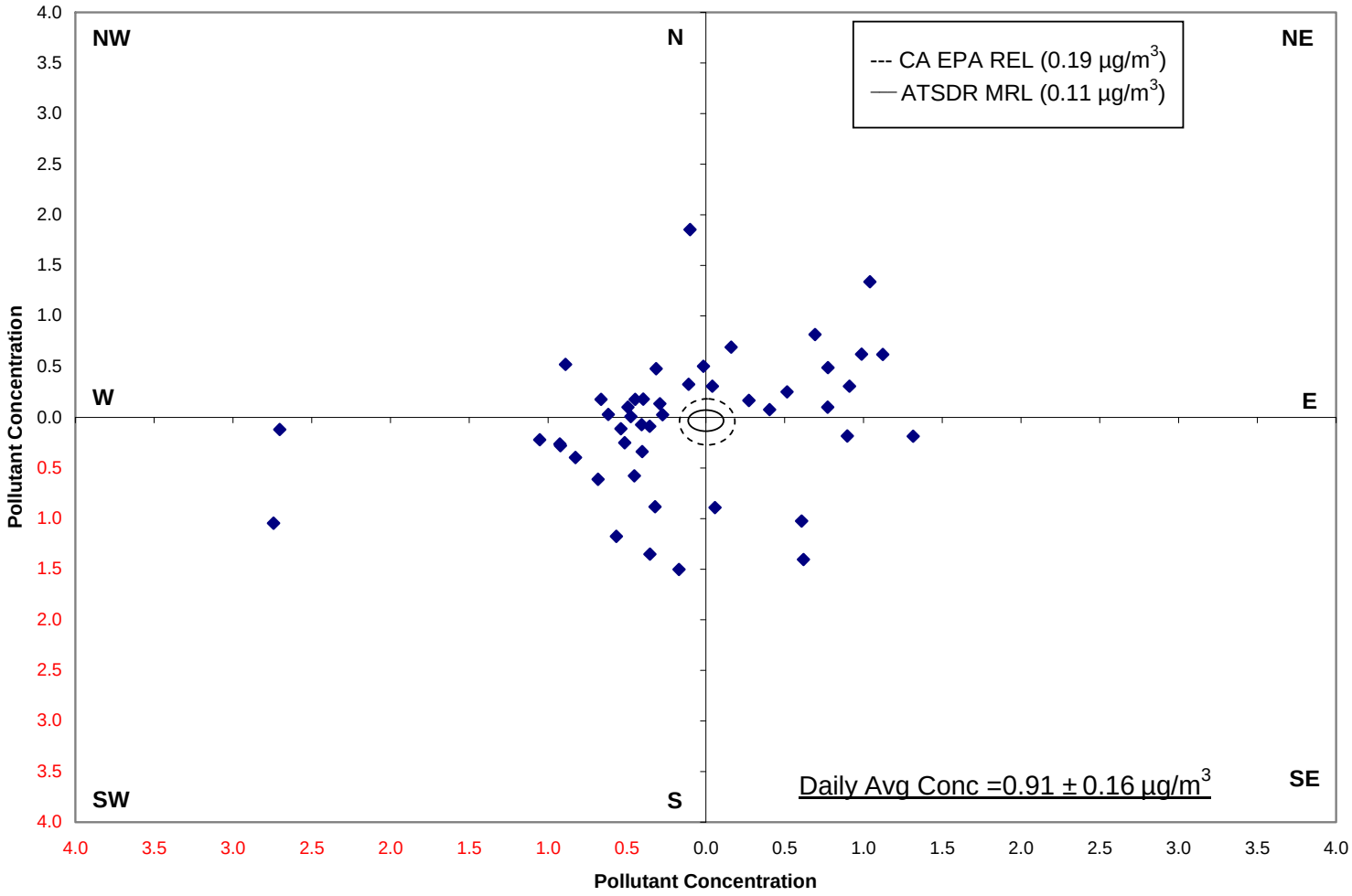
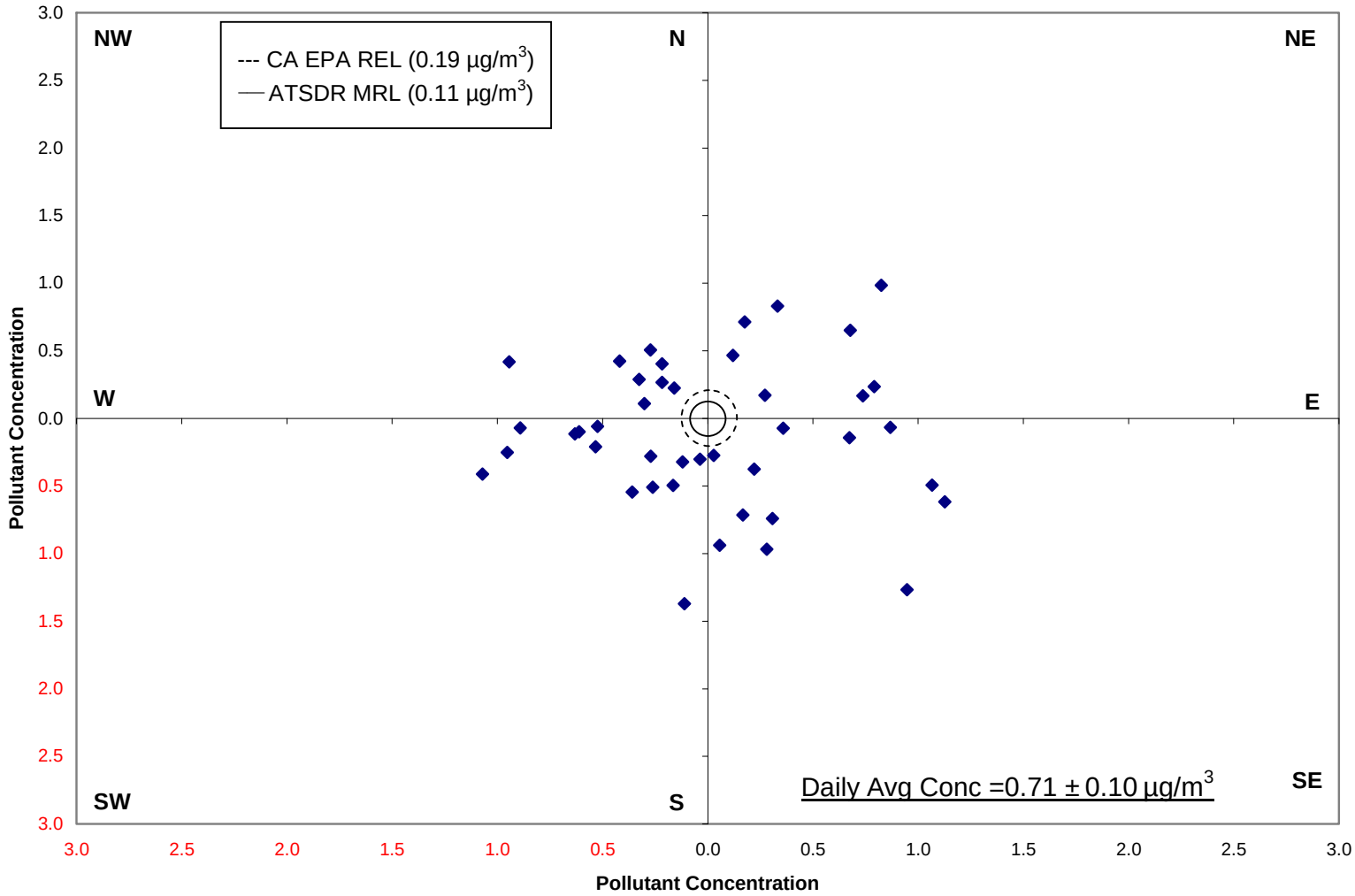


Figure 25-6. Acrolein Pollution Rose for SFSD



- Figure 25-5 for CUSD shows that concentrations exceeding the acute risk factors occurred with a variety of wind directions, although most frequently with winds from the west. The highest concentrations of acrolein occurred with westerly and west-southwesterly winds. Given that no point sources are located within 10 miles of the CUSD site, acrolein concentrations may be attributable to mobile sources. The monitoring site is located near the intersection of two major roadways in the area.

- Figure 25-6 for SFSD shows that concentrations exceeding the acute risk factors occurred with a variety of wind directions, which is consistent with mobile source emissions. Most point sources within 10 miles of the SFSD site were located towards the northwest of the site. As Figure 25-2 shows, the SFSD site is located near major roadways, such as I-229 and Highway 42.

25.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

25.4.1 Pearson Correlation Analysis

Table 25-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the South Dakota monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for CUSD from Table 25-5:

- Strong positive correlations were calculated for formaldehyde and carbon tetrachloride and maximum, average, dew point, and wet bulb temperatures. This indicates that increasing temperature and humidity levels correlate to increasing concentrations of these pollutants.

- A few strong correlations were calculated for 1,1,2,2-tetrachloroethane. However, the low number of measured detections may skew the correlations.

- Most of the remaining correlations were weak at CUSD.

Table 25-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the South Dakota Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Custer, South Dakota – CUSD								
Acetaldehyde	62	0.08	0.03	-0.05	-0.01	-0.11	0.06	-0.24
Acrolein	47	0.27	0.26	0.24	0.26	-0.04	-0.24	-0.19
Benzene	61	-0.18	-0.20	-0.23	-0.22	-0.05	-0.09	0.07
1,3-Butadiene	52	-0.17	-0.17	-0.19	-0.18	-0.02	-0.13	0.11
Carbon Tetrachloride	60	0.54	0.56	0.56	0.59	-0.14	-0.14	-0.28
Formaldehyde	62	0.58	0.55	0.45	0.52	-0.21	-0.05	-0.29
1,1,2,2-Tetrachloroethane	7	-0.28	-0.38	-0.52	-0.42	-0.20	0.52	-0.15
Sioux Falls, South Dakota – SFSD								
Acetaldehyde	60	0.39	0.38	0.33	0.36	-0.30	0.07	-0.37
Acrolein	42	0.28	0.25	0.26	0.25	0.02	-0.12	-0.07
Acrylonitrile	10	0.72	0.75	0.76	0.76	0.35	-0.52	0.05
Benzene	59	-0.09	-0.18	-0.17	-0.18	0.11	-0.01	-0.36
1,3-Butadiene	45	-0.09	-0.15	-0.13	-0.14	0.14	0.12	-0.37
Carbon Tetrachloride	59	0.57	0.54	0.53	0.54	-0.14	-0.24	-0.22
Formaldehyde	60	0.19	0.21	0.19	0.20	-0.14	-0.02	-0.07

The following observations are gathered for SFSD from Table 25-5:

- Similar to CUSD, strong positive correlations were calculated for carbon tetrachloride and maximum, average, dew point, and wet bulb temperatures. This indicates that increasing temperature and humidity levels correlate to increasing concentrations of these pollutants.

- Acrylonitrile also exhibited strong positive correlations with these parameters. However, the low number of measured detections may skew the correlations.

- Most of the remaining correlations were weak.

25.4.2 Composite Back Trajectory Analysis

Figures 25-7 and 25-8 are composite back trajectory maps for the South Dakota monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

The following observations can be made from Figure 25-7:

- Back trajectories originated predominantly from all directions except the north and northeast at CUSD.

- The 24-hour airshed domain was somewhat large at CUSD, with trajectories originating as far away as Alberta, Canada, nearly 800 miles away.

- The majority of the trajectories originated within 500 miles of the site.

The following observations can be made from Figure 25-8:

- Back trajectories originated from a variety of directions around SFSD, although predominantly from the south, northwest, and north.

- The 24-hour airshed domain was larger at SFSD, with the longest trajectory originating over 900 miles away. However, most of the trajectories originated within 500 miles of the site.

25.4.3 Wind Rose Analysis

Hourly wind data from the Custer County and Foss Field Airports were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind

Figure 25-7. Composite Back Trajectory Map for CUSD

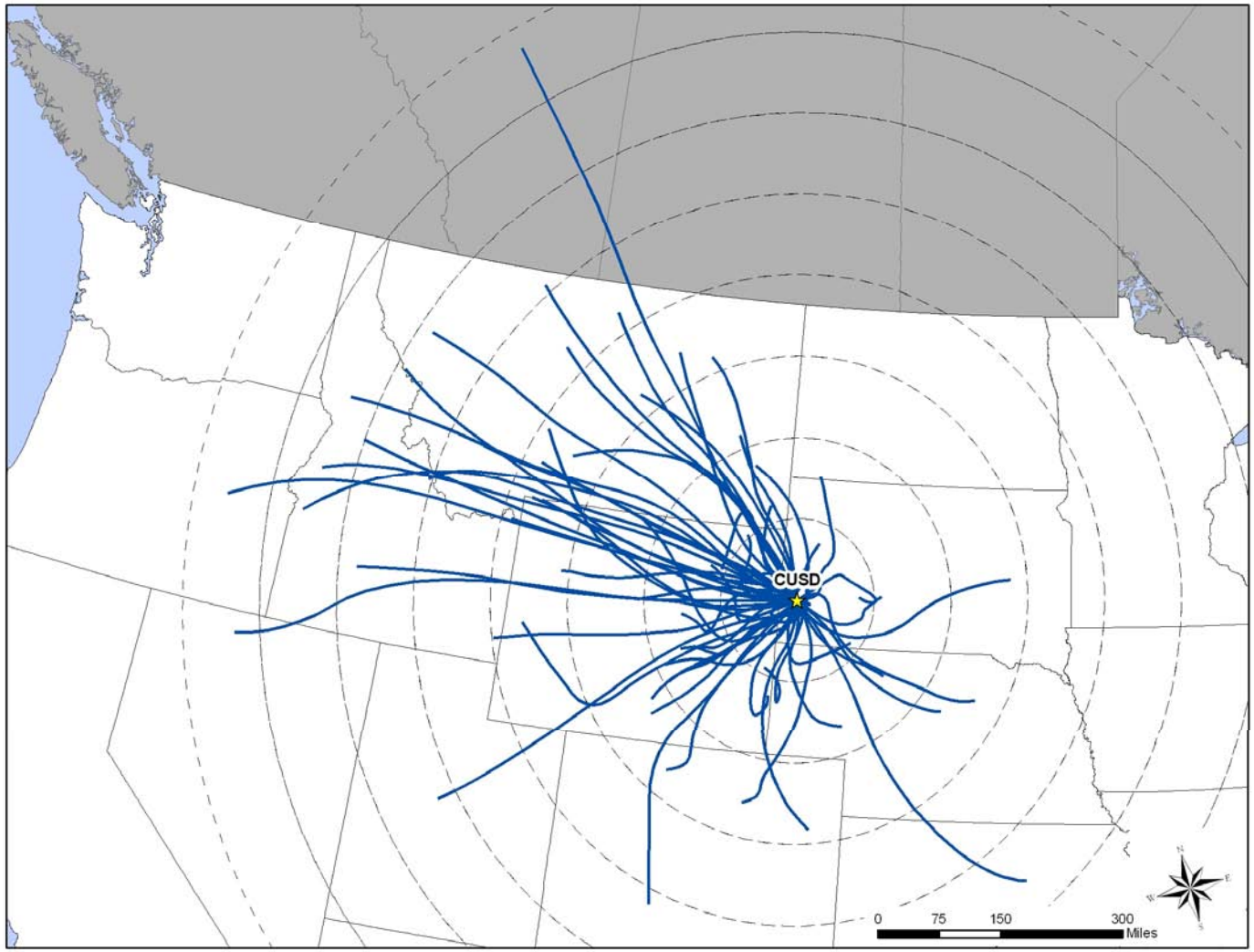
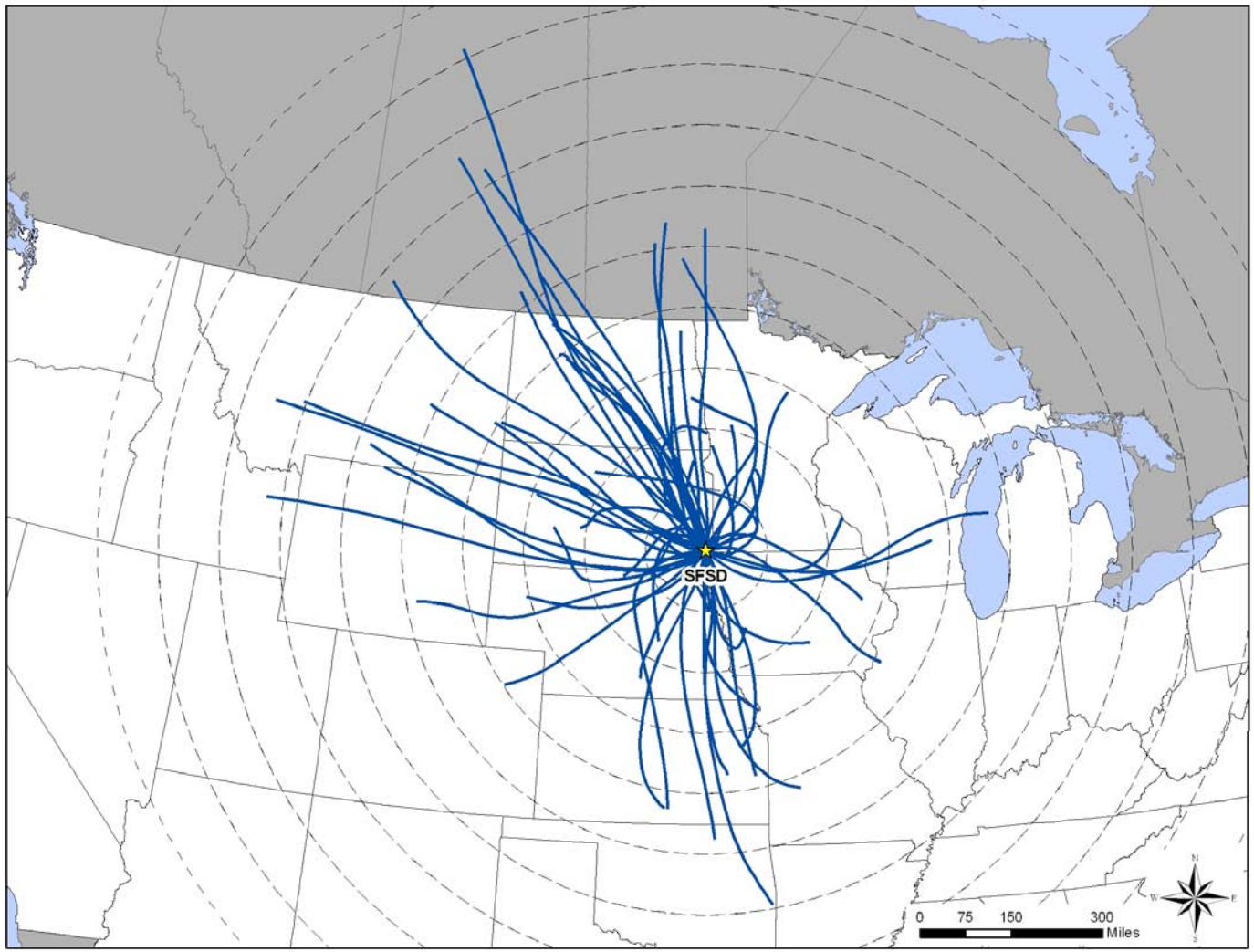


Figure 25-8. Composite Back Trajectory Map for SFSD



rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 25-9 and 25-10 are the wind roses for the South Dakota monitoring sites on days that sampling occurred.

Observations from Figure 25-9 for CUSD include:

- Hourly winds were predominantly out of the west (15 percent of observations), west-southwest (9 percent), and west-northwest (9 percent) on days that samples were collected near CUSD.
- Calm winds (< 2 knots) were recorded for 17 percent of the observations.
- Wind speeds ranging from 7 to 11 knots were recorded most often.
- The strongest winds tended to have a westerly component.

Observations from Figure 25-10 for SFSD include:

- Hourly winds were predominantly out of south (11 percent of observations), east (8 percent), and north-northwest (8 percent) on days that samples were collected near SFSD.
- Calm winds were observed for 14 percent of the observations, while wind speeds of 7 to 11 knots were recorded most frequently.
- Wind speeds greater than 22 knots were recorded most frequently with a northerly component.

25.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and acetylene-ethylene mobile tracer analysis.

25.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Custer and Minnehaha Counties were obtained from the South Dakota Department of Revenue and Regulation and the U.S. Census

Figure 25-9. Wind Rose for CUSD Sampling Days

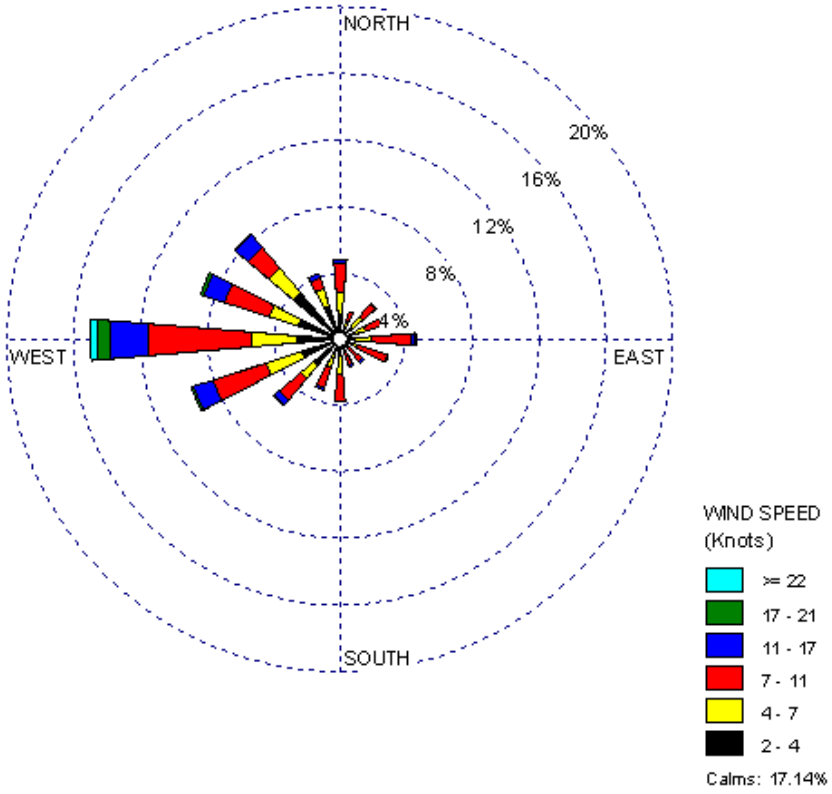
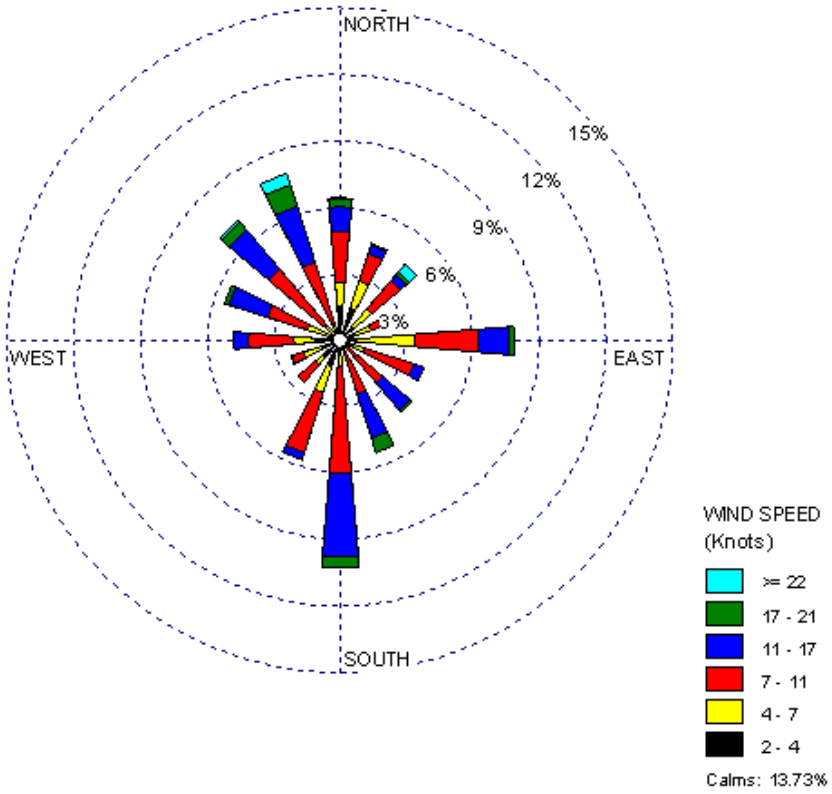


Figure 25-10. Wind Rose for SFSD Sampling Days



Bureau, and are summarized in Table 25-6. Table 25-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 25-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 25-6 include:

- The CUSD monitoring site has a significantly lower county and 10-mile population than the SFSD site, as well as a significantly lower county and estimated 10-mile vehicle ownership.

- CUSD has the lowest county and 10-mile population, the second lowest county vehicle registration, and the lowest estimated 10-mile vehicle ownership of all participating UATMP sites. However, the CUSD site has the highest registration-population ratio.

- SFSD is in the bottom third of UATMP sites for the population and vehicle registration statics.

- While the daily traffic flow near CUSD is significantly lower than at SFSD, these two sites' daily traffic counts are both on the low end compared to other UATMP sites.

25.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- For both South Dakota sites, the benzene-ethylbenzene ratio was higher than the xylenes-ethylbenzene ratio, which is the opposite of the roadside study.

Table 25-6. Motor Vehicle Information for the South Dakota Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
CUSD	7,944	14,191	1.79	5,492	9,811	1,940
SFSD	163,281	202,696	1.24	161,598	200,607	4,320

- For CUSD, the benzene-ethylbenzene ratio exceeded the toluene-ethylbenzene ratio (6.42 ± 0.66 and 6.00 ± 0.51, respectively).

- At SFSD, the toluene-ethylbenzene ratio (10.70 ± 2.32) was significantly higher than that of the roadside study (5.85).

25.5.3 Mobile Tracer Analysis

As previously stated, CUSD and SFSD sampled for SNMOC in addition to VOC. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.)

Table 3-11 shows:

- CUSD's ethylene-acetylene ratio (1.43) is closer to the 1.7 ratio, although still lower.

- SFSD's ethylene-acetylene ratio (1.22) was lower than the 1.7 ratio and lower than CUSD's ratio.

- These ratios suggest that while mobile sources may be influencing the air quality at the South Dakota monitoring sites, there may also be atmospheric chemical processes affecting the quantities of ethylene in these areas. Known sinks of ethylene include reactions with ozone, as well as soil (NLMb).

25.6 Trends Analysis

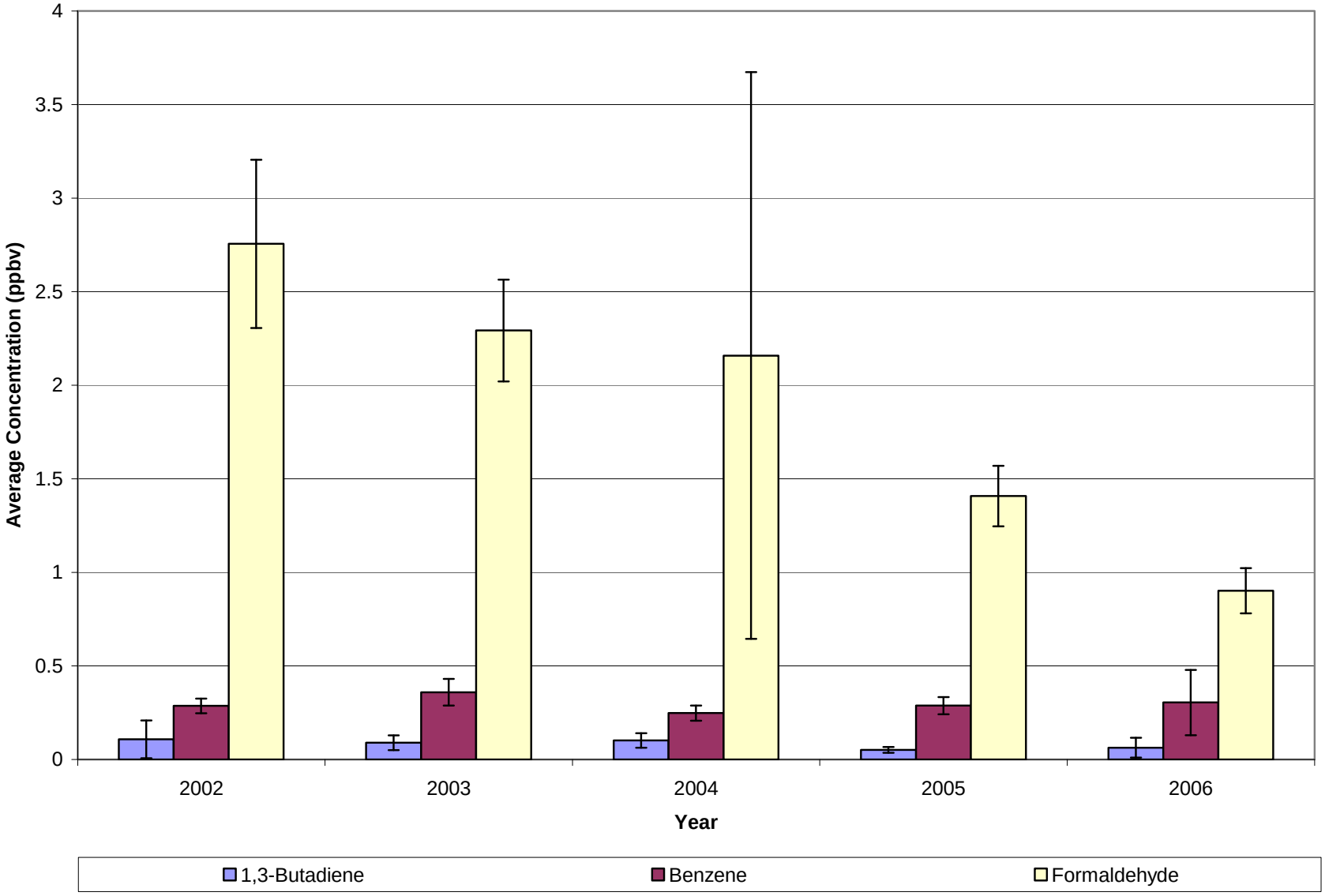
For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The CUSD monitoring site has participated in the UATMP since 2002. Figures 25-11 and 25-12 present the trends analysis for formaldehyde, benzene, and 1,3-butadiene for CUSD and SFSD, respectively.

The following observations can be made from Figure 25-11 for CUSD:

- Formaldehyde concentrations have decreased since 2002.

- Similarly, 1,3-butadiene concentrations appear to decrease over the four year period prior to 2006, but the large confidence intervals in 2002 and 2006 indicate that the decrease is not statistically significant.

Figure 25-11. Comparison of the Yearly Averages for the CUSD Monitoring Site



- Benzene concentrations have not changed significantly since 2002 at CUSD, although the large confidence interval in 2006 shows that outliers are likely affecting the average.

The following observations can be made from Figure 25-12 for SFSD:

- Carbonyl compounds were not sampled for at SFSD until 2002, as indicated in Figure 25-12. The large confidence interval, represented by the error bars in 2002, indicates that the formaldehyde concentration may have been driven upward by a few outliers, which makes it difficult to determine if formaldehyde concentrations actually decreased from 2002 to 2003. Taking confidence intervals into account, it appears that formaldehyde concentrations have remained roughly the same since 2003.

- The 1,3-butadiene concentration was highest in 2002, similar to formaldehyde, but again, the high confidence interval indicates that the 1,3-butadiene concentration may have been influenced by a few outliers. In 2004, 1,3-butadiene was detected only once at SFSD, as the absence of a confidence interval indicates. Overall, 1,3-butadiene concentrations seem to be decreasing slightly.

- Benzene concentrations have not changed significantly since 2000.

25.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the South Dakota sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 25-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 25-7. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the South Dakota sites is as follows:

- The census tract for CUSD is 46033995200, which had a population of 2,758, which represents approximately 37.9 percent of the Custer County population in 2000.

- The census tract for SFSD is 46099001802, which had a population of 7,498, which also represents approximately 5.1 percent of the county population in 2000.

Figure 25-12. Comparison of the Yearly Averages for the SFSD Monitoring Site

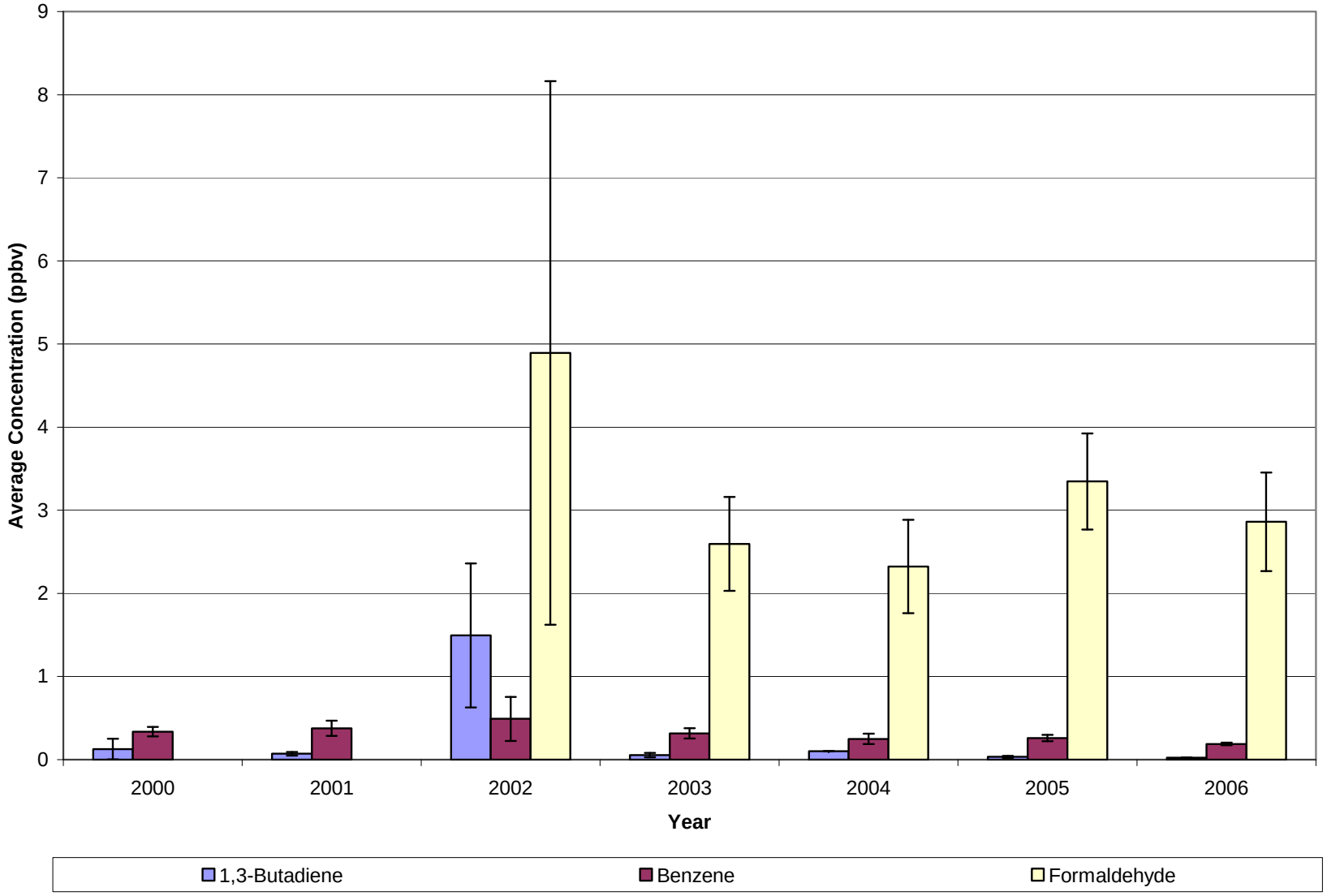


Table 25-7. Chronic Risk Summary for the Monitoring Sites in South Dakota

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)[3]	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Custer, South Dakota (CUSD) – Census Tract ID 46033995200								
Acetaldehyde	0.0000022	0.009	0.43	0.95	0.05	1.25 ± 0.16	2.75	0.14
Acrolein	NR	0.00002	0.03	NR	1.52	0.73 ± 0.15	NR	36.65
Acrylonitrile	0.000068	0.002	<0.01	0.01	<0.01	0.06 ± <0.01	4.31	0.03
Benzene	0.0000078	0.03	0.26	2.07	0.01	0.89 ± 0.44	6.97	0.03
1,3-Butadiene	0.00003	0.002	0.01	0.39	0.01	0.13 ± 0.11	3.92	0.07
Carbon Tetrachloride	0.000015	0.04	0.21	3.11	0.01	0.58 ± 0.05	8.72	0.01
p-Dichlorobenzene	0.000011	0.8	<0.01	0.01	<0.01	0.03 ± 0.01	0.31	<0.01
1,2-Dichloroethane	0.000026	2.4	<0.01	<0.01	<0.01	0.03 ± <0.01	0.81	<0.01
Formaldehyde	5.5E-09	0.0098	0.31	<0.01	0.03	1.11 ± 0.15	0.01	0.11
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± <0.01	1.58	<0.01
n-Hexane	NR	0.2	0.02	NR	<0.01	1.23 ± 0.95	NR	0.01
1,1,2,2-Tetrachloroethane	0.000058	NR	<0.01	<0.01	NR	0.05 ± 0.01	3.14	NR
Tetrachloroethylene	0.0000059	0.27	<0.01	0.01	<0.01	0.08 ± 0.03	0.45	<0.01
Toluene	NR	0.4	0.12	NR	<0.01	1.85 ± 1.78	NR	<0.01
Trichloroethylene	0.000002	0.6	0.03	0.07	<0.01	0.04 ± 0.02	0.08	<0.01
Xylenes	NR	0.1	0.21	NR	<0.01	2.07 ± 1.48	NR	0.02
Sioux Falls, South Dakota (SFSD) – Census Tract ID 46099001802								
Acetaldehyde	0.0000022	0.009	0.68	1.50	0.08	3.30 ± 0.63	7.27	0.37
Acrolein	NR	0.00002	0.02	NR	1.21	0.54 ± 0.10	NR	27.18
Acrylonitrile	0.000068	0.002	<0.01	0.02	<0.01	0.14 ± 0.06	9.85	0.07
Benzene	0.0000078	0.03	0.69	5.41	0.02	0.59 ± 0.05	4.60	0.02
1,3-Butadiene	0.00003	0.002	0.06	1.82	0.03	0.05 ± <0.01	1.49	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.12	0.01	0.62 ± 0.05	9.25	0.02
p-Dichlorobenzene	0.000011	0.8	0.02	0.17	<0.01	0.03 ± 0.01	0.35	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.67	<0.01	0.03 ± <0.01	0.80	<0.01
Formaldehyde	5.5E-09	0.0098	0.80	<0.01	0.08	3.52 ± 0.73	0.02	0.36

Table 25-7. Chronic Risk Summary for the Monitoring Sites in South Dakota (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^{3)}$	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± 0.01	1.63	<0.01
Tetrachloroethylene	0.0000059	0.27	0.09	0.51	<0.01	0.08 ± 0.02	0.50	<0.01

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

The following observations can be made for CUSD from Table 25-7:

- Xylenes and toluene had the highest annual averages by mass concentration for CUSD. But neither of these pollutants have cancer risk factors.

- Carbon tetrachloride and benzene had both the highest NATA-modeled and annual average-based cancer risks for CUSD, although the cancer risks based on the annual averages were more than twice the NATA-modeled risk.

- Acrolein had the highest NATA-modeled and annual average-based noncancer risk for CUSD, although the annual average-based HQ (36.65) was significantly higher than the NATA-modeled HQ (1.52).

The following observations can be made for SFSD from Table 25-7:

- Acetaldehyde and formaldehyde's annual averages for SFSD were an order of magnitude higher than any of the other pollutants of interest's annual averages. These two pollutants also have some of the highest NATA-modeled concentrations, although they were significantly lower than the annual averages.

- While acrylonitrile had the highest annual average-based cancer risk (9.85 in-a-million) for SFSD, its NATA-modeled risk was two orders of magnitude lower (0.02 in-a-million).

- Benzene had the highest NATA-modeled cancer risk for SFSD, and its modeled concentration and risk were very similar to the actual average and associated risk for 2006.

- Acrolein had the highest NATA-modeled and annual average-based noncancer risk for SFSD, although the annual average-based HQ (27.18) was significantly higher than the NATA-modeled HQ (1.21).

25.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 25-8 and 25-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 25-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 25-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the

Table 25-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in South Dakota

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Custer, South Dakota – CUSD – Custer County					
Benzene	13.77	Benzene	1.07E-04	Carbon Tetrachloride	8.72
Formaldehyde	4.91	1,3-Butadiene	3.30E-05	Benzene	6.97
Acetaldehyde	2.25	Polycyclic Organic Matter as 15-PAH	1.96E-05	Acrylonitrile	4.31
Tetrachloroethylene	1.58	Lead	1.56E-05	1,3-Butadiene	3.92
1,3-Butadiene	1.10	Naphthalene	1.52E-05	1,1,2,2-Tetrachloroethane	3.14
Dichloromethane	0.57	Polycyclic Organic Matter as 7-PAH	1.26E-05	Acetaldehyde	2.75
Naphthalene	0.45	Polycyclic Organic Matter as non-15 PAH	1.06E-05	Hexachloro-1,3-butadiene	1.58
Polycyclic Organic Matter as 15-PAH	0.36	Tetrachloroethylene	9.31E-06	1,2-Dichloroethane	0.81
p-Dichlorobenzene	0.16	Acetaldehyde	4.95E-06	Tetrachloroethylene	0.45
Polycyclic Organic Matter as 7-PAH	0.07	*p*-Dichlorobenzene	1.77E-06	*p*-Dichlorobenzene	0.31
Sioux Falls, South Dakota – SFSD – Minnehaha County					
Benzene	132.45	Benzene	1.03E-03	Acrylonitrile	9.85
Formaldehyde	53.88	Lead	3.98E-04	Carbon Tetrachloride	9.25
Acetaldehyde	24.45	1,3-Butadiene	3.65E-04	Acetaldehyde	7.27
1,3-Butadiene	12.17	Naphthalene	1.57E-04	Benzene	4.60
Dichloromethane	11.98	Polycyclic Organic Matter as 15-PAH	1.35E-04	Hexachloro-1,3-butadiene	1.63
Tetrachloroethylene	6.04	Arsenic	1.22E-04	1,3-Butadiene	1.49
Naphthalene	4.62	Polycyclic Organic Matter as non-15 PAH	8.45E-05	1,2-Dichloroethane	0.80
p-Dichlorobenzene	3.27	Polycyclic Organic Matter as 7-PAH	6.54E-05	Tetrachloroethylene	0.50
Polycyclic Organic Matter as 15-PAH	2.46	Acetaldehyde	5.38E-05	*p*-Dichlorobenzene	0.35
Trichloroethylene	1.05	Ethylene Oxide	3.77E-05	Formaldehyde	0.02

Table 25-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in South Dakota

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Sioux Falls, South Dakota – SFSD – Minnehaha County					
Toluene	30.33	Acrolein	14,131.59	Acrolein	36.65
Xylenes	20.11	1,3-Butadiene	549.45	Acetaldehyde	0.14
Benzene	13.77	Formaldehyde	501.10	Formaldehyde	0.11
Formaldehyde	4.91	Benzene	458.93	1,3-Butadiene	0.07
Ethylbenzene	4.80	Cyanide	292.55	Acrylonitrile	0.03
n-Hexane	4.00	Acetaldehyde	250.03	Benzene	0.03
Methanol	2.50	Xylenes	201.07	Xylenes	0.02
Acetaldehyde	2.25	Naphthalene	148.53	Carbon Tetrachloride	0.01
Styrene	1.71	Toluene	75.82	*n*-Hexane	0.01
Tetrachloroethylene	1.58	Hydrochloric Acid	31.03	Toluene	<0.01
Sioux Falls, South Dakota – SFSD – Minnehaha County					
Toluene	318.26	Acrolein	146,524.06	Acrolein	27.18
Xylenes	235.83	1,3-Butadiene	6,086.91	Acetaldehyde	0.37
Benzene	132.45	Formaldehyde	5,497.45	Formaldehyde	0.36
Methanol	85.68	Benzene	4,415.13	Acrylonitrile	0.07
Hydrochloric Acid	63.23	Hydrochloric Acid	3,161.30	1,3-Butadiene	0.02
Formaldehyde	53.88	Acetaldehyde	2,716.33	Benzene	0.02
Ethylbenzene	46.98	Xylenes	2,358.33	Carbon Tetrachloride	0.02
n-Hexane	40.28	Cyanide	1,874.27	Hexachloro-1,3-butadiene	<0.01
Methyl Ethyl Ketone	37.81	Naphthalene	1,541.21	Tetrachloroethylene	<0.01
Styrene	28.27	Nickel	1,447.07	*p*-Dichlorobenzene	<0.01

emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. The South Dakota sites sampled for VOC, SNMOC, and carbonyls. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 25-8:

- Benzene was the highest emitted pollutant with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the second highest and fourth highest cancer risk based on the 2006 annual average for CUSD and SFSD, respectively.

- Carbon tetrachloride had the highest and second highest cancer risk based on the 2006 annual averages for CUSD and SFSD, yet this pollutant was neither one of the highest emitted nor one of the most toxic in Custer and Minnehaha Counties based on the 2002 NEI emission inventory.

- Acrylonitrile had the highest cancer risk for SFSD and the third highest cancer risk for CUSD, although this pollutant, like carbon tetrachloride, was neither one of the highest emitted nor one of the most toxic.

The following observations can be made from Table 25-9:

- Toluene and xylenes were the highest emitted pollutants with noncancer risk factors in both Custer and Minnehaha Counties.

- These pollutants rank seventh and ninth, respectively, for noncancer toxicity-weighted emissions for Custer County, and seventh and tenth, respectively, for noncancer risk for CUSD.

- Xylenes ranked seventh in Minnehaha County, but toluene did not make the top 10 toxicity-weighted emissions. Neither xylenes nor toluene made the top 10 list for noncancer risk for SFSD.

- Acrolein had the highest noncancer toxicity-weighted emissions in both Custer and Minnehaha Counties, and had the highest noncancer risks based on the 2006 annual average for both sites, but did not appear in the list of highest emitted pollutants.

South Dakota Pollutant Summary

- *The pollutants of interest common to each of the South Dakota sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.*

- *Formaldehyde and acetaldehyde had the highest daily averages for CUSD and SFSD.*

- *Acrolein exceeded the short-term risk factors at both South Dakota sites.*

- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of formaldehyde have been decreasing at CUSD since 2002, while remaining steady at SFSD.*

26.0 Sites in Tennessee

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Tennessee (LDTN and MSTN). Both sites are located southwest of Knoxville in Loudon. Figures 26-1 and 26-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 26-3 identifies point source emission locations within 10 miles of these sites as reported to the 2002 NEI for point sources. The LDTN and MSTN sites have approximately two dozen point sources nearby and several of these are involved in waste treatment and disposal, polymer and resin production, or fuel combustion processes.

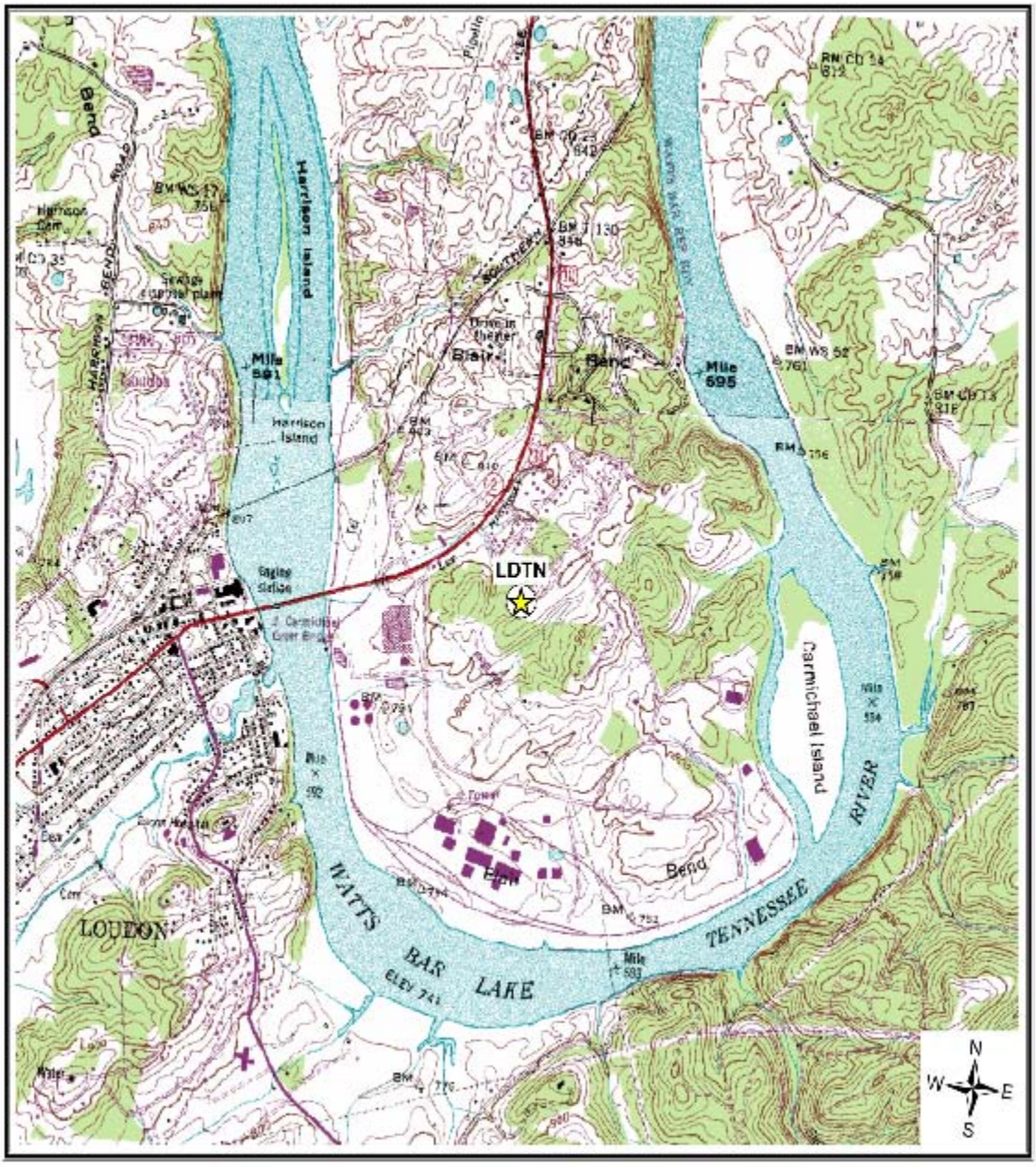
Loudon is located to the southwest of Knoxville. The Tennessee River runs through town, influencing the areas weather by moderating temperatures and affecting wind patterns. The Appalachian Mountains lie to the east. The area has ample rainfall year-round and, like Nashville, experiences all four seasons (Ruffner and Bair, 1987 and http://www.blueshoenashville.com/weather.html).

Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the monitoring sites is the Knoxville McGhee-Tyson Airport (WBAN 03894). Table 26-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 26-1 is the 95 percent confidence interval for each parameter. As shown in Table 26-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

26.1 Risk Screening and Pollutants of Interest

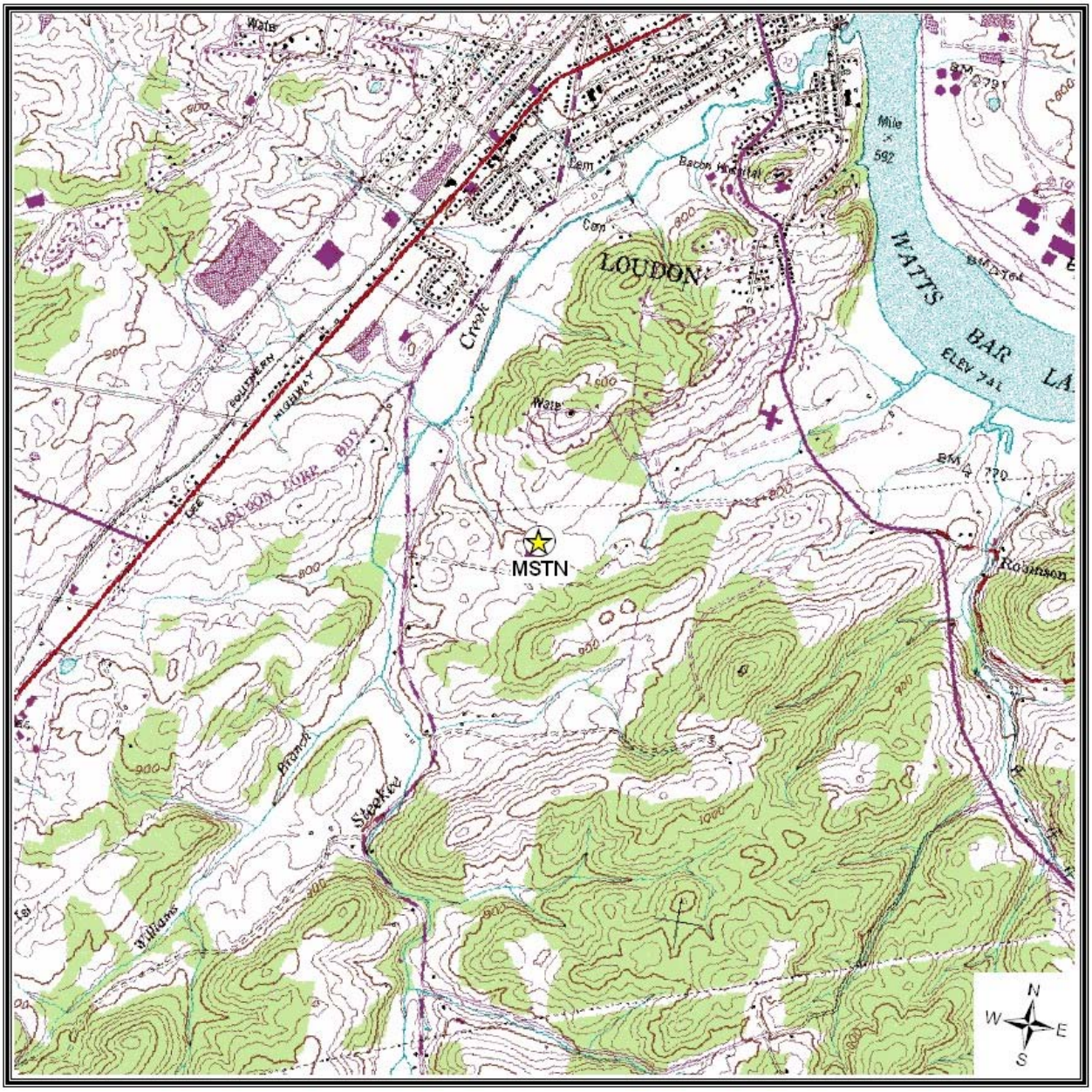
Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 26-1. Loudon, Tennessee (LDTN) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:25,000.

Figure 26-2. Loudon, Tennessee (MSTN) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:25,000.

Figure 26-3. Facilities Located Within 10 Miles of LDTN and MSTN

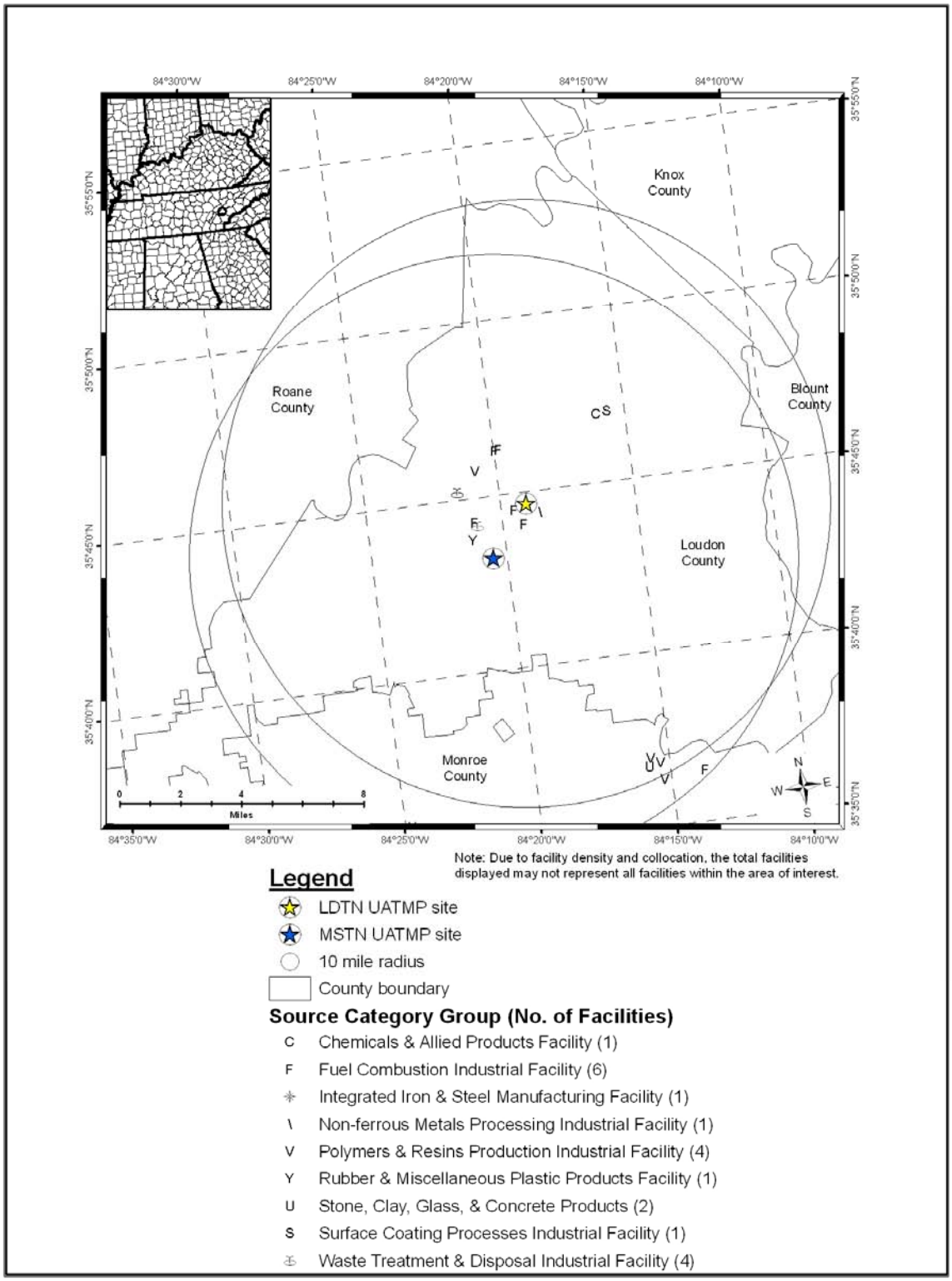


Table 26-1. Average Meteorological Conditions near the Monitoring Sites in Tennessee

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
LDTN	13891	All 2006	69.95 ± 1.58	59.78 ± 1.52	47.89 ± 1.62	53.50 ± 1.42	67.91 ± 1.19	1017.32 ± 0.60	5.46 ± 0.30
		Sampling Day	70.86 ± 3.83	60.74 ± 3.55	49.29 ± 3.50	54.50 ± 3.14	69.46 ± 3.30	1016.46 ± 1.43	6.00 ± 0.81
MSTN	13891	All 2006	69.95 ± 1.58	59.78 ± 1.52	47.89 ± 1.62	53.50 ± 1.42	67.91 ± 1.19	1017.32 ± 0.60	5.46 ± 0.30
		Sampling Day	72.56 ± 3.77	62.34 ± 3.51	50.45 ± 3.72	55.85 ± 3.18	68.59 ± 3.37	1016.89 ± 1.33	5.52 ± 0.75

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total screens. The Tennessee sites sampled for carbonyls compounds and VOC only. Table 26-2 presents the pollutants that failed at least one screen at the Tennessee monitoring sites.

Table 26-2. Comparison of Measured Concentrations and EPA Screening Values for the Tennessee Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Loudon, Tennessee – LDTN					
Acetaldehyde	55	56	98.21	15.85	15.85
Benzene	55	55	100.00	15.85	31.70
Carbon Tetrachloride	55	55	100.00	15.85	47.55
Formaldehyde	49	56	87.50	14.12	61.67
Acrolein	48	48	100.00	13.83	75.50
1,3-Butadiene	39	48	81.25	11.24	86.74
p-Dichlorobenzene	35	51	68.63	10.09	96.83
Hexachloro-1,3-butadiene	5	5	100.00	1.44	98.27
Tetrachloroethylene	2	27	7.41	0.58	98.85
Acrylonitrile	2	2	100.00	0.58	99.42
1,1,2,2-Tetrachloroethane	1	1	100.00	0.29	99.71
Chloromethylbenzene	1	1	100.00	0.29	100.00
Total	347	405	85.68		
Loudon, Tennessee – MSTN					
Acetaldehyde	50	51	98.04	16.34	16.34
Benzene	49	49	100.00	16.01	32.35
Carbon Tetrachloride	49	49	100.00	16.01	48.37
Formaldehyde	44	51	86.27	14.38	62.75
Acrolein	44	44	100.00	14.38	77.12
p-Dichlorobenzene	36	47	76.60	11.76	88.89
1,3-Butadiene	26	40	65.00	8.50	97.39
Acrylonitrile	5	5	100.00	1.63	99.02
Tetrachloroethylene	3	29	10.34	0.98	100.00
Total	306	365	83.84		

The following observations are shown in Table 26-2:

- Twelve 12 pollutants failed at least one screen at LDTN and a total of 347 measured concentrations failed screens.

- Nine pollutants failed at least one screen at MSTN and a total of 306 measured concentrations failed screens.

- The same seven pollutants contributed to 95 percent of the total failed screens for both Tennessee monitoring sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and *p*-dichlorobenzene.

- Acrolein, benzene, and carbon tetrachloride, concentrations failed 100 percent of screens at each site.

26.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal average concentrations are presented in Table 26-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for LDTN are shown in Table 26-3:

- Acetaldehyde, benzene, carbon tetrachloride, and formaldehyde were detected in every sample collected at the Tennessee monitoring sites.

- Formaldehyde had the highest average concentration by mass (2.58 ± 0.47 $\mu g/m^3$) for LDTN, followed by acetaldehyde (2.21 ± 0.32 $\mu g/m^3$).

Table 26-3. Daily and Seasonal Averages for the Pollutants of Interest for the Tennessee Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Loudon, Tennessee – LDTN												
Acetaldehyde	56	56	2.21	0.32	1.83	0.75	2.48	0.59	2.63	0.46	1.76	0.61
Acrolein	48	55	0.64	0.10	0.64	0.24	0.46	0.17	0.72	0.15	0.46	0.16
Benzene	55	55	1.02	0.12	1.05	0.20	0.99	0.17	1.07	0.26	0.97	0.29
1,3-Butadiene	48	55	0.07	0.01	0.07	0.02	0.05	0.02	0.05	0.02	0.07	0.03
Carbon Tetrachloride	55	55	0.65	0.06	0.53	0.04	0.54	0.05	0.83	0.13	0.75	0.13
p-Dichlorobenzene	51	55	0.12	0.02	0.14	0.05	0.09	0.02	0.13	0.02	0.09	0.03
Formaldehyde	56	56	2.58	0.47	1.26	0.28	2.39	0.71	4.83	0.74	1.55	0.30
Loudon, Tennessee – MSTN												
Acetaldehyde	51	51	1.26	0.12	0.99	0.31	1.32	0.26	1.37	0.19	1.20	0.20
Acrolein	44	49	1.00	0.18	0.62	0.30	1.37	0.49	0.84	0.18	0.71	0.19
Benzene	49	49	0.87	0.12	0.81	0.26	1.09	0.32	0.74	0.12	0.84	0.22
1,3-Butadiene	40	49	0.06	0.01	NR	NR	0.05	0.03	0.04	0.01	0.06	0.03
Carbon Tetrachloride	49	49	0.66	0.04	0.56	0.05	0.57	0.05	0.72	0.07	0.74	0.08
p-Dichlorobenzene	47	49	0.18	0.03	NR	NR	0.19	0.06	0.25	0.07	0.12	0.03
Formaldehyde	51	51	2.81	0.48	1.19	0.36	3.17	0.85	4.52	0.64	1.50	0.30

NR = Not reportable due to the low number of measured detections.

- The seasonal averages did not vary much, with the exceptions of formaldehyde and carbon tetrachloride.

- Formaldehyde was significantly higher in the summer than in other seasons.

- Carbon tetrachloride was higher in the summer and autumn than in other seasons.

The following observations for MSTN are shown in Table 26-3:

- Formaldehyde had the highest daily average concentration by mass (2.81 ± 0.48 $\mu g/m^3$), followed by acetaldehyde (1.26 ± 0.12 $\mu g/m^3$).

- Most of the pollutants of interest had seasonal averages that varied little, with the exception of carbon tetrachloride and formaldehyde.

- Formaldehyde was significantly higher in the spring and summer (3.17 ± 0.85 $\mu g/m^3$ and 4.52 ± 0.64 $\mu g/m^3$, respectively) than in winter or autumn (1.19 ± 0.36 $\mu g/m^3$ and 1.50 ± 0.30 $\mu g/m^3$, respectively).

- Carbon tetrachloride was higher in summer and autumn than in other seasons.

26.3 Non-Chronic Risk Evaluation

Non-chronic risk is evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen at either site, only acrolein exceeded the acute risk values, and its non-chronic risk is summarized in Table 26-4.

The following observations about acrolein are shown in Table 26-4:

- All of the measured detections of acrolein at the Tennessee monitoring sites exceeded the ATSDR acute value of 0.11 $\mu g/m^3$and all but one exceeded the California REL value of 0.19 $\mu g/m^3$.

- The average acrolein concentration for MSTN was higher than for LDTN (1.00 ± 0.18 $\mu g/m^3$ vs. 0.64 ± 0.10 $\mu g/m^3$, respectively).

- Seasonal acrolein averages were used to evaluate intermediate risk. Every seasonal average for both Tennessee sites exceeded the intermediate risk factor.

Table 26-4. Non-Chronic Risk Summary for the Tennessee Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate -term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
LDTN	TO-15	Acrolein	0.64 ± 0.10	0.11	48	0.19	48	0.09	0.64 ± 0.24	0.46 ± 0.17	0.72 ± 0.15	0.46 ± 0.16
MSTN	TO-15	Acrolein	1.00 ± 0.18	0.11	44	0.19	43	0.09	0.62 ± 0.30	1.37 ± 0.49	0.84 ± 0.18	0.71 ± 0.19

- For the MSTN site, the summer acrolein average of 1.37 ± 0.49 $\mu g/m^3$ was more than 14 times the ATSDR intermediate-term MRL of 0.09 $\mu g/m^3$.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of daily concentration and daily average wind direction. Figures 26-4 and 26-5 are pollution roses for acrolein for the Tennessee monitoring sites.

Observations gleaned from the acrolein pollution roses include:

- Figure 26-4 shows that all acrolein concentrations exceeded the acute risk factors at LDTN, indicated by a dashed (CALEPA REL) and solid line (ATSDR MRL). Figure 26-5 shows that all acrolein concentrations at MSTN exceeded the ATSDR MRL, while all but one exceeded the CALEPA REL.

- The pollution roses for both sites showed few acrolein measured detections occurred with southerly, southeasterly, or easterly winds.

- LDTN is located on a mile-wide strip of land bounded on either side by the Tennessee River. A major roadway through town runs just to the northwest of the monitoring site (Figure 26-1). MSTN is located to the southwest of LDTN and south of the town of Loudon. Several point sources lie between LDTN and MSTN, which are located about a mile apart.

26.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

26.4.1 Pearson Correlation Analysis

Table 26-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Tennessee monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

Figure 26-4. Acrolein Pollution Rose for LDTN

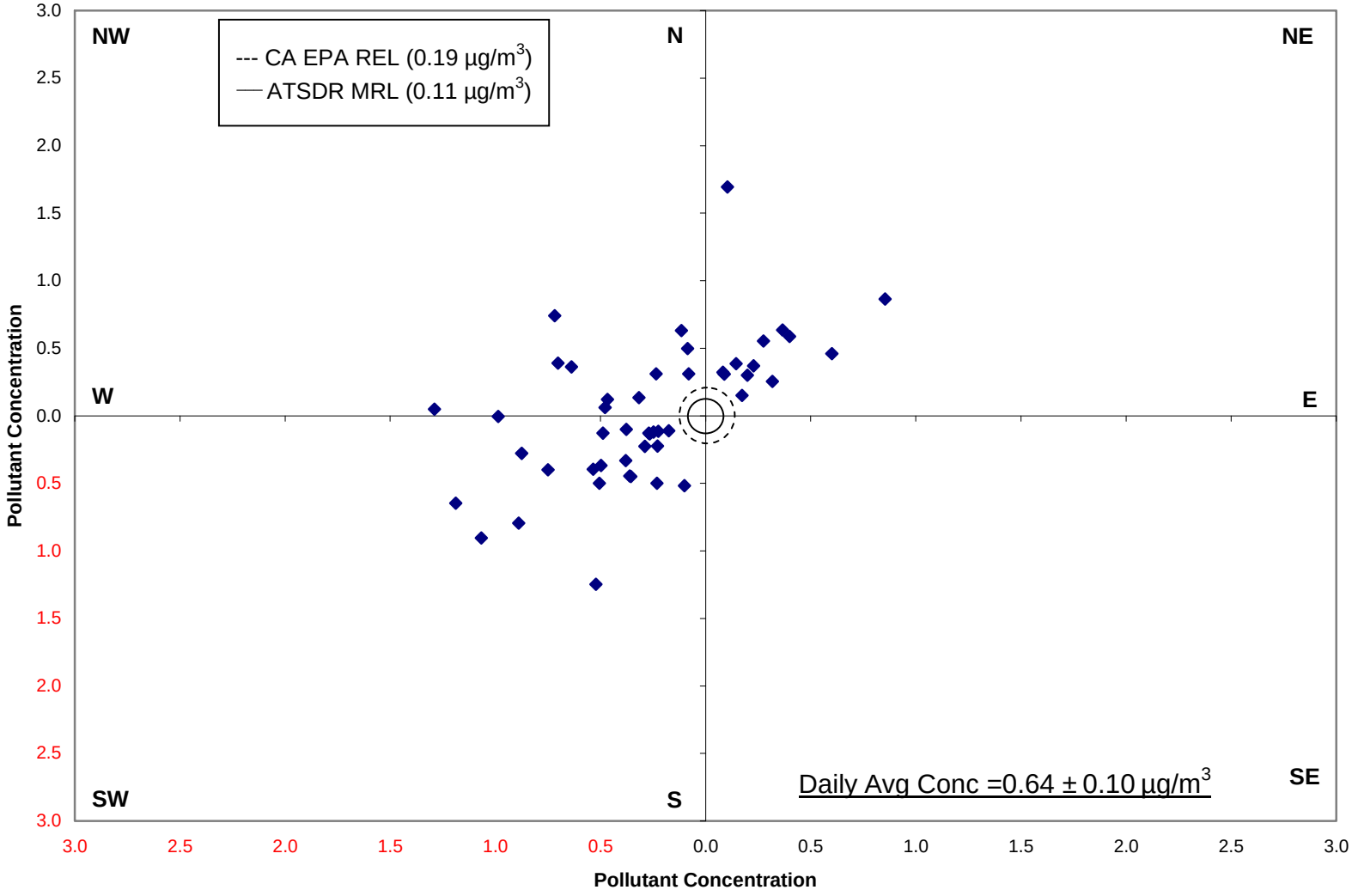


Figure 26-5. Acrolein Pollution Rose for MSTN

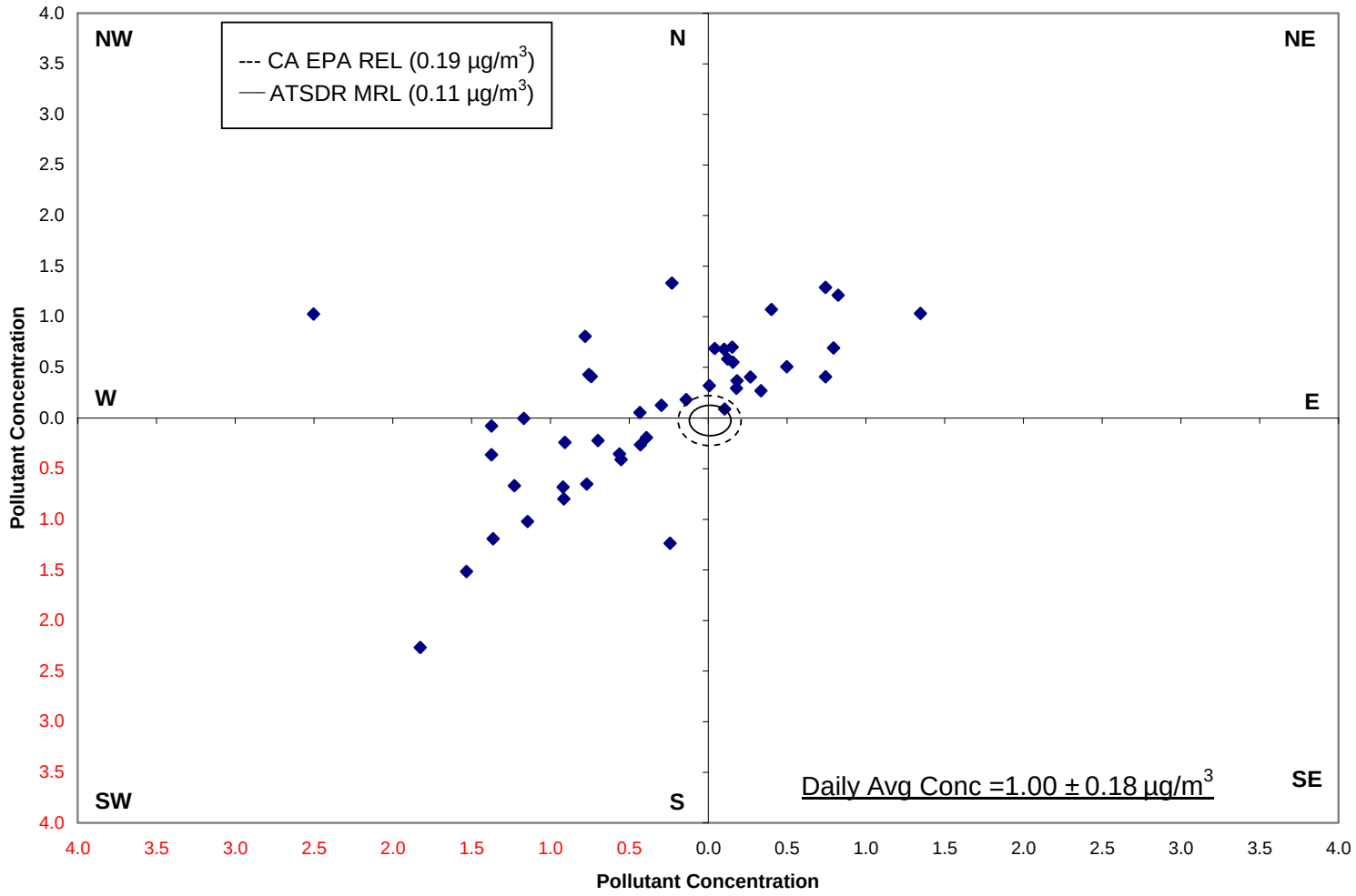


Table 26-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Tennessee Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Loudon, Tennessee – LDTN								
Acetaldehyde	56	0.39	0.32	0.14	0.23	-0.42	0.33	-0.26
Acrolein	48	0.12	0.18	0.22	0.20	0.10	-0.13	-0.07
Benzene	55	-0.04	-0.02	0.03	0.00	0.11	0.22	-0.11
1,3-Butadiene	48	-0.21	-0.25	-0.28	-0.27	-0.04	0.30	-0.30
Carbon Tetrachloride	55	0.42	0.42	0.42	0.43	0.02	0.12	-0.23
p-Dichlorobenzene	51	0.02	0.08	0.17	0.13	0.21	-0.13	0.08
Formaldehyde	56	0.84	0.82	0.65	0.74	-0.36	0.12	-0.21
Loudon Middle School, Loudon, Tennessee – MSTN								
Acetaldehyde	51	0.34	0.27	0.02	0.13	-0.55	0.35	-0.25
Acrolein	44	0.19	0.17	0.07	0.11	-0.19	-0.10	-0.05
Benzene	49	-0.08	-0.14	-0.22	-0.19	-0.23	0.30	-0.13
1,3-Butadiene	40	-0.26	-0.32	-0.30	-0.32	-0.03	0.37	-0.25
Carbon Tetrachloride	49	0.22	0.24	0.29	0.27	0.20	-0.11	-0.17
p-Dichlorobenzene	47	0.52	0.56	0.48	0.54	-0.05	-0.20	0.03
Formaldehyde	51	0.79	0.80	0.62	0.72	-0.35	-0.16	-0.03

The following observations are gathered for LDTN from Table 26-5:

- Strong positive correlations were calculated between formaldehyde and maximum, average, dew point, and wet bulb temperatures. This indicates that increasing temperatures and moisture content lead to increasing formaldehyde concentrations. This supports the high summer formaldehyde average discussed in Section 26.2.

- All of the correlations with scalar wind speed for LDTN were negative, with the exception of *p*-dichlorobenzene, indicating that decreasing wind speeds lead to increasing concentrations of most of the pollutants of interest.

The following observations are gathered for MSTN from Table 26-5:

- Strong positive correlations were calculated between formaldehyde and maximum, average, dew point, and wet bulb temperatures. This indicates that increasing temperatures and moisture content lead to increasing formaldehyde concentrations. These formaldehyde correlations also support the higher summer formaldehyde averages discussed in Section 26.2.

- *p*-Dichlorobenzene also exhibited strong positive correlations with maximum, average, dew point, and wet bulb temperatures.

- Acetaldehyde exhibited a strong negative correlation with relative humidity, indicating that increasing humidity leads to decreasing acetaldehyde concentrations.

- All of the correlations with scalar wind speed for MSTN were negative, with the exception of *p*-dichlorobenzene, indicating that decreasing wind speeds lead to increasing concentrations of most of the pollutants of interest.

26.4.2 Composite Back Trajectory Analysis

Figures 26-6 and 26-7 are composite back trajectory maps for the Tennessee monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

The following observations can be made from Figure 26-6 and 26-7:

- Back trajectories originated from a variety of directions at LDTN. The 24-hour airshed domain was somewhat large at LDTN, with trajectories originating as far away as Iowa or Texas, or greater than 600 miles away. However, most of the trajectories originated within 300 miles of the site, and nearly all originate within 400 miles of the LDTN monitoring site.

Figure 26-6. Composite Back Trajectory Map for LDTN

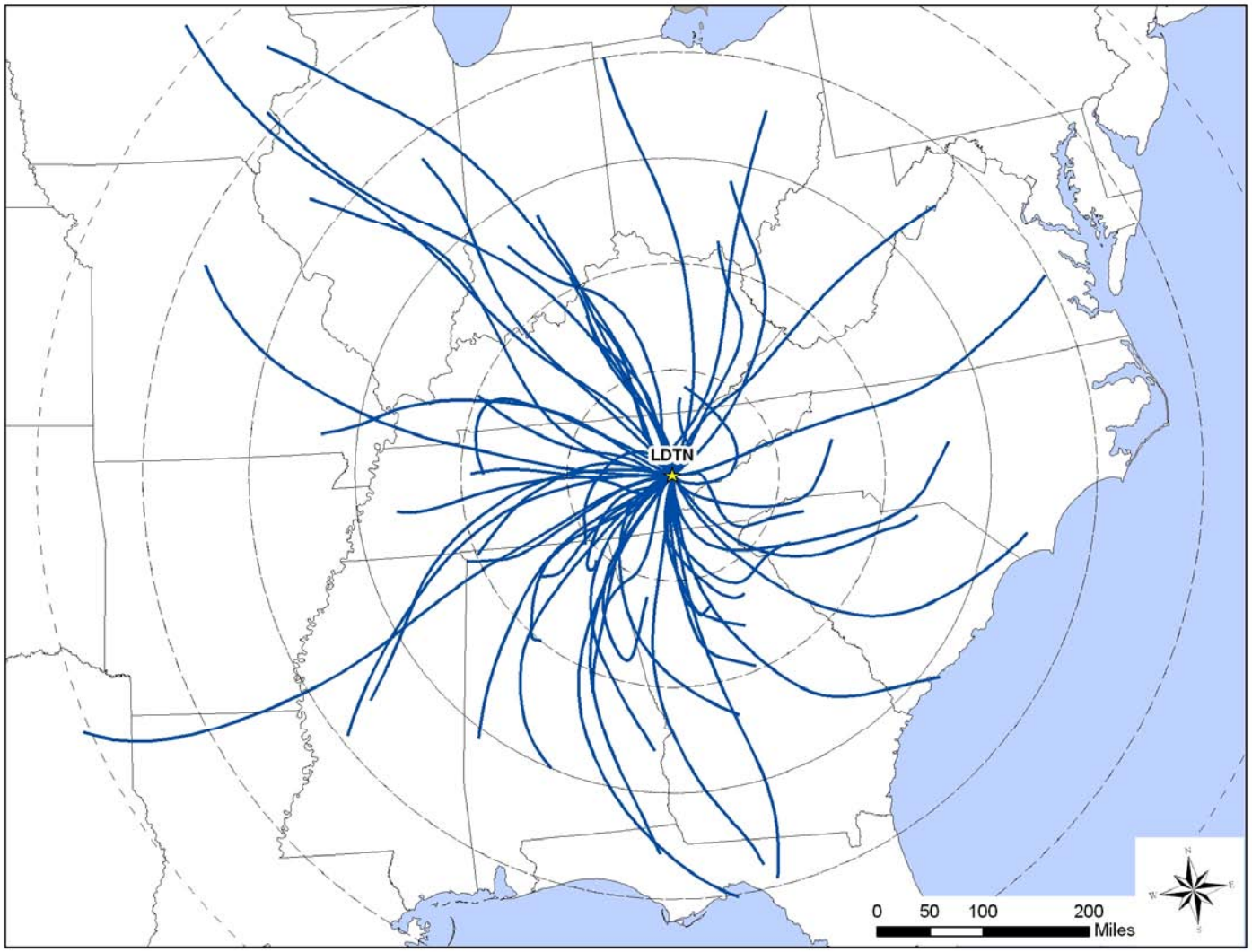
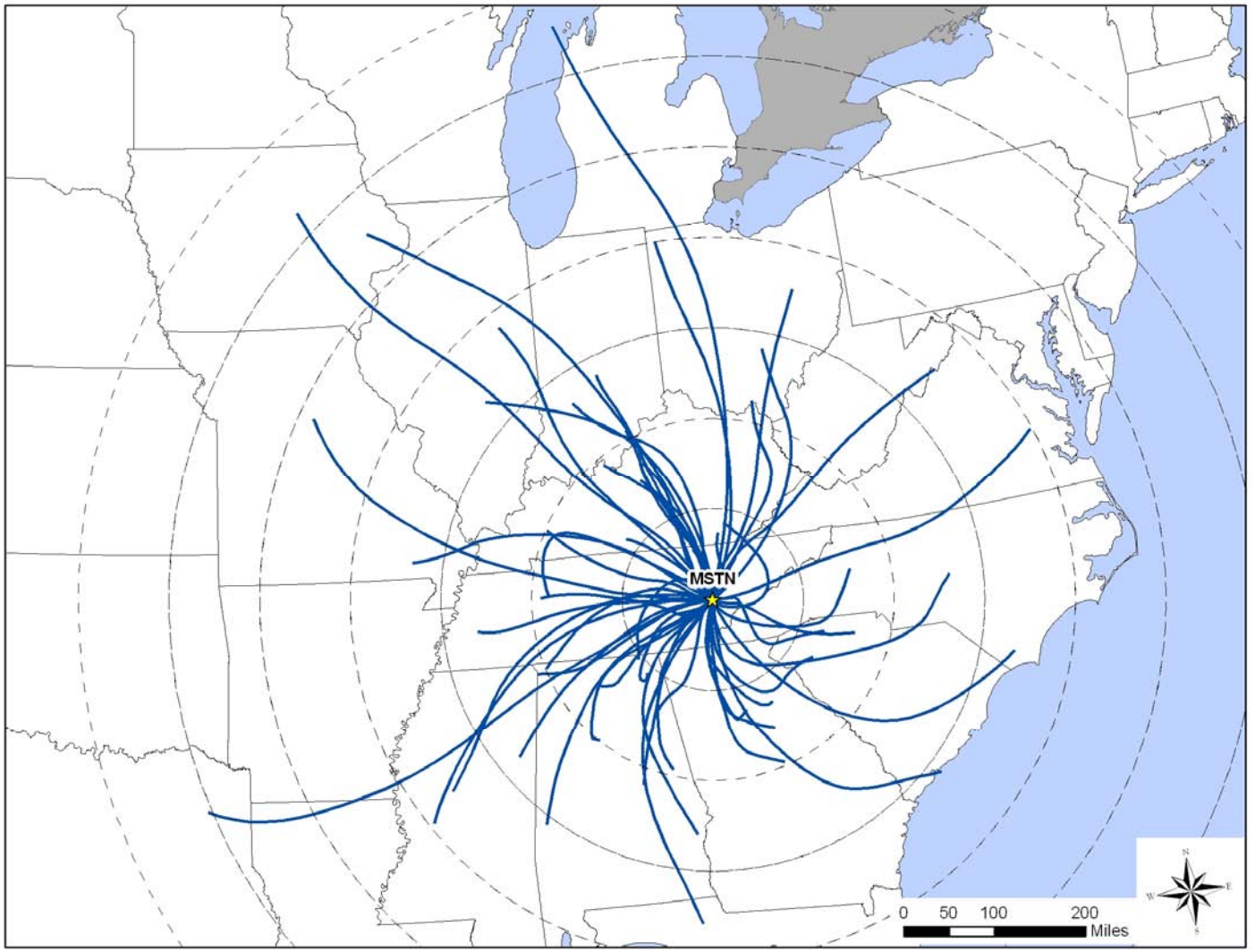


Figure 26-7. Composite Back Trajectory Map for MSTN



- Back trajectories also originated from a variety of directions at MSTN. The 24-hour airshed domain was similar to LDTN's, with trajectories originating over 600 miles away.

26.4.3 Wind Rose Analysis

Hourly wind data from the Knoxville McGhee-Tyson Airport weather station were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 26-8 and 26-9 are the wind roses for the Tennessee monitoring sites on days that sampling occurred.

Observations from Figures 26-8 and 26-9 include:

- Hourly winds were predominantly out of the west, west-southwest, and southwest on days that samples were collected near MSTN and LDTN.
- Winds from these directions also tended to be stronger in nature than winds from other directions.
- Calm winds (<2 knots) were recorded for approximately 20 percent of the hourly observations.

26.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

26.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Dickson County and Loudon County were obtained from the Tennessee Department of Safety and the U.S. Census Bureau, and are summarized in Table 26-6. Table 26-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 26-6 contains the

Figure 26-8. Wind Rose for LDTN Sampling Days

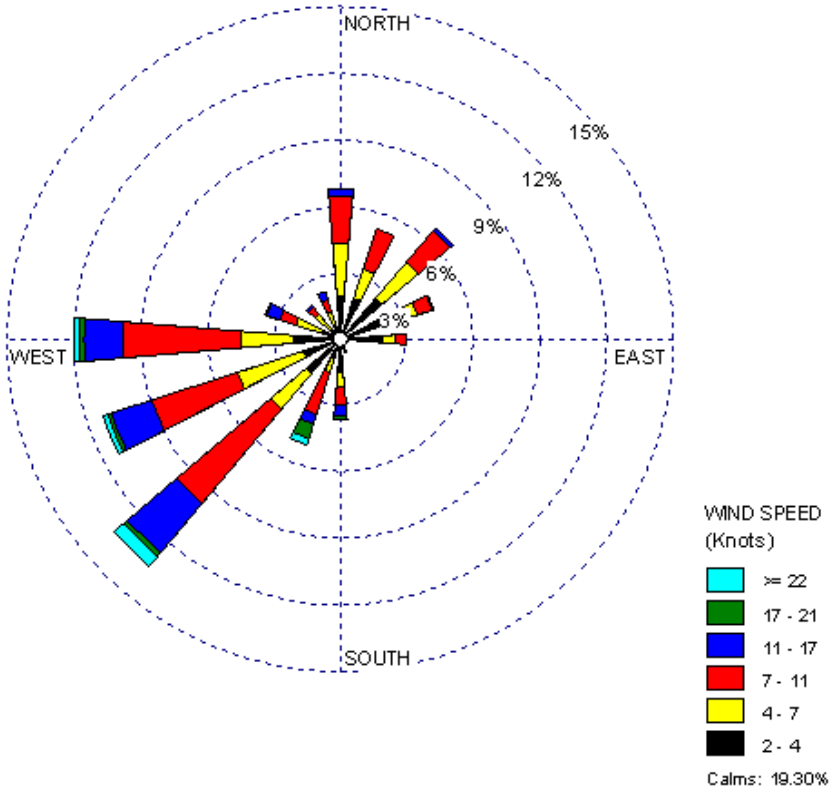


Figure 26-9. Wind Rose for MSTN Sampling Days

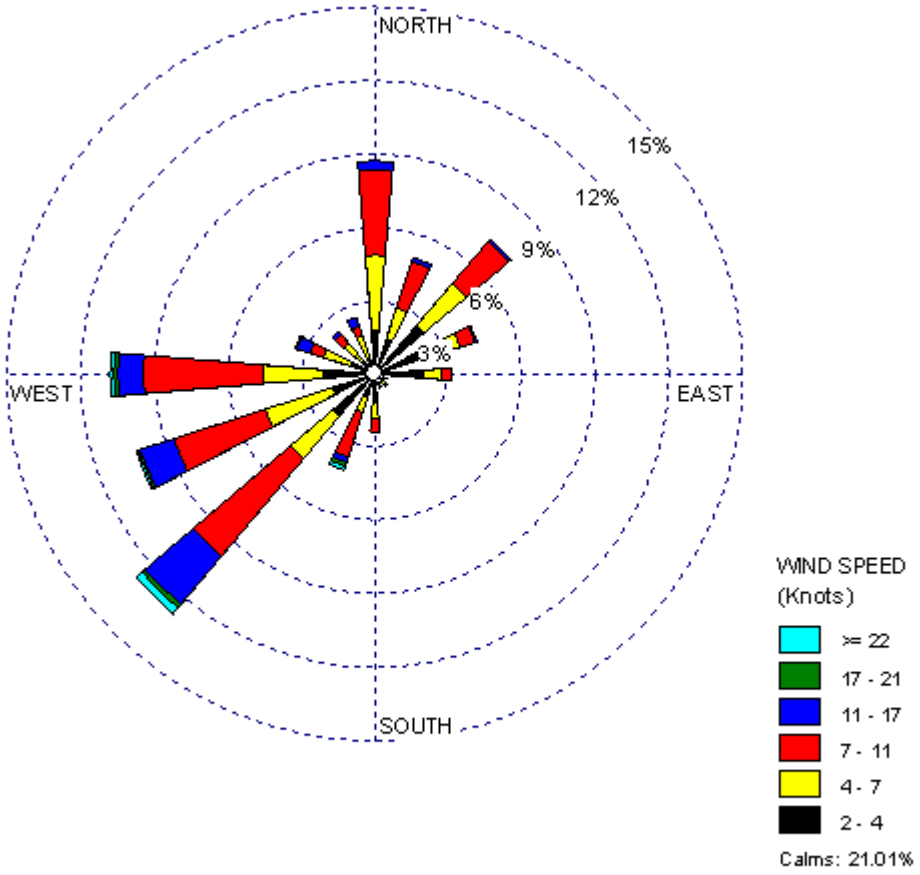


Table 26-6. Motor Vehicle Information for the Tennessee Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
LDTN	44,566	50,519	1.13	48,670	55,171	12,945
MSTN	44,566	50,519	1.13	48,670	55,171	7,287

average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 26-6 include:

- The county populations, vehicle registration, and vehicle-to-population ratio are all the same for LDTN and MSTN because they are in the same county. In addition, these sites are within the same zip code, so their 10-mile population and vehicle registration are also the same.

- The sites vary when it comes to traffic count, with LDTN having nearly twice the daily traffic passing the site.

- Compared to other UATMP sites, LDTN and MSTN are in the lower third of sites for population and vehicle registration. Both are in the top 10 sites for vehicle to population ratio.

26.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-2 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the Tennessee monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- The ratios of the Tennessee sites generally resemble each other.

- For both sites, the toluene-ethylbenzene ratio was significantly higher than the roadside study.

- The benzene-ethylbenzene ratio was higher than the xylenes-ethylbenzene ratio for both sites, which is the reverse of the roadside study.

26.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was

conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The LDTN monitoring site has participated in the UATMP since 2003. Figure 26-10 presents the trends analysis for formaldehyde, benzene, and 1,3-butadiene for LDTN. MSTN has not participated in the UATMP for three consecutive years, therefore a trends analysis was not conducted.

Results from the trend analysis for LDTN include:

- Concentrations of formaldehyde decreased significantly between 2003 and 2005 at the LDTN monitoring site; the concentration remained steady in 2006.
- 1,3-Butadiene was not detected during the 2003 program year; concentrations peaked in 2004 and have decreased since then.
- Concentrations of benzene have been fairly constant at LDTN.

26.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Tennessee sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 26-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 26-7. The NATA data are presented for the census tracts where the monitoring sites are located.

The census tract information for the Tennessee sites is as follows:

- The census tract for LDTN is 47105060200, which had a population of 9,529, which represents approximately 24.4 percent of the Loudon County population in 2000.
- The census tract for MSTN is 47105060500, which had a population of 7,898, which also represents approximately 20.2 percent of the county population in 2000.

Figure 26-10. Comparison of Yearly Averages for the LDTN Monitoring Site

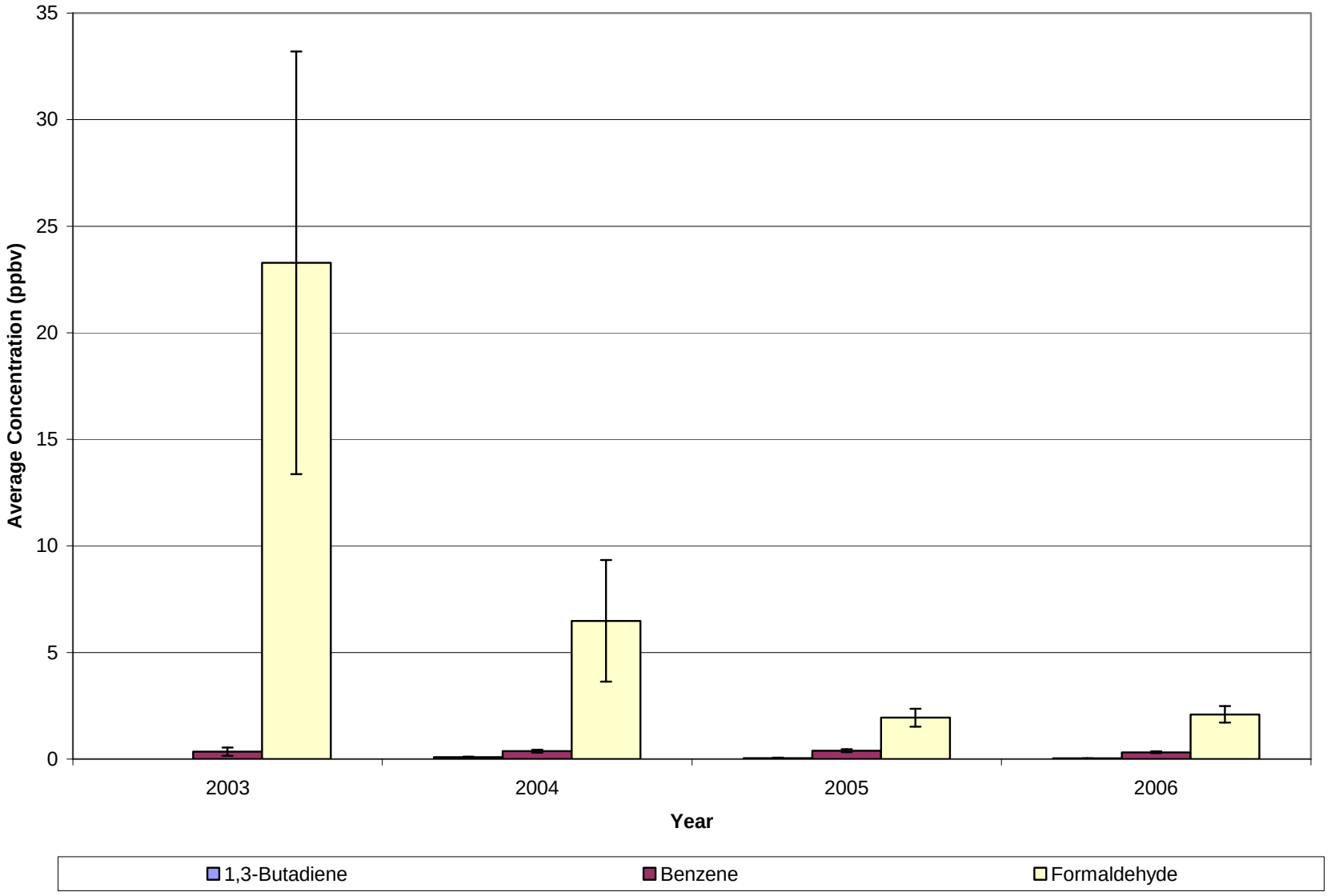


Table 26-7. Chronic Risk Summary for the Monitoring Sites in Tennessee

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Loudon, Tennessee (LDTN) – Census Tract ID 47105060200								
Acetaldehyde	0.0000022	0.009	1.22	2.69	0.14	2.21 ± 0.32	4.86	0.25
Acrolein	NR	0.00002	0.06	NR	2.99	0.58 ± 0.10	NR	28.90
Acrylonitrile	0.000068	0.002	<0.01	0.06	<0.01	0.07 ± 0.01	4.43	0.03
Benzene	0.0000078	0.03	0.89	6.95	0.03	1.02 ± 0.12	7.99	0.03
1,3-Butadiene	0.00003	0.002	0.03	0.77	0.01	0.06 ± 0.01	1.84	0.03
Carbon Tetrachloride	0.000015	0.04	0.21	3.19	0.01	0.65 ± 0.06	9.82	0.02
Chloromethylbenzene	0.000049	NR	<0.01	<0.01	NR	0.01 ± <0.01	0.71	NR
***p*-Dichlorobenzene**	0.000011	0.8	0.02	0.17	<0.01	0.11 ± 0.02	1.26	<0.01
Formaldehyde	5.5E-09	0.0098	0.78	<0.01	0.08	2.58 ± 0.47	0.01	0.26
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.09 ± 0.02	1.90	<0.01
1,1,2,2-Tetrachloroethane	0.000058	NR	0.01	0.72	NR	0.05 ± <0.01	2.61	NR
Tetrachloroethylene	0.0000059	0.27	0.02	0.15	<0.01	0.07 ± 0.01	0.41	<0.01
Loudon, Tennessee (MSTN) – Census Tract ID 47105060500								
Acetaldehyde	0.0000022	0.009	1.05	2.31	0.12	1.26 ± 0.12	2.76	0.14
Acrolein	NR	0.00002	0.05	NR	2.39	0.91 ± 0.18	NR	45.72
Acrylonitrile	0.000068	0.002	<0.01	0.04	<0.01	0.09 ± 0.03	5.88	0.04
Benzene	0.0000078	0.03	0.72	5.60	0.02	0.87 ± 0.12	6.79	0.03
1,3-Butadiene	0.00003	0.002	0.02	0.47	0.01	0.05 ± 0.01	1.41	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.66 ± 0.04	9.94	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.01	0.12	<0.01	0.17 ± 0.03	1.88	<0.01
Formaldehyde	5.5E-09	0.0098	0.73	<0.01	0.07	2.81 ± 0.48	0.02	0.29
Tetrachloroethylene	0.0000059	0.27	0.02	0.10	<0.01	0.09 ± 0.03	0.52	<0.01

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

The following observations can be made from Table 26-7:

- Formaldehyde and acetaldehyde had the highest annual averages by mass concentration for the Tennessee sites. Although the formaldehyde averages were fairly similar, acetaldehyde average was significantly lower for MSTN.

- Carbon tetrachloride and benzene had the highest annual average-based cancer risks for LDTN and MSTN, while acrolein had the highest noncancer risk for both sites.

- While the carbon tetrachloride and benzene risks were similar for both sites, the acrolein HQ was significantly higher for MSTN.

- NATA-modeled concentrations and risks of the pollutants of interest for the Tennessee sites were fairly similar.

- For both sites, acetaldehyde, benzene, and formaldehyde had the highest concentrations; benzene, carbon tetrachloride, and acetaldehyde had the highest cancer risks; acrolein had the only noncancer HQ greater than 1.0.

26.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 26-8 and 26-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 26-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 26-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. The Tennessee sites sampled for VOC and carbonyl compounds only. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

Table 26-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Tennessee

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (Loudon County)		Top 10 Cancer Toxicity-Weighted Emissions (Loudon County)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Loudon, Tennessee – LDTN					
Benzene	79.28	Benzene	6.18E-04	Carbon Tetrachloride	9.82
Acetaldehyde	56.93	1,3-Butadiene	2.25E-04	Benzene	7.99
Formaldehyde	26.50	Acetaldehyde	1.25E-04	Acetaldehyde	4.86
1,3-Butadiene	7.50	Arsenic	1.14E-04	Acrylonitrile	4.43
Dichloromethane	3.84	Naphthalene	7.14E-05	1,1,2,2-Tetrachloroethane	2.61
Naphthalene	2.10	Polycyclic Organic Matter as 15-PAH	6.55E-05	Hexachloro-1,3-butadiene	1.90
Tetrachloroethylene	2.06	Hexavalent Chromium	5.75E-05	1,3-Butadiene	1.84
Polycyclic Organic Matter as 15-PAH	1.19	Polycyclic Organic Matter as 7-PAH	4.60E-05	*p*-Dichlorobenzene	1.26
p-Dichlorobenzene	0.89	Polycyclic Organic Matter as non-15 PAH	3.55E-05	Chloromethylbenzene	0.71
Trichloroethylene	0.49	Nickel	2.43E-05	Tetrachloroethylene	0.41
Loudon, Tennessee – MSTN					
Benzene	79.28	Benzene	6.18E-04	Carbon Tetrachloride	9.94
Acetaldehyde	56.93	1,3-Butadiene	2.25E-04	Benzene	6.79
Formaldehyde	26.50	Acetaldehyde	1.25E-04	Acrylonitrile	5.88
1,3-Butadiene	7.50	Arsenic	1.14E-04	Acetaldehyde	2.76
Dichloromethane	3.84	Naphthalene	7.14E-05	*p*-Dichlorobenzene	1.88
Naphthalene	2.10	Polycyclic Organic Matter as 15-PAH	6.55E-05	1,3-Butadiene	1.41
Tetrachloroethylene	2.06	Hexavalent Chromium	5.75E-05	Tetrachloroethylene	0.52
Polycyclic Organic Matter as 15-PAH	1.19	Polycyclic Organic Matter as 7-PAH	4.60E-05	Formaldehyde	0.02
p-Dichlorobenzene	0.89	Polycyclic Organic Matter as non-15 PAH	3.55E-05		
Trichloroethylene	0.49	Nickel	2.43E-05		

Table 26-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Tennessee

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (Loudon County)		Top 10 Noncancer Toxicity-Weighted Emissions (Loudon County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Loudon, Tennessee – LDTN					
Carbon Disulfide	1,130.08	Acrolein	75,675.31	Acrolein	28.90
Toluene	200.00	Manganese	10,827.61	Formaldehyde	0.26
Hydrochloric Acid	146.47	Hydrochloric Acid	7,323.53	Acetaldehyde	0.25
Xylenes	133.59	Acetaldehyde	6,325.04	Benzene	0.03
Styrene	85.00	1,3-Butadiene	3,750.57	Acrylonitrile	0.03
Benzene	79.28	Formaldehyde	2,704.13	1,3-Butadiene	0.03
Acetaldehyde	56.93	Benzene	2,642.72	Carbon Tetrachloride	0.02
Hexane	33.19	Nickel	2,337.56	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	32.76	Carbon Disulfide	1,614.40	Tetrachloroethylene	<0.01
Methanol	27.13	Xylenes	1,335.93	*p*-Dichlorobenzene	<0.01
Loudon, Tennessee – MSTN					
Carbon Disulfide	1,130.08	Acrolein	75,675.31	Acrolein	45.72
Toluene	200.00	Manganese	10,827.61	Formaldehyde	0.29
Hydrochloric Acid	146.47	Hydrochloric Acid	7,323.53	Acetaldehyde	0.14
Xylenes	133.59	Acetaldehyde	6,325.04	Acrylonitrile	0.04
Styrene	85.00	1,3-Butadiene	3,750.57	Benzene	0.03
Benzene	79.28	Formaldehyde	2,704.13	1,3-Butadiene	0.02
Acetaldehyde	56.93	Benzene	2,642.72	Carbon Tetrachloride	0.02
Hexane	33.19	Nickel	2,337.56	Tetrachloroethylene	<0.01
Ethylbenzene	32.76	Carbon Disulfide	1,614.40	*p*-Dichlorobenzene	<0.01
Methanol	27.13	Xylenes	1,335.93		

The following observations can be made from Table 26-8:

- Benzene was the highest emitted pollutant with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the second highest cancer risk based on the 2006 annual averages for LDTN and MSTN.

- Carbon tetrachloride had the highest cancer risk based on the 2006 annual averages for both sites, yet this pollutant was neither one of the highest emitted nor one of the most toxic in Loudon County, based on the 2002 NEI emission inventory.

- In addition to benzene, acetaldehyde and 1,3-butadiene appeared on all three "top 10" lists.

The following observations can be made from Table 26-9:

- Carbon disulfide was the highest emitted pollutant with a noncancer risk factor in Loudon County. This pollutant had the ninth highest noncancer toxicity-weighted emissions for Loudon County.

- Like most UATMP counties, acrolein had the highest noncancer toxicity-weighted emissions and had the highest noncancer risks based on the 2006 annual averages for both sites. However, acrolein did not appear in the list of highest emitted pollutants.

Tennessee Pollutant Summary

- *The pollutants of interest common to each of the Tennessee sites were acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and, p-dichlorobenzene.*

- *Formaldehyde had the highest daily average for both MSTN and LDTN. Formaldehyde was also highest during summer for both sites.*

- *Acrolein exceeded the short-term risk factors at both Tennessee sites.*

- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation showed that concentrations formaldehyde decreased at LDTN since the onset of sampling in 2003 through 2005, then held steady in 2006.*

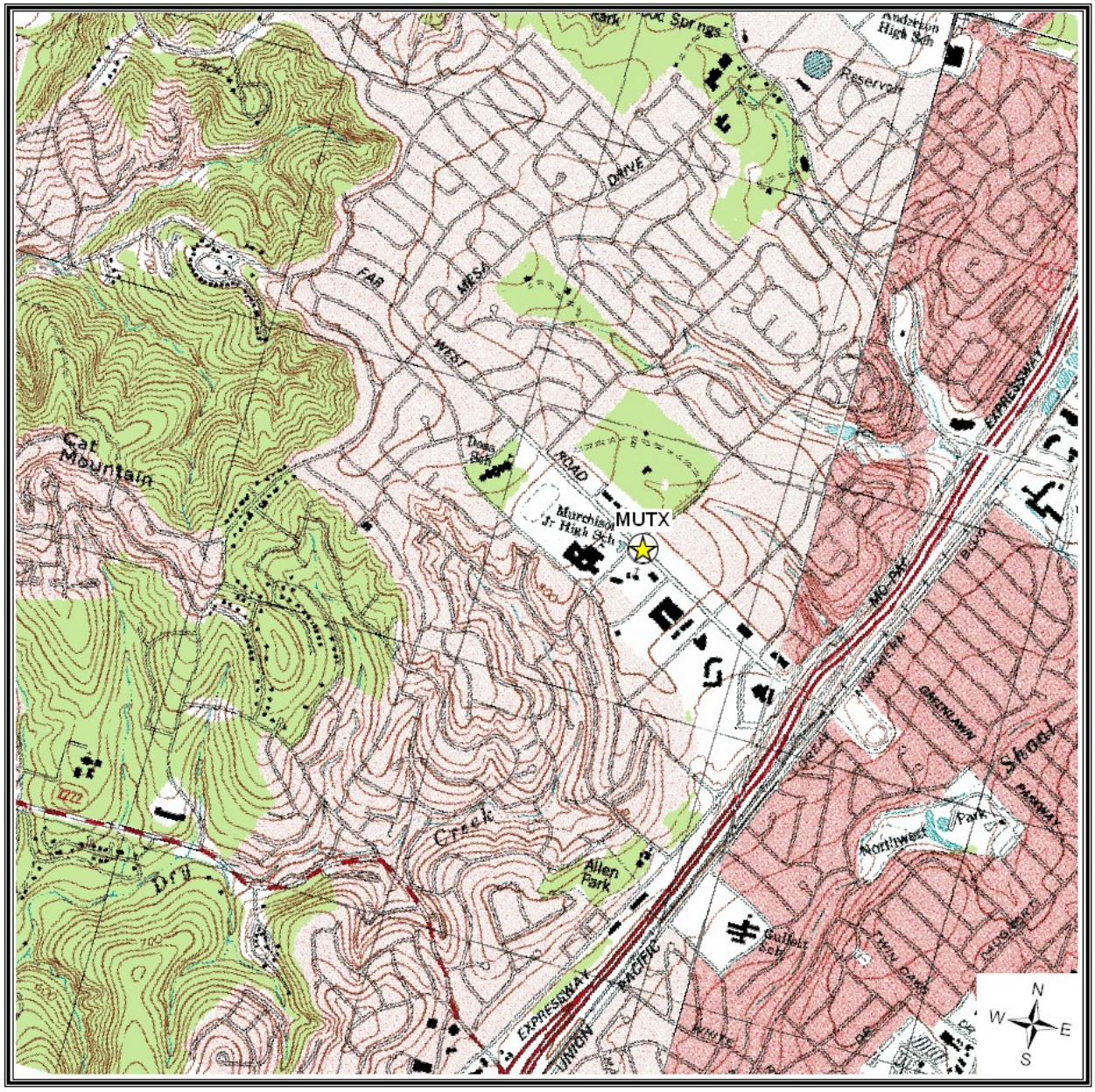
27.0 Sites in Texas

This section presents meteorological, concentration, and spatial trends for the five UATMP sites in or near the Austin, Texas area (MUTX, PITX, RRTX, TRTX, WETX, and YDSP). One UATMP site, YDSP, is located in El Paso. Figures 27-1 through 27-6 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 27-7 and 27-8 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 27-7 shows, four monitoring sites are located within Travis County and the city of Austin (MUTX, PITX, TRTX, and WETX), while one is located further north in the neighboring town of Round Rock in Williamson County (RRTX). The monitoring sites are oriented in a line running roughly north-south, with RRTX the furthest north and TRTX the furthest south. There are a variety of point sources in the Austin area including, but not limited to, rubber and miscellaneous plastic products production, processes using utility boilers, mineral product processing, and chemical and allied product production. YDSP is located within a mile of the US-Mexico border, as shown in Figure 27-8. Most of the nearby sources (US only) are located to the north and northwest of the monitoring site, and are primarily involved in fuel combustion industries, liquids distribution, and petroleum and natural gas production and refining. Across the border from YSDP in Mexico is Ciudad Juarez, a large industrial city.

Sites sampling in the Austin, Texas area were funded to sample for one year, beginning in the summer of 2005 and continuing through the summer of 2006, though the start and end dates vary slightly from site-to-site. The YSDP site sampled from March 2005 to March 2006. In order to facilitate analysis, the entire dataset for the one year of sampling for these sites is included here, as described in Section 3.0.

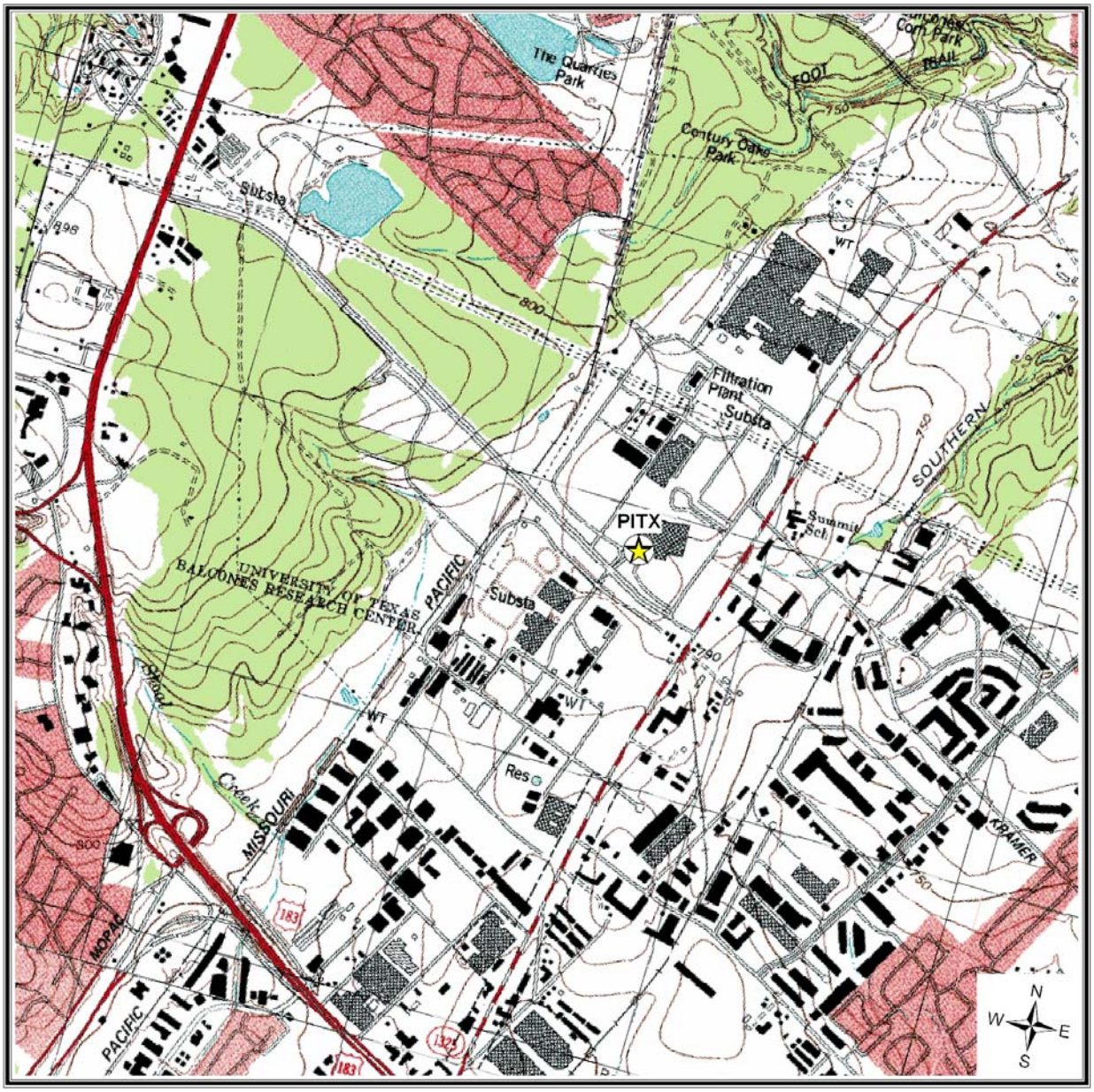
The city of Austin experiences a modified subtropical climate, that is, mild winters with only a handful of below freezing temperatures each year, and hot, muggy summers, due in part to the flow from the Gulf of Mexico. Northerly winds are prevalent in the winter and southeasterly winds are predominant in the summer. Precipitation is fairly evenly distributed throughout the year, through most frequently in the form of thunderstorms in the spring and summer. In contrast to Austin, El Paso's climate is more characteristic of the desert southwest. Winters are

Figure 27-1. Austin, Texas (MUTX) Monitoring Site



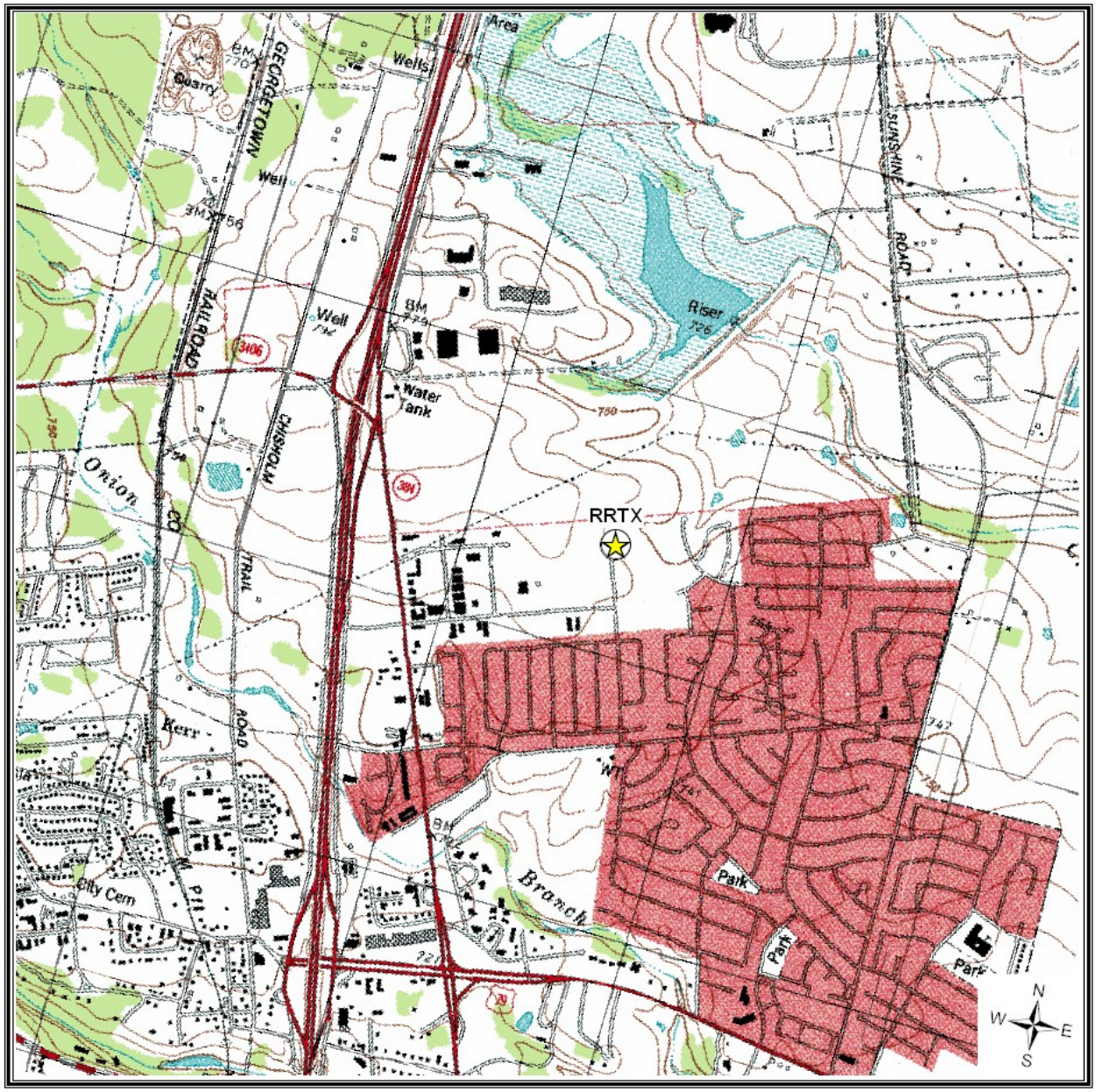
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 27-2. Austin, Texas (PITX) Monitoring Site



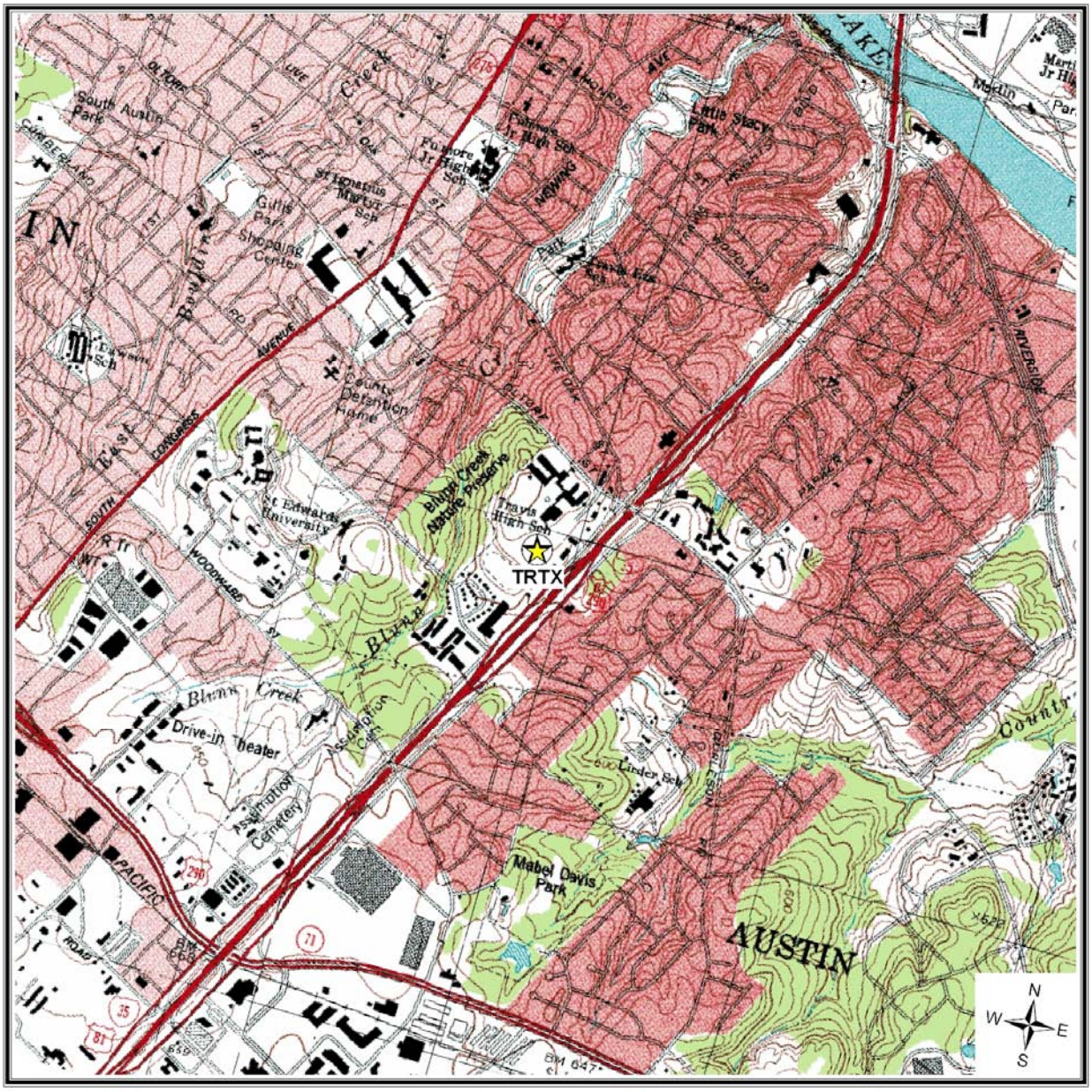
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 27-3. Round Rock, Texas (RRTX) Monitoring Site



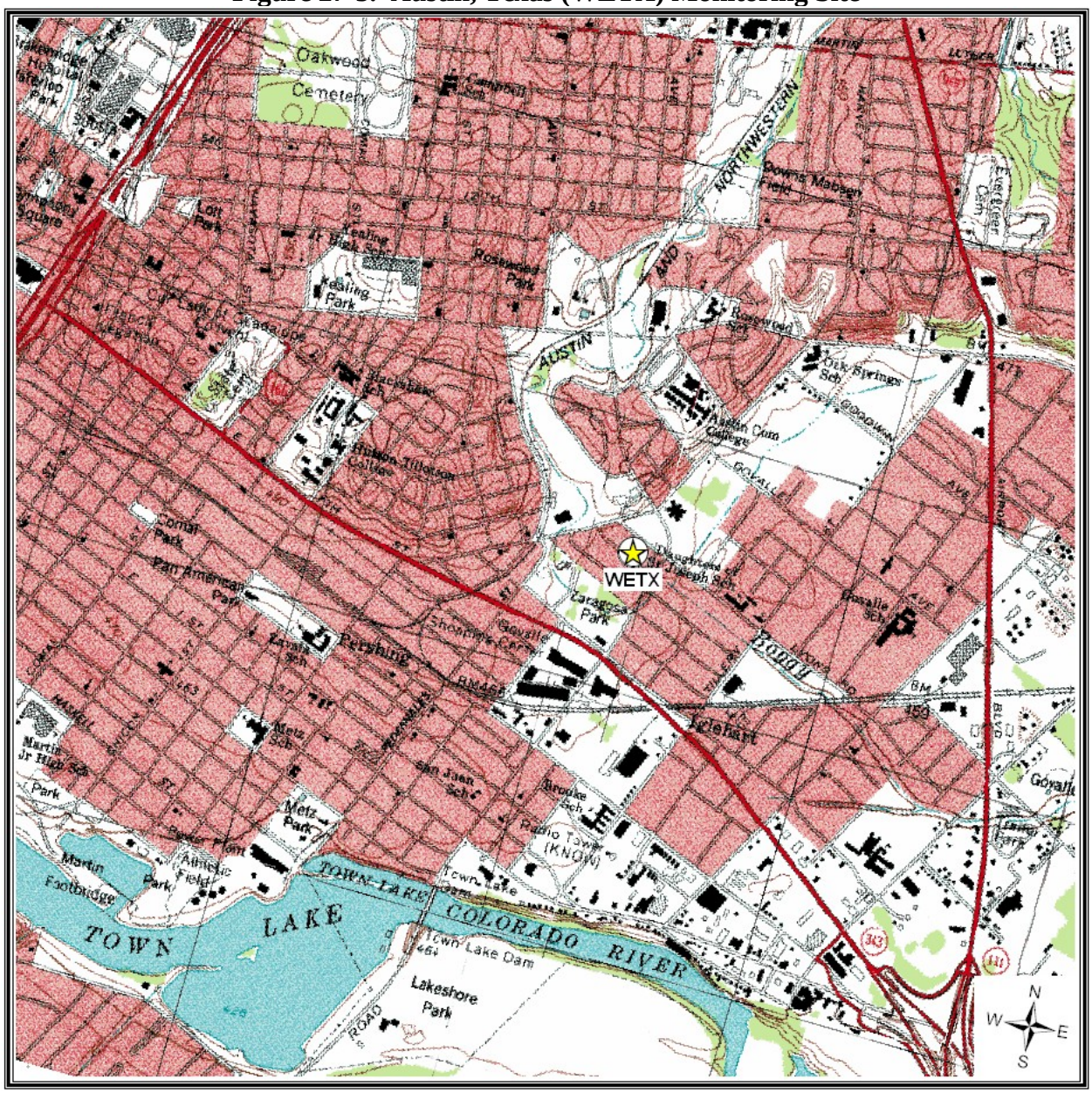
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 27-4. Austin, Texas (TRTX) Monitoring Site



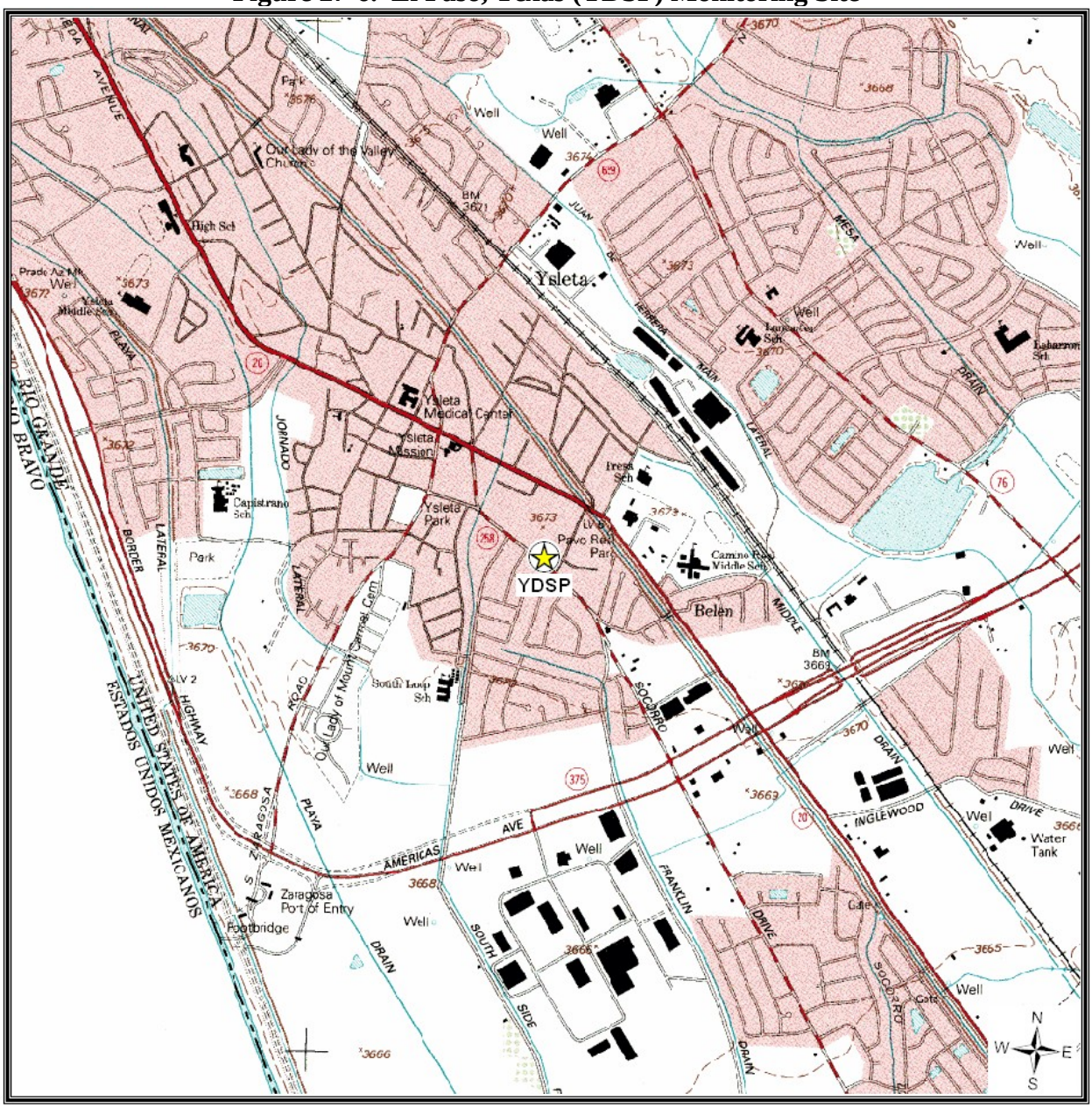
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 27-5. Austin, Texas (WETX) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 27-6. El Paso, Texas (YDSP) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 27-7. Facilities Located Within 10 Miles of MUTX, PITX, RRTX, TRTX, and WETX

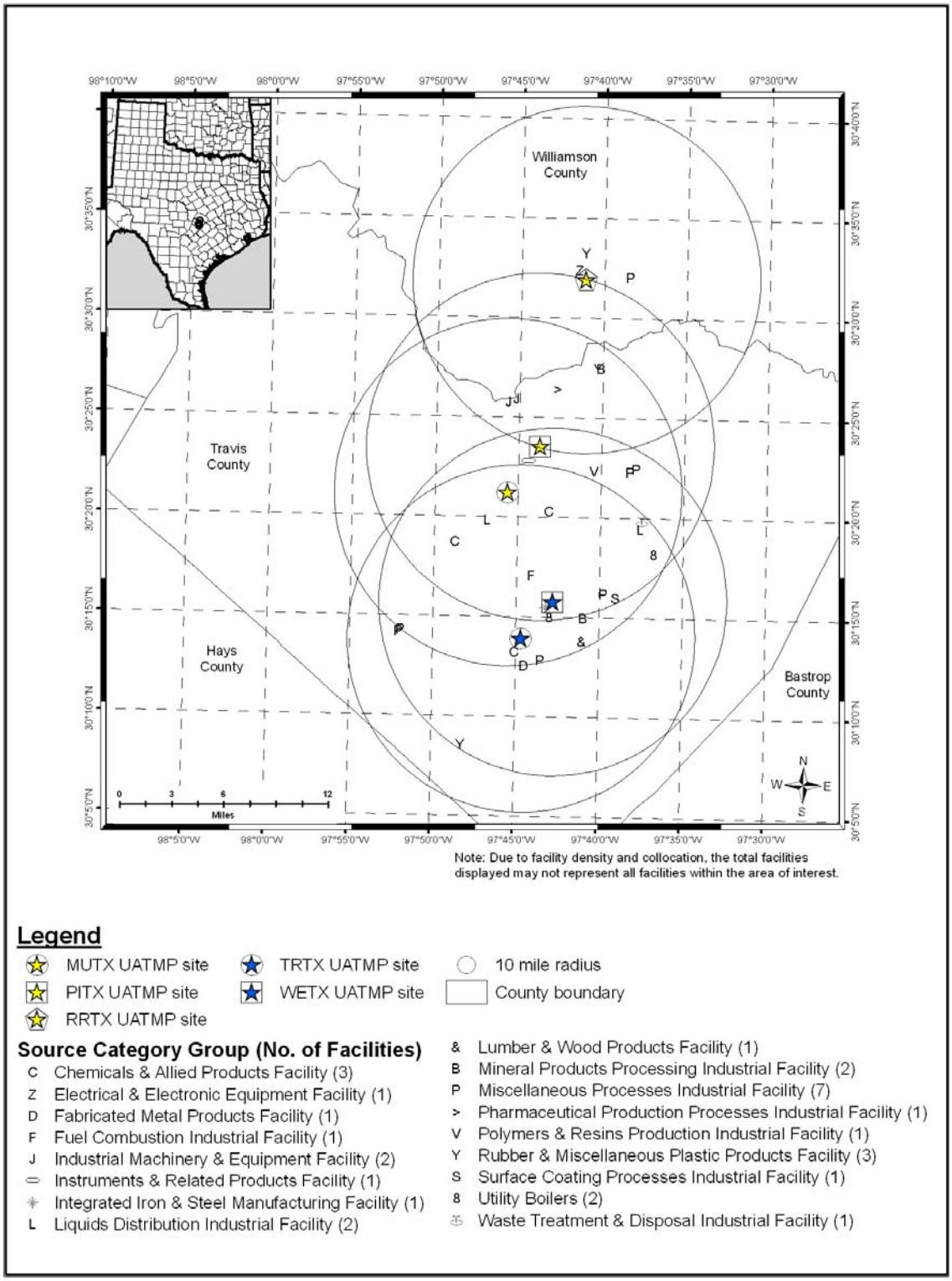
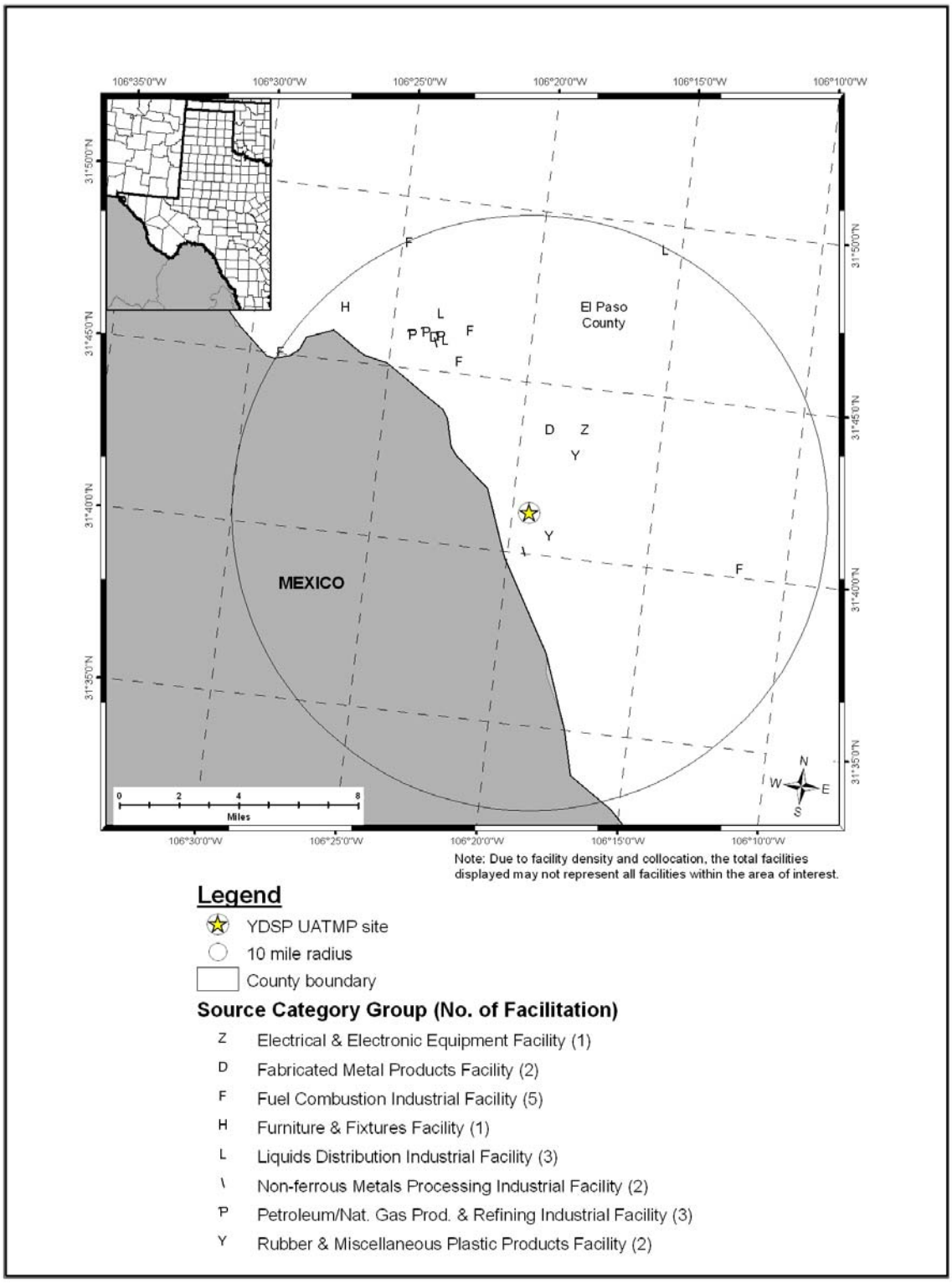


Figure 27-8. Facilities Located Within 10 Miles of YDSP



very mild, summers are hot, often with large diurnal temperature fluctuations, and precipitation is infrequent. Summertime thunderstorms tend to produce the heaviest rainfalls. Dust and sandstorms occur occasionally (Ruffner and Bair, 1987).

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005 and 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the MUTX and PITX monitoring sites is Camp Mabry Army National Guard (WBAN 13958); the weather station closest to the TRTX and WETX monitoring sites is Austin-Bergstrom International Airport (WBAN 13904); the closest weather station to RRTX is Georgetown Municipal Airport (WBAN 53942); and El Paso International Airport (WBAN 23044) is closest to YDSP.

Table 27-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) from July 2005 to June 2006 for the Austin sites, and April 2005 to March 2006 for YDSP as well as on days samples were collected. Also included in Table 27-1 is the 95 percent confidence interval for each parameter. As shown in Table 27-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

27.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Texas monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the guidance document as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens

Table 27-1. Average Meteorological Conditions near the Monitoring Sites in Texas

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
MUTX	13958	All 2006	82.08 ± 1.39	70.65 ± 1.33	53.55 ± 1.63	61.04 ± 1.27	59.14 ± 1.45	1015.95 ± 0.60	4.75 ± 0.20
		Sampling Day	83.43 ± 3.76	72.28 ± 3.74	54.47 ± 4.91	62.20 ± 3.67	57.87 ± 4.41	1015.84 ± 1.34	4.90 ± 0.71
PITX	13958	All 2006	82.08 ± 1.39	70.65 ± 1.33	53.55 ± 1.63	61.04 ± 1.27	59.14 ± 1.45	1015.95 ± 0.60	4.75 ± 0.20
		Sampling Day	83.14 ± 3.91	72.13 ± 3.87	54.53 ± 5.04	62.17 ± 3.77	58.29 ± 4.55	1016.05 ± 1.38	5.03 ± 0.73
RRTX	53942	All 2006	80.65 ± 1.43	68.66 ± 1.42	49.92 ± 1.62	60.05 ± 1.26	55.06 ± 1.21	NA[1]	6.38 ± 0.30
		Sampling Day	82.83 ± 4.04	70.86 ± 4.23	52.04 ± 4.97	61.16 ± 3.92	55.46 ± 3.53	NA[1]	5.49 ± 0.97
TRTX	13904	All 2006	83.22 ± 1.37	70.17 ± 1.38	54.99 ± 1.65	61.49 ± 1.33	63.53 ± 1.30	1015.73 ± 0.60	6.60 ± 0.30
		Sampling Day	83.94 ± 4.02	71.53 ± 4.13	55.90 ± 5.32	62.61 ± 4.12	62.92 ± 4.50	1015.57 ± 1.53	6.44 ± 1.03
WETX	13904	All 2006	83.22 ± 1.37	70.17 ± 1.38	54.99 ± 1.65	61.49 ± 1.33	63.53 ± 1.30	1015.73 ± 0.60	6.60 ± 0.30
		Sampling Day	85.00 ± 3.83	72.48 ± 3.93	57.12 ± 5.06	63.58 ± 3.93	63.44 ± 4.18	1015.66 ± 1.36	6.20 ± 0.98
YDSP	23044	All 2006	78.72 ± 1.45	66.82 ± 1.49	33.72 ± 1.82	50.51 ± 1.23	34.11 ± 1.64	1012.35 ± 0.59	7.48 ± 0.35
		Sampling Day	76.00 ± 3.47	64.07 ± 3.49	31.33 ± 4.52	48.53 ± 2.96	34.06 ± 4.18	1013.01 ± 1.47	8.02 ± 1.08

[1]This station did not record seal level pressure.

contribute to the top 95 percent of the site's total screens. Table 27-2 presents the pollutants that failed at least one screen at the Texas monitoring sites. The Austin sites sampled for carbonyls, VOC, and metals, while the El Paso site sampled for VOC only. In addition, WETX also sampled for hexavalent chromium. The Austin sites also sampled for total NMOC, but TNMOC is not considered in the determination of the pollutants of interest. The number of pollutants failing the screen varies by site, as indicated in Table 27-2, and a brief summary of each site's risk screening is provided below:

- Fifteen pollutants with a total of 250 measured concentrations failed screens at MUTX;
- Thirteen pollutants with a total of 240 measured concentrations failed screens at PITX;
- Fourteen pollutants with a total of 265 measured concentrations failed screens at RRTX;
- Nineteen pollutants with a total of 270 measured concentrations failed screens at TRTX;
- Twenty pollutants with a total of 277 measured concentrations failed screens at WETX; and
- Nine pollutants with a total of 273 measured concentrations failed screens at YDSP.

Additional observations from Table 27-2 include:

- The pollutants of interest also varied by site, yet the following five pollutants contributed to the top 95 percent of the total failed screens at each Texas monitoring site: acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene.
- Of the five pollutants that were the same among all six sites, three pollutants of interest, acrolein, benzene, and carbon tetrachloride, had 100 percent of their measured detections fail screens.

Table 27-2. Comparison of Measured Concentration and EPA Screening Values for the Texas Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Murchison Middle School, Austin, Texas – MUTX					
Carbon Tetrachloride	31	31	100.00	12.40	12.40
Benzene	31	31	100.00	12.40	24.80
Formaldehyde	30	30	100.00	12.00	36.80
Acetaldehyde	30	30	100.00	12.00	48.80
Acrolein	26	26	100.00	10.40	59.20
1,3-Butadiene	23	24	95.83	9.20	68.40
Arsenic (PM_{10})	23	30	76.67	9.20	77.60
p-Dichlorobenzene	20	25	80.00	8.00	85.60
Tetrachloroethylene	17	21	80.95	6.80	92.40
Manganese (PM_{10})	10	30	33.33	4.00	96.40
Hexachloro-1,3-butadiene	5	5	100.00	2.00	98.40
1,2-Dichloroethane	1	1	100.00	0.40	98.80
Nickel (PM_{10})	1	30	3.33	0.40	99.20
Chloromethylbenzene	1	1	100.00	0.40	99.60
Acrylonitrile	1	1	100.00	0.40	100.00
Total	250	316	79.11		
Pickle Research Center, Austin, Texas – PITX					
Acetaldehyde	31	31	100.00	12.92	12.92
Benzene	31	31	100.00	12.92	25.83
Carbon Tetrachloride	31	31	100.00	12.92	38.75
Formaldehyde	31	31	100.00	12.92	51.67
Arsenic (PM_{10})	26	32	81.25	10.83	62.50
Acrolein	24	24	100.00	10.00	72.50
1,3-Butadiene	22	26	84.62	9.17	81.67
p-Dichlorobenzene	19	28	67.86	7.92	89.58
Manganese (PM_{10})	16	32	50.00	6.67	96.25
Tetrachloroethylene	4	15	26.67	1.67	97.92
Hexachloro-1,3-butadiene	3	3	100.00	1.25	99.17
Nickel (PM_{10})	1	32	3.13	0.42	99.58
Trichloroethylene	1	4	25.00	0.42	100.00
Total	240	320	75.00		
Round Rock, Texas – RRTX					
Formaldehyde	32	32	100.00	12.08	12.08
Acetaldehyde	32	32	100.00	12.08	24.15
Benzene	30	30	100.00	11.32	35.47
Carbon Tetrachloride	30	30	100.00	11.32	46.79
Acrolein	26	26	100.00	9.81	56.60
Arsenic (PM_{10})	26	33	78.79	9.81	66.42
p-Dichlorobenzene	25	29	86.21	9.43	75.85
1,3-Butadiene	22	24	91.67	8.30	84.15

Table 27-2. Comparison of Measured Concentration and EPA Screening Values for the Texas Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Manganese (PM_{10})	18	33	54.55	6.79	90.94
Tetrachloroethylene	16	23	69.57	6.04	96.98
Hexachloro-1,3-butadiene	5	5	100.00	1.89	98.87
Acrylonitrile	1	1	100.00	0.38	99.25
Nickel (PM_{10})	1	33	3.03	0.38	99.62
Chloromethylbenzene	1	1	100.00	0.38	100.00
Total	265	332	79.82		
Travis High School, Austin, Texas – TRTX					
Carbon Tetrachloride	31	31	100.00	11.48	11.48
Benzene	31	31	100.00	11.48	22.96
Acetaldehyde	30	30	100.00	11.11	34.07
Formaldehyde	30	30	100.00	11.11	45.19
1,3-Butadiene	28	28	100.00	10.37	55.56
Arsenic (PM_{10})	26	30	86.67	9.63	65.19
p-Dichlorobenzene	25	29	86.21	9.26	74.44
Acrolein	22	22	100.00	8.15	82.59
Manganese (PM_{10})	16	30	53.33	5.93	88.52
Tetrachloroethylene	11	17	64.71	4.07	92.59
Hexachloro-1,3-butadiene	6	6	100.00	2.22	94.81
Cadmium (PM_{10})	6	30	20.00	2.22	97.04
1,2-Dichloroethane	2	2	100.00	0.74	97.78
Chloromethylbenzene	1	1	100.00	0.37	98.15
1,1,2,2-Tetrachloroethane	1	1	100.00	0.37	98.52
1,1,2-Trichloroethane	1	1	100.00	0.37	98.89
Nickel (PM_{10})	1	30	3.33	0.37	99.26
1,2-Dibromoethane	1	1	100.00	0.37	99.63
Vinyl Chloride	1	10	10.00	0.37	100.00
Total	270	360	75.00		
Webberville Road, Austin, Texas – WETX					
Arsenic (PM_{10})	31	34	91.18	11.19	11.19
Benzene	28	28	100.00	10.11	21.30
Carbon Tetrachloride	28	28	100.00	10.11	31.41
1,3-Butadiene	28	28	100.00	10.11	41.52
p-Dichlorobenzene	27	27	100.00	9.75	51.26
Acetaldehyde	24	29	82.76	8.66	59.93
Formaldehyde	24	29	82.76	8.66	68.59
Manganese (PM_{10})	23	34	67.65	8.30	76.90
Acrolein	22	22	100.00	7.94	84.84
Tetrachloroethylene	11	21	52.38	3.97	88.81
Hexachloro-1,3-butadiene	8	8	100.00	2.89	91.70
Xylenes	7	28	25.00	2.53	94.22
1,2-Dichloroethane	5	5	100.00	1.81	96.03

Table 27-2. Comparison of Measured Concentration and EPA Screening Values for the Texas Monitoring Sites (Continued)

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Acrylonitrile	4	4	100.00	1.44	97.47
1,1,2,2-Tetrachloroethane	2	2	100.00	0.72	98.19
Nickel (PM_{10})	1	34	2.94	0.36	98.56
Cadmium (PM_{10})	1	34	2.94	0.36	98.92
Hexavalent Chromium	1	21	4.76	0.36	99.28
Chloromethylbenzene	1	1	100.00	0.36	99.64
1,2-Dibromoethane	1	1	100.00	0.36	100.00
Total	277	418	66.27		
El Paso, Texas – YDSP					
Benzene	57	57	100.00	20.88	20.88
Carbon Tetrachloride	57	57	100.00	20.88	41.76
1,3-Butadiene	51	51	100.00	18.68	60.44
p-Dichlorobenzene	43	46	93.48	15.75	76.19
Acrolein	21	21	100.00	7.69	83.88
Tetrachloroethylene	15	28	53.57	5.49	89.38
Hexachloro-1,3-butadiene	14	14	100.00	5.13	94.51
Xylenes	12	57	21.05	4.40	98.90
Trichloroethylene	3	32	9.38	1.10	100.00
Total	273	363	75.21		

27.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. The seasons presented for the Texas sites will range from Spring 2005 through Spring 2006 in order to accommodate their summer-to-summer sampling schedule. A summer 2006 seasonal average will not be possible due to the low number of samples compared to the detection criteria. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average.

Annual averages are calculated for monitoring sites where sampling began no later than February and ended no earlier than November, but this duration has been adjusted for the Texas sites. The daily and seasonal average concentrations are presented in Table 27-3. Annual averages are presented and discussed in further detail in later sections.

The following observations for the Austin sites are shown in Table 27-3:

- Among the daily averages for the Austin sites, acrolein measured the highest concentration by mass, ranging from 5.50 ± 2.93 μg/m^3 for PITX to 9.08 ± 3.70 μg/m^3 for RRTX.

- Formaldehyde had the second highest daily average for each Austin site, ranging from 3.28 ± 0.77 μg/m^3 for MUTX to 3.72 ± 0.52 μg/m^3 for RRTX.

- With the exception of WETX, acetaldehyde measured the third highest daily average for each Austin site.

- As the Austin sites did not begin monitoring until mid-June, late-June, or early July 2005, no seasonal averages could be calculated for spring and summer 2005 (except for metals). In addition, the 1-in-12 sampling schedule limited the seasonal average availability. With the exception of MUTX, acrolein autumn averages could not be calculated.

- The autumn seasonal averages that were available did not differ significantly from the daily averages for the Austin monitoring sites.

The following observations for the El Paso site are shown in Table 27-3:

- The pollutants with the highest daily averages were total xylenes (7.37 ± 1.37 μg/m^3), acrolein (4.48 ± 4.09 μg/m^3), and benzene (2.33 ± 0.34 μg/m^3).

- The YDSP site began sampling in March. Although many of the pollutants of interest had higher concentrations in autumn than spring or summer, most of these differences were not statistically significant.

- The one exception was the autumn benzene concentration.

- Acrolein had no seasonal averages due to a low detection rate.

Table 27-3. Daily and Seasonal Averages for the Pollutants of Interest for the Texas Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Spring 2005		Summer 2005		Autumn 2005		Winter 2006		Spring 2006	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Murchison Middle School, Austin, Texas – MUTX														
Acetaldehyde	30	30	1.43	0.18	NA	NA	NR	NR	1.83	0.32	NR	NR	1.38	0.22
Acrolein	26	30	4.31	1.36	NA	NA	NR	NR	4.89	2.63	NR	NR	NR	NR
Arsenic (PM_{10})	30	30	<0.001	<0.001	NA	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NR	NR
Benzene	31	31	0.94	0.13	NA	NA	NR	NR	1.07	0.13	NR	NR	0.67	0.19
1,3-Butadiene	24	31	0.09	0.02	NA	NA	NR	NR	0.11	0.02	NR	NR	NR	NR
Carbon Tetrachloride	31	31	0.63	0.06	NA	NA	NR	NR	0.74	0.07	NR	NR	0.58	0.17
p-Dichlorobenzene	25	31	0.26	0.10	NA	NA	NR	NR	0.21	0.07	NR	NR	NR	NR
Formaldehyde	30	30	2.82	0.44	NA	NA	NR	NR	2.82	0.74	NR	NR	2.52	0.35
Manganese (PM_{10})	30	30	0.005	0.001	NA	NA	0.002	0.001	0.007	0.004	0.005	0.001	NR	NR
Tetrachloroethylene	21	31	0.37	0.12	NA	NA	NR	NR	0.42	0.22	NR	NR	NR	NR
Pickle Research Center, Austin, Texas – PITX														
Acetaldehyde	31	31	1.43	0.19	NA	NA	NR	NR	1.83	0.36	NR	NR	1.25	0.25
Acrolein	24	30	3.13	1.36	NA	NA	NR	NR	NR	NR	NR	NR	1.63	0.62
Arsenic (PM_{10})	32	32	<0.001	<0.001	NA	NA	NR	NR	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Benzene	31	31	0.80	0.11	NA	NA	NR	NR	1.04	0.23	NR	NR	0.58	0.14
1,3-Butadiene	26	31	0.08	0.02	NA	NA	NR	NR	0.13	0.03	NR	NR	NR	NR
Carbon Tetrachloride	31	31	0.68	0.06	NA	NA	NR	NR	0.73	0.08	NR	NR	0.59	0.15
p-Dichlorobenzene	28	31	0.25	0.09	NA	NA	NR	NR	0.20	0.09	NR	NR	0.09	0.02
Formaldehyde	31	31	2.88	0.44	NA	NA	NR	NR	3.12	0.62	NR	NR	2.32	0.30
Manganese (PM_{10})	32	32	0.006	0.002	NA	NA	NR	NR	0.009	0.005	0.007	0.002	0.004	0.001
Round Rock, Texas – RRTX														
Acetaldehyde	32	32	1.47	0.17	NA	NA	NR	NR	1.77	0.19	NR	NR	1.23	0.23
Acrolein	26	29	5.14	2.08	NA	NA	NR	NR	NR	NR	NR	NR	2.66	1.39
Arsenic (PM_{10})	33	33	<0.001	<0.001	NA	NA	<0.001	<0.001	0.001	<0.001	0.001	<0.001	NR	NR
Benzene	30	30	0.98	0.18	NA	NA	NR	NR	1.10	0.16	NR	NR	0.63	0.13
1,3-Butadiene	24	30	0.09	0.03	NA	NA	NR	NR	0.11	0.04	NR	NR	NR	NR
Carbon Tetrachloride	30	30	0.66	0.06	NA	NA	NR	NR	0.73	0.11	NR	NR	0.58	0.13
p-Dichlorobenzene	29	30	0.27	0.10	NA	NA	NR	NR	0.24	0.08	NR	NR	0.14	0.03

Table 27-3. Daily and Seasonal Averages for the Pollutants of Interest for the Texas Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily		Spring 2005		Summer 2005		Autumn 2005		Winter 2006		Spring 2006	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Formaldehyde	32	32	3.30	0.39	NA	NA	NR	NR	3.41	0.44	NR	NR	2.58	0.28
Manganese (PM_{10})	33	33	0.006	0.001	NA	NA	0.003	0.001	0.008	0.003	0.008	0.003	NR	NR
Tetrachloroethylene	23	30	0.32	0.11	NA	NA	NR	NR	0.30	0.12	NR	NR	NR	NR
Travis High School, Austin, Texas – TRTX														
Acetaldehyde	30	30	1.49	0.21	NA	NA	NR	NR	1.81	0.35	1.27	0.09	1.30	0.41
Acrolein	22	31	3.62	1.38	NA	NA	NR	NR	NR	NR	NR	NR	2.21	1.02
Arsenic (PM_{10})	30	30	0.001	0.001	NA	NA	NR	NR	0.001	0.001	0.001	<0.001	NR	NR
Benzene	31	31	1.11	0.17	NA	NA	NR	NR	1.31	0.27	NR	NR	0.75	0.23
1,3-Butadiene	28	31	0.16	0.03	NA	NA	NR	NR	0.21	0.06	NR	NR	NR	NR
Cadmium (PM_{10})	30	30	<0.001	<0.001	NA	NA	NR	NR	0.001	<0.001	<0.001	<0.001	NR	NR
Carbon Tetrachloride	31	31	0.68	0.07	NA	NA	NR	NR	0.69	0.12	NR	NR	0.57	0.11
p-Dichlorobenzene	29	31	0.27	0.08	NA	NA	NR	NR	0.30	0.10	NR	NR	0.11	0.03
Formaldehyde	30	30	3.01	0.45	NA	NA	NR	NR	3.35	0.59	1.89	0.30	2.54	0.46
Hexachloro-1,3-butadiene	6	31	0.20	0.12	NA	NA	NR	NR	NR	NR	NR	NR	NR	NR
Manganese (PM_{10})	30	30	0.005	0.001	NA	NA	NR	NR	0.007	0.003	0.006	<0.001	NR	NR
Tetrachloroethylene	17	31	0.31	0.12	NA	NA	NR	NR	NR	NR	NR	NR	NR	NR
Webberville Road, Austin, Texas – WETX														
Acetaldehyde	29	29	1.69	0.35	NA	NA	NR	NR	2.30	0.43	NR	NR	1.54	0.55
Acrolein	22	26	4.87	1.24	NA	NA	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic (PM_{10})	34	34	0.001	0.001	NA	NA	<0.001	<0.001	0.003	0.003	0.001	<0.001	0.001	<0.001
Benzene	28	28	1.88	0.32	NA	NA	NR	NR	2.04	0.58	2.07	0.88	NR	NR
1,3-Butadiene	28	28	0.33	0.09	NA	NA	NR	NR	0.39	0.15	0.43	0.27	NR	NR
Carbon Tetrachloride	28	28	0.67	0.04	NA	NA	NR	NR	0.70	0.08	0.60	0.12	NR	NR
p-Dichlorobenzene	27	28	0.41	0.08	NA	NA	NR	NR	0.39	0.14	0.40	0.17	NR	NR
1,2-Dichloroethane	5	27	0.08	0.02	NA	NA	NR	NR	NR	NR	NR	NR	NR	NR
Formaldehyde	29	29	2.72	0.54	NA	NA	NR	NR	3.50	0.39	NR	NR	2.44	0.87
Hexachloro-1,3-butadiene	8	28	0.20	0.05	NA	NA	NR	NR	NR	NR	NR	NR	NR	NR
Manganese (PM_{10})	34	34	0.007	0.001	NA	NA	0.004	0.002	0.009	0.003	0.007	0.002	0.005	0.001
Tetrachloroethylene	21	28	0.24	0.07	NA	NA	NR	NR	0.21	0.09	0.28	0.17	NR	NR

Table 27-3. Daily and Seasonal Averages for the Pollutants of Interest for the Texas Monitoring Sites (Continued)

Pollutant	# of Measured Detections	# of Samples	Daily		Spring 2005		Summer 2005		Autumn 2005		Winter 2006		Spring 2006	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Xylenes	28	28	9.43	4.22	NA	NA	NR	NR	5.73	2.17	5.35	3.27	NR	NR
El Paso, Texas – YDSP														
Acrolein	21	43	2.25	1.94	NR	NR	NR	NR	NR	NR	0.62	0.20	NA	NA
Benzene	57	57	2.39	0.30	1.79	0.33	1.65	0.50	2.68	0.44	3.12	0.62	NA	NA
1,3-Butadiene	51	57	0.36	0.06	NR	NR	0.20	0.08	0.32	0.08	0.52	0.13	NA	NA
Carbon Tetrachloride	57	57	0.59	0.04	0.53	0.06	0.59	0.06	0.72	0.08	0.55	0.06	NA	NA
p-Dichlorobenzene	46	57	0.51	0.14	NR	NR	0.29	0.13	0.72	0.37	0.53	0.13	NA	NA
Hexachloro-1,3-butadiene	14	57	0.19	0.04	NR	NR	NR	NR	1.02	0.40	NR	NR	NA	NA
Tetrachloroethylene	28	57	0.53	0.62	NR	NR	NR	NR	0.13	0.04	0.18	0.06	NA	NA
Xylenes	57	57	7.32	1.10	5.24	1.33	5.85	2.60	7.81	1.59	9.80	2.12	NA	NA

NA= Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

27.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for Texas monitoring sites was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute or the intermediate risk values at the Texas sites, and each site's non-chronic risk is summarized in Table 27-4.

The following observations about acrolein are shown in Table 27-4:

- All of the acrolein measured detections at the Texas sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$.
- The average daily concentration ranged from 2.25 ± 1.94 $\mu g/m^3$ (for YDSP) to 5.14 ± 2.08 $\mu g/m^3$ (for RRTX), which were an order of magnitude higher than either acute risk factor.
- Few seasonal averages for acrolein could be calculated for the Texas sites, predominately due to a low overall detection rate and a 1-in-12 sampling schedule. However, seasonal averages of acrolein, where available, exceeded the intermediate risk MRL.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration and wind direction. For all six Texas monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 27-9 through 27-14 are pollution roses for acrolein for the Texas sites. As discussed above, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL). Because the scale in Figures 27-9 through 27-14 is so large, the risk factors cannot be shown accurately, and therefore do not appear on the pollution roses. However, the values of the risk factors are still provided in the Figures.

Table 27-4. Non-Chronic Risk Summary for the Texas Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate MRL (µg/m^3)	Spring 2005 Average (µg/m^3)	Summer 2005 Average (µg/m^3)	Autumn 2005 Average (µg/m^3)	Winter 2006 Average (µg/m^3)	Spring 2006 Average (µg/m^3)
MUTX	TO-15	Acrolein	4.31 ± 1.36	0.11	26	0.19	26	0.09	NA	NR	4.89 ± 2.63	NR	NR
PITX	TO-15	Acrolein	3.13 ± 1.36	0.11	24	0.19	24	0.09	NA	NR	NR	NR	1.63 ± 0.62
RRTX	TO-15	Acrolein	5.14 ± 2.08	0.11	26	0.19	26	0.09	NA	NR	NR	NR	2.66 ± 1.39
TRTX	TO-15	Acrolein	3.62 ± 1.38	0.11	22	0.19	22	0.09	NA	NR	NR	NR	2.21 ± 1.02
WETX	TO-15	Acrolein	4.87 ± 1.24	0.11	22	0.19	22	0.09	NA	NR	NR	NR	NR
YDSP	TO-15	Acrolein	2.25 ± 1.94	0.11	21	0.19	21	0.09	NR	NR	NR	0.62 ± 0.20	NA

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

Figure 27-9. Acrolein Pollution Rose for MUTX

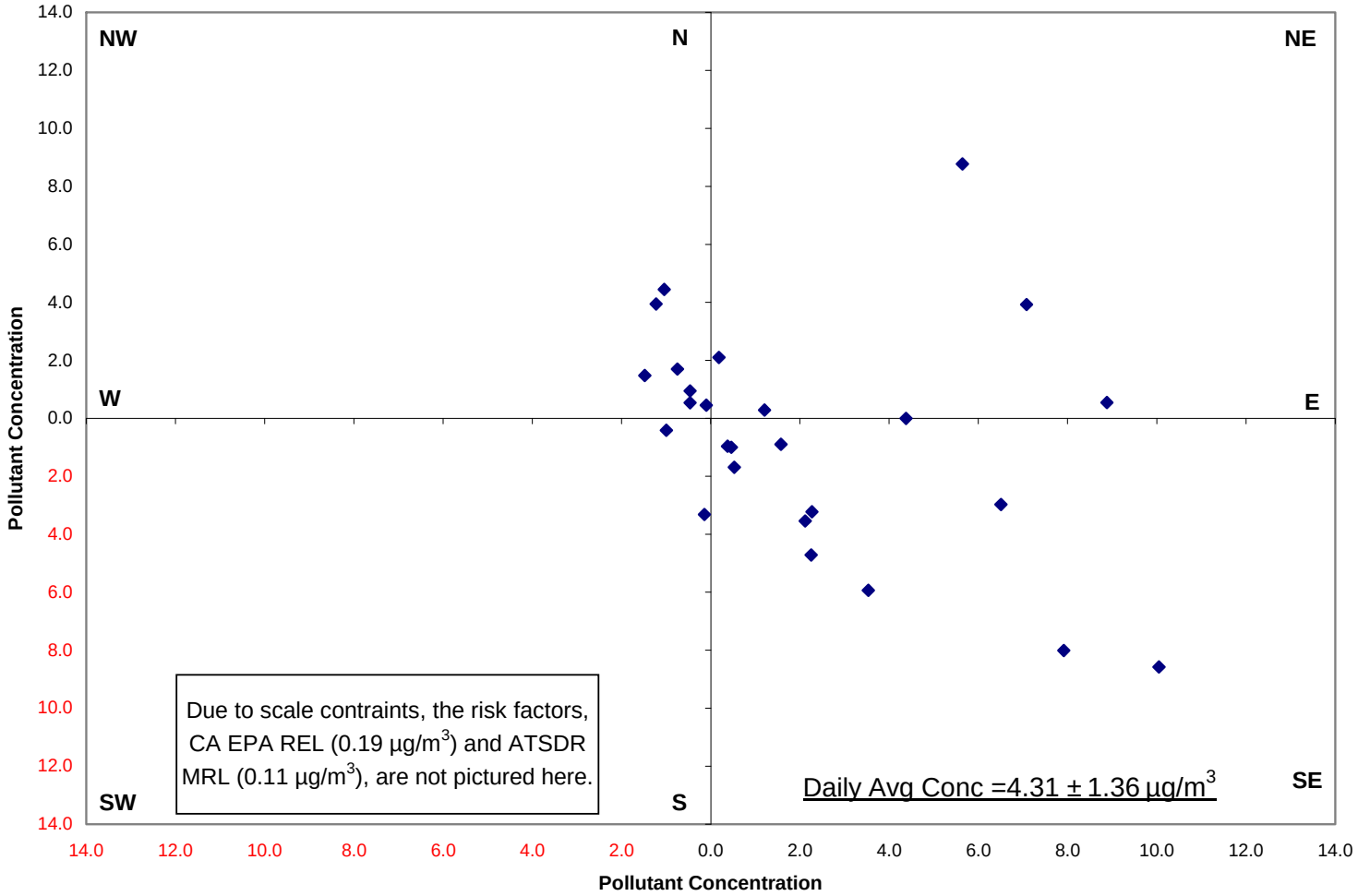


Figure 27-10. Acrolein Pollution Rose for PITX

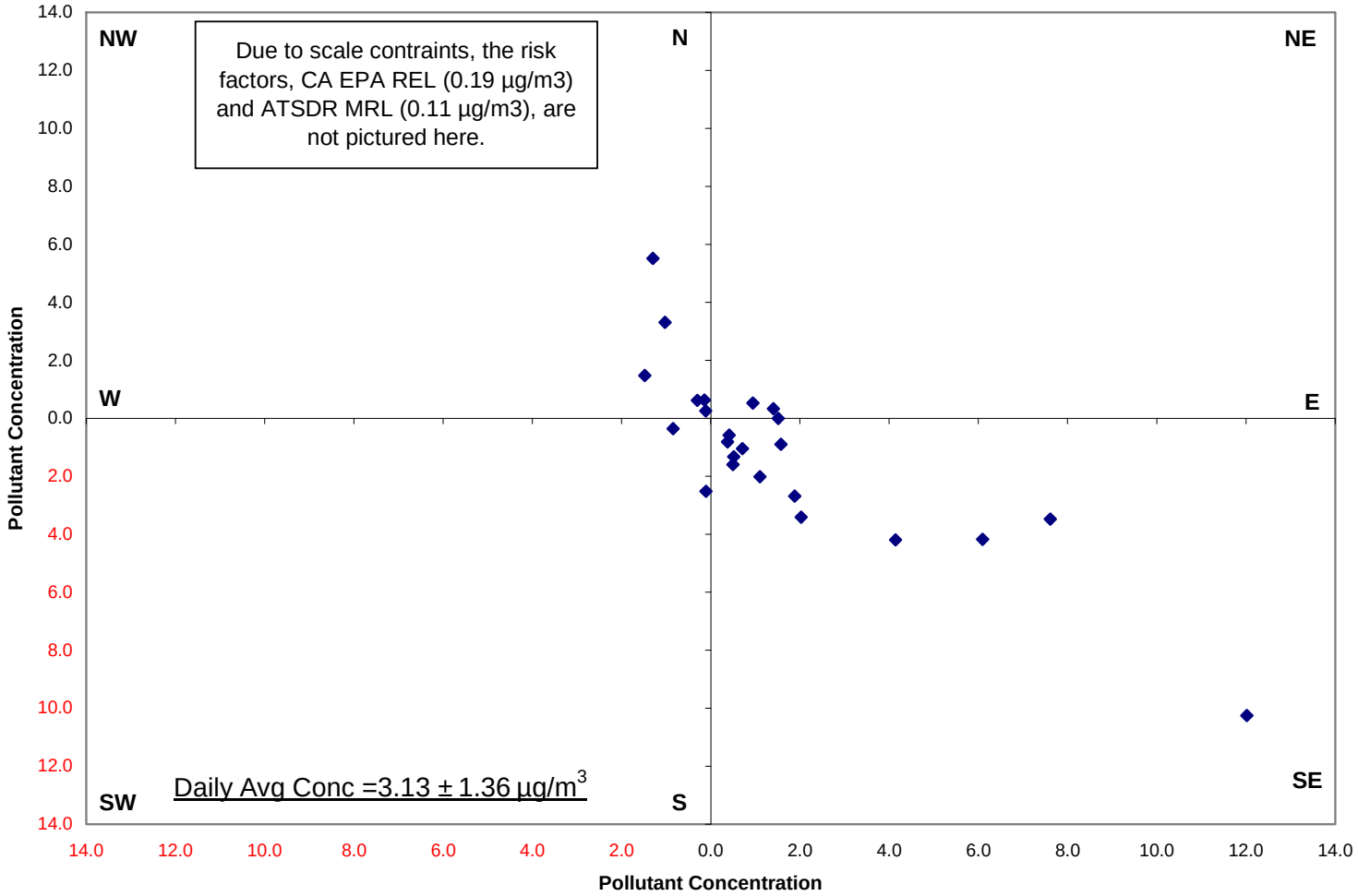


Figure 27-11. Acrolein Pollution Rose for RRTX

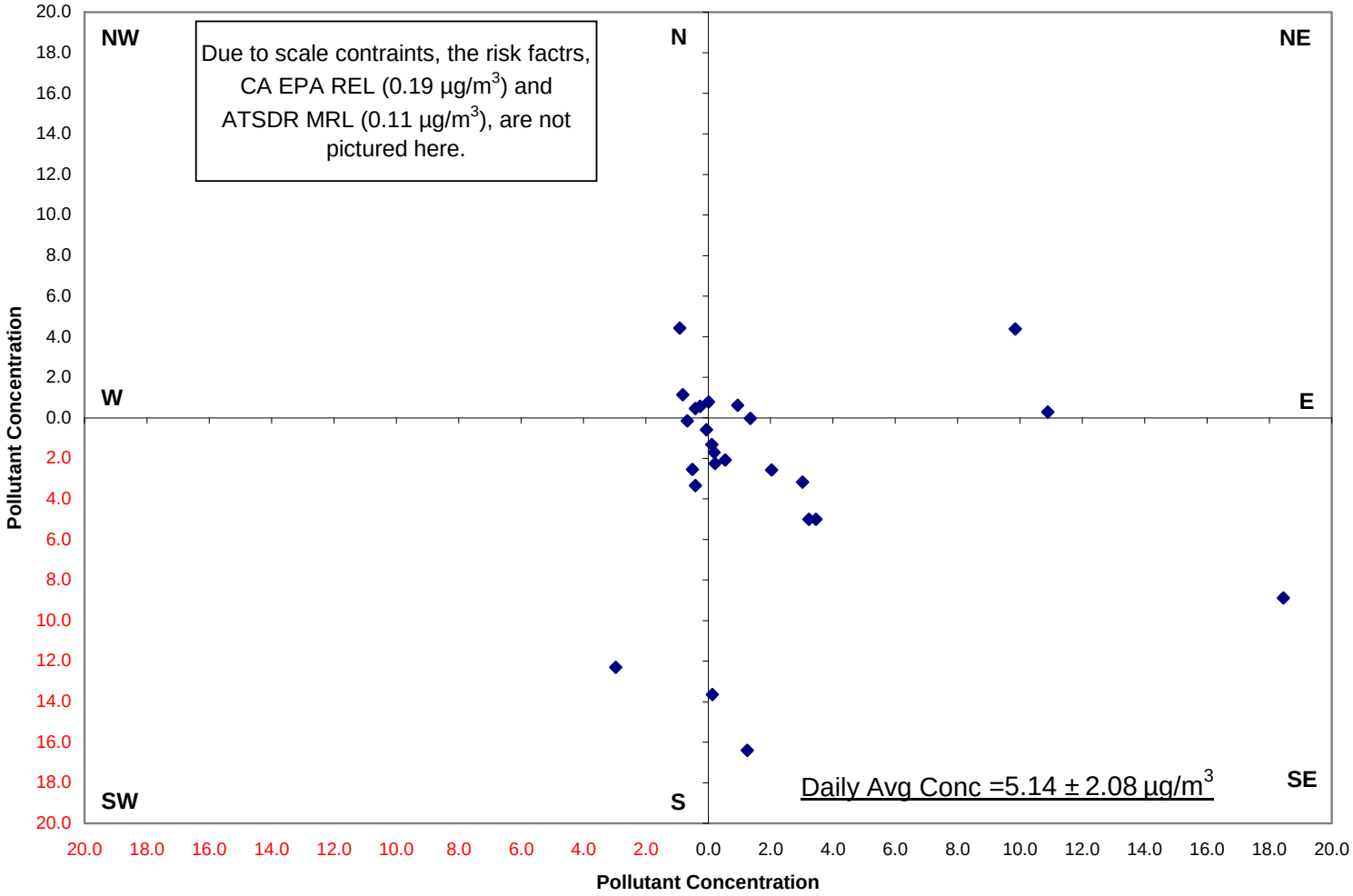


Figure 27-12. Acrolein Pollution Rose for TRTX

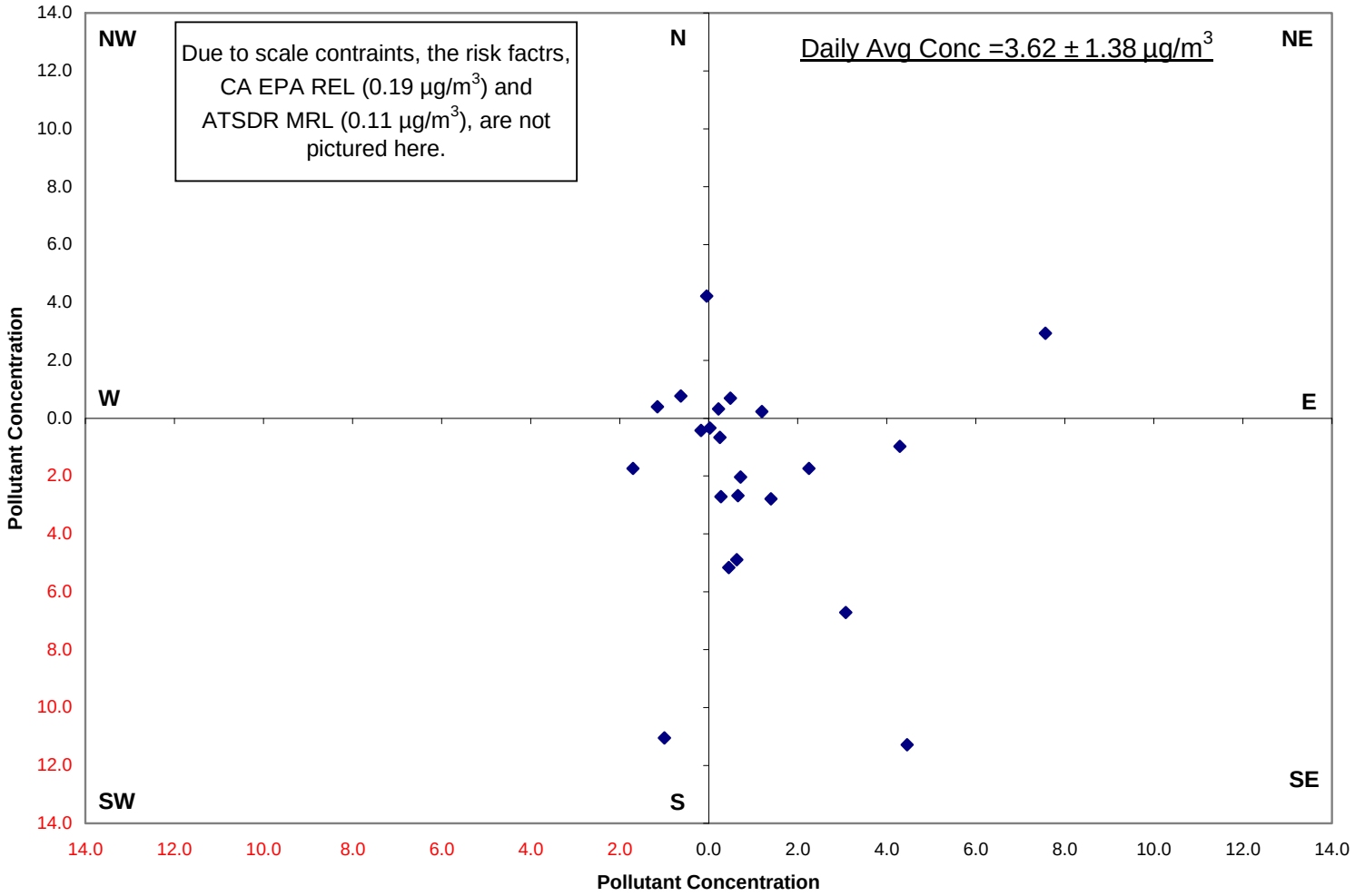


Figure 27-13. Acrolein Pollution Rose for WETX

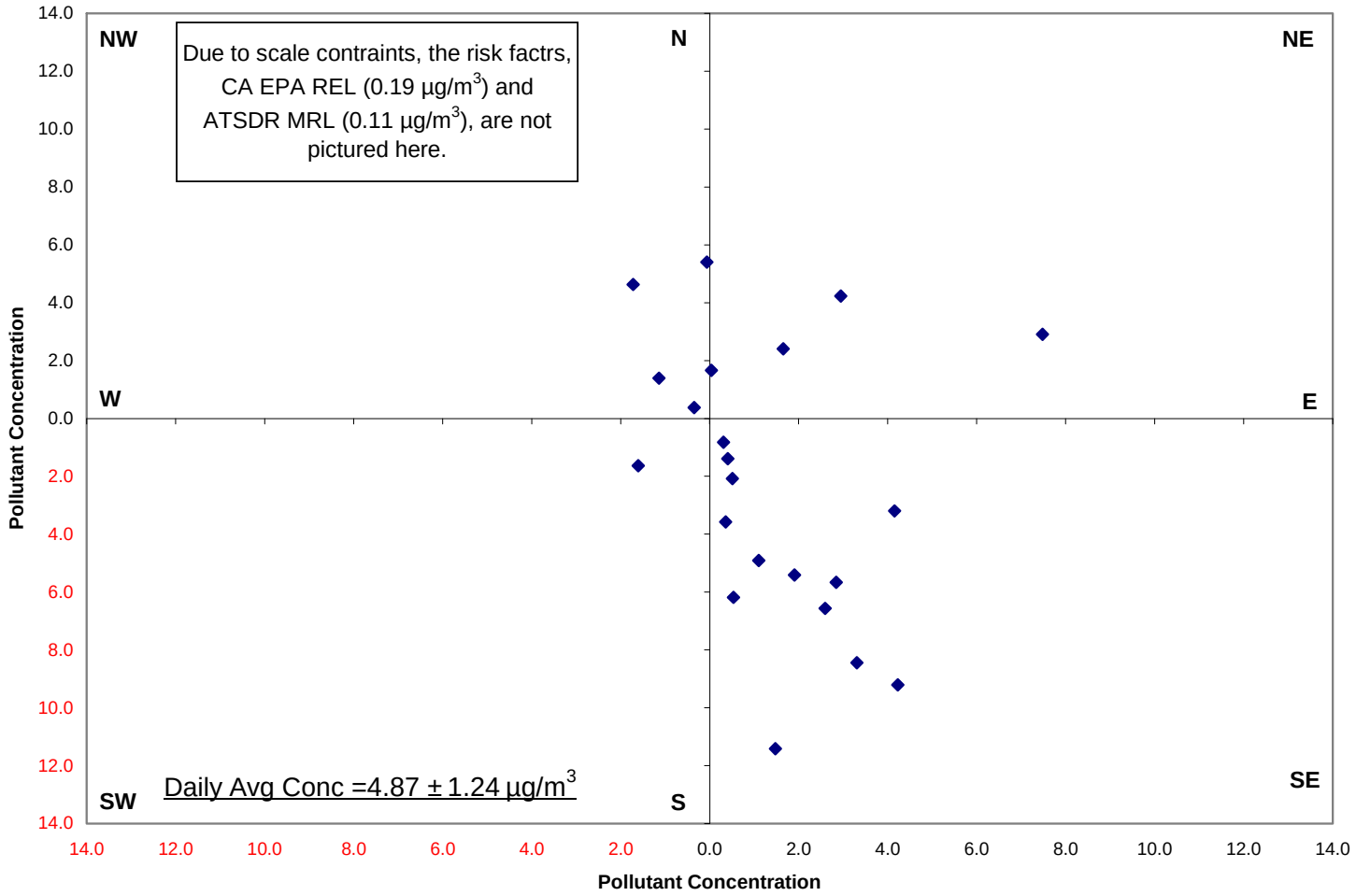
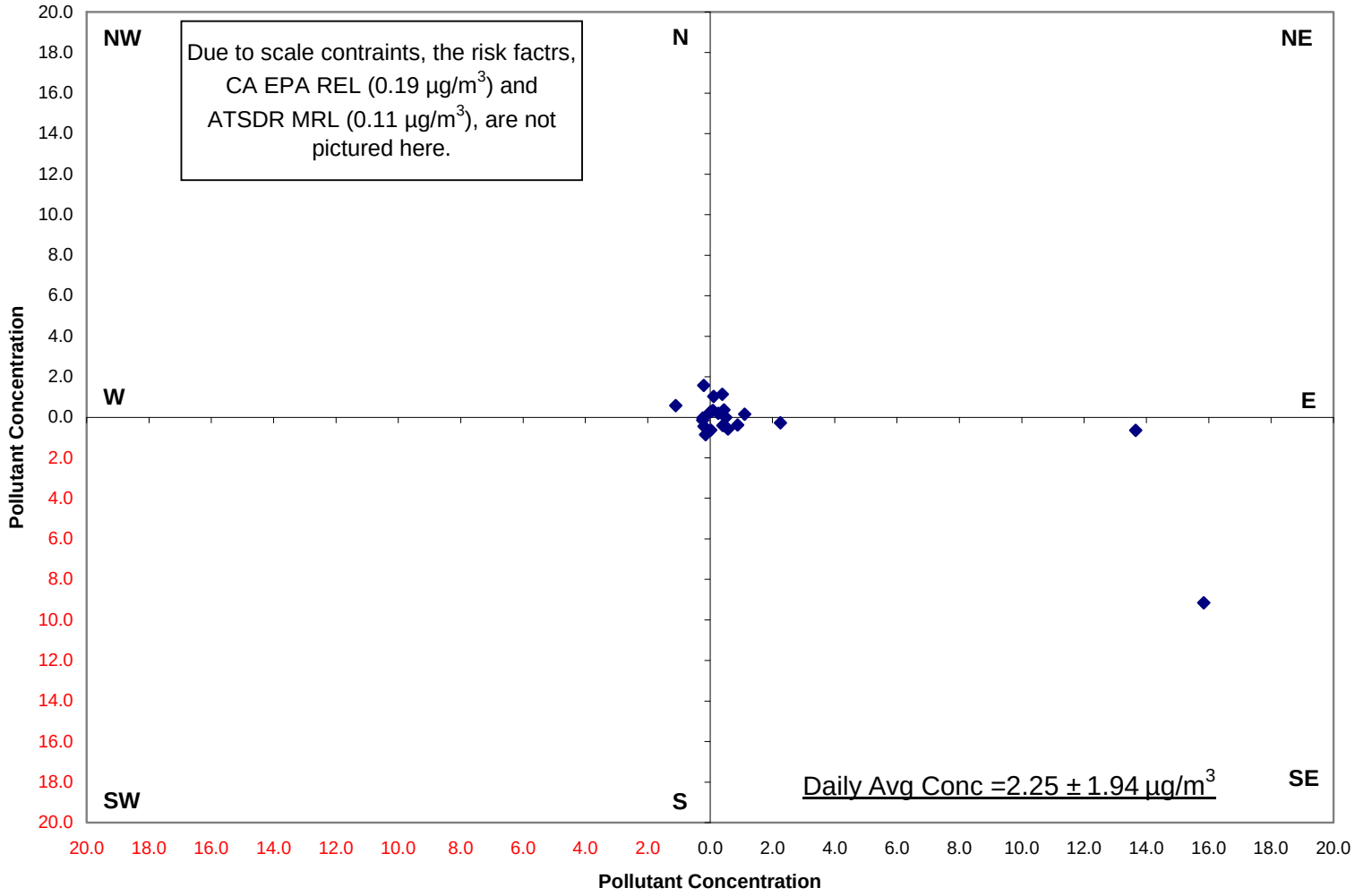


Figure 27-14. Acrolein Pollution Rose for YDSP



Observations gleaned from the acrolein pollutions roses include:

- Figure 27-9 is the acrolein pollution rose for the MUTX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources, although there is an apparent lack of measured detections associated with a southwesterly wind. The MUTX monitoring site is located in a primarily residential area on the Murchison Middle School grounds. The eastern edge of the school grounds is bordered by a major thoroughfare, the Mo-Pac expressway, which is paralleled by a railway. The highest concentration of acrolein occurred on August 26, 2005 with a southeasterly wind.

- Figure 27-10 is the acrolein pollution rose for the PITX monitoring site, and its pattern is similar to MUTX's pollution rose. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources, although there is an apparent lack of measured detections associated with northeasterly and southwesterly winds. The PITX monitoring site is located at the University of Texas Pickle Research Center, which is near the intersection of two major roadways: the Mo-Pac Expressway and Highway 183. The highest concentration of acrolein also occurred on August 26, 2005 with a southeasterly wind.

- Figure 27-11 is the acrolein pollution rose for the RRTX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. The RRTX monitoring site is located on the northern edge of a residential area. Just to the west of the monitoring site, running north-south, is I-35. The Georgetown railroad parallels I-35 on the west side. The highest concentration of acrolein occurred on August 2, 2005 with an east-southeasterly wind.

- Figure 27-12 is the acrolein pollution rose for the TRTX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. The TRTX monitoring site is located at Travis High School, which is just off I-35 on Oltorf Street, in a highly residential area of Austin. The highest concentration of acrolein occurred on August 14, 2005 with a south-southeasterly wind.

- Figure 27-13 is the acrolein pollution rose for the WETX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources, although primarily from the southeast and south. The WETX monitoring site is located in a residential area off East 7th Street, which intersects I-35 about a mile and half west of the site. The Northwestern Railroad loops around the area where WETX is located. Zaragosa Park and Recreation Center is very close to the monitoring site. The highest concentration of acrolein occurred on June 10, 2006 with a south-southeasterly wind.

- Figure 27-14 is the acrolein pollution rose for the YDSP monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. Most of the acrolein measured detections are within a tight cluster around the center of the pollution rose, with most concentrations less than 2.0 $\mu g/m^3$. However, the highest concentrations of acrolein occurred on July 5 and 11, 2005 with an east and east-southeasterly wind. The YDSP monitoring site is located in a residential area on the southeast side of El Paso, TX. The 375 Loop, or Americas Avenue, runs less than a mile to the south of the site. The 375 Loop intersects I-10 a couple miles east of YDSP. The US-Mexican border is less than 1.5 miles from the site.

27.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

27.4.1 Pearson Correlation Analysis

Table 27-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the Texas monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for the Austin sites from Table 27-5:

- At most of the Austin sites, strong positive correlations were calculated between acrolein, *p*-dichlorobenzene, and formaldehyde and maximum, average, dew point, and wet bulb temperatures, indicating that concentrations of these pollutants increase as temperature and moisture content increase.

- Most of the correlations between the pollutants of interest and scalar wind speed were negative, indicating that as wind speeds decrease, concentrations of the pollutants of interest tend to increase.

The following observations are gathered for the El Paso site from Table 27-5:

- With few exceptions, all of the correlations between the pollutants of interest and the temperature and moisture parameters were negative, which indicates that as temperature and moisture content decrease, concentrations of the pollutants of interest tend to increase.

Table 27-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Texas Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Murchison Middle School, Austin, Texas – MUTX								
Acetaldehyde	30	0.13	0.13	0.12	0.10	0.06	0.10	-0.71
Acrolein	26	0.59	0.59	0.39	0.49	-0.13	0.04	-0.56
Arsenic (PM_{10})	30	0.22	0.25	0.25	0.25	0.14	-0.24	-0.19
Benzene	31	0.24	0.25	0.43	0.36	0.49	-0.25	-0.51
1,3-Butadiene	24	-0.22	-0.27	-0.01	-0.14	0.44	0.18	-0.45
Carbon Tetrachloride	31	0.26	0.18	0.00	0.06	-0.27	-0.06	-0.13
p-Dichlorobenzene	25	0.59	0.58	0.57	0.60	0.15	-0.15	-0.34
Formaldehyde	30	0.63	0.66	0.51	0.57	0.07	-0.14	-0.52
Manganese (PM_{10})	30	-0.30	-0.37	-0.31	-0.35	-0.10	0.32	0.14
Tetrachloroethylene	21	-0.15	-0.14	-0.16	-0.16	-0.07	0.25	-0.44
Pickle Research Center, Austin, Texas – PITX								
Acetaldehyde	31	-0.06	-0.07	-0.11	-0.12	-0.12	0.17	-0.38
Acrolein	24	0.54	0.50	0.38	0.44	0.02	-0.21	-0.49
Arsenic (PM_{10})	32	-0.08	-0.06	0.09	0.02	0.34	-0.12	-0.31
Benzene	31	0.11	0.10	0.12	0.10	0.11	-0.02	-0.44
1,3-Butadiene	26	-0.24	-0.30	-0.33	-0.33	-0.26	0.55	-0.49
Carbon Tetrachloride	31	0.29	0.27	0.14	0.20	-0.15	-0.29	0.18
p-Dichlorobenzene	28	0.58	0.58	0.50	0.54	0.06	-0.25	-0.30
Formaldehyde	31	0.66	0.67	0.51	0.58	0.01	-0.21	-0.36
Manganese (PM_{10})	32	-0.30	-0.39	-0.40	-0.41	-0.23	0.26	-0.07
Round Rock, Texas – RRTX								
Acetaldehyde	32	0.17	0.09	-0.05	-0.05	-0.11	NA[1]	-0.45
Acrolein	26	0.29	0.32	0.37	0.38	0.26	NA[1]	-0.22
Arsenic (PM_{10})	33	-0.18	-0.18	-0.07	-0.03	0.23	NA[1]	-0.29
Benzene	30	0.20	0.15	0.08	0.02	-0.04	NA[1]	-0.39
1,3-Butadiene	24	-0.05	-0.16	-0.22	-0.37	-0.30	NA[1]	-0.12
Carbon Tetrachloride	30	0.27	0.27	0.26	0.36	0.18	NA[1]	-0.37
p-Dichlorobenzene	29	0.44	0.44	0.46	0.39	0.21	NA[1]	-0.25

Table 27-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Texas Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Formaldehyde	32	0.44	0.44	0.37	0.35	0.07	NA[1]	-0.53
Manganese (PM_{10})	33	-0.38	-0.54	-0.59	-0.50	-0.40	NA[1]	0.03
Tetrachloroethylene	23	-0.07	-0.13	-0.25	-0.07	-0.07	NA[1]	0.25
Travis High School, Austin, Texas – TRTX								
Acetaldehyde	30	-0.03	-0.03	0.04	0.01	0.13	0.17	-0.38
Acrolein	22	0.58	0.51	0.49	0.52	0.17	-0.12	-0.05
Arsenic (PM_{10})	30	0.25	0.28	0.29	0.29	0.20	-0.10	0.00
Benzene	31	0.09	0.04	0.12	0.09	0.24	0.09	-0.39
1,3-Butadiene	28	-0.07	-0.21	-0.16	-0.20	0.02	0.16	-0.43
Cadmium (PM_{10})	30	-0.05	0.02	0.15	0.10	0.31	-0.04	0.15
Carbon Tetrachloride	31	0.36	0.26	0.06	0.14	-0.38	-0.09	0.25
p-Dichlorobenzene	29	0.50	0.40	0.38	0.39	0.14	-0.16	-0.30
Formaldehyde	30	0.53	0.53	0.46	0.50	0.15	-0.08	-0.27
Hexachloro-1,3-butadiene	6	-0.52	-0.56	-0.45	-0.51	0.17	0.03	0.54
Manganese (PM_{10})	30	-0.37	-0.49	-0.42	-0.47	-0.14	0.37	-0.07
Tetrachloroethylene	17	-0.22	-0.31	-0.24	-0.29	-0.01	0.27	-0.05
Webberville Road, Austin, Texas – WETX								
Acetaldehyde	29	-0.29	-0.39	-0.30	-0.35	0.00	0.33	-0.56
Acrolein	22	0.70	0.70	0.55	0.62	0.06	-0.19	-0.42
Arsenic (PM_{10})	34	-0.22	-0.35	-0.31	-0.34	-0.06	0.29	-0.33
Benzene	28	-0.05	-0.19	-0.07	-0.14	0.20	-0.08	-0.60
1,3-Butadiene	28	-0.22	-0.39	-0.30	-0.36	-0.01	0.07	-0.46
Carbon Tetrachloride	28	0.33	0.30	0.37	0.34	0.36	-0.22	-0.02
p-Dichlorobenzene	27	0.20	0.02	0.06	0.03	0.15	-0.28	-0.40
1,2-Dichloroethane	5	0.87	0.85	0.72	0.75	0.34	-0.81	-0.57
Formaldehyde	29	-0.04	-0.13	-0.04	-0.08	0.16	0.21	-0.56
Hexachloro-1,3-butadiene	8	-0.02	0.10	0.15	0.15	0.20	-0.24	0.05
Manganese (PM_{10})	34	-0.32	-0.46	-0.53	-0.53	-0.41	0.35	0.00
Tetrachloroethylene	21	-0.10	-0.19	-0.01	-0.11	0.32	-0.30	-0.36

Table 27-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Texas Monitoring Sites (Continued)

Pollutant	# of Measured Detections	Maximum Temperature	Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Xylenes	28	0.33	0.31	0.19	0.23	-0.10	-0.28	0.00
El Paso, Texas – YDSP								
Acrolein	21	0.64	0.58	0.36	0.44	-0.05	-0.43	-0.04
Benzene	57	-0.28	-0.40	-0.46	-0.47	-0.31	0.28	-0.47
1,3-Butadiene	51	-0.44	-0.53	-0.60	-0.61	-0.40	0.36	-0.32
Carbon Tetrachloride	57	0.00	0.03	0.22	0.14	0.33	0.12	-0.29
p-Dichlorobenzene	46	0.07	0.00	-0.07	-0.06	-0.17	-0.02	-0.35
Hexachloro-1,3-butadiene	14	-0.15	-0.11	-0.15	-0.16	-0.15	0.01	0.12
Tetrachloroethylene	28	-0.06	0.01	-0.07	-0.03	-0.13	-0.45	0.82
Xylenes	57	-0.20	-0.30	-0.40	-0.39	-0.33	0.23	-0.43

[1] The station nearest RRTX did not record sea level pressure.

- Like the Austin sites, most of the correlations with scalar wind speed were negative. However, tetrachloroethylene exhibited a very strong positive correlation with this parameter.

27.4.2 Composite Back Trajectory Analysis

Figures 27-15 through 27-20 are composite back trajectory maps for the Texas monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site represents 100 miles.

The following observations can be made from Figures 27-15 through 27-19:

- Back trajectories predominantly originated from the southeast for the Austin sites.
- The 24-hour airshed domains were rather large at these sites, with trajectories originating as far away as Nebraska (> 800 miles). However, the bulk of the trajectories originated within 500 miles of the sites.
- Trajectories originating to the northwest of the sites were the longest, which indicates that stronger winds originated from the northwest.

The following observations can be made from Figure 27-20:

- Back trajectories originated from a variety of directions at YDSP, although most frequently from the southeast, southwest, and west.
- The 24-hour airshed domain was somewhat smaller at YDSP, with trajectories originating as far away as near Baja California (> 400 miles).
- However, most of the trajectories originated within 300 miles of the site.
- The majority of the 24-hour back trajectories originated from Mexico.

27.4.3 Wind Rose Analysis

As mentioned in Section 27.0, weather data from the four closest weather stations to monitoring sites were obtained to correlate concentrations and meteorological conditions. Hourly wind data from these stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different

Figure 27-15. Composite Back Trajectory Map for MUTX

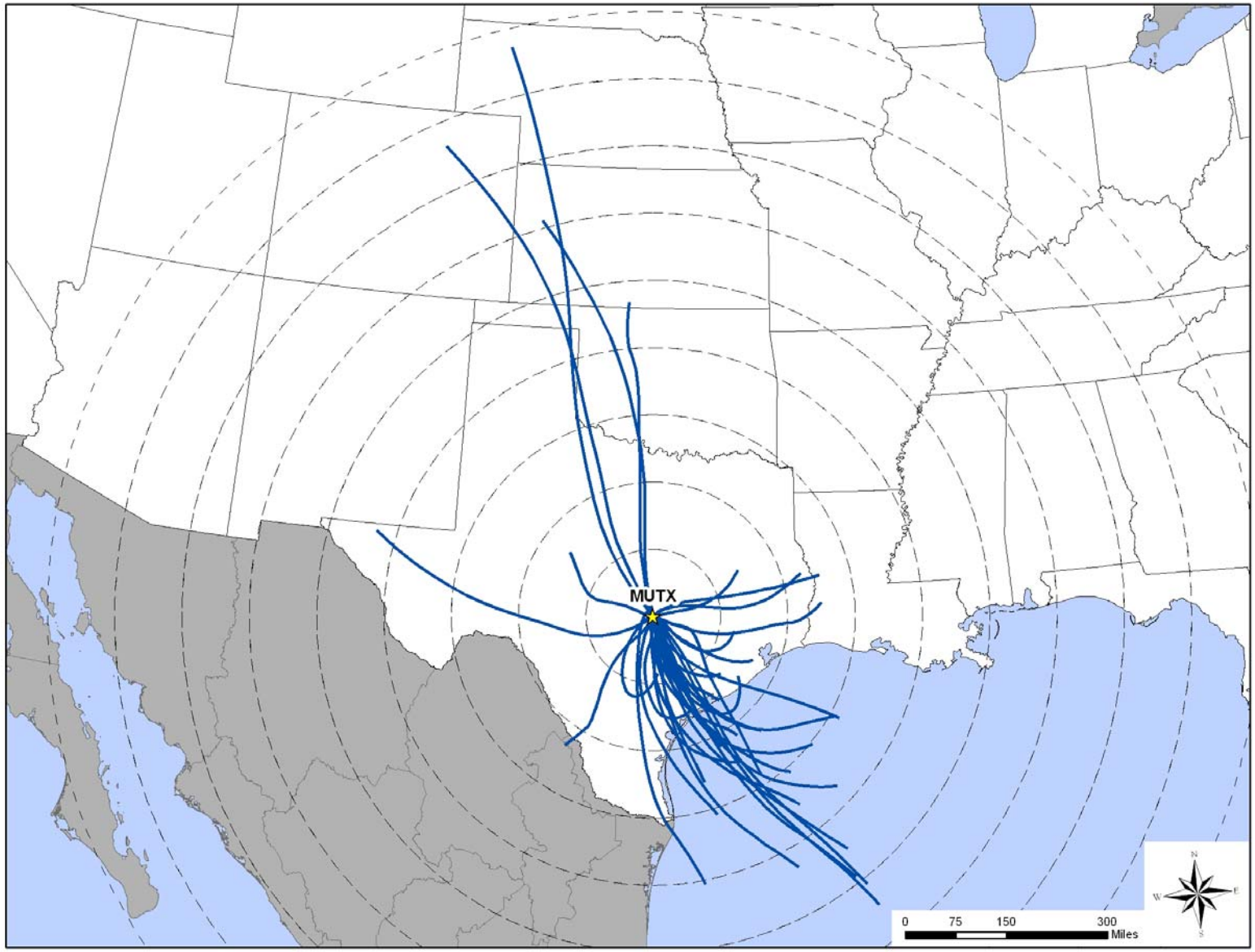


Figure 27-16. Composite Back Trajectory Map for PITX

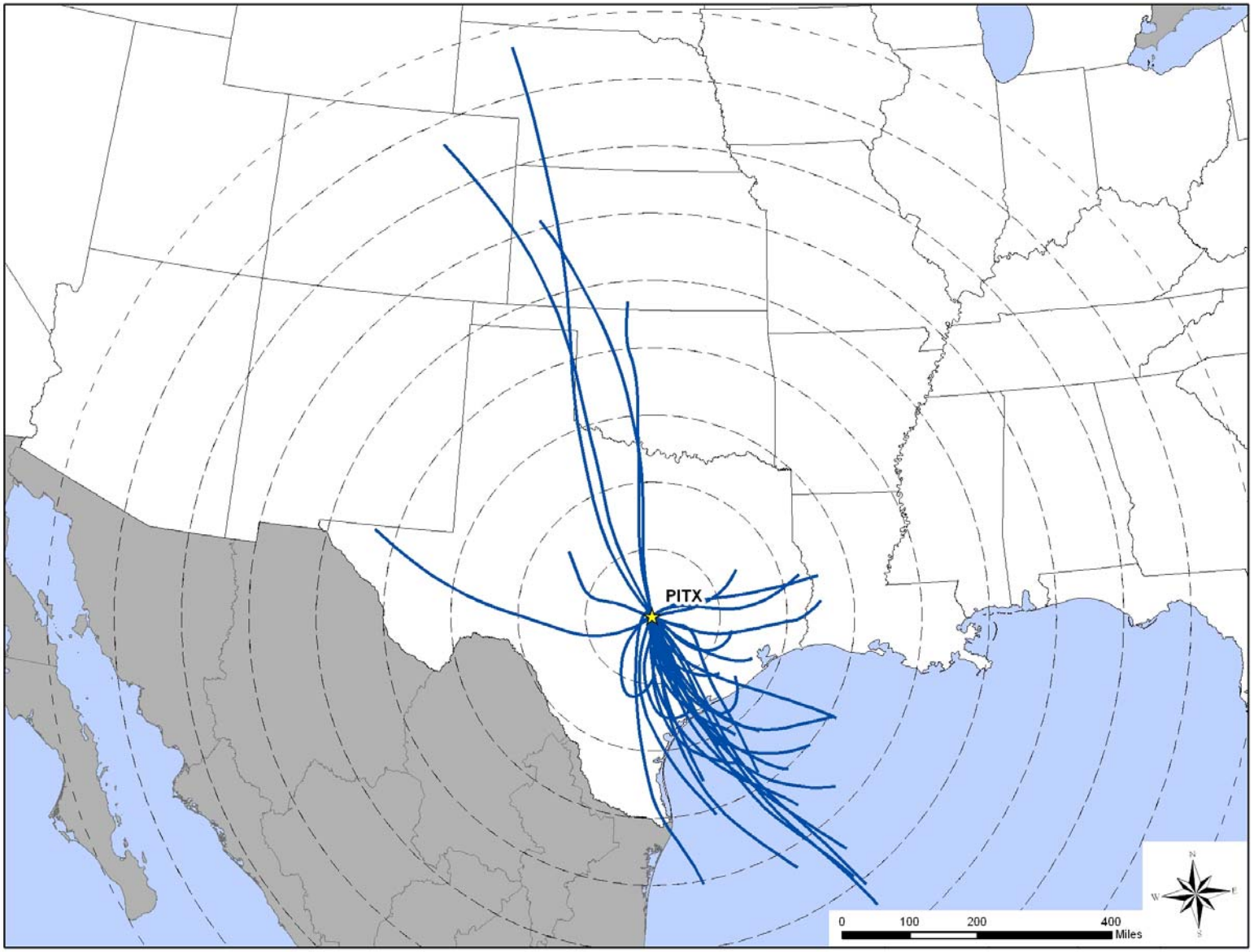


Figure 27-17. Composite Back Trajectory Map for RRTX

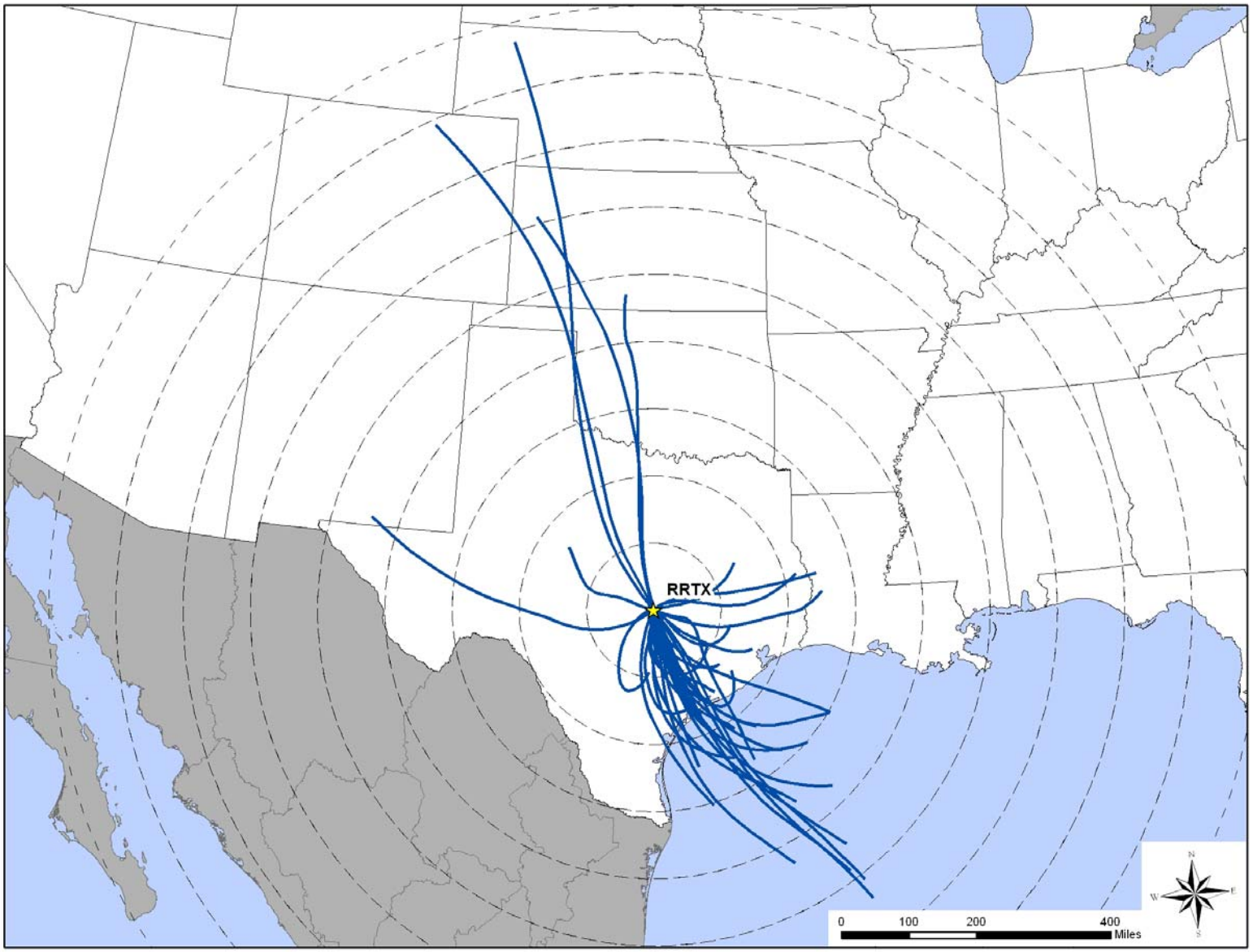


Figure 27-18. Composite Back Trajectory Map for TRTX

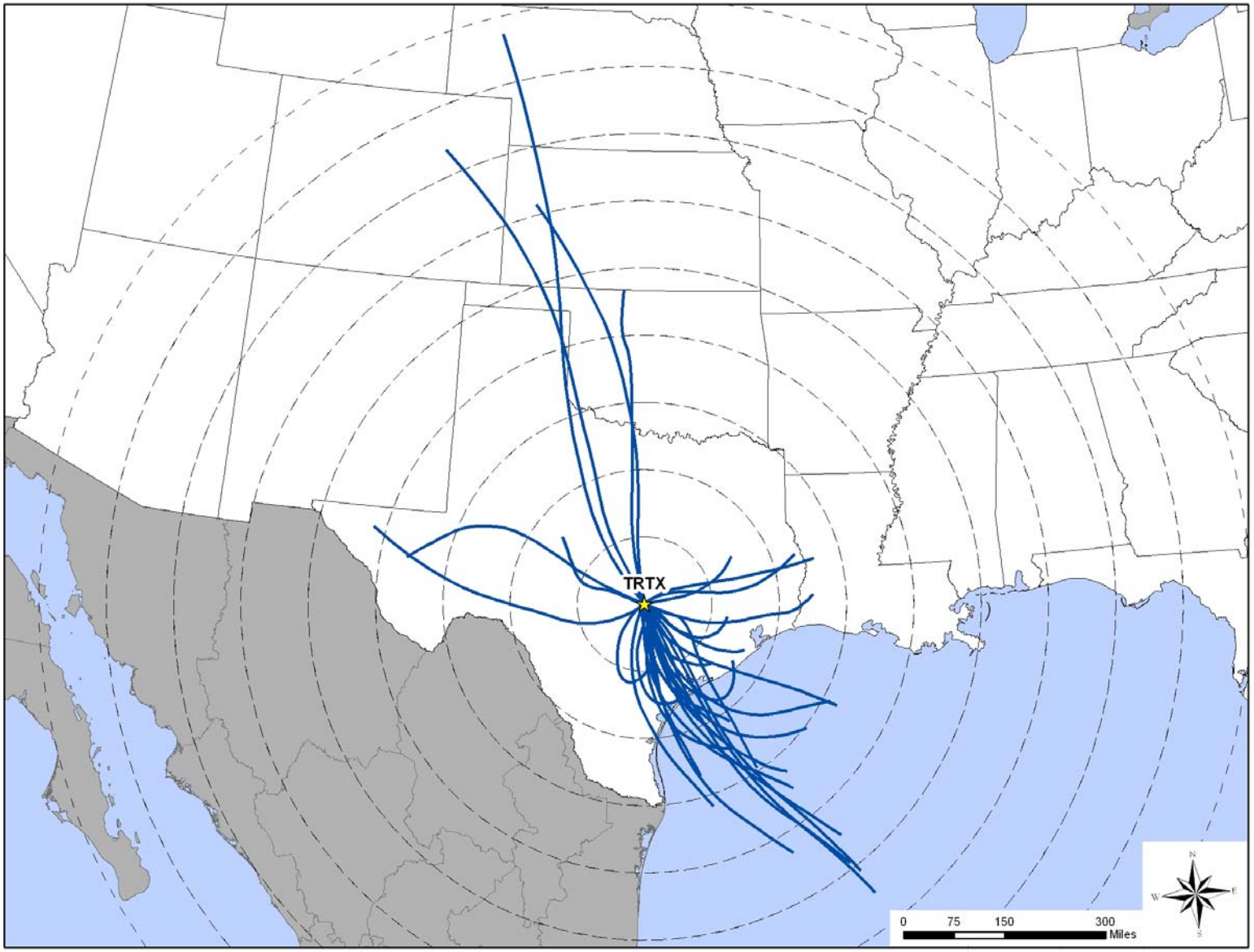


Figure 27-19. Composite Back Trajectory Map for WETX

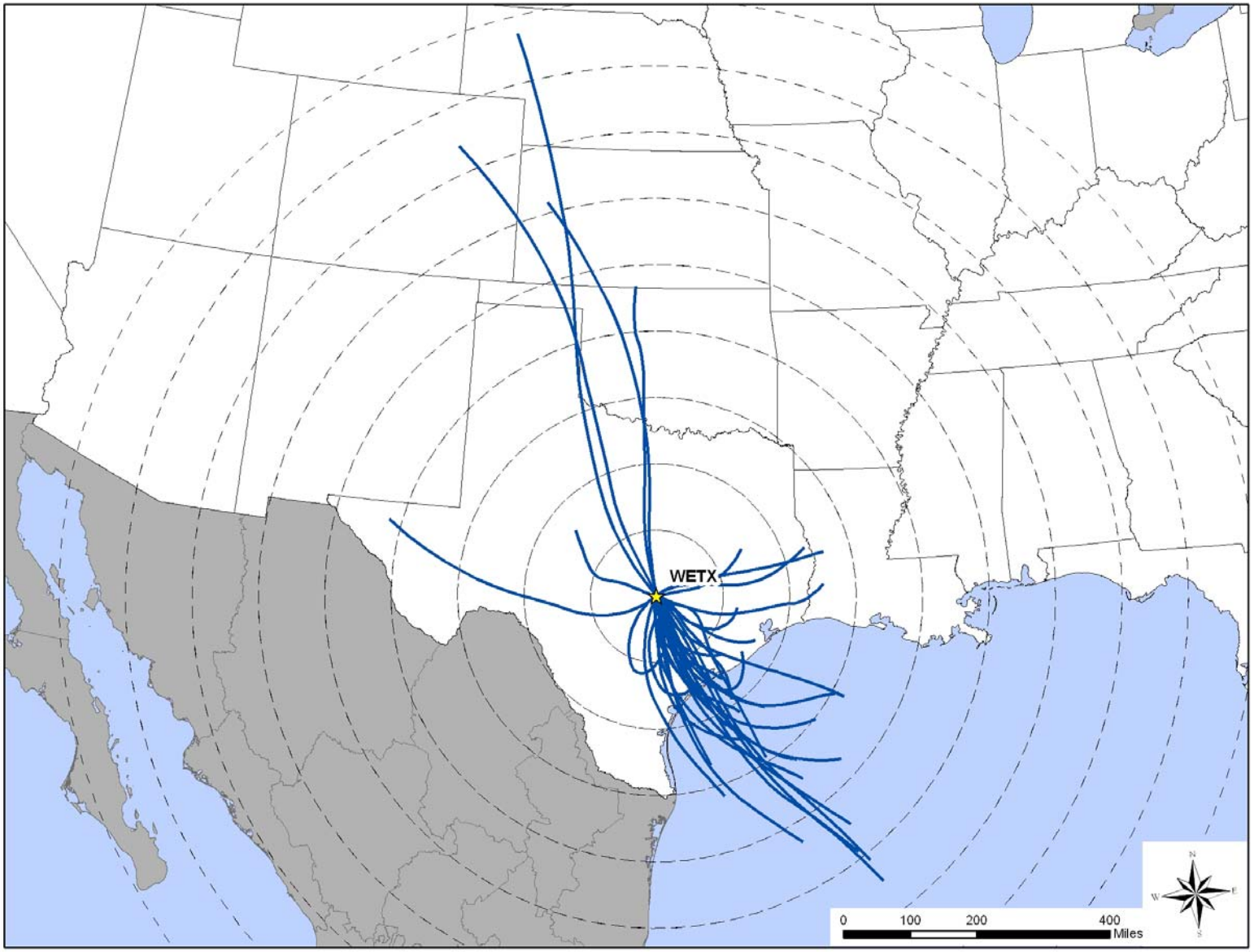
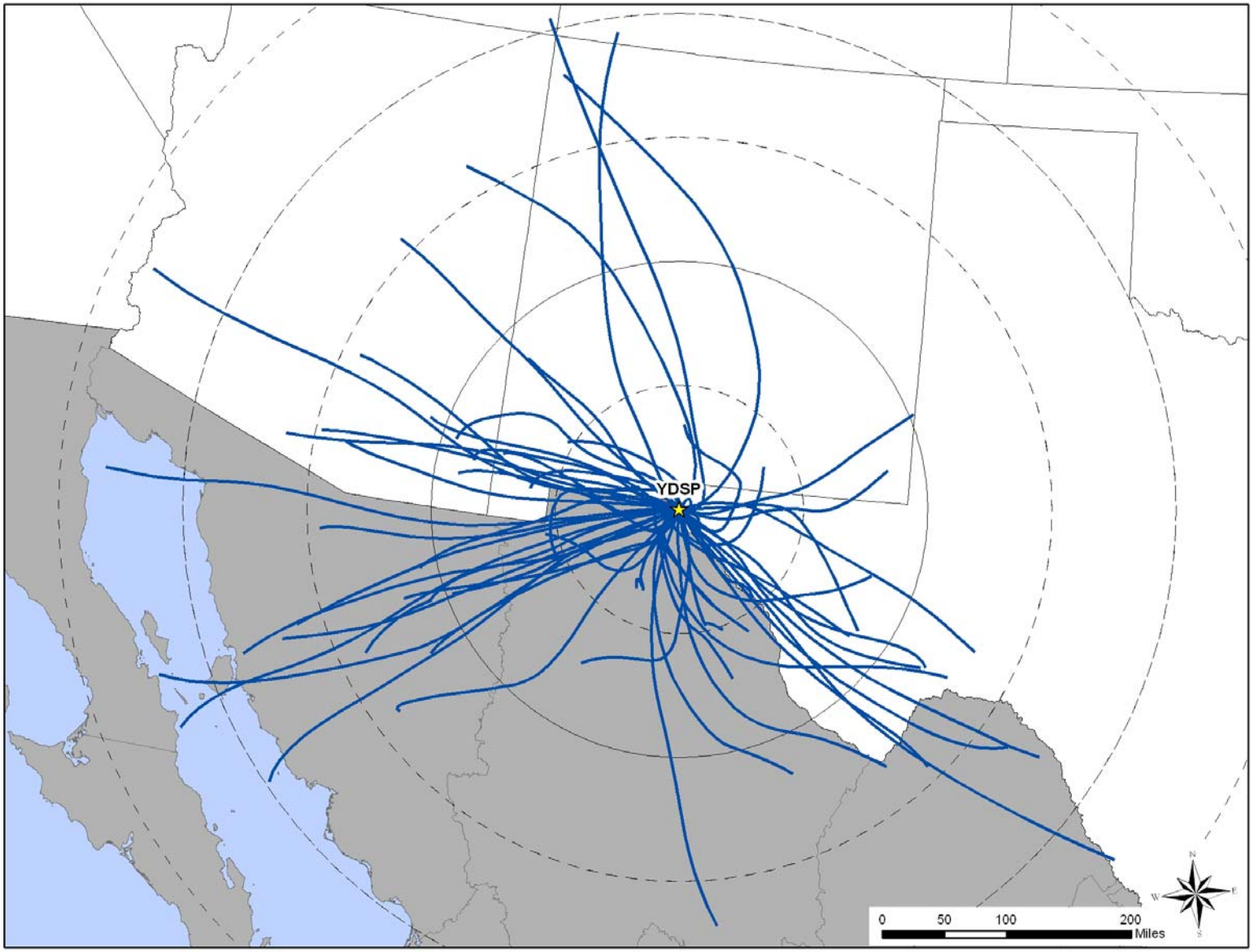


Figure 27-20. Composite Back Trajectory Map for YDSP



shading to represent wind speeds. Figures 27-21 through 27-26 are the wind roses for the Texas monitoring sites on days that sampling occurred.

Observations from Figures 27-21 through 27-25 include:

- Hourly winds were predominantly out of the south, southeast, and south-southeast on days that samples were collected near the Austin sites.
- Calm winds (<2 knots) were recorded for 23 to 33 percent of the hourly measurements.
- Wind speeds ranged from 7 to 11 knots near these sites.

Observations from Figures 27-26 include:

- The wind rose for YDSP was much different than the wind roses for the Austin sites.
- Hourly winds were predominantly out of the east (11 percent of observations), north (10 percent), and west (9 percent) near YDSP on days that samples were collected.
- Calm winds (<2 knots) were recorded for less than 11 percent of the hourly measurements.
- For wind speeds greater than 2 knots, over 30 percent of observations ranged from 7 to 11 knots.
- Figure 27-26 shows that wind speeds greater than 22 knots tended to occur most frequently with southwesterly and westerly winds.

27.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as these sites did not sample for SNMOC.

27.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Travis, Williamson, and El Paso Counties were obtained from the Texas Department of Transportation and the U.S. Census Bureau, and are summarized in Table 27-6. Table 27-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each

Figure 27-21. Wind Rose for MUTX Sampling Days

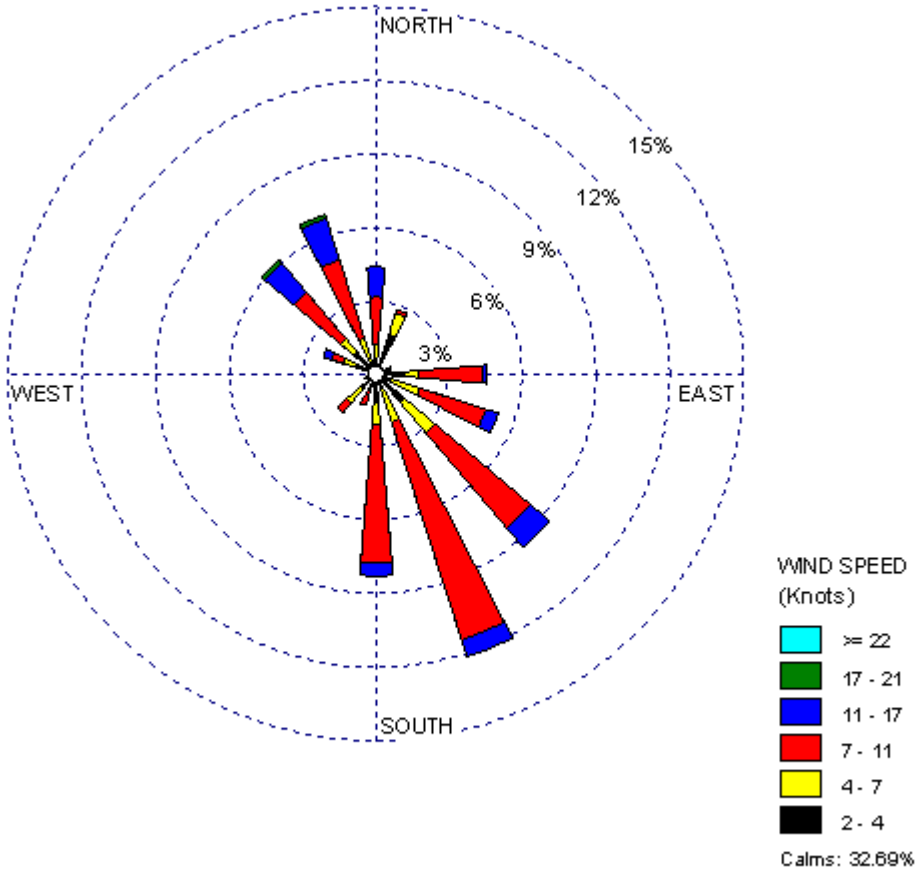


Figure 27-22. Wind Rose for PITX Sampling Days

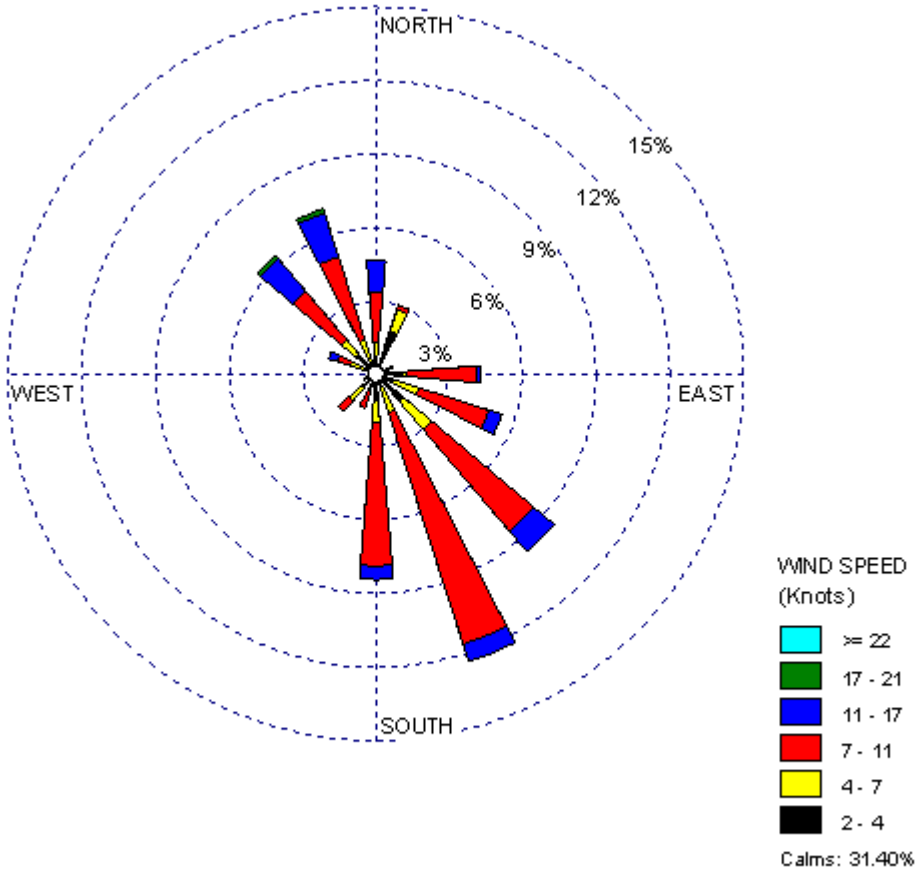


Figure 27-23. Wind Rose for RRTX Sampling Days

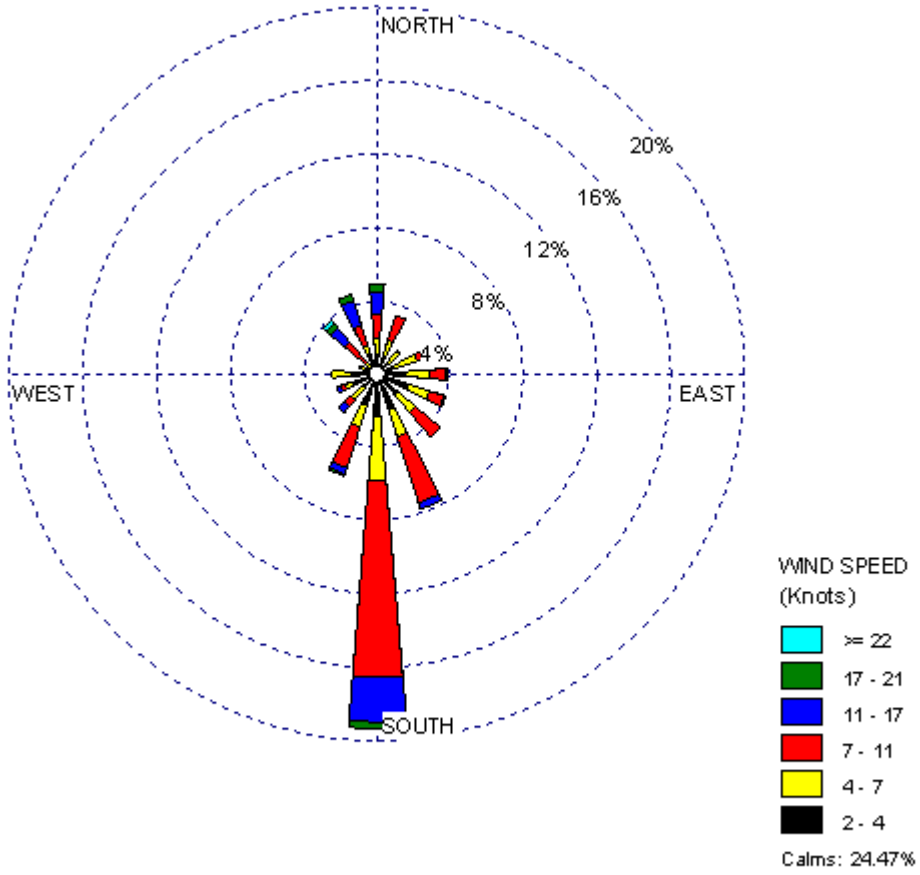


Figure 27-24. Wind Rose for TRTX Sampling Days

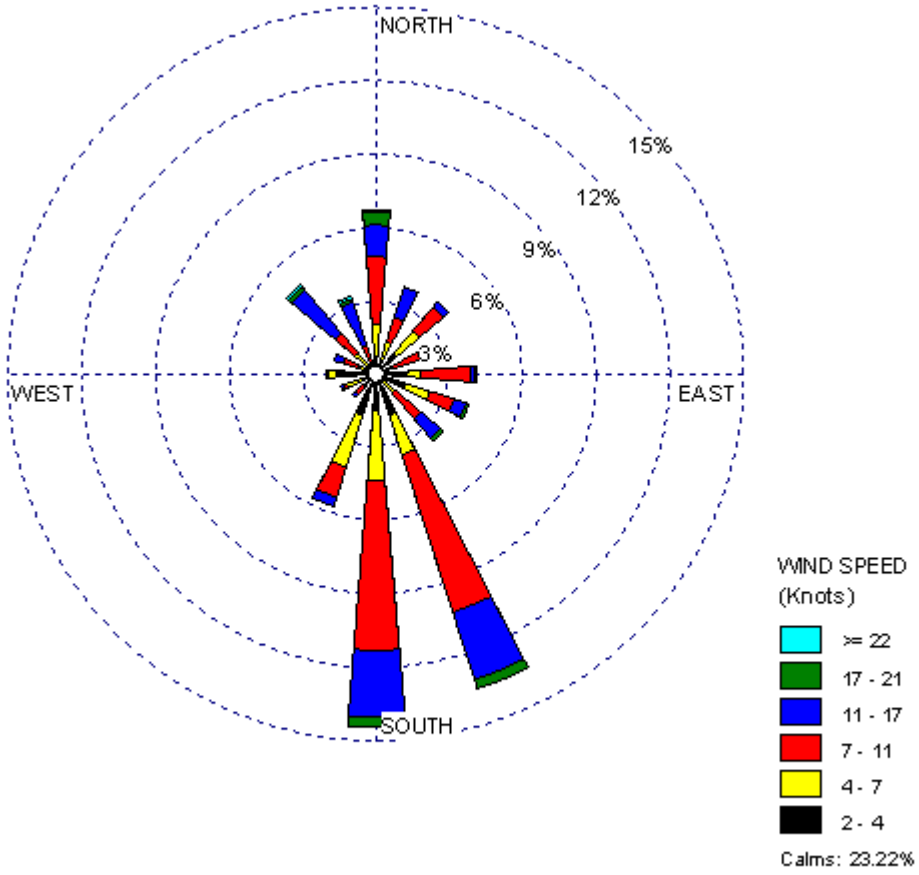


Figure 27-25. Wind Rose for WETX Sampling Days

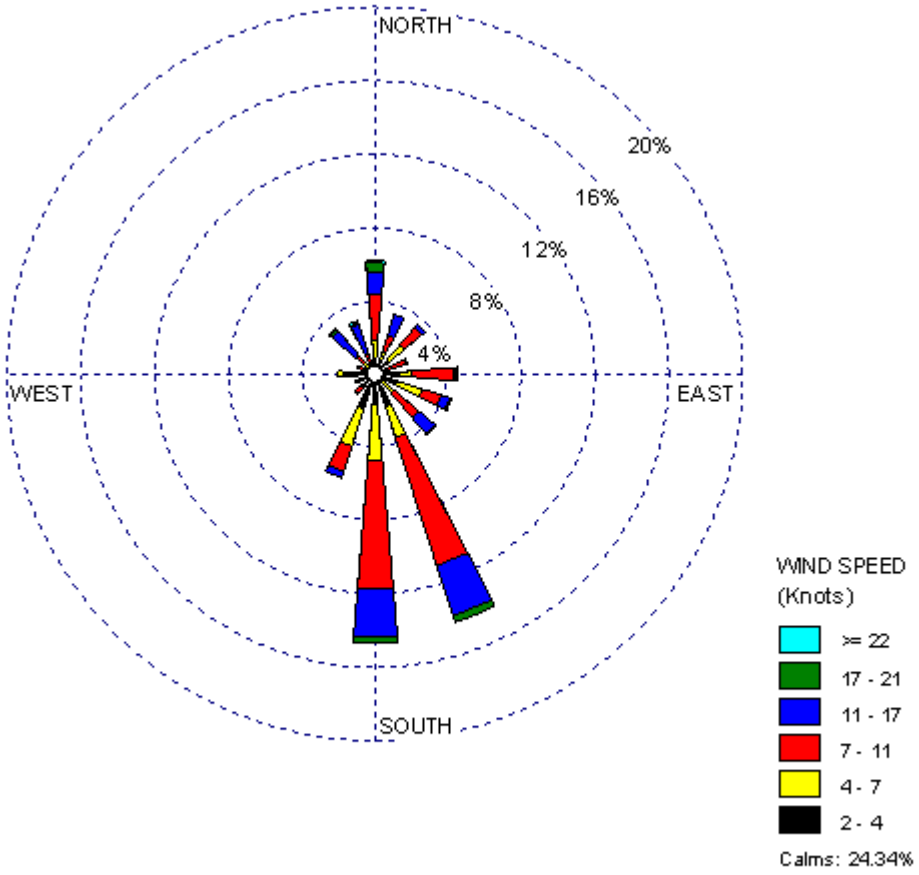


Figure 27-26. Wind Rose for YDSP Sampling Days

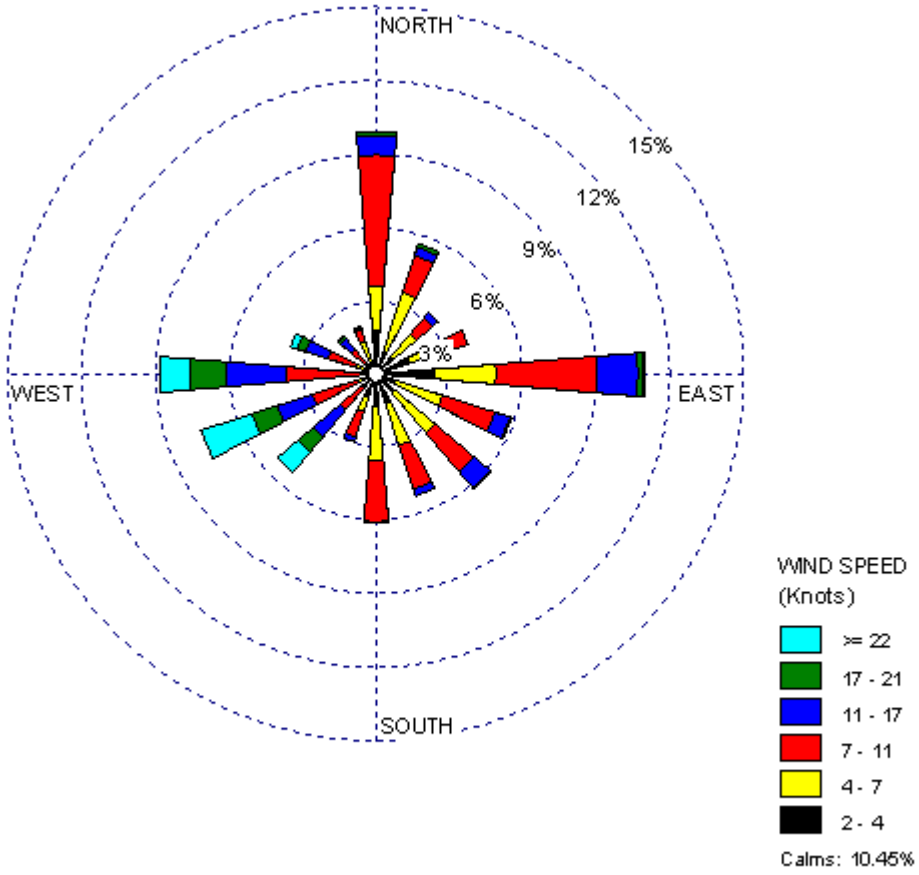


Table 27-6. Motor Vehicle Information for the Texas Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
MUTX	921,006	731,956	0.79	696,128	553,238	4,374
PITX	921,006	731,956	0.79	672,699	534,618	33,936
RRTX	353,830	285,183	0.81	387,701	312,483	20,900
TRTX	921,006	731,956	0.79	560,699	445,607	27,114
WETX	921,006	731,956	0.79	677,505	538,437	5,733
YDSP	736,310	533,438	0.72	443,463	321,278	12,400

site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 27-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 27-6 include:

- The RRTX monitoring site has a significantly lower county and 10-mile population than the other Austin sites, as well as a significantly lower county and 10-mile estimated vehicle ownership.
- The vehicle-population ratios are very similar for Travis and Williamson Counties.
- The YDSP site has a higher population and vehicle ownership than RRTX, but is lower than the remaining Austin sites.
- Due to its low vehicle per person ratio, although the YDSP's 10-mile population is higher than RRTX, the 10-mile vehicle ownership near YDSP is just slightly higher than at RRTX.
- Of the five Austin sites, PITX experiences the most daily traffic, while MUTX experiences the least.
- Compared to other UATMP sites, the four Austin-proper sites are on the lower end of the more populous locations.
- The vehicle per person ratios for MUTX, PITX, RRTX, TRTX, and WETX are in the middle of the range of UATMP sites, while the YDSP ratio is on the low-side.

27.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impacts of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- Of the six Texas sites, the YDSP monitoring site's ratios most resembled those of the roadside study, suggesting that mobile source emissions are a major influence at this site, although its benzene-ethylbenzene and xylenes-ethylbenzene ratios were closer together than the roadside study's (3.02 ± 0.27 and 3.59 ± 0.08 for YDSP vs. 2.85 and 4.55 for the roadside study).

- The ratios for MUTX, PITX, TRTX, and WETX were very similar to each other. The ratios were all lower than those of the roadside study and the benzene-ethylbenzene and xylenes-ethylbenzene ratios were closer together than those of the roadside study.

- The RRTX ratios resemble the other Austin sites except that its toluene-ethylbenzene ratio was significantly higher than those of the other sites and those of the roadside study (11.87 ± 1.77 for RRTX and 5.85 for the roadside study).

27 .6 Trends Analysis

A trends analysis could not be performed for the Texas sites as these sites have not participated in the UATMP for three consecutive years.

27.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Texas sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 27-7. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA were retrieved and are also presented in Table 27-7. The NATA data are presented for the census tract where the monitoring site is located.

The following observations can be made about MUTX, PITX, RRTX, and TRTX for the annual averages-based risks from Table 27-7:

- Formaldehyde and acrolein had the two highest annual averages of all the pollutants of interest for MUTX, PITX, RRTX, and TRTX. However, formaldehyde presents very little cancer risk, as shown by its cancer URE, and acrolein has no cancer risk factor.

Table 27-7. Chronic Risk Summary for the Monitoring Sites in Texas

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005/2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Murchison Middle School, Austin, Texas (MUTX) – Census Tract ID 48453001718								
Acetaldehyde	0.0000022	0.009	1.57	3.45	0.17	1.43 ± 0.18	3.15	0.16
Acrolein	NR	0.00002	0.11	NR	5.35	3.74 ± 1.29	NR	186.97
Acrylonitrile	0.000068	0.002	0.00	0.01	<0.01	0.07 ± 0.03	4.97	0.04
Arsenic	0.0043	0.00003	0.01	0.04	<0.01	<0.01 ± <0.01	2.04	0.02
Benzene	0.0000078	0.03	1.75	13.63	0.06	0.94 ± 0.13	7.31	0.03
1,3-Butadiene	0.00003	0.002	0.16	4.94	0.08	0.08 ± 0.02	2.27	0.04
Carbon Tetrachloride	0.000015	0.04	0.22	3.24	0.01	0.63 ± 0.06	9.50	0.02
Chloromethylbenzene	0.000049	NR	0.00	<0.01	NR	0.06 ± 0.02	2.81	NR
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.38	<0.01	0.22 ± 0.09	2.43	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	0.95	<0.01	0.05 ± 0.01	1.40	<0.01
Formaldehyde	5.5E-09	0.0098	1.57	0.01	0.16	2.82 ± 0.44	0.02	0.29
Hexachloro-1,3-butadiene	0.000022	0.09	0.00	0.03	<0.01	0.56 ± 0.24	12.34	0.01
Manganese	NR	0.00005	0.35	NR	0.01	<0.01 ± <0.01	NR	0.10
Nickel	0.00016	0.000065	0.00	0.03	<0.01	<0.01 ± <0.01	0.18	0.02
Tetrachloroethylene	0.0000059	0.27	0.24	1.42	<0.01	0.27 ± 0.10	1.60	<0.01
Pickle Research Center, Austin, Texas (PITX) – Census Tract ID 48453001849								
Acetaldehyde	0.0000022	0.009	1.67	3.67	0.19	1.43 ± 0.19	3.14	0.16
Acrolein	NR	0.00002	0.12	NR	6.22	2.51 ± 1.18	NR	125.65
Arsenic	0.0043	0.00003	0.01	0.06	<0.01	<0.01 ± <0.01	1.95	0.02
Benzene	0.0000078	0.03	1.70	13.24	0.06	0.80 ± 0.11	6.22	0.03
1,3-Butadiene	0.00003	0.002	0.16	4.7	0.08	0.07 ± 0.02	2.15	0.04
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.68 ± 0.06	10.20	0.02
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.35	<0.01	0.23 ± 0.09	2.57	<0.01
Formaldehyde	5.5E-09	0.0098	1.75	0.01	0.18	2.88 ± 0.44	0.02	0.29
Hexachloro-1,3-butadiene	0.000022	0.09	0.00	0.03	<0.01	0.75 ± 0.32	16.50	0.01
Manganese	NR	0.00005	1.89	NR	0.04	0.01 ± <0.01	NR	0.12
Nickel	0.00016	0.000065	0.49	0.08	0.01	<0.01 ± <0.01	0.20	0.02

Table 27-7. Chronic Risk Summary for the Monitoring Sites in Texas (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005/2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Tetrachloroethylene	0.0000059	0.27	0.24	1.4	<0.01	0.11 ± 0.03	0.65	<0.01
Trichloroethylene	0.000002	0.6	0.09	0.18	<0.01	0.09 ± 0.05	0.18	<0.01
Round Rock, Texas (RRTX) – Census Tract ID 48491021502								
Acetaldehyde	0.0000022	0.009	1.31	2.89	0.15	1.47 ± 0.17	3.24	0.16
Acrolein	NR	0.00002	0.08	NR	4.18	4.61 ± 1.95	NR	230.36
Acrylonitrile	0.000068	0.002	0.00	0.01	<0.01	0.06 ± 0.01	4.08	0.03
Arsenic	0.0043	0.00003	0.01	0.03	<0.01	<0.01 ± <0.01	2.10	0.02
Benzene	0.0000078	0.03	1.36	10.61	0.05	0.98 ± 0.18	7.66	0.03
1,3-Butadiene	0.00003	0.002	0.11	3.34	0.06	0.08 ± 0.03	2.38	0.04
Carbon Tetrachloride	0.000015	0.04	0.21	3.21	0.01	0.66 ± 0.06	9.88	0.02
Chloromethylbenzene	0.000049	NR	0.00	<0.01	NR	0.05 ± 0.02	2.60	NR
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.46	<0.01	0.27 ± 0.09	2.93	<0.01
Formaldehyde	5.5E-09	0.0098	1.32	0.01	0.13	3.03 ± 0.39	0.02	0.34
Hexachloro-1,3-butadiene	0.000022	0.09	0.00	0.03	<0.01	0.58 ± 0.25	12.75	0.01
Manganese	NR	0.00005	0.14	NR	<0.01	0.01 ± <0.01	NR	0.11
Nickel	0.00016	0.000065	0.00	0.03	<0.01	<0.01 ± <0.01	0.20	0.02
Tetrachloroethylene	0.0000059	0.27	0.15	0.9	<0.01	0.26 ± 0.09	1.52	<0.01
Travis High School, Austin, Texas (TRTX) – Census Tract ID 48453002308								
Acetaldehyde	0.0000022	0.009	1.42	3.12	0.16	1.49 ± 0.21	3.28	0.17
Acrolein	NR	0.00002	0.10	NR	4.85	2.58 ± 1.13	NR	129.14
Arsenic	0.0043	0.00003	0.01	0.03	<0.01	<0.01 ± <0.01	4.33	0.03
Benzene	0.0000078	0.03	1.69	13.15	0.06	1.11 ± 0.17	8.67	0.04
1,3-Butadiene	0.00003	0.002	0.17	5.11	0.09	0.14 ± 0.03	4.24	0.07
Cadmium	0.0018	0.00002	0.00	0.01	<0.01	<0.01 ± <0.01	0.67	0.02
Carbon Tetrachloride	0.000015	0.04	0.21	3.18	0.01	0.68 ± 0.07	10.17	0.02
Chloromethylbenzene	0.000049	NR	0.00	<0.01	NR	0.06 ± 0.02	2.76	NR
1,2-Dibromoethane	0.00022	0.0008	0.02	5.15	0.03	0.11 ± 0.03	24.59	0.14
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.36	<0.01	0.26 ± 0.08	2.82	<0.01

Table 27-7. Chronic Risk Summary for the Monitoring Sites in Texas (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005/2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
1,2-Dichloroethane	0.000026	2.4	0.04	0.93	<0.01	0.06 ± 0.02	1.63	<0.01
Formaldehyde	5.5E-09	0.0098	1.52	0.01	0.15	3.01 ± 0.45	0.02	0.31
Hexachloro-1,3-butadiene	0.000022	0.09	0.00	0.03	<0.01	0.50 ± 0.23	10.91	0.01
Manganese	NR	0.00005	0.18	NR	<0.01	0.01 ± <0.01	NR	0.11
Nickel	0.00016	0.000065	0.19	0.03	<0.01	<0.01 ± <0.01	0.23	0.02
1,1,2,2-Tetrachloroethane	0.000058	NR	0.05	3.12	NR	0.10 ± 0.03	5.72	NR
Tetrachloroethylene	0.0000059	0.27	0.23	1.36	<0.01	0.20 ± 0.08	1.16	<0.01
1,1,2-Trichloroethane	0.000016	0.4	0.00	<0.01	<0.01	0.06 ± 0.03	0.98	<0.01
Vinyl Chloride	0.0000088	0.1	0.05	0.46	<0.01	0.03 ± 0.01	0.26	<0.01
Webberville Road, Austin, Texas (WETX) – Census Tract ID 48453000802								
Acetaldehyde	0.0000022	0.009	1.57	3.46	0.17	1.69 ± 0.35	3.73	0.19
Acrolein	NR	0.00002	0.13	NR	6.64	4.12 ± 1.25	NR	206.23
Acrylonitrile	0.000068	0.002	0.00	0.01	<0.01	0.19 ± 0.12	12.98	0.10
Arsenic	0.0043	0.00003	0.01	0.02	<0.01	<0.01 ± <0.01	4.48	0.03
Benzene	0.0000078	0.03	1.53	11.92	0.05	1.88 ± 0.32	14.70	0.06
1,3-Butadiene	0.00003	0.002	0.16	4.73	0.08	0.33 ± 0.09	9.93	0.17
Cadmium	0.0018	0.00002	0.00	0.01	<0.01	<0.01 ± <0.01	0.25	0.01
Carbon Tetrachloride	0.000015	0.04	0.22	3.24	0.01	0.67 ± 0.04	10.02	0.02
Chloromethylbenzene	0.000049	NR	0.00	<0.01	NR	0.06 ± 0.03	2.98	NR
1,2-Dibromoethane	0.00022	0.0008	0.02	5.23	0.03	0.10 ± 0.02	22.73	0.13
***p*-Dichlorobenzene**	0.000011	0.8	0.04	0.39	<0.01	0.40 ± 0.08	4.44	<0.01
1,2-Dichloroethane	0.000026	2.4	0.04	0.94	<0.01	0.06 ± 0.01	1.49	<0.01
Formaldehyde	5.5E-09	0.0098	1.65	0.01	0.17	2.72 ± 0.54	0.01	0.28
Hexachloro-1,3-butadiene	0.000022	0.09	0.00	0.03	<0.01	0.49 ± 0.23	10.82	0.01
Hexavalent Chromium	0.012	0.0001	0.00	0.18	<0.01	<0.01 ± <0.01	0.36	<0.01
Manganese	NR	0.00005	0.19	NR	<0.01	0.01 ± <0.01	NR	0.14
Nickel	0.00016	0.000065	0.00	0.03	<0.01	<0.01 ± <0.01	0.21	0.02
1,1,2,2-Tetrachloroethane	0.000058	NR	0.05	3.18	NR	0.09 ± 0.02	5.10	NR

Table 27-7. Chronic Risk Summary for the Monitoring Sites in Texas (Continued)

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2005/2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Tetrachloroethylene	0.0000059	0.27	0.21	1.25	<0.01	0.19 ± 0.06	1.14	<0.01
Xylenes	NR	0.1	2.10	NR	0.02	9.43 ± 4.22	NR	0.09
El Paso, Texas (YDSP) – Census Tract ID 48141003902								
Acrolein	NR	0.00002	0.04	NR	1.78	1.14 ± 1.00	NR	56.81
Benzene	0.0000078	0.03	0.87	6.79	0.03	2.39 ± 0.30	18.65	0.08
1,3-Butadiene	0.00003	0.002	0.09	2.63	0.04	0.33 ± 0.06	9.79	0.16
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	0.59 ± 0.04	8.92	0.01
***p*-Dichlorobenzene**	0.000011	0.8	0.03	0.34	<0.01	0.45 ± 0.12	4.93	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	0.00	0.03	<0.01	0.74 ± 0.17	16.17	0.01
Tetrachloroethylene	0.0000059	0.27	0.14	0.81	<0.01	0.32 ± 0.31	1.89	<0.01
Trichloroethylene	0.000002	0.6	0.07	0.13	<0.01	0.18 ± 0.04	0.37	<0.01
Xylenes	NR	0.1	0.91	NR	0.01	7.32 ± 1.10	NR	0.07

* Metals sampled with PM_{10} filters

BOLD indicates a pollutant of interest

NR = a risk factor is not available and therefore, no risk calculation can be made.

- Hexachloro-1,3-butadiene poses the highest cancer risk of the pollutants of interest for MUTX, PITX, and RRTX. This pollutant has the second highest cancer risk for TRTX, following 1,2-dibromoethane.

- 1,2-Dibromoethane was only detected twice at TRTX, and the annual average was calculated using the 1/2 MDL substitution for non-detects, as outlined in Section 3.3.5. While the resulting cancer risk (24.59 in-a-million) appears high, the annual average from which the cancer risk was based (0.11 $\mu g/m^3$) was less than the MDL of this pollutant (0.25 $\mu g/m^3$).

- Other pollutants with higher cancer risks include carbon tetrachloride and benzene.

- The only pollutant with noncancer HQs greater than 1.0 was acrolein. The noncancer risks of this pollutant for these four sites were the highest of all UATMP sites, and ranged from 125.65 (for PITX) to 230.36 (for RRTX).

- All of the other noncancer risks for the remaining pollutants were less than 0.40.

The following observations can be made about WETX for the annual averages-based risks from Table 27-7:

- Xylenes had the highest annual averages for WETX, followed by acrolein and formaldehyde. However, 1,2-dibromoethane had the highest cancer risk for WETX. This pollutant was detected five times at WETX.

- Other pollutants with cancer risks greater than 1 in-a-million for WETX include benzene, acrylonitrile, hexachloro-1,3-butadiene, and carbon tetrachloride.

- Similar to the other Austin sites, acrolein was the only pollutant with a noncancer HQ greater than 1.0 for WETX and its value was similarly high.

The following observations can be made about YDSP for the annual averages-based risks from Table 27-7:

- Xylenes had the highest annual averages for YDSP, followed by benzene and acrolein.

- Benzene had the highest cancer risk for this site (18.65 in-a-million), although xylenes have no cancer risk URE.

- Hexachloro-1,3-butadiene also had a cancer risk greater than 10 in-a-million (16.17 in-a-million).

- Similar to the Austin sites, acrolein was the only pollutant with a noncancer HQ greater than 1.0. Although its HQ was significantly lower than the Austin sites, this pollutant still had one of the higher noncancer HQs of the UATMP sites.

The following observations can be made for the NATA-modeled risks from Table 27-7:

- Benzene had the highest NATA-modeled cancer risk for all of the Texas sites, and these risks tended to be slightly higher than those calculated from the annual averages for the Austin sites. The modeled concentrations for benzene also tended to be higher than the annual averages.

- Acrolein was the only pollutant with a noncancer HQ greater than 1.0 according to NATA, but the noncancer HQ was significantly lower, ranging from 1.78 for YDSP to 6.64 for WETX.

27.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 27-8 and 27-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 27-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 27-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on the annual average are limited to those pollutants failing at least one screen.

The following observations can be made from Table 27-8:

- Benzene was the highest emitted pollutant with cancer risk factor in all three Texas Counties, had the highest toxicity-weighted emissions in all three counties, and had one of the top five highest cancer risks for all six Texas sites.

Table 27-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Texas

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Murchison Middle School, Austin, Texas (MUTX) – Travis County					
Benzene	579.83	Benzene	4.52E-03	Hexachloro-1,3-butadiene	12.34
Formaldehyde	239.99	1,3-Butadiene	2.05E-03	Carbon Tetrachloride	9.50
Tetrachloroethylene	118.95	Lead	8.08E-04	Benzene	7.31
Dichloromethane	94.78	Tetrachloroethylene	7.02E-04	Acrylonitrile	4.97
Acetaldehyde	86.05	Naphthalene	5.86E-04	Acetaldehyde	3.15
1,3-Butadiene	68.34	1,3-Dichloropropene	2.57E-04	Chloromethylbenzene	2.81
1,3-Dichloropropene	64.30	*p*-Dichlorobenzene	2.26E-04	*p*-Dichlorobenzene	2.43
Trichloroethylene	28.89	Acetaldehyde	1.89E-04	1,3-Butadiene	2.27
p-Dichlorobenzene	20.54	Polycyclic Organic Matter as 15-PAH	1.82E-04	Arsenic	2.04
Naphthalene	17.22	Polycyclic Organic Matter as 7-PAH	1.82E-04	Tetrachloroethylene	1.60
Pickle Research Center, Austin, Texas (PITX) – Travis County					
Benzene	579.83	Benzene	4.52E-03	Hexachloro-1,3-butadiene	16.50
Formaldehyde	239.99	1,3-Butadiene	2.05E-03	Carbon Tetrachloride	10.20
Tetrachloroethylene	118.95	Lead	8.08E-04	Benzene	6.22
Dichloromethane	94.78	Tetrachloroethylene	7.02E-04	Acetaldehyde	3.14
Acetaldehyde	86.05	Naphthalene	5.86E-04	*p*-Dichlorobenzene	2.57
1,3-Butadiene	68.34	1,3-Dichloropropene	2.57E-04	1,3-Butadiene	2.15
1,3-Dichloropropene	64.30	*p*-Dichlorobenzene	2.26E-04	Arsenic	1.95
Trichloroethylene	28.89	Acetaldehyde	1.89E-04	Tetrachloroethylene	0.65
p-Dichlorobenzene	20.54	Polycyclic Organic Matter as 15-PAH	1.82E-04	Nickel	0.20
Naphthalene	17.22	Polycyclic Organic Matter as 7-PAH	1.82E-04	Trichloroethylene	0.18

Table 27-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Texas (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Travis High School, Austin, Texas (TRTX) – Travis County					
Benzene	579.83	Benzene	4.52E-03	1,2-Dibromoethane	24.59
Formaldehyde	239.99	1,3-Butadiene	2.05E-03	Hexachloro-1,3-butadiene	10.91
Tetrachloroethylene	118.95	Lead	8.08E-04	Carbon Tetrachloride	10.17
Dichloromethane	94.78	Tetrachloroethylene	7.02E-04	Benzene	8.67
Acetaldehyde	86.05	Naphthalene	5.86E-04	1,1,2,2-Tetrachloroethane	5.72
1,3-Butadiene	68.34	1,3-Dichloropropene	2.57E-04	Arsenic	4.33
1,3-Dichloropropene	64.30	*p*-Dichlorobenzene	2.26E-04	1,3-Butadiene	4.24
Trichloroethylene	28.89	Acetaldehyde	1.89E-04	Acetaldehyde	3.28
p-Dichlorobenzene	20.54	Polycyclic Organic Matter as 15-PAH	1.82E-04	*p*-Dichlorobenzene	2.82
Naphthalene	17.22	Polycyclic Organic Matter as 7-PAH	1.82E-04	Chloromethylbenzene	2.76
Webberville Road, Austin, Texas (WETX) – Travis County					
Benzene	579.83	Benzene	4.52E-03	1,2-Dibromoethane	22.73
Formaldehyde	239.99	1,3-Butadiene	2.05E-03	Benzene	14.70
Tetrachloroethylene	118.95	Lead	8.08E-04	Acrylonitrile	12.98
Dichloromethane	94.78	Tetrachloroethylene	7.02E-04	Hexachloro-1,3-butadiene	10.82
Acetaldehyde	86.05	Naphthalene	5.86E-04	Carbon Tetrachloride	10.02
1,3-Butadiene	68.34	1,3-Dichloropropene	2.57E-04	1,3-Butadiene	9.93
1,3-Dichloropropene	64.30	*p*-Dichlorobenzene	2.26E-04	1,1,2,2-Tetrachloroethane	5.10
Trichloroethylene	28.89	Acetaldehyde	1.89E-04	Arsenic	4.48
p-Dichlorobenzene	20.54	Polycyclic Organic Matter as 15-PAH	1.82E-04	*p*-Dichlorobenzene	4.44
Naphthalene	17.22	Polycyclic Organic Matter as 7-PAH	1.82E-04	Acetaldehyde	3.73

Table 27-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Monitoring Sites in Texas (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Round Rock, Texas (RRTX) – Williamson County					
Benzene	160.04	Benzene	1.25E-03	Hexachloro-1,3-butadiene	12.75
Formaldehyde	76.00	Lead	8.84E-04	Carbon Tetrachloride	9.88
Dichloromethane	40.79	1,3-Butadiene	5.65E-04	Benzene	7.66
Acetaldehyde	29.76	Naphthalene	1.89E-04	Acrylonitrile	4.08
1,3-Dichloropropene	20.68	Tetrachloroethylene	1.07E-04	Acetaldehyde	3.24
1,3-Butadiene	18.85	1,3-Dichloropropene	8.27E-05	*p*-Dichlorobenzene	2.93
Tetrachloroethylene	18.08	Polycyclic Organic Matter as 15-PAH	7.27E-05	Chloromethylbenzene	2.60
p-Dichlorobenzene	6.50	*p*-Dichlorobenzene	7.15E-05	1,3-Butadiene	2.38
Naphthalene	5.57	Acetaldehyde	6.55E-05	Arsenic	2.10
Trichloroethylene	5.03	Hexavalent Chromium	6.20E-05	Tetrachloroethylene	1.52
El Paso, Texas (YDSP) – El Paso County					
Benzene	420.95	Benzene	3.28E-03	Benzene	18.65
Formaldehyde	164.95	1,3-Butadiene	1.21E-03	Hexachloro-1,3-butadiene	16.17
Dichloromethane	78.73	Lead	4.19E-04	1,3-Butadiene	9.79
Tetrachloroethylene	67.21	Tetrachloroethylene	3.97E-04	Carbon Tetrachloride	8.92
Acetaldehyde	63.75	Naphthalene	3.50E-04	*p*-Dichlorobenzene	4.93
1,3-Dichloropropene	55.70	1,3-Dichloropropene	2.23E-04	Tetrachloroethylene	1.89
1,3-Butadiene	40.17	Arsenic	1.90E-04	Trichloroethylene	0.37
Trichloroethylene	19.20	*p*-Dichlorobenzene	1.88E-04		
p-Dichlorobenzene	17.11	Acetaldehyde	1.40E-04		
Naphthalene	10.29	Polycyclic Organic Matter as 15-PAH	1.18E-04		

Table 27-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Texas

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Murchison Middle School, Austin, Texas (MUTX) – Travis County					
Toluene	1,762.66	Acrolein	588,285.13	Acrolein	186.97
Xylenes	1,128.96	2,4-Toluene Diisocyanate	63,744.61	Formaldehyde	0.29
Benzene	579.83	1,3-Butadiene	34,171.65	Acetaldehyde	0.16
Hexane	347.59	Formaldehyde	24,488.63	Manganese	0.10
Methanol	299.90	Benzene	19,327.66	1,3-Butadiene	0.04
Ethylbenzene	268.08	Xylenes	11,289.60	Acrylonitrile	0.04
Formaldehyde	239.99	Acetaldehyde	9,561.34	Benzene	0.03
1,1,1-Trichloroethane	206.47	Naphthalene	5,741.14	Nickel	0.02
Methyl Ethyl Ketone	167.89	Cyanide	4,433.78	Carbon Tetrachloride	0.02
Methyl Isobutyl Ketone	157.17	Toluene	4,406.66	Arsenic	0.02
Pickle Research Center, Austin, Texas (PITX) – Travis County					
Toluene	1,762.66	Acrolein	588,285.13	Acrolein	125.65
Xylenes	1,128.96	2,4-Toluene Diisocyanate	63,744.61	Formaldehyde	0.29
Benzene	579.83	1,3-Butadiene	34,171.65	Acetaldehyde	0.16
Hexane	347.59	Formaldehyde	24,488.63	Manganese	0.12
Methanol	299.90	Benzene	19,327.66	1,3-Butadiene	0.04
Ethylbenzene	268.08	Xylenes	11,289.60	Benzene	0.03
Formaldehyde	239.99	Acetaldehyde	9,561.34	Nickel	0.02
1,1,1-Trichloroethane	206.47	Naphthalene	5,741.14	Carbon Tetrachloride	0.02
Methyl Ethyl Ketone	167.89	Cyanide	4,433.78	Arsenic	0.02
Methyl Isobutyl Ketone	157.17	Toluene	4,406.66	Hexachloro-1,3-butadiene	0.01

Table 27-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Texas (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Travis High School, Austin, Texas (TRTX) – Travis County					
Toluene	1,762.66	Acrolein	588,285.13	Acrolein	129.14
Xylenes	1,128.96	2,4-Toluene Diisocyanate	63,744.61	Formaldehyde	0.31
Benzene	579.83	1,3-Butadiene	34,171.65	Acetaldehyde	0.17
Hexane	347.59	Formaldehyde	24,488.63	1,2-Dibromoethane	0.14
Methanol	299.90	Benzene	19,327.66	Manganese	0.11
Ethylbenzene	268.08	Xylenes	11,289.60	1,3-Butadiene	0.07
Formaldehyde	239.99	Acetaldehyde	9,561.34	Benzene	0.04
1,1,1-Trichloroethane	206.47	Naphthalene	5,741.14	Arsenic	0.03
Methyl Ethyl Ketone	167.89	Cyanide	4,433.78	Nickel	0.02
Methyl Isobutyl Ketone	157.17	Toluene	4,406.66	Cadmium	0.02
Webberville Road, Austin, Texas (WETX) – Travis County					
Toluene	1,762.66	Acrolein	588,285.13	Acrolein	206.23
Xylenes	1,128.96	2,4-Toluene Diisocyanate	63,744.61	Formaldehyde	0.28
Benzene	579.83	1,3-Butadiene	34,171.65	Acetaldehyde	0.19
Hexane	347.59	Formaldehyde	24,488.63	1,3-Butadiene	0.17
Methanol	299.90	Benzene	19,327.66	Manganese	0.14
Ethylbenzene	268.08	Xylenes	11,289.60	1,2-Dibromoethane	0.13
Formaldehyde	239.99	Acetaldehyde	9,561.34	Acrylonitrile	0.10
1,1,1-Trichloroethane	206.47	Naphthalene	5,741.14	Xylenes	0.09
Methyl Ethyl Ketone	167.89	Cyanide	4,433.78	Benzene	0.06
Methyl Isobutyl Ketone	157.17	Toluene	4,406.66	Arsenic	0.03

Table 27-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Monitoring Sites in Texas (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Round Rock, Texas (RRTX) – Williamson County					
Toluene	493.03	Acrolein	228,165.45	Acrolein	230.36
Xylenes	313.61	1,3-Butadiene	9,424.62	Formaldehyde	0.34
Benzene	160.04	Formaldehyde	7,754.92	Acetaldehyde	0.16
Methanol	95.79	(Including Benzene From Gasoline)	5,334.50	Manganese	0.11
Hexane	86.53	2,4-Toluene Diisocyanate	4,380.41	1,3-Butadiene	0.04
Formaldehyde	76.00	Acetaldehyde	3,306.43	Benzene	0.03
Ethylbenzene	71.81	Xylenes	3,136.12	Acrylonitrile	0.03
Methyl Isobutyl Ketone	71.36	Naphthalene	1,856.88	Nickel	0.02
1,1,1-Trichloroethane	62.64	Glycol Ethers	1,333.96	Carbon Tetrachloride	0.02
Methyl Ethyl Ketone	57.77	Toluene	1,232.57	Arsenic	0.02
El Paso, Texas (YDSP) – El Paso County					
Toluene	1,174.89	Acrolein	384,705.08	Acrolein	56.81
Xylenes	692.74	1,3-Butadiene	20,086.92	1,3-Butadiene	0.16
1,1,1-Trichloroethane	628.41	2,4-Toluene Diisocyanate	18,598.29	Benzene	0.08
Benzene	420.95	Formaldehyde	16,831.76	Xylenes	0.07
Methanol	252.37	Chlorine	14,160.00	Carbon Tetrachloride	0.01
Hexane	223.33	Benzene	14,031.79	Hexachloro-1,3-butadiene	0.01
Methyl Ethyl Ketone	199.61	Manganese	13,529.83	Tetrachloroethylene	<0.01
Formaldehyde	164.95	Acetaldehyde	7,083.26	p-Dichlorobenzene	<0.01
Ethylbenzene	159.31	Xylenes	6,927.37	Trichloroethylene	<0.01
Methyl Isobutyl Ketone	105.48	Glycol Ethers	4,450.35		

- While hexachloro-1,3-butadiene and carbon tetrachloride had some of the highest annual average-based cancer risks for all the sites, these pollutants did not rank in the top 10 for mass emissions or for toxicity-weighted emissions.

- Although lead and 1,3-butadiene also had high toxicity-weighted emissions, only 1,3-butadiene appeared on all three top 10 lists.

The following observations can be made from Table 27-9:

- Like many UATMP counties, toluene and xylenes had the highest emissions in Travis, Williamson, and El Paso Counties for pollutants with noncancer risk factors. These two pollutants also had some of the highest toxicity-weighted emissions in Travis and Williamson Counties. For El Paso County, toluene did not appear on the highest toxicity-weighted emissions list.

- Acrolein had the highest toxicity-weighted emissions for all three counties, but did not appear on the list of highest emitted pollutants. Acrolein also had the highest noncancer risk for each of the Texas sites.

- Formaldehyde, which had the second highest noncancer risk based on annual averages for the Austin sites (YDSP did not sample carbonyls), also appeared on each of the top 10 emissions and toxicity-weighted emissions lists.

Texas Pollutant Summary

- *The pollutants of interest common to each of the Texas sites were acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and p-dichlorobenzene.*

- *Acrolein had the highest daily average for all five Austin sites, while total xylenes had the highest at the El Paso site.*

- *Acrolein exceeded the short-term risk factors at all six Texas sites.*

28.0 Site in Utah

This section presents meteorological, concentration, and spatial trends for the UATMP site in Bountiful, Utah (BTUT), located just north of Salt Lake City. Figure 28-1 is a topographical map showing the monitoring site in its urban location. Figure 28-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. Most of the point sources near the Bountiful site are located south of the site. A number of these sources are involved in fuel combustion processes, petroleum and natural gas production and refining, and fabricated metal product production.

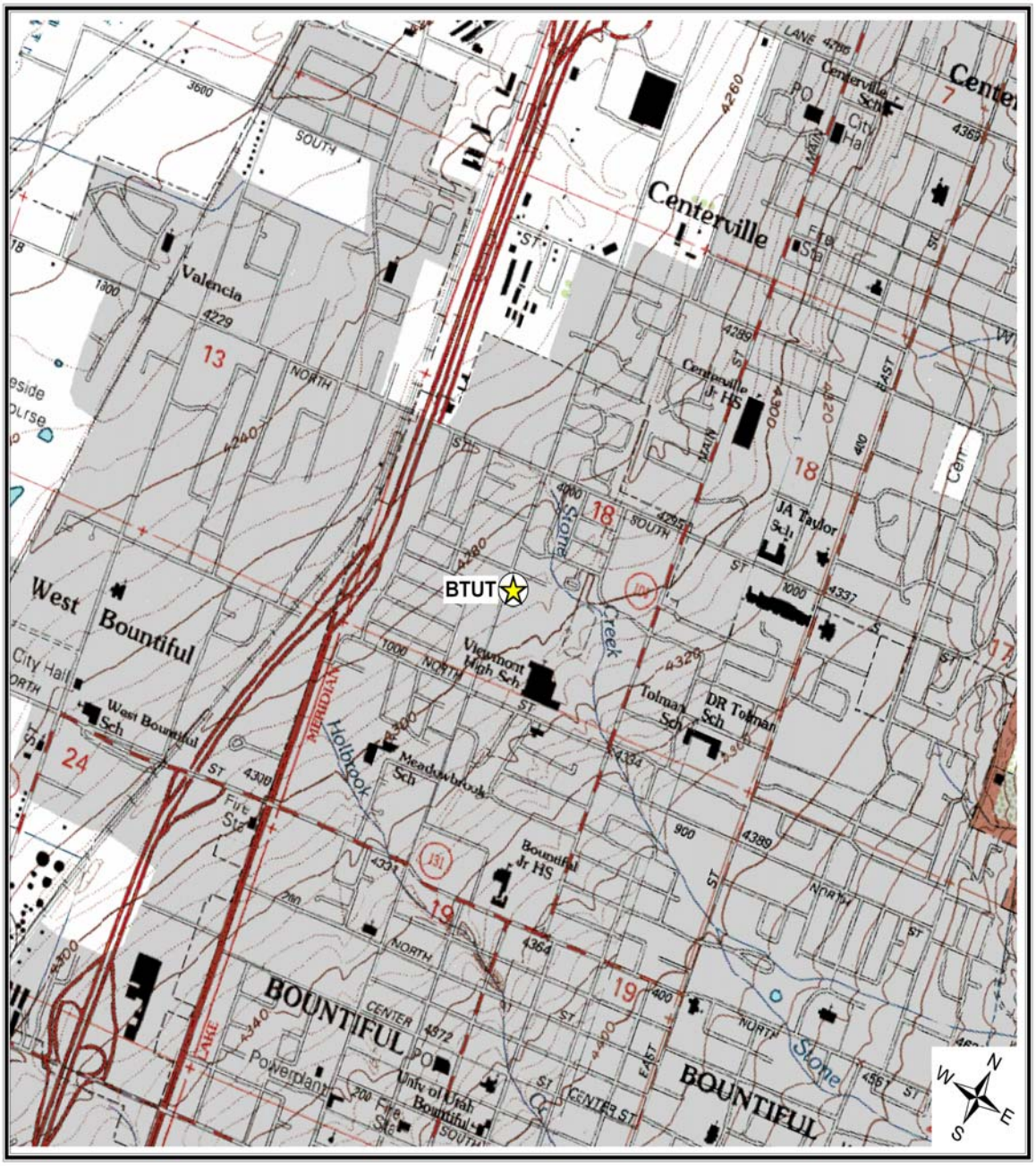
The Salt Lake City area has a semi-arid continental climate, with large seasonal variations. The area is dry, located on the west side of the Wasatch Mountains, and the Great Salt Lake tends to have a moderating influence on the city's temperature. Moderate winds flow out of the southeast on average (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the BTUT monitoring site is Salt Lake City International Airport (WBAN 24127). Table 28-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 28-1 is the 95 percent confidence interval. As shown in Table 28-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

28.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Michigan monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs

Figure 28-1. Bountiful, Utah (BTUT) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 28-2. Facilities Located Within 10 Miles of BTUT

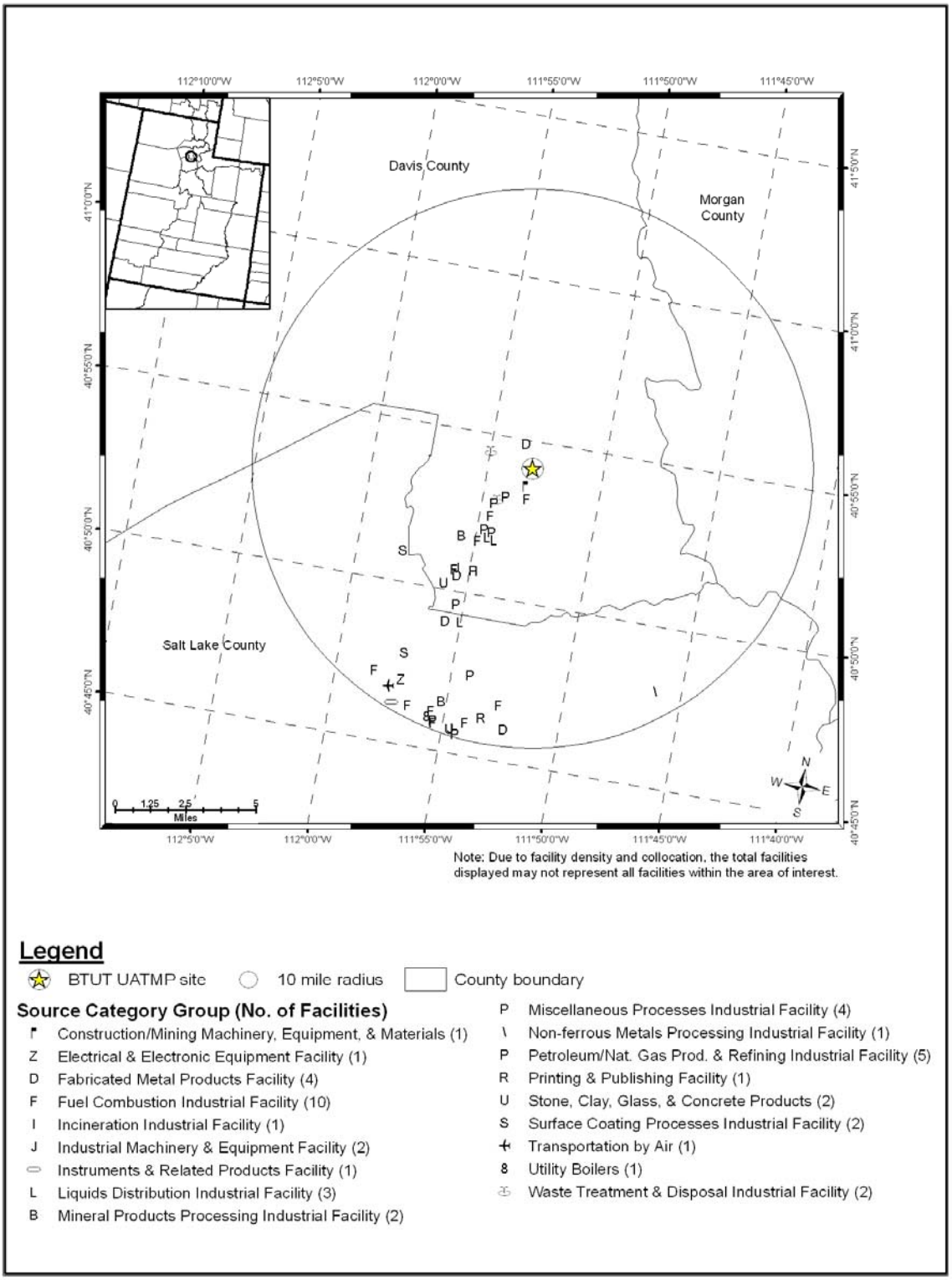


Table 28-1. Average Meteorological Conditions near the Monitoring Site in Utah

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
BTUT	24127	All 2006	64.18 ± 2.16	53.77 ± 1.96	33.13 ± 1.02	43.25 ± 1.28	52.65 ± 1.90	1015.71 ± 0.82	7.38 ± 0.29
		Sampling Day	64.40 ± 5.12	53.42 ± 4.63	33.10 ± 2.39	43.10 ± 3.05	52.91 ± 4.25	1016.38 ± 2.12	7.25 ± 0.79

are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. The BTUT monitoring site sampled for carbonyls, SNMOC, VOC, and metals. Table 28-2 presents the seventeen pollutants that failed at least one screen at BTUT.

Table 28-2. Comparison of Measured Concentrations and EPA Screening Values for the Utah Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bountiful, UT – BTUT					
Acetaldehyde	60	60	100.00	12.77	12.77
Formaldehyde	60	60	100.00	12.77	25.53
Benzene	59	59	100.00	12.55	38.09
Carbon Tetrachloride	58	59	98.31	12.34	50.43
Arsenic (PM_{10})	52	58	89.66	11.06	61.49
1,3-Butadiene	51	53	96.23	10.85	72.34
Acrolein	43	43	100.00	9.15	81.49
Manganese (PM_{10})	36	58	62.07	7.66	89.15
Tetrachloroethylene	26	49	53.06	5.53	94.68
Cadmium (PM_{10})	10	58	17.24	2.13	96.81
p-Dichlorobenzene	6	33	18.18	1.28	98.09
Hexachloro-1,3-butadiene	2	2	100.00	0.43	98.51
1,2-Dichloroethane	2	2	100.00	0.43	98.94
Hexavalent Chromium	2	54	3.70	0.43	99.36
Xylenes	1	59	1.69	0.21	99.57
Acrylonitrile	1	1	100.00	0.21	99.79
Nickel (PM_{10})	1	58	1.72	0.21	100.00
Total	470	766	61.36		

The following observations are shown in Table 28-2:

- A total of 470 measured concentrations failed screens.

- The risk screening process for BTUT resulting in 10 pollutants of interest: acetaldehyde (60 failed screens), formaldehyde (60), benzene (59), carbon tetrachloride (58), arsenic (52), 1,3-butadiene (51), acrolein (43), manganese (36), tetrachloroethylene (26), and cadmium (10).

- Of the 10 pollutants of interest, acetaldehyde, acrolein, benzene, and formaldehyde had 100 percent of their measured detections fail screens.

28.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 28-3. Annual averages are presented and discussed in further detail in later sections.

The following observations are shown in Table 28-3:

- Acetaldehyde, arsenic, benzene, formaldehyde, manganese, cadmium, and carbon tetrachloride were detected in every sample collected at BTUT.

- Among the daily averages, formaldehyde had the highest concentration by mass (5.63 ± 0.97 $\mu g/m^3$), followed by acetaldehyde (3.37 ± 0.37 $\mu g/m^3$) and benzene (1.16 ± 0.14 $\mu g/m^3$).

- Seasonal averages did not vary much for each pollutant of interest for BTUT, with the exception of formaldehyde, which was significantly higher, in the summer.

28.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for BTUT was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and

Table 28-3. Daily and Seasonal Averages for the Pollutants of Interest for the Utah Monitoring Site

Pollutant	# of Measured Detections	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Bountiful, UT – BTUT												
Acetaldehyde	60	60	3.37	0.37	2.77	0.46	3.07	0.58	4.91	0.76	2.73	0.46
Acrolein	43	59	0.74	0.22	0.35	0.15	NR	NR	0.54	0.15	0.96	0.58
Arsenic (PM_{10})	58	58	0.0007	0.0001	0.0010	0.0005	0.0005	0.0001	0.0007	0.0001	0.0006	0.0002
Benzene	59	59	1.16	0.14	1.63	0.32	0.84	0.19	0.86	0.11	1.25	0.22
1,3-Butadiene	53	59	0.13	0.03	0.18	0.04	0.10	0.04	0.05	0.01	0.10	0.02
Cadmium (PM_{10})	58	58	0.0008	0.0006	0.0015	0.0013	0.0012	0.0020	0.0003	0.0001	0.0002	0.0001
Carbon Tetrachloride	59	59	0.61	0.05	0.52	0.06	0.47	0.10	0.70	0.09	0.72	0.10
Formaldehyde	60	60	5.63	0.97	3.44	0.49	4.58	0.86	10.57	2.20	3.99	0.79
Manganese (PM_{10})	58	58	0.0079	0.0012	0.0056	0.0020	0.0074	0.0030	0.0104	0.0017	0.0080	0.0017
Tetrachloroethylene	49	59	0.21	0.04	0.25	0.08	0.11	0.05	0.16	0.07	0.18	0.05

NR = Not reportable due to low number of measured detections.

REL factors, as well as compare seasonal averages to the intermediate MRL. Of the seventeen pollutants with at least one failed screen at BTUT, only acrolein exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 28-4.

The following observations about acrolein are shown in Table 28-4:

- All forty-three acrolein measured detections were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$.
- The average detected concentration was 0.74 ± 0.22 $\mu g/m^3$, which was nearly four times the California REL value.
- For the intermediate acrolein risk, seasonal averages were compared to the ATSDR intermediate value of 0.09 $\mu g/m^3$. Every seasonal average of acrolein exceeded the intermediate risk value, although an acrolein spring concentration could not be calculated due to the low number of measured detections.

For the pollutants that exceeded the acute risk factors, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of daily concentration and daily average wind direction. Figure 28-3 is the pollution rose for acrolein for BTUT.

Observations gleaned from the acrolein pollution rose include:

- All of the acrolein concentrations exceeded the acute risk factors, indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).
- The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources, although they tend to occur more often with northwesterly and southeasterly winds. BTUT is located on the grounds of a high school, which is located just east of I-15 (Figure 28-1).
- The highest concentration of acrolein occurred with a south-southeasterly wind.

28.4 Meteorological and Concentration Analysis

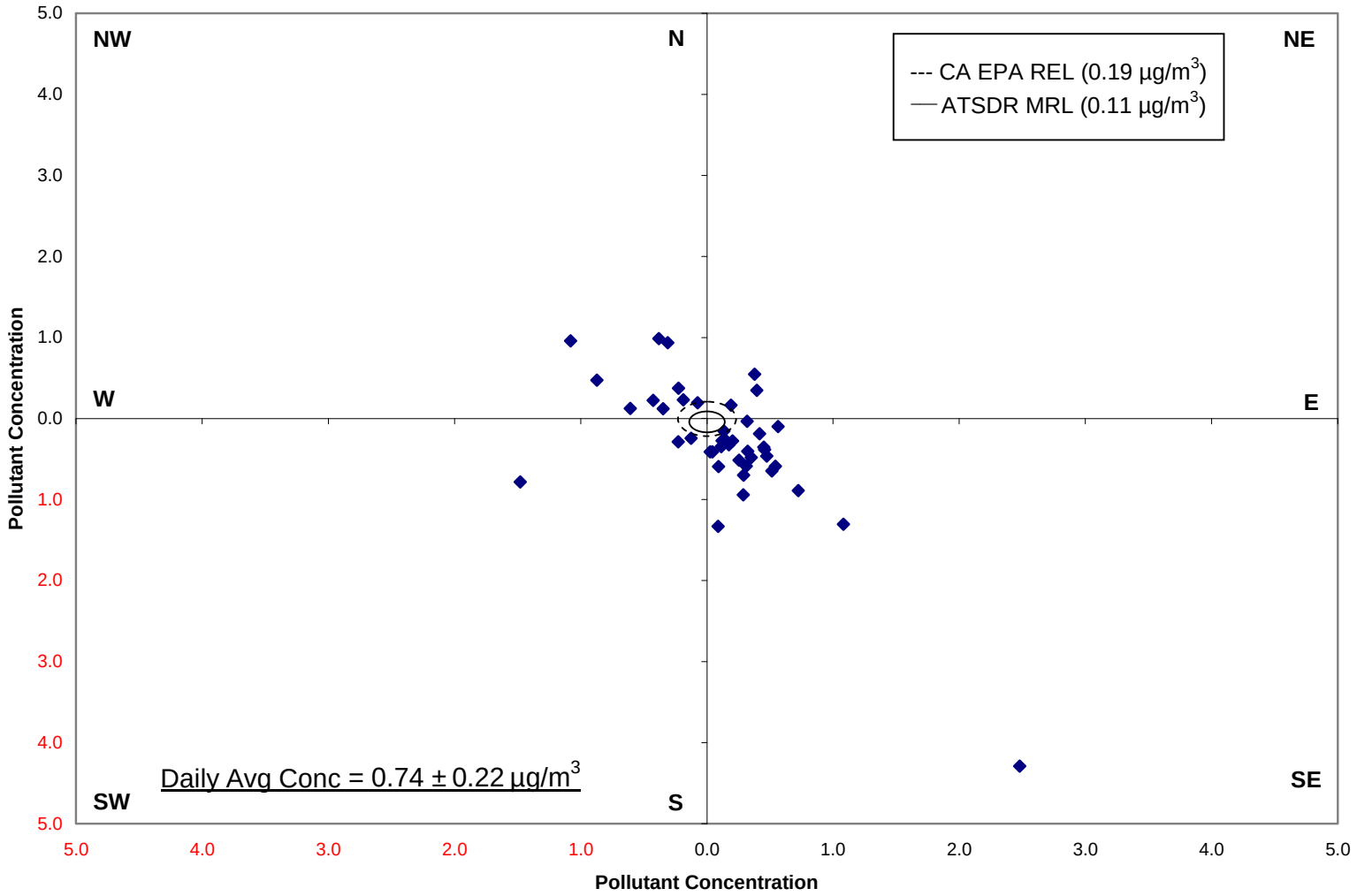
The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters

Table 28-4. Non-Chronic Risk Summary for the Utah Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
BTUT	TO-15	Acrolein	0.74 ± 0.22	0.11	43	0.19	43	0.09	0.35 ± 0.15	NR	0.54 ± 0.15	0.96 ± 0.58

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of measured detections.

Figure 28-3. Acrolein Pollution Rose for BTUT



(such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

28.4.1 Pearson Correlation Analysis

Table 28-5 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the BTUT monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for BTUT from Table 28-5:

- Acetaldehyde, formaldehyde, and manganese exhibited strong positive correlations with maximum and average temperatures. This indicates that increasing temperatures correlate to increasing concentrations of these pollutants.

- Acetaldehyde, formaldehyde, and manganese also exhibited strong positive correlations with dew point and wet bulb temperature, but strong negative correlations with relative humidity. While this may seem to be conflicting, each of these moisture variables is highly dependent on the ambient temperature. (For more information about the moisture variables, please refer to Section 3.1.6.2.) These correlations indicate that moisture content is an important factor in the concentrations of these pollutants at this site.

28.4.2 Composite Back Trajectory Analysis

Figure 28-4 is a composite back trajectory map for the BTUT monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 28-4 represents 100 miles.

The following observations can be made from Figure 28-4:

- Back trajectories predominantly originated from the south and northwest at BTUT.

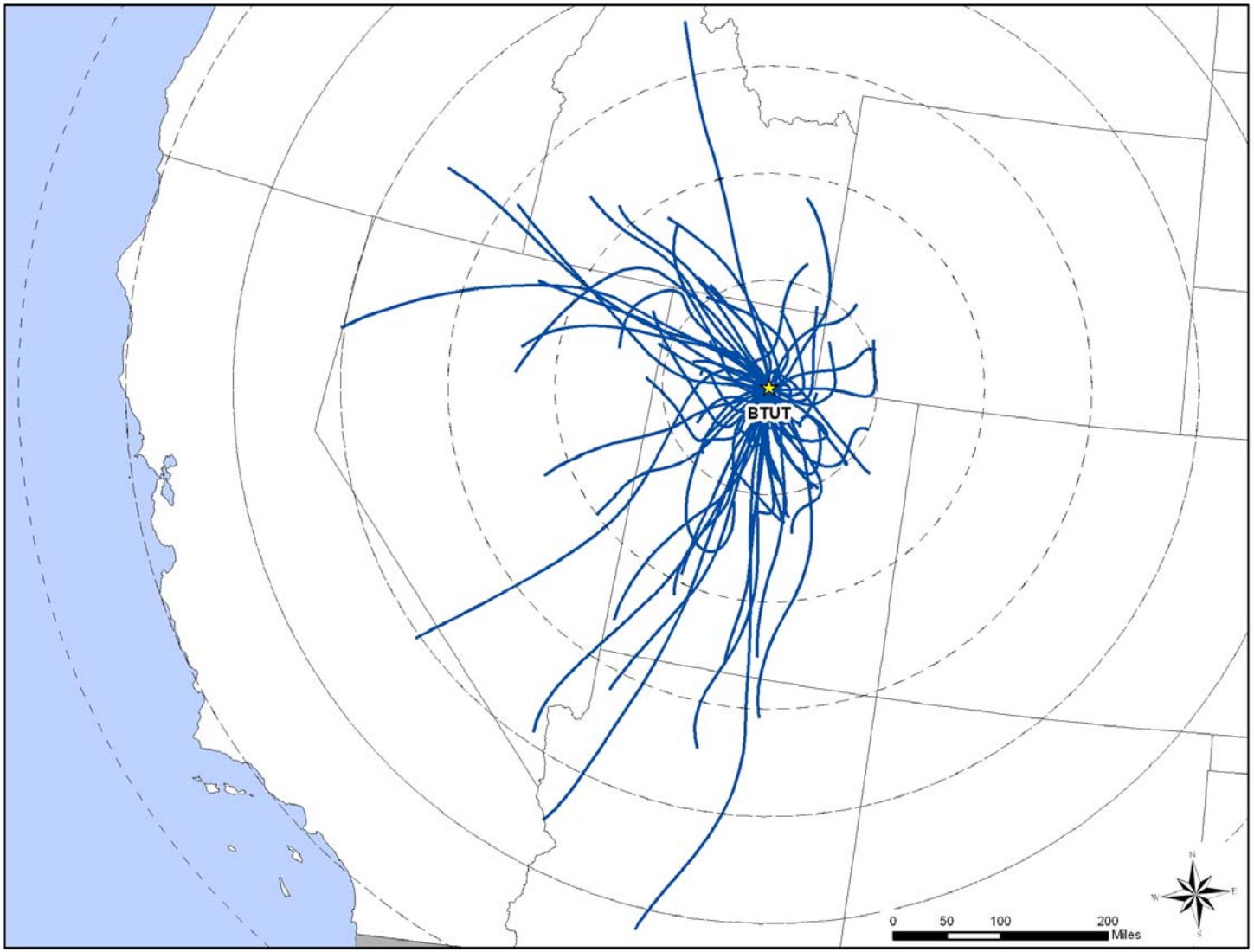
- The 24-hour airshed domain was somewhat smaller at BTUT when compared to other UATMP sites; 67 percent of the trajectories originated within 200 miles of the site and 84 percent were within 300 miles of the site.

- Some trajectories originated as far away as southern Arizona (> 500 miles).

Table 28-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Utah Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Bountiful, UT – BTUT								
1,3-Butadiene	53	-0.39	-0.42	-0.43	-0.43	0.28	0.37	-0.27
Acetaldehyde	60	0.60	0.59	0.44	0.54	-0.57	-0.18	-0.05
Acrolein	43	0.16	0.16	0.17	0.17	-0.13	-0.35	0.30
Arsenic (PM_{10})	58	-0.16	-0.19	-0.30	-0.25	0.06	0.39	-0.38
Benzene	59	-0.35	-0.41	-0.41	-0.43	0.32	0.50	-0.19
Cadmium (PM_{10})	58	-0.06	-0.06	-0.08	-0.06	0.01	0.05	0.26
Carbon Tetrachloride	59	0.43	0.42	0.47	0.44	-0.27	-0.15	0.09
Formaldehyde	60	0.73	0.74	0.58	0.69	-0.69	-0.34	0.06
Manganese (PM_{10})	58	0.65	0.62	0.38	0.55	-0.70	-0.15	-0.08
Tetrachloroethylene	49	-0.12	-0.14	-0.18	-0.17	0.08	0.23	0.00

Figure 28-4. Composite Back Trajectory Map for BTUT



28.4.3 Wind Rose Analysis

Hourly wind data from the Salt Lake City International Airport near the BTUT monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 28-5 is the wind rose for the BTUT monitoring site on day that sampling occurred.

The following observations can be made from Figure 28-5:

- Hourly winds were predominantly out of the south-southeast (15 percent of observations), southeast (15 percent), and south (13 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on sampling days.
- Calm winds (<2 knots) were recorded for 9 percent of the observations.
- Wind speeds greater than 22 knots were only observed with south and south-southeasterly winds.

28.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and ethylene-acetylene mobile tracer analysis.

28.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Davis County, UT were obtained from the Utah State Tax Commission and the U.S. Census Bureau, and are summarized in Table 28-6. Table 28-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 28-6 contains the average daily traffic

Figure 28-5. Wind Rose for BTUT Sampling Days

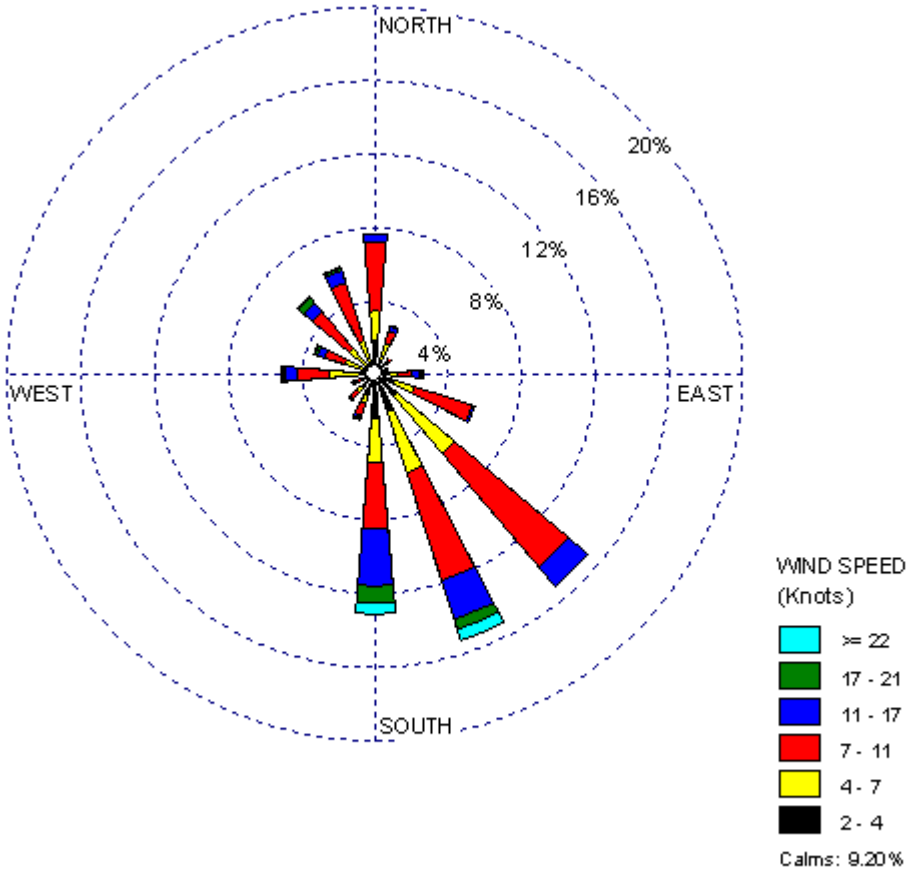


Table 28-6. Motor Vehicle Information for the Utah Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
BTUT	276,259	223,379	0.81	246,163	199,044	33,310

information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 28-6 include:

- Compared to other UATMP sites, BTUT's county and 10-mile population is in the low to mid range, as is its county-level vehicle registration and estimated 10-mile vehicle registration.
- The average daily traffic count falls in the middle of the range compared to other UATMP sites.
- The BTUT monitoring site is located in a commercial area and is located in an urban-city center setting.

28.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions.

The BTEX table and figure show the following:

- The benzene-ethylbenzene ratio (4.86 ± 0.34) was slightly higher than the xylenes-ethylbenzene ratio (4.52 ± 0.19), unlike that of the roadside study.
- Similar to the roadside study, the BTUT toluene-ethylbenzene ratio (8.49 ± 0.44) was the highest concentration ratio.

28.5.3 Mobile Tracer Analysis

As previously stated, BTUT sampled for SNMOCs in addition to VOCs. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.)

Table 3-11 shows:

- The ethylene to acetylene ratio for BTUT, 1.30, was somewhat lower than the 1.7 ratio.

- This ratio suggests that while mobile sources may be influencing the air quality at the Utah monitoring site, there may also be atmospheric chemical processes affecting the quantities of ethylene in this area. Known sinks of ethylene include reactions with ozone, as well as soil (NLMb).

28.6 Trends Analysis

For sites that participated in the UATMP prior to 2005, and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. BTUT has participated in the UATMP since 2003. Figure 28-6 presents the trends analysis results for formaldehyde, benzene, and 1,3-butadiene for BTUT.

The following observations were made:

- Concentrations of formaldehyde appear to have decreased slightly after having increased significantly over the prior three year period, as presented in Figure 28-6.

- Concentrations of 1,3-butadiene and benzene both decreased slightly after showing little change from previous years.

28.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Utah site and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 28-7. The NATA data is presented for the census tract where the monitoring site is located. Additionally, the pollutants of interest are bolded.

Figure 28-6. Comparison of Yearly Averages for the BTUT Monitoring Site

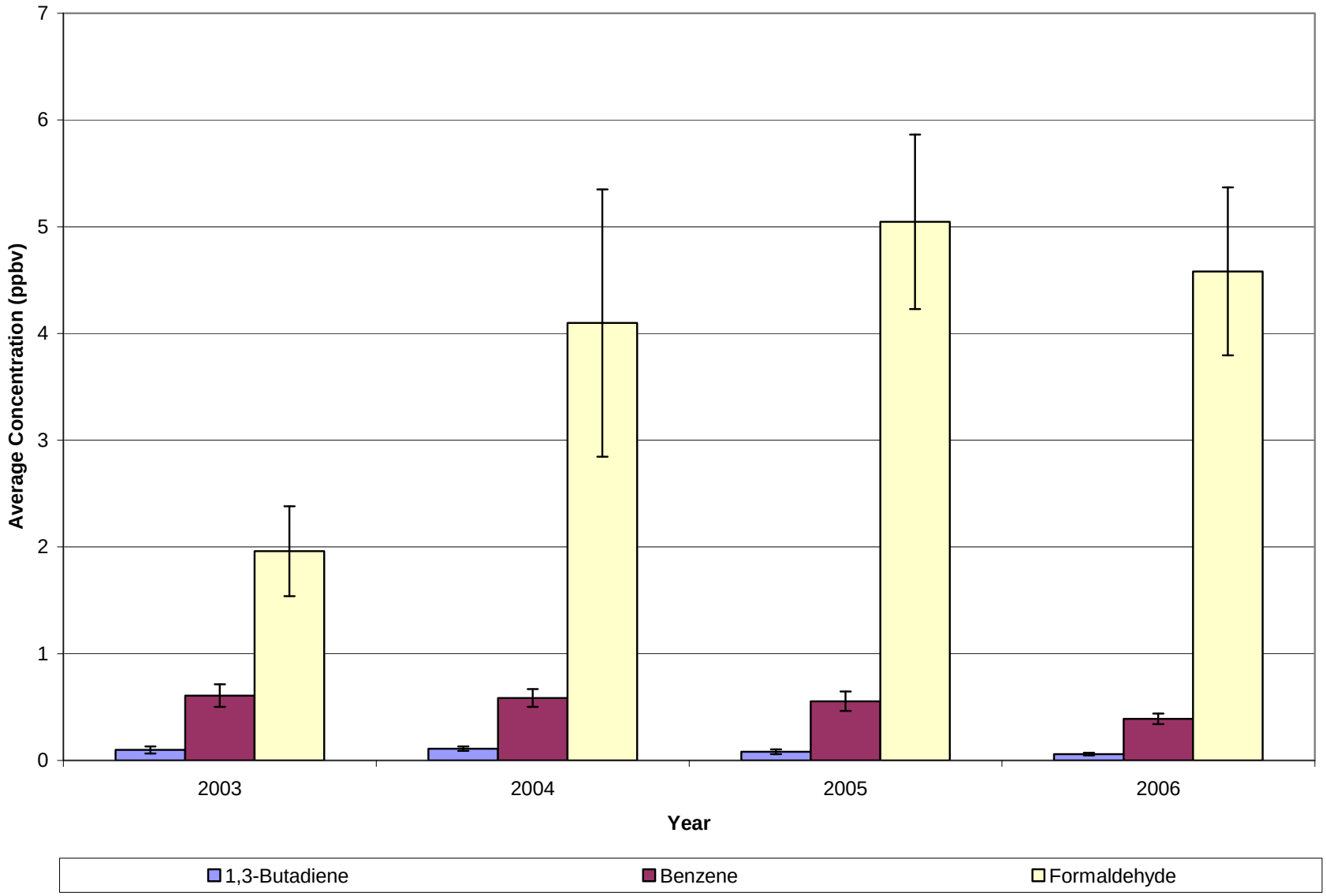


Table 28-7. Chronic Risk Summary for the Monitoring Site in Utah

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Bountiful, Utah (BTUT) – Census Tract ID 49011126600								
Acetaldehyde	0.0000022	0.009	1.15	2.53	0.13	3.37 ± 0.37	7.41	0.37
Acrolein	NR	0.00002	0.08	NR	4.05	0.58 ± 0.18	NR	28.77
Acrylonitrile	0.000068	0.002	<0.01	0.05	<0.01	0.07 ± 0.02	4.88	0.04
Arsenic*	0.0043	0.00003	0.28	1.22	0.01	<0.01 ± <0.01	3.51	0.03
Benzene	0.0000078	0.03	1.52	11.88	0.05	1.16 ± 0.14	9.09	0.04
1,3-Butadiene	0.00003	0.002	0.11	3.38	0.06	0.11 ± 0.02	3.21	0.05
Cadmium*	0.0018	0.00002	0.07	0.12	<0.01	<0.01 ± <0.01	0.47	0.01
Carbon Tetrachloride	0.000015	0.04	0.21	3.16	0.01	0.61 ± 0.05	9.08	0.02
p-Dichlorobenzene	0.000011	0.8	0.03	0.37	<0.01	0.06 ± 0.03	0.67	<0.01
1,2-Dichloroethane	0.000026	2.4	0.03	0.71	<0.01	0.03 ± <0.01	0.83	<0.01
Formaldehyde	5.5E-09	0.0098	1.23	0.01	0.13	5.63 ± 0.97	0.03	0.57
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	0.07 ± 0.01	1.63	<0.01
Hexavalent Chromium	0.012	0.0001	<0.01	0.68	<0.01	<0.01 ± <0.01	0.43	<0.01
Nickel*	0.00016	0.000065	0.32	0.05	<0.01	<0.01 ± <0.01	0.15	0.01
Manganese*	NR	0.00005	0.29	NR	0.01	0.01 ± <0.01	NR	0.17
Tetrachloroethylene	0.0000059	0.27	0.12	0.68	<0.01	0.18 ± 0.04	1.05	<0.01
Xylenes	NR	0.1	2.24	NR	0.02	3.02 ± 0.78	NR	0.03

*Metals sampled were sampled with PM_{10} filters
BOLD indicates a pollutant of interest
NR = a risk factor is not available and therefore, no risk calculation can be made.

The following observations can be made from Table 28-7:

- The pollutants with the top 3 annual averages by mass concentration were formaldehyde (5.63 ± 0.97 µg/m^3), acetaldehyde (3.37 ± 0.37 µg/m^3), and xylenes (3.02 ± 0.78 µg/m^3); however, the pollutants with the highest cancer risks were not necessarily these pollutants.

- Benzene and carbon tetrachloride exhibited the highest cancer risks at 9.09 in-a-million and 9.08 in-a-million, respectively. Other pollutants with cancer risks greater than 1 in-a-million based on the annual average include: acetaldehyde; acrylonitrile; arsenic; 1,3-butadiene; hexachloro-1,3-butadiene; and tetrachloroethylene.

- Acrolein was the only pollutant that exhibited a noncancer HQ greater than 1 (28.77). All other noncancer HQs were less than 0.75.

In addition to the annual averages and risks based on 2006 monitoring data, data from EPA's 1999 NATA were retrieved and are also presented in Table 28-7. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for BTUT is as follows:

- The census tract for is 49011126600.

- This census tract had a population of 5,116, which represents approximately 2.1 percent of the county population in 2000.

The following observations about BTUT from NATA include:

- Although xylenes, benzene, and formaldehyde had the highest NATA-modeled concentrations, this did not translate to the highest cancer risks.

- Benzene, 1,3-butadiene, and carbon tetrachloride had the highest cancer risks. (Total xylenes do not have a cancer risk factor.)

- Only benzene had a modeled cancer risk greater than 10 in-a-million (11.88). This compares favorably with the 2006 benzene cancer risk calculated from the annual average.

- Acrolein was again the only pollutant that exhibited a modeled noncancer HQ greater than 1 (4.05), although this was roughly seven times less than the risk based on the 2006 annual average.

- All other NATA-modeled noncancer HQs were less than 0.20.

28.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 28-8 and 28-9 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 28-8 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk (in-a-million) as calculated from the annual average. Table 28-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer risks based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 28-8:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor, had the highest cancer toxicity-weighted emissions, and had the highest cancer risk based on the 2006 annual average for BTUT.

- Although formaldehyde was the second highest emitted pollutant according to the 2002 NEI, the cancer risk factor was relatively low, so this pollutant was not listed on either the toxicity-weighted emissions or the annual average-based cancer risk.

- Acetaldehyde, 1,3-butadiene, and tetrachloroethylene each appeared in all three top 10 lists.

- Carbon tetrachloride, which had the second-highest cancer risk based on the annual average for BTUT, was not emitted in high quantities in Davis County, Utah.

The following observations can be made from Table 28-9:

- Although toluene was the highest emitted pollutant (by mass) with a noncancer risk factor, it did not rank in the top 10 based on toxicity-weighted emissions or the annual average-based noncancer risk.

Table 28-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for BTUT

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Davis County)		Top 10 Based on Cancer Toxicity-Weighted Emissions (for Davis County)		Top 10 Cancer Risks Based on Annual Average Concentration (for BTUT)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Bountiful, Utah – BTUT					
Benzene	227.11	Benzene	1.77E-03	Benzene	9.09
Formaldehyde	71.13	1,3-Butadiene	6.26E-04	Carbon Tetrachloride	9.08
Dichloromethane	29.21	Naphthalene	1.52E-04	Acetaldehyde	7.41
Acetaldehyde	27.74	Tetrachloroethylene	7.95E-05	Acrylonitrile	4.88
1,3-Butadiene	20.87	Acetaldehyde	6.10E-05	1,3-Butadiene	3.21
Tetrachloroethylene	13.48	Polycyclic Organic Matter as 15-PAH	6.02E-05	Arsenic	3.07
p-Dichlorobenzene	5.36	p-Dichlorobenzene	5.89E-05	Hexachloro-1,3-butadiene	1.63
Naphthalene	4.48	Polycyclic Organic Matter as 7-PAH	4.90E-05	Cadmium	1.41
Trichloroethylene	2.92	Acrylonitrile	3.05E-05	Tetrachloroethylene	1.05
Polycyclic Organic Matter as 15-PAH	1.09	Polycyclic Organic Matter as non-15-PAH	2.34E-05	1,2-Dichloroethane	0.83

Table 28-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for BTUT

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Davis County)		Top 10 Based on Noncancer Toxicity-Weighted Emissions (for Davis County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for BTUT)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Bountiful, Utah – BTUT					
Toluene	681.49	Acrolein	231,458.77	Acrolein	28.77
Xylenes	489.16	Hexamethylene Diisocyanate	12,645.00	Formaldehyde	0.57
Benzene	227.11	1,3-Butadiene	10,436.73	Acetaldehyde	0.37
n-Hexane	113.93	Manganese	9,087.72	Manganese	0.16
Ethylbenzene	106.11	Benzene	7,570.43	1,3-Butadiene	0.05
Methanol	93.65	Formaldehyde	7,258.18	Cadmium	0.04
Methyl Ethyl Ketone	89.92	Xylenes	4,891.56	Benzene	0.04
Methyl Isobutyl Ketone	87.13	Chlorine	4,710.00	Acrylonitrile	0.04
Formaldehyde	71.13	Cyanide	3,915.00	Xylenes	0.03
1,1,1-Trichloroethane	51.76	Acetaldehyde	3,082.11	Arsenic	0.02

- Acrolein had the highest noncancer toxicity-weighted emissions, and had the highest noncancer risk based on the 2006 annual average for BTUT, but did not appear in the list of highest emitted pollutants.

- Formaldehyde, benzene, and xylenes each appeared on all three top 10 lists.

Utah Pollutant Summary

- *The pollutants of interest at the Utah site were acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, cadmium, formaldehyde, manganese, and tetrachloroethylene.*

- *Formaldehyde had the highest daily average for BTUT. Formaldehyde was highest during the summer.*

- *Acrolein exceeded the short-term risk factors at BTUT.*

- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation showed that concentrations of all three have decreased slightly since 2005.*

29.0 Site in Vermont

This section presents meteorological, concentration, and spatial trends for the UATMP site in Underhill, Vermont (UNVT), which is near Burlington. Figure 29-1 is a topographical map showing the monitoring site in its rural location. Figure 29-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. UNVT is located near only four point sources; each source is involved in different industrial activities.

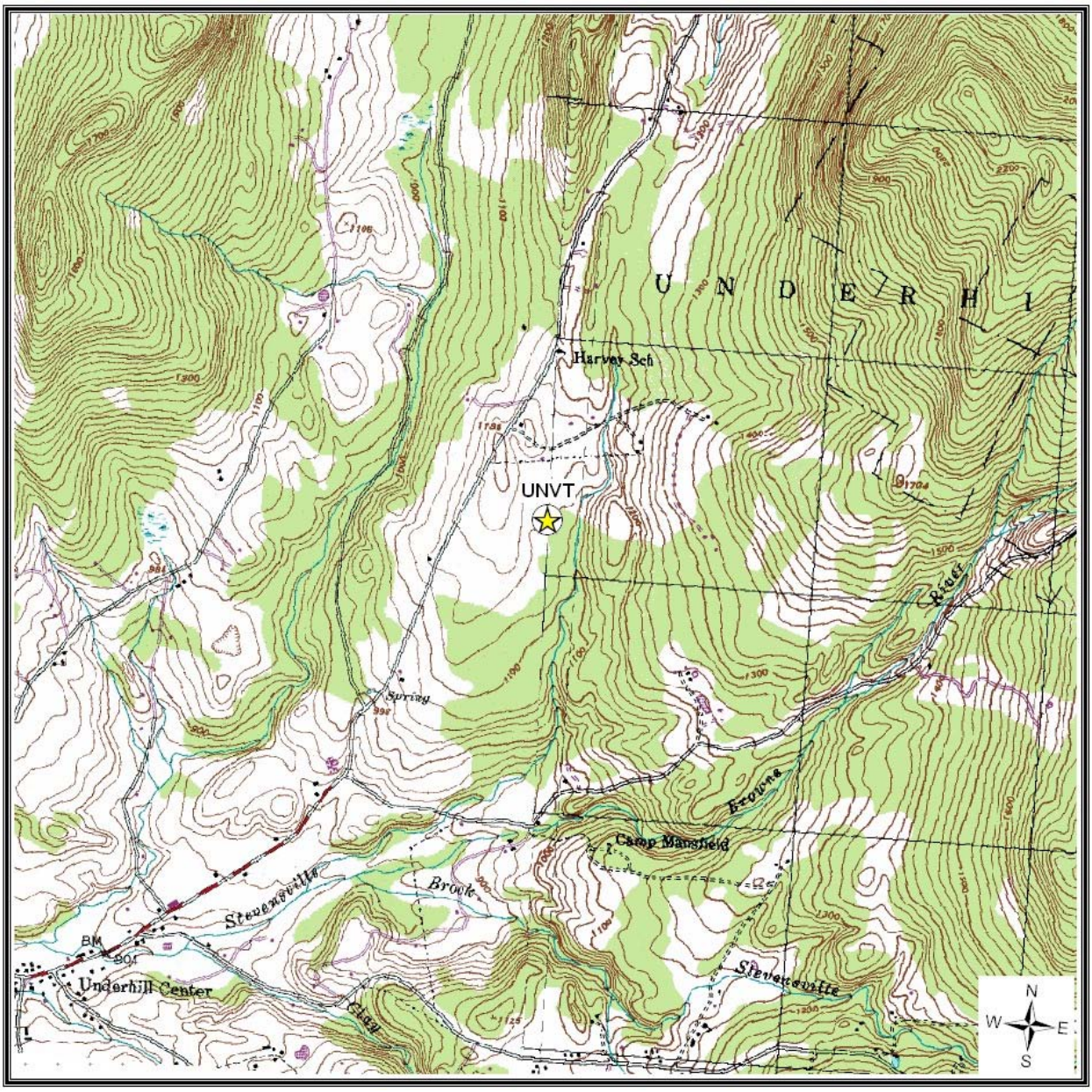
The city of Burlington resides just to the east of Lake Champlain in northwest Vermont. Lake Champlain has a moderating affect on the city, keeping the city slightly warmer than it could be given its New England location. Vermont is affected by most storm systems that track across the country, producing variable weather. Average annual winds come from the south, ahead of advancing weather systems. However, these storm systems are moderated somewhat due to the Adirondacks to the west and Green Mountains to the east (Ruffner and Bair, 1987).

Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the UNVT monitoring site is at Morrisville-Stowe St Airport (WBAN 54771). Table 29-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 29-1 is the 95 percent confidence interval. As shown in Table 29-1, average meteorological conditions on sampling days were representative of average weather conditions throughout the year.

29.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Vermont monitoring site. As described in Section 3.1.4, the methodology for evaluating pollutants of

Figure 29-1. Underhill, Vermont (UNVT) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:29,000.

Figure 29-2. Facilities Located Within 10 Miles of UNVT

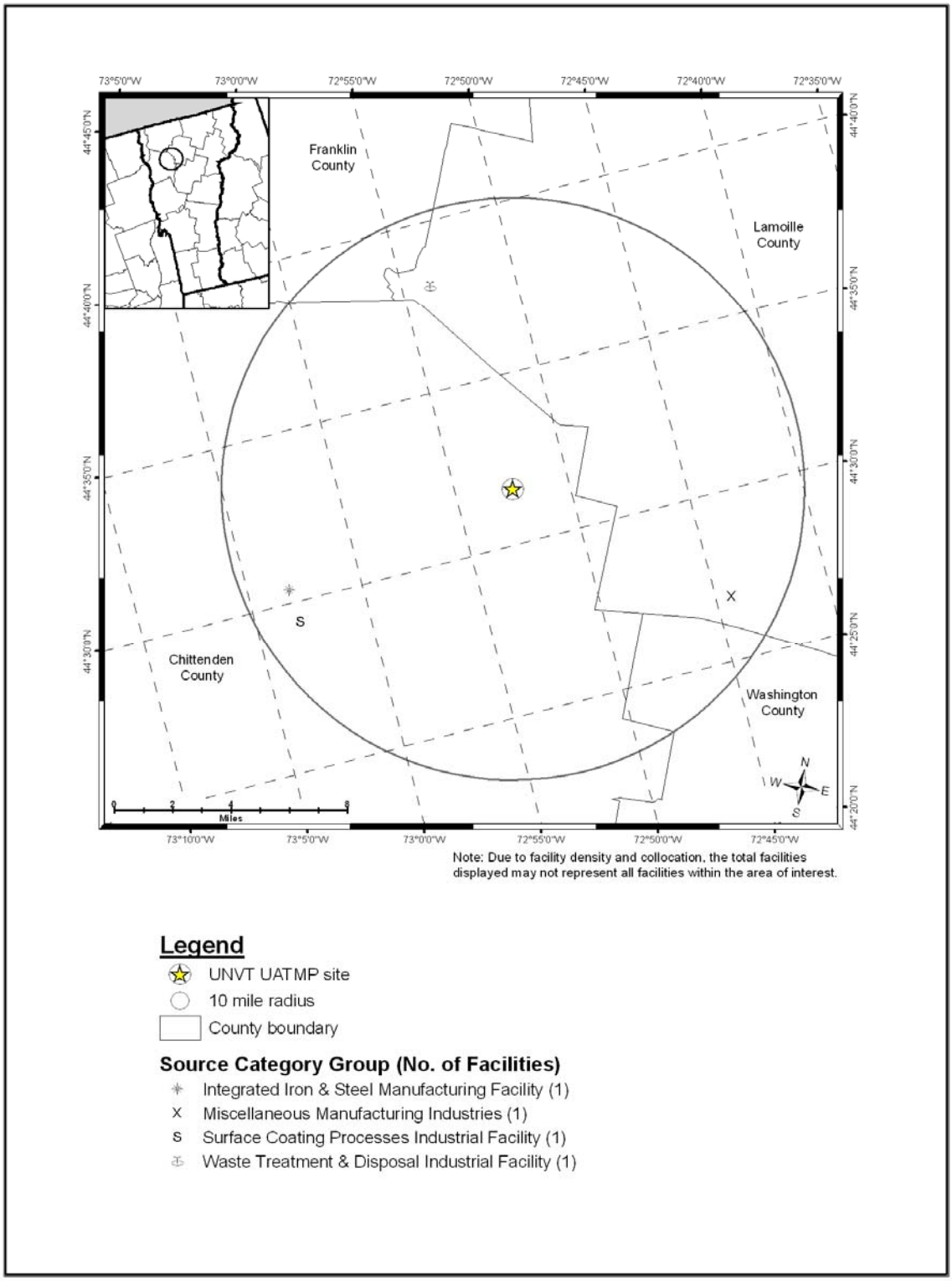


Table 29-1. Average Meteorological Conditions near the Monitoring Site in Vermont

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
UNVT	54771	All 2006	54.80 ± 1.97	45.56 ± 1.79	36.84 ± 1.83	41.61 ± 1.69	74.40 ± 1.09	1015.36 ± 0.81	3.11 ± 0.22
		Sampling Day	54.39 ± 4.55	45.63 ± 4.21	37.36 ± 4.36	41.89 ± 3.97	75.60 ± 2.66	1015.52 ± 1.88	2.65 ± 0.42

interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Hexavalent chromium was the only pollutant sampled for at the UNVT monitoring site. Table 29-2 shows that one measured detection of hexavalent chromium failed the screen.

Table 29-2. Comparison of Measured Concentrations and EPA Screening Values at the Vermont Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Underhill, Vermont – UNVT					
Hexavalent Chromium	1	22	4.55	100.00	100.00

29.2 Concentration Averages

Three types of concentration averages were calculated for hexavalent chromium: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there are at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 29-3. Annual averages are presented and discussed in further detail in later sections.

Table 29-3. Daily and Seasonal Averages for the Pollutants of Interest for the Vermont Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Underhill, Vermont – UNVT												
Hexavalent Chromium	22	59	0.039	0.033	NR	NR	0.015	0.005	0.044	0.049	NR	NR

NR = Not reported due to small number of measured detections.

The following observations are shown in Table 29-3:

- The daily average concentration of hexavalent chromium for UNVT was 0.039 ± 0.033 ng/m^3.
- Only spring and summer seasonal averages could be calculated due to the low number of measured detections in the other seasons.
- The high confidence interval for the summer average indicates that this seasonal average was probably influenced by outliers.

29.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data at UNVT was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. None of the seasonal averages of hexavalent chromium exceeded the intermediate risk value for UNVT. Acute risk could not be evaluated because hexavalent chromium has no acute risk factors.

29.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

29.4.1 Pearson Correlation Analysis

Table 29-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters at the UNVT monitoring site. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered for UNVT from Table 29-4:

- Hexavalent chromium exhibited weak correlations with the meteorological parameters.

Table 29-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Vermont Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Underhill, Vermont – UNVT								
Hexavalent Chromium	22	0.40	0.31	0.20	0.25	-0.29	0.11	-0.03

- This indicates that concentrations of hexavalent chromium were not influenced by meteorological conditions at UNVT.

29.4.2 Composite Back Trajectory Analysis

Figure 29-3 is a composite back trajectory map for the UNVT monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 29-3 represents 100 miles.

The following observations can be made from Figure 29-3:

- Back trajectories originated from a variety of directions at UNVT.
- The 24-hour airshed domain was large at UNVT, with trajectories originating as far away as northern Canada (> 700 miles). However, the majority of the trajectories originated within 400 miles of the UNVT monitoring site.

29.4.3 Wind Rose Analysis

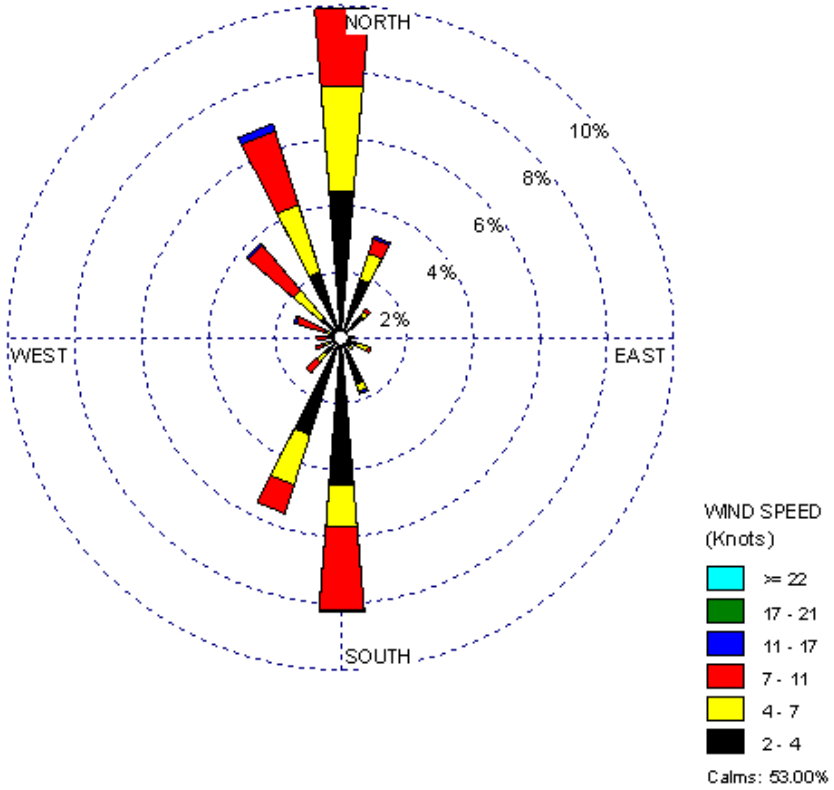
Hourly wind data from the Morrisville-Stowe Airport near the UNVT monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 29-4 is the wind rose for the UNVT monitoring site on days that sampling occurred.

Observations from Figure 29-4 include:

- Hourly winds were predominantly out of the north (10 percent of observations), south (8 percent), and north-northwest (7 percent) on sampling days.
- Calm winds (<2 knots) were recorded for 53 percent of the observations.
- For winds greater than 2 knots, wind speeds were mostly from 2 to 4 knots, indicating that winds tended to be very light on sampling days near UNVT. This is confirmed in Table 29-1.

Figure 29-3. Composite Back Trajectory Map for UNVT

Figure 29-4. Wind Rose for UNVT Sampling Days



29.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could not be performed as ERG did not analyze for VOCs at this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

29.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration was not available in Chittenden County, Vermont. Thus, state-level vehicle registration from the Energy Information Administration (EIA) was allocated to the county-level using the county-level population proportion. County-level population information was obtained from the U.S. Census Bureau, and is summarized in Table 29-5. Table 29-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 29-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 29-5 include:

- Compared to other UATMP sites, UNVT's county and 10-mile population and vehicle registration, as well as daily traffic volume, are in the lowest third of the range.

29.6 Trends Analysis

A trends analysis could not be performed for UNVT as this site has not participated in the UATMP for three consecutive years.

29.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at UNVT and where the *annual average* could be calculated. Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 29-6. In

Table 29-5. Motor Vehicle Information for the Vermont Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
UNVT	150,069	122,119	0.81	33,622	27,360	1,200

Table 29-6. Chronic Risk Summary for the Monitoring Site in Vermont

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Underhill, Vermont (UNVT) – Census Tract ID 500070025900								
Hexavalent Chromium	0.012	0.0001	<0.01	0.02	<0.01	<0.01 ± <0.01	0.22	<0.01

addition, data from EPA's 1999 NATA were retrieved and are presented in Table 29-6. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for UNVT is as follows:

- The UNVT monitoring site is located in census tract 50007002900.
- The population for the census tract where the UNVT monitoring site is located was 6,037, which represents four percent of Chittenden County's population in 2000.

The following observations can be made for UNVT from Table 29-6:

- Both the NATA-modeled and annual average concentration for hexavalent chromium were less than 0.01 $\mu g/m^3$.
- In terms of cancer risk, the NATA-modeled and calculated cancer risks were both less than 1 in-a-million, although the annual average-based cancer risk (0.22 in-a-million) was an order of magnitude greater than the NATA-modeled cancer risk (0.02 in-a-million).
- Both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium.

29.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 29-7 and 29-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 29-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the hexavalent chromium cancer risk (in-a-million) as calculated from the annual average. Table 29-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be.

The following observations can be made from Table 29-7:

- Benzene was the highest emitted pollutant with a cancer risk factor and had the highest cancer toxicity-weighted emissions for Chittenden County, Vermont.

Table 29-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for UNVT

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for Chittenden County)		Top 10 Cancer Toxicity-Weighted Emissions (for Chittenden County)		Top 10 Cancer Risks Based on Annual Average Concentration (for UNVT)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Underhill, Vermont – UNVT					
Benzene	226.79	Benzene	1.77E-03	Hexavalent Chromium	0.22
Formaldehyde	64.13	1,3-Butadiene	6.28E-04		
Acetaldehyde	22.88	Lead	3.98E-04		
1,3-Butadiene	20.93	Arsenic	1.77E-04		
Dichloromethane	14.46	Polycyclic Organic Matter as 7-PAH	1.71E-04		
Tetrachloroethylene	7.55	Naphthalene	1.59E-04		
Naphthalene	4.68	Polycyclic Organic Matter as 15-PAH	9.25E-05		
p-Dichlorobenzene	3.19	Hexavalent Chromium	5.35E-05		
Trichloroethylene	1.68	Acetaldehyde	5.03E-05		
Polycyclic Organic Matter as 15-PAH	1.68	Tetrachloroethylene	4.45E-05		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for UNVT

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for Chittenden County)		Top 10 Noncancer Toxicity-Weighted Emissions (for Chittenden County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for UNVT)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Underhill, Vermont – UNVT					
Toluene	517.82	Acrolein	476,741.53	Hexavalent Chromium	<0.01
Xylenes	379.64	Manganese	41,238.62		
Benzene	226.79	1,3-Butadiene	10,462.70		
Methanol	93.76	Benzene	7,559.79		
Ethylbenzene	86.92	Formaldehyde	6,544.11		
Formaldehyde	64.13	Chlorine	5,031.08		
Hexane	63.01	Xylenes	3,796.43		
Methyl Ethyl Ketone	38.28	Acetaldehyde	2,542.15		
Ethylene Glycol	29.24	Nickel	1,735.32		
Hydrochloric Acid	26.25	Naphthalene	1,560.36	.	

- Five of 10 pollutants (benzene, acetaldehyde, tetrachloroethylene, 1,3-butadiene, and naphthalene) appeared on both the highest emitted list and the highest cancer toxicity-weighted emissions list, indicating that most of the highest emitted pollutants were also the most toxic.

- Hexavalent chromium, the only pollutant sampled for at UNVT, had a low cancer risk based its annual average (0.22 in-a-million). This pollutant ranks 8th on the highest cancer toxicity-weighted emissions list, but did not appear on the highest emissions list.

The following observations can be made from Table 29-8:

- Toluene was the highest emitted pollutant with noncancer risk factor in Chittenden County. But like most other UATMP counties, toluene did not rank in the top 10 pollutants based on toxicity-weighted emissions.

- Xylenes, which had the second highest emissions in Chittenden County, did appear on the list of pollutants based on toxicity-weighted emissions (seventh).

- Acrolein had the highest noncancer toxicity-weighted emissions, but did not appear in the list of highest emitted pollutants. Hexavalent chromium did not rank in the top 10 highest emitted pollutants with noncancer risk factors or the 10 highest noncancer toxicity-weighted emissions in Chittenden County.

Vermont Pollutant Summary

- *UNVT sampled only for hexavalent chromium. Only one measured detection failed a screen.*

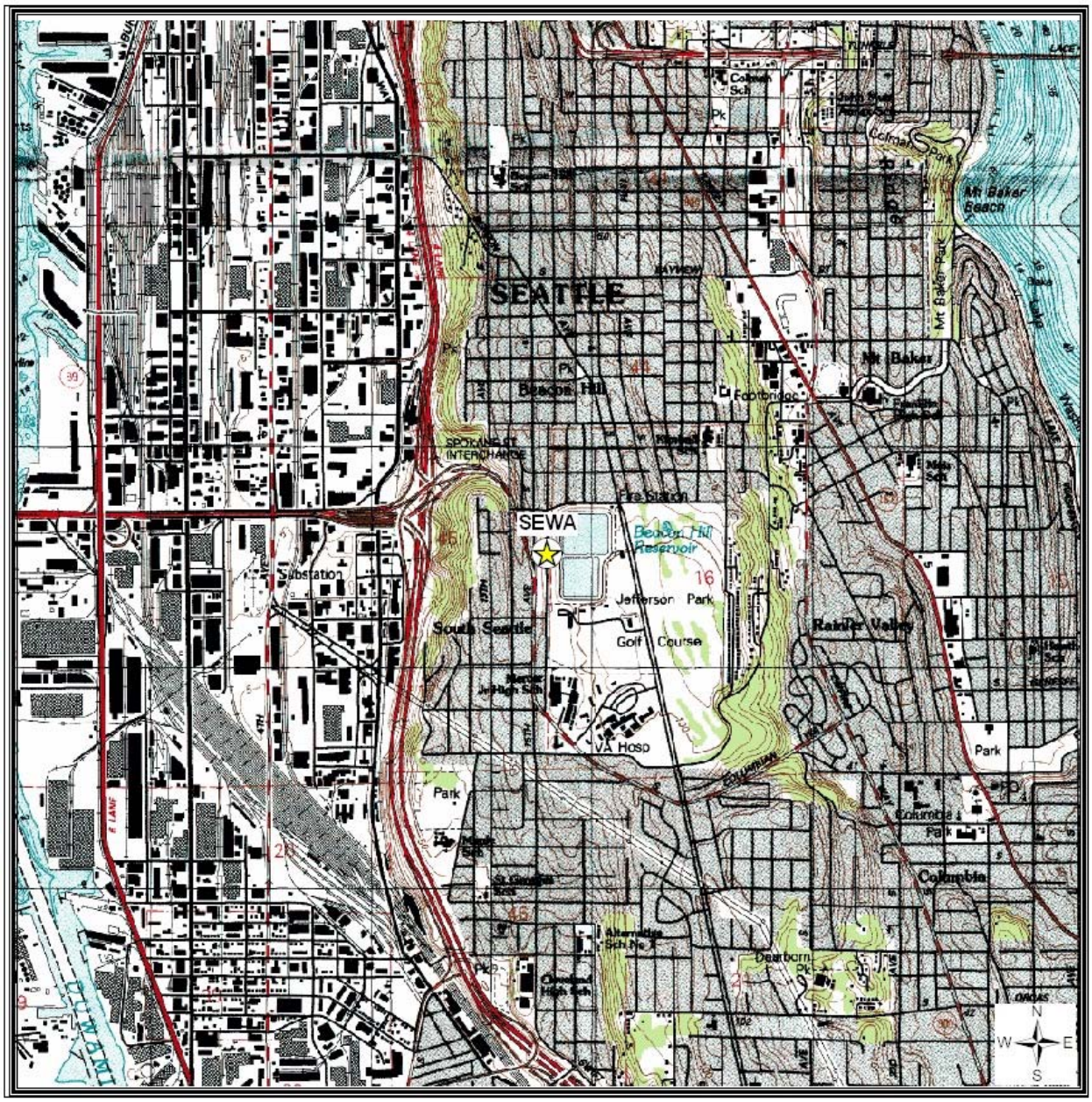
30.0 Site in Washington

This section presents meteorological, concentration, and spatial trends for the UATMP site in Seattle, Washington (SEWA). Figure 30-1 is a topographical map showing the monitoring site in its urban location. Figure 30-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. SEWA is located near several point sources, which are involved in a variety of activities, including surface coating processes and fabricated metal products production.

Seattle is located between the Puget Sound and Lake Washington, and is situated between the Olympic Mountains to the west and the Cascades to the east. The city experiences a mild climate as the mountains moderate storm systems that move into the Pacific Northwest and both the mountains and the sound shield the city from the temperature extremes. Although the city is known for being rainy, the actual precipitation totals tend to be lower compared to many locations east of the Rocky Mountains (Ruffner and Bair, 1987).

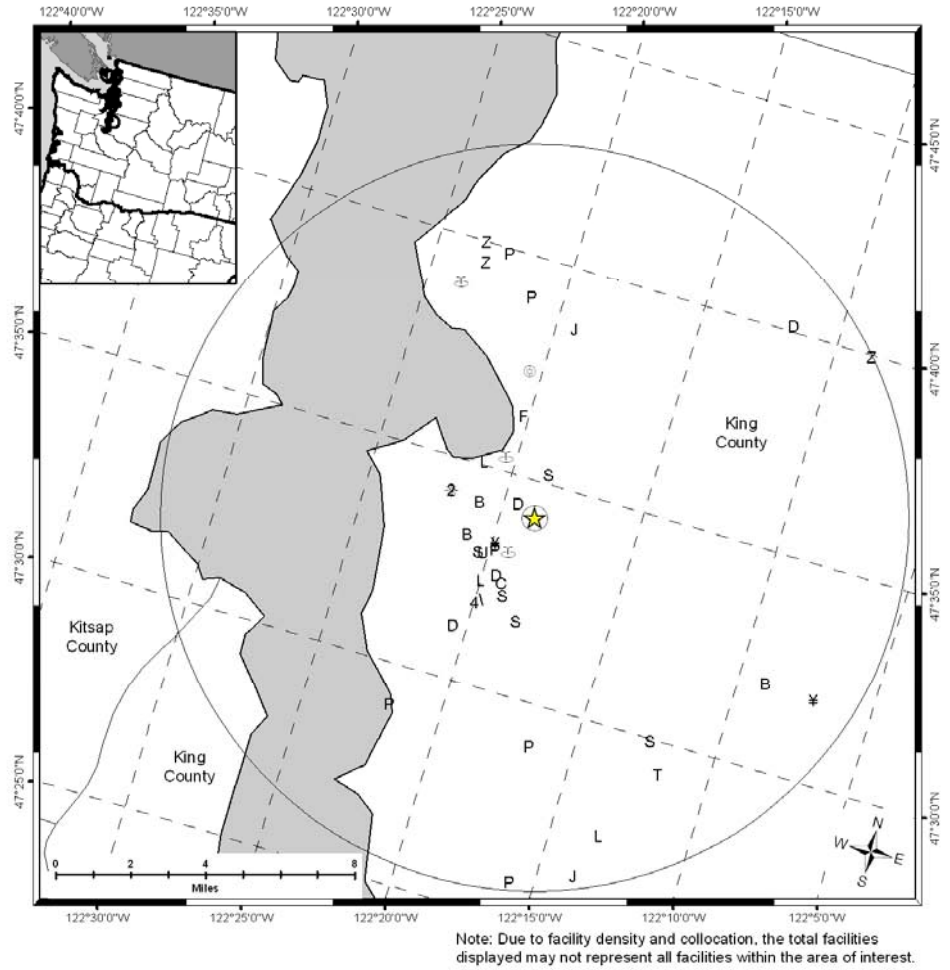
Hourly meteorological data at a weather station near this site were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the SEWA monitoring site is at Boeing Field/King County International Airport (WBAN 24234). Table 30-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 30-1 is the 95 percent confidence interval. As shown in Table 30-1, average temperatures on sampling days were somewhat cooler than average weather conditions throughout the year. SEWA sampled in January and February, then missed March through September, and resumed sampling in November and December. This gap in sampling would explain the difference in temperature profiles.

Figure 30-1. Seattle, Washington (SEWA) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:30,000.

Figure 30-2. Facilities Located Within 10 Miles of SEWA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Legend

SEWA UATMP site 10 mile radius County boundary

Source Category Group (No. of Facilities)

- ¥ Automotive Repair, Services, & Parking (2)
- ◎ Business Services Facility (1)
- C Chemicals & Allied Products Facility (1)
- Z Electrical & Electronic Equipment Facility (3)
- D Fabricated Metal Products Facility (4)
- F Fuel Combustion Industrial Facility (1)
- J Industrial Machinery & Equipment Facility (2)
- ✳ Integrated Iron & Steel Manufacturing Facility (1)
- L Liquids Distribution Industrial Facility (3)
- B Mineral Products Processing Industrial Facility (3)
- P Miscellaneous Processes Industrial Facility (6)
- \ Non-ferrous Metals Processing Industrial Facility (1)
- 2 Nonmetallic Minerals, Except Fuels (1)
- 4 Production of Organic Chemicals Industrial Facility (1)
- U Stone, Clay, Glass, & Concrete Products (1)
- S Surface Coating Processes Industrial Facility (5)
- T Transportation Equipment (1)
- ⛢ Waste Treatment & Disposal Industrial Facility (3)

Table 30-1. Average Meteorological Conditions near the Monitoring Site in Washington

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
SEWA	24234	All 2006	60.28 ± 1.25	53.10 ± 1.05	42.55 ± 0.86	47.86 ± 0.83	70.39 ± 1.28	1016.64 ± 0.74	5.17 ± 0.24
		Sampling Day	49.88 ± 1.76	44.31 ± 1.79	36.42 ± 3.43	41.02 ± 2.05	76.39 ± 5.65	1017.01 ± 4.00	6.76 ± 1.55

30.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the SEWA monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. Hexavalent chromium was the only pollutant sampled for at the SEWA monitoring site. Table 30-2 shows that one measured detection of hexavalent chromium failed the screen at SEWA.

Table 30-2. Comparison of Measured Concentrations and EPA Screening Values for the Washington Monitoring Site

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Seattle, Washington – SEWA					
Hexavalent Chromium	1	12	8.33	100.00	100.00

30.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects were incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 30-3. Annual averages are discussed in further detail in later sections.

Table 30-3. Daily and Seasonal Averages for the Pollutants of Interest for the Washington Monitoring Site

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.	Avg (ng/m^3)	Conf. Int.
Seattle, Washington – SEWA												
Hexavalent Chromium	12	13	0.08	0.06	0.07	0.06	NA	NA	NA	NA	NR	NR

NA= Not available due to the short sampling duration.
NR= Not recorded due to low number of measured detections.

The following observations are shown in Table 30-3:

- The daily average for hexavalent chromium for SEWA was 0.08 ± 0.06 ng/m^3.
- Only a winter seasonal average could be calculated due to the low number of measured detections in the some seasons and the lack of sampling in others.

30.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for SEWA was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare the preprocessed daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. The winter hexavalent chromium average did not exceed the intermediate risk value. Acute risk could not be evaluated because hexavalent chromium has no acute risk factors.

30.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

30.4.1 Pearson Correlation Analysis

Table 30-4 presents the summary of Pearson correlation coefficients for hexavalent chromium and select meteorological parameters for the SEWA monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.)

The following observations are gathered from Table 30-4:

- A strong negative correlation was calculated for scalar wind speed (-0.51). This indicates that decreasing wind speeds lead to increasing concentrations.
- Hexavalent chromium exhibited weak correlations with most of the other meteorological parameters for SEWA. This indicates that, with the exception of scalar wind speed, meteorological conditions do not greatly influence hexavalent chromium concentrations at SEWA.

Table 30-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Washington Monitoring Site

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Seattle, Washington – SEWA								
Hexavalent Chromium	12	0.17	0.05	0.20	0.16	0.26	0.12	-0.51

30.4.2 Composite Back Trajectory Analysis

Figure 30-3 is a composite back trajectory map for the SEWA monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the site in Figure 30-3 represents 100 miles.

The following observations can be made from Figure 30-3:

- Back trajectories originated from a variety of directions at SEWA, although there was a lack of trajectories originating from the north.
- The 24-hour airshed domain was large at SEWA, with trajectories originating over 900 miles away. However, most of the trajectories originated within 500 miles of the site.
- The composite back trajectory map might look much different with a full year of sampling days.

30.4.3 Wind Rose Analysis

Hourly wind data from the Boeing Field/King County Airport near the SEWA monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 30-4 is the wind rose for the SEWA monitoring site on days that sampling occurred.

Observations from Figure 30-4 include:

- Hourly winds were predominantly out of the south (26 percent of observations), south-southeast (21 percent), and southeast (13 percent) on sampling days.
- Wind speeds ranged from 7 to 11 knots on most days that samples were collected.
- Calm winds (<2 knots) were recorded for 16 percent of the total measurements.

30.5 Spatial Characteristics Analysis

The following sub-section describes and discusses the results of the following spatial analysis: population, vehicle ownership, and traffic data comparisons. A BTEX analysis could

Figure 30-3. Composite Back Trajectory Map for SEWA

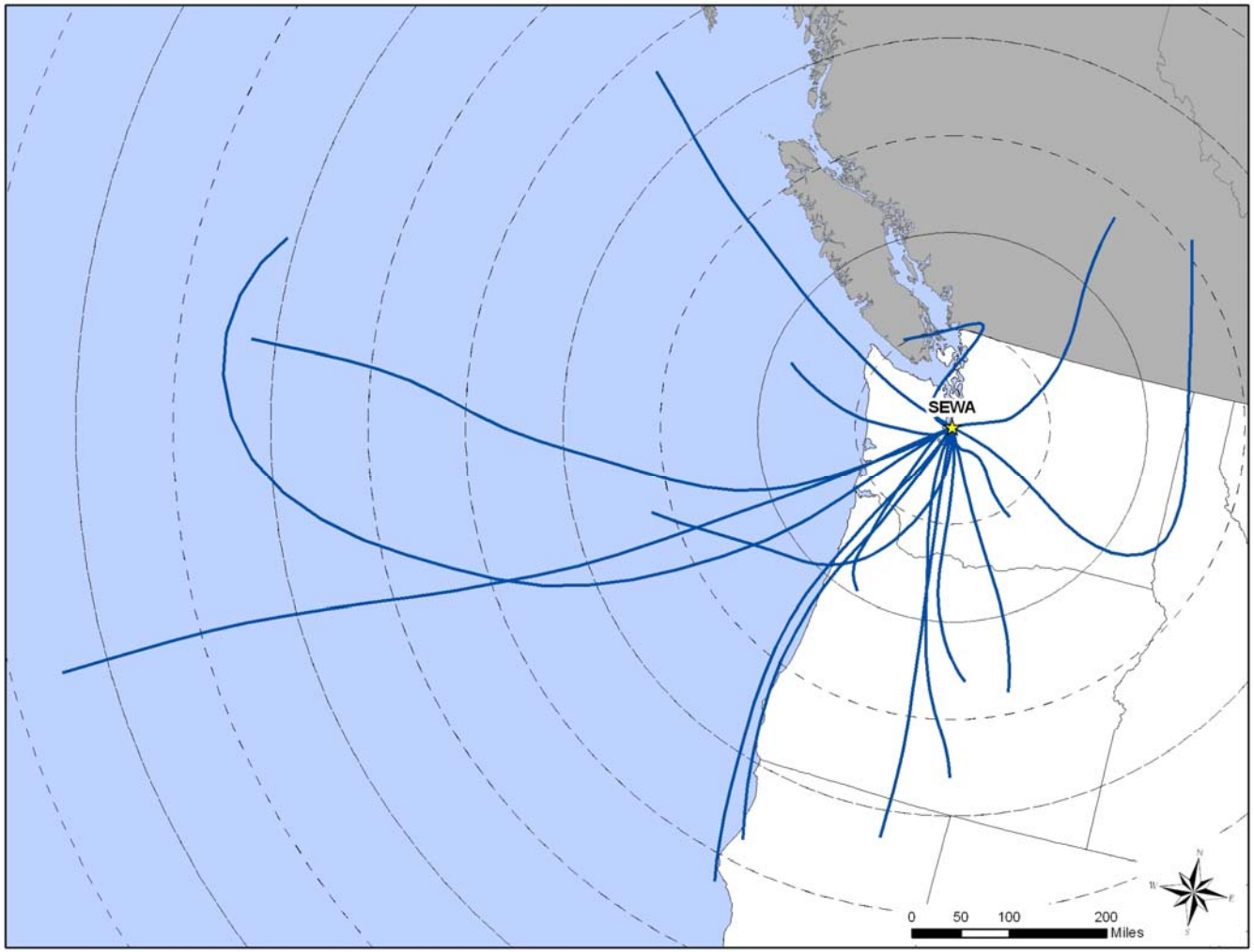
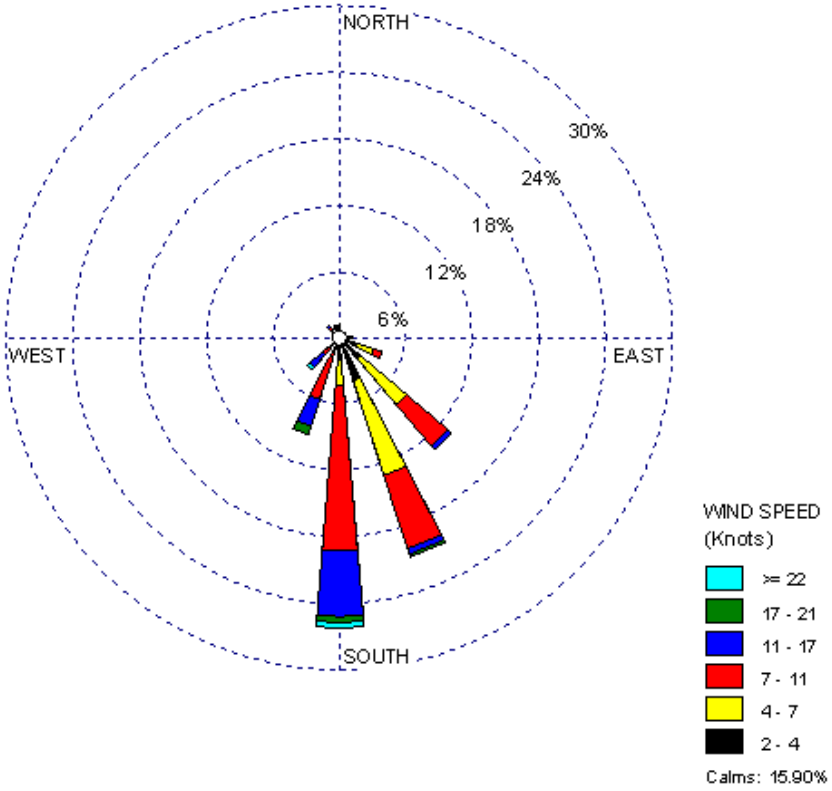


Figure 30-4. Wind Rose for SEWA Sampling Days



not be performed as ERG did not analyze for VOCs at this site. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

30.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level registration and population information for King County was obtained from the Washington Department of Licensing and the U.S. Census Bureau, and is summarized in Table 30-5. Table 30-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 30-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 30-5 include:

- Compared to other UATMP sites, SEWA's county population and vehicle registration are in the top five sites.
- SEWA's 10-mile population and estimated 10-mile vehicle ownership are in the top third compared to other UATMP sites.
- The daily traffic volume is in the middle of the range.

30.6 Trends Analysis

A trends analysis could not be performed for SEWA as this site has not participated in the UATMP for three consecutive years.

30.7 Chronic Risk Analysis

A chronic risk analysis was completed for hexavalent chromium for SEWA. While SEWA's sampling duration appears to meet the criteria for annual averages provided in Section 3.3.5, SEWA has a sampling gap from March to September. Therefore, annual averages could not be calculated and annual average-based cancer and noncancer risks cannot be assessed. However, data from EPA's 1999 NATA were retrieved and are presented in Table 30-6. The NATA data are presented for the census tract where the monitoring site is located.

Table 30-5. Motor Vehicle Information for the Washington Monitoring Site

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
SEWA	1,826,732	1,726,115	0.94	887,100	838,238	20,000

Table 30-6. Chronic Risk Summary for the Monitoring Site in Washington

Pollutant	Cancer URE ($\mu g/m^3$)	Noncancer RfC ($\mu g/m^3$)	1999 NATA			2006 UATMP		
			Modeled Concentration ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average ($\mu g/m^3$)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Seattle, Washington (SEWA) – Census Tract ID 53033010000								
Hexavalent Chromium	0.012	0.0001	<0.01	7.46	0.01	NA	NA	NA

NA = annual average not available

The census tract information for SEWA is as follows:

- The census tract for SEWA is 53033010000.
- This census tract had a population of 8,139 in 2000 and represents approximately 0.1 percent of the King County population.

The following observations can be made from Table 30-6:

- NATA-modeled cancer risk due to hexavalent chromium for SEWA was 7.46 in-a-million.
- Noncancer risk due to hexavalent chromium was very low (0.01).

30.8 Toxicity-Weighted Emissions Assessment

Tables 30-7 and 30-8 present a risk-based assessment of county-level emissions based on cancer and noncancer toxicity, respectively. Table 30-7 presents the 10 pollutants with the highest emissions from the 2002 NEI and the 10 pollutants with the highest toxicity-weighted emissions. The 10 pollutants with the highest cancer risk based on annual averages could not be calculated because there are no annual averages. Table 30-8 presents similar information, but is based on noncancer risk factors. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer tables, although the actual value of the emissions will be.

The following observations can be made from Table 30-7:

- Benzene, formaldehyde, and acetaldehyde had the highest emissions (by mass) in King County for pollutants with cancer risk factors, but only benzene (which ranked first) and acetaldehyde (which ranked ninth) were among the pollutants with the top 10 highest cancer toxicity-weighted emissions.
- In addition to acetaldehyde and formaldehyde, 1,3-butadiene, tetrachloroethylene, naphthalene, *p*-dichlorobenzene, and POM as 15-PAH were among the highest emitted and had some of the highest cancer toxicity-weighted emissions. This indicates that the highest emitted pollutants in King County also tend to be the most toxic.

Table 30-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for SEWA

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (for King County)		Top 10 Cancer Toxicity-Weighted Emissions (for King County)		Top 10 Cancer Risks Based on Annual Average Concentration (for SEWA)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Seattle, Washington – SEWA					
Benzene	2,863.10	Benzene	2.23E-02		
Formaldehyde	945.95	1,3-Butadiene	7.62E-03		
Acetaldehyde	336.17	Lead	3.34E-03		
1,3-Butadiene	253.92	Naphthalene	2.28E-03		
Tetrachloroethylene	138.20	Polycyclic Organic Matter as 15-PAH	1.47E-03		
Dichloromethane	114.91	Polycyclic Organic Matter as non-15 PAH	1.02E-03		
Naphthalene	67.06	Polycyclic Organic Matter as 7-PAH	9.32E-04		
Trichloroethylene	46.11	Tetrachloroethylene	8.15E-04		
p-Dichlorobenzene	37.70	Acetaldehyde	7.40E-04		
Polycyclic Organic Matter as 15-PAH	26.68	*p*-Dichlorobenzene	4.15E-04		

Table 30-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for SEWA

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (for King County)		Top 10 Noncancer Toxicity-Weighted Emissions (for King County)		Top 10 Noncancer Risks Based on Annual Average Concentrations (for SEWA)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Seattle, Washington – SEWA					
Toluene	5,803.57	Acrolein	2,782,750.42		
Xylenes	3,841.44	1,3-Butadiene	126,959.02		
Benzene	2,863.10	Formaldehyde	96,525.87		
Formaldehyde	945.95	Benzene	95,436.79		
Methanol	943.68	Xylenes	38,414.41		
Ethylbenzene	908.89	Acetaldehyde	37,352.35		
Hexane	891.06	Naphthalene	22,353.99		
Methyl Ethyl Ketone	466.76	Manganese	18,256.20		
Acetaldehyde	336.17	Glycol Ethers	14,911.49		
Ethylene Glycol	323.63	Toluene	14,508.92	.	

The following observations can be made from Table 30-8:

- Like many UATMP counties, toluene and xylenes had the highest emissions in King County. But unlike many UATMP counties, both of these pollutants were also among those with the top 10 highest noncancer toxicity-weighted emissions.

- In addition to toluene and xylenes, benzene, acetaldehyde, and formaldehyde also appeared on both lists.

- Acrolein, which did not have one of the highest total emissions, had the highest noncancer toxicity-weighted emissions.

Washington Pollutant Summary

- *SEWA sampled only for hexavalent chromium. Only one measured detection failed a screen.*

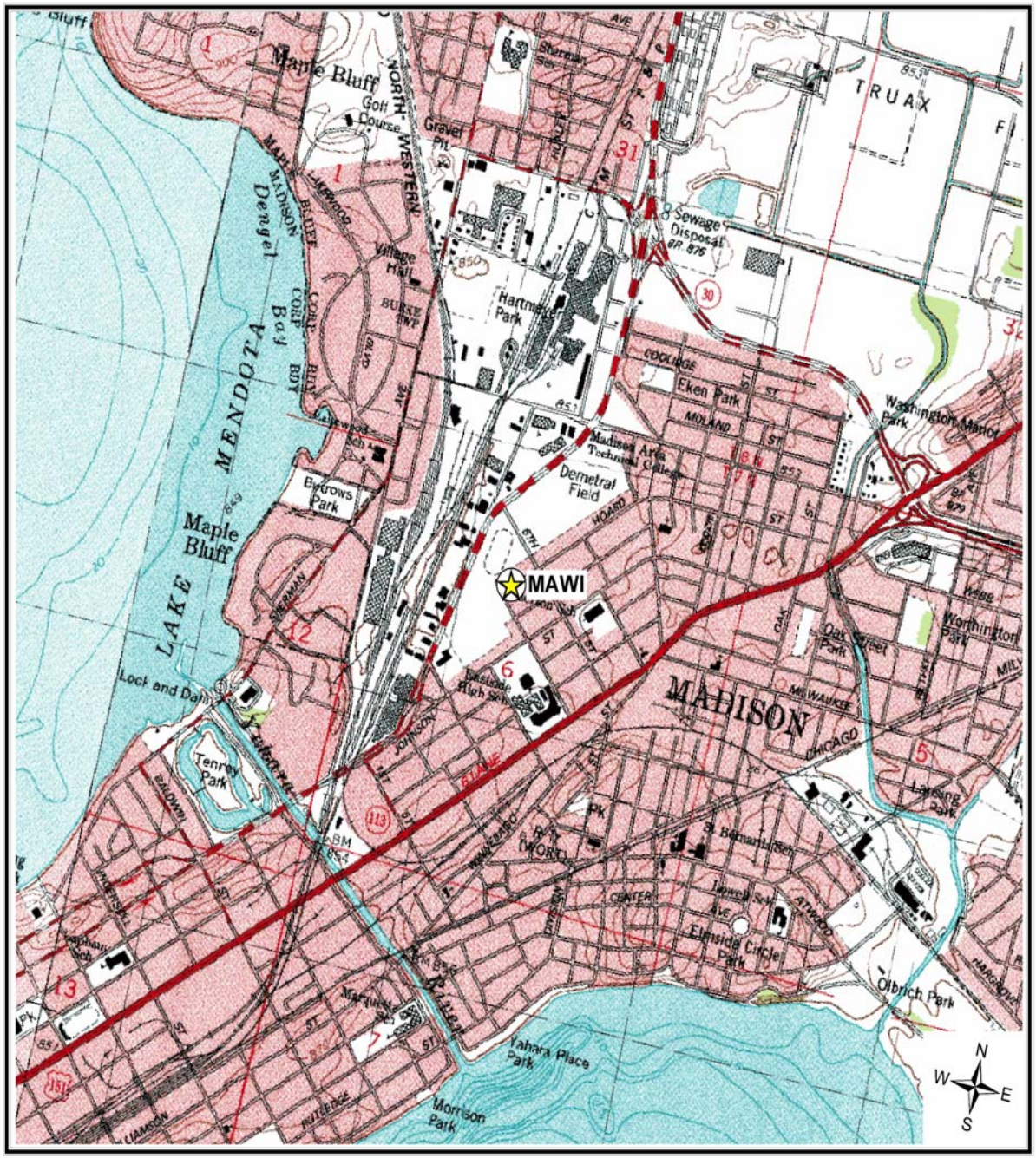
31.0 Sites in Wisconsin

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Wisconsin (MAWI and MVWI), located in Madison and Mayville, respectively. Figure 31-1 and 31-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figure 31-3 and 31-4 identifies point source emission locations within 10 miles of the sites as reported in the 2002 NEI for point sources. Figure 31-3 shows that MAWI is surrounded by a number of point sources, of which the majority is involved in fuel combustion industries. Figure 31-4 shows that fewer sources surround MVWI, but the majority of them are also involved in fuel combustion processes.

Madison is located in south-central Wisconsin. Much of the city lies between Lake Mendota and Lake Monona. Madison's Great Lakes location ensures that the area experiences frequent weather systems, fairly typical of a continental climate. Temperatures can fluctuate drastically with potent weather systems, and the frozen lakes offer little moderating effects in the winter. Spring and summer tend to bring the most precipitation, but Madison also receives an abundance of snow. Average wind direction depends on season. Summer and fall bring southerly winds, while northwesterly winds are most common in the winter and spring (Ruffner and Bair, 1987). The town of Mayville is located to the northwest of Milwaukee. This area experiences a highly variable, continental climate as weather systems frequently push across the region. Wintertime temperature extremes are moderated somewhat by the proximity to Lake Michigan. Lake effect snows can occur with winds with an easterly component, although they are more common closer to the coast (Ruffner and Bair, 1987).

Hourly meteorological data at weather stations near these sites were retrieved for all of 2006. These data were used to determine how meteorological conditions on sampling days vary from normal conditions throughout the year. They were also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the MAWI monitoring site is Dane County Regional - Traux Field Airport (WBAN 14837) and the weather station closest to the MVWI site is West Bend Municipal Airport (WBAN 04875). Table 31-1 presents average meteorological conditions of temperature (average

Figure 31-1. Madison, Wisconsin (MAWI) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 31-2. Mayville, Wisconsin (MVWI) Monitoring Site

Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 31-3. Facilities Located Within 10 Miles of MAWI

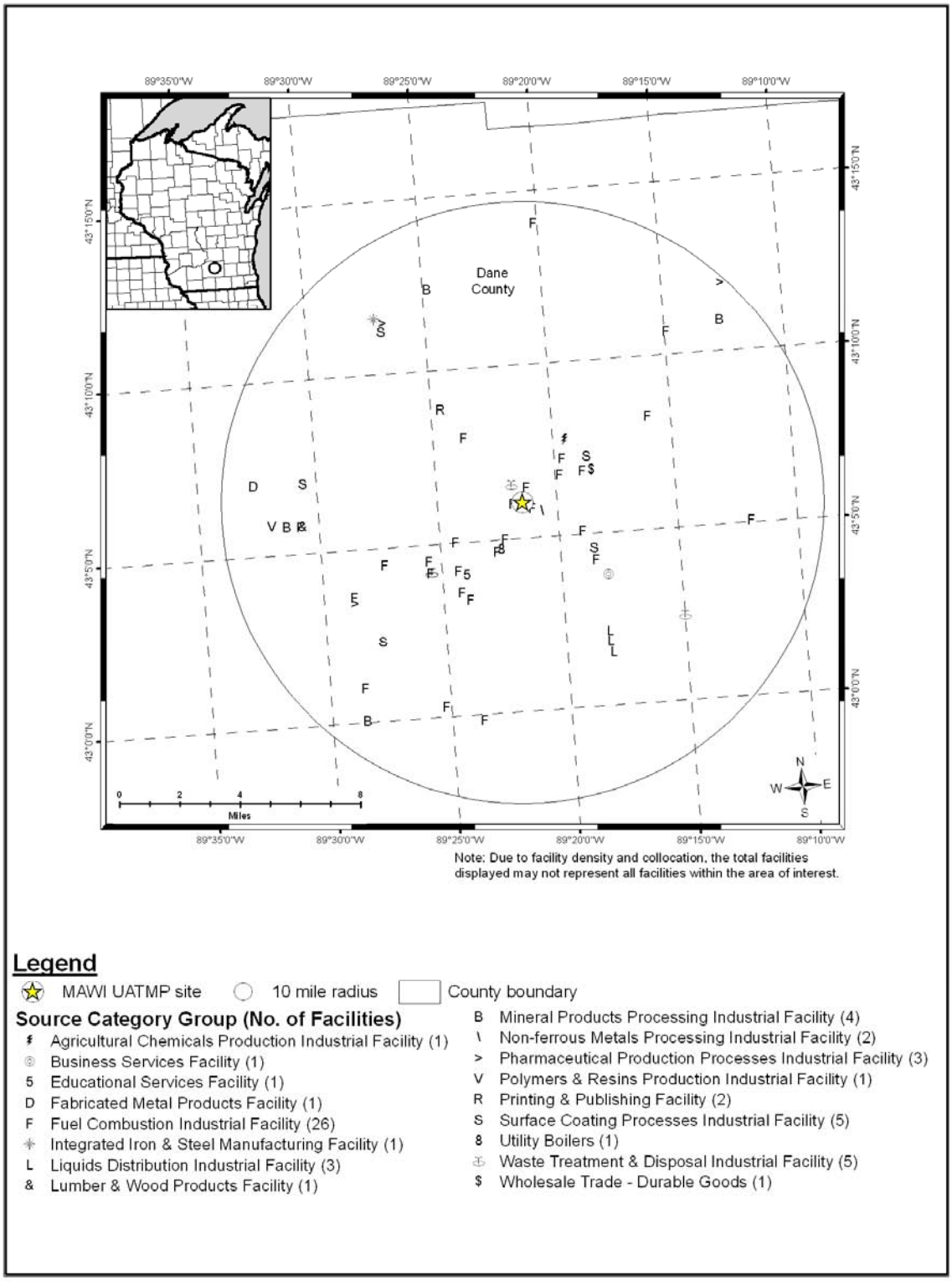


Figure 31-4. Facilities Located Within 10 Miles of MVWI

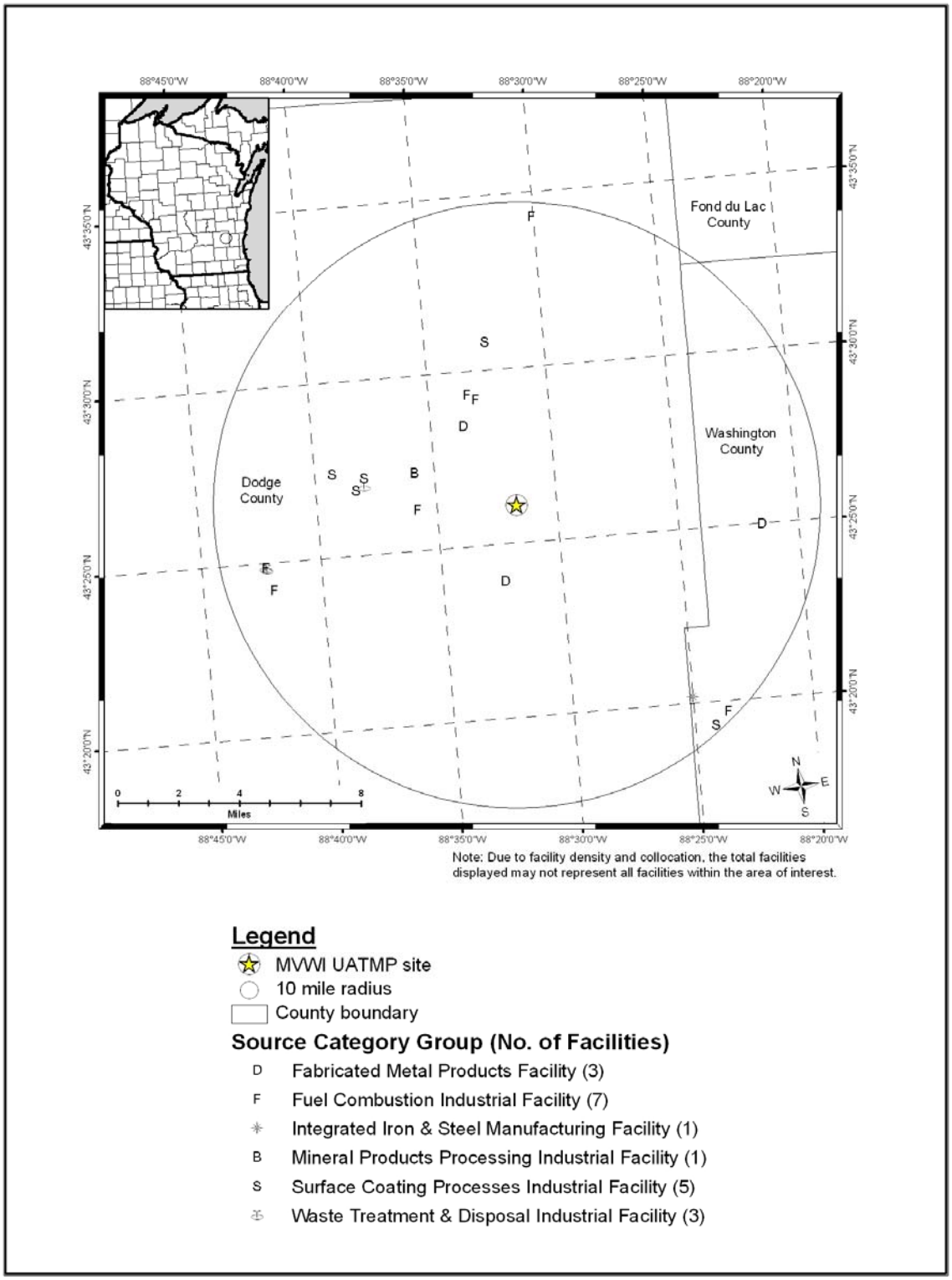


Table 31-1. Average Meteorological Conditions near the Monitoring Sites in Wisconsin

Site	WBAN	Average Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average Scalar Wind Speed (kt)
MAWI	14837	All 2006	57.35 ± 1.97	49.05 ± 1.85	39.25 ± 1.82	44.40 ± 1.69	71.52 ± 1.21	1015.66 ± 0.75	6.58 ± 0.27
		Sampling Day	35.75 ± 3.68	30.13 ± 3.44	24.26 ± 4.52	28.09 ± 3.68	79.61 ± 5.61	1010.26 ± 5.23	6.99 ± 1.58
MVWI	04875	All 2006	56.30 ± 1.96	48.41 ± 1.79	39.85 ± 1.74	44.36 ± 1.64	74.90 ± 1.21	NA[1]	5.48 ± 0.30
		Sampling Day	56.64 ± 4.85	48.54 ± 4.30	39.30 ± 3.97	44.10 ± 3.80	73.57 ± 3.27	NA[1]	5.69 ± 0.74

[1] Sea level pressure was not recorded at the West Bend Airport.

maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average scalar wind speed) for the entire year and on days samples were collected. Also included in Table 31-1 is the 95 percent confidence interval for each parameter. As shown in Table 31-1, average meteorological conditions on sampling days near MVWI were fairly representative of average weather conditions throughout the year, but this does not appear to be the case for MAWI. Temperatures on sampling days near MAWI seem much colder because this site only sampled through the end of February; therefore, the only the coldest months were captured.

31.1 Risk Screening and Pollutants of Interest

Risk screening was completed to identify the pollutants of interest for the Wisconsin monitoring sites. As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006d). Each measured pollutant concentration was compared to a risk screening value. A total of 81 HAPs are listed in the EPA guidance as having risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. The MAWI site sampled for carbonyls and VOC, and the MVWI site sampled for hexavalent chromium only. Table 31-2 presents the pollutants that failed at least one screen at MAWI and MVWI.

The following observations are shown in Table 31-2:

- A total of 42 measured concentrations failed screens at MAWI.
- The pollutants of interest for MAWI were benzene (8 failed screens), acetaldehyde (8), carbon tetrachloride (8), formaldehyde (6), 1,3-butadiene (6), and hexachloro-1,3-butadiene (4).
- Of the six pollutants of interest for MAWI, acetaldehyde, benzene, carbon tetrachloride, and hexachloro-1,3-butadiene failed 100 percent of the screens.

Table 31-2. Comparison of Measured Concentrations and EPA Screening Values for the Wisconsin Monitoring Sites

Pollutant	# of Failures	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Madison, Wisconsin – MAWI					
Acetaldehyde	8	8	100.00	19.05	19.05
Benzene	8	8	100.00	19.05	38.10
Carbon Tetrachloride	8	8	100.00	19.05	57.14
1,3-Butadiene	6	7	85.71	14.29	71.43
Formaldehyde	6	8	75.00	14.29	85.71
Hexachloro-1,3-butadiene	4	4	100.00	9.52	95.24
Tetrachloroethylene	2	4	50.00	4.76	100.00
Total	42	47	89.36		
Mayville, Wisconsin – MVWI					
Hexavalent Chromium	0	37	0.00	0.00	0.00

- None of the hexavalent chromium measured detections at MVWI failed the screen. However, in order to facilitate analysis, hexavalent chromium was considered MVWI's pollutant of interest.

31.2 Concentration Averages

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average concentration of all measured detections. If there were at least seven measured detections within each season, then a *seasonal* average was calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven measured detections in a respective season. Finally, the *annual* average is the average concentration of all measured detections and 1/2 MDLs substituted for non-detects. The resulting daily average concentrations may therefore be inherently higher than the annual average concentrations where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages were calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal average concentrations are presented in Table 31-3. Annual averages are presented and discussed in further detail in later sections.

Table 31-3. Daily and Seasonal Averages for the Pollutants of Interest for the Wisconsin Monitoring Sites

Pollutant	# of Measured Detections	# of Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Madison, Wisconsin (MAWI)												
Acetaldehyde	8	8	1.17	0.23	1.17	0.23	NA	NA	NA	NA	NA	NA
Benzene	8	8	0.79	0.18	0.79	0.18	NA	NA	NA	NA	NA	NA
1,3-Butadiene	7	8	0.08	0.03	0.07	0.03	NA	NA	NA	NA	NA	NA
Carbon Tetrachloride	8	8	0.57	0.05	0.57	0.05	NA	NA	NA	NA	NA	NA
Formaldehyde	8	8	1.26	0.30	1.26	0.30	NA	NA	NA	NA	NA	NA
Hexachloro-1,3-butadiene	4	8	0.19	0.05	NR	NR	NA	NA	NA	NA	NA	NA
Mayville, Wisconsin (MVWI)												
Hexavalent Chromium	37	60	2.1E-05	3.6E-06	1.1E-05	3.7E-06	1.6E-05	4.3E-06	2.0E-05	7.4E-06	1.5E-05	6.0E-06

NA = Not available due to short sampling duration.

The following observations are shown in Table 31-3:

- Acetaldehyde, benzene, formaldehyde, and carbon tetrachloride were detected in every sample collected at MAWI, while hexachloro-1,3-butadiene was detected in only half of the samples collected.

- Among the daily averages for MAWI, formaldehyde had the highest concentration by mass (1.26 ± 0.30 μg/m^3), followed closely by acetaldehyde (1.17 ± 0.23 μg/m^3).

- Seasonal averages of the pollutants of interest for MAWI could only be calculated for winter.

- The daily average concentration of hexavalent chromium for MVWI was 0.021 ± 0.004 μg/m^3.

- Seasonal hexavalent chromium concentrations for the MVWI site did not vary much statistically.

31.3 Non-Chronic Risk Evaluation

Non-chronic risk for the concentration data for MAWI and MVWI was evaluated using ATSDR short-term (acute) and intermediate MRL and California EPA acute REL factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare the preprocessed daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. None of the pollutants measured at either Wisconsin site exceeded the acute or intermediate risk values.

31.4 Meteorological and Concentration Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson correlation coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

31.4.1 Pearson Correlation Analysis

Table 31-4 presents the summary of Pearson correlation coefficients for each of the pollutants of interest and select meteorological parameters for the MAWI and MVWI monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson correlations.)

The following observations are gathered from Table 31-4:

- While strong correlations were calculated for several pollutant-meteorological combinations for MAWI, the low number of measured detections warrants caution in interpretation as a low number of measured detections can skew the correlations.

- Nearly all the pollutants (except carbon tetrachloride) exhibited positive correlations with temperature and negative correlations with scalar wind speed. This indicates that these variables may play an important role in the concentrations of the pollutants of interest for MAWI.

- Hexavalent chromium exhibited strong positive correlations with dew point and wet bulb temperatures for MVWI. This indicates that as moisture content increases, concentrations of this pollutant also increase.

31.4.2 Composite Back Trajectory Analysis

Figure 31-5 and 31-6 are a composite back trajectory maps for the MAWI and MVWI monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each concentric circle around the sites represents 100 miles.

The following observations can be made from Figure 31-5:

- Back trajectories originated from a variety of directions at MAWI, although no trajectories originated to the east and southeast of the site.

- The 24-hour airshed domain was somewhat large at MAWI, with trajectories originating as far away as Ontario, Canada, (> 600 miles).

- The composite trajectory map for MAWI might look much different with a full year's worth of sampling days.

Table 31-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters for the Wisconsin Monitoring Sites

Pollutant	# of Measured Detections	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	Sea Level Pressure	Scalar Wind Speed
Madison, WI – MAWI								
1,3-Butadiene	7	0.39	0.15	-0.05	0.05	-0.32	-0.10	-0.80
Acetaldehyde	8	0.34	0.06	-0.11	-0.02	-0.30	-0.02	-0.85
Benzene	8	0.57	0.35	0.11	0.24	-0.31	-0.19	-0.69
Carbon Tetrachloride	8	-0.42	-0.27	-0.38	-0.33	-0.49	0.61	0.38
Formaldehyde	8	0.13	-0.14	-0.42	-0.27	-0.75	0.24	-0.61
Hexachloro-1,3-butadiene	4	0.85	0.79	0.73	0.76	0.54	-0.69	-0.88
Mayville, Wisconsin – MVWI								
Hexavalent Chromium	37	0.48	0.48	0.53	0.51	0.04	NA	0.04

NA = Sea level pressure was not recorded at the West Bend Airport.

Figure 31-5. Composite Back Trajectory Map for MAWI

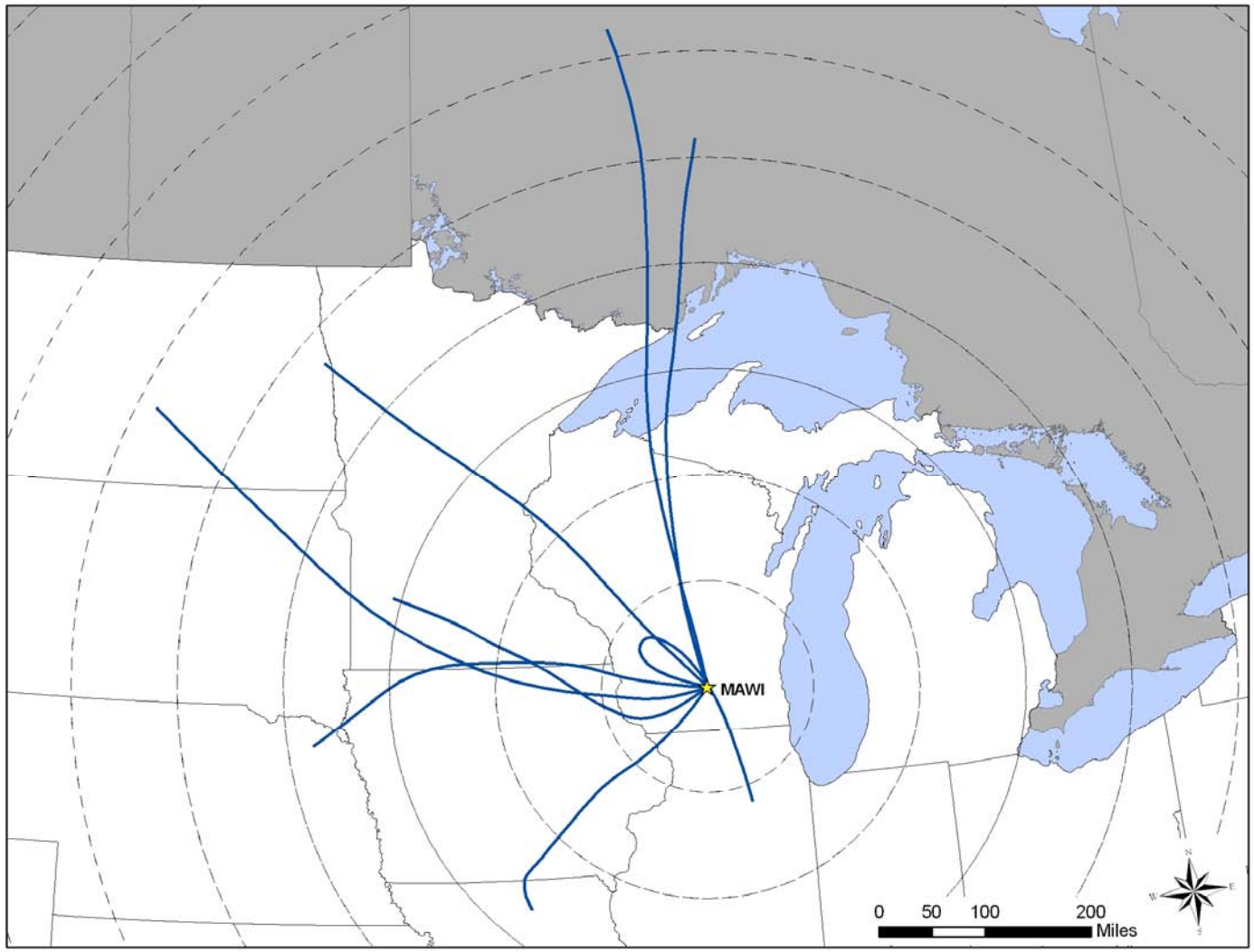
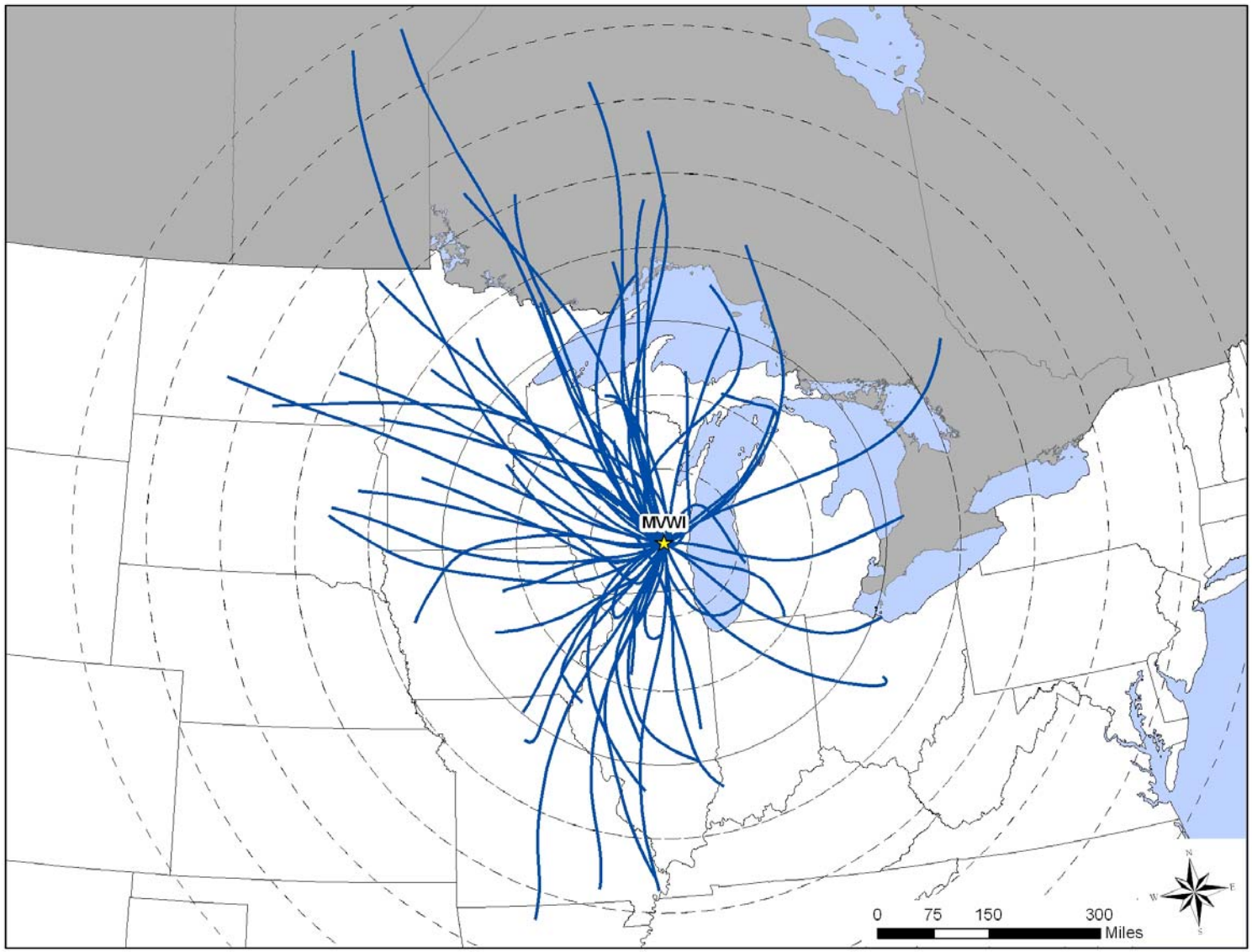


Figure 31-6. Composite Back Trajectory Map for MVWI



The following observations can be made from Figure 31-6:

- The composite back trajectory map for MVWI looks much different than the MAWI back trajectory map.
- Back trajectories originated from a variety of directions at MVWI.
- The 24-hour airshed domain was large, with the longest trajectories originating nearly 800 miles away in Manitoba, Canada. However, nearly 85 percent of trajectories originated within 500 miles of MVWI.

31.4.3 Wind Rose Analysis

Hourly wind data from the Traux Field Airport and the West Bend Municipal Airport were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 31-7 and 31-8 are the wind roses for the MAWI and MVWI monitoring sites on days that sampling occurred.

Observations from Figure 31-7 for MAWI include:

- Hourly winds near MAWI were predominantly out of the northwest (23 percent of observations) and north-northwest (17 percent) on sampling days.
- Calm winds (<2 knots) were recorded for 8 percent of the observations.
- Wind speeds frequently ranged from 7 to 11 knots on day that samples were collected.

Observations from Figure 31-7 for MVWI include:

- Calm winds were observed for 25 percent of the observations taken near MVWI.
- For wind speeds greater than 2 knots, hourly winds near MVWI were predominately from the west (11 percent) and the wind speed ranged from 7 to 11 knots.

Figure 31-7. Wind Rose for MAWI Sampling Days

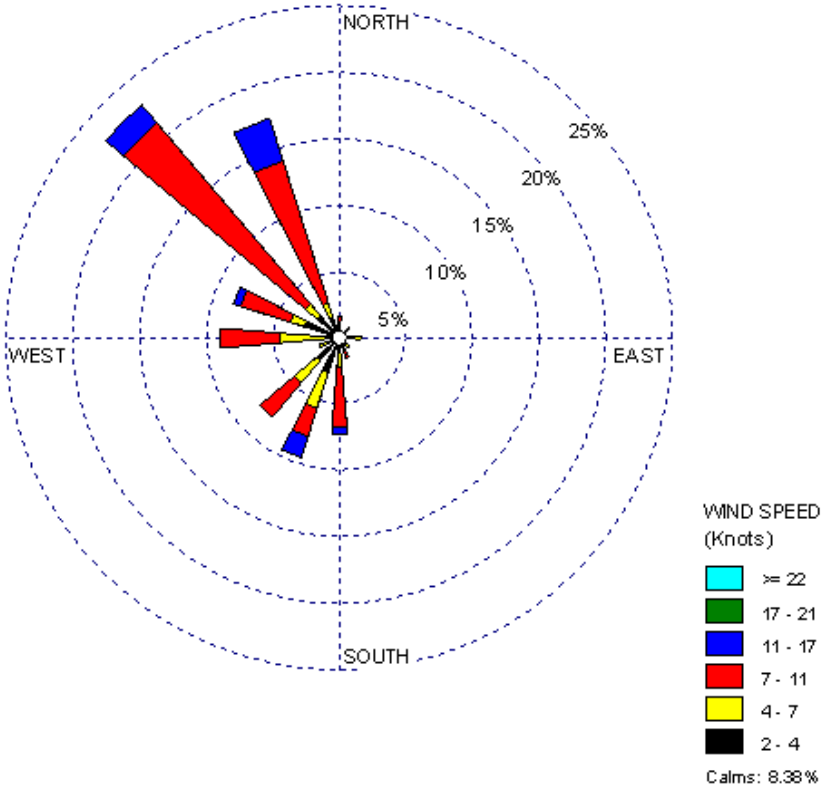
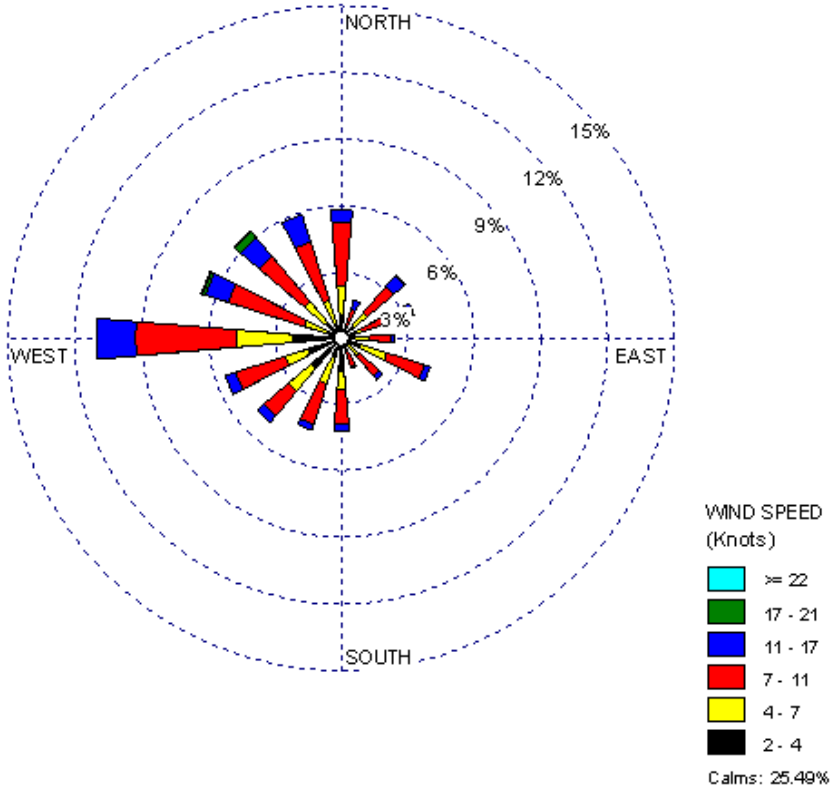


Figure 31-8. Wind Rose for MVWI Sampling Days



31.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis. A mobile tracer analysis could not be performed as this site did not sample for SNMOC.

31.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Dane County, WI were obtained from the Wisconsin Department of Transportation and the U.S. Census Bureau, and are summarized in Table 31-5. Table 31-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 31-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Observations gleaned from Table 31-5 include:

- The population and vehicle ownership near MAWI is significantly higher than near MVWI.

- Compared to other UATMP sites, the MAWI site's county and 10-mile population and vehicle registration count falls in the middle of the range. The average daily traffic count also falls in the middle of the range compared to other UATMP sites. The MAWI monitoring site is considered a residential but urban-city center area.

- The MVWI site's county and 10-mile population and vehicle registration fall in the lower third compared to other UATMP sites. However, MVWI's vehicle registration-to-population ratio was the ninth highest of all UATMP sites.

31.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area-to-urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-12 and Figure 3-4 depict the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-

Table 31-5. Motor Vehicle Information for the Wisconsin Monitoring Sites

Site	2006 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration: Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
MAWI	463,826	425,763	0.92	364,645	334,721	23,750
MVWI	88,983	95,112	1.07	24,688	26,388	5,990

road, or motor vehicle, emissions. MVWI is not included in this analysis as this site did not sample VOC.

The BTEX figure and table show the following:

- For the MAWI site, the xylenes-ethylbenzene ratio (3.42 ± 0.37) was lower than the benzene-ethylbenzene ratio (5.83 ± 0.89), which is the reverse of the roadside study (4.55 and 2.85, respectively).

- The toluene-ethylbenzene ratio (5.95 ± 0.65) was very similar to that of the roadside study (5.85).

- The benzene-ethylbenzene and toluene-ethylbenzene ratios are very similar for MAWI.

31.6 Trends Analysis

For sites that participated in the UATMP prior to 2005 and are still participating in the 2006 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The MAWI site has participated since 2004. Figure 31-9 presents the trends analysis results for formaldehyde, benzene, and 1,3-butadiene for MAWI.

The following observations can be made from Figure 31-9:

- Benzene and 1,3-butadiene decreased significantly from 2004 to 2005. Concentrations of these pollutants did not change significantly in 2006.

- Formaldehyde, which doubled between 2004 and 2005, appears to have returned to approximately the 2004 level.

31.7 Chronic Risk Analysis

A chronic risk analysis was completed for the pollutants that failed at least one screen at the Wisconsin sites and where the *annual average* concentrations could be calculated (refer to Section 3.3.5 regarding the definition of an annual average). Annual averages, theoretical cancer and noncancer risk, cancer UREs and/or noncancer RfCs are presented in Table 31-6. Additionally, the pollutants of interest are bolded. Finally, data from EPA's 1999 NATA for the pollutants that failed at least one screen at MAWI and MVWI were retrieved and are presented in

Figure 31-9. Comparison of Yearly Averages for the MAWI Monitoring Site

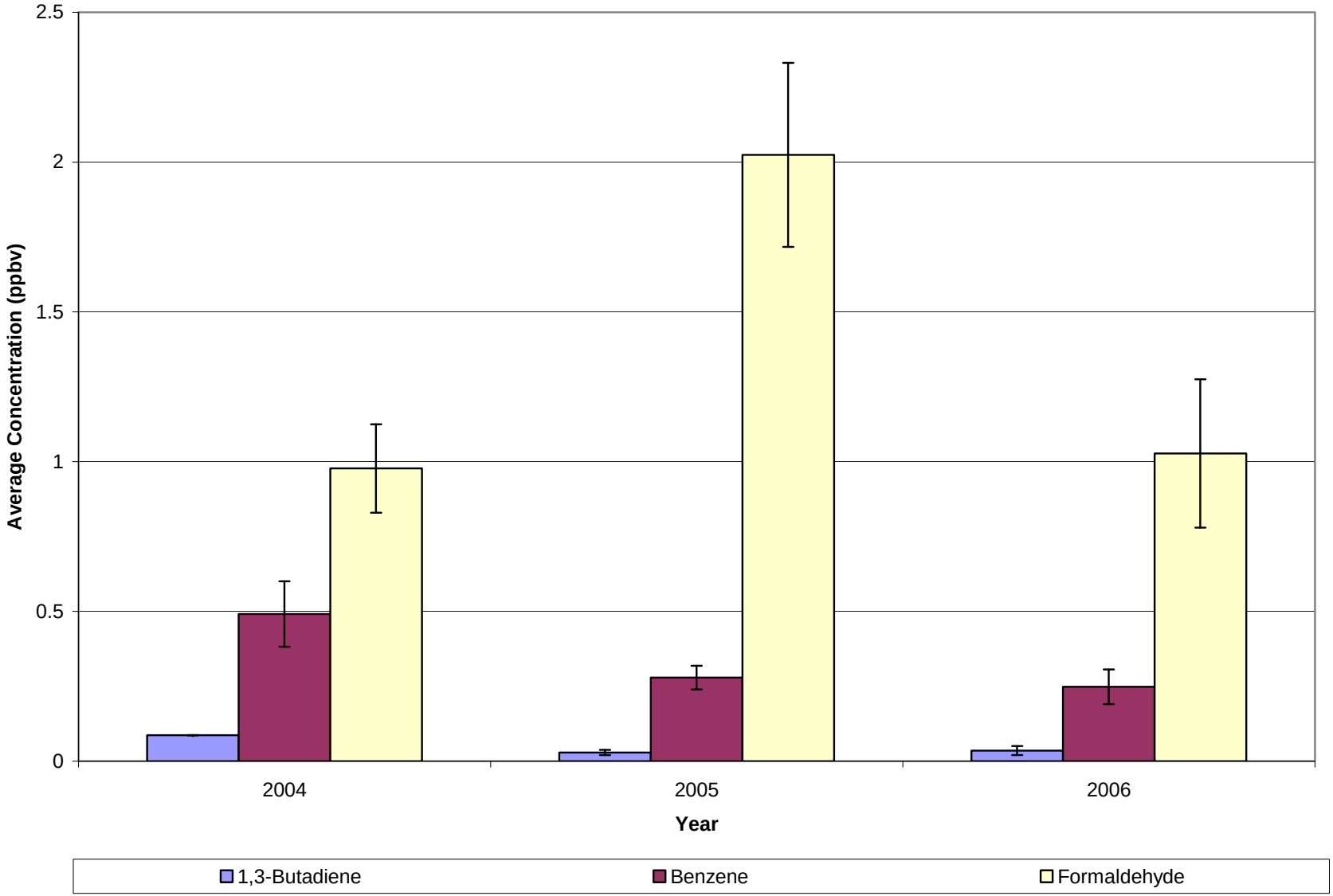


Table 31-6. Chronic Risk Summary for the Monitoring Sites in Wisconsin

Pollutant	Cancer URE (µg/m^3)	Noncancer RfC (µg/m^3)	1999 NATA			2006 UATMP		
			Modeled Concentration (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)	Annual Average (µg/m^3)	Cancer Risk (in-a-million)	Noncancer Risk (HQ)
Madison, Wisconsin (MAWI) – Census Tract ID 55025002100								
Acetaldehyde	0.0000022	0.009	1.16	2.55	0.13	NA	NA	NA
Benzene	0.0000078	0.03	1.70	13.30	0.06	NA	NA	NA
1,3-Butadiene	0.00003	0.002	0.17	4.98	0.08	NA	NA	NA
Carbon Tetrachloride	0.000015	0.04	0.21	3.17	0.01	NA	NA	NA
Formaldehyde	5.5E-09	0.0098	1.34	0.01	0.14	NA	NA	NA
Hexachloro-1,3-butadiene	0.000022	0.09	<0.01	0.03	<0.01	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	0.18	1.07	<0.01	NA	NA	NA
Mayville, Wisconsin (MVWI) – Census Tract ID 55027961400								
Hexavalent Chromium	0.012	0.0001	<0.01	0.07	<0.01	<0.01 ± <0.01	0.18	<0.01

BOLD indicates a pollutant of interest
NA = annual average not available

Table 31-6. The NATA data are presented for the census tract where the monitoring site is located.

The census tract information for the Wisconsin sites is as follows:

- The MAWI monitoring site is located in census tract 55025002100, while the MVWI monitoring site is located in census tract 55027961400.

- The population for the census tract where the MAWI monitoring site is located was 5,093, which represents about 1.2 percent of Dane County's population in 2000.

- The population for the census tract where the MVWI monitoring site is located was 4,065, which represents about 4.7 percent of Dodge County's population in 2000.

The following observations based on annual averages can be made from Table 31-6:

- MAWI ended sampling in February; therefore, no annual averages, and annual average-based cancer and noncancer risks, could be calculated.

- Hexavalent chromium, which was the only pollutant sampled for at MVWI, had an annual average that was less than 0.01 $\mu g/m^3$. Cancer and noncancer risk attributable to hexavalent chromium near MVWI was low.

The following observations based on NATA can be made from Table 31-6:

- Benzene (13.30 in-a-million), 1,3-butadiene (4.98), and carbon tetrachloride (3.17) have the highest cancer risks in the census tract where MAWI resides.

- Noncancer risk was low for the pollutants of interest for MAWI, with all HQs less than 0.15.

- Both the NATA-modeled and annual average concentration for hexavalent chromium for MVWI was less than 0.01 $\mu g/m^3$.

- The NATA-modeled cancer risk (0.07 in-a-million) for hexavalent chromium was less than the annual average-based cancer risk (0.18 in-a-million, respectively) for MVWI, although both were low.

- Both noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects due to hexavalent chromium for MVWI.

31.8 Toxicity-Weighted Emissions Assessment

In addition to the chronic risk analysis discussed above, Tables 31-7 and 31-8 present a risk-based assessment of the county-level emissions based on cancer and noncancer toxicity, respectively. Table 31-7 presents the 10 pollutants with the highest emissions from the 2002 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the hexavalent chromium cancer risk (in-a-million) as calculated from the annual average. Table 31-8 identifies the 10 pollutants with the highest emissions, noncancer toxicity-weighted emissions, and the hexavalent chromium noncancer risk (HQ) as calculated from the annual average. The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, the highest emitted pollutants in the cancer table may not be the same as the noncancer table, although the actual value of the emissions will be. Secondly, each site sampled for specific types of pollutants. Therefore, the cancer and noncancer risk based on each site's annual average is limited to those pollutants for which each respective site sampled. In addition, the highest cancer and noncancer risks based on annual averages are limited to those pollutants failing at least one screen.

The following observations can be made from Table 31-7:

- Benzene was the highest emitted pollutant (by mass) with a cancer risk factor and had the highest cancer toxicity-weighted emissions for both Dane and Dodge Counties (MAWI and MVWI, respectively).

- Formaldehyde had the second highest emissions in both Dane and Dodge Counties (MAWI and MVWI, respectively), but this pollutant did not appear on the list of highest cancer toxicity-weighted emissions, indicating that this pollutant has a relatively low cancer toxicity.

- Hexavalent chromium was the only pollutant with a cancer risk based on an annual average for MVWI. This pollutant was not one of the pollutants with the highest cancer toxicity-weighted emissions in Dodge County (MVWI), although it ranked ninth highest in Dane County (MAWI).

The following observations can be made from Table 31-8:

- Toluene and xylenes were the highest emitted pollutants with noncancer risk factors in both Dane and Dodge Counties (MAWI and MVWI, respectively), but only xylenes ranked in the top 10 based on toxicity-weighted emissions.

Table 31-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risks for Pollutants with Cancer UREs for the Wisconsin Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risks Based on Annual Average Concentration (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk (in-a-million)**
Madison, Wisconsin (MAWI) – Dane County					
Benzene	539.91	Benzene	4.21E-03		
Formaldehyde	141.58	1,3-Butadiene	1.23E-03		
Tetrachloroethylene	97.09	Lead	9.93E-04		
Dichloromethane	90.42	Polycyclic Organic Matter as non-15 PAH	8.80E-04		
Acetaldehyde	52.57	Naphthalene	7.78E-04		
1,3-Butadiene	41.06	Arsenic	6.81E-04		
1,3-Dichloropropene	32.06	Tetrachloroethylene	5.73E-04		
Naphthalene	22.90	Polycyclic Organic Matter as 15-PAH	3.42E-04		
p-Dichlorobenzene	16.61	Hexavalent Chromium	2.72E-04		
Trichloroethylene	13.61	Polycyclic Organic Matter as 7-PAH	2.17E-04		
Mayville, Wisconsin (MVWI) – Dodge County					
Benzene	166.79	Benzene	1.30E-03	Hexavalent Chromium	0.18
Formaldehyde	34.69	Lead	3.09E-04		
Dichloromethane	14.99	Polycyclic Organic Matter as non-15 PAH	3.05E-04		
Tetrachloroethylene	14.87	1,3-Butadiene	2.42E-04		
Acetaldehyde	13.71	Naphthalene	1.65E-04		
1,3-Butadiene	8.05	Polycyclic Organic Matter as 15-PAH	9.00E-05		
1,3-Dichloropropene	6.31	Tetrachloroethylene	8.77E-05		
Trichloroethylene	5.12	Polycyclic Organic Matter as 7-PAH	6.00E-05		
Naphthalene	4.85	*p*-Dichlorobenzene	3.61E-05		
p-Dichlorobenzene	3.28	Acetaldehyde	3.02E-05		

Table 31-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risks for Pollutants with Noncancer RfCs for the Wisconsin Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risks Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk (HQ)**
Madison, Wisconsin (MAWI) – Dane County					
Toluene	1,234.32	Manganese	702,704.63		
Xylenes	843.56	Acrolein	451,626.89		
Benzene	539.91	1,3-Butadiene	20,529.76		
Methyl Ethyl Ketone	410.93	Benzene	17,997.01		
1,1,1-Trichloroethane	347.17	Formaldehyde	14,447.15		
Methyl Isobutyl Ketone	232.35	Hydrochloric Acid	10,059.72		
Methanol	224.01	Bromomethane	8,953.95		
Hydrochloric Acid	201.19	Xylenes	8,435.61		
Hexane	170.86	Naphthalene	7,631.73		
Ethylbenzene	167.35	Nickel	6,906.09		
Mayville, Wisconsin (MVWI) – Dodge County					
Toluene	332.41	Acrolein	95,406.11	Hexavalent Chromium	<0.01
Xylenes	173.12	Manganese	5,767.56		
Benzene	166.79	Benzene	5,559.69		
Methyl Ethyl Ketone	61.15	1,3-Butadiene	4,026.54		
1,1,1-Trichloroethane	52.24	Formaldehyde	3,539.37		
Methanol	37.30	Bromomethane	1,760.75		
Ethylbenzene	36.39	Xylenes	1,731.25		
Hexane	36.32	Naphthalene	1,617.45		
Formaldehyde	34.69	Acetaldehyde	1,523.59		
Glycol Ethers	22.98	Cyanide	1,384.47		

- Acrolein and manganese had the highest noncancer toxicity-weighted emissions in Dodge County (MVWI), but manganese had higher toxicity-weighted emissions than acrolein in Dane County (MAWI). This is unusual because acrolein has the highest toxicity-weighted emissions for most of the UATMP counties. Yet, acrolein did not appear in the list of highest emitted pollutants.

- Hexavalent chromium did not rank in the top 10 highest emitted pollutants with noncancer risk factors or the 10 highest noncancer toxicity-weighted emissions in either county, and had a very low noncancer risk, based on the annual average for MVWI.

Wisconsin Pollutant Summary

- *The pollutants of interest at MAWI were acetaldehyde, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and hexachloro-1,3-butadiene. MVWI sampled only for hexavalent chromium.*

- *No pollutants exceeded the short-term risk factors at these sites.*

32.0 Data Quality

This section discusses the data quality of the ambient air concentrations for the 2006 UATMP dataset. In accordance with the Data Quality Objectives (DQOs) presented in ERG's EPA-approved QAPP, the following quality assessments were performed: completeness, precision, and bias (also called accuracy). Completeness statistics were presented in Section 2.0 of this report. The goal of 85 percent completeness was met by most sites. As indicators of the reliability and representativeness of experimental measurements, both precision and bias are considered when interpreting ambient air monitoring data. The quality assessments presented in this section shows that the 2006 monitoring data are of a known and high quality. All calculations are based on sample concentrations measured above the MDL for each pollutant. The overall precision level (the average for all sites) meets the data quality objective, which is a 15 percent coefficient of variation, and adheres to the guidelines in the NATTS TAD.

32.1 Precision

Precision refers to the agreement between independent measurements performed according to identical protocols and procedures. Method precision, or s*ampling and analytical precision,* quantifies random errors associated with collecting ambient air samples and analyzing the samples in the laboratory. Precision is evaluated by comparing concentrations measured in duplicate or collocated samples collected from the same air parcel. A *duplicate* sample is a sample collected simultaneously with a primary sample using the same sampling system (i.e., two separate samples through the same sampling system at the same time). This simultaneous collection is typically achieved by teeing the line from the sampler to two canisters and doubling the flow rate applied to achieve integration over the 24-hour collection period. *Collocated* samples are samples collected simultaneously using two independent collection systems at the same location at the same time.

Both approaches provide valuable, but different, assessments of method precision:

- Analysis of duplicate samples provides information on the potential for variability (or precision) expected from a single collection system, but does not provide information on the variability expected between different collection systems (inter-system assessment).

- Analysis of collocated samples provides information on the potential for variability (or precision) expected between different collection systems, but does not provide information on the variability expected from single collection systems (intra-system assessment).

During 2006, duplicate and collocated samples were collected on at least 10 percent of the scheduled sampling days, as outlined in the QAPP. Most of these samples were analyzed in replicate. Duplicate/collocated samples were not collected for SVOC because there were no collocated samplers and the samplers used were not equipped to collect duplicate samples. Therefore, method precision for SVOC is not discussed in this section.

To calculate sampling and analytical precision, data analysts compare the concentrations of the two duplicates/collocates for each compound. This report uses three parameters to quantify random errors indicated by duplicate/collocated analyses of samples:

- ***Average concentration difference*** simply quantifies how duplicate or collocated analytical results differ, on average, for each pollutant and each sample. When interpreting central tendency estimates for specific pollutants sampled during the 2006 monitoring effort, participating agencies are encouraged to compare central tendencies to the average concentration differences. If a pollutant's average concentration difference exceeds or nearly equals its central tendency, the analytical method may not be capable of precisely characterizing the concentrations. Therefore, data interpretation for these pollutants should be made with caution. Average concentration differences are calculated by subtracting the first analytical result from the second analytical result and averaging the difference for each pollutant.

- ***Relative percent difference (RPD)*** expresses average concentration differences relative to the average concentrations measured during duplicate or collocated analyses. The RPD is calculated as follows:

$$\frac{X_1 - X_2}{\overline{X}} \times 100 = RPD$$

Where:

X_1 is the ambient air concentration of a given pollutant measured in one sample;
X_2 is the concentration of the same pollutant measured during duplicate or collocated analysis; and
X is the arithmetic mean of X_1 and X_2.

As this equation shows, duplicate analyses with low variability have lower RPDs (and better precision), and duplicate analyses with high variability have higher RPDs (and poorer precision).

- ***Coefficient of Variation (CV)*** provides a relative measure of data dispersion compared to the mean.

$$CV = \frac{\sigma}{\overline{X}} \times 100$$

Where:

σ is the standard deviation of the sets of duplicate or collocated results;
$\overline{X}$ is the arithmetic mean of the sets of duplicate or collocated results;

The CV is used to determine the imprecision in survey estimates introduced from analysis. A coefficient of one percent would indicate that the analytical results could vary slightly due to sampling error, while a variation of 50 percent means that the results are more imprecise. The CV for two duplicate samples was calculated for each pollutant and each site.

The following approach was employed to estimate how precisely the central laboratory analyzed 2006 samples:

- CVs, RPDs, and concentration differences were calculated for every duplicate or collocated analysis performed during the program. In cases where pollutants were not detected during duplicate analyses, non-detects were replaced with 1/2 the MDL.

- To make an overall estimate of method precision, program-average CVs, RPDs, and absolute concentration differences were calculated for each pollutant by averaging the values from the individual duplicate or collocated analyses. The expression "average variability" or "median variability" for a given dataset refers to the average or median CV.

It is important to note that EPA has recently revised the methodology for assessing method precision in "Revisions to Ambient Air Monitoring Regulations; Final Rule," finalized October 17, 2006 (USEPA, 2006e). The new methodology has been applied to the 2006 Monitoring Network report. The primary change includes the substitution of 1/2 MDLs for non-detects in calculating precision statistics. In some cases, this substitution affected the calculated RPDs and CVs by causing those values to increase.

The Alabama (ETAL, NBAL, PVAL, SIAL), Oklahoma, and Wisconsin sites, as well as a few other sites were not included in this section because of the low number of valid duplicate or collocated samples throughout the 2006 sampling period. Table 32-1 presents the 2006 Monitoring Program average precision for VOC, SNMOC, carbonyl compounds, hexavalent chromium, and metals. The overall carbonyl compounds, hexavalent chromium, and metals

compounds precision (the average for all sites) meets the Program DQOs, which are 15 percent coefficient of variation. The overall VOC and SNMOC precision is slightly above the Program DQOs. Tables 32-2 through 32-9, 32-11 through 32-14, 32-16 through 32-25, and 32-27 through 32-30 present average concentration differences, RPDs, and CVs as estimates of duplicate sampling and analytical variability for VOC, SNMOC, carbonyls, and metal compounds, respectively. Tables 32-10, 32-15, 32-26, and 32-31 present the average CVs per pollutant and per site. Table 32-32 presents the average CV for hexavalent chromium per site.

Table 32-1. Average Precision by Method

Method	Average Coefficient of Variation (%)
VOC	21.18
SNMOC	21.49
Carbonyl Compounds	11.30
Hexavalent Chromium	10.03
Metals	11.33

32.1.1 VOC Sampling and Analytical Precision

Table 32-2 presents the sampling and analytical data precision for all duplicate and collocated VOC samples. The average concentration differences observed for duplicate and collocated analyses of VOC range from 0.003 ppbv (dibromochloromethane and dichlorotetrafluoroethane) to 7.57 ppbv (acetonitrile). Pollutants exceeding the 15 percent control limit for CV and a 25 percent control limit for RPD are bolded. Thirty-one out of 60 VOC show greater variation than the target of 15 percent.

Table 32-2. VOC Sampling and Analytical Precision: 228 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	164	**63.97**	7.57	**45.24**
Acetylene	224	14.03	0.14	9.92
Acrolein	179	**53.04**	0.18	**37.51**
Acrylonitrile	11	**47.55**	0.05	**33.62**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	228	16.59	0.06	11.73

Table 32-2. VOC Sampling and Analytical Precision: 228 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	9	**85.44**	0.01	**60.42**
Bromoform	0	NA	NA	NA
Bromomethane	188	21.30	0.005	**15.06**
1,3-Butadiene	190	20.42	0.01	14.44
Carbon Disulfide	200	**35.76**	0.24	**25.29**
Carbon Tetrachloride	228	19.21	0.02	13.59
Chlorobenzene	8	**78.01**	0.01	**55.16**
Chloroethane	137	**47.25**	0.01	**33.41**
Chloroform	161	**39.05**	0.02	**27.61**
Chloromethane	228	6.02	0.04	4.26
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	8	**38.99**	0.003	**27.57**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	2	**137.41**	0.01	**97.16**
o-Dichlorobenzene	2	NA	0.01	NA
p-Dichlorobenzene	165	**39.36**	0.01	**27.83**
Dichlorodifluoromethane	228	5.48	0.03	3.88
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	5	**62.31**	0.01	**44.06**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	5	**159.12**	0.08	**112.51**
trans-1,2-Dichloroethylene	5	**67.78**	0.01	**47.93**
Dichloromethane	219	**27.16**	1.06	**19.20**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	1	**73.22**	0.01	**51.78**
Dichlorotetrafluoroethane	228	19.31	0.003	13.65
Ethyl Acrylate	1	NA	0.01	NA
Ethyl *tert*-Butyl Ether	6	NA	NA	NA
Ethylbenzene	228	19.02	0.12	13.45
Hexachloro-1,3-butadiene	14	**81.40**	0.02	**57.56**
Methyl Ethyl Ketone	216	**44.30**	0.22	**31.32**
Methyl Isobutyl Ketone	174	**49.02**	0.03	**34.66**
Methyl Methacrylate	5	**100.52**	0.28	**71.08**
Methyl *tert*-Butyl Ether	48	**28.85**	0.01	**20.40**
n-Octane	181	**40.05**	0.01	**28.32**
Propylene	228	17.12	0.07	12.10
Styrene	192	**29.94**	0.11	**21.17**
1,1,2,2-Tetrachloroethane	2	**43.01**	0.004	**30.42**
Tetrachloroethylene	157	**37.83**	0.04	**26.75**
Toluene	228	20.13	0.15	14.24
1,2,4-Trichlorobenzene	2	**59.62**	0.01	**42.16**
1,1,1-Trichloroethane	227	16.71	0.01	11.81
1,1,2-Trichloroethane	0	NA	NA	NA

Table 32-2. VOC Sampling and Analytical Precision: 228 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Trichloroethylene	56	**84.65**	0.02	**59.86**
Trichlorofluoromethane	228	7.53	0.02	5.33
Trichlorotrifluoroethane	228	10.72	0.01	7.58
1,2,4-Trimethylbenzene	219	**27.86**	0.02	**19.70**
1,3,5-Trimethylbenzene	198	**26.87**	0.01	**19.00**
Vinyl chloride	12	**77.39**	0.01	**54.72**
m,p-Xylene	228	20.59	0.08	14.56
o-Xylene	226	19.94	0.03	14.10

The VOC sampling and analytical data for all collocated samples are presented in Table 32-3. The range of variability was 4.82 percent (chloromethane) to 139.98 percent (methyl methacrylate). The median variability is 27.99 percent.

Table 32-3. VOC Sampling and Analytical Precision: 80 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	56	**112.91**	14.40	**79.84**
Acetylene	80	17.69	0.14	12.51
Acrolein	65	**47.42**	0.21	**33.53**
Acrylonitrile	8	**38.62**	0.08	**27.31**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	80	**26.83**	0.08	**18.97**
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	9	**85.44**	0.01	**60.42**
Bromoform	0	NA	NA	NA
Bromomethane	57	**32.41**	0.01	**22.92**
1,3-Butadiene	64	22.75	0.01	**16.09**
Carbon Disulfide	60	**69.83**	0.44	**49.38**
Carbon Tetrachloride	80	13.58	0.01	9.60
Chlorobenzene	8	**78.01**	0.01	**55.16**
Chloroethane	45	**56.15**	0.01	**39.71**
Chloroform	56	**37.52**	0.02	NA
Chloromethane	80	6.81	0.04	4.82
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	8	**38.99**	0.003	**27.57**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	66	**57.74**	0.02	**40.83**
Dichlorodifluoromethane	80	6.83	0.04	4.83

Table 32-3. VOC Sampling and Analytical Precision: 80 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	2	**93.20**	0.01	**65.90**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	1	**134.24**	0.03	**94.92**
trans-1,2-Dichloroethylene	1	9.59	<0.001	6.78
Dichloromethane	73	**40.00**	0.05	**28.28**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	80	19.69	0.003	13.92
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	80	**33.01**	0.34	**23.34**
Hexachloro-1,3-butadiene	7	**96.14**	0.02	**67.98**
Methyl Ethyl Ketone	77	**48.91**	0.30	**34.58**
Methyl Isobutyl Ketone	62	**53.72**	0.05	**37.98**
Methyl Methacrylate	3	**197.96**	0.56	**139.98**
Methyl *tert*-Butyl Ether	6	**110.00**	0.03	**77.78**
n-Octane	58	**59.73**	0.02	**42.24**
Propylene	80	21.47	0.07	**15.18**
Styrene	62	**39.58**	0.30	**27.99**
1,1,2,2-Tetrachloroethane	2	**43.01**	0.00	**30.42**
Tetrachloroethylene	49	**54.94**	0.04	**38.85**
Toluene	80	**35.05**	0.17	**24.78**
1,2,4-Trichlorobenzene	2	**59.62**	0.01	**42.16**
1,1,1-Trichloroethane	79	22.89	0.01	**16.19**
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	23	**92.05**	0.03	**65.09**
Trichlorofluoromethane	80	12.84	0.04	9.08
Trichlorotrifluoroethane	80	16.83	0.03	11.90
1,2,4-Trimethylbenzene	76	**37.46**	0.03	**26.49**
1,3,5-Trimethylbenzene	72	**30.63**	0.01	**21.66**
Vinyl chloride	4	**63.37**	0.01	**44.81**
m,p-Xylene	80	**29.19**	0.20	**20.64**
o-Xylene	80	**30.17**	0.05	**21.33**

Table 32-4 presents the results from all duplicate analyses for VOC. The variability ranges from 2.18 percent (methyl methacrylate) to 121.31 percent (*cis*-1,2-dichloroethylene). The median variability is 16.57 percent, which shows that most of the pollutants meet the program DQO.

Table 32-4. VOC Sampling and Analytical Precision: 148 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	108	**41.39**	4.42	**29.27**
Acetylene	144	12.35	0.15	8.73
Acrolein	114	**55.64**	0.16	**39.34**
Acrylonitrile	3	**56.48**	0.03	**39.94**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	148	11.86	0.04	8.39
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	131	17.26	0.004	12.20
1,3-Butadiene	126	19.53	0.02	13.81
Carbon Disulfide	140	22.65	0.16	**16.02**
Carbon Tetrachloride	148	21.81	0.02	**15.42**
Chlorobenzene	0	NA	NA	NA
Chloroethane	92	**42.79**	0.01	**30.26**
Chloroform	105	**39.88**	0.02	**28.20**
Chloromethane	148	5.65	0.04	4.00
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	2	**137.41**	0.01	**97.16**
o-Dichlorobenzene	2	NA	0.01	NA
p-Dichlorobenzene	99	**27.11**	0.01	**19.17**
Dichlorodifluoromethane	148	4.86	0.03	3.44
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	3	**31.41**	0.01	**22.21**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	4	**171.56**	0.10	**121.31**
trans-1,2-Dichloroethylene	4	**125.97**	0.02	**89.07**
Dichloromethane	146	21.23	1.53	**15.01**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	1	**73.22**	0.01	**51.78**
Dichlorotetrafluoroethane	148	19.13	0.003	13.53
Ethyl Acrylate	1	NA	0.01	NA
Ethyl *tert*-Butyl Ether	6	NA	NA	NA
Ethylbenzene	148	12.56	0.01	8.88
Hexachloro-1,3-butadiene	7	**66.67**	0.01	**47.14**
Methyl Ethyl Ketone	139	**42.17**	0.18	**29.82**
Methyl Isobutyl Ketone	112	**46.85**	0.02	**33.13**
Methyl Methacrylate	2	3.08	0.01	2.18
Methyl *tert*-Butyl Ether	42	12.62	0.01	8.93
n-Octane	123	**31.11**	0.01	**22.00**
Propylene	148	15.11	0.08	10.68
Styrene	130	**25.49**	0.02	**18.03**

Table 32-4. VOC Sampling and Analytical Precision: 148 Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	108	**28.50**	0.04	**20.15**
Toluene	148	13.25	0.14	9.37
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	148	13.27	0.004	9.38
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	33	**78.73**	0.01	**55.67**
Trichlorofluoromethane	148	5.09	0.01	3.60
Trichlorotrifluoroethane	148	7.90	0.01	5.59
1,2,4-Trimethylbenzene	143	23.43	0.01	**16.57**
1,3,5-Trimethylbenzene	126	24.52	0.01	**17.34**
Vinyl chloride	8	**86.74**	0.01	**61.33**
m,p-Xylene	148	16.62	0.03	11.75
o-Xylene	146	15.21	0.01	10.76

Table 32-5 through 32-9 present the VOC precision data results for all of the NATTS sites that sampled VOC (BTUT, DEMI, GPCO, NBIL, and S4MO, respectively).

Table 32-5 presents the results from VOC duplicate analysis for BTUT. Variability ranges from 2.76 percent (trichlorofluoromethane) to 52.77 percent (acrolein) with an average of 12.12 percent.

Table 32-5. VOC Sampling and Analytical Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	7	13.62	0.20	9.63
Acetylene	12	4.33	0.05	3.07
Acrolein	10	**74.63**	0.28	**52.77**
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	4.68	0.02	3.31
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	12	11.11	0.002	7.86
1,3-Butadiene	12	12.17	0.01	8.61
Carbon Disulfide	12	8.35	0.28	5.91

Table 32-5. VOC Sampling and Analytical Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Carbon Tetrachloride	12	**35.65**	0.02	**25.21**
Chlorobenzene	0	NA	NA	NA
Chloroethane	9	**35.00**	0.01	**24.75**
Chloroform	9	16.67	0.01	11.79
Chloromethane	12	3.92	0.02	2.77
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	1	NA	0.01	NA
o-Dichlorobenzene	1	NA	0.01	NA
p-Dichlorobenzene	12	22.22	0.003	**15.71**
Dichlorodifluoromethane	12	4.87	0.03	3.44
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	1	NA	0.03	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	1	NA	0.01	NA
Dichloromethane	12	16.00	0.02	11.31
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	11.11	0.002	7.86
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	11.89	0.01	8.41
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	10	**46.25**	0.23	**32.70**
Methyl Isobutyl Ketone	12	15.20	0.01	10.75
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	12	14.83	0.01	10.48
Propylene	12	10.64	0.05	7.53
Styrene	10	19.09	0.01	13.50
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	12	10.37	0.003	7.33
Toluene	12	7.29	0.06	5.15
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	6.67	0.002	4.71
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	1	NA	0.01	NA
Trichlorofluoromethane	12	3.91	0.01	2.76
Trichlorotrifluoroethane	12	5.30	0.01	3.75
1,2,4-Trimethylbenzene	12	**34.81**	0.04	**24.62**
1,3,5-Trimethylbenzene	12	**30.00**	0.01	**21.21**

Table 32-5. VOC Sampling and Analytical Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Vinyl chloride	1	NA	0.01	NA
m,p-Xylene	12	11.61	0.04	8.21
o-Xylene	12	11.82	0.02	8.36

Table 32-6 presents the precision results from VOC collocated analysis for DEMI. These results show a low to high level variability, ranging from 1.50 percent (dichlorodifluoromethane) to 44.89 percent (methyl isobutyl ketone). The average CV, which is within the Program DQO, is 11.27 percent.

Table 32-6. VOC Sampling and Analytical Precision: 10 Collocated Samples for Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	8	8.61	1.01	6.09
Acetylene	10	13.39	0.09	9.46
Acrolein	6	22.04	0.05	**15.59**
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	10	3.90	0.02	2.76
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	6	NA	NA	NA
1,3-Butadiene	6	NA	NA	NA
Carbon Disulfide	0	NA	NA	NA
Carbon Tetrachloride	10	11.53	0.01	8.15
Chlorobenzene	6	22.22	0.003	**15.71**
Chloroethane	6	22.22	0.003	**15.71**
Chloroform	10	**36.54**	0.04	**25.84**
Chloromethane	10	2.21	0.01	1.57
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	8	16.67	0.003	11.79
Dichlorodifluoromethane	10	2.12	0.01	1.50
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA

Table 32-6. VOC Sampling and Analytical Precision: 10 Collocated Samples for Detroit, MI (DEMI) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	10	11.08	0.01	7.83
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	10	13.33	0.002	9.43
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	10	16.74	0.01	11.83
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	10	24.24	0.08	**17.14**
Methyl Isobutyl Ketone	7	**63.48**	0.02	**44.89**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	6	**46.15**	0.03	**32.64**
Propylene	10	3.72	0.01	2.63
Styrene	7	**35.32**	0.01	**24.98**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	8	9.59	0.02	6.78
Toluene	10	5.70	0.02	4.03
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	10	8.00	0.002	5.66
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	2	NA	NA	NA
Trichlorofluoromethane	10	2.95	0.01	2.09
Trichlorotrifluoroethane	10	9.79	0.01	6.92
1,2,4-Trimethylbenzene	10	8.57	0.01	6.06
1,3,5-Trimethylbenzene	10	8.00	0.002	5.66
Vinyl chloride	0	NA	NA	NA
m,p-Xylene	10	8.64	0.01	6.11
o-Xylene	10	9.63	0.01	6.81

Table 32-7 presents the results from VOC duplicate analysis for GPCO. The variability ranges from 2.18 percent (methyl methacrylate) to 53.01 percent (chloroform). The average variability is 13.35 percent.

Table 32-7. VOC Sampling and Analytical Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	12	**26.01**	0.24	**18.39**
Acetylene	12	6.14	0.08	4.34
Acrolein	12	**71.03**	0.20	**50.22**
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	6.41	0.03	4.53
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	10	13.33	0.002	9.43
1,3-Butadiene	12	19.59	0.01	13.85
Carbon Disulfide	12	8.07	0.12	5.71
Carbon Tetrachloride	12	24.22	0.02	**17.12**
Chlorobenzene	0	NA	NA	NA
Chloroethane	9	16.98	0.001	12.01
Chloroform	7	**74.97**	0.01	**53.01**
Chloromethane	12	6.37	0.04	4.50
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	8	**33.33**	0.01	**23.57**
Dichlorodifluoromethane	12	6.22	0.04	4.40
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	12	12.37	0.01	8.75
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	11.11	0.002	7.86
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	6.79	0.01	4.80
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	10	**39.31**	0.12	**27.79**
Methyl Isobutyl Ketone	9	**59.59**	0.02	**42.14**
Methyl Methacrylate	2	3.08	0.01	2.18
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	12	NA	NA	NA
Propylene	12	8.46	0.04	5.98
Styrene	12	24.56	0.02	**17.36**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA

Table 32-7. VOC Sampling and Analytical Precision: 12 Duplicate Samples for Grand Junction, CO (GPCO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Tetrachloroethylene	12	19.74	0.01	13.96
Toluene	12	7.41	0.04	5.24
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	6.67	0.002	4.71
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	0	NA	NA	NA
Trichlorofluoromethane	12	4.07	0.01	2.88
Trichlorotrifluoroethane	12	5.51	0.01	3.90
1,2,4-Trimethylbenzene	12	12.88	0.01	9.11
1,3,5-Trimethylbenzene	12	NA	NA	NA
Vinyl chloride	0	NA	NA	NA
m,p-Xylene	12	6.50	0.02	4.60
o-Xylene	12	6.80	0.01	4.81

Table 32-8 presents the results from VOC collocated analysis for NBIL. The variability, in terms of CV, ranges from 2.66 percent (carbon tetrachloride) to 80.90 percent (*p*-dichlorobenzene). The average and median CV are 38.15 percent and 35.73 percent, respectively. The average and the median CV show that the variability of most compounds at the NBIL site are mid- to high-level.

Table 32-8. VOC Sampling and Analytical Precision: 12 Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	6	**84.93**	0.24	**60.06**
Acetylene	12	16.55	0.07	11.70
Acrolein	8	**81.36**	0.17	**57.53**
Acrylonitrile	1	**32.93**	0.01	**23.29**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	12	**48.73**	0.07	**34.46**
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	8	**33.33**	0.01	**23.57**
Bromoform	0	NA	NA	NA
Bromomethane	10	**26.67**	0.004	**18.86**
1,3-Butadiene	8	**48.89**	0.01	**34.57**
Carbon Disulfide	8	**46.54**	0.02	**32.91**
Carbon Tetrachloride	12	3.76	0.01	2.66
Chlorobenzene	0	NA	NA	NA
Chloroethane	8	**87.49**	0.02	**61.86**
Chloroform	11	**69.02**	0.06	**48.80**

Table 32-8. VOC Sampling and Analytical Precision: 12 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Chloromethane	12	8.65	0.04	6.12
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	7	15.60	0.001	11.03
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	7	**114.41**	0.03	**80.90**
Dichlorodifluoromethane	12	11.04	0.06	7.81
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	1	9.59	<0.001	6.78
Dichloromethane	10	**72.43**	0.11	**51.21**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	12	**33.33**	0.01	**23.57**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	12	**47.41**	0.02	**33.52**
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	10	**101.87**	0.67	**72.03**
Methyl Isobutyl Ketone	6	**77.29**	0.06	**54.65**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	7	**95.28**	0.01	**67.37**
Propylene	12	**46.02**	0.08	**32.54**
Styrene	6	**52.17**	0.01	**36.89**
1,1,2,2-Tetrachloroethane	1	**43.01**	0.004	**30.42**
Tetrachloroethylene	9	**105.70**	0.04	**74.74**
Toluene	12	**68.86**	0.13	**48.69**
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	12	**61.21**	0.03	**43.28**
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	7	**114.35**	0.05	**80.85**
Trichlorofluoromethane	12	**32.91**	0.14	**23.27**
Trichlorotrifluoroethane	12	6.11	0.01	4.32
1,2,4-Trimethylbenzene	9	**72.60**	0.02	**51.33**
1,3,5-Trimethylbenzene	8	**64.80**	0.01	**45.82**
Vinyl chloride	0	NA	NA	NA
m,p-Xylene	12	**52.94**	0.06	**37.43**
o-Xylene	12	**54.57**	0.03	**38.59**

Table 32-9 presents the results from VOC duplicate analysis for S4MO. The variability ranges from 2.04 percent (chloromethane) to 61.33 percent (vinyl chloride), with a median CV of 15.13 percent.

Table 32-9. VOC Sampling and Analytical Precision: 10 Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	6	**52.21**	1.52	**36.92**
Acetylene	10	3.90	0.02	2.76
Acrolein	8	**51.17**	0.14	**36.19**
Acrylonitrile	1	**54.16**	0.02	**38.30**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	10	7.51	0.02	5.31
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	10	13.33	0.002	9.43
1,3-Butadiene	10	4.44	0.002	3.14
Carbon Disulfide	6	**25.46**	0.02	**18.00**
Carbon Tetrachloride	10	**40.15**	0.02	**28.39**
Chlorobenzene	0	NA	NA	NA
Chloroethane	7	**74.86**	0.01	**52.93**
Chloroform	8	NA	NA	NA
Chloromethane	10	2.88	0.02	2.04
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	8	NA	NA	NA
Dichlorodifluoromethane	10	4.25	0.02	3.01
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	10	11.79	0.02	8.34
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	10	**26.67**	0.004	**18.86**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	10	23.58	0.02	**16.67**
Hexachloro-1,3-butadiene	0	NA	NA	NA

Table 32-9. VOC Sampling and Analytical Precision: 10 Duplicate Samples for St. Louis, MO (S4MO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Methyl Ethyl Ketone	10	**34.51**	0.21	**24.40**
Methyl Isobutyl Ketone	9	**56.94**	0.02	**40.26**
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	10	13.33	0.002	9.43
Propylene	10	11.28	0.03	7.98
Styrene	10	**33.70**	0.02	**23.83**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	8	10.00	0.002	7.07
Toluene	10	6.53	0.03	4.62
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	10	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	6	NA	NA	NA
Trichlorofluoromethane	10	11.72	0.04	8.29
Trichlorotrifluoroethane	10	3.81	0.004	2.69
1,2,4-Trimethylbenzene	10	**39.52**	0.01	**27.95**
1,3,5-Trimethylbenzene	9	**45.95**	0.01	**32.49**
Vinyl chloride	1	**86.74**	0.01	**61.33**
m,p-Xylene	10	19.23	0.02	13.60
o-Xylene	10	21.40	0.01	**15.13**

Table 32-10 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV. The results from duplicate and collocated samples show low- to high- level variability among sites, ranging from an average CV of 11.27 percent at DEMI to 39.00 percent at WETX. The average pollutant-specific CV ranged from 3.88 percent (dichlorodifluoromethane) to 112.51 percent (*cis*-1,2-dichloroethylene). The overall average is 21.18 percent. This is higher than the Program DQO of 15 percent overall CV per site.

32.1.2 SNMOC Sampling and Analytical Precision

The SNMOC sampling and analytical precision for duplicate and collocated samples is presented in Table 32-11. The average concentration differences observed for duplicate and collocated sample analysis range from 0.02 ppbC (1,3-butadiene) to 48.09 ppbC (TNMOC). The variation ranges from 6.31 percent (propane) to 114.98 percent (*cis*-2-hexene).

Table 32-10. VOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Elizabeth, NJ (ELNJ)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)
Acetonitrile	***45.24***	13.11	9.63	**24.70**	**41.67**	**24.87**	6.09	**39.76**	**18.39**	**16.61**	**84.23**
Acetylene	*9.92*	13.40	3.07	6.62	8.64	4.40	9.46	9.52	4.34	7.92	**15.72**
Acrolein	***37.51***	**43.86**	**52.77**	**33.61**	**30.57**	**17.24**	**15.59**	**41.35**	**50.22**	**47.42**	**16.57**
Acrylonitrile	***33.62***	**78.36**	NA	NA	NA	3.16	NA	NA	NA	NA	NA
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	*11.73*	10.79	3.31	9.46	10.08	7.26	2.76	7.17	4.53	6.89	7.44
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***60.42***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	***15.06***	9.43	7.86	1.27	NAN	**15.92**	NA	NA	9.43	**29.56**	**44.33**
1,3-Butadiene	*14.44*	**18.21**	8.61	6.73	**33.70**	7.20	NA	6.10	13.85	6.60	5.05
Carbon Disulfide	***25.29***	**18.59**	5.91	11.76	**24.63**	**19.97**	NA	11.43	5.71	**19.17**	**37.59**
Carbon Tetrachloride	*13.59*	4.80	**25.21**	7.25	**26.73**	10.25	8.15	**20.42**	**17.12**	3.64	**23.23**
Chlorobenzene	***55.16***	NA	NA	NA	NA	NA	**15.71**	NA	NA	NA	NA
Chloroethane	***33.41***	**34.96**	**24.75**	14.14	**30.02**	**31.43**	**15.71**	**21.43**	12.01	**33.94**	**35.36**
Chloroform	***27.61***	4.99	11.79	9.43	11.79	**44.07**	**25.84**	NA	**53.01**	**33.04**	5.51
Chloromethane	*4.26*	2.85	2.77	6.46	2.81	5.55	1.57	4.42	4.50	4.22	7.69
Chloromethylbenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	***27.57***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***97.16***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	***27.83***	10.03	**15.71**	NA	**39.56**	**23.57**	11.79	1.84	**23.57**	**26.71**	**38.77**
Dichlorodifluoromethane	*3.88*	2.64	3.44	4.60	1.88	5.52	1.50	3.97	4.40	4.10	7.96
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 32-10. VOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Elizabeth, NJ (ELNJ)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)
1,2-Dichloroethane	***44.06***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***112.51***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	***47.93***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloromethane	***19.20***	9.45	11.31	0.75	**21.78**	7.39	7.83	7.09	8.75	**15.15**	**29.21**
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	***51.78***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*13.65*	7.86	7.86	NA	6.73	6.73	9.43	13.47	7.86	13.47	**23.57**
Ethyl Acrylate	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*13.45*	10.04	8.41	2.77	**15.31**	5.69	11.83	8.69	4.80	13.03	**19.58**
Hexachloro-1,3-butadiene	***57.56***	NA	NA	NA	**47.14**	NA	NA	NA	NA	NA	**101.39**
Methyl Ethyl Ketone	***31.32***	**49.16**	**32.70**	**22.39**	**30.33**	**31.38**	**17.14**	13.61	**27.79**	**28.83**	**18.26**
Methyl Isobutyl Ketone	***34.66***	**22.65**	10.75	**21.89**	**56.57**	**21.25**	**44.89**	**46.81**	**42.14**	**42.92**	**19.34**
Methyl Methacrylate	***71.08***	NA	NA	NA	NA	NA	NA	NA	2.18	NA	NA
Methyl *tert*-Butyl Ether	***20.40***	3.14	NA	4.43	13.30	NA	NA	1.48	NA	NA	NA
n-Octane	***28.32***	**50.15**	10.48	NA	**30.63**	4.13	**32.64**	9.64	NA	10.97	**28.84**
Propylene	*12.10*	**21.20**	7.53	3.77	11.44	10.47	2.63	7.68	5.98	11.82	9.94
Styrene	***21.17***	**18.56**	13.50	**15.71**	10.04	5.63	**24.98**	**28.65**	**17.36**	12.51	12.33
1,1,2,2-Tetrachloroethane	***30.42***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	***26.75***	**21.66**	7.33	4.29	NA	NA	6.78	2.74	13.96	**15.08**	14.44
Toluene	*14.24*	10.69	5.15	7.52	8.93	4.31	4.03	5.92	5.24	**15.99**	9.69
1,2,4-Trichlorobenzene	***42.16***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	*11.81*	12.57	4.71	NA	12.12	6.73	5.66	NA	4.71	8.08	14.14
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	***59.86***	NA	NA	NA	NA	NA	NA	5.66	NA	**111.34**	NA

Table 32-10. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Elizabeth, NJ (ELNJ)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)
Trichlorofluoromethane	*5.33*	2.27	2.76	3.82	1.03	5.76	2.09	3.51	2.88	3.73	10.29
Trichlorotrifluoroethane	*7.58*	3.05	3.75	7.63	2.80	5.83	6.92	5.00	3.90	5.15	10.54
1,2,4-Trimethylbenzene	***19.70***	12.59	**24.62**	14.50	**17.09**	0.06	6.06	**17.59**	9.11	**26.09**	**33.73**
1,3,5-Trimethylbenzene	***19.00***	**15.37**	**21.21**	NA	**31.20**	0.64	5.66	14.82	NA	13.47	NA
Vinyl chloride	***54.72***	NA	NA	NA	NA	NA	NA	NA	NA	**61.33**	NA
m,p-Xylene	*14.56*	10.39	8.21	9.06	**24.58**	2.33	6.11	9.44	4.60	9.70	14.37
o-Xylene	*14.10*	10.71	8.36	6.40	**19.65**	**20.00**	6.81	12.27	4.81	10.19	**16.65**
Average	***21.18***	***17.42***	*12.12*	*10.04*	***20.76***	*11.96*	*11.27*	*13.15*	*13.35*	***20.90***	***23.86***

Table 32-10. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	Nashville, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Acetonitrile	***45.24***	**76.28**	**60.06**	**98.28**	**36.92**	**37.82**	10.12	**133.15**	8.59	**119.23**
Acetylene	*9.92*	8.17	11.70	12.22	2.76	12.83	**17.89**	13.79	9.88	**16.18**
Acrolein	***37.51***	11.89	**57.53**	**22.10**	**36.19**	**59.92**	**37.28**	**71.61**	**38.90**	**28.00**
Acrylonitrile	***33.62***	NA	**23.29**	NA	**38.30**	NA	NA	**25.24**	NA	**33.40**
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	*11.73*	**23.86**	**34.46**	**16.05**	5.31	3.15	5.20	**27.43**	**19.87**	**17.90**
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***60.42***	NA	**23.57**	NA	NA	NA	NA	**97.26**	NA	NA
Bromoform	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	***15.06***	NA	**18.86**	9.43	9.43	9.43	**23.57**	11.79	8.93	**16.69**
1,3-Butadiene	*14.44*	7.07	**34.57**	**18.86**	3.14	11.79	**20.97**	**18.86**	**23.75**	14.88
Carbon Disulfide	***25.29***	4.27	**32.91**	**31.47**	**18.00**	**28.36**	9.33	**85.99**	3.92	**86.13**
Carbon Tetrachloride	*13.59*	6.66	2.66	**28.39**	**28.39**	8.31	11.38	11.75	8.63	5.15
Chlorobenzene	***55.16***	NA	NA	NA	NA	NA	NA	NA	NA	**94.61**
Chloroethane	***33.41***	**23.57**	**61.86**	**51.78**	**52.93**	**20.01**	NA	**60.14**	**35.72**	**41.60**
Chloroform	***27.61***	3.93	**48.80**	**45.16**	NA	**23.57**	**34.05**	**24.75**	**39.32**	**50.34**
Chloromethane	*4.26*	3.02	6.12	6.60	2.04	2.85	4.08	4.75	2.82	5.75
Chloromethylbenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	***27.57***	NA	11.03	NA	NA	NA	NA	**44.11**	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***97.16***	NA	NA	NA	NA	NA	NA	NA	**97.16**	NA
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	***27.83***	**31.65**	**80.90**	**15.82**	NA	NA	**15.71**	**39.56**	NA	**42.30**
Dichlorodifluoromethane	*3.88*	2.34	7.81	3.20	3.01	3.47	1.75	5.33	2.72	4.03
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 32-10. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	Nashville, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
1,2-Dichloroethane	***44.06***	NA	NA	**22.21**	NA	NA	NA	NA	NA	**65.90**
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***112.51***	NA	NA	**128.16**	NA	**114.46**	NA	NA	NA	**94.92**
trans-1,2-Dichloroethylene	***47.93***	NA	6.78	NA	NA	NA	**89.07**	NA	NA	NA
Dichloromethane	***19.20***	**18.28**	**51.21**	12.73	8.34	**22.52**	**38.54**	**28.08**	**31.36**	**35.07**
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	***51.78***	NA	NA	**51.78**	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*13.65*	9.43	**23.57**	**18.86**	**18.86**	**31.43**	NA	NA	**15.71**	3.63
Ethyl Acrylate	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*13.45*	11.37	**33.52**	8.08	**16.67**	4.71	4.15	**20.73**	13.06	**43.00**
Hexachloro-1,3-butadiene	***57.56***	NA	NA	**47.14**	NA	NA	NA	NA	NA	**34.57**
Methyl Ethyl Ketone	***31.32***	**20.26**	**72.03**	**25.43**	**24.40**	**23.77**	**30.05**	**54.08**	**47.83**	**25.72**
Methyl Isobutyl Ketone	***34.66***	**40.63**	**54.65**	**31.57**	**40.26**	**72.49**	**15.34**	**35.85**	6.01	**32.55**
Methyl Methacrylate	***71.08***	NA	NA	NA	NA	NA	NA	NA	NA	**139.98**
Methyl *tert*-Butyl Ether	***20.40***	**77.78**	NA	NA	NA	NA	**22.28**	NA	NA	NA
n-Octane	***28.32***	NA	**67.37**	11.79	9.43	**78.57**	10.48	**62.29**	**15.71**	**20.04**
Propylene	*12.10*	**15.40**	**32.54**	10.18	7.98	**15.71**	**17.55**	**15.73**	7.55	14.83
Styrene	***21.17***	13.65	**36.89**	**23.91**	**23.83**	**17.41**	**15.78**	**29.39**	**31.47**	**50.69**
1,1,2,2-Tetrachloroethane	***30.42***	NA	**30.42**	NA	NA	NA	NA	NA	NA	**30.42**
Tetrachloroethylene	***26.75***	10.83	**74.74**	8.80	7.07	**79.52**	**40.77**	**86.41**	**20.47**	**39.90**
Toluene	*14.24*	**37.85**	**48.69**	9.21	4.62	**23.23**	2.78	**32.30**	**18.20**	**16.12**
1,2,4-Trichlorobenzene	***42.16***	NA	NA	NA	NA	NA	NA	NA	NA	**42.16**
1,1,1-Trichloroethane	*11.81*	NA	**43.28**	5.66	NA	4.71	**25.14**	5.66	NA	12.20
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	***59.86***	**51.46**	**80.85**	**61.46**	NA	NA	12.86	**44.53**	**87.05**	**83.52**

Table 32-10. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average	Nashville, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Trichlorofluoromethane	*5.33*	3.21	**23.27**	2.30	8.29	4.00	3.32	13.06	3.08	2.55
Trichlorotrifluoroethane	*7.58*	5.15	4.32	4.38	2.69	7.35	**17.76**	7.43	3.35	**37.03**
1,2,4-Trimethylbenzene	***19.70***	**15.93**	**51.33**	**22.39**	**27.95**	9.43	5.83	**22.63**	**28.15**	**29.24**
1,3,5-Trimethylbenzene	***19.00***	11.79	**45.82**	NA	**32.49**	NA	9.51	13.47	NA	**31.55**
Vinyl chloride	***54.72***	**61.33**	NA	**61.33**	**61.33**	NA	NA	NA	NA	**28.28**
m,p-Xylene	*14.56*	11.93	**37.43**	**17.52**	13.60	**18.90**	4.92	**16.66**	**19.52**	**37.34**
o-Xylene	*14.10*	**19.34**	**38.59**	3.14	**15.13**	8.08	5.53	14.15	**15.56**	**32.47**
Average	***21.18***	***21.28***	***38.15***	***27.07***	***19.29***	***26.13***	***18.16***	***35.70***	***22.91***	***39.00***

Table 32-11. SNMOC Sampling and Analytical Precision: 64 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	64	11.31	0.25	7.99
Benzene	64	16.95	0.24	11.99
1,3-Butadiene	27	18.11	0.02	12.81
n-Butane	64	15.58	0.70	11.02
cis-2-Butene	51	**26.22**	0.05	**18.54**
trans-2-Butene	51	**30.35**	0.06	**21.46**
Cyclohexane	60	19.92	0.13	14.08
Cyclopentane	58	20.44	0.72	14.45
Cyclopentene	20	**49.09**	0.22	**34.71**
n-Decane	56	**34.01**	0.16	**24.05**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	35	**52.94**	0.30	**37.43**
p-Diethylbenzene	29	**49.82**	0.11	**35.23**
2,2-Dimethylbutane	62	17.98	0.08	12.71
2,3-Dimethylbutane	59	10.11	0.06	7.15
2,3-Dimethylpentane	61	**29.40**	0.17	**20.79**
2,4-Dimethylpentane	60	21.34	0.06	**15.09**
n-Dodecane	29	**41.74**	0.30	**29.51**
1-Dodecene	13	**47.13**	0.35	**33.32**
Ethane	63	20.41	1.72	14.43
Ethylbenzene	64	**27.23**	0.18	**19.25**
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	60	**25.67**	0.51	**18.15**
m-Ethyltoluene	61	22.28	0.10	**15.76**
o-Ethyltoluene	50	20.31	0.05	14.36
p-Ethyltoluene	59	**30.31**	0.09	**21.43**
n-Heptane	62	**27.56**	0.20	**19.49**
1-Heptene	43	**48.45**	0.09	**34.26**
n-Hexane	64	22.15	0.31	**15.66**
1-Hexene	54	**36.45**	0.09	**25.78**
cis-2-Hexene	1	**162.60**	2.00	**114.98**
trans-2-Hexene	5	**39.83**	0.11	**28.17**
Isobutane	64	11.10	0.33	7.85
Isobutene/1-Butene	61	**35.03**	0.39	**24.77**
Isopentane	61	19.62	2.13	13.88
Isoprene	56	21.92	0.15	**15.50**
Isopropylbenzene	30	**30.80**	0.04	**21.78**
2-Methyl-1-butene	52	19.58	0.11	13.85
2-Methyl-2-butene	50	**37.96**	0.09	**26.84**
3-Methyl-1-butene	1	**76.21**	0.20	**53.89**
Methylcyclohexane	63	**32.56**	0.24	**23.02**
Methylcyclopentane	64	18.21	0.12	13.02
2-Methylheptane	59	**26.30**	0.09	**18.59**
3-Methylheptane	52	24.28	0.06	**17.17**
2-Methylhexane	53	**41.87**	0.29	**29.61**
3-Methylhexane	63	**45.47**	0.69	**32.15**

Table 32-11. SNMOC Sampling and Analytical Precision: 64 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
3-Methylpentane	64	17.21	0.16	12.12
2-Methylpentane	62	**29.25**	0.84	**20.68**
4-Methyl-1-pentene	6	18.46	0.04	13.05
2-Methyl-1-pentene	11	**44.08**	0.09	**31.17**
n-Nonane	59	**28.49**	0.11	**20.14**
1-Nonene	42	**50.28**	0.21	**35.55**
n-Octane	62	**25.05**	0.12	**17.72**
1-Octene	28	**47.18**	0.10	**33.36**
n-Pentane	64	23.51	4.83	**16.62**
1-Pentene	59	**34.69**	0.12	**24.53**
cis-2-Pentene	44	**34.63**	0.05	**24.49**
trans-2-Pentene	57	20.36	0.05	14.39
a-Pinene	52	**42.94**	0.36	**30.36**
b-Pinene	6	**54.59**	0.34	**38.60**
Propane	64	8.92	0.57	6.31
n-Propylbenzene	48	**35.15**	0.08	**24.85**
Propylene	64	21.27	0.19	**15.04**
Propyne	0	NA	NA	NA
Styrene	38	**60.77**	0.68	**42.97**
TNMOC (Speciated)	64	15.85	15.47	11.21
TNMOC (w/unknowns)	64	**25.19**	48.09	**17.81**
Toluene	64	**25.48**	1.44	**18.02**
n-Tridecane	5	**68.06**	0.27	**48.13**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	51	**38.66**	0.11	**27.34**
1,2,4-Trimethylbenzene	63	**33.91**	0.37	**23.98**
1,3,5-Trimethylbenzene	53	**26.99**	0.07	**19.08**
2,2,3-Trimethylpentane	38	**47.66**	0.14	**33.70**
2,2,4-Trimethylpentane	64	21.11	0.14	14.48
2,3,4-Trimethylpentane	58	**27.38**	0.09	**19.36**
n-Undecane	40	**44.04**	0.25	**31.14**
1-Undecene	18	21.20	0.05	14.99
m-Xylene/*p*-Xylene	64	22.75	0.36	**16.09**
o-Xylene	62	24.93	0.19	**17.63**

Table 32-12 presents the sampling and analytical data precision for duplicate SNMOC samples. The variation ranges from 2.62 (propane) to 114.98 (*cis*-2-hexene), with a median CV of 15.09 percent.

Table 32-12. SNMOC Sampling and Analytical Precision: 52 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	52	10.18	0.26	7.20
Benzene	52	8.52	0.17	6.02
1,3-Butadiene	24	16.99	0.03	12.02
n-Butane	52	5.67	0.41	4.01
cis-2-Butene	43	18.78	0.04	13.28
trans-2-Butene	43	**28.81**	0.07	**20.37**
Cyclohexane	49	14.74	0.12	10.42
Cyclopentane	47	20.88	0.89	14.76
Cyclopentene	16	**51.09**	0.26	**36.13**
n-Decane	45	**28.20**	0.11	**19.94**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	26	**44.28**	0.18	**31.31**
p-Diethylbenzene	25	**39.38**	0.09	**27.85**
2,2-Dimethylbutane	51	16.50	0.09	11.67
2,3-Dimethylbutane	47	6.50	0.04	4.60
2,3-Dimethylpentane	50	23.90	0.13	**16.90**
2,4-Dimethylpentane	48	16.24	0.05	11.48
n-Dodecane	22	**37.28**	0.33	**26.36**
1-Dodecene	7	**47.24**	0.41	**33.41**
Ethane	51	17.70	0.69	12.52
Ethylbenzene	52	20.17	0.15	14.26
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	48	24.06	0.42	**17.02**
m-Ethyltoluene	50	15.45	0.08	10.93
o-Ethyltoluene	39	19.56	0.05	13.83
p-Ethyltoluene	48	**26.01**	0.07	**18.39**
n-Heptane	50	12.98	0.08	9.18
1-Heptene	37	**32.76**	0.07	**23.16**
n-Hexane	52	12.83	0.24	9.07
1-Hexene	47	**35.91**	0.09	**25.39**
cis-2-Hexene	1	**162.60**	2.00	**114.98**
trans-2-Hexene	4	22.84	0.11	**16.15**
Isobutane	52	6.83	0.35	4.83
Isobutene/1-Butene	50	22.72	0.31	**16.07**
Isopentane	50	13.49	2.05	9.54
Isoprene	47	16.64	0.11	11.77
Isopropylbenzene	27	**30.71**	0.04	**21.71**
2-Methyl-1-butene	42	15.80	0.12	11.17
2-Methyl-2-butene	44	**29.21**	0.07	**20.66**
3-Methyl-1-butene	1	**76.21**	0.20	**53.89**
Methylcyclohexane	51	24.08	0.15	**17.02**
Methylcyclopentane	52	10.92	0.09	7.90
2-Methylheptane	48	21.34	0.07	**15.09**
3-Methylheptane	42	23.81	0.07	**16.84**
2-Methylhexane	43	**29.39**	0.16	**20.78**
3-Methylhexane	51	**37.29**	0.60	**26.36**

Table 32-12. SNMOC Sampling and Analytical Precision: 52 Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
3-Methylpentane	52	13.25	0.13	9.31
2-Methylpentane	52	21.07	0.39	14.90
4-Methyl-1-pentene	6	18.46	0.04	13.05
2-Methyl-1-pentene	10	11.44	0.05	8.09
n-Nonane	48	**25.82**	0.09	**18.26**
1-Nonene	35	**44.69**	0.23	**31.60**
n-Octane	51	19.55	0.10	13.82
1-Octene	23	**48.55**	0.10	**34.33**
n-Pentane	52	19.47	5.83	13.77
1-Pentene	47	**30.47**	0.12	**21.54**
cis-2-Pentene	38	**27.01**	0.04	**19.10**
trans-2-Pentene	46	13.13	0.04	9.28
a-Pinene	43	**45.30**	0.41	**32.03**
b-Pinene	6	**54.59**	0.34	**38.60**
Propane	52	3.70	0.40	2.62
n-Propylbenzene	40	**32.56**	0.07	**23.02**
Propylene	52	16.64	0.15	11.76
Propyne	0	NA	NA	NA
Styrene	35	**50.64**	0.38	**35.81**
TNMOC (Speciated)	52	9.75	14.14	6.89
TNMOC (w/unknowns)	52	19.40	35.97	13.72
Toluene	52	15.54	1.51	10.99
n-Tridecane	4	**48.41**	0.28	**34.23**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	44	**30.12**	0.07	**21.30**
1,2,4-Trimethylbenzene	51	**29.92**	0.38	**21.15**
1,3,5-Trimethylbenzene	44	**25.42**	0.06	**17.98**
2,2,3-Trimethylpentane	29	**44.82**	0.13	**31.69**
2,2,4-Trimethylpentane	52	17.70	0.10	11.96
2,3,4-Trimethylpentane	46	19.29	0.06	13.64
n-Undecane	31	**39.83**	0.24	**28.17**
1-Undecene	14	19.65	0.04	13.90
m-Xylene/*p*-Xylene	52	16.01	0.26	11.32
o-Xylene	51	19.69	0.11	13.92

Tables 32-13 and 32-14 present the SNMOC sampling and analytical precision data for NATTS sites (BTUT and NBIL, respectively). Table 32-13 shows that the SNMOC variation for the duplicate samples at BTUT ranges from 1.46 percent (propane) to 59.72 percent (*n*-tridecane). The average CV is 14.04 percent, which is within the Program DQO. Table 32-14 shows the SNMOC precision data for the collocated samples at NBIL. All but two pollutants (acetylene and cyclopentane) in Table 32-14 are outside the Program DQO.

Table 32-13. SNMOC Sampling and Analytical Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	12	4.13	0.17	2.92
Benzene	12	5.97	0.14	4.22
1,3-Butadiene	7	10.28	0.01	7.27
n-Butane	12	2.89	0.48	2.04
cis-2-Butene	12	13.12	0.04	9.28
trans-2-Butene	12	**26.87**	0.08	**19.00**
Cyclohexane	12	5.43	0.04	3.84
Cyclopentane	12	5.12	0.02	3.62
Cyclopentene	3	10.09	0.02	7.14
n-Decane	12	11.63	0.03	8.23
1-Decene	0	NA	NA	NA
m-Diethylbenzene	6	**77.57**	0.28	**54.85**
p-Diethylbenzene	5	**38.36**	0.10	**27.12**
2,2-Dimethylbutane	12	21.09	0.11	14.91
2,3-Dimethylbutane	12	4.62	0.03	3.26
2,3-Dimethylpentane	12	15.80	0.18	11.17
2,4-Dimethylpentane	12	11.90	0.07	8.41
n-Dodecane	5	**46.02**	0.11	**32.54**
1-Dodecene	2	**55.28**	0.15	**39.09**
Ethane	12	3.24	0.18	2.29
Ethylbenzene	12	15.69	0.10	11.09
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	10	7.71	0.21	5.45
m-Ethyltoluene	12	21.46	0.13	**15.17**
o-Ethyltoluene	12	**26.85**	0.08	**18.99**
p-Ethyltoluene	12	**35.47**	0.12	**25.08**
n-Heptane	12	10.47	0.11	7.40
1-Heptene	11	20.15	0.06	14.25
n-Hexane	12	2.95	0.07	2.08
1-Hexene	12	16.09	0.04	11.38
cis-2-Hexene	0	NA	NA	NA
trans-2-Hexene	0	NA	NA	NA
Isobutane	12	2.10	0.23	1.49
Isobutene/1-Butene	12	6.90	0.09	4.88
Isopentane	12	13.72	2.15	9.70
Isoprene	11	13.99	0.04	9.89
Isopropylbenzene	6	18.39	0.03	13.00
2-Methyl-1-butene	12	20.84	0.13	14.73
2-Methyl-2-butene	12	18.60	0.06	13.15
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	12	4.65	0.07	3.29
Methylcyclopentane	12	8.49	0.12	6.73
2-Methylheptane	12	8.98	0.03	6.35
3-Methylheptane	12	15.26	0.05	10.79
2-Methylhexane	12	16.97	0.12	12.00
3-Methylhexane	12	21.92	0.45	**15.50**

Table 32-13. SNMOC Sampling and Analytical Precision: 12 Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
3-Methylpentane	12	8.38	0.11	5.68
2-Methylpentane	12	8.54	0.27	6.04
4-Methyl-1-pentene	2	**25.56**	0.05	**18.08**
2-Methyl-1-pentene	2	10.96	0.01	7.75
n-Nonane	12	16.14	0.05	11.41
1-Nonene	12	**27.37**	0.05	**19.35**
n-Octane	12	15.28	0.08	10.80
1-Octene	5	**69.00**	0.12	**48.79**
n-Pentane	12	8.28	0.47	5.85
1-Pentene	11	21.81	0.07	**15.42**
cis-2-Pentene	12	6.40	0.01	4.52
trans-2-Pentene	12	9.83	0.03	6.95
a-Pinene	9	**78.99**	0.53	**55.85**
b-Pinene	0	NA	NA	NA
Propane	12	2.07	0.30	1.46
n-Propylbenzene	12	**31.16**	0.07	**22.03**
Propylene	12	7.10	0.14	5.02
Propyne	0	NA	NA	NA
Styrene	8	**43.53**	0.17	**30.78**
TNMOC (Speciated)	12	2.81	2.57	1.99
TNMOC (w/unknowns)	12	6.48	10.00	4.58
Toluene	12	6.83	0.37	4.83
n-Tridecane	1	**84.46**	0.52	**59.72**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	12	**37.96**	0.09	**26.84**
1,2,4-Trimethylbenzene	12	**27.39**	0.23	**19.37**
1,3,5-Trimethylbenzene	12	**29.45**	0.09	**20.83**
2,2,3-Trimethylpentane	10	**37.70**	0.09	**26.66**
2,2,4-Trimethylpentane	12	11.97	0.10	6.22
2,3,4-Trimethylpentane	12	17.43	0.09	12.33
n-Undecane	8	**43.97**	0.11	**31.09**
1-Undecene	2	11.20	0.01	7.92
m-Xylene/*p*-Xylene	12	9.87	0.28	6.98
o-Xylene	12	13.35	0.12	9.44

Table 32-14. SNMOC Sampling and Analytical Precision: 12 Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	12	15.80	0.22	11.18
Benzene	12	**50.70**	0.49	**35.85**
1,3-Butadiene	3	22.57	0.02	**15.96**
n-Butane	12	**55.20**	1.85	**39.03**
cis-2-Butene	8	**55.99**	0.07	**39.59**

Table 32-14. SNMOC Sampling and Analytical Precision: 12 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
trans-2-Butene	8	**36.54**	0.04	**25.84**
Cyclohexane	11	**40.61**	0.15	**28.72**
Cyclopentane	11	18.68	0.04	13.21
Cyclopentene	4	**41.08**	0.06	**29.05**
n-Decane	11	**57.26**	0.36	**40.49**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	9	**87.56**	0.78	**61.91**
p-Diethylbenzene	4	**91.59**	0.21	**64.77**
2,2-Dimethylbutane	11	23.91	0.07	**16.91**
2,3-Dimethylbutane	12	24.54	0.14	**17.35**
2,3-Dimethylpentane	11	**51.38**	0.34	**36.33**
2,4-Dimethylpentane	12	**41.75**	0.11	**29.52**
n-Dodecane	7	**59.58**	0.18	**42.13**
1-Dodecene	6	**46.78**	0.19	**33.08**
Ethane	12	**31.23**	5.82	**22.08**
Ethylbenzene	12	**55.46**	0.31	**39.22**
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	12	**32.07**	0.89	**22.68**
m-Ethyltoluene	11	**49.61**	0.21	**35.08**
o-Ethyltoluene	11	23.33	0.06	**16.50**
p-Ethyltoluene	11	**47.52**	0.16	**33.60**
n-Heptane	12	**85.88**	0.68	**60.72**
1-Heptene	6	**111.19**	0.18	**78.62**
n-Hexane	12	**59.39**	0.58	**42.00**
1-Hexene	7	**38.63**	0.09	**27.32**
cis-2-Hexene	0	NA	NA	NA
trans-2-Hexene	1	**73.81**	0.12	**52.19**
Isobutane	12	**28.19**	0.24	**19.93**
Isobutene/1-Butene	11	**84.25**	0.70	**59.57**
Isopentane	11	**44.14**	2.45	**31.22**
Isoprene	9	**43.02**	0.28	**30.42**
Isopropylbenzene	3	**31.19**	0.05	**22.05**
2-Methyl-1-butene	10	**34.73**	0.06	**24.56**
2-Methyl-2-butene	6	**72.93**	0.16	**51.57**
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	12	**66.50**	0.60	**47.02**
Methylcyclopentane	12	**47.37**	0.22	**33.49**
2-Methylheptane	11	**46.12**	0.19	**32.61**
3-Methylheptane	10	**26.13**	0.05	**18.48**
2-Methylhexane	10	**91.82**	0.81	**64.93**
3-Methylhexane	12	**78.18**	1.07	**55.28**
3-Methylpentane	12	**33.05**	0.28	**23.37**
2-Methylpentane	10	**61.96**	2.61	**43.81**
4-Methyl-1-pentene	0	NA	NA	NA
2-Methyl-1-pentene	1	**142.01**	0.19	**100.41**
n-Nonane	11	**39.16**	0.21	**27.69**

Table 32-14. SNMOC Sampling and Analytical Precision: 12 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
1-Nonene	7	**72.63**	0.16	**51.36**
n-Octane	11	**47.07**	0.18	**33.28**
1-Octene	5	**41.67**	0.06	**29.46**
n-Pentane	12	**39.65**	0.86	**28.04**
1-Pentene	12	**51.59**	0.12	**36.48**
cis-2-Pentene	6	**65.12**	0.09	**46.04**
trans-2-Pentene	11	**49.28**	0.08	**34.84**
a-Pinene	9	**33.49**	0.18	**23.68**
b-Pinene	0	NA	NA	NA
Propane	12	**29.81**	1.26	**21.08**
n-Propylbenzene	8	**45.52**	0.12	**32.18**
Propylene	12	**39.82**	0.35	**28.16**
Propyne	0	NA	NA	NA
Styrene	3	**101.26**	1.87	**71.60**
TNMOC (Speciated)	12	**40.28**	20.82	**28.48**
TNMOC (w/unknowns)	12	**48.34**	96.55	**34.18**
Toluene	12	**65.24**	1.19	**46.13**
n-Tridecane	1	**107.36**	0.25	**75.91**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	7	**72.83**	0.26	**51.50**
1,2,4-Trimethylbenzene	12	**49.91**	0.32	**35.29**
1,3,5-Trimethylbenzene	9	**33.24**	0.08	**23.50**
2,2,3-Trimethylpentane	9	**59.01**	0.15	**41.72**
2,2,4-Trimethylpentane	12	**34.75**	0.33	**24.57**
2,3,4-Trimethylpentane	12	**59.74**	0.21	**42.24**
n-Undecane	9	**60.88**	0.31	**43.05**
1-Undecene	4	**25.83**	0.07	**18.27**
m-Xylene/*p*-Xylene	12	**49.71**	0.77	**35.15**
o-Xylene	11	**45.92**	0.48	**32.47**

Table 32-15 presents the average CV per pollutant, per pollutant per site, per site, and the overall CV. The results from duplicate and collocated samples show low- to high-level variability among sites, ranging from an average CV of 14 percent at BTUT to 37.03 percent at NBIL, with an average of 21.49 percent. This overall average exceeds the 15 percent CV Program DQO.

Table 32-15. SNMOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Northbrook, IL (NBIL)	Sioux Falls, SD (SFSD)
Acetylene	*7.99*	2.92	4.17	5.47	11.18	**16.24**
Benzene	*11.99*	4.22	3.46	12.42	**35.85**	4.00
1,3-Butadiene	*12.81*	7.27	9.77	**20.88**	**15.96**	10.14
n-Butane	*11.02*	2.04	4.55	5.56	**39.03**	3.90
cis-2-Butene	***18.54***	9.28	7.14	**15.55**	**39.59**	**21.15**
trans-2-Butene	***21.46***	**19.00**	**17.78**	**34.15**	**25.84**	10.54
Cyclohexane	*14.08*	3.84	8.52	**20.70**	**28.72**	8.63
Cyclopentane	*14.45*	3.62	13.28	**27.34**	13.21	14.80
Cyclopentene	***34.71***	7.14	**25.39**	**80.85**	**29.05**	**31.14**
n-Decane	***24.05***	8.23	13.80	**30.50**	**40.49**	**27.25**
1-Decene	*NA*	NA	NA	NA	NA	NA
m-Diethylbenzene	***37.43***	**54.85**	**18.40**	**29.85**	**61.91**	**22.13**
p-Diethylbenzene	***35.23***	**27.12**	**33.13**	**38.42**	**64.77**	12.71
2,2-Dimethylbutane	*12.71*	14.91	3.13	**18.59**	**16.91**	10.03
2,3-Dimethylbutane	*7.15*	3.26	6.59	6.10	**17.35**	2.43
2,3-Dimethylpentane	***20.79***	11.17	**17.18**	**27.57**	**36.33**	11.70
2,4-Dimethylpentane	***15.09***	8.41	5.47	**20.79**	**29.52**	11.25
n-Dodecane	***29.51***	**32.54**	**27.73**	11.14	**42.13**	**34.03**
1-Dodecene	***33.32***	**39.09**	**50.18**	10.94	**33.08**	NA
Ethane	*14.43*	2.29	**19.99**	1.96	**22.08**	**25.82**
Ethylbenzene	***19.25***	11.09	**22.82**	10.22	**39.22**	12.91
2-Ethyl-1-butene	*NA*	NA	NA	NA	NA	NA
Ethylene	***18.15***	5.45	**26.32**	7.51	**22.68**	**28.79**
m-Ethyltoluene	***15.76***	**15.17**	6.45	12.02	**35.08**	10.06
o-Ethyltoluene	*14.36*	**18.99**	4.16	**20.42**	**16.50**	11.75
p-Ethyltoluene	***21.43***	**25.08**	12.93	**16.53**	**33.60**	**19.03**
n-Heptane	***19.49***	7.40	11.45	6.40	**60.72**	11.44
1-Heptene	***34.26***	14.25	**26.60**	**28.92**	**78.62**	**22.89**
n-Hexane	***15.66***	2.08	6.87	9.75	**42.00**	**17.60**
1-Hexene	***25.78***	11.38	**21.39**	**34.83**	**27.32**	**33.97**
cis-2-Hexene	***114.98***	NA	**114.98**	NA	NA	NA
trans-2-Hexene	***28.17***	NA	4.31	**27.99**	**52.19**	NA
Isobutane	*7.85*	1.49	2.26	8.76	**19.93**	6.82
Isobutene/1-Butene	***24.77***	4.88	15.00	8.55	**59.57**	**35.84**
Isopentane	*13.88*	9.70	13.14	5.39	**31.22**	9.94
Isoprene	***15.50***	9.89	5.75	13.01	**30.42**	**18.42**
Isopropylbenzene	***21.78***	13.00	7.79	**43.96**	**22.05**	**22.10**
2-Methyl-1-butene	*13.85*	14.73	9.35	8.82	**24.56**	11.77
2-Methyl-2-butene	***26.84***	13.15	**35.48**	**21.57**	**51.57**	12.41
3-Methyl-1-butene	***53.89***	NA	NA	NA	NA	**53.89**
Methylcyclohexane	***23.02***	3.29	**19.95**	**21.40**	**47.02**	**23.45**

Table 32-15. SNMOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Northbrook, IL (NBIL)	Sioux Falls, SD (SFSD)
Methylcyclopentane	*13.02*	6.73	12.29	6.87	**33.49**	5.71
2-Methylheptane	***18.59***	6.35	**16.88**	**17.99**	**32.61**	**19.14**
3-Methylheptane	***17.17***	10.79	12.01	13.96	**18.48**	**30.60**
2-Methylhexane	***29.61***	12.00	14.42	**26.02**	**64.93**	**30.67**
3-Methylhexane	***32.15***	**15.50**	**15.78**	**44.20**	**55.28**	**29.98**
3-Methylpentane	*12.12*	5.68	9.87	14.09	**23.37**	7.57
2-Methylpentane	***20.68***	6.04	**23.60**	**19.99**	**43.81**	9.96
4-Methyl-1-pentene	*13.05*	**18.08**	13.24	7.84	NA	NA
2-Methyl-1-pentene	***31.17***	7.75	7.67	8.84	**100.41**	NA
n-Nonane	***20.14***	11.41	10.23	**18.29**	**27.69**	**33.09**
1-Nonene	***35.55***	**19.35**	**28.27**	**57.55**	**51.36**	**21.23**
n-Octane	***17.72***	10.80	5.81	13.76	**33.28**	**24.92**
1-Octene	***33.36***	**48.79**	**27.89**	**44.52**	**29.46**	**16.13**
n-Pentane	***16.62***	5.85	12.51	9.65	**28.04**	**27.06**
1-Pentene	***24.53***	**15.42**	**25.63**	**28.34**	**36.48**	**16.78**
cis-2-Pentene	***24.49***	4.52	**22.79**	**33.83**	**46.04**	**15.26**
trans-2-Pentene	*14.39*	6.95	7.24	**18.50**	**34.84**	4.43
a-Pinene	***30.36***	**55.85**	**22.01**	10.32	**23.68**	**39.93**
b-Pinene	***38.60***	NA	2.14	**56.63**	NA	**57.02**
Propane	*6.31*	1.46	4.79	2.82	**21.08**	1.40
n-Propylbenzene	***24.85***	**22.03**	7.11	**42.21**	**32.18**	**20.73**
Propylene	***15.04***	5.02	11.92	12.61	**28.16**	**17.51**
Propyne	*NA*	NA	NA	NA	NA	NA
Styrene	***42.97***	**30.78**	**17.27**	13.74	**71.60**	**81.45**
TNMOC (Speciated)	*11.21*	1.99	6.95	7.28	**28.48**	11.35
TNMOC (w/unknowns)	***17.81***	4.58	10.15	14.18	**34.18**	**25.96**
Toluene	***18.02***	4.83	5.49	10.41	**46.13**	**23.24**
n-Tridecane	***48.13***	**59.72**	8.74	NA	**75.91**	NA
1-Tridecene	*NA*	NA	NA	NA	NA	NA
1,2,3-Trimethylbenzene	***27.34***	**26.84**	12.59	**26.43**	**51.50**	**19.32**
1,2,4-Trimethylbenzene	***23.98***	**19.37**	10.53	**22.63**	**35.29**	**32.09**
1,3,5-Trimethylbenzene	***19.08***	**20.83**	**19.97**	**16.63**	**23.50**	**14.48**
2,2,3-Trimethylpentane	***33.70***	**26.66**	**34.16**	**33.07**	**41.72**	**32.88**
2,2,4-Trimethylpentane	*14.48*	6.22	10.58	14.28	**24.57**	**16.74**
2,3,4-Trimethylpentane	***19.36***	12.33	10.13	12.68	**42.24**	**19.43**
n-Undecane	***31.14***	**31.09**	8.14	**39.69**	**43.05**	**33.75**
1-Undecene	*14.99*	7.92	**21.16**	NAN	**18.27**	12.61
m-Xylene/*p*-Xylene	***16.09***	6.98	8.11	8.93	**35.15**	**21.26**
o-Xylene	***17.63***	9.44	11.42	**20.84**	**32.47**	13.99
Average	***21.49***	*14.00*	***15.55***	***20.48***	***37.03***	***20.41***

32.1.3 Carbonyl Compounds Sampling and Analytical Precision

Table 32-16, presents the sampling and analytical data for duplicate and collocated carbonyl samples. The average concentration difference ranged from 0.005 ppbv for isovaleraldehyde to 0.33 ppbv for formaldehyde.

Table 32-16. Carbonyl Sampling and Analytical Precision: 316 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	316	12.41	0.12	8.77
Acetone	316	16.08	0.10	11.37
Benzaldehyde	313	16.29	0.01	11.52
Butyraldehyde	313	11.95	0.01	8.45
Crotonaldehyde	300	12.67	0.01	8.96
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	315	11.71	0.33	8.28
Hexaldehyde	307	16.20	0.01	11.46
Isovaleraldehyde	133	**27.47**	0.005	**19.43**
Propionaldehyde	314	11.33	0.01	8.01
Tolualdehydes	302	24.84	0.01	**17.56**
Valeraldehyde	306	14.82	0.01	10.48

The carbonyl sampling and analytical data for the 82 collocated samples are presented in Table 32-17. The CV for carbonyl compounds range from 8.54 percent (isovaleraldehyde) to 20.14 percent (benzaldehyde).

Table 32-17. Carbonyl Sampling and Analytical Precision: 82 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	82	22.27	0.15	**15.75**
Acetone	82	**25.15**	0.15	**17.79**
Benzaldehyde	79	**28.49**	0.01	**20.14**
Butyraldehyde	79	19.27	0.01	13.62
Crotonaldehyde	74	19.56	0.01	13.83
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 32-17. Carbonyl Sampling and Analytical Precision: 82 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Formaldehyde	82	23.36	0.40	**16.52**
Hexaldehyde	79	21.73	0.01	**15.37**
Isovaleraldehyde	33	12.07	0.01	8.54
Propionaldehyde	80	18.40	0.01	13.01
Tolualdehydes	78	24.82	0.01	**17.55**
Valeraldehyde	78	17.74	0.01	12.55

Table 32-18 presents results from carbonyl duplicate sample analysis. The data show a low- to mid-level variability, ranging from 5.81 percent (formaldehyde) to 21.85 percent (isovaleraldehyde), with an average of 10.12 percent.

Table 32-18. Carbonyl Sampling and Analytical Precision: 234 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	234	9.45	0.11	6.68
Acetone	234	13.35	0.09	9.45
Benzaldehyde	234	12.63	0.01	8.93
Butyraldehyde	234	9.76	0.01	6.90
Crotonaldehyde	226	10.60	0.01	7.50
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	233	8.21	0.31	5.81
Hexaldehyde	228	14.54	0.01	10.28
Isovaleraldehyde	100	**30.90**	0.004	**21.85**
Propionaldehyde	234	9.21	0.01	6.51
Tolualdehydes	224	24.84	0.01	**17.57**
Valeraldehyde	228	13.94	0.01	9.86

Tables 32-19 through 32-25 present results from carbonyl precision data for the NATTS sites (BTUT, DEMI, GPCO, NBIL, S4MO, SKFL, and SYFL, respectively). Table 32-19 shows that the carbonyl compound variation for the duplicate samples at BTUT ranges from 2.35 percent (acetaldehyde) to 43.52 percent (tolualdehydes), with an average of 12.69 percent.

Table 32-19. Carbonyl Sampling and Analytical Precision: 12 Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	12	3.33	0.05	2.35
Acetone	12	9.21	0.13	6.51
Benzaldehyde	12	12.56	0.004	8.88
Butyraldehyde	12	5.59	0.01	3.95
Crotonaldehyde	10	11.23	0.005	7.94
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	5.23	0.14	3.70
Hexaldehyde	12	19.44	0.01	13.75
Isovaleraldehyde	7	**54.56**	0.01	**38.58**
Propionaldehyde	12	3.74	0.005	2.65
Tolualdehydes	11	**61.55**	0.03	**43.52**
Valeraldehyde	12	10.97	0.01	7.76

Table 32-20 shows the carbonyl results for the collocated samples at DEMI. The average concentration difference between collocated samples ranged from 0.003 ppbv (isovaleraldehyde) to 0.31 ppbv (formaldehyde), and the average variability was 9.61 percent.

Table 32-20. Carbonyl Sampling and Analytical Precision: 8 Collocated Samples for Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	8	9.01	0.08	6.37
Acetone	8	8.13	0.05	5.75
Benzaldehyde	8	24.09	0.01	**17.03**
Butyraldehyde	8	7.38	0.01	5.21
Crotonaldehyde	6	9.32	0.01	6.59
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	8	10.84	0.31	7.67
Hexaldehyde	8	12.04	0.005	8.51
Isovaleraldehyde	6	20.26	0.003	14.33
Propionaldehyde	8	8.99	0.01	6.36
Tolualdehydes	8	23.25	0.01	**16.44**
Valeraldehyde	8	11.67	0.004	8.25

Table 32-21 shows the carbonyl results for the duplicate samples at GPCO. The duplicate variability ranges from 1.32 percent (formaldehyde) to 18.86 percent (isovaleraldehyde). The average variability is 5.90 percent, which is within the Program DQO.

Table 32-21. Carbonyl Sampling and Analytical Precision: 10 Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	10	2.64	0.03	1.87
Acetone	10	3.34	0.05	2.36
Benzaldehyde	10	10.57	0.01	7.48
Butyraldehyde	10	3.95	0.004	2.79
Crotonaldehyde	10	7.02	0.01	4.96
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	10	1.87	0.06	1.32
Hexaldehyde	10	12.89	0.003	9.12
Isovaleraldehyde	6	**26.67**	0.004	**18.86**
Propionaldehyde	10	5.14	0.004	3.63
Tolualdehydes	10	9.59	0.004	6.78
Valeraldehyde	10	2.38	0.001	1.68

Table 32-22 presents the carbonyl sampling and analytical precision data for collocated samples at NBIL. The variability ranges from 29.94 percent for propionaldehyde to 66.96 percent for formaldehyde, with an average CV of 40.68 percent. All pollutants have RPD and CV outside the Program DQO.

Table 32-22. Carbonyl Sampling and Analytical Precision: 16 Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	16	**44.97**	0.38	**31.80**
Acetone	16	**72.38**	0.56	**51.18**
Benzaldehyde	16	**76.62**	0.03	**54.18**
Butyraldehyde	16	**47.41**	0.03	**33.52**
Crotonaldehyde	16	**50.04**	0.02	**35.39**
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	16	**94.70**	1.24	**66.96**
Hexaldehyde	16	**47.61**	0.02	**33.66**
Isovaleraldehyde	2	NA	NA	NA

Table 32-22. Carbonyl Sampling and Analytical Precision: 16 Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	16	**42.34**	0.04	**29.94**
Tolualdehydes	16	**55.40**	0.02	**39.17**
Valeraldehyde	16	**43.89**	0.01	**31.04**

Table 32-23 shows the carbonyl results for duplicate samples at S4MO. All compounds show a variability well within the DQO of 15 percent, with an overall average CV of 5.75 percent.

Table 32-23. Carbonyl Sampling and Analytical Precision: 14 Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	14	1.93	0.03	1.36
Acetone	14	6.16	0.06	4.35
Benzaldehyde	14	14.97	0.01	10.59
Butyraldehyde	14	5.87	0.002	4.15
Crotonaldehyde	12	3.70	0.002	2.62
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	14	4.54	0.06	3.21
Hexaldehyde	14	8.54	0.002	6.04
Isovaleraldehyde	8	15.27	0.003	10.80
Propionaldehyde	14	11.54	0.004	8.16
Tolualdehydes	14	6.86	0.003	4.85
Valeraldehyde	14	10.14	0.003	7.17

Table 32-24 presents the carbonyl results for duplicate samples at SKFL. Two compounds (isovaleraldehyde and tolualdehydes) are outside the specifications for RPD and CV, with the overall average falling within the specifications. The average RPD is 14.83 percent and the average CV is 10.49 percent.

Table 32-24. Carbonyl Sampling and Analytical Precision: 12 Duplicate Samples for Tampa, FL (SKFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	12	6.05	0.04	4.28
Acetone	12	5.25	0.04	3.71
Benzaldehyde	12	16.69	0.01	11.80
Butyraldehyde	12	12.64	0.01	8.94
Crotonaldehyde	12	11.67	0.01	8.25
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	12	5.47	0.12	3.86
Hexaldehyde	12	13.52	0.003	9.56
Isovaleraldehyde	4	**30.00**	0.01	**21.21**
Propionaldehyde	12	10.78	0.01	7.63
Tolualdehydes	11	**45.92**	0.01	**32.47**
Valeraldehyde	12	5.15	0.001	3.64

Table 32-25 shows carbonyl sampling and analytical precision data for duplicate samples at SYFL. Only one compound (tolualdehydes) is outside the Program DQO for RPD and CV. The average RPD is 12.35 percent and the average CV is 8.74 percent.

Table 32-25. Carbonyl Sampling and Analytical Precision: 14 Duplicate Samples for Tampa, FL (SYFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	14	15.19	0.08	10.74
Acetone	14	6.42	0.02	4.54
Benzaldehyde	14	14.18	0.004	10.03
Butyraldehyde	14	14.54	0.01	10.28
Crotonaldehyde	14	10.51	0.01	7.43
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	14	14.43	0.23	10.21
Hexaldehyde	14	11.20	0.004	7.92
Isovaleraldehyde	6	6.39	0.001	4.52
Propionaldehyde	14	11.43	0.01	8.08
Tolualdehydes	14	**25.42**	0.01	**17.98**
Valeraldehyde	14	6.19	0.002	4.38

Table 32-26 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV. The duplicate and collocated sample results show low- to high-level variability among the sites, ranging from an average CV of 3.80 percent at LDTN to 40.68 percent at NBIL, with an overall average of 11.30 percent. This is within the 15 percent CV Program DQO.

Table 32-26. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site

Pollutant	Average	St. Petersburg, FL (AZFL)	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)
Acetaldehyde	*8.77*	5.83	4.41	2.35	2.65	8.64	7.38	6.37
Acetone	*11.37*	10.49	9.46	6.51	6.22	**15.47**	2.92	5.75
Benzaldehyde	*11.52*	6.46	6.57	8.88	5.69	7.81	13.46	**17.03**
Butyraldehyde	*8.45*	6.50	3.10	3.95	6.65	4.57	6.99	5.21
Crotonaldehyde	*8.96*	6.53	11.28	7.94	3.94	11.78	5.60	6.59
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*8.28*	1.73	4.87	3.70	4.30	11.38	8.53	7.67
Hexaldehyde	*11.46*	9.83	7.97	13.75	7.92	5.20	5.54	8.51
Isovaleraldehyde	***19.43***	**37.71**	NA	**38.58**	**23.01**	**22.32**	**46.06**	14.33
Propionaldehyde	*8.01*	2.27	10.20	2.65	4.33	5.99	6.04	6.36
Tolualdehydes	***17.56***	12.91	**19.24**	**43.52**	**16.28**	**19.26**	**21.60**	**16.44**
Valeraldehyde	*10.48*	**19.11**	**21.28**	7.76	6.05	7.27	8.62	8.25
Average	*11.30*	*10.85*	*9.84*	*12.69*	*7.91*	*10.88*	*12.07*	*9.32*

Pollutant	Average	Elizabeth, NJ (ELNJ)	Davie, FL (FLFL)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)	Nashville, TN (MSTN)
Acetaldehyde	*8.77*	1.09	**27.27**	**17.62**	1.87	2.29	0.85	1.40
Acetone	*11.37*	3.90	**27.60**	12.99	2.36	7.96	1.60	2.46
Benzaldehyde	*11.52*	6.19	**17.25**	14.13	7.48	9.55	8.88	7.38
Butyraldehyde	*8.45*	1.87	14.69	**15.32**	2.79	10.23	2.99	2.76
Crotonaldehyde	*8.96*	3.17	12.60	11.59	4.96	10.64	3.72	3.50
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*8.28*	2.19	1.79	**17.53**	1.32	3.54	1.67	1.00
Hexaldehyde	*11.46*	9.91	**18.55**	**17.58**	9.12	9.21	6.61	4.19
Isovaleraldehyde	***19.43***	**22.45**	**32.27**	**20.80**	**18.86**	6.84	2.16	3.15
Propionaldehyde	*8.01*	5.17	11.26	**15.06**	3.63	4.81	1.31	2.51
Tolualdehydes	***17.56***	11.23	**31.96**	14.05	6.78	10.19	9.57	4.44
Valeraldehyde	*10.48*	4.59	**18.03**	**15.40**	1.68	9.56	2.46	5.55
Average	*11.30*	*6.52*	***19.39***	***15.64***	*5.53*	*7.71*	*3.80*	*3.49*

Table 32-26. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Orlando, FL (ORFL)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)
Acetaldehyde	*8.77*	**31.80**	4.08	5.78	1.36	3.56	11.75
Acetone	*11.37*	**51.18**	8.25	14.43	4.35	12.36	6.94
Benzaldehyde	*11.52*	**54.18**	0.37	7.30	10.59	7.76	9.07
Butyraldehyde	*8.45*	**33.52**	3.83	2.28	4.15	7.26	6.03
Crotonaldehyde	*8.96*	**35.39**	9.74	8.34	2.62	7.15	3.82
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*8.28*	**66.96**	2.59	3.33	3.21	6.83	7.61
Hexaldehyde	*11.46*	**33.66**	6.05	5.64	6.04	12.28	**22.47**
Isovaleraldehyde	***19.43***	NA	**37.22**	**22.69**	10.80	11.73	8.75
Propionaldehyde	*8.01*	**29.94**	5.08	2.24	8.16	7.48	2.68
Tolualdehydes	***17.56***	**39.17**	**22.53**	9.76	4.85	14.00	**15.28**
Valeraldehyde	*10.48*	**31.04**	8.74	8.24	7.17	**15.35**	6.37
Average	*11.30*	***40.68***	*9.86*	*8.18*	*5.75*	*9.61*	*9.16*

Pollutant	Average	Tampa, FL (SKFL)	Tampa, FL (SMFL)	Schiller Park, IL (SPIL)	Tampa, FL (SYFL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Acetaldehyde	*8.77*	4.28	9.49	**38.40**	10.74	1.21	**15.66**
Acetone	*11.37*	3.71	6.91	**34.91**	4.54	**21.67**	10.81
Benzaldehyde	*11.52*	11.80	6.03	8.78	10.03	12.26	**24.62**
Butyraldehyde	*8.45*	8.94	11.54	14.54	10.28	7.07	**22.71**
Crotonaldehyde	*8.96*	8.25	8.35	**27.18**	7.43	4.24	6.61
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*8.28*	3.86	11.66	8.49	10.21	5.96	13.32
Hexaldehyde	*11.46*	9.56	6.90	**19.35**	7.92	14.25	**19.87**
Isovaleraldehyde	***19.43***	**21.21**	7.42	NA	4.52	NA	14.50
Propionaldehyde	*8.01*	7.63	13.18	**19.17**	8.08	4.25	**18.78**
Tolualdehydes	***17.56***	**32.47**	11.33	**24.40**	**17.98**	**16.13**	11.26
Valeraldehyde	*10.48*	3.64	12.16	13.10	4.38	11.76	14.88
Average	*11.30*	*10.49*	*9.54*	***20.83***	*8.74*	*9.88*	***15.73***

32.1.4 Metals Sampling and Analytical Precision

The sampling and analytical variation for all collocated PM_{10} metals samples are presented in Table 32-27. The average CV values, as well as the average RPD values, show low to high-level variability among the sites, with average CVs ranging from 4.76 percent for arsenic to 49.65 percent for mercury, with an overall average at 12.67 percent.

Table 32-27. PM_{10} Metal Sampling and Analytical Precision: 84 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	84	7.15	0.07	5.06
Arsenic	84	6.74	0.05	4.76
Beryllium	84	**30.75**	0.003	**21.74**
Cadmium	84	18.86	0.06	13.34
Chromium	84	9.70	0.20	6.86
Cobalt	84	15.17	0.03	10.73
Lead	84	7.82	0.60	5.53
Manganese	84	7.56	0.52	5.35
Mercury	70	**70.21**	0.04	**49.65**
Nickel	84	15.03	0.16	10.63
Selenium	84	8.07	0.05	5.70

Tables 32-28 through 32-30 present the results from collocated PM_{10} metals at the NATTS sites (BOMA, BTUT, and S4MO, respectively). Variability ranged from 1.26 percent for nickel at BOMA to 55.97 percent for mercury at S4MO.

Table 32-28. PM_{10} Metal Sampling and Analytical Precision: 54 Collocated Samples at Boston, MA (BOMA)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	54	11.97	0.12	8.46
Arsenic	54	9.90	0.06	7.00
Beryllium	54	**48.30**	0.002	**34.15**
Cadmium	54	**36.80**	0.10	**26.02**
Chromium	54	13.64	0.26	9.64
Cobalt	54	11.23	0.02	7.94
Lead	54	12.49	0.50	8.83
Manganese	54	11.39	0.35	8.05
Mercury	49	**61.27**	0.02	**43.33**
Nickel	54	11.66	0.22	8.25
Selenium	54	11.20	0.05	7.92

Table 32-29. PM_{10} Metal Sampling and Analytical Precision: 4 Collocated Samples at Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	4	4.41	0.04	3.12
Arsenic	4	5.28	0.05	3.73
Beryllium	4	**25.26**	0.01	**17.86**
Cadmium	4	9.52	0.01	6.73
Chromium	4	5.97	0.15	4.22
Cobalt	4	10.48	0.02	7.41
Lead	4	3.66	0.22	2.59
Manganese	4	5.05	0.52	3.57
Mercury	0	NA	NA	NA
Nickel	4	1.78	0.02	1.26
Selenium	4	6.59	0.05	4.66

Table 32-30. PM_{10} Metal Sampling and Analytical Precision: 26 Collocated Samples at St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	26	5.08	0.06	3.59
Arsenic	26	5.04	0.04	3.56
Beryllium	26	18.69	<0.001	13.21
Cadmium	26	10.25	0.08	7.25
Chromium	26	9.49	0.20	6.71
Cobalt	26	23.79	0.04	**16.82**
Lead	26	7.32	1.08	5.18
Manganese	26	6.25	0.69	4.42
Mercury	21	**79.15**	0.06	**55.97**
Nickel	26	**31.65**	0.25	**22.38**
Selenium	26	6.41	0.06	4.53

Table 32-31 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV. The results from collocated samples show low to high level variability among sites, ranging from 5.52 percent at BTUT to 15.42 percent at BOMA, with an overall average of 11.33 percent.

Table 32-31. Metals Sampling and Analytical Precision: Coefficient of Variation for all Collocated Samples by Site

Pollutant	Average	Boston, MA (BOMA)	Bountiful, UT (BTUT)	St. Louis, MO (S4MO)
Antimony	*5.06*	8.46	3.12	3.59
Arsenic	*4.76*	7.00	3.73	3.56
Beryllium	***21.74***	**34.15**	**17.86**	13.21
Cadmium	*13.34*	26.02	6.73	7.25
Chromium	*6.86*	9.64	4.22	6.71
Cobalt	*10.73*	7.94	7.41	**16.82**
Lead	*5.53*	8.83	2.59	5.18
Manganese	*5.35*	8.05	3.57	4.42
Mercury	***49.65***	**43.33**	NA	**55.97**
Nickel	*10.63*	8.25	1.26	**22.38**
Selenium	*5.70*	7.92	4.66	4.53
Average	*11.33*	***15.42***	*5.52*	*13.06*

32.1.5 Hexavalent Chromium Sampling and Analytical Precision

The hexavalent chromium sampling and analytical precision data is shown in Table 32-32. The average concentration differences observed for collocated analyses of hexavalent chromium ranged from <0.001 ng/m^3 at CHSC and UNVT to 0.013 ng/m^3 at BOMA. The average RPD was lower than the Program DQO specified 25 percent, with an overall average RPD of 8.0 percent. The RPD ranged from 0.70 percent at UNVT to 21.21 percent at PRRI. The CV ranged from 0.50 percent at UNVT to 18.40 percent at PRRI, with an overall average of 10.30 percent, which is within the 15 percent Program DQO.

Table 32-32. Hexavalent Chromium Sampling and Analytical Precision: Collocated Samples

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
BTUT	98	5.96	0.009	**17.35**
BOMA	12	6.51	0.013	**16.70**
CHSC	12*	2.42	<0.001	1.70
DEMI	40	4.99	0.010	14.50
GPCO	12	12.36	0.004	14.80
HAKY	12*	11.41	0.003	**15.10**
MVWI	12*	8.38	0.002	5.90
NBIL	42	2.49	0.006	10.30
PRRI	12*	21.21	0.003	**18.40**
PXSS	12	2.21	0.004	2.90
S4MO	12	7.46	0.006	13.60
SDGA	38	7.65	0.005	11.40
SYFL	14*	17.17	0.002	5.10
UNVT	12*	0.70	<0.001	0.50
WADC	12*	9.72	0.002	6.90
Average	*33*	*8.00*	*0.005*	*10.30*

* Over half of the measured detections were under the detection limit.

32.2 Analytical Precision

Analytical precision is a measurement of random errors associated with the process of analyzing environmental samples. These errors may result from various factors, but typically originate from random "noise" inherent to analytical instruments. Laboratories can easily evaluate analytical precision by comparing concentrations measured during replicate analysis of ambient air samples. The number of observations from Tables 32-29 through 32-47, in comparison to the respective tables listed for duplicate analyses in Tables 32-2 through 32-19, is approximately twice as high because each sample produces a replicate for each duplicate (or collocated) sample. Overall, the replicate analyses of both duplicate and collocated samples of VOC, SNMOC, carbonyl compounds, and hexavalent chromium suggest the analytical precision level is within the Program DQOs.

Collocated samples were collected for metals, which provide sampling and analytical precision. However, replicate analyses were not performed for metals. Therefore, metals analytical precision will not be discussed in this section.

32.2.1 VOC Analytical Precision

In Table 32-33, the replicate analyses of all duplicate and collocated samples show that for most of the pollutants, the VOC analysis precision was within the Program DQO of 15 percent for CV. The precision of the VOC analytical method, in terms of average concentration difference, ranges from 0.001 ppbv for several compounds to 1.32 ppbv for acetonitrile. In terms of CV, the overall average variability is 18.65 percent and the median CV is 9.11 percent. The low median CV shows that most of the pollutant variabilities are low. The relatively high average variability is likely due to the substitution of non-detects with 1/2 the MDL.

Table 32-33. VOC Analytical Precision:
476 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	347	11.07	1.32	7.39
Acetylene	468	7.49	0.06	5.30
Acrolein	376	10.93	0.03	7.73
Acrylonitrile	22	**36.76**	0.004	**25.99**
tert-Amyl Methyl Ether	0	22.22	0.001	**15.71**
Benzene	476	7.58	0.02	5.36
Bromochloromethane	0	3.51	0.001	2.48
Bromodichloromethane	18	23.64	0.002	**16.71**
Bromoform	0	NA	NA	NA
Bromomethane	397	12.62	0.002	9.09
1,3-Butadiene	396	11.24	0.005	7.57
Carbon disulfide	414	6.93	0.07	4.79
Carbon Tetrachloride	476	6.87	0.01	4.86
Chlorobenzene	30	**29.34**	0.001	**20.75**
Chloroethane	288	14.51	0.002	10.26
Chloroform	343	17.27	0.004	11.90
Chloromethane	476	5.41	0.03	3.83
Chloromethylbenzene	2	8.70	0.001	6.15
Chloroprene	2	**33.72**	0.001	**23.84**
Dibromochloromethane	18	**38.10**	0.001	**26.94**
1,2-Dibromoethane	2	NA	NA	NA
m-Dichlorobenzene	7	**98.99**	0.01	**70.00**
o-Dichlorobenzene	7	**120.38**	0.001	**85.12**

Table 32-33. VOC Analytical Precision:
476 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
p-Dichlorobenzene	344	14.25	0.003	10.07
Dichlorodifluoromethane	476	4.64	0.02	3.28
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	13	**34.10**	0.002	**18.05**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	5	**160.38**	0.01	**113.41**
trans-1,2-Dichloroethylene	10	**31.23**	0.003	**22.08**
Dichloromethane	459	9.38	0.07	6.63
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	1	**73.22**	0.001	**51.78**
Dichlorotetrafluoroethane	475	12.88	0.002	9.11
Ethyl Acrylate	1	**55.18**	0.001	**39.02**
Ethyl *tert*-Butyl Ether	11	**38.90**	0.003	**27.51**
Ethylbenzene	475	8.58	0.01	5.80
Hexachloro-1,3-butadiene	30	**51.02**	0.002	**36.08**
Methyl Ethyl Ketone	451	12.42	0.04	8.78
Methyl Isobutyl Ketone	362	21.01	0.01	14.86
Methyl Methacrylate	13	**38.87**	0.02	**27.48**
Methyl *tert*-Butyl Ether	92	14.85	0.004	9.47
n-Octane	386	19.06	0.004	13.48
Propylene	476	6.61	0.03	4.68
Styrene	405	12.56	0.01	8.50
1,1,2,2-Tetrachloroethane	5	**43.01**	0.001	**30.42**
Tetrachloroethylene	334	11.98	0.01	8.47
Toluene	476	6.96	0.08	4.92
1,2,4-Trichlorobenzene	4	**49.63**	0.003	**35.09**
1,1,1-Trichloroethane	474	10.16	0.002	7.18
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	119	**29.58**	0.002	**20.92**
Trichlorofluoromethane	476	4.91	0.01	3.47
Trichlorotrifluoroethane	476	5.79	0.01	4.09
1,2,4-Trimethylbenzene	455	9.87	0.01	6.98
1,3,5-Trimethylbenzene	410	13.03	0.003	9.07
Vinyl chloride	29	**61.47**	0.001	**43.46**
m,p-Xylene	476	8.89	0.02	6.29
o-Xylene	473	9.17	0.01	6.49

Table 32-34 shows the results from replicate analyses of all collocated VOC samples. The replicate results from collocated samples show variation for the pollutants ranging from <0.001 percent (*trans*-1,2-dichloroethylene) to 0.45 percent (acetonitrile), as indicated by

average concentration differences. The overall average variability is 17.50 percent, which is slightly outside the Program DQO.

Table 32-34. VOC Analytical Precision: 182 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	134	11.50	0.45	8.13
Acetylene	182	7.45	0.05	5.27
Acrolein	152	9.63	0.04	6.81
Acrylonitrile	18	**47.29**	0.01	**33.44**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	182	8.08	0.02	5.71
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	18	23.64	0.002	**16.71**
Bromoform	0	NA	NA	NA
Bromomethane	136	17.34	0.002	12.26
1,3-Butadiene	149	8.36	0.003	5.91
Carbon disulfide	138	6.58	0.05	4.30
Carbon Tetrachloride	182	7.03	0.01	4.97
Chlorobenzene	30	**37.34**	0.002	**26.41**
Chloroethane	108	13.09	0.002	9.26
Chloroform	132	9.91	0.004	7.01
Chloromethane	182	5.13	0.03	3.62
Chloromethylbenzene	2	15.38	0.001	10.88
Chloroprene	0	NA	NA	NA
Dibromochloromethane	18	**38.10**	0.001	**26.94**
1,2-Dibromoethane	2	NA	NA	NA
m-Dichlorobenzene	3	**191.92**	0.01	**135.71**
o-Dichlorobenzene	2	NA	NA	NA
p-Dichlorobenzene	155	10.95	0.003	7.74
Dichlorodifluoromethane	182	4.75	0.02	3.36
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	7	7.85	0.000	5.55
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	1	**134.24**	0.002	**94.92**
trans-1,2-Dichloroethylene	3	9.59	<0.001	6.78
Dichloromethane	169	8.52	0.01	6.03
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	181	9.94	0.002	7.03
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	181	10.01	0.02	6.23
Hexachloro-1,3-butadiene	16	**61.30**	0.002	**43.35**

Table 32-34. VOC Analytical Precision:
182 Replicate Analyses for all Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Methyl Ethyl Ketone	176	13.21	0.05	9.34
Methyl Isobutyl Ketone	141	21.22	0.01	**15.01**
Methyl Methacrylate	8	8.23	0.01	5.82
Methyl *tert*-Butyl Ether	12	**43.61**	0.002	**44.00**
n-Octane	139	20.29	0.004	14.35
Propylene	182	7.16	0.02	5.06
Styrene	144	13.71	0.01	9.69
1,1,2,2-Tetrachloroethane	5	**43.01**	0.001	**30.42**
Tetrachloroethylene	120	11.82	0.005	8.36
Toluene	182	7.08	0.04	5.01
1,2,4-Trichlorobenzene	4	**49.63**	0.003	**35.09**
1,1,1-Trichloroethane	180	11.95	0.002	8.45
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	58	18.82	0.002	13.31
Trichlorofluoromethane	182	4.70	0.01	3.32
Trichlorotrifluoroethane	182	5.93	0.01	4.19
1,2,4-Trimethylbenzene	173	11.49	0.01	8.13
1,3,5-Trimethylbenzene	164	13.33	0.002	8.83
Vinyl chloride	12	**86.85**	0.003	**61.41**
m,p-Xylene	182	7.14	0.02	5.05
o-Xylene	181	8.34	0.01	5.89

Table 32-35 shows the results from replicate analyses of all duplicate VOC samples. The variation of the replicate results from the duplicate samples ranges from 1.43 percent (chloromethylbenzene) to 119.57 percent (*cis*-1,2-dichloroethylene), as represented by the CV. The overall average variability is 16.67 percent, and the median CV is 8.34 percent.

Table 32-35. VOC Analytical Precision:
294 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	213	10.85	1.75	7.02
Acetylene	286	7.51	0.07	5.31
Acrolein	224	11.53	0.03	8.15
Acrylonitrile	4	22.72	0.002	**16.06**

Table 32-35. VOC Analytical Precision: 294 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
tert-Amyl Methyl Ether	0	22.22	0.001	**15.71**
Benzene	294	7.35	0.03	5.20
Bromochloromethane	0	3.51	0.001	2.48
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	261	10.25	0.002	7.28
1,3-Butadiene	247	12.57	0.01	8.34
Carbon disulfide	276	7.09	0.08	5.01
Carbon Tetrachloride	294	6.79	0.01	4.80
Chlorobenzene	0	13.33	0.001	9.43
Chloroethane	180	14.98	0.002	10.60
Chloroform	211	20.66	0.004	14.16
Chloromethane	294	5.54	0.04	3.92
Chloromethylbenzene	0	2.02	0.001	1.43
Chloroprene	2	**33.72**	0.001	**23.84**
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	4	6.06	0.001	4.29
o-Dichlorobenzene	5	**120.38**	0.001	**85.12**
p-Dichlorobenzene	189	15.75	0.003	11.13
Dichlorodifluoromethane	294	4.59	0.02	3.24
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	6	**42.85**	0.002	**22.21**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	4	**169.10**	0.02	**119.57**
trans-1,2-Dichloroethylene	7	**45.66**	0.004	**32.29**
Dichloromethane	290	9.77	0.10	6.91
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	1	**73.22**	0.001	**51.78**
Dichlorotetrafluoroethane	294	14.35	0.002	10.14
Ethyl Acrylate	1	**55.18**	0.001	**39.02**
Ethyl *tert*-Butyl Ether	11	**38.90**	0.003	**27.51**
Ethylbenzene	294	7.91	0.01	5.60
Hexachloro-1,3-butadiene	14	**40.74**	0.001	**28.81**
Methyl Ethyl Ketone	275	12.05	0.04	8.52
Methyl Isobutyl Ketone	221	20.92	0.01	14.79
Methyl Methacrylate	5	**69.51**	0.02	**49.15**
Methyl *tert*-Butyl Ether	80	5.26	0.004	3.72
n-Octane	247	18.50	0.005	13.08
Propylene	294	6.36	0.03	4.50
Styrene	261	12.03	0.01	7.96
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	214	12.04	0.01	8.51

Table 32-35. VOC Analytical Precision:
294 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Toluene	294	6.90	0.09	4.88
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	294	9.08	0.002	6.42
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	61	**34.97**	0.003	**24.72**
Trichlorofluoromethane	294	5.01	0.01	3.54
Trichlorotrifluoroethane	294	5.73	0.01	4.05
1,2,4-Trimethylbenzene	282	9.12	0.01	6.45
1,3,5-Trimethylbenzene	246	12.93	0.003	9.15
Vinyl chloride	17	**53.01**	0.001	**37.48**
m,p-Xylene	294	9.70	0.03	6.86
o-Xylene	292	9.56	0.01	6.76

Tables 32-36 through 32-40 present the precision data results from VOC replicate analyses for all the samples taken at the NATTS sites (BTUT, DEMI, GPCO, NBIL, and S4MO, respectively). These results show low- to high-level variability among the sites, as represented by CV, ranging from 1.04 percent (for carbon disulfide at NBIL) to 85.12 percent (for *o*-dichlorobenzene at GPCO), with an average of 9.01 percent. This is within the Program DQO of 15 percent overall CV per site.

Table 32-36. VOC Analytical Precision:
24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT)

Compound	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	15	22.55	0.11	8.12
Acetylene	24	13.53	0.11	9.57
Acrolein	20	13.42	0.03	9.49
Acrylonitrile	0	NA	NA	NA
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	24	6.87	0.03	4.86
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	24	NA	NA	NA
1,3-Butadiene	24	4.07	0.003	2.88
Carbon disulfide	24	4.32	0.15	3.05
Carbon Tetrachloride	24	5.15	0.01	3.64

Table 32-36. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Chlorobenzene	0	NA	NA	NA
Chloroethane	18	3.17	0.001	2.24
Chloroform	17	**34.80**	0.004	**24.61**
Chloromethane	24	4.89	0.03	3.45
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	2	NA	NA	NA
o-Dichlorobenzene	2	NA	NA	NA
p-Dichlorobenzene	23	9.32	0.001	6.59
Dichlorodifluoromethane	24	4.65	0.03	3.29
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	2	**65.71**	0.005	**22.21**
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	1	NA	0.001	NA
Dichloromethane	24	6.26	0.01	4.43
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	24	11.11	0.002	7.86
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	24	6.69	0.01	4.73
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	20	12.84	0.05	9.08
Methyl Isobutyl Ketone	24	6.08	0.003	4.30
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	24	5.19	0.003	3.67
Propylene	24	4.69	0.03	3.32
Styrene	22	22.31	0.004	**15.77**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	23	18.72	0.004	13.24
Toluene	24	7.55	0.05	5.34
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	24	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	2	**66.67**	0.001	**47.14**
Trichlorofluoromethane	24	4.33	0.01	3.06
Trichlorotrifluoroethane	24	6.83	0.01	4.83
1,2,4-Trimethylbenzene	24	10.10	0.01	7.14
1,3,5-Trimethylbenzene	24	9.63	0.003	6.81

Table 32-36. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Vinyl chloride	2	NA	NA	NA
m,p-Xylene	24	8.48	0.02	6.00
o-Xylene	24	4.64	0.01	3.28

Table 32-37. VOC Analytical Precision: 32 Replicate Analyses for Collocated Samples for Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	32	7.60	0.27	5.37
Acetylene	36	10.16	0.05	7.19
Acrolein	28	8.17	0.01	5.78
Acrylonitrile	1	**103.31**	0.004	**73.05**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	36	7.35	0.02	5.19
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	28	4.76	<0.001	3.37
1,3-Butadiene	28	12.40	0.003	8.77
Carbon disulfide	16	6.37	0.002	4.50
Carbon Tetrachloride	36	8.00	0.01	5.66
Chlorobenzene	24	7.14	0.001	5.05
Chloroethane	28	4.76	<0.001	3.37
Chloroform	36	4.68	0.004	3.31
Chloromethane	36	5.26	0.02	3.72
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	32	NA	NA	NA
Dichlorodifluoromethane	36	4.98	0.02	3.52
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	36	10.64	0.01	7.52

Table 32-37. VOC Analytical Precision: 32 Replicate Analyses for Collocated Samples for Detroit, MI (DEMI) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	36	11.11	0.001	7.86
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	36	5.02	0.003	3.55
Hexachloro-1,3-butadiene	3	20.52	<0.001	14.51
Methyl Ethyl Ketone	36	6.22	0.02	4.40
Methyl Isobutyl Ketone	28	9.19	0.003	6.50
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	28	20.29	0.003	14.35
Propylene	36	4.69	0.01	3.32
Styrene	30	11.26	0.002	7.96
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	32	7.90	0.005	5.59
Toluene	36	6.53	0.03	4.62
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	36	6.67	0.001	4.71
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	14	NA	NA	NA
Trichlorofluoromethane	36	5.11	0.01	3.61
Trichlorotrifluoroethane	36	8.65	0.01	6.12
1,2,4-Trimethylbenzene	36	6.04	0.004	4.27
1,3,5-Trimethylbenzene	36	10.26	0.002	7.26
Vinyl chloride	2	NA	NA	NA
m,p-Xylene	36	6.09	0.01	4.30
o-Xylene	36	5.11	0.003	3.61

Table 32-38. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	24	16.24	0.11	11.49
Acetylene	24	5.14	0.07	3.63
Acrolein	24	15.12	0.03	10.69
Acrylonitrile	0	NA	NA	NA

Table 32-38. VOC Analytical Precision:
24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	24	4.38	0.02	3.10
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	20	NA	NA	NA
1,3-Butadiene	24	13.24	0.01	9.36
Carbon disulfide	24	5.49	0.08	3.88
Carbon Tetrachloride	24	5.84	0.01	4.13
Chlorobenzene	0	NA	NA	NA
Chloroethane	18	7.41	0.001	5.24
Chloroform	15	**37.49**	0.004	**26.51**
Chloromethane	24	5.38	0.03	3.80
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	1	**120.38**	0.001	**85.12**
p-Dichlorobenzene	15	18.81	0.002	13.30
Dichlorodifluoromethane	24	4.67	0.03	3.30
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	24	6.18	0.01	4.37
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	24	16.67	0.003	11.79
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	24	8.90	0.01	6.29
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	19	23.91	0.04	**16.90**
Methyl Isobutyl Ketone	19	**30.98**	0.01	**21.91**
Methyl Methacrylate	5	**69.51**	0.02	**49.15**
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	24	6.83	0.003	4.83
Propylene	24	5.54	0.03	3.92
Styrene	24	4.37	0.003	3.09
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	24	11.72	0.004	8.29

Table 32-38. VOC Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Toluene	24	6.63	0.05	4.69
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	24	3.33	0.001	2.36
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	0	NA	NA	NA
Trichlorofluoromethane	24	5.62	0.02	3.98
Trichlorotrifluoroethane	24	6.50	0.01	4.59
1,2,4-Trimethylbenzene	24	9.72	0.01	6.87
1,3,5-Trimethylbenzene	24	7.57	0.003	5.35
Vinyl chloride	0	NA	NA	NA
m,p-Xylene	24	8.16	0.03	5.77
o-Xylene	24	7.70	0.01	5.45

Table 32-39. VOC Analytical Precision: 24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	12	10.86	0.02	7.68
Acetylene	24	7.73	0.03	5.47
Acrolein	16	10.31	0.02	7.29
Acrylonitrile	2	**43.55**	0.01	**30.79**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	24	9.01	0.01	6.37
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	16	7.27	0.002	5.14
Bromoform	0	NA	NA	NA
Bromomethane	20	13.33	0.002	9.43
1,3-Butadiene	16	8.33	0.001	5.89
Carbon disulfide	16	1.47	0.001	1.04
Carbon Tetrachloride	24	6.92	0.01	4.89
Chlorobenzene	0	NA	NA	NA
Chloroethane	15	12.89	0.001	9.11
Chloroform	22	5.38	0.005	3.81
Chloromethane	24	5.55	0.03	3.93
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	14	9.52	0.001	6.73
1,2-Dibromoethane	0	NA	NA	NA

Table 32-39. VOC Analytical Precision: 24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	14	8.16	0.002	5.77
Dichlorodifluoromethane	24	4.10	0.02	2.90
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	1	9.59	<0.001	6.78
Dichloromethane	20	6.06	0.01	4.28
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	24	22.22	0.003	**15.71**
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	24	10.98	0.003	7.76
Hexachloro-1,3-butadiene	0	NA	NA	NA
Methyl Ethyl Ketone	21	**26.04**	0.09	**18.41**
Methyl Isobutyl Ketone	12	4.04	0.002	2.86
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	15	21.17	0.003	14.97
Propylene	24	8.87	0.02	6.27
Styrene	13	**26.63**	0.002	**18.83**
1,1,2,2-Tetrachloroethane	1	**43.01**	0.001	**30.42**
Tetrachloroethylene	18	9.08	0.004	6.42
Toluene	24	9.91	0.03	7.01
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	24	4.21	0.002	2.98
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	14	13.61	0.002	9.62
Trichlorofluoromethane	24	3.30	0.01	2.33
Trichlorotrifluoroethane	24	3.14	0.003	2.22
1,2,4-Trimethylbenzene	18	13.56	0.003	9.59
1,3,5-Trimethylbenzene	16	NA	NA	NA
Vinyl chloride	0	NA	NA	NA
m,p-Xylene	24	9.26	0.01	6.55
o-Xylene	24	7.33	0.003	5.18

Table 32-40. VOC Analytical Precision: 22 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	12	8.67	0.19	6.13
Acetylene	22	4.22	0.02	2.98
Acrolein	16	8.81	0.02	6.23
Acrylonitrile	1	**54.16**	0.003	**38.30**
tert-Amyl Methyl Ether	0	NA	NA	NA
Benzene	22	6.49	0.01	4.59
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	0	NA	NA	NA
Bromomethane	22	12.12	0.002	8.57
1,3-Butadiene	22	6.23	0.002	4.41
Carbon disulfide	12	12.41	0.01	8.77
Carbon Tetrachloride	22	9.61	0.01	6.80
Chlorobenzene	0	NA	NA	NA
Chloroethane	16	16.67	0.002	11.79
Chloroform	18	8.89	0.002	6.29
Chloromethane	22	3.64	0.02	2.57
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	1	**59.66**	0.001	**42.18**
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	16	5.00	0.001	3.54
Dichlorodifluoromethane	22	3.13	0.02	2.21
1,1-Dichloroethane	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	0	NA	NA	NA
Dichloromethane	22	6.63	0.01	4.69
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	22	12.12	0.002	8.57
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	22	6.06	0.01	4.28
Hexachloro-1,3-butadiene	2	**66.67**	0.001	**47.14**
Methyl Ethyl Ketone	22	7.43	0.04	5.25
Methyl Isobutyl Ketone	18	4.41	0.003	3.11
Methyl Methacrylate	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
n-Octane	22	6.06	0.001	4.29

Table 32-40. VOC Analytical Precision:
22 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propylene	22	3.51	0.01	2.48
Styrene	22	4.81	0.003	3.40
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	18	22.65	0.005	**16.01**
Toluene	22	3.30	0.01	2.34
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	22	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	12	22.22	0.002	**15.71**
Trichlorofluoromethane	22	3.04	0.01	2.15
Trichlorotrifluoroethane	22	2.08	0.002	1.47
1,2,4-Trimethylbenzene	20	5.56	0.003	3.93
1,3,5-Trimethylbenzene	18	7.41	0.001	5.24
Vinyl chloride	2	NA	NA	NA
m,p-Xylene	22	6.24	0.01	4.41
o-Xylene	22	9.36	0.004	6.62

Table 32-41 shows the average CV per pollutant, per pollutant per site, per site, and the overall average CV. The average site CV ranged from 5.63 percent at MSTN to 15.90 percent at LDTN, with an overall program average CV of 9.92 percent. This meets the 15 percent CV Program DQO.

Table 32-41. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Elizabeth, NJ (ELNJ)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)
Acetonitrile	*7.39*	4.86	8.12	6.82	9.00	6.54	5.37	6.94	11.49	7.13	8.96
Acetylene	*5.30*	3.71	9.57	7.53	7.69	3.78	7.19	4.89	3.63	4.62	5.10
Acrolein	*7.73*	**16.92**	9.49	5.02	6.91	6.80	5.78	4.34	10.69	7.53	9.39
Acrylonitrile	***25.99***	6.73	NA	NA	NA	3.16	**73.05**	NA	NA	NA	NA
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	*5.36*	6.11	4.86	5.22	6.39	4.86	5.19	5.85	3.10	6.59	6.59
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***16.71***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	*9.09*	3.72	NA	14.99	NA	4.04	3.37	NA	NA	5.71	**20.84**
1,3-Butadiene	*7.57*	4.96	2.88	2.89	**30.15**	14.29	8.77	11.19	9.36	3.09	4.49
Carbon disulfide	*4.79*	2.87	3.05	6.79	3.65	6.27	4.50	5.03	3.88	5.85	2.83
Carbon Tetrachloride	*4.86*	4.57	3.64	4.16	6.92	4.39	5.66	4.69	4.13	5.22	7.61
Chlorobenzene	***20.75***	NA	NA	NA	NA	NA	5.05	NA	NA	NA	NA
Chloroethane	*10.26*	6.89	2.24	**18.78**	**15.01**	**15.71**	3.37	11.91	5.24	4.71	NA
Chloroform	*11.90*	10.06	**24.61**	8.53	5.89	**19.21**	3.31	**15.35**	**26.51**	7.99	4.82
Chloromethane	*3.83*	2.67	3.45	3.88	4.39	3.95	3.72	5.65	3.80	4.99	3.69
Chloromethylbenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	***26.94***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***70.00***	NA	NA	NA	NA	NA	NA	NA	NA	NA	**135.71**
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	**85.12**	NA	NA
p-Dichlorobenzene	*10.07*	2.41	6.59	7.91	**26.37**	11.79	NA	7.67	13.30	**19.15**	**15.59**
Dichlorodifluoromethane	*3.28*	2.63	3.29	3.70	2.37	3.78	3.52	4.37	3.30	4.06	4.21
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	***18.05***	NA	**22.21**	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 32-41. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Elizabeth, NJ (ELNJ)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)
cis-1,2-Dichloroethylene	***113.41***	NA	NA	NA	NA	**116.09**	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	***22.08***	NA	NA	NA	NA	4.16	NA	NA	NA	NA	NA
Dichloromethane	*6.63*	2.91	4.43	5.01	12.21	5.27	7.52	5.95	4.37	8.83	5.31
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	***51.78***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*9.11*	3.93	7.86	6.73	10.10	**16.84**	7.86	6.73	11.79	13.47	7.86
Ethyl Acrylate	***39.02***	NA	NA	**39.02**	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	***27.51***	**27.51**	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*5.80*	5.46	4.73	4.44	6.31	6.95	3.55	2.17	6.29	5.81	9.51
Hexachloro-1,3-butadiene	***36.08***	NA	NA	NA	**23.57**	NA	14.51	NA	NA	NA	**101.39**
Methyl Ethyl Ketone	*8.78*	**17.35**	9.08	6.91	6.71	12.50	4.40	7.12	**16.90**	5.93	6.13
Methyl Isobutyl Ketone	*14.86*	**20.69**	4.30	7.59	**29.04**	**17.21**	6.50	**18.91**	**21.91**	10.72	8.27
Methyl Methacrylate	***27.48***	NA	NA	NA	NA	NA	NA	NA	**49.15**	NA	NA
Methyl *tert*-Butyl Ether	*9.47*	1.57	NA	3.92	3.21	NA	NA	6.44	NA	NA	NA
n-Octane	*13.48*	**33.24**	3.67	14.37	10.77	4.58	14.35	6.71	4.83	9.63	**16.84**
Propylene	*4.68*	3.55	3.32	4.59	7.66	4.40	3.32	6.20	3.92	4.59	6.59
Styrene	*8.50*	13.65	**15.77**	4.08	5.24	7.22	7.96	12.60	3.09	5.36	2.17
1,1,2,2-Tetrachloroethane	***30.42***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	*8.47*	**17.33**	13.24	7.61	6.84	10.33	5.59	2.84	8.29	1.29	NA
Toluene	*4.92*	4.90	5.34	8.18	3.54	4.12	4.62	4.95	4.69	4.65	5.01
1,2,4-Trichlorobenzene	***35.09***	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	*7.18*	8.64	NA	8.08	8.08	3.37	4.71	10.77	2.36	4.04	**21.80**
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	***20.92***	NA	**47.14**	12.57	NA	7.86	NA	8.49	NA	NA	NA
Trichlorofluoromethane	*3.47*	2.22	3.06	3.69	3.64	4.24	3.61	4.10	3.98	5.00	4.53
Trichlorotrifluoroethane	*4.09*	2.71	4.83	6.09	3.17	4.12	6.12	5.33	4.59	5.01	3.22
1,2,4-Trimethylbenzene	*6.98*	5.03	7.14	8.60	4.29	6.28	4.27	3.57	6.87	**15.47**	**16.30**

Table 32-41. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Elizabeth, NJ (ELNJ)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)
1,3,5-Trimethylbenzene	*9.07*	8.40	6.81	4.04	**18.72**	**15.44**	7.26	3.46	5.35	6.73	12.26
Vinyl chloride	***43.46***	NA	NA	**30.67**	NA	NA	NA	NA	NA	**20.44**	NA
m,p-Xylene	*6.29*	4.85	6.00	6.35	9.55	4.70	4.30	4.81	5.77	6.30	4.61
o-Xylene	*6.49*	6.35	3.28	9.22	6.46	11.16	3.61	7.18	5.45	4.41	12.27
Average	*9.92*	*8.16*	*8.47*	*8.76*	*9.80*	*11.04*	*7.87*	*6.97*	*11.39*	*7.24*	***15.80***

Table 32-41. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Nashville, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Acetonitrile	*7.39*	5.61	7.68	NA	6.13	7.82	5.61	**15.87**	3.81	5.30
Acetylene	*5.30*	3.29	5.47	5.31	2.98	5.49	5.23	6.23	4.57	4.35
Acrolein	*7.73*	3.77	7.29	4.25	6.23	**15.66**	9.81	9.56	2.31	5.08
Acrylonitrile	***25.99***	NA	**30.79**	NA	**38.30**	NA	NA	**25.24**	NA	4.67
tert-Amyl Methyl Ether	*NA*	NA	NA	**15.71**	NA	NA	NA	NA	NA	NA
Benzene	*5.36*	4.24	6.37	5.70	4.59	4.49	6.87	6.74	2.94	5.15
Bromochloromethane	*NA*	NA	NA	2.48	NA	NA	NA	NA	NA	NA
Bromodichloromethane	***16.71***	NA	5.14	NA	NA	NA	NA	**28.28**	NA	NA
Bromoform	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	*9.09*	NA	9.43	9.43	8.57	NA	NA	NA	4.47	**15.40**

Table 32-41. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Nashville, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
1,3-Butadiene	*7.57*	1.96	5.89	5.89	4.41	13.47	4.06	6.10	1.75	8.24
Carbon disulfide	*4.79*	2.01	1.04	2.68	8.77	6.31	5.89	4.34	4.14	11.05
Carbon Tetrachloride	*4.86*	1.09	4.89	5.99	6.80	3.44	3.85	4.85	4.66	5.73
Chlorobenzene	***20.75***	NA	NA	9.43	NA	NA	NA	NA	NA	**47.76**
Chloroethane	*10.26*	NA	9.11	6.67	11.79	9.43	NA	3.21	**18.78**	**21.34**
Chloroform	*11.90*	3.54	3.81	**24.78**	6.29	**17.68**	7.73	11.68	9.43	14.88
Chloromethane	*3.83*	2.72	3.93	3.15	2.57	4.22	5.11	4.36	3.12	3.33
Chloromethylbenzene	*NA*	NA	NA	1.43	NA	NA	NA	NA	NA	10.88
Chloroprene	*NA*	NA	NA	NA	**42.18**	5.50	NA	NA	NA	NA
Dibromochloromethane	***26.94***	NA	6.73	NA	NA	NA	NA	**47.14**	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	***70.00***	NA	NA	4.29	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	*10.07*	5.55	5.77	**17.34**	3.54	NA	6.41	6.73	NA	5.06
Dichlorodifluoromethane	*3.28*	2.09	2.90	1.81	2.21	3.80	4.11	4.33	2.73	3.10
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	***18.05***	NA	NA	**22.21**	NA	**22.21**	NA	NA	NA	5.55
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	***113.41***	NA	NA	**128.16**	NA	**114.46**	NA	NA	NA	**94.92**
trans-1,2-Dichloroethylene	***22.08***	NA	6.78	3.63	NA	NA	**89.07**	6.78	NA	NA
Dichloromethane	*6.63*	1.66	4.28	3.75	4.69	7.09	6.43	7.14	**18.88**	10.26
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	***51.78***	NA	NA	**51.78**	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	*9.11*	4.71	**15.71**	4.29	8.57	**23.57**	7.86	4.29	NA	1.75
Ethyl Acrylate	***39.02***	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	***27.51***	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 32-41. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Nashville, TN (MSTN)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Schiller Park. IL (SPIL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Ethylbenzene	*5.80*	4.85	7.76	3.91	4.28	7.86	8.32	7.92	6.22	3.77
Hexachloro-1,3-butadiene	***36.08***	NA	NA	**15.71**	**47.14**	NA	NA	NA	NA	14.14
Methyl Ethyl Ketone	*8.78*	3.46	**18.41**	2.92	5.25	7.81	7.12	**19.13**	5.17	4.52
Methyl Isobutyl Ketone	*14.86*	**23.81**	2.86	**15.15**	3.11	**34.47**	5.58	**35.34**	3.57	13.28
Methyl Methacrylate	***27.48***	NA	NA	NA	NA	NA	NA	NA	NA	5.82
Methyl *tert*-Butyl Ether	*9.47*	NA	NA	0.65	NA	NA	6.51	NA	NA	**44.00**
n-Octane	*13.48*	9.42	14.97	13.62	4.29	**37.70**	9.37	**23.19**	**17.28**	7.30
Propylene	*4.68*	5.58	6.27	3.19	2.48	6.04	4.38	5.28	4.13	3.33
Styrene	*8.50*	4.50	**18.83**	11.10	3.40	9.13	6.89	2.53	5.89	**22.18**
1,1,2,2-Tetrachloroethane	***30.42***	NA	**30.42**	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	*8.47*	**16.25**	6.42	4.40	**16.01**	10.83	8.51	7.94	3.16	5.59
Toluene	*4.92*	4.29	7.01	7.51	2.34	3.23	6.93	4.74	3.06	4.39
1,2,4-Trichlorobenzene	***35.09***	NA	NA	NA	NA	NA	NA	NA	NA	**35.09**
1,1,1-Trichloroethane	*7.18*	2.83	2.98	9.43	NA	7.07	NA	8.69	2.36	9.70
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	***20.92***	**17.41**	9.62	12.55	**15.71**	NA	6.43	9.46	**87.05**	**16.74**
Trichlorofluoromethane	*3.47*	2.36	2.33	1.71	2.15	4.44	5.17	4.03	2.64	3.08
Trichlorotrifluoroethane	*4.09*	2.94	2.22	3.58	1.47	6.64	2.18	5.22	2.92	5.42
1,2,4-Trimethylbenzene	*6.98*	2.57	9.59	2.24	3.93	11.90	7.09	11.30	1.45	4.73
1,3,5-Trimethylbenzene	*9.07*	11.79	NA	**17.59**	5.24	8.51	9.45	NA	NA	4.02
Vinyl chloride	***43.46***	NA	NA	NA	NA	NA	**61.33**	NA	NA	**61.41**
m,p-Xylene	*6.29*	4.82	6.55	6.78	4.41	13.11	7.07	6.24	9.41	3.78
o-Xylene	*6.49*	4.23	5.18	3.59	6.62	11.90	7.47	6.57	4.80	3.50
Average	*9.92*	*5.63*	*8.41*	*11.60*	*8.98*	*14.36*	*10.90*	*10.92*	*8.60*	*13.65*

32.2.2 SNMOC Analytical Precision

Table 32-42 presents replicate analytical data for all duplicate and collocated SNMOC samples. The average concentration differences observed for replicate analyses of SNMOC ranged from 0.03 (several individual compounds) to 17.26 (TNMOC) ppbC. For most of the pollutants, the SNMOC precision was within the Program DQO of 15 percent. The overall average variability is 11.27 percent.

Table 32-42. SNMOC Analytical Precision: 128 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	128	5.02	0.09	3.55
Benzene	128	6.13	0.09	4.34
1,3-Butadiene	53	13.07	0.03	9.24
n-Butane	128	4.05	0.16	2.86
cis-2-Butene	101	12.07	0.03	8.53
trans-2-Butene	101	12.36	0.03	8.74
Cyclohexane	119	10.56	0.04	7.47
Cyclopentane	118	11.48	0.11	8.12
Cyclopentene	45	**25.32**	0.09	**17.90**
n-Decane	112	13.81	0.07	9.76
1-Decene	1	**30.59**	0.07	**21.63**
m-Diethylbenzene	67	**25.27**	0.12	**17.87**
p-Diethylbenzene	58	**34.30**	0.07	**24.25**
2,2-Dimethylbutane	123	10.53	0.04	7.45
2,3-Dimethylbutane	117	8.52	0.03	6.02
2,3-Dimethylpentane	122	8.18	0.05	5.79
2,4-Dimethylpentane	121	11.95	0.04	8.45
n-Dodecane	59	**34.29**	0.19	**24.25**
1-Dodecene	25	**37.03**	0.12	**26.19**
Ethane	125	9.56	0.41	6.76
Ethylbenzene	128	13.41	0.07	9.48
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	123	11.85	0.29	8.38
m-Ethyltoluene	123	10.65	0.05	7.53
o-Ethyltoluene	98	13.90	0.05	9.83
p-Ethyltoluene	119	15.55	0.04	11.00
n-Heptane	124	8.05	0.05	5.69
1-Heptene	87	17.07	0.03	12.07
n-Hexane	128	6.35	0.08	4.49
1-Hexene	109	14.32	0.04	10.12
cis-2-Hexene	5	**41.89**	0.10	**29.62**
trans-2-Hexene	11	**44.85**	0.08	**31.71**

Table 32-42. SNMOC Analytical Precision: 128 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isobutane	128	1.77	0.06	1.26
Isobutene/1-Butene	122	4.30	0.05	3.04
Isopentane	122	2.98	0.33	2.11
Isoprene	111	9.60	0.05	6.79
Isopropylbenzene	60	**25.26**	0.04	**17.86**
2-Methyl-1-butene	104	11.55	0.07	8.16
2-Methyl-2-butene	102	19.58	0.04	13.85
3-Methyl-1-butene	3	**62.55**	0.23	**44.23**
Methylcyclohexane	125	9.33	0.08	6.60
Methylcyclopentane	128	7.31	0.05	5.17
2-Methylheptane	119	10.69	0.03	7.56
3-Methylheptane	106	13.42	0.03	9.49
2-Methylhexane	104	10.91	0.06	7.71
3-Methylhexane	127	9.50	0.11	6.71
3-Methylpentane	128	6.88	0.05	4.86
2-Methylpentane	124	7.73	0.18	5.47
4-Methyl-1-pentene	11	24.30	0.07	**17.18**
2-Methyl-1-pentene	20	16.02	0.03	11.33
n-Nonane	120	13.12	0.04	9.28
1-Nonene	83	**29.07**	0.06	**20.55**
n-Octane	124	7.84	0.04	5.54
1-Octene	58	22.04	0.05	**15.58**
n-Pentane	128	3.62	1.12	2.56
1-Pentene	114	11.74	0.04	8.30
cis-2-Pentene	90	17.17	0.03	12.14
trans-2-Pentene	115	11.74	0.03	8.30
a-Pinene	102	11.16	0.10	7.89
b-Pinene	17	**27.47**	0.11	**19.43**
Propane	128	1.23	0.12	0.87
n-Propylbenzene	100	19.58	0.04	13.85
Propylene	128	4.07	0.04	2.88
Propyne	0	NA	NA	NA
Styrene	75	**30.65**	0.34	**21.67**
TNMOC (Speciated)	128	5.42	17.26	3.83
TNMOC (w/unknowns)	128	4.70	8.20	3.32
Toluene	128	5.93	0.26	4.19
n-Tridecane	9	**60.85**	0.33	**43.03**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	105	**25.27**	0.07	**17.87**
1,2,4-Trimethylbenzene	124	9.88	0.07	6.99
1,3,5-Trimethylbenzene	105	15.77	0.03	11.15
2,2,3-Trimethylpentane	76	**31.05**	0.07	**21.96**
2,2,4-Trimethylpentane	128	8.59	0.08	6.08
2,3,4-Trimethylpentane	116	10.17	0.03	7.19

Table 32-42. SNMOC Analytical Precision:
128 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
n-Undecane	82	16.96	0.16	11.99
1-Undecene	33	**32.80**	0.13	**23.20**
m-Xylene/*p*-Xylene	128	8.71	0.14	6.16
o-Xylene	125	12.11	0.06	8.57

Table 32-43 presents results from SNMOC replicate analyses for all of the duplicate samples. These results show low- to high-level variability, ranging from 0.77 percent (propane) to 44.23 percent (3-methyl-1-butene). The overall average variability is 10.86 percent.

Table 32-43. SNMOC Analytical Precision:
104 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	104	5.43	0.11	3.84
Benzene	104	5.37	0.09	3.79
1,3-Butadiene	47	13.23	0.04	9.36
n-Butane	104	3.07	0.16	2.17
cis-2-Butene	85	11.45	0.03	8.10
trans-2-Butene	85	11.21	0.04	7.92
Cyclohexane	97	10.90	0.04	7.70
Cyclopentane	96	12.38	0.13	8.75
Cyclopentene	36	**25.27**	0.10	**17.87**
n-Decane	90	13.83	0.05	9.78
1-Decene	1	**30.59**	0.07	**21.63**
m-Diethylbenzene	50	23.54	0.10	**16.65**
p-Diethylbenzene	48	**34.36**	0.08	**24.29**
2,2-Dimethylbutane	101	10.09	0.04	7.13
2,3-Dimethylbutane	94	7.14	0.03	5.05
2,3-Dimethylpentane	100	8.56	0.04	6.05
2,4-Dimethylpentane	97	13.12	0.05	9.27
n-Dodecane	45	**35.77**	0.23	**25.29**
1-Dodecene	14	**38.43**	0.13	**27.18**
Ethane	101	11.56	0.48	8.18
Ethylbenzene	104	14.09	0.08	9.96
2-Ethyl-1-butene	0	NA	NA	NA

Table 32-43. SNMOC Analytical Precision: 104 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Ethylene	99	13.98	0.32	9.89
m-Ethyltoluene	100	9.31	0.04	6.58
o-Ethyltoluene	76	12.54	0.05	8.87
p-Ethyltoluene	96	14.32	0.04	10.13
n-Heptane	100	6.77	0.04	4.79
1-Heptene	74	15.34	0.03	10.84
n-Hexane	104	5.86	0.08	4.15
1-Hexene	95	15.39	0.04	10.88
cis-2-Hexene	5	**41.89**	0.10	**29.62**
trans-2-Hexene	10	**44.85**	0.07	**31.71**
Isobutane	104	1.57	0.06	1.11
Isobutene/1-Butene	100	4.05	0.05	2.86
Isopentane	100	2.98	0.36	2.11
Isoprene	93	9.63	0.06	6.81
Isopropylbenzene	53	24.82	0.03	**17.55**
2-Methyl-1-butene	85	10.89	0.07	7.70
2-Methyl-2-butene	88	16.58	0.03	11.72
3-Methyl-1-butene	3	**62.55**	0.23	**44.23**
Methylcyclohexane	102	8.99	0.08	6.36
Methylcyclopentane	104	8.01	0.05	5.66
2-Methylheptane	97	10.51	0.03	7.43
3-Methylheptane	86	13.10	0.03	9.27
2-Methylhexane	85	10.99	0.07	7.77
3-Methylhexane	103	9.99	0.12	7.06
3-Methylpentane	104	6.42	0.05	4.54
2-Methylpentane	104	8.72	0.18	6.16
4-Methyl-1-pentene	11	24.30	0.07	**17.18**
2-Methyl-1-pentene	18	17.34	0.04	12.26
n-Nonane	97	12.18	0.04	8.61
1-Nonene	70	**29.07**	0.06	**20.56**
n-Octane	102	7.34	0.04	5.19
1-Octene	47	24.48	0.06	**17.31**
n-Pentane	104	3.49	1.38	2.47
1-Pentene	90	13.02	0.04	9.21
cis-2-Pentene	77	14.69	0.03	10.39
trans-2-Pentene	93	10.62	0.03	7.51
a-Pinene	84	11.73	0.12	8.30
b-Pinene	17	**27.47**	0.11	**19.43**
Propane	104	1.09	0.12	0.77
n-Propylbenzene	83	22.59	0.04	**15.97**
Propylene	104	4.03	0.04	2.85
Propyne	0	NA	NA	NA
Styrene	70	21.60	0.11	**15.27**
TNMOC (Speciated)	104	2.89	3.98	2.04

Table 32-43. SNMOC Analytical Precision:
104 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
TNMOC (w/unknowns)	104	4.87	8.43	3.44
Toluene	104	4.74	0.26	3.35
n-Tridecane	8	**37.60**	0.37	**26.59**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	89	22.43	0.05	**15.86**
1,2,4-Trimethylbenzene	100	10.63	0.08	7.51
1,3,5-Trimethylbenzene	87	17.54	0.03	12.40
2,2,3-Trimethylpentane	58	**34.25**	0.08	**24.22**
2,2,4-Trimethylpentane	104	9.19	0.08	6.50
2,3,4-Trimethylpentane	92	10.75	0.04	7.60
n-Undecane	64	18.42	0.19	13.03
1-Undecene	27	21.64	0.09	**15.30**
m-Xylene/*p*-Xylene	104	8.36	0.14	5.91
o-Xylene	102	10.67	0.06	7.55

Table 32-44 through 32-45 present the results from SNMOC replicate analyses for all the duplicate and collocated samples at NATTS sites (BTUT and NBIL). These results show low- to high-level variability at these sites, as represented by CV, ranging from 0.34 percent (for isobutane at BTUT) to 75.91 percent (for *n*-tridecane at NBIL), with an average of 10.49 percent. This is within the 15 percent Program DQO.

Table 32-44. SNMOC Analytical Precision:
56 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	24	8.52	0.22	6.03
Benzene	24	5.74	0.11	4.06
1,3-Butadiene	14	5.94	0.01	4.20
n-Butane	24	0.83	0.10	0.59
cis-2-Butene	24	8.85	0.03	6.26
trans-2-Butene	24	18.21	0.05	12.88
Cyclohexane	24	5.48	0.04	3.87
Cyclopentane	24	6.00	0.02	4.25
Cyclopentene	9	**64.19**	0.17	**45.39**
n-Decane	24	12.93	0.04	9.14
1-Decene	1	**30.59**	0.07	**21.63**

Table 32-44. SNMOC Analytical Precision: 56 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
m-Diethylbenzene	12	15.54	0.03	10.99
p-Diethylbenzene	10	**31.52**	0.05	**22.29**
2,2-Dimethylbutane	24	9.15	0.05	6.47
2,3-Dimethylbutane	24	6.29	0.05	4.45
2,3-Dimethylpentane	24	4.72	0.05	3.34
2,4-Dimethylpentane	24	10.07	0.06	7.12
n-Dodecane	10	**29.65**	0.11	**20.97**
1-Dodecene	3	**36.59**	0.10	**25.87**
Ethane	23	**26.75**	1.02	**18.92**
Ethylbenzene	24	9.06	0.06	6.41
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	21	18.57	0.36	13.13
m-Ethyltoluene	24	9.21	0.05	6.51
o-Ethyltoluene	24	15.73	0.04	11.12
p-Ethyltoluene	24	12.74	0.04	9.01
n-Heptane	24	6.00	0.07	4.25
1-Heptene	22	12.63	0.04	8.93
n-Hexane	24	4.40	0.10	3.11
1-Hexene	24	16.73	0.05	11.83
cis-2-Hexene	2	**80.58**	0.13	**56.98**
trans-2-Hexene	0	NA	NA	NA
Isobutane	24	0.48	0.04	0.34
Isobutene/1-Butene	24	3.86	0.06	2.73
Isopentane	24	0.90	0.10	0.63
Isoprene	22	12.62	0.05	8.93
Isopropylbenzene	12	16.49	0.03	11.66
2-Methyl-1-butene	24	11.93	0.06	8.44
2-Methyl-2-butene	24	11.97	0.04	8.47
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	24	6.60	0.10	4.67
Methylcyclopentane	24	4.91	0.06	3.47
2-Methylheptane	24	9.11	0.03	6.44
3-Methylheptane	24	8.41	0.03	5.95
2-Methylhexane	24	14.82	0.11	10.48
3-Methylhexane	24	4.92	0.10	3.48
3-Methylpentane	24	3.31	0.05	2.34
2-Methylpentane	24	4.04	0.12	2.86
4-Methyl-1-pentene	2	14.96	0.03	10.58
2-Methyl-1-pentene	4	4.78	0.004	3.38
n-Nonane	24	14.08	0.04	9.96
1-Nonene	22	**40.56**	0.06	**28.68**
n-Octane	24	4.62	0.03	3.27
1-Octene	11	15.16	0.03	10.72
n-Pentane	24	2.46	0.18	1.74

Table 32-44. SNMOC Analytical Precision:
56 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
1-Pentene	21	11.44	0.04	8.09
cis-2-Pentene	24	11.35	0.02	8.03
trans-2-Pentene	24	8.34	0.03	5.90
a-Pinene	17	13.85	0.06	9.79
b-Pinene	2	**28.65**	0.06	**20.26**
Propane	24	0.72	0.10	0.51
n-Propylbenzene	24	18.71	0.04	13.23
Propylene	24	2.29	0.05	1.62
Propyne	0	NA	NA	NA
Styrene	16	**27.86**	0.11	**19.70**
TNMOC (Speciated)	24	3.39	3.51	2.40
TNMOC (w/unknowns)	24	3.86	5.75	2.73
Toluene	24	4.93	0.21	3.48
n-Tridecane	2	**50.21**	0.59	**35.51**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	24	17.95	0.03	12.69
1,2,4-Trimethylbenzene	24	9.18	0.07	6.49
1,3,5-Trimethylbenzene	24	13.85	0.04	9.79
2,2,3-Trimethylpentane	19	16.32	0.04	11.54
2,2,4-Trimethylpentane	24	6.10	0.08	4.31
2,3,4-Trimethylpentane	24	8.64	0.04	6.11
n-Undecane	16	17.02	0.04	12.03
1-Undecene	3	12.20	0.02	8.63
m-Xylene/*p*-Xylene	24	6.61	0.15	4.67
o-Xylene	24	7.12	0.05	5.04

Table 32-45. SNMOC Analytical Precision:
24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	24	3.42	0.03	2.42
Benzene	24	9.20	0.09	6.50
1,3-Butadiene	6	12.40	0.01	8.77
n-Butane	24	7.96	0.15	5.63
cis-2-Butene	16	14.53	0.03	10.27
trans-2-Butene	16	17.00	0.03	12.02
Cyclohexane	22	9.22	0.03	6.52
Cyclopentane	22	7.91	0.02	5.59

Table 32-45. SNMOC Analytical Precision: 24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Cyclopentene	9	**25.50**	0.06	**18.03**
n-Decane	22	13.74	0.13	9.71
1-Decene	0	NA	NA	NA
m-Diethylbenzene	17	**32.16**	0.17	**22.74**
p-Diethylbenzene	10	**34.07**	0.07	**24.09**
2,2-Dimethylbutane	22	12.31	0.03	8.70
2,3-Dimethylbutane	23	14.00	0.03	9.90
2,3-Dimethylpentane	22	6.68	0.05	4.72
2,4-Dimethylpentane	24	7.26	0.02	5.13
n-Dodecane	14	**28.41**	0.06	**20.09**
1-Dodecene	11	**32.83**	0.09	**23.21**
Ethane	24	1.57	0.14	1.11
Ethylbenzene	24	10.69	0.03	7.56
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	24	3.31	0.13	2.34
m-Ethyltoluene	23	16.02	0.05	11.33
o-Ethyltoluene	22	19.34	0.05	13.68
p-Ethyltoluene	23	20.48	0.04	14.48
n-Heptane	24	13.16	0.07	9.31
1-Heptene	13	24.02	0.03	**16.99**
n-Hexane	24	8.28	0.08	5.86
1-Hexene	14	10.03	0.02	7.09
cis-2-Hexene	0	NA	NA	NA
trans-2-Hexene	1	NA	0.11	NA
Isobutane	24	2.59	0.04	1.83
Isobutene/1-Butene	22	5.33	0.05	3.77
Isopentane	22	2.95	0.18	2.09
Isoprene	18	9.48	0.04	6.70
Isopropylbenzene	7	**26.98**	0.05	**19.08**
2-Methyl-1-butene	19	14.15	0.09	10.01
2-Methyl-2-butene	14	**31.60**	0.06	**22.34**
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	23	10.70	0.05	7.57
Methylcyclopentane	24	4.50	0.03	3.18
2-Methylheptane	22	11.41	0.02	8.07
3-Methylheptane	20	14.70	0.03	10.39
2-Methylhexane	19	10.59	0.05	7.49
3-Methylhexane	24	7.52	0.09	5.32
3-Methylpentane	24	8.72	0.04	6.17
2-Methylpentane	20	3.79	0.16	2.68
4-Methyl-1-pentene	0	NA	NA	NA
2-Methyl-1-pentene	2	12.05	0.01	8.52
n-Nonane	23	16.89	0.04	11.94
1-Nonene	13	**29.03**	0.07	**20.53**

Table 32-45. SNMOC Analytical Precision:
24 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL) (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
n-Octane	22	9.85	0.04	6.97
1-Octene	11	12.28	0.03	8.68
n-Pentane	24	4.13	0.08	2.92
1-Pentene	24	6.59	0.02	4.66
cis-2-Pentene	13	**27.07**	0.03	**19.14**
trans-2-Pentene	22	16.21	0.03	11.46
a-Pinene	18	8.85	0.04	6.25
b-Pinene	0	NA	NA	NA
Propane	24	1.81	0.11	1.28
n-Propylbenzene	17	7.56	0.02	5.34
Propylene	24	4.22	0.04	2.99
Propyne	0	NA	NA	NA
Styrene	5	**66.86**	1.25	**47.28**
TNMOC (Speciated)	24	15.54	70.37	10.99
TNMOC (w/unknowns)	24	4.03	7.27	2.85
Toluene	24	10.68	0.25	7.55
n-Tridecane	1	**107.36**	0.25	**75.91**
1-Tridecene	0	NA	NA	NA
1,2,3-Trimethylbenzene	16	**36.59**	0.13	**25.88**
1,2,4-Trimethylbenzene	24	6.90	0.04	4.88
1,3,5-Trimethylbenzene	18	8.73	0.03	6.17
2,2,3-Trimethylpentane	18	18.25	0.05	12.90
2,2,4-Trimethylpentane	24	6.23	0.06	4.40
2,3,4-Trimethylpentane	24	7.86	0.02	5.56
n-Undecane	18	11.13	0.06	7.87
1-Undecene	6	**66.28**	0.25	**46.87**
m-Xylene/*p*-Xylene	24	10.12	0.13	7.15
o-Xylene	23	17.88	0.06	12.64

Table 32-46 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV. The average site CV ranged from 8.83 percent at CUSD to 11.27 percent at NBIL, with an overall program average CV of 10.28 percent. This overall average variability is within the 15 percent CV Program DQO.

Table 32-46. SNMOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Northbrook, IL (NBIL)	Sioux Falls, SD (SFSD)
Acetylene	*3.55*	6.03	1.26	1.79	2.42	6.26
Benzene	*4.34*	4.06	3.78	3.76	6.50	3.58
1,3-Butadiene	*9.24*	4.20	6.29	11.80	8.77	**15.14**
n-Butane	*2.86*	0.59	1.01	3.02	5.63	4.07
cis-2-Butene	*8.53*	6.26	3.98	10.03	10.27	12.13
trans-2-Butene	*8.74*	12.88	6.06	6.30	12.02	6.46
Cyclohexane	*7.47*	3.87	7.86	10.17	6.52	8.91
Cyclopentane	*8.12*	4.25	14.55	10.61	5.59	5.60
Cyclopentene	***17.90***	**45.39**	8.32	8.32	**18.03**	9.44
n-Decane	*9.76*	9.14	14.35	5.73	9.71	9.88
1-Decene	***21.63***	**21.63**	NA	NA	NA	NA
m-Diethylbenzene	***17.87***	10.99	**16.02**	4.56	**22.74**	**35.02**
p-Diethylbenzene	***24.25***	**22.29**	**26.32**	**35.23**	**24.09**	13.34
2,2-Dimethylbutane	*7.45*	6.47	8.80	6.91	8.70	6.34
2,3-Dimethylbutane	*6.02*	4.45	4.90	5.79	9.90	5.07
2,3-Dimethylpentane	*5.79*	3.34	9.13	8.09	4.72	3.66
2,4-Dimethylpentane	*8.45*	7.12	10.09	12.09	5.13	7.80
n-Dodecane	***24.25***	**20.97**	**18.64**	12.12	**20.09**	**49.43**
1-Dodecene	***26.19***	**25.87**	11.69	**43.97**	**23.21**	NA
Ethane	*6.76*	**18.92**	9.60	0.57	1.11	3.61
Ethylbenzene	*9.48*	6.41	14.41	7.70	7.56	11.33
2-Ethyl-1-butene	*NA*	NA	NA	NA	NA	NA
Ethylene	*8.38*	13.13	12.39	1.73	2.34	12.30
m-Ethyltoluene	*7.53*	6.51	5.48	6.83	11.33	7.51
o-Ethyltoluene	*9.83*	11.12	4.46	11.71	13.68	8.19
p-Ethyltoluene	*11.00*	9.01	8.57	9.53	14.48	13.39
n-Heptane	*5.69*	4.25	5.42	3.60	9.31	5.89
1-Heptene	*12.07*	8.93	**15.81**	**15.08**	**16.99**	3.55
n-Hexane	*4.49*	3.11	5.33	3.01	5.86	5.13
1-Hexene	*10.12*	11.83	8.99	14.34	7.09	8.37
cis-2-Hexene	***29.62***	**56.98**	2.26	NA	NA	NA
trans-2-Hexene	***31.71***	NA	**23.35**	**40.08**	NA	NA
Isobutane	*1.26*	0.34	0.99	1.37	1.83	1.75
Isobutene/1-Butene	*3.04*	2.73	2.65	2.29	3.77	3.78
Isopentane	*2.11*	0.63	3.80	2.35	2.09	1.66
Isoprene	*6.79*	8.93	4.41	4.91	6.70	8.99
Isopropylbenzene	***17.86***	11.66	7.16	**36.90**	**19.08**	14.50
Isopentane	*8.16*	8.44	9.24	7.10	10.01	6.03
Isoprene	*13.85*	8.47	12.44	14.87	**22.34**	11.12
Isopropylbenzene	***44.23***	NA	NA	NA	NA	**44.23**
2-Methyl-1-butene	*6.60*	4.67	7.53	8.10	7.57	5.14
2-Methyl-2-butene	*5.17*	3.47	7.76	6.50	3.18	4.91

Table 32-46. SNMOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Continued)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Northbrook, IL (NBIL)	Sioux Falls, SD (SFSD)
2-Methylheptane	*7.56*	6.44	5.97	10.65	8.07	6.66
3-Methylheptane	*9.49*	5.95	7.83	13.34	10.39	9.95
2-Methylhexane	*7.71*	10.48	8.30	9.48	7.49	2.82
3-Methylhexane	*6.71*	3.48	4.47	11.51	5.32	8.79
3-Methylpentane	*4.86*	2.34	2.64	6.61	6.17	6.55
2-Methylpentane	*5.47*	2.86	8.94	5.21	2.68	7.65
4-Methyl-1-pentene	***17.18***	10.58	**16.24**	**28.56**	NA	13.36
2-Methyl-1-pentene	*11.33*	3.38	3.36	**30.03**	8.52	NA
n-Nonane	*9.28*	9.96	10.76	7.06	11.94	6.66
1-Nonene	***20.55***	**28.68**	12.17	13.86	**20.53**	**27.52**
n-Octane	*5.54*	3.27	6.92	4.56	6.97	6.01
1-Octene	***15.58***	10.72	**16.60**	**21.22**	8.68	**20.69**
n-Pentane	*2.56*	1.74	2.00	4.38	2.92	1.76
1-Pentene	*8.30*	8.09	12.96	6.98	4.66	8.80
cis-2-Pentene	*12.14*	8.03	4.03	**19.71**	**19.14**	9.79
trans-2-Pentene	*8.30*	5.90	6.72	6.67	11.46	10.77
a-Pinene	*7.89*	9.79	6.90	3.83	6.25	12.67
b-Pinene	***19.43***	**20.26**	**23.93**	**31.90**	NA	1.61
Propane	*0.87*	0.51	0.80	0.71	1.28	1.06
n-Propylbenzene	*13.85*	13.23	8.22	**28.65**	5.34	13.79
Propylene	*2.88*	1.62	2.11	1.76	2.99	5.90
Propyne	*NA*	NA	NA	NA	NA	NA
Styrene	***21.67***	**19.70**	4.87	10.20	**47.28**	**26.31**
TNMOC (Speciated)	*3.83*	2.40	1.78	1.96	10.99	2.03
TNMOC (w/unknowns)	*3.32*	2.73	2.60	4.87	2.85	3.57
Toluene	*4.19*	3.48	3.96	2.48	7.55	3.48
n-Tridecane	***43.03***	**35.51**	**17.67**	NA	**75.91**	NA
1-Tridecene	*NA*	NA	NA	NA	NA	NA
1,2,3-Trimethylbenzene	***17.87***	12.69	14.15	**17.44**	**25.88**	**19.16**
1,2,4-Trimethylbenzene	*6.99*	6.49	5.65	12.33	4.88	5.59
1,3,5-Trimethylbenzene	*11.15*	9.79	**18.45**	12.05	6.17	9.30
2,2,3-Trimethylpentane	***21.96***	11.54	**27.25**	**27.71**	12.90	**30.38**
2,2,4-Trimethylpentane	*6.08*	4.31	5.83	6.86	4.40	8.99
2,3,4-Trimethylpentane	*7.19*	6.11	6.41	7.83	5.56	10.07
n-Undecane	*11.99*	12.03	10.10	9.87	7.87	**20.10**
1-Undecene	***23.20***	8.63	14.34	NA	**46.87**	**22.95**
m-Xylene/*p*-Xylene	*6.16*	4.67	5.49	3.26	7.15	10.22
o-Xylene	*8.57*	5.04	6.82	11.69	12.64	6.64
Average	*10.28*	*9.76*	*8.83*	*11.03*	*11.27*	*10.49*

32.2.3 Carbonyl Compound Analytical Precision

In Table 32-47, the replicate analyses for duplicate and collocated samples show that laboratory carbonyl analysis precision is within the control limits of 15 percent CV. The overall average variability is 1.90 percent. In terms of average concentration difference, the carbonyl precision ranges from 0.001 ppbv for benzaldehyde, crotonaldehyde, isovaleraldehyde, and hexaldehyde to 0.01 ppbv for formaldehyde.

Table 32-47. Carbonyl Analytical Precision: 734 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	734	0.57	0.005	0.41
Acetone	734	0.77	0.005	0.55
Benzaldehyde	726	3.36	0.001	2.38
Butyraldehyde	728	2.72	0.002	1.92
Crotonaldehyde	698	2.82	0.001	1.99
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	732	0.68	0.01	0.48
Hexaldehyde	714	4.12	0.001	2.91
Isovaleraldehyde	317	3.33	0.001	2.35
Propionaldehyde	730	2.53	0.002	1.79
Tolualdehydes	704	4.39	0.002	3.10
Valeraldehyde	711	4.20	0.002	2.97

Table 32-48 shows the results from replicate analyses of all collocated carbonyl samples taken at DEMI, LDTN, MSTN, NBIL, SPIL, and WETX. The replicate results from collocated samples show variation for the pollutants ranging from 0.43 percent (acetaldehyde) to 3.10 percent (tolualdehydes). The overall average variability is 1.86 percent.

Table 32-48. Carbonyl Analytical Precision:
264 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	264	0.60	0.004	0.43
Acetone	264	0.64	0.004	0.45
Benzaldehyde	256	3.35	0.001	2.37
Butyraldehyde	258	2.25	0.002	1.59
Crotonaldehyde	244	3.78	0.002	2.68
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	264	0.69	0.01	0.49
Hexaldehyde	256	4.27	0.003	3.02
Isovaleraldehyde	116	3.42	0.001	2.42
Propionaldehyde	260	2.16	0.002	1.53
Tolualdehydes	254	4.38	0.001	3.10
Valeraldehyde	254	3.46	0.001	2.44

Table 32-49 shows the results from replicate analyses for all duplicate carbonyl samples. The replicate results from duplicate samples show variation for the pollutants ranging from 0.40 percent (acetaldehyde) to 3.13 percent (valeraldehyde). The overall average variability is 1.91 percent.

Table 32-49. Carbonyl Analytical Precision:
470 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	470	0.57	0.01	0.40
Acetone	470	0.81	0.005	0.57
Benzaldehyde	470	3.37	0.001	2.38
Butyraldehyde	470	2.86	0.002	2.02
Crotonaldehyde	454	2.53	0.001	1.79
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	468	0.68	0.01	0.48
Hexaldehyde	458	4.07	0.001	2.88
Isovaleraldehyde	201	3.30	0.001	2.34

Table 32-49. Carbonyl Analytical Precision:
470 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	470	2.64	0.002	1.86
Tolualdehydes	450	4.39	0.002	3.10
Valeraldehyde	457	4.42	0.002	3.13

Tables 32-50 through 32-56 present the precision results from carbonyl replicate analyses for duplicate and collocated samples at NATTS sites (BTUT, DEMI, GPCO, NBIL, S4MO, SKFL, and SYFL, respectively). The replicate results from the NATTS duplicate samples show low-level variability among the sites, ranging from 0.10 percent for acetone at GPCO to 12.79 percent for valeraldehyde at BTUT. The average CV, 1.97 percent, is within the Program DQO of 15 percent overall CV per site.

Table 32-50. Carbonyl Analytical Precision:
24 Replicate Analyses for Duplicate Samples for Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	24	0.44	0.01	0.31
Acetone	24	0.42	0.01	0.29
Benzaldehyde	24	4.62	0.002	3.26
Butyraldehyde	24	0.74	0.001	0.52
Crotonaldehyde	20	2.99	0.001	2.11
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	24	0.60	0.02	0.43
Hexaldehyde	24	1.81	0.001	1.28
Isovaleraldehyde	14	2.29	<0.001	1.62
Propionaldehyde	24	1.86	0.003	1.31
Tolualdehydes	22	5.50	0.003	3.89
Valeraldehyde	23	18.09	0.02	12.79

Table 32-51. Carbonyl Analytical Precision: 110 Replicate Analyses for Collocated Samples for Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	110	0.75	0.01	0.53
Acetone	110	0.70	0.01	0.49
Benzaldehyde	108	5.77	0.002	4.08
Butyraldehyde	110	2.86	0.004	2.02
Crotonaldehyde	104	5.07	0.003	3.58
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	110	0.91	0.02	0.64
Hexaldehyde	108	5.58	0.003	3.94
Isovaleraldehyde	62	6.07	0.001	4.29
Propionaldehyde	110	2.49	0.003	1.76
Tolualdehydes	108	7.25	0.002	5.13
Valeraldehyde	108	5.41	0.002	3.83

Table 32-52. Carbonyl Analytical Precision: 20 Replicate Analyses for Duplicate Samples for Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	20	0.48	0.004	0.34
Acetone	20	0.15	0.002	0.10
Benzaldehyde	20	2.70	0.001	1.91
Butyraldehyde	20	2.23	0.002	1.58
Crotonaldehyde	20	2.96	0.001	2.09
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	20	0.42	0.01	0.29
Hexaldehyde	20	4.51	0.001	3.19
Isovaleraldehyde	12	2.83	<0.001	2.00
Propionaldehyde	20	2.17	0.002	1.54
Tolualdehydes	20	3.24	0.001	2.29
Valeraldehyde	20	3.56	0.001	2.51

Table 32-53. Carbonyl Analytical Precision:
32 Replicate Analyses for Collocated Samples for Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	32	0.62	0.003	0.44
Acetone	32	0.58	0.003	0.41
Benzaldehyde	32	2.15	0.001	1.52
Butyraldehyde	32	1.40	0.001	0.99
Crotonaldehyde	32	3.35	0.001	2.37
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	32	0.49	0.01	0.35
Hexaldehyde	32	1.78	0.001	1.26
Isovaleraldehyde	4	NA	NA	NA
Propionaldehyde	32	1.78	0.001	1.26
Tolualdehydes	32	5.31	0.002	3.75
Valeraldehyde	32	1.81	0.001	1.28

Table 32-54. Carbonyl Analytical Precision:
28 Replicate Analyses for Duplicate Samples for St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	28	0.40	0.01	0.28
Acetone	28	0.42	0.01	0.30
Benzaldehyde	28	3.00	0.001	2.12
Butyraldehyde	28	2.78	0.002	1.96
Crotonaldehyde	24	3.82	0.001	2.70
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	28	0.51	0.01	0.36
Hexaldehyde	28	4.11	0.001	2.90
Isovaleraldehyde	16	2.13	0.001	1.51
Propionaldehyde	28	3.48	0.003	2.46
Tolualdehydes	28	6.35	0.003	4.49
Valeraldehyde	28	2.79	0.001	1.97

Table 32-55. Carbonyl Analytical Precision: 24 Replicate Analyses for Duplicate Samples for Tampa, FL (SKFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	24	0.48	0.003	0.34
Acetone	24	0.76	0.002	0.54
Benzaldehyde	24	2.15	0.001	1.52
Butyraldehyde	24	2.49	0.002	1.76
Crotonaldehyde	24	1.73	0.001	1.23
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	24	0.59	0.01	0.42
Hexaldehyde	24	3.32	0.001	2.35
Isovaleraldehyde	8	0.94	<0.001	0.67
Propionaldehyde	24	3.65	0.003	2.58
Tolualdehydes	22	3.85	0.001	2.72
Valeraldehyde	24	3.29	0.001	2.33

Table 32-56. Carbonyl Analytical Precision: 28 Replicate Analyses for Duplicate Samples for Tampa, FL (SYFL)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	28	0.90	0.005	0.63
Acetone	28	1.46	0.004	1.03
Benzaldehyde	28	4.12	0.001	2.91
Butyraldehyde	28	2.23	0.002	1.58
Crotonaldehyde	28	2.38	0.002	1.68
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	28	0.84	0.01	0.59
Hexaldehyde	28	3.40	0.001	2.40
Isovaleraldehyde	12	4.62	0.001	3.26
Propionaldehyde	28	4.01	0.003	2.84
Tolualdehydes	28	4.23	0.001	2.99
Valeraldehyde	28	3.87	0.001	2.73

Table 32-57 presents the average CV per pollutant, per pollutant per site, per site, and the overall CV. The replicate results from duplicate and collocated samples show low-level variability among the sites, ranging from 1.36 percent at NBIL to 2.76 percent at DEMI. The average CV is 1.90 percent, which is well with in the requested 15 percent overall CV per site.

Table 32-57. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average	St. Petersburg, FL (AZFL)	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)
Acetaldehyde	*0.41*	0.59	0.43	0.31	0.62	0.46	0.36	0.53
Acetone	*0.55*	0.52	0.94	0.29	1.50	0.39	0.29	0.49
Benzaldehyde	*2.38*	3.00	2.30	3.26	0.60	3.44	2.71	4.08
Butyraldehyde	*1.92*	2.47	2.98	0.52	3.15	1.76	1.20	2.02
Crotonaldehyde	*1.99*	1.55	2.63	2.11	1.34	1.82	2.09	3.58
2,5-Dimethylbenzaldehyde	*NA*	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*0.48*	0.44	1.07	0.43	0.83	0.45	0.67	0.64
Hexaldehyde	*2.91*	2.93	3.21	1.28	2.74	3.05	3.65	3.94
Isovaleraldehyde	*2.35*	NA	NA	1.62	3.56	3.18	2.22	4.29
Propionaldehyde	*1.79*	1.67	3.04	1.31	1.86	1.50	1.28	1.76
Tolualdehydes	*3.10*	2.13	4.34	3.89	6.24	3.10	3.32	5.13
Valeraldehyde	*2.97*	2.40	3.11	12.79	3.85	2.74	2.31	3.83
Average	*1.90*	*1.77*	*2.40*	*2.53*	*2.39*	*1.99*	*1.83*	*2.76*

Table 32-57. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Elizabeth, NJ (ELNJ)	Davie, FL (FLFL)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)	Nashville, TN (MSTN)
Acetaldehyde	*0.41*	0.27	0.10	0.47	0.34	0.47	0.36	0.24
Acetone	*0.55*	0.36	0.69	0.69	0.10	0.70	0.27	0.35
Benzaldehyde	*2.38*	3.32	2.18	3.02	1.91	2.21	2.33	3.20
Butyraldehyde	*1.92*	1.27	2.24	1.83	1.58	2.33	2.26	1.95

Table 32-57. Carbonyl Analytical Precision:
Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Elizabeth, NJ (ELNJ)	Davie, FL (FLFL)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Nashville, TN (LDTN)	Nashville, TN (MSTN)
Crotonaldehyde	*1.99*	2.67	1.76	1.49	2.09	1.80	2.97	2.70
2,5-Dimethylbenzaldehyde	*NA*	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*0.48*	0.33	0.36	0.30	0.29	0.92	0.57	0.44
Hexaldehyde	*2.91*	3.28	2.93	3.03	3.19	3.10	2.95	2.50
Isovaleraldehyde	*2.35*	3.65	3.20	2.62	2.00	2.02	0.42	3.60
Propionaldehyde	*1.79*	2.52	1.53	1.39	1.54	2.04	0.99	1.55
Tolualdehydes	*3.10*	3.87	2.38	2.02	2.29	3.43	2.46	2.64
Valeraldehyde	*2.97*	2.07	2.04	2.11	2.51	3.39	1.61	2.54
Average	*1.90*	*2.15*	*1.77*	*1.72*	*1.62*	*2.04*	*1.56*	*1.97*

Table 32-57. Carbonyl Analytical Precision:
Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Orlando, FL (ORFL)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)	San Juan, PR (SJPR)	Tampa, FL (SKFL)
Acetaldehyde	*0.41*	0.44	0.34	0.30	0.28	0.32	0.19	0.34
Acetone	*0.55*	0.41	0.52	0.37	0.30	0.33	0.84	0.54
Benzaldehyde	*2.38*	1.52	1.40	2.62	2.12	2.53	1.57	1.52
Butyraldehyde	*1.92*	0.99	2.22	1.60	1.96	1.06	2.87	1.76
Crotonaldehyde	*1.99*	2.37	0.97	1.04	2.70	2.90	1.08	1.23
2,5-Dimethylbenzaldehyde	*NA*	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	*0.48*	0.35	0.31	0.34	0.36	0.39	0.31	0.42
Hexaldehyde	*2.91*	1.26	1.94	2.66	2.90	3.16	3.93	2.35
Isovaleraldehyde	*2.35*	NA	NA	NA	1.51	NA	1.44	0.67
Propionaldehyde	*1.79*	1.26	1.74	1.09	2.46	1.03	1.46	2.58
Tolualdehydes	*3.10*	3.75	3.01	1.60	4.49	3.35	2.90	2.72
Valeraldehyde	*2.97*	1.28	3.80	2.86	1.97	2.29	3.75	2.33
Average	*1.90*	*1.36*	*1.63*	*1.45*	*1.91*	*1.74*	*1.85*	*1.50*

Table 32-57. Carbonyl Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average	Tampa, FL (SMFL)	Schiller Park, IL (SPIL)	Tampa, FL (SYFL)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Acetaldehyde	*0.41*	0.97	0.38	0.63	0.21	0.59
Acetone	*0.55*	0.73	0.55	1.03	0.32	0.63
Benzaldehyde	*2.38*	2.37	1.41	2.91	2.62	1.67
Butyraldehyde	*1.92*	2.88	0.77	1.58	3.17	1.54
Crotonaldehyde	*1.99*	0.89	2.61	1.68	1.93	1.82
2,5-Dimethylbenzaldehyde	*NA*	NA	NA	NA	NA	NA
Formaldehyde	*0.48*	0.38	0.20	0.59	0.41	0.72
Hexaldehyde	*2.91*	3.56	5.03	2.40	2.35	2.42
Isovaleraldehyde	*2.35*	1.75	NA	3.26	NA	1.35
Propionaldehyde	*1.79*	1.51	1.82	2.84	2.88	1.77
Tolualdehydes	*3.10*	2.27	2.37	2.99	1.74	2.23
Valeraldehyde	*2.97*	2.59	3.07	2.73	0.85	2.34
Average	*1.90*	*1.81*	*1.82*	*2.06*	*1.65*	*1.55*

32.2.4 Hexavalent Chromium Analytical Precision

Table 32-58 presents the hexavalent chromium analytical precision data. The duplicate hexavalent chromium samples for the WETX site were not analyzed in replicate, therefore is not included. The range of variability for hexavalent chromium is 1.00 percent (CHSC) to 11.70 percent (WADC), with the overall average variation of 4.4 percent.

Table 32-58. Hexavalent Chromium Analytical Precision: Replicate Analyses for Collocated Samples

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
BTUT	70	0.22	0.001	4.00
BOMA	8	10.34	0.004	7.30
CHSC	8*	1.41	<0.001	1.00
DEMI	30	1.94	0.004	5.30
GPCO	8	3.52	0.002	3.60
HAKY	8*	1.39	0.002	9.30

Table 32-58. Hexavalent Chromium Analytical Precision: Replicate Analyses for Collocated Samples (Continued)

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
MVWI	8*	NA	NA	NA
NBIL	62	0.02	0.002	2.80
PRRI	8*	0.14	NA	1.20
PXSS	12	0.14	0.01	4.50
S4MO	8	3.74	0.002	2.60
SDGA	8	2.32	0.001	1.60
SYFL	12*	0.60	0.001	2.90
UNVT	12*	NA	NA	NA
WADC	8*	16.51	0.002	11.70
Average	*26*	*3.25*	*0.002*	*4.40*

* Over half of the detects were under the detection limit.

32.3 Bias

Laboratories typically evaluate their bias (or accuracy) by analyzing external audit samples and comparing the measured concentrations obtained to the known concentrations of those audit samples. Bias, or accuracy, indicates the extent to which experimental measurements represent their corresponding "true" or "actual" values.

The accuracy of the 2006 monitoring data can also be assessed qualitatively by reviewing the accuracy of the monitoring methods and how they were implemented:

- The sampling and analytical methods used in the 2006 monitoring effort have been approved by EPA for accurately measuring ambient levels of various compounds—an approval that is based on many years of research into the development of ambient air monitoring methodologies.

- When collecting and analyzing ambient air samples, all field sampling staff and laboratory analysts strictly followed quality control and quality assurance guidelines detailed in the respective monitoring methods. This strict adherence to the well-documented sampling and analytical methods suggests, though certainly does not prove, that the 2006 monitoring data accurately represent ambient air quality.

32.3.1 Proficiency Test Studies

Laboratories participating in NATTS are provided with proficiency test (PT) audit samples on a quarterly basis for VOC, carbonyls, and metals. These PT samples can be used as a measure of analytical accuracy.

Tables 32-59 through 32-61 present ERG's results from the 2006 NATTS PT audit samples for carbonyls, metals, and VOC, respectively. The acceptable percent difference from the true values is ± 25 percent, and the values exceeding this criteria are bolded in the tables. While there are a few values outside the Program DQOs, there are no compounds that are consistently over for multiple audits.

Table 32-59. Carbonyl NATTS PT Audit Samples – Percent Difference from True Value

Pollutant	June, 2006	October, 2006
Acetaldehyde	0.8	-2.5
Crotonaldehyde	**-31.0**	**-28.0**
Formaldehyde	-9.7	-16.8

Table 32-60. Metals NATTS PT Audit Samples – Percent Difference from True Value

Pollutant	April, 2006	July, 2006	September, 2006	November, 2006
Arsenic	17.3	10.8	2.3	**25.1**
Beryllium	15.5	16.0	1.4	23.6
Cadmium	19.9	3.8	-1.9	17.4
Lead	13.0	5.5	-6.6	4.5
Manganese	20.8	-10.0	-9.5	-0.5
Nickel	14.8	-3.0	-8.2	1.1

Table 32-61. VOC NATTS PT Audit Samples – Percent Difference from True Value

Pollutant	May, 2006	August, 2006	October, 2006	December, 2006
Acrolein	Not included	Not included	**-36.5**	**-27.2**
Benzene	-14.1	-1.4	-5.0	**-31.2**
1,3-Butadiene	8.5	3.9	3.9	7.3
Carbon Tetrachloride	-4.0	-18.8	4.3	-1.7
Chloroform	14.6	0.0	-2.1	3.2
1,2-Dibromoethane	7.6	22.5	4.6	-18.5

Table 32-61. VOC NATTS PT Audit Samples – Percent Difference from True Value (Continued)

Pollutant	May, 2006	August, 2006	October, 2006	December, 2006
1,2-Dichloroethane	**27.1**	9.8	5.1	-10.7
Dichloromethane	14.1	10.5	8.5	8.0
1,2-Dichloropropane	-12.8	-1.4	-3.2	-8.2
cis-1,3-Dichloropropene	3.5	13.3	-0.6	**-35.6**
trans-1,3-Dichloropropene	1.4	17.9	1.2	**-39.3**
1,1,2,2-Tetrachloroethane	-5.6	11.4	-2.9	-20.5
Tetrachloroethylene	-13.3	-9.7	-12.6	-21.4
Trichloroethylene	13.9	**50.6**	10.1	-8.1
Vinyl Chloride	-5.1	-11.4	-18.5	-9.2

33.0 Conclusions and Recommendations

As presented in this report, UATMP monitoring data offer a wealth of information for evaluating trends, patterns, and the potential for health risk in air quality and should ultimately help a wide range of audiences understand the complex nature of urban and rural air pollution. The following discussion summarizes the primary conclusions drawn from this report and presents recommendations for ongoing urban air monitoring efforts.

33.1 Conclusions

Characterization of the 2006 UATMP monitoring data identified the following notable trends and patterns in national-level and state-level urban air pollution:

33.1.1 National-Level Conclusions

- *Ambient air concentration data sets.* Generally, the data met the quality objectives for completeness. The target for completeness was 85-100 percent. Sixteen of 139 data sets failed to comply with the data quality objective of 85 percent completeness. Forty-nine data sets achieved 100 percent completeness.

- *NATTS sites.* Eighteen of the 59 sites are EPA-designated NATTS sites (BOMA, BTUT, CHSC, DEMI, GPCO, HAKY, LAOR, MVWI, NBIL, PRRI, PXSS, S4MO, SDGA, SEWA, SKFL, SYFL, UNVT, and WADC).

- *Number of samples for UATMP pollutants.* 182,974 valid measurements of urban air toxics were made.

- *Ambient air concentrations of urban air toxics.* Approximately 78 percent of the measured concentrations were less than 1 $\mu g/m^3$. Less than 3 percent of the concentrations were greater than 5 $\mu g/m^3$.

- *Measured Detections.* Ninety-one pollutants were not detected at any of the participating sites. However, if SVOC analysis measured with SW-846 Method 8270 are excluded, nine pollutants (bromochloromethane; 1,1-dichloroethane; *cis*-1,3-dichloropropene; *trans*-1,3-dichloropropene; 2,5-dimethylbenzaldehyde; l-decene; 2-ethyl-1-butene; l-tridecene; and propyne) were not detected at any of the participating sites.

- *Nationwide Pollutants of Interest.* The pollutants of interest at the national level, based on the number of exceedances, or "failures", of the preliminary risk screening values, included: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, formaldehyde, hexachloro-1,3-butadiene, hexavalent chromium, manganese, naphthalene, and tetrachloroethylene. The pollutants of interest varied for the individual sites.

- *Short-term Risk.* Three pollutants of interest (acrolein, benzene, and formaldehyde) had daily measurements that exceeded one or both of the short-term risk factors. Acrolein exceeded the ATSDR short-term MRL and the CALEPA REL at thirty-three sites; benzene exceeded the ATSDR short-term MRL at SIAL; and formaldehyde exceeded the ATSDR short-term MRL at INDEM, NBIL, and SPIL (all within the Chicago MSA).

- *Chronic Cancer Risk.* The cancer risk calculated for SIAL for benzene (48 in-a-million) was the highest of all annual average-based cancer risks. By comparison, NATA-modeled cancer risk was highest for arsenic at ININ (208 in-a-million), dichloromethane at BAPR (71 in-a-million), and benzene at MIMN (39 in-a-million), based on the NATA.

- *Chronic Noncancer Risk.* Five sites exhibited acrolein HQs based on annual averages greater than 100, each in the Austin, Texas area. Twenty-eight other sites had acrolein HQs that were greater than 1.0. In addition, manganese had HQs greater than 1.0 for the three Birmingham, Alabama sites, and formaldehyde's HQs were greater than 1.0 for SPIL and INDEM. Noncancer risk (HQ) based on NATA was highest for acrolein for ELNJ (35.46), and only acrolein had modeled HQ values greater than 1.0.

- *Pearson Correlations.* Pearson Correlations between each pollutant of interest and various meteorological parameters were computed for each site. Generally, the meteorological parameters had poor correlations with the nationwide pollutants of interest across all the sites. The Pearson Correlations were much stronger at the individual sites.

- *Automobile Impacts.* Maricopa County, AZ had the highest vehicle registration, while Jefferson County, AL had the highest hydrocarbon average concentration of all the UATMP counties. The Schiller Park site (SPIL) near Chicago had the highest daily traffic passing by the monitor (214,900), and Cook County, IL, the county where SPIL is located , also had the highest nonroad emissions of all the participating sites; Wayne County, MI, the county where DEMI is located, had the highest on-road emissions of all the sites. The Cherokee Nation site (CNEP) in Pryor, Oklahoma had the lowest daily traffic volume (5).

- *Emissions and Toxicity Weighted Emissions.* Benzene is the pollutant (with a cancer risk factor) that had the highest county-level emissions for most UATMP counties. This pollutant also had the highest toxicity-weighted emissions. Acrolein had the highest toxicity-weighted emissions of pollutants with noncancer risk factors, although it was not emitted in high enough quantities to rank in the top 10 for any UATMP county.

33.1.2 Supplementary Observations and Interpretations

- Acetaldehyde and formaldehyde were the two most common pollutants of interest for the UATMP sites. All sites that sampled carbonyls had acetaldehyde and formaldehyde as pollutants of interest. Benzene and carbon tetrachloride were the two most common VOC pollutants of interest. Every site that sampled VOC had these two pollutants as pollutants of interest.

- Formaldehyde frequently had the highest daily average for the UATMP sites; this pollutant had the highest daily average for twenty-eight sites. Xylenes followed with seven sites.

- Pearson correlations calculated between formaldehyde and the temperature parameters (maximum and average temperature) for many UATMP sites were at least moderately strong and positive. This indicates that as temperatures increase, concentrations of formaldehyde also increase. At some of these same sites, the summer formaldehyde average tended to be higher than other seasons, supporting this observation.

- Pearson correlations calculated between most of the pollutants of interest and the scalar wind speed at most UATMP sites tended to be negative. This indicates that as wind speed decreases, concentrations of the pollutants of interest increase.

- Pearson correlations calculated between hexachloro-1,3-butadiene and the meteorological parameters for many UATMP appear to be strong. It must be noted that this compound was detected fairly infrequently at most sites, and that this low number of measured detections may skew the correlations into appearing stronger than they might be with a large measurement population.

- Carbon tetrachloride often had relatively high cancer risks based on annual averages for the UATMP sites, but tended to have relatively low emissions and toxicity-weighted emissions according to the NEI emissions inventory. This suggests that this pollutant is present in "background" levels of ambient air; that is, it is consistently present at similar levels at any given location. Although production of this pollutant has declined sharply over the last thirty years due to its role as an ozone depleting substance, it has a relatively long atmospheric lifetime.

- Acrolein emissions and mass concentrations are relatively low when compared to other pollutants. However, due to the high toxicity of this pollutant, low mass concentrations translated into very high noncancer risks. This trend was also evident when the acrolein emissions were toxicity-weighted; the toxicity-weighted value was often several orders of magnitude higher than other pollutants. Acrolein was also a national noncancer risk driver according to NATA.

33.1.3 State-Level Conclusions

- *Alabama*.

  - The Alabama sites began sampling in mid-July 2005 and continued through June 2006. They sampled for VOC, carbonyl compounds, SVOC, and metals (TSP at all four sites, PM_{10} at NBAL). In order to facilitate analysis, data from the entire year's worth of sampling were utilized in the site-specific analyses.

  - The pollutants of interest common to each Alabama site were: acrolein, arsenic, formaldehyde, carbon tetrachloride, manganese, acetaldehyde, benzene, naphthalene, hexachloro-1,3-butadiene, and *p*-dichlorobenzene.

  - Of the pollutants of interest for each site, total xylenes had the highest daily average for ETAL and NBAL, while formaldehyde had the highest daily average for PVAL, and benzene was highest for SIAL.

  - Acrolein exceeded the short-term risk factors at all of the Alabama sites each time it was measured. One benzene concentration exceeded the short-term risk factor at SIAL. Where seasonal averages could be calculated for acrolein, they exceeded the intermediate risk factors. None of the seasonal averages of benzene for SIAL exceeded the intermediate risk factor.

  - Most of the pollutants of interest, especially formaldehyde, exhibited positive correlations with maximum, average, dew point, and wet bulb temperatures across the Alabama sites. Negative correlations were consistently calculated between most of the pollutants of interest and scalar wind speed.

  - As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the Alabama sites. The airshed domains were comparable in size to other UATMP sites, as the farthest away back trajectories originated was 600 miles.

  - The wind roses for the Birmingham sites show that calm winds were observed for about 1/3 of observations, and that northerly, south-southeasterly, and southerly winds were predominant near the Birmingham sites. The PVAL site's wind rose shows that while calm winds were also observed 1/3 of the time, southerly, westerly, and west-northwesterly winds were most common.

  - Benzene had the highest annual average-based cancer risks for ETAL, NBAL, and SIAL, while hexachloro-1,3-butadiene had the highest annual average-based cancer risk for PVAL. By comparison, benzene, 1,3-butadiene, and acetaldehyde had the highest NATA-modeled cancer risk for the three Birmingham census tracts, while benzene, carbon tetrachloride, and acetaldehyde had the highest NATA-modeled cancer risk for the PVAL census tract.

- Acrolein exhibited the highest annual average-based and NATA-modeled noncancer risks for each of the Alabama sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in Jefferson County, Alabama, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions in Jefferson County.

- *Arizona*.

  - The PXSS site sampled for metals (PM_{10}) and hexavalent chromium.

  - The pollutants of interest for PXSS were: manganese, arsenic, and hexavalent chromium.

  - Of the pollutants of interest, manganese had the highest daily average for PXSS, and was two orders of magnitude higher than the daily averages of the other pollutants of interest.

  - No concentrations exceeded the short-term risk factors at PXSS.

  - Correlations between the pollutants of interest for PXSS and the meteorological parameters were mostly weak.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at PXSS. The airshed domain was somewhat smaller in size compared to other UATMP sites, as the farthest away a back trajectory originated was just over 500 miles.

  - The wind rose shows that winds were predominantly from the east near PXSS.

  - Arsenic had the highest annual average-based cancer risk for PXSS. In comparison, hexavalent chromium had the highest NATA-modeled cancer risk for the census tract where PXSS is located. The NATA-modeled cancer risks for the pollutants that failed at least one screen at PXSS tended to be at least an order of magnitude lower than those based on the annual averages.

  - Manganese exhibited the highest annual average-based noncancer risk for PXSS. Although none of the annual average-based noncancer risks were greater than 1, they tended to be at least an order of magnitude higher than the NATA-modeled noncancer risks.

  - Benzene was the highest emitted pollutant with a cancer risk factor in Maricopa County, Arizona, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-

emissions, while acrolein had the highest noncancer toxicity weighted-emissions in Maricopa County.

- *Colorado*.

  - The GPCO site sampled for VOC and carbonyl compounds.

  - The pollutants of interest for GPCO were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, acrolein, tetrachloroethylene, and *p*-dichlorobenzene.

  - Of the pollutants of interest, formaldehyde had the highest daily average for GPCO, followed by acetaldehyde and benzene. Formaldehyde was highest in summer; carbon tetrachloride was highest in summer and autumn; and benzene and 1,3-butadiene were highest in autumn and winter.

  - Every acrolein concentration exceeded the short-term risk factors for GPCO, and every seasonal average of acrolein exceeded the intermediate-term risk factor.

  - Correlations between the pollutants of interest for GPCO and the temperature parameters support the trends shown by the seasonal averages. Additionally, all of the correlations with wind speed were negative.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at GPCO, although less frequently from the northeast, east, and southeast. The airshed domain was somewhat smaller in size compared to other UATMP sites, as the farthest away a back trajectory originated is less than 500 miles.

  - The wind rose shows that easterly and southeasterly winds were most frequently observed near GPCO.

  - A trends analysis shows that formaldehyde may be increasing at GPCO. Outliers measured in the 2004 make the identification of a long-term trend difficult.

  - Benzene had the highest annual average-based and NATA-modeled cancer risk for GPCO, although the risk based on the annual average was an order of magnitude higher.

  - Acrolein had the highest annual average-based and NATA-modeled noncancer risk for GPCO, although the risk based on the annual average was an order of magnitude higher.

  - Benzene was the highest emitted pollutant with a cancer risk factor in Mesa County, Colorado, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-

emissions, while acrolein had the highest noncancer toxicity weighted-emissions in Mesa County.

- *District of Columbia*.

  - The WADC site sampled for hexavalent chromium only, and therefore hexavalent chromium was this site's only pollutant of interest. Hexavalent chromium failed one screen at WADC.

  - The summer average concentration of hexavalent chromium was significantly higher than the other seasonal averages, but the high confidence interval suggests that the summer average was influenced by outliers. The highest concentration of hexavalent chromium at WADC was measured on July 4, 2006.

  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded at WADC.

  - Correlations between hexavalent chromium for WADC and the meteorological parameters tended to be weak.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at WADC, although less frequently from the east. The airshed domain was comparable in size to other UATMP sites, as the farthest away a back trajectory originated is greater than 600 miles.

  - The wind rose shows that southerly winds were most frequently observed near WADC.

  - The annual average-based and NATA-modeled cancer and noncancer risks attributable to hexavalent chromium for WADC were very similar.

  - Benzene was the highest emitted pollutant with a cancer risk factor in the District of Columbia, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Florida*.

  - The seven Florida sites sampled for carbonyl compounds. In addition, SYFL also sampled hexavalent chromium.

  - Two carbonyl compounds have risk screening values, formaldehyde and acetaldehyde. These pollutants failed screens at every Florida site and were the pollutants of interest for each site.

- Formaldehyde tended to have the highest daily average for each of the Florida sites, although the difference was not statistically significant for all sites.

- No concentrations of acetaldehyde or formaldehyde exceeded the short-term risk factors at the Florida sites.

- Acetaldehyde exhibited negative correlations with the moisture variables for the Florida sites, and formaldehyde exhibited mostly positive correlations with the temperature parameters for the Florida sites.

- As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the Florida sites. The airshed domains were comparable in size to other UATMP sites, as the farthest away back trajectories originated is nearly 600 miles.

- Similar to the back trajectories, the wind roses show that winds from a variety of directions were observed near the Florida sites.

- A trends analysis was conducted for AZFL, GAFL, ORFL, SKFL, and SYFL. Formaldehyde seems to be increasing at AZFL and GAFL, decreasing at ORFL, and is difficult to assess at SKFL and SYFL due to large confidence intervals in years prior to 2006.

- Annual average-based and NATA-modeled cancer risks for acetaldehyde and formaldehyde for the Florida sites were very similar, although no cancer risks based on annual average were available for FLFL.

- Annual average-based and NATA-modeled noncancer risks for acetaldehyde and formaldehyde for the Florida sites were very similar, and were all less than 1.0. Again, a noncancer risk based on the annual average was not available for FLFL.

- Benzene was the highest emitted pollutant with a cancer risk factor in the counties with UATMP monitoring sites. Benzene also had the highest cancer toxicity weighted-emissions in Hillsborough, Orange, and Pinellas Counties, while naphthalene had the highest cancer toxicity weighted-emissions in Broward County.

- Xylenes were the highest emitted pollutant with a noncancer risk factor in Broward County; hydrochloric acid was the highest emitted pollutant with a noncancer risk factor in Hillsborough County; and toluene was the highest emitted pollutant with a noncancer risk factor in Orange and Pinellas Counties. Yet, acrolein had the highest noncancer toxicity weighted-emissions.

- *Georgia*.

  - The SDGA site sampled for hexavalent chromium only, and was therefore this site's only pollutant of interest. Hexavalent chromium failed five screens at SDGA.

  - The concentration of hexavalent chromium was highest in the summer and lowest in winter, although the difference was not statistically significant.

  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded at SDGA.

  - Correlations between hexavalent chromium for SDGA and the meteorological parameters tended to be weak.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at SDGA. The airshed domain was comparable in size to other UATMP sites, as the farthest away a back trajectory originated is greater than 600 miles.

  - The wind rose shows that northwesterly winds were most frequently observed near SDGA.

  - The annual average-based and NATA-modeled cancer and noncancer risks attributable to hexavalent chromium for SDGA were very similar.

  - Benzene was the highest emitted pollutant with a cancer risk factor in De Kalb County, Georgia, while methyl isobutyl ketone was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Illinois*.

  - NBIL sampled for carbonyl compounds, VOC, SNMOC, hexavalent chromium, and metals (PM_{10}), while SPIL sampled for carbonyls and VOC only.

  - The pollutants of interest common to each Illinois site were: acrolein, formaldehyde, carbon tetrachloride, tetrachloroethylene, acetaldehyde, benzene, trichloroethylene, 1,3-butadiene, and *p*-dichlorobenzene.

  - Of the pollutants of interest for each site, formaldehyde had the highest daily average for both sites. The daily average concentration was significantly higher for SPIL than for NBIL. The high confidence interval for NBIL indicates that this average was driven by outliers. The relatively large formaldehyde concentration for winter and the corresponding confidence interval show that the outlier(s) were

measured during winter. For SPIL, formaldehyde was highest in summer and spring, but like NBIL's winter average, the large confidence intervals show that outliers were affecting these averages.

- Acrolein and formaldehyde exceeded the short-term risk factors at the Illinois sites. While nearly all of the acrolein measured detections exceeded the short-term risk factors, a total of five formaldehyde concentrations exceeded the short-term risk factors at NBIL and SPIL. Where seasonal averages could be calculated for acrolein, they exceeded the intermediate risk factors. None of the seasonal averages of formaldehyde exceeded the intermediate risk factor.

- Correlations between formaldehyde for SPIL and the temperature parameters were the strongest calculated for these sites, and support the trends shown by the seasonal formaldehyde averages for this site. Correlations with wind speed were nearly all negative.
- As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the Illinois sites. The airshed domains were larger in size than other UATMP sites, as some back trajectories originated over 800 miles away.

- While winds from a variety of directions were observed near the Illinois sites, westerly and southerly winds were observed more frequently.

- A trends analysis was conducted for the Illinois sites, although carbonyl sampling has not been performed long enough for a trends analysis. Benzene and 1,3-butadiene have been decreasing at NBIL and appear to be holding steady at SPIL.

- Carbon tetrachloride and benzene had the highest annual average-based cancer risks for both NBIL and SPIL. By comparison, benzene and 1,3-butadiene had the highest NATA-modeled cancer risks for the Chicago census tracts.

- Acrolein exhibited the highest annual average-based and NATA-modeled noncancer risks for the Illinois sites. For SPIL, formaldehyde also had a noncancer risk based on the annual average greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Cook County, Illinois, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions in Cook County.

- *Indiana.*

  - IDIN sampled for carbonyl compounds, hexavalent chromium, and metals (PM_{10}); ININ sampled for carbonyl compounds and metals (PM_{10}); and WPIN and INDEM sampled for carbonyls only.

- The pollutants of interest common to each Indiana site were formaldehyde and acetaldehyde.

- Formaldehyde had the highest daily average for all four sites, but was particularly high for INDEM. The INDEM average was higher than any other daily average concentration for a UATMP site, which is consistent with findings from 2005. Seasonal averages of formaldehyde for INDEM indicate that while relatively high concentrations of formaldehyde were recorded throughout the year, the highest measurements occurred during spring and summer.

- Formaldehyde exceeded the short-term risk factors at INDEM. Nearly half of the measured concentrations of formaldehyde exceeded the ATSDR MRL, and half of those concentrations also exceeded the CALEPA REL. Three of the four seasonal averages of formaldehyde exceeded the intermediate-term MRL.

- Many of the pollutants of interest exhibited moderately strong to very strong correlations with the meteorological parameters for the Indiana monitoring sites. But the number of detects must be considered because a low number of detects can skew the correlations.

- As illustrated by the composite 24-hour back trajectory maps for the Indianapolis sites, the back trajectories originated primarily from the south-southeast and northwest. However, a complete sampling year of trajectories is necessary for a more accurate assessment. Back trajectories originated from a variety of directions around the INDEM site. The airshed domain was larger in size than other UATMP sites, as some back trajectories originated over 800 miles away.

- The wind roses for the Indiana sites do not resemble each other. Winds from a variety of directions were frequently measured near IDIN and ININ, although less frequently from the northeast; near INDEM, calm, southerly, and westerly winds were frequently observed; and near WPIN, southwesterly and westerly winds were most common.

- A trends analysis was conducted for the INDEM site for formaldehyde. Formaldehyde concentrations have been relatively high at INDEM since the onset of UATMP sampling, but the large confidence intervals indicate that little significant change has occurred.

- Annual averages, and hence cancer and noncancer risks, could be calculated for INDEM only. Although the annual average was high for formaldehyde, the cancer risk was low because formaldehyde has a low cancer toxicity. However, formaldehyde has a high noncancer toxicity, and this is reflected in its noncancer risk. The NATA-modeled concentration and risks for formaldehyde did not reflect the concentration and theoretical risks resulting from the ambient monitoring. The NATA-modeled cancer risk for arsenic near ININ was the

highest cancer risk for any of the site-specific pollutants of interest. The NATA-modeled cancer risk for arsenic near IDIN was significantly lower.

- Benzene was the highest emitted pollutant with a cancer risk factor in both Marion and Lake Counties, while coke oven emissions had the highest cancer toxicity weighted-emissions in these counties. Toluene was the highest emitted pollutant with a noncancer toxicity factor in Marion County, while hydrochloric acid was the highest emitted pollutant with a noncancer toxicity factor in Lake County. Like most UATMP counties, acrolein had the highest noncancer toxicity weighted-emissions in Marion County, but the second highest noncancer toxicity weighted-emissions in Lake County. Manganese had the highest noncancer toxicity weighted-emissions in Lake County.

- *Kentucky*.

  - The HAKY site sampled for hexavalent chromium only. Although this pollutant did not fail any screens, it was still considered this site's pollutant of interest in order to facilitate analysis.

  - The concentration of hexavalent chromium was highest in the summer and lowest in winter, although the difference was not statistically significant.

  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded for HAKY.

  - Correlations between hexavalent chromium for HAKY and the temperature and moisture variables were moderately strong and positive.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at HAKY. The airshed domain was comparable in size to other UATMP sites, as the farthest away a back trajectory originated was greater than 600 miles.

  - The wind rose shows that calm winds prevailed and that winds with an easterly component were rarely observed near HAKY.

  - The annual average-based and NATA-modeled cancer and noncancer risks attributable to hexavalent chromium for HAKY were low.

  - Benzene was the highest emitted pollutant with a cancer risk factor in Hazard County, Kentucky, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Massachusetts.*

  - The BOMA site sampled for metals (PM_{10}) and hexavalent chromium.

  - The pollutants of interest for BOMA were: arsenic, manganese, nickel, and hexavalent chromium.

  - Manganese and nickel had the highest daily averages for BOMA, and were one and two orders of magnitude higher than the daily averages of arsenic and hexavalent chromium, respectively.

  - No concentrations exceeded the short-term risk factors at BOMA.

  - A strong negative correlation was calculated between nickel and average temperature. The pollutants of interest had negative correlations with scalar wind speed.
  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at BOMA. The airshed domain was somewhat larger in size than other UATMP sites, as the farthest away a back trajectory originated was over 700 miles.

  - The wind rose shows that southwesterly, westerly, and northwesterly winds were most frequently observed near BOMA.

  - Arsenic had the highest annual average-based cancer risk for BOMA. Although hexavalent chromium had the highest NATA-modeled cancer risk for the census tract where BOMA is located, the cancer risk was similar to the risk calculated from the annual average.

  - Manganese exhibited the highest annual average-based noncancer risk for BOMA, although the HQ was very low. Both the annual average-based and NATA-modeled noncancer risks for BOMA were very low.

  - Unlike most UATMP counties, formaldehyde (rather than benzene) was the highest emitted pollutant with a cancer risk factor in Suffolk County, Massachusetts, although benzene had the highest cancer toxicity weighted-emissions. Toluene was the highest emitted pollutant with a noncancer risk factor, while acrolein had the highest noncancer toxicity weighted-emissions in Suffolk County.

- *Michigan.*

  - DEMI sampled for carbonyl compounds, VOC, and hexavalent chromium, while ITCMI sampled for SVOC only.

- The pollutants of interest for the DEMI monitoring site were: acrolein, formaldehyde, carbon tetrachloride, tetrachloroethylene, acetaldehyde, benzene, hexavalent chromium, 1,3-butadiene, and *p*-dichlorobenzene. Benzo(a)pyrene was the only pollutant to fail screens at ITCMI.

- Of the pollutants of interest for DEMI, formaldehyde had the highest daily average. Formaldehyde averages tended to higher in the warmer seasons than the colder seasons.

- Acrolein exceeded the short-term risk factors at DEMI. All four seasonal averages of acrolein exceeded the intermediate risk factor.

- For DEMI, formaldehyde exhibited positive correlations with the temperature and moisture parameters. In addition, most of the pollutants of interest exhibited negative correlations with the scalar wind speed. Correlations between benzo(a)pyrene and the meteorological parameters for ITCMI were weak.

- As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the Michigan sites. The airshed domains for these sites were somewhat larger in size than other UATMP sites, as some back trajectories originated almost 800 miles away.

- While winds from a variety of directions were observed near the DEMI monitoring site, winds with an easterly component were observed less frequently. Near ITCMI, northwesterly winds were predominant.

- A trends analysis was conducted for DEMI. Formaldehyde decreased from 2005 to 2006, but because the 2004 average concentration was skewed by outliers, a trends assessment beyond 2005 is inconclusive. Benzene and 1,3-butadiene appear to be holding steady.

- Carbon tetrachloride had the highest annual average-based cancer risk for DEMI, followed by benzene and tetrachloroethylene. By comparison, benzene and 1,3-butadiene had the highest NATA-modeled cancer risks for the DEMI census tract, which were both an order of magnitude higher than the annual average-based cancer risks for these pollutants. The annual average-based and NATA-modeled cancer risk attributable to benzo(a)pyrene for ITCMI were low.

- Acrolein exhibited the highest annual average-based and NATA-modeled noncancer risks for the DEMI, although the annual average-based noncancer risk for this pollutant was an order of magnitude higher than the NATA-modeled noncancer risk. Benzo(a)pyrene does not have a noncancer risk factor.

- Benzene was the highest emitted pollutant with a cancer risk factor in both Wayne and Chippewa Counties, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-

emissions in Chippewa County, but coke oven emissions had the highest cancer toxicity weighted-emissions in Wayne County. Acrolein had the highest noncancer toxicity weighted-emissions in both counties.

- *Minnesota*.

  - The MIMN site sampled for VOC, metals (TSP), and carbonyl compounds.

  - The pollutants of interest for MIMN were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, manganese, arsenic, nickel, acrolein, tetrachloroethylene, and *p*-dichlorobenzene.

  - Of the pollutants of interest, acetaldehyde and formaldehyde had the highest daily averages for MIMN. Because this site sampled through the end of April, summer and autumn averages could not be calculated.

  - Every measured detection of acrolein exceeded the short-term risk factors at MIMN.
  - Correlations between formaldehyde, acetaldehyde, and p-dichlorobenzene and maximum and average temperatures were strong and positive. While acrolein exhibited strong correlations with certain meteorological parameters for MIMN, the low detection rate might skew the correlations.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at MIMN. The airshed domain was comparable in size to other UATMP sites, but the map might look much different with a full sample year's worth of trajectories.

  - The wind rose shows that northwesterly and northerly winds were most frequently observed near MIMN, but southeasterly winds are also common.

  - Due to the short sampling duration, annual averages, and hence cancer and noncancer risks, could not be calculated. Benzene had the highest cancer risk in MIMN's census tract according to NATA. The risk attributable to benzene near MIMN was the third highest modeled cancer risk of any of the site-specific pollutants of interest. Acrolein had the only NATA-modeled noncancer risk greater than 1.0 for MIMN.

  - Benzene was the highest emitted pollutant with a cancer risk factor in Hennepin County, Minnesota, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions in Hennepin County.

- *Mississippi.*

  - TUMS sampled for VOC and carbonyl compounds, while GPMS sampled for SNMOC and SVOC in addition to carbonyls and VOC.

  - The pollutants of interest common to each Mississippi site were: acrolein, formaldehyde, carbon tetrachloride, acetaldehyde, benzene, 1,3-butadiene, and *p*-dichlorobenzene.

  - Of the pollutants of interest for each site, formaldehyde and acetaldehyde had the highest daily averages for both sites. Formaldehyde tended to be highest in summer and lowest in winter.

  - Acrolein exceeded the short-term risk factors at the Mississippi sites. All four seasonal averages of acrolein exceeded the intermediate risk factor.

  - Acrolein, carbon tetrachloride, and formaldehyde exhibited moderately strong to strong positive correlations with the temperature and moisture variables (except relative humidity) for GPMS. Formaldehyde also exhibited this tendency for TUMS. Nearly all of the correlations between the pollutants of interest and the scalar wind speed were negative.
  - As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the Mississippi sites, although less frequently from the east. The airshed domain was slightly larger at GPMS than at TUMS, but both are comparable in size to other UATMP sites. The longest trajectories are those originating from the northwest.

  - Northerly and southerly winds are most often observed near the Mississippi sites, according to the wind roses. Calm winds were also frequently observed.

  - A trends analysis was conducted for the Mississippi sites. Formaldehyde and benzene both increased from 2004 to 2005 at GPMS, which could be related to Hurricane Katrina. Formaldehyde decreased at TUMS between 2001 and 2004 and has been steady since.

  - Carbon tetrachloride had the highest annual average-based cancer risk for both GPMS and TUMS. By comparison, benzene had the highest NATA-modeled cancer risks for the census tracts in which the Mississippi sites are located. The benzene NATA-modeled and annual average-based cancer risks were very similar.

  - Acrolein was the only pollutant of interest to have annual average-based and NATA-modeled noncancer risks greater than 1.0 for the Mississippi sites, although the annual average based noncancer risks were significantly higher.

- Benzene was the highest emitted pollutant with a cancer risk factor in Harrison County, while xylenes were the highest emitted pollutant with a noncancer risk factor. In Lee County, dichloromethane was the highest emitted pollutant with a cancer risk factor, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions in Harrison County, while hexavalent chromium had the highest cancer toxicity weighted-emissions in Lee County. Acrolein had the highest noncancer toxicity weighted-emissions in both counties.

- *Missouri.*

  - The S4MO site sampled for VOC, metals (PM_{10}), hexavalent chromium, and carbonyl compounds.

  - The pollutants of interest for S4MO were**:** formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, manganese, arsenic, cadmium, acrolein, tetrachloroethylene, and *p*-dichlorobenzene.

  - Of the pollutants of interest, formaldehyde had the highest daily average for S4MO. Formaldehyde tended to be highest in the summer and acetaldehyde was highest in the spring.

  - Acrolein exceeded the short-term risk factors at S4MO. Seasonal averages of acrolein, where they could be calculated, exceeded the intermediate risk factor.

  - Correlations between formaldehyde and maximum, average, dew point, and wet bulb temperatures were strong and positive, which support the trends shown by the seasonal averages. Carbon tetrachloride exhibited a similar tendency with the temperature parameters. Correlations with scalar wind speed were all negative.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at S4MO, although less frequently from the east and southeast. The airshed domain was larger in size than other UATMP sites, with trajectories more than 800 miles long.

  - The wind rose shows that southeasterly and southerly winds were most frequently observed near S4MO.

  - A trends analysis was conducted for S4MO. Benzene, formaldehyde, and 1,3-butadiene averages have decreased in recent years.

  - Carbon tetrachloride and benzene had the highest annual average-based cancer risks for S4MO. Benzene had the highest NATA-modeled cancer risk for the S4MO census tract, although the risk was an order of magnitude higher than annual average-based cancer risk for benzene.

- Acrolein exhibited the highest annual average-based and NATA-modeled noncancer risks for S4MO site.

- Benzene was the highest emitted pollutant with a cancer risk factor in St Louis County, Missouri, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions in St Louis County.

- *New Jersey.*

  - The New Jersey sites sampled for VOC and carbonyl compounds.

  - The pollutants of interest common to all four New Jersey sites are: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, acrolein**,** and tetrachloroethylene.

  - Of the pollutants of interest, formaldehyde and acetaldehyde had the highest daily average for the New Jersey sites. Formaldehyde was higher in summer; carbon tetrachloride was highest in summer and autumn; and benzene and 1,3-butadiene were highest in autumn and winter.

  - Every acrolein concentration exceeded the short-term ATSDR MRL and most exceeded the CALEPA REL at the New Jersey sites. Every seasonal average, where there were enough measured detections, exceeded the intermediate-term risk factor.

  - For most of the New Jersey sites, acetaldehyde, formaldehyde, and carbon tetrachloride exhibited strong positive correlations with the temperature parameters, and formaldehyde and carbon tetrachloride exhibited strong positive correlations with the moisture parameters.

  - As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the New Jersey sites, although less frequently from the east. The airshed domains were comparable in size to other UATMP sites, as some back trajectories originated more than 600 miles away.

  - The wind roses show that winds with a westerly component were more frequently observed than winds with an easterly component near CANJ and ELNJ, while calm winds were observed over half the time near CHNJ and NBNJ.

  - A trends analysis shows that the New Jersey sites have been sampling for an extended period of time as part of the UATMP. Concentrations of formaldehyde, benzene, and 1,3-butadiene have been decreasing slightly over the last few years at CANJ; formaldehyde and benzene exhibit deceasing trends at CHNJ; benzene

and 1,3-butadiene are decreasing while formaldehyde is increasing at ELNJ; and benzene and formaldehyde decreased at NBNJ.

- Carbon tetrachloride had the highest annual average-based cancer risk for CANJ, CHNJ, and NBNJ, while acetaldehyde had the highest annual average-based cancer risk for ELNJ. Benzene had the highest NATA-modeled cancer risk for all four New Jersey sites.

- Acrolein had the highest annual average-based and NATA-modeled noncancer risk for the New Jersey sites. Although the risk based on the annual average was an order of magnitude higher than the NATA-modeled risk for CANJ, CHNJ, and NBNJ, the acrolein risks for ELNJ were very similar.

- Benzene was the highest emitted pollutant with a cancer risk factor in Camden, Morris, Union, and Middlesex Counties, while toluene was the highest emitted pollutant with a noncancer risk factor in these four counties. Benzene also had the highest cancer toxicity weighted-emissions in each county, while acrolein had the highest noncancer toxicity weighted-emissions in each county.

- *North Carolina*.

  - The two North Carolina sites sampled for carbonyl compounds.

  - Two carbonyl compounds have risk screening values, formaldehyde and acetaldehyde. These pollutants failed screens at each site and were the pollutants of interest for each site.

  - Formaldehyde tended to have the highest daily average for each site, although the difference was not statistically significant. Seasonal averages could not be calculated due to the short sampling duration combined with the 1-in-12 sampling schedule.

  - No concentrations of acetaldehyde or formaldehyde exceeded the short-term risk factors at the North Carolina sites.

  - Formaldehyde exhibited strong positive correlations with the temperature parameters at the North Carolina sites, and both formaldehyde and acetaldehyde exhibited strong negative correlations with relative humidity.

  - As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at CANC and RTPNC, although primarily from the southwest. However, the maps might look much different with a full sample year's worth of trajectories.

- Similar to the back trajectories, the wind roses show that southwesterly winds were frequently observed near the North Carolina sites. Again, the wind roses might look much different with a full sample year's worth of wind observations.

- A trends analysis was conducted for CANC and RTPNC. Inclusion of confidence intervals shows that formaldehyde concentrations have changed little at these sites over the last few years.

- Annual averages could not be calculated for the North Carolina sites due to the short sampling duration; therefore, theoretical cancer risks could not be calculated. However, NATA-modeled cancer risks for acetaldehyde for the RTPNC census tract were roughly twice as high as the CANC census tract. NATA-modeled formaldehyde cancer risks were low for both sites' census tracts.

- NATA-modeled noncancer risks for acetaldehyde and formaldehyde at the North Carolina sites were low.

- While benzene was the highest emitted pollutant with a cancer risk factor in Durham County, North Carolina, formaldehyde was the highest emitted pollutant with a cancer risk factor in Montgomery County. Benzene had the highest cancer toxicity weighted-emissions in both counties.

- Toluene was the highest emitted pollutant with a noncancer risk factor in both Durham and Montgomery Counties. Yet, acrolein had the highest noncancer toxicity weighted-emissions.

- *Oklahoma*.

  - CNEP sampled for VOC only, while the Tulsa sites (TOOK, TSOK, and TUOK) sampled for VOC, carbonyl compounds and metals (TSP).

  - The pollutants of interest common to each Oklahoma site were acrolein, benzene, 1,3-butadiene, and carbon tetrachloride.

  - Acrolein had the highest daily average for CNEP; xylenes had the highest daily average for TOOK and TSOK; and formaldehyde had the highest daily average for TUOK. Seasonal average availability varied by site due to the varied start dates.

  - Every acrolein concentration exceeded the short-term ATSDR MRL and most exceeded the CALEPA REL at the Oklahoma sites. Every seasonal average, where there were enough measured detections, exceeded the intermediate-term risk factor.

  - Pearson correlations with the meteorological parameters for CNEP were weak. Several pollutants of interest for the Tulsa sites exhibited strong positive

correlations with the temperature and moisture variables, especially formaldehyde.

- As illustrated by the composite 24-hour back trajectory maps for the Oklahoma sites, back trajectories originated primarily from the north and south. The airshed domains were larger in size for these sites than other UATMP sites, as some back trajectories originated over 800 miles away.

- The wind roses for the Oklahoma sites show that southerly winds were predominant during the period of sampling for each site.

- Annual averages, and hence cancer and noncancer risks, could not be calculated for the CNEP and TSOK sites. Benzene had the highest annual average-based cancer risk for both TOOK and TUOK. Benzene also had the highest NATA-modeled cancer risk for each of the sites.

- Acrolein had the highest the only NATA-modeled noncancer risk greater than 1.0 for the Oklahoma sites and for TOOK and TUOK, the only annual average-based noncancer risk greater than 1.0. However, the risks based on the annual average were an order of magnitude higher.

- Benzene was the highest emitted pollutant with a cancer risk factor in both Mayes and Tulsa Counties. Benzene also had the highest cancer toxicity weighted-emissions in Tulsa County, while arsenic had the highest cancer toxicity weighted-emissions in Mayes County. Toluene was the highest emitted pollutant with a noncancer toxicity factor in both counties, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Oregon.*

  - The LAOR site sampled for hexavalent chromium only. Although this pollutant did not fail any screens, it was still considered this site's pollutant of interest in order to facilitate analysis.

  - Seasonal average concentrations of hexavalent chromium could not be calculated due to the short sampling duration.

  - Hexavalent chromium does not have acute risk factors.

  - Although some Pearson correlations were strong, the low number of detects likely skewed the correlations.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated primarily from the southwest. However, the map might look much different with a full sample year's worth of trajectories.

- The wind rose shows that southerly and southeasterly winds prevailed near LAOR.

- Annual averages could not be calculated for LAOR due to the short sampling duration; therefore, theoretical cancer and noncancer risks could not be calculated. The NATA-modeled cancer and noncancer risks attributable to hexavalent chromium for LAOR were low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Union County, Oregon, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene follows POM as non-15 PAH as the pollutant highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Puerto Rico*.

  - The Puerto Rico sites sampled for VOC and carbonyl compounds.

  - The pollutants of interest common to both sites were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, acrolein, xylenes, and *p*-dichlorobenzene.

  - Of the pollutants of interest, dichloromethane had the highest daily average concentration for BAPR, while total xylenes had the highest daily average concentration for SJPR.

  - Every acrolein concentration exceeded the ATSDR short-term risk factor at SJPR and BAPR and most exceeded the CALEPA REL. Every seasonal average of acrolein exceeded the intermediate-term risk factor for the Puerto Rico sites.
  - Correlations between carbon tetrachloride and the temperature and moisture parameters were strong and positive for BAPR, while the remaining correlations were weak. Acetaldehyde exhibited strong negative correlations with these same parameters for SJPR, while the remaining correlations were weak.

  - As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated primarily the northeast and east at the Puerto Rico sites. The airshed domains were comparable in size to other UATMP sites, as the farthest away a back trajectory originated is about 700 miles.

  - The wind rose shows that easterly and east-northeasterly winds were most frequently observed near BAPR and SJPR.

  - *p*-Dichloromethane had the highest annual average-based cancer risk for both BAPR and SJPR, although NATA-modeled risks from this pollutant were an order of magnitude lower. Dichloromethane had the highest NATA-modeled cancer risk for BAPR, which was the second highest NATA-modeled cancer risk

for all site-specific pollutants of interest. Tetrachloroethylene had the highest NATA-modeled cancer risk for SJPR.

- Acrolein had the highest annual average-based and NATA-modeled noncancer risk for BAPR and SJPR, although the risk based on the annual average was an order of magnitude higher.

- Benzene was the highest emitted pollutant with a cancer risk factor in Bayamon Municipio, Puerto Rico, while dichloromethane was the highest emitted pollutant with a cancer risk factor in Barceloneta Municipio. These two pollutants also had the highest cancer toxicity weighted-emissions in each respective county. Toluene was the highest emitted pollutant with a noncancer risk factor in Bayamon Municipio, while dichloromethane was the highest emitted pollutant with a noncancer risk factor in Barceloneta Municipio. Acrolein, however, had the highest noncancer toxicity weighted-emissions in both municipios.

- *Rhode Island*.

  - The PRRI site sampled for hexavalent chromium only, and was therefore this site's only pollutant of interest. Hexavalent chromium failed three screens at PRRI.

  - The concentration of hexavalent chromium was highest in the summer and lowest in winter, although the difference is not statistically significant.

  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded at PRRI.

  - Correlations between hexavalent chromium for PRRI and the meteorological parameters tended to be weak.
  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at PRRI. The airshed domain was comparable in size to other UATMP sites, as the farthest away a back trajectory originated is nearly 700 miles.

  - The wind rose shows that winds with a westerly component were observed more frequently than winds with an easterly component near PRRI.

  - The annual average-based cancer risk attributable to hexavalent chromium was an order of magnitude lower than the NATA-modeled cancer risk for PRRI. Noncancer risk from hexavalent chromium was very low.

  - Benzene was the highest emitted pollutant with a cancer risk factor in Providence County, Rhode Island, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *South Carolina*.
  - The CHSC site sampled for hexavalent chromium only. Although this pollutant did not fail any screens, it was still considered this site's pollutant of interest in order to facilitate analysis.
  - Due to the low detection rate, a winter and autumn seasonal average concentration of hexavalent chromium could not be calculated.
  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded at CHSC in the seasons where averages could be calculated.
  - Correlations between hexavalent chromium at CHSC and the meteorological parameters were weak.
  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at CHSC. The airshed domain was comparable in size to other UATMP sites, as the farthest away a back trajectory originated is greater than 600 miles.
  - The wind rose shows that calm winds were observed for one-third of measurements. Southwesterly winds were also common near CHSC.
  - The annual average-based and NATA-modeled cancer and noncancer risks attributable to hexavalent chromium for CHSC were low.
  - Benzene was the highest emitted pollutant with a cancer risk factor in Chesterfield County, South Carolina, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.
- *South Dakota*.
  - The South Dakota sites sampled for VOC, SNMOC, and carbonyl compounds.
  - The pollutants of interest common to both sites were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and acrolein.
  - Of the pollutants of interest, acetaldehyde and formaldehyde had the highest daily average concentrations for both sites, although the concentrations for SFSD were more than twice the average concentrations for CUSD. Formaldehyde was highest in summer for both sites, and acetaldehyde was higher in summer and autumn for SFSD.

- Every acrolein concentration exceeded the short-term risk factors at CUSD and SFSD. Every seasonal average of acrolein, where it could be calculated, exceeded the intermediate-term risk factor for the South Dakota sites.

- Correlations between carbon tetrachloride and the maximum, average, dew point and wet bulb temperatures were strong and positive for both South Dakota sites. Formaldehyde also had strong positive correlations with these parameters for CUSD. Acrylonitrile also had strong positive correlations with these parameters for SFSD, but was detected few times.

- The composite 24-hour back trajectory maps for CUSD and SFSD were different from each other. Trajectories rarely originated from the north and east at CUSD, while trajectories originated from a variety of directions at SFSD. The airshed domains for these sites were larger in size than most other UATMP sites, as trajectories originated greater than 700 miles away.

- The wind roses show that southwesterly, westerly, and northwesterly winds were most frequently observed near CUSD, while winds from other directions were frequently observed near SFSD.

- A trends analysis was conducted for SFSD and CUSD. Formaldehyde concentrations have been decreasing at CUSD, while benzene and 1,3-butadiene have changed little. Formaldehyde and benzene have not changed significantly at SFSD, while 1,3-butadiene has decreased somewhat.

- Carbon tetrachloride had both the highest annual average-based and NATA-modeled cancer risk for CUSD. The annual average-based cancer risk from acrylonitrile was slightly higher than the carbon tetrachloride risk for SFSD, although carbon tetrachloride had the NATA-modeled risk for SFSD.

- Acrolein had the highest annual average-based and NATA-modeled noncancer risk for CUSD and SFSD, although the risk based on the annual average was an order of magnitude higher.

- Benzene was the highest emitted pollutant with a cancer risk factor in both Custer and Minnehaha Counties, while toluene was the highest emitted pollutant with a noncancer risk factor in both counties. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Tennessee*.

  - The Tennessee sites sampled for VOC and carbonyl compounds.

- The pollutants of interest common to both sites were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, acrolein, and *p*-dichlorobenzene.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for both MSTN and LDTN. Formaldehyde tended to be highest during the summer for both sites.

- Every acrolein concentration exceeded the ATSDR short-term risk factor at LDTN and MSTN and most exceeded the CALEPA REL. Every seasonal average of acrolein exceeded the intermediate-term risk factor for the Tennessee sites.

- Correlations between formaldehyde and the maximum, average, dew point, and wet bulb temperatures were strong and positive for both sites. *p*-Dichlorobenzene exhibited a similar trend for MSTN but not for LDTN. Nearly all the correlations with wind speed were negative for both sites.

- As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from at variety of directions at the Tennessee sites. The airshed domains were comparable in size to other UATMP sites, as the farthest away a back trajectory originated is greater than 600 miles.

- The wind rose shows that southwesterly and westerly winds were most frequently observed near LDTN and MSTN.

- A trends analysis for LDTN shows that formaldehyde and 1,3-butadiene has been decreasing and benzene has changed little.

- Carbon tetrachloride had the highest annual average-based cancer risk for LDTN and MSTN, while benzene had the highest NATA-modeled cancer risk for the sites.

- Acrolein had the highest annual average-based and NATA-modeled noncancer risk for LDTN and MSTN, although the risk based on the annual average was an order of magnitude higher.

- Benzene was the highest emitted pollutant with a cancer risk factor in Loudon County, Tennessee, and also had the highest cancer toxicity weighted-emissions in this county. Carbon disulfide was the highest emitted pollutant with a noncancer risk factor in Loudon County, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Texas*.

  - The Austin and Round Rock, Texas sites began sampling in late June or early July 2005 and continued through June 2006. They sampled for VOC, carbonyl compounds, TNMOC, and metals (PM_{10}). In addition, the El Paso, Texas site sampled VOC from March 2005 to March 2006. In order to facilitate analysis, data from the entire year's worth of sampling for each site were utilized in the site-specific analyses.

  - The pollutants of interest common to each Texas site were**:** acrolein, carbon tetrachloride, benzene, 1,3-butadiene, and *p*-dichlorobenzene.

  - Of the pollutants of interest for each Austin or Round Rock site, acrolein had the highest daily average for each site, followed by formaldehyde. Total xylenes had the highest daily average for YDSP.

  - Acrolein exceeded the short-term risk factors at all of the Texas sites each time it was measured. Where seasonal averages could be calculated for acrolein, they exceeded the intermediate risk factors.

  - Acrolein, formaldehyde, and *p*-dichlorobenzene exhibited positive correlations with the temperature and moisture parameters for most of the Austin sites, although WETX did not follow this trend. Most of the pollutants exhibited negative correlations with the temperature and moisture parameters for YDSP. Nearly all of the correlations with scalar wind speed for the Texas sites were negative.

  - As illustrated by the composite 24-hour back trajectory maps for the Austin/Round Rock sites, the back trajectories originated primarily from the southeast, although the longest trajectories originated from the north. For the El Paso site, trajectories originated primarily from the southeast and southwest, and the airshed domain was much smaller than the other Texas sites.

  - The wind roses show that southeasterly and southerly winds were observed most frequently near the Austin/Round Rock sites. Northerly, easterly, and westerly winds prevailed near YSDP.

  - The pollutants with the highest annual-average based cancer risks in the Austin/Round Rock census tracts were the pollutants that were detected infrequently, such as hexachloro-1,3-butadiene and 1,2-dibromoethane. Benzene had the highest NATA-modeled cancer risks in the Austin/Round Rock census tracts, which was also on the high end for the annual-average based cancer risks. Benzene exhibited the highest annual average-based and NATA-modeled cancer risks at the El Paso site.

- Acrolein exhibited the highest annual average-based and NATA-modeled noncancer risks at each of the Texas sites. However, the annual average-based noncancer risks attributable to acrolein for the Austin/Round Rock sites were the highest calculated of all pollutants for any UATMP site.

- Benzene was the highest emitted pollutant with a cancer risk factor in Travis, Williamson, and El Paso Counties, Texas, while toluene was the highest emitted pollutant with a noncancer risk factor in each of these counties. Benzene also had the highest cancer toxicity weighted-emissions in Travis, Williamson, and El Paso Counties, while acrolein had the highest noncancer toxicity weighted-emissions in these counties.

- *Utah.*

  - The BTUT site sampled for VOC, SNMOC, metals (PM_{10}), hexavalent chromium, and carbonyl compounds.

  - The pollutants of interest at BTUT were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, manganese, arsenic, cadmium, acrolein, and tetrachloroethylene.

  - Of the pollutants of interest, formaldehyde had the highest daily average for BTUT. Formaldehyde was significantly higher in the summer.

  - Acrolein exceeded the short-term risk factors at BTUT. Seasonal averages of acrolein, where they could be calculated, exceeded the intermediate risk factor.

  - Strong correlations were calculated between acetaldehyde, formaldehyde, and manganese and the temperature and moisture variables.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at BTUT. The airshed domain was smaller in size than other UATMP sites, with the longest trajectory originating just over 500 miles away.

  - The wind rose shows that southeasterly and southerly winds were most frequently observed near BTUT.

  - A trends analysis was conducted for BTUT. Concentrations of benzene have decreased slightly; 1,3-butadiene is remaining steady; and formaldehyde concentrations have leveled off after the increase in 2004.

  - Benzene had the highest annual average-based cancer risks for BTUT, followed closely by carbon tetrachloride. Benzene had the highest NATA-modeled cancer risk for the BTUT census tract, which was similar to the annual average based-risk.

- Acrolein exhibited the highest annual average-based and NATA-modeled noncancer risks for BTUT site.

- Benzene was the highest emitted pollutant with a cancer risk factor in Davis County, Utah, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions in Davis County.

- *Vermont*.

  - The UNVT site sampled for hexavalent chromium only, and was therefore this site's only pollutant of interest. Hexavalent chromium failed one screen at UNVT.

  - The low number of measured detections of hexavalent chromium prevented winter and autumn seasonal averages from being calculated. The large confidence interval indicates that outliers likely impacted the summer average concentration.

  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded for UNVT.

  - Correlations between hexavalent chromium for UNVT and the meteorological parameters were weak.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated from a variety of directions at UNVT. The airshed domain was rather large, as the farthest away a back trajectory originated is greater than 700 miles.

  - The wind rose shows that calm winds prevailed near UNVT.

  - The annual average-based cancer risk attributable to hexavalent chromium was an order of magnitude higher than the NATA-modeled cancer risk for UNVT, although both are low. Noncancer risk from hexavalent chromium was very low.

  - Benzene was the highest emitted pollutant with a cancer risk factor in Chittenden County, Vermont, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Washington*.

  - The SEWA site sampled for hexavalent chromium only, and was therefore this site's only pollutant of interest. Hexavalent chromium failed one screen at SEWA.

  - The gap in sampling from March through September at SEWA prevented most seasonal averages from being calculated.

  - Hexavalent chromium does not have acute risk factors. While an intermediate-term risk factor is available, it was not exceeded at SEWA in winter.

  - Most of the correlations between hexavalent chromium for SEWA and the meteorological parameters were weak. The one exception is the correlation with scalar wind speed.

  - As illustrated by the composite 24-hour back trajectory map, the back trajectories originated primarily from the south and southwest. However, the map might look much different with a full sample year's worth of trajectories.

  - The wind rose shows that southerly and southeasterly winds prevailed near SEWA.

  - Annual averages could not be calculated for SEWA due to the short sampling duration; therefore, theoretical cancer and noncancer risks could not be calculated. The NATA-modeled cancer risk attributable to hexavalent chromium for SEWA was higher than other sites that sampled hexavalent chromium. The NATA-modeled noncancer risk was low.

  - Benzene was the highest emitted pollutant with a cancer risk factor in King County, Washington, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also had the highest cancer toxicity weighted-emissions, while acrolein had the highest noncancer toxicity weighted-emissions.

- *Wisconsin*.

  - The MVWI site sampled for hexavalent chromium only. Although this pollutant did not fail any screens, it was still considered this site's pollutant of interest in order to facilitate analysis. MAWI sampled for carbonyl compounds and VOC through the end of February. The pollutants of interest for MAWI were: formaldehyde, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and hexachloro-1,3-butadiene.

  - Seasonal average concentrations of hexavalent chromium for MWVI did not vary much from season to season. Of the pollutants of interest for MAWI,

formaldehyde and acetaldehyde had the highest daily average concentrations. Only winter seasonal averages could be calculated for this site.

- No pollutants exceeded the short term risk factors at the Wisconsin sites.

- Although some Pearson correlations for MAWI were strong, the low number of detects likely skewed the correlations. Hexavalent chromium exhibited strong positive correlations with the dew point and wet bulb temperatures.

- As illustrated by the composite 24-hour back trajectory map for MAWI, the back trajectories originated primarily from the north and west. However, the map might look much different with a full sampling year's worth of trajectories. The back trajectories originated from a variety of directions at MVWI. The airshed domain was rather large in size for this site, as the farthest away a back trajectory originated was nearly 800 miles.

- The wind rose shows that northwesterly winds prevailed near MAWI during the sampling period. Westerly winds were commonly observed near MVWI, although winds from a variety of directions were also observed.

- Annual averages could not be calculated for MAWI due to the short sampling duration; therefore, theoretical cancer and noncancer risks could not be calculated. Benzene exhibited the highest cancer risk based on NATA for the MAWI census tract. The annual average-based and NATA-modeled cancer and noncancer risks attributable to hexavalent chromium for MWVI were low.

- Benzene was the highest emitted pollutant with a cancer risk factor in Dane and Dodge Counties, Wisconsin, while toluene was the highest emitted pollutant with a noncancer risk factor. Benzene also was the pollutant highest cancer toxicity weighted-emissions in these counties. While acrolein had the highest noncancer toxicity weighted-emissions in Dodge County, manganese had the highest noncancer toxicity weighted-emissions in Dane County.

33.1.4 Data Quality

Based on data from duplicate and collocated samples (where applicable), the precision of the sampling methods and concentration measurements was determined for the 2006 UATMP using relative percent difference (RPD), coefficient of variation (CV), and average concentration difference calculations. The overall precision was well within UATMP data quality objectives and monitoring method guidelines. Sampling and analytical method accuracy is assured by using proven methods and following strict quality control and quality assurance guidelines.

33.2 Recommendations

In light of the lessons learned from the 2006 UATMP, a number of recommendations for future National Monitoring Programs are supported:

- *Incorporate/Update Risk in State Implementation Plans (SIPs).* Use risk calculations to design SIPs to implement policies that will reduce the potential for human health risk.

- *Encourage state/local/tribal agencies to assess, refine, and/or verify HAP and VOC emission inventories.* State/local/tribal agencies should compare the UATMP ambient data with existing emissions inventories to, at the very least, identify and/or verify emission sources of concern and assess source category completeness. The emissions inventory would then be used to develop modeled concentrations useful to compare against ambient monitoring data.

- *Continue to identify and implement improvements to the sampling and analytical methods.* The improvements made to the analytical methods prior to the 1999-2000 UATMP allowed for measurement of ambient air concentrations of 11 pollutants that were not measured during previous programs. Sponsoring agencies and a variety of interested parties now have important information about air quality within their urban areas. Further research is encouraged to identify other method improvements that would allow the UATMP to better characterize urban air pollution.

- *Continue to strive to develop standard conventions for interpreting air monitoring data.* The lack of consistent approaches to present and summarize ambient air monitoring data complicates or invalidates comparisons between different studies. Additional research should be conducted on the feasibility of establishing standard approaches for analyzing and reporting air monitoring data. The approach in determining "pollutants of interest" and the presentation of daily, seasonal, and annual averages are attempts at this standardization.

- *Prepare a report* characterizing all years of the UATMP and then update it yearly to better assess trends in concentrations and risk and better understand the nature of U.S. urban air pollution.

- *Consider more rigorous study of the impact of automobile emissions on ambient air quality using the complete UATMP data set.* Because the UATMP has monitoring sites where years of continuous data are collected, a real opportunity exists to evaluate the importance and impact of automobile emissions on ambient air quality. Suggested areas of study include reformulated gas, additional signature compound assessments and parking lot characterizations.

- *Update site characterization parameters.* Several characterization parameters, such as average daily traffic volume for the monitoring sites are provided in AQS by the agency responsible for the site and are provided in this report. Many of these

parameters are ten or more years old. Updated information regarding such parameters would provide higher quality information for understanding the dynamics surrounding each monitoring site.

- *Encourage continued and long term participation in the UATMP.* Continuing ambient air monitoring at fixed locations can provide insight into long term trends in urban air quality and the potential for urban air pollution to cause adverse health effects among the general population. Therefore, state and local agencies should be strongly encouraged either to develop and implement their own ambient air monitoring programs or to participate in future National Monitoring Programs.

- *Encourage year-round participation in the UATMP.* Many of the analyses presented in the 2006 UATMP require a full year of data to be most useful and representative of conditions experienced at each specified location. Therefore, state and local agencies should be strongly encouraged to implement year-long ambient air monitoring programs in addition to participating in future UATMP monitoring efforts.

- *Encourage case studies based on findings from the UATMP.* Often, the UATMP will identify an interesting tendency or trend, or highlight an event at a particular site(s). An example from the 2006 report includes the observation of high hexavalent chromium concentrations on July 4th, 2006. Further examination of the data in conjunction with meteorological phenomena and potential emissions events or incidents, or further site characterization may help identify state and local agencies pinpoint issues affecting air quality in their area.

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