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2008-2009 National Monitoring Programs (UATMP, NATTS, and CSATAM) Volume I: Main

By:
Eastern Research Group, Inc.
Morrisville, NC 27560

Prepared for:
Margaret Dougherty and Michael N. Jones
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

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Research Triangle Park, NC 27711

2008-2009 National Monitoring Programs (UATMP, NATTS, and CSATAM)

Final Report
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Prepared for:

Margaret Dougherty and Michael N. Jones
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Prepared by:

Eastern Research Group, Inc.
601 Keystone Park Drive, Suite 700
Morrisville, NC 27560

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

List of Appendices

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

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LIST OF TABLES (Continued)

LIST OF ACRONYMS

AADT	Average annual daily traffic
AGL	Above ground level
AIRS	Aerometric Information and Retrieval System
AQS	Air Quality System (of the Aerometric Information and Retrieval System)
ASE	Accelerated Solvent Extractor
ATSDR	Agency for Toxic Substances and Disease Registry
CBSA	Core-based statistical area(s)
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
CSATAM	Community-Scale Air Toxics Ambient Monitoring
CV	Coefficient of variation
DNPH	2,4-dinitrophenylhydrazine
DQO	Data Quality Objective(s)
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
F	Fahrenheit
GC	Gas chromatography
GC/MS-FID	Gas chromatography/mass spectrometry and flame ionization detection
GHG	Greenhouse gas(es)
GIS	Geographical Information System
GWP	Global Warming Potential
HAP	Hazardous Air Pollutant(s)
HPLC	High-performance liquid chromatography
HQ	Hazard Quotient
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IC	Ion Chromatography
ICP-MS	Inductively coupled plasma mass spectrometry
kt	Knots
mb	Millibar
MDL	Method Detection Limit
mg/m^3	Milligrams per cubic meter
mL	Milliliter
MQO	Method Quality Objective(s)
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 Available

LIST OF ACRONYMS (Continued)

ND	Non-detect
NEI	National Emissions Inventory
ng/m^3	Nanograms per cubic meter
NMOC	Non-Methane Organic Compound(s)
NMP	National Monitoring Programs
NOAA	National Oceanic and Atmospheric Administration
NOx	Oxides of Nitrogen
NR	Not Reportable
NWS	National Weather Service
PAMS	Photochemical Assessment Monitoring Stations
PAH	Polycyclic Aromatic Hydrocarbons
PM	Particulate Matter
PM_{10}	Particulate matter less than 10 microns
POM	Polycyclic Organic Matter
ppbC	Parts per billion carbon
ppbv	Parts per billion (by volume)
ppm	Parts per million
PUF	Polyurethane foam
QAPP	Quality Assurance Project Plan
RfC	Reference Concentration(s)
RFG	Reformulated gasoline
RPD	Relative percent difference
SIM	Selected ion monitoring
SIP	State Implementation Plan(s)
SNMOC	Speciated Nonmethane Organic Compound(s)
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
TSV	Total spatial variance
$\mu g/m^3$	Micrograms per cubic meter
µL	Microliter
URE	Unit Risk Estimate(s)
UV-Vis	Ultraviolet-Visible
VMT	Vehicle miles traveled
WBAN	Weather Bureau/Army/Navy ID

Abstract

This report presents the results and conclusions from the ambient air monitoring conducted as part of the 2008 and 2009 National Monitoring Programs (NATTS, UATMP, and CSATAM)-three individual programs with different goals, but result in a better understanding and appreciation of the nature and extent of toxic air pollution. The 2008-2009 NMP includes data from samples collected at 73 monitoring sites that collected 24-hour air samples, typically on a 1-in-6 or 1-in-12 day schedule. Thirty-nine sites sampled for 61 volatile organic compounds (VOC); 49 sites sampled for 15 carbonyl compounds; 11 sites sampled for 80 speciated nonmethane organic compounds (SNMOC); 32 sites sampled for 22 polycyclic aromatic hydrocarbons (PAH); 19 sites sampled for 11 metals; and 21 sites sampled for hexavalent chromium. Overall, over 462,000 ambient air concentrations were measured during the 2008-2009 NMP. 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 2008-2009 NTMP serve a wide range of purposes. Not only do these data characterize the nature and extent of air pollution close to the 73 individual monitoring sites participating in these programs, but they also identify trends and patterns that may be common to both urban and rural environments, and across the country. Therefore, this report presents results that are specific to particular monitoring locations and presents other results that are common to all environments. The results presented provide additional insight into the complex nature of air pollution. The raw data are included in the appendices of this report.

1.0 Introduction

Air pollution incorporates many components that originate from a wide range of stationary, mobile, and natural emissions sources. Because some of these components include air toxics (i.e., Hazardous Air Pollutants) that are known or suspected to have the potential for negative human health impacts, the U.S. Environmental Protection Agency (EPA) encourages state, local, and tribal agencies to understand and appreciate the nature and extent of toxic air pollution in their respective locations. To achieve this goal, EPA sponsors the National Monitoring Programs (NMP), which include the Photochemical Assessment Monitoring Stations (PAMS) network; Urban Air Toxics Monitoring Program (UATMP); National Air Toxics Trends Stations (NATTS) network; Community-Scale Air Toxics Ambient Monitoring (CSATAM) Program; and monitoring for other pollutants such as Non-Methane Organic Compounds (NMOC). This report focuses on monitoring sites participating in the UATMP, NATTS, and CSATAM programs. These programs have the following program-specific objectives:

- The primary purpose of the UATMP is to characterize the composition and magnitude of air pollution through ambient air monitoring.
- The primary purpose of the CSATAM program is to conduct local-scale investigative air toxics monitoring projects.
- The primary goal of the NATTS network is to obtain a statistically significant quantity of high-quality representative air toxics measurements such that long-term trends can be identified.

1.1 Background

EPA began the NMOC program in 1984. Monitoring for selected compounds was performed during the morning hours of the summer ozone season. NMOC data were to be used to understand ozone formation and to develop ozone control strategies. The UATMP was initiated by EPA in 1988 as an extension of the existing NMOC program to meet the increasing need for information on air toxics. Over the years, the program has grown in both participation levels and pollutants targeted (EPA, 2009a). The program has allowed for the identification of compounds that are prevalent in ambient air and for participating agencies to screen air samples for concentrations of air toxics that could potentially result in adverse human health effects.

The NATTS network was created to generate long-term ambient air toxics concentration data at specific fixed sites across the country. The NATTS Pilot program was developed and implemented during 2001 and 2002, leading to the development and initial implementation of the NATTS network during 2003 and 2004. The goal of the program is to estimate the concentrations of air toxics on a national level at fixed sites that remain active over an extended period of time (EPA, 2009a). The generation of large quantities of high-quality data over an extended period may allow concentration trends (i.e., any substantial increase or decrease over a period of time) to be identified. The data generated are also used for validating modeling results and emissions inventories, assessing current regulatory benchmarks, and assessing the potential for developing cancerous and noncancerous health effects (EPA, 2011a). The initial site locations were based on results from preliminary air toxics pilot programs such as the 1996 National Air Toxics Assessment (NATA), which used air toxics emissions data to model ambient monitoring concentrations across the nation. Monitoring sites were placed in both urban and rural locations. Urban areas were chosen to measure population exposure, while rural areas were chosen to determine background levels of air pollution (EPA, 2009b). Currently, 27 NATTS sites are strategically placed across the country (EPA, 2009c).

The CSATAM Program was “initiated in 2004 and is intended to support state, local, and tribal agencies in conducting discreet, investigative projects of approximately 2-year durations” via periodic grant competitions (EPA, 2009a). The objectives of the CSATAM Program “include identifying and profiling air toxics sources; developing and assessing emerging measurement methods; characterizing the degree and extent of local air toxics problems; and tracking progress of air toxics reduction activities” (EPA, 2009a).

Many environmental and health agencies have participated in these programs to assess the sources, effects, and changes in air pollution within their jurisdictions. In past reports, measurements from NATTS, UATMP, and CSATAM monitoring sites have been presented together and referred to as “UATMP sites.” In this report, a distinction is made among the three programs due to the increasing number of sites covered under each program. As such, it is appropriate to describe each program; to distinguish among their purposes and scopes; and to integrate the data, which allows each program’s objectives and goals to complement each other.

1.2 The Report

This report summarizes and interprets the 2008 and 2009 NATTS, UATMP, and CSATAM monitoring efforts of the NMP, which include up to 24 months of 1-in-6 or 1-in-12 day measurements of ambient air samples at 73 monitoring sites in or near 46 urban/rural locations in 28 states and the District of Columbia, including 39 metropolitan statistical areas (MSA). Much of the data analysis and interpretation in this report focuses on pollutant-specific risk potential.

In past NMP reports, a single calendar year's worth of sample data are included for summary and analysis. However, this report incorporates data from samples collected during both 2008 and 2009.

This report provides both a qualitative overview of air toxics pollution at selected urban and rural locations and a quantitative data analysis of the factors that appear to affect the behavior of air toxics in urban and rural areas most significantly. This report also focuses on data characterizations for each of the 73 different air sampling locations, a site-specific approach that allows for a much more detailed evaluation of the factors (e.g., emissions sources, natural sources, meteorological influences) that affect air quality differently from one location to the next.

This report offers participating agencies useful insights into important air quality issues. For example, participating agencies can use trends and patterns in the monitoring data to determine whether levels of air pollution present public health concerns, to identify which emissions sources contribute most to air pollution, or to forecast whether proposed pollution control initiatives might significantly improve air quality. Monitoring data may also be compared to modeling results, such as from EPA's NATA.

Policy-relevant questions that the monitoring data may help answer include the following:

- Which anthropogenic sources substantially affect 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 contained in this report are applied to every participating NATTS, UATMP, or CSATAM monitoring site, depending upon pollutants sampled and duration of sampling. Although many types of analyses are presented, state and local environmental agencies are encouraged to perform additional evaluations of the monitoring data so that the many factors that affect their specific ambient air quality can be understood fully.

To facilitate examination of the 2008 and 2009 NATTS, UATMP, and CSATAM monitoring data, henceforth referred to as NMP 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 System (AQS) of EPA's Aerometric Information Retrieval System (AIRS) at http://www.epa.gov/ttn/airs/airsaqs/.

This report is organized into 36 sections and 16 appendices. 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 data analyses without having to read the entire report, it is recommended that Sections 1 through 4 (Introduction, Monitoring Network Overview, Data Treatments/Methods, and Results) and Sections 34 and 35 (Quality Assurance and Summary of Results and Recommendations) be read as complements to the individual state sections. Table 1-1 highlights the contents of each section.

Table 1-1. Organization of the 2008-2009 National Monitoring Programs Report

Report Section	Section Title	Overview of Contents
1	Introduction	This section serves as an introduction to the background and scope of the National Monitoring Programs (specifically, the NATTS, UATMP, and CSATAM).
2	The 2008-2009 National Monitoring Programs Network	This section provides information on the 2008-2009 National Monitoring Programs and network: • Monitoring locations • Pollutants selected for monitoring • Sampling and analytical methods • Sampling schedules • Completeness of the air monitoring programs.
3	Summary of the 2008-2009 National Monitoring Programs Data Treatments and Methods	This section presents and discusses the data treatments used on the 2008-2009 National Monitoring Programs data to determine significant trends and relationships in the data; characterize data based on how ambient air concentrations varied with monitoring location and with time; interpret the significance of the observed spatial and temporal variations; and evaluate risk.
4	Summary of the 2008-2009 National Monitoring Programs Results	This section presents and discusses the results of the data treatments from the 2008-2009 National Monitoring Programs data.
5	Site in Alaska	Monitoring results for the site in the Anchorage, AK MSA (ANAK)
6	Sites in Arizona	Monitoring results for the sites in the Phoenix-Mesa-Scottsdale, AZ MSA (PXSS and SPAZ)
7	Sites in California	Monitoring results for the sites in the Los Angeles-Long Beach-Santa Ana, CA MSA (CELA), Riverside-San Bernardino-Ontario, CA MSA (RUCA), and San Jose-Sunnyvale-Santa Clara, CA MSA (SJJCA)
8	Sites in Colorado	Monitoring results for the sites in the Grand Junction, CO MSA (GPCO) and Garfield County (BRCO, MOCO, PACO, RICO, and RUCO)
9	Site in the District of Columbia	Monitoring results for the site in the Washington-Arlington-Alexandria, DC-VA-MD-WV MSA (WADC)
10	Sites in Florida	Monitoring results for the sites in the Orlando-Kissimmee, FL MSA (ORFL and PAFL), Miami-Ft. Lauderdale-Pompano Beach, FL MSA (CCFL and FLFL), and Tampa-St. Petersburg-Clearwater, FL MSA (AZFL, GAFL, SKFL, and SYFL)
11	Site in Georgia	Monitoring results for the site in the Atlanta-Sandy Springs-Marietta, GA MSA (SDGA)

Table 1-1. Organization of the 2008-2009 National Monitoring Programs Report (Continued)

Report Section	Section Title	Overview of Contents
12	Sites in Illinois	Monitoring results for the sites in the Chicago-Naperville-Joliet, IL-IN-WI MSA (NBIL and SPIL)
13	Sites in Indiana	Monitoring results for the sites in the Chicago-Naperville-Joliet, IL-IN-WI MSA (INDEM), and Indianapolis-Carmel, IN MSA (IDIN, ININ, and WPIN)
14	Sites in Kentucky	Monitoring results for the sites in Hazard (HAKY) and Grayson, KY (GLKY)
15	Site in Massachusetts	Monitoring results for the site in the Boston-Cambridge-Quincy, MA-NH MSA (BOMA)
16	Sites in Michigan	Monitoring results for the sites in the Detroit-Warren-Livonia, MI MSA (DEMI) and Sault Sainte Marie, MI (ITCMI)
17	Sites in Mississippi	Monitoring results for the sites in the Tupelo, MS MSA (TUMS) and Gulfport-Biloxi, MS MSA (GPMS)
18	Site in Missouri	Monitoring results for the site in the St. Louis, MO-IL MSA (S4MO)
19	Sites in New Jersey	Monitoring results for the sites in the New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (CHNJ, ELNJ, and NBNJ) and Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA (CANJ)
20	Sites in New York	Monitoring results for the sites in the New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (BXNY), Rochester, NY MSA (ROCH), and Buffalo-Niagara Falls, NY MSA (TONY)
21	Site in Ohio	Monitoring results for the site in the Columbus, OH MSA (COOH)
22	Sites in Oklahoma	Monitoring results for the sites in the Tulsa, OK MSA (TOOK, TMOK, TSOK, and TUOK), Oklahoma City, OK MSA (MWOK and OCOK), and Pryor, OK (CNEP, PROK)
23	Site in Oregon	Monitoring results for the site in the Portland-Vancouver-Beaverton, OR-WA MSA (PLOR)
24	Site in Rhode Island	Monitoring results for the site in the Providence-New Bedford-Fall River, RI-MA MSA (PRRI)
25	Site in South Carolina	Monitoring results for the site in Chesterfield, SC (CHSC)
26	Sites in South Dakota	Monitoring results for the sites in Custer, SD (CUSD), Sioux City, IA-NE-SD MSA (UCSD), and the Sioux Falls, SD MSA (SSSD)

Table 1-1. Organization of the 2008-2009 National Monitoring Programs Report (Continued)

Report Section	Section Title	Overview of Contents
27	Sites in Tennessee	Monitoring results for the sites in the Knoxville, TN MSA (LDTN and MSTN) and Memphis, TN-MS-AR MSA (METN)
28	Site in Texas	Monitoring results for the site in the Houston-Sugar Land-Baytown, TX MSA (CAMS 35)
29	Site in Utah	Monitoring results for the site in the Ogden-Clearfield, UT MSA (BTUT)
30	Site in Vermont	Monitoring results for the NATTS site in the Burlington-South Burlington, VT MSA (UNVT)
31	Site in Virginia	Monitoring results for the site in the Richmond, VA MSA (RIVA)
32	Sites in Washington	Monitoring results for the sites in the Seattle-Tacoma-Bellevue, WA MSA (SEWA, CEWA, EQWA, ESWA, and EYWA)
33	Site in Wisconsin	Monitoring results for the site in the Beaver Dam, WI MSA (MVWI)
34	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 2008-2009 National Monitoring Programs ambient air monitoring data.
35	Summary of Results and Recommendations	This section summarizes the most significant findings of the report and makes several recommendations for future projects that involve ambient air monitoring.
36	References	This section lists the references cited throughout the report.

2.0 The 2008-2009 National Monitoring Programs Network

Agencies operating NATTS, UATMP, or CSATAM sites that choose to participate under the NMP have their samples analyzed by EPA's contract laboratory, Eastern Research Group, Inc. (ERG) in Morrisville, NC. Data from 73 monitoring sites that collected 24-hour integrated ambient air samples for up to 24 months, at 1-in-6 or 1-in-12 day sampling intervals, are included in this report. Samples were analyzed for concentrations of selected hydrocarbons, halogenated hydrocarbons, and polar compounds from canister samples [Speciated Nonmethane Organic Compounds (SNMOC) and/or Method TO-15], carbonyl compounds from sorbent cartridge samples (Method TO-11A), polycyclic aromatic hydrocarbons (PAH) from polyurethane foam (PUF) and XAD-2® resin samples (Method TO-13A), hexavalent chromium from sodium bicarbonate-coated filters (EPA-approved method), and trace metals from filters (Method IO-3.5). Section 2.2 provides further details on each of the sampling methodologies used to collect and analyze samples. Note that agencies operating these sites are not required to have their samples analyzed by ERG or may not have samples for all methods analyzed by ERG, as they may have their own laboratories or use other contract laboratories. In these cases, data are generated by sources other than ERG and are not included in this report.

The following sections review the monitoring locations, pollutants selected for monitoring, collection schedules, sampling and analytical methods, and completeness of the 2008-2009 NMP dataset.

2.1 Monitoring Locations

For the NATTS Program, monitor siting is based on the need to assess population exposure and background-level concentrations. For the UATMP and CSATAM programs, representatives from the state, local, and tribal agencies that voluntarily participate in the programs select the monitoring locations based on specific siting criteria and study needs. Among the programs, 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., Custer, SD and Chesterfield, SC). Figure 2-1 shows the locations of the 73 monitoring sites participating in the 2008-2009 programs, which encompass 46 different urban and rural areas. 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 metropolitan or micropolitan statistical area (U.S. Census Bureau, 2007).

Table 2-1 lists the respective monitoring program and the years of program participation for the 73 monitoring sites. Forty-eight monitoring sites have been included in previous annual reports. Twenty-five new sites began sampling in 2008 or 2009 – 19 in 2008 and six in 2009.

As Figure 2-1 and Table 2-1 show, the 2008-2009 NMP sites are widely distributed across the country. Detailed information about the monitoring sites is provided in Table 2-2 and Appendix A. Monitoring sites that are designated as part of the NATTS network are indicated by bold italic type in Table 2-1 and subsequent tables throughout this report in order to distinguish this program from the other two programs. Table 2-2 shows that the location types of the monitoring sites vary significantly, based on elevation, population, land use, climatology, and topography. A more detailed look at each monitoring site's surroundings is provided in the individual state sections.

For record-keeping and reporting purposes, each site was assigned the following:

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

This report cites the four- or five-letter site code when presenting selected monitoring results. For reference, each site's AQS site code is provided in Table 2-2.

Figure 2-1. Locations of the 2008-2009 National Monitoring Programs Monitoring Sites

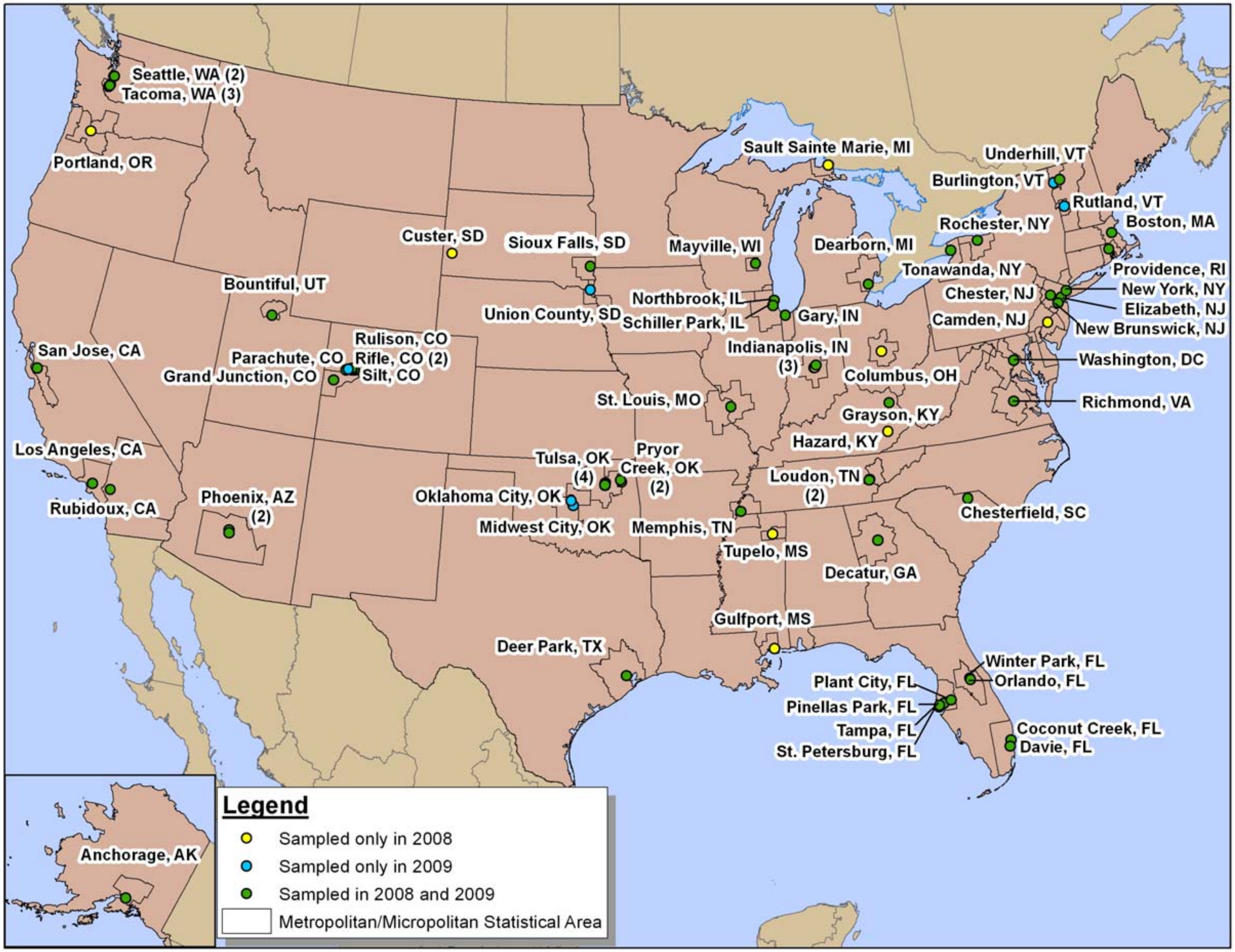

Table 2-1. 2008-2009 National Monitoring Programs Sites and Past Program Participation

Monitoring Location and Site	Program	2000 and Earlier	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anchorage, AK (ANAK)	UATMP									✓	✓
Boston, MA ***(BOMA)***	NATTS				✓	✓	✓	✓	✓	✓	✓
Bountiful, UT ***(BTUT)***	NATTS				✓	✓	✓	✓	✓	✓	✓
Burlington, VT (BURVT)	UATMP										✓
Camden, NJ (CANJ)	UATMP	1989,1991-1992, 1994-2000	✓	✓	✓	✓	✓	✓	✓	✓	
Chester, NJ (CHNJ)	UATMP		✓	✓	✓	✓	✓	✓	✓	✓	✓
Chesterfield, SC ***(CHSC)***	NATTS						✓	✓	✓	✓	✓
Coconut Creek, FL (CCFL)	UATMP									✓	✓
Columbus, OH (COOH)	UATMP									✓	
Custer, SD (CUSD)	UATMP			✓	✓	✓	✓	✓	✓	✓	
Davie, FL (FLFL)	UATMP						✓	✓	✓	✓	✓
Dearborn, MI ***(DEMI)***	NATTS		✓	✓	✓	✓	✓	✓	✓	✓	✓
Decatur, GA ***(SDGA)***	NATTS						✓	✓	✓	✓	✓
Deer Park, TX ***(CAMS 35)***	NATTS								✓	✓	✓
Elizabeth, NJ (ELNJ)	UATMP	1999-2000	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gary, IN (INDEM)	UATMP					✓	✓	✓	✓	✓	✓
Grand Junction, CO ***(GPCO)***	NATTS					✓	✓	✓	✓	✓	✓
Grayson, KY ***(GLKY)***	NATTS									✓	✓

BOLD = EPA-designated NATTS site.

Table 2-1. 2008-2009 National Monitoring Programs Sites and Past Program Participation (Continued)

Monitoring Location and Site	Program	2000 and Earlier	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gulfport, MS (GPMS)	UATMP		✓	✓	✓	✓	✓	✓	✓	✓	
Hazard, KY ***(HAKY)***	NATTS						✓	✓	✓	✓	
Indianapolis, IN (ININ)	CSATAM							✓	✓	✓	
Indianapolis, IN (IDIN)	CSATAM							✓	✓	✓	
Indianapolis, IN (WPIN)	UATMP							✓	✓	✓	✓
Los Angeles, CA ***(CELA)***	NATTS								✓	✓	✓
Loudon, TN (LDTN)	UATMP				✓	✓	✓	✓	✓	✓	✓
Loudon, TN (MSTN)	UATMP							✓	✓	✓	✓
Mayville, WI ***(MVWI)***	NATTS						✓	✓	✓	✓	✓
Memphis, TN (METN)	UATMP									✓	✓
Midwest City, OK (MWOK)	UATMP										✓
New Brunswick, NJ (NBNJ)	UATMP		✓	✓	✓	✓	✓	✓	✓	✓	✓
New York City, NY ***(BXNY)***	NATTS								✓	✓	✓
Northbrook, IL ***(NBIL)***	NATTS				✓	✓	✓	✓	✓	✓	✓
Oklahoma City (OCOK)	UATMP										✓
Orlando, FL (PAFL)	UATMP									✓	✓
Parachute, CO (PACO)	CSATAM									✓	✓
Phoenix, AZ ***(PXSS)***	NATTS		✓	✓	✓	✓		✓	✓	✓	✓
Phoenix, AZ (SPAZ)	UATMP		✓	✓	✓	✓			✓	✓	✓

BOLD = EPA-designated NATTS site.

Table 2-1. 2008-2009 National Monitoring Programs Sites and Past Program Participation (Continued)

Monitoring Location and Site	Program	2000 and Earlier	2001	2002	2003	2004	2005	2006	2007	2008	2009
Pinellas Park, FL ***(SKFL)***	NATTS					✓	✓	✓	✓	✓	✓
Plant City, FL ***(SYFL)***	NATTS					✓	✓	✓	✓	✓	✓
Portland, OR ***(PLOR)***	NATTS			✓	✓					✓	
Providence, RI ***(PRRI)***	NATTS						✓	✓	✓	✓	✓
Pryor Creek, OK (CNEP)	UATMP							✓	✓	✓	✓
Pryor Creek, OK (PROK)	UATMP									✓	✓
Richmond, VA ***(RIVA)***	NATTS									✓	✓
Rifle, CO (MOCO)	CSATAM									✓	✓
Rifle, CO (RICO)	CSATAM									✓	✓
Rulison, CO (RUCO)	CSATAM										✓
Rochester, NY ***(ROCH)***	NATTS								✓	✓	✓
Rubidoux, CA ***(RUCA)***	NATTS								✓	✓	✓
Rutland, VT (RUVT)	UATMP	1995-1999		✓							✓
San Jose, CA ***(SJJCA)***	NATTS									✓	✓
Sault Ste. Marie, MI (ITCMI)	UATMP				✓	✓	✓	✓	✓	✓	
Schiller Park, IL (SPIL)	UATMP				✓	✓	✓	✓	✓	✓	✓
Seattle, WA (CEWA)	CSATAM									✓	✓
Seattle, WA (SEWA)	NATTS						✓	✓	✓	✓	✓

BOLD = EPA-designated NATTS site.

Table 2-1. 2008-2009 National Monitoring Programs Sites and Past Program Participation (Continued)

Monitoring Location and Site	Program	2000 and Earlier	2001	2002	2003	2004	2005	2006	2007	2008	2009
Silt, CO (BRCO)	CSATAM									✓	✓
Sioux Falls, SD (SSSD)	UATMP									✓	✓
St. Louis, MO ***(S4MO)***	NATTS			✓	✓	✓	✓	✓	✓	✓	✓
St. Petersburg, FL (AZFL)	UATMP	1992	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tacoma, WA (EQWA)	CSATAM									✓	✓
Tacoma, WA (ESWA)	CSATAM									✓	✓
Tacoma, WA (EYWA)	CSATAM									✓	✓
Tampa, FL (GAFL)	UATMP		✓	✓	✓	✓	✓	✓	✓	✓	✓
Tonawanda, NY (TONY)	CSATAM									✓	✓
Tulsa, OK (TMOK)	UATMP										✓
Tulsa, OK (TOOK)	UATMP							✓	✓	✓	✓
Tulsa, OK (TSOK)	UATMP							✓	✓	✓	
Tulsa, OK (TUOK)	UATMP							✓	✓	✓	✓
Tupelo, MS (TUMS)	UATMP		✓	✓	✓	✓	✓	✓	✓	✓	
Underhill, VT ***(UNVT)***	NATTS			✓			✓	✓	✓	✓	✓
Union County, SD (UCSD)	UATMP										✓
Washington, D.C. ***(WADC)***	NATTS						✓	✓	✓	✓	✓
Winter Park, FL (ORFL)	UATMP	1991			✓	✓	✓	✓	✓	✓	✓

BOLD = EPA-designated NATTS site.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
ANAK	02-020-0018	Anchorage, AK	Residential	Suburban	24,143 (2008)	246,599	335,703 (2008)	1,393.63	3,125.12
AZFL	12-103-0018	Azalea Park, St. Petersburg, FL	Residential	Suburban	30,500 (2009)	569,744	896,957 (2009)	2,445.77	5,061.11
BOMA	25-025-0042	Boston, MA	Commercial	Urban/City Center	31,400 (2007)	1,585,962	489,937 (2008)	1,477.77	2,105.82
BRCO	08-045-0009	Silt, CO	Agricultural	Rural	150 (2002)	22,054	77,026 (2008)	1,729.90	481.24
BTUT	49-011-0004	Bountiful, UT	Residential	Suburban	111,065 (2009)	251,597	241,541 (2009)	905.16	1,399.46
BURVT	50-007-0014	Burlington, VT	Commercial	Urban/City Center	12,000 (2002)	114,649	223,316 (2010)	617.21	972.56
BXNY	36-005-0110	New York City, NY	Residential	Urban/City Center	100,230 (2008)	6,531,354	246,190 (2008)	3,778.06	1,917.66
CAMS 35	48-201-1039	Deer Park, TX	Residential	Suburban	31,043 (2004)	741,262	2,982,632 (2009)	19,193.59	13,404.56
CANJ	34-007-0003	Camden, NJ	Residential	Suburban	4,206 (2008)	2,003,209	372,132 (Ratio)[d]	1,307.66	1,972.32
CCFL	12-011-5005	Coconut Creek, FL	Residential	Suburban	38,500 (2009)	923,091	1,436,626 (2009)	8,460.78	7,682.45
CELA	06-037-1103	Los Angeles, CA	Residential	Urban/City Center	238,000 (2005)	3,739,626	7,498,722 (2008)	26,182.92	26,070.93

BOLD = EPA-designated NATTS site.

[a] AADT is average annual daily traffic.

[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO's hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
CEWA	53-033-0057	Seattle, WA	Industrial	Suburban	47,000 (2009)	860,890	1,772,343 (2009)	4,730.72	12,488.07
CHNJ	34-027-3001	Chester, NJ	Agricultural	Rural	12,917 (2010)	242,969	342,994 (Ratio)[d]	1,300.97	2,658.79
CHSC	45-025-0001	Chesterfield, SC	Forest	Rural	650 (2009)	5,432	40,133 (2007)	423.55	286.41
CNEP	40-097-9014	Pryor, OK	Agricultural	Rural	4,600 (2008)	29,152	30,023 (2009)	395.68	341.60
COOH	39-049-0034	Columbus, OH	Commercial	Urban/City Center	143,360 (2006)	939,504	1,101,479 (2008)	4,427.27	5,487.42
CUSD	46-033-0003	Custer, SD	Residential	Suburban	2,500 (2007)	5,549	14,714 (2008)	111.60	100.73
DEMI	26-163-0033	Dearborn, MI	Industrial	Suburban	104,100 (2009)	1,138,740	1,341,276 (2009)	7,917.32	11,547.35
ELNJ	34-039-0004	Elizabeth, NJ	Industrial	Suburban	250,885 (2002)	2,205,797	369,610 (Ratio)[d]	1,804.23	2,031.21
EQWA	53-053-0031	Tacoma, WA	Industrial	Suburban	21,000 (2009)	641,623	757,027 (2009)	3,061.04	4,852.07
ESWA	53-053-0029	Tacoma, WA	Commercial	Suburban	154,000 (2009)	627,789	757,027 (2009)	3,061.04	4,852.07
EYWA	53-053-0034	Tacoma, WA	Residential	Suburban	196,000 (2009)	694,266	757,027 (2009)	3,061.04	4,852.07

BOLD = EPA-designated NATTS site.

[a] AADT is average annual daily traffic.

[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO’s hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
FLFL	12-011-1002	Davie, FL	Commercial	Suburban	14,000 (2009)	1,327,088	1,436,626 (2009)	8,460.78	7,682.45
GAFL	12-057-1065	Tampa, FL	Commercial	Suburban	29,000 (2009)	475,725	1,137,069 (2009)	7,888.07	5,891.40
GLKY	21-043-0500	Grayson, KY	Residential	Rural	428 (2009)	14,815	28,371 (2008)	124.99	240.36
GPCO[e]	08-077-0017 08-077-0018	Grand Junction, CO	Commercial	Urban/City Center	11,800 (2009)	108,432	182,518 (2008)	672.84	765.15
GPMS	28-047-0008	Gulfport, MS	Commercial	Rural	27,000 (2007)	155,056	173,974 (2008)	2,853.56	1,800.96
HAKY	21-193-0003	Hazard, KY	Residential	Suburban	21,359 (2008)	31,861	25,654 (2008)	355.43	131.87
IDIN	18-097-0085	Indianapolis, IN	Military Reservation	Urban/City Center	77,250 (2002)	594,540	814,682 (2008)	3,890.15	4,355.52
INDEM	18-089-0022	Gary, IN	Industrial	Urban/City Center	23,280 (2007)	414,726	416,995 (2008)	2,620.20	2,327.59
ININ	18-097-0057	Indianapolis, IN	Residential	Urban/City Center	97,780 (2002)	668,574	814,682 (2008)	3,890.15	4,355.52
ITCMI	26-033-0901	Sault Sainte Marie, MI	Residential	Rural	5,200 (2008)	21,803	37,629 (2008)	258.43	620.69
LDTN	47-105-0108	Loudon, TN	Residential	Suburban	12,560 (2009)	50,501	57,565 (2010)	1,499.70	533.23

BOLD = EPA-designated NATTS site.

[a] AADT is average annual daily traffic.

[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO's hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
METN	47-157-0010	Memphis, TN	Residential	Suburban	57,872 (2009)	412,435	682,581 (2010)	4,276.87	4,613.82
MOCO	Mobile site, no AQS Code	Rifle, CO	Agricultural	Rural	N/A	16,364	77,026 (2008)	1,729.90	481.24
MSTN	47-105-0109	Loudon, TN	Residential	Suburban	7,691 (2008)	50,501	57,565 (2010)	1,499.70	533.23
MVWI	55-027-0007	Mayville, WI	Agricultural	Rural	3,500 (2004)	24,804	93,219 (2008)	504.04	620.48
MWOK	40-109-0041	Midwest City, OK	Commercial	Urban/City Center	59,165 (2008)	345,291	685,765 (2009)	1,888.14	4,679.95
NBIL	17-031-4201	Northbrook, IL	Residential	Suburban	34,100 (2009)	870,561	2,128,822 (2008)	19,083.43	15,077.17
NBNJ	34-023-0006	New Brunswick, NJ	Agricultural	Rural	110,653 (2009)	788,786	555,187 (Ratio)[d]	2,369.53	3,353.62
OCOK	40-109-1037	Oklahoma City, OK	Residential	Suburban	61,500 (2008)	330,027	685,765 (2009)	1,888.14	4,679.95
ORFL	12-095-2002	Winter Park, FL	Commercial	Urban/City Center	32,000 (2009)	1,008,282	1,055,967 (2009)	4,996.38	6,275.32
PACO	08-045-0005	Parachute, CO	Residential	Urban/City Center	919 (2002)	6,664	77,026 (2008)	1,729.90	481.24
PAFL	12-095-1004	Orlando, FL	Commercial	Suburban	51,500 (2009)	879,184	1,055,967 (2009)	4,996.38	6,275.32

BOLD = EPA-designated NATTS site.

[a] AADT is average annual daily traffic.

[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO’s hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
PLOR	41-051-0246	Portland, OR	Residential	Urban/City Center	5,457 (2005)	1,008,125	748,648 (2007)	8,500.27	3,193.72
PROK	40-097-0187	Pryor Creek, OK	Industrial	Suburban	18,400 (2008)	29,152	30,023 (2009)	395.68	341.60
PRRI	44-007-0022	Providence, RI	Residential	Urban/City Center	136,800 (2009)	670,441	142,334 (2006)	1,081.48	2,607.42
PXSS	04-013-9997	Phoenix, AZ	Residential	Urban/City Center	206,000 (2007)	1,511,946	3,753,941 (2009)	9,929.52	13,209.33
RICO	08-045-0007	Rifle, CO	Commercial	Urban/City Center	4,800 (2009)	16,364	77,026 (2008)	1,729.90	481.24
RIVA	51-087-0014	Richmond, VA	Residential	Suburban	74,000 (2009)	477,486	347,913 (2009)	1,567.58	1,534.78
ROCH	36-055-1007	Rochester, NY	Residential	Urban/City Center	105,038 (2008)	636,955	552,964 (2008)	5,644.58	3,829.32
RUCA	06-065-8001	Rubidoux, CA	Residential	Suburban	18,365 (2009)	1,000,923	1,685,246 (2008)	4,173.27	5,510.43
RUCO	None	Rifle, CO	Agricultural	Rural	583 (2002)	16,364	77,026 (2008)	1,729.90	481.24
RUVT	50-021-0002	Rutland, VT	Commercial	Urban/City Center	6,600 (2008)	35,118	118,002 (2010)	284.83	469.30
S4MO	29-510-0085	St. Louis, MO	Residential	Urban/City Center	81,174 (2009)	816,098	1,132,283 (2009)	2,016.50	1,481.70

BOLD = EPA-designated NATTS site.

[a] AADT is average annual daily traffic.

[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO’s hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
SDGA	13-089-0002	Decatur, GA	Residential	Suburban	9,200 (2008)	776,511	467,962 (2009)	2,566.55	3,402.47
SEWA	53-033-0080	Seattle, WA	Industrial	Suburban	236,000 (2009)	912,020	1,772,343 (2009)	4,730.72	12,488.07
SJJCA	06-085-0005	San Jose, CA	Commercial	Urban/City Center	6,000 (2005)	1,435,158	1,508,850 (2008)	5,346.24	4,294.91
SKFL	12-103-0026	Pinellas Park, FL	Residential	Suburban	51,000 (2009)	672,839	896,957 (2009)	2,445.77	5,061.11
SPAZ	04-013-4003	Phoenix, AZ	Residential	Urban/City Center	113,000 (2007)	896,909	3,753,941 (2009)	9,929.52	13,209.33
SPIL	17-031-3103	Schiller Park, IL	Mobile	Suburban	213,500 (2009)	2,049,963	2,128,822 (2008)	19,083.43	15,077.17
SSSD	46-099-0008	Sioux Falls, SD	Commercial	Urban/City Center	22,087 (2009)	167,000	200,008 (2008)	531.25	688.29
SYFL	12-057-3002	Plant City, FL	Residential	Rural	10,400 (2009)	311,528	1,137,069 (2009)	7,888.07	5,891.40
TMOK	40-143-1127	Tulsa, OK	Residential	Urban/City Center	11,900 (2008)	321,574	520,938 (2009)	1,699.70	4,375.07
TONY	36-029-1013	Tonawanda, NY	Industrial	Urban/City Center	74,406 (2008)	611,359	664,102 (2008)	6,124.39	4,588.72
TOOK	40-143-0235	Tulsa, OK	Industrial	Urban/City Center	62,400 (2008)	446,016	520,938 (2009)	1,699.70	4,375.07

BOLD = EPA-designated NATTS site.

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[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO's hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

Table 2-2. Site Characterizing Information for 2008-2009 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	Population Residing Within 10 Miles of the Monitoring Site[b]	County-level Vehicle Registration, # of Vehicles (Year)	County-level Stationary Source HAP Emissions from the 2005 NEI[c] (tpy)	County-level Mobile Source HAP Emissions from the 2005 NEI[c] (tpy)
TSOK	40-143-0172	Tulsa, OK	Residential	Suburban	62,100 (2008)	337,331	511,990 (2008)	1,699.70	4,375.07
TUMS	28-081-0005	Tupelo, MS	Commercial	Suburban	12,000 (2007)	71,697	73,635 (2008)	910.26	688.09
TUOK	40-143-0191	Tulsa, OK	Residential	Urban/City Center	46,000 (2008)	447,932	520,938 (2009)	1,699.70	4,375.07
UCSD	46-127-0001	Union County, SD	Agricultural	Rural	156 (2007)	6,796	22,304 (2008)	88.60	119.43
UNVT	50-007-0007	Underhill, VT	Forest	Rural	1,200 (2005)	14,408	223,316 (2010)	617.21	972.56
WADC	11-001-0043	Washington, D.C.	Commercial	Urban/City Center	7,600 (2008)	1,860,974	171,255 (2008)	696.73	1,834.77
WPIN	18-097-0078	Indianapolis, IN	Residential	Suburban	143,759 (2007)	766,042	814,682 (2008)	3,890.15	4,355.52

BOLD = EPA-designated NATTS site.

[a] AADT is average annual daily traffic.

[b] Reference: http://xionetic.com/zipfinddeluxe.aspx.

[c] Reference: EPA, 2011b.

[d] The proportion of county-level population to the state-level population was applied to state-level vehicle registration figure and used as a surrogate when county-level vehicle registration counts were not available.

[e] GPCO’s hexavalent chromium monitor is at a separate, but adjacent, location; as such, this site has two AQS codes.

NA = Not available.

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 potential contributions of stationary and mobile source emissions on ambient air quality at each site, Table 2-2 also lists the following:

- Stationary and mobile source HAP emissions in the monitoring site's residing county, according to the 2005 National Emissions Inventory (NEI).
- The number of people living within 10 miles of each monitoring site.
- The county-level number of motor vehicles registered in each site's respective county, based on total vehicle registrations.
- The number of vehicles passing the nearest available roadway to the monitoring site, generally expressed as average annual daily traffic (AADT).

2.2 Analytical Methods and Pollutants Targeted for Monitoring

Air pollution typically contains hundreds of components, including, but not limited to, volatile organic compounds (VOC), metals, and particulate matter. Because the sampling and analysis required to monitor for every component of air pollution has been prohibitively expensive, the NMP focuses on specific pollutants that are analyzed using specific methods, as listed below. The target pollutants varied significantly from monitoring site to monitoring site.

- *Compendium Method TO-15* was used to measure ambient air concentrations of 61 VOC.
- *EPA-approved SNMOC Method* was used to measure 80 ozone precursors. This method was often used concurrently with Method TO-15.
- *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 22 PAH.
- *Compendium Method IO-3.5* was used to measure ambient air concentrations of 11 metals.

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

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

The detection limits of the analytical methods must be considered carefully when interpreting the corresponding ambient air monitoring data. By definition, method detection limits (MDLs) 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 measurement results, including highly variable concentrations or “non-detect” observations (i.e., the pollutant was not detected by the instrument). Data analysts should exercise caution when interpreting monitoring data with a high percentage of reported concentrations at levels near or below the corresponding detection limits.

MDLs are determined annually at the ERG laboratory using 40 CFR, Part 136 Appendix B procedures (EPA, 2011c) in accordance with the specifications presented in the NATTS Technical Assistance Document (TAD) (EPA, 2009b). This procedure involves analyzing at least seven replicate standards prepared on/in the appropriate sampling media (per analytical method). Instrument-specific detection limits (replicate analysis of standards only) are not determined because sample contamination and preparation variability would not be considered.

In 2009, a new MDL procedure was used to determine the MDLs for two of the metals analytes – total chromium and nickel. This method was used for pollutants in which high background concentrations are seen in the filter media method, as prescribed by "Appendix D: DQ FAC Single Laboratory Procedure v2.4" (FAC, 2007). The method involves analyzing at least seven replicate samples extracted from blank sampling media and calculating the MDL from the results.

Tables 2-3 through 2-8 identify the specific target pollutants for each method and their corresponding MDLs. For the VOC and SNMOC analyses, the experimentally-determined MDLs do not change within a given year unless the sample was diluted. The 2008 and 2009 VOC and SNMOC MDLs are presented by year in Tables 2-3 and 2-4, respectively. For the rest of the analyses, the MDLs vary due to the actual volume pulled through the sample or if the sample was diluted. For these analyses, the range and average of each MDL is presented for each pollutant in Tables 2-5 through 2-8. Pollutant-specific MDLs are also presented in Appendix B.

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

2.2.1 VOC and SNMOC Concurrent Sampling and Analytical Methods

VOC and SNMOC sampling and analysis can be performed concurrently in accordance with a combination of EPA Compendium Method TO-15 (EPA, 1999a) and the procedure presented in EPA's "Technical Assistance Document for Sampling and Analysis of Ozone Precursors" (EPA, 1998). When referring to SNMOC, this report may refer to this method as the "concurrent SNMOC method" or "concurrent SNMOC analysis" because both methods were often employed at the same time to analyze the same sample. Ambient air samples for VOC and/or concurrent SNMOC analysis were collected in passivated stainless steel canisters. The ERG laboratory distributed the prepared canisters (i.e., cleaned and evacuated) to the monitoring sites before each scheduled sample collection event, and site operators connected the canisters to air sampling equipment prior to each sample day. Prior to field sampling, the passivated canisters had internal pressures much lower than atmospheric pressure. Using this pressure differential, ambient air naturally flowed into the canisters automatically once an associated system solenoid valve was actuated. 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, the solenoid valve automatically stopped ambient air from flowing into the canister. Site operators recovered and returned the canisters, along with the Chain of Custody forms and all associated documentation, to the ERG 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 and/or 80 SNMOC, and calculated the total nonmethane organic compounds (TNMOC) concentration. TNMOC is the sum of all hydrocarbon concentrations within the sample. Because isobutene and 1-butene elute from the GC column at the same time, the SNMOC analytical method reports only the sum of the concentrations for these two compounds, and not the separate concentration for each compound. The same approach applies to *m*-xylene and *p*-xylene for both the VOC and concurrent SNMOC methods. These raw data are presented in Appendices C and D.

Table 2-3 presents the MDLs for the laboratory analysis of VOC samples and Table 2-4 presents the MDLs for the analysis of SNMOC samples. The MDL for every VOC is lower than 0.07 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 0.44 ppbC.

Table 2-3. 2008-2009 VOC Method Detection Limits

Pollutant	2008 MDL (ppbv)	2009 MDL (ppbv)	Pollutant	2008 MDL (ppbv)	2009 MDL (ppbv)
Acetonitrile	0.022	0.058	Dichloromethane	0.018	0.008
Acetylene	0.009	0.012	1,2-Dichloropropane	0.010	0.003
Acrolein	0.020	0.015	*cis*-1,3-Dichloropropene	0.007	0.003
Acrylonitrile	0.009	0.015	*trans*-1,3-Dichloropropene	0.007	0.003
tert-Amyl Methyl Ether	0.013	0.007	Dichlorotetrafluoroethane	0.003	0.001
Benzene	0.010	0.006	Ethyl Acrylate	0.021	0.060

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

Table 2-3. 2008-2009 VOC Method Detection Limits (Continued)

Pollutant	2008 MDL (ppbv)	2009 MDL (ppbv)	Pollutant	2008 MDL (ppbv)	2009 MDL (ppbv)
Bromochloromethane	0.006	0.005	Ethyl *tert*-Butyl Ether	0.005	0.007
Bromodichloromethane	0.007	0.002	Ethylbenzene	0.008	0.004
Bromoform	0.005	0.002	Hexachloro-1,3-Butadiene	0.017	0.012
Bromomethane	0.004	0.002	Methyl Ethyl Ketone	0.028	0.039
1,3-Butadiene	0.005	0.003	Methyl Isobutyl Ketone	0.016	0.005
Carbon Tetrachloride	0.004	0.002	Methyl Methacrylate	0.012	0.028
Carbon Disulfide	0.004	0.002	Methyl *tert*-Butyl Ether	0.005	0.014
Chlorobenzene	0.008	0.002	*n*-Octane	0.005	0.004
Chloroethane	0.004	0.002	Propylene	0.019	0.037
Chloroform	0.007	0.002	Styrene	0.021	0.003
Chloromethane	0.008	0.006	1,1,2,2-Tetrachloroethane	0.009	0.003
Chloromethylbenzene	0.011	0.002	Tetrachloroethylene	0.006	0.003
Chloroprene	0.007	0.003	Toluene	0.023	0.008
Dibromochloromethane	0.005	0.001	1,2,4-Trichlorobenzene	0.030	0.007
1,2-Dibromoethane	0.007	0.001	1,1,1-Trichloroethane	0.005	0.001
m-Dichlorobenzene	0.015	0.004	1,1,2-Trichloroethane	0.008	0.003
o-Dichlorobenzene	0.015	0.004	Trichloroethylene	0.004	0.002
p-Dichlorobenzene	0.012	0.004	Trichlorofluoromethane	0.003	0.002
Dichlorodifluoromethane	0.005	0.004	Trichlorotrifluoroethane	0.007	0.003
1,1-Dichloroethane	0.007	0.002	1,2,4-Trimethylbenzene	0.016	0.005
1,2-Dichloroethane	0.009	0.002	1,3,5-Trimethylbenzene	0.016	0.004
1,1-Dichloroethene	0.005	0.003	Vinyl Chloride	0.005	0.002
cis-1,2-Dichloroethylene	0.007	0.017	*m,p*-Xylene[1]	0.019	0.007
trans-1,2-Dichloroethylene	0.005	0.003	*o*-Xylene	0.008	0.003

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

Table 2-4. 2008-2009 SNMOC Method Detection Limits[1]

Pollutant	2008 MDL (ppbC)	2009 MDL (ppbC)	Pollutant	2008 MDL (ppbC)	2009 MDL (ppbC)
Acetylene	0.11	0.08	2-Methyl-1-Pentene	0.43	0.26
Benzene	0.24	0.21	4-Methyl-1-Pentene	0.43	0.26
1,3-Butadiene	0.19	0.22	2-Methyl-2-Butene	0.20	0.20
n-Butane	0.11	0.22	Methylcyclohexane	0.15	0.14
cis-2-Butene	0.19	0.17	Methylcyclopentane	0.13	0.14
trans-2-Butene	0.13	0.10	2-Methylheptane	0.18	0.13
Cyclohexane	0.22	0.21	3-Methylheptane	0.20	0.13
Cyclopentane	0.08	0.13	2-Methylhexane	0.18	0.22

[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 reports 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.

Table 2-4. 2008-2009 SNMOC Method Detection Limits[1] (Continued)

Pollutant	2008 MDL (ppbC)	2009 MDL (ppbC)	Pollutant	2008 MDL (ppbC)	2009 MDL (ppbC)
Cyclopentene	0.20	0.20	3-Methylhexane	0.23	0.14
n-Decane	0.20	0.19	2-Methylpentane	0.08	0.12
1-Decene	0.20	0.25	3-Methylpentane	0.18	0.17
m-Diethylbenzene	0.18	0.25	*n*-Nonane	0.17	0.18
p-Diethylbenzene	0.12	0.18	1-Nonene	0.32	0.28
2,2-Dimethylbutane	0.14	0.17	*n*-Octane	0.24	0.19
2,3-Dimethylbutane	0.20	0.21	1-Octene	0.31	0.29
2,3-Dimethylpentane	0.39	0.24	*n*-Pentane	0.10	0.15
2,4-Dimethylpentane	0.24	0.17	1-Pentene	0.12	0.10
n-Dodecane	0.42	0.35	*cis*-2-Pentene	0.19	0.16
1-Dodecene	0.42	0.35	*trans*-2-Pentene	0.19	0.17
Ethane	0.09	0.13	*a*-Pinene	0.32	0.25
2-Ethyl-1-butene	0.43	0.26	*b*-Pinene	0.20	0.25
Ethylbenzene	0.21	0.19	Propane	0.18	0.20
Ethylene	0.07	0.12	*n*-Propylbenzene	0.19	0.20
m-Ethyltoluene	0.15	0.15	Propylene	0.07	0.10
o-Ethyltoluene	0.29	0.12	Propyne	0.18	0.20
p-Ethyltoluene	0.26	0.23	Styrene	0.25	0.29
n-Heptane	0.20	0.18	Toluene	0.33	0.23
1-Heptene	0.39	0.24	*n*-Tridecane	0.42	0.35
n-Hexane	0.23	0.16	1-Tridecene	0.42	0.35
1-Hexene	0.43	0.26	1,2,3-Trimethylbenzene	0.22	0.20
cis-2-Hexene	0.43	0.26	1,2,4-Trimethylbenzene	0.24	0.19
trans-2-Hexene	0.43	0.26	1,3,5-Trimethylbenzene	0.20	0.14
Isobutane	0.08	0.14	2,2,3-Trimethylpentane	0.31	0.29
Isobutene/1-Butene[2]	0.14	0.12	2,2,4-Trimethylpentane	0.22	0.15
Isopentane	0.17	0.17	2,3,4-Trimethylpentane	0.18	0.15
Isoprene	0.20	0.20	*n*-Undecane	0.17	0.12
Isopropylbenzene	0.32	0.28	1-Undecene	0.17	0.12
2-Methyl-1-Butene	0.20	0.20	*m,p*-Xylene[2]	0.31	0.21
3-Methyl-1-Butene	0.20	0.20	*o*-Xylene	0.17	0.21

[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 reports 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.

2.2.2 Carbonyl Compound Sampling and Analytical Method

Following the specifications of EPA Compendium Method TO-11A (EPA,1999b), ambient air samples for carbonyl compound analysis were collected by passing ambient air through an ozone scrubber and then 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. The ERG laboratory distributed the DNPH cartridges to the monitoring sites prior to each scheduled sample collection event and site operators connected the cartridges to the air sampling equipment. After each 24-hour sampling period, site operators recovered and returned the cartridges, along with the Chain of Custody forms and all associated documentation, to the ERG laboratory for analysis.

To quantify concentrations of carbonyl compounds in the sampled ambient air, laboratory analysts eluted the exposed DNPH cartridges with acetonitrile. High-performance liquid chromatography (HPLC) analysis and ultraviolet detection of these solutions determined the relative amounts of individual carbonyl compounds present in the original air sample. Because butyraldehyde and isobutyraldehyde elute from the HPLC column at the same time, the carbonyl compound analytical method reports 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. These raw data are presented in Appendix E.

Table 2-5 lists the MDLs reported by the ERG laboratory for measuring concentrations of 15 carbonyl compounds. Although the sensitivity varies from pollutant-to-pollutant and from site-to-site due to the different volumes pulled through the samples, the average detection limit reported by the ERG laboratory for every pollutant is less than 0.015 ppbv.

Table 2-5. 2008-2009 Carbonyl Compound Method Detection Limits

Pollutant	Minimum MDL (ppbv)	Maximum MDL (ppbv)	Average MDL (ppbv)
Acetaldehyde	0.0020	0.0800	0.0104
Acetone	0.0010	0.0330	0.0045
Benzaldehyde	0.0005	0.0140	0.0020
Butyraldehyde[1]	0.0009	0.0160	0.0027
Crotonaldehyde	0.0008	0.0270	0.0037
2,5-Dimethylbenzaldehyde	0.0003	0.0140	0.0017
Formaldehyde	0.0040	0.0670	0.0113
Hexaldehyde	0.0005	0.0200	0.0024
Isovaleraldehyde	0.0005	0.0140	0.0020
Propionaldehyde	0.0010	0.0200	0.0036
Tolualdehydes[1]	0.0010	0.0170	0.0038
Valeraldehyde	0.0007	0.0190	0.0025

[1] Because butyraldehyde/isobutyraldehyde elute from the HPLC column at the same time, the carbonyl compound analytical method reports 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 isomers.

2.2.3 PAH Sampling and Analytical Method

PAH sampling was performed in accordance with EPA Compendium Method TO-13A (EPA, 1999c) and ASTM D6209-98 (ASTM, 2004). The ERG laboratory prepared sampling media and supplied them to the sites before each scheduled sample collection event. The clean sampling PUF/ XAD-2® cartridge and quartz filter are installed in a high volume sampler by the site operators and allowed to sample for 24 hours. Sample collection modules and Chain of Custody forms and all associated documentation were shipped to the ERG laboratory after sample collection. Within 14 days of sampling, the filter and cartridge are extracted together using a toluene in hexane solution using the Dionex Accelerated Solvent Extractor (ASE) 350 or ASE 300. The sample extract is concentrated to a final volume of 1.0 milliliter (mL). A volume of 1 microliter (μL) is injected into the GC/MS operating in the selected ion monitoring (SIM) mode to analyze 22 PAH. PAH raw data are presented in Appendix F.

Table 2-6 lists the MDLs for the 22 PAH target pollutants. Although the sensitivity varies from pollutant-to-pollutant and from site-to-site due to the different volumes pulled through the samples, the average MDLs for PAH ranged from 0.054 to 0.433 nanograms per cubic meter (ng/m^3). Note: the number of pollutants measured by Method TO-13A increased by three parameters in February 2008. These pollutants are denoted in Table 2-6.

Table 2-6. 2008-2009 PAH Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
Acenaphthene	0.023	0.200	0.054
Acenaphthylene	0.021	0.228	0.056
Anthracene	0.018	0.246	0.056
Benzo(a)anthracene	0.035	0.298	0.081
Benzo(a)pyrene	0.039	0.286	0.084
Benzo(b)fluoranthene	0.038	0.276	0.092
Benzo(e)pyrene	0.032	0.327	0.096
Benzo(g,h,i)perylene	0.022	0.303	0.080
Benzo(k)fluoranthene	0.028	0.278	0.071
Chrysene	0.026	0.190	0.064
Coronene	0.028	0.362	0.098
Cyclopenta[cd]pyrene[1]	0.041	0.383	0.116
Dibenz(a,h)anthracene	0.031	0.262	0.084
Fluoranthene	0.025	0.216	0.059
Fluorene	0.025	0.179	0.058
9-Fluorenone[1]	0.030	0.220	0.064
Indeno(1,2,3-cd)pyrene	0.026	0.283	0.081
Naphthalene	0.157	1.380	0.433
Perylene	0.018	0.239	0.064
Phenanthrene	0.038	0.297	0.098
Pyrene	0.026	0.278	0.069
Retene[1]	0.032	0.267	0.074

[1] These pollutants were added to Method TO-13A in February 2008.

2.2.4 Metals Sampling and Analytical Method

Sampling for the determination of metals in or on particulate matter was performed by the sites in accordance with EPA Compendium Method IO-3.5 (EPA, 1999d). Ambient air samples for metals analysis were collected by passing ambient air through either 47mm Teflon® filters or 8 x 10” quartz filters, depending on the separate and distinct sampling apparatus used to collect the sample; the 47mm Teflon® filter is used for low-volume samplers, whereas the 8 x 10" quartz filter is used for high-volume samplers. Filters used by monitoring sites are provided by EPA. Sites sampled for either particulate matter less than 10 microns (PM$_{10}$) or total suspended particulate (TSP). Particulates in the ambient air were collected on the filters and after a 24-hour sampling period, site operators recovered and sent the filters, along with the Chain of Custody forms and all associated documentation, to the ERG laboratory for analysis.

Upon receipt at the laboratory, the whole filters (47mm Teflon®) or filter strips (8 x 10" quartz) were digested using a dilute nitric acid solution. The digestate was then quantified using inductively coupled plasma mass spectrometry (ICP-MS) to determine the concentration of individual metals present in the original air sample. These raw data are presented in Appendix G.

Table 2-7 lists the MDLs for the analysis of the metal samples. Due to the difference in sample volume/filter collection media, there are two sets of MDLs listed in Table 2-7. Although the sensitivity varies from pollutant-to-pollutant and from site-to-site due to the different volumes pulled through the samples, the average MDLs ranged from 0.007 to 0.348 ng/m^3 for the quartz filters and from 0.041 to 1.066 ng/m^3 for the Teflon® filters.

Table 2-7. 2008-2009 Metals Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)	Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
8 X 10" Quartz Filters				**47mm Teflon® Filters**			
Antimony	0.004	0.030	0.007	Antimony	0.005	0.080	0.063
Arsenic	0.009	0.460	0.010	Arsenic	0.007	0.080	0.044
Beryllium	0.001	0.062	0.007	Beryllium	0.001	0.150	0.082
Cadmium	0.008	0.082	0.021	Cadmium	0.010	0.260	0.140
Chromium	0.142	2.980	0.348	Chromium	0.280	4.360	1.066
Cobalt	0.006	0.044	0.008	Cobalt	0.004	0.070	0.041
Lead	0.018	5.580	0.154	Lead	0.010	0.390	0.204
Manganese	0.016	5.710	0.083	Manganese	0.040	0.270	0.162
Mercury	0.003	1.680	0.024	Mercury	0.010	1.350	0.617
Nickel	0.088	6.600	0.181	Nickel	0.005	5.030	0.627
Selenium	0.013	0.665	0.019	Selenium	0.010	1.950	0.357

2.2.5 Hexavalent Chromium Sampling and Analytical Method

Hexavalent chromium was measured using an EPA-approved approach. For a detailed description of the method, refer to the "Standard Operating Procedure for the Determination of Hexavalent Chromium in Ambient Air Analyzed by Ion Chromatography (IC)" (EPA, 2006a).

Ambient air samples for hexavalent chromium analysis were collected by passing ambient air through sodium bicarbonate impregnated acid-washed cellulose filters. ERG prepared and distributed filters secured in Teflon cartridges to the monitoring sites prior to each scheduled sample collection event and site operators connected the cartridges to the air sampling equipment. After a 24-hour sampling period, site operators recovered the cartridges and Chain of Custody forms and sent them to the ERG laboratory for analysis. Upon receipt at the laboratory, the filters were extracted using a sodium bicarbonate solution. Ion chromatography (IC) analysis and Ultraviolet-Visible (UV-Vis**)** detection of these extracts determined the amount of hexavalent chromium present in each sample.

The MDL is experimentally determined at the ERG laboratory for each site; the average MDL for the program, which is presented in Table 2-8, was 0.0058 ng/m^3. Raw data are presented in Appendix H.

Table 2-8. 2008-2009 Hexavalent Chromium Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
Hexavalent Chromium	0.0038	0.0126	0.0058

2.3 Sample Collection Schedules

Tables 2-9 through Table 2-11 present the first and last date on which sample collection occurred for each monitoring site sampling in 2008 (Table 2-9), 2009 (Table 2-10), and for those sites performing special studies that overlapped years (Table 2-11). The first sample date for each site is generally in January 2008 and continued through December 2009, although there were several exceptions. The following sites began sampling after January 2008:

- The Parachute, Rifle, and Silt, CO sites (PACO, RICO, MOCO, and BRCO) started sampling carbonyl compounds in February 2008.

- The Decatur, GA site (SDGA) re-started sampling hexavalent chromium in May 2008.

- The Pinellas Park, FL site (SKFL) started sampling hexavalent chromium in June 2008.

- The Memphis, TN site (METN) started sampling in June 2008.

- The Davie, FL site (FLFL) and Pompano Beach, FL site (CCFL) started sampling VOC in July 2008.

- The Richmond, VA site (RIVA) started sampling in October 2008.

- The Cherokee Nation, OK site (CNEP) started sampling metals in January 2009.

- The Burlington, Rutland, and Underhill, VT sites (BURVT, RUVT, and UNVT) started sampling VOC in February 2009; UNVT also started sampling carbonyl compounds in July 2009.

- The Midwest City and Oklahoma City, OK sites (MWOK and OCOK) started sampling in May 2009.

In addition, many sites, particularly NATTS sites, began sampling PAH in 2008, although most began later than January 2008:

- The Chesterfield, SC (CHSC), Mayville, WI (MVWI), Seattle, WA (SEWA), and Pinnellas Park, FL (SKFL) sites began sampling PAH in March 2008.

- The Bountiful, UT (BTUT), Dearborn, MI (DEMI), Grand Junction, CO (GPCO), Hazard, KY (HAKY), St. Louis, MO (S4MO), and Plant City, FL (SYFL) sites began sampling PAH in April 2008.

- The Boston, MA (BOMA) and San Jose, CA (SJJCA) sites began sampling PAH in May 2008.

- The Northbrook, IL (NBIL), Underhill, VT (UNVT), and Washington, D.C. (WADC) sites began sampling PAH in June 2008.

- The New York City, NY (BXNY), Providence, RI (PRRI), Rochester, NY (ROCH), and Tonawanda, NY (TONY) sites began sampling PAH in July 2008.

Eleven sites ended sampling before December 2009:

- The Sault Sainte Marie, MI site (ITCMI) stopped sampling in February 2008.

- The Gulfport and Tupelo, MS sites (GPMS and TUMS) stopped sampling in March 2008.

- Two Indianapolis, IN sites (IDIN and ININ) stopped sampling in September 2008.
- The Camden, NJ site (CANJ) stopped sampling in October 2008.
- The Tampa, FL site (GAFL) stopped sampling in March 2009.
- The Davie, FL site (FLFL) and Pompano Beach, FL site (CCFL) stopped sampling VOC in March 2009.
- The two Loudon, TN sites (LDTN and MSTN) stopped sampling in October 2009.

Several monitoring sites sampled for a 1- or 2-year duration as part of special studies and did not follow a January to December sampling year:

- The Columbus, OH site (COOH) sampled from December 2007 to December 2008.
- The Anchorage, AK site (ANAK) sampled from October 2008 to October 2009.
- The Seattle and Tacoma, WA sites (CEWA, EQWA, ESWA, and EYWA) sampled from November 2008 to October 2009.
- The Portland, OR site (PLOR) sampled under the NMP for a 3-month duration lasting from March through June 2008.
- The Cherokee Nation site (CNEP) stopped sampling VOC in March 2008; metals sampling began in January 2009 and continued through May 2009.
- Sample collection dates for ANAK, COOH, CEWA, EQWA, ESWA, and EYWA are shown in Table 2-11 because sampling at these sites was part of special studies that overlapped years.

Table 2-9. 2008 Sampling Schedules and Completeness Rates

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
AZFL	1/1/08	12/26/08	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOMA	1/1/08	12/26/08	--	--	--	--	--	--	61	61	100	60	61	98	--	--	--	38	40	95
BRCO	1/14/08	12/26/08	31	28	>100	--	--	--	--	--	--	--	--	--	59	58	>100	--	--	--
BTUT	1/1/08	12/26/08	60	61	98	62	61	>100	61	61	100	60	61	98	61	61	100	14	16	88
BXNY	1/1/08	12/26/08	--	--	--	--	--	--	59	61	97	--	--	--	--	--	--	28	30	93
CAMS 35	1/19/08	12/26/08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	54	58	93
CANJ	1/1/08	10/21/08	38	50	76	37	50	74	--	--	--	--	--	--	--	--	--	--	--	--
CCFL	7/17/08	12/26/08	--	--	--	28	28	100	--	--	--	--	--	--	--	--	--	--	--	--
CELA	1/1/08	12/26/08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	61	100
CHNJ	1/1/08	12/26/08	57	61	93	58	61	95	--	--	--	--	--	--	--	--	--	--	--	--
CHSC	1/1/08	12/26/08	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	47	47	100
CNEP	1/1/08	3/31/08	--	--	--	14	16	88	--	--	--	--	--	--	--	--	--	--	--	--
CUSD	1/1/08	12/26/08	60	61	98	60	61	98	--	--	--	--	--	--	60	61	98	--	--	--
DEMI[b]	1/1/08	12/26/08	45	61	74	61	61	100	58	61	95	--	--	--	--	--	--	41	45	91
ELNJ	1/1/08	12/26/08	55	61	90	54	61	89	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
[b] Carbonyl compound completeness is less than 85 percent because a leak was discovered in the primary sampler line and primary samples between January 2008 and March 2008 were invalidated.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-9. 2008 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
FLFL	7/17/08	12/26/08	--	--	--	28	28	100	--	--	--	--	--	--	--	--	--	--	--	--
GAFL	1/1/08	12/26/08	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GLKY	7/5/08	12/26/08	--	--	--	--	--	--	30	30	100	--	--	--	--	--	--	30	30	100
GPCO	1/1/08	12/26/08	61	61	100	61	61	100	61	61	100	--	-	--	--	--	--	45	45	100
GPMS	1/1/08	3/6/08	11	11	100	10	11	91	--	--	--	--	--	--	10	11	91	--	--	--
HAKY	1/1/08	5/30/08	--	--	--	--	--	--	26	26	100	--	--	--	--	--	--	8	8	100
IDIN	1/1/08	9/27/08	47	46	>100	--	--	--	--	--	--	45	46	98	--	--	--	--	--	--
INDEM	1/1/08	12/26/08	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ININ	1/1/08	9/27/08	49	46	>100	--	--	--	--	--	--	40	46	87	--	--	--	--	--	--
ITCMI	1/1/08	2/6/08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	7	100
LDTN	1/1/08	12/30/08	61	61	100	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
METN	6/5/08	12/26/08	37	35	>100	34	35	97	--	--	--	--	--	--	--	--	--	--	--	--
MOCO	1/14/08	12/26/08	27	31	87	--	--	--	--	--	--	--	--	--	59	58	>100	--	--	--
MSTN	1/1/08	12/26/08	62	61	>100	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
MVWI	1/1/08	12/26/08	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	47	49	96

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
[b] Carbonyl compound completeness is less than 85 percent because a leak was discovered in the primary sampler line and primary samples between January 2008 and March 2008 were invalidated.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-9. 2008 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
NBIL	1/1/08	12/26/08	59	61	97	64	61	>100	61	61	100	56	61	92	64	61	>100	35	35	100
NBNJ	1/1/08	12/26/08	56	61	92	55	61	90	--	--	--	--	--	--	--	--	--	--	--	--
ORFL	1/1/08	12/26/08	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PACO	1/14/08	12/26/08	29	28	>100	--	--	--	--	--	--	--	--	--	59	58	>100	--	--	--
PAFL	1/7/08	12/20/08	--	--	--	--	--	--	--	--	--	30	30	100	--	--	--	--	--	--
PLOR	3/19/08	6/29/08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16	18	89
PROK	10/21/08	12/26/08	10	12	83	11	12	92	--	--	--	9	11	81	--	--	--	--	--	--
PRRI	1/1/08	12/26/08	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	27	30	90
PXSS	1/1/08	12/26/08	61	61	100	52	61	85	59	61	97	57	61	93	--	--	--	59	61	97
RICO	1/14/08	12/26/08	31	28	>100	--	--	--	--	--	--	--	--	--	60	58	>100	--	--	--
RIVA	10/3/08	12/26/08	--	--	--	--	--	--	15	15	100	--	--	--	--	--	--	13	15	87
ROCH	1/1/08	12/26/08	--	--	--	--	--	--	58	61	95	--	--	--	--	--	--	29	30	97
RUCA	1/1/08	12/26/08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	59	61	97
S4MO	1/1/08	12/26/08	60	61	98	61	61	100	60	61	98	61	61	100	--	--	--	44	45	98
SDGA	1/1/08	12/26/08	--	--	--	--	--	--	29	39	74	--	--	--	--	--	--	60	61	98

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
[b] Carbonyl compound completeness is less than 85 percent because a leak was discovered in the primary sampler line and primary samples between January 2008 and March 2008 were invalidated.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-9. 2008 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
SEWA	1/1/08	12/26/08	62	61	>100	61	61	100	61	61	100	60	61	98	--	--	--	47	49	96
SJJCA	1/1/08	12/26/08	--	--	--	--	--	--	--	--	--	61	61	100	--	--	--	40	40	100
SKFL	1/1/08	12/26/08	60	61	98	--	--	--	32	33	97	--	--	--	--	--	--	50	51	98
SPAZ	1/13/08	12/14/08	--	--	--	29	30	97	--	--	--	--	--	--	--	--	--	--	--	--
SPIL	1/1/08	12/26/08	57	61	93	57	61	93	--	--	--	--	--	--	--	--	--	--	--	--
SSSD	1/1/08	12/26/08	55	61	90	60	61	98	--	--	--	--	--	--	60	61	98	--	--	--
SYFL	1/1/08	12/26/08	60	61	98	--	--	--	60	61	98	--	--	--	--	--	--	45	45	100
TONY	7/5/08	12/26/08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	30	30	100
TOOK	1/1/08	12/26/08	56	61	92	57	61	93	--	--	--	60	61	98	--	--	--	--	--	--
TSOK	1/1/08	9/27/08	41	46	89	41	46	89	--	--	--	42	46	91	--	--	--	--	--	--
TUMS	1/1/08	3/7/08	12	12	100	12	12	100	--	--	--	--	--	--	--	--	--	--	--	--
TUOK	1/1/08	12/26/08	57	61	93	58	61	95	--	--	--	59	61	97	--	--	--	--	--	--
UNVT	1/1/08	12/26/08	--	--	--	--	--	--	60	61	98	59	61	97	--	--	--	29	31	94
WADC	1/1/08	12/26/08	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	28	31	90
WPIN	1/1/08	12/20/08	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
[b] Carbonyl compound completeness is less than 85 percent because a leak was discovered in the primary sampler line and primary samples between January 2008 and March 2008 were invalidated.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-10. 2009 Sampling Schedules and Completeness Rates

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
AZFL	1/1/09	12/30/09	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOMA	1/1/09	12/27/09	--	--	--	--	--	--	61	61	100	61	61	100	--	--	--	59	61	97
BRCO	1/7/09	12/27/09	26	30	87	--	--	--	--	--	--	--	--	--	57	61	93	--	--	--
BTUT	1/1/09	12/27/09	64	61	>100	66	61	>100	61	61	100	59	61	97	66	61	>100	60	61	98
BURVT	2/12/09	12/21/09	--	--	--	26	27	96	--	--	--	--	--	--	--	--	--	--	--	--
BXNY	1/1/09	12/27/09	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	60	61	98
CAMS 35	1/1/09	12/27/09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	61	98
CCFL	1/1/09	3/26/09	--	--	--	14	15	93	--	--	--	--	--	--	--	--	--	--	--	--
CELA	1/1/09	12/27/09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	61	98
CHNJ	1/1/09	12/27/09	60	61	98	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
CHSC	1/1/09	12/27/09	--	--	--	--	--	--	58	61	95	--	--	--	--	--	--	55	61	90
CNEP	1/1/09	5/31/09	--	--	--	--	--	--	--	--	--	22	26	85	--	--	--	--	--	--
DEMI	1/1/09	12/27/09	59	61	97	59	61	97	62	61	>100	--	--	--	--	--	--	61	61	100
ELNJ	1/1/09	12/27/09	61	61	100	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--
FLFL	1/1/09	3/26/09	--	--	--	15	15	100	--	--	--	--	--	--	--	--	--	--	--	--
GAFL	1/1/09	3/20/09	14	14	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-10. 2009 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
GLKY	1/1/09	12/27/09	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	61	61	100
GPCO	1/1/09	12/30/09	62	61	>100	59	61	97	63	61	>100	--	-	--	--	--	--	61	61	100
INDEM	1/1/09	12/27/09	58	61	95	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LDTN	1/1/09	10/4/09	46	47	98	47	47	100	--	--	--	--	--	--	--	--	--	--	--	--
METN	1/1/09	12/27/09	61	61	100	57	61	93	--	--	--	--	--	--	--	--	--	--	--	--
MOCO	1/7/09	2/18/09	3	3	100	--	--	--	--	--	--	--	--	--	7	9	78	--	--	--
MSTN	1/1/09	10/4/09	47	47	100	44	47	94	--	--	--	--	--	--	--	--	--	--	--	--
MVWI	1/1/09	12/15/09	--	--	--	--	--	--	59	59	100	--	--	--	--	--	--	56	59	95
MWOK	5/19/09	12/29/09	39	38	>100	39	38	>100	--	--	--	38	38	100	--	--	--	--	--	--
NBIL	1/1/09	12/27/09	61	61	100	57	61	93	60	61	98	61	61	100	57	61	93	60	61	98
NBNJ	1/1/09	12/27/09	56	61	92	55	61	90	--	--	--	--	--	--	--	--	--	--	--	--
OCOK	5/19/09	12/27/09	39	38	>100	37	38	97	--	--	--	38	38	100	--	--	--	--	--	--
ORFL	1/1/09	12/27/09	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PACO	1/7/09	12/27/09	30	30	100	--	--	--	--	--	--	--	--	--	58	61	95	--	--	--
PAFL	1/1/09	12/27/09	--	--	--	--	--	--	--	--	--	31	31	100	--	--	--	--	--	--
PROK	1/1/09	12/27/09	50	61	82	62	61	>100	--	--	--	61	61	100	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-10. 2009 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
PRRI	1/1/09	12/27/09	--	--	--	--	--	--	60	61	98	--	--	--	--	--	--	61	61	100
PXSS	1/1/09	12/29/09	59	61	97	57	61	93	57	61	93	61	61	100	--	--	--	56	61	92
RICO	1/7/09	12/27/09	29	30	97	--	--	--	--	--	--	--	--	--	61	61	100	--	--	--
RIVA	1/1/09	12/29/09	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	61	61	100
ROCH	1/1/09	12/27/09	--	--	--	--	--	--	57	61	93	--	--	--	--	--	--	58	61	95
RUCA	1/1/09	12/27/09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	61	100
RUCO	1/31/09	12/27/09	24	28	86	--	--	--	--	--	--	--	--	--	53	56	95	--	--	--
RUVT	2/12/09	12/21/09	--	--	--	25	27	93	--	--	--	--	--	--	--	--	--	--	--	--
S4MO	1/1/09	12/29/09	61	61	100	60	61	98	61	61	100	58	61	95	--	--	--	59	61	97
SDGA	1/1/09	12/27/09	--	--	--	--	--	--	58	61	95	--	--	--	--	--	--	59	61	97
SEWA	1/1/09	12/27/09	64	61	>100	62	61	>100	61	61	100	59	61	97	--	--	--	61	61	100
SJJCA	1/1/09	12/27/09	--	--	--	--	--	--	--	--	--	40	41	98	--	--	--	61	61	100
SKFL	1/1/09	12/27/09	61	61	100	--	--	--	61	61	100	--	--	--	--	--	--	61	61	100
SPAZ	1/1/09	12/28/09	--	--	--	30	31	97	--	--	--	--	--	--	--	--	--	--	--	--
SPIL	1/1/09	12/27/09	59	61	97	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--
SSSD	1/1/09	12/27/09	59	61	97	60	61	98	--	--	--	--	--	--	60	61	98	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-10. 2009 Sampling Schedules and Completeness Rates (Continued)

Site	**Monitoring Period**[a]		**Carbonyl Compounds**			**VOC**			**Hexavalent Chromium**			**Metals**			**SNMOC**			**PAH**		
	First Sample	**Last Sample**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
SYFL	1/1/09	12/27/09	60	61	98	--	--	--	60	61	98	--	--	--	--	--	--	60	61	98
TMOK	4/1/09	12/27/09	45	46	98	44	46	96	--	--	--	45	46	98	--	--	--			
TONY	1/1/09	12/27/09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	61	100
TOOK	1/1/09	12/27/09	62	61	>100	60	61	98	--	--	--	61	61	100	--	--	--	--	--	--
TUOK	1/1/09	3/26/09	15	15	100	12	15	80	--	--	--	13	15	87	--	--	--	--	--	--
UCSD	1/31/09	12/27/09	52	56	93	49	56	88	--	--	--	--	--	--	49	56	88	--	--	--
UNVT	1/1/09	12/27/09	26	27	96	51	54	94	61	61	100	60	61	98	--	--	--	61	61	100
WADC	1/1/09	12/27/09	--	--	--	--	--	--	60	61	98	--	--	--	--	--	--	58	61	95
WPIN	1/1/09	12/27/09	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.
C = Completeness (%).
[a] Begins with 1st valid sample.
BOLD = EPA-designated NATTS site.
Orange shading indicates a completeness below the DQO of 85%.

Table 2-11. Sampling Schedules and Completeness Rates for Sites Performing Special Studies Overlapping Years

Site	Monitoring Period[a]		Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
ANAK	10/22/08	10/16/09	--	--	--	62	60	>100	--	--	--	--	--	--	--	--	--	61	60	>100
CEWA	11/2/08	10/28/09	57	61	93	59	61	97	--	--	--	--	--	--	--	--	--	59	61	97
COOH[b]	12/20/07	12/26/08	64	63	>100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EQWA	11/2/08	10/28/09	59	61	97	58	61	96	--	--	--	--	--	--	--	--	--	61	61	100
ESWA	11/2/08	10/28/09	59	61	97	58	61	95	--	--	--	--	--	--	--	--	--	60	61	98
EYWA[c]	11/8/08	10/28/09	0	60	0	58	60	97	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.

B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.

C = Completeness (%).

[a] Begins with 1st valid sample.

[b] COOH began sampling in December 2007; the two 2007 samples are included here.

[c] Carbonyl compound completeness is zero because a leak was discovered in the instrument probe and all carbonyl compound samples for the entire study period were invalidated.

Orange shading indicates a completeness below the DQO of 85%.

In addition, the instruments at several monitoring sites moved to alternative locations mid-year:

- The Hazard, KY site (HAKY) stopped sampling in May 2008 and the instrumentation was moved to the Grayson, KY site (GLKY). Sampling at GLKY began in July 2008.
- One of the Tulsa, OK sites (TSOK) stopped sampling in September 2008 and the instrumentation was moved to the Pryor Creek, OK site (PROK). Sampling at PROK began in October 2008.
- The Custer, SD site (CUSD) stopped sampling in December 2008 and the instrumentation was moved to the Union County, SD site (UCSD). Sampling began at UCSD in January 2009.
- The MOCO site stopped sampling carbonyl compounds in January 2009 and stopped sampling SNMOC in February 2009. The instrumentation was moved to a new site in Rulison, CO (RUCO) and sampling there began later in January 2009.
- Another Tulsa, OK site (TUOK) stopped sampling in March 2009 and the instrumentation was moved to another Tulsa, OK location (TMOK). Sampling at TMOK began in April 2009.

According to the NMP schedule, 24-hour integrated samples were to be collected at each monitoring site every 1-in-6 or 1-in-12 days (dependent upon location and monitoring objectives) and each sample collection began and ended at midnight, local standard time. The one exception is for the Garfield County, CO sites, which began collecting manual samples in 2009. For these sites, samples were generally collected from mid-morning of one day to mid-morning of the next. Tables 2-9 through 2-11 show the following:

- 39 sites collected VOC samples and 47 sites collected carbonyl compound samples; VOC and carbonyl compound samples were collected concurrently at 32 sites.
- 32 sites collected PAH samples.
- 11 sites collected SNMOC samples.
- 19 sites collected metal samples.
- 21 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 sample days for select methods when duplicate samplers were available. Field blanks were collected once a month for carbonyl compounds, hexavalent chromium, metals, and PAH. Sampling calendars were distributed to help site operators schedule the collection of samples, duplicates, and field blanks. In cases where a valid sample was not collected for a given scheduled sample 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 1-in-6 or 1-in-12 day sampling schedule provides cost-effective approaches to data collection for trends characterization of toxic pollutants in ambient air and ensures that sample 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 than the 1-in-12 day schedule, data characterization based on this schedule tends to be more representative.

2.4 Completeness

Completeness refers to the number of valid samples collected and analyzed compared to the number of total samples expected based on a 1-in-6 or 1-in-12 day sample schedule. Monitoring programs that consistently generate valid samples have higher completeness than programs that consistently have invalid samples. The completeness of an air monitoring program, therefore, can be a qualitative measure of the reliability of air sampling and laboratory analytical equipment and a measure of the efficiency with which the program is managed. The completeness for each monitoring site for 2008 is presented in Table 2-9; completeness for 2009 is presented in Table 2-10; and completeness for sites sampling as part of special studies overlapping years is presented in Table 2-11. Table 2-12 presents method-specific completeness for both years of sampling. Appendix I identifies samples that were invalidated and lists the specific reasons, based on the applied AQS null code.

Table 2-12. Method Completeness Rates for 2008 and 2009[1]

Sampling Period	Carbonyl Compounds			VOC			Hexavalent Chromium			Metals			SNMOC			PAH		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
2008	1,856	1,935	96	1,292	1,355	95	1,095	1,119	98	759	789	96	492	487	>100	1,073	1,110	97
2009	1,841	1,934	95	1,576	1,624	97	1,203	1,218	99	768	784	98	468	487	96	1,690	1,725	98

[1] This table incorporates samples from the sites performing special studies overlapping years listed in Table 2-11.

A = Number of valid samples collected.

B = Number of valid samples that should be collected based on sample schedule and start/end date of sampling.

C = Completeness (%).

The following observations summarize the completeness of the monitoring datasets for samples collected during the 2008-2009 NMP sampling years, as shown in Table 2-9 through Table 2-12. Please note that the site-specific completeness ranges presented below do not incorporate the sites performing special studies and thus reflect only the results from Tables 2-9 and 2-10. The overall completeness shown below includes samples for all sites in order to reflect results from Table 2-12.

- For VOC sampling, the site-specific completeness for 2008 ranged from 74 to greater than 100 percent, with an overall completeness of 95 percent; the site-specific completeness for 2009 ranged from 80 to greater than 100 percent, with an overall completeness of 97 percent.

- For SNMOC sampling, the site-specific completeness for 2008 ranged from 90 to greater than 100 percent, with an overall completeness of more than 100 percent; the site-specific completeness for 2009 ranged from 78 to greater than 100 percent, with an overall completeness of 96 percent.

- For carbonyl compound sampling, the site-specific completeness for 2008 ranged from 74 to greater than 100 percent, with an overall completeness of 96 percent; the site-specific completeness for 2009 ranged from 82 to greater than 100 percent, with an overall completeness of 95 percent.

- For PAH sampling, the site-specific completeness for 2008 ranged from 87 to 100 percent, with an overall completeness of 97 percent; the site-specific completeness for 2009 ranged from 90 to 100 percent, with an overall completeness of 98 percent.

- For metals sampling, the site-specific completeness for 2008 ranged from 82 to 100 percent, with an overall completeness of 96 percent; the site-specific completeness for 2009 ranged from 85 to 100 percent, with an overall completeness of 98 percent.

- For hexavalent chromium sampling, the site-specific completeness for 2008 ranged from 74 to 100 percent, with an overall completeness of 98 percent; the site-specific completeness for 2009 ranged from 93 to greater than 100 percent, with an overall completeness of 99 percent.

The data quality objective (DQO) for completeness based on the EPA-approved Quality Assurance Project Plan (QAPP) specifies that at least 85 percent of samples from a given monitoring site must be collected and analyzed successfully to be considered sufficient for data trends analysis (ERG, 2008 and ERG, 2009). The data in Tables 2-9 through 2-11 show that 10 datasets (six datasets in 2008, three datasets in 2009, and one dataset from sites performing special studies overlapping sample years) from a total of 291 datasets from the 2008-2009 NMP monitoring sites did not meet this data quality objective (cells highlighted in orange in Tables 2-9 through 2-11).

- The VOC canisters from CANJ often arrived at the laboratory with either no vacuum remaining or a vacuum too great for the analytical system to handle. The majority of the carbonyl compound samples were invalidated due to collection errors.

- A leak was found in the sample line of the primary carbonyl compound sampler at the DEMI monitoring site; as such, primary samples from January 2008 through most of March 2008 were invalidated, resulting in carbonyl compound completeness less than 85 percent.

- The Puget Sound Clean Air Authority discovered a leak in the instrument probe and invalidated all carbonyl compound samples for EYWA. In addition, selected individual pollutant results from VOC samples were invalidated or flagged, at the agency's discretion.

- A number of power failures contributed to PROK's low carbonyl compound completeness, as did poor QA results in April 2009 and a series of collection errors in September 2009. A late 2008 start-up combined with missed samples resulted in a completeness less than 85 percent for PROK metals.

- New hexavalent chromium samplers were installed at SDGA in spring 2008 and the site operators had difficulty getting them to work properly throughout both years.

- The instrumentation at TUOK was moved to a new location in March 2009; as such, this site did not have time to make up invalid VOC samples.

- The instrumentation at MOCO was moved to a new location in February 2009; as such, this site did not have time to make up invalid SNMOC samples.

3.0 Summary of the 2008-2009 National Monitoring Programs Data Treatment and Methods

Results from the program-wide data analyses are presented in Section 4 and results from the site-specific data analyses are presented in the individual state sections, Sections 5 through 33.

This section summarizes the data treatment and approaches used to evaluate the measurements generated from samples collected during the 2008 and 2009 NMP sampling years. These data were analyzed on a program-wide basis as well as a site-specific basis.

A total of 462,422 valid air toxics concentrations (including non-detects, duplicate analyses, replicate analyses, and analyses for collocated samples) were produced from over 18,129 samples collected at 73 sites during the 2008-2009 reporting years. A tabular presentation of the raw data and statistical summaries is found in Appendices C through O, as presented in Table 3-1.

Table 3-1. Overview and Layout of Data Presented

Pollutant Group	Number of Sites	Appendix	
		Raw Data	Statistical Summary
VOC	39	C	J
SNMOC	11	D	K
Carbonyl Compounds	47	E	L
PAH	32	F	M
Metals	19	G	N
Hexavalent Chromium	21	H	O

3.1 Approach to Data Treatment

This section examines the various statistical tools employed to characterize the data collected during the 2008-2009 sampling years. Certain data analyses were performed at the program-level, other data analyses were performed at both the program-level and on a site-specific basis, and still other approaches were reserved for site-specific data analyses only. Regardless of the data analysis employed, it is important to understand how the concentration data were treated. The following paragraphs describe techniques used to prepare this large quantity of data for data analysis.

All duplicate (or collocated) and replicate measurements were averaged together in order to calculate a single concentration for each pollutant for each method for each sample day at each monitoring site. This is referred to as the *preprocessed daily measurement*.

Concentrations of *m,p*-xylene and *o*-xylene were summed together and are henceforth referred to as "total xylenes," "xylenes (total)," or simply "xylenes" throughout the remainder of this report, with a few exceptions. One exception is Section 4.1, which examines the results of basic statistical calculations performed on the dataset. Table 4-1 and Table 4-4, which are the method-specific statistics for VOC and SNMOC, respectively, present the xylenes results retained as *m,p*-xylene and *o*-xylene species. This is also true of the Quality Assurance section (Section 34).

In order to compare concentrations across multiple sampling methods, all concentrations have been converted to a common unit of measure: microgram per cubic meter ($\mu g/m^3$). However, whenever a particular sampling method is isolated from others, such as in Tables 4-1 through 4-6, the statistical parameters are presented in the units of measure associated with the particular sampling method. As such, it is important to pay very close attention to the unit of measure associated with each data analysis discussed in this and subsequent sections of the report.

The concentration averages presented in this report are often provided with their associated 95 percent confidence intervals. Confidence intervals represent the interval within which the true average concentration falls 95 percent of the time. The confidence interval includes an equal amount of quantities above and below the concentration average. For example, an annual average concentration may be written as $1.25 \pm 0.25\ \mu g/m^3$, thus the interval over which the true average would be expected to fall would be between 1.00 to 1.50 $\mu g/m^3$ (EPA, 2011d).

3.1.1 Approach to Preparing and Presenting "Concentration Averages"

This report presents various duration-based averages to summarize the measurements for a specific site. The following paragraphs describe these averages:

- daily averages
- quarterly averages
- annual averages
- study averages

The *daily average* of a particular pollutant is simply the average concentration of all measured detections over a given calendar year (up to 12 months). If there were at least seven measured detections within a given calendar quarter, then a *quarterly average* was calculated. Up to eight quarterly averages may be calculated for the 2-year period of sampling. A quarterly average was not calculated for pollutants with less than seven measured detections within a respective quarter. The quarterly average includes the substitution of zeros for all non-detects. The substitution of zeros for non-detects may have a significant impact on the average concentrations of pollutants that are rarely measured at or above the associated detection limit and/or have a relatively high MDL. The first quarter in a calendar year includes concentrations from January, February, and March; the second quarter includes April, May, and June; the third quarter includes July, August, and September; and the fourth quarter includes October, November, and December.

An *annual average* includes all measured detections and substituted zeros for non-detects for a given calendar year. Annual averages were calculated for monitoring sites where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Thus, up to two annual averages may be presented per site (January-December 2008 and January – December 2009).

Several sites sampled for a 12-month duration as part of CSATAM grants, but did not begin sampling at the beginning of a calendar year, as outlined in Section 2.3. For example, the Anchorage, Alaska site (ANAK) sampled from October 2008 to October 2009. For these sites, a single *study average* is presented, provided that the same criteria for calculating an annual average are met. These sites include:

- ANAK (October 2008-October 2009)
- CEWA, EQWA, ESWA, and EYWA (November 2008-October 2009)
- COOH (December 2007-December 2008)

3.2 Human Health Risk and the Pollutants of Interest

A practical approach to making an assessment on a large number of measurements is to focus on a subset of pollutants based on the end-use of the dataset. Thus, a subset of pollutants is selected for further data analyses for each annual NMP report. In NMP annual reports prior to 2003, this subset was based on the frequency and magnitude of concentrations (previously called "prevalent compounds"). Since the 2003 NMP annual report, health risk-based calculations have been used to identify "pollutants of interest." For the 2008-2009 NMP report, the pollutants of interest are also based on risk potential. The following paragraphs provide an overview of health risk terms and concepts and outline how the pollutants of interest are determine and then used throughout the remainder of the report.

EPA defines risk as "the probability that damage to life, health, or the environment will occur as a result of a given hazard (such as exposure to a toxic chemical)" (EPA, 2011e). Human health risk can be defined in terms of time. Chronic effects develop from repeated exposure over long periods of time; acute effects develop from a single exposure or from exposures over short periods of time (EPA, 2006b). Health risk is also route-specific; that is, risk will vary dependent upon route of exposure (i.e., oral vs. inhalation). Because this report covers air toxics in ambient air, only the inhalation route is considered. Hazardous air pollutants (HAPs) are those pollutants 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, 2011f).

Health risks are typically divided into cancer risk and noncancer health risks when referring to human health risk. 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. Noncancer health effects include conditions such as asthma; noncancer health risks are presented as a value below which no adverse health effects are expected (EPA, 2011e). In order to assess health risk, EPA and other agencies develop screening values, such as cancer unit risk estimates (UREs) and noncancer reference concentrations (RfCs), to estimate cancer and noncancer risks and to identify (or screen) where air toxics concentrations may present a human health risk.

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 datasets (EPA, 2006b). This *preliminary risk 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 pollutants analyzed under the NMP have screening values; of the 172 pollutants sampled under the NMP, 72 pollutants have screening values in the guidance document. The screening values used in this analysis are presented in Appendix P[1].

Preprocessed daily measurements of the target pollutants were compared to these chronic risk screening values in order to identify pollutants of interest across the program. The following risk screening process was used to identify pollutants of interest:

1. The TO-15 and SNMOC methods have 12 pollutants in common. If a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used. The purpose of this data treatment is to have one concentration per pollutant per day per site.

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.

4. The percent contribution of the number of failed screens to the total number of failed screens program-wide was calculated for each applicable pollutant.

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[1] The risk screening process used in this report comes from EPA Region 4’s report “A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Datasets” but the screening values referenced in that report come from EPA’s Office of Air Quality Planning and Standards (OAQPS) Toxicity Values Table 1. Thus, revisions to that table, and hence the screening values, have been incorporated into the 2008-2009 NMP report (EPA, 2010a).

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

In regards to Step 5 above, the actual cumulative contribution may exceed 95 percent in order to include all pollutants contributing to the minimum 95 percent criteria (refer to acrylonitrile in Table 4-7 for an example). In addition, if the 95 percent cumulative criterion is reached, but the next pollutant contributed equally to the number of failed screens, that pollutant was also designated as a pollutant of interest. Results for the program-wide risk screening process are provided in Section 4.2.

Laboratory analysts have indicated that acetonitrile values may be artificially high (or non-existent) 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 must be determined on a site-specific basis by the agency responsible for the site. Thus, acetonitrile results are excluded from certain program-wide and site-specific data analyses, particularly those related to risk.

For the 2008-2009 NMP report, another step for identifying the pollutants of interest was added. In addition to the preliminary risk-screening approach described above, the pollutants of interest designation was further refined based on the NATTS TAD (EPA, 2009b). This document identifies 19 pollutants (“Method Quality Objective (MQO) Core Analytes”) that participating sites are required to sample and analyze for under the NATTS program. Table 3-2 presents these 19 MQO Core Analytes. Monitoring for these pollutants is required because they are major health risk drivers according to EPA (EPA, 2009b).

With the exception of acrolein, all of the pollutants listed in Table 3-2 are inherently considered pollutants of interest due to their designation as NATTS MQO Core Analytes. If a pollutant listed in Table 3-2 did not meet the pollutant of interest criteria based on the preliminary risk screening approach outlined above, that pollutant was added to the list of program-wide pollutants of interest.

Table 3-2. NATTS MQO Core Analytes

Pollutant	Class/Method
Acrolein	VOC/TO-15
Benzene	
1,3-Butadiene	
Carbon Tetrachloride	
Chloroform	
Tetrachloroethylene	
Trichloroethylene	
Vinyl Chloride	
Acetaldehyde	Carbonyl Compounds/TO-11A
Formaldehyde	
Hexavalent chromium	Metals/EPA
Naphthalene	PAH/TO-13A
Benzo(a)pyrene	
Arsenic	Metals/IO-3.5
Beryllium	
Cadmium	
Manganese	
Lead	
Nickel	

Although it is a NATTS MQO Core Analyte, acrolein was excluded from the preliminary risk screening process due to questions about the consistency and reliability of the measurements (EPA, 2010b). Thus, the results from sampling and analysis of this pollutant have been excluded from any risk-related analyses presented in this report, similar to acetonitrile (as discussed above).

The pollutants of interest designation is reserved for pollutants targeted for sampling through the NMP that meet the identified criteria. Recall from Section 2.0 that agencies operating monitoring sites that participate under the NMP are not required to have their samples analyzed by EPA's contract laboratory or may measure analytes other than those targeted under the NMP. In these cases, data are generated by sources other than ERG and are not included in the preliminary risk screening process or any other data analysis contained in this report.

3.3 Risk Screening Evaluation Using Minimum Risk Levels

In addition to the preliminary risk screening described above, a second risk screening was conducted using the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) health benchmarks (ATSDR, 2009). An MRL is a concentration of a hazardous substance that is “likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure” (ATSDR, 2011). MRLs are intended to be used as screening tools, similar to the risk screening approach discussed above, and “exposure to a level above the MRL does not mean that adverse health effects will occur” (ATSDR, 2011). ATSDR defines MRLs for three durations of exposure: acute, intermediate, and chronic exposure. Acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater (ATSDR, 2011). MRLs, as published by ATSDR, are presented in parts per million (ppm) for gases and milligrams per cubic meter (mg/m^3) for particulates. The MRLs used in this report have been converted to µg/m^3, have one significant figure, and are presented in Appendix P.

For this risk screening evaluation, the preprocessed daily measurements were compared to acute MRLs; quarterly averages were compared to intermediate MRLs; and annual averages (or study averages in lieu of annual averages) were compared to chronic MRLs. Section 4.2.2 presents, for each pollutant, the number of preprocessed daily measurements, quarterly averages, and/or annual/study averages that were higher than their respective MRL, summed to the program level. The number of site-specific concentrations and/or time period averages that were higher than their respective MRLs is expanded upon in the individual state sections.

3.4 Additional Program-Level Analyses of the 2008-2009 National Monitoring Programs Dataset

This section summarizes additional analyses performed on the 2008-2009 NMP dataset at the program level. 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 quarter-to-quarter. The results of these analyses are presented in Sections 4.3 and 4.4.

3.4.1 The Impact of Mobile Source Emissions on Spatial Variations

Mobile source emissions from motor vehicles contribute significantly to air pollution. "Mobile sources" refer to emitters of air pollutants that move, or can be moved, from place to place and include both on-road and non-road emissions (EPA, 2011g). 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 pollutants. The magnitude of these emissions 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 a variety of parameters to quantify and evaluate the impact of motor vehicle emissions on ambient air quality, which are discussed further in Section 4.3:

- Emissions data from the NEI
- Total hydrocarbon concentrations
- Motor vehicle ownership data
- Estimated daily traffic volume
- Vehicle miles traveled (VMT)

This report uses Pearson correlation coefficients to measure the degree of correlation between two variables, such as the ones listed above. 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. In this report, correlation coefficients greater than or equal to 0.50 and less than or equal to -0.50 are classified as strong, while correlation coefficients less than 0.50 and greater than -0.50 are classified as weak.

The number of observations used in a calculation is an important factor to consider when analyzing the correlations. A correlation using relatively few observations may skew the correlation, making the degree of correlation appear higher (or lower) than it may actually be. Thus, in this report, five data points must be available to present a correlation.

3.4.2 Variability Analyses

Variability refers to the degree of difference among values in a dataset. 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 program sites. The coefficient of variation provides a relative measure of variability by expressing standard deviation to the magnitude of the arithmetic mean for up to 2 years of sampling for each of the pollutants of interest, as identified in Section 4.2. It is particularly useful when comparing different sets of data because it is unitless (Pagano, P. and Gauvreau, K., 2000). In this report, variability across data distributions for different sites and different pollutants are compared. The coefficients of variation are shown in the form of scatter plots, where data points represent the coefficients of variation and a trend line is plotted to show linearity. In addition, the "R^2" value is also shown on each scatter plot. R^2 is the coefficient of determination and is an indicator of how dependant one variable is on the other. If R^2 is equal to 1.0, the data exhibit perfect linearity; the lower R^2, the less dependent the variables are each other (Pagano, P. and Gauvreau, K., 2000). 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).

Quarterly variability is the second type of variability assessed in this report. The concentration data for each site were divided into four quarters for each year, as described in Section 3.1.1. The measurement detection criteria, also described in Section 3.1.1, are maintained here as well. The site-specific quarterly averages are illustrated by bar graphs for each program-level pollutant of interest. This analysis allows for a determination of a quarterly (or seasonal) correlation with the magnitude of concentrations for a specific pollutant.

3.4.3 Greenhouse Gas Assessment

Currently, there is considerable discussion about climate change amongst atmospheric and environmental scientists. Climate change refers to an extended period of change in meteorological variables used to determine climate, such as temperature and precipitation. Researchers are typically concerned with greenhouse gases (GHGs), which are those that cause heat to be retained in the atmosphere (EPA, 2011h).

Agencies researching the effects of greenhouse gases tend to concentrate primarily on tropospheric levels of these gases. The troposphere is the lowest level of the atmosphere, whose height varies depending on season and latitude. This is also the layer in which weather phenomenon occur (NOAA, 2011a). A handful of VOC measured with Method TO-15 are greenhouse gases, although these measurements reflect the concentration at the surface, or in the breathing zone, and do not represent the entire troposphere. Section 4.5 presents the 10 GHGs currently measured with Method TO-15, their Global Warming Potential (GWP), and the average concentration across the NMP program. GWP is a way to determine a pollutant's ability to retain heat relative to carbon dioxide, which is one of the predominant anthropogenic GHGs in the atmosphere (EPA, 2011i and NOAA, 2011b). In the future, additional GHG pollutants may be added to the NMP Method TO-15 target pollutant list in order to assess their surface-level ambient concentrations.

3.5 Additional Site-Specific Analyses

In addition to many of the analyses described in the preceding sections, the state-specific sections contain additional analyses that are applicable only at the 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 individual state-specific sections (Sections 5 through 33).

3.5.1 Site Characterization

For each site participating in the NMP for 2008-2009, a site characterization was performed. This analysis includes a review of the nearby surroundings of a monitoring location; plotting of emissions sources surrounding a monitoring site; and obtaining population, vehicle registration, traffic data, and other information.

3.5.2 Meteorological Analysis

Several site-specific meteorological analyses were performed in order to help readers to determine which meteorological factors may play a role in a given site's air quality. First, an overview of general climatology is provided, based on the area in which each site in located, to give readers a general idea of what types of meteorological conditions likely impact the site. Next, the average (or mean) for several meteorological parameters (such as temperature and relative humidity) are provided. Two averages are presented, one to cover the entire period of sampling and one specific to sample days only, which allows for the determination of how meteorological conditions on sample days varied from typical conditions throughout the period. These averages are based on hourly meteorological observations collected from the National Weather Service (NWS) weather station nearest each site and obtained from the National Climatic Data Center (NCDC, 2007, 2008, and 2009).

In addition to the climate summary and the statistical calculations performed on meteorological observations collected near each monitoring site, the following sections describe the additional meteorological analyses that were performed for each monitoring site. These analyses were performed to further characterize the meteorology at or near each monitoring site and to determine if the meteorological conditions on days samples were collected were representative of conditions typically experienced at each site.

3.5.2.1 Back Trajectory Analysis

A back trajectory 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 1 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 1 hour prior to the current observation), the wind speed and direction are used again to determine where the air was 1 hour before. Back trajectory calculations are also governed by other meteorological parameters, such as pressure and temperature. Each time segment is referred to as a “time step.” Although back trajectories may be modeled for extended periods of time (weeks), trajectories were constructed for durations of 24 hours to match the 24-hour sampling duration.

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 NWS and other cooperative agencies. The model used is the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) (Draxler, R.R. and Rolph, G.D., 1997; 1998 and Draxler, R.R., 1999). Back trajectories were computed for each sample day, and a composite back trajectory map for each year was constructed for each monitoring site using Geographical Information System (GIS) software. Trajectories are modeled with an initial height of 50 meters above ground level (AGL), and each sample day’s trajectory is plotted to create a composite back trajectory map. One value of the composite back trajectory map is the estimation of a 24-hour air shed domain for each site. An air shed 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 air shed domain to evaluate regions where long-range transport may affect their monitoring site.

In addition to the composite back trajectory map, the HYSPLIT model was used to perform trajectory cluster analysis. This analysis is a grouping technique that allows the program to create a subset of trajectories or “clusters” that represent trajectories originating from similar locations. For each monitoring site and for each year, data from each sample day trajectory was used as input for the cluster analysis program. The model compares the end points between each trajectory and calculates a spatial variance. Trajectories that are similar to each other have lower spatial variances while trajectories that are dissimilar have larger spatial variances. The model then provides the user with information about total spatial variance (TSV) among the trajectories, which allows the user to determine how many clusters best represent a given group of trajectories (Draxler, R.R., et. al., 2009). Similar to the composite map, once the cluster trajectories for each site were computed, a cluster map was constructed for each monitoring site using GIS software. Both the direction and the distance from monitoring site are considered in the clustering process. A minimum of 30 trajectories must be available for the model to run the cluster analysis. The cluster analysis is useful for scientifically and quantitatively determining where the air most often originates for a given location. Further, for this report, the cluster analysis map for each year may be compared for each site.

Each site-specific composite back trajectory map includes only a year's worth of sample day back trajectories; thus, a 2008 and/or 2009 composite map is presented for each site. Conversely, the cluster analyses for both years are presented on a single map, with 2008 clusters in blue and 2009 clusters in red. For sites sampling for a 12-month duration overlapping 2008 and 2009, as specified in Section 3.1.1, a single composite back trajectory map was constructed, but the individual trajectories are color-coded by year. The cluster analysis for these sites are based on back trajectories covering the entire sample period.

3.5.2.2 Wind Rose 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 as petals positioned around 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 (with sufficient data) into a wind rose software program, WRPLOT (Lakes, 2010). For each year of sampling, two wind roses were constructed. First, a wind rose presenting the wind data for the entire calendar year; second, a wind rose presenting the wind data for only the sample days within that given year. In addition, historical data were used to construct a historical wind rose for years prior to sampling. Thus, the potential for five wind roses is possible for sites sampling over both 2008 and 2009. For sites sampling for a 12-month duration overlapping 2008 and 2009, as specified in Section 3.1.1, wind roses representing wind observations for the entire study period and representing the days on which samples were collected during the study period are presented.

A wind rose is often used in determining where to install 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 on a number of days, the wind rose shows the frequency at which wind speed and direction are measured near the monitoring site. Thus, the back trajectory analysis 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 a monitoring site.

3.5.3 Site Trends Analysis

Table 2-1 presents current monitoring sites that have participated in the NMP in previous years. Site-specific trends analyses were conducted for sites with at least 5 years of method-specific data analyzed under the NMP. The approach to this trends analysis is described below and the results are presented in the individual state sections (Sections 5 through 33).

In 2009, EPA expanded the list of Core Analytes for the NATTS program to 19 pollutants, as discussed in Section 3.2. For this report, a trends analysis was conducted for the selected Core Analytes shown in Table 3-3.

Table 3-3. NATTS MQO Core Analytes Selected for Trends Analysis

Pollutant	Class/Method
Benzene	VOC/TO-15
1,3-Butadiene	
Acetaldehyde	Carbonyl Compounds/TO-11A
Formaldehyde	
Hexavalent Chromium	Hexavalent Chromium
Arsenic	Metals/IO-3.5
Manganese	

The trends figures and subsequent analyses for the 2008-2009 NMP report are presented as 3-year rolling statistical metrics. The following criteria were used to calculate valid rolling statistical metrics:

- Analysis performed under the NMP.
- A minimum of at least 5 years of concurrent data.

Twenty-six sites met the criteria for 3-year rolling statistical metrics to be calculated. A trends analysis was not performed for the PAH Core Analytes because they have not been sampled for a long enough duration under the NMP.

The five individual 3-year rolling statistical metrics are presented as box and whisker plots, or simply boxplots, an example of which can be seen in Figure 8-32. The statistical metrics shown include the minimum and maximum concentration measured during each 3-year period (as shown by the upper and lower value of the lines extending from the box); the 5th percentile, 50th percentile (or median), and 95th percentile (as shown by the y-values corresponding with the bottom, gray line, or top of the box, respectively); and the 3-year rolling average concentration (as denoted by the white diamond). Each of the five rolling metrics represents all measurements from that 3-year period. The inclusion of the rolling average allows for a smoothing of raw data in order to identify long-term trends (NIST, 2011).

Data used in this analysis were downloaded from EPA’s AQS database (EPA, 2011j). Non-detects are uploaded into AQS as zeros (EPA, 2009b). Similar to other analyses presented in this report, zeros representing these non-detects were incorporated into the statistical calculations. Samples with precision data (duplicates, collocates, and/or replicates) were averaged together to allow for the determination of a single concentration per pollutant per site per date, reflecting the data treatment described in Section 3.1.

3.5.4 Risk Screening and Pollutants of Interest

The risk screening process described in Section 3.2 and applied at the program-level was also completed for each individual monitoring site to determine site-specific pollutants of interest. Once these were determined, time-period averages (daily, quarterly, annual, and/or study) were calculated and these were used for various risk-related analyses at the site-specific level, as described below.

- Comparison to ATSDR MRLs, as described in Section 3.3, including the emission tracer analysis described below.
- The calculation of cancer and noncancer surrogate risk approximations.
- Risk-based emissions assessment.

3.5.4.1 Emission Tracer Analysis

The preprocessed daily measurements and various time-period averages for each site-specific pollutant of interest were compared to the ATSDR MRL health benchmarks in the same fashion described in Section 3.3. To further this analysis, pollution roses were created for each of the site-specific pollutants of interest that were higher than their respective ATSDR acute MRL health benchmark to help identify the geographical area where the emissions sources of these pollutants may have originated. A pollution rose is a plot of the ambient concentration versus the wind speed and direction; high concentrations may be shown in relation to the direction of potential emissions sources.

3.5.4.2 Cancer and Noncancer Surrogate Risk Approximations

Risk was further examined by calculating cancer and noncancer surrogate risk approximations for each of the site-specific pollutants of interest. The cancer risk approximations presented in this report estimate the cancer risk due to exposure at the annual average concentration over a 70-year period, not the risk resulting from exposure over the time period covered in this report. A cancer risk approximation less than 1 in-a-million is considered negligible; a cancer risk greater than 1 in-a-million but less than 100 in-a-million is generally considered acceptable; and a cancer risk greater than 100 in-a-million is considered significant (EPA, 2009d). Noncancer risk is presented as the Noncancer Hazard Quotient (HQ). According to EPA, “If the HQ is calculated to be equal to or less than 1.0, then no adverse health effects are expected as a result of exposure. If the HQ is greater than 1.0, then adverse health effects are possible” (EPA, 2011e).

The risk factors applied to calculate cancer and noncancer surrogate risk approximations are typically UREs or RfCs (respectively), which are developed by EPA. However, UREs and RfCs are not available for all pollutants. In the absence of EPA values, risk factors developed by agencies with credible methods and that are similar in scope and definition were used (EPA, 2011k). Cancer URE and noncancer RfC risk factors can be applied to the annual (or study) averages to approximate surrogate chronic risk estimates based on ambient monitoring data. While these risk approximations do not incorporate human activity patterns and therefore do not reflect true human inhalation exposure, they may allow analysts to further refine their focus by identifying concentrations of specific pollutants that may present health risks. Cancer UREs and/or noncancer RfCs, site-specific annual (or study) averages, and corresponding annual (or study) average-based surrogate chronic risk approximations are presented in each state section (Sections 5 through 33).

3.5.4.3 Risk-Based Emissions Assessment

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. The development of various health-based risk factors has allowed analysts to apply weight to the emissions of pollutants based on toxicity rather than mass emissions. This approach considers both a pollutant’s toxicity potential and the quantity emitted.

This assessment compares county-level emissions to toxicity-weighted emissions based on the EPA-approved approach described below (EPA, 2007). The 10 pollutants with the highest total mass emissions and the associated toxicity-weighted emissions for pollutants with cancer and noncancer toxicity factors are presented in each state section. While the absolute magnitude of the pollutant-specific toxicity-weighted emissions is not meaningful, the relevant magnitude of toxicity-weighted emissions is useful in identifying the order of potential priority for air quality managers. Higher values suggest greater priority; however, even the highest values may not reflect potential cancer effects greater than the level of concern (100 in-a-million) or potential noncancer effects above the level of concern (e.g., HQ = 1.0). The pollutants exhibiting the 10 highest annual (or study) average-based surrogate chronic cancer and noncancer risk approximations are also presented in each state section. The results of this data analysis may help state, local, and tribal agencies better understand which pollutants emitted, from a toxicity basis, are of the greatest concern.

The toxicity-weighted emissions approach consists of the following steps:

1. Obtain HAP emissions data for all anthropogenic sectors from the NEI. For point sources, sum the process-level emissions to the county-level.

2. Apply the mass extraction speciation profiles to extract metal and cyanide mass. The only exception is for two chromium species: chromium and chromium compounds.

3. For chromium and chromium compounds, trivalent chromium (non-toxic) must be separated from hexavalent chromium (toxic). To do this, apply the chromium speciation profile to extract the hexavalent chromium mass by industry group.

4. Apply weight to the emissions derived from the steps above based on their toxicity.

    a. To apply weight based on cancer toxicity, multiply the emissions of each pollutant by its cancer URE.

    b. To apply weight based on noncancer toxicity, divide the emissions of each pollutant by its noncancer RfC.

The PAH measured using Method TO-13A are a sub-group of Polycyclic Organic Matter (POM). Because these compounds are often not speciated into individual compounds in the NEI, the PAH are grouped into POM Groups in order to assess risk attributable to these pollutants (EPA, 2009e). Thus, emissions data and toxicity-weighted emissions for PAH are presented by POM Groups for this analysis. Table 3-4 presents the 22 PAH measured by Method TO-13A and their associated POM Groups. Note that naphthalene emissions are reported to the NEI individually; therefore, naphthalene is not included in one of the POM Groups. Also note that four of the pollutants listed in Table 3-4 do not have assigned POM Groups.

Table 3-4. POM Groups for PAHs

Pollutant	POM Group
Acenaphthene	Group 2
Acenaphthylene	Group 2
Anthracene	Group 2
Benzo(a)anthracene	Group 6
Benzo(a)pyrene	Group 5
Benzo(b)fluoranthene	Group 6
Benzo(e)pyrene	Group 2
Benzo(g,h,i)perylene	Group 2
Benzo(k)fluoranthene	Group 6
Chrysene	Group 7
Coronene	NA
Cyclopenta[cd]pyrene	NA
Dibenz(a,h)anthracene	Group 5
Fluoranthene	Group 2
Fluorene	Group 2
9-Fluorenone	NA
Indeno(1,2,3-cd)pyrene	Group 6
Naphthalene*	NA
Perylene	Group 2
Phenanthrene	Group 2
Pyrene	Group 2
Retene	NA

* Naphthalene emissions are reported to the NEI individually; therefore, naphthalene is not included in one of the POM Groups.
NA = no POM Group assigned.

4.0 Summary of the 2008-2009 National Monitoring Programs Data

This section summarizes the results of the data analyses performed on the NMP dataset as described in Section 3.

4.1 Statistical Results

This section examines the following statistical parameters for each analytical method: 1) detection rates of the target pollutants, 2) concentration ranges and data distribution, and 3) central tendency statistics. Tables 4-1 through 4-6 present statistical summaries for the target pollutants and Sections 4.1.1 through 4.1.3 review the basic findings of these statistical calculations.

4.1.1 Target Pollutant Detection Rates

Every pollutant has an MDL, as described in Section 2.2. Quantification below the MDL is possible, although the measurement's reliability is lower. If a concentration does not exceed the MDL, it does not mean that the pollutant is not present in the air. If the instrument does not generate a numerical concentration, the measurement is marked as "ND," or "non-detect." As explained in Section 2.2, data analysts should exercise caution when interpreting monitoring data with a high percentage of reported concentrations at levels near or below the corresponding MDLs. Therefore, a thorough review of the number of measured detections, the number of non-detects, and the total number of samples is beneficial to understanding the representativeness of the interpretations made.

Tables 4-1 through 4-6 summarize the number of times the target pollutants were detected out of the number of valid samples collected and analyzed. Approximately 57 percent of the reported measurements (including duplicate analyses, replicate analyses, and analyses for collocated samples) were above the MDLs. The percentages listed below represent the percent of measurements that were above the MDLs:

- 48.4 percent of VOC
- 83.1 percent of carbonyl compounds
- 59.5 percent of PAH

- 53.5 percent of SNMOC
- 86.6 percent of metals
- 49.6 percent of hexavalent chromium samples.

Although every pollutant sampled for was detected at least once, some pollutants were always detected while others were infrequently detected. Similar to previous years' reports, acetaldehyde, formaldehyde, and acetone had the greatest number of measured detections (3,697), using the preprocessed daily measurements. These pollutants were reported in every valid carbonyl compound sample collected (3,697). Toluene and benzene were detected in every VOC sample collected (2,868). Antimony, manganese, and lead were detected in every metal sample collected (1,527).

Eight pollutants (isobutane, ethane, propane, propylene, toluene, 2-methylpentane, *n*-hexane, and acetylene) were detected in every SNMOC sample collected (960). Benzene is also a pollutant measured by the SNMOC method. While it was detected in every VOC sample collected, five non-detects were reported by the concurrent SNMOC method. Further review shows that benzene was present in these samples, but co-eluted with another compound during analysis and could not be separated to allow for individual quantitation. According to ERG's approved procedures, the measurement was reported as non-detect, but flagged accordingly.

Naphthalene, phenanthrene, and fluoranthene were detected in every PAH sample collected (2,762). However, it is important to note that the number of pollutants measured by Method TO-13A increased by three pollutants (cyclopenta[c,d]pyrene, 9-fluorenone, and retene) in February 2008, as discussed in Section 2.2.3. Thus, sites sampling PAH early in 2008 have three less pollutants reported for early samples than sites that began sampling later in the year. Of the 2,762 PAH samples collected, 2,725 samples included these additional pollutants.

Table 4-1. 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	2,699	0.003	577.55	3.73	0.06	0.32	0.45	0.16	0.87	23.34	6.25
Acetylene	2,864	0.041	10.80	0.94	1.23	0.65	0.69	0.42	1.06	0.98	1.04
Acrolein	2,780	0.006	31.20	0.37	0.24	0.23	0.24	0.14	0.38	0.85	2.33
Acrylonitrile	527	0.005	4.01	0.24	0.05	0.07	0.09	0.04	0.16	0.45	1.91
tert-Amyl Methyl Ether	64	0.001	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.65
Benzene	2,868	0.021	10.70	0.35	0.14	0.25	0.26	0.17	0.39	0.40	1.13
Bromochloromethane	6	0.004	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.95
Bromodichloromethane	232	0.002	0.64	0.04	0.01	0.02	0.02	0.01	0.04	0.06	1.68
Bromoform	81	0.001	0.02	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.53
Bromomethane	2,788	0.005	1.92	0.02	0.01	0.01	0.01	0.01	0.01	0.06	3.57
1,3-Butadiene	2,696	0.002	1.16	0.04	0.01	0.02	0.03	0.01	0.04	0.05	1.32
Carbon Tetrachloride	2,864	0.004	0.22	0.11	0.10	0.11	0.11	0.09	0.13	0.03	0.28
Carbon Disulfide	2,848	0.002	53.00	1.40	0.01	0.04	0.11	0.02	1.27	3.94	2.81
Chlorobenzene	101	0.002	0.21	0.07	<0.01	0.08	0.04	0.01	0.12	0.06	0.78
Chloroethane	2,457	0.004	0.35	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.95
Chloroform	2,692	0.001	1.55	0.04	0.02	0.03	0.03	0.02	0.04	0.07	1.51
Chloromethane	2,867	0.063	6.58	0.66	0.63	0.64	0.65	0.57	0.72	0.20	0.31
Chloromethylbenzene	35	0.002	0.04	0.01	0.01	0.01	0.01	<0.01	0.01	0.01	0.95
Chloroprene	33	0.002	0.18	0.03	0.01	0.01	0.02	0.01	0.05	0.04	1.17
Dibromochloromethane	275	0.001	0.19	0.01	<0.01	0.01	0.01	<0.01	0.01	0.02	1.60
1,2-Dibromoethane	13	0.002	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.49
m-Dichlorobenzene	24	0.001	0.04	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	1.26
o-Dichlorobenzene	7	0.001	0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.67
p-Dichlorobenzene	2,167	0.001	1.26	0.02	0.01	0.01	0.01	0.01	0.02	0.05	2.42
Dichlorodifluoromethane	2,865	0.029	1.98	0.58	0.55	0.57	0.57	0.51	0.64	0.11	0.20
1,1-Dichloroethane	32	0.002	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.55
1,2-Dichloroethane	116	0.005	0.31	0.02	0.02	0.02	0.02	0.02	0.02	0.03	1.40
1,1-Dichloroethene	52	0.002	0.04	0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	1.03
cis-1,2-Dichloroethylene	23	0.044	0.11	0.08	0.10	0.08	0.08	0.07	0.10	0.02	0.25
trans-1,2-Dichloroethylene	83	0.002	0.50	0.02	<0.01	0.01	0.01	0.01	0.01	0.06	2.95

[a] Number of measured detections out of 2,868 valid samples.

Table 4-1. 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	2,865	0.016	124.00	0.39	0.07	0.11	0.14	0.08	0.19	3.16	8.09
1,2-Dichloropropane	17	0.004	0.02	0.01	<0.01	0.01	0.01	<0.01	0.01	<0.01	0.51
cis-1,3-Dichloropropene	11	0.002	0.09	0.02	<0.01	0.01	0.01	<0.01	0.02	0.02	1.47
trans-1,3-Dichloropropene	13	0.003	0.08	0.01	0.01	0.01	0.01	0.01	0.01	0.02	1.60
Dichlorotetrafluoroethane	2,841	0.004	0.19	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.86
Ethyl Acrylate	19	0.001	0.17	0.02	<0.01	<0.01	0.01	<0.01	0.01	0.04	2.20
Ethyl *tert*-Butyl Ether	16	0.001	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	1.78
Ethylbenzene	2,862	0.003	1.66	0.07	0.02	0.04	0.05	0.02	0.08	0.10	1.32
Hexachloro-1,3-butadiene	27	0.002	0.17	0.02	<0.01	0.01	0.01	<0.01	0.01	0.03	2.17
Methyl Ethyl Ketone	2,800	0.004	10.20	0.38	0.17	0.28	0.30	0.19	0.46	0.40	1.04
Methyl Isobutyl Ketone	2,638	0.001	4.98	0.04	0.02	0.03	0.03	0.02	0.04	0.11	2.68
Methyl Methacrylate	260	0.001	1.51	0.06	0.01	0.02	0.03	0.01	0.05	0.15	2.43
Methyl tert-Butyl Ether	219	0.001	0.30	0.02	0.01	0.01	0.01	0.01	0.02	0.03	1.91
n-Octane	2,557	0.000	0.81	0.03	0.01	0.02	0.02	0.01	0.03	0.04	1.42
Propylene	2,866	0.022	18.30	0.52	0.29	0.30	0.33	0.20	0.52	0.95	1.82
Styrene	2,529	0.002	6.39	0.04	0.01	0.02	0.02	0.01	0.03	0.18	4.08
1,1,2,2-Tetrachloroethane	12	0.001	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.08
Tetrachloroethylene	2,531	0.003	0.70	0.03	0.01	0.02	0.02	0.01	0.04	0.04	1.26
Toluene	2,868	0.015	60.90	0.59	0.09	0.29	0.32	0.16	0.62	1.50	2.52
1,2,4-Trichlorobenzene	20	0.002	0.57	0.05	<0.01	0.01	0.01	<0.01	0.02	0.12	2.51
1,1,1-Trichloroethane	2,865	0.002	0.40	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.64
1,1,2-Trichloroethane	64	0.002	0.01	0.01	<0.01	0.01	<0.01	<0.01	0.01	<0.01	0.40
Trichloroethylene	1,011	0.001	2.35	0.04	0.01	0.02	0.02	0.01	0.03	0.17	3.94
Trichlorofluoromethane	2,810	0.001	5.61	0.29	0.30	0.28	0.28	0.25	0.31	0.14	0.49
Trichlorotrifluoroethane	2,807	0.011	0.47	0.10	0.10	0.10	0.10	0.09	0.11	0.02	0.19
1,2,4-Trimethylbenzene	2,830	0.002	7.64	0.06	0.03	0.04	0.04	0.02	0.07	0.17	2.76
1,3,5-Trimethylbenzene	2,715	0.001	2.46	0.02	0.01	0.01	0.01	0.01	0.02	0.05	2.66
Vinyl chloride	462	0.002	0.07	0.01	<0.01	0.01	0.01	<0.01	0.01	0.01	1.02
m,p-Xylene	2,862	0.004	6.53	0.20	0.06	0.11	0.11	0.06	0.23	0.29	1.44
o-Xylene	2,851	0.002	2.32	0.07	0.03	0.04	0.04	0.02	0.09	0.10	1.38

[a] Number of measured detections out of 2,868 valid samples.

Table 4-2. 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	3,697	0.026	13.40	0.99	1.04	0.80	0.82	0.56	1.23	0.71	0.72
Acetone	3,697	0.016	13.00	1.20	1.04	0.98	0.93	0.61	1.52	0.92	0.76
Benzaldehyde	3,585	0.004	0.70	0.03	0.01	0.02	0.02	0.02	0.04	0.04	1.19
Butyraldehyde	3,674	0.004	3.64	0.08	0.06	0.06	0.06	0.04	0.10	0.09	1.13
Crotonaldehyde	3,646	0.006	2.51	0.11	0.02	0.05	0.06	0.03	0.12	0.16	1.51
2,5-Dimethylbenzaldehyde	6	0.008	0.09	0.05	NA	0.04	0.03	0.01	0.08	0.03	0.72
Formaldehyde	3,697	0.014	406.00	3.03	1.57	1.67	1.67	1.08	2.63	16.40	5.41
Hexaldehyde	3,546	0.004	1.57	0.04	0.02	0.03	0.03	0.02	0.04	0.07	1.74
Isovaleraldehyde	663	0.004	0.51	0.02	0.01	0.02	0.02	0.01	0.02	0.03	1.47
Propionaldehyde	3,683	0.004	3.29	0.12	0.08	0.10	0.09	0.06	0.15	0.10	0.84
Tolualdehydes	3,581	<0.001	0.47	0.03	0.02	0.03	0.03	0.02	0.04	0.03	0.87
Valeraldehyde	3,405	0.004	2.94	0.03	0.01	0.02	0.02	0.02	0.04	0.06	1.90

[a] Number of measured detections out of 3,697 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-3. Statistical Summaries of the PAH Concentrations

Pollutant	# of Measured Detections[a]	Minimum (ng/m³)	Maximum (ng/m³)	Arithmetic Mean (ng/m³)	Mode (ng/m³)	Median (ng/m³)	Geometric Mean (ng/m³)	First Quartile (ng/m³)	Third Quartile (ng/m³)	Standard Deviation (ng/m³)	Coefficient of Variation
Acenaphthene	2,667	0.062	160.00	4.76	1.18	2.56	2.56	1.20	5.45	8.24	1.73
Acenaphthylene	1,633	0.005	194.00	1.96	1.30	0.83	0.86	0.37	2.05	5.65	2.89
Anthracene	1,578	0.018	50.20	1.02	1.24	0.43	0.46	0.21	0.90	2.45	2.42
Benzo(a)anthracene	2,201	0.007	6.47	0.16	0.11	0.07	0.08	0.03	0.16	0.35	2.16
Benzo(a)pyrene	1,711	0.007	10.90	0.18	0.12	0.08	0.09	0.05	0.17	0.38	2.18
Benzo(b)fluoranthene	2,524	0.012	15.60	0.30	0.11	0.14	0.15	0.07	0.31	0.57	1.93
Benzo(e)pyrene	2,271	0.007	9.95	0.18	0.13	0.09	0.10	0.05	0.19	0.33	1.88
Benzo(g,h,i)perylene	2,289	0.007	30.10	0.20	0.11	0.10	0.11	0.06	0.21	0.68	3.36
Benzo(k)fluoranthene	2,054	0.004	4.05	0.10	0.14	0.05	0.05	0.03	0.11	0.17	1.72
Chrysene	2,636	0.011	9.22	0.29	0.11	0.16	0.17	0.09	0.31	0.52	1.76
Coronene	1,684	0.012	20.20	0.13	0.11	0.07	0.08	0.04	0.14	0.51	3.86
Cyclopenta[cd]pyrene[b]	571	0.006	14.10	0.22	0.11	0.09	0.10	0.05	0.18	0.68	3.14
Dibenz(a,h)anthracene	263	0.001	0.52	0.08	0.06	0.06	0.06	0.04	0.10	0.07	0.89
Fluoranthene	2,762	0.014	83.60	2.46	1.13	1.45	1.41	0.74	2.74	3.71	1.51
Fluorene	2,725	0.028	121.00	5.17	1.84	3.32	3.38	1.87	5.88	6.99	1.35
9-Fluorenone[b]	2,490	0.026	29.50	1.65	1.07	1.21	1.15	0.65	2.05	1.72	1.04
Indeno(1,2,3-cd)pyrene	1,662	0.011	17.30	0.22	0.11	0.13	0.13	0.07	0.23	0.50	2.28
Naphthalene	2,762	0.400	3210.00	103.76	107.00	66.50	61.02	33.13	120.00	167.65	1.62
Perylene	896	0.006	1.91	0.07	0.04	0.04	0.05	0.03	0.08	0.10	1.35
Phenanthrene	2,762	0.054	211.00	10.89	11.00	6.55	6.43	3.27	12.70	14.98	1.38
Pyrene	2,760	0.016	106.00	1.53	1.04	0.95	0.89	0.49	1.72	2.92	1.91
Retene[b]	2,518	0.007	53.00	0.53	0.11	0.22	0.25	0.12	0.46	1.51	2.83

[a] Number of measured detections out of 2,763 valid samples.

[b] These pollutants were added to the PAH pollutant list in February 2008, thus these pollutants were analyzed for in fewer samples than the remaining pollutants (2,725).

Table 4-4. 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	960	0.23	38.60	1.92	1.12	1.37	1.43	0.88	2.13	2.21	1.15
Benzene	955	0.29	29.30	2.55	1.06	1.71	1.77	0.91	3.25	2.63	1.03
1,3-Butadiene	385	0.03	5.69	0.20	0.08	0.15	0.15	0.09	0.26	0.32	1.54
n-Butane	958	0.19	359.00	20.15	17.70	11.10	9.37	3.32	26.23	28.65	1.42
cis-2-Butene	754	0.03	3.27	0.27	0.13	0.17	0.19	0.11	0.28	0.33	1.23
trans-2-Butene	836	0.05	5.83	0.33	0.11	0.20	0.23	0.14	0.32	0.44	1.35
Cyclohexane	932	0.06	183.00	3.28	0.14	1.52	1.22	0.27	4.38	7.25	2.21
Cyclopentane	930	0.05	5.12	0.77	1.10	0.56	0.51	0.25	0.99	0.76	0.98
Cyclopentene	634	0.04	3.40	0.35	0.26	0.27	0.27	0.18	0.41	0.31	0.90
n-Decane	932	0.07	194.00	1.64	1.06	0.69	0.73	0.35	1.49	7.85	4.80
1-Decene	3	0.15	0.76	0.37	NA	0.19	0.28	0.17	0.48	0.28	0.77
m-Diethylbenzene	533	0.04	5.60	0.30	0.13	0.19	0.21	0.13	0.33	0.48	1.57
p-Diethylbenzene	333	0.02	3.19	0.33	0.08	0.14	0.18	0.09	0.30	0.47	1.44
2,2-Dimethylbutane	923	0.07	8.89	0.72	0.26	0.51	0.50	0.26	0.93	0.72	0.99
2,3-Dimethylbutane	934	0.03	14.20	1.27	1.10	0.89	0.74	0.29	1.69	1.42	1.11
2,3-Dimethylpentane	935	0.08	11.90	0.84	1.04	0.63	0.60	0.31	1.05	0.86	1.02
2,4-Dimethylpentane	916	0.04	22.90	0.58	0.19	0.42	0.39	0.20	0.72	0.89	1.54
n-Dodecane	897	0.05	142.00	1.69	0.33	0.55	0.60	0.29	1.20	8.45	5.00
1-Dodecene	374	0.03	7.47	0.41	0.09	0.21	0.24	0.13	0.40	0.69	1.70
Ethane	960	1.81	670.00	62.63	102.00	19.60	23.66	6.80	81.45	94.16	1.50
2-Ethyl-1-butene	1	0.17		NA							
Ethylbenzene	931	0.07	7.99	0.65	1.06	0.42	0.45	0.24	0.83	0.75	1.15
Ethylene	957	0.37	14.50	2.64	1.92	2.07	2.11	1.37	3.06	1.99	0.76
m-Ethyltoluene	909	0.05	4.50	0.51	0.36	0.36	0.37	0.21	0.68	0.48	0.94
o-Ethyltoluene	767	0.04	11.60	0.37	0.16	0.27	0.27	0.16	0.46	0.51	1.37
p-Ethyltoluene	847	0.04	6.33	0.34	0.16	0.25	0.26	0.15	0.43	0.36	1.05
n-Heptane	947	0.08	35.40	2.91	2.69	1.40	1.19	0.30	3.94	4.14	1.42
1-Heptene	752	0.05	6.01	0.87	1.81	0.57	0.49	0.20	1.19	0.94	1.08
n-Hexane	960	0.12	477.00	5.85	10.60	3.15	2.57	0.78	7.22	16.58	2.83
1-Hexene	748	0.03	1.14	0.16	0.11	0.15	0.15	0.11	0.20	0.09	0.55

[a] Number of measured detections out of 960 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-4. 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
cis-2-Hexene	258	0.04	2.03	0.16	0.05	0.12	0.12	0.08	0.18	0.17	1.10
trans-2-Hexene	134	0.03	0.45	0.11	0.05	0.11	0.10	0.06	0.14	0.07	0.58
Isobutane	960	0.10	462.00	17.44	1.16	8.49	6.53	1.73	22.83	27.59	1.58
Isobutene/1-Butene	755	0.14	65.30	2.72	1.93	2.16	1.96	1.22	3.63	3.01	1.10
Isopentane	895	0.33	731.00	26.86	15.50	17.30	16.09	9.98	28.20	52.41	1.95
Isoprene	821	0.04	9.11	0.68	0.11	0.29	0.35	0.14	0.74	0.97	1.42
Isopropylbenzene	431	0.03	0.58	0.13	0.11	0.11	0.11	0.08	0.15	0.07	0.55
2-Methyl-1-Butene	611	0.03	68.60	0.80	1.01	0.47	0.43	0.24	0.83	3.00	3.75
3-Methyl-1-Butene	77	0.07	1.87	0.33	0.12	0.21	0.25	0.15	0.40	0.32	0.96
2-Methyl-1-Pentene	138	0.04	0.40	0.12	0.11	0.10	0.11	0.08	0.13	0.07	0.57
4-Methyl-1-Pentene	120	0.04	8.15	0.37	0.08	0.20	0.23	0.15	0.40	0.77	2.04
2-Methyl-2-Butene	652	0.04	5.28	0.37	0.16	0.27	0.27	0.16	0.42	0.39	1.06
Methylcyclohexane	909	0.04	85.40	6.25	10.90	2.56	1.79	0.27	8.79	9.16	1.47
Methylcyclopentane	958	0.10	299.00	2.99	1.50	1.59	1.38	0.45	3.65	10.07	3.37
2-Methylheptane	786	0.04	12.70	1.00	1.23	0.58	0.54	0.23	1.23	1.24	1.24
3-Methylheptane	809	0.04	9.67	0.76	1.24	0.44	0.44	0.20	0.92	0.93	1.23
2-Methylhexane	902	0.07	24.30	1.87	1.52	1.23	1.15	0.54	2.42	2.17	1.16
3-Methylhexane	876	0.08	37.70	1.69	1.01	1.12	0.99	0.40	2.23	2.32	1.37
2-Methylpentane	960	0.19	70.30	5.29	1.24	3.53	3.18	1.34	6.89	6.16	1.16
3-Methylpentane	954	0.11	162.00	3.02	2.10	1.89	1.57	0.57	3.81	6.09	2.02
n-Nonane	907	0.05	22.90	1.17	0.08	0.54	0.57	0.22	1.30	1.84	1.57
1-Nonene	525	0.04	3.44	0.27	0.12	0.18	0.19	0.12	0.29	0.31	1.17
n-Octane	935	0.06	33.10	2.06	0.13	0.89	0.85	0.24	2.54	3.08	1.49
1-Octene	266	0.04	2.38	0.21	0.16	0.14	0.15	0.08	0.21	0.26	1.22
n-Pentane	959	0.19	543.00	13.32	12.90	7.10	6.07	2.08	15.85	26.15	1.96
1-Pentene	944	0.05	42.20	0.71	0.17	0.23	0.28	0.16	0.39	2.88	4.06
cis-2-Pentene	566	0.03	17.20	0.25	0.07	0.13	0.14	0.09	0.20	1.12	4.48
trans-2-Pentene	800	0.05	3.12	0.28	0.13	0.19	0.21	0.13	0.34	0.28	0.99
a-Pinene	648	0.03	11.10	0.53	0.14	0.31	0.33	0.19	0.55	0.95	1.80
b-Pinene	89	0.03	4.02	0.50	0.27	0.28	0.29	0.14	0.50	0.69	1.38

[a] Number of measured detections out of 960 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-4. 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
Propane	960	0.57	525.00	45.76	120.00	24.08	21.27	7.06	58.30	61.27	1.34
n-Propylbenzene	774	0.04	2.00	0.22	0.13	0.18	0.18	0.12	0.27	0.16	0.74
Propylene	960	0.20	13.00	1.11	1.02	0.77	0.87	0.55	1.27	1.04	0.93
Propyne	1	0.09		NA							
Styrene	248	0.03	7.08	0.44	0.16	0.23	0.25	0.14	0.40	0.87	1.99
Toluene	960	0.21	220.00	6.42	10.30	3.83	3.59	1.72	7.50	13.12	2.04
n-Tridecane	423	0.03	12.00	0.40	0.05	0.17	0.19	0.10	0.35	1.12	2.79
1-Tridecene	89	0.03	1.55	0.15	0.05	0.09	0.11	0.06	0.16	0.19	1.22
1,2,3-Trimethylbenzene	645	0.02	33.60	0.31	0.14	0.18	0.19	0.12	0.30	1.35	4.38
1,2,4-Trimethylbenzene	933	0.04	13.50	0.75	1.30	0.49	0.50	0.26	0.95	0.88	1.18
1,3,5-Trimethylbenzene	751	0.03	9.79	0.48	0.17	0.31	0.32	0.17	0.59	0.60	1.25
2,2,3-Trimethylpentane	594	0.04	2.85	0.38	0.20	0.30	0.29	0.18	0.46	0.32	0.85
2,2,4-Trimethylpentane	801	0.03	14.80	0.69	0.19	0.36	0.40	0.19	0.77	1.03	1.48
2,3,4-Trimethylpentane	822	0.05	4.93	0.29	0.13	0.19	0.22	0.14	0.32	0.32	1.10
n-Undecane	925	0.04	438.00	2.98	1.04	0.88	0.93	0.44	1.88	21.06	7.06
1-Undecene	324	0.04	16.50	0.63	0.16	0.31	0.34	0.15	0.73	1.29	2.06
m-Xylene/*p*-Xylene	954	0.07	36.30	2.88	1.18	1.65	1.60	0.69	3.81	3.43	1.19
o-Xylene	942	0.05	6.65	0.76	1.10	0.50	0.52	0.26	1.03	0.75	0.98
SNMOC (Sum of Knowns)	960	12.00	2200.00	261.81	180.00	152.00	149.60	59.50	338.50	305.33	1.17
Sum of Unknowns	960	8.35	1170.00	62.84	18.50	42.15	45.25	27.10	71.35	78.52	1.25
TNMOC	960	30.15	2520.00	324.58	286.00	213.50	210.30	97.73	422.25	339.84	1.05

[a] Number of measured detections out of 960 valid samples.

NA = Statistical parameter(s) could not be calculated.

Table 4-5. 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$_{10}$)	1,079	0.016	47.60	1.22	1.08	0.79	0.71	0.43	1.35	2.06	1.68
Arsenic (PM$_{10}$)	1,073	0.011	23.10	0.71	0.46	0.48	0.49	0.28	0.84	1.00	1.40
Beryllium (PM$_{10}$)	834	<0.001	0.11	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	1.29
Cadmium (PM$_{10}$)	1,077	0.007	9.71	0.22	0.06	0.11	0.12	0.06	0.21	0.56	2.50
Chromium (PM$_{10}$)	975	0.011	8.60	2.19	1.43	1.96	1.94	1.49	2.90	0.97	0.44
Cobalt (PM$_{10}$)	1,065	0.001	2.63	0.16	0.07	0.10	0.09	0.06	0.18	0.23	1.44
Lead (PM$_{10}$)	1,079	0.090	97.53	4.53	1.69	2.94	2.97	1.70	4.94	6.52	1.44
Manganese (PM$_{10}$)	1,079	0.088	734.00	7.38	11.30	4.22	4.17	2.21	8.91	23.30	3.16
Mercury (PM$_{10}$)	856	<0.001	4.19	0.11	0.01	0.03	0.03	0.01	0.09	0.27	2.51
Nickel (PM$_{10}$)	1,033	0.005	26.90	1.35	1.11	0.99	0.95	0.68	1.47	1.61	1.19
Selenium (PM$_{10}$)	1,068	0.004	5.42	0.57	0.24	0.34	0.35	0.20	0.67	0.65	1.14
Antimony (TSP)	448	0.076	4.70	0.66	0.16	0.51	0.52	0.35	0.81	0.55	0.82
Arsenic (TSP)	446	0.066	8.72	0.75	0.70	0.56	0.56	0.36	0.83	0.84	1.12
Beryllium (TSP)	443	0.001	0.25	0.01	0.00	0.01	0.01	0.01	0.02	0.02	1.22
Cadmium (TSP)	448	0.015	0.98	0.18	0.17	0.15	0.14	0.09	0.21	0.13	0.73
Chromium (TSP)	448	0.885	7.49	2.34	1.09	1.98	2.09	1.43	3.06	1.19	0.51
Cobalt (TSP)	448	0.046	21.40	0.59	0.18	0.27	0.30	0.17	0.48	1.45	2.44
Lead (TSP)	448	0.443	50.45	4.13	2.84	3.20	3.15	2.03	4.76	4.07	0.98
Manganese (TSP)	448	1.430	216.00	16.76	14.40	12.60	12.55	8.23	20.33	16.71	1.00
Mercury (TSP)	440	0.001	2.53	0.08	0.01	0.02	0.03	0.01	0.06	0.22	2.86
Nickel (TSP)	448	0.228	10.20	1.01	1.09	0.79	0.83	0.56	1.18	0.82	0.81
Selenium (TSP)	448	0.049	14.20	0.92	0.95	0.64	0.59	0.38	0.97	1.37	1.48

[a] For PM$_{10}$, number of measured detections out of 1,079 valid samples.

[b] For TSP, number of measured detections out of 448 valid samples.

Table 4-6. 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	1,194	0.001	0.69	0.04	0.01	0.02	0.02	0.01	0.04	0.05	1.49

[a] Number of measured detections out of 2,298 valid samples.

Similar to previous year's reports, BTUT and NBIL had the greatest number of measured detections (15,622 for BTUT and 14,121 for NBIL). They were also the only two sites that collected samples for all six analytical methods/pollutant groups. Yet, the detection rates for these sites (71 and 65 percent) were not as high as other sites. Detection rates for sites that sampled suites of pollutants that are frequently detected tended to be higher (refer to the list of method-specific percentages of measurements above the MDL listed above). For example, metals were rarely reported as non-detects. As a result, sites that sampled only metals (such as PAFL) would likely have higher detection rates. PAFL's detection rate is 99 percent. Conversely, VOCs had the lowest detection rate (48.4 percent). A site measuring only VOC would likely have lower detection rates, such as SPAZ (54.7 percent).

4.1.2 Concentration Range and Data Distribution

The concentrations measured during the 2008-2009 NMP show a wide range of variability. The minimum and maximum concentration measured for each target pollutant is presented in Tables 4-1 through 4-6 (in respective pollutant group units). Some pollutants, such as acetonitrile, had a wide range of concentrations measured, while other pollutants, such as carbon tetrachloride, did not, even though they were both detected frequently. The pollutant for each method-specific pollutant group with the largest range in measured concentrations is as follows:

- For VOC, acetonitrile (0.003 to 578 ppbv)
- For SNMOC, isopentane (0.33 to 731 ppbC)
- For carbonyl compounds, formaldehyde (0.014 to 406 ppbv)
- For PAH, naphthalene (0.400 to 3,210 ng/m^3)
- For metals, both size fractions, manganese (0.088 to 734 ng/m^3 for PM_{10} and 1.43 to 216 ng/m^3 for TSP)
- For hexavalent chromium, 0.0014 to 0.685 ng/m^3.

On July 4, 2006, a large number of monitoring sites that sampled for hexavalent chromium measured elevated concentrations. Hexavalent chromium is a component in fireworks

(NLM, 2011) and it is possible that Independence Day fireworks celebrations may have caused this increased concentration level. Based on the 1-in-6 sampling schedule for 2008, samples were collected on July 5, 2008. Seven out of 21 sites sampling hexavalent chromium measured their highest 2008 hexavalent chromium concentration on July 5, 2008. The measurement from GPCO on July 5, 2008 was the highest hexavalent chromium concentration measured for any site sampling this pollutant over the two-year period. Further, of the five highest hexavalent chromium concentrations measured for any site during the 2008-2009 sampling years, three were sampled on July 5, 2008. Additional examples of this phenomenon can be seen in the site-specific trends analysis section of the individual state sections. Additional studies of this phenomenon were recommended in the 2006 UATMP Report. The next year hexavalent chromium will be sampled on July 4 would be 2012.

4.1.3 Central Tendency

In addition to the number of measured detections and the concentration ranges, Tables 4-1 through 4-6 also present a number of central tendency and data distribution statistics (arithmetic mean, geometric mean, mode, median, first and third quartiles, standard deviation, and coefficient of variation) for each of the pollutants sampled during the 2008-2009 NMP by respective pollutant group units. A multitude of observations can be made from these tables. The pollutants with the three highest average concentrations, by mass, for each pollutant group are provided below, with respective confidence intervals.

The top three VOC by average mass concentration, as presented in Table 4-1, are:

- acetonitrile (3.73 ± 0.88 ppbv)
- carbon disulfide (1.40 ± 0.14 ppbv)
- acetylene (0.94 ± 0.04 ppbv).

The top three carbonyl compounds by average mass concentration, as presented in Table 4-2, are:

- formaldehyde (3.03 ± 0.53 ppbv)

- acetone (1.20 ± 0.03 ppbv)
- acetaldehyde (0.99 ± 0.02 ppbv).

The top three PAH by average mass concentration, as presented in Tables 4-3, are:

- naphthalene (103.76 ± 6.26 ng/m^3)
- phenanthrene (10.89 ± 0.56 ng/m^3)
- fluorene (5.17 ± 0.26 ng/m^3).

The top three SNMOC by average mass concentration, as presented in Table 4-4, are:

- ethane (62.63 ± 5.96 ppbC)
- propane (45.76 ± 3.88 ppbC)
- isopentane (26.86 ± 3.44 ppbC).

The top three metals by average mass concentration for both PM_{10} and TSP fractions, as presented in Table 4-5, are;

- manganese (TSP = 16.71 ± 1.55 ng/m^3, PM_{10} = 7.37 ± 1.39 ng/m^3)
- lead (TSP= 4.13 ± 0.38 ng/m^3, PM_{10} = 4.53 ± 0.39 ng/m^3)
- total chromium (TSP = 2.34 ± 0.11 ng/m^3, PM_{10} = 2.19 ± 0.06 ng/m^3).

The average mass concentration of hexavalent chromium, as presented in Table 4-6, is 0.04 ± 0.003 ng/m^3.

The program-wide average concentration for the highest PAH and SNMOC increased from 2007. This is not surprising, however, given the large increase in the number of sites sampling these suites of pollutants.

Appendices J through O present similar statistical calculations, but are based on each individual sample, including duplicate, collocated, and replicate analyses, rather than the preprocessed daily measurements (as presented here).

4.2 Risk Screening and Pollutants of Interest

Based on the preliminary risk screening approach described in Section 3.2, Table 4-7 identifies the pollutants that failed at least one screen; summarizes each pollutant's total number of measured detections, percentage of screens failed, and cumulative percentage of failed screens; and highlights those pollutants contributing to the top 95 percent of failed screens (shaded in gray) and thereby designated as program-wide pollutants of interest.

Table 4-7 shows that formaldehyde failed the highest number of screens (3,693), and also had the highest number of measured detections (3,697). This is equivalent to a 99.89 percent failure rate. This is an increase of approximately 10 percent compared to the 2007 report. However, the risk screening value decreased by an order of magnitude for formaldehyde, from 0.98 µg/m^3 in previous reports to 0.077 µg/m^3, based on the 2010 OAQPS Toxicity table (EPA, 2010a). Other pollutants with revised screening levels since the last report include lead (from 0.15 µg/m^3 to 0.015 µg/m^3), ethylbenzene (from 100 µg/m^3 to 0.4 µg/m^3), carbon tetrachloride (from 0.067 µg/m^3 to 0.17 µg/m^3), and nickel (0.0021 µg/m^3 to 0.009 µg/m^3). Propionaldehyde previously did not have a screening level, but does for this report because it now has a screening value in the 2010 OAQPS Toxicity Table (EPA, 2010a).

Although formaldehyde failed the highest number of screens, it did not have the highest failure rate. 1,2-Dibromoethane had the highest percentage of failed screens (100 percent). While this pollutant failed 100 percent of screens, it was detected only 13 times. Thus, the number of failed screens, the number of measured detections, and the failure rate must all be considered when reviewing the results of the risk screening process. Other pollutants with relatively high failure rates include formaldehyde, benzene, acrylonitrile, 1,2-dichloroethane, and carbon tetrachloride. While each of these pollutants failed more than 99 percent of screens, 1,2-dichloroethane and acrylonitrile were detected in fewer than 20 percent of samples collected.

Table 4-7. Program–Level Risk Screening Summary

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Failed Screens	% of Total Failures	Cumulative % Contribution
Formaldehyde	0.077	3,693	3,697	99.89	15.52	15.52
Acetaldehyde	0.45	3,609	3,697	97.62	15.17	30.70
Benzene	0.13	3,335	3,340	99.85	14.02	44.72
Carbon Tetrachloride	0.17	2,839	2,864	99.13	11.93	56.65
Naphthalene	0.029	2,174	2,762	78.71	9.14	65.79
1,3-Butadiene	0.033	2,137	2,870	74.46	8.98	74.77
Arsenic	0.00023	1,286	1,519	84.66	5.41	80.18
Tetrachloroethylene	0.17	975	2,531	38.52	4.10	84.28
Manganese	0.005	865	1,527	56.65	3.64	87.91
Ethylbenzene	0.4	808	3,330	24.26	3.40	91.31
p-Dichlorobenzene	0.091	730	2,167	33.69	3.07	94.38
Acrylonitrile	0.015	525	527	99.62	2.21	96.59
Dichloromethane	2.1	166	2,865	5.79	0.70	97.28
1,2-Dichloroethane	0.038	115	116	99.14	0.48	97.77
Hexavalent Chromium	0.000083	100	1,194	8.38	0.42	98.19
Cadmium	0.00056	70	1,525	4.59	0.29	98.48
Propionaldehyde	0.8	65	3,683	1.76	0.27	98.76
Trichloroethylene	0.5	53	1,011	5.24	0.22	98.98
Lead	0.015	48	1,527	3.14	0.20	99.18
Benzo(a)pyrene	0.00091	48	1,711	2.81	0.20	99.38
Chloromethylbenzene	0.02	25	35	71.43	0.11	99.49
Xylenes	10	23	3,335	0.69	0.10	99.58
Carbon Disulfide	70	22	2,848	0.77	0.09	99.68
Bromomethane	0.5	19	2,788	0.68	0.08	99.76
Hexachloro-1,3-butadiene	0.045	14	27	51.85	0.06	99.82
1,2-Dibromoethane	0.0017	13	13	100.00	0.05	99.87
Nickel	0.009	8	1,481	0.54	0.03	99.90
Vinyl chloride	0.11	6	462	1.30	0.03	99.93
1,1,2,2-Tetrachloroethane	0.017	5	12	41.67	0.02	99.95
Cobalt	0.01	3	1,513	0.20	0.01	99.96
Antimony	0.02	2	1,527	0.13	0.01	99.97
Benzo(b)fluoranthene	0.0091	1	2,524	0.04	<0.01	99.97
Chloromethane	9	1	2,867	0.03	<0.01	99.98
Indeno(1,2,3-cd)pyrene	0.0091	1	1,662	0.06	<0.01	99.98
1,2-Dichloropropane	0.053	1	17	5.88	<0.01	99.99
n-Hexane	70	1	960	0.10	<0.01	99.99
trans-1,3-Dichloropropene	0.25	1	13	7.69	<0.01	100.00
cis-1,3-Dichloropropene	0.25	1	11	9.09	<0.01	100.00
Beryllium	0.00042	0	1,277			
Chloroform	9.8	0	2,692			
Total		23,788	70,527	33.73		

BOLD = EPA MQO NATTS Core Analyte.

The 18 NATTS MQO Core Analytes (excluding acrolein) are bolded in Table 4-7. Several NATTS MQO Core Analytes failed screens, but did not contribute to the top 95 percent of failed screens (such as hexavalent chromium). However, as described in Section 3.2, all NATTS MQO Core Analytes are designated as program-wide pollutants of interest. Two pollutants, chloroform and beryllium, were added to Table 4-7 because they are NATTS MQO Core Analytes, even though they did not fail any screens. Note that three of the pollutants contributing to the top 95 percent of failed screens (ethylbenzene, *p*-dichlorobenzene, and acrylonitrile) are not NATTS MQO Core Analytes.

The program-level pollutants of interest, as indicated by the shading and/or bolding in Table 4-7, were identified as follows:

- Acetaldehyde
- Acrylonitrile
- Arsenic
- Benzene
- Benzo(a)pyrene
- Beryllium
- 1,3-Butadiene
- Cadmium
- Carbon Tetrachloride
- Chloroform
- *p*-Dichlorobenzene
- Ethylbenzene
- Formaldehyde
- Hexavalent Chromium
- Lead
- Manganese
- Naphthalene
- Nickel
- Tetrachloroethylene
- Trichloroethylene
- Vinyl Chloride

The 2008-2009 list of pollutants of interest identified via the preliminary risk screening approach is similar to the 2007 list of pollutants of interest. However, NATTS MQO Core Analytes that did not make the top 95 percent of contributions were not added to the pollutants of interest list for that report; thus, these additional pollutants account for most of the differences between the two lists. One exception, though, is naphthalene. Naphthalene was just outside the 95 percent criteria cut-off for the 2007 pollutants of interest designation.

Of the 72 pollutants sampled for under the NMP that have corresponding screening values, concentrations of 38 HAPs failed at least one screen (38 percent). Of these, a total of 23,788 of 66,558 concentrations (35.74 percent) failed screens. If the measured detections for chloroform and beryllium (the two NATTS MQO Core Analytes that did not fail any screens) are included in the total number of concentrations, as shown in Table 4-7, the percentage of failed screens is nearly 34 percent. If all of the pollutants with screening values are considered (including those that did not fail any screens), the percentage of concentrations failing screens is much less (23,788 of 122,616, or 19.40 percent).

Table 4-8 presents the total number of failed screens per site, in descending order, as a means of comparing the results of the risk screening process across the sites. As shown, PXSS had the largest number of failed screens (1,241), followed by S4MO (1,095) and BTUT (1,088). In addition to the number of failed screens, Table 4-8 also provides the total number of screens conducted (one screen per valid preprocessed daily measurement for each site for all pollutants with screening values). The failure rate, as a percentage, was determined from the number of failed screens and the total number of screens conducted (based on applicable measured detections) and is also provided in Table 4-8.

Table 4-8. Site-Specific Risk Screening Comparison

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
PXSS	1,241	5,337	23.25	5
S4MO	1,095	5,577	19.63	5
BTUT	1,088	5,230	20.80	6
TOOK	968	3,789	25.55	3
SEWA	924	5,389	17.15	5
GPCO	920	4,381	21.00	4
ELNJ	851	2,774	30.68	2
NBIL	840	5,344	15.72	6
DEMI	818	4,371	18.71	4
SPIL	727	2,544	28.58	2
NBNJ	630	2,544	24.76	2
METN	600	2,142	28.01	2
SSSD	579	2,707	21.39	3
CHNJ	578	2,550	22.67	2
TUOK	562	2,278	24.67	3
LDTN	538	2,373	22.67	2
MSTN	516	2,295	22.48	2
PROK	446	2,221	20.08	3
RICO	414	990	41.82	2
EQWA	389	2,197	17.71	3
CEWA	377	2,183	17.27	3
ESWA	373	2,109	17.69	3
TMOK	364	1,440	25.28	3
SPAZ	351	1,231	28.51	1
PACO	349	889	39.26	2
SKFL	347	1,990	17.44	3
ANAK	332	1,977	16.79	2
SYFL	307	1,720	17.85	3
CUSD	288	1,266	22.75	3
TSOK	287	1,322	21.71	3
CANJ	282	912	30.92	2
MWOK	273	1,207	22.62	3
UCSD	260	1,137	22.87	3
OCOK	252	1,171	21.52	3

[1] Total number of measured detections for all pollutants with screening values, not just those failing screens.

BOLD = EPA-designated NATTS Site

Table 4-8. Site-Specific Risk Screening Comparison (Continued)

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
BRCO	241	815	29.57	2
AZFL	241	361	66.76	1
ORFL	238	360	66.11	1
WPIN	238	357	66.67	1
INDEM	238	351	67.81	1
BOMA	232	2,703	8.58	3
UNVT	217	2,744	7.91	5
EYWA	214	872	24.54	2
FLFL	177	833	21.25	1
CCFL	164	813	20.17	1
IDIN	163	585	27.86	2
ININ	160	540	29.63	2
SJJCA	157	2,236	7.02	2
GAFL	147	222	66.22	1
COOH	131	192	68.23	1
MOCO	129	448	28.79	2
RUCO	123	392	31.38	2
CELA	121	1,665	7.27	1
SDGA	107	1,540	6.95	2
CAMS 35	101	1,445	6.99	1
RUCA	99	1,534	6.45	1
TONY	96	1,480	6.49	1
BXNY	90	1,455	6.19	2
PRRI	86	1,385	6.21	2
RUVT	84	460	18.26	1
BURVT	83	493	16.84	1
WADC	83	1,192	6.96	2
CNEP	73	467	15.63	2
RIVA	72	1,022	7.05	2
PAFL	66	600	11.00	1
GPMS	56	236	23.73	3
ROCH	56	1,114	5.03	2
TUMS	55	263	20.91	2
MVWI	34	1,326	2.56	2
PLOR	16	213	7.51	1
GLKY	15	1,150	1.30	2
CHSC	9	940	0.96	2
HAKY	7	123	5.69	2
ITCMI	3	102	2.94	1

[1] Total number of measured detections for all pollutants with screening values, not just those failing screens.

BOLD = EPA-designated NATTS Site

The total number of screens and the number of pollutant groups measured by each site must also be considered when interpreting the results in Table 4-8. For example, sites sampling three, four, or five pollutant groups tended to have a higher number of failed screens. Although COOH, AZFL, and INDEM had the highest failure rates (67-68 percent), each of these sites sampled only one pollutant group (carbonyl compounds). Three pollutants measured with Method TO-11A (carbonyl compounds) have screening values (acetaldehyde, formaldehyde, and propionaldehyde) and two of these pollutants typically fail all or most of the screens conducted, as shown in Table 4-7. Thus, sites sampling only carbonyl compounds have relatively high failure rates. Conversely, sites that sampled several pollutant groups tended to have lower failure rates due to the larger number of HAPs screened, as is the case with NBIL, S4MO, and SEWA, to name a few. For this reason, the number of pollutant groups for which sampling was conducted is also presented in Table 4-8. Every site had at least one pollutant fail a screen.

The following sections focus only on those pollutants designated as program-level pollutants of interest.

4.2.1 Concentrations of the Pollutants of Interest

Concentrations of the program-level pollutants of interest vary significantly, among the pollutants and among the sites. Tables 4-9 through 4-12 present the top 10 daily average concentrations and 95 percent confidence intervals by site and year for each of the program-level pollutants of interest (for VOC, carbonyl compounds, PAH, and metals respectively). As described in Section 3.1.1, a daily average is the average concentration of all measured detections for a given year. However, a minimum of two measured detections was required for Tables 4-9 through 4-12. Note that daily average concentrations for 2008 are highlighted in gray in Tables 4-9 through 4-12, while 2009 daily average concentrations are shown in white. It is also important to note that the average concentrations for PAH in Table 4-11 and metals in Table 4-12 are reported in ng/m^3 for ease of viewing, while daily average concentrations in Tables 4-9 and 4-10 are reported in μg/m^3.

Table 4-9. Daily Average Concentration Comparison of the VOC Pollutants of Interest

Rank	Acrylonitrile (µg/m^3)	Benzene (µg/m^3)	1,3-Butadiene (µg/m^3)	Carbon Tetrachloride (µg/m^3)	Chloroform (µg/m^3)
1	***GPCO*** 2.38 ± 4.19	ANAK 5.69 ± 2.37	ANAK 0.30 ± 0.12	SPIL 0.84 ± 0.05	***DEMI*** 0.96 ± 0.10
2	SPAZ 2.11 ± 0.44	ANAK 2.84 ± 1.01	SPAZ 0.23 ± 0.06	***SEWA*** 0.84 ± 0.04	***NBIL*** 0.68 ± 0.23
3	SPAZ 1.95 ± 0.55	PACO 2.70 ± 0.49	***PXSS*** 0.23 ± 0.06	***NBIL*** 0.83 ± 0.05	***DEMI*** 0.65 ± 0.10
4	***BTUT*** 1.89 ± 1.23	TOOK 2.61 ± 0.48	***PXSS*** 0.23 ± 0.05	FLFL 0.83 ± 0.08	***NBIL*** 0.63 ± 0.28
5	METN 1.89 ± 3.93	RUCO 2.43 ± 0.37	SPAZ 0.22 ± 0.07	ESWA 0.78 ± 0.05	***PXSS*** 0.44 ± 0.06
6	ELNJ 1.56 ± 0.35	PACO 2.31 ± 0.44	PACO 0.21 ± 0.28	***SEWA*** 0.77 ± 0.04	***PXSS*** 0.44 ± 0.06
7	MSTN 1.45 ± 3.17	RICO 2.23 ± 0.36	EYWA 0.18 ± 0.12	EQWA 0.77 ± 0.17	LDTN 0.40 ± 0.09
8	TSOK 1.34 ± 1.68	MOCO 1.96 ± 1.21	***GPCO*** 0.16 ± 0.04	CEWA 0.76 ± 0.05	PROK 0.32 ± 0.16
9	***S4MO*** 1.04 ± 2.05	***GPCO*** 1.94 ± 0.32	CEWA 0.16 ± 0.05	EQWA 0.76 ± 0.05	LDTN 0.29 ± 0.05
10	***PXSS*** 0.76 ± 0.29	ELNJ 1.83 ± 1.23	ELNJ 0.16 ± 0.09	LDTN 0.76 ± 0.06	CCFL 0.29 ± 0.07

BOLD = EPA-designated NATTS Site.

Daily average concentrations in gray are from 2008, while those in white are from 2009.

Table 4-9. Daily Average Concentration Comparison of the VOC Pollutants of Interest (Continued)

Rank	*p*-Dichlorobenzene (µg/m^3)	Ethylbenzene (µg/m^3)	Tetrachloroethylene (µg/m^3)	Trichloroethylene (µg/m^3)	Vinyl Chloride (µg/m^3)
1	***S4MO*** 0.36 ± 0.26	ANAK 1.28 ± 0.47	CANJ 0.48 ± 0.23	UCSD 3.51 ± 1.92	ESWA 0.03 ± 0.07
2	CUSD 0.29 ± 0.40	ELNJ 0.88 ± 0.17	ANAK 0.47 ± 0.30	SPIL 0.63 ± 0.24	TSOK 0.03 ± 0.05
3	***BTUT*** 0.27 ± 0.29	TOOK 0.78 ± 0.24	***PXSS*** 0.47 ± 0.10	SPIL 0.43 ± 0.19	TUMS 0.03 ± 0.04
4	SPAZ 0.27 ± 0.08	EYWA 0.75 ± 0.38	***PXSS*** 0.46 ± 0.11	ANAK 0.22 ± 0.33	CANJ 0.03 ± 0.01
5	***PXSS*** 0.27 ± 0.04	SPAZ 0.72 ± 0.16	CEWA 0.43 ± 0.42	***NBIL*** 0.19 ± 0.09	GPMS 0.03 ± 0.04
6	***BTUT*** 0.25 ± 0.15	ANAK 0.69 ± 0.30	***GPCO*** 0.43 ± 0.09	CANJ 0.18 ± 0.07	LDTN 0.03 ± 0.05
7	FLFL 0.21 ± 0.08	***PXSS*** 0.63 ± 0.11	SPIL 0.36 ± 0.09	***NBIL*** 0.18 ± 0.08	CHNJ 0.03 ± 0.02
8	***PXSS*** 0.20 ± 0.03	UCSD 0.61 ± 0.31	ELNJ 0.35 ± 0.07	EQWA 0.17 ± 0.05	BURVT 0.02 ± 0.02
9	SPAZ 0.20 ± 0.04	SPAZ 0.60 ± 0.15	EQWA 0.34 ± 0.20	***S4MO*** 0.16 ± 0.05	EQWA 0.02 ± 0.01
10	METN 0.19 ± 0.08	PACO 0.59 ± 0.13	***GPCO*** 0.33 ± 0.07	CEWA 0.15 ± 0.04	ELNJ 0.02 ± 0.01

BOLD = EPA-designated NATTS Site.

Daily average concentrations in gray are from 2008, while those in white are from 2009.

Table 4-10. Daily Average Concentration Comparison of the Carbonyl Compound Pollutants of Interest

Rank	Acetaldehyde ($\mu g/m^3$)	Formaldehyde ($\mu g/m^3$)
1	INDEM 3.77 ± 0.75	INDEM 75.13 ± 36.25
2	METN 3.17 ± 0.72	PROK 7.79 ± 6.42
3	GAFL 2.97 ± 0.91	ININ 6.27 ± 0.95
4	***GPCO*** 2.90 ± 0.22	UCSD 5.97 ± 5.20
5	***SKFL*** 2.87 ± 0.28	***GPCO*** 4.11 ± 0.29
6	***PXSS*** 2.86 ± 0.30	***GPCO*** 4.02 ± 0.27
7	UCSD 2.75 ± 0.97	ELNJ 3.80 ± 0.53
8	***PXSS*** 2.70 ± 0.24	***PXSS*** 3.62 ± 0.25
9	NBNJ 2.58 ± 0.48	***PXSS*** 3.57 ± 0.23
10	COOH 2.53 ± 0.42	METN 3.53 ± 0.86

BOLD = EPA-designated NATTS Site.
Daily average concentrations in gray are from 2008, while those in white are from 2009.

Table 4-11. Daily Average Concentration Comparison of the PAH Pollutants of Interest

Rank	**Benzo(a)pyrene (ng/m^3)**	**Naphthalene (ng/m^3)**
1	TONY 0.73 ± 0.75	TONY 615.92 ± 169.24
2	ESWA 0.69 ± 0.52	TONY 555.95 ± 213.09
3	ANAK 0.54 ± 0.31	***GPCO*** 198.42 ± 26.68
4	***GPCO*** 0.44 ± 0.15	***CELA*** 167.58 ± 30.00
5	ESWA 0.39 ± 0.18	***RIVA*** 149.52 ± 63.83
6	***PXSS*** 0.31 ± 0.20	ESWA 143.81 ± 61.07
7	***PRRI*** 0.28 ± 0.11	***DEMI*** 137.66 ± 31.00
8	***UNVT*** 0.28 ± 0.45	***BXNY*** 133.76 ± 18.3
9	***GPCO*** 0.27 ± 0.14	***S4MO*** 131.49 ± 36.16
10	CEWA 0.27 ± 0.26	***WADC*** 128.63 ± 24.29

BOLD = EPA-designated NATTS Site.
Daily average concentrations in gray are from 2008,
while those in white are from 2009.

Table 4-12. Daily Average Concentration Comparison of the Metals Pollutants of Interest

Rank	Arsenic (PM_{10}) (ng/m^3)	Arsenic (TSP) (ng/m^3)	Beryllium (PM_{10}) (ng/m^3)	Beryllium (TSP) (ng/m^3)	Cadmium (PM_{10}) (ng/m^3)	Cadmium (TSP) (ng/m^3)	Hexavalent Chromium (ng/m^3)	Lead (PM_{10}) (ng/m^3)	Lead (TSP) (ng/m^3)
1	***S4MO*** 1.52 ± 0.81	TUOK 1.14 ± 0.44	***PXSS*** 0.018 ± 0.004	TMOK 0.031 ± 0.013	***S4MO*** 1.00 ± 0.43	TOOK 0.25 ± 0.05	***PXSS*** 0.10 ± 0.03	***S4MO*** 14.31 ± 4.28	TOOK 8.23 ± 2.09
2	***BTUT*** 1.17 ± 0.43	TMOK 0.99 ± 0.26	***PXSS*** 0.013 ± 0.004	TOOK 0.018 ± 0.003	***S4MO*** 0.75 ± 0.32	TOOK 0.25 ± 0.03	***PXSS*** 0.08 ± 0.01	***S4MO*** 9.94 ± 3.35	TUOK 5.58 ± 1.55
3	IDIN 1.08 ± 0.24	TOOK 0.89 ± 0.16	***BTUT*** 0.012 ± 0.004	TOOK 0.015 ± 0.003	***BOMA*** 0.25 ± 0.03	TUOK 0.24 ± 0.09	***BOMA*** 0.06 ± 0.03	IDIN 5.85 ± 1.66	TOOK 4.63 ± 0.55
4	ININ 1.05 ± 0.21	TSOK 0.83 ± 0.31	***BTUT*** 0.011 ± 0.003	PROK 0.014 ± 0.005	ININ 0.24 ± 0.04	TMOK 0.21 ± 0.05	***BOMA*** 0.06 ± 0.03	ININ 5.72 ± 1.12	TUOK 4.47 ± 0.87
5	***S4MO*** 0.96 ± 0.21	TOOK 0.68 ± 0.08	ININ 0.007 ± 0.002	CNEP 0.013 ± 0.005	***BOMA*** 0.22 ± 0.02	PROK 0.17 ± 0.06	***DEMI*** 0.05 ± 0.02	***PXSS*** 4.87 ± 0.73	TSOK 4.18 ± 0.73
6	PAFL 0.77 ± 0.16	TUOK 0.65 ± 0.21	***S4MO*** 0.006 ± 0.001	OCOK 0.013 ± 0.004	IDIN 0.21 ± 0.05	TUOK 0.16 ± 0.03	***DEMI*** 0.05 ± 0.02	***BOMA*** 4.44 ± 1.04	TMOK 4.04 ± 0.70
7	***NBIL*** 0.75 ± 0.16	CNEP 0.56 ± 0.13	IDIN 0.006 ± 0.001	PROK 0.013 ± 0.003	***BTUT*** 0.20 ± 0.10	CNEP 0.16 ± 0.04	***SEWA*** 0.04 ± 0.01	PAFL 4.43 ± 1.77	CNEP 3.11 ± 0.74
8	***NBIL*** 0.73 ± 0.15	PROK 0.55 ± 0.22	***NBIL*** 0.005 ± 0.001	TUOK 0.013 ± 0.002	***NBIL*** 0.18 ± 0.04	TSOK 0.15 ± 0.02	***SEWA*** 0.04 ± 0.01	***NBIL*** 4.33 ± 0.79	PROK 2.35 ± 0.47
9	PAFL 0.73 ± 0.20	OCOK 0.52 ± 0.16	***S4MO*** 0.005 ± 0.001	TUOK 0.010 ± 0.002	***NBIL*** 0.14 ± 0.02	PROK 0.14 ± 0.03	***BTUT*** 0.04 ± 0.01	***SEWA*** 4.07 ± 1.08	PROK 2.29 ± 0.69
10	***PXSS*** 0.71 ± 0.16	MWOK 0.49 ± 0.11	***NBIL*** 0.004 ± 0.001	TSOK 0.009 ± 0.002	***PXSS*** 0.14 ± 0.02	MWOK 0.09 ± 0.02	***S4MO*** 0.03 ± 0.02	***PXSS*** 4.04 ± 0.86	MWOK 2.05 ± 0.31

BOLD = EPA-designated NATTS Site.

Daily average concentrations in gray are from 2008, while those in white are from 2009.

Table 4-12. Daily Average Concentration Comparison of the Metals Pollutants of Interest (Continued)

Rank	Manganese (PM$_{10}$) (ng/m^3)	Manganese (TSP) (ng/m^3)	Nickel (PM$_{10}$) (ng/m^3)	Nickel (TSP) (ng/m^3)
1	***S4MO*** 21.92 ± 23.61	TMOK 31.46 ± 11.43	***BTUT*** 2.75 ± 1.09	TOOK 1.53 ± 0.19
2	***PXSS*** 16.56 ± 3.41	TOOK 25.54 ± 4.12	***SEWA*** 2.61 ± 0.67	TMOK 1.41 ± 0.5
3	***PXSS*** 15.09 ± 2.22	TOOK 19.61 ± 2.32	***SEWA*** 2.19 ± 0.48	TSOK 1.22 ± 0.22
4	***SEWA*** 11.03 ± 2.61	TUOK 16.78 ± 2.53	***BOMA*** 1.77 ± 0.24	TUOK 1.15 ± 0.47
5	***BTUT*** 8.68 ± 1.50	TSOK 15.91 ± 3.42	PAFL 1.63 ± 0.80	TOOK 1.04 ± 0.11
6	***S4MO*** 8.08 ± 1.40	TUOK 14.94 ± 2.48	***PXSS*** 1.62 ± 0.38	TUOK 0.98 ± 0.12
7	***SEWA*** 7.15 ± 1.85	OCOK 11.33 ± 2.29	***PXSS*** 1.45 ± 0.25	MWOK 0.89 ± 0.30
8	***NBIL*** 7.10 ± 1.86	CNEP 11.28 ± 2.27	***BOMA*** 1.42 ± 0.17	CNEP 0.84 ± 0.15
9	***BTUT*** 7.01 ± 1.20	PROK 11.06 ± 3.88	***SJJCA*** 1.16 ± 0.13	PROK 0.72 ± 0.15
10	***NBIL*** 5.44 ± 0.91	PROK 8.84 ± 1.22	***S4MO*** 1.15 ± 0.13	OCOK 0.54 ± 0.08

BOLD = EPA-designated NATTS Site.

Daily average concentrations in gray are from 2008, while those in white are from 2009.

Note that not all sites sampled each pollutant; thus, the list of possible sites presented in Tables 4-9 through 4-12 is limited to those sites sampling each pollutant. Daily average concentrations for multiple years for a given site may indicate a trend in relatively high concentrations. However, only eight sites sampled TSP metals; thus, repetition of a site in the list may be the result of few sites sampling TSP metals rather than a trend in relatively high daily average concentrations.

Some observations from Tables 4-9 through 4-12 include the following:

- The highest daily average concentration was calculated for formaldehyde for INDEM for 2008 (75.13 ± 36.25 µg/m^3). INDEM's 2008 daily average formaldehyde concentration is an order of magnitude higher than the other nine daily average formaldehyde concentrations shown in Table 4-10. INDEM's 2009 daily average formaldehyde concentration ranked 33rd among the sites sampling formaldehyde. INDEM's 2008 acetaldehyde average was also the highest daily average concentration among sites sampling this pollutant, while its 2009 daily average ranked 51st.

- Behind INDEM, PROK and UCSD have relatively high 2009 daily average concentrations of formaldehyde, ranking second and fourth respectively. Yet, their confidence intervals are nearly as high as their daily averages, indicating that these daily averages are influenced by outliers. Conversely, ININ's 2008 daily average formaldehyde concentration ranked third highest and has a relatively low confidence interval. This indicates that ININ's concentrations tended to run higher on a regular basis, as opposed to being influenced by outliers (37 of 50 measured detections at ININ were greater than the average formaldehyde for the NMP program (3.03 ppbv, as shown in Table 4-2).

- For VOC, ANAK's 2008 daily average concentrations topped the lists for benzene, 1,3-butadiene, and ethylbenzene. In addition, ANAK's 2009 daily average benzene concentration ranked second among sites sampling VOC.

- UCSD's 2009 daily average trichloroethylene concentration (3.51 ± 1.92 µg/m^3) is five times higher than the next highest daily average (SPIL 2008, 0.63 ± 0.24 µg/m^3).

- TONY's 2009 and 2008 daily average naphthalene concentrations ranked first and second among sites sampling this pollutant. These daily average concentrations were three and two times the third-ranking daily average concentration for naphthalene (GPCO, 2009). TONY's 2008 benzo(a)pyrene average was the highest daily average concentration among sites sampling this pollutant, while its 2009 daily average ranked 11th.

- For hexavalent chromium, PXSS had the two highest daily average concentrations, BOMA ranked third and fourth, DEMI ranked fifth and sixth, and SEWA ranked seventh and eighth.

- S4MO had the highest daily average concentration of the following metals: arsenic, cadmium, lead, and manganese (all PM_{10}).

- PXSS was on the top 10 list for 16 of the 21 program-level pollutants of interest, for a total of 27 appearances in Tables 4-9 through 4-12. S4MO was on the top 10 list for 11 of the 21 program-level pollutants of interest, for a total of 16 times appearances in Tables 4-9 through 4-12. TOOK and NBIL each appear on these tables 14 times.

- A monitoring site from the Seattle-Tacoma area (CEWA, EQWA, ESWA, EYWA, and SEWA) appears in Tables 4-9 through 4-12 a total of 34 times.

- Daily average concentrations for 2008 appear in Tables 4-9 through 4-12 a total of 148 times compared to 122 times for 2009.

4.2.2 Risk Screening Assessment Using MRLs

A summary of the program-level MRL risk assessment is presented in Table 4-13. Benzene and formaldehyde are the only pollutants with at least one concentration or time-period average concentration higher than their respective ATSDR heath risk benchmarks. Out of 3,697 measured detections of formaldehyde, 14 concentrations were higher than the ATSDR acute MRL (50 $\mu g/m^3$). Eleven of these were measured at INDEM, two at PROK, and one at UCSD. One measured detection of benzene (measured at ELNJ) was higher than the ATSDR acute MRL for benzene (30 $\mu g/m^3$). Concentrations that were higher than their respective acute MRL are discussed on a site-specific basis in further detail in Sections 5 through 33.

Out of 252 quarterly averages of formaldehyde, two quarterly averages were higher than the ATSDR intermediate MRL (40 $\mu g/m^3$); these were calculated for the second and third quarters of 2008 for INDEM. None of the quarterly averages of benzene were higher than the ATSDR intermediate MRL of 20 $\mu g/m^3$. Quarterly average concentrations that were greater than their respective intermediate MRL are discussed on a site-specific basis in further detail in Sections 5 through 33. Graphical displays of the site-specific quarterly averages for the program-level pollutants of interest are presented and discussed in Section 4.4.2.

Table 4-13. Program-Level MRL Risk Screening Assessment

		Acute Risk		Intermediate Risk					Chronic Risk	
Sampling Method	**Pollutant**	**ATSDR Acute MRL[1] (µg/m^3)**	**# of Concentrations > MRL/ # of Measured Detections**	**ATSDR Intermediate MRL[1] (µg/m^3)**	**# of 1st Quarter Avg Conc > MRL/ # of Quarterly Averages**	**# of 2nd Quarter Avg Conc > MRL/ # of Quarterly Averages**	**# of 3rd Quarter Avg Conc > MRL/ # of Quarterly Averages**	**# of 4th Quarter Avg Conc > MRL/ # of Quarterly Averages**	**ATSDR Chronic MRL[1] (µg/m^3)**	**# of Annual* Avg Conc > MRL/ # of Annual Averages**
TO-11A	Formaldehyde	50	14/3,697	40	0/60	1/65	1/67	0/60	10	1/62
TO-15	Benzene	30	1/3,340	20	0/59	0/58	0/59	0/56	10	0/54

[1] Reflects the use of one significant digit for MRLs.

*Total number includes both study averages and annual average.

Of the 62 valid annual and study averages of formaldehyde, only one annual average (for INDEM, 2008) was higher than the ATSDR chronic MRL for formaldehyde (10 µg/m^3). None of the annual averages of benzene were higher than the ATSDR chronic MRL of 10 µg/m^3. There were also no study averages of formaldehyde or benzene that were higher than their ATSDR chronic MRLs. Annual averages that were higher than their respective chronic MRL are also discussed in further detail on a site-specific basis in Sections 5 through 33.

4.3 The Impact of Mobile Sources

Ambient air is significantly impacted by mobile sources, as discussed in Section 3.4.1. Table 4-14 contains several parameters that are used to assess mobile source impacts on air quality near the monitoring sites, including emissions data from the NEI, concentration data, and site-characterizing data, such as vehicle ownership.

4.3.1 Mobile Source Emissions

On-road emissions come from mobile sources such as automobiles, buses, and construction vehicles that use roadways; non-road emissions come from the remaining mobile sources such as locomotives, lawn mowers, and boats (EPA, 2011g). Table 4-14 contains county-level on-road and non-road HAP emissions from the 2005 NEI. Mobile source emissions tend to be highest in large urban areas and lowest in rural areas. Estimated on-road county emissions were highest in Los Angeles County, CA, where CELA is located, followed by Cook County, IL, where NBIL and SPIL are located, and Wayne County, MI, where DEMI is located while estimated on-road emissions were lowest in Custer County and Union County, SD, and Perry County, KY, where CUSD, UCSD, and HAKY are located, respectively. Estimated non-road county emissions were also highest in Los Angeles County, CA, followed by Harris County, TX, where CAMS 35 is located, and Maricopa County, AZ, where SPAZ and PXSS are located. Estimated non-road county emissions were lowest in Perry and Carter County, KY and Custer and Union County, SD, where HAKY, GLKY, CUSD, and UCSD are located, respectively.

Table 4-14. Summary of Mobile Source Information by Monitoring Site

Site	County Motor Vehicle Registration (# of Vehicles)	Estimated 10-Mile Ownership (# of Vehicles)	Annual Average Daily Traffic (# of Vehicles)	VMT by Urban Area (thousands)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Daily Average[1] (ppbv)	Acetylene Daily Average[1] (ppbv)
ANAK	335,703	289,279	24,143	4,612	1,184.54	1,940.58	7.18	2.26
AZFL	896,957	562,188	30,500	62,865	3,513.93	1,547.18	NA	NA
BOMA	489,937	1,031,107	31,400	92,756	1,257.73	848.09	NA	NA
BRCO	77,026	30,174	150	NA	361.30	119.94	NA	NA
BTUT	241,541	202,013	111,065	10,791	951.77	447.70	4.14	1.32
BURVT	223,316	168,094	12,000	3,236	622.32	350.23	2.10	0.90
BXNY	246,190	1,150,769	100,230	299,125	1,338.24	579.42	NA	NA
CAMS 35	2,982,632	543,090	31,043	106,872	7,249.40	6,155.15	NA	NA
CANJ	372,132	1,441,239	4,206	105,823	1,288.99	683.33	3.81	0.95
CCFL	1,436,626	750,724	38,500	129,658	5,325.44	2,357.02	2.60	0.67
CELA	7,498,722	2,847,521	238,000	275,665	17,811.66	8,259.27	NA	NA
CEWA	1,772,343	796,159	47,000	69,801	8,626.43	3,861.65	3.13	1.32
CHNJ	342,994	170,591	12,917	299,125	1,616.51	1,042.29	1.47	0.53
CHSC	40,133	5,065	650	NA	191.81	94.60	NA	NA
CNEP	30,023	21,845	4,600	NA	219.47	122.13	1.41	0.66
COOH	1,101,479	916,548	143,360	30,553	4,205.31	1,282.10	NA	NA
CUSD	14,714	10,901	2,500	NA	37.71	63.02	2.59	0.61
DEMI	1,341,276	793,087	104,100	99,633	9,680.22	1,867.13	2.48	0.96
ELNJ	369,610	1,548,715	250,885	299,125	1,432.66	598.55	6.64	1.23
EQWA	757,027	609,568	21,000	69,801	3,298.90	1,553.17	3.04	1.11
ESWA	757,027	596,425	154,000	69,801	3,298.90	1,553.17	3.55	1.31
EYWA	757,027	659,581	196,000	69,801	3,298.90	1,553.17	NR	1.18
FLFL	1,436,626	1,079,284	14,000	129,658	5,325.44	2,357.02	2.39	0.63
GAFL	1,137,069	452,543	29,000	62,865	3,965.94	1,925.47	NA	NA

[1] This parameter is only available for monitoring sites sampling VOC.

BOLD = EPA-designated NATTS Site.

NA = Data not available.

NR = Data not reportable.

Table 4-14. Summary of Mobile Source Information by Monitoring Site (Continued)

Site	County Motor Vehicle Registration (# of Vehicles)	Estimated 10-Mile Ownership (# of Vehicles)	Annual Average Daily Traffic (# of Vehicles)	VMT by Urban Area (thousands)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Daily Average[1] (ppbv)	Acetylene Daily Average[1] (ppbv)
GLKY	28,371	15,700	428	NA	217.32	23.04	NA	NA
GPCO	182,518	135,467	11,800	2,000	529.72	235.43	4.77	1.70
GPMS	173,974	151,158	27,000	7,446	789.15	1,011.81	1.80	0.76
HAKY	25,654	27,953	21,359	NA	110.72	21.15	NA	NA
IDIN	814,682	550,173	77,250	33,581	3,387.05	968.47	NA	NA
INDEM	416,995	349,929	23,280	172,794	1,533.93	793.66	NA	NA
ININ	814,682	618,682	97,780	33,581	3,387.05	968.47	NA	NA
ITCMI	37,629	21,052	5,200	NA	172.48	448.22	NA	NA
LDTN	57,565	62,217	12,560	15,741	298.54	234.69	1.70	0.69
METN	682,581	305,923	57,872	25,974	3,075.57	1,538.25	3.47	0.97
MOCO	77,026	22,389	NA	NA	361.30	119.94	NA	NA
MSTN	57,565	62,217	7,691	15,741	298.54	234.69	1.66	0.59
MVWI	93,219	26,475	3,500	NA	326.22	294.27	NA	NA
MWOK	685,765	330,385	59,165	30,576	3,605.09	1,074.86	1.38	0.52
NBIL	2,128,822	350,531	34,100	172,794	9,845.43	5,231.74	1.66	0.73
NBNJ	555,187	553,816	110,653	299,125	2,324.52	1,029.11	2.15	0.77
OCOK	685,765	315,780	61,500	30,576	3,605.09	1,074.86	1.40	0.42
ORFL	1,055,967	979,965	32,000	43,691	4,044.30	2,231.01	NA	NA
PACO	77,026	9,118	919	NA	361.30	119.94	NA	NA
PAFL	1,055,967	854,493	51,500	43,691	4,044.30	2,231.01	NA	NA
PLOR	748,648	1,056,207	14,884	34,294	2,317.87	875.85	NA	NA
PROK	30,023	21,845	18,400	NA	219.47	122.13	1.49	0.69
PRRI	142,334	152,028	136,800	26,006	1,948.90	658.53	NA	NA
PXSS	3,753,941	1,410,780	206,000	78,147	7,692.98	5,516.35	5.23	1.61

[1] This parameter is only available for monitoring sites sampling VOC.

BOLD = EPA-designated NATTS Site.

NA = Data not available.

NR = Data not reportable.

Table 4-14. Summary of Mobile Source Information by Monitoring Site (Continued)

Site	County Motor Vehicle Registration (# of Vehicles)	Estimated 10-Mile Ownership (# of Vehicles)	Annual Average Daily Traffic (# of Vehicles)	VMT by Urban Area (thousands)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Daily Average[1] (ppbv)	Acetylene Daily Average[1] (ppbv)
RICO	77,026	22,389	4,800	NA	361.30	119.94	NA	NA
RIVA	347,913	560,443	74,000	26,709	1,187.70	347.08	NA	NA
ROCH	552,964	480,049	105,038	16,267	2,908.63	920.69	NA	NA
RUCA	1,685,246	793,625	18,365	42,835	4,015.24	1,495.19	NA	NA
RUVT	118,002	65,763	6,600	NA	291.50	177.80	2.01	0.78
S4MO	1,132,283	931,123	81,174	66,114	1,180.46	301.25	2.24	0.84
SDGA	467,962	486,271	9,200	127,008	2,359.97	1,042.50	NA	NA
SEWA	1,772,343	843,445	236,000	69,801	8,626.43	3,861.65	2.27	0.87
SJJCA	1,508,850	1,213,374	6,000	36,859	3,094.21	1,200.70	NA	NA
SKFL	896,957	663,915	51,000	62,865	3,513.93	1,547.18	NA	NA
SPAZ	3,753,941	836,896	113,000	78,147	7,692.98	5,516.35	5.46	1.83
SPIL	2,128,822	825,416	213,500	172,794	9,845.43	5,231.74	2.19	0.96
SSSD	200,008	182,473	22,087	2,984	514.19	174.10	1.74	0.56
SYFL	1,137,069	296,347	10,400	62,865	3,965.94	1,925.47	NA	NA
TMOK	520,938	278,291	11,900	20,208	3,108.27	1,266.80	3.31	0.84
TONY	664,102	446,529	74,406	20,787	3,658.77	929.95	NA	NA
TOOK	520,938	385,983	62,400	20,208	3,108.27	1,266.80	3.79	0.72
TSOK	511,990	288,342	62,100	19,948	3,108.27	1,266.80	2.10	0.58
TUMS	73,635	65,066	12,000	NA	467.57	220.52	1.27	0.65
TUOK	520,938	387,641	46,000	20,208	3,108.27	1,266.80	2.77	0.89
UCSD	22,304	10,390	156	NA	83.54	35.89	1.82	0.33
UNVT	223,316	21,125	1,200	3,236	622.32	350.23	0.64	0.31
WADC	171,255	531,472	7,600	98,704	1,313.86	520.90	NA	NA
WPIN	814,682	700,522	143,759	33,581	3,387.05	968.47	NA	NA

[1] This parameter is only available for monitoring sites sampling VOC.

BOLD = EPA-designated NATTS Site.

NA = Data not available.

NR = Data not reportable.

4.3.2 Hydrocarbon Concentrations

Hydrocarbons are organic compounds that contain only carbon and hydrogen. Hydrocarbons are derived mostly from crude petroleum sources and are classified according to their arrangement of atoms as alicyclic, aliphatic, and aromatic. Hydrocarbons are of prime economic importance because they encompass the constituents of the major fossil fuels, petroleum and natural gas, as well as plastics, waxes, and oils. Hydrocarbons in the atmosphere originate from natural sources and from various anthropogenic sources, such as the combustion of fuel and biomass, petroleum refining, petrochemical manufacturing, solvent use, and gas and oil production and use. In urban air pollution, these components, along with oxides of nitrogen (NOx) and sunlight, contribute to the formation of tropospheric ozone. According to the EPA, approximately 47 percent of hydrocarbon emissions are from mobile sources (both on-road and non-road) (EPA, 2011l). Thus, the concentration of hydrocarbons in ambient air may act as an indicator of mobile source activity levels. Several hydrocarbons are sampled with Method TO-15, including benzene, ethylbenzene, and toluene.

Table 4-14 presents the daily average of the sum of hydrocarbon concentrations for each site sampling VOC. Note that only sites sampling VOC have data in this column. Table 4-14 shows that ANAK, ELNJ, PXSS, and SPAZ had the highest hydrocarbon averages among the monitoring sites. With the exception of ANAK, each of these sites is located in a highly populated urban area and in close proximity to heavily traveled roadways. For example, ELNJ is located near Exit 13 on I-95 near New York City.

The two sites with the lowest hydrocarbon averages (UNVT and TUMS) are located in rural areas. However, the sites with the third and fourth lowest hydrocarbon averages are MWOK (in Midwest City, a suburb of Oklahoma City, OK) and OCOK (Oklahoma City, OK), respectively. The daily average hydrocarbon concentration can be compared to other indicators of mobile source activity, such as the ones discussed below, to determine if correlations exist.

Please note the hydrocarbon averages in Table 4-14 represent all applicable concentrations over the 2008-2009 sampling period. Also note that certain pollutant concentrations were invalidated per the Puget Sound Clean Air Authority for the EYWA site, as discussed in Section 2.4; thus, average hydrocarbon concentrations are not presented in Table 4-14 for this site.

4.3.3 Motor Vehicle Ownership

Another indicator of motor vehicle activity near the monitoring sites is the total number of vehicles owned by residents in the county where each monitoring site is located, which includes passenger vehicles, trucks, and commercial vehicles, as well as vehicles that can be regional in use such as boats or snowmobiles. Actual county-level vehicle registration data were obtained from the applicable state or local agency, where possible. If data were not available, vehicle registration data are available at the state-level (FHWA, 2008 and FHWA, 2009a). The county proportion of the state population was then applied to the state registration count.

The county-level motor vehicle ownership data and the average hydrocarbon concentration are presented in Table 4-14. The ownership data presented in Table 4-14 represent the most recently available data applicable to a monitoring site's sample dates (i.e., if a site stopped sampling in 2008, vehicle ownership data from the previous year were retained). As previously discussed, ANAK, ELNJ, PXSS, and SPAZ had the highest average hydrocarbon concentrations, respectively, while UNVT, TUMS, MWOK, and OCOK had the lowest. Table 4-14 also shows that SPAZ, PXSS, NBIL, and SPIL had the highest county-level vehicle ownership of the sites sampling VOC, while CUSD, UCSD, CNEP, and PROK have the lowest. CELA, which had the highest county-level vehicle ownership of all the sites, did not sample VOC. The Pearson correlation coefficient calculated between these two datasets is 0.31. While this correlation falls below the "strong" classification, it does indicate a positive correlation between hydrocarbon concentrations and vehicle registration.

The vehicle ownership at the county-level may not be completely indicative of the ownership in a particular area. As an illustration, for a county with a large city in the middle of its boundaries and less populated areas surrounding it, the total county-level ownership may be more representative of areas inside the city limits than in the rural outskirts. Therefore, a vehicle registration-to-population ratio was developed for each county with a monitoring site. Each ratio was then applied to the 10-mile population surrounding the sites (from Table 2-2) and is presented in Table 4-14. Table 4-14 shows that ELNJ, CANJ, and PXSS have the highest 10-mile estimated vehicle ownership of the sites sampling VOC, while UCSD, CUSD, and UNVT have the lowest. Again, CELA, which had the highest 10-mile vehicle ownership of all the sites, did not sample VOC under the NMP. The Pearson correlation coefficient calculated between the average hydrocarbon calculations and the 10-mile vehicle registration estimates is 0.50. This represents a strong positive correlation, indicating that as vehicle registration inside the 10-mile radius increases, concentration of hydrocarbons tend to proportionally increase.

Other factors may impact the reliability of motor vehicle ownership data as an indicator of ambient air monitoring data results:

- Estimates of higher vehicle 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.

- Emissions sources in the area other than motor vehicles may significantly affect levels of hydrocarbons in the ambient air.

4.3.4 Estimated Traffic Volume

In NMP reports prior to 2007, traffic data, which represents the average number of vehicles passing a monitoring site on a daily basis, were obtained from AQS. However, much of the populated traffic data reflected traffic conditions during site initiation, and were often 5 or more years old. Thus, beginning with the 2007 NMP report, updated traffic data were obtained from state and local agencies, primarily Departments of Transportation. Most of the numbers in this report reflect AADT, which is “the total volume of traffic on a highway segment for 1 year, divided by the number of days in the year,” and incorporates both directions of traffic (FL DOT, 2007). Most AADT counts obtained were based on data from 2002 to 2009. The updated traffic values are presented in Table 4-14. The traffic data presented in Table 4-14 represents the most recently available data applicable to the monitoring site (i.e., if a site stopped sampling in 2008, traffic data from the previous year were retained).

Several limitations exist to obtaining the AADT near each monitoring site. AADT statistics are developed for roadways, such as interstates, state highways, or local roadways, which are managed by different municipalities or government agencies. AADT is not always available in rural areas or for secondary roadways. For monitoring sites located near interstates, the AADT for the interstate segment closest to the site was obtained. For other monitoring sites, the highway or secondary road closest to the monitoring site was used. Only one AADT value was obtained for each monitoring site, which is different from the approach for previous NMP reports. The intersection or roadway chosen for each monitoring site is discussed in each individual state section (Sections 5 through 33).

Table 4-14 shows that ELNJ, SEWA, and SPIL have the highest daily traffic volume of the sites sampling VOC, while UCSD, UNVT, and CUSD have the lowest. For all monitoring sites (not just those sampling VOC), the highest daily traffic volume occurs near ELNJ, CELA, and SEWA. ELNJ is located near Exit 13 on I-95; CELA is located in downtown Los Angeles; and SEWA is located in Seattle near the intersection of I-5 and I-9. ELNJ has the highest traffic volume and the second highest hydrocarbon average (behind ANAK), but SEWA and SPIL, which have the second and third highest traffic volumes, have the 20th and 22nd highest hydrocarbon averages, respectively. CELA did not measure VOC. A Pearson correlation coefficient calculated between the average hydrocarbon calculations and the traffic counts is 0.40. While this correlation is not a “strong” correlation, it does indicate a positive correlation between hydrocarbon concentrations and traffic volumes.

4.3.5 Vehicle Miles Traveled

Another approach to determine how mobile sources affect urban air quality is to review VMT. This approach was not included in NMP reports prior to 2007. VMT is “the sum of distances traveled by all motor vehicles in a specified system of highways for a given period of time” (OR DOT, 2011). Thus, VMT values tend to be rather large (in the millions). County-level data are not available for all states. However, daily VMT data for 2008 are available from the Federal Highway Administration (FHWA) by urban area (FHWA, 2009b). The MSA designations are used to designate in which urban area each monitoring site resides. For example, CAMS 35 is located in Deer Park, Texas. This city is located near Houston and is part of the Houston-Sugarland-Baytown, TX MSA. Therefore, VMT for CAMS 35 is for the value reported for Houston. VMT are presented in Table 4-14, where available.

The urban areas with NMP sites with the highest VMT are New York, Los Angeles, and Chicago. A Pearson correlation coefficient calculated between the average hydrocarbon concentrations and VMT is very weak (0.06), indicating virtually no relationship between the two and is similar to the correlation calculated for the 2007 NMP report. It is important to note that many of the sites with larger VMT did not measure VOC (such as CELA, BXNY, INDEM). In addition, VMT was not available for sites not in "urban areas," as defined by the FHWA. Five sites that measured VOC are not in "urban areas".

4.4 Variability Analysis

This section presents the results of the two variability analyses described in Section 3.4.2.

4.4.1 Coefficient of Variation

Figures 4-1 through 4-21 are graphical displays of site-specific coefficient of variations (standard deviation vs. average concentration) for the program-level pollutants of interest. The figures show that several of the pollutants appear to exhibit the "clustering" discussed in Section 3.4.2. Formaldehyde appears to exhibit clustering in Figure 4-13; however, the data point representing INDEM's 2008 average and standard deviation are significantly higher than the others. If this data point was removed and the scales adjusted, the formaldehyde concentrations would show more variability. The same is true for naphthalene in Figure 4-17 and trichloroethylene in Figure 4-20. These examples demonstrate that the range of concentrations must be considered when interpreting the graphs.

Figure 4-9 for carbon tetrachloride exhibits clustering, or uniformity in concentrations. Carbon tetrachloride is a pollutant that was used worldwide as a refrigerant. However, it was identified as an ozone-depleting substance in the stratosphere and its use was banned at the Kyoto Protocol. This pollutant has a long lifetime in the atmosphere, but slowly degrades over time. Since being banned, its concentration in ambient air is fairly ubiquitous regardless of where it is measured. The compressed range of associated coefficients of variations shown in

Figure 4-9 not only supports this expected uniformity (i.e., lack of variability) in “background” concentrations of carbon tetrachloride, but is also a testament to the representativeness of the data generated under the NMP.

Although many of the other pollutants do not exhibit easily classifiable clustering, or even appear to follow a linear pattern, many of them are thrown off by one or two data points that do not fall in line with the others. For example, the larger standard deviations exhibited for *p*-dichlorobenzene in Figure 4-11 indicate that these averages were influenced by outliers. Excluding some of these data points would likely allow the rest to follow a more linear trend line. Vinyl chloride in Figure 4-21 is another example. Measurements of vinyl chloride are generally low and yield relatively low averages and standard deviations. For several sites, only one measured detection was reported over the entire 2-year period, as shown by those data points with a zero standard deviation. For other sites, outliers resulted in relatively large standard deviations.

Figure 4-1. Coefficient of Variation Analysis of Acetaldehyde Across 46 Sites

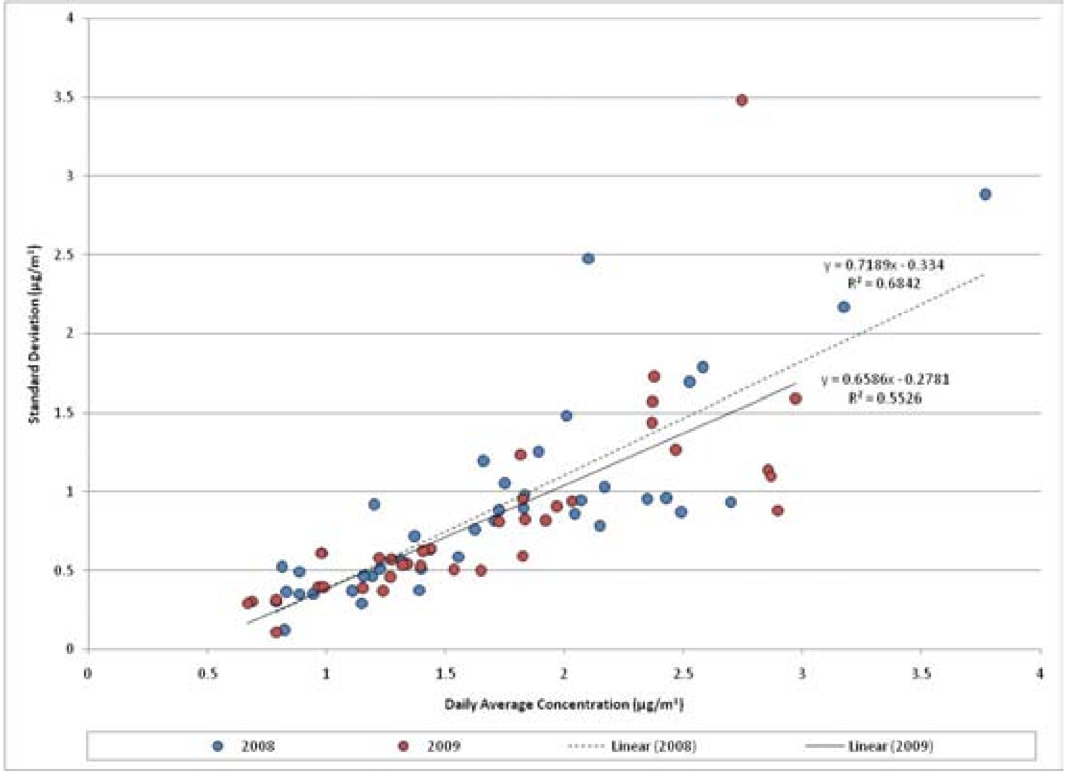


Figure 4-2. Coefficient of Variation Analysis of Acrylonitrile Across 37 Sites

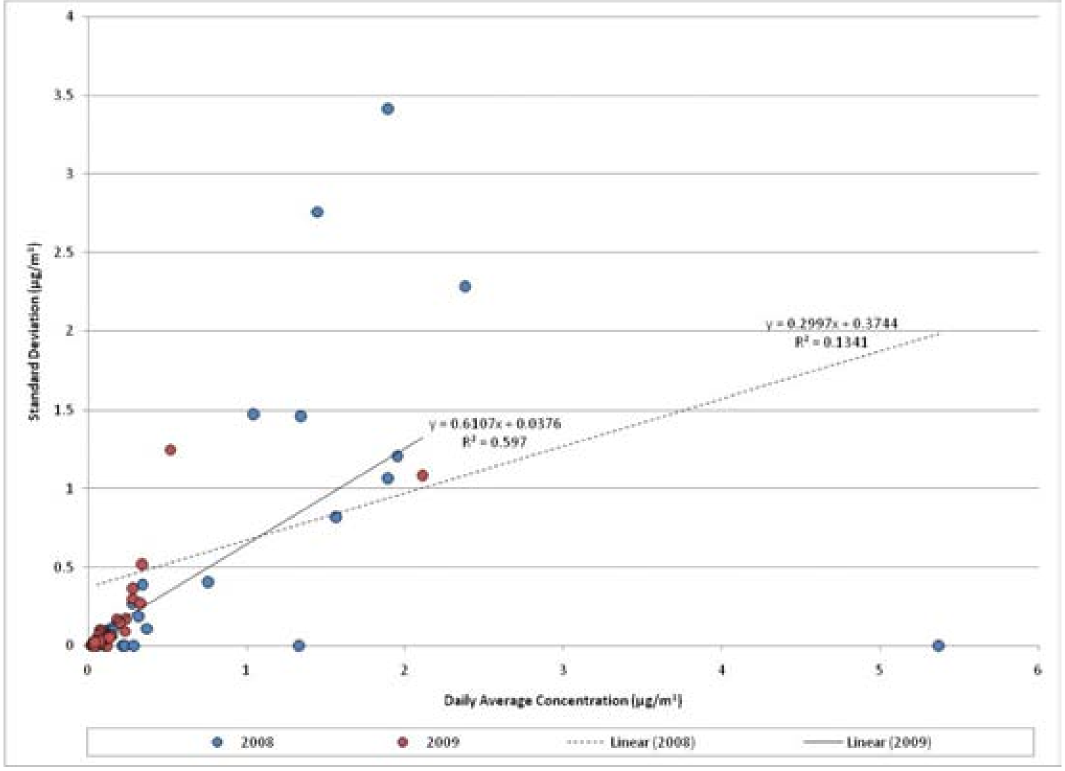


Figure 4-3a. Coefficient of Variation Analysis of Arsenic (PM_{10}) Across 11 Sites

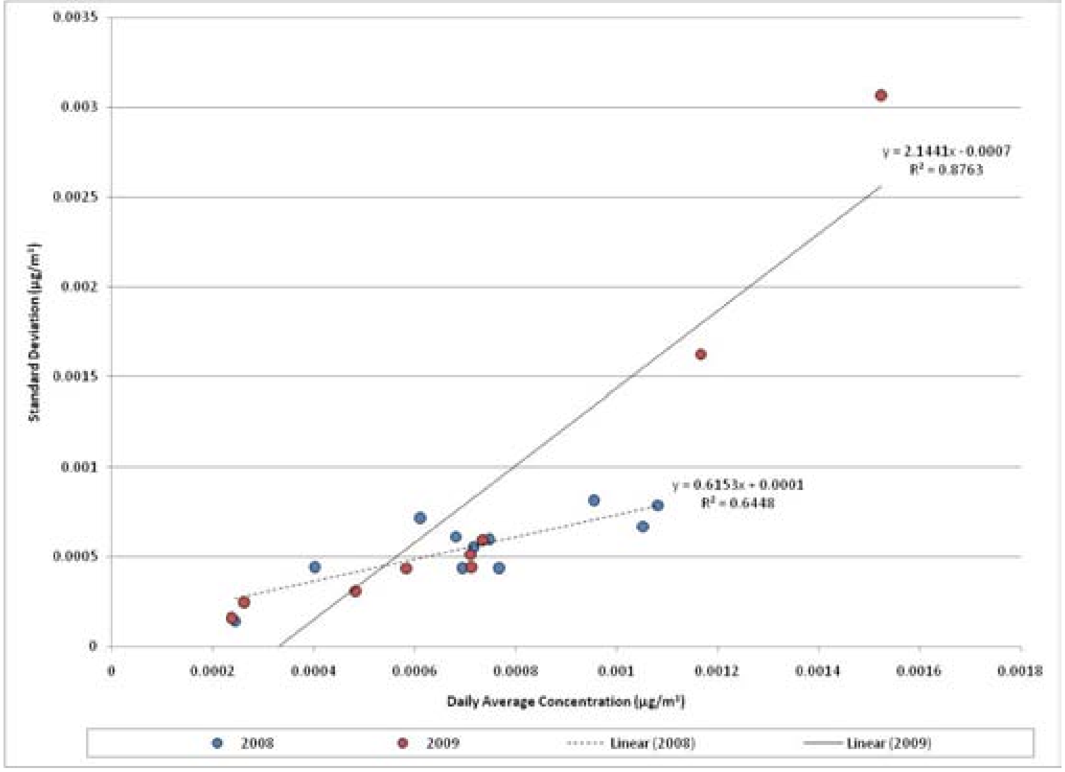


Figure 4-3b. Coefficient of Variation Analysis of Arsenic (TSP) Across 8 Sites

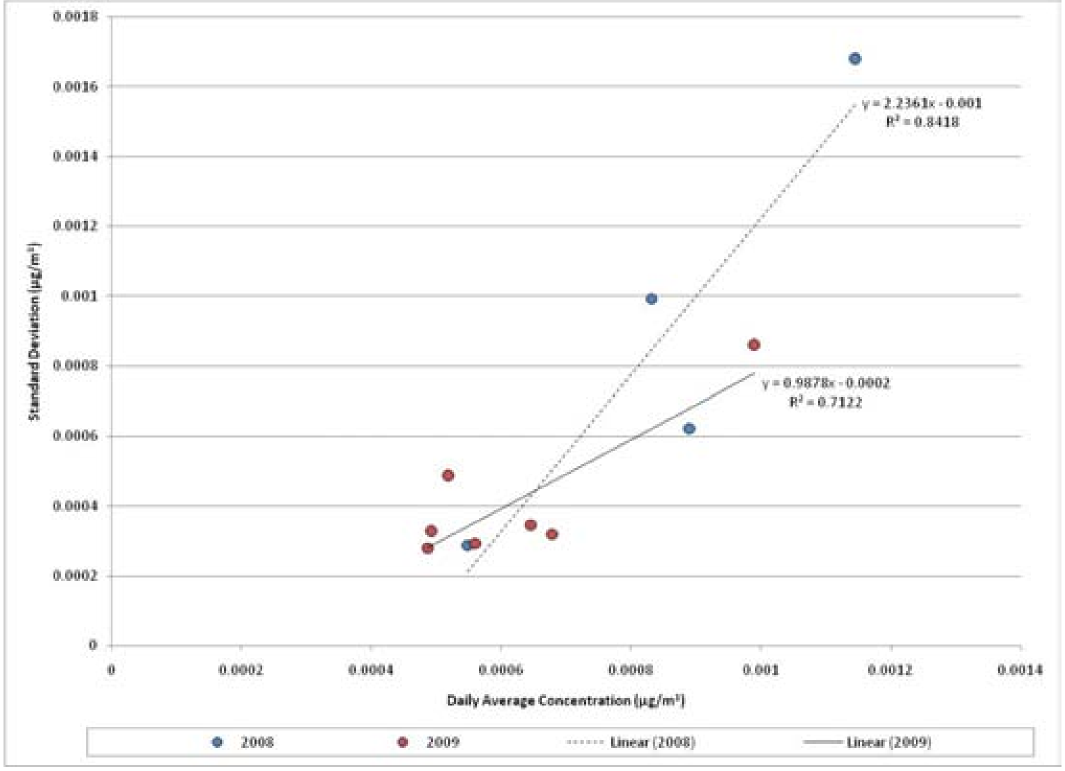


Figure 4-4. Coefficient of Variation Analysis of Benzene Across 44 Sites

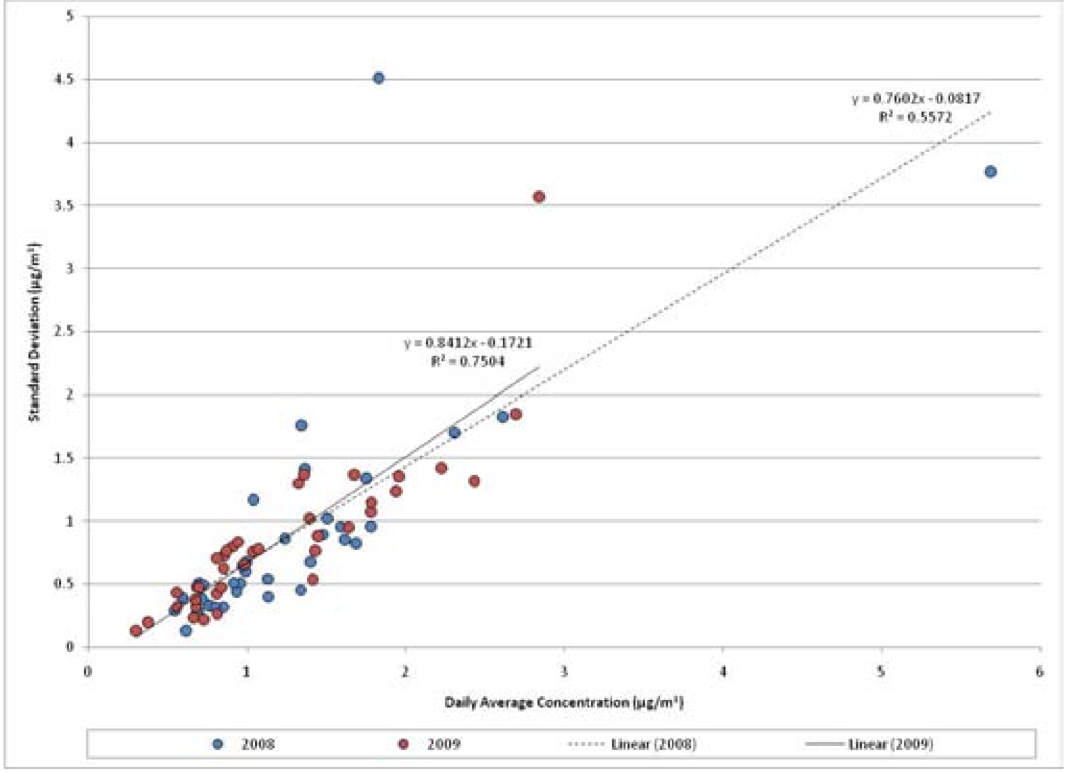


Figure 4-5. Coefficient of Variation Analysis of Benzo(a)pyrene Across 32 Sites

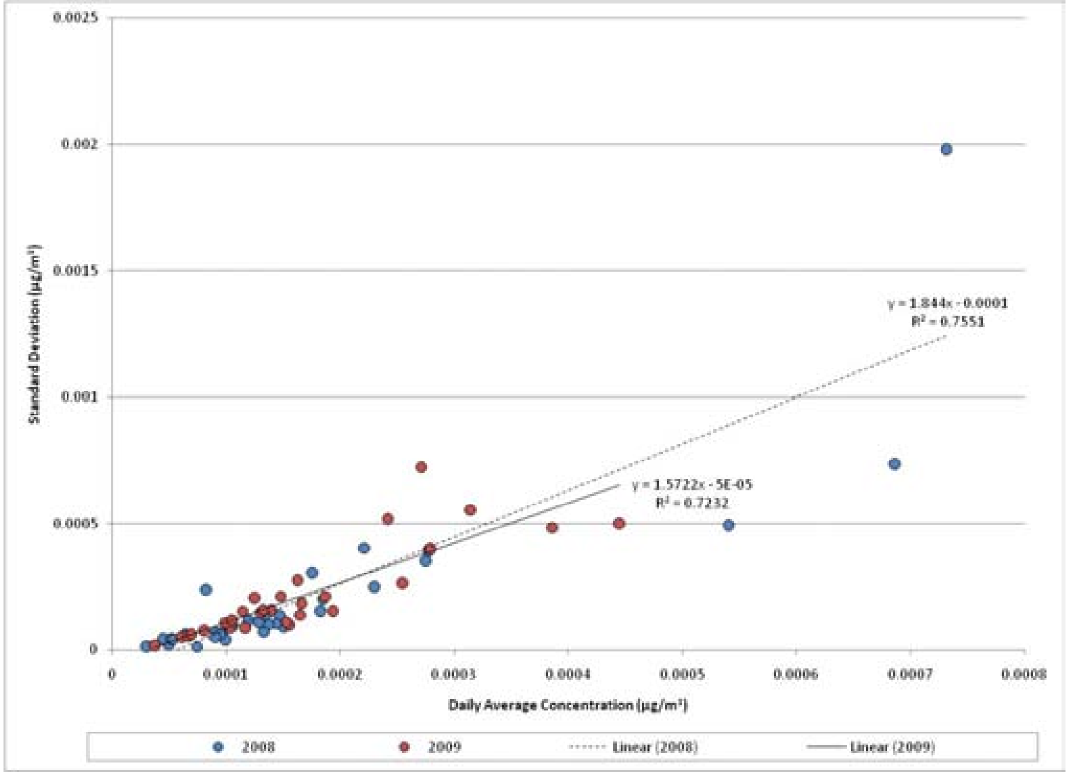


Figure 4-6a. Coefficient of Variation Analysis of Beryllium (PM_{10}) Across 11 Sites

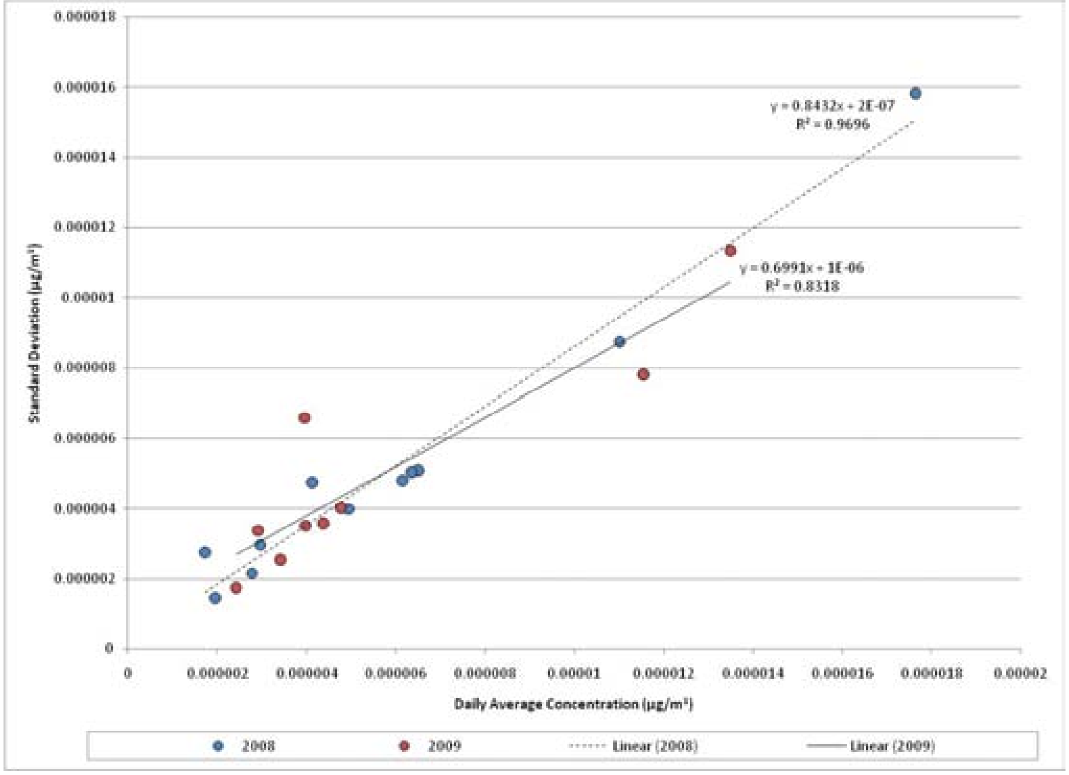


Figure 4-6b. Coefficient of Variation Analysis of Beryllium (TSP) Across 8 Sites

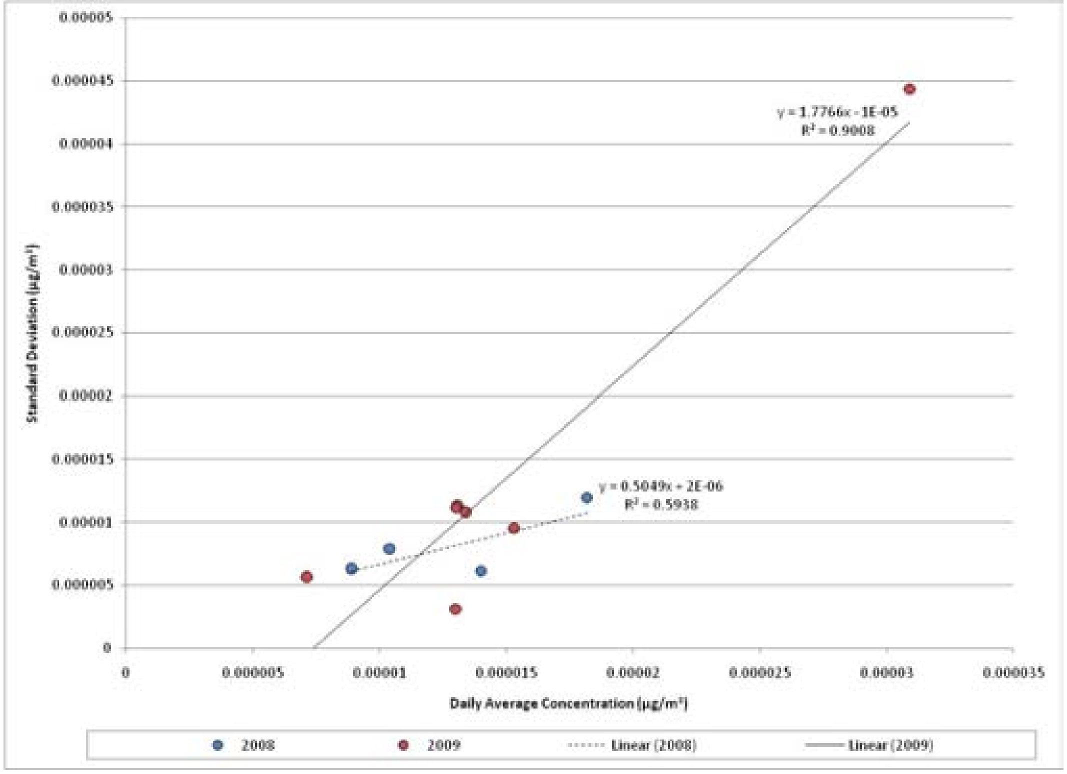


Figure 4-7. Coefficient of Variation Analysis of 1,3-Butadiene Across 44 Sites

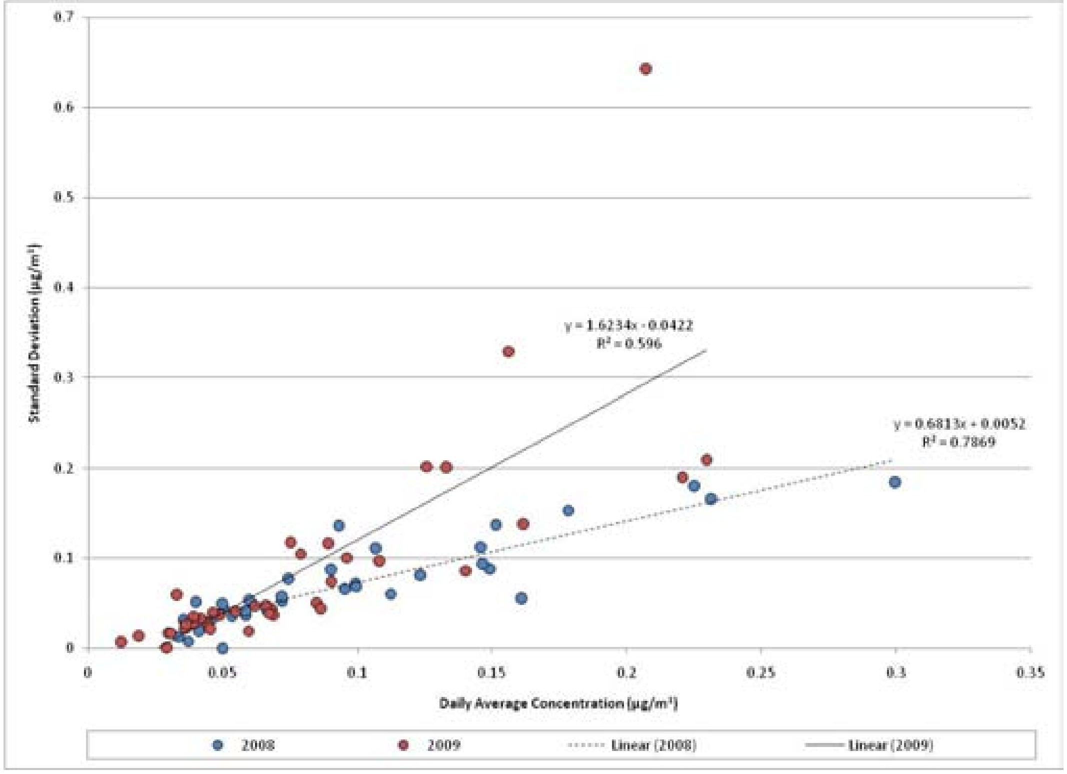


Figure 4-8a. Coefficient of Variation Analysis of Cadmium (PM_{10}) Across 11 Sites

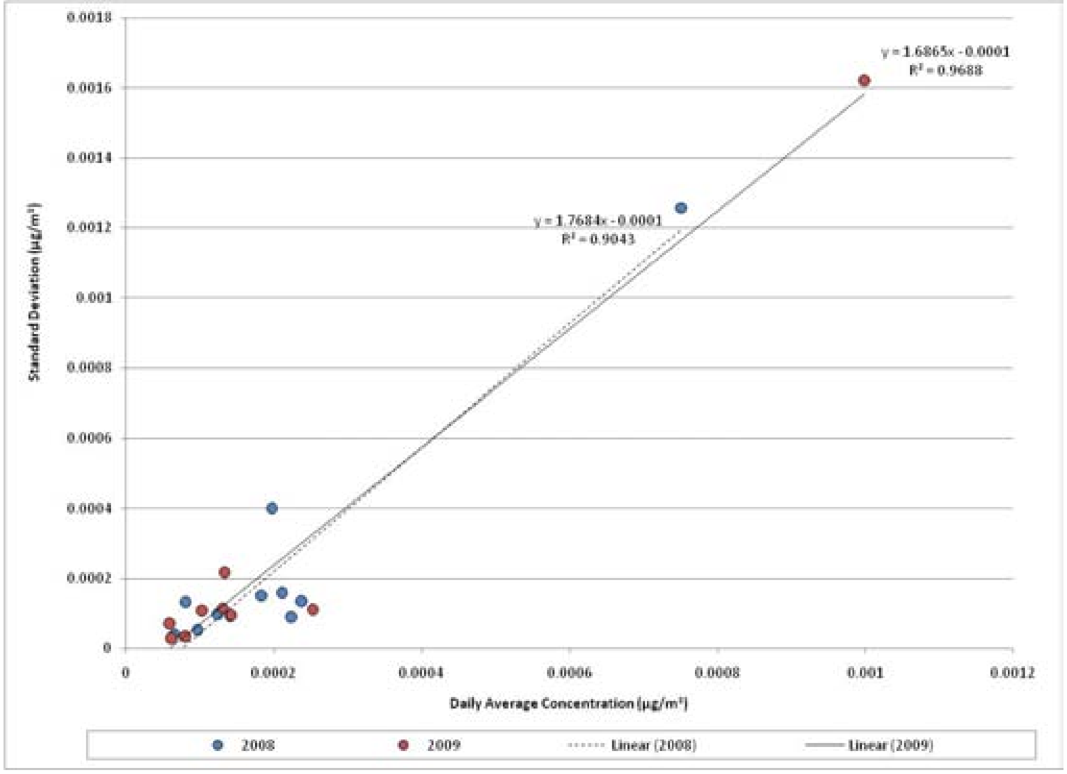


Figure 4-8b. Coefficient of Variation Analysis of Cadmium (TSP) Across 8 Sites

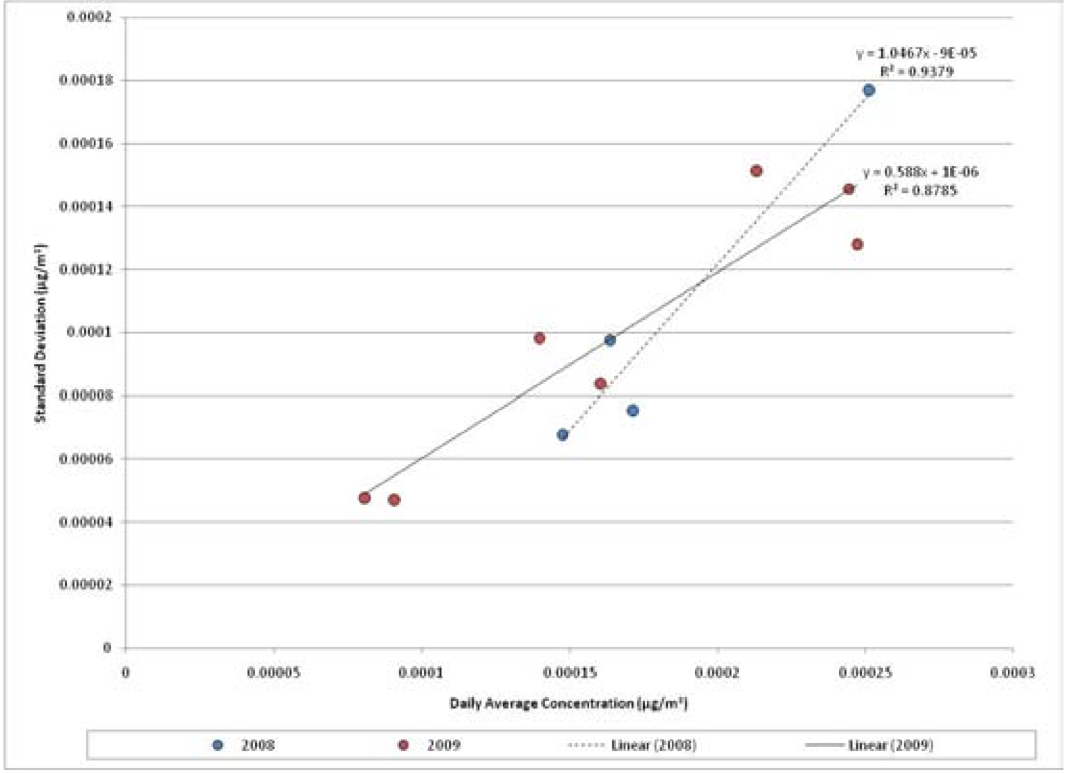


Figure 4-9. Coefficient of Variation Analysis of Carbon Tetrachloride Across 39 Sites

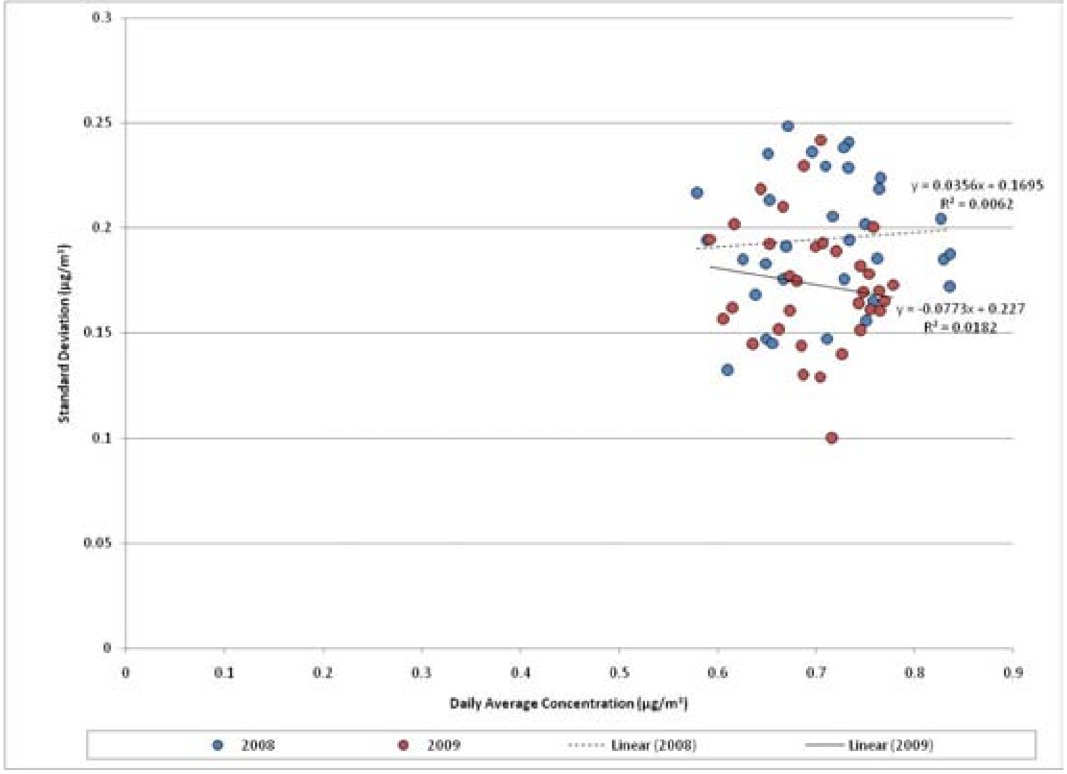


Figure 4-10. Coefficient of Variation Analysis of Chloroform Across 38 Sites

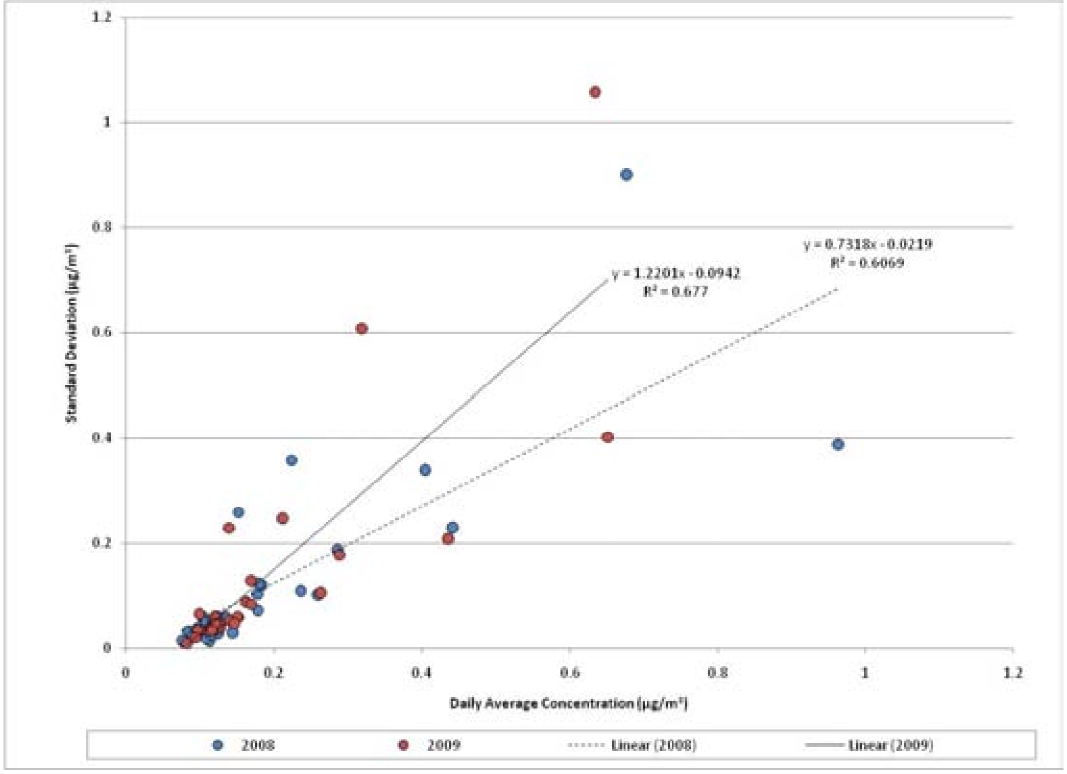


Figure 4-11. Coefficient of Variation Analysis of *p*-Dichlorobenzene Across 39 Sites

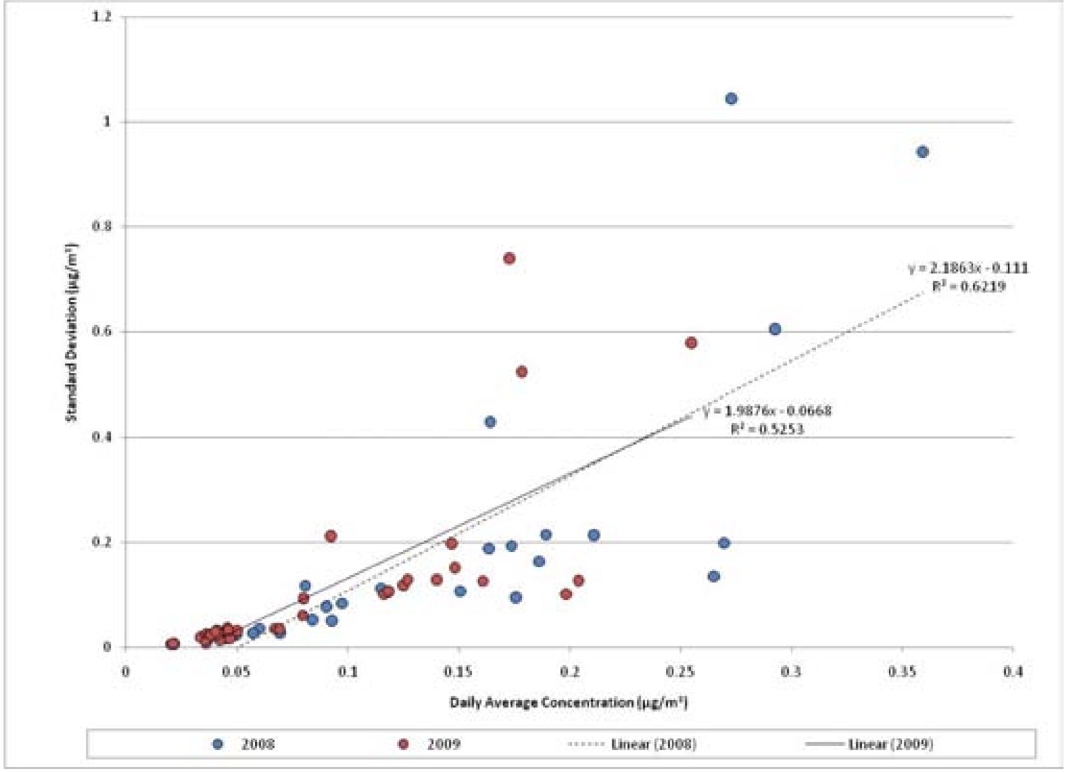


Figure 4-12. Coefficient of Variation Analysis of Ethylbenzene Across 44 Sites

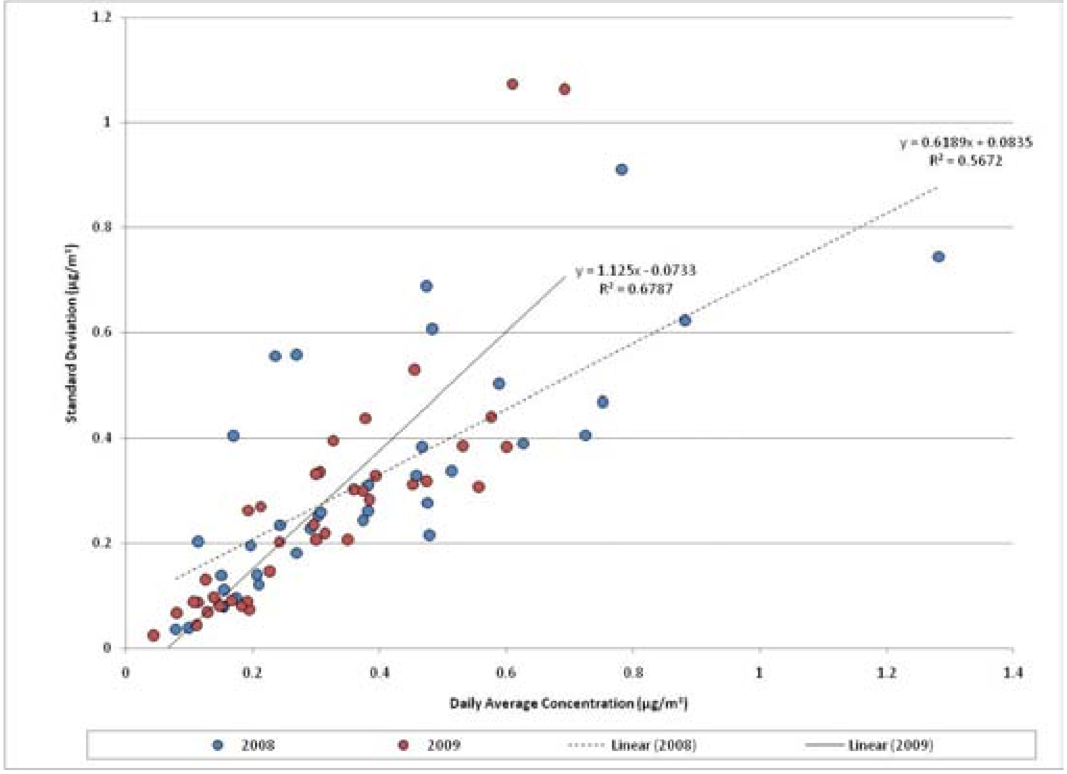


Figure 4-13. Coefficient of Variation Analysis of Formaldehyde Across 46 Sites

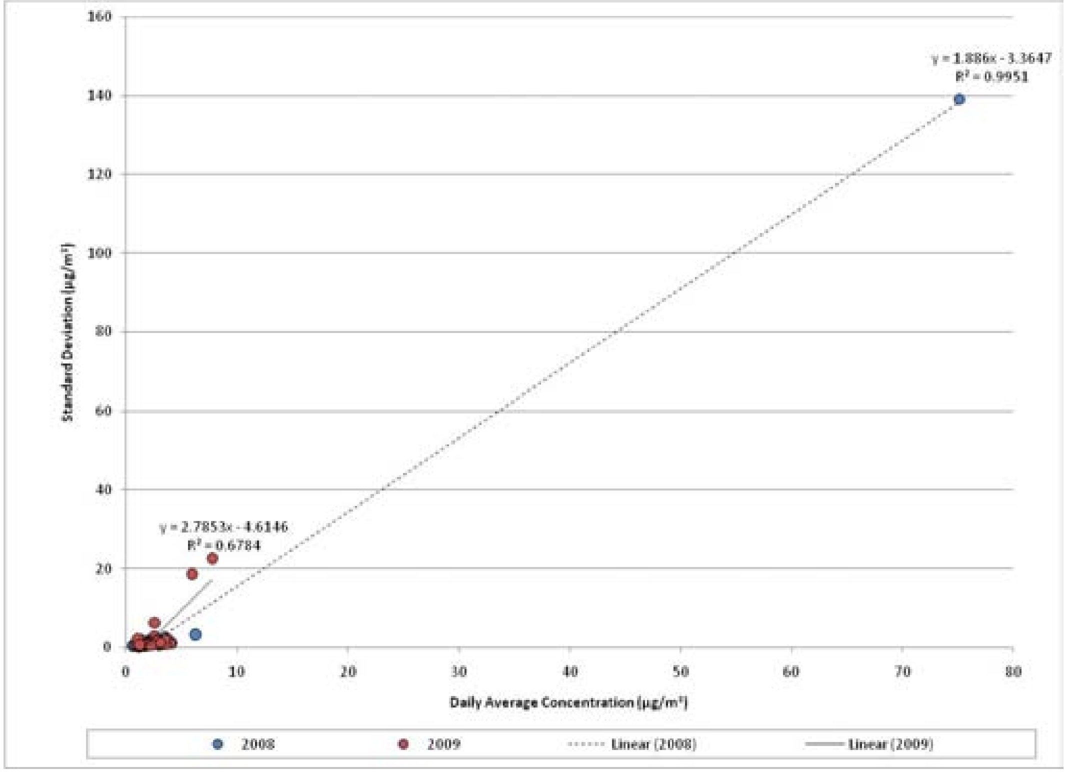


Figure 4-14. Coefficient of Variation Analysis of Hexavalent Chromium Across 21 Sites

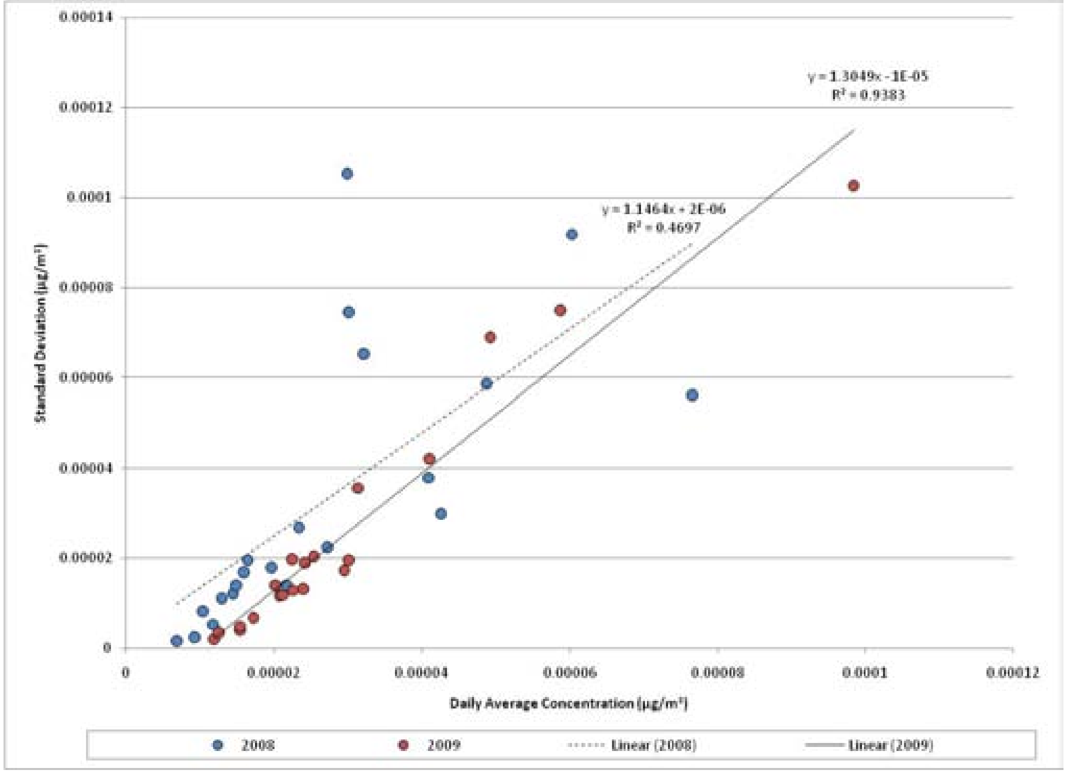


Figure 4-15a. Coefficient of Variation Analysis of Lead (PM_{10}) Across 11 Sites

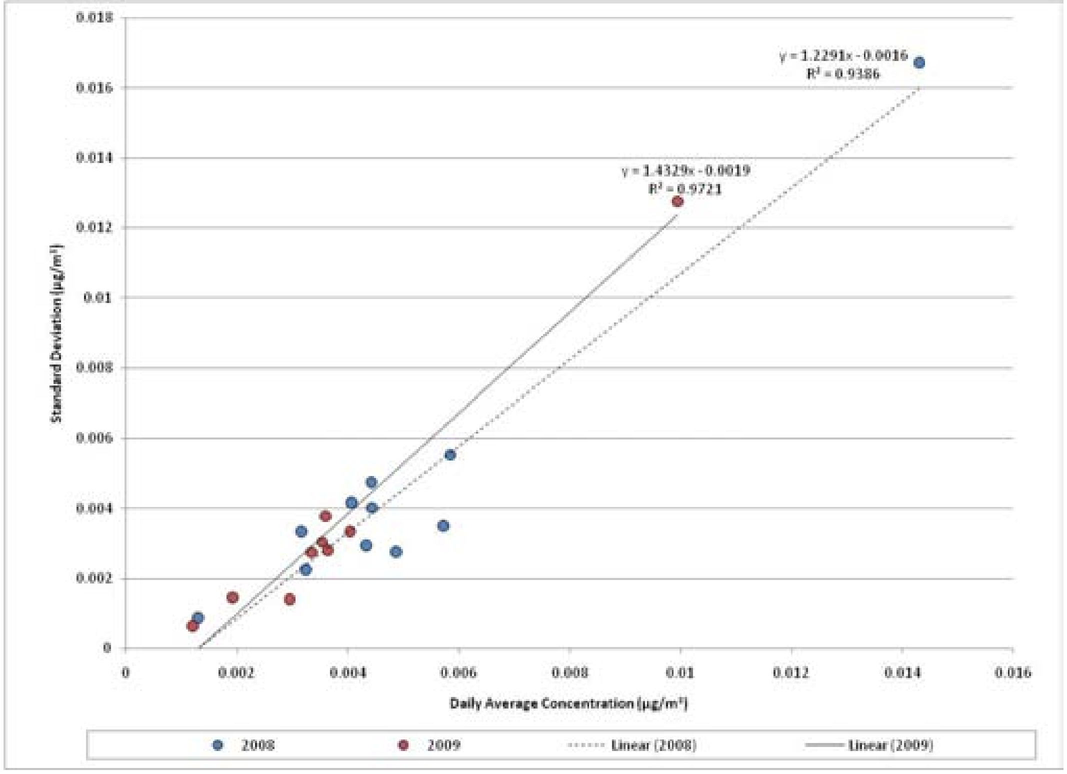


Figure 4-15b. Coefficient of Variation Analysis of Lead (TSP) Across 8 Sites

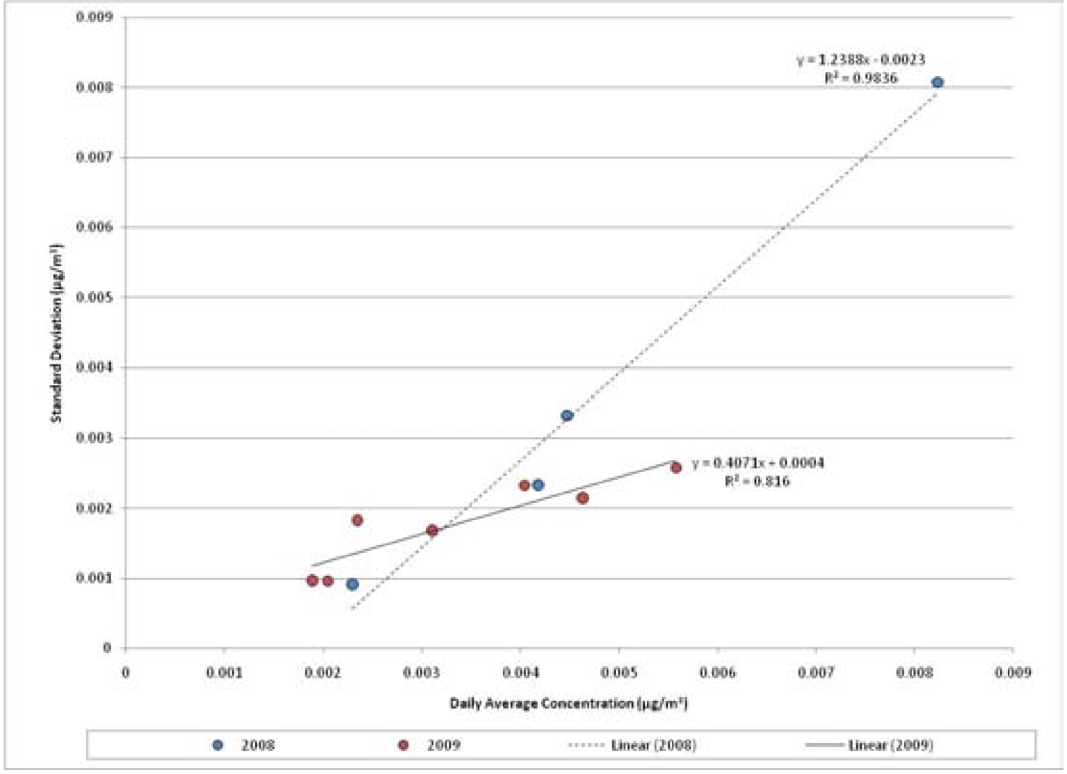


Figure 4-16a. Coefficient of Variation Analysis of Manganese (PM_{10}) Across 11 Sites

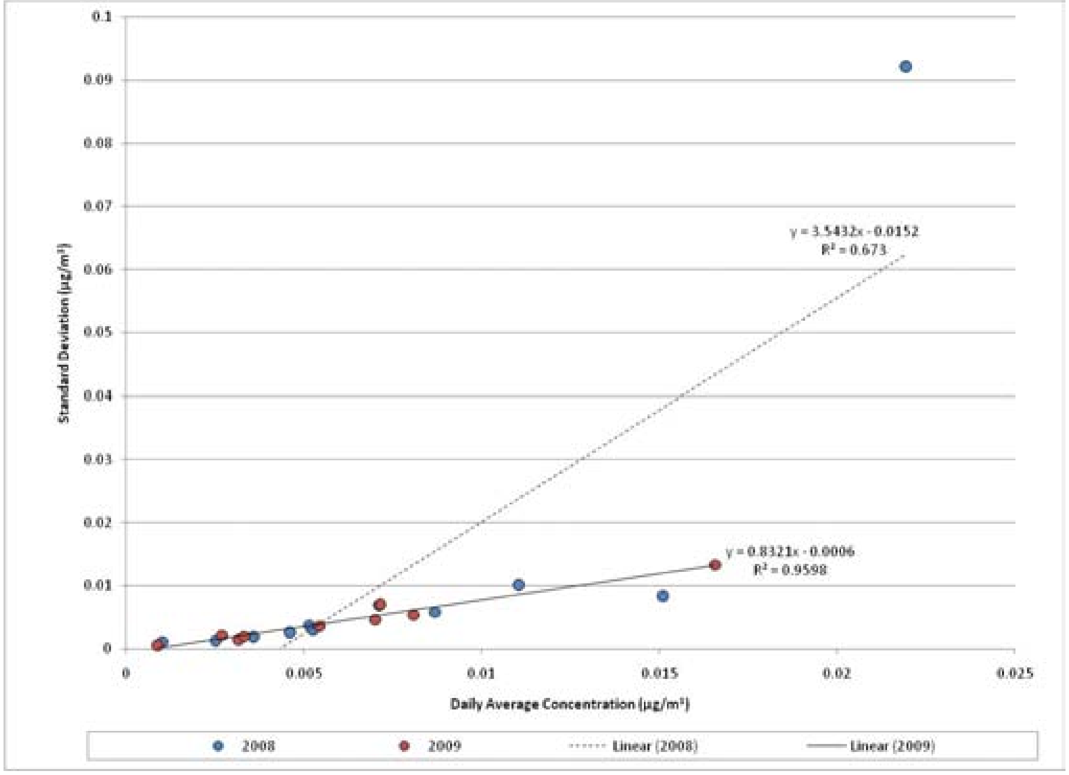


Figure 4-16b. Coefficient of Variation Analysis of Manganese (TSP) Across 8 Sites

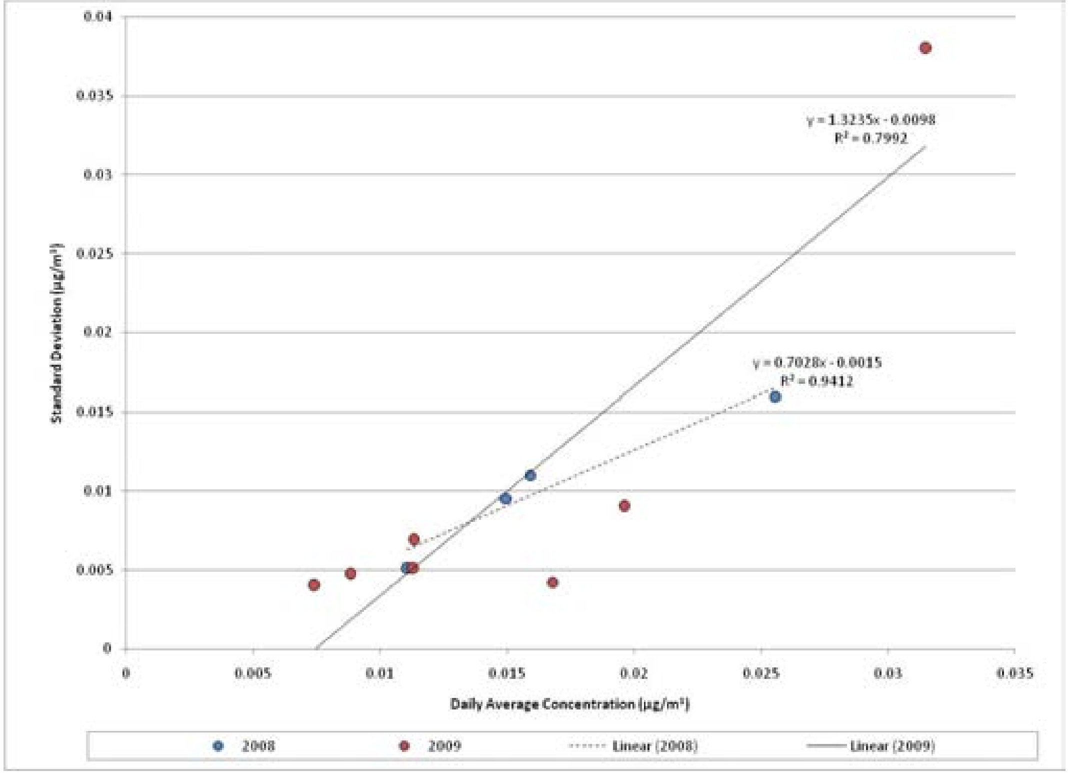


Figure 4-17. Coefficient of Variation Analysis of Naphthalene Across 32 Sites

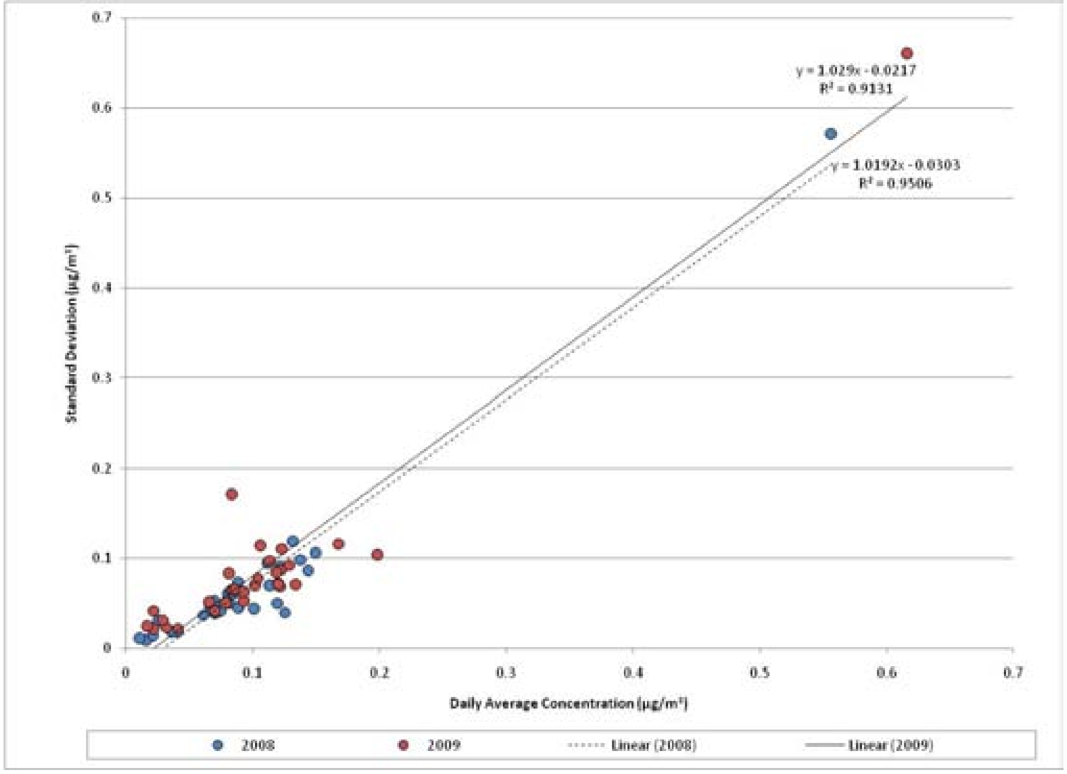


Figure 4-18a. Coefficient of Variation Analysis of Nickel (PM_{10}) Across 11 Sites

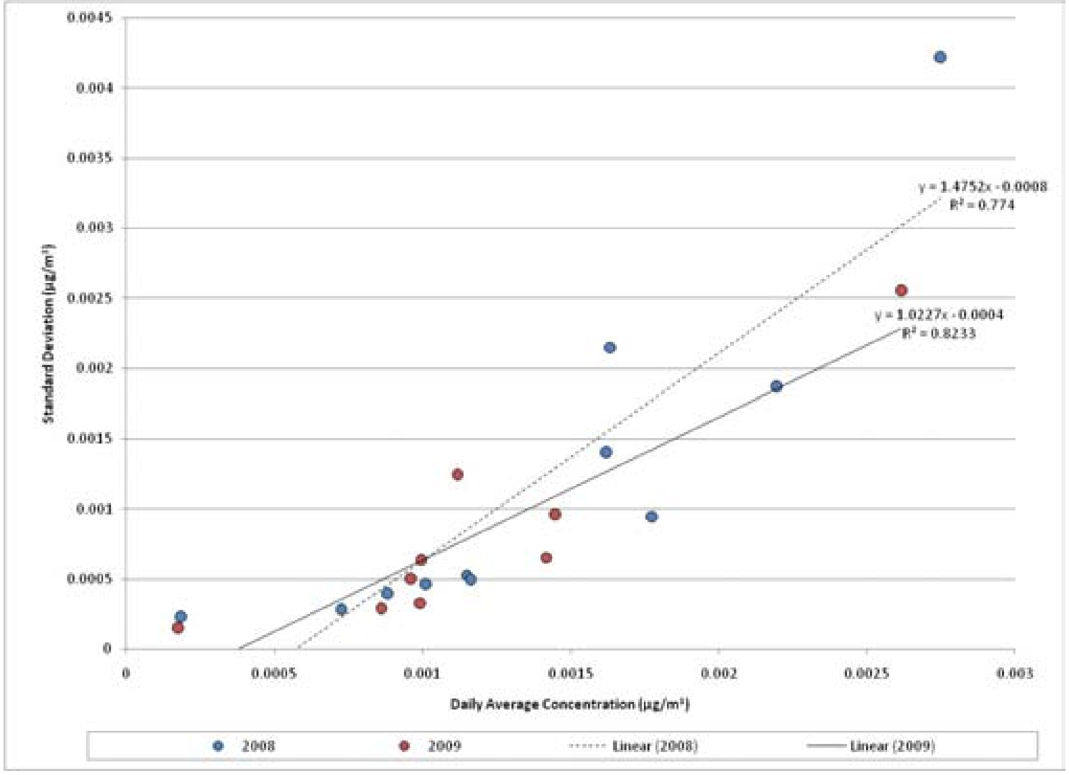


Figure 4-18b. Coefficient of Variation Analysis of Nickel (TSP) Across 8 Sites

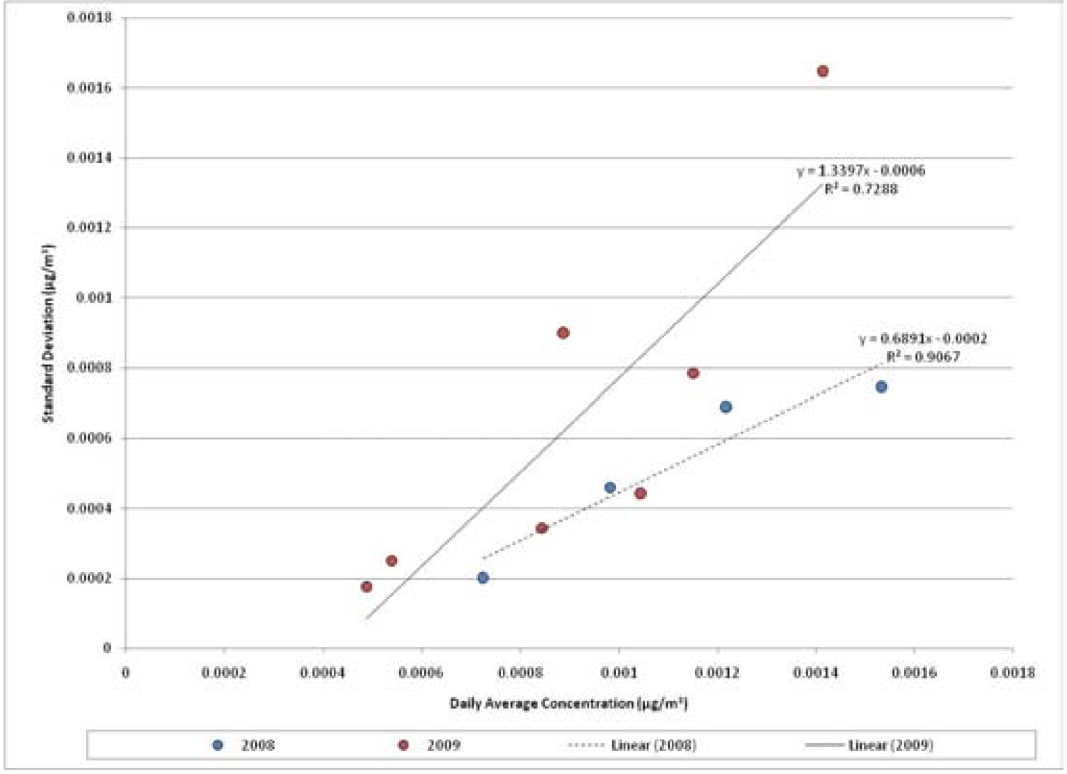


Figure 4-19. Coefficient of Variation Analysis of Tetrachloroethylene Across 39 Sites

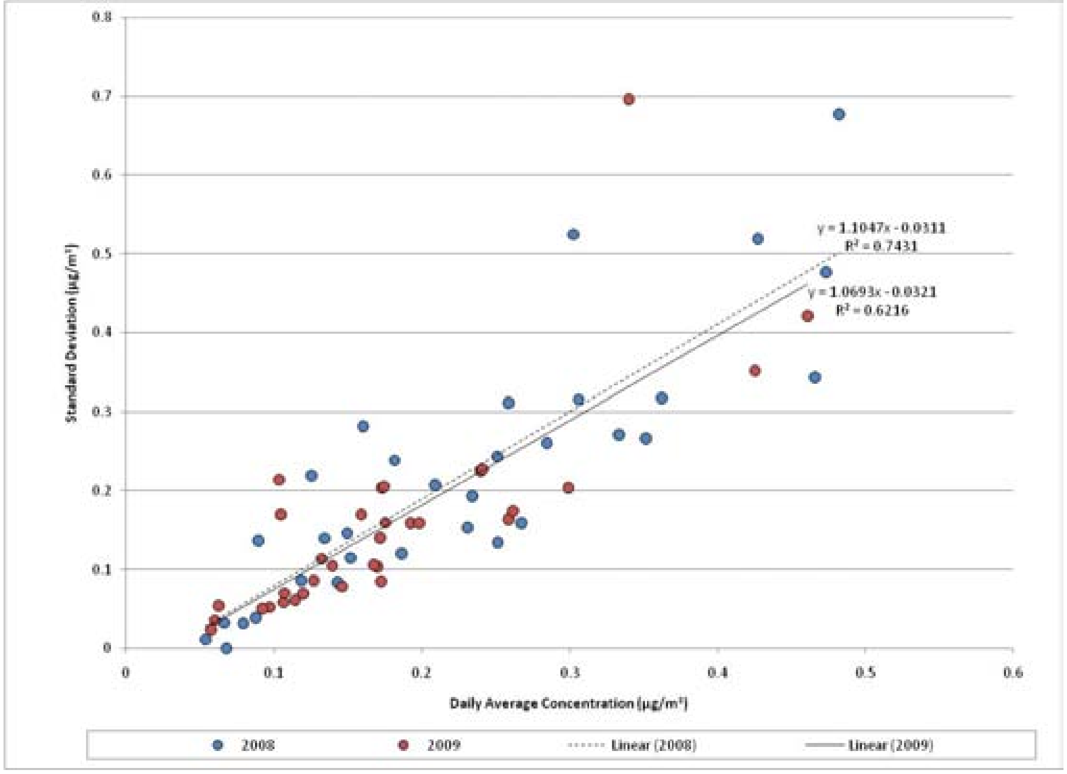


Figure 4-20. Coefficient of Variation Analysis of Trichloroethylene Across 36 Sites

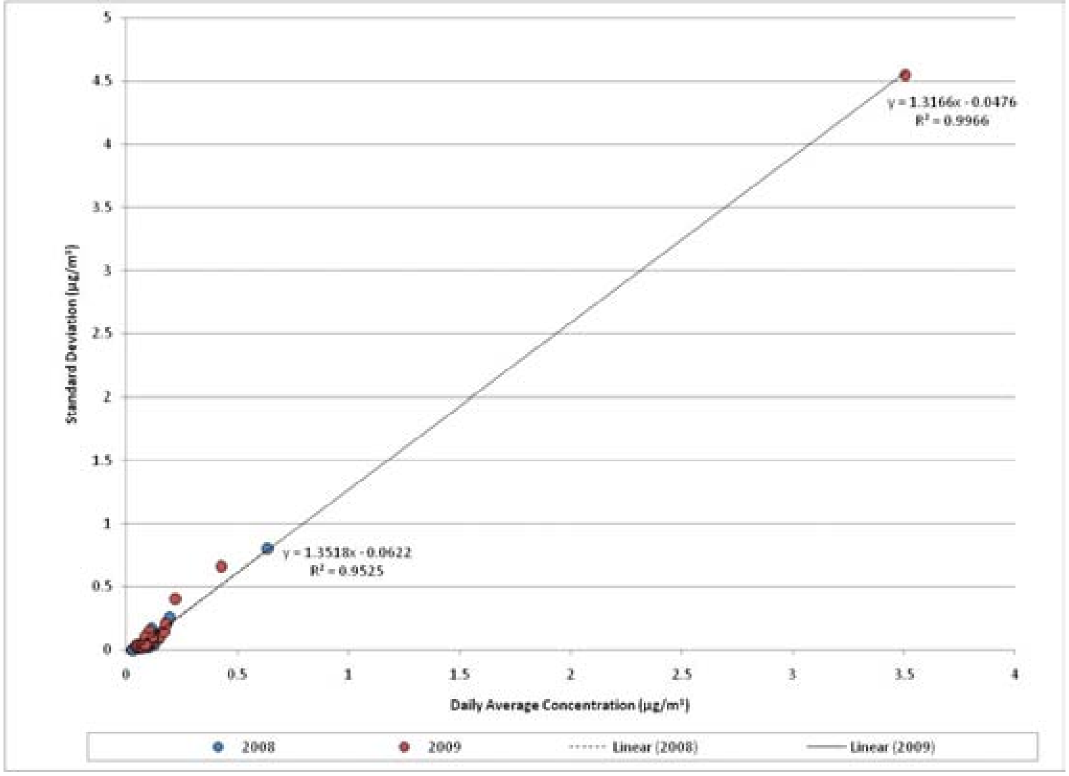
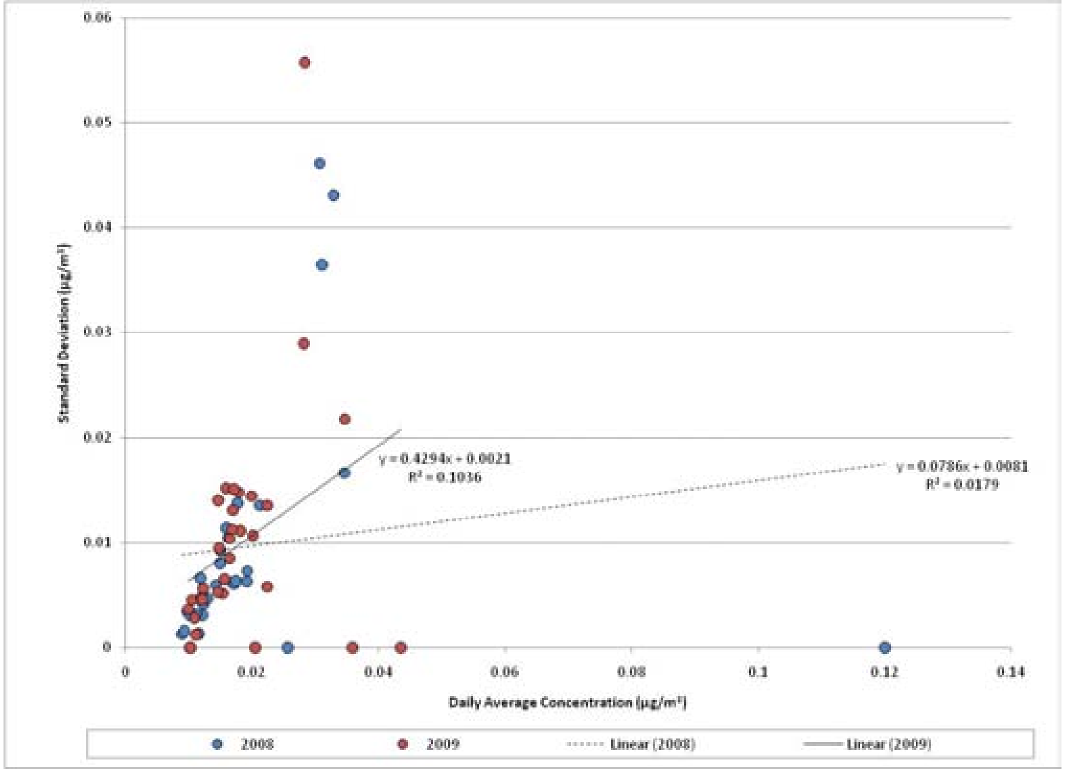


Figure 4-21. Coefficient of Variation Analysis of Vinyl Chloride Across 38 Sites



4.4.2 Quarterly Variability Analysis

Figures 4-22 through 4-42 provide a graphical display of the average concentrations by quarter and year for the program-level pollutants of interest. Quarterly averages are calculated based on criteria specified in Section 3.1.1. If the pollutant of interest has a corresponding ATSDR Intermediate MRL, as defined in Section 3.3, then this value is indicated on the graph and is plotted where applicable.

Gaps in the figures for the pollutants of interest can be attributed to two reasons. First, some of the program-wide pollutants of interest were measured frequently in some quarters but not in others and, as a result of the quarterly average criteria, do not have quarterly averages shown. One of the most apparent examples of this is Figure 4-23 for acrylonitrile. This pollutant was not frequently detected, thus few quarterly averages appear in Figure 4-23. (Although this pollutant was detected in only 20 percent of VOC samples collected, its risk screening value is relatively low; thus all but two of the 527 measured detections of this pollutant failed screens.) Another reason is due to the sampling duration of each site. Many sites started late or ended early, which also results in a lack of valid quarterly averages. For example, benzene is almost always detected in VOC samples, thus the gaps in Figure 4-25 are primarily due to sampling duration. Both examples can be shown in Figure 4-32 for *p*-dichlorobenzene. For example, CCFL started sampling in July 2008 and ended in March 2009; thus, quarterly averages could be calculated for only the third and fourth quarters of 2008 and the first quarter of 2009. Conversely, SSSD sampled continuously in both years but detected this pollutant enough to meet the quarterly average criteria for only three out of eight quarters. As such, both the start and stop dates of each site and the quarterly average criteria must be considered when interpreting the quarterly average concentration graphs.

Some pollutants of interest, such as arsenic, formaldehyde, benzene, and acetaldehyde, were detected year-round. Comparing the quarterly averages for the sites with four valid quarterly averages in a year may reveal a trend for these pollutants. For example, formaldehyde averages tended to be highest in the third quarter, as shown in Figure 4-34, followed by second quarter, both of which contain warmer months of the year. Conversely, benzene averages tended to be higher during the first quarter followed by the fourth quarter, or the colder months, as shown in Figure 4-25. The seasonal behavior of benzene and formaldehyde suggests the influence of reformulated gasoline (RFG), as the benzene content is typically lowered during warmer periods (i.e., summer and spring). Refineries typically begin production of RFG during the spring and end in the autumn. Additionally, methyl *tert*-butyl ether (MTBE) is often used as an RFG additive in fuels to replace the lowered benzene content. Research has shown that the combustion of fuels containing MTBE leads to the secondary production of formaldehyde. Thus, while benzene concentrations decrease during the summer months, formaldehyde concentrations may increase if MTBE is used in the gasoline blend. Other pollutants may not exhibit such a trend.

Figure 4-22. Comparison of Average Quarterly Acetaldehyde Concentrations

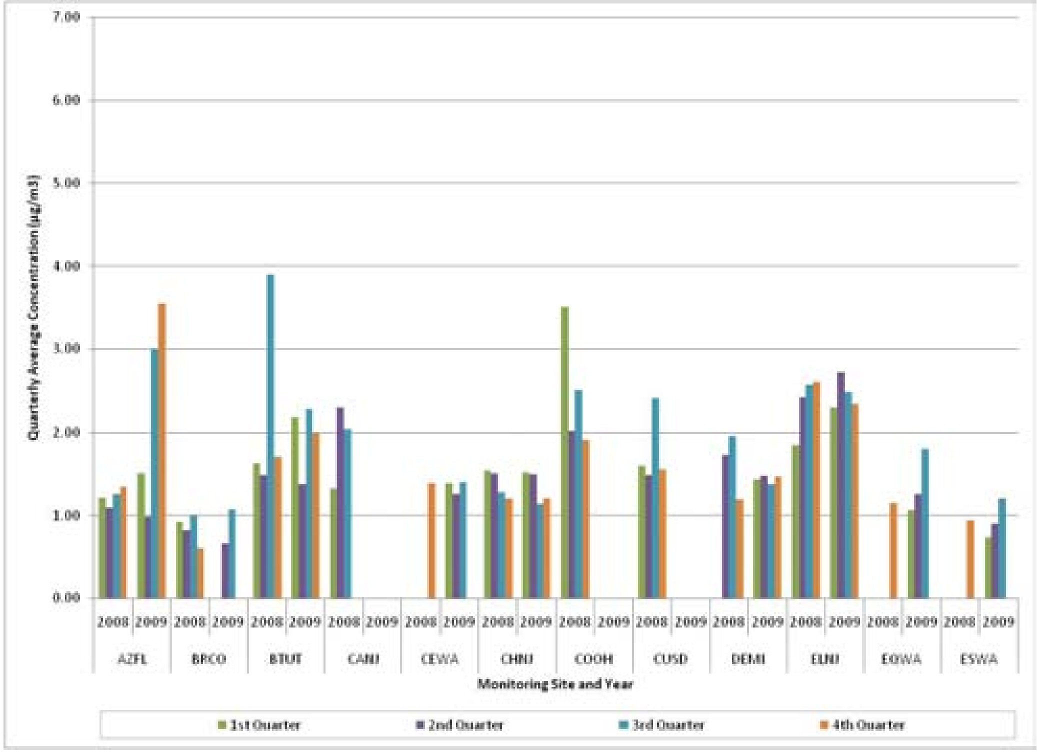


Figure 4-22. Comparison of Average Quarterly Acetaldehyde Concentrations (Continued)

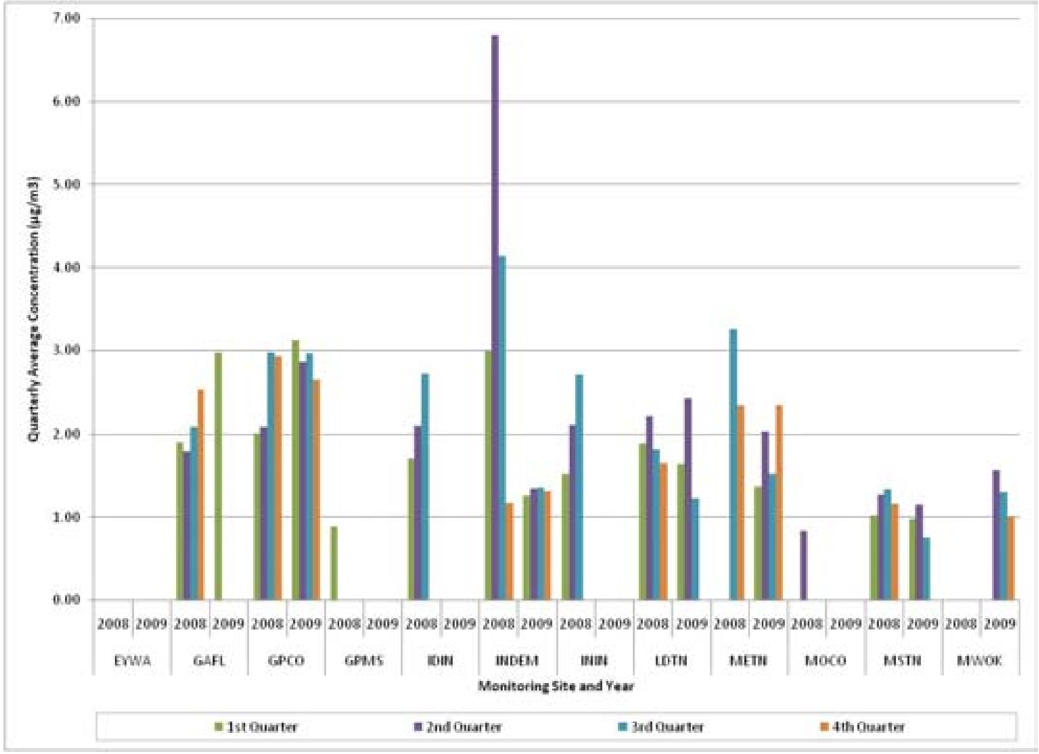


Figure 4-22. Comparison of Average Quarterly Acetaldehyde Concentrations (Continued)

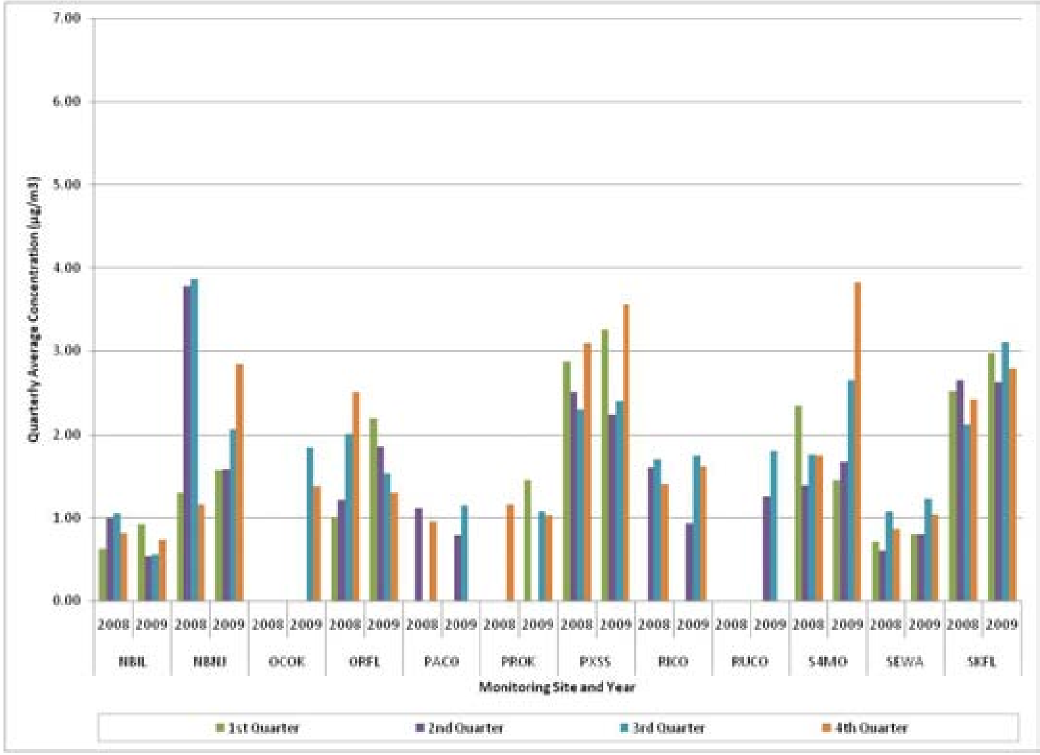


Figure 4-22. Comparison of Average Quarterly Acetaldehyde Concentrations (Continued)

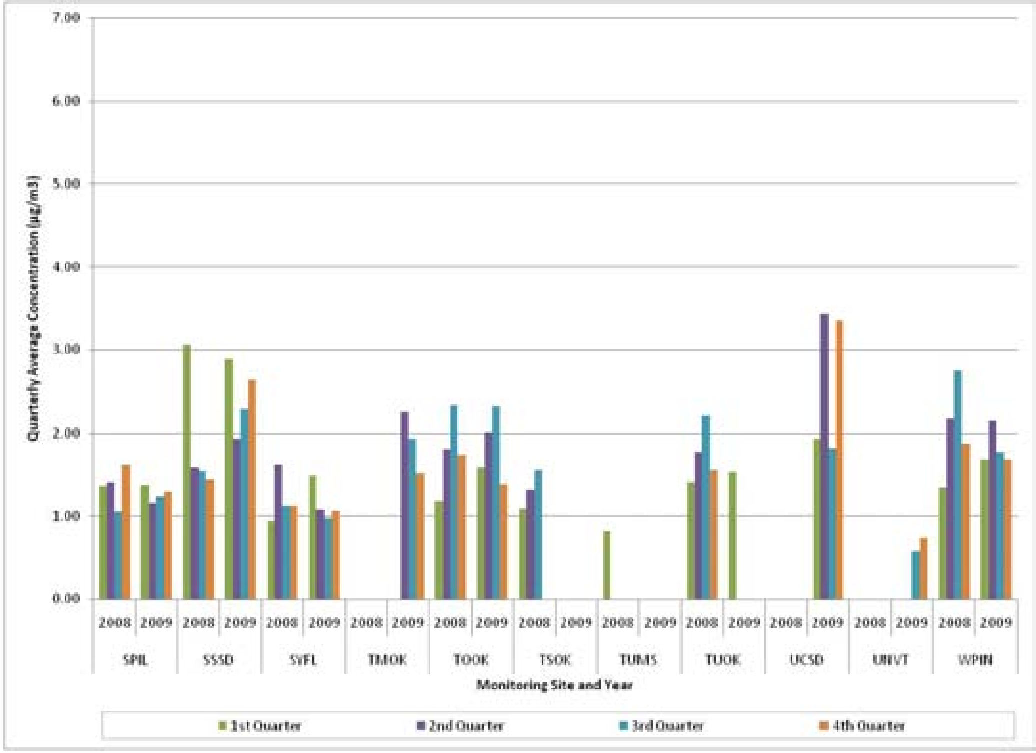


Figure 4-23. Comparison of Average Quarterly Acrylonitrile Concentrations

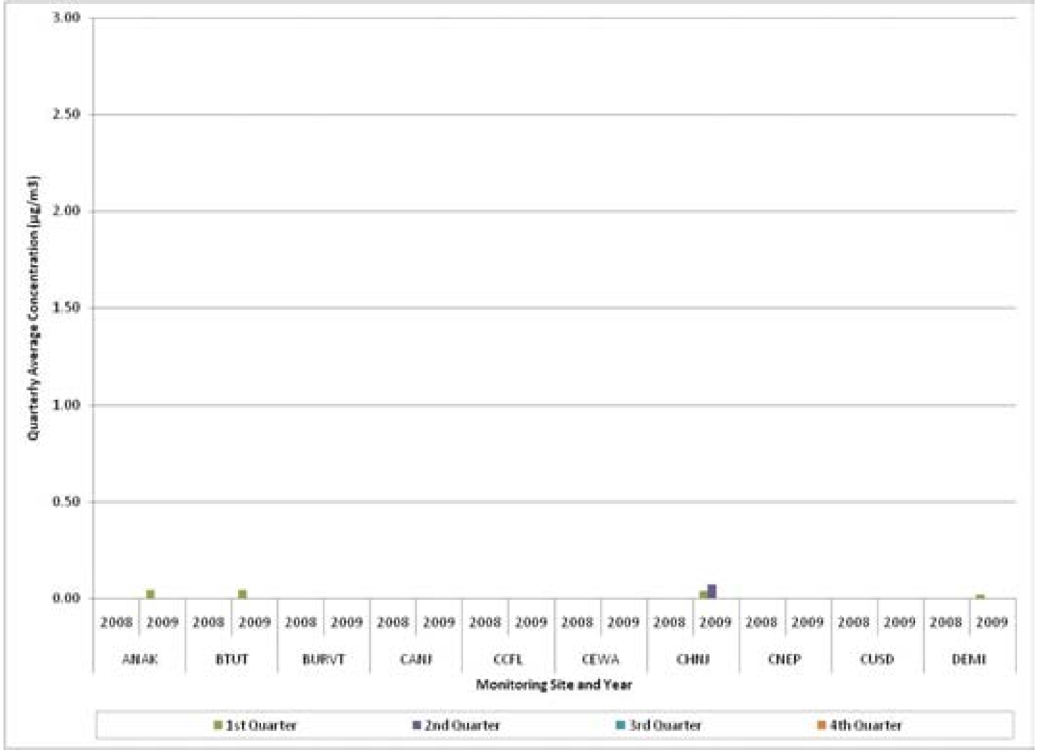


Figure 4-23. Comparison of Average Quarterly Acrylonitrile Concentrations (Continued)

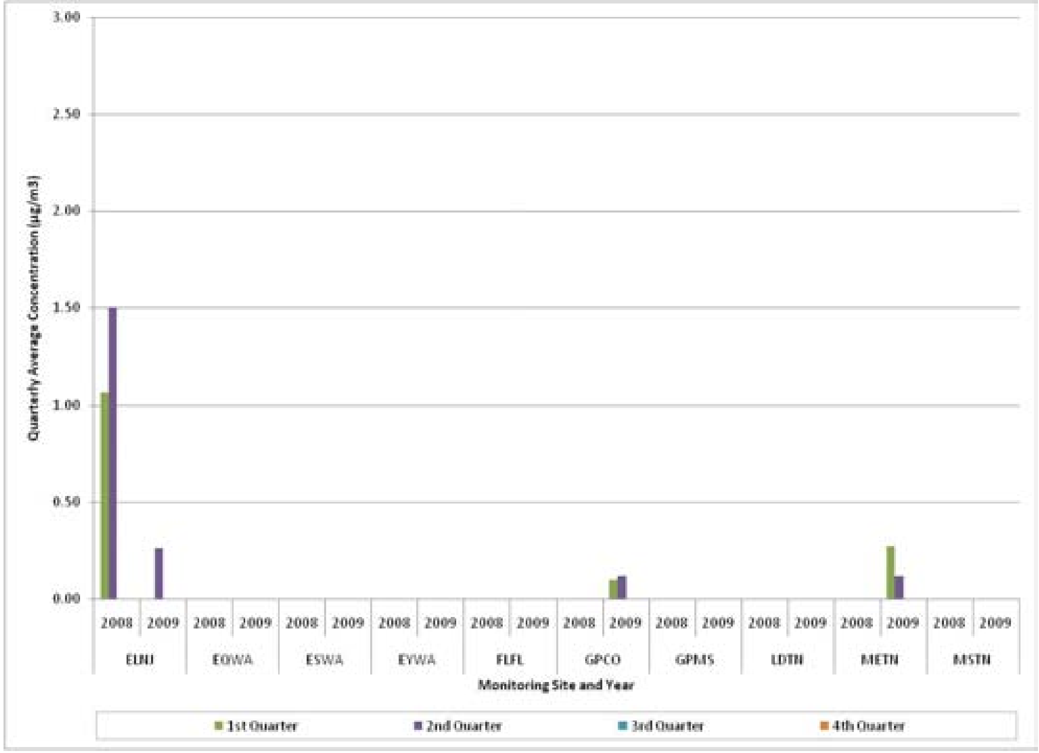


Figure 4-23. Comparison of Average Quarterly Acrylonitrile Concentrations (Continued)

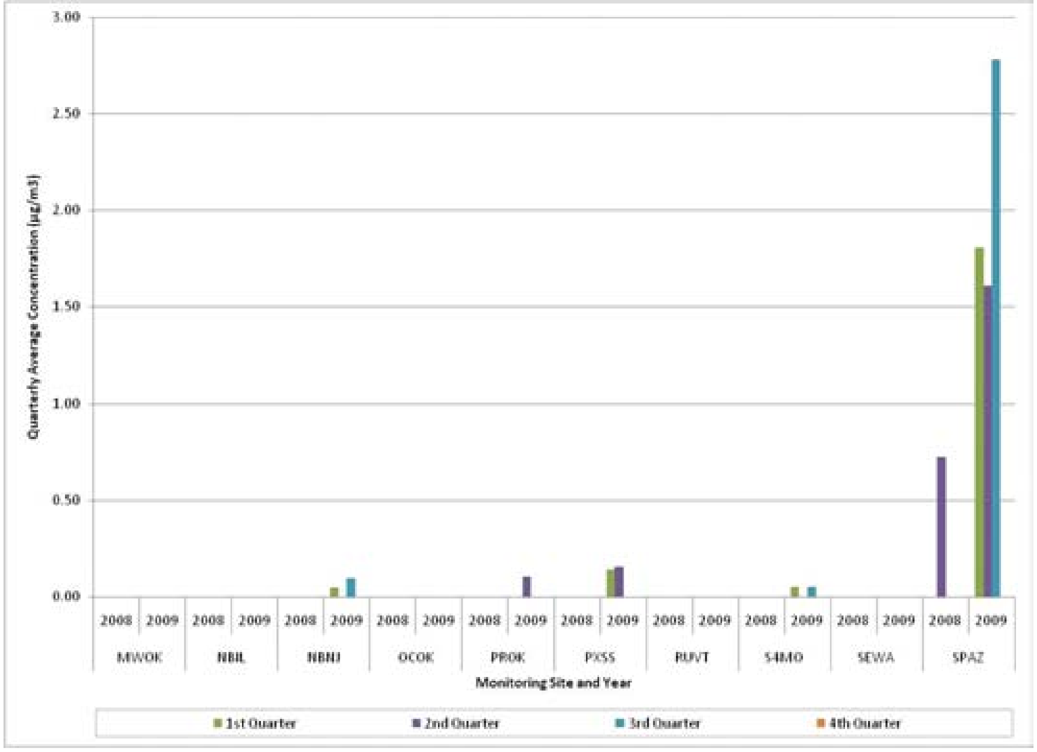


Figure 4-23. Comparison of Average Quarterly Acrylonitrile Concentrations (Continued)

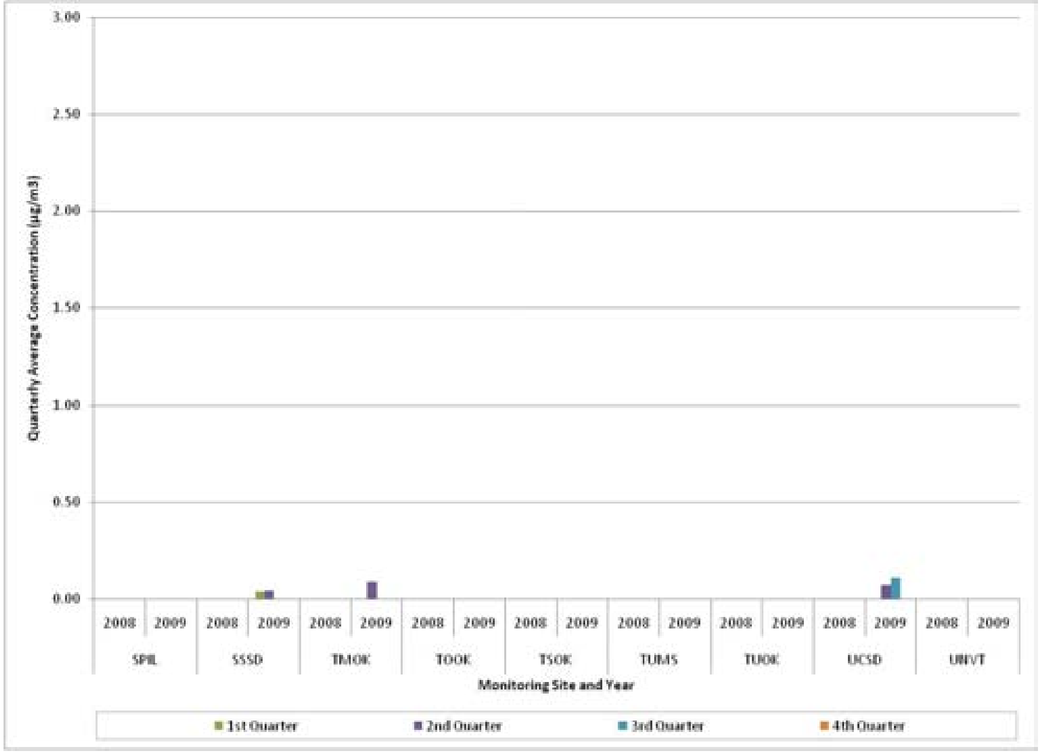


Figure 4-24a. Comparison of Average Quarterly Arsenic (PM_{10}) Concentrations

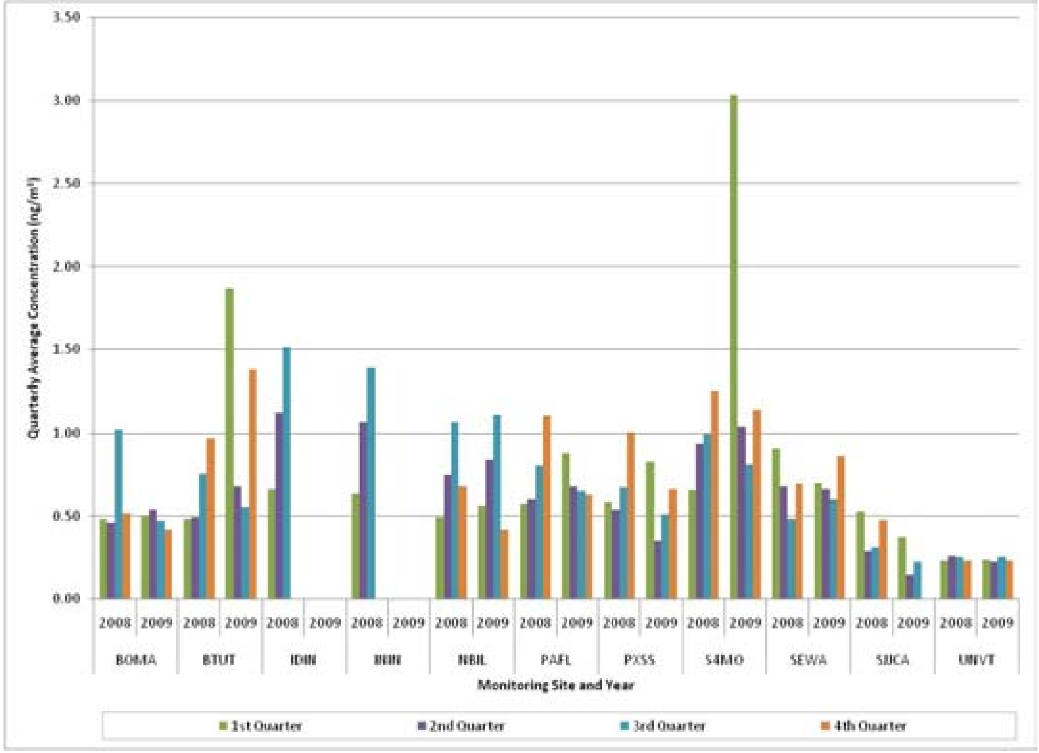


Figure 4-24b. Comparison of Average Quarterly Arsenic (TSP) Concentrations

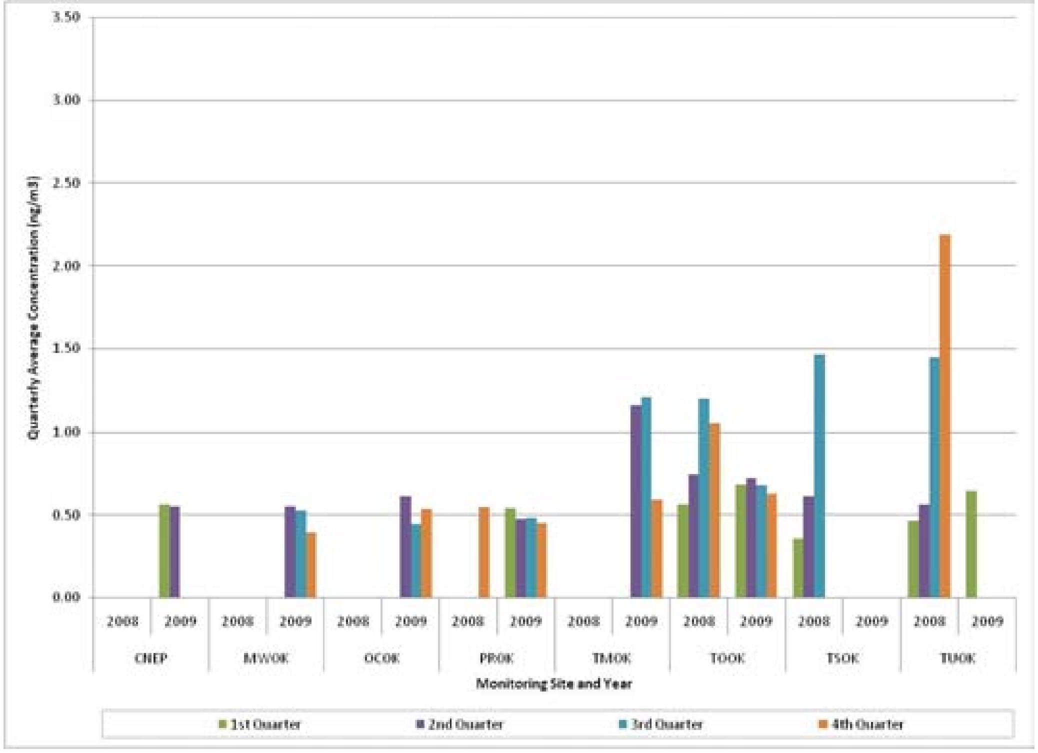


Figure 4-25. Comparison of Average Quarterly Benzene Concentrations

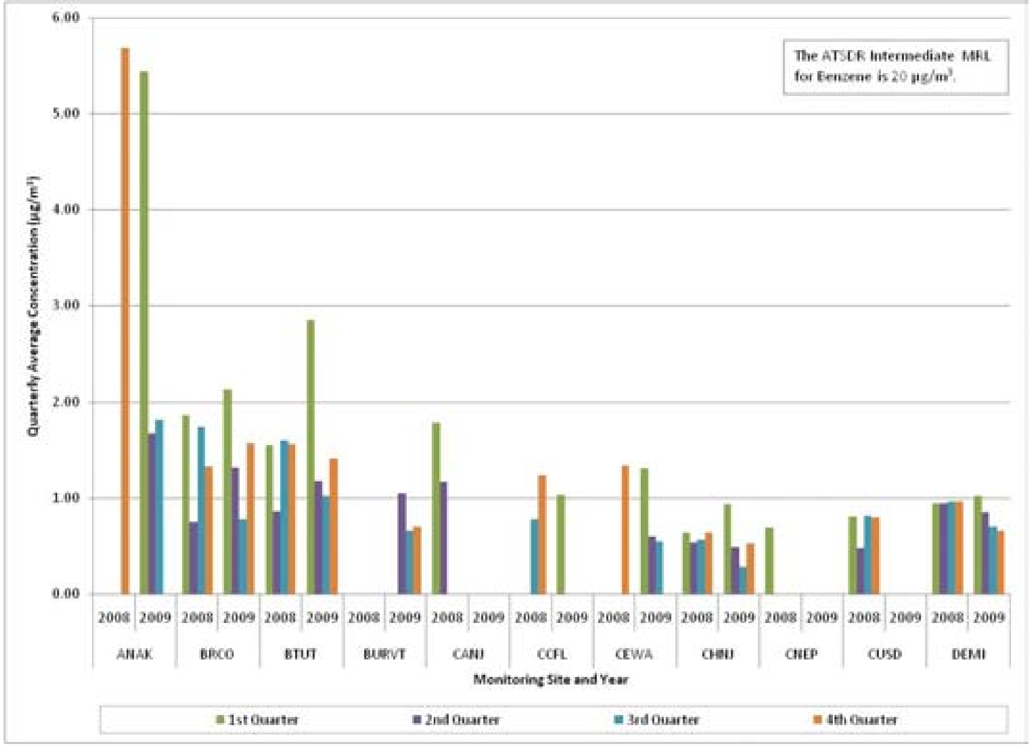

The ATSDR Intermediate MRL for Benzene is 20 µg/m³.

Figure 4-25. Comparison of Average Quarterly Benzene Concentrations (Continued)

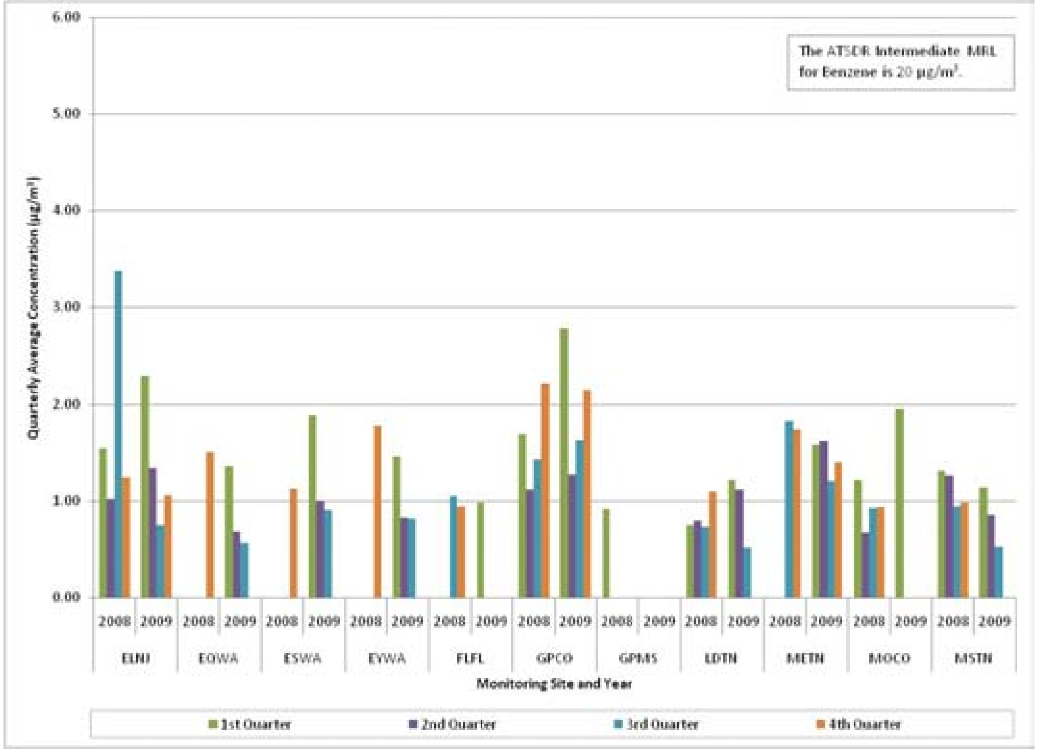


Figure 4-25. Comparison of Average Quarterly Benzene Concentrations (Continued)

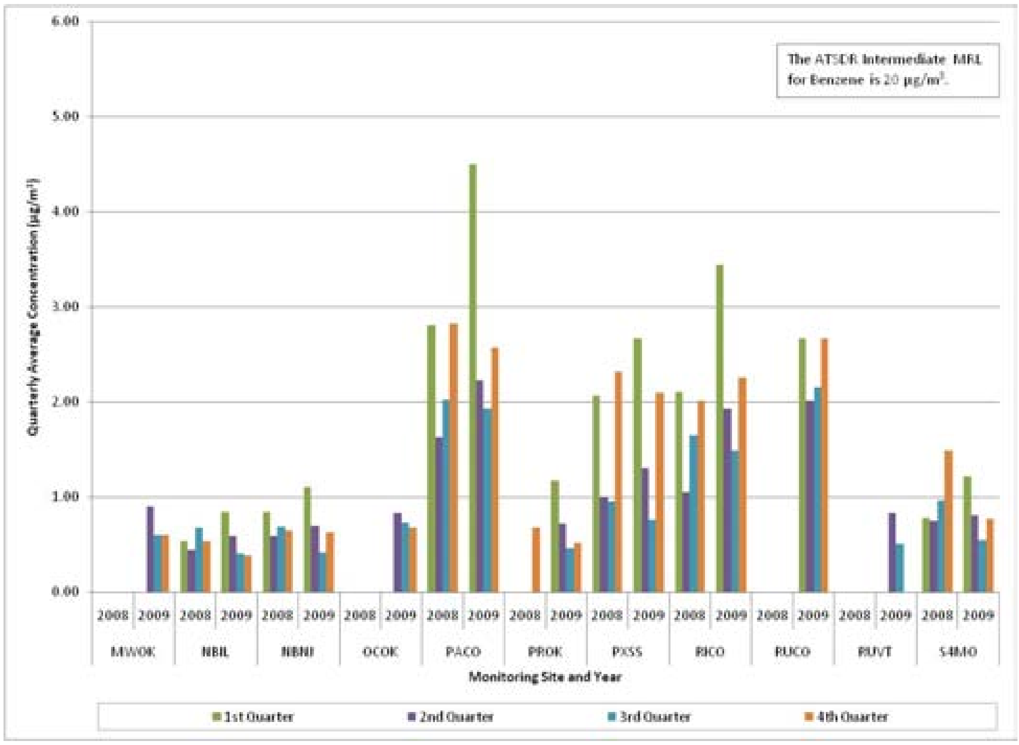


Figure 4-25. Comparison of Average Quarterly Benzene Concentrations (Continued)

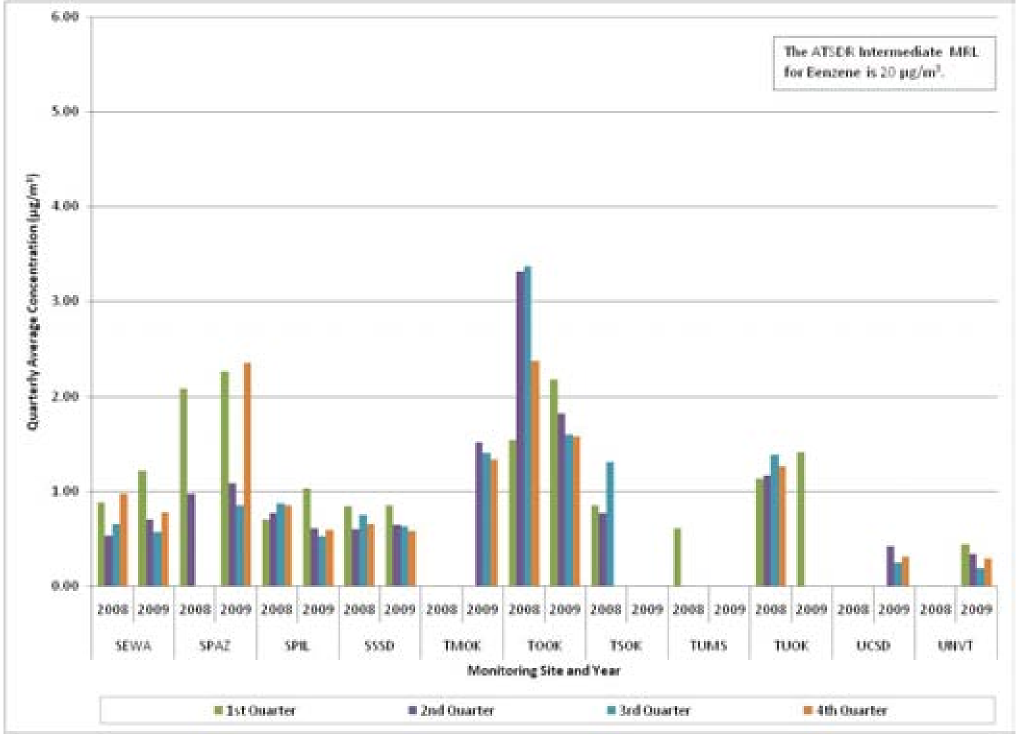


Figure 4-26. Comparison of Average Quarterly Benzo(a)pyrene Concentrations

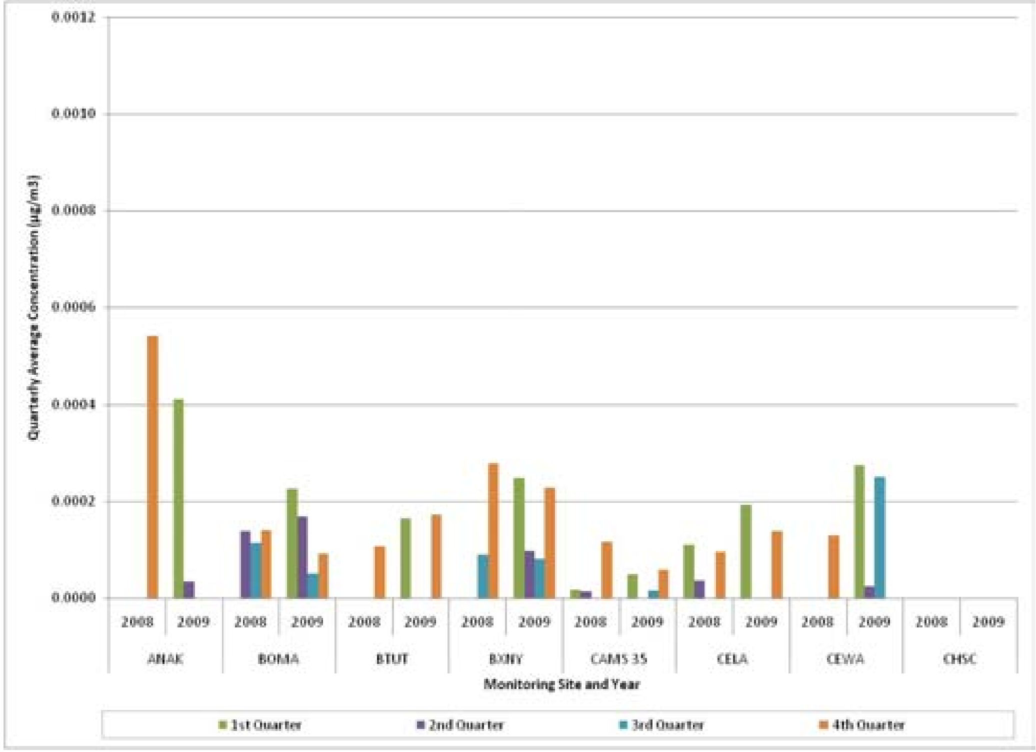


Figure 4-26. Comparison of Average Quarterly Benzo(a)pyrene Concentrations (Continued)

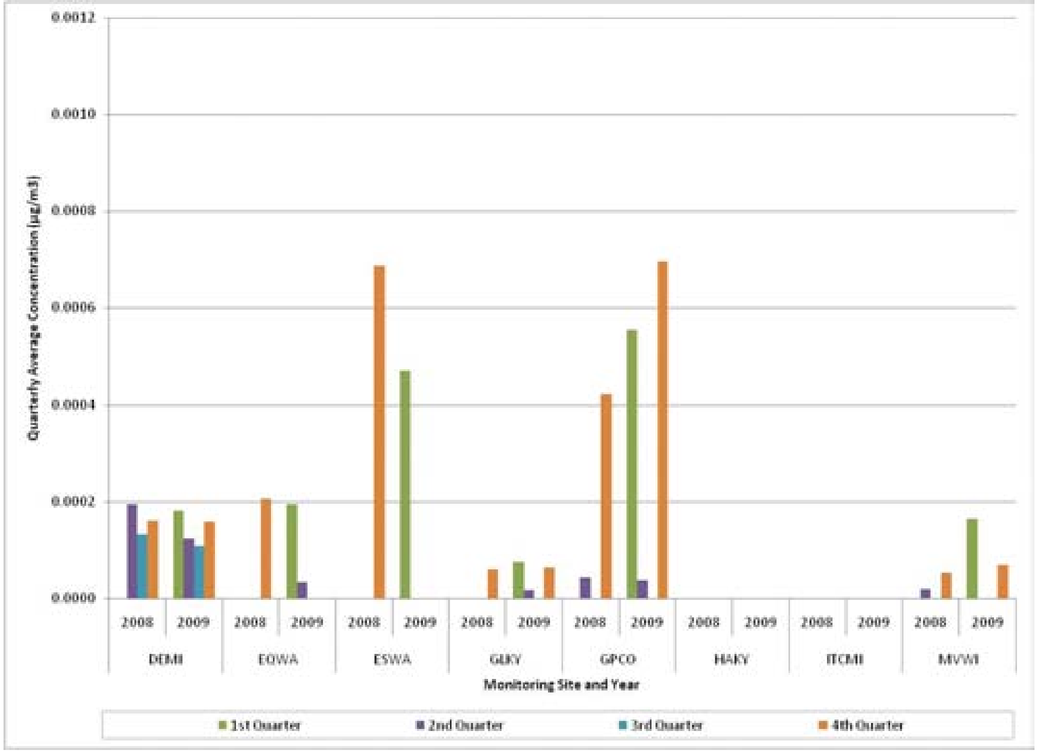


Figure 4-26. Comparison of Average Quarterly Benzo(a)pyrene Concentrations (Continued)

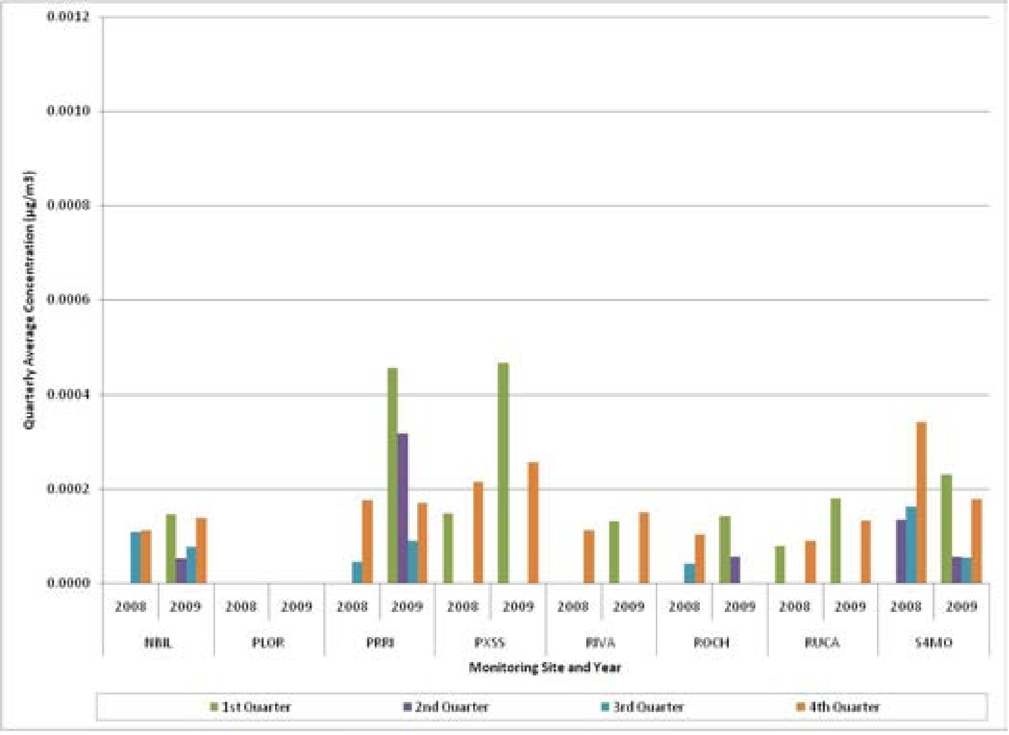


Figure 4-26. Comparison of Average Quarterly Benzo(a)pyrene Concentrations (Continued)

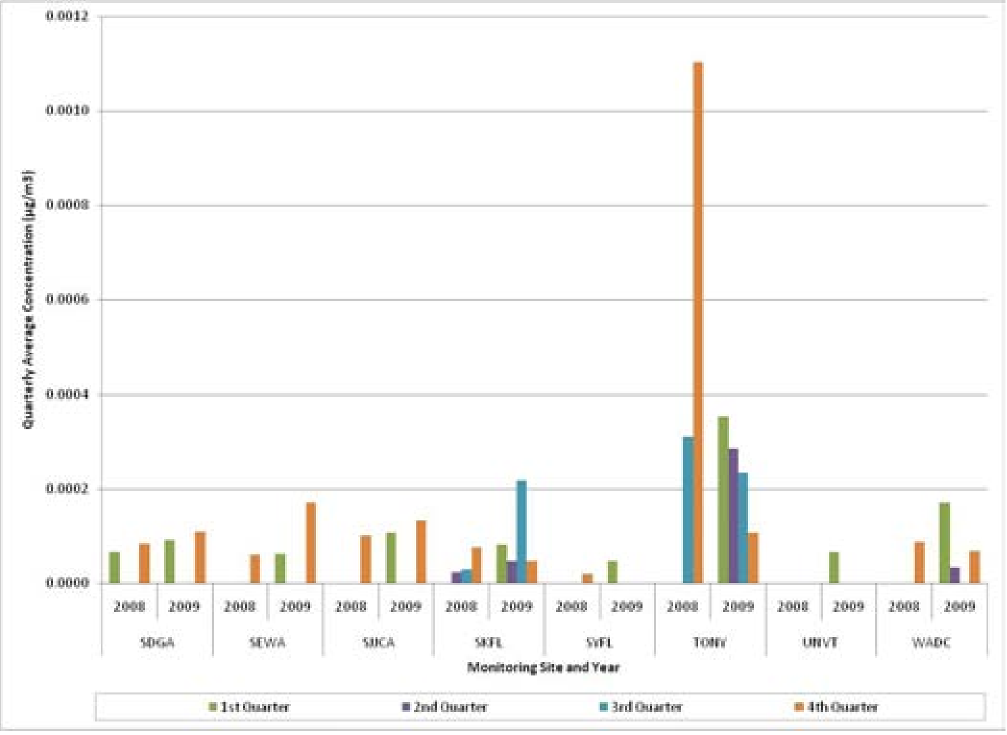


Figure 4-27a. Comparison of Average Quarterly Beryllium (PM_{10}) Concentrations

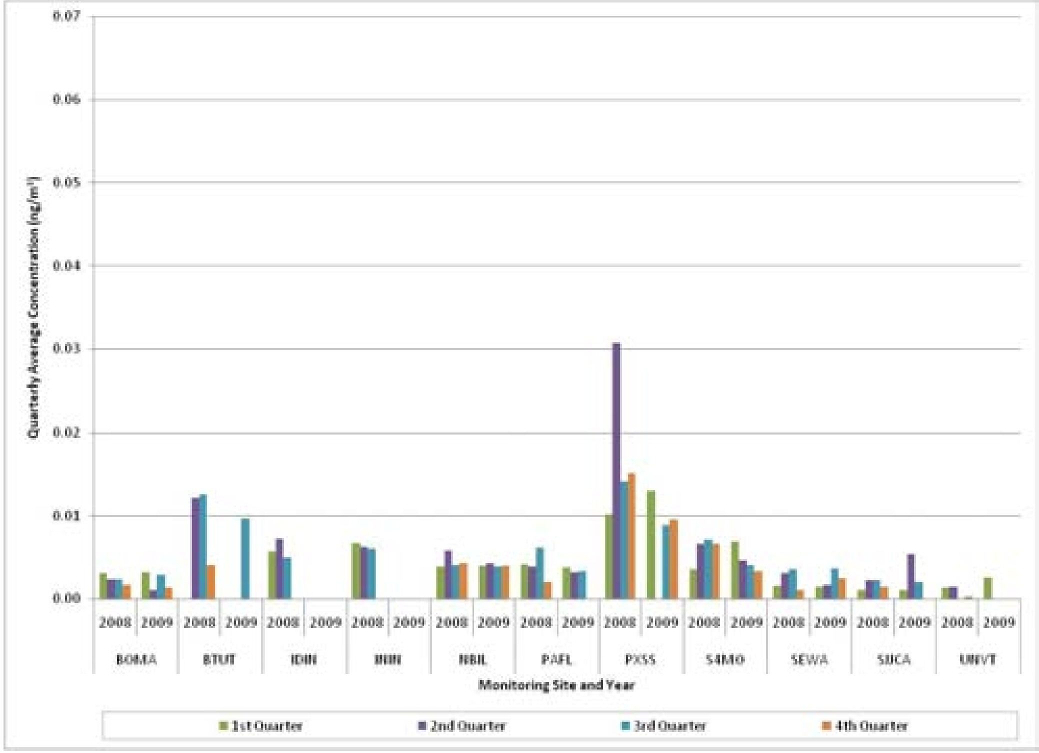


Figure 4-27b. Comparison of Average Quarterly Beryllium (TSP) Concentrations

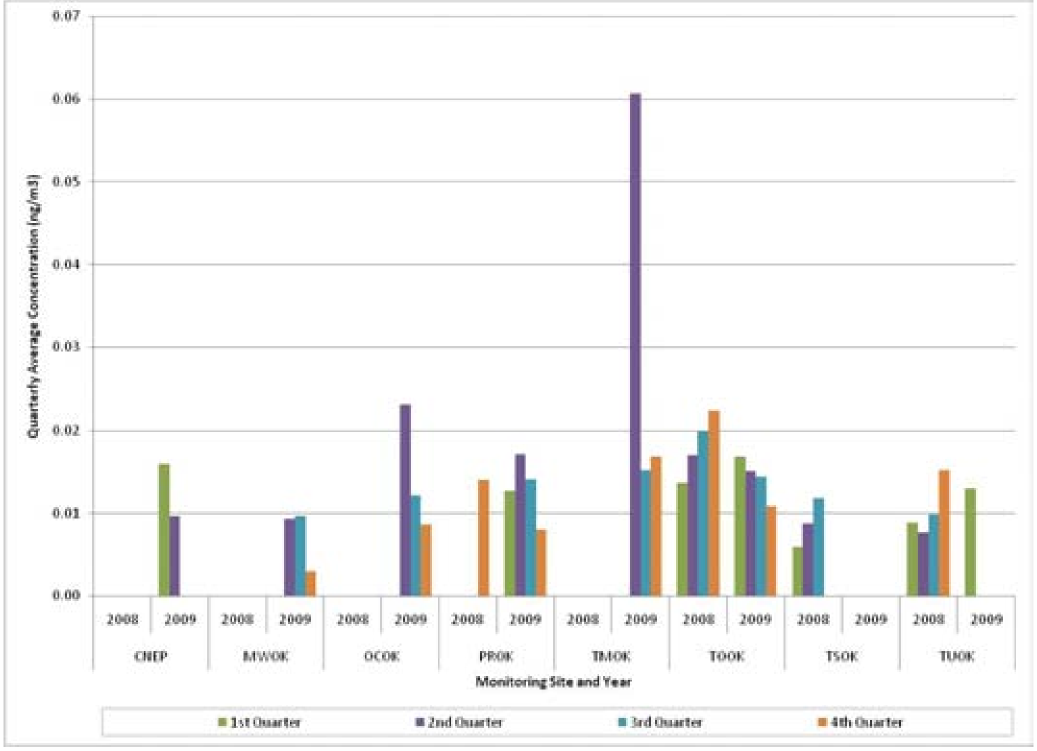


Figure 4-28. Comparison of Average Quarterly 1,3-Butadiene Concentrations

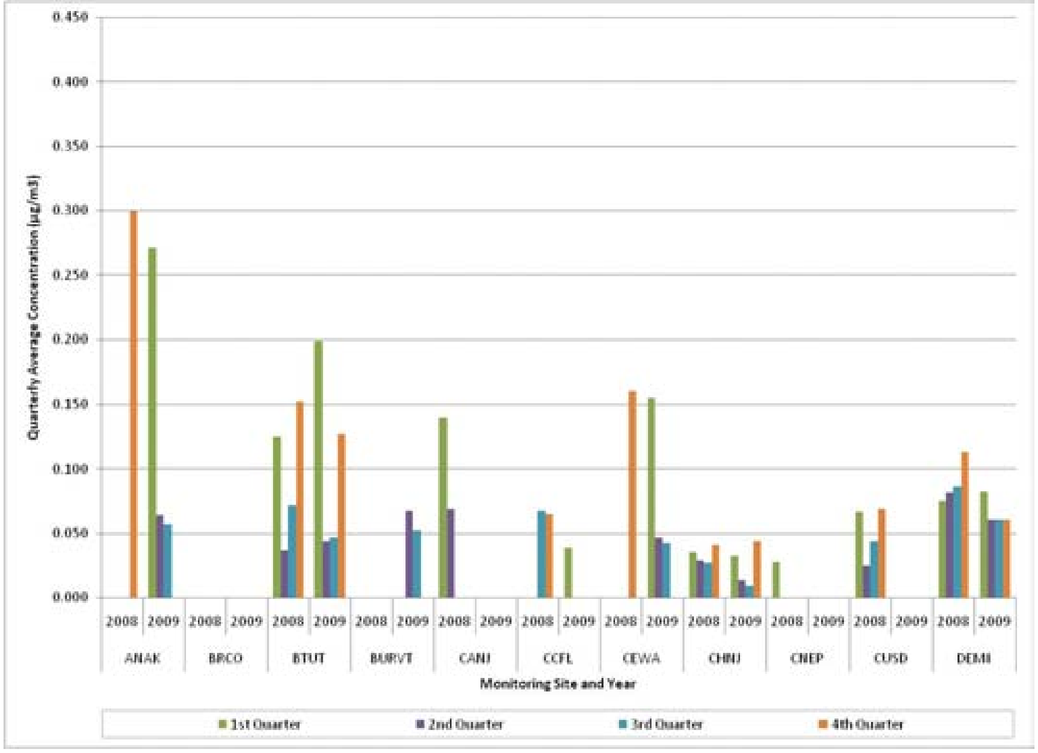


Figure 4-28. Comparison of Average Quarterly 1,3-Butadiene Concentrations (Continued)

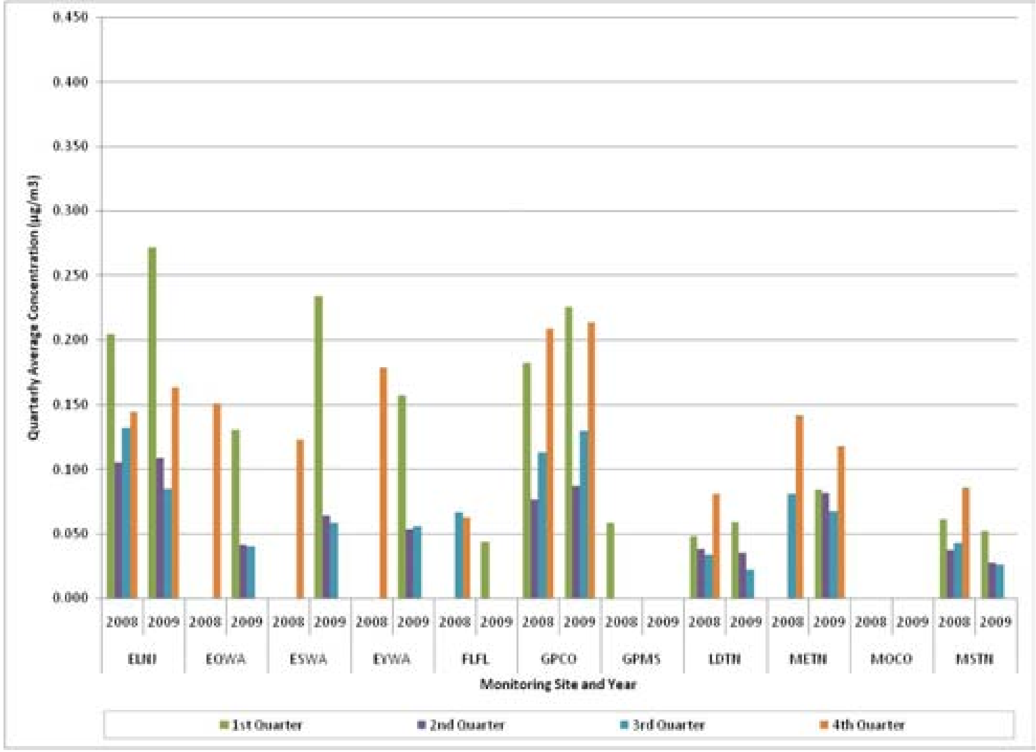


Figure 4-28. Comparison of Average Quarterly 1,3-Butadiene Concentrations (Continued)

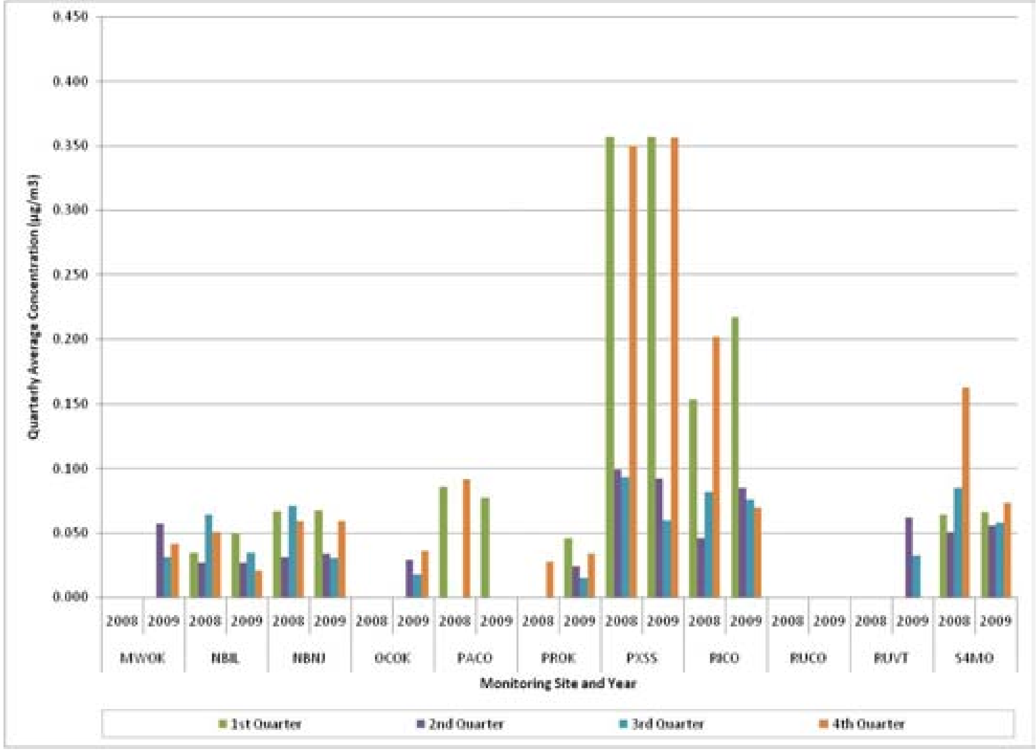


Figure 4-28. Comparison of Average Quarterly 1,3-Butadiene Concentrations (Continued)

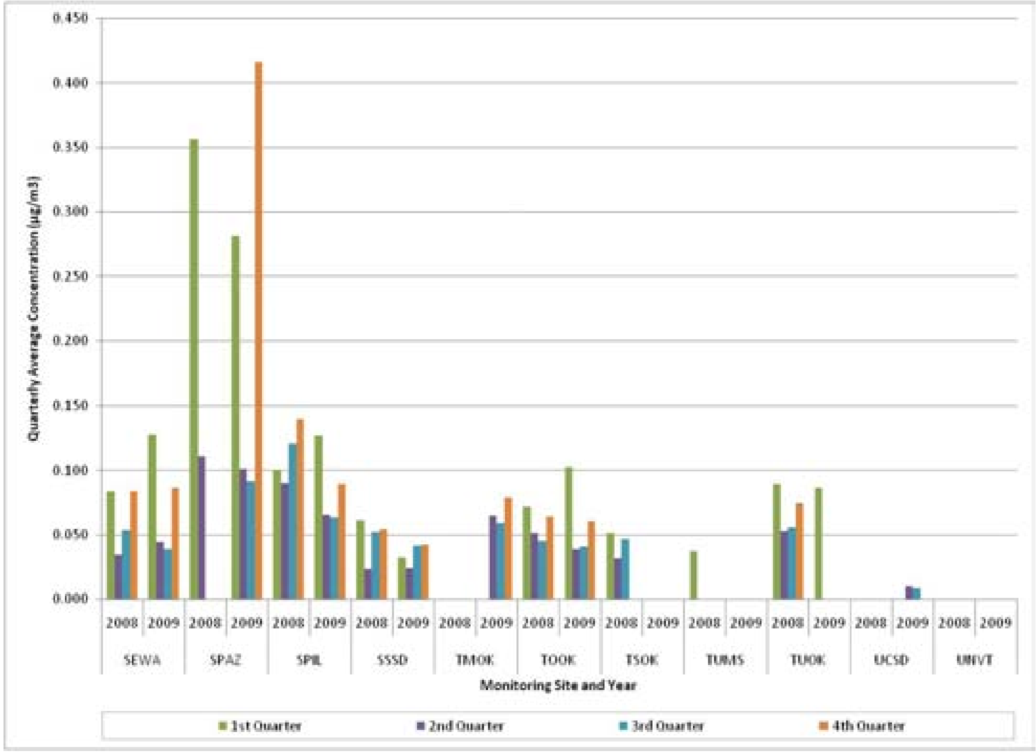


Figure 4-29a. Comparison of Average Quarterly Cadmium (PM_{10}) Concentrations

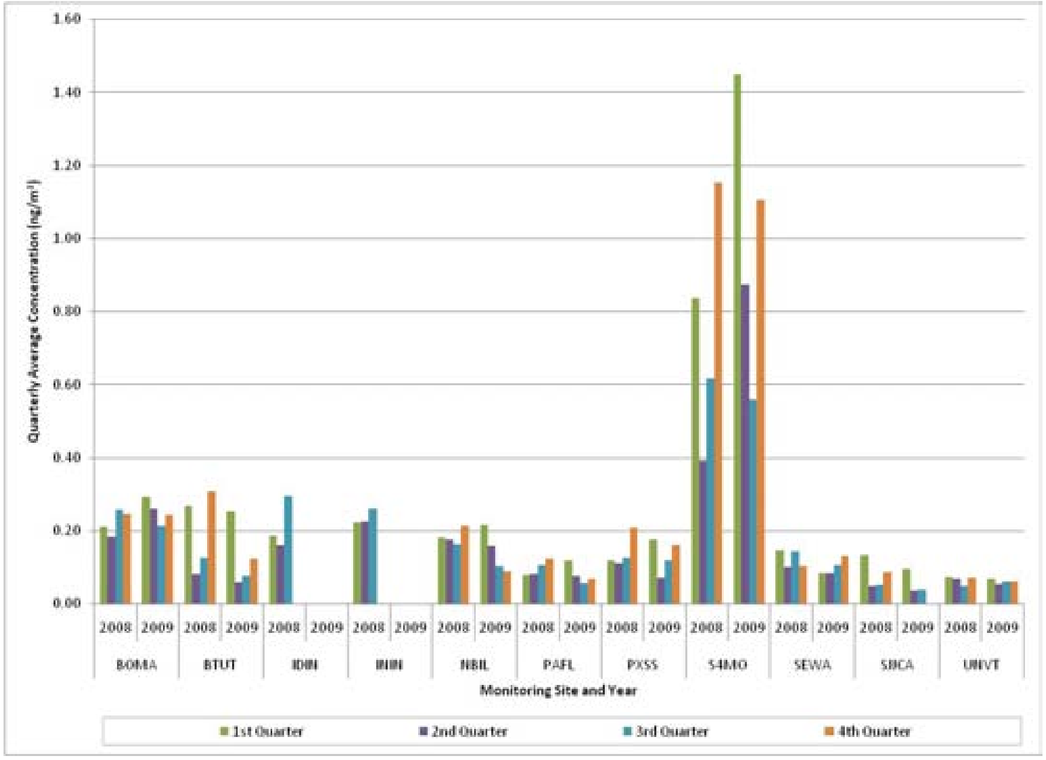


Figure 4-29b. Comparison of Average Quarterly Cadmium (TSP) Concentrations

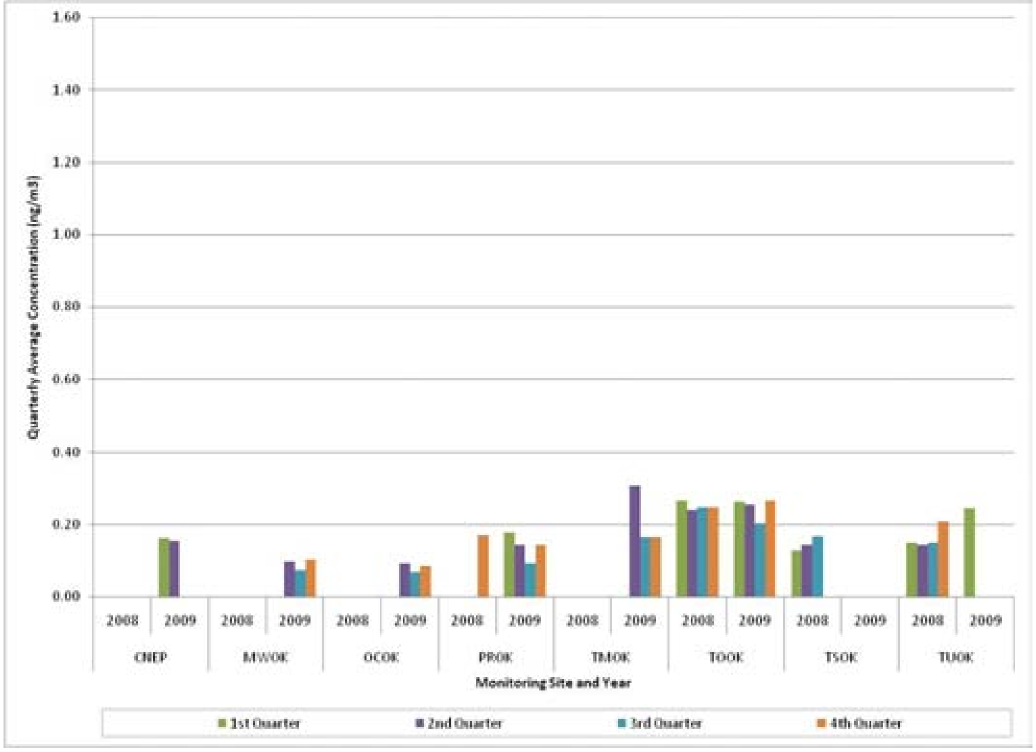


Figure 4-30. Comparison of Average Quarterly Carbon Tetrachloride Concentrations

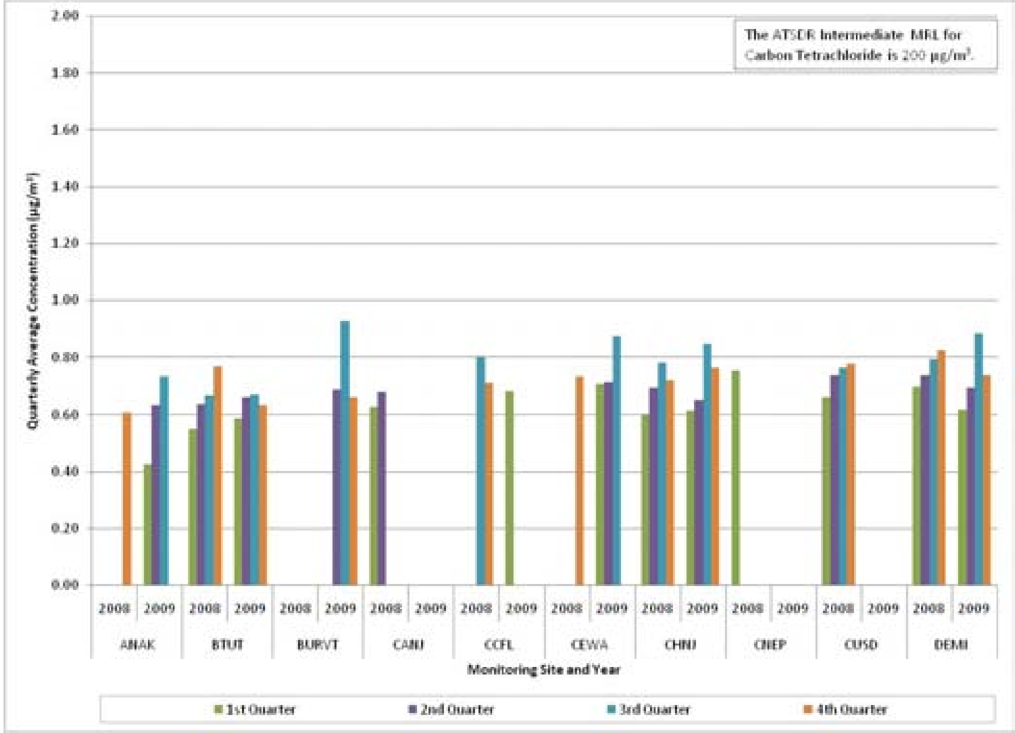


Figure 4-30. Comparison of Average Quarterly Carbon Tetrachloride Concentrations (Continued)

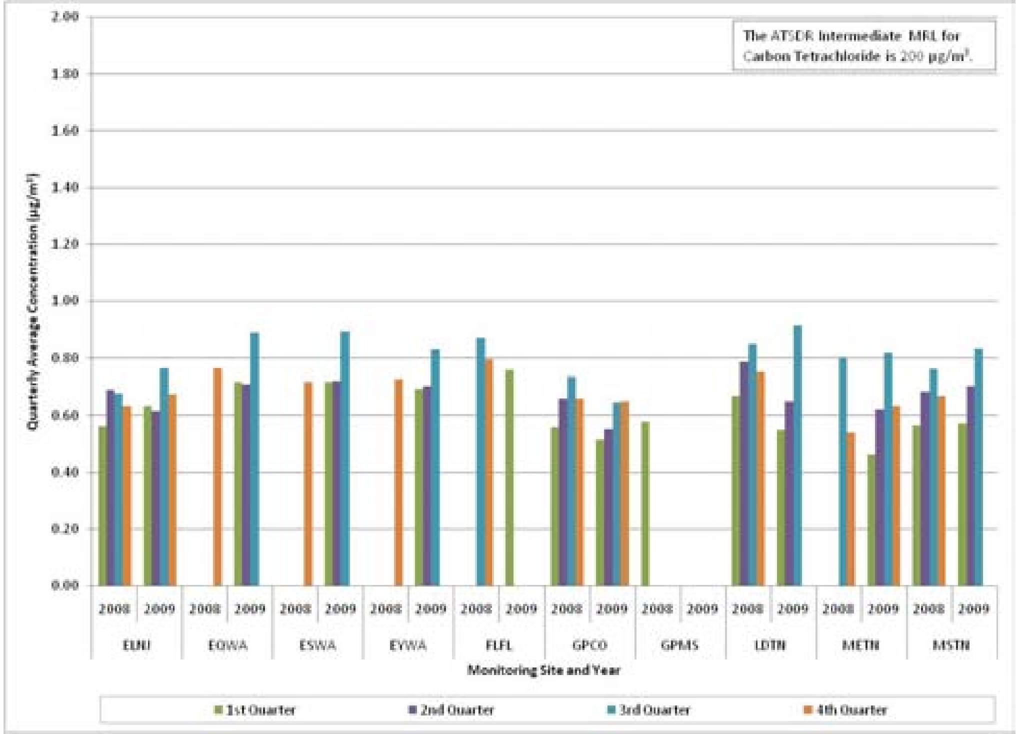


Figure 4-30. Comparison of Average Quarterly Carbon Tetrachloride Concentrations (Continued)

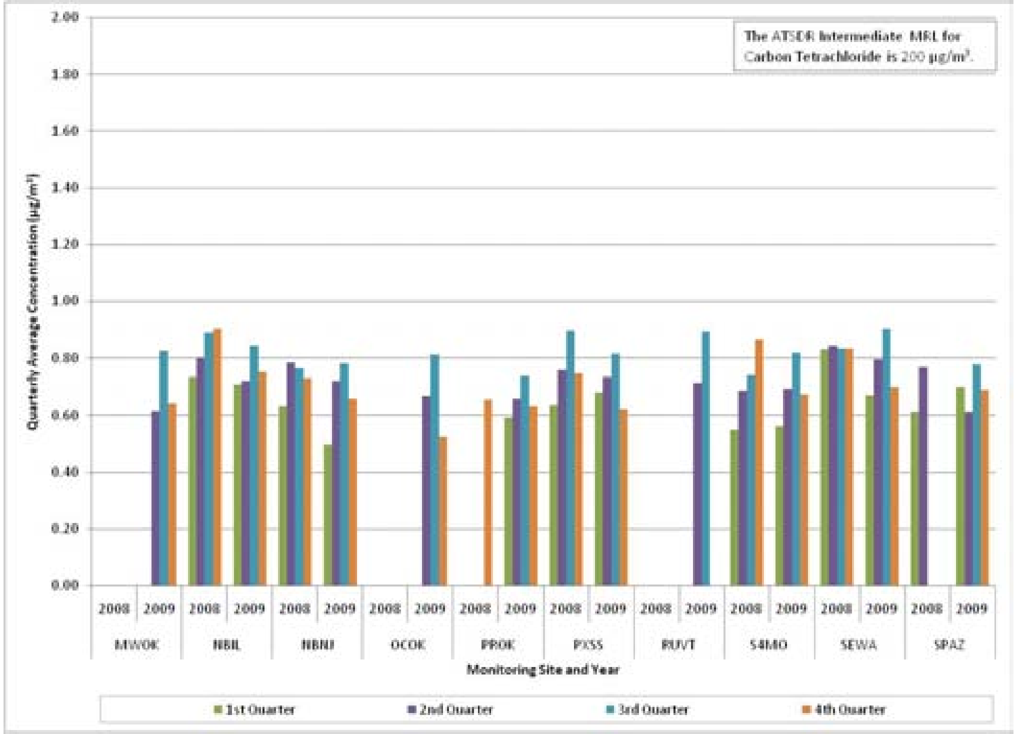


Figure 4-30. Comparison of Average Quarterly Carbon Tetrachloride Concentrations (Continued)

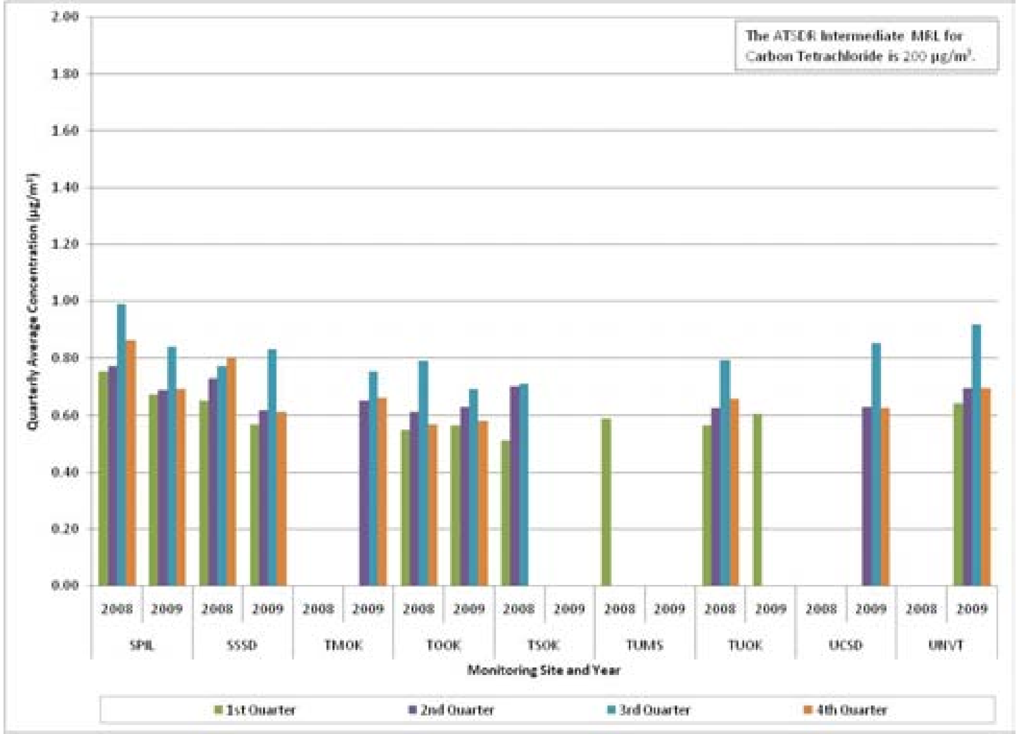


Figure 4-31. Comparison of Average Quarterly Chloroform Concentrations

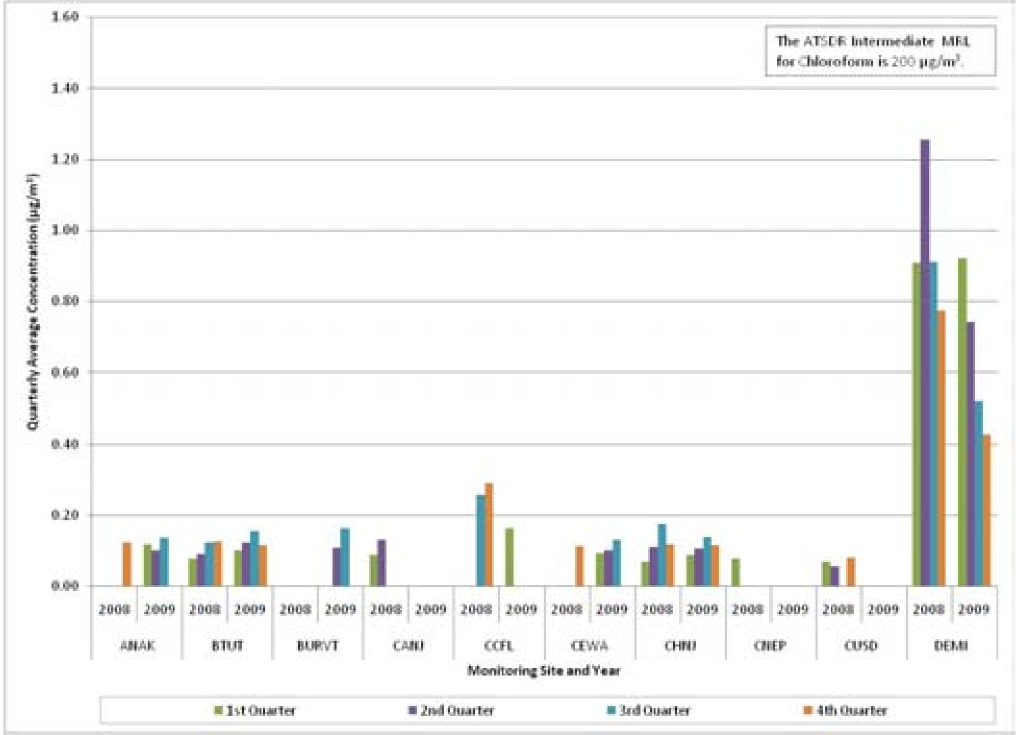


Figure 4-31. Comparison of Average Quarterly Chloroform Concentrations (Continued)

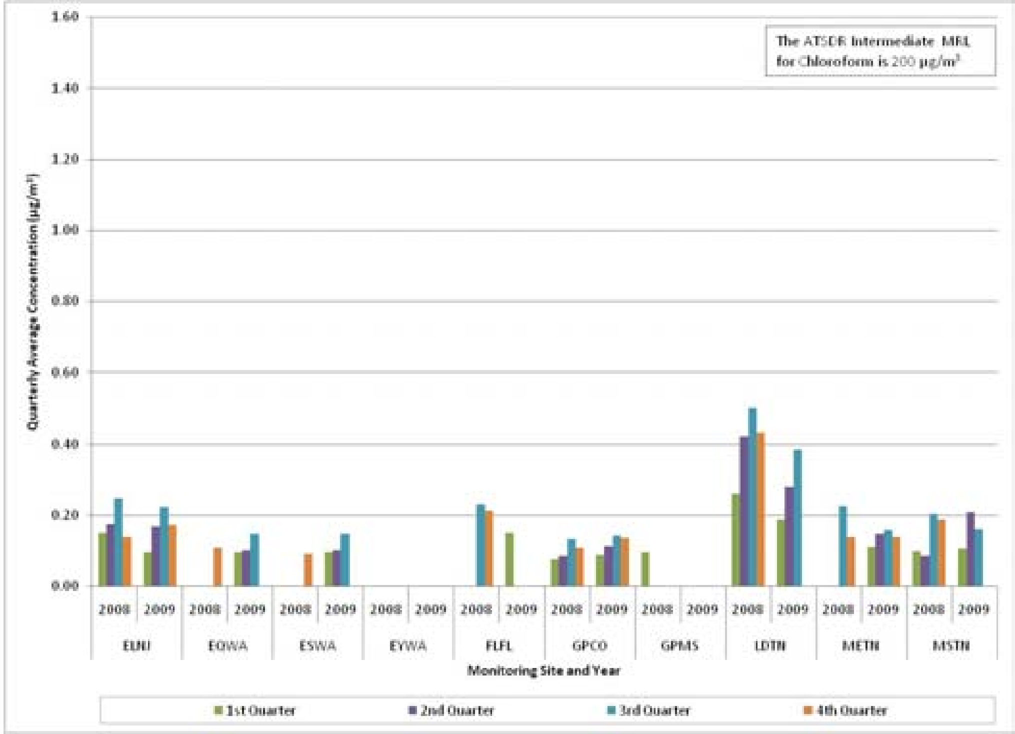


Figure 4-31. Comparison of Average Quarterly Chloroform Concentrations (Continued)

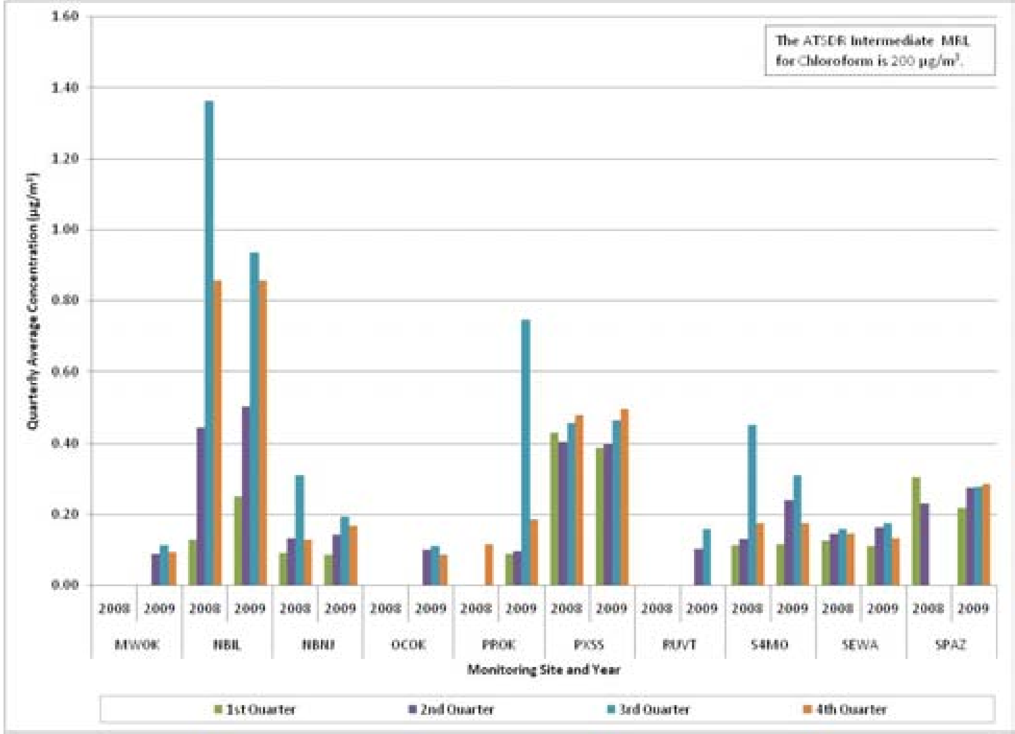
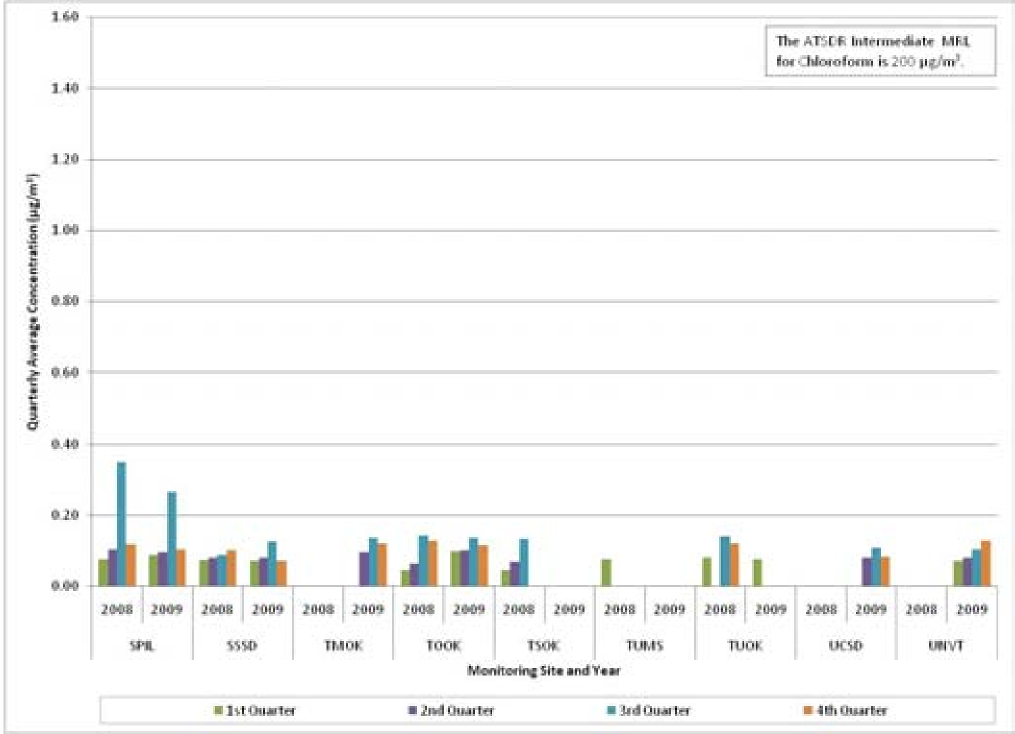
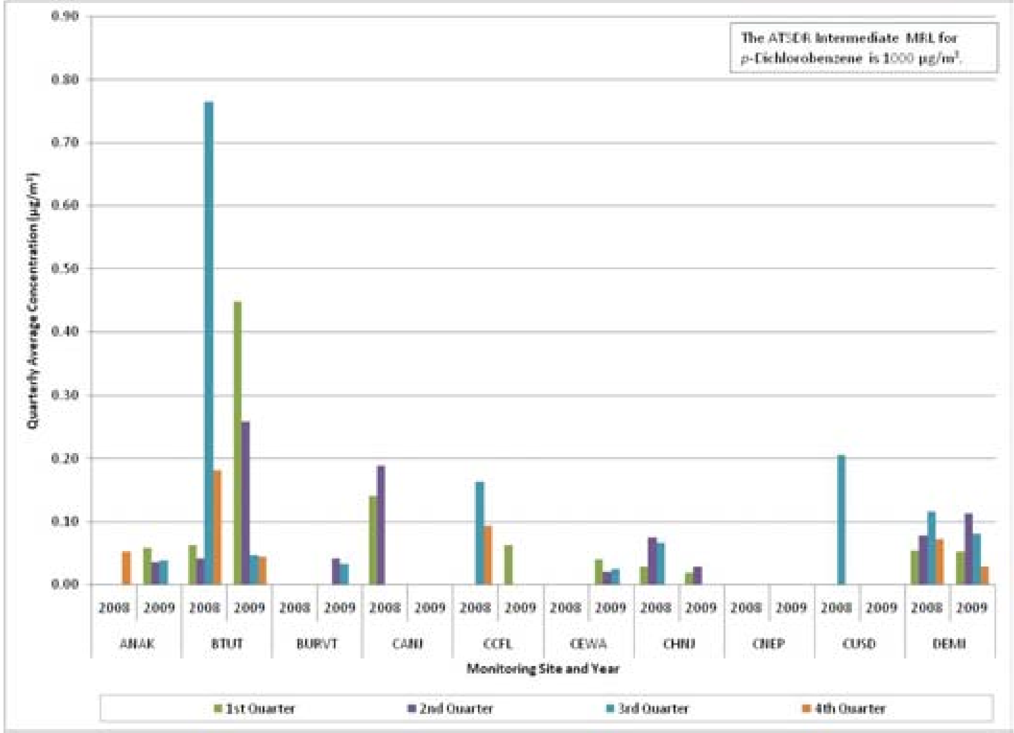


Figure 4-31. Comparison of Average Quarterly Chloroform Concentrations (Continued)



The ATSDR Intermediate MRL for Chloroform is 200 µg/m³.

Figure 4-32. Comparison of Average Quarterly *p*-Dichlorobenzene Concentrations



The ATSDR Intermediate MRL for *p*-Dichlorobenzene is 1000 µg/m³.

Figure 4-32. Comparison of Average Quarterly *p*-Dichlorobenzene Concentrations (Continued)

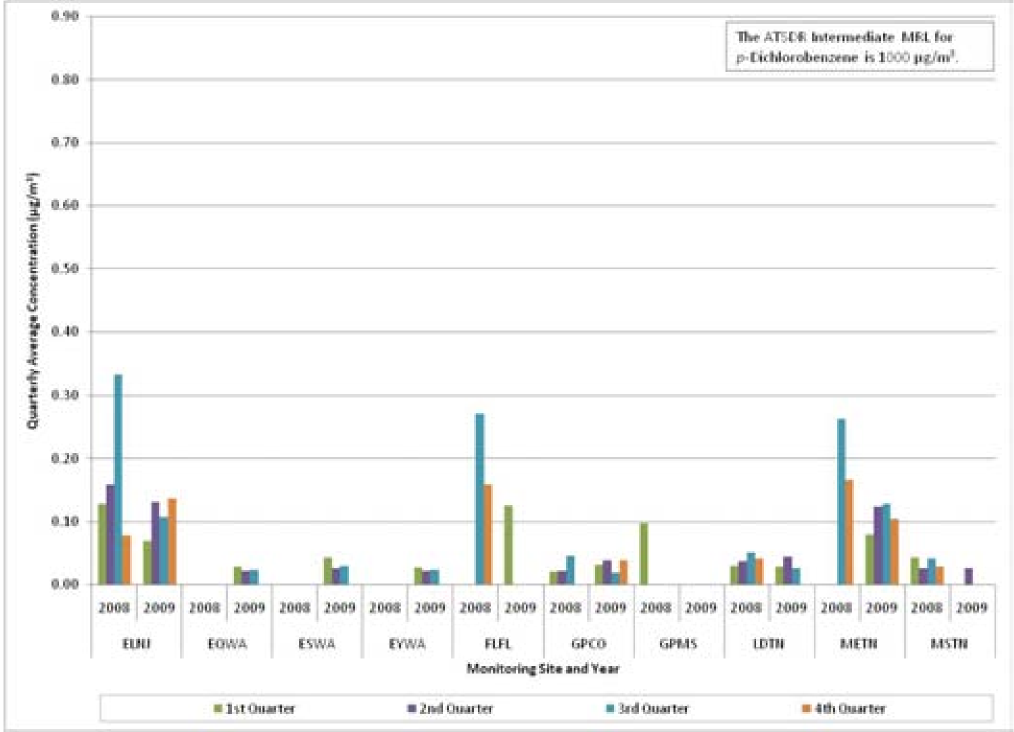


Figure 4-32. Comparison of Average Quarterly *p*-Dichlorobenzene Concentrations (Continued)

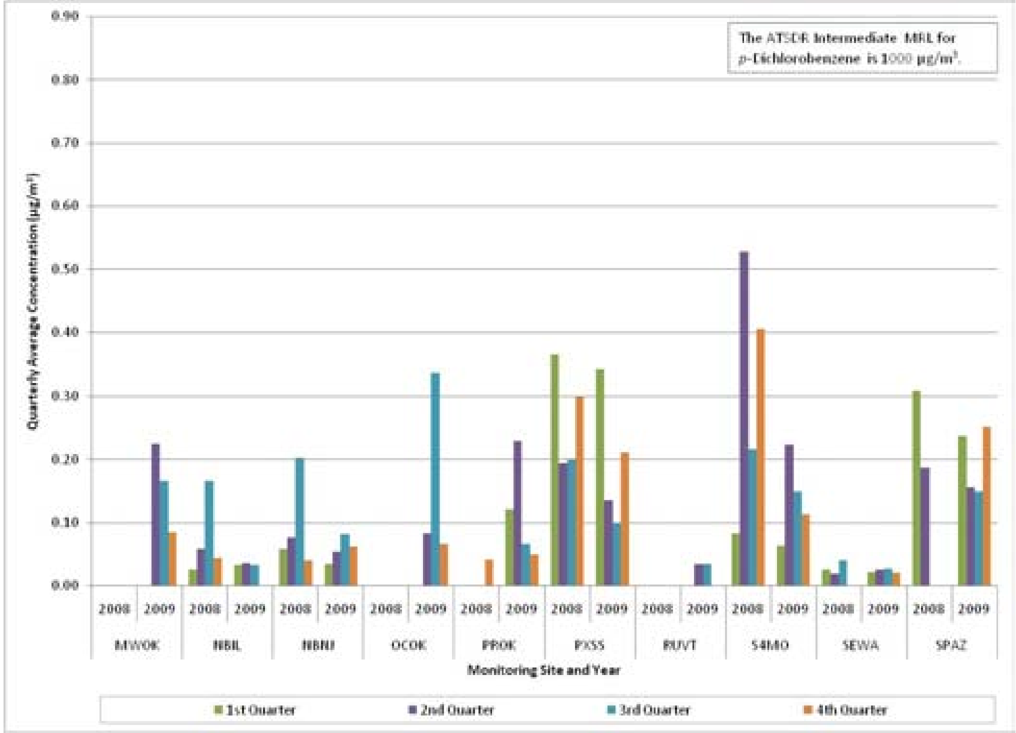


Figure 4-32. Comparison of Average Quarterly *p*-Dichlorobenzene Concentrations (Continued)

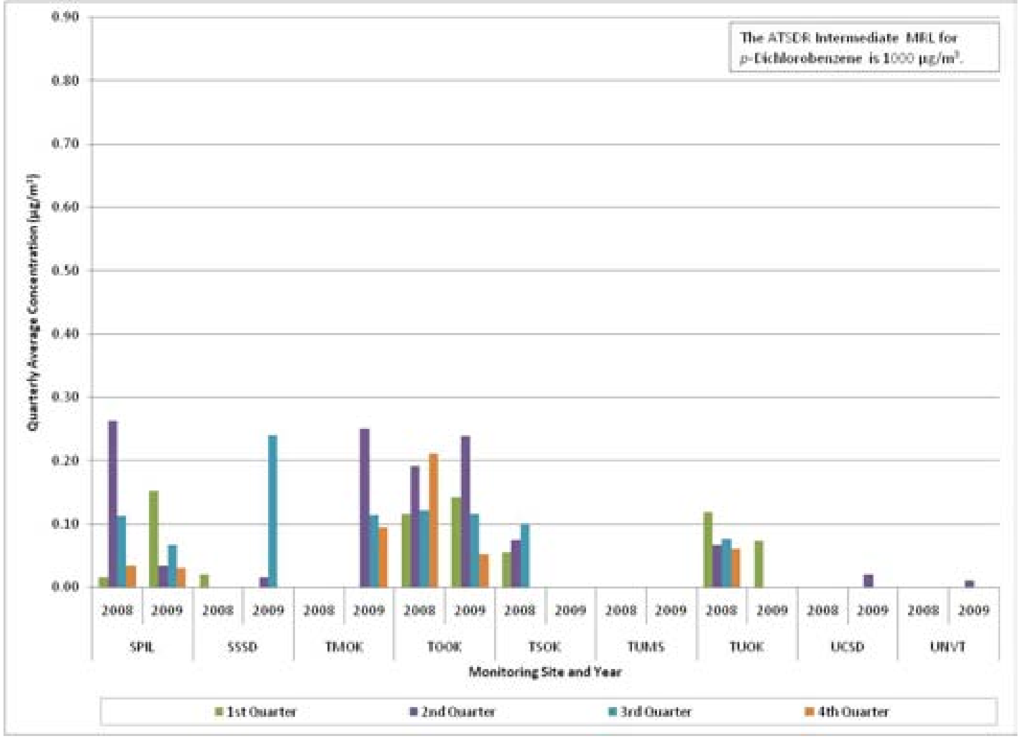


Figure 4-33. Comparison of Average Quarterly Ethylbenzene Concentrations

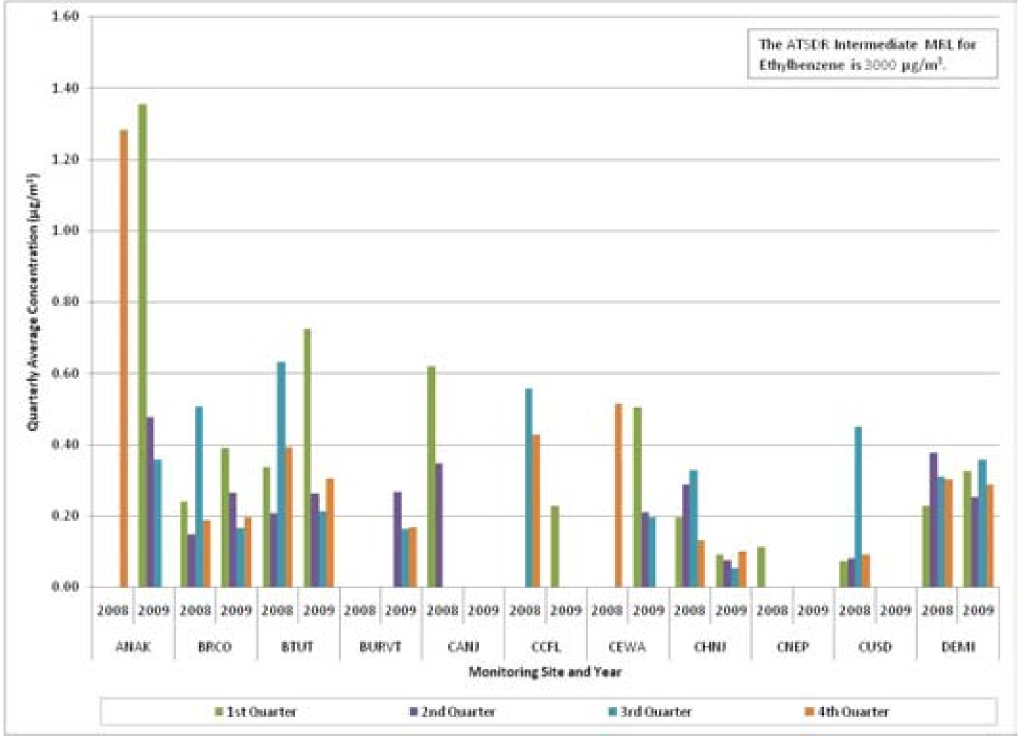


Figure 4-33. Comparison of Average Quarterly Ethylbenzene Concentrations (Continued)

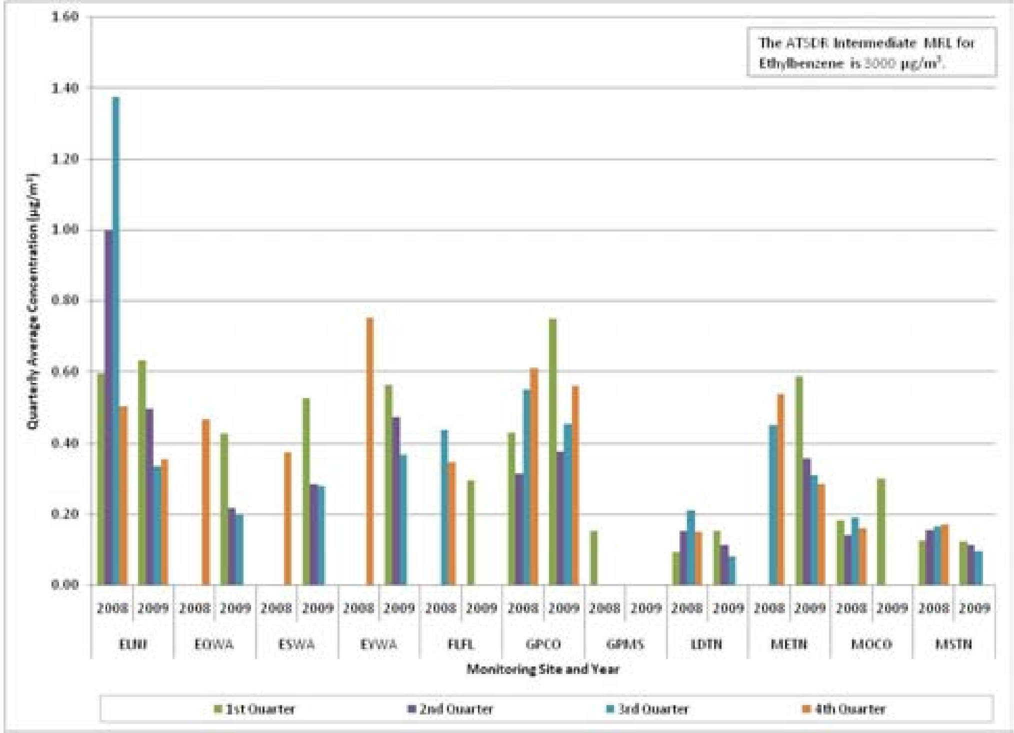


Figure 4-33. Comparison of Average Quarterly Ethylbenzene Concentrations (Continued)

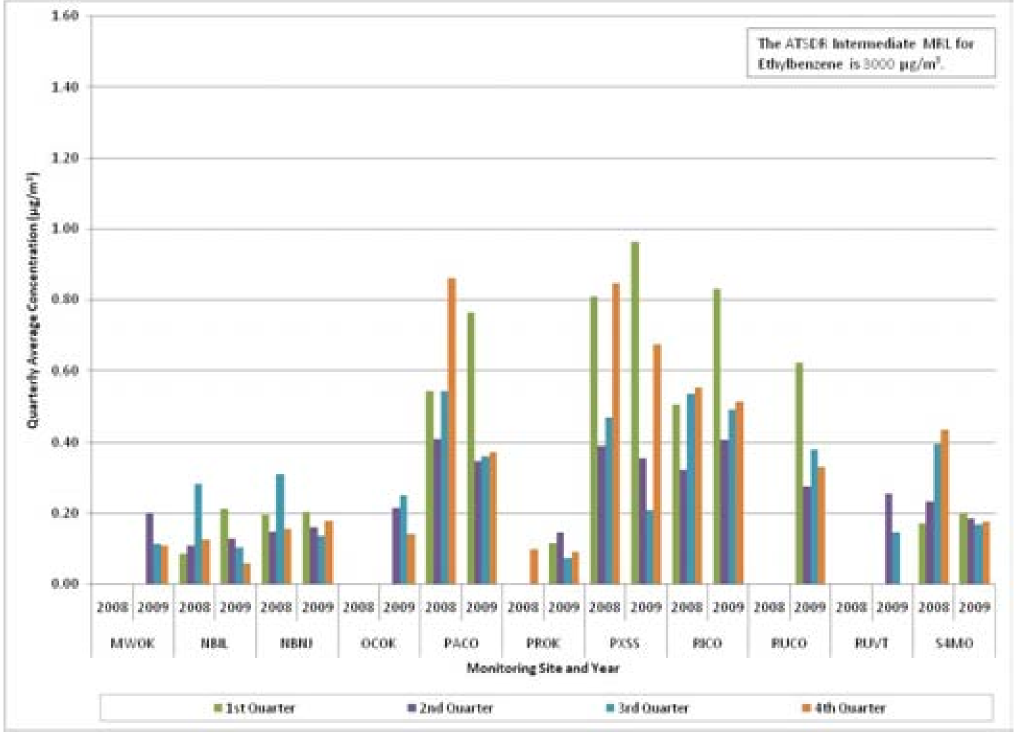


Figure 4-33. Comparison of Average Quarterly Ethylbenzene Concentrations (Continued)

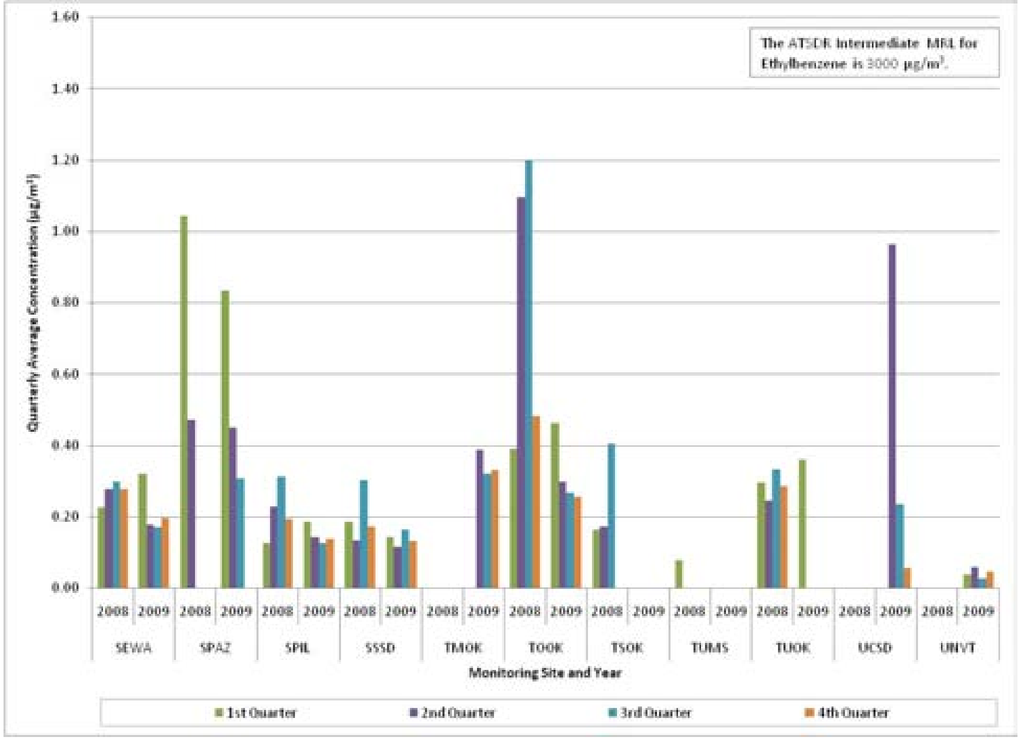


Figure 4-34. Comparison of Average Quarterly Formaldehyde Concentrations

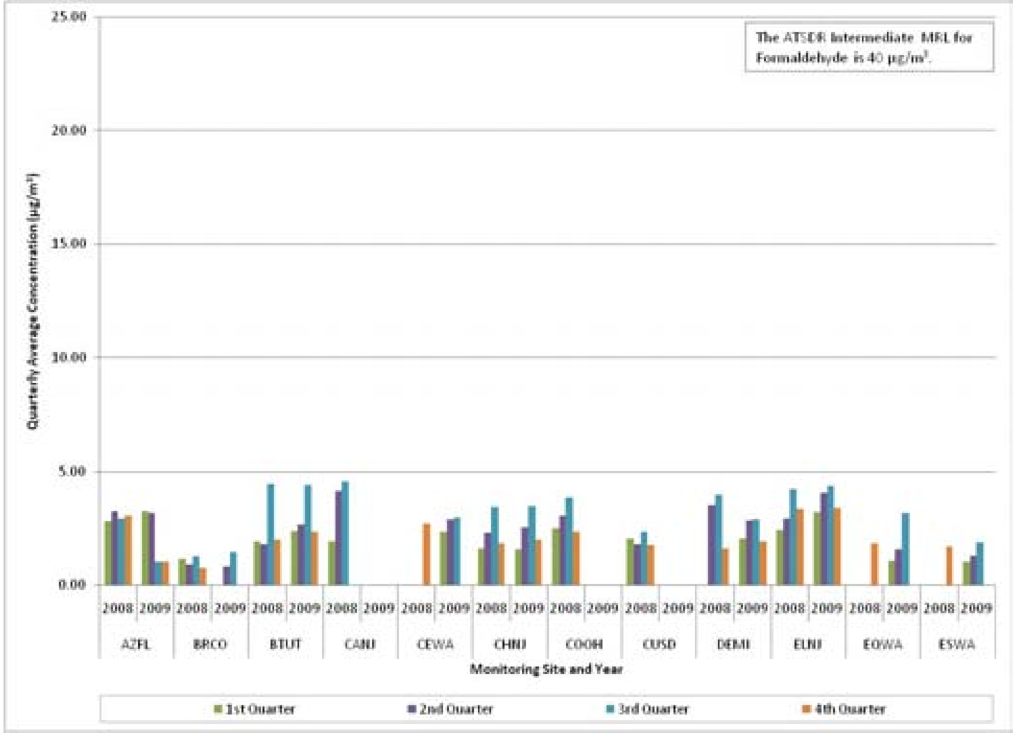


Figure 4-34. Comparison of Average Quarterly Formaldehyde Concentrations (Continued)

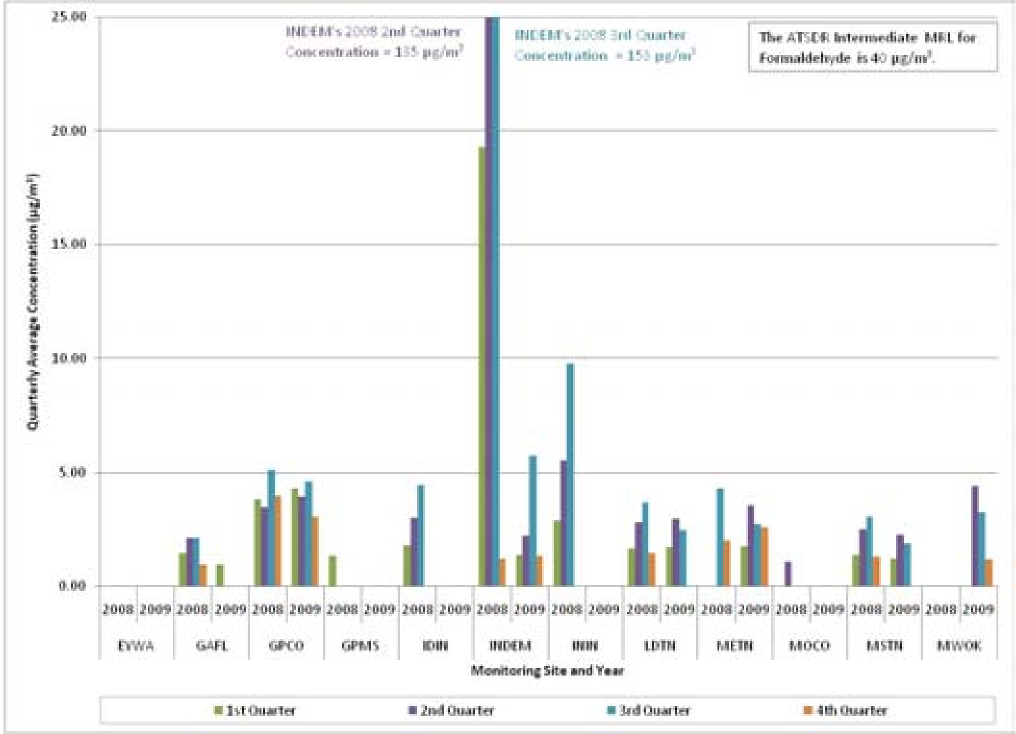


Figure 4-34. Comparison of Average Quarterly Formaldehyde Concentrations (Continued)

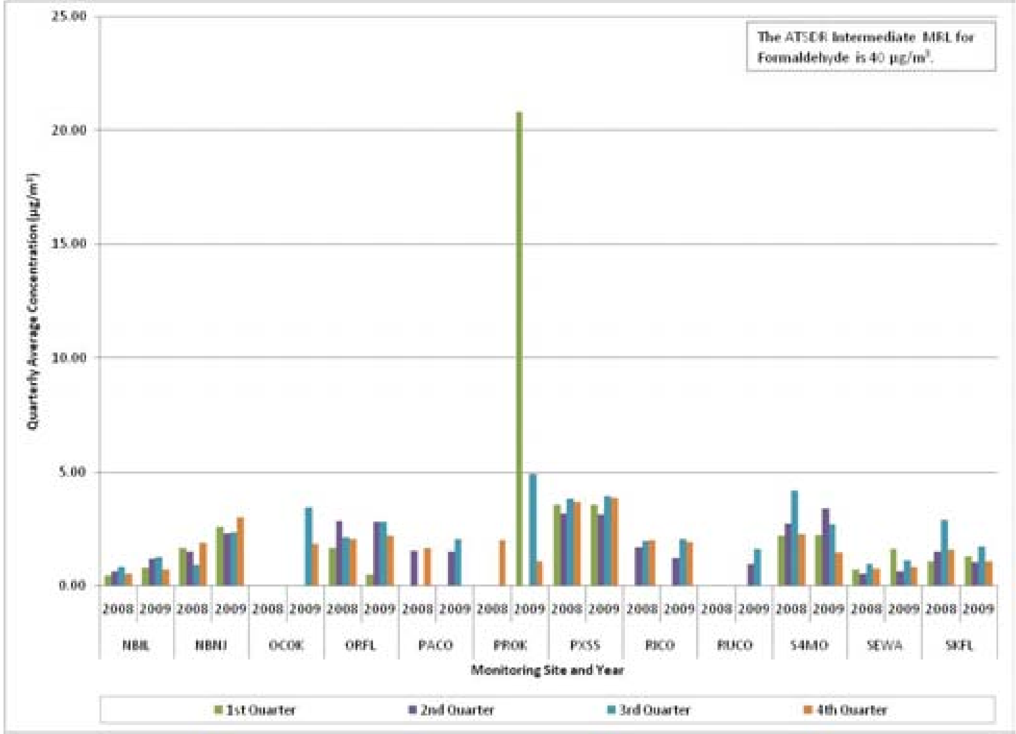


Figure 4-34. Comparison of Average Quarterly Formaldehyde Concentrations (Continued)

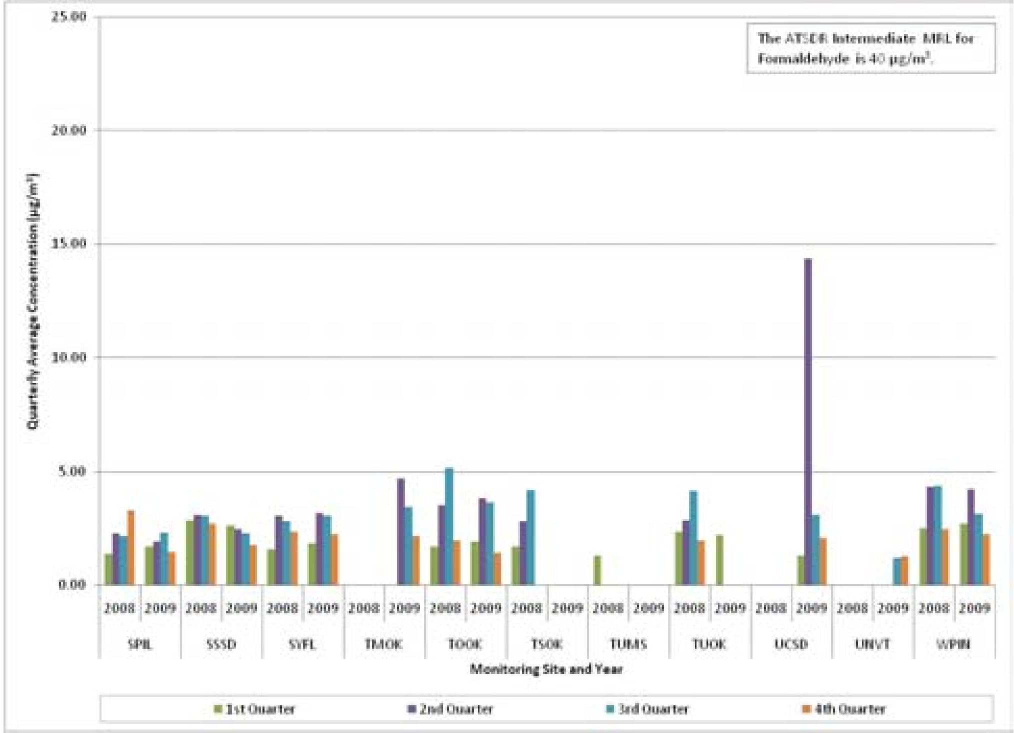


Figure 4-35. Comparison of Average Quarterly Hexavalent Chromium Concentrations

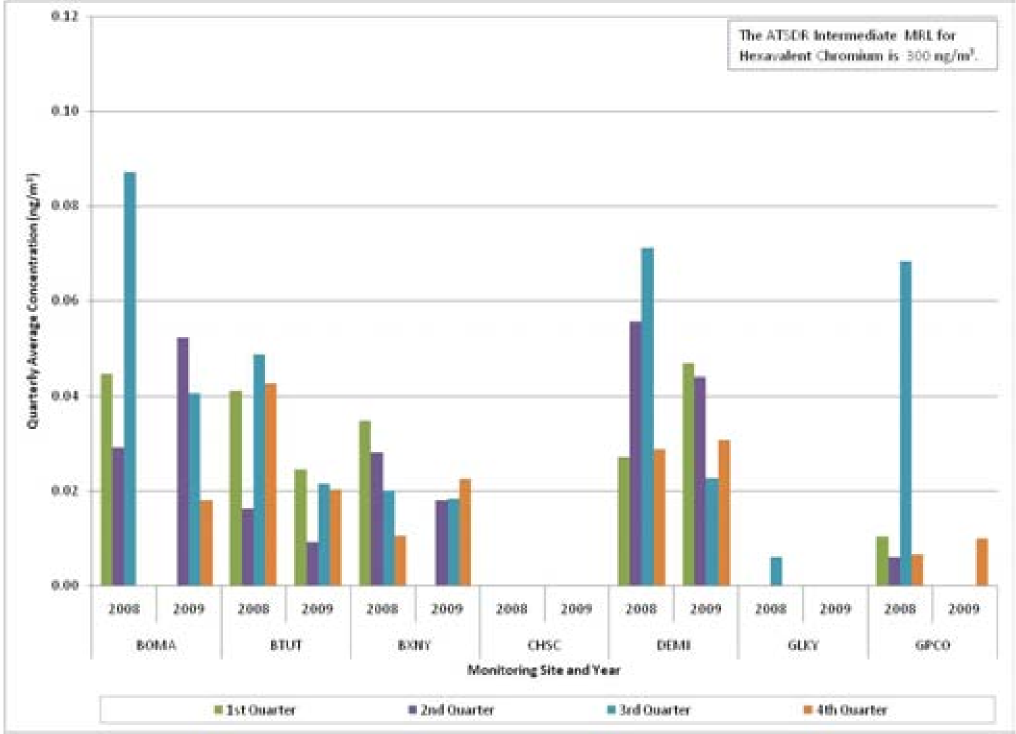


Figure 4-35. Comparison of Average Quarterly Hexavalent Chromium Concentrations (Continued)

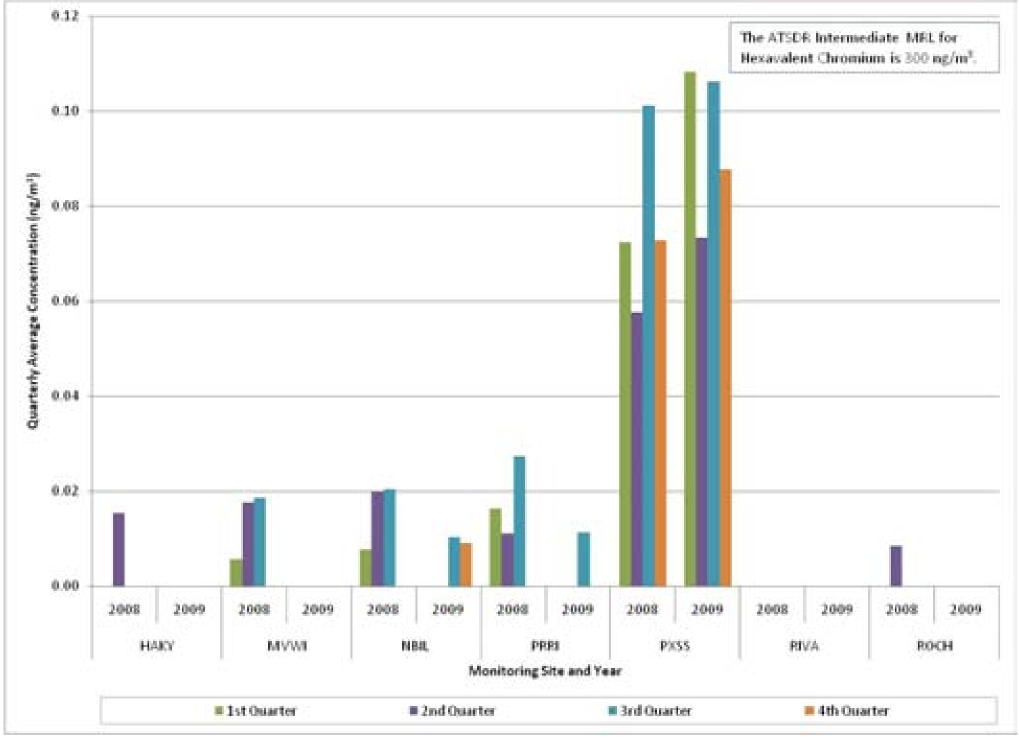


Figure 4-35. Comparison of Average Quarterly Hexavalent Chromium Concentrations (Continued)

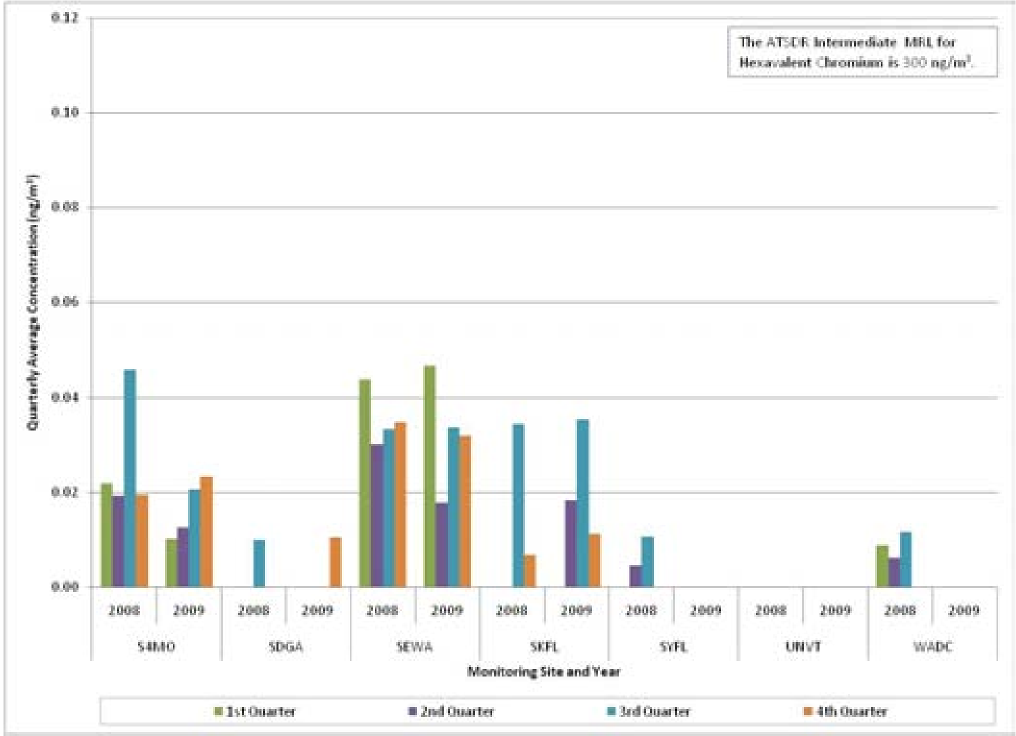


Figure 4-36a. Comparison of Average Quarterly Lead (PM_{10}) Concentrations

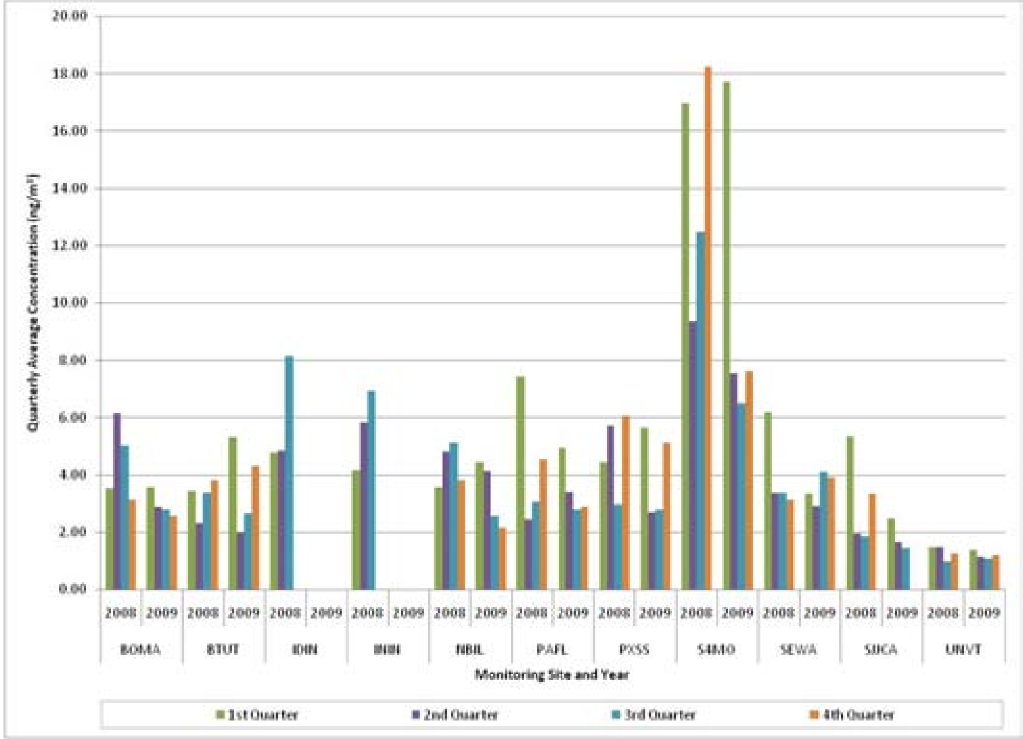


Figure 4-36b. Comparison of Average Quarterly Lead (TSP) Concentrations

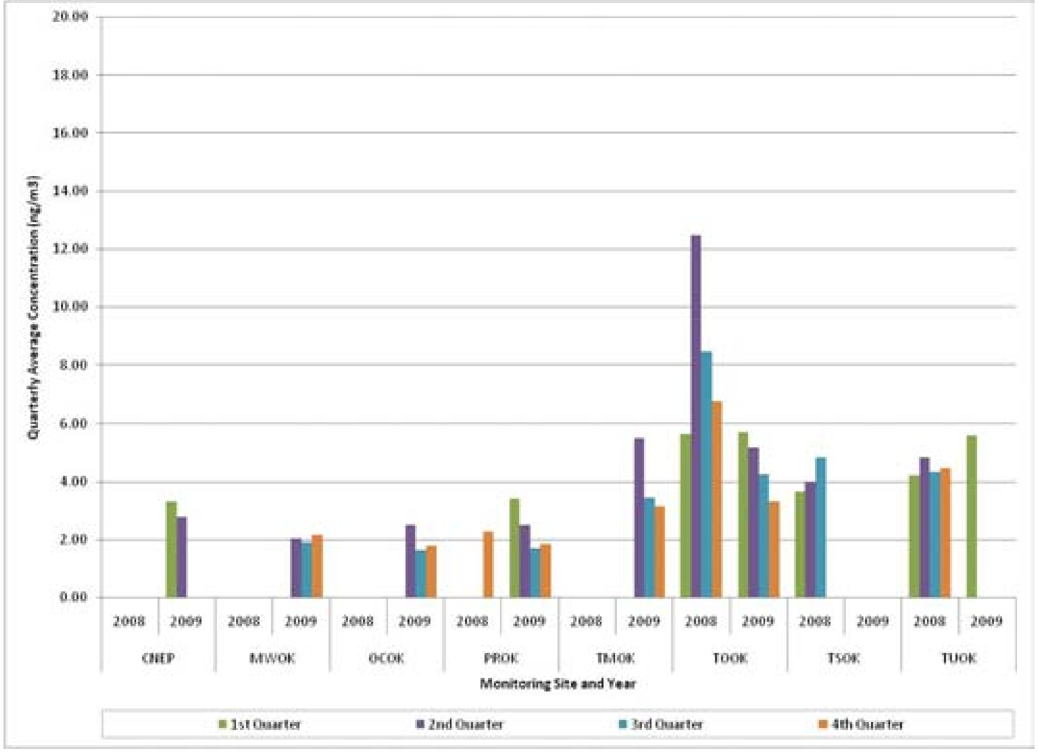


Figure 4-37a. Comparison of Average Quarterly Manganese (PM_{10}) Concentrations

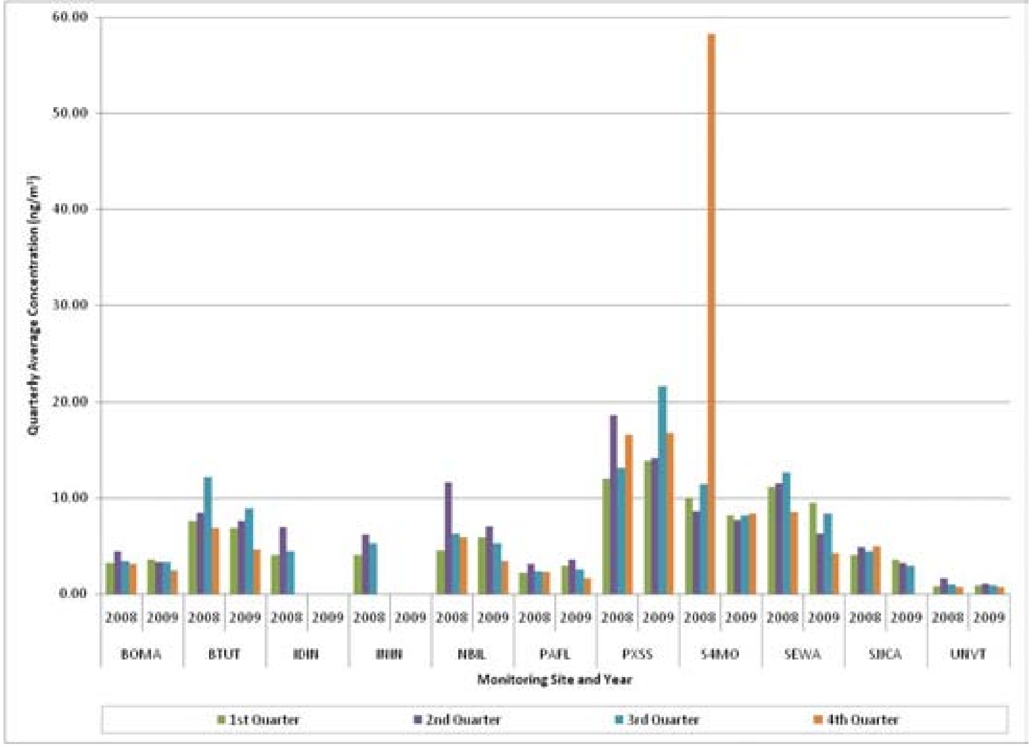


Figure 4-37b. Comparison of Average Quarterly Manganese (TSP) Concentrations

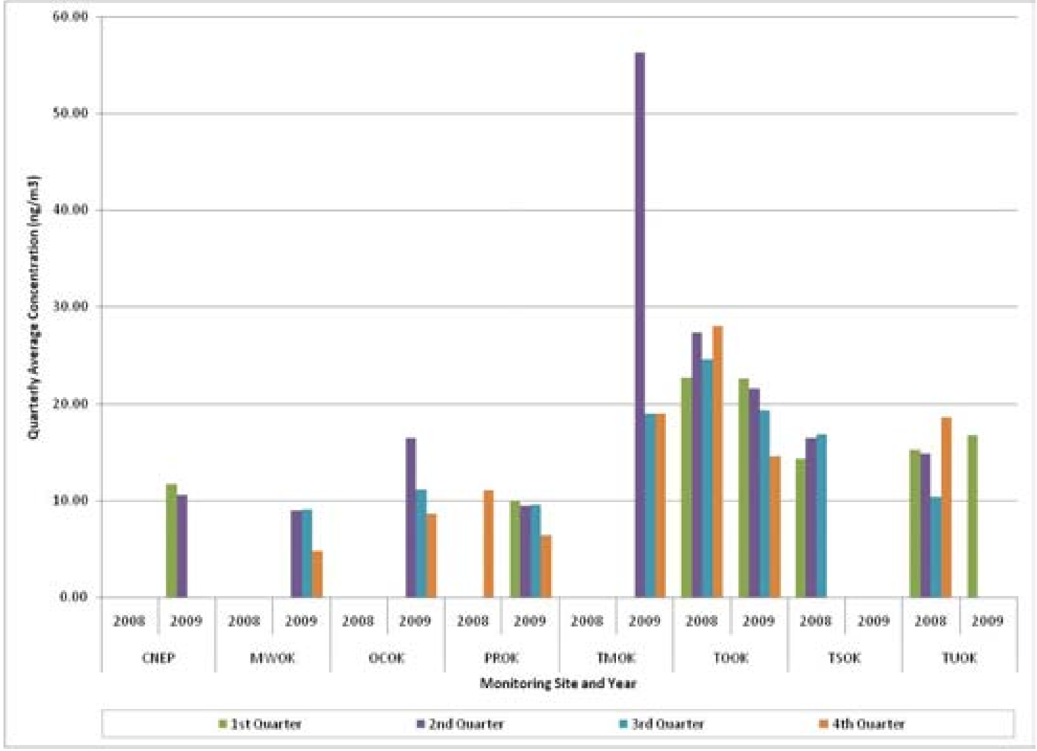


Figure 4-38. Comparison of Average Quarterly Naphthalene Concentrations

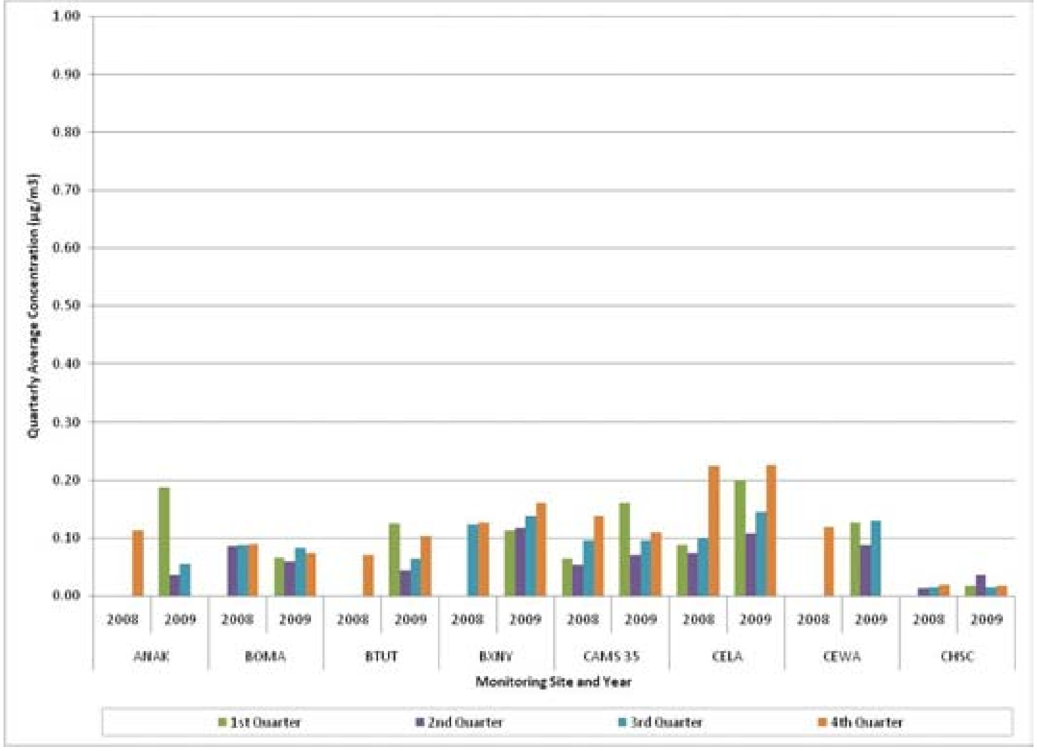


Figure 4-38. Comparison of Average Quarterly Naphthalene Concentrations (Continued)

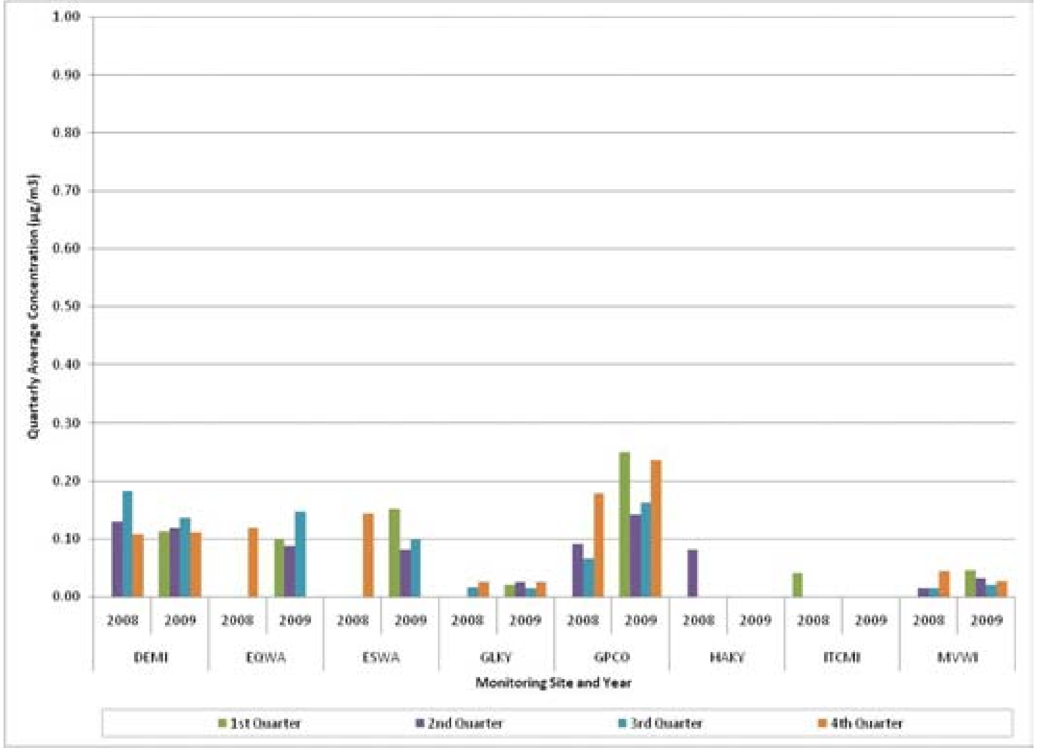


Figure 4-38. Comparison of Average Quarterly Naphthalene Concentrations (Continued)

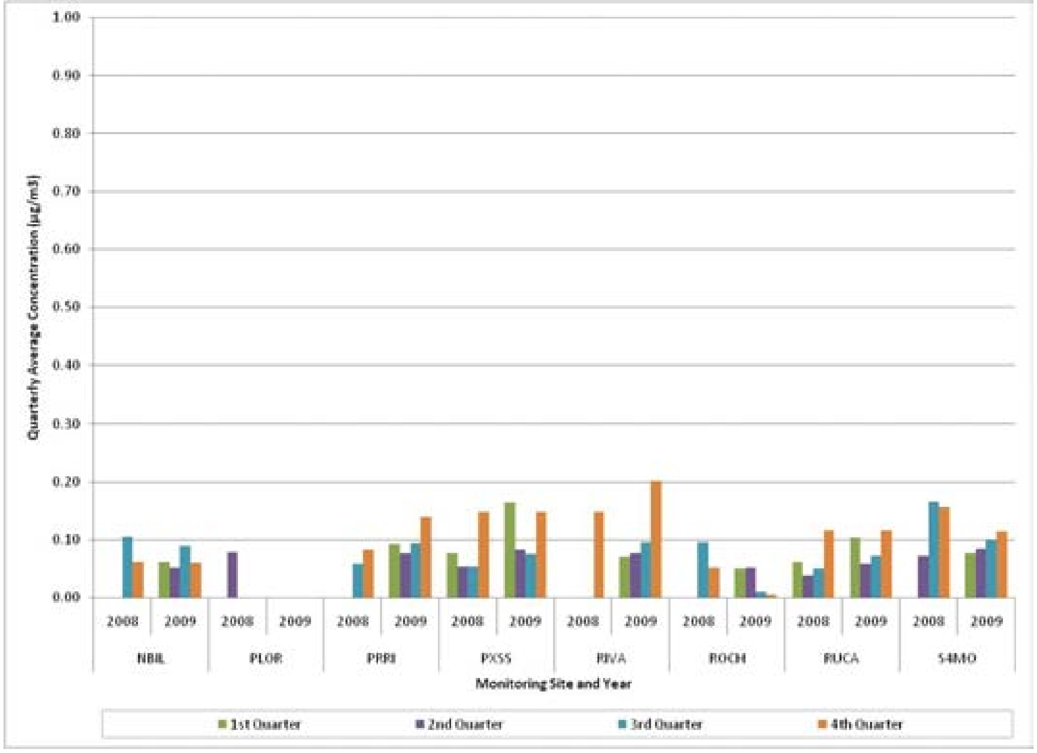


Figure 4-38. Comparison of Average Quarterly Naphthalene Concentrations (Continued)

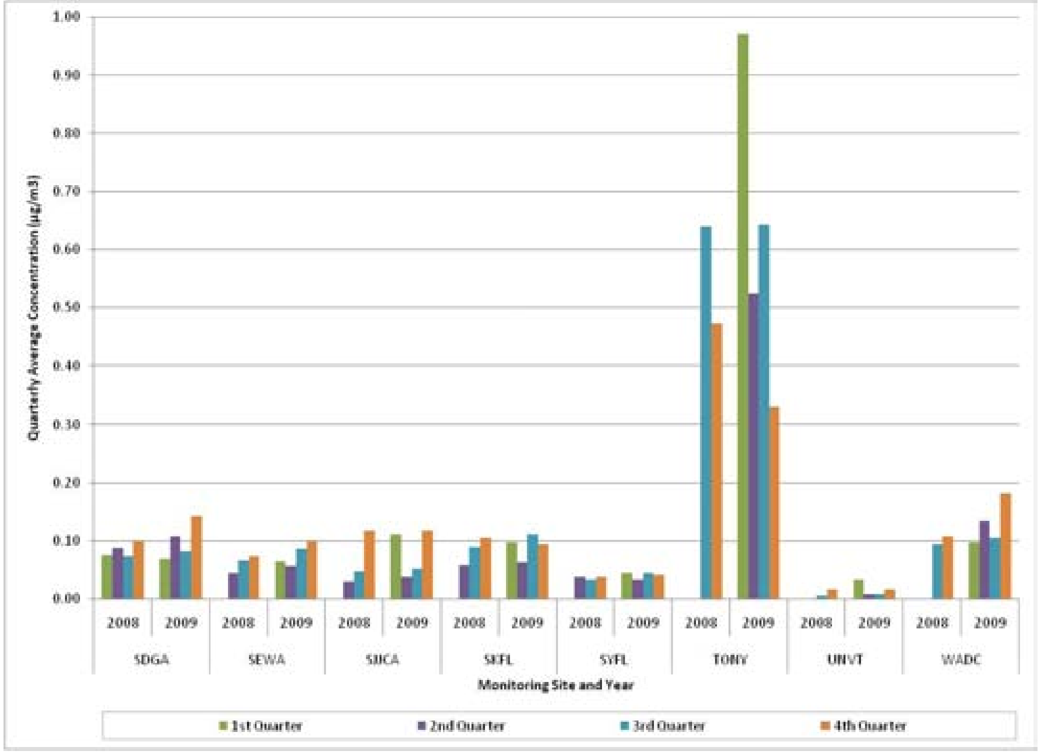


Figure 4-39a. Comparison of Average Quarterly Nickel (PM_{10}) Concentrations

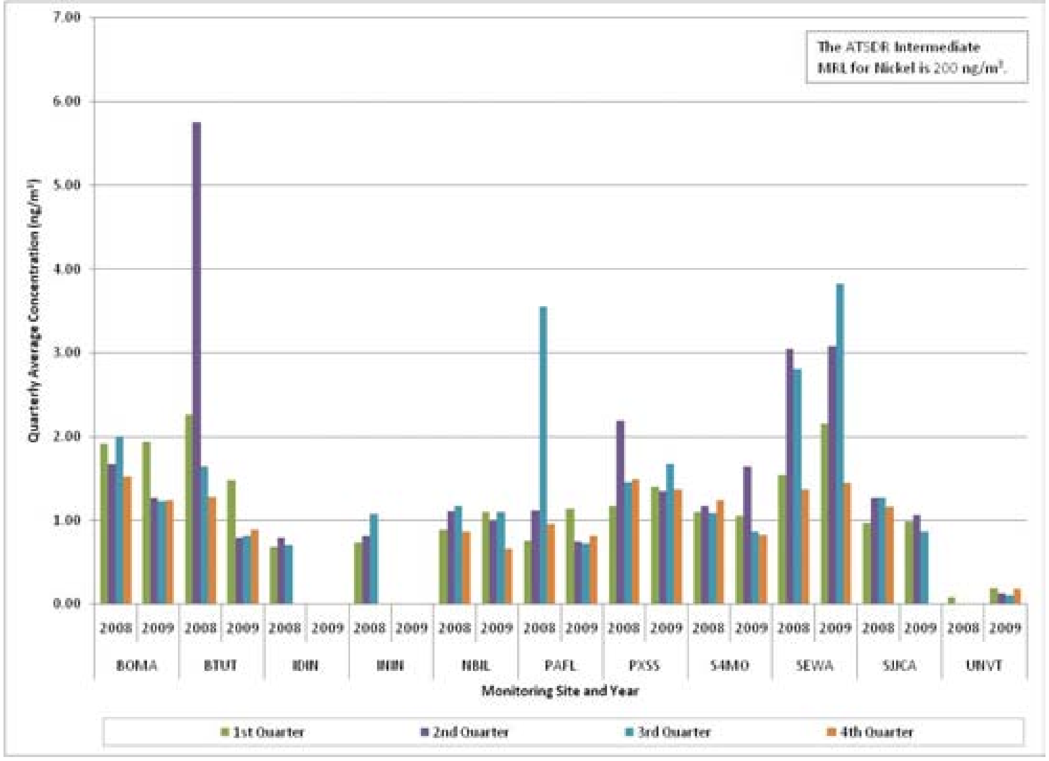


Figure 4-39b. Comparison of Average Quarterly Nickel (TSP) Concentrations

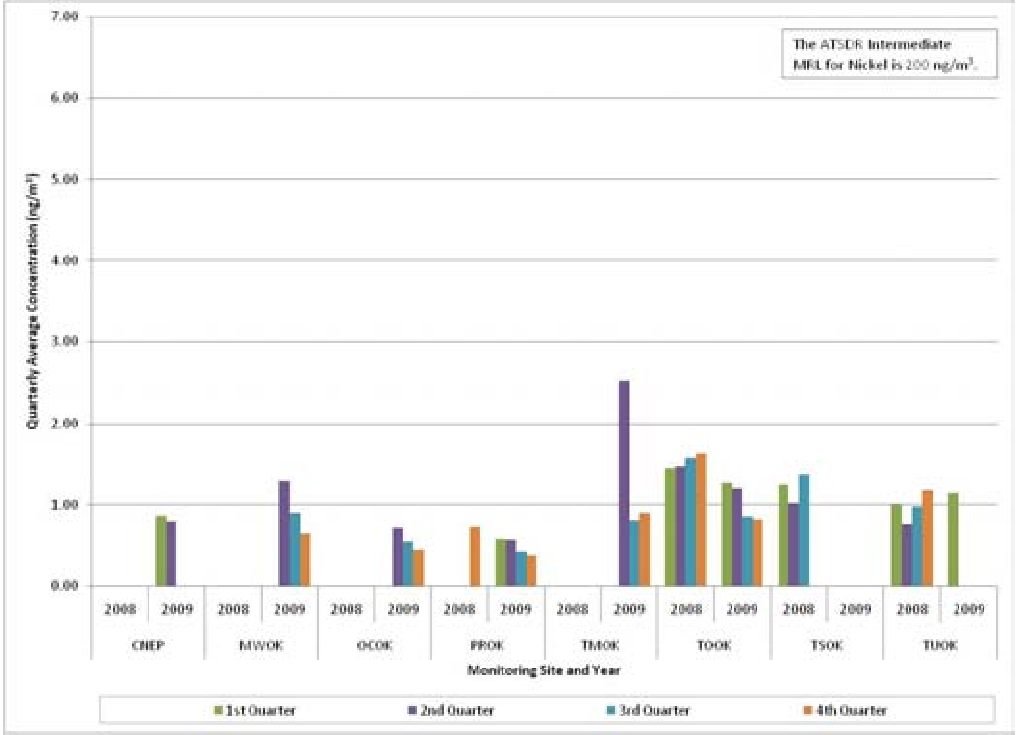


Figure 4-40. Comparison of Average Quarterly Tetrachloroethylene Concentrations

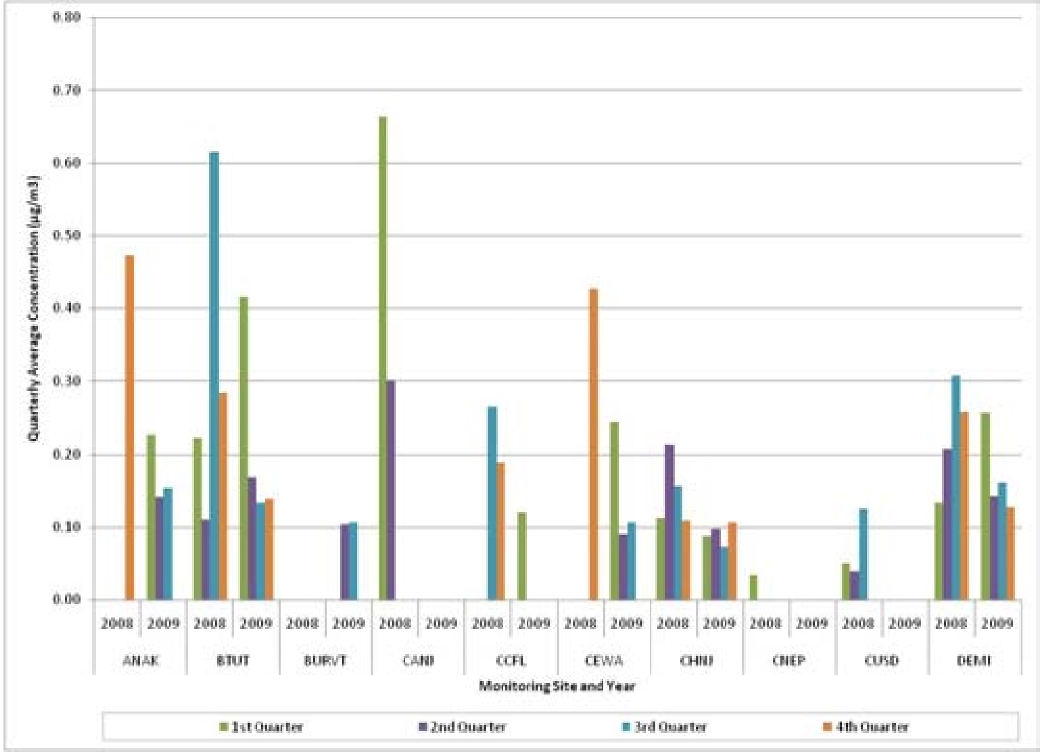


Figure 4-40. Comparison of Average Quarterly Tetrachloroethylene Concentrations (Continued)

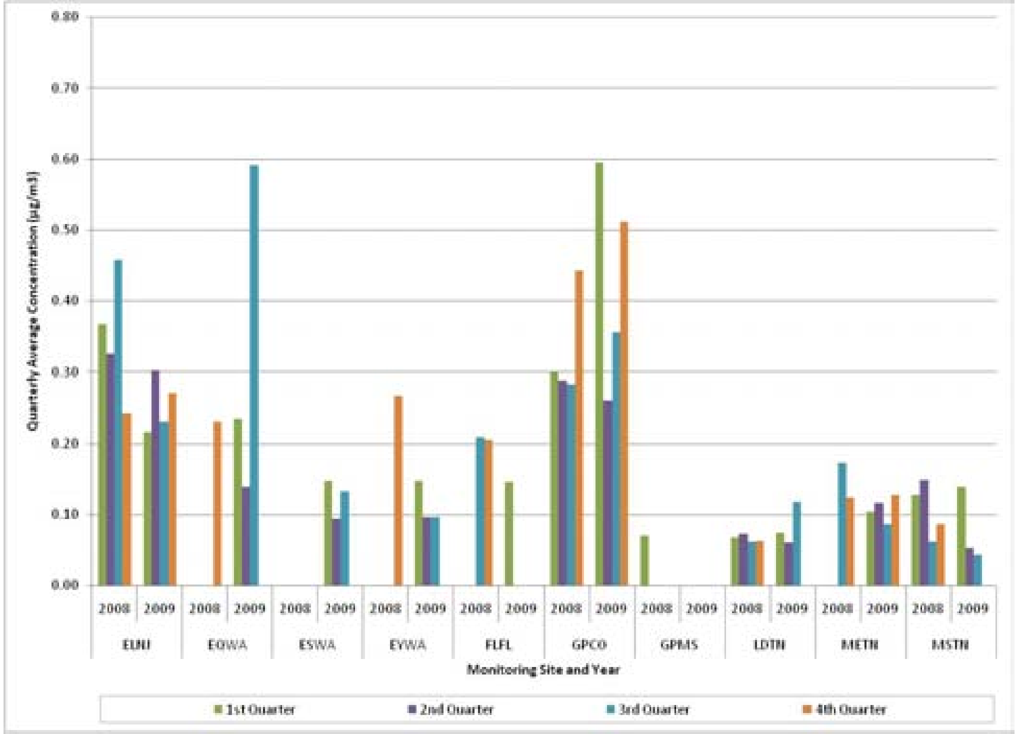


Figure 4-40. Comparison of Average Quarterly Tetrachloroethylene Concentrations (Continued)

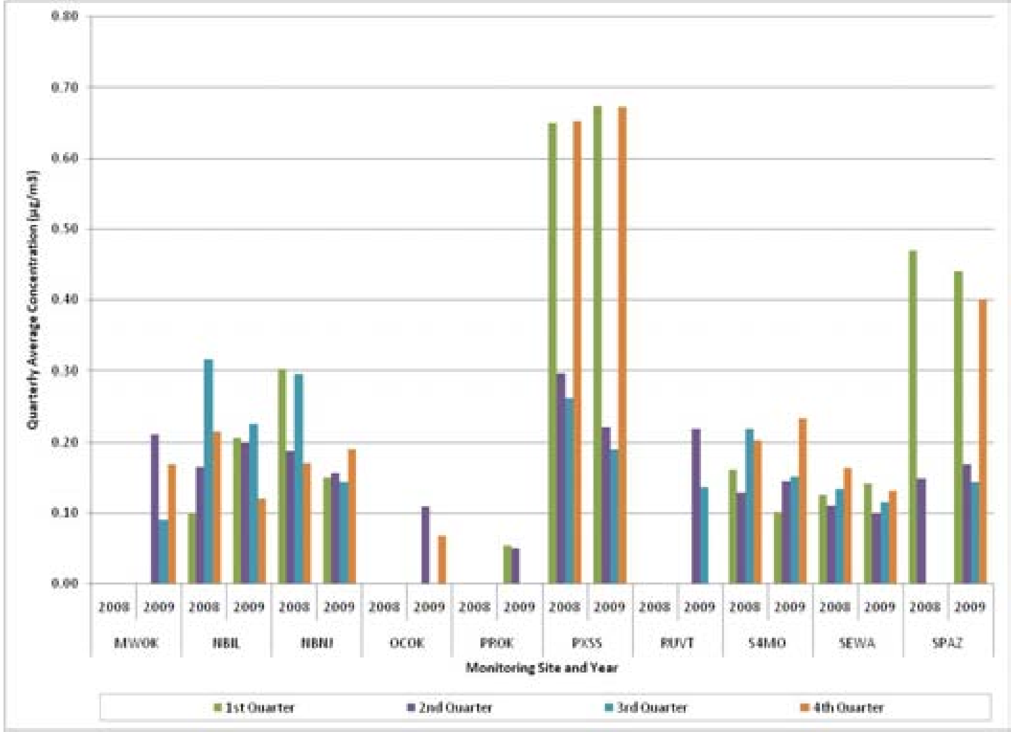


Figure 4-40. Comparison of Average Quarterly Tetrachloroethylene Concentrations (Continued)

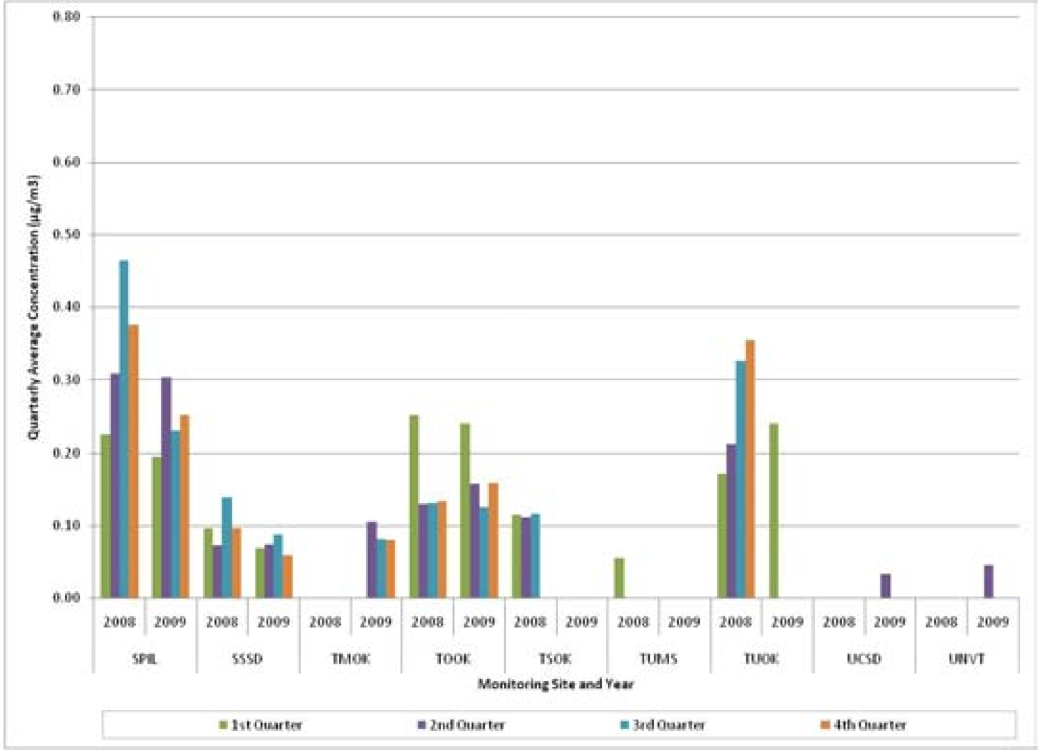


Figure 4-41. Comparison of Average Quarterly Trichloroethylene Concentrations

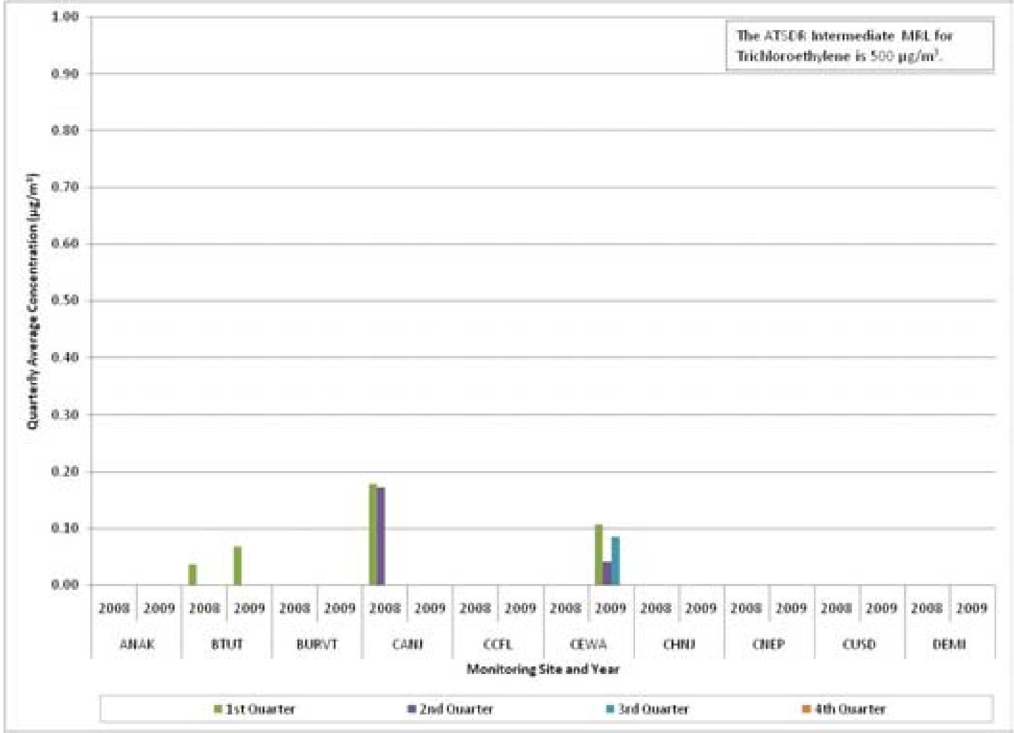


Figure 4-41. Comparison of Average Quarterly Trichloroethylene Concentrations (Continued)

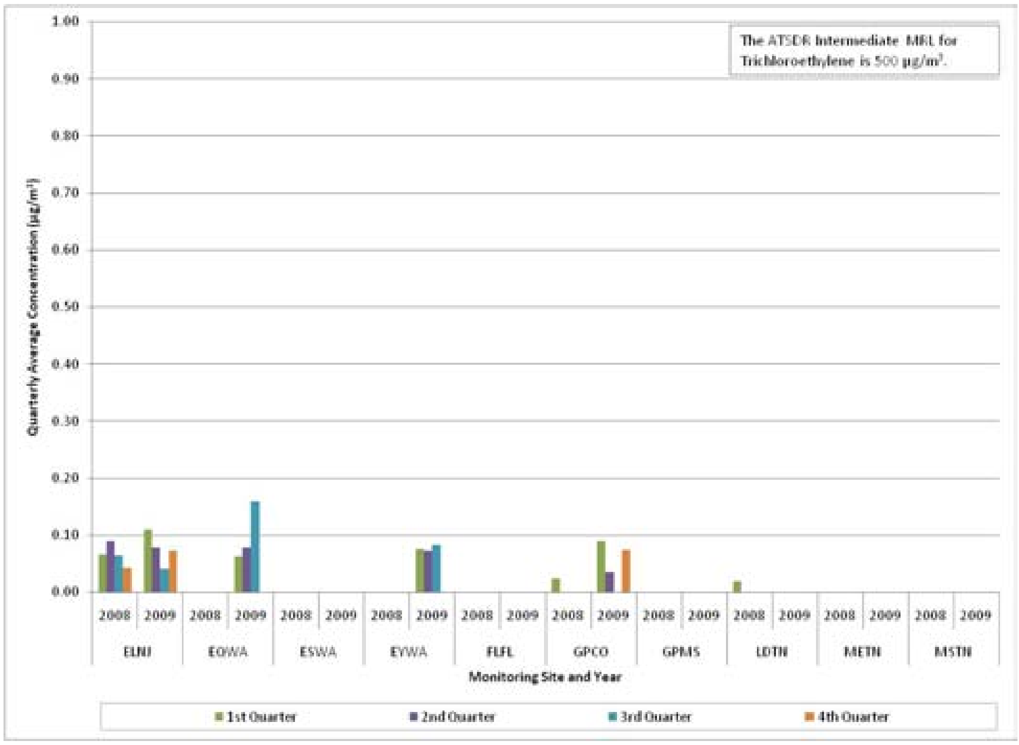


Figure 4-41. Comparison of Average Quarterly Trichloroethylene Concentrations (Continued)

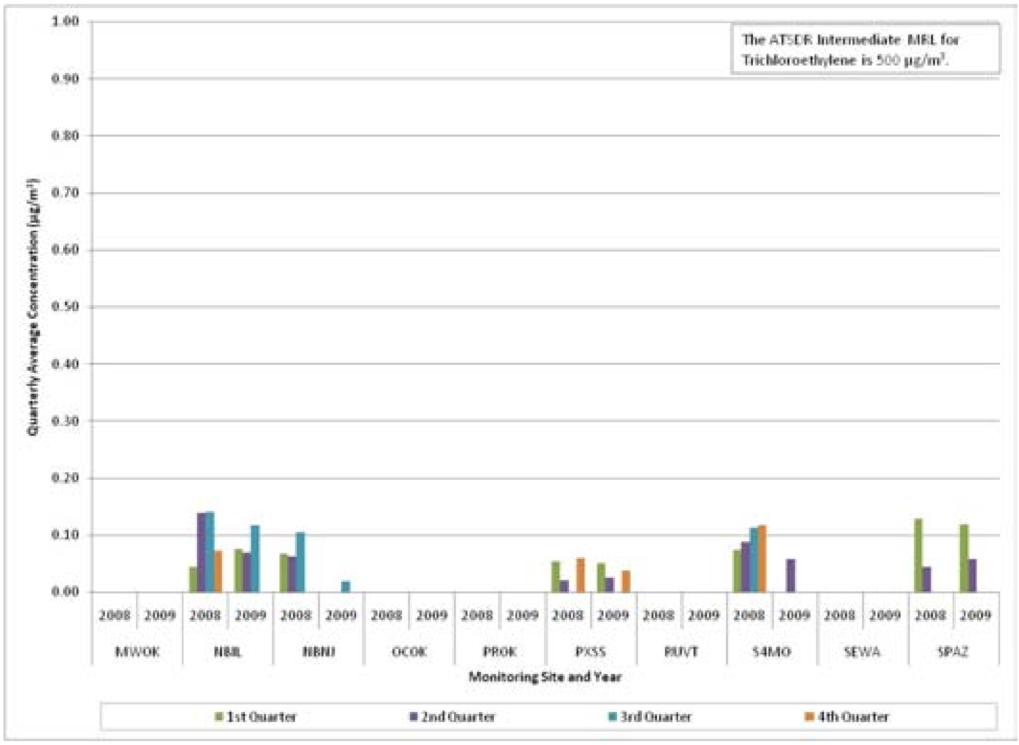


Figure 4-41. Comparison of Average Quarterly Trichloroethylene Concentrations (Continued)

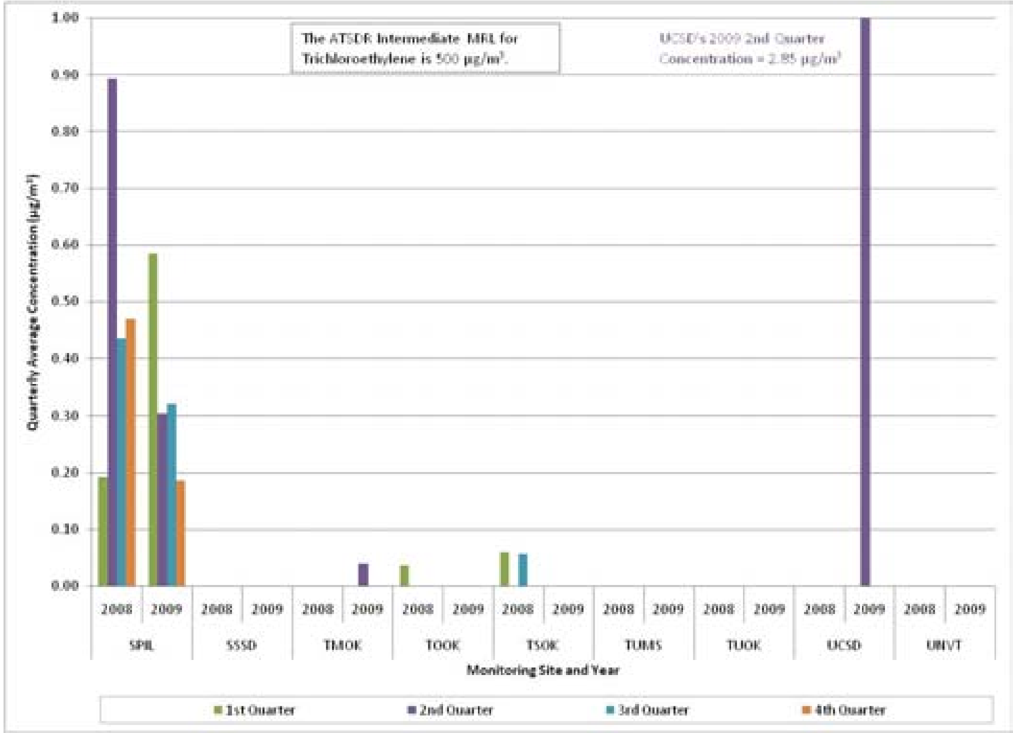


Figure 4-42. Comparison of Average Quarterly Vinyl Chloride Concentrations

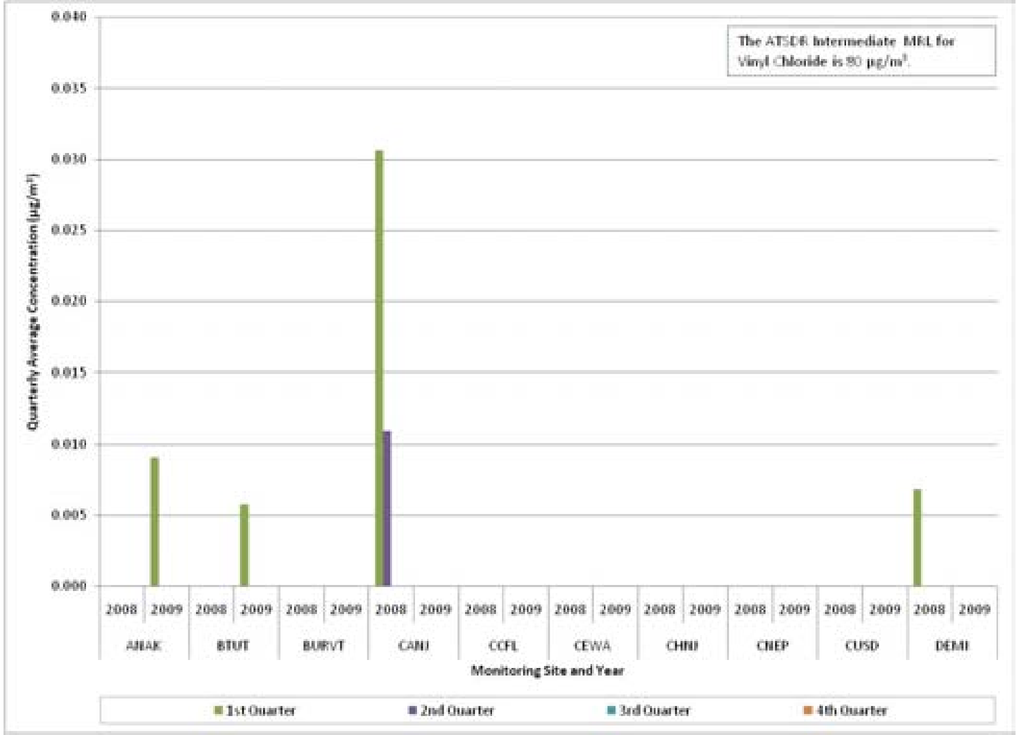


Figure 4-42. Comparison of Average Quarterly Vinyl Chloride Concentrations (Continued)

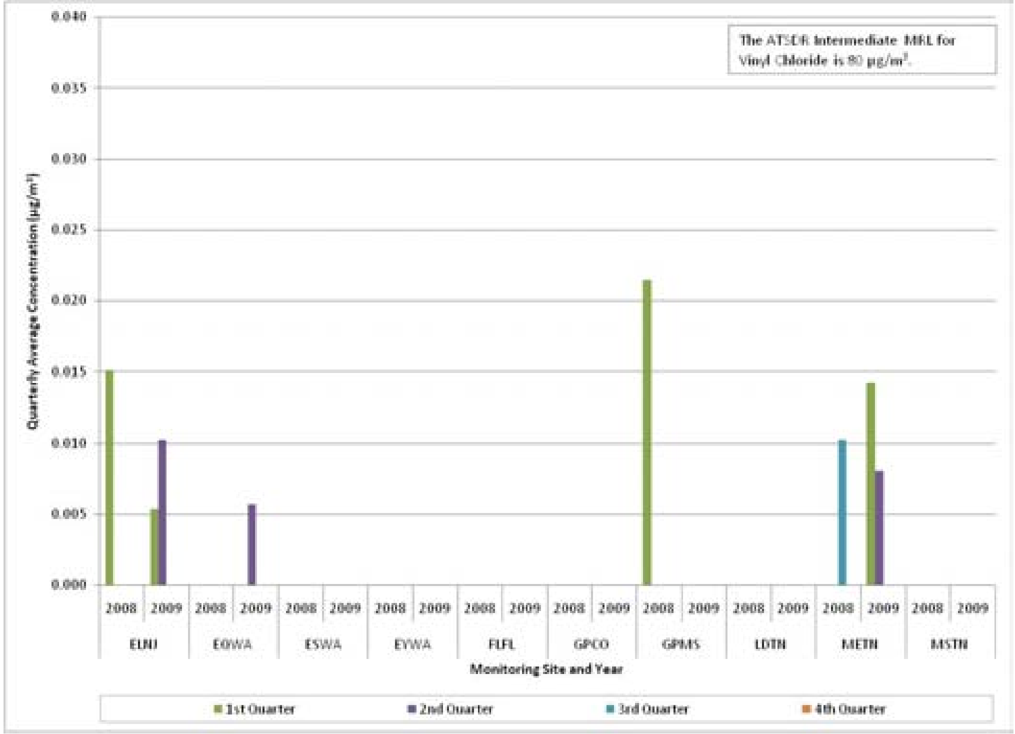


Figure 4-42. Comparison of Average Quarterly Vinyl Chloride Concentrations (Continued)

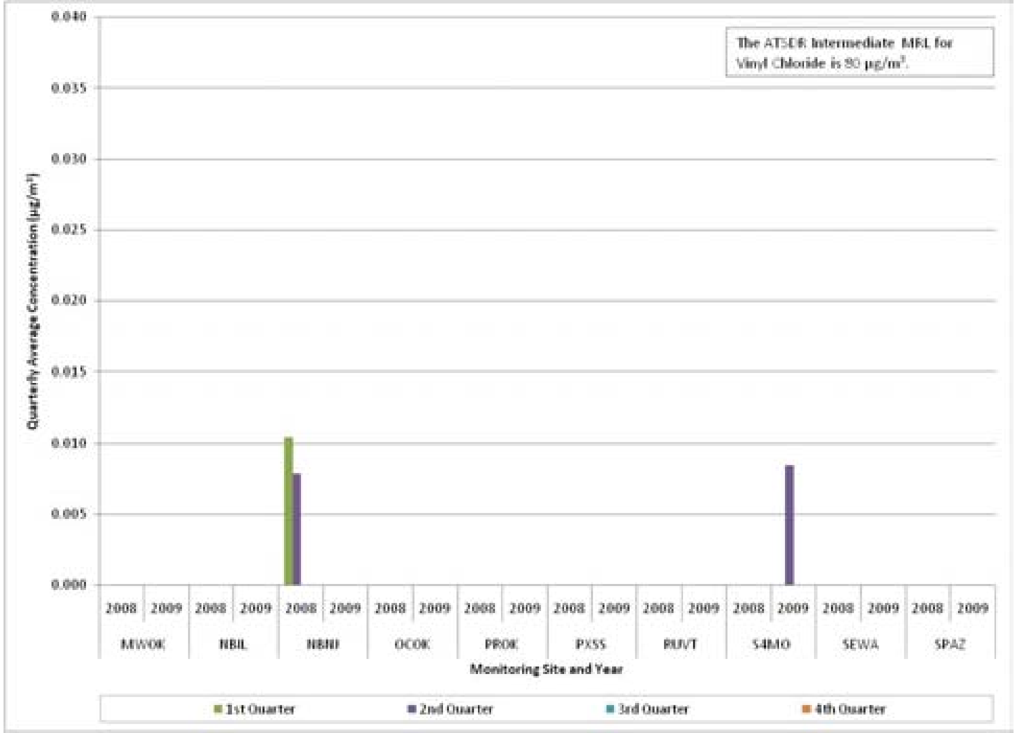
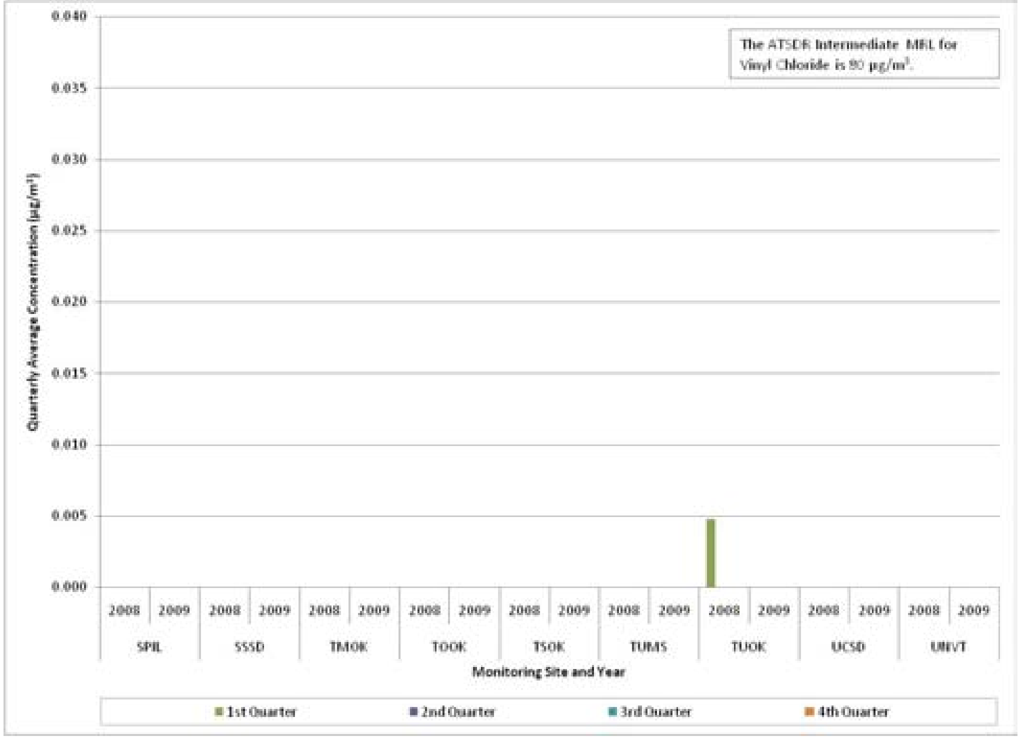


Figure 4-42. Comparison of Average Quarterly Vinyl Chloride Concentrations (Continued)



The quarterly average comparison also allows for the identification of sites with unusually high concentrations of the pollutants of interest compared to other sites and when those high concentrations were measured. For example, Figure 4-34 shows that INDEM's 2008 formaldehyde concentrations are significantly higher than other sites. INDEM's 2009 formaldehyde concentrations were significantly lower than those for 2008, although INDEM's 2009 third quarter average is still generally higher than most of other sites sampling formaldehyde. Another example of inter-site comparison is Figure 4-41 for trichloroethylene. This pollutant was detected in approximately 20 percent of VOC samples and thus does not have many valid quarterly averages. However, two sites stand out in Figure 4-41, SPIL and UCSD. SPIL has four valid quarterly averages for both years and all eight of them are higher than any of the other valid quarterly averages for this pollutant, except one. This exception is for UCSD's second quarter 2009 average concentration, which is more than three times SPIL's highest quarterly average. Of the 34 trichloroethylene concentrations greater than 1 $\mu g/m^3$ measured at NMP sites, UCSD accounts for 11 of these and SPIL accounts for 17.

With one exception, quarterly average concentrations were significantly below their respective ATSDR Intermediate MRLs, as discussed in Section 4.2.2, generally by an order of magnitude or more. The one exception is for formaldehyde, as shown in Figure 4-34. INDEM's 2008 second and third quarter averages are more than three times the ATSDR Intermediate MRL for this pollutant. These quarterly averages are discussed further in Section 13.

Additional observations from Figures 4-22 through 4-42 include the following:

- INDEM's acetaldehyde quarterly average concentrations for 2008 follow the same trends as this site's formaldehyde quarterly concentrations, as shown in Figure 4-22.
- Benzo(a)pyrene tended to be detected most frequently in the first and fourth quarters (the colder months), as these are the quarters with the most valid quarterly averages (81 valid first and fourth quarter averages vs. 41 valid second and third quarter averages), as shown in Figure 4-27.
- Quarterly average 1,3-butadiene concentrations tended to be highest in the first and fourth quarters (the colder months). Figure 4-28 shows that these two quarters tended to track together when a site sampled continuously across the years.

- The range of quarterly average concentrations for carbon tetrachloride ranged from 0.43 µg/m^3 to 0.99 µg/m^3, as shown in Figure 4-30, confirming the expected uniformity discussed above in Section 4.4.1.

- DEMI, LDTN, NBIL, and PXSS tended to have higher quarterly averages of chloroform compared to other NMP sites. Also, concentrations of this pollutant tended to be higher in the third and fourth quarters, which is demonstrated by LDTN, NBIL and PXSS in Figure 4-31, but not DEMI.

- Quarterly averages of naphthalene at TONY are significantly higher than those for other monitoring sites, particularly the first quarter of 2009, as shown in Figure 4-38. Unfortunately, sampling at TONY did not begin July 2008, thus a comparison to the first quarter of 2008 is not possible.

- S4MO had the highest quarterly average concentrations of arsenic, cadmium, lead, and manganese (of the sites sampling PM_{10} metals). For arsenic and manganese, only one quarterly average was significantly higher than other sites, while most of all of the quarterly averages were higher for cadmium and lead.

- Only sites in Oklahoma sampled TSP metals. Among them, the Tulsa sites tended to have higher quarterly averages compared to the Pryor or Oklahoma City sites.

4.5 Greenhouse Gases

Table 4-15 presents the program-level daily average concentrations by year for the 10 GHGs measured using Method TO-15, in descending order by GWP. As shown, each of the GHGs is detected in nearly every sample collected (there were a total 2,868 VOC samples collected). Chloroform was the only pollutant detected in less than 95 percent of VOC samples collected, although it was still detected in over 93 percent of samples. Dichlorodifluoromethane has the highest GWP (10,600), as well as the highest program-level daily averages for both years (2.68 ± 0.03 µg/m^3 and 3.05 ± 0.03 µg/m^3). Bromomethane has both the lowest GWP (5) and the lowest program-level daily averages (0.08 ± 0.02 µg/m^3 for 2008 and 0.05 ± <0.01 µg/m^3 for 2009).

Table 4-15. Greenhouse Gases Measured by Method TO-15

Pollutant	Global Warming Potential[1] (100 yrs)	Total # of Measured Detections	2008 Program Daily Average ($\mu g/m^3$)	2009 Program Daily Average ($\mu g/m^3$)
Dichlorodifluoromethane	10,600	2,865	2.68 ± 0.03	3.05 ± 0.03
Dichlorotetrafluoroethane	9,800	2,841	0.14 ± 0.01	0.15 ± <0.01
Trichlorotrifluoroethane	6,000	2,807	0.70 ± 0.01	0.84 ± 0.01
Trichlorofluoromethane	4,600	2,810	1.49 ± 0.02	1.76 ± 0.05
Carbon Tetrachloride	1,800	2,864	0.72 ± 0.01	0.70 ± 0.01
1,1,1-Trichloroethane	140	2,865	0.10 ± <0.01	0.08 ± <0.01
Chloroform	30	2,692	0.24 ± 0.02	0.20 ± 0.02
Chloromethane	16	2,867	1.37 ± 0.03	1.37 ± 0.01
Dichloromethane	10	2,865	1.03 ± 0.36	1.63 ± 0.67
Bromomethane	5	2,788	0.08 ± 0.02	0.05 ± <0.01

[1] GWP presented here are taken from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR) (IPCC, 2001).

5.0 Site in Alaska

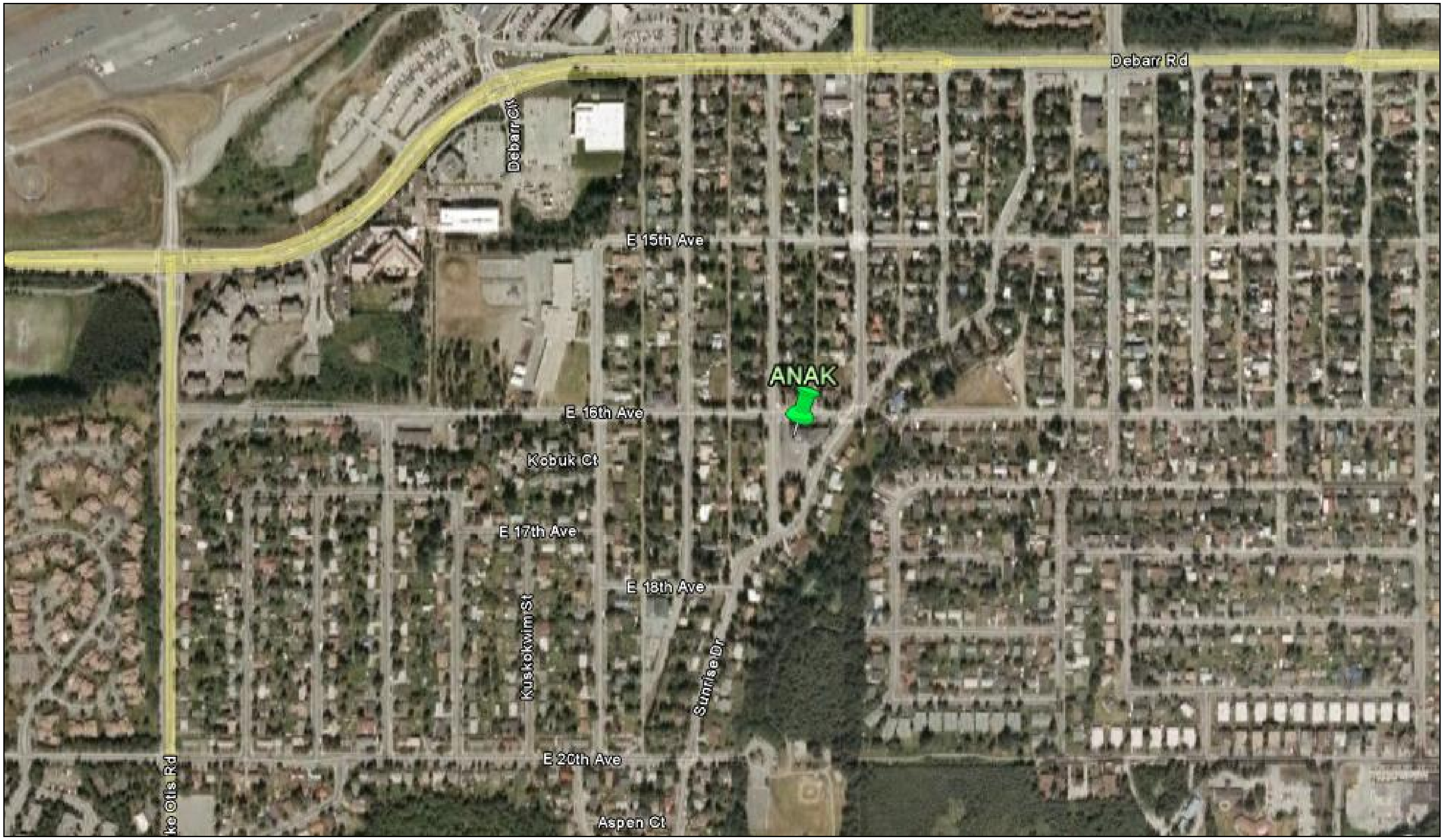
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP site in Alaska, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

5.1 Site Characterization

This section characterizes the ANAK monitoring site by providing geographical and physical information about the location of the monitoring site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The ANAK monitoring site is located in Anchorage, Alaska. Figure 5-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 5-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 5-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 5-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 5-1. Anchorage, Alaska (ANAK) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 1,561 feet

Figure 5-2. NEI Point Sources Located Within 10 Miles of ANAK

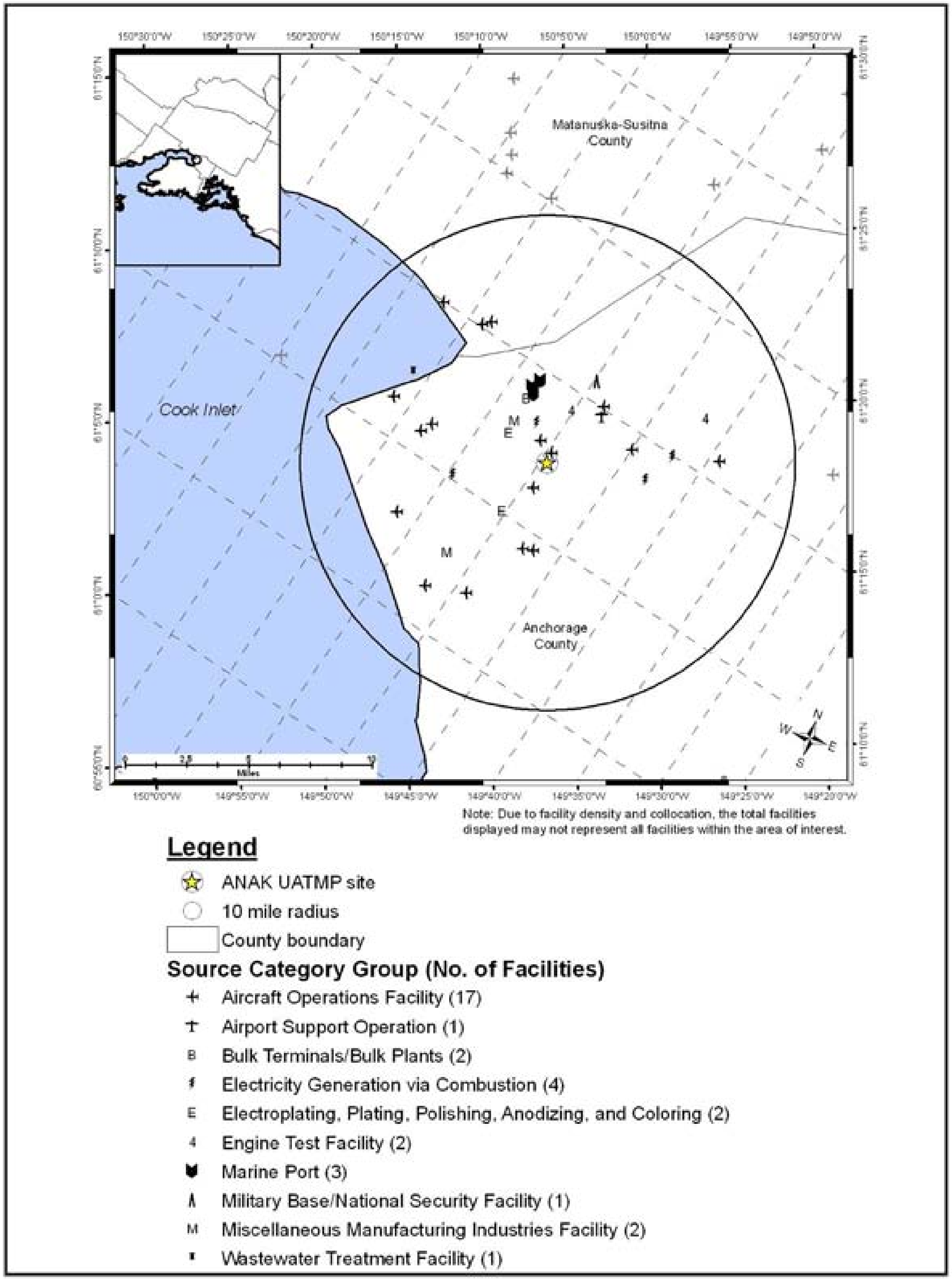

Matanuska-Susitna County
Anchorage County
Cook Inlet
Miles
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
ANAK UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (17)
Airport Support Operation (1)
Bulk Terminals/Bulk Plants (2)
Electricity Generation via Combustion (4)
Electroplating, Plating, Polishing, Anodizing, and Coloring (2)
Engine Test Facility (2)
Marine Port (3)
Military Base/National Security Facility (1)
Miscellaneous Manufacturing Industries Facility (2)
Wastewater Treatment Facility (1)

Table 5-1. Geographical Information for the Alaska Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
ANAK	02-020-0018	Anchorage	Anchorage	Anchorage	61.205861, -149.824722	Residential	Suburban	CO, Meteorological parameters, PM_{10}, $PM_{2.5}$.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

Anchorage is located near the end of the Cook Inlet, on the landmass between the Knik Arm and the Turnagain Arm. The city is surrounded primarily by mountains, including several national parks. The monitoring site is located in the north-central portion of the city, in the parking lot of Trinity Christian Reformed Church, off 16th Avenue. Figure 5-1 shows that residential subdivisions surround the monitoring site, and that Merrill Field Airport is located approximately 1/2 mile to the northwest. As Figure 5-2 shows, there are several point sources scattered around ANAK, the most numerous of which are included in the aircraft operations source category group. This source category includes airports as well as small runways, heliports, or landing pads. The point source closest to ANAK is a landing pad at the nearby Alaska Regional Hospital. Other emissions source categories surrounding ANAK include electricity generation via combustion, marine ports, and electroplating, plating, polishing, anodizing, and coloring.

Table 5-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Alaska monitoring site. Information provided in Table 5-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for the Anchorage Borough were obtained from the Alaska Department of Motor Vehicles (AK DMV, 2011) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 5-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 5-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 5-2 presents the daily VMT for the Anchorage urban area.

Table 5-2. Population, Motor Vehicle, and Traffic Information for the Alaska Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
ANAK	286,174	335,703	1.17	246,599	289,279	24,143	4,612

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2008 data from the Alaska DMV (AK DMV, 2011).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2008 data from the Alaska DOT (AK DOT, 2008).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

Observations from Table 5-2 include the following:

- ANAK's county and 10-mile populations were in the lower third of the range compared to all counties with NMP sites while the county-level and 10-mile vehicle registrations were in the middle of the range.

- The vehicle-per-person ratio was among the higher ratios compared to other NMP sites, indicating that many people have more than one vehicle.

- The traffic volume experienced near ANAK was in the middle of the range compared to other NMP sites. The traffic estimate was based on the segment of Debarr Road between Bragaw Street and Airport Heights Drive.

- The Anchorage urban area VMT was one of the lowest among urban areas with NMP sites.

5.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Alaska on sample days, as well as over the course of the study period.

5.2.1 Climate Summary

The city of Anchorage is surrounded by the waters of the Cook Inlet to the north, west, and south. The climate of Anchorage is considered a transition zone from maritime to continental (WRCC, 2011). The Chugach Mountains to the south prevent warm, moist air from moving northward from the Gulf of Alaska while the Alaska Range to the north acts as a barrier to very cold air moving southward. Although there are four distinct seasons in Anchorage, winters are long, extending from October through April, and snowfall is common. Due to its high latitude, daylight lasts about 19 hours in June and only six hours in December. Winds are generally light, although very strong winds off the surrounding mountains occur occasionally during the winter (Bair, 1992).

5.2.2 Meteorological Conditions during the Study Period

Hourly meteorological data from the NWS weather station nearest this site were retrieved for October 2008 to October 2009 to correspond with the period of sampling (NCDC, 2008 and 2009). The closest NWS weather station to ANAK is located at Merrill Field Airport (WBAN 26409). Additional information about the Merrill Field weather station is provided in Table 5-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the study period.

Table 5-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire study period. Also included in Table 5-3 is the 95 percent confidence interval for each parameter. As shown in Table 5-3, average meteorological conditions on sample days were fairly representative of average weather conditions experienced throughout the sample period.

5.2.3 Back Trajectory Analysis

Figure 5-3 is the composite back trajectory map for days on which samples were collected at the Alaska monitoring site over the sample period from October 2008 to October 2009 (note that 2008 sample day trajectories are shown in blue and 2009 sample day trajectories are shown in red). Figure 5-4 is the cluster analysis based on sample day back trajectories over the entire sample period. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite map, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 5-3 and 5-4 represents 100 miles.

Table 5-3. Average Meteorological Conditions near the Alaska Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Anchorage, Alaska - ANAK										
Merrill Field Airport 26409 (61.217, -149.855)	1.28 miles 341.0° (NNW)	Oct 2008-Oct 2009	Sample Day	44.4 ± 5.0	37.5 ± 4.8	27.1 ± 4.4	33.3 ± 4.3	68.5 ± 2.9	1011.7 ± 2.7	2.8 ± 0.5
			All Days	43.2 ± 2.1	36.7 ± 2.0	27.1 ± 1.9	32.8 ± 1.8	70.4 ± 1.2	1011.1 ± 1.1	3.0 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the study period averages.

Figure 5-3. 2008-2009 Composite Back Trajectory Map for ANAK

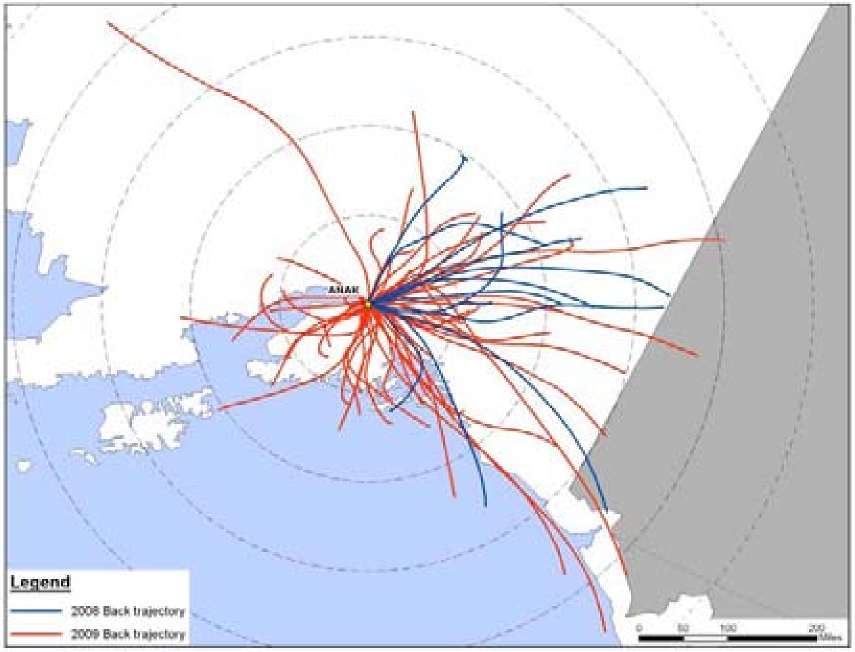
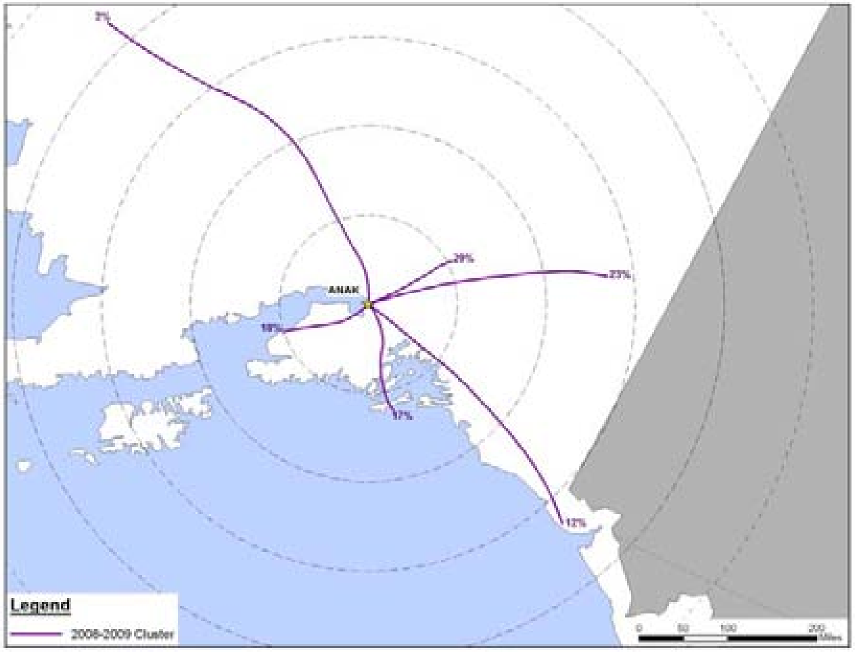


Figure 5-4. Back Trajectory Cluster Map for ANAK



Observations from Figures 5-3 and 5-4 include the following:

- The 24-hour air shed domain for ANAK was smaller in size compared to many other NMP monitoring sites. The farthest away a back trajectory originated was towards Juneau, the state capital of Alaska, or about 450 miles away. However, the average trajectory length was 188 miles and nearly 84 percent of trajectories originated within 300 miles of the site.

- Back trajectories originated primarily to the north-northeast to east-northeast of ANAK on sample days. Another cluster of trajectories originated from the east, southeast, and south and were generally shorter in length.

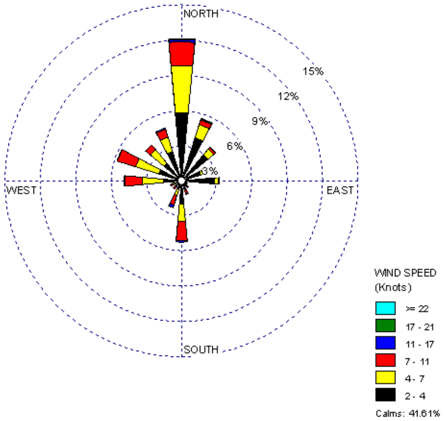
- The cluster analysis shows that over 50 percent of trajectories originated from the northeast or east. Nearly 20 percent of trajectories originated from the south-southeast to south-southwest and roughly within 100 or so miles of the site. Nearly 20 percent originated from the northwest, west, or southwest. Twelve percent of trajectories originated towards Juneau and southeast Alaska. The long cluster trajectory (2 percent) represents a single trajectory originating over south-central Alaska.

5.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at Merrill Field Airport were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

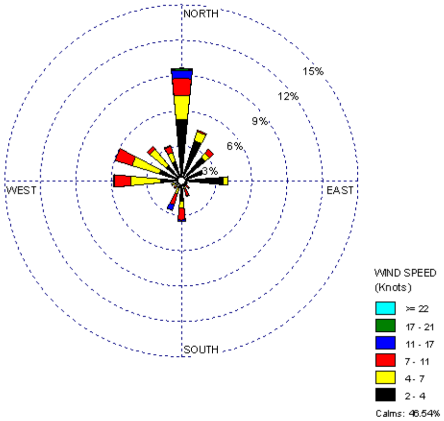
Figure 5-5 presents three different wind roses for the Alaska monitoring site. First, a historical wind rose representing 1998 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose representing wind observations for the entire October 2008 to October 2009 study period is presented. Finally, a wind rose representing the days on which samples were collected is presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire study period.

Figure 5-5. Wind Roses for the Merrill Field Airport Weather Station near ANAK



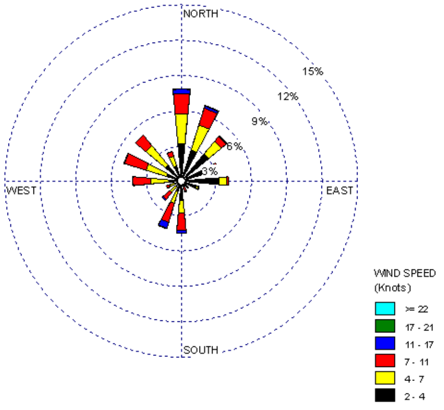
Wind Rose

Study Period



Wind Rose

Sample Day



**1998 – 2007 Historical
Wind Rose**

Observations from Figure 5-5 for ANAK include the following:

- The historical wind rose shows that calm winds (≤ 2 knots) account for nearly 40 percent of the hourly wind measurements from 1998 to 2007. In addition, northerly, north-northeasterly, and northeasterly winds were the most commonly observed wind directions near ANAK, accounting for 20 percent of the observations.

- The sample period wind patterns have some similarities to the historical wind patterns. Calm winds were observed for nearly 42 percent of the observations. Northerly winds were the most commonly observed wind direction both historically and during the sample period, but accounted for a higher percentage of observations during the sample period.

- The sample day wind patterns are similar to the sample period wind patterns, although there are some slight differences. Calm winds accounted for nearly 47 percent of the observations on sample days vs. 42 percent over the entire period. Northerly winds accounted for less than 10 percent of wind directions on sample days vs. 12 percent over the entire period.

5.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the ANAK monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 5-4 presents ANAK's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the ANAK monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. ANAK sampled for VOC and PAH.

Table 5-4. Risk Screening Results for the Alaska Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Anchorage, Alaska - ANAK						
Benzene	0.13	62	62	100.00	18.67	18.67
Carbon Tetrachloride	0.17	60	62	96.77	18.07	36.75
1,3-Butadiene	0.033	57	62	91.94	17.17	53.92
Naphthalene	0.029	51	61	83.61	15.36	69.28
Ethylbenzene	0.4	34	62	54.84	10.24	79.52
Tetrachloroethylene	0.17	29	62	46.77	8.73	88.25
Acrylonitrile	0.015	21	21	100.00	6.33	94.58
p-Dichlorobenzene	0.091	6	51	11.76	1.81	96.39
Benzo(a)pyrene	0.00091	5	38	13.16	1.51	97.89
Xylenes	10	4	62	6.45	1.20	99.10
1,2-Dichloroethane	0.038	1	1	100.00	0.30	99.40
Dichloromethane	2.1	1	62	1.61	0.30	99.70
Trichloroethylene	0.5	1	10	10.00	0.30	100.00
Total		332	616	53.90		

Observations from Table 5-4 include the following:

- Thirteen pollutants failed at least one screen for ANAK, of which seven are NATTS MQO Core Analytes.
- Eight pollutants, of which five are NATTS MQO Core Analytes, were initially identified as ANAK's pollutants of interest. Benzo(a)pyrene and trichloroethylene were added to ANAK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of ANAK's total failed screens.
- Chloroform and vinyl chloride were added to ANAK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These pollutants are not shown in Table 5-4. Chloroform was detected in all 62 samples collected; vinyl chloride was detected in 16 of 62 samples collected.
- As shown in Table 5-4, approximately 54 percent of measured detections failed screens (of the pollutants failing at least one screen).
- Every concentration of benzene and over 90 percent of carbon tetrachloride and 1,3-butadiene concentrations failed screens.

5.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Alaska monitoring site. Concentration averages are provided for the pollutants of interest for the ANAK monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

5.4.1 2008-2009 Concentration Averages

Daily, quarterly, and study concentration averages were calculated for the pollutants of interest for ANAK, as described in Section 3.1.1. The *daily* average of a particular pollutant is simply the average concentration of all measured detections within the study period. If there were at least seven measured detections within a given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, in lieu of an annual average, the *study* average for a pollutant includes all measured detections and substituted zeros for non-detects over the period of sampling. Study averages were calculated for monitoring sites that sampled for a 1-year period that overlapped 2008 and 2009, provided that at least three quarterly averages could be calculated and method completeness was greater than or equal to 85 percent, as described in Section 3.1.1. The study averages for ANAK represent the sample period from October 2008 to October 2009. Daily, quarterly, and study averages are presented in Table 5-5, where applicable. Note that concentrations of the PAHs are presented in ng/m^3 for ease of viewing.

Observations for ANAK from Table 5-5 include the following:

- The daily averages of benzene and ethylbenzene were at least an order of magnitude higher than the other pollutants of interest. The same is also true for all of benzene’s quarterly averages and its study average concentration.

- Based on the available quarterly averages, benzene and 1,3-butadiene concentrations were highest during the colder months of the year. A few other pollutants appear to exhibit this trend as well, but the differences are not statistically significant.

Table 5-5. Daily, Quarterly, and Study Average Concentrations of the Pollutants of Interest for the Alaska Monitoring Site

Pollutant	2008					2009					Study Average (µg/m^3)
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	
Anchorage, Alaska - ANAK											
Acrylonitrile	ND	NR	NR	NR	NA	0.12 ± 0.03	0.04 ± 0.02	NA	NA	NA	NA
Benzene	5.69 ± 2.37	NR	NR	NR	5.69 ± 2.37	2.84 ± 1.01	5.44 ± 3.07	1.67 ± 0.41	1.81 ± 0.52	NA	3.39 ± 0.96
1,3-Butadiene	0.30 ± 0.12	NR	NR	NR	0.30 ± 0.12	0.13 ± 0.06	0.27 ± 0.18	0.06 ± 0.02	0.06 ± 0.02	NA	0.16 ± 0.05
Carbon Tetrachloride	0.61 ± 0.08	NR	NR	NR	0.61 ± 0.08	0.62 ± 0.06	0.43 ± 0.10	0.63 ± 0.07	0.73 ± 0.07	NA	0.62 ± 0.05
Chloroform	0.12 ± 0.02	NR	NR	NR	0.12 ± 0.02	0.12 ± 0.02	0.12 ± 0.05	0.10 ± 0.01	0.14 ± 0.02	NA	0.12 ± 0.01
p-Dichlorobenzene	0.07 ± 0.02	NR	NR	NR	0.05 ± 0.02	0.05 ± 0.01	0.06 ± 0.02	0.04 ± 0.01	0.04 ± 0.01	NA	0.04 ± 0.01
Ethylbenzene	1.28 ± 0.47	NR	NR	NR	1.28 ± 0.47	0.69 ± 0.30	1.36 ± 0.94	0.48 ± 0.21	0.36 ± 0.11	NA	0.81 ± 0.26
Tetrachloroethylene	0.47 ± 0.30	NR	NR	NR	0.47 ± 0.30	0.17 ± 0.03	0.23 ± 0.08	0.14 ± 0.03	0.15 ± 0.04	NA	0.23 ± 0.07
Trichloroethylene	0.06 ± 0.04	NR	NR	NR	NA	0.22 ± 0.33	NA	NA	NA	NA	NA
Vinyl Chloride	0.01 ± <0.01	NR	NR	NR	NA	0.01 ± 0.01	0.01 ± 0.01	NA	NA	NA	NA
Benzo(a)pyrene[a]	0.54 ± 0.31	NR	NR	NR	0.54 ± 0.31	0.24 ± 0.21	0.41 ± 0.42	0.03 ± 0.02	NA	NA	0.21 ± 0.12
Naphthalene[a]	113.59 ± 43.91	NR	NR	NR	113.59 ± 43.91	83.44 ± 49.12	187.73 ± 184.08	36.84 ± 5.51	55.95 ± 13.04	NA	89.37 ± 40.17

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or study average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

- Because sampling took place from October 2008 to October 2009, ANAK does not have first, second or third quarter averages for 2008 or fourth quarter averages for 2009. There were not enough measured detections of some pollutants, such as acrylonitrile, for quarterly or study averages to be calculated.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Alaska site from those tables include the following:

- ANAK's 2008 and 2009 daily average benzene concentrations were the highest for this pollutant among all NMP sites sampling benzene. The 2008 daily average concentration of benzene for ANAK (5.69 ± 2.37 $\mu g/m^3$) was twice the 2009 daily average concentration of benzene (2.84 ± 1.01 $\mu g/m^3$). However, it is important to note that the 2008 daily average incorporates only October through December.

- The 2008 daily average concentrations of 1,3-butadiene and ethylbenzene for ANAK also topped the list of highest daily average concentrations for these program-level pollutants of interest.

5.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. ANAK has not sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

5.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the ANAK monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

5.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the ANAK monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for ANAK were compared to the acute MRL; quarterly averages were compared to the intermediate MRL; and study averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the ANAK monitoring site were higher than their respective MRL noncancer health risk benchmarks.

5.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Alaska monitoring site and where *study average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for study averages and how cancer and noncancer surrogate risk approximations are calculated). Study averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 5-6, where applicable.

Observations for ANAK from Table 5-6 include the following:

- The pollutants with the highest daily average concentrations by mass were benzene, ethylbenzene, and carbon tetrachloride.

- Based on the study averages and cancer UREs, benzene, 1,3-butadiene, and carbon tetrachloride had the three highest cancer risk approximations, respectively. The benzene cancer risk approximation was an order of magnitude higher than the cancer risk approximation for 1,3-butadiene and carbon tetrachloride.

- ANAK’s cancer risk approximation for benzene is the highest cancer risk approximation for this pollutant among all NMP’s sites (including all annual and study averages).

- None of ANAK’s pollutants of interest had noncancer risk approximations greater than 1.0. The highest noncancer risk approximation among ANAK’s pollutants of interest was 0.11 (for benzene).

Table 5-6. Cancer and Noncancer Surrogate Risk Approximations for the Alaska Monitoring Site

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections	# of Quarterly Averages	Study Average (µg/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Anchorage, Alaska - ANAK							
Acrylonitrile	0.000068	0.002	21	1	NA	NA	NA
Benzene	0.0000078	0.03	62	4	3.39 ± 0.96	26.46	0.11
Benzo(a)pyrene[a]	0.001	--	38	3	<0.01 ± <0.01	0.21	--
1,3-Butadiene	0.00003	0.002	62	4	0.16 ± 0.05	4.78	0.08
Carbon Tetrachloride	0.000006	0.1	62	4	0.62 ± 0.05	3.69	0.01
Chloroform	--	0.098	62	4	0.12 ± 0.01	--	0.01
p-Dichlorobenzene	0.000011	0.8	51	4	0.04 ± 0.01	0.48	0.01
Ethylbenzene	0.0000025	1	62	4	0.81 ± 0.26	2.02	0.01
Naphthalene[a]	0.000034	0.003	61	4	0.09 ± 0.04	3.04	0.03
Tetrachloroethylene	0.0000059	0.27	62	4	0.23 ± 0.07	1.35	0.01
Trichloroethylene	0.000002	0.6	10	0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	16	1	NA	NA	NA

NA = Not available due to the criteria for calculating a study average.

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the study average concentration of this pollutant in ng/m^3, refer back to Table 5-5.

5.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 5-7 and 5-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 5-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the study averages. Table 5-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from study averages.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations provided in Tables 5-7 and 5-8 are limited to those pollutants for which the site sampled. As discussed in Section 5.3, ANAK sampled for PAH and VOC. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 5-7 include the following:

- Benzene was the highest emitted pollutant in the Anchorage Borough, had the highest-toxicity weighted emissions, and had the highest cancer risk approximation.
- Seven of the highest emitted pollutants in the Anchorage Borough also had the highest toxicity-weighted emissions. Four pollutants (benzene, 1,3-butadiene, naphthalene, and tetrachloroethylene) appear on all three lists.
- POM Group 2 was the seventh highest emitted "pollutant" in Anchorage Borough and ranked fourth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at ANAK including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for ANAK.

Table 5-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Alaska Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Anchorage, Alaska (Anchorage Borough) - ANAK					
Benzene	485.65	Benzene	3.79E-03	Benzene	26.46
Formaldehyde	171.72	Formaldehyde	2.15E-03	1,3-Butadiene	4.78
Acetaldehyde	63.81	1,3-Butadiene	9.95E-04	Carbon Tetrachloride	3.69
1,3-Butadiene	33.17	POM, Group 2	6.76E-04	Naphthalene	3.04
Dichloromethane	22.25	Naphthalene	3.27E-04	Ethylbenzene	2.02
Tetrachloroethylene	16.30	Arsenic, PM	3.21E-04	Tetrachloroethylene	1.35
POM, Group 2	12.29	Hexavalent Chromium, PM	2.96E-04	*p*-Dichlorobenzene	0.48
Naphthalene	9.61	Acetaldehyde	1.40E-04	Benzo(a)pyrene	0.21
p-Dichlorobenzene	5.75	POM, Group 3	1.02E-04		
Trichloroethylene	1.53	Tetrachloroethylene	9.62E-05		

[1] These cancer risk approximations are based on the study averages.

Table 5-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Alaska Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Anchorage, Alaska (Anchorage Borough) - ANAK					
Toluene	1,733.33	Acrolein	545,446.13	Benzene	0.11
Xylenes	735.47	Formaldehyde	17,522.76	1,3-Butadiene	0.08
Benzene	485.65	1,3-Butadiene	16,583.59	Naphthalene	0.03
Formaldehyde	171.72	Benzene	16,188.44	Carbon Tetrachloride	0.01
Ethylbenzene	161.73	Xylenes	7,354.68	Chloroform	<0.01
Hydrochloric acid	144.12	Hydrochloric acid	7,205.89	Tetrachloroethylene	<0.01
Hexane	143.07	Acetaldehyde	7,090.29	Ethylbenzene	<0.01
Methanol	105.89	Toluene	4,333.34	*p*-Dichlorobenzene	<0.01
Acetaldehyde	63.81	Cyanide Compounds, gas	3,290.04		
1,3-Butadiene	33.17	Naphthalene	3,203.53		

[1] These noncancer risk approximations are based on the study averages.

Observations from Table 5-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Anchorage Borough. The toxicity-weighted emissions for these pollutants ranked eighth, fifth, and fourth highest, respectively.
- Seven of the highest emitted pollutants in the Anchorage Borough also had the highest toxicity-weighted emissions. Only two pollutants, benzene and 1,3-butadiene, appear on all three lists.
- Acrolein, while not one of the 10 highest emitted pollutants in the Anchorage Borough, had the highest toxicity-weighted emissions, indicating the relatively high toxicity of this pollutant in low quantities. Because questions have been raised about the reliability of acrolein measurements, as described in Section 3.2, this pollutant was excluded from all risk-related analyses in this report.

5.6 Summary of the 2008-2009 Monitoring Data for ANAK

Results from several of the treatments described in this section include the following:

- ❖ *A total of 13 pollutants failed screens for ANAK; seven of these are NATTS MQO Core Analytes.*
- ❖ *Of the site-specific pollutants of interest for ANAK, benzene had the highest daily average concentration for both years.*
- ❖ *The quarterly average concentrations of benzene and 1,3-butadiene were highest during the colder months of the study period.*
- ❖ *None of the preprocessed daily measurements and none of the quarterly or study average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

6.0 Sites in Arizona

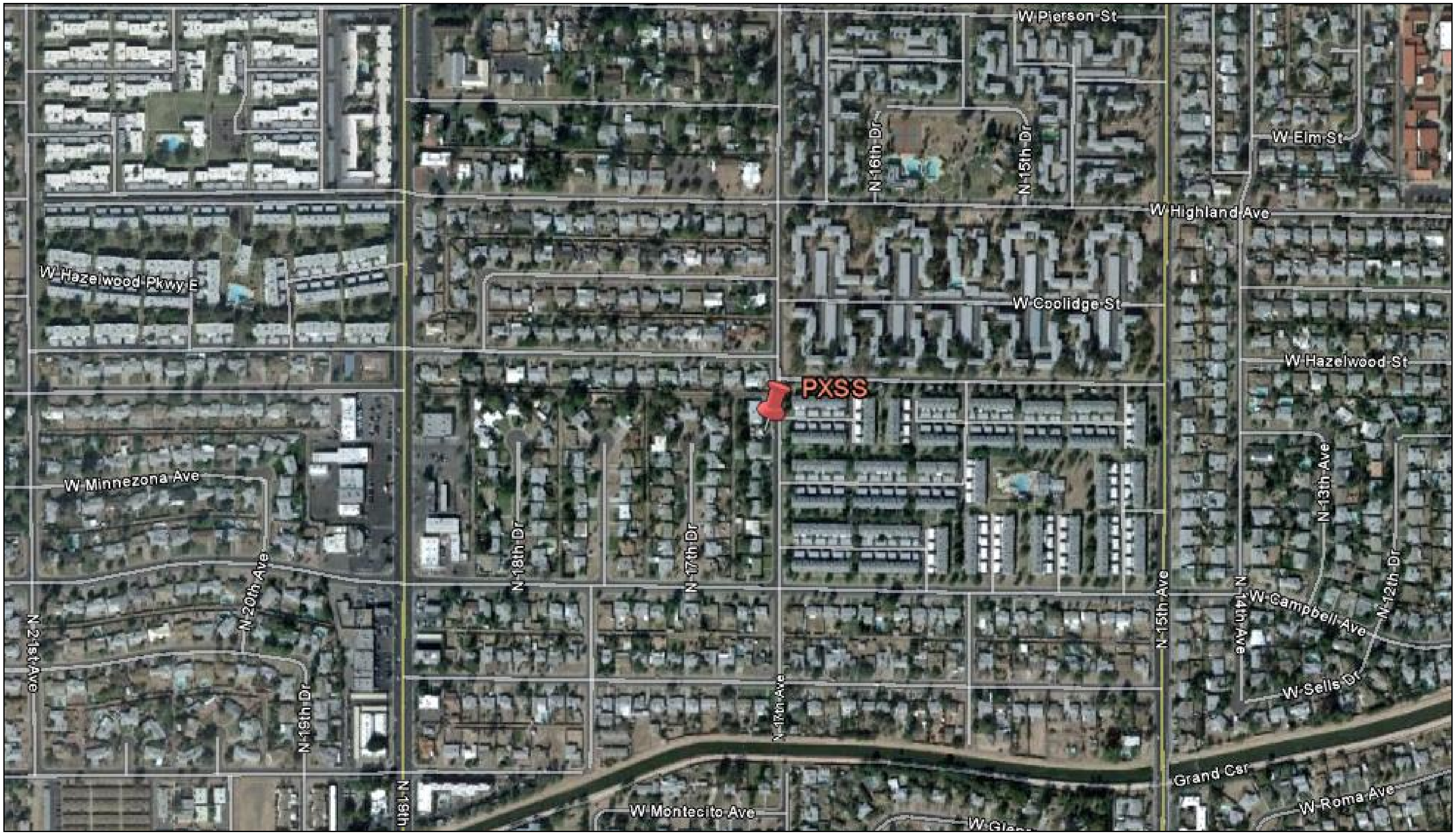
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Arizona, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

6.1 Site Characterization

This section characterizes the Arizona monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

The Arizona monitoring sites are located in Phoenix, Arizona. Figures 6-1 and 6-2 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figure 6-3 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the map in Figure 6-3. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 6-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

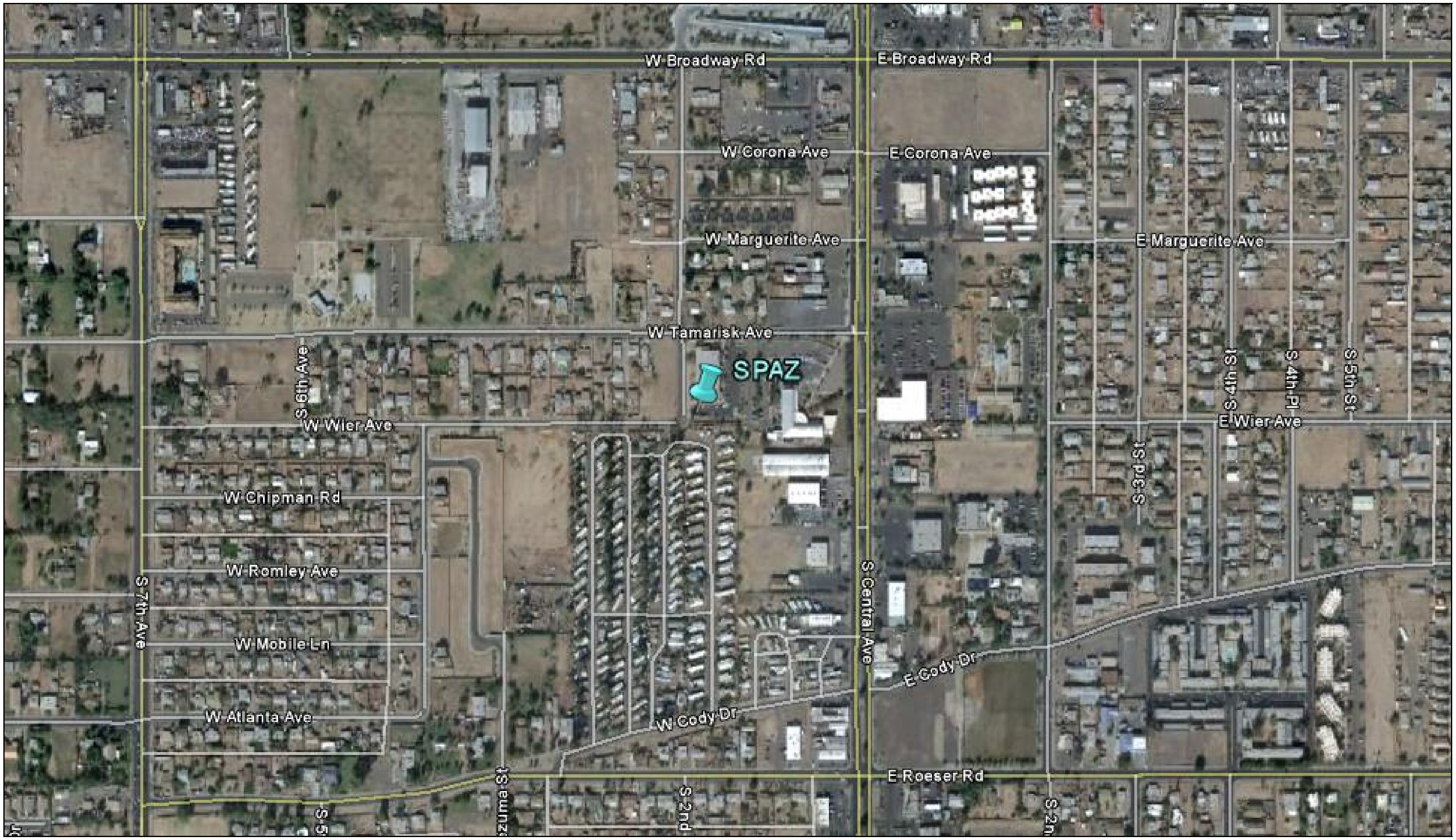
Figure 6-1. Phoenix, Arizona (PXSS) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale 2 inches = 1,408 feet

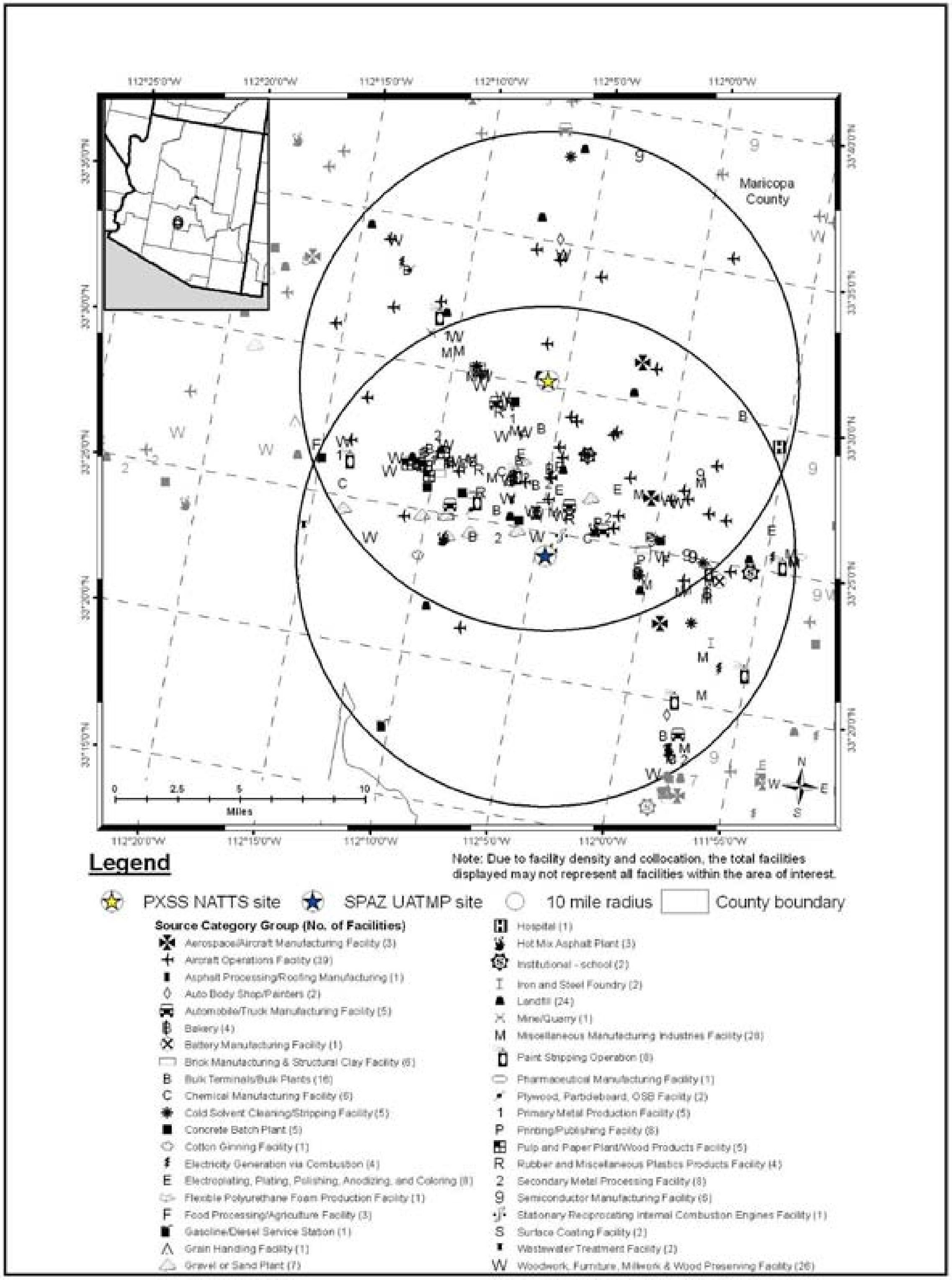
Figure 6-2. South Phoenix, Arizona (SPAZ) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale 2 inches = 1,511 feet

Figure 6-3. NEI Point Sources Located Within 10 Miles of PXSS and SPAZ


112°25'0"W
112°20'0"W
112°15'0"W
112°10'0"W
112°5'0"W
112°0'0"W
33°40'0"N
33°35'0"N
33°30'0"N
33°25'0"N
33°20'0"N
33°15'0"N
111°55'0"W
Maricopa County
0
2.5
5
10
Miles
N
E
S
W
Legend
PXSS NATTS site
SPAZ UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (3)
Aircraft Operations Facility (39)
Asphalt Processing/Roofing Manufacturing (1)
Auto Body Shop/Painters (2)
Automobile/Truck Manufacturing Facility (5)
Bakery (4)
Battery Manufacturing Facility (1)
Brick Manufacturing & Structural Clay Facility (6)
B Bulk Terminals/Bulk Plants (16)
C Chemical Manufacturing Facility (6)
Cold Solvent Cleaning/Stripping Facility (5)
Concrete Batch Plant (5)
Cotton Ginning Facility (1)
Electricity Generation via Combustion (4)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (8)
Flexible Polyurethane Foam Production Facility (1)
F Food Processing/Agriculture Facility (3)
Gasoline/Diesel Service Station (1)
Grain Handling Facility (1)
Gravel or Sand Plant (7)
Hospital (1)
Hot Mix Asphalt Plant (3)
Institutional - school (2)
Iron and Steel Foundry (2)
Landfill (24)
Mine/Quarry (1)
M Miscellaneous Manufacturing Industries Facility (28)
Paint Stripping Operation (8)
Pharmaceutical Manufacturing Facility (1)
Plywood, Particleboard, OSB Facility (2)
1 Primary Metal Production Facility (5)
P Printing/Publishing Facility (8)
Pulp and Paper Plant/Wood Products Facility (5)
R Rubber and Miscellaneous Plastics Products Facility (4)
2 Secondary Metal Processing Facility (8)
9 Semiconductor Manufacturing Facility (6)
Stationary Reciprocating Internal Combustion Engines Facility (1)
S Surface Coating Facility (2)
Wastewater Treatment Facility (2)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (26)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 6-1. Geographical Information for the Arizona Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
PXSS	04-013-9997	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ MSA	33.503731, -112.095809	Residential	Urban/City Center	Haze, CO, SO_2, NOy, NO, NO_2, NOx, PAMS, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, PM Coarse, $PM_{2.5}$ Speciation.
SPAZ	04-013-4003	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ MSA	33.40316, -112.07533	Residential	Urban/City Center	CO, PAMS, O_3, Meteorological parameters, $PM_{2.5}$, PM Coarse.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

PXSS is located in central Phoenix while SPAZ is located farther south. Figure 6-1 shows that PXSS is located in a highly residential area on North 17th Avenue in central Phoenix. The Grand Canal is shown at the bottom of Figure 6-1. The monitoring site is approximately three-quarters of a mile east of I-17 and 2 miles north of I-10. Figure 6-2 shows that SPAZ is located in South Phoenix, near the intersection of W. Tamarisk Avenue and S. Central Avenue. SPAZ is surrounded on the west side by residential properties and commercial properties to the east. SPAZ is located approximately 1 mile south of I-17.

As Figure 6-3 shows, SPAZ and PXSS are located within 10 miles of each other. The majority of emissions sources are located to the south of PXSS and north of SPAZ. The source categories with the highest number of sources near these monitoring sites include the aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads; woodwork, furniture, millwork, and wood preserving facilities; and landfills. The emissions source nearest PXSS is a landfill while the source nearest SPAZ is an aircraft landing strip.

Table 6-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Arizona monitoring sites. Information provided in Table 6-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Maricopa County were obtained from the Arizona Department of Transportation (AZ DOT, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 6-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 6-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. For both sites, traffic data for locations along I-17 were selected. Finally, Table 6-2 presents the daily VMT for the Phoenix urban area.

Table 6-2. Population, Motor Vehicle, and Traffic Information for the Arizona Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
PXSS	4,023,132	3,753,941	0.93	1,511,946	1,410,780	206,000	78,147
SPAZ	4,023,132	3,753,941	0.93	896,909	836,896	113,000	78,147

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Arizona DOT (AZ DOT, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2007 data from the Arizona DOT (AZ DOT, 2007).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site

Observations from Table 6-2 include the following:

- Maricopa County had the fourth highest county population and second highest county-level vehicle registration compared to other counties with NMP sites.

- The vehicle-per-person ratio was just less than one vehicle per person. This ratio falls in the middle of the range compared to other NMP sites.

- The 10-mile radius population and estimated vehicle ownership were higher near PXSS than SPAZ.

- PXSS experienced nearly twice the annual average traffic volume compared to SPAZ, based on locations along I-17. The traffic volume near PXSS was among the highest compared to traffic volumes near other NMP sites.

- The Phoenix area VMT was among the top third compared to other urban areas with NMP sites.

6.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Arizona on sample days, as well as over the course of each year.

6.2.1 Climate Summary

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°F. 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 (Bair, 1992, and WRCC, 2011).

6.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to PXSS and SPAZ is located at Phoenix Sky Harbor International Airport (WBAN 23183). Additional information about the Sky Harbor weather station is provided in Table 6-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 6-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 6-3 is the 95 percent confidence interval for each parameter. As shown in Table 6-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout the year for both years. Table 6-3 also shows that these sites experienced the lowest relative humidity levels among NMP sites.

Table 6-3. Average Meteorological Conditions near the Arizona Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Phoenix, Arizona - PXSS										
Phoenix Sky Harbor Intl Airport 23183 (33.443, -111.99)	7.15 miles 136° (SE)	2008	Sample Day	85.7 ± 3.8	75.2 ± 3.7	37.3 ± 3.5	55.7 ± 2.4	31.3 ± 4.0	1011.9 ± 1.3	5.5 ± 0.5
			All 2008	86.0 ± 1.7	75.4 ± 1.6	37.6 ± 1.5	55.9 ± 1.0	31.9 ± 1.8	1011.4 ± 0.6	5.3 ± 0.2
		2009	Sample Day	87.9 ± 3.7	77.0 ± 3.7	34.8 ± 2.8	55.3 ± 2.2	26.2 ± 2.8	1011.1 ± 1.2	5.1 ± 0.6
			All 2009	86.9 ± 1.6	76.2 ± 1.6	35.6 ± 1.3	55.2 ± 1.0	27.8 ± 1.4	1011.2 ± 0.5	5.2 ± 0.2
South Phoenix, Arizona – SPAZ										
Phoenix Sky Harbor Intl Airport 23183 (33.443, -111.99)	5.43 miles 70° (ENE)	2008	Sample Day	87.2 ± 5.6	76.7 ± 5.5	37.8 ± 6.0	56.6 ± 3.7	31.2 ± 6.5	1010.6 ± 1.8	5.2 ± 0.7
			All 2008	86.0 ± 1.7	75.4 ± 1.6	37.6 ± 1.5	55.9 ± 1.0	31.9 ± 1.8	1011.4 ± 0.6	5.3 ± 0.2
		2009	Sample Day	86.9 ± 5.8	75.9 ± 5.8	33.4 ± 4.3	54.3 ± 3.5	25.5 ± 4.0	1011.1 ± 2.0	5.1 ± 0.9
			All 2009	86.9 ± 1.6	76.2 ± 1.6	35.6 ± 1.3	55.2 ± 1.0	27.8 ± 1.4	1011.2 ± 0.5	5.2 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full-year averages.

6.2.3 Back Trajectory Analysis

Figure 6-4 and Figure 6-5 are the composite back trajectory maps for days on which samples were collected at the PXSS monitoring site in 2008 and 2009, respectively. Figure 6-6 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Similarly, Figures 6-7 and 6-8 are the composite back trajectory maps for days on which samples were collected at the SPAZ monitoring site in 2008 and 2009, respectively, and Figure 6-9 is the cluster analysis for both years. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 6-4 through 6-9 represents 100 miles.

Observations from Figures 6-4 through 6-6 for PXSS include the following:

- The 24-hour air shed domain was smaller for PXSS than for many other NMP monitoring sites. The farthest away a trajectory originated from PXSS was central Nevada, or approximately 450 miles away. However, most trajectories (nearly 90 percent) originated less than 250 miles from PXSS.

- Back trajectories originated from a variety of directions at PXSS, although many trajectories originated from the southwest and west. A secondary group of trajectories originated from the north and northeast. On the 2009 composite map, a third group of trajectories originated from the east, but fewer originated from this direction in 2008.

- The cluster analysis map supports the observations above regarding the direction of trajectory origin as well as the observations about trajectory distances. Nearly all of the cluster trajectories originated within 300 miles of PXSS.

Observations from Figures 6-7 through 6-9 for SPAZ include the following:

- Samples were collected every 12 days at SPAZ, which is half the frequency of sample collection at PXSS. As a result, fewer trajectories are shown in Figures 6-7 and 6-8.

- The composite trajectory maps for SPAZ have a trajectory distribution pattern similar to PXSS. The cluster analysis maps are also similar to each other. This is expected given their close proximity to each other.

- Similar to PXSS, most trajectories originated within 250 miles of SPAZ.

Figure 6-4. 2008 Composite Back Trajectory Map for PXSS

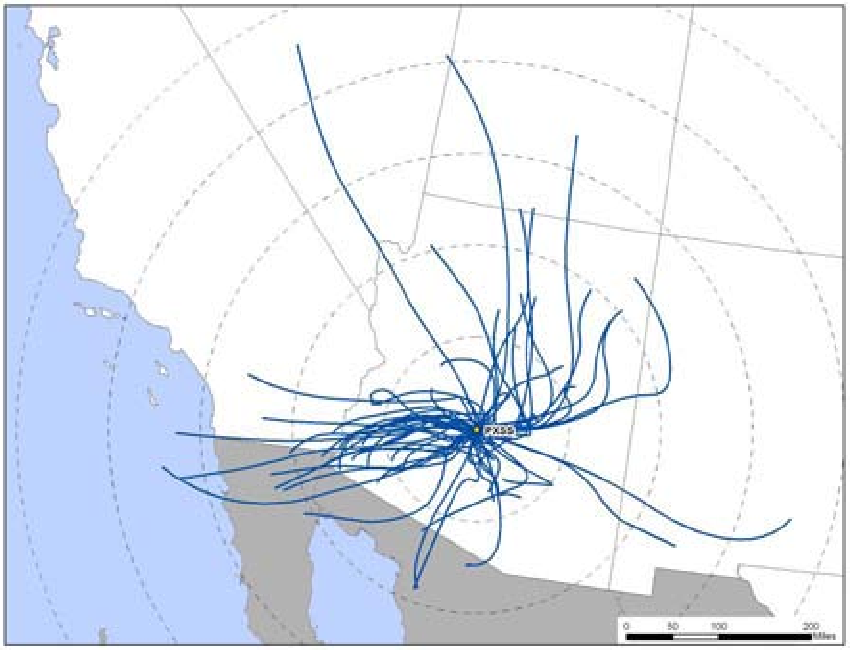


Figure 6-5. 2009 Composite Back Trajectory Map for PXSS

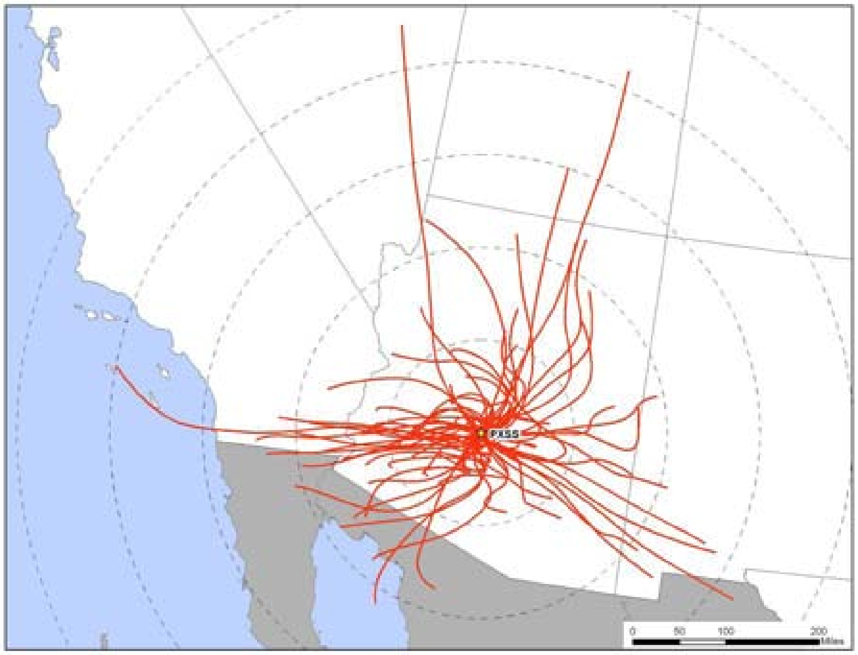


Figure 6-6. Back Trajectory Cluster Map for PXSS

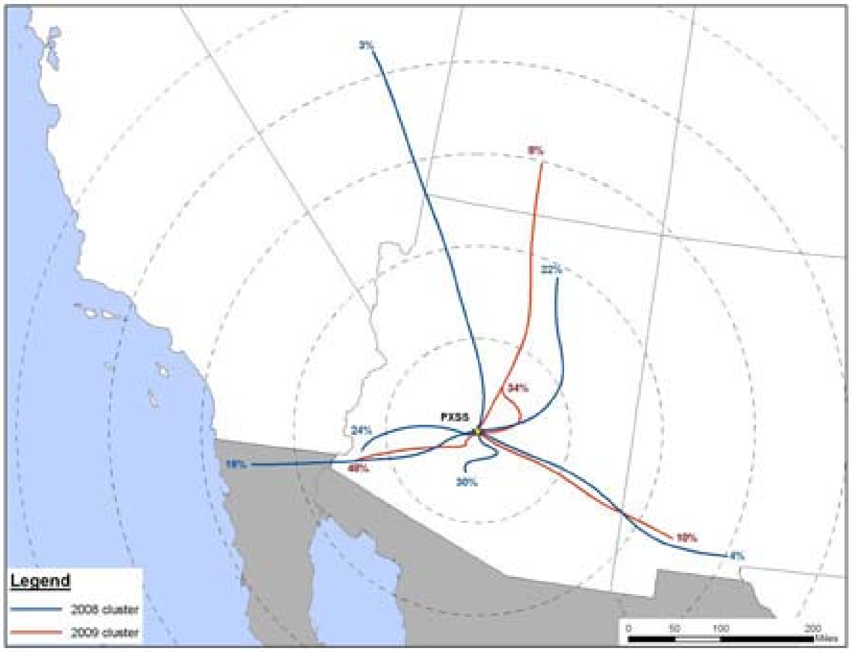


Figure 6-7. 2008 Composite Back Trajectory Map for SPAZ

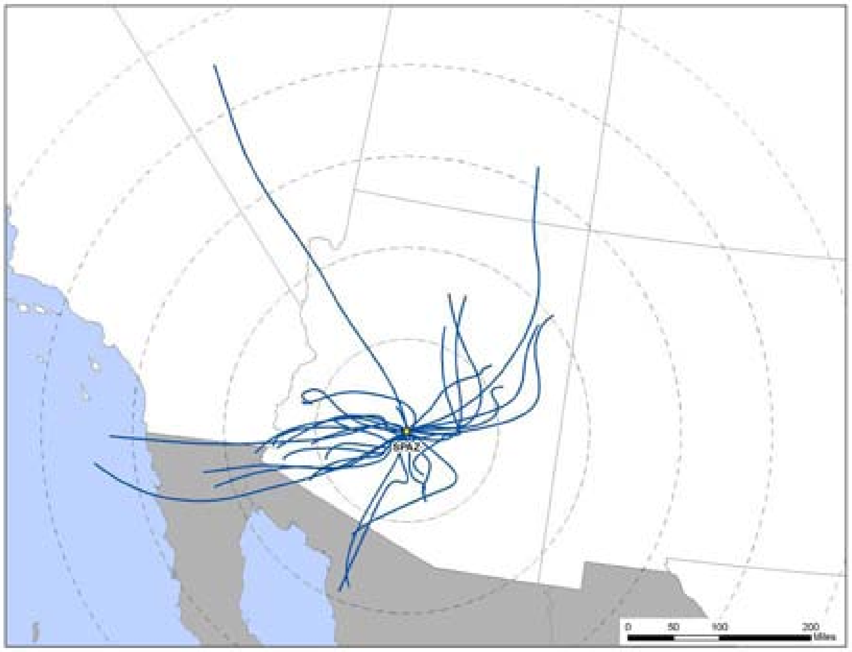


Figure 6-8. 2009 Composite Back Trajectory Map for SPAZ

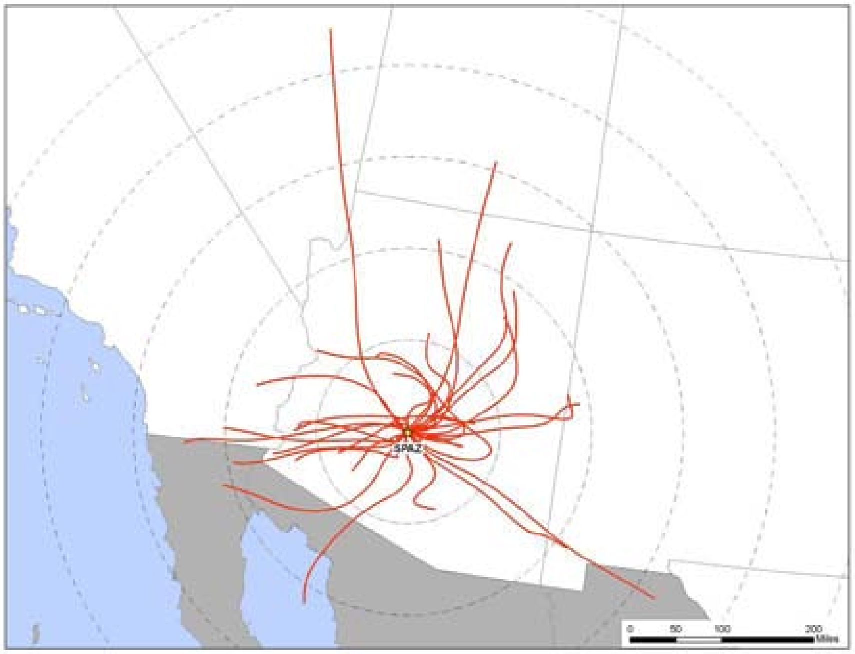
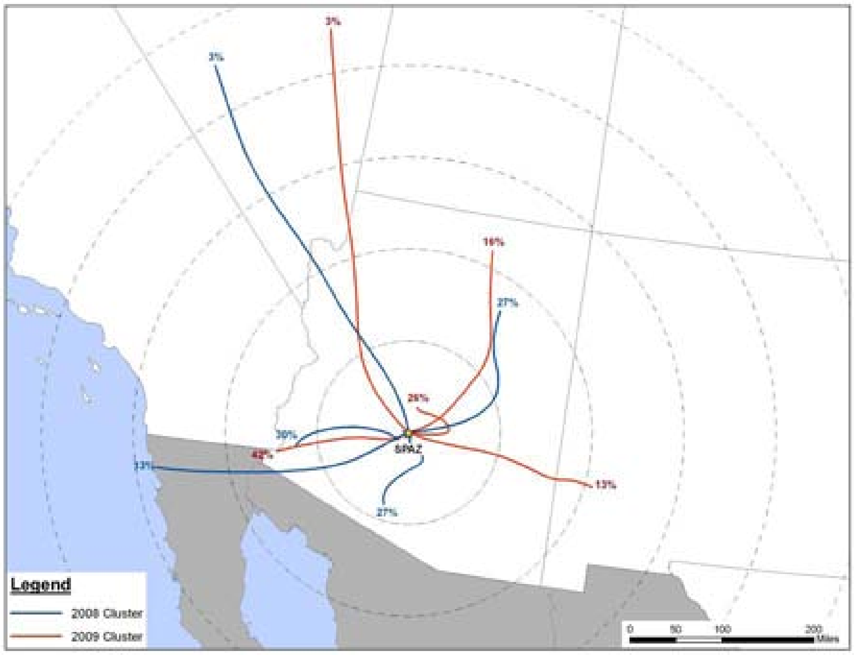


Figure 6-9. Back Trajectory Cluster Map for SPAZ



6.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at Phoenix Sky Harbor International Airport were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 6-10 presents five different wind roses for the PXSS monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 6-11 presents the five different wind roses for the SPAZ monitoring site.

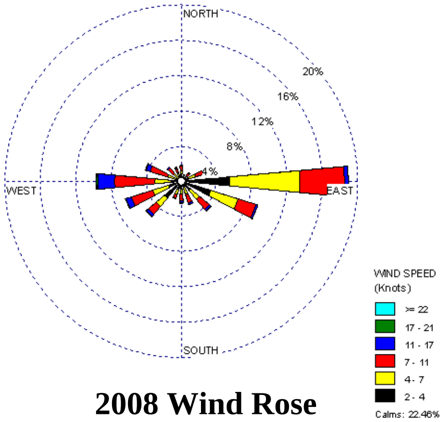
Observations from Figures 6-10 and 6-11 for the Arizona monitoring sites include the following:

- Because the NWS weather station at Phoenix Sky Harbor International Airport is the closest weather station to both PXSS and SPAZ, the historical, 2008, and 2009 wind roses for PXSS are the same as for SPAZ.

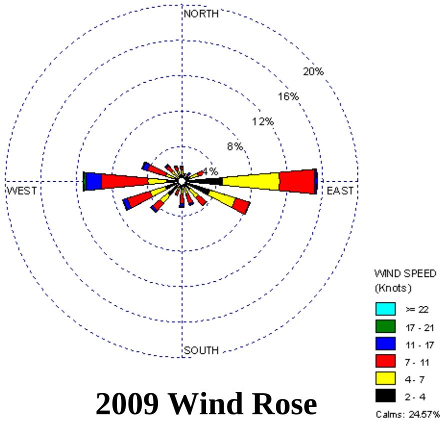
- The historical wind rose shows that calm winds (≤ 2 knots) account for nearly 25 percent of the hourly wind measurements from 1997 to 2007. Easterly, westerly, and east-southeasterly winds were the most commonly observed wind directions near PXSS and SPAZ. Winds from the northwest, north, and northeast were infrequently observed, as were winds from the south.

- The 2008 and 2009 wind patterns are similar to the historical wind patterns. Further, the sample day wind patterns for each year and for each site also resemble the historical wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

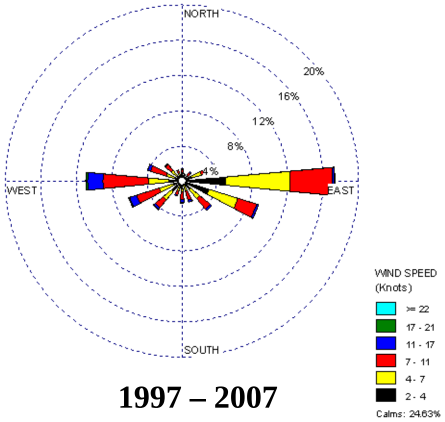
Figure 6-10. Wind Roses for the Phoenix Sky Harbor International Airport Weather Station near PXSS



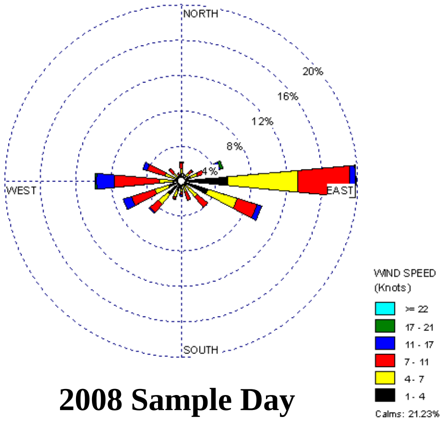
2008 Wind Rose



2009 Wind Rose

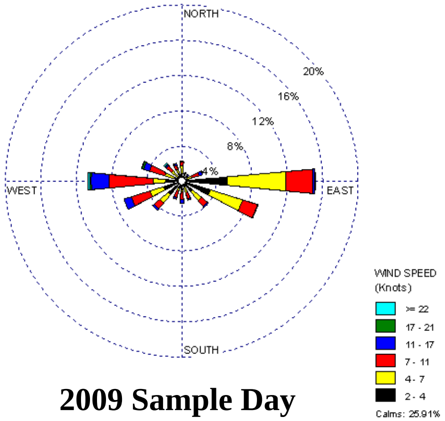


1997 – 2007
Historical Wind Rose



2008 Sample Day

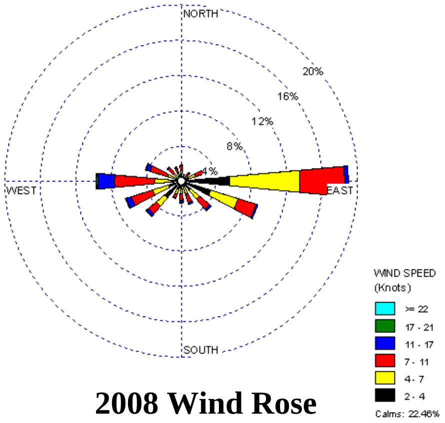
Wind Rose



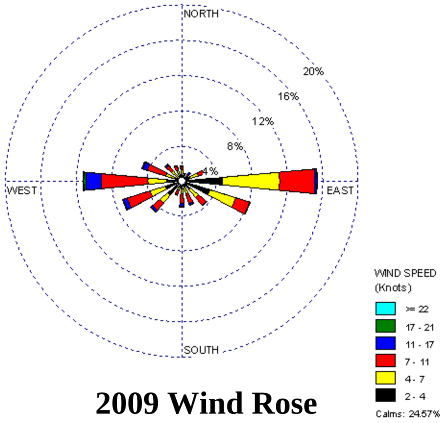
2009 Sample Day

Wind Rose

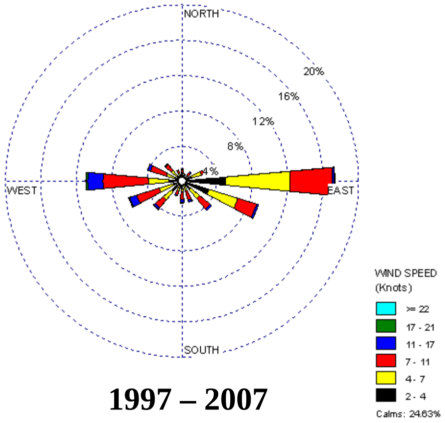
Figure 6-11. Wind Roses for the Phoenix Sky Harbor International Airport Weather Station near SPAZ



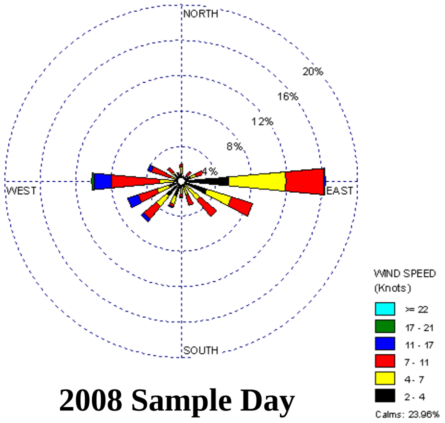
2008 Wind Rose



2009 Wind Rose

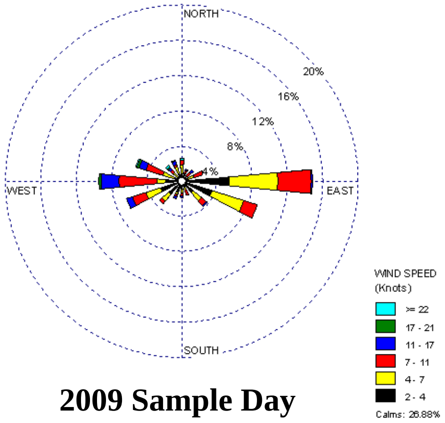


1997 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

6.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Arizona monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 6-4 presents PXSS’s and SPAZ’s pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. PXSS sampled for VOC, carbonyl compounds, PAH, metals (PM_{10}), and hexavalent chromium; SPAZ sampled for VOC only.

Observations from Table 6-4 include the following:

- The number of pollutants failing screens varied significantly between the two monitoring sites; this is expected given the different pollutants measured at each site.

- Twenty-three pollutants failed at least one screen for PXSS, of which 13 are NATTS MQO Core Analytes.

- Thirteen pollutants, of which 10 are NATTS MQO Core Analytes, were initially identified as PXSS’s pollutants of interest. Benzo(a)pyrene, cadmium (PM_{10}) and lead (PM_{10}) were added to PXSS’s pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of PXSS’s total failed screens. Five additional NATTS MQO Core Analytes were added to PXSS’s pollutants of interest, even though their concentrations did not fail any screens: beryllium, chloroform, nickel, trichloroethylene, and vinyl chloride. These five pollutants are not shown in Table 6-4.

- For PXSS, 60 percent of the measured detections failed screens (of the pollutants failing at least one screen).

Table 6-4. Risk Screening Results for the Arizona Monitoring Sites

Pollutant	**Screening Value ($\mu g/m^3$)**	**# of Failed Screens**	**# of Measured Detections**	**% of Screens Failed**	**% of Total Failures**	**Cumulative % Contribution**
Phoenix, Arizona - PXSS						
Acetaldehyde	0.45	120	120	100.00	9.67	9.67
Formaldehyde	0.077	120	120	100.00	9.67	19.34
Manganese (PM_{10})	0.005	112	118	94.92	9.02	28.36
Naphthalene	0.029	110	114	96.49	8.86	37.23
Benzene	0.13	109	109	100.00	8.78	46.01
Carbon Tetrachloride	0.17	109	109	100.00	8.78	54.79
1,3-Butadiene	0.033	104	109	95.41	8.38	63.17
Arsenic (PM_{10})	0.00023	103	117	88.03	8.30	71.47
p-Dichlorobenzene	0.091	98	109	89.91	7.90	79.37
Tetrachloroethylene	0.17	80	109	73.39	6.45	85.82
Ethylbenzene	0.4	64	109	58.72	5.16	90.98
Hexavalent Chromium	0.000083	39	112	34.82	3.14	94.12
Acrylonitrile	0.015	35	35	100.00	2.82	96.94
Dichloromethane	2.1	15	109	13.76	1.21	98.15
1,2-Dichloroethane	0.038	8	8	100.00	0.64	98.79
Propionaldehyde	0.8	5	120	4.17	0.40	99.19
Benzo(a)pyrene	0.00091	2	65	3.08	0.16	99.36
Chloromethylbenzene	0.02	2	2	100.00	0.16	99.52
1,2-Dibromoethane	0.0017	2	2	100.00	0.16	99.68
Antimony (PM_{10})	0.02	1	118	0.85	0.08	99.76
Cadmium (PM_{10})	0.00056	1	118	0.85	0.08	99.84
Hexachloro-1,3-butadiene	0.045	1	2	50.00	0.08	99.92
Lead (PM_{10})	0.015	1	118	0.85	0.08	100.00
Total		1,241	2,052	60.48		
South Phoenix, Arizona - SPAZ						
Benzene	0.13	58	59	98.31	16.52	16.52
Carbon Tetrachloride	0.17	58	58	100.00	16.52	33.05
1,3-Butadiene	0.033	57	58	98.28	16.24	49.29
p-Dichlorobenzene	0.091	51	58	87.93	14.53	63.82
Acrylonitrile	0.015	47	47	100.00	13.39	77.21
Ethylbenzene	0.4	38	57	66.67	10.83	88.03
Tetrachloroethylene	0.17	37	56	66.07	10.54	98.58
1,2-Dichloroethane	0.038	3	4	75.00	0.85	99.43
Carbon Disulfide	70	1	59	1.69	0.28	99.72
1,1,2,2-Tetrachloroethane	0.017	1	1	100.00	0.28	100.00
Total		351	457	76.81		

- Even though PXSS failed the highest number of screens (1,241) among all NMP sites (refer to Table 4-8 of Section 4.2), the failure rate for PXSS, when incorporating all pollutants with screening values, was much lower, at 23 percent. This is due primarily to the relatively high number of pollutants sampled at this site, as discussed in Section 4.2.

- Ten pollutants failed screens for SPAZ, of which four are NATTS MQO Core Analytes. Seven pollutants were initially identified as pollutants of interest for SPAZ. Three NATTS MQO Core Analytes were added to SPAZ's pollutants of interest, even though their concentrations did not fail any screens: chloroform, trichloroethylene, and vinyl chloride. These three pollutants are not shown in Table 6-4.

- For SPAZ, nearly 77 percent of the measured detections failed screens (of the pollutants failing at least one screen).

- Of the pollutants of interest for PXSS, 100 percent of the measured detections of acetaldehyde, acrylonitrile, benzene, carbon tetrachloride, and formaldehyde failed screens. The same is true for carbon tetrachloride and acrylonitrile for SPAZ.

6.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Arizona monitoring sites. Concentration averages are provided for the pollutants of interest for each Arizona site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

6.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Arizona site, as described in Section 3.1.1. The *daily* average of a particular pollutant is simply the average concentration of all measured detections within a given year. If there were at least seven measured detections within a given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects for each year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 6-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium for PXSS are presented in ng/m^3 for ease of viewing.

Observations for PXSS from Table 6-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde, acetaldehyde, and benzene for both 2008 and 2009. These were the only pollutants with daily average concentrations greater than 1 µg/m^3. Note that the daily averages are the same as the annual averages for these pollutants, indicating that these pollutants were detected in every sample collected.

- Acrylonitrile, benzo(a)pyrene, and vinyl chloride were detected relatively few times at PXSS; as a result, few quarterly averages and no annual averages could be calculated for these pollutants.

- Based on the available quarterly averages, concentrations of benzene, 1,3-butadiene, ethylbenzene, *p*-dichlorobenzene, and tetrachloroethylene tended to be higher during the colder months.

- Concentrations of naphthalene also appear higher during the colder months. A closer look at the first quarter of 2009 and the fourth quarters of both years show rather large confidence intervals associated with these averages, indicating the presence of outliers. A review of the data shows that the two highest concentrations of naphthalene were measured on December 20, 2008 and January 1, 2009. Further, of the 11 concentrations of naphthalene greater than 200 ng/m^3, all were measured in one of these three quarters (three in the fourth quarter of 2008, four in the first quarter of 2009, and four in the fourth quarter of 2009).

- Benzo(a)pyrene concentrations for the fourth quarter of 2008 and first quarter of 2009 also have large confidence intervals. A review of the data shows that the two highest concentrations of this pollutant were measured on the same days as the two highest concentrations of naphthalene. The highest benzo(a)pyrene concentration was measured at PXSS on January 1, 2009 (3.12 ng/m^3) and was the third highest concentration of this pollutant measured among all NMP sites sampling PAH. The second highest benzo(a)pyrene concentration was measured at PXSS on December 20, 2008 (1.76 ng/m^3) and was the 11th highest concentration of this pollutant among all NMP sites sampling PAH.

Table 6-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Phoenix, Arizona - PXSS												
Acetaldehyde	2.70 ± 0.24	2.87 ± 0.49	2.52 ± 0.53	2.31 ± 0.35	3.09 ± 0.53	2.70 ± 0.24	2.86 ± 0.30	3.26 ± 0.62	2.25 ± 0.40	2.41 ± 0.38	3.56 ± 0.76	2.86 ± 0.30
Acrylonitrile	0.76 ± 0.29	NA	NA	NA	NA	NA	0.33 ± 0.11	0.14 ± 0.07	0.16 ± 0.10	NA	NA	NA
Benzene	1.59 ± 0.27	2.07 ± 0.43	1.01 ± 0.24	0.96 ± 0.38	2.33 ± 0.63	1.59 ± 0.27	1.78 ± 0.29	2.67 ± 0.52	1.31 ± 0.43	0.76 ± 0.27	2.10 ± 0.48	1.78 ± 0.29
1,3-Butadiene	0.23 ± 0.05	0.36 ± 0.09	0.10 ± 0.03	0.09 ± 0.04	0.35 ± 0.11	0.23 ± 0.05	0.23 ± 0.06	0.36 ± 0.12	0.09 ± 0.03	0.06 ± 0.03	0.36 ± 0.11	0.23 ± 0.06
Carbon Tetrachloride	0.76 ± 0.05	0.64 ± 0.06	0.76 ± 0.09	0.90 ± 0.09	0.75 ± 0.09	0.76 ± 0.05	0.70 ± 0.03	0.68 ± 0.07	0.73 ± 0.07	0.81 ± 0.07	0.62 ± 0.05	0.70 ± 0.03
Chloroform	0.44 ± 0.06	0.43 ± 0.09	0.40 ± 0.14	0.46 ± 0.18	0.48 ± 0.13	0.44 ± 0.06	0.44 ± 0.06	0.39 ± 0.07	0.40 ± 0.10	0.47 ± 0.16	0.50 ± 0.13	0.44 ± 0.06
p-Dichlorobenzene	0.27 ± 0.04	0.37 ± 0.08	0.19 ± 0.05	0.20 ± 0.06	0.30 ± 0.08	0.27 ± 0.04	0.20 ± 0.03	0.34 ± 0.07	0.14 ± 0.04	0.10 ± 0.02	0.21 ± 0.05	0.20 ± 0.03
Ethylbenzene	0.63 ± 0.11	0.81 ± 0.20	0.39 ± 0.12	0.47 ± 0.18	0.85 ± 0.27	0.63 ± 0.11	0.58 ± 0.12	0.96 ± 0.27	0.36 ± 0.10	0.21 ± 0.07	0.67 ± 0.20	0.58 ± 0.12
Formaldehyde	3.57 ± 0.23	3.58 ± 0.43	3.16 ± 0.50	3.85 ± 0.39	3.69 ± 0.51	3.57 ± 0.23	3.62 ± 0.25	3.56 ± 0.50	3.12 ± 0.41	3.95 ± 0.39	3.86 ± 0.72	3.62 ± 0.25
Tetrachloroethylene	0.47 ± 0.10	0.65 ± 0.19	0.30 ± 0.14	0.26 ± 0.10	0.65 ± 0.23	0.47 ± 0.10	0.46 ± 0.11	0.67 ± 0.19	0.22 ± 0.08	0.19 ± 0.11	0.67 ± 0.29	0.46 ± 0.11
Trichloroethylene	0.08 ± 0.02	0.05 ± 0.02	0.02 ± 0.01	NA	0.06 ± 0.03	0.05 ± 0.02	0.07 ± 0.01	0.05 ± 0.02	0.03 ± 0.02	NA	0.04 ± 0.02	0.03 ± 0.01
Vinyl Chloride	0.01 ± <0.01	NA	NA	NA	NA	NA	0.01 ± 0.01	NA	NA	NA	NA	NA
Arsenic (PM_{10})[a]	0.72 ± 0.15	0.59 ± 0.28	0.54 ± 0.13	0.67 ± 0.39	1.01 ± 0.34	0.70 ± 0.15	0.58 ± 0.11	0.83 ± 0.27	0.35 ± 0.08	0.51 ± 0.23	0.66 ± 0.25	0.58 ± 0.11

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m³ for ease of viewing.

Table 6-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Benzo(a)pyrene [a]	0.18 ± 0.11	0.15 ± 0.07	NA	NA	0.22 ± 0.24	NA	0.31 ± 0.20	0.47 ± 0.48	NA	NA	0.26 ± 0.13	NA
Beryllium (PM_{10}) [a]	0.02 ± <0.01	0.01 ± <0.01	0.03 ± 0.01	0.01 ± <0.01	0.02 ± 0.01	0.02 ± <0.01	0.01 ± <0.01	0.01 ± 0.01	NA	0.01 ± 0.01	0.01 ± <0.01	0.01 ± <0.01
Cadmium (PM_{10}) [a]	0.14 ± 0.02	0.12 ± 0.04	0.11 ± 0.01	0.13 ± 0.07	0.21 ± 0.06	0.14 ± 0.02	0.13 ± 0.03	0.18 ± 0.08	0.07 ± 0.02	0.12 ± 0.06	0.16 ± 0.05	0.13 ± 0.03
Hexavalent Chromium [a]	0.08 ± 0.01	0.07 ± 0.02	0.06 ± 0.02	0.10 ± 0.04	0.07 ± 0.03	0.08 ± 0.01	0.10 ± 0.03	0.11 ± 0.05	0.07 ± 0.04	0.11 ± 0.08	0.09 ± 0.05	0.09 ± 0.03
Lead (PM_{10}) [a]	4.87 ± 0.73	4.45 ± 1.49	5.71 ± 1.54	2.97 ± 1.18	6.05 ± 1.33	4.87 ± 0.73	4.04 ± 0.86	5.65 ± 2.67	2.70 ± 0.69	2.78 ± 0.97	5.12 ± 1.73	4.04 ± 0.86
Manganese (PM_{10}) [a]	15.09 ± 2.22	11.97 ± 3.26	18.67 ± 6.77	13.17 ± 3.21	16.62 ± 3.73	15.09 ± 2.22	16.56 ± 3.41	13.87 ± 3.56	14.16 ± 3.16	21.64 ± 13.08	16.73 ± 3.46	16.56 ± 3.41
Naphthalene [a]	84.08 ± 16.97	76.66 ± 15.58	53.57 ± 18.17	54.44 ± 19.24	148.21 ± 48.95	84.08 ± 16.97	120.17 ± 19.31	164.47 ± 55.07	83.33 ± 15.10	75.64 ± 21.31	148.17 ± 39.47	118.02 ± 19.43
Nickel (PM_{10}) [a]	1.62 ± 0.38	1.17 ± 0.63	2.19 ± 1.11	1.46 ± 0.66	1.48 ± 0.60	1.56 ± 0.37	1.45 ± 0.25	1.40 ± 0.27	1.34 ± 0.42	1.68 ± 0.85	1.37 ± 0.33	1.45 ± 0.25
South Phoenix, Arizona - SPAZ												
Acrylonitrile	1.95 ± 0.55	NA	0.73 ± 0.41	NA	NA	NA	2.11 ± 0.44	1.81 ± 1.01	1.61 ± 0.66	2.78 ± 0.67	NA	1.83 ± 0.46
Benzene	1.48 ± 0.34	2.09 ± 0.41	0.97 ± 0.31	NA	NA	NA	1.64 ± 0.35	2.26 ± 0.45	1.09 ± 0.45	0.85 ± 0.23	2.35 ± 0.98	1.64 ± 0.35
1,3-Butadiene	0.23 ± 0.06	0.36 ± 0.08	0.11 ± 0.04	NA	NA	NA	0.22 ± 0.07	0.28 ± 0.12	0.10 ± 0.04	0.09 ± 0.02	0.42 ± 0.20	0.22 ± 0.07
Carbon Tetrachloride	0.71 ± 0.06	0.61 ± 0.08	0.77 ± 0.09	NA	NA	NA	0.72 ± 0.04	0.70 ± 0.08	0.61 ± 0.20	0.78 ± 0.09	0.69 ± 0.08	0.69 ± 0.06
Chloroform	0.26 ± 0.04	0.30 ± 0.06	0.23 ± 0.06	NA	NA	NA	0.26 ± 0.04	0.22 ± 0.04	0.27 ± 0.07	0.28 ± 0.13	0.29 ± 0.10	0.26 ± 0.04

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 6-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites (Continued)

Pollutant	**2008**						**2009**					
	Daily Average (µg/m^3)	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
p-Dichlorobenzene	0.27 ± 0.08	0.31 ± 0.07	0.19 ± 0.12	NA	NA	NA	0.20 ± 0.04	0.24 ± 0.08	0.16 ± 0.05	0.15 ± 0.05	0.25 ± 0.12	0.20 ± 0.04
Ethylbenzene	0.72 ± 0.16	1.04 ± 0.21	0.47 ± 0.15	NA	NA	NA	0.60 ± 0.15	0.83 ± 0.29	0.45 ± 0.17	0.31 ± 0.08	NA	0.58 ± 0.15
Tetrachloroethylene	0.27 ± 0.06	0.47 ± 0.07	0.15 ± 0.06	NA	NA	NA	0.30 ± 0.08	0.44 ± 0.18	0.17 ± 0.08	0.14 ± 0.05	0.40 ± 0.18	0.29 ± 0.08
Trichloroethylene	0.11 ± 0.02	0.13 ± 0.04	0.04 ± 0.02	NA	NA	NA	0.11 ± 0.02	0.12 ± 0.06	0.06 ± 0.02	NA	NA	NA
Vinyl Chloride	ND	NA	NA	NA	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Observations for SPAZ from Table 6-5 include the following:

- The pollutants with the highest daily average concentrations by mass were acrylonitrile and benzene for both years of sampling. These were the only pollutants with daily average concentrations greater than 1 $\mu g/m^3$.

- The 2009 daily average concentration of benzene is the same as the annual average, which indicates that this pollutant was detected in every sample collected. The same is not true for acrylonitrile. The 2009 daily average concentration is $2.11 \pm 0.44\ \mu g/m^3$ while its 2009 annual average is $1.83 \pm 0.46\ \mu g/m^{3.}$ This difference illustrates the effect that substituting zeros for non-detects can have on concentration averages. Zeros were substituted for four of the 29 VOC samples collected at SPAZ.

- Third and fourth quarter 2008 averages could not be calculated for any of the pollutants of interest because the 1-in-12 sampling schedule often does not provide enough samples to meet the seven-detect criteria, especially when one or two samples are invalidated (as was the case for this site for the third quarter of 2008). Nearly all of the pollutants of interest have quarterly and annual averages for 2009.

- Based on the available 2009 quarterly averages, concentrations of benzene, 1,3-butadiene, ethylbenzene, *p*-dichlorobenzene, and tetrachloroethylene appear to exhibit a trend similar to PXSS, in that the concentrations were higher during the colder months. However, a closer look at the confidence intervals reveals that these differences were not statistically significant.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for PXSS and SPAZ from those tables include the following:

- PXSS and SPAZ appear in Tables 4-9 through 4-12 a total of 35 times.

- PXSS had the two highest daily average concentrations (both years) for hexavalent chromium and beryllium (PM_{10}) of all NMP sites. Further, PXSS had third and fourth highest daily average concentrations of 1,3-butdiene (2009 and 2008, respectively); the fifth and sixth highest daily average concentrations of chloroform (2008 and 2009, respectively); the third and fourth highest daily average concentrations of tetrachloroethylene (2008 and 2009, respectively); and the second and third highest daily average concentrations of manganese (PM_{10}) (2009 and 2008, respectively) among NMP sites sampling these pollutants.

- As shown in Table 4-9, of the program-level pollutants of interest, SPAZ had second and third highest daily average concentrations of acrylonitrile (2009 and 2008, respectively); the second and fifth highest daily average concentrations of 1,3-butadiene (2008 and 2009, respectively); the fourth and ninth highest daily average concentrations of *p*-dichlorobenzene (2008 and 2009, respectively); and the fifth and ninth highest daily average concentrations of ethylbenzene (2008 and 2009, respectively) among all NMP sites sampling VOC.

6.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. Neither PXSS nor SPAZ have sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

6.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Arizona monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

6.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Arizona monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Arizona monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

6.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Arizona monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated).

Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 6-6, where applicable.

Observations for PXSS from Table 6-6 include the following:

- As discussed in Section 6.4.1, the pollutants with the highest daily average concentrations by mass were formaldehyde, acetaldehyde, and benzene for both years.
- Based on the annual averages and cancer UREs, formaldehyde, benzene, and 1,3-butadiene had the three highest cancer risk approximations for each year, respectively. (Acetaldehyde's cancer risk approximation for each year ranked fourth highest.) An additional six pollutants had cancer risk approximations greater than 1.0 in-a-million for 2008 and an additional seven pollutants had cancer risk approximations greater than 1.0 in-a-million for 2009.
- The cancer risk approximations for the pollutants of interest based on 2008 annual averages were generally similar to the cancer risk approximations based on 2009 annual averages.
- None of PXSS's pollutants of interest had noncancer risk approximations greater than 1.0. The pollutant with the highest noncancer risk approximation was formaldehyde (0.36 for 2008 and 0.37 for 2009).
- The noncancer risk approximations for the pollutants of interest based on 2008 annual averages were generally similar to the noncancer risk approximations based on 2009 annual averages.

Observations for SPAZ from Table 6-6 include the following:

- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for 2008 due to the annual average criteria, as discussed in Section 6.4.1.
- The pollutants with the highest annual average concentrations by mass were acrylonitrile and benzene for 2009.
- Based on the annual averages for 2009 and cancer UREs, acrylonitrile had the highest cancer risk approximation (124.48 in-a-million), which is an order of magnitude higher than the next highest cancer risk approximation (benzene, 12.79 in-a-million). The acrylonitrile cancer risk approximation for SPAZ was the second highest cancer risk approximation calculated among any of the NMP site-specific pollutants of interest (behind only INDEM's 2008 formaldehyde cancer risk approximation).

Table 6-6. Cancer and Noncancer Surrogate Risk Approximations for the Arizona Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
Phoenix, Arizona - PXSS										
Acetaldehyde	0.0000022	0.009	61/4	2.70 ± 0.24	5.94	0.30	59/4	2.86 ± 0.30	6.28	0.32
Acrylonitrile	0.000068	0.002	10/0	NA	NA	NA	25/2	NA	NA	NA
Arsenic (PM_{10})[a]	0.0043	0.000015	56/4	<0.01 ± <0.01	3.03	0.05	61/4	<0.01 ± <0.01	2.51	0.04
Benzene	0.0000078	0.03	52/4	1.59 ± 0.27	12.42	0.05	57/4	1.78 ± 0.29	13.90	0.06
Benzo(a)pyrene[a]	0.001	--	33/2	NA	NA	--	32/2	NA	NA	--
Beryllium (PM_{10})[a]	0.0024	0.00002	56/4	<0.01 ± <0.01	0.04	<0.01	35/3	<0.01 ± <0.01	0.02	<0.01
1,3-Butadiene	0.00003	0.002	52/4	0.23 ± 0.05	6.75	0.11	57/4	0.23 ± 0.06	6.89	0.11
Cadmium (PM_{10})[a]	0.0018	0.00001	57/4	<0.01 ± <0.01	0.25	0.01	61/4	<0.01 ± <0.01	0.24	0.01
Carbon Tetrachloride	0.000006	0.1	52/4	0.76 ± 0.05	4.55	0.01	57/4	0.70 ± 0.03	4.23	0.01
Chloroform	--	0.098	52/4	0.44 ± 0.06	--	<0.01	57/4	0.44 ± 0.06	--	<0.01
p-Dichlorobenzene	0.000011	0.8	52/4	0.27 ± 0.04	2.92	<0.01	57/4	0.20 ± 0.03	2.24	<0.01
Ethylbenzene	0.0000025	1	52/4	0.63 ± 0.11	1.57	<0.01	57/4	0.58 ± 0.12	1.44	<0.01
Formaldehyde	0.000013	0.0098	61/4	3.57 ± 0.23	46.40	0.36	59/4	3.62 ± 0.25	47.02	0.37
Hexavalent Chromium[a]	0.012	0.0001	58/4	<0.01 ± <0.01	0.90	<0.01	54/4	<0.01 ± <0.01	1.12	<0.01

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 6-5.

Table 6-6. Cancer and Noncancer Surrogate Risk Approximations for the Arizona Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
Lead (PM$_{10}$)[a]	--	0.00015	57/4	<0.01 ± <0.01	--	0.03	61/4	<0.01 ± <0.01	--	0.03
Manganese (PM$_{10}$)[a]	--	0.00005	57/4	0.02 ± <0.01	--	0.30	61/4	0.02 ± <0.01	--	0.33
Naphthalene[a]	0.000034	0.003	59/4	0.08 ± 0.02	2.86	0.03	55/4	0.12 ± 0.02	4.01	0.04
Nickel (PM$_{10}$)[a]	0.000312	0.00009	55/4	<0.01 ± <0.01	0.49	0.02	61/4	<0.01 ± <0.01	0.45	0.02
Tetrachloroethylene	0.0000059	0.27	52/4	0.47 ± 0.10	2.75	<0.01	57/4	0.46 ± 0.11	2.72	<0.01
Trichloroethylene	0.000002	0.6	31/3	0.05 ± 0.02	0.09	<0.01	28/3	0.03 ± 0.01	0.06	<0.01
Vinyl Chloride	0.0000088	0.1	5/0	NA	NA	NA	7/0	NA	NA	NA
South Phoenix, Arizona - SPAZ										
Acrylonitrile	0.000068	0.002	21/1	NA	NA	NA	26/3	1.83 ± 0.46	124.48	0.92
Benzene	0.0000078	0.03	29/2	NA	NA	NA	30/4	1.64 ± 0.35	12.79	0.05
1,3-Butadiene	0.00003	0.002	28/2	NA	NA	NA	30/4	0.22 ± 0.07	6.62	0.11
Carbon Tetrachloride	0.000006	0.1	29/2	NA	NA	NA	29/4	0.69 ± 0.06	4.15	0.01
p-Dichlorobenzene	0.000011	0.8	28/2	NA	NA	NA	30/4	0.20 ± 0.04	2.18	<0.01
Chloroform	--	0.098	29/2	NA	NA	NA	30/4	0.26 ± 0.04	--	<0.01

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 6-5.

Table 6-6. Cancer and Noncancer Surrogate Risk Approximations for the Arizona Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Ethylbenzene	0.0000025	1	28/2	NA	NA	NA	29/3	0.58 ± 0.15	1.45	<0.01
Tetrachloroethylene	0.0000059	0.27	27/2	NA	NA	NA	29/4	0.29 ± 0.08	1.71	<0.01
Trichloroethylene	0.000002	0.6	23/2	NA	NA	NA	25/2	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	0/0	NA	NA	NA	1/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 6-5.

- All of the pollutants of interest for SPAZ had cancer risk approximations (where they could be calculated) greater than 1.0 in-a-million, based on the annual averages for 2009.

- None of SPAZ's pollutants of interest had noncancer risk approximations greater than 1.0. The pollutant with the highest noncancer risk approximation was acrylonitrile (0.92). Similar to its cancer risk approximation, the acrylonitrile noncancer risk approximation was the second highest noncancer risk approximation calculated among any of the NMP site-specific pollutants of interest (behind only INDEM's 2008 formaldehyde noncancer risk approximation).

6.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 6-7 and 6-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 6-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 6-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 6.3, PXSS sampled for VOC, carbonyl compounds, PAH, metals (PM_{10}), and hexavalent chromium; SPAZ sampled for VOC only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 6-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Arizona 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Phoenix, Arizona (Maricopa County) - PXSS					
Benzene	1,809.25	Formaldehyde	1.83E-02	Formaldehyde	47.02
Formaldehyde	1,466.06	Benzene	1.41E-02	Formaldehyde	46.40
Acetaldehyde	530.77	1,3-Butadiene	9.06E-03	Benzene	13.90
1,3-Butadiene	302.07	Naphthalene	5.51E-03	Benzene	12.42
Tetrachloroethylene	287.55	POM, Group 2	3.88E-03	1,3-Butadiene	6.89
1,3-Dichloropropene	238.48	Arsenic, PM	2.38E-03	1,3-Butadiene	6.75
Dichloromethane	162.32	Hexavalent Chromium, PM	2.16E-03	Acetaldehyde	6.28
Naphthalene	162.03	Tetrachloroethylene	1.70E-03	Acetaldehyde	5.94
p-Dichlorobenzene	123.55	*p*-Dichlorobenzene	1.36E-03	Carbon Tetrachloride	4.55
POM, Group 2	70.57	Acetaldehyde	1.17E-03	Carbon Tetrachloride	4.23
South Phoenix, Arizona (Maricopa County) - SPAZ					
Benzene	1,809.25	Formaldehyde	1.83E-02	Acrylonitrile	124.48
Formaldehyde	1,466.06	Benzene	1.41E-02	Benzene	12.79
Acetaldehyde	530.77	1,3-Butadiene	9.06E-03	1,3-Butadiene	6.62
1,3-Butadiene	302.07	Naphthalene	5.51E-03	Carbon Tetrachloride	4.15
Tetrachloroethylene	287.55	POM, Group 2	3.88E-03	*p*-Dichlorobenzene	2.18
1,3-Dichloropropene	238.48	Arsenic, PM	2.38E-03	Tetrachloroethylene	1.71
Dichloromethane	162.32	Hexavalent Chromium, PM	2.16E-03	Ethylbenzene	1.45
Naphthalene	162.03	Tetrachloroethylene	1.70E-03		
p-Dichlorobenzene	123.55	*p*-Dichlorobenzene	1.36E-03		
POM, Group 2	70.57	Acetaldehyde	1.17E-03		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 6-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Arizona 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Phoenix, Arizona (Maricopa County) - PXSS					
Toluene	5,464.99	Acrolein	6,346,324.90	Formaldehyde	0.37
Xylenes	3,828.86	1,3-Butadiene	151,037.15	Formaldehyde	0.36
Benzene	1,809.25	Formaldehyde	149,598.27	Manganese (PM$_{10}$)	0.33
Formaldehyde	1,466.06	Bromomethane	66,526.00	Acetaldehyde	0.32
Methanol	1,279.42	Benzene	60,308.20	Manganese (PM$_{10}$)	0.30
Hexane	1,109.64	Acetaldehyde	58,974.77	Acetaldehyde	0.30
Ethylbenzene	840.01	Naphthalene	54,009.14	1,3-Butadiene	0.11
Methyl *tert* butyl ether	704.09	Cyanide Compounds, gas	38,836.89	1,3-Butadiene	0.11
1,1,1-Trichloroethane	634.01	Xylenes	38,288.64	Benzene	0.06
Acetaldehyde	530.77	Arsenic, PM	18,474.24	Benzene	0.05
South Phoenix, Arizona (Maricopa County) - SPAZ					
Toluene	5,464.99	Acrolein	6,346,324.90	Acrylonitrile	0.92
Xylenes	3,828.86	1,3-Butadiene	151,037.15	1,3-Butadiene	0.11
Benzene	1,809.25	Formaldehyde	149,598.27	Benzene	0.05
Formaldehyde	1,466.06	Bromomethane	66,526.00	Carbon Tetrachloride	0.01
Methanol	1,279.42	Benzene	60,308.20	Chloroform	<0.01
Hexane	1,109.64	Acetaldehyde	58,974.77	Tetrachloroethylene	<0.01
Ethylbenzene	840.01	Naphthalene	54,009.14	Ethylbenzene	<0.01
Methyl *tert* butyl ether	704.09	Cyanide Compounds, gas	38,836.89	*p*-Dichlorobenzene	<0.01
1,1,1-Trichloroethane	634.01	Xylenes	38,288.64		
Acetaldehyde	530.77	Arsenic, PM	18,474.24		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 6-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Maricopa County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were formaldehyde, benzene, and 1,3-butadiene.

- Eight of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Similar to the pollutants with the highest toxicity-weighted emissions, formaldehyde, benzene, and 1,3-butadiene had highest cancer surrogate risk approximations for PXSS, each with their 2009 cancer risk approximation first followed by their 2008 cancer risk approximation. Acetaldehyde and carbon tetrachloride were also among the pollutants with the highest cancer surrogate risk approximations for PXSS. Carbon tetrachloride does not appear on the list of ten highest emissions or ten highest toxicity-weighted emissions for Maricopa County.

- POM Group 2 was the tenth highest emitted "pollutant" in Maricopa County and ranked fifth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at PXSS including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for PXSS.

- While acrylonitrile's cancer risk approximation was the highest cancer risk approximation for SPAZ and was the second highest cancer risk approximation calculated among all NMP sites, this pollutant appears on neither emissions-based list.

- With the exception of acrylonitrile, the cancer risk approximations for SPAZ were similar to the cancer risk approximations for PXSS. (Note: acrylonitrile was not detected frequently enough at PXSS for an annual average to be calculated.)

Observations from Table 6-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Maricopa County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.

- Four of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Acrolein had the highest toxicity-weighted emissions (by an order of magnitude) for Maricopa County. Although acrolein was sampled for at both sites, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Formaldehyde, manganese, acetaldehyde, 1,3-butadiene, and benzene had the highest noncancer risk approximations for PXSS. Of these, formaldehyde, benzene, and 1,3-butadiene also appear on both emissions-based lists.

- While acrylonitrile's noncancer risk approximation was the highest noncancer risk approximation for SPAZ and had the second highest noncancer risk approximation calculated among all NMP sites, this pollutant appears on neither emissions-based list.

6.6 Summary of the 2008-2009 Monitoring Data for PXSS and SPAZ

Results from several of the treatments described in this section include the following:

- ❖ *Twenty-three pollutants failed screens for PXSS; 13 of these are NATTS MQO Core Analytes. Ten pollutants failed screens for SPAZ, of which four are NATTS MQO Core Analytes.*

- ❖ *Of the site-specific pollutants of interest for PXSS, formaldehyde had the highest daily average concentration for both years; for SPAZ, acrylonitrile had the highest daily average concentration for both years.*

- ❖ *Concentrations of several VOC, including benzene and 1,3-butadiene, tended to be higher during the colder months of the years.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

7.0 Sites in California

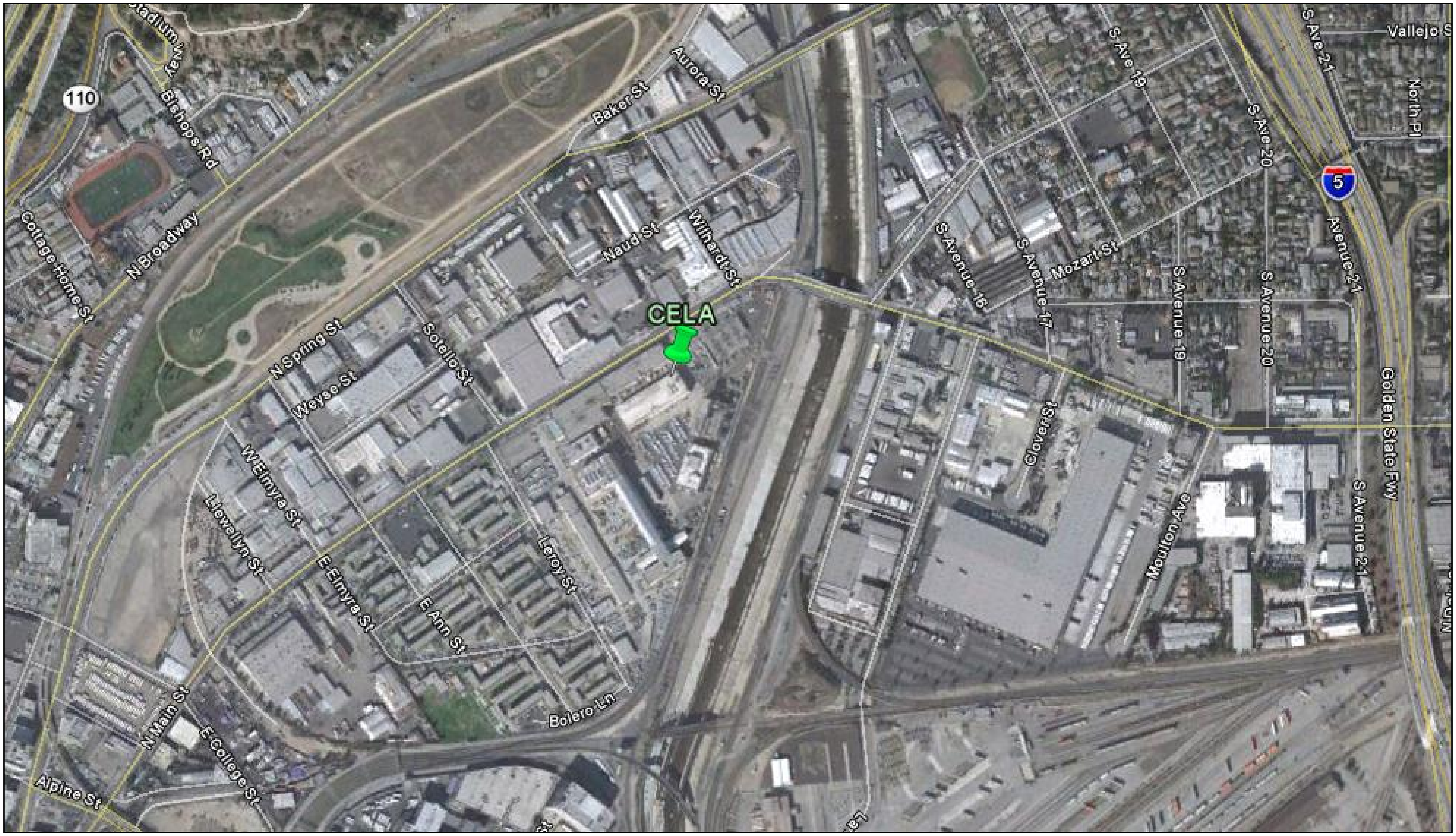
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at three NATTS sites in California, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

7.1 Site Characterization

This section characterizes the California monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

The California sites are located in Los Angeles, Rubidoux, and San Jose. Figures 7-1 through 7-3 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figures 7-4 through 7-6 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 7-4 through 7-6. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 7-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land, location setting, and locational coordinates.

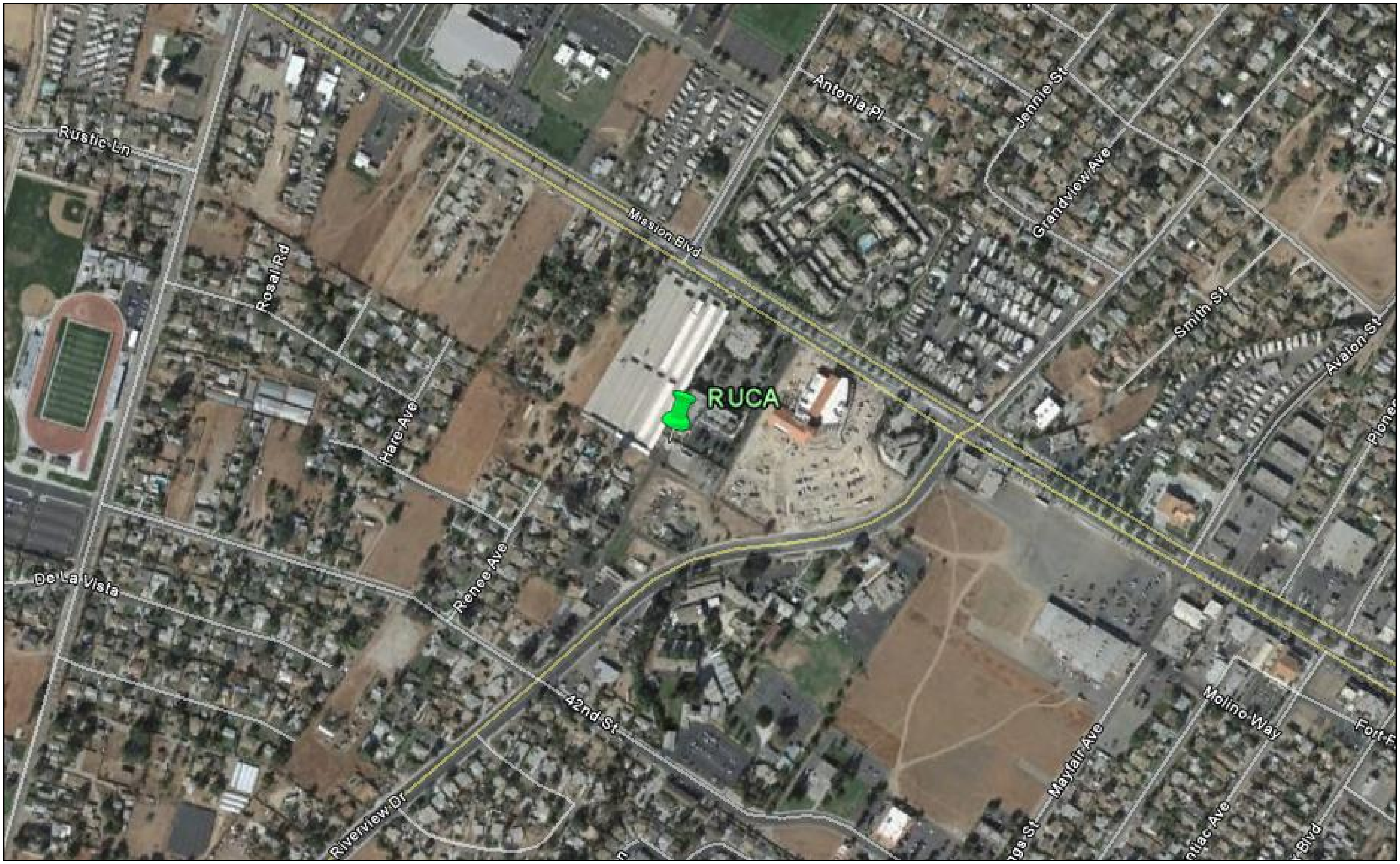
Figure 7-1. Los Angeles, California (CELA) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 1,803 feet

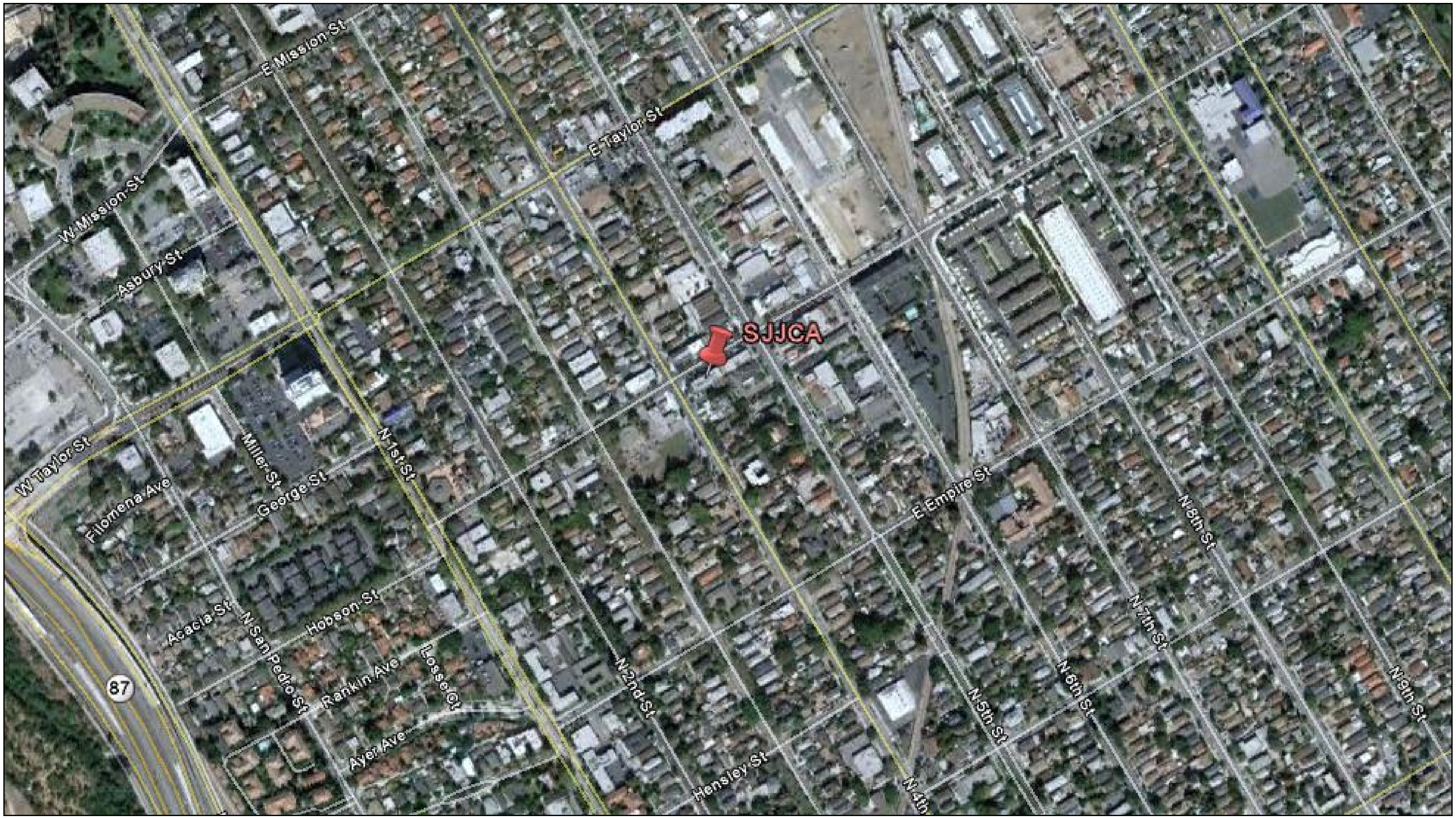
Figure 7-2. Rubidoux, California (RUCA) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

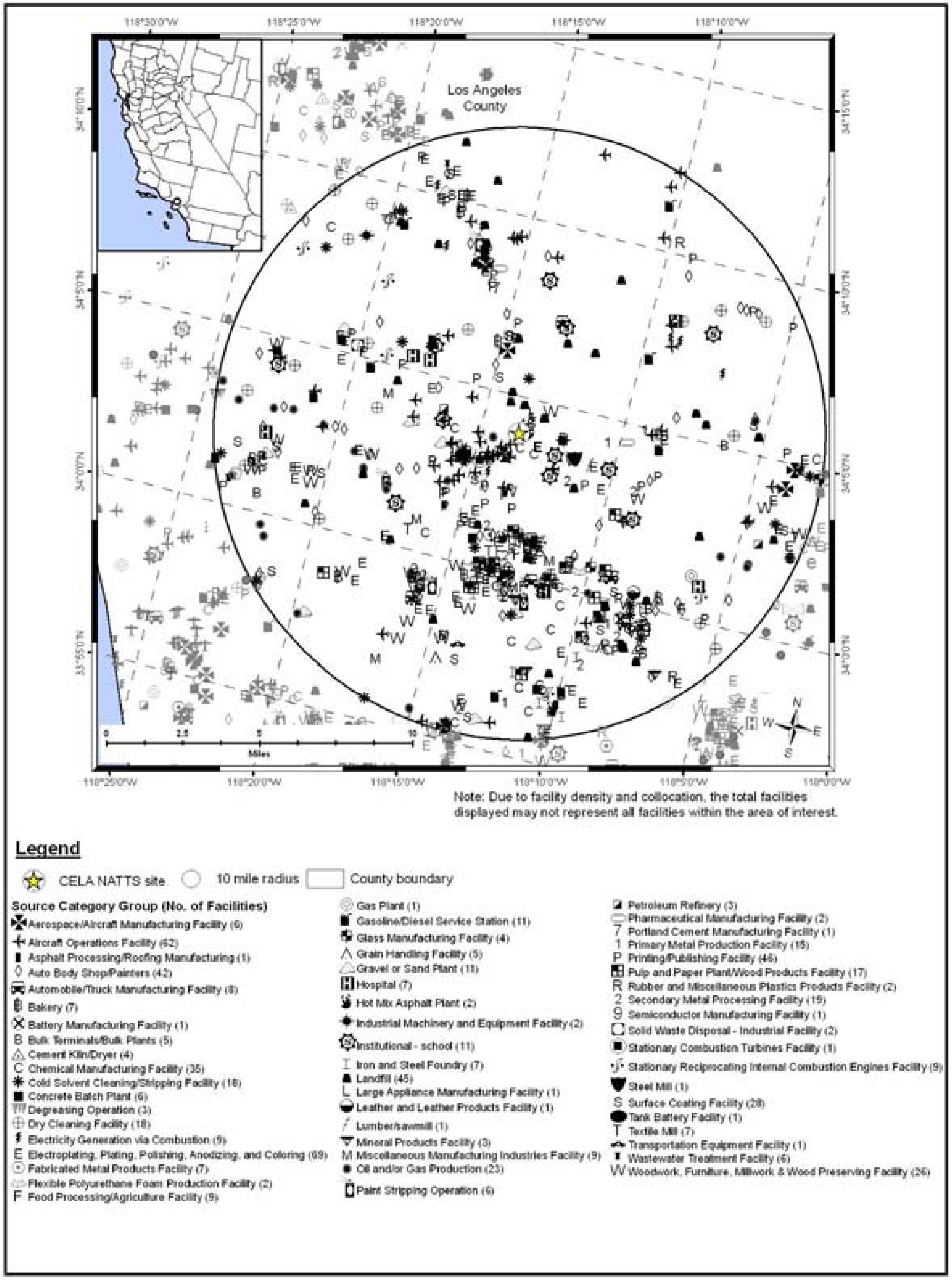
Scale: 2 inches = 1,484 feet

Figure 7-3. San Jose, California (SJJCA) Monitoring Site



©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,551 feet

Figure 7-4. NEI Point Sources Located Within 10 Miles of CELA


118°30'0"W
118°25'0"W
118°20'0"W
118°15'0"W
118°10'0"W
118°5'0"W
118°0'0"W
34°15'0"N
34°10'0"N
34°5'0"N
34°0'0"N
33°55'0"N
Los Angeles County
0
2.5
5
10
Miles
N
E
S
W
Legend
CELA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (6)
Aircraft Operations Facility (62)
Asphalt Processing/Roofing Manufacturing (1)
Auto Body Shop/Painters (42)
Automobile/Truck Manufacturing Facility (8)
Bakery (7)
Battery Manufacturing Facility (1)
Bulk Terminals/Bulk Plants (5)
Cement Kiln/Dryer (4)
Chemical Manufacturing Facility (35)
Cold Solvent Cleaning/Stripping Facility (18)
Concrete Batch Plant (6)
Degreasing Operation (3)
Dry Cleaning Facility (18)
Electricity Generation via Combustion (9)
Electroplating, Plating, Polishing, Anodizing, and Coloring (69)
Fabricated Metal Products Facility (7)
Flexible Polyurethane Foam Production Facility (2)
Food Processing/Agriculture Facility (9)
Gas Plant (1)
Gasoline/Diesel Service Station (11)
Glass Manufacturing Facility (4)
Grain Handling Facility (5)
Gravel or Sand Plant (11)
Hospital (7)
Hot Mix Asphalt Plant (2)
Industrial Machinery and Equipment Facility (2)
Institutional - school (11)
Iron and Steel Foundry (7)
Landfill (45)
Large Appliance Manufacturing Facility (1)
Leather and Leather Products Facility (1)
Lumber/sawmill (1)
Mineral Products Facility (3)
Miscellaneous Manufacturing Industries Facility (9)
Oil and/or Gas Production (23)
Paint Stripping Operation (6)
Petroleum Refinery (3)
Pharmaceutical Manufacturing Facility (2)
Portland Cement Manufacturing Facility (1)
Primary Metal Production Facility (15)
Printing/Publishing Facility (46)
Pulp and Paper Plant/Wood Products Facility (17)
Rubber and Miscellaneous Plastics Products Facility (2)
Secondary Metal Processing Facility (19)
Semiconductor Manufacturing Facility (1)
Solid Waste Disposal - Industrial Facility (2)
Stationary Combustion Turbines Facility (1)
Stationary Reciprocating Internal Combustion Engines Facility (9)
Steel Mill (1)
Surface Coating Facility (28)
Tank Battery Facility (1)
Textile Mill (7)
Transportation Equipment Facility (1)
Wastewater Treatment Facility (6)
Woodwork, Furniture, Millwork & Wood Preserving Facility (26)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 7-5. NEI Point Sources Located Within 10 Miles of RUCA

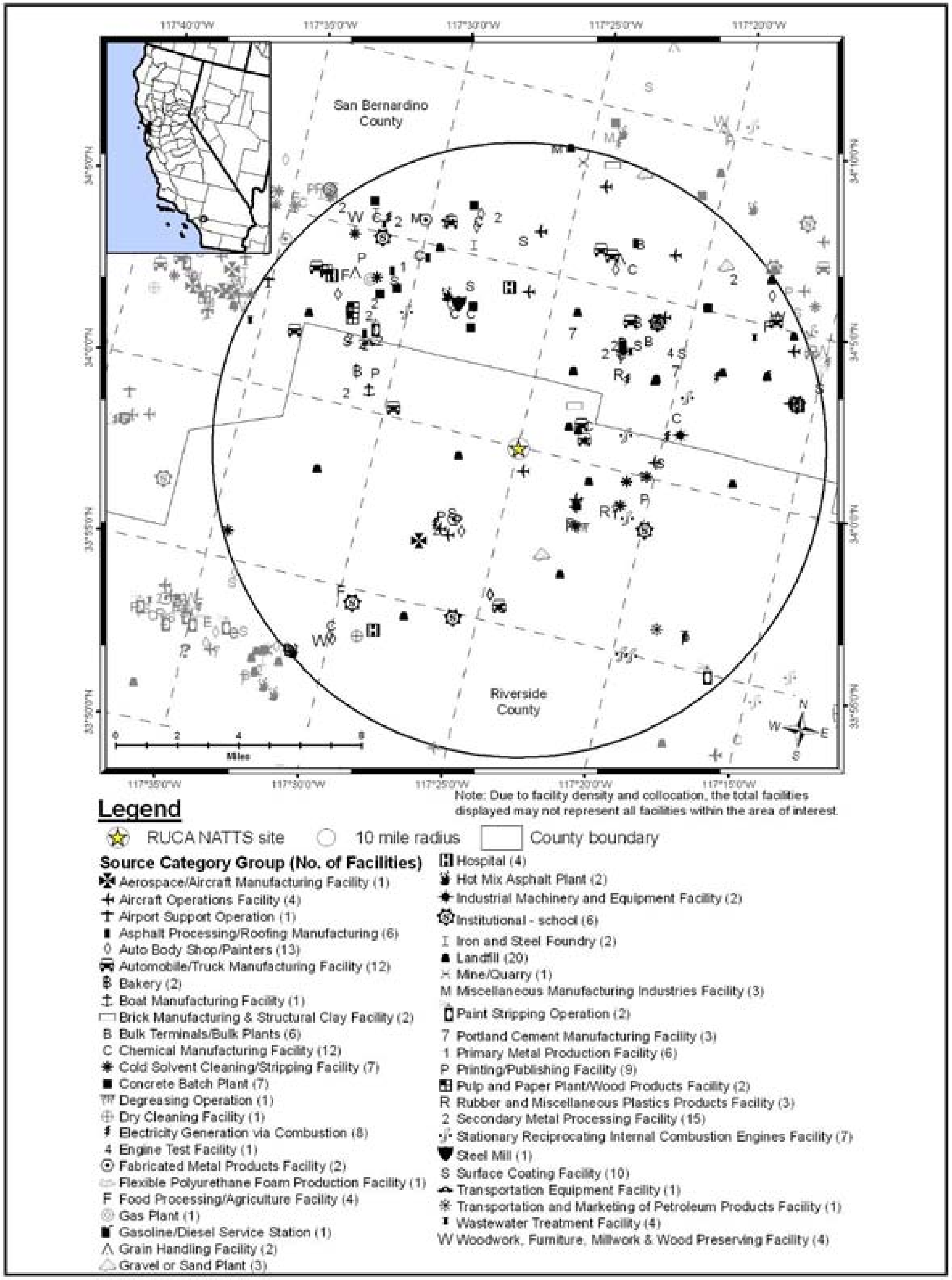
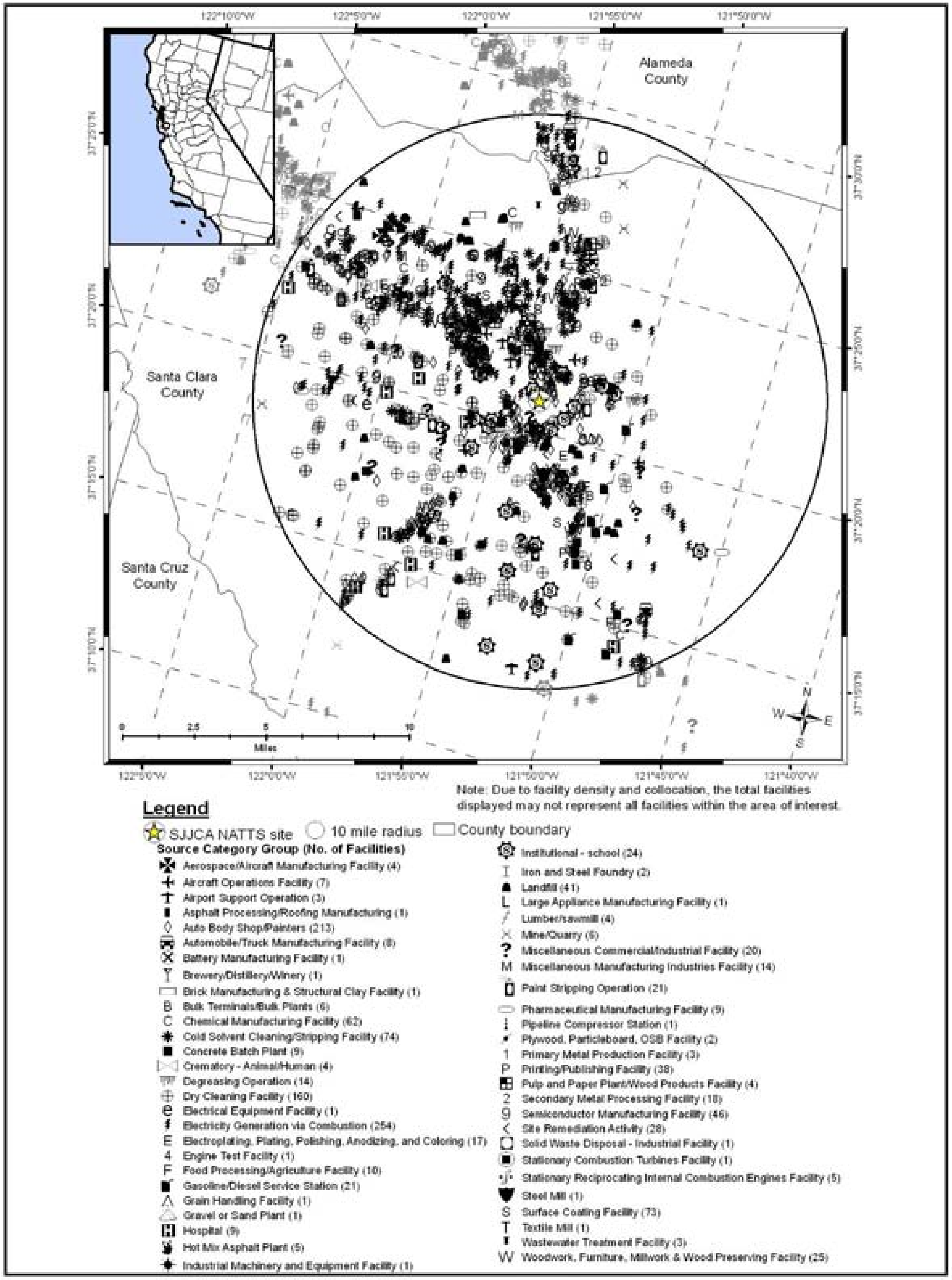

117°40'0"W
117°35'0"W
117°30'0"W
117°25'0"W
117°20'0"W
34°5'0"N
34°0'0"N
33°55'0"N
33°50'0"N
34°10'0"N
34°5'0"N
34°0'0"N
33°55'0"N
San Bernardino County
Riverside County
0
2
4
8
Miles
N
E
S
W
117°35'0"W
117°30'0"W
117°25'0"W
117°20'0"W
117°15'0"W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
RUCA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (1)
Aircraft Operations Facility (4)
Airport Support Operation (1)
Asphalt Processing/Roofing Manufacturing (6)
Auto Body Shop/Painters (13)
Automobile/Truck Manufacturing Facility (12)
Bakery (2)
Boat Manufacturing Facility (1)
Brick Manufacturing & Structural Clay Facility (2)
B Bulk Terminals/Bulk Plants (6)
C Chemical Manufacturing Facility (12)
Cold Solvent Cleaning/Stripping Facility (7)
Concrete Batch Plant (7)
Degreasing Operation (1)
Dry Cleaning Facility (1)
Electricity Generation via Combustion (8)
4 Engine Test Facility (1)
Fabricated Metal Products Facility (2)
Flexible Polyurethane Foam Production Facility (1)
F Food Processing/Agriculture Facility (4)
Gas Plant (1)
Gasoline/Diesel Service Station (1)
Grain Handling Facility (2)
Gravel or Sand Plant (3)
Hospital (4)
Hot Mix Asphalt Plant (2)
Industrial Machinery and Equipment Facility (2)
Institutional - school (6)
I Iron and Steel Foundry (2)
Landfill (20)
Mine/Quarry (1)
M Miscellaneous Manufacturing Industries Facility (3)
Paint Stripping Operation (2)
7 Portland Cement Manufacturing Facility (3)
1 Primary Metal Production Facility (6)
P Printing/Publishing Facility (9)
Pulp and Paper Plant/Wood Products Facility (2)
R Rubber and Miscellaneous Plastics Products Facility (3)
2 Secondary Metal Processing Facility (15)
Stationary Reciprocating Internal Combustion Engines Facility (7)
Steel Mill (1)
S Surface Coating Facility (10)
Transportation Equipment Facility (1)
Transportation and Marketing of Petroleum Products Facility (1)
Wastewater Treatment Facility (4)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (4)

Figure 7-6. NEI Point Sources Located Within 10 Miles of SJJCA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

122°10'0"W
122°5'0"W
122°0'0"W
121°55'0"W
121°50'0"W
37°25'0"N
37°20'0"N
37°15'0"N
37°10'0"N
37°30'0"N
37°25'0"N
37°20'0"N
37°15'0"N
Alameda County
Santa Clara County
Santa Cruz County
0
2.5
5
10
Miles
N
W
E
S
122°5'0"W
122°0'0"W
121°55'0"W
121°50'0"W
121°45'0"W
121°40'0"W
Legend
SJJCA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (4)
Aircraft Operations Facility (7)
Airport Support Operation (3)
Asphalt Processing/Roofing Manufacturing (1)
Auto Body Shop/Painters (213)
Automobile/Truck Manufacturing Facility (8)
Battery Manufacturing Facility (1)
Brewery/Distillery/Winery (1)
Brick Manufacturing & Structural Clay Facility (1)
B Bulk Terminals/Bulk Plants (6)
C Chemical Manufacturing Facility (62)
Cold Solvent Cleaning/Stripping Facility (74)
Concrete Batch Plant (9)
Crematory - Animal/Human (4)
Degreasing Operation (14)
Dry Cleaning Facility (160)
Electrical Equipment Facility (1)
Electricity Generation via Combustion (254)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (17)
4 Engine Test Facility (1)
F Food Processing/Agriculture Facility (10)
Gasoline/Diesel Service Station (21)
Grain Handling Facility (1)
Gravel or Sand Plant (1)
Hospital (9)
Hot Mix Asphalt Plant (5)
Industrial Machinery and Equipment Facility (1)
Institutional - school (24)
Iron and Steel Foundry (2)
Landfill (41)
L Large Appliance Manufacturing Facility (1)
Lumber/sawmill (4)
Mine/Quarry (6)
? Miscellaneous Commercial/Industrial Facility (20)
M Miscellaneous Manufacturing Industries Facility (14)
Paint Stripping Operation (21)
Pharmaceutical Manufacturing Facility (9)
Pipeline Compressor Station (1)
Plywood, Particleboard, OSB Facility (2)
1 Primary Metal Production Facility (3)
P Printing/Publishing Facility (38)
Pulp and Paper Plant/Wood Products Facility (4)
2 Secondary Metal Processing Facility (18)
9 Semiconductor Manufacturing Facility (46)
< Site Remediation Activity (28)
Solid Waste Disposal - Industrial Facility (1)
Stationary Combustion Turbines Facility (1)
Stationary Reciprocating Internal Combustion Engines Facility (5)
Steel Mill (1)
S Surface Coating Facility (73)
T Textile Mill (1)
Wastewater Treatment Facility (3)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (25)

Table 7-1. Geographical Information for the California Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
CELA	06-037-1103	Los Angeles	Los Angeles	Los Angeles-Long Beach-Santa Ana, CA MSA	34.06659, -118.22688	Residential	Urban/City Center	TSP, TSP Speciation, Hexavalent chromium, CO, SO_2, NO, NO_2, NOx, PAMS, Carbonyl compounds, VOC, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, $PM_{2.5}$ Speciation.
RUCA	06-065-8001	Rubidoux	Riverside	Riverside-San Bernardino-Ontario, CA MSA	33.99958, -117.41601	Residential	Suburban	Haze, TSP, TSP Speciation, Hexavalent chromium, CO, SO_2, NO, NO_2, NOx, PAMS, VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, PM coarse, $PM_{2.5}$, $PM_{2.5}$ Speciation.
SJJCA	06-085-0005	San Jose	Santa Clara	San Jose-Sunnyvale-Santa Clara, CA MSA	37.3485, -121.895	Commercial	Urban/City Center	TSP Speciation, Hexavalent chromium, CO, SO_2, NO, NO_2, NOx, VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, Black carbon, PM coarse, $PM_{2.5}$, $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

CELA is located on the rooftop of a two-story building just northeast of downtown Los Angeles, near Dodgers' Stadium. Figure 7-1 shows that CELA is surrounded by major freeways, including I-5, Route 110, and Highway 101. Although the area is classified as residential, a freight yard is located to the south of the site. The Los Angeles River runs north-south just east of the site. This monitoring site was originally set up as an emergency response monitor. As Figure 7-4 shows, CELA is situated among numerous point sources. A large number of emissions sources within 10 miles of CELA are involved in electroplating, plating, polishing, anodizing, and coloring; aircraft operations, which include airports as well as small runways, heliports, or landing pads; printing or publishing; and landfills.

RUCA is located just outside of Riverside, in a residential area of the suburban town of Rubidoux. Highway 60 runs east-west to the north of the site. Flabob Airport is located about three-quarters of a mile to the southeast of the site. Figure 7-2 shows that RUCA is adjacent to a power substation near the intersection of Mission Boulevard and Riverview Drive. Figure 7-5 shows that fewer emissions sources surround RUCA than CELA. Most of the emissions sources are located to the northeast and northwest of the site. The point source located closest to RUCA is Flabob Airport. The emissions source categories with the highest number of sources near RUCA include landfills, secondary metal processing facilities, and auto body shops.

SJJCA is located in central San Jose. Figure 7-3 shows that SJJCA is located in a commercial area surrounded by residential areas. A railroad is shown just east of the monitoring site, running north-south in Figure 7-3. Guadalupe Parkway, which can be seen on the bottom left of Figure 7-3, intersects with I-880 approximately 1 mile northwest of the monitoring site. San Jose International Airport is just on the other side of this intersection. Figure 7-6 shows that the density of point sources is higher near SJJCA than CELA and RUCA. The emissions source categories with the highest number of sources are electricity generation via combustion; auto body shops; dry cleaners; cold solvent cleaning and stripping; and surface coating processes.

Table 7-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the

California monitoring sites. Information provided in Table 6-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration for Los Angeles (CELA), Riverside (RUCA), and Santa Clara (SJJCA) Counties were obtained from the California Department of Motor Vehicles (CA DMV, 2008). Population data for all three counties were obtained from the U.S. Census Bureau (Census Bureau, 2010). Table 7-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 7-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 7-2 presents the daily VMT for each urban area.

Table 7-2. Population, Motor Vehicle, and Traffic Information for the California Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
CELA	9,848,011	7,498,722	0.76	3,739,626	2,847,521	238,000	275,665
RUCA	2,125,440	1,685,246	0.79	1,000,923	793,625	18,365	42,835
SJJCA	1,784,642	1,508,850	0.85	1,435,158	1,213,374	6,000	36,859

[1] Reference: Census Bureau, 2010.

[2] County-level vehicle registration reflects 2008 data from the California DMV (CA DMV, 2008).

[3] Reference: http://xionetic.com/zipfinddeluxe.aspx

[4] Annual Average Daily Traffic reflects 2005 data from the LA Almanac (CELA); 2009 data from the Riverside County Transportation Department (RUCA); and 2005 data from the San Jose DOT (SJJCA) (LA Almanac, 2005; Riverside, 2009; San Jose, 2006).

[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

BOLD = EPA-designated NATTS Site.

Observations from Table 7-2 include the following:

- CELA had the highest county population and county-level vehicle registration compared to all counties with NMP sites. CELA also had the highest 10-mile estimated vehicle ownership. However, the 10-mile population near this site ranked second behind BXNY, which is located in Bronx County and part of New York City.

- Riverside and Santa Clara Counties were also in the top 10 for county population and county-level vehicle registration among counties with NMP sites.

- Among the California sites, the vehicle-per-person ratios were lowest for the most populous area and higher for less populated area. In general, this trend is also true among all NMP sites.

- CELA experienced the second highest annual average daily traffic among NMP sites, and has a substantially higher traffic volume than both RUCA and SJJCA. The traffic count for CELA was based on data from Exit 136 off I-5 at Main Street. The traffic count for RUCA was based on data from Mission Boulevard, west of Riverview Drive. The traffic count for SJJCA was based on the intersection of North 4th Street and Jackson Street.

- The Los Angeles urban area's VMT ranked second among urban areas with NMP sites, behind New York City, while the Riverside and San Jose areas were in the middle of the range.

7.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in California on sample days, as well as over the course of each year.

7.2.1 Climate Summary

The climate of Los Angeles is generally mild. While the proximity to the Pacific Ocean acts as a moderating influence on the Los Angeles area, the elevation changes between the mountains and valleys allow the distance from the ocean to create substantial differences in temperature, rainfall, and wind over a relatively short distance. Precipitation falls primarily in winter months, while summers tend to be dry. Stagnant wind conditions in the summer can result in air pollution episodes, while breezy Santa Ana winds can create hot, dusty conditions. Fog and cloudy conditions are more prevalent near the coast than further inland (Bair, 1992 and WRCC, 2011).

San Jose is located to the southeast of San Francisco, near the base of the San Francisco Bay. The city is situated in the Santa Clara Valley, between the Santa Cruz Mountains to the south and west and the Diablo Range to the east. San Jose experiences a Mediterranean climate, with distinct wet-dry seasons. The period from November through March represents the wet season, with cool but mild conditions prevailing. Little rain falls the rest of the year and conditions tend to be warm and sunny. San Jose is not outside the marine influences of the cold ocean currents typically affecting the San Francisco area (Bair, 1992 and NWS, 1999).

7.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The NWS weather station nearest CELA is located at Downtown Los Angeles/USC Campus; the nearest NWS weather station to RUCA is located at Riverside Municipal Airport; and the nearest NWS station to SJJCA is located at San Jose International (WBAN 93134, 03171 and 23293, respectively). Additional information about these weather stations is provided in Table 7-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 7-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information on days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 7-3 is the 95 percent confidence interval for each parameter. As shown in Table 7-3, average meteorological conditions on sample days near these sites were fairly representative of average weather conditions throughout the year for both years. Table 7-3 also shows how marked the temperature differences are between two sites (CELA and RUCA) less than 50 miles apart, as alluded to in Section 7.2.1. These sites also have large differences in average wind speeds. As expected, conditions near SJJCA tended to be cooler.

Table 7-3. Average Meteorological Conditions near the California Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Los Angeles, California – CELA										
Downtown L.A./USC Campus Airport 93134 (34.03, -118.30)	4.60 miles 249° (WSW)	2008	Sample Day	74.7 ± 2.5	64.5 ± 2.0	49.0 ± 2.6	56.2 ± 1.8	61.2 ± 3.3	1015.1 ± 1.0	1.3 ± 0.2
			All 2008	75.1 ± 1.0	64.9 ± 0.8	48.3 ± 1.1	56.1 ± 0.7	59.4 ± 1.5	1014.6 ± 0.4	1.4 ± 0.1
		2009	Sample Day	74.9 ± 2.3	64.7 ± 1.8	49.9 ± 2.3	56.7 ± 1.6	62.6 ± 3.3	1014.4 ± 0.9	1.2 ± 0.2
			All 2009	74.7 ± 1.0	64.7 ± 0.7	48.8 ± 1.1	56.3 ± 0.7	60.8 ± 1.5	1014.6 ± 0.4	1.3 ± 0.1
Rubidoux, California – RUCA										
Riverside Municipal Airport 03171 (33.95, -117.44)	3.51 miles 214° (SW)	2008	Sample Day	83.6 ± 5.3	69.6 ± 4.1	48.9 ± 4.0	58.0 ± 3.1	54.2 ± 5.8	1012.7 ± 1.3	5.6 ± 0.7
			All 2008	84.3 ± 2.0	69.9 ± 1.5	47.2 ± 1.8	57.6 ± 1.2	51.1 ± 2.5	1013.1 ± 0.6	5.8 ± 0.3
		2009	Sample Day	80.0 ± 3.4	66.1 ± 2.7	45.5 ± 2.6	55.1 ± 1.9	54.6 ± 4.1	1013.5 ± 0.9	3.6 ± 0.3
			All 2009	78.9 ± 1.4	65.5 ± 1.0	44.0 ± 1.3	54.4 ± 0.8	53.5 ± 1.9	1013.7 ± 0.4	3.8 ± 0.1
San Jose, California – SJJCA										
San Jose Intl. Airport 23293 (37.36, -121.93)	1.95 miles 325° (NW)	2008	Sample Day	70.3 ± 2.9	59.4 ± 2.2	46.2 ± 1.8	52.4 ± 1.6	65.4 ± 2.9	1017.3 ± 1.3	5.3 ± 0.6
			All 2008	70.6 ± 1.2	59.4 ± 0.9	45.3 ± 0.8	52.1 ± 0.7	63.8 ± 1.3	1016.8 ± 0.5	5.3 ± 0.3
		2009	Sample Day	69.6 ± 2.9	59.0 ± 2.1	46.4 ± 1.7	52.4 ± 1.6	66.2 ± 2.8	1016.5 ± 1.0	5.1 ± 0.5
			All 2009	70.4 ± 1.1	59.4 ± 0.8	45.7 ± 0.8	52.2 ± 0.7	63.9 ± 1.1	1016.5 ± 0.5	5.2 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

7.2.3 Back Trajectory Analysis

Figure 7-7 and Figure 7-8 are the composite back trajectory maps for days on which samples were collected at the CELA monitoring site in 2008 and 2009, respectively. Figure 7-9 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 7-10 and 7-11 are the composite back trajectory maps for days on which samples were collected at the RUCA monitoring site in 2008 and 2009, respectively, and Figure 7-12 is the cluster analysis for both years. Finally, Figures 7-13 and 7-14 are the composite back trajectory maps for days on which samples were collected at the SJJCA monitoring site in 2008 and 2009, respectively, and Figure 7-15 is the cluster analysis for both years. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 7-7 through 7-15 represents 100 miles.

Figure 7-7. 2008 Composite Back Trajectory Map for CELA

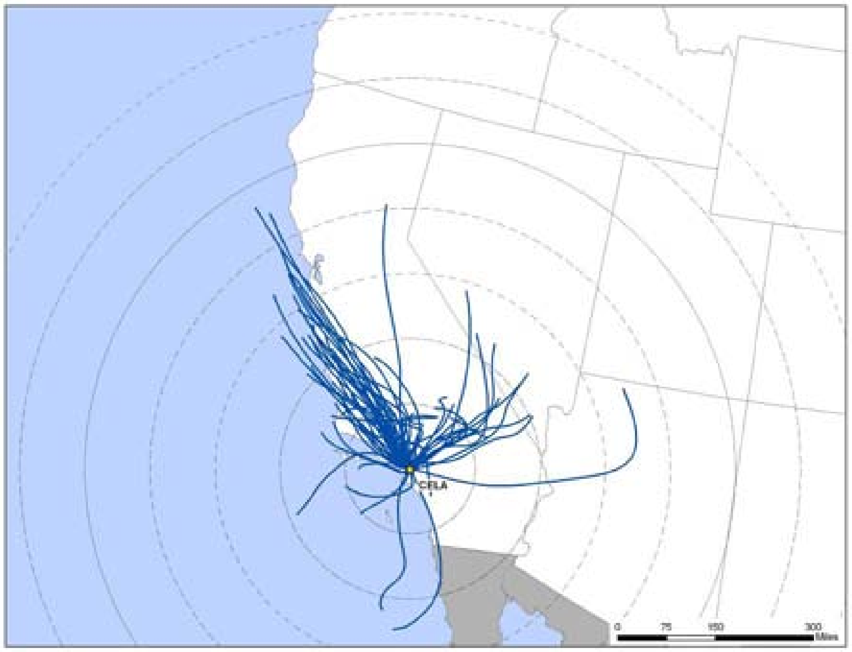


Figure 7-8. 2009 Composite Back Trajectory Map for CELA

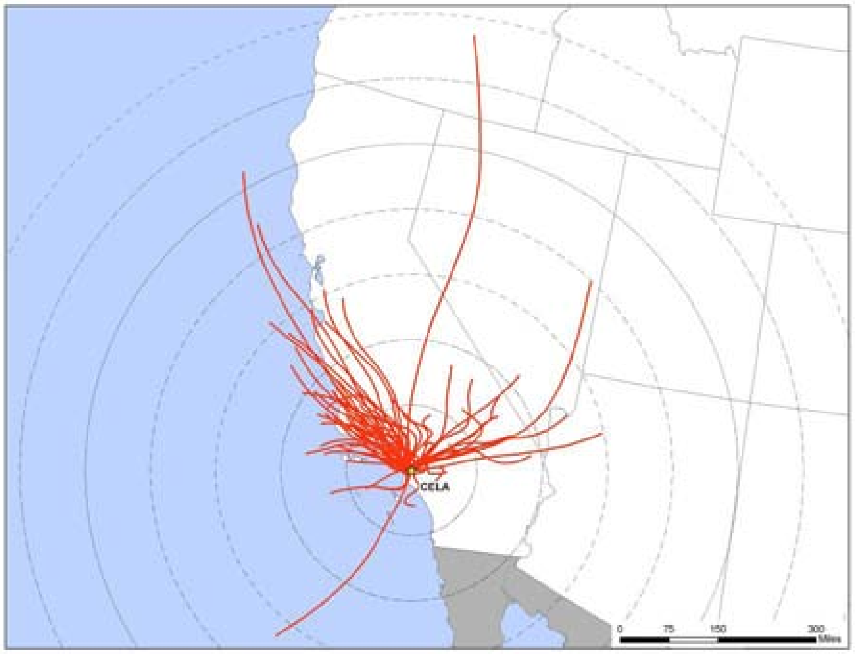


Figure 7-9. Back Trajectory Cluster Map for CELA

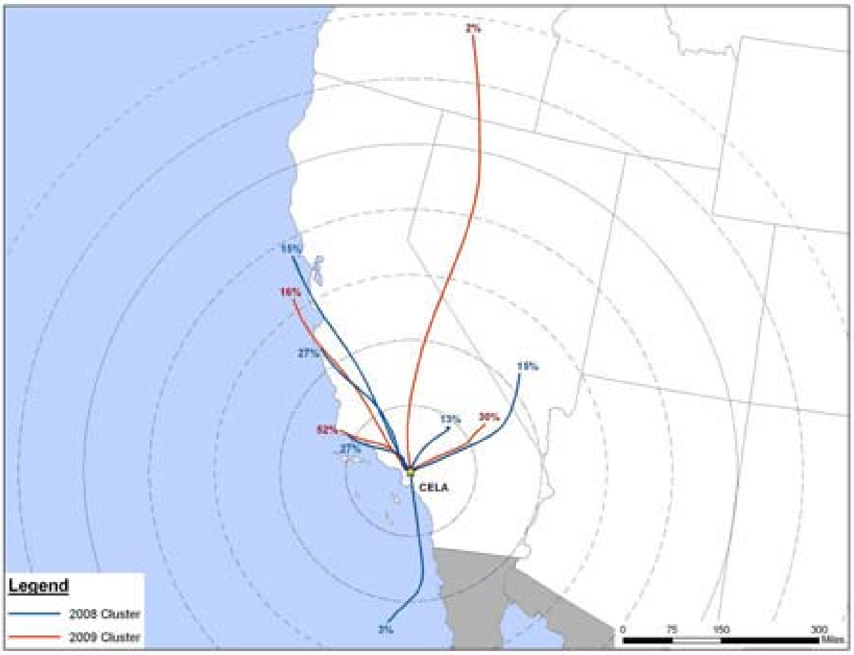


Figure 7-10. 2008 Composite Back Trajectory Map for RUCA

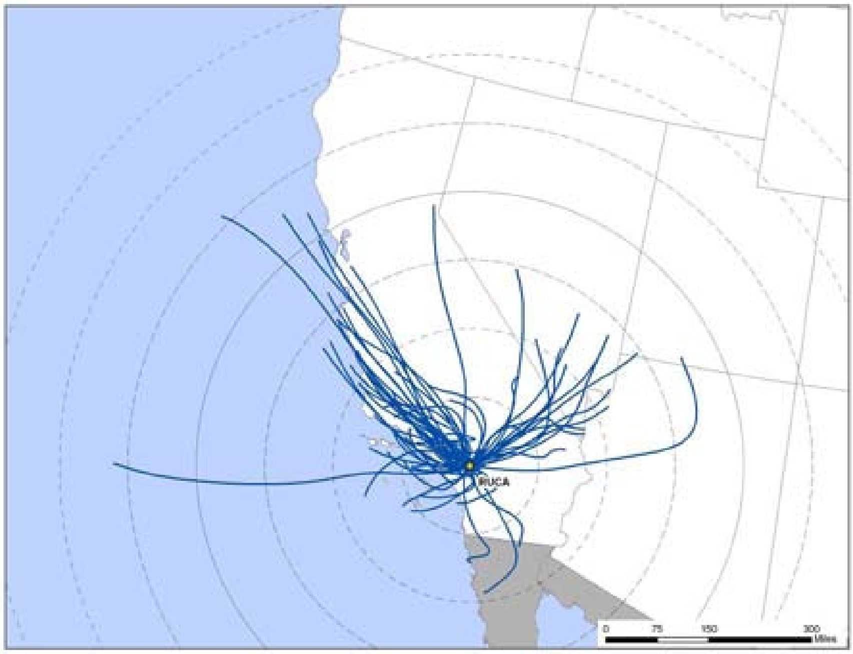


Figure 7-11. 2009 Composite Back Trajectory Map for RUCA

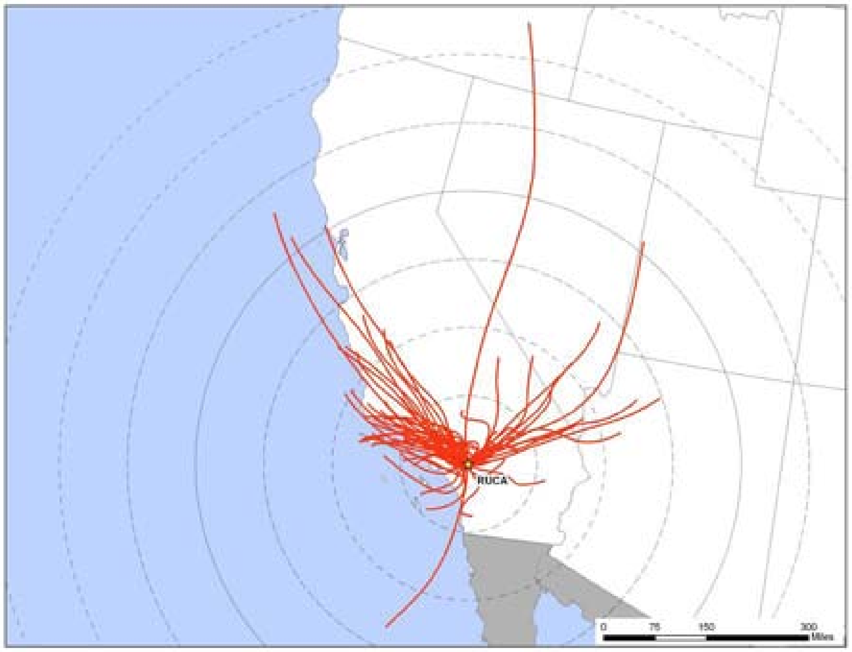


Figure 7-12. Back Trajectory Cluster Map for RUCA

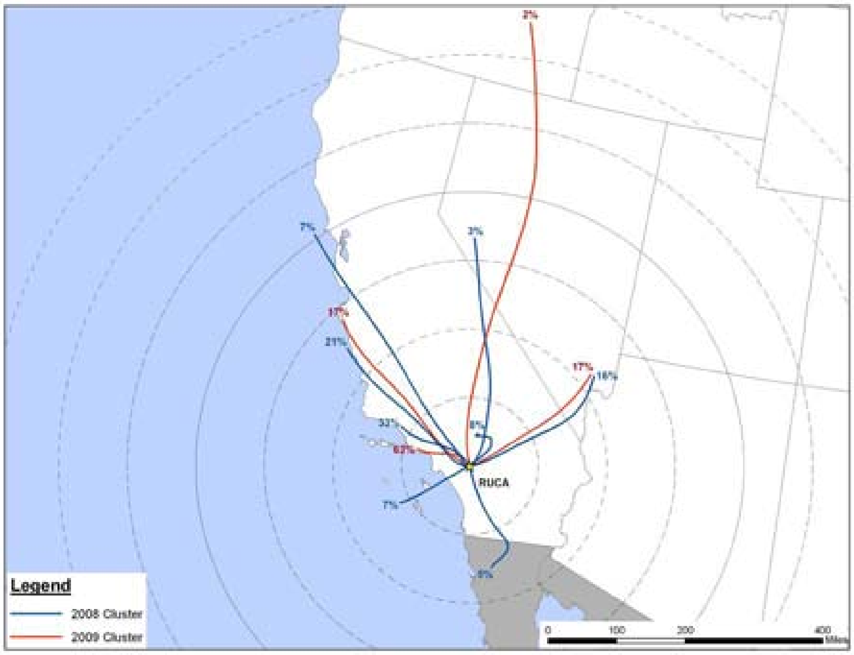


Figure 7-13. 2008 Composite Back Trajectory Map for SJJCA

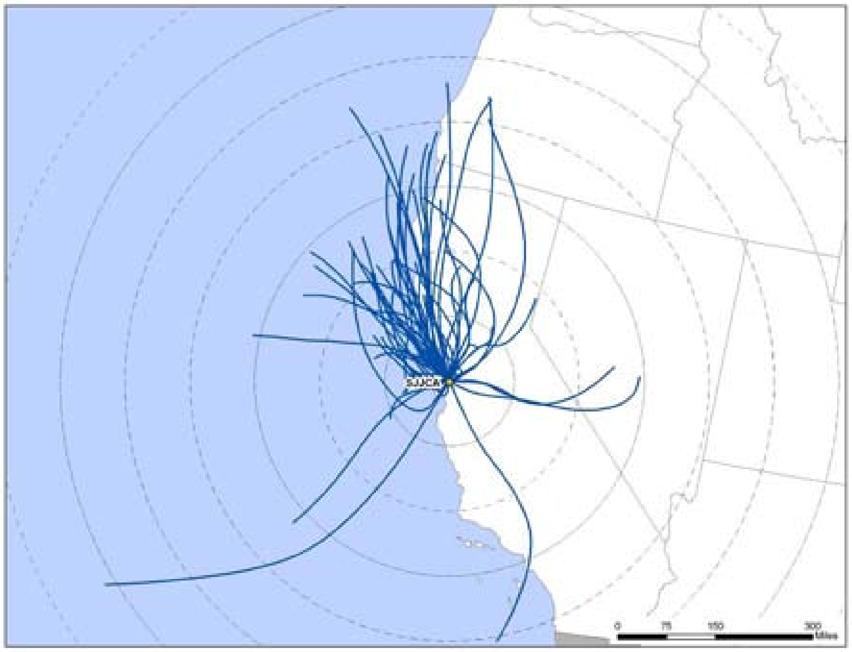


Figure 7-14. 2009 Composite Back Trajectory Map for SJJCA

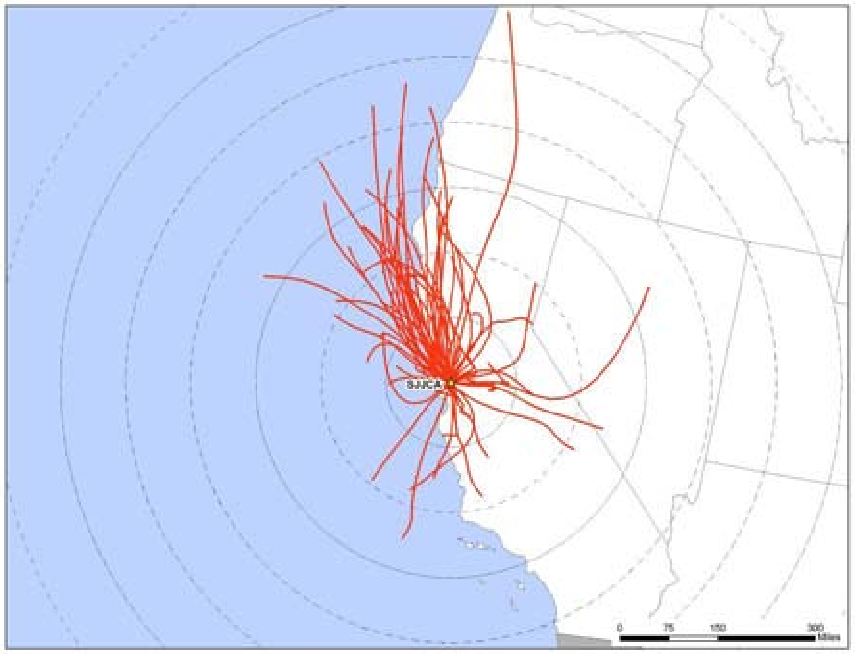
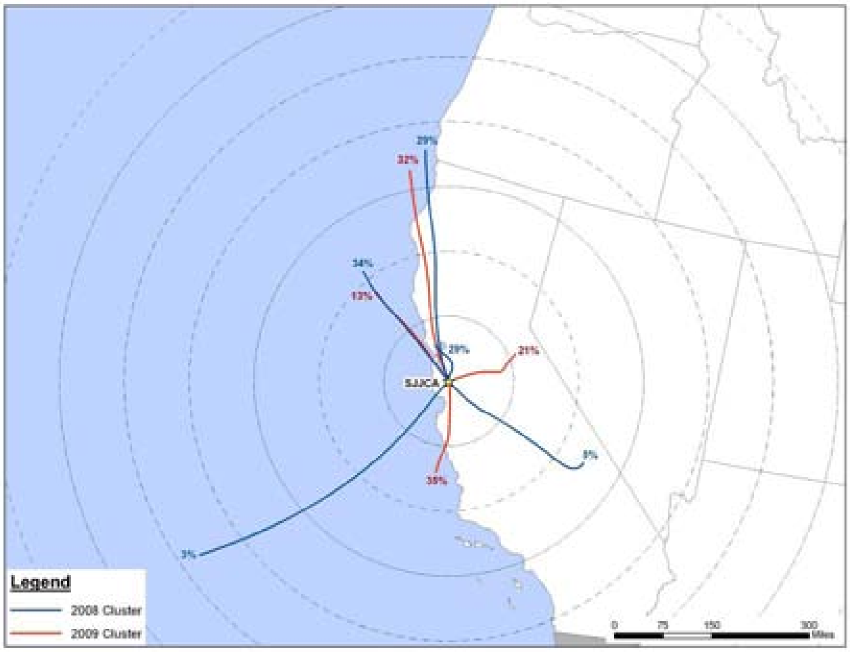


Figure 7-15. Back Trajectory Cluster Map for SJJCA



Observations from Figures 7-7 through 7-9 for CELA include the following:

- The 24-hour air shed domain was somewhat smaller for CELA than for many other NMP monitoring sites, based on the average distance of the trajectories. The farthest away a trajectory originated was central Oregon, or less than 700 miles away. However, most trajectories (86 percent) originated within 300 miles of CELA.

- Back trajectories originated from a variety of directions at CELA. However, a large cluster of trajectories originated from the northwest of the site. Another cluster originated from the northeast. Very few originated from the east, southeast, south, or southwest.

- The cluster analysis shows that nearly 70 percent of trajectories originated from the northwest in both years. The cluster analysis also shows that approximately 30 percent of trajectories originated from the northeast. The 2008 cluster analysis is in fairly good agreement with the 2009 cluster analysis.

Observations from Figures 7-10 through 7-12 for RUCA include the following:

- Not surprisingly, the back trajectories for RUCA resemble the ones for CELA. The 24-hour air shed domain for RUCA is similar in size to CELA, as the farthest away a trajectory originated was also in central Oregon, or approximately 650 miles away. Like CELA, most trajectories (90 percent) originated within 300 miles of RUCA.

- Back trajectories originated from a variety of directions at RUCA. A large cluster of trajectories originated from the northwest of the site and a secondary cluster originated from the northeast. Few trajectories originated from the east, southeast, or south.

- The cluster analysis shows that nearly 80 percent of trajectories in 2008 and 60 percent in 2009 originated from the northwest. The cluster analysis also shows that approximately 20 percent of trajectories originated from the northeast. The 2008 cluster analysis is, for the most part, in fairly good agreement with the 2009 cluster analysis.

Observations from Figures 7-13 through 7-15 for SJJCA include the following:

- Based on the length of the average trajectory, the 24-hour air shed domain for SJJCA is larger than the other two California sites, although the farthest away a trajectory originated was just over 600 miles away, well offshore over the Pacific. However, 76 percent of trajectories originated within 300 miles of SJJCA and 91 percent originated within 400 miles of the site.

- Back trajectories originated from a variety of directions at SJJCA. A large number of trajectories originated from areas to the northwest and north of the site. Few trajectories originated from the east, southeast, south, and southwest.

- The cluster analysis for 2008 shows that 63 percent of trajectories originated from the northwest and north. Another 29 percent of trajectories originated within 100 miles of the site and are represented by the short trajectory over San Francisco Bay. Only five back trajectories, representing approximately eight percent of sample days, originated from the southeast, south, or southwest.

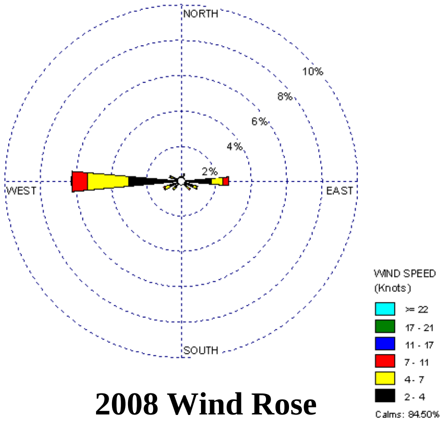
- Although the 2009 cluster analysis shows the same tendency for trajectories to originate from the northwest or north of the site (45 percent), it also shows more variability in trajectory origin as 21 percent originated from the east and 35 percent originated from the southeast to southwest.

7.2.4 Wind Rose Comparison

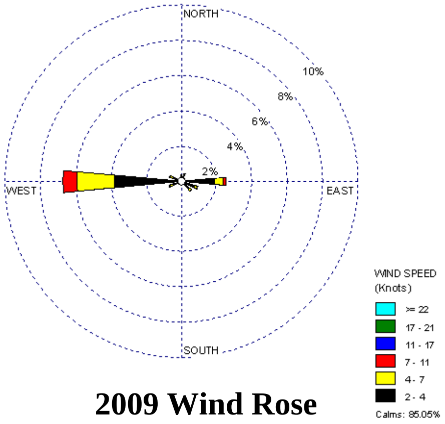
Hourly wind data from the NWS weather stations at the Downtown Los Angeles/USC Campus (for CELA), Riverside Municipal Airport (for RUCA), and San Jose International Airport (for SJJCA) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 7-16 presents five different wind roses for the CELA monitoring site. First, a historical wind rose representing 2000 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 7-17 and 7-18 present the five different wind roses for the RUCA and SJJCA monitoring sites, respectively.

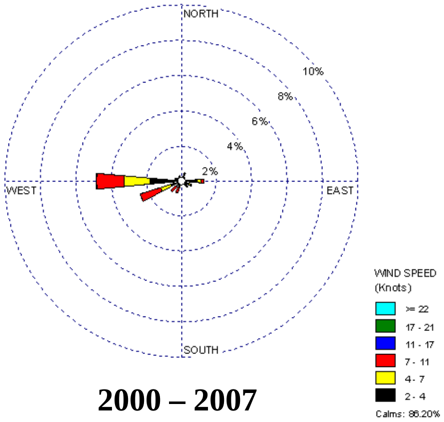
Figure 7-16. Wind Roses for the Downtown Los Angeles/USC Campus Weather Station near CELA



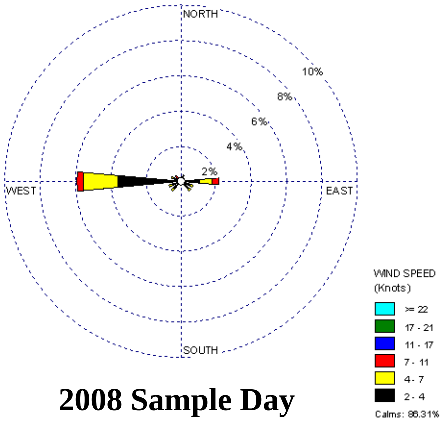
2008 Wind Rose



2009 Wind Rose

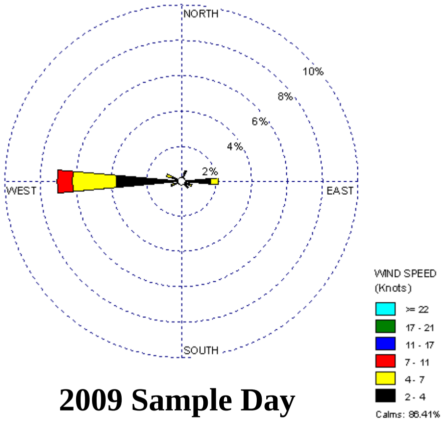


2000 – 2007
Historical Wind Rose



2008 Sample Day

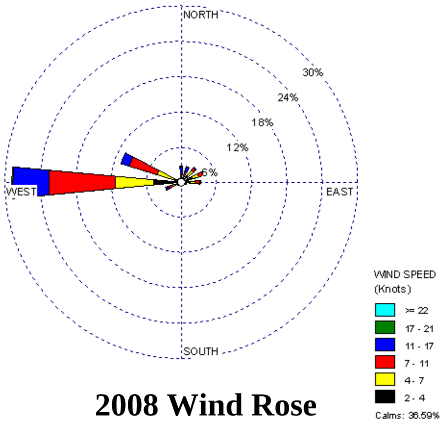
Wind Rose



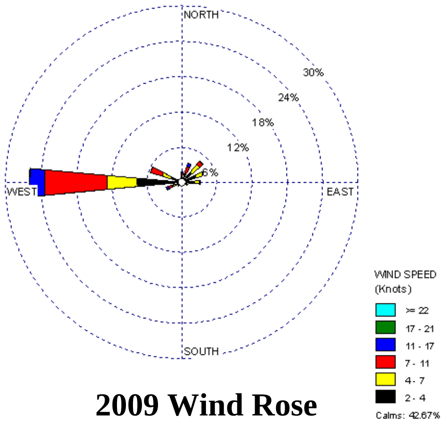
2009 Sample Day

Wind Rose

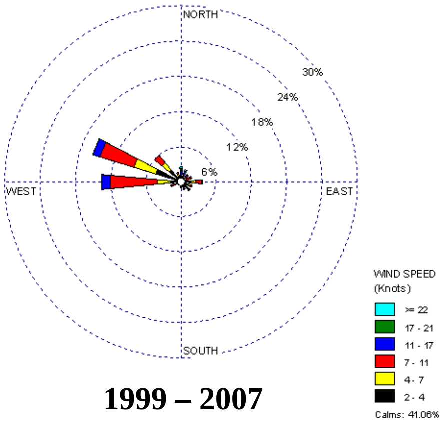
Figure 7-17. Wind Roses for the Riverside Municipal Airport Weather Station near RUCA



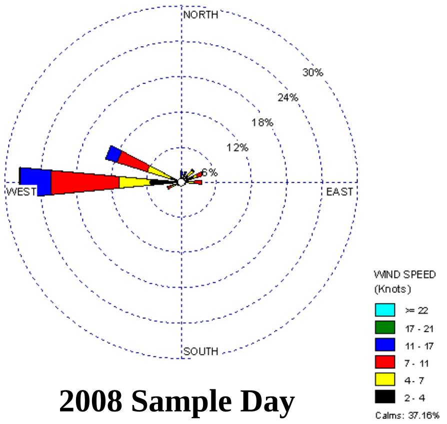
2008 Wind Rose



2009 Wind Rose

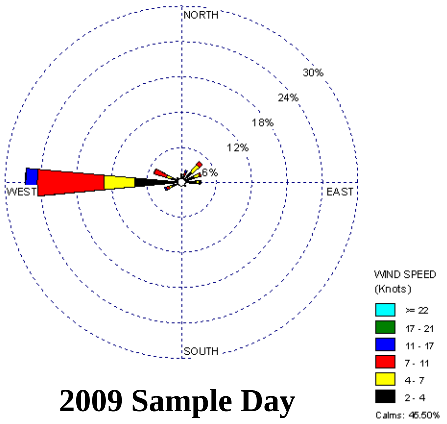


1999 – 2007
Historical Wind Rose



2008 Sample Day

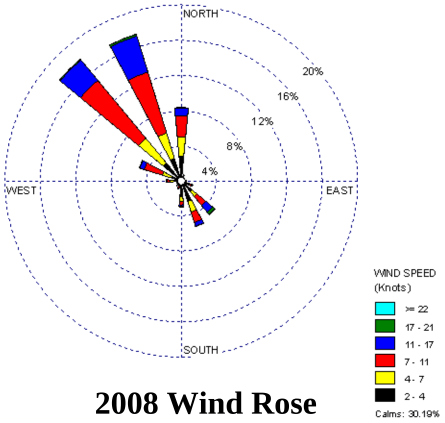
Wind Rose



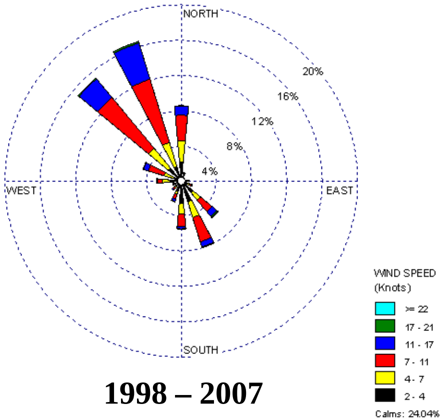
2009 Sample Day

Wind Rose

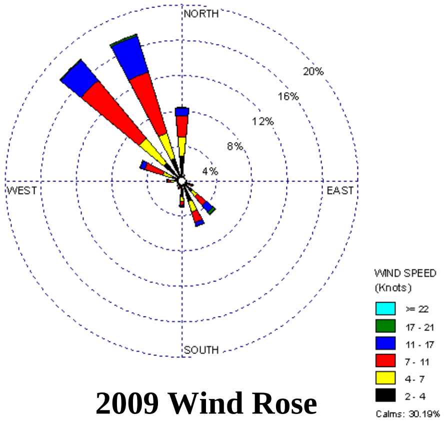
Figure 7-18. Wind Roses for the San Jose International Airport Weather Station near SJJCA



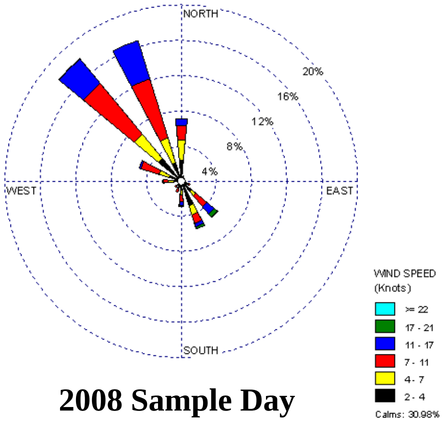
2008 Wind Rose



1998 – 2007
Historical Wind Rose

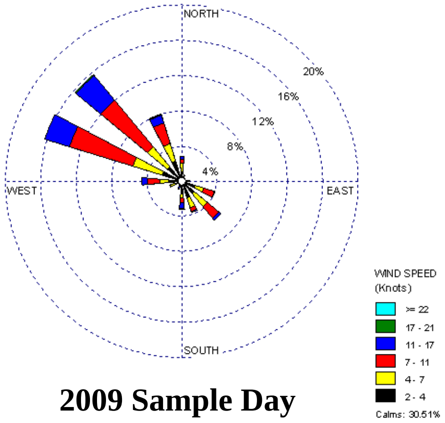


2009 Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 7-16 for CELA include the following:

- Historically, winds were generally light near this site, with calm winds (≤ 2 knots) observed for 86 percent of the wind observations. For wind speeds greater than 2 knots, westerly and west-southwesterly winds were most common. Wind speeds greater than 11 knots were not measured at this weather station.

- The 2008 and 2009 wind roses are similar to the historical wind rose in wind patterns, although easterly winds were observed slightly more often for both years. Further, the wind patterns shown on the sample day wind roses for each year also resemble the historical and full-year wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year(s) and historically.

Observations from Figure 7-17 for RUCA include the following:

- Although calm winds were observed approximately 40 percent of the time near RUCA, westerly, west-northwesterly, and northwesterly winds were frequently observed, based on the historical wind rose.

- The 2008 and 2009 wind roses are similar in wind patterns to the historical wind rose, although westerly winds were observed more often than west-northwesterly winds for both years.

- The wind patterns shown on the sample day wind roses for each year resemble the wind patterns shown on the full-year wind roses, indicating that conditions on sample days were representative of those experienced over the entire year.

Observations from Figure 7-18 for SJJCA include the following:

- Historically, 40 percent of winds were from the northwest to north. Another 20 percent of winds were from the southeast to south. Northeasterly, easterly, and southwesterly winds were rarely observed. Approximately one-quarter of the winds were calm.

- The wind patterns shown on the 2008 and 2009 wind roses are similar to the wind patterns shown on the historical wind rose, although calm winds were observed slightly more often for both years. Further, the wind patterns shown on the sample day wind roses for each year also resemble the wind patterns shown on the historical and full-year wind roses, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

7.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the California monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 7-4 presents the pollutants of interest for CELA, RUCA, and SJJCA. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. CELA and RUCA sampled for PAH only, while SJJCA sampled for metals (PM_{10}) and PAH.

Table 7-4. Risk Screening Results for the California Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Los Angeles, California - CELA						
Naphthalene	0.029	120	121	99.17	99.17	99.17
Benzo(a)pyrene	0.00091	1	71	1.41	0.83	100.00
Total		121	192	63.02		
Rubidoux, California - RUCA						
Naphthalene	0.029	98	120	81.67	98.99	98.99
Benzo(a)pyrene	0.00091	1	58	1.72	1.01	100.00
Total		99	178	55.62		
San Jose, California - SJJCA						
Naphthalene	0.029	76	101	75.25	48.41	48.41
Arsenic (PM_{10})	0.00023	55	99	55.56	35.03	83.44
Manganese (PM_{10})	0.005	24	101	23.76	15.29	98.73
Cadmium (PM_{10})	0.00056	1	101	0.99	0.64	99.36
Lead (PM_{10})	0.015	1	101	0.99	0.64	100.00
Total		157	503	31.21		

Observations from Table 7-4 include the following:

- Naphthalene failed the bulk of screens for both CELA and RUCA, each contributing to nearly 99 percent of failed screens. Although benzo(a)pyrene failed only one screen for each site, it was added as a pollutant of interest for both sites because it is a NATTS MQO Core Analyte.

- Five pollutants failed screens for SJJCA, all of which are NATTS MQO Core Analytes. Three of these were initially identified as SJJCA's pollutants of interest. Cadmium and lead were added, even though they did not contribute to 95 percent of SJJCA's total failed screens, because they are NATTS MQO Core Analytes. Three additional NATTS MQO Core Analytes were added to SJJCA's pollutants of interest, even though their concentrations did not fail any screens: beryllium, nickel, and benzo(a)pyrene. These three pollutants are not shown in Table 7-4.

7.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the California monitoring sites. Concentration averages are provided for the pollutants of interest for each site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

7.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual averages were calculated for the pollutants of interest for each California site, as described in Section 3.1.1. The *daily* average of a particular pollutant is simply the average concentration of all measured detections within a given year. If there were at least seven measured detections within a given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid seasonal averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 7-5, where applicable, and are shown in ng/m^3 for ease of viewing.

Table 7-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the California Monitoring Sites

Pollutant	2008						2009					
	Daily Average (ng/m^3)	**1st Quarter Average (ng/m^3)**	**2nd Quarter Average (ng/m^3)**	**3rd Quarter Average (ng/m^3)**	**4th Quarter Average (ng/m^3)**	**Annual Average (ng/m^3)**	**Daily Average (ng/m^3)**	**1st Quarter Average (ng/m^3)**	**2nd Quarter Average (ng/m^3)**	**3rd Quarter Average (ng/m^3)**	**4th Quarter Average (ng/m^3)**	**Annual Average (ng/m^3)**
Los Angeles, California - CELA												
Benzo(a)pyrene	0.11 ± 0.03	0.11 ± 0.06	0.04 ± 0.04	NA	0.10 ± 0.05	0.06 ± 0.02	0.15 ± 0.07	0.19 ± 0.18	NA	NA	0.14 ± 0.06	NA
Naphthalene	121.16 ± 23.33	87.91 ± 20.05	74.26 ± 17.31	100.17 ± 24.58	225.41 ± 66.40	121.16 ± 23.33	167.58 ± 30.00	200.71 ± 70.23	107.59 ± 23.59	146.36 ± 37.49	227.26 ± 91.63	167.58 ± 30.00
Rubidoux, California - RUCA												
Benzo(a)pyrene	0.09 ± 0.03	0.08 ± 0.03	NA	NA	0.09 ± 0.05	NA	0.16 ± 0.10	0.18 ± 0.22	NA	NA	0.13 ± 0.08	NA
Naphthalene	66.00 ± 12.00	62.24 ± 20.44	38.19 ± 12.49	50.18 ± 11.14	116.77 ± 30.22	66.00 ± 12.00	85.97 ± 16.88	104.34 ± 55.25	58.21 ± 12.27	72.38 ± 18.69	116.83 ± 40.88	85.97 ± 16.88
San Jose, California - SJJCA												
Arsenic (PM$_{10}$)	0.40 ± 0.11	0.53 ± 0.39	0.29 ± 0.10	0.31 ± 0.08	0.48 ± 0.20	0.40 ± 0.11	0.26 ± 0.08	0.38 ± 0.19	0.14 ± 0.05	0.22 ± 0.08	NR	0.25 ± 0.08
Benzo(a)pyrene	0.13 ± 0.09	NR	NA	NA	0.10 ± 0.08	NA	0.17 ± 0.08	0.11 ± 0.08	NA	NA	0.13 ± 0.10	NA
Beryllium (PM$_{10}$)	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01	<0.01 ± <0.01	NR	<0.01 ± <0.01
Cadmium (PM$_{10}$)	0.08 ± 0.03	0.13 ± 0.13	0.05 ± 0.01	0.05 ± 0.03	0.09 ± 0.02	0.08 ± 0.03	0.06 ± 0.02	0.10 ± 0.06	0.04 ± 0.01	0.04 ± 0.02	NR	0.06 ± 0.02
Lead (PM$_{10}$)	3.16 ± 0.86	5.33 ± 2.94	1.95 ± 0.65	1.85 ± 0.43	3.36 ± 0.86	3.16 ± 0.86	1.93 ± 0.46	2.49 ± 1.14	1.66 ± 0.41	1.46 ± 0.43	NR	1.93 ± 0.46
Manganese (PM$_{10}$)	4.60 ± 0.68	4.04 ± 1.20	4.90 ± 1.46	4.49 ± 1.38	5.02 ± 1.70	4.60 ± 0.68	3.32 ± 0.63	3.60 ± 1.55	3.24 ± 0.62	2.98 ± 0.81	NR	3.32 ± 0.63
Naphthalene	69.67 ± 16.77	NR	30.88 ± 6.07	46.83 ± 13.05	118.36 ± 29.33	69.67 ± 16.77	81.04 ± 21.35	111.05 ± 66.77	37.66 ± 11.43	51.60 ± 18.98	117.08 ± 40.37	81.04 ± 21.35
Nickel (PM$_{10}$)	1.16 ± 0.13	0.96 ± 0.26	1.27 ± 0.27	1.27 ± 0.22	1.16 ± 0.29	1.16 ± 0.13	0.99 ± 0.10	0.99 ± 0.23	1.06 ± 0.15	0.87 ± 0.12	NR	0.99 ± 0.10

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for the California monitoring sites from Table 7-5 include the following:

- Naphthalene and benzo(a)pyrene were pollutants of interest for each site. The daily average concentrations of naphthalene were similar for RUCA and SJJCA while the daily average concentration for CELA was almost twice that of RUCA and SJJCA. The daily average concentrations of benzo(a)pyrene were fairly similar among the California sites.

- The fourth quarter naphthalene averages for both 2008 and 2009 for CELA are significantly higher than the other quarterly averages. The high confidence interval for each indicates the likely presence of outliers. Of the 25 naphthalene concentrations greater than 200 ng/m^3 measured at CELA, 13 of these were measured during October-December (regardless of year). CELA's 2008 annual average of naphthalene ranked fourth highest among all NMP sites sampling this pollutant (the 2009 annual average ranked 15th).

- PAH sampling did not begin until late spring 2008 at SJJCA, thus first quarter 2008 averages for this site could not be calculated. In addition, benzo(a)pyrene was often not detected enough for quarterly averages to be calculated for any of the sites, therefore several quarterly and annual averages are not available for this pollutant. Because September 2009 through December 2009 metals samples were not sent to the ERG laboratory until February 2011, results from those samples have not been included in this report, thus fourth quarter 2009 averages could not be calculated.

- Arsenic, cadmium, and lead have relatively large confidence intervals for their first quarter 2008 averages for SJJCA. A review of their concentrations shows that the highest concentration for each of these pollutants over the 2 years of sampling was measured on January 1, 2008.

7.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. None of the California monitoring sites have sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

7.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each California monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

7.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the California monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the California monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

7.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the California monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 7-6, where applicable.

Table 7-6. Cancer and Noncancer Surrogate Risk Approximations for the California Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE $(\mu g/m^3)^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (ng/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (ng/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Los Angeles, California - CELA										
Benzo(a)pyrene	0.001	--	36/3	0.06 ± 0.02	0.06	--	35/2	NA	NA	--
Naphthalene	0.000034	0.003	61/4	121.16 ± 23.33	4.12	0.04	60/4	167.58 ± 30.00	5.70	0.06
Rubidoux, California - RUCA										
Benzo(a)pyrene	0.001	--	29/2	NA	NA	--	29/2	NA	NA	--
Naphthalene	0.000034	0.003	59/4	66.00 ± 12.00	2.24	0.02	61/4	85.97 ± 16.88	2.92	0.03
San Jose, California - SJJCA										
Arsenic (PM_{10})	0.0043	0.000015	61/4	0.40 ± 0.11	1.73	0.03	38/3	0.25 ± 0.08	1.07	0.02
Benzo(a)pyrene	0.001	--	12/1	NA	NA	--	24/2	NA	NA	--
Beryllium (PM_{10})	0.0024	0.00002	54/4	<0.01 ± <0.01	<0.01	<0.01	30/3	<0.01 ± <0.01	0.01	<0.01
Cadmium (PM_{10})	0.0018	0.00001	61/4	0.08 ± 0.03	0.14	0.01	40/3	0.06 ± 0.02	0.11	0.01
Lead (PM_{10})	--	0.00015	61/4	3.16 ± 0.86	--	0.02	40/3	1.93 ± 0.46	--	0.01
Manganese (PM_{10})	--	0.00005	61/4	4.60 ± 0.68	--	0.09	40/3	3.32 ± 0.63	--	0.07
Naphthalene	0.000034	0.003	40/3	69.67 ± 16.77	2.37	0.02	61/4	81.04 ± 21.35	2.76	0.03
Nickel (PM_{10})	0.000312	0.00009	61/4	1.16 ± 0.13	0.36	0.01	40/3	0.99 ± 0.10	0.31	0.01

NA = Not available due to the criteria for calculating an annual average.
-- = a Cancer URE or Noncancer RfC is not available.

Observations for the California sites from Table 7-6 include the following:

- Naphthalene presented the highest cancer risk among the pollutants of interest for all three California monitoring sites. The cancer risk approximations ranged from 2.24 in-a-million for RUCA (2008) to 5.70 in-a-million for CELA (2009).

- Benzo(a)pyrene was not detected frequently enough for many annual averages to be calculated for the California sites; in addition, SJJCA did not begin sampling PAH until May 2008. Thus, only one cancer risk approximation could be calculated (for CELA, 2008). Further, a noncancer RfC is not available for this pollutant, thus noncancer risk approximations could not be calculated.

- Of the metals sampled at SJJCA, arsenic presented the highest cancer risk, as it is the only metal for which a cancer risk approximation was greater than 1.0 in-a-million (1.73 in-a-million for 2008 and 1.07 in-a-million for 2009).

- All of the noncancer risk approximations for the pollutants of interest for the California monitoring sites were less than 1.0, indicating no risk of noncancer health effects.

7.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 7-7 and 7-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 7-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 7-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 7-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the California 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Los Angeles, California (Los Angeles County) - CELA					
Formaldehyde	4,395.87	Formaldehyde	5.49E-02	Naphthalene	5.70
Benzene	2,838.77	Benzene	2.21E-02	Naphthalene	4.12
Dichloromethane	2,374.84	1,3-Butadiene	1.48E-02	Benzo(a)pyrene	0.06
Acetaldehyde	1,643.94	Naphthalene	1.45E-02		
Tetrachloroethylene	1,407.36	Hexavalent Chromium, PM	1.02E-02		
p-Dichlorobenzene	509.49	Tetrachloroethylene	8.30E-03		
1,3-Butadiene	491.71	POM, Group 2	5.77E-03		
Naphthalene	425.51	*p*-Dichlorobenzene	5.60E-03		
Trichloroethylene	175.89	Acetaldehyde	3.62E-03		
POM, Group 2	104.93	Arsenic, PM	2.01E-03		
Rubidoux, California (Riverside County) - RUCA					
Formaldehyde	1,176.18	Formaldehyde	1.47E-02	Naphthalene	2.92
Benzene	609.89	Benzene	4.76E-03	Naphthalene	2.24
Acetaldehyde	451.42	1,3-Butadiene	3.52E-03		
Dichloromethane	282.22	Naphthalene	2.86E-03		
Tetrachloroethylene	216.69	Hexavalent Chromium, PM	2.65E-03		
1,3-Butadiene	117.44	POM, Group 2	1.80E-03		
Naphthalene	84.14	Tetrachloroethylene	1.28E-03		
p-Dichlorobenzene	83.99	Acetaldehyde	9.93E-04		
1,3-Dichloropropene	65.83	*p*-Dichlorobenzene	9.24E-04		
POM, Group 2	32.69	Arsenic, PM	4.87E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 7-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the California 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	Emissions (tpy)	Pollutant	Cancer Toxicity Weight	Pollutant	Cancer Risk Approximation (in-a-million)
San Jose, California (Santa Clara County) - SJJCA					
Formaldehyde	688.69	Formaldehyde	8.61E-03	Naphthalene	2.76
Benzene	476.21	Hexavalent Chromium, PM	5.58E-03	Naphthalene	2.37
Dichloromethane	351.66	Benzene	3.71E-03	Arsenic (PM_{10})	1.73
Acetaldehyde	287.85	1,3-Butadiene	2.52E-03	Arsenic (PM_{10})	1.07
Tetrachloroethylene	194.91	Naphthalene	2.26E-03	Nickel (PM_{10})	0.36
p-Dichlorobenzene	90.84	Arsenic, PM	1.34E-03	Nickel (PM_{10})	0.31
1,3-Butadiene	83.84	Tetrachloroethylene	1.15E-03	Cadmium (PM_{10})	0.14
Naphthalene	66.45	POM, Group 2	1.01E-03	Cadmium (PM_{10})	0.11
Trichloroethylene	25.44	*p*-Dichlorobenzene	9.99E-04	Beryllium (PM_{10})	0.01
POM, Group 2	18.41	Acetaldehyde	6.33E-04	Beryllium (PM_{10})	<0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 7-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the California 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)**[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Los Angeles, California (Los Angeles County) - CELA					
Toluene	9,219.53	Acrolein	8,054,479.35	Naphthalene	0.06
1,1,1-Trichloroethane	6,517.63	Formaldehyde	448,558.58	Naphthalene	0.04
Xylenes	6,151.29	1,3-Butadiene	245,853.71		
Formaldehyde	4,395.87	Acetaldehyde	182,659.89		
Methanol	3,364.78	Chlorine	146,076.95		
Benzene	2,838.77	Naphthalene	141,836.57		
Hexane	2,445.37	Manganese, PM	103,313.75		
Dichloromethane	2,374.84	Benzene	94,625.56		
Acetaldehyde	1,643.94	Nickel, PM	94,055.05		
Ethylbenzene	1,573.09	Xylenes	61,512.92		
Rubidoux, California (Riverside County) - RUCA					
Toluene	1,783.28	Acrolein	2,741,696.81	Naphthalene	0.03
Xylenes	1,179.27	Formaldehyde	120,018.74	Naphthalene	0.02
Formaldehyde	1,176.18	Chlorine	85,206.48		
Benzene	609.89	1,3-Butadiene	58,720.28		
1,1,1-Trichloroethane	576.88	Acetaldehyde	50,157.87		
Methanol	520.68	Manganese, PM	44,870.54		
Acetaldehyde	451.42	Bromomethane	29,494.00		
Hexane	426.22	Naphthalene	28,046.14		
Ethylbenzene	295.40	Benzene	20,329.70		
Dichloromethane	282.22	Nickel, PM	12,912.59		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 7-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the California 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
San Jose, California (Santa Clara County) - SJJCA					
Toluene	1,775.40	Acrolein	1,209,155.75	Manganese (PM_{10})	0.09
1,1,1-Trichloroethane	1,404.62	Chlorine	83,800.79	Manganese (PM_{10})	0.07
Xylenes	1,050.94	Formaldehyde	70,274.06	Naphthalene	0.03
Formaldehyde	688.69	1,3-Butadiene	41,921.42	Arsenic (PM_{10})	0.03
Methanol	666.25	Acetaldehyde	31,983.45	Naphthalene	0.02
Benzene	476.21	Naphthalene	22,150.89	Lead (PM_{10})	0.02
Hexane	447.33	Benzene	15,873.67	Arsenic (PM_{10})	0.02
Dichloromethane	351.66	Manganese, PM	13,990.75	Nickel (PM_{10})	0.01
Acetaldehyde	287.85	Xylenes	10,509.43	Lead (PM_{10})	0.01
Ethylbenzene	262.94	Arsenic, PM	10,400.56	Nickel (PM_{10})	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 7.3, all three California monitoring sites sampled for PAH and SJJCA also sampled PM_{10} metals. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 7-7 include the following:

- Formaldehyde, benzene, dichloromethane, and acetaldehyde were the highest emitted pollutants with cancer UREs in all three California counties (although not necessarily in that order). The quantity emitted was much higher for Los Angeles County than Riverside and Santa Clara Counties.

- Formaldehyde was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for each county. Benzene, 1,3-butadiene, naphthalene, and hexavalent chromium rounded out the top five for each county (although not necessarily in that order).

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for all three counties.

- Naphthalene was the only pollutant to appear on all three lists for all three counties. This pollutant also had the highest cancer risk approximations for all three sites (2009 followed by 2008 for each site).

- Arsenic, which had the third (2008) and fourth (2009) highest cancer risk approximations for SJJCA, had the sixth highest toxicity-weighted emissions for Santa Clara County, but did not have one of the 10 highest total emissions for the county. This was the only pollutant sampled by SJJCA, other than naphthalene, to appear on either emissions-based list.

- POM Group 2 was among the highest emitted "pollutants" in all three counties and among the pollutants with the highest toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at these monitoring sites including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for CELA, RUCA, or SJJCA.

Observations from Table 7-8 include the following:

- Toluene was the highest emitted pollutant in each county. Consistent with pollutants having cancer UREs, emissions were higher in Los Angeles County than Riverside and Santa Clara County.

- While acrolein had the highest toxicity-weighted emissions for each county, this pollutant did not appear on the highest emissions list for any of the sites.

- Four of the highest emitted pollutants also have the highest toxicity-weighted emissions for Los Angeles and Santa Clara Counties, while only three of the highest emitted pollutants also have the highest toxicity-weighted emissions for Riverside County.

- Napthalene, the only pollutant for which a noncancer risk approximation could be calculated for CELA and RUCA, had one of the 10 highest toxicity-weighted emissions, but did not appear on the list of the 10 highest total emissions for either county. Naphthalene also had one of the 10 highest toxicity-weighted emissions for Santa Clara County, and ranked third (2009) and fifth (2008) for noncaner risk approximations for SJJCA.

- Besides naphthalene, manganese and arsenic are the only two pollutants for which noncancer risk approximations could be calculated for SJJCA and that also appear on the list of 10 highest toxicity-weighted emissions totals. None of the metals appear on the list of the 10 highest total emissions.

7.6 Summary of the 2008-2009 Monitoring Data for CELA, RUCA, and SJJCA

Results from several of the treatments described in this section include the following:

- ❖ *Naphthalene and benzo(a)pyrene failed screens for CELA and RUCA, although benzo(a)pyrene only failed one screen for each site. Naphthalene and four metals failed screens for SJJCA; two additional metals and benzo(a)pyrene were added to SJJCA's pollutants of interest.*

- ❖ *Naphthalene had the highest daily average concentration among all the pollutants of interest for the California sites. The daily average concentrations of naphthalene were similar in magnitude for RUCA and SJJCA while the daily average concentration for CELA was almost twice that of RUCA and SJJCA. CELA's 2008 daily average naphthalene concentration was the fourth highest daily average among NMP sites sampling PAH.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

8.0 Sites in Colorado

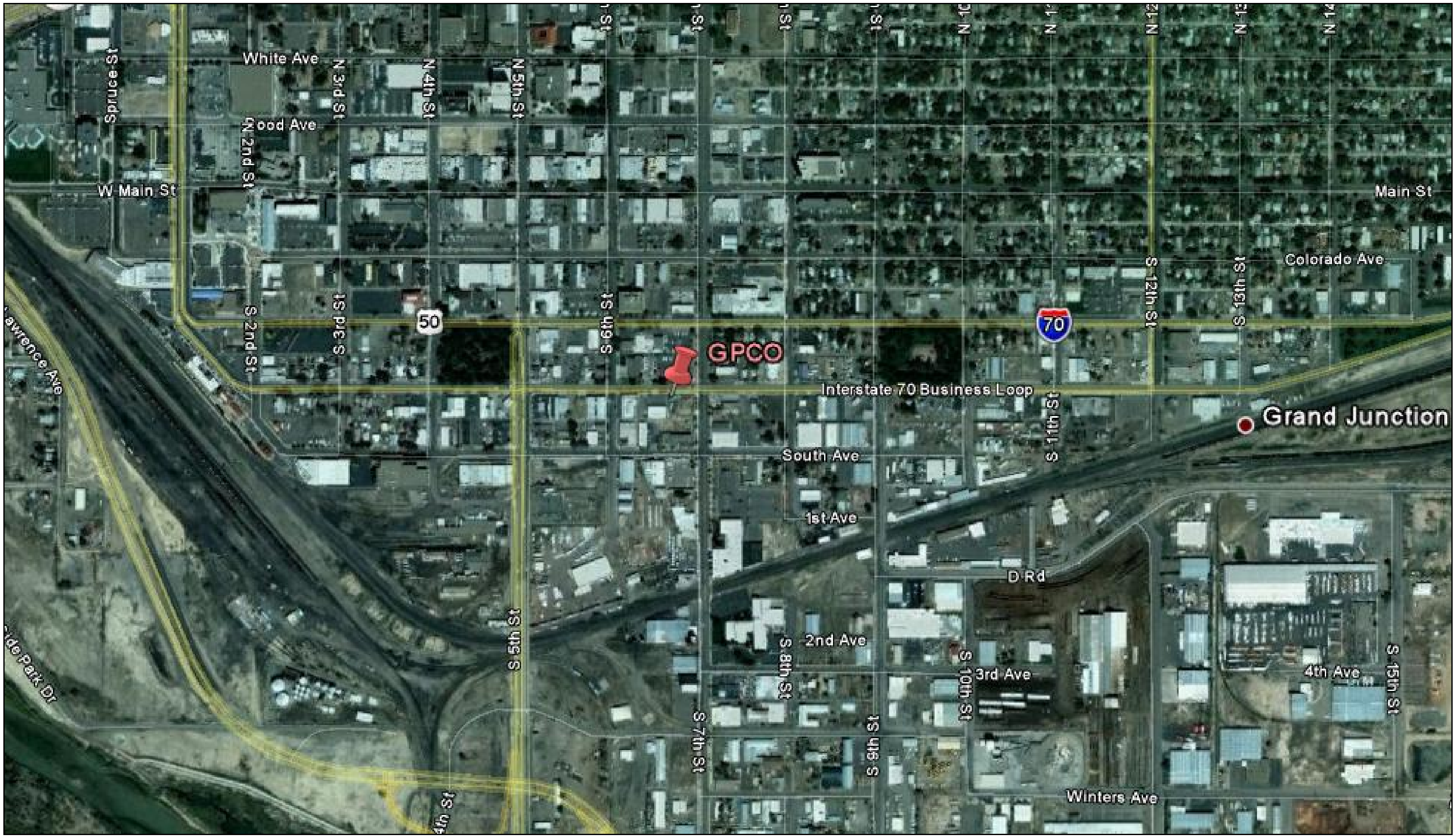
This section explores the spatial and temporal characteristics of the ambient monitoring concentrations measured at the CSATAM and NATTS sites in Colorado, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

8.1 Site Characterization

This section characterizes the Colorado monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

The NATTS site is located in Grand Junction (GPCO), while the other five sites are located in Garfield County, northeast of Grand Junction, in the towns of Silt (BRCO), Rifle (MOCO and RICO), Rulison (RUCO), and Parachute (PACO). Figures 8-1 through 8-6 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban and rural locations. Figures 8-7 and 8-8 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of each site are included in the counts provided below the maps in Figures 8-7 and 8-8. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 8-1 describes the areas surrounding the monitoring sites by providing supplemental geographical information such as land use, location setting, and locational coordinates.

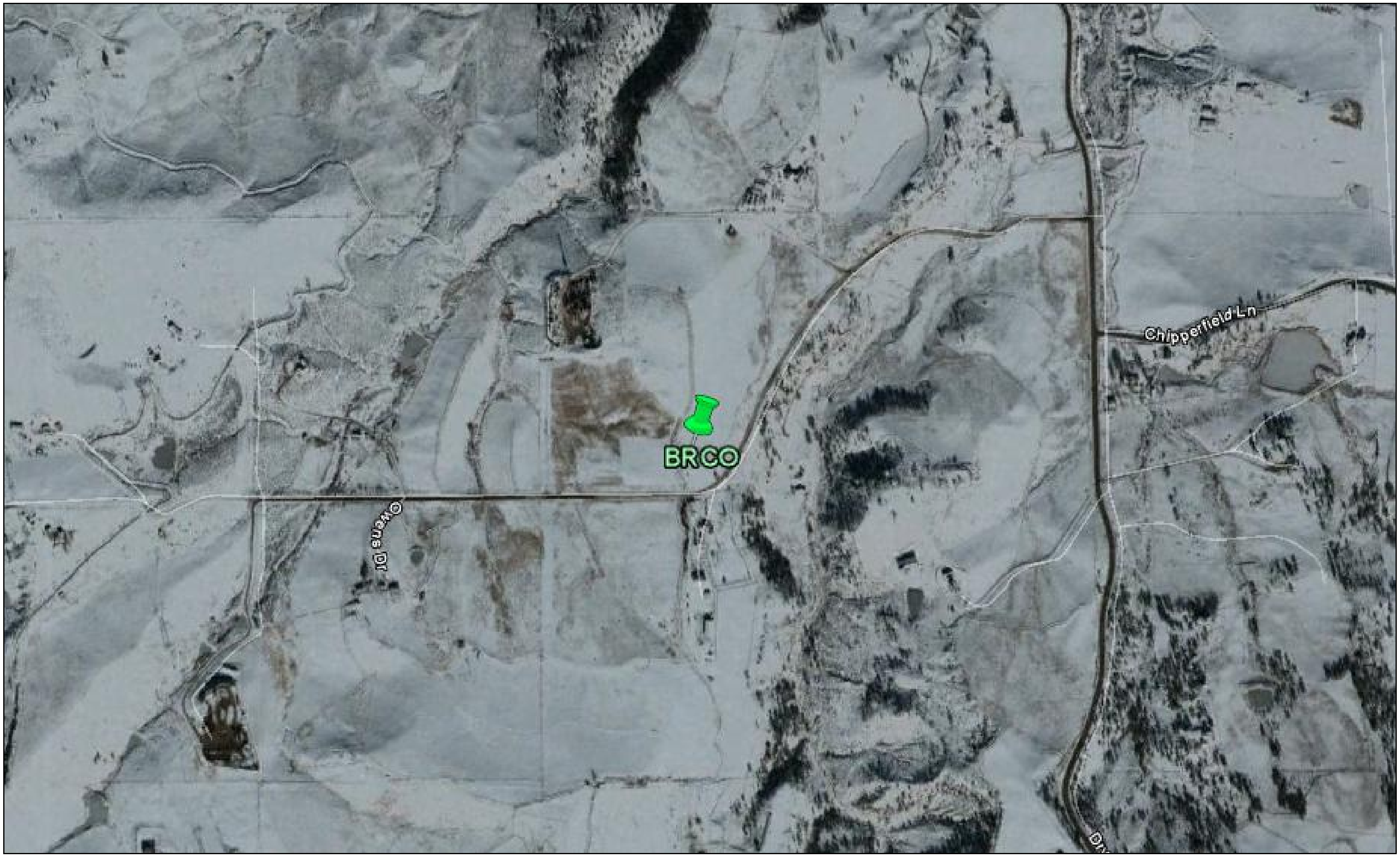
Figure 8-1. Grand Junction, Colorado (GPCO) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 2,213 feet

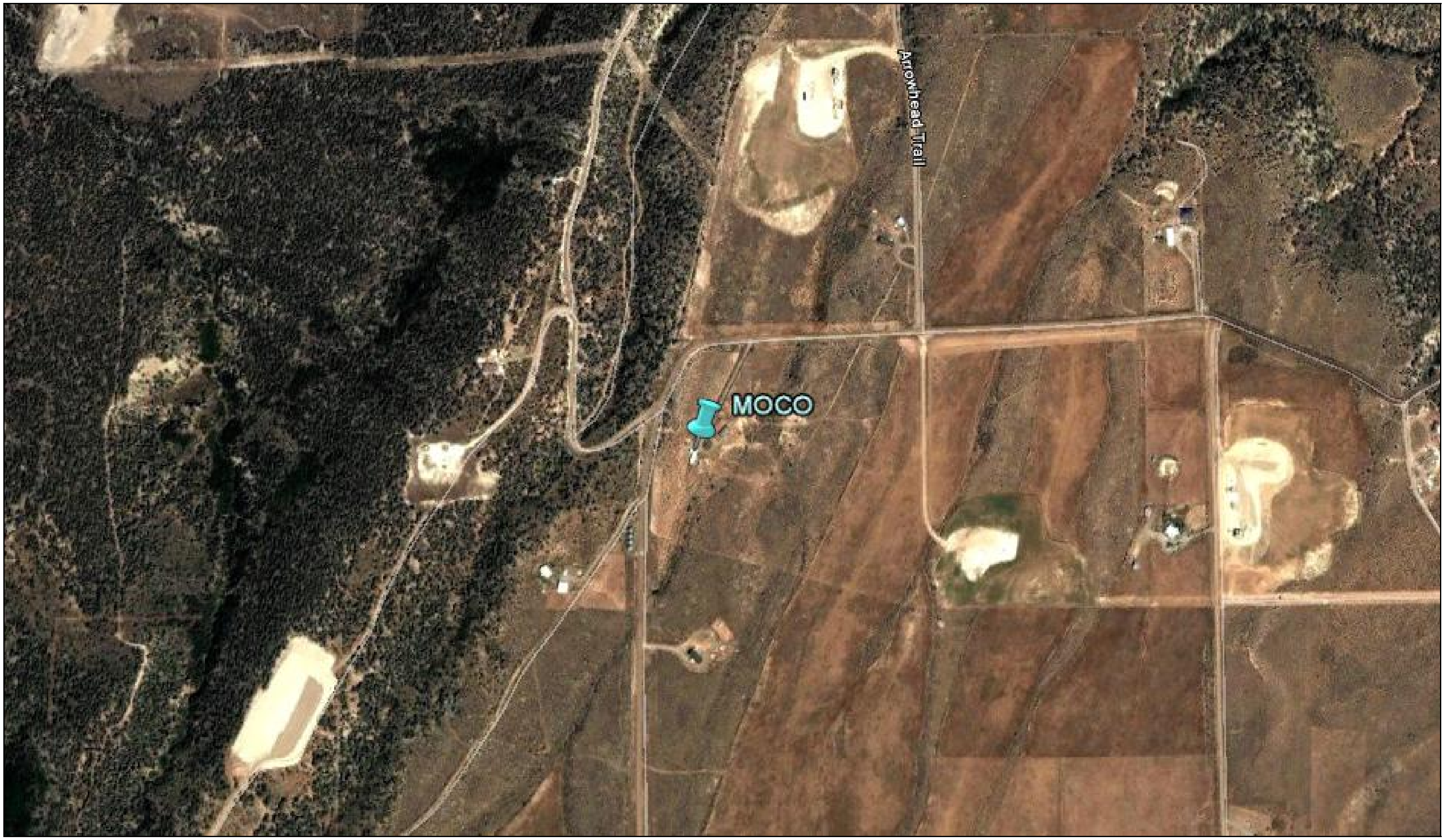
Figure 8-2. Silt, Colorado (BRCO) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 2,030 feet

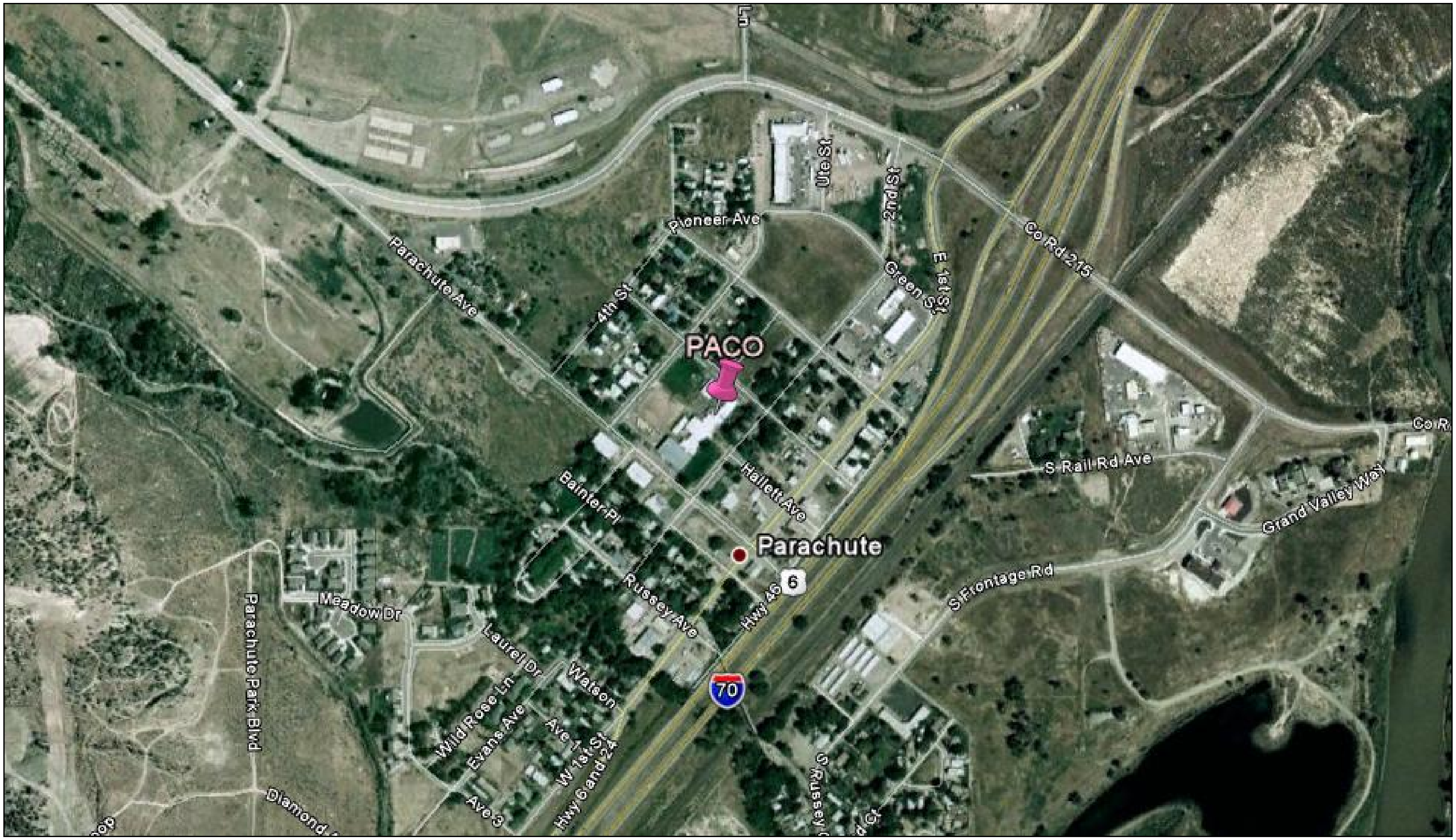
Figure 8-3. Rifle, Colorado (MOCO) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

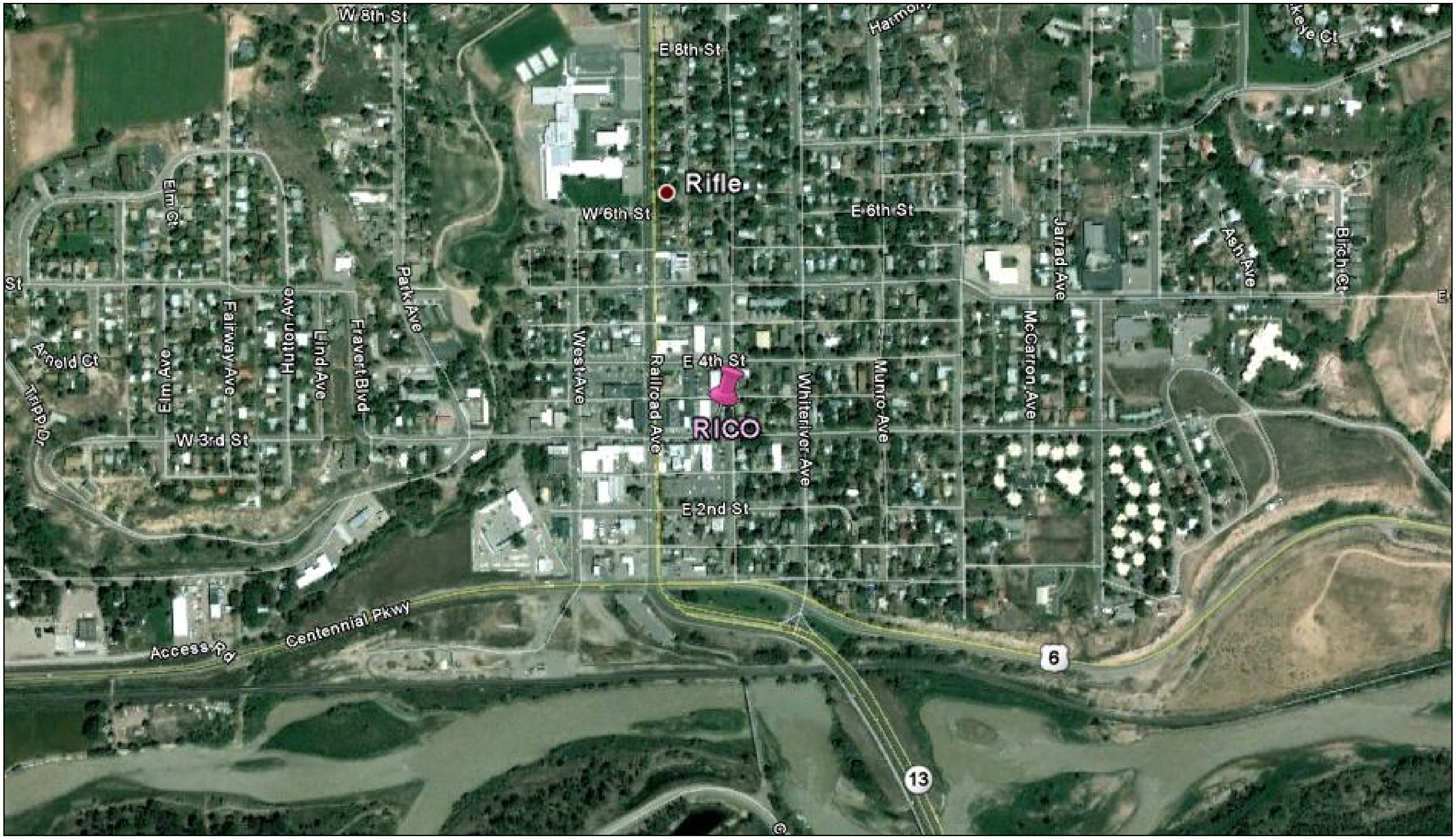
Scale: 2 inches = 1,902 feet

Figure 8-4. Parachute, Colorado (PACO) Monitoring Site



©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,869 feet

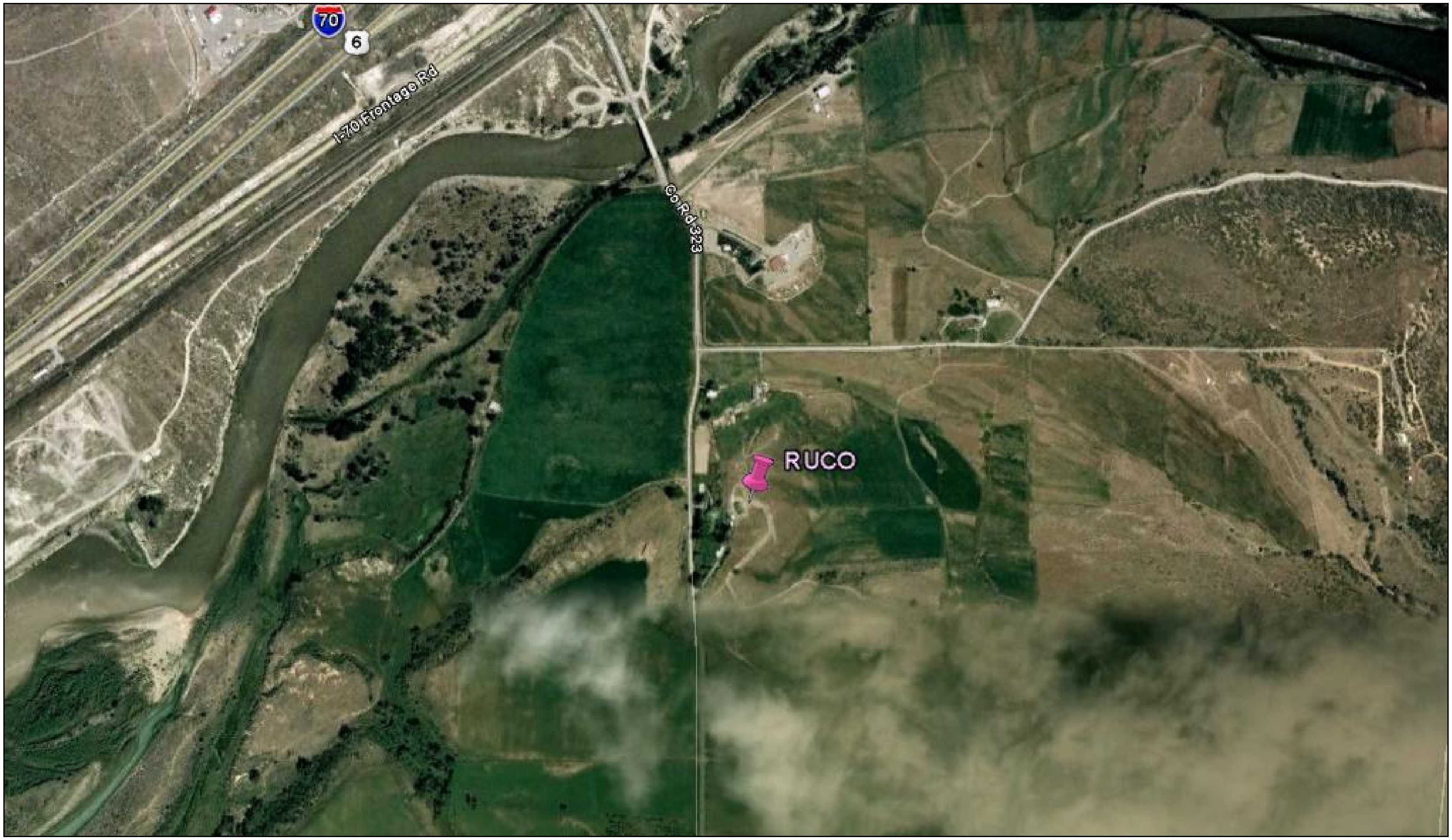
Figure 8-5. Rifle, Colorado (RICO) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 2,002 feet

Figure 8-6. Rulison, Colorado (RUCO) Monitoring Site



©2010 Google Earth, accessed 11/17/2010 Scale: 2 inches = 2,153 feet

Figure 8-7. NEI Point Sources Located Within 10 Miles of GPCO

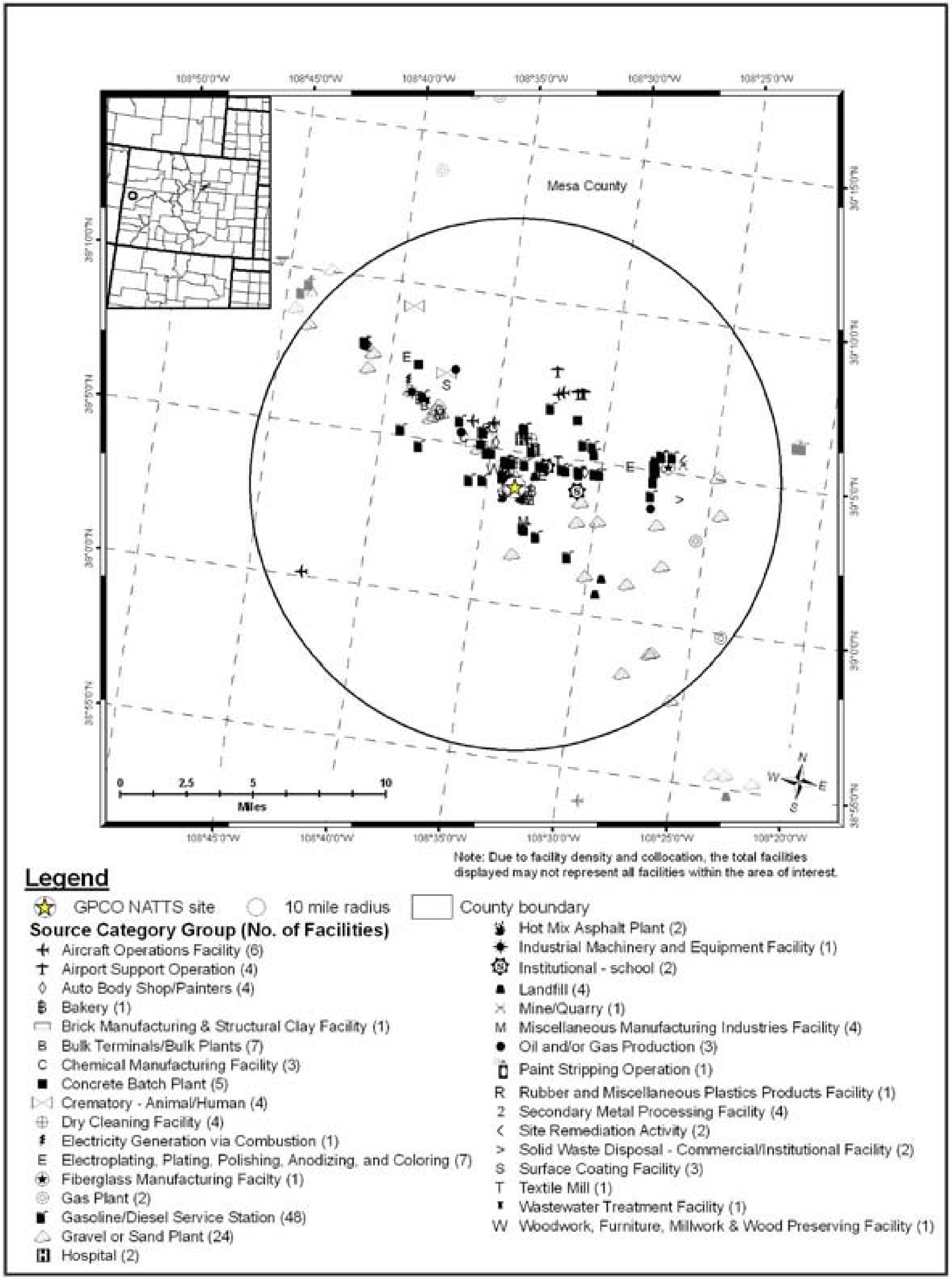

108°50'0"W
108°45'0"W
108°40'0"W
108°35'0"W
108°30'0"W
108°25'0"W
108°20'0"W
39°15'0"N
39°10'0"N
39°5'0"N
39°0'0"N
38°55'0"N
Mesa County
0
2.5
5
10
Miles
N
W
E
S
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
GPCO NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (6)
Airport Support Operation (4)
Auto Body Shop/Painters (4)
Bakery (1)
Brick Manufacturing & Structural Clay Facility (1)
B Bulk Terminals/Bulk Plants (7)
C Chemical Manufacturing Facility (3)
Concrete Batch Plant (5)
Crematory - Animal/Human (4)
Dry Cleaning Facility (4)
Electricity Generation via Combustion (1)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (7)
Fiberglass Manufacturing Facilty (1)
Gas Plant (2)
Gasoline/Diesel Service Station (48)
Gravel or Sand Plant (24)
Hospital (2)
Hot Mix Asphalt Plant (2)
Industrial Machinery and Equipment Facility (1)
Institutional - school (2)
Landfill (4)
Mine/Quarry (1)
M Miscellaneous Manufacturing Industries Facility (4)
Oil and/or Gas Production (3)
Paint Stripping Operation (1)
R Rubber and Miscellaneous Plastics Products Facility (1)
2 Secondary Metal Processing Facility (4)
< Site Remediation Activity (2)
> Solid Waste Disposal - Commercial/Institutional Facility (2)
S Surface Coating Facility (3)
T Textile Mill (1)
Wastewater Treatment Facility (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Figure 8-8. NEI Point Sources Located Within 10 Miles of BRCO, MOCO, PACO, RICO, and RUCO

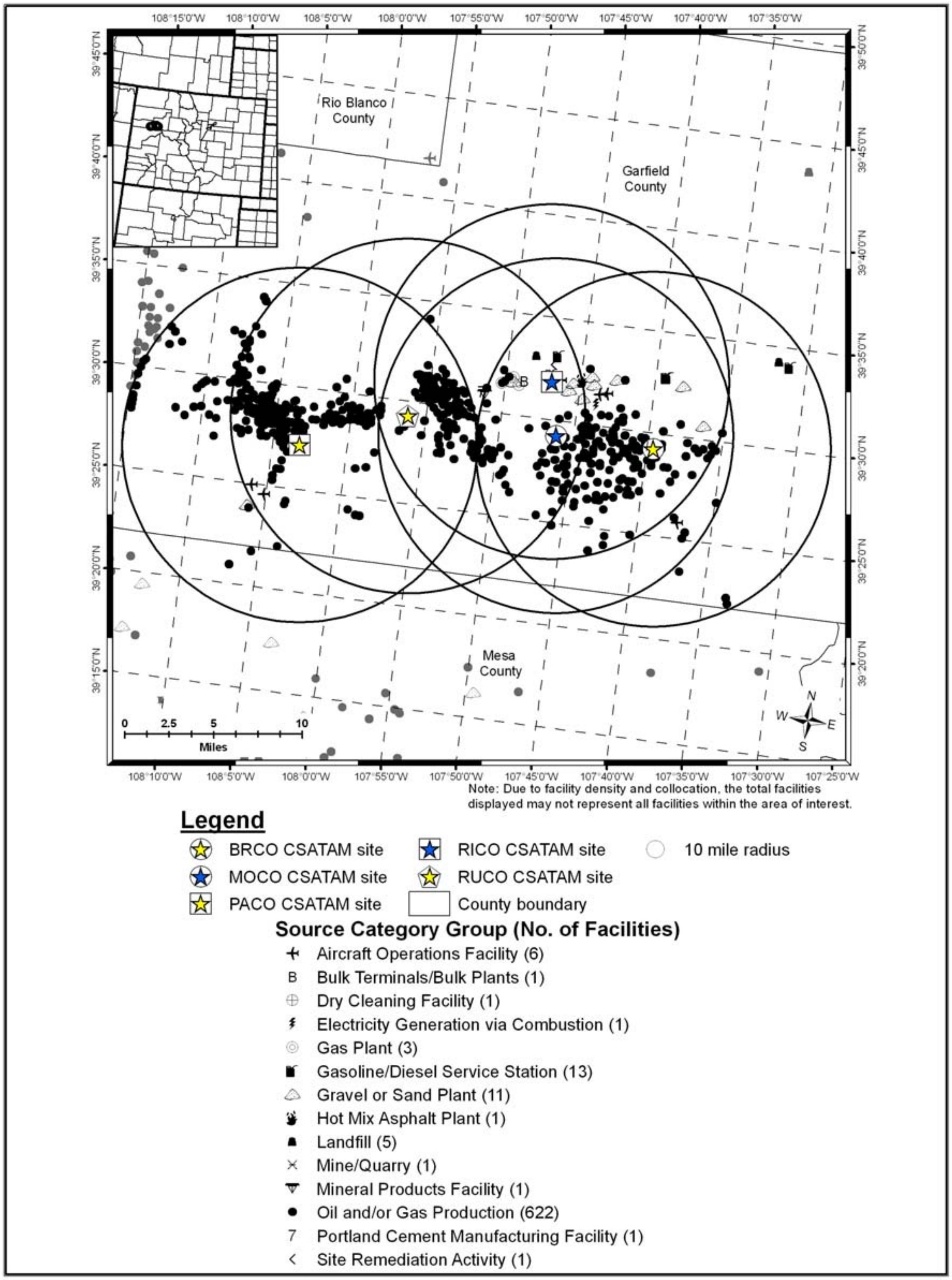

108°15'0"W
108°10'0"W
108°5'0"W
108°0'0"W
107°55'0"W
107°50'0"W
107°45'0"W
107°40'0"W
107°35'0"W
Rio Blanco County
Garfield County
Mesa County
39°45'0"N
39°40'0"N
39°35'0"N
39°30'0"N
39°25'0"N
39°20'0"N
39°15'0"N
39°50'0"N
39°45'0"N
39°40'0"N
39°35'0"N
39°30'0"N
39°25'0"N
39°20'0"N
B
0
2.5
5
10
Miles
N
W
E
S
108°10'0"W
108°5'0"W
108°0'0"W
107°55'0"W
107°50'0"W
107°45'0"W
107°40'0"W
107°35'0"W
107°30'0"W
107°25'0"W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
BRCO CSATAM site
MOCO CSATAM site
PACO CSATAM site
RICO CSATAM site
RUCO CSATAM site
County boundary
10 mile radius
Source Category Group (No. of Facilities)
Aircraft Operations Facility (6)
B Bulk Terminals/Bulk Plants (1)
Dry Cleaning Facility (1)
Electricity Generation via Combustion (1)
Gas Plant (3)
Gasoline/Diesel Service Station (13)
Gravel or Sand Plant (11)
Hot Mix Asphalt Plant (1)
Landfill (5)
Mine/Quarry (1)
Mineral Products Facility (1)
Oil and/or Gas Production (622)
7 Portland Cement Manufacturing Facility (1)
Site Remediation Activity (1)

Table 8-1. Geographical Information for the Colorado Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
GPCO	08-077-0017 & 08-077-0018	Grand Junction	Mesa	Grand Junction, CO MSA	39.064289, -108.56155	Commercial	Urban/City Center	Meteorological parameters, CO, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
BRCO	08-045-0009	Silt	Garfield	Not in an MSA	39.487755, -107.659685	Agricultural	Rural	None.
MOCO	Revolving Site (no AQS entry)	Rifle	Garfield	Not in an MSA	39.488433, -107.7699	Agricultural	Rural	No AQS entry.
PACO	08-045-0005	Parachute	Garfield	Not in an MSA	39.453654, -108053259	Residential	Urban/City Center	PM_{10}.
RICO	08-045-0007	Rifle	Garfield	Not in an MSA	39.531813, -107.782298	Commercial	Urban/City Center	PM_{10}.
RUCO	Revolving Site (no AQS entry)	Rulison	Garfield	Not in an MSA	39.488744, -107.936989	Agricultural	Rural	None.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The GPCO monitoring site is comprised of two locations. The first is a small 1-story shelter that houses the VOC and carbonyl compound samplers, with the PAH sampler located just outside the shelter. The second location is on an adjacent 2-story building that has the hexavalent chromium samplers on the roof. As a result, two AQS codes are provided in Table 8-1. Figure 8-1 shows that the area surrounding GPCO is of mixed usage, with commercial businesses to the west, northwest and north, residential areas to the northeast and east, and industrial areas to the southeast, south and southwest. The site's location is next to one of the major east-west roads in Grand Junction (I-70 Business). A railroad runs east-west to the south of the GPCO monitoring site, and merges with another railroad to the southwest of the site. As Figure 8-7 shows, GPCO is located within 10 miles of numerous emissions sources. Many of the sources are located along a diagonal line running roughly northwest to southeast along Highways 6 and 50 and Business 70. Many of the point sources near GPCO fall into the gasoline/diesel service station and gravel or sand plant source categories.

The BRCO monitoring site is located on Bell/Melton Ranch, off Owens Drive, approximately 4 miles south of the town of Silt. The site is both rural and agricultural in nature. As shown in Figure 8-2, the closest major roadway is County Road 331, Dry Hollow Road.

MOCO is located on Brock Ranch, off a dirt road spurring from Grass Mesa Road, as shown in Figure 8-3. This location is less than 3 miles south of the town of Rifle. The site is both rural and agricultural in nature. This site operated for approximately 1 year; the instrumentation was relocated to the RUCO site for 2009 (see below).

PACO is located on the roof of the old Parachute High School building, which is presently operating as a day care facility. This location is in the center of the town of Parachute, as shown in Figure 8-4. The surrounding area is considered residential. Interstate-70 is less than a quarter of a mile from the monitoring site.

RICO is located on the roof of the Henry Annex Building in downtown Rifle. This location is at the crossroads of several major roadways through town, as shown in Figure 8-5.

Highway 13 and US-6 intersect just south of the site and I-70 is just over a half-mile south of the monitoring site. The surrounding area is considered commercial.

RUCO is located on the Potter Ranch, in Rulison, Colorado, about halfway between the towns of Parachute and Rifle. This location is less than 1 mile south of the I-70, as shown in Figure 8-6. The surrounding area is considered rural and agricultural.

The five Garfield County sites are located along a line running roughly east-west and spanning approximately 20 miles; hence they are shown together in Figure 8-8. As shown, there are more than 600 petroleum or natural gas wells (collectively shown as the oil and/or gas production source category) within 10 miles of these sites. One reason Garfield County is conducting air monitoring is to characterize the air quality impacts of these wells on the surrounding areas (GCPH, 2007).

Table 8-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Colorado monitoring sites. Information provided in Table 8-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Mesa (GPCO) and Garfield Counties were obtained from the Colorado Department of Revenue (CO DOR, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 8-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 8-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 8-2 presents the daily VMT for the Grand Junction urban area; no VMT data were available for the areas surrounding the Garfield County sites.

Table 8-2. Population, Motor Vehicle, and Traffic Information for the Colorado Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
BRCO	56,298	77,026	1.37	22,054	30,174	150	NA
GPCO	146,093	182,518	1.25	108,432	135,467	11,800	2,000
MOCO	56,298	77,026	1.37	16,364	22,389	NA	NA
PACO	56,298	77,026	1.37	6,664	9,118	919	NA
RICO	56,298	77,026	1.37	16,364	22,389	4,800	NA
RUCO	56,298	77,026	1.37	16,364	22,389	583	NA

[1] Reference: Census Bureau, 2010.

[2] County-level vehicle registration reflects 2008 data from the Colorado Department of Revenue (CO DOR, 2009).

[3] Reference: http://xionetic.com/zipfinddeluxe.aspx

[4] Annual Average Daily Traffic for GPCO and RICO reflects 2009 data from the Colorado DOT and for BRCO, PACO, and RUCO reflects 2002 data from Garfield County (CO DOT, 2009 and GCRBD, 2002). No traffic data were available near MOCO.

[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

NA = Data unavailable.

BOLD = EPA-designated NATTS Site.

Observations from Table 8-2 include the following:

- Mesa County's population and vehicle ownership were considerably higher than those for Garfield County. This is also true for its 10-mile population and vehicle ownership. However, both counties ranked in the bottom-third compared to all counties with NMP sites.

- The vehicle-per-person ratios for all six sites were among the highest for all NMP sites.

- The traffic volume near GPCO is also considerably higher than the traffic volume near the Garfield County sites. While the traffic volume near GPCO is in the bottom-third compared to other NMP sites, the traffic volumes near the Garfield County sites were among the lowest. The traffic estimate for GPCO came from Business-70 between 5th and 7th Streets; from the junction of County Roads 331 and 326 for BRCO; from County Road 215 (approaching I-70) for PACO; from the junction of US-6 and Highway 13 for RICO; and just south of the intersection of County Roads 323 and 320 for RUCO. Traffic data were not available for MOCO.

- The Grand Junction area VMT was the lowest among urban areas with NMP sites. The Garfield County sites are not in an urban area and therefore no VMT is available.

8.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Colorado on sample days, as well as over the course of each year.

8.2.1 Climate Summary

Grand Junction is located in a mountain valley on the west side of the Rockies. The valley location of the city helps protect it 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 (Bair, 1992). 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 (Boubel, et al., 1994).

The towns of Parachute, Rifle, Rulison, and Silt are located to the northeast of Grand Junction, across the county line and along I-70. These towns are located along a river valley running north of the Grand Mesa. Similar to Grand Junction, these towns are shielded from drastic changes in weather by the surrounding terrain and tend to experience fairly dry conditions for most of the year. Wind patterns in these towns are affected by the high canyons, the Colorado River, and valley breezes (WRCC, 2011).

8.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The NWS weather station nearest GPCO is located at Walker Field Airport (WBAN 23066); the closest weather station to the five Garfield County sites is located at Garfield County Regional Airport (WBAN 03016). Additional information about these weather stations is provided in Table 8-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 8-3. Average Meteorological Conditions near the Colorado Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Silt, Colorado - BRCO										
Garfield Co. Regional Airport 03016 (39.53, -107.73)	4.25 miles 316° (NW)	2008	Sample Day	62.7 ± 5.3	47.3 ± 4.6	26.4 ± 3.0	37.5 ± 3.4	51.6 ± 4.1	1016.6 ± 2.1	4.2 ± 0.5
			All Year	61.6 ± 2.3	47.0 ± 1.9	26.0 ± 1.2	37.2 ± 1.4	52.3 ± 1.9	1016.5 ± 0.9	4.0 ± 0.2
		2009	Sample Day	65.5 ± 5.6	49.7 ± 4.9	27.3 ± 3.0	38.9 ± 3.5	50.7 ± 4.6	1016.7 ± 2.1	4.1 ± 0.5
			All Year	62.1 ± 2.2	47.6 ± 2.0	27.3 ± 1.3	37.9 ± 1.4	53.3 ± 1.8	1016.3 ± 0.8	4.2 ± 0.2
Grand Junction, Colorado - GPCO										
Walker Field Airport 23066 (39.12, -108.54)	4.95 miles 22° (NNE)	2008	Sample Day	63.3 ± 5.4	50.9 ± 4.9	25.3 ± 2.6	38.9 ± 3.2	45.4 ± 5.2	1015.0 ± 2.2	6.2 ± 0.7
			All Year	64.0 ± 2.3	51.7 ± 2.1	25.3 ± 1.2	39.4 ± 1.4	44.6 ± 2.3	1015.0 ± 0.9	5.9 ± 0.3
		2009	Sample Day	64.4 ± 5.4	51.5 ± 5.0	27.5 ± 3.0	39.8 ± 3.5	47.3 ± 4.9	1015.0 ± 2.0	5.9 ± 0.6
			All Year	64.6 ± 2.3	52.2 ± 2.1	27.8 ± 1.3	40.4 ± 1.5	46.6 ± 2.1	1014.9 ± 0.9	6.0 ± 0.3
Brock Ranch, Rifle, Colorado - MOCO										
Garfield Co. Regional Airport 03016 (39.53, -107.73)	3.40 miles 48° (NE)	2008	Sample Day	62.7 ± 5.3	47.2 ± 4.7	26.3 ± 3.1	37.4 ± 3.4	51.6 ± 4.1	1016.6 ± 2.1	4.2 ± 0.5
			All Year	61.6 ± 2.3	47.0 ± 1.9	26.0 ± 1.2	37.2 ± 1.4	52.3 ± 1.9	1016.5 ± 0.9	4.0 ± 0.2
		2009	Sample Day	40.8 ± 3.2	28.8 ± 4.3	19.5 ± 4.5	25.4 ± 4.0	70.2 ± 5.0	1023.0 ± 7.7	2.6 ± 1.0
			All Year	62.1 ± 2.2	47.6 ± 2.0	27.3 ± 1.3	37.9 ± 1.4	53.3 ± 1.8	1016.3 ± 0.8	4.2 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 8-3. Average Meteorological Conditions near the Colorado Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Parachute, Colorado - PACO										
Garfield Co. Regional Airport 03016 (39.53, -107.73)	17.19 miles 81° (E)	2008	Sample Day	62.2 ± 5.5	46.9 ± 4.8	26.2 ± 3.2	37.1 ± 3.5	52.0 ± 4.2	1016.8 ± 2.1	4.1 ± 0.5
			All Year	61.6 ± 2.3	47.0 ± 1.9	26.0 ± 1.2	37.2 ± 1.4	52.3 ± 1.9	1016.5 ± 0.9	4.0 ± 0.2
		2009	Sample Day	65.9 ± 5.6	50.1 ± 5.0	27.5 ± 3.0	39.2 ± 3.5	50.2 ± 4.6	1016.5 ± 2.2	4.1 ± 0.5
			All Year	62.1 ± 2.2	47.6 ± 2.0	27.3 ± 1.3	37.9 ± 1.4	53.3 ± 1.8	1016.3 ± 0.8	4.2 ± 0.2
Rifle, Colorado - RICO										
Garfield Co. Regional Airport 03016 (39.53, -107.73)	2.86 miles 105° (ESE)	2008	Sample Day	63.1 ± 5.3	47.7 ± 4.6	26.7 ± 3.0	37.8 ± 3.3	51.5 ± 4.1	1016.4 ± 2.1	4.2 ± 0.5
			All Year	61.6 ± 2.3	47.0 ± 1.9	26.0 ± 1.2	37.2 ± 1.4	52.3 ± 1.9	1016.5 ± 0.9	4.0 ± 0.2
		2009	Sample Day	64.4 ± 5.2	48.9 ± 4.7	26.9 ± 2.8	38.4 ± 3.2	51.0 ± 4.3	1016.4 ± 2.0	4.1 ± 0.5
			All Year	62.1 ± 2.2	47.6 ± 2.0	27.3 ± 1.3	37.9 ± 1.4	53.3 ± 1.8	1016.3 ± 0.8	4.2 ± 0.2
Rulison, Colorado - RUCO										
Garfield Co. Regional Airport 03016 (39.53, -107.73)	10.91 miles 83° (E)	2009	Sample Day	66.3 ± 5.6	50.4 ± 5.0	27.2 ± 3.1	39.2 ± 3.5	49.2 ± 4.4	1016.1 ± 2.0	4.2 ± 0.5
			All Year	62.1 ± 2.2	47.6 ± 2.0	27.3 ± 1.3	37.9 ± 1.4	53.3 ± 1.8	1016.3 ± 0.8	4.2 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 8-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 8-3 is the 95 percent confidence interval for each parameter. As shown in Table 8-3, average meteorological conditions on sample days near each site were fairly representative of average weather conditions throughout the year, with one exception. MOCO stopped sampling in February 2009; thus only sample days in the colder and drier months of the year are included in the 2009 sample day average. This explains the difference in several of the meteorological parameters for MOCO in 2009.

8.2.3 Back Trajectory Analysis

Figure 8-9 and Figure 8-10 are the composite back trajectory maps for days on which samples were collected at the GPCO monitoring site in 2008 and 2009, respectively. Figure 8-11 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 8-12 through 8-25 are the composite and cluster back trajectory maps for the Garfield County monitoring sites. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 8-9 through 8-25 represents 100 miles.

Figure 8-9. 2008 Composite Back Trajectory Map for GPCO

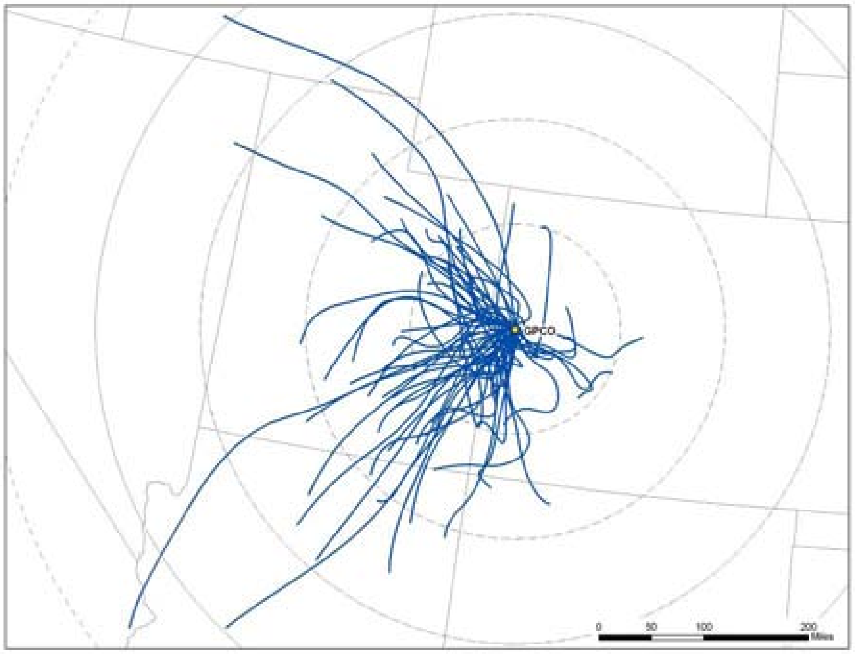


Figure 8-10. 2009 Composite Back Trajectory Map for GPCO

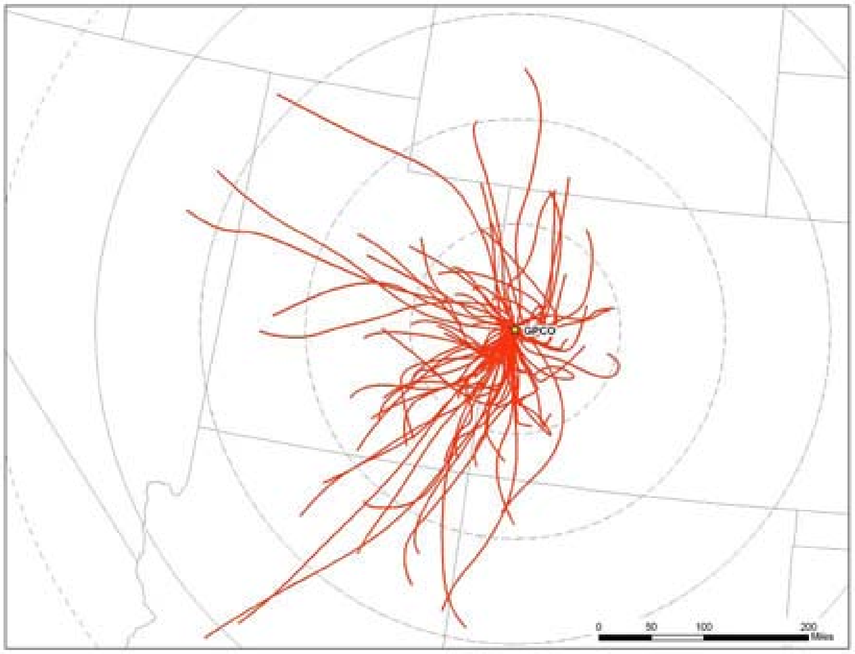


Figure 8-11. Back Trajectory Cluster Map for GPCO

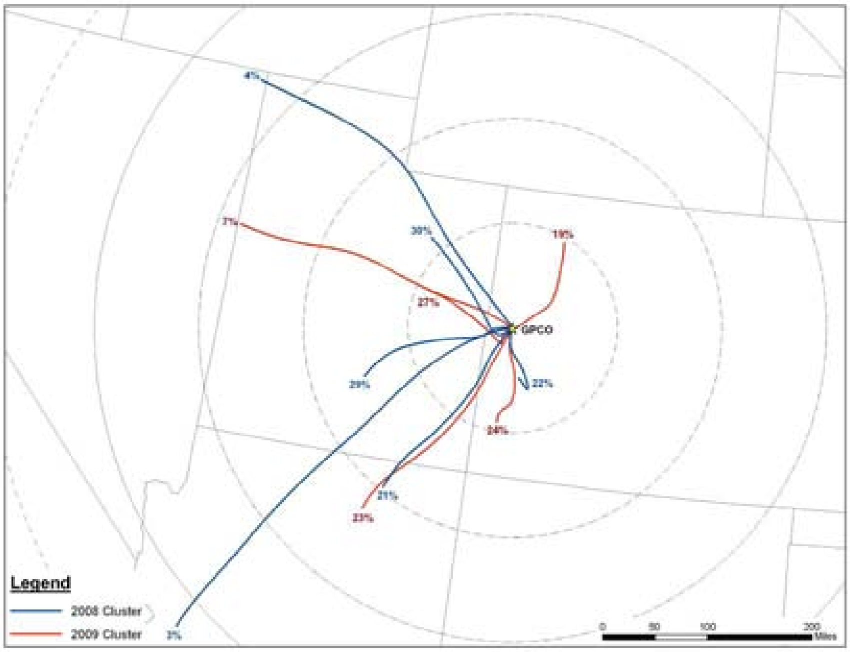


Figure 8-12. 2008 Composite Back Trajectory Map for BRCO

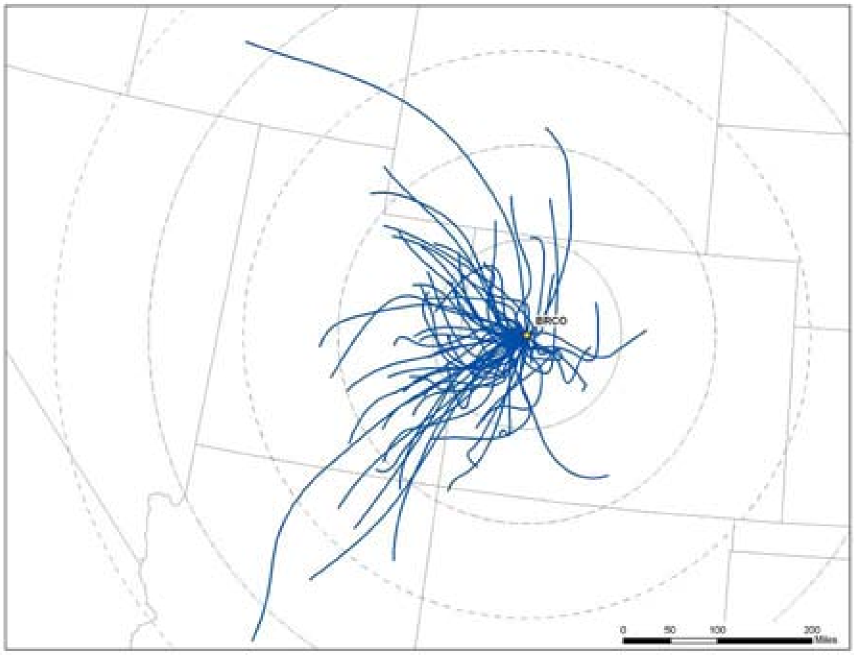


Figure 8-13. 2009 Composite Back Trajectory Map for BRCO

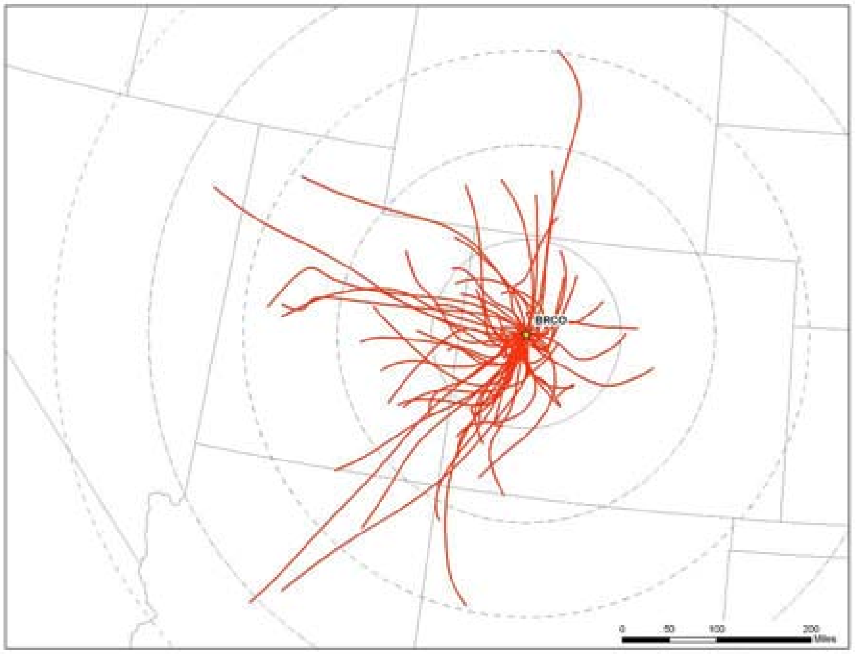


Figure 8-14. Back Trajectory Cluster Map for BRCO

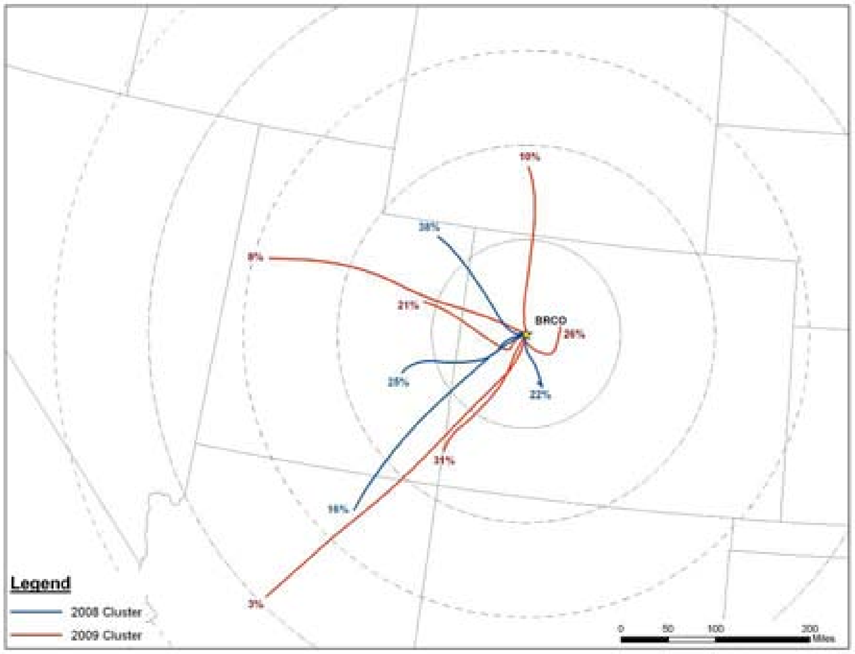


Figure 8-15. 2008 Composite Back Trajectory Map for MOCO

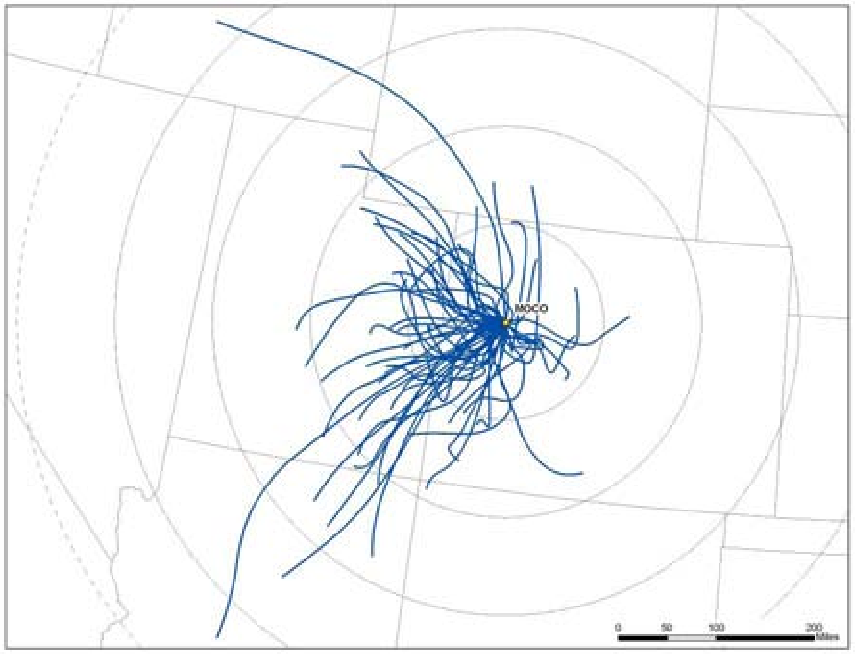


Figure 8-16. 2009 Composite Back Trajectory Map for MOCO

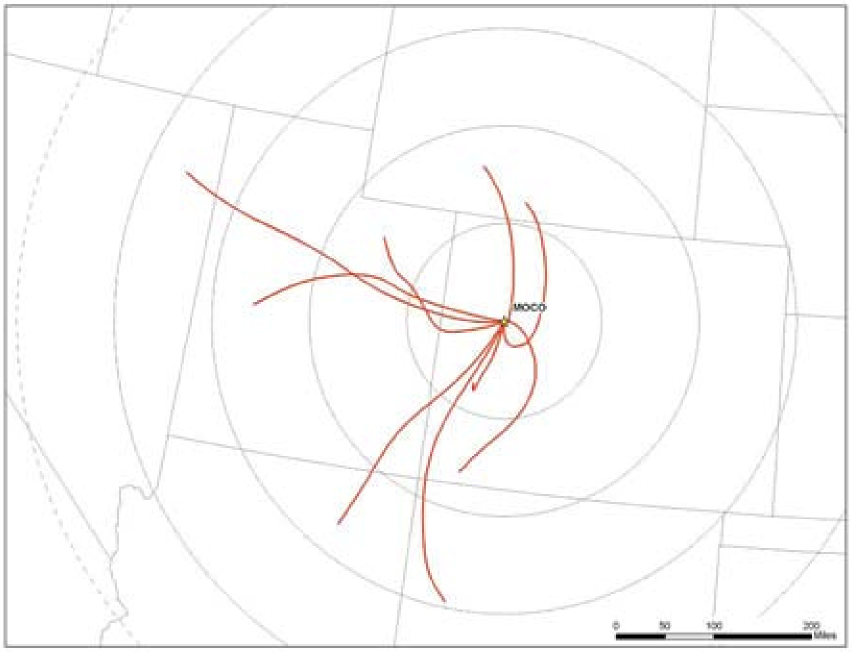


Figure 8-17. Back Trajectory Cluster Map for MOCO

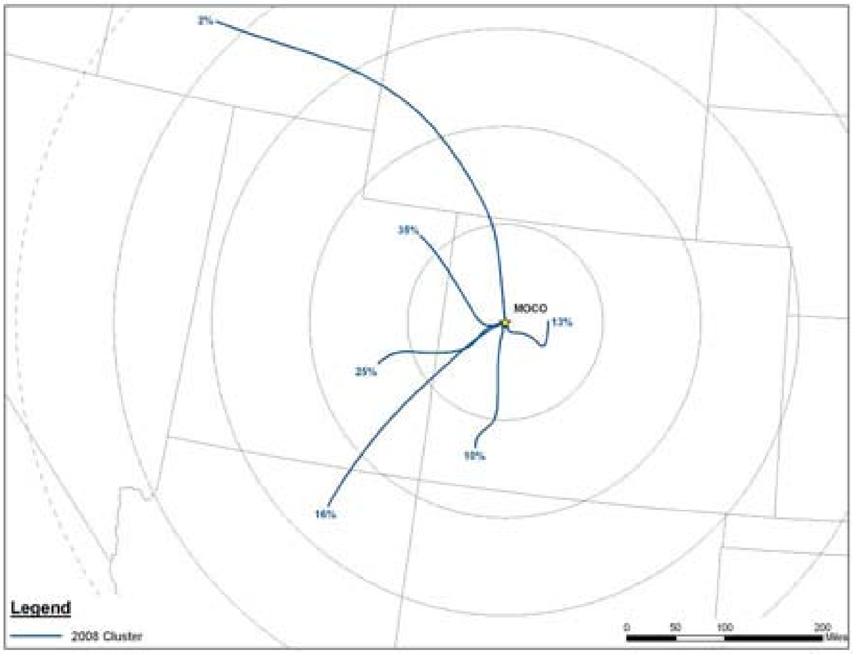


Figure 8-18. 2008 Composite Back Trajectory Map for PACO

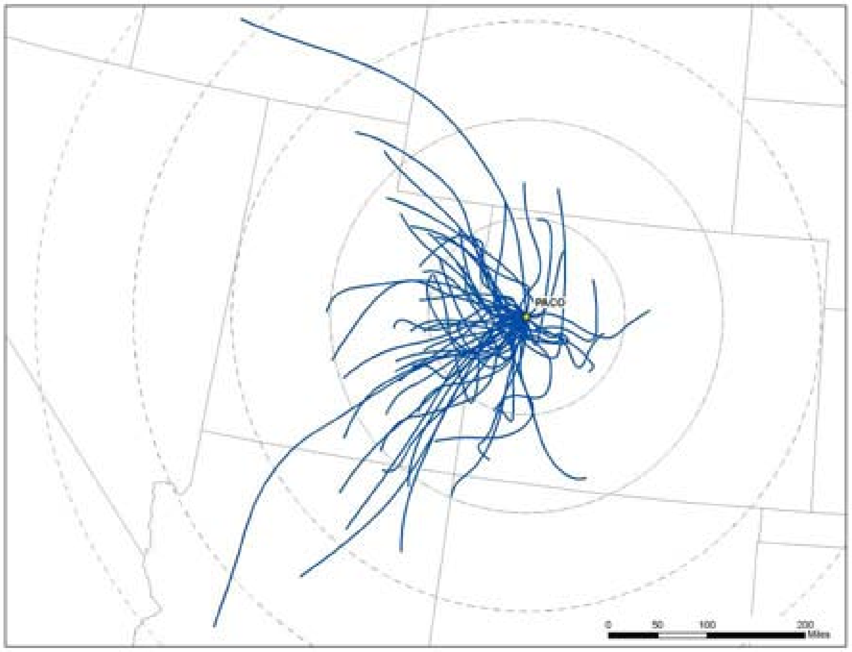


Figure 8-19. 2009 Composite Back Trajectory Map for PACO

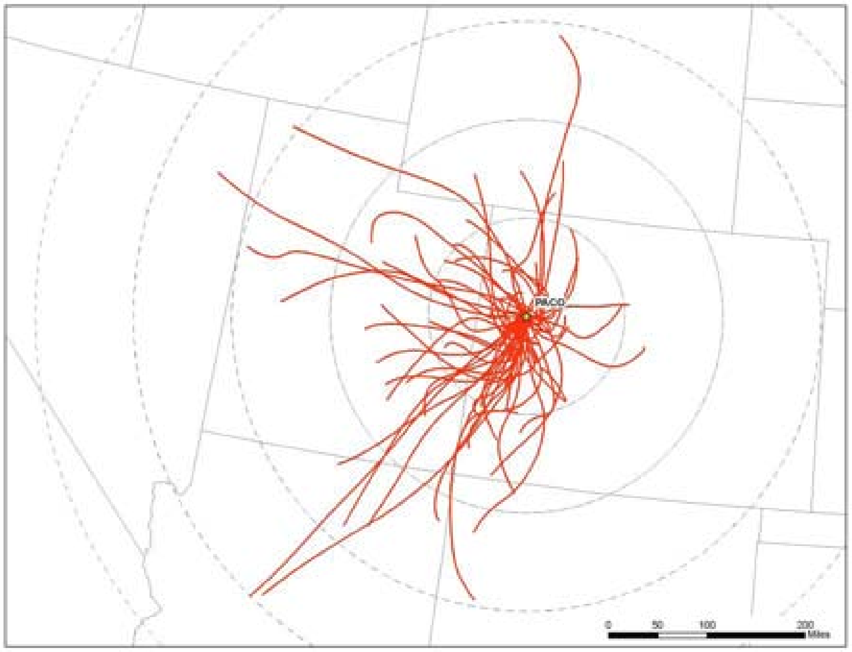


Figure 8-20. Back Trajectory Cluster Map for PACO

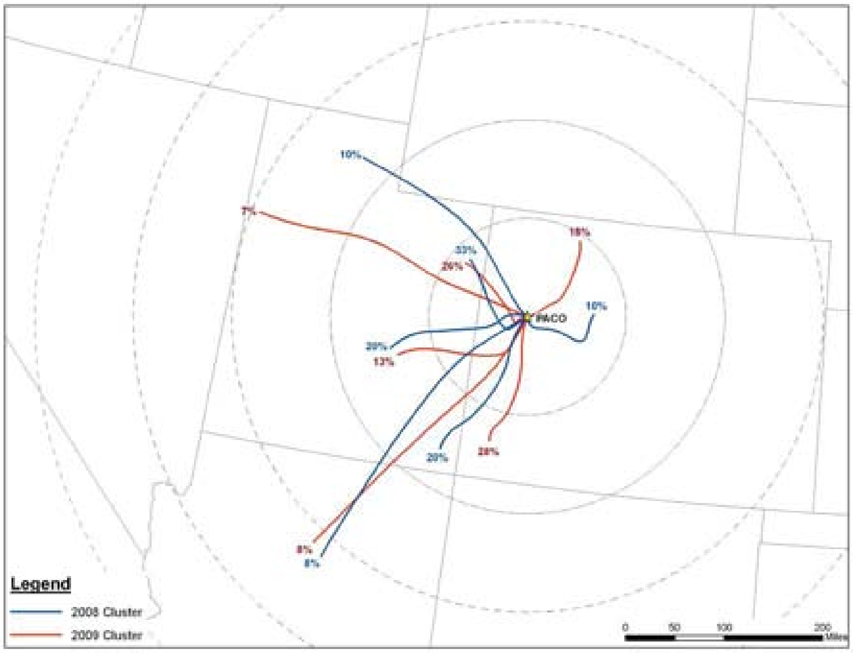


Figure 8-21. 2008 Composite Back Trajectory Map for RICO

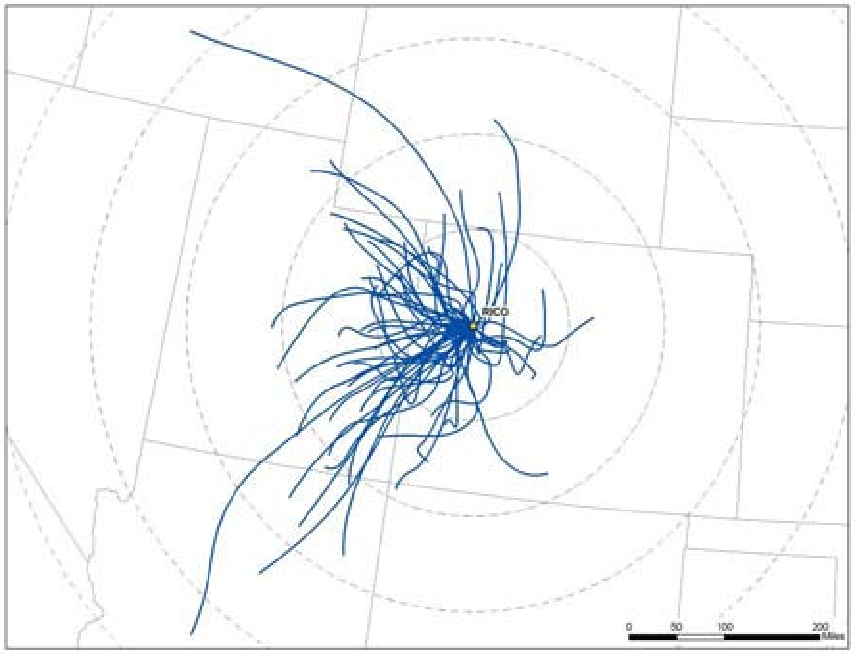


Figure 8-22. 2009 Composite Back Trajectory Map for RICO

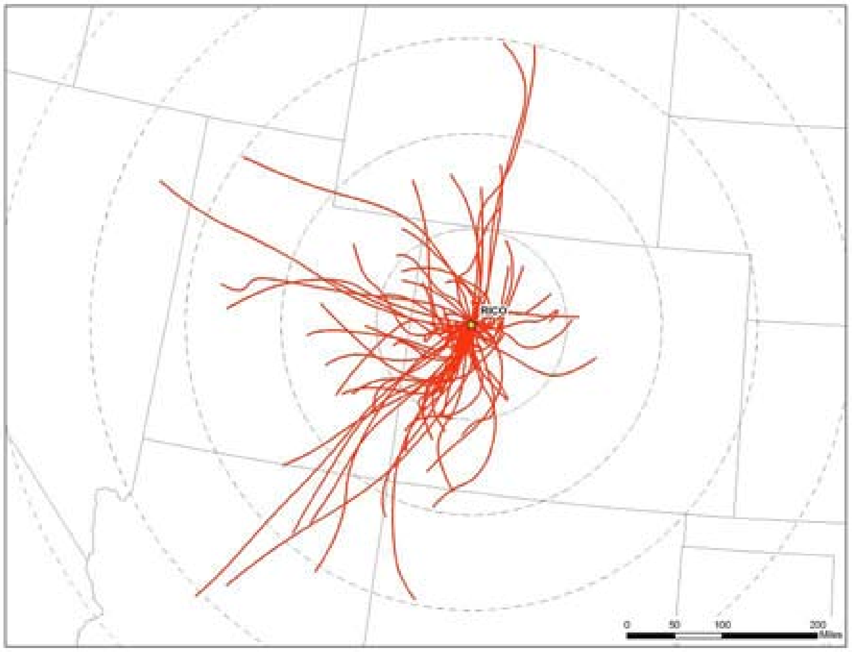


Figure 8-23. Back Trajectory Cluster Map for RICO

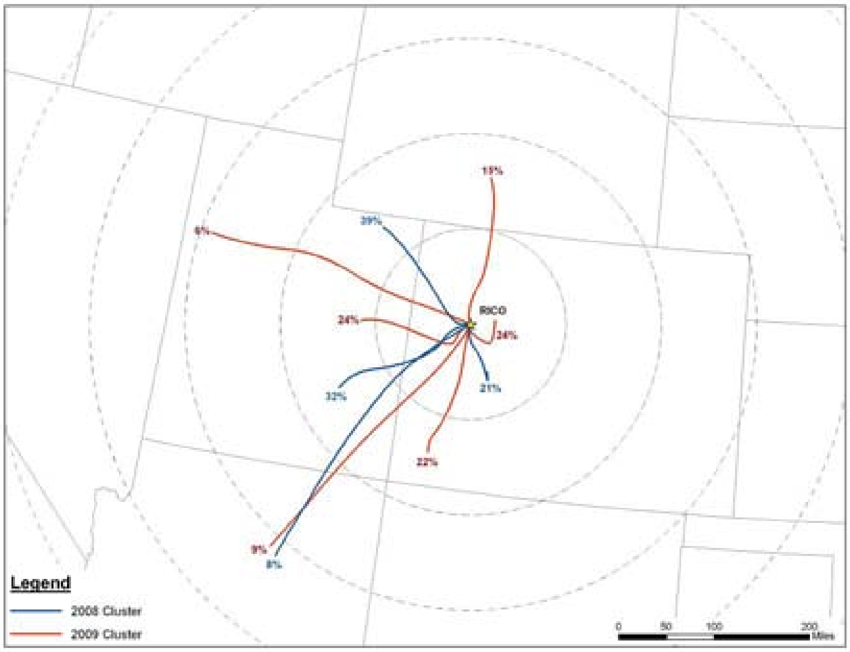


Figure 8-24. 2009 Composite Back Trajectory Map for RUCO

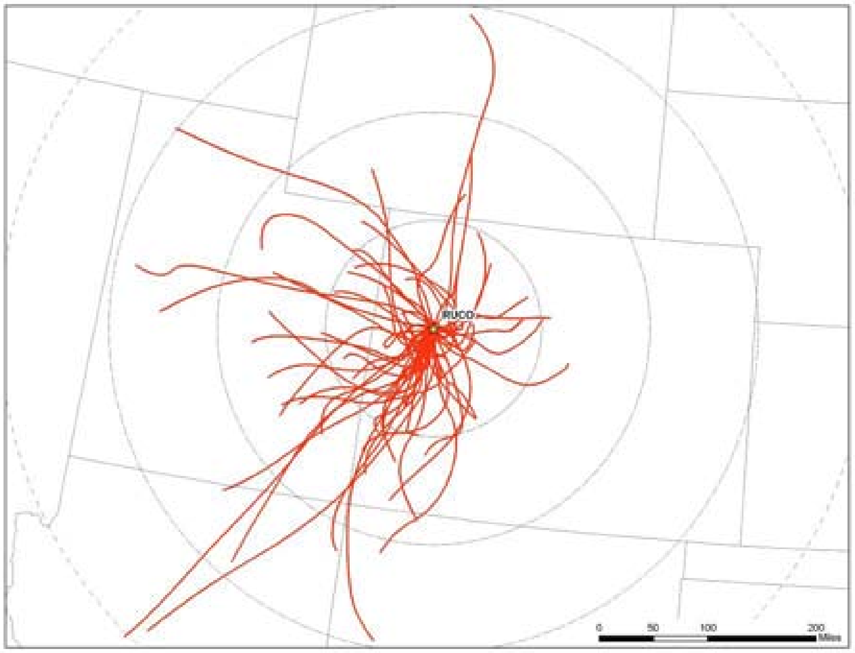
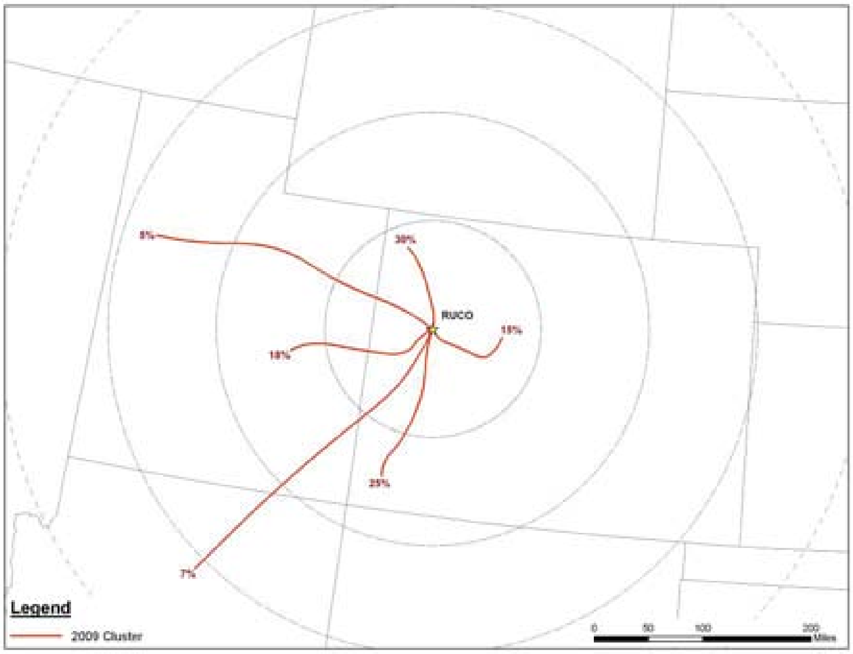


Figure 8-25. 2009 Back Trajectory Cluster Map for RUCO



Observations for GPCO from Figures 8-9 through 8-11 include the following:

- The 24-hour air shed domain for GPCO was smaller than many other NMP monitoring sites. The farthest away a trajectory originated was over the Mojave Desert of California, or greater than 450 miles away. However, most trajectories (77 percent) originated within 200 miles of GPCO and the average trajectory length was 150 miles.

- Back trajectories originated from a variety of directions at GPCO, although many of them had a westerly component.

- The cluster analysis shows that back trajectories frequently originated from the northwest, west, and southwest. Shorter back trajectories originating from the south were also common. The 2008 cluster originating to the southeast (labeled 22 percent) represented several relatively short back trajectories originating from the east, southeast, and east. Similarly, the 2009 cluster originating to the northeast (labeled 19 percent) represented several relatively short back trajectories originating from the north, northeast, and east.

Observations from Figures 8-12 through 8-25 for the Garfield County sites include the following:

- The composite back trajectory maps for the Garfield County sites resemble the ones for GPCO. This is expected, given the sites' close proximity to GPCO.

- The 24-hour air shed domains were among the smallest in size compared to other NMP sites, with longest trajectories originating over central Arizona, or less than 450 miles away. The average back trajectory length ranged from 140 (RUCO) to 160 (MOCO) miles for the Garfield County sites.

- Most of the back trajectories had a westerly component, as confirmed by the cluster analysis maps.

8.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at the Walker Field Airport (for GPCO) and Garfield County Regional Airport (for BRCO, MOCO, PACO, RICO, and RUCO) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

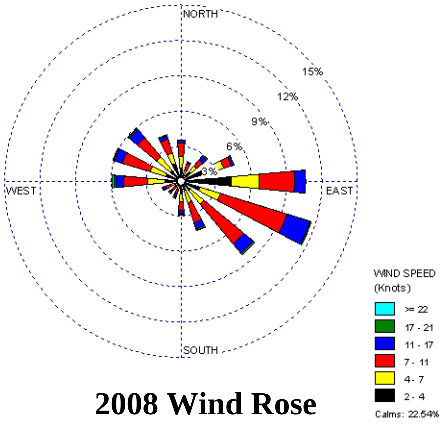
Figure 8-26 presents five different wind roses for the GPCO monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 8-27 through 8-31 present the different wind roses for the Garfield County monitoring sites.

Observations from Figure 8-26 for GPCO include the following:

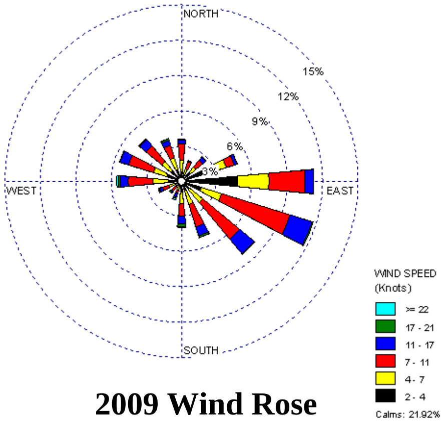
- The historical wind rose shows that easterly, east-southeasterly, and southeasterly winds were prevalent near GPCO. Calm winds (≤ 2 knots) were observed for approximately 20 percent of the hourly wind measurements.

- The 2008 and 2009 wind roses exhibit similar wind patterns as the historical wind rose. Further, the sample day wind patterns for each year also resemble the historical and full-year wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

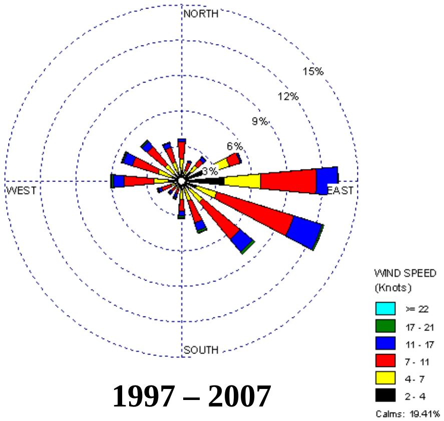
Figure 8-26. Wind Roses for the Walker Field Airport Weather Station near GPCO



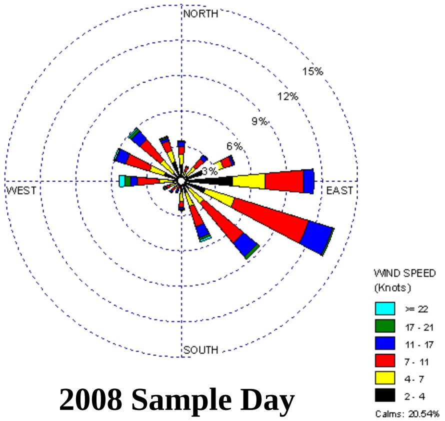
2008 Wind Rose



2009 Wind Rose

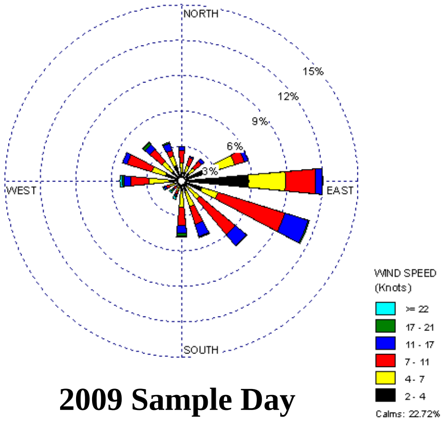


1997 – 2007
Historical Wind Rose



2008 Sample Day

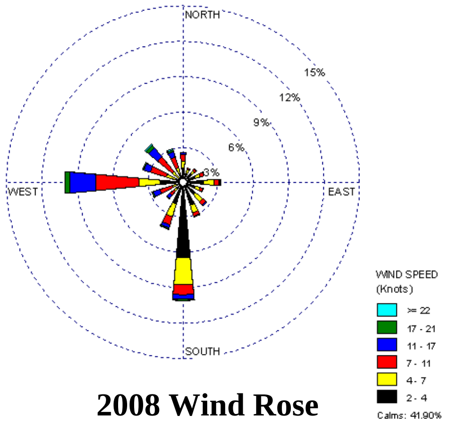
Wind Rose



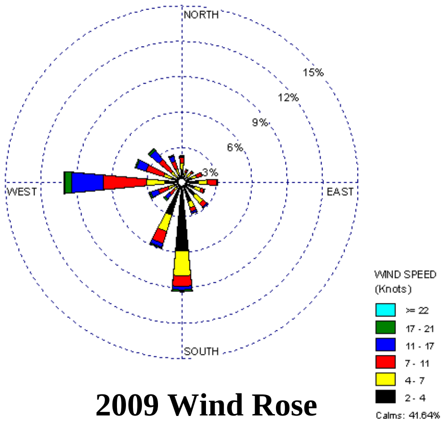
2009 Sample Day

Wind Rose

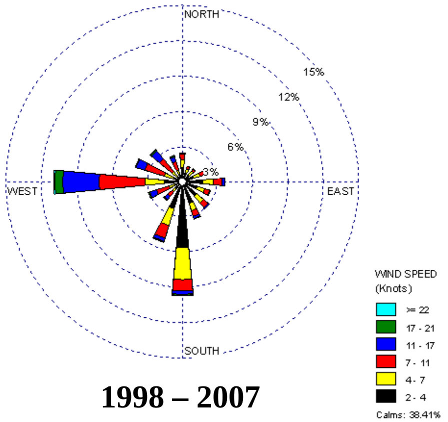
Figure 8-27. Wind Roses for the Garfield County Regional Airport near BRCO



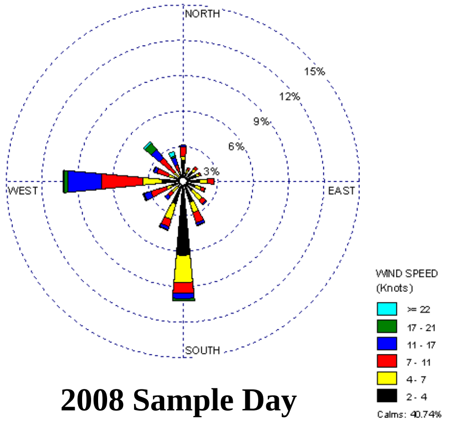
2008 Wind Rose



2009 Wind Rose

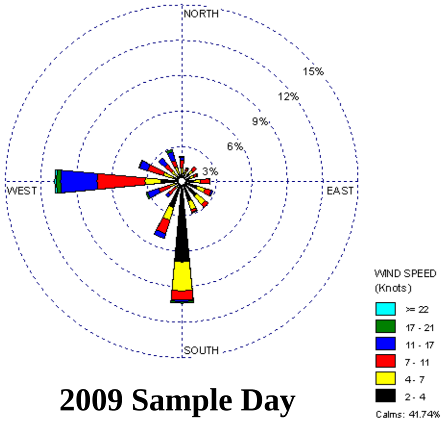


1998 – 2007
Historical Wind Rose



2008 Sample Day

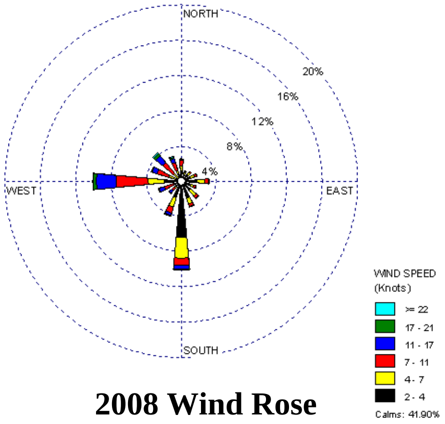
Wind Rose



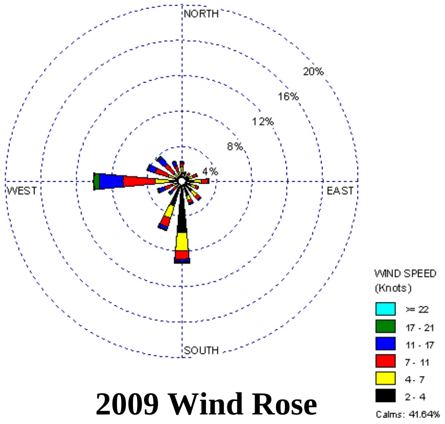
2009 Sample Day

Wind Rose

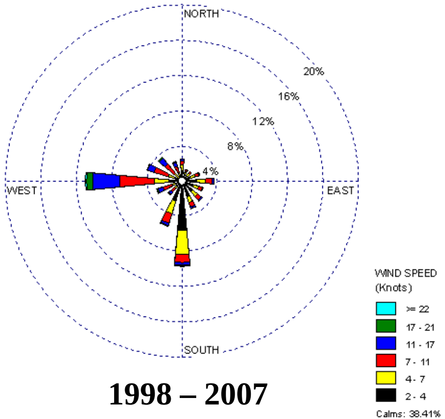
Figure 8-28. Wind Roses for the Garfield County Regional Airport near MOCO



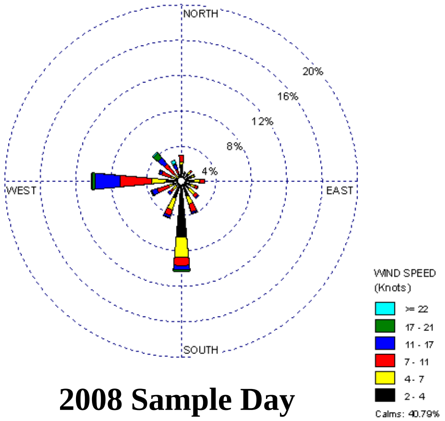
2008 Wind Rose



2009 Wind Rose

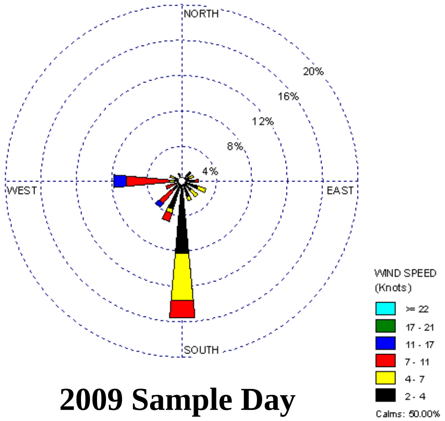


1998 – 2007
Historical Wind Rose



2008 Sample Day

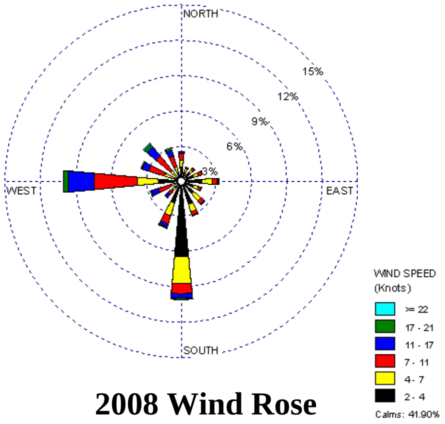
Wind Rose



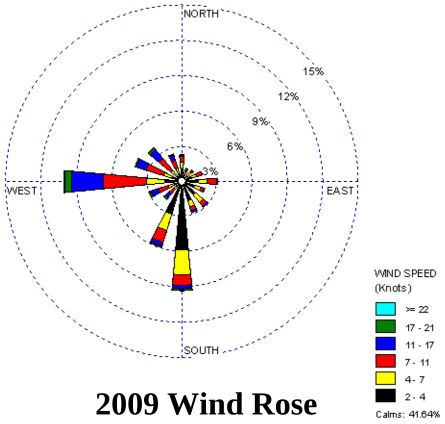
2009 Sample Day

Wind Rose

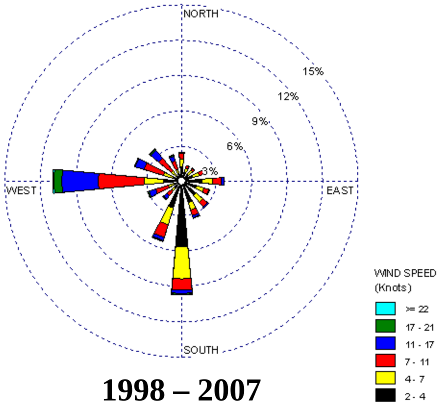
Figure 8-29. Wind Roses for the Garfield County Regional Airport near PACO



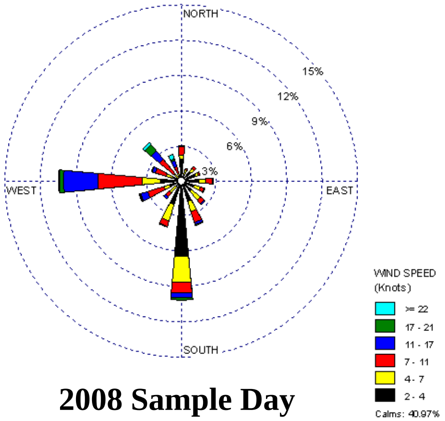
2008 Wind Rose



2009 Wind Rose

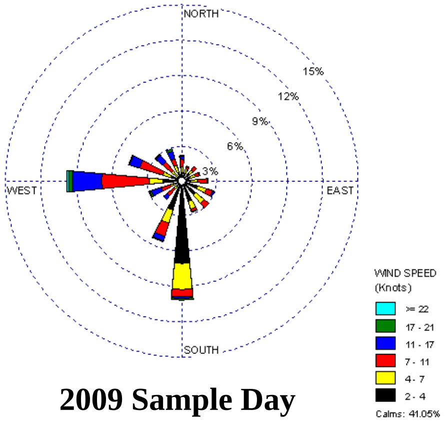


1998 – 2007
Historical Wind Rose



2008 Sample Day

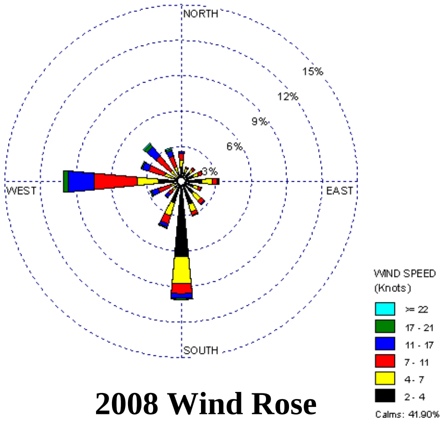
Wind Rose



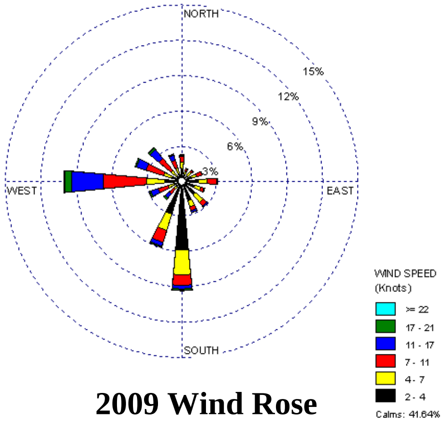
2009 Sample Day

Wind Rose

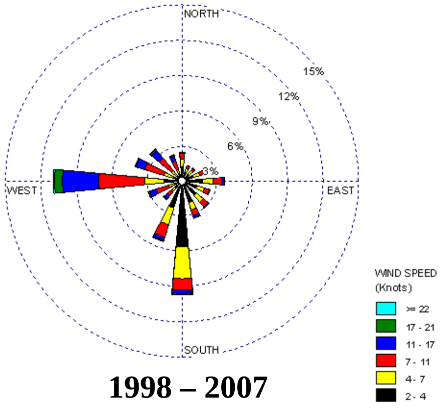
Figure 8-30. Wind Roses for the Garfield County Regional Airport near RICO



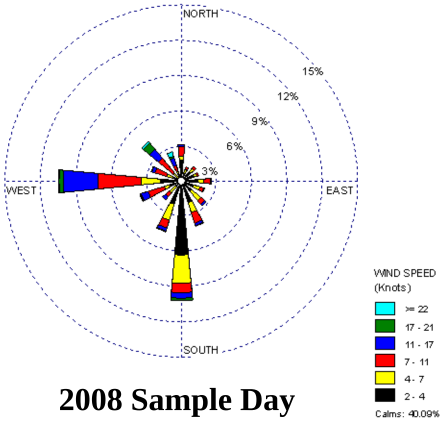
2008 Wind Rose



2009 Wind Rose

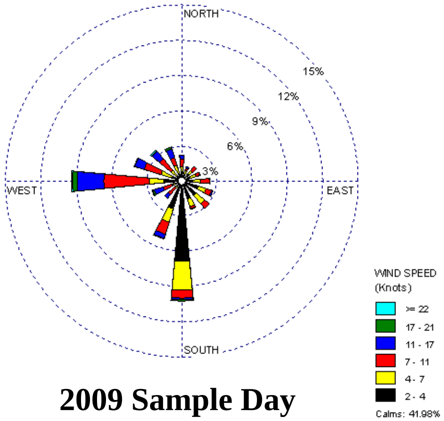


1998 – 2007
Historical Wind Rose



2008 Sample Day

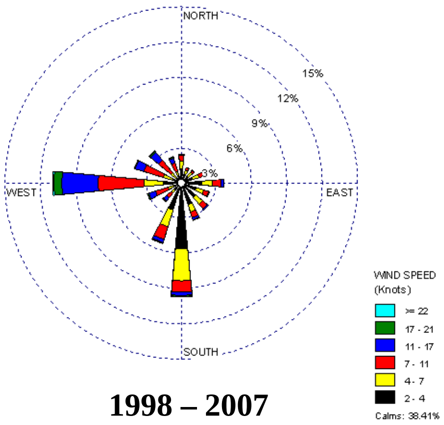
Wind Rose



2009 Sample Day

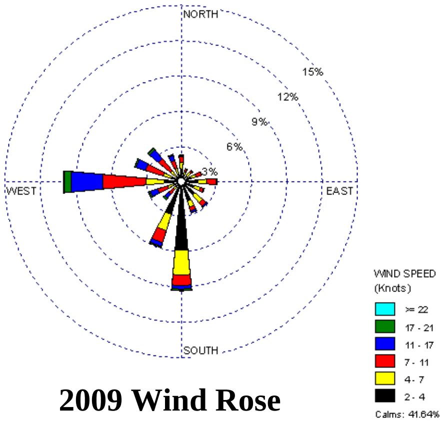
Wind Rose

Figure 8-31. Wind Roses for the Garfield County Regional Airport near RUCO

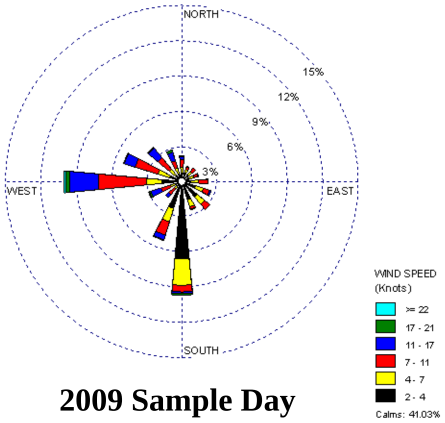


1998 – 2007

Historical Wind Rose



2009 Wind Rose



2009 Sample Day

Wind Rose

Observations from Figures 8-27 through 8-31 for the Garfield County sites include the following:

- The wind roses for the Garfield County sites are nearly identical to each other. This is expected given that the wind observations came from the same NWS weather station for all five sites.
- The historical wind roses show that calm winds were prevalent (38 percent of observations) near these five monitoring sites. Westerly and southerly winds were also common.
- The 2008 and 2009 wind roses exhibit similar wind patterns as the historical wind rose. Further, the sample day wind patterns for each year also resemble the historical and full-year wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically. Even MOCO's 2009 sample day wind rose exhibits the calm, westerly, and southerly wind direction tendencies, even though only sample days in January and February are included.
- RUCO does not have 2008 or 2008 sample day wind roses in Figure 8-31 because sampling did not begin until 2009.

8.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Colorado monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 8-4 presents the pollutants of interest for each Colorado monitoring site. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. GPCO sampled for VOC, carbonyls, PAH, and hexavalent chromium; the Garfield County sites sampled for SNMOC and carbonyls only.

Table 8-4. Risk Screening Results for the Colorado Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Silt, Colorado - BRCO						
Benzene	0.13	116	116	100.00	48.13	48.13
Formaldehyde	0.077	57	57	100.00	23.65	71.78
Acetaldehyde	0.45	46	57	80.70	19.09	90.87
Ethylbenzene	0.4	14	114	12.28	5.81	96.68
1,3-Butadiene	0.033	7	10	70.00	2.90	99.59
Xylenes	10	1	116	0.86	0.41	100.00
Total		241	470	51.28		
Grand Junction, Colorado - GPCO						
Acetaldehyde	0.45	123	123	100.00	13.37	13.37
Formaldehyde	0.077	123	123	100.00	13.37	26.74
Benzene	0.13	120	120	100.00	13.04	39.78
Carbon Tetrachloride	0.17	117	120	97.50	12.72	52.50
1,3-Butadiene	0.033	116	120	96.67	12.61	65.11
Naphthalene	0.029	98	106	92.45	10.65	75.76
Tetrachloroethylene	0.17	93	119	78.15	10.11	85.87
Ethylbenzene	0.4	61	120	50.83	6.63	92.50
Acrylonitrile	0.015	31	31	100.00	3.37	95.87
Benzo(a)pyrene	0.00091	13	72	18.06	1.41	97.28
Dichloromethane	2.1	13	120	10.83	1.41	98.70
1,2-Dichloroethane	0.038	7	7	100.00	0.76	99.46
1,2-Dibromoethane	0.0017	2	2	100.00	0.22	99.67
p-Dichlorobenzene	0.091	1	80	1.25	0.11	99.78
Hexavalent Chromium	0.000083	1	65	1.54	0.11	99.89
Xylenes	10	1	120	0.83	0.11	100.00
Total		920	1,448	63.54		

Table 8-4. Risk Screening Results for the Colorado Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Brock Ranch, Rifle, Colorado - MOCO						
Benzene	0.13	66	66	100.00	51.16	51.16
Formaldehyde	0.077	30	30	100.00	23.26	74.42
Acetaldehyde	0.45	27	30	90.00	20.93	95.35
Ethylbenzene	0.4	5	64	7.81	3.88	99.22
1,3-Butadiene	0.033	1	3	33.33	0.78	100.00
Total		129	193	66.84		
Parachute, Colorado - PACO						
Benzene	0.13	117	117	100.00	33.52	33.52
Ethylbenzene	0.4	64	116	55.17	18.34	51.86
Formaldehyde	0.077	59	59	100.00	16.91	68.77
Acetaldehyde	0.45	56	59	94.92	16.05	84.81
1,3-Butadiene	0.033	48	53	90.57	13.75	98.57
Xylenes	10	5	117	4.27	1.43	100.00
Total		349	521	66.99		
Rifle, Colorado - RICO						
Benzene	0.13	121	121	100.00	29.23	29.23
1,3-Butadiene	0.033	94	95	98.95	22.71	51.93
Ethylbenzene	0.4	76	121	62.81	18.36	70.29
Acetaldehyde	0.45	60	60	100.00	14.49	84.78
Formaldehyde	0.077	60	60	100.00	14.49	99.28
Xylenes	10	3	121	2.48	0.72	100.00
Total		414	578	71.63		
Rulison, Colorado - RUCO						
Benzene	0.13	52	52	100.00	42.28	42.28
Formaldehyde	0.077	24	24	100.00	19.51	61.79
Acetaldehyde	0.45	23	24	95.83	18.70	80.49
Ethylbenzene	0.4	18	53	33.96	14.63	95.12
1,3-Butadiene	0.033	6	13	46.15	4.88	100.00
Total		123	166	74.10		

Observations from Table 8-4 include the following:

- Sixteen pollutants failed at least one screen for GPCO, of which nine are NATTS MQO Core Analytes.

- Nine pollutants were initially identified as pollutants of interest for GPCO based on the risk screening process, of which seven are NATTS MQO Core Analytes. Benzo(a)pyrene and hexavalent chromium were added to GPCO's pollutants of interest, even though they did not contribute to 95 percent of GPCO's total failed screens. Three additional NATTS MQO Core Analytes were also added to GPCO's pollutants of interest, although they are not shown in Table 8-4 because their concentrations did not fail any screens: chloroform, trichloroethylene, and vinyl chloride.

- The number of pollutants failing screens for the Garfield County sites ranged from five to six. Five pollutants (1,3-butadiene, benzene, ethylbenzene, formaldehyde, and acetaldehyde) failed screens for each Garfield County site. Three pollutants (benzene, formaldehyde, and acetaldehyde) were identified as pollutants of interest for all five sites. While 1,3-butadiene did fail screens for BRCO, MOCO, and RUCO, it did not contribute to 95 percent of the total failed screens, but was added to the pollutants of interest due to its NATTS MQO Core Analyte classification.

- Note that carbonyl compound samples were collected on a 1-in-12 day sampling schedule at the Garfield County sites, while SNMOC were collected on a 1-in-6 day sampling schedule; thus there are roughly half the number of samples of carbonyl compounds than SNMOC.

- Benzene and formaldehyde failed 100 percent of screens for all six Colorado sites.

8.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Colorado monitoring sites. Concentration averages are provided for the pollutants of interest for each Colorado monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the sites, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

8.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Colorado site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 8-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium for GPCO are presented in ng/m^3 for ease of viewing.

Observations for GPCO from Table 8-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (4.11 ± 0.29 µg/m^3 in 2008 and 4.02 ± 0.27 µg/m^3 in 2009) and acetaldehyde (2.49 ± 0.22 µg/m^3 in 2008 and 2.90 ± 0.22 µg/m^3 in 2009).

- The 2008 daily average concentration of acrylonitrile (2.38 ± 4.19 µg/m^3) was significantly higher than its 2009 daily average concentration (0.28 ± 0.11 µg/m^3), although the very large confidence interval for 2008 raises questions about outliers. This pollutant was detected only three times in 2008 and its measurements ranged from 0.163 to 5.52 µg/m^3. In 2009, this pollutant was detected 28 times and its measurements ranged from 0.09 to 1.29 µg/m^3. Note that most quarterly averages and no annual averages could be calculated for this pollutant due to the low detection rate.

- Benzene was the only other pollutant of interest for GPCO with a daily average concentration greater than 1 µg/m^3.

- In 2008, formaldehyde concentrations were highest during third quarter of the year. While this appears to be true for 2009 as well, the difference is not statistically significant for 2009.

Table 8-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Grand Junction, Colorado - GPCO												
Acetaldehyde	2.49 ± 0.22	2.01 ± 0.37	2.09 ± 0.38	2.97 ± 0.34	2.93 ± 0.52	2.49 ± 0.22	2.90 ± 0.22	3.12 ± 0.74	2.87 ± 0.40	2.96 ± 0.27	2.65 ± 0.44	2.90 ± 0.22
Acrylonitrile	2.38 ± 4.19	NA	NA	NA	NA	NA	0.28 ± 0.11	0.10 ± 0.05	0.12 ± 0.07	NA	NA	NA
Benzene	1.62 ± 0.22	1.70 ± 0.40	1.12 ± 0.17	1.44 ± 0.31	2.21 ± 0.63	1.62 ± 0.22	1.94 ± 0.32	2.78 ± 0.59	1.28 ± 0.21	1.63 ± 0.89	2.15 ± 0.50	1.94 ± 0.32
1,3-Butadiene	0.15 ± 0.03	0.18 ± 0.07	0.08 ± 0.02	0.11 ± 0.04	0.21 ± 0.07	0.15 ± 0.03	0.16 ± 0.04	0.23 ± 0.08	0.09 ± 0.02	0.13 ± 0.08	0.21 ± 0.07	0.16 ± 0.04
Carbon Tetrachloride	0.65 ± 0.06	0.56 ± 0.12	0.66 ± 0.12	0.74 ± 0.13	0.66 ± 0.13	0.65 ± 0.06	0.59 ± 0.05	0.51 ± 0.08	0.55 ± 0.10	0.65 ± 0.12	0.65 ± 0.11	0.59 ± 0.05
Chloroform	0.10 ± 0.02	0.08 ± 0.01	0.09 ± 0.01	0.13 ± 0.06	0.11 ± 0.01	0.10 ± 0.02	0.12 ± 0.01	0.09 ± 0.02	0.11 ± 0.02	0.14 ± 0.02	0.14 ± 0.02	0.12 ± 0.01
Ethylbenzene	0.48 ± 0.07	0.43 ± 0.12	0.32 ± 0.06	0.55 ± 0.14	0.61 ± 0.20	0.48 ± 0.07	0.53 ± 0.10	0.75 ± 0.25	0.38 ± 0.07	0.46 ± 0.27	0.56 ± 0.12	0.53 ± 0.10
Formaldehyde	4.11 ± 0.29	3.83 ± 0.51	3.47 ± 0.60	5.13 ± 0.54	4.00 ± 0.44	4.11 ± 0.29	4.02 ± 0.27	4.31 ± 0.55	3.97 ± 0.48	4.61 ± 0.44	3.06 ± 0.42	4.02 ± 0.27
Tetrachloroethylene	0.33 ± 0.07	0.30 ± 0.10	0.29 ± 0.17	0.28 ± 0.10	0.44 ± 0.18	0.33 ± 0.07	0.43 ± 0.09	0.60 ± 0.24	0.26 ± 0.07	0.36 ± 0.17	0.51 ± 0.22	0.43 ± 0.09
Trichloroethylene	0.09 ± 0.04	0.02 ± 0.02	NA	NA	NA	NA	0.11 ± 0.02	0.09 ± 0.04	0.04 ± 0.03	NA	0.07 ± 0.05	0.06 ± 0.02
Vinyl Chloride	0.02 ± 0.01	NA	NA	NA	NA	NA	0.02 ± 0.01	NA	NA	NA	NA	NA
Benzo(a)pyrene[a]	0.27 ± 0.14	NR	0.04 ± 0.02	NA	0.42 ± 0.22	NA	0.44 ± 0.15	0.55 ± 0.27	0.04 ± 0.02	NA	0.70 ± 0.27	0.34 ± 0.12
Hexavalent Chromium[a]	0.03 ± 0.03	0.01 ± 0.01	0.01 ± <0.01	0.07 ± 0.12	0.01 ± <0.01	0.02 ± 0.02	0.02 ± <0.01	NA	NA	NA	0.01 ± <0.01	NA
Naphthalene[a]	111.88 ± 28.42	NR	91.31 ± 22.79	66.47 ± 27.16	177.85 ± 69.38	111.88 ± 28.42	198.42 ± 26.68	250.09 ± 75.46	143.05 ± 32.34	162.2 ± 35.92	236.69 ± 52.12	198.42 ± 26.68

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 8-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
Silt, Colorado - BRCO												
Acetaldehyde	0.83 ± 0.13	0.92 ± 0.37	0.83 ± 0.24	1.00 ± 0.26	0.61 ± 0.22	0.83 ± 0.13	0.79 ± 0.13	NA	0.66 ± 0.30	1.08 ± 0.17	NA	NA
Benzene	1.34 ± 0.46	1.87 ± 0.52	0.75 ± 0.15	1.74 ± 1.91	1.33 ± 0.39	1.34 ± 0.46	1.39 ± 0.27	2.13 ± 0.65	1.32 ± 0.49	0.78 ± 0.16	1.58 ± 0.68	1.39 ± 0.27
1,3-Butadiene	0.04 ± 0.01	NA	NA	NA	NA	NA	0.05 ± 0.04	NA	NA	NA	NA	NA
Ethylbenzene	0.27 ± 0.15	0.24 ± 0.06	0.15 ± 0.04	0.51 ± 0.62	0.19 ± 0.06	0.26 ± 0.14	0.24 ± 0.05	0.39 ± 0.16	0.27 ± 0.15	0.16 ± 0.05	0.20 ± 0.07	0.24 ± 0.05
Formaldehyde	1.01 ± 0.14	1.14 ± 0.37	0.92 ± 0.20	1.25 ± 0.27	0.75 ± 0.21	1.01 ± 0.14	1.37 ± 0.73	NA	0.82 ± 0.25	1.46 ± 0.12	NA	NA
Brock Ranch, Rifle, Colorado - MOCO												
Acetaldehyde	0.79 ± 0.12	NA	0.84 ± 0.17	NA	NA	NA	0.79 ± 0.20	NA	NR	NR	NR	NA
Benzene	0.94 ± 0.11	1.22 ± 0.29	0.68 ± 0.14	0.93 ± 0.19	0.94 ± 0.23	0.94 ± 0.11	1.96 ± 1.21	1.96 ± 1.21	NR	NR	NR	NA
1,3-Butadiene	0.05 ± <0.01	NA	NA	NA	NA	NA	0.03 ± <0.01	NA	NR	NR	NR	NA
Formaldehyde	1.06 ± 0.14	NA	1.07 ± 0.16	NA	NA	NA	1.13 ± 0.30	NA	NR	NR	NR	NA
Parachute, Colorado - PACO												
Acetaldehyde	1.11 ± 0.14	NA	1.12 ± 0.25	NA	0.95 ± 0.35	NA	0.99 ± 0.15	NA	0.79 ± 0.24	1.16 ± 0.29	NA	NA
Benzene	2.31 ± 0.44	2.81 ± 1.03	1.63 ± 0.49	2.02 ± 0.50	2.83 ± 1.31	2.31 ± 0.44	2.70 ± 0.49	4.50 ± 1.62	2.23 ± 0.56	1.93 ± 0.45	2.57 ± 0.85	2.70 ± 0.49
1,3-Butadiene	0.10 ± 0.03	0.09 ± 0.03	NA	NA	0.09 ± 0.05	NA	0.21 ± 0.28	0.08 ± 0.03	NA	NA	NA	NA

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 8-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Ethylbenzene	0.59 ± 0.13	0.54 ± 0.17	0.41 ± 0.13	0.55 ± 0.23	0.86 ± 0.42	0.59 ± 0.13	0.45 ± 0.08	0.76 ± 0.29	0.35 ± 0.09	0.36 ± 0.09	0.37 ± 0.11	0.44 ± 0.08
Formaldehyde	1.74 ± 0.18	NA	1.55 ± 0.24	NA	1.66 ± 0.40	NA	1.73 ± 0.22	NA	1.52 ± 0.43	2.03 ± 0.26	NA	NA
Rifle, Colorado - RICO												
Acetaldehyde	1.56 ± 0.21	NA	1.61 ± 0.43	1.71 ± 0.51	1.40 ± 0.47	1.56 ± 0.21	1.40 ± 0.20	NA	0.94 ± 0.24	1.75 ± 0.35	1.62 ± 0.24	1.40 ± 0.20
Benzene	1.69 ± 0.21	2.10 ± 0.60	1.05 ± 0.20	1.65 ± 0.26	2.02 ± 0.45	1.69 ± 0.21	2.23 ± 0.36	3.44 ± 1.19	1.93 ± 0.62	1.49 ± 0.29	2.25 ± 0.57	2.23 ± 0.36
1,3-Butadiene	0.15 ± 0.03	0.15 ± 0.05	0.05 ± 0.02	0.08 ± 0.03	0.20 ± 0.06	0.12 ± 0.03	0.14 ± 0.03	0.22 ± 0.06	0.08 ± 0.02	0.08 ± 0.02	0.07 ± 0.05	0.11 ± 0.02
Ethylbenzene	0.48 ± 0.06	0.51 ± 0.13	0.32 ± 0.06	0.54 ± 0.07	0.56 ± 0.14	0.48 ± 0.06	0.56 ± 0.08	0.83 ± 0.26	0.41 ± 0.11	0.49 ± 0.09	0.52 ± 0.11	0.56 ± 0.08
Formaldehyde	1.89 ± 0.28	NA	1.68 ± 0.34	1.98 ± 0.54	2.00 ± 0.83	1.89 ± 0.28	1.68 ± 0.20	NA	1.24 ± 0.25	2.05 ± 0.23	1.91 ± 0.34	1.68 ± 0.20
Rulison, Colorado - RUCO												
Acetaldehyde	NR	NR	NR	NR	NR	NR	1.27 ± 0.24	NA	1.26 ± 0.52	1.80 ± 0.28	NA	NA
Benzene	NR	NR	NR	NR	NR	NR	2.43 ± 0.37	2.66 ± 0.95	2.01 ± 0.54	2.16 ± 0.74	2.66 ± 0.74	2.39 ± 0.37
1,3-Butadiene	NR	NR	NR	NR	NR	NR	0.05 ± 0.02	NA	NA	NA	NA	NA
Ethylbenzene	NR	NR	NR	NR	NR	NR	0.38 ± 0.08	0.62 ± 0.39	0.28 ± 0.10	0.38 ± 0.09	0.33 ± 0.08	0.38 ± 0.08
Formaldehyde	NR	NR	NR	NR	NR	NR	1.21 ± 0.14	NA	0.97 ± 0.10	1.62 ± 0.15	NA	NA

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

- The third quarter 2008 hexavalent chromium concentration is relatively high compared to other quarterly averages and has a large confidence interval, indicating the presence of outliers. A review of the data shows that the highest hexavalent chromium concentration was measured on July 5, 2008. As discussed in Section 4.1.2, this was the highest hexavalent chromium concentration measured for any site sampling this pollutant over the 2-year period. Yet, the 2008 daily average concentration for this site ranked 14th highest among all NMP sites sampling this pollutant.

- Concentrations of naphthalene appear higher during the colder months. A closer look at the first quarter of 2009 and the fourth quarters of both years shows rather large confidence intervals associated with these averages. A review of the data shows that the two highest concentrations of naphthalene were measured on January 13, 2009 (523 ng/m^3) and November 17, 2008 (499 ng/m^3). Further, of the 15 concentrations of naphthalene greater than 300 ng/m^3 measured at this site, all but one were measured in one of these three quarters (two in the fourth quarter of 2008, four in the first quarter of 2009, and eight in the fourth quarter of 2009).

- Benzo(a)pyrene concentrations for the fourth quarter of 2008 and first and fourth quarters of 2009 also have large confidence intervals. A review of the data shows that the highest concentration of this pollutant was measured on the same day as the highest concentration of naphthalene. The highest benzo(a)pyrene concentration was measured at GPCO on January 13, 2009 (1.72 ng/m^3). Of the 11 benzo(a)pyrene concentrations greater than 1 ng/m^3, all were measured in one of these three quarters (three in the fourth quarter of 2008, two in the first quarter of 2009, and six in the fourth quarter of 2009).

- Several quarterly averages could not be calculated for trichloroethylene, benzo(a)pyrene, hexavalent chromium, and vinyl chloride because there were not enough detects for quarterly averages to be calculated. In addition, PAH sampling at GPCO began in April 2008; thus first quarter 2008 averages could not be calculated.

Observations for the Garfield County sites from Table 8-5 include the following:

- With the exception of RUCO, benzene and formaldehyde had the highest daily average concentrations by mass for each of the Garfield County sites for each year. Daily average concentrations of formaldehyde ranged from 1.00 ± 0.14 µg/m^3 for BRCO (2008) to 1.89 ± 0.28 µg/m^3 for RICO (2008). Daily average concentrations of benzene ranged from 0.94 ± 0.11 µg/m^3 for MOCO (2008) to 2.70 ± 0.49 µg/m^3 for PACO (2009). For RUCO, benzene and acetaldehyde were the pollutants with the highest daily average concentrations (although formaldehyde was not much lower than acetaldehyde).

- The third quarter 2008 average concentrations of benzene and ethylbenzene for BRCO have very large confidence intervals, indicating that these averages are influenced by outliers. The concentration of benzene measured on July 29, 2008

(13.7 µg/m^3) was nearly three times higher than the next highest benzene concentration measured at BRCO, the highest benzene concentration measured among all the Garfield County sites, and the fourth highest benzene concentration measured among NMP sites. Similarly, the ethylbenzene concentration measured on July 29, 2008 at BRCO (4.35 µg/m^3) was more than three times higher than the next highest concentration measured at BRCO, the highest ethylbenzene concentration measured among all the Garfield County sites, and the fifth highest ethylbenzene concentration measured among NMP sites.

- Few quarterly averages could be calculated for MOCO due to a combination of a 1-in-12 day sampling schedule (for carbonyls), a low detection rate (for 1,3-butadiene), a first quarter 2009 end date to sampling, and a completeness below 85 percent for SNMOC in 2009. But among those that could be calculated, the first quarter 2009 average concentration of benzene has a large confidence interval, indicating that this average is influenced by outliers. The two highest concentrations of benzene were measured at this site on January 7, 2009 (4.72 µg/m^3) and January 13, 2009 (3.14 µg/m^3).

- The first quarter 2009 average concentration of benzene for PACO appears significantly higher than the other quarterly averages for this pollutant. The relatively large confidence interval indicates that this average is influenced by outliers. Of the 10 highest measurements of benzene at PACO, five were collected during the first quarter of 2009.

- The 2009 daily average concentration of 1,3-butadiene for PACO has a large confidence interval, indicating that this average is influenced by outliers. The 1,3-butadiene concentration measured on December 27, 2009 (3.15 µg/m^3) was an order of magnitude higher than the next highest concentration measured at this site, and the highest concentration of this pollutant measured among all NMP sites.

- The first quarter 2009 average concentration of benzene for RICO appears significantly higher than the other quarterly averages for this pollutant. The relatively large confidence interval indicates that this average is influenced by outliers. The five highest measurements of benzene from RICO were collected during the first quarter of 2009.

- Because RUCO did not begin sampling until 2009, no 2008 averages are available.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Colorado sites from those tables include the following:

- As shown in Tables 4-9 through 4-12, the daily average concentrations of eight pollutants for GPCO were among the 10 highest average concentrations for all NMP sites. The 2008 daily average concentration of acrylonitrile for GPCO was the highest among all NMP sites.

- As shown in Table 4-9, the Garfield County sites account for five of the 10 highest daily average concentrations of benzene. PACO's 2008 and 2009 daily average concentrations of benzene both appear in this table, ranking third (2009) and sixth (2008). PACO also had one of the 10 highest daily average concentrations of 1,3-butadiene and ethylbenzene. None of the daily average concentrations of the carbonyl compounds for the Garfield County sites appear in Table 4-10.

8.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. While the Garfield County sites have not sampled continuously for 5 years as part of the NMP, GPCO has sampled carbonyl compounds and VOC since 2004 and hexavalent chromium since 2005. Thus, Figures 8-32 through 8-36 present the 3-year rolling statistical metrics for acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and hexavalent chromium for GPCO, respectively. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Observations from Figure 8-32 for acetaldehyde measurements at GPCO include the following:

- The maximum acetaldehyde concentration was measured during the 2004-2006 time frame, specifically 2004. The maximum concentrations measured in subsequent time periods were significantly lower. The two highest acetaldehyde concentrations (93 and 55 $\mu g/m^3$) were measured in 2004 and the six highest acetaldehyde concentrations (ranging from 93 $\mu g/m^3$ to 6.35 $\mu g/m^3$) were all measured in 2004 and 2005.

- The 5th and 95th percentiles, the median and the average show relatively little variation over time if the 2004-2006 time frame is excluded.

- Although difficult to discern in Figure 8-32, the rolling average and median values became more similar to each other over the periods shown. This indicates decreasing variability in the central tendency of acetaldehyde concentrations measured over the periods shown.

Figure 8-32. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at GPCO

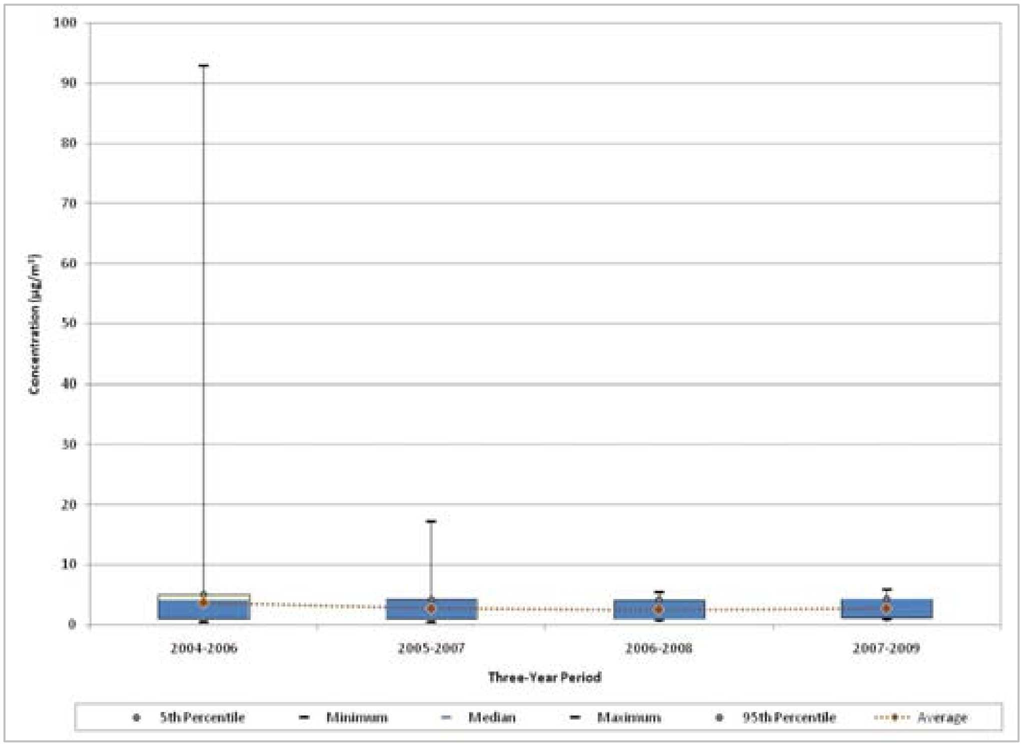


Figure 8-33. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at GPCO

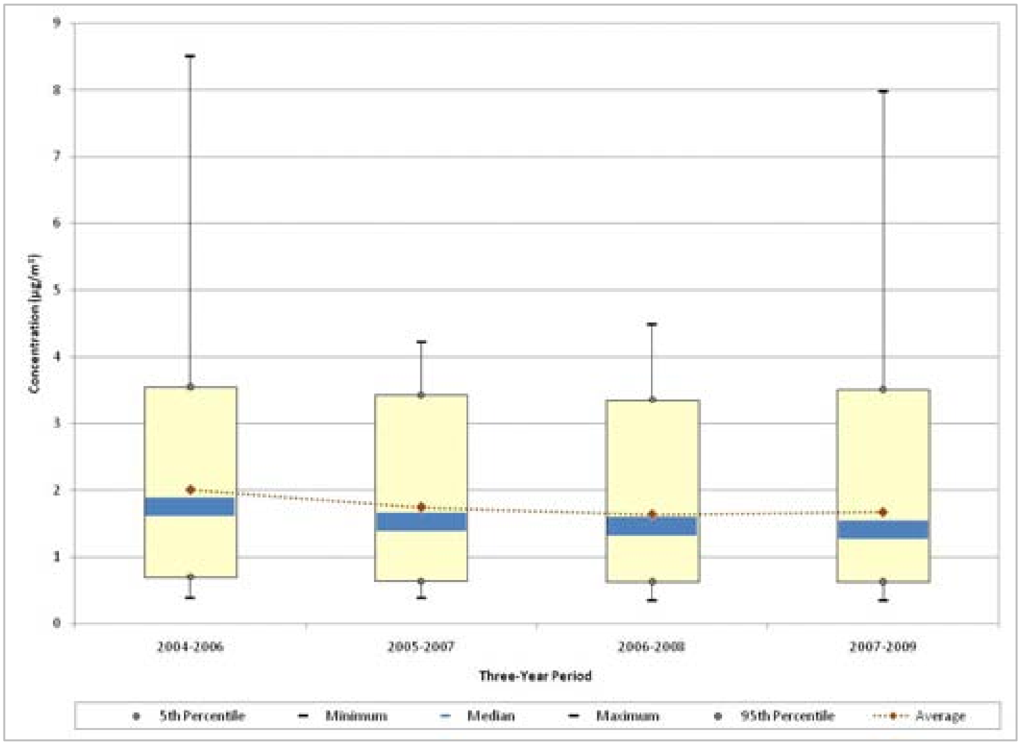


Figure 8-34. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at GPCO

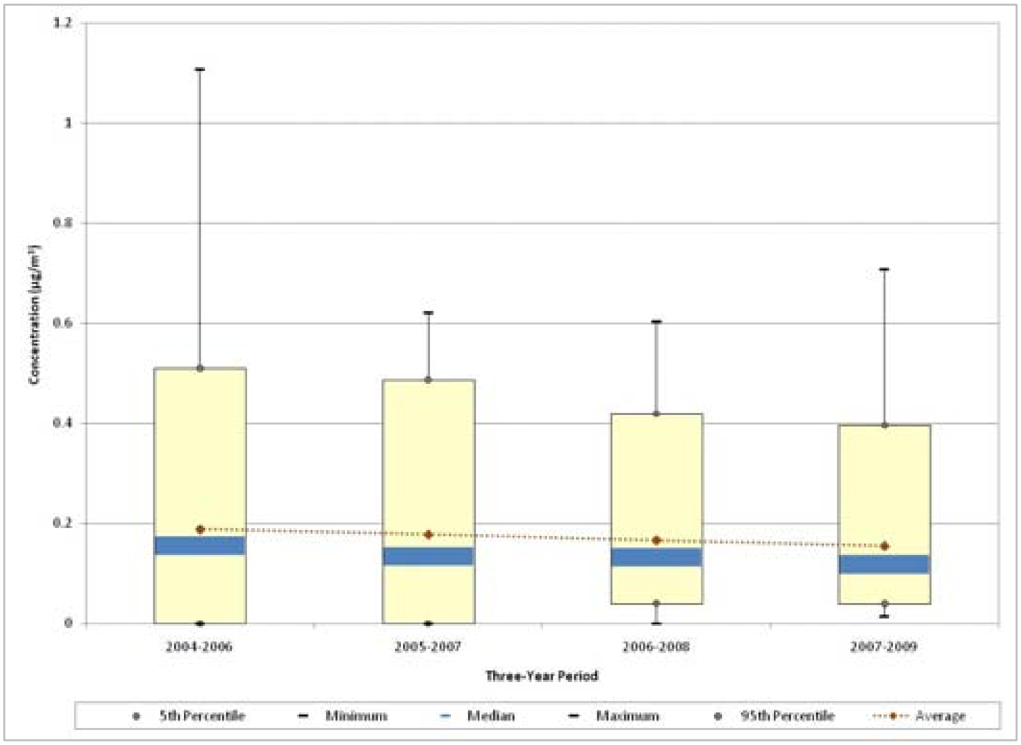


Figure 8-35. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at GPCO

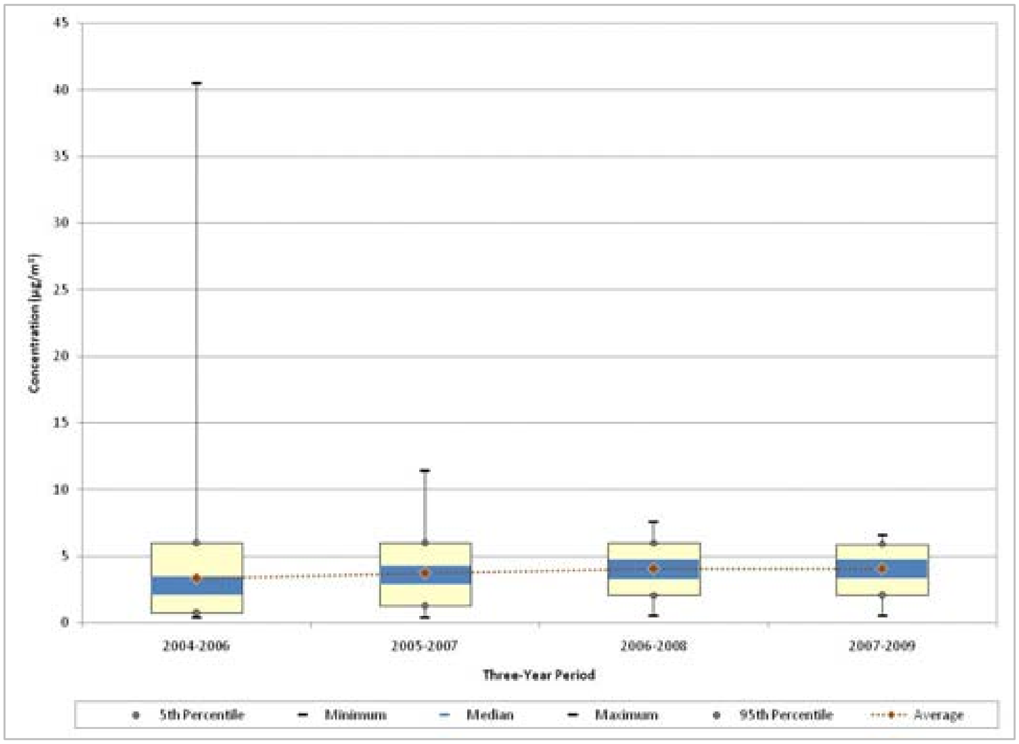
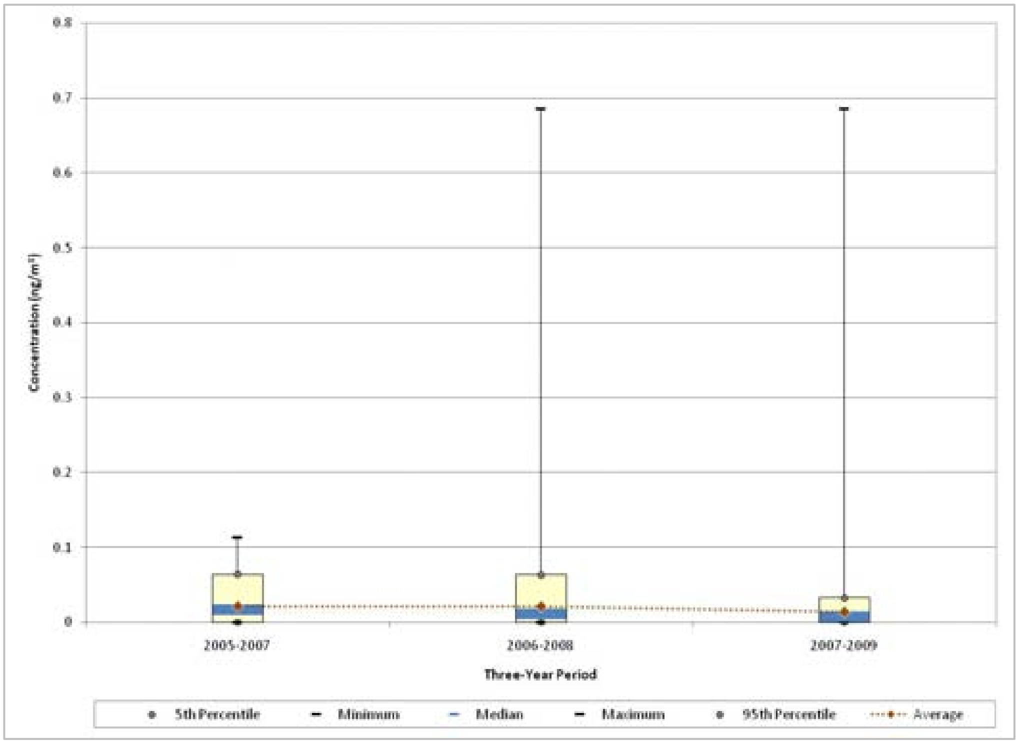


Figure 8-36. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at GPCO



Observations from Figure 8-33 for benzene measurements at GPCO include the following:

- The maximum benzene concentration was measured on December 11, 2004. The maximum concentrations measured in subsequent years were much lower until July 9, 2009, when a similar concentration was measured.

- The 5th and 95th percentiles and the median have decreased slightly over time. The rolling average decreased as well, but increased slightly during the final 3-year period, primarily as a result of the high concentration measured in 2009 (if this concentration was removed from consideration, the average would continue its slight decreasing trend).

- The minimum concentration was greater than zero for all 3-year time periods, indicating that there were no non-detects reported for benzene over the period of sampling.

Observations from Figure 8-34 for 1,3-butadiene measurements at GPCO include the following:

- Similar to benzene, the maximum 1,3-butadiene concentration was measured on December 11, 2004. The maximum concentrations measured in subsequent time periods were lower.

- The rolling average concentrations appear to have a slight decreasing trend; however, confidence intervals calculated from the individual concentrations show that this decrease is not statistically significant.

- In addition to the rolling average, the median and 95th percentile also exhibit a decreasing trend in concentrations.

- Conversely, the 5th percentile increased for 2006-2008 and 2007-2009 and the minimum concentration increased for 2007-2009. The number of non-detects decreased from approximately 30 percent in 2004 and 2005, to eight percent in 2006, and none in 2007, 2008, and 2009.

Observations from Figure 8-35 for formaldehyde measurements at GPCO include the following:

- The trends graph for formaldehyde resembles the graph for acetaldehyde in that the maximum formaldehyde concentration was measured in 2004. The three highest concentrations of formaldehyde were measured on the same days as the three highest acetaldehyde concentrations. The maximum concentrations in subsequent time periods were significantly lower.

- Unlike acetaldehyde, the rolling average formaldehyde concentrations (as well as several other statistical parameters) have a slight increasing trend.

- Although difficult to discern in Figure 8-35, the rolling average and median became more similar to each other over the periods shown. This indicates decreasing variability in the central tendency.

Observations from Figure 8-36 for hexavalent chromium measurements at GPCO include the following:

- The maximum hexavalent chromium concentration was measured on July 5, 2008 (0.685 ng/m^3). Only two measurements from GPCO are greater than 0.1 ng/m^3, with the other being measured on August 9, 2006 (0.113 ng/m^3), which is the maximum concentration shown for the 2005-2007 time period.

- The rolling average concentrations of hexavalent chromium exhibit a slight decreasing trend, although the confidence intervals calculated on the dataset are relatively wide due, at least in part, to the maximum concentrations. However, the median concentrations also show a decreasing trend, and this parameter is influenced less by outliers.

- Both the minimum concentration and 5th percentile for all three 3-year periods shown are zero, indicating the presence of non-detects. The percentage of non-detects has been increasing for each year of sampling at GPCO.

8.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Colorado monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

8.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Colorado monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Colorado monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

8.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Colorado monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk estimates approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 8-6, where applicable.

Table 8-6. Cancer and Noncancer Surrogate Risk Approximations for the Colorado Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/ Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/ Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Silt, Colorado - BRCO										
Acetaldehyde	0.0000022	0.009	31/4	0.83 ± 0.13	1.83	0.09	26/2	NA	NA	NA
Benzene	0.0000078	0.03	59/4	1.34 ± 0.46	10.46	0.04	57/4	1.39 ± 0.27	10.87	0.05
1,3-Butadiene	0.00003	0.002	3/0	NA	NA	NA	7/0	NA	NA	NA
Ethylbenzene	0.0000025	1	57/4	0.26 ± 0.14	0.65	<0.01	57/4	0.24 ± 0.05	0.61	<0.01
Formaldehyde	0.000013	0.0098	31/4	1.01 ± 0.14	13.09	0.10	26/2	NA	NA	NA
Grand Junction, Colorado - GPCO										
Acetaldehyde	0.0000022	0.009	61/4	2.49 ± 0.22	5.48	0.28	62/4	2.90 ± 0.22	6.37	0.32
Acrylonitrile	0.000068	0.002	3/0	NA	NA	NA	28/2	NA	NA	NA
Benzene	0.0000078	0.03	61/4	1.62 ± 0.22	12.62	0.05	59/4	1.94 ± 0.32	15.11	0.06
Benzo(a)pyrene[a]	0.001	--	26/2	NA	NA	--	46/3	<0.01 ± <0.01	0.34	--
1,3-Butadiene	0.00003	0.002	61/4	0.15 ± 0.03	4.37	0.07	59/4	0.16 ± 0.04	4.85	0.08
Carbon Tetrachloride	0.000006	0.1	61/4	0.65 ± 0.06	3.91	0.01	59/4	0.59 ± 0.05	3.56	0.01
Chloroform	--	0.098	59/4	0.10 ± 0.02	--	<0.01	58/4	0.12 ± 0.01	--	<0.01

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
NR = Not reportable because sampling was not conducted during this time period.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 8-5.

Table 8-6. Cancer and Noncancer Surrogate Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation Cancer (in-a-million)	Risk Approximation Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation Cancer (in-a-million)	Risk Approximation Noncancer (HQ)
Ethylbenzene	0.0000025	1	61/4	0.48 ± 0.07	1.19	<0.01	59/4	0.53 ± 0.10	1.33	<0.01
Formaldehyde	0.000013	0.0098	61/4	4.11 ± 0.29	53.37	0.42	62/4	4.02 ± 0.27	52.20	0.41
Hexavalent Chromium[a]	0.012	0.0001	40/4	<0.01 ± <0.01	0.24	0.00	25/1	NA	NA	NA
Naphthalene[a]	0.000034	0.003	45/3	0.11 ± 0.03	3.80	0.04	61/4	0.20 ± 0.03	6.75	0.07
Tetrachloroethylene	0.0000059	0.27	60/4	0.33 ± 0.07	1.94	0.00	59/4	0.43 ± 0.09	2.51	<0.01
Trichloroethylene	0.000002	0.6	17/1	NA	NA	NA	30/3	0.06 ± 0.02	0.12	<0.01
Vinyl Chloride	0.0000088	0.1	6/0	NA	NA	NA	12/0	NA	NA	NA
Brock Ranch, Rifle, Colorado - MOCO										
Acetaldehyde	0.0000022	0.009	27/1	NA	NA	NA	3/0	NA	NA	NA
Benzene	0.0000078	0.03	59/4	0.94 ± 0.11	7.30	0.03	7/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	1/0	NA	NA	NA	2/0	NA	NA	NA
Formaldehyde	0.000013	0.0098	27/1	NA	NA	NA	3/0	NA	NA	NA
Parachute, Colorado - PACO										
Acetaldehyde	0.0000022	0.009	29/2	NA	NA	NA	30/2	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 8-5.

Table 8-6. Cancer and Noncancer Surrogate Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE (μg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/ Valid Quarterly Averages	Annual Average (μg/m^3)	Risk Approximation		# of Measured Detections/ Valid Quarterly Averages	Annual Average (μg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Benzene	0.0000078	0.03	59/4	2.31 ± 0.44	18.00	0.08	58/4	2.70 ± 0.49	21.03	0.09
1,3-Butadiene	0.00003	0.002	31/2	NA	NA	NA	22/1	NA	NA	NA
Ethylbenzene	0.0000025	1	59/4	0.59 ± 0.13	1.47	<0.01	57/4	0.44 ± 0.08	1.11	<0.01
Formaldehyde	0.000013	0.0098	29/2	NA	NA	NA	30/2	NA	NA	NA
Rifle, Colorado - RICO										
Acetaldehyde	0.0000022	0.009	31/3	1.56 ± 0.21	3.42	0.17	29/3	1.40 ± 0.20	3.07	0.16
Benzene	0.0000078	0.03	60/4	1.69 ± 0.21	13.15	0.06	61/4	2.23 ± 0.36	17.36	0.07
1,3-Butadiene	0.00003	0.002	49/4	0.12 ± 0.03	3.59	0.06	46/4	0.11 ± 0.02	3.17	0.05
Ethylbenzene	0.0000025	1	60/4	0.48 ± 0.06	1.20	<0.01	61/4	0.56 ± 0.08	1.39	<0.01
Formaldehyde	0.000013	0.0098	31/3	1.89 ± 0.28	24.63	0.19	29/3	1.68 ± 0.20	21.88	0.17
Rulison, Colorado - RUCO										
Acetaldehyde	0.0000022	0.009	NR	NR	NR	NR	24/2	NA	NA	NA
Benzene	0.0000078	0.03	NR	NR	NR	NR	52/4	2.39 ± 0.37	18.62	0.08
1,3-Butadiene	0.00003	0.002	NR	NR	NR	NR	13/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
NR = Not reportable because sampling was not conducted during this time period.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 8-5.

Table 8-6. Cancer and Noncancer Surrogate Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation: Cancer (in-a-million)	Risk Approximation: Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation: Cancer (in-a-million)	Risk Approximation: Noncancer (HQ)
Ethylbenzene	0.0000025	1	NR	NR	NR	NR	53/4	0.38 ± 0.08	0.96	<0.01
Formaldehyde	0.000013	0.0098	NR	NR	NR	NR	24/2	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 8-5.

Observations for GPCO from Table 8-6 include the following:

- Formaldehyde, acetaldehyde, and benzene had the highest annual average concentrations for GPCO for each year.

- Formaldehyde also had the highest cancer risk approximations for each year (53.37 in-a-million for 2008 and 52.20 in-a-million for 2009). Benzene had the second highest cancer risk approximations for each year (12.62 in-a-million for 2008 and 15.11 in-a-million for 2009). While acetaldehyde had the third highest cancer risk approximations for 2008 (5.48 in-a-million), naphthalene had the third highest for 2009 (6.75 in-a-million).

- None of the pollutants of interest for GPCO had noncancer risk approximations greater than 1.0. For both years, formaldehyde had the highest noncancer risk approximation (0.42 for 2008 and 0.41 for 2009).

Observations for the Garfield County sites from Table 8-6 include the following:

- Annual averages, and thus cancer and noncancer surrogate risk approximations, could not be calculated for acetaldehyde and formaldehyde for MOCO, PACO, and RUCO. This is due to the 1-in-12 day sampling schedule for these pollutants. Where annual averages could be calculated for these pollutants (BRCO for 2008 and RICO for both years), formaldehyde had the highest cancer risk approximations among the pollutants of interest.

- For all sites except MOCO, benzene's cancer risk approximation was greater than 10 in-a-million, ranging from 10.46 in-a-million (BRCO, 2008) to 21.03 in-a-million (PACO, 2009). PACO's 2009 benzene cancer risk approximation was the second highest benzene cancer risk approximation compared to other NMP sites.

- None of the noncancer risk approximations calculated for the Garfield County sites were greater than 1.0.

8.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 8-7 and 8-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 8-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 8-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective monitoring site sampled. As discussed in Section 8.3, GPCO sampled for VOC, carbonyl compounds, PAH, and hexavalent chromium; the Garfield County sites sampled for SNMOC and carbonyl compounds only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Grand Junction, Colorado (Mesa County) - GPCO					
Benzene	162.40	Benzene	1.27E-03	Formaldehyde	53.37
Formaldehyde	93.35	Formaldehyde	1.17E-03	Formaldehyde	52.20
Acetaldehyde	31.45	1,3-Butadiene	6.44E-04	Benzene	15.11
1,3-Butadiene	21.46	Hexavalent Chromium, PM	2.94E-04	Benzene	12.62
Dichloromethane	9.74	POM, Group 2	2.43E-04	Naphthalene	6.75
Naphthalene	6.08	Arsenic, PM	2.08E-04	Acetaldehyde	6.37
POM, Group 2	4.43	Naphthalene	2.07E-04	Acetaldehyde	5.48
Tetrachloroethylene	2.79	Acetaldehyde	6.92E-05	1,3-Butadiene	4.85
Trichloroethylene	1.49	Acrylonitrile	5.94E-05	1,3-Butadiene	4.37
Vinyl chloride	1.19	POM, Group 5	3.10E-05	Carbon Tetrachloride	3.91
Silt, Colorado (Garfield County) - BRCO					
Benzene	348.74	Formaldehyde	3.23E-03	Formaldehyde	13.09
Formaldehyde	258.65	Benzene	2.72E-03	Benzene	10.87
Acetaldehyde	56.30	1,3-Butadiene	3.80E-04	Benzene	10.46
1,3-Butadiene	12.66	POM, Group 2	2.55E-04	Acetaldehyde	1.83
Naphthalene	6.06	Naphthalene	2.06E-04	Ethylbenzene	0.65
POM, Group 2	4.64	Acetaldehyde	1.24E-04	Ethylbenzene	0.61
Dichloromethane	4.21	POM, Group 5	3.42E-05		
Tetrachloroethylene	2.72	Arsenic, PM	2.00E-05		
Trichloroethylene	0.28	POM, Group 6	1.90E-05		
Vinyl chloride	0.25	Tetrachloroethylene	1.61E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Brock Ranch, Rifle, Colorado (Garfield County) - MOCO					
Benzene	348.74	Formaldehyde	3.23E-03	Benzene	7.30
Formaldehyde	258.65	Benzene	2.72E-03		
Acetaldehyde	56.30	1,3-Butadiene	3.80E-04		
1,3-Butadiene	12.66	POM, Group 2	2.55E-04		
Naphthalene	6.06	Naphthalene	2.06E-04		
POM, Group 2	4.64	Acetaldehyde	1.24E-04		
Dichloromethane	4.21	POM, Group 5	3.42E-05		
Tetrachloroethylene	2.72	Arsenic, PM	2.00E-05		
Trichloroethylene	0.28	POM, Group 6	1.90E-05		
Vinyl chloride	0.25	Tetrachloroethylene	1.61E-05		
Parachute, Colorado (Garfield County) - PACO					
Benzene	348.74	Formaldehyde	3.23E-03	Benzene	21.03
Formaldehyde	258.65	Benzene	2.72E-03	Benzene	18.00
Acetaldehyde	56.30	1,3-Butadiene	3.80E-04	Ethylbenzene	1.47
1,3-Butadiene	12.66	POM, Group 2	2.55E-04	Ethylbenzene	1.11
Naphthalene	6.06	Naphthalene	2.06E-04		
POM, Group 2	4.64	Acetaldehyde	1.24E-04		
Dichloromethane	4.21	POM, Group 5	3.42E-05		
Tetrachloroethylene	2.72	Arsenic, PM	2.00E-05		
Trichloroethylene	0.28	POM, Group 6	1.90E-05		
Vinyl chloride	0.25	Tetrachloroethylene	1.61E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Rifle, Colorado (Garfield County) - RICO					
Benzene	348.74	Formaldehyde	3.23E-03	Formaldehyde	24.63
Formaldehyde	258.65	Benzene	2.72E-03	Formaldehyde	21.88
Acetaldehyde	56.30	1,3-Butadiene	3.80E-04	Benzene	17.36
1,3-Butadiene	12.66	POM, Group 2	2.55E-04	Benzene	13.15
Naphthalene	6.06	Naphthalene	2.06E-04	1,3-Butadiene	3.59
POM, Group 2	4.64	Acetaldehyde	1.24E-04	Acetaldehyde	3.42
Dichloromethane	4.21	POM, Group 5	3.42E-05	1,3-Butadiene	3.17
Tetrachloroethylene	2.72	Arsenic, PM	2.00E-05	Acetaldehyde	3.07
Trichloroethylene	0.28	POM, Group 6	1.90E-05	Ethylbenzene	1.39
Vinyl chloride	0.25	Tetrachloroethylene	1.61E-05	Ethylbenzene	1.20
Rulison, Colorado (Garfield County) - RUCO					
Benzene	348.74	Formaldehyde	3.23E-03	Benzene	18.62
Formaldehyde	258.65	Benzene	2.72E-03	Ethylbenzene	0.96
Acetaldehyde	56.30	1,3-Butadiene	3.80E-04		
1,3-Butadiene	12.66	POM, Group 2	2.55E-04		
Naphthalene	6.06	Naphthalene	2.06E-04		
POM, Group 2	4.64	Acetaldehyde	1.24E-04		
Dichloromethane	4.21	POM, Group 5	3.42E-05		
Tetrachloroethylene	2.72	Arsenic, PM	2.00E-05		
Trichloroethylene	0.28	POM, Group 6	1.90E-05		
Vinyl chloride	0.25	Tetrachloroethylene	1.61E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Colorado 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Grand Junction, Colorado (Mesa County) - GPCO					
Toluene	422.53	Acrolein	394,843.90	Formaldehyde	0.42
Xylenes	250.16	1,3-Butadiene	10,730.31	Formaldehyde	0.41
Benzene	162.40	Formaldehyde	9,525.34	Acetaldehyde	0.32
Formaldehyde	93.35	Benzene	5,413.22	Acetaldehyde	0.28
Hexane	70.23	Manganese, PM	3,611.11	1,3-Butadiene	0.08
Ethylbenzene	57.58	Acetaldehyde	3,494.46	1,3-Butadiene	0.07
Methanol	54.74	Xylenes	2,501.56	Naphthalene	0.07
Acetaldehyde	31.45	Naphthalene	2,025.06	Benzene	0.06
Hydrofluoric acid	25.25	Arsenic, PM	1,612.39	Benzene	0.05
Styrene	23.36	Cyanide Compounds, gas	1,469.46	Naphthalene	0.04
Silt, Colorado (Garfield County) - BRCO					
Toluene	660.85	Acrolein	888,510.43	Formaldehyde	0.10
Xylenes	549.04	Formaldehyde	26,392.89	Acetaldehyde	0.09
Benzene	348.74	Benzene	11,624.62	Benzene	0.05
Formaldehyde	258.65	1,3-Butadiene	6,330.64	Benzene	0.04
Hexane	124.06	Acetaldehyde	6,255.11	Ethylbenzene	<0.01
Acetaldehyde	56.30	Xylenes	5,490.43	Ethylbenzene	<0.01
Ethylbenzene	53.03	Naphthalene	2,019.22		
Acrolein	17.77	Toluene	1,652.13		
Methanol	17.19	Hexane	620.29		
1,3-Butadiene	12.66	Cyanide Compounds, gas	553.52		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Colorado 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Brock Ranch, Rifle, Colorado (Garfield County) - MOCO					
Toluene	660.85	Acrolein	888,510.43	Benzene	0.03
Xylenes	549.04	Formaldehyde	26,392.89		
Benzene	348.74	Benzene	11,624.62		
Formaldehyde	258.65	1,3-Butadiene	6,330.64		
Hexane	124.06	Acetaldehyde	6,255.11		
Acetaldehyde	56.30	Xylenes	5,490.43		
Ethylbenzene	53.03	Naphthalene	2,019.22		
Acrolein	17.77	Toluene	1,652.13		
Methanol	17.19	Hexane	620.29		
1,3-Butadiene	12.66	Cyanide Compounds, gas	553.52		
Parachute, Colorado (Garfield County) - PACO					
Toluene	660.85	Acrolein	888,510.43	Benzene	0.09
Xylenes	549.04	Formaldehyde	26,392.89	Benzene	0.08
Benzene	348.74	Benzene	11,624.62	Ethylbenzene	<0.01
Formaldehyde	258.65	1,3-Butadiene	6,330.64	Ethylbenzene	<0.01
Hexane	124.06	Acetaldehyde	6,255.11		
Acetaldehyde	56.30	Xylenes	5,490.43		
Ethylbenzene	53.03	Naphthalene	2,019.22		
Acrolein	17.77	Toluene	1,652.13		
Methanol	17.19	Hexane	620.29		
1,3-Butadiene	12.66	Cyanide Compounds, gas	553.52		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 8-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Colorado 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Rifle, Colorado (Garfield County) - RICO					
Toluene	660.85	Acrolein	888,510.43	Formaldehyde	0.19
Xylenes	549.04	Formaldehyde	26,392.89	Acetaldehyde	0.17
Benzene	348.74	Benzene	11,624.62	Formaldehyde	0.17
Formaldehyde	258.65	1,3-Butadiene	6,330.64	Acetaldehyde	0.16
Hexane	124.06	Acetaldehyde	6,255.11	Benzene	0.07
Acetaldehyde	56.30	Xylenes	5,490.43	1,3-Butadiene	0.06
Ethylbenzene	53.03	Naphthalene	2,019.22	Benzene	0.06
Acrolein	17.77	Toluene	1,652.13	1,3-Butadiene	0.05
Methanol	17.19	Hexane	620.29	Ethylbenzene	<0.01
1,3-Butadiene	12.66	Cyanide Compounds, gas	553.52	Ethylbenzene	<0.01
Rulison, Colorado (Garfield County) - RUCO					
Toluene	660.85	Acrolein	888,510.43	Benzene	0.08
Xylenes	549.04	Formaldehyde	26,392.89	Ethylbenzene	<0.01
Benzene	348.74	Benzene	11,624.62		
Formaldehyde	258.65	1,3-Butadiene	6,330.64		
Hexane	124.06	Acetaldehyde	6,255.11		
Acetaldehyde	56.30	Xylenes	5,490.43		
Ethylbenzene	53.03	Naphthalene	2,019.22		
Acrolein	17.77	Toluene	1,652.13		
Methanol	17.19	Hexane	620.29		
1,3-Butadiene	12.66	Cyanide Compounds, gas	553.52		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 8-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in both Garfield and Mesa County, although the quantity emitted for each pollutant was roughly twice as high in Garfield County than Mesa County.

- In Garfield County, the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were formaldehyde, benzene, and 1,3-butadiene. In Mesa County, the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, formaldehyde, 1,3-butadiene.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions in Garfield County while six of the highest emitted pollutants also had the highest toxicity-weighted emissions in Mesa County.

- For GPCO, five of the six pollutants with the highest cancer risk approximations (across both years) also appear on both emissions-based lists for Mesa County. For the Garfield County sites, ethylbenzene is the only pollutant where cancer risk approximations could be calculated and that did not appear on the emissions-based lists for Garfield County.

- POM Group 2 was the seventh highest emitted "pollutant" in Mesa County and ranked fifth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at GPCO including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for GPCO.

- Benzo(a)pyrene is included in POM Group 5. While this pollutant was not detected frequently enough for annual averages to be calculated, and thus does not have cancer risk approximations, it should be noted that POM Group 5 ranked 10th highest for toxicity-weighted emissions in Mesa County.

- POM Groups 2, 5, and 6 appear on Garfield County's list of 10 highest toxicity-weighted emissions (only POM Group 2 appears among the highest emitted). PAH were not sampled at the Garfield County sites.

Observations from Table 8-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Mesa and Garfield County, although the emissions were higher in Garfield County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties was acrolein. Although acrolein was sampled for at GPCO, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Behind acrolein, formaldehyde, 1,3-butadiene, and benzene were among the top four for each county, although not necessarily in that order.

- Four of the highest emitted pollutants in Mesa County also had the highest toxicity-weighted emissions, while eight of the highest emitted pollutants in Garfield County (including acrolein) also had the highest toxicity-weighted emissions, which is a relatively high number of similar pollutants between these two emissions-based lists, compared to other counties with NMP sites.

- Formaldehyde, acetaldehyde, and benzene appear on all three lists for GPCO. Additionally, 1,3-butadiene and naphthalene appear on the noncancer risk approximation and toxicity-weighted lists, but neither pollutant is among the highest emitted in Mesa County.

- With the exception of ethylbenzene, all of the pollutants on the noncancer risk approximations lists for the Garfield County sites also appear on both emissions-based lists. Although ethylbenzene is one of the highest emitted pollutants in Garfield County, it is not among the most toxic.

8.6 Summary of the 2008-2009 Monitoring Data for the Sites in Colorado

Results from several of the treatments described in this section include the following:

- ❖ *Sixteen pollutants failed at least one screen for GPCO, while the number of pollutants failing screens for the Garfield County sites ranged from five to six.*

- ❖ *Of the site-specific pollutants of interest, formaldehyde had the highest daily average concentration for GPCO (both years), MOCO (2008), and RICO (2008). Benzene had the highest daily average concentration for BRCO (both years), MOCO (2009), PACO (both years), RICO (2009) and RUCO (2009).*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

9.0 Site in the District of Columbia

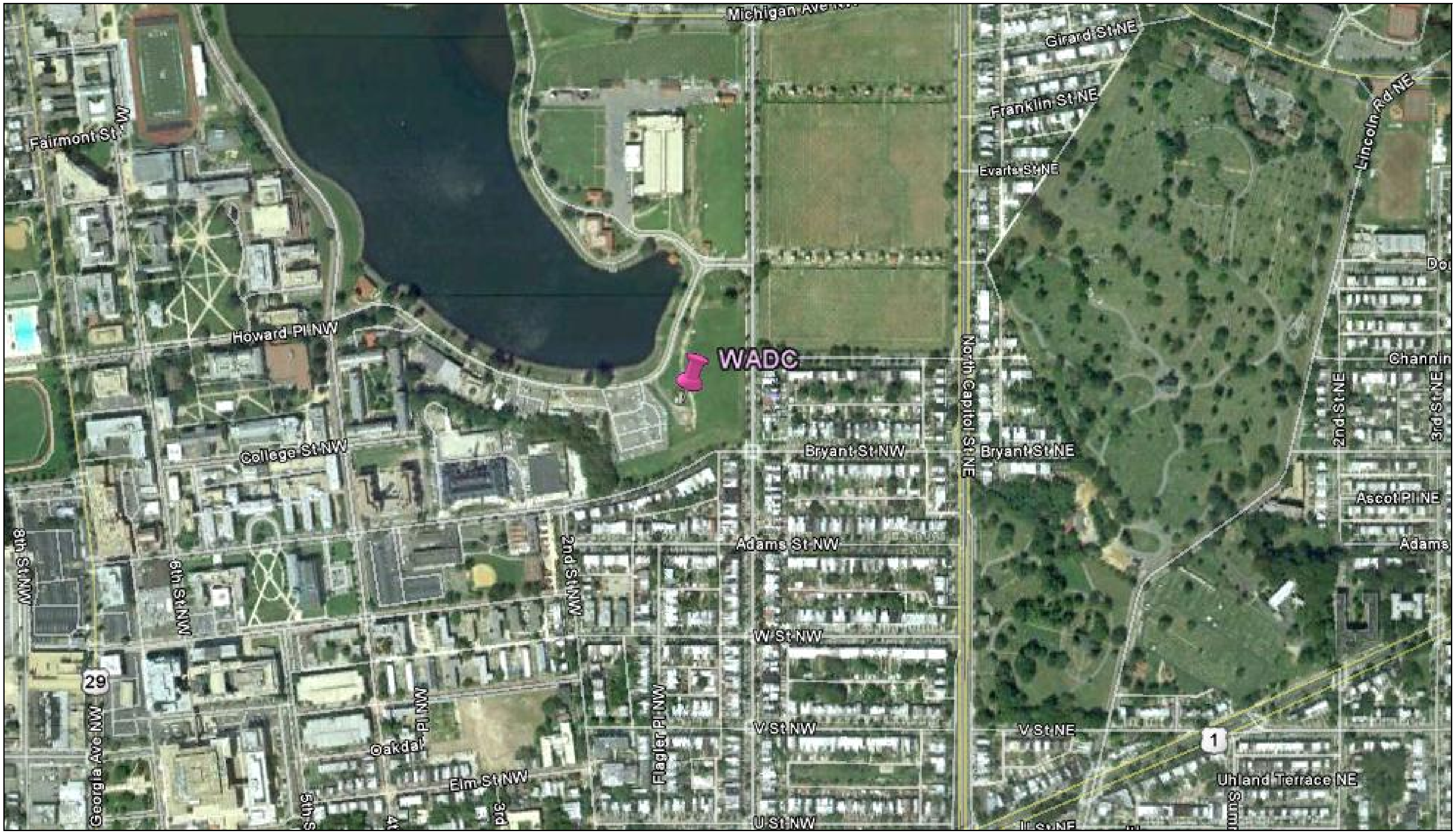
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Washington, D.C., and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

9.1 Site Characterization

This section characterizes the Washington, D.C. monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

Figure 9-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 9-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 9-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 9-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 9-1. Washington, D.C. (WADC) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 1,719 feet

Figure 9-2. NEI Point Sources Located Within 10 Miles of WADC

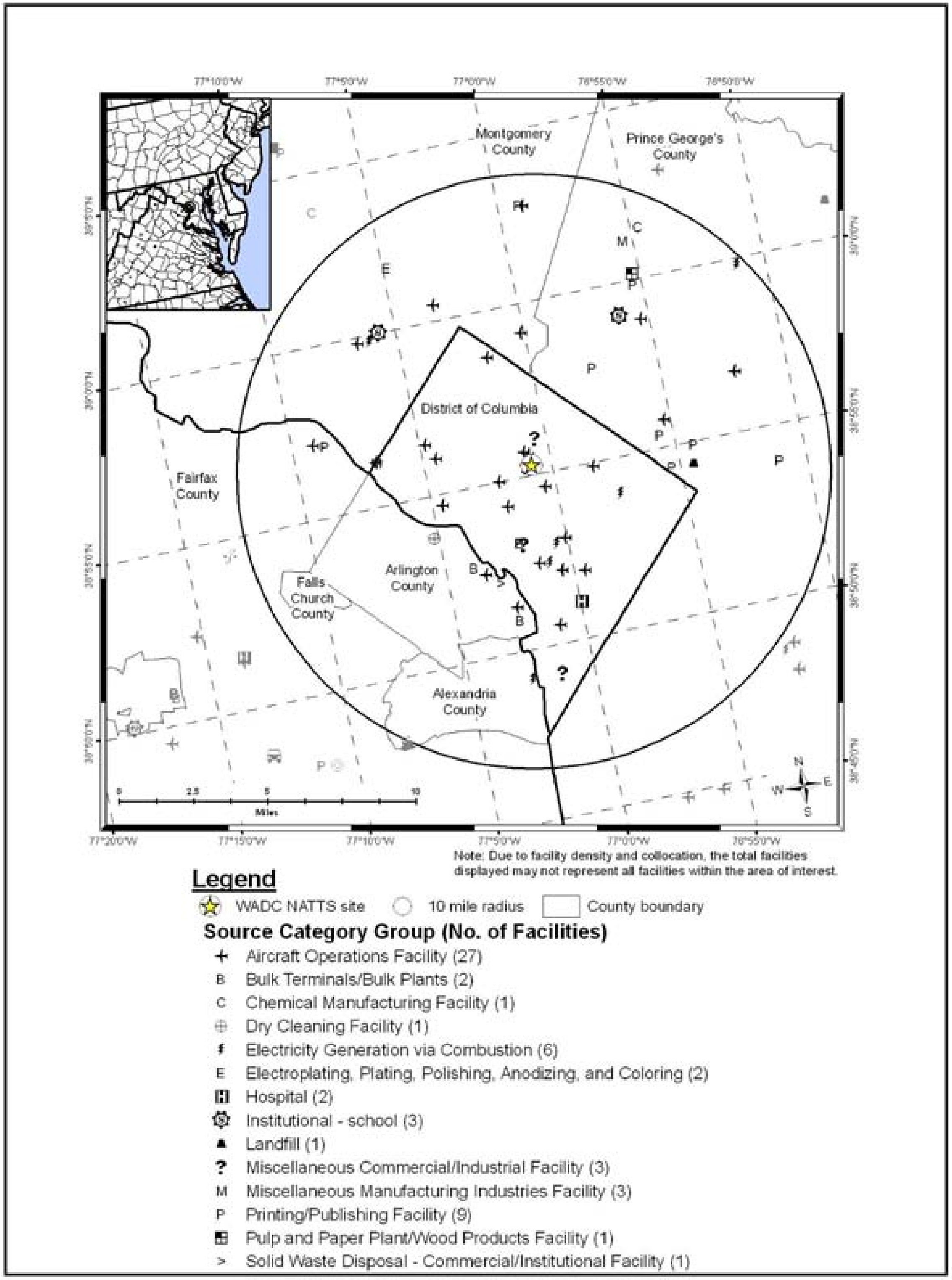

77°10'0"W
77°5'0"W
77°0'0"W
76°55'0"W
76°50'0"W
39°5'0"N
39°0'0"N
38°55'0"N
38°50'0"N
38°45'0"N
Montgomery County
Prince George's County
District of Columbia
Fairfax County
Arlington County
Falls Church County
Alexandria County
0
2.5
5
10
Miles
N
E
S
W
77°20'0"W
77°15'0"W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
☆ WADC NATTS site
○ 10 mile radius
☐ County boundary
Source Category Group (No. of Facilities)
+ Aircraft Operations Facility (27)
B Bulk Terminals/Bulk Plants (2)
C Chemical Manufacturing Facility (1)
⊕ Dry Cleaning Facility (1)
f Electricity Generation via Combustion (6)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (2)
H Hospital (2)
Institutional - school (3)
▲ Landfill (1)
? Miscellaneous Commercial/Industrial Facility (3)
M Miscellaneous Manufacturing Industries Facility (3)
P Printing/Publishing Facility (9)
Pulp and Paper Plant/Wood Products Facility (1)
> Solid Waste Disposal - Commercial/Institutional Facility (1)

Table 9-1. Geographical Information for the Washington, D.C. Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
WADC	11-001-0043	Washington, D.C.	District Of Columbia	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	38.921847, -77.013178	Commercial	Urban/City Center	Arsenic, CO, VOC, SO_2, NOy, NO, NO_2, NOx, PAMS, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, PM_{10} Speciation, Black carbon, PM Coarse, $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

Figure 9-1 shows that the WADC monitoring site 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 located in a commercial area, and is surrounded by a hospital, a cemetery, and a university. As Figure 9-2 shows, WADC is surrounded by relatively few point sources, most of which are in the aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads. Aside from aircraft operations, printing and publishing and electricity generation via combustion are the most numerous source categories within 10 miles of the WADC monitoring site. The two closest sources to WADC are not visible in Figure 9-2 because the symbol for the site is covering them; they are Howard University and D.C. General Hospital.

Table 9-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Washington, D.C. monitoring site. Information provided in Table 9-2 represents the most recent year of sampling (2009), unless otherwise indicated. District-level vehicle registration and population data were obtained from the Federal Highway Administration (FHWA, 2009a) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 9-2 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 estimate of 10-mile vehicle registration was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 9-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 9-2 presents the daily VMT for the Washington, D.C. urban area.

Table 9-2. Population, Motor Vehicle, and Traffic Information for the Washington, D.C. Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
WADC	599,657	171,255	0.29	1,860,974	531,472	7,600	98,704

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2008 data from the Federal Highway Administration (FHWA, 2009a).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2008 data from the District DOT (DC DOT, 2008).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 9-2 include the following:

- Washington, D.C.'s population was in the middle of the range compared to all counties with NMP sites. However, its 10-mile population was among the highest.
- The District-level vehicle registration was in the bottom third compared to all counties with NMP sites, while its 10-mile ownership was in the middle of the range.
- The vehicle-per-person ratio was the third lowest among NMP sites, behind only BXNY and PRRI.
- The traffic volume experienced near WADC is in the bottom third compared to other NMP monitoring sites. The traffic estimate used came from the intersection of Bryant Street and First Street.
- The District area VMT ranked in the top third among urban areas with NMP sites.

9.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Washington, D.C. on sample days, as well as over the course of each year.

9.2.1 Climate Summary

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. Precipitation is evenly distributed across the seasons (Bair, 1992).

9.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to WADC is located at Ronald Reagan Washington National Airport (WBAN 13743). Additional information about the Ronald Reagan Washington National Airport weather station is provided in Table 9-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 9-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 9-3 is the 95 percent confidence interval for each parameter. As shown in Table 9-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout the year for both years.

9.2.3 Back Trajectory Analysis

Figure 9-3 and Figure 9-4 are the composite back trajectory maps for days on which samples were collected at the WADC monitoring site in 2008 and 2009, respectively. Figure 9-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 9-3 through 9-5 represents 100 miles.

Table 9-3. Average Meteorological Conditions near the Washington, D.C. Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Washington, D.C. - WADC										
Ronald Reagan Washington National Airport 13743 (38.87, -77.03)	4.06 miles 183° (S)	2008	Sample Day	67.0 ± 4.5	59.7 ± 4.2	45.2 ± 4.5	52.4 ± 3.8	61.7 ± 3.4	1017.0 ± 2.0	6.8 ± 0.7
			All Year	67.0 ± 1.8	59.0 ± 1.7	44.1 ± 1.8	51.6 ± 1.5	60.6 ± 1.4	1017.6 ± 0.8	7.1 ± 0.3
		2009	Sample Day	66.2 ± 4.5	58.2 ± 4.2	44.7 ± 4.4	51.5 ± 3.8	63.7 ± 3.3	1015.6 ± 2.0	7.0 ± 0.8
			All Year	64.7 ± 1.8	57.0 ± 1.7	43.6 ± 1.9	50.5 ± 1.6	63.7 ± 1.5	1017.5 ± 0.7	7.1 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Figure 9-3. 2008 Composite Back Trajectory Map for WADC

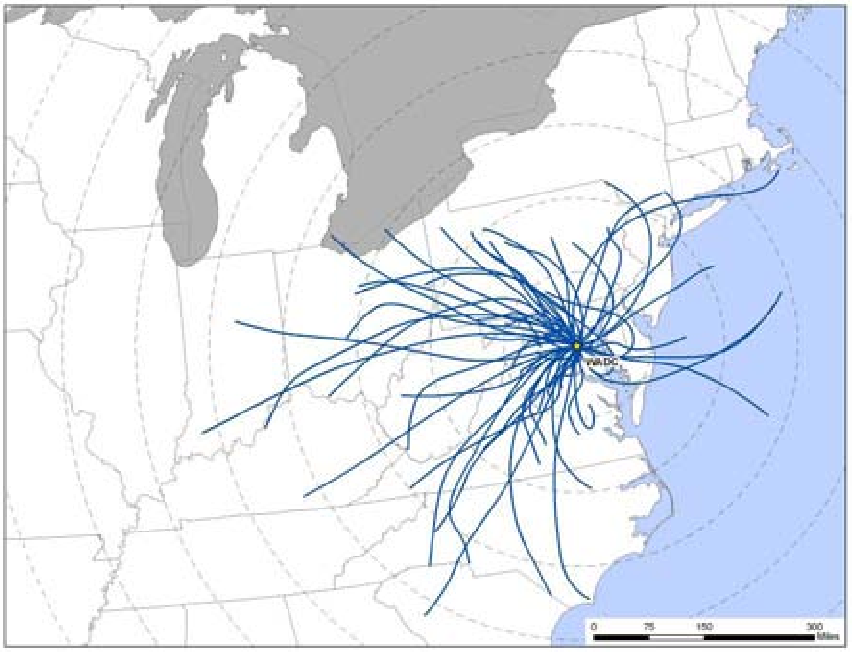


Figure 9-4. 2009 Composite Back Trajectory Map for WADC

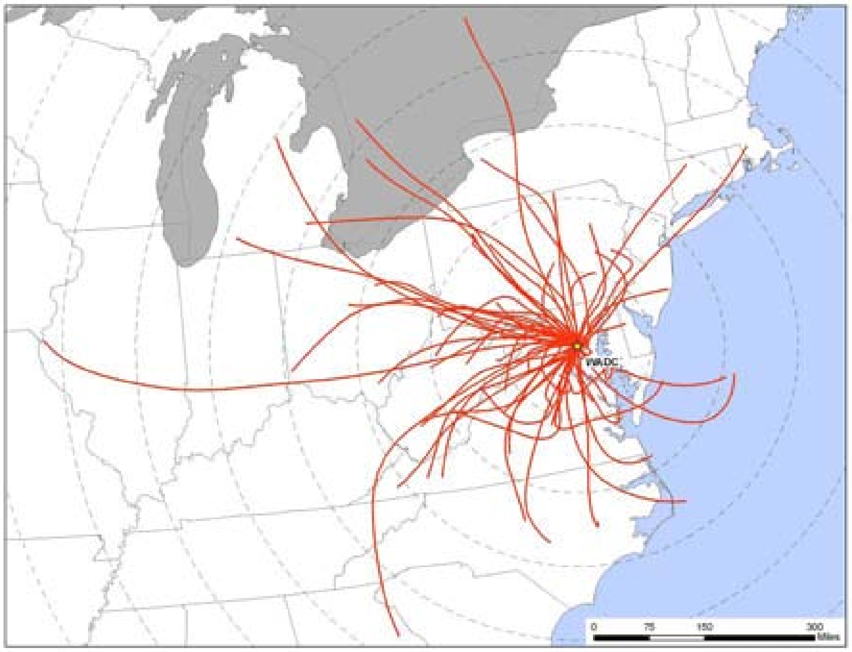
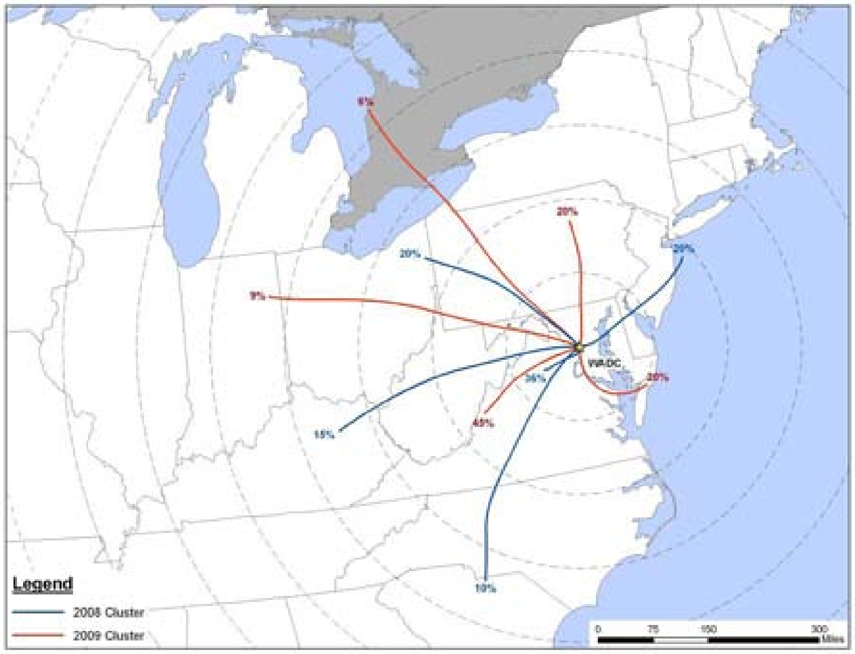


Figure 9-5. Back Trajectory Cluster Map for WADC



Observations from Figures 9-3 through 9-5 include the following:

- Back trajectories originated from a variety of directions at WADC. Figure 9-3 for 2008 shows that few trajectories originated from the southeast and south, while Figure 9-4 for 2009 shows that few trajectories originated from the east.

- The 24-hour air shed domain for WADC was comparable in size to many other NMP monitoring sites. The farthest away a trajectory originated was southeast Iowa, or approximately 725 miles away. However, the average trajectory length was 215 miles and 90 percent of back trajectories originated within 400 miles of the site.

- Cluster analysis for 2008 shows that 36 percent of trajectories originated within 100 to 150 miles of the site and generally to the west. Another 45 percent of trajectories originated to the southwest to northwest but farther from the site. Trajectories generally originating from the northeast to east were also common. The cluster analysis for 2009 also shows that trajectories originating from the southwest to northwest were common. More trajectories originated to the southeast and over the Chesapeake Bay in 2009 than 2008.

9.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at Ronald Reagan Washington National Airport were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

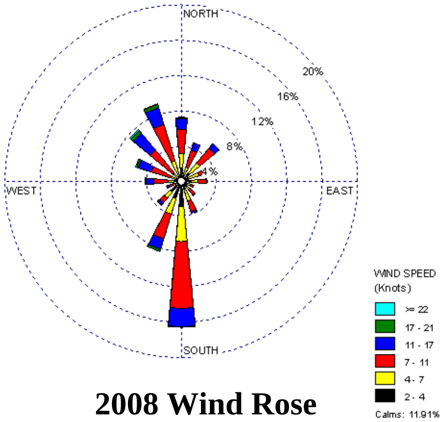
Figure 9-6 presents five different wind roses for the WADC monitoring site. First, a historical wind rose representing 1999 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Observations from Figure 9-6 for WADC include the following:

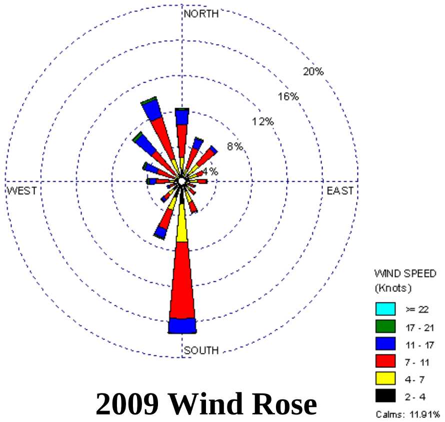
- Historically, southerly to south-southwesterly winds account for approximately 25 percent of wind observations near WADC, followed by northwesterly to northerly winds (23 percent). Calm winds (≤ 2 knots) were observed for approximately 10 percent of the hourly measurements.

- Both the 2008 and 2009 full-year wind patterns are similar to the wind patterns shown on the historical wind rose, indicating that these years were similar to what is expected climatologically near this site. Further, the sample day wind patterns for both years are similar to the full-year and historical wind patterns. This indicates that conditions on sample days were representative of conditions experienced throughout the year.

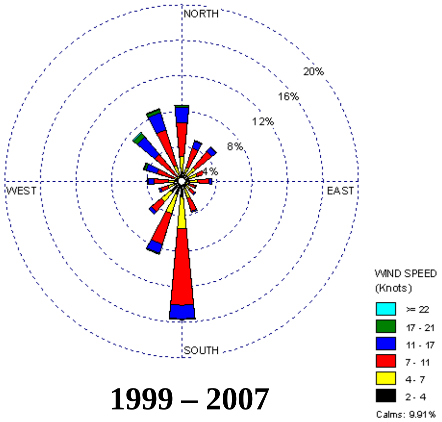
Figure 9-6. Wind Roses for the Ronald Reagan Washington National Airport Weather Station near WADC



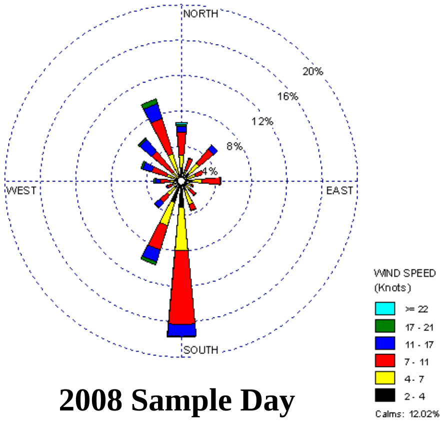
2008 Wind Rose



2009 Wind Rose

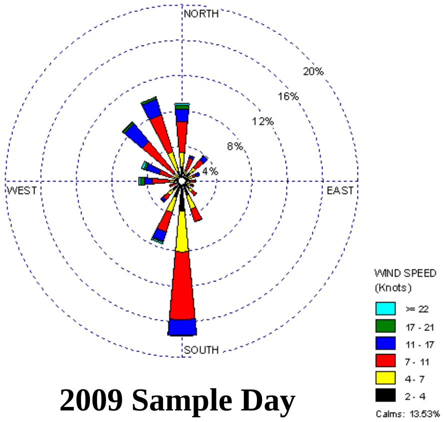


1999 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

9.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Washington, D.C. monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 9-4 presents WADC’s pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the WADC monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. WADC sampled for hexavalent chromium and PAH.

Table 9-4. Risk Screening Results for the Washington, D.C. Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Washington, D.C. - WADC						
Naphthalene	0.029	83	86	96.51	100.00	100.00
Total		83	86	96.51		

Observations from Table 9-4 include the following:

- Naphthalene was the only pollutant to fail screens for WADC. Almost 97 percent of measured detections of naphthalene (83 out of 86) failed screens.

- Benzo(a)pyrene and hexavalent chromium were added as pollutants of interest for WADC because they are the other NATTS MQO Core Analytes measured by this site. These two pollutants are not shown in Table 9-4.

9.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Washington, D.C. monitoring site. Concentration averages are provided for the pollutants of interest for the WADC monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

9.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual averages were calculated for the pollutants of interest for WADC, as described in Section 3.1.1. The *daily* average of a particular pollutant is simply the average concentration of all measured detections within a given year. If there were at least seven measured detections within a given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 9-5, where applicable. The averages presented in Table 9-5 are shown in ng/m^3 for ease of viewing.

Observations for WADC from Table 9-5 include the following:

- Sampling for PAH did not begin until the end of June 2008, which is why naphthalene and benzo(a)pyrene do not have first and second quarter averages (and thus annual averages) for 2008.

- The daily average concentrations of naphthalene for both 2008 and 2009 were significantly higher than the daily average concentrations of benzo(a)pyrene and hexavalent chromium. The 2009 daily average naphthalene concentration appears somewhat higher than the 2008 daily average, although the difference is not statistically significant.

- The 2009 daily average concentration of naphthalene ranked 10th highest among sites sampling this pollutant (the 2008 daily average concentration ranked 26th), as shown in Table 4-11.

Table 9-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Washington, D.C. Monitoring Site

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Washington, D.C. - WADC												
Benzo(a)pyrene	0.09 ± 0.03	NR	NA	NA	0.09 ± 0.03	NA	0.11 ± 0.04	0.17 ± 0.10	0.04 ± 0.02	NA	0.07 ± 0.03	0.07 ± 0.03
Hexavalent Chromium	0.01 ± 0.01	0.01 ± 0.01	0.01 ± <0.01	0.01 ± 0.01	NA	0.01 ± <0.01	0.02 ± 0.01	NA	NA	NA	NA	NA
Naphthalene	101.11 ± 17.09	NR	NA	93.56 ± 32.59	108.36 ± 20.36	NA	128.63 ± 24.29	97.89 ± 34.06	134.44 ± 44.34	105.38 ± 22.37	182.19 ± 80.95	128.63 ± 24.29

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not reportable because sampling was not conducted during this time period.

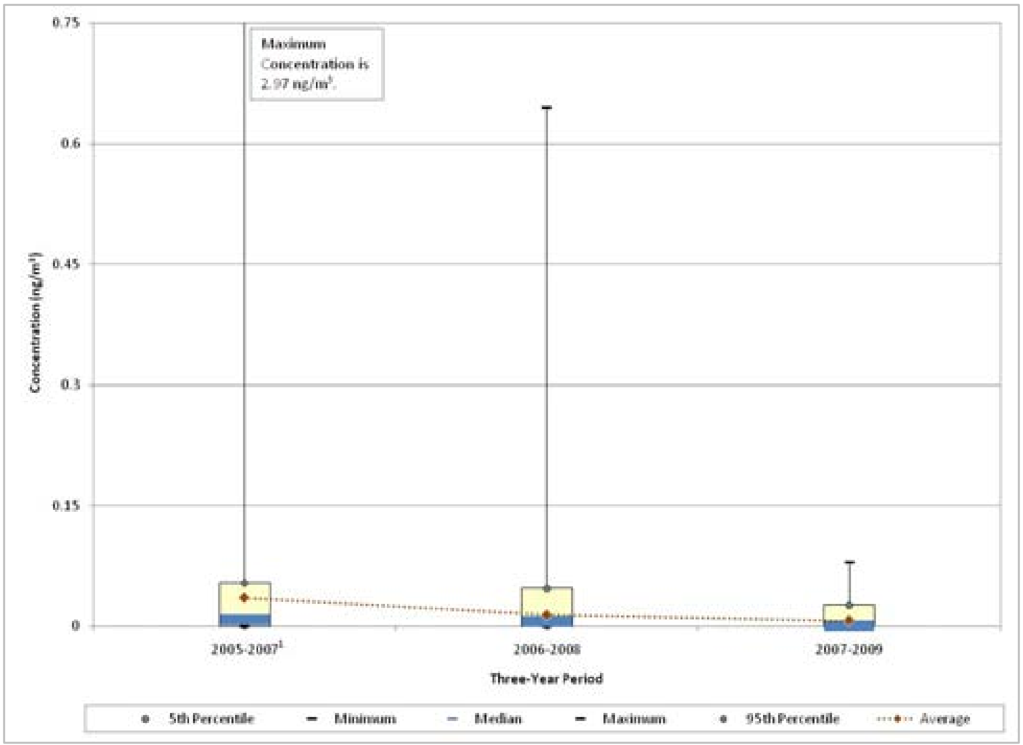
9.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. WADC has sampled hexavalent chromium under the NMP since 2005. Thus, Figure 9-7 presents the 3-year rolling statistical metrics for hexavalent chromium for WADC. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Observations from Figure 9-7 for hexavalent chromium measurements at WADC include the following:

- Sampling for hexavalent chromium began in March 2005.
- The maximum hexavalent chromium concentration was measured on August 20, 2005 (2.97 ng/m^3), and is an order of magnitude higher than the next highest measurement (0.645 ng/m^3 measured on July 4, 2006). This is also the highest hexavalent chromium measured at any site since the onset of sampling for this pollutant. Even the second-highest measurement for WADC is an order of magnitude higher than most other concentrations measured at this site (all but three measurements are less than 0.1 ng/m^3).
- Because of the magnitude of these maximum concentrations, it is difficult to determine if the decrease shown in the rolling average concentrations is attributable to an actual decrease in concentrations or just the shifting of the data to a 3-year period without one of these high values. However, the median and 95th percentile also exhibit a decreasing trend. These parameters are influenced less by outliers.
- The confidence interval calculated for the 2007-2009 period is much narrower, indicating much less variability in the concentrations measured. A decreasing trend may be verified with additional years of sampling.

Figure 9-7. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at WADC



[1]Hexavalent chromium sampling at WADC began in March 2005.

9.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the WADC monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

9.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Washington, D.C monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the WADC monitoring site were higher than their respective MRL noncancer health risk benchmarks.

9.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for WADC and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for calculating annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 9-6, where applicable.

Observations for WADC from Table 9-6 include the following:

- Annual averages for 2008 (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for the PAH pollutants of interest because sampling did not begin until June 2008 (and less than three quarterly averages are available).

- Naphthalene’s cancer risk approximation for 2009 was greater than 1.0 in-a-million (4.37 in-a-million), while its noncancer risk approximation was well below an HQ greater than 1.0 (0.04). Benzo(a)pyrene’s cancer risk approximation for 2009 was much less than napthalene’s (0.07 in-a-million). A noncancer RfC is not available for benzo(a)pyrene, thus a noncancer risk approximation could not be calculated.

- The cancer surrogate risk approximation based on hexavalent chromium’s 2008 annual average concentration was well below 1.0 in-a-million (0.09 in-a-million). The noncancer surrogate risk approximation was also low (<0.01). A 2009 annual average (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for hexavalent chromium because this pollutant was not detected enough for at least three quarterly averages to be calculated.

Table 9-6. Cancer and Noncancer Surrogate Risk Approximations for the Washington, D.C. Monitoring Site

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE ($\mu g/m^3$)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/ Valid Quarterly Averages**	**Annual Average (ng/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/ Valid Quarterly Averages**	**Annual Average (ng/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Washington, D.C. - WADC										
Benzo(a)pyrene	0.001	--	16/1	NA	NA	--	37/3	0.07 ± 0.03	0.07	--
Hexavalent Chromium	0.012	0.0001	30/3	0.01 ± <0.01	0.09	<0.01	17/0	NA	NA	NA
Naphthalene	0.000034	0.003	28/2	NA	NA	NA	58/4	128.63 ± 24.29	4.37	0.04

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

9.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 9-7 and 9-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 9-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 9-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 9.3, WADC sampled for PAH and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 9-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Washington, D.C. Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Washington, D.C. – WADC					
Benzene	193.46	Formaldehyde	1.61E-03	Naphthalene	4.37
Formaldehyde	128.72	Benzene	1.51E-03	Hexavalent Chromium	0.09
Acetaldehyde	49.87	1,3-Butadiene	9.74E-04	Benzo(a)pyrene	0.07
Tetrachloroethylene	35.16	Naphthalene	3.99E-04		
1,3-Butadiene	32.46	Tetrachloroethylene	2.07E-04		
Trichloroethylene	16.03	Arsenic, PM	1.48E-04		
p-Dichlorobenzene	12.18	Hexavalent Chromium, PM	1.40E-04		
Naphthalene	11.75	*p*-Dichlorobenzene	1.34E-04		
Dichloromethane	8.85	Acetaldehyde	1.10E-04		
POM, Group 2	1.41	POM, Group 2	7.76E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 9-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Washington, D.C. Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Washington, D.C. - WADC					
Toluene	496.56	Acrolein	378,797.19	Naphthalene	0.04
Methyl *tert*-butyl ether	419.68	1,3-Butadiene	16,228.69	Hexavalent Chromium	<0.01
Xylenes	337.55	Formaldehyde	13,134.79		
Methanol	198.99	Cyanide Compounds, gas	7,313.33		
Benzene	193.46	Benzene	6,448.63		
Formaldehyde	128.72	Acetaldehyde	5,541.47		
Ethylbenzene	75.59	Naphthalene	3,915.55		
Hexane	68.97	Xylenes	3,375.48		
1,1,1-Trichloroethane	60.44	Chlorine	2,655.00		
Acetaldehyde	49.87	Toluene	1,241.41		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 9-7 include the following:

- Benzene and formaldehyde were the highest emitted pollutants with cancer UREs in the District of Columbia. Formaldehyde and benzene were the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs).

- Eight of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Naphthalene was the only pollutant sampled for at WADC that appears on both emissions-based lists. Naphthalene was the eighth highest emitted pollutant with a cancer URE in the District of Columbia and had the fourth highest toxicity-weighted emissions (of the pollutants with cancer UREs). While hexavalent chromium was not one of the 10 highest emitted pollutants in the District, its toxicity-weighted emissions ranked seventh highest (of the pollutants with cancer UREs).

- POM Group 2 was both the tenth highest emitted "pollutant" in the District and ranked tenth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at WADC including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for WADC.

Observations from Table 9-8 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in the District of Columbia.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.

- Five of the highest emitted pollutants in the District of Columbia also had the highest toxicity-weighted emissions.

- Naphthalene was the only pollutant sampled for at WADC that also appeared on either emissions-based list. Naphthalene had the seventh highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) but was not one of the 10 highest emitted pollutants.

9.6 Summary of the 2008-2009 Monitoring Data for WADC

Results from several of the treatments described in this section include the following:

❖ *Naphthalene was the only pollutant to fail screens for WADC. However, hexavalent chromium and benzo(a)pyrene were added to WADC's pollutants of interest because they are NATTS MQO Core Analytes.*

- *Of the site-specific pollutants of the interest, naphthalene had the highest daily average concentrations for WADC.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

10.0 Sites in Florida

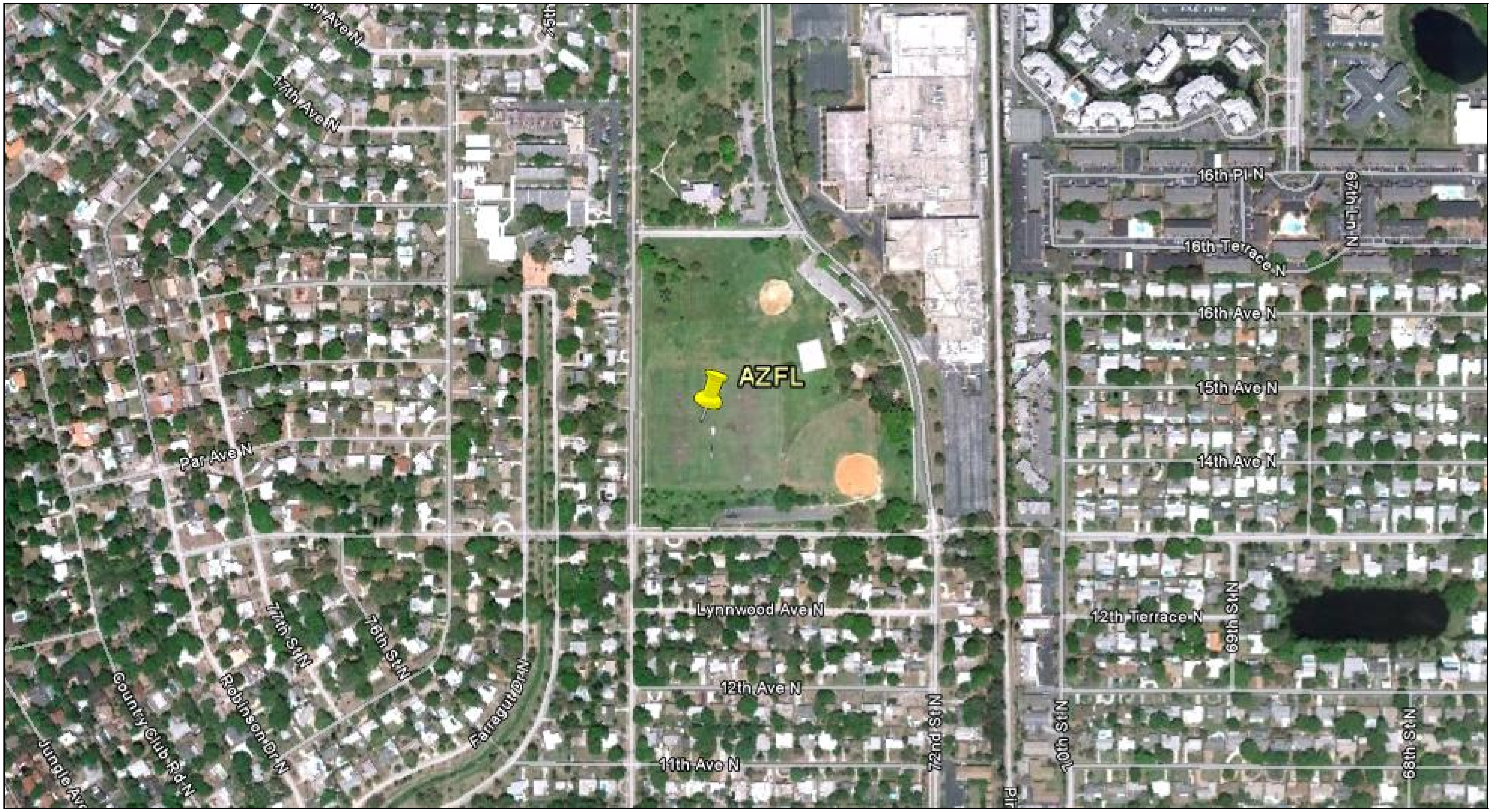
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Florida, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

10.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

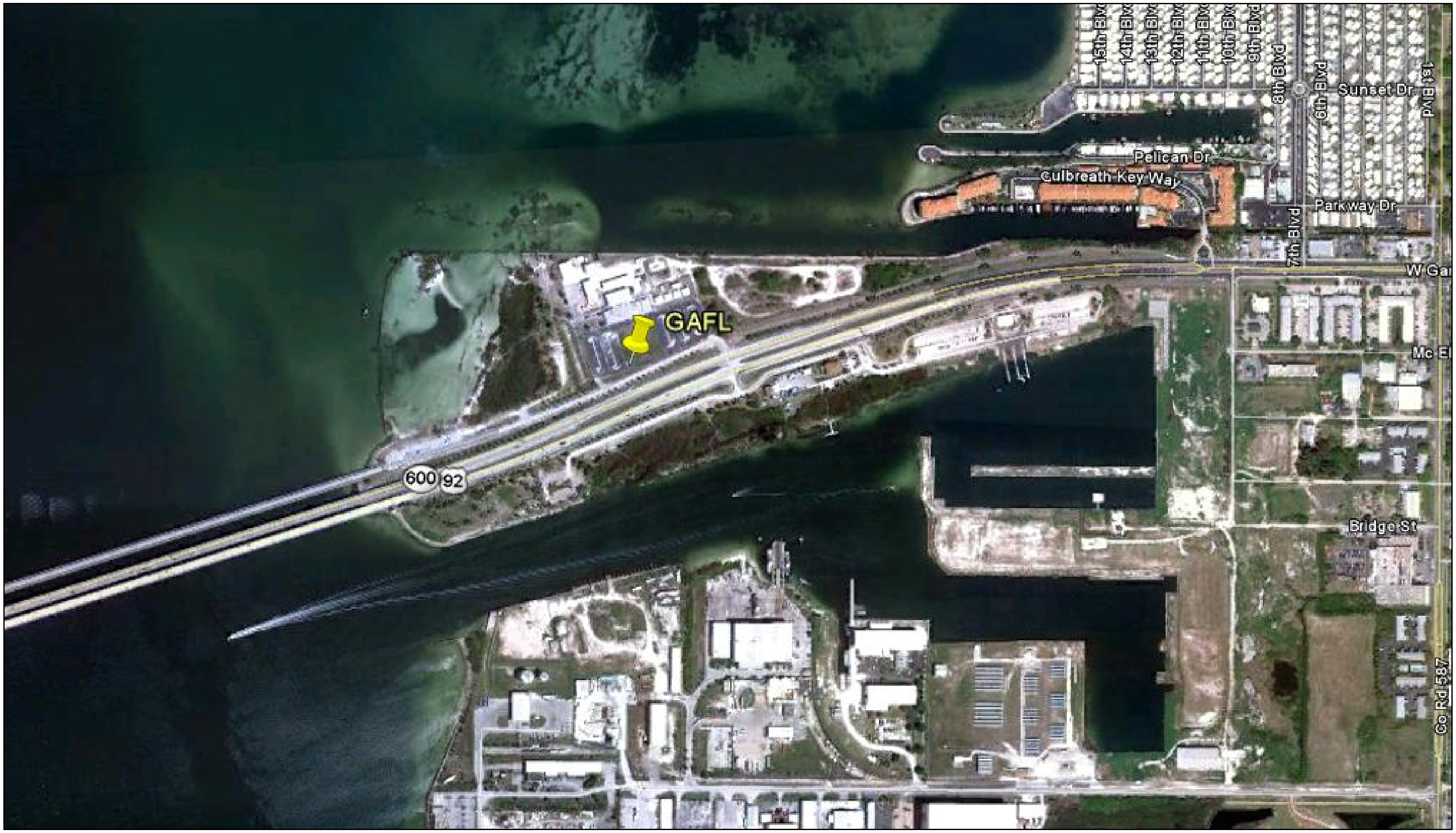
The Florida sites are located in several different urban areas. Sites located in the Tampa-St. Petersburg-Clearwater, FL MSA include AZFL, GAFL, SKFL, and SYFL. CCFL and FLFL are located in the Miami-Fort Lauderdale-Pompano Beach, FL MSA. ORFL and PAFL are located in the Orlando-Kissimmee, FL MSA. Figures 10-1 through 10-8 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban and rural locations. Figures 10-9 through 10-11 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 10-9 through 10-11. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 10-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 10-1. St. Petersburg, Florida (AZFL) Monitoring Site



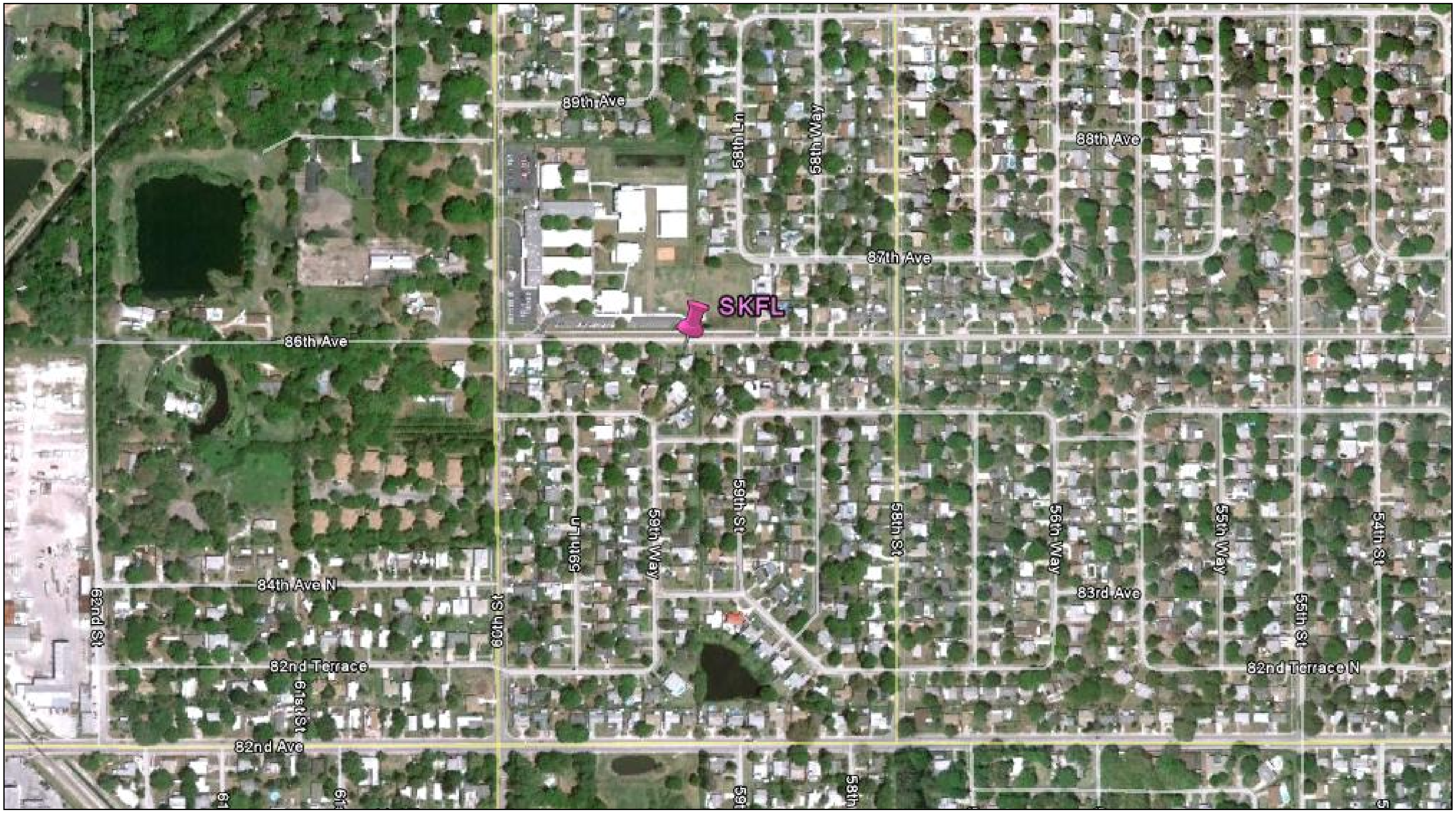
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,419 feet

Figure 10-2. Tampa, Florida (GAFL) Monitoring Site



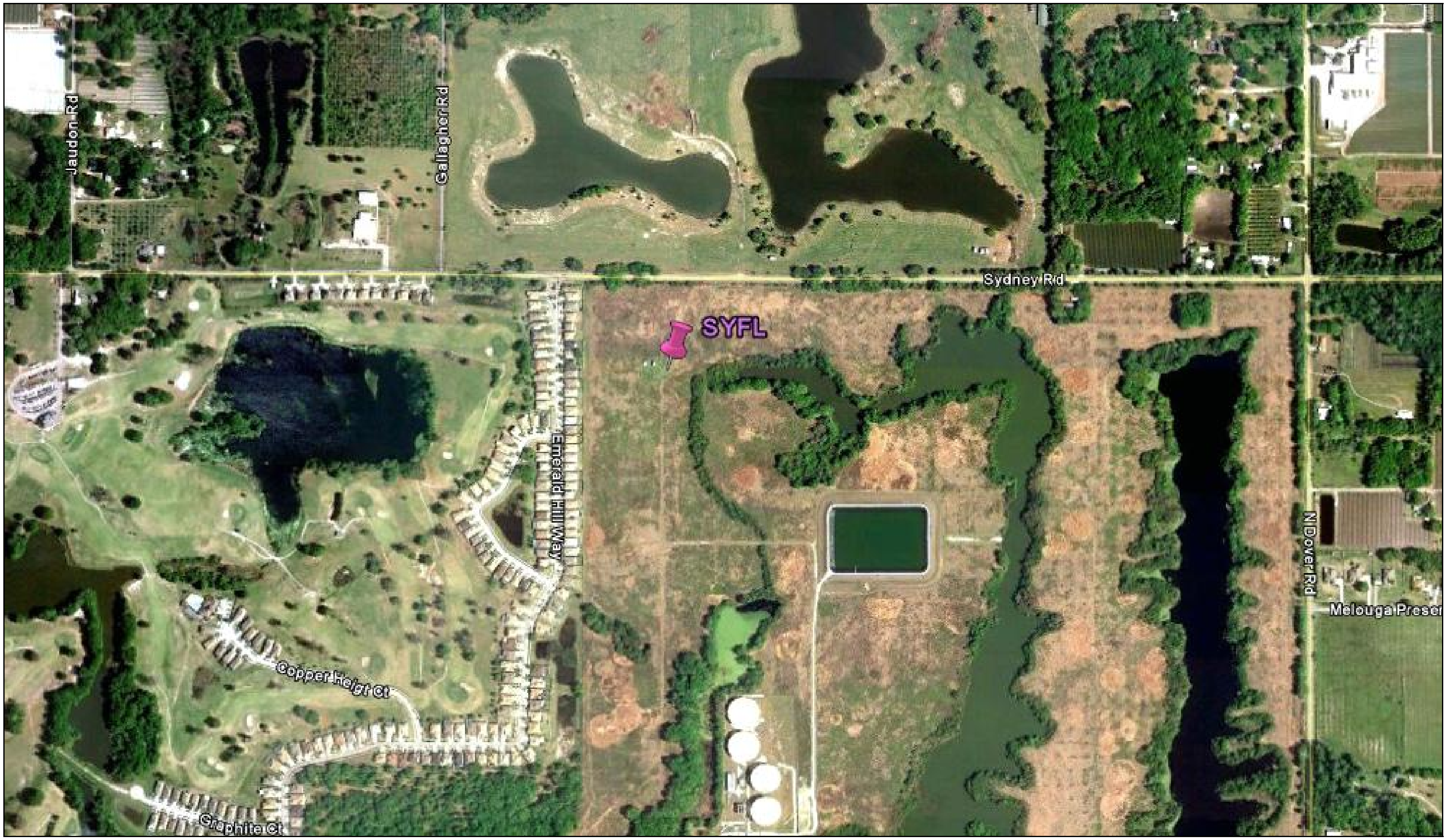
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,870 feet

Figure 10-3. Pinellas Park, Florida (SKFL) Monitoring Site



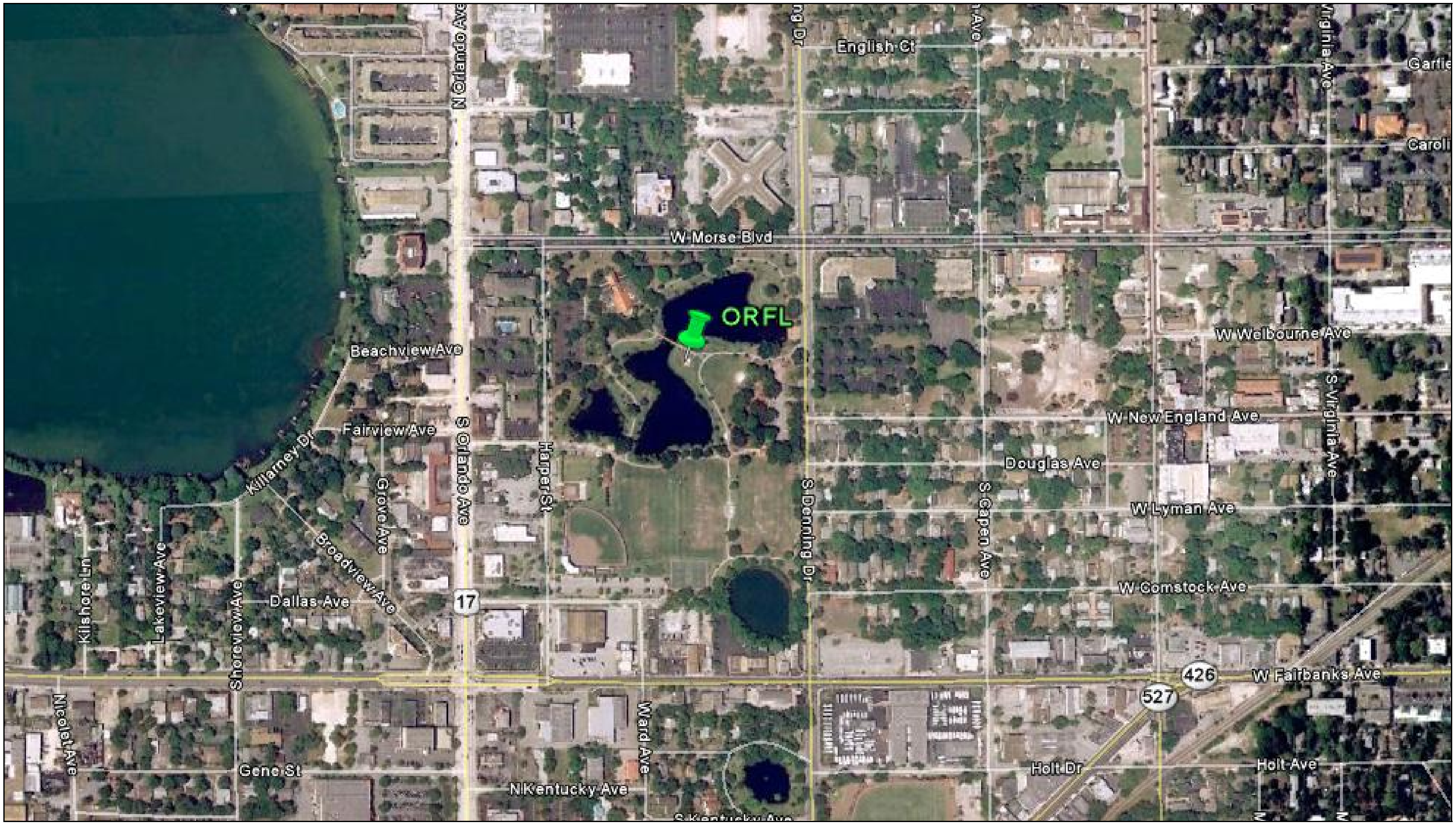
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,309 feet

Figure 10-4. Plant City, Florida (SYFL) Monitoring Site



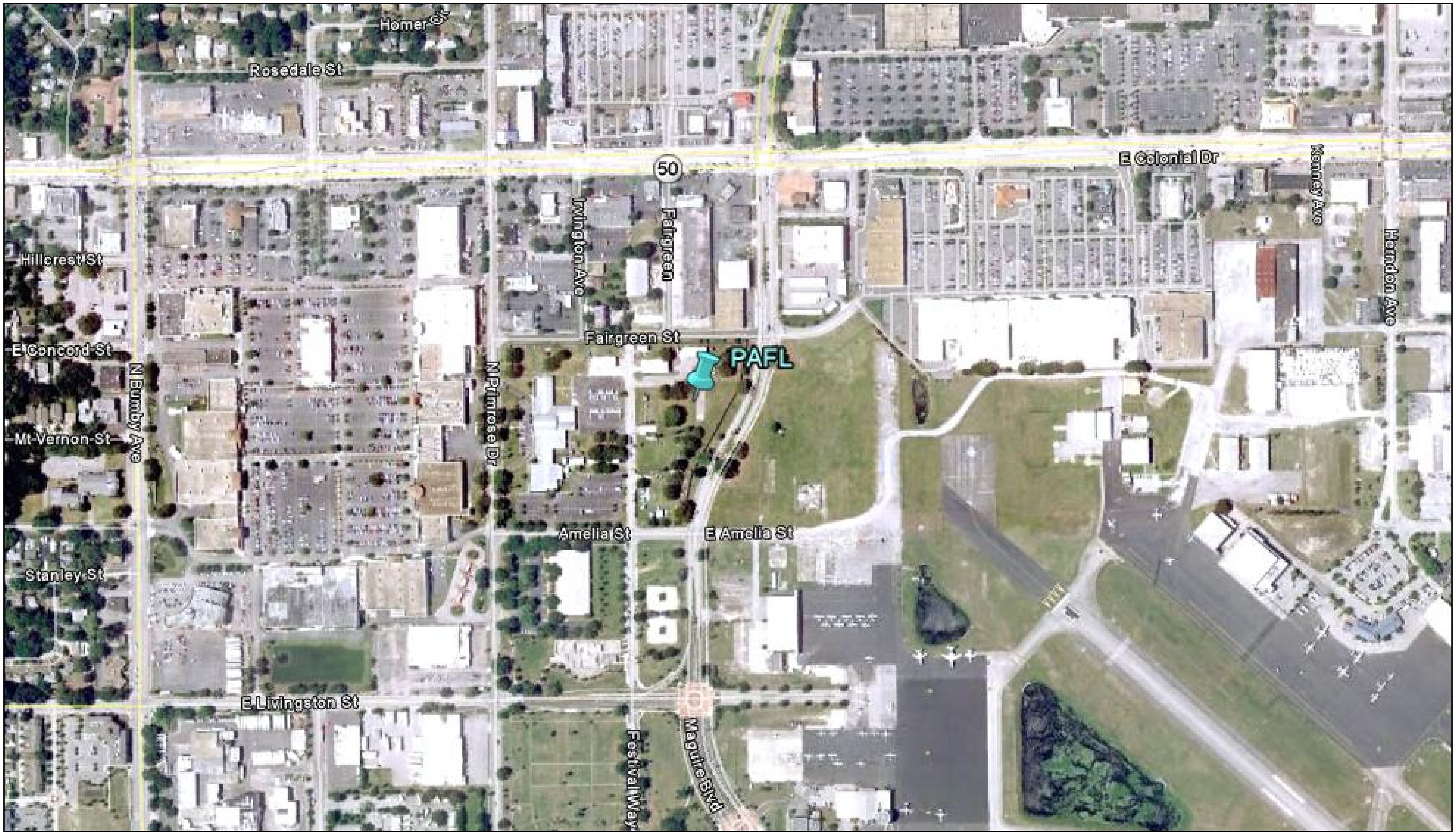
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 2,157 feet

Figure 10-5. Winter Park, Florida (ORFL) Monitoring Site



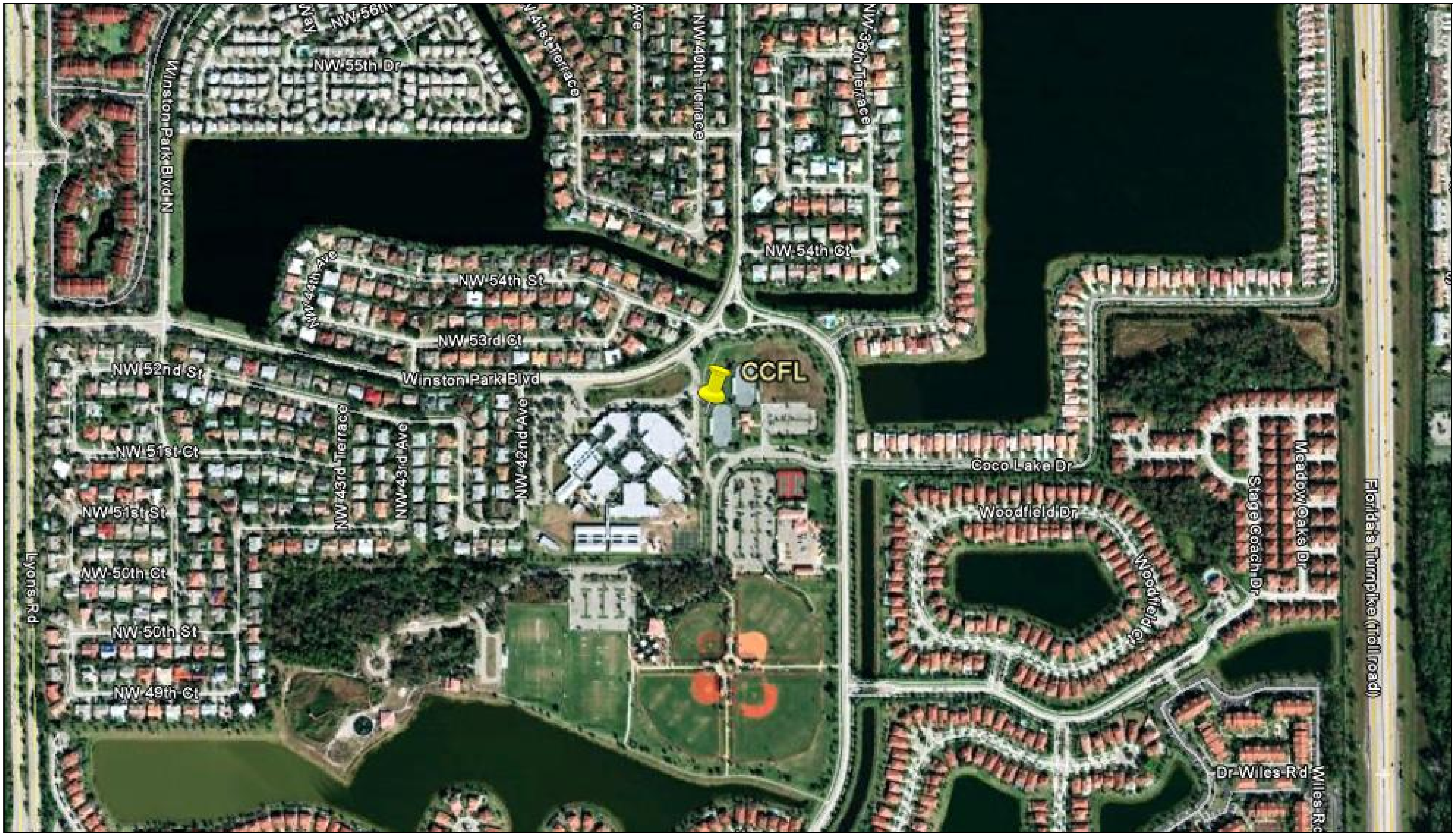
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,547 feet

Figure 10-6. Orlando, Florida (PAFL) Monitoring Site



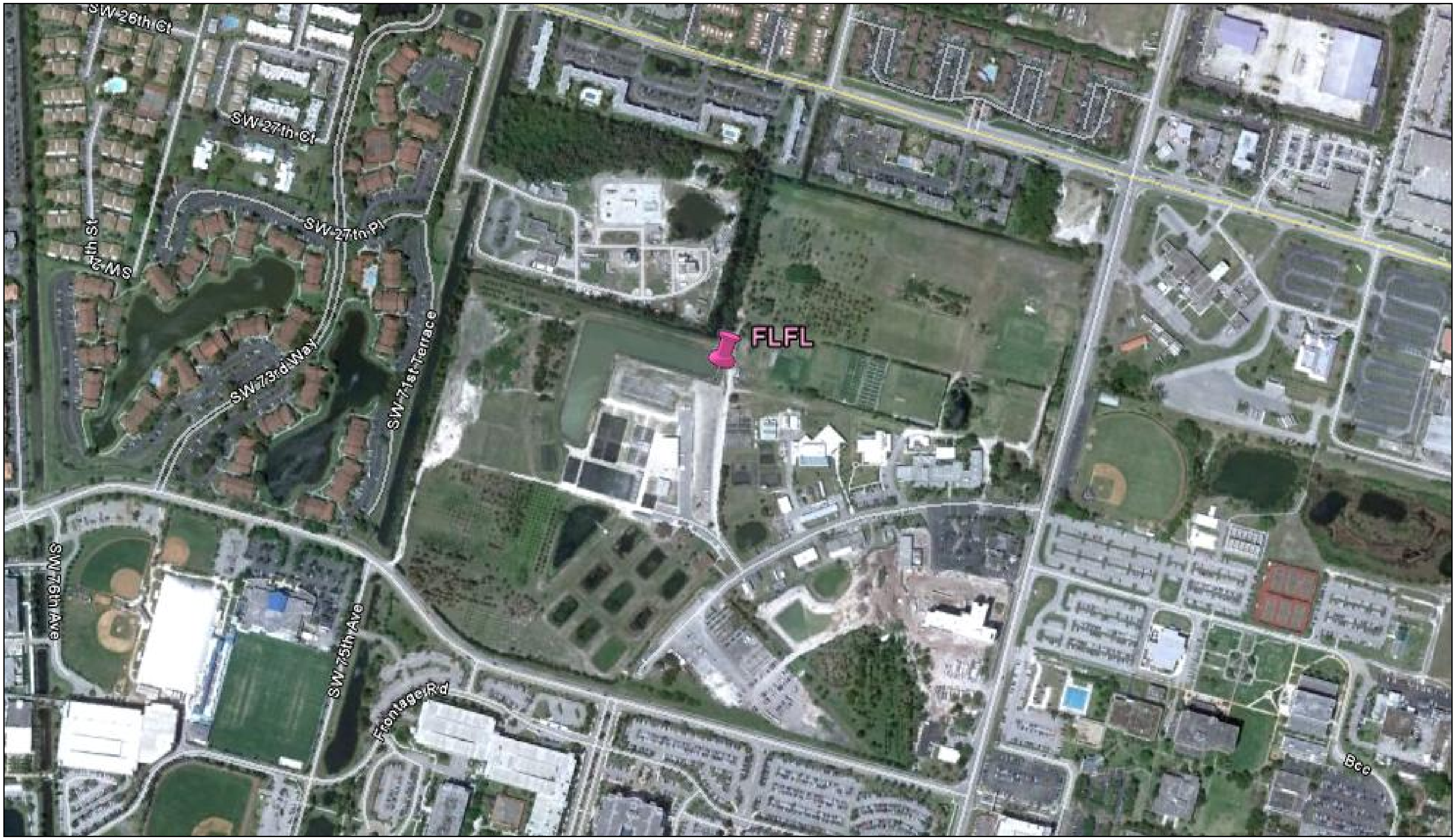
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,517 feet

Figure 10-7. Coconut Creek, Florida (CCFL) Monitoring Site



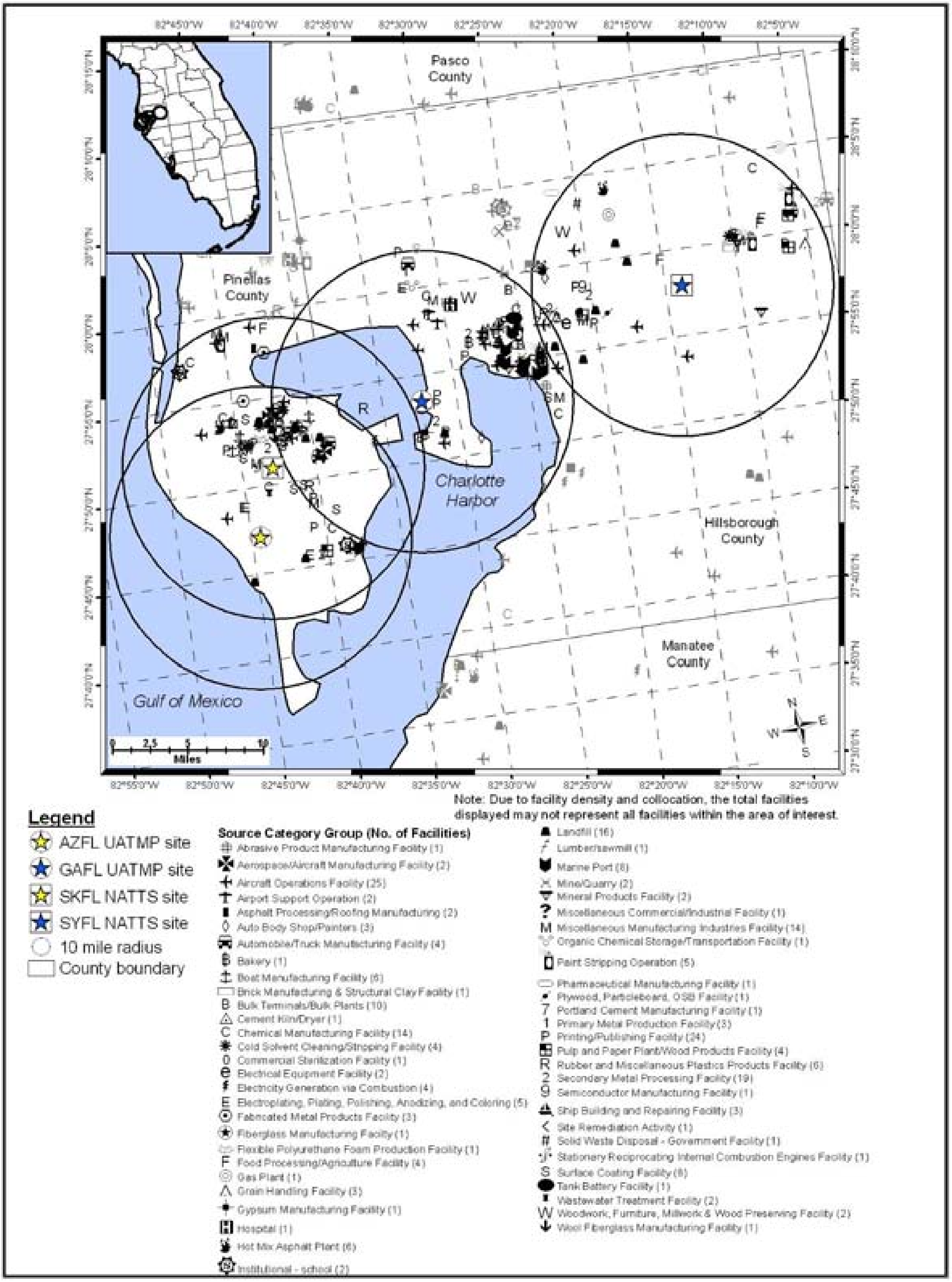
©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,690 feet

Figure 10-8. Davie, Florida (FLFL) Monitoring Site



©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,561 feet

Figure 10-9. NEI Point Sources Located Within 10 Miles of the Tampa/St. Petersburg, Florida Monitoring Sites



Pasco County
Pinellas County
Hillsborough County
Manatee County
Charlotte Harbor
Gulf of Mexico
0 2.5 5 10
Miles
82°55'0"W
82°50'0"W
82°45'0"W
82°40'0"W
82°35'0"W
82°30'0"W
82°25'0"W
82°20'0"W
82°15'0"W
82°10'0"W
82°5'0"W
28°15'0"N
28°10'0"N
28°5'0"N
28°0'0"N
27°55'0"N
27°50'0"N
27°45'0"N
27°40'0"N
27°35'0"N
27°30'0"N
N
E
W
S
Legend
AZFL UATMP site
GAFL UATMP site
SKFL NATTS site
SYFL NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Abrasive Product Manufacturing Facility (1)
Aerospace/Aircraft Manufacturing Facility (2)
Aircraft Operations Facility (25)
Airport Support Operation (2)
Asphalt Processing/Roofing Manufacturing (2)
Auto Body Shop/Painters (3)
Automobile/Truck Manufacturing Facility (4)
Bakery (1)
Boat Manufacturing Facility (6)
Brick Manufacturing & Structural Clay Facility (1)
Bulk Terminals/Bulk Plants (10)
Cement Kiln/Dryer (1)
Chemical Manufacturing Facility (14)
Cold Solvent Cleaning/Stripping Facility (4)
Commercial Sterilization Facility (1)
Electrical Equipment Facility (2)
Electricity Generation via Combustion (4)
Electroplating, Plating, Polishing, Anodizing, and Coloring (5)
Fabricated Metal Products Facility (3)
Fiberglass Manufacturing Facility (1)
Flexible Polyurethane Foam Production Facility (1)
Food Processing/Agriculture Facility (4)
Gas Plant (1)
Grain Handling Facility (3)
Gypsum Manufacturing Facility (1)
Hospital (1)
Hot Mix Asphalt Plant (6)
Institutional - school (2)
Landfill (16)
Lumber/sawmill (1)
Marine Port (8)
Mine/Quarry (2)
Mineral Products Facility (2)
Miscellaneous Commercial/Industrial Facility (1)
Miscellaneous Manufacturing Industries Facility (14)
Organic Chemical Storage/Transportation Facility (1)
Paint Stripping Operation (5)
Pharmaceutical Manufacturing Facility (1)
Plywood, Particleboard, OSB Facility (1)
Portland Cement Manufacturing Facility (1)
Primary Metal Production Facility (3)
Printing/Publishing Facility (24)
Pulp and Paper Plant/Wood Products Facility (4)
Rubber and Miscellaneous Plastics Products Facility (6)
Secondary Metal Processing Facility (19)
Semiconductor Manufacturing Facility (1)
Ship Building and Repairing Facility (3)
Site Remediation Activity (1)
Solid Waste Disposal - Government Facility (1)
Stationery Reciprocating Internal Combustion Engines Facility (1)
Surface Coating Facility (8)
Tank Battery Facility (1)
Wastewater Treatment Facility (2)
Woodwork, Furniture, Millwork & Wood Preserving Facility (2)
Wool Fiberglass Manufacturing Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 10-10. NEI Point Sources Located Within 10 Miles of ORFL and PAFL

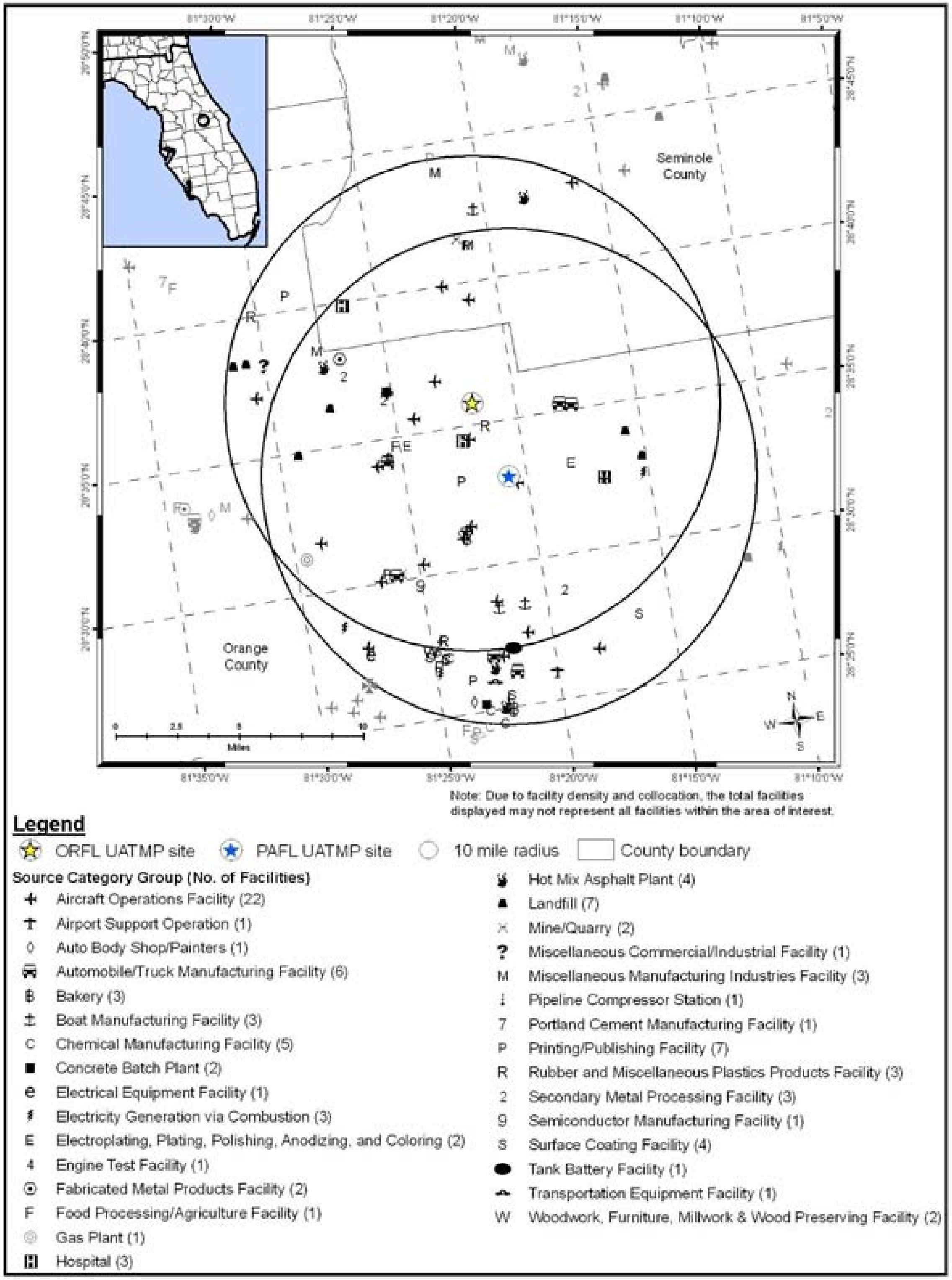
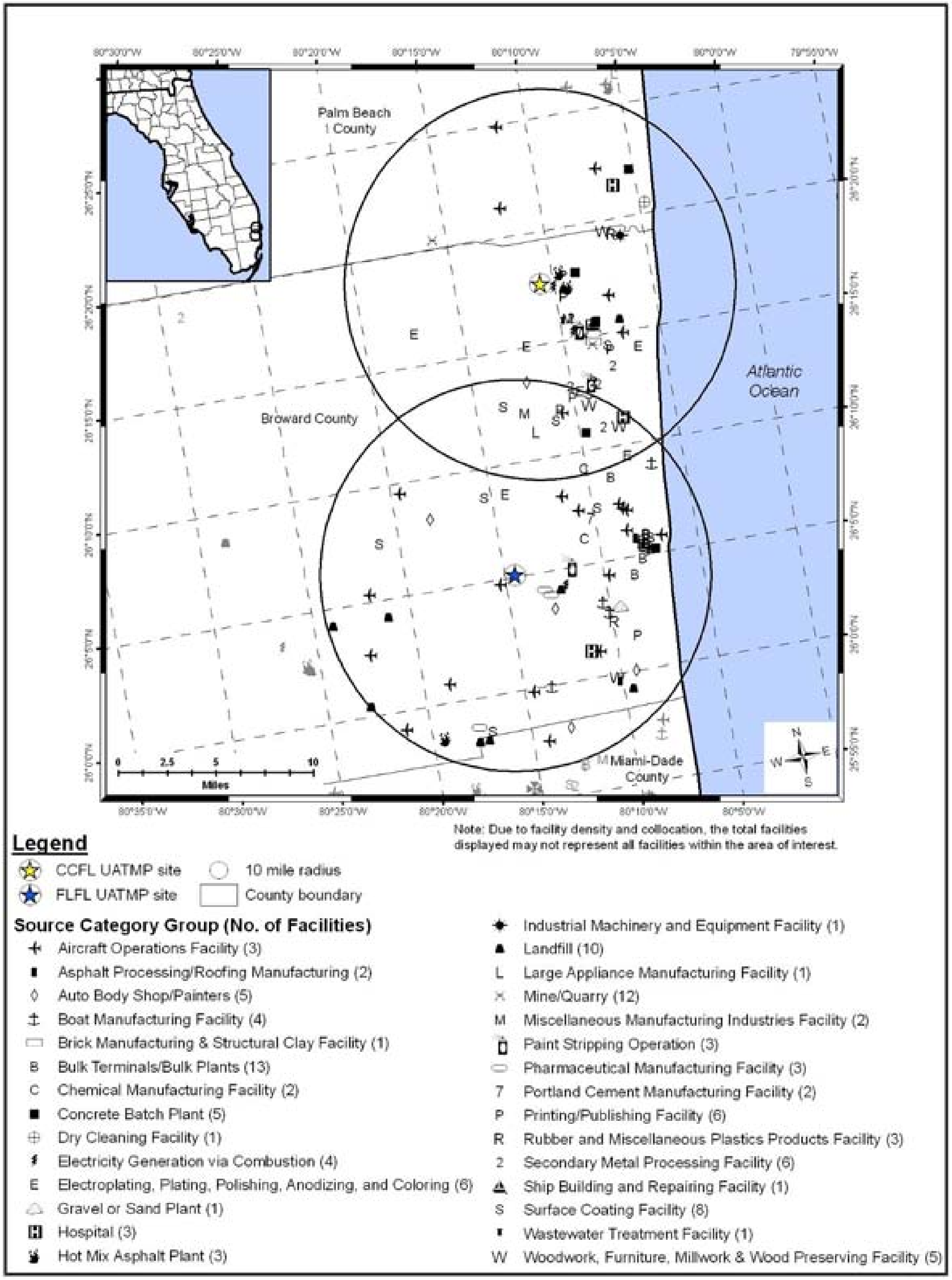

81°30'0"W
81°25'0"W
81°20'0"W
81°15'0"W
81°10'0"W
81°5'0"W
81°35'0"W
81°30'0"W
81°25'0"W
81°20'0"W
81°15'0"W
81°10'0"W
28°50'0"N
28°45'0"N
28°40'0"N
28°35'0"N
28°30'0"N
28°45'0"N
28°40'0"N
28°35'0"N
28°30'0"N
28°25'0"N
Seminole County
Orange County
N
W
E
S
0
2.5
5
10
Miles
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
ORFL UATMP site
PAFL UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (22)
Airport Support Operation (1)
Auto Body Shop/Painters (1)
Automobile/Truck Manufacturing Facility (6)
Bakery (3)
Boat Manufacturing Facility (3)
C Chemical Manufacturing Facility (5)
Concrete Batch Plant (2)
Electrical Equipment Facility (1)
Electricity Generation via Combustion (3)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (2)
4 Engine Test Facility (1)
Fabricated Metal Products Facility (2)
F Food Processing/Agriculture Facility (1)
Gas Plant (1)
Hospital (3)
Hot Mix Asphalt Plant (4)
Landfill (7)
Mine/Quarry (2)
? Miscellaneous Commercial/Industrial Facility (1)
M Miscellaneous Manufacturing Industries Facility (3)
Pipeline Compressor Station (1)
7 Portland Cement Manufacturing Facility (1)
P Printing/Publishing Facility (7)
R Rubber and Miscellaneous Plastics Products Facility (3)
2 Secondary Metal Processing Facility (3)
9 Semiconductor Manufacturing Facility (1)
S Surface Coating Facility (4)
Tank Battery Facility (1)
Transportation Equipment Facility (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Figure 10-11. NEI Point Sources Located Within 10 Miles of CCFL and FLFL



Palm Beach County
Broward County
Miami-Dade County
Atlantic Ocean
Miles
0
2.5
5
10
N
E
S
W
Legend
CCFL UATMP site
FLFL UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (3)
Asphalt Processing/Roofing Manufacturing (2)
Auto Body Shop/Painters (5)
Boat Manufacturing Facility (4)
Brick Manufacturing & Structural Clay Facility (1)
Bulk Terminals/Bulk Plants (13)
Chemical Manufacturing Facility (2)
Concrete Batch Plant (5)
Dry Cleaning Facility (1)
Electricity Generation via Combustion (4)
Electroplating, Plating, Polishing, Anodizing, and Coloring (6)
Gravel or Sand Plant (1)
Hospital (3)
Hot Mix Asphalt Plant (3)
Industrial Machinery and Equipment Facility (1)
Landfill (10)
Large Appliance Manufacturing Facility (1)
Mine/Quarry (12)
Miscellaneous Manufacturing Industries Facility (2)
Paint Stripping Operation (3)
Pharmaceutical Manufacturing Facility (3)
Portland Cement Manufacturing Facility (2)
Printing/Publishing Facility (6)
Rubber and Miscellaneous Plastics Products Facility (3)
Secondary Metal Processing Facility (6)
Ship Building and Repairing Facility (1)
Surface Coating Facility (8)
Wastewater Treatment Facility (1)
Woodwork, Furniture, Millwork & Wood Preserving Facility (5)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 10-1. Geographical Information for the Florida Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
AZFL	12-103-0018	St. Petersburg	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.785556, -82.74	Residential	Suburban	NO, NO_2, NOx, VOC, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$.
CCFL	12-011-5005	Coconut Creek	Broward	Miami-Fort Lauderdale-Pompano Beach, FL	26.295, -80.177778	Residential	Suburban	Meteorological parameters, PM_{10}, $PM_{2.5}$.
FLFL	12-011-1002	Davie	Broward	Miami-Fort Lauderdale-Pompano Beach, FL	26.08534, -80.24104	Commercial	Suburban	Carbonyl compounds, Meteorological parameters, PM_{10}, $PM_{2.5}$, $PM_{2.5}$ Speciation.
GAFL	12-057-1065	Tampa	Hillsborough	Tampa-St. Petersburg-Clearwater, FL	27.892222, -82.538611	Commercial	Suburban	NO, NO_2, NOx, VOC, O_3, PM_{10}, PM_{10} Speciation, $PM_{2.5}$.
ORFL	12-095-2002	Winter Park	Orange	Orlando-Kissimmee, FL	28.596444, -81.362444	Commercial	Urban/City Center	CO, SO_2, NO, NO_2, NOx, VOC, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$.
PAFL	12-095-1004	Orlando	Orange	Orlando-Kissimmee, FL	28.550833, -81.345556	Commercial	Suburban	Meteorological parameters, PM_{10}, $PM_{2.5}$.
SKFL	12-103-0026	Pinellas Park	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.850041, -82.714590	Residential	Suburban	VOC, Meteorological parameters, PM_{10} Speciation, Black carbon, $PM_{2.5}$ Speciation.
SYFL	12-057-3002	Plant City	Hillsborough	Tampa-St. Petersburg-Clearwater, FL	27.96565, -82.2304	Residential	Rural	CO, SO_2, NOy, NO, NO_2, NOx, VOC, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

AZFL is located at Azalea Park in St. Petersburg. Figure 10-1 shows that the area surrounding AZFL consists of mixed land use, including residential, commercial, and industrial properties. Heavily traveled roadways are located less than 1 mile from the monitoring site. AZFL is just over 1 mile east of Boca Ciega Bay.

GAFL is located near the east side of the Gandy Bridge on Highway 92 in Tampa. Figure 10-2 shows that GAFL is located on a small peninsula on old Tampa Bay. The setting is suburban and the surrounding area has mixed land use, including residential, commercial and industrial areas.

SKFL is located in Pinellas Park, north of St. Petersburg. This site is on the property of Skyview Elementary School near 86th Avenue North. Figure 10-3 shows that SKFL is located in a residential area. Population exposure is the purpose behind monitoring in this location.

SYFL is located in Plant City, which is also part of the Tampa-St. Petersburg-Clearwater, FL MSA, although it is on the eastern outskirts of the area. Unlike the other program sites, the SYFL monitoring site is in a rural area although, as Figure 10-4 shows, a residential community lies to the west of the site. This site serves as a background site, although the impact of increased development in the area is likely being captured by the monitor.

Figure 10-9 shows the location of the Tampa/St. Petersburg sites in relation to each other. SYFL is located the furthest east and AZFL is the furthest west. A large cluster of point sources is located just north of SKFL. Another cluster of emissions sources is located about halfway between SYFL and GAFL. Aircraft operations, which include airports as well as small runways, heliports, or landing pads, printing and publishing facilities, secondary metal processing facilities, landfills, and chemical manufacturing facilities are the source categories with the highest number of emissions sources in the Tampa/St. Petersburg area (based on the areas covered by the 10-mile radii).

ORFL is located in Winter Park, north of Orlando. Figure 10-5 shows that ORFL is located near Lake Mendsen, east of Lake Killarney and south of Winter Park Village. This site lies in a commercial area and serves as a population exposure monitor.

PAFL is located in northern Orlando, on the northwestern edge of the Orlando Executive Airport property, as shown in Figure 10-6. The area is considered commercial and experiences heavy traffic. The airport is bordered by Colonial Drive to the north and the East-West Expressway (Toll Road 408) to the south. A large shopping mall is located to the northeast of the site, just north of the airport, between Colonial Drive and Maguire Boulevard. In addition, I-4 runs north-south less than 2 miles to the west of the monitoring site.

Figure 10-10 shows that ORFL is located a few miles north of PAFL. Most of the point sources are located on the western side of the 10-mile radii. Although the emissions sources surrounding ORFL and PAFL are involved in a variety of industries and processes, aircraft operations, printing and publishing facilities, and landfills are the source categories with the highest number of emissions sources within 10 miles of these sites.

CCFL is located at Twin Lakes Park, adjacent to Winston Park Elementary, off Winston Park Boulevard in Coconut Creek, Florida. This location is approximately 6 miles from the Atlantic Ocean. The surrounding area includes residential areas to the west, north, and east, with Banyon Trails Park to the south. Several small lakes are infused throughout the neighborhoods, as shown in Figure 10-7.

FLFL is also located on Florida’s east coast (approximately 8 miles from the coastline) in Davie, near Ft. Lauderdale. The site is located at the Agricultural Research Center on the University of Florida campus. Figure 10-8 shows that the surrounding area is suburban and commercial. The site is less than 1 mile south of I-595 and other major highways are also located within a few miles of the site.

Figure 10-11 shows that CCFL lies roughly 15 miles north of FLFL. Most of the point sources are located on the eastern side of the 10-mile radii, paralleling the major thoroughfares in the area (including I-95, US-1, and the Turnpike). Although the emissions sources surrounding CCFL and FLFL are involved in a variety of operations, bulk terminals/bulk plants, mines/quarries, landfills, and surface coating facilities are the source categories with the highest number of emissions sources within 10 miles of these sites.

Table 10-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Florida monitoring sites. Information provided in Table 10-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Pinellas, Broward, Hillsborough, and Orange Counties were obtained from the Florida Department of Highway Safety and Motor Vehicles (FL DHSMV, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 10-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 10-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 10-2 presents the daily VMT for each urban area.

Observations from Table 10-2 include the following:

- Broward County, where FLFL and CCFL are located, is the most populous of the Florida counties with monitoring sites, although Hillsborough and Orange Counties both have over 1 million people. Broward County is the ninth most populous county of all the counties with NMP sites covered in this report.

- Of the eight Florida monitoring sites, FLFL and ORFL have the highest population within 10 miles of all the Florida sites. The FLFL 10-mile population ranked tenth highest among NMP sites.

- With the exception of Pinellas County (AZFL and SKFL), the vehicle registration counts for the Florida sites are all over 1 million, with Broward County having the most. The 10-mile ownership estimates are more variable.

Table 10-2. Population, Motor Vehicle, and Traffic Information for the Florida Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
AZFL	909,013	896,957	0.99	569,744	562,188	30,500	62,865
CCFL	1,766,476	1,436,626	0.81	923,091	750,724	38,500	129,658
FLFL	1,766,476	1,436,626	0.81	1,327,088	1,079,284	14,000	129,658
GAFL	1,195,317	1,137,069	0.95	475,725	452,543	29,000	62,865
ORFL	1,086,480	1,055,967	0.97	1,008,282	979,965	32,000	43,691
PAFL	1,086,480	1,055,967	0.97	879,184	854,493	51,500	43,691
SKFL	909,013	896,957	0.99	672,839	663,915	51,000	62,865
SYFL	1,195,317	1,137,069	0.95	311,528	296,347	10,400	62,865

[1] Reference: Census Bureau, 2010.

[2] County-level vehicle registration reflects 2009 data from the Florida DHSMV (FL DHSMV, 2009).

[3] Reference: http://xionetic.com/zipfinddeluxe.aspx

[4] Annual Average Daily Traffic reflects 2009 data from the Florida DOT (FL DOT, 2009).

[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

BOLD = EPA-designated NATTS Site.

- The vehicle-per-person ratios ranged from 0.81 (CCFL and FLFL) to 0.99 (AZFL and SKFL).

- VMT was highest for the Miami/Ft. Lauderdale urban area and lowest for the Orlando urban area among the Florida sites. The Miami/Ft. Lauderdale VMT ranked fourth highest among urban areas with NMP sites, behind New York City, Los Angeles, and Chicago.

- Traffic volumes near the Florida monitoring sites were mid-range compared to other NMP sites. The following list provides the roadways or intersections from which the traffic data were obtained:
  AZFL – Tyrone Boulevard, west of 66th Street North
  CCFL – Lyons Road, south of Sawgrass Expressway
  FLFL – College Avenue, south of Nova Drive
  GAFL – Gandy Boulevard, east of Gandy Bridge
  ORFL – Orlando Avenue, north of Morse Boulevard
  PAFL – Colonial/MLK Boulevard, between Bennett Road and Bumby Avenue
  SKFL – Park Boulevard, east of 66th Street North
  SYFL – Martin Luther King Jr. Boulevard (574), east of McIntosh Road

10.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Florida on sample days, as well as over the course of each year.

10.2.1 Climate Summary

The Tampa, Orlando, and Miami areas all experience 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. Precipitation tends to be concentrated during the summer and fall, as afternoon thunderstorms occur frequently. Semi-permanent high pressure offshore over the Atlantic Ocean extends westward towards Florida in the winter, resulting in reduced precipitation amounts. Land and sea breezes affect each coastal location and the proximity to the Atlantic Ocean or Gulf of Mexico can have a marked affect on the local meteorological conditions. Florida's orientation and location between the warm waters of the Gulf of Mexico and the Atlantic Ocean and Caribbean Sea make it susceptible to tropical systems (Bair, 1992 and FCC, 2011).

10.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations near these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s). The NWS weather station closest to the AZFL monitoring site is located at St. Petersburg/Whitted Airport (WBAN 92806); closest to GAFL and SYFL is at Tampa International Airport (WBAN 12842); closest to SKFL is at St. Petersburg/Clearwater International Airport (WBAN 12873); closest to ORFL and PAFL is at Orlando Executive Airport (WBAN 12841); closest to CCFL is at Pompano Beach Airpark Airport (WBAN 92805); and closest to FLFL is at Ft. Lauderdale/ Hollywood International Airport (WBAN 12849). Additional information about each of these weather stations is provided in Table 10-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 10-3. Average Meteorological Conditions near the Florida Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
St. Petersburg, Florida - AZFL										
St. Petersburg/ Whitted Airport 92806 (27.77, -82.63)	6.77 miles 94° (E)	2008	Sample Day	81.5 ± 2.0	74.5 ± 2.1	63.5 ± 2.3	67.7 ± 2.0	70.3 ± 2.6	1017.0 ± 1.0	7.4 ± 0.8
			All Year	80.6 ± 0.9	73.8 ± 0.9	62.8 ± 1.0	67.0 ± 0.9	70.1 ± 1.0	1017.3 ± 0.5	7.7 ± 0.3
		2009	Sample Day	79.6 ± 2.4	73.1 ± 2.5	63.6 ± 2.9	67.3 ± 2.5	73.5 ± 2.4	1016.6 ± 1.1	7.4 ± 0.8
			All Year	80.4 ± 0.9	73.7 ± 1.0	64.3 ± 1.1	67.9 ± 1.0	73.8 ± 1.0	1016.9 ± 0.5	7.0 ± 0.3
Coconut Creek, Florida – CCFL										
Pompano Beach Airpark Airport 92805 (26.25, -80.11)	5.22 miles 116° (ESE)	2008	Sample Day	82.4 ± 2.4	76.8 ± 2.7	67.2 ± 3.4	70.6 ± 2.9	73.5 ± 2.9	1016.9 ± 1.5	8.0 ± 1.3
			All Year	81.8 ± 0.6	75.9 ± 0.7	65.7 ± 0.9	69.5 ± 0.7	72.1 ± 1.0	1017.4 ± 0.4	8.8 ± 0.3
		2009	Sample Day	74.3 ± 3.2	66.9 ± 3.6	56.3 ± 5.2	60.9 ± 4.1	70.6 ± 5.5	1019.8 ± 2.5	9.8 ± 1.3
			All Year	82.3 ± 0.7	76.0 ± 0.8	65.8 ± 1.0	69.5 ± 0.8	71.9 ± 0.9	1017.2 ± 0.4	7.8 ± 0.3
Davie, Florida – FLFL										
Ft Lauderdale/ Hollywood Intl Airport 12849 (26.07, -80.15)	5.34 miles 90° (E)	2008	Sample Day	84.0 ± 2.3	78.2 ± 2.6	65.4 ± 3.0	70.0 ± 2.6	65.8 ± 2.5	1016.7 ± 1.5	8.0 ± 1.3
			All Year	83.8 ± 0.6	77.7 ± 0.7	64.5 ± 0.9	69.3 ± 0.7	64.9 ± 0.9	1017.0 ± 0.4	8.5 ± 0.3
		2009	Sample Day	76.8 ± 3.0	69.1 ± 3.4	55.3 ± 5.2	61.3 ± 3.9	63.3 ± 5.0	1019.5 ± 2.5	9.4 ± 1.0
			All Year	83.4 ± 0.7	77.0 ± 0.7	66.1 ± 1.0	70.1 ± 0.8	70.3 ± 1.0	1016.8 ± 0.4	7.5 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 10-3. Average Meteorological Conditions near the Florida Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Tampa, Florida - GAFL										
Tampa International Airport 12842 (27.96, -82.54)	4.74 miles 351° (N)	2008	Sample Day	82.3 ± 1.9	73.9 ± 2.1	62.1 ± 2.6	66.7 ± 2.1	68.7 ± 2.8	1017.5 ± 1.0	5.9 ± 0.5
			All Year	81.4 ± 0.8	73.0 ± 0.9	61.1 ± 1.2	65.8 ± 0.9	68.4 ± 1.1	1017.8 ± 0.5	5.9 ± 0.2
		2009	Sample Day	72.6 ± 4.2	62.8 ± 4.3	49.0 ± 6.7	55.7 ± 4.8	63.7 ± 7.5	1020.3 ± 3.2	5.9 ± 1.2
			All Year	81.5 ± 0.9	73.3 ± 1.0	62.7 ± 1.3	66.9 ± 1.0	71.2 ± 1.1	1017.4 ± 0.5	5.1 ± 0.2
Winter Park, Florida – ORFL										
Orlando Executive Airport 12841 (28.55, -81.33)	3.94 miles 145° (SE)	2008	Sample Day	82.7 ± 1.9	73.2 ± 2.0	60.8 ± 2.5	65.7 ± 2.0	68.0 ± 2.9	1018.0 ± 1.1	6.2 ± 0.7
			All Year	81.6 ± 0.9	72.2 ± 0.9	60.0 ± 1.2	64.9 ± 0.9	67.9 ± 1.0	1018.5 ± 0.5	6.3 ± 0.3
		2009	Sample Day	82.1 ± 2.5	72.8 ± 2.5	61.7 ± 3.2	66.1 ± 2.6	70.5 ± 2.6	1017.4 ± 1.2	6.0 ± 0.6
			All Year	82.0 ± 1.0	72.4 ± 1.0	61.3 ± 1.3	65.8 ± 1.0	70.8 ± 1.1	1017.9 ± 0.5	5.9 ± 0.3
Orlando, Florida – PAFL										
Orlando Executive Airport 12841 (28.55, -81.33)	0.84 miles 109° (ESE)	2008	Sample Day	83.9 ± 2.5	74.0 ± 2.6	62.5 ± 3.0	66.9 ± 2.4	69.9 ± 3.8	1017.4 ± 1.5	6.5 ± 1.0
			All Year	81.6 ± 0.9	72.2 ± 0.9	60.0 ± 1.2	64.9 ± 0.9	67.9 ± 1.0	1018.5 ± 0.5	6.3 ± 0.3
		2009	Sample Day	81.4 ± 3.6	72.0 ± 3.7	61.3 ± 4.9	65.7 ± 4.0	71.3 ± 3.9	1017.6 ± 1.6	6.3 ± 1.2
			All Year	82.0 ± 1.0	72.4 ± 1.0	61.3 ± 1.3	65.8 ± 1.0	70.8 ± 1.1	1017.9 ± 0.5	5.9 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 10-3. Average Meteorological Conditions near the Florida Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Pinellas Park, Florida - SKFL										
St Petersburg-Clearwater Intl Airport 12873 (27.91, -82.69)	4.48 miles 12° (NNE)	2008	Sample Day	82.2 ± 1.9	73.6 ± 2.2	62.8 ± 2.5	67.0 ± 2.1	70.9 ± 2.5	1017.5 ± 1.0	6.8 ± 0.8
			All Year	81.6 ± 0.9	73.4 ± 0.9	62.7 ± 1.1	66.9 ± 0.9	71.2 ± 1.0	1017.8 ± 0.5	6.9 ± 0.3
		2009	Sample Day	81.8 ± 2.4	73.8 ± 2.4	63.0 ± 3.0	67.2 ± 2.4	70.8 ± 2.4	1017.0 ± 1.1	6.9 ± 0.8
			All Year	81.9 ± 1.0	73.6 ± 1.0	63.1 ± 1.2	67.2 ± 1.0	71.4 ± 0.9	1017.4 ± 0.5	6.7 ± 0.3
Plant City, Florida – SYFL										
Tampa International Airport 12842 (27.96, -82.54)	18.27 miles 260° (W)	2008	Sample Day	82.2 ± 1.9	73.8 ± 2.1	61.9 ± 2.6	66.6 ± 2.1	68.7 ± 2.8	1017.5 ± 1.1	5.9 ± 0.5
			All Year	81.4 ± 0.8	73.0 ± 0.9	61.1 ± 1.2	65.8 ± 0.9	68.4 ± 1.1	1017.8 ± 0.5	5.9 ± 0.2
		2009	Sample Day	81.1 ± 2.4	73.2 ± 2.5	62.3 ± 3.2	66.6 ± 2.6	70.7 ± 2.8	1017.0 ± 1.1	5.3 ± 0.6
			All Year	81.5 ± 0.9	73.3 ± 1.0	62.7 ± 1.3	66.9 ± 1.0	71.2 ± 1.1	1017.4 ± 0.5	5.1 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 10-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 10-3 is the 95 percent confidence interval for each parameter. As shown in Table 10-3, average meteorological conditions on sample days in 2008 were fairly representative of average weather conditions during the entire year. This is also true for 2009 for AZFL, ORFL, PAFL, SKFL, and SYFL; the other three sites show differences between their full-year averages and their sample day averages. GAFL, FLFL, and CCFL stopped sampling in March 2009, which explains why conditions on sample days appear cooler and drier than conditions for the entire year.

10.2.3 Back Trajectory Analysis

Figure 10-12 and Figure 10-13 are the composite back trajectory maps for days on which samples were collected at the AZFL monitoring site in 2008 and 2009, respectively. Figure 10-14 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Similarly, Figures 10-15 through 10-35 are the composite and cluster back trajectory maps for the remaining Florida monitoring sites. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 10-12 through 10-35 represents 100 miles.

Figure 10-12. 2008 Composite Back Trajectory Map for AZFL

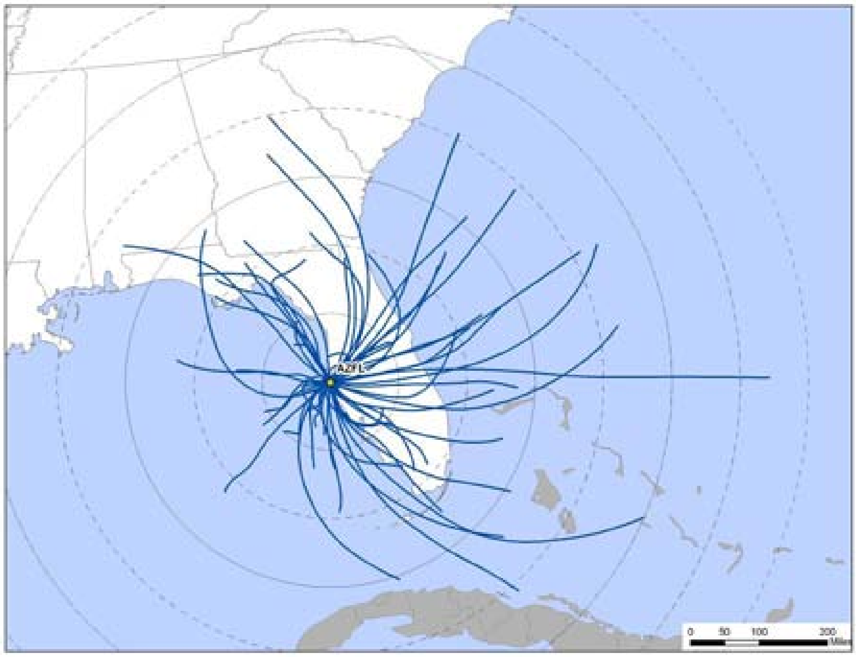


Figure 10-13. 2009 Composite Back Trajectory Map for AZFL

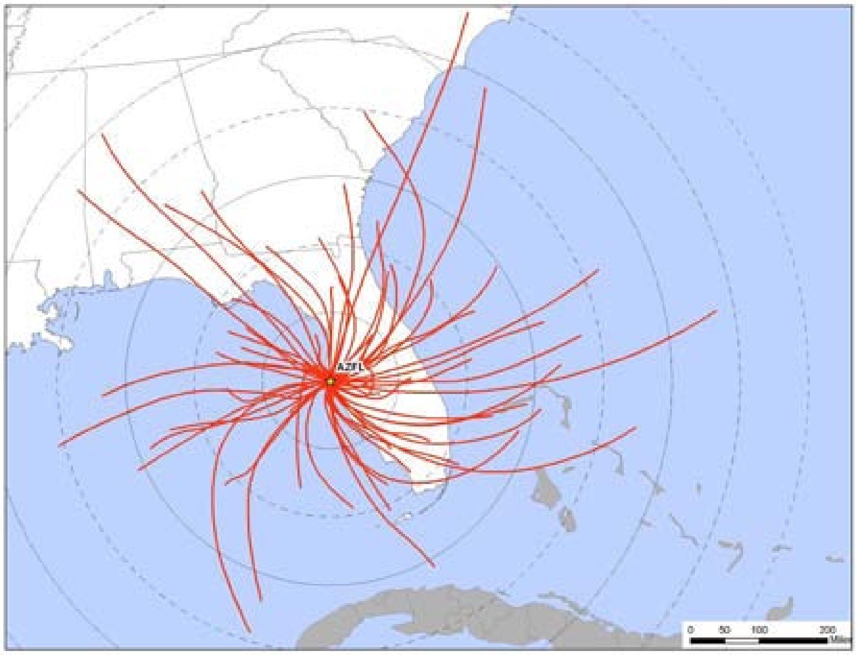


Figure 10-14. Back Trajectory Cluster Map for AZFL

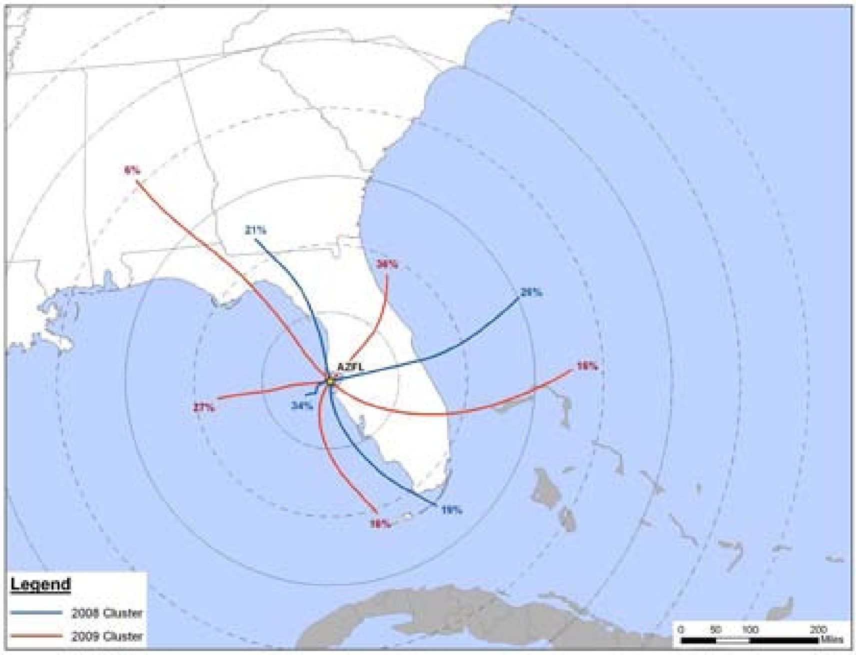


Figure 10-15. 2008 Composite Back Trajectory Map for GAFL

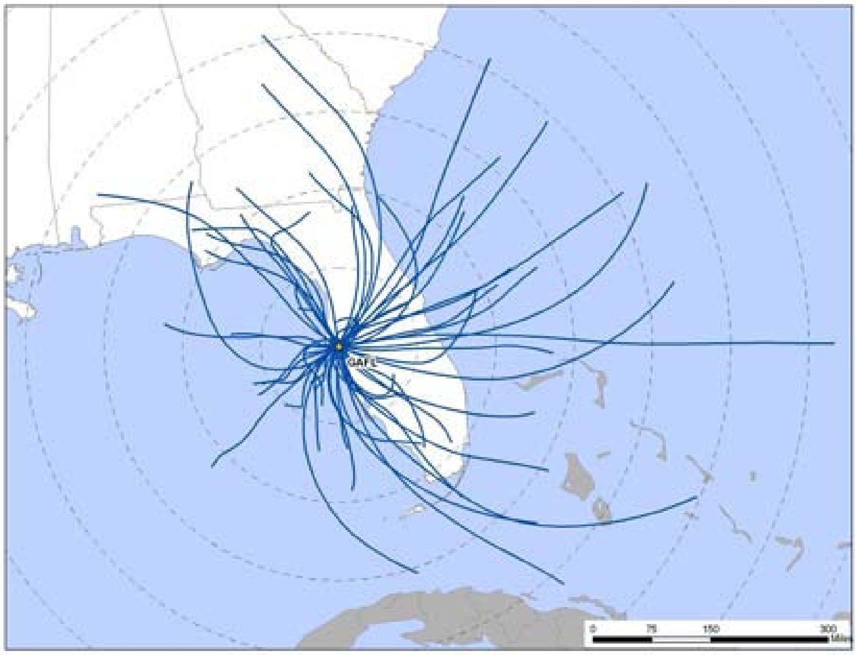


Figure 10-16. 2009 Composite Back Trajectory Map for GAFL

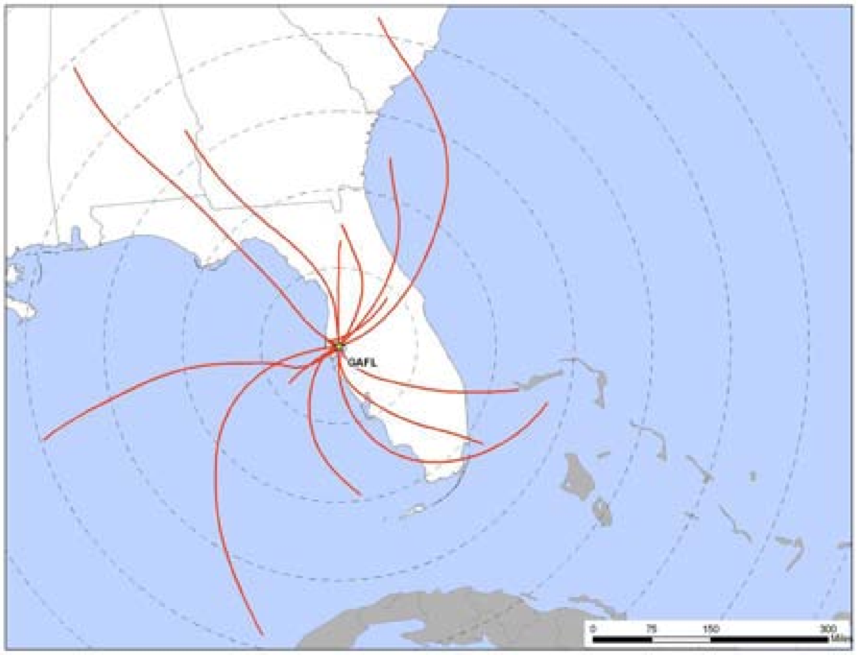


Figure 10-17. 2008 Back Trajectory Cluster Map for GAFL

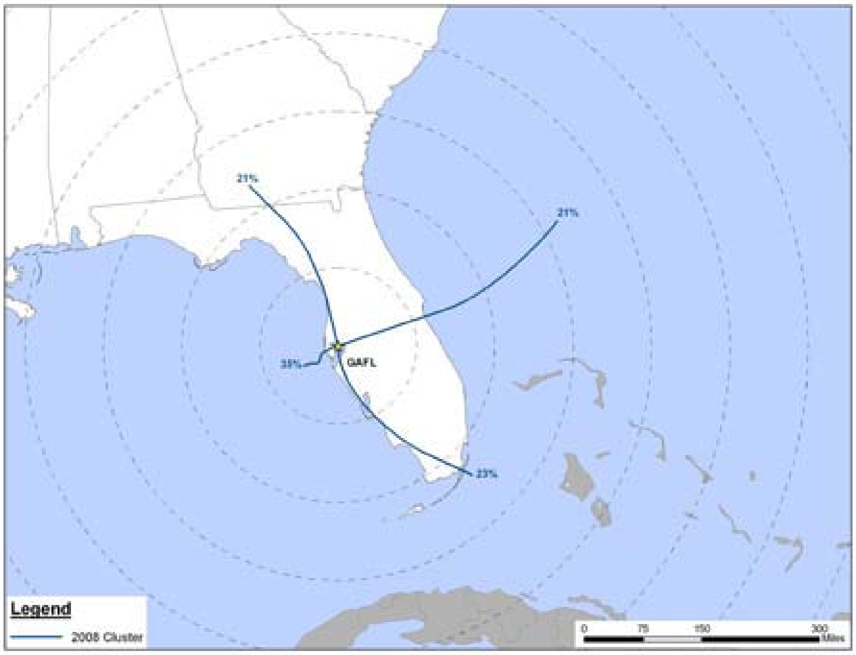


Figure 10-18. 2008 Composite Back Trajectory Map for SKFL

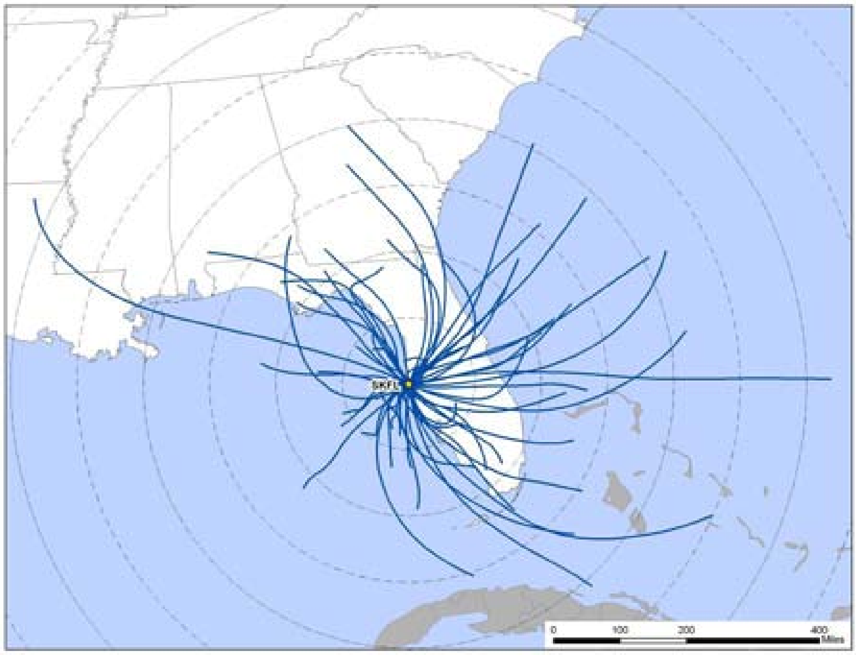


Figure 10-19. 2009 Composite Back Trajectory Map for SKFL

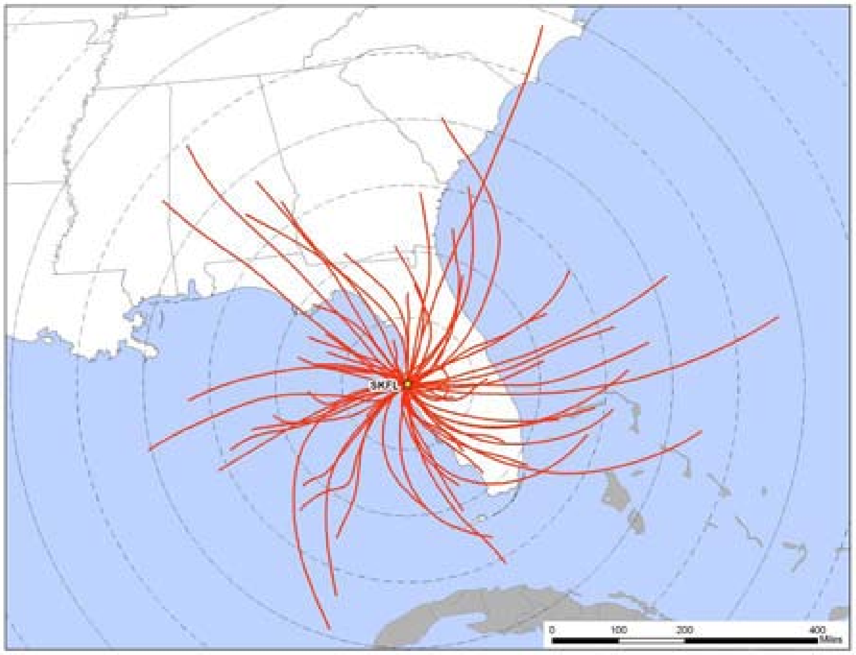


Figure 10-20. Back Trajectory Cluster Map for SKFL

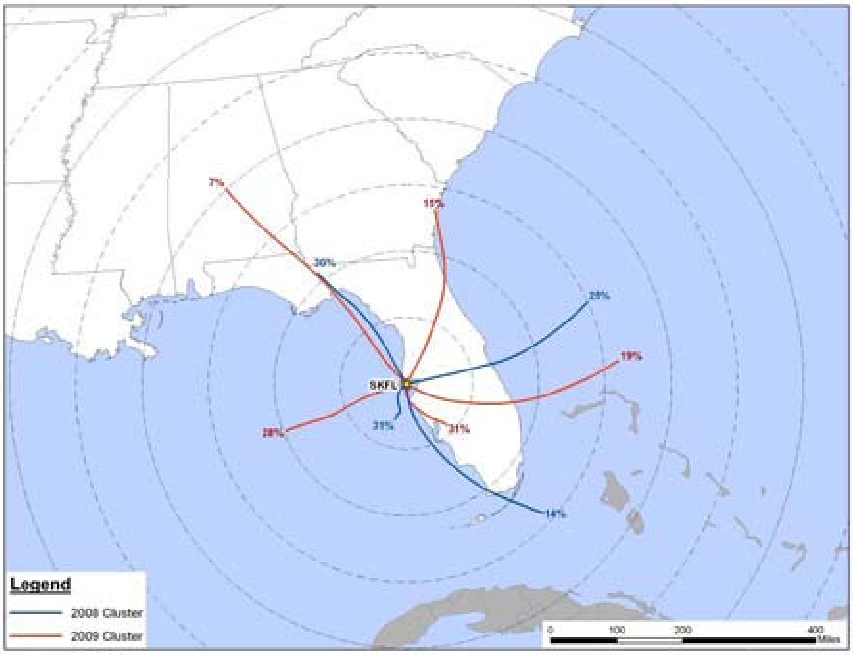


Figure 10-21. 2008 Composite Back Trajectory Map for SYFL

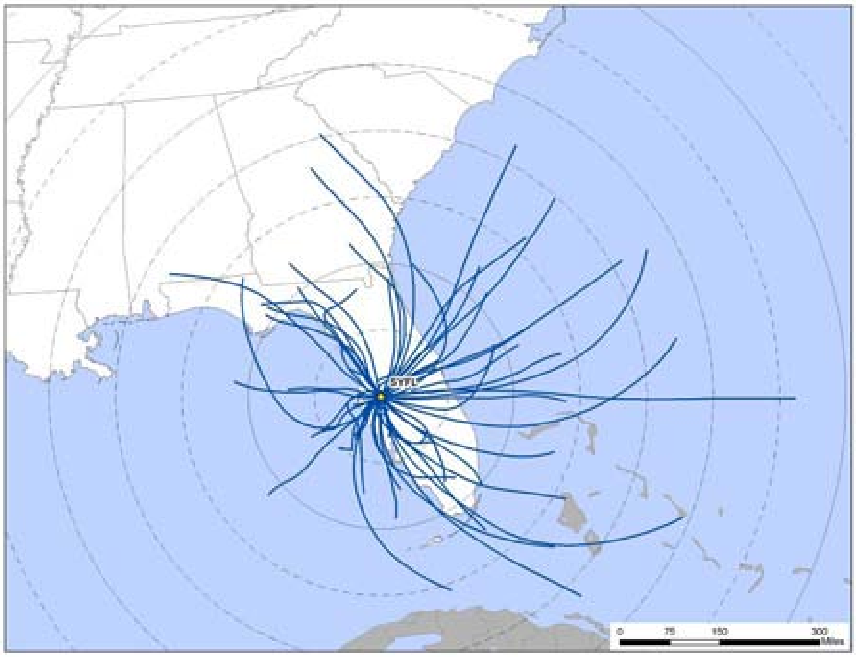


Figure 10-22. 2009 Composite Back Trajectory Map for SYFL

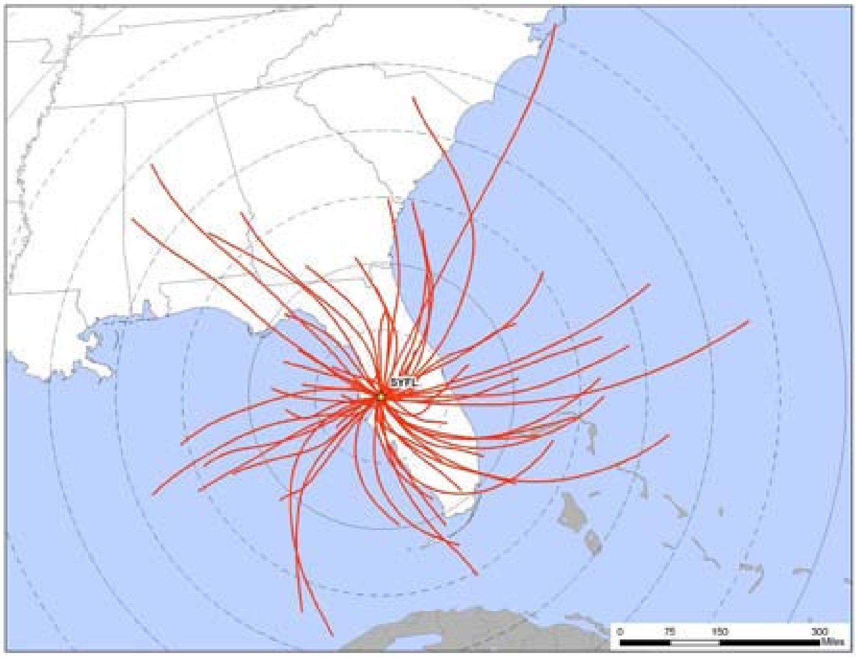


Figure 10-23. Back Trajectory Cluster Map for SYFL

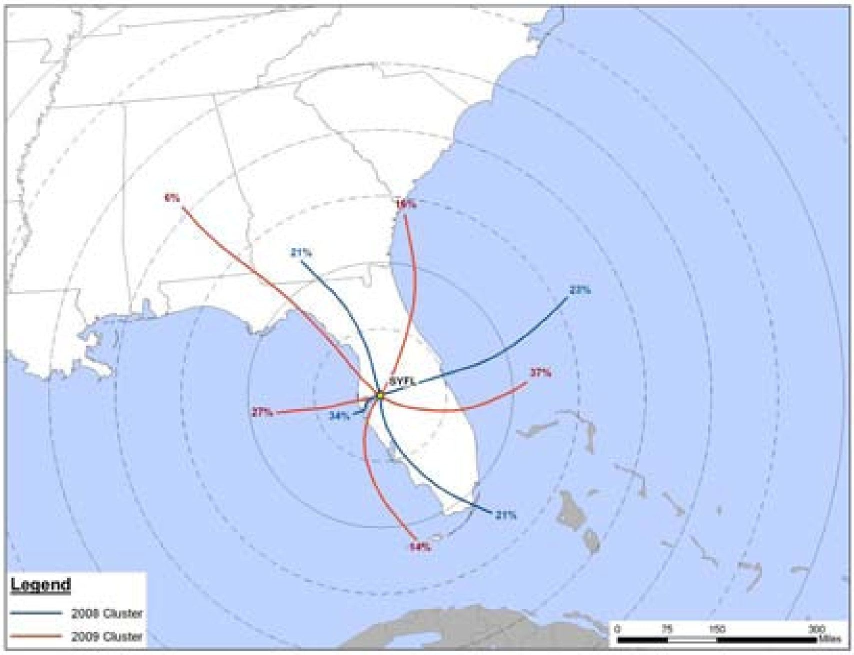


Figure 10-24. 2008 Composite Back Trajectory Map for ORFL

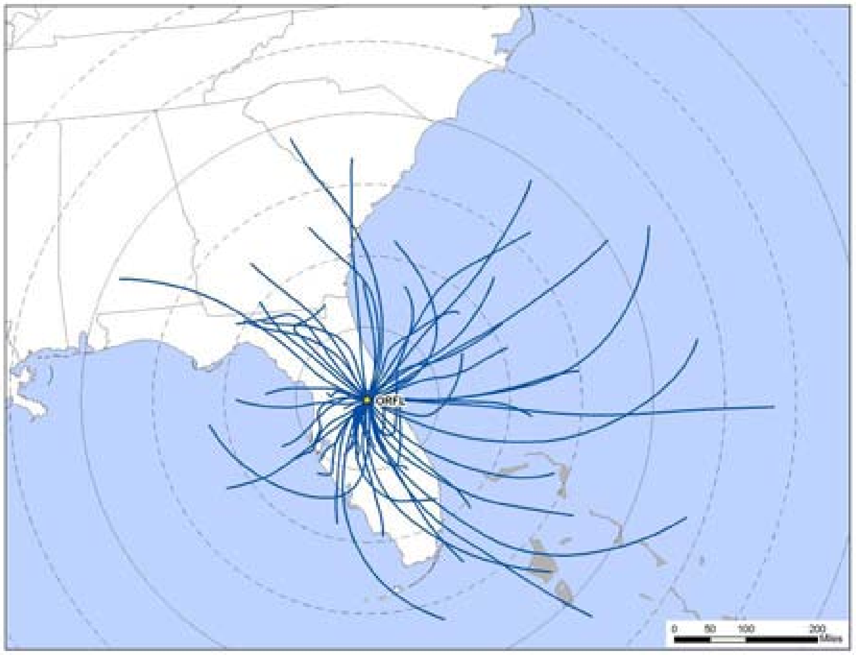


Figure 10-25. 2009 Composite Back Trajectory Map for ORFL

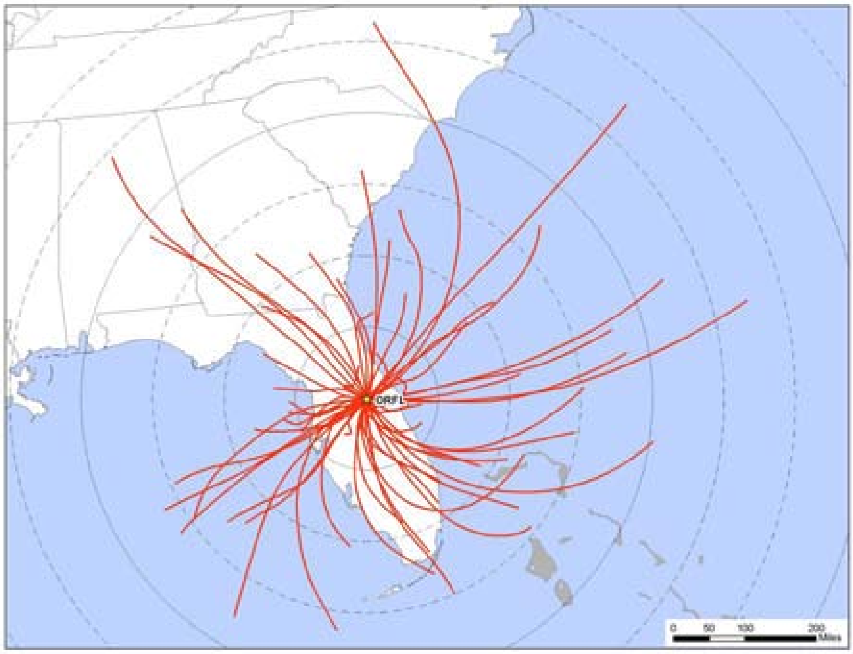


Figure 10-26. Back Trajectory Cluster Map for ORFL

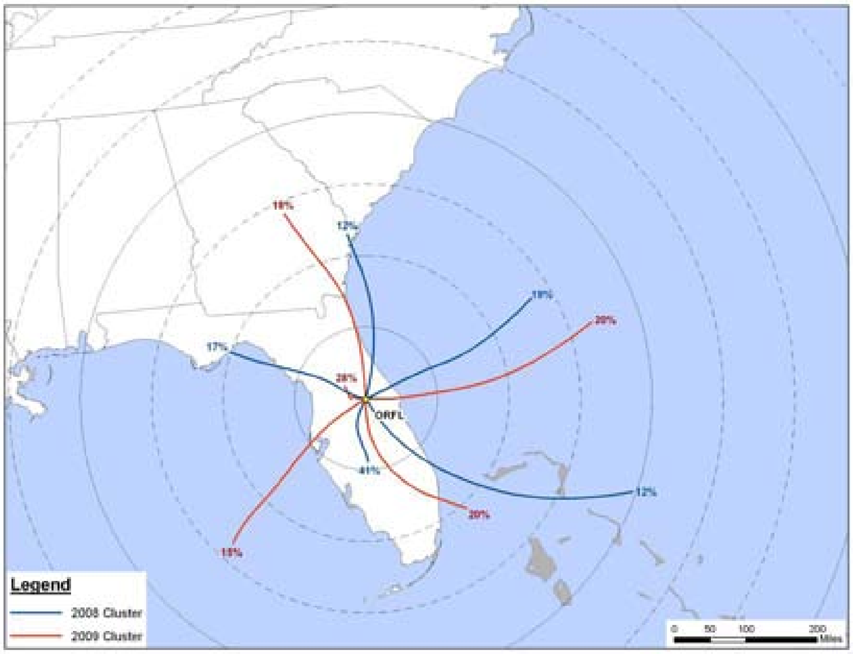


Figure 10-27. 2008 Composite Back Trajectory Map for PAFL

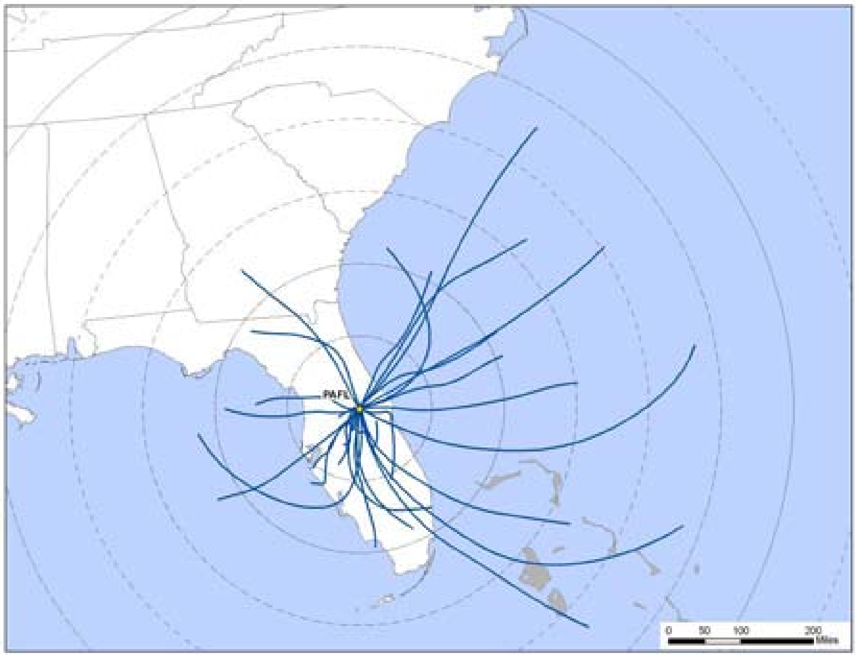


Figure 10-28. 2009 Composite Back Trajectory Map for PAFL

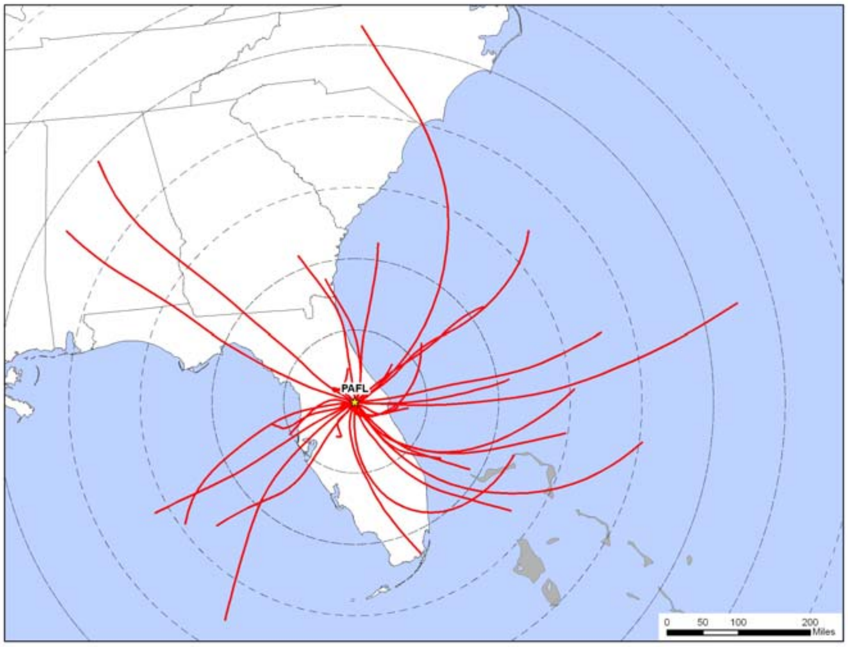


Figure 10-29. Back Trajectory Cluster Map for PAFL

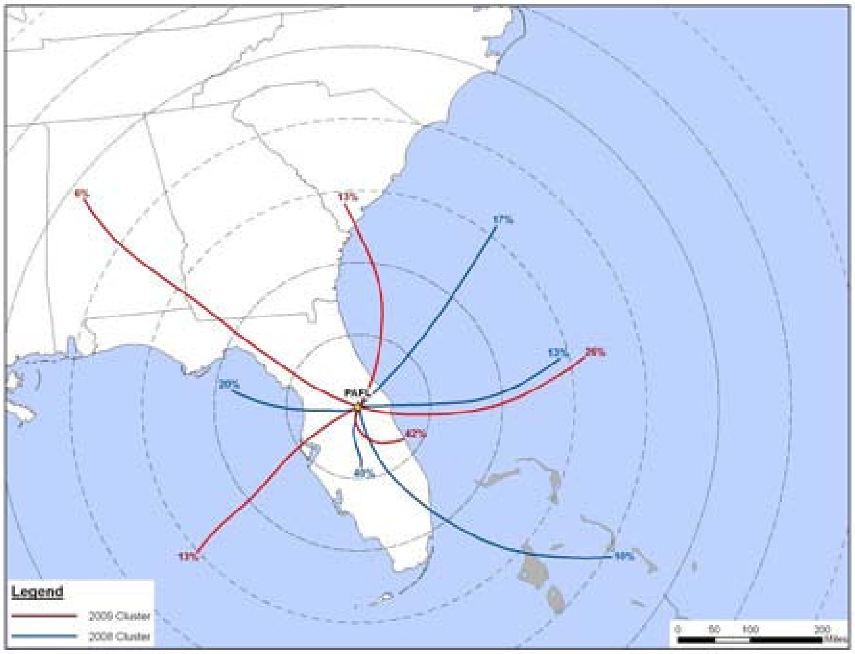


Figure 10-30. 2008 Composite Back Trajectory Map for CCFL

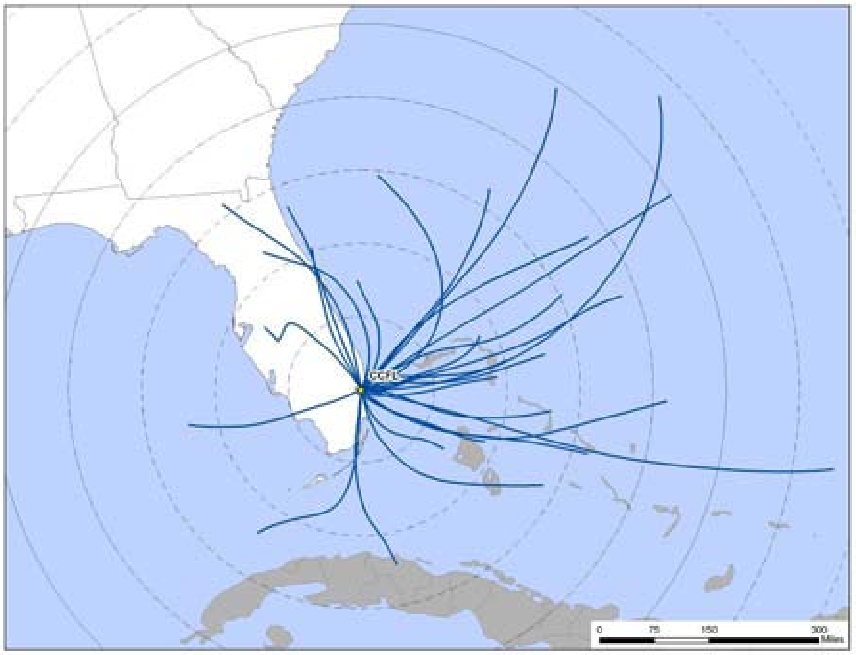


Figure 10-31. 2009 Composite Back Trajectory Map for CCFL

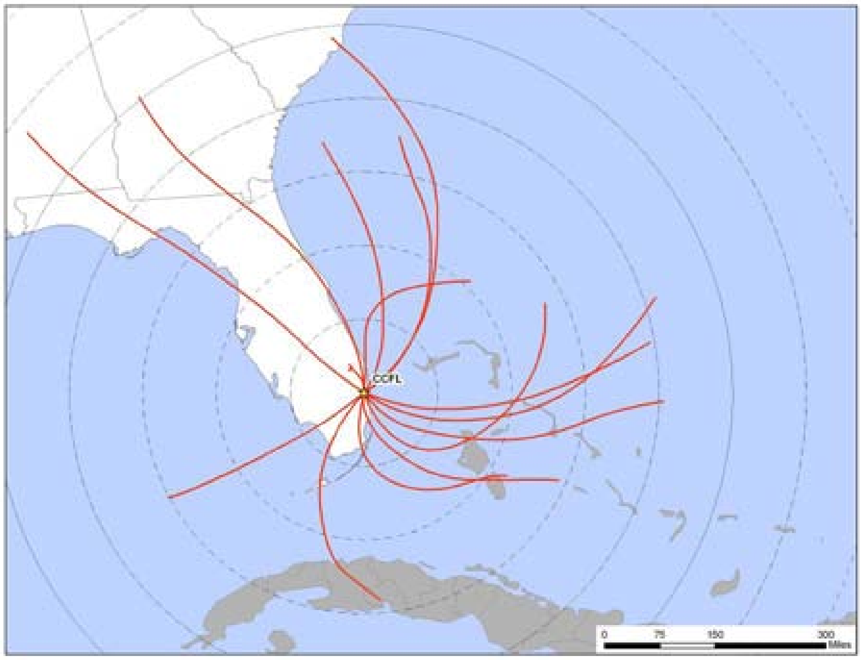


Figure 10-32. 2008 Back Trajectory Cluster Map for CCFL

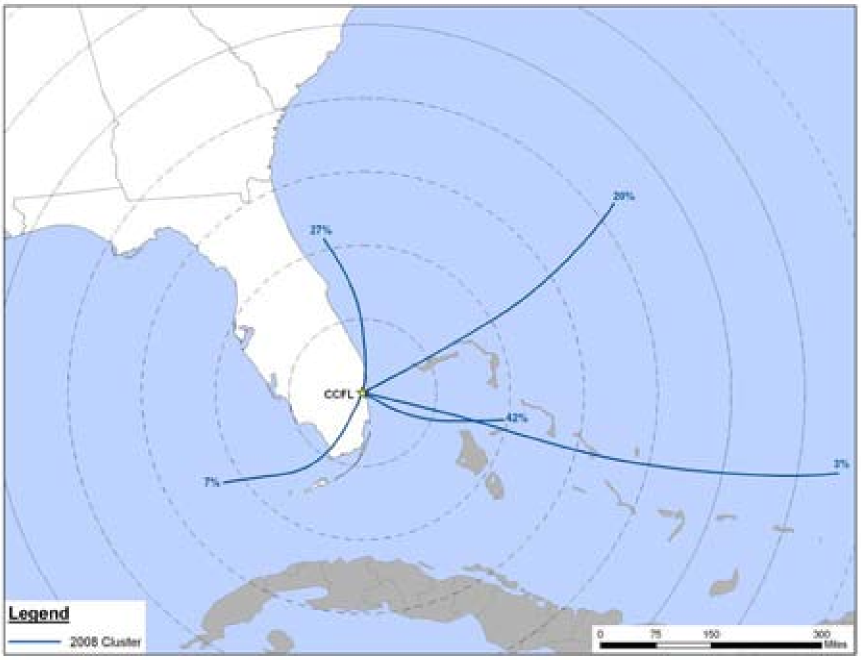


Figure 10-33. 2008 Composite Back Trajectory Map for FLFL

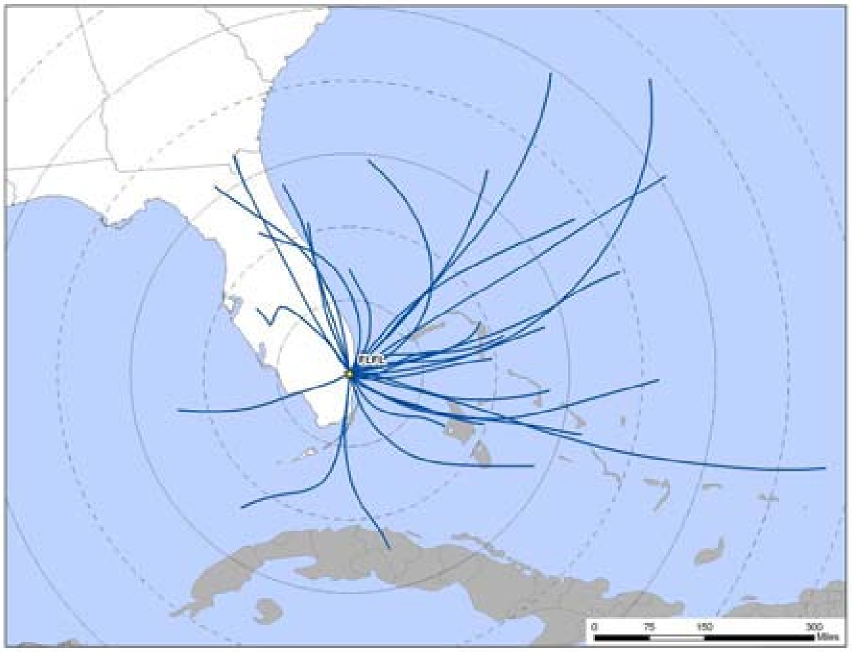


Figure 10-34. 2009 Composite Back Trajectory Map for FLFL

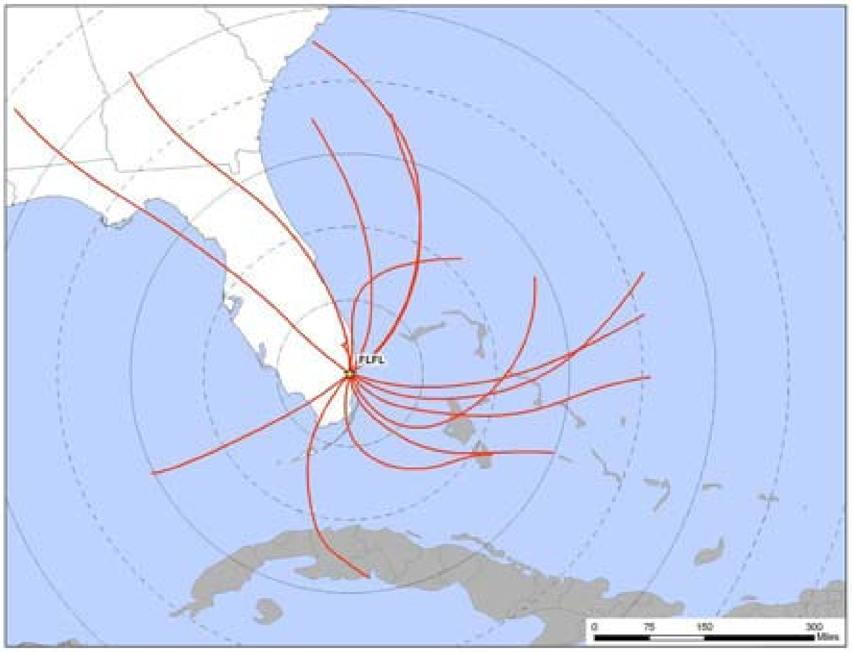
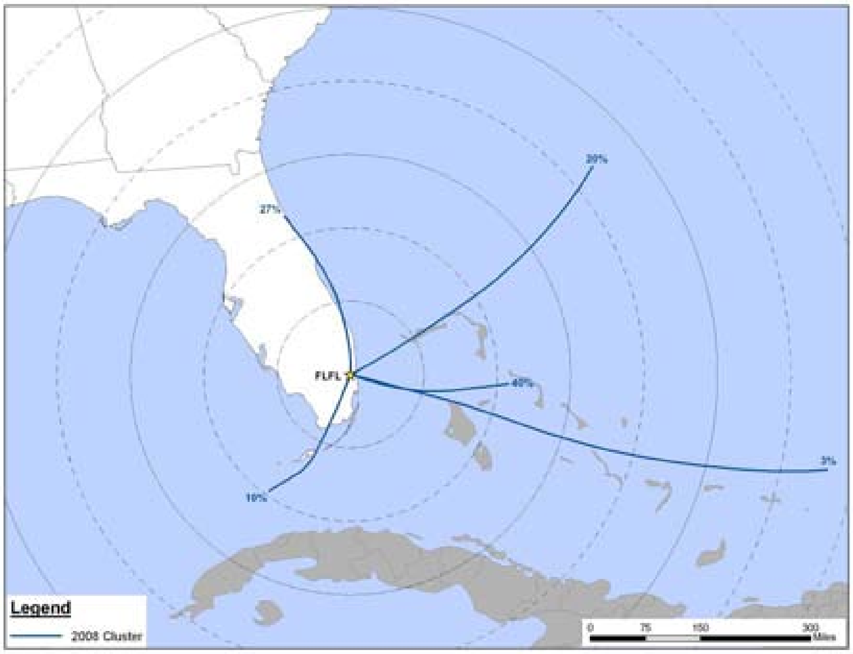


Figure 10-35. 2008 Back Trajectory Cluster Map for FLFL



Observations from Figures 10-12 through 10-23 for the Tampa/St. Petersburg sites include the following:

- The composite back trajectory maps for the Tampa/St. Petersburg sites are generally similar to each other.
- Back trajectories originated from a variety of directions at the Tampa/St. Petersburg sites.
- The 24-hour air shed domains for these sites were comparable in size to other NMP monitoring sites. For all four sites, the farthest away a trajectory originated was over the Atlantic Ocean, or less than 650 miles away. The SKFL 2008 map shows a second trajectory of similar length originating over northeast Louisiana.
- Most trajectories (between 87 and 88 percent for each site) originated within 400 miles of the Tampa/St. Petersburg monitoring sites. The average trajectory length was approximately 230 miles for each site (except GAFL, which was slightly lower at 224 miles).
- GAFL stopped sampling in March 2009 and thus does not have as many trajectories factored into its average values. Because fewer than 30 sample days are available for 2009, a 2009 cluster analysis could not be performed for this site.
- The cluster maps for AZFL, SKFL, and SYFL generally look like pinwheels, indicating that trajectories originated from a variety of directions.

Observations from Figures 10-24 through 10-29 for ORFL and PAFL include the following:

- Even though they are close in proximity to each other, the trajectory distribution for PAFL is different than the trajectory distribution for ORFL because sampling at PAFL occurred on a 1-in-12 day schedule, yielding approximately half the sample days as ORFL.
- The 24-hour air shed domains were somewhat smaller in size compared to the other Florida monitoring sites. The furthest away a trajectory originated was nearly 550 miles away for PAFL and 570 miles for ORFL, both over the Atlantic Ocean.
- Similar to the Tampa/St. Petersburg sites, most trajectories (84 percent for PAFL and 90 percent for ORFL) originated with 400 miles of ORFL and PAFL. The average trajectory length for ORFL and PAFL were 228 and 210 miles, respectively.

- The cluster maps for ORFL and PAFL also look like pinwheels, indicating that trajectories originated from a variety of directions, although the cluster maps do show that trajectories originating within 100 miles of the sites were most common.

Observations from Figures 10-30 through 10-35 for CCFL and FLFL include the following:

- Sampling was conducted at CCFL and FLFL from July 2008 through March 2009. Two full years' worth of back trajectories would likely have a different trajectory distribution than those presented in Figures 10-30 through 10-35.

- Back trajectories originated from a variety of directions from these sites, although easterly and northeasterly directions appear prevalent.

- The 24-hour air shed domains were slightly larger in size for these sites compared to the other Florida monitoring sites. The farthest away a trajectory originated was over the Atlantic, or greater than 650 miles away. However, most (89 percent for both sites) originated within 500 miles of the sites.

- The average trajectory lengths for CCFL and FLFL were 303 miles and 308 miles, respectively. These average trajectory distances were among the highest for all NMP sites.

- The 2008 cluster maps for these sites show that most trajectories (greater than 60 percent) originated eastward over the Atlantic Ocean. A cluster analysis for 2009 could not be performed because fewer than 30 sample days are available for 2009 for these sites.

10.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations near the Florida sites, as presented in Section 10.2.2, were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 10-36 presents five different wind roses for the AZFL monitoring site. First, a historical wind rose representing 1999 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 10-37 through 10-43 present the five different wind roses for the remaining Florida monitoring sites.

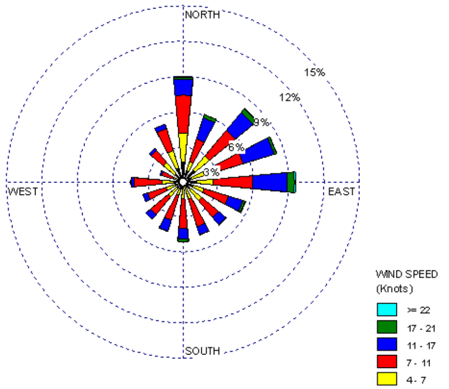
Observations from Figure 10-36 for AZFL include the following:

- The historical wind rose shows that calm winds (≤ 2 knots) account for less than 10 percent of the hourly wind measurements from 1999 to 2007. Northerly, northeasterly, and easterly winds were the most commonly observed wind directions near AZFL while winds from the southwest to west-northwest were the least frequently observed wind directions.

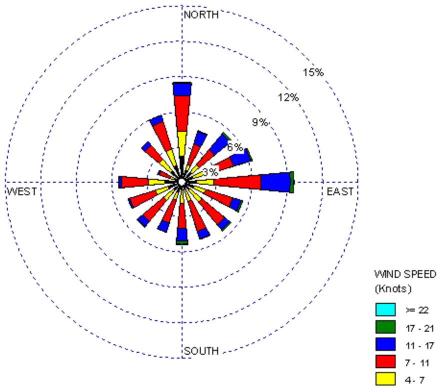
- The 2008 and 2009 wind roses are generally similar in wind patterns to the historical wind rose, indicating that conditions during 2008 and 2009 were representative of those experienced historically.

- The 2008 sample day wind patterns favor the full-year wind patterns, although a higher percentage of southerly winds were observed. Similarly, the 2009 sample day wind patterns favor the full-year wind patterns, although a higher percentage of west-southwesterly winds were observed.

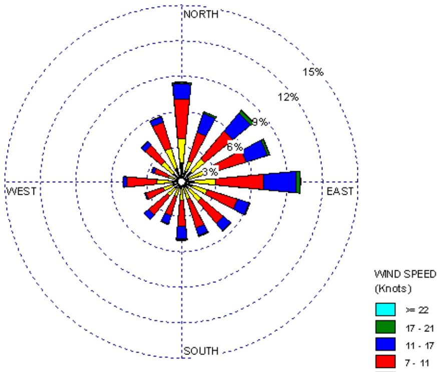
Figure 10-36. Wind Roses for the St. Petersburg/Whitted Airport Weather Station near AZFL



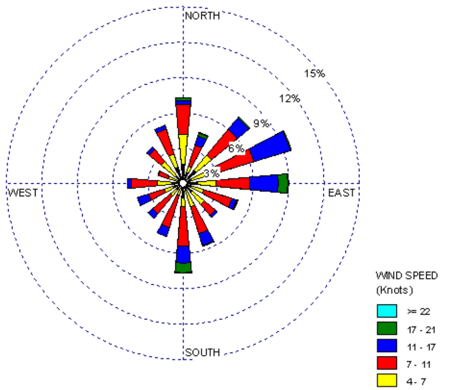
2008 Wind Rose



2009 Wind Rose

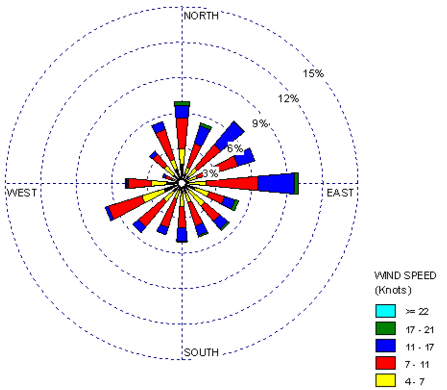


1999 – 2007
Historical Wind Rose



2008 Sample Day

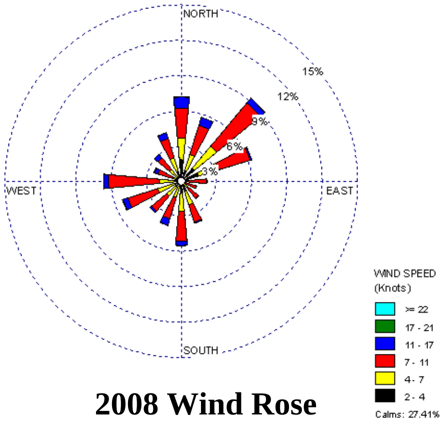
Wind Rose



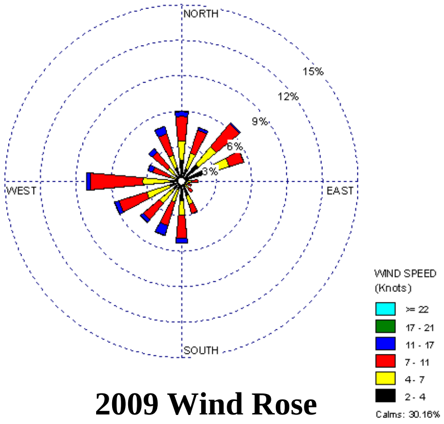
2009 Sample Day

Wind Rose

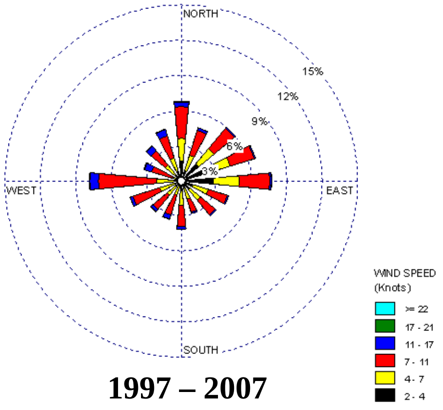
Figure 10-37. Wind Roses for the Tampa International Airport Weather Station near GAFL



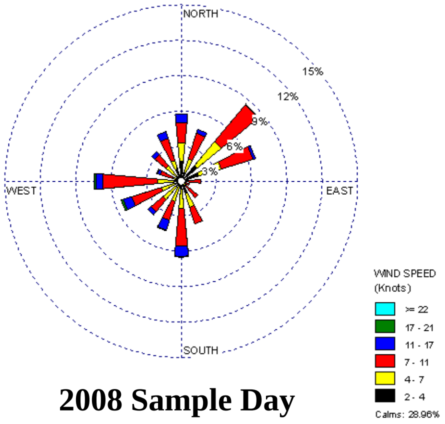
2008 Wind Rose



2009 Wind Rose

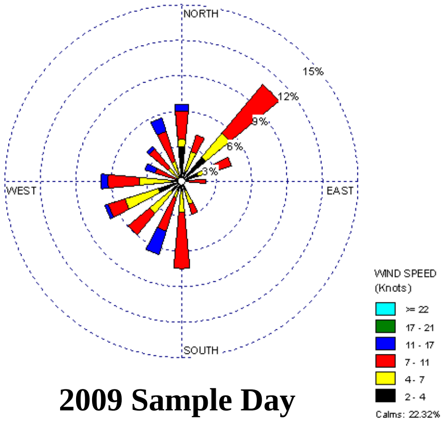


1997 – 2007
Historical Wind Rose



2008 Sample Day

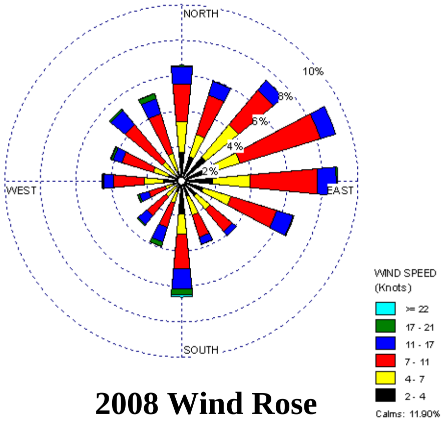
Wind Rose



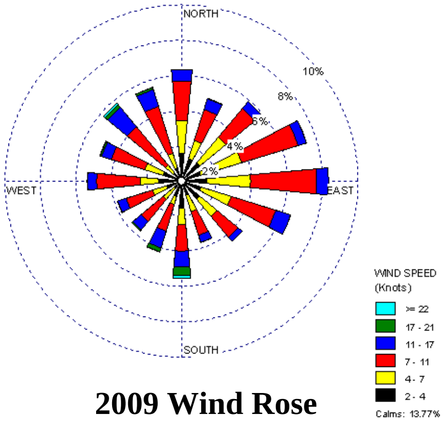
2009 Sample Day

Wind Rose

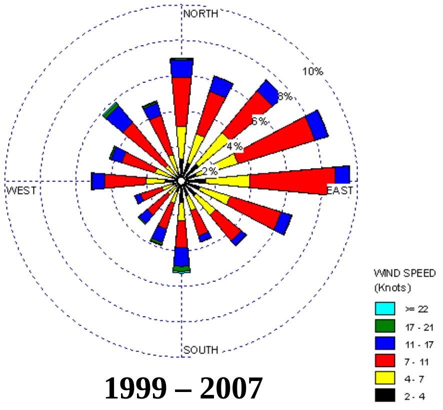
Figure 10-38. Wind Roses for the St. Petersburg/Clearwater International Airport Weather Station near SKFL



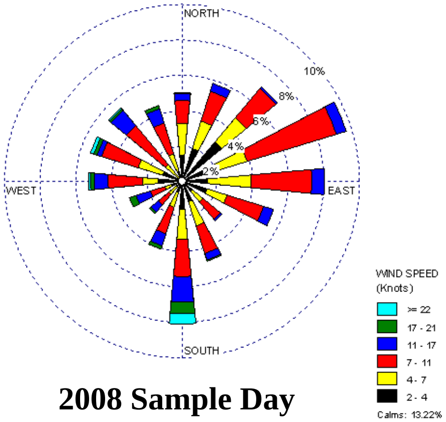
2008 Wind Rose



2009 Wind Rose

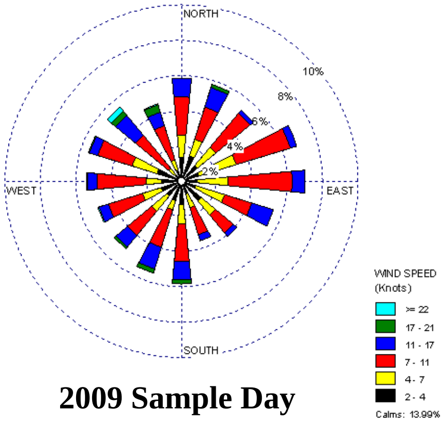


1999 – 2007
Historical Wind Rose



2008 Sample Day

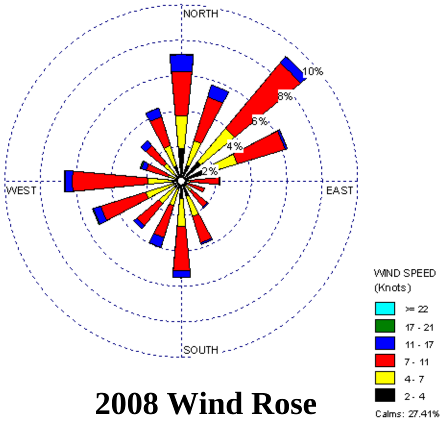
Wind Rose



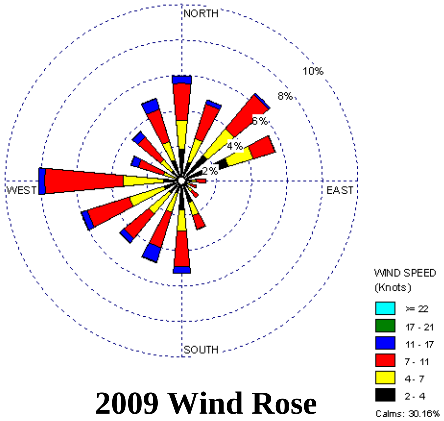
2009 Sample Day

Wind Rose

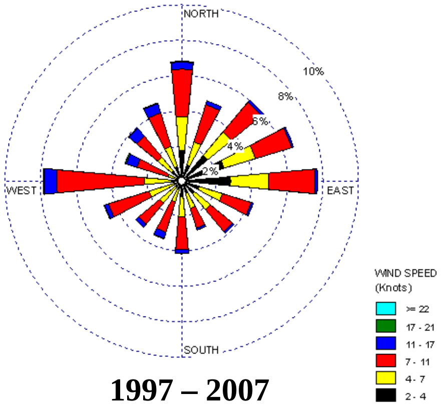
Figure 10-39. Wind Roses for the Tampa International Airport Weather Station near SYFL



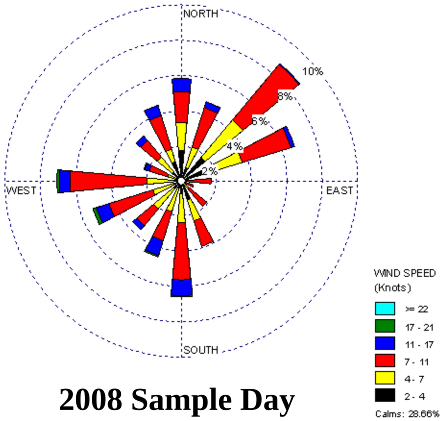
2008 Wind Rose



2009 Wind Rose

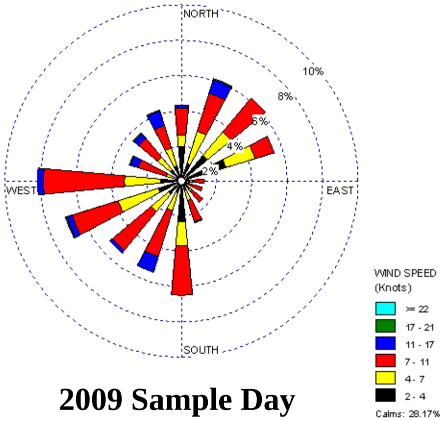


1997 – 2007
Historical Wind Rose



2008 Sample Day

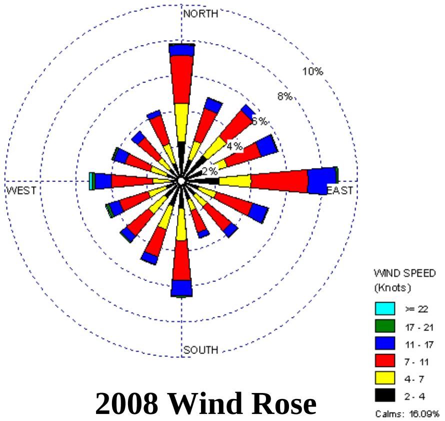
Wind Rose



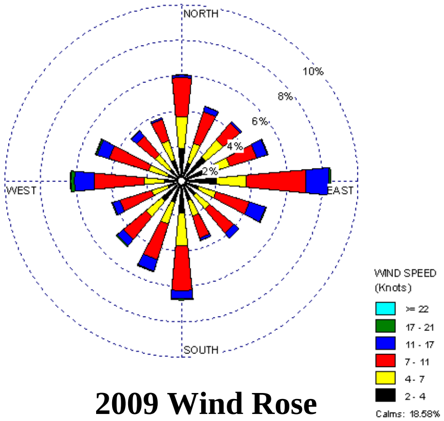
2009 Sample Day

Wind Rose

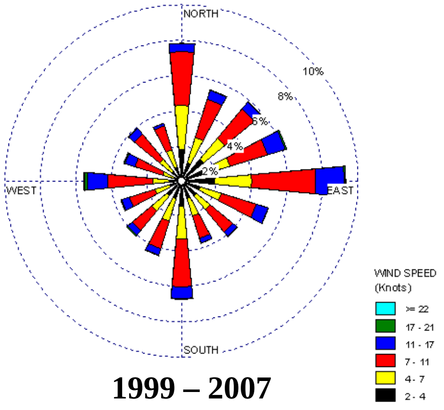
Figure 10-40. Wind Roses for the Orlando Executive Airport Weather Station near ORFL



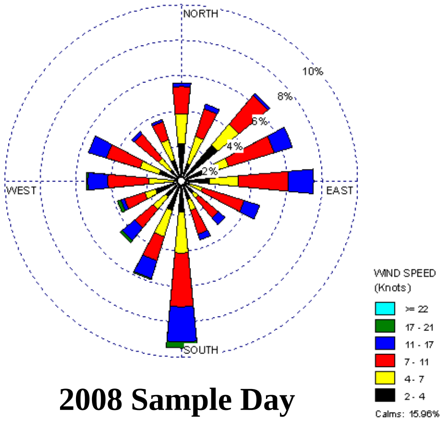
2008 Wind Rose



2009 Wind Rose

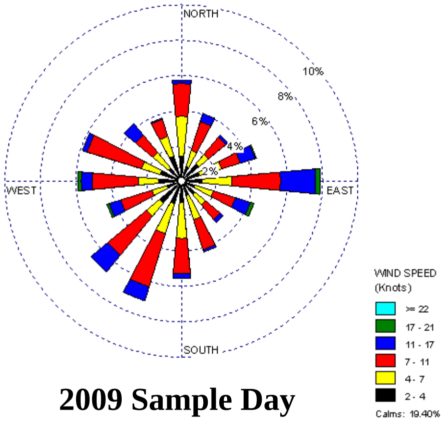


1999 – 2007
Historical Wind Rose



2008 Sample Day

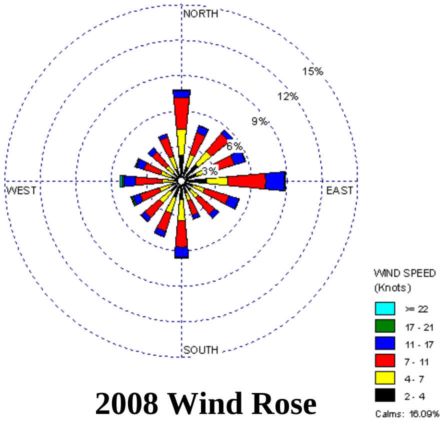
Wind Rose



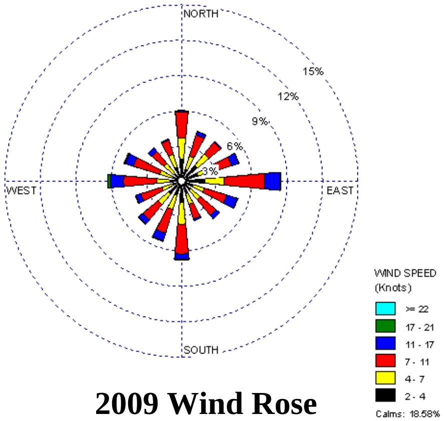
2009 Sample Day

Wind Rose

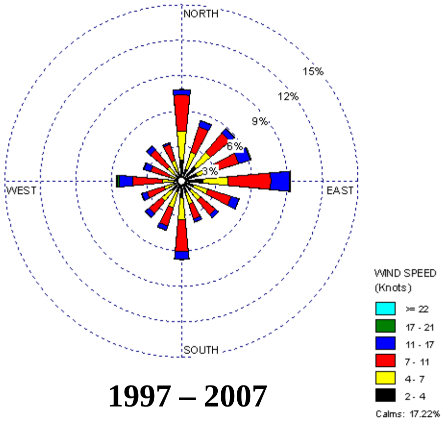
Figure 10-41. Wind Roses for the Orlando Executive Airport Weather Station near PAFL



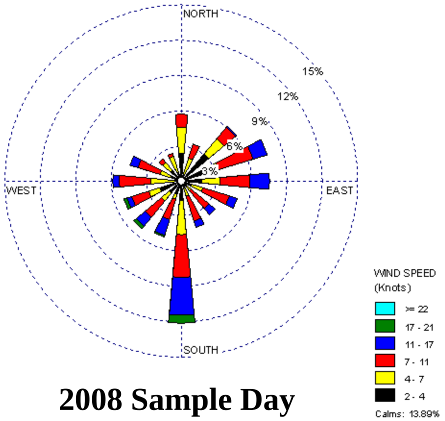
2008 Wind Rose



2009 Wind Rose

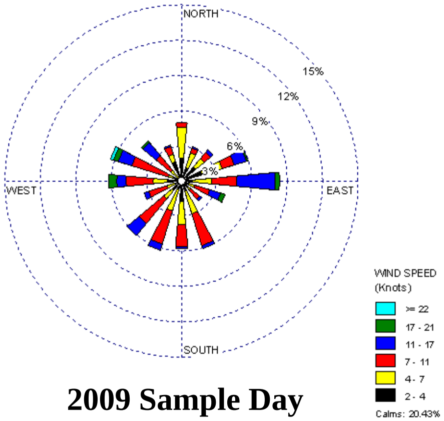


1997 – 2007
Historical Wind Rose



2008 Sample Day

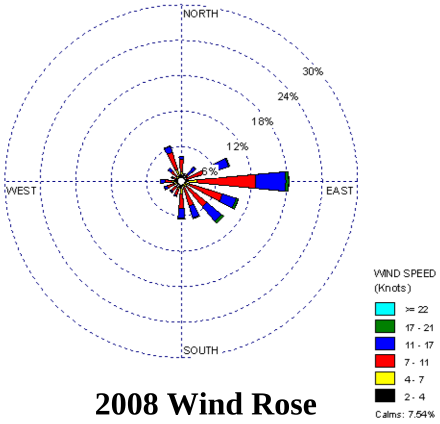
Wind Rose



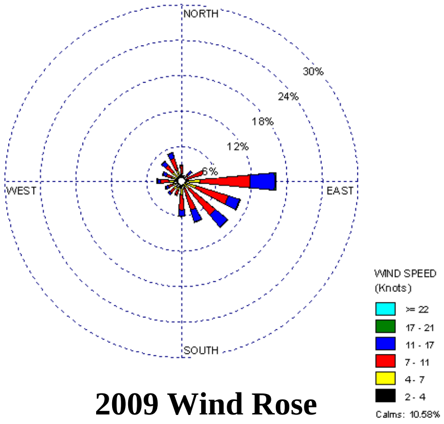
2009 Sample Day

Wind Rose

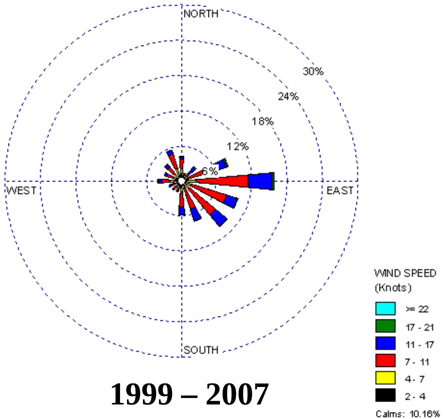
Figure 10-42. Wind Roses for the Pompano Beach Airpark Airport Weather Station near CCFL



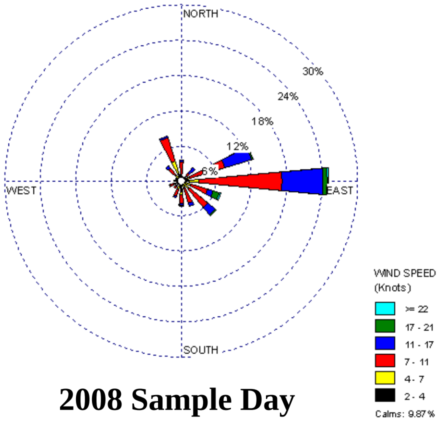
2008 Wind Rose



2009 Wind Rose

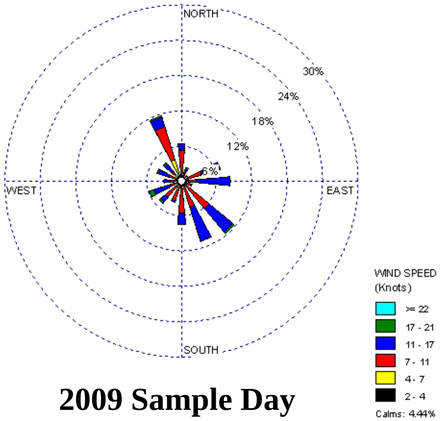


1999 – 2007
Historical Wind Rose



2008 Sample Day

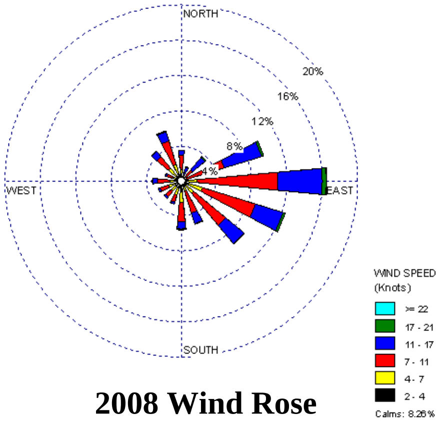
Wind Rose



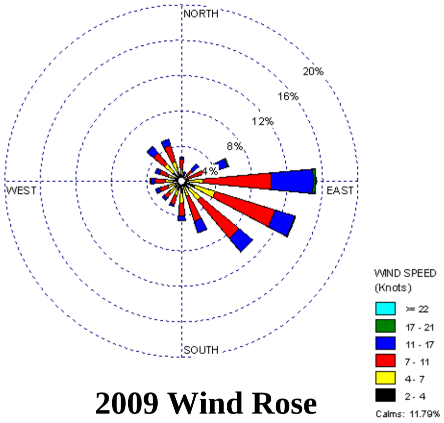
2009 Sample Day

Wind Rose

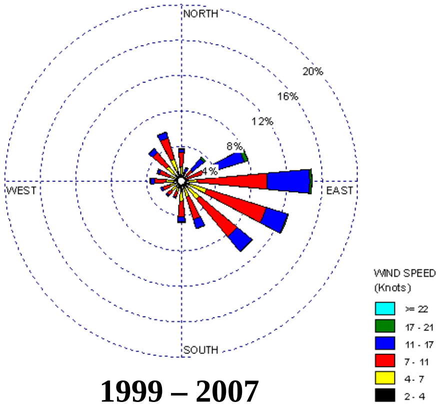
Figure 10-43. Wind Roses for the Ft. Lauderdale/Hollywood International Airport Weather Station near FLFL



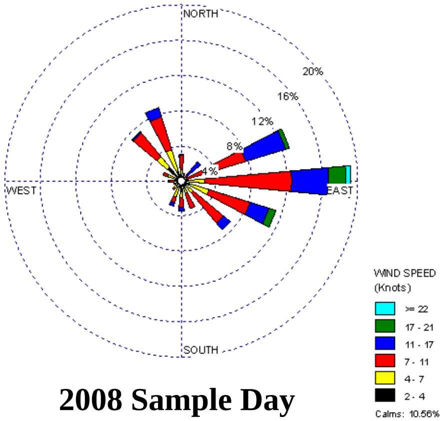
2008 Wind Rose



2009 Wind Rose

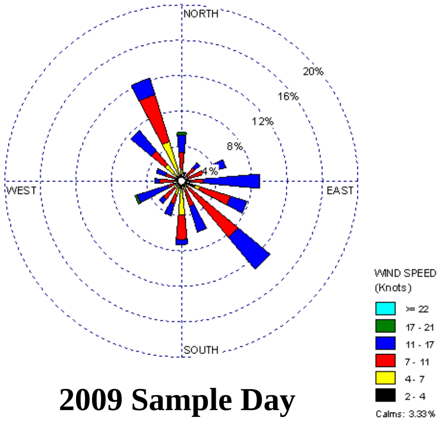


1999 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 10-37 for GAFL include the following:

- The historical wind rose shows that calm winds (≤ 2 knots) account for nearly one-fifth of the hourly wind measurements from 1997 to 2007. Northerly, northeasterly, and easterly winds were commonly observed near GAFL, although westerly winds were observed just as often.

- The 2008 and 2009 wind roses exhibit a higher number of calm wind observations compared to the historical wind rose, as well as fewer observations of easterly and southeasterly winds.

- The 2008 sample day wind patterns are generally similar to the full-year wind patterns, indicating that conditions on sample days were similar to those experienced throughout the year. The 2009 sample day wind rose shows a higher number of northeasterly wind observations as well as southerly and southwesterly wind observations than the full-year wind rose. The 2009 sample day wind rose only includes sample days through March 2009, which likely explains the differences shown in Figure 10-37.

Observations from Figure 10-38 for SKFL include the following:

- The historical wind rose shows that winds from a variety of directions were observed near SKFL from 1999 to 2007, although northerly, northeasterly, easterly, and east-southeasterly winds were most common. Calm winds account for approximately 10 percent of the hourly wind measurements.

- The 2008 and 2009 wind patterns are similar to those shown on the historical wind rose, indicating that conditions during 2008 and 2009 were representative of those experienced historically.

- The 2008 sample day wind rose is similar in wind patterns to the full-year wind rose.

- The 2009 sample day wind rose is also similar in wind patterns to the full-year wind rose.

Observations from Figure 10-39 for SYFL include the following:

- The historical wind rose shows that calm winds (≤ 2 knots) account for approximately one-fifth of the hourly wind measurements from 1997 to 2007. Winds from all directions are observed near SYFL, although winds with a southerly component are observed less often than winds from other directions. Winds from due west and due east were observed the most.

- The 2008 wind rose exhibits a higher percentage of calm winds, an increased number of winds from the northeast, an increased number of winds from the south, and fewer winds from due east. The 2008 sample day wind rose is similar in wind patterns to the full-year wind rose, indicating that conditions on sample days were representative of wind conditions experienced throughout the year.

- The 2009 wind rose also exhibits a higher percentage of calm winds than the historical wind rose, but shows an increased percentage of winds from the south to southwest to west and even fewer winds from due east. The 2009 sample day wind rose is similar in wind patterns to the full-year wind rose, indicating that conditions on sample days were representative of wind conditions experienced throughout the year.

Observations from Figures 10-40 and 10-41 for ORFL and PAFL include the following:

- The closest NWS station to ORFL and PAFL is the Orlando Executive Airport. Thus, the historical and full-year wind roses for these sites are the same. (Note that the wind roses for PAFL are on a 15 percent scale while the ORFL wind roses are on a 10 percent scale. The scales are different in order to accommodate the different percentage ranges for the sample day wind roses.)

- The historical wind rose shows that from 1999 to 2007 winds from all directions were observed near ORFL, although winds from the due north, due south, due east or with an easterly component are observed more often than winds from the remaining directions.

- The 2008 and 2009 wind roses exhibit similar wind direction distributions as the historical wind rose, indicating that conditions during the years of sampling were similar to those experienced historically near ORFL and PAFL.

- The 2008 sample day wind roses for both sites show a higher percentage of southerly winds observed. The 2009 sample day wind rose for ORFL shows a higher percentage of south-southwesterly and southwesterly winds observed. This is also true for PAFL, although south-southeasterly winds were also observed more frequently.

Observations from Figures 10-42 and 10-43 for CCFL and FLFL include the following:

- The closest NWS station to CCFL is Pompano Beach Airpark and the closest weather station to FLFL is Ft. Lauderdale International Airport. These stations are approximately 12 miles apart and both reside within 3 miles of the Atlantic Ocean. It is not surprising then that the wind patterns shown on the historical and full-year wind roses for these sites are similar to each other. (Note that the wind roses for CCFL are on a 30 percent scale while the FLFL wind roses are on a 20 percent scale).

- The historical and full-year wind roses for these sites show that winds from the east-northeast to southeast accounted for nearly 50 percent of the wind observations. Calm winds were observed for approximately 10 percent of observations near CCFL and FLFL.

- These two sites operated from July 2008 to March 2009. Thus, the sample day wind roses reflect sample days only within this time frame.

- The 2008 sample day wind patterns are similar to their full-year wind patterns, while the 2009 sample day wind patterns show more variability. Both 2009 sample day wind roses exhibit a higher percentage of north-northwesterly winds, fewer easterly winds and a much lower calm rate. These differences likely illustrate seasonal variations in wind patterns at these locations.

10.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Florida monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 10-4 presents the pollutants of interest for each of the Florida monitoring sites. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. AZFL, GAFL, and ORFL sampled for carbonyl compounds only. SKFL and SYFL sampled hexavalent chromium and PAH in addition to carbonyl compounds. PAFL sampled only PM_{10} metals. Finally, CCFL and FLFL sampled only VOC.

Table 10-4. Risk Screening Results for the Florida Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Petersburg, Florida - AZFL						
Formaldehyde	0.077	121	121	100.00	50.21	50.21
Acetaldehyde	0.45	120	121	99.17	49.79	100.00
Total		241	242	99.59		
Coconut Creek, Florida - CCFL						
Benzene	0.13	42	42	100.00	25.61	25.61
Carbon Tetrachloride	0.17	42	42	100.00	25.61	51.22
1,3-Butadiene	0.033	24	39	61.54	14.63	65.85
p-Dichlorobenzene	0.091	19	36	52.78	11.59	77.44
Tetrachloroethylene	0.17	15	38	39.47	9.15	86.59
Ethylbenzene	0.4	10	42	23.81	6.10	92.68
Acrylonitrile	0.015	4	4	100.00	2.44	95.12
Bromomethane	0.5	2	41	4.88	1.22	96.34
Dichloromethane	2.1	2	42	4.76	1.22	97.56
Chloromethylbenzene	0.02	1	1	100.00	0.61	98.17
1,2-Dichloroethane	0.038	1	1	100.00	0.61	98.78
cis-1,3-Dichloropropene	0.25	1	1	100.00	0.61	99.39
trans-1,3-Dichloropropene	0.25	1	1	100.00	0.61	100.00
Total		164	330	49.70		
Davie, Florida - FLFL						
Benzene	0.13	43	43	100.00	24.29	24.29
Carbon Tetrachloride	0.17	43	43	100.00	24.29	48.59
1,3-Butadiene	0.033	26	40	65.00	14.69	63.28
p-Dichlorobenzene	0.091	26	42	61.90	14.69	77.97
Tetrachloroethylene	0.17	24	38	63.16	13.56	91.53
Ethylbenzene	0.4	12	43	27.91	6.78	98.31
Acrylonitrile	0.015	1	1	100.00	0.56	98.87
Bromomethane	0.5	1	42	2.38	0.56	99.44
Chloromethane	9	1	43	2.33	0.56	100.00
Total		177	335	52.84		
Tampa, Florida - GAFL						
Formaldehyde	0.077	74	74	100.00	50.34	50.34
Acetaldehyde	0.45	73	74	98.65	49.66	100.00
Total		147	148	99.32		
Winter Park, Florida - ORFL						
Formaldehyde	0.077	120	120	100.00	50.42	50.42
Acetaldehyde	0.45	118	120	98.33	49.58	100.00
Total		238	240	99.17		

Table 10-4. Risk Screening Results for the Florida Monitoring Sites (Continued)

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Orlando, Florida - PAFL						
Arsenic (PM_{10})	0.00023	58	61	96.30	87.88	87.88
Manganese (PM_{10})	0.005	4	61	7.41	6.06	93.94
Lead (PM_{10})	0.015	3	61	5.56	4.55	98.48
Nickel (PM_{10})	0.009	1	61	1.85	1.52	100.00
Total		66	244	27.05		
Pinellas Park, Florida - SKFL						
Acetaldehyde	0.45	121	121	100.00	34.87	34.87
Formaldehyde	0.077	121	121	100.00	34.87	69.74
Naphthalene	0.029	100	111	90.09	28.82	98.56
Hexavalent Chromium	0.000083	3	56	5.36	0.86	99.42
Benzo(a)pyrene	0.00091	2	93	2.15	0.58	100.00
Total		347	502	69.12		
Plant City, Florida - SYFL						
Formaldehyde	0.077	120	120	100.00	39.09	39.09
Acetaldehyde	0.45	119	120	99.17	38.76	77.85
Naphthalene	0.029	67	105	63.81	21.82	99.67
Propionaldehyde	0.8	1	120	0.83	0.33	100.00
Total		307	465	66.02		

Observations from Table 10-4 include the following:

- Acetaldehyde and formaldehyde were the only two pollutants to fail screens for AZFL, GAFL, and ORFL. These two pollutants contributed equally to the total number of failed screens for each site. These three sites sampled only carbonyl compounds; acetaldehyde, formaldehyde, and propionaldehyde are the only carbonyl compounds with screening values. Propionaldehyde did not fail any screens for these three sites.

- Thirteen VOC failed screens for CCFL, of which four are NATTS MQO Core Analytes. The risk screening process yielded seven pollutants of interest, including the four NATTS MQO Core Analytes. Three additional VOC NATTS MQO Core Analytes (chloroform, trichloroethylene, and vinyl chloride) were added to CCFL's pollutants of interest, even though they did not fail any screens. These three pollutants are not shown in Table 10-4.

- Nine VOC failed screens for FLFL, of which four are NATTS MQO Core Analytes. The risk screening process yielded six pollutants of interest, including the four NATTS MQO Core Analytes. Three additional VOC NATTS MQO Core Analytes (chloroform, vinyl chloride, and trichloroethylene) were added to FLFL's pollutants of interest, even though they did not fail any screens. These three pollutants are not shown in Table 10-4.

- Four metals (arsenic, lead, nickel, and manganese) failed screens for PAFL; all of these are NATTS MQO Core Analytes. Arsenic, manganese, and lead were initially identified as PAFL's pollutants of interest, with arsenic failing the bulk of the screens (88 percent). Nickel was added as a pollutant of interest because it is a NATTS MQO Core Analyte. Two additional metal NATTS MQO Core Analytes, cadmium and beryllium, were added to PAFL's pollutants of interest, even though they did not fail any screens. These two pollutants are not shown in Table 10-4.

- Five pollutants failed screens for SKFL, all of which are NATTS MQO Core Analytes. While hexavalent chromium and benzo(a)pyrene were not identified as pollutants of interest through the risk screening process, they were added because they are NATTS MQO Core Analytes.

- Four pollutants failed screens for SYFL; three of these are NATTS MQO Core Analytes and were initially identified as SYFL's pollutants of interest. Two additional NATTS MQO Core Analytes, hexavalent chromium and benzo(a)pyrene, were added to SYFL's pollutants of interest, even though they did not fail any screens. These pollutants are not shown in Table 10-4.

- Of the five sites sampling carbonyl compounds, formaldehyde failed 100 percent of screens for all five sites. Of the two sites sampling VOC, benzene and carbon tetrachloride failed 100 percent of screens for both sites.

10.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Florida monitoring sites. Concentration averages are provided for the pollutants of interest for each Florida site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

10.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Florida site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 10-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium are presented in ng/m^3 for ease of viewing.

Table 10-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
St. Petersburg, Florida – AZFL												
Acetaldehyde	1.23 ± 0.13	1.21 ± 0.26	1.10 ± 0.24	1.26 ± 0.36	1.35 ± 0.21	1.23 ± 0.13	2.37 ± 0.41	1.51 ± 0.39	0.99 ± 0.18	3.00 ± 0.79	3.55 ± 0.77	2.37 ± 0.41
Formaldehyde	3.02 ± 0.18	2.84 ± 0.36	3.24 ± 0.52	2.93 ± 0.30	3.08 ± 0.28	3.02 ± 0.18	2.01 ± 0.30	3.24 ± 0.35	3.16 ± 0.41	1.03 ± 0.18	1.05 ± 0.11	2.01 ± 0.30
Coconut Creek, Florida – CCFL												
Acrylonitrile	ND	NR	NR	NA	NA	NA	0.08 ± 0.08	NA	NR	NR	NR	NA
Benzene	1.04 ± 0.45	NR	NR	0.78 ± 0.29	1.24 ± 0.78	NA	1.04 ± 0.44	1.04 ± 0.44	NR	NR	NR	NA
1,3-Butadiene	0.07 ± 0.03	NR	NR	0.07 ± 0.04	0.07 ± 0.05	NA	0.04 ± 0.02	0.04 ± 0.02	NR	NR	NR	NA
Carbon Tetrachloride	0.75 ± 0.08	NR	NR	0.80 ± 0.11	0.71 ± 0.11	NA	0.69 ± 0.08	0.69 ± 0.08	NR	NR	NR	NA
Chloroform	0.29 ± 0.07	NR	NR	0.26 ± 0.04	0.29 ± 0.13	NA	0.16 ± 0.05	0.16 ± 0.05	NR	NR	NR	NA
p-Dichlorobenzene	0.15 ± 0.05	NR	NR	0.16 ± 0.07	0.09 ± 0.05	NA	0.07 ± 0.02	0.06 ± 0.02	NR	NR	NR	NA
Ethylbenzene	0.48 ± 0.24	NR	NR	0.56 ± 0.47	0.43 ± 0.25	NA	0.23 ± 0.08	0.23 ± 0.08	NR	NR	NR	NA
Tetrachloroethylene	0.26 ± 0.13	NR	NR	0.27 ± 0.25	0.19 ± 0.11	NA	0.12 ± 0.04	0.12 ± 0.04	NR	NR	NR	NA
Trichloroethylene	0.10 ± 0.07	NR	NR	NA	NA	NA	0.05 ± 0.05	NA	NR	NR	NR	NA
Vinyl Chloride	ND	NR	NR	NA	NA	NA	0.02 ± 0.02	NA	NR	NR	NR	NA

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.
ND = Not detected during sampling for this time period.
[a] Average concentrations provided for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Table 10-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Davie, Florida – FLFL												
Benzene	0.99 ± 0.23	NR	NR	1.05 ± 0.46	0.95 ± 0.27	NA	0.99 ± 0.36	0.99 ± 0.36	NR	NR	NR	NA
1,3-Butadiene	0.07 ± 0.02	NR	NR	0.07 ± 0.04	0.06 ± 0.03	NA	0.04 ± 0.02	0.04 ± 0.02	NR	NR	NR	NA
Carbon Tetrachloride	0.83 ± 0.08	NR	NR	0.87 ± 0.11	0.80 ± 0.11	NA	0.76 ± 0.11	0.76 ± 0.11	NR	NR	NR	NA
Chloroform	0.24 ± 0.04	NR	NR	0.23 ± 0.09	0.21 ± 0.06	NA	0.15 ± 0.03	0.15 ± 0.03	NR	NR	NR	NA
p-Dichlorobenzene	0.21 ± 0.08	NR	NR	0.27 ± 0.17	0.16 ± 0.08	NA	0.12 ± 0.06	0.12 ± 0.06	NR	NR	NR	NA
Ethylbenzene	0.38 ± 0.12	NR	NR	0.44 ± 0.22	0.35 ± 0.15	NA	0.30 ± 0.13	0.30 ± 0.13	NR	NR	NR	NA
Tetrachloroethylene	0.25 ± 0.06	NR	NR	0.21 ± 0.09	0.21 ± 0.09	NA	0.15 ± 0.04	0.15 ± 0.04	NR	NR	NR	NA
Trichloroethylene	0.14 ± 0.08	NR	NR	NA	NA	NA	0.07 ± 0.02	NA	NR	NR	NR	NA
Vinyl Chloride	0.01 ± <0.01	NR	NR	NA	NA	NA	0.02 ± <0.01	NA	NR	NR	NR	NA
Tampa, Florida – GAFL												
Acetaldehyde	2.07 ± 0.24	1.90 ± 0.46	1.79 ± 0.50	2.09 ± 0.40	2.54 ± 0.62	2.07 ± 0.24	2.97 ± 0.91	2.97 ± 0.91	NR	NR	NR	NA
Formaldehyde	1.67 ± 0.27	1.45 ± 0.49	2.13 ± 0.66	2.13 ± 0.44	0.94 ± 0.34	1.67 ± 0.27	0.94 ± 0.26	0.94 ± 0.26	NR	NR	NR	NA

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Table 10-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Winter Park, Florida – ORFL												
Acetaldehyde	1.66 ± 0.31	1.01 ± 0.19	1.22 ± 0.21	2.02 ± 0.90	2.52 ± 0.76	1.66 ± 0.31	1.73 ± 0.21	2.20 ± 0.72	1.86 ± 0.25	1.53 ± 0.21	1.31 ± 0.18	1.73 ± 0.21
Formaldehyde	2.17 ± 0.48	1.65 ± 0.24	2.88 ± 0.63	2.12 ± 0.40	2.06 ± 1.91	2.17 ± 0.48	2.10 ± 0.33	0.48 ± 0.15	2.82 ± 0.74	2.84 ± 0.43	2.21 ± 0.27	2.10 ± 0.33
Orlando, Florida - PAFL[a]												
Arsenic (PM$_{10}$) [a]	0.77 ± 0.16	0.58 ± 0.22	0.60 ± 0.36	0.81 ± 0.33	1.10 ± 0.40	0.77 ± 0.16	0.71 ± 0.16	0.88 ± 0.45	0.68 ± 0.41	0.65 ± 0.27	0.63 ± 0.25	0.71 ± 0.16
Beryllium (PM$_{10}$) [a]	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	0.01 ± 0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	NA	<0.01 ± <0.01
Cadmium (PM$_{10}$) [a]	0.10 ± 0.02	0.08 ± 0.03	0.08 ± 0.02	0.11 ± 0.07	0.12 ± 0.03	0.10 ± 0.02	0.08 ± 0.01	0.12 ± 0.03	0.08 ± 0.02	0.06 ± 0.01	0.07 ± 0.02	0.08 ± 0.01
Lead (PM$_{10}$) [a]	4.43 ± 1.77	7.42 ± 5.97	2.46 ± 0.83	3.06 ± 1.82	4.54 ± 3.18	4.43 ± 1.77	3.54 ± 1.11	4.95 ± 3.86	3.42 ± 1.59	2.80 ± 2.00	2.89 ± 1.24	3.54 ± 1.11
Manganese (PM$_{10}$) [a]	2.52 ± 0.49	2.23 ± 0.75	3.16 ± 1.40	2.42 ± 1.12	2.32 ± 1.02	2.52 ± 0.49	2.68 ± 0.77	2.93 ± 0.44	3.57 ± 2.99	2.56 ± 1.06	1.66 ± 0.38	2.68 ± 0.77
Nickel (PM$_{10}$)[a]	1.63 ± 0.80	0.76 ± 0.13	1.11 ± 0.30	3.55 ± 2.83	0.96 ± 0.20	1.63 ± 0.80	0.86 ± 0.11	1.14 ± 0.30	0.75 ± 0.11	0.73 ± 0.10	0.81 ± 0.19	0.86 ± 0.11
Pinellas Park, Florida – SKFL												
Acetaldehyde	2.43 ± 0.25	2.53 ± 0.49	2.64 ± 0.46	2.12 ± 0.36	2.43 ± 0.70	2.43 ± 0.25	2.87 ± 0.28	2.97 ± 0.87	2.62 ± 0.55	3.11 ± 0.33	2.79 ± 0.48	2.87 ± 0.28
Formaldehyde	1.76 ± 0.25	1.05 ± 0.11	1.50 ± 0.38	2.91 ± 0.50	1.59 ± 0.36	1.76 ± 0.25	1.28 ± 0.13	1.31 ± 0.23	1.04 ± 0.25	1.72 ± 0.25	1.07 ± 0.21	1.28 ± 0.13
Benzo(a)pyrene[a]	0.05 ± 0.01	NA	0.02 ± 0.01	0.03 ± 0.01	0.07 ± 0.04	0.04 ± 0.01	0.12 ± 0.06	0.08 ± 0.03	0.05 ± 0.01	0.22 ± 0.16	0.05 ± 0.03	0.11 ± 0.05

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Table 10-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Hexavalent Chromium [a]	0.03 ± 0.03	NR	NA	0.03 ± 0.05	0.01 ± 0.01	NA	0.03 ± 0.01	NA	0.02 ± 0.01	0.04 ± 0.03	0.01 ± 0.01	0.02 ± 0.01
Naphthalene [a]	82.51 ± 18.33	NA	57.93 ± 12.53	89.41 ± 30.77	104.47 ± 51.46	82.51 ± 18.33	92.80 ± 16.15	96.69 ± 39.49	63.75 ± 26.97	110.81 ± 27.57	94.67 ± 37.99	92.80 ± 16.15
Plant City, Florida – SYFL												
Acetaldehyde	1.20 ± 0.24	0.95 ± 0.18	1.62 ± 0.87	1.13 ± 0.36	1.13 ± 0.18	1.20 ± 0.24	1.15 ± 0.10	1.49 ± 0.25	1.09 ± 0.18	0.98 ± 0.13	1.06 ± 0.16	1.15 ± 0.10
Formaldehyde	2.42 ± 0.53	1.56 ± 0.24	3.04 ± 2.09	2.81 ± 0.48	2.34 ± 0.29	2.42 ± 0.53	2.60 ± 0.24	1.86 ± 0.25	3.19 ± 0.55	3.04 ± 0.43	2.25 ± 0.34	2.60 ± 0.24
Benzo(a)pyrene [a]	0.03 ± 0.01	NR	NA	NA	0.02 ± 0.01	NA	0.07 ± 0.02	0.05 ± 0.04	NA	NA	NA	NA
Hexavalent Chromium [a]	0.01 ± <0.01	NA	<0.01 ± <0.01	0.01 ± 0.01	NA	NA	0.02 ± <0.01	NA	NA	NA	NA	NA
Naphthalene [a]	36.30 ± 5.61	NR	37.54 ± 9.12	33.33 ± 6.89	38.01 ± 13.51	36.30 ± 5.61	41.23 ± 5.71	44.45 ± 14.73	33.95 ± 13.86	45.20 ± 8.21	41.31 ± 9.63	41.23 ± 5.71

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Observations from Table 10-5 include the following:

- AZFL's 2008 daily average concentration of formaldehyde was the highest daily average concentration of all pollutants of interest among the Florida sites (3.02 ± 0.18 μg/m^3). Daily average concentrations of formaldehyde ranged from 0.97 ± 0.26 μg/m^3 (GAFL, 2009) to 3.02 ± 0.18 μg/m^3 (AZFL, 2008).

- The daily average concentrations of acetaldehyde ranged from 1.15 ± 0.10 μg/m^3 (SYFL, 2009) to 2.97 ± 0.91 μg/m^3 (GAFL, 2009). GAFL and SKFL's 2009 daily average concentrations of acetaldehyde ranked third and fifth highest (respectively) among all NMP sites sampling carbonyl compounds, as shown in Table 4-10.

- For the two sites sampling VOC, benzene had the highest daily average concentration of all of the pollutants of interest. For both sites, the daily average concentration of benzene for 2008 was very similar to the 2009 daily average concentration. Note that because sampling at CCFL and FLFL was performed from July 2008 to March 2009, few quarterly averages and no annual averages could be calculated.

- For PAFL, lead had the highest daily average concentration for both years among the PM_{10} metals. The first quarter lead average for 2008 is much higher than the other quarterly averages and also has a large confidence interval. A review of the data shows that the two highest concentrations of lead were measured during the first quarter of 2008 (20.2 ng/m^3 on February 12, 2008 and 17.7 ng/m^3 on March 31, 2008). Of the five concentrations greater than 10 ng/m^3 measured at PAFL, three were measured during the first quarter of 2008, one was measured during the fourth quarter of 2008, and one was measured during the first quarter of 2009. The confidence intervals for these two quarters also exhibit large confidence intervals.

- PAFL's 2008 daily average concentration of lead was the seventh highest among NMP sites sampling PM_{10} metals, as shown in Table 4-12. PAFL also had the sixth (2008) and ninth (2009) highest daily average concentrations of arsenic and the fifth highest daily average concentration of nickel (2008).

- SKFL began sampling hexavalent chromium in June 2008; thus, two quarterly averages and an annual average could not be calculated for 2008. The confidence interval for the third quarter 2008 is actually higher than the average itself, indicating the presence of outliers. A review of the data shows that the highest concentration of hexavalent chromium was measured on July 5, 2008. This was the eighth highest hexavalent chromium concentration measured for any NMP site sampling this pollutant over the 2-year period and, as discussed in Section 4.1.2, was one of several relatively high concentrations measured on this date. The 2008 daily average concentration for this site ranked 11th highest among all NMP sites sampling hexavalent chromium.

- SKFL and SYFL began sampling PAH in March 2008 and April 2008, respectively. The concentration averages of naphthalene for SYFL exhibit much less variability than the concentration averages for SKFL. The measurements for SYFL range from

9.22 to 116.5 ng/m^3, with a median concentration of 35.2 ng/m^3. Conversely, the measurements for SKFL range from 8.55 to 340 ng/m^3, with a median concentration of 64.5 ng/m^3.

10.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. Thus, AZFL, GAFL, ORFL, SKFL, and SYFL have sampled carbonyl compounds as part of the NMP for at least 5 consecutive years. Figures 10-44 through 10-53 present the 3-year rolling statistical metrics for acetaldehyde and formaldehyde for each of these sites. In addition, SYFL has sampled hexavalent chromium since 2005; thus, Figure 10-54 presents the 3-year rolling statistical metrics for hexavalent chromium for SYFL. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Observations from Figure 10-44 for acetaldehyde measurements at AZFL include the following:

- Carbonyl compounds have been measured at AZFL since 2001, making this site one of the longer running UATMP sites.
- The maximum acetaldehyde concentration was measured in 2003, but a similar concentration was also measured in 2009.
- The rolling average and median concentrations increased through the 2003-2005 time frame then began to decrease significantly. The rolling average actually increased for the 2007-2009 time frame, although the median continued its decreasing trend.
- The rolling averages and the median values are similar to each other for several of the 3-year periods shown, but the spread between the two increased for the final time frame. This indicates increasing variability in the central tendency of acetaldehyde concentrations measured over that period. The spread of concentrations measured also increased, as shown by widening difference between the 5th and 95th percentiles for this period. Note that of the 17 concentrations of acetaldehyde greater than 5 µg/m^3, six of them were measured in 2003, five in 2004, and six in 2009, with none measured in the years in between.
- Note that with the exception of the 2001-2003 time frame, the minimum concentration for each 3-year period is greater than zero. Only two non-detects of acetaldehyde have been reported since the onset of carbonyl compound sampling (both in 2001).

Figure 10-44. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at AZFL

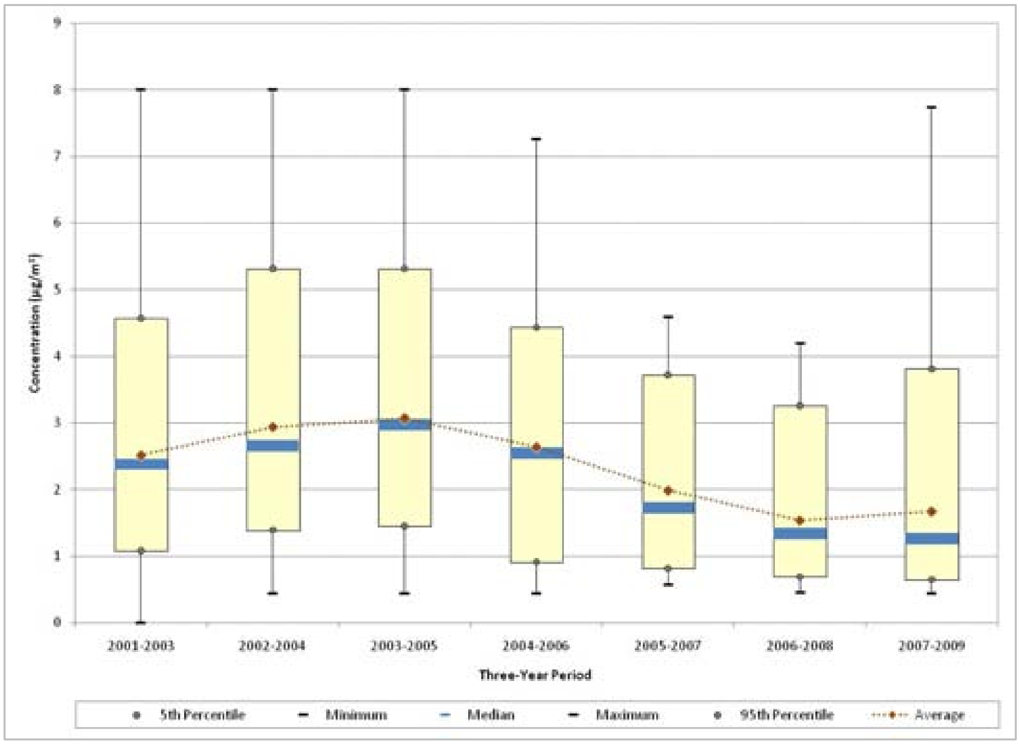


Figure 10-45. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at AZFL

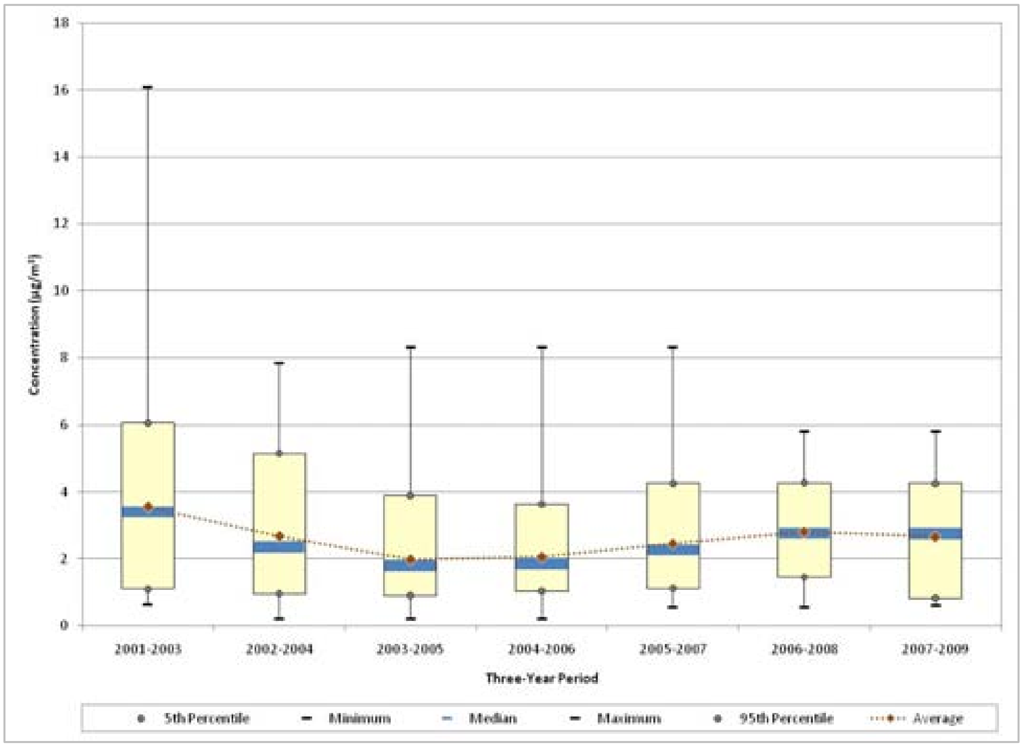


Figure 10-46. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at GAFL

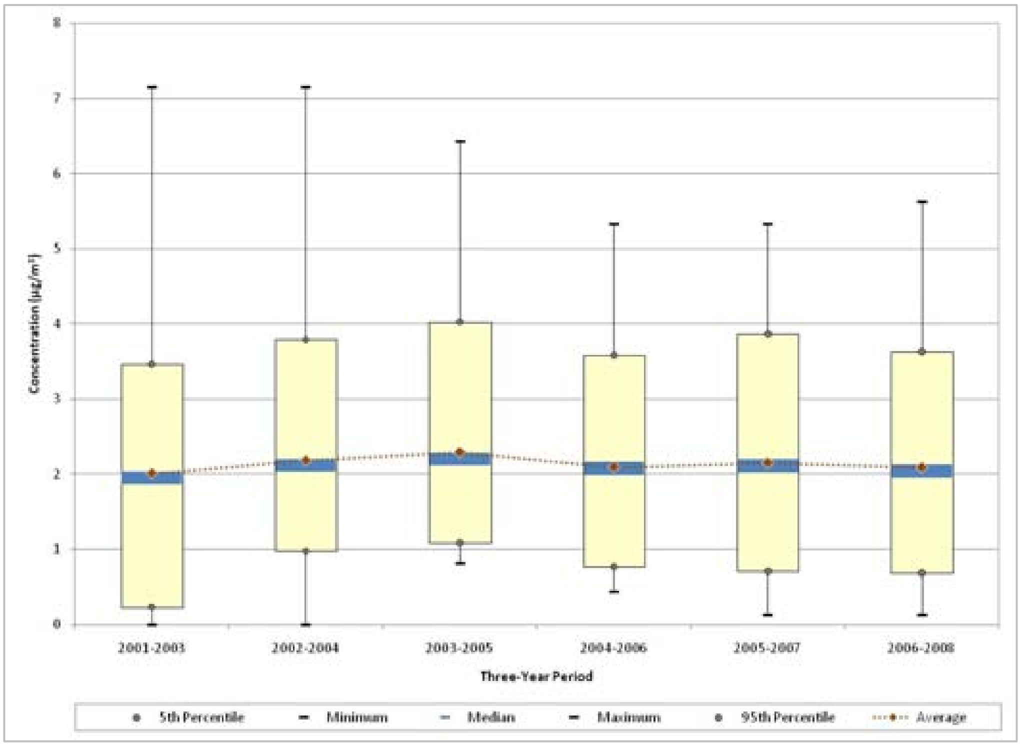


Figure 10-47. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at GAFL

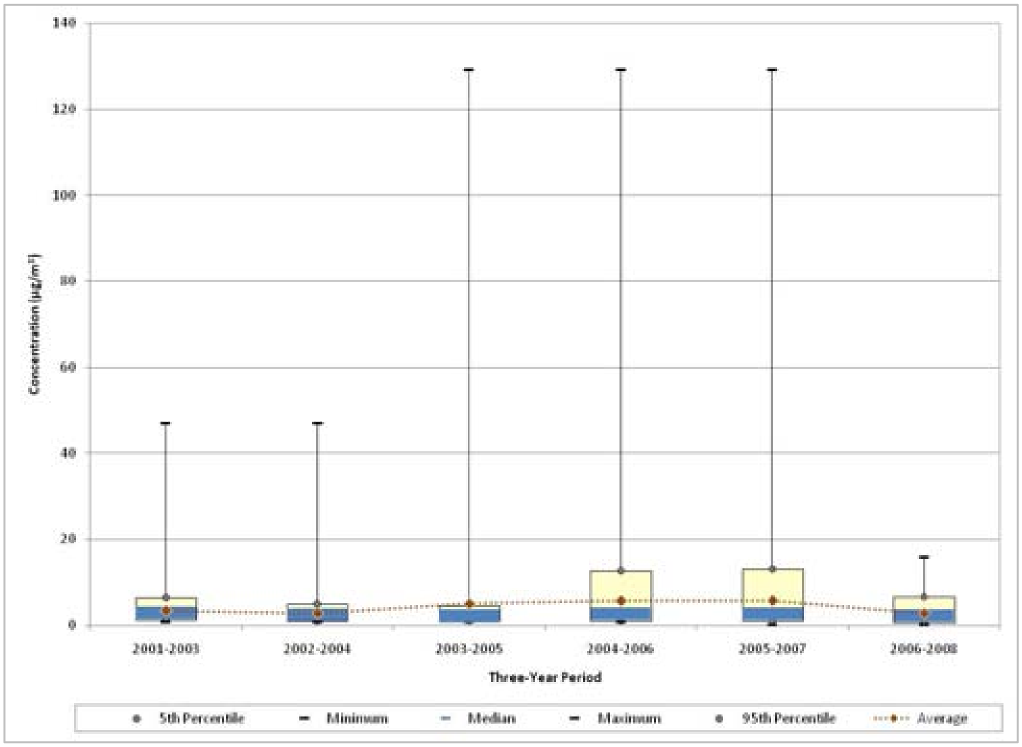
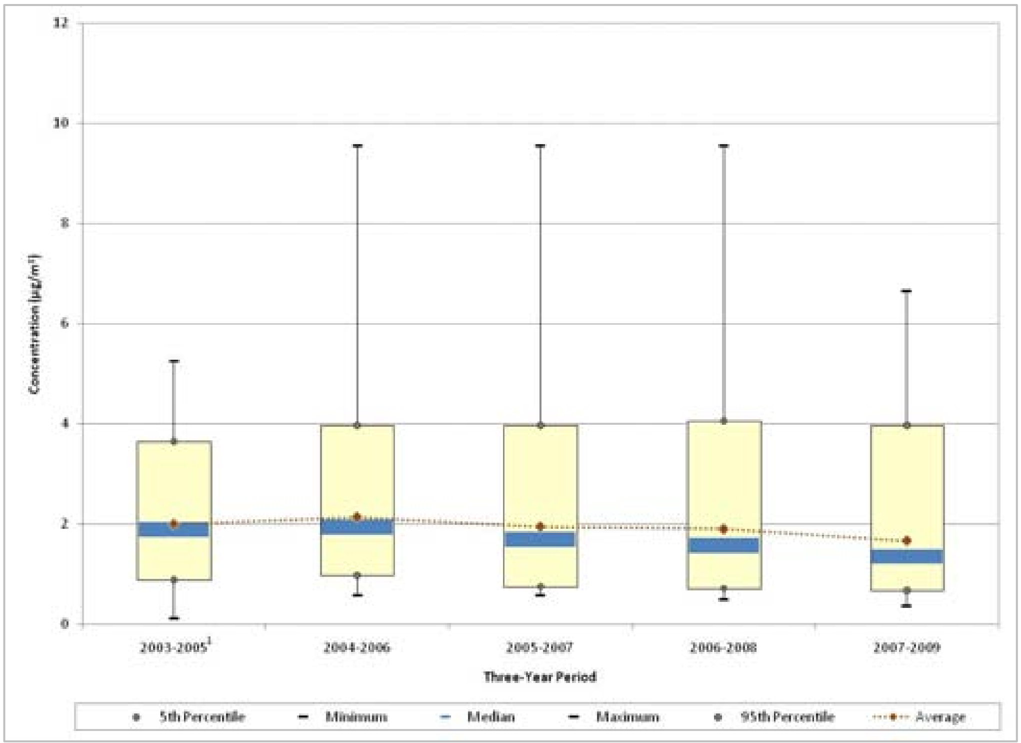
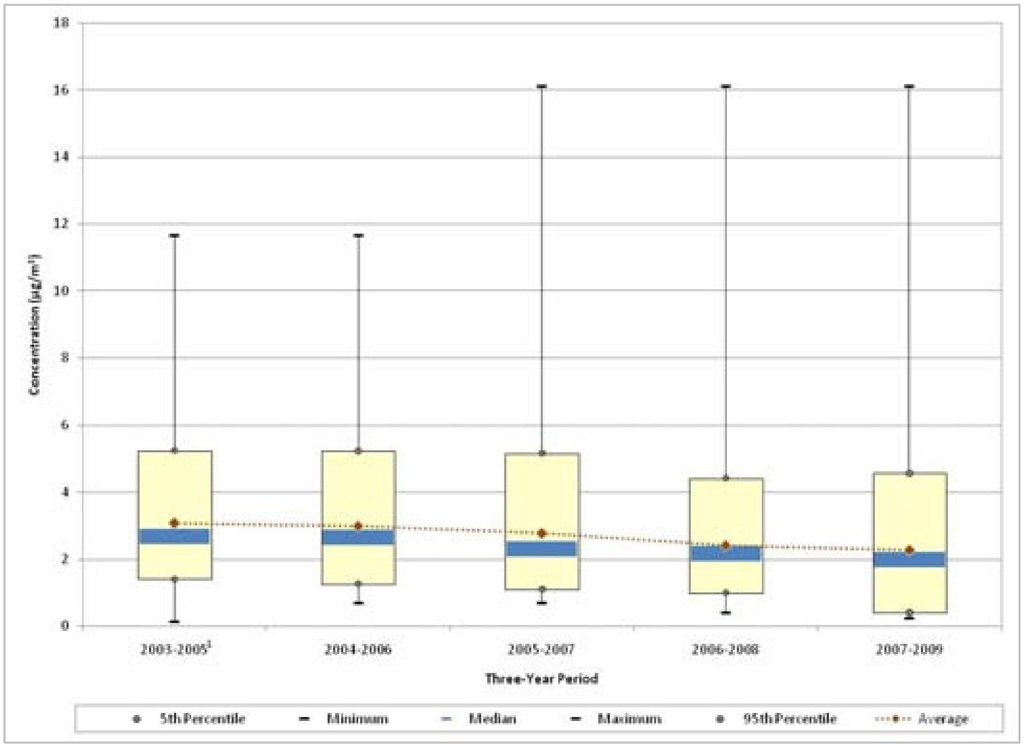


Figure 10-48. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at ORFL



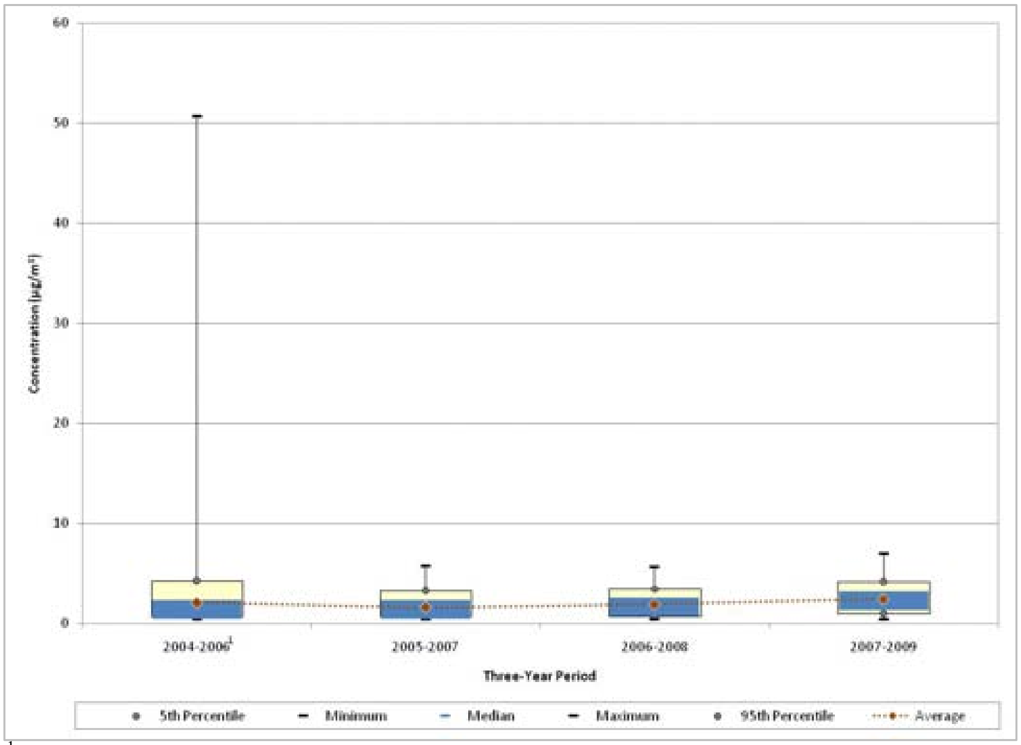
[1] Sampling for carbonyl compounds at ORFL began in April 2003.

Figure 10-49. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at ORFL



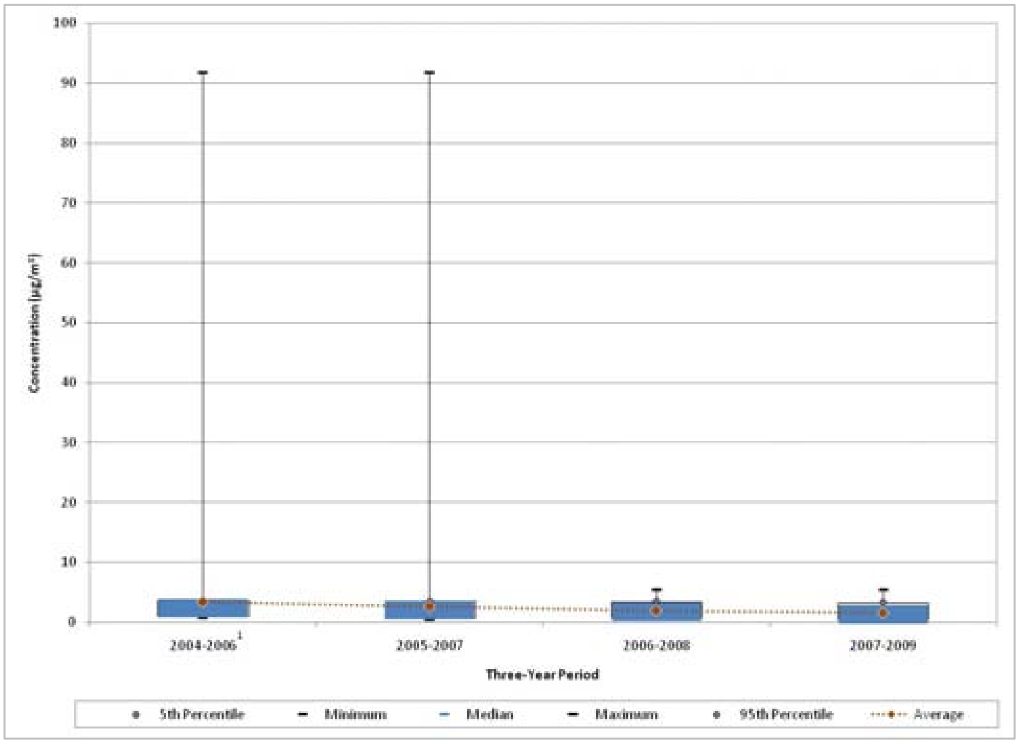
[1] Sampling for carbonyl compounds at ORFL began in April 2003.

Figure 10-50. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at SKFL



[1]Sampling for carbonyl compounds at SKFL began in July 2004.

Figure 10-51. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at SKFL



[1]Sampling for carbonyl compounds at SKFL began in July 2004.

Figure 10-52. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at SYFL

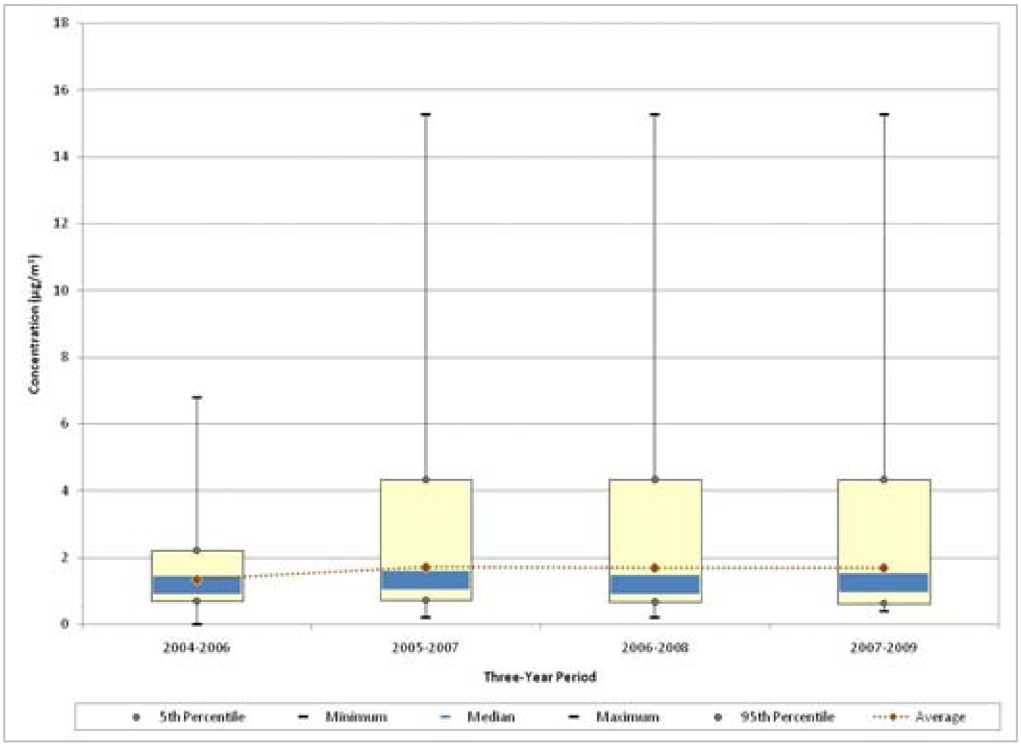


Figure 10-53. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at SYFL

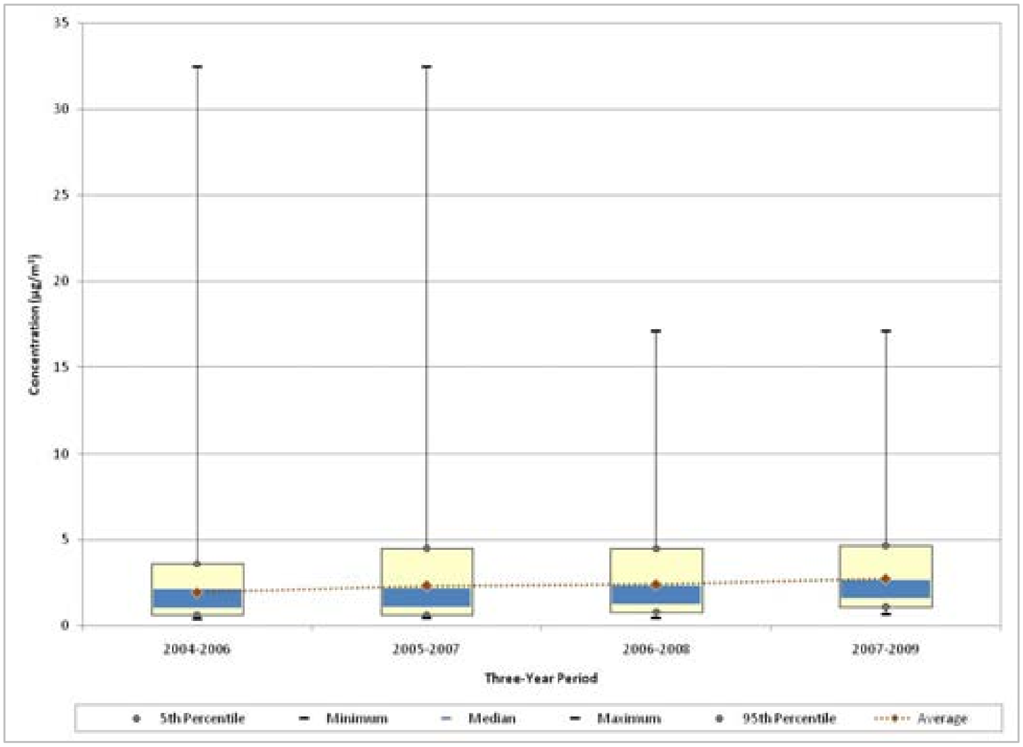
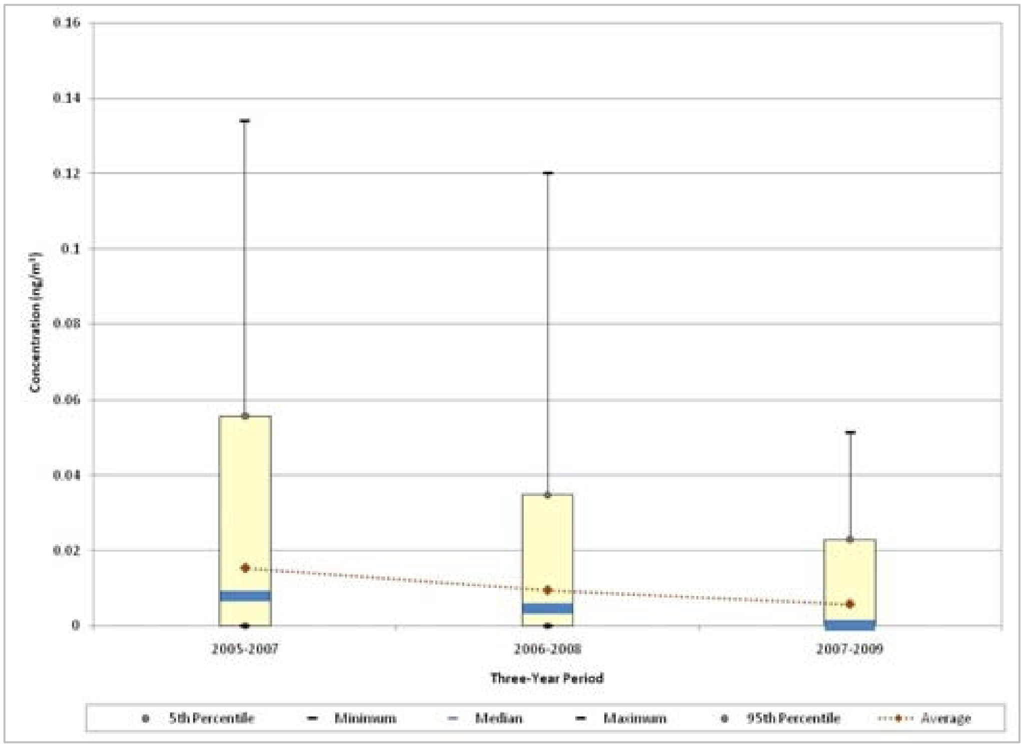


Figure 10-54. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at SYFL



Observations from Figure 10-45 for formaldehyde measurements at AZFL include the following:

- The maximum formaldehyde concentration was measured in 2001, after which the highest concentration measured decreased by nearly half. The three highest concentrations of formaldehyde were measured in 2001 and ranged from 9.30 to 16.09 µg/m^3.

- The rolling average concentration decreased through the 2003-2005 time frame, was static through 2004-2006, then began increasing again. The final time frame shows just a slight decrease from the previous 3-year period. The median concentrations show a similar pattern.

- Note that the trends for formaldehyde in Figure 10-45 are almost the opposite of the trends shown for acetaldehyde in Figure 10-44.

- The minimum concentration for each 3-year period is greater than zero. No non-detects of formaldehyde have been reported since the onset of carbonyl compound sampling in 2001.

Observations from Figure 10-46 for acetaldehyde measurements at GAFL include the following:

- Carbonyl compounds have also been measured at GAFL since 2001. However, this site stopped sampling in March 2009; thus, 2009 data have not been included in Figure 10-46.

- The maximum acetaldehyde concentration was measured in 2002. The first two 3-year periods have the widest range of concentrations measured.

- The rolling average concentrations have not changed significantly over the 8 years of sampling.

- The rolling averages and the median values are similar to each other for each 3-year period shown. This indicates little variability in the central tendency of acetaldehyde concentrations measured over the periods shown in Figure 10-46.

- Note that with the exception of the 2001-2003 and 2002-2004 time frames, the minimum concentration for each 3-year period is greater than zero. Seven non-detects of acetaldehyde have been reported since the onset of carbonyl compound sampling (all in 2001 and 2002).

Observations from Figure 10-47 for formaldehyde measurements at GAFL include the following:

- The maximum formaldehyde concentration was measured in 2005. Several unusually high concentrations of formaldehyde were measured at GAFL in May and June of 2005, ranging from 18 $\mu g/m^3$ to 129 $\mu g/m^3$. Only one other concentration fell into this range and was measured in 2002 (47 $\mu g/m^3$).

- The outliers mentioned above caused increases in the rolling averages for the affected 3-year periods. Although difficult to discern in Figure 10-47, the average concentration for the 2003-2005 time frame is greater than the 95th percentile, reflecting the effects of the outliers. Yet, the median concentrations, or the 50th percentiles, changed little over the years of sampling.

- The minimum concentration for each 3-year period is greater than zero. No non-detects of formaldehyde have been reported since the onset of carbonyl compound sampling in 2001.

Observations from Figure 10-48 for acetaldehyde measurements at ORFL include the following:

- Carbonyl compounds have been measured at ORFL since April 2003.

- The maximum acetaldehyde concentration was measured in 2006.
- The rolling average concentrations show a slight decreasing trend beginning with the 2005-2007 time frame.
- The spread of concentrations measured appears fairly static, as shown by the 5th and 95th percentiles.
- The minimum concentration for each 3-year period is greater than zero. No non-detects of acetaldehyde have been reported since the onset of carbonyl compound sampling in 2003.

Observations from Figure 10-49 for formaldehyde measurements at ORFL include the following:

- The maximum formaldehyde concentration was measured in 2007, although a similar concentration was also measured in 2008.
- Even with the relatively high concentrations measured in later years, several of the statistical parameters shows a slight decreasing trend for the last several time frames.
- The minimum concentration for each 3-year period is greater than zero. No non-detects of formaldehyde have been reported since the onset of carbonyl compound sampling in 2003.

Observations from Figure 10-50 for acetaldehyde measurements at SKFL include the following:

- Carbonyl compounds have been measured at SKFL since July 2004.
- The maximum acetaldehyde concentration was measured in 2004 (50.73 $\mu g/m^3$) and is more than six times higher than the next highest measurement (8.16 $\mu g/m^3$), also measured in 2004.
- Although difficult to discern in Figure 10-50, the rolling average concentrations show a decrease from the first to the second 3-year period, then an increasing trend beginning with the 2006-2008 time frame and continuing into the 2007-2009 time frame. The median and 95th percentiles also exhibit this pattern.
- The minimum concentration for each 3-year period is greater than zero. No non-detects of acetaldehyde have been reported since the onset of carbonyl compound sampling in 2004.

Observations from Figure 10-51 for formaldehyde measurements at SKFL include the following:

- Two high formaldehyde concentrations were measured at SKFL, one in 2005 (91.69 µg/m^3) and one in 2004 (70.40 µg/m^3). Aside from these two measurements, all other concentrations measured at this site were at least an order of magnitude lower. The high 2004 formaldehyde concentration corresponded with the high acetaldehyde concentration (both measured on August 31, 2004).

- Although difficult to discern in Figure 10-51, the rolling average and median concentrations show a steady decreasing trend over the periods shown, while the difference between the 5th and 95th percentiles has changed little over the period of sampling.

- The minimum concentration for each 3-year period is greater than zero. No non-detects of formaldehyde have been reported since the onset of carbonyl compound sampling in 2004.

Observations from Figure 10-52 for acetaldehyde measurements at SYFL include the following:

- Carbonyl compounds have been measured at SYFL since January 2004.

- The maximum acetaldehyde concentration was measured on January 18, 2007 (15.26 µg/m^3). The next highest concentration, also measured in 2007, is roughly half of the highest measured concentration (7.55 µg/m^3).

- The rolling average concentrations show an increase from 2004-2006 to 2005-2007, after which little change is shown. The median concentrations also exhibit this pattern.

- With the exception of the 2004-2006 time frame, the minimum concentration for each 3-year period is greater than zero. Only one non-detect of acetaldehyde has been reported since the onset of carbonyl compound sampling (2004).

Observations from Figure 10-53 for formaldehyde measurements at SYFL include the following:

- The highest formaldehyde concentration measured at SKFL was measured in 2005 (32.49 µg/m^3), and was nearly twice the next highest concentration measured in 2008 (17.11 µg/m^3), although several measurements similar in magnitude to this one were also measured in 2007.

- Both the rolling average and median concentrations show a slight increasing trend over the periods shown.

- The minimum concentration for each 3-year period is greater than zero. No non-detects of formaldehyde have been reported since the onset of carbonyl compound sampling in 2004.

Observations from Figure 10-54 for hexavalent chromium measurements at SYFL include the following:

- Hexavalent chromium sampling at SYFL began in January 2005.
- The highest formaldehyde concentration measured at SYFL was measured on July 3, 2005 and was similar in magnitude to the next highest concentration, measured on July 4, 2006.
- Both the rolling average and median concentrations exhibit a significant decreasing trend over the periods shown, as do the other statistical parameters.
- Note that the minimum concentration, 5th percentile, and median concentration for the 2007-2009 period are all zero. This indicates an increase in the number of non-detects reported; the percentage of non-detects increased from 42 percent in 2007 to 70 percent in 2009.

10.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Florida monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with risk.

10.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Florida monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Florida monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

10.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Florida sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 of this report regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 10-6, where applicable.

Observations for the Florida sites from Table 10-6 include the following:

- Formaldehyde had the highest cancer surrogate risk approximation among the site-specific pollutants of interest, ranging from 16.65 in-a-million (for SKFL, 2009) to 39.31 in-a-million (for AZFL).

- Among the sites sampling carbonyl compounds, the cancer surrogate risk approximations for formaldehyde were an order of magnitude higher than the cancer surrogate risk approximations for acetaldehyde, which ranged from 2.54 in-a-million (for SYFL, 2009) to 6.31 in-a-million (for SKFL, 2009).

- For PAFL, where metals sampling was conducted, arsenic had the highest cancer risk approximations (3.30 in-a-million for 2008 and 3.06 in-a-million for 2009). The cancer surrogate risk approximations were less than 1.0 in-a-million for the remaining pollutants, where a cancer URE is available.

- For the two sites sampling PAH and hexavalent chromium in addition to carbonyl compounds, naphthalene had the third highest cancer risk approximations for each site for both years, behind formaldehyde and acetaldehyde. Cancer risk approximations for hexavalent chromium and benzo(a)pyrene calculated for SKFL were less than 1.0 in-a-million and could not be calculated for SYFL for either year due to the relatively low detection rate.

- All of the noncancer risk approximations for the site-specific pollutants of interest were less than 1.0 (where they could be calculated), indicating no risk of noncancer health effects.

- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for CCFL and FLFL because sampling did not begin until July 2008 and ended in March 2009 (and less than three quarterly averages are available for either year).

Table 10-6. Cancer and Noncancer Surrogate Risk Approximations for the Florida Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Detects/Valid Quarters	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)
St. Petersburg, Florida - AZFL										
Acetaldehyde	0.0000022	0.009	61/4	1.23 ± 0.13	2.70	0.14	60/4	2.37 ± 0.41	5.22	0.26
Formaldehyde	0.000013	0.0098	61/4	3.02 ± 0.18	39.31	0.31	60/4	2.01 ± 0.30	26.16	0.21
Coconut Creek, Florida - CCFL										
Acrylonitrile	0.000068	0.002	0/0	NA	NA	NA	4/0	NA	NA	NA
Benzene	0.0000078	0.03	28/2	NA	NA	NA	14/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	25/2	NA	NA	NA	14/1	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	28/2	NA	NA	NA	14/1	NA	NA	NA
Chloroform	--	0.098	27/2	NA	NA	NA	14/1	NA	NA	NA
p-Dichlorobenzene	0.000011	0.8	23/2	NA	NA	NA	13/1	NA	NA	NA
Ethylbenzene	0.0000025	1	28/2	NA	NA	NA	14/1	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	24/2	NA	NA	NA	14/1	NA	NA	NA
Trichloroethylene	0.000002	0.6	9/0	NA	NA	NA	2/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	0/0	NA	NA	NA	2/0	NA	NA	NA

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 10-5.

Table 10-6. Cancer and Noncancer Surrogate Risk Approximations for the Florida Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Davie, Florida - FLFL										
Benzene	0.0000078	0.03	28/2	NA	NA	NA	15/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	25/2	NA	NA	NA	15/1	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	28/2	NA	NA	NA	15/1	NA	NA	NA
Chloroform	--	0.098	26/2	NA	NA	NA	15/1	NA	NA	NA
p-Dichlorobenzene	0.000011	0.8	27/2	NA	NA	NA	15/1	NA	NA	NA
Ethylbenzene	0.0000025	1	28/2	NA	NA	NA	15/1	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	23/2	NA	NA	NA	15/1	NA	NA	NA
Trichloroethylene	0.000002	0.6	9/0	NA	NA	NA	4/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	2/0	NA	NA	NA	1/0	NA	NA	NA
Tampa, Florida – GAFL										
Acetaldehyde	0.0000022	0.009	60/4	2.07 ± 0.24	4.55	0.23	14/1	NA	NA	NA
Formaldehyde	0.000013	0.0098	60/4	1.67 ± 0.27	21.70	0.17	14/1	NA	NA	NA
Winter Park, Florida – ORFL										
Acetaldehyde	0.0000022	0.009	59/4	1.66 ± 0.31	3.65	0.18	61/4	1.73 ± 0.21	3.80	0.19

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 10-5.

Table 10-6. Cancer and Noncancer Surrogate Risk Approximations for the Florida Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
Formaldehyde	0.000013	0.0098	59/4	2.17 ± 0.48	28.20	0.22	61/4	2.10 ± 0.33	27.29	0.21
Orlando, Florida - PAFL[a]										
Arsenic (PM_{10}) [a]	0.0043	0.000015	30/4	<0.01 ± <0.01	3.30	0.05	31/4	<0.01 ± <0.01	3.06	0.05
Beryllium (PM_{10}) [a]	0.0024	0.00002	30/4	<0.01 ± <0.01	0.01	0.00	23/3	<0.01 ± <0.01	0.01	<0.01
Cadmium (PM_{10}) [a]	0.0018	0.00001	30/4	<0.01 ± <0.01	0.17	0.01	31/4	<0.01 ± <0.01	0.14	0.01
Lead (PM_{10}) [a]	--	0.00015	30/4	<0.01 ± <0.01	--	0.03	31/4	<0.01 ± <0.01	--	0.02
Manganese (PM_{10}) [a]	--	0.00005	30/4	<0.01 ± <0.01	--	0.05	31/4	<0.01 ± <0.01	--	0.05
Nickel (PM_{10}) [a]	0.000312	0.00009	30/4	<0.01 ± <0.01	0.51	0.02	31/4	<0.01 ± <0.01	0.27	0.01
Pinellas Park, Florida - SKFL										
Acetaldehyde	0.0000022	0.009	60/4	2.43 ± 0.25	5.34	0.27	61/4	2.87 ± 0.28	6.31	0.32
Benzo(a)pyrene [a]	0.001	--	41/3	<0.01 ± <0.01	0.04	--	52/4	<0.01 ± <0.01	0.11	--
Formaldehyde	0.000013	0.0098	60/4	1.76 ± 0.25	22.85	0.18	61/4	1.28 ± 0.13	16.65	0.13
Hexavalent Chromium [a]	0.012	0.0001	20/2	NA	NA	NA	36/3	<0.01 ± <0.01	0.22	<0.01
Naphthalene [a]	0.000034	0.003	50/3	0.08 ± 0.02	2.81	0.03	61/4	0.09 ± 0.02	3.16	0.03

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 10-5.

Table 10-6. Cancer and Noncancer Surrogate Risk Approximations for the Florida Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Plant City, Florida - SYFL										
Acetaldehyde	0.0000022	0.009	60/4	1.20 ± 0.24	2.64	0.13	60/4	1.15 ± 0.10	2.54	0.13
Benzo(a)pyrene [a]	0.001	--	17/1	NA	NA	--	22/1	NA	NA	--
Formaldehyde	0.000013	0.0098	60/4	2.42 ± 0.53	31.43	0.25	60/4	2.60 ± 0.24	33.79	0.27
Hexavalent Chromium [a]	0.012	0.0001	26/2	NA	NA	NA	18/0	NA	NA	NA
Naphthalene [a]	0.000034	0.003	45/3	0.04 ± 0.01	1.23	0.01	60/4	0.04 ± 0.01	1.40	0.01

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 10-5.

10.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 10-7 and 10-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 10-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 10-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 10.3, AZFL, GAFL, and ORFL sampled for carbonyl compounds only; SKFL and SYFL sampled hexavalent chromium and PAH in addition to carbonyl compounds; PAFL sampled only PM_{10} metals; and CCFL and FLFL sampled only VOC. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 10-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Coconut Creek, Florida (Broward County) - CCFL					
Benzene	934.90	Benzene	7.29E-03		
Dichloromethane	635.52	Formaldehyde	5.84E-03		
Formaldehyde	467.29	1,3-Butadiene	4.12E-03		
Acetaldehyde	182.08	Naphthalene	2.37E-03		
1,3-Butadiene	137.27	Nickel, PM	1.88E-03		
Tetrachloroethylene	119.74	Arsenic, PM	1.19E-03		
1,3-Dichloropropene	116.00	Hexavalent Chromium, PM	8.75E-04		
Naphthalene	69.78	POM, Group 2	8.39E-04		
Trichloroethylene	61.21	Tetrachloroethylene	7.06E-04		
p-Dichlorobenzene	59.41	*p*-Dichlorobenzene	6.54E-04		
Davie, Florida (Broward County) - FLFL					
Benzene	934.90	Benzene	7.29E-03		
Dichloromethane	635.52	Formaldehyde	5.84E-03		
Formaldehyde	467.29	1,3-Butadiene	4.12E-03		
Acetaldehyde	182.08	Naphthalene	2.37E-03		
1,3-Butadiene	137.27	Nickel, PM	1.88E-03		
Tetrachloroethylene	119.74	Arsenic, PM	1.19E-03		
1,3-Dichloropropene	116.00	Hexavalent Chromium, PM	8.75E-04		
Naphthalene	69.78	POM, Group 2	8.39E-04		
Trichloroethylene	61.21	Tetrachloroethylene	7.06E-04		
p-Dichlorobenzene	59.41	*p*-Dichlorobenzene	6.54E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Tampa, Florida (Hillsborough County) - GAFL					
Benzene	773.05	Benzene	6.03E-03	Formaldehyde	21.70
Formaldehyde	449.22	Formaldehyde	5.62E-03	Acetaldehyde	4.55
Acetaldehyde	173.48	1,3-Butadiene	3.27E-03		
1,3-Butadiene	109.07	Hexavalent Chromium, PM	1.39E-03		
Tetrachloroethylene	58.96	Naphthalene	1.13E-03		
Naphthalene	33.10	POM, Group 2	6.82E-04		
Dichloromethane	31.34	Arsenic, PM	4.28E-04		
Trichloroethylene	21.07	Acetaldehyde	3.82E-04		
POM, Group 2	12.39	Tetrachloroethylene	3.48E-04		
Chloromethylbenzene	1.80	Cadmium, PM	2.98E-04		
Plant City, Florida (Hillsborough County) - SYFL					
Benzene	773.05	Benzene	6.03E-03	Formaldehyde	33.79
Formaldehyde	449.22	Formaldehyde	5.62E-03	Formaldehyde	31.43
Acetaldehyde	173.48	1,3-Butadiene	3.27E-03	Acetaldehyde	2.64
1,3-Butadiene	109.07	Hexavalent Chromium, PM	1.39E-03	Acetaldehyde	2.54
Tetrachloroethylene	58.96	Naphthalene	1.13E-03	Naphthalene	1.40
Naphthalene	33.10	POM, Group 2	6.82E-04	Naphthalene	1.23
Dichloromethane	31.34	Arsenic, PM	4.28E-04		
Trichloroethylene	21.07	Acetaldehyde	3.82E-04		
POM, Group 2	12.39	Tetrachloroethylene	3.48E-04		
Chloromethylbenzene	1.80	Cadmium, PM	2.98E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Winter Park, Florida (Orange County) – ORFL					
Benzene	788.36	Benzene	6.15E-03	Formaldehyde	28.20
Formaldehyde	412.16	Formaldehyde	5.15E-03	Formaldehyde	27.29
Acetaldehyde	146.83	1,3-Butadiene	3.50E-03	Acetaldehyde	3.80
1,3-Butadiene	116.70	Arsenic, PM	2.73E-03	Acetaldehyde	3.65
Tetrachloroethylene	62.56	Hexavalent Chromium, PM	1.59E-03		
Naphthalene	27.83	Naphthalene	9.46E-04		
Trichloroethylene	24.14	POM, Group 2	6.38E-04		
Dichloromethane	17.37	Tetrachloroethylene	3.69E-04		
POM, Group 2	11.60	Acetaldehyde	3.23E-04		
Chloromethylbenzene	0.97	Nickel, PM	1.16E-04		
Orlando, Florida (Orange County) – PAFL					
Benzene	788.36	Benzene	6.15E-03	Arsenic	3.30
Formaldehyde	412.16	Formaldehyde	5.15E-03	Arsenic	3.06
Acetaldehyde	146.83	1,3-Butadiene	3.50E-03	Nickel	0.51
1,3-Butadiene	116.70	Arsenic, PM	2.73E-03	Nickel	0.27
Tetrachloroethylene	62.56	Hexavalent Chromium, PM	1.59E-03	Cadmium	0.17
Naphthalene	27.83	Naphthalene	9.46E-04	Cadmium	0.14
Trichloroethylene	24.14	POM, Group 2	6.38E-04	Beryllium	0.01
Dichloromethane	17.37	Tetrachloroethylene	3.69E-04	Beryllium	0.01
POM, Group 2	11.60	Acetaldehyde	3.23E-04		
Chloromethylbenzene	0.97	Nickel, PM	1.16E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
St. Petersburg, Florida (Pinellas County) - AZFL					
Benzene	619.89	Benzene	4.84E-03	Formaldehyde	39.31
Formaldehyde	249.94	Formaldehyde	3.12E-03	Formaldehyde	26.16
Acetaldehyde	99.28	1,3-Butadiene	2.53E-03	Acetaldehyde	5.22
1,3-Butadiene	84.20	Hexavalent Chromium, PM	1.31E-03	Acetaldehyde	2.70
Dichloromethane	63.56	Nickel, PM	1.06E-03		
Naphthalene	21.46	Naphthalene	7.30E-04		
Trichloroethylene	20.68	Arsenic, PM	6.15E-04		
Nickel, PM	6.65	POM, Group 2	3.53E-04		
POM, Group 2	6.41	Acetaldehyde	2.18E-04		
Tetrachloroethylene	4.54	Ethylene oxide	5.01E-05		
Pinellas Park, Florida (Pinellas County) - SKFL					
Benzene	619.89	Benzene	4.84E-03	Formaldehyde	22.85
Formaldehyde	249.94	Formaldehyde	3.12E-03	Formaldehyde	16.65
Acetaldehyde	99.28	1,3-Butadiene	2.53E-03	Acetaldehyde	6.31
1,3-Butadiene	84.20	Hexavalent Chromium, PM	1.31E-03	Acetaldehyde	5.34
Dichloromethane	63.56	Nickel, PM	1.06E-03	Naphthalene	3.16
Naphthalene	21.46	Naphthalene	7.30E-04	Naphthalene	2.81
Trichloroethylene	20.68	Arsenic, PM	6.15E-04	Hexavalent Chromium	0.22
Nickel, PM	6.65	POM, Group 2	3.53E-04	Benzo(a)pyrene	0.11
POM, Group 2	6.41	Acetaldehyde	2.18E-04	Benzo(a)pyrene	0.04
Tetrachloroethylene	4.54	Ethylene oxide	5.01E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Coconut Creek, Florida (Broward County) - CCFL					
Toluene	3,656.59	Acrolein	1,674,544.56		
Xylenes	2,547.83	Nickel, PM	180,638.36		
Methanol	2,317.03	1,3-Butadiene	68,632.54		
Hexane	973.79	Formaldehyde	47,682.69		
Benzene	934.90	Bromomethane	32,400.36		
Dichloromethane	635.52	Benzene	31,163.49		
Ethylbenzene	593.24	Xylenes	25,478.33		
Formaldehyde	467.29	Naphthalene	23,258.97		
Methyl isobutyl ketone	435.44	Cyanide Compounds, gas	20,343.58		
1,1,1-Trichloroethane	434.76	Acetaldehyde	20,230.95		
Davie, Florida (Broward County) - FLFL					
Toluene	3,656.59	Acrolein	1,674,544.56		
Xylenes	2,547.83	Nickel, PM	180,638.36		
Methanol	2,317.03	1,3-Butadiene	68,632.54		
Hexane	973.79	Formaldehyde	47,682.69		
Benzene	934.90	Bromomethane	32,400.36		
Dichloromethane	635.52	Benzene	31,163.49		
Ethylbenzene	593.24	Xylenes	25,478.33		
Formaldehyde	467.29	Naphthalene	23,258.97		
Methyl isobutyl ketone	435.44	Cyanide Compounds, gas	20,343.58		
1,1,1-Trichloroethane	434.76	Acetaldehyde	20,230.95		

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[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Tampa, Florida (Hillsborough County) - GAFL					
Hydrochloric acid	3,146.99	Acrolein	1,627,641.80	Acetaldehyde	0.23
Toluene	2,264.29	Hydrochloric acid	157,349.28	Formaldehyde	0.17
Xylenes	1,555.25	1,3-Butadiene	54,534.69		
Methanol	1,177.05	Formaldehyde	45,838.59		
Hydroflouric acid	1,058.97	Hydrofluoric acid	35,299.15		
Benzene	773.05	Manganese, PM	35,225.71		
Hexane	533.06	Benzene	25,768.46		
Formaldehyde	449.22	Nickel, PM	23,732.86		
Ethylbenzene	376.61	Acetaldehyde	19,275.05		
Methyl isobutyl ketone	369.87	Xylenes	15,552.51		
Plant City, Florida (Hillsborough County) - SYFL					
Hydrochloric acid	3,146.99	Acrolein	1,627,641.80	Formaldehyde	0.27
Toluene	2,264.29	Hydrochloric acid	157,349.28	Formaldehyde	0.25
Xylenes	1,555.25	1,3-Butadiene	54,534.69	Acetaldehyde	0.13
Methanol	1,177.05	Formaldehyde	45,838.59	Acetaldehyde	0.13
Hydroflouric acid	1,058.97	Hydrofluoric acid	35,299.15	Naphthalene	0.01
Benzene	773.05	Manganese, PM	35,225.71	Naphthalene	0.01
Hexane	533.06	Benzene	25,768.46		
Formaldehyde	449.22	Nickel, PM	23,732.86		
Ethylbenzene	376.61	Acetaldehyde	19,275.05		
Methyl isobutyl ketone	369.87	Xylenes	15,552.51		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Winter Park, Florida (Orange County) - ORFL					
Toluene	2,409.09	Acrolein	1,672,607.91	Formaldehyde	0.22
Hydrochloric acid	1,675.29	Hydrochloric acid	83,764.57	Formaldehyde	0.21
Xylenes	1,642.46	1,3-Butadiene	58,347.59	Acetaldehyde	0.19
Methanol	982.56	Formaldehyde	42,057.19	Acetaldehyde	0.18
Benzene	788.36	Benzene	26,278.70		
Hexane	508.49	Arsenic, PM	21,177.44		
Formaldehyde	412.16	Xylenes	16,424.62		
Ethylbenzene	394.60	Acetaldehyde	16,314.39		
Methyl isobutyl ketone	340.49	Cyanide Compounds, gas	11,330.16		
Styrene	238.22	Nickel, PM	11,178.12		
Orlando, Florida (Orange County) - PAFL					
Toluene	2,409.09	Acrolein	1,672,607.91	Manganese	0.05
Hydrochloric acid	1,675.29	Hydrochloric acid	83,764.57	Arsenic	0.05
Xylenes	1,642.46	1,3-Butadiene	58,347.59	Manganese	0.05
Methanol	982.56	Formaldehyde	42,057.19	Arsenic	0.05
Benzene	788.36	Benzene	26,278.70	Lead	0.03
Hexane	508.49	Arsenic, PM	21,177.44	Lead	0.02
Formaldehyde	412.16	Xylenes	16,424.62	Nickel	0.02
Ethylbenzene	394.60	Acetaldehyde	16,314.39	Cadmium	0.01
Methyl isobutyl ketone	340.49	Cyanide Compounds, gas	11,330.16	Nickel	0.01
Styrene	238.22	Nickel, PM	11,178.12	Cadmium	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 10-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
St. Petersburg, Florida (Pinellas County) - AZFL					
Toluene	1,858.03	Acrolein	661,403.85	Formaldehyde	0.31
Xylenes	1,181.25	Nickel, PM	102,336.91	Acetaldehyde	0.26
Methanol	1,167.27	1,3-Butadiene	42,099.40	Formaldehyde	0.21
Benzene	619.89	Formaldehyde	25,503.77	Acetaldehyde	0.14
Hexane	415.39	Benzene	20,663.06		
Ethylbenzene	305.86	Manganese, PM	17,952.22		
Formaldehyde	249.94	Xylenes	11,812.48		
Methyl *tert* butyl ether	227.40	Acetaldehyde	11,031.19		
Styrene	226.60	Naphthalene	7,153.44		
Hydrochloric acid	100.35	Hydrochloric acid	5,017.72		
Pinellas Park, Florida (Pinellas County) - SKFL					
Toluene	1,858.03	Acrolein	661,403.85	Acetaldehyde	0.32
Xylenes	1,181.25	Nickel, PM	102,336.91	Acetaldehyde	0.27
Methanol	1,167.27	1,3-Butadiene	42,099.40	Formaldehyde	0.18
Benzene	619.89	Formaldehyde	25,503.77	Formaldehyde	0.13
Hexane	415.39	Benzene	20,663.06	Naphthalene	0.03
Ethylbenzene	305.86	Manganese, PM	17,952.22	Naphthalene	0.03
Formaldehyde	249.94	Xylenes	11,812.48	Hexavalent Chromium	<0.01
Methyl *tert* butyl ether	227.40	Acetaldehyde	11,031.19		
Styrene	226.60	Naphthalene	7,153.44		
Hydrochloric acid	100.35	Hydrochloric acid	5,017.72		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 10-7 include the following:

- Benzene and formaldehyde were the highest emitted pollutants with cancer UREs in three of the four Florida counties (Pinellas, Hillsborough, and Orange). In Broward County, benzene and dichloromethane were the highest emitted pollutants. Dichloromethane emissions were an order of magnitude higher in Broward County than the other three counties.

- Benzene, formaldehyde, and 1,3-butadiene had the highest toxicity-weighted emissions for all four counties.

- For Broward County, six of the highest emitted pollutants also had the highest toxicity-weighted emissions; seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Orange, Hillsborough, and Pinellas Counties. Four pollutants, formaldehyde, benzene, naphthalene, and 1,3-butadiene appeared on both lists for each county.

- Hexavalent chromium and arsenic were among the pollutants with the highest cancer toxicity-weighted emissions, yet were not among the highest emitted pollutants in any of the four counties.

- Formaldehyde, which had the highest cancer risk approximation for all sites sampling carbonyl compounds, was one of the highest emitted pollutants and had one of the highest toxicity-weighted emissions for each county.

- PAFL sampled only metals; arsenic and nickel had the highest cancer risk approximations for this site. These pollutants appear on the list of 10 highest toxicity-weighted emissions for Orange County, yet neither appears on the list of highest quantity emitted, indicating the relative toxicity of a low amount of emissions.

Observations from Table 10-8 include the following:

- Toluene was the highest emitted pollutant with a noncancer RfC in Broward, Pinellas, and Orange Counties, while hydrochloric acid topped the list for Hillsborough County.

- Acrolein had the highest toxicity-weighted emissions of the pollutants with noncancer RfCs for each county, but does not appear in any county’s list of 10 highest emitted pollutants.

- Between three and five of the highest emitted pollutants also had the highest toxicity-weighted emissions for each county. Three pollutants (benzene, xylenes, and formaldehyde) appeared on both lists for all three counties.

- Formaldehyde and acetaldehyde appeared on the highest toxicity-weighted emissions list for each county. Formaldehyde appears on all three lists for each county that sampled carbonyl compounds.

10.6 Summary of the 2008-2009 Monitoring Data for the Florida Sites

Results from several of the treatments described in this section include the following:

- *Acetaldehyde and formaldehyde failed screens for AZFL, GAFL, and ORFL; both of these pollutants are NATTS MQO Core Analytes. Thirteen VOC failed screens for CCFL, of which four are NATTS MQO Core Analytes. Nine VOC failed screens for FLFL, of which four are also NATTS MQO Core Analytes. Four metals failed screens for PAFL, of which all are NATTS MQO Core Analytes. Five pollutants failed screens for SKFL, all of which are NATTS MQO Core Analytes. Finally, four pollutants failed screens for SYFL, three of which are NATTS MQO Core Analytes.*

- *Formaldehyde had the highest daily average concentration of any of the pollutants of interest among the Florida sites, the highest of which was calculated for AZFL for 2008.*

- *GAFL and SKFL's 2009 daily average concentrations of acetaldehyde ranked third and fifth highest (respectively) among all NMP sites sampling carbonyl compounds. PAFL's 2008 daily average concentration of lead was the seventh highest among NMP sites sampling PM_{10} metals; PAFL also had the sixth (2008) and ninth (2009) highest daily average concentrations of arsenic and the fifth highest daily average concentration of nickel (2008).*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest for the Florida sites, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

11.0 Site in Georgia

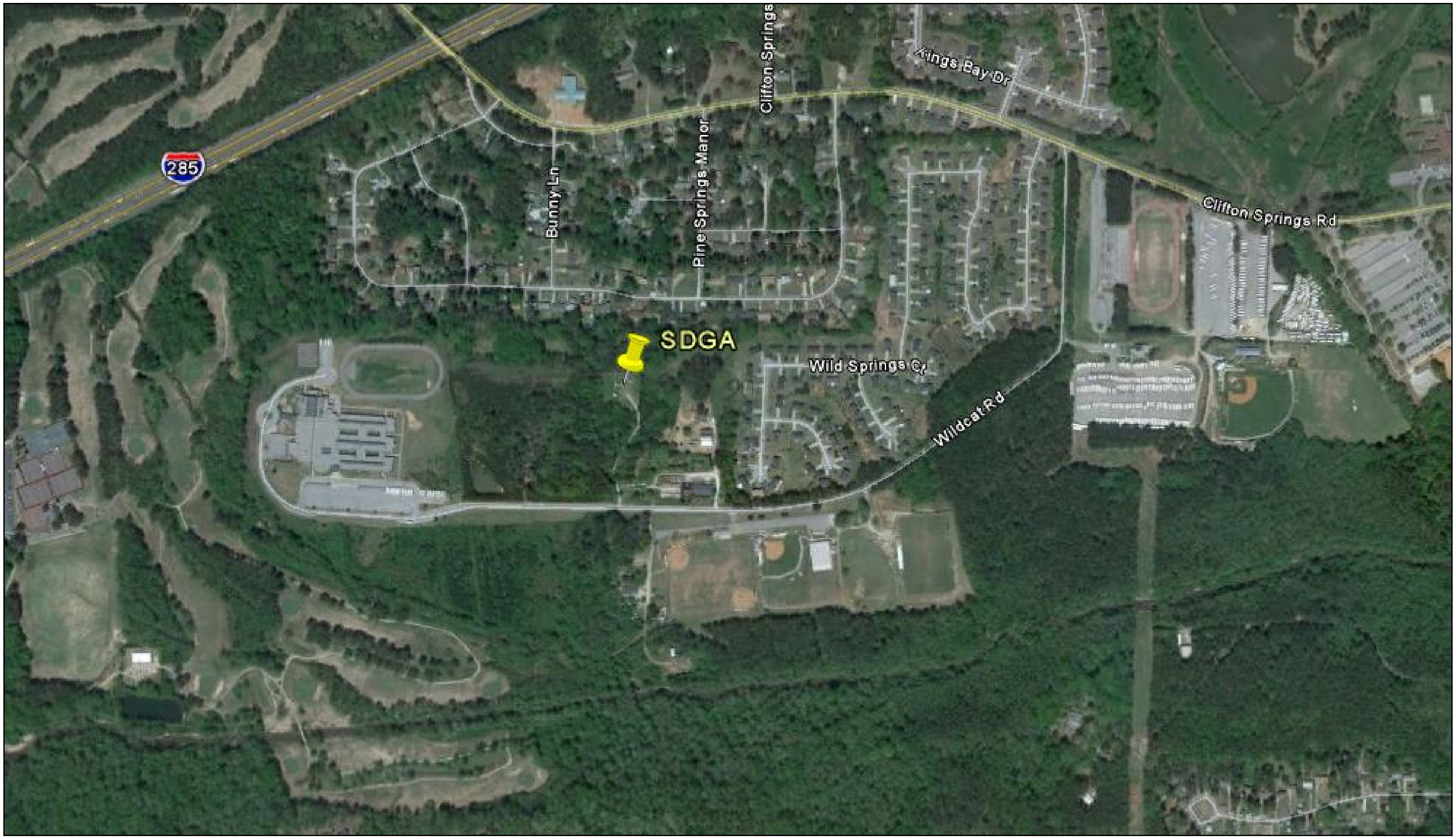
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Georgia, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

11.1 Site Characterization

This section characterizes the SDGA monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The SDGA monitoring is located in Decatur, Georgia, southeast of Atlanta. Figure 11-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 11-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 11-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 11-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

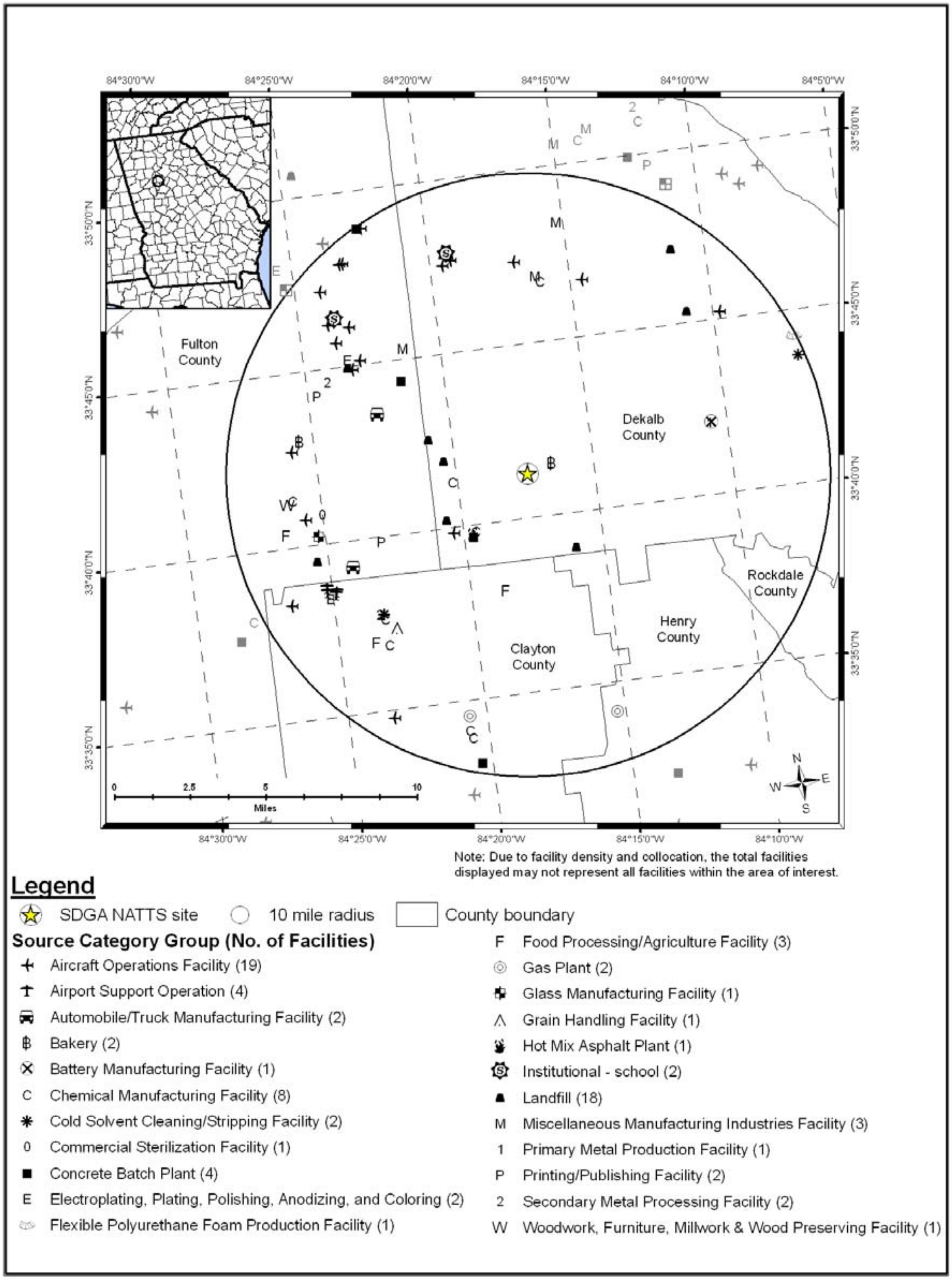
Figure 11-1. Decatur, Georgia (SDGA) Monitoring Site



©2010 Google Earth, accessed 11/9/2010

Scale: 2 inches = 2,156 feet

Figure 11-2. NEI Point Sources Located Within 10 Miles of SDGA



84°30'0"W
84°25'0"W
84°20'0"W
84°15'0"W
84°10'0"W
84°5'0"W
33°50'0"N
33°45'0"N
33°40'0"N
33°35'0"N
Fulton County
Dekalb County
Rockdale County
Henry County
Clayton County
0
2.5
5
10
Miles
N
E
S
W
Legend
SDGA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (19)
Airport Support Operation (4)
Automobile/Truck Manufacturing Facility (2)
Bakery (2)
Battery Manufacturing Facility (1)
C Chemical Manufacturing Facility (8)
Cold Solvent Cleaning/Stripping Facility (2)
0 Commercial Sterilization Facility (1)
Concrete Batch Plant (4)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (2)
Flexible Polyurethane Foam Production Facility (1)
F Food Processing/Agriculture Facility (3)
Gas Plant (2)
Glass Manufacturing Facility (1)
Λ Grain Handling Facility (1)
Hot Mix Asphalt Plant (1)
Institutional - school (2)
Landfill (18)
M Miscellaneous Manufacturing Industries Facility (3)
1 Primary Metal Production Facility (1)
P Printing/Publishing Facility (2)
2 Secondary Metal Processing Facility (2)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 11-1. Geographical Information for the Georgia Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
SDGA	13-089-0002	Decatur	DeKalb	Atlanta-Sandy Springs-Marietta, GA	33.688007, -84.290325	Residential	Suburban	CO, SO_2, NOy, NO, NO_2, NOx, PAMS, Carbonyl compounds, VOC, O_3, Meteorological parameters, PM_{10}, PM Coarse, PM_{10} Speciation, Black carbon, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

SDGA is located on the DeKalb County Schools Environmental Education property off Wildcat Road. Figure 11-1 shows that residential subdivisions, a greenhouse and horse barn, an athletic field, and a high school surround the monitoring site. A golf course backs up against the school property. Interstate-285 is located less than 1 mile north of the site. As Figure 11-2 shows, SDGA is located near several point sources, most of which are located to the northwest and west of the site. These emissions sources are involved in a wide variety of industries, of which aircraft operations (which includes airports as well as small runways, heliports, or landing pads), landfills, and chemical manufacturing facilities are the most numerous. The point source closest to SDGA is a bakery.

Table 11-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Georgia monitoring site. Information provided in Table 11-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for DeKalb County were obtained from the Georgia Department of Revenue (GA DOR, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 11-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 11-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 11-2 presents the daily VMT for the Atlanta urban area.

Table 11-2. Population, Motor Vehicle, and Traffic Information for the Georgia Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
SDGA	747,274	467,962	0.63	776,511	486,271	9,200	127,008

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Georgia DOR (GA DOR, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2008 data from the Georgia DOT (GA DOT, 2008).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 11-2 include the following:

- SDGA's county-level population and vehicle registration were in the middle of the range compared to other counties with NMP sites. The same is also true for its 10-mile population and estimated vehicle ownership.
- The vehicle-per-person ratio was among the lowest compared to other NMP sites.
- The traffic volume experienced near SDGA ranked in the bottom third compared to other monitoring sites. The traffic estimate used came from Clifton Spring Road, between Wildcat Road and Clifton Church Road.
- The Atlanta area VMT was the fifth highest among urban areas with NMP sites.

11.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Georgia on sample days, as well as over the course of each year.

11.2.1 Climate Summary

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, tempering cold air outbreaks from the north as well as summer heat waves. Summers are warm and humid while winters are relatively mild, although snow is not uncommon. The semi-permanent Bermuda High Pressure offshore over the Atlantic Ocean is a dominant weather feature affecting the Atlanta area, which pulls warm, moist air into the region. Precipitation is ample, although autumn is the driest season (Bair, 1992 and GSCO, 1998).

11.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to SDGA is located at W. B. Hartsfield/Atlanta International Airport (WBAN 13874). Additional information about the Hartsfield weather station is provided in Table 11-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 11-3. Average Meteorological Conditions near the Georgia Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Decatur, Georgia - SDGA										
W.B. Hartsfield/Atlanta Intl Airport 13874 (33.64, -84.43)	8.17 miles 239° (WSW)	2008	Sample Day	71.9 ± 3.5	62.9 ± 3.5	48.5 ± 3.9	55.3 ± 3.2	62.7 ± 3.4	1017.6 ± 1.4	7.1 ± 0.8
			All Year	71.3 ± 1.5	62.1 ± 1.5	47.9 ± 1.7	54.6 ± 1.4	63.0 ± 1.4	1018.2 ± 0.6	7.1 ± 0.3
		2009	Sample Day	68.1 ± 3.5	59.4 ± 3.5	48.2 ± 3.9	53.6 ± 3.3	69.5 ± 3.5	1017.7 ± 1.4	7.4 ± 0.6
			All Year	70.4 ± 1.5	61.7 ± 1.5	50.7 ± 1.7	55.8 ± 1.4	70.3 ± 1.5	1017.7 ± 0.6	6.9 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 11-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 11-3 is the 95 percent confidence interval for each parameter. As shown in Table 11-3, average meteorological conditions on 2008 sample days were fairly representative of average weather conditions throughout the year. For 2009, sample days appear slightly cooler than average conditions throughout the year. Several invalid collection events were made up in December 2009; thus, a higher number of observations from one of the colder months of the year were factored into the 2009 sample day averages.

11.2.3 Back Trajectory Analysis

Figure 11-3 and Figure 11-4 are the composite back trajectory maps for days on which samples were collected at the SDGA monitoring site in 2008 and 2009, respectively. Figure 11-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 11-3 through 11-5 represents 100 miles.

Observations from Figures 11-3 through 11-5 include the following:

- Back trajectories originated from a variety of directions at SDGA.
- The 24-hour air shed domain for SDGA was somewhat smaller in size compared to other NMP monitoring sites. While the farthest away a trajectory originated was northeast Missouri, or nearly 600 miles away, the average back trajectory length was 195 miles. Eighty-six percent of back trajectories originated within 300 miles of the site.
- The cluster analysis shows relatively good agreement between the clusters of the two different years. Trajectories originating from the southeast of SDGA occurred infrequently, while trajectories originating from the south or southwest, the northwest to north, and the northeast to east (and within a relatively short distance) were most common.

Figure 11-3. 2008 Composite Back Trajectory Map for SDGA

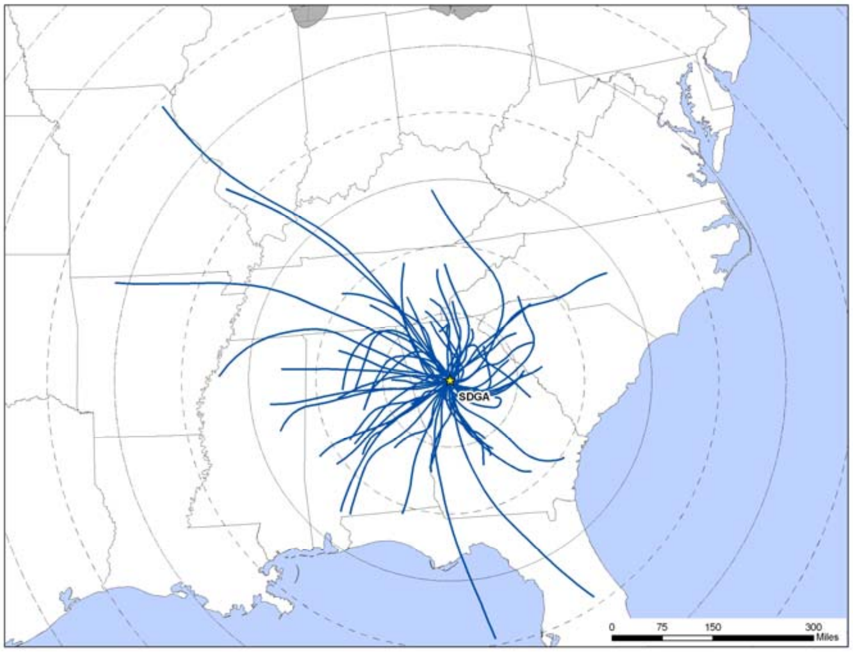


Figure 11-4. 2009 Composite Back Trajectory Map for SDGA

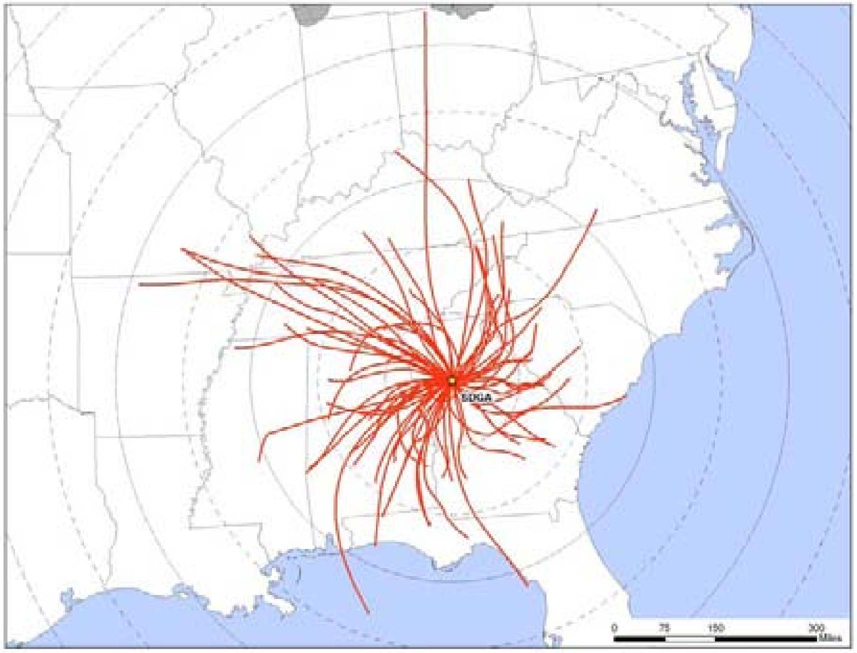
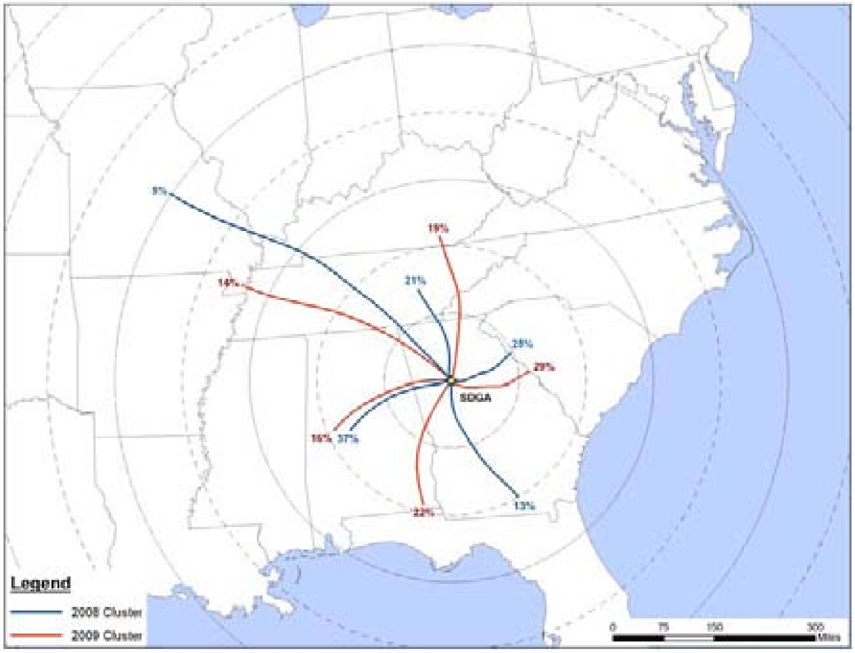


Figure 11-5. Back Trajectory Cluster Map for SDGA

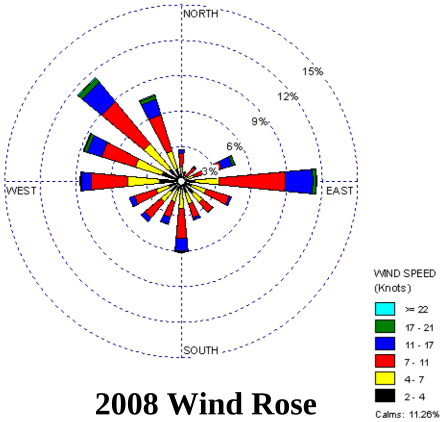


11.2.4 Wind Rose Comparison

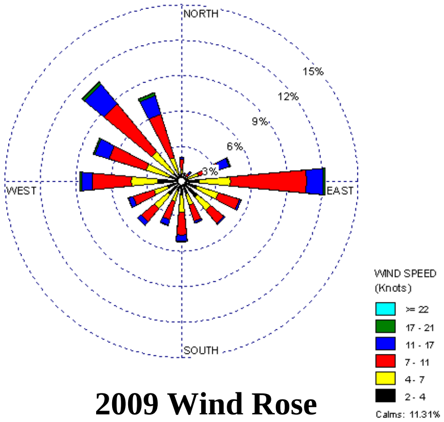
Hourly wind data from the NWS weather station at Hartsfield International Airport near SDGA were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 11-6 presents five different wind roses for the SDGA monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

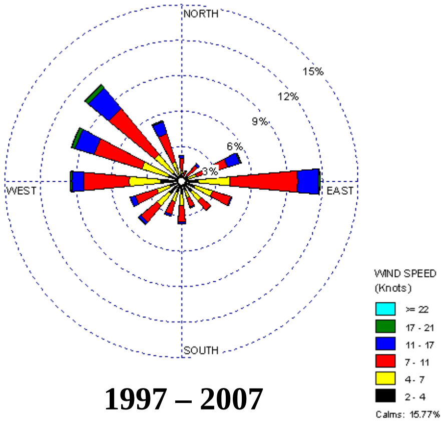
Figure 11-6. Wind Roses for the Hartsfield International Airport Weather Station near SDGA



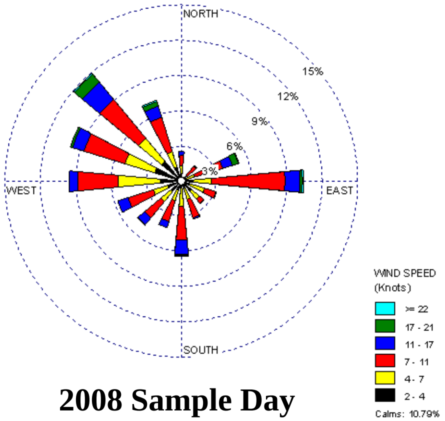
2008 Wind Rose



2009 Wind Rose

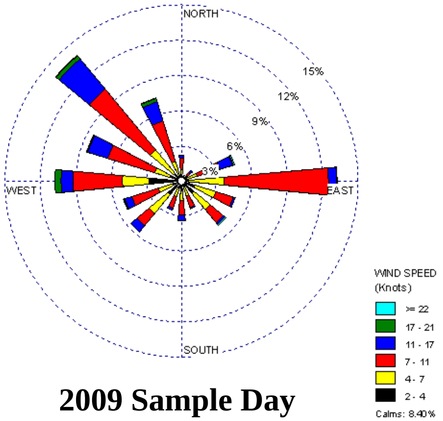


1997 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 11-6 for SDGA include the following:

- The historical wind rose shows that winds from the west to north-northwest account for approximately one-third of wind observations. Easterly winds were also common. Calm winds (≤ 2 knots) were observed for nearly 16 percent of the hourly wind measurements.

- The wind patterns on both the 2008 and 2009 full-year wind roses resemble those of the historical wind rose, indicating that the conditions observed in 2008 and 2009 were similar to what is expected climatologically near this site. Further, the sample day wind patterns for both years are similar to the wind patterns shown on the full-year and historical wind roses. This indicates that conditions on sample days were representative of conditions experienced throughout the year(s).

11.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for SDGA in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 11-4 presents SDGA's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. SDGA sampled for PAH and hexavalent chromium only.

Table 11-4. Risk Screening Results for the Georgia Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Decatur, Georgia - SDGA						
Naphthalene	0.029	106	119	89.08	99.07	99.07
Hexavalent Chromium	0.000083	1	38	2.63	0.93	100.00
Total		107	157	68.15		

Observations from Table 11-4 for SDGA include the following:

- Naphthalene and hexavalent chromium failed screens. Naphthalene failed 106 out of 119 screens (89 percent), while hexavalent chromium failed only one screen (out of 38).

- Benzo(a)pyrene was added as a pollutant of interest for SDGA because it is the other NATTS MQO Core Analyte measured by the site. This pollutant is not shown in Table 11-4.

11.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Georgia monitoring site. Concentration averages are provided for the pollutants of interest for the SDGA monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

11.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for SDGA, as described in Section 3.1.1. The *daily* average of a particular pollutant is simply the average concentration of all measured detections within a given year. If there were at least seven measured detections within a given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent.

Daily, quarterly, and annual averages are presented in Table 11-5, where applicable. The averages presented in Table 11-5 are shown in ng/m^3 for ease of viewing.

Observations for SDGA from Table 11-5 include the following:

- Sampling for hexavalent chromium did not begin until May 2008. This pollutant was detected in less than half of the samples collected over both years (38 out of 87 valid samples). In addition, method completeness was less than 85 percent for 2008, as described in Section 2.4. All of these reasons contribute to why few averages are presented for hexavalent chromium in Table 11-5.

- The benzo(a)pyrene detection rate was approximately 50 percent, which is why few averages are presented for this pollutant in Table 11-5.

- The daily average concentrations of naphthalene were significantly higher than the daily average concentrations of benzo(a)pyrene and hexavalent chromium. Although these averages appear high, the 2009 daily average concentration ranked 24th and the 2008 daily average concentration ranked 33rd among other NMP sites sampling naphthalene.

- For naphthalene, the daily average and annual average concentrations are equal to each other for both years (i.e., the annual average includes no zero substitutions for non-detects because there were no non-detects). But higher confidence intervals are shown for some of the quarterly averages (for example, first quarter 2008) compared to the annual or daily averages. This is because there was a wide range of concentrations measured at this site. For example, for the first quarter of 2008, there were 14 measured detections ranging from 23 to 318 ng/m^3. The range of concentrations for other quarters exhibited similar ranges.

Table 11-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Georgia Monitoring Site

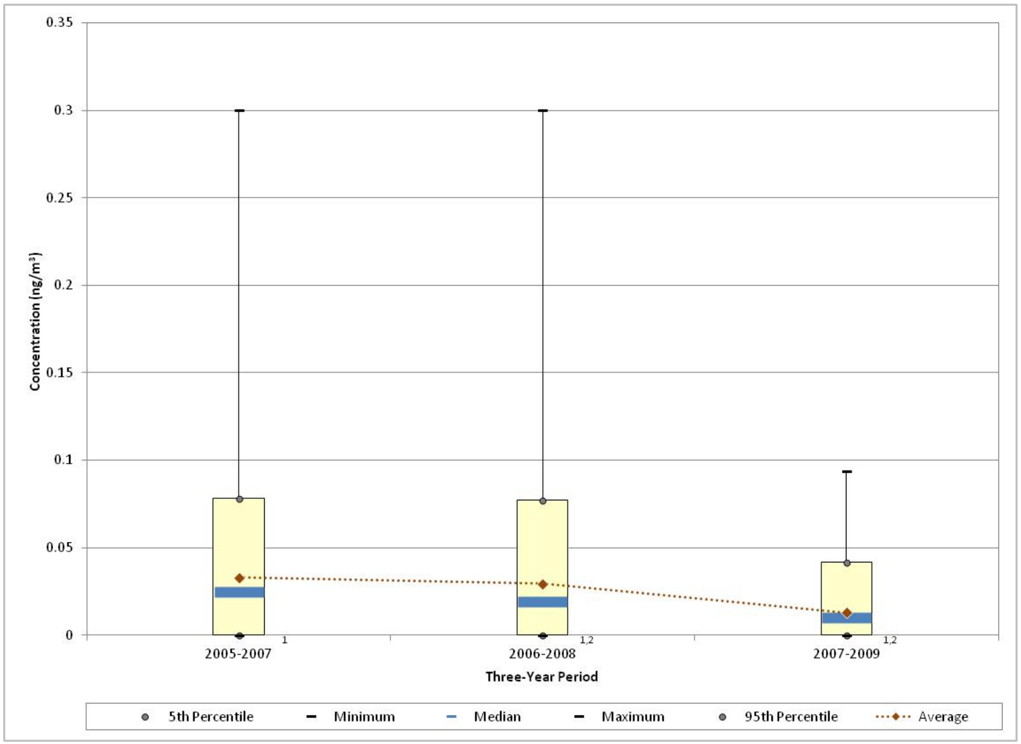
Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Decatur, Georgia - SDGA												
Benzo(a)pyrene	0.10 ± 0.02	0.07 ± 0.04	NA	NA	0.09 ± 0.04	NA	0.10 ± 0.04	0.09 ± 0.05	NA	NA	0.11 ± 0.07	NA
Hexavalent Chromium	0.01 ± 0.01	ND	NA	0.01 ± 0.01	NA	NA*	0.03 ± 0.01	NA	NA	NA	0.01 ± 0.01	NA
Naphthalene	84.98 ± 15.72	75.80 ± 43.23	88.13 ± 22.89	74.72 ± 20.42	100.43 ± 41.62	84.98 ± 15.72	104.21 ± 20.29	69.23 ± 28.00	108.96 ± 48.81	82.15 ± 26.35	142.93 ± 44.95	104.21 ± 20.29

NA = Not available due to the criteria for calculating a quarterly and/or annual average.
ND = Not detected during sampling for this time period.
*Method completeness was less than 85 percent.

11.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. SDGA has sampled hexavalent chromium under the NMP since 2005. Thus, Figure 11-7 presents the 3-year rolling statistical metrics for hexavalent chromium for SDGA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 11-7. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at SDGA



[1] Samples were not collected between September 2007 and May 2008.

[2] Completeness was less than 85 percent for 2008.

Observations from Figure 11-7 for hexavalent chromium measurements at SDGA include the following:

- The maximum hexavalent chromium concentration was measured on November 25, 2006 (0.300 ng/m^3), and thus appears as the maximum concentration for the first two 3-year periods. Only five concentrations measured at SDGA were greater than 0.1 ng/m^3 and all five were measured in 2005 or 2006.

- The rolling average concentration shows a slight decrease from 2005-2007 to 2006-2008, and a significant decrease from 2006-2008 to 2007-2009. The median and 95th percentile exhibit a similar trend.

- Both the minimum concentration and 5th percentile for all three 3-year periods shown are zero, indicating the presence of non-detects. The percentage of non-detects has varied from as little as 5 percent (2007) to as much as 64 percent (2009).

- As denoted in Figure 11-7, sampling for hexavalent chromium began in February 2005. There was a gap in sampling from September 2007 to May 2008. Also, method completeness for 2008 was below 85 percent.

11.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the SDGA monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

11.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the SDGA monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; quarterly averages were compared to the intermediate MRL; and annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the SDGA monitoring site were higher than their respective MRL noncancer health risk benchmarks.

11.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the SDGA monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated).

Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 11-6, where applicable.

Observations for SDGA from Table 11-6 include the following:

- Naphthalene was the only pollutant for which annual averages could be calculated.
- Both of naphthalene's cancer risk approximations were greater than 1.0 in-a-million (2.89 in-a-million for 2008 and 3.54 in-a-million for 2009). Both of naphthalene's noncancer risk approximations were well below 1.0 (0.03 for both years).
- Cancer and noncancer risk approximations could not be calculated for benzo(a)pyrene because this pollutant did not meet the detection criteria for calculating an annual average.
- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for hexavalent chromium due to the sampling completeness and/or detection criteria.

11.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 11-7 and 11-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 11-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 11-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 11-6. Cancer and Noncancer Surrogate Risk Approximations for the Georgia Monitoring Site

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/ Valid Quarterly Averages	Annual Average (ng/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average (ng/m^3)	Cancer (in-a-million)	Noncancer (HQ)
Decatur, Georgia - SDGA										
Benzo(a)pyrene	0.001	--	27/2	NA	NA	NA	35/2	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	17/1	NA	NA	NA	21/1	NA	NA	NA
Naphthalene	3.4E-05	0.003	60/4	84.98 ± 15.72	2.89	0.03	59/4	104.21 ± 20.29	3.54	0.03

-- = A Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

Table 11-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Georgia Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Decatur, Georgia (DeKalb County) - SDGA					
Benzene	455.26	Benzene	3.55E-03	Naphthalene	3.54
Formaldehyde	216.01	Formaldehyde	2.70E-03	Naphthalene	2.89
Dichloromethane	120.19	Arsenic, PM	2.54E-03		
Acetaldehyde	84.52	1,3-Butadiene	1.74E-03		
1,3-Butadiene	57.90	Hexavalent Chromium, PM	1.60E-03		
Tetrachloroethylene	52.63	Naphthalene	7.33E-04		
Naphthalene	21.55	POM, Group 2	3.59E-04		
Trichloroethylene	11.90	Tetrachloroethylene	3.11E-04		
POM, Group 2	6.53	Acetaldehyde	1.86E-04		
Bis(2-ethylhexyl)phthalate	1.57	Cadmium, PM	1.20E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 11-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Georgia Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Decatur, Georgia (DeKalb County) - SDGA					
Toluene	1,522.92	Acrolein	748,452.27	Naphthalene	0.03
Xylenes	1,263.88	1,3-Butadiene	28,949.09	Naphthalene	0.03
Benzene	455.26	Formaldehyde	22,041.97		
Methanol	275.24	Arsenic, PM	19,723.69		
Ethylbenzene	265.86	Benzene	15,175.43		
Hexane	232.79	Xylenes	12,638.76		
Formaldehyde	216.01	Acetaldehyde	9,390.60		
Hydroflouric acid	202.42	Cyanide Compounds, gas	8,419.85		
Ethylene glycol	181.94	Nickel, PM	7,414.19		
Methyl isobutyl ketone	158.92	Naphthalene	7,183.87		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual average are limited to those pollutants for which each respective site sampled. As discussed in Section 11.3, SDGA sampled for PAH and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. Because annual averages for hexavalent chromium and benzo(a)pyrene could not be calculated, for the reasons discussed in Sections 11.4.1 and 11.5.2, cancer and noncancer surrogate risk approximations were not calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 11-7 include the following:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants with cancer UREs in DeKalb County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, formaldehyde, and arsenic.
- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for DeKalb County.
- Naphthalene, which was the only pollutant with cancer risk approximations for SDGA, has the sixth highest toxicity-weighted emissions and seventh highest emissions for DeKalb County.
- Hexavalent chromium ranked fifth highest for toxicity-based emissions, but is not among one of the highest emitted pollutants in DeKalb County.
- POM Group 2 was the ninth highest emitted "pollutant" in DeKalb County and ranked seventh for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at SDGA including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for SDGA.

Observations from Table 11-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in DeKalb County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.

- Three of the highest emitted pollutants in DeKalb County also have the highest toxicity-weighted emissions.

- While naphthalene is not one of the 10 highest emitted pollutants with a noncancer toxicity factor in Dekalb County, it does have one of the highest toxicity-weighted emissions (tenth).

11.6 Summary of the 2008-2009 Monitoring Data for SDGA

Results from several of the treatments described in this section include the following:

- *Naphthalene and hexavalent chromium failed at least one screen for SDGA. Benzo(a)pyrene was added to SDGA's pollutants of interest because it is a NATTS MQO Core Analyte.*

- *Of the site-specific pollutants of the interest, naphthalene had the highest daily average concentrations for SDGA.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than any of their associated MRL noncancer health risk benchmarks.*

12.0 Sites in Illinois

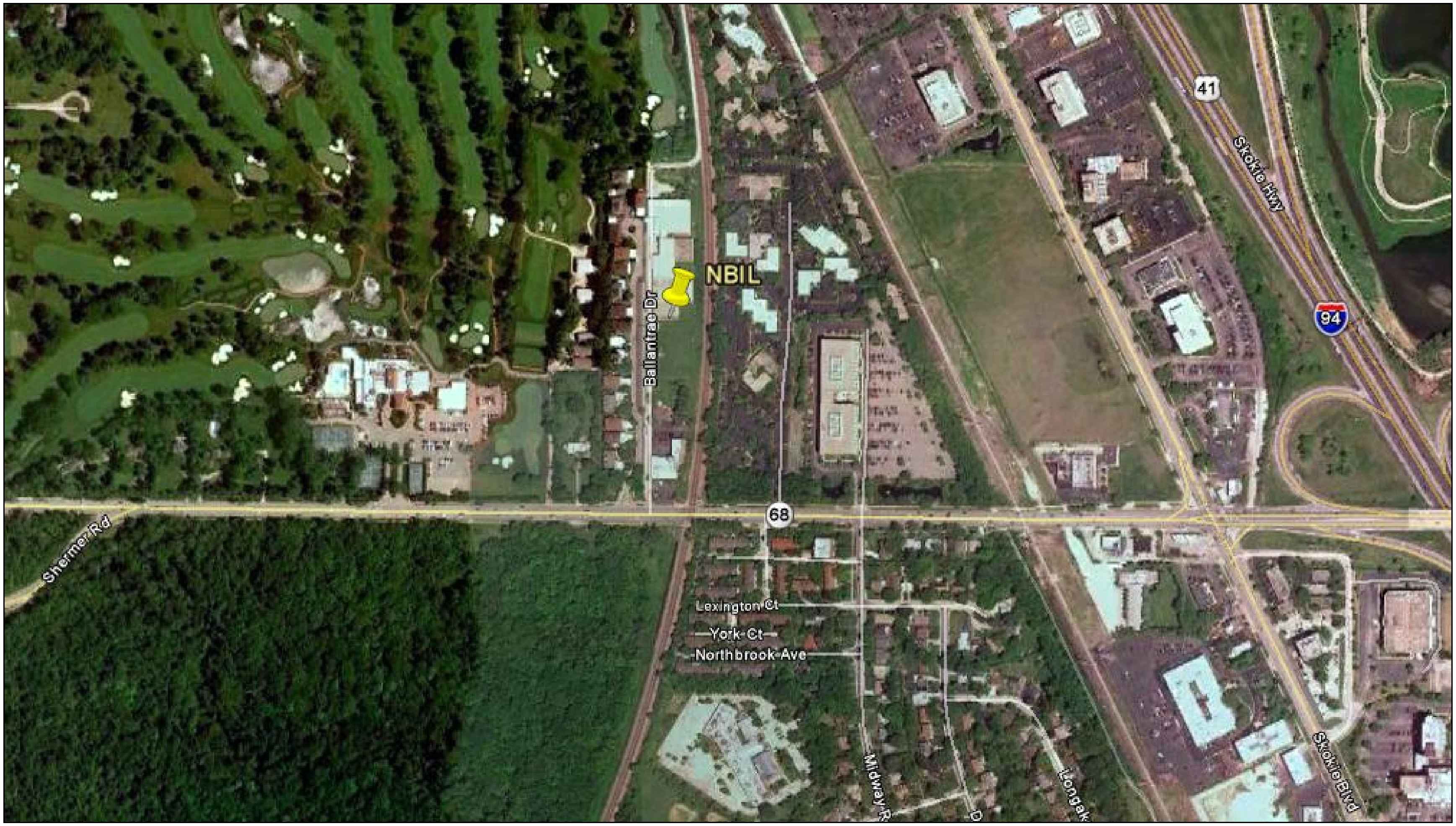
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Illinois, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

12.1 Site Characterization

This section characterizes the Illinois monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

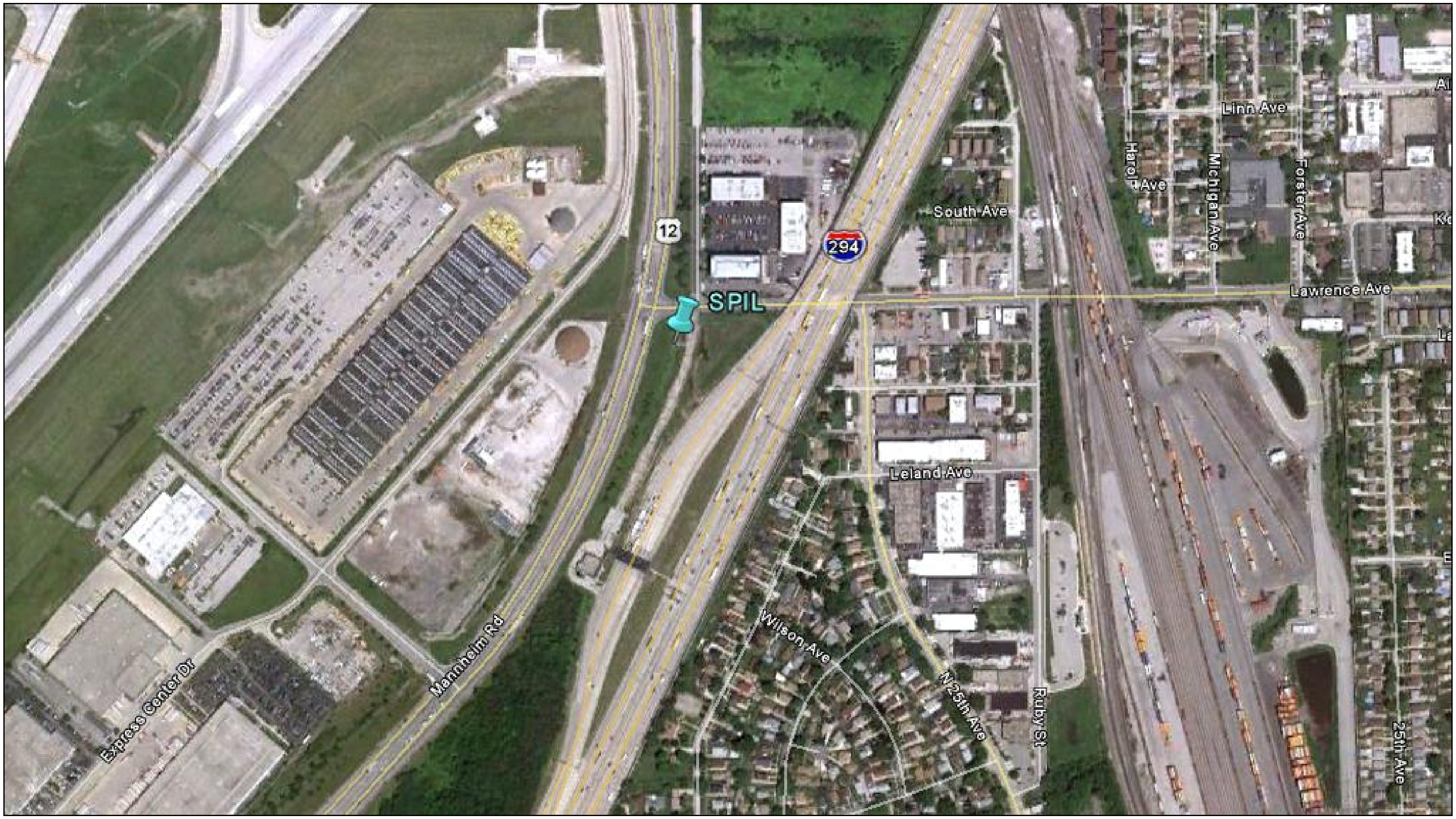
Both sites are located in northwestern suburbs of Greater Chicago. More specifically, NBIL is located in Northbrook and SPIL is located in Schiller Park. Figures 12-1 and 12-2 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figure 12-3 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the map in Figure 12-3. Thus, sources outside each 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 12-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 12-1. Northbrook, Illinois (NBIL) Monitoring Site



©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,495 feet

Figure 12-2. Schiller Park, Illinois (SPIL) Monitoring Site



©2010 Google Earth, accessed 11/9/2010 Scale: 2 inches = 1,516 feet

Figure 12-3. NEI Point Sources Located Within 10 Miles of NBIL and SPIL

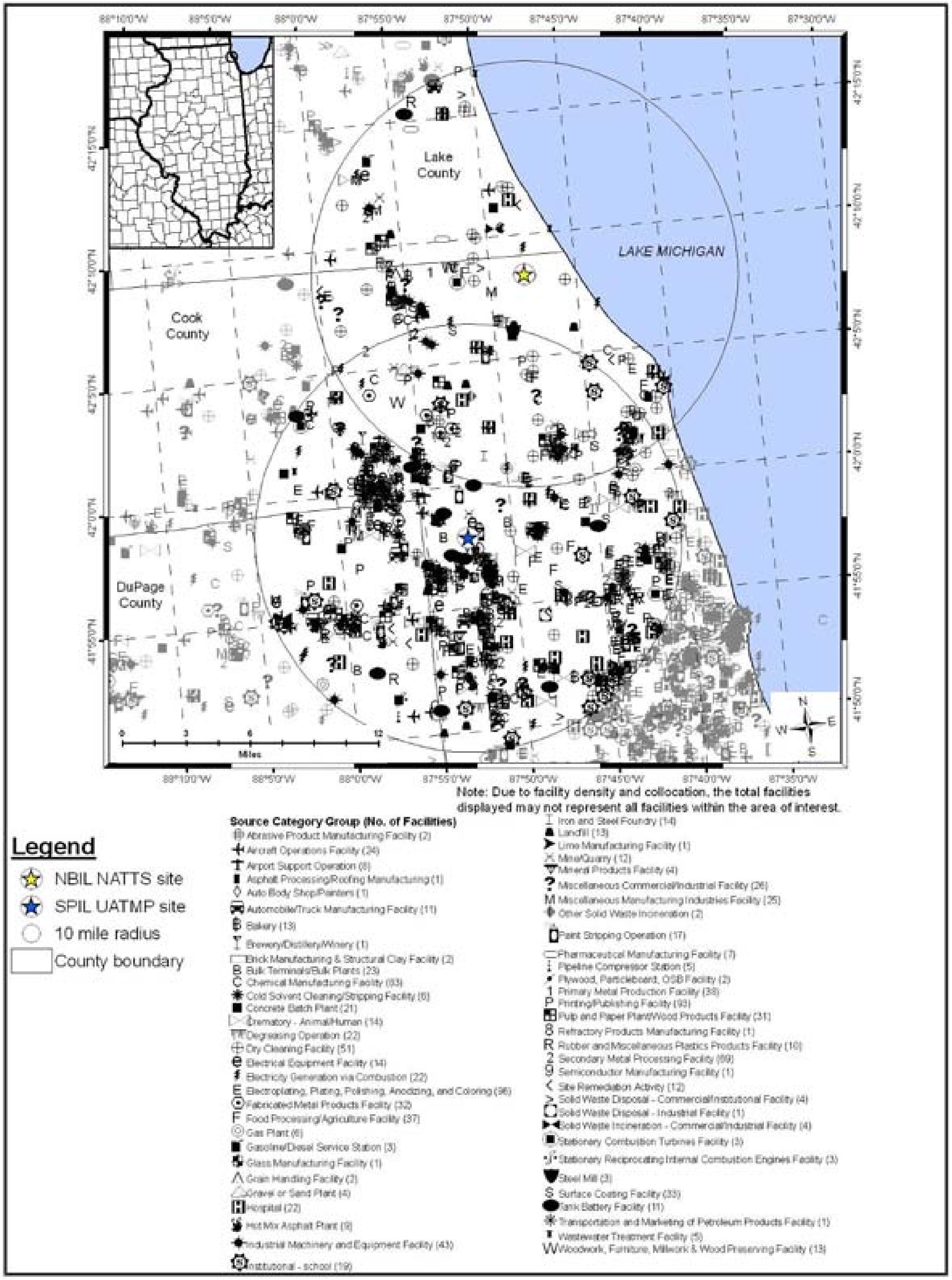

88°10'0"W
88°5'0"W
88°0'0"W
87°55'0"W
87°50'0"W
87°45'0"W
87°40'0"W
87°35'0"W
87°30'0"W
42°15'0"N
42°10'0"N
42°5'0"N
42°0'0"N
41°55'0"N
41°50'0"N
Lake County
Cook County
DuPage County
LAKE MICHIGAN
N
E
S
W
0
3
6
12
Miles
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
NBIL NATTS site
SPIL UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Abrasive Product Manufacturing Facility (2)
Aircraft Operations Facility (34)
Airport Support Operation (8)
Asphalt Processing/Roofing Manufacturing (1)
Auto Body Shop/Painters (1)
Automobile/Truck Manufacturing Facility (11)
Bakery (13)
Brewery/Distillery/Winery (1)
Brick Manufacturing & Structural Clay Facility (2)
Bulk Terminals/Bulk Plants (23)
Chemical Manufacturing Facility (83)
Cold Solvent Cleaning/Stripping Facility (6)
Concrete Batch Plant (21)
Crematory - Animal/Human (14)
Degreasing Operation (22)
Dry Cleaning Facility (51)
Electrical Equipment Facility (14)
Electricity Generation via Combustion (22)
Electroplating, Plating, Polishing, Anodizing, and Coloring (96)
Fabricated Metal Products Facility (32)
Food Processing/Agriculture Facility (37)
Gas Plant (6)
Gasoline/Diesel Service Station (3)
Glass Manufacturing Facility (1)
Grain Handling Facility (2)
Gravel or Sand Plant (4)
Hospital (22)
Hot Mix Asphalt Plant (9)
Industrial Machinery and Equipment Facility (43)
Institutional - school (19)
Iron and Steel Foundry (14)
Landfill (13)
Lime Manufacturing Facility (1)
Mine/Quarry (12)
Mineral Products Facility (4)
Miscellaneous Commercial/Industrial Facility (26)
Miscellaneous Manufacturing Industries Facility (25)
Other Solid Waste Incineration (2)
Paint Stripping Operation (17)
Pharmaceutical Manufacturing Facility (7)
Pipeline Compressor Station (5)
Plywood, Particleboard, OSB Facility (2)
Primary Metal Production Facility (38)
Printing/Publishing Facility (93)
Pulp and Paper Plant/Wood Products Facility (31)
Refractory Products Manufacturing Facility (1)
Rubber and Miscellaneous Plastics Products Facility (10)
Secondary Metal Processing Facility (69)
Semiconductor Manufacturing Facility (1)
Site Remediation Activity (12)
Solid Waste Disposal - Commercial/Institutional Facility (4)
Solid Waste Disposal - Industrial Facility (1)
Solid Waste Incineration - Commercial/Industrial Facility (4)
Stationary Combustion Turbines Facility (3)
Stationary Reciprocating Internal Combustion Engines Facility (3)
Steel Mill (3)
Surface Coating Facility (33)
Tank Battery Facility (11)
Transportation and Marketing of Petroleum Products Facility (1)
Wastewater Treatment Facility (5)
Woodwork, Furniture, Millwork & Wood Preserving Facility (13)

Table 12-1. Geographical Information for the Illinois Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
NBIL	17-031-4201	Northbrook	Cook County	Chicago-Naperville-Joliet, IL-IN-WI	42.139996, -87.799227	Residential	Suburban	TSP, TSP Metals, CO, Hg, SO_2, NO, NO_2, NOx, NH_3, PAMS, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, $PM_{2.5}$ Speciation.
SPIL	17-031-3103	Schiller Park	Cook County	Chicago-Naperville-Joliet, IL-IN-WI	41.965193, -87.876265	Mobile	Suburban	TSP, TSP Metals, CO, NO, NO_2, NOx, Meteorological parameters, $PM_{2.5}$.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

NBIL is located on the property of the Northbrook Water Filtration Station. Figure 12-1 shows that NBIL is located off State Highway 68, Dundee Road, near Exit 29 on I-94. A railway intersects Dundee Road close to the site. The surrounding area is classified as suburban and residential. Commercial, residential, and forested areas are nearby.

SPIL is located on the eastern edge of the Chicago-O'Hare International Airport on Mannheim Road. The nearest runway is less than 1/2 mile from the site. Figure 12-2 shows that SPIL is located north of the Irving Park Road exit on I-294. The surrounding area is classified as suburban and mobile. Commercial and residential areas are nearby.

Figure 12-3 shows that NBIL and SPIL are located within approximately 12 miles of each other. Each site is located within 10 miles of numerous point sources. The source categories with the largest number of sources are electroplating, plating, polishing, anodizing, and coloring; printing and publishing; chemical manufacturing; secondary metal processing; and dry cleaning. Few point sources are located within 2 miles of NBIL, with most of the sources located farther west or south. The closest source to NBIL is under the label for the site in Figure 12-3; this source is a dry cleaning facility. Numerous sources are located in close proximity of SPIL. The two point sources within 1/2 mile of SPIL are involved in electroplating, plating, polishing, anodizing, and coloring; and woodwork, furniture, millwork, and wood preserving.

Table 12-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Illinois monitoring sites. Information provided in Table 12-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Cook County were obtained from the Illinois Secretary of State (IL SOS, 2008) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 12-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 12-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Traffic data for NBIL is for Dundee Road near the railroad crossing; traffic data for SPIL is from I-294 and the intersection of Mannheim Road and Lawrence Avenue. Finally, Table 12-2 presents the daily VMT for the Chicago urban area.

Table 12-2. Population, Motor Vehicle, and Traffic Information for the Illinois Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
NBIL	5,287,037	2,128,822	0.40	870,561	350,531	34,100	172,794
SPIL	5,287,037	2,128,822	0.40	2,049,963	825,416	213,500	172,794

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2008 data from the Illinois Secretary of State (IL SOS, 2008).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Illinois DOT (IL DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 12-2 include the following:

- Cook County had the second highest county-level population (behind Los Angeles County) and fourth highest county-level vehicle registration (behind Los Angeles County, CA; Maricopa County, AZ; and Harris County, TX) compared to all counties with NMP sites.
- The vehicle-per-person ratio for these sites was among the lowest compared to other NMP sites.
- The 10-mile radius population and estimated vehicle ownership were much higher near SPIL than NBIL.
- SPIL experienced a higher annual average daily traffic volume than NBIL. SPIL's traffic volume was the fourth highest among all NMP sites, behind ELNJ, CELA, and SEWA.
- The Chicago area VMT ranked third among urban areas with NMP sites (behind only New York and Los Angeles).

12.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Illinois on sample days, as well as over the course of each year.

12.2.1 Climate Summary

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. In the winter, the origin of an air mass determines the amount and type of precipitation. The largest snowfalls tend to occur when cold air masses flow southward over Lake Michigan, most of which does not freeze in winter. Wind speeds average around 10 miles per hour, but can be greater due to winds channeling between tall buildings downtown, giving the city its nickname, “The Windy City” (Bair, 1992).

12.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The two closest NWS weather stations are located at Palwaukee Municipal Airport (near NBIL) and O’Hare International Airport (near SPIL), WBAN 04838 and 94846, respectively. Additional information about the Palwaukee and O’Hare weather stations is provided in Table 12-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 12-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 12-3 is the 95 percent confidence interval for each parameter. As shown in Table 12-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout the year for both years.

Table 12-3. Average Meteorological Conditions near the Illinois Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Northbrook, Illinois - NBIL										
Palwaukee Municipal Airport 04838 (42.12, -87.91)	5.27 miles 250° (WSW)	2008	Sample Day	57.9 ± 5.1	49.6 ± 4.9	39.3 ± 4.6	44.7 ± 4.4	70.3 ± 2.6	1015.7 ± 1.7	7.1 ± 0.8
			All Year	56.7 ± 2.2	48.5 ± 2.1	38.1 ± 2.0	43.6 ± 1.9	69.6 ± 1.1	1016.8 ± 0.8	6.8 ± 0.3
		2009	Sample Day	56.1 ± 4.7	48.3 ± 4.5	37.7 ± 4.3	43.3 ± 4.1	69.1 ± 2.6	1015.3 ± 2.0	6.7 ± 0.8
			All Year	56.1 ± 2.0	48.4 ± 1.9	37.7 ± 1.9	43.4 ± 1.7	68.9 ± 1.1	1016.9 ± 0.8	6.3 ± 0.3
Schiller Park, Illinois - SPIL										
O'Hare International Airport 94846 (41.99, -87.91)	2.32 miles 303° (WNW)	2008	Sample Day	58.0 ± 5.4	49.8 ± 5.1	38.9 ± 4.7	44.5 ± 4.5	68.9 ± 2.9	1015.4 ± 1.7	8.9 ± 0.9
			All Year	57.1 ± 2.2	49.0 ± 2.1	37.9 ± 2.0	43.7 ± 1.9	68.1 ± 1.1	1016.3 ± 0.7	8.4 ± 0.3
		2009	Sample Day	56.1 ± 5.0	48.3 ± 4.9	37.8 ± 4.5	43.3 ± 4.3	69.3 ± 2.9	1015.1 ± 2.1	8.2 ± 0.8
			All Year	56.7 ± 2.1	49.0 ± 2.0	38.1 ± 1.9	43.9 ± 1.8	68.7 ± 1.2	1016.4 ± 0.8	7.9 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

12.2.3 Back Trajectory Analysis

Figure 12-4 and Figure 12-5 are the composite back trajectory maps for days on which samples were collected at the NBIL monitoring site in 2008 and 2009, respectively. Figure 12-6 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 12-7 and 12-8 are the composite back trajectory maps for days on which samples were collected at the SPIL monitoring site in 2008 and 2009, respectively, and Figure 12-9 is the cluster analysis for both years. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 12-4 through 12-9 represents 100 miles.

Figure 12-4. 2008 Composite Back Trajectory Map for NBIL

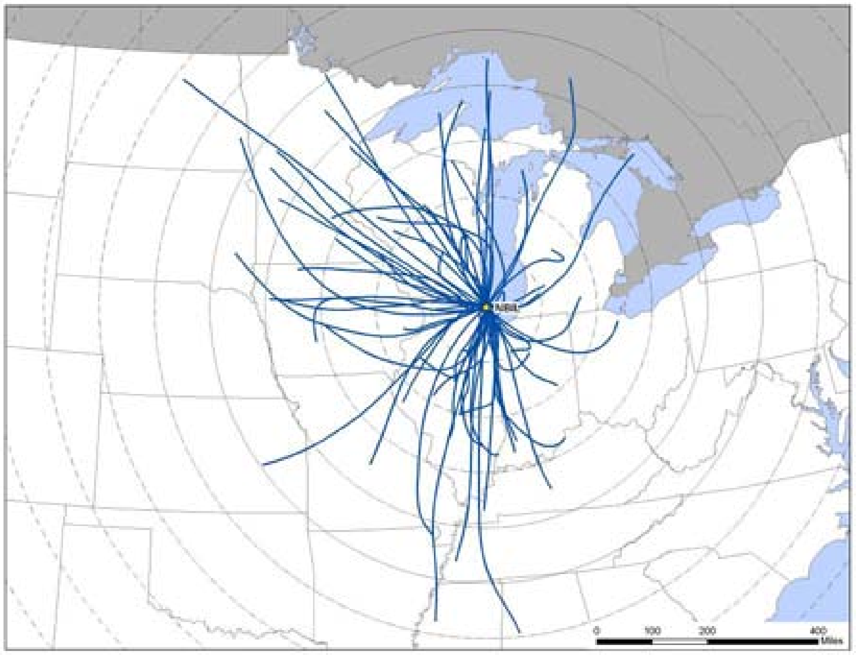


Figure 12-5. 2009 Composite Back Trajectory Map for NBIL

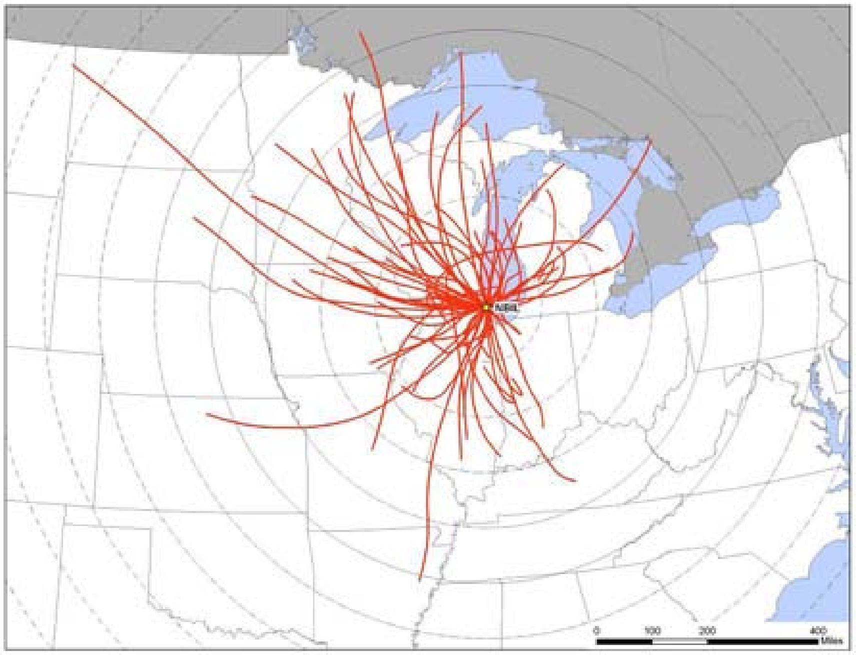


Figure 12-6. Back Trajectory Cluster Map for NBIL

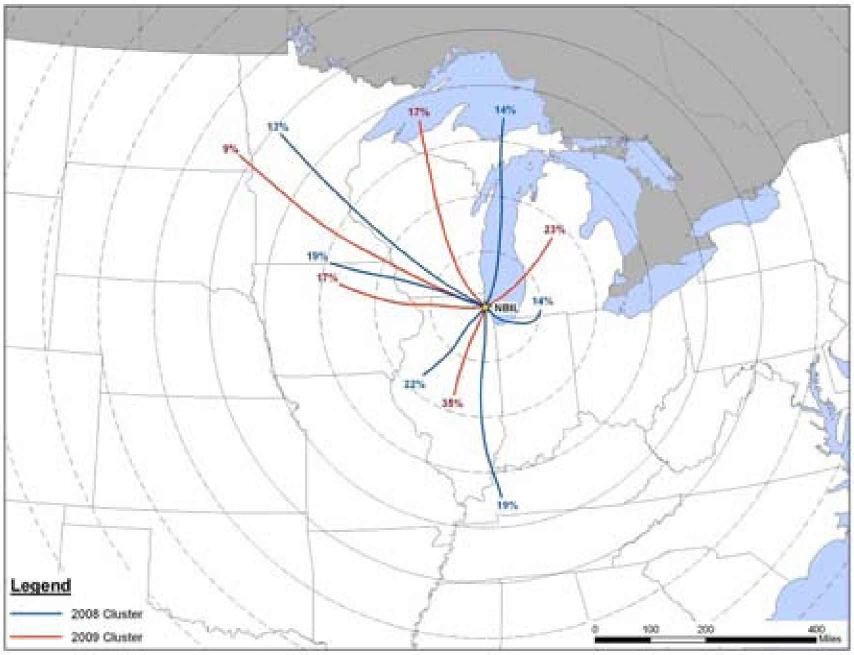


Figure 12-7. 2008 Composite Back Trajectory Map for SPIL

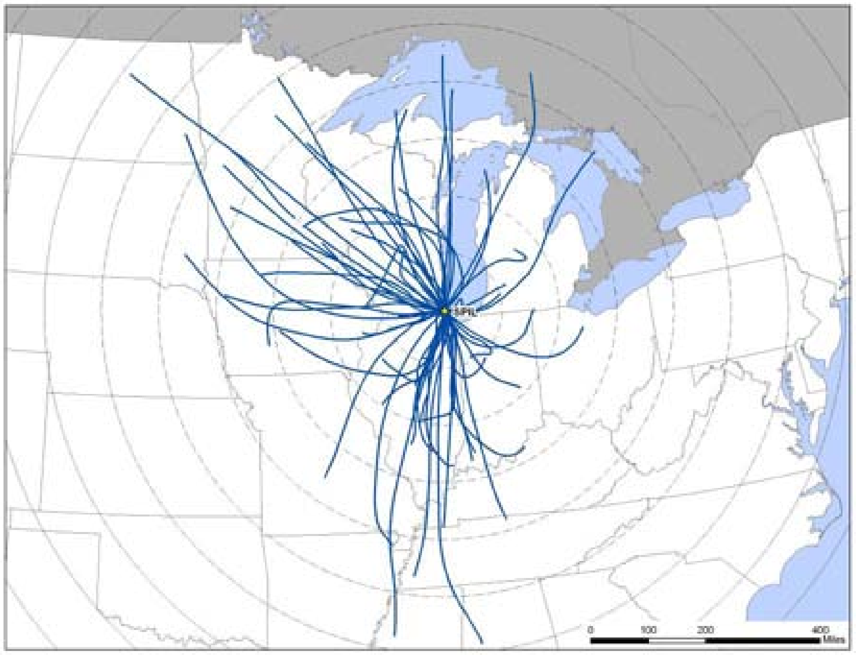


Figure 12-8. 2009 Composite Back Trajectory Map for SPIL

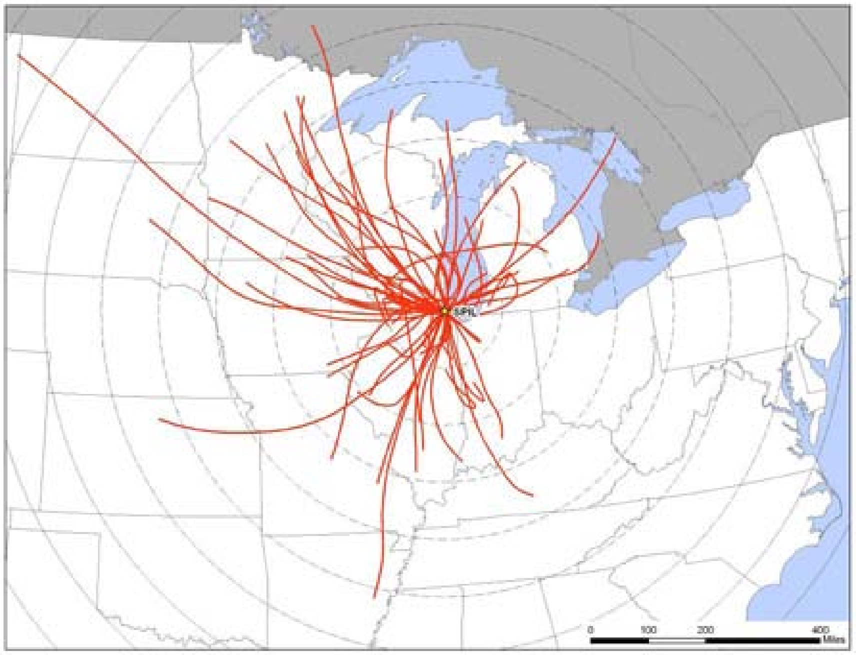
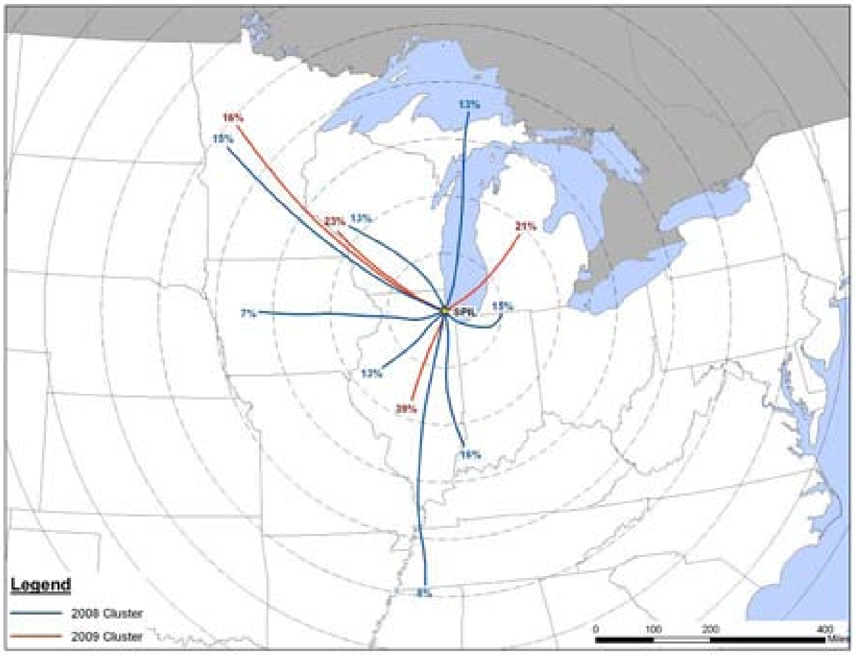


Figure 12-9. Back Trajectory Cluster Map for SPIL



Observations from Figures 12-4 through 12-9 include the following:

- The composite back trajectory maps for NBIL and SPIL are similar to each other. This is expected given their proximity to each other.

- Back trajectories originated from a variety of directions at the sites, although less frequently from the east and southeast. The predominant direction of trajectory origin appears to be from the south and west to northwest.

- The 24-hour air shed domains for NBIL and SPIL were among the largest compared to other NMP sites, as the farthest away a trajectory originated was along the North Dakota/Montana border, over 850 miles away. However, the average trajectory length for these sites was approximately 280 miles and most (approximately 80 percent) trajectories originated within 400 miles of the sites.

- The cluster maps show that back trajectories originating from a northerly, northwesterly, southwesterly, and southerly direction were common. Back trajectories infrequently originated from the east to southeast.

12.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at Palwaukee Municipal Airport (for NBIL) and O'Hare International Airport (for SPIL) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 12-10 presents five different wind roses for the NBIL monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 12-11 presents the five different wind roses for the SPIL monitoring site.

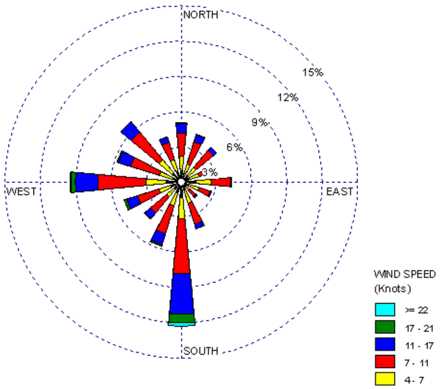
Observations from Figure 12-10 for NBIL include the following:

- The historical wind rose for NBIL shows that winds from a variety of directions were observed, although winds from the south, south-southwest, and west accounted for approximately one-quarter of all observations. Winds from the east to southeast were observed the least often. Calm winds (≤2 knots) were observed for approximately 16 percent of the hourly measurements.

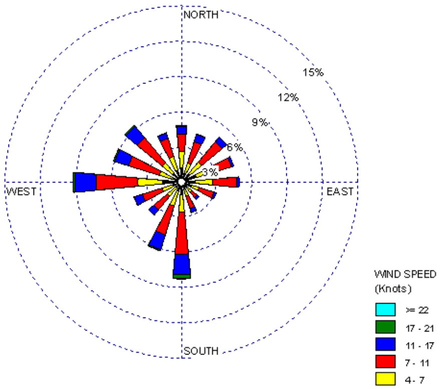
- The 2008 wind rose exhibits similar patterns in wind directions as the historical wind rose, although southerly winds were observed more often. The 2008 sample day wind patterns resemble the 2008 full-year wind patterns, indicating that conditions on sample days were representative of conditions experienced throughout the year.

- The wind patterns shown on the 2009 wind rose also resemble the historical wind patterns, although southerly and southwesterly winds were observed less often while winds from the west to northwest were observed more often. The 2009 sample day wind patterns resemble the 2009 full-year wind patterns, although winds from the west to northwest account for an even higher percentage of the wind observations.

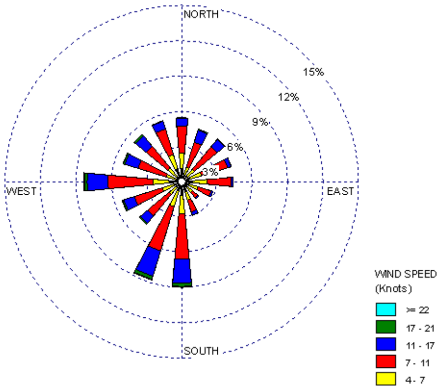
Figure 12-10. Wind Roses for the Palwaukee Municipal Airport Weather Station near NBIL



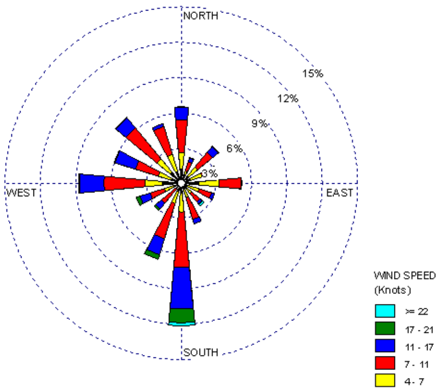
2008 Wind Rose



2009 Wind Rose

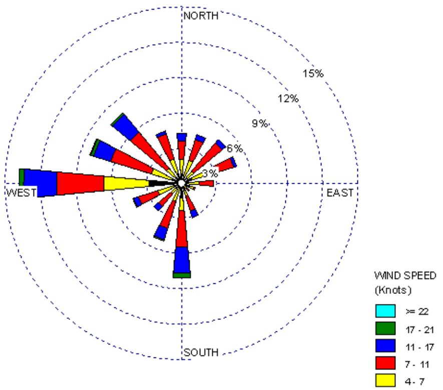


1997 – 2007
Historical Wind Rose



2008 Sample Day

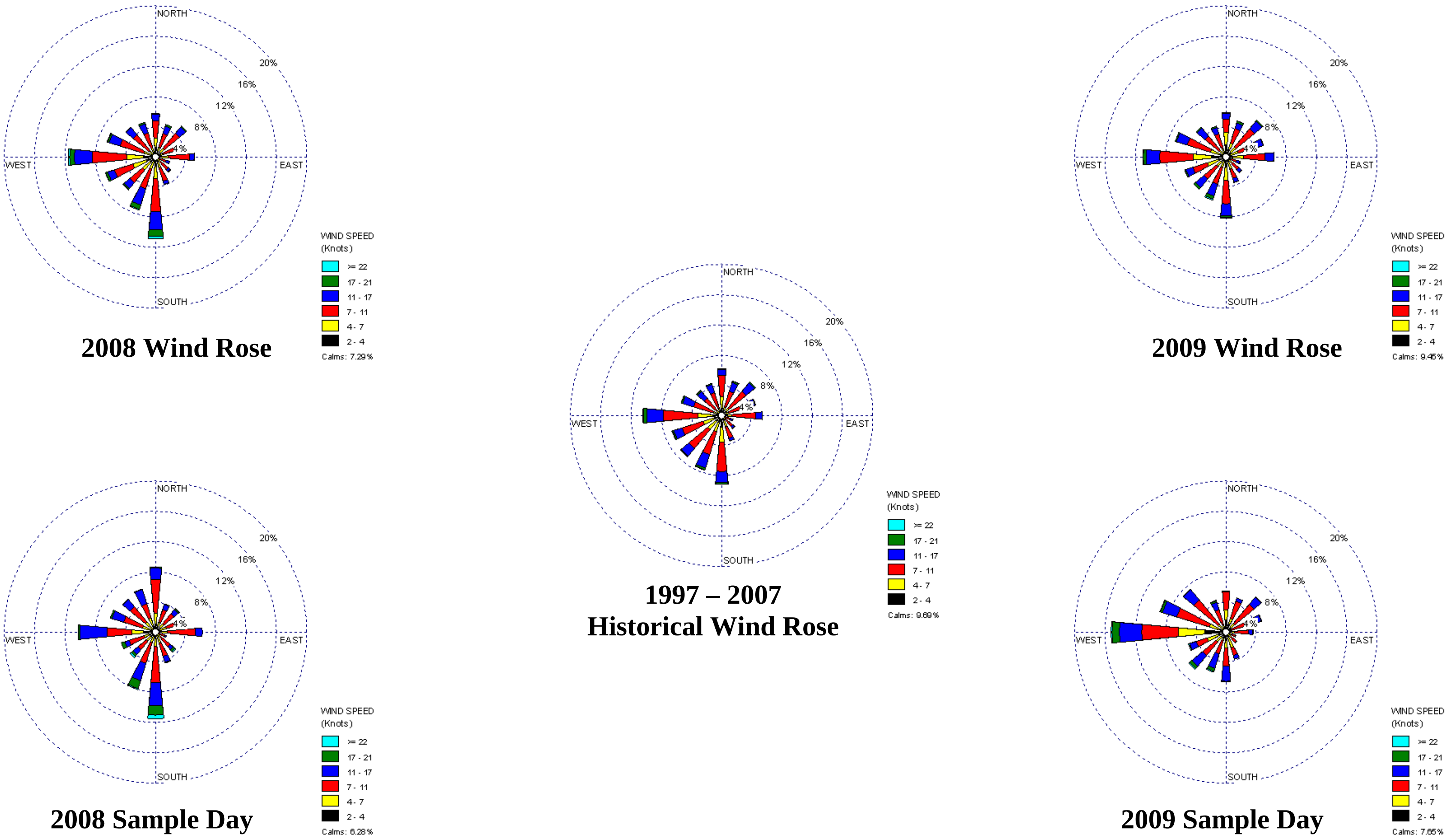
Wind Rose



2009 Sample Day

Wind Rose

Figure 12-11. Wind Roses for the O’Hare International Airport Weather Station near SPIL



2008 Wind Rose

2009 Wind Rose

1997 – 2007
Historical Wind Rose

2008 Sample Day

2009 Sample Day

Wind Rose

Wind Rose

Observations from Figure 12-11 for SPIL include the following:

- The historical wind rose for SPIL shows that winds from a variety of directions were observed, although winds from the south, southwest, and west account for the highest percentage of observations (approximately 40 percent). Winds from the southeast quadrant were observed the least often. Calm winds (≤ 2 knots) were observed for approximately 10 percent of the hourly measurements.

- The 2008 wind rose exhibits similar patterns in wind directions as the historical wind rose. The 2008 sample day wind patterns resemble the 2008 full-year wind patterns, although with a slightly higher percentage of northerly winds. This indicates that conditions on sample days were representative of conditions experienced throughout the year.

- The wind patterns shown on the 2009 wind rose also resemble the historical wind patterns. The 2009 sample day wind patterns resemble the 2009 full-year wind patterns, although winds from the west to northwest account for a higher percentage of the wind observations.

12.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Illinois monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 12-4 presents NBIL's and SPIL's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. NBIL sampled for VOC, carbonyl compounds, SNMOC, metals (PM_{10}), SVOC and hexavalent chromium, and is one of two NMP sites sampling for all six pollutant groups. SPIL sampled for VOC and carbonyl compounds only.

Table 12-4. Risk Screening Results for the Illinois Monitoring Sites

Pollutant	**Screening Value ($\mu g/m^3$)**	**# of Failed Screens**	**# of Measured Detections**	**% of Screens Failed**	**% of Total Failures**	**Cumulative % Contribution**
Northbrook, Illinois - NBIL						
Benzene	0.13	121	121	100.00	14.40	14.40
Carbon Tetrachloride	0.17	121	121	100.00	14.40	28.81
Formaldehyde	0.077	119	120	99.17	14.17	42.98
Arsenic (PM_{10})	0.00023	103	117	88.03	12.26	55.24
Acetaldehyde	0.45	98	120	81.67	11.67	66.90
Naphthalene	0.029	72	95	75.79	8.57	75.48
Manganese (PM_{10})	0.005	52	117	44.44	6.19	81.67
1,3-Butadiene	0.033	50	103	48.54	5.95	87.62
Tetrachloroethylene	0.17	44	114	38.60	5.24	92.86
p-Dichlorobenzene	0.091	19	74	25.68	2.26	95.12
Dichloromethane	2.1	15	121	12.40	1.79	96.90
Ethylbenzene	0.4	8	120	6.67	0.95	97.86
Acrylonitrile	0.015	5	5	100.00	0.60	98.45
1,2-Dichloroethane	0.038	4	4	100.00	0.48	98.93
Hexachloro-1,3-butadiene	0.045	3	3	100.00	0.36	99.29
Trichloroethylene	0.5	3	61	4.92	0.36	99.64
Bromomethane	0.5	1	117	0.85	0.12	99.76
Cadmium (PM_{10})	0.00056	1	117	0.85	0.12	99.88
Lead (PM_{10})	0.015	1	117	0.85	0.12	100.00
Total		840	1,767	47.54		
Schiller Park, Illinois - SPIL						
Benzene	0.13	116	116	100.00	15.96	15.96
Carbon Tetrachloride	0.17	116	116	100.00	15.96	31.91
Formaldehyde	0.077	115	116	99.14	15.82	47.73
Acetaldehyde	0.45	114	116	98.28	15.68	63.41
1,3-Butadiene	0.033	112	116	96.55	15.41	78.82
Tetrachloroethylene	0.17	76	109	69.72	10.45	89.27
Trichloroethylene	0.5	29	92	31.52	3.99	93.26
p-Dichlorobenzene	0.091	22	80	27.50	3.03	96.29
Ethylbenzene	0.4	7	116	6.03	0.96	97.25
Propionaldehyde	0.8	7	114	6.14	0.96	98.21
Dichloromethane	2.1	5	116	4.31	0.69	98.90
1,2-Dichloroethane	0.038	3	3	100.00	0.41	99.31
Acrylonitrile	0.015	2	2	100.00	0.28	99.59
Hexachloro-1,3-butadiene	0.045	2	2	100.00	0.28	99.86
1,2-Dibromoethane	0.0017	1	1	100.00	0.14	100.00
Total		727	1,215	59.84		

Observations from Table 12-4 include the following:

- Nineteen pollutants, including 12 NATTS MQO Core Analytes, failed screens for NBIL. Approximately 48 percent of the measured detections for these pollutants failed screens.

- Based on the risk screening process, 10 pollutants, of which nine are NATTS MQO Core Analytes, were identified as pollutants of interest for NBIL. Three additional NATTS MQO Core Analytes (lead, cadmium, and trichloroethylene) were added to NBIL's list of pollutants of interest, even though they did not contribute to 95 percent of the failed screens for NBIL. In addition, six more NATTS MQO Core Analytes were added to NBIL's list of pollutants of interest, even though they did not fail any screens (chloroform, vinyl chloride, beryllium, benzo(a)pyrene, hexavalent chromium, and nickel). These six pollutants are not shown in Table 12-4.

- Benzene and carbon tetrachloride were detected in every VOC sample collected at NBIL and failed 100 percent of screens. While acrylonitrile, 1,2-dichloroethane, and hexachloro-1,3-butadiene also failed 100 percent of screens for NBIL, these pollutants were detected in only three to five of all 121 samples collected.

- Fifteen pollutants, including seven NATTS MQO Core Analytes, failed screens for SPIL. NBIL sampled four additional methods than SPIL, yet the number of pollutants failing screens was fairly similar (19 for NBIL and 15 for SPIL).

- Based on the risk screening process, eight pollutants, of which seven are NATTS MQO Core Analytes, were identified as pollutants of interest for SPIL. Two additional NATTS MQO Core Analytes were added to SPIL's list of pollutants of interest, even though they did not fail any screens (chloroform and vinyl chloride). These two pollutants are not shown in Table 12-4.

- Similar to NBIL, benzene and carbon tetrachloride failed 100 percent of their screens for SPIL. This is also true for acrylonitrile, hexachloro-1,3-butadiene, 1,2-dichloroethane, and 1,2-dibromoethane, which were detected in three or fewer samples collected.

- Recall from Section 3.2 that if a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used for the risk screening process. As NBIL sampled both VOC (TO-15) and SNMOC, the TO-15 results were used for the 12 pollutants these methods have in common.

12.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Illinois monitoring sites. Concentration averages are provided for the pollutants of interest for each Illinois site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

12.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Illinois site, as described in Section 3.1.1. 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 given calendar quarter, then a quarterly average was calculated. The quarterly average calculations include the substitution zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 12-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium for NBIL are presented in ng/m^3 for ease of viewing.

Table 12-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
Northbrook, Illinois - NBIL												
Acetaldehyde	0.89 ± 0.13	0.63 ± 0.27	1.00 ± 0.28	1.06 ± 0.25	0.81 ± 0.23	0.89 ± 0.13	0.69 ± 0.08	0.92 ± 0.21	0.54 ± 0.06	0.56 ± 0.09	0.74 ± 0.16	0.69 ± 0.08
Benzene	0.55 ± 0.07	0.54 ± 0.08	0.44 ± 0.10	0.68 ± 0.24	0.54 ± 0.13	0.55 ± 0.07	0.56 ± 0.09	0.85 ± 0.20	0.60 ± 0.16	0.40 ± 0.14	0.39 ± 0.09	0.56 ± 0.09
1,3-Butadiene	0.05 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.06 ± 0.04	0.05 ± 0.03	0.04 ± 0.01	0.04 ± 0.01	0.05 ± 0.02	0.03 ± 0.01	0.03 ± 0.02	0.02 ± 0.01	0.03 ± 0.01
Carbon Tetrachloride	0.83 ± 0.05	0.73 ± 0.08	0.80 ± 0.05	0.89 ± 0.11	0.90 ± 0.12	0.83 ± 0.05	0.75 ± 0.04	0.71 ± 0.10	0.72 ± 0.06	0.84 ± 0.07	0.75 ± 0.11	0.75 ± 0.04
Chloroform	0.68 ± 0.23	0.13 ± 0.03	0.44 ± 0.14	1.36 ± 0.46	0.86 ± 0.73	0.68 ± 0.23	0.63 ± 0.28	0.25 ± 0.17	0.50 ± 0.17	0.94 ± 0.40	0.86 ± 1.08	0.63 ± 0.28
p-Dichlorobenzene	0.12 ± 0.03	0.03 ± 0.02	0.06 ± 0.03	0.17 ± 0.08	0.04 ± 0.03	0.07 ± 0.03	0.05 ± 0.01	0.03 ± 0.02	0.04 ± 0.02	0.03 ± 0.02	NA	0.03 ± 0.01
Formaldehyde	0.61 ± 0.10	0.43 ± 0.13	0.63 ± 0.19	0.84 ± 0.26	0.53 ± 0.19	0.61 ± 0.10	1.00 ± 0.16	0.79 ± 0.14	1.21 ± 0.48	1.26 ± 0.30	0.72 ± 0.14	1.00 ± 0.16
Tetrachloroethylene	0.21 ± 0.05	0.10 ± 0.03	0.17 ± 0.06	0.32 ± 0.18	0.21 ± 0.10	0.20 ± 0.05	0.20 ± 0.04	0.21 ± 0.09	0.20 ± 0.09	0.23 ± 0.12	0.12 ± 0.05	0.19 ± 0.04
Trichloroethylene	0.19 ± 0.09	0.04 ± 0.03	0.14 ± 0.13	0.14 ± 0.16	0.07 ± 0.06	0.10 ± 0.05	0.18 ± 0.08	0.08 ± 0.06	0.07 ± 0.05	0.12 ± 0.09	NA	0.09 ± 0.04
Vinyl Chloride	0.02 ± 0.01	NA	NA	NA	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA
Arsenic (PM$_{10}$)[a]	0.75 ± 0.16	0.49 ± 0.11	0.75 ± 0.25	1.07 ± 0.45	0.68 ± 0.37	0.75 ± 0.16	0.73 ± 0.15	0.56 ± 0.16	0.84 ± 0.27	1.11 ± 0.47	0.42 ± 0.11	0.73 ± 0.15
Benzo(a)pyrene [a]	0.12 ± 0.04	NR	NA	0.11 ± 0.08	0.11 ± 0.06	NA	0.12 ± 0.02	0.15 ± 0.05	0.05 ± 0.02	0.08 ± 0.03	0.14 ± 0.07	0.10 ± 0.02

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 12-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Beryllium (PM_{10}) [a]	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Cadmium (PM_{10}) [a]	0.18 ± 0.04	0.18 ± 0.04	0.18 ± 0.06	0.16 ± 0.07	0.21 ± 0.14	0.18 ± 0.04	0.14 ± 0.02	0.22 ± 0.07	0.16 ± 0.05	0.10 ± 0.03	0.09 ± 0.02	0.14 ± 0.02
Hexavalent Chromium [a]	0.02 ± <0.01	0.01 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	NA	0.01 ± <0.01	0.02 ± <0.01	NA	NA	0.01 ± 0.01	0.01 ± 0.01	NA
Lead (PM_{10}) [a]	4.33 ± 0.79	3.57 ± 0.85	4.80 ± 1.58	5.12 ± 2.05	3.82 ± 1.83	4.33 ± 0.79	3.34 ± 0.70	4.43 ± 1.49	4.14 ± 2.11	2.58 ± 0.63	2.17 ± 0.64	3.34 ± 0.70
Manganese (PM_{10}) [a]	7.10 ± 1.86	4.53 ± 1.15	11.67 ± 6.53	6.30 ± 2.15	5.91 ± 2.30	7.10 ± 1.86	5.44 ± 0.91	5.96 ± 2.53	7.02 ± 1.73	5.28 ± 1.28	3.38 ± 1.42	5.44 ± 0.91
Naphthalene [a]	80.11 ± 20.75	NR	NA	104.65 ± 37.16	61.35 ± 28.96	NA	65.92 ± 13.25	60.98 ± 33.84	52.11 ± 25.32	89.09 ± 26.76	59.61 ± 22.17	65.92 ± 13.25
Nickel (PM_{10}) [a]	1.01 ± 0.12	0.89 ± 0.22	1.11 ± 0.24	1.18 ± 0.35	0.87 ± 0.16	1.01 ± 0.12	0.96 ± 0.13	1.10 ± 0.28	0.99 ± 0.22	1.09 ± 0.36	0.66 ± 0.10	0.96 ± 0.13
Schiller Park, Illinois - SPIL												
Acetaldehyde	1.37 ± 0.19	1.37 ± 0.23	1.41 ± 0.31	1.06 ± 0.40	1.62 ± 0.58	1.37 ± 0.19	1.27 ± 0.12	1.37 ± 0.33	1.17 ± 0.18	1.23 ± 0.16	1.30 ± 0.29	1.27 ± 0.12
Benzene	0.80 ± 0.08	0.71 ± 0.09	0.77 ± 0.14	0.88 ± 0.29	0.86 ± 0.18	0.80 ± 0.08	0.68 ± 0.08	1.03 ± 0.25	0.62 ± 0.08	0.52 ± 0.11	0.59 ± 0.12	0.68 ± 0.08
1,3-Butadiene	0.11 ± 0.02	0.10 ± 0.03	0.09 ± 0.02	0.12 ± 0.03	0.14 ± 0.04	0.11 ± 0.02	0.08 ± 0.01	0.13 ± 0.04	0.07 ± 0.01	0.06 ± 0.01	0.09 ± 0.03	0.08 ± 0.01
Carbon Tetrachloride	0.84 ± 0.05	0.75 ± 0.08	0.77 ± 0.08	0.99 ± 0.12	0.86 ± 0.10	0.84 ± 0.05	0.73 ± 0.04	0.67 ± 0.09	0.69 ± 0.06	0.84 ± 0.06	0.69 ± 0.06	0.73 ± 0.04
Chloroform	0.15 ± 0.07	0.08 ± 0.01	0.10 ± 0.01	0.35 ± 0.32	0.12 ± 0.02	0.15 ± 0.07	0.14 ± 0.06	0.09 ± 0.02	0.10 ± 0.02	0.27 ± 0.23	0.10 ± 0.02	0.14 ± 0.06

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 12-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
p-Dichlorobenzene	0.16 ± 0.14	0.02 ± 0.01	0.26 ± 0.36	0.11 ± 0.07	0.04 ± 0.03	0.11 ± 0.09	0.09 ± 0.07	0.15 ± 0.22	0.03 ± 0.01	0.07 ± 0.04	0.03 ± 0.02	0.07 ± 0.05
Formaldehyde	2.26 ± 0.45	1.37 ± 0.22	2.26 ± 0.48	2.18 ± 0.64	3.29 ± 1.59	2.26 ± 0.45	1.85 ± 0.21	1.69 ± 0.39	1.93 ± 0.48	2.32 ± 0.46	1.48 ± 0.33	1.85 ± 0.21
Tetrachloroethylene	0.36 ± 0.09	0.23 ± 0.09	0.31 ± 0.07	0.46 ± 0.23	0.38 ± 0.25	0.34 ± 0.08	0.26 ± 0.05	0.20 ± 0.08	0.30 ± 0.13	0.23 ± 0.08	0.25 ± 0.07	0.25 ± 0.05
Trichloroethylene	0.63 ± 0.24	0.19 ± 0.16	0.89 ± 0.63	0.44 ± 0.31	0.47 ± 0.32	0.50 ± 0.20	0.43 ± 0.19	0.58 ± 0.63	0.31 ± 0.16	0.32 ± 0.28	0.19 ± 0.16	0.34 ± 0.16
Vinyl Chloride	0.01 ± 0.01	NA	NA	NA	NA	NA	0.02 ± 0.02	NA	NA	NA	NA	NA

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Observations for NBIL from Table 12-5 include the following:

- None of the daily average concentrations for any of the pollutants of interest were greater than 1.00 µg/m^3. The pollutants with the highest 2008 daily average concentrations by mass were acetaldehyde (0.89 ± 0.13 µg/m^3), carbon tetrachloride (0.83 ± 0.05 µg/m^3), and chloroform (0.68 ± 0.23 µg/m^3). The pollutants with the highest 2009 daily average concentrations by mass were formaldehyde (1.00 ± 0.16 µg/m^3), carbon tetrachloride (0.75 ± 0.04 µg/m^3), and acetaldehyde (0.69 ± 0.08 µg/m^3).

- Concentrations of most of the pollutants of interest for NBIL did not vary significantly from quarter to quarter. However, a few quarterly averages do stand out, as described below.

- Chloroform concentrations appear significantly higher during the summer and fall. The high confidence interval for the both the 2008 and 2009 fourth quarter average indicates that outliers are likely influencing these averages. The two highest chloroform concentrations were measured nearly one year apart, on October 4, 2009 (7.58 µg/m^3) and October 3, 2008 (5.72 µg/m^3). In addition, these two chloroform concentrations were the highest measured among all NMP sites sampling this pollutant.

- The 2008 second quarter average of manganese was twice as high as most other quarterly averages for this pollutant. The confidence interval was also relatively high, indicating the likely influence of outliers. A review of the data shows that the three highest concentrations of manganese were all measured during the second quarter of 2008 (41.8 ng/m^3 on April 24, 2008; 26.1 ng/m^3 on May 6, 2008, and 24.3 ng/m^3 on April 30, 2008). The April 24, 2008 concentration was the sixth highest manganese concentration measured among all NMP sites sampling PM_{10} metals.

Observations for SPIL from Table 12-5 include the following:

- The pollutants with the highest 2008 daily average concentrations by mass were formaldehyde (2.26 ± 0.45 µg/m^3), acetaldehyde (1.37 ± 0.19 µg/m^3), and carbon tetrachloride (0.84 ± 0.05 µg/m^3). The pollutants with the highest 2009 daily average concentrations were also formaldehyde (1.85 ± 0.21 µg/m^3), acetaldehyde (1.27 ± 0.12 µg/m^3), and carbon tetrachloride (0.73 ± 0.04 µg/m^3). The acetaldehyde and formaldehyde concentrations were significantly higher for SPIL than for NBIL, while the carbon tetrachloride concentrations were nearly identical.

- Concentrations of most of the pollutants of interest for SPIL did not vary significantly across calendar quarters. However, a few quarterly averages do stand out, as described below.

- Several of the quarterly average concentrations of trichloroethylene have rather large confidence intervals, particularly the second quarter of 2008 and the first quarter of

2009, indicating that outliers are likely influencing these averages. The two highest trichloroethylene concentrations were measured on June 5, 2008 (4.38 μg/m^3) and February 9, 2009 (3.80 μg/m^3). Of the 17 concentrations of trichloroethylene that were greater than 1 μg/m^3, six of these were measured during the second quarter of 2008 and three were measured during the first quarter of 2009.

- In addition to trichloroethylene, *p*-dichlorobenzene also had large confidence intervals for the second quarter of 2008 and the first quarter of 2009. The highest *p*-dichlorobenzene concentration (and the seventh highest among all NMP sites) was measured at SPIL on June 17, 2008 (2.71 μg/m^3). The second highest *p*-dichlorobenzene concentration was measured at SPIL on January 1, 2009 (1.41 μg/m^3). The third highest concentration measured at SPIL was significantly lower than these, at 0.319 μg/m^3 on September 28, 2009.

- The 2008 fourth quarter average concentration of formaldehyde also had a high confidence interval. Of the six formaldehyde concentrations greater than 4.0 μg/m^3, four were measured during the fourth quarter of 2008, and ranged from 10.6 μg/m^3 (measured on November 26, 2008) to 4.38 μg/m^3 (measured on December 2, 2008).

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for NBIL and SPIL from those tables include the following:

- As shown in Table 4-9, SPIL and NBIL had the highest and third highest daily average concentration of carbon tetrachloride (2008), respectively. NBIL's 2008 and 2009 daily average concentrations of chloroform were the second and fourth highest (respectively) among all NMP sites sampling this pollutant. SPIL had the second and third highest daily average concentrations of trichloroethylene while NBIL had the fifth and seventh highest daily average concentrations of this pollutant.

- As shown in Table 4-12, NBIL appears a total of nine times among the sites with the highest daily average concentrations of the PM_{10} metals. However, it is important to note that only 11 sites sampled PM_{10} metals.

12.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. NBIL and SPIL have sampled VOC under the NMP since 2003. Both sites have also sampled carbonyl compounds since 2005. Additionally, NBIL has also sampled PM_{10} metals and hexavalent chromium since 2005. Figures 12-12 through 12-18 present the 3-year rolling statistical metrics for acetaldehyde, arsenic, benzene, 1,3-butadiene, formaldehyde, hexavalent chromium, and manganese for NBIL, respectively. Figures 12-19 through 12-22 present the 3-year rolling statistical metrics for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde for SPIL, respectively. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

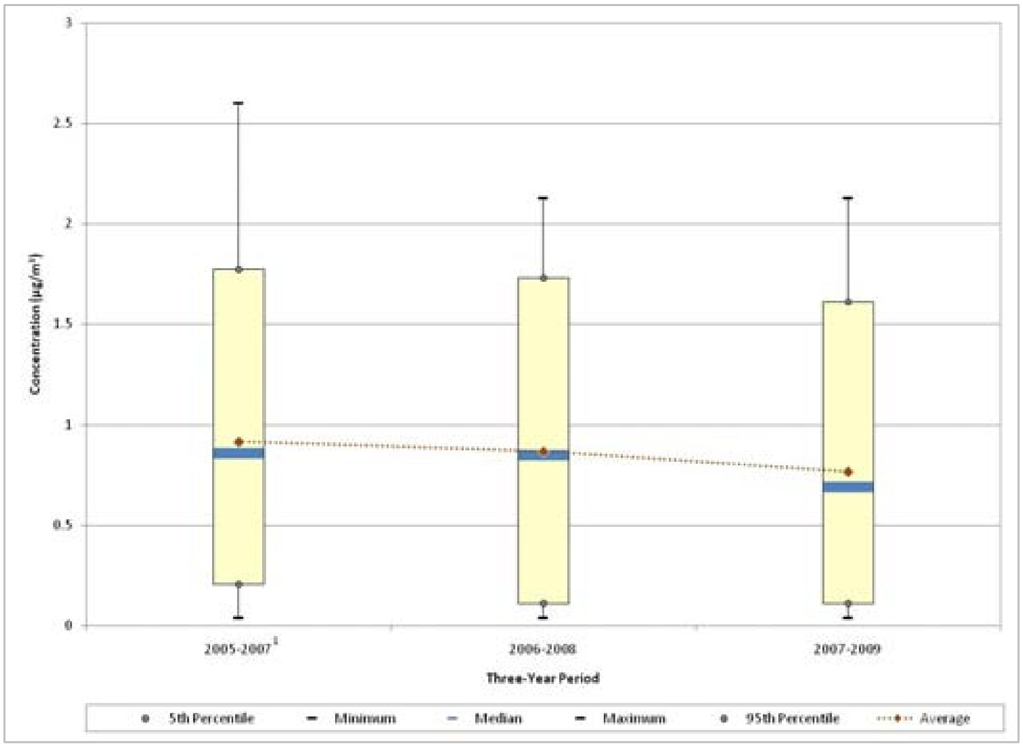
Observations from Figure 12-12 for acetaldehyde measurements at NBIL include the following:

- Carbonyl compound sampling at NBIL began in March 2005, as denoted in Figure 12-12.
- The maximum acetaldehyde concentration was measured on September 7, 2005, although similar concentrations were also measured in 2006 and 2008.
- The rolling average and median concentrations, as well as the other statistical parameters, have a decreasing trend over the time periods shown.
- Note that the minimum concentration for each 3-year period is greater than zero, indicating that there were no non-detects of acetaldehyde reported since the onset of carbonyl compound sampling.

Observations from Figure 12-13 for arsenic (PM_{10}) measurements at NBIL include the following:

- Metals sampling at NBIL began in January 2005.
- The maximum arsenic concentration was measured on July 12, 2008.
- The rolling average and median concentrations show relatively little change over the period of sampling.
- Note that the minimum concentration for each 3-year period is greater than zero, indicating that there were no non-detects of arsenic reported since the onset of metals sampling.

Figure 12-12. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at NBIL



[1] Carbonyl compound sampling at NBIL began in March 2005.

Figure 12-13. Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at NBIL

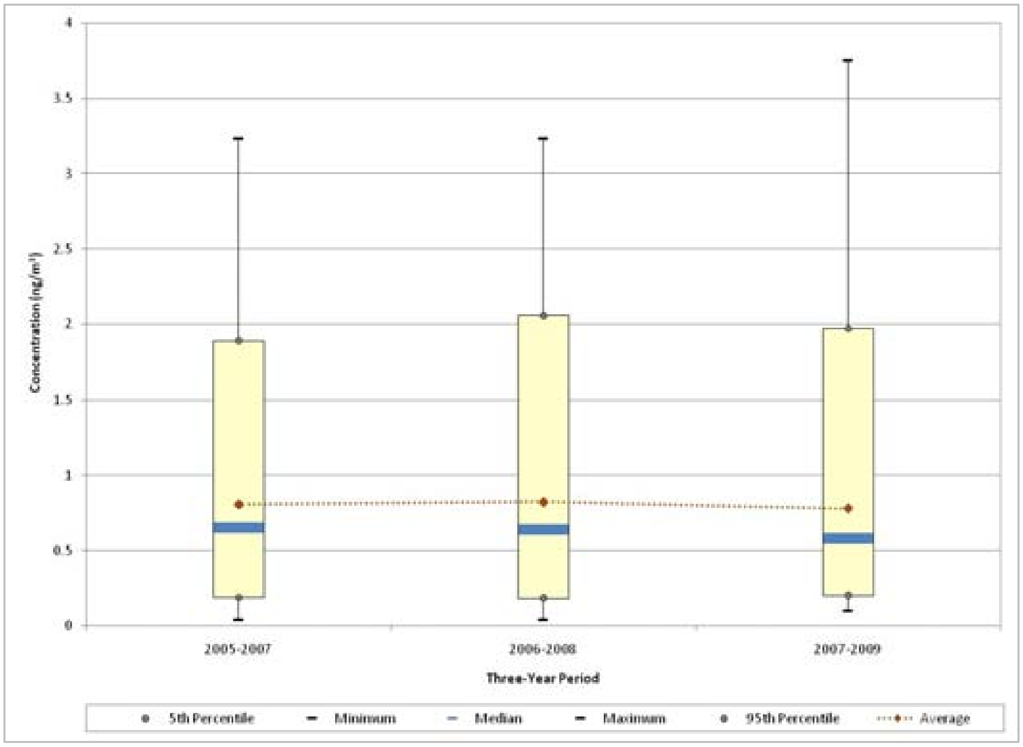
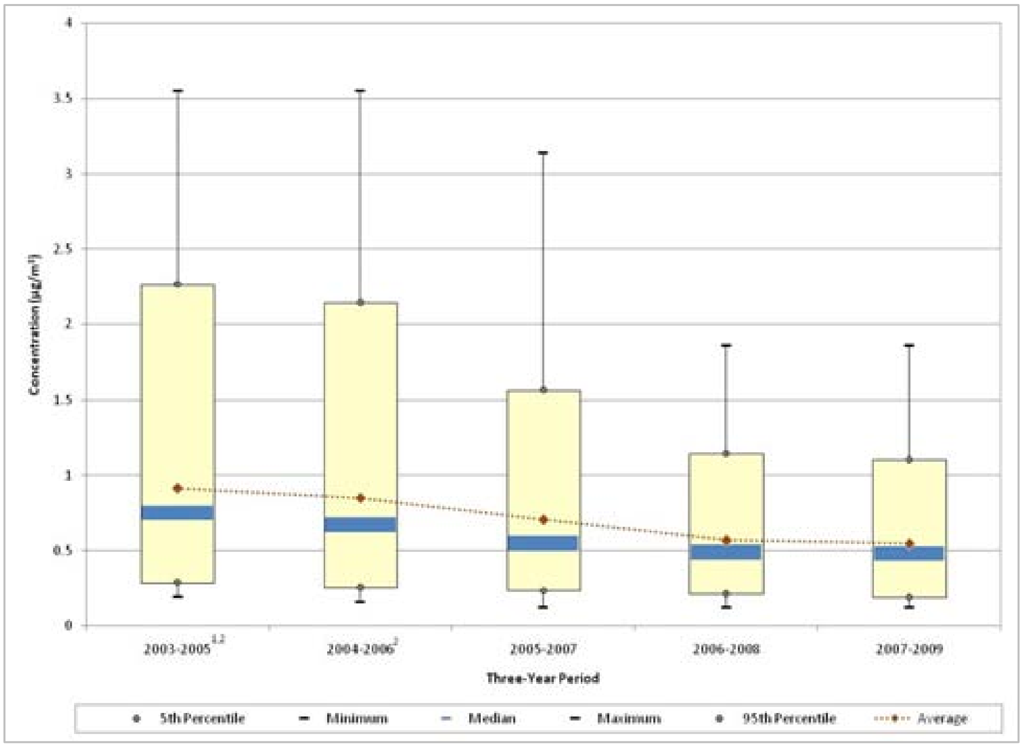


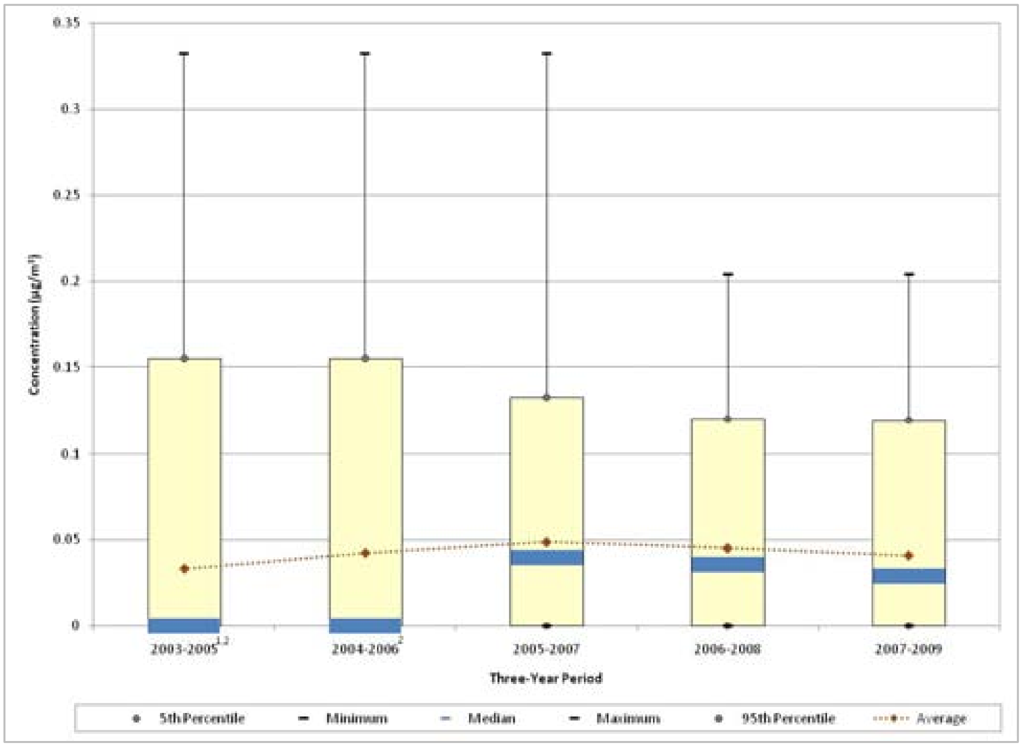
Figure 12-14. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at NBIL



[1] VOC sampling at NBIL began in April 2003.

[2] No VOC samples were collected from November to December 2004.

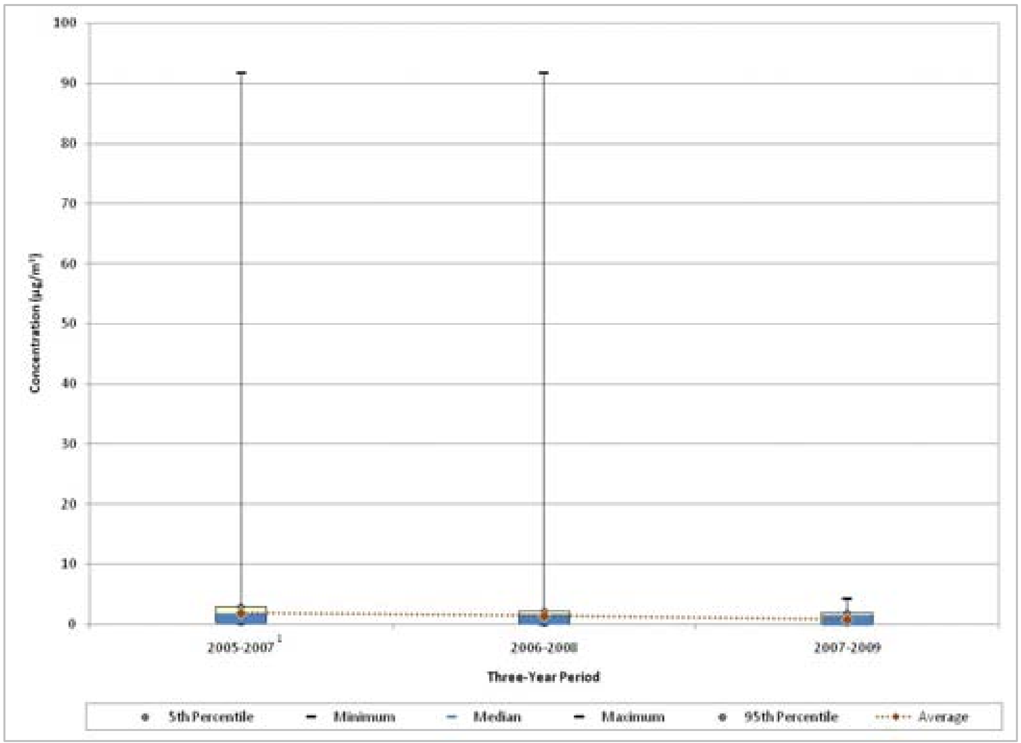
Figure 12-15. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBIL



[1]VOC sampling at NBIL began in April 2003.

[2]No VOC samples were collected from November to December 2004.

Figure 12-16. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at NBIL



[1]Carbonyl compound sampling at NBIL began in March 2005.

Figure 12-17. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at NBIL

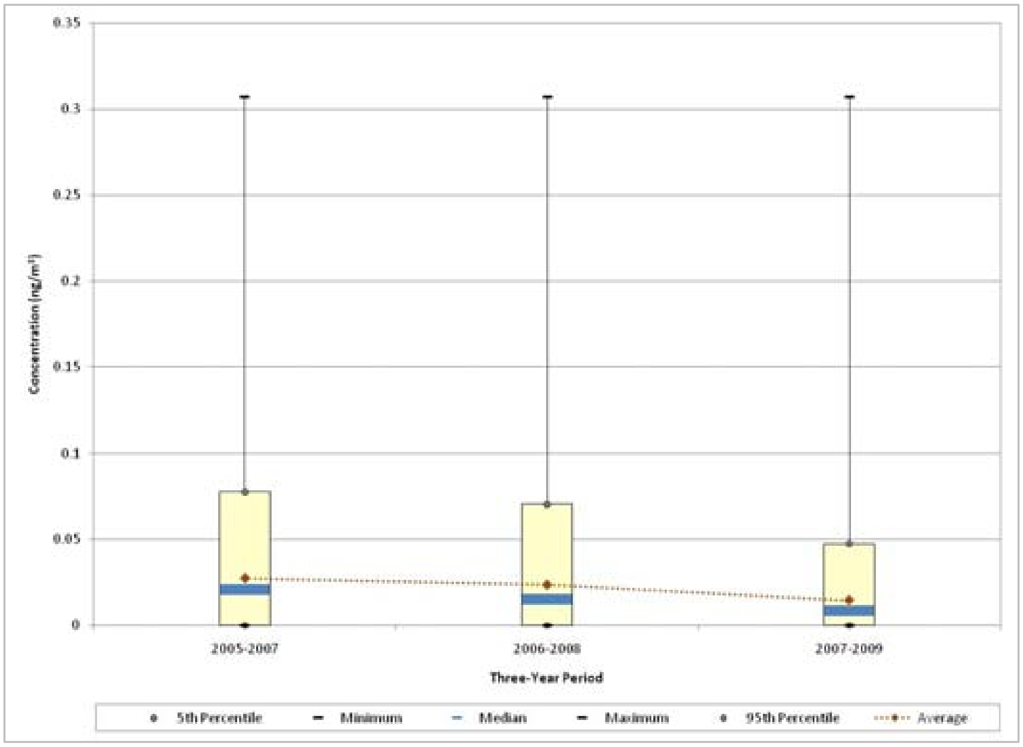


Figure 12-18. Three-Year Rolling Statistical Metrics for Manganese (PM_{10}) Concentrations Measured at NBIL

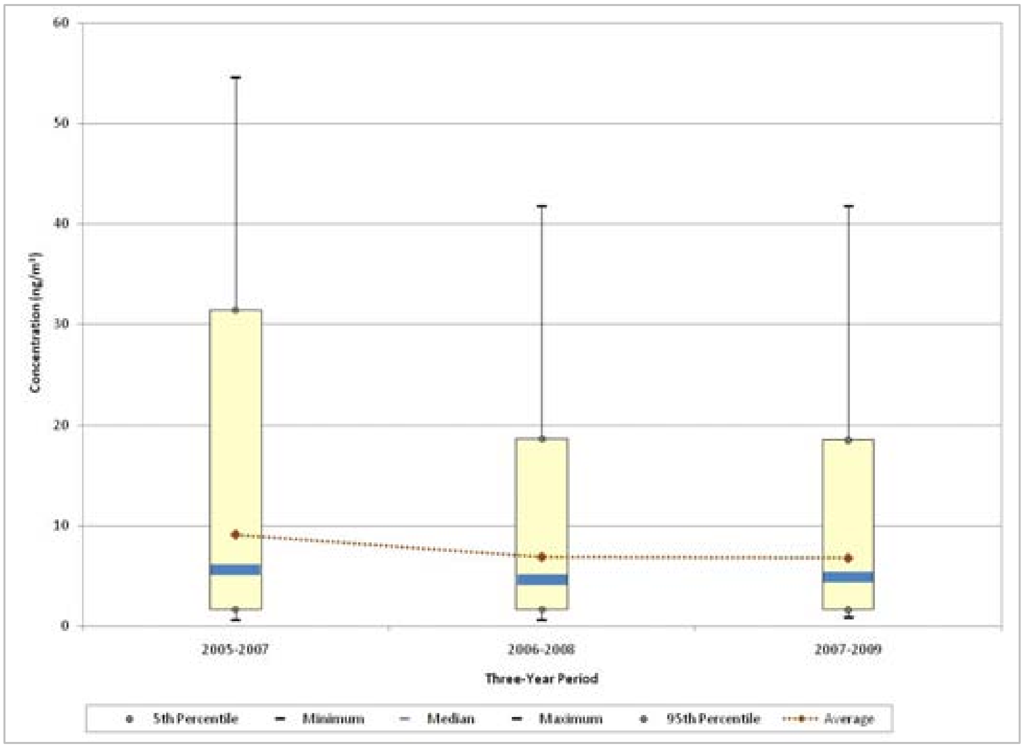
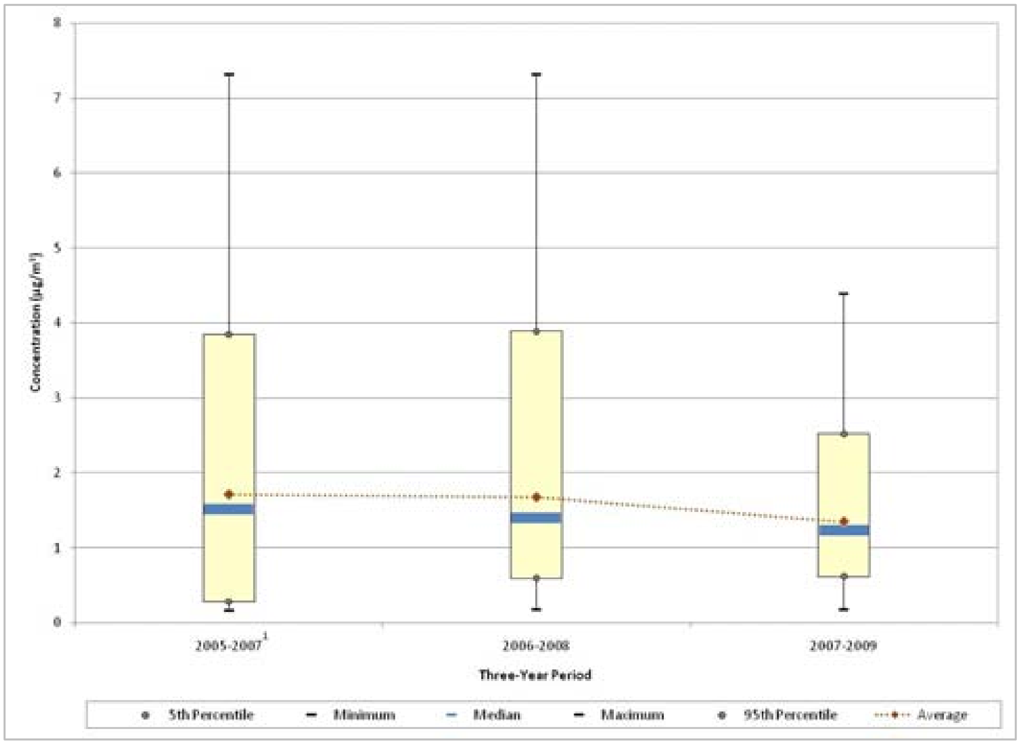
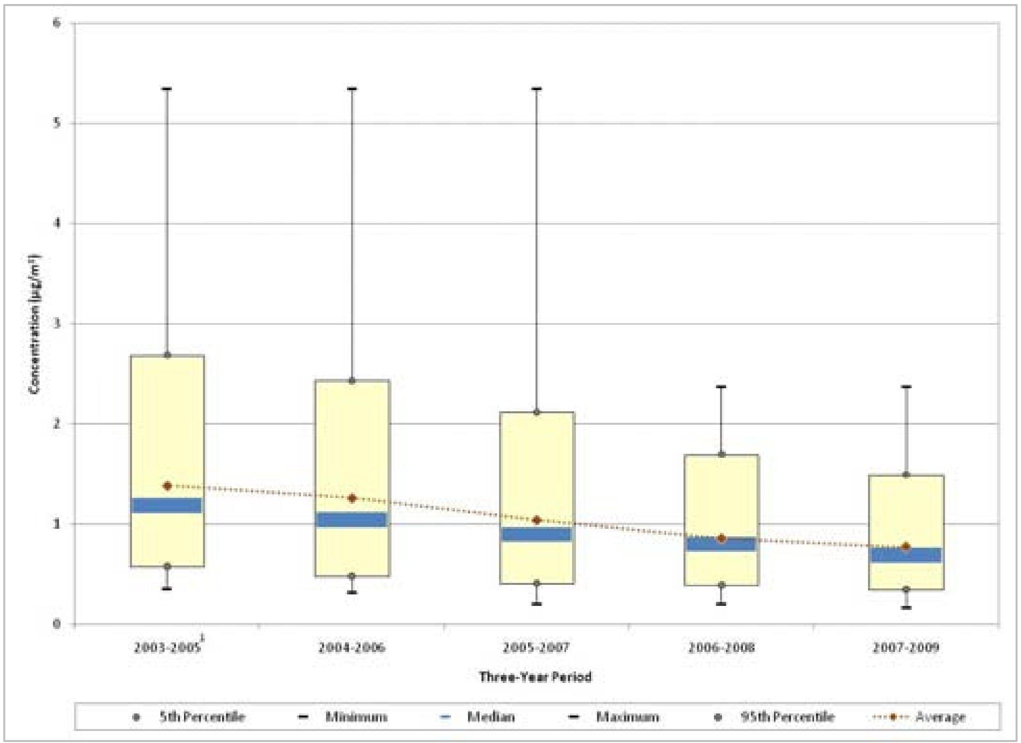


Figure 12-19. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at SPIL



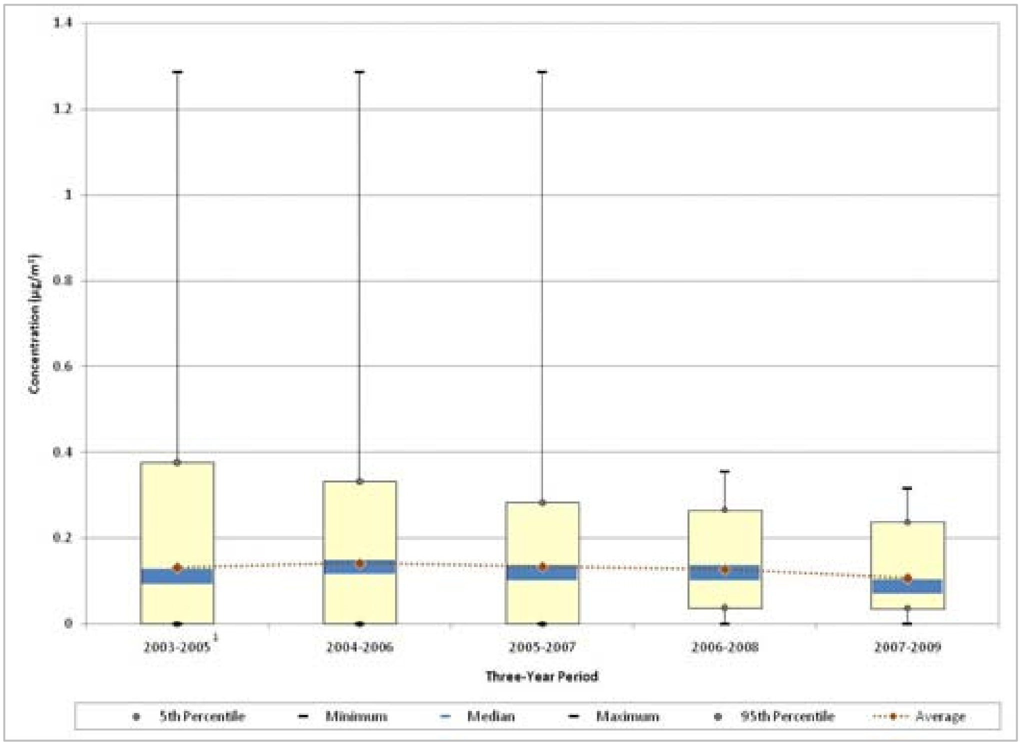
[1] Carbonyl compound sampling at SPIL began in February 2005.

Figure 12-20. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at SPIL



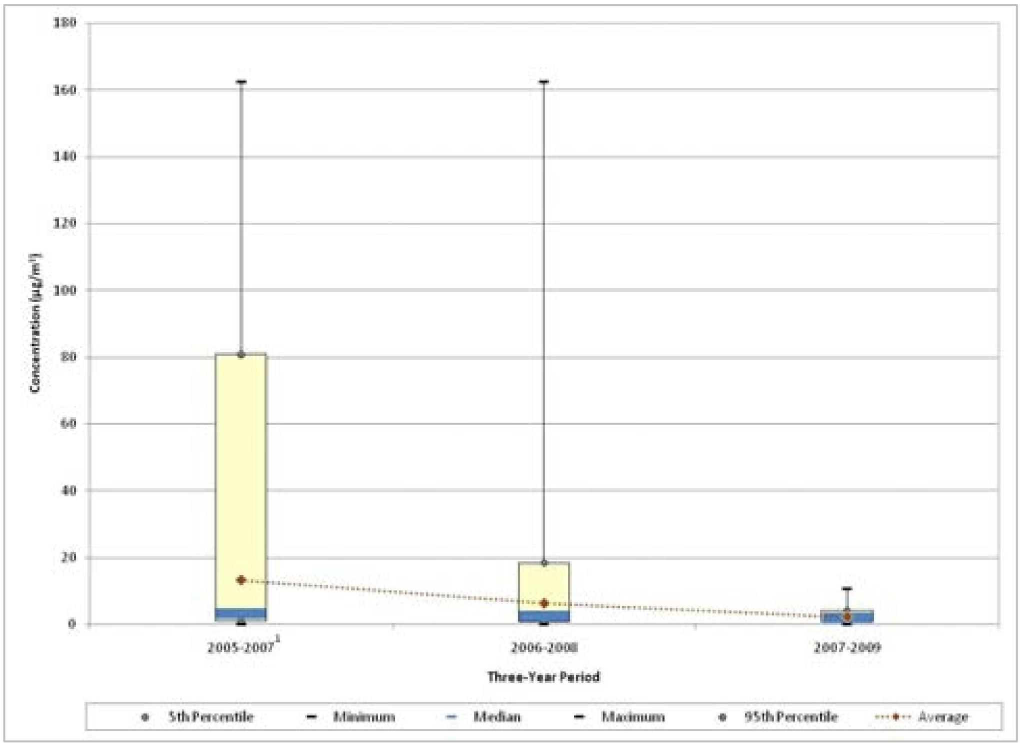
[1] VOC sampling at SPIL began in April 2003.

Figure 12-21. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPIL



[1] VOC sampling at SPIL began in April 2003.

Figure 12-22. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at SPIL



[1] Carbonyl compound sampling at SPIL began in February 2005.

Observations from Figure 12-14 for benzene measurements at NBIL include the following:

- VOC sampling at NBIL began in April 2003, as denoted in Figure 12-14. In addition, there was a gap in sampling from November to December 2004.
- The maximum benzene concentration was measured on September 18, 2004, although similar measurements were also measured in 2005.
- The rolling average and median concentrations, as well as each of the other statistical parameters, have a decreasing trend over the time periods shown.
- The difference between the 5th and 95th percentiles has decreased over the period of sampling, indicating that the spread of concentrations measured is becoming smaller. In addition, the rolling average and median concentrations became more similar to each other over time, which also indicates less variability in the central tendency for this site.
- Note that the minimum concentration for each 3-year period is greater than zero, indicating that there were no non-detects of benzene reported since the onset of VOC sampling.

Observations from Figure 12-15 for 1,3-butadiene measurements at NBIL include the following:

- VOC sampling at NBIL began in April 2003, as denoted in Figure 12-15. In addition, there was a gap in sampling from November to December 2004.
- The maximum 1,3-butadiene concentration was measured in 2005.
- The rolling average concentrations exhibit an increasing trend through the 2005-2007 time frame, after which a decreasing trend is shown, although confidence intervals calculated on these averages indicate that neither trend is statistically significant.
- The minimum, 5th percentile, and median concentrations were all zero for the first two 3-year periods, indicating the presence of non-detects (at least 50 percent). The number of non-detects reported has fluctuated from year to year, from as high as 87 percent (2004) to as low as seven percent (2007). From the 2005-2007 time frame on, the median exhibits a similar trend as the rolling average.

Observations from Figure 12-16 for formaldehyde measurements at NBIL include the following:

- Carbonyl compound sampling at NBIL began in March 2005, as denoted in Figure 12-16.
- The maximum formaldehyde concentration was measured on January 5, 2006 (91.7 $\mu g/m^3$). Note that the next highest concentration (measured in 2005) was less than one-tenth of the maximum concentration shown (8.47 $\mu g/m^3$).
- Although the rolling average concentrations show a decreasing trend, it is difficult to determine is this decrease is statistically significant due to the high variability associated with the first two 3-year periods.
- Although difficult to discern in Figure 12-16, 90 percent of the measurements for the 2005-2007 period fell between 0.3 and 3 $\mu g/m^3$ and this spread of measurements decreased for each additional 3-year period.
- Similar to other pollutants, the minimum concentration for each 3-year period is greater than zero, indicating that there were no non-detects of formaldehyde reported since the onset of carbonyl compound sampling.

Observations from Figure 12-17 for hexavalent chromium measurements at NBIL include the following:

- Hexavalent chromium sampling at NBIL began in January 2005.

- The maximum hexavalent chromium concentration was measured on July 5, 2007 (0.307 ng/m^3). Only five measurements from NBIL are greater than 0.1 ng/m^3, with the others ranging from 0.235 to 0.108 ng/m^3 (of which four of the five were measured in 2006).

- The rolling average concentrations of hexavalent chromium exhibit a decreasing trend, as do the medians and 95th percentiles.

- Both the minimum concentration and 5th percentile for all three 3-year periods shown are zero, indicating the presence of non-detects. The percentage of non-detects has been increasing for each year of sampling at NBIL since 2007.

Observations from Figure 12-18 for manganese (PM_{10}) measurements at NBIL include the following:

- Metals sampling at NBIL began in January 2005.

- The maximum manganese concentration was measured on August 26, 2005.

- The rolling average exhibits a decrease from 2005-2007 to 2006-2008, then levels out for 2007-2009. The median exhibits a similar trend from 2005-2007 to 2006-2008, then increases slightly for 2007-2009. The 95th percentile decreased by roughly half from 2005-2007 to 2006-2008.

- The rolling average and median concentrations became more similar to each other over time, indicating less variability in the central tendency for this site.

- Note that the minimum concentration for each 3-year period is greater than zero, indicating that there were no non-detects of manganese reported since the onset of metals sampling.

Observations from Figure 12-19 for acetaldehyde measurements at SPIL include the following:

- Carbonyl compound sampling at SPIL began in February 2005, as denoted in Figure 12-19.

- The maximum acetaldehyde concentration was measured on May 29, 2006. Of the eight acetaldehyde concentrations greater than 4.0 µg/m^3, all but one was measured in 2006.

- The rolling average concentrations for the 2005-2007 and 2006-2008 periods were similar to each other, but the 2007-2009 period exhibited a decrease from the previous 3-year periods. Although difficult to discern in Figure 12-19, the median concentrations show a decreasing trend across all the periods.

Observations from Figure 12-20 for benzene measurements at SPIL include the following:

- VOC sampling at SPIL began in April 2003, as denoted in Figure 12-20.
- The maximum benzene concentration was measured in 2005, which explains why the maximum concentration for the first three time periods was the same.
- Similar to NBIL, the median and average rolling concentrations have a decreasing trend over the time periods shown.
- The difference between the 5th and 95th percentiles has decreased over time and the rolling average and median concentrations became more similar to each other over the period of sampling, both indicators of decreasing variability in the central tendency.
- The minimum concentration for each 3-year period is greater than zero, indicating that no non-detects of benzene have been reported since the onset of VOC sampling.

Observations from Figure 12-21 for 1,3-butadiene measurements at SPIL include the following:

- VOC sampling at SPIL began in April 2003.
- The maximum concentration of 1,3-butadiene was measured on February 3, 2005. Only three concentrations greater than 0.5 $\mu g/m^3$ have been measured at SPIL, one in 2004 and two in 2005. This explains the large decrease in the maximum concentration for the 2006-2008 and 2007-2009 time frames.
- The average and median concentrations have changed very little over the period of sampling, although there is a slight decrease shown for the last 3-year period.
- 1,3-Butadiene's detection rate has increased over time as the MDL has improved, ranging from approximately 45 percent non-detects in 2003 and 2004 to zero non-detects in 2008 and 2009.

Observations from Figure 12-22 for formaldehyde measurements at SPIL include the following:

- Carbonyl compound sampling at SPIL began in February 2005, as denoted in Figure 12-22.
- The maximum formaldehyde concentration was measured on May 29, 2006, which is the same day the highest acetaldehyde concentration was measured. Three additional formaldehyde concentrations greater than 100 $\mu g/m^3$ were measured in 2005. Of the 20 concentrations greater than 20 $\mu g/m^3$, all were measured in 2005 and 2006.
- The rolling average concentrations exhibit a dramatic decreasing trend. Although difficult to discern in Figure 12-22, the median concentration decreased as well.

12.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Illinois monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

12.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Illinois monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Illinois monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

12.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Illinois monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 12-6, where applicable.

Observations for NBIL from Table 12-6 include the following:

- Acetaldehyde, carbon tetrachloride, and chloroform were the pollutants with the highest 2008 annual average concentrations while formaldehyde, carbon tetrachloride, and acetaldehyde had the highest 2009 annual average concentrations.
- Formaldehyde, carbon tetrachloride, and benzene had the highest cancer surrogate risk approximations for both years.
- None of NBIL's pollutants of interest had noncancer surrogate risk approximations greater than 1.0.

Observations for SPIL from Table 12-6 include the following:

- Formaldehyde, acetaldehyde, and carbon tetrachloride were the pollutants with the highest annual average concentrations for SPIL for both years.
- Formaldehyde had the highest cancer surrogate risk approximations (29.37 in-a-million for 2008 and 24.02 in-a-million for 2009, respectively). These cancer risk approximations were two to three times higher than the cancer risk approximations for NBIL.
- In general, the cancer risk approximations for SPIL tended to be slightly higher than for NBIL.
- None of SPIL's pollutants of interest had noncancer surrogate risk approximations greater than 1.0.

Table 12-6. Cancer and Noncancer Surrogate Risk Approximations for the Illinois Monitoring Sites

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Northbrook, Illinois - NBIL										
Acetaldehyde	2.2E-06	0.009	59/4	0.89 ± 0.13	1.95	0.10	61/4	0.69 ± 0.08	1.51	0.08
Arsenic (PM$_{10}$) [a]	0.0043	0.000015	56/4	<0.01 ± <0.01	3.22	0.05	61/4	<0.01 ± <0.01	3.16	0.05
Benzene	7.8E-06	0.03	64/4	0.55 ± 0.07	4.25	0.02	57/4	0.56 ± 0.09	4.37	0.02
Benzo(a)pyrene [a]	0.001	--	31/2	NA	NA	NA	53/4	<0.01 ± <0.01	0.10	--
Beryllium (PM$_{10}$) [a]	0.0024	0.00002	51/4	<0.01 ± <0.01	0.01	<0.01	56/4	<0.01 ± <0.01	0.01	<0.01
1,3-Butadiene	0.00003	0.002	55/4	0.04 ± 0.01	1.30	0.02	48/4	0.03 ± 0.01	0.99	0.02
Cadmium (PM$_{10}$) [a]	0.0018	0.00001	56/4	<0.01 ± <0.01	0.33	0.02	61/4	<0.01 ± <0.01	0.26	0.01
Carbon Tetrachloride	0.000006	0.1	64/4	0.83 ± 0.05	4.98	0.01	57/4	0.75 ± 0.04	4.53	0.01
Chloroform	--	0.098	64/4	0.68 ± 0.23	--	0.01	57/4	0.63 ± 0.28	--	0.01
p-Dichlorobenzene	0.000011	0.8	39/4	0.07 ± 0.03	0.79	<0.01	35/3	0.03 ± 0.01	0.31	<0.01
Formaldehyde	0.000013	0.0098	59/4	0.61 ± 0.10	7.96	0.06	61/4	1.00 ± 0.16	12.99	0.10
Hexavalent Chromium [a]	0.012	0.0001	39/3	<0.01 ± <0.01	0.17	<0.01	26/2	NA	NA	NA
Lead (PM$_{10}$) [a]	--	0.00015	56/4	<0.01 ± <0.01	--	0.03	61/4	<0.01 ± <0.01	--	0.02

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 12-5.

Table 12-6. Cancer and Noncancer Surrogate Risk Approximations for the Illinois Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Manganese (PM_{10}) [a]	--	0.00005	56/4	0.01 ± <0.01	--	0.14	61/4	0.01 ± <0.01	--	0.11
Naphthalene [a]	0.000034	0.003	35/2	NA	NA	NA	60/4	0.07 ± 0.01	2.24	0.02
Nickel (PM_{10}) [a]	0.000312	0.00009	56/4	<0.01 ± <0.01	0.32	0.01	61/4	<0.01 ± <0.01	0.30	0.01
Tetrachloroethylene	5.9E-06	0.27	60/4	0.20 ± 0.05	1.16	<0.01	54/4	0.19 ± 0.04	1.11	<0.01
Trichloroethylene	0.000002	0.6	33/4	0.10 ± 0.05	0.20	<0.01	28/3	0.09 ± 0.04	0.18	<0.01
Vinyl Chloride	8.8E-06	0.1	5/0	NA	NA	NA	4/0	NA	NA	NA
Schiller Park, Illinois - SPIL										
Acetaldehyde	2.2E-06	0.009	57/4	1.37 ± 0.19	3.02	0.15	59/4	1.27 ± 0.12	2.79	0.14
Benzene	7.8E-06	0.03	57/4	0.80 ± 0.08	6.24	0.03	59/4	0.68 ± 0.08	5.28	0.02
1,3-Butadiene	0.00003	0.002	57/4	0.11 ± 0.02	3.37	0.06	59/4	0.08 ± 0.01	2.55	0.04
Carbon Tetrachloride	0.000006	0.1	57/4	0.84 ± 0.05	5.02	0.01	59/4	0.73 ± 0.04	4.36	0.01
Chloroform	--	0.098	57/4	0.15 ± 0.07	--	<0.01	59/4	0.14 ± 0.06	--	<0.01
p-Dichlorobenzene	0.000011	0.8	37/4	0.11 ± 0.09	1.17	<0.01	43/4	0.07 ± 0.05	0.74	<0.01
Formaldehyde	0.000013	0.0098	57/4	2.26 ± 0.45	29.37	0.23	59/4	1.85 ± 0.21	24.02	0.19

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 12-5.

Table 12-6. Cancer and Noncancer Surrogate Risk Approximations for the Illinois Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)
Tetrachloroethylene	5.9E-06	0.27	53/4	0.34 ± 0.08	1.99	<0.01	56/4	0.25 ± 0.05	1.46	<0.01
Trichloroethylene	0.000002	0.6	45/4	0.50 ± 0.20	1.00	<0.01	47/4	0.34 ± 0.16	0.68	<0.01
Vinyl Chloride	8.8E-06	0.1	3/0	NA	NA	NA	6/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 12-5.

12.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 12-7 and 12-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 12-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from annual averages. Table 12-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 12.3, SPIL sampled for VOC and carbonyl compounds. NBIL sampled for these pollutants as well, but also sampled for SNMOC, metals, SVOC, and hexavalent chromium. In addition, the cancer and noncancer risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. NBIL and SPIL sampled year-round for each pollutant group mentioned above, with the exception of PAH sampling, which began at NBIL in June 2008. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Illinois 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Northbrook, Illinois (Cook County) - NBIL					
Benzene	1,951.56	Formaldehyde	1.63E-02	Formaldehyde	12.99
Formaldehyde	1,304.59	Benzene	1.52E-02	Formaldehyde	7.96
Tetrachloroethylene	1,173.15	Hexavalent Chromium, PM	9.93E-03	Carbon Tetrachloride	4.98
Acetaldehyde	821.34	Naphthalene	9.90E-03	Carbon Tetrachloride	4.53
p-Dichlorobenzene	523.38	1,3-Butadiene	8.33E-03	Benzene	4.37
Dichloromethane	436.48	Tetrachloroethylene	6.92E-03	Benzene	4.25
Naphthalene	291.27	*p*-Dichlorobenzene	5.76E-03	Arsenic	3.22
Trichloroethylene	277.58	Acetaldehyde	1.81E-03	Arsenic	3.16
1,3-Butadiene	277.57	Arsenic, PM	1.74E-03	Naphthalene	2.24
1,3-Dichloropropene	89.84	Cadmium, PM	1.26E-03	Acetaldehyde	1.95
Schiller Park, Illinois (Cook County) - SPIL					
Benzene	1,951.56	Formaldehyde	1.63E-02	Formaldehyde	29.37
Formaldehyde	1,304.59	Benzene	1.52E-02	Formaldehyde	24.02
Tetrachloroethylene	1,173.15	Hexavalent Chromium, PM	9.93E-03	Benzene	6.24
Acetaldehyde	821.34	Naphthalene	9.90E-03	Benzene	5.28
p-Dichlorobenzene	523.38	1,3-Butadiene	8.33E-03	Carbon Tetrachloride	5.02
Dichloromethane	436.48	Tetrachloroethylene	6.92E-03	Carbon Tetrachloride	4.36
Naphthalene	291.27	*p*-Dichlorobenzene	5.76E-03	1,3-Butadiene	3.37
Trichloroethylene	277.58	Acetaldehyde	1.81E-03	Acetaldehyde	3.02
1,3-Butadiene	277.57	Arsenic, PM	1.74E-03	Acetaldehyde	2.79
1,3-Dichloropropene	89.84	Cadmium, PM	1.26E-03	1,3-Butadiene	2.55

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Illinois 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Northbrook, Illinois (Cook County) - NBIL					
Toluene	7,537.70	Acrolein	3,446,170.83	Manganese	0.14
Xylenes	5,018.17	Manganese, PM	317,637.10	Manganese	0.11
Methanol	3,427.81	1,3-Butadiene	138,786.44	Formaldehyde	0.10
Benzene	1,951.56	Formaldehyde	133,121.82	Acetaldehyde	0.10
Methyl isobutyl ketone	1,324.28	Bromomethane	113,706.43	Acetaldehyde	0.08
Formaldehyde	1,304.59	Naphthalene	97,088.44	Formaldehyde	0.06
Tetrachloroethylene	1,173.15	Nickel, PM	95,351.29	Arsenic	0.05
1,1,1-Trichloroethane	1,133.91	Acetaldehyde	91,260.19	Arsenic	0.05
Hexane	1,106.10	Benzene	65,052.08	Lead	0.03
Ethylene glycol	1,091.60	Xylenes	50,181.67	Lead	0.02
Schiller Park, Illinois (Cook County) - SPIL					
Toluene	7,537.70	Acrolein	3,446,170.83	Formaldehyde	0.23
Xylenes	5,018.17	Manganese, PM	317,637.10	Formaldehyde	0.19
Methanol	3,427.81	1,3-Butadiene	138,786.44	Acetaldehyde	0.15
Benzene	1,951.56	Formaldehyde	133,121.82	Acetaldehyde	0.14
Methyl isobutyl ketone	1,324.28	Bromomethane	113,706.43	1,3-Butadiene	0.06
Formaldehyde	1,304.59	Naphthalene	97,088.44	1,3-Butadiene	0.04
Tetrachloroethylene	1,173.15	Nickel, PM	95,351.29	Benzene	0.03
1,1,1-Trichloroethane	1,133.91	Acetaldehyde	91,260.19	Benzene	0.02
Hexane	1,106.10	Benzene	65,052.08	Carbon Tetrachloride	0.01
Ethylene glycol	1,091.60	Xylenes	50,181.67	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 12-7 include the following:

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in Cook County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Cook County were formaldehyde, benzene, and hexavalent chromium.

- Seven of the highest emitted pollutants in Cook County also had the highest toxicity-weighted emissions.

- For both monitoring sites, formaldehyde had the highest cancer surrogate risk approximations. This pollutant ranks high on all three lists shown in Table 12-7. For NBIL, benzene, naphthalene, and acetaldehyde appear on all three lists. For SPIL, benzene, 1,3-butadiene, and acetaldehyde appear on all three lists.

- Carbon tetrachloride, which appears among the highest cancer risk approximations for both sites, did not appear on either emissions-based list.

- Arsenic, which appears among the highest cancer risk approximations for NBIL (SPIL did not sample metals), has the ninth highest toxicity-weighted emissions, but does not appear among the highest emitted pollutants in Cook County.

- NBIL is one of two NMP sites that sampled pollutants from all six methods. Interestingly, at least one pollutant from each of the six methods appears on the list of highest toxicity-weighted emissions.

Observations from Table 12-8 include the following:

- Toluene, xylenes, and methanol were the highest emitted pollutants with noncancer RfCs in Cook County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Cook County were acrolein, manganese, and 1,3-butadiene. Although acrolein was sampled for at NBIL and SPIL, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions (benzene, formaldehyde, and xylenes).

- Manganese had the highest noncancer risk approximations for NBIL (albeit well below an HQ of 1.0). This pollutant has the second highest toxicity-weighted emissions, but did not appear on the list of highest emitted pollutants in Cook County.

- Formaldehyde appears on all three lists for both sites. Benzene also appears on all three lists for SPIL (but did not appear among the pollutants with the highest noncancer risk approximations for NBIL).

12.6 Summary of the 2008-2009 Monitoring Data for NBIL and SPIL

Results from several of the treatments described in this section include the following:

- ❖ *Nineteen pollutants, including 12 NATTS MQO Core Analytes, failed screens for NBIL. Fifteen pollutants, including seven NATTS MQO Core Analytes, failed screens for SPIL.*

- ❖ *None of the daily average concentrations for any of the pollutants of interest for NBIL were greater than 1.00 µg/m*^{3}*. The two highest chloroform concentrations measured at NBIL were the highest measured among all NMP sites sampling this pollutant.*

- ❖ *The pollutants with the highest daily average concentrations for SPIL were formaldehyde, acetaldehyde, and carbon tetrachloride for both years. The acetaldehyde and formaldehyde concentrations were significantly higher for SPIL than for NBIL, while the carbon tetrachloride concentrations were nearly identical.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than any of the associated MRL noncancer health risk benchmarks.*

13.0 Sites in Indiana

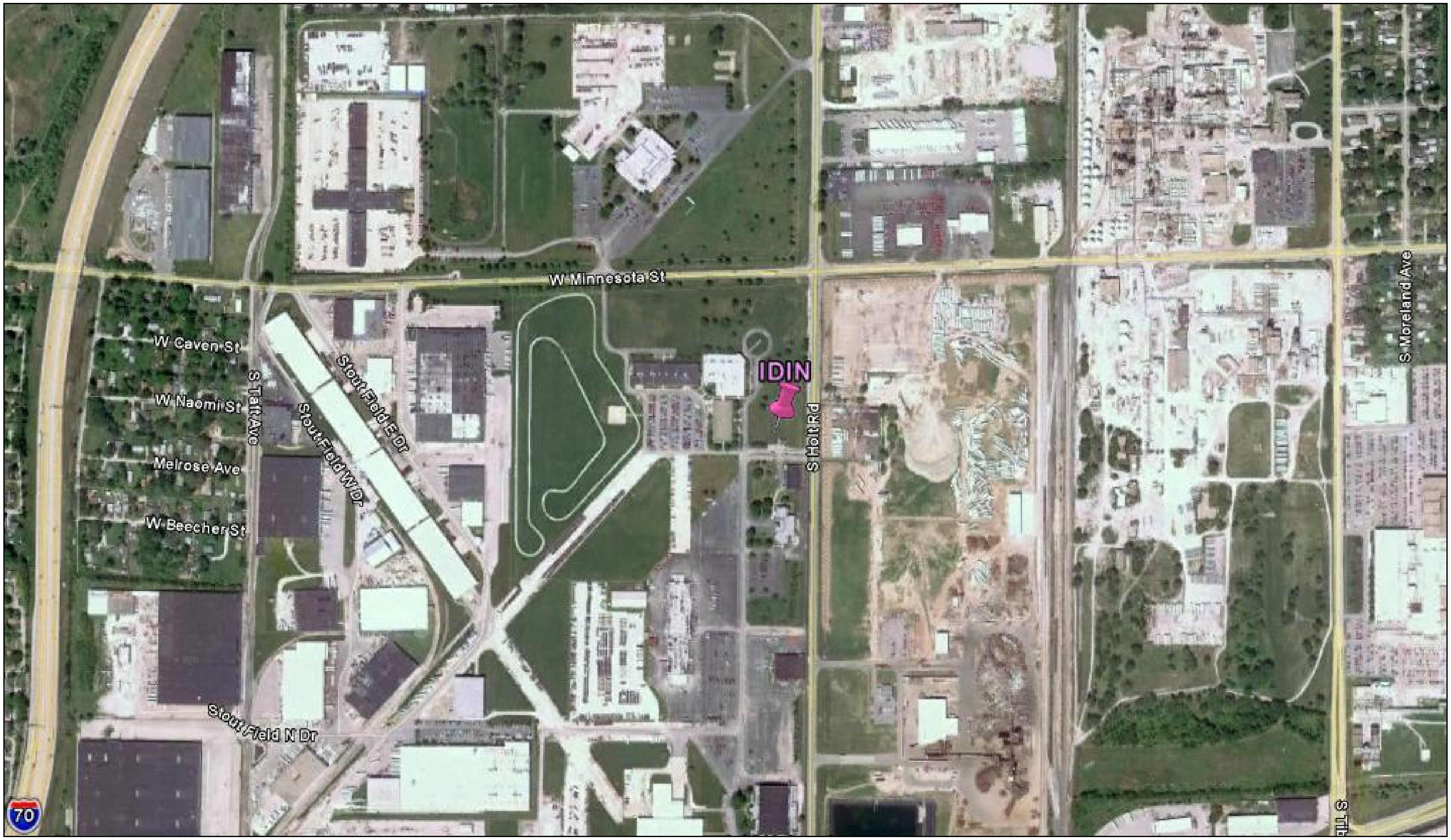
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP and CSATAM sites in Indiana, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

13.1 Site Characterization

This section characterizes the Indiana monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

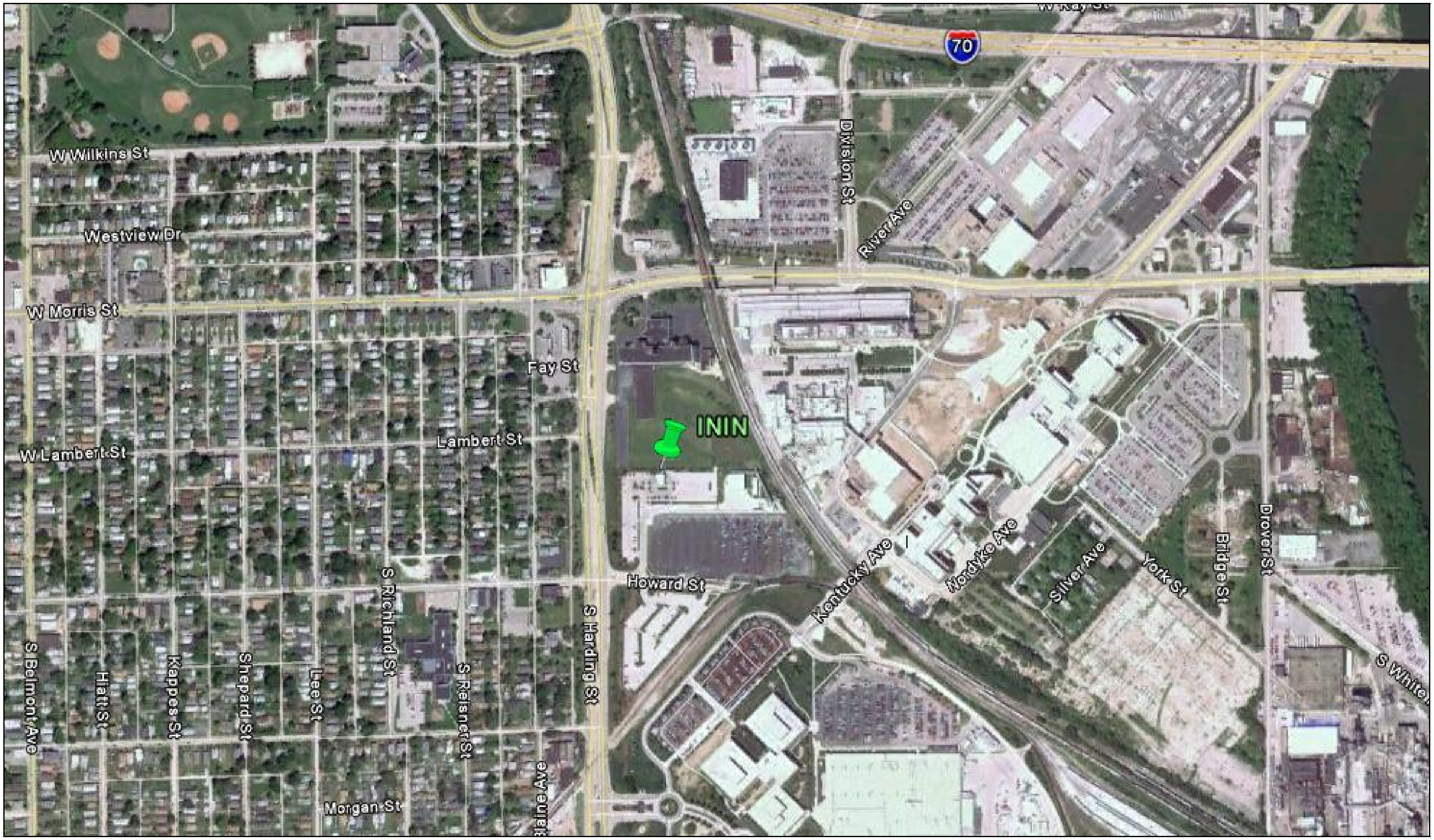
Three Indiana sites (ININ, IDIN, and WPIN) are located in the Indianapolis-Carmel, IN MSA, while a fourth INDEM is located in the Chicago-Naperville-Joliet, IL-IN-WI MSA. Figures 13-1 through 13-4 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figures 13-5 and 13-6 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 13-5 and 13-6. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 13-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 13-1. Indianapolis, Indiana (IDIN) Monitoring Site



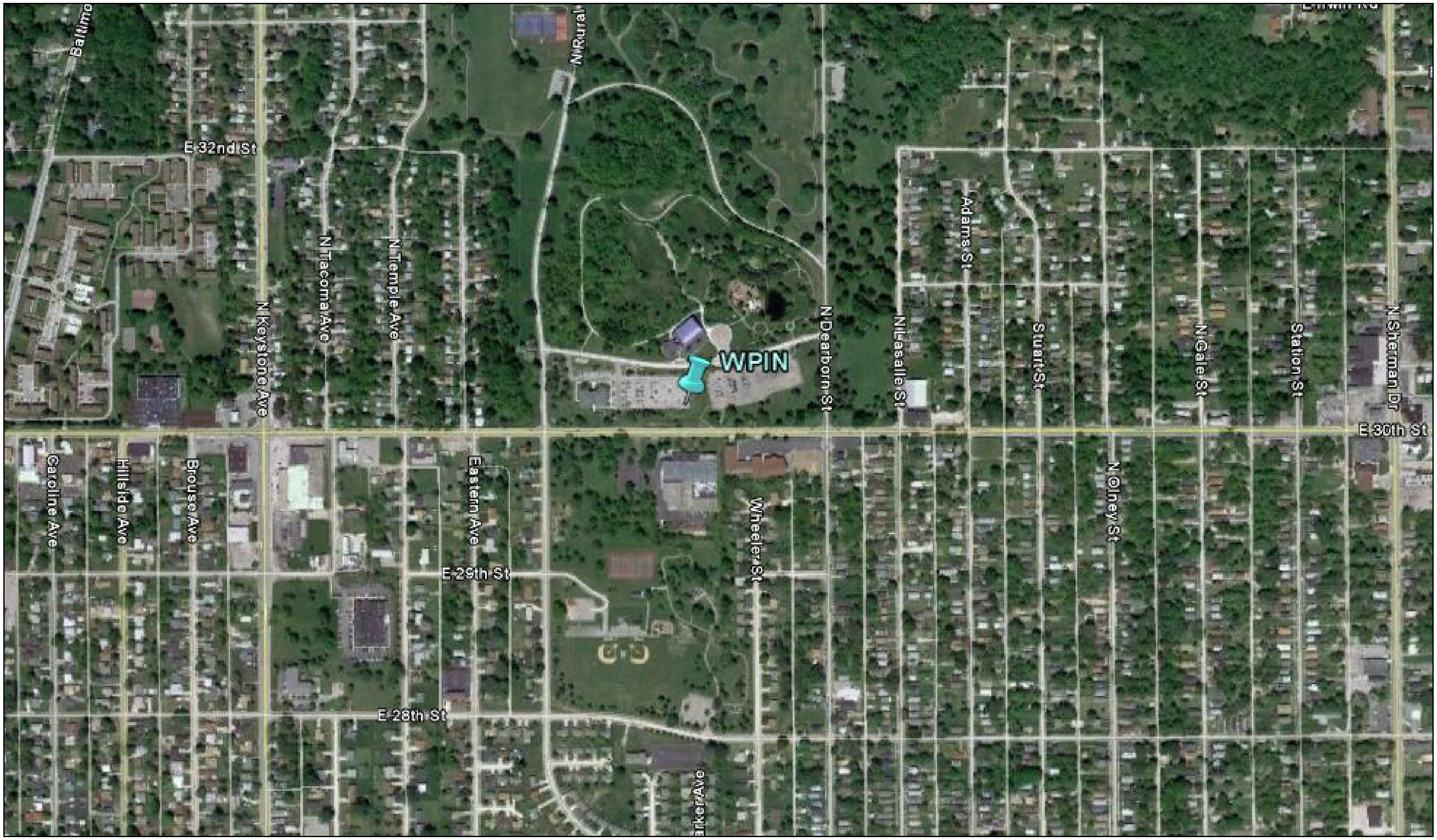
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,959 feet

Figure 13-2. Indianapolis, Indiana (ININ) Monitoring Site



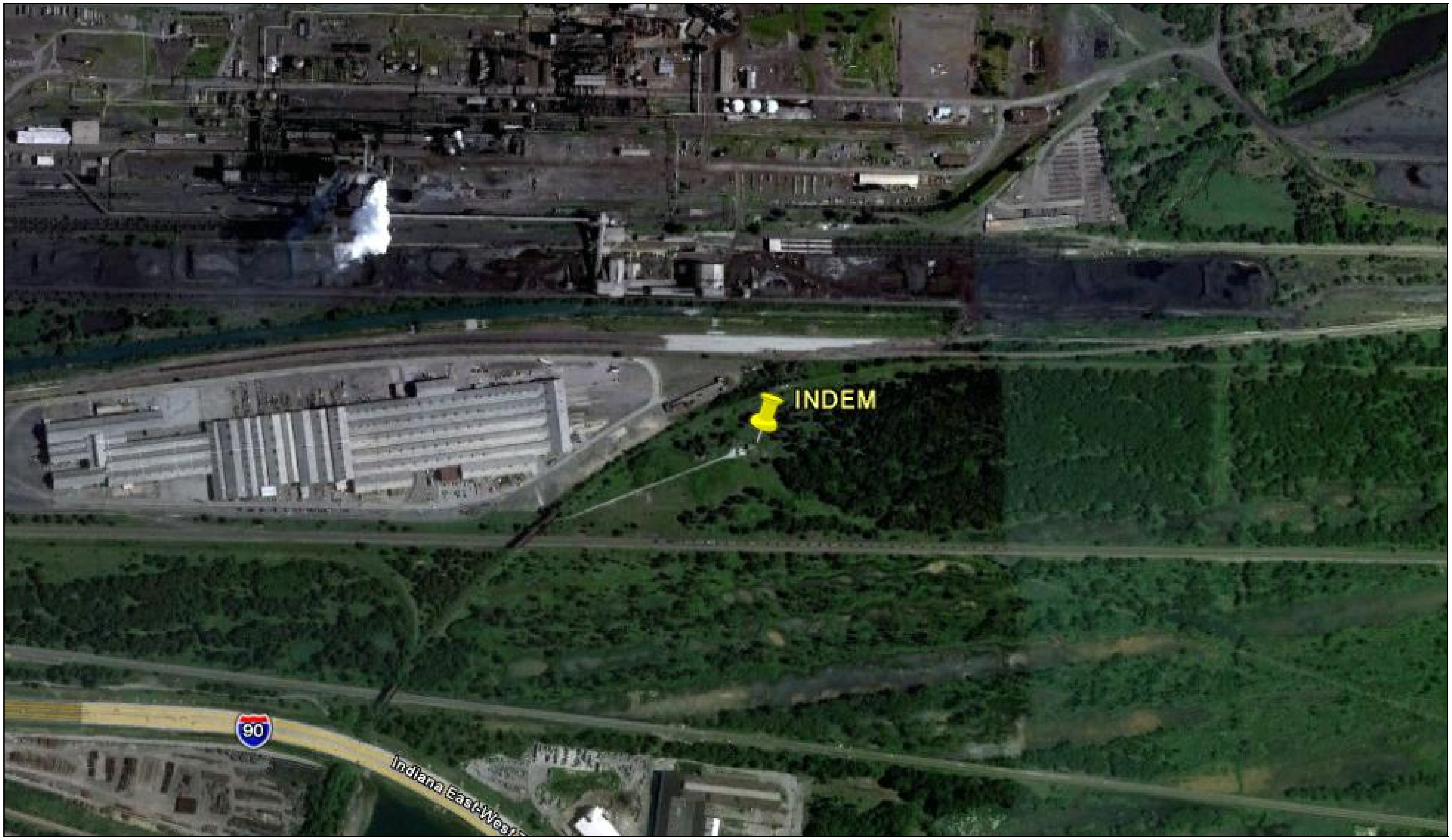
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,851 feet

Figure 13-3. Indianapolis, Indiana (WPIN) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,924 feet

Figure 13-4. Gary, Indiana (INDEM) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,119 feet

Figure 13-5. NEI Point Sources Located Within 10 Miles of IDIN, ININ, and WPIN

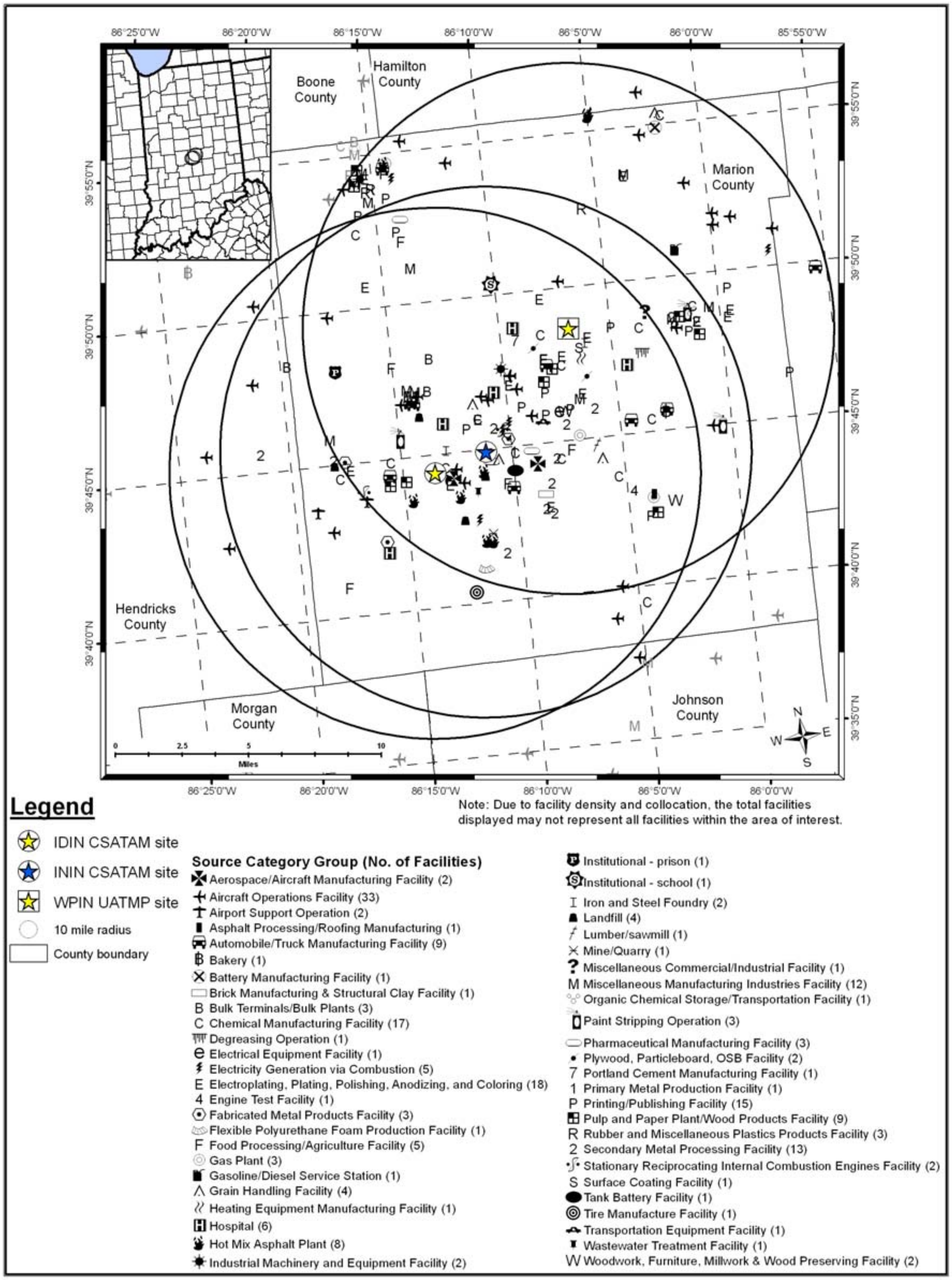
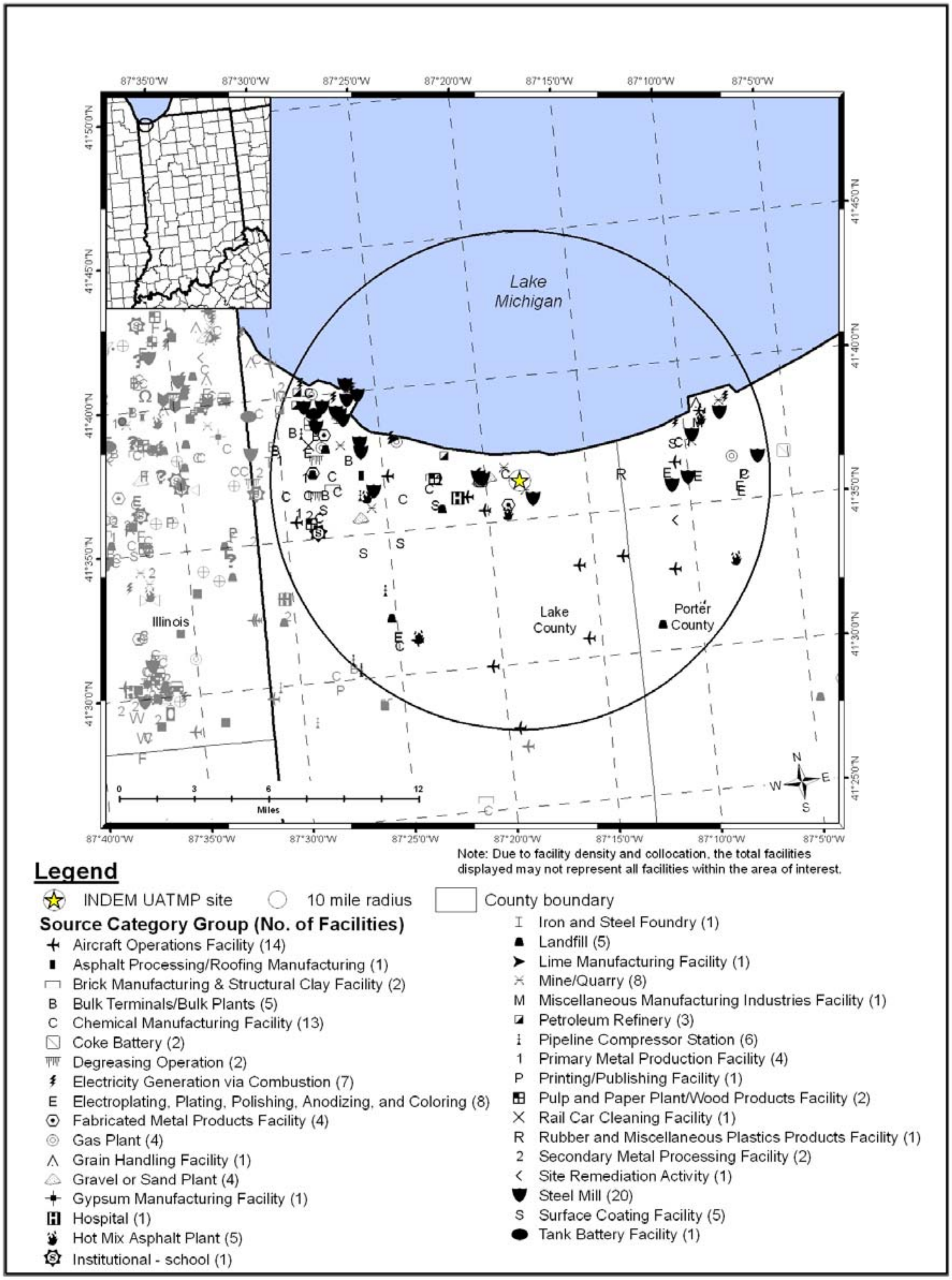

86°25'0"W
86°20'0"W
86°15'0"W
86°10'0"W
86°5'0"W
86°0'0"W
85°55'0"W
39°55'0"N
39°50'0"N
39°45'0"N
39°40'0"N
39°35'0"N
Boone County
Hamilton County
Marion County
Hendricks County
Morgan County
Johnson County
0 2.5 5 10
Miles
N
S
E
W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
IDIN CSATAM site
ININ CSATAM site
WPIN UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (2)
Aircraft Operations Facility (33)
Airport Support Operation (2)
Asphalt Processing/Roofing Manufacturing (1)
Automobile/Truck Manufacturing Facility (9)
Bakery (1)
Battery Manufacturing Facility (1)
Brick Manufacturing & Structural Clay Facility (1)
Bulk Terminals/Bulk Plants (3)
Chemical Manufacturing Facility (17)
Degreasing Operation (1)
Electrical Equipment Facility (1)
Electricity Generation via Combustion (5)
Electroplating, Plating, Polishing, Anodizing, and Coloring (18)
Engine Test Facility (1)
Fabricated Metal Products Facility (3)
Flexible Polyurethane Foam Production Facility (1)
Food Processing/Agriculture Facility (5)
Gas Plant (3)
Gasoline/Diesel Service Station (1)
Grain Handling Facility (4)
Heating Equipment Manufacturing Facility (1)
Hospital (6)
Hot Mix Asphalt Plant (8)
Industrial Machinery and Equipment Facility (2)
Institutional - prison (1)
Institutional - school (1)
Iron and Steel Foundry (2)
Landfill (4)
Lumber/sawmill (1)
Mine/Quarry (1)
Miscellaneous Commercial/Industrial Facility (1)
Miscellaneous Manufacturing Industries Facility (12)
Organic Chemical Storage/Transportation Facility (1)
Paint Stripping Operation (3)
Pharmaceutical Manufacturing Facility (3)
Plywood, Particleboard, OSB Facility (2)
Portland Cement Manufacturing Facility (1)
Primary Metal Production Facility (1)
Printing/Publishing Facility (15)
Pulp and Paper Plant/Wood Products Facility (9)
Rubber and Miscellaneous Plastics Products Facility (3)
Secondary Metal Processing Facility (13)
Stationary Reciprocating Internal Combustion Engines Facility (2)
Surface Coating Facility (1)
Tank Battery Facility (1)
Tire Manufacture Facility (1)
Transportation Equipment Facility (1)
Wastewater Treatment Facility (1)
Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Figure 13-6. NEI Point Sources Located Within 10 Miles of INDEM


87°35'0"W
87°30'0"W
87°25'0"W
87°20'0"W
87°15'0"W
87°10'0"W
87°5'0"W
41°50'0"N
41°45'0"N
41°40'0"N
41°35'0"N
41°30'0"N
41°25'0"N
87°40'0"W
87°0'0"W
Lake Michigan
Lake County
Porter County
Illinois
0
3
6
12
Miles
N
E
S
W
Legend
INDEM UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (14)
Asphalt Processing/Roofing Manufacturing (1)
Brick Manufacturing & Structural Clay Facility (2)
Bulk Terminals/Bulk Plants (5)
Chemical Manufacturing Facility (13)
Coke Battery (2)
Degreasing Operation (2)
Electricity Generation via Combustion (7)
Electroplating, Plating, Polishing, Anodizing, and Coloring (8)
Fabricated Metal Products Facility (4)
Gas Plant (4)
Grain Handling Facility (1)
Gravel or Sand Plant (4)
Gypsum Manufacturing Facility (1)
Hospital (1)
Hot Mix Asphalt Plant (5)
Institutional - school (1)
Iron and Steel Foundry (1)
Landfill (5)
Lime Manufacturing Facility (1)
Mine/Quarry (8)
Miscellaneous Manufacturing Industries Facility (1)
Petroleum Refinery (3)
Pipeline Compressor Station (6)
Primary Metal Production Facility (4)
Printing/Publishing Facility (1)
Pulp and Paper Plant/Wood Products Facility (2)
Rail Car Cleaning Facility (1)
Rubber and Miscellaneous Plastics Products Facility (1)
Secondary Metal Processing Facility (2)
Site Remediation Activity (1)
Steel Mill (20)
Surface Coating Facility (5)
Tank Battery Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 13-1. Geographical Information for the Indiana Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
IDIN	18-097-0085	Indianapolis	Marion	Indianapolis-Carmel, IN	39.740383, -86.225950	Military Reservation	Urban/City Center	VOC and SNMOC.
INDEM	18-089-0022	Gary	Lake	Chicago-Naperville-Joliet, IL-IN-WI	41.606667, -87.304722	Industrial	Urban/City Center	VOC, SO_2, NO, NO_2, NOx, PAMS, O_3, Meteorological parameters, PM_{10}, Black carbon, UV Carbon, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
ININ	18-097-0057	Indianapolis	Marion	Indianapolis-Carmel, IN	39.749019, -86.186314	Residential	Urban/City Center	SO_2, VOC, and Meteorological parameters.
WPIN	18-097-0078	Indianapolis	Marion	Indianapolis-Carmel, IN	39.811097, -86.114469	Residential	Suburban	TSP Metals, CO, VOC, SNMOC, SO_2, NOy, NO, O_3, Meteorological parameters, PM_{10}, Black carbon, UV Carbon, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

IDIN is located in southwest Indianapolis at Stout Field, a National Guard Armory and former airfield. Figure 13-1 shows that the area surrounding IDIN is fairly industrialized, with several industrial facilities just to the east of the monitoring site. The placement of this site is based on results from NATA. Heavily traveled roadways, including I-70, are located less than 1 mile from the monitoring site.

ININ is located in central Indianapolis, about a half-mile south of I-70. Residential areas are located to the west of the site, while industrial areas are located to the east, as shown in Figure 13-2. The placement of this site is also based on results from NATA.

WPIN is located in northeast Indianapolis, at Washington Park near East 30th Street. Figure 13-3 shows that the area surrounding WPIN is suburban and residential, with little industry in close proximity.

Figure 13-5 shows that IDIN, ININ, and WPIN are located within 10 miles of many point sources, most of which are located towards the center of Marion County. The source categories with the highest number of sources near these monitoring sites include aircraft operations, which include airports as well as small runways, heliports, or landing pads; chemical manufacturing; electroplating, plating, polishing, anodizing, and coloring; and printing and publishing.

INDEM is located in Gary, Indiana, a few miles east of the Indiana-Illinois border and southeast of Chicago. Gary is located on the southernmost bank of Lake Michigan. The site is just north of I-90 and I-65. Although INDEM resides on the Indiana Dunes National Lakeshore, the surrounding area is highly industrialized, as shown in Figure 13-4. Figure 13-6 shows that the majority of point sources are located to the west of INDEM. The sources closest to INDEM are a steel mill, a chemical manufacturer, and two mines/quarries. The source categories with the highest number of sources within 10 miles of INDEM include steel mills, aircraft operations, chemical manufacturing, and mines/quarries.

Table 13-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Indiana monitoring sites. Information provided in Table 13-2 represents the most recent year of sampling (for IDIN and ININ, 2008; for WPIN and INDEM, 2009), unless otherwise indicated. County-level vehicle registration and population data for Marion and Lake Counties were obtained from the Indiana Bureau of Motor Vehicles (IN BMV, 2009) and the U.S. Census Bureau (Census Bureau, 2009 and 2010), respectively. Table 13-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 13-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. For the Indianapolis sites, data from the nearest available point on I-70 were obtained (between Exits 75 and 77 for IDIN; between Exits 78 and 79 for ININ; and between Exits 85 and 87 for WPIN); for INDEM, data for the I-65 intersection with Highway 12/20 were obtained. Finally, Table 13-2 presents the daily VMT for each urban area.

Table 13-2. Population, Motor Vehicle, and Traffic Information for the Indiana Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
IDIN	880,380	814,682	0.93	594,540	550,173	77,250	33,581
INDEM	494,211	416,995	0.84	414,726	349,929	23,280	172,794
ININ	880,380	814,682	0.93	668,574	618,682	97,780	33,581
WPIN	890,879	814,682	0.91	766,042	700,522	143,759	33,581

[1] Reference: Census Bureau, 2009 and 2010.
[2] County-level vehicle registration reflects 2008 data from the Indiana Bureau of Motor Vehicles (IN BMV, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2002 data from the Indiana DOT (IDIN and ININ) and 2007 data from the Indiana DOT (WPIN and INDEM) (IN DOT, 2002 and 2007).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

Observations from Table 13-2 include the following:

- Marion County had almost twice the county population and vehicle registration as Lake County. The difference between the two counties decreases somewhat when focusing on the 10-mile populations and ownership estimates.

- The vehicle-per-person ratios for the Indianapolis sites were greater than the ratio for INDEM.

- WPIN experienced a higher traffic volume than the other Indianapolis sites, although traffic estimates for all three sites were based on data from I-70. The traffic volume near WPIN is the eighth highest among NMP sites.

- Traffic volume for INDEM is significantly less than the traffic volume for the Indianapolis sites.

- The VMT shown for INDEM is based on the Chicago urban area. The Chicago area VMT ranked third among urban areas with NMP sites, while the VMT for the Indianapolis area was in the middle of the range.

13.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Indiana on sample days, as well as over the course of each year.

13.2.1 Climate Summary

The city of Indianapolis is located in the center of Indiana, and experiences a temperate continental climate and a frequently changing weather pattern. Summers are warm and often humid, as moist air flows northward out of the Gulf of Mexico. Winters are chilly with occasional Arctic outbreaks. Precipitation is spread rather evenly throughout the year, with much of the spring and summer precipitation resulting from showers and thunderstorms. The prevailing wind direction is southwesterly (Bair, 1992 and ISCO, 2002).

The city of 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 while lakes breezes can bring relief from summer heat (Bair, 1992; Gary, 2011; and ISCO, 2002).

13.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The two closest NWS weather stations are located at Indianapolis International Airport (near the Indianapolis monitoring sites) and Lansing Municipal Airport (near INDEM), WBAN 93819 and 04879, respectively. Additional information about these weather stations is provided in Table 13-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 13-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 13-3 is the 95 percent confidence interval for each parameter. Note that because IDIN and ININ sampled from January through September 2008, only 2008 data are provided for these sites.

As shown in Table 13-3, average meteorological conditions on sample days appear slightly warmer than average weather conditions for IDIN and ININ. This is because sampling at these two sites concluded in September 2008, as mentioned above, thereby missing some of the cooler months of the year. Average meteorological conditions on sample days were fairly representative of average weather conditions throughout both years for WPIN and INDEM.

Table 13-3. Average Meteorological Conditions near the Indiana Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
South Holt Road, Indianapolis, Indiana - IDIN										
Indianapolis Intl Airport 93819 (39.71, -86.27)	3.12 miles 222° (SW)	2008	Sample Day	65.7 ± 5.5	57.1 ± 5.3	44.6 ± 4.8	50.5 ± 4.6	65.8 ± 2.8	1015.6 ± 1.6	8.8 ± 1.1
			All Year	61.4 ± 2.1	52.6 ± 2.0	41.1 ± 1.8	46.9 ± 1.8	67.6 ± 1.1	1016.7 ± 0.7	8.4 ± 0.3
Gary, Indiana – INDEM										
Lansing Municipal Airport 04879 (41.54, -87.52)	11.36 miles 241° (WSW)	2008	Sample Day	58.5 ± 5.6	49.9 ± 5.2	40.2 ± 5.0	45.2 ± 4.8	71.8 ± 2.8	NA	7.6 ± 1.2
			All Year	58.6 ± 2.2	50.1 ± 2.1	40.2 ± 2.0	45.2 ± 1.9	71.3 ± 1.1	NA	6.8 ± 0.4
		2009	Sample Day	57.2 ± 5.0	49.0 ± 4.9	39.3 ± 4.8	44.5 ± 4.5	71.4 ± 2.8	NA	6.4 ± 1.0
			All Year	57.8 ± 2.0	49.4 ± 1.9	39.6 ± 1.9	44.7 ± 1.8	71.4 ± 1.1	NA	6.0 ± 0.4
South Harding, Indianapolis, Indiana - ININ										
Indianapolis Intl Airport 93819 (39.71, -86.27)	5.07 miles 232° (SW)	2008	Sample Day	66.5 ± 5.5	57.8 ± 5.3	44.9 ± 4.8	50.9 ± 4.6	64.8 ± 2.9	1015.7 ± 1.6	8.7 ± 1.1
			All Year	61.4 ± 2.1	52.6 ± 2.0	41.1 ± 1.8	46.9 ± 1.8	67.6 ± 1.1	1016.7 ± 0.7	8.4 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

NA= Sea level pressure was not recorded at the Lansing Municipal Airport

Table 13-3. Average Meteorological Conditions near the Indiana Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Washington Park, Indianapolis, Indiana - WPIN										
Indianapolis Intl Airport 93819 (39.71, -86.27)	10.53 miles 222° (SW)	2008	Sample Day	62.5 ± 5.2	54.2 ± 4.9	42.3 ± 4.5	48.1 ± 4.3	66.6 ± 2.5	1015.8 ± 1.5	9.0 ± 1.0
			All Year	61.4 ± 2.1	52.6 ± 2.0	41.1 ± 1.8	46.9 ± 1.8	67.6 ± 1.1	1016.7 ± 0.7	8.4 ± 0.3
		2009	Sample Day	61.0 ± 4.9	52.8 ± 4.9	41.3 ± 4.7	47.1 ± 4.4	67.5 ± 2.8	1015.2 ± 1.9	8.3 ± 1.1
			All Year	61.3 ± 1.9	53.2 ± 1.9	41.5 ± 1.8	47.4 ± 1.7	67.2 ± 1.2	1016.5 ± 0.7	8.0 ± 0.4

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

NA= Sea level pressure was not recorded at the Lansing Municipal Airport

13.2.3 Back Trajectory Analysis

Figure 13-7 and Figure 13-9 are the composite back trajectory maps for days on which samples were collected at the IDIN and ININ monitoring sites in 2008, respectively. Figures 13-8 and 13-10 are the 2008 cluster analyses for both sites. Figure 13-11 and Figure 13-12 are the composite back trajectory maps for days on which samples were collected at WPIN in 2008 and 2009, respectively. Figure 13-13 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 13-14 and 13-15 are the composite back trajectory maps for days on which samples were collected at the INDEM monitoring site in 2008 and 2009, respectively, and Figure 13-16 is the cluster analysis for both years. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 13-7 through 13-16 represents 100 miles.

Figure 13-7. 2008 Composite Back Trajectory Map for IDIN

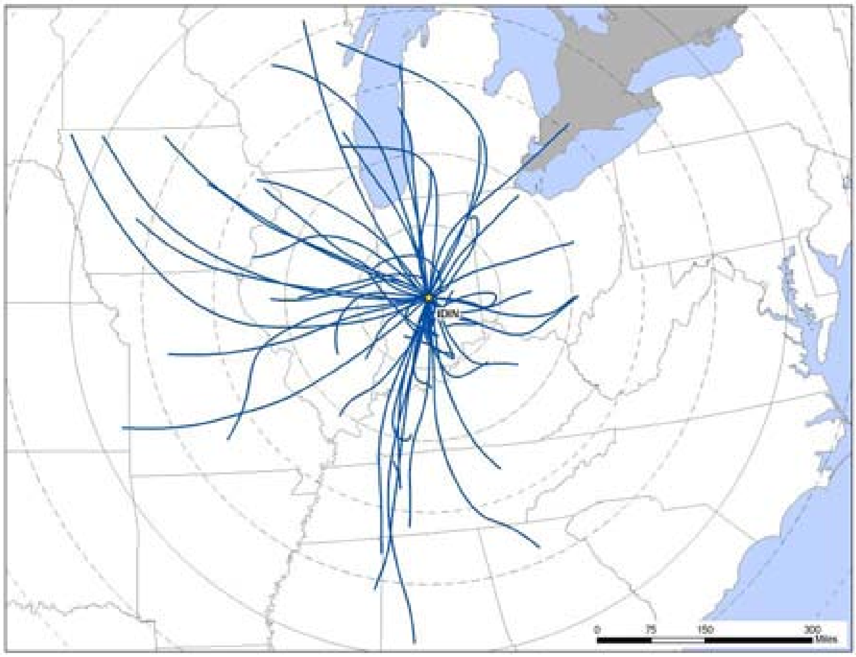


Figure 13-8. 2008 Back Trajectory Cluster Map for IDIN

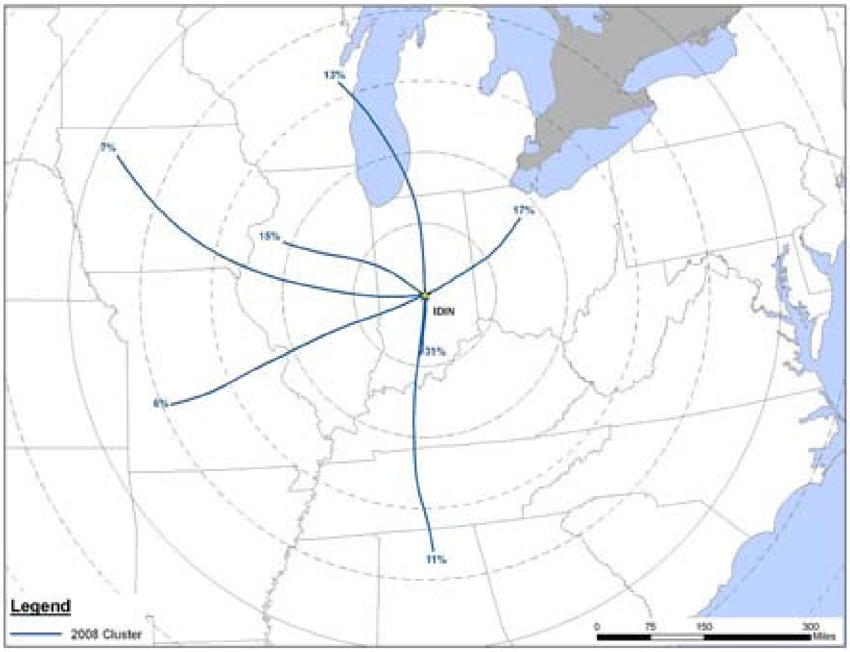


Figure 13-9. 2008 Composite Back Trajectory Map for ININ

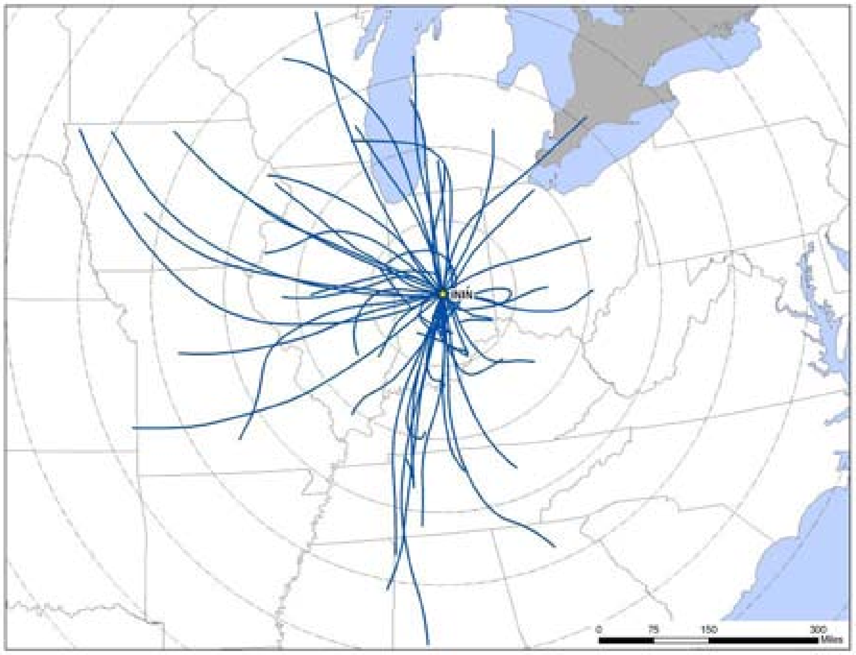


Figure 13-10. 2008 Back Trajectory Cluster Map for ININ

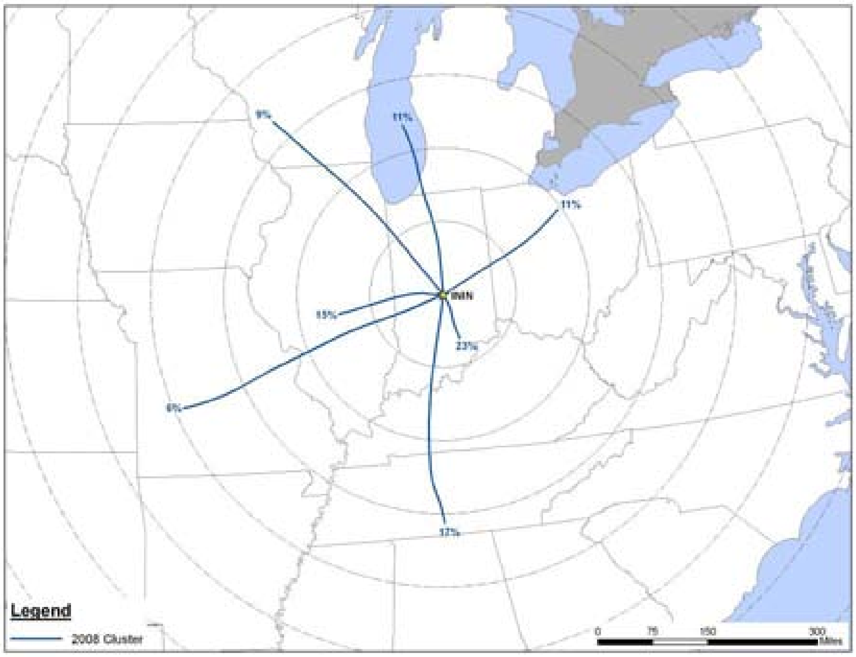


Figure 13-11. 2008 Composite Back Trajectory Map for WPIN

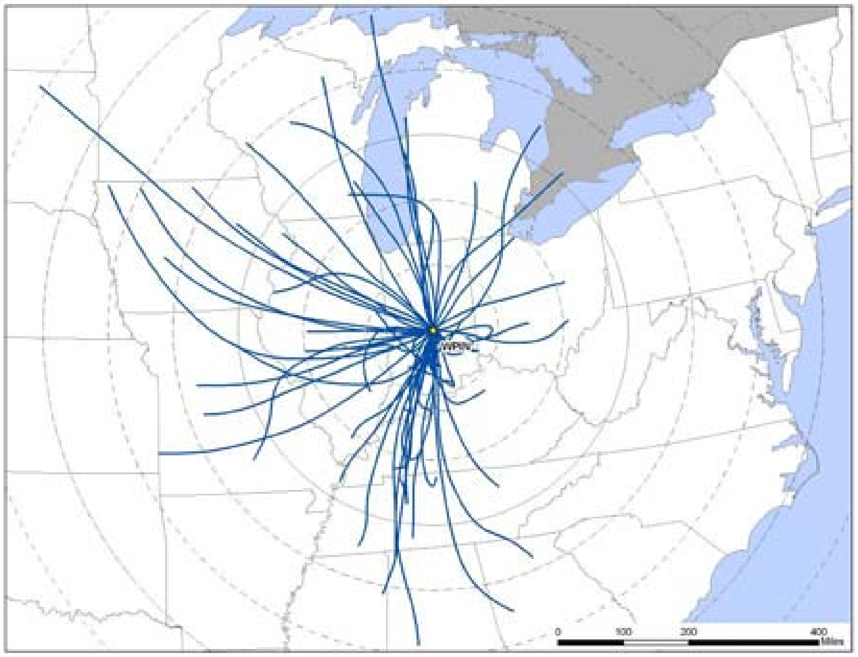


Figure 13-12. 2009 Composite Back Trajectory Map for WPIN

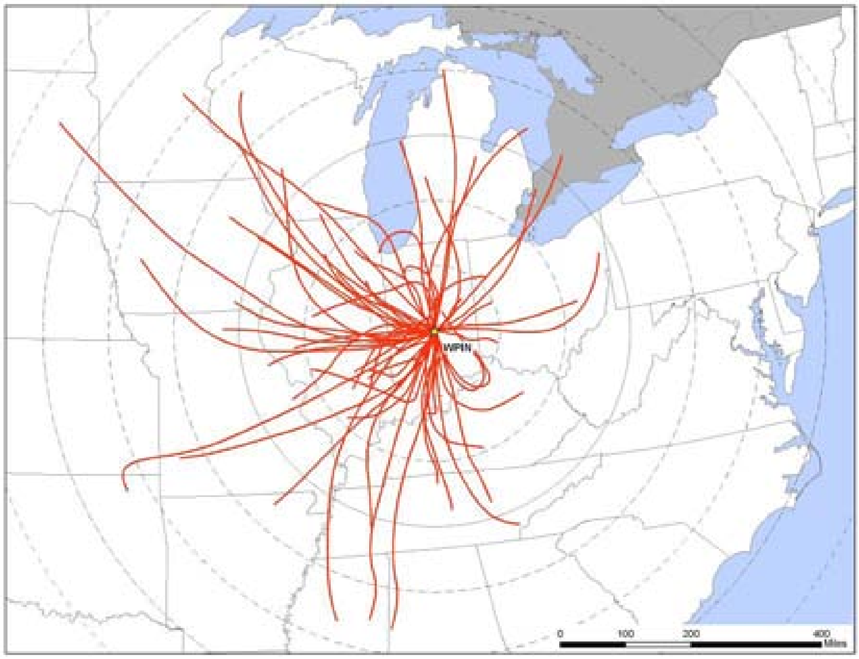


Figure 13-13. Back Trajectory Cluster Map for WPIN

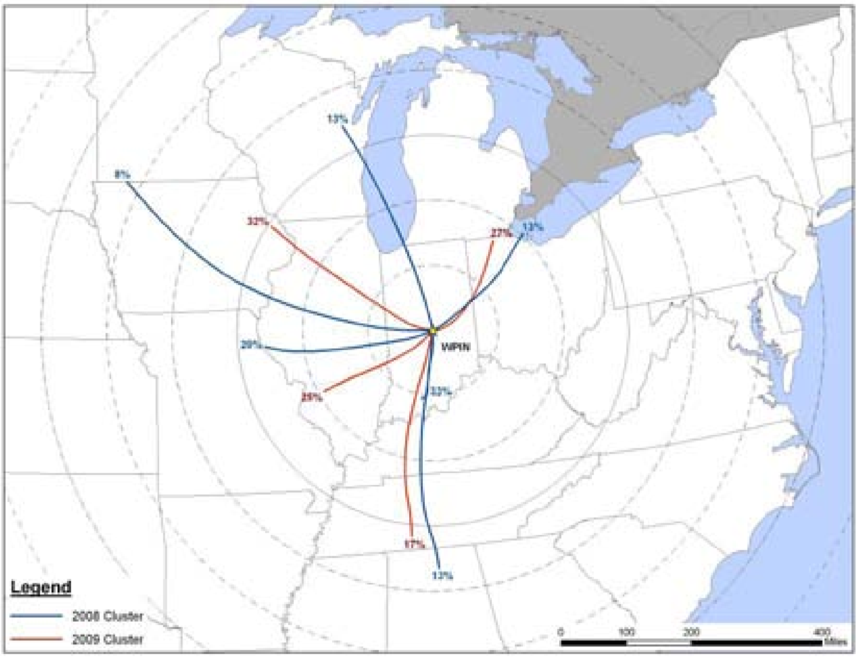


Figure 13-14. 2008 Composite Back Trajectory Map for INDEM

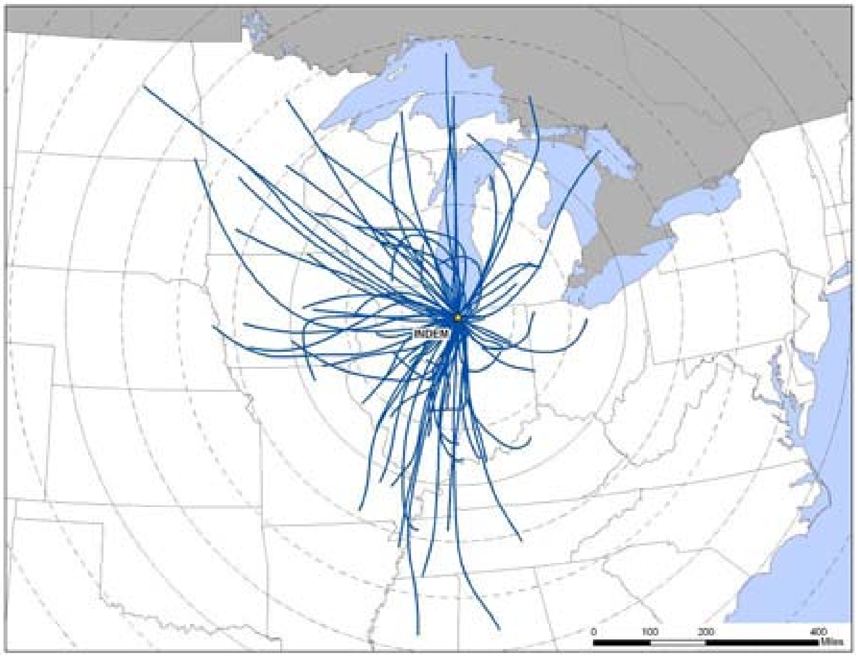


Figure 13-15. 2009 Composite Back Trajectory Map for INDEM

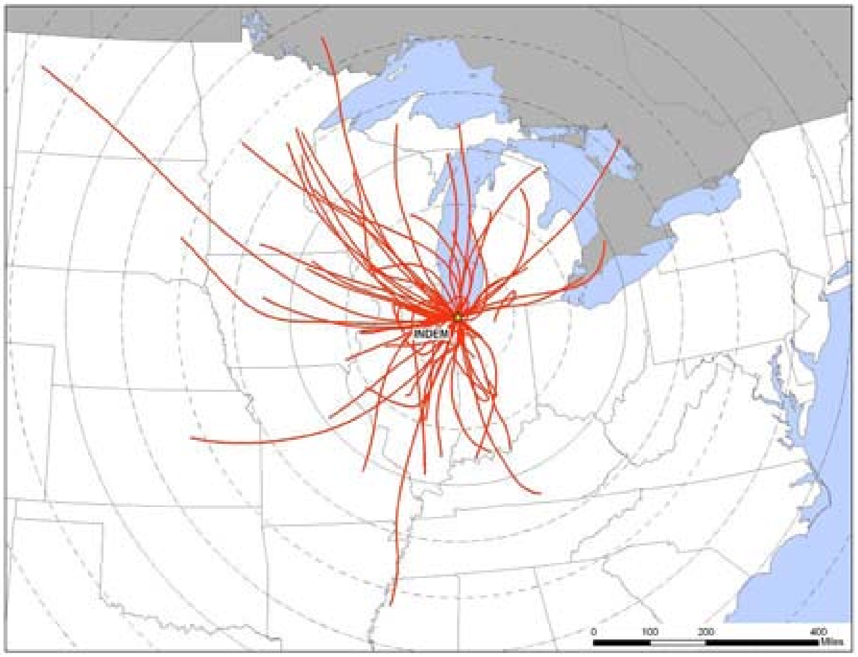
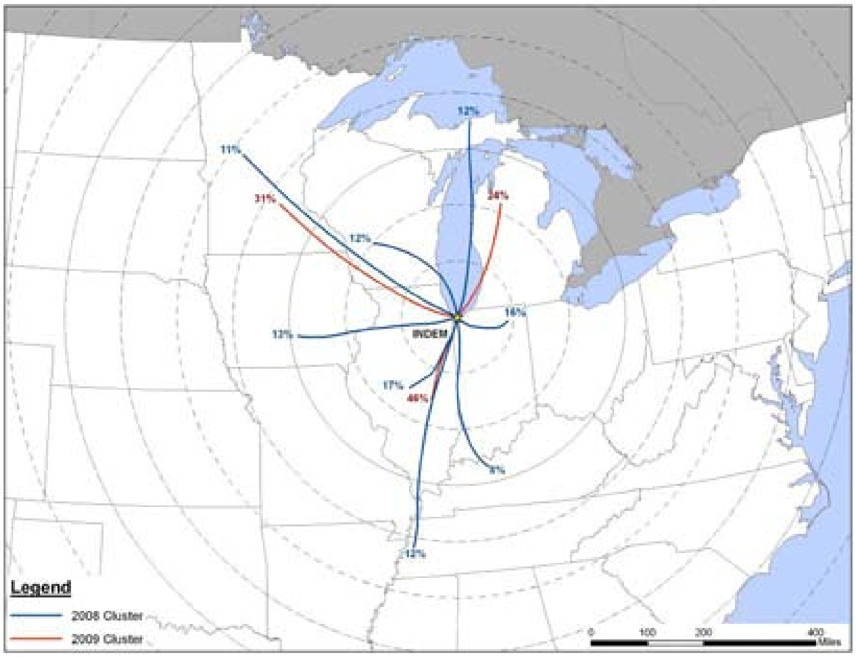


Figure 13-16. Back Trajectory Cluster Map for INDEM



Observations from Figures 13-7 through 13-10 for the IDIN and ININ sites include the following:

- The composite back trajectory distributions for these sites resemble to each other. This is expected given their proximity to each other as well as the similarity in sample days (both sampled January through September 2008).
- Back trajectories originated from a variety of directions at these two sites, although less frequently from the southeast.
- The 24-hour air shed domains were comparable in size to many other monitoring sites. The farthest away a trajectory originated was the northwest corner of Iowa, or just less than 550 miles away. However, the average trajectory length was 239 miles and most trajectories (approximately 86 percent) originated within 400 miles.
- The cluster analyses for these sites are also similar to each other, as over 40 percent of trajectories originated to the south for both sites and 35 percent originated from the west, northwest, and north.

Observations from Figures 13-11 through 13-13 for WPIN include the following:

- The 2008 composite back trajectory distribution for this site resembles the ones for IDIN and ININ. However, the 2008 composite map for this site includes an additional 3 months of sample days.

- Back trajectories originated from a variety of directions at WPIN, although less frequently from the east and southeast.

- The 24-hour air shed domain was slightly larger in size compared to many other NMP monitoring sites as the farthest away a trajectory originated was the northeast South Dakota, or greater than 700 miles away. The average trajectory length was 261 miles, while most trajectories (88 percent) originated within 450 miles of WPIN.

- Similar ININ and IDIN, the cluster analysis for WPIN shows that trajectories from southerly, westerly and northwesterly, and northeasterly directions are most common.

Observations from Figures 13-14 through 13-16 for INDEM include the following:

- Back trajectories originated from a variety of directions at INDEM, although less frequently from the east and southeast, similar to the Indianapolis sites.

- The 24-hour air shed domain was among the largest for any NMP site, as the farthest away a trajectory originated was northwest North Dakota, or nearly greater than 850 miles away. However, the average trajectory length was 271 miles, and most trajectories (89 percent) originated within 450 miles of INDEM.

- The cluster analysis for INDEM shows that trajectories originating from the south, southwest, west, northwest, or north account for the majority of trajectories.

13.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations near the Indiana sites, as presented in Section 13.2.2, were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 13-17 presents three different wind roses for the IDIN monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year is presented. Finally, a wind rose representing days on which samples were collected in 2008 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 13-18 presents similar wind roses for the ININ monitoring site.

Figure 13-19 presents five different wind roses for WPIN. First, a historical wind rose representing 1997 to 2007 is presented. Next, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Lastly, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. Figure 13-20 presents the five different wind roses for the INDEM monitoring site.

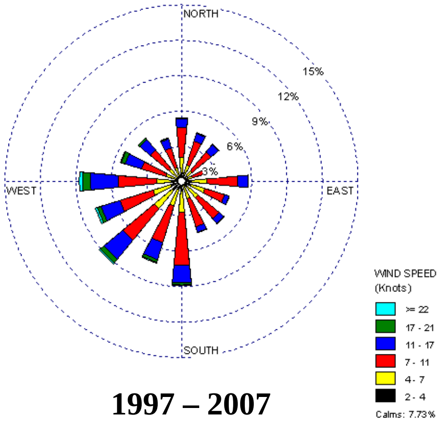
Observations from Figures 13-17 and 13-18 for IDIN and ININ, respectively, include the following:

- Because the NWS weather station at Indianapolis International Airport is the closest weather station to both IDIN and ININ, the historical and 2008 wind roses for IDIN are the same as for ININ.

- The historical wind roses show that southerly, southwesterly, and westerly winds were the most commonly observed wind directions near these sites. Calm winds (≤ 2 knots) were observed for less than eight percent of observations.

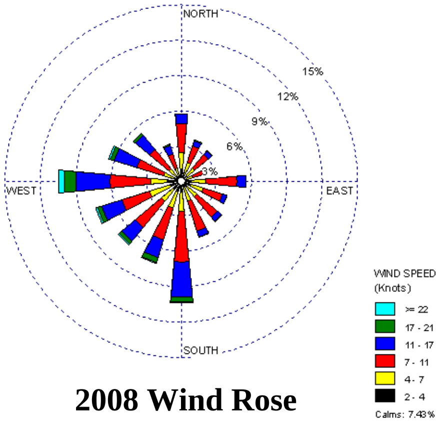
- The 2008 wind roses exhibit wind patterns similar to the historical wind patterns, with winds from due south and due west observed slightly more frequently. The 2008 sample day wind roses show winds from due south, due west, and due north accounting for the majority of the wind directions. It is important to note that sampling concluded in September 2008, and a wind rose incorporating the last three months of sample days may exhibit a different wind pattern.

Figure 13-17. Wind Roses for the Indianapolis International Airport Weather Station near IDIN

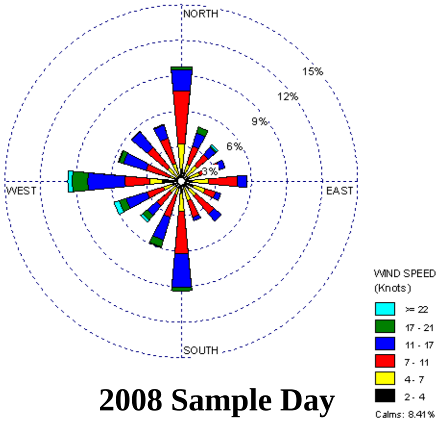


1997 – 2007

Historical Wind Rose

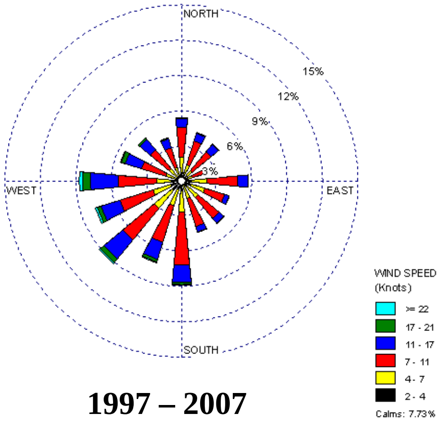


2008 Wind Rose



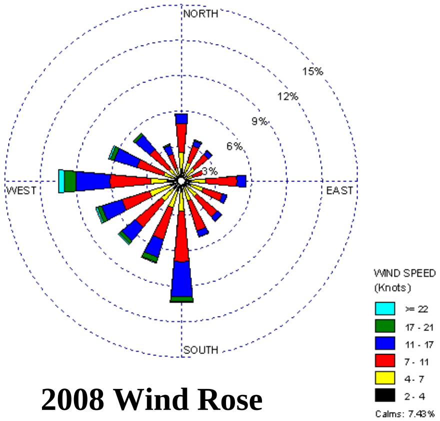
2008 Sample Day
Wind Rose

Figure 13-18. Wind Roses for the Indianapolis International Airport Weather Station near ININ

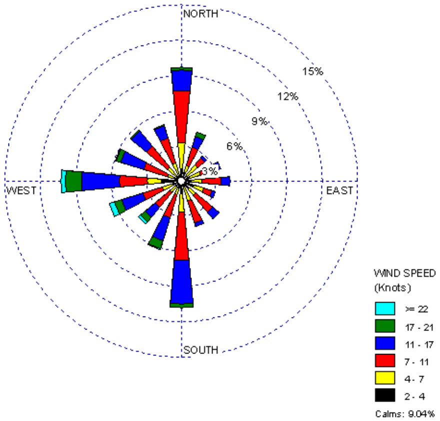


1997 – 2007

Historical Wind Rose



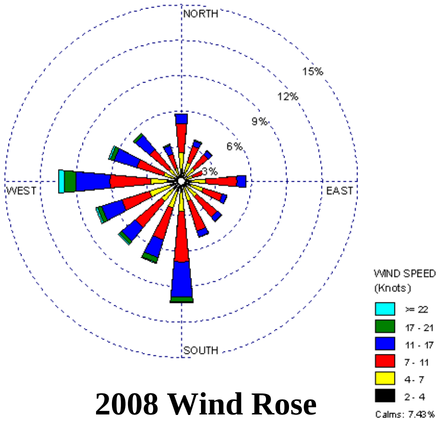
2008 Wind Rose



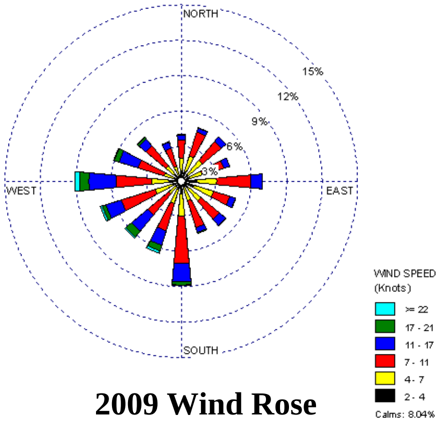
2008 Sample Day

Wind Rose

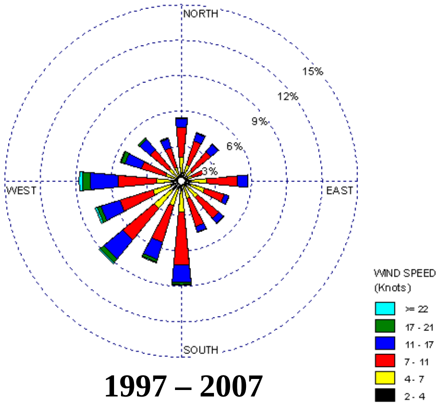
Figure 13-19. Wind Roses for the Indianapolis International Airport Weather Station near WPIN



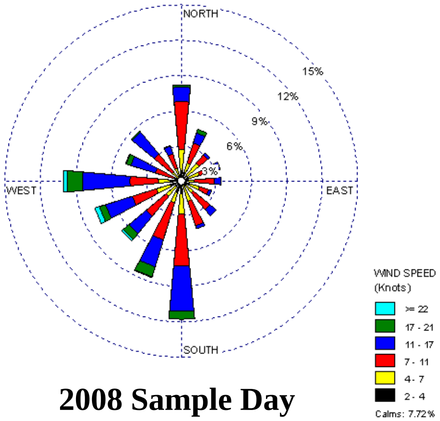
2008 Wind Rose



2009 Wind Rose

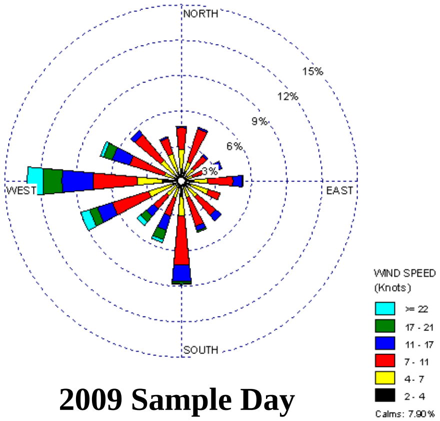


1997 – 2007
Historical Wind Rose



2008 Sample Day

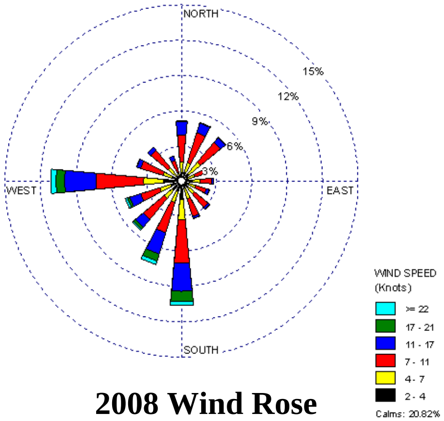
Wind Rose



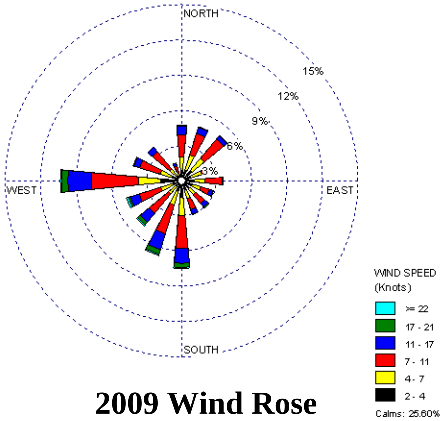
2009 Sample Day

Wind Rose

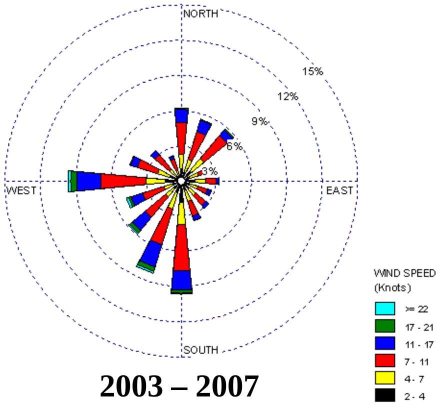
Figure 13-20. Wind Roses for the Lansing Municipal Airport Weather Station near INDEM



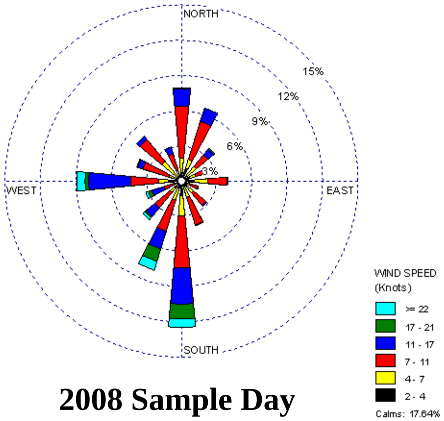
2008 Wind Rose



2009 Wind Rose

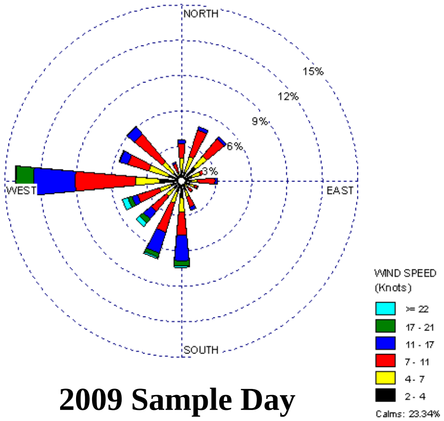


2003 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 13-19 for WPIN include the following:

- The NWS weather station at Indianapolis International Airport is also the closest weather station to WPIN; thus, the historical and 2008 wind roses for WPIN are the same as for IDIN and ININ.

- Recall that southerly, southwesterly, and westerly winds were the most commonly observed wind directions near WPIN. Calm winds (≤ 2 knots) were observed for less than eight percent of observations.

- The 2008 and 2009 wind patterns resemble the historical wind patterns, although winds from due south and due west observed slightly more frequently in 2008.

- Consistent with to the 2008 full-year wind rose, the 2008 sample day wind rose shows that winds from south to southwest to west account for the majority of the wind directions, although northerly winds were observed slightly more frequently.

- The 2009 sample day wind rose shows that winds from west-southwest, west, and west-northwest were observed more frequently on sample days than during the entire year. Further, a higher percentage of wind speeds on sample days were greater than 22 knots than during all of 2009.

Observations from Figure 13-20 for INDEM include the following:

- The historical wind rose for INDEM shows that winds from the south to south-southwest and west were predominant over the 2003-2007 time frame. Northerly to northeasterly winds off Lake Michigan accounted for approximately 20 percent of the measurements, as did calm winds.

- The wind patterns shown on the 2008 wind rose and the 2008 sample day wind rose resemble the wind patterns shown on the historical wind rose. Winds were somewhat stronger in 2008 as the percentage of winds from 17-21 and greater than 22 knots is higher.

- The 2009 wind rose exhibits similar wind patterns as the historical wind rose, although the calm rate is higher and the percentage of winds from the south and southwest is somewhat less. The 2009 sample day wind rose has a higher percentage of winds from due west and a slightly higher percentage of winds from the west-northwest and northwest compared to the 2009 full-year wind rose.

13.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Indiana monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 13-4 presents the pollutants of interest for the Indiana monitoring sites. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. IDIN and ININ sampled for carbonyl compounds and metals (PM_{10}); WPIN and INDEM sampled for carbonyl compounds only.

Observations from Table 13-4 include the following:

- Eight pollutants failed screens for IDIN; of these, six are NATTS MQO Core Analytes (antimony and propionaldehyde are not). Four pollutants were identified through the risk screening process as pollutants of interest for IDIN (acetaldehyde, formaldehyde, arsenic, and manganese); cadmium and lead were added to the list because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. Beryllium and nickel were also added to IDIN's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens; these two pollutants are not shown in Table 13-4.

- Seven pollutants failed screens for ININ; all but one of these are NATTS MQO Core Analytes (propionaldehyde is not). The same four pollutants were initially identified as pollutants of interest for ININ as IDIN (acetaldehyde, formaldehyde, arsenic, and manganese). Lead and cadmium were added as pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. Beryllium and nickel were added to the list because they are NATTS MQO Core Analytes, even though they did not fail any screens; these two pollutants are not shown in Table 13-4.

- Formaldehyde, acetaldehyde, and propionaldehyde are the only carbonyl compounds with risk screening values. All three pollutants failed screens for INDEM while only acetaldehyde and formaldehyde failed screens for WPIN.

- Acetaldehyde and formaldehyde were identified as pollutants of interest for all four sites. Every measured concentration of acetaldehyde and formaldehyde failed screens for all four Indiana sites.

Table 13-4. Risk Screening Results for the Indiana Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
South Holt Road, Indianapolis, Indiana - IDIN						
Acetaldehyde	0.45	47	47	100.00	28.83	28.83
Formaldehyde	0.077	47	47	100.00	28.83	57.67
Arsenic (PM$_{10}$)	0.00023	44	45	97.78	26.99	84.66
Manganese (PM$_{10}$)	0.005	18	45	40.00	11.04	95.71
Lead (PM$_{10}$)	0.015	3	45	6.67	1.84	97.55
Propionaldehyde	0.8	2	47	4.26	1.23	98.77
Antimony (PM$_{10}$)	0.02	1	45	2.22	0.61	99.39
Cadmium (PM$_{10}$)	0.00056	1	45	2.22	0.61	100.00
Total		163	366	44.54		
Gary, Indiana - INDEM						
Acetaldehyde	0.45	117	117	100.00	49.16	49.16
Formaldehyde	0.077	117	117	100.00	49.16	98.32
Propionaldehyde	0.8	4	117	3.42	1.68	100.00
Total		238	351	67.81		
South Harding, Indianapolis, Indiana - ININ						
Acetaldehyde	0.45	49	49	100.00	30.63	30.63
Formaldehyde	0.077	49	49	100.00	30.63	61.25
Arsenic (PM$_{10}$)	0.00023	39	40	97.50	24.38	85.63
Manganese (PM$_{10}$)	0.005	18	40	45.00	11.25	96.88
Lead (PM$_{10}$)	0.015	3	40	7.50	1.88	98.75
Cadmium (PM$_{10}$)	0.00056	1	40	2.50	0.63	99.38
Propionaldehyde	0.8	1	49	2.04	0.63	100.00
Total		160	307	52.12		
Washington Park, Indianapolis, Indiana - WPIN						
Acetaldehyde	0.45	119	119	100.00	50.00	50.00
Formaldehyde	0.077	119	119	100.00	50.00	100.00
Total		238	238	100.00		

13.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Indiana monitoring sites. Concentration averages are provided for the pollutants of interest for each Indiana site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

13.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Indiana site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages for the Indiana sites are presented in Table 13-5, where applicable. Note that concentrations of the metals for IDIN and ININ are presented in ng/m^3 for ease of viewing.

Table 13-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Indiana Monitoring Sites

Pollutant	2008						2009					
	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
South Holt Road, Indianapolis, Indiana - IDIN												
Acetaldehyde	2.17 ± 0.30	1.71 ± 0.48	2.09 ± 0.27	2.72 ± 0.73	NR	2.17 ± 0.30	NR	NR	NR	NR	NR	NR
Formaldehyde	3.10 ± 0.44	1.83 ± 0.38	3.01 ± 0.45	4.46 ± 0.84	NR	3.10 ± 0.44	NR	NR	NR	NR	NR	NR
Arsenic (PM_{10}) [a]	1.08 ± 0.24	0.66 ± 0.14	1.12 ± 0.42	1.51 ± 0.54	NR	1.08 ± 0.24	NR	NR	NR	NR	NR	NR
Beryllium (PM_{10}) [a]	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	<0.01 ± <0.01	NR	0.01 ± <0.01	NR	NR	NR	NR	NR	NR
Cadmium (PM_{10}) [a]	0.21 ± 0.05	0.18 ± 0.04	0.16 ± 0.05	0.30 ± 0.14	NR	0.21 ± 0.05	NR	NR	NR	NR	NR	NR
Lead (PM_{10}) [a]	5.85 ± 1.66	4.78 ± 1.77	4.85 ± 1.25	8.15 ± 4.88	NR	5.85 ± 1.66	NR	NR	NR	NR	NR	NR
Manganese (PM_{10}) [a]	5.15 ± 1.12	4.03 ± 1.21	6.99 ± 2.88	4.44 ± 1.14	NR	5.15 ± 1.12	NR	NR	NR	NR	NR	NR
Nickel (PM_{10}) [a]	0.73 ± 0.09	0.68 ± 0.12	0.80 ± 0.20	0.70 ± 0.12	NR	0.73 ± 0.09	NR	NR	NR	NR	NR	NR
Gary, Indiana - INDEM												
Acetaldehyde	3.77 ± 0.75	3.00 ± 0.44	6.80 ± 1.09	4.13 ± 1.99	1.17 ± 0.29	3.77 ± 0.75	1.32 ± 0.14	1.26 ± 0.13	1.35 ± 0.31	1.36 ± 0.48	1.31 ± 0.21	1.32 ± 0.14
Formaldehyde	75.13 ± 36.25	19.28 ± 5.52	133.09 ± 76.38	152.06 ± 117.67	1.23 ± 0.28	75.13 ± 36.25	2.59 ± 1.63	1.37 ± 0.17	2.26 ± 0.68	5.74 ± 7.49	1.33 ± 0.22	2.59 ± 1.63

NR = Not reportable because sampling was not conducted during this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 13-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Indiana Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
South Harding Road, Indianapolis, Indiana - ININ												
Acetaldehyde	2.15 ± 0.23	1.52 ± 0.22	2.11 ± 0.27	2.71 ± 0.40	NR	2.15 ± 0.23	NR	NR	NR	NR	NR	NR
Formaldehyde	6.27 ± 0.95	2.90 ± 0.60	5.53 ± 0.72	9.74 ± 1.11	NR	6.27 ± 0.95	NR	NR	NR	NR	NR	NR
Arsenic (PM$_{10}$) [a]	1.05 ± 0.21	0.63 ± 0.11	1.07 ± 0.38	1.39 ± 0.42	NR	1.05 ± 0.21	NR	NR	NR	NR	NR	NR
Beryllium (PM$_{10}$) [a]	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	NR	0.01 ± <0.01	NR	NR	NR	NR	NR	NR
Cadmium (PM$_{10}$) [a]	0.24 ± 0.04	0.22 ± 0.06	0.23 ± 0.08	0.26 ± 0.09	NR	0.24 ± 0.04	NR	NR	NR	NR	NR	NR
Lead (PM$_{10}$) [a]	5.72 ± 1.12	4.15 ± 0.75	5.85 ± 1.97	6.93 ± 2.46	NR	5.72 ± 1.12	NR	NR	NR	NR	NR	NR
Manganese (PM$_{10}$) [a]	5.26 ± 0.96	4.11 ± 1.72	6.20 ± 1.85	5.29 ± 1.53	NR	5.26 ± 0.96	NR	NR	NR	NR	NR	NR
Nickel (PM$_{10}$) [a]	0.88 ± 0.13	0.73 ± 0.14	0.81 ± 0.14	1.07 ± 0.31	NR	0.88 ± 0.13	NR	NR	NR	NR	NR	NR
Washington Park, Indianapolis, Indiana - WPIN												
Acetaldehyde	2.04 ± 0.22	1.34 ± 0.17	2.19 ± 0.35	2.76 ± 0.43	1.87 ± 0.51	2.04 ± 0.22	1.83 ± 0.15	1.68 ± 0.22	2.15 ± 0.34	1.77 ± 0.21	1.69 ± 0.43	1.83 ± 0.15
Formaldehyde	3.44 ± 0.37	2.51 ± 0.33	4.33 ± 0.66	4.40 ± 0.71	2.46 ± 0.56	3.44 ± 0.37	3.10 ± 0.33	2.71 ± 0.46	4.24 ± 0.88	3.15 ± 0.34	2.24 ± 0.47	3.10 ± 0.33

NR = Not reportable because sampling was not conducted during this time.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Observations for the Indianapolis sites from Table 13-5 include the following:

- Because sampling was conducted from January through September 2008 at IDIN and ININ, there are no averages available for the fourth quarter of 2008 or any of 2009.

- Formaldehyde exhibited the highest daily average concentration by mass of the pollutants of interest for all three Indianapolis sites. The 2008 daily average concentration of formaldehyde for ININ was nearly twice the daily average concentration of this pollutant for IDIN or WPIN (both years); it also ranked third highest among all NMP sites sampling this pollutant. Acetaldehyde concentrations were similar to each other among these three sites.

- Formaldehyde concentrations were highest during the second and third quarters for all three sites for 2008, particularly for ININ (note that fourth quarter averages are not available for IDIN and ININ). For 2009, the difference between the quarterly averages for WPIN is less marked.

- Among the metals sampled at IDIN and ININ, lead and manganese had the highest daily average concentrations. The daily and annual average concentrations for these two sites were similar to each other in magnitude.

- The confidence interval for IDIN's lead average for the third quarter of 2008 is rather large, indicating the likely influence of outliers. A review of the data shows that the highest concentration for IDIN was measured on July 29, 2008 (35.3 ng/m^3). The next highest concentration was also measured in July but was nearly half as high (18.2 ng/m^3 on July 5, 2008). The July 29, 2008 concentration was the sixth highest lead concentration measured among NMP sites sampling PM_{10} metals.

Observations for INDEM from Table 13-5 include the following:

- Similar to the Indianapolis sites, formaldehyde had the highest daily average concentration for INDEM. However, formaldehyde's 2008 daily average concentration (75.13 ± 36.25 μg/m^3) is an order of magnitude higher than its 2009 daily average concentration (2.59 ± 1.63 μg/m^3).

- INDEM's 2008 quarterly averages of formaldehyde show that the highest concentrations were measured in the second and third quarters. A review of the data shows that 10 formaldehyde concentrations greater than 200 μg/m^3 were measured between June 5, 2008 and August 4, 2008, ranging from 219 to 500 μg/m^3.

- A review of INDEM's 2009 formaldehyde data shows that the highest concentration (49 μg/m^3) was measured on September 22, 2009. The next highest concentration measured during 2009 was less than 10 μg/m^3. By contrast, in 2008, 35 of the 59 samples had formaldehyde concentrations greater than 10 μg/m^3.

- INDEM's acetaldehyde concentrations generally follow a similar pattern to formaldehyde, although the concentrations are not nearly as high. Thirty-eight of the 41 concentrations of acetaldehyde greater than 2 μg/m^3 were measured in 2008.

- INDEM's formaldehyde concentrations have historically been higher than any other NMP site sampling carbonyl compounds. In 2009, the state of Indiana replaced their multi-port carbonyl samplers and their formaldehyde concentrations decreased substantially (as did their acetaldehyde concentrations, but the difference is less dramatic). During the summer PAMS season, which begins on June 1, a state-owned multi-channel collection system is used at INDEM to collect multiple samples per day. At the end of each PAMS season, sample collection goes back to a state-owned single-channel collection system. The multi-channel sampler used at INDEM during the PAMS season was replaced in 2009. Given that the elevated concentrations of formaldehyde were typically measured during the summer, this sampler change could account for the differences in the concentrations for 2009 compared to previous years. Thus, the elevated concentrations from previous years were likely related to the multi-channel collection equipment and may not reflect the actual levels in the ambient air.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Indiana sites from those tables include the following:

- As shown in Table 4-10, INDEM's 2008 daily average concentration of formaldehyde was the highest average among all NMP sites sampling this pollutant, and was an order of magnitude higher than the next highest daily average of formaldehyde (7.79 ± 6.42 μg/m^3 for PROK, 2009). Consequently, the 2009 daily average of formaldehyde ranked 33rd among all NMP sites.

- INDEM also had the highest daily average concentration of acetaldehyde (2008), as shown in Table 4-10, while its 2009 daily average ranked 51st.

- ININ had the third highest daily average concentration (2008) of formaldehyde, behind INDEM (2008) and PROK (2009), as shown in Table 4-10.

- As shown in Table 4-12, the 2008 daily average concentrations of arsenic, beryllium cadmium, and lead for IDIN and ININ were among the 10 highest daily average concentrations of these pollutants.

13.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. INDEM has sampled carbonyl compounds since 2004; thus, Figures 13-21 and 13-22 present the 3-year rolling statistical metrics for acetaldehyde and formaldehyde for INDEM, respectively. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Observations from Figure 13-21 for acetaldehyde measurements at INDEM include the following:

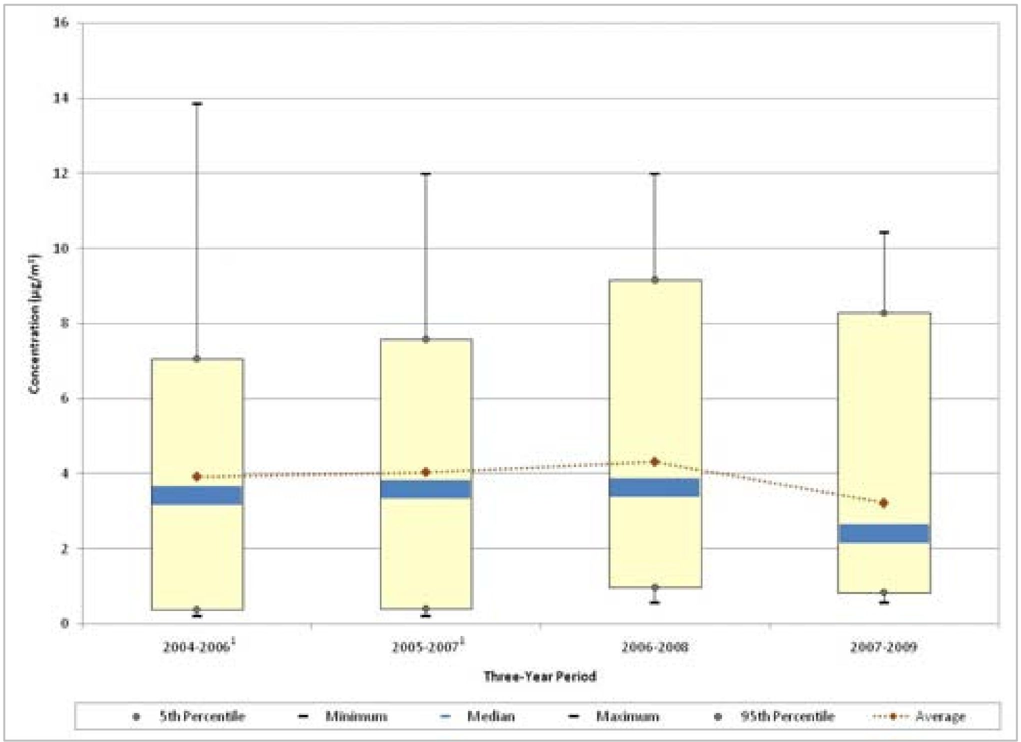
- The maximum acetaldehyde concentration (13.8 µg/m^3) was measured during the 2004-2006 time frame, specifically June 14, 2004. An additional four concentrations measured were greater than 10 µg/m^3 (one in 2006 and three in 2008).

- Most of the statistical parameters show a slight increasing trend through the 2006-2008 time frame, but show a decrease for the final time frame. The average and median concentrations for the final time frame decreased below the levels of the first time frame.

- Note that the carbonyl samplers were switched out in 2009, which seems to have had a significant impact on the concentrations measured, particularly with respect to formaldehyde, as discussed below.

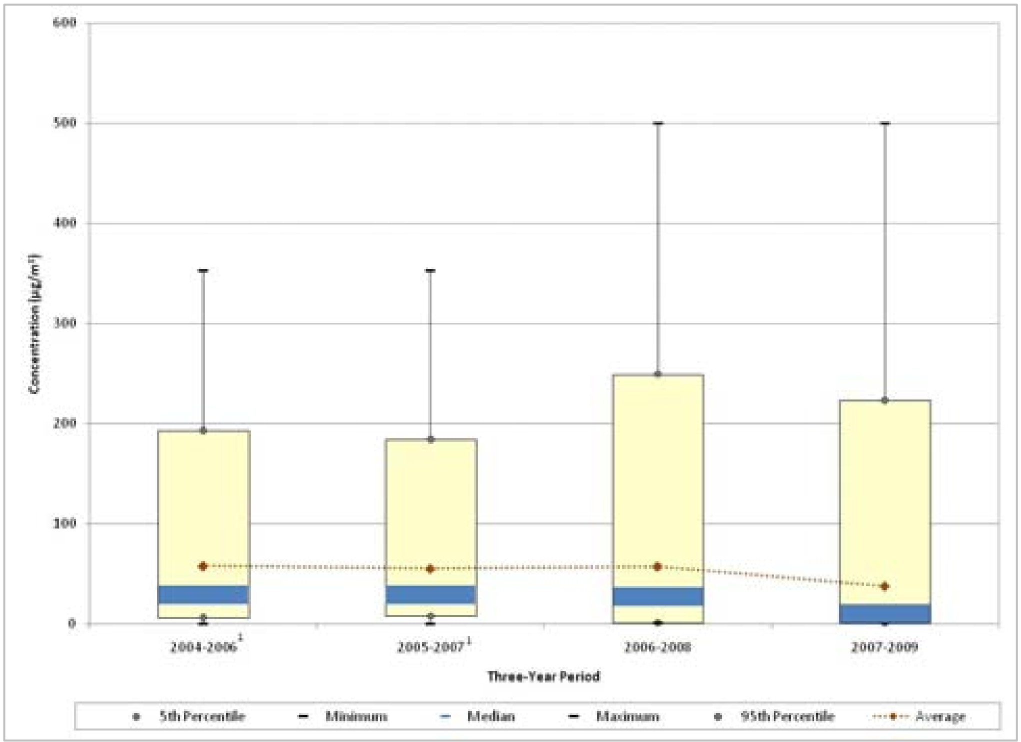
- There was a 3-month gap in sampling between September and November 2005 at the INDEM site, which is denoted in Figure 13-21.

Figure 13-21. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at INDEM



[1]Carbonyl compound samples were not collected from September to November 2005.

Figure 13-22. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at INDEM



[1]Carbonyl compound samples were not collected from September to November 2005.

Observations from Figure 13-22 for formaldehyde measurements at INDEM include the following:

- Five formaldehyde concentrations greater than 400 $\mu g/m^3$ were measured in the summer of 2008 (ranging from 414 to 499 $\mu g/m^3$). While these are extremely high values of formaldehyde, concentrations of formaldehyde have been historically high at this site, as shown by the statistics in Figure 13-22.

- The rolling average and median concentrations changed little through the 2006-2008 time frame, but show a decrease for the final time frame. Although the decrease is not statistically significant, note that the confidence intervals are wide for each of the averages shown due to the large range of concentrations measured at this site.

- The rolling average and the median values are not similar to each other; the median is roughly half of the average for each time period. This reflects the influence of the outliers on the average concentrations compared to the median concentrations.

- The rolling averages shown for INDEM are the highest of any rolling averages calculated for any other NMP site measuring formaldehyde. Note that the carbonyl samplers were switched out in 2009, as discussed in Section 13.4.1, which seems to have had a significant impact on the formaldehyde concentrations measured.

- There was a 3-month gap in sampling between September and November 2005 at the INDEM site, which is denoted in Figure 13-22.

13.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Indiana monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

13.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Indiana monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRLs; the quarterly averages were compared to the intermediate MRLs; and the annual averages were compared to the chronic MRLs. The results of this risk screening are summarized in Table 13-6. Where a quarterly or annual average exceeds the applicable MRL, the concentration is bolded.

Observations about formaldehyde in Table 13-6 include the following:

- Formaldehyde was the only pollutant of interest for INDEM where a preprocessed daily measurement and/or time-period average was greater than one or more of the MRL health risk benchmarks.

- Eleven out of 59 (approximately one-fifth) measured detections of formaldehyde from 2008 were greater than the ATSDR acute MRL for formaldehyde (50 µg/m^3). Conversely, no measured detections of formaldehyde from 2009 were greater than the ATSDR acute MRL for formaldehyde. Only three other concentrations of formaldehyde from other NMP sites exceeded the acute MRL.

- Both the second and third quarter 2008 averages were greater than the ATSDR intermediate MRL (40 µg/m^3). Conversely, none of the 2009 quarterly averages of formaldehyde were greater than the ATSDR intermediate MRL. No other quarterly averages of formaldehyde for any other NMP sites were greater than the ATSDR intermediate MRL.

- The 2008 annual average of formaldehyde for INDEM was greater than the ATSDR chronic MRL for formaldehyde (10 µg/m^3). This is the only annual average that was greater than the ATSDR chronic MRL among all NMP sites sampling this pollutant, or any other pollutant with a chronic MRL. The 2008 annual average of formaldehyde for INDEM (75.13 ± 36.25 µg/m^3) was more than seven times the ATSDR chronic MRL.

For the pollutants whose concentrations were greater than their respective ATSDR acute MRL noncancer health risk benchmark, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration vs. wind speed and wind direction, as described in Section 3.5.4.1. Figure 13-23 is the formaldehyde pollution rose for INDEM.

Observations from the Figure 13-23 include the following:

- There were 11 measured detections that were greater than the ATSDR acute MRL (50 µg/m^3) for formaldehyde (shown in yellow and orange).

- Concentrations greater than the ATSDR acute MRL were measured on days with winds blowing from the south to southwest; north, northeast, and east; or northwest. The five highest concentrations occurred on days where wind observations were from the south or southwest.

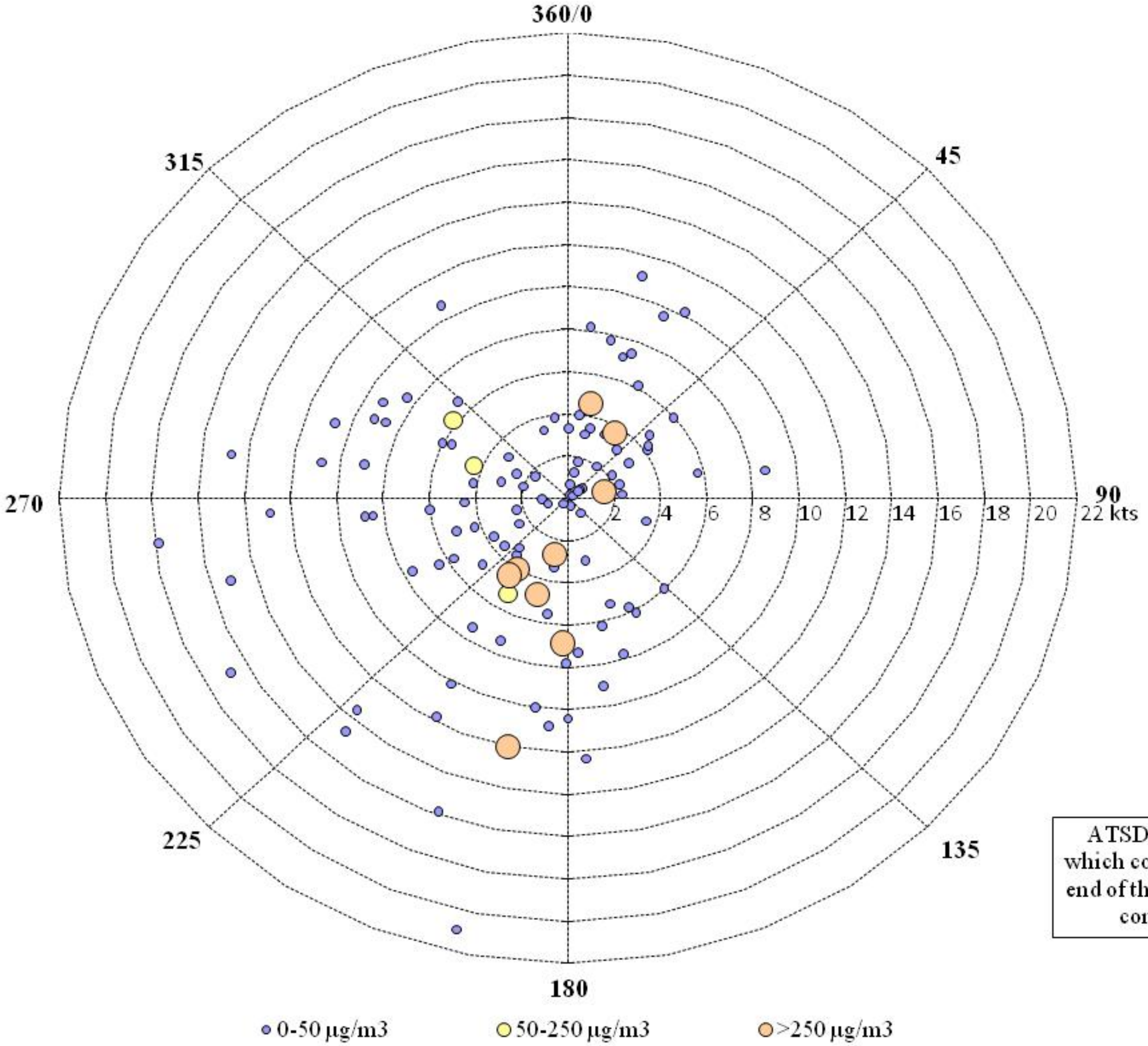
Table 13-6. MRL Risk Screening Assessment Summary for the Indiana Monitoring Sites

		Acute			Intermediate					Chronic	
Pollutant	**Year**	**ATSDR Acute MRL[1] (µg/m^3)**	**# of Concentrations > MRL**	**# of Measured Detections**	**ATSDR Intermediate MRL[1] (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**ATSDR Chronic MRL[1] (µg/m^3)**	**Annual Average (µg/m^3)**
Gary, Indiana - INDEM											
Formaldehyde	2008	50	11	59	40	19.28 ± 5.52	**133.09 ± 76.38**	**152.06 ± 117.67**	1.23 ± 0.28	10	**75.13 ± 36.25**
	2009		0	58		1.37 ± 0.17	2.26 ± 0.68	5.74 ± 7.49	1.33 ± 0.22		2.59 ± 1.63

Bolded = a quarterly or annual average concentration is greater than one or more of the intermediate or chronic MRLs.

[1] Reflects the use of one significant digit for MRL.

Figure 13-23. Formaldehyde Pollution Rose for INDEM



ATSDR MRL = 50 µg/m^3, which corresponds to the upper end of the 0-50 µg/m^3 (or blue) concentration range

13.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Indiana monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 13-7, where applicable.

Observations for the Indiana sites from Table 13-7 include the following:

- The pollutants with the highest annual average concentrations were formaldehyde and acetaldehyde for all four Indiana sites.

- For each site, the cancer risk approximations for formaldehyde were at least an order of magnitude higher than the cancer risk approximations for acetaldehyde. The cancer risk approximations for formaldehyde for INDEM (2008, 976.72 in-a-million) and ININ (2008, 81.52 in-a-million) were the highest and fourth highest calculated cancer risk approximations (respectively) among all site-specific pollutants of interest. Further, INDEM's 2008 formaldehyde cancer risk approximation (976.72 in-a-million) was nearly 30 times higher than its 2009 formaldehyde cancer risk approximation (33.61 in-a-million).

- INDEM's 2008 acetaldehyde cancer risk approximation (8.29 in-a-million) was nearly three times as high as its 2009 acetaldehyde cancer risk approximation (2.91 in-a-million) and twice the cancer risk approximations for the other three sites.

- For the two sites sampling metals (IDIN and ININ), arsenic had the highest cancer risk approximations among the metals (4.65 and 4.52 in-a-million, respectively). Arsenic's cancer risk approximations were just slightly less than acetaldehyde's cancer risk approximations for each site.

- INDEM's 2008 formaldehyde noncancer risk approximation was the only noncancer risk approximation greater than 1.0 (7.67 for INDEM) among the Indiana sites. Further, it was the only pollutant among all NMP sites' pollutants of interest with a noncancer risk approximation greater than 1.0.

Table 13-7. Cancer and Noncancer Surrogate Risk Approximations for the Indiana Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
South Holt Road, Indianapolis, Indiana - IDIN										
Acetaldehyde	2.2E-06	0.009	47/3	2.17 ± 0.30	4.77	0.24	NR	NR	NR	NR
Arsenic (PM_{10}) [a]	0.0043	1.5E-05	45/3	<0.01 ± <0.01	4.65	0.07	NR	NR	NR	NR
Beryllium (PM_{10}) [a]	0.0024	0.00002	44/3	<0.01 ± <0.01	0.01	0.00	NR	NR	NR	NR
Cadmium (PM_{10}) [a]	0.0018	0.00001	45/3	<0.01 ± <0.01	0.38	0.02	NR	NR	NR	NR
Formaldehyde	1.3E-05	0.0098	47/3	3.10 ± 0.44	40.26	0.32	NR	NR	NR	NR
Lead (PM_{10}) [a]	--	0.00015	45/3	0.01 ± <0.01	--	0.04	NR	NR	NR	NR
Manganese (PM_{10}) [a]	--	0.00005	45/3	0.01 ± <0.01	--	0.10	NR	NR	NR	NR
Nickel (PM_{10}) [a]	0.00031	0.00009	45/3	<0.01 ± <0.01	0.23	0.01	NR	NR	NR	NR
Gary, Indiana - INDEM										
Acetaldehyde	2.2E-06	0.009	59/4	3.77 ± 0.75	8.29	0.42	58/4	1.32 ± 0.14	2.91	0.15
Formaldehyde	1.3E-05	0.0098	59/4	75.13 ± 36.25	976.72	7.67	58/4	2.59 ± 1.63	33.61	0.26

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 13-5.

NR = Not reportable because sampling was not conducted during this time period.

Table 13-7. Cancer and Noncancer Surrogate Risk Approximations for the Indiana Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
South Harding Road, Indianapolis, Indiana - ININ										
Acetaldehyde	2.2E-06	0.009	49/3	2.15 ± 0.23	4.73	0.24	NR	NR	NR	NR
Arsenic (PM_{10}) [a]	0.0043	1.5E-05	40/3	<0.01 ± <0.01	4.52	0.07	NR	NR	NR	NR
Beryllium (PM_{10}) [a]	0.0024	0.00002	39/3	<0.01 ± <0.01	0.02	<0.01	NR	NR	NR	NR
Cadmium (PM_{10}) [a]	0.0018	0.00001	40/3	<0.01 ± <0.01	0.43	0.02	NR	NR	NR	NR
Formaldehyde	1.3E-05	0.0098	49/3	6.27 ± 0.95	81.52	0.64	NR	NR	NR	NR
Lead (PM_{10}) [a]	--	0.00015	40/3	0.01 ± <0.01	--	0.04	NR	NR	NR	NR
Manganese (PM_{10}) [a]	--	0.00005	40/3	0.01 ± <0.01	--	0.11	NR	NR	NR	NR
Nickel (PM_{10}) [a]	0.00031	0.00009	40/3	<0.01 ± <0.01	0.27	0.01	NR	NR	NR	NR
Washington Park, Indianapolis, Indiana - WPIN										
Acetaldehyde	2.2E-06	0.009	59/4	2.04 ± 0.22	4.50	0.23	60/4	1.83 ± 0.15	4.02	0.20
Formaldehyde	1.3E-05	0.0098	59/4	3.44 ± 0.37	44.75	0.35	60/4	3.10 ± 0.33	40.33	0.32

-- = a Cancer URE or Noncancer RfC is not available.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 13-5.

NR = Not reportable because sampling was not conducted during this time period.

13.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 13-8 and 13-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 13-8 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 13-9 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 13.3, IDIN and ININ sampled for carbonyl compounds and metals (PM_{10}) while WPIN and INDEM sampled for carbonyl compounds only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 13-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Indiana 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
South Holt Road, Indianapolis, Indiana (Marion County) - IDIN					
Benzene	641.04	Coke Oven Emissions, PM	9.91E-03	Formaldehyde	40.26
Formaldehyde	372.53	Benzene	5.00E-03	Acetaldehyde	4.77
Acetaldehyde	229.28	Formaldehyde	4.66E-03	Arsenic (PM_{10})	4.65
Dichloromethane	120.25	1,3-Butadiene	3.30E-03	Cadmium (PM_{10})	0.38
1,3-Butadiene	110.10	Hexavalent Chromium, PM	3.02E-03	Nickel (PM_{10})	0.23
1,3-Dichloropropene	62.40	Arsenic, PM	2.34E-03	Beryllium (PM_{10})	0.01
Naphthalene	60.88	Naphthalene	2.07E-03		
Trichloroethylene	38.75	Cadmium, PM	6.26E-04		
Tetrachloroethylene	17.09	Acetaldehyde	5.04E-04		
Coke Oven Emissions, PM	15.98	POM, Group 2	3.51E-04		
South Harding Road, Indianapolis, Indiana (Marion County) - ININ					
Benzene	641.04	Coke Oven Emissions, PM	9.91E-03	Formaldehyde	81.52
Formaldehyde	372.53	Benzene	5.00E-03	Acetaldehyde	4.73
Acetaldehyde	229.28	Formaldehyde	4.66E-03	Arsenic (PM_{10})	4.52
Dichloromethane	120.25	1,3-Butadiene	3.30E-03	Cadmium (PM_{10})	0.43
1,3-Butadiene	110.10	Hexavalent Chromium, PM	3.02E-03	Nickel (PM_{10})	0.27
1,3-Dichloropropene	62.40	Arsenic, PM	2.34E-03	Beryllium (PM_{10})	0.02
Naphthalene	60.88	Naphthalene	2.07E-03		
Trichloroethylene	38.75	Cadmium, PM	6.26E-04		
Tetrachloroethylene	17.09	Acetaldehyde	5.04E-04		
Coke Oven Emissions, PM	15.98	POM, Group 2	3.51E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk.

Table 13-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Indiana 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Washington Park, Indianapolis, Indiana (Marion County) - WPIN					
Benzene	641.04	Coke Oven Emissions, PM	9.91E-03	Formaldehyde	44.75
Formaldehyde	372.53	Benzene	5.00E-03	Formaldehyde	40.33
Acetaldehyde	229.28	Formaldehyde	4.66E-03	Acetaldehyde	4.50
Dichloromethane	120.25	1,3-Butadiene	3.30E-03	Acetaldehyde	4.02
1,3-Butadiene	110.10	Hexavalent Chromium, PM	3.02E-03		
1,3-Dichloropropene	62.40	Arsenic, PM	2.34E-03		
Naphthalene	60.88	Naphthalene	2.07E-03		
Trichloroethylene	38.75	Cadmium, PM	6.26E-04		
Tetrachloroethylene	17.09	Acetaldehyde	5.04E-04		
Coke Oven Emissions, PM	15.98	POM, Group 2	3.51E-04		
Gary, Indiana (Lake County) - INDEM					
Benzene	338.28	Coke Oven Emissions, PM	3.45E-02	Formaldehyde	976.72
Formaldehyde	170.33	Benzene	2.64E-03	Formaldehyde	33.61
Acetaldehyde	121.74	Formaldehyde	2.13E-03	Acetaldehyde	8.29
Coke Oven Emissions, PM	55.68	Naphthalene	1.75E-03	Acetaldehyde	2.91
Dichloromethane	52.03	Hexavalent Chromium, PM	1.44E-03		
Naphthalene	51.45	Arsenic, PM	1.43E-03		
1,3-Butadiene	40.92	1,3-Butadiene	1.23E-03		
1,3-Dichloropropene	35.15	Cadmium, PM	3.13E-04		
p-Dichlorobenzene	7.77	Nickel, PM	2.84E-04		
POM, Group 2	4.45	Acetaldehyde	2.68E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk.

Table 13-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Indiana 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
South Holt Road, Indianapolis, Indiana (Marion County) - IDIN					
Toluene	1,774.26	Acrolein	1,138,416.25	Formaldehyde	0.32
Xylenes	1,115.00	1,3-Butadiene	55,049.15	Acetaldehyde	0.24
Hydrochloric acid	997.58	Hydrochloric acid	49,878.89	Manganese (PM$_{10}$)	0.10
Benzene	641.04	Manganese, PM	45,357.24	Arsenic (PM$_{10}$)	0.07
Methanol	424.94	Formaldehyde	38,013.73	Lead (PM$_{10}$)	0.04
Formaldehyde	372.53	Acetaldehyde	25,475.83	Cadmium (PM$_{10}$)	0.02
Hexane	271.87	Benzene	21,367.96	Nickel (PM$_{10}$)	0.01
Methyl isobutyl ketone	254.84	Naphthalene	20,291.96	Beryllium (PM$_{10}$)	<0.01
Ethylbenzene	234.39	Bromomethane	18,587.43		
Acetaldehyde	229.28	Arsenic, PM	18,153.99		
South Harding Road, Indianapolis, Indiana (Marion County) - ININ					
Toluene	1,774.26	Acrolein	1,138,416.25	Formaldehyde	0.64
Xylenes	1,115.00	1,3-Butadiene	55,049.15	Acetaldehyde	0.24
Hydrochloric acid	997.58	Hydrochloric acid	49,878.89	Manganese (PM$_{10}$)	0.11
Benzene	641.04	Manganese, PM	45,357.24	Arsenic (PM$_{10}$)	0.07
Methanol	424.94	Formaldehyde	38,013.73	Lead (PM$_{10}$)	0.04
Formaldehyde	372.53	Acetaldehyde	25,475.83	Cadmium (PM$_{10}$)	0.02
Hexane	271.87	Benzene	21,367.96	Nickel (PM$_{10}$)	0.01
Methyl isobutyl ketone	254.84	Naphthalene	20,291.96	Beryllium (PM$_{10}$)	<0.01
Ethylbenzene	234.39	Bromomethane	18,587.43		
Acetaldehyde	229.28	Arsenic, PM	18,153.99		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk.

Table 13-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Indiana 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Washington Park, Indianapolis, Indiana (Marion County) - WPIN					
Toluene	1,774.26	Acrolein	1,138,416.25	Formaldehyde	0.35
Xylenes	1,115.00	1,3-Butadiene	55,049.15	Formaldehyde	0.32
Hydrochloric acid	997.58	Hydrochloric acid	49,878.89	Acetaldehyde	0.23
Benzene	641.04	Manganese, PM	45,357.24	Acetaldehyde	0.20
Methanol	424.94	Formaldehyde	38,013.73		
Formaldehyde	372.53	Acetaldehyde	25,475.83		
Hexane	271.87	Benzene	21,367.96		
Methyl isobutyl ketone	254.84	Naphthalene	20,291.96		
Ethylbenzene	234.39	Bromomethane	18,587.43		
Acetaldehyde	229.28	Arsenic, PM	18,153.99		
Gary, Indiana (Lake County) - INDEM					
Hydrochloric acid	967.92	Acrolein	544,317.82	Formaldehyde	7.67
Toluene	927.05	Manganese, PM	527,549.71	Acetaldehyde	0.42
Xylenes	659.40	Hydrochloric acid	48,395.79	Formaldehyde	0.26
Benzene	338.28	Nickel, PM	27,290.23	Acetaldehyde	0.15
Hexane	230.83	1,3-Butadiene	20,458.76		
Methanol	224.72	Chlorine	18,637.70		
Formaldehyde	170.33	Formaldehyde	17,380.96		
Acetaldehyde	121.74	Naphthalene	17,149.74		
Methyl isobutyl ketone	108.68	Acetaldehyde	13,526.57		
Ethylbenzene	106.92	Benzene	11,275.97		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk

Observations from Table 13-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the three highest emitted pollutants with cancer UREs in both Marion and Lake County.

- Coke oven emissions, benzene, and formaldehyde were the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for both Marion and Lake Counties. Coke oven emissions ranked fourth for Lake County and tenth for Marion County among the highest emitted pollutants.

- Six of the highest emitted pollutants in both counties also had the highest toxicity-weighted emissions (coke oven emissions, benzene, formaldehyde, acetaldehyde, naphthalene, and 1,3-butadiene).

- While several metals (arsenic, cadmium, hexavalent chromium, and nickel) were among the pollutants with the highest toxicity-weighted emissions for both counties, none of these appeared on the list of highest emitted pollutants for either county. This demonstrates that a pollutant does not have to be emitted in large quantities to be toxic.

- Acetaldehyde and formaldehyde are the only pollutants for which cancer risk approximations could be calculated for all four sites. Acetaldehyde and formaldehyde appear on all three lists for all four Indiana sites.

- Of the metals for IDIN and ININ, arsenic had the highest cancer surrogate risk approximations (behind formaldehyde and acetaldehyde) and was the only other pollutant with a cancer risk approximation greater than 1.0 in-a-million. Arsenic had the sixth highest toxicity-weighted emissions for Marion County.

Observations from Table 13-9 include the following:

- While hydrochloric acid was the highest emitted pollutant with a noncancer RfC in Lake County, it was the third highest emitted pollutant in Marion County (yet the quantity emitted was slightly higher in Marion County). Toluene was the highest emitted pollutant with a noncancer RfC in Marion County and its emissions were nearly twice that of Lake County.

- Acrolein was the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties. Manganese and hydrochloric acid were second and third for Lake County, while 1,3-butadiene and hydrochloric acid were second and third for Marion County.

- Four of the highest emitted pollutants in both counties also had the highest toxicity-weighted emissions (hydrochloric acid, formaldehyde, acetaldehyde, and benzene).

- The pollutants with the highest noncancer risk approximations were formaldehyde and acetaldehyde for all four sites. These two pollutants also ranked among the pollutants with the highest emissions and toxicity-weighted emissions for both counties.

- Manganese and arsenic, the pollutants with the third and fourth highest noncancer risk approximations for IDIN and ININ, also appeared among the pollutants with the highest toxicity-weighted emissions for Marion County (fourth and tenth, respectively).

13.6 Summary of the 2008-2009 Monitoring Data for the Indiana Monitoring Sites

Results from several of the treatments described in this section include the following:

- *Eight pollutants, five metals and three carbonyl compounds, failed screens for IDIN; seven pollutants, four metals and three carbonyl compounds, failed screens for ININ. Three carbonyl compounds failed screens for INDEM and two failed screens for WPIN.*

- *Formaldehyde had the highest daily average concentration for each of the Indiana monitoring sites. The 2008 daily average concentration of formaldehyde for INDEM was the highest among all participating monitoring sites, but was significantly lower for 2009.*

- *Eleven individual concentrations, two quarterly averages, and one annual average (all for 2008) of formaldehyde were greater than the acute, intermediate, and chronic ATSDR MRL noncancer health risk benchmarks for INDEM, respectively.*

14.0 Sites in Kentucky

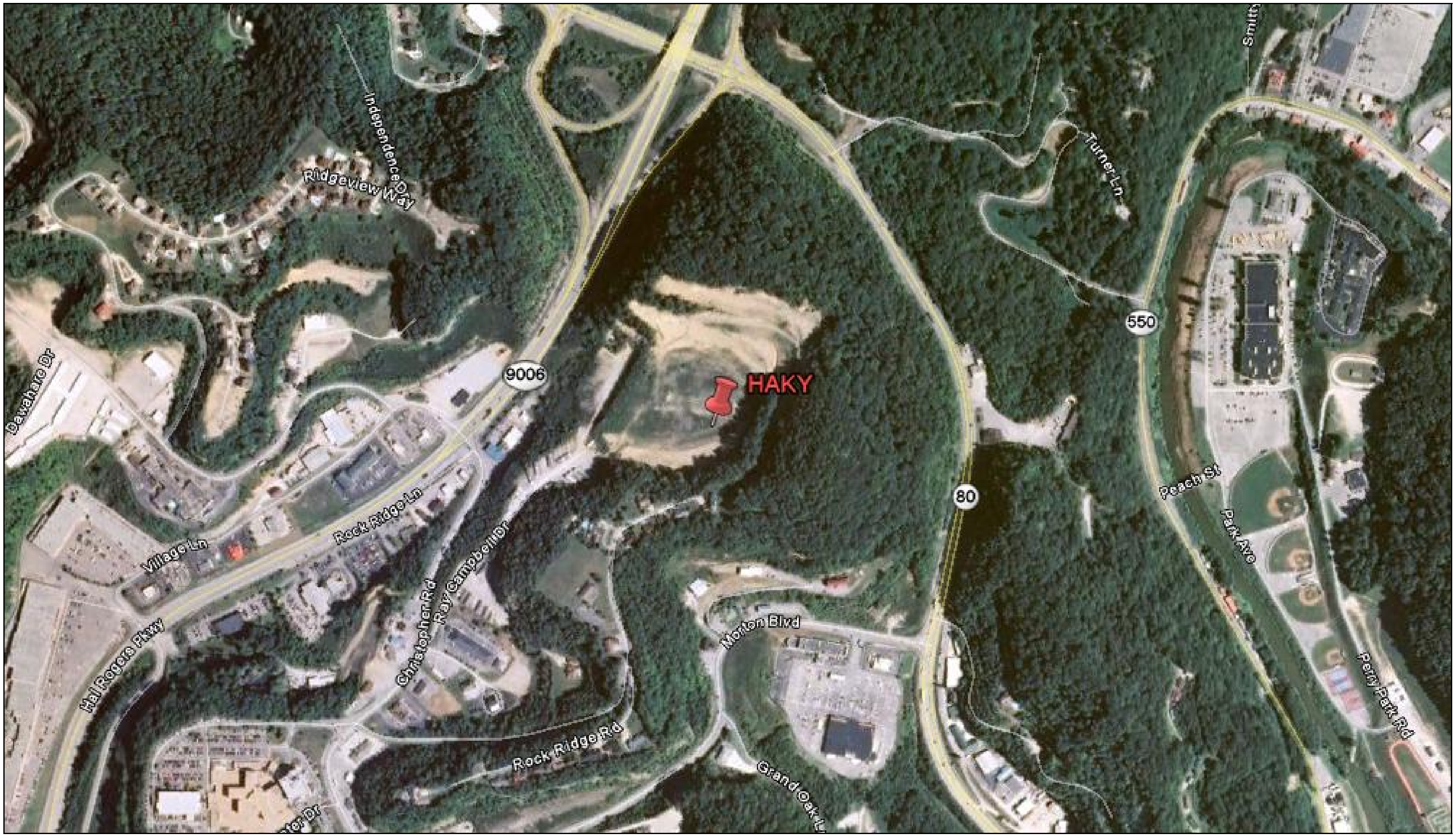
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS sites in Kentucky, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

14.1 Site Characterization

This section characterizes the Kentucky monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

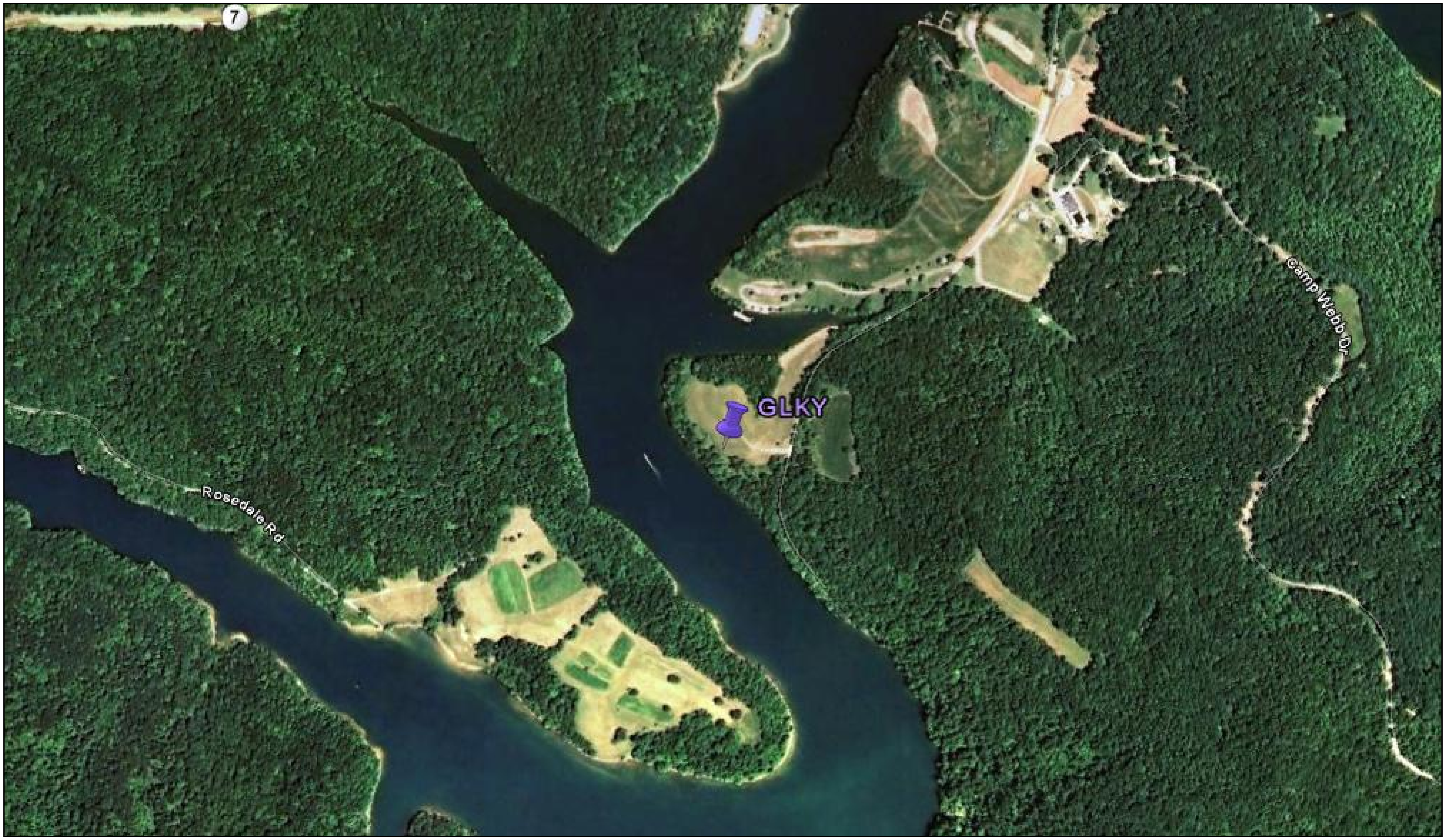
The monitoring site near Hazard (HAKY) was moved in June 2008 to its new location near Grayson (GLKY). Because data from both locations are presented in this section, the locations of the sites are viewed separately and examined individually. Figures 14-1 and 14-2 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their rural locations. Figures 14-3 and 14-4 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of each site are included in the facility counts provided below the map in Figures 14-3 and 14-4. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 14-1 describes the areas surrounding the monitoring sites by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 14-1. Hazard, Kentucky (HAKY) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,109 feet

Figure 14-2. Grayson, Kentucky (GLKY) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,158 feet

Figure 14-3. NEI Point Sources Located Within 10 Miles of HAKY

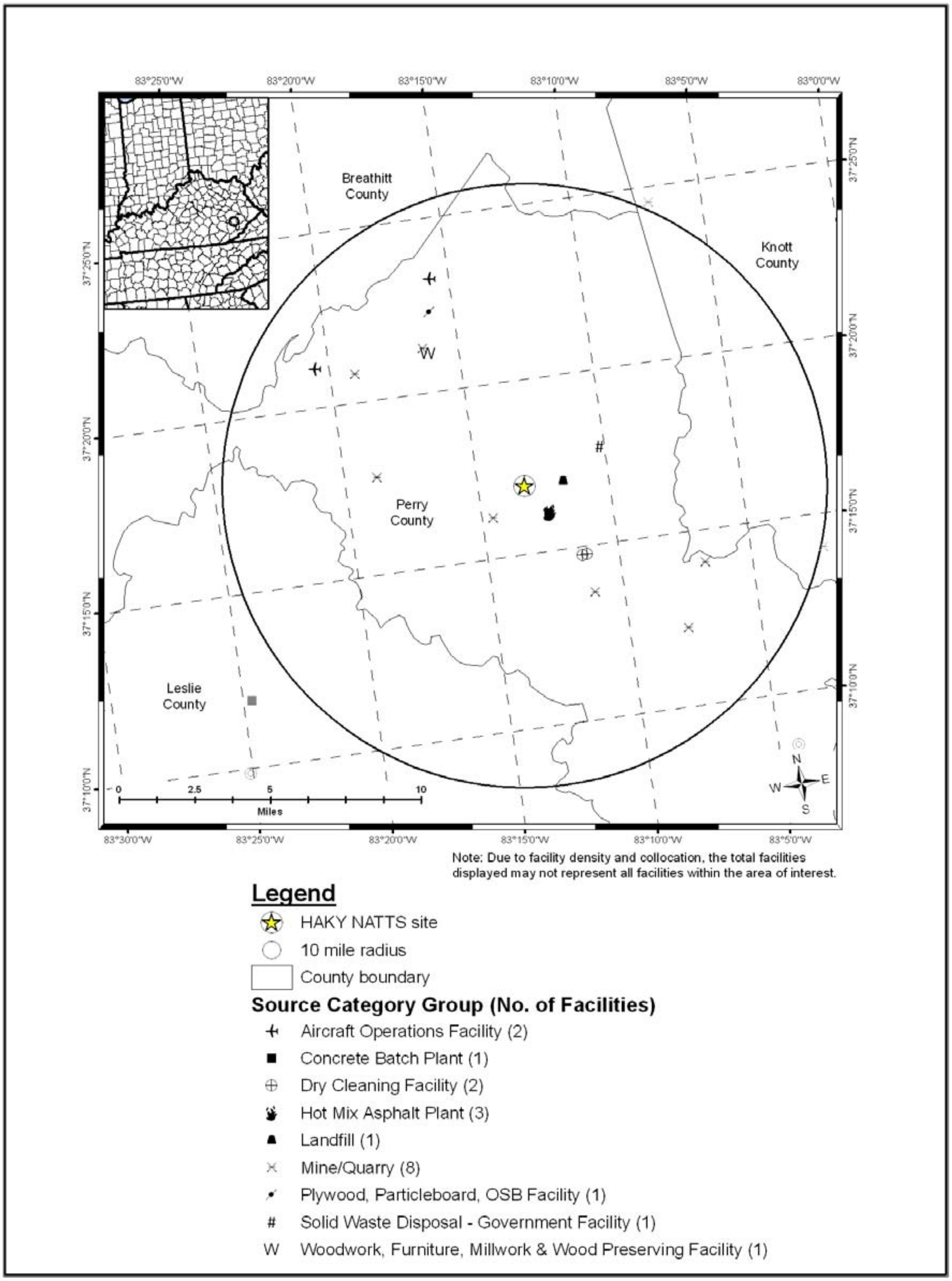
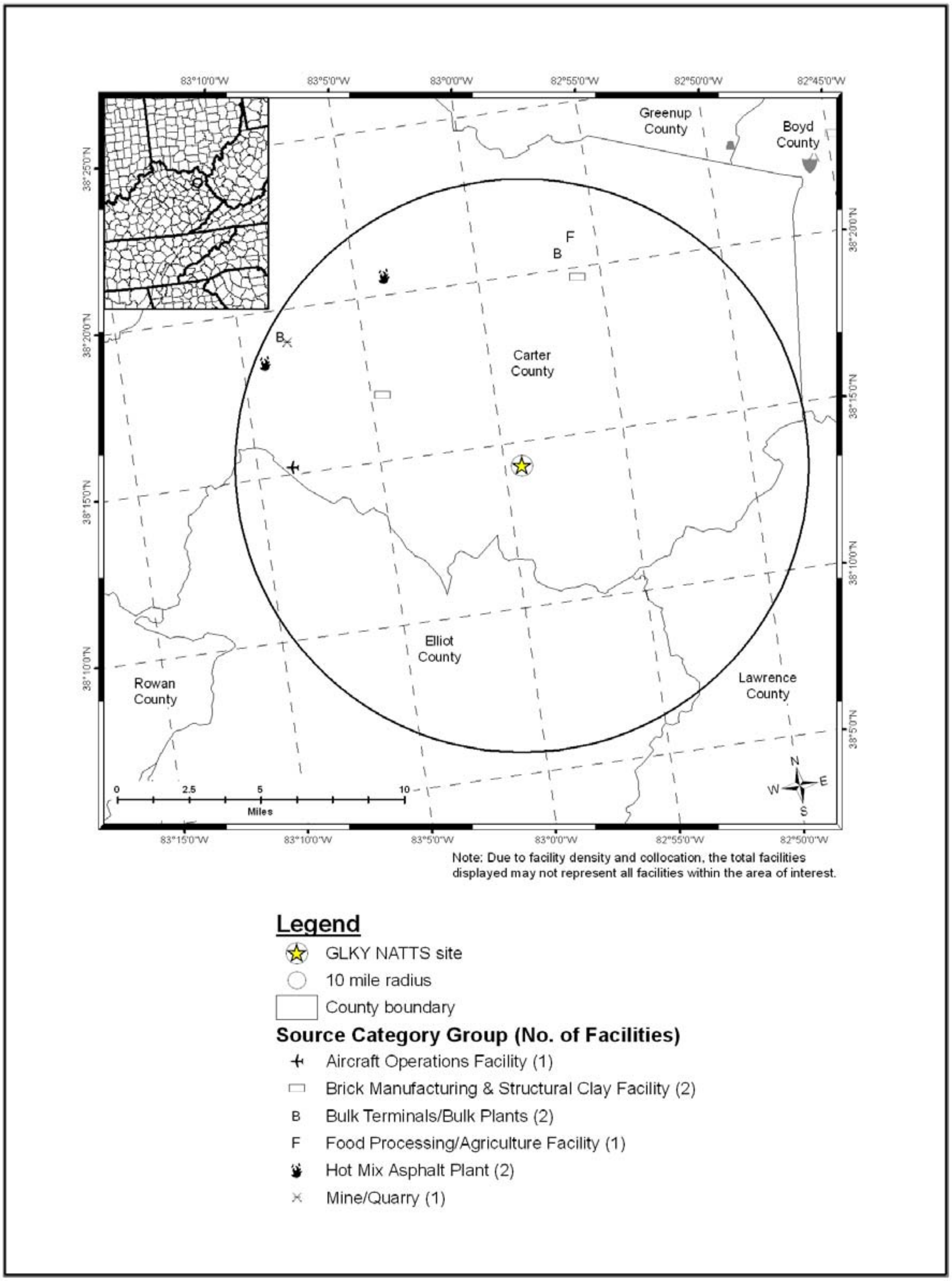

83°25'0"W
83°20'0"W
83°15'0"W
83°10'0"W
83°5'0"W
83°0'0"W
37°25'0"N
37°20'0"N
37°15'0"N
37°10'0"N
83°30'0"W
Breathitt County
Knott County
Perry County
Leslie County
W
#
0
2.5
5
10
Miles
N
E
S
W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
HAKY NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (2)
Concrete Batch Plant (1)
Dry Cleaning Facility (2)
Hot Mix Asphalt Plant (3)
Landfill (1)
Mine/Quarry (8)
Plywood, Particleboard, OSB Facility (1)
Solid Waste Disposal - Government Facility (1)
Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Figure 14-4. NEI Point Sources Located Within 10 Miles of GLKY



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 14-1. Geographical Information for the Kentucky Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
GLKY	21-043-005	Grayson	Carter	Not in an MSA	38.238333, -82-988333	Residential	Rural	VOC, Carbonyl compounds, O_3, Meteorological parameters, Wet Deposition, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation
HAKY	21-193-0003	Hazard	Perry	Not in an MSA	37.283056, -83.220278	Residential	Suburban	VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The HAKY monitoring site is located in southeastern Kentucky, between the towns of Hazard and Bonnyman, just on the outskirts of the Daniel Boone National Forest. The site is located on the property of the Perry County Horse Park and is west of Perry Central High School. The Hal Rogers Parkway and State Highways 15 and 80 merge just to the north of the monitoring site. As Figure 14-3 shows, HAKY is located near a relatively low number of point sources, which are located mainly to the northwest, east, and southeast of the monitoring site. The source categories with the highest number of sources within 10 miles of HAKY are mines/quarries (eight) and hot mix asphalt plants (three).

Grayson Lake is located in northeast Kentucky, south of Grayson, KY, and west of the Huntington-Ashland, WV-KY MSA. The Little Sandy River feeds into Grayson Lake, which is a U.S. Army Corps of Engineers-managed project, and part of the Kentucky State Parks system. The lake is narrow and winding, with sandstone cliffs rising to up to 200 feet above the lake surface (KY, 2011 and ACE, 2011). The closest road to the monitoring site is a service road feeding into Camp Grayson. Figure 14-4 shows that fewer point sources surround GLKY than HAKY and none are located within 5 miles of the monitoring site. The sources within 10 miles of GLKY are located to the west, northwest, and north of the site.

Table 14-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Kentucky monitoring sites. Information provided in Table 14-2 represents the most recent year of sampling (for HAKY, 2008; for GLKY, 2009), unless otherwise indicated. County-level vehicle registration and population data for Perry and Carter Counties were obtained from the Kentucky Transportation Cabinet (KYTC, 2009a) and the U.S. Census Bureau (Census Bureau, 2009 and 2010), respectively. Table 14-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of the sites is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 14-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. VMT was not available for either Kentucky monitoring site due to the rural nature of the surrounding areas.

Table 14-2. Population, Motor Vehicle, and Traffic Information for the Kentucky Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
GLKY	26,771	28,371	1.06	14,815	15,700	428	NA
HAKY	29,241	25,654	0.88	31,861	27,953	21,359	NA

[1] Reference: Census Bureau, 2009 and 2010.
[2] County-level vehicle registration reflects 2008 data from the Kentucky Transportation Cabinet (KYTC, 2009a).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2008 data for HAKY and 2009 data for GLKY from the Kentucky Transportation Cabinet (KYTC, 2008 and 2009b).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
NA = Data unavailable.
BOLD = EPA-designated NATTS Site.

Observations from Table 14-2 include the following:

- The Carter and Perry County populations were among the lowest compared to all counties with NMP sites. GLKY and HAKY's 10-mile populations were also on the low end. The corresponding vehicle ownership data mimicked these rankings. The rather low population and vehicle ownership compared to other NMP sites is not surprising given the rural nature of the surrounding areas.

- The vehicle-per-person ratio was higher for GLKY (1.06) than HAKY (0.88).

- The traffic volume experienced near HAKY was significantly higher than GLKY. Although situated in a rural area, HAKY was also located near the intersection of heavily traveled roadways (the traffic estimate used came from the Daniel Boone Parkway, a major thoroughfare across southeast Kentucky). By contrast, traffic data for GLKY came from the intersection of State Road 1496 with Camp Webb Road, one of several secondary roads leading to Grayson Lake.

14.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Kentucky on sample days, as well as over the course of each year.

14.2.1 Climate Summary

Kentucky experiences a continental climate, where conditions tend to be slightly cooler and drier in the northeast portion of the state and warmer and cooler in the southwest portion. Kentucky's mid-latitude location ensures an active weather pattern, in a convergence zone between cooler air from the north and warm, moist air from the south. The state enjoys all four seasons. Summers are persistently warm and humid; winters are cloudy but not harsh; and spring and fall are pleasant. Precipitation is well distributed throughout the year, although fall tends to be driest and spring wettest (KCC, 2011).

14.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to HAKY is located at Julian Carroll Airport in Jackson, Kentucky (WBAN 03889) and the closest station to GLKY is located at Tri-State/M.J. Ferguson Field Airport (WBAN 03860). Additional information about these weather stations is provided in Table 14-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 14-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for 2008 for HAKY and both 2008 and 2009 for GLKY. Also included in Table 14-3 is the 95 percent confidence interval for each parameter. As shown in Table 14-3, average meteorological conditions on 2008 sample days appear warmer at GLKY and cooler at HAKY compared to average weather conditions throughout 2008. This is because sampling occurred at HAKY from January 2008 through May 2008 and at GLKY from July 2008 through December 2008. Average meteorological conditions on 2009 sample days at GLKY, when the site sampled year-round, were fairly representative of average weather conditions throughout 2009.

Table 14-3. Average Meteorological Conditions near the Kentucky Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Grayson, Kentucky - GLKY										
Tri-St/M.J. Ferguson Field Airport 03860 (38.38, -82.56)	24.28 miles 58° (ENE)	2008	Sample Day	69.1 ± 6.4	58.5 ± 5.7	47.1 ± 5.5	52.5 ± 5.1	69.7 ± 4.5	1017.7 ± 1.7	3.4 ± 0.6
			All Year	65.2 ± 1.9	54.9 ± 1.7	43.0 ± 1.7	48.9 ± 1.6	67.7 ± 1.2	1017.4 ± 0.7	4.4 ± 0.2
		2009	Sample Day	62.7 ± 4.1	53.7 ± 3.9	42.6 ± 4.3	48.4 ± 3.7	69.5 ± 3.3	1016.5 ± 1.9	4.4 ± 0.6
			All Year	63.8 ± 1.8	54.5 ± 1.7	44.3 ± 1.8	49.5 ± 1.6	71.7 ± 1.4	1017.2 ± 0.7	4.2 ± 0.2
Hazard, Kentucky - HAKY										
Julian Carroll Airport 03889 (37.39, -83.31)	21.79 miles 339° (NNW)	2008	Sample Day	59.7 ± 6.2	49.0 ± 5.9	34.5 ± 5.4	42.4 ± 5.0	61.0 ± 5.5	1016.0 ± 3.0	4.4 ± 1.1
			All Year	64.8 ± 1.8	55.5 ± 1.7	42.6 ± 1.7	49.1 ± 1.6	65.3 ± 1.4	1017.6 ± 0.6	2.9 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

14.2.3 Back Trajectory Analysis

Figure 14-5 is the composite back trajectory map for days on which samples were collected at the HAKY monitoring site in 2008, respectively. A cluster analysis could not be conducted for HAKY because there were fewer than 30 sample days for this site. Figure 14-6 and Figure 14-7 are the composite back trajectory maps for days on which samples were collected at GLKY in 2008 and 2009, respectively. Figure 14-8 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 14-5 through 14-8 represents 100 miles.

Figure 14-5. 2008 Composite Back Trajectory Map for HAKY

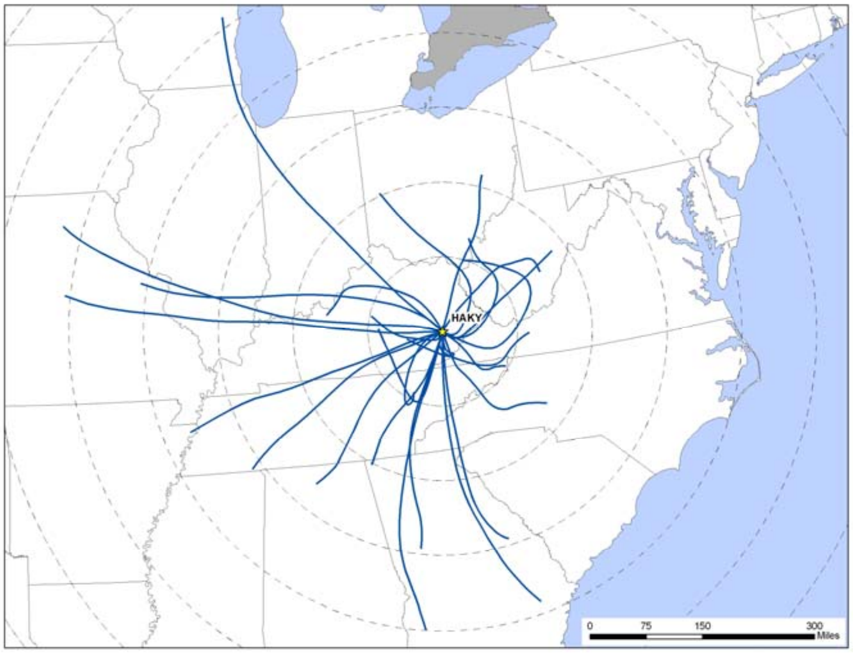


Figure 14-6. 2008 Composite Back Trajectory Map for GLKY

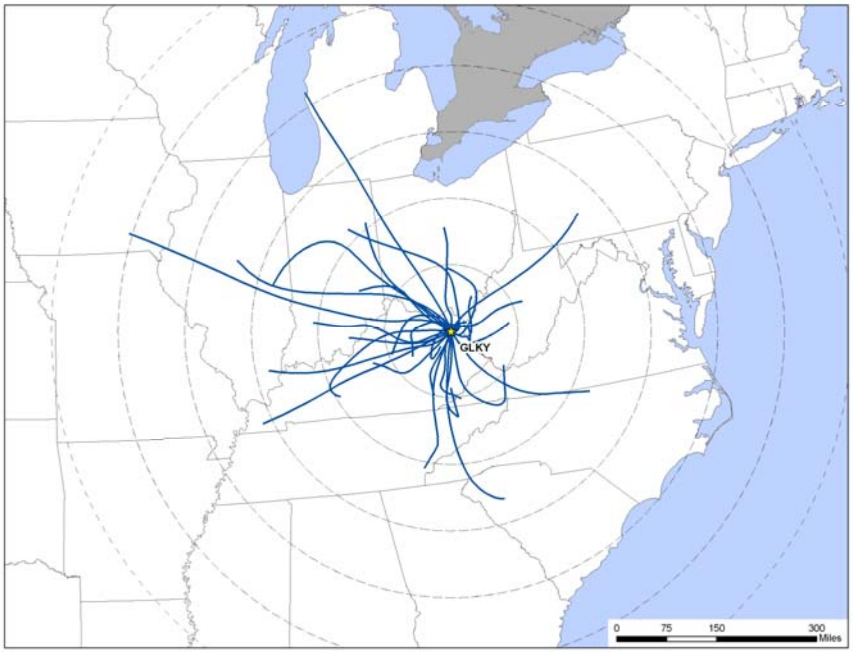


Figure 14-7. 2009 Composite Back Trajectory Map for GLKY

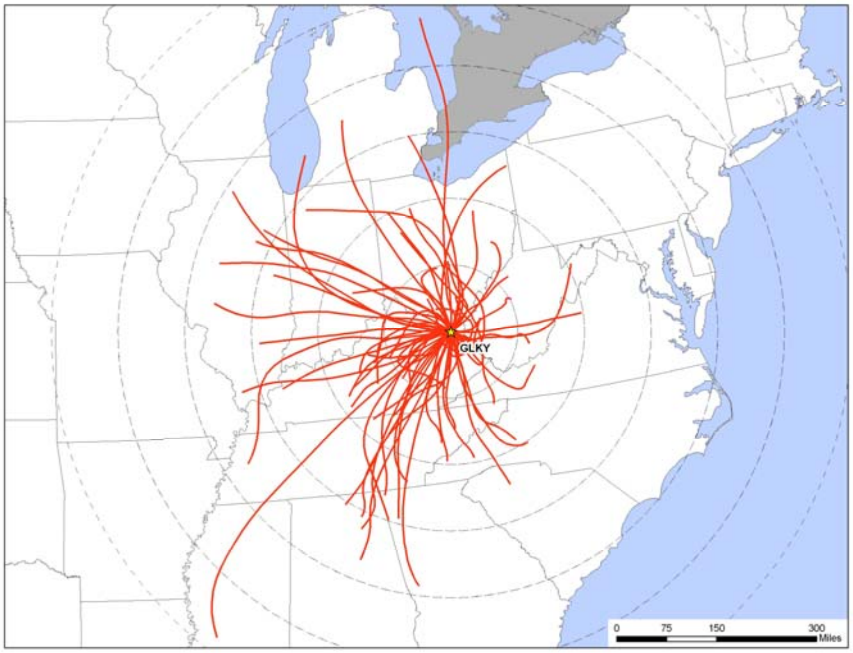
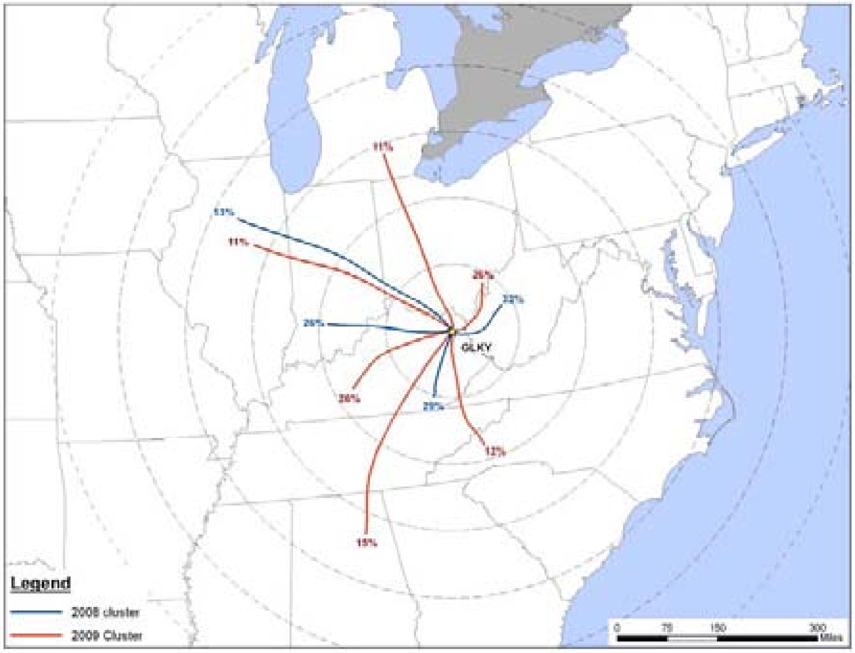


Figure 14-8. Back Trajectory Cluster Map for GLKY



Observations from Figure 14-5 for HAKY include the following:

- Back trajectories originated from a variety of directions at HAKY.
- The farthest away a trajectory originated was north-central Missouri, or greater than 500 miles away. The average trajectory length was 243 miles. Eighty-five percent of trajectories originated within 400 miles of the monitoring site.
- Sampling was conducted for only 5 months of the year at HAKY. Figure 14-5 may have a different trajectory pattern if it included a year's worth of sample days.

Observations from Figures 14-6 through 14-8 for GLKY include the following:

- Back trajectories originated from a variety of directions at GLKY.
- The farthest away a back trajectory originated was south-central Mississippi, or nearly 600 miles away; however, the average trajectory length was 205 miles and 89 percent of trajectories originated within 350 miles of the monitoring site.
- Sampling was conducted for only 6 months of 2008 at GLKY. Figure 14-6 may have a different trajectory pattern if a year's worth of sample days were included. Figure 14-7 for 2009 includes a full year's worth of sample days.

- The cluster analysis for GLKY shows that in 2008 roughly a third of trajectories originated from the northeast and east, 30 percent from the southeast and south, and 40 percent from the west and northwest. In 2009, roughly 25 percent of trajectories originated from the northeast and east (and within 200 miles of the site), 22 percent from the northwest and west, 12 percent from the south, and approximately 40 percent from the southwest and west.

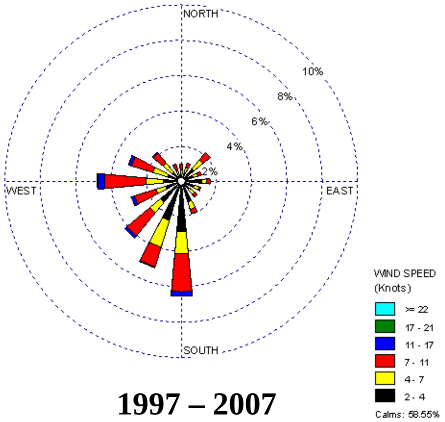
14.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at Julian Carroll Airport near HAKY and the Tri-State/M.J. Ferguson Field Airport near GLKY were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” around a 16-point compass, and uses different colors to represent wind speeds.

Figure 14-9 presents three different wind roses for the HAKY monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year is presented. Finally, a wind rose representing days on which samples were collected in 2008 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

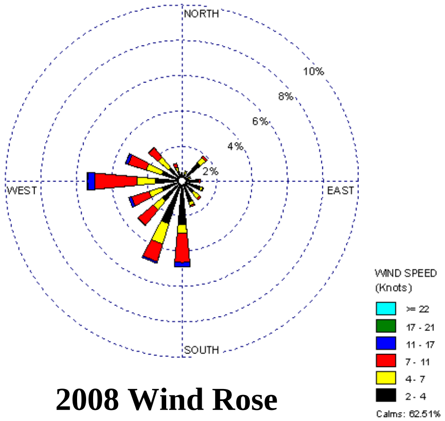
Figure 14-10 presents five different wind roses for the GLKY. First, a historical wind rose representing 1998 to 2007 is presented. Next, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Lastly, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented.

Figure 14-9. Wind Roses for the Julian Carroll Airport Weather Station near HAKY

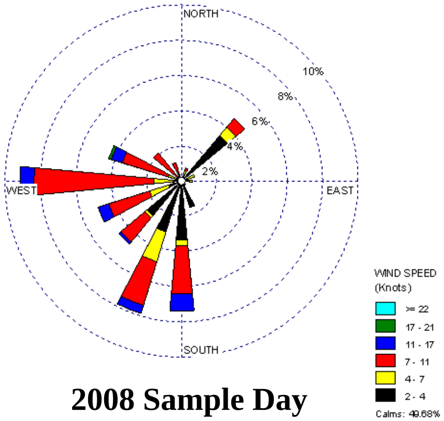


1997 – 2007

Historical Wind Rose



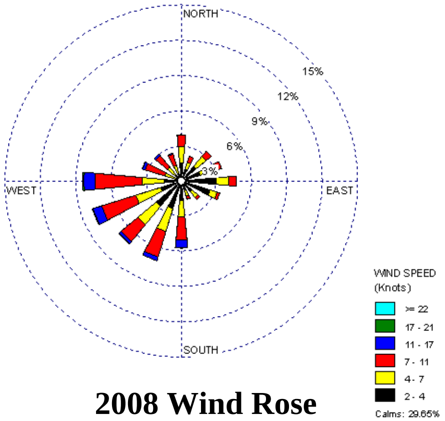
2008 Wind Rose



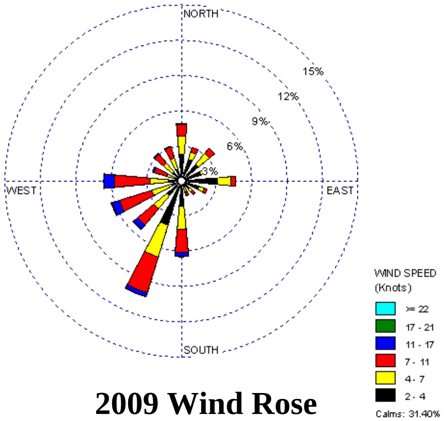
2008 Sample Day

Wind Rose

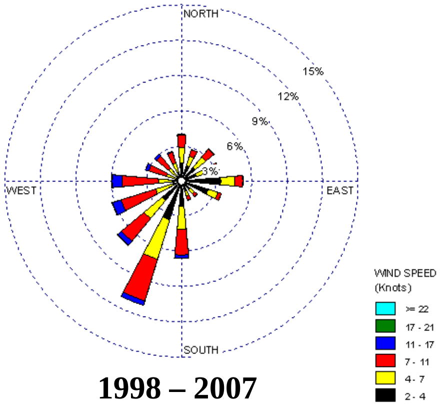
Figure 14-10. Wind Roses for the Tri-State/M.J. Ferguson Field Airport Weather Station near GLKY



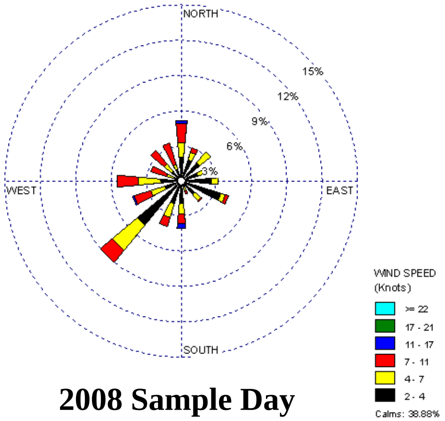
2008 Wind Rose



2009 Wind Rose

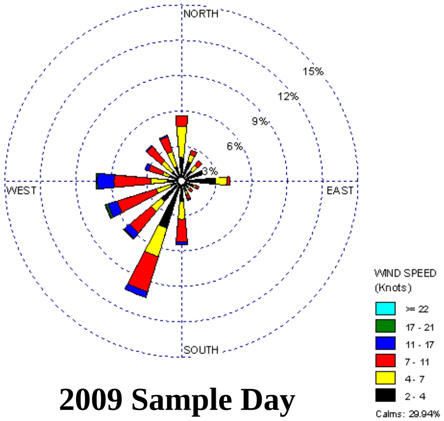


1998 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 14-9 for HAKY include the following:

- The historical wind rose shows that calm winds (≤ 2 knots) were observed nearly 60 percent of the observations from 1997 to 2007. Southerly, southwesterly, and westerly winds were the most commonly observed wind directions near this site.
- The wind patterns shown on the 2008 wind rose are similar to the historical wind patterns, indicating that conditions in 2008 were typical of conditions experienced historically.
- The 2008 sample day wind rose shows a similar wind direction tendency as the 2008 full-year wind rose, but the percentages appear to have doubled. There were also fewer calm observations on sample days (by about 13 percent). It is important to note that sampling concluded at this site in May 2008, and a wind rose incorporating a full year's worth of sample days may exhibit different wind patterns.

Observations from Figure 14-10 for GLKY include the following:

- The historical wind rose shows that calm winds were observed for nearly 28 percent of the hourly measurements near GLKY. Winds from the south to southwest to west make up the majority of observations near GLKY, particularly those from south-southwest.
- The 2008 wind rose is similar to the historical wind rose in that calm winds account for nearly 30 percent of the wind observations, but shows a slightly higher percentage of winds from the west-southwest and west than from the south-southwest and south. The 2008 sample day wind rose exhibits a higher percentage of calms winds and winds from the southwest and a lower percentage of winds from the south, south-southwest, west-southwest, and west. It is important to note that sampling began at this site in July 2008, and that a wind rose incorporating a full year's worth of sample days may exhibit different wind patterns.
- The 2009 sample day wind rose exhibits wind patterns similar to the 2009 full-year wind rose, as well as to the historical wind rose, indicating that conditions on sample days were representative of those typically experienced at this site.

14.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Kentucky monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 14-4 presents GLKY's and HAKY's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. Both sites sampled for hexavalent chromium and PAH.

Table 14-4. Risk Screening Results for the Kentucky Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Grayson, Kentucky - GLKY						
Naphthalene	0.029	15	91	16.48	100.00	100.00
Total		15	91	16.48		
Hazard, Kentucky - HAKY						
Naphthalene	0.029	7	8	87.50	100.00	100.00
Total		7	8	87.50		

Observations from Table 14-4 include the following:

- Naphthalene was the only pollutant to fail screens for either site. Naphthalene failed roughly 17 percent of its screens for GLKY and nearly 88 percent of its screens for HAKY. However, the total number of measured detections is worth noting (91 for GLKY, eight for HAKY). HAKY began sampling PAH in April 2008 and ended sampling in May 2008 when the site was relocated; thus, only eight PAH samples were collected during this time.

- Hexavalent chromium and benzo(a)pyrene were added to each Kentucky site's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. Neither pollutant is shown in Table 14-4.

14.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Kentucky monitoring sites. Concentration averages are provided for the pollutants of interest for each Kentucky site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

14.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Kentucky site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 14-5, where applicable. The averages presented in Table 14-5 are shown in ng/m^3 for ease of viewing.

Table 14-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Grayson, Kentucky - GLKY												
Benzo(a)pyrene	0.10 ± 0.04	NR	NR	NA	0.06 ± 0.04	NA	0.08 ± 0.03	0.08 ± 0.04	0.02 ± 0.01	NA	0.06 ± 0.05	0.04 ± 0.02
Hexavalent Chromium	0.01 ± <0.01	NR	NR	0.01 ± <0.01	NA	NA	0.02 ± <0.01	NA	NA	NA	NA	NA
Naphthalene	21.46 ± 5.29	NR	NR	16.82 ± 4.01	25.53 ± 9.17	NA	21.72 ± 5.56	21.74 ± 7.68	25.02 ± 17.67	14.10 ± 3.43	25.84 ± 9.35	21.72 ± 5.56
Hazard, Kentucky - HAKY												
Benzo(a)pyrene	0.14 ± 0.10	NR	NA	NR	NR	NA	NR	NR	NR	NR	NR	NR
Hexavalent Chromium	0.02 ± 0.01	NA	0.02 ± 0.02	NR	NR	NA	NR	NR	NR	NR	NR	NR
Naphthalene	81.54 ± 41.03	NR	81.54 ± 41.03	NR	NR	NA	NR	NR	NR	NR	NR	NR

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for HAKY from Table 14-5 include the following:

- The daily average concentration of naphthalene was significantly higher than the daily average concentration of hexavalent chromium and benzo(a)pyrene.
- The daily average concentration of naphthalene has a rather large confidence interval, indicating that this average is likely influenced by outliers. The first two concentrations, measured on April 18, 2008 and April 24, 2008 (151 and 171 ng/m^3, respectively), were significantly higher than the other concentrations measured at this site (the other six measurements ranged from 27.6 ng/m^3 to 96.0 ng/m^3).
- Similar to naphthalene, the two benzo(a)pyrene concentrations measured on April 18, 2008 and April 24, 2008 were an order of magnitude higher than the other measured detections of this pollutant. Note that PAH were sampled only from April to May 2008 at this site.
- Hexavalent chromium was sampled from January to May 2008. This pollutant was detected infrequently during the first quarter of 2008 and a quarterly average could not be calculated.

Observations for GLKY from Table 14-5 include the following:

- The daily average concentration of naphthalene was significantly higher than the daily average concentration of hexavalent chromium and benzo(a)pyrene.
- The 2008 daily average concentrations of GLKY's three pollutants of interest were similar to their corresponding 2009 daily average concentrations.
- Hexavalent chromium was not detected frequently enough for more than one quarterly average concentration to be calculated (third quarter 2008).
- Naphthalene's second quarter average for 2009 has a rather large confidence interval, indicating that this average is likely influenced by outliers. A review of the data shows that the highest concentration was measured on June 30, 2009 (160 ng/m^3) and was more than twice the next highest concentration (74.4 ng/m^3).
- The available quarterly averages of naphthalene show that concentrations tended to be lower during the summer months. But there is enough variability in the quarterly averages that the difference is not statistically significant.

14.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in

Section 3.5.3. HAKY was relocated to GLKY in 2008; therefore, the trends analysis was not conducted for either site.

14.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the Kentucky monitoring sites. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

14.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Kentucky monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the three pollutants of interest for either Kentucky monitoring site, where they could be calculated, were higher than their respective MRL noncancer health risk benchmarks.

14.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Kentucky monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages for 2008 (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for the pollutants of interest because moving the physical location of the site from HAKY to GLKY mid-year did not yield enough data for either site. Annual averages for 2009, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations for GLKY are presented in Table 14-6, where applicable.

Table 14-6. Cancer and Noncancer Surrogate Risk Approximations for the Kentucky Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (ng/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (ng/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Grayson, Kentucky - GLKY										
Benzo(a)pyrene	0.001	--	13/1	NA	NA	NA	31/3	0.04 ± 0.02	0.04	--
Hexavalent Chromium	0.012	0.0001	9/1	NA	NA	NA	8/0	NA	NA	NA
Naphthalene	3.4E-05	0.003	30/2	NA	NA	NA	61/4	21.72 ± 5.56	0.74	0.01
Hazard, Kentucky - HAKY										
Benzo(a)pyrene	0.001	--	6/0	NA	NA	NA	NR	NR	NR	NR
Hexavalent Chromium	0.012	0.0001	13/1	NA	NA	NA	NR	NR	NR	NR
Naphthalene	3.4E-05	0.003	8/1	NA	NA	NA	NR	NR	NR	NR

NA = Not available due to the criteria for calculating an annual average.
-- = a Cancer URE or Noncancer RfC is not available.
NR = Not reportable because sampling was not conducted during this time.

Observations for GLKY from Table 14-6 include the following:

- The 2009 cancer risk approximations for naphthalene and benzo(a)pyrene were both less than 1.0 in-a-million (0.74 and 0.04 in-a-million, respectively).
- The noncancer risk approximation for naphthalene is well below an HQ of 1.0 (0.01). A noncancer risk approximation for benzo(a)pyrene could not be calculated because there is not an RfC for this pollutant.
- An annual average, and therefore cancer and noncancer risk approximations, could not be calculated for hexavalent chromium due to the low detection rate.

14.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 14-7 and 14-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 14-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 14-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 14.3, HAKY and GLKY sampled for hexavalent chromium and PAH. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. As mentioned in Section 14.5.2, because annual averages could not be calculated for 2008, cancer and noncancer surrogate risk approximations were also not calculated for that year. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 14-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Grayson, Kentucky (Carter County) - GLKY					
Benzene	38.90	Formaldehyde	3.99E-04	Naphthalene	0.74
Formaldehyde	31.93	Benzene	3.03E-04	Benzo(a)pyrene	0.04
Acetaldehyde	9.49	1,3-Butadiene	1.92E-04		
1,3-Butadiene	6.41	POM, Group 2	7.76E-05		
Naphthalene	2.27	Naphthalene	7.71E-05		
Dichloromethane	2.00	POM, Group 5	2.52E-05		
Tetrachloroethylene	1.60	POM, Group 3	2.29E-05		
POM, Group 2	1.41	Acetaldehyde	2.09E-05		
p-Dichlorobenzene	0.57	Hexavalent Chromium, PM	1.74E-05		
POM, Group 6	0.14	POM, Group 6	1.37E-05		
Hazard, Kentucky (Perry County) - HAKY					
Formaldehyde	117.38	Formaldehyde	1.47E-03		
Benzene	70.17	1,3-Butadiene	5.55E-04		
Acetaldehyde	23.19	Benzene	5.47E-04		
1,3-Butadiene	18.51	POM, Group 2	1.96E-04		
Tetrachloroethylene	3.86	POM, Group 5	7.23E-05		
POM, Group 2	3.56	POM, Group 6	5.22E-05		
Dichloromethane	2.40	Acetaldehyde	5.10E-05		
Naphthalene	1.43	Naphthalene	4.86E-05		
p-Dichlorobenzene	0.62	POM, Group 3	2.52E-05		
POM, Group 6	0.52	Tetrachloroethylene	2.28E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk.

Table 14-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Kentucky 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Grayson, Kentucky (Carter County) - GLKY					
Toluene	99.54	Acrolein	173,978.28	Naphthalene	0.01
Xylenes	63.13	Formaldehyde	3,258.54		
Benzene	38.90	1,3-Butadiene	3,205.64		
Formaldehyde	31.93	Benzene	1,296.68		
Hexane	16.35	Acetaldehyde	1,054.77		
Ethylbenzene	15.25	Cyanide Compounds, gas	933.21		
Methyl *tert*-butyl ether	11.51	Naphthalene	755.62		
Acetaldehyde	9.49	Xylenes	631.28		
Methanol	8.45	Toluene	248.84		
1,3-Butadiene	6.41	Hydrochloric acid	125.92		
Hazard, Kentucky (Perry County) - HAKY					
Formaldehyde	117.38	Acrolein	915,419.16		
Toluene	78.90	Formaldehyde	11,977.10		
Benzene	70.17	1,3-Butadiene	9,253.03		
Xylenes	48.74	Acetaldehyde	2,576.30		
Acetaldehyde	23.19	Benzene	2,339.03		
Methanol	19.07	Methylenediphenyl diisocyanate, gas	1,795.59		
1,3-Butadiene	18.51	Cyanide Compounds, gas	984.82		
Acrolein	18.31	Xylenes	487.41		
Hexane	10.08	Manganese, PM	482.42		
Ethylbenzene	8.95	Naphthalene	476.53		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk.

Observations from Table 14-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in both Carter and Perry Counties (although not necessarily in that order). The emissions of these pollutants in Perry County were at least twice that emitted in Carter County (three times for formaldehyde). The overall emissions for these counties were low compared to other counties with NMP sites.

- Formaldehyde was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for both counties.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Carter County, while eight of the highest emitted pollutants also had the highest toxicity-weighted emissions for Perry County.

- Naphthalene appears on both emissions-based lists for Carter County and has the highest cancer risk approximation for this county.

- For both counties, two POM Groups appear among the highest emitted pollutants, POM Group 2 and POM Group 6. Four POM Groups appear among the pollutants with the highest toxicity-weighted emissions, POM Groups 2, 3, 5, and 6. Benzo(a)pyrene, a pollutant of interest for both monitoring sites, is part of POM Group 5.

Observations from Table 14-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Carter County, while formaldehyde again topped the list of emitted pollutants with noncancer RfCs in Perry County (followed by toluene, benzene, and xylenes).

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) was acrolein for both counties. Acrolein was the eighth highest emitted pollutant in Perry County but did not appear on Carter County's list of highest emitted pollutants.

- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for both counties (although the pollutants were not all the same between the two counties).

- While naphthalene does not appear among the pollutants with the highest emissions (of the pollutants with noncancer RfCs), it ranked seventh on the list of highest toxicity-weighted emissions for Carter County (and tenth for Perry County).

14.6 Summary of the 2008-2009 Monitoring Data for GLKY and HAKY

Results from several of the treatments described in this section include the following:

- *Naphthalene failed screens for both GLKY and HAKY. Benzo(a)pyrene and hexavalent chromium were added to these sites' pollutants of interest because they are NATTS MQO Core Analytes.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

15.0 Site in Massachusetts

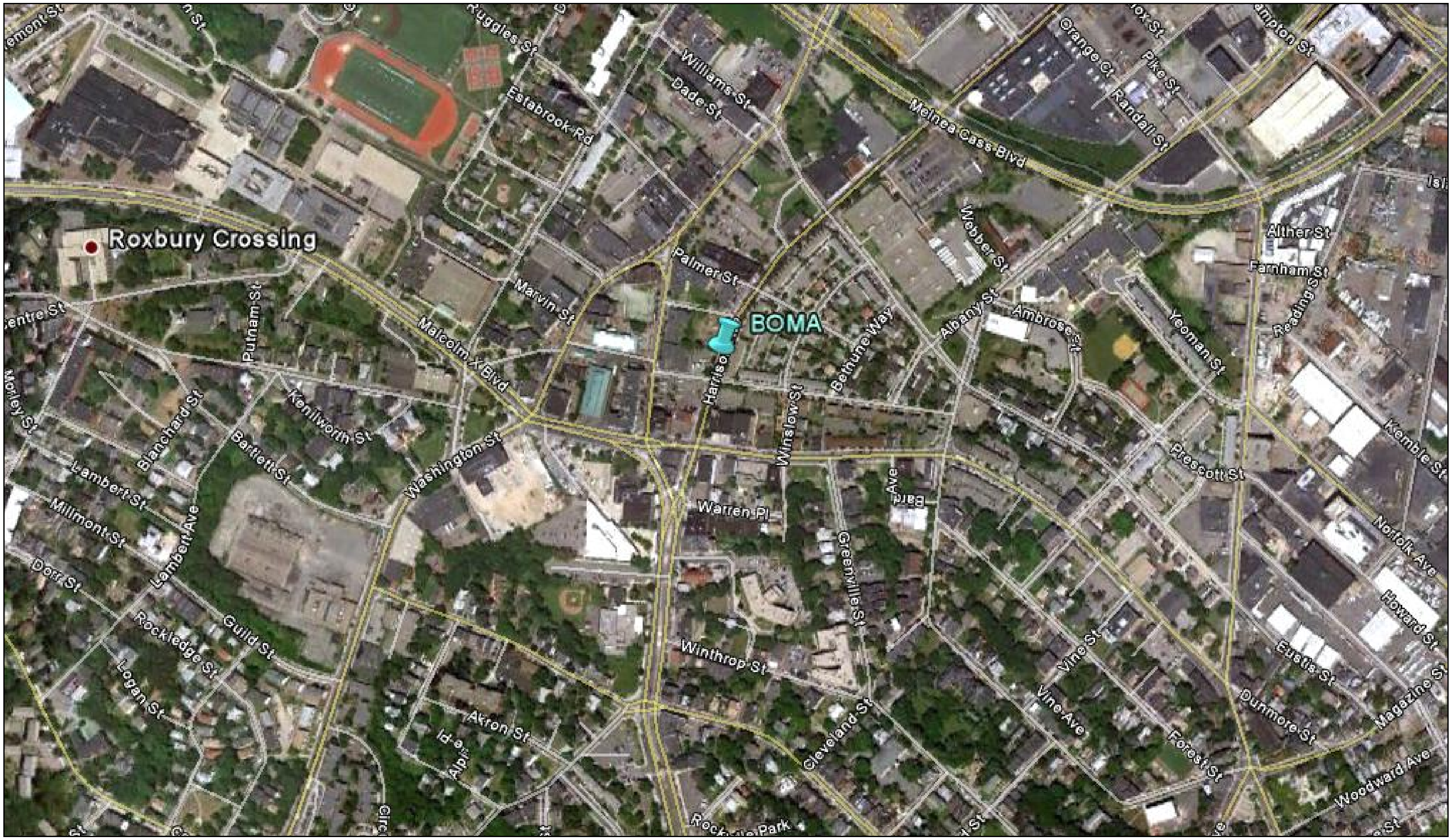
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Massachusetts, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

15.1 Site Characterization

This section characterizes the BOMA monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The BOMA monitoring site is located in Boston, MA. Figure 15-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 15-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 15-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 15-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 15-1. Boston, Massachusetts (BOMA) Monitoring Site



©2010 Google Earth, accessed 11/17/2010

Scale: 2 inches = 1,477 feet

Figure 15-2. NEI Point Sources Located Within 10 Miles of BOMA

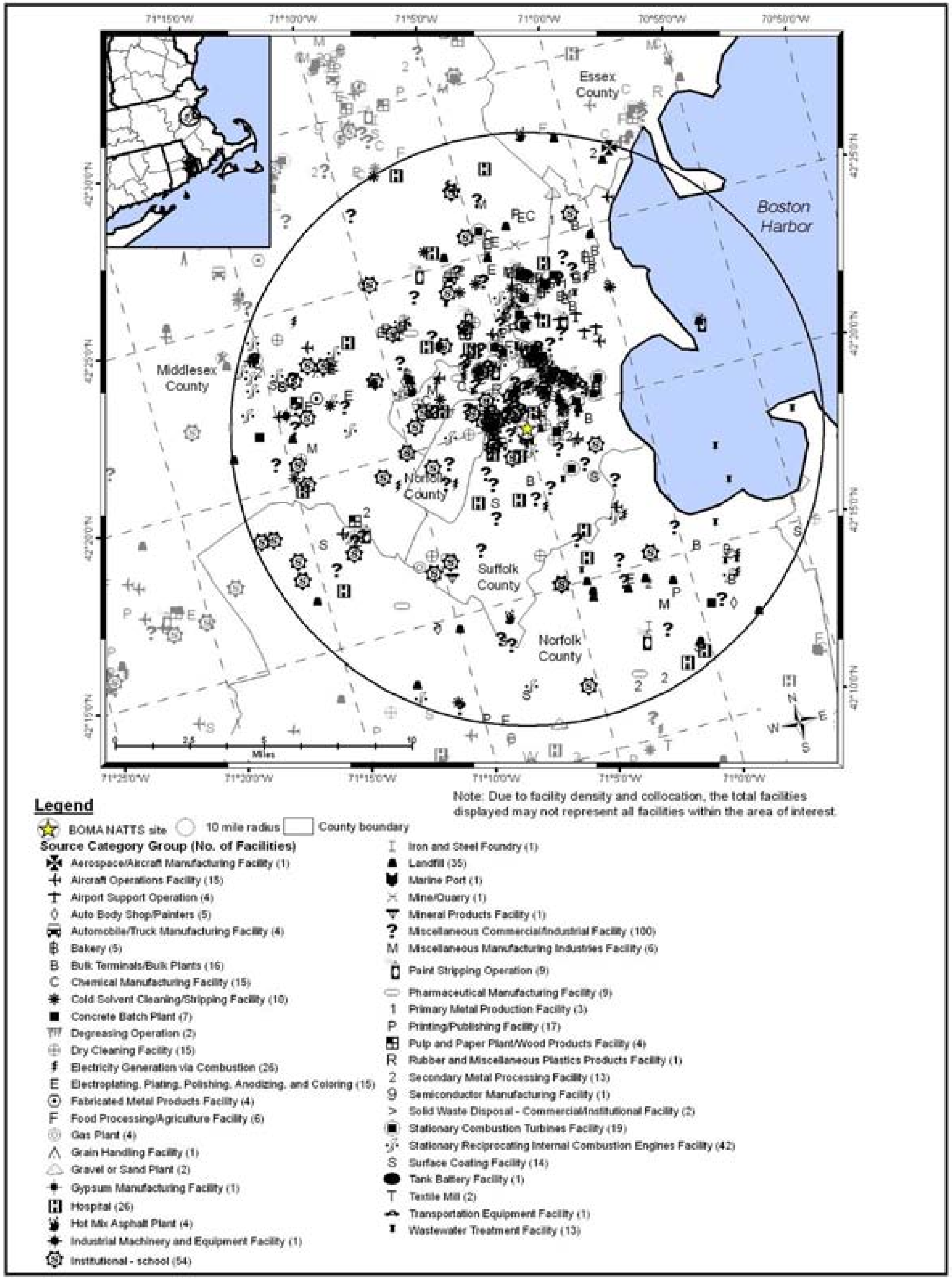

71°15'0"W
71°10'0"W
71°5'0"W
71°0'0"W
70°55'0"W
70°50'0"W
42°30'0"N
42°25'0"N
42°20'0"N
42°15'0"N
42°10'0"N
Essex County
Boston Harbor
Middlesex County
Norfolk County
Suffolk County
Norfolk County
0
2.5
5
10
Miles
N
E
S
W
71°25'0"W
71°20'0"W
71°15'0"W
71°10'0"W
71°5'0"W
71°0'0"W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
BOMA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (1)
Aircraft Operations Facility (15)
Airport Support Operation (4)
Auto Body Shop/Painters (5)
Automobile/Truck Manufacturing Facility (4)
Bakery (5)
Bulk Terminals/Bulk Plants (16)
Chemical Manufacturing Facility (15)
Cold Solvent Cleaning/Stripping Facility (10)
Concrete Batch Plant (7)
Degreasing Operation (2)
Dry Cleaning Facility (15)
Electricity Generation via Combustion (26)
Electroplating, Plating, Polishing, Anodizing, and Coloring (15)
Fabricated Metal Products Facility (4)
Food Processing/Agriculture Facility (6)
Gas Plant (4)
Grain Handling Facility (1)
Gravel or Sand Plant (2)
Gypsum Manufacturing Facility (1)
Hospital (26)
Hot Mix Asphalt Plant (4)
Industrial Machinery and Equipment Facility (1)
Institutional - school (54)
Iron and Steel Foundry (1)
Landfill (35)
Marine Port (1)
Mine/Quarry (1)
Mineral Products Facility (1)
Miscellaneous Commercial/Industrial Facility (100)
Miscellaneous Manufacturing Industries Facility (6)
Paint Stripping Operation (9)
Pharmaceutical Manufacturing Facility (9)
Primary Metal Production Facility (3)
Printing/Publishing Facility (17)
Pulp and Paper Plant/Wood Products Facility (4)
Rubber and Miscellaneous Plastics Products Facility (1)
Secondary Metal Processing Facility (13)
Semiconductor Manufacturing Facility (1)
Solid Waste Disposal - Commercial/Institutional Facility (2)
Stationary Combustion Turbines Facility (19)
Stationary Reciprocating Internal Combustion Engines Facility (42)
Surface Coating Facility (14)
Tank Battery Facility (1)
Textile Mill (2)
Transportation Equipment Facility (1)
Wastewater Treatment Facility (13)

Table 15-1. Geographical Information for the Massachusetts Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
BOMA	25-025-0042	Boston	Suffolk	Boston-Cambridge-Quincy, MA-NH	42.32944, -71.0825	Commercial	Urban/City Center	Lead (TSP), CO, VOC, SO_2, NO, NO_2, NOx, PAMS/NMOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, Black carbon, $PM_{2.5}$, $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The BOMA monitoring is located at Dudley Square in Roxbury, a southwest neighborhood of Boston. The surrounding area is commercial as well as residential, as shown in Figure 15-1. The monitoring site is approximately 1.25 miles south of I-90 and 1 mile west of I-93. The original purpose for the location of this site was to measure population exposure to a city bus terminal located across the street from the monitoring site. In recent years, the buses servicing the area were converted to compressed natural gas (CNG). As Figure 15-2 shows, BOMA is located near a large number of point sources, with a high density of sources located within a few miles to the northwest, north, and northeast of the site. The source categories with the highest number of emissions sources surrounding BOMA include institutional facilities (schools), facilities using stationary reciprocating internal combustion engines, landfills, hospitals, and electricity generating units (via combustion).

Table 15-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Massachusetts monitoring site. Information provided in Table 15-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Suffolk County were obtained from the Massachusetts Registry of Motor Vehicles (MA RMV, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 15-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 15-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 15-2 presents the daily VMT for the Boston urban area.

Table 15-2. Population, Motor Vehicle, and Traffic Information for the Massachusetts Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
BOMA	753,580	489,937	0.65	1,585,962	1,031,107	31,400	92,756

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2008 data from the Massachusetts RMV (MA RMV, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2007 data from the Massachusetts DOT (MA DOT, 2007).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 15-2 include the following:

- The Suffolk County population was in the middle of the range compared to other counties with NMP sites, while BOMA's 10-mile population was among the higher 10-mile populations.

- Similar to the populations, the Suffolk County vehicle registration was in the middle of the range compared to other counties with NMP sites, while its 10-mile estimated ownership was among the higher estimates.

- The vehicle-per-person ratio was among the lowest ratios compared to other NMP sites.

- The traffic volume experienced near BOMA ranked in the middle of the range compared to other NMP sites. The traffic estimate used came from Melnea Cass Boulevard between Washington Street and Harrison Avenue.

- VMT for the Boston area ranked tenth among urban areas with NMP sites.

15.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Massachusetts on sample days, as well as over the course of each year.

15.2.1 Climate Summary

Boston's New England location ensures that the city experiences a fairly active weather pattern. Storm systems frequently track across the region, bringing ample precipitation to the area. The proximity to the Atlantic Ocean helps moderate temperatures, 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. Coastal storm systems called “Nor’easters,” strong low pressure systems affecting the Mid-Atlantic and New England states that produce heavy rain or snow and winds up to hurricane strength, often produce the heaviest snowfalls for the area (Bair, 1992 and NOAA, 2011a).

15.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to BOMA is located at Logan International Airport (WBAN 14739). Additional information about the Logan Airport weather station is provided in Table 15-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 15-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 15-3 is the 95 percent confidence interval for each parameter. As shown in Table 15-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout both years.

15.2.3 Back Trajectory Analysis

Figure 15-3 and Figure 15-4 are the composite back trajectory maps for days on which samples were collected at the BOMA monitoring site in 2008 and 2009, respectively. Figure 15-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 15-3 through 15-5 represents 100 miles.

Table 15-3. Average Meteorological Conditions near the Massachusetts Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Boston, Massachusetts - BOMA										
Logan International Airport 14739 (42.36, -71.01)	4.07 miles 42° (NE)	2008	Sample Day	57.9 ± 4.1	51.4 ± 4.0	39.3 ± 4.4	46.0 ± 3.7	66.1 ± 4.1	1016.3 ± 2.1	8.6 ± 0.8
			All Year	58.8 ± 1.8	51.9 ± 1.7	39.2 ± 1.8	46.2 ± 1.6	64.7 ± 1.6	1015.9 ± 0.8	9.0 ± 0.3
		2009	Sample Day	59.1 ± 4.1	52.0 ± 3.9	41.3 ± 4.3	47.1 ± 3.7	69.7 ± 3.7	1013.0 ± 2.2	9.8 ± 0.8
			All Year	57.4 ± 1.8	50.7 ± 1.7	39.0 ± 1.9	45.5 ± 1.6	66.9 ± 1.6	1015.8 ± 0.8	9.3 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Figure 15-3. 2008 Composite Back Trajectory Map for BOMA

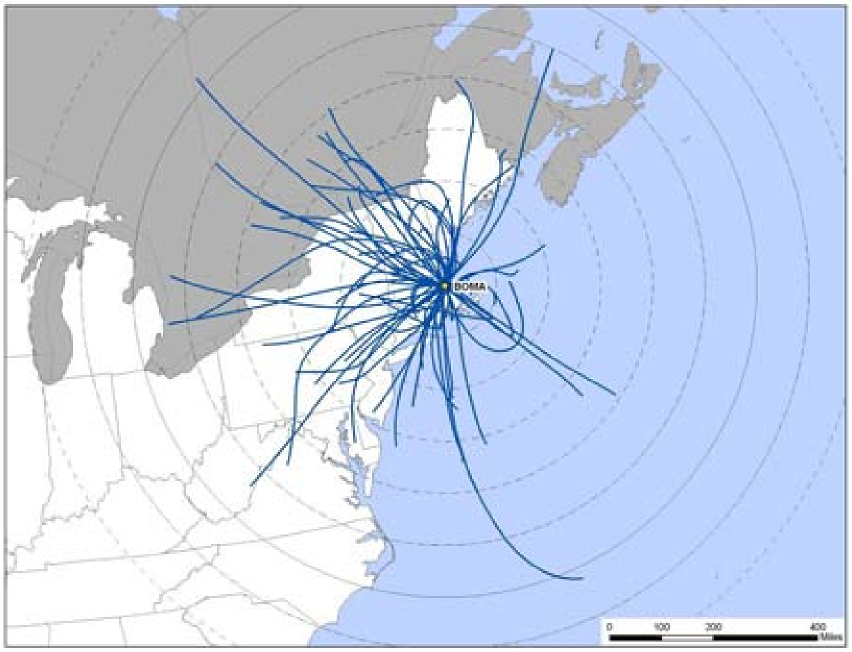


Figure 15-4. 2009 Composite Back Trajectory Map for BOMA

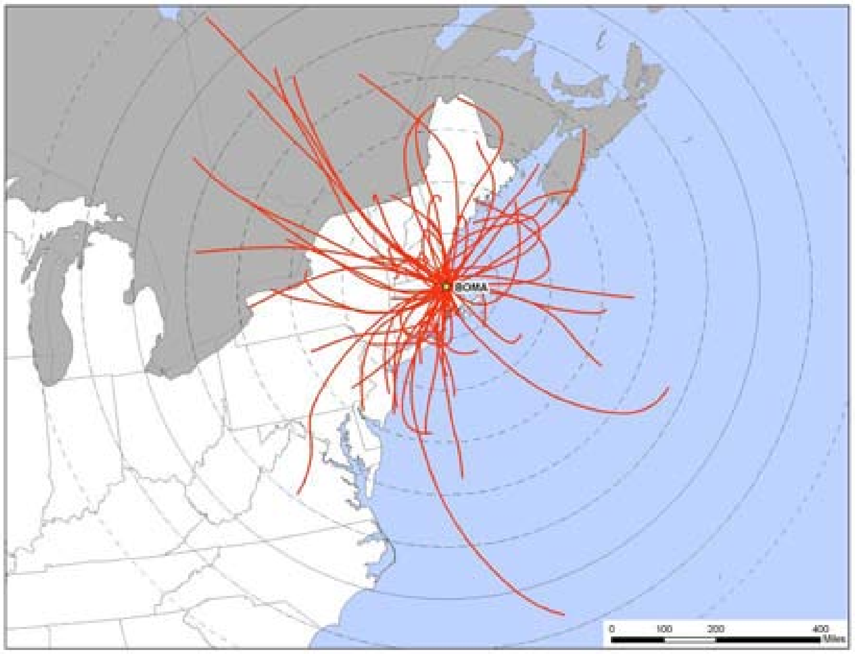
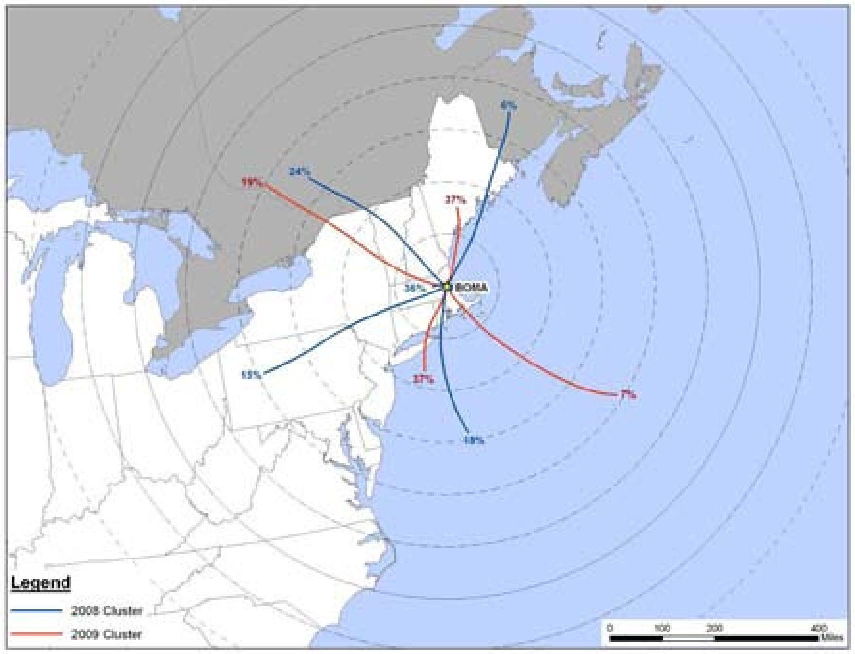


Figure 15-5. Back Trajectory Cluster Map for BOMA



Observations from Figures 15-3 through 15-5 include the following:

- The 2008 and 2009 composite back trajectory maps are similar to each other in that back trajectories originated from a variety of directions at BOMA.

- The 24-hour air shed domain for BOMA was comparable in size to other NMP monitoring sites. The farthest away a trajectory originated was nearly 700 miles, over northwest Quebec, Canada. However, the average trajectory length was 263 miles. Most trajectories (84 percent) originated within 400 miles of the monitoring site.

- The 2008 cluster analysis shows that 36 percent of trajectories originated within approximately 200 miles of BOMA. The short cluster that actually loops around BOMA represents several trajectories originating from a variety of directions but within 200 or so miles of the site. It is important to recall that the HYSPLIT model includes both distance and direction when determining clusters. Another 24 percent of trajectories originated to the north-northwest, 18 percent to the southeast to southwest, and 15 percent to the west. Only four trajectories, or 6 percent, originated to the northeast.

- The 2009 cluster analysis shows that 37 percent of trajectories originated from the north-northwest to north-northeast and another 37 percent originated from the southeast to southwest. Both of these percentages include shorter trajectories originating within 200-300 miles of the site that had either a northerly or southerly component, respectively. Another 24 percent of trajectories originated from the west to northwest to north and were generally 300 or more miles long. Trajectories originating to the east to southeast and offshore accounted for another seven percent of trajectories.

15.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at Logan International Airport near BOMA were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 15-6 presents five different wind roses for the BOMA monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

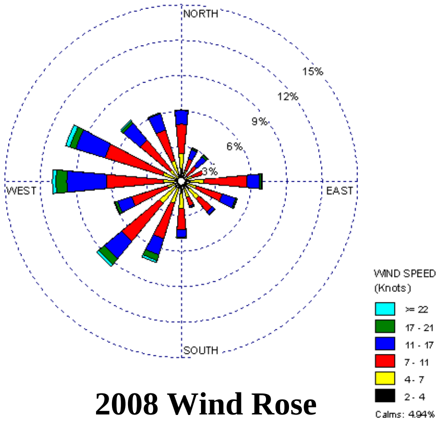
Observations from Figure 15-6 for BOMA include the following:

- The historical wind rose shows that calm winds (≤ 2 knots) account for less than four percent of the wind observations. Winds with a westerly component (south-southwesterly to north-northwesterly) make up the bulk (nearly 60 percent) of winds greater than 2 knots.

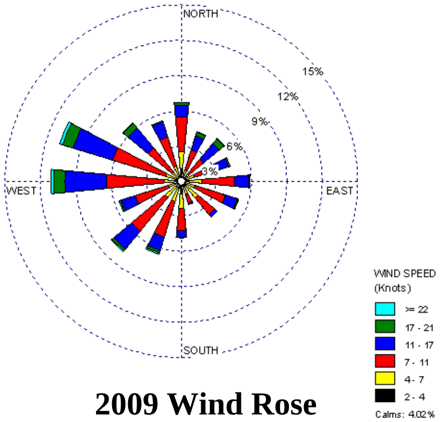
- The wind patterns shown on the 2008 and 2009 wind roses resemble the historical wind patterns, indicating that wind conditions during 2008 and 2009 were typical of conditions normally experienced.

- The sample day wind patterns for each year also resemble the historical wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

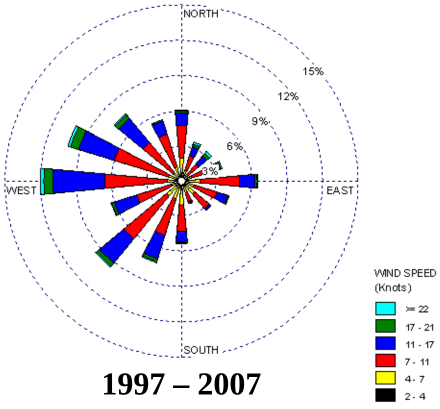
Figure 15-6. Wind Roses for the Logan International Airport Weather Station near BOMA



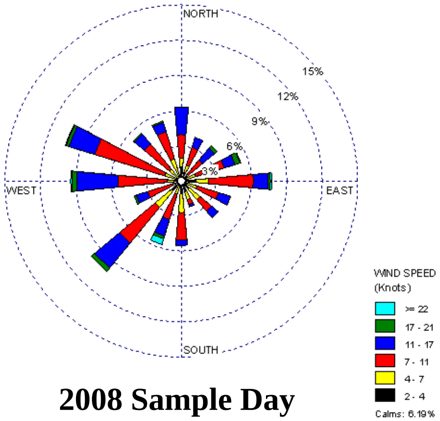
2008 Wind Rose



2009 Wind Rose

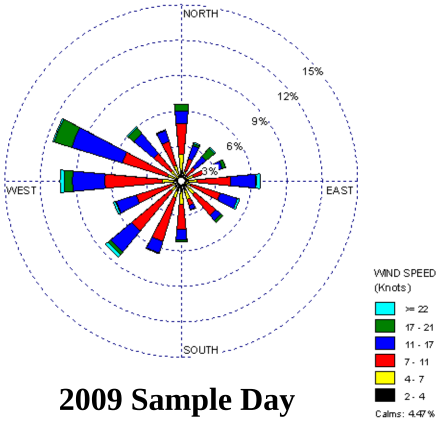


1997 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

15.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Massachusetts monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 15-4 presents BOMA’s pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. BOMA sampled for metals (PM_{10}), PAH, and hexavalent chromium.

Table 15-4. Risk Screening Results for the Massachusetts Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Boston, Massachusetts - BOMA						
Arsenic (PM_{10})	0.00023	104	121	85.95	44.83	44.83
Naphthalene	0.029	91	97	93.81	39.22	84.05
Manganese (PM_{10})	0.005	17	121	14.05	7.33	91.38
Hexavalent Chromium	0.000083	15	78	19.23	6.47	97.84
Cadmium (PM_{10})	0.00056	3	121	2.48	1.29	99.14
Benzo(a)pyrene	0.00091	1	90	1.11	0.43	99.57
Lead (PM_{10})	0.015	1	121	0.83	0.43	100.00
Total		232	749	30.97		

Observations from Table 15-4 include the following:

- Seven pollutants failed at least one screen for BOMA; all seven are NATTS MQO Core Analytes.

- Approximately one-third of the measured detections (of the pollutants that failed at least one screen) failed screens for BOMA.

- Four of the seven pollutants failing screens were initially identified as pollutants of interest for BOMA based on the risk screening process. Cadmium, benzo(a)pyrene, and lead were added to BOMA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the failed screens. Beryllium and nickel were also added to BOMA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are not shown in Table 15-4.

15.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Massachusetts monitoring site. Concentration averages are provided for the pollutants of interest for BOMA, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

15.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for BOMA, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 15-5, where applicable. The concentration averages in Table 15-5 are presented in ng/m^3 for ease of viewing.

Table 15-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Massachusetts Monitoring Site

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Boston, Massachusetts - BOMA												
Arsenic (PM$_{10}$)	0.61 ± 0.18	0.48 ± 0.22	0.46 ± 0.13	1.02 ± 0.74	0.52 ± 0.13	0.61 ± 0.18	0.48 ± 0.08	0.50 ± 0.18	0.54 ± 0.17	0.47 ± 0.13	0.42 ± 0.18	0.48 ± 0.08
Benzo(a)pyrene	0.15 ± 0.03	NR	0.14 ± 0.05	0.11 ± 0.05	0.14 ± 0.07	0.13 ± 0.03	0.14 ± 0.04	0.23 ± 0.06	0.17 ± 0.13	0.05 ± 0.01	0.09 ± 0.03	0.14 ± 0.04
Beryllium (PM$_{10}$)	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Cadmium (PM$_{10}$)	0.22 ± 0.02	0.21 ± 0.04	0.18 ± 0.02	0.26 ± 0.07	0.25 ± 0.05	0.22 ± 0.02	0.25 ± 0.03	0.29 ± 0.06	0.26 ± 0.06	0.21 ± 0.06	0.24 ± 0.05	0.25 ± 0.03
Hexavalent Chromium	0.06 ± 0.03	0.04 ± 0.04	0.03 ± 0.02	0.09 ± 0.07	NA	0.04 ± 0.02	0.06 ± 0.03	NA	0.05 ± 0.05	0.04 ± 0.03	0.02 ± 0.02	0.03 ± 0.02
Lead (PM$_{10}$)	4.44 ± 1.04	3.53 ± 0.76	6.16 ± 3.69	5.02 ± 1.82	3.14 ± 0.80	4.44 ± 1.04	2.95 ± 0.36	3.58 ± 0.74	2.89 ± 0.52	2.79 ± 0.66	2.57 ± 0.94	2.95 ± 0.36
Manganese (PM$_{10}$)	3.57 ± 0.49	3.25 ± 0.78	4.44 ± 1.60	3.42 ± 0.67	3.18 ± 0.68	3.57 ± 0.49	3.17 ± 0.37	3.56 ± 0.94	3.36 ± 0.51	3.28 ± 0.69	2.50 ± 0.83	3.17 ± 0.37
Naphthalene	88.68 ± 14.97	NR	86.41 ± 49.67	88.39 ± 19.04	90.33 ± 22.17	88.68 ± 14.97	70.33 ± 10.85	66.42 ± 30.65	59.46 ± 12.93	83.36 ± 24.24	73.41 ± 21.62	70.33 ± 10.85
Nickel (PM$_{10}$)	1.77 ± 0.24	1.92 ± 0.42	1.67 ± 0.54	1.99 ± 0.68	1.52 ± 0.38	1.77 ± 0.24	1.42 ± 0.17	1.94 ± 0.38	1.27 ± 0.27	1.23 ± 0.29	1.24 ± 0.32	1.42 ± 0.17

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for BOMA from Table 15-5 include the following:

- Naphthalene was the pollutant with the highest daily average concentrations by mass for both years (88.68 ± 14.97 ng/m^3 for 2008 and 70.33 ± 10.85 ng/m^3 for 2009). The daily average concentrations for the remaining pollutants of interest were at least an order of magnitude lower.

- Because sampling for PAH did not begin until May 2008, first quarter 2008 averages could not be calculated for these pollutants. Additionally, there are two quarters for which hexavalent chromium averages could not be calculated due to the low number of measured detections.

- The second quarter 2008 lead average concentration has a large confidence interval, indicating that this average concentration was likely influenced by outliers. The highest concentration of lead was measured at BOMA on April 24, 2008 (29.9 ng/m^3). This is more than twice the next highest measurement (14.8 ng/m^3 measured on July 5, 2008). The difference between the 2008 daily and annual averages and the 2009 daily and annual averages is statistically significant; the 2008 averages are higher than the 2009 averages. The seven highest lead concentrations were all measured in 2008.

- The second quarter 2008 manganese average concentration also has a relatively large confidence interval. The highest concentration of manganese was also measured on April 24, 2008 (11.3 ng/m^3). The next three highest measurements were also measured during the second quarter of 2008 (ranging from 6.98 to 8.89 ng/m^3).

- The highest quarterly average of arsenic was calculated for the third quarter of 2008. Further, this average concentration has a large confidence interval, indicating that this average concentration was likely influenced by outliers. A review of the data shows that the arsenic concentration measured on July 5, 2008 (5.45 ng/m^3) was nearly three times the next highest concentration (1.95 ng/m^3 measured on January 7, 2008). Further, this concentration was the fifth highest arsenic (PM_{10}) concentration measured among all NMP sites sampling PM_{10} metals. Of the 121 measurements of arsenic from BOMA, only 10 were greater than 1 ng/m^3.

- The hexavalent chromium averages for third quarter of 2008 and the second quarter of 2009 have relatively large confidence intervals as well as concentrations that are higher than the other quarters. A review of the data shows that the two highest concentrations of hexavalent chromium were measured during these two quarters (0.525 ng/m^3 on September 27, 2008 and 0.352 ng/m^3 on June 18, 2009). These two concentrations are the third and ninth highest hexavalent chromium concentrations measured among all NMP sites sampling this pollutant.

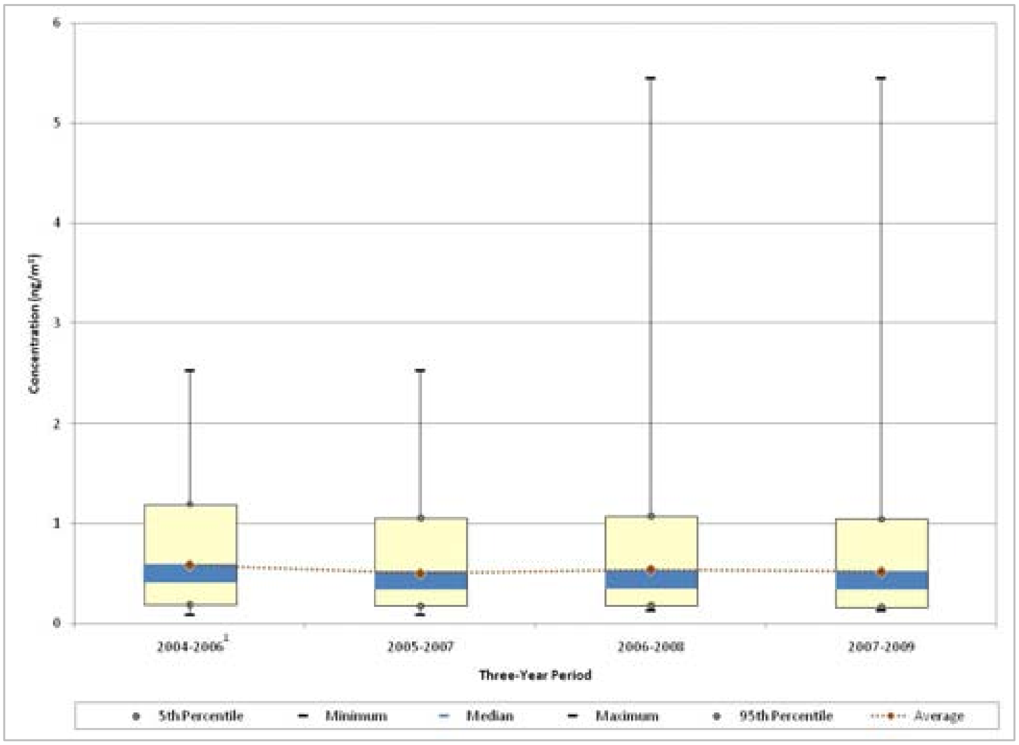
Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for BOMA from those tables include the following:

- BOMA's 2008 and 2009 daily average concentrations of hexavalent chromium ranked third and fourth highest, respectively, second only to PXSS (both years).
- BOMA's 2008 daily average concentration of lead ranked third highest among other sites sampling PM_{10} metals. The 2009 daily average concentration of lead ranked much lower at 17th.
- BOMA's daily average concentrations of cadmium ranked third (2009) and fifth (2008) highest, compared to other sites sampling PM_{10} metals.
- BOMA's daily average concentrations of nickel ranked fourth (2008) and eight (2009) highest, compared to other sites sampling PM_{10} metals.

15.4.2 Concentration Trends

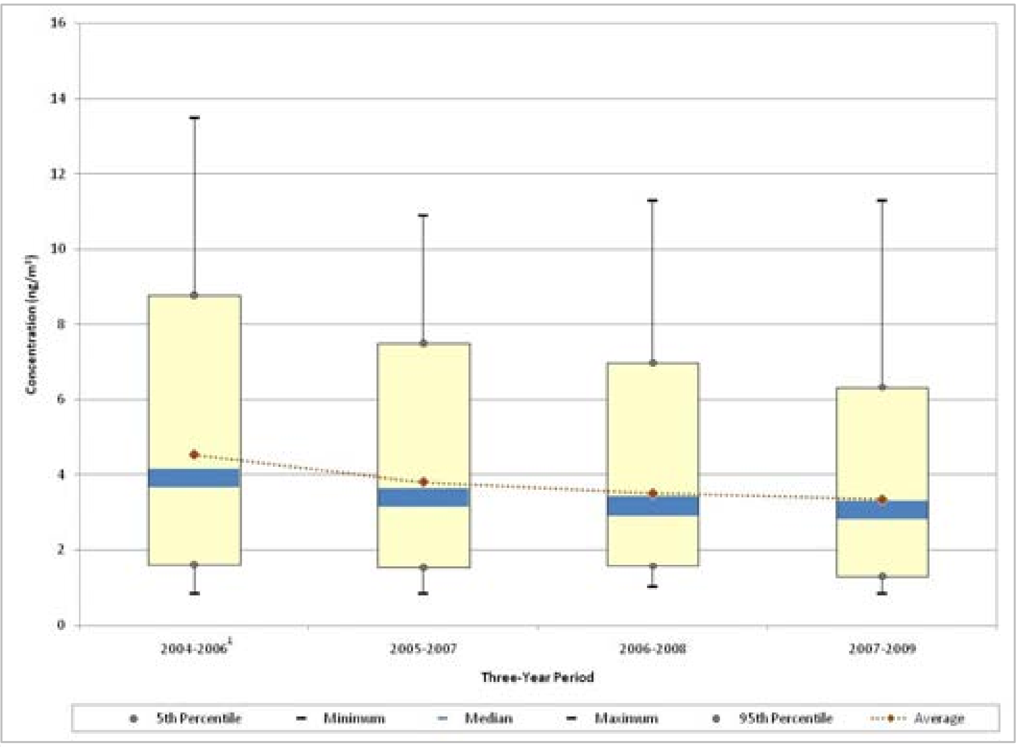
A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. BOMA has been sampling metals since 2003 and hexavalent chromium since 2005. Thus, Figures 15-7 through 15-9 present the 3-year rolling statistical metrics for arsenic, manganese, and hexavalent chromium for BOMA, respectively. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

Figure 15-7. Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BOMA



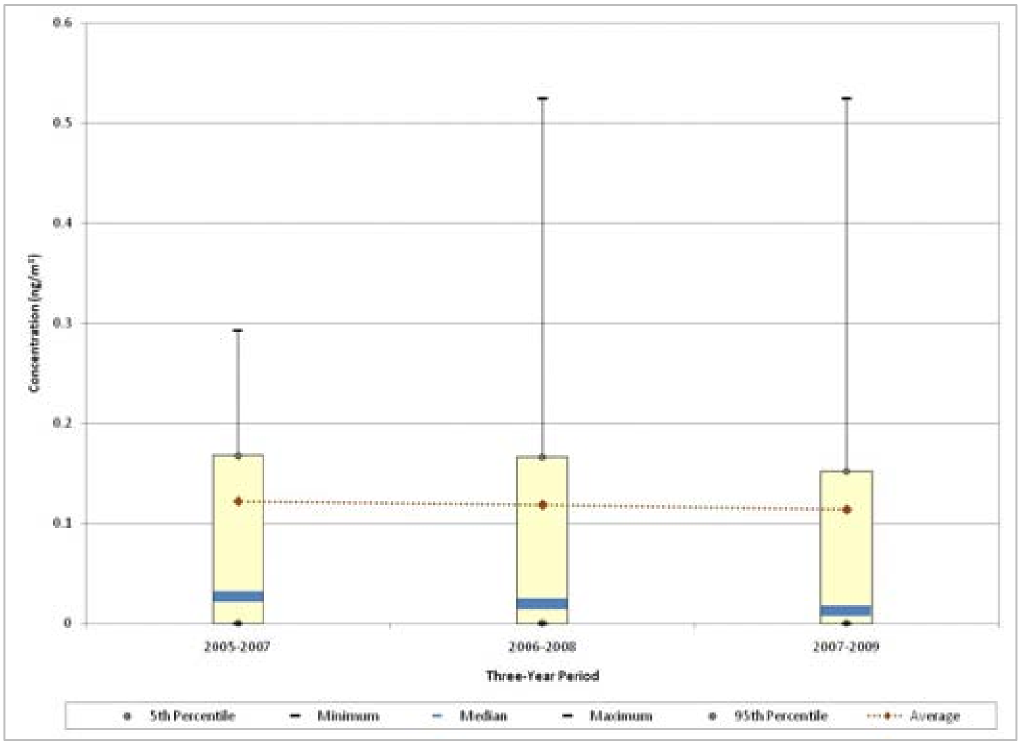
[1] Samples were not collected between April 3 and May 21 and September 24 through November 6 in 2004.

Figure 15-8. Three-Year Rolling Statistical Metrics for Manganese (PM_{10}) Concentrations Measured at BOMA



[1] Samples were not collected between April 3 and May 21 and September 24 through November 6 in 2004.

Figure 15-9. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at BOMA



Observations from Figure 15-7 for arsenic measurements at BOMA include the following:

- The maximum arsenic concentration shown was measured on July 5, 2008 and was discussed in the previous section. The next highest concentration measured was approximately half as high and was measured in 2006 (and is shown as the maximum concentration for the first two 3-year periods).

- The average rolling concentrations show very little change over the years of sampling, which is also true of most for the other statistical parameters.

- While metals sampling began in 2003, data from that year were excluded from this analysis because sampling did not begin until October. In addition, some samples were not collected in parts of April, May, September and October 2004, which is denoted in Figure 15-7.

Observations from Figure 15-8 for manganese measurements at BOMA include the following:

- The maximum manganese concentration was measured in 2004. Of the five measurements greater than 10 ng/m^3, two were measured in 2004, two in 2005, and one in 2008.
- The rolling average and median concentrations exhibit a steady decreasing trend over the years of sampling. Other statistical measures, such as the median and 95th percentile, also show a downward trend.
- While sampling of metals began in 2003, data from that year were excluded from this analysis because sampling did not begin until October. In addition, some samples were not collected in parts of April, May, September and October 2004, which is denoted in Figure 15-8.

Observations from Figure 15-9 for hexavalent chromium measurements at BOMA include the following:

- The maximum hexavalent chromium concentration was measured in 2008 (0.525 ng/m^3). Less than 10 percent of measurements were greater than 0.1 ng/m^3.
- While the average concentration has been decreasing slightly since the onset of sampling, that decrease is not statistically significant. The medians and 95th percentiles also show slight decreases.
- The minimum and 5th percentile are both zero across the period of sampling, indicating the presence of non-detects. The percentage of non-detects has been increasing since 2007, with a minimum of 11 percent in 2006 to a maximum of 43 percent in 2009.

15.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the BOMA monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

15.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Massachusetts monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the BOMA site were higher than their respective MRL noncancer health risk benchmarks.

15.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Massachusetts monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 15-6, where applicable.

Observations for BOMA from Table 15-6 include the following:

- Naphthalene had the highest annual average concentration for both years. Lead, manganese, and nickel also had annual average concentrations greater than 1.0 ng/m^3.
- Naphthalene and arsenic were the only pollutants of interest with cancer surrogate risk approximations greater than 1.0 in-a-million (for both years).
- None of BOMA's pollutants of interest had noncancer risk approximations greater than 1.0, indicating little risk of noncancer effects due to these pollutants.

Table 15-6. Cancer and Noncancer Surrogate Risk Approximations for the Massachusetts Monitoring Site

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/ Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation		# of Measured Detections/ Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Boston, Massachusetts - BOMA										
Arsenic (PM$_{10}$)	0.0043	1.5E-05	60/4	0.61 ± 0.18	2.63	0.04	61/4	0.48 ± 0.08	2.08	0.03
Benzo(a)pyrene	0.001	--	33/3	0.13 ± 0.03	0.13	--	57/4	0.14 ± 0.04	0.14	--
Beryllium (PM$_{10}$)	0.0024	0.00002	51/4	<0.01 ± <0.01	0.01	<0.01	52/4	<0.01 ± <0.01	0.00	<0.01
Cadmium (PM$_{10}$)	0.0018	0.00001	60/4	0.22 ± 0.02	0.40	0.02	61/4	0.25 ± 0.03	0.45	0.03
Hexavalent Chromium	0.012	0.0001	43/3	0.04 ± 0.02	0.51	<0.01	35/3	0.03 ± 0.02	0.40	<0.01
Lead (PM$_{10}$)	--	0.00015	60/4	4.44 ± 1.04	--	0.03	61/4	2.95 ± 0.36	--	0.02
Manganese (PM$_{10}$)	--	0.00005	60/4	3.57 ± 0.49	--	0.07	61/4	3.17 ± 0.37	--	0.06
Naphthalene	3.4E-05	0.003	38/3	88.68 ± 14.97	3.02	0.03	59/4	70.33 ± 10.85	2.39	0.02
Nickel (PM$_{10}$)	0.00031	0.00009	60/4	1.77 ± 0.24	0.55	0.02	61/4	1.42 ± 0.17	0.44	0.02

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

15.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 15-7 and 15-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 15-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 15-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer risk approximations based on each site’s annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 15.3, BOMA sampled for PAH, metals, and hexavalent chromium. In addition, the cancer and noncancer risk approximations are limited to those pollutants with enough data to meet the criteria for an annual average to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 15-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Massachusetts Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Boston, Massachusetts (Suffolk County) - BOMA					
Benzene	237.85	Formaldehyde	2.31E-03	🟩 Naphthalene	🟩 3.02
Formaldehyde	184.62	Benzene	1.86E-03	🟩 Arsenic (PM_{10})	🟩 2.63
Acetaldehyde	80.66	Hexavalent Chromium, PM	1.26E-03	Naphthalene	2.39
Dichloromethane	57.33	1,3-Butadiene	1.12E-03	Arsenic (PM_{10})	2.08
1,3-Butadiene	37.23	Naphthalene	7.80E-04	🟩 Nickel (PM_{10})	🟩 0.55
Tetrachloroethylene	30.98	POM, Group 1	4.34E-04	🟩 Hexavalent Chromium	🟩 0.51
Naphthalene	22.93	POM, Group 2	3.15E-04	Cadmium (PM_{10})	0.45
POM, Group 1	7.89	Arsenic, PM	2.17E-04	Nickel (PM_{10})	0.44
Trichloroethylene	6.48	Tetrachloroethylene	1.83E-04	Hexavalent Chromium	0.40
POM, Group 2	5.72	POM, Group 5	1.81E-04	🟩 Cadmium (PM_{10})	🟩 0.40

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 15-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Massachusetts Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Boston, Massachusetts (Suffolk County) - BOMA					
Toluene	636.92	Acrolein	553,023.75	Manganese (PM_{10})	0.07
Methyl *tert*-butyl ether	481.18	Formaldehyde	18,839.27	Manganese (PM_{10})	0.06
Xylenes	480.55	1,3-Butadiene	18,612.93	Arsenic (PM_{10})	0.04
Methanol	402.31	Nickel, PM	9,826.37	Arsenic (PM_{10})	0.03
Benzene	237.85	Acetaldehyde	8,962.38	Lead (PM_{10})	0.03
Formaldehyde	184.62	Cyanide Compounds, gas	8,719.15	Naphthalene	0.03
Methyl isobutyl ketone	145.83	Benzene	7,928.46	Cadmium (PM_{10})	0.03
Ethylene glycol	122.82	Naphthalene	7,644.00	Naphthalene	0.02
Hexane	90.15	Xylenes	4,805.53	Cadmium (PM_{10})	0.02
Ethylbenzene	88.46	Glycol ethers, gas	2,607.50	Nickel (PM_{10})	0.02

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 15-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Suffolk County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were formaldehyde, benzene, and hexavalent chromium.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Naphthalene and arsenic were the pollutants with the highest cancer surrogate risk approximations for BOMA. Naphthalene ranked seventh on the list for emissions and fifth for toxicity-weighted emissions. Arsenic ranked eighth on the list of highest toxicity-weighted emissions but was not among the highest emitted. Hexavalent chromium was the only other pollutant of interest for BOMA that also appears on one of the emissions-based lists; this pollutant had the third highest toxicity-weighted emissions.

- POM Groups 1 and 2 were among the 10 highest emitted "pollutants" in Suffolk County and also ranked among the 10 highest for toxicity-weighted emissions. POM Group 1 includes unspeciated polycyclic organic matter (POM). POM Group 2 includes several PAH sampled for at BOMA including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for BOMA. Benzo(a)pyrene is part of POM Group 5, which ranked tenth for toxicity-weighted emissions for Suffolk County.

Observations from Table 15-8 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in Suffolk County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, formaldehyde, and 1,3-butadiene.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Naphthalene, which had the sixth (2008) and eighth (2009) highest noncancer risk approximations, had the seventh highest toxicity-weighted emissions but was not among the highest emitted pollutants in Suffolk County. Nickel, which had the tenth (2008) highest noncancer risk approximation, had the fourth highest toxicity-weighted emissions but was also not among the highest emitted pollutants. The remaining pollutants of interest did not appear on either emissions-based list.

15.6 Summary of the 2008-2009 Monitoring Data for BOMA

Results from several of the treatments described in this section include the following:

- *Seven pollutants failed screens for BOMA, of which all were NATTS MQO Core Analytes.*

- *Naphthalene had the highest daily average concentration for both years among the pollutants of interest for BOMA.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

16.0 Sites in Michigan

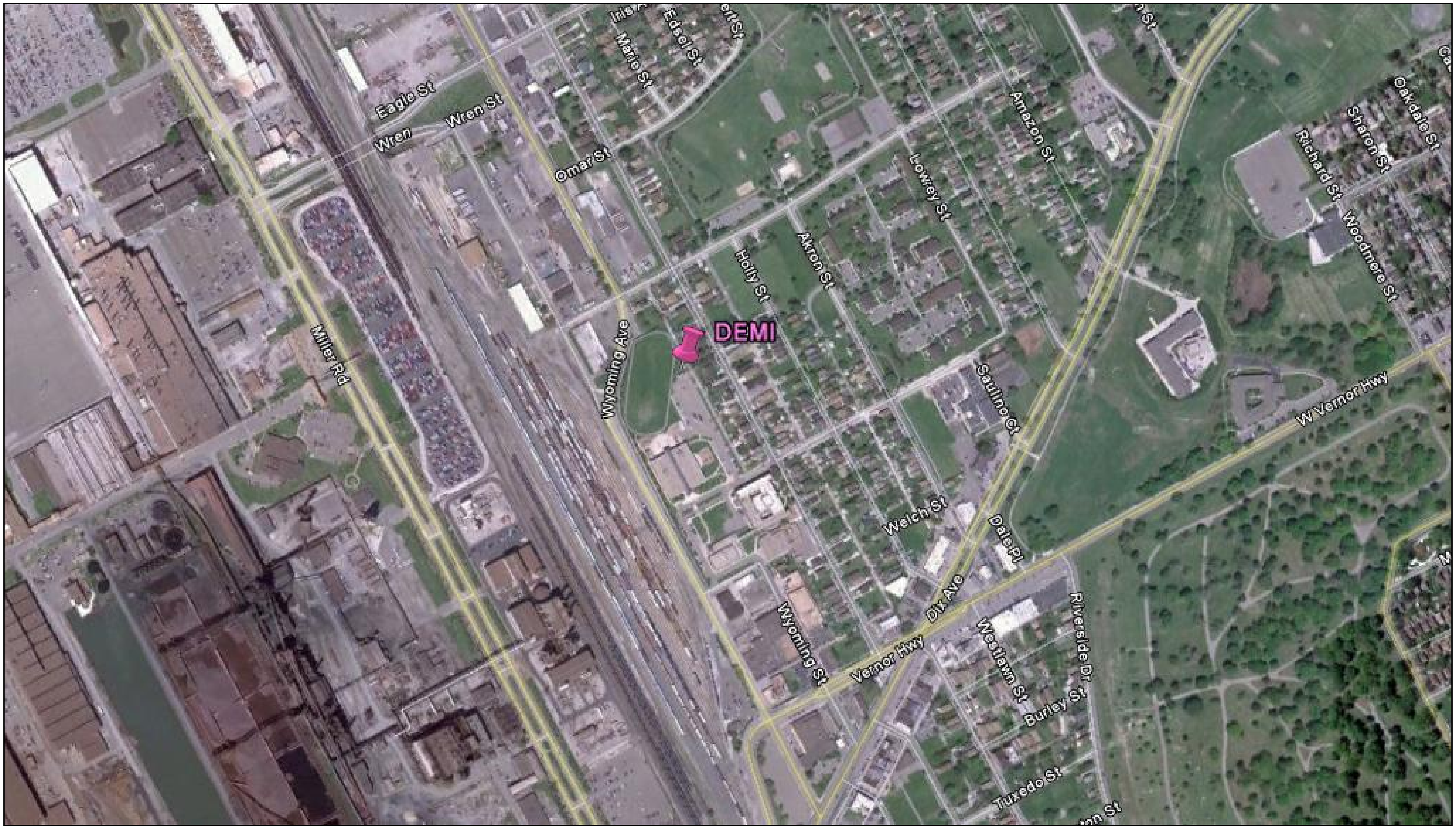
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP sites in Michigan, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

16.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

The DEMI monitoring site is located in the Detroit-Warren-Livonia, MI MSA; the ITCMI monitoring site is located in Sault Sainte Marie, MI. Figures 16-1 and 16-2 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figures 16-3 and 16-4 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of each site are included in the facility counts provided below the maps in Figures 16-3 and 16-4. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 16-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

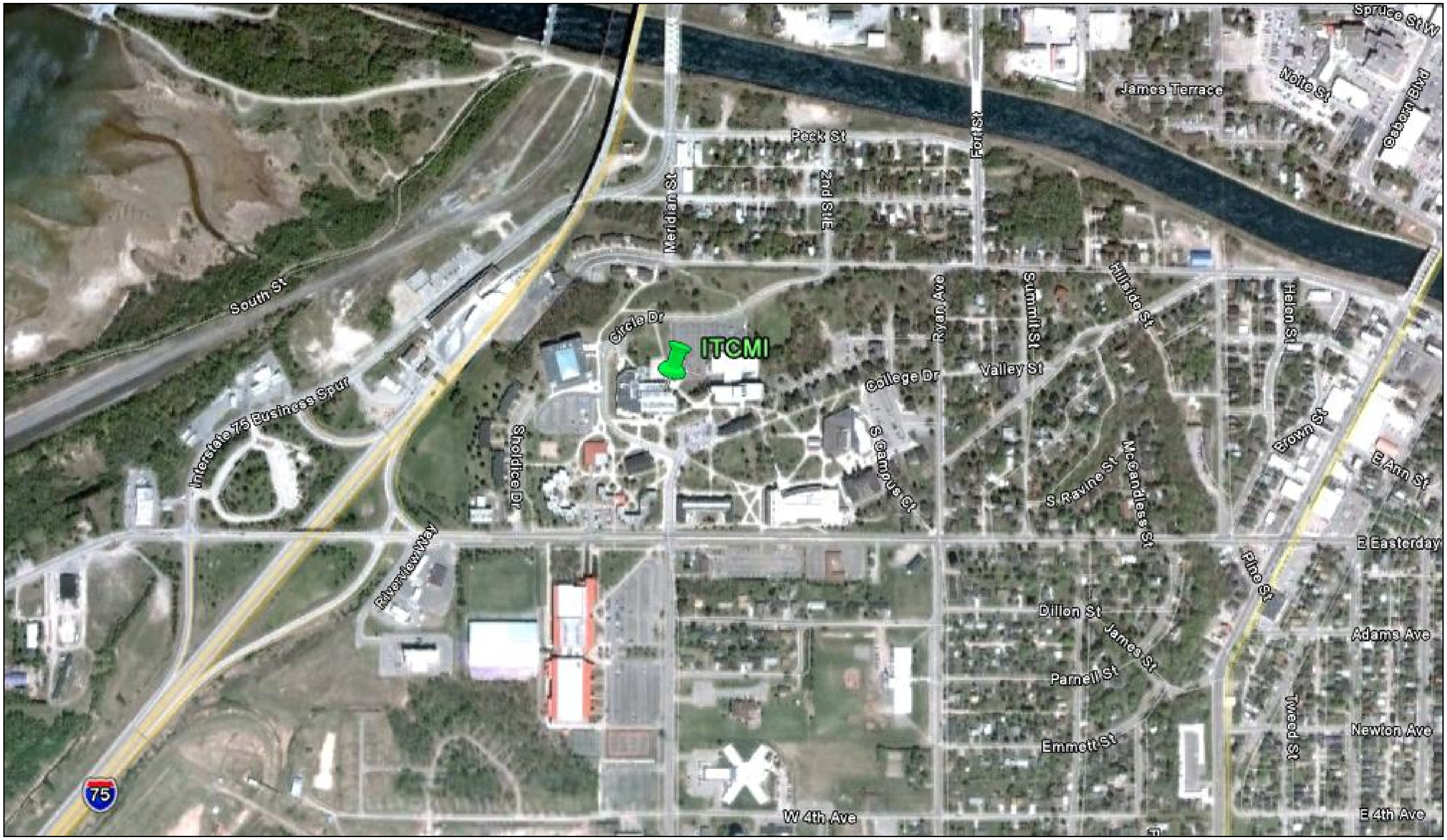
Figure 16-1. Dearborn, Michigan (DEMI) Monitoring Site



©2010 Google Earth, accessed 11/10/2010

Scale: 2 inches = 1,914 feet

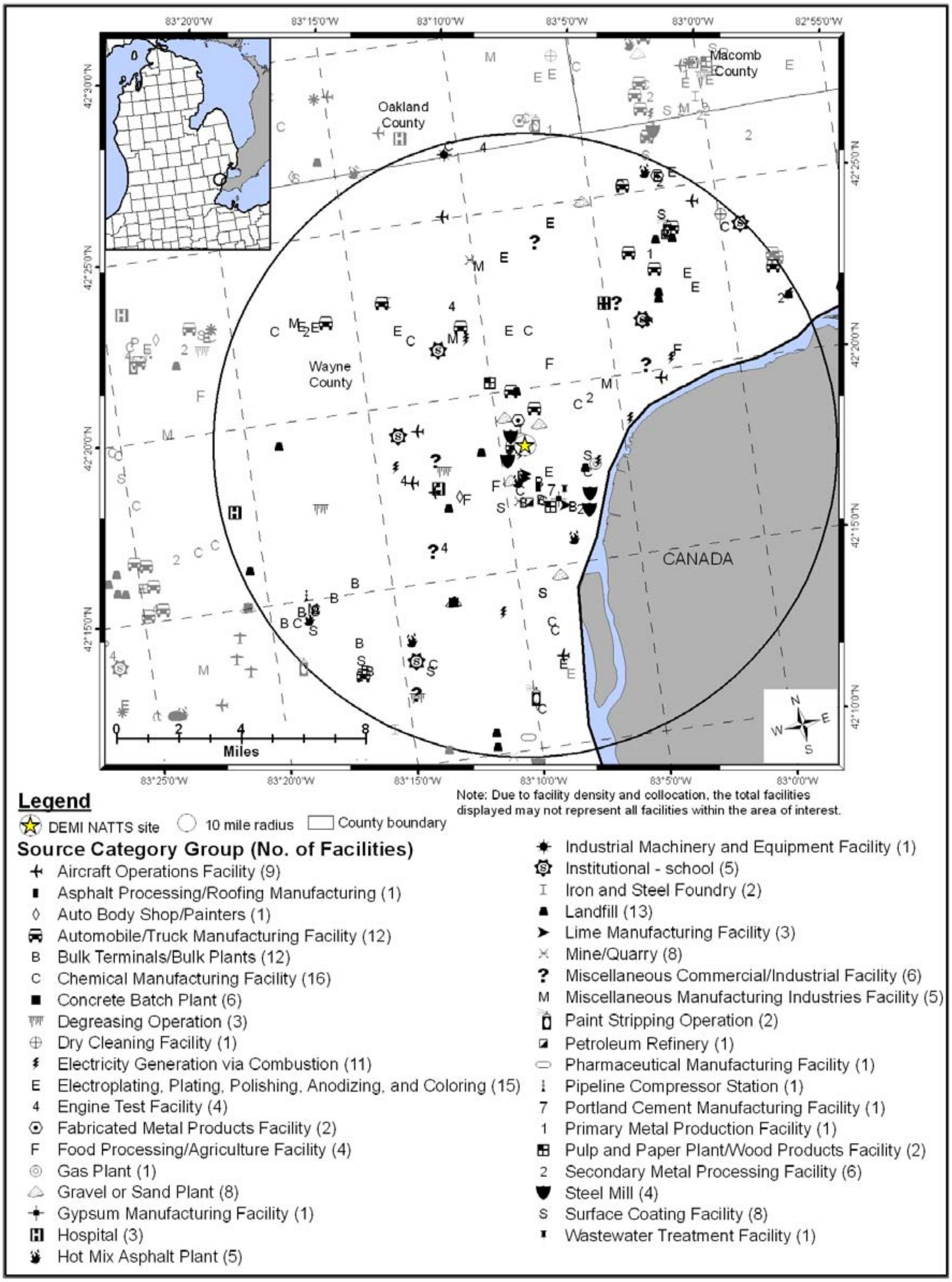
Figure 16-2. Sault Sainte Marie, Michigan (ITCMI) Monitoring Site



©2010 Google Earth, accessed 11/10/2010

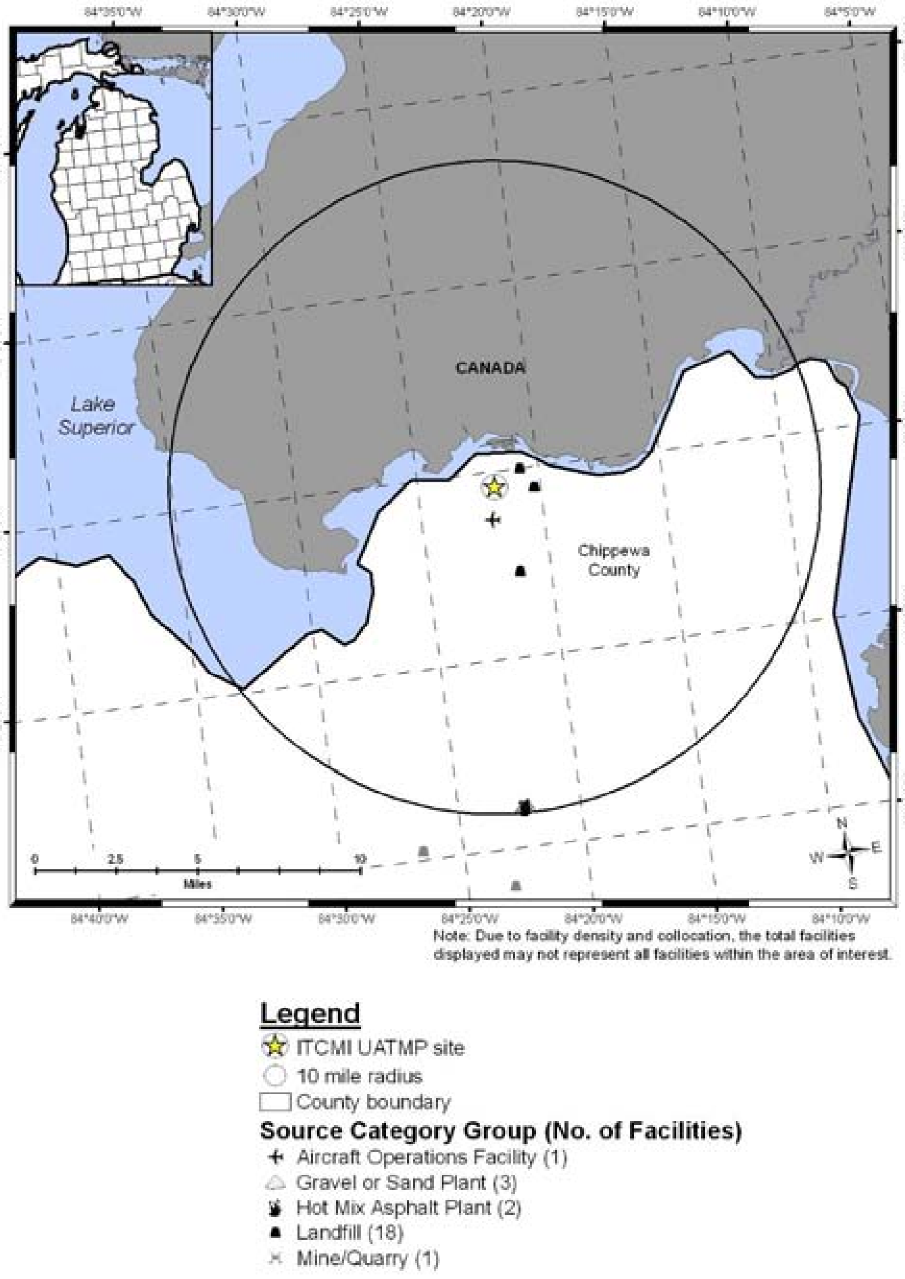
Scale: 2 inches = 1,923 feet

Figure 16-3. NEI Point Sources Located Within 10 Miles of DEMI


83°20'0"W
83°15'0"W
83°10'0"W
83°5'0"W
83°0'0"W
82°55'0"W
42°30'0"N
42°25'0"N
42°20'0"N
42°15'0"N
42°10'0"N
Oakland County
Macomb County
Wayne County
CANADA
N
E
S
W
0
2
4
8
Miles
83°25'0"W
83°20'0"W
83°15'0"W
83°10'0"W
83°5'0"W
83°0'0"W
Legend
DEMI NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (9)
Asphalt Processing/Roofing Manufacturing (1)
Auto Body Shop/Painters (1)
Automobile/Truck Manufacturing Facility (12)
Bulk Terminals/Bulk Plants (12)
Chemical Manufacturing Facility (16)
Concrete Batch Plant (6)
Degreasing Operation (3)
Dry Cleaning Facility (1)
Electricity Generation via Combustion (11)
Electroplating, Plating, Polishing, Anodizing, and Coloring (15)
Engine Test Facility (4)
Fabricated Metal Products Facility (2)
Food Processing/Agriculture Facility (4)
Gas Plant (1)
Gravel or Sand Plant (8)
Gypsum Manufacturing Facility (1)
Hospital (3)
Hot Mix Asphalt Plant (5)
Industrial Machinery and Equipment Facility (1)
Institutional - school (5)
Iron and Steel Foundry (2)
Landfill (13)
Lime Manufacturing Facility (3)
Mine/Quarry (8)
Miscellaneous Commercial/Industrial Facility (6)
Miscellaneous Manufacturing Industries Facility (5)
Paint Stripping Operation (2)
Petroleum Refinery (1)
Pharmaceutical Manufacturing Facility (1)
Pipeline Compressor Station (1)
Portland Cement Manufacturing Facility (1)
Primary Metal Production Facility (1)
Pulp and Paper Plant/Wood Products Facility (2)
Secondary Metal Processing Facility (6)
Steel Mill (4)
Surface Coating Facility (8)
Wastewater Treatment Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 16-4. NEI Point Sources Located Within 10 Miles of ITCMI



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 16-1. Geographical Information for the Michigan Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
DEMI	26-163-0033	Dearborn	Wayne	Detroit-Warren-Livonia, MI	42.30754, -83.14961	Industrial	Suburban	TSP, TSP Metals, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
ITCMI	26-033-0901	Sault Ste. Marie	Chippewa	Sault Ste. Marie, MI	46.493611, -84.364167	Residential	Rural	VOC, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

DEMI is located at Paul Costea Park in Dearborn, just southwest of Detroit. The surrounding area is both suburban and industrial in nature. Figure 16-1 shows that a freight yard is located to the west of the site and a residential neighborhood is located to the east. Industrial sources such as an auto and steel manufacturing facility are also located in the vicinity. Heavily traveled roadways surround the monitoring site, as the site lies between I-75 and I-94. As Figure 16-3 shows, numerous point sources surround DEMI, a cluster of which is located just west and south of the site. The source categories with the most point sources within 10 miles of DEMI include chemical manufacturing; electroplating, plating, polishing, anodizing, and coloring; landfills; automobile and truck manufacturing; and bulk terminals and bulk plants.

ITCMI is located on the property of Lake Superior State University in Sault Sainte Marie and is operated by the Intertribal Council of Michigan. Monitoring was initiated at this location because tribal members were concerned about industrial emissions sources across the St. Mary’s River in Ontario, Canada. Figure 16-2 shows that ITCMI is east of I-75 and south of the Edison Sault Power Canal. The area surrounding ITCMI is primarily residential. As Figure 16-4 shows, most of the point sources in the U.S. within 10 miles of ITCMI are landfills. The closest emissions source to ITCMI is a landfill and the Sault Ste. Marie Municipal Airport. Any possible emissions sources located in Canada are not provided in Figure 16-4.

Table 16-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Michigan monitoring sites. Information provided in Table 16-2 represents the most recent year of sampling (for DEMI, 2009, for ITCMI, 2008), unless otherwise indicated. County-level vehicle registration and population data for Wayne and Chippewa Counties were obtained from the Michigan Department of State (MDS, 2009 and 2010) and the U.S. Census Bureau (Census Bureau, 2009 and 2010), respectively. Table 16-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 16-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 16-2 presents the daily VMT for the Detroit urban area (VMT is not available for the Sault Sainte Marie area).

Table 16-2. Population, Motor Vehicle, and Traffic Information for the Michigan Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
DEMI	1,925,848	1,341,276	0.70	1,138,740	793,087	104,100	99,633
ITCMI	38,971	37,629	0.97	21,803	21,052	5,200	NA

[1] Reference: Census Bureau, 2009 and 2010.

[2] County-level vehicle registration reflects 2009 data (DEMI) and 2008 data (ITCMI) from the Michigan Department of State (MDS, 2009 and 2010).

[3] Reference: http://xionetic.com/zipfinddeluxe.aspx

[4] Annual Average Daily Traffic reflects 2009 data (DEMI) and 2008 data (ITCMI) from the Michigan DOT (MI DOT, 2008 and 2009).

[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

NA = Data unavailable.

BOLD = EPA-designated NATTS Site.

Observations from Table 16-2 include the following:

- Wayne County’s population and vehicle registration were among the highest for counties with NMP sites. Conversely, Chippewa County had one of the lower county populations and county-level vehicle registrations compared to all counties with NMP sites. This difference between the two Michigan sites is also reflected in the population and ownership estimates within 10 miles.
- The vehicle-per-person ratio for ITCMI was nearly 1 vehicle per person, which is higher than the vehicle-per-person ratio for DEMI.
- DEMI experienced a significantly higher average daily traffic volume than ITCMI. Traffic for ITCMI was obtained from I-75 near the intersection of West Spruce Street and Portage Avenue; traffic for DEMI was obtained from I-94, from Ford Plant Road to Rotunda Drive.
- The Detroit area VMT ranked eighth among urban areas with NMP sites.

16.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Michigan on sample days, as well as over the course of each year.

16.2.1 Climate Summary

Detroit is located in a region of active weather. Winters tend to be cold and wet, while summers are generally mild, although temperatures exceeding 90°F are not uncommon. 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 the Detroit area 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. Precipitation is fairly well distributed throughout the year, with summer precipitation coming primarily in the form of showers and thunderstorms. Approximately 30 inches of snow falls on average during winter (Bair, 1992 and MSU, 2011a).

Sault Sainte 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 lakes. Once ice begins to build up on the lakes in winter, their moderating influence weakens. This location experiences ample precipitation, especially during lake-effect snow events. Winter snow falls are heaviest with air passing over Lake Superior while summer rain events often occur with a southeasterly flow over Lake Michigan. Air masses that pass over the lakes in autumn result in cloudy conditions and may produce heavy fog conditions (Bair, 1992 and MSU, 2011b).

16.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The two closest NWS weather stations are located at Detroit-Metropolitan Airport (near DEMI) and Sault Ste. Marie Municipal Airport (near ITCMI), WBAN 94847 and 14847, respectively. Additional information about these weather stations is provided in Table 16-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 16-3. Average Meteorological Conditions near the Michigan Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Dearborn, Michigan - DEMI										
Detroit/ Metropolitan Airport 94847 (42.22, -83.35)	11.53 miles 228° (SW)	2008	Sample Day	58.5 ± 5.0	50.6 ± 4.6	39.5 ± 4.3	45.2 ± 4.1	68.1 ± 2.6	1015.6 ± 1.6	7.7 ± 0.8
			All Year	57.9 ± 2.1	49.6 ± 2.0	38.0 ± 1.8	44.1 ± 1.7	67.1 ± 1.1	1016.4 ± 0.8	7.5 ± 0.3
		2009	Sample Day	57.4 ± 4.7	49.4 ± 4.6	38.6 ± 4.4	44.3 ± 4.1	69.0 ± 2.7	1014.9 ± 2.1	7.9 ± 0.9
			All Year	57.6 ± 2.0	49.5 ± 1.9	38.6 ± 1.8	44.3 ± 1.7	68.7 ± 1.2	1016.6 ± 0.8	7.1 ± 0.3
Sault Sainte Marie, Michigan - ITCMI										
Slt. Ste. Marie Municipal Airport 14847 (46.47, -84.37)	1.84 miles 177° (S)	2008	Sample Day	24.1 ± 7.8	18.3 ± 9.4	13.1 ± 11.4	17.0 ± 10.0	81.1 ± 8.6	1016.8 ± 5.4	6.6 ± 2.1
			All Year	48.7 ± 2.1	40.9 ± 2.0	32.8 ± 1.9	37.4 ± 1.8	74.9 ± 1.1	1014.7 ± 0.8	6.1 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 16-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 16-3 is the 95 percent confidence interval for each parameter. As shown in Table 16-3, average meteorological conditions on sample days at DEMI were fairly representative of average weather conditions throughout the year for both years. 2008 Sample days at ITCMI appear much colder than the entire year, according to Table 16-3. However, sampling was discontinued at ITCMI in February 2008. As such, the sample day averages only represent sample days for the two coldest months of the year.

16.2.3 Back Trajectory Analysis

Figure 16-5 and Figure 16-6 are the composite back trajectory maps for days on which samples were collected at the DEMI monitoring site in 2008 and 2009, respectively. Figure 16-7 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figure 16-8 is the composite back trajectory map for days on which samples were collected at the ITCMI monitoring site in 2008. A cluster analysis could not be conducted for ITCMI because there were fewer than 30 sampling days for this site. An in-depth description of these maps and how they were generated was presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 16-5 through 16-8 represents 100 miles.

Figure 16-5. 2008 Composite Back Trajectory Map for DEMI

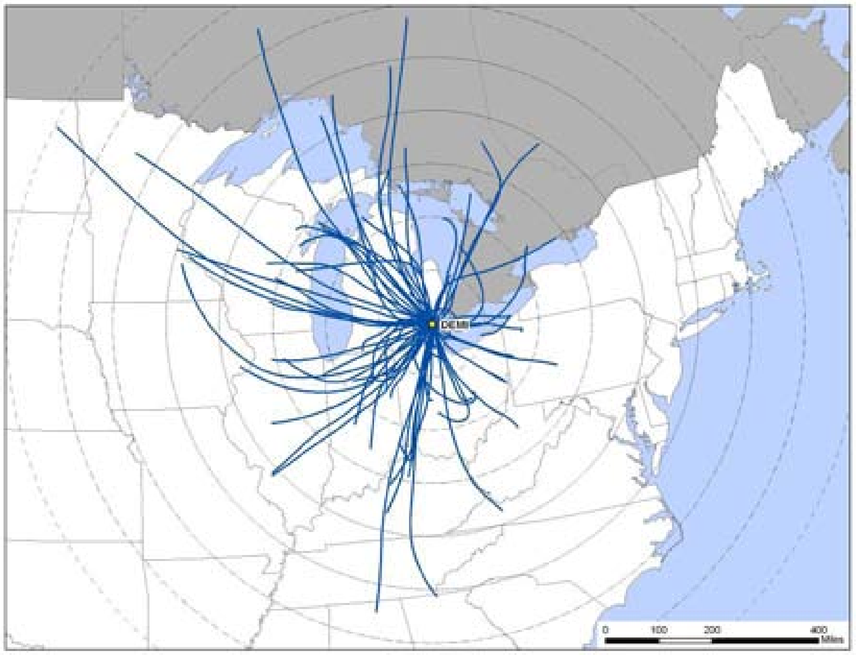


Figure 16-6. 2009 Composite Back Trajectory Map for DEMI

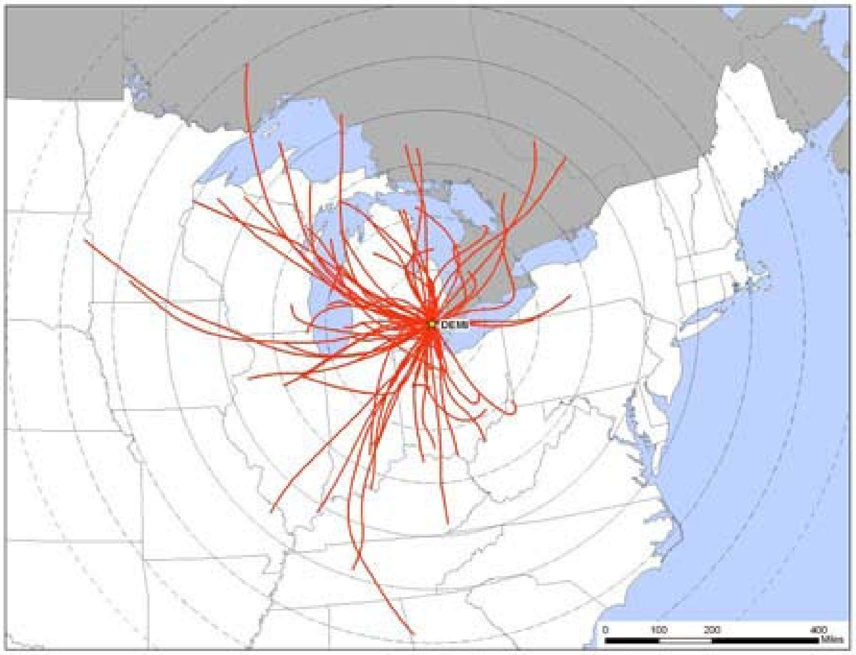


Figure 16-7. Back Trajectory Cluster Map for DEMI

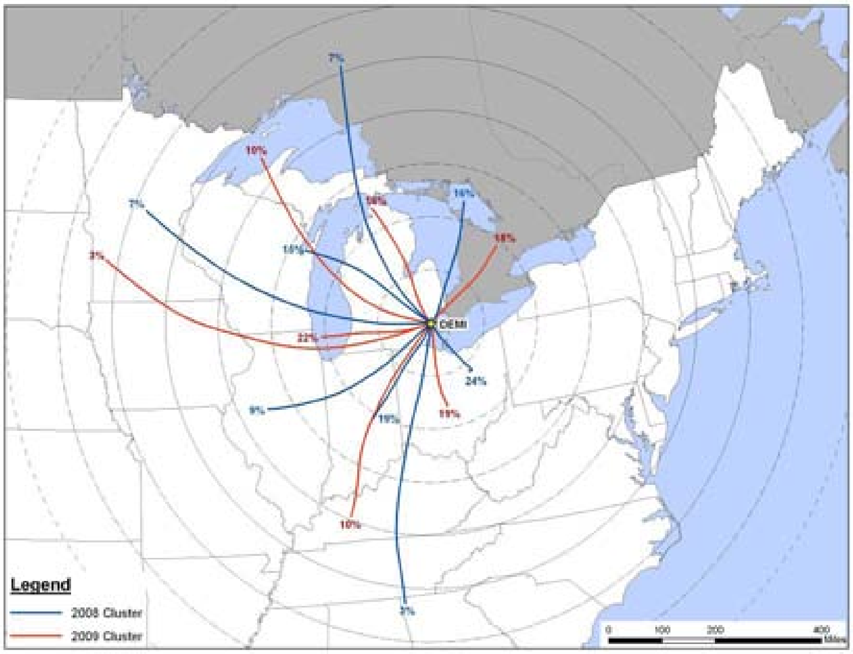
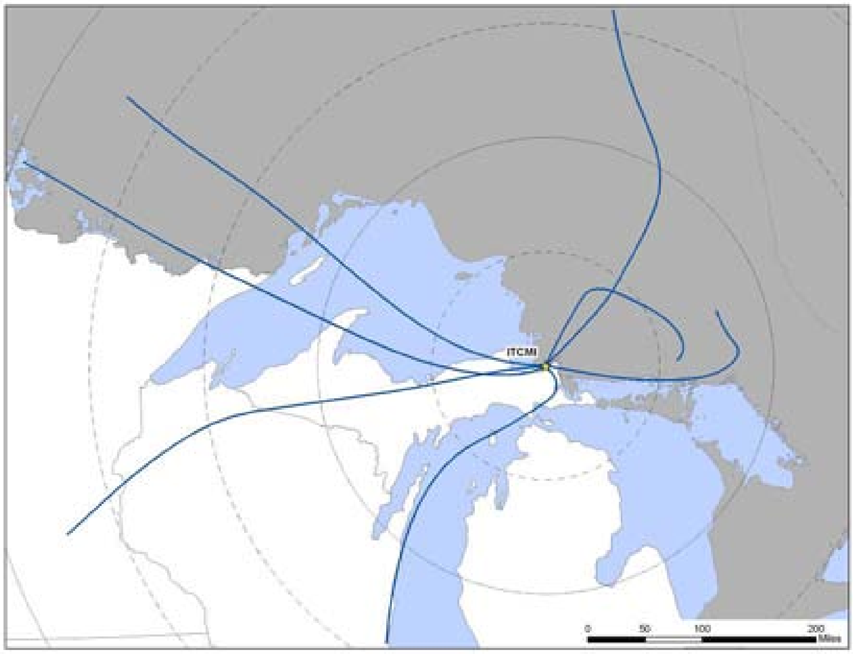


Figure 16-8. 2008 Composite Back Trajectory Map for ITCMI



Observations from Figures 16-5 through 16-7 for DEMI include the following:

- Back trajectories originated from a variety of directions at the DEMI site, although fewer trajectories originated from the east.

- The 24-hour air shed domain for DEMI was somewhat larger in size compared to other NMP monitoring sites. The farthest away a trajectory originated was northeast North Dakota, or nearly 800 miles away. However, the average trajectory length was 280 miles and over 90 percent of trajectories originated within 500 miles of the site.

- The cluster analysis shows that the majority of the trajectories originated from a direction with a westerly component. There are seven to eight clusters for each year mainly because HYSPLIT factors both direction and distance into the cluster analysis. Trajectories originating from southwesterly, westerly, and northwesterly directions were fairly numerous. Trajectories originating between Lake Huron, the Toronto metropolitan area, and Lake Eerie were also common. The cluster trajectory originating from the southeast (2008, 24%) and the cluster trajectory originating from the south-southeast (2009, 19%) both represent trajectories originating from the southeast to south to southwest, as well as relatively short trajectories originating from within 100-200 miles of DEMI.

Observations from Figure 16-8 for ITCMI include the following:

- Because there are so few trajectories shown in Figure 16-8, it is difficult to distinguish a trajectory pattern for this site.

- The farthest away a trajectory originated was nearly 500 miles away, over southwest Ontario, Canada. Based on the longest trajectory, the 24-hour air shed domain for ITCMI was smaller than other NMP sites but based on the average trajectory length, the air shed would seem one of the largest. However, a composite map with a year’s worth of trajectories would likely have a different trajectory distribution.

16.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at the Detroit-Metropolitan (for DEMI) and Sault Ste. Marie International (for ITCMI) Airports were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 16-9 presents five different wind roses for the DEMI monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 16-10 presents three different wind roses for the ITCMI monitoring site (historical, 2008, and 2008 sample day wind roses).

Observations from Figure 16-9 for DEMI include the following:

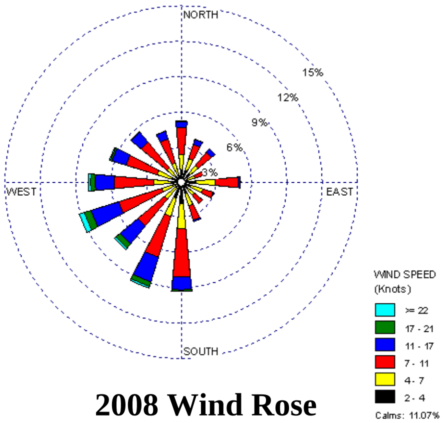
- The historical wind rose for DEMI shows that winds from a variety of directions were observed near DEMI, although winds from the southeastern quadrant were observed less frequently than winds from other directions. Calm winds (≤ 2 knots) were observed for approximately 10 percent of the hourly measurements. The strongest winds were observed with southwesterly and westerly winds.

- The wind patterns on both the 2008 and 2009 wind roses resemble the historical wind patterns, indicating that conditions during those years were consistent with those experienced historically.

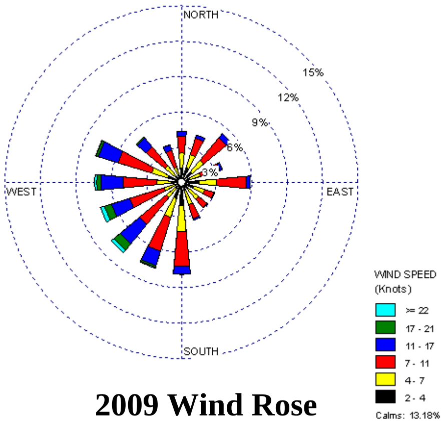
- The 2008 sample day wind rose resembles the 2008 full-year wind rose, although there is some variation in the percentages of winds. For example, the full-year wind rose has six percent west-northwesterly winds while the 2008 sample day wind rose has nine percent.

- The 2009 sample day wind rose generally resembles the 2009 full-year wind rose, although there is more variation in the percentages of winds. For example, the full-year wind rose has eight percent west-northwesterly winds while the 2009 sample day wind rose has nearly 12 percent.

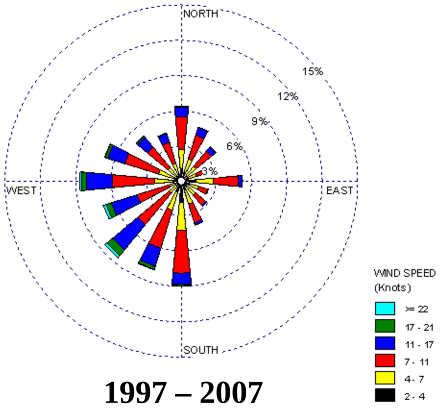
Figure 16-9. Wind Roses for the Detroit-Metropolitan Airport Weather Station near DEMI



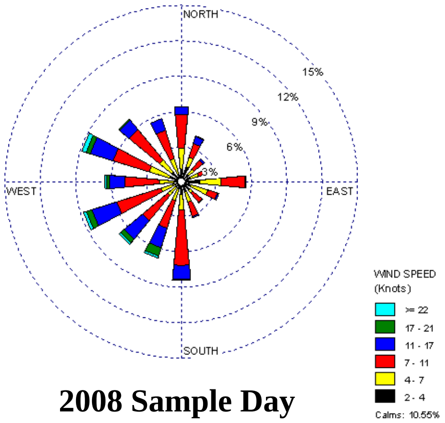
2008 Wind Rose



2009 Wind Rose

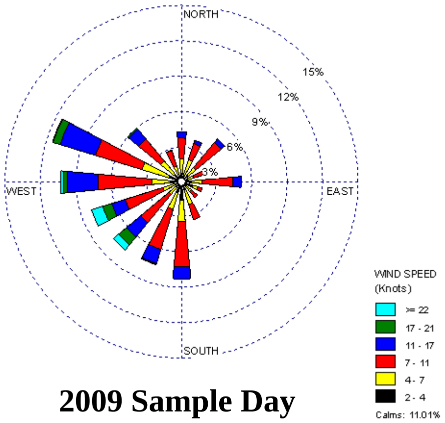


1997 – 2007
Historical Wind Rose



2008 Sample Day

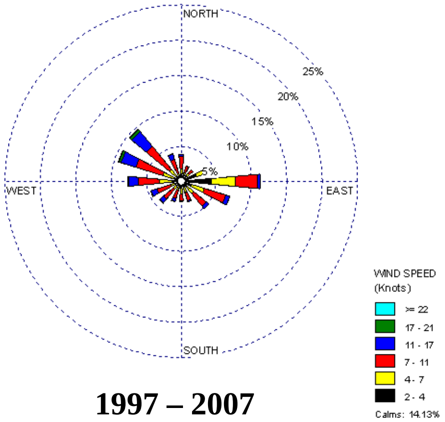
Wind Rose



2009 Sample Day

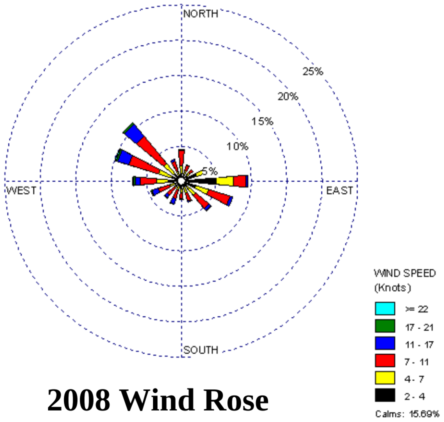
Wind Rose

Figure 16-10. Wind Roses for the Sault Sainte Marie International Airport Weather Station near ITCMI

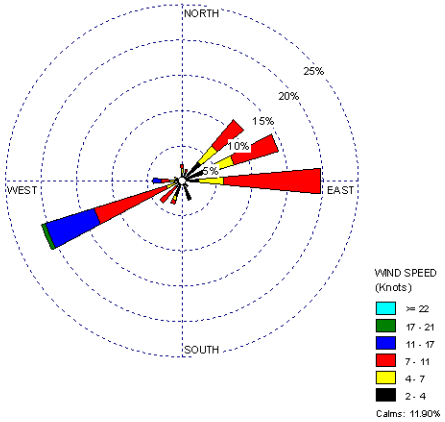


1997 – 2007

Historical Wind Rose



2008 Wind Rose



2008 Sample Day

Wind Rose

Observations from Figure 16-10 for ITCMI include the following:

- The historical wind rose shows that winds from the west-northwest to northwest and due east were observed most frequently. Calm winds were observed for approximately 14 percent of the hourly measurements.
- The wind patterns shown on the 2008 wind rose resemble the historical wind patterns, indicating that conditions during 2008 were consistent with those experienced historically.
- The wind patterns shown on the 2008 sample day wind rose are not similar to the full-year wind patterns for ITCMI. However, this wind rose incorporates only seven sample days for January and February 2008. A wind rose that incorporates an entire year's worth of sample days would likely exhibit different wind patterns.

16.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Michigan monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 16-4 presents DEMI's and ITCMI's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. DEMI sampled for VOC, PAH, carbonyl compounds, and hexavalent chromium; ITCMI sampled for PAH only.

Table 16-4. Risk Screening Results for the Michigan Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Dearborn, Michigan - DEMI						
Benzene	0.13	120	120	100.00	14.67	14.67
Carbon Tetrachloride	0.17	119	119	100.00	14.55	29.22
1,3-Butadiene	0.033	105	117	89.74	12.84	42.05
Acetaldehyde	0.45	104	104	100.00	12.71	54.77
Formaldehyde	0.077	104	104	100.00	12.71	67.48
Naphthalene	0.029	101	102	99.02	12.35	79.83
Tetrachloroethylene	0.17	51	112	45.54	6.23	86.06
p-Dichlorobenzene	0.091	26	104	25.00	3.18	89.24
Ethylbenzene	0.4	23	120	19.17	2.81	92.05
Chloromethylbenzene	0.02	20	20	100.00	2.44	94.50
Acrylonitrile	0.015	19	19	100.00	2.32	96.82
Hexavalent Chromium	0.000083	14	98	14.29	1.71	98.53
Dichloromethane	2.1	7	120	5.83	0.86	99.39
1,2-Dichloroethane	0.038	4	4	100.00	0.49	99.88
Propionaldehyde	0.8	1	104	0.96	0.12	100.00
Total		818	1,367	59.84		
Sault Ste. Marie, Michigan - ITCMI						
Naphthalene	0.029	3	7	42.86	100.00	100.00
Total		3	7	42.86		

Observations from Table 16-4 for DEMI include the following:

- Fifteen pollutants, of which eight are NATTS MQO Core Analytes, failed at least one screen for DEMI.

- Eleven pollutants contributed to 95 percent of all failed screens for DEMI; of these seven are NATTS MQO Core Analytes. Hexavalent chromium was added to DEMI's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. Four additional pollutants (benzo(a)pyrene, chloroform, trichloroethylene, and vinyl chloride) were also added to the list, even though they did not fail any screens. These four pollutants are not shown in Table 16-4.

- Of the pollutants failing screens, nearly 60 percent of their measured detections failed screens. Seven pollutants failed 100 percent of their screens.

Observations from Table 16-4 for ITCMI include the following:

- Of the PAH measured at ITCMI, only naphthalene failed screens. Less than half of the measured detections of naphthalene were greater than the screening value. It is important to note that ITCMI stopped sampling in February 2008.

- Benzo(a)pyrene was added to ITCMI's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not fail any screens. This pollutant is not shown in Table 16-4.

16.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Michigan monitoring sites. Concentration averages are provided for the pollutants of interest for each site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

16.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Michigan site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 16-5, where applicable. Note that concentrations of the PAH and hexavalent chromium are presented in ng/m^3 for ease of viewing.

Table 16-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Michigan Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
Dearborn, Michigan - DEMI												
Acetaldehyde	1.63 ± 0.23	NA	1.73 ± 0.30	1.95 ± 0.54	1.20 ± 0.33	NA*	1.44 ± 0.17	1.44 ± 0.32	1.48 ± 0.37	1.38 ± 0.33	1.46 ± 0.39	1.44 ± 0.17
Acrylonitrile	0.10 ± 0.07	NA	NA	NA	NA	NA	0.05 ± 0.02	0.02 ± 0.02	NA	NA	NA	NA
Benzene	0.96 ± 0.13	0.95 ± 0.19	0.95 ± 0.19	0.97 ± 0.22	0.97 ± 0.47	0.96 ± 0.13	0.81 ± 0.11	1.02 ± 0.18	0.85 ± 0.26	0.71 ± 0.27	0.66 ± 0.17	0.81 ± 0.11
1,3-Butadiene	0.09 ± 0.02	0.08 ± 0.02	0.08 ± 0.05	0.09 ± 0.03	0.11 ± 0.08	0.09 ± 0.02	0.07 ± 0.01	0.08 ± 0.02	0.06 ± 0.02	0.06 ± 0.03	0.06 ± 0.03	0.07 ± 0.01
Carbon Tetrachloride	0.76 ± 0.05	0.70 ± 0.06	0.74 ± 0.06	0.79 ± 0.13	0.82 ± 0.12	0.76 ± 0.05	0.75 ± 0.04	0.62 ± 0.11	0.70 ± 0.06	0.88 ± 0.11	0.74 ± 0.08	0.73 ± 0.05
Chloroform	0.96 ± 0.10	0.91 ± 0.16	1.26 ± 0.16	0.91 ± 0.20	0.77 ± 0.23	0.96 ± 0.10	0.65 ± 0.10	0.92 ± 0.26	0.74 ± 0.27	0.52 ± 0.10	0.43 ± 0.09	0.65 ± 0.10
Chloromethylbenzene	0.04 ± 0.01	NA	0.02 ± 0.01	NA	NA	NA	0.03 ± <0.01	NA	NA	NA	NA	NA
p-Dichlorobenzene	0.09 ± 0.02	0.05 ± 0.02	0.08 ± 0.03	0.12 ± 0.04	0.07 ± 0.07	0.08 ± 0.02	0.08 ± 0.02	0.05 ± 0.02	0.11 ± 0.05	0.08 ± 0.03	0.03 ± 0.02	0.07 ± 0.02
Ethylbenzene	0.30 ± 0.06	0.23 ± 0.09	0.38 ± 0.18	0.31 ± 0.08	0.30 ± 0.17	0.30 ± 0.06	0.31 ± 0.09	0.32 ± 0.17	0.25 ± 0.10	0.36 ± 0.24	0.29 ± 0.20	0.31 ± 0.09
Formaldehyde	3.01 ± 0.47	NA	3.52 ± 0.51	3.98 ± 1.04	1.63 ± 0.31	NA*	2.46 ± 0.28	2.05 ± 0.45	2.86 ± 0.69	2.91 ± 0.57	1.94 ± 0.37	2.46 ± 0.28

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

*Method completeness did not meet the 85 percent criteria.

[a] Average concentrations provided for the pollutants below the black line for DEMI and for all averages for ITCMI are presented in ng/m^3 for ease of viewing.

Table 16-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Michigan Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
Tetrachloroethylene	0.23 ± 0.05	0.13 ± 0.03	0.21 ± 0.08	0.31 ± 0.10	0.26 ± 0.16	0.23 ± 0.05	0.19 ± 0.04	0.26 ± 0.13	0.14 ± 0.05	0.16 ± 0.06	0.13 ± 0.08	0.17 ± 0.04
Trichloroethylene	0.11 ± 0.06	NA	NA	NA	NA	NA	0.09 ± 0.03	NA	NA	NA	NA	NA
Vinyl Chloride	0.02 ± 0.01	0.01 ± <0.01	NA	NA	NA	NA	0.02 ± 0.01	NA	NA	NA	NA	NA
Benzo(a)pyrene[a]	0.18 ± 0.05	NR	0.20 ± 0.12	0.13 ± 0.09	0.16 ± 0.05	0.16 ± 0.05	0.16 ± 0.03	0.18 ± 0.05	0.12 ± 0.06	0.11 ± 0.04	0.16 ± 0.07	0.14 ± 0.03
Hexavalent Chromium[a]	0.05 ± 0.02	0.03 ± 0.01	0.06 ± 0.02	0.07 ± 0.06	0.03 ± 0.02	0.04 ± 0.02	0.05 ± 0.02	0.05 ± 0.05	0.04 ± 0.04	0.02 ± 0.01	0.03 ± 0.02	0.04 ± 0.02
Naphthalene[a]	137.66 ± 31.00	NR	130.72 ± 46.13	182.95 ± 67.32	107.91 ± 51.12	137.66 ± 31.00	121.20 ± 17.55	113.69 ± 28.50	119.87 ± 56.48	136.29 ± 27.07	111.77 ± 37.79	121.20 ± 17.55
Sault Sainte Marie, Michigan - ITCMI												
Benzo(a)pyrene[a]	0.07 ± 0.02	NA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Naphthalene[a]	41.00 ± 16.16	41.00 ± 16.16	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

*Method completeness did not meet the 85 percent criteria.

[a] Average concentrations provided for the pollutants below the black line for DEMI and for all averages for ITCMI are presented in ng/m^3 for ease of viewing.

Observations for DEMI from Table 16-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde and acetaldehyde (both years); all other daily average concentrations were less than 1.0 µg/m^3.

- The daily averages for nearly all of DEMI's pollutants of interest were higher in 2008 than in 2009; however, most of these differences were not statistically significant (chloroform was the only one that was).

- Quarterly averages for several pollutants (such as acrylonitrile and trichloroethylene) could not be calculated due to the detection criteria. In addition, 2008 annual averages were not calculated for formaldehyde and acetaldehyde for DEMI because this method (Method TO-11A) did not meet the 85 percent completeness criteria. A leak was found in the sample line, which resulted in the collection of non-representative samples, and 3 months of samples were invalidated, as discussed in Section 2.4. Finally, sampling for PAH did not begin until April 2008; thus, no first quarter 2008 averages could be calculated.

- Although the averages for formaldehyde appear higher during the warmer months of the year, the confidence intervals indicate that the difference is not significant for most of them.

- Several of the VOC exhibited relatively high confidence intervals for the third quarter of 2008. A review of the data shows that the highest concentration for several pollutants, including benzene, 1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene, was measured on October 15, 2008.

- Hexavalent chromium exhibited relatively high confidence intervals for the third quarter of 2008 and the first and second quarters of 2009. Three concentrations, one in each quarter, were greater than 0.3 ng/m^3 (0.392 ng/m^3 on July 5, 2008; 0.372 ng/m^3 on January 1, 2009; and 0.317 ng/m^3 on May 13, 2009). These three concentrations ranked fifth, sixth, and tenth highest among all NMP sites sampling hexavalent chromium.

- Naphthalene exhibited a relatively high confidence interval for the third quarter of 2008. The highest concentration of this pollutant (432 ng/m^3) was measured on October 15, 2008, similar to several of the VOC.

Observations for ITCMI from Table 16-5 include the following:

- The daily average concentration of naphthalene was significantly higher than the daily average concentration of benzo(a)pyrene.

- Because PAH sampling was discontinued in February 2008, a quarterly average is only available for naphthalene for the first quarter of 2008. There were not enough detects of benzo(a)pyrene for a first quarter average.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for DEMI from those tables include the following:

- DEMI had the first (2008) and third (2009) highest daily average concentrations of chloroform (NBIL's 2008 average ranked second).
- DEMI had the fifth (2009) and sixth (2008) highest daily average concentrations of hexavalent chromium, behind only PXSS and BOMA.
- DEMI's 2008 naphthalene concentration ranked seventh highest among NMP sites sampling this pollutant (the 2009 daily average ranked 14th).

16.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. DEMI has sampled VOC and carbonyl compounds under the NMP since 2003 and hexavalent chromium since 2005. However, a trends analysis was not conducted for the carbonyl compounds. As discussed in Section 16.4.1, the all carbonyl compound samples from the primary sampler were invalidated from March 13, 2007 through March 25, 2008 due to a leak in the sample line. Thus, Figures 16-11 through 16-13 present the 3-year rolling statistical metrics for benzene, 1,3-butadiene, and hexavalent chromium for DEMI. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects. Although ITCMI has sampled PAH under the NMP since 2003, and therefore meets the criteria for a trends analysis to be conducted, this site stopped sampling at the beginning of February 2008. Because seven samples collected at the beginning of 2008 are not considered representative of the entire year, the trends analysis was not conducted.

Figure 16-11. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at DEMI

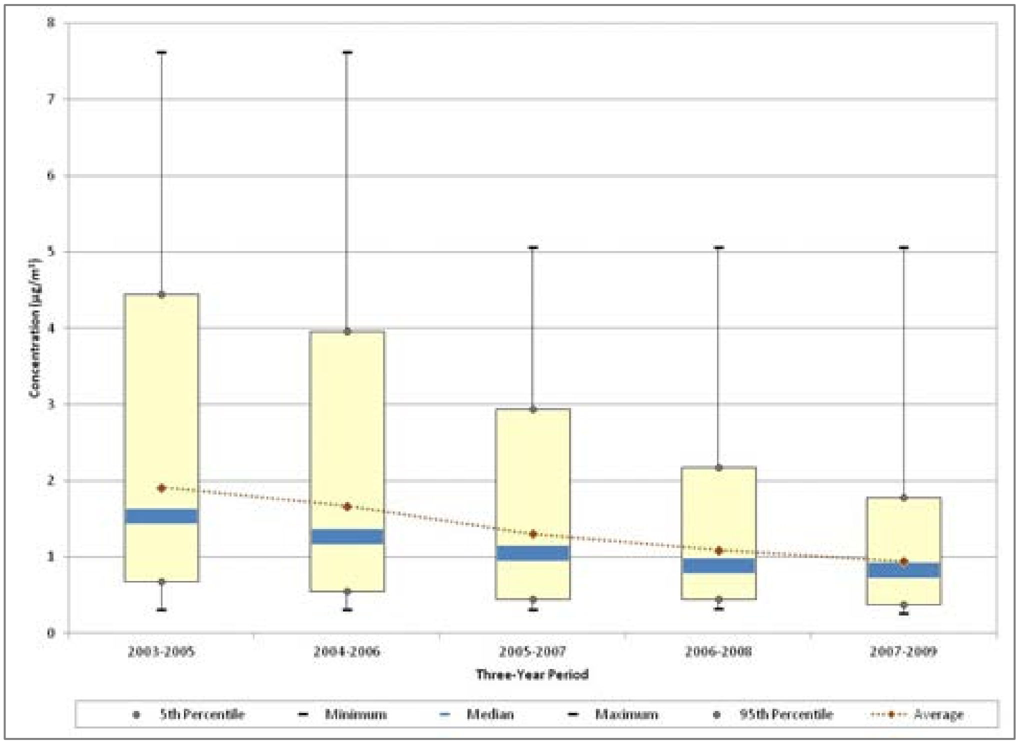


Figure 16-12. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at DEMI

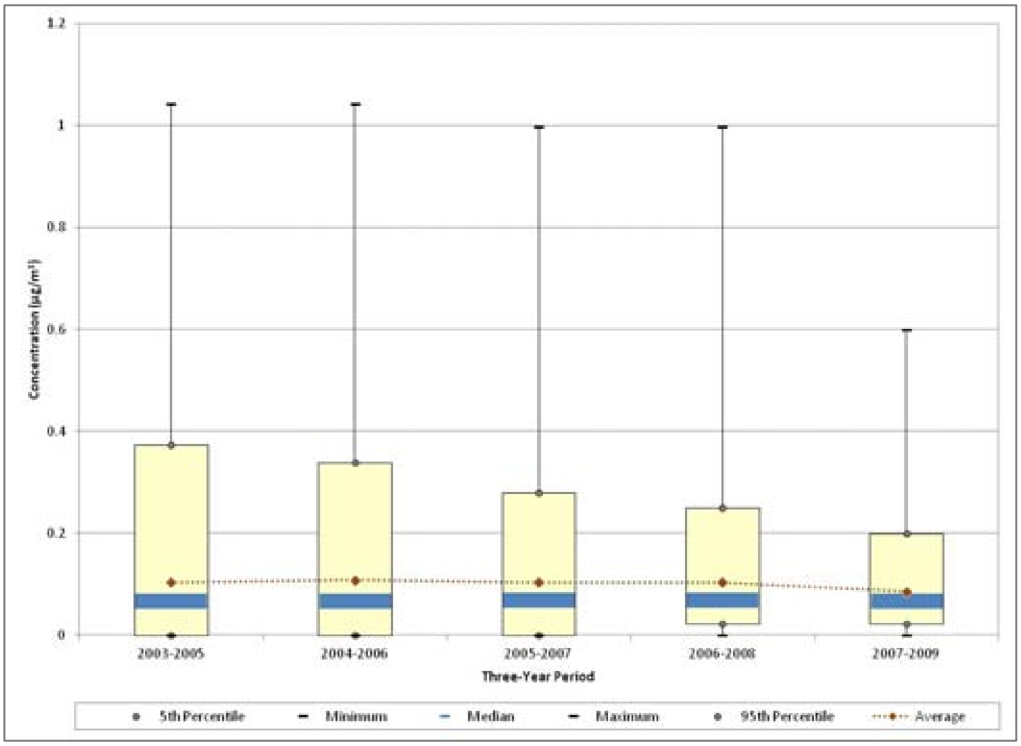
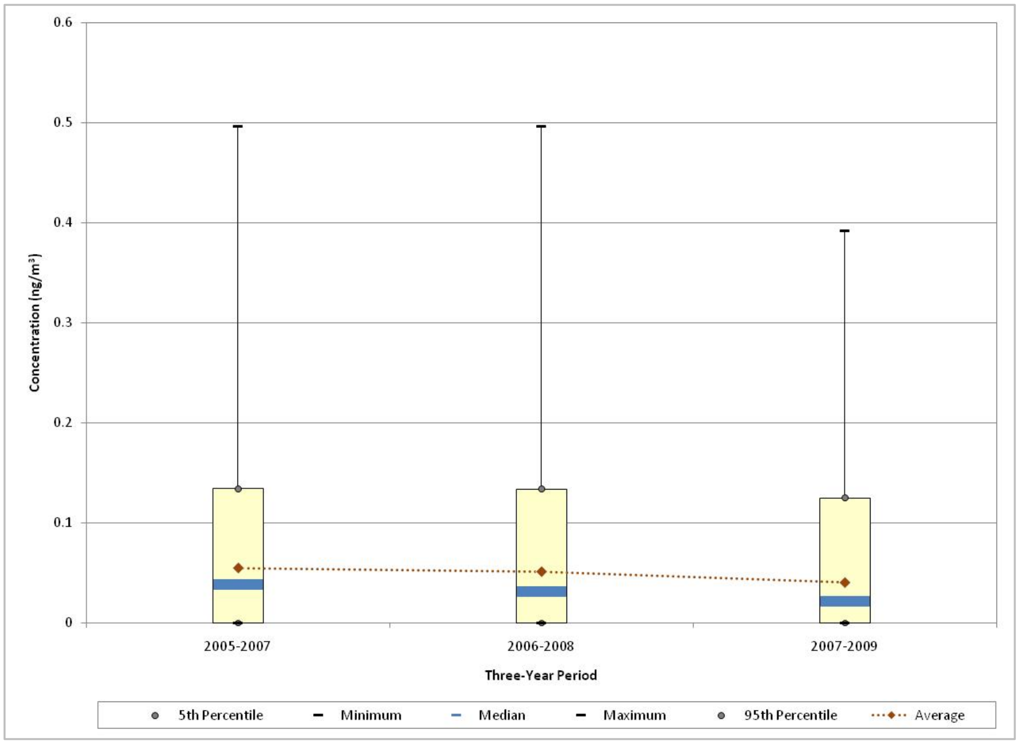


Figure 16-13. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at DEMI



Observations from Figure 16-11 for benzene measurements at DEMI include the following:

- The maximum benzene concentration shown was measured in 2004.
- Both the median and rolling average concentrations exhibit a decreasing trend over the time periods shown.
- The 5th and 95th percentiles each show a steady decreasing trend as does the difference between the two percentiles.
- Note that sampling increased from a 1-in-12 day sampling schedule in 2003 to a 1-in-6 day sampling schedule in 2004, which continues into 2009.
- The minimum concentration was greater than zero for all 3-year periods, indicating that this pollutant has been detected in every sample collected at DEMI.

Observations from Figure 16-12 for 1,3-butadiene measurements at DEMI include the following:

- The maximum, 95th percentile, average, and median concentrations all exhibit a decrease for the 2007-2009 time period from the previous 3-year period.

- The rolling average concentrations have been fairly steady over most of the time periods shown, although a slight decrease is shown for the final 3-year period. A review of the confidence intervals calculated for these averages indicates that this decrease is not statistically significant.

- The minimum and 5th percentile are both zero for the first three 3-year periods shown, indicating the presence of non-detects reported for this pollutant. Since 2003, the rate of non-detects has decreased from a maximum of 60 percent (2004) down to less than two percent in 2008.

- Note that sampling increased from a 1-in-12 day sampling schedule in 2003 to a 1-in-6 day sampling schedule in 2004, which continues into 2009.

Observations from Figure 16-13 for hexavalent chromium measurements at DEMI include the following:

- The maximum hexavalent chromium concentration was measured in 2006. The two highest hexavalent chromium concentrations for this site were both measured around July 4th – 0.496 ng/m^3 on July 4, 2006 and 0.392 ng/m^3 on July 5, 2008.

- A slight decrease in the 95th percentile, the rolling average, and the rolling median concentrations is shown over the period of sampling. Although the rolling average concentrations show a slight decrease over time, the confidence intervals calculated indicate that the difference is not statistically significant.

- The minimum concentrations and 5th percentiles for all 3-year periods were zero, indicating the presence of non-detects.

16.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Michigan monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

16.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Michigan monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Michigan monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

16.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Michigan monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 16-6, where applicable.

Table 16-6. Cancer and Noncancer Surrogate Risk Approximations for the Michigan Monitoring Sites

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE $(\mu g/m^3)^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average $(\mu g/m^3)$**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average $(\mu g/m^3)$**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Dearborn, Michigan - DEMI										
Acetaldehyde	2.2E-06	0.009	45/3	NA*	NA	NA	59/4	1.44 ± 0.17	3.16	0.16
Acrylonitrile	6.8E-05	0.002	5/0	NA	NA	NA	14/1	NA	NA	NA
Benzene	7.8E-06	0.03	61/4	0.96 ± 0.13	7.48	0.03	59/4	0.81 ± 0.11	6.32	0.03
Benzo(a)pyrene[a]	0.001	--	37/3	<0.01 ± <0.01	0.16	--	56/4	<0.01 ± <0.01	0.14	--
1,3-Butadiene	0.00003	0.002	60/4	0.09 ± 0.02	2.66	0.04	57/4	0.07 ± 0.01	1.98	0.03
Carbon Tetrachloride	6E-06	0.1	61/4	0.76 ± 0.05	4.57	0.01	58/4	0.73 ± 0.05	4.41	0.01
Chloroform	--	0.098	61/4	0.96 ± 0.10	--	0.01	59/4	0.65 ± 0.10	--	0.01
Chloromethylbenzene	4.9E-05	--	19/1	NA	NA	--	1/0	NA	NA	--
p-Dichlorobenzene	1.1E-05	0.8	54/4	0.08 ± 0.02	0.88	<0.01	50/4	0.07 ± 0.02	0.74	<0.01
Ethylbenzene	2.5E-06	1	61/4	0.30 ± 0.06	0.76	<0.01	59/4	0.31 ± 0.09	0.77	<0.01
Formaldehyde	1.3E-05	0.0098	45/3	NA*	NA	NA	59/4	2.46 ± 0.28	31.99	0.25
Hexavalent Chromium[a]	0.012	0.0001	53/4	<0.01 ± <0.01	0.53	<0.01	45/4	<0.01 ± <0.01	0.43	<0.01

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

NR = Not reportable because sampling was not conducted during this time period.

*Method completeness did not meet the 85 percent criteria.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 16-5.

Table 16-6. Cancer and Noncancer Surrogate Risk Approximations for the Michigan Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Naphthalene[a]	3.4E-05	0.003	41/3	0.14 ± 0.03	4.68	0.05	61/4	0.12 ± 0.02	4.12	0.04
Tetrachloroethylene	5.9E-06	0.27	59/4	0.23 ± 0.05	1.34	<0.01	53/4	0.17 ± 0.04	1.02	<0.01
Trichloroethylene	2E-06	0.6	10/0	NA	NA	NA	12/0	NA	NA	NA
Vinyl Chloride	8.8E-06	0.1	12/1	NA	NA	NA	11/0	NA	NA	NA
Sault Sainte Marie, Michigan - ITCMI										
Benzo(a)pyrene	0.001	--	3/0	NA	NA	NA	NR	NR	NR	NR
Naphthalene	3.4E-05	0.003	7/1	NA	NA	NA	NR	NR	NR	NR

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
NR = Not reportable because sampling was not conducted during this time period.
*Method completeness did not meet the 85 percent criteria.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 16-5.

Observations from Table 16-6 include the following:

- The pollutants with the highest 2008 annual average concentrations for DEMI were chloroform, benzene, and carbon tetrachloride. The pollutants with the highest 2009 annual average concentrations for DEMI were formaldehyde, acetaldehyde, and benzene.

- Recall that 2008 annual averages could not be calculated for carbonyl compounds for DEMI due to not meeting the completeness criteria; thus, surrogate risk approximations could not be calculated.

- The pollutants with the highest 2008 cancer surrogate risk approximations for DEMI were benzene, naphthalene, and carbon tetrachloride (7.48, 4.68, and 4.57 in-a-million, respectively). The pollutants with the highest 2009 cancer surrogate risk approximations for DEMI were formaldehyde, benzene, and carbon tetrachloride (31.99, 6.32, and 4.41 in-a-million, respectively).

- For DEMI, none of the pollutants of interest had associated noncancer risk approximations greater than 1.0.

- No annual averages could be calculated for ITCMI as sampling at this site concluded in February 2008; thus, no surrogate risk approximations could be calculated.

16.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 16-7 and 16-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 16-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 16-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 16-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Michigan 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Sault Sainte Marie, Michigan (Chippewa County) - ITCMI					
Benzene	75.62	Benzene	5.90E-04		
Formaldehyde	44.80	Formaldehyde	5.60E-04		
Tetrachloroethylene	18.83	1,3-Butadiene	3.42E-04		
Acetaldehyde	14.85	POM, Group 2	1.56E-04		
1,3-Butadiene	11.40	Naphthalene	1.38E-04		
Dichloromethane	7.31	Tetrachloroethylene	1.11E-04		
Naphthalene	4.05	Acrylonitrile	6.80E-05		
POM, Group 2	2.84	Arsenic, PM	5.29E-05		
1,3-Dichloropropene	2.80	POM, Group 3	4.25E-05		
Trichloroethylene	1.79	Acetaldehyde	3.27E-05		
Dearborn, Michigan (Wayne County) - DEMI					
Benzene	1,751.65	Coke Oven Emissions, PM	1.70E-02	Formaldehyde	31.99
Formaldehyde	724.19	Benzene	1.37E-02	Benzene	7.48
Tetrachloroethylene	387.89	Formaldehyde	9.05E-03	Benzene	6.32
Acetaldehyde	288.81	1,3-Butadiene	6.36E-03	Naphthalene	4.68
Dichloromethane	285.84	Naphthalene	4.41E-03	Carbon Tetrachloride	4.57
1,3-Butadiene	211.85	POM, Group 5	3.82E-03	Carbon Tetrachloride	4.41
1,3-Dichloropropene	147.65	Cadmium, PM	2.79E-03	Naphthalene	4.12
Naphthalene	129.66	Tetrachloroethylene	2.29E-03	Acetaldehyde	3.16
p-Dichlorobenzene	76.63	Hexavalent Chromium, PM	1.84E-03	1,3-Butadiene	2.66
Trichloroethylene	57.13	POM, Group 2	1.05E-03	1,3-Butadiene	1.98

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 16-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Michigan 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Sault Sainte Marie, Michigan (Chippewa County) - ITCMI					
Toluene	301.83	Acrolein	251,053.25		
Xylenes	151.09	1,3-Butadiene	5,700.11		
Benzene	75.62	Formaldehyde	4,571.79		
Formaldehyde	44.80	Benzene	2,520.67		
Ethylbenzene	34.67	Nickel, PM	2,108.46		
Hexane	30.13	Acetaldehyde	1,650.31		
Tetrachloroethylene	18.83	Xylenes	1,510.85		
Methanol	16.00	Naphthalene	1,350.46		
Acetaldehyde	14.85	Cyanide Compounds, gas	950.52		
1,3-Butadiene	11.40	Bromomethane	782.00		
Dearborn, Michigan (Wayne County) - DEMI					
Toluene	4,939.39	Acrolein	2,126,585.96	Formaldehyde	0.25
Xylenes	3,067.43	Manganese, PM	264,229.35	Acetaldehyde	0.16
Benzene	1,751.65	1,3-Butadiene	105,925.42	Naphthalene	0.05
Hydrochloric acid	1,190.41	Cadmium, PM	77,484.64	1,3-Butadiene	0.04
Methanol	967.33	Formaldehyde	73,897.05	Naphthalene	0.04
Hexane	796.97	Hydrochloric acid	59,520.34	1,3-Butadiene	0.03
Formaldehyde	724.19	Benzene	58,388.41	Benzene	0.03
Ethylbenzene	721.80	Naphthalene	43,219.34	Benzene	0.03
Methyl isobutyl ketone	454.32	Bromomethane	41,210.45	Chloroform	0.01
1,1,1-Trichloroethane	423.91	Nickel, PM	38,170.50	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. Further, the cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 16.3, DEMI sampled for VOC, PAH, carbonyl compounds, and hexavalent chromium, while ITCMI sampled for PAH only. In addition, the cancer and noncancer risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 16-7 include the following:

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in both Wayne and Chippewa Counties, although the magnitudes of the emissions were very different.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Wayne County were coke oven emissions, benzene, and formaldehyde. The pollutants with the highest toxicity-weighted emissions for Chippewa County were benzene, formaldehyde, and 1,3-butadiene.

- Five of the highest emitted pollutants in Wayne County also had the highest toxicity-weighted emissions. Seven of the highest emitted pollutants in Chippewa County had the highest toxicity-weighted emissions.

- For DEMI, formaldehyde (2009 only), benzene, naphthalene, carbon tetrachloride, acetaldehyde (2009 only), and 1,3-butadiene had the highest cancer surrogate risk approximations. Benzene, formaldehyde, 1,3-butadiene, and naphthalene also appear on both emissions-based lists. Acetaldehyde was one of the highest emitted pollutants but did not appear among those with the highest toxicity-weighted emissions. Carbon tetrachloride did not appear on either emissions-based list.

- POM Group 2 was the eighth highest emitted "pollutant" in Chippewa County and ranked fourth for toxicity-weighted emissions; POM Group 2 ranked tenth for toxicity-weighted emissions in Wayne County. POM Group 2 includes several PAH sampled for at DEMI and ITCMI including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for these two sites.

- Benzo(a)pyrene is part of POM Group 5, which ranked sixth for toxicity-weighted emissions for Wayne County but was not among the highest emitted pollutants.

- POM Group 3, which has one of the 10 highest toxicity-weighted emissions for Chippewa County, does not include pollutants sampled with Method TO-13.

- No cancer risk approximations could be calculated for ITCMI.

Observations from Table 16-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in both Wayne and Chippewa Counties, although the magnitude of the emissions was very different.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Wayne County were acrolein, manganese, and 1,3-butadiene. The pollutants with the highest toxicity-weighted emissions for Chippewa County were acrolein, 1,3-butadiene, and formaldehyde. Although acrolein was sampled for at DEMI, this pollutant was excluded from the pollutants of interest designation and thus subsequent risk screening evaluations due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Three of the highest emitted pollutants in Wayne County also had the highest toxicity-weighted emissions. Five of the highest emitted pollutants in Chippewa County also had the highest toxicity-weighted emissions.

- The pollutant with the highest noncancer risk approximation for DEMI was formaldehyde (0.25 for 2009), although none of the pollutants of interest had associated noncancer risk approximations greater than 1.0. Formaldehyde emissions ranked seventh for Wayne County; formaldehyde also had the fifth highest toxicity-weighted emissions.

- Noncancer risk approximations could not be calculated for ITCMI.

16.6 Summary of the 2008-2009 Monitoring Data for DEMI and ITCMI

Results from several of the treatments described in this section include the following:

- ❖ *Fifteen pollutants, of which eight are NATTS MQO Core Analytes, failed screens for DEMI. Naphthalene was the only pollutant to fail screens for ITCMI.*

- ❖ *Of the site-specific pollutants of interest, formaldehyde had the highest daily average concentration for DEMI (both years), while naphthalene had the highest daily average concentration for ITCMI (2008).*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than any of the associated MRL noncancer health risk benchmarks.*

17.0 Sites in Mississippi

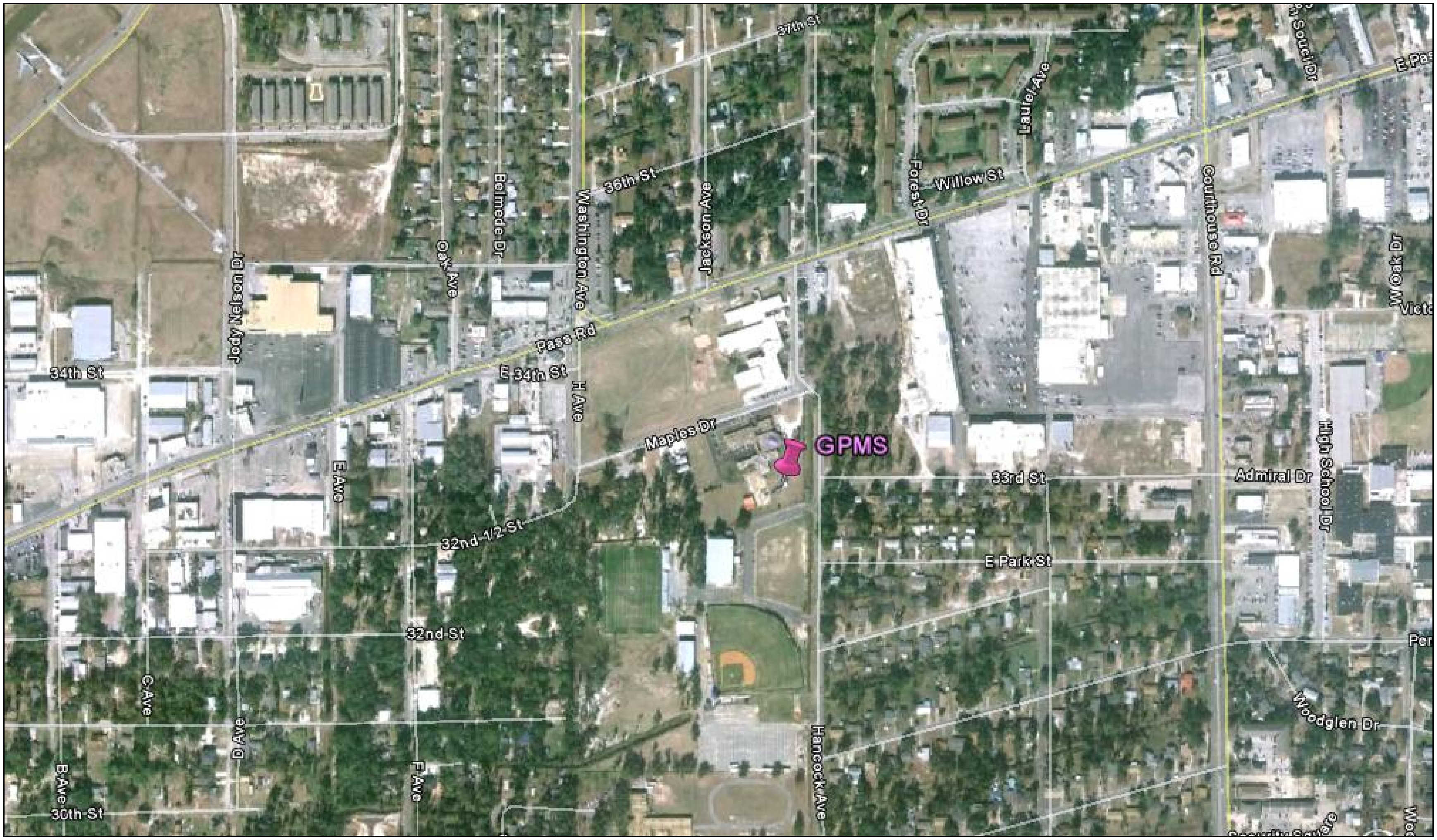
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at UATMP sites in Mississippi, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

17.1 Site Characterization

This section characterizes the Mississippi monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

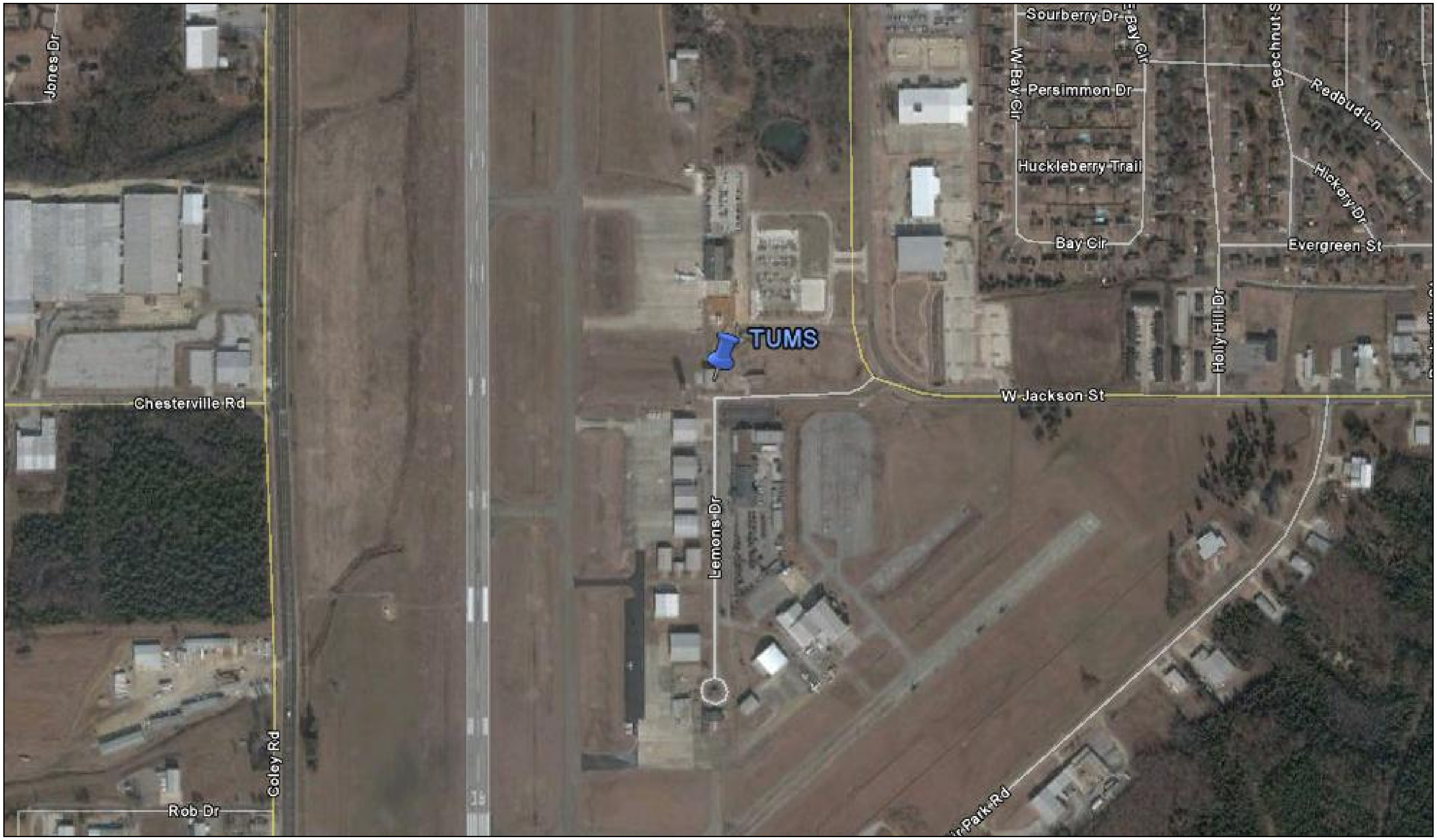
The GPMS monitoring site is located in the Gulfport-Biloxi, MS MSA and the TUMS monitoring site is located in the Tupelo, MS MSA. Figures 17-1 and 17-2 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban and rural locations. Figures 17-3 and 17-4 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 17-3 and 17-4. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 17-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 17-1. Gulfport, Mississippi (GPMS) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,575 feet

Figure 17-2. Tupelo, Mississippi (TUMS) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,772 feet

Figure 17-3. NEI Point Sources Located Within 10 Miles of GPMS

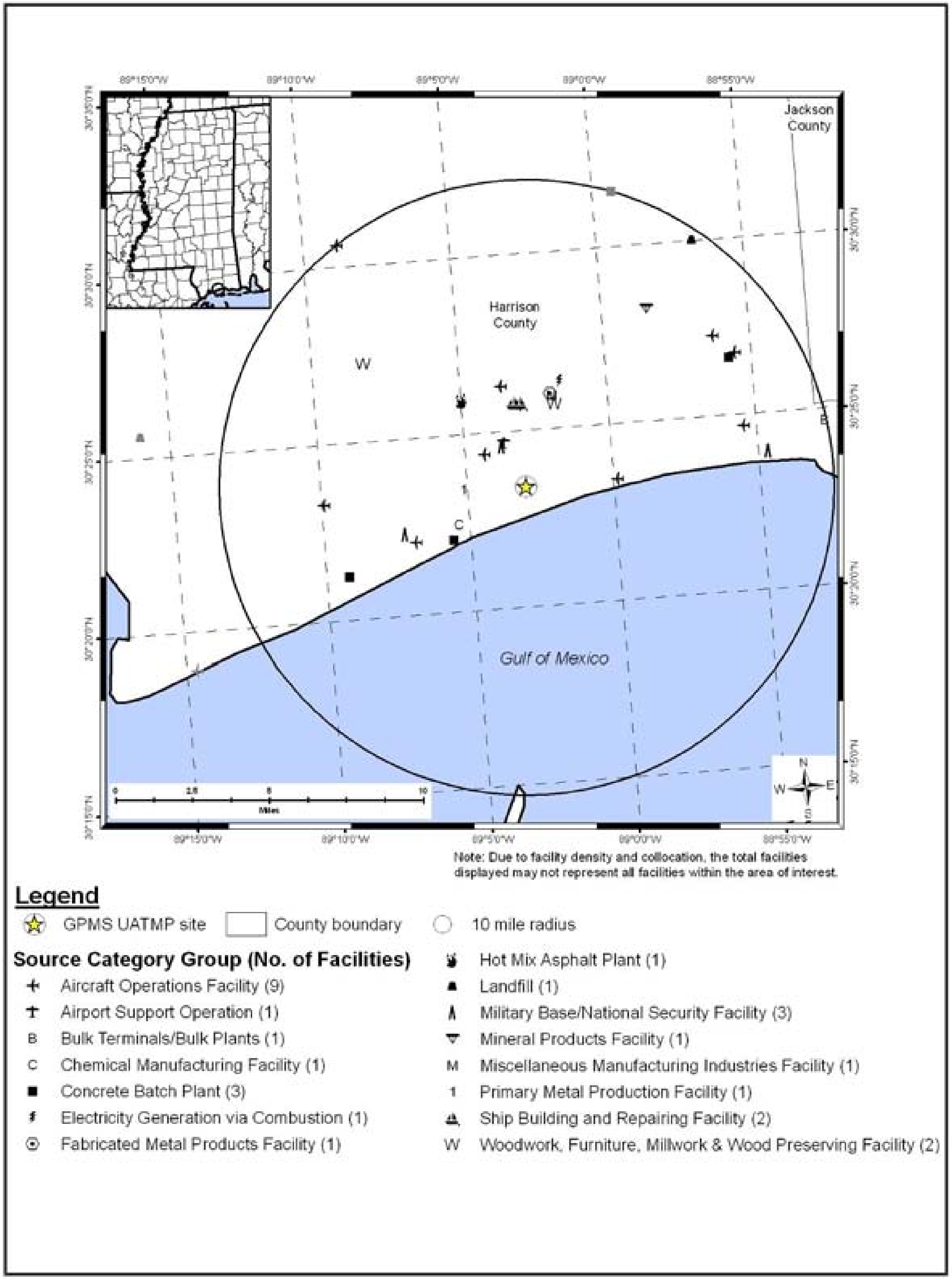

89°15'0"W
89°10'0"W
89°5'0"W
89°0'0"W
88°55'0"W
30°35'0"N
30°30'0"N
30°25'0"N
30°20'0"N
30°15'0"N
Jackson County
Harrison County
Gulf of Mexico
0
2.5
5
10
Miles
N
E
S
W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
GPMS UATMP site
County boundary
10 mile radius
Source Category Group (No. of Facilities)
Aircraft Operations Facility (9)
Airport Support Operation (1)
B Bulk Terminals/Bulk Plants (1)
C Chemical Manufacturing Facility (1)
Concrete Batch Plant (3)
Electricity Generation via Combustion (1)
Fabricated Metal Products Facility (1)
Hot Mix Asphalt Plant (1)
Landfill (1)
Military Base/National Security Facility (3)
Mineral Products Facility (1)
M Miscellaneous Manufacturing Industries Facility (1)
1 Primary Metal Production Facility (1)
Ship Building and Repairing Facility (2)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Figure 17-4. NEI Point Sources Located Within 10 Miles of TUMS

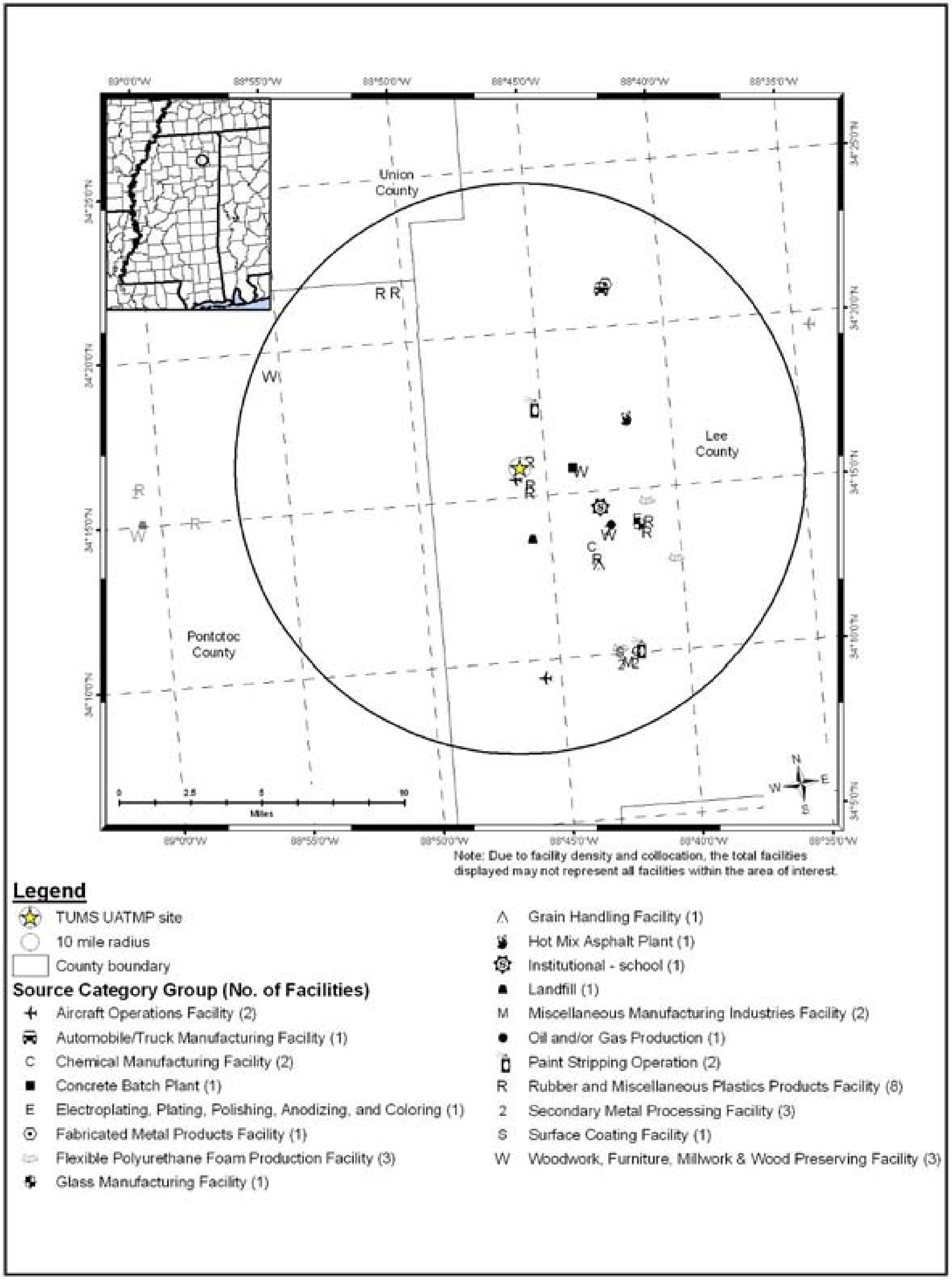

89°0'0"W
88°55'0"W
88°50'0"W
88°45'0"W
88°40'0"W
88°35'0"W
34°25'0"N
34°20'0"N
34°15'0"N
34°10'0"N
34°5'0"N
Union County
Lee County
Pontotoc County
0
2.5
5
10
Miles
N
S
E
W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
TUMS UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (2)
Automobile/Truck Manufacturing Facility (1)
C Chemical Manufacturing Facility (2)
Concrete Batch Plant (1)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (1)
Fabricated Metal Products Facility (1)
Flexible Polyurethane Foam Production Facility (3)
Glass Manufacturing Facility (1)
Grain Handling Facility (1)
Hot Mix Asphalt Plant (1)
Institutional - school (1)
Landfill (1)
M Miscellaneous Manufacturing Industries Facility (2)
Oil and/or Gas Production (1)
Paint Stripping Operation (2)
R Rubber and Miscellaneous Plastics Products Facility (8)
2 Secondary Metal Processing Facility (3)
S Surface Coating Facility (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (3)

Table 17-1. Geographical Information for the Mississippi Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
GPMS	28-047-0008	Gulfport	Harrison	Gulfport-Biloxi, MS	30.390139, -89.049722	Commercial	Rural	Asbestos, Hexavalent chromium, SVOC, O_3, Meteorological parameters, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation
TUMS	28-081-0005	Tupelo	Lee	Tupelo, MS	34.264917, -88.766222	Commercial	Suburban	O_3, Meteorological parameters, and $PM_{2.5}$.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

GPMS is located in the coastal city of Gulfport, less than 1 mile from the shore and approximately 1/2 mile from the Gulfport-Biloxi International Airport. The surrounding area is lightly commercial as well as residential. The monitoring site is located behind the Harrison County Youth Court building, as shown in Figure 17-1. The site is positioned between several major thoroughfares through Gulfport, including Business 90, Pass Road, and I-10. Keesler Air Force Base and a U.S. Naval Reserve Station are within a few miles of the monitoring site. As Figure 17-3 shows, relatively few point sources are located near GPMS. Most of the emissions sources are located to the north of the site. The source categories with the highest number of sources are the aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads; concrete batch plants; and military bases/national security facilities.

TUMS is located on the west side of Tupelo, a town in the northeast corner of the state. Figure 17-2 shows that TUMS is located on the property of the Tupelo Regional Airport. Residential and light commercial areas surround the airport. As Figure 17-4 shows, point sources within a 10 mile radius of TUMS are primarily located to the east and southeast of the site. A number of the emissions sources near TUMS are involved in rubber and miscellaneous plastics production, including several located in very close proximity to the monitoring site.

Table 17-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Mississippi monitoring sites. Information provided in Table 17-2 represents the most recent year of sampling (2008), unless otherwise indicated. County-level vehicle registration and population data for Harrison and Lee Counties were obtained from the Mississippi State Tax Commission (MS STC, 2008) and the U.S. Census Bureau (Census Bureau, 2009), respectively. Table 17-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 17-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 17-2 presents the daily VMT for the Gulfport urban area (VMT was not available for Tupelo).

Table 17-2. Population, Motor Vehicle, and Traffic Information for the Mississippi Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
GPMS	178,460	173,974	0.97	155,056	151,158	27,000	7,446
TUMS	81,139	73,635	0.91	71,697	65,066	12,000	NA

[1] Reference: Census Bureau, 2009.
[2] County-level vehicle registration reflects 2008 data from the Mississippi State Tax Commission (MS STC, 2008).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2007 data from the Mississippi DOT (MS DOT, 2007).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
NA = Data unavailable.

Observations from Table 17-2 include the following:

- The Harrison County population is more than twice the Lee County population, although both are relatively low compared to other counties with NMP monitoring sites. The same is true of the 10-mile populations.
- The county-level and 10-mile vehicle ownership estimates for GPMS and TUMS reflect the same trends as the populations.
- The vehicle-per-person ratio for GPMS was nearly 1 vehicle per person, which falls in the mid to upper end of the range compared to other NMP sites. The ratio for TUMS was slightly lower than the ratio for GPMS.
- GPMS experienced a higher annual average daily traffic volume than TUMS. Compared to other NMP sites, the traffic near TUMS was in the mid to low end of the range while the traffic volume for GPMS was in the middle of the range. Traffic for GPMS was obtained from Pass Road, east of Hancock Avenue; traffic for TUMS was obtained from Coley Road, north of State Road 6.
- The Gulfport area VMT was among the lowest for urban areas with NMP sites.

17.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Mississippi on sample days, as well as over the course of the year.

17.2.1 Climate Summary

High temperatures and humidity, due to the predominant southerly flow out of the Gulf of Mexico, can make this region feel uncomfortable during the warmer months of the year, but the Gulf also acts as a moderating influence in the wintertime. Precipitation is distributed fairly evenly throughout the year, although the northern portions of the state experience higher precipitation amounts during winter in association with frontal systems, while the coastal regions experience higher precipitation amounts in summer in association with thunderstorms (NCDC, 2011).

17.2.2 Meteorological Conditions in 2008

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 (NCDC, 2008). The two closest NWS weather stations are located at Gulfport-Biloxi Regional Airport (near GPMS) and Tupelo Municipal Airport (near TUMS), WBAN 93874 and 93862, respectively. Additional information about these weather stations is provided in Table 17-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year.

Table 17-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year (for 2008 only). Also included in Table 17-3 is the 95 percent confidence interval for each parameter. As shown in Table 17-3, there seems to be a wide disparity between conditions on sample days and those experienced throughout the year. This is because both sites stopped sampling in March 2008, thereby capturing sample days for only the colder months of the year.

Table 17-3. Average Meteorological Conditions near the Mississippi Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Gulfport, Mississippi - GPMS										
Gulfport, MS/Biloxi Regional Airport 93870 (30.41, -89.07)	1.64 miles 311° (NW)	2008	Sample Day	61.7 ± 5.0	52.5 ± 5.0	42.6 ± 6.7	48.0 ± 5.2	72.4 ± 8.5	1019.2 ± 3.7	7.9 ± 1.5
			All Year	76.3 ± 1.2	67.7 ± 1.3	58.5 ± 1.5	62.5 ± 1.3	74.6 ± 1.1	1017.5 ± 0.6	5.7 ± 0.3
Tupelo, Mississippi - TUMS										
Tupelo Municipal Airport 93862 (34.26, -88.77)	0.37 miles 219° (SW)	2008	Sample Day	52.2 ± 7.8	43.3 ± 6.0	32.0 ± 7.6	38.8 ± 6.0	66.7 ± 7.6	1019.7 ± 4.5	7.6 ± 1.7
			All Year	71.8 ± 1.6	61.4 ± 1.6	50.4 ± 1.7	55.5 ± 1.5	70.5 ± 1.1	1017.7 ± 0.6	5.5 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

17.2.3 Back Trajectory Analysis

Figure 17-5 and Figure 17-6 are the composite back trajectory maps for days on which samples were collected at the GPMS and TUMS monitoring sites in 2008, respectively. Cluster analyses could not be conducted for GPMS and TUMS because there were fewer than 30 sample days for these sites. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For both maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. Each concentric circle around the sites in Figures 17-5 through 17-6 represents 100 miles.

Observations from Figure 17-5 for GPMS include the following:

- Back trajectories originated from a variety of directions at the GPMS site.
- The 24-hour air shed domain for GPMS was somewhat smaller in size than TUMS and other NMP monitoring sites. The farthest away a trajectory originated was west-central Arkansas, or just over 400 miles away. However, most trajectories originated within 350 miles of the site.
- A composite back trajectory map with a full year's worth of sample days would likely exhibit a different trajectory distribution.

Observations from Figure 17-6 for TUMS include the following:

- Back trajectories also originated from a variety of directions at the TUMS site.
- The 24-hour air shed domain for TUMS was comparable in size to other NMP monitoring sites. The farthest away a trajectory originated was west-central Iowa, or nearly 650 miles away. However, most trajectories originated within 350 miles of the site.
- A composite back trajectory map with a full year's worth of sample days would likely exhibit a different trajectory distribution.

Figure 17-5. 2008 Composite Back Trajectory Map for GPMS

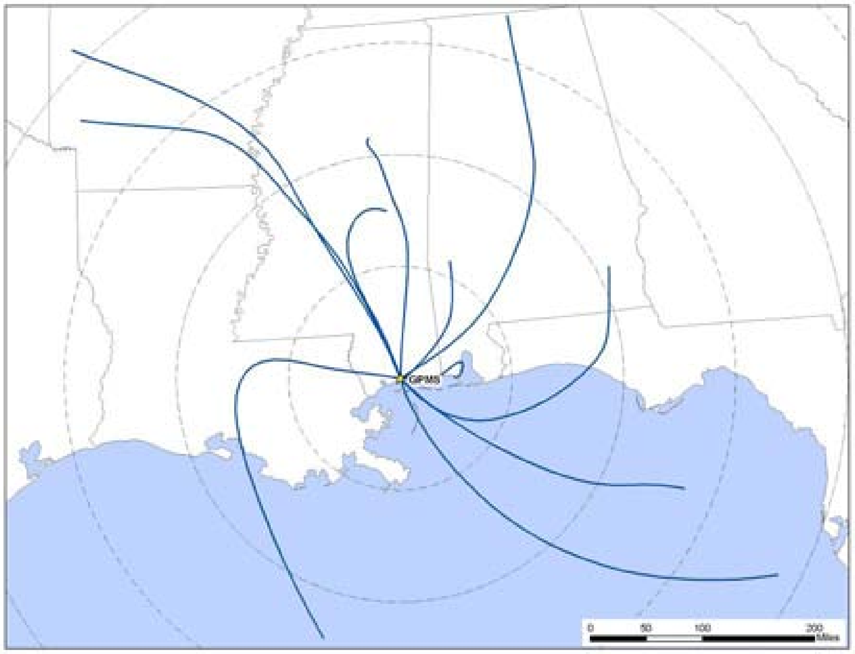
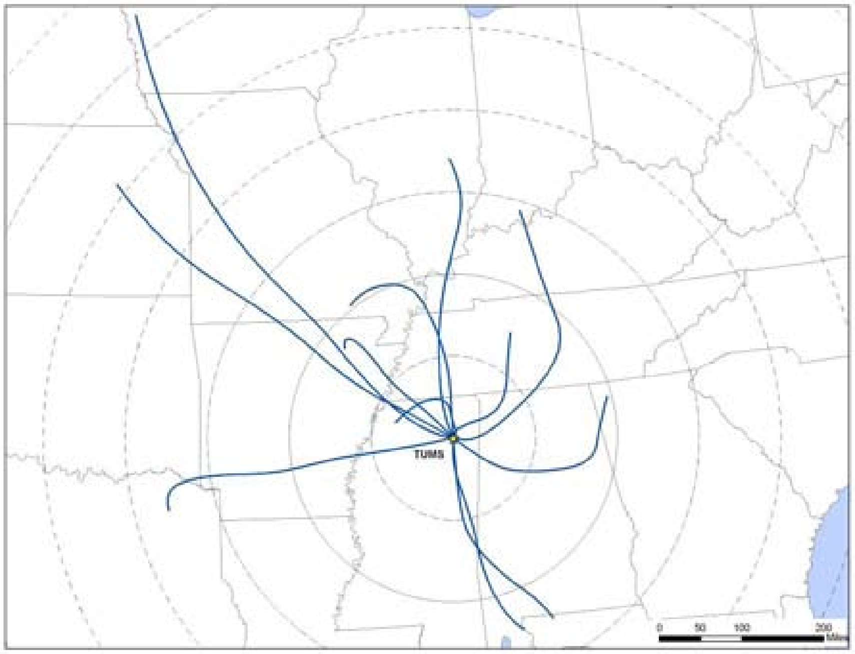


Figure 17-6. 2008 Composite Back Trajectory Map for TUMS



17.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at Gulfport-Biloxi Regional Airport (for GPMS) and Tupelo Municipal Airport (for TUMS) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 17-7 presents three different wind roses for the GPMS monitoring site. First, a historical wind rose representing 1999 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year is presented. Finally, a wind rose representing days on which samples were collected in 2008 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 17-8 presents the wind roses for the TUMS monitoring site.

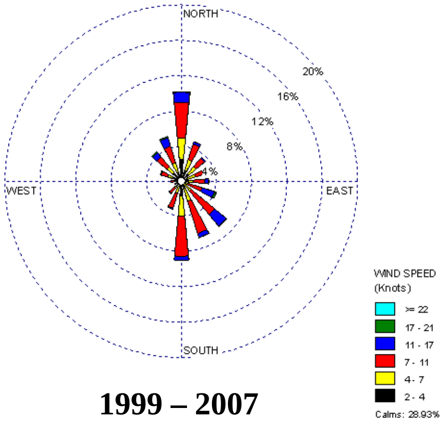
Observations from Figure 17-7 for GPMS include the following:

- Calm winds (≤2 knots) account for approximately one-third of observations for the historical wind rose. Winds from southeast to south account for a combined 25 percent of observations while winds from the north account for 10 percent of observations. The remaining 35 percent of observations are spread around varying directions, although very few of those are from the southwest to west.

- The wind patterns shown on the 2008 wind rose resemble the historical wind patterns, indicating that conditions in 2008 were typical of wind conditions normally experienced near the site.

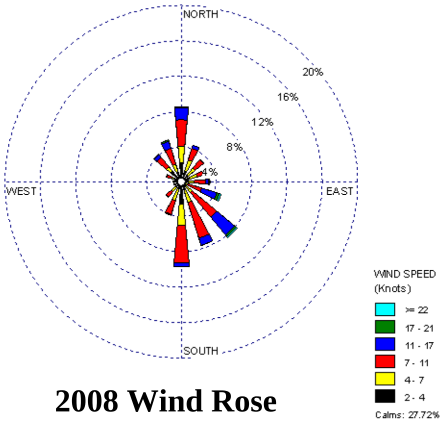
- The 2008 sample day wind rose does not resemble the historical or 2008 full-year wind rose, as winds from the northwest to north-northwest account for the largest percentage of wind directions on sample days. However, the sample day wind rose only includes sample days through March 2008 and likely reflects a seasonal wind pattern.

Figure 17-7. Wind Roses for the Gulfport-Biloxi Regional Airport Weather Station near GPMS

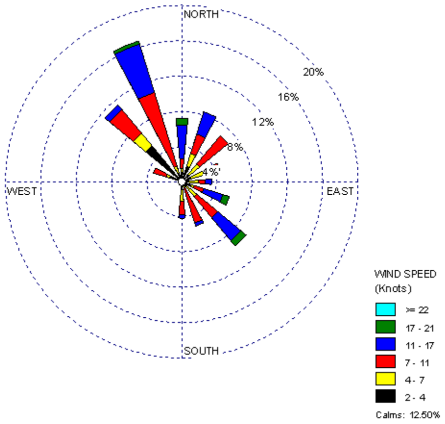


1999 – 2007

Historical Wind Rose



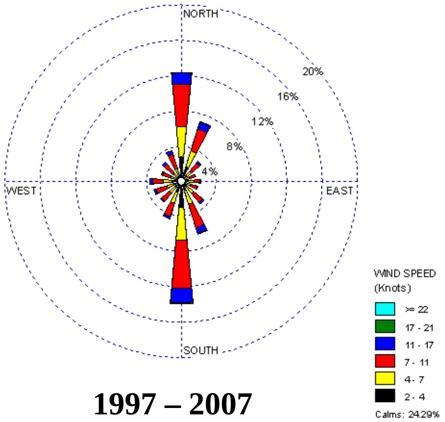
2008 Wind Rose



2008 Sample Day

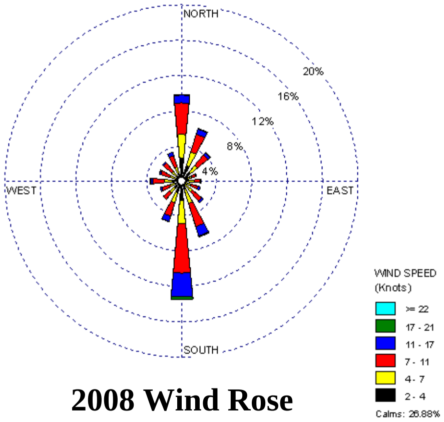
Wind Rose

Figure 17-8. Wind Roses for the Tupelo Municipal Airport Weather Station near TUMS

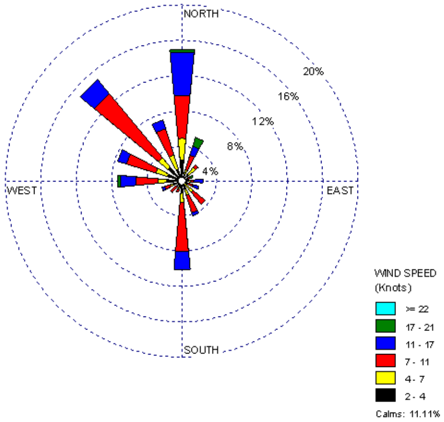


1997 – 2007

Historical Wind Rose



2008 Wind Rose



2008 Sample Day Wind Rose

Observations from Figure 17-8 for TUMS include the following:

- Historically, winds from the north and north-northeast, and south-southeast and south were observed most frequently near TUMS. Calm winds were observed for approximately one-quarter of the hourly measurements.

- The wind patterns shown on the 2008 wind rose resemble the historical wind patterns, indicating that conditions in 2008 were typical of wind conditions normally experienced near the site.

- Although the 2008 sample day wind rose does show the predominant northerly and southerly wind directions, there is a much higher percentage of winds from the northwest quadrant. The percentage of calm wind observations is also much lower. However, the sample day wind rose only includes sample days through March 2008 and likely reflects a seasonal wind pattern.

17.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Mississippi monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 17-4 presents the pollutants of interest for GPMS and TUMS. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. GPMS and TUMS both sampled for VOC and carbonyl compounds. In addition, SNMOC were also sampled at GPMS.

Table 17-4. Risk Screening Results for the Mississippi Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Gulfport, Mississippi - GPMS						
Acetaldehyde	0.45	11	11	100.00	19.64	19.64
Formaldehyde	0.077	11	11	100.00	19.64	39.29
Benzene	0.13	10	10	100.00	17.86	57.14
Carbon Tetrachloride	0.17	10	10	100.00	17.86	75.00
1,3-Butadiene	0.033	8	10	80.00	14.29	89.29
p-Dichlorobenzene	0.091	4	10	40.00	7.14	96.43
Acrylonitrile	0.015	1	1	100.00	1.79	98.21
Vinyl chloride	0.11	1	7	14.29	1.79	100.00
Total		56	70	80.00		
Tupelo, Mississippi - TUMS						
Acetaldehyde	0.45	12	12	100.00	21.82	21.82
Benzene	0.13	12	12	100.00	21.82	43.64
Formaldehyde	0.077	12	12	100.00	21.82	65.45
Carbon Tetrachloride	0.17	11	12	91.67	20.00	85.45
1,3-Butadiene	0.033	5	11	45.45	9.09	94.55
Acrylonitrile	0.015	1	1	100.00	1.82	96.36
1,2-Dichloroethane	0.038	1	1	100.00	1.82	98.18
Vinyl chloride	0.11	1	6	16.67	1.82	100.00
Total		55	67	82.09		

Observations from Table 17-4 include the following:

- Eight pollutants failed at least one screen for GPMS. Eight pollutants also failed at least one screen for TUMS. Six of the eight pollutants failing screens for each site were NATTS MQO Core Analytes. Seven of the eight pollutants failing screens were the same between the two sites.

- The risk screening process identified six pollutants of interest for GPMS, of which five are NATTS MQO Core Analytes. Vinyl chloride, which did not contribute to 95 percent of the total failed screens, was added to the pollutants of interest for GPMS because it is a NATTS MQO Core Analyte. Three additional pollutants were added to the pollutants of interest for GPMS because they are also NATTS MQO Core Analytes, even though they did not fail any screens: chloroform, tetrachloroethylene, and trichloroethylene. These three pollutants are not shown in Table 17-4.

- The risk screening process identified eight pollutants of interest for TUMS, of which six are NATTS MQO Core Analytes. Note that although acrylonitrile is the last pollutant contributing to 95 percent of failed screens, both vinyl chloride and 1,2-dichloroethane failed the same number of screens (one each). Because the order for pollutants failing the same number of screens is based on alphabetical order, and and results in the inclusion of acrylonitrile but exclusion of other pollutants failing the same number of screens, each of these three pollutants is considered a pollutant of interest.

- Three additional pollutants were added to the pollutants of interest for TUMS because they are also NATTS MQO Core Analytes, even though they did not fail any screens: chloroform, tetrachloroethylene, and trichloroethylene. These three pollutants are not shown in Table 17-4.

- Acetaldehyde, acrylonitrile, benzene, and formaldehyde failed 100 percent of their screens for both sites. Note that acrylonitrile was detected only once at each site.

17.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Mississippi monitoring sites. Concentration averages are provided for the pollutants of interest for each Mississippi site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

17.4.1 2008 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Mississippi site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 17-5, where applicable.

Table 17-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Mississippi Monitoring Sites

Pollutant	2008					
	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Gulfport, Mississippi - GPMS						
Acetaldehyde	0.89 ± 0.23	0.89 ± 0.23	NR	NR	NR	NA
Benzene	0.92 ± 0.36	0.92 ± 0.36	NR	NR	NR	NA
1,3-Butadiene	0.06 ± 0.03	0.06 ± 0.03	NR	NR	NR	NA
Carbon Tetrachloride	0.58 ± 0.15	0.58 ± 0.15	NR	NR	NR	NA
Chloroform	0.10 ± 0.03	0.10 ± 0.03	NR	NR	NR	NA
p-Dichlorobenzene	0.10 ± 0.06	0.10 ± 0.06	NR	NR	NR	NA
Formaldehyde	1.35 ± 0.34	1.35 ± 0.34	NR	NR	NR	NA
Tetrachloroethylene	0.09 ± 0.03	0.07 ± 0.03	NR	NR	NR	NA
Trichloroethylene	0.03 ± <0.01	NA	NR	NR	NR	NA
Vinyl Chloride	0.03 ± 0.04	0.02 ± 0.03	NR	NR	NR	NA
Tupelo, Mississippi - TUMS						
Acetaldehyde	0.82 ± 0.08	0.82 ± 0.08	NR	NR	NR	NA
Acrylonitrile	0.29 ± <0.01	NA	NR	NR	NR	NA
Benzene	0.61 ± 0.08	0.61 ± 0.08	NR	NR	NR	NA
1,3-Butadiene	0.04 ± 0.01	0.04 ± 0.01	NR	NR	NR	NA
Carbon Tetrachloride	0.59 ± 0.12	0.59 ± 0.12	NR	NR	NR	NA
Chloroform	0.08 ± 0.01	0.08 ± 0.01	NR	NR	NR	NA
1,2-Dichloroethane	0.06 ± <0.01	NA	NR	NR	NR	NA
Formaldehyde	1.32 ± 0.18	1.32 ± 0.18	NR	NR	NR	NA
Tetrachloroethylene	0.07 ± 0.02	0.06 ± 0.02	NR	NR	NR	NA
Trichloroethylene	0.03 ± <0.01	NA	NR	NR	NR	NA
Vinyl chloride	0.03 ± 0.04	NA	NR	NR	NR	NA

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations from Table 17-5 include the following:

- The pollutants with the highest daily average concentrations by mass for GPMS were formaldehyde (1.35 ± 0.34 µg/m^3), benzene (0.92 ± 0.36 µg/m^3), and acetaldehyde (0.89 ± 0.23 µg/m^3).

- The pollutants with the highest daily average concentrations by mass for TUMS were also formaldehyde (1.32 ± 0.18 µg/m^3), acetaldehyde (0.82 ± 0.08 µg/m^3), and benzene (0.61 ± 0.08 µg/m^3).

- The first quarter was the only quarter for which quarterly averages could be calculated, as GPMS and TUMS stopped sampling in March 2008.

- Note that for most of the pollutants of interest for the Mississippi sites, the daily average was equal to the first quarterly average, as most pollutants were detected in every sample collected. Exceptions include tetrachloroethylene and vinyl chloride.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for TUMS and GPMS from the tables include the following:

- TUMS and GPMS had the third and fifth highest daily average concentrations of vinyl chloride, respectively (both for 2008). However, as shown in Table 17-5, the confidence interval for this pollutant is higher than the daily average concentration for each site, indicating that outliers are influencing the average. One relatively high concentration of vinyl chloride was measured at each site in March 2008 (0.14 µg/m^3 measured at GPMS on March 6, 2008 and 0.13 µg/m^3 measured at TUMS on March 1, 2008). Each of these measurements was an order of magnitude higher than other vinyl chloride concentrations measured at the sites.

17.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. Although GPMS and TUMS have sampled VOC and carbonyl compounds under the NMP since 2003, and therefore meet the criteria for a trends analysis to be conducted, these sites stopped sampling at the beginning of March 2008. Because it is unlikely that the samples collected at the beginning of 2008 are representative of the entire year, the trends analysis was not conducted.

17.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Mississippi monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

17.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Mississippi monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Mississippi monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

17.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Mississippi monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages (and therefore cancer and noncancer surrogate approximations) could not be calculated for the Mississippi monitoring sites' pollutants of interest because sampling ended in March 2008 (and less than three quarterly averages are available), as shown in Table 17-6.

Table 17-6. Cancer and Noncancer Surrogate Risk Approximations for the Mississippi Monitoring Sites

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008 # of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncaner Risk Approximation (HQ)
Gulfport, Mississippi - GPMS						
Acetaldehyde	2.2E-06	0.009	11/1	NA	NA	NA
Benzene	7.8E-06	0.03	10/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	10/1	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	10/1	NA	NA	NA
Chloroform	--	0.098	10/1	NA	NA	NA
p-Dichlorobenzene	0.000011	0.8	10/1	NA	NA	NA
Formaldehyde	0.000013	0.0098	11/1	NA	NA	NA
Tetrachloroethylene	5.9E-06	0.27	8/1	NA	NA	NA
Trichloroethylene	0.000002	0.6	1/0	NA	NA	NA
Vinyl Chloride	8.8E-06	0.1	7/1	NA	NA	NA
Tupelo, Mississippi - TUMS						
Acetaldehyde	2.2E-06	0.009	12/1	NA	NA	NA
Acrylonitrile	0.000068	0.002	1/0	NA	NA	NA
Benzene	7.8E-06	0.03	12/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	11/1	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	12/1	NA	NA	NA
Chloroform	--	0.098	12/1	NA	NA	NA
1,2-Dichloroethane	0.000026	2.4	1/0	NA	NA	NA
Formaldehyde	0.000013	0.0098	12/1	NA	NA	NA
Tetrachloroethylene	5.9E-06	0.27	10/1	NA	NA	NA
Trichloroethylene	0.000002	0.6	1/0	NA	NA	NA
Vinyl chloride	8.8E-06	0.1	6/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.

17.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 17-7 and 17-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 17-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 17-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages.

Table 17-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Mississippi 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Gulfport, Mississippi (Harrison County) - GPMS					
Benzene	253.69	Hexavalent Chromium, PM	3.18E-03		
Formaldehyde	244.64	Formaldehyde	3.06E-03		
Acetaldehyde	59.64	Benzene	1.98E-03		
1,3-Butadiene	48.20	1,3-Butadiene	1.45E-03		
Dichloromethane	16.39	Arsenic, PM	7.58E-04		
Tetrachloroethylene	16.03	POM, Group 2	3.63E-04		
POM, Group 2	6.61	Naphthalene	2.01E-04		
Naphthalene	5.90	Acetaldehyde	1.31E-04		
p-Dichlorobenzene	4.11	POM, Group 5	1.17E-04		
Trichloroethylene	1.20	Nickel, PM	9.76E-05		
Tupelo, Mississippi (Lee County) - TUMS					
Dichloromethane	146.90	Formaldehyde	8.66E-04		
Benzene	96.25	Benzene	7.51E-04		
Formaldehyde	69.31	1,3-Butadiene	4.49E-04		
Acetaldehyde	23.05	Hexavalent Chromium, PM	1.54E-04		
1,3-Butadiene	14.96	Naphthalene	1.33E-04		
Tetrachloroethylene	6.34	POM, Group 2	1.11E-04		
Naphthalene	3.92	1,2-Dibromo-3-chloropropane	1.07E-04		
Trichloroethylene	2.40	Dichloromethane	6.90E-05		
POM, Group 2	2.01	Arsenic, PM	5.33E-05		
p-Dichlorobenzene	1.74	Acetaldehyde	5.07E-05		

Table 17-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Mississippi 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Gulfport, Mississippi (Harrison County) - GPMS					
Xylenes	972.71	Acrolein	1,628,163.58		
Toluene	759.22	Manganese, PM	64,982.33		
Hydrochloric acid	578.35	Chlorine	59,000.00		
Benzene	253.69	Hydrochloric acid	28,917.45		
Formaldehyde	244.64	Formaldehyde	24,962.88		
Ethylbenzene	205.28	1,3-Butadiene	24,101.68		
Hexane	191.20	Xylenes	9,727.09		
Methanol	123.76	Nickel, PM	9,388.70		
Hydroflouric acid	100.07	Benzene	8,456.45		
Methyl isobutyl ketone	70.84	Acetaldehyde	6,626.76		
Tupelo, Mississippi (Lee County) - TUMS					
Toluene	346.52	Acrolein	327,135.74		
Xylenes	256.13	1,3-Butadiene	7,481.54		
Methyl isobutyl ketone	204.12	Formaldehyde	7,072.32		
Dichloromethane	146.90	2,4-Toluene diisocyanate	4,091.84		
Benzene	96.25	Benzene	3,208.27		
Formaldehyde	69.31	Manganese, PM	2,946.76		
Methanol	68.41	Acetaldehyde	2,561.42		
Hexane	62.04	Xylenes	2,561.26		
Ethylbenzene	47.64	Cyanide Compounds, gas	1,930.87		
Glycol ethers, gas	36.52	Glycol ethers, gas	1,825.78		

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 17.3, GPMS and TUMS both sampled for VOC and carbonyl compounds; GPMS also sampled for SNMOC. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. As discussed above, annual averages, and thus cancer and noncancer surrogate risk approximations, could not be calculated for either Mississippi site. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 17-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Harrison County. Dichloromethane was the highest emitted pollutant in Lee County, followed by benzene, formaldehyde, and acetaldehyde. With the exception of dichloromethane and trichloroethylene, emissions tended to be higher in Harrison County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Harrison County were hexavalent chromium, formaldehyde, benzene, and 1,3-butadiene. These pollutants also had the highest toxicity-weighted emissions for Lee County, although not in that same order.

- Six of the highest emitted pollutants in Harrison County also had the highest toxicity-weighted emissions. Seven of the highest emitted pollutants in Lee County also had the highest toxicity-weighted emissions.

Observations from Table 17-9 include the following:

- Xylenes, toluene, and hydrochloric acid were the highest emitted pollutants with noncancer RfCs in Harrison County. Toluene, xylenes, and methyl isobutyl ketone were the highest emitted pollutants in Lee County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties was acrolein. This pollutant is not among the 10 highest emitted pollutants in either county. Although acrolein was sampled for at both sites, this pollutant was excluded from the pollutant of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the highest emitted pollutants in Harrison County also had the highest toxicity-weighted emissions. Four of the highest emitted pollutants in Lee County also had the highest toxicity-weighted emissions (three of the four pollutants were the same between the two counties).

17.6 Summary of the 2008 Monitoring Data for GPMS and TUMS

Results from several of the treatments described in this section include the following:

- *Eight pollutants failed screens for each Mississippi monitoring site; of these, six were NATTS MQO Core Analytes.*

- *Of the site-specific pollutants of interest, formaldehyde had the highest daily average concentration for each monitoring site.*

- *None of the preprocessed daily measurements and none of the first quarter 2008 average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

18.0 Site in Missouri

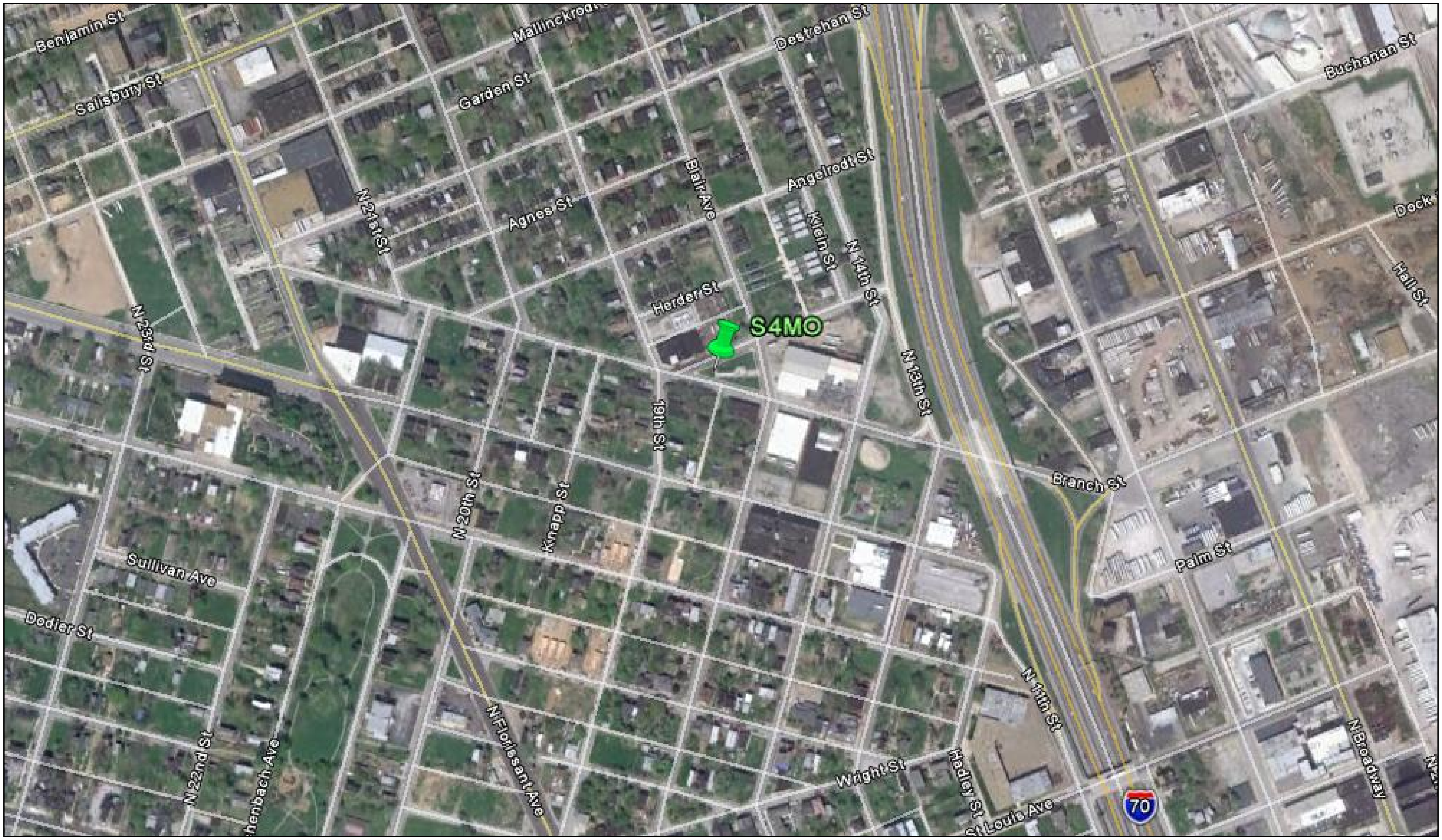
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Missouri, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

18.1 Site Characterization

This section characterizes the S4MO monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The S4MO monitoring site is located in the St. Louis, MO-IL MSA. Figure 18-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 18-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 18-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 18-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

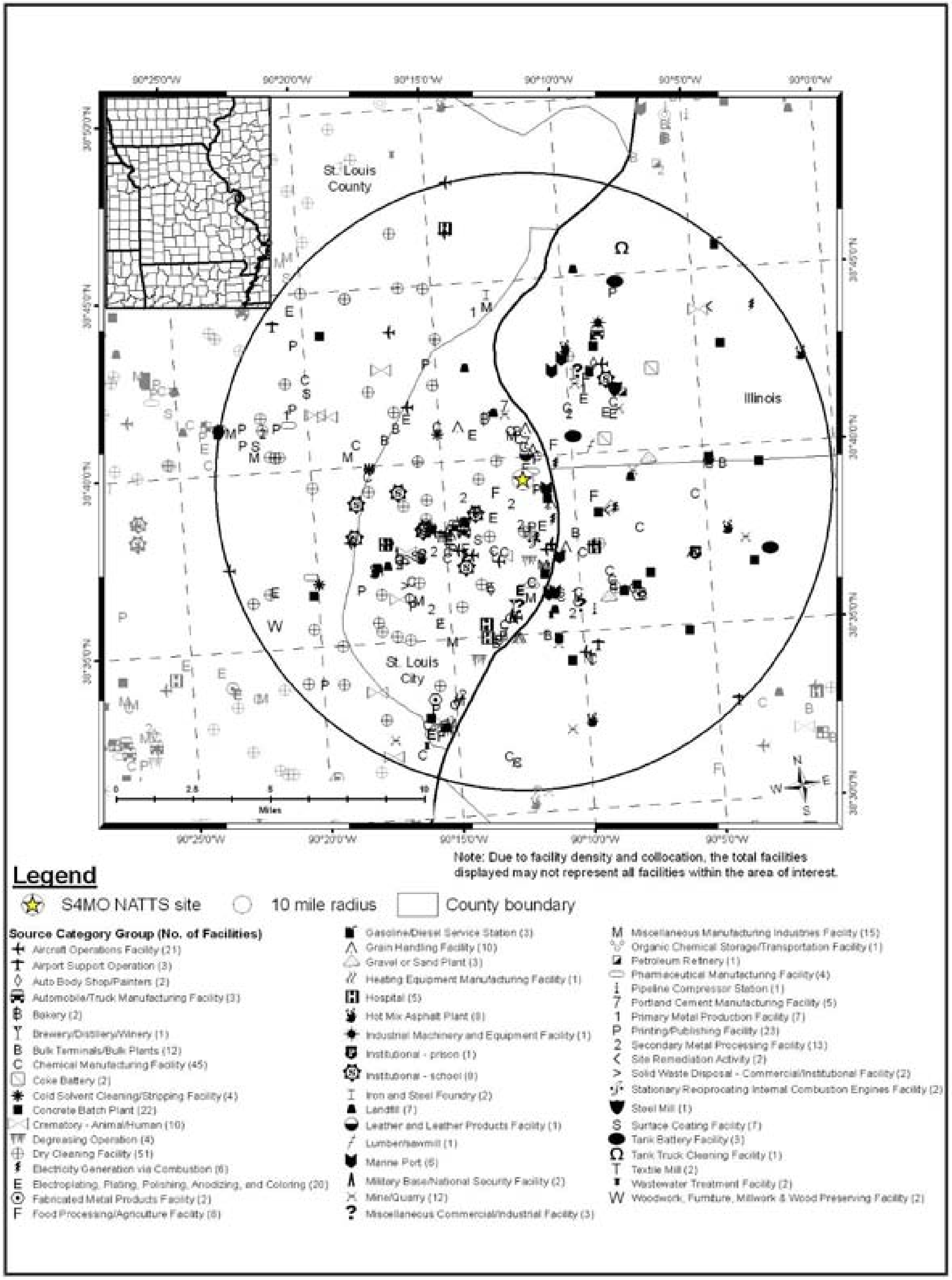
Figure 18-1. St. Louis, Missouri (S4MO) Monitoring Site



©2010 Google Earth, accessed 11/10/2010

Scale: 2 inches = 1,385 feet

Figure 18-2. NEI Point Sources Located Within 10 Miles of S4MO


90°25'0"W
90°20'0"W
90°15'0"W
90°10'0"W
90°5'0"W
90°0'0"W
38°50'0"N
38°45'0"N
38°40'0"N
38°35'0"N
38°30'0"N
St. Louis County
St. Louis City
Illinois
0
2.5
5
10
Miles
N
S
E
W
Legend
S4MO NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (21)
Airport Support Operation (3)
Auto Body Shop/Painters (2)
Automobile/Truck Manufacturing Facility (3)
Bakery (2)
Brewery/Distillery/Winery (1)
B Bulk Terminals/Bulk Plants (12)
C Chemical Manufacturing Facility (45)
Coke Battery (2)
Cold Solvent Cleaning/Stripping Facility (4)
Concrete Batch Plant (22)
Crematory - Animal/Human (10)
Degreasing Operation (4)
Dry Cleaning Facility (51)
Electricity Generation via Combustion (6)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (20)
Fabricated Metal Products Facility (2)
F Food Processing/Agriculture Facility (8)
Gasoline/Diesel Service Station (3)
Grain Handling Facility (10)
Gravel or Sand Plant (3)
Heating Equipment Manufacturing Facility (1)
Hospital (5)
Hot Mix Asphalt Plant (8)
Industrial Machinery and Equipment Facility (1)
Institutional - prison (1)
Institutional - school (8)
Iron and Steel Foundry (2)
Landfill (7)
Leather and Leather Products Facility (1)
Lumber/sawmill (1)
Marine Port (6)
Military Base/National Security Facility (2)
Mine/Quarry (12)
? Miscellaneous Commercial/Industrial Facility (3)
M Miscellaneous Manufacturing Industries Facility (15)
Organic Chemical Storage/Transportation Facility (1)
Petroleum Refinery (1)
Pharmaceutical Manufacturing Facility (4)
Pipeline Compressor Station (1)
7 Portland Cement Manufacturing Facility (5)
1 Primary Metal Production Facility (7)
P Printing/Publishing Facility (23)
2 Secondary Metal Processing Facility (13)
< Site Remediation Activity (2)
> Solid Waste Disposal - Commercial/Institutional Facility (2)
Stationary Reciprocating Internal Combustion Engines Facility (2)
Steel Mill (1)
S Surface Coating Facility (7)
Tank Battery Facility (3)
Ω Tank Truck Cleaning Facility (1)
T Textile Mill (2)
Wastewater Treatment Facility (2)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 18-1. Geographical Information for the Missouri Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
S4MO	29-510-0085	St. Louis	St. Louis	St. Louis, MO-IL	38.656436, -90.198661	Residential	Urban/City Center	CO, O_3, Meteorological parameters, PM_{10}, Black carbon, $PM_{2.5}$, $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

S4MO is located in central St. Louis. Figure 18-1 shows that the S4MO monitoring site is located less than 1/4 mile west of I-70. The Mississippi River, which separates Missouri from Illinois, is less than 1 mile east of the site. Although the area directly around the monitoring site is residential, industrial facilities are located just on the other side of I-70. Figure 18-2 shows that a large number of point sources are located within 10 miles of S4MO. The source categories with the highest number of point sources surrounding S4MO are involved in dry cleaning; chemical manufacturing; printing and publishing; concrete batching; and aircraft operations, which include airports as well as small runways, heliports, or landing pads. In the immediate vicinity of S4MO are an electroplating, plating, polishing, anodizing, and coloring facility; a pharmaceutical manufacturing facility; and a printing and publishing facility.

Table 18-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Missouri monitoring site. Information provided in Table 18-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for St. Louis City and County were obtained from the Missouri Department of Revenue (MO DOR, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 18-2 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 estimate of the 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 18-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 18-2 presents the daily VMT for the St. Louis urban area.

Table 18-2. Population, Motor Vehicle, and Traffic Information for the Missouri Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
S4MO	992,408	1,132,283	1.14	816,098	931,123	81,174	66,114

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Missouri DOR (MO DOR, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Missouri DOT (MO DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 18-2 include the following:

- S4MO's county and 10-mile populations were in the upper third of the range compared to other counties with NMP sites. This is also true for its county-level and 10-mile vehicle ownership.
- The vehicle-per-person ratio was in the top third compared to other NMP sites.
- The traffic volume experienced near S4MO was also in the top third compared to other NMP monitoring sites. The traffic estimate used came from I-70 near Exit 250.
- The St. Louis area VMT ranked in the mid to upper end of the range among urban areas with NMP sites.

18.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Missouri on sample days, as well as over the course of each year.

18.2.1 Climate Summary

The City of St. Louis is located along the Mississippi River, which makes up Missouri's eastern border. St. Louis has a climate that is continental in nature, with cold, dry winters; warm, somewhat wetter summers; and significant seasonal variability. Warm, moist air flowing northward from the Gulf of Mexico alternating with cold, dry air marching southward from Canada and the northern U.S. result in weather patterns that do not persist for very long. The City of St. Louis does experience the urban heat island effect, retaining more heat within the city than outlying areas (Bair, 1992 and MCC, 2011).

18.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station is located at St. Louis Downtown Airport (WBAN 03960). Additional information about this weather station is provided in Table 18-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 18-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 18-3 is the 95 percent confidence interval for each parameter. As shown in Table 18-3, average meteorological conditions on sample days in 2008 were fairly representative of average weather conditions throughout the year. For 2009, sample days appear slightly cooler than conditions over the entire year. Several invalid sample collection events were made-up in January, March, November, and December, leading to a higher number of sample days in cooler months of the year factoring into the sample day averages.

18.2.3 Back Trajectory Analysis

Figure 18-3 and Figure 18-4 are the composite back trajectory maps for days on which samples were collected at the S4MO monitoring site in 2008 and 2009, respectively. Figure 18-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 18-3 through 18-5 represents 100 miles.

Table 18-3. Average Meteorological Conditions near the Missouri Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction From Site	Year	Average Type[1]	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)
St. Louis, Missouri – S4MO										
St. Louis Downtown Airport 03960 (38.57, -90.16)	6.26 miles 157° (SSE)	2008	Sample Day	64.0 ± 5.0	55.1 ± 4.6	44.0 ± 4.7	49.6 ± 4.2	68.6 ± 2.6	1016.8 ± 1.5	7.4 ± 0.9
			All Year	64.2 ± 2.0	54.5 ± 1.9	43.5 ± 1.9	49.0 ± 1.8	69.0 ± 1.0	1017.2 ± 0.7	6.5 ± 0.3
		2009	Sample Day	62.1 ± 4.5	52.8 ± 4.3	41.9 ± 4.5	47.6 ± 4.0	69.3 ± 3.0	1017.1 ± 1.8	6.3 ± 0.8
			All Year	64.5 ± 1.9	55.0 ± 1.8	44.3 ± 1.9	49.6 ± 1.7	69.7 ± 1.2	1016.6 ± 0.7	6.0 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Figure 18-3. 2008 Composite Back Trajectory Map for S4MO

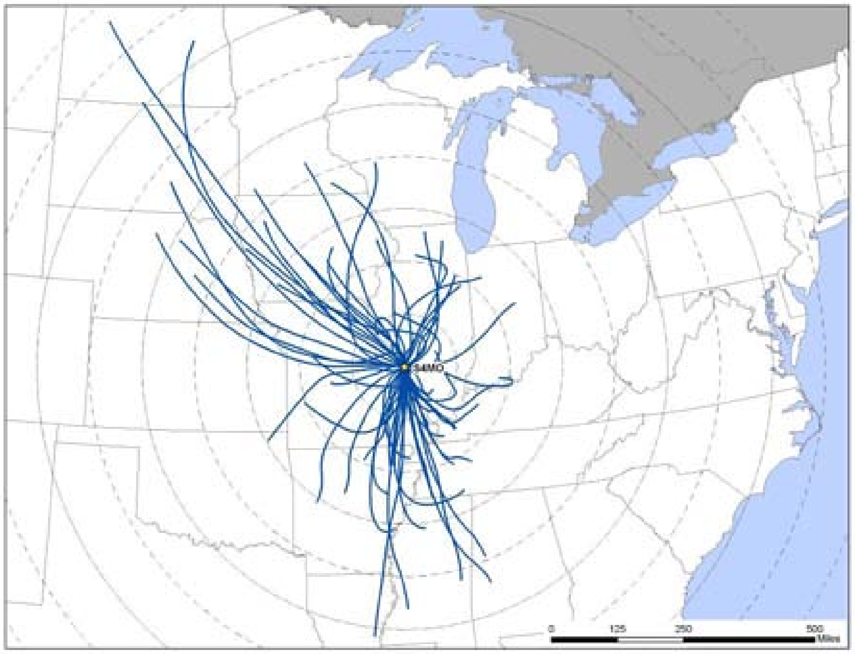


Figure 18-4. 2009 Composite Back Trajectory Map for S4MO

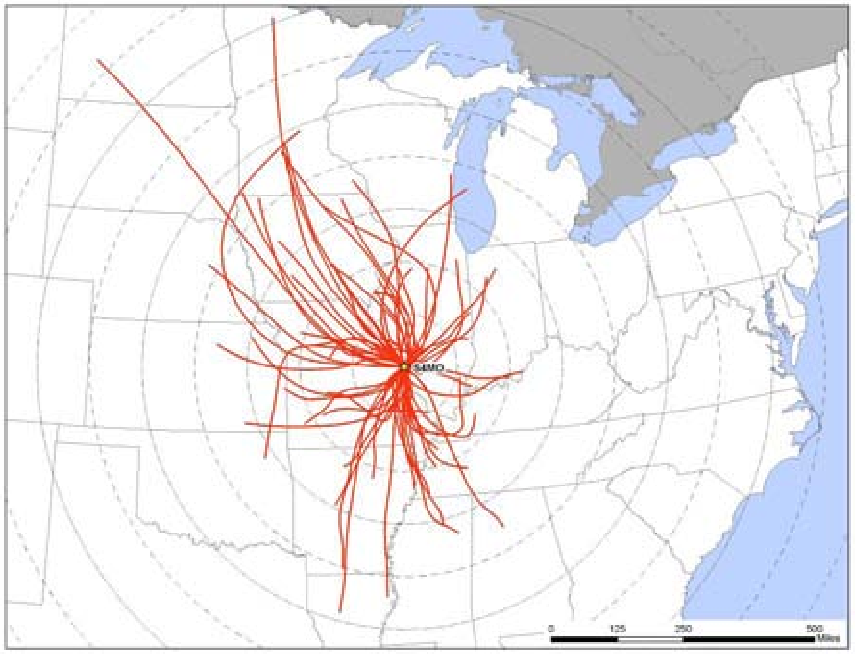
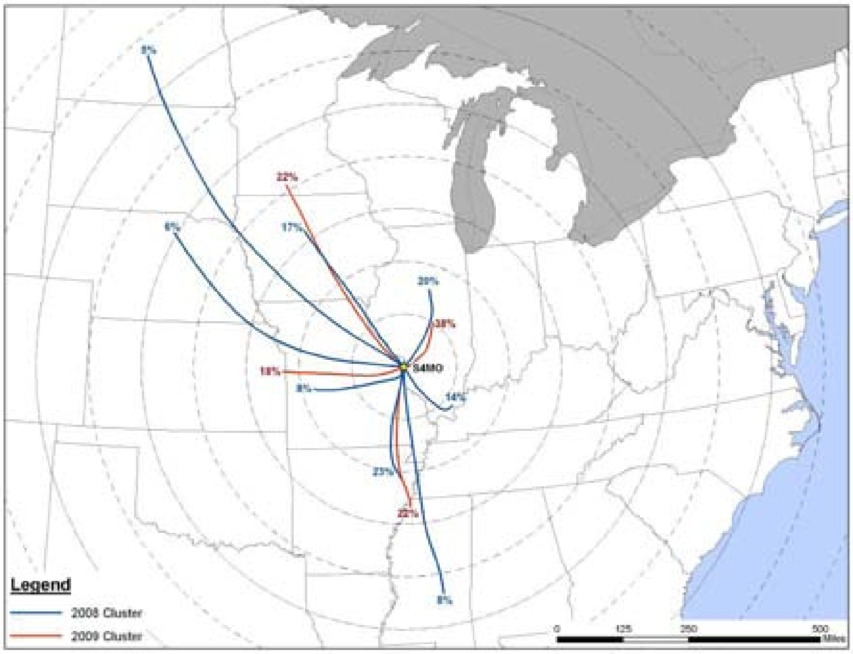


Figure 18-5. Back Trajectory Cluster Map for S4MO



Observations from Figures 18-3 through 18-5 for S4MO include the following:

- Back trajectories originated from a variety of directions at S4MO.
- The 24-hour air shed domain for S4MO was comparable in size to other NMP sites. The farthest away a trajectory originated was over 850 miles, over northwest North Dakota, which was among the longest trajectories for any NMP site. However, the average trajectory length was 268 miles. Most trajectories (82 percent) originated within 400 miles of the monitoring site.
- The cluster analysis shows that many trajectories originated to the west, northwest, and north of S4MO. Another cluster of trajectories originated to the south of the monitoring site. A third cluster of trajectories originated to the northeast, east, and southeast and within a relatively short distance of S4MO, generally within 200 miles of the site and over the state of Illinois.

18.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at St. Louis Downtown Airport near S4MO were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 18-6 presents five different wind roses for the S4MO monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

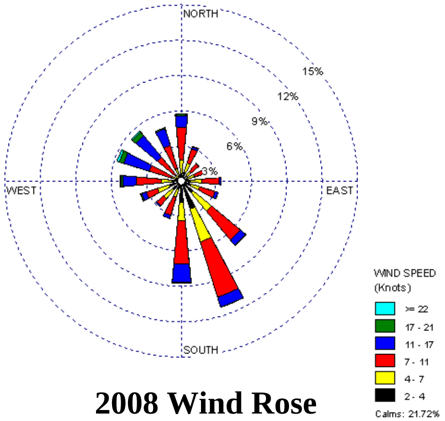
Observations from Figure 18-6 for S4MO include the following:

- The historical wind rose shows that winds from the southeast, south-southeast, and south were frequently observed near S4MO. Winds from these directions accounted for just over 25 percent of observations. Calm winds (≤2 knots) were observed for approximately 23 percent of the hourly wind measurements. Winds from the west, northwest, and north account for another quarter of the observations.

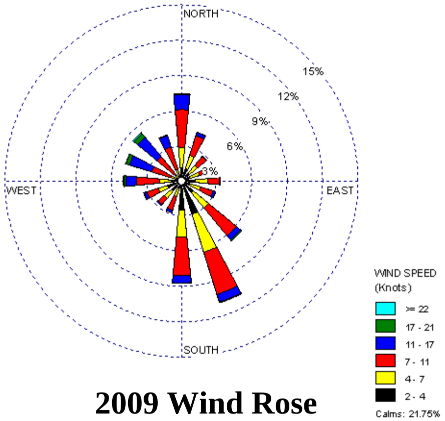
- The wind patterns shown on the 2008 wind rose resemble the historical wind patterns, indicating that conditions in 2008 were typical of those experienced historically. The 2008 sample day wind patterns also resemble the historical wind patterns, although there were fewer calm winds and slightly more south-southeasterly, southerly, and west-northwesterly winds observed.

- The 2009 wind patterns also resemble the historical wind patterns. The 2009 sample day wind patterns also resemble the historical and full-year wind patterns, but with slightly less south-southeasterly and southerly winds and more northwesterly and north-northeasterly winds observed.

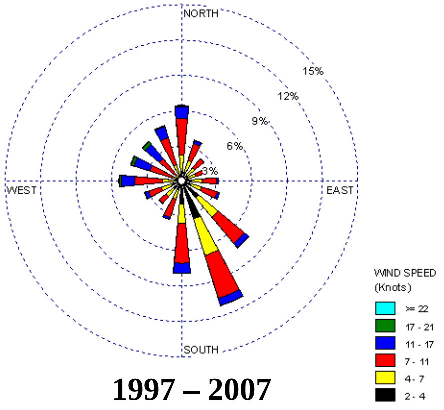
Figure 18-6. Wind Roses for the St. Louis Downtown Airport Weather Station near S4MO



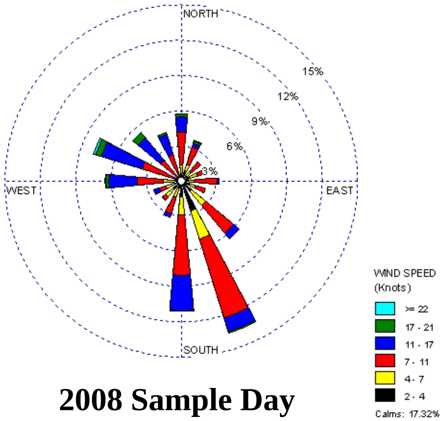
2008 Wind Rose



2009 Wind Rose

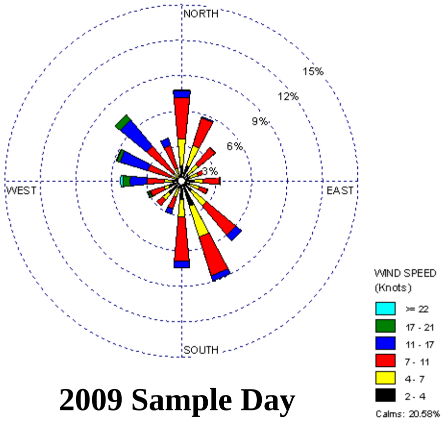


1997 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

18.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for S4MO in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 18-4 presents S4MO's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. S4MO sampled for VOC, PAH, carbonyl compounds, metals (PM_{10}), and hexavalent chromium.

Observations from Table 18-4 include the following:

- Twenty-three pollutants, of which 15 are NATTS MQO Core Analytes, failed at least one screen for S4MO.
- Nearly 48 percent of measured detections failed screens (of the pollutants that failed at least one screen) for S4MO. S4MO had the second highest number of failed screens among all NMP sites, behind only PXSS.
- Six pollutants failed 100 percent of screens for S4MO: benzene, acetaldehyde, formaldehyde, acrylonitrile, 1,2-dichloroethane, and 1,2-dibromoethane. (Note that these last two pollutants were detected in only a few samples).
- Thirteen pollutants were identified as pollutants of interest for S4MO based on the risk screening process; of these, 11 were NATTS MQO Core Analytes. Four additional pollutants (nickel, hexavalent chromium, trichloroethylene, and benzo(a)pyrene) were added to S4MO's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of S4MO's failed screens. Three more pollutants (beryllium, chloroform, and vinyl chloride) were also added to S4MO's pollutants of interest because they are NATTS

MQO Core Analytes, even though they did not fail any screens. These three pollutants are not shown in Table 18-4.

Table 18-4. Risk Screening Results for the Missouri Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Louis, Missouri - S4MO						
Acetaldehyde	0.45	121	121	100.00	11.05	11.05
Benzene	0.13	121	121	100.00	11.05	22.10
Formaldehyde	0.077	121	121	100.00	11.05	33.15
Carbon Tetrachloride	0.17	116	121	95.87	10.59	43.74
Arsenic (PM_{10})	0.00023	115	119	96.64	10.50	54.25
1,3-Butadiene	0.033	102	114	89.47	9.32	63.56
Naphthalene	0.029	97	103	94.17	8.86	72.42
Manganese (PM_{10})	0.005	84	119	70.59	7.67	80.09
Cadmium (PM_{10})	0.00056	44	119	36.97	4.02	84.11
p-Dichlorobenzene	0.091	44	110	40.00	4.02	88.13
Tetrachloroethylene	0.17	40	117	34.19	3.65	91.78
Acrylonitrile	0.015	29	29	100.00	2.65	94.43
Lead (PM_{10})	0.015	24	119	20.17	2.19	96.62
Ethylbenzene	0.4	14	121	11.57	1.28	97.90
1,2-Dichloroethane	0.038	7	7	100.00	0.64	98.54
Dichloromethane	2.1	6	121	4.96	0.55	99.09
Bromomethane	0.5	2	118	1.69	0.18	99.27
Hexavalent Chromium	0.000083	2	84	2.38	0.18	99.45
Trichloroethylene	0.5	2	61	3.28	0.18	99.63
Benzo(a)pyrene	0.00091	1	92	1.09	0.09	99.73
1,2-Dibromoethane	0.0017	1	1	100.00	0.09	99.82
Nickel (PM_{10})	0.009	1	119	0.84	0.09	99.91
Propionaldehyde	0.8	1	121	0.83	0.09	100.00
Total		1,095	2,278	48.07		

18.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Missouri monitoring site. Concentration averages are provided for the pollutants of interest for the S4MO site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

18.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for S4MO, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 18-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium are presented in ng/m^3 for ease of viewing.

Observations for S4MO from Table 18-5 include the following:

- The pollutants with the highest 2008 daily average concentrations by mass were formaldehyde (2.86 ± 0.42 µg/m^3), acetaldehyde (1.83 ± 0.25 µg/m^3), and acrylonitrile (1.04 ± 2.05 µg/m^3). The pollutants with the highest 2009 daily average concentrations by mass were formaldehyde (2.46 ± 0.35 µg/m^3), acetaldehyde (2.37 ± 0.37 µg/m^3), and benzene (0.84 ± 0.12 µg/m^3).

- Note that not one quarterly average could be calculated for acrylonitrile for 2008 (and thus, no annual average either). This pollutant was detected in only four samples in 2008. Further, the concentrations ranged from 0.087 µg/m^3 to 3.59 µg/m^3, which explains the large confidence interval associated with this daily average. The daily average for 2009 is much lower and is based on more measured detections.

- The fourth quarter 2008 average for 1,3-butadiene is higher than the other quarterly averages and has a large confidence interval associated with it, indicating the likely presence of outliers. The highest concentration of 1,3-butadiene measured at this site was 1.03 µg/m^3, which was measured on November 26, 2008. This concentration was nearly three times higher than the next highest measurement (0.355 µg/m^3 measured on October 9, 2008), and the fourth highest 1,3-butadiene concentration among NMP sites sampling this pollutant. Note that of the 10 highest concentrations of 1,3-butadiene measured at S4MO, half of them were measured during this quarter.

Table 18-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Missouri Monitoring Site

Pollutant	**2008**						**2009**					
	Daily Average (µg/m^3)	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
St. Louis, Missouri - S4MO												
Acetaldehyde	1.83 ± 0.25	2.35 ± 0.61	1.39 ± 0.27	1.76 ± 0.35	1.75 ± 0.63	1.83 ± 0.25	2.37 ± 0.37	1.45 ± 0.21	1.68 ± 0.26	2.64 ± 0.75	3.82 ± 0.92	2.37 ± 0.37
Acrylonitrile	1.04 ± 2.05	NA	NA	NA	NA	NA	0.11 ± 0.02	0.05 ± 0.03	NA	0.05 ± 0.04	NA	NA
Benzene	1.00 ± 0.17	0.78 ± 0.16	0.76 ± 0.15	0.97 ± 0.22	1.49 ± 0.60	1.00 ± 0.17	0.84 ± 0.12	1.22 ± 0.32	0.81 ± 0.20	0.55 ± 0.11	0.77 ± 0.21	0.84 ± 0.12
1,3-Butadiene	0.09 ± 0.04	0.06 ± 0.02	0.05 ± 0.01	0.09 ± 0.03	0.16 ± 0.14	0.09 ± 0.03	0.07 ± 0.01	0.07 ± 0.02	0.06 ± 0.01	0.06 ± 0.02	0.07 ± 0.04	0.06 ± 0.01
Carbon Tetrachloride	0.71 ± 0.06	0.55 ± 0.15	0.69 ± 0.10	0.74 ± 0.09	0.86 ± 0.10	0.71 ± 0.06	0.69 ± 0.06	0.56 ± 0.12	0.69 ± 0.12	0.82 ± 0.07	0.68 ± 0.15	0.69 ± 0.06
Chloroform	0.22 ± 0.09	0.11 ± 0.04	0.13 ± 0.03	0.45 ± 0.36	0.18 ± 0.05	0.22 ± 0.09	0.21 ± 0.06	0.12 ± 0.03	0.24 ± 0.18	0.31 ± 0.16	0.18 ± 0.07	0.21 ± 0.06
Formaldehyde	2.86 ± 0.42	2.18 ± 0.25	2.76 ± 0.72	4.18 ± 1.18	2.26 ± 0.63	2.86 ± 0.42	2.46 ± 0.35	2.24 ± 0.49	3.41 ± 0.97	2.72 ± 0.57	1.45 ± 0.30	2.46 ± 0.35
p-Dichlorobenzene	0.36 ± 0.26	0.08 ± 0.06	0.53 ± 0.78	0.22 ± 0.14	0.41 ± 0.46	0.31 ± 0.23	0.15 ± 0.05	0.06 ± 0.06	0.22 ± 0.17	0.15 ± 0.06	0.11 ± 0.05	0.14 ± 0.05
Tetrachloroethylene	0.19 ± 0.03	0.16 ± 0.07	0.13 ± 0.03	0.22 ± 0.04	0.20 ± 0.09	0.18 ± 0.03	0.16 ± 0.04	0.10 ± 0.03	0.15 ± 0.05	0.15 ± 0.04	0.23 ± 0.18	0.16 ± 0.04
Trichloroethylene	0.16 ± 0.05	0.07 ± 0.06	0.09 ± 0.05	0.11 ± 0.07	0.12 ± 0.10	0.10 ± 0.03	0.12 ± 0.04	NA	0.06 ± 0.03	NA	NA	NA
Vinyl Chloride	0.01 ± <0.01	NA	NA	NA	NA	NA	0.02 ± 0.01	NA	0.01 ± 0.01	NA	NA	NA
Arsenic (PM_{10})[a]	0.96 ± 0.21	0.66 ± 0.13	0.94 ± 0.40	0.99 ± 0.29	1.25 ± 0.71	0.96 ± 0.21	1.52 ± 0.81	3.04 ± 3.00	1.04 ± 0.82	0.81 ± 0.31	1.14 ± 0.53	1.52 ± 0.81

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 18-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Missouri Monitoring Site (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Benzo(a)pyrene [a]	0.22 ± 0.13	NR	0.14 ± 0.08	0.16 ± 0.09	0.34 ± 0.37	0.21 ± 0.12	0.15 ± 0.03	0.23 ± 0.06	0.06 ± 0.03	0.05 ± 0.03	0.18 ± 0.07	0.13 ± 0.03
Beryllium (PM_{10})[a]	0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Cadmium (PM_{10})[a]	0.75 ± 0.32	0.84 ± 0.83	0.39 ± 0.17	0.62 ± 0.24	1.15 ± 0.99	0.75 ± 0.32	1.00 ± 0.43	1.45 ± 1.34	0.87 ± 0.34	0.56 ± 0.54	1.11 ± 1.03	1.00 ± 0.43
Hexavalent Chromium [a]	0.03 ± 0.02	0.02 ± 0.01	0.02 ± 0.01	0.05 ± 0.07	0.02 ± 0.01	0.03 ± 0.02	0.03 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01
Lead (PM_{10})[a]	14.31 ± 4.28	16.97 ± 11.58	9.38 ± 4.43	12.47 ± 4.55	18.23 ± 11.62	14.31 ± 4.28	9.94 ± 3.35	17.72 ± 11.74	7.56 ± 2.80	6.49 ± 2.54	7.63 ± 4.23	9.94 ± 3.35
Manganese (PM_{10})[a]	21.92 ± 23.61	10.09 ± 4.65	8.64 ± 2.65	11.45 ± 3.15	58.27 ± 99.50	21.92 ± 23.61	8.08 ± 1.40	8.14 ± 1.81	7.75 ± 1.85	8.15 ± 4.00	8.32 ± 4.11	8.08 ± 1.40
Naphthalene [a]	131.49 ± 36.16	NR	72.47 ± 21.23	166.43 ± 55.53	157.31 ± 92.98	131.49 ± 36.16	93.06 ± 13.61	77.87 ± 19.51	84.68 ± 19.08	99.23 ± 31.94	113.79 ± 40.65	93.06 ± 13.61
Nickel (PM_{10})[a]	1.15 ± 0.13	1.10 ± 0.24	1.18 ± 0.22	1.09 ± 0.24	1.24 ± 0.41	1.15 ± 0.13	1.12 ± 0.33	1.05 ± 0.16	1.64 ± 1.16	0.87 ± 0.32	0.82 ± 0.18	1.12 ± 0.33

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

- The second quarter 2008 average concentration for *p*-dichlorobenzene is higher than the other quarterly averages and has a large confidence interval associated with it. The highest concentration of *p*-dichlorobenzene measured at this site was 6.17 µg/m^3, which was measured on June 23, 2008. This concentration was nearly twice as high as the next highest measurement (3.13 µg/m^3 measured on October 3, 2008), and the second highest *p*-dichlorobenzene concentration among NMP sites sampling VOC.

- While all four quarterly averages of trichloroethylene could be calculated for all of 2008, only one could be calculated for 2009. There were 15 fewer measured detections of this pollutant in 2009 than in 2008 (38 in 2008 vs. 23 in 2009).

- Similar to other sites, the highest hexavalent chromium concentration for S4MO was measured on July 5, 2008. This concentration is an order of magnitude higher than its next highest measurement and is reflected in the third quarter 2008 average for this pollutant.

- Note that the third and fourth quarter 2008 averages of naphthalene are higher than the others and have large confidence intervals associated with them. The four highest concentrations of this pollutant were measured between September and November 2008. Further, of the 16 concentrations greater than or equal to 150 ng/m^3, 11 of them were measured in the third and fourth quarters of 2008 (an additional three were measured in the same two quarters in 2009).

- The fourth quarter 2008 average of benzo(a)pyrene also exhibited a large confidence interval, indicating the presence of outliers. The highest concentration of this pollutant was 2.64 ng/m^3 (measured on November 26, 2008), which was an order of magnitude higher than the next highest measurement (0.599 ng/m^3 measured on August 16, 2008). This was the sixth highest benzo(a)pyrene measurement among all NMP sites sampling PAH.

- Several of the quarterly averages for the metals are highest in the first or fourth quarters of either year. But several of these have rather large confidence intervals associated with outliers, as described in the next several bullets.

- The first quarter 2009 arsenic average is significantly higher than the other quarterly averages and has a large confidence interval associated with it. The highest arsenic concentration measured at S4MO was 23.1 ng/m^3, which is more than three times higher than the next highest concentration (6.93 ng/m^3). This was also the highest arsenic measurement among all NMP sites sampling metals.

- The first and fourth quarter averages of cadmium for both 2008 and 2009 have large confidence intervals associated with them. Of the 26 cadmium concentrations greater than 1 ng/m^3 measured among all NMP sites sampling metals, 22 were measured at S4MO, including the highest measurement of 9.71 ng/m^3, which was measured on January 31, 2009.

- Similar to cadmium, the first and fourth quarter averages of lead for 2008 and the first quarter average of lead for 2009 have large confidence intervals associated with them. Of the 19 lead concentrations greater than 25 ng/m^3 measured among all NMP sites sampling metals, 14 were measured at S4MO, including the highest measurement of 97.53 ng/m^3, which was measured on March 1, 2008.

- The fourth quarter average of manganese for 2008 also has a large confidence interval associated with it. On November 26, 2008, the concentration of manganese measured at S4MOs was 734 ng/m^3, which was also the highest measurement among all NMP sites sampling metals. The next highest manganese concentration measured at S4MO was an order of magnitude less (at 31.2 ng/m^3).

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for S4MO from those tables include the following:

- S4MO had the highest daily average concentration of arsenic (2009), cadmium (both years), lead (both years), manganese (2008), and *p*-dichlorobenzene (2008) among all NMP sites sampling those pollutants.

- Daily averages for an additional six pollutants for S4MO were among the 10 highest for all NMP sites. Conversely, S4MO's daily average concentrations for the carbonyl compounds were not among the 10 highest daily averages among all NMP sites.

18.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. S4MO has sampled VOC and carbonyl compounds under the NMP since 2002, metals since 2003, and hexavalent chromium since 2005. Thus, Figures 18-7 through 18-13 present the 3-year rolling statistical metrics for acetaldehyde, arsenic, benzene, 1,3-butadiene, formaldehyde, hexavalent chromium, and manganese (respectively) for S4MO. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 18-7. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at S4MO

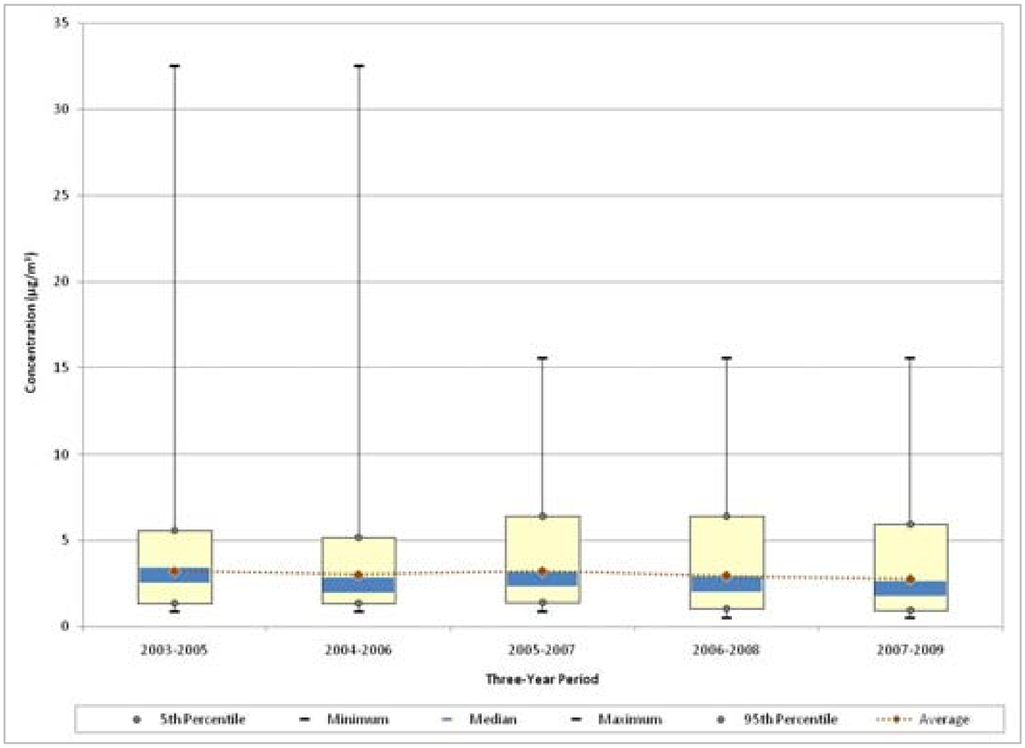
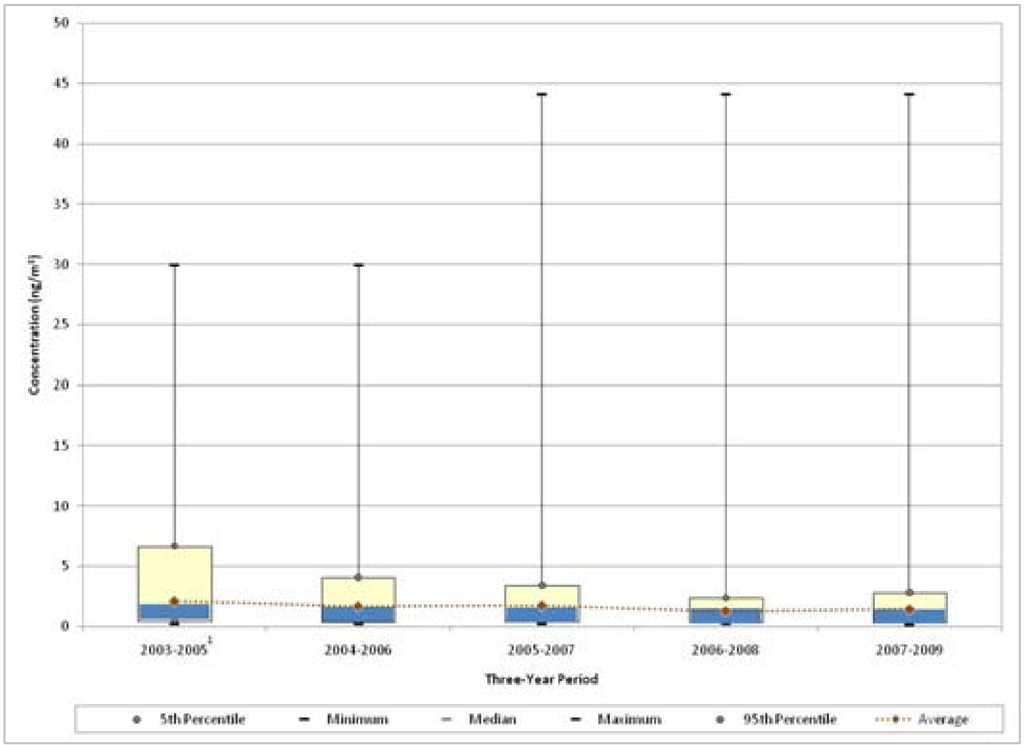


Figure 18-8. Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at S4MO



[1] Metals sampling at S4MO began in July 2003.

Figure 18-9. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at S4MO

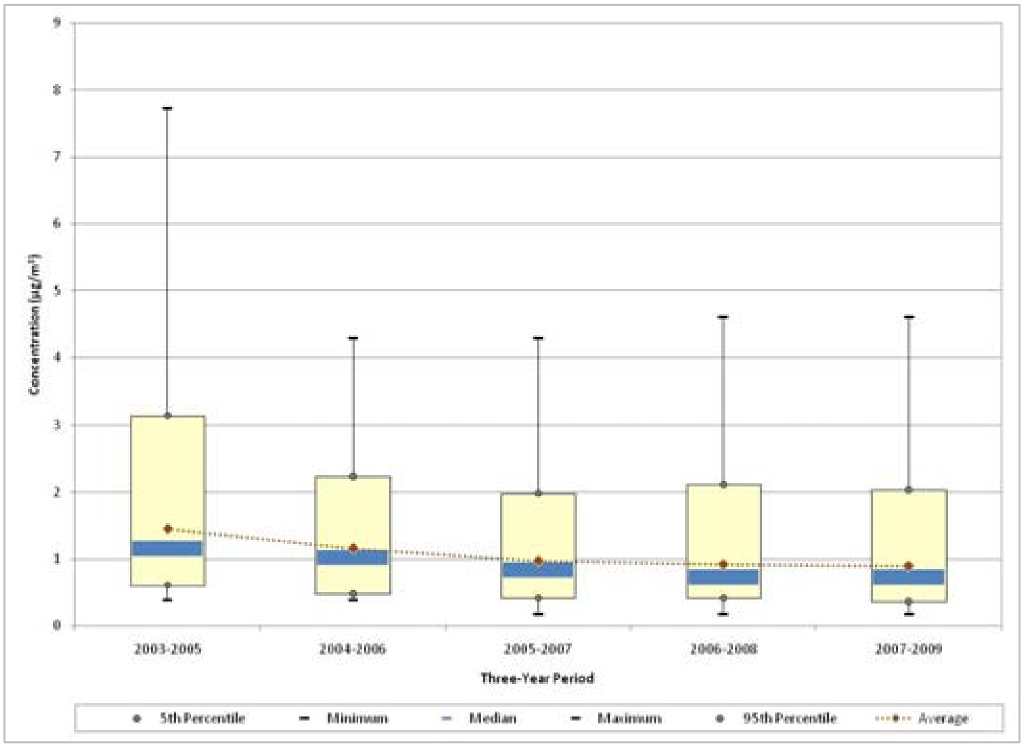


Figure 18-10. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at S4MO

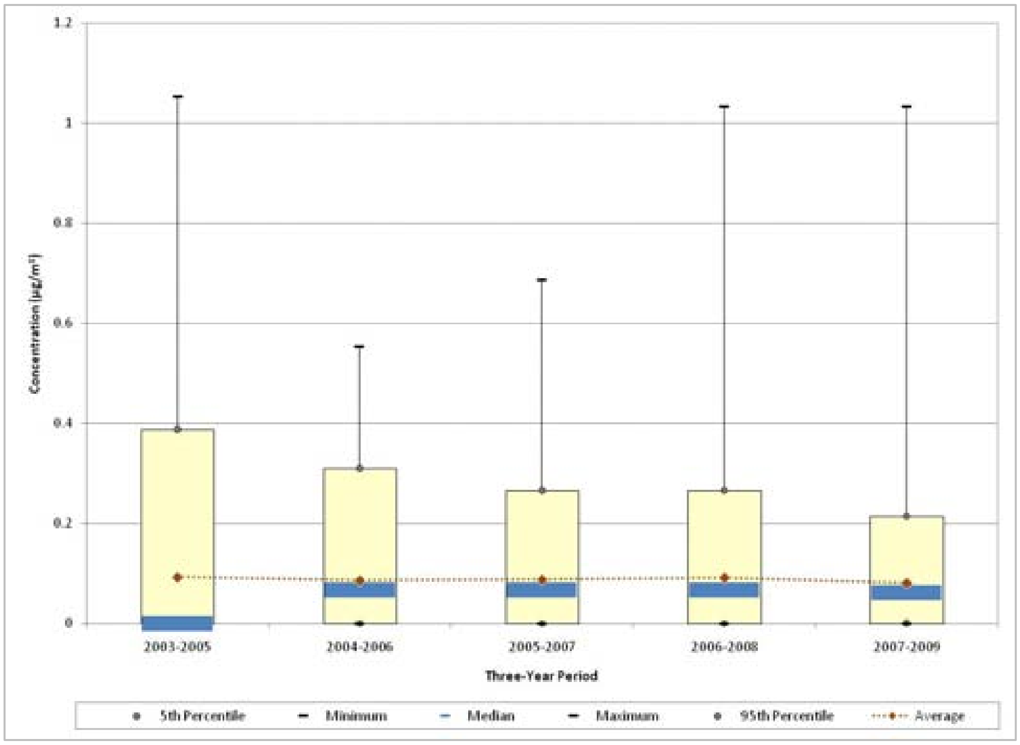


Figure 18-11. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at S4MO

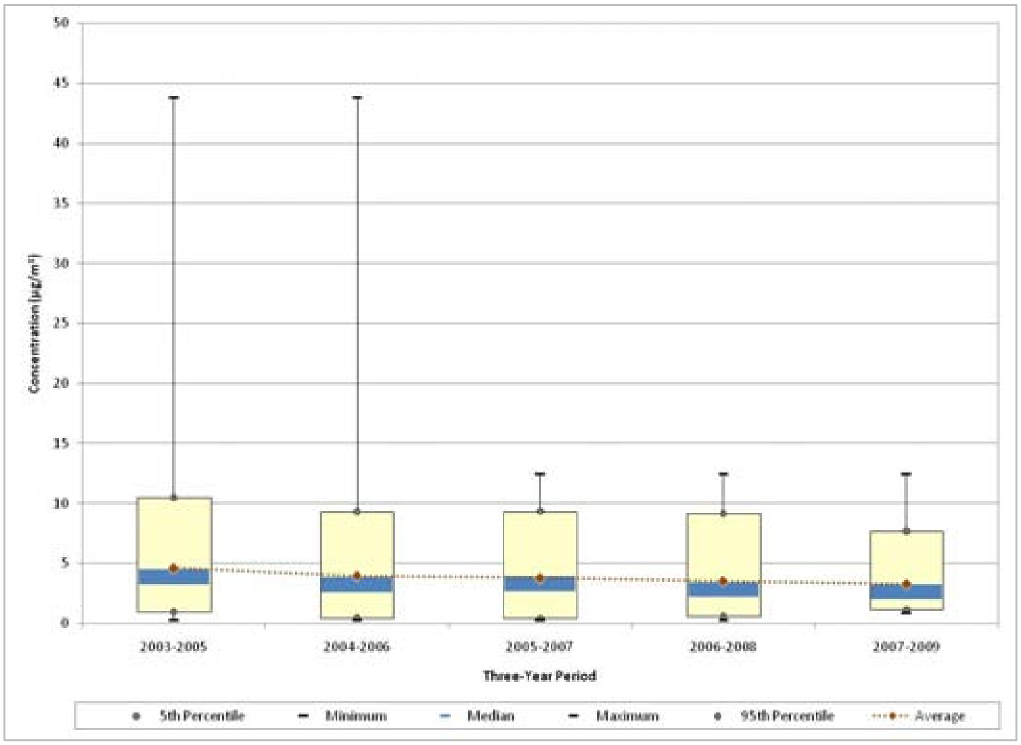


Figure 18-12. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at S4MO

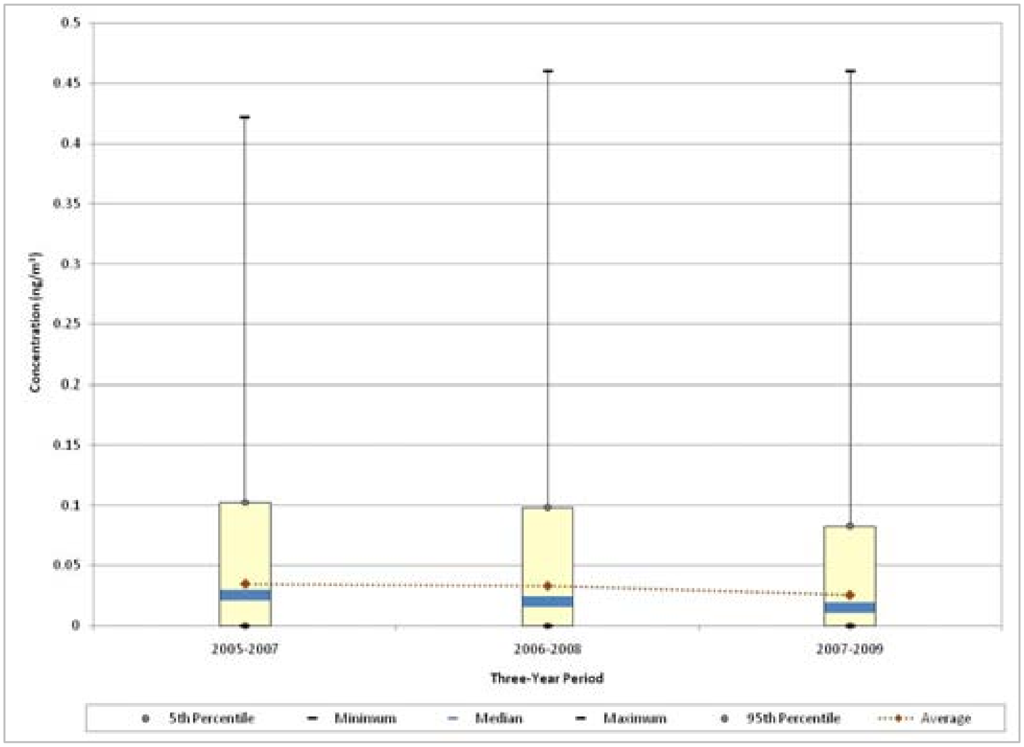
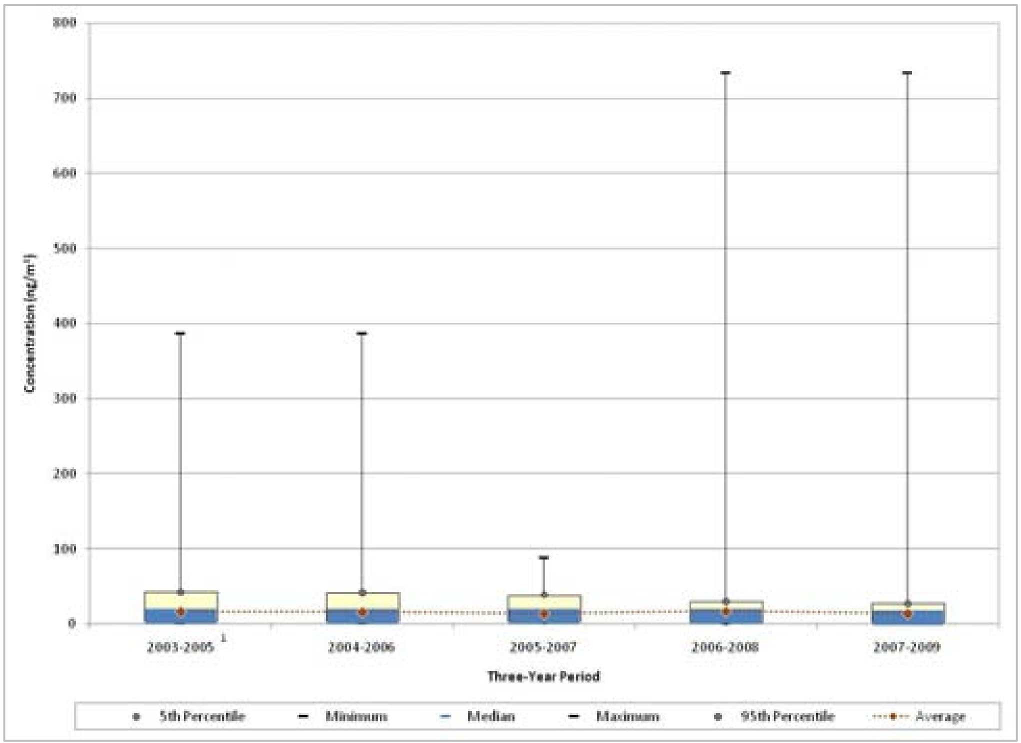


Figure 18-13. Three-Year Rolling Statistical Metrics for Manganese (PM_{10}) Concentrations Measured at S4MO



[1] Metals sampling at S4MO began in July 2003.

Observations from Figure 18-7 for acetaldehyde include the following:

- Because carbonyl compound sampling did not begin until December 2002, 2002 data were excluded from this analysis because 1 month of sampling is not enough to be representative of an entire year.

- The maximum acetaldehyde concentration was measured in 2004 and is more than twice the next highest concentration (measured in 2007).

- The rolling average concentration has fluctuated between approximately 2.75 and 3.25 µg/m^3 across the period of sampling and corresponding confidence intervals confirm that a significant increasing or decreasing trend is not apparent.

- Even though the maximum concentration has decreased over the sampling period, the variability of the concentrations measured has increased overall, as indicated by the increasing spread between the 5th and 95th percentiles.

- Note that the minimum concentration measured is greater than zero for all 3-year periods, indicating that there were no non-detects reported for acetaldehyde since the onset of sampling.

Observations from Figure 18-8 for arsenic include the following:

- S4MO began sampling metals in July 2003, as denoted in Figure 18-8.

- The maximum arsenic concentration was measured on December 26, 2007, and therefore affects the 2005-2007, 2006-2008, and 2007-2009 time frames.

- Even so, several of the statistical parameters exhibit a slight decreasing trend since the onset of sampling. However, confidence intervals calculated for the average concentrations show that the decrease in the rolling averages is not statistically significant.

Observations from Figure 18-9 for benzene measurements include the following:

- Because VOC sampling did not begin until December 2002, 2002 data was excluded from this analysis because one month of sampling is not enough to be representative of an entire year.

- All four benzene concentrations that were greater than 5 $\mu g/m^3$ were measured in 2003.

- The rolling average and median concentrations exhibit a decreasing trend over the period of sampling that flattens out during the final 3-year period shown.

- The minimum concentration measured is greater than zero for all 3-year periods, indicating that there were no non-detects reported for benzene since the onset of sampling.

Observations from Figure 18-10 for 1,3-butadiene include the following:

- Because VOC sampling did not begin until December 2002, 2002 data were excluded from this analysis because one month of sampling is not enough to be representative of an entire year.

- Only two 1,3-butaidene concentrations greater than 1.0 $\mu g/m^3$ have been measured at S4MO, one in 2003 and the other in 2008.

- The rolling average concentrations have fluctuated from approximately 0.8 to 0.9 $\mu g/m^3$ over the years of sampling.

- The median concentration has remained relatively unchanged since sampling for 1,3-butadiene began at S4MO, with the exception of the increase following the first 3-year period. During the 2003-2005 sample period, the median concentration was zero, indicating the at least half of the measurements were non-detects. The percentage of non-detects has been decreasing, from as high as 66 percent in 2004 to as low as two percent in 2008.

Observations from Figure 18-11 for formaldehyde include the following:

- Because carbonyl compound sampling did not begin until December 2002, 2002 data were excluded from this analysis because one month of sampling is not enough to be representative of an entire year.

- The maximum formaldehyde concentration was measured in 2004 and is more than three times the next highest concentration (also measured in 2004).

- Both the median and average concentrations exhibit a slight decreasing trend. The 95th percentile also exhibits a decreasing trend, while the 5th percentile has increased for the last two periods of sampling.

- The minimum concentration measured is greater than zero for all 3-year periods, indicating that there were no non-detects reported for formaldehyde since the onset of sampling.

Observations from Figure 18-12 for hexavalent chromium include the following:

- The maximum hexavalent chromium concentration was measured on July 5, 2008; the second highest hexavalent chromium concentration was measured on July 4, 2006. These two concentrations support the potential correlation between hexavalent chromium concentrations and fireworks discussed in Section 4.1.2.

- The average concentration, as well as the median and 95th percentile, exhibit decreases in concentration. Confidence intervals calculated for the rolling averages indicate that this decrease is not statistically significant.

- For each 3-year period shown, both the minimums and 5th percentiles are zero, indicating the presence of non-detects. The percentage of non-detects has ranged from 15 percent (2007) to 43 percent (2009).

Observations from Figure 18-13 for manganese include the following:

- S4MO began sampling metals in July 2003, as denoted in Figure 18-13.

- The maximum manganese concentration was measured on November 26, 2008 and is nearly twice the next highest concentration (measured in 2004).

- No significant increase or decrease in the rolling average concentrations is shown in Figure 18-13. Yet, the medians and 5th and 95th percentiles exhibit decreases for several periods, indicating a general decrease in the majority of concentrations measured since sampling began in 2003.

18.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the S4MO monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

18.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the S4MO monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the S4MO monitoring site were higher than their respective MRL noncancer health risk benchmarks.

18.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the S4MO monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 18-6, where applicable.

Table 18-6. Cancer and Noncancer Surrogate Risk Approximations for the Missouri Monitoring Site

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)
St. Louis, Missouri - S4MO										
Acetaldehyde	2.2E-06	0.009	60/4	1.83 ± 0.25	4.03	0.20	61/4	2.37 ± 0.37	5.21	0.26
Acrylonitrile	6.8E-05	0.002	4/0	NA	NA	NA	25/2	NA	NA	NA
Arsenic (PM$_{10}$)[a]	0.0043	1.5E-05	61/4	<0.01 ± <0.01	4.11	0.06	58/4	<0.01 ± <0.01	6.55	0.10
Benzene	7.8E-06	0.03	61/4	1.00 ± 0.17	7.77	0.03	60/4	0.84 ± 0.12	6.54	0.03
Benzo(a)pyrene[a]	0.001	--	42/3	<0.01 ± <0.01	0.21	--	50/4	<0.01 ± <0.01	0.13	--
Beryllium (PM$_{10}$)[a]	0.0024	0.00002	57/4	<0.01 ± <0.01	0.01	<0.01	58/4	<0.01 ± <0.01	0.01	<0.01
1,3-Butadiene	0.00003	0.002	59/4	0.09 ± 0.03	2.70	0.05	55/4	0.06 ± 0.01	1.89	0.03
Cadmium (PM$_{10}$)[a]	0.0018	0.00001	61/4	<0.01 ± <0.01	1.35	0.08	58/4	<0.01 ± <0.01	1.80	0.10
Carbon Tetrachloride	6E-06	0.1	61/4	0.71 ± 0.06	4.26	0.01	60/4	0.69 ± 0.06	4.13	0.01
Chloroform	--	0.098	59/4	0.22 ± 0.09	--	<0.01	60/4	0.21 ± 0.06	--	<0.01
p-Dichlorobenzene	1.1E-05	0.8	53/4	0.31 ± 0.23	3.43	<0.01	57/4	0.14 ± 0.05	1.53	<0.01
Formaldehyde	1.3E-05	0.0098	60/4	2.86 ± 0.42	37.20	0.29	61/4	2.46 ± 0.35	32.02	0.25
Hexavalent Chromium[a]	0.012	0.0001	49/4	<0.01 ± <0.01	0.31	<0.01	35/4	<0.01 ± <0.01	0.20	<0.01

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 18-5.

Table 18-6. Cancer and Noncancer Surrogate Risk Approximations for the Missouri Monitoring Site (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
Lead (PM_{10}) [a]	--	0.00015	61/4	0.01 ± <0.01	--	0.10	58/4	0.01 ± <0.01	--	0.07
Manganese (PM_{10}) [a]	--	0.00005	61/4	0.02 ± 0.02	--	0.44	58/4	0.01 ± <0.01	--	0.16
Naphthalene [a]	3.4E-05	0.003	44/3	0.13 ± 0.04	4.47	0.04	59/4	0.09 ± 0.01	3.16	0.03
Nickel (PM_{10}) [a]	0.00031	0.00009	61/4	<0.01 ± <0.01	0.36	0.01	58/4	<0.01 ± <0.01	0.35	0.01
Tetrachloroethylene	5.9E-06	0.27	58/4	0.18 ± 0.03	1.05	<0.01	59/4	0.16 ± 0.04	0.92	<0.01
Trichloroethylene	2E-06	0.6	38/4	0.10 ± 0.03	0.20	<0.01	23/1	NA	NA	NA
Vinyl Chloride	8.8E-06	0.1	17/0	NA	NA	NA	19/1	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 18-5.

Observations for S4MO from Table 18-6 include the following:

- The pollutants with the highest annual averages were formaldehyde, acetaldehyde, and benzene for both years.
- For 2008, formaldehyde, benzene, naphthalene, carbon tetrachloride, and arsenic had the highest cancer risk approximations. Formaldehyde, arsenic, benzene, acetaldehyde, and carbon tetrachloride had the highest cancer risk approximations for 2009.
- The cancer risk approximations for formaldehyde were an order of magnitude higher than the pollutant with the next highest cancer risk approximation for both years.
- None of the pollutants of interest for S4MO had noncancer risk approximations greater than 1.0.

18.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 18-7 and 18-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 18-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 18-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on the site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 18.3, S4MO sampled for VOC, PAH, carbonyl compounds, metals (PM_{10}), and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 18-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Missouri Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
St. Louis, Missouri (St. Louis City) - S4MO					
Benzene	247.70	Benzene	1.93E-03	Formaldehyde	37.20
Formaldehyde	154.17	Formaldehyde	1.93E-03	Formaldehyde	32.02
Acetaldehyde	93.91	Hexavalent Chromium, PM	1.05E-03	Benzene	7.77
Trichloroethylene	44.32	1,3-Butadiene	8.88E-04	Arsenic (PM_{10})	6.55
1,3-Butadiene	29.59	Arsenic, PM	5.41E-04	Benzene	6.54
Tetrachloroethylene	18.50	Naphthalene	4.10E-04	Acetaldehyde	5.21
Dichloromethane	17.41	Acetaldehyde	2.07E-04	Naphthalene	4.47
Naphthalene	12.06	Tetrachloroethylene	1.09E-04	Carbon Tetrachloride	4.26
POM, Group 2	0.87	Trichloroethylene	8.86E-05	Carbon Tetrachloride	4.13
p-Dichlorobenzene	0.33	POM, Group 2	4.76E-05	Arsenic (PM_{10})	4.11

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 18-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Missouri Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
St. Louis, Missouri (St. Louis City) - S4MO					
Toluene	605.17	Acrolein	386,304.66	Manganese (PM_{10})	0.44
Methanol	515.95	Chlorine	35,898.36	Formaldehyde	0.29
Xylenes	384.93	Hydrochloric acid	18,087.68	Acetaldehyde	0.26
Hydrochloric acid	361.75	Formaldehyde	15,731.90	Formaldehyde	0.25
Ethylene glycol	255.84	1,3-Butadiene	14,792.75	Acetaldehyde	0.20
Benzene	247.70	Acetaldehyde	10,434.98	Manganese (PM_{10})	0.16
Formaldehyde	154.17	Manganese, PM	8,658.25	Arsenic (PM_{10})	0.10
Methyl isobutyl ketone	141.15	Benzene	8,256.52	Cadmium (PM_{10})	0.10
Methyl tert butyl ether	98.13	Cyanide Compounds, gas	4,401.73	Lead (PM_{10})	0.10
Acetaldehyde	93.91	Arsenic, PM	4,194.71	Cadmium (PM_{10})	0.08

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 18-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in St. Louis.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, formaldehyde, and hexavalent chromium.
- Eight of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Four of the pollutants with the highest cancer risk approximations for S4MO also appear on both emissions-based lists (formaldehyde, acetaldehyde, benzene, and naphthalene). While arsenic is not one of the highest emitted pollutants, it does appear on the list of highest toxicity-weighted emissions. Carbon tetrachloride was also among the pollutants with the highest cancer surrogate risk approximations, yet this pollutant appeared on neither emissions-based list.
- POM Group 2 was the ninth highest emitted "pollutant" in St. Louis and ranked tenth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at S4MO including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for S4MO.

Observations from Table 18-8 include the following:

- Toluene, methanol, and xylenes were the highest emitted pollutants with noncancer RfCs in St. Louis.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, chlorine, and hydrochloric acid. Although acrolein was sampled for at S4MO, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.
- Four of the highest emitted pollutants also had the highest toxicity-weighted emissions.
- Formaldehyde and acetaldehyde were among the pollutants with the highest noncancer risk approximations for S4MO and also appear on both emissions-based lists. Manganese, the pollutant with the highest noncancer risk approximation, is also one of the pollutants with the highest toxicity-weighted emissions but is not one of the highest emitted. This is also true for arsenic.

18.6 Summary of the 2008-2009 Monitoring Data for S4MO

Results from several of the treatments described in this section include the following:

- *Twenty-three pollutants, of which 15 are NATTS MQO Core Analytes, failed screens for S4MO.*

- *Formaldehyde and acetaldehyde had the highest daily average concentrations for S4MO for both years. S4MO had the highest daily average concentration of arsenic, cadmium, lead, manganese, and p-dichlorobenzene among all NMP sites sampling these pollutants.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest for S4MO, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

19.0 Sites in New Jersey

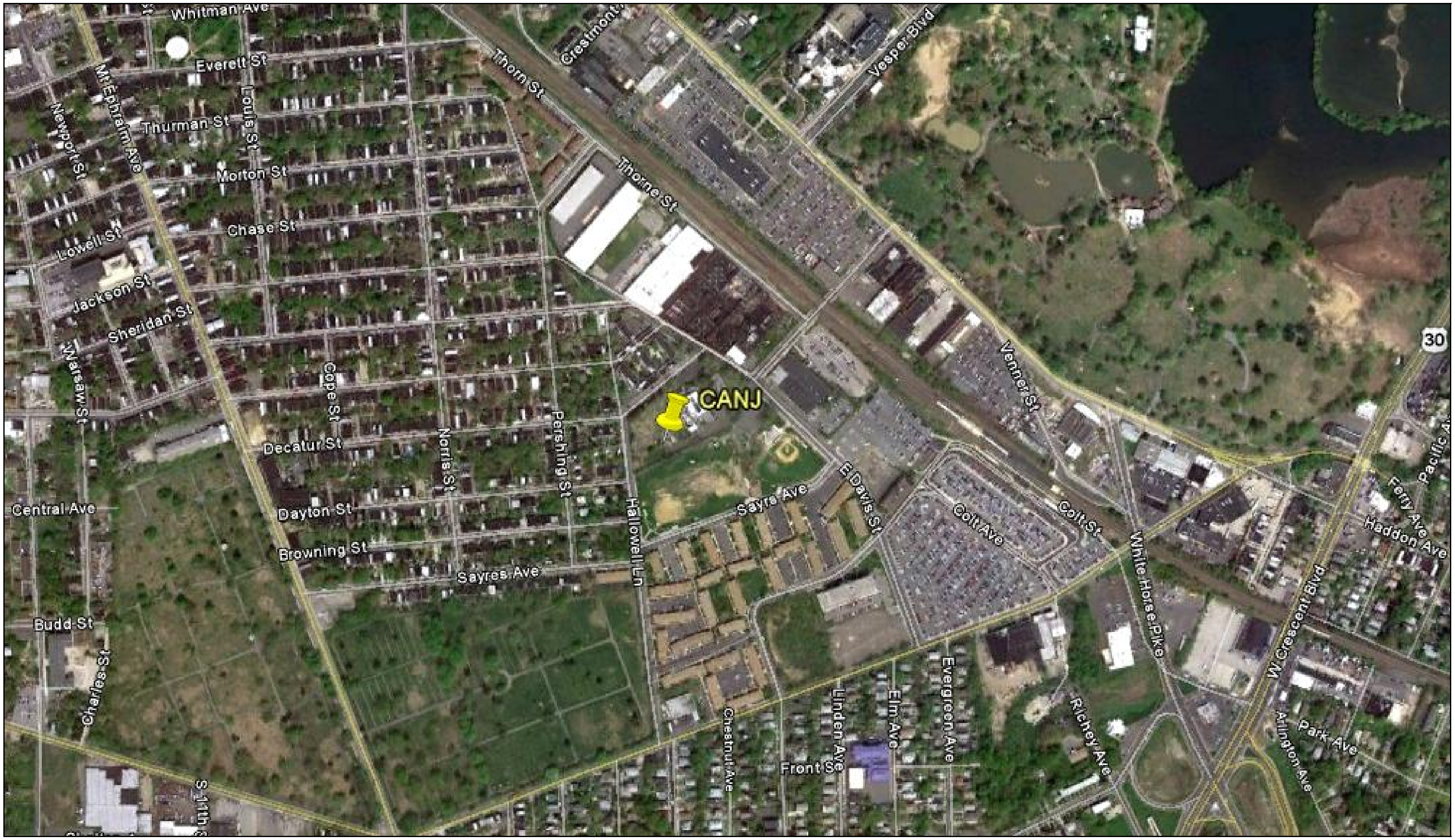
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at UATMP sites in New Jersey, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

19.1 Site Characterization

This section characterizes the New Jersey monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring data.

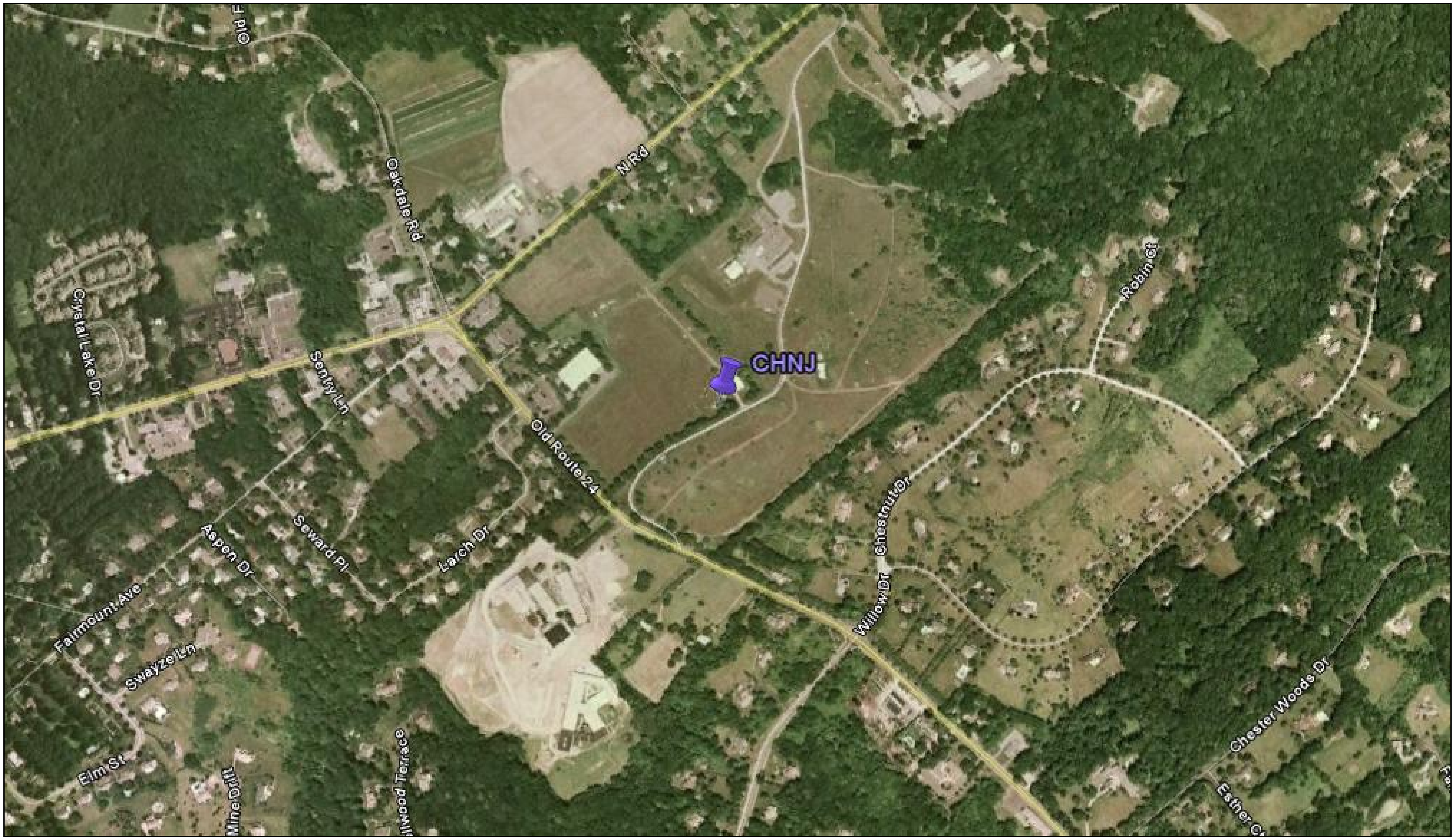
The New Jersey sites are located in several different urban areas. Figures 19-1 through 19-4 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban and rural locations. Figures 19-5 through 19-7 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 19-5 through 19-7. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 19-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 19-1. Camden, New Jersey (CANJ) Monitoring Site



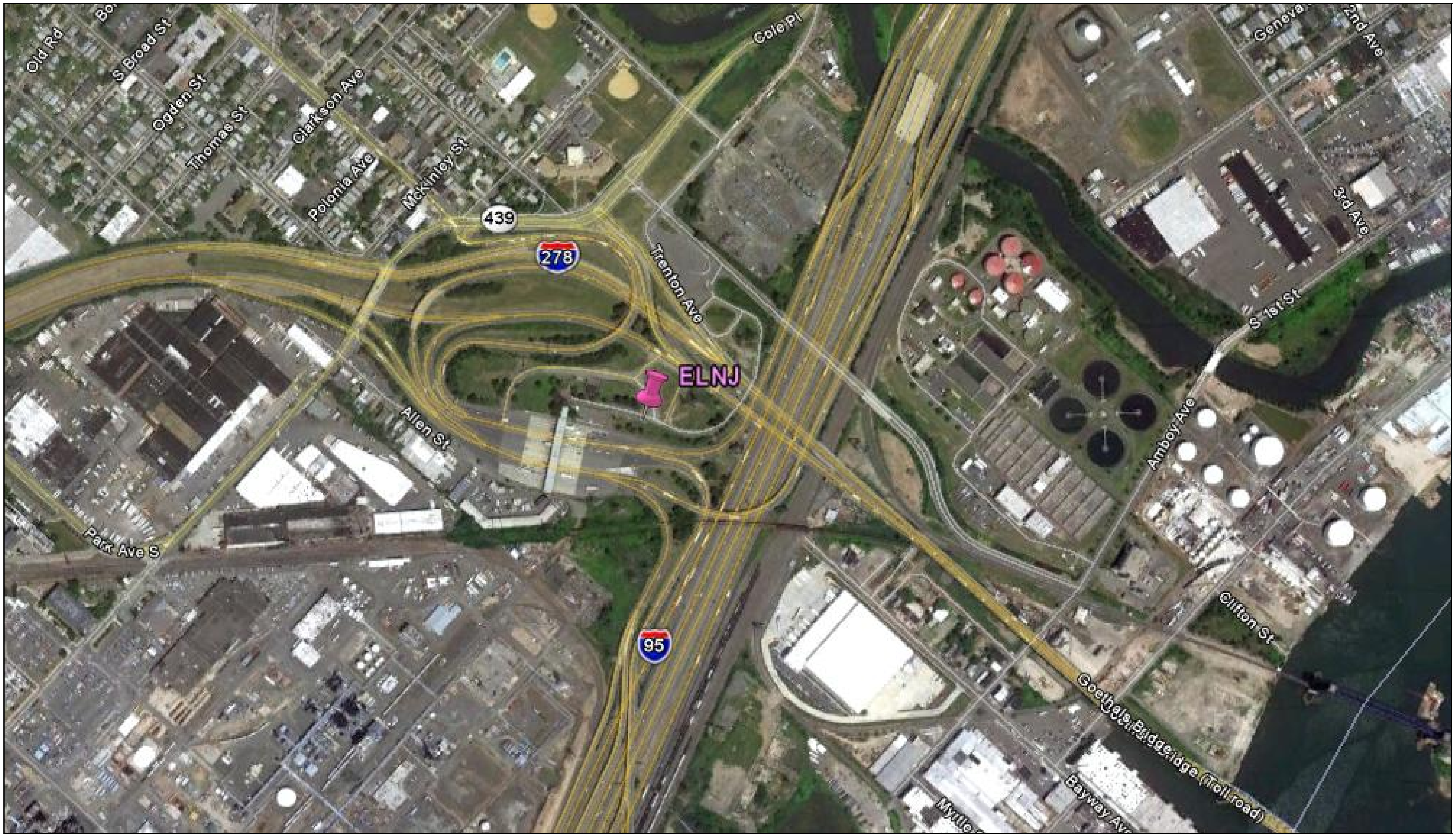
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,821 feet

Figure 19-2. Chester, New Jersey (CHNJ) Monitoring Site



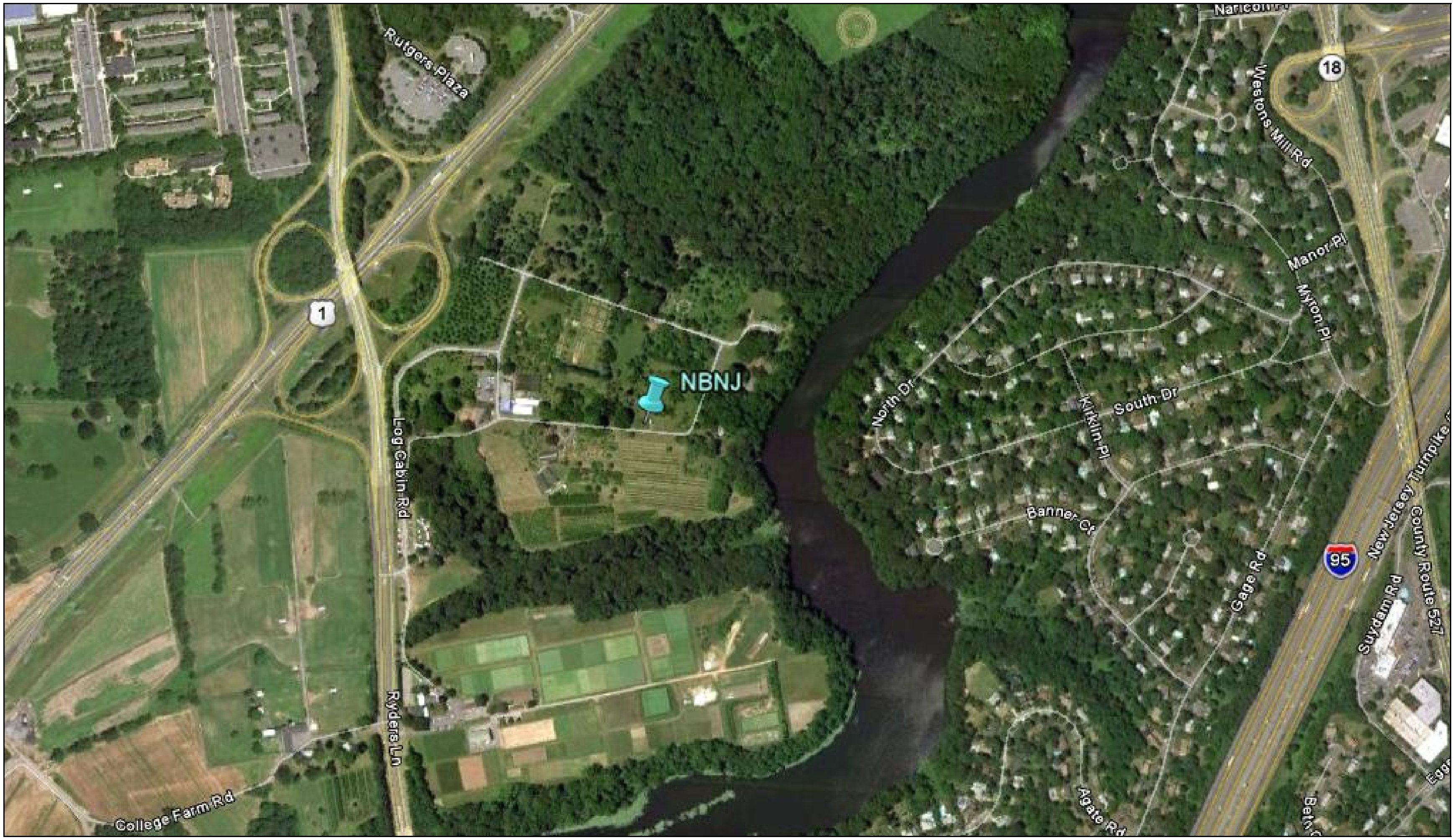
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,035 feet

Figure 19-3. Elizabeth, New Jersey (ELNJ) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,946 feet

Figure 19-4. New Brunswick, New Jersey (NBNJ) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,890 feet

Figure 19-5. NEI Point Sources Located Within 10 Miles of CANJ

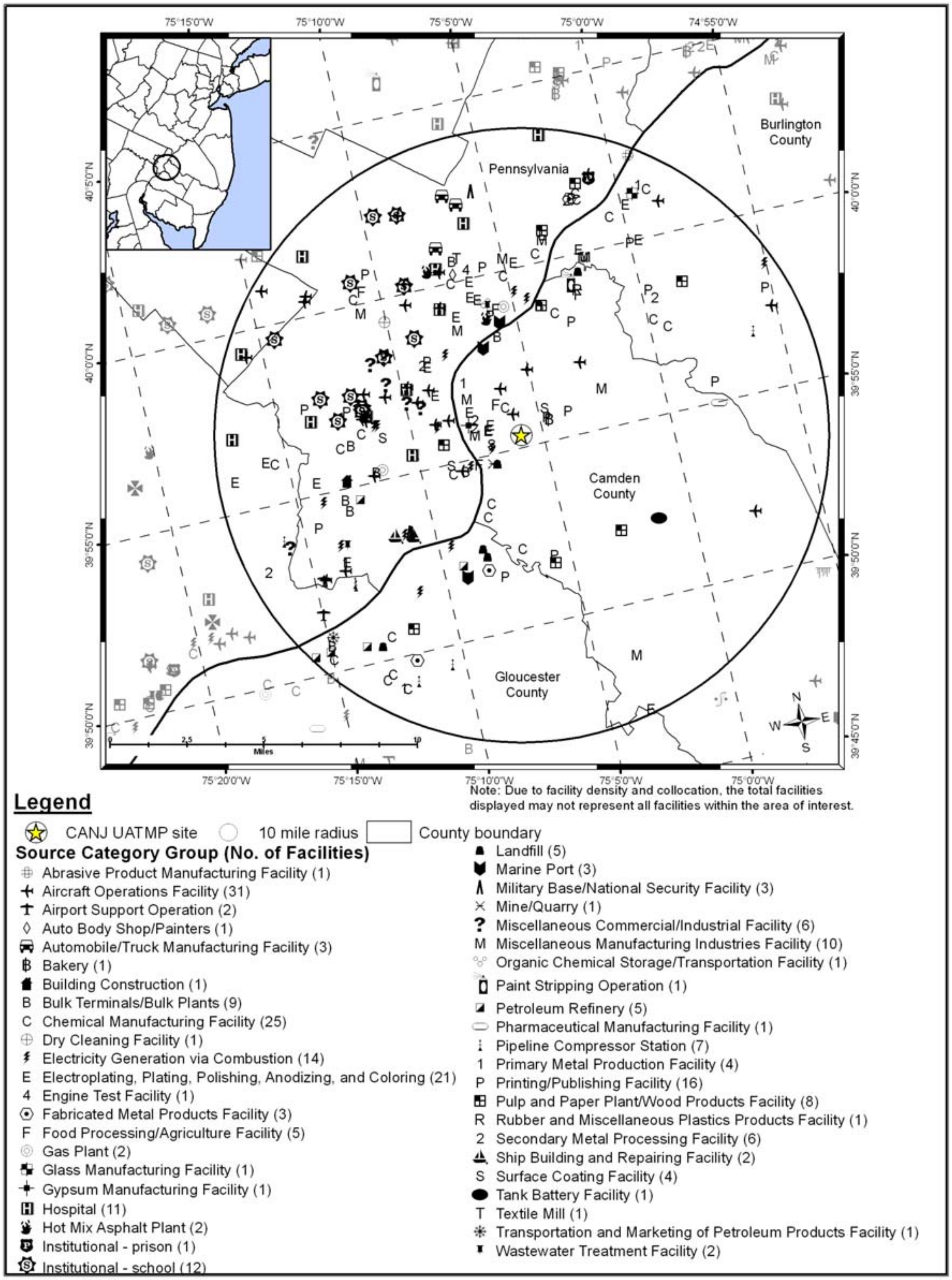
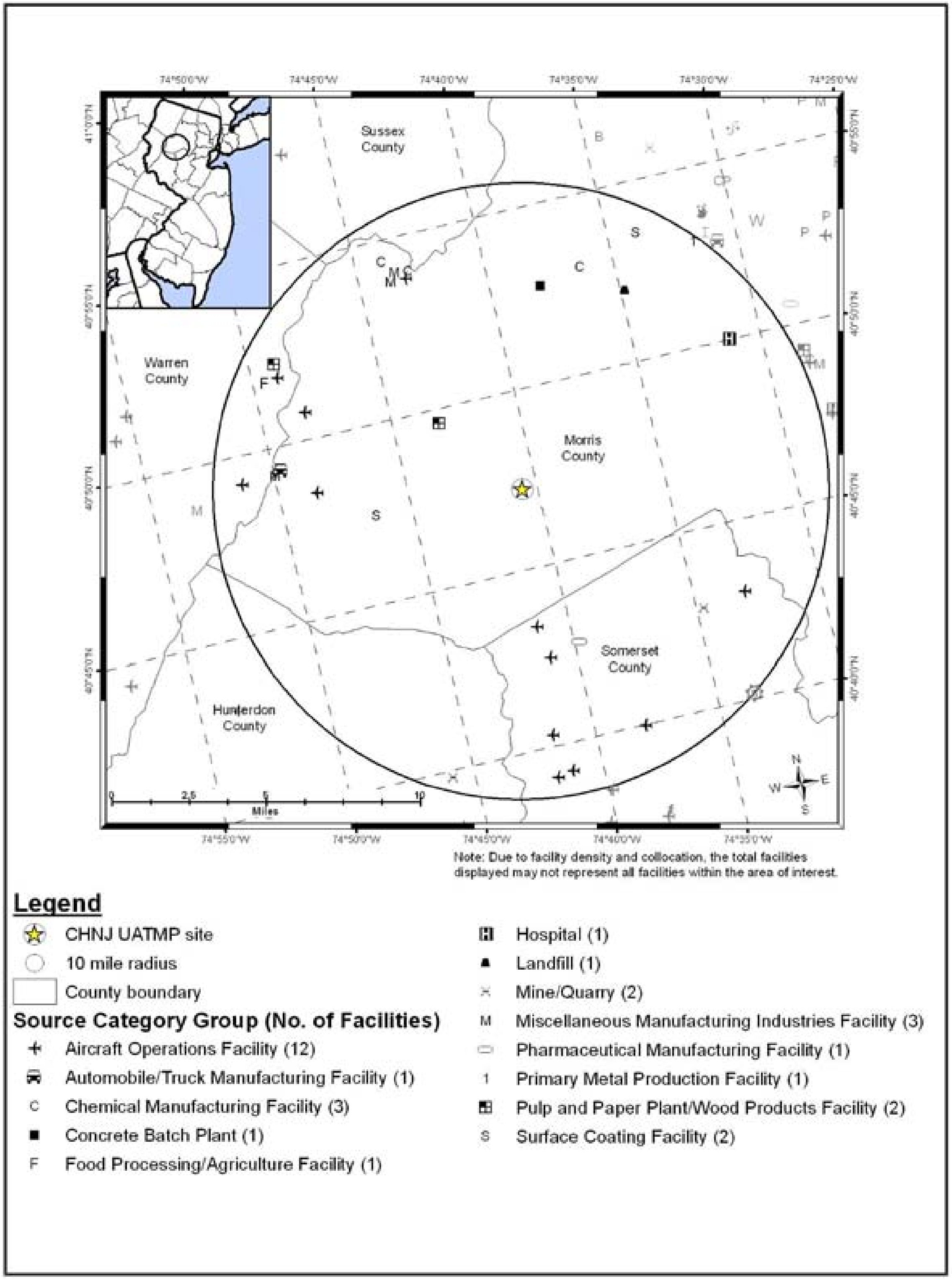

75°15'0"W
75°10'0"W
75°5'0"W
75°0'0"W
74°55'0"W
75°20'0"W
75°15'0"W
75°10'0"W
75°5'0"W
75°0'0"W
40°5'0"N
40°0'0"N
39°55'0"N
39°50'0"N
40°0'0"N
39°55'0"N
39°50'0"N
39°45'0"N
Pennsylvania
Burlington County
Camden County
Gloucester County
0 2.5 5 10 Miles
N E S W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
CANJ UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Abrasive Product Manufacturing Facility (1)
Aircraft Operations Facility (31)
Airport Support Operation (2)
Auto Body Shop/Painters (1)
Automobile/Truck Manufacturing Facility (3)
Bakery (1)
Building Construction (1)
B Bulk Terminals/Bulk Plants (9)
C Chemical Manufacturing Facility (25)
Dry Cleaning Facility (1)
Electricity Generation via Combustion (14)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (21)
4 Engine Test Facility (1)
Fabricated Metal Products Facility (3)
F Food Processing/Agriculture Facility (5)
Gas Plant (2)
Glass Manufacturing Facility (1)
Gypsum Manufacturing Facility (1)
Hospital (11)
Hot Mix Asphalt Plant (2)
Institutional - prison (1)
Institutional - school (12)
Landfill (5)
Marine Port (3)
Military Base/National Security Facility (3)
Mine/Quarry (1)
? Miscellaneous Commercial/Industrial Facility (6)
M Miscellaneous Manufacturing Industries Facility (10)
Organic Chemical Storage/Transportation Facility (1)
Paint Stripping Operation (1)
Petroleum Refinery (5)
Pharmaceutical Manufacturing Facility (1)
Pipeline Compressor Station (7)
1 Primary Metal Production Facility (4)
P Printing/Publishing Facility (16)
Pulp and Paper Plant/Wood Products Facility (8)
R Rubber and Miscellaneous Plastics Products Facility (1)
2 Secondary Metal Processing Facility (6)
Ship Building and Repairing Facility (2)
S Surface Coating Facility (4)
Tank Battery Facility (1)
T Textile Mill (1)
Transportation and Marketing of Petroleum Products Facility (1)
Wastewater Treatment Facility (2)

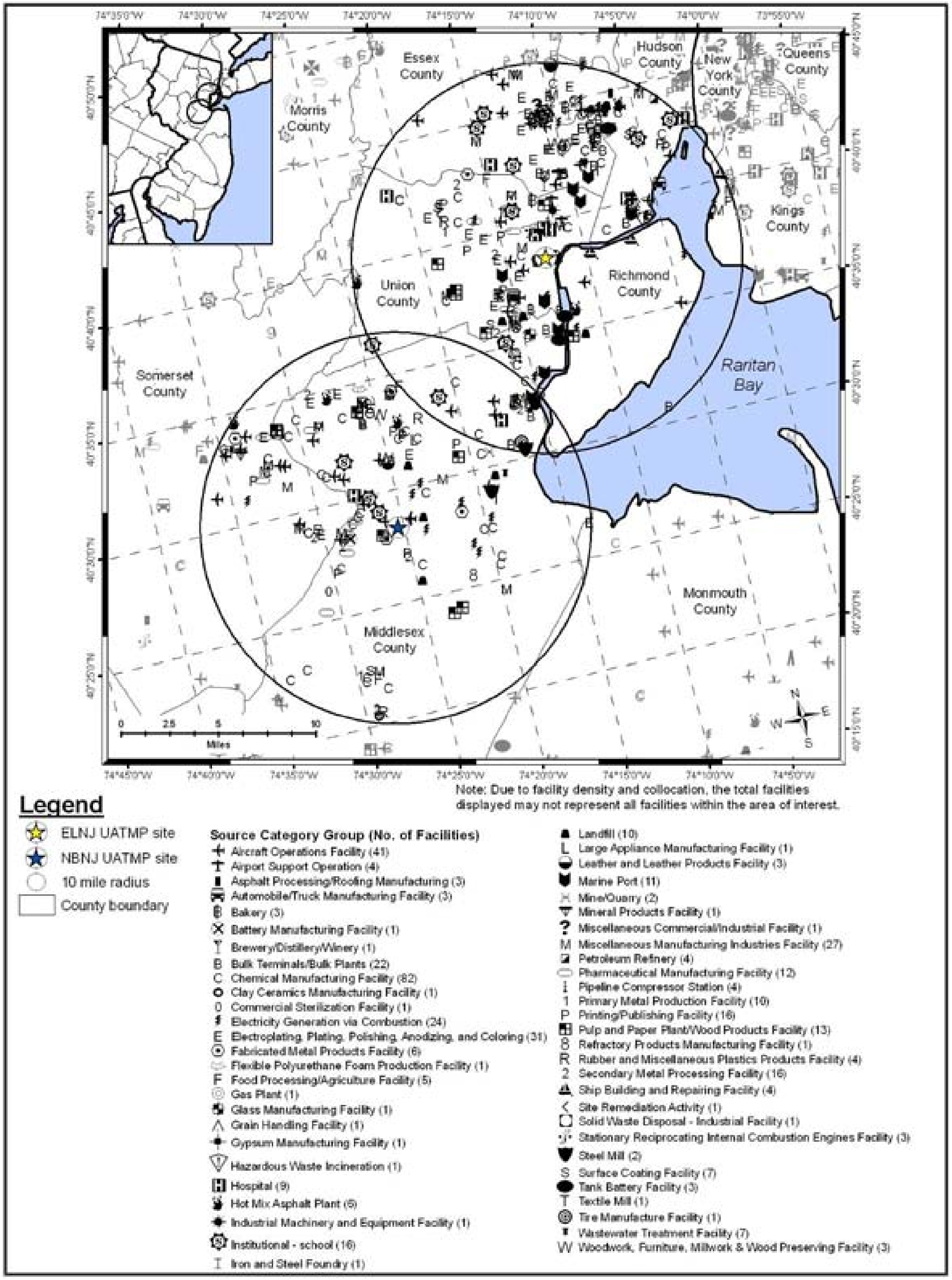
Figure 19-6. NEI Point Sources Located Within 10 Miles of CHNJ



Sussex County
Warren County
Morris County
Somerset County
Hunterdon County
0 2.5 5 10
Miles
N
E
S
W
Legend
☆ CHNJ UATMP site
○ 10 mile radius
County boundary
Source Category Group (No. of Facilities)
+ Aircraft Operations Facility (12)
Automobile/Truck Manufacturing Facility (1)
C Chemical Manufacturing Facility (3)
■ Concrete Batch Plant (1)
F Food Processing/Agriculture Facility (1)
Hospital (1)
▲ Landfill (1)
× Mine/Quarry (2)
M Miscellaneous Manufacturing Industries Facility (3)
⊂⊃ Pharmaceutical Manufacturing Facility (1)
1 Primary Metal Production Facility (1)
Pulp and Paper Plant/Wood Products Facility (2)
S Surface Coating Facility (2)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 19-7. NEI Point Sources Located Within 10 Miles of ELNJ and NBNJ


Essex County
Hudson County
New York County
Queens County
Morris County
Kings County
Union County
Richmond County
Raritan Bay
Somerset County
Monmouth County
Middlesex County
0 2.5 5 10
Miles
N
E
S
W
74°45'0"W
74°40'0"W
74°35'0"W
74°30'0"W
74°25'0"W
74°20'0"W
74°15'0"W
74°10'0"W
74°5'0"W
74°0'0"W
73°55'0"W
40°45'0"N
40°40'0"N
40°35'0"N
40°30'0"N
40°25'0"N
40°20'0"N
40°15'0"N
Legend
ELNJ UATMP site
NBNJ UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (41)
Airport Support Operation (4)
Asphalt Processing/Roofing Manufacturing (3)
Automobile/Truck Manufacturing Facility (3)
Bakery (3)
Battery Manufacturing Facility (1)
Brewery/Distillery/Winery (1)
B Bulk Terminals/Bulk Plants (22)
C Chemical Manufacturing Facility (82)
Clay Ceramics Manufacturing Facility (1)
0 Commercial Sterilization Facility (1)
Electricity Generation via Combustion (24)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (31)
Fabricated Metal Products Facility (6)
Flexible Polyurethane Foam Production Facility (1)
F Food Processing/Agriculture Facility (5)
Gas Plant (1)
Glass Manufacturing Facility (1)
Grain Handling Facility (1)
Gypsum Manufacturing Facility (1)
Hazardous Waste Incineration (1)
Hospital (9)
Hot Mix Asphalt Plant (6)
Industrial Machinery and Equipment Facility (1)
Institutional - school (16)
Iron and Steel Foundry (1)
Landfill (10)
L Large Appliance Manufacturing Facility (1)
Leather and Leather Products Facility (3)
Marine Port (11)
Mine/Quarry (2)
Mineral Products Facility (1)
? Miscellaneous Commercial/Industrial Facility (1)
M Miscellaneous Manufacturing Industries Facility (27)
Petroleum Refinery (4)
Pharmaceutical Manufacturing Facility (12)
Pipeline Compressor Station (4)
1 Primary Metal Production Facility (10)
P Printing/Publishing Facility (16)
Pulp and Paper Plant/Wood Products Facility (13)
8 Refractory Products Manufacturing Facility (1)
R Rubber and Miscellaneous Plastics Products Facility (4)
2 Secondary Metal Processing Facility (16)
Ship Building and Repairing Facility (4)
< Site Remediation Activity (1)
Solid Waste Disposal - Industrial Facility (1)
Stationary Reciprocating Internal Combustion Engines Facility (3)
Steel Mill (2)
S Surface Coating Facility (7)
Tank Battery Facility (3)
T Textile Mill (1)
Tire Manufacture Facility (1)
Wastewater Treatment Facility (7)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (3)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 19-1. Geographical Information for the New Jersey Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
CANJ	34-007-0003	Camden	Camden	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	39.92304, -75.09762	Residential	Suburban	SO_2, NO, NO_2, NOx, PAMS, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, $PM_{2.5}$ Speciation
CHNJ	34-027-3001	Chester	Morris	New York-Northern New Jersey-Long Island, NY-NJ-PA	40.78763, -74.6763	Agricultural	Rural	SO_2, NO, NO_2, O_3, Meteorological parameters, $PM_{2.5}$, $PM_{2.5}$ Speciation
ELNJ	34-039-0004	Elizabeth	Union	New York-Northern New Jersey-Long Island, NY-NJ-PA	40.64144, -74.20836	Industrial	Suburban	SO_2, NO_2, NOx, Meteorological parameters, $PM_{2.5}$, $PM_{2.5}$ Speciation
NBNJ	34-023-0006	New Brunswick	Middlesex	New York-Northern New Jersey-Long Island, NY-NJ-PA	40.472786, -74.42251	Agricultural	Rural	Meteorological parameters, $PM_{2.5}$, $PM_{2.5}$ Speciation

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA 2011j).

CANJ is located in Camden, which lies just across the Pennsylvania/New Jersey border and Delaware River, east of Philadelphia. CANJ is the UATMP's longest operating monitoring site, although sampling at this site ceased in October 2008. Figure 19-1 shows that the monitoring site is located at Whitman Park Field, near the intersection of Davis Street and Copewood Street. The areas west and south of CANJ are residential, while commercial areas are located to the north and east. Heavily traveled roadways, including I-676, are located less than 1 mile from the monitoring site and a railroad lies less than 1/2 mile northeast of the site. As Figure 19-5 shows, CANJ is located within 10 miles of a number of point sources, most of which are located across the border in Pennsylvania. Although emissions sources within 10 miles of CANJ are involved in a variety of industries, the source categories with the largest number of emissions sources surrounding CANJ are the aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads; chemical manufacturing; and electroplating, plating, polishing, anodizing, and coloring.

CHNJ is located in northern New Jersey, west of the New York City metropolitan area. Figure 19-2 shows that CHNJ is located in an open area near Building 1 on the property of Bell Labs, which is owned by Alcatel-Lucent. The surrounding area is rural and agricultural with a rolling topography, but surrounded by small neighborhoods. Although the location is considered part of the New York City MSA, the site's location is outside most of the urbanized areas. Figure 19-6 shows that few sources are close to CHNJ and that the source category with the highest number of emissions sources surrounding CHNJ is the aircraft operations category.

ELNJ is located in the city of Elizabeth, which lies just south of Newark and west of Newark Bay and Staten Island, New York. As Figure 19-3 shows, the monitoring site is located just off Exit 13 of the New Jersey Turnpike (I-95), near the toll plaza. Interstate-278 intersects the Turnpike here as well. The surrounding area is highly industrialized, with the Bayway oil refinery located just southwest of the site. Additional industry is located to the west and southwest, while residential neighborhoods are located to the northwest and north of the site.

NBNJ is located in New Brunswick, less than 20 miles southwest of Elizabeth. The monitoring site is located on the property of Rutgers University's Cook-Douglass campus, on a horticultural farm. The surrounding area is agricultural and rural, although residential neighborhoods are located to the east, across a branch of the Raritan River, as shown in Figure 19-4. County Road 617 and US-1 intersect just west of the site and I-95 runs northeast-southwest about 1 mile east of the site.

Figure 19-7 shows that the outer portions of NBNJ and ELNJ's 10-mile radii intersect and that numerous emissions sources surround these two sites. The bulk of the emissions sources are located in northern Middlesex County and northeastward toward New York City and northern New Jersey. The source categories with the highest number of emissions sources in the vicinity of these sites are chemical manufacturing facilities; aircraft operations; and electroplating, plating, polishing, anodizing, and coloring. The emissions sources in closest proximity to the ELNJ monitoring site are involved in food processing and wastewater treatment. The emissions sources in closest proximity to the NBNJ monitoring site are involved in aircraft operations.

Table 19-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the New Jersey monitoring sites. Information provided in Table 19-2 represents the most recent year of sampling (for CANJ, 2008, for the other three, 2009), unless otherwise indicated. County-level vehicle registration data for Union, Morris, Camden, and Middlesex Counties were not available from the State of New Jersey. Thus, state-level vehicle registration, which was obtained from the Federal Highway Administration (FHWA, 2009a and 2011), was allocated to the county level using the county-level proportion of the state population. State-level and county-level population information for these counties was obtained from the U.S. Census Bureau (Census Bureau, 2009 and 2010). Table 19-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site.

Table 19-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 19-2 presents the daily VMT for the New York and Philadelphia urban areas.

Table 19-2. Population, Motor Vehicle, and Traffic Information for the New Jersey Monitoring Sites

Site	Estimated County Population[1]	Estimated Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
CANJ	517,234	372,132	0.72	2,003,209	1,441,239	4,206	105,823
CHNJ	488,518	342,994	0.70	242,969	170,591	12,917	299,125
ELNJ	526,426	369,610	0.70	2,205,797	1,548,715	250,885	299,125
NBNJ	790,738	555,187	0.70	788,786	553,816	110,653	299,125

[1] Reference: Census Bureau, 2009 and 2010.

[2] County-level vehicle registration reflects an estimate based on state-level vehicle registration from the FHWA and the county-level proportion of the state population data (FHWA, 2009a and 2011).

[3] Reference: http://xionetic.com/zipfinddeluxe.aspx

[4] Annual Average Daily Traffic reflects data from the New Jersey DOT for the following years: 2008 for CANJ, 2010 for CHNJ, 2002 for ELNJ, and 2009 for NBNJ (NJ DOT, 2002, 2008, 2009, and 2010).

[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

Observations from Table 19-2 include the following:

- Middlesex County, where NBNJ is located, had the highest county population of the New Jersey sites. But ELNJ had the highest 10-mile population among the four New Jersey sites, although CANJ was not far behind.

- Compared to NMP monitoring sites in other locations, the county-level populations were in the middle of the range. However, ELNJ had one of the highest 10-mile populations, as did CANJ. NBNJ's 10-mile population was in the middle of the range while CHNJ's 10-mile population was in the bottom third compared to other NMP sites.

- The estimated county-level vehicle ownership was highest for NBNJ while fairly similar across the remaining New Jersey sites. The registration estimates were in the middle of the range compared to other program sites. ELNJ and CANJ had two of the highest 10-mile vehicle ownership estimates compared to other NMP sites.

- ELNJ experienced a significantly higher average traffic volume than other New Jersey sites, while CANJ experienced the least. Traffic data for ELNJ were obtained from I-95, between Exit 13 and 13A; traffic data for CANJ were obtained from the intersection of Euclid Avenue and Haddon Avenue; traffic data for CHNJ were obtained from Main Street (County Road 513) near Highway 206; and traffic data for NBNJ were obtained from US-1 near State Road 617 (Ryders Lane).

- VMT for the New York City metropolis ranked highest among all urban areas with NMP sites (and among all U.S. urban areas). The VMT for the Philadelphia area ranked seventh among urban areas with NMP sites.

19.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in New Jersey on sample days, as well as over the course of each year.

19.2.1 Climate Summary

Frontal systems push across the state of New Jersey regularly, producing variable weather. The state's 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. Large urban areas within the state experience the urban heat island effect, in which the urban areas retain more heat than outlying areas. New Jersey's mid-Atlantic location also allows for ample annual precipitation and relatively high humidity. A southwesterly wind is most common in the summer and a northwesterly wind is typical in the winter. Winds from the west and northwest result in air masses that dry out, stabilize, and warm up as they move eastward from higher elevations to sea level (Bair, 1992 and Rutgers, 2011).

19.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The three closest NWS weather stations are located at Philadelphia International Airport (near CANJ), Somerville-Somerset Airport (near CHNJ and NBNJ), and Newark International Airport (near ELNJ), WBAN 13739, 54785, and 14734, respectively. Additional information about these weather stations is provided in Table 19-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 19-3. Average Meteorological Conditions near the New Jersey Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Camden, New Jersey - CANJ										
Philadelphia International Airport 13739 (39.87, -75.23)	7.67 miles 227° (SW)	2008	Sample Day	67.7 ± 5.3	59.7 ± 5.0	45.1 ± 5.3	52.4 ± 4.5	62.2 ± 4.3	1016.1 ± 2.3	7.8 ± 0.9
			All Year	64.5 ± 1.8	56.4 ± 1.7	42.0 ± 1.8	49.5 ± 1.6	61.9 ± 1.4	1017.1 ± 0.8	8.2 ± 0.3
Chester, New Jersey - CHNJ										
Somerville, New Jersey/Somerset Airport 54785 (40.62, -74.67)	11.30 miles 165° (SSE)	2008	Sample Day	63.6 ± 4.8	52.9 ± 4.4	40.9 ± 4.9	47.4 ± 4.1	68.6 ± 4.0	1016.1 ± 2.1	3.1 ± 0.5
			All Year	62.9 ± 1.9	52.3 ± 1.7	41.0 ± 1.8	47.0 ± 1.6	69.5 ± 1.4	1016.3 ± 0.8	3.5 ± 0.2
		2009	Sample Day	63.1 ± 4.7	53.1 ± 4.3	43.0 ± 4.6	48.3 ± 4.0	71.9 ± 3.2	1013.8 ± 2.1	3.1 ± 0.6
			All Year	61.5 ± 1.8	51.6 ± 1.7	41.0 ± 2.0	46.8 ± 1.7	70.3 ± 1.4	1016.3 ± 0.8	3.2 ± 0.3
Elizabeth, New Jersey - ELNJ										
Newark International Airport 14734 (40.72, -74.17)	5.50 miles 7° (N)	2008	Sample Day	63.3 ± 4.7	55.7 ± 4.5	39.8 ± 4.6	48.2 ± 3.9	58.7 ± 3.9	1016.6 ± 2.1	7.9 ± 0.8
			All Year	63.2 ± 1.8	55.5 ± 1.7	39.5 ± 1.8	48.0 ± 1.5	58.3 ± 1.5	1016.6 ± 0.8	8.3 ± 0.3
		2009	Sample Day	64.0 ± 4.7	56.6 ± 4.3	41.6 ± 4.6	49.4 ± 3.9	60.5 ± 3.4	1014.1 ± 2.1	8.3 ± 0.9
			All Year	62.0 ± 1.8	54.5 ± 1.7	39.1 ± 1.9	47.5 ± 1.6	58.8 ± 1.5	1016.5 ± 0.8	8.1 ± 0.4

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 19-3. Average Meteorological Conditions near the New Jersey Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
New Brunswick, New Jersey - NBNJ										
Somerville, New Jersey/Somerset Airport 54785 (40.62, -74.67)	16.05 miles 297° (WNW)	2008	Sample Day	65.2 ± 4.7	53.8 ± 4.3	41.8 ± 4.8	48.1 ± 4.1	68.6 ± 3.5	1016.6 ± 2.0	3.0 ± 0.5
			All Year	62.9 ± 1.9	52.3 ± 1.7	41.0 ± 1.8	47.0 ± 1.6	69.5 ± 1.4	1016.3 ± 0.8	3.5 ± 0.2
		2009	Sample Day	63.2 ± 4.7	53.4 ± 4.3	43.5 ± 4.7	48.7 ± 4.1	72.6 ± 3.2	1014.2 ± 2.0	3.1 ± 0.6
			All Year	61.5 ± 1.8	51.6 ± 1.7	41.0 ± 2.0	46.8 ± 1.7	70.3 ± 1.4	1016.3 ± 0.8	3.2 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 19-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 19-3 is the 95 percent confidence interval for each parameter. As shown in Table 19-3, average meteorological conditions on sample days were representative of average weather conditions throughout the years for CHNJ, ELNJ, and NBNJ. For CANJ, temperatures on sample days in 2008 appear slightly warmer than all days in 2008. Recall though, that sampling at CANJ stopped in October 2008, thereby excluding some of the cooler months of the year, which likely explains the difference.

19.2.3 Back Trajectory Analysis

Figure 19-8 is the composite back trajectory map for days on which samples were collected at the CANJ monitoring site in 2008 while Figure 19-9 is the cluster analysis for this site. Figure 19-10 and Figure 19-11 are the composite back trajectory maps for days on which samples were collected at CHNJ in 2008 and 2009, respectively. Figure 19-12 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Likewise, Figures 19-13 through 19-18 are the composite back trajectory and cluster analysis maps for the ELNJ and NBNJ monitoring sites. An in-depth description of these maps and how they were generated was presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 19-8 through 19-18 represents 100 miles.

Figure 19-8. 2008 Composite Back Trajectory Map for CANJ

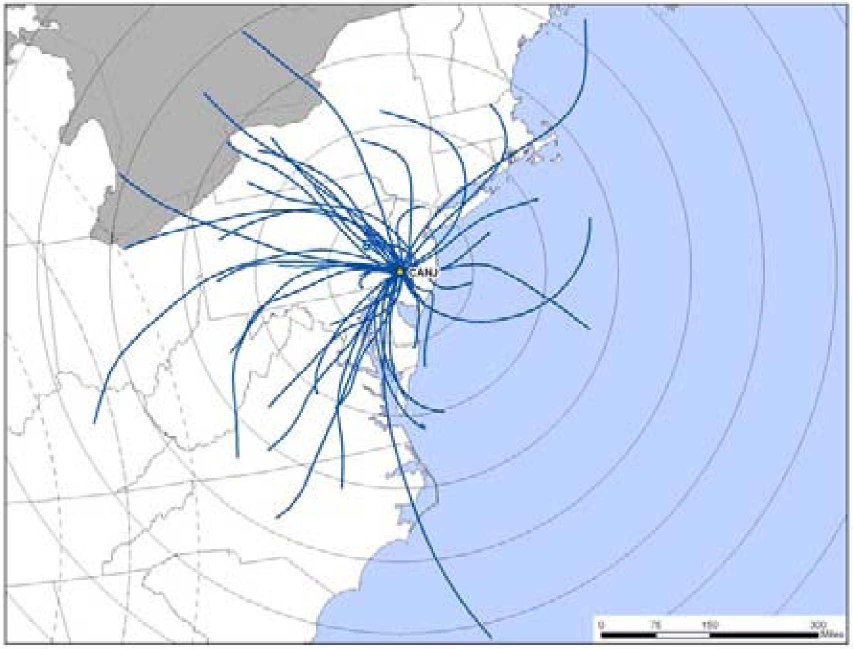


Figure 19-9. 2008 Back Trajectory Cluster Map for CANJ

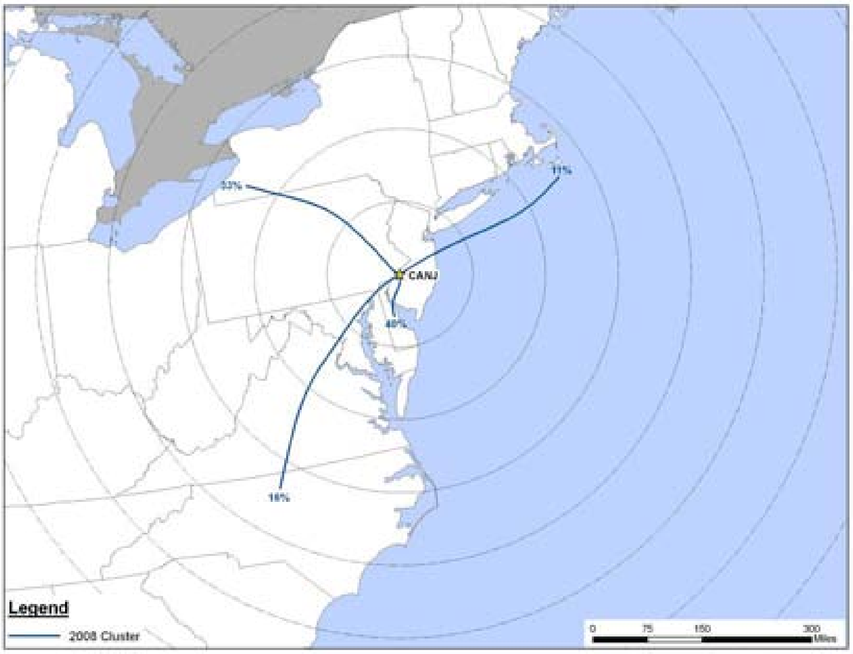


Figure 19-10. 2008 Composite Back Trajectory Map for CHNJ

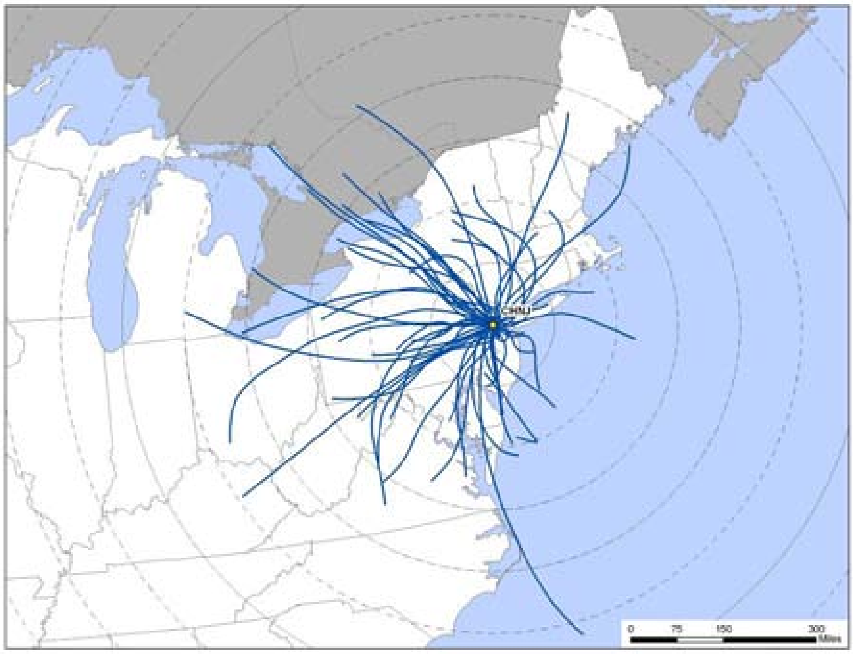


Figure 19-11. 2009 Composite Back Trajectory Map for CHNJ

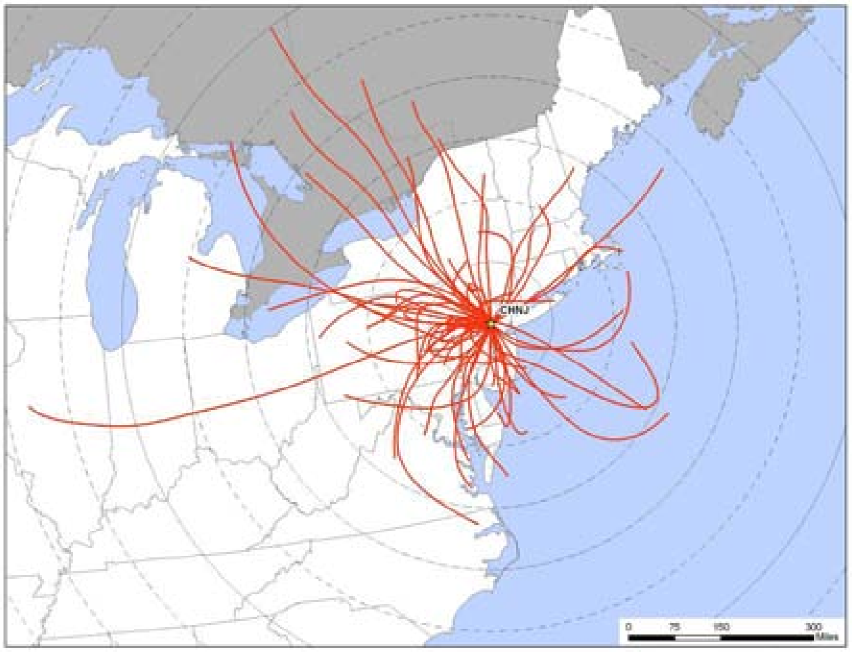


Figure 19-12. Back Trajectory Cluster Map for CHNJ

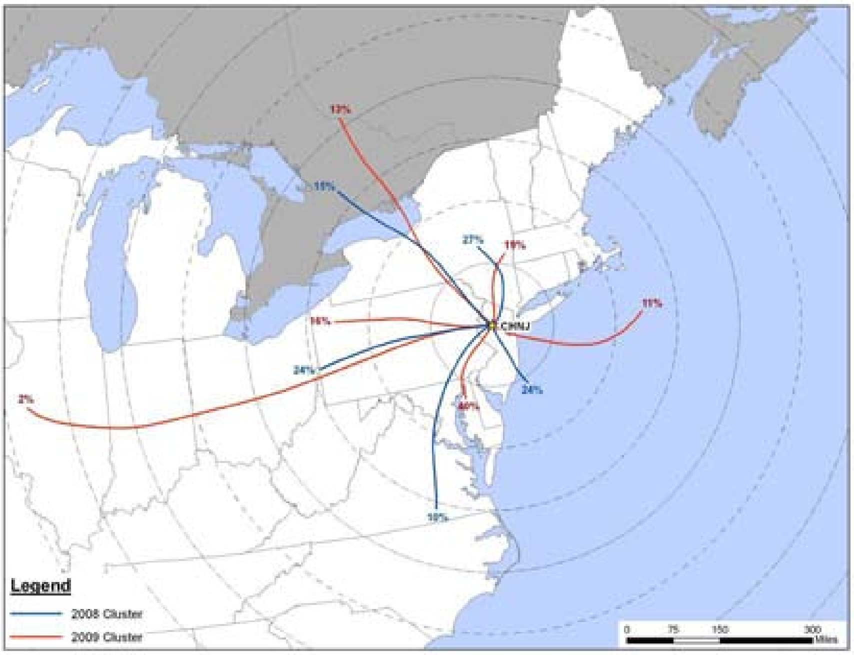


Figure 19-13. 2008 Composite Back Trajectory Map for ELNJ

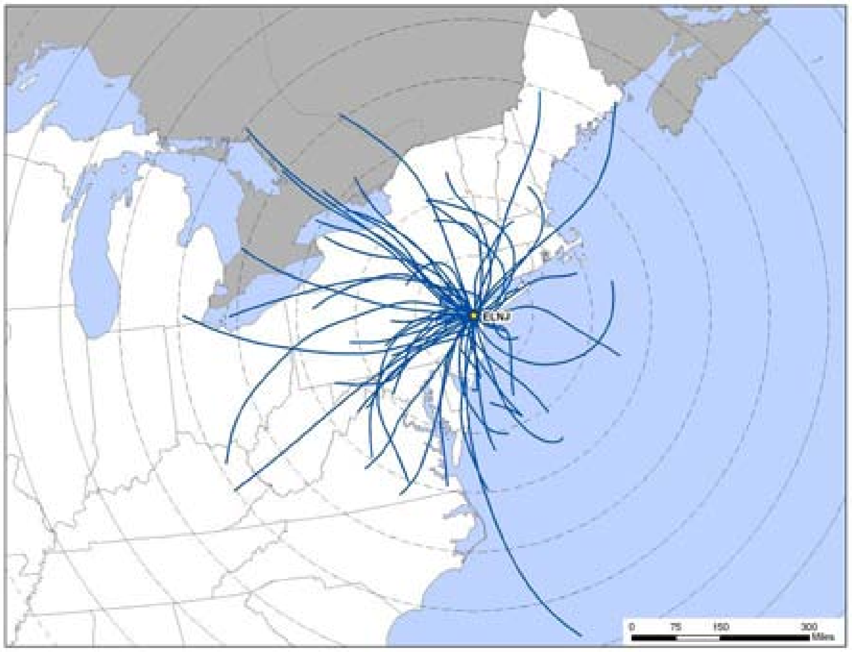


Figure 19-14. 2009 Composite Back Trajectory Map for ELNJ

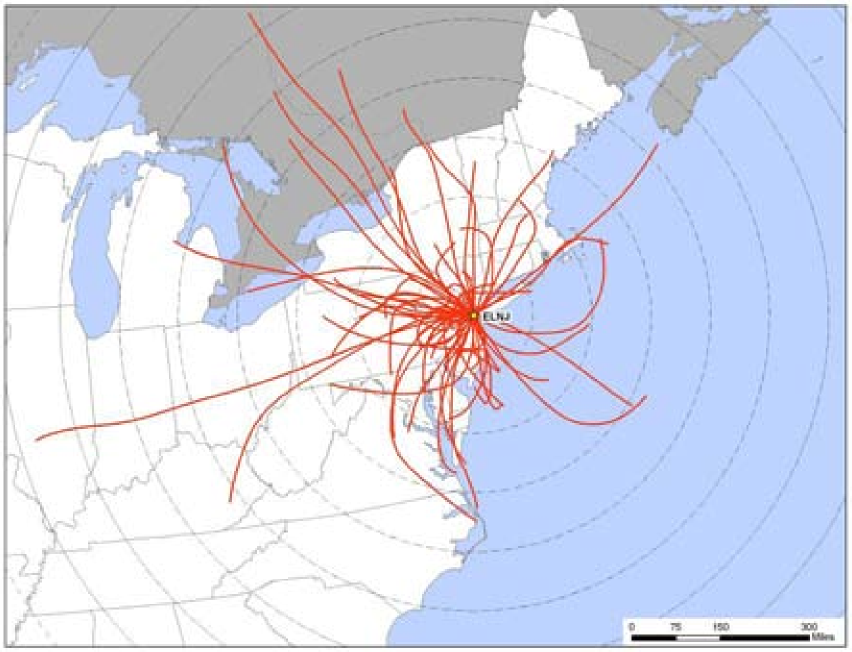


Figure 19-15. Back Trajectory Cluster Map for ELNJ

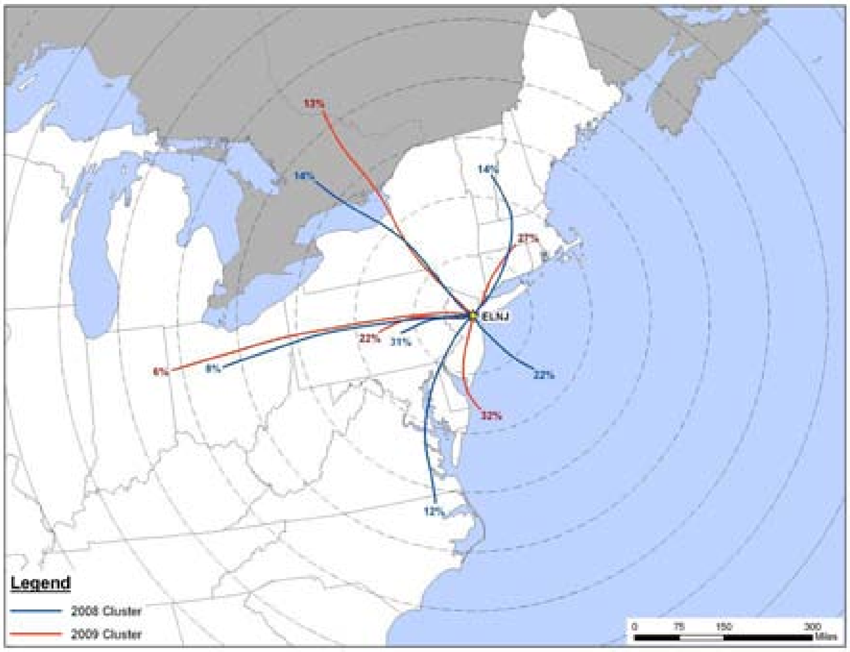


Figure 19-16. 2008 Composite Back Trajectory Map for NBNJ

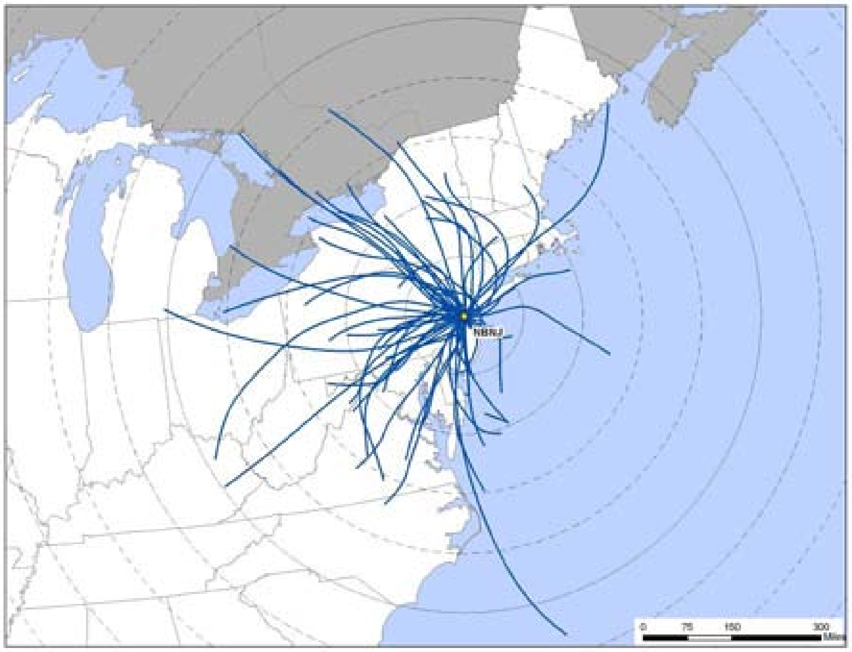


Figure 19-17. 2009 Composite Back Trajectory Map for NBNJ

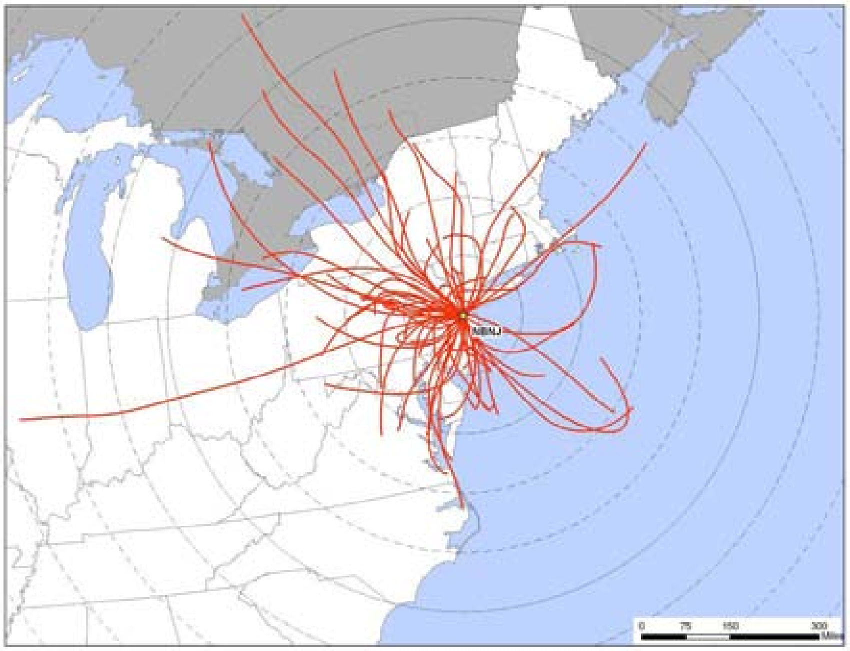
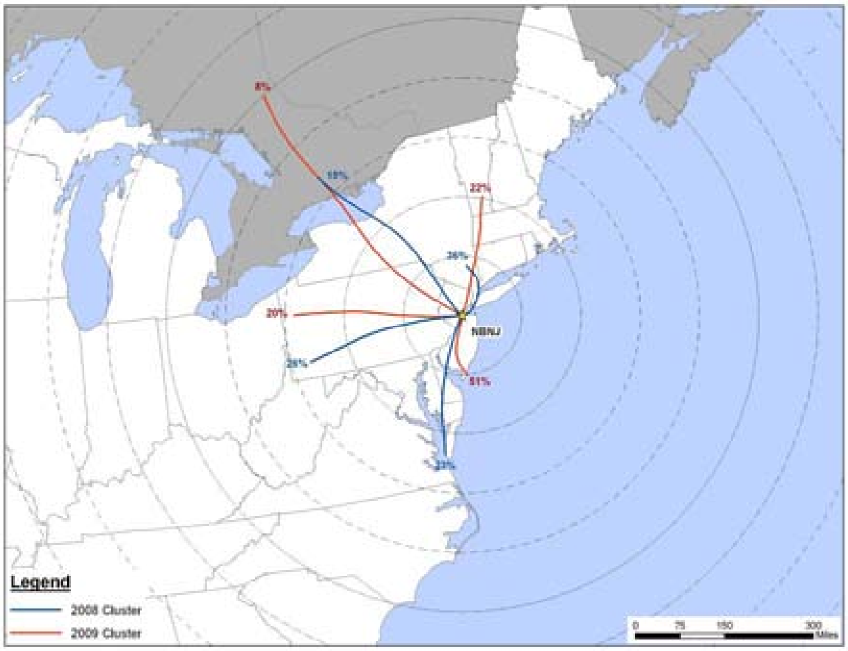


Figure 19-18. Back Trajectory Cluster Map for NBNJ



Observations from Figures 19-8 through 19-18 include the following:

- Due to their relatively close proximity to each other and the standardization of sample days, the back trajectories shown on each composite back trajectory map for the New Jersey sites are fairly similar to each other.

- Back trajectories originated from a variety of directions at the sites, although fewer from the east and southeast.

- CANJ stopped sampling in October 2008 and thus has fewer trajectories on its composite back trajectory map. It also does not have a 2009 back trajectory analysis.

- For CANJ, the farthest away a trajectory originated was off the North Carolina coast, or just over 500 miles away. However, most trajectories originated within 300 miles of the site and the average trajectory length was 228 miles.

- Forty percent of CANJ back trajectories originated within 100-200 miles of the site and predominantly from the southwest (recall that both direction and distance factor into the cluster analysis). Another 10 percent also originated towards the southwest, but farther from the site. One-third of trajectories originated to the northwest of the site. The remaining 11 percent originated from the northeast and east.

- The 24-hour air shed domains for CHNJ, ELNJ, and NBNJ were similar in size to each other. The longest trajectory originated over central Illinois, nearly 800 miles away. This trajectory was created for February 12, 2009, a day that a strong low pressure system moved across the northeast part of the country. The average trajectory length for these sites ranged from 229 miles (CHNJ) to 238 miles (NBNJ).

- For CHNJ, ELNJ, and NBNJ, the cluster trajectories shown for the cluster analyses for 2008 are fairly similar in location to the cluster analyses for 2009, although the percentages vary. The cluster maps show a propensity for trajectories to originate from the south and southwest, west, northwest, and north (and rarely from the east) at these sites.

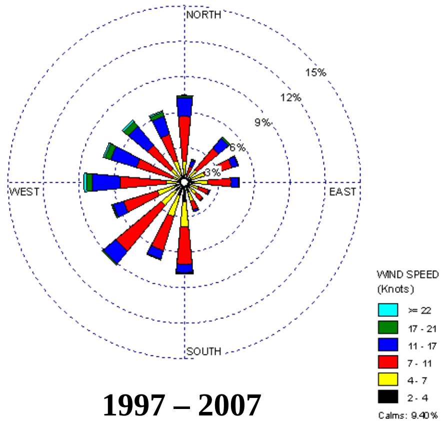
19.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations near the New Jersey sites, as presented in Section 19.2.2, were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 19-19 presents three different wind roses for the CANJ monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year is presented. Finally, a wind rose representing days on which samples were collected in 2008 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Because CANJ stopped sampling in 2008, no 2009 wind roses are presented.

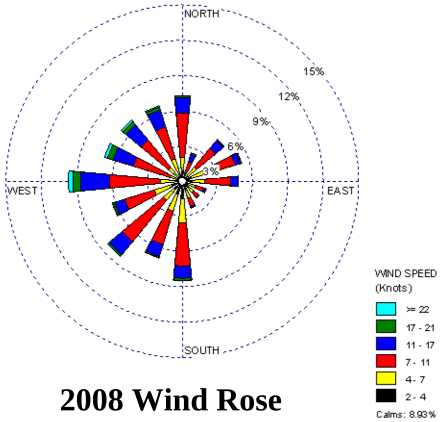
Figure 19-20 presents five different wind roses for CHNJ. First, a historical wind rose representing 1997 to 2007 is presented. Next, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Lastly, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. Figures 19-21 and 19-22 present the five different wind roses for the ELNJ and NBNJ monitoring sites.

Figure 19-19. Wind Roses for the Philadelphia International Airport Weather Station near CANJ

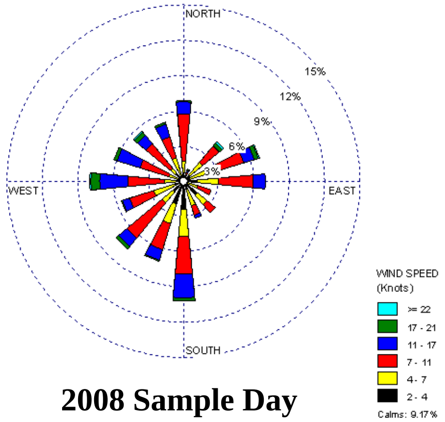


1997 – 2007

Historical Wind Rose



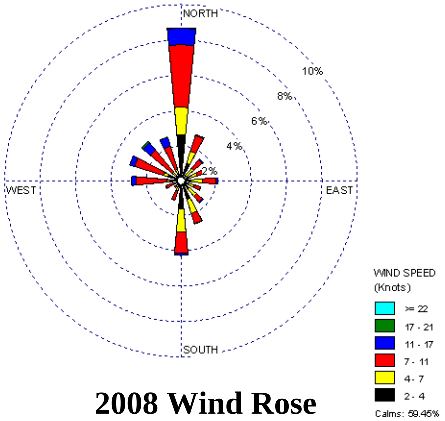
2008 Wind Rose



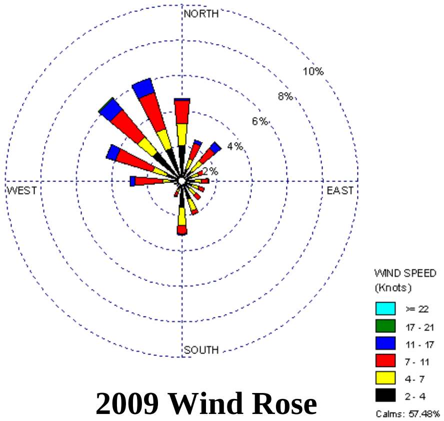
2008 Sample Day

Wind Rose

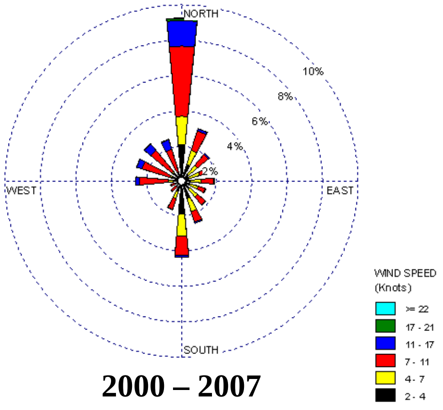
Figure 19-20. Wind Roses for the Summerville-Somerset Airport Weather Station near CHNJ



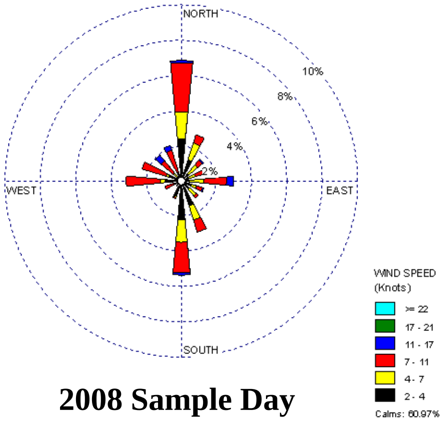
2008 Wind Rose



2009 Wind Rose

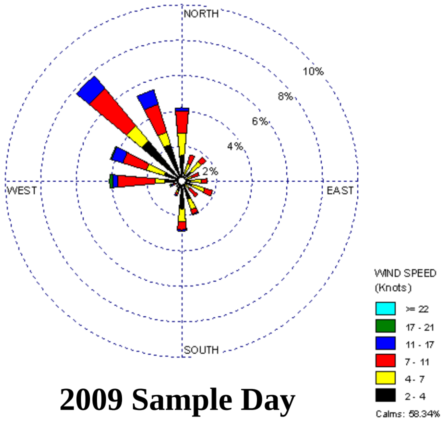


2000 – 2007
Historical Wind Rose



2008 Sample Day

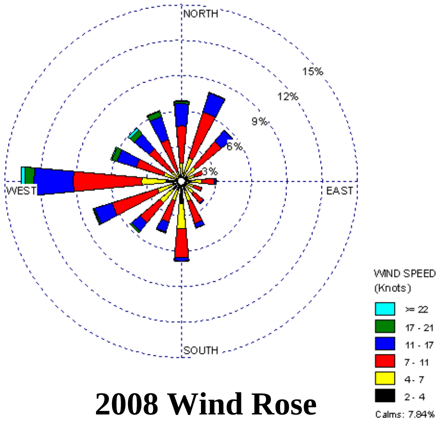
Wind Rose



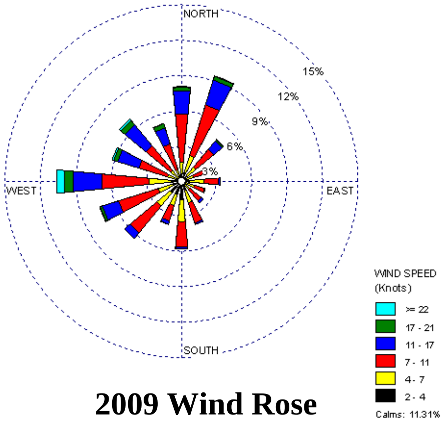
2009 Sample Day

Wind Rose

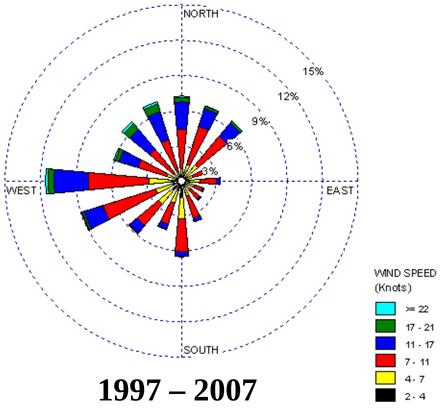
Figure 19-21. Wind Roses for the Newark International Airport Weather Station near ELNJ



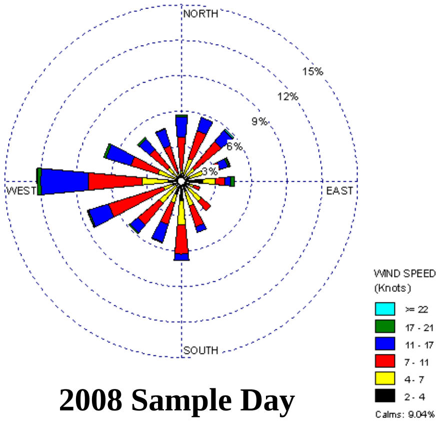
2008 Wind Rose



2009 Wind Rose

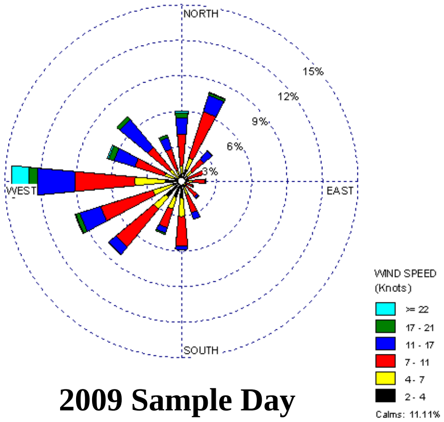


1997 – 2007
Historical Wind Rose



2008 Sample Day

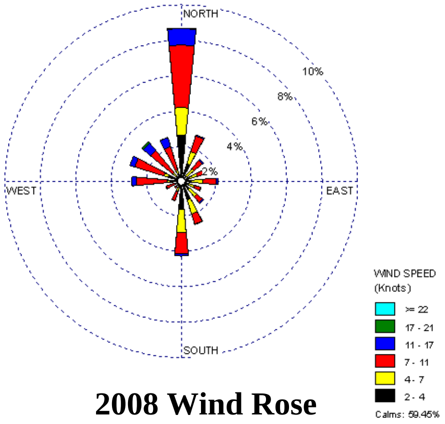
Wind Rose



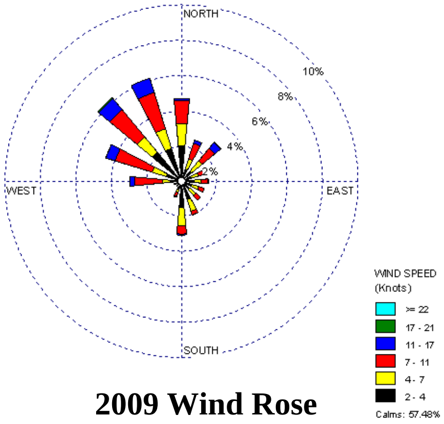
2009 Sample Day

Wind Rose

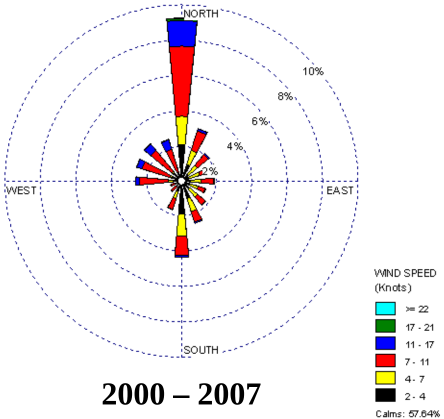
Figure 19-22. Wind Roses for the Summerville-Somerset Airport Weather Station near NBNJ



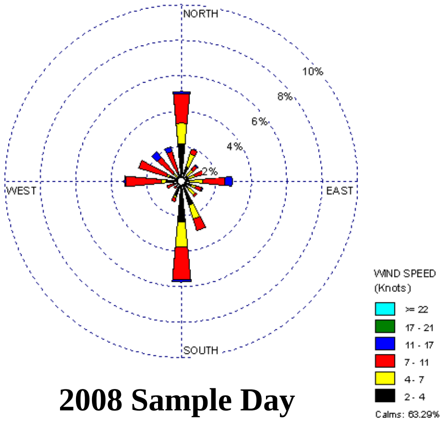
2008 Wind Rose



2009 Wind Rose

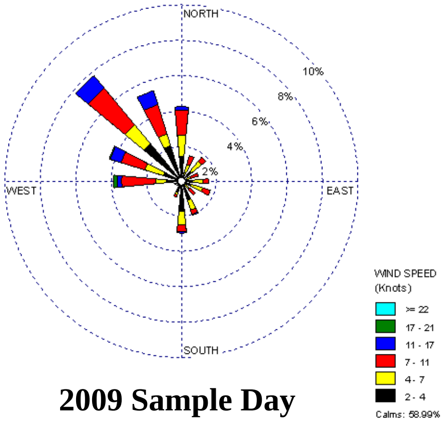


2000 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 19-19 for CANJ include the following:

- The historical wind rose shows that winds from a variety of directions were observed near CANJ, although winds infrequently came from the southeast quadrant. Calm winds (≤2 knots) were observed for less than 10 percent of observations.

- The wind patterns shown on the 2008 wind rose resemble the historical wind patterns, as do the 2008 sample day wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

Observations from Figures 19-20 and 19-22 for CHNJ and NBNJ include the following:

- The historical and full-year wind roses for CHNJ and NBNJ are identical because the Somerville/Somerset Airport is the closest weather station to both sites; thus, the wind data are the same.

- The historical wind roses for these sites show that calm winds accounted for nearly 60 percent of observations. For wind speeds greater than 2 knots, northerly winds were observed most frequently, while southwesterly winds were rarely observed.

- The wind patterns shown on the 2008 wind roses resemble the historical wind patterns, as do the 2008 sample day wind patterns, indicating that conditions in 2008 were similar to conditions typically experienced near these sites.

- While the 2009 wind roses and 2009 sample day wind roses do exhibit the same prevalence for calm winds as the historical and 2008 wind roses, they do not exhibit the same northerly predominance as the other wind roses for wind speeds greater than 2 knots. Instead, there was an increase in winds from the northwest quadrant. It is important to note that each circle in Figures 19-20 and 19-22 represents two percent, and that the outer circle represents 10 percent. Even though the northerly wind direction percentage for the 2008 and historical wind roses appear significantly higher than the percentages for the other wind directions, it still represents less than 10 percent of the observations. Thus, the northerly wind direction percentage ranged from roughly nine percent for the historical and 2008 wind roses to five percent for 2009.

Observations from Figure 19-21 for ELNJ include the following:

- The historical wind rose shows that winds from a variety of directions were observed near ELNJ, although easterly and southeasterly winds were observed infrequently. Calm winds were observed for approximately eight percent of observations. The strongest winds were associated with westerly and northwesterly winds.

- The wind patterns shown on the 2008 and 2009 wind roses generally resemble the historical wind patterns, as do the sample day wind patterns for each year. This indicates that conditions on sample days were representative of those experienced over the entire year(s) and historically.

19.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the New Jersey monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 19-4 presents the pollutants of interest for the New Jersey sites. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. All four New Jersey monitoring sites sampled for VOC and carbonyl compounds.

Table 19-4. Risk Screening Results for the New Jersey Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Camden, New Jersey - CANJ						
Acetaldehyde	0.45	38	38	100.00	13.48	13.48
Formaldehyde	0.077	38	38	100.00	13.48	26.95
Benzene	0.13	37	37	100.00	13.12	40.07
1,3-Butadiene	0.033	37	37	100.00	13.12	53.19
Carbon Tetrachloride	0.17	37	37	100.00	13.12	66.31
Tetrachloroethylene	0.17	32	37	86.49	11.35	77.66
p-Dichlorobenzene	0.091	29	37	78.38	10.28	87.94
Bromomethane	0.5	12	37	32.43	4.26	92.20
Ethylbenzene	0.4	12	37	32.43	4.26	96.45
Acrylonitrile	0.015	3	3	100.00	1.06	97.52
Dichloromethane	2.1	2	37	5.41	0.71	98.23
Vinyl chloride	0.11	2	26	7.69	0.71	98.94
1,2-Dichloroethane	0.038	1	1	100.00	0.35	99.29
Propionaldehyde	0.8	1	38	2.63	0.35	99.65
Trichloroethylene	0.5	1	34	2.94	0.35	100.00
Total		282	474	59.49		
Chester, New Jersey - CHNJ						
Benzene	0.13	119	119	100.00	20.59	20.59
Carbon Tetrachloride	0.17	117	119	98.32	20.24	40.83
Formaldehyde	0.077	117	117	100.00	20.24	61.07
Acetaldehyde	0.45	116	117	99.15	20.07	81.14
Acrylonitrile	0.015	37	37	100.00	6.40	87.54
1,3-Butadiene	0.033	29	94	30.85	5.02	92.56
Tetrachloroethylene	0.17	19	106	17.92	3.29	95.85
p-Dichlorobenzene	0.091	7	65	10.77	1.21	97.06
Ethylbenzene	0.4	6	119	5.04	1.04	98.10
1,2-Dichloroethane	0.038	5	5	100.00	0.87	98.96
1,2-Dibromoethane	0.0017	2	2	100.00	0.35	99.31
Dichloromethane	2.1	1	119	0.84	0.17	99.48
Hexachloro-1,3-butadiene	0.045	1	1	100.00	0.17	99.65
Trichloroethylene	0.5	1	23	4.35	0.17	99.83
Xylenes	10	1	119	0.84	0.17	100.00
Total		578	1,162	49.74		

Table 19-4. Risk Screening Results for the New Jersey Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Elizabeth, New Jersey - ELNJ						
Formaldehyde	0.077	116	116	100.00	13.63	13.63
Acetaldehyde	0.45	115	116	99.14	13.51	27.14
Benzene	0.13	113	113	100.00	13.28	40.42
1,3-Butadiene	0.033	113	113	100.00	13.28	53.70
Carbon Tetrachloride	0.17	113	113	100.00	13.28	66.98
Tetrachloroethylene	0.17	78	112	69.64	9.17	76.15
Ethylbenzene	0.4	63	112	56.25	7.40	83.55
p-Dichlorobenzene	0.091	60	107	56.07	7.05	90.60
Acrylonitrile	0.015	47	47	100.00	5.52	96.12
Dichloromethane	2.1	13	113	11.50	1.53	97.65
Propionaldehyde	0.8	8	116	6.90	0.94	98.59
1,2-Dichloroethane	0.038	5	5	100.00	0.59	99.18
Xylenes	10	3	113	2.65	0.35	99.53
Chloromethylbenzene	0.02	1	2	50.00	0.12	99.65
1,2-Dibromoethane	0.0017	1	1	100.00	0.12	99.76
1,1,2,2-Tetrachloroethane	0.017	1	2	50.00	0.12	99.88
Trichloroethylene	0.5	1	78	1.28	0.12	100.00
Total		851	1,379	61.71		
New Brunswick, New Jersey - NBNJ						
Acetaldehyde	0.45	112	112	100.00	17.78	17.78
Formaldehyde	0.077	112	112	100.00	17.78	35.56
Benzene	0.13	110	110	100.00	17.46	53.02
Carbon Tetrachloride	0.17	109	110	99.09	17.30	70.32
1,3-Butadiene	0.033	63	106	59.43	10.00	80.32
Tetrachloroethylene	0.17	46	105	43.81	7.30	87.62
p-Dichlorobenzene	0.091	32	95	33.68	5.08	92.70
Acrylonitrile	0.015	27	27	100.00	4.29	96.98
Ethylbenzene	0.4	8	110	7.27	1.27	98.25
1,2-Dichloroethane	0.038	4	4	100.00	0.63	98.89
Dichloromethane	2.1	3	110	2.73	0.48	99.37
Trichloroethylene	0.5	2	52	3.85	0.32	99.68
1,2-Dibromoethane	0.0017	1	1	100.00	0.16	99.84
Propionaldehyde	0.8	1	112	0.89	0.16	100.00
Total		630	1,166	54.03		

Observations from Table 19-4 include the following:

- Fifteen pollutants failed at least one screen for CANJ, of which eight are NATTS MQO Core Analytes; 15 failed screens for CHNJ, of which seven are NATTS MQO Core Analytes; 17 failed screens for ELNJ (seven are NATTS MQO Core Analytes); and 14 failed screens for NBNJ (seven are NATTS MQO Core Analytes).

- The risk screening process identified nine pollutants of interest for CANJ (of which six are NATTS MQO Core Analytes). Vinyl chloride and trichloroethylene were added as pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of failed screens. Chloroform was also added because it is a NATTS MQO Core Analyte, even though it did not fail any screens. Chloroform is not shown in Table 19-4.

- The risk screening process identified seven pollutants of interest for CHNJ (of which six are NATTS MQO Core Analytes). Trichloroethylene was added as a pollutant of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of failed screens. Chloroform and vinyl chloride were also added because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are not shown in Table 19-4.

- The risk screening process identified nine pollutants of interest for ELNJ (of which six are NATTS MQO Core Analytes). Trichloroethylene was added as a pollutant of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of failed screens. Chloroform and vinyl chloride were also added because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are not shown in Table 19-4.

- The risk screening process identified eight pollutants of interest for NBNJ (of which six are NATTS MQO Core Analytes). Trichloroethylene was added as a pollutant of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of failed screens. Chloroform and vinyl chloride were also added because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are not shown in Table 19-4.

- Measured detections of formaldehyde and benzene failed 100 percent of screens for all four sites.

- The total failure rate ranged from 49.74 percent for CHNJ to 61.71 percent for ELNJ (of the pollutants with at least one failed screen). As shown in Table 4-8, ELNJ failed the seventh highest number of screens among all NMP sites, but sampled the fewest methods (two) of the sites that failed more screens.

19.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the New Jersey monitoring sites. Concentration averages are provided for the pollutants of interest for each New Jersey site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

19.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each New Jersey site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 19-5, where applicable.

Table 19-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites

	2008						2009					
Pollutant	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
Camden, New Jersey – CANJ												
Acetaldehyde	1.83 ± 0.29	1.33 ± 0.33	2.30 ± 0.60	2.04 ± 0.54	NA	NA*	NR	NR	NR	NR	NR	NR
Benzene	1.36 ± 0.47	1.79 ± 1.16	1.17 ± 0.18	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Bromomethane	0.81 ± 0.48	0.91 ± 1.03	0.96 ± 0.66	NA	NA	NA*	NR	NR	NR	NR	NR	NR
1,3-Butadiene	0.10 ± 0.02	0.14 ± 0.05	0.07 ± 0.01	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Carbon Tetrachloride	0.65 ± 0.05	0.63 ± 0.05	0.68 ± 0.10	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Chloroform	0.13 ± 0.02	0.09 ± 0.02	0.13 ± 0.03	NA	NA	NA*	NR	NR	NR	NR	NR	NR
p-Dichlorobenzene	0.18 ± 0.03	0.14 ± 0.04	0.19 ± 0.03	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Ethylbenzene	0.47 ± 0.23	0.62 ± 0.57	0.35 ± 0.06	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Formaldehyde	3.31 ± 0.55	1.94 ± 0.36	4.14 ± 1.01	4.57 ± 0.79	NA	NA*	NR	NR	NR	NR	NR	NR
Tetrachloroethylene	0.48 ± 0.23	0.66 ± 0.55	0.30 ± 0.10	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Trichloroethylene	0.18 ± 0.07	0.18 ± 0.16	0.17 ± 0.08	NA	NA	NA*	NR	NR	NR	NR	NR	NR
Vinyl Chloride	0.03 ± 0.01	0.03 ± 0.03	0.01 ± 0.01	NA	NA	NA*	NR	NR	NR	NR	NR	NR

*Method completeness was less than 85 percent for CANJ for both methods.
NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Table 19-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Chester, New Jersey - CHNJ												
Acetaldehyde	1.40 ± 0.14	1.55 ± 0.23	1.51 ± 0.36	1.28 ± 0.32	1.20 ± 0.12	1.40 ± 0.14	1.34 ± 0.14	1.52 ± 0.29	1.50 ± 0.31	1.14 ± 0.15	1.21 ± 0.37	1.34 ± 0.14
Acrylonitrile	0.34 ± 0.29	NA	NA	NA	NA	NA	0.12 ± 0.02	0.04 ± 0.02	0.07 ± 0.03	NA	NA	NA
Benzene	0.60 ± 0.10	0.64 ± 0.09	0.54 ± 0.25	0.56 ± 0.32	0.64 ± 0.15	0.60 ± 0.10	0.56 ± 0.11	0.94 ± 0.27	0.49 ± 0.18	0.29 ± 0.04	0.53 ± 0.23	0.56 ± 0.11
1,3-Butadiene	0.04 ± 0.01	0.04 ± 0.02	0.03 ± 0.04	0.03 ± 0.03	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.02	0.03 ± 0.02	0.01 ± 0.01	0.01 ± <0.01	0.04 ± 0.05	0.02 ± 0.01
Carbon Tetrachloride	0.70 ± 0.06	0.60 ± 0.07	0.70 ± 0.14	0.78 ± 0.12	0.72 ± 0.16	0.70 ± 0.06	0.72 ± 0.05	0.61 ± 0.08	0.65 ± 0.05	0.85 ± 0.10	0.76 ± 0.11	0.72 ± 0.05
Chloroform	0.12 ± 0.02	0.07 ± 0.02	0.11 ± 0.04	0.18 ± 0.03	0.12 ± 0.03	0.12 ± 0.02	0.11 ± 0.01	0.09 ± 0.02	0.11 ± 0.01	0.14 ± 0.01	0.11 ± 0.02	0.11 ± 0.01
Formaldehyde	2.25 ± 0.31	1.60 ± 0.20	2.31 ± 0.64	3.46 ± 0.91	1.85 ± 0.26	2.25 ± 0.31	2.43 ± 0.30	1.57 ± 0.22	2.56 ± 0.40	3.47 ± 0.64	2.03 ± 0.59	2.43 ± 0.30
Tetrachloroethylene	0.16 ± 0.08	0.11 ± 0.04	0.21 ± 0.26	0.16 ± 0.08	0.11 ± 0.03	0.15 ± 0.07	0.11 ± 0.02	0.09 ± 0.03	0.10 ± 0.02	0.07 ± 0.03	0.11 ± 0.05	0.09 ± 0.02
Trichloroethylene	0.11 ± 0.10	NA	NA	NA	NA	NA	0.05 ± 0.02	NA	NA	NA	NA	NA
Vinyl Chloride	0.02 ± 0.01	NA	NA	NA	NA	NA	0.03 ± 0.02	NA	NA	NA	NA	NA

*Method completeness was less than 85 percent for CANJ for both methods.
NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Table 19-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
Elizabeth, New Jersey - ELNJ												
Acetaldehyde	2.35 ± 0.26	1.85 ± 0.43	2.43 ± 0.83	2.56 ± 0.45	2.60 ± 0.39	2.35 ± 0.26	2.47 ± 0.32	2.30 ± 0.52	2.72 ± 0.65	2.49 ± 0.50	2.35 ± 1.04	2.47 ± 0.32
Acrylonitrile	1.56 ± 0.35	1.07 ± 0.41	1.50 ± 0.67	NA	NA	NA	0.28 ± 0.16	NA	0.26 ± 0.26	NA	NA	NA
Benzene	1.83 ± 1.23	1.55 ± 0.58	1.02 ± 0.23	3.38 ± 4.92	1.24 ± 0.28	1.83 ± 1.23	1.36 ± 0.36	2.28 ± 1.22	1.34 ± 0.42	0.76 ± 0.10	1.06 ± 0.48	1.36 ± 0.36
1,3-Butadiene	0.15 ± 0.02	0.20 ± 0.07	0.11 ± 0.03	0.13 ± 0.03	0.14 ± 0.04	0.15 ± 0.02	0.16 ± 0.09	0.27 ± 0.34	0.11 ± 0.02	0.09 ± 0.01	0.16 ± 0.09	0.16 ± 0.09
Carbon Tetrachloride	0.64 ± 0.05	0.56 ± 0.04	0.69 ± 0.12	0.68 ± 0.11	0.64 ± 0.09	0.64 ± 0.05	0.67 ± 0.04	0.63 ± 0.11	0.61 ± 0.06	0.77 ± 0.06	0.67 ± 0.09	0.67 ± 0.04
Chloroform	0.18 ± 0.02	0.15 ± 0.03	0.18 ± 0.04	0.25 ± 0.04	0.14 ± 0.02	0.18 ± 0.02	0.17 ± 0.02	0.10 ± 0.01	0.17 ± 0.04	0.22 ± 0.03	0.17 ± 0.06	0.17 ± 0.02
p-Dichlorobenzene	0.19 ± 0.05	0.13 ± 0.05	0.16 ± 0.06	0.33 ± 0.13	0.08 ± 0.04	0.18 ± 0.04	0.12 ± 0.03	0.07 ± 0.03	0.13 ± 0.04	0.11 ± 0.04	0.14 ± 0.10	0.11 ± 0.03
Ethylbenzene	0.88 ± 0.17	0.59 ± 0.27	1.00 ± 0.26	1.37 ± 0.45	0.51 ± 0.14	0.87 ± 0.17	0.46 ± 0.14	0.63 ± 0.53	0.50 ± 0.10	0.33 ± 0.06	0.36 ± 0.17	0.46 ± 0.14
Formaldehyde	3.24 ± 0.39	2.45 ± 0.58	2.96 ± 0.77	4.22 ± 0.81	3.36 ± 0.77	3.24 ± 0.39	3.80 ± 0.53	3.23 ± 1.14	4.06 ± 0.81	4.39 ± 0.91	3.39 ± 1.46	3.80 ± 0.53
Tetrachloroethylene	0.35 ± 0.07	0.37 ± 0.21	0.33 ± 0.12	0.46 ± 0.13	0.24 ± 0.07	0.35 ± 0.07	0.26 ± 0.04	0.22 ± 0.08	0.30 ± 0.08	0.23 ± 0.06	0.27 ± 0.14	0.25 ± 0.04
Trichloroethylene	0.10 ± 0.02	0.07 ± 0.04	0.09 ± 0.03	0.06 ± 0.04	0.04 ± 0.03	0.07 ± 0.02	0.10 ± 0.04	0.11 ± 0.13	0.08 ± 0.02	0.04 ± 0.02	0.07 ± 0.04	0.08 ± 0.03
Vinyl Chloride	0.02 ± 0.01	0.02 ± 0.01	NA	NA	NA	NA	0.02 ± <0.01	0.01 ± <0.01	0.01 ± 0.01	NA	NA	NA

*Method completeness was less than 85 percent for CANJ for both methods.

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Table 19-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

	2008						2009					
Pollutant	**Daily Average ($\mu g/m^3$)**	**1st Quarter Average ($\mu g/m^3$)**	**2nd Quarter Average ($\mu g/m^3$)**	**3rd Quarter Average ($\mu g/m^3$)**	**4th Quarter Average ($\mu g/m^3$)**	**Annual Average ($\mu g/m^3$)**	**Daily Average ($\mu g/m^3$)**	**1st Quarter Average ($\mu g/m^3$)**	**2nd Quarter Average ($\mu g/m^3$)**	**3rd Quarter Average ($\mu g/m^3$)**	**4th Quarter Average ($\mu g/m^3$)**	**Annual Average ($\mu g/m^3$)**
New Brunswick, New Jersey - NBNJ												
Acetaldehyde	2.58 ± 0.48	1.31 ± 0.25	3.78 ± 1.18	3.87 ± 0.72	1.16 ± 0.26	2.58 ± 0.48	2.03 ± 0.25	1.58 ± 0.22	1.58 ± 0.42	2.06 ± 0.47	2.84 ± 0.58	2.03 ± 0.25
Acrylonitrile	0.28 ± 0.37	NA	NA	NA	NA	NA	0.15 ± 0.03	0.05 ± 0.03	NA	0.09 ± 0.05	NA	NA
Benzene	0.70 ± 0.08	0.85 ± 0.20	0.59 ± 0.13	0.69 ± 0.16	0.65 ± 0.09	0.70 ± 0.08	0.69 ± 0.13	1.11 ± 0.45	0.70 ± 0.14	0.41 ± 0.04	0.63 ± 0.18	0.69 ± 0.13
1,3-Butadiene	0.06 ± 0.01	0.07 ± 0.03	0.03 ± 0.01	0.07 ± 0.03	0.06 ± 0.01	0.06 ± 0.01	0.05 ± 0.01	0.07 ± 0.03	0.03 ± 0.01	0.03 ± 0.01	0.06 ± 0.03	0.05 ± 0.01
Carbon Tetrachloride	0.73 ± 0.05	0.63 ± 0.04	0.78 ± 0.08	0.76 ± 0.12	0.73 ± 0.12	0.73 ± 0.05	0.67 ± 0.05	0.50 ± 0.10	0.72 ± 0.09	0.78 ± 0.06	0.66 ± 0.08	0.67 ± 0.05
Chloroform	0.18 ± 0.03	0.09 ± 0.03	0.13 ± 0.04	0.31 ± 0.08	0.13 ± 0.04	0.17 ± 0.03	0.15 ± 0.02	0.09 ± 0.01	0.14 ± 0.03	0.19 ± 0.02	0.17 ± 0.04	0.15 ± 0.02
p-Dichlorobenzene	0.11 ± 0.03	0.06 ± 0.03	0.08 ± 0.03	0.20 ± 0.09	0.04 ± 0.02	0.10 ± 0.03	0.07 ± 0.01	0.03 ± 0.02	0.05 ± 0.02	0.08 ± 0.02	0.06 ± 0.03	0.06 ± 0.01
Formaldehyde	1.47 ± 0.22	1.67 ± 0.25	1.51 ± 0.56	0.93 ± 0.30	1.87 ± 0.59	1.47 ± 0.22	2.57 ± 0.74	2.61 ± 1.01	2.31 ± 0.58	2.38 ± 0.52	3.00 ± 2.90	2.57 ± 0.74
Tetrachloroethylene	0.25 ± 0.07	0.30 ± 0.23	0.19 ± 0.07	0.29 ± 0.11	0.17 ± 0.03	0.24 ± 0.07	0.17 ± 0.03	0.15 ± 0.07	0.16 ± 0.04	0.14 ± 0.03	0.19 ± 0.10	0.16 ± 0.03
Trichloroethylene	0.13 ± 0.04	0.07 ± 0.05	0.06 ± 0.04	0.10 ± 0.08	NA	0.07 ± 0.03	0.08 ± 0.05	NA	NA	0.02 ± 0.01	NA	NA
Vinyl Chloride	0.02 ± <0.01	0.01 ± 0.01	0.01 ± <0.01	NA	NA	NA	0.02 ± <0.01	NA	NA	NA	NA	NA

*Method completeness was less than 85 percent for CANJ for both methods.

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for CANJ from Table 19-5 include the following:

- The pollutants of interest with the highest daily average concentrations by mass for 2008 were formaldehyde (3.31 ± 0.55 μg/m^3), acetaldehyde (1.83 ± 0.29 μg/m^3), and benzene (1.36 ± 0.47 μg/m^3).

- Several of the pollutants of interest have rather large confidence intervals for the first quarter of 2008, indicating that the concentration averages are influenced by outliers. For example, the first quarter 2008 benzene average was 1.79 ± 1.16 μg/m^3. The highest concentration of benzene was measured on March 31, 2008 (9.42 μg/m^3), and was more than three times the next highest benzene concentration measured at CANJ. The highest concentrations of several VOC were measured on March 31, 2008, including 1,3-butadiene, ethylbenzene, trichloroethylene, and vinyl chloride.

- Because neither VOC nor carbonyl compounds met the completeness criteria of 85 percent for CANJ, annual averages were not calculated. Sampling at this site ceased in October 2008.

Observations for CHNJ from Table 19-5 include the following:

- The pollutants of interest with the highest daily average concentrations by mass were formaldehyde, acetaldehyde, and carbon tetrachloride for both years of sampling.

- While concentrations of most of the pollutants of interest for CHNJ did not vary significantly from quarter to quarter, formaldehyde and chloroform tended to be higher during the warmer months.

- The 2008 daily average of acrylonitrile has a rather large confidence interval, indicating that the concentration average was influenced by outliers. The 2008 daily average of acrylonitrile was 0.34 ± 0.29 μg/m^3 while the 2009 daily average was 0.12 ± 0.02 μg/m^3. The two highest concentrations of acrylonitrile were measured in June 2008 (1.09 μg/m^3 and 1.02 μg/m^3), and were nearly three times the next highest concentration measured at CHNJ (0.317 μg/m^3). Measurements of acrylonitrile at CHNJ ranged from 0.0413 μg/m^3 to 1.09 μg/m^3 with a median concentration of 0.111 μg/m^3. This pollutant was detected in 37 of 119 valid samples (31 percent detection rate); thus, this pollutant has few quarterly averages and no annual averages.

- Quarterly and annual averages could not be calculated for vinyl chloride or trichloroethylene because these pollutants were not detected frequently enough.

Observations for ELNJ from Table 19-5 include the following:

- The pollutants of interest with the highest daily average concentrations by mass were formaldehyde, acetaldehyde, and benzene for both years of sampling.

- The confidence interval for benzene's 2008 daily average is rather high, indicating that this average is influenced by outliers. A review of the quarterly average concentrations shows that the confidence interval for the third quarter of 2008 is higher than the average itself. The highest concentration of benzene was measured on July 29, 2008 (34.3 µg/m^3). This concentration was also the highest measured among all NMP sites sampling benzene and was more than four times the next highest concentration measured at ELNJ (8.00 µg/m^3).

- The confidence interval for 1,3-butadiene's first quarter 2009 average concentration is higher than the average itself, indicating that this average is influenced by outliers. The highest concentration of 1,3-butadiene was measured at ELNJ on January 19, 2009 (2.57 µg/m^3) and is the second highest measurement of 1,3-butadiene among all NMP sites. The next highest concentration measured at ELNJ was an order of magnitude lower.

- The confidence interval for ethylbenzene's first quarter 2009 average concentration is relatively high. The highest ethylbenzene concentration was also measured on January 19, 2009. But the second highest ethylbenzene concentration was measured on July 29, 2008, corresponding with benzene's highest measurement at this site.

- There is a significant difference between ELNJ's 2008 and 2009 daily average concentrations of acrylonitrile (1.56 ± 0.35 µg/m^3 for 2008 vs. 0.28 ± 0.16 µg/m^3 for 2009). There were 47 measured detections of this pollutant and measurements ranged from 0.126 µg/m^3 to 4.18 µg/m^3. Note that all but one of the 24 concentrations greater than 0.5 µg/m^3 were measured in 2008.

- Concentrations of most of the pollutants of interest for ELNJ did not vary significantly from quarter to quarter. However, concentrations of chloroform and formaldehyde tended to be highest during the warmer months.

- Quarterly and annual averages could not be calculated for vinyl chloride because this pollutant was not detected frequently enough.

Observations for NBNJ from Table 19-5 include the following:

- The pollutants of interest with the highest 2008 daily average concentrations by mass were acetaldehyde (2.58 ± 0.48 µg/m^3), formaldehyde (1.47 ± 0.22 µg/m^3), and carbon tetrachloride (0.73 ± 0.05 µg/m^3). The pollutants of interest with the highest 2009 daily average concentrations by mass were formaldehyde (2.57 ± 0.74 µg/m^3), acetaldehyde (2.03 ± 0.25 µg/m^3), and benzene (0.69 ± 0.13 µg/m^3). Note that the daily average concentrations of carbon tetrachloride and benzene were similar to each other for both years.

- The confidence intervals for acetaldehyde's second and third quarterly averages for 2008 are rather high, indicating that these averages are likely influenced by outliers.

Seventeen of the 20 highest acetaldehyde concentrations were measured between April and August 2008.

- The 2008 daily average of acrylonitrile has a large confidence interval, indicating that the concentration average was influenced by outliers. The 2008 daily average of acrylonitrile was 0.28 ± 0.37 $\mu g/m^3$. This pollutant was detected only four times in 2008 and its measurements spanned an order of magnitude (ranging from 0.070 to 0.737 $\mu g/m^3$), hence the large confidence interval. The highest concentration of acrylonitrile was measured on June 29, 2008; interestingly, the highest acrylonitrile concentration for CANJ was also measured on this date, as was the second highest acrylonitrile concentration for CHNJ. Although the highest acrylonitrile concentration for ELNJ was not measured on this date, it was measured on June 11, 2008, which is when the highest acrylonitrile concentration was measured at CHNJ.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the New Jersey sites from those tables include the following:

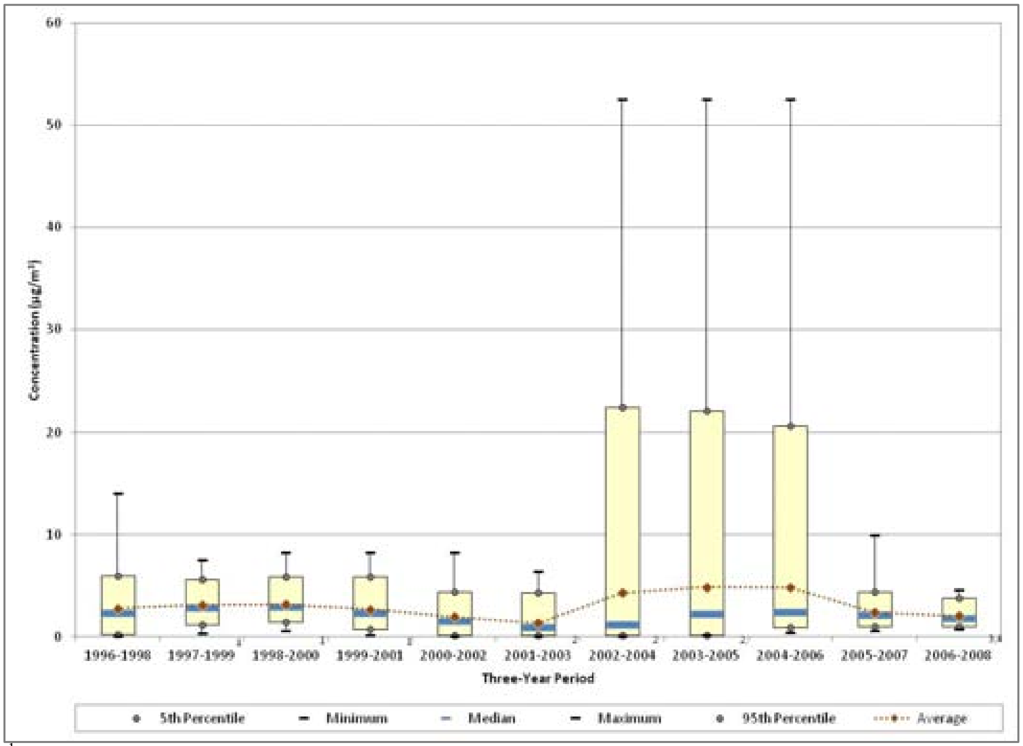
- The New Jersey sites appear in Table 4-9 for VOC a total of 10 times (CANJ – 3; CHNJ – 1; ELNJ – 6; and NBNJ – 0). CANJ had the highest daily average concentration of tetrachloroethylene among NMP sites sampling VOC.

- The New Jersey sites appear in Table 4-10 for carbonyl compounds twice. NBNJ had the ninth highest daily average concentration of acetaldehyde (2008), while its 2009 daily average ranked 23rd. ELNJ had the seventh highest daily average concentration of formaldehyde (2009), while its 2008 daily average ranked 14th.

19.4.2 Concentration Trends

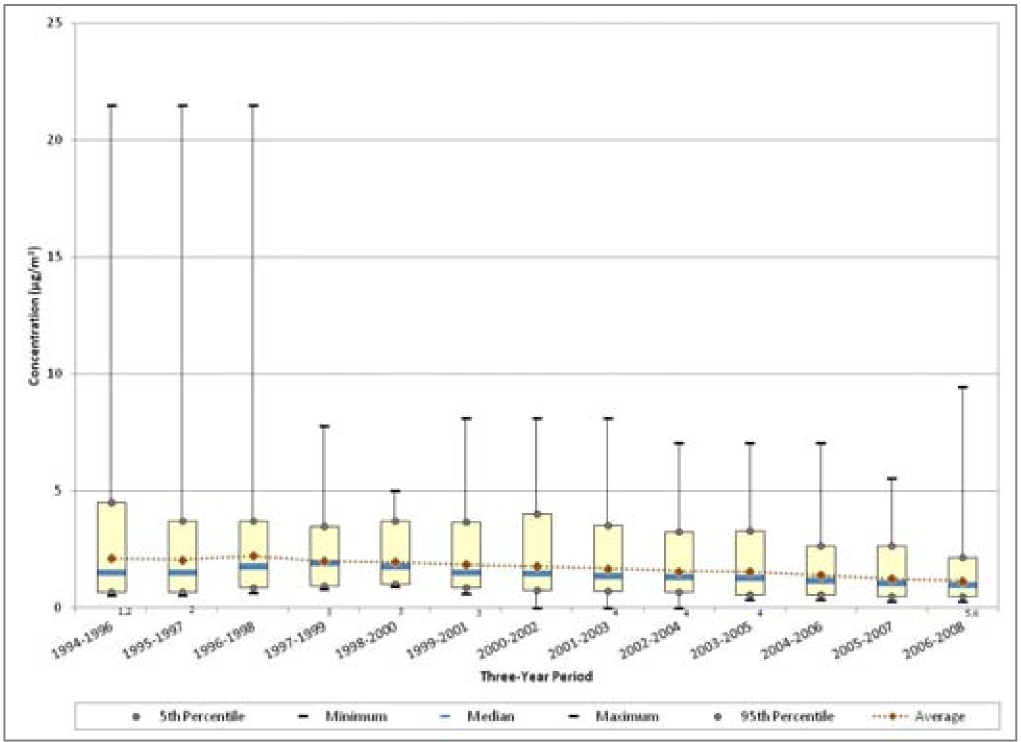
A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. The New Jersey sites have sampled VOC and carbonyl compounds under the NMP for many years. CANJ has sampled since 1994; ELNJ since 2000; and CHNJ and NBNJ since 2001. Thus, Figures 19-23 through 19-38 present the 3-year rolling statistical metrics for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde for each New Jersey monitoring sit). The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 19-23. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at CANJ



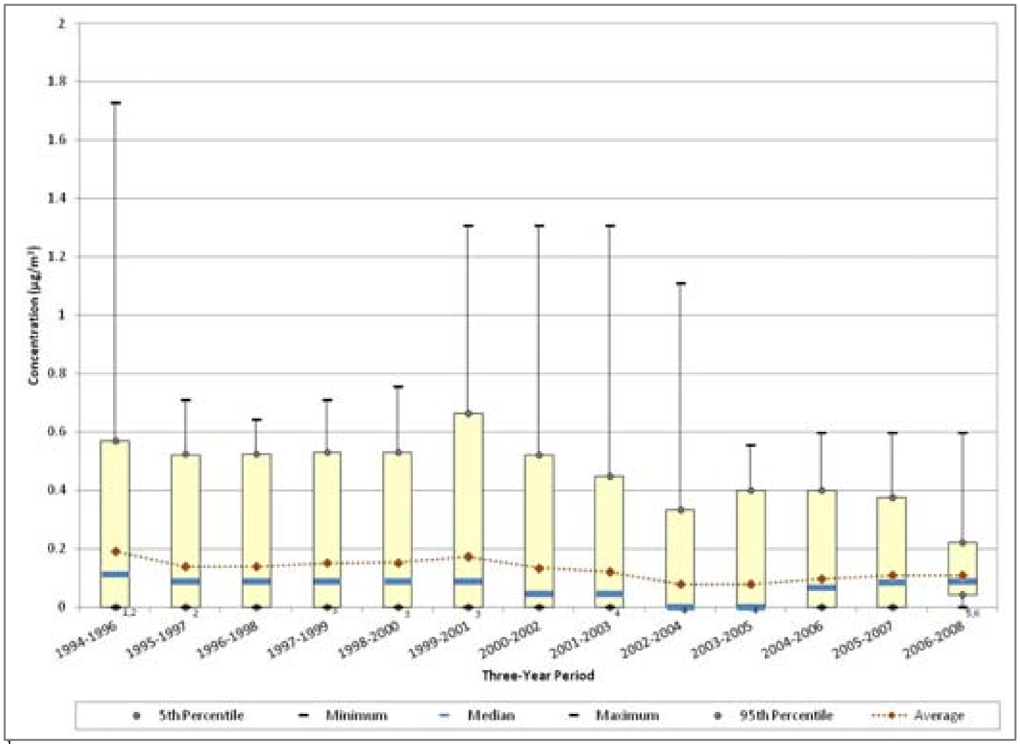
[1] No carbonyl compound samples were collected in October 1999.
[2] No carbonyl compound samples were collected from October to December 2003.
[3] Method completeness was less than 85 percent in 2008.
[4] Carbonyl compound sampling concluded in October 2008.

Figure 19-24. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CANJ



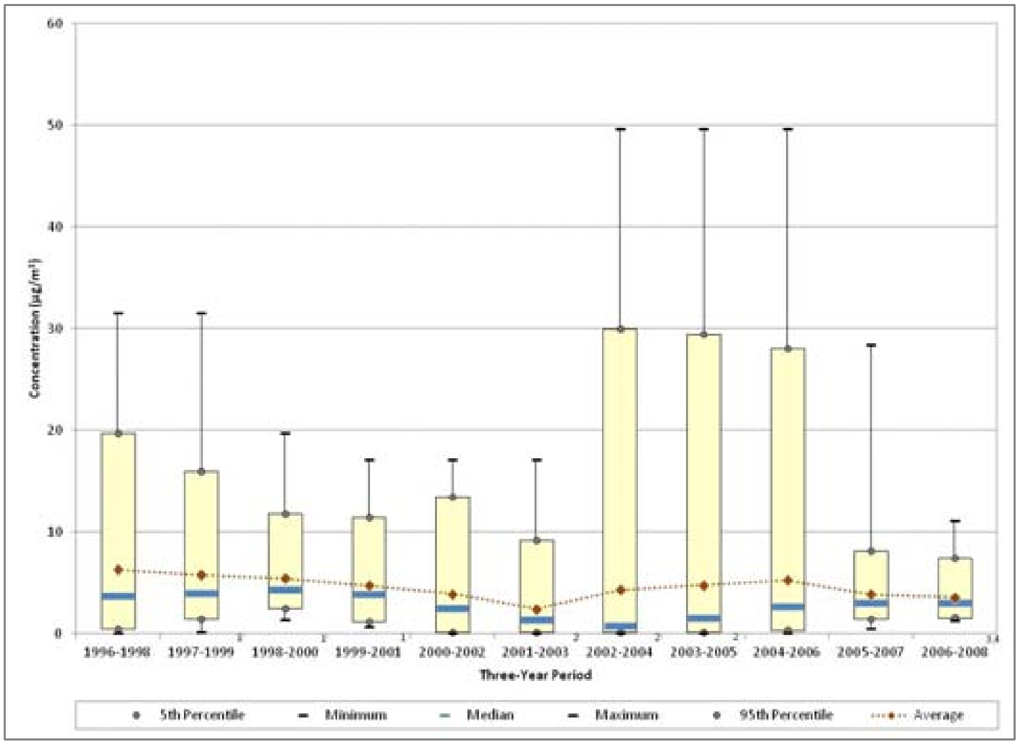
[1] VOC sampling began in July 1994.
[2] No VOC samples were collected from July to September 1995.
[3] No VOC samples were collected in October 1999.
[4] No VOC samples were collected from October to December 2003.
[5] Method completeness was less than 85 percent in 2008.
[6] VOC sampling concluded in October 2008.

Figure 19-25. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CANJ



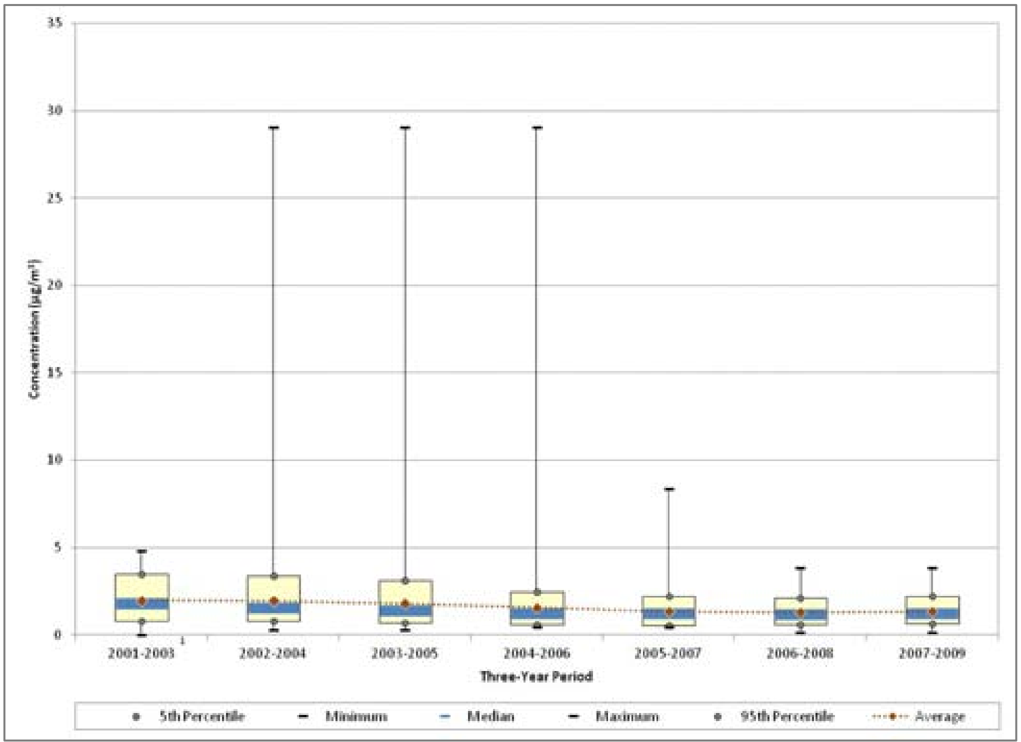
[1] VOC sampling began in July 1994.
[2] No VOC samples were collected from July to September 1995.
[3] No VOC samples were collected in October 1999.
[4] No VOC samples were collected from October to December 2003.
[5] Method completeness was less than 85 percent in 2008.
[6] VOC sampling concluded in October 2008.

Figure 19-26. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CANJ



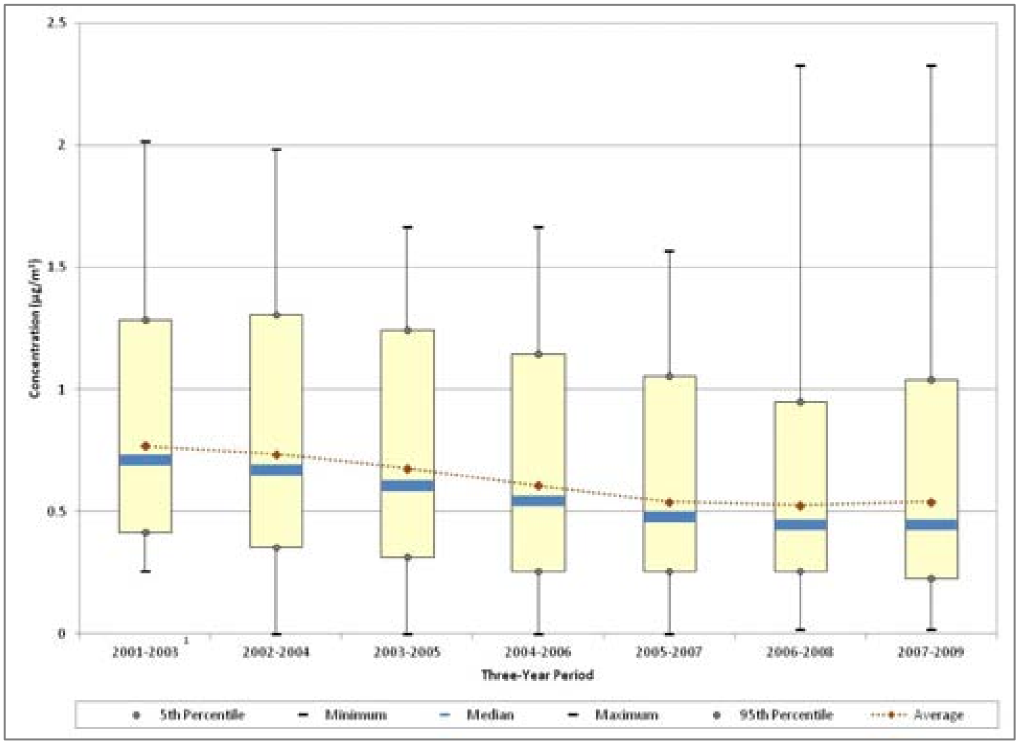
[1] No carbonyl compound samples were collected in October 1999.
[2] No carbonyl compound samples were collected from October to December 2003.
[3] Method completeness was less than 85 percent in 2008.
[4] Carbonyl compound sampling concluded in October 2008.

Figure 19-27. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at CHNJ



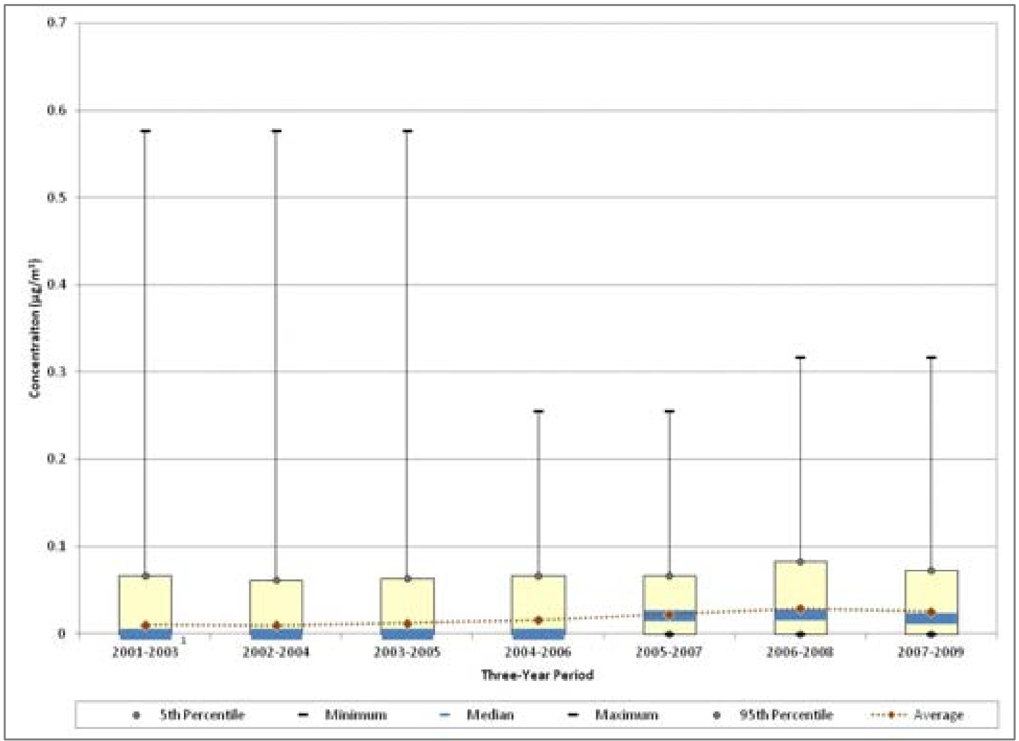
[1]Carbonyl compound sampling began in May 2001.

Figure 19-28. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CHNJ



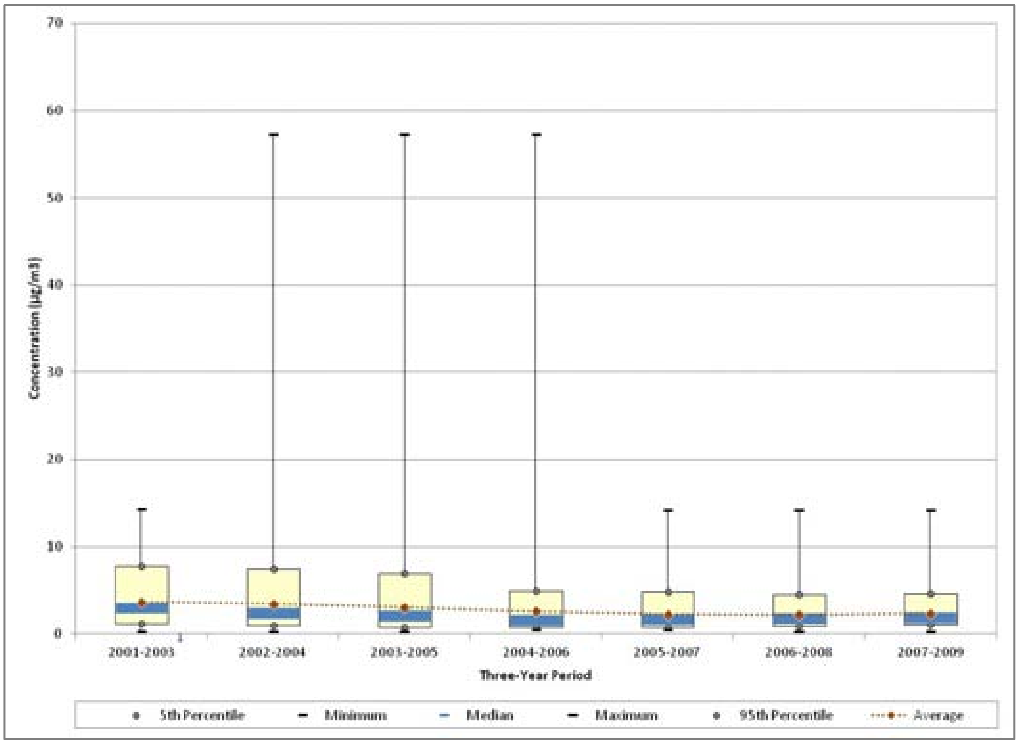
[1]VOC sampling began in May 2001.

Figure 19-29. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CHNJ



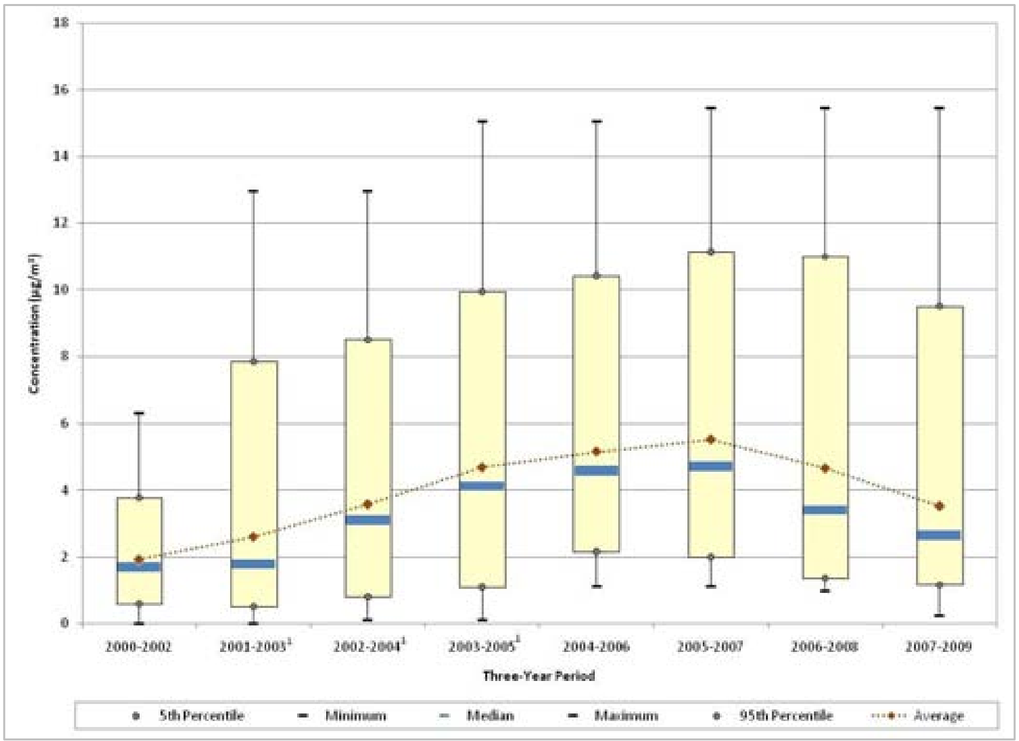
[1]VOC sampling began in May 2001.

Figure 19-30. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CHNJ



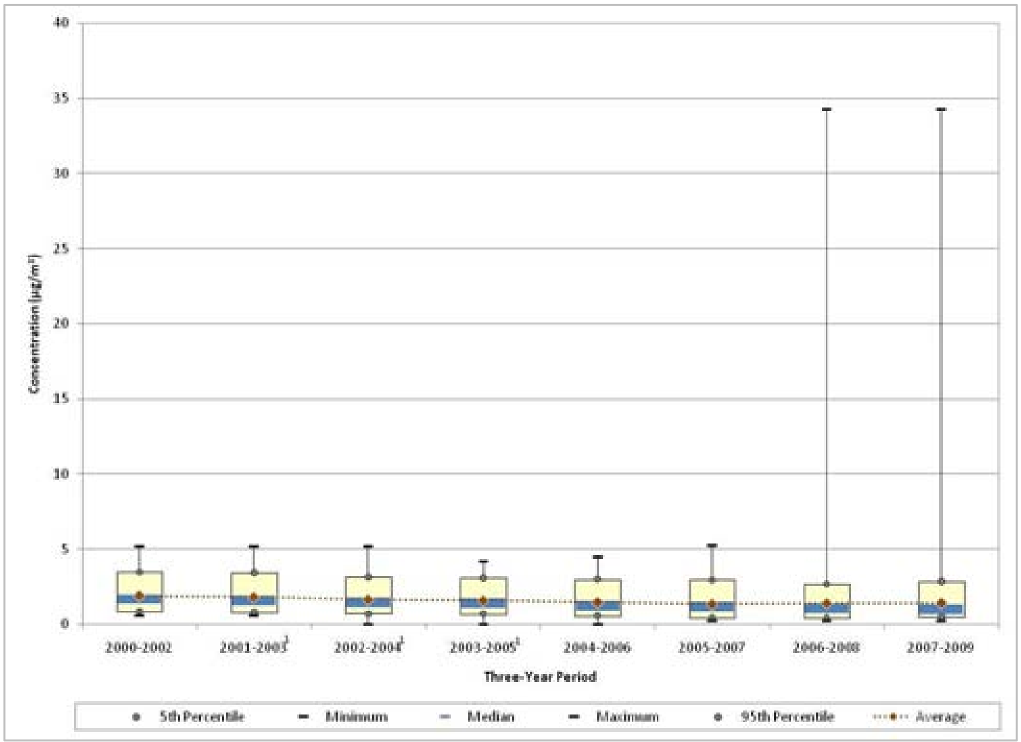
[1]Carbonyl compound sampling began in May 2001.

Figure 19-31. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at ELNJ



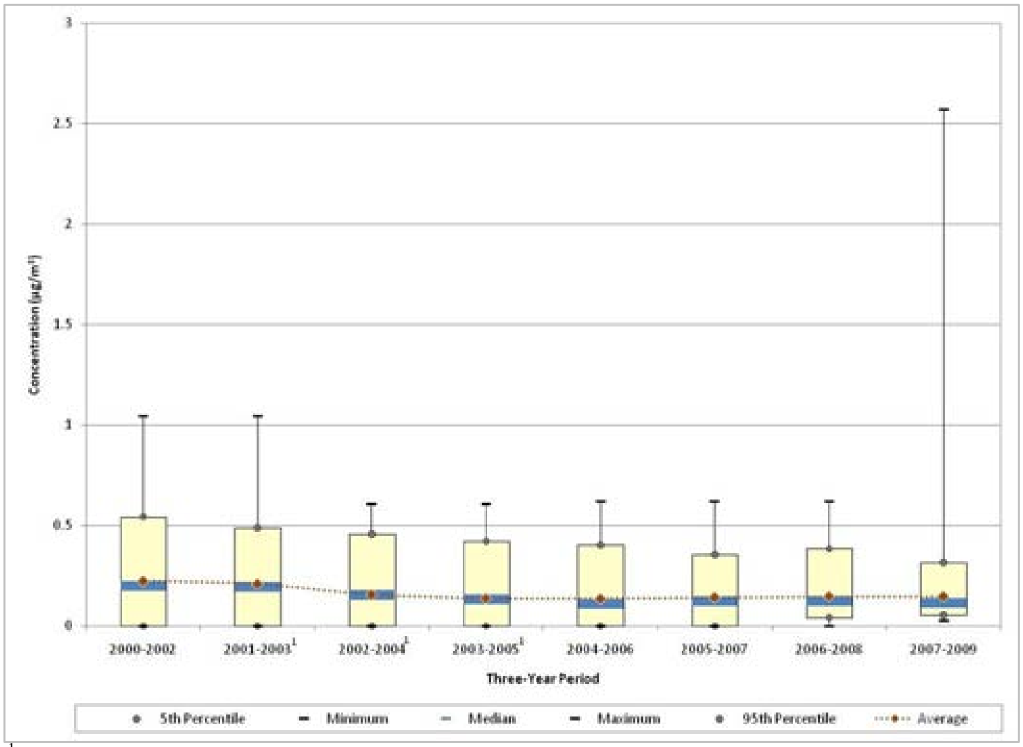
[1] No carbonyl compound samples were collected in January 2003.

Figure 19-32. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at ELNJ



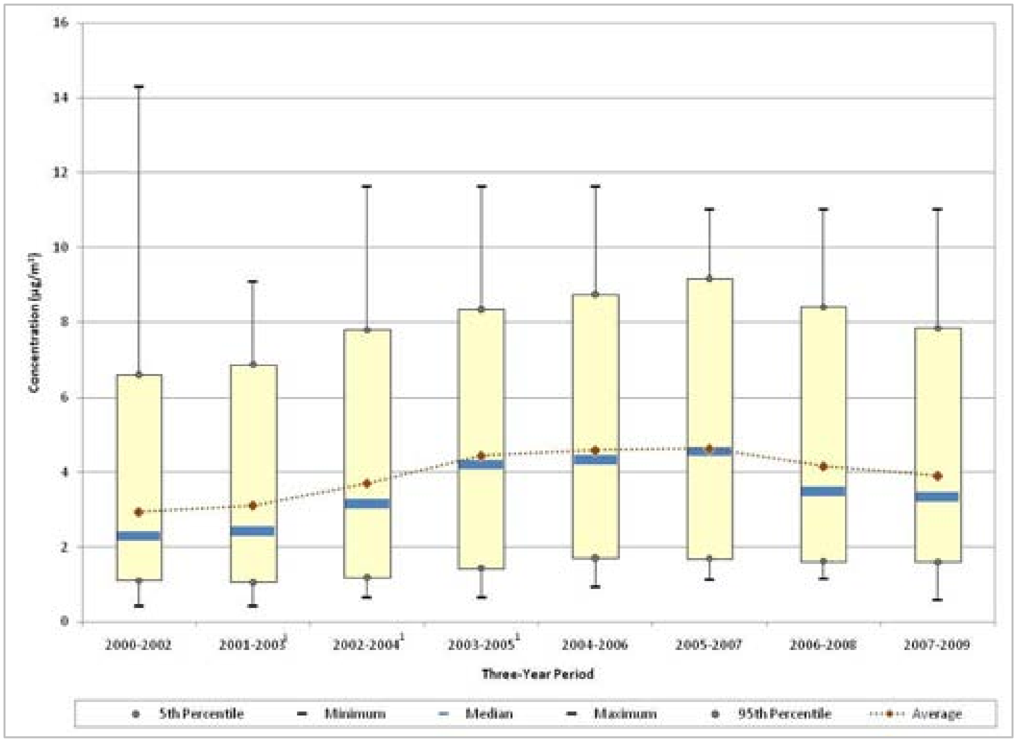
[1] No VOC samples were collected in January 2003.

Figure 19-33. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at ELNJ



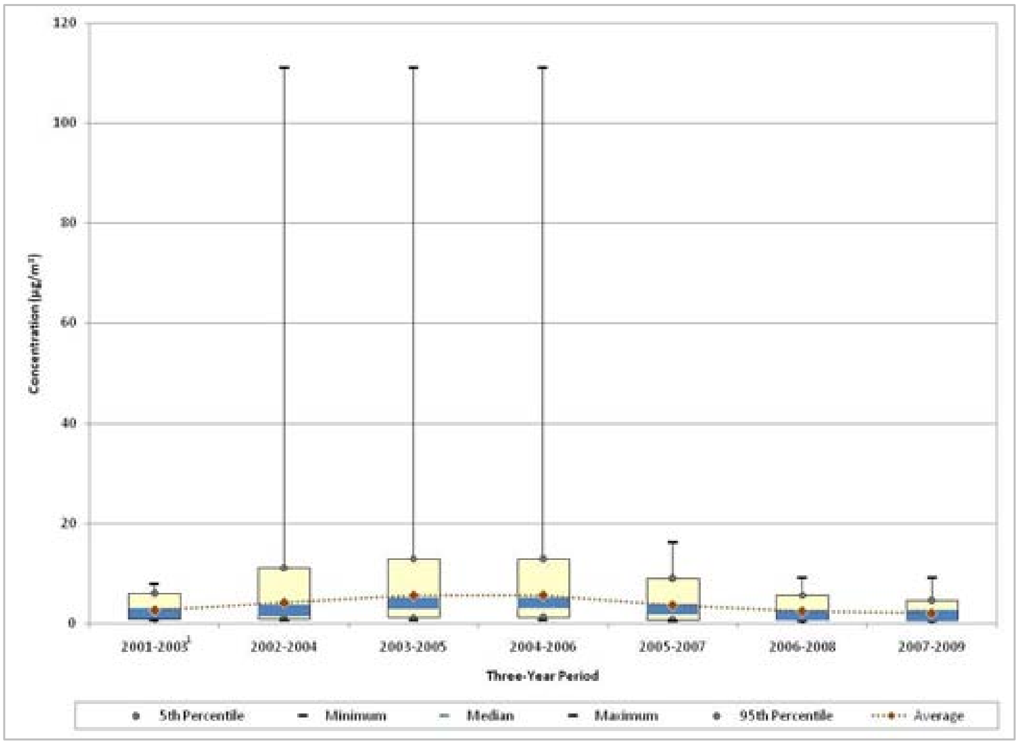
[1]No VOC samples were collected in January 2003.

Figure 19-34. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at ELNJ



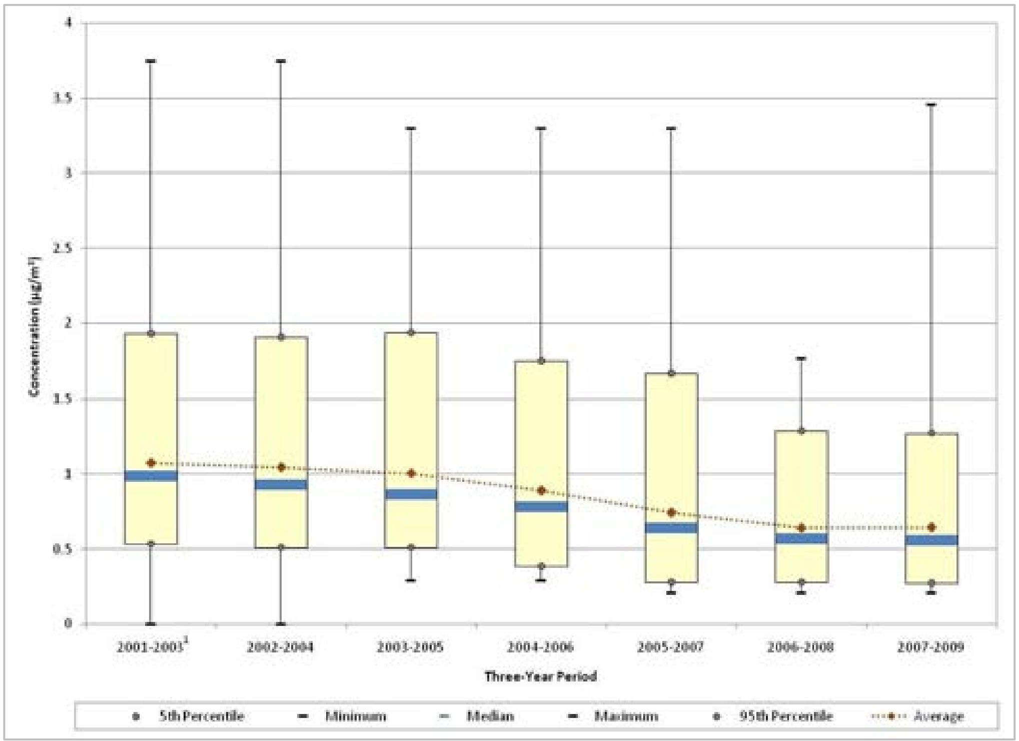
[1]No carbonyl compound samples were collected in January 2003.

Figure 19-35. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at NBNJ



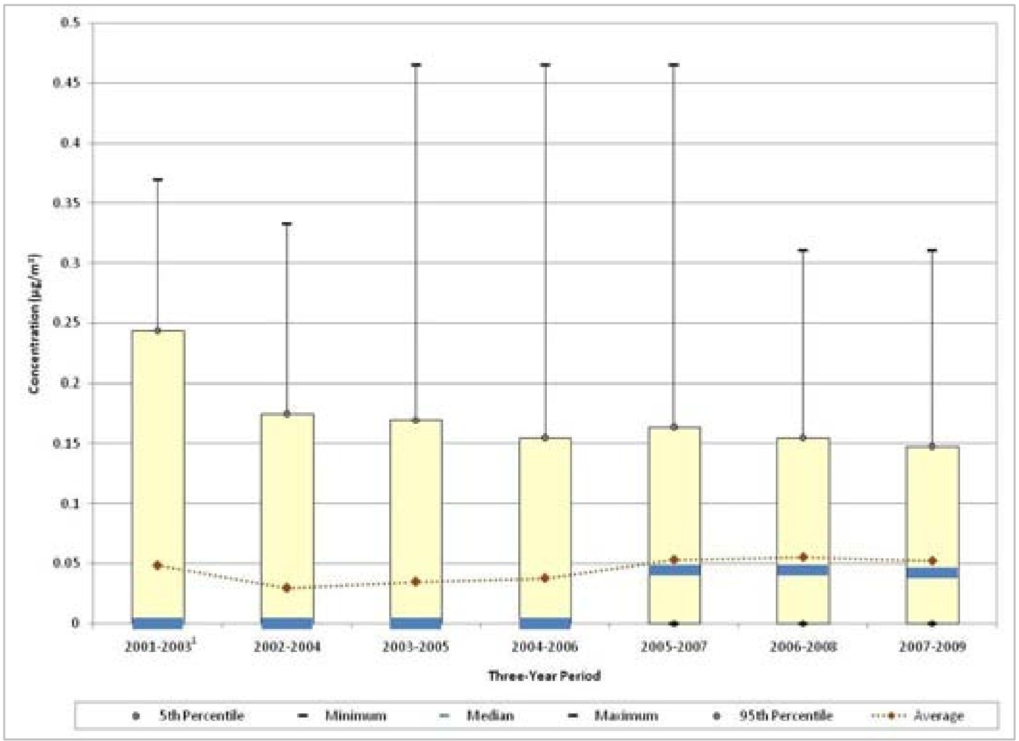
[1] Carbonyl compound sampling began May 2001.

Figure 19-36. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at NBNJ



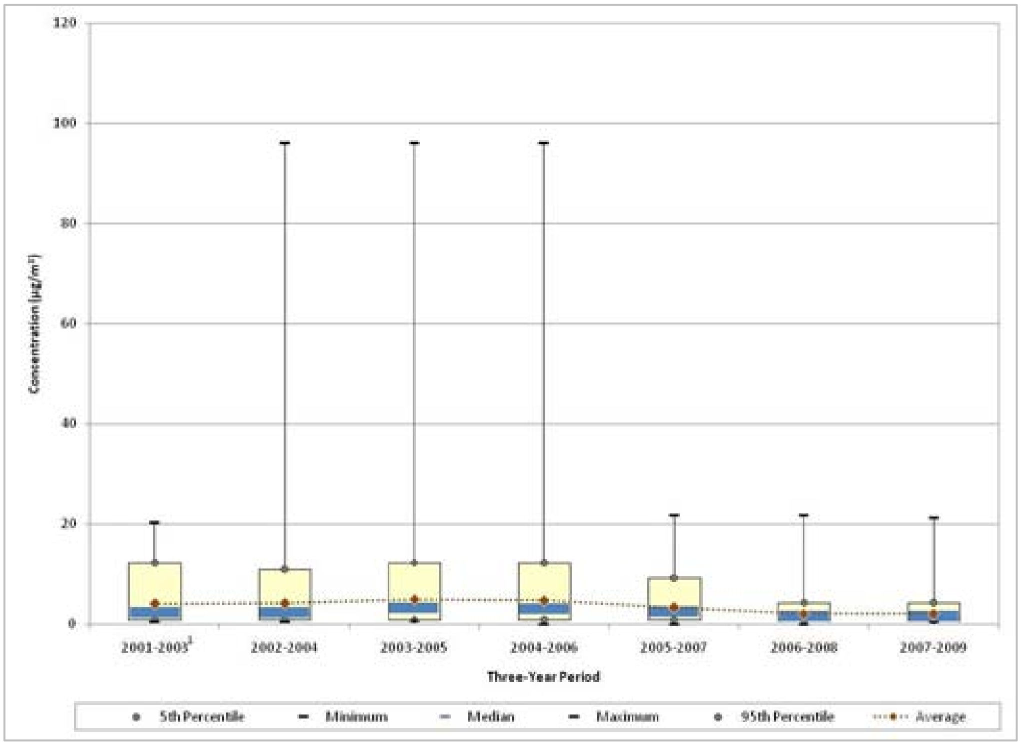
[1] VOC sampling began May 2001.

Figure 19-37. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBNJ



¹VOC sampling began May 2001.

Figure 19-38. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at NBNJ



¹Carbonyl compound sampling began May 2001.

Observations from Figure 19-23 for acetaldehyde measurements at CANJ include the following:

- CANJ is the UATMP's longest running site. Sampling of carbonyl compounds began in October 1995 and continued through October 2008. The first 3 months of data were excluded from this analysis because 3 months is not enough to be representative of the entire year. Short gaps in sampling have occurred throughout the years and are denoted in Figure 19-23. Sampling in 2008 did not meet the 85 percent method completeness objective, which is also denoted in Figure 19-23.

- The maximum acetaldehyde concentration was measured in 2004. In addition, the 13 highest acetaldehyde concentrations measured at CANJ were all measured 2004 (ranging from 14.5 $\mu g/m^3$ to 52.5 $\mu g/m^3$).

- Prior to years including 2004 data, the rolling average and median concentrations show a decreasing tend. Excluding the years that incorporate 2004 data, the averages and medians still exhibit increases for the 2005-2007 and 2006-2008 time frames from the 2001-2003 level.

Observations from Figure 19-24 for benzene measurements at CANJ include the following:

- Sampling of VOC began in July 1994 and continued through October 2008. Short gaps in sampling have occurred throughout the years and are denoted in Figure 19-24. Sampling in 2008 did not meet the 85 percent method completeness objective, which is also denoted in Figure 19-24.

- The maximum benzene concentration was measured in 1996 and was more than twice the next highest maximum concentration (measured in 2008).

- Although the range of concentrations measured varies, a slight decreasing trend in the average and median concentrations is evident beginning around the 1997-1999 time frame and continuing through the last time frame.

Observations from Figure 19-25 for 1,3-butadiene measurements at CANJ include the following:

- Sampling of VOC began in July 1994 and continued through October 2008. Short gaps in sampling have occurred throughout the years and are denoted in Figure 19-25. Sampling in 2008 did not meet the 85 percent method completeness objective, which is also denoted in Figure 19-25.

- The highest concentration of 1,3-butadiene was measured in 1994. Similar concentrations were measured in 2001 and 2002.

- The average and median concentrations have fluctuated over the years of sampling. The averages were lowest for the 2002-2004 and 2003-2005 time frames but increased in the following periods. Overall, average concentrations appear to have decreased slightly since the onset of sampling. The median shows a similar decrease.

- The average and median concentrations have become more similar to each other over the most recent periods shown. This is likely due to the increased detection rate. 1,3-Butadiene's detection rate has increased over time as the MDL has improved and results in less substitutions for non-detects.

Observations from Figure 19-26 for formaldehyde measurements at CANJ include the following:

- Sampling of carbonyl compounds began in October 1995 and continued through October 2008. The first three months of data were excluded from this analysis because three months is not enough to be representative of the entire year. Short gaps in sampling have occurred throughout the years and are denoted in Figure 19-26. Sampling in 2008 did not meet the 85 percent method completeness objective, which is also denoted in Figure 19-26.

- Similar to acetaldehyde, the maximum formaldehyde concentration was measured in 2004. The seven highest concentrations of formaldehyde since the onset of sampling were measured in 2004, which explains the increasing difference in the central tendency statistics (median and average concentrations) during the time periods incorporating measurements from 2004. The average and median concentration were similar again for the 2005-2007 and 2006-2008 time frames. This tendency is similar to the acetaldehyde graph.

- A decreasing trend in the average concentrations is apparent until the 2002-2004 time frame. Excluding the years that incorporate 2004 data, the averages did increase for the 2005-2007 and 2006-2008 time frames from the 2001-2003 level.

Observations from Figure 19-27 for acetaldehyde measurements at CHNJ include the following:

- Carbonyl compound sampling at CHNJ began in May 2001.

- Similar to CANJ, the maximum acetaldehyde concentration was measured in 2004. The next two highest concentrations were measured in 2004 and 2005; excluding these three concentrations, all other acetaldehyde concentrations measured at CHNJ were less than 5 $\mu g/m^3$.

- The rolling average and the median values were similar to each other for each time period after 2004-2006. This indicates relatively little variability in the central tendency of acetaldehyde concentrations measured at CHNJ over the periods shown.

- Although difficult to discern in Figure 19-27, a decreasing trend in the average and median acetaldehyde concentrations is shown since the onset of sampling, although both the median and average concentrations leveled out across the last two periods shown.

Observations from Figure 19-28 for benzene measurements at CHNJ include the following:

- Similar to carbonyl compounds, VOC sampling at CHNJ began in May 2001.

- The four highest benzene concentrations were measured in 2008 and 2009, although no benzene measurement at CHNJ was greater than 2.5 $\mu g/m^3$.

- Similar to acetaldehyde, the average and median concentrations show a decreasing trend that levels out over the last two 3-year periods.

Observations from Figure 19-29 for 1,3-butadiene measurements at CHNJ include the following:

- VOC sampling at CHNJ began in May 2001.

- The maximum 1,3-butadiene concentration was measured in 2003 and was nearly twice the next highest concentration, which was measured in 2008.

- The rolling average and median concentrations have an increasing trend through 2006-2008 and then decrease slightly for the final time frame.

- The minimum, 5th percentile, and median concentrations were all zero through the 2004-2006 time frame, indicating the presence of non-detects (at least 50 percent). The number of non-detects reported has decreased through the years as the MDL has improved, from as high as 97 percent in 2001 to as low as 17 percent in 2008.

Observations from Figure 19-30 for formaldehyde measurements at CHNJ include the following:

- Carbonyl compound sampling at CHNJ began in May 2001.

- The statistical metrics presented on the formaldehyde graph for CHNJ are similar to those on the acetaldehyde graph for CHNJ.

- The maximum formaldehyde concentration shown was measured in 2004. This concentration of formaldehyde was nearly four times the maximum concentrations shown for other periods not including 2004. The second highest concentration was also measured in 2004, but was nearly half the magnitude. These two maximum concentrations were measured on the same days as the acetaldehyde maximum concentrations.

- Although difficult to discern in Figure 19-30, a decreasing trend in the average formaldehyde concentrations is shown for several periods, although the average concentrations leveled out across the last two periods.

Observations from Figure 19-31 for acetaldehyde measurements at ELNJ include the following:

- Carbonyl compound sampling at ELNJ began in January 2000. A 1-month period when samples were not collected occurred in January 2003, as denoted in Figure 19-31.

- The maximum acetaldehyde concentration was measured in 2007, although concentrations of similar magnitude were also measured in 2005 and 2006.

- The rolling average and the median concentrations have steadily increased over the period of sampling, although a decrease is apparent for the 2006-2008 and 2007-2009 time frames.

- The difference between the rolling average and the median values has increased since the 2003-2005 period (but decreased slightly for the last 3-year period). The widening difference between these statistical parameters indicates increasing variability in the central tendency.

Observations from Figure 19-32 for benzene measurements at ELNJ include the following:

- VOC sampling at ELNJ also began in January 2000. A 1-month period when samples were not collected occurred in January 2003, as denoted in Figure 19-32.

- The maximum benzene concentration was measured in 2008 and was more than four times higher than the next highest concentration (measured in 2009).

- Although difficult to discern in Figure 19-32, a decreasing trend in the rolling average and median concentrations is shown across all time frames through 2005-2007. Even with the higher concentrations measured in 2008 and 2009, the average concentrations for the 2006-2008 and 2007-2009 time frames were similar to the average concentration for the 2005-2007 time frame and the median concentration continued its decreasing trends through these periods.

- The wider difference between the rolling average and the median concentrations for the 2006-2008 and 2007-2009 time frames illustrates the effects of outliers on the average concentration.

Observations from Figure 19-33 for 1,3-butadiene measurements at ELNJ include the following:

- VOC sampling at ELNJ began in January 2000. A 1-month period when samples were not collected occurred in January 2003, as denoted in Figure 19-33.
- The maximum concentration of 1,3-butadiene was measured in 2009 and is nearly two and a half times the next highest concentration (measured in 2001). These two concentrations are the only measurements of 1,3-butadiene from ELNJ greater than 1 μg/m^3.
- The graph for 1,3-butadiene shows a decreasing trend in the earlier years of sampling, then a leveling off of average concentrations. Even with the higher concentrations measured in 2009, the average concentration for the 2007-2009 time frame was similar to the average concentrations for the previous five 3-year periods. The median concentrations show a similar pattern.

Observations from Figure 19-34 for formaldehyde measurements at ELNJ include the following:

- Carbonyl compound sampling at ELNJ began in January 2000. A 1-month period when samples were not collected occurred in January 2003, as denoted in Figure 19-34.
- The maximum formaldehyde concentration was measured in 2000.
- Similar to acetaldehyde, the rolling average and the median concentrations have steadily increased over the period of sampling, although decreases are shown for the 2006-2008 and 2007-2009 time frames.

Observations from Figure 19-35 for acetaldehyde measurements at NBNJ include the following:

- Carbonyl compound sampling at NBNJ began in May 2001.

- Similar to CANJ and CHNJ, the maximum acetaldehyde concentration was measured in 2004. This concentration of acetaldehyde (111.2 μg/m^3) was nearly seven times higher, and an order of magnitude higher, than the next highest concentration (16.19 μg/m^3 measured in 2005). Of the 29 concentrations greater than 8 μg/m^3, 28 were measured in 2004 or 2005.

- Given the shear magnitude of the outlier, it is not surprising that the average concentration appears to increase beginning with the inclusion of 2004 data then decreases after.

Observations from Figure 19-36 for benzene measurements at NBNJ include the following:

- VOC sampling at NBNJ also began in May 2001.

- The maximum benzene concentration was measured in 2002, but similar concentrations were also measured in 2005 and 2009.

- The rolling averages and the median values were similar to each other for each time period shown. This indicates relatively little variability in the central tendency.

- A decreasing trend in the average and median concentrations is shown across the period of sampling, although the concentrations leveled out for the final time frame.

Observations from Figure 19-37 for 1,3-butadiene measurements at NBNJ include the following:

- Sampling for VOC began in May 2001.

- The maximum concentration was measured in 2005.

- The average concentrations of 1,3-butadiene at NBNJ have fluctuated just slightly over the years of sampling, ranging from 0.030 to 0.055 μg/m^3.

- The minimum, 5th percentile, and median concentrations were all zero through the 2004-2006 time frame, indicating the presence of non-detects (at least 50 percent). The number of non-detects reported has decreased through the later years as the MDL has improved, from as high as 93 percent in 2004 to as low as two percent in 2008.

Observations from Figure 19-38 for formaldehyde measurements at NBNJ include the following:

- Carbonyl compound sampling at NBNJ began in May 2001.

- The statistical metrics presented on the graph for formaldehyde are similar to those on the graph for acetaldehyde.

- The maximum formaldehyde concentration was measured on the same day in 2004 that the highest acetaldehyde concentration was measured. This concentration of formaldehyde was more than four times the maximum concentrations shown for other periods not including 2004. Note that concentrations around 20 µg/m^3 were measured in 2001, 2003, 2006, and 2009.

- Given the shear magnitude of the outlier, it is not surprising that the rolling average concentration appears to increase beginning with the 2002-2004 time frame then decrease after the 2004-2006 time frame. The decrease from the 2005-2007 to the 2006-2008 time frame is fairly significant, although this is difficult to discern in Figure 19-38. The rolling average concentration for the 2007-2009 period is similar to the average concentration for the 2006-2008 period.

19.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each New Jersey monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

19.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the New Jersey monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of this risk screening are summarized in Table 19-6. Where a quarterly or annual average exceeds the applicable MRL, the concentration is bolded.

Table 19-6. MRL Risk Screening Assessment Summary for the New Jersey Monitoring Sites

		Acute			Intermediate					Chronic	
Pollutant	**Year**	**ATSDR Short MRL[1] (µg/m^3)**	**# of Concentrations > MRL**	**# of Measured Detections**	**ATSDR Intermediate MRL[1] (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**ATSDR Chronic MRL[1] (µg/m^3)**	**Annual Average (µg/m^3)**
Elizabeth, New Jersey - ELNJ											
Benzene	2008	30	1	54	20	1.55 ± 0.58	1.02 ± 0.23	3.38 ± 4.92	1.24 ± 0.28	10	1.83 ± 1.23
	2009		0	59		2.28 ± 1.22	1.34 ± 0.42	0.76 ± 0.10	1.06 ± 0.48		1.36 ± 0.36

Bolded = a quarterly or annual average concentration is greater than one or more of the intermediate or chronic MRLs.

[1] Reflects the use of one significant digit for MRL.

Observations from Table 19-6 include the following:

- Benzene was the only pollutant of interest (for ELNJ) where a preprocessed daily measurement and/or time-period average was greater than one or more of the MRL health risk benchmarks.

- One preprocessed daily measurement of benzene for ELNJ (out of 113 measured detections) was greater than the acute MRL. This measurement was discussed in Section 19.4.1 and is the only instance where a preprocessed daily measurement was greater than the acute MRL for benzene among all NMP sites sampling this pollutant.

- None of the quarterly averages of benzene came close to the intermediate MRL; neither annual average of benzene for ELNJ was greater than the chronic MRL.

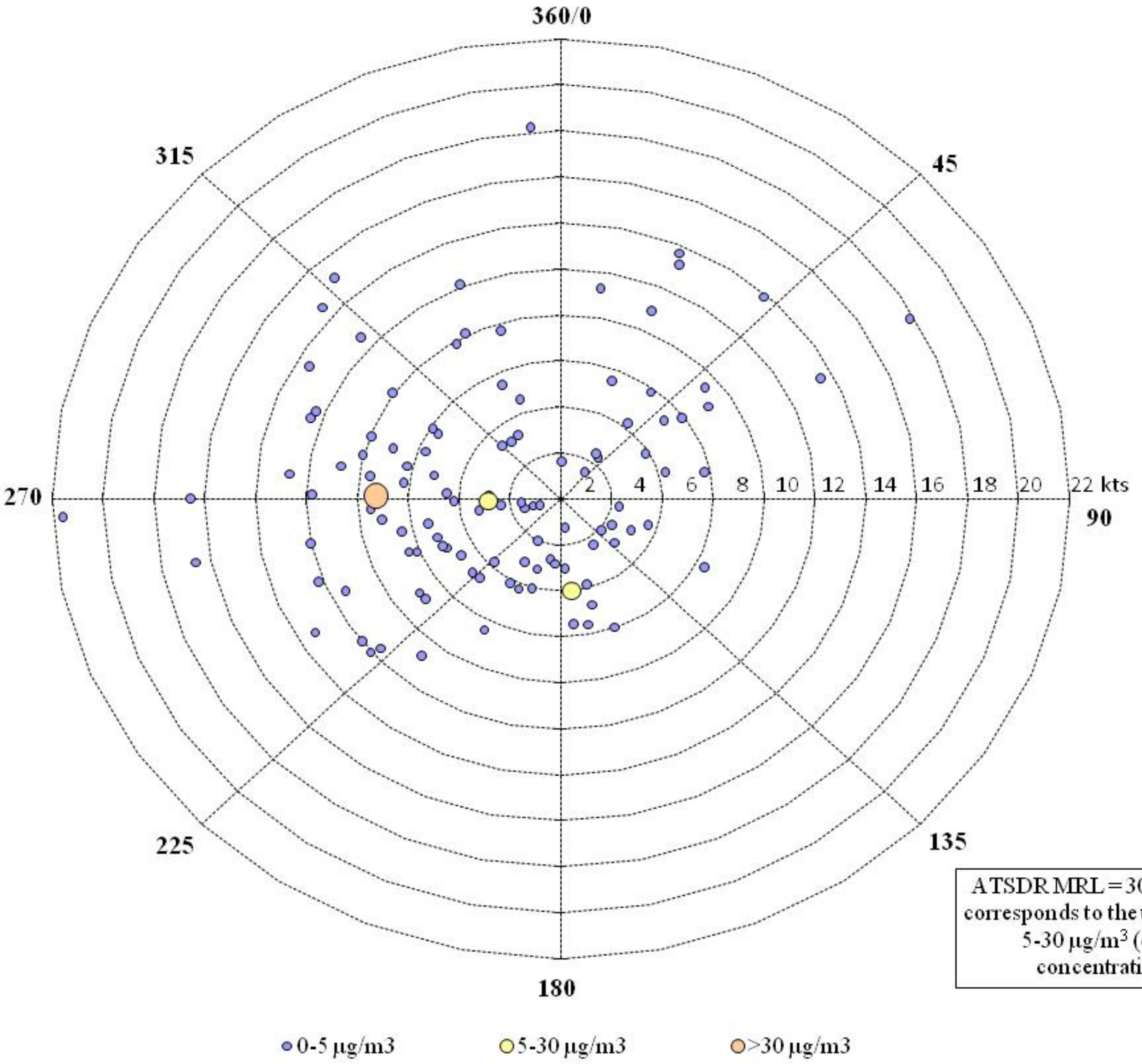
For the pollutants whose concentrations were greater than their respective ATSDR acute MRL noncancer health risk benchmark, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration vs. wind speed and wind direction, as described in Section 3.5.4.1. Figure 19-39 is the benzene pollution rose for ELNJ.

Observations from Figure 19-39 for benzene include the following:

- The concentration that was greater than the ATSDR acute MRL for benzene at ELNJ was measured on a day with winds blowing from the west (shown in orange). The second highest concentration was also measured on a day with westerly winds. Figure 19-7 shows that many emissions sources are located to the west of ELNJ.

- Most of the concentrations of benzene (those less than 5 $\mu g/m^3$ and shown in blue) were measured on days with winds from a variety of wind directions. This suggests a uniform emissions source such as mobile sources.

Figure 19-39. Benzene Pollution Rose for ELNJ



ATSDR MRL = 30 µg/m^3, which corresponds to the upper end of the 5-30 µg/m^3 (or yellow) concentration range

19.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the New Jersey monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 19-7, where applicable.

Observations from Table 19-7 include the following:

- Annual averages for 2008, and therefore cancer and noncancer surrogate risk approximations, could not be calculated for CANJ because this site did not meet the 85 percent method completeness criteria. In addition, sampling at this site concluded in October 2008.

- For CHNJ, the pollutants with the highest annual averages were formaldehyde, acetaldehyde, and carbon tetrachloride (for both years). Formaldehyde had the highest cancer risk approximations for this site for both years, followed by benzene and carbon tetrachloride. The cancer risk approximations for formaldehyde were at least an order of magnitude higher the approximations for the other pollutants of interest. None of the pollutants of interest for CHNJ had noncancer risk approximations greater than 1.0.

- For ELNJ, the pollutants with the highest annual averages were formaldehyde, acetaldehyde, and benzene (for both years). These three pollutants also had the highest cancer risk approximations for this site for both years. The cancer risk approximations for these pollutants were the highest calculated among the New Jersey sites. None of the pollutants of interest for ELNJ had noncancer risk approximations greater than 1.0.

- For NBNJ, the pollutants with the highest annual averages were formaldehyde, acetaldehyde, benzene, and carbon tetrachloride (although the order varied by year). These four pollutants also had the highest cancer risk approximations for this site for both years, although the 2009 cancer risk approximation for formaldehyde was 50 percent higher than the 2008 cancer risk approximation. None of the pollutants of interest for NBNJ had noncancer risk approximations greater than 1.0.

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Table 19-7. Cancer and Noncancer Surrogate Risk Approximations for the New Jersey Monitoring Sites

			2008				**2009**			
					Risk Approximation				**Risk Approximation**	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/ Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/ Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Camden, New Jersey - CANJ										
Acetaldehyde	2.2E-06	0.009	38/3	NA*	NA	NA	NR	NR	NR	NR
Benzene	7.8E-06	0.03	37/2	NA*	NA	NA	NR	NR	NR	NR
Bromomethane	--	0.005	37/2	NA*	NA	NA	NR	NR	NR	NR
1,3-Butadiene	0.00003	0.002	37/2	NA*	NA	NA	NR	NR	NR	NR
Carbon Tetrachloride	6E-06	0.1	37/2	NA*	NA	NA	NR	NR	NR	NR
Chloroform	--	0.098	35/2	NA*	NA	NA	NR	NR	NR	NR
p-Dichlorobenzene	1.1E-05	0.8	37/2	NA*	NA	NA	NR	NR	NR	NR
Ethylbenzene	2.5E-06	1	37/2	NA*	NA	NA	NR	NR	NR	NR
Formaldehyde	1.3E-05	0.0098	38/3	NA*	NA	NA	NR	NR	NR	NR
Tetrachloroethylene	5.9E-06	0.27	37/2	NA*	NA	NA	NR	NR	NR	NR
Trichloroethylene	2E-06	0.6	34/2	NA*	NA	NA	NR	NR	NR	NR
Vinyl Chloride	8.8E-06	0.1	26/2	NA*	NA	NA	NR	NR	NR	NR

NA = Not available due to the criteria for calculating an annual average.

* Completeness was less than 85 percent for Carbonyl compounds and VOC for CANJ in 2008.

NR = Not reportable because sampling was not conducted during this time period.

-- = a Cancer URE or Noncancer RfC is not available.

Table 19-7. Cancer and Noncancer Surrogate Risk Approximations for the New Jersey Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/ Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)
Chester, New Jersey - CHNJ										
Acetaldehyde	2.2E-06	0.009	57/4	1.40 ± 0.14	3.07	0.16	60/4	1.34 ± 0.14	2.95	0.15
Acrylonitrile	6.8E-05	0.002	9/0	NA	NA	NA	28/2	NA	NA	NA
Benzene	7.8E-06	0.03	58/4	0.60 ± 0.10	4.64	0.02	61/4	0.56 ± 0.11	4.34	0.02
1,3-Butadiene	0.00003	0.002	48/4	0.03 ± 0.01	0.99	0.02	46/4	0.02 ± 0.01	0.74	0.01
Carbon Tetrachloride	6E-06	0.1	58/4	0.70 ± 0.06	4.18	0.01	61/4	0.72 ± 0.05	4.32	0.01
Chloroform	--	0.098	56/4	0.12 ± 0.02	--	0.00	61/4	0.11 ± 0.01	--	<0.01
Formaldehyde	1.3E-05	0.0098	57/4	2.25 ± 0.31	29.27	0.23	60/4	2.43 ± 0.30	31.58	0.25
Tetrachloroethylene	5.9E-06	0.27	54/4	0.15 ± 0.07	0.88	<0.01	52/4	0.09 ± 0.02	0.54	<0.01
Trichloroethylene	2E-06	0.6	13/0	NA	NA	NA	10/0	NA	NA	NA
Vinyl Chloride	8.8E-06	0.1	7/0	NA	NA	NA	9/0	NA	NA	NA

NA = Not available due to the criteria for calculating an annual average.
* Completeness was less than 85 percent for Carbonyl compounds and VOC for CANJ in 2008.
NR = Not reportable because sampling was not conducted during this time period.
-- = a Cancer URE or Noncancer RfC is not available.

Table 19-7. Cancer and Noncancer Surrogate Risk Approximations for the New Jersey Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/ Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)
Elizabeth, New Jersey - ELNJ										
Acetaldehyde	2.2E-06	0.009	55/4	2.35 ± 0.26	5.17	0.26	61/4	2.47 ± 0.32	5.43	0.27
Acrylonitrile	6.8E-05	0.002	24/2	NA	NA	NA	23/1	NA	NA	NA
Benzene	7.8E-06	0.03	54/4	1.83 ± 1.23	14.28	0.06	59/4	1.36 ± 0.36	10.61	0.05
1,3-Butadiene	0.00003	0.002	54/4	0.15 ± 0.02	4.48	0.07	59/4	0.16 ± 0.09	4.68	0.08
Carbon Tetrachloride	6E-06	0.1	54/4	0.64 ± 0.05	3.83	0.01	59/4	0.67 ± 0.04	4.04	0.01
Chloroform	--	0.098	54/4	0.18 ± 0.02	--	<0.01	58/4	0.17 ± 0.02	--	<0.01
p-Dichlorobenzene	1.1E-05	0.8	51/4	0.18 ± 0.04	1.93	<0.01	56/4	0.11 ± 0.03	1.21	<0.01
Ethylbenzene	2.5E-06	1	53/4	0.87 ± 0.17	2.16	<0.01	59/4	0.46 ± 0.14	1.14	<0.01
Formaldehyde	1.3E-05	0.0098	55/4	3.24 ± 0.39	42.14	0.33	61/4	3.80 ± 0.53	49.34	0.39
Tetrachloroethylene	5.9E-06	0.27	54/4	0.35 ± 0.07	2.08	<0.01	58/4	0.25 ± 0.04	1.50	<0.01
Trichloroethylene	2E-06	0.6	35/4	0.07 ± 0.02	0.13	<0.01	43/4	0.08 ± 0.03	0.15	<0.01
Vinyl Chloride	8.8E-06	0.1	21/1	NA	NA	NA	22/2	NA	NA	NA

NA = Not available due to the criteria for calculating an annual average.
* Completeness was less than 85 percent for Carbonyl compounds and VOC for CANJ in 2008.
NR = Not reportable because sampling was not conducted during this time period.
-- = a Cancer URE or Noncancer RfC is not available.

Table 19-7. Cancer and Noncancer Surrogate Risk Approximations for the New Jersey Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
New Brunswick, New Jersey - NBNJ										
Acetaldehyde	2.2E-06	0.009	56/4	2.58 ± 0.48	5.68	0.29	56/4	2.03 ± 0.25	4.47	0.23
Acrylonitrile	6.8E-05	0.002	4/0	NA	NA	NA	23/2	NA	NA	NA
Benzene	7.8E-06	0.03	55/4	0.70 ± 0.08	5.43	0.02	55/4	0.69 ± 0.13	5.37	0.02
1,3-Butadiene	0.00003	0.002	54/4	0.06 ± 0.01	1.72	0.03	52/4	0.05 ± 0.01	1.39	0.02
Carbon Tetrachloride	6E-06	0.1	55/4	0.73 ± 0.05	4.37	0.01	55/4	0.67 ± 0.05	4.04	0.01
Chloroform	--	0.098	52/4	0.17 ± 0.03	--	<0.01	55/4	0.15 ± 0.02	--	<0.01
p-Dichlorobenzene	1.1E-05	0.8	47/4	0.10 ± 0.03	1.08	<0.01	48/4	0.06 ± 0.01	0.66	<0.01
Formaldehyde	1.3E-05	0.0098	56/4	1.47 ± 0.22	19.05	0.15	56/4	2.57 ± 0.74	33.42	0.26
Tetrachloroethylene	5.9E-06	0.27	53/4	0.24 ± 0.07	1.43	<0.01	52/4	0.16 ± 0.03	0.93	<0.01
Trichloroethylene	2E-06	0.6	31/3	0.07 ± 0.03	0.14	<0.01	21/1	NA	NA	NA
Vinyl Chloride	8.8E-06	0.1	20/2	NA	NA	NA	15/0	NA	NA	NA

NA = Not available due to the criteria for calculating an annual average.
* Completeness was less than 85 percent for Carbonyl compounds and VOC for CANJ in 2008.
NR = Not reportable because sampling was not conducted during this time period.
-- = a Cancer URE or Noncancer RfC is not available.

19.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 19-8 and 19-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 19-8 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 19-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 19.3, all four New Jersey monitoring sites sampled for VOC and carbonyl compounds. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. The completeness criteria was not met by CANJ for 2008 and sampling was not conducted in 2009; annual averages, and thus, cancer and noncancer risk approximations, were not calculated for this site. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 19-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New Jersey 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	Emissions (tpy)	Pollutant	Cancer Toxicity Weight	Pollutant	Cancer Risk Approximation (in-a-million)
Camden, New Jersey (Camden County) - CANJ					
Benzene	243.28	Benzene	1.90E-03		
Formaldehyde	137.08	Formaldehyde	1.71E-03		
Dichloromethane	54.82	1,3-Butadiene	1.12E-03		
Acetaldehyde	48.03	Naphthalene	9.20E-04		
Tetrachloroethylene	38.54	Hexavalent Chromium, PM	2.75E-04		
1,3-Butadiene	37.46	Tetrachloroethylene	2.27E-04		
1,3-Dichloropropene	36.95	*p*-Dichlorobenzene	2.10E-04		
Naphthalene	27.05	POM, Group 2	1.89E-04		
p-Dichlorobenzene	19.07	1,3-Dichloropropene	1.48E-04		
POM, Group 2	3.43	Arsenic, PM	1.31E-04		
Chester, New Jersey (Morris County) - CHNJ					
Benzene	366.55	Benzene	2.86E-03	Formaldehyde	31.58
Formaldehyde	187.29	Formaldehyde	2.34E-03	Formaldehyde	29.27
Acetaldehyde	101.88	1,3-Butadiene	1.59E-03	Benzene	4.64
Dichloromethane	62.55	Naphthalene	1.10E-03	Benzene	4.34
1,3-Butadiene	53.03	Hexavalent Chromium, PM	4.61E-04	Carbon Tetrachloride	4.32
1,3-Dichloropropene	34.55	POM, Group 2	3.03E-04	Carbon Tetrachloride	4.18
Naphthalene	32.41	Acetaldehyde	2.24E-04	Acetaldehyde	3.07
Tetrachloroethylene	30.12	*p*-Dichlorobenzene	1.96E-04	Acetaldehyde	2.95
p-Dichlorobenzene	17.84	Tetrachloroethylene	1.78E-04	1,3-Butadiene	0.99
Trichloroethylene	6.59	Arsenic, PM	1.71E-04	Tetrachloroethylene	0.88

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 19-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New Jersey 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Elizabeth, New Jersey (Union County) - ELNJ					
Benzene	269.38	Benzene	2.10E-03	Formaldehyde	49.34
Formaldehyde	132.55	Formaldehyde	1.66E-03	Formaldehyde	42.14
Dichloromethane	81.85	1,3-Butadiene	1.19E-03	Benzene	14.28
Acetaldehyde	77.83	Naphthalene	1.03E-03	Benzene	10.61
Tetrachloroethylene	41.52	Hexavalent Chromium, PM	5.37E-04	Acetaldehyde	5.43
1,3-Butadiene	39.68	Nickel, PM	3.52E-04	Acetaldehyde	5.17
1,3-Dichloropropene	38.31	Arsenic, PM	2.46E-04	1,3-Butadiene	4.68
Naphthalene	30.32	Tetrachloroethylene	2.45E-04	1,3-Butadiene	4.48
p-Dichlorobenzene	19.80	*p*-Dichlorobenzene	2.18E-04	Carbon Tetrachloride	4.04
Trichloroethylene	4.52	POM, Group 2	1.86E-04	Carbon Tetrachloride	3.83
New Brunswick, New Jersey (Middlesex County) - NBNJ					
Benzene	432.22	Benzene	3.37E-03	Formaldehyde	33.42
Formaldehyde	234.98	Formaldehyde	2.94E-03	Formaldehyde	19.05
Acetaldehyde	134.58	1,3-Butadiene	1.98E-03	Acetaldehyde	5.68
Dichloromethane	113.20	Naphthalene	1.74E-03	Benzene	5.43
1,3-Butadiene	66.14	Hexavalent Chromium, PM	7.75E-04	Benzene	5.37
Tetrachloroethylene	59.91	Tetrachloroethylene	3.53E-04	Acetaldehyde	4.47
1,3-Dichloropropene	55.98	*p*-Dichlorobenzene	3.18E-04	Carbon Tetrachloride	4.37
Naphthalene	51.27	Acetaldehyde	2.96E-04	Carbon Tetrachloride	4.04
p-Dichlorobenzene	28.93	POM, Group 2	2.50E-04	1,3-Butadiene	1.72
Trichloroethylene	7.84	Arsenic, PM	2.39E-04	Tetrachloroethylene	1.43

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 19-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the New Jersey 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Camden, New Jersey (Camden County) - CANJ					
Toluene	685.00	Acrolein	513,488.74		
Methyl *tert*-butyl ether	519.45	1,3-Butadiene	18,731.68		
Xylenes	461.26	Formaldehyde	13,988.12		
Benzene	243.28	Bromomethane	10,308.00		
Formaldehyde	137.08	Manganese, PM	9,687.12		
Methyl isobutyl ketone	135.51	Naphthalene	9,016.45		
1,1,1-Trichloroethane	120.65	Benzene	8,109.26		
Hexane	92.70	Cyanide Compounds, gas	6,433.60		
Ethylbenzene	85.32	Acetaldehyde	5,336.27		
Methanol	60.27	Xylenes	4,612.58		
Chester, New Jersey (Morris County) - CHNJ					
Toluene	912.78	Acrolein	632,121.64	Formaldehyde	0.25
Xylenes	644.82	1,3-Butadiene	26,515.07	Formaldehyde	0.23
Methyl *tert*-butyl ether	385.58	Formaldehyde	19,111.72	Acetaldehyde	0.16
Benzene	366.55	Nickel, PM	12,733.85	Acetaldehyde	0.15
Formaldehyde	187.29	Benzene	12,218.32	Benzene	0.02
Ethylbenzene	128.70	Acetaldehyde	11,319.68	Benzene	0.02
Hexane	128.31	Naphthalene	10,801.68	1,3-Butadiene	0.02
Methyl isobutyl ketone	116.06	Bromomethane	9,638.01	1,3-Butadiene	0.01
1,1,1-Trichloroethane	109.08	Xylenes	6,448.25	Carbon Tetrachloride	0.01
Acetaldehyde	101.88	Cyanide Compounds, gas	5,943.86	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 19-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the New Jersey 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Elizabeth, New Jersey (Union County) - ELNJ					
Toluene	822.91	Acrolein	424,739.79	Formaldehyde	0.39
Xylenes	550.31	Nickel, PM	33,843.04	Formaldehyde	0.33
Methyl *tert*-butyl ether	327.36	Manganese, PM	21,856.61	Acetaldehyde	0.27
Hexane	327.10	1,3-Butadiene	19,839.41	Acetaldehyde	0.26
Benzene	269.38	Formaldehyde	13,525.91	1,3-Butadiene	0.08
Methyl isobutyl ketone	181.53	Bromomethane	10,686.00	1,3-Butadiene	0.07
Formaldehyde	132.55	Naphthalene	10,105.63	Benzene	0.06
1,1,1-Trichloroethane	122.48	Benzene	8,979.26	Benzene	0.05
Ethylbenzene	106.11	Acetaldehyde	8,647.61	Carbon Tetrachloride	0.01
Dichloromethane	81.85	Cyanide Compounds, gas	6,607.85	Carbon Tetrachloride	0.01
New Brunswick, New Jersey (Middlesex County) - NBNJ					
Toluene	1,333.00	Acrolein	682,738.17	Acetaldehyde	0.29
Xylenes	872.97	1,3-Butadiene	33,071.28	Formaldehyde	0.26
Methyl *tert*-butyl ether	525.26	Formaldehyde	23,977.55	Acetaldehyde	0.23
Benzene	432.22	Naphthalene	17,088.42	Formaldehyde	0.15
Hexane	241.23	Manganese, PM	15,818.86	1,3-Butadiene	0.03
Formaldehyde	234.98	Bromomethane	15,616.01	Benzene	0.02
Methyl isobutyl ketone	227.56	Acetaldehyde	14,952.91	1,3-Butadiene	0.02
1,1,1-Trichloroethane	177.07	Benzene	14,407.38	Benzene	0.02
Ethylbenzene	170.65	Titanium tetrachloride	12,410.00	Carbon Tetrachloride	0.01
Acetaldehyde	134.58	Nickel, PM	9,580.97	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 19-8 include the following:

- Benzene and formaldehyde were the highest emitted pollutants with cancer UREs in Union, Middlesex, Morris, and Camden Counties, although the quantity varied across the counties.

- Benzene, formaldehyde, 1,3-butadiene, naphthalene, and hexavalent chromium were the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for all four counties.

- Six of the 10 highest emitted pollutants in Union County also had the highest toxicity-weighted emissions; seven of the highest emitted pollutants in Morris and Middlesex Counties also had the highest toxicity-weighted emissions; and eight of the highest emitted pollutants in Camden County also had the highest toxicity-weighted emissions.

- Formaldehyde, benzene, and 1,3-butadiene were among the pollutants with the highest cancer risk approximations for CHNJ, ELNJ, and NBNJ. These pollutants also appeared on both emissions-based lists. Conversely, carbon tetrachloride appeared on neither emissions-based list for these three New Jersey sites but appeared among the pollutants with the highest cancer risk approximations for each site.

Observations from Table 19-9 include the following:

- Toluene was the highest emitted pollutant with a noncancer RfC in Camden, Union, Middlesex, and Morris Counties, although the quantity varied. Toluene did not appear on any county’s list of highest toxicity-weighted emissions and was not a pollutant of interest for any site.

- Acrolein was the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all four counties but was not among the highest emitted pollutants for any of the New Jersey counties. Although acrolein was sampled for at all four sites, this pollutant was excluded from the pollutant of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the 10 highest emitted pollutants for Morris County also had the highest toxicity-weighted emissions; three appeared on both emissions-based lists for Camden and Middlesex Counties; and two appeared on both emissions-based lists for Union County.

- Formaldehyde and acetaldehyde were among the pollutants with the highest noncancer risk approximations for CHNJ, ELNJ, and NBNJ (although all were less than an HQ of 1.0). These pollutants also appeared among the pollutants with the highest toxicity-weighted emissions for all counties. Formaldehyde was also one of the highest emitted pollutants with noncancer RfCs in all four counties. Acetaldehyde was one of the highest emitted pollutants for Morris and Middlesex Counties, but not Union or Camden Counties.

19.6 Summary of the 2008-2009 Monitoring Data for the New Jersey Monitoring Sites

Results from several of the treatments described in this section include the following:

- *Fourteen pollutants failed at least one screen for NBNJ, 15 pollutants failed at least one screen for CANJ and CHNJ, and 17 failed screens for ELNJ.*

- *Formaldehyde had the highest daily average concentration for all four sites for both years, with one exception. Acetaldehyde had the highest daily average concentration in 2008 for the NBNJ, followed by formaldehyde.*

- *One individual concentration of benzene was greater than the acute MRL health risk benchmark (for ELNJ). All of the quarterly and annual average concentrations of the pollutants of interest, where they could be calculated, were below their associated MRL noncancer health risk benchmarks.*

20.0 Sites in New York

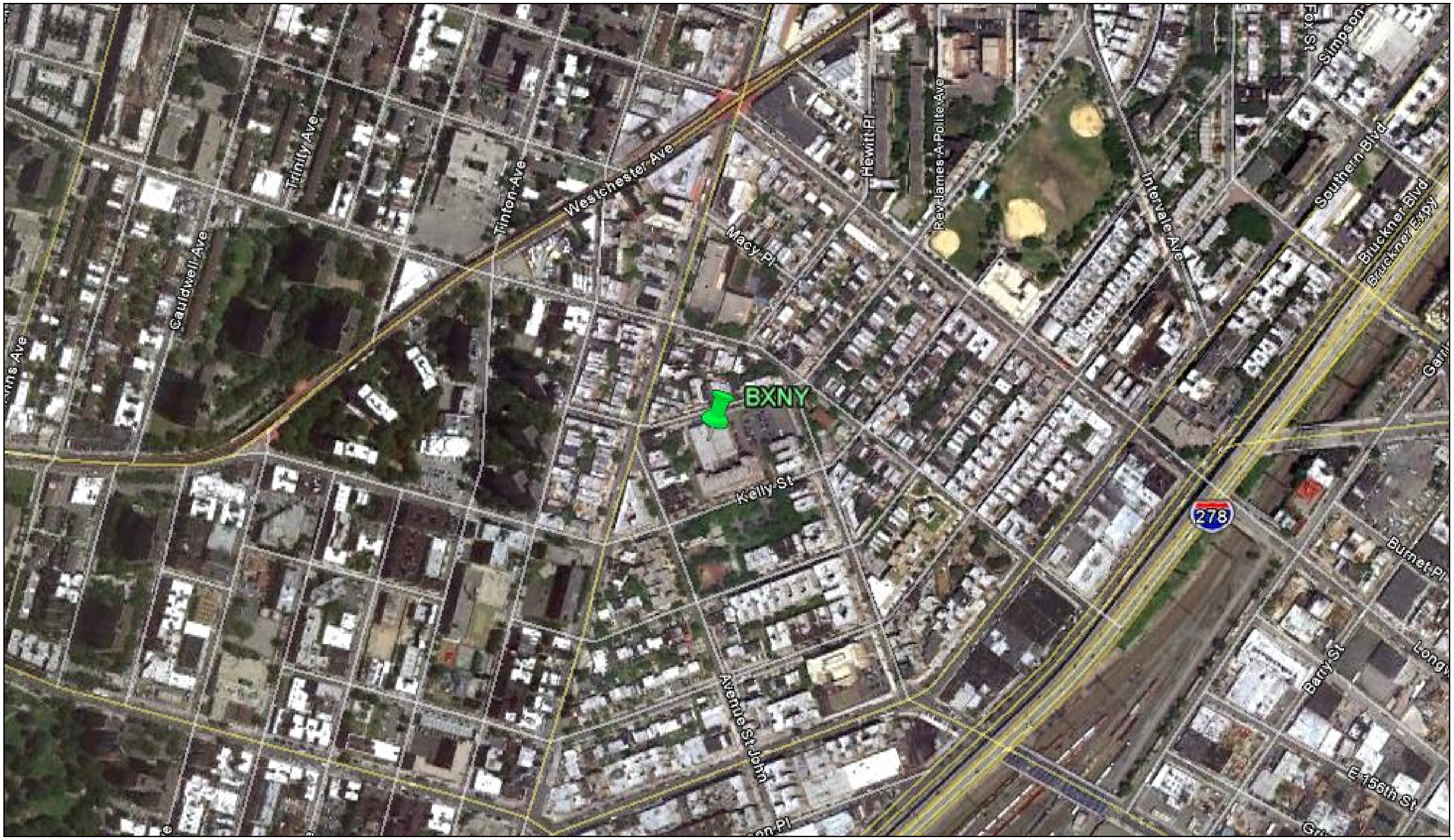
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and CSATAM sites in New York, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

20.1 Site Characterization

This section characterizes the New York monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

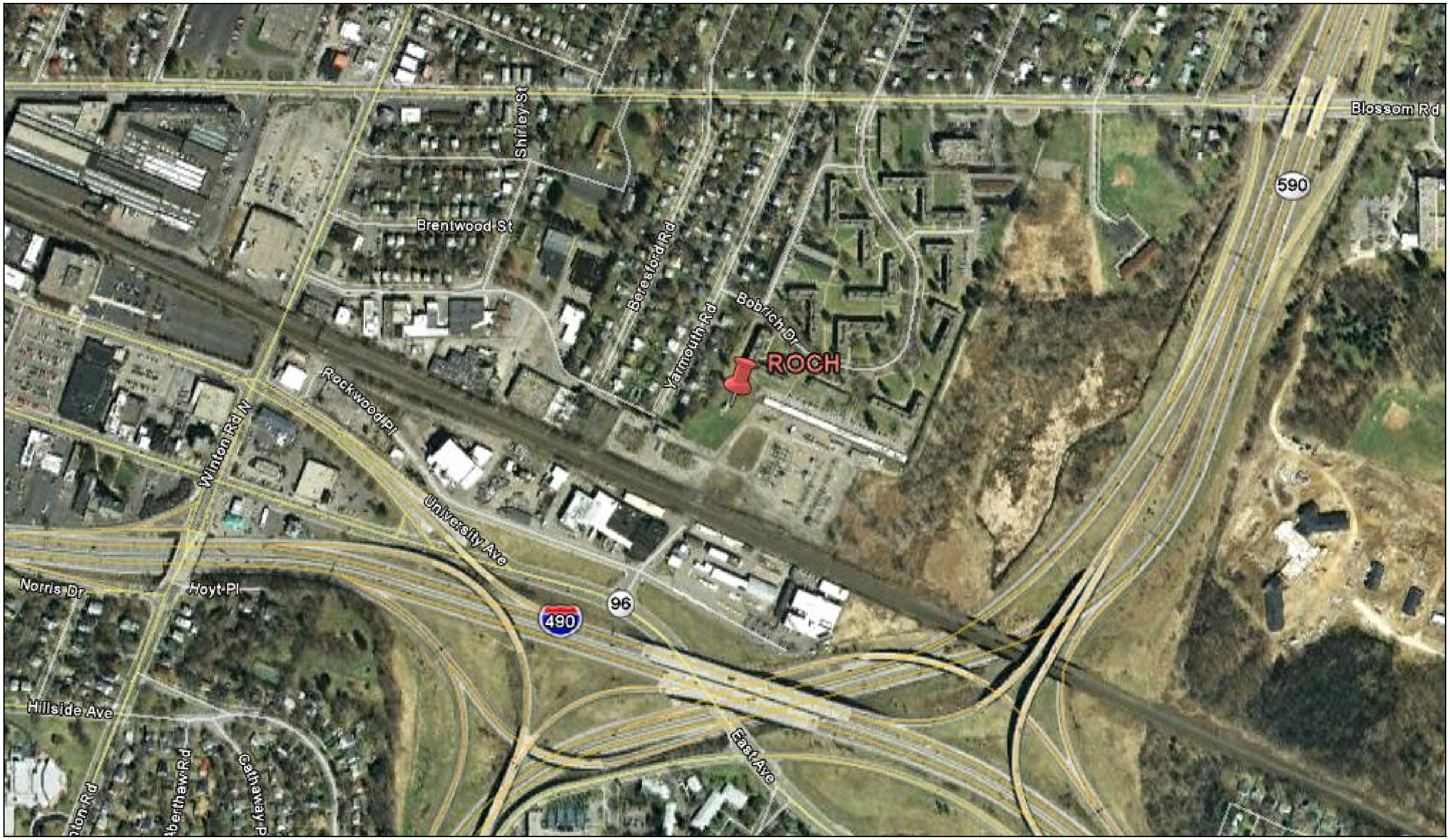
The New York monitoring sites are located in New York City (BXNY), Rochester (ROCH), and Tonawanda (TONY). Figures 20-1 through 20-3 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figures 20-4 through 20-6 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 20-4 through 20-6. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 20-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 20-1. New York City, New York (BXNY) Monitoring Site



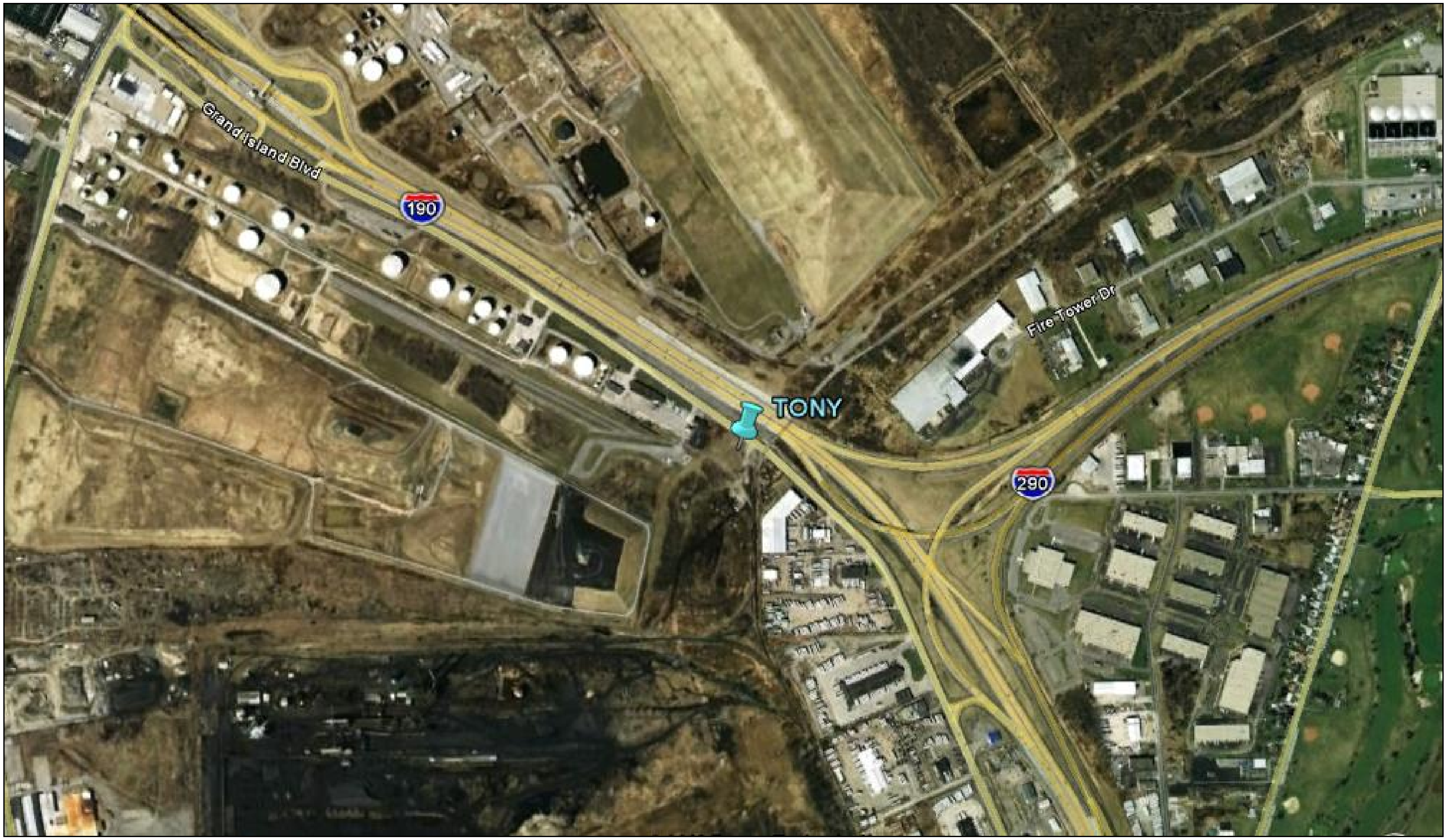
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,492 feet

Figure 20-2. Rochester, New York (ROCH) Monitoring Site



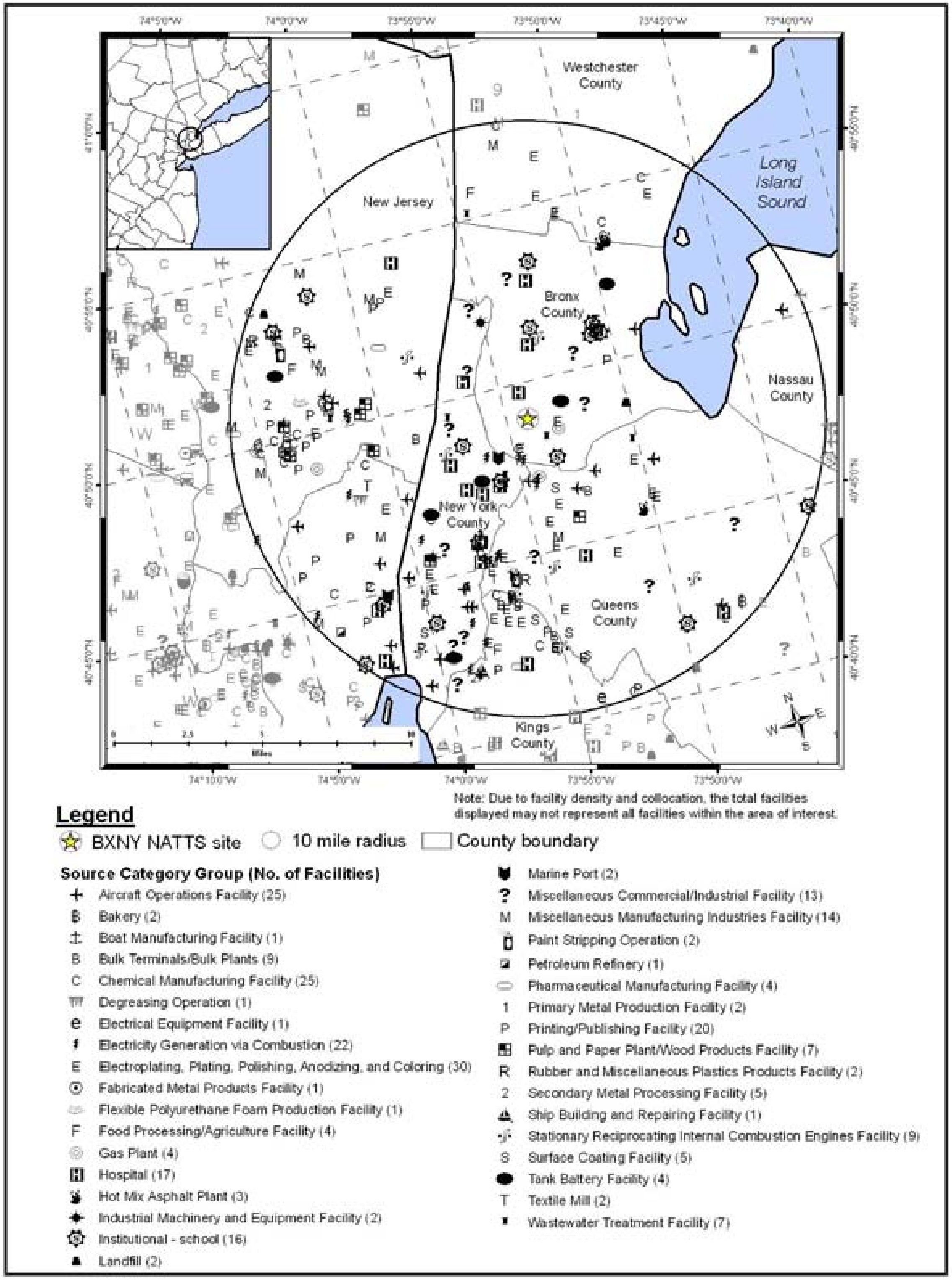
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,444 feet

Figure 20-3. Tonawanda, New York (TONY) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,418 feet

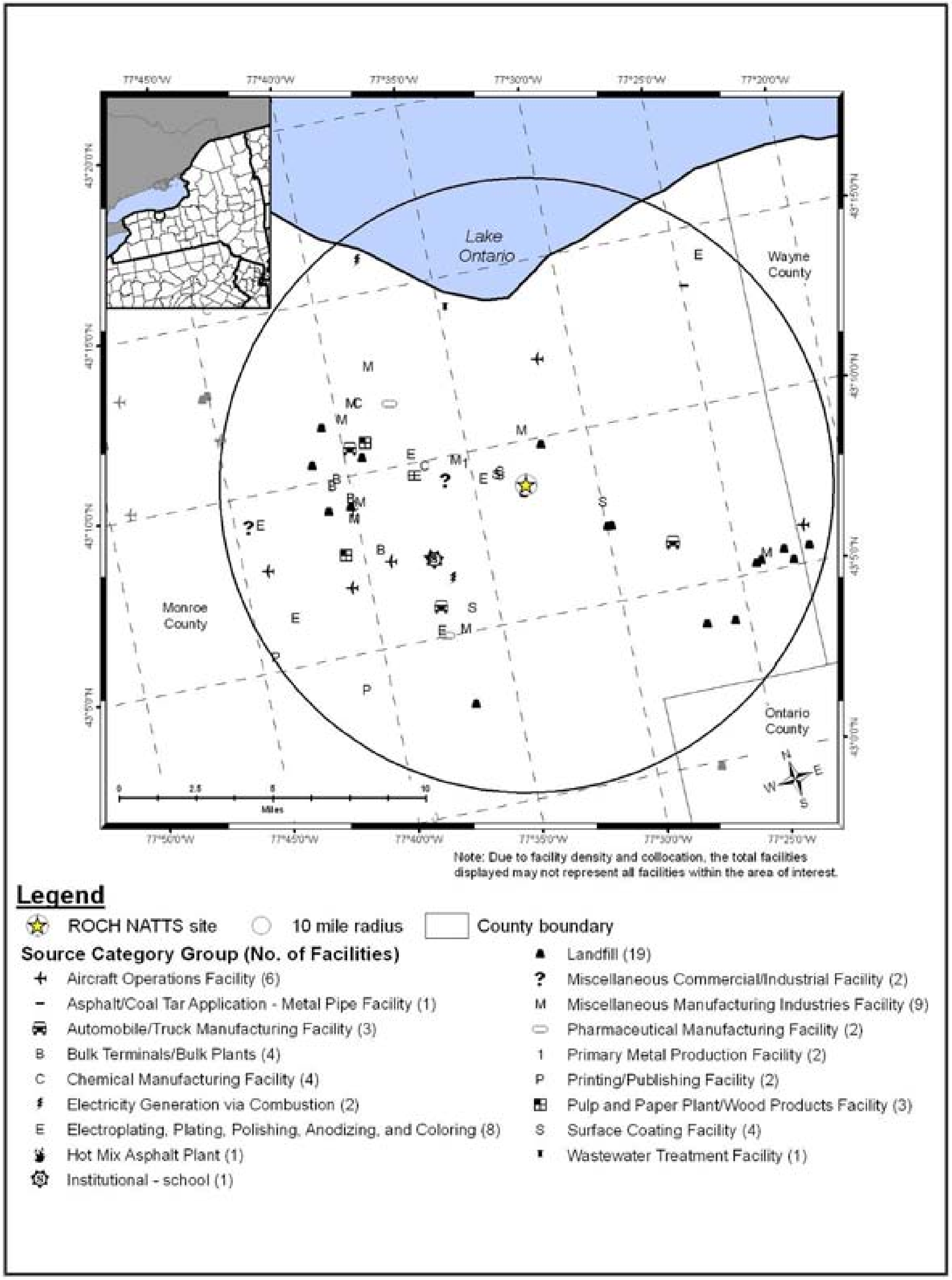
Figure 20-4. NEI Point Sources Located Within 10 Miles of BXNY



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

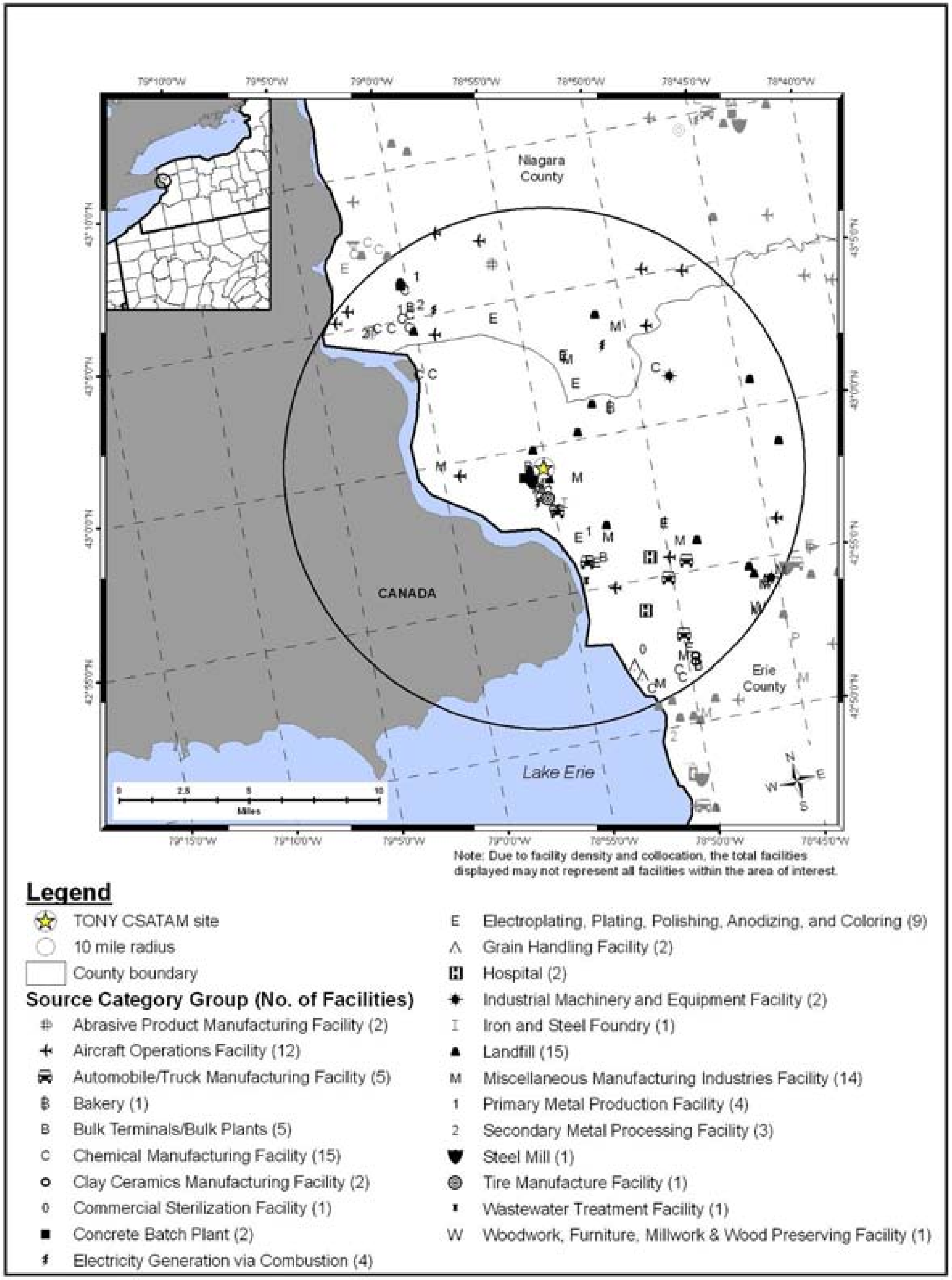
Westchester County
New Jersey
Long Island Sound
Bronx County
Nassau County
New York County
Queens County
Kings County
74°5'0"W
74°0'0"W
73°55'0"W
73°50'0"W
73°45'0"W
73°40'0"W
74°10'0"W
41°0'0"N
40°55'0"N
40°50'0"N
40°45'0"N
40°40'0"N
0
2.5
5
10
Miles
N
E
S
W
Legend
BXNY NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (25)
Bakery (2)
Boat Manufacturing Facility (1)
Bulk Terminals/Bulk Plants (9)
Chemical Manufacturing Facility (25)
Degreasing Operation (1)
Electrical Equipment Facility (1)
Electricity Generation via Combustion (22)
Electroplating, Plating, Polishing, Anodizing, and Coloring (30)
Fabricated Metal Products Facility (1)
Flexible Polyurethane Foam Production Facility (1)
Food Processing/Agriculture Facility (4)
Gas Plant (4)
Hospital (17)
Hot Mix Asphalt Plant (3)
Industrial Machinery and Equipment Facility (2)
Institutional - school (16)
Landfill (2)
Marine Port (2)
Miscellaneous Commercial/Industrial Facility (13)
Miscellaneous Manufacturing Industries Facility (14)
Paint Stripping Operation (2)
Petroleum Refinery (1)
Pharmaceutical Manufacturing Facility (4)
Primary Metal Production Facility (2)
Printing/Publishing Facility (20)
Pulp and Paper Plant/Wood Products Facility (7)
Rubber and Miscellaneous Plastics Products Facility (2)
Secondary Metal Processing Facility (5)
Ship Building and Repairing Facility (1)
Stationary Reciprocating Internal Combustion Engines Facility (9)
Surface Coating Facility (5)
Tank Battery Facility (4)
Textile Mill (2)
Wastewater Treatment Facility (7)

Figure 20-5. NEI Point Sources Located Within 10 Miles of ROCH


77°45'0"W
77°40'0"W
77°35'0"W
77°30'0"W
77°25'0"W
77°20'0"W
43°20'0"N
43°15'0"N
43°10'0"N
43°5'0"N
43°15'0"N
43°10'0"N
43°5'0"N
43°0'0"N
Lake Ontario
Wayne County
Monroe County
Ontario County
0
2.5
5
10
Miles
N
E
W
S
77°50'0"W
77°45'0"W
77°40'0"W
77°35'0"W
77°30'0"W
77°25'0"W
Legend
ROCH NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (6)
Asphalt/Coal Tar Application - Metal Pipe Facility (1)
Automobile/Truck Manufacturing Facility (3)
B Bulk Terminals/Bulk Plants (4)
C Chemical Manufacturing Facility (4)
Electricity Generation via Combustion (2)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (8)
Hot Mix Asphalt Plant (1)
Institutional - school (1)
Landfill (19)
? Miscellaneous Commercial/Industrial Facility (2)
M Miscellaneous Manufacturing Industries Facility (9)
Pharmaceutical Manufacturing Facility (2)
1 Primary Metal Production Facility (2)
P Printing/Publishing Facility (2)
Pulp and Paper Plant/Wood Products Facility (3)
S Surface Coating Facility (4)
Wastewater Treatment Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 20-6. NEI Point Sources Located Within 10 Miles of TONY



79°10'0"W
79°5'0"W
79°0'0"W
78°55'0"W
78°50'0"W
78°45'0"W
78°40'0"W
43°10'0"N
43°5'0"N
43°0'0"N
42°55'0"N
42°50'0"N
Niagara County
CANADA
Lake Erie
Erie County
0
2.5
5
10
Miles
N
E
S
W
79°15'0"W
Legend
TONY CSATAM site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Abrasive Product Manufacturing Facility (2)
Aircraft Operations Facility (12)
Automobile/Truck Manufacturing Facility (5)
Bakery (1)
B Bulk Terminals/Bulk Plants (5)
C Chemical Manufacturing Facility (15)
Clay Ceramics Manufacturing Facility (2)
0 Commercial Sterilization Facility (1)
Concrete Batch Plant (2)
Electricity Generation via Combustion (4)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (9)
Grain Handling Facility (2)
Hospital (2)
Industrial Machinery and Equipment Facility (2)
I Iron and Steel Foundry (1)
Landfill (15)
M Miscellaneous Manufacturing Industries Facility (14)
1 Primary Metal Production Facility (4)
2 Secondary Metal Processing Facility (3)
Steel Mill (1)
Tire Manufacture Facility (1)
Wastewater Treatment Facility (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 20-1. Geographical Information for the New York Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
BXNY	36-005-0110	New York	Bronx	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA	40.81616, -73.90207	Residential	Urban/City Center	Haze, SO_2, NO, NO_2, NOx, O_3, VOC, Carbonyl compounds, Meteorological parameters, PM Coarse, Black Carbon, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
ROCH	36-055-1007	Rochester	Monroe	Rochester, NY MSA	43.146198, -77.54813	Residential	Urban/City Center	CO, SO_2, VOC, Carbonyl compounds, O_3, Meteorological parameters, Black Carbon, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
TONY	36-029-1013	Tonawanda	Erie	Buffalo-Niagara Falls, NY	42.988433, -78.918589	Industrial	Urban/City Center	VOC, $PM_{2.5}$, Carbonyl compounds, and PAMS.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

BXNY is located on the property of Public School 52 (PS 52) in the Bronx Borough of New York City, northeast of Manhattan. The site was established in 1999 and is considered one of the premier particulate sampling sites in New York City. The surrounding area is urban and residential, as shown in Figure 20-1. The Bruckner Expressway (I-278) is located a few blocks east of the monitoring site and other heavily traveled roadways are located within a few miles of the site. BXNY is less than 1/2 mile from the East River. As Figure 20-4 shows, numerous point sources are located within 10 miles of the BXNY site. The bulk of the emissions sources are located to the southwest of the site, with another cluster to the northwest. The source categories with the highest number of emissions sources surrounding BXNY include electroplating, plating, polishing, anodizing, and coloring; chemical manufacturing; aircraft operations, which include airports as well as small runways, heliports, or landing pads; and electricity generation via combustion. The point source closest to BXNY is a wastewater treatment facility.

ROCH is located on the east side of Rochester, in western New York, at a power substation. Rochester is approximately halfway between Syracuse and Buffalo, and Lake Ontario lies to the north. Although the area north and west of the site is primarily residential, as Figure 20-2 shows, a rail road transverses the area just south of the site, and I-590 and I-490 intersect farther south. The site is used by researchers from several universities for short-term monitoring studies. As Figure 20-5 shows, point sources within a 10-mile radius of ROCH are located primarily on the west side of the 10-mile radius. The source categories with the highest number of emissions sources surrounding ROCH include landfills; electroplating, plating, polishing, anodizing, and coloring; and aircraft operations. The source closest to ROCH is a hot mix asphalt plant, less than 1/4 mile away.

TONY is located in Tonawanda, New York, north of Buffalo, along the eastern branch of the Niagara River. The area is wedged between Lake Erie to the south and Lake Ontario to the north, with the river flowing in-between the two. The monitoring site is located off Grand Island Boulevard (324), which parallels I-190, and is less than 1/2 mile from the I-190 and I-290 interchange. The surrounding area is industrial and the site itself resides under high power transmission lines. There are 45 companies regulated by the state of New York within close proximity of this monitoring site (NYS DEC, 2009), including chemical manufacturers, bulk terminals/plants, landfills, facilities generating electricity via combustion, a concrete batch plant, an iron and steel foundry, and a steel mill. Figure 20-6 shows this cluster of point sources immediately south and southwest of TONY. The source categories with the most numerous sources within 10 miles of TONY include chemical manufacturing; landfills; aircraft operations; and electroplating, plating, polishing, anodizing, and coloring. Note that any possible emissions sources located in Canada are not provided in Figure 20-6.

Table 20-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the New York monitoring sites. Information provided in Table 20-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for the Bronx, Monroe, and Erie Counties were obtained from the New York State Department of Motor Vehicles (NYS DMV, 2008) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 20-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 20-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 20-2 presents the daily VMT for the New York City, Rochester, and Buffalo urban areas.

Table 20-2. Population, Motor Vehicle, and Traffic Information for the New York Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
BXNY	1,397,287	246,190	0.18	6,531,354	1,150,769	100,230	299,125
ROCH	733,703	552,964	0.75	636,955	480,049	105,038	16,267
TONY	909,247	664,102	0.73	611,359	446,529	74,406	20,787

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2008 data from the New York State DMV (NYS DMV, 2008).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average daily traffic reflects 2008 data from the New York State DOT (NYS DOT, 2008).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 20-2 include the following:

- Bronx County had the 10th highest county population but the highest 10-mile radius population of all NMP sites.

- County-level vehicle ownership for Bronx County was in the mid to low range among NMP sites. Although the 10-mile ownership estimate was among the highest for all NMP sites, given the large population living within 10 miles, the vehicle-per-person ratio is very low (0.18), which was the lowest vehicle-per-person ratio calculated. This might seem surprising given the high population, but may be explained by the use of mass transportation systems.

- The populations surrounding ROCH and TONY are lower than BXNY. However, the county-level vehicle ownership is higher near these sites. The same is not true of the 10-mile ownership estimate.

- The population and vehicle ownership data for ROCH and TONY were in the middle of the range compared to NMP other sites.

- The traffic volumes near ROCH and BXNY are fairly similar to each other and were in the mid to upper end of the range among NMP monitoring sites. The traffic near TONY is one-fourth less than the traffic for the other two sites. The traffic data for BXNY were obtained from I-278 between I-87 and I-895; the traffic data for ROCH were obtained from I-490 between Winston Road and I-590; the traffic data for TONY were obtained from I-190 between Exit 16 and 17.

- The New York City area VMT was the highest among all urban areas with NMP sites. By comparison, VMT for the Buffalo and Rochester urban areas were on the mid to low end of the range.

20.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in New York on sample days, as well as over the course of each year.

20.2.1 Climate Summary

Weather is somewhat variable in New York City as frontal systems frequently affect the area. Precipitation is spread fairly evenly throughout the year, with thunderstorms in the summer and fall and more significant rain or snow events in the winter and spring. The proximity to the Atlantic Ocean offers a moderating influence from cold outbreaks; the summer heat and the urban heat island effect also tend to keep the city warmer than outlying areas and often results in a relatively small diurnal range of temperatures. In addition, air sinking down from the mountains to the west can help drive temperatures higher during warm spells (Bair, 1992).

Rochester is located in western New York and borders Lake Ontario's south side. Elevation increases significantly from the shore to the southern-most parts of the city, rising over 800 feet. While the lake acts as a moderating influence on the city's temperatures, both in the summer and the winter, it also plays a major factor in the city's precipitation patterns. Lake effect snow enhances the area's snowfall totals, although snowfall rates tend to be higher near Lake Ontario than farther inland. Spring and summer tend to be sunny while cloudy conditions are prevalent in the fall and winter (Bair, 1992 and NOAA, 2011a).

Cloudy conditions prevail over the Buffalo area from late autumn through early spring, and snowy conditions are common. Lake-effect snow events may to lead to heavy snowfall, with heavier snowfalls to the south of Buffalo and closer to the shore than towards the Tonawanda area. Lake-effect snows tend to diminish after Lake Erie freezes. Because Lake Erie is so cold (and eventually frozen) during the winter, areas immediately near the shore may be much colder than farther inland during the spring and summer. Due to the stabilizing effects of the Lake, the Buffalo area experiences one of the sunniest and driest summers along the northeast coast. But with the arrival of autumn, cooler air passes over the warmer Lake, increasing cloud cover. Southwesterly winds prevail over the area, but winds off Lake Erie tend to be stronger than farther inland. Wind direction in Tonawanda can be altered by its proximity to the Niagara River. Summer temperature extremes are tempered by the area's location between Lake Erie and Lake Ontario (Bair, 1992 and NOAA, 2011b).

20.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather stations are located at La Guardia International Airport (near BXNY), Greater Rochester International Airport (near ROCH), and Niagara Falls International Airport (near TONY), WBAN 14732, 14768, and 04724, respectively. Additional information about these weather stations is provided in Table 20-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 20-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 20-3 is the 95 percent confidence interval for each parameter.

Table 20-3. Average Meteorological Conditions near the New York Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
New York City, New York - BXNY										
La Guardia Airport 14732 (40.78, -73.88)	2.77 miles 144° (SE)	2008	Sample Day	63.3 ± 4.5	56.7 ± 4.3	40.9 ± 4.4	49.1 ± 3.8	58.5 ± 3.9	1016.0 ± 2.1	8.7 ± 0.7
			All Year	62.7 ± 1.8	56.1 ± 1.7	40.4 ± 1.8	48.6 ± 1.5	58.4 ± 1.4	1016.4 ± 0.8	9.3 ± 0.3
		2009	Sample Day	63.7 ± 4.4	57.2 ± 4.1	43.6 ± 4.4	50.6 ± 3.7	63.6 ± 3.8	1013.8 ± 2.2	9.0 ± 0.9
			All Year	60.8 ± 1.8	54.5 ± 1.7	40.5 ± 1.9	48.0 ± 1.6	61.7 ± 1.5	1016.4 ± 0.8	9.2 ± 0.4
Rochester, New York - ROCH										
Greater Rochester Intl Airport 14768 (43.12, -77.68)	6.44 miles 240° (WSW)	2008	Sample Day	57.1 ± 4.8	49.1 ± 4.3	38.0 ± 4.2	43.9 ± 3.9	68.2 ± 2.9	1015.6 ± 1.9	7.6 ± 0.8
			All Year	57.4 ± 2.0	49.1 ± 1.8	37.8 ± 1.8	43.8 ± 1.7	67.6 ± 1.0	1016.1 ± 0.8	7.8 ± 0.3
		2009	Sample Day	55.1 ± 4.7	47.9 ± 4.3	38.6 ± 4.5	43.7 ± 4.1	73.3 ± 3.3	1013.6 ± 2.4	7.7 ± 0.9
			All Year	55.4 ± 1.9	47.3 ± 1.8	37.7 ± 1.9	43.0 ± 1.7	71.9 ± 1.2	1016.5 ± 0.8	7.0 ± 0.3
Tonawanda, New York - TONY										
Niagara Falls Intl Airport 04724 (43.11, -78.95)	8.28 miles 341° (NNW)	2008	Sample Day	60.2 ± 6.9	52.7 ± 6.2	44.7 ± 6.0	48.7 ± 5.7	76.1 ± 2.9	1016.5 ± 2.2	7.7 ± 1.3
			All Year	56.0 ± 2.0	47.9 ± 1.8	39.0 ± 1.8	43.7 ± 1.7	73.5 ± 1.0	1016.3 ± 0.8	8.6 ± 0.4
		2009	Sample Day	55.1 ± 4.9	48.2 ± 4.5	39.3 ± 4.5	44.0 ± 4.2	73.9 ± 3.2	1014.0 ± 2.4	8.6 ± 1.0
			All Year	55.6 ± 2.0	47.8 ± 1.8	38.3 ± 1.8	43.4 ± 1.7	72.1 ± 1.1	1016.7 ± 0.8	7.9 ± 0.4

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

As shown in Table 20-3, average meteorological conditions on 2008 sample days near BXNY were fairly representative of average weather conditions throughout that year, while conditions on 2009 sample days appear slightly warmer and wetter than average conditions throughout 2009. Several missed sample days from early in the year were made up in the month of July, likely accounting for this difference. Average meteorological conditions on sample days near ROCH were fairly representative of average weather conditions experienced throughout each respective year. Average meteorological conditions on 2008 sample days near TONY appear warmer than for the entire year. This site began sampling in July 2008; therefore, the sample day averages do not incorporate conditions from some of the coldest months of the year, which likely explains the differences shown in Table 20-3. Average meteorological conditions on 2009 sample days near TONY were fairly representative of average weather conditions throughout that year.

20.2.3 Back Trajectory Analysis

Figure 20-7 and Figure 20-8 are the composite back trajectory maps for days on which samples were collected at the BXNY monitoring site in 2008 and 2009, respectively. Figure 20-9 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 20-10 through 20-12 are the composite back trajectory and cluster analysis maps for days on which samples were collected at the ROCH monitoring site and Figures 20-13 through 20-15 are the composite back trajectory and cluster analysis maps for days on which samples were collected at the TONY monitoring site. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 20-7 through 20-15 represents 100 miles.

Figure 20-7. 2008 Composite Back Trajectory Map for BXNY

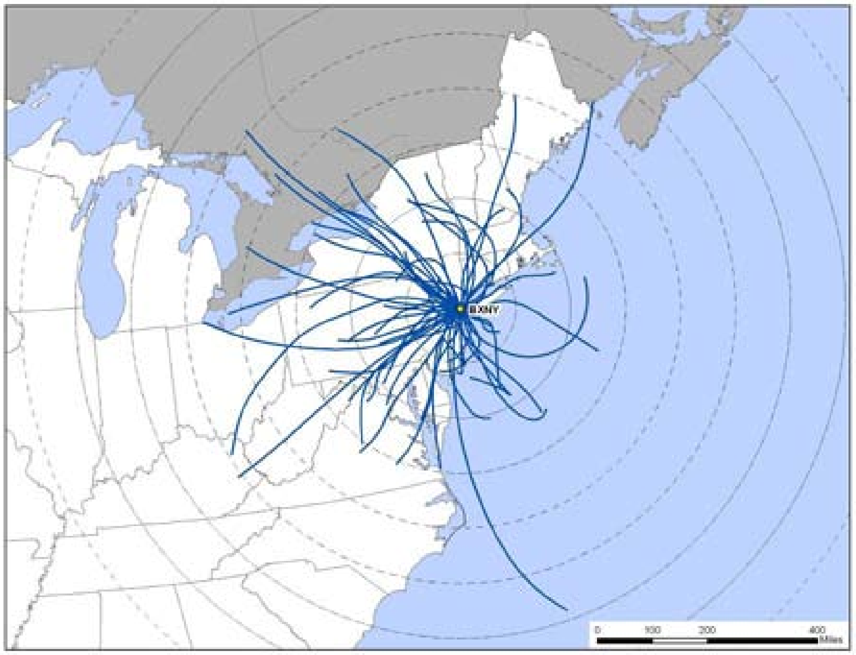


Figure 20-8. 2009 Composite Back Trajectory Map for BXNY

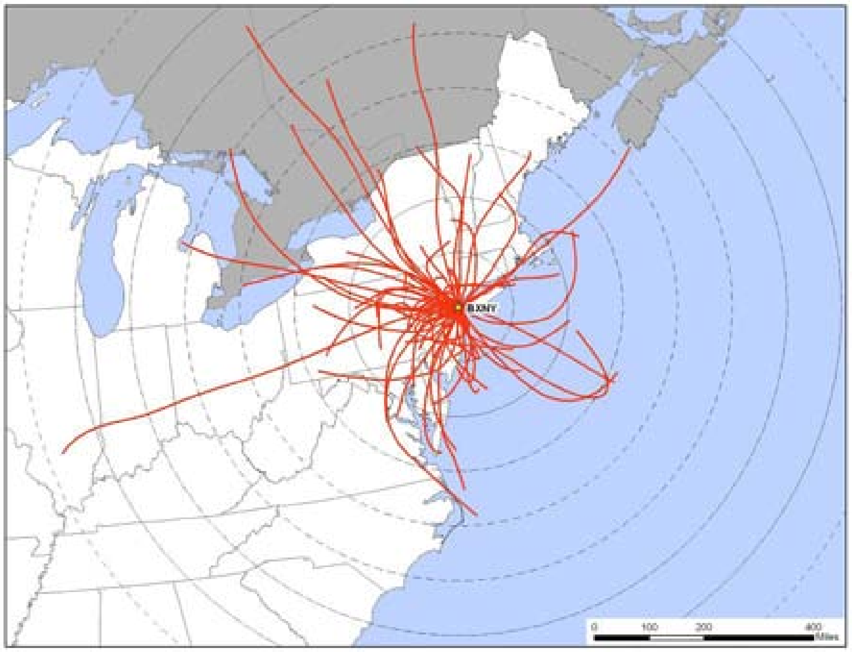


Figure 20-9. Back Trajectory Cluster Map for BXNY

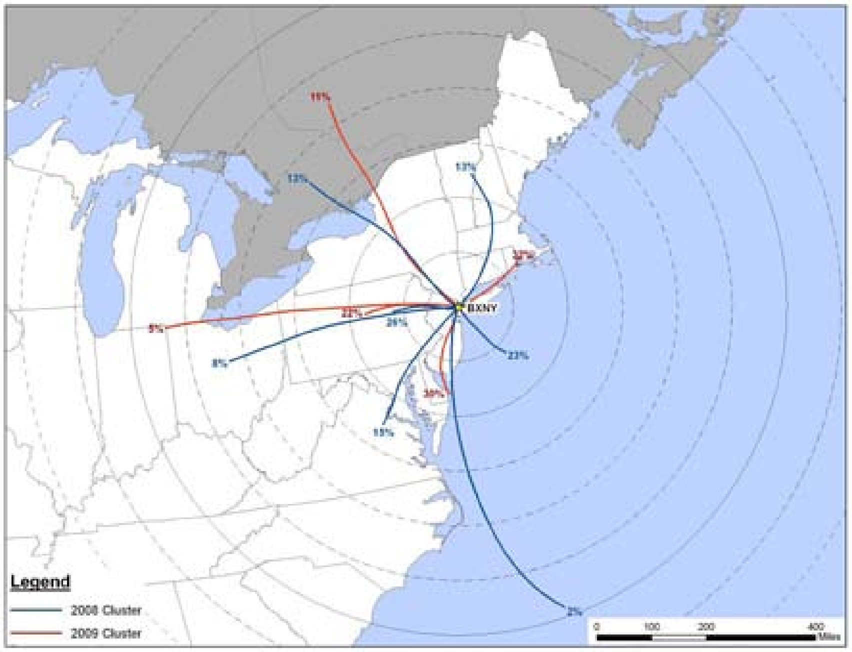


Figure 20-10. 2008 Composite Back Trajectory Map for ROCH

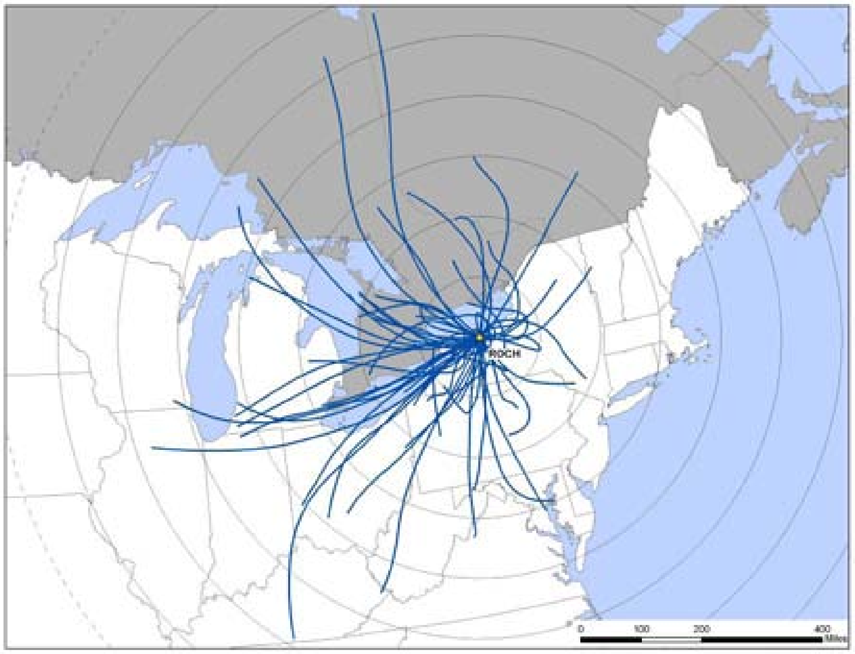


Figure 20-11. 2009 Composite Back Trajectory Map for ROCH

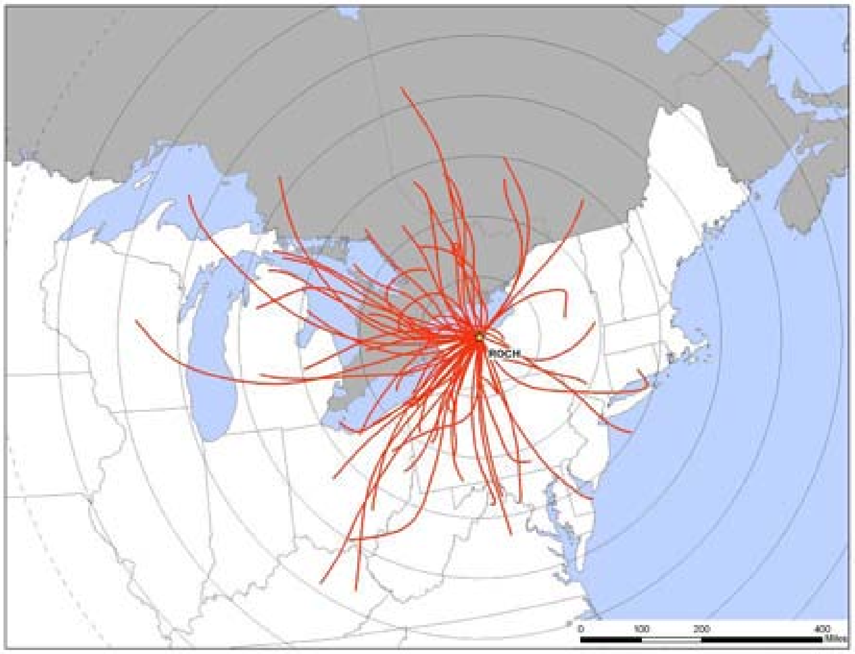


Figure 20-12. Back Trajectory Cluster Map for ROCH

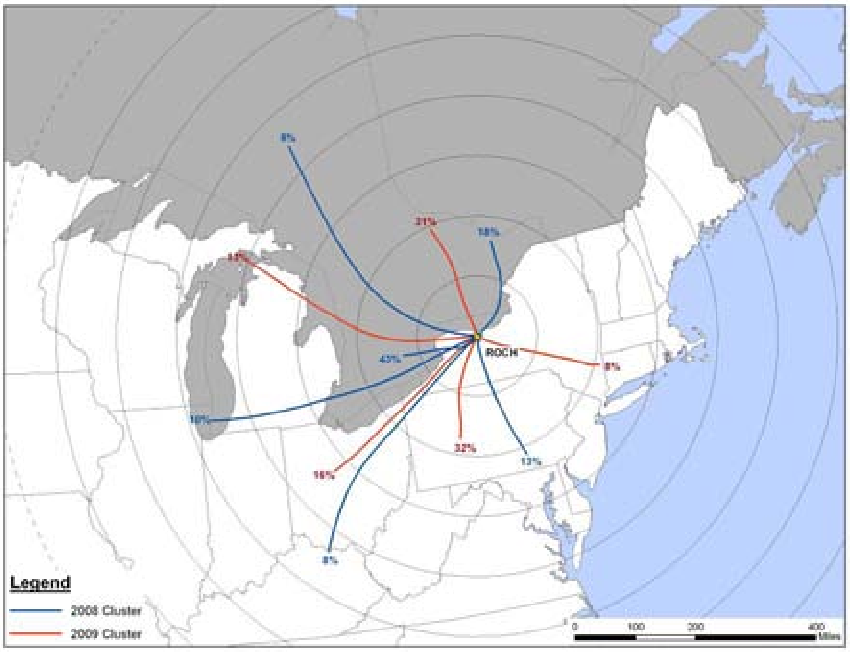


Figure 20-13. 2008 Composite Back Trajectory Map for TONY

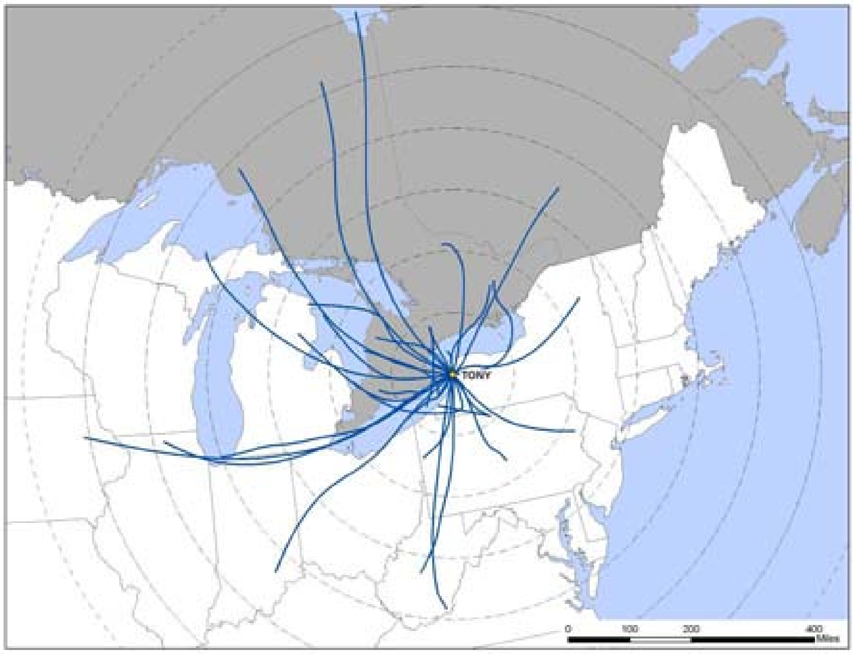


Figure 20-14. 2009 Composite Back Trajectory Map for TONY

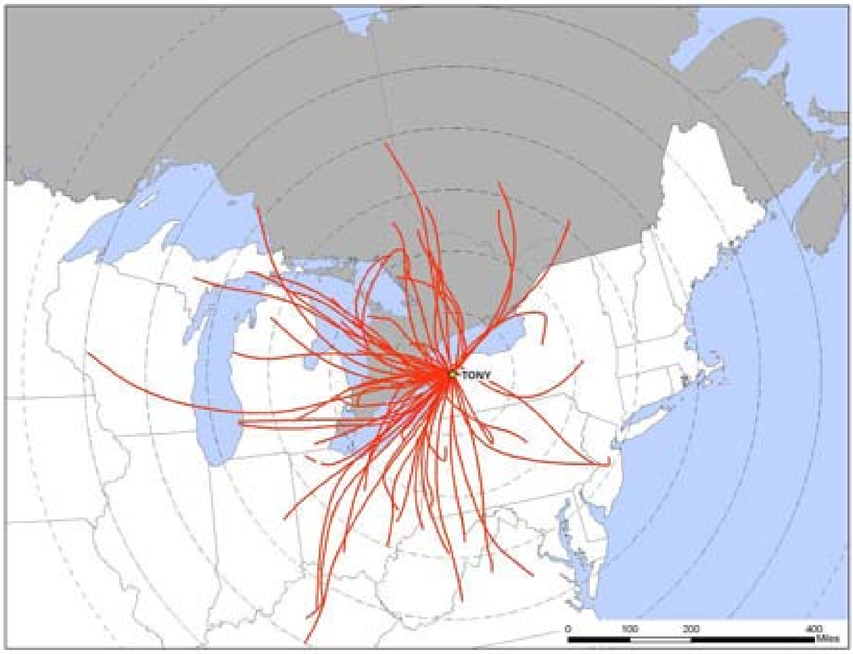
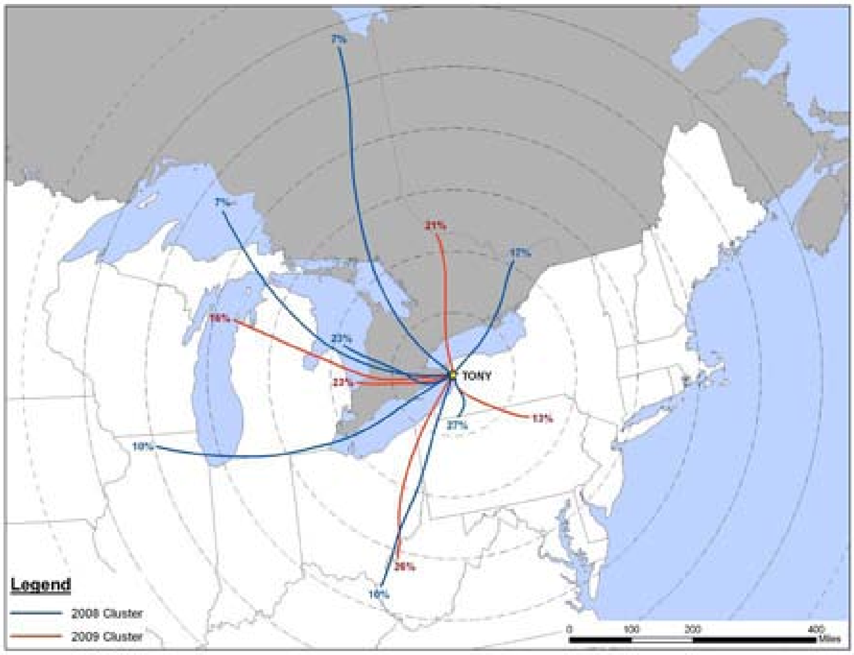


Figure 20-15. Back Trajectory Cluster Map for TONY



Observations from Figures 20-7 through 20-9 for BXNY include the following:

- Back trajectories originated from a variety of directions at BXNY, although less frequently from the east.

- The 24-hour air shed domain for BXNY was somewhat larger in size compared to other NMP sites, as the farthest away a trajectory originated was nearly 775 miles to the southwest, over southern Illinois. However, the average trajectory length was 235 miles and more than 85 percent of trajectories originated within 400 miles of the site.

- The cluster analysis shows that trajectories often originated to the west, northwest, northeast, and south of BXNY. Note that for 2008, there are three cluster trajectories representing trajectories with a southerly component; a relatively short one to the southeast (23 percent), a long one from due south (2 percent), and a medium-length one to the southwest (15 percent). For 2009, the cluster analysis program grouped these types of trajectories as one cluster trajectory (30 percent).

Observations from Figures 20-10 through 20-12 for ROCH include the following:

- Back trajectories originated from a variety of directions at ROCH.

- The 24-hour air shed domain for ROCH was comparable in size to other NMP sites. The farthest away a trajectory originated was south-central Kentucky, or nearly

600 miles away. However, the average trajectory length was 255 miles and 84 percent of trajectories originated within 400 miles of the site.

- The cluster analysis shows that the bulk of trajectories originated to the southwest, west, or northwest of the monitoring site. Note that the 2009 cluster trajectory originating to the south of the site (32 percent) represents trajectories originating from due south, south-southwest, and southwest. Similarly, the 2009 cluster trajectory originating to the north of the site (31 percent) represents trajectories originating from the northwest, due north, northeast.

Observations from Figures 20-13 through 20-15 for TONY include the following:

- Back trajectories originated from a variety of directions at TONY, although less frequently from the east.
- The 24-hour air shed domain for TONY was comparable in size to ROCH as well as other NMP sites. The farthest away a trajectory originated was over the southern tip of James Bay, which divides the provinces of Quebec and Ontario, Canada, or just greater than 600 miles away. However, the average trajectory length was 265 miles and nearly 85 percent of trajectories originated within 400 miles of the site.
- The cluster analysis shows that over 40 percent of trajectories originated to the southwest, west, or northwest of TONY for each year. Trajectories also originated to the south to southwest and north.
- Note that Figure 20-13 includes 2008 back trajectories from July to December 2008 only, based on the start date of the sampling effort, and thus the cluster analysis for 2008 includes sample day trajectories only from this period as well.

20.2.4 Wind Rose Comparison

Hourly wind data from the weather stations at the La Guardia International Airport (for BXNY), Greater Rochester International Airport (for ROCH), and Niagara Falls International Airport (for TONY) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 20-16 presents five different wind roses for the BXNY monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 20-17 and 20-18 present the five different wind roses for the ROCH and TONY monitoring sites, respectively.

Observations from Figure 20-16 for BXNY include the following:

- The historical wind rose shows that winds from the southwest, northwest, and northeast quadrants were frequently observed, while winds from the southeast quadrant were rarely observed. Among these wind directions, northwesterly and southerly winds were observed the most. Calm winds (≤2 knots) were observed for less than six percent of the hourly measurements near BXNY, while the strongest winds were most frequently observed with northwesterly winds.

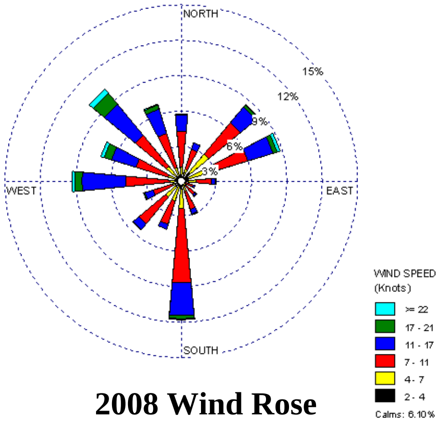
- The wind patterns shown on the 2008 and 2009 wind roses are similar to the historical wind patterns. Further, the sample day wind patterns for each year also resemble those shown on the historical wind rose, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

Observations from Figure 20-17 for ROCH include the following:

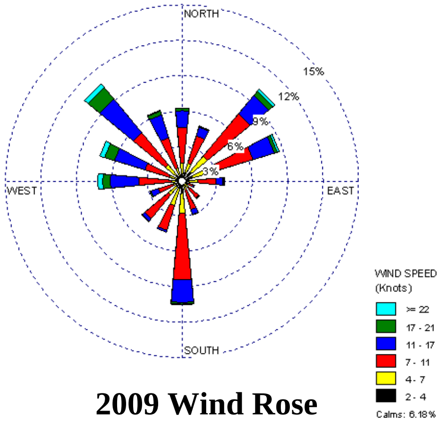
- The historical wind rose shows that winds from the south-southwest to west were frequently observed, while winds from other directions were infrequently observed. Calm winds were observed for less than 10 percent of the hourly measurements near ROCH, while the strongest winds were most frequently observed with west-southwesterly and westerly winds.

- The wind patterns shown on the 2008 and 2009 wind roses are similar to the historical wind patterns for ROCH. In addition, the sample day wind patterns for each year also resemble those shown on the historical wind rose, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

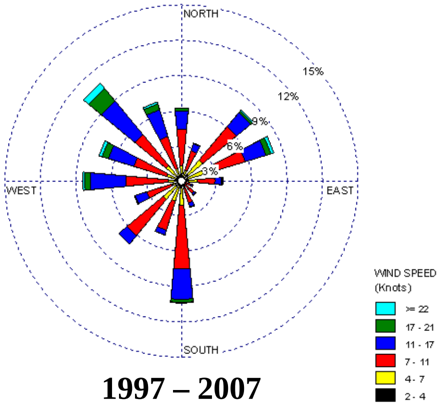
Figure 20-16. Wind Roses for the LaGuardia International Airport Weather Station near BXNY



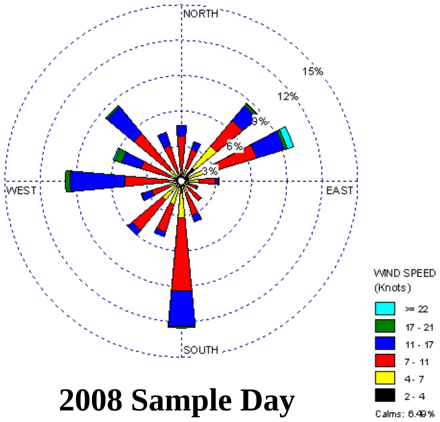
2008 Wind Rose



2009 Wind Rose

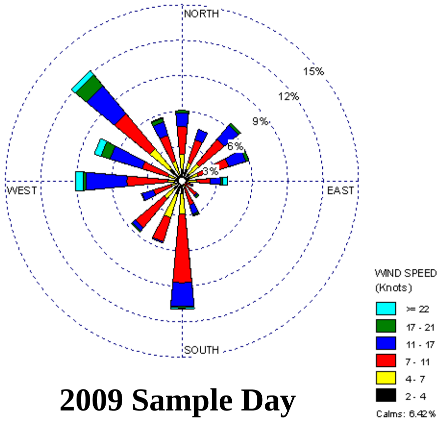


1997 – 2007
Historical Wind Rose



2008 Sample Day

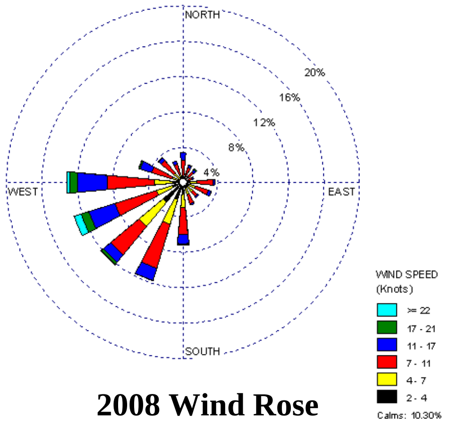
Wind Rose



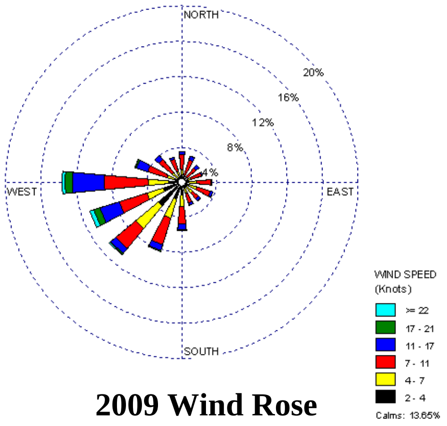
2009 Sample Day

Wind Rose

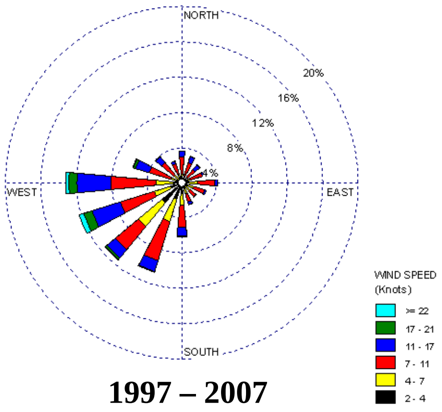
Figure 20-17. Wind Roses for the Greater Rochester International Airport Weather Station near ROCH



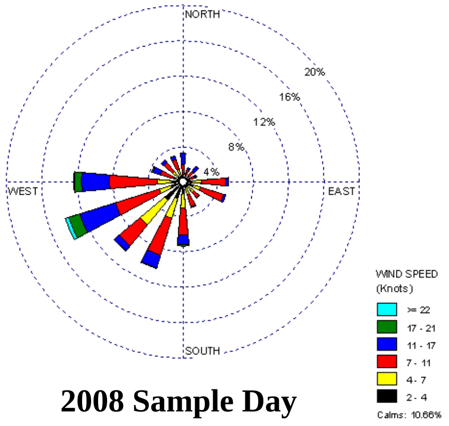
2008 Wind Rose



2009 Wind Rose

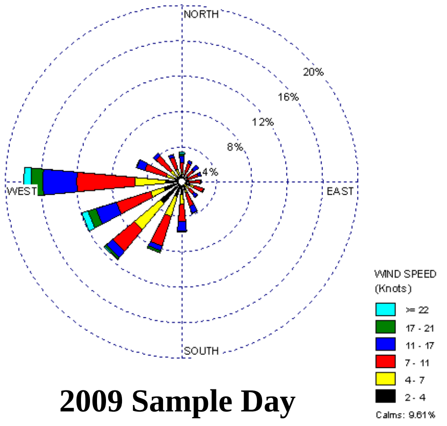


1997 – 2007
Historical Wind Rose



2008 Sample Day

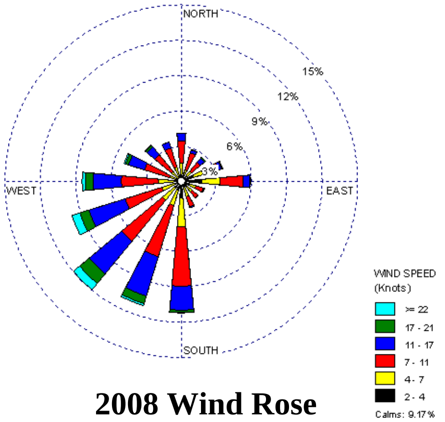
Wind Rose



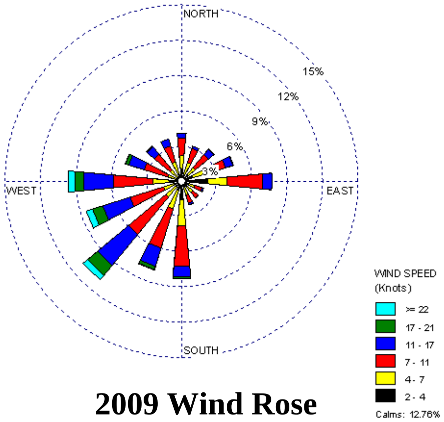
2009 Sample Day

Wind Rose

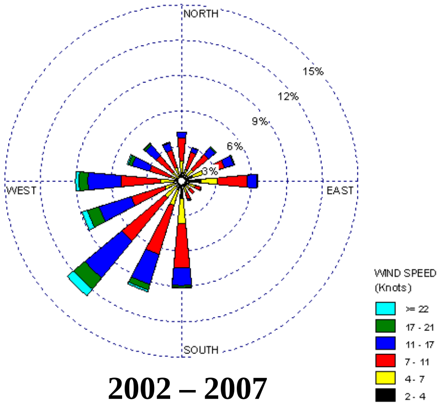
Figure 20-18. Wind Roses for the Niagara Falls International Airport Weather Station near TONY



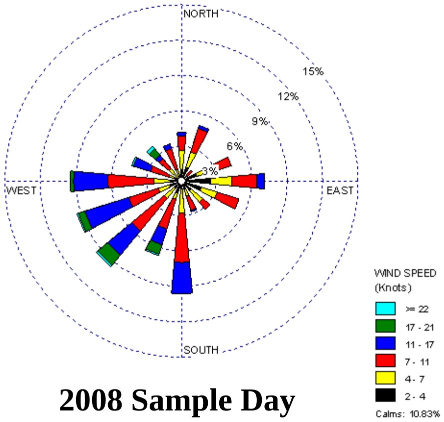
2008 Wind Rose



2009 Wind Rose

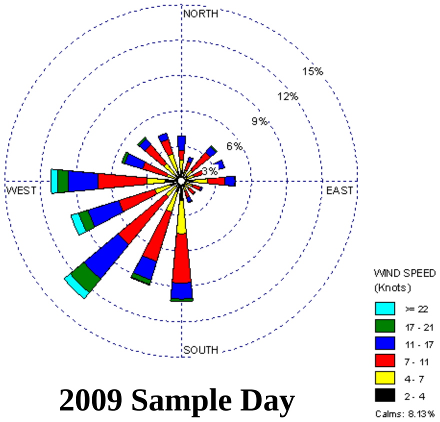


2002 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 20-18 for TONY include the following:

- The wind patterns for TONY resemble the wind patterns for ROCH.
- The historical wind rose shows that winds from the south to southwest to west were the most frequently observed wind directions. Calm winds account for approximately 10 percent of the hourly measurements near TONY. The strongest winds were most frequently observed with southwesterly, west-southwesterly, and westerly winds, those generally flowing off Lake Erie.
- The wind patterns shown on the 2008 and 2009 wind roses are similar to the historical wind patterns for TONY. In addition, the sample day wind patterns for each year also resemble the historical wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.
- The 2008 sample day wind rose mirrors the full-year and historical wind roses in direction, but lacks the higher wind speed observations that the other wind roses have. Recall the sampling at TONY did not begin until July 2008, thereby missing the "windier" months of the year.

20.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the New York monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 20-4 presents the pollutants of interest of for the New York monitoring sites. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. ROCH and BXNY sampled for hexavalent chromium and PAH while TONY sampled only for PAH.

Table 20-4. Risk Screening Results for the New York Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
New York City, New York - BXNY						
Naphthalene	0.029	88	88	100.00	97.78	97.78
Benzo(a)pyrene	0.00091	1	84	1.19	1.11	98.89
Hexavalent Chromium	0.000083	1	96	1.04	1.11	100.00
Total		90	268	33.58		
Rochester, New York - ROCH						
Naphthalene	0.029	55	87	63.22	98.21	98.21
Hexavalent Chromium	0.000083	1	39	2.56	1.79	100.00
Total		56	126	44.44		
Tonawanda, New York - TONY						
Naphthalene	0.029	87	91	95.60	90.63	90.63
Benzo(a)pyrene	0.00091	7	88	7.95	7.29	97.92
Benzo(b)fluoranthene	0.0091	1	90	1.11	1.04	98.96
Indeno(1,2,3-cd)pyrene	0.0091	1	88	1.14	1.04	100.00
Total		96	357	26.89		

Observations from Table 20-4 include the following:

- All three NATTS MQO Core Analytes sampled for at BXNY failed screens. Naphthalene was the only pollutant identified as a pollutant of interest for BXNY by the risk screening process. Benzo(a)pyrene and hexavalent chromium were added as pollutants of interest because they are NATTS MQO Core analytes, even though they did not contribute to 95 percent of the total failed screens.

- Naphthalene and hexavalent chromium failed screens for ROCH. Naphthalene was the only pollutant identified as a pollutant of interest for ROCH by the risk screening process. Hexavalent chromium was added as a pollutant of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. In addition, benzo(a)pyrene was added as a pollutant of interest even though it did not fail any screens because it is also a NATTS MQO Core Analyte; this pollutant is not shown in Table 20-4.

- Four PAH, of which two are the NATTS MQO Core Analytes for this method, failed screens for TONY. Of the 32 NMP sites sampling PAH, only TONY had failed screens for benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene. Napthalene and benzo(a)pyrene were identified as pollutants of interest for TONY by the risk screening process.

- Naphthalene failed the majority of screens for each New York monitoring site, as this pollutant failed from 63 percent of screens (ROCH) to 100 percent of screens (BXNY).

20.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the New York monitoring sites. Concentration averages are provided for the pollutants of interest for each New York site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

20.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each New York site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 20-5, where applicable. Note that concentration averages have been converted to ng/m^3 in Table 20-5 for ease of viewing.

Table 20-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the New York Monitoring Sites

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
New York City, New York - BXNY												
Benzo(a)pyrene	0.18 ± 0.08	NR	NR	0.09 ± 0.03	0.28 ± 0.15	NA	0.16 ± 0.04	0.25 ± 0.11	0.10 ± 0.03	0.08 ± 0.03	0.23 ± 0.09	0.16 ± 0.04
Hexavalent Chromium	0.03 ± 0.01	0.03 ± 0.02	0.03 ± 0.01	0.02 ± 0.01	0.01 ± <0.01	0.02 ± 0.01	0.02 ± <0.01	NA	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± <0.01
Naphthalene	125.54 ± 15.37	NR	NR	123.85 ± 22.78	127.49 ± 22.50	NA	133.76 ± 18.30	113.51 ± 26.41	118.14 ± 29.06	138.37 ± 21.09	161.38 ± 60.70	133.76 ± 18.30
Rochester, New York - ROCH												
Benzo(a)pyrene	0.10 ± 0.02	NR	NR	0.04 ± 0.03	0.10 ± 0.03	NA	0.10 ± 0.03	0.14 ± 0.06	0.06 ± 0.02	NA	NA	NA
Hexavalent Chromium	0.02 ± 0.01	NA	0.01 ± <0.01	NA	NA	NA	0.02 ± 0.01	NA	NA	NA	NA	NA
Naphthalene	74.58 ± 15.89	NR	NR	95.26 ± 26.01	52.43 ± 9.69	NA	29.31 ± 8.23	50.41 ± 12.97	51.63 ± 18.40	9.46 ± 8.36	5.84 ± 6.96	29.31 ± 8.23
Tonawanda, New York - TONY												
Benzo(a)pyrene	0.73 ± 0.75	NR	NR	0.31 ± 0.20	1.10 ± 1.47	NA	0.25 ± 0.07	0.35 ± 0.16	0.29 ± 0.17	0.23 ± 0.12	0.11 ± 0.05	0.25 ± 0.07
Naphthalene	555.95 ± 213.09	NR	NR	639.67 ± 348.69	472.23 ± 268.35	NA	615.92 ± 169.24	971.01 ± 413.28	524.81 ± 287.68	642.64 ± 430.12	331.31 ± 146.96	615.92 ± 169.24

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations from Table 20-5 include the following:

- The daily average concentration of naphthalene was significantly higher than the daily averages of any of the other pollutants of interest for the New York sites.

- Because sampling for PAH at all three New York sites began in July 2008, first and second quarter 2008 averages are not available for these pollutants. The calculation of quarterly averages is also governed by the number of measured detections, which also explains why some additional averages are not available.

- The daily average naphthalene concentration for TONY is significantly higher than for BXNY and ROCH, as well as any other NMP site sampling PAH. The daily average concentration of naphthalene for TONY is 555.95 ± 213.09 ng/m^3 for 2008 and 615.92 ± 169.24 ng/m^3 for 2009. The next highest daily average concentration was 198.41 ± 30.00 ng/m^3 for CELA (2009), as shown in Table 4-11. Of the nearly 50 measurements of naphthalene greater than 500 ng/m^3 among NMP sites sampling this pollutant, 39 of the concentrations were measured at TONY (and one at BXNY). Further, there were 16 measurements of naphthalene at TONY greater than 1000 ng/m^3. Although at least one of these concentrations was measured in every quarter except the fourth quarter of 2009, the bulk of them were measured in the first quarter of 2009 (six).

- TONY also had the highest daily average concentration of benzo(a)pyrene among NMP sites (for 2008, as shown in Table 4-11), but the high confidence interval indicates that this average is influenced by outliers. A review of the quarterly averages reveals that outliers were measured during the fourth quarter of 2008. The highest concentration at TONY was measured on October 27, 2008 (10.9 ng/m^3) and was nearly five times the next highest measured concentration (2.14 ng/m^3 measured on November 8, 2008). Of the five measurements of benzo(a)pyrene greater than 1.00 ng/m^3, three of the concentrations were measured at TONY during the fourth quarter of 2008 (with the others being the third quarter of 2008 and the first quarter of 2009).

- Naphthalene concentrations began to fall significantly after the first year of sampling at ROCH, which can be seen in the third and fourth quarter averages of 2009. The fourth quarter 2009 naphthalene average for ROCH was the lowest quarterly average among all NMP sites sampling this pollutant and its third quarter 2009 average was the fifth lowest among all sites.

20.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. The New York monitoring sites have not sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

20.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each New York monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

20.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the New York monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the New York monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

20.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the New York monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 20-6, where applicable.

Table 20-6. Cancer and Noncancer Surrogate Risk Approximations for the New York Monitoring Sites

			2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation	
Pollutant	**Cancer URE ($(\mu g/m^3)^{-1}$)**	**Noncancer RfC (mg/m^3)**			**Cancer (in-a-million)**	**Noncancer (HQ)**			**Cancer (in-a-million)**	**Noncancer (HQ)**
New York City, New York - BXNY										
Benzo(a)pyrene	0.001	--	27/2	NA	NA	NA	57/4	0.16 ± 0.04	0.16	--
Hexavalent Chromium	0.012	0.0001	51/4	0.02 ± 0.01	0.28	<0.01	45/3	0.02 ± <0.01	0.21	<0.01
Naphthalene	3.4E-05	0.003	28/2	NA	NA	NA	60/4	133.76 ± 18.30	4.55	0.04
Rochester, New York - ROCH										
Benzo(a)pyrene	0.001	--	21/2	NA	NA	NA	28/2	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	26/1	NA	NA	NA	13/0	NA	NA	NA
Naphthalene	3.4E-05	0.003	29/2	NA	NA	NA	58/4	29.31 ± 8.23	1.00	0.01
Tonawanda, New York - TONY										
Benzo(a)pyrene	0.001	--	29/2	NA	NA	NA	59/4	0.25 ± 0.07	0.25	--
Naphthalene	3.4E-05	0.003	30/2	NA	NA	NA	61/4	615.92 ± 169.24	20.94	0.21

NA = Not available due to the duration criteria for calculating an annual average.
-- = a Cancer URE or Noncancer RfC is not available.

Observations for New York sites from Table 20-6 include the following:

- BXNY's hexavalent chromium was the only pollutant for which sampling was conducted long enough and where enough quarterly averages were available to meet the criteria for calculating an annual average for 2008.

- Based on BXNY's 2008 annual average hexavalent chromium concentration, the cancer and noncancer surrogate risk approximations are well below the associated levels of concern.

- Annual averages for all pollutants of interest are available for 2009 (except hexavalent chromium and benzo(a)pyrene for ROCH).

- For all three sites, naphthalene was the pollutant with the highest cancer risk approximation, ranging from 1.00 in-a-million for ROCH to 20.94 in-a-million for TONY. The corresponding noncancer risk approximations were all well below an HQ of 1.0.

20.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 20-7 and 20-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 20-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 20-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 20-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New York 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
New York City, New York (Bronx County) - BXNY					
Tetrachloroethylene	304.07	Naphthalene	2.58E-03	Naphthalene	4.55
Benzene	279.60	Benzene	2.18E-03	Hexavalent Chromium	0.28
Dichloromethane	134.46	Hexavalent Chromium, PM	1.91E-03	Hexavalent Chromium	0.21
Formaldehyde	120.05	Tetrachloroethylene	1.79E-03	Benzo(a)pyrene	0.16
1,3-Dichloropropene	108.33	Formaldehyde	1.50E-03		
Naphthalene	75.97	1,3-Butadiene	1.02E-03		
Acetaldehyde	66.70	1,3-Dichloropropene	4.33E-04		
1,3-Butadiene	34.07	Arsenic, PM	3.55E-04		
p-Dichlorobenzene	23.90	*p*-Dichlorobenzene	2.63E-04		
Vinyl chloride	7.73	Nickel, PM	1.94E-04		
Rochester, New York (Monroe County) - ROCH					
Benzene	630.25	Benzene	4.92E-03	Naphthalene	1.00
Dichloromethane	361.37	Naphthalene	2.76E-03		
Formaldehyde	210.83	Formaldehyde	2.64E-03		
Tetrachloroethylene	149.59	1,3-Butadiene	2.30E-03		
Acetaldehyde	96.61	Arsenic, PM	1.89E-03		
Naphthalene	81.28	Hexavalent Chromium, PM	1.62E-03		
1,3-Butadiene	76.62	Tetrachloroethylene	8.83E-04		
1,3-Dichloropropene	59.07	POM, Group 2	3.56E-04		
Trichloroethylene	37.88	Cadmium, PM	3.17E-04		
p-Dichlorobenzene	13.28	Nickel, PM	2.56E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 20-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New York 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Tonawanda, New York (Erie County) - TONY					
Benzene	804.96	Benzene	6.28E-03	Naphthalene	20.94
Formaldehyde	305.32	Coke Oven Emissions, PM	5.57E-03	Benzo(a)pyrene	0.25
Tetrachloroethylene	207.93	Hexavalent Chromium, PM	4.44E-03		
Dichloromethane	156.31	Formaldehyde	3.82E-03		
Acetaldehyde	148.44	Naphthalene	3.35E-03		
1,3-Butadiene	103.88	1,3-Butadiene	3.12E-03		
Naphthalene	98.48	Tetrachloroethylene	1.23E-03		
1,3-Dichloropropene	75.60	POM, Group 2	6.54E-04		
Trichloroethylene	29.81	Arsenic, PM	6.48E-04		
p-Dichlorobenzene	17.24	Acrylonitrile	4.25E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 20-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the New York 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
New York City, New York (Bronx County) - BXNY					
Toluene	824.45	Acrolein	983,985.46	Naphthalene	0.04
Methanol	824.38	Bromomethane	30,060.32	Hexavalent Chromium	<0.01
Xylenes	714.45	Naphthalene	25,323.95	Hexavalent Chromium	<0.01
Hexane	477.06	Nickel, PM	18,642.76		
1,1,1-Trichloroethane	322.27	1,3-Butadiene	17,034.32		
Tetrachloroethylene	304.07	Cyanide Compounds, gas	16,844.67		
Methyl *tert*-butyl ether	284.66	Formaldehyde	12,249.95		
Benzene	279.60	Manganese, PM	10,746.49		
Ethylene glycol	164.83	Benzene	9,320.12		
Bromomethane	150.30	Acetaldehyde	7,410.98		
Rochester, New York (Monroe County) - ROCH					
Toluene	1,818.36	Acrolein	693,043.13	Naphthalene	0.01
Xylenes	1,248.51	1,3-Butadiene	38,310.53		
Methanol	773.87	Hydrochloric acid	36,546.14		
Hydrochloric acid	730.92	Naphthalene	27,092.44		
Hexane	674.48	Nickel, PM	24,588.59		
Benzene	630.25	Formaldehyde	21,513.26		
Methyl isobutyl ketone	523.39	Benzene	21,008.25		
Ethylene glycol	418.74	Bromomethane	16,476.01		
Dichloromethane	361.37	Manganese, PM	14,834.99		
1,1,1-Trichloroethane	307.38	Arsenic, PM	14,630.72		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 20-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the New York 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Tonawanda, New York (Erie County) - TONY					
Toluene	2,347.29	Acrolein	936,272.11	Naphthalene	0.21
Xylenes	1,394.12	1,3-Butadiene	51,941.88		
Hydrochloric acid	861.51	Hydrochloric acid	43,075.63		
Benzene	804.96	Nickel, PM	38,867.25		
Hexane	788.98	Naphthalene	32,825.17		
Methanol	700.54	Formaldehyde	31,155.23		
1,1,1-Trichloroethane	346.48	Manganese, PM	28,074.75		
Methyl isobutyl ketone	334.82	Benzene	26,832.06		
Formaldehyde	305.32	Bromomethane	22,586.07		
Ethylbenzene	276.34	Acetaldehyde	16,492.97		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncaner surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 20.3, all three New York sites sampled PAH; BXNY and ROCH also sampled hexavalent chromium. In addition, the cancer and noncancer risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. Because sampling for PAH did not begin at the New York sites until July 2008, cancer and noncancer risk approximations for 2008 were not calculated.

Observations from Table 20-7 include the following:

- Tetrachloroethylene, benzene, dichloromethane, and formaldehyde were the highest emitted pollutants with cancer UREs in all three New York counties, although not necessarily in that order. The magnitudes of the emissions varied by county.

- Naphthalene, followed closely by benzene, was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Bronx County. Benzene had the highest toxicity-weighted emissions for Monroe County, while naphthalene ranked second highest. Benzene and coke oven emissions had the highest toxicity-weighted emissions for Erie County.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Bronx County; five of the highest emitted pollutants also had the highest toxicity-weighted emissions for Monroe and Erie Counties.

- Naphthalene had the highest cancer risk approximation for all three New York sites (2009), and appeared on both emissions-based lists. Hexavalent chromium, which was the only pollutant with a cancer risk approximation for both years for BXNY, was also the pollutant with the third highest toxicity-weighted emissions for Bronx County.

- Emissions of POM Group 2 ranked among the 10 highest for toxicity emissions for both Monroe and Erie Counties. POM Group 2 includes several PAH sampled for at ROCH and TONY including acenaphthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for ROCH or TONY.

Observations from Table 20-8 include the following:

- Methanol, xylenes, and toluene were the highest emitted pollutants with noncancer RfCs in both Bronx and Monroe Counties, although not necessarily in that order; toluene, xylenes, and hydrochloric acid were the highest emitted pollutants with noncancer RfCs in Erie County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) was acrolein for all three counties.

- Two to three of the highest emitted pollutants in Bronx, Monroe, and Erie Counties were also among the pollutants with the highest toxicity-weighted emissions for each county.

- Naphthalene, which had the highest (albeit low) noncancer risk approximations for all three New York sites (2009), appeared among the pollutants with the highest toxicity-weighted emissions, but was not among the highest emitted pollutants. Hexavalent chromium, which was the only pollutant for which a noncancer risk approximation could be calculated for both years for BXNY, was not on either emissions-based list for Bronx County.

20.6 Summary of the 2008-2009 Monitoring Data for the New York Monitoring Sites

Results from several of the treatments described in this section include the following:

- ❖ *Three pollutants failed screens for BXNY, two failed screens for ROCH, and four failed screens for TONY.*

- ❖ *Of the site-specific pollutants of interest, naphthalene had the highest daily average concentration for each New York site. Further, TONY had the highest concentrations of naphthalene among all NMP sites sampling PAH.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

21.0 Site in Ohio

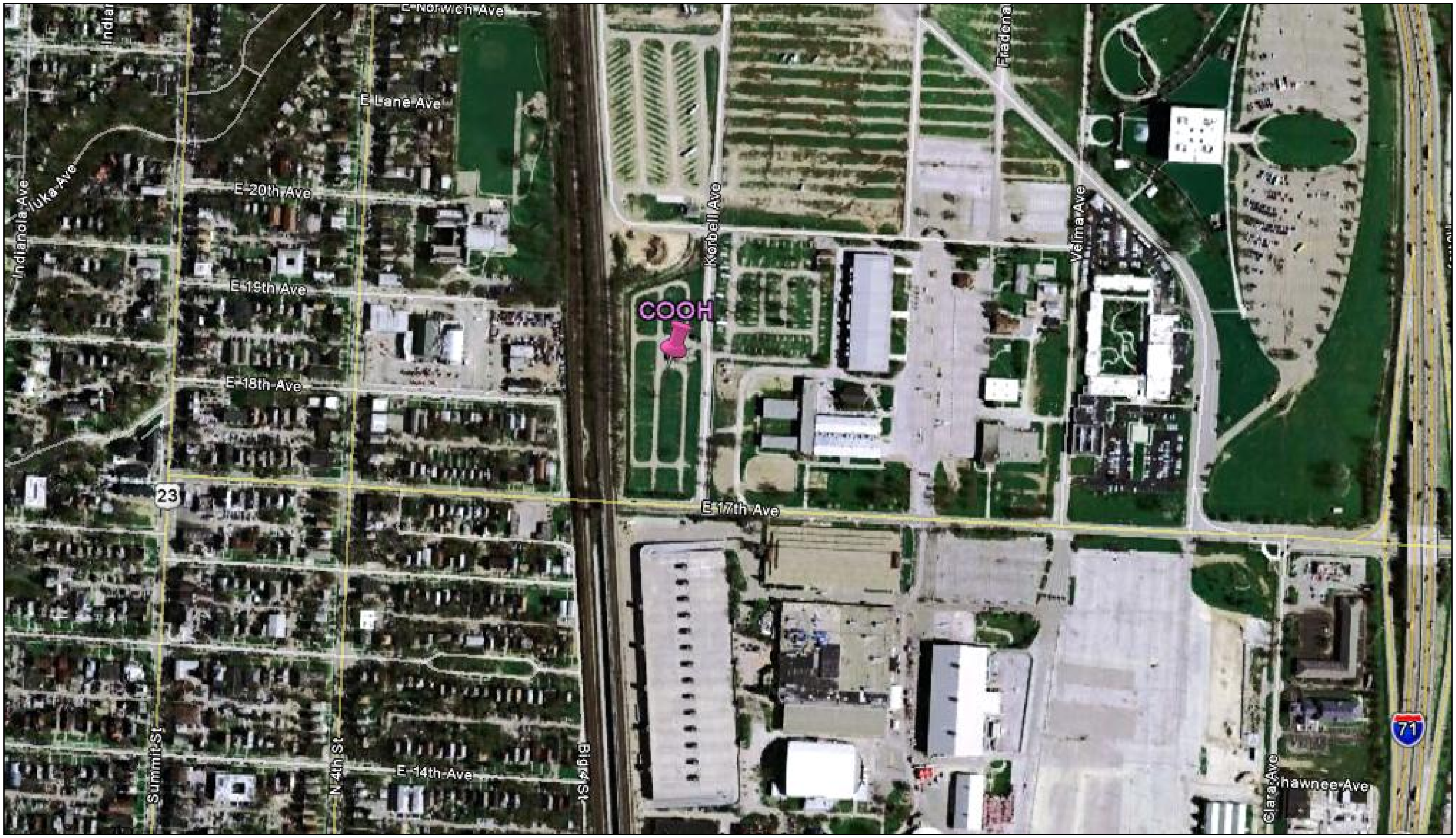
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP site in Ohio, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

21.1 Site Characterization

This section characterizes the COOH monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

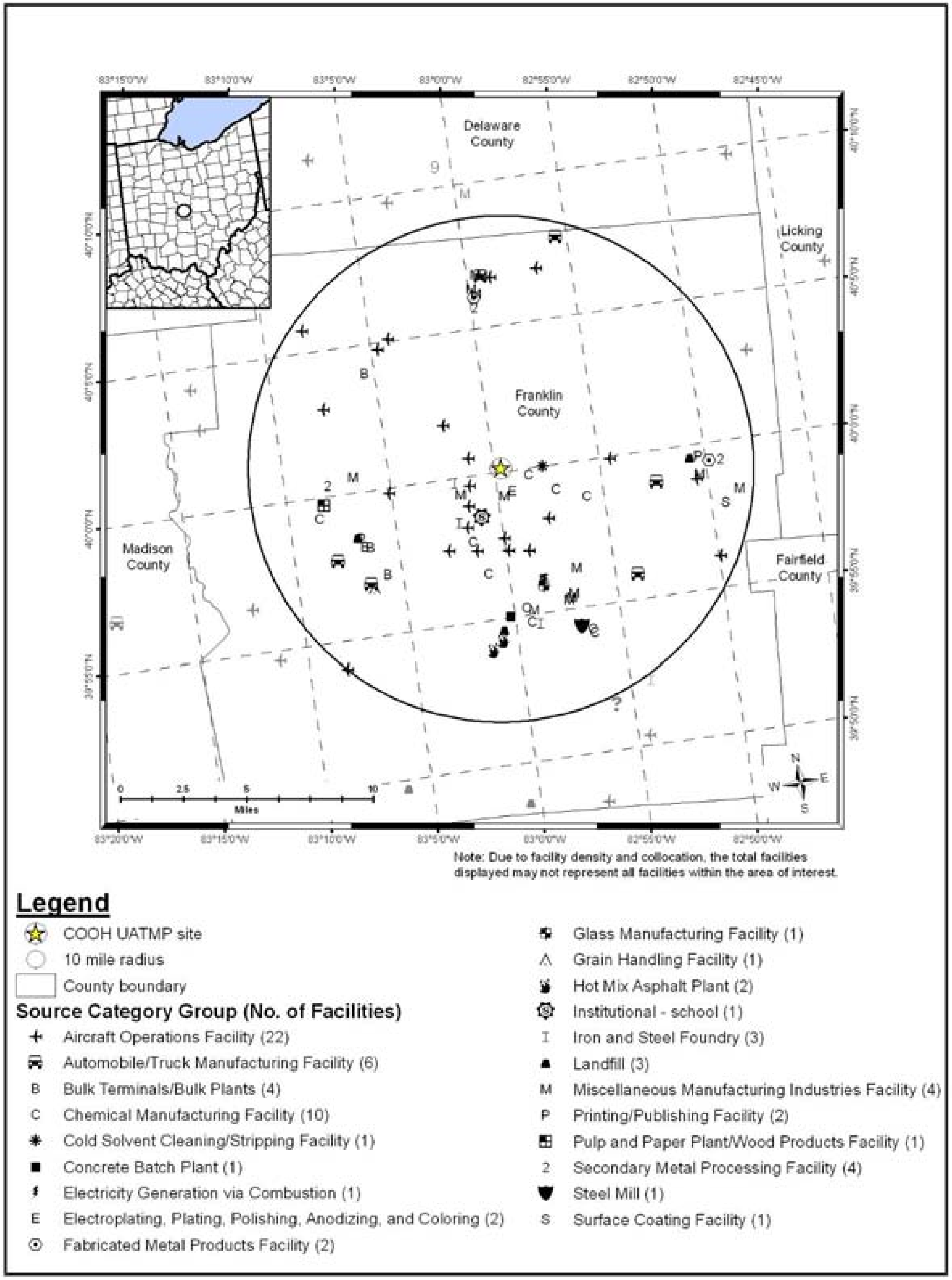
The COOH monitoring site is located in the Columbus, Ohio MSA. Figure 21-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 21-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 21-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 21-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 21-1. Columbus, Ohio (COOH) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,488 feet

Figure 21-2. NEI Point Sources Located Within 10 Miles of COOH


Delaware County
Licking County
Franklin County
Madison County
Fairfield County
0 2.5 5 10
Miles
N
E
S
W
Legend
COOH UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (22)
Automobile/Truck Manufacturing Facility (6)
Bulk Terminals/Bulk Plants (4)
Chemical Manufacturing Facility (10)
Cold Solvent Cleaning/Stripping Facility (1)
Concrete Batch Plant (1)
Electricity Generation via Combustion (1)
Electroplating, Plating, Polishing, Anodizing, and Coloring (2)
Fabricated Metal Products Facility (2)
Glass Manufacturing Facility (1)
Grain Handling Facility (1)
Hot Mix Asphalt Plant (2)
Institutional - school (1)
Iron and Steel Foundry (3)
Landfill (3)
Miscellaneous Manufacturing Industries Facility (4)
Printing/Publishing Facility (2)
Pulp and Paper Plant/Wood Products Facility (1)
Secondary Metal Processing Facility (4)
Steel Mill (1)
Surface Coating Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 21-1. Geographical Information for the Ohio Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
COOH	39-049-0034	Columbus	Franklin	Columbus, OH MSA	40.0025, -82.994444	Commercial	Urban/City Center	Naphthalene, SO_2, VOC, SNMOC, and $PM_{2.5}$.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

COOH sampled for a 1-year period beginning on December 20, 2007 and concluding on December 26, 2008. The COOH monitoring site is located in the capital city of Columbus, in central Ohio. The site is located on the property of the State Fairgrounds, as shown in Figure 21-1. The surrounding area is mixed in usage. Figure 21-1 is divided roughly down the middle by a railroad. The areas to the east of the tracks are commercial and areas to the west are residential. Interstate-71 runs roughly parallel with the railroad, less than 1/2 mile east of the fairgrounds, as shown on the right-hand side of Figure 21-1. As Figure 21-2 shows, COOH is surrounded by a number of point sources, most of which are located within the southern half of the 10-mile radius. The emissions source closest to COOH, which is approximately 1 mile to the southeast, is involved in electroplating, plating, polishing, anodizing, and coloring. The source category with the largest number of sources is the aircraft operations source category group, which includes airports as well as small runways, heliports, or landing pads. Several of these are located within 2 miles of COOH and include a local news affiliate, a hospital, and a meeting center.

Table 21-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Ohio monitoring site. Information provided in Table 21-2 represents the most recent year of sampling (2008), unless otherwise indicated. County-level vehicle registration and population data for Franklin County were obtained from the Ohio Bureau of Motor Vehicles (OH BMV, 2008) and the U.S. Census Bureau (Census Bureau, 2009), respectively. Table 21-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 21-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 21-2 presents the daily VMT for the Columbus urban area.

Table 21-2. Population, Motor Vehicle, and Traffic Information for the Ohio Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
COOH	1,129,067	1,101,479	0.98	939,504	916,548	143,360	30,553

[1] Reference: Census Bureau, 2009.
[2] County-level vehicle registration reflects 2008 data from the Ohio BMV (OH BMV, 2008).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2006 data from the Ohio DOT (OH DOT, 2006).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

Observations from Table 21-2 include the following:

- COOH's county-level and 10-mile populations were in the top third compared to all counties with NMP sites. This is also true for its county-level and 10-mile vehicle ownership.
- The vehicle-per-person ratio was just less than 1.0 and also in the top-third compared to other NMP sites.
- The traffic volume experienced near COOH ranked ninth when compared to other monitoring sites. The traffic estimate used came from I-71 at 17th Avenue.
- The Columbus area VMT was in the middle of the range among urban areas with NMP sites.

21.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Ohio on sample days, as well as over the course of the study period.

21.2.1 Climate Summary

Columbus is located roughly in the center of Ohio, in the heart of the Ohio River Valley. Frontal systems frequently move across the Ohio Valley, providing the area with variable weather conditions. Cool air masses from the northwest often move across the area in winter, while warmer air originating from the Gulf of Mexico is more common in the summer. The metropolitan area tends to be warmer than outlying areas, typical of urban areas. With a rolling topography and four rivers flowing roughly north to south through the city, morning fog associated with air drainage can occur, most often in the summer and fall. Rainfall is fairly evenly distributed throughout the year (Bair, 1992).

21.2.2 Meteorological Conditions during the Study Period

Hourly meteorological data from the NWS weather station nearest this site were retrieved for December 2007 to December 2008 to correspond with the period of sampling (NCDC, 2007 and 2008). The closest NWS weather station is located at Port Columbus International Airport (WBAN 14821). Additional information about this weather station is provided in Table 21-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the study period.

Table 21-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire study period. Also included in Table 21-3 is the 95 percent confidence interval for each parameter. As shown in Table 21-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout the study period.

Table 21-3. Average Meteorological Conditions near the Ohio Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Columbus, Ohio - COOH										
Port Columbus International Airport 14821 (39.99, -82.88)	5.71 miles 90° (E)	Dec 2007-Dec 2008	Sample Day	62.0 ± 4.7	53.0 ± 4.4	39.9 ± 4.1	46.5 ± 3.9	64.0 ± 2.7	1016.8 ± 1.6	7.2 ± 0.9
			All Days	61.6 ± 2.0	52.9 ± 1.9	40.0 ± 1.7	46.5 ± 1.6	64.5 ± 1.1	1016.9 ± 0.7	7.0 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the study period averages.

21.2.3 Back Trajectory Analysis

Figure 21-3 is the composite back trajectory map for days on which samples were collected at the Ohio monitoring site over the sample period from December 2007 to December 2008 (note that 2007 sample day trajectories are shown in orange and 2008 sample day trajectories are shown in blue). Figure 21-4 is the cluster analysis based on back trajectories over the entire sample period. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite map, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For both maps, each concentric circle around the site in Figures 21-3 and 21-4 represents 100 miles.

Observations from Figures 21-3 and 21-4 include the following:

- Back trajectories originated from a variety of directions at COOH.
- The 24-hour air shed domain for COOH was comparable in size to other NMP monitoring sites. The farthest away a back trajectory originated was central Iowa, or nearly 600 miles away. However, the average trajectory length was 240 miles and most trajectories originated within 400 miles of the site.
- The cluster analysis shows that more than one-half of back trajectories originated from the southeast, south, and southwest of the site. This trajectory also includes a few trajectories originating from other directions but a relatively short distance from the site (recall that distance, as well as direction, is factored into the clusters). Another 27 percent of trajectories originated from the southwest to northwest of the site, and just over 20 percent originated from the northwest to northeast.

Figure 21-3. 2007-2008 Composite Back Trajectory Map for COOH

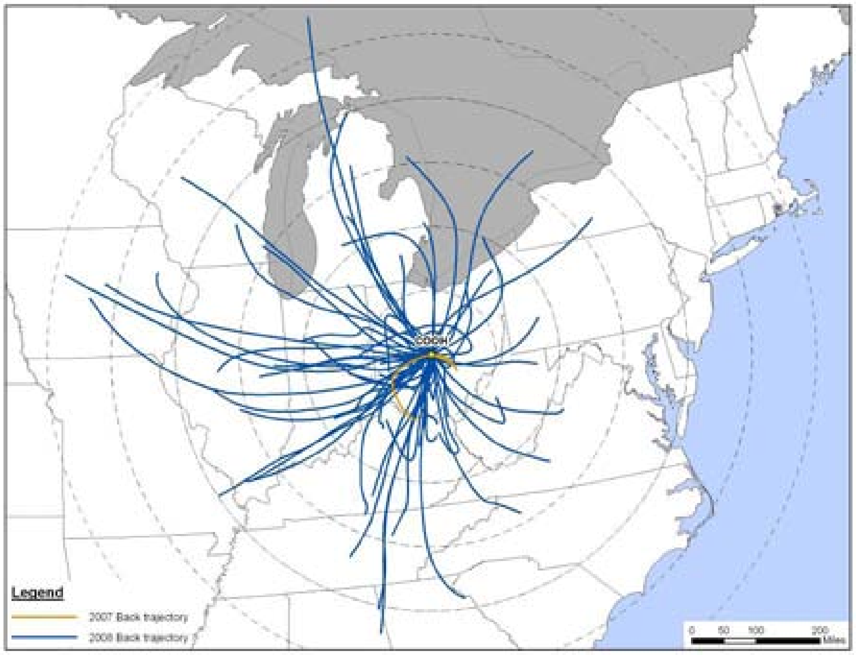
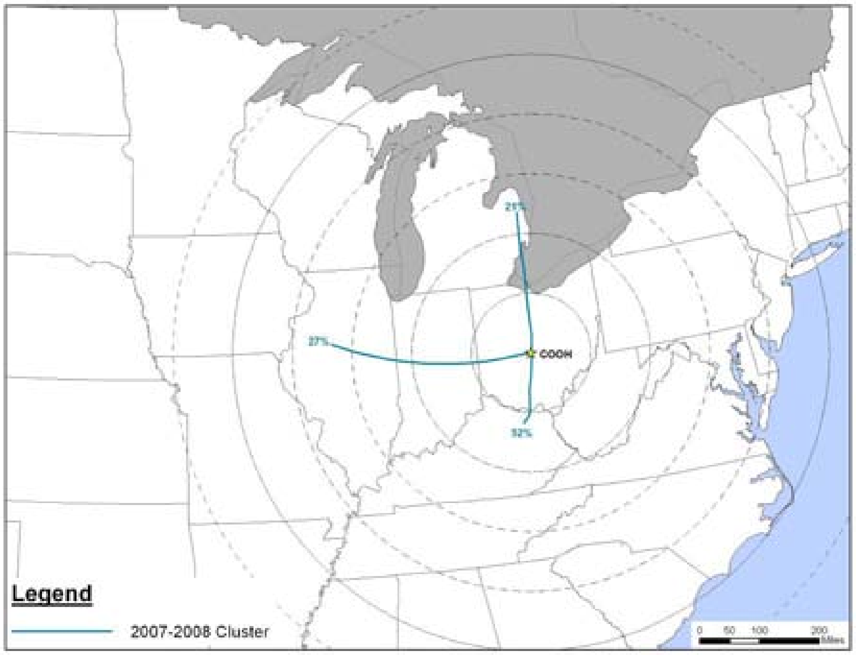


Figure 21-4. Back Trajectory Cluster Map for COOH



21.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at Port Columbus International Airport near COOH were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

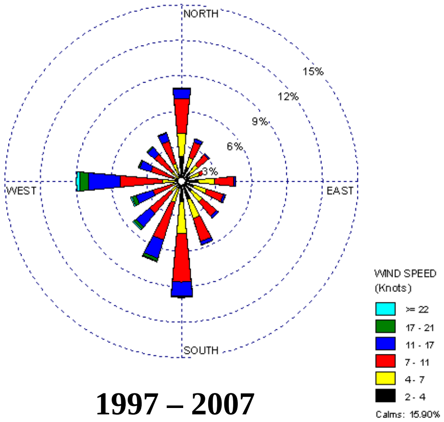
Figure 21-5 presents three different wind roses for the Ohio monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose representing wind observations for the entire December 2007 to December 2008 study period is presented. Finally, a wind rose representing the days on which samples were collected is presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire study period.

Observations from Figure 21-5 for COOH include the following:

- The historical wind rose shows that southerly, westerly and northerly winds were the most frequently observed wind directions near COOH. Calm winds (≤2 knots) were observed for approximately 15 percent of the hourly wind measurements. The strongest winds often had a westerly component.

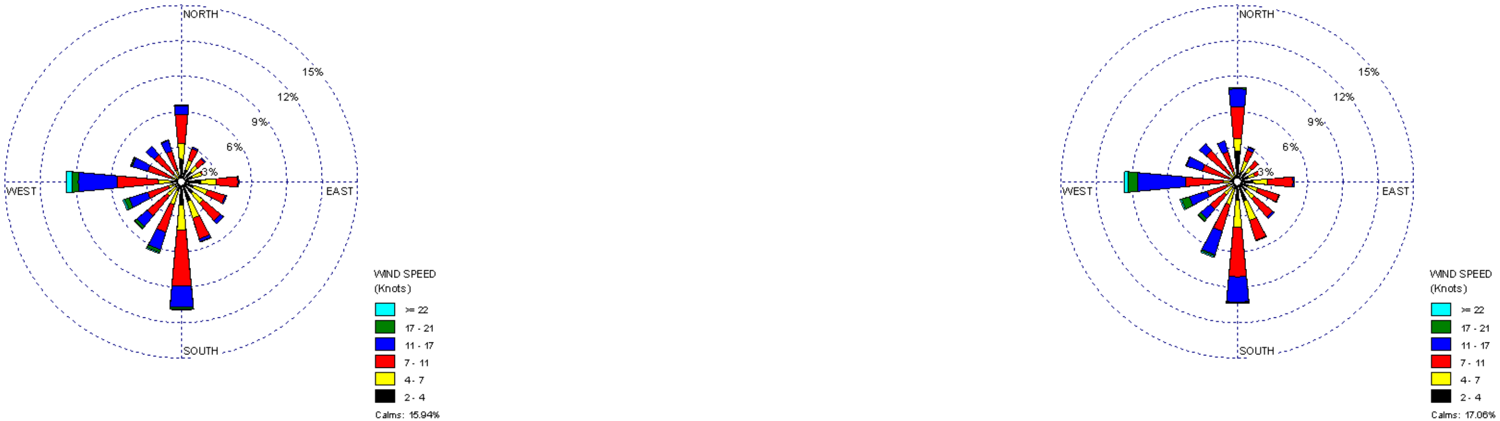
- The wind patterns shown on the study period wind rose resemble those on the historical wind rose, as do the wind patterns on the sample day wind rose, indicating conditions on sample days were similar to conditions experienced during the entire study period and historically.

Figure 21-5. Wind Roses for the Port Columbus International Airport Weather Station near COOH



1997 – 2007

Historical Wind Rose



Sample Period

Wind Rose

Sample Day

Wind Rose

21.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the COOH monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 21-4 presents COOH’s pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the COOH monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. COOH sampled for carbonyl compounds only.

Table 21-4. Risk Screening Results for the Ohio Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Columbus, Ohio - COOH						
Acetaldehyde	0.45	64	64	100.00	48.85	48.85
Formaldehyde	0.077	64	64	100.00	48.85	97.71
Propionaldehyde	0.8	3	64	4.69	2.29	100.00
Total		131	192	68.23		

Observations from Table 21-4 include the following:

- Acetaldehyde, formaldehyde, and propionaldehyde are the only carbonyl compounds with screening values and all three failed at least one screen for COOH.
- Acetaldehyde and formaldehyde contributed equally to COOH’s total failed screens and each failed 100 percent of their screens. Conversely, propionaldehyde failed only three screens out of 64 (roughly five percent).
- The risk screening process identified acetaldehyde and formaldehyde as pollutants of interest for COOH.

21.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Ohio monitoring site. Concentration averages are provided for the pollutants of interest for the COOH monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

21.4.1 2007-2008 Concentration Averages

Daily, quarterly, and study concentration averages were calculated for the pollutants of interest for COOH, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, in lieu of an annual average, the *study* average for a pollutant includes all measured detections and substituted zeros for non-detects over the period of sampling. Study averages were calculated for monitoring sites that sampled for a 1-year period that overlapped years, provided that at least three valid quarterly averages could be calculated and method completeness was greater than or equal to 85 percent. The study averages for COOH represent the sample period from December 2007 to December 2008. Daily, quarterly, and study averages are presented in Table 21-5, where applicable.

Table 21-5. Daily, Quarterly, and Study Average Concentrations of the Pollutants of Interest for the Ohio Monitoring Site

Pollutant	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Study Average (µg/m^3)
Columbus, Ohio - COOH						
Acetaldehyde	2.53 ± 0.42	3.50 ± 1.07	2.02 ± 0.59	2.51 ± 0.70	1.92 ± 0.75	2.53 ± 0.42
Formaldehyde	2.92 ± 0.32	2.50 ± 0.46	3.07 ± 0.66	3.87 ± 0.73	2.34 ± 0.54	2.92 ± 0.32

Observations for COOH from Table 21-5 include the following:

- The daily average concentration of formaldehyde and acetaldehyde are similar in magnitude to each other.
- The daily and annual averages are the same for each pollutant because these pollutants were detected in every sample collected at COOH.
- The first quarter 2008 acetaldehyde average is higher than the other quarterly averages and has a relatively large confidence interval, indicating that this average may be influenced by outliers. The two highest concentrations of acetaldehyde were measured on December 20, 2007 and December 26, 2007, which were the first two days of sampling at this site. The concentration measured on December 20, 2007 was the fifth highest acetaldehyde concentration measured among NMP sites sampling this pollutant.
- The daily average acetaldehyde concentration for COOH was the tenth highest compared to other NMP sites. Conversely, COOH's daily average formaldehyde concentration ranked 22nd.

21.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. COOH has not sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

21.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the COOH monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

21.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Ohio monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the study averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Ohio monitoring site were higher than their respective MRL noncancer health risk benchmarks.

21.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Ohio monitoring site and where *study average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for study averages and how cancer and noncancer surrogate risk approximations are calculated). Study averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 21-6, where applicable.

Table 21-6. Cancer and Noncancer Surrogate Risk Approximations for the Ohio Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections	# of Valid Quarterly Averages	Study Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Columbus, Ohio - COOH							
Acetaldehyde	0.0000022	0.009	64	4	2.53 ± 0.42	5.56	0.28
Formaldehyde	0.000013	0.0098	64	4	2.92 ± 0.32	37.90	0.30

Observations for COOH from Table 21-6 include the following:

- Of the two carbonyl compound pollutants of interest, the cancer risk approximation for formaldehyde (37.90 in-a-million) was an order of magnitude higher than the cancer risk approximation for acetaldehyde (5.56 in-a-million).
- Neither pollutant had a noncancer surrogate risk approximation greater than the level of concern (an HQ greater than or equal to 1.0).

21.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 21-7 and 21-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 21-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the

10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the study averages. Table 21-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from study averages.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on COOH's study averages are limited to those pollutants for which the site sampled. As discussed in Section 21.3, COOH sampled for carbonyl compounds only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for study averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 21-7 include the following:

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in Franklin County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, hexavalent chromium, and formaldehyde.
- Seven the highest emitted pollutants also have the highest toxicity-weighted emissions for Franklin County.
- Formaldehyde, which was the pollutant with a highest cancer risk approximation for COOH, appears on both emissions-based lists. While acetaldehyde was one of the highest emitted pollutants, it did not have one of the 10 highest toxicity-weighted emissions.

Table 21-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Ohio Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Columbus, Ohio (Franklin County) - COOH					
Benzene	653.22	Benzene	5.10E-03	Formaldehyde	37.90
Formaldehyde	298.73	Hexavalent Chromium, PM	4.39E-03	Acetaldehyde	5.56
Tetrachloroethylene	178.33	Formaldehyde	3.73E-03		
Dichloromethane	145.14	1,3-Butadiene	2.48E-03		
Acetaldehyde	143.63	Naphthalene	1.98E-03		
1,3-Dichloropropene	86.95	Tetrachloroethylene	1.05E-03		
1,3-Butadiene	82.73	Ethylene oxide	8.12E-04		
Naphthalene	58.32	Arsenic, PM	3.58E-04		
Trichloroethylene	15.85	1,3-Dichloropropene	3.48E-04		
Ethylene oxide	9.23	POM, Group 2	3.40E-04		

[1] These cancer risk approximations are based on the study averages.

Table 21-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Ohio Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Columbus, Ohio (Franklin County) - COOH					
Toluene	2,691.52	Acrolein	873,996.75	Formaldehyde	0.30
Xylenes	1,826.70	1,3-Butadiene	41,364.62	Acetaldehyde	0.28
Methanol	733.47	Formaldehyde	30,482.90		
Benzene	653.22	Manganese, PM	28,800.88		
1,1,1-Trichloroethane	421.23	Nickel, PM	22,400.46		
Ethylbenzene	376.78	Benzene	21,773.89		
Hexane	370.11	Naphthalene	19,438.74		
Methyl isobutyl ketone	350.11	Xylenes	18,266.98		
Formaldehyde	298.73	Acetaldehyde	15,959.09		
Ethylene glycol	227.20	Chlorine	10,018.76		

[1] These noncancer risk approximations are based on the study averages.

Observations from Table 21-8 include the following:

- Toluene, xylenes, and methanol were the highest emitted pollutants with noncancer RfCs in Franklin County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.

- Three of the highest emitted pollutants (benzene, xylenes, and formaldehyde) in Franklin County also have the highest toxicity-weighted emissions.

- Formaldehyde, which had the highest noncancer risk approximation (albeit low), appears on both emissions-based lists. While acetaldehyde had one of the 10 highest toxicity-weighted emissions, it was not one of the highest emitted pollutants with noncancer RfCs.

21.6 Summary of the 2007-2008 Monitoring Data for COOH

Results from several of the treatments described in this section include the following:

- ❖ *Acetaldehyde, formaldehyde, and propionaldehyde failed screens for COOH.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or study average concentrations of the pollutants of interest were higher than any of their associated MRL noncancer health risk benchmarks.*

22.0 Sites in Oklahoma

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in Oklahoma, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

22.1 Site Characterization

This section characterizes the Oklahoma monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

Three Oklahoma sites (TOOK, TSOK, and TUOK) are located in the Tulsa, OK MSA. Another site, CNEP, is located south of Pryor Creek, Oklahoma and within the boundaries of the Cherokee Nation. The TSOK site moved from Tulsa to Pryor Creek in mid-2008, and was renamed PROK. The TUOK site moved to a new Tulsa location in April 2009 and was renamed TMOK. The data from each of these sites are viewed separately and examined individually. There are also two sites in the Oklahoma City, OK MSA that began sampling in May 2009. One site is located in Oklahoma City (OCOK) and another is located just outside Oklahoma City in Midwest City (MWOK).

Figures 22-1 through 22-8 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban and rural locations. Figures 22-9 through 22-11 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of each site are included in the facility counts provided below the maps in Figures 22-9 through 22-11. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 22-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

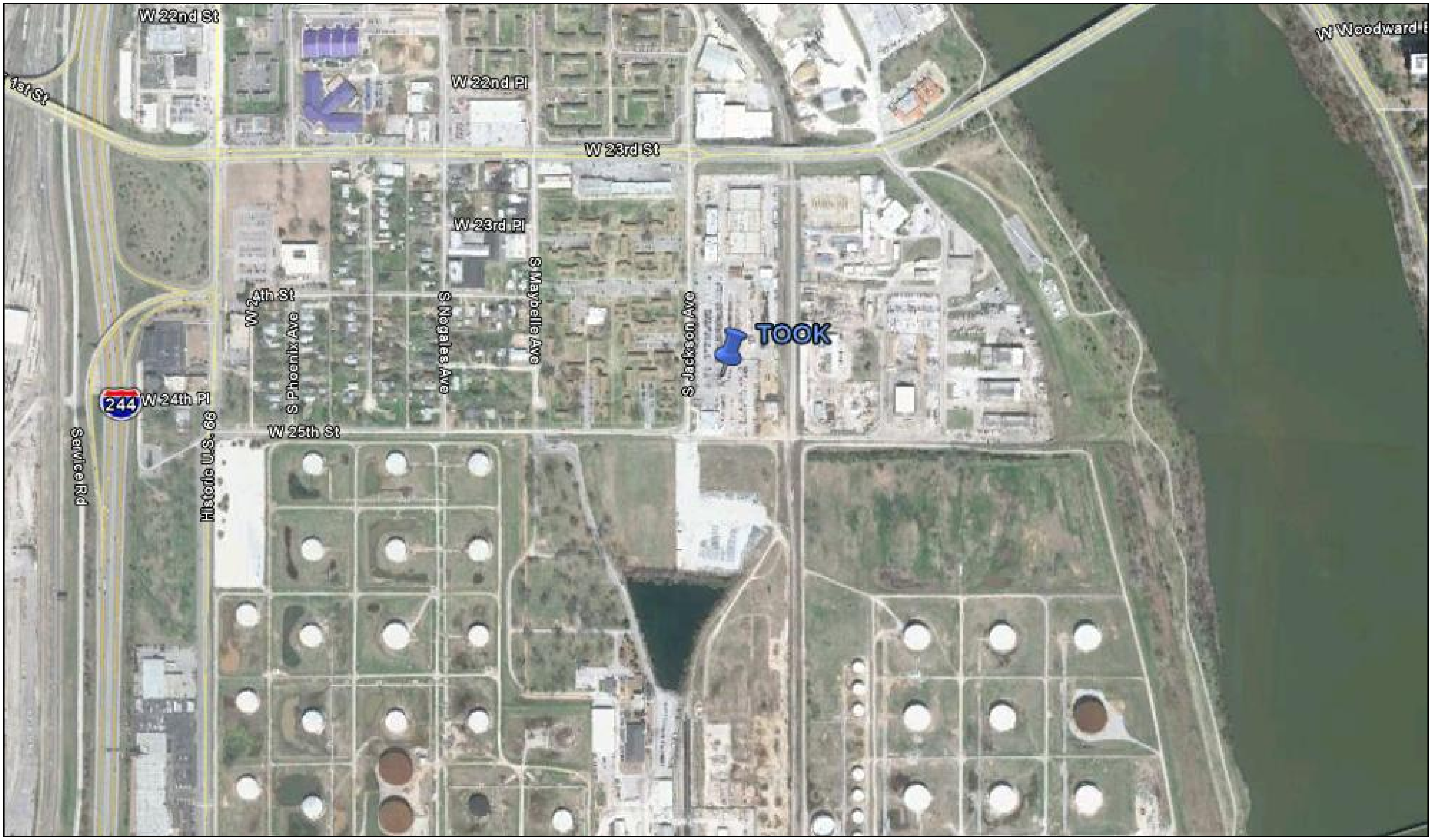
TOOK is located in West Tulsa, on the southwest side of the Arkansas River. The site is located in the parking lot of the Public Works building. The surrounding area is primarily industrial. As shown in Figure 22-1, an oil refinery is located just south of the site. Another refinery is located to the northwest of the site. The monitoring site is positioned between the Arkansas River and I-244, which runs parallel to Southwest Boulevard. A rail yard is located on the opposite side of I-244.

TSOK is located in central Tulsa, north of Exit 6 on I-244 and west of US-75. The site is located on the property of Oklahoma State University's Tulsa campus, as shown in Figure 22-2. B.S. Roberts Park is located to the north of the site and a railroad switching station is located close the monitoring site. Much of the surrounding area is residential, although downtown Tulsa is just on the other side of I-244.

TUOK is located just on the other side of the Arkansas River from TOOK, south of downtown Tulsa. The site is located just 50 feet south of the US-64/US-75/Highway 51 interchange, as shown in Figure 22-3. Although commercial areas are located immediately to the west, the surrounding areas are primarily residential.

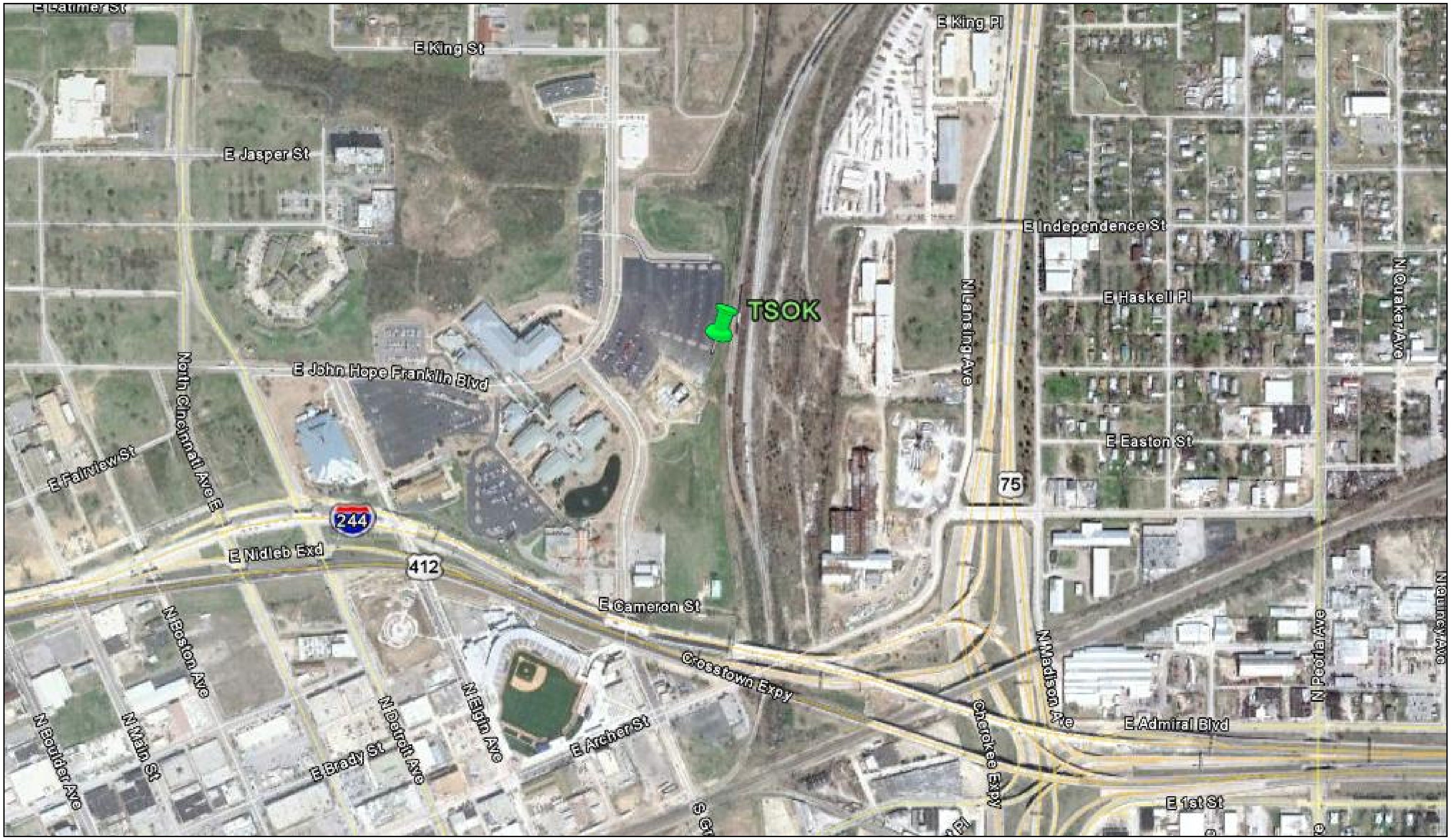
The monitoring instruments at TUOK were moved to the TMOK location at the end of March 2009. TMOK is located in north Tulsa on the property of Fire Station Number 24. As shown in Figure 22-4, the intersection of Peoria Avenue (Highway 11) and East 36th Street North lies just to the northeast of the site. The surrounding areas are primarily residential, with heavily wooded areas to the east.

Figure 22-1. Tulsa, Oklahoma (TOOK) Monitoring Site



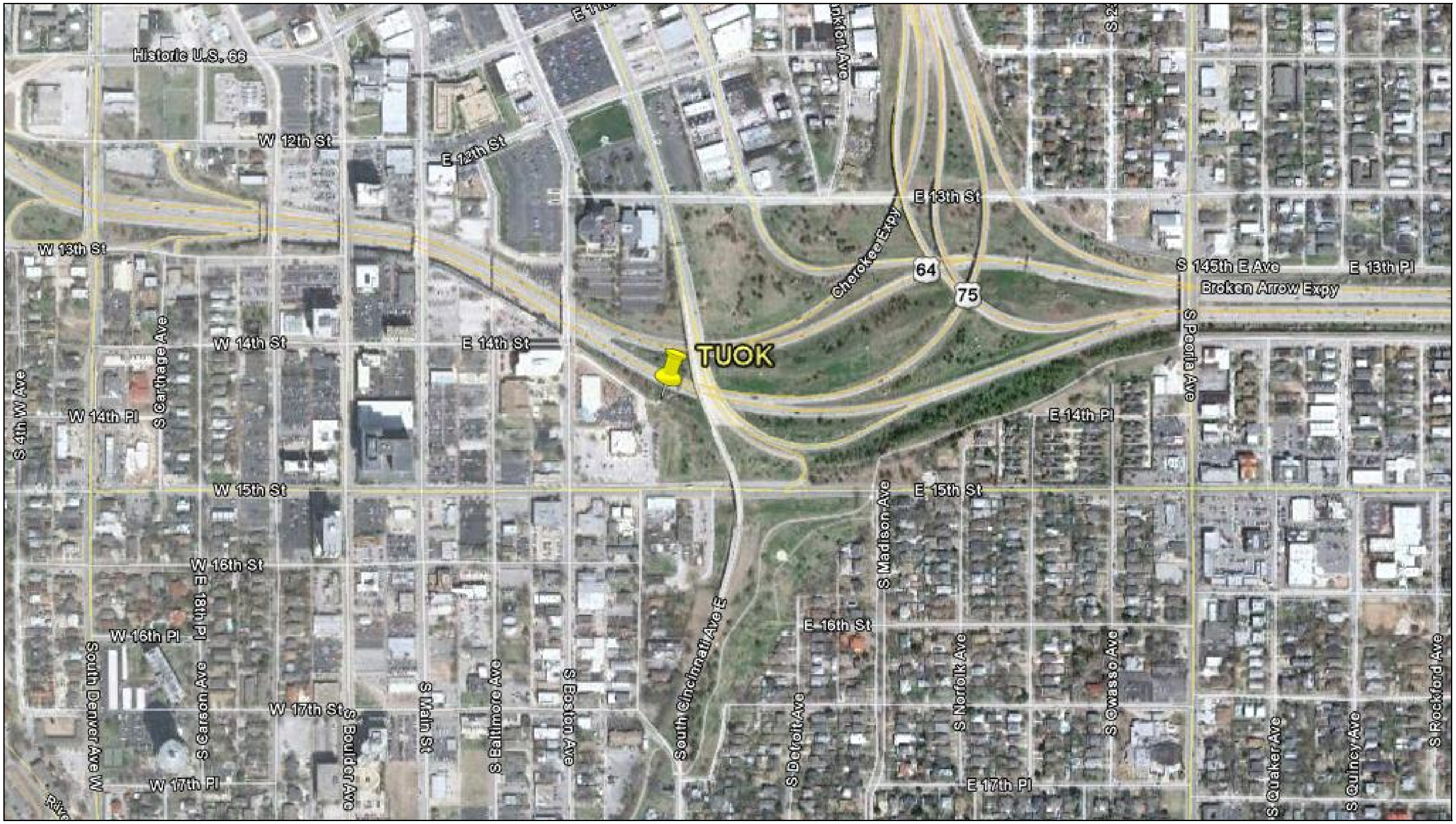
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,853 feet

Figure 22-2. Tulsa, Oklahoma (TSOK) Monitoring Site



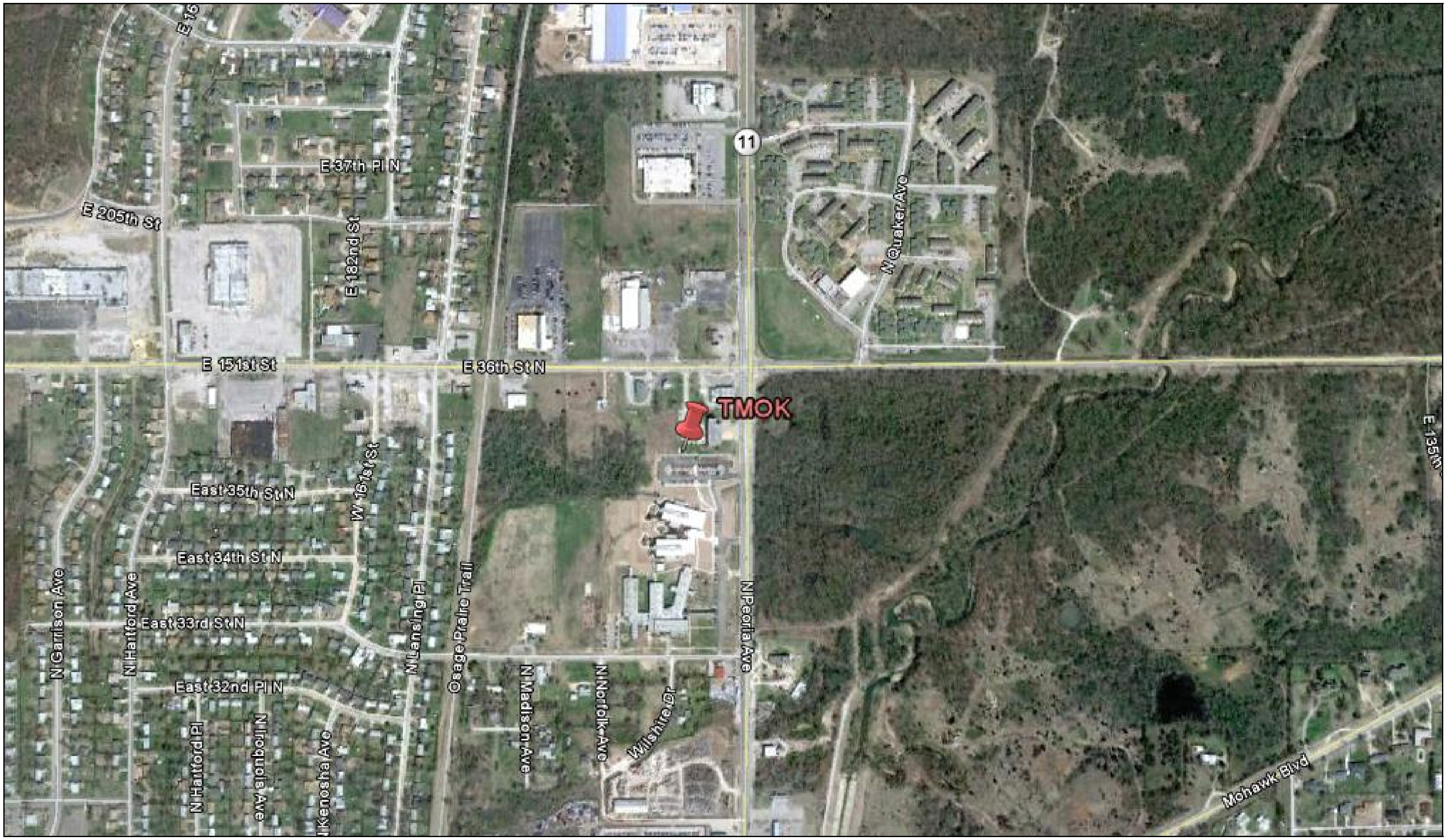
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,858 feet

Figure 22-3. Tulsa, Oklahoma (TUOK) Monitoring Site



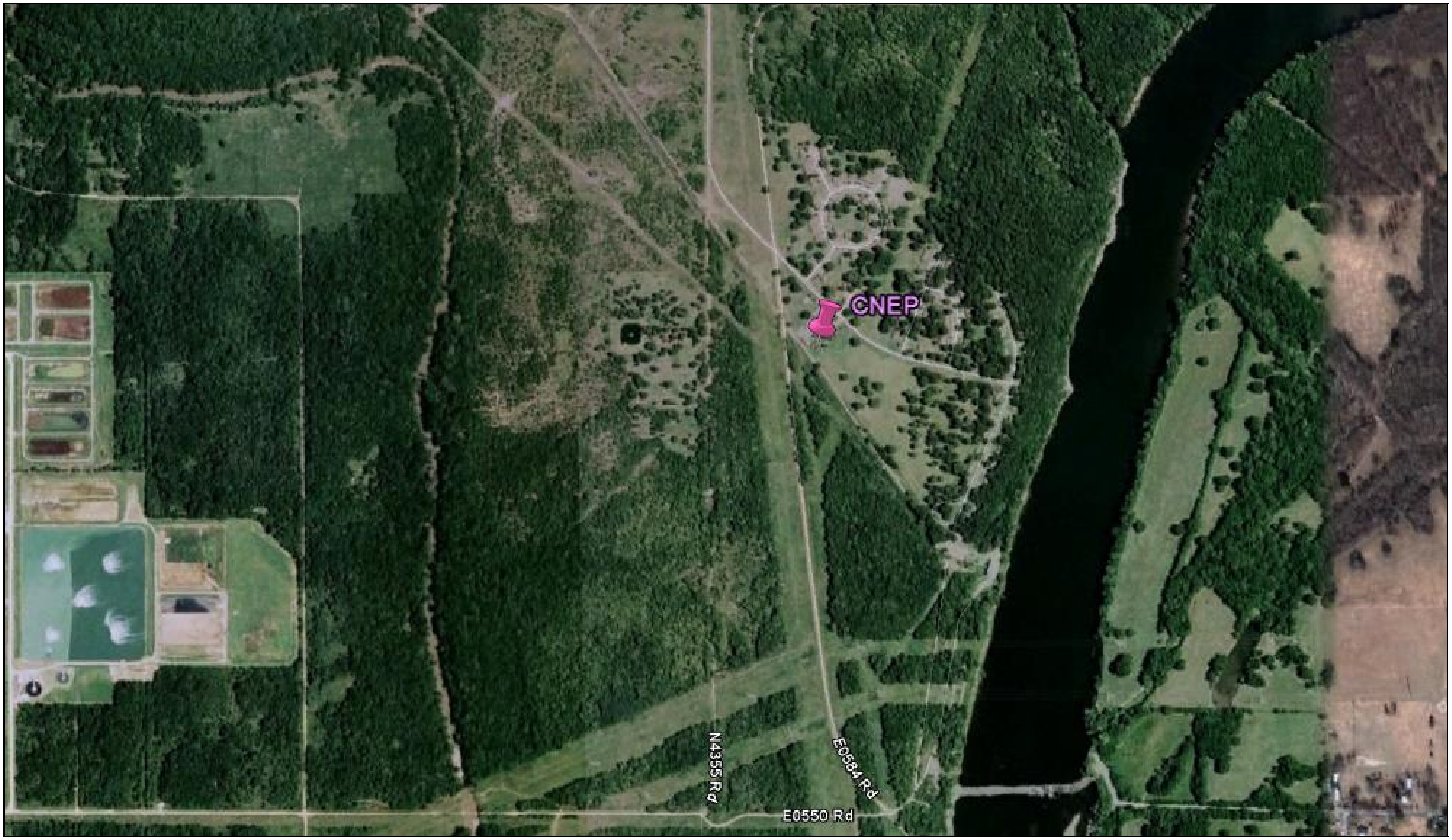
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,800 feet

Figure 22-4. Tulsa, Oklahoma (TMOK) Monitoring Site



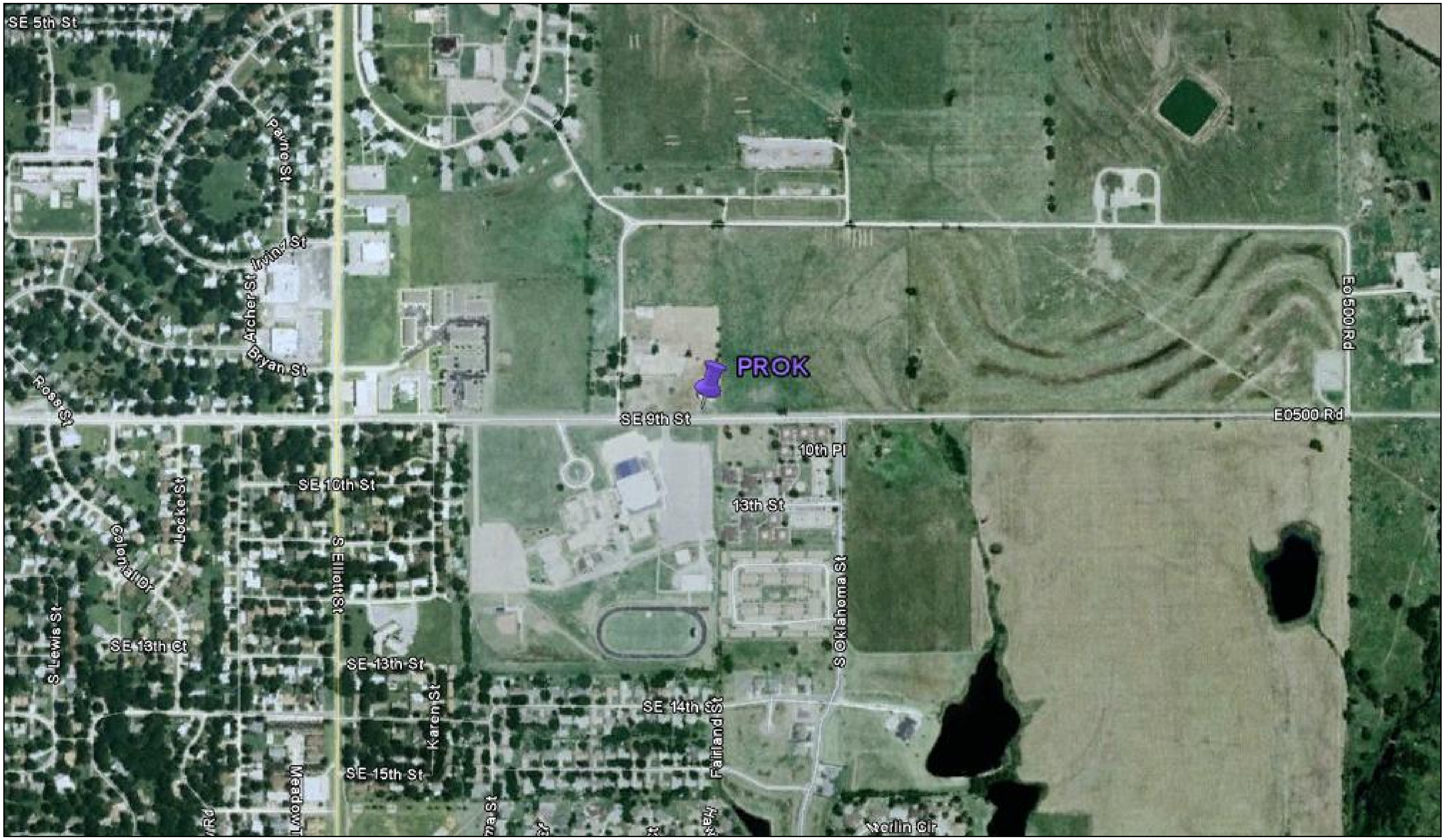
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,794 feet

Figure 22-5. Cherokee Heights, Pryor Creek, Oklahoma (CNEP) Monitoring Site



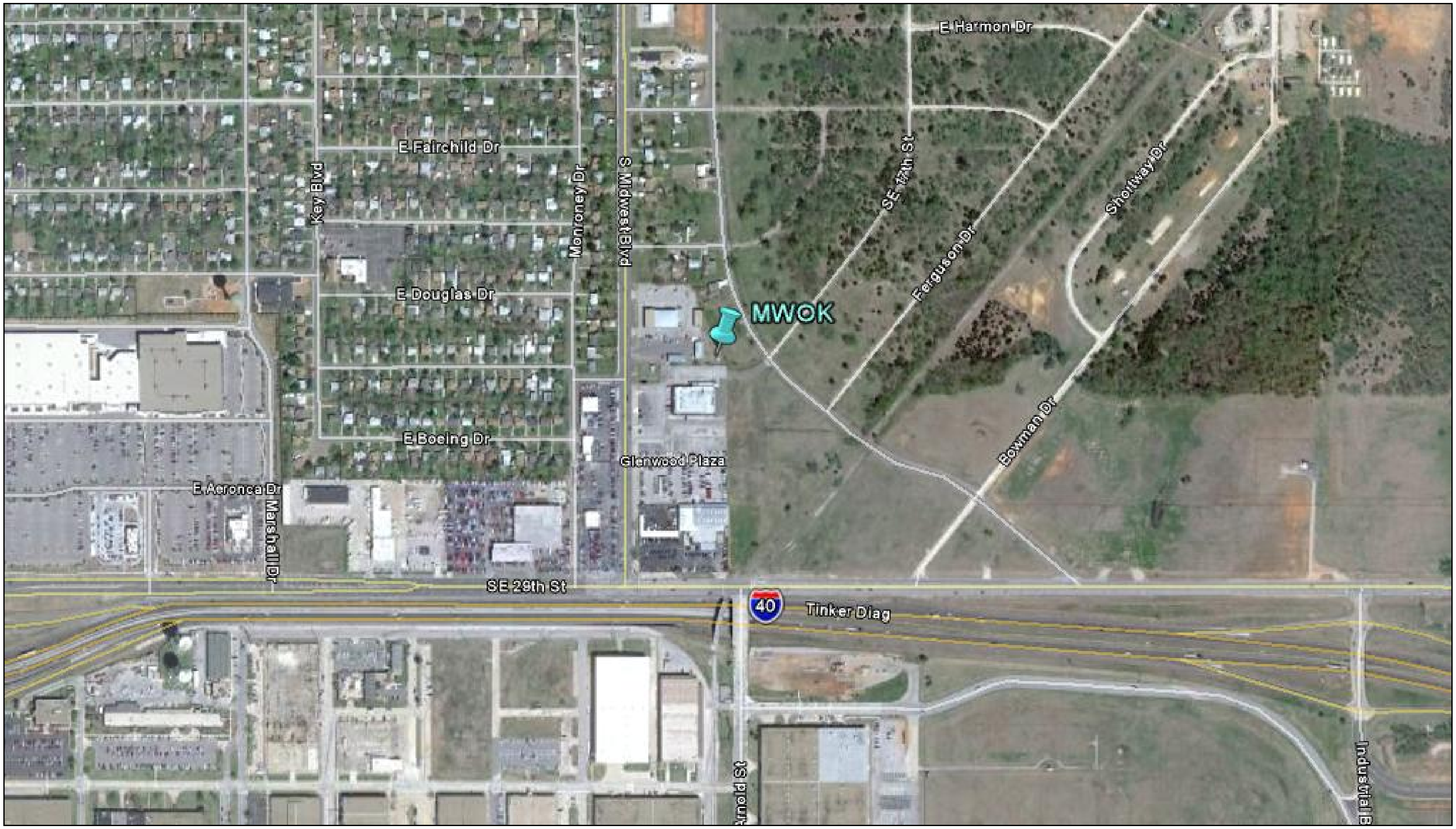
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,605 feet

Figure 22-6. Pryor Creek, Oklahoma (PROK) Monitoring Site



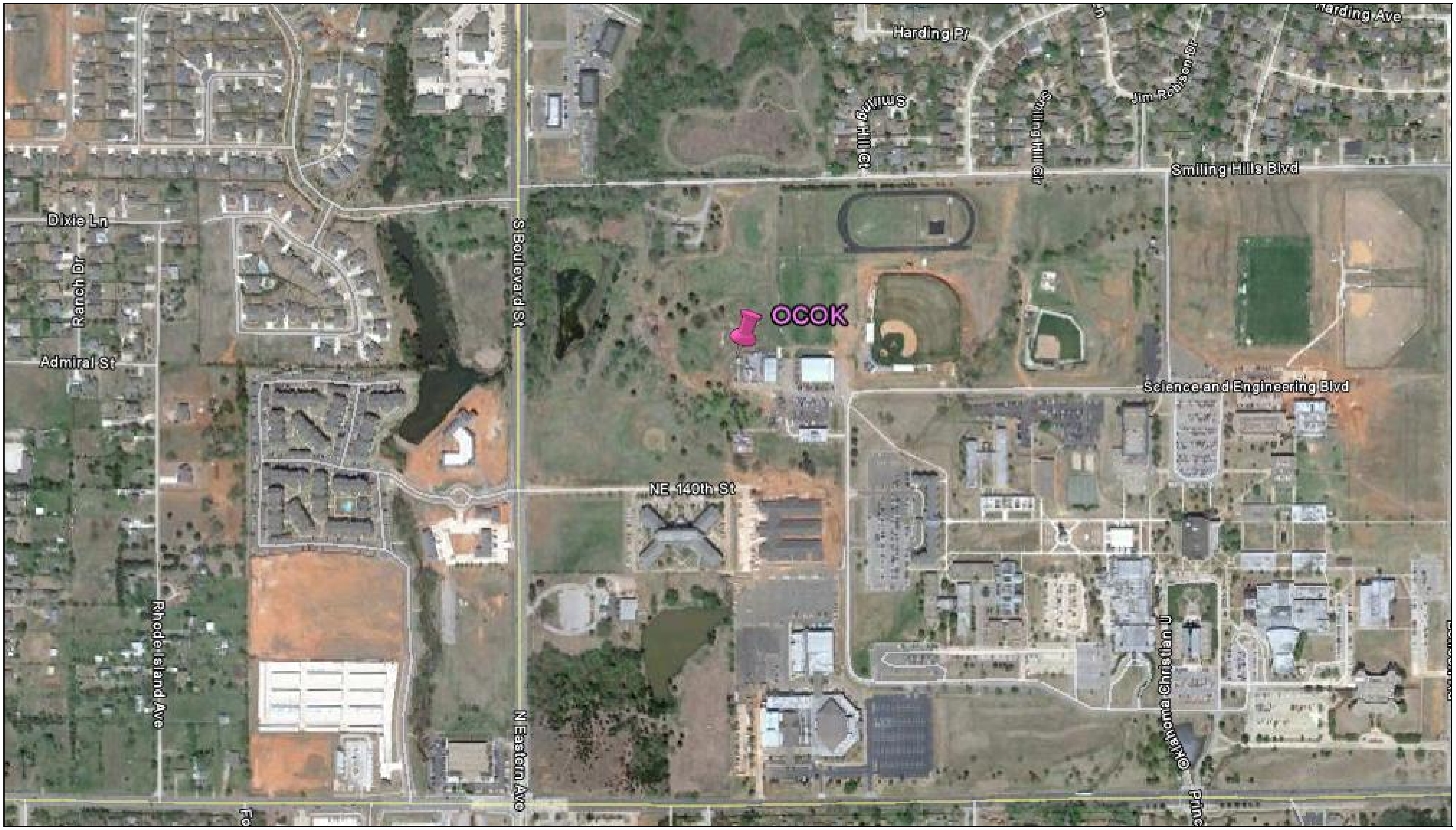
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,058 feet

Figure 22-7. Midwest City, Oklahoma (MWOK) Monitoring Site



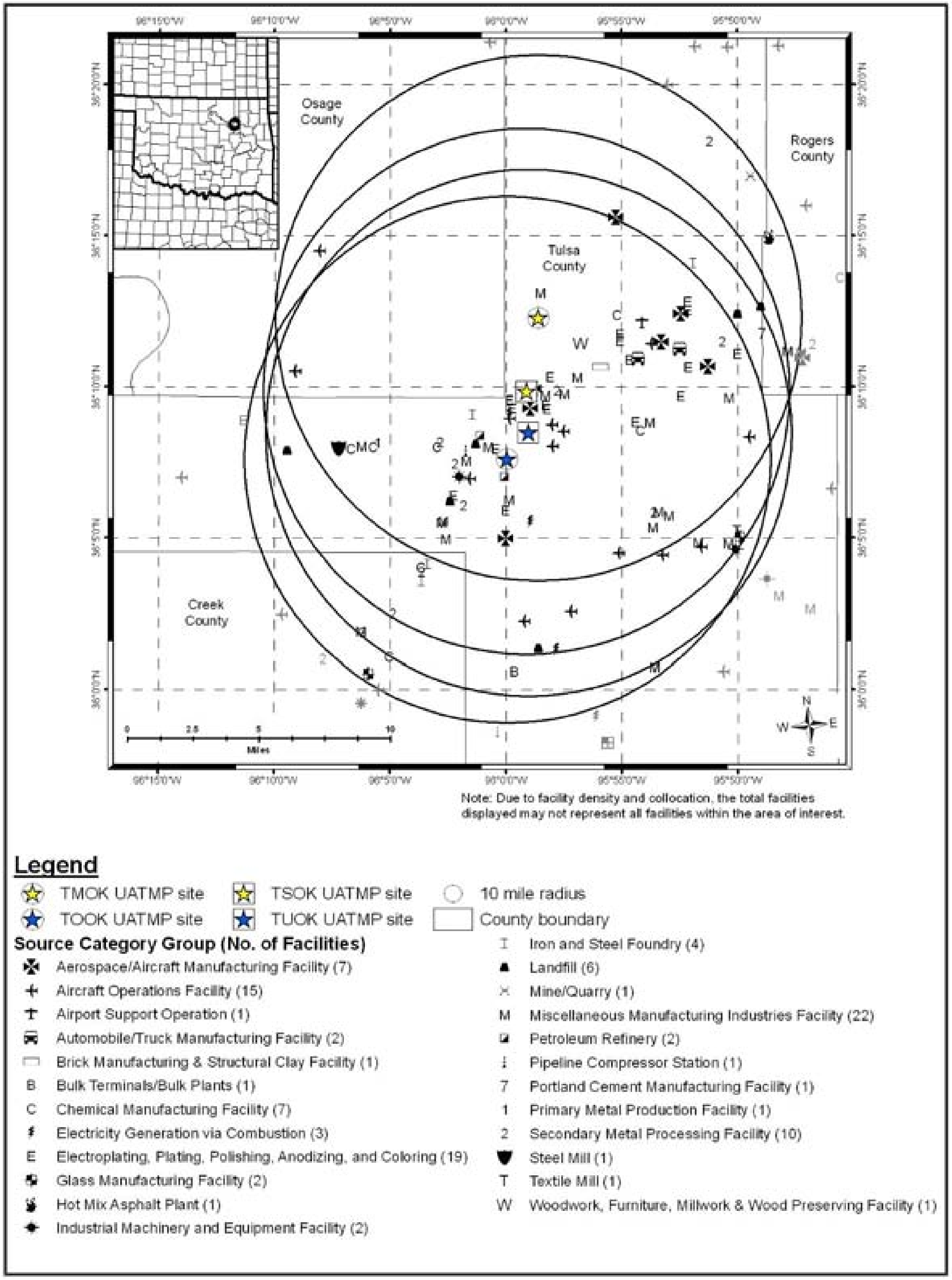
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,511 feet

Figure 22-8. Oklahoma City, Oklahoma (OCOK) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,706 feet

Figure 22-9. NEI Point Sources Located Within 10 Miles of TMOK, TOOK, TSOK and TUOK


96°15'0"W
96°10'0"W
96°5'0"W
96°0'0"W
95°55'0"W
95°50'0"W
36°20'0"N
36°15'0"N
36°10'0"N
36°5'0"N
36°0'0"N
Osage County
Rogers County
Tulsa County
Creek County
0
2.5
5
10
Miles
N
S
E
W
Legend
TMOK UATMP site
TSOK UATMP site
10 mile radius
TOOK UATMP site
TUOK UATMP site
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (7)
Aircraft Operations Facility (15)
Airport Support Operation (1)
Automobile/Truck Manufacturing Facility (2)
Brick Manufacturing & Structural Clay Facility (1)
B Bulk Terminals/Bulk Plants (1)
C Chemical Manufacturing Facility (7)
Electricity Generation via Combustion (3)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (19)
Glass Manufacturing Facility (2)
Hot Mix Asphalt Plant (1)
Industrial Machinery and Equipment Facility (2)
I Iron and Steel Foundry (4)
Landfill (6)
Mine/Quarry (1)
M Miscellaneous Manufacturing Industries Facility (22)
Petroleum Refinery (2)
Pipeline Compressor Station (1)
7 Portland Cement Manufacturing Facility (1)
1 Primary Metal Production Facility (1)
2 Secondary Metal Processing Facility (10)
Steel Mill (1)
T Textile Mill (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 22-10. NEI Point Sources Located Within 10 Miles of CNEP and PROK

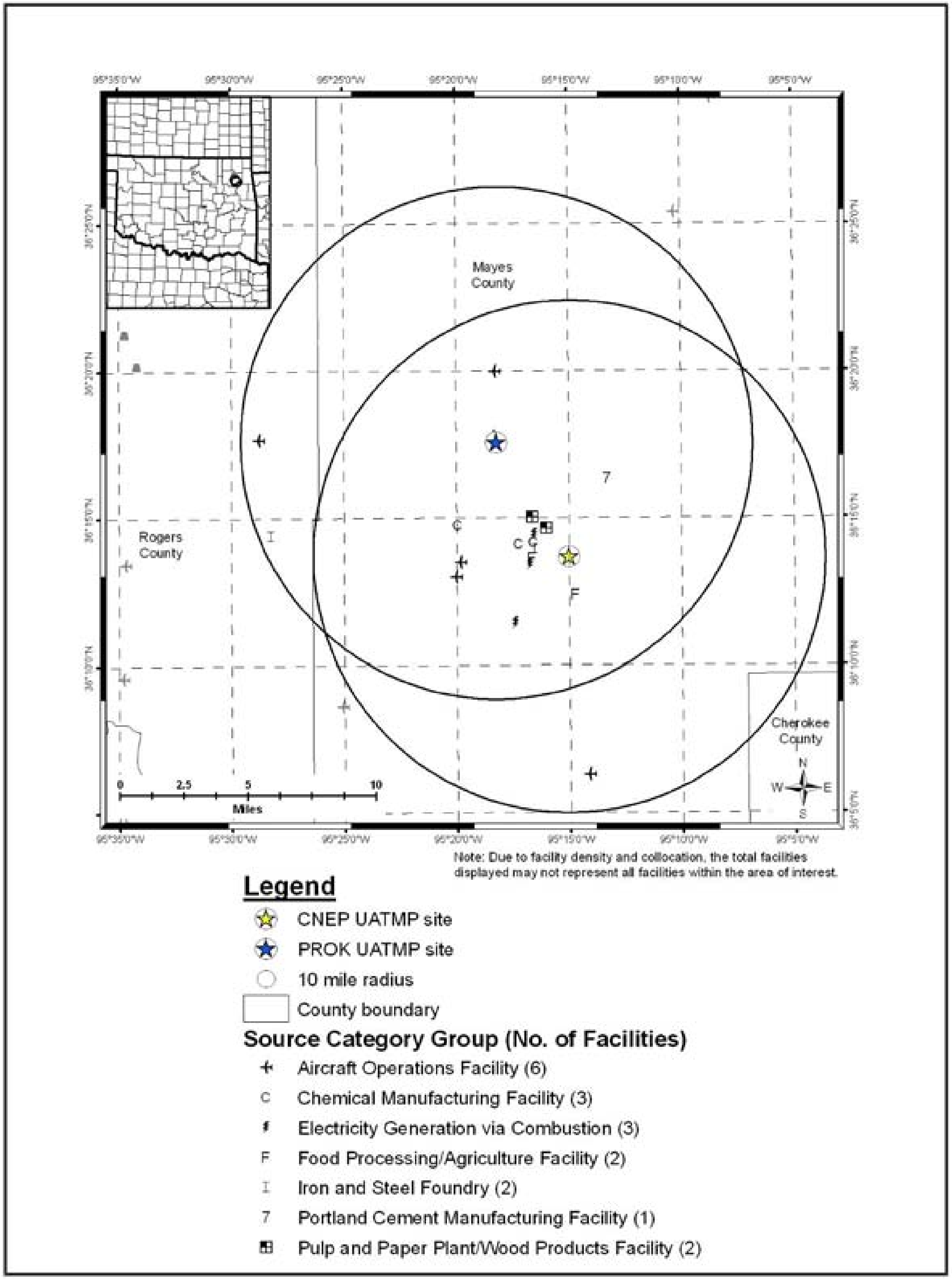

95°35'0"W
95°30'0"W
95°25'0"W
95°20'0"W
95°15'0"W
95°10'0"W
95°5'0"W
36°25'0"N
36°20'0"N
36°15'0"N
36°10'0"N
36°5'0"N
Mayes County
Rogers County
Cherokee County
N
S
E
W
0
2.5
5
10
Miles
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
CNEP UATMP site
PROK UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (6)
Chemical Manufacturing Facility (3)
Electricity Generation via Combustion (3)
Food Processing/Agriculture Facility (2)
Iron and Steel Foundry (2)
Portland Cement Manufacturing Facility (1)
Pulp and Paper Plant/Wood Products Facility (2)

Figure 22-11. NEI Point Sources Located Within 10 Miles of MWOK and OCOK

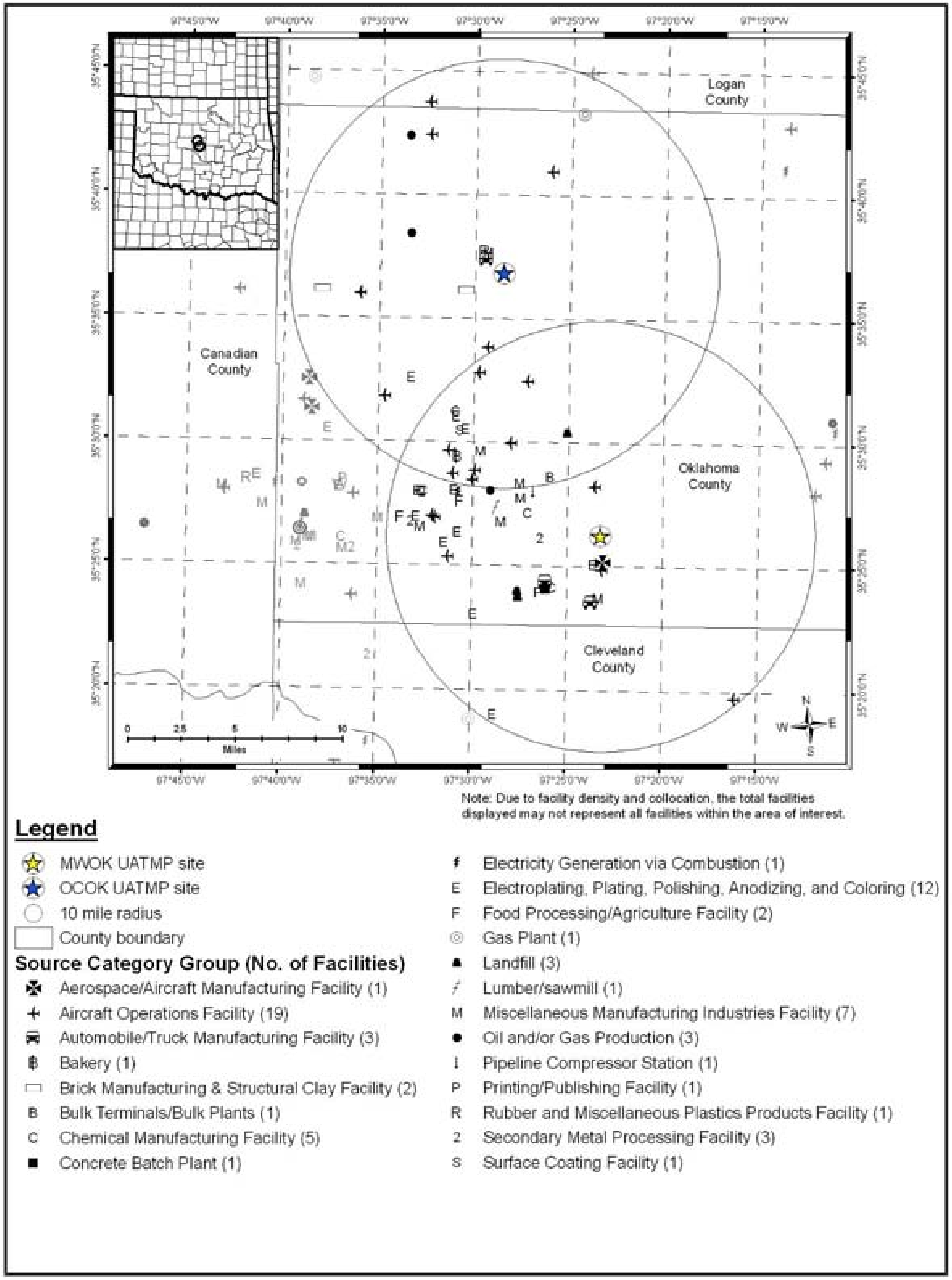

97°45'0"W
97°40'0"W
97°35'0"W
97°30'0"W
97°25'0"W
97°20'0"W
97°15'0"W
35°45'0"N
35°40'0"N
35°35'0"N
35°30'0"N
35°25'0"N
35°20'0"N
Logan County
Canadian County
Oklahoma County
Cleveland County
0 2.5 5 10
Miles
N
W
E
S
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
MWOK UATMP site
OCOK UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (1)
Aircraft Operations Facility (19)
Automobile/Truck Manufacturing Facility (3)
Bakery (1)
Brick Manufacturing & Structural Clay Facility (2)
B Bulk Terminals/Bulk Plants (1)
C Chemical Manufacturing Facility (5)
Concrete Batch Plant (1)
Electricity Generation via Combustion (1)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (12)
F Food Processing/Agriculture Facility (2)
Gas Plant (1)
Landfill (3)
Lumber/sawmill (1)
M Miscellaneous Manufacturing Industries Facility (7)
Oil and/or Gas Production (3)
Pipeline Compressor Station (1)
P Printing/Publishing Facility (1)
R Rubber and Miscellaneous Plastics Products Facility (1)
2 Secondary Metal Processing Facility (3)
S Surface Coating Facility (1)

Table 22-1. Geographical Information for the Oklahoma Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
TOOK	40-143-0235	Tulsa	Tulsa	Tulsa, OK	36.126945, -95.998941	Industrial	Urban/City Center	SO_2 and H_2S.
TSOK	40-143-0172	Tulsa	Tulsa	Tulsa, OK	36.164435, -95.985204	Residential	Suburban	None.
TUOK	40-143-0191	Tulsa	Tulsa	Tulsa, OK	36.141697, -95.983793	Residential	Urban/City Center	CO and PM_{10}.
TMOK	40-143-1127	Tulsa	Tulsa	Tulsa, OK	36.204902, -95.976537	Residential	Urban/City Center	CO, SO_2, NOy, NO, NO_2, NOx, O_3, Meteorological parameters, PM_{10}, PM Coarse, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
CNEP	40-097-9014	Pryor Creek	Mayes	Not in an MSA	36.228408, -95.249943	Agricultural	Rural	SO_2, NOy, NO, NO_2, NOx, O_3, Meteorological parameters, PM_{10}, and $PM_{2.5}$.
PROK	40-097-0187	Pryor Creek	Mayes	Not in an MSA	36.292941, -95.303409	Industrial	Suburban	None.
MWOK	40-109-0041	Midwest City	Oklahoma	Oklahoma City, OK MSA	35.437641, -97.387254	Commercial	Urban/City Center	None.
OCOK	40-109-1037	Oklahoma City	Oklahoma	Oklahoma City, OK MSA	35.614131, -97.475083	Residential	Suburban	SO_2, NO, NO_2, NOx, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

Figure 22-9 shows that the four Tulsa sites are located within a few miles of each other, with the TMOK site the farthest out. Most of the emissions sources are located along a line running northeast-southwest across Tulsa County. The source categories with the highest number of sources surrounding the Tulsa sites the aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads; the electroplating, plating, polishing, anodizing, and coloring source category; and the secondary metal processing source category.

The CNEP monitoring site was established by the Cherokee Nation Environmental Program in the tribal community of Cherokee Heights, about halfway between the towns of Pryor Creek and Locust Grove, in northeastern Oklahoma. Due to the rural nature of the area, the satellite image is zoomed farther out than the satellite images for the Tulsa sites. Figure 22-5 shows the streets of the Cherokee Heights neighborhood, which backs up to a branch of the Grand River from Lake Hudson. The immediate area is rural and agricultural, although an industrial park is located to the west of the community, part of which can be seen on the left-hand side of Figure 22-5.

PROK is located on the eastern edge of the town of Pryor Creek, on the property of Pryor Creek High School, approximately 5 miles northwest of the CNEP monitoring site. Residential areas are located to the northwest, west, and south of the site, while agricultural areas are located to the east, as shown in Figure 22-6. The monitoring site is located due north (and downwind) of the aforementioned industrial park.

Figure 22-10 shows that fewer point sources are located within 10 miles of CNEP and PROK. A cluster of sources is located just west and northwest of CNEP and southeast of PROK. The emissions sources surrounding these sites are involved in a variety of processes, including source categories such as aircraft operations; pulp and paper production; chemical manufacturing; food processing; and electricity generation via combustion.

The MWOK monitoring site is located in Midwest City, southeast of Oklahoma City. The site is located in a commercial area on Midwest Boulevard just north of I-40. This site is located at a school enrollment center just north of Tinker Air Force Base, the northern portion of which can be seen just south of I-40 in Figure 22-7. Residential areas are located to the northwest, north, and northeast.

OCOK is located in northern Oklahoma City, on the property of Oklahoma Christian University of Science and Arts. The site is located in the northwest corner of the University, near the athletic fields. The areas surrounding the university are primarily residential. Heavily traveled roadways such as I-35 to the east and I-44 to the south are within a few miles of the site, although outside the boundaries of Figure 22-8.

Figure 22-11 shows that MWOK and OCOK are approximately 13 miles apart and that most of the point sources located within 10 miles of them are located between the sites in the center of Oklahoma City (south of OCOK and west and northwest of MWOK). The source categories with the highest number of sources surrounding the two sites include the aircraft operations source category; the electroplating, plating, polishing, anodizing, and coloring source category; and the chemical manufacturing source category. The source closest to OCOK is an automobile/truck manufacturing facility; the source closest to MWOK is an aerospace/aircraft manufacturing facility.

Table 22-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Oklahoma monitoring sites. Information provided in Table 22-2 represents the most recent year of sampling (2008 for TSOK, 2009 for all other sites), unless otherwise indicated. County-level vehicle registration and population data for Tulsa, Mayes, and Oklahoma Counties were obtained from the Oklahoma Tax Commission (OKTC, 2008 and 2009) and the U.S. Census Bureau (Census Bureau, 2009 and 2010), respectively. Table 22-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 22-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 22-2 presents the daily VMT for the Tulsa and Oklahoma City urban areas (VMT was not available for the sites near Pryor Creek).

Table 22-2. Population, Motor Vehicle, and Traffic Information for the Oklahoma Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
TOOK	601,961	520,938	0.87	446,016	385,983	62,400	20,208
TSOK	591,982	511,990	0.85	337,331	288,342	62,100	20,208
TUOK	601,961	520,938	0.87	447,932	387,641	46,000	20,208
TMOK	601,961	520,938	0.87	321,574	278,291	11,900	20,208
CNEP	40,065	30,023	0.75	29,152	21,845	4,600	NA
PROK	40,065	30,023	0.75	29,152	21,845	18,400	NA
MWOK	716,704	685,765	0.96	345,291	330,385	59,165	30,576
OCOK	716,704	685,765	0.96	330,027	315,780	61,500	30,576

[1] Reference: Census Bureau, 2009 and 2010.
[2] County-level vehicle registration reflects 2008 and 2009 data from the Oklahoma Tax Commission (OKTC, 2008 and 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2008 data from the OK DOT (OK DOT, 2008).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
NA = Data unavailable.

Observations from Table 22-2 include the following:

- The Mayes County population is significantly lower than the Tulsa County and Oklahoma County populations. This is also true of the 10-mile populations. Compared to other NMP monitoring sites, the Tulsa and Oklahoma City populations were in the middle of the range, while Pryor Creek's populations were on the low end.

- The Mayes County vehicle registration is also significantly lower than vehicle registration for Tulsa and Oklahoma Counties. Similar observations can be made for the 10-mile vehicle registration estimates. These observations are expected given the rural nature of the area surrounding CNEP and PROK compared to the urban location of the Tulsa and Oklahoma City sites. Compared to other NMP monitoring sites, the ownership estimates followed a similar pattern as the populations.

- The average daily traffic volume passing the CNEP site is the lowest among the Oklahoma monitoring sites, while the traffic passing by TOOK is the highest.

- VMT for the Oklahoma City area is more than the VMT for the Tulsa area (30 vs. 20 million miles, respectively). The Oklahoma City VMT is in the middle of the range, while the Tulsa VMT is in the bottom third compared to other urban areas with NMP sites. For comparison purposes, VMT for the New York City area is 300 million miles. VMT was not available for the Pryor Creek area.

22.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Oklahoma on sample days, as well as over the course of each year.

22.2.1 Climate Summary

Tulsa is located in northeast Oklahoma, just southeast of the Osage Indian Reservation, and along the Arkansas River. Pryor Creek is also in northeast Oklahoma, approximately 30 miles east of Tulsa. Oklahoma City is located in the center of the state. These areas are characterized by a continental climate, with very warm summers and cool winters. Precipitation is generally concentrated in the spring and summer months, with spring as the wettest season, although precipitation amounts generally decrease across the state from east to west. Spring and summer precipitation usually results from showers and thunderstorms, while fall and winter precipitation accompanies frontal systems. A southerly wind prevails for much of the year, bringing warm, moist air northward from the Gulf of Mexico. Oklahoma is part of "Tornado Alley", where severe thunderstorms capable of producing strong winds, hail, and tornadoes occur more frequently; tornadoes are more prevalent here than any other region in the U.S. (Bair, 1992; NCDC, 2011; and NOAA, 2011e).

22.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The two closest NWS weather stations to the Tulsa sites are located at Richard Lloyd Jones Jr. Airport (near TOOK and TUOK) and Tulsa International Airport (near TSOK and TMOK), WBAN 53908 and 13968, respectively. The closest NWS weather station to the Pryor Creek sites is located at Claremore Regional Airport, WBAN 53940. The two closest NWS weather stations to the Oklahoma City sites are located at Tinker Air Force Base Airport (near MWOK) and Wiley Post Airport (near OCOK), WBAN 13919 and 03954, respectively. Additional information about these weather stations is provided in Table 22-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the years.

Table 22-3. Average Meteorological Conditions near the Oklahoma Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Tulsa, Oklahoma - TOOK										
Richard Lloyd Jones Jr. Airport 53908 (36.04, -95.98)	6.11 miles 173° (S)	2008	Sample Day	72.4 ± 4.4	61.5 ± 4.4	47.6 ± 4.6	54.1 ± 4.0	63.7 ± 2.7	1016.1 ± 1.8	7.2 ± 0.8
			All Year	71.3 ± 1.8	60.0 ± 1.8	46.6 ± 1.9	53.0 ± 1.7	64.6 ± 1.2	1016.8 ± 0.7	6.3 ± 0.3
		2009	Sample Day	69.7 ± 4.4	59.0 ± 4.3	45.3 ± 4.8	52.1 ± 4.0	64.2 ± 3.3	1016.6 ± 1.5	5.1 ± 0.6
			All Year	70.5 ± 1.8	60.0 ± 1.8	46.7 ± 1.8	53.0 ± 1.6	65.1 ± 1.3	1016.7 ± 0.7	5.5 ± 0.3
Tulsa, Oklahoma - TSOK										
Tulsa International Airport 13968 (36.20, -95.89)	5.72 miles 66° (ENE)	2008	Sample day	73.4 ± 5.6	63.9 ± 5.5	49.9 ± 5.5	56.1 ± 4.9	63.5 ± 3.5	1014.8 ± 2.1	9.6 ± 1.2
			All 2008	70.9 ± 1.8	60.5 ± 1.8	46.5 ± 1.9	53.2 ± 1.7	63.1 ± 1.3	1015.7 ± 0.7	8.7 ± 0.4
Tulsa, Oklahoma - TUOK										
Richard Lloyd Jones Jr. Airport 53908 (36.04, -95.98)	7.08 miles 180° (S)	2008	Sample day	71.1 ± 4.5	60.1 ± 4.4	46.2 ± 4.6	52.9 ± 4.0	63.6 ± 2.8	1016.1 ± 1.9	7.2 ± 0.8
			All Year	71.3 ± 1.8	60.0 ± 1.8	46.6 ± 1.9	53.0 ± 1.7	64.6 ± 1.2	1016.8 ± 0.7	6.3 ± 0.3
		2009	Sample Day	57.5 ± 5.5	45.4 ± 5.3	27.7 ± 6.4	38.2 ± 4.9	53.3 ± 5.7	1018.0 ± 3.6	6.0 ± 1.3
			All Year	70.5 ± 1.8	60.0 ± 1.8	46.7 ± 1.8	53.0 ± 1.6	65.1 ± 1.3	1016.7 ± 0.7	5.5 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

NA = Sea level pressure was not recorded at the Claremore Regional Airport.

Table 22-3. Average Meteorological Conditions near the Oklahoma Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Tulsa, Oklahoma - TMOK										
Tulsa International Airport 13968 (36.20, -95.89)	4.80 miles 96° (E)	2009	Sample Day	75.1 ± 5.1	65.7 ± 5.0	52.1 ± 4.9	57.9 ± 4.4	64.7 ± 3.8	1014.7 ± 1.7	7.7 ± 1.0
			All Year	69.9 ± 1.9	60.2 ± 1.8	46.2 ± 1.8	52.9 ± 1.6	63.2 ± 1.3	1015.6 ± 0.7	8.2 ± 0.4
Cherokee Heights, Pryor Creek, Oklahoma - CNEP										
Claremore Regional Airport 53940 (36.29, -95.47)	12.35 miles 291° (WNW)	2008	Sample Day	50.1 ± 9.2	40.6 ± 7.9	28.1 ± 7.7	35.8 ± 7.2	64.6 ± 6.5	NA	8.2 ± 1.4
			All Year	68.9 ± 1.8	57.9 ± 1.8	47.3 ± 2.0	52.7 ± 1.8	70.8 ± 1.3	NA	7.3 ± 0.4
		2009	Sample Day	63.0 ± 6.5	50.7 ± 6.6	37.1 ± 7.9	44.7 ± 6.5	62.9 ± 5.5	NA	7.4 ± 1.7
			All Year	68.9 ± 1.9	58.0 ± 1.8	47.4 ± 1.9	52.5 ± 1.7	71.2 ± 1.4	NA	6.9 ± 0.4
Pryor Creek, Oklahoma - PROK										
Claremore Regional Airport 53940 (36.29, -95.47)	8.67 miles 270° (W)	2008	Sample Day	62.3 ± 7.0	49.6 ± 6.3	37.6 ± 8.5	44.3 ± 6.7	66.3 ± 7.8	NA	9.6 ± 3.0
			All Year	68.9 ± 1.8	57.9 ± 1.8	47.3 ± 2.0	52.7 ± 1.8	70.8 ± 1.3	NA	7.3 ± 0.4
		2009	Sample Day	70.6 ± 4.3	59.7 ± 4.3	48.5 ± 4.6	53.8 ± 4.0	69.9 ± 3.1	NA	6.7 ± 0.7
			All Year	68.9 ± 1.9	58.0 ± 1.8	47.4 ± 1.9	52.5 ± 1.7	71.2 ± 1.4	NA	6.9 ± 0.4

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

NA = Sea level pressure was not recorded at the Claremore Regional Airport.

Table 22-3. Average Meteorological Conditions near the Oklahoma Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Midwest City, Oklahoma - MWOK										
Tinker AFB/Airport 13919 (35.42, -97.39)	1.56 miles 178° (S)	2009	Sample Day	72.8 ± 6.2	62.7 ± 5.7	51.2 ± 5.5	56.2 ± 5.0	69.7 ± 4.6	1016.3 ± 1.8	8.3 ± 0.8
			All Year	70.0 ± 1.8	59.5 ± 1.8	46.9 ± 1.8	52.9 ± 1.6	66.9 ± 1.7	1015.6 ± 0.7	9.8 ± 0.4
Oklahoma City - OCOK										
Wiley Post Airport 03954 (35.53, -97.65)	10.69 miles 240° (WSW)	2009	Sample Day	74.5 ± 6.0	64.5 ± 5.7	51.0 ± 5.2	56.7 ± 4.8	64.9 ± 3.9	1015.5 ± 1.7	9.0 ± 1.1
			All Year	70.7 ± 1.9	60.3 ± 1.8	45.6 ± 1.8	52.5 ± 1.6	62.2 ± 1.5	1015.4 ± 0.7	10.3 ± 0.4

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

NA = Sea level pressure was not recorded at the Claremore Regional Airport.

Table 22-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year according to when each site was sampling. Also included in Table 22-3 is the 95 percent confidence interval for each parameter.

Observations from Table 22-3 include the following:

- For TOOK, conditions on sample days in both years were representative of average weather conditions throughout 2008 and 2009.
- For TSOK, conditions on sample days in 2008 appear warmer than conditions across 2009. TSOK discontinued sampling in September 2008, thus missing some of the cooler months of the year.
- For TUOK, conditions on 2008 sample days were representative of average weather conditions throughout 2008. Conditions on sample days in 2009 appear considerably cooler and drier than conditions across 2009. This site discontinued sampling in March 2009, thereby missing the warmer and wetter months of the year.
- For TMOK, conditions on sample days in 2009 appear warmer than conditions across 2009. This site began sampling in April 2009, thus missing the coldest months of the year.
- For CNEP, conditions on sample days in both 2008 and 2009 appear cooler and drier than conditions overall in 2008 or 2009. This is likely due to an abbreviated sample period. CNEP sampled VOC from January through March 2008 and TSP metals from January to May 2009 as part of separate monitoring efforts at the same location.
- For PROK, conditions on sample days in 2008 appear cooler and drier than conditions across 2008. This site began sampling in October 2008, thereby missing the warmest and wettest months of the year. Although sampling at PROK continued throughout 2009, conditions on 2009 sample days also appear slightly warmer than average weather conditions throughout 2009. Several invalid samples were made up in June, July, and August 2009, thereby increasing the number of summer sample days.
- For MWOK and OCOK, conditions on sample days in 2009 appear warmer than conditions across 2009 for both sites. These sites began sampling in May 2009, thus missing the coldest months of the year.

22.2.3 Back Trajectory Analysis

Figure 22-12 and Figure 22-13 are the composite back trajectory maps for days on which samples were collected at the TOOK monitoring site in 2008 and 2009, respectively. Figure 22-14 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 22-15 through 22-30 are the composite back trajectory and cluster analysis maps for the remaining Oklahoma sites, where applicable. A cluster analysis could not be conducted for all sites for all years because there were fewer than 30 sample days for certain sites. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 22-12 through 22-30 represents 100 miles.

Observations from Figures 22-12 through 22-30 include the following:

- The back trajectory maps for the Tulsa sites, the Pryor Creek sites, and the Oklahoma City sites are similar to each other in trajectory distribution. This is somewhat expected, given their relatively close proximity to each other and the similarity in sample days, although not all sites sampled on the same days over the 2-year period.

- Each of the sites show a strong tendency for trajectories to originate from the south-southeast to south-southwest of the sites, and from the northwest to northeast of the sites. A few trajectories also originated from the east to southeast, but they infrequently originated from the west.

- For the Tulsa and Pryor Creek sites, the farthest away a trajectory originated was western or central South Dakota, or between 650 and 750 miles away. However, the average trajectory length for these sites ranged from 250 to 300 miles.

- For the Oklahoma City sites, the farthest away a trajectory originated was central South Dakota, or approximately 600 miles away. However, the average trajectory length for these sites was just less than 250 miles.

Figure 22-12. 2008 Composite Back Trajectory Map for TOOK

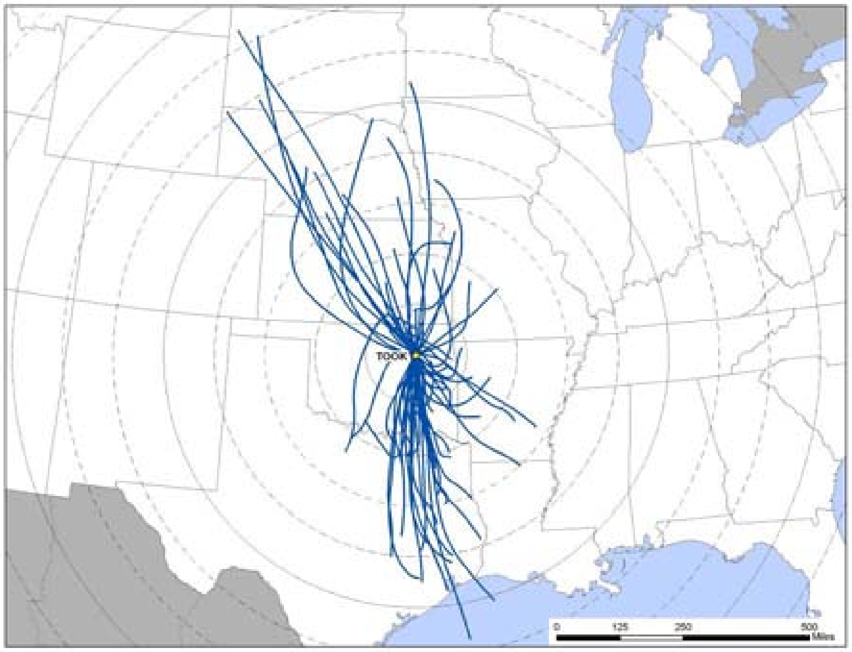


Figure 22-13. 2009 Composite Back Trajectory Map for TOOK

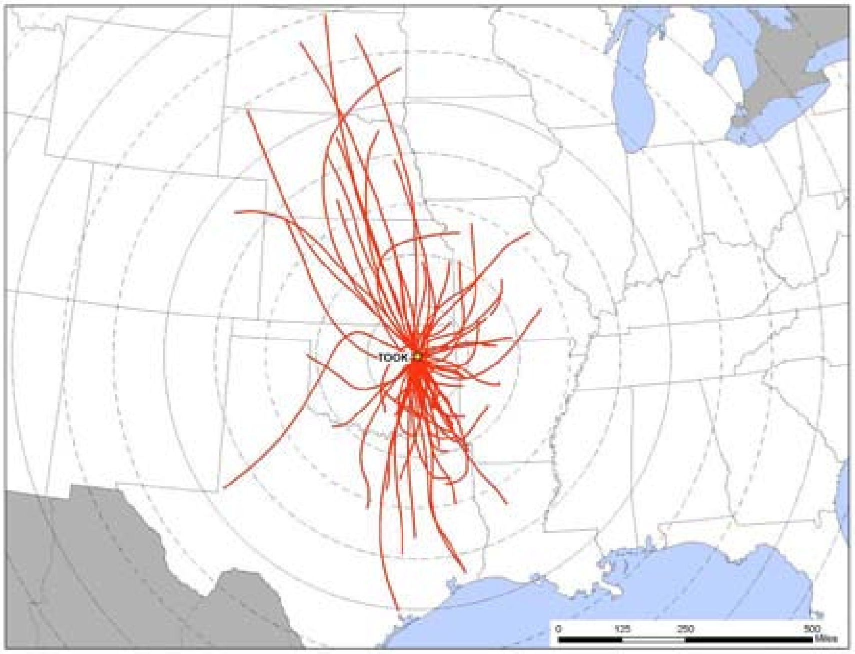


Figure 22-14. Back Trajectory Cluster Map for TOOK

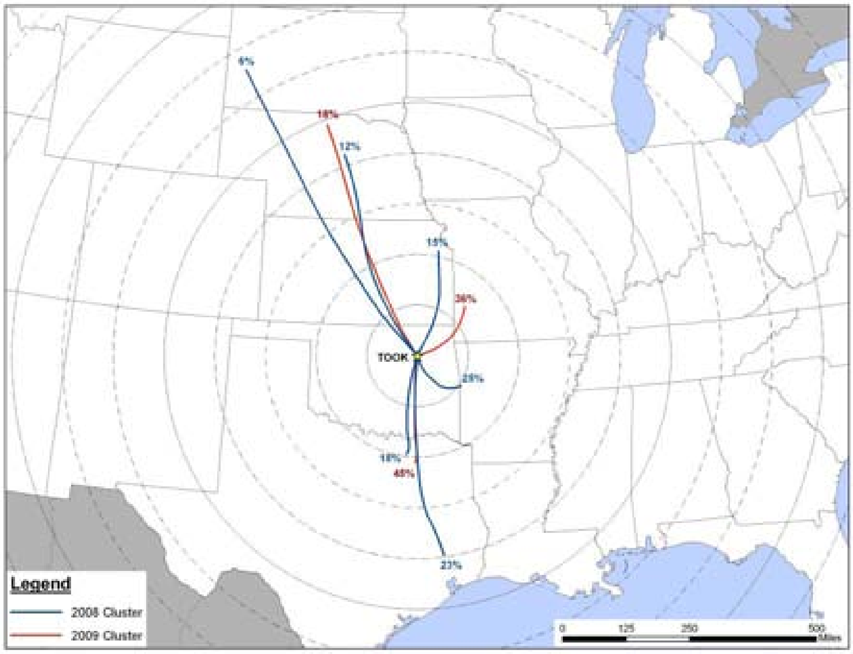


Figure 22-15. 2008 Composite Back Trajectory Map for TSOK

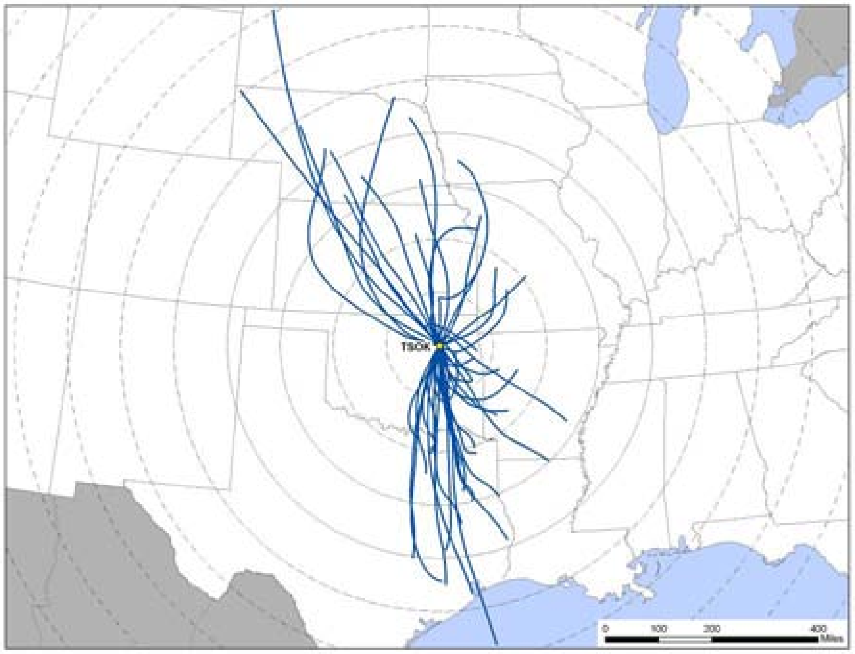


Figure 22-16. 2008 Back Trajectory Cluster Map for TSOK

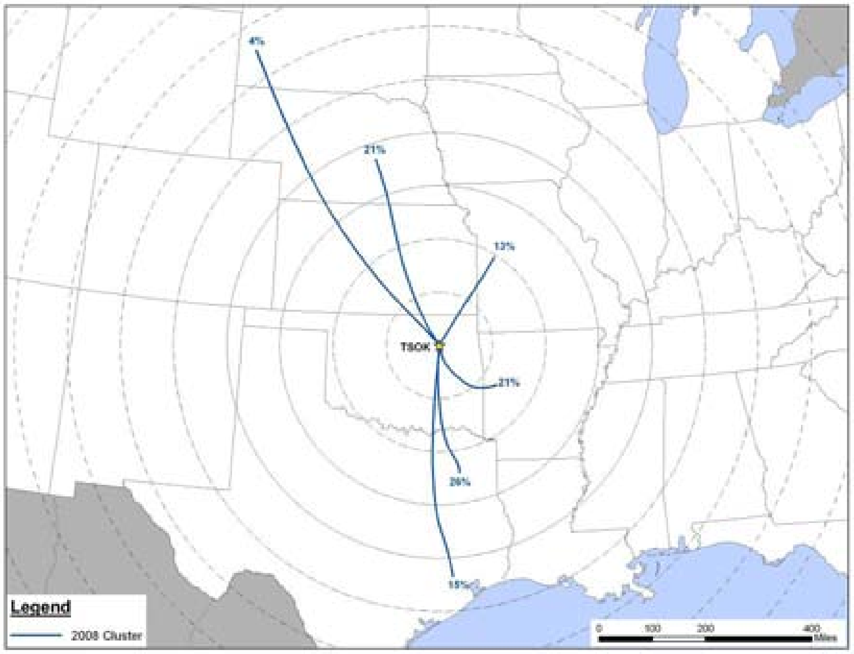


Figure 22-17. 2008 Composite Back Trajectory Map for TUOK

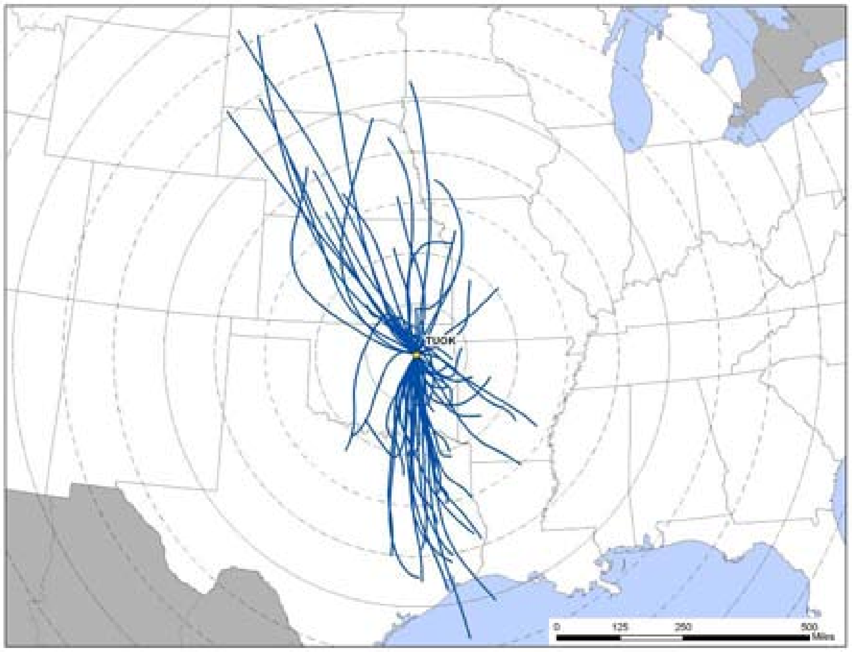


Figure 22-18. 2009 Composite Back Trajectory Map for TUOK

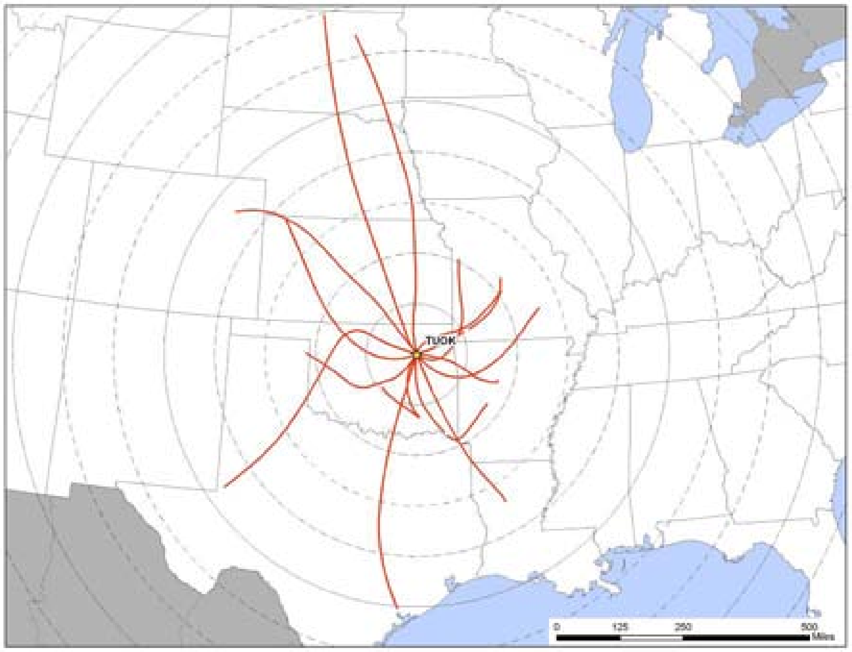


Figure 22-19. 2008 Back Trajectory Cluster Map for TUOK

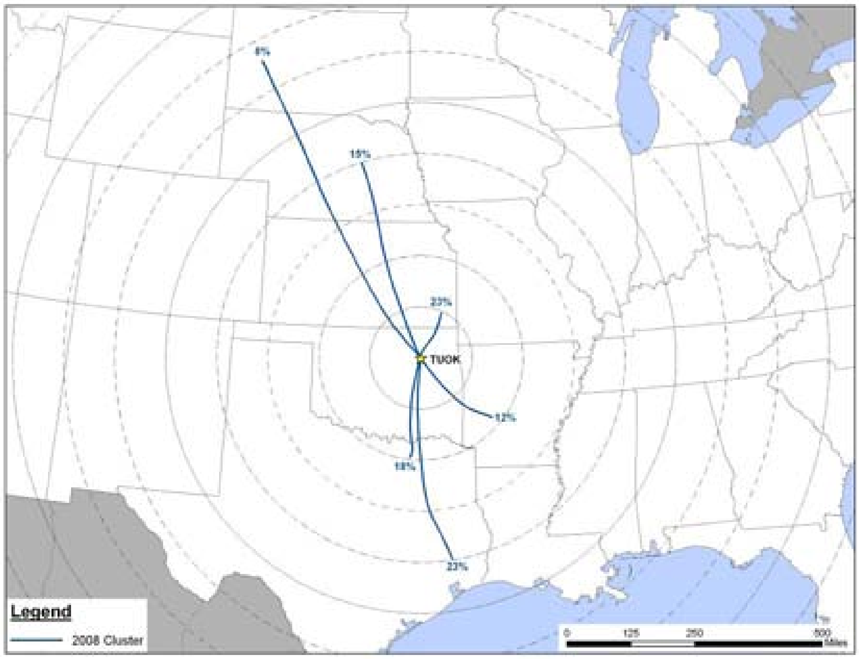


Figure 22-20. 2009 Composite Back Trajectory Map for TMOK

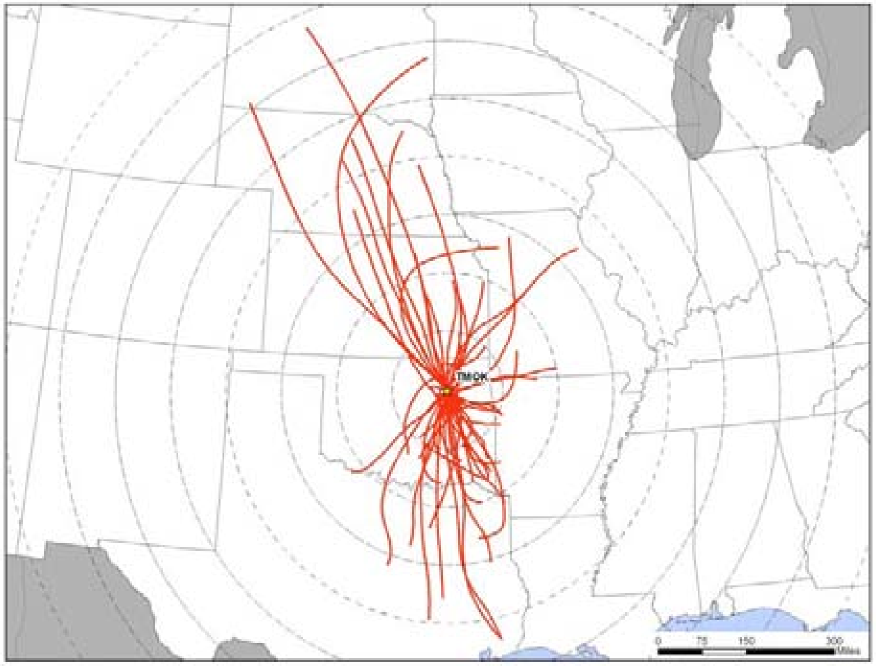


Figure 22-21. 2009 Back Trajectory Cluster Map for TMOK

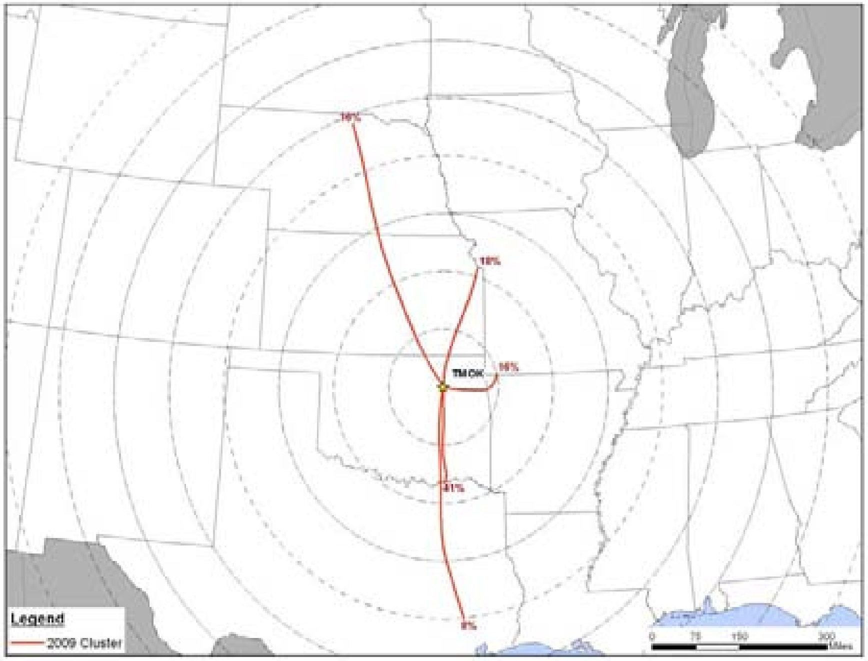


Figure 22-22. 2008 Composite Back Trajectory Map for CNEP

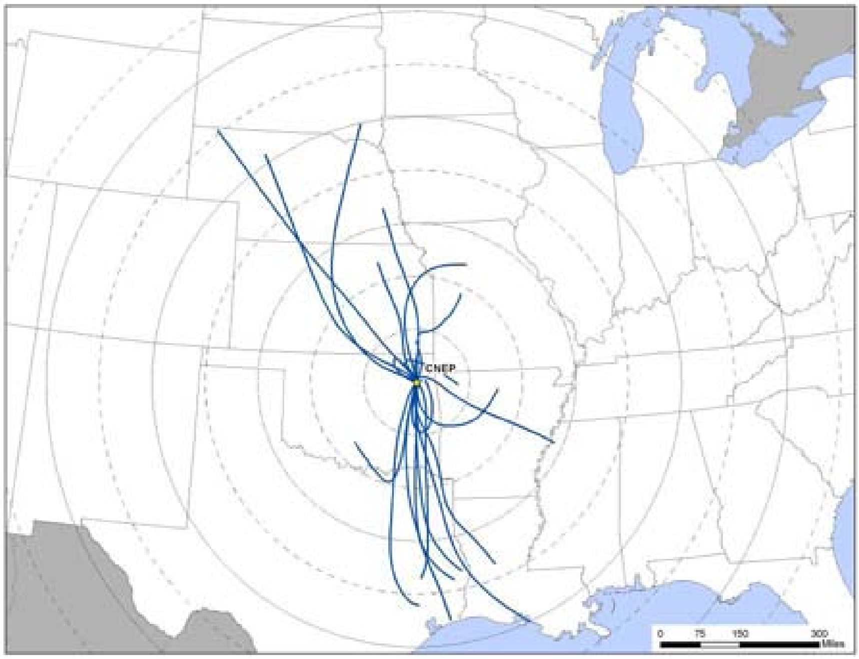


Figure 22-23. 2009 Composite Back Trajectory Map for CNEP

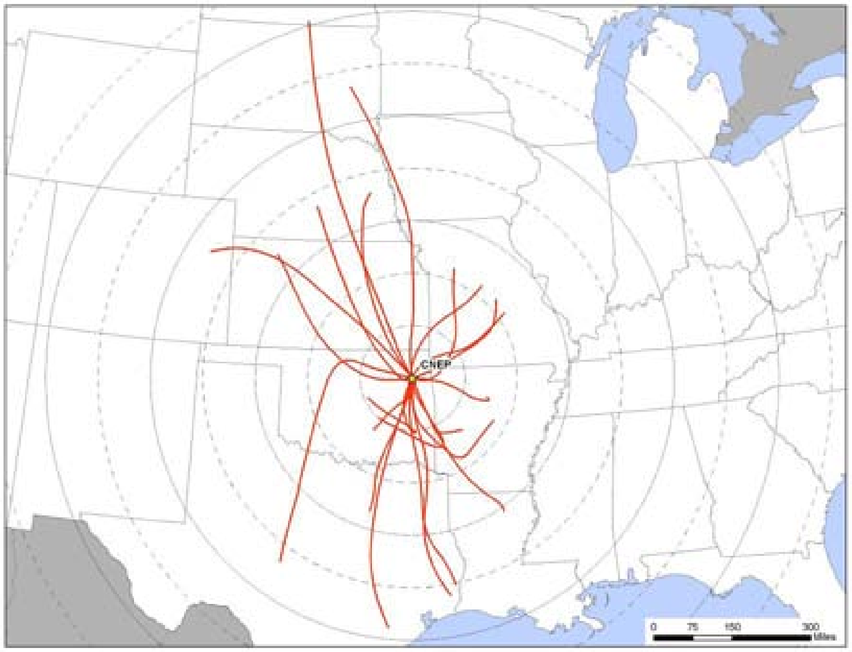


Figure 22-24. 2008 Composite Back Trajectory Map for PROK

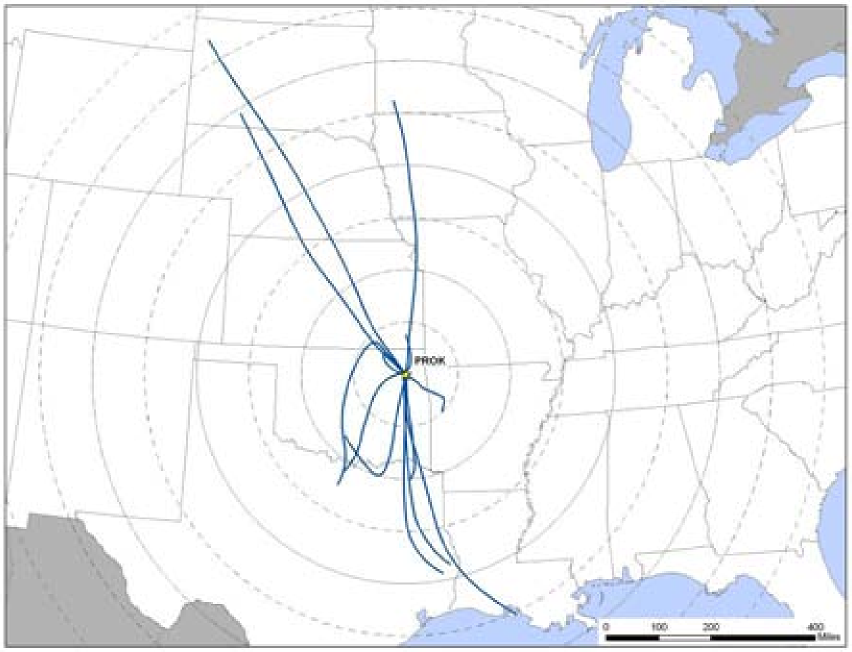


Figure 22-25. 2009 Composite Back Trajectory Map for PROK

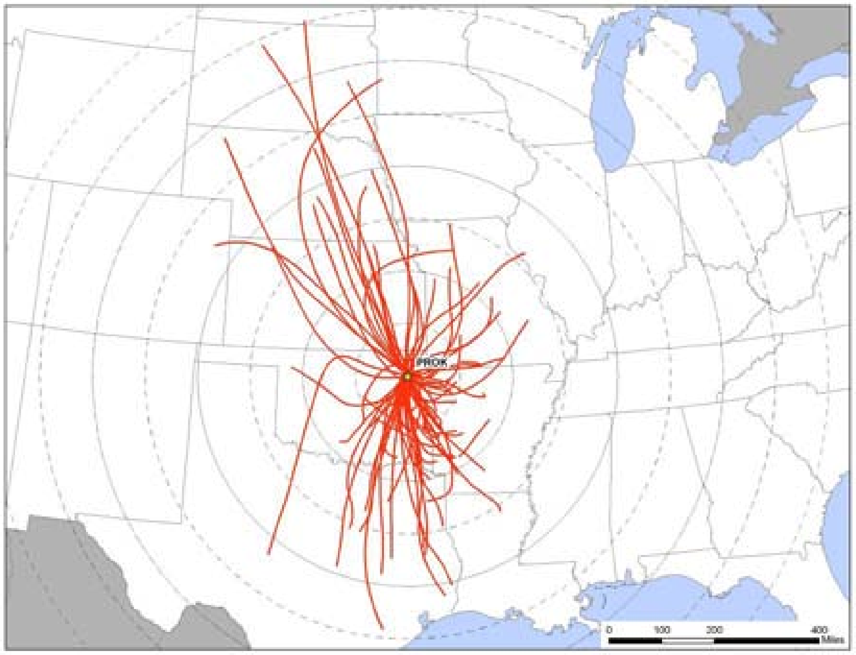


Figure 22-26. 2009 Back Trajectory Cluster Map for PROK

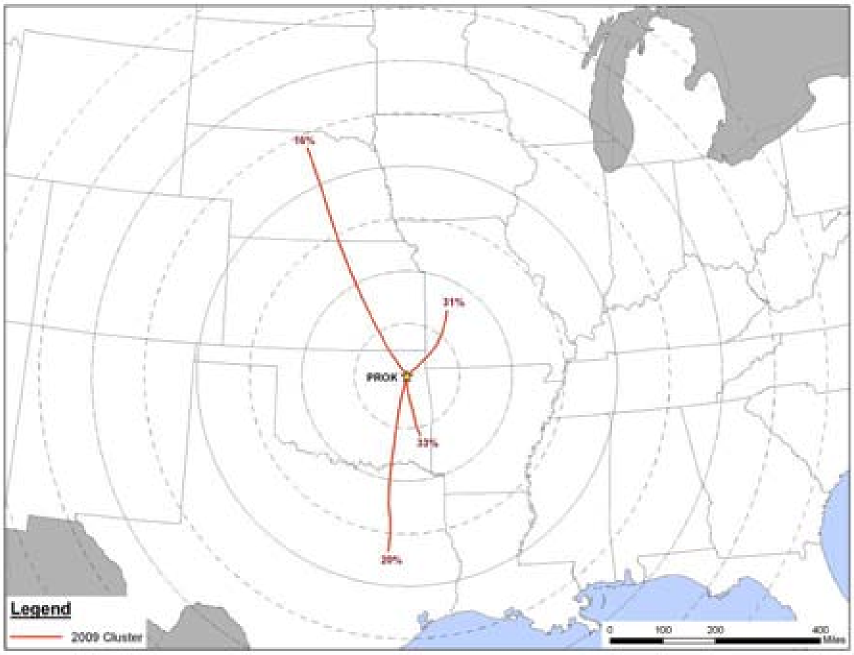


Figure 22-27. 2009 Composite Back Trajectory Map for MWOK

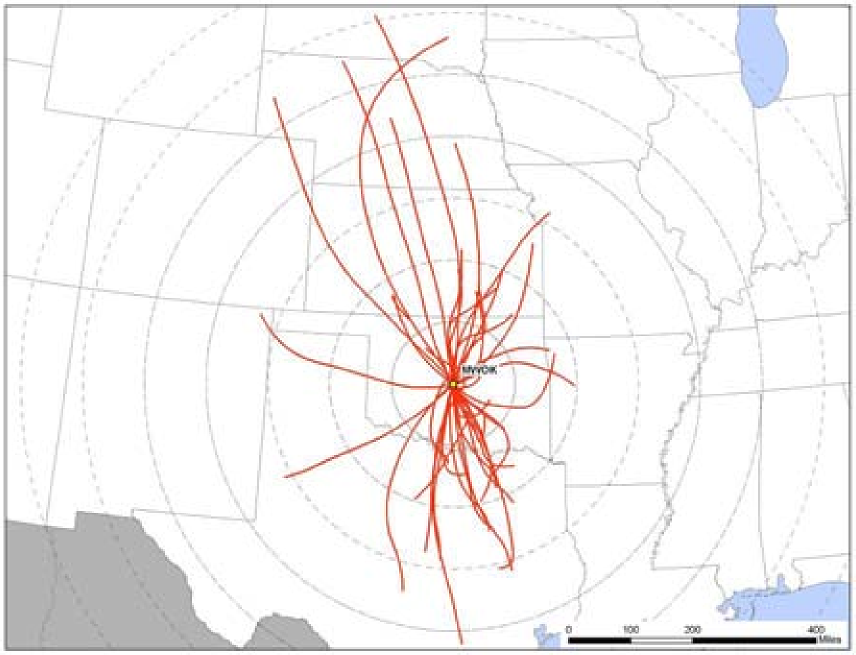


Figure 22-28. 2009 Back Trajectory Cluster Map for MWOK

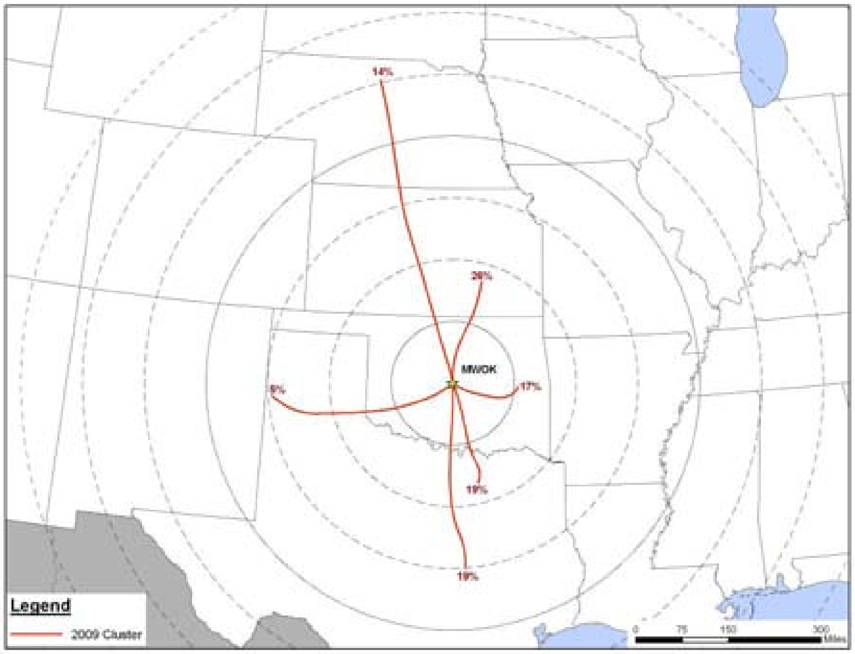


Figure 22-29. 2009 Composite Back Trajectory Map for OCOK

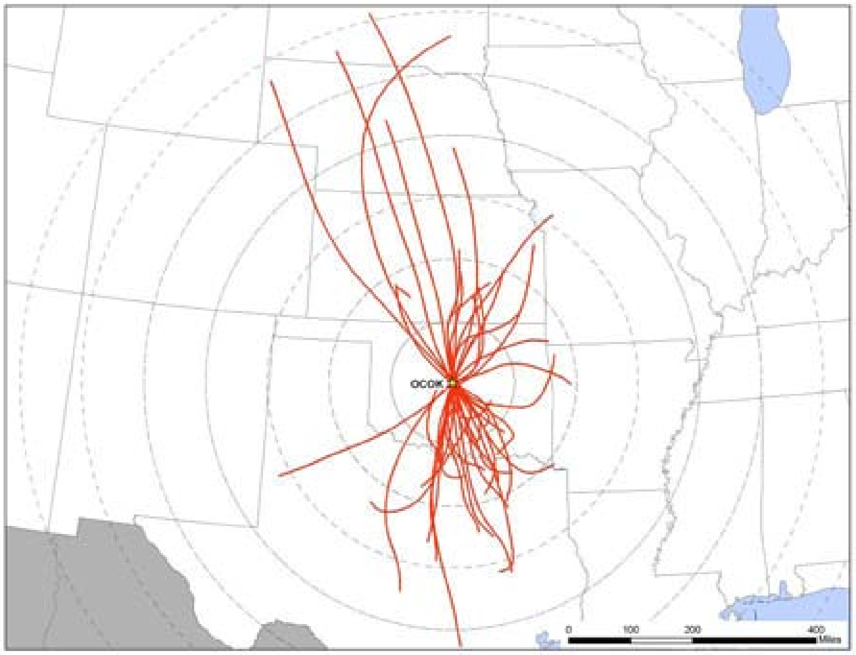
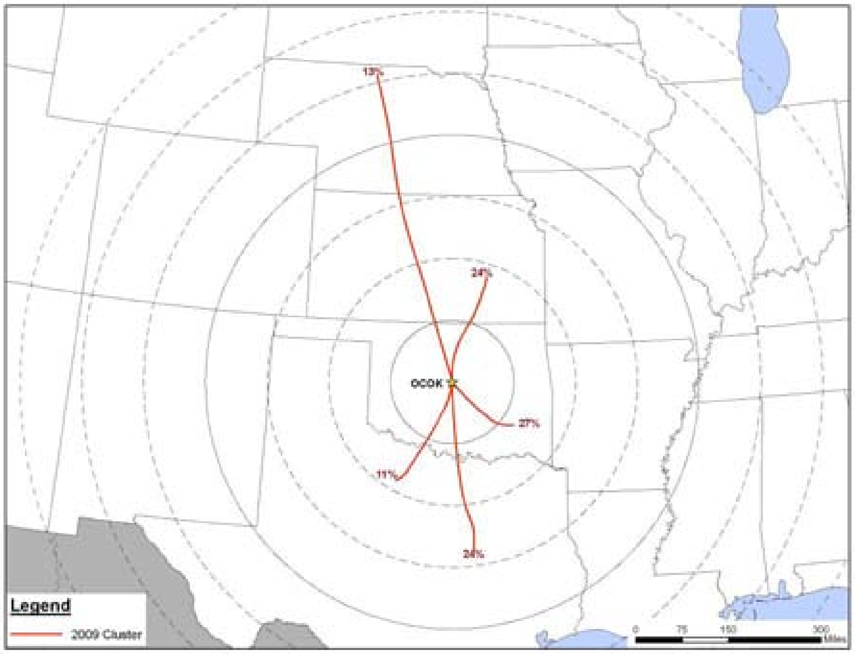


Figure 22-30. 2009 Back Trajectory Cluster Map for OCOK



22.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at Richard Lloyd Jones Junior Airport (for TOOK and TUOK), Tulsa International Airport (for TSOK and TMOK), Claremore Regional Airport (for CNEP and PROK), Wiley Post Airport (for OCOK), and Tinker Air Force Base (for MWOK) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 22-31 presents five different wind roses for the TOOK monitoring site. First, a historical wind rose representing 1998 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 22-32 through 22-39 present the different wind roses for the remaining Oklahoma monitoring sites. Please note that because several of the monitoring sites sampled in 2008 only or 2009 only, there may be less than five wind roses presented for a given monitoring site.

Observations from Figures 22-31 through 22-39 include the following:

- Even though the historical data shown are from five different weather stations and represent slightly different time periods, the wind patterns shown on wind roses for the Oklahoma sites are similar to each other. Each of the historical wind roses shows that southerly winds prevailed near each Oklahoma monitoring site, accounting for one-fifth to one-third of the observations among the historical time periods. The historical wind roses varied in the percentage of calm winds (≤2 knots) observed, ranging from as little as six percent at the Wiley Post Airport (OCOK) to as high as 32 percent at the Richard Lloyd Jones Jr. Airport (TOOK, TUOK). Further, calm winds, winds from the south-southeast through south-southwest, and winds from the north-northwest to north-northeast account for almost all observations at these sites; winds from the west or east are rarely observed.

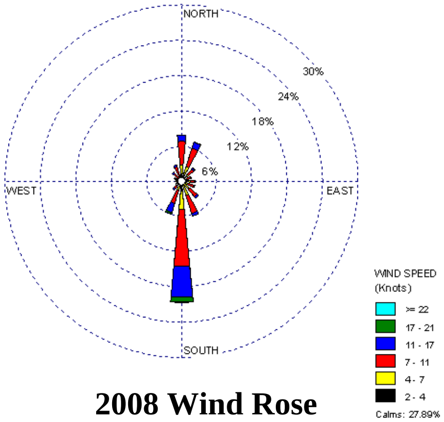
- For TOOK, the 2008 and 2009 wind patterns are very similar to the historical wind patterns, as are the sample day wind patterns for both years. This indicates that conditions on sample days were representative of those experienced over the entire year for both years and historically.

- Although TSOK stopped sampling in September 2008, both its 2008 full-year and 2008 sample day wind roses exhibit wind patterns similar to the historical wind patterns for the Tulsa International Airport over the period shown.

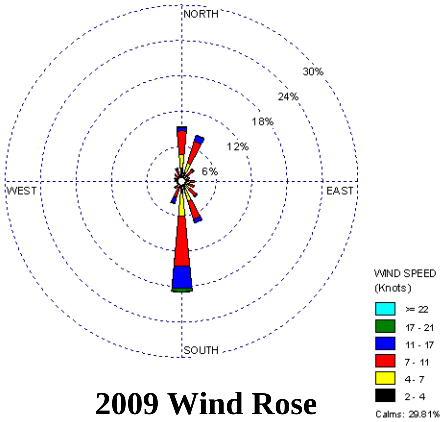
- For TUOK, the 2008 and 2009 wind patterns are very similar to the historical wind patterns, as are the 2008 sample day wind patterns. Although TUOK stopped sampling in March 2009, its 2009 sample day wind rose still exhibits similarities in wind patterns to the historical and full-year wind roses.

- For TMOK, the wind patterns shown on both the 2009 full-year and the 2009 sample day wind roses resemble the historical wind patterns, although there is a slightly higher percentage of southeasterly and south-southeasterly winds observed in 2009 than over the historical period, and a slightly higher percentage of northwesterly to north-northwesterly winds observed on sample days in 2009. Note that sampling began at TMOK in April 2009, thus missing sample days during the first quarter.

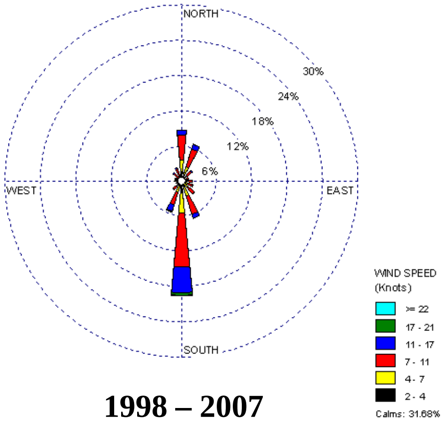
Figure 22-31. Wind Roses for the Richard Lloyd Jones Jr. Airport Weather Station near TOOK



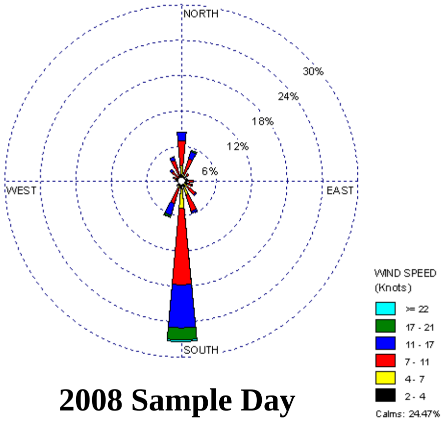
2008 Wind Rose



2009 Wind Rose

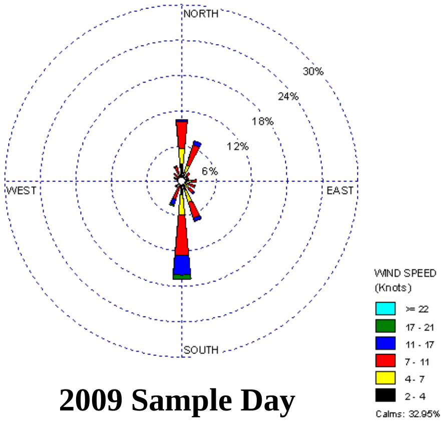


1998 – 2007
Historical Wind Rose



2008 Sample Day

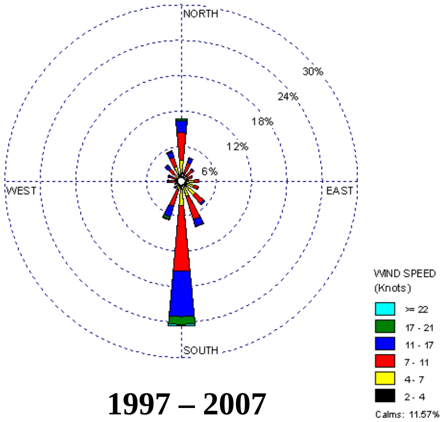
Wind Rose



2009 Sample Day

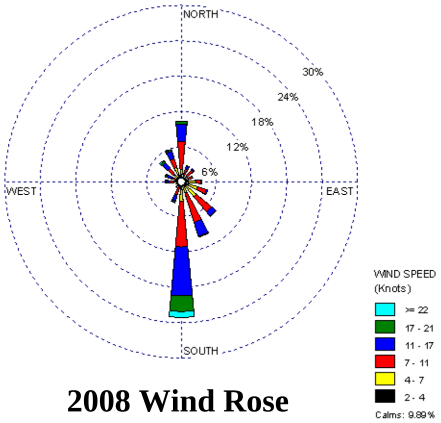
Wind Rose

Figure 22-32. Wind Roses for the Tulsa International Airport Weather Station near TSOK

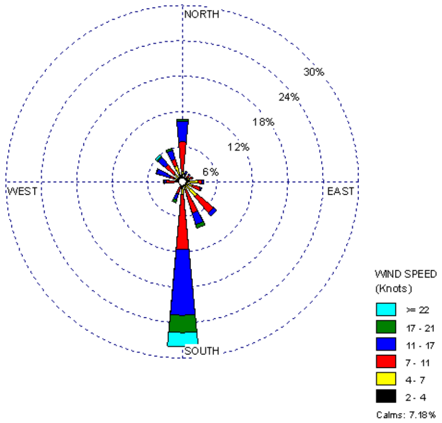


1997 – 2007

Historical Wind Rose



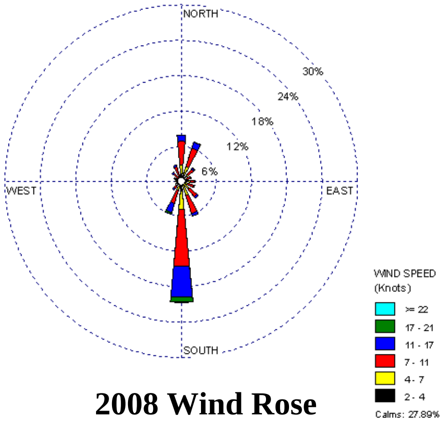
2008 Wind Rose



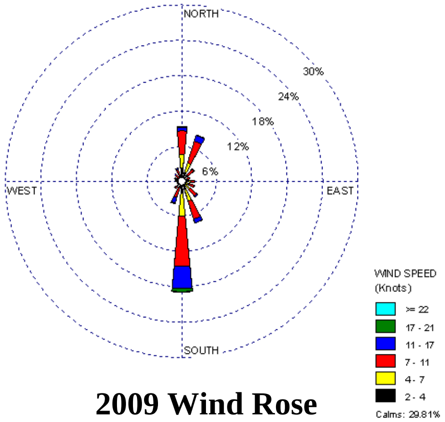
2008 Sample Day

Wind Rose

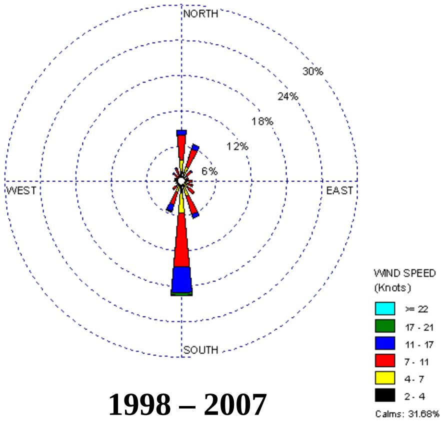
Figure 22-33. Wind Roses for the Richard Lloyd Jones Jr. Airport Weather Station near TUOK



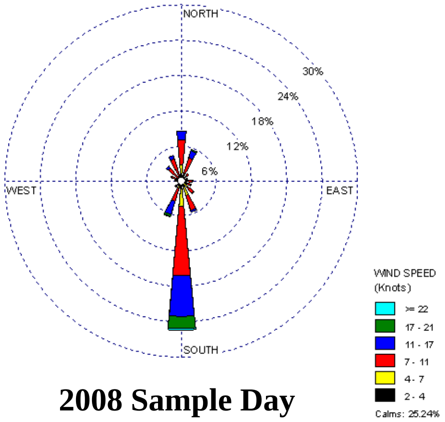
2008 Wind Rose



2009 Wind Rose

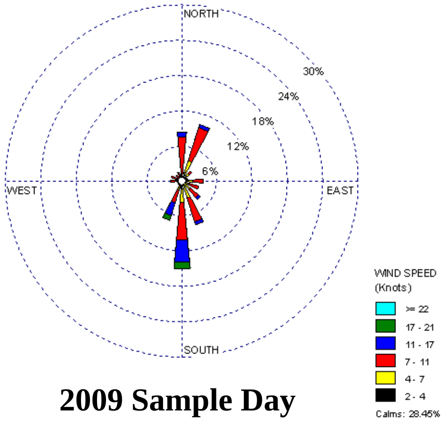


1998 – 2007
Historical Wind Rose



2008 Sample Day

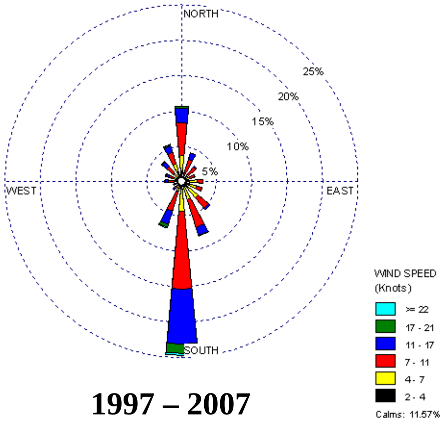
Wind Rose



2009 Sample Day

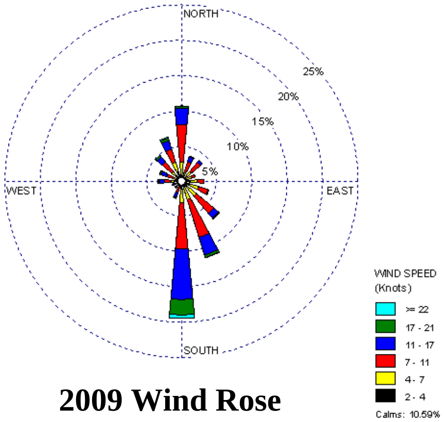
Wind Rose

Figure 22-34. Wind Roses for the Tulsa International Airport Weather Station near TMOK

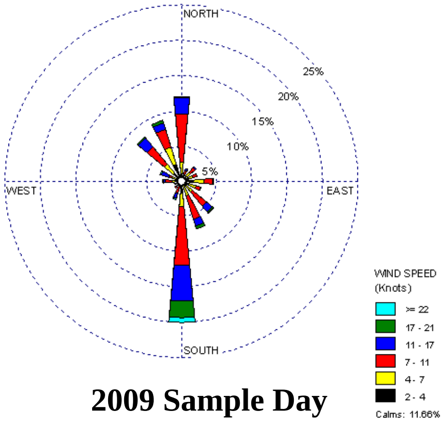


1997 – 2007

Historical Wind Rose

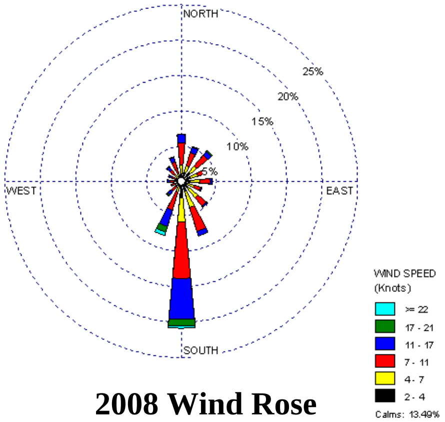


2009 Wind Rose

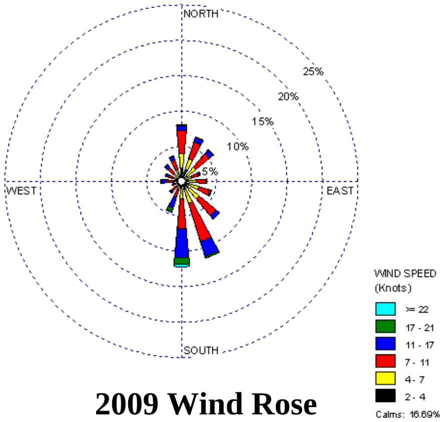


2009 Sample Day Wind Rose

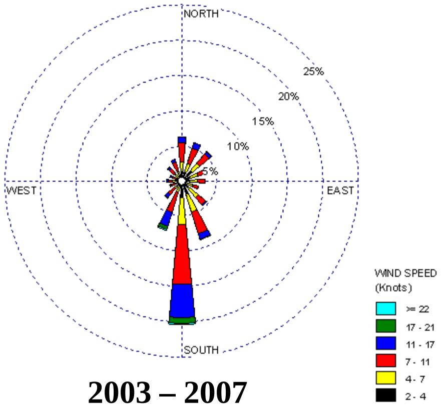
Figure 22-35. Wind Roses for the Claremore Regional Airport Weather Station near CNEP



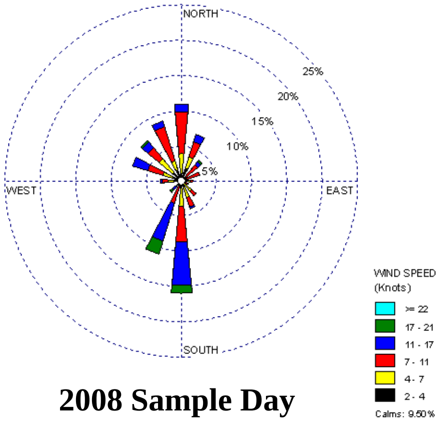
2008 Wind Rose



2009 Wind Rose

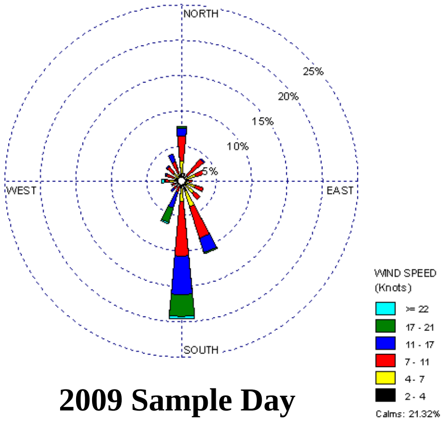


2003 – 2007
Historical Wind Rose



2008 Sample Day

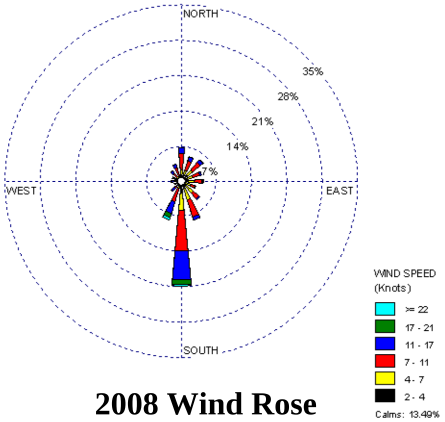
Wind Rose



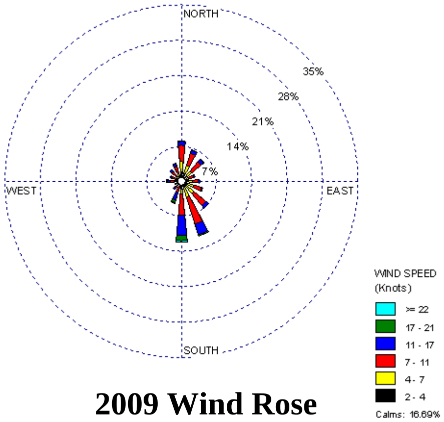
2009 Sample Day

Wind Rose

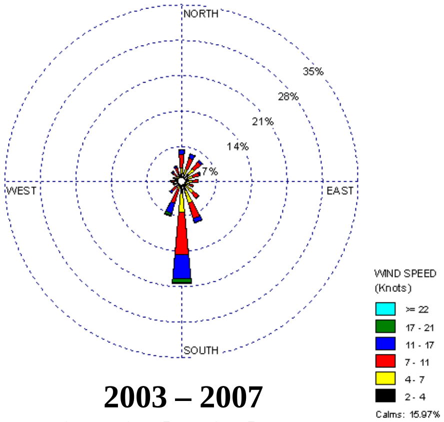
Figure 22-36. Wind Roses for the Claremore Regional Airport Weather Station near PROK



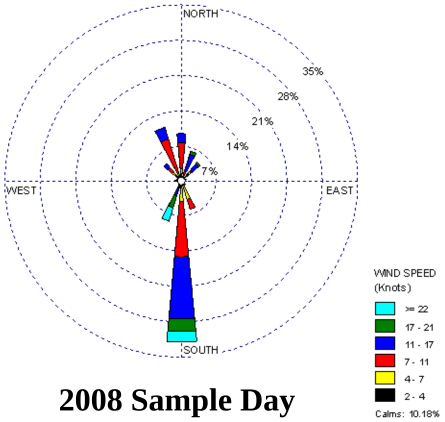
2008 Wind Rose



2009 Wind Rose

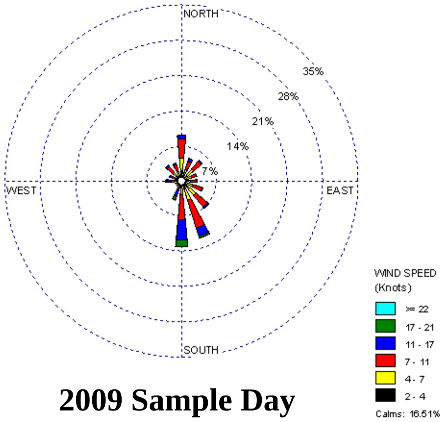


2003 – 2007
Historical Wind Rose



2008 Sample Day

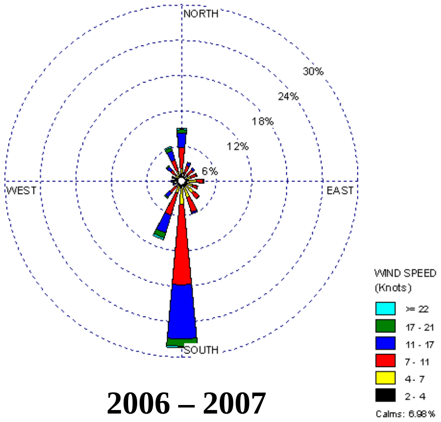
Wind Rose



2009 Sample Day

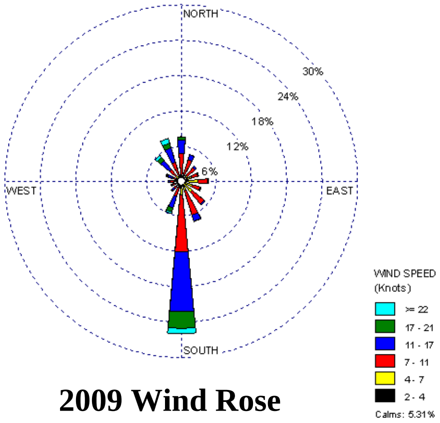
Wind Rose

Figure 22-37. Wind Roses for the Tinker Air Force Base Airport Weather Station near MWOK

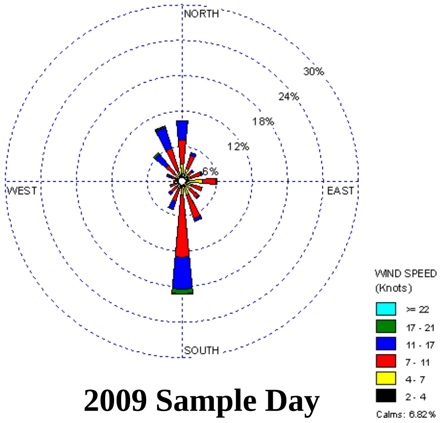


2006 – 2007

Historical Wind Rose



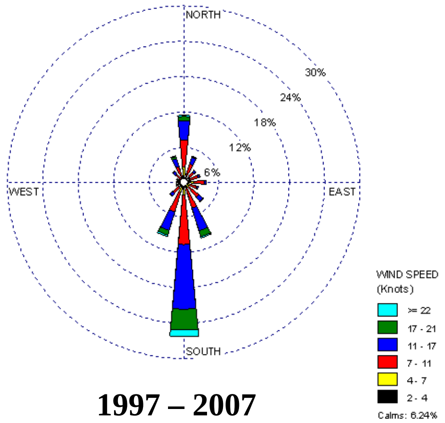
2009 Wind Rose



2009 Sample Day

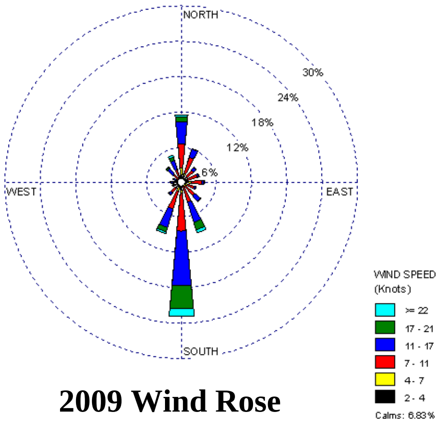
Wind Rose

Figure 22-38. Wind Roses for the Wiley Post Airport Weather Station near OCOK

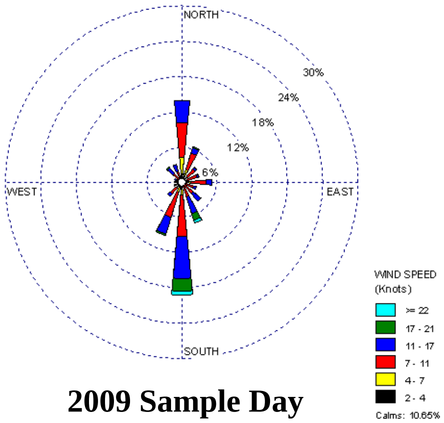


1997 – 2007

Historical Wind Rose



2009 Wind Rose



2009 Sample Day

Wind Rose

- The historical wind roses for CNEP and PROK show that winds from the south-southeast to south-southwest account for approximately 40 percent of wind observations near these sites. Winds from the north to northeast account for nearly 20 percent of observations, as do calm winds. The 2008 wind patterns resemble those shown on the historical wind rose. The 2009 wind rose shows that south-southeasterly and southerly winds accounted for roughly the same percentage of observations (approximately 12 percent each), a more even distribution than the historical wind rose.

- For CNEP, the 2008 sample day wind rose shares characteristics with the full-year wind rose, although there were more wind observations from the west-northwest to north-northwest, fewer south-southeasterly winds, and fewer calm winds on sample days. CNEP sampled from January to March 2008; thus, wind patterns for a full-year's worth of wind observations on sample days would likely look different. The 2009 sample day wind patterns have several differences from the full-year wind patterns. In 2009, CNEP sampled from January to May 2009 and wind patterns for a full-year's worth of wind observations on sample days would likely look different.

- For PROK, the 2008 sample day wind rose shows a significantly higher percentage of southerly winds than the full-year wind rose. PROK began sampling in October 2008; thus, wind patterns for a full-year's worth of wind observations on sample days would likely look different. The 2009 sample day wind patterns are very similar to the full-year wind patterns, indicating that conditions on sample days were representative of conditions experienced throughout the year.

- For MWOK, the historical wind rose includes only two years worth of data. The 2009 wind patterns resemble the historical wind patterns, although there were slightly fewer south-southwesterly wind observations and more northwesterly to north-northwesterly winds observations. The 2009 sample day wind rose resembles the historical and 2009 full-year wind rose, but like the full-year wind rose, has more northwesterly to north-northwesterly winds observations and fewer southerly and south-southwesterly wind observations. Similar to OCOK, sampling at MWOK began in May 2009.

- For OCOK, the wind patterns shown on the 2009 wind rose are similar to the historical wind patterns. The 2009 sample day wind rose for OCOK is also similar to these wind roses, although the calm rate is higher, and the percentage of southerly winds decreased while the percentage of northerly winds increased somewhat. Recall that sampling at OCOK began in May 2009, thereby missing the first four and a half months worth of sample days.

22.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Oklahoma monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 22-4 presents the pollutants of interest for each Oklahoma monitoring site. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. The four Tulsa sites, PROK, OCOK, and MWOK sampled for VOC, carbonyl compounds, and metals (TSP); CNEP sampled for VOC in for the first quarter of 2008 and metals in the first half of 2009.

Table 22-4. Risk Screening Results for the Oklahoma Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Tulsa, Oklahoma - TOOK						
Arsenic (TSP)	0.00023	119	121	98.35	12.29	12.29
Acetaldehyde	0.45	118	118	100.00	12.19	24.48
Formaldehyde	0.077	118	118	100.00	12.19	36.67
Manganese (TSP)	0.005	118	121	97.52	12.19	48.86
Benzene	0.13	117	117	100.00	12.09	60.95
Carbon Tetrachloride	0.17	115	117	98.29	11.88	72.83
1,3-Butadiene	0.033	80	114	70.18	8.26	81.10
p-Dichlorobenzene	0.091	60	110	54.55	6.20	87.29
Ethylbenzene	0.4	47	117	40.17	4.86	92.15
Tetrachloroethylene	0.17	31	111	27.93	3.20	95.35
Acrylonitrile	0.015	10	10	100.00	1.03	96.38
Propionaldehyde	0.8	8	118	6.78	0.83	97.21
Cadmium (TSP)	0.00056	7	121	5.79	0.72	97.93
Lead (TSP)	0.015	7	121	5.79	0.72	98.66
1,2-Dichloroethane	0.038	6	6	100.00	0.62	99.28
Dichloromethane	2.1	2	117	1.71	0.21	99.48
Xylenes	10	2	117	1.71	0.21	99.69
Cobalt (TSP)	0.01	1	121	0.83	0.10	99.79
Hexachloro-1,3-butadiene	0.045	1	1	100.00	0.10	99.90
Trichloroethylene	0.5	1	33	3.03	0.10	100.00
Total		968	1,929	50.18		
Tulsa, Oklahoma - TSOK						
Acetaldehyde	0.45	41	41	100.00	14.29	14.29
Benzene	0.13	41	41	100.00	14.29	28.57
Formaldehyde	0.077	41	41	100.00	14.29	42.86
Manganese (TSP)	0.005	40	42	95.24	13.94	56.79
Carbon Tetrachloride	0.17	39	40	97.50	13.59	70.38
Arsenic (TSP)	0.00023	38	41	92.68	13.24	83.62
1,3-Butadiene	0.033	20	39	51.28	6.97	90.59
p-Dichlorobenzene	0.091	11	37	29.73	3.83	94.43
Ethylbenzene	0.4	5	41	12.20	1.74	96.17
Tetrachloroethylene	0.17	5	35	14.29	1.74	97.91
Acrylonitrile	0.015	4	5	80.00	1.39	99.30
1,2-Dichloroethane	0.038	1	1	100.00	0.35	99.65
Propionaldehyde	0.8	1	41	2.44	0.35	100.00
Total		287	445	64.49		

Table 22-4. Risk Screening Results for the Oklahoma Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Tulsa, Oklahoma - TUOK						
Acetaldehyde	0.45	72	72	100.00	12.81	12.81
Formaldehyde	0.077	72	72	100.00	12.81	25.62
Arsenic (TSP)	0.00023	71	72	98.61	12.63	38.26
Benzene	0.13	70	70	100.00	12.46	50.71
Carbon Tetrachloride	0.17	69	69	100.00	12.28	62.99
Manganese (TSP)	0.005	68	72	94.44	12.10	75.09
1,3-Butadiene	0.033	55	68	80.88	9.79	84.88
Tetrachloroethylene	0.17	36	66	54.55	6.41	91.28
p-Dichlorobenzene	0.091	21	62	33.87	3.74	95.02
Ethylbenzene	0.4	13	70	18.57	2.31	97.33
Acrylonitrile	0.015	6	6	100.00	1.07	98.40
Cadmium (TSP)	0.00056	2	72	2.78	0.36	98.75
Cobalt (TSP)	0.01	2	72	2.78	0.36	99.11
Propionaldehyde	0.8	2	72	2.78	0.36	99.47
1,2-Dichloroethane	0.038	1	1	100.00	0.18	99.64
Lead (TSP)	0.015	1	72	1.39	0.18	99.82
1,1,2,2-Tetrachloroethane	0.017	1	1	100.00	0.18	100.00
Total		562	989	56.83		
Tulsa, Oklahoma -TMOK						
Acetaldehyde	0.45	44	45	97.78	12.09	12.09
Benzene	0.13	44	44	100.00	12.09	24.18
Carbon Tetrachloride	0.17	44	44	100.00	12.09	36.26
Formaldehyde	0.077	44	45	97.78	12.09	48.35
Manganese (TSP)	0.005	43	45	95.56	11.81	60.16
Arsenic (TSP)	0.00023	38	45	84.44	10.44	70.60
1,3-Butadiene	0.033	37	44	84.09	10.16	80.77
p-Dichlorobenzene	0.091	28	44	63.64	7.69	88.46
Acrylonitrile	0.015	16	16	100.00	4.40	92.86
Ethylbenzene	0.4	12	44	27.27	3.30	96.15
1,2-Dichloroethane	0.038	3	3	100.00	0.82	96.98
Propionaldehyde	0.8	3	44	6.82	0.82	97.80
Tetrachloroethylene	0.17	3	37	8.11	0.82	98.63
Cadmium (TSP)	0.00056	2	45	4.44	0.55	99.18
Chloromethylbenzene	0.02	1	1	100.00	0.27	99.45
Dichloromethane	2.1	1	44	2.27	0.27	99.73
Nickel (TSP)	0.009	1	45	2.22	0.27	100.00
Total		364	635	57.32		

Table 22-4. Risk Screening Results for the Oklahoma Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Cherokee Heights, Pryor Creek, Oklahoma - CNEP						
Arsenic (TSP)	0.00023	21	22	95.45	28.77	28.77
Manganese (TSP)	0.005	20	22	90.91	27.40	56.16
Benzene	0.13	14	14	100.00	19.18	75.34
Carbon Tetrachloride	0.17	14	14	100.00	19.18	94.52
1,3-Butadiene	0.033	3	11	27.27	4.11	98.63
Ethylbenzene	0.4	1	14	7.14	1.37	100.00
Total		73	97	75.26		
Pryor Creek, Oklahoma - PROK						
Benzene	0.13	73	73	100.00	16.37	16.37
Carbon Tetrachloride	0.17	73	73	100.00	16.37	32.74
Formaldehyde	0.077	60	60	100.00	13.45	46.19
Acetaldehyde	0.45	59	60	98.33	13.23	59.42
Arsenic (TSP)	0.00023	58	70	82.86	13.00	72.42
Manganese (TSP)	0.005	53	70	75.71	11.88	84.30
1,3-Butadiene	0.033	25	66	37.88	5.61	89.91
p-Dichlorobenzene	0.091	22	66	33.33	4.93	94.84
Acrylonitrile	0.015	14	14	100.00	3.14	97.98
1,2-Dichloroethane	0.038	4	4	100.00	0.90	98.88
Dichloromethane	2.1	2	73	2.74	0.45	99.33
Ethylbenzene	0.4	1	73	1.37	0.22	99.55
Propionaldehyde	0.8	1	60	1.67	0.22	99.78
Tetrachloroethylene	0.17	1	34	2.94	0.22	100.00
Total		446	796	56.03		
Midwest City, Oklahoma - MWOK						
Acetaldehyde	0.45	39	39	100.00	14.29	14.29
Benzene	0.13	39	39	100.00	14.29	28.57
Carbon Tetrachloride	0.17	39	39	100.00	14.29	42.86
Formaldehyde	0.077	39	39	100.00	14.29	57.14
Arsenic (TSP)	0.00023	29	37	78.38	10.62	67.77
1,3-Butadiene	0.033	25	35	71.43	9.16	76.92
p-Dichlorobenzene	0.091	25	38	65.79	9.16	86.08
Manganese (TSP)	0.005	23	38	60.53	8.42	94.51
Tetrachloroethylene	0.17	9	33	27.27	3.30	97.80
1,2-Dichloroethane	0.038	3	3	100.00	1.10	98.90
Acrylonitrile	0.015	2	2	100.00	0.73	99.63
Ethylbenzene	0.4	1	39	2.56	0.37	100.00
Total		273	381	71.65		

Table 22-4. Risk Screening Results for the Oklahoma Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Oklahoma City, Oklahoma - OCOK						
Acetaldehyde	0.45	39	39	100.00	15.48	15.48
Formaldehyde	0.077	39	39	100.00	15.48	30.95
Benzene	0.13	37	37	100.00	14.68	45.63
Carbon Tetrachloride	0.17	36	37	97.30	14.29	59.92
Arsenic (TSP)	0.00023	31	38	81.58	12.30	72.22
Manganese (TSP)	0.005	28	38	73.68	11.11	83.33
p-Dichlorobenzene	0.091	14	34	41.18	5.56	88.89
1,3-Butadiene	0.033	13	35	37.14	5.16	94.05
Acrylonitrile	0.015	7	7	100.00	2.78	96.83
1,2-Dichloroethane	0.038	4	4	100.00	1.59	98.41
Tetrachloroethylene	0.17	2	23	8.70	0.79	99.21
Dichloromethane	2.1	1	37	2.70	0.40	99.60
Ethylbenzene	0.4	1	37	2.70	0.40	100.00
Total		252	405	62.22		

Observations from Table 22-4 include the following:

- Twenty pollutants failed at least one screen for TOOK; 13 pollutants failed screens for TSOK; 17 pollutants failed at least one screen for TUOK; 17 pollutants failed screens for TMOK; 6 pollutants failed at least one screen for CNEP; 14 pollutants failed screens for PROK; 12 pollutants failed screens for MWOK; and 13 pollutants failed screens for OCOK.

- The risk screening process identified 10 pollutants of interest for TOOK, of which eight are NATTS MQO Core Analytes. Cadmium, lead, and trichloroethylene were added to TOOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. Four additional pollutants (beryllium, chloroform, lead, and vinyl chloride) were added to TOOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These four pollutants do not appear in Table 22-4.

- The risk screening process identified 10 pollutants of interest for TSOK, of which eight are NATTS MQO Core Analytes. Seven additional pollutants (three VOC and four metals) were added to TSOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These additional pollutants do not appear in Table 22-4.

- The risk screening process identified nine pollutants of interest for TUOK, of which eight are NATTS MQO Core Analytes. Cadmium and lead were added to TUOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. Five additional pollutants (beryllium, chloroform, nickel, trichloroethylene, and vinyl chloride) were added to TUOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These five pollutants do not appear in Table 22-4.

- The risk screening process identified 10 pollutants of interest for TMOK, of which seven are NATTS MQO Core Analytes. Cadmium, nickel, and tetrachloroethylene were added to TMOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. Five additional pollutants (beryllium, chloroform, lead, trichloroethylene, and vinyl chloride) were added to TMOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These five pollutants do not appear in Table 22-4.

- The risk screening process identified five pollutants of interest for CNEP, of which all are NATTS MQO Core Analytes. An additional four VOC (chloroform, tetrachloroethylene, trichloroethylene, and vinyl chloride) and four metals (beryllium, cadmium, lead, and nickel) were added to CNEP's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These eight pollutants are not shown in Table 22-4.

- The risk screening process identified nine pollutants of interest for PROK, of which seven are NATTS MQO Core Analytes. Tetrachloroethylene was added to PROK's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. An additional seven pollutants (three VOC and four metals) were added to PROK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These seven pollutants do not appear in Table 22-4.

- The risk screening process identified nine pollutants of interest for MWOK, of which eight are NATTS MQO Core Analytes. An additional seven pollutants (three VOC and four metals) were added to MWOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These seven pollutants do not appear in Table 22-4.

- The risk screening process identified nine pollutants of interest for OCOK, of which seven are NATTS MQO Core Analytes. Tetrachloroethylene was added to OCOK's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. Beryllium, cadmium, chloroform, lead, and nickel were added to OCOK's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These pollutants do not appear in Table 22-4. Trichloroethylene and vinyl chloride are also NATTS MQO Core Analytes, but because these pollutants were not detected at OCOK, they were not included in this site's pollutants of interest.

- Benzene failed 100 percent of screens for each site. If CNEP is excluded (this site sampled only VOC and metals and is therefore the limiting factor), formaldehyde also failed 100 percent of screens for each site.

- The percentage of measured detections failing screens (of the pollutants that failed at least one screen) ranged from 50 percent (TOOK) to 75 percent (CNEP). Note that while TOOK's percentage is the lowest, it had the highest number of pollutants fail screens and the highest number of failed screens.

22.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Oklahoma monitoring sites. Concentration averages are provided for the pollutants of interest for each Oklahoma site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

22.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Oklahoma site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 22-5, where applicable. Note that concentrations of metals are presented in ng/m^3 for ease of viewing in Table 22-5.

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Tulsa, Oklahoma - TOOK												
Acetaldehyde	1.73 ± 0.24	1.18 ± 0.24	1.81 ± 0.35	2.34 ± 0.57	1.74 ± 0.65	1.73 ± 0.24	1.84 ± 0.21	1.59 ± 0.34	2.02 ± 0.49	2.33 ± 0.42	1.39 ± 0.29	1.84 ± 0.21
Benzene	2.61 ± 0.48	1.55 ± 0.62	3.31 ± 0.89	3.37 ± 1.23	2.37 ± 1.06	2.61 ± 0.48	1.78 ± 0.30	2.18 ± 0.78	1.83 ± 0.62	1.61 ± 0.41	1.59 ± 0.60	1.78 ± 0.30
1,3-Butadiene	0.06 ± 0.01	0.07 ± 0.04	0.05 ± 0.02	0.05 ± 0.02	0.06 ± 0.04	0.06 ± 0.01	0.06 ± 0.01	0.10 ± 0.04	0.04 ± 0.01	0.04 ± 0.01	0.06 ± 0.02	0.06 ± 0.01
Carbon Tetrachloride	0.63 ± 0.05	0.55 ± 0.07	0.61 ± 0.06	0.79 ± 0.12	0.57 ± 0.12	0.63 ± 0.05	0.61 ± 0.04	0.56 ± 0.08	0.63 ± 0.04	0.69 ± 0.11	0.58 ± 0.09	0.61 ± 0.04
Chloroform	0.13 ± 0.02	0.05 ± 0.02	0.06 ± 0.03	0.14 ± 0.06	0.13 ± 0.04	0.09 ± 0.02	0.12 ± 0.01	0.10 ± 0.02	0.10 ± 0.03	0.14 ± 0.02	0.11 ± 0.02	0.11 ± 0.01
Ethylbenzene	0.78 ± 0.24	0.39 ± 0.21	1.10 ± 0.64	1.20 ± 0.66	0.48 ± 0.22	0.78 ± 0.24	0.31 ± 0.06	0.46 ± 0.17	0.30 ± 0.09	0.27 ± 0.13	0.25 ± 0.07	0.31 ± 0.06
Formaldehyde	2.98 ± 0.49	1.70 ± 0.28	3.52 ± 0.60	5.14 ± 1.38	1.95 ± 0.54	2.98 ± 0.49	2.73 ± 0.43	1.93 ± 0.29	3.83 ± 0.94	3.66 ± 0.93	1.41 ± 0.26	2.73 ± 0.43
p-Dichlorobenzene	0.17 ± 0.05	0.12 ± 0.07	0.19 ± 0.02	0.12 ± 0.07	0.21 ± 0.20	0.16 ± 0.05	0.14 ± 0.03	0.14 ± 0.09	0.24 ± 0.07	0.12 ± 0.04	0.05 ± 0.01	0.14 ± 0.03
Tetrachloroethylene	0.18 ± 0.07	0.25 ± 0.21	0.13 ± 0.06	0.13 ± 0.06	0.13 ± 0.08	0.17 ± 0.06	0.17 ± 0.04	0.24 ± 0.13	0.16 ± 0.06	0.13 ± 0.04	0.16 ± 0.05	0.17 ± 0.04
Trichloroethylene	0.13 ± 0.06	0.04 ± 0.02	NA	NA	NA	NA	0.09 ± 0.02	NA	NA	NA	NA	NA
Vinyl Chloride	0.01 ± <0.01	NA	NA	NA	NA	NA	0.02 ± 0.01	NA	NA	NA	NA	NA
Arsenic (TSP) [a]	0.89 ± 0.16	0.57 ± 0.14	0.75 ± 0.15	1.20 ± 0.46	1.05 ± 0.37	0.89 ± 0.16	0.68 ± 0.08	0.68 ± 0.16	0.72 ± 0.13	0.68 ± 0.19	0.63 ± 0.21	0.68 ± 0.08

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.
ND = Not detected during sampling for this time period.
[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.
[*] Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

	2008						2009					
Pollutant	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
Beryllium (TSP) [a]	0.02 ± <0.01	0.01 ± <0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± <0.01	0.02 ± <0.01	0.02 ± <0.01	0.02 ± 0.01	0.01 ± 0.01	0.01 ± <0.01	0.01 ± <0.01
Cadmium (TSP) [a]	0.25 ± 0.05	0.27 ± 0.09	0.24 ± 0.07	0.25 ± 0.13	0.25 ± 0.08	0.25 ± 0.05	0.25 ± 0.03	0.26 ± 0.07	0.26 ± 0.06	0.20 ± 0.05	0.26 ± 0.09	0.25 ± 0.03
Lead (TSP) [a]	8.23 ± 2.09	5.66 ± 1.36	12.46 ± 7.41	8.46 ± 3.83	6.78 ± 2.67	8.23 ± 2.09	4.63 ± 0.55	5.72 ± 1.11	5.19 ± 1.38	4.27 ± 0.85	3.32 ± 0.72	4.63 ± 0.55
Manganese (TSP) [a]	25.54 ± 4.12	22.67 ± 7.20	27.36 ± 12.10	24.50 ± 7.02	27.96 ± 8.24	25.54 ± 4.12	19.61 ± 2.32	22.60 ± 3.91	21.65 ± 5.31	19.41 ± 4.51	14.65 ± 4.66	19.61 ± 2.32
Nickel (TSP) [a]	1.53 ± 0.19	1.46 ± 0.38	1.47 ± 0.41	1.57 ± 0.47	1.63 ± 0.38	1.53 ± 0.19	1.04 ± 0.11	1.27 ± 0.26	1.21 ± 0.25	0.86 ± 0.13	0.82 ± 0.18	1.04 ± 0.11
Tulsa, Oklahoma - TSOK												
Acetaldehyde	1.31 ± 0.18	1.09 ± 0.22	1.32 ± 0.31	1.56 ± 0.40	NR	1.31 ± 0.18	NR	NR	NR	NR	NR	NR
Benzene	0.97 ± 0.21	0.86 ± 0.18	0.78 ± 0.14	1.31 ± 0.60	NR	0.97 ± 0.21	NR	NR	NR	NR	NR	NR
1,3-Butadiene	0.05 ± 0.01	0.05 ± 0.02	0.03 ± 0.01	0.05 ± 0.02	NR	0.04 ± 0.01	NR	NR	NR	NR	NR	NR
Carbon Tetrachloride	0.65 ± 0.07	0.51 ± 0.11	0.70 ± 0.11	0.71 ± 0.16	NR	0.64 ± 0.07	NR	NR	NR	NR	NR	NR
Chloroform	0.11 ± 0.02	0.05 ± 0.02	0.07 ± 0.02	0.13 ± 0.05	NR	0.08 ± 0.02	NR	NR	NR	NR	NR	NR
Ethylbenzene	0.24 ± 0.07	0.16 ± 0.07	0.17 ± 0.10	0.40 ± 0.18	NR	0.24 ± 0.07	NR	NR	NR	NR	NR	NR
Formaldehyde	2.83 ± 0.54	1.68 ± 0.33	2.81 ± 0.56	4.18 ± 1.30	NR	2.83 ± 0.54	NR	NR	NR	NR	NR	NR

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ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

[*] Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
p-Dichlorobenzene	0.08 ± 0.02	0.06 ± 0.02	0.07 ± 0.02	0.10 ± 0.05	NR	0.08 ± 0.02	NR	NR	NR	NR	NR	NR
Tetrachloroethylene	0.13 ± 0.05	0.12 ± 0.09	0.11 ± 0.06	0.12 ± 0.08	NR	0.11 ± 0.04	NR	NR	NR	NR	NR	NR
Trichloroethylene	0.11 ± 0.04	0.06 ± 0.04	NA	0.06 ± 0.04	NR	NA	NR	NR	NR	NR	NR	NR
Vinyl Chloride	0.03 ± 0.05	NA	NA	NA	NR	NA	NR	NR	NR	NR	NR	NR
Arsenic (TSP)[a]	0.83 ± 0.31	0.36 ± 0.10	0.61 ± 0.15	1.47 ± 0.84	NR	0.81 ± 0.31	NR	NR	NR	NR	NR	NR
Beryllium (TSP)[a]	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	NR	0.01 ± 0	NR	NR	NR	NR	NR	NR
Cadmium (TSP)[a]	0.15 ± 0.02	0.13 ± 0.03	0.14 ± 0.04	0.17 ± 0.05	NR	0.15 ± 0.02	NR	NR	NR	NR	NR	NR
Lead (TSP)[a]	4.18 ± 0.73	3.67 ± 1.12	4.02 ± 1.27	4.85 ± 1.51	NR	4.18 ± 0.73	NR	NR	NR	NR	NR	NR
Manganese (TSP)[a]	15.91 ± 3.42	14.35 ± 7.33	16.53 ± 6.33	16.83 ± 4.89	NR	15.91 ± 3.42	NR	NR	NR	NR	NR	NR
Nickel (TSP)[a]	1.22 ± 0.22	1.25 ± 0.50	1.02 ± 0.20	1.38 ± 0.40	NR	1.22 ± 0.22	NR	NR	NR	NR	NR	NR
Tulsa, Oklahoma – TUOK												
Acetaldehyde*	1.71 ± 0.22	1.41 ± 0.28	1.77 ± 0.45	2.22 ± 0.58	1.55 ± 0.44	1.71 ± 0.22	1.54 ± 0.28	1.54 ± 0.28	NR	NR	NR	NA
Benzene	1.24 ± 0.23	1.14 ± 0.32	1.17 ± 0.35	1.39 ± 0.75	1.27 ± 0.40	1.24 ± 0.23	1.41 ± 0.34	1.41 ± 0.34	NR	NR	NR	NA

NR = Not reportable because sampling was not conducted during this time period.

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ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

*Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
1,3-Butadiene	0.07 ± 0.02	0.09 ± 0.03	0.05 ± 0.02	0.06 ± 0.02	0.07 ± 0.04	0.07 ± 0.02	0.09 ± 0.03	0.09 ± 0.03	NR	NR	NR	NA
Carbon Tetrachloride	0.67 ± 0.05	0.56 ± 0.07	0.63 ± 0.14	0.79 ± 0.09	0.66 ± 0.13	0.66 ± 0.05	0.61 ± 0.10	0.61 ± 0.10	NR	NR	NR	NA
Chloroform	0.12 ± 0.02	0.08 ± 0.02	NA	0.14 ± 0.06	0.12 ± 0.02	0.10 ± 0.02	0.08 ± 0.01	0.08 ± 0.02	NR	NR	NR	NA
Formaldehyde	2.75 ± 0.38	2.34 ± 0.34	2.86 ± 0.68	4.15 ± 1.25	1.97 ± 0.43	2.75 ± 0.38	2.22 ± 0.31	2.22 ± 0.31	NR	NR	NR	NA
p-Dichlorobenzene	0.09 ± 0.01	0.12 ± 0.03	0.07 ± 0.01	0.08 ± 0.03	0.06 ± 0.04	0.08 ± 0.01	0.08 ± 0.06	0.07 ± 0.06	NR	NR	NR	NA
Tetrachloroethylene	0.28 ± 0.07	0.17 ± 0.08	0.21 ± 0.07	0.33 ± 0.12	0.35 ± 0.22	0.27 ± 0.07	0.24 ± 0.14	0.24 ± 0.14	NR	NR	NR	NA
Trichloroethylene	0.13 ± 0.06	NA	NA	NA	NA	NA	0.12 ± 0.10	NA	NR	NR	NR	NA
Vinyl Chloride	0.01 ± <0.01	<0.01 ± <0.01	NA	NA	NA	NA	0.01 ± <0.01	NA	NR	NR	NR	NA
Arsenic (TSP) [a]	1.14 ± 0.44	0.47 ± 0.08	0.56 ± 0.12	1.44 ± 1.09	2.19 ± 1.36	1.14 ± 0.44	0.65 ± 0.21	0.65 ± 0.21	NR	NR	NR	NA
Beryllium (TSP) [a]	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	0.02 ± 0.01	0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	NR	NR	NR	NA
Cadmium (TSP) [a]	0.16 ± 0.03	0.15 ± 0.03	0.14 ± 0.04	0.15 ± 0.04	0.21 ± 0.08	0.16 ± 0.03	0.24 ± 0.09	0.24 ± 0.09	NR	NR	NR	NA
Lead (TSP) [a]	4.47 ± 0.87	4.21 ± 0.87	4.86 ± 2.75	4.35 ± 1.59	4.46 ± 1.67	4.47 ± 0.87	5.58 ± 1.55	5.58 ± 1.55	NR	NR	NR	NA
Manganese (TSP) [a]	14.94 ± 2.48	15.27 ± 4.15	14.86 ± 5.85	10.41 ± 3.36	18.60 ± 6.00	14.94 ± 2.48	16.78 ± 2.53	16.78 ± 2.53	NR	NR	NR	NA

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[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

*Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Nickel (TSP)[a]	0.98 ± 0.12	1.00 ± 0.20	0.77 ± 0.13	0.98 ± 0.21	1.18 ± 0.36	0.98 ± 0.12	1.15 ± 0.47	1.15 ± 0.47	NR	NR	NR	NA
Tulsa, Oklahoma - TMOK												
Acetaldehyde	NR	NR	NR	NR	NR	NR	1.92 ± 0.25	NR	2.26 ± 0.49	1.93 ± 0.31	1.52 ± 0.42	1.92 ± 0.25
Acrylonitrile	NR	NR	NR	NR	NR	NR	0.20 ± 0.08	NR	0.09 ± 0.06	NA	NA	NA
Benzene	NR	NR	NR	NR	NR	NR	1.43 ± 0.23	NR	1.51 ± 0.43	1.41 ± 0.34	1.34 ± 0.48	1.43 ± 0.23
1,3-Butadiene	NR	NR	NR	NR	NR	NR	0.07 ± 0.01	NR	0.07 ± 0.02	0.06 ± 0.01	0.08 ± 0.02	0.07 ± 0.01
Carbon Tetrachloride	NR	NR	NR	NR	NR	NR	0.69 ± 0.04	NR	0.65 ± 0.05	0.75 ± 0.07	0.66 ± 0.09	0.69 ± 0.04
Chloroform	NR	NR	NR	NR	NR	NR	0.12 ± 0.01	NR	0.10 ± 0.02	0.14 ± 0.03	0.12 ± 0.03	0.12 ± 0.02
Ethylbenzene	NR	NR	NR	NR	NR	NR	0.35 ± 0.06	NR	0.39 ± 0.12	0.32 ± 0.07	0.33 ± 0.15	0.35 ± 0.06
Formaldehyde	NR	NR	NR	NR	NR	NR	3.49 ± 0.58	NR	4.68 ± 1.07	3.44 ± 0.92	2.17 ± 0.59	3.49 ± 0.58
p-Dichlorobenzene	NR	NR	NR	NR	NR	NR	0.16 ± 0.04	NR	0.25 ± 0.08	0.11 ± 0.03	0.09 ± 0.03	0.16 ± 0.04
Tetrachloroethylene	NR	NR	NR	NR	NR	NR	0.11 ± 0.02	NR	0.11 ± 0.04	0.08 ± 0.04	0.08 ± 0.05	0.09 ± 0.02
Trichloroethylene	NR	NR	NR	NR	NR	NR	0.10 ± 0.03	NR	0.04 ± 0.03	NA	NA	NA

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*Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Vinyl Chloride	NR	NR	NR	NR	NR	NR	0.01 ± 0.01	NR	NA	NA	NA	NA
Arsenic (TSP) [a]	NR	NR	NR	NR	NR	NR	0.99 ± 0.26	NR	1.17 ± 0.56	1.21 ± 0.43	0.59 ± 0.31	0.99 ± 0.26
Beryllium (TSP) [a]	NR	NR	NR	NR	NR	NR	0.03 ± 0.01	NR	0.06 ± 0.04	0.02 ± 0.01	0.02 ± 0.01	0.03 ± 0.01
Cadmium (TSP) [a]	NR	NR	NR	NR	NR	NR	0.21 ± 0.05	NR	0.31 ± 0.11	0.17 ± 0.06	0.17 ± 0.04	0.21 ± 0.05
Lead (TSP) [a]	NR	NR	NR	NR	NR	NR	4.04 ± 0.70	NR	5.51 ± 1.50	3.45 ± 0.60	3.16 ± 1.15	4.04 ± 0.70
Manganese (TSP) [a]	NR	NR	NR	NR	NR	NR	31.46 ± 11.43	NR	56.31 ± 30.44	19.03 ± 5.56	19.04 ± 8.84	31.46 ± 11.43
Nickel (TSP) [a]	NR	NR	NR	NR	NR	NR	1.41 ± 0.50	NR	2.52 ± 1.33	0.82 ± 0.15	0.90 ± 0.36	1.41 ± 0.50
Cherokee Heights, Pryor Creek, Oklahoma - CNEP												
Benzene	0.70 ± 0.29	0.70 ± 0.29	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR
1,3-Butadiene	0.04 ± 0.02	0.03 ± 0.02	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR
Carbon Tetrachloride	0.75 ± 0.09	0.75 ± 0.09	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR
Chloroform	0.08 ± 0.01	0.08 ± 0.01	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR
Tetrachloroethylene	0.05 ± 0.01	0.03 ± 0.02	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR

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[a] Average concentrations provided for the pollutants below the black line are presented in ng/m³ for ease of viewing.
[*]Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Trichloroethylene	0.04 ± 0.02	NA	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR
Vinyl Chloride	0.01 ± <0.01	NA	NR	NR	NR	NA	NR	NR	NR	NR	NR	NR
Arsenic (TSP)[a]	NR	NR	NR	NR	NR	NR	0.56 ± 0.13	0.56 ± 0.15	0.55 ± 0.26	NR	NR	NR
Beryllium (TSP)[a]	NR	NR	NR	NR	NR	NR	0.01 ± <0.01	0.02 ± 0.01	0.01 ± <0.01	NR	NR	NR
Cadmium (TSP)[a]	NR	NR	NR	NR	NR	NR	0.16 ± 0.04	0.16 ± 0.06	0.15 ± 0.04	NR	NR	NR
Lead (TSP)[a]	NR	NR	NR	NR	NR	NR	3.11 ± 0.74	3.32 ± 1.12	2.79 ± 0.99	NR	NR	NR
Manganese (TSP)[a]	NR	NR	NR	NR	NR	NR	11.28 ± 2.27	11.73 ± 2.52	10.63 ± 4.66	NR	NR	NR
Nickel (TSP)[a]	NR	NR	NR	NR	NR	NR	0.84 ± 0.15	0.87 ± 0.23	0.80 ± 0.21	NR	NR	NR
Pryor Creek, Oklahoma – PROK												
Acetaldehyde	1.16 ± 0.33	NR	NR	NR	1.16 ± 0.33	NA*	1.22 ± 0.17	1.45 ± 0.49	NA	1.07 ± 0.25	1.03 ± 0.13	NA*
Acrylonitrile	ND	NR	NR	NR	ND	ND	0.15 ± 0.04	NA	0.10 ± 0.05	NA	NA	NA
Benzene	0.68 ± 0.17	NR	NR	NR	0.68 ± 0.17	NA	0.70 ± 0.12	1.17 ± 0.43	0.73 ± 0.16	0.47 ± 0.07	0.52 ± 0.10	0.70 ± 0.12
1,3-Butadiene	0.03 ± 0.01	NR	NR	NR	0.03 ± 0.01	NA	0.03 ± <0.01	0.05 ± 0.01	0.02 ± <0.01	0.01 ± <0.01	0.03 ± 0.01	0.03 ± <0.01

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Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)	Daily Average (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Carbon Tetrachloride	0.66 ± 0.10	NR	NR	NR	0.66 ± 0.10	NA	0.66 ± 0.04	0.59 ± 0.10	0.66 ± 0.06	0.74 ± 0.05	0.63 ± 0.11	0.66 ± 0.04
Chloroform	0.12 ± 0.02	NR	NR	NR	0.12 ± 0.02	NA	0.32 ± 0.16	0.09 ± 0.01	0.10 ± 0.02	0.75 ± 0.48	0.19 ± 0.08	0.30 ± 0.15
Formaldehyde	2.02 ± 0.45	NR	NR	NR	2.02 ± 0.45	NA*	7.79 ± 6.42	20.83 ± 24.82	NA	4.91 ± 1.08	1.07 ± 0.19	NA*
p-Dichlorobenzene	0.06 ± 0.02	NR	NR	NR	0.04 ± 0.02	NA	0.13 ± 0.03	0.12 ± 0.11	0.23 ± 0.05	0.07 ± 0.03	0.05 ± 0.02	0.12 ± 0.03
Tetrachloroethylene	0.07 ± <0.01	NR	NR	NR	NA	NA	0.06 ± 0.02	0.05 ± 0.05	0.05 ± 0.02	NA	NA	NA
Trichloroethylene	ND	NR	NR	NR	ND	ND	0.05 ± 0.05	NA	NA	NA	NA	NA
Vinyl Chloride	0.03 ± <0.01	NR	NR	NR	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA
Arsenic (TSP) [a]	0.55 ± 0.22	NR	NR	NR	0.55 ± 0.22	NA*	0.49 ± 0.07	0.54 ± 0.14	0.48 ± 0.15	0.48 ± 0.13	0.45 ± 0.17	0.49 ± 0.07
Beryllium (TSP) [a]	0.01 ± <0.01	NR	NR	NR	0.01 ± <0.01	NA*	0.01 ± <0.01	0.01 ± <0.01	0.02 ± 0.01	0.01 ± 0.01	0.01 ± <0.01	0.01 ± <0.01
Cadmium (TSP) [a]	0.17 ± 0.06	NR	NR	NR	0.17 ± 0.06	NA*	0.14 ± 0.03	0.18 ± 0.07	0.14 ± 0.04	0.09 ± 0.02	0.14 ± 0.06	0.14 ± 0.03
Lead (TSP) [a]	2.29 ± 0.69	NR	NR	NR	2.29 ± 0.69	NA*	2.35 ± 0.47	3.41 ± 1.71	2.52 ± 0.73	1.70 ± 0.34	1.86 ± 0.54	2.35 ± 0.47
Manganese (TSP) [a]	11.06 ± 3.88	NR	NR	NR	11.06 ± 3.88	NA*	8.84 ± 1.22	10.09 ± 1.67	9.49 ± 2.65	9.56 ± 3.30	6.43 ± 1.88	8.84 ± 1.22

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m³ for ease of viewing.

*Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Nickel (TSP) [a]	0.72 ± 0.15	NR	NR	NR	0.72 ± 0.15	NA*	0.49 ± 0.05	0.59 ± 0.07	0.57 ± 0.10	0.42 ± 0.07	0.38 ± 0.08	0.49 ± 0.05
Midwest City, Oklahoma – MWOK												
Acetaldehyde	NR	NR	NR	NR	NR	NR	1.24 ± 0.12	NR	1.57 ± 0.20	1.30 ± 0.18	1.01 ± 0.16	1.24 ± 0.12
Benzene	NR	NR	NR	NR	NR	NR	0.66 ± 0.08	NR	0.90 ± 0.26	0.60 ± 0.09	0.60 ± 0.08	0.66 ± 0.08
1,3-Butadiene	NR	NR	NR	NR	NR	NR	0.05 ± 0.01	NR	0.06 ± 0.01	0.03 ± 0.01	0.04 ± 0.02	0.04 ± 0.01
Carbon Tetrachloride	NR	NR	NR	NR	NR	NR	0.71 ± 0.06	NR	0.62 ± 0.05	0.82 ± 0.12	0.64 ± 0.08	0.71 ± 0.06
Chloroform	NR	NR	NR	NR	NR	NR	0.10 ± 0.01	NR	0.09 ± 0.02	0.11 ± 0.02	0.09 ± 0.02	0.10 ± 0.01
Formaldehyde	NR	NR	NR	NR	NR	NR	2.65 ± 0.56	NR	4.43 ± 1.29	3.27 ± 0.77	1.18 ± 0.24	2.65 ± 0.56
p-Dichlorobenzene	NR	NR	NR	NR	NR	NR	0.15 ± 0.05	NR	0.22 ± 0.08	0.17 ± 0.12	0.08 ± 0.01	0.14 ± 0.05
Tetrachloroethylene	NR	NR	NR	NR	NR	NR	0.17 ± 0.07	NR	0.21 ± 0.08	0.09 ± 0.04	0.17 ± 0.15	0.15 ± 0.06
Trichloroethylene	NR	NR	NR	NR	NR	NR	0.07 ± 0.04	NR	NA	NA	NA	NA
Vinyl Chloride	NR	NR	NR	NR	NR	NR	0.01 ± 0.01	NR	NA	NA	NA	NA
Arsenic (TSP) [a]	NR	NR	NR	NR	NR	NR	1.24 ± 0.12	NR	1.57 ± 0.20	1.30 ± 0.18	1.01 ± 0.16	1.24 ± 0.12

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

[*] Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Beryllium (TSP) [a]	NR	NR	NR	NR	NR	NR	0.01 ± <0.01	NR	0.01 ± <0.01	0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01
Cadmium (TSP) [a]	NR	NR	NR	NR	NR	NR	0.09 ± 0.02	NR	0.10 ± 0.03	0.07 ± 0.02	0.10 ± 0.03	0.09 ± 0.02
Lead (TSP) [a]	NR	NR	NR	NR	NR	NR	2.05 ± 0.31	NR	2.05 ± 0.26	1.93 ± 0.43	2.16 ± 0.70	2.05 ± 0.31
Manganese (TSP) [a]	NR	NR	NR	NR	NR	NR	7.40 ± 1.33	NR	9.02 ± 1.03	9.11 ± 2.67	4.81 ± 1.37	7.40 ± 1.33
Nickel (TSP) [a]	NR	NR	NR	NR	NR	NR	0.89 ± 0.30	NR	1.29 ± 1.24	0.90 ± 0.36	0.65 ± 0.28	0.89 ± 0.30
Oklahoma City, Oklahoma – OCOK												
Acetaldehyde	NR	NR	NR	NR	NR	NR	1.65 ± 0.16	NR	NA	1.85 ± 0.27	1.37 ± 0.21	NA
Acrylonitrile	NR	NR	NR	NR	NR	NR	0.23 ± 0.08	NR	NA	NA	NA	NA
Benzene	NR	NR	NR	NR	NR	NR	0.73 ± 0.07	NR	0.84 ± 0.11	0.74 ± 0.14	0.68 ± 0.11	0.73 ± 0.07
1,3-Butadiene	NR	NR	NR	NR	NR	NR	0.03 ± 0.01	NR	0.03 ± 0.01	0.02 ± <0.01	0.04 ± 0.01	0.03 ± 0.01
Carbon Tetrachloride	NR	NR	NR	NR	NR	NR	0.65 ± 0.06	NR	0.67 ± 0.06	0.81 ± 0.07	0.52 ± 0.09	0.65 ± 0.06
Chloroform	NR	NR	NR	NR	NR	NR	0.10 ± 0.01	NR	0.10 ± 0.03	0.11 ± 0.03	0.09 ± 0.01	0.10 ± 0.01
Formaldehyde	NR	NR	NR	NR	NR	NR	2.80 ± 0.40	NR	NA	3.45 ± 0.65	1.86 ± 0.25	NA

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.
ND = Not detected during sampling for this time period.
[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.
[*]Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Table 22-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
p-Dichlorobenzene	NR	NR	NR	NR	NR	NR	0.18 ± 0.18	NR	0.08 ± 0.03	0.34 ± 0.49	0.07 ± 0.02	0.16 ± 0.17
Tetrachloroethylene	NR	NR	NR	NR	NR	NR	0.10 ± 0.02	NR	0.11 ± 0.06	NA	0.07 ± 0.03	NA
Arsenic (TSP) [a]	NR	NR	NR	NR	NR	NR	0.52 ± 0.16	NR	0.61 ± 0.15	0.45 ± 0.14	0.54 ± 0.39	0.52 ± 0.16
Beryllium (TSP) [a]	NR	NR	NR	NR	NR	NR	0.01 ± <0.01	NR	0.02 ± 0.01	0.01 ± <0.01	0.01 ± 0.01	0.01 ± <0.01
Cadmium (TSP) [a]	NR	NR	NR	NR	NR	NR	0.08 ± 0.02	NR	0.09 ± 0.03	0.07 ± 0.02	0.09 ± 0.03	0.08 ± 0.02
Lead (TSP) [a]	NR	NR	NR	NR	NR	NR	1.89 ± 0.32	NR	2.52 ± 0.45	1.64 ± 0.43	1.81 ± 0.63	1.89 ± 0.32
Manganese (TSP) [a]	NR	NR	NR	NR	NR	NR	11.33 ± 2.29	NR	16.53 ± 3.58	11.19 ± 3.38	8.69 ± 4.03	11.33 ± 2.29
Nickel (TSP) [a]	NR	NR	NR	NR	NR	NR	0.54 ± 0.08	NR	0.71 ± 0.14	0.55 ± 0.15	0.44 ± 0.11	0.54 ± 0.08

NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

*Method completeness was less than 85 percent for PROK carbonyl compounds (both years) and metals (2008).

Observations for the Tulsa sites from Table 22-5 include the following:

- Formaldehyde had the highest daily average concentration by mass for each site, followed by acetaldehyde and benzene, with one exception. For 2008, the average daily concentration for benzene was greater than the average daily concentration of acetaldehyde for TOOK.

- For TMOK, several of the metals have relatively large confidence intervals associated with their second quarter 2009 averages. For beryllium, lead, manganese, and nickel, the maximum concentrations were measured on June 18, 2009 and June 6, 2009. Several of the highest metals measurements were from samples collected at the TMOK site. For example, TMOK had the highest two measurements of beryllium among all NMP sites sampling TSP or PM_{10} metals; further, of the 13 concentrations greater than or equal to 0.5 ng/m^3 among all sites, over half were measured at TMOK. TMOK also had the second and third highest manganese concentration measured at any NMP site measuring metals (behind only S4MO). The fifth highest concentration of nickel among any of the NMP sites sampling metals was measured at TMOK.

- Several of the quarterly average concentrations of benzene for TOOK have fairly large confidence intervals. The highest benzene concentration was measured on September 27, 2008 (8.26 µg/m^3), which was the tenth highest benzene measurement among all sites sampling this pollutant. Of the 59 concentrations of benzene that are greater than 5 µg/m^3 (among all NMP sites), 11 of these were measured at TOOK. Of these 11 concentrations, nine were measured in 2008, which explains the significant difference between the 2008 and 2009 daily average concentration. One of the measurements greater than 5 µg/m^3 was measured at TUOK, which likely explains it's relatively high third quarter 2008 benzene confidence interval.

- Both lead and manganese have relatively large confidence intervals associated with their second quarter 2008 averages for TOOK. The two highest concentrations of manganese, measured on May 21, 2008 and April 30, 2008 (74.75 ng/m^3 and 74.55 ng/m^3, respectively), ranked sixth and seventh highest among all NMP sites sampling metals. Similarly, the two highest concentrations of lead, measured on June 5, 2008 and April 30, 2008 (50.45 ng/m^3 and 29.63 ng/m^3, respectively), ranked fifth and 15th highest among all NMP sites sampling metals.

- The third and fourth quarter 2008 averages of arsenic for TUOK are higher than the other quarterly averages and have relatively large confidence intervals associated with them. Of all NMP sites sampling arsenic, TUOK has the third, fourth, and sixth highest measurements of this pollutant. Of the 12 measurements of arsenic greater than 4 ng/m^3 among all NMP sites, one-third of them were from samples collected at TUOK (and all four of these concentrations were measured between September 27, 2008 and October 21, 2008).

- TSOK also had a relatively large confidence interval associated with its high third quarter arsenic average for 2008 (no fourth quarter average is available because sampling ended in September 2008). There are seven measurements of arsenic greater than 1 ng/m^3 from TSOK, and five of them were from samples collected during the third quarter of 2008. The arsenic concentration from the September 27, 2008 sample was the seventh highest arsenic concentration measured among all NMP sites sampling metals.

Observations for CNEP from Table 22-5 include the following:

- Carbon tetrachloride (0.75 ± 0.09 µg/m^3) and benzene (0.70 ± 0.29 µg/m^3) exhibited the highest daily average concentrations by mass for the VOC measured in 2008.

- Because sampling was conducted at CNEP from January through March 2008, only first quarter averages could be calculated.

- Manganese (11.28 ± 2.27 ng/m^3) and lead (3.11 ± 0.74 ng/m^3) exhibited the highest daily average concentrations by mass for the TSP metals measured in 2009.

- Because metals sampling was conducted at CNEP from January through May 2009, only first and second quarter averages could be calculated.

Observations for PROK from Table 22-5 include the following:

- Formaldehyde, acetaldehyde, and benzene were the pollutants with the highest daily average concentrations by mass for both years for PROK.

- Because sampling was conducted at PROK from October through December 2008, only fourth quarter averages could be calculated for 2008. Further, method completeness was less than 85 percent for carbonyl compounds and metals for 2008. Several VOC do not have quarterly averages for 2009 because they were detected infrequently and thus do not have annual averages for 2009. Additionally, method completeness was less than 85 percent for carbonyl compounds for 2009; thus, annual averages could not be calculated for carbonyl compounds for 2009.

- There is a significant difference between the 2008 and 2009 daily average concentrations of formaldehyde for PROK. In addition, there is a large confidence interval associated with the 2009 daily average, indicating the likely influence of outliers. The two highest concentrations of formaldehyde were measured on March 26, 2009 (118 µg/m^3) and March 14, 2009 (117 µg/m^3). Both concentrations are an order of magnitude higher than the third highest concentration, also measured in March 2009 (17.1 µg/m^3). The two highest acetaldehyde concentrations were also measured on March 14 and March 26, but were not as high. The maximum concentrations of several VOC were also measured on these dates in March.

Observations for the Oklahoma City sites from Table 22-5 include the following:

- OCOK and MWOK began sampling in May 2009.

- Formaldehyde and acetaldehyde had the highest daily average concentrations by mass for both sites. The concentrations for these pollutants were similar in value for each site, as were most of the other pollutants of interest. A few differences include the arsenic concentration at MWOK was twice the arsenic concentration at OCOK; also, trichloroethylene and vinyl chloride were not detected at OCOK, but were at MWOK.

- The second quarter 2009 average concentrations were the highest among the quarterly averages for several of the pollutants of interest for MWOK, although not necessarily significantly higher.

- The second quarter 2009 nickel average concentration for MWOK has a large confidence interval associated with it, indicating the presence of outliers. The highest nickel concentration was measured on June 24, 2009 (5.28 ng/m^3). The next highest concentration was measured a month later and was roughly half the concentration (2.91 ng/m^3).

- For OCOK, annual averages could not be calculated for the carbonyl compounds because there were not three valid quarterly averages (because several invalid samples during the second quarter of 2009 resulted in fewer than seven measured detections for this quarter).

- With the exception of cadmium, the second quarter 2009 average concentrations of the metals were the highest among the quarterly averages for OCOK, although not necessarily significantly higher.

- The daily average, third quarter average, and annual average of *p*-dichlorobenzene for OCOK have large confidence intervals associated with them, indicating the presence of outliers. The highest concentration of this pollutant was measured on September 22, 2009 (3.18 µg/m^3) and is an order of magnitude higher than the next highest concentration (0.199 µg/m^3). Further, this is the fifth highest concentration of *p*-dichlorobenzene measured among all NMP sites sampling VOC.

- The fourth quarter 2009 average arsenic concentration for OCOK has a large confidence interval associated with it, indicating the presence of outliers. The highest arsenic concentration was measured on October 10, 2009 (3.11 ng/m^3) and is three times higher than the next highest concentration (0.993 ng/m^3).

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Oklahoma sites include the following:

- TOOK had the third highest daily average of concentration of benzene (2.61 ± 0.48 µg/m^3, 2008), behind only ANAK and ELNJ, as shown in Table 4-9. TOOK also had the third highest daily average of concentration of ethylbenzene (0.78 ± 0.24 µg/m^3, 2008), behind only ANAK and ELNJ.

- PROK had the second highest daily average concentration of formaldehyde (7.79 ± 6.42 μg/m^3, 2009), behind only INDEM's daily average concentration of formaldehyde (although PROK's daily average was an order of magnitude lower than INDEM's). No other Oklahoma site appears in Table 4-10 for the carbonyl compounds.

- The Oklahoma sites were the only NMP sites to monitor for TSP metals, so they are the only sites that appear in Table 4-12 under TSP metals. TMOK had the highest daily average concentration of beryllium among all NMP sites sampling metals (both PM_{10} or TSP) and TOOK had the highest daily average concentration of manganese among all NMP sites sampling metals (both PM_{10} or TSP).

22.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. None of the Oklahoma sites have sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

22.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Oklahoma monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

22.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Oklahoma monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of this screening are summarized in Table 22-6. Where a quarterly or annual average exceeds the applicable MRL, the concentration is bolded.

Table 22-6. MRL Risk Screening Assessment Summary for the Oklahoma Monitoring Sites

		Acute			**Intermediate**					**Chronic**	
Pollutant	**Year**	**ATSDR Acute MRL^1 (µg/m^3)**	**# of Concentrations > MRL**	**# of Measured Detections**	**ATSDR Intermediate MRL^1 (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**ATSDR Chronic MRL^1 (µg/m^3)**	**Annual Average (µg/m^3)**
Pryor Creek, Oklahoma - PROK											
Formaldehyde	2008	50	0	10	40	NR	NR	NR	2.02 ± 0.45	10	NA*
	2009		2	50		20.83 ± 24.82	NA	4.91 ± 1.08	1.07 ± 0.19		NA*

Bolded = a quarterly or annual average concentration is greater than one or more of the intermediate or chronic MRLs.

[1] Reflects the use of one significant digit for MRL.

NA= Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not available because sampling was not conducted during this quarter.

* Method completeness less than 85 percent.

Observations from Table 22-6 include the following:

- Formaldehyde was the only pollutant of interest (for PROK) where a preprocessed daily measurement and/or time-period average was greater than one or more of the MRL health risk benchmarks.

- Two out of 50 (four percent) measured detections of formaldehyde from 2009 were greater than the ATSDR acute MRL for formaldehyde (50 $\mu g/m^3$). Conversely, no measured detections of formaldehyde from 2008 exceeded the ATSDR acute MRL for formaldehyde.

- None of the quarterly averages of formaldehyde, where they could be calculated, were greater than the ATSDR intermediate MRL.

- Annual averages of formaldehyde for 2008 could not be calculated for PROK because 1) sampling began in October 2008, and 2) method completeness was less than 85 percent. Annual averages of formaldehyde for 2009 could not be calculated for PROK because method completeness was also less than 85 percent.

For the pollutants whose concentrations were greater than their respective ATSDR acute MRL noncancer health risk benchmark, the concentrations were further examined by developing pollution roses for those pollutants. A pollution rose is a plot of concentration vs. wind speed and wind direction, as described in Section 3.5.4.1. Figure 22-39 is the formaldehyde pollution rose for PROK.

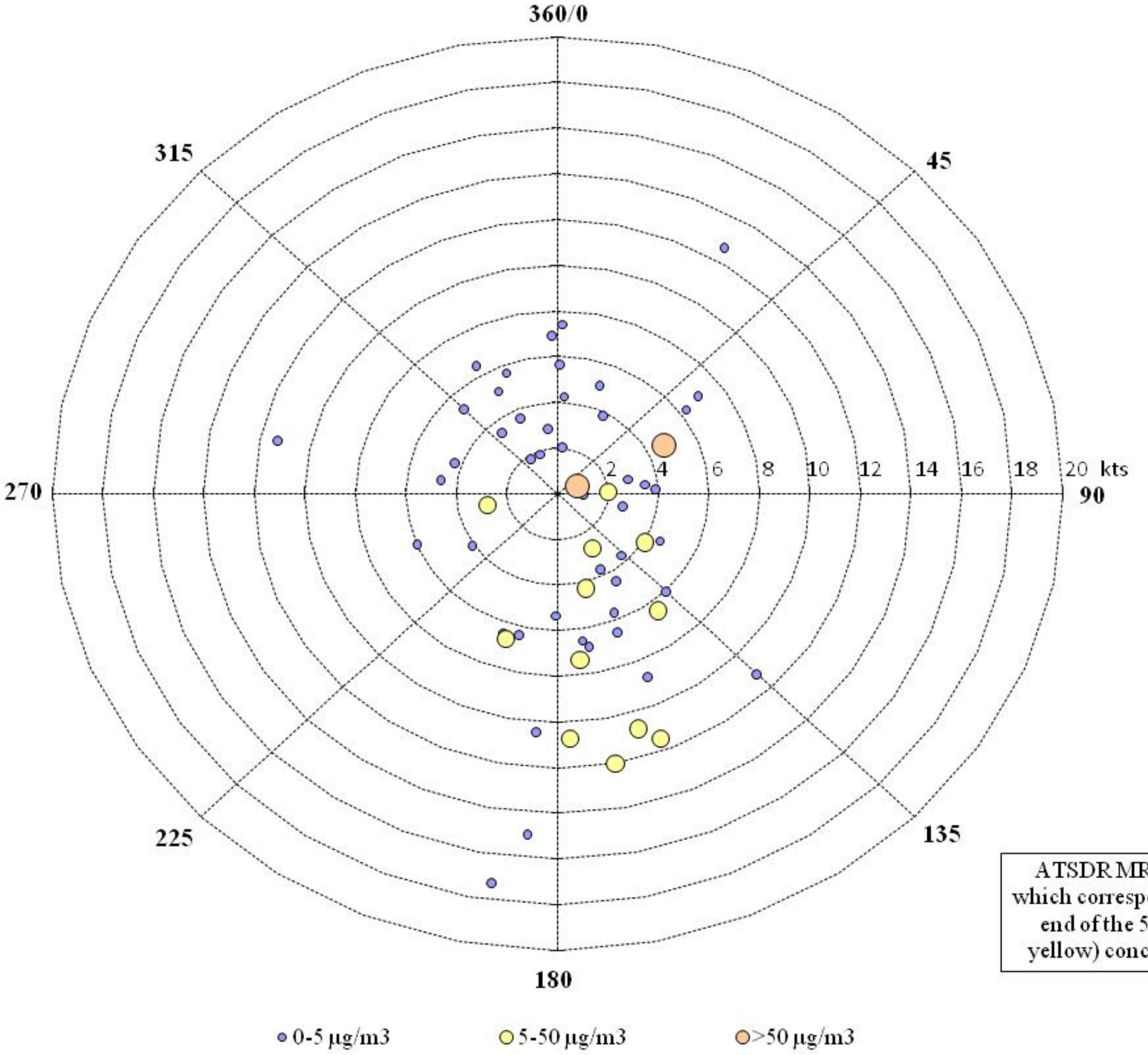
Observations from Figure 22-39 for PROK include the following:

- There were two measured detections that were greater than the ATSDR acute MRL for formaldehyde (shown in orange).

- The two concentrations greater than the ATSDR acute MRL were measured on days with winds blowing from the east-northeast (on average).

- Other higher concentrations of formaldehyde (shown in yellow) were measured on days with wind observations from the south (7), southeast (3), east (1), and west (1), on average.

Figure 22-39. Formaldehyde Pollution Rose for PROK



ATSDR MRL = 50 µg/m^3, which corresponds to the upper end of the 5-50 µg/m^3 (or yellow) concentration range

22.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Oklahoma monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 22-7, where applicable.

Observations from Table 22-7 include the following:

- Formaldehyde and benzene had the highest cancer risk approximations for all of the Oklahoma monitoring sites, where they could be calculated. Benzene cancer risk approximations ranged from 5.17 in-a-million for MWOK in 2009 to 20.38 in-a-million for TOOK in 2008. Formaldehyde cancer risk approximations ranged from 34.46 in-a-million for MWOK in 2009 to 45.31 in-a-million for TMOK in 2009.

- Among the metals, arsenic had the highest cancer risk approximations for all of the Oklahoma monitoring sites, ranging from 2.06 in-a-million for OCOK (2009) to 4.92 in-a-million for TUOK (2008).

- None of the pollutants of interest had noncancer risk approximations greater than 1.0, the HQ level of concern.

- For TOOK, formaldehyde, benzene, and arsenic had the highest cancer risk approximations for 2008, while formaldehyde, benzene, and acetaldehyde had the highest cancer risk approximations for 2009. Note that the difference between the cancer risk approximations for arsenic and acetaldehyde for 2008 are very similar.

- For TSOK, formaldehyde, benzene, and carbon tetrachloride had the highest cancer risk approximations for 2008.

- For TUOK, formaldehyde, benzene, and arsenic had the highest cancer risk approximations for 2008.

- For TMOK, formaldehyde, benzene, and arsenic had the highest cancer risk approximations for 2009.

- Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for the pollutants of interest for CNEP because of the abbreviated sample periods for each year.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Tulsa, Oklahoma - TOOK										
Acetaldehyde	0.0000022	0.009	56/4	1.73 ± 0.24	3.80	0.19	62/4	1.84 ± 0.21	4.04	0.20
Arsenic (TSP)[a]	0.0043	0.000015	60/4	<0.01 ± <0.01	3.82	0.06	61/4	<0.01 ± <0.01	2.91	0.05
Benzene	0.0000078	0.03	57/4	2.61 ± 0.48	20.38	0.09	60/4	1.78 ± 0.30	13.91	0.06
Beryllium (TSP)[a]	0.0024	0.00002	60/4	<0.01 ± <0.01	0.04	<0.01	57/4	<0.01 ± <0.01	0.03	<0.01
1,3-Butadiene	0.00003	0.002	56/4	0.06 ± 0.01	1.76	0.03	58/4	0.06 ± 0.01	1.79	0.03
Cadmium (TSP)[a]	0.0018	0.00001	60/4	<0.01 ± <0.01	0.45	0.03	61/4	<0.01 ± <0.01	0.45	0.02
Carbon Tetrachloride	0.000006	0.1	57/4	0.63 ± 0.05	3.75	0.01	60/4	0.61 ± 0.04	3.69	0.01
Chloroform	--	0.098	39/4	0.09 ± 0.02	--	<0.01	58/4	0.11 ± 0.01	--	<0.01
p-Dichlorobenzene	0.000011	0.8	52/4	0.16 ± 0.05	1.74	<0.01	58/4	0.14 ± 0.03	1.49	<0.01
Ethylbenzene	0.0000025	1	57/4	0.78 ± 0.24	1.96	<0.01	60/4	0.31 ± 0.06	0.79	<0.01
Formaldehyde	0.000013	0.0098	56/4	2.98 ± 0.49	38.76	0.30	62/4	2.73 ± 0.43	35.55	0.28
Lead (TSP)[a]	--	0.00015	60/4	0.01 ± <0.01	--	0.05	61/4	<0.01 ± <0.01	--	0.03

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Manganese (TSP)[a]	--	0.00005	60/4	0.03 ± <0.01	--	0.51	61/4	0.02 ± <0.01	--	0.39
Nickel (TSP)[a]	0.000312	0.00009	60/4	<0.01 ± <0.01	0.48	0.02	61/4	<0.01 ± <0.01	0.33	0.01
Tetrachloroethylene	0.0000059	0.27	52/4	0.17 ± 0.06	0.98	<0.01	59/4	0.17 ± 0.04	1.00	<0.01
Trichloroethylene	0.000002	0.6	18/1	NA	NA	NA	15/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	6/0	NA	NA	NA	7/0	NA	NA	NA
Tulsa, Oklahoma - TSOK										
Acetaldehyde	0.0000022	0.009	41/3	1.31 ± 0.18	2.89	0.15	NR	NR	NR	NR
Arsenic (TSP)[a]	0.0043	0.000015	41/3	<0.01 ± <0.01	3.49	0.05	NR	NR	NR	NR
Benzene	0.0000078	0.03	41/3	0.97 ± 0.21	7.60	0.03	NR	NR	NR	NR
Beryllium (TSP)[a]	0.0024	0.00002	42/3	<0.01 ± <0.01	0.02	<0.01	NR	NR	NR	NR
1,3-Butadiene	0.00003	0.002	39/3	0.04 ± 0.01	1.32	0.02	NR	NR	NR	NR
Cadmium (TSP)[a]	0.0018	0.00001	42/3	<0.01 ± <0.01	0.27	0.01	NR	NR	NR	NR
Carbon Tetrachloride	0.000006	0.1	40/3	0.64 ± 0.07	3.82	0.01	NR	NR	NR	NR

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Chloroform	--	0.098	31/3	0.08 ± 0.02	--	<0.01	NR	NR	NR	NR
p-Dichlorobenzene	0.000011	0.8	37/3	0.08 ± 0.02	0.83	<0.01	NR	NR	NR	NR
Ethylbenzene	0.0000025	1	41/3	0.24 ± 0.07	0.61	<0.01	NR	NR	NR	NR
Formaldehyde	0.000013	0.0098	41/3	2.83 ± 0.54	36.80	0.29	NR	NR	NR	NR
Lead (TSP)[a]	--	0.00015	42/3	<0.01 ± <0.01	--	0.03	NR	NR	NR	NR
Manganese (TSP)[a]	--	0.00005	42/3	0.02 ± <0.01	--	0.32	NR	NR	NR	NR
Nickel (TSP)[a]	0.000312	0.00009	42/3	<0.01 ± <0.01	0.38	0.01	NR	NR	NR	NR
Tetrachloroethylene	0.0000059	0.27	35/3	0.11 ± 0.04	0.68	<0.01	NR	NR	NR	NR
Trichloroethylene	0.000002	0.6	22/2	NA	NA	NA	NR	NR	NR	NR
Vinyl Chloride	0.0000088	0.1	2/0	NA	NA	NA	NR	NR	NR	NR
Tulsa, Oklahoma - TUOK										
Acetaldehyde	0.0000022	0.009	57/4	1.71 ± 0.22	3.76	0.19	15/1	NA	NA	NA
Arsenic (TSP)[a]	0.0043	0.000015	59/4	<0.01 ± <0.01	4.92	0.08	13/1	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Benzene	0.0000078	0.03	58/4	1.24 ± 0.23	9.67	0.04	12/1	NA	NA	NA
Beryllium (TSP)[a]	0.0024	0.00002	59/4	<0.01 ± <0.01	0.02	<0.01	13/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	56/4	0.07 ± 0.02	2.08	0.03	12/1	NA	NA	NA
Cadmium (TSP)[a]	0.0018	0.00001	59/4	<0.01 ± <0.01	0.29	0.02	13/1	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	57/4	0.66 ± 0.05	3.95	0.01	12/1	NA	NA	NA
Chloroform	--	0.098	46/3	0.10 ± 0.02	--	<0.01	11/1	NA	NA	NA
p-Dichlorobenzene	0.000011	0.8	51/4	0.08 ± 0.01	0.90	<0.01	11/1	NA	NA	NA
Formaldehyde	0.000013	0.0098	57/4	2.75 ± 0.38	35.76	0.28	15/1	NA	NA	NA
Lead (TSP)[a]	--	0.00015	59/4	<0.01 ± <0.01	--	0.03	13/1	NA	NA	NA
Manganese (TSP)[a]	--	0.00005	59/4	0.01 ± <0.01	--	0.30	13/1	NA	NA	NA
Nickel (TSP)[a]	0.000312	0.00009	59/4	<0.01 ± <0.01	0.31	0.01	13/1	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	54/4	0.27 ± 0.07	1.56	<0.01	12/1	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
*Method completeness did not meet the 85 percent criteria.
NR = Not reportable because sampling was not conducted during this time period.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Trichloroethylene	0.000002	0.6	18/0	NA	NA	NA	6/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	10/1	NA	NA	NA	1/0	NA	NA	NA
Tulsa, Oklahoma – TMOK										
Acetaldehyde	0.0000022	0.009	NR	NR	NR	NR	45/3	1.92 ± 0.25	4.23	0.21
Acrylonitrile	0.000068	0.002	NR	NR	NR	NR	16/1	NA	NA	NA
Arsenic (TSP)[a]	0.0043	0.000015	NR	NR	NR	NR	45/3	<0.01 ± <0.01	4.25	0.07
Benzene	0.0000078	0.03	NR	NR	NR	NR	44/3	1.43 ± 0.23	11.15	0.05
Beryllium (TSP)[a]	0.0024	0.00002	NR	NR	NR	NR	45/3	<0.01 ± <0.01	0.07	<0.01
1,3-Butadiene	0.00003	0.002	NR	NR	NR	NR	44/3	0.07 ± 0.01	2.02	0.03
Cadmium (TSP)[a]	0.0018	0.00001	NR	NR	NR	NR	45/3	<0.01 ± <0.01	0.38	0.02
Carbon Tetrachloride	0.000006	0.1	NR	NR	NR	NR	44/3	0.69 ± 0.04	4.12	0.01
Chloroform	--	0.098	NR	NR	NR	NR	42/3	0.12 ± 0.02	--	<0.01
p-Dichlorobenzene	0.000011	0.8	NR	NR	NR	NR	44/3	0.16 ± 0.04	1.77	<0.01

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
*Method completeness did not meet the 85 percent criteria.
NR = Not reportable because sampling was not conducted during this time period.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Ethylbenzene	0.0000025	1	NR	NR	NR	NR	44/3	0.35 ± 0.06	0.87	<0.01
Formaldehyde	0.000013	0.0098	NR	NR	NR	NR	45/3	3.49 ± 0.58	45.31	0.36
Lead (TSP)[a]	--	0.00015	NR	NR	NR	NR	45/3	<0.01 ± <0.01	--	0.03
Manganese (TSP)[a]	--	0.00005	NR	NR	NR	NR	45/3	0.03 ± 0.01	--	0.63
Nickel (TSP)[a]	0.000312	0.00009	NR	NR	NR	NR	45/3	<0.01 ± <0.01	0.44	0.02
Tetrachloroethylene	0.0000059	0.27	NR	NR	NR	NR	37/3	0.09 ± 0.02	0.53	<0.01
Trichloroethylene	0.000002	0.6	NR	NR	NR	NR	12/1	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	NR	NR	NR	NR	4/0	NA	NA	NA
Cherokee Heights, Pryor Creek, Oklahoma - CNEP										
Arsenic (TSP)[a]	0.0043	0.000015	NR	NR	NR	NR	22/2	NA	NA	NA
Benzene	0.0000078	0.03	14/1	NA	NA	NA	NR	NR	NR	NR
Beryllium (TSP)[a]	0.0024	0.00002	NR	NR	NR	NR	22/2	NA	NA	NA
1,3-Butadiene	0.00003	0.002	11/1	NA	NA	NA	NR	NR	NR	NR

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Cadmium (TSP)[a]	0.0018	0.00001	NR	NR	NR	NR	22/2	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	14/1	NA	NA	NA	NR	NR	NR	NR
Chloroform	--	0.098	14/1	NA	NA	NA	NR	NR	NR	NR
Lead (TSP)[a]	--	0.00015	NR	NR	NR	NR	22/2	NA	NA	NA
Manganese (TSP)[a]	--	0.00005	NR	NR	NR	NR	22/2	NA	NA	NA
Nickel (TSP)[a]	0.000312	0.00009	NR	NR	NR	NR	22/2	NA	NA	NA
Tetrachloroethylene	0.0000059	0.27	9/1	NA	NA	NA	NR	NR	NR	NR
Trichloroethylene	0.000002	0.6	3/0	NA	NA	NA	NR	NR	NR	NR
Vinyl Chloride	0.0000088	0.1	6/0	NA	NA	NA	NR	NR	NR	NR
Pryor Creek, Oklahoma – PROK										
Acetaldehyde	0.0000022	0.009	10/1	NA*	NA	NA	50/3	NA*	NA	NA
Acrylonitrile	0.000068	0.002	0/0	ND	ND	ND	14/1	NA	NA	NA
Arsenic (TSP)[a]	0.0043	0.000015	9/1	NA*	NA	NA	61/4	<0.01 ± <0.01	2.09	0.03

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

			2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average ($\mu g/m^3$)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average ($\mu g/m^3$)	Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)			Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Benzene	0.0000078	0.03	11/1	NA	NA	NA	62/4	0.70 ± 0.12	5.45	0.02
Beryllium (TSP)[a]	0.0024	0.00002	9/1	NA*	NA	NA	61/4	<0.01 ± <0.01	0.03	<0.01
1,3-Butadiene	0.00003	0.002	9/1	NA	NA	NA	57/4	0.03 ± <0.01	0.84	0.01
Cadmium (TSP)[a]	0.0018	0.00001	9/1	NA*	NA	NA	61/4	<0.01 ± <0.01	0.25	0.01
Carbon Tetrachloride	0.000006	0.1	11/1	NA	NA	NA	62/4	0.66 ± 0.04	3.97	0.01
Chloroform	--	0.098	11/1	NA	NA	NA	59/4	0.30 ± 0.15	--	<0.01
p-Dichlorobenzene	0.000011	0.8	8/1	NA	NA	NA	58/4	0.12 ± 0.03	1.31	<0.01
Formaldehyde	0.000013	0.0098	10/1	NA*	NA	NA	50/3	NA*	NA	NA
Lead (TSP)[a]	--	0.00015	9/1	NA*	NA	NA	61/4	<0.01 ± <0.01	--	0.02
Manganese (TSP)[a]	--	0.00005	9/1	NA*	NA	NA	61/4	0.01 ± <0.01	--	0.18
Nickel (TSP)[a]	0.000312	0.00009	9/1	NA*	NA	NA	61/4	<0.01 ± <0.01	0.15	0.01
Tetrachloroethylene	0.0000059	0.27	1/0	NA	NA	NA	33/2	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Trichloroethylene	0.000002	0.6	0/0	NA	NA	NA	3/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	1/0	NA	NA	NA	6/0	NA	NA	NA
Midwest City, Oklahoma - MWOK										
Acetaldehyde	0.0000022	0.009	NR	NR	NR	NR	39/3	1.24 ± 0.12	2.72	0.14
Arsenic (TSP)[a]	0.0043	0.000015	NR	NR	NR	NR	37/3	<0.01 ± <0.01	2.06	0.03
Benzene	0.0000078	0.03	NR	NR	NR	NR	39/3	0.66 ± 0.08	5.17	0.02
Beryllium (TSP)[a]	0.0024	0.00002	NR	NR	NR	NR	37/3	<0.01 ± <0.01	0.02	<0.01
1,3-Butadiene	0.00003	0.002	NR	NR	NR	NR	35/3	0.04 ± 0.01	1.22	0.02
Cadmium (TSP)[a]	0.0018	0.00001	NR	NR	NR	NR	38/3	<0.01 ± <0.01	0.16	0.01
Carbon Tetrachloride	0.000006	0.1	NR	NR	NR	NR	39/3	0.71 ± 0.06	4.24	0.01
Chloroform	--	0.098	NR	NR	NR	NR	39/3	0.10 ± 0.01	--	<0.01
p-Dichlorobenzene	0.000011	0.8	NR	NR	NR	NR	38/3	0.14 ± 0.05	1.59	<0.01
Formaldehyde	0.000013	0.0098	NR	NR	NR	NR	39/3	2.65 ± 0.56	34.46	0.27

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

*Method completeness did not meet the 85 percent criteria.

NR = Not reportable because sampling was not conducted during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Cancer (in-a-million)	Noncancer (HQ)
Lead (TSP)[a]	--	0.00015	NR	NR	NR	NR	38/3	<0.01 ± <0.01	--	0.01
Manganese (TSP)[a]	--	0.00005	NR	NR	NR	NR	38/3	0.01 ± <0.01	--	0.15
Nickel (TSP)[a]	0.000312	0.00009	NR	NR	NR	NR	38/3	<0.01 ± <0.01	0.28	0.01
Tetrachloroethylene	0.0000059	0.27	NR	NR	NR	NR	33/3	0.15 ± 0.06	0.87	<0.01
Trichloroethylene	0.000002	0.6	NR	NR	NR	NR	5/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	NR	NR	NR	NR	3/0	NA	NA	NA
Oklahoma City, Oklahoma – OCOK										
Acetaldehyde	0.0000022	0.009	NR	NR	NR	NR	39/2	NA	NA	NA
Acrylonitrile	0.000068	0.002	NR	NR	NR	NR	7/0	NA	NA	NA
Arsenic (TSP)[a]	0.0043	0.000015	NR	NR	NR	NR	38/3	<0.01 ± <0.01	2.23	0.03
Benzene	0.0000078	0.03	NR	NR	NR	NR	37/3	0.73 ± 0.07	5.68	0.02
Beryllium (TSP)[a]	0.0024	0.00002	NR	NR	NR	NR	38/3	<0.01 ± <0.01	0.03	<0.01
1,3-Butadiene	0.00003	0.002	NR	NR	NR	NR	35/3	0.03 ± 0.01	0.85	0.01

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
*Method completeness did not meet the 85 percent criteria.
NR = Not reportable because sampling was not conducted during this time period.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

Table 22-7. Cancer and Noncancer Surrogate Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Cadmium (TSP)[a]	0.0018	0.00001	NR	NR	NR	NR	38/3	<0.01 ± <0.01	0.14	0.01
Carbon Tetrachloride	0.000006	0.1	NR	NR	NR	NR	37/3	0.65 ± 0.06	3.91	0.01
Chloroform	--	0.098	NR	NR	NR	NR	36/3	0.10 ± 0.01	--	<0.01
p-Dichlorobenzene	0.000011	0.8	NR	NR	NR	NR	34/3	0.16 ± 0.17	1.80	<0.01
Formaldehyde	0.000013	0.0098	NR	NR	NR	NR	39/2	NA	NA	NA
Lead (TSP)[a]	--	0.00015	NR	NR	NR	NR	38/3	<0.01 ± <0.01	--	0.01
Manganese (TSP)[a]	--	0.00005	NR	NR	NR	NR	38/3	0.01 ± <0.01	--	0.23
Nickel (TSP)[a]	0.000312	0.00009	NR	NR	NR	NR	38/3	<0.01 ± <0.01	0.17	0.01
Tetrachloroethylene	0.0000059	0.27	NR	NR	NR	NR	23/2	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
*Method completeness did not meet the 85 percent criteria.
NR = Not reportable because sampling was not conducted during this time period.
[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 22-5.

- For PROK, annual averages, and thus cancer and noncancer surrogate risk approximations, for the carbonyl compounds could not be calculated because method completeness was less than 85 percent. Among the metals and VOC, benzene had the highest cancer risk approximations for 2009 (5.45 in-a-million).

- For MWOK, formaldehyde, benzene, and carbon tetrachloride had the highest cancer risk approximations for 2009.

- For OCOK, metals and VOC were the only pollutants for which annual averages, and thus cancer and noncancer risk approximations, could be calculated. Among the metals, arsenic had the highest cancer risk approximation for 2009 (2.23 in-a-million). Among the VOC, benzene and carbon tetrachloride had the highest cancer risk approximations for 2009 (5.68 and 3.91 in-a-million, respectively).

22.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 22-8 and 22-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 22-8 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 22-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 22.3, CNEP sampled for VOC and TSP metals, while the remaining Oklahoma sites sampled carbonyl compounds in addition to VOC and TSP metals. In addition, the cancer and noncancer risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated, as discussed in previous sections. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 22-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Tulsa, Oklahoma (Tulsa County) - TOOK					
Benzene	569.56	Hexavalent Chromium, PM	5.08E-03	Formaldehyde	38.76
Formaldehyde	248.40	Benzene	4.44E-03	Formaldehyde	35.55
Acetaldehyde	97.47	Formaldehyde	3.10E-03	Benzene	20.38
1,3-Butadiene	75.81	1,3-Butadiene	2.27E-03	Benzene	13.91
Tetrachloroethylene	63.11	Naphthalene	9.20E-04	Acetaldehyde	4.04
Naphthalene	27.07	POM, Group 2	6.02E-04	Arsenic (TSP)	3.82
Dichloromethane	14.71	Tetrachloroethylene	3.72E-04	Acetaldehyde	3.80
p-Dichlorobenzene	12.21	Acetaldehyde	2.14E-04	Carbon Tetrachloride	3.75
POM, Group 2	10.95	Arsenic, PM	1.77E-04	Carbon Tetrachloride	3.69
Trichloroethylene	10.92	Nickel, PM	1.43E-04	Arsenic (TSP)	2.91
Tulsa, Oklahoma (Tulsa County) - TSOK					
Benzene	569.56	Hexavalent Chromium, PM	5.08E-03	Formaldehyde	36.80
Formaldehyde	248.40	Benzene	4.44E-03	Benzene	7.60
Acetaldehyde	97.47	Formaldehyde	3.10E-03	Carbon Tetrachloride	3.82
1,3-Butadiene	75.81	1,3-Butadiene	2.27E-03	Arsenic (TSP)	3.49
Tetrachloroethylene	63.11	Naphthalene	9.20E-04	Acetaldehyde	2.89
Naphthalene	27.07	POM, Group 2	6.02E-04	1,3-Butadiene	1.32
Dichloromethane	14.71	Tetrachloroethylene	3.72E-04	*p*-Dichlorobenzene	0.83
p-Dichlorobenzene	12.21	Acetaldehyde	2.14E-04	Tetrachloroethylene	0.68
POM, Group 2	10.95	Arsenic, PM	1.77E-04	Ethylbenzene	0.61
Trichloroethylene	10.92	Nickel, PM	1.43E-04	Nickel (TSP)	0.38

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Tulsa, Oklahoma (Tulsa County) - TUOK					
Benzene	569.56	Hexavalent Chromium, PM	5.08E-03	Formaldehyde	35.76
Formaldehyde	248.40	Benzene	4.44E-03	Benzene	9.67
Acetaldehyde	97.47	Formaldehyde	3.10E-03	Arsenic (TSP)	4.92
1,3-Butadiene	75.81	1,3-Butadiene	2.27E-03	Carbon Tetrachloride	3.95
Tetrachloroethylene	63.11	Naphthalene	9.20E-04	Acetaldehyde	3.76
Naphthalene	27.07	POM, Group 2	6.02E-04	1,3-Butadiene	2.08
Dichloromethane	14.71	Tetrachloroethylene	3.72E-04	Tetrachloroethylene	1.56
p-Dichlorobenzene	12.21	Acetaldehyde	2.14E-04	*p*-Dichlorobenzene	0.90
POM, Group 2	10.95	Arsenic, PM	1.77E-04	Nickel (TSP)	0.31
Trichloroethylene	10.92	Nickel, PM	1.43E-04	Cadmium (TSP)	0.29
Tulsa, Oklahoma (Tulsa County) - TMOK					
Benzene	569.56	Hexavalent Chromium, PM	5.08E-03	Formaldehyde	45.31
Formaldehyde	248.40	Benzene	4.44E-03	Benzene	11.15
Acetaldehyde	97.47	Formaldehyde	3.10E-03	Arsenic (TSP)	4.25
1,3-Butadiene	75.81	1,3-Butadiene	2.27E-03	Acetaldehyde	4.23
Tetrachloroethylene	63.11	Naphthalene	9.20E-04	Carbon Tetrachloride	4.12
Naphthalene	27.07	POM, Group 2	6.02E-04	1,3-Butadiene	2.02
Dichloromethane	14.71	Tetrachloroethylene	3.72E-04	*p*-Dichlorobenzene	1.77
p-Dichlorobenzene	12.21	Acetaldehyde	2.14E-04	Ethylbenzene	0.87
POM, Group 2	10.95	Arsenic, PM	1.77E-04	Tetrachloroethylene	0.53
Trichloroethylene	10.92	Nickel, PM	1.43E-04	Nickel (TSP)	0.44

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Cherokee Heights, Pryor Creek, Oklahoma (Mayes County) - CNEP					
Benzene	73.77	Arsenic, PM	4.08E-03		
Formaldehyde	66.14	Formaldehyde	8.27E-04		
Acetaldehyde	17.57	Hexavalent Chromium, PM	6.96E-04		
1,3-Butadiene	11.35	Benzene	5.75E-04		
Dichloromethane	3.49	1,3-Butadiene	3.40E-04		
Naphthalene	2.69	Cadmium, PM	2.05E-04		
POM, Group 2	2.68	POM, Group 2	1.47E-04		
Trichloroethylene	1.85	Nickel, PM	1.04E-04		
Chloromethylbenzene	1.48	Naphthalene	9.15E-05		
Isophorone	1.29	Chloromethylbenzene	7.24E-05		
Pryor Creek, Oklahoma (Mayes County) - PROK					
Benzene	73.77	Arsenic, PM	4.08E-03	Benzene	5.45
Formaldehyde	66.14	Formaldehyde	8.27E-04	Carbon Tetrachloride	3.97
Acetaldehyde	17.57	Hexavalent Chromium, PM	6.96E-04	Arsenic (TSP)	2.09
1,3-Butadiene	11.35	Benzene	5.75E-04	*p*-Dichlorobenzene	1.31
Dichloromethane	3.49	1,3-Butadiene	3.40E-04	1,3-Butadiene	0.84
Naphthalene	2.69	Cadmium, PM	2.05E-04	Cadmium (TSP)	0.25
POM, Group 2	2.68	POM, Group 2	1.47E-04	Nickel (TSP)	0.15
Trichloroethylene	1.85	Nickel, PM	1.04E-04	Beryllium (TSP)	0.03
Chloromethylbenzene	1.48	Naphthalene	9.15E-05		
Isophorone	1.29	Chloromethylbenzene	7.24E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Midwest City, Oklahoma (Oklahoma County) - MWOK					
Benzene	649.26	Benzene	5.06E-03	Formaldehyde	34.46
Formaldehyde	330.07	Formaldehyde	4.13E-03	Benzene	5.17
Acetaldehyde	118.67	Hexavalent Chromium, PM	3.01E-03	Carbon Tetrachloride	4.24
Tetrachloroethylene	98.55	1,3-Butadiene	2.67E-03	Acetaldehyde	2.72
1,3-Butadiene	89.04	Naphthalene	9.40E-04	Arsenic (TSP)	2.06
Dichloromethane	87.34	Tetrachloroethylene	5.81E-04	*p*-Dichlorobenzene	1.59
Naphthalene	27.63	POM, Group 2	4.07E-04	1,3-Butadiene	1.22
p-Dichlorobenzene	14.73	Arsenic, PM	2.78E-04	Tetrachloroethylene	0.87
Vinyl chloride	12.42	Acetaldehyde	2.61E-04	Nickel (TSP)	0.28
POM, Group 2	7.41	*p*-Dichlorobenzene	1.62E-04	Cadmium (TSP)	0.16
Oklahoma City, Oklahoma (Oklahoma County) - OCOK					
Benzene	649.26	Benzene	5.06E-03	Benzene	5.68
Formaldehyde	330.07	Formaldehyde	4.13E-03	Carbon Tetrachloride	3.91
Acetaldehyde	118.67	Hexavalent Chromium, PM	3.01E-03	Arsenic (TSP)	2.23
Tetrachloroethylene	98.55	1,3-Butadiene	2.67E-03	*p*-Dichlorobenzene	1.80
1,3-Butadiene	89.04	Naphthalene	9.40E-04	1,3-Butadiene	0.85
Dichloromethane	87.34	Tetrachloroethylene	5.81E-04	Nickel (TSP)	0.17
Naphthalene	27.63	POM, Group 2	4.07E-04	Cadmium (TSP)	0.14
p-Dichlorobenzene	14.73	Arsenic, PM	2.78E-04	Beryllium (TSP)	0.03
Vinyl chloride	12.42	Acetaldehyde	2.61E-04		
POM, Group 2	7.41	*p*-Dichlorobenzene	1.62E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Tulsa, Oklahoma (Tulsa County) - TOOK					
Toluene	1,730.91	Acrolein	875,027.63	Manganese (TSP)	0.51
Xylenes	1,128.05	Manganese, PM	41,010.03	Manganese (TSP)	0.39
Benzene	569.56	1,3-Butadiene	37,902.71	Formaldehyde	0.30
Hexane	343.93	Formaldehyde	25,346.77	Formaldehyde	0.28
Methanol	318.21	Benzene	18,985.36	Acetaldehyde	0.20
Ethylbenzene	283.89	Nickel, PM	13,795.21	Acetaldehyde	0.19
Formaldehyde	248.40	Xylenes	11,280.47	Benzene	0.09
Methyl isobutyl ketone	134.04	Acetaldehyde	10,830.28	Benzene	0.06
Acetaldehyde	97.47	Naphthalene	9,024.03	Arsenic (TSP)	0.06
Ethylene glycol	92.10	Cyanide Compounds, gas	7,120.19	Lead (TSP)	0.05
Tulsa, Oklahoma (Tulsa County) - TSOK					
Toluene	1,730.91	Acrolein	875,027.63	Manganese (TSP)	0.32
Xylenes	1,128.05	Manganese, PM	41,010.03	Formaldehyde	0.29
Benzene	569.56	1,3-Butadiene	37,902.71	Acetaldehyde	0.15
Hexane	343.93	Formaldehyde	25,346.77	Arsenic (TSP)	0.05
Methanol	318.21	Benzene	18,985.36	Benzene	0.03
Ethylbenzene	283.89	Nickel, PM	13,795.21	Lead (TSP)	0.03
Formaldehyde	248.40	Xylenes	11,280.47	1,3-Butadiene	0.02
Methyl isobutyl ketone	134.04	Acetaldehyde	10,830.28	Cadmium (TSP)	0.01
Acetaldehyde	97.47	Naphthalene	9,024.03	Nickel (TSP)	0.01
Ethylene glycol	92.10	Cyanide Compounds, gas	7,120.19	Carbon Tetrachloride	0.01

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[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Tulsa, Oklahoma (Tulsa County) - TUOK					
Toluene	1,730.91	Acrolein	875,027.63	Manganese (TSP)	0.30
Xylenes	1,128.05	Manganese, PM	41,010.03	Formaldehyde	0.28
Benzene	569.56	1,3-Butadiene	37,902.71	Acetaldehyde	0.19
Hexane	343.93	Formaldehyde	25,346.77	Arsenic (TSP)	0.08
Methanol	318.21	Benzene	18,985.36	Benzene	0.04
Ethylbenzene	283.89	Nickel, PM	13,795.21	1,3-Butadiene	0.03
Formaldehyde	248.40	Xylenes	11,280.47	Lead (TSP)	0.03
Methyl isobutyl ketone	134.04	Acetaldehyde	10,830.28	Cadmium (TSP)	0.02
Acetaldehyde	97.47	Naphthalene	9,024.03	Nickel (TSP)	0.01
Ethylene glycol	92.10	Cyanide Compounds, gas	7,120.19	Carbon Tetrachloride	0.01
Tulsa, Oklahoma (Tulsa County) - TMOK					
Toluene	1,730.91	Acrolein	875,027.63	Manganese (TSP)	0.63
Xylenes	1,128.05	Manganese, PM	41,010.03	Formaldehyde	0.36
Benzene	569.56	1,3-Butadiene	37,902.71	Acetaldehyde	0.21
Hexane	343.93	Formaldehyde	25,346.77	Arsenic (TSP)	0.07
Methanol	318.21	Benzene	18,985.36	Benzene	0.05
Ethylbenzene	283.89	Nickel, PM	13,795.21	1,3-Butadiene	0.03
Formaldehyde	248.40	Xylenes	11,280.47	Lead (TSP)	0.03
Methyl isobutyl ketone	134.04	Acetaldehyde	10,830.28	Cadmium (TSP)	0.02
Acetaldehyde	97.47	Naphthalene	9,024.03	Nickel (TSP)	0.02
Ethylene glycol	92.10	Cyanide Compounds, gas	7,120.19	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Cherokee Heights, Pryor Creek, Oklahoma (Mayes County) - CNEP					
Toluene	138.84	Acrolein	405,829.34		
Xylenes	91.20	Arsenic, PM	31,621.18		
Benzene	73.77	Manganese, PM	26,555.45		
Formaldehyde	66.14	Nickel, PM	10,032.54		
Methanol	59.05	Formaldehyde	6,748.78		
Hydrochloric acid	58.77	Cadmium, PM	5,688.25		
Ethylene glycol	25.53	1,3-Butadiene	5,673.27		
Hexane	24.27	Hydrochloric acid	2,938.45		
Ethylbenzene	20.93	Mercury	2,828.35		
Acetaldehyde	17.57	Benzene	2,459.14		
Pryor Creek, Oklahoma (Mayes County) - PROK					
Toluene	138.84	Acrolein	405,829.34	Manganese (TSP)	0.18
Xylenes	91.20	Arsenic, PM	31,621.18	Arsenic (TSP)	0.03
Benzene	73.77	Manganese, PM	26,555.45	Benzene	0.02
Formaldehyde	66.14	Nickel, PM	10,032.54	Lead (TSP)	0.02
Methanol	59.05	Formaldehyde	6,748.78	1,3-Butadiene	0.01
Hydrochloric acid	58.77	Cadmium, PM	5,688.25	Cadmium (TSP)	0.01
Ethylene glycol	25.53	1,3-Butadiene	5,673.27	Carbon Tetrachloride	0.01
Hexane	24.27	Hydrochloric acid	2,938.45	Nickel (TSP)	0.01
Ethylbenzene	20.93	Mercury	2,828.35	Chloroform	<0.01
Acetaldehyde	17.57	Benzene	2,459.14	Beryllium (TSP)	<0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 22-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Oklahoma 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Midwest City, Oklahoma (Oklahoma County) - MWOK					
Toluene	1,800.62	Acrolein	1,254,645.66	Formaldehyde	0.27
Xylenes	1,135.73	1,3-Butadiene	44,517.76	Manganese (TSP)	0.15
Benzene	649.26	Formaldehyde	33,680.68	Acetaldehyde	0.14
Hexane	432.98	Benzene	21,641.85	Arsenic (TSP)	0.03
Methanol	360.00	Acetaldehyde	13,185.11	Benzene	0.02
Formaldehyde	330.07	Xylenes	11,357.32	1,3-Butadiene	0.02
Ethylbenzene	279.35	Naphthalene	9,211.00	Lead (TSP)	0.01
Acetaldehyde	118.67	Cyanide Compounds, gas	8,349.19	Nickel (TSP)	0.01
Tetrachloroethylene	98.55	Manganese, PM	7,497.62	Cadmium (TSP)	0.01
1,3-Butadiene	89.04	Toluene	4,501.56	Carbon Tetrachloride	0.01
Oklahoma City, Oklahoma (Oklahoma County) - OCOK					
Toluene	1,800.62	Acrolein	1,254,645.66	Manganese (TSP)	0.23
Xylenes	1,135.73	1,3-Butadiene	44,517.76	Arsenic (TSP)	0.03
Benzene	649.26	Formaldehyde	33,680.68	Benzene	0.02
Hexane	432.98	Benzene	21,641.85	1,3-Butadiene	0.01
Methanol	360.00	Acetaldehyde	13,185.11	Lead (TSP)	0.01
Formaldehyde	330.07	Xylenes	11,357.32	Cadmium (TSP)	0.01
Ethylbenzene	279.35	Naphthalene	9,211.00	Carbon Tetrachloride	0.01
Acetaldehyde	118.67	Cyanide Compounds, gas	8,349.19	Nickel (TSP)	0.01
Tetrachloroethylene	98.55	Manganese, PM	7,497.62	Chloroform	<0.01
1,3-Butadiene	89.04	Toluene	4,501.56	Beryllium (TSP)	<0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 22-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Mayes, Oklahoma, and Tulsa Counties. The benzene and formaldehyde emissions for Mayes County were an order of magnitude lower than the emissions for Oklahoma and Tulsa Counties.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Mayes County were arsenic, formaldehyde, and hexavalent chromium; the pollutants with the highest toxicity-weighted emissions for Oklahoma County were benzene, formaldehyde, and hexavalent chromium; and the pollutants with the highest toxicity-weighted emissions for Tulsa County were hexavalent chromium, benzene, and formaldehyde.

- Six of the highest emitted pollutants in Mayes County also had the highest toxicity-weighted emissions. Eight of the highest emitted pollutants in Oklahoma County also had the highest toxicity-weighted emissions. Seven of the highest emitted pollutants in Tulsa County also had the highest toxicity-weighted emissions.

- While hexavalent chromium and arsenic were among the pollutants with the highest toxicity-weighted emissions, neither was among the highest emitted pollutants. This indicates that lower emissions can translate to higher risk levels.

- Where they could be calculated, benzene and formaldehyde had the highest cancer risk approximations among the Oklahoma sites' pollutants of interest. These pollutants appeared on both emissions-based lists for all eight sites. Conversely, carbon tetrachloride, another pollutant with relatively highest cancer risk approximations, does not appear on either emissions-based list.

Observations from Table 22-9 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Mayes, Oklahoma, and Tulsa Counties, although the magnitude of the emissions is much higher in Tulsa and Oklahoma Counties than in Mayes County.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all three counties. Yet, this pollutant was not among the highest emitted pollutants for any of the three counties. This indicates that lower emissions can still translate to higher risk levels. Acrolein was sampled for at all of the Oklahoma sites, but this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Three of the highest emitted pollutants in Mayes County also have the highest toxicity-weighted emissions; six of the highest emitted pollutants in Oklahoma

County also have the highest toxicity-weighted emissions; and four of the highest emitted pollutants in Tulsa County also have the highest toxicity-weighted emissions.

- Five of the 10 pollutants with the highest noncancer toxicity-weighted emissions in Mayes County were metals.

- Formaldehyde and manganese generally had the highest noncancer risk approximations among the Oklahoma sites, where they could be calculated. Formaldehyde appears on both emissions-based lists for each of the three counties. Manganese appears among the pollutants with the highest toxicity-weighted emissions for each of the three counties.

- It is important to note that for the metals, the emissions-based lists are PM_{10} while the Oklahoma sites sampled TSP metals.

22.6 Summary of the 2008-2009 Monitoring Data for the Oklahoma Monitoring Sites

Results from several of the treatments described in this section include the following:

❖ *Twenty pollutants failed at least one screen for TOOK; 13 pollutants failed screens for TSOK; 17 pollutants failed at least one screen for TUOK; 17 pollutants failed screens for TMOK; 6 pollutants failed at least one screen for CNEP; 14 pollutants failed screens for PROK; 12 pollutants failed screens for MWOK; and 13 pollutants failed screens for OCOK.*

❖ *Formaldehyde had the highest daily average concentration for each site, except CNEP, which did not sample carbonyl compounds. Among the metals, manganese had the highest daily average concentration for each site.*

❖ *TMOK had the highest daily average concentration of beryllium among all NMP sites sampling metals and TOOK had the highest daily average concentration of manganese among all NMP sites sampling metals.*

❖ *Two preprocessed daily measurements of formaldehyde for PROK were greater than the associated acute MRL health risk benchmark. None of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than any of the associated MRL noncancer health risk benchmarks.*

23.0 Site in Oregon

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Oregon, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

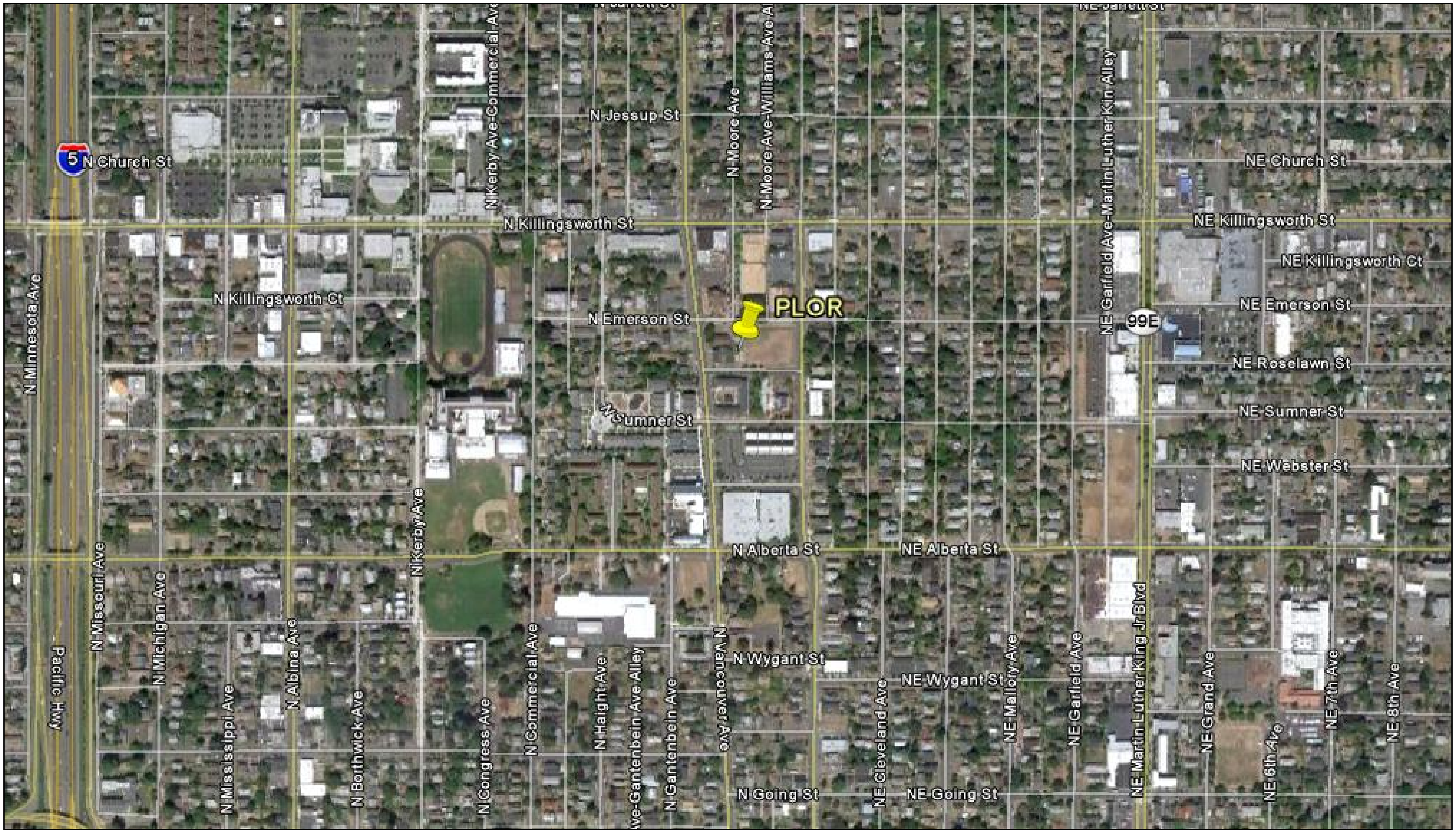
23.1 Site Characterization

This section characterizes the PLOR monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The PLOR monitoring site is located in Portland, Oregon. PAH samples from PLOR were analyzed by ERG from March through June 2008 only, after which the state of Oregon began analyzing their own samples. Because PLOR is a NATTS site, the PAH analytical results had to be compared to EPA's contract laboratory before the Oregon DEQ laboratory could begin their own analysis.

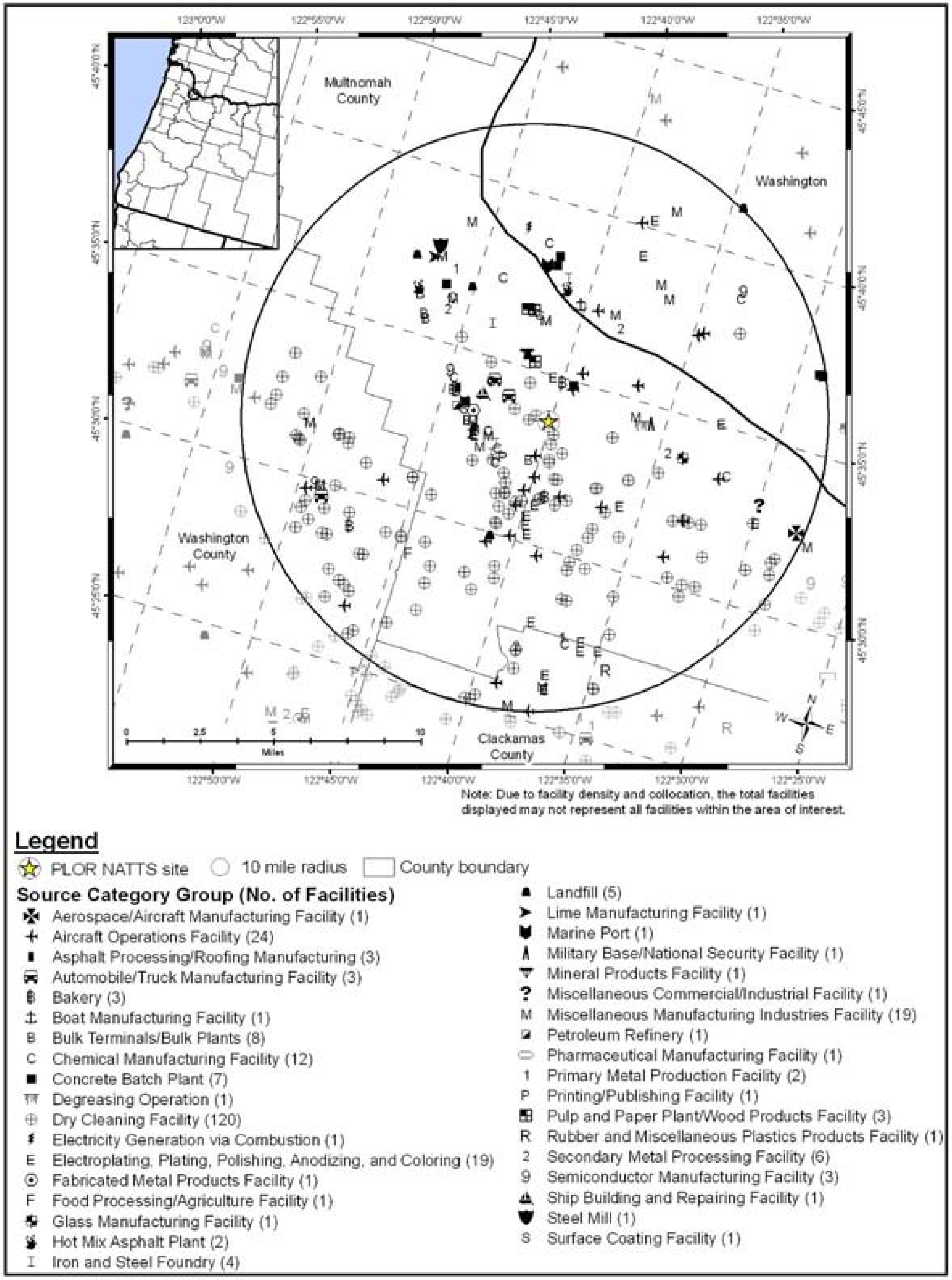
Figure 23-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 23-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 23-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 23-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 23-1. Portland, Oregon (PLOR) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,606 feet

Figure 23-2. NEI Point Sources Located Within 10 Miles of PLOR



123°0'0"W
122°55'0"W
122°50'0"W
122°45'0"W
122°40'0"W
122°35'0"W
45°40'0"N
45°35'0"N
45°30'0"N
45°25'0"N
45°45'0"N
45°40'0"N
45°35'0"N
45°30'0"N
122°50'0"W
122°45'0"W
122°40'0"W
122°35'0"W
122°30'0"W
122°25'0"W
Multnomah County
Washington
Washington County
Clackamas County
0
2.5
5
10
Miles
N
W
E
S
Legend
☆ PLOR NATTS site
○ 10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (1)
Aircraft Operations Facility (24)
Asphalt Processing/Roofing Manufacturing (3)
Automobile/Truck Manufacturing Facility (3)
Bakery (3)
Boat Manufacturing Facility (1)
B Bulk Terminals/Bulk Plants (8)
C Chemical Manufacturing Facility (12)
Concrete Batch Plant (7)
Degreasing Operation (1)
Dry Cleaning Facility (120)
Electricity Generation via Combustion (1)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (19)
Fabricated Metal Products Facility (1)
F Food Processing/Agriculture Facility (1)
Glass Manufacturing Facility (1)
Hot Mix Asphalt Plant (2)
I Iron and Steel Foundry (4)
Landfill (5)
Lime Manufacturing Facility (1)
Marine Port (1)
Military Base/National Security Facility (1)
Mineral Products Facility (1)
? Miscellaneous Commercial/Industrial Facility (1)
M Miscellaneous Manufacturing Industries Facility (19)
Petroleum Refinery (1)
Pharmaceutical Manufacturing Facility (1)
1 Primary Metal Production Facility (2)
P Printing/Publishing Facility (1)
Pulp and Paper Plant/Wood Products Facility (3)
R Rubber and Miscellaneous Plastics Products Facility (1)
2 Secondary Metal Processing Facility (6)
9 Semiconductor Manufacturing Facility (3)
Ship Building and Repairing Facility (1)
Steel Mill (1)
S Surface Coating Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 23-1. Geographical Information for the Oregon Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
PLOR	41-051-0246	Portland	Multnomah	Portland, OR	45.561301, -122.678784	Residential	Urban/City Center	TSP Metals, Carbonyl compounds, VOC, Meteorological parameters, PM_{10}, PM_{10} Metals, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The city of Portland is located in northwest Oregon, approximately 65 miles from the Oregon coast. The Columbia River runs north of the city, which acts as a natural state boundary between Oregon and Washington. The Williamette River branches off the Columbia River and runs southward through the city. The PLOR monitoring site is located in north-central Portland, in a primarily residential area. Jefferson High School, of which the track and athletic fields are prominent features in Figure 23-1, lies to the west of the site, and an apartment complex and Humboldt Primary are located to the southwest. Interstate-5 runs north-south approximately 1/2 mile to the west, a few blocks from the high school, and Highway 99 parallels I-5 to the east of the monitoring site. As Figure 23-2 shows, PLOR is surrounded by numerous point sources. The source category with the most emissions sources is the dry cleaning facility category (120); these sources make up the bulk of the sources below a line drawn east-west through the center of the 10-mile radius. The emissions sources closest to PLOR are in this category. The aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads, and the electroplating, plating, polishing, anodizing, and coloring source category also have a number of sources surrounding PLOR.

Table 23-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Oregon monitoring site. Information provided in Table 23-2 represents the most recent year of sampling (2008), unless otherwise indicated. County-level vehicle registration and population data for Multnomah County were obtained from the Oregon Department of Motor Vehicles (OR DMV, 2007) and the U.S. Census Bureau (Census Bureau, 2009), respectively. Table 23-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 23-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 23-2 presents the daily VMT for the Portland area.

Table 23-2. Population, Motor Vehicle, and Traffic Information for the Oregon Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
PLOR	714,567	748,648	1.05	1,008,125	1,056,207	5,457	34,294

[1] Reference: Census Bureau, 2009.
[2] County-level vehicle registration reflects 2007 data from Oregon DMV (OR DMV, 2007).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2005 data from the Portland BOT (Portland BOT, 2005).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 23-2 include the following:

- PLOR's county population was in the middle of the range compared to all counties with NMP sites, but its 10-mile population was in the top third. This trend is also true for its county-level and 10-mile vehicle ownership.
- The vehicle-per-person ratio was also in the top third compared to other NMP sites.
- The traffic volume experienced near PLOR was in the lower third compared to other NMP monitoring sites. The traffic estimate used came from Northeast Killingsworth Street at North Williams Avenue.
- The Portland area VMT was in the middle of the range among urban areas with NMP sites.

23.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Oregon on sample days, as well as over the course of the year.

23.2.1 Climate Summary

The city of Portland is located between the Cascade Mountains to the east and the Coast Range to the west. While the Coast Range provides slight shielding from weather systems moving in from offshore, the Cascade Mountains provide orographic lift, enhancing rainfall on the east side of the city and areas farther east. Winters are generally mild and rainy with southeasterly winds prevailing; summers are pleasant with northwesterly winds. Rainfall is abundant from fall through spring, but very limited in the summer. Snowfall is infrequent. Mount

Hood to the east and Mount St. Helens to the north are visible from the city on clear days (Bair, 1992).

23.2.2 Meteorological Conditions in 2008

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 (NCDC, 2008). The closest NWS weather station is located at Portland International Airport (WBAN 24229). Additional information about this weather station is provided in Table 23-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year.

Table 23-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year. Also included in Table 23-3 is the 95 percent confidence interval for each parameter. Although sampling at PLOR was conducted from March through June 2008, average meteorological conditions on sample days appear to be fairly representative of average weather conditions throughout the year, as shown in Table 23-3. This is likely because the temperature extremes of summer and winter are not incorporated into the sample day averages. The largest apparent difference between the sample day and the full-year averages was for relative humidity, which is likely due to seasonal differences in moisture content, as discussed above.

Table 23-3. Average Meteorological Conditions near the Oregon Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Portland, Oregon - PLOR										
Portland International Airport 24229 (45.59, -122.60)	4.14 miles 77° (ENE)	2008	Sample Day	63.1 ± 6.1	54.1 ± 4.8	42.2 ± 3.5	48.2 ± 3.7	66.7 ± 3.0	1019.6 ± 2.5	5.2 ± 0.9
			All Year	61.4 ± 1.5	53.0 ± 1.2	43.1 ± 1.0	47.9 ± 1.0	72.3 ± 1.3	1018.6 ± 0.7	5.8 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

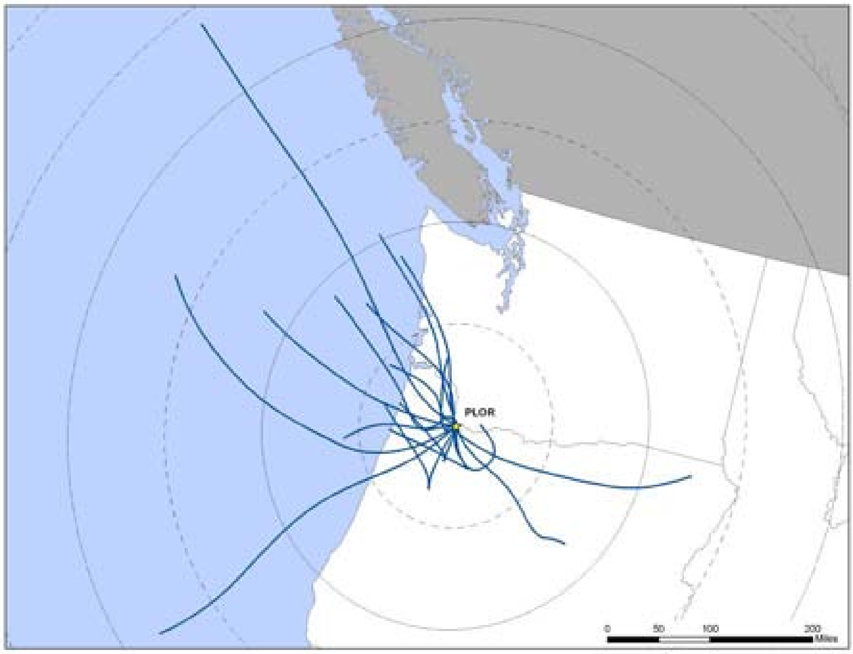
23.2.3 Back Trajectory Analysis

Figure 23-3 is the composite back trajectory map for days on which samples were collected at the PLOR monitoring site in 2008. A cluster analysis could not be conducted for PLOR because there were fewer than 30 sample days for this site. An in-depth description of this map and how it was generated is presented in Section 3.5.2.1. For the composite map, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. Each concentric circle around the site in Figure 23-3 represents 100 miles.

Observations from Figure 23-3 include the following:

- Back trajectories originated primarily over the Pacific Ocean, from the west and northwest.
- The 24-hour air shed domain for PLOR was somewhat smaller in size compared to other NMP monitoring sites. The farthest away a trajectory originated was offshore Vancouver Island, British Columbia, Canada, or greater than 450 miles away. However, the average trajectory length was less than 175 miles long and most trajectories originated within 250 miles of the site.
- The back trajectory distribution may look different with a full year's worth of sample days.

Figure 23-3. 2008 Composite Back Trajectory Map for PLOR



23.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at Portland International Airport were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

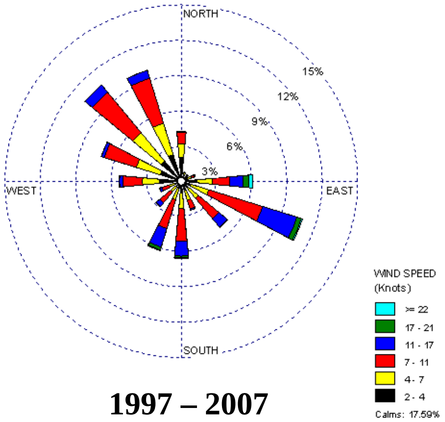
Figure 23-4 presents three different wind roses for the PLOR monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year is presented. Finally, a wind rose for days that samples were collected in 2008 is presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Observations from Figure 23-4 for PLOR include the following:

- The historical wind rose shows that northwesterly, north-northwesterly, and east-southeasterly winds were observed the most near PLOR. Calm winds (≤2 knots) were observed for approximately 18 percent of the hourly wind measurements, while the strongest winds were observed with easterly and east-southeasterly winds.

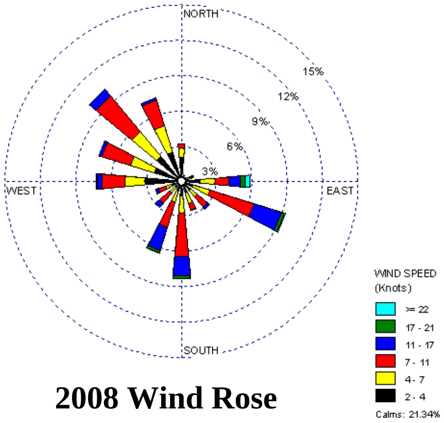
- The wind patterns shown on the 2008 wind rose are similar to the historical wind patterns. The sample day wind patterns are similar the 2008 and historical wind patterns, although there are a few differences. The east-southeasterly “petal” is not as prominent and westerly and west-northwesterly winds were observed more frequently. Recall that sampling at PLOR occurred from March to June 2008; thus, a wind rose incorporating a full year’s worth of sample day wind observations may exhibit different wind patterns.

Figure 23-4. Wind Roses for the Portland International Airport Weather Station near PLOR

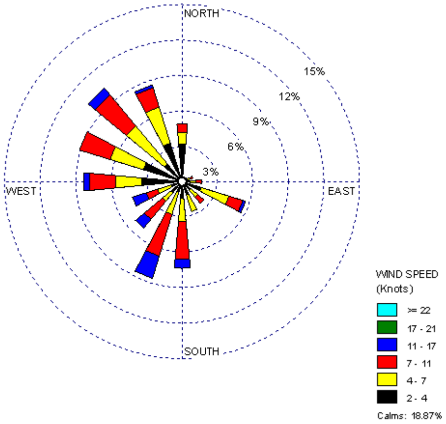


1997 – 2007

Historical Wind Rose



2008 Wind Rose



2008 Sample Day

Wind Rose

23.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Oregon monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 23-4 presents PLOR’s pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. PLOR sampled for PAH only. PAH samples from PLOR were analyzed by ERG from March through June 2008 only.

Table 23-4. Risk Screening Results for the Oregon Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Portland, Oregon - PLOR						
Naphthalene	0.029	16	16	100.00	100.00	100.00
Total		16	16	100.00		

Observations from Table 23-4 include the following:

- Naphthalene was the only pollutant to fail at least one screen for PLOR. Naphthalene was detected in all 16 valid samples collected and it failed the screen for 100 percent of them.

- Benzo(a)pyrene was added to PLOR’s pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not fail any screens. This pollutant is not shown in Table 23-4.

23.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Oregon monitoring site. Concentration averages are provided for the pollutants of interest for the PLOR monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

23.4.1 2008 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for PLOR, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 23-5, where applicable. The averages presented in Table 23-5 are shown in ng/m^3 for ease of viewing.

Table 23-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Oregon Monitoring Site

Pollutant	2008					
	Daily Average (ng/m^3)	**1st Quarter Average (ng/m^3)**	**2nd Quarter Average (ng/m^3)**	**3rd Quarter Average (ng/m^3)**	**4th Quarter Average (ng/m^3)**	**Annual Average (ng/m^3)**
Portland, Oregon – PLOR						
Benzo(a)pyrene	0.04 ± 0.03	NA	NA	NR	NR	NA
Naphthalene	88.54 ± 24.02	NA	78.15 ± 23.69	NR	NR	NA

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for PLOR from Table 23-5 include the following:

- Because PAH sampling did not begin until March 2008 and ended in June 2008, PLOR has few quarterly averages and no annual averages for naphthalene and benzo(a)pyrene.

- The daily average concentration of naphthalene is significantly higher than the daily average concentration of benzo(a)pyrene.

- The highest concentration of both pollutants was measured on March 25, 2008. For benzo(a)pyrene, this concentration (0.164 ng/m^3) was an order of magnitude higher than the next highest measurement (0.062 ng/m^3), which likely explains the relatively large confidence interval associated with the daily average. The nine measured detections of benzo(a)pyrene ranged from ranged from 0.0109 to 0.164 ng/m^3; the remaining seven were non-detects.

23.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. Although PLOR has participated in the UATMP program in the past (2002-2003), sampling has not been conducted continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

23.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the PLOR monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

23.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Oregon monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Oregon monitoring site were higher than their respective MRL noncancer health risk benchmarks.

23.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Oregon monitoring site and where the *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages (and therefore cancer and noncancer surrogate risk approximations) could not be calculated for naphthalene or benzo(a)pyrene because sampling was conducted for only four months in 2008, as shown in Table 23-6.

Table 23-6. Cancer and Noncancer Surrogate Risk Approximations for the Oregon Monitoring Site

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008 # of Measured Detections/Valid Quarterly Averages	 Annual Average (µg/m^3)	 Cancer Risk Approximation (in-a-million)	 Noncancer Risk Approximation (HQ)
Portland, Oregon - PLOR						
Benzo(a)pyrene	0.001	--	9/0	NA	NA	NA
Naphthalene	0.000034	0.003	16/1	NA	NA	NA

NA = Not available due to the criteria for calculating an annual average.
-- = a Cancer URE or Noncancer RfC is not available.

23.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 23-7 and 23-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 23-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 23-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 23.3, PLOR sampled for PAH. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. Because PAH sampling was conducted for only four months in 2008, cancer and noncancer surrogate risk approximations were not calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 23-7 include the following:

- Dichloromethane was the highest emitted pollutant with a cancer URE in Multnomah County, followed by benzene and formaldehyde.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were POM Group 1, formaldehyde, and POM Group 3.
- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Multnomah County.
- Naphthalene, which was the only pollutant to fail screens for PLOR, appears on both emissions-based lists.
- POM Groups 1, 2, and 3 were among the pollutants with the highest toxicity-weighted emissions. These groups incorporate various PAH. POM Group 1 includes unspeciated POM; POM Group 2 includes several PAH measured at PLOR including acenaphthylene, benzo(e)pyrene, fluoranthene, and phenanthrene; and POM Group 3 includes 7,12-dimethylbenz[a]anthracene. Benzo(a)pyrene, one of PLOR's pollutants of interest, is part of POM Group 5.

Table 23-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oregon Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Portland, Oregon (Multnomah County) - PLOR					
Dichloromethane	1,975.76	POM, Group 1	7.06E-03		
Benzene	498.72	Formaldehyde	5.60E-03		
Formaldehyde	448.23	POM, Group 3	4.48E-03		
Tetrachloroethylene	173.83	Benzene	3.89E-03		
Acetaldehyde	161.26	1,3-Butadiene	3.70E-03		
POM, Group 1	128.29	Naphthalene	1.56E-03		
1,3-Butadiene	123.19	Hexavalent Chromium, PM	1.37E-03		
1,3-Dichloropropene	53.62	Tetrachloroethylene	1.03E-03		
Naphthalene	45.90	Dichloromethane	9.29E-04		
p-Dichlorobenzene	26.18	POM, Group 2	7.18E-04		

Table 23-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Oregon Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Portland, Oregon (Multnomah County) - PLOR					
Toluene	2,049.73	Acrolein	3,596,761.10		
Dichloromethane	1,975.76	Hexamethylene-1,6-diisocyanate	265,000.00		
Xylenes	1,260.89	Cyanide Compounds, gas	130,344.31		
Methanol	706.18	Manganese, PM	75,486.12		
1,1,1-Trichloroethane	604.47	1,3-Butadiene	61,596.86		
Methyl isobutyl ketone	511.68	4,4'-Methylenediphenyl diisocyanate	51,652.50		
Benzene	498.72	Formaldehyde	45,737.52		
Formaldehyde	448.23	2,4-Toluene diisocyanate	25,453.12		
Cyanide Compounds, gas	391.03	Nickel, PM	22,887.15		
Ethylene glycol	295.35	Acetaldehyde	17,917.77		

Observations from Table 23-8 include the following:

- Toluene, dichloromethane, and xylenes were the highest emitted pollutants with noncancer RfCs in Multnomah County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, hexamethylene-1,6-diisocyanate, and gaseous cyanide compounds. Several diisocyantes are listed among the pollutants with the highest toxicity-weighted emissions for Multnomah County while none of them appear among the highest emitted pollutants.

- Only two of the highest emitted pollutants in Multnomah County also have the highest toxicity-weighted emissions.

23.6 Summary of the 2008 Monitoring Data for PLOR

Results from several of the treatments described in this section include the following:

- ❖ *Naphthalene was the only pollutant to fail screens for PLOR; benzo(a)pyrene was added as a pollutant of interest because it is a NATTS MQO Core Analyte.*

- ❖ *None of the preprocessed daily measurements and none of the second quarter 2008 average concentrations of either pollutant of interest were higher than their associated MRL noncancer health risk benchmarks.*

24.0 Site in Rhode Island

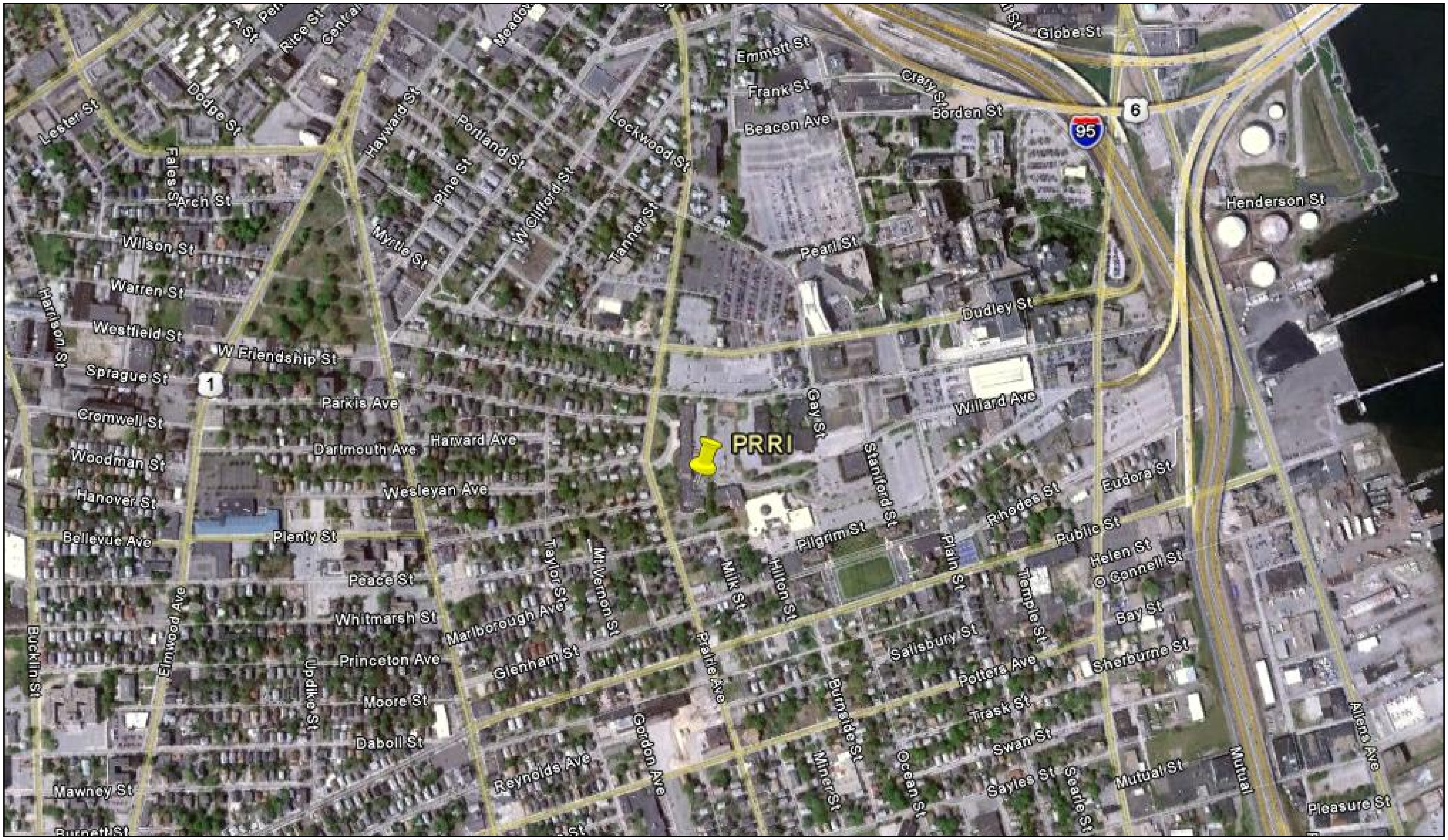
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Rhode Island, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

24.1 Site Characterization

This section characterizes the PRRI monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The PRRI monitoring site is located in south Providence. Figure 24-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 24-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 24-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 24-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

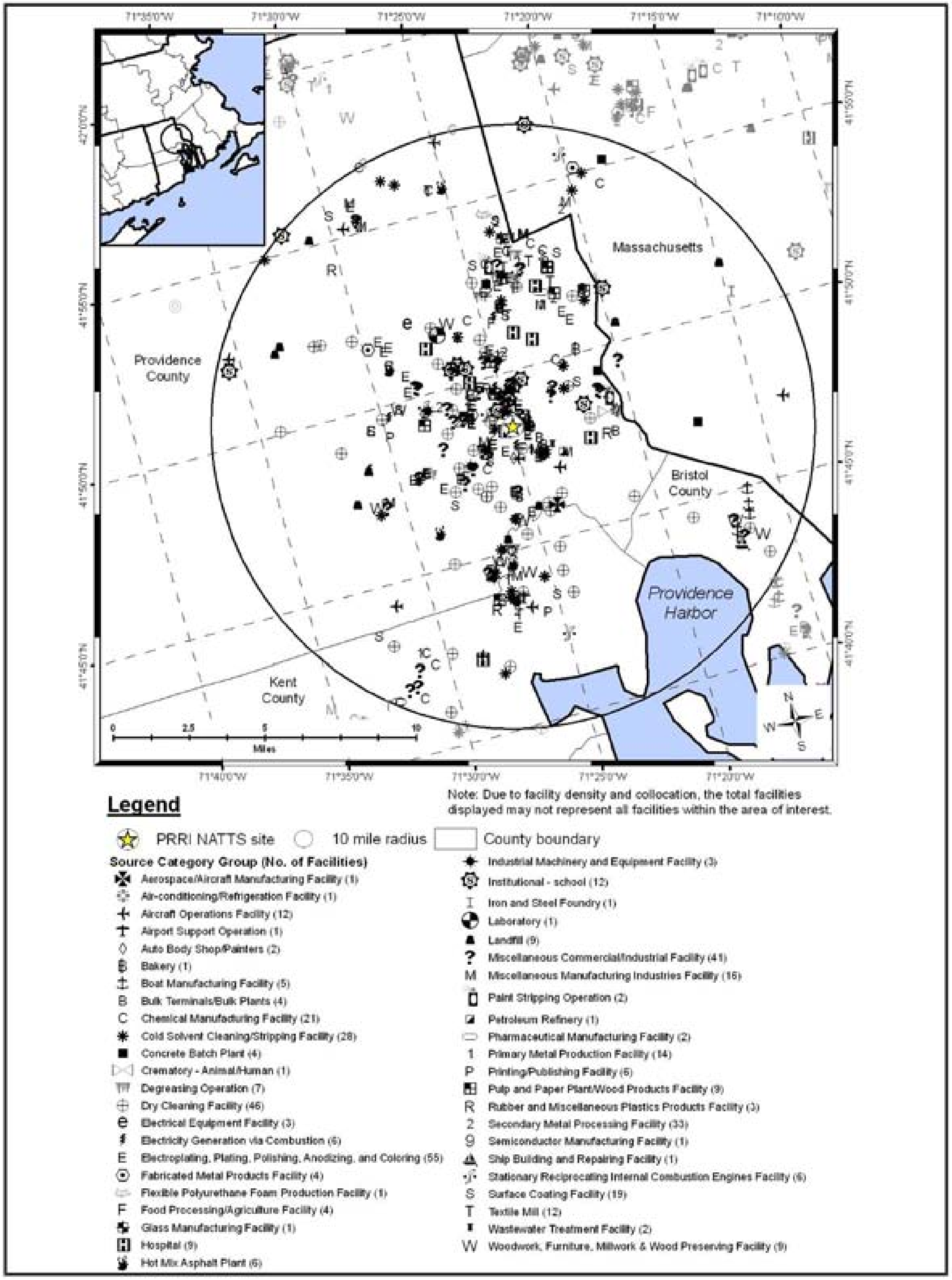
Figure 24-1. Providence, Rhode Island (PRRI) Monitoring Site



©2010 Google Earth, accessed 11/10/2010

Scale: 2 inches = 2,072 feet

Figure 24-2. NEI Point Sources Located Within 10 Miles of PRRI


71°35'0"W
71°30'0"W
71°25'0"W
71°20'0"W
71°15'0"W
71°10'0"W
42°0'0"N
41°55'0"N
41°50'0"N
41°45'0"N
41°55'0"N
41°50'0"N
41°45'0"N
41°40'0"N
Massachusetts
Providence County
Bristol County
Kent County
Providence Harbor
0
2.5
5
10
Miles
N
E
W
S
71°40'0"W
71°35'0"W
71°30'0"W
71°25'0"W
71°20'0"W
Legend
PRRI NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (1)
Air-conditioning/Refrigeration Facility (1)
Aircraft Operations Facility (12)
Airport Support Operation (1)
Auto Body Shop/Painters (2)
Bakery (1)
Boat Manufacturing Facility (5)
B Bulk Terminals/Bulk Plants (4)
C Chemical Manufacturing Facility (21)
Cold Solvent Cleaning/Stripping Facility (28)
Concrete Batch Plant (4)
Crematory - Animal/Human (1)
Degreasing Operation (7)
Dry Cleaning Facility (46)
Electrical Equipment Facility (3)
Electricity Generation via Combustion (6)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (55)
Fabricated Metal Products Facility (4)
Flexible Polyurethane Foam Production Facility (1)
F Food Processing/Agriculture Facility (4)
Glass Manufacturing Facility (1)
Hospital (9)
Hot Mix Asphalt Plant (6)
Industrial Machinery and Equipment Facility (3)
Institutional - school (12)
I Iron and Steel Foundry (1)
Laboratory (1)
Landfill (9)
? Miscellaneous Commercial/Industrial Facility (41)
M Miscellaneous Manufacturing Industries Facility (16)
Paint Stripping Operation (2)
Petroleum Refinery (1)
Pharmaceutical Manufacturing Facility (2)
1 Primary Metal Production Facility (14)
P Printing/Publishing Facility (6)
Pulp and Paper Plant/Wood Products Facility (9)
R Rubber and Miscellaneous Plastics Products Facility (3)
2 Secondary Metal Processing Facility (33)
9 Semiconductor Manufacturing Facility (1)
Ship Building and Repairing Facility (1)
Stationary Reciprocating Internal Combustion Engines Facility (6)
S Surface Coating Facility (19)
T Textile Mill (12)
Wastewater Treatment Facility (2)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (9)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 24-1. Geographical Information for the Rhode Island Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
PRRI	44-007-0022	Providence	Providence	Providence-New Bedford-Fall River, RI-MA	41.807949, -71.415	Residential	Urban/City Center	PAMS, VOC, Carbonyl Compounds, Meteorological parameters, PM_{10}, PM_{10} Speciation, Black Carbon, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

Figure 24-1 shows that the areas to the west and south of PRRI are residential, but areas to the north and east are commercial. A hospital lies to the northeast of the site, just north of Dudley Street. About 1/2 mile to the east I-95 runs north-south, then turns northwestward, entering downtown Providence. Narragansett Bay and the Port of Providence are a few tenths of a mile farther to the east, just on the other side of I-95. Figure 24-2 shows that a large number of point sources are located within 10 miles of PRRI, especially to the north of the site. Many of these sources seem to parallel I-95. The source categories with the largest number of point sources include electroplating, plating, polishing, anodizing, and coloring facilities; dry cleaners; secondary metal processing facilities; cold solvent cleaning and stripping facilities; and chemical manufacturers.

Table 24-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Rhode Island monitoring site. Information provided in Table 24-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Providence County were obtained from the Rhode Island Data Control (RI DC, 2006) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 24-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 24-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 24-2 presents the daily VMT for the Providence area.

Table 24-2. Population, Motor Vehicle, and Traffic Information for the Rhode Island Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
PRRI	627,690	142,334	0.23	670,441	152,028	136,800	26,006

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2006 data from Rhode Island Data Control (RI DC, 2006).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Rhode Island DOT (RI DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 24-2 include the following:

- Providence County's population was in the middle of the range compared to other counties with NMP sites, as was the 10-mile population.
- The county-level vehicle registration was in the bottom third compared to other counties with NMP sites, as was its 10-mile ownership estimate.
- The vehicle-per-person ratio was second lowest compared to other NMP sites.
- The traffic volume experienced near PRRI was the tenth highest compared to other monitoring sites. The traffic estimate used came from I-95 near the I-195 interchange.
- The Providence area VMT was the on the mid to low end of the range among urban areas with NMP sites.

24.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Rhode Island on sample days, as well as over the course of each year.

24.2.1 Climate Summary

Providence is a coastal city on the Narragansett Bay, which opens to the Rhode Island Sound and the Atlantic Ocean. The city's proximity to the Sound and the Atlantic Ocean 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 and precipitation in Providence is well distributed throughout the year. Weather is fairly variable as frequent storm systems affect the New England region (Bair, 1992).

24.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest the site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station is located at Theodore F. Green State Airport (WBAN 14765). Additional information about the T.F. Green weather station is provided in Table 24-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 24-3. Average Meteorological Conditions near the Rhode Island Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Providence, Rhode Island - PRRI										
Theodore F. Green State Airport 14765 (41.72, -71.43)	6.00 miles 173° (S)	2008	Sample Day	60.9 ± 4.5	52.4 ± 4.4	40.0 ± 4.7	46.7 ± 4.0	66.2 ± 4.1	1016.4 ± 2.0	6.9 ± 0.7
			All Year	60.7 ± 1.8	52.3 ± 1.7	39.5 ± 1.9	46.5 ± 1.6	64.9 ± 1.5	1016.3 ± 0.8	7.3 ± 0.3
		2009	Sample Day	58.8 ± 4.4	51.4 ± 4.2	40.7 ± 4.7	46.6 ± 4.0	69.8 ± 3.6	1014.0 ± 2.2	7.8 ± 0.7
			All Year	58.5 ± 1.8	50.7 ± 1.7	39.0 ± 1.9	45.6 ± 1.6	66.9 ± 1.5	1016.2 ± 0.8	7.5 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Table 24-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 24-3 is the 95 percent confidence interval for each parameter. As shown in Table 24-3, average meteorological conditions on sample days were representative of average weather conditions throughout the year for both years.

24.2.3 Back Trajectory Analysis

Figure 24-3 and Figure 24-4 are the composite back trajectory maps for days on which samples were collected at the PRRI monitoring site in 2008 and 2009, respectively. Figure 24-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 24-3 through 24-5 represents 100 miles.

Observations from Figures 24-3 through 24-5 for PRRI include the following:

- Back trajectories originated from a variety of directions at PRRI.
- The farthest away a trajectory originated was west-central Michigan, or nearly 700 miles away. However, the average trajectory length was 262 miles long. More than 85 percent of back trajectories originated within 450 miles of the site.
- The cluster analysis for 2008 exhibits similarities to the cluster analysis for 2009. Both cluster analyses include a cluster trajectory representing trajectories originating from the northwest (19 percent for 2008 and 15 percent for 2009) and a cluster trajectory representing trajectories originating from the north to east (23 percent for 2008 and 30 percent for 2009). The three cluster trajectories originating roughly to the southwest for 2008 (11, 15, and 32 percent) are represented by a single cluster trajectory for 2009 (55 percent).

Figure 24-3. 2008 Composite Back Trajectory Map for PRRI

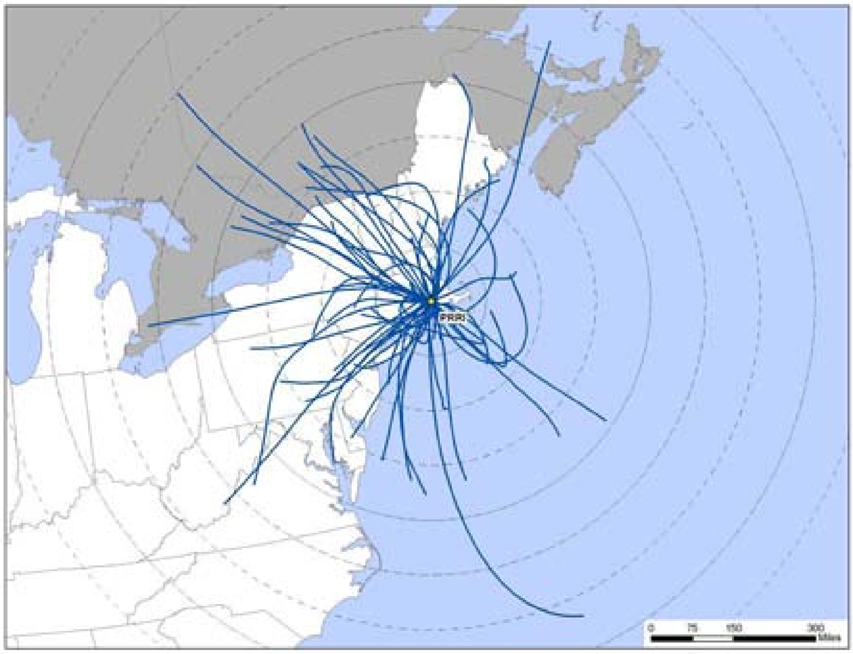


Figure 24-4. 2009 Composite Back Trajectory Map for PRRI

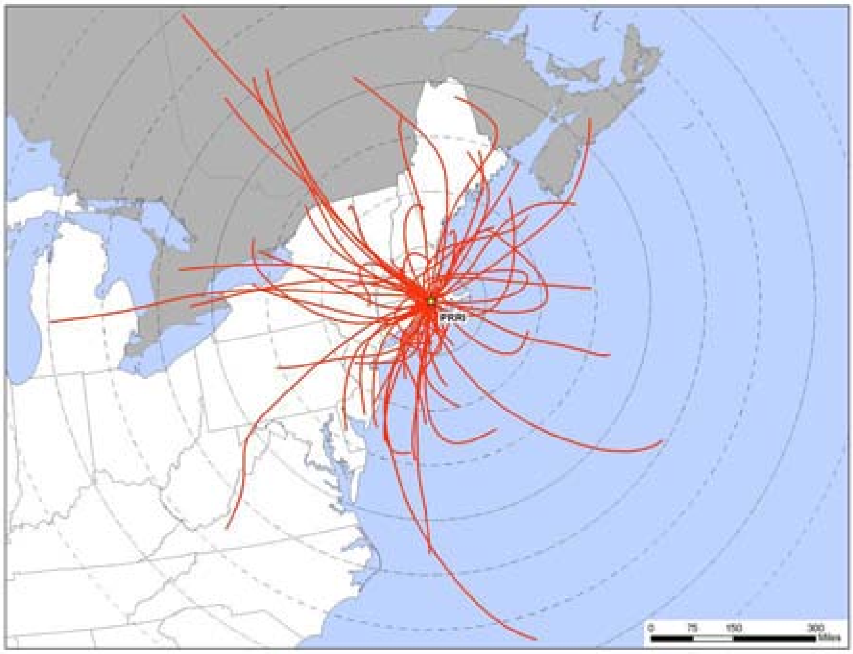
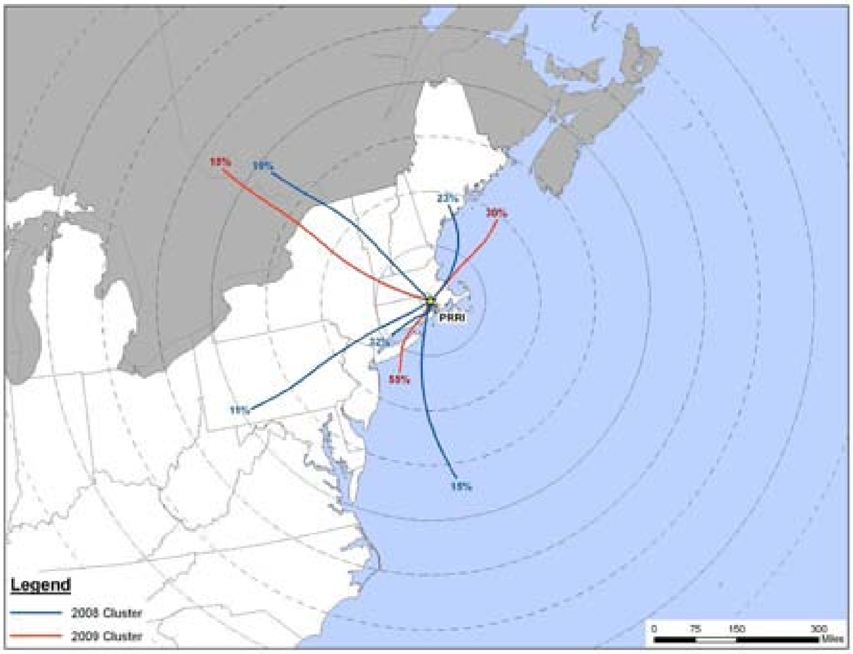


Figure 24-5. Back Trajectory Cluster Map for PRRI

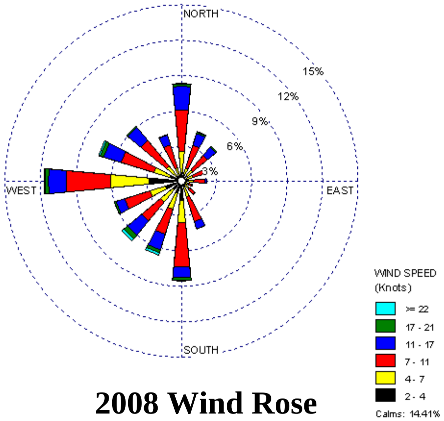


24.2.4 Wind Rose Comparison

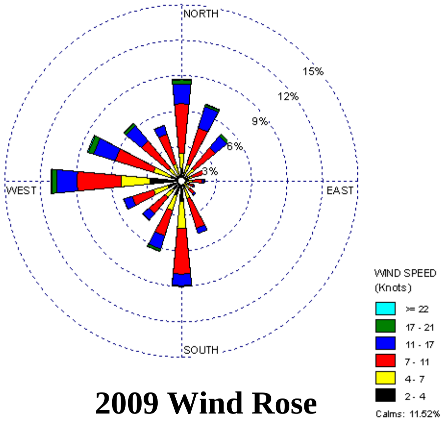
Hourly wind data from the NWS weather station at T.F. Green Airport near PRRI were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 24-6 presents five different wind roses for the PRRI monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

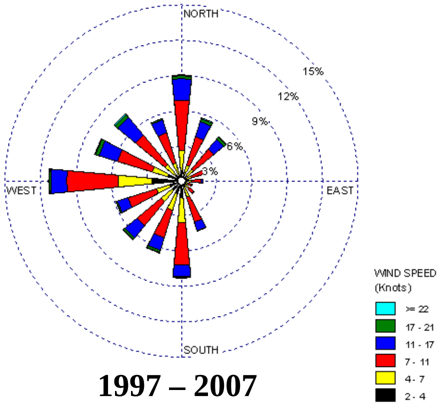
Figure 24-6. Wind Roses for the T.F. Green State Airport Weather Station near PRRI



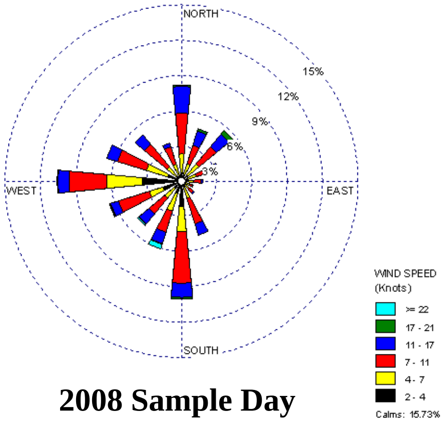
2008 Wind Rose



2009 Wind Rose

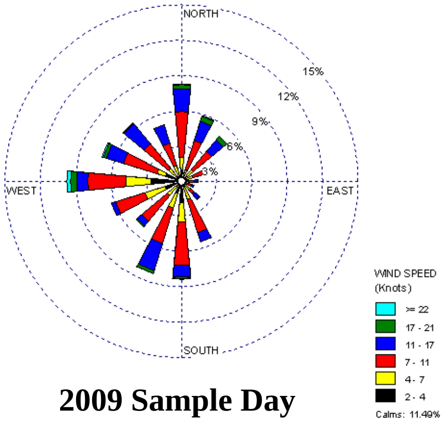


**1997 – 2007
Historical Wind Rose**



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 24-6 for PRRI include the following:

- The historical wind rose for PRRI shows that while westerly winds were observed the most (11 percent of observations), wind directions from the western quadrants and due north and due south are common near PRRI. Calm winds (≤ 2 knots) account for less than 10 percent of the hourly measurements.

- The wind patterns shown on the 2008 and 2009 wind roses for PRRI are similar to the historical wind patterns, although there were slightly more calm observations in 2008. These similarities indicate that these years were similar to what is expected climatologically near this site. Further, the wind patterns shown on the sample day wind roses for both years are similar to the full-year and historical wind patterns. This indicates that conditions on sample days were representative of conditions experienced throughout each year.

24.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Rhode Island monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 24-4 presents PRRI's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for PRRI are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. PRRI sampled for PAH and hexavalent chromium.

Table 24-4. Risk Screening Results for the Rhode Island Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Providence, Rhode Island - PRRI						
Naphthalene	0.029	83	88	94.32	96.51	96.51
Hexavalent Chromium	0.000083	2	58	3.45	2.33	98.84
Benzo(a)pyrene	0.00091	1	79	1.27	1.16	100.00
Total		86	225	38.22		

Observations from Table 24-4 include the following:

- Three pollutants (naphthalene, benzo(a)pyrene, and hexavalent chromium) failed screens for PRRI. Naphthalene failed nearly 97 percent of PRRI's failed screens (83 out of 88 total failed screens).

- Naphthalene was identified as the only pollutant of interest for PRRI based on the risk screening process. Benzo(a)pyrene and hexavalent chromium were added to PRRI's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of failed screens.

- Note that sampling for PAH did not begin at PRRI until July 2008; therefore half as many PAH samples were collected than hexavalent chromium samples in 2008.

24.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Rhode Island monitoring site. Concentration averages are provided for the pollutants of interest for the PRRI monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

24.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for PRRI, as described in Section 3.3. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 24-5, where applicable. The averages presented in Table 24-5 are shown in ng/m^3 for ease of viewing.

Observations for PRRI from Table 24-5 include the following:

- Sampling for PAH did not begin until July 2008; as such, first and second quarter 2008 (and thus, annual averages) could not be calculated for these pollutants. In addition, hexavalent chromium was not detected often enough in several quarters for some quarterly averages to be calculated.

- The daily average concentrations of naphthalene were significantly higher than the daily averages of the other two pollutants of interest for both years.

- The second quarter 2009 benzo(a)pyrene average has a large confidence interval associated with it. The maximum concentration of this pollutant was measured on April 16, 2009 (2.86 ng/m^3) and was nearly four times the next highest concentration. The April 16 measurement was also the fourth highest measurement of benzo(a)pyrene among all NMP sites sampling PAH. Table 4-11 shows that the 2009 daily average concentration of benzo(a)pyrene for PRRI was the seventh highest among all NMP sites sampling this pollutant.

- Even though the maximum benzo(a)pyrene concentration at PRRI was measured in April 2009, the first quarter 2009 average is actually higher than the second quarter average. Of the 15 measurements greater than 0.35 ng/m^3, 10 of these were measured during the first quarter of 2009. This could suggest a seasonal correlation with concentrations of this pollutant, but is difficult to determine without the first two quarters of data for 2008. Figure 4-28 also suggests this correlation, as discussed in Section 4.4.2, but the start date and detection rates of this pollutant make this difficult to determine for PRRI.

Table 24-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Rhode Island Monitoring Site

	2008						2009					
Pollutant	**Daily Average (ng/m^3)**	**1st Quarter Average (ng/m^3)**	**2nd Quarter Average (ng/m^3)**	**3rd Quarter Average (ng/m^3)**	**4th Quarter Average (ng/m^3)**	**Annual Average (ng/m^3)**	**Daily Average (ng/m^3)**	**1st Quarter Average (ng/m^3)**	**2nd Quarter Average (ng/m^3)**	**3rd Quarter Average (ng/m^3)**	**4th Quarter Average (ng/m^3)**	**Annual Average (ng/m^3)**
Providence, Rhode Island - PRRI												
Benzo(a)pyrene	0.13 ± 0.05	NR	NR	0.05 ± 0.02	0.18 ± 0.07	NA	0.28 ± 0.11	0.46 ± 0.13	0.32 ± 0.38	0.09 ± 0.05	0.17 ± 0.06	0.25 ± 0.10
Hexavalent Chromium	0.02 ± 0.01	0.02 ± 0.01	0.01 ± 0.01	0.03 ± 0.02	NA	0.01 ± 0.01	0.02 ± 0.01	NA	NA	0.01 ± 0.01	NA	NA
Naphthalene	71.71 ± 15.66	NR	NR	59.11 ± 16.36	83.42 ± 26.00	NA	101.64 ± 17.91	92.43 ± 39.72	77.43 ± 18.80	93.94 ± 23.21	140.08 ± 51.06	101.64 ± 17.91

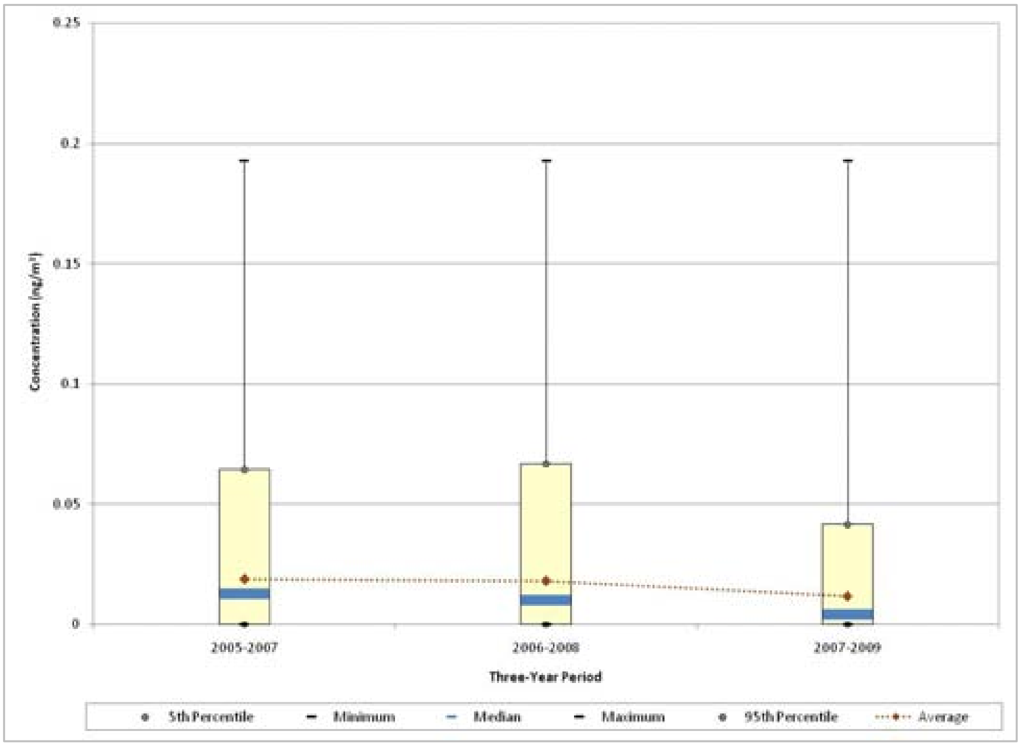
NR = Not reportable because sampling was not conducted during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

24.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. PRRI has sampled hexavalent chromium under the NMP since 2005. Thus, Figure 24-7 presents the 3-year rolling statistical metrics for hexavalent chromium for PRRI. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 24-7. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at PRRI



Observations from Figure 24-7 for hexavalent chromium measurements at PRRI include the following:

- Sampling for hexavalent chromium at PRRI began in January 2005.

- The maximum hexavalent chromium concentration was measured on August 28, 2007 (0.193 ng/m^3), although a similar concentration was measured on July 4, 2006 (0.192 ng/m^3).

- The rolling average concentrations were very similar in magnitude for 2005-2007 and 2006-2008, but exhibit a decrease for 2007-2009. Confidence intervals calculated for these averages show that the decrease from 2006-2008 to 2007-2009 was not statistically significant. A similar trend is shown for the median concentrations.

- For each 3-year period shown, the minimum and 5th percentile are zero, indicating the presence of non-detects. The number of non-detects reported has varied by year, from as low as 18 percent in 2006 to as high as 65 percent in 2009.

24.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the PRRI monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

24.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Rhode Island monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the PRRI monitoring site were higher than their respective MRL noncancer health risk benchmarks.

24.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Rhode Island monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 24-6, where applicable.

Table 24-6. Cancer and Noncancer Surrogate Risk Approximations for the Rhode Island Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Providence, Rhode Island - PRRI										
Benzo(a)pyrene	0.001	--	24/2	NA	NA	--	55/4	0.25 ± 0.10	0.25	--
Hexavalent Chromium	0.012	0.0001	37/3	0.01 ± 0.01	0.17	<0.01	21/1	NA	NA	NA
Naphthalene	3.4E-05	0.003	27/2	NA	NA	NA	61/4	101.64 ± 17.91	3.46	0.03

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

Observations for PRRI from Table 24-6 include the following:

- Because PAH sampling did not begin until July 2008, annual averages (and therefore cancer and noncancer risk approximations) could not be calculated for the PAH for 2008. For 2009, the cancer surrogate risk approximation for naphthalene (3.46 in-a-million) was higher than the cancer surrogate risk approximation for benzo(a)pyrene. The noncancer risk approximation for naphthalene (0.03) was well below than the level of concern for noncancer, which is an HQ of 1.0. There is no noncancer RfC for benzo(a)pyrene.

- For 2008, the cancer surrogate risk approximation (0.17 in-a-million) and the noncancer risk approximation (<0.01) for hexavalent chromium were low. For 2009, an annual average for hexavalent chromium (and therefore cancer and noncancer risk approximations) could not be calculated due to the relatively high number of non-detects.

24.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 24-7 and 24-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 24-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 24-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 24-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Rhode Island Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Providence, Rhode Island (Providence County) - PRRI					
Benzene	245.84	Benzene	1.92E-03	Naphthalene	3.46
Formaldehyde	149.28	Formaldehyde	1.87E-03	Benzo(a)pyrene	0.25
Tetrachloroethylene	82.18	Hexavalent Chromium, PM	1.30E-03	Hexavalent Chromium	0.17
Acetaldehyde	51.29	1,3-Butadiene	1.18E-03		
1,3-Butadiene	39.34	Naphthalene	7.19E-04		
Trichloroethylene	33.78	Tetrachloroethylene	4.85E-04		
Dichloromethane	24.91	Arsenic, PM	2.76E-04		
Naphthalene	21.16	Cadmium, PM	1.84E-04		
p-Dichlorobenzene	13.64	POM, Group 2	1.62E-04		
POM, Group 2	2.94	Nickel, PM	1.62E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 24-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Rhode Island Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Providence, Rhode Island (Providence County) - PRRI					
Toluene	770.99	Acrolein	447,840.11	Naphthalene	0.03
Methyl *tert*-butyl ether	639.55	1,3-Butadiene	19,672.36	Hexavalent Chromium	<0.01
Xylenes	530.42	Nickel, PM	15,557.59		
Methanol	320.57	Formaldehyde	15,232.49		
Benzene	245.84	Benzene	8,194.51		
Formaldehyde	149.28	Cyanide Compounds, gas	7,811.56		
Ethylbenzene	122.45	Naphthalene	7,052.46		
Hexane	109.00	Acetaldehyde	5,699.25		
Tetrachloroethylene	82.18	Chlorine	5,630.00		
Acetaldehyde	51.29	Xylenes	5,304.23		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on the site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 24.3, PRRI sampled for PAH and hexavalent chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 24-7 include the following:

- Benzene, formaldehyde, and tetrachloroethylene were the highest emitted pollutants with cancer UREs in Providence County.
- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by formaldehyde and hexavalent chromium. While hexavalent chromium, which is one of PRRI's pollutants of interest, had the third highest toxicity-weighted emissions for Providence County, it did not appear on the list of highest emitted pollutants.
- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Providence County.
- Naphthalene, which had the highest cancer risk approximation among the pollutants of interest for PRRI, had the eighth highest emissions and the fifth highest toxicity-weighted emissions.
- POM Group 2 was both the tenth highest emitted "pollutant" in Providence County and ranked ninth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at PRRI including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for PRRI.

Observations from Table 24-8 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in Providence County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and nickel.

- Four of the highest emitted pollutants in Providence County also had the highest toxicity-weighted emissions.

- Hexavalent chromium and benzo(a)pyrene did not appear on the list of highest emitted pollutants or the list of highest toxicity-weighted emissions for pollutants with noncancer toxicity factors; naphthalene ranked seventh on the list of pollutants with the highest toxicity-weighted emissions.

24.6 Summary of the 2008-2009 Monitoring Data for PRRI

Results from several of the treatments described in this section include the following:

- ❖ *Naphthalene, hexavalent chromium, and benzo(a)pyrene failed at least one screen for PRRI.*

- ❖ *Of the site-specific pollutants of the interest, naphthalene had the highest daily average concentration for PRRI for both years.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

25.0 Site in South Carolina

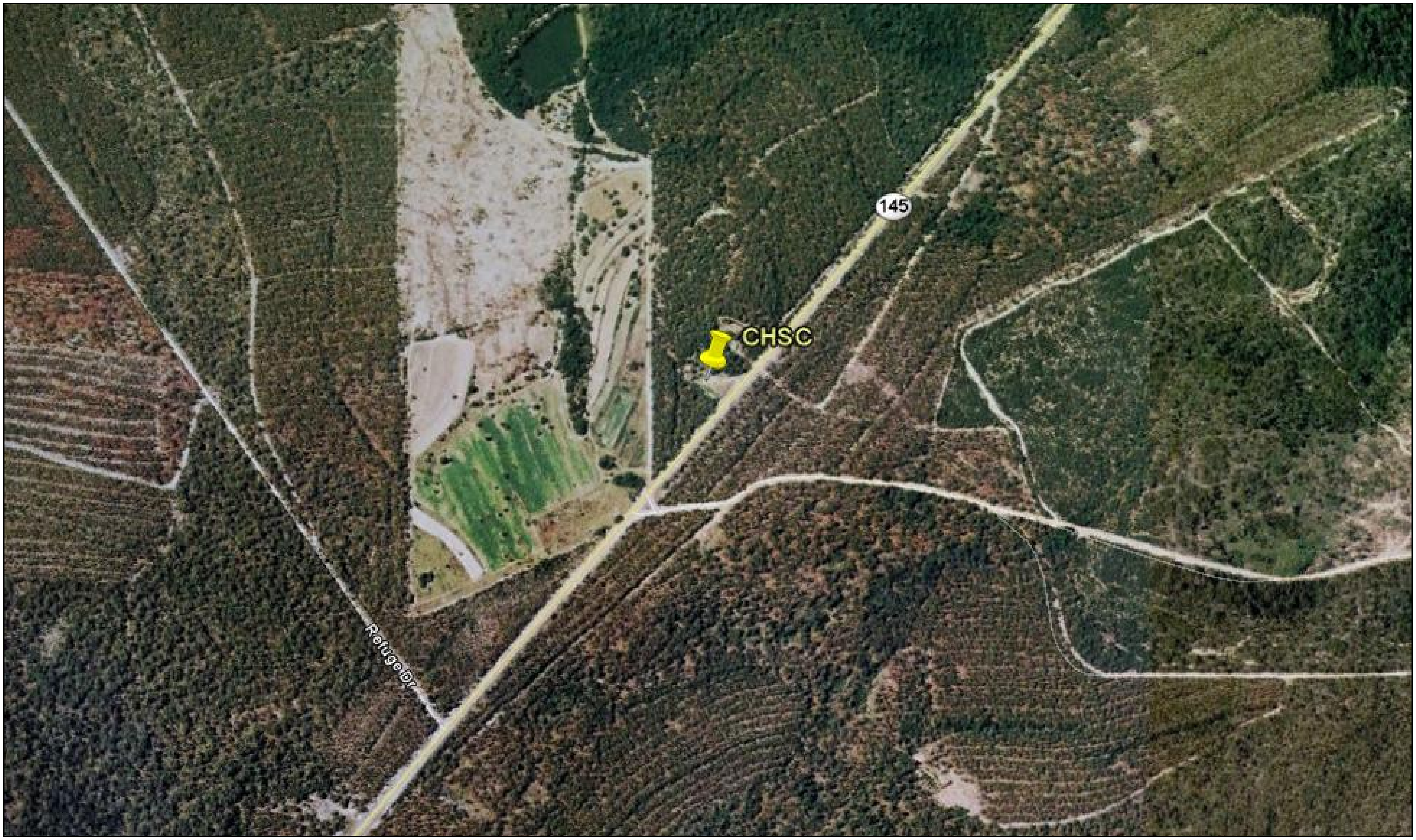
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in South Carolina, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

25.1 Site Characterization

This section characterizes the CHSC monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

CHSC is located in central Chesterfield County, South Carolina. Figure 25-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its rural location. Figure 25-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 25-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 25-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

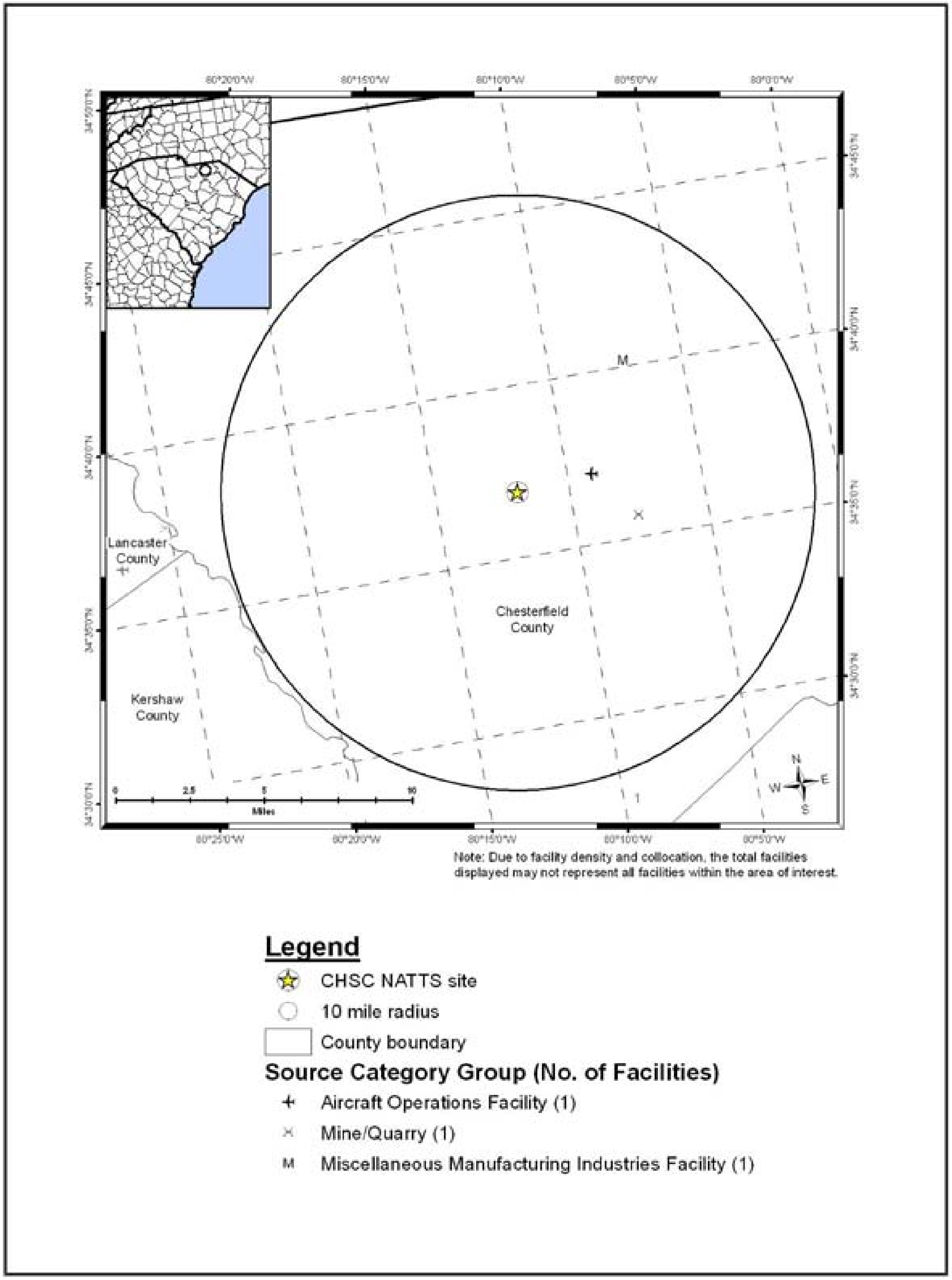
Figure 25-1. Chesterfield, South Carolina (CHSC) Monitoring Site



©2010 Google Earth, accessed 11/10/2010

Scale: 2 inches = 2,138 feet

Figure 25-2. NEI Point Sources Located Within 10 Miles of CHSC



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 25-1. Geographical Information for the South Carolina Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
CHSC	45-025-0001	Not in a city	Chesterfield	Not in an MSA	34.615367, -80.198789	Forest	Rural	TSP, TSP Metals, VOC, O_3, Meteorological parameters, PM_{10}, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

CHSC is located about 15 miles south of the North and South Carolina border, between the towns of McBee and Chesterfield. The monitoring site is located near the Ruby fire tower and, as Figure 25-1 shows, is located just off State Road 145. The surrounding area is rural in nature and is part of the Carolina Sandhills Wildlife Refuge. Figure 25-2 shows that few point sources are located within 10 miles of CHSC.

Table 25-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the South Carolina monitoring site. Information provided in Table 25-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Chesterfield County were obtained from the South Carolina Department of Public Safety (SC DPS, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 25-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 25-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. VMT was not available for the CHSC monitoring site because it is not part of an urban area.

Table 25-2. Population, Motor Vehicle, and Traffic Information for the South Carolina Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
CHSC	43,037	40,133	0.93	5,432	5,065	650	NA

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2007 data from South Carolina DPS (SC DPS, 2007).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the South Carolina DOT (SC DOT, 2010).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
NA = Data unavailable.
BOLD = EPA-designated NATTS Site.

Observations from Table 25-2 include the following:

- Chesterfield County's population was among lowest compared to other counties with NMP sites. This site's 10-mile population was the lowest among NMP sites sampling in 2009. Similar rankings were found for both the county-level and 10-mile vehicle ownerships.
- The vehicle-per-person ratio was in the middle of the range among NMP sites.
- The traffic volume experienced near CHSC ranked among the lowest compared to other NMP monitoring sites. The traffic estimate used came from State Road 145 between State Road 109 and US-1.

25.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in South Carolina on sample days, as well as over the course of each year.

25.2.1 Climate Summary

The town of Chesterfield is located just south of the North Carolina/South Carolina border, about 35 miles northwest of the city of Florence. Although the area experiences all four seasons, South Carolina's southeastern location ensures mild winters and long, hot summers. Summers are dominated by the Bermuda high pressure system over the Atlantic, which allows southwesterly winds to prevail, bringing in warm, moist air out of the Gulf of Mexico. During winter, winds out of the southwest shift northeasterly after frontal systems move across the area. Chesterfield County leads the state in average number of sleet and freezing rain events per year (Bair, 1992 and SC SCO, 2011).

25.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station is located at the Monroe Airport in Monroe, North Carolina (WBAN 53872). Additional information about the Monroe Airport weather station is provided in Table 25-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 25-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 25-3 is the 95 percent confidence interval for each parameter. As shown in Table 25-3, average meteorological conditions on sample days were representative of average weather conditions throughout the year for both years.

25.2.3 Back Trajectory Analysis

Figure 25-3 and Figure 25-4 are the composite back trajectory maps for days on which samples were collected at the CHSC monitoring site in 2008 and 2009, respectively. Figure 25-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 25-3 through 25-5 represents 100 miles.

Observations from Figures 25-3 through 25-5 for CHSC include the following:

- Back trajectories originated from a variety of directions at CHSC, although a large number of trajectories originated from a southwesterly and westerly direction. A second group originated from the northeast.

- The 24-hour air shed domain for CHSC was similar in size to other NMP monitoring sites. The farthest away a trajectory originated was near Chicago, or just greater than 600 miles away. However, the average trajectory length was 204 miles and most trajectories (87 percent) originated within 350 miles of the site.

- The cluster analysis shows that at least 50 percent of trajectories originated from the southwest and west for both years. Another predominant trajectory origin is from the north to northeast. The short red cluster trajectory (31 percent) actually represents trajectories originating from a variety of directions, but within 150 miles of CHSC. The blue cluster trajectory originating far to the northwest (2 percent) represents a single trajectory, the one originating near Chicago.

Table 25-3. Average Meteorological Conditions near the South Carolina Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Chesterfield, South Carolina - CHSC										
Monroe Airport 53872 (35.02, -80.62)	35.81 miles 311° (NW)	2008	Sample Day	70.5 ± 3.9	60.7 ± 3.6	49.4 ± 4.0	54.8 ± 3.4	70.2 ± 3.9	1017.9 ± 1.7	5.4 ± 0.7
			All Year	70.9 ± 1.6	60.6 ± 1.5	48.3 ± 1.7	54.2 ± 1.4	67.9 ± 1.5	1018.7 ± 0.7	5.6 ± 0.3
		2009	Sample Day	71.2 ± 4.0	60.8 ± 3.8	48.9 ± 4.2	54.5 ± 3.6	68.3 ± 3.3	1017.0 ± 1.7	5.5 ± 0.8
			All Year	70.1 ± 1.6	60.4 ± 1.5	48.7 ± 1.7	54.3 ± 1.5	69.1 ± 1.5	1018.3 ± 0.7	5.1 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Figure 25-3. 2008 Composite Back Trajectory Map for CHSC

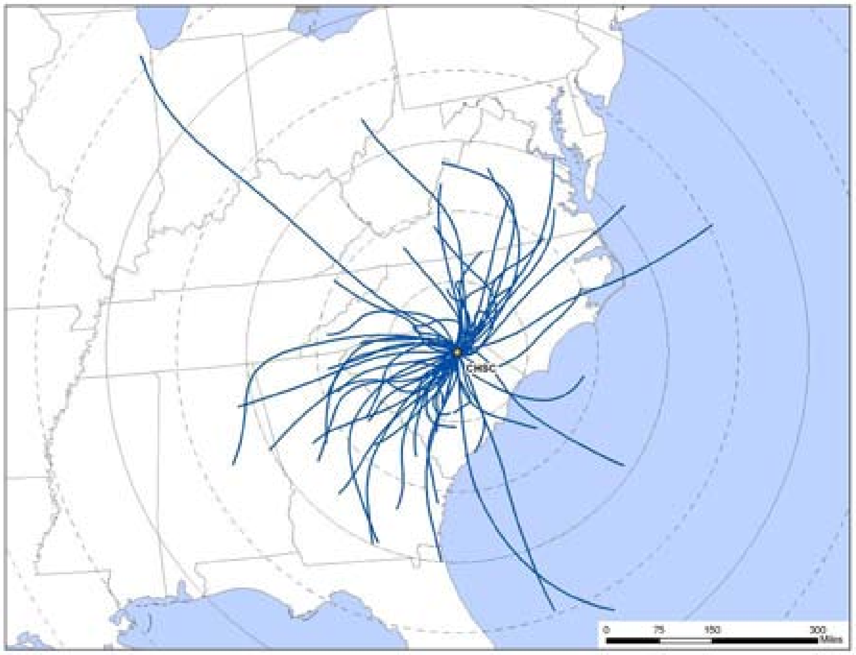


Figure 25-4. 2009 Composite Back Trajectory Map for CHSC

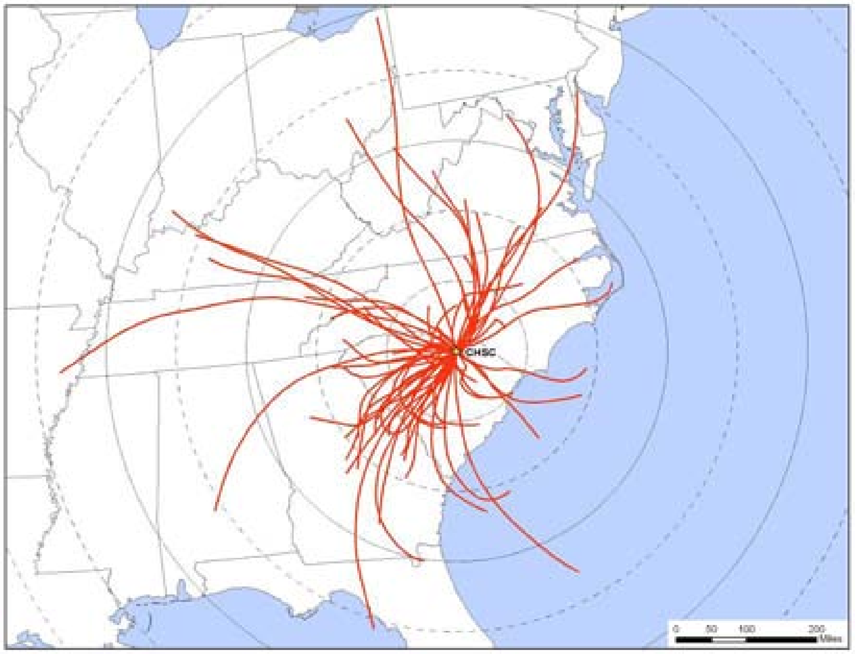
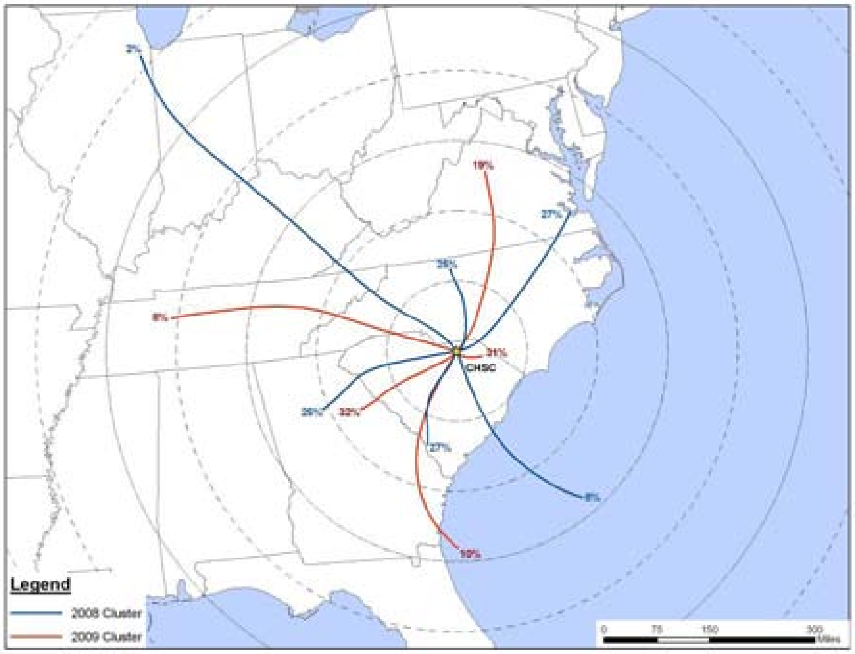


Figure 25-5. Back Trajectory Cluster Map for CHSC

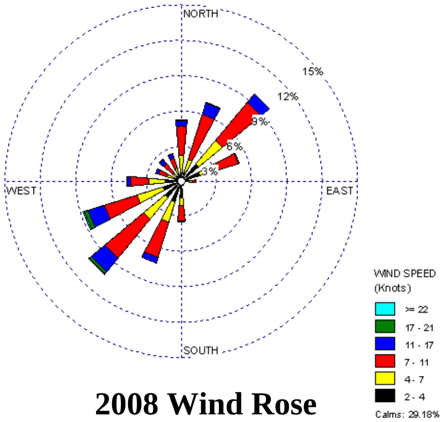


25.2.4 Wind Rose Comparison

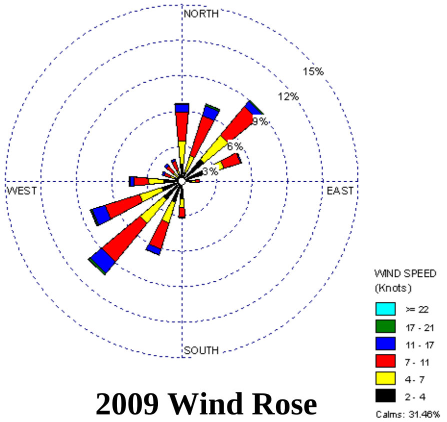
Hourly wind data from the NWS weather station at Monroe Airport near CHSC were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 25-6 presents five different wind roses for the CHSC monitoring site. First, a historical wind rose representing 2000 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

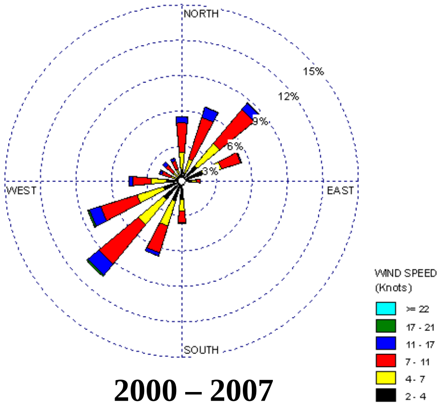
Figure 25-6. Wind Roses for the Monroe Airport Weather Station near CHSC



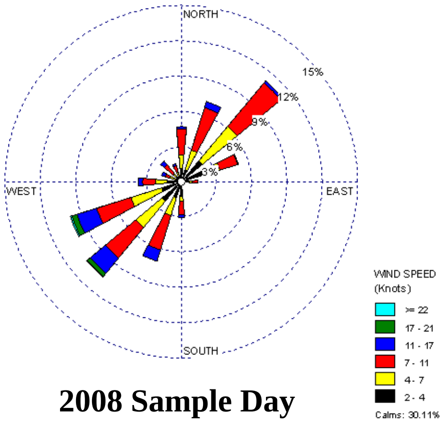
2008 Wind Rose



2009 Wind Rose

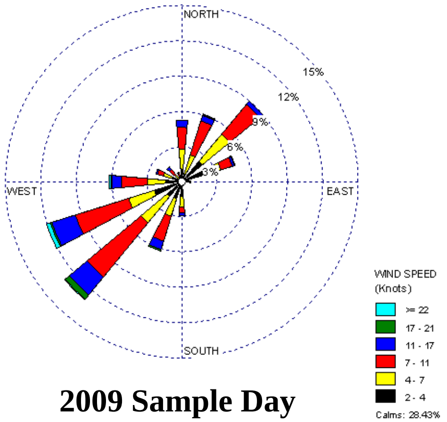


2000 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 25-6 for CHSC include the following:

- The historical wind rose for CHSC shows that calm winds (≤ 2 knots) account for nearly one-third of the hourly measurements. Winds from the south-southwest to west-southwest are the prevailing directions, although winds from the north-northeast to east-northeast are often observed as well. Winds from the southeast quadrant are generally not observed.

- The wind patterns shown on the 2008 and 2009 wind roses for CHSC are similar to the historical wind patterns. These similarities indicate that these years were similar to what is expected climatologically near this site. Further, the sample day wind patterns for both years are similar to the full-year and historical wind patterns, indicating that conditions on sample days were representative of conditions experienced throughout each year.

25.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the South Carolina monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 25-4 presents CHSC's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. CHSC sampled hexavalent chromium and PAH.

Table 25-4. Risk Screening Results for the South Carolina Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Chesterfield, South Carolina - CHSC						
Naphthalene	0.029	9	102	8.82	100.00	100.00
Total		9	102	8.82		

Observations from Table 25-4 include the following:

- Naphthalene was detected in 102 samples collected at CHSC and failed nine screens, or approximately nine percent of screens.
- This site had the third lowest number of failed screens (9) among all NMP sites.
- Benzo(a)pyrene and hexavalent chromium were added to CHSC's pollutant of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These pollutants are not shown in Table 25-4.

25.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the South Carolina monitoring site. Concentration averages are provided for the pollutants of interest for the CHSC monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

25.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for CHSC, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 25-5, where applicable. The averages presented in Table 25-5 are shown in ng/m^3 for ease of viewing.

Observations for CHSC from Table 25-5 include the following:

- The daily average concentration of naphthalene was significantly higher than the daily average of hexavalent chromium and benzo(a)pyrene for both years. Compared to other NMP sites, CHSC had some of the lowest daily average concentrations of these three pollutants.

- The quarterly average concentrations of naphthalene generally did not vary significantly from quarter to quarter. However, the second quarter average for 2009 is higher than the other quarters and has a large confidence interval associated with it. The maximum naphthalene concentration was measured on May 1, 2009 (323 ng/m^3) and was nearly six times the next highest measurement (55.9 ng/m^3). The concentrations measured at CHSC ranged from 5.00 ng/m^3 to 323 ng/m^3, with a median concentration of 14.35 ng/m^3.

- Quarterly averages for benzo(a)pyrene and hexavalent chromium could not be calculated due to the low number of measured detections in each quarter; thus, annual averages could not be calculated either.

Table 25-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the South Carolina Monitoring Site

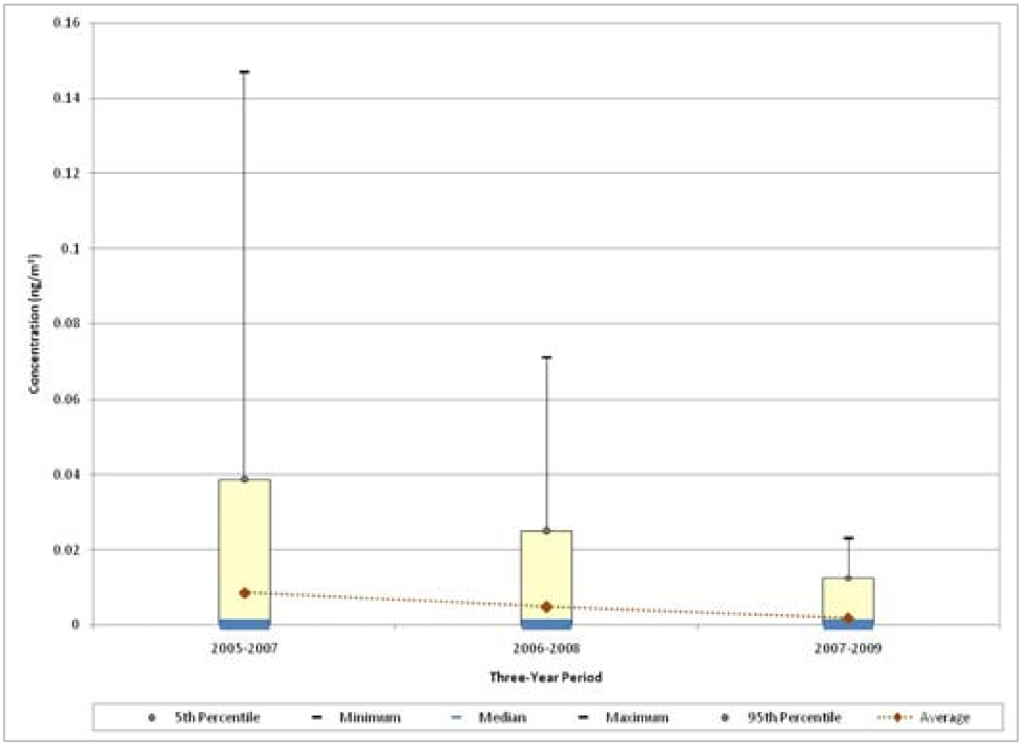
Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Chesterfield, South Carolina - CHSC												
Benzo(a)pyrene	0.05 ± 0.02	NA	NA	NA	NA	NA	0.04 ± 0.01	NA	NA	NA	NA	NA
Hexavalent Chromium	0.01 ± <0.01	NA	NA	NA	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA
Naphthalene	15.89 ± 2.65	NA	13.07 ± 4.46	15.29 ± 2.23	19.07 ± 6.43	15.89 ± 2.65	21.71 ± 11.22	17.41 ± 5.83	36.33 ± 45.67	15.09 ± 2.18	17.85 ± 3.93	21.71 ± 11.22

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

25.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. CHSC has sampled hexavalent chromium under the NMP since 2005. Thus, Figure 25-7 presents the 3-year rolling statistical metrics for hexavalent chromium for CHSC. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 25-7. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at CHSC



Observations from Figure 25-7 for hexavalent chromium measurements at CHSC include the following:

- Sampling for hexavalent chromium at CHSC began in January 2005.
- The maximum concentration of hexavalent chromium was measured on March 23, 2005. The maximum concentration of hexavalent chromium measured in subsequent time periods was considerably lower.

- In addition to the maximum concentration, the 95th percentile and rolling average concentrations of hexavalent chromium exhibit a decreasing trend over the periods shown.

- The minimum, 5th percentile, and median concentrations were all zero for each 3-year period shown in Figure 25-7, indicating that at least 50 percent of the measurements collected at CHSC were non-detects.

25.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the CHSC monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

25.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the South Carolina monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the CHSC monitoring site were higher than their respective MRL noncancer health risk benchmarks.

25.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the South Carolina monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 25-6, where applicable.

Table 25-6. Cancer and Noncancer Surrogate Risk Approximations for the South Carolina Monitoring Site

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Cancer (in-a-million)	Noncancer (HQ)
Chesterfield, South Carolina - CHSC										
Benzo(a)pyrene	0.001	--	8/0	NA	NA	NA	12/0	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	16/0	NA	NA	NA	5/0	NA	NA	NA
Naphthalene	3.4E-05	0.003	47/3	15.89 ± 2.65	0.54	0.01	55/4	21.71 ± 11.22	0.74	0.01

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

Observations for CHSC from Table 25-6 include the following:

- Annual average concentrations could only be calculated for naphthalene.
- The cancer risk approximations for naphthalene were low for CHSC for both years (0.54 in-a-million for 2008 and 0.74 in-a-million for 2009).
- The noncancer risk approximations for naphthalene were very low (0.01 for both years).

25.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 25-7 and 25-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 25-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from annual averages. Table 25-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from the annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer risk surrogate approximations based on the site's annual averages are limited to those pollutants for which the site sampled. As discussed in Section 25.3, CHSC sampled for PAH and hexavalent chromium only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 25-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the South Carolina Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	Emissions (tpy)	Pollutant	Cancer Toxicity Weight	Pollutant	Cancer Risk Approximation (in-a-million)
Chesterfield, South Carolina (Chesterfield County) - CHSC					
Formaldehyde	93.91	Formaldehyde	1.17E-03	Naphthalene	0.74
Benzene	83.73	Benzene	6.53E-04	Naphthalene	0.54
Acetaldehyde	20.18	1,3-Butadiene	5.39E-04		
1,3-Butadiene	17.98	POM, Group 2	1.94E-04		
Dichloromethane	7.23	Hexavalent Chromium, PM	1.52E-04		
POM, Group 2	3.53	Naphthalene	8.40E-05		
Trichloroethylene	2.86	POM, Group 5	6.32E-05		
Naphthalene	2.47	Acetaldehyde	4.44E-05		
Tetrachloroethylene	1.66	POM, Group 6	4.36E-05		
p-Dichlorobenzene	0.92	POM, Group 3	2.90E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 25-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the South Carolina Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Chesterfield, South Carolina (Chesterfield County) - CHSC					
Toluene	142.04	Acrolein	677,390.85	Naphthalene	0.01
Xylenes	99.34	Formaldehyde	9,582.82	Naphthalene	0.01
Formaldehyde	93.91	1,3-Butadiene	8,989.59		
Benzene	83.73	Benzene	2,791.09		
Methanol	33.54	Acetaldehyde	2,241.74		
Ethylene glycol	31.98	Cyanide Compounds, gas	1,383.99		
Hexane	20.55	Nickel, PM	1,241.10		
Acetaldehyde	20.18	Xylenes	993.37		
Methyl isobutyl ketone	19.43	Naphthalene	823.16		
Ethylbenzene	18.74	Glycol ethers, gas	795.68		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 25-7 include the following:

- Formaldehyde, benzene, and acetaldehyde were the highest emitted pollutants with cancer UREs in Chesterfield County.

- Formaldehyde, benzene, and 1,3-butadiene were the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Chesterfield County.

- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Chesterfield County.

- Naphthalene, which was the only pollutant of interest with annual averages for CHSC, had the eighth highest emissions and the sixth highest toxicity-weighted emissions for Chesterfield County.

- Hexavalent chromium ranked fifth for its toxicity-weighted emissions, but was not among the highest emitted pollutants.

- Several POM Groups appear among the pollutants with the highest toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at CHSC including acenapthylene, fluoranthene, perylene, and phenanthrene. POM Group 5 includes benzo(a)pyrene, which is one of CHSC's pollutants of interest. POM Group 6 includes benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene, all of which were sampled at CHSC. POM Group 3 does not include any pollutants sampled at CHSC.

Observations from Table 25-8 include the following:

- Toluene, xylenes, and formaldehyde were the highest emitted pollutants with noncancer RfCs in Chesterfield County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, formaldehyde, and 1,3-butadiene.

- Four of the highest emitted pollutants in Chesterfield County also had the highest toxicity-weighted emissions.

- Naphthalene, which was the only pollutant of interest with annual averages for CHSC, did not appear on among the highest emitted pollutants, but ranked ninth among the pollutants with the 10 highest toxicity-weighted emissions.

25.6 Summary of the 2008-2009 Monitoring Data for CHSC

Results from several of the treatments described in this section include the following:

- *Naphthalene was the only pollutant to fail screens for CHSC.*

- *Of the site-specific pollutants of the interest, naphthalene had the highest daily average concentration for CHSC for both years.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

26.0 Sites in South Dakota

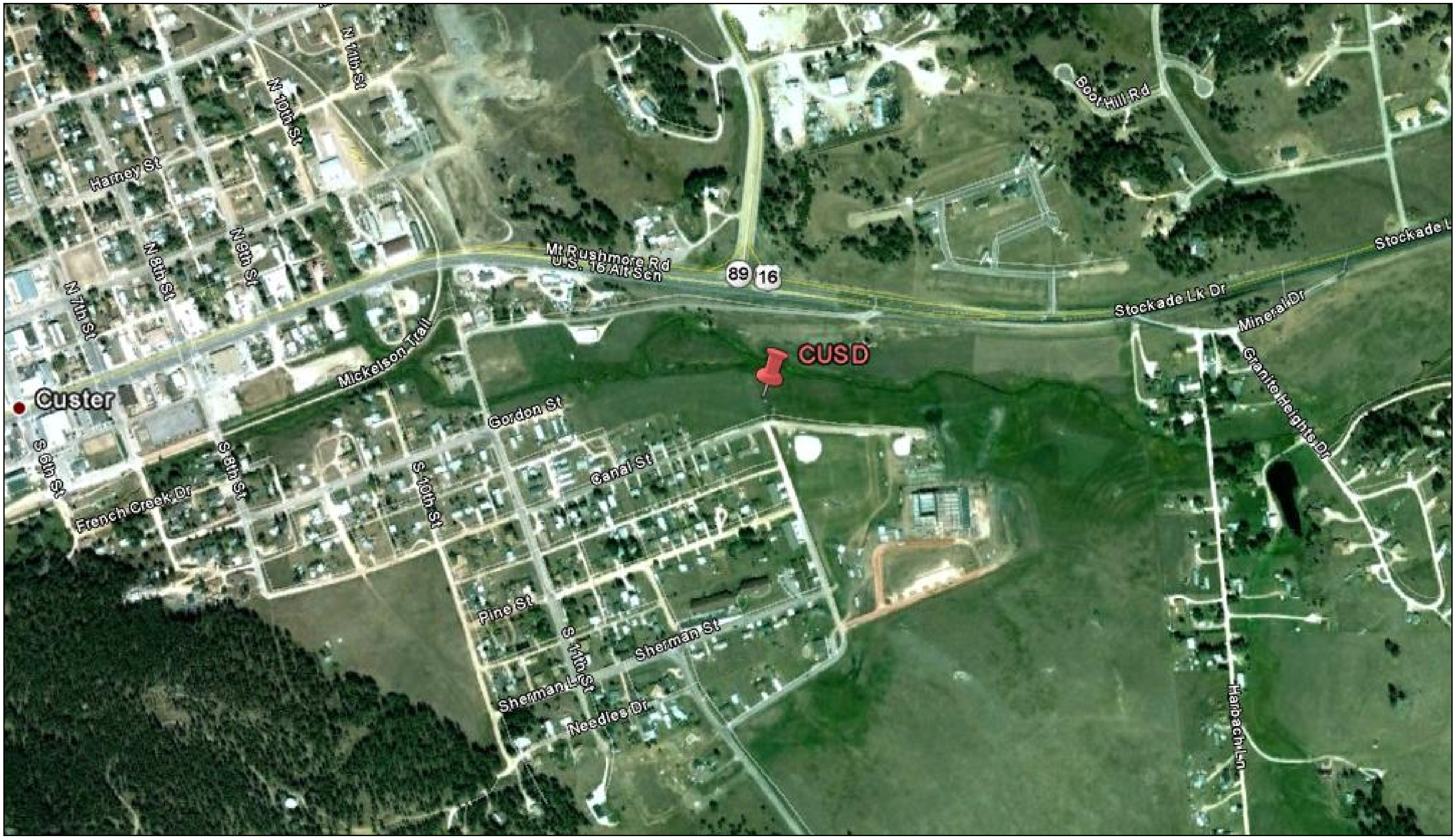
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in South Dakota, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

26.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the location of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

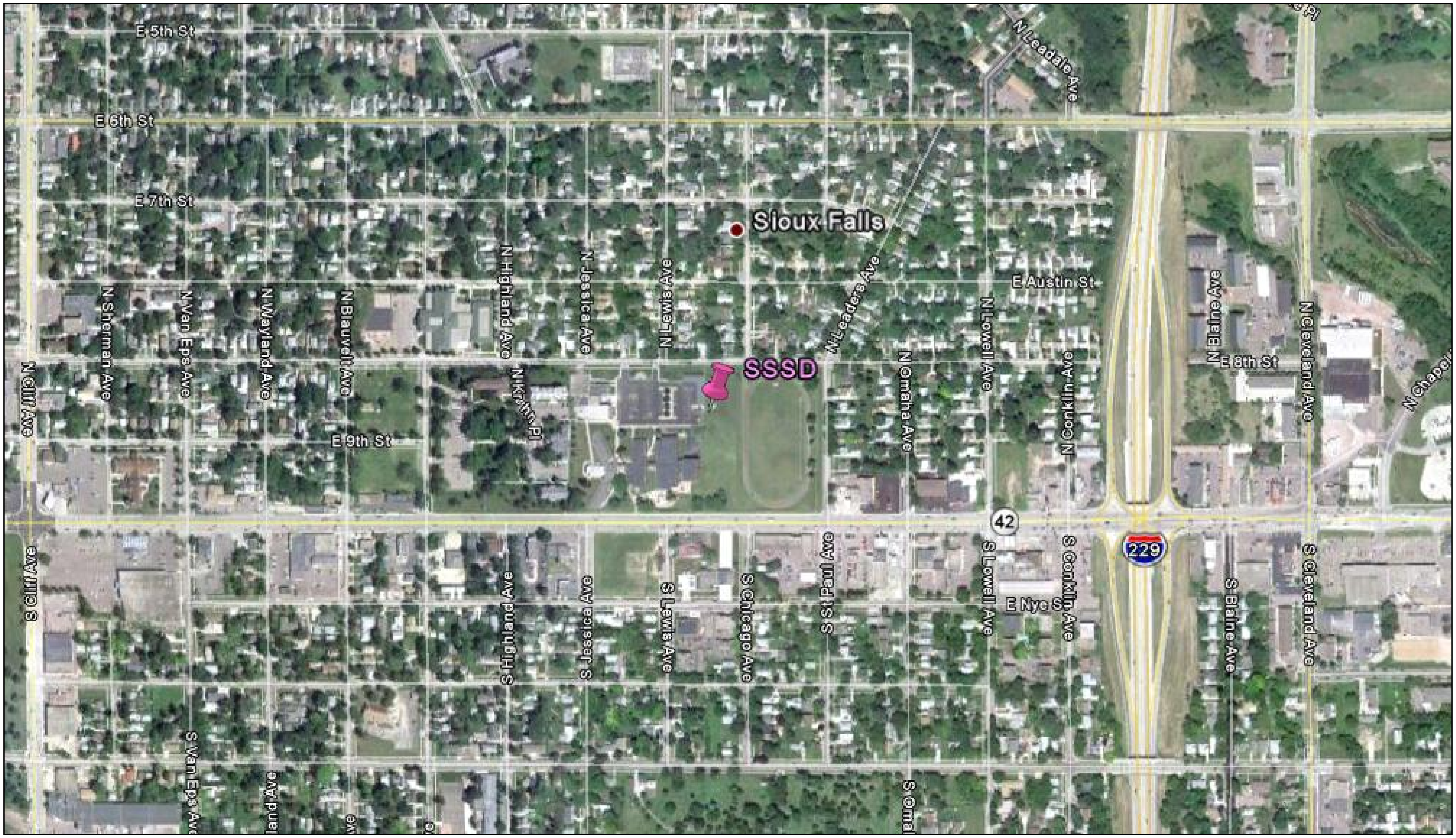
One monitoring site is located in Sioux Falls, South Dakota (SSSD). Another monitoring site is located in Custer, South Dakota (CUSD). The instrumentation at the CUSD site was moved across the state from Custer to Union County after completing sampling in 2008, and was renamed UCSD. Figures 26-1 through 26-3 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their rural and urban locations. Figures 26-4 through 26-6 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 26-4 through 26-6. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 26-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 26-1. Custer, South Dakota (CUSD) Monitoring Site



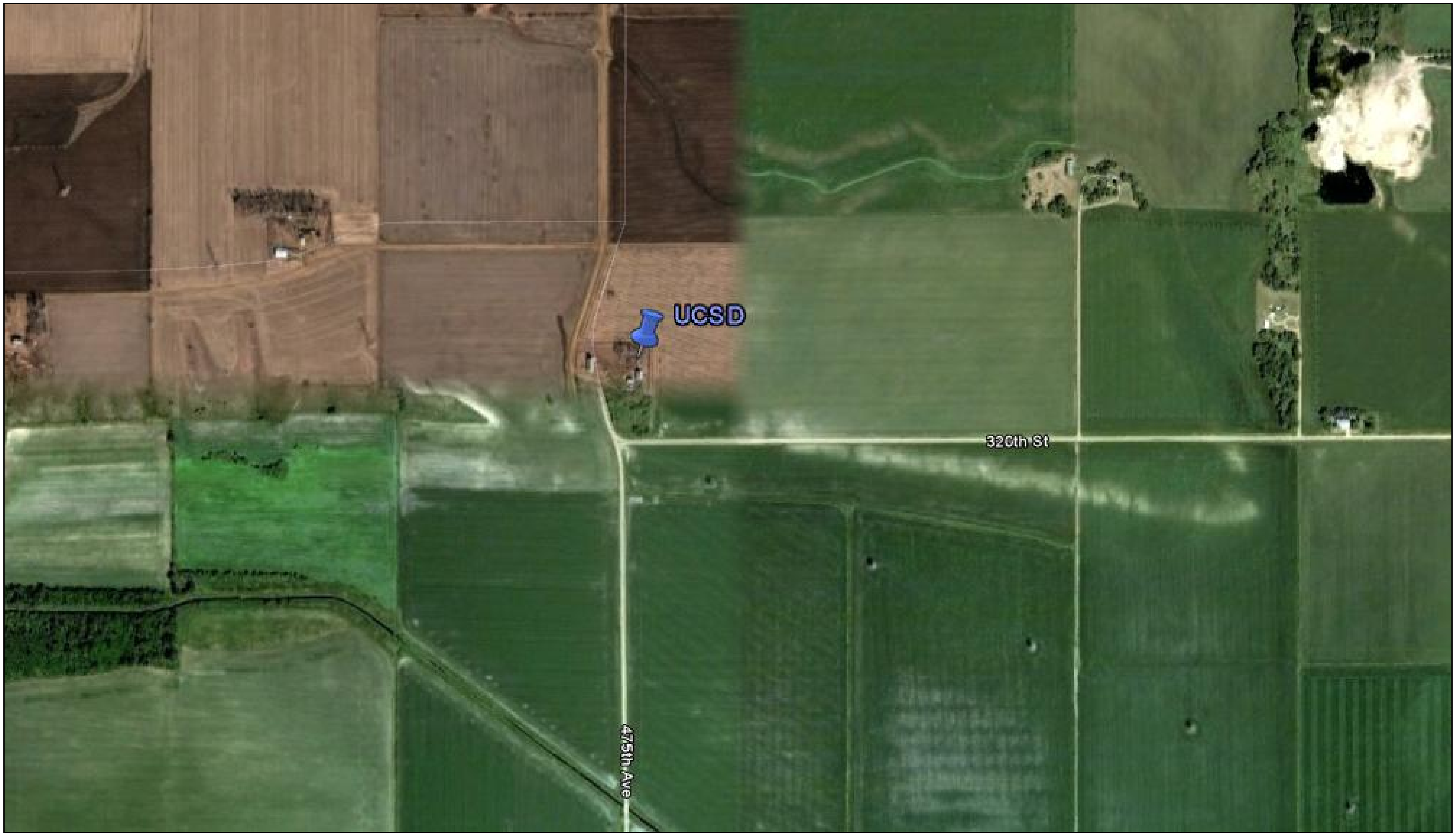
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,917 feet

Figure 26-2. Sioux Falls, South Dakota (SSSD) Monitoring Site



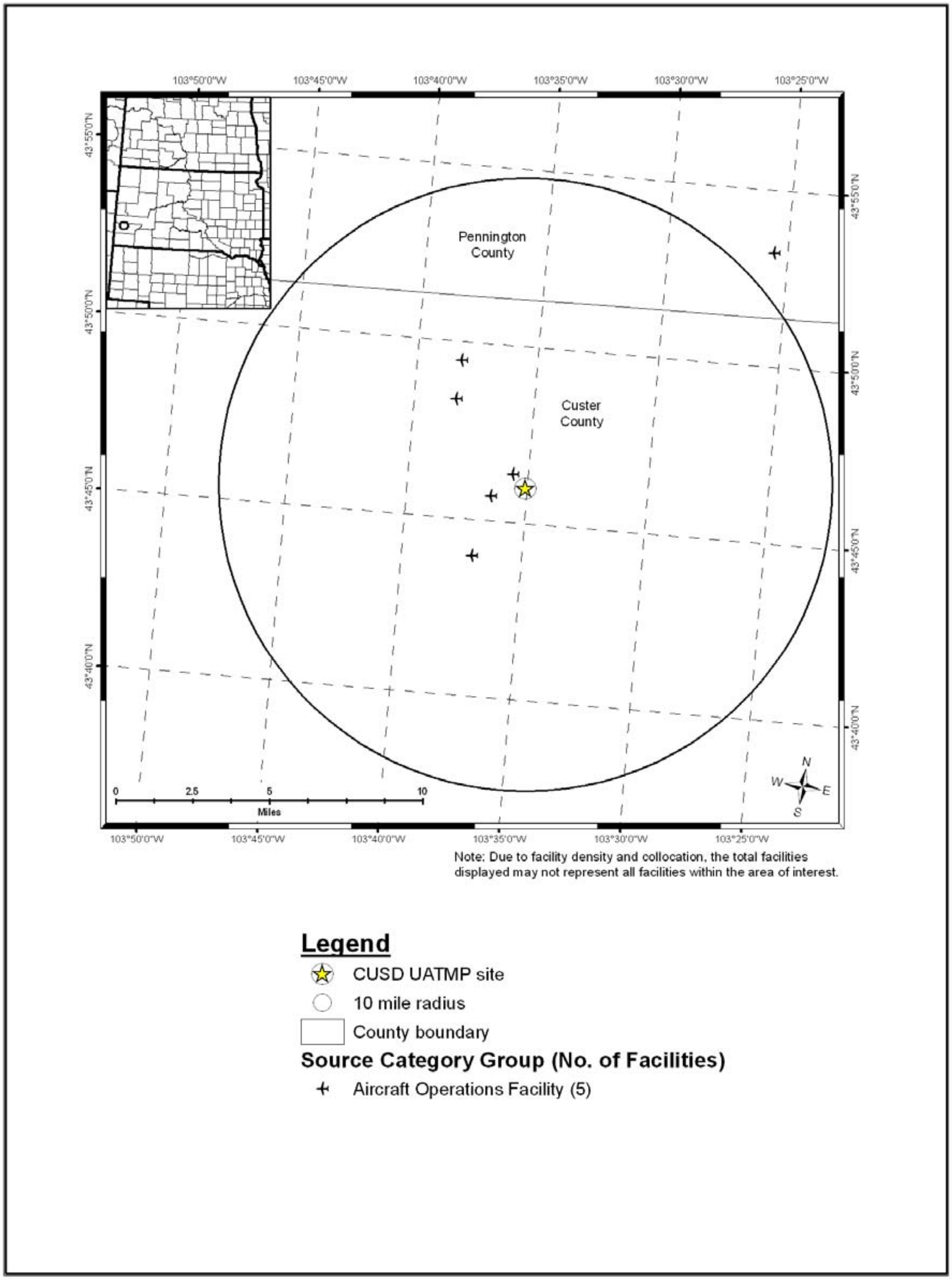
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,673 feet

Figure 26-3. Union County, South Dakota (UCSD) Monitoring Site



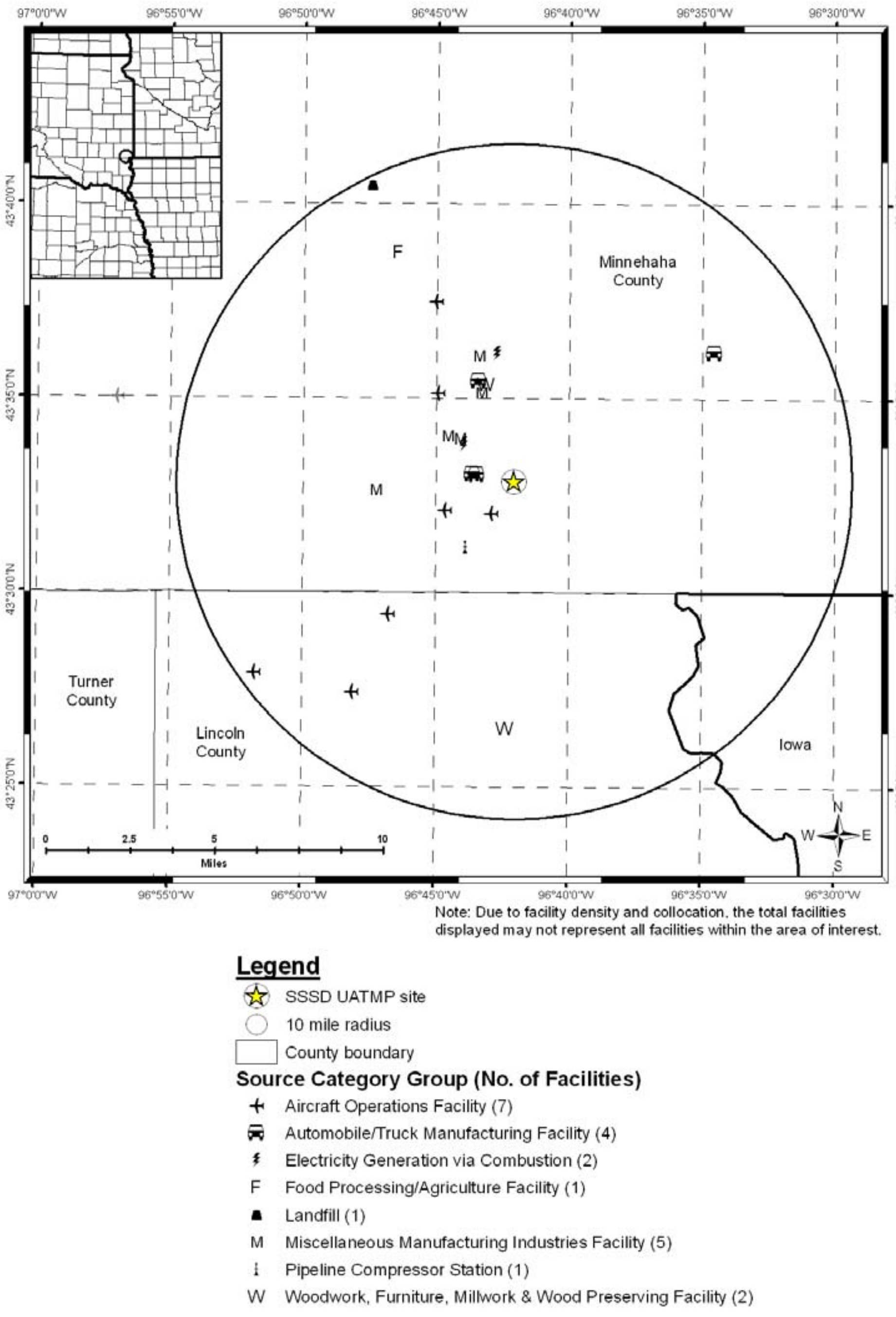
©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 2,348 feet

Figure 26-4. NEI Point Sources Located Within 10 Miles of CUSD



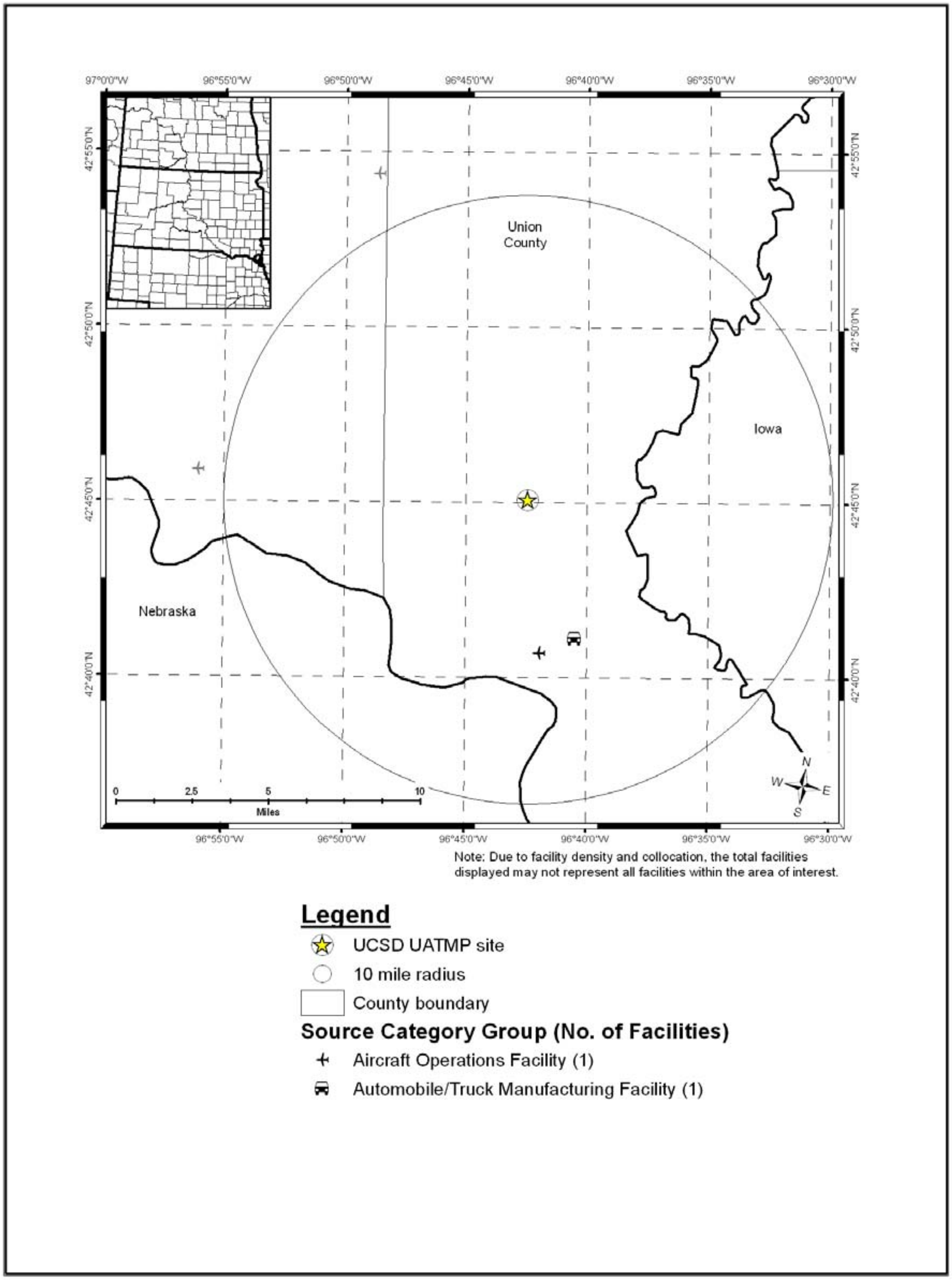
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 26-5. NEI Point Sources Located Within 10 Miles of SSSD


97°0'0"W
96°55'0"W
96°50'0"W
96°45'0"W
96°40'0"W
96°35'0"W
96°30'0"W
43°40'0"N
43°35'0"N
43°30'0"N
43°25'0"N
Minnehaha County
Turner County
Lincoln County
Iowa
F
M
W
0
2.5
5
10
Miles
N
S
E
W
Legend
SSSD UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (7)
Automobile/Truck Manufacturing Facility (4)
Electricity Generation via Combustion (2)
F Food Processing/Agriculture Facility (1)
Landfill (1)
M Miscellaneous Manufacturing Industries Facility (5)
Pipeline Compressor Station (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 26-6. NEI Point Sources Located Within 10 Miles of UCSD



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 26-1. Geographical Information for the South Dakota Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
CUSD	46-033-0003	Custer	Custer	Not in an MSA	43.766798, -103.584695	Residential	Suburban	None.
SSSD	46-099-0008	Sioux Falls	Minnehaha	Sioux Falls, SD	43.54792, -96.700769	Commercial	Urban/City Center	SO_2, NOy, NO, NO_2, NOx, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, and $PM_{2.5}$ Speciation.
UCSD	46-127-0001	Not in a City	Union	Sioux City, IA-NE-SD MSA	42.751518, -96.707208	Agricultural	Rural	CO, SO_2, NO, NO_2, NOx, Meteorological parameters, PM_{10}, and $PM_{2.5}$.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

CUSD is located in the town of Custer on the west side of the state, southwest of Rapid City. The town is located in the Black Hills and lies west of Custer State Park. The monitoring site is located just south of the Highway 89 and Highway 16 intersection, on the property of a sports complex on the outskirts of town. A residential subdivision is located just south and west of the site, as shown in Figure 26-1. Mobile sources and burning (wildfires and residential heating) are the primary emissions sources in the area. As Figure 26-4 shows, the only point sources located within 10 miles of the CUSD monitoring site are in the aircraft operations source category, which include airports as well as small runways, heliports, or landing pads. The closest aircraft operation to CUSD is the heliport at the Custer Regional Hospital.

SSSD is located on the east side of Sioux Falls, in eastern South Dakota. In previous years, the monitoring site was located at an elementary school on Bahnson Avenue. At the end of the 2007, the monitoring site was moved to a location at the South Dakota School for the Deaf, approximately 1 mile northwest of the previous location. The surrounding area is mixed usage, with both commercial and residential areas surrounding the site. SSSD is less than 1/2 mile from the intersection of Highway 42 and I-229, as shown in Figure 26-2. As Figure 26-5 shows, most of the emissions sources within 10 miles of SSSD are to the west of an imaginary line drawn down the center of the 10-mile radius around SSSD. The source categories with the highest number of sources include the aircraft operations category and the automobile/truck manufacturing category.

UCSD is located in Union County, the southeastern-most county of the state, where the South Dakota state border follows the Missouri River and comes to a point near Sioux City, Iowa at the Nebraska and Iowa borders. The UCSD monitoring site is located in a rural and agricultural area, as shown in Figure 26-3, north of Elk Point and southeast of Junction City. Interstate-29 runs northwest-southeast through the center of Union County and lies less than 1.5 miles west of UCSD. Figure 26-6 shows that there are only two point sources located within 10 miles of the site. However, UCSD is southeast of a proposed power plant and oil refinery (SD DENR, 2009). These facilities will be located approximately 3 to 4 miles north-northwest of the site.

Table 26-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the South Dakota monitoring sites. Information provided in Table 26-2 represents the most recent year of sampling (for CUSD, 2008 and for SSSD and UCSD, 2009), unless otherwise indicated. County-level vehicle registration and population data for Custer, Minnehaha, and Union Counties were obtained from the South Dakota Department of Revenue, Motor Vehicle Division (SD DOR, 2008) and the U.S. Census Bureau (Census Bureau, 2009 and 2010), respectively. Table 26-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 26-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 26-2 presents the daily VMT for the Sioux Falls and Sioux City urban areas (VMT was not available for Custer).

Table 26-2. Population, Motor Vehicle, and Traffic Information for the South Dakota Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
CUSD	7,811	14,714	1.96	5,549	10,901	2,500	NA
SSSD	183,048	200,008	1.09	167,000	182,473	22,087	2,984
UCSD	14,589	22,304	1.53	6,796	10,390	156	2,070

[1] Reference: Census Bureau, 2009 and 2010.
[2] County-level vehicle registration reflects 2008 data from the South Dakota DOR (SD DOR, 2008).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2007 data (for CUSD and UCSD) and 2009 data (for SSSD) from the South Dakota DOT (SD DOT, 2007 and 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
NA = Data unavailable.

Observations from Table 26-2 include the following:

- Although SSSD's county-level population was significantly higher than UCSD and CUSD's, all three county-level populations were in the bottom third compared to other counties with NMP sites. Custer County's population was the lowest of all NMP sites sampling in 2008 while Union County's population was the lowest of all

NMP sites sampling in 2009. The 10-mile populations for each site were also on the low side compared to other NMP sites, particularly CUSD and UCSD.

- SSSD's county-level vehicle registration was an order of magnitude higher than UCSD and CUSD's, yet all three county-level vehicle registrations were on the low side compared to other counties with NMP sites. Custer County and Union County's registrations were the lowest of all NMP counties, while Minnehaha County was in the bottom third. The 10-mile vehicle ownership estimates mimicked the rankings of the county-level vehicle ownerships.

- The vehicle-per-person ratios for these sites were among the highest, indicating that residents likely own multiple vehicles. The ratio for CUSD is the highest among all NMP sites (nearly two vehicles per person).

- The traffic volume for SSSD is an order of magnitude higher than the traffic volume for CUSD and two orders of magnitude higher than the traffic volume for UCSD. The traffic near UCSD is the second lowest among all NMP sites. Traffic data for CUSD were obtained for the intersection of Highways 16 and 89; traffic data for SSSD were obtained for 10th Avenue at Mable Avenue; traffic data for UCSD were obtained for 475th Avenue near 317th Street.

- The Sioux Falls and Sioux City area VMTs were the lowest among urban areas with NMP sites (behind only the Grand Junction urban area).

26.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in South Dakota on sample days, as well as over the course of each year.

26.2.1 Climate Summary

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, with the spring and summer seasons receiving more than half of the annual rainfall. On average, a south wind blows in the summer and a northwesterly wind blows in the winter. Flooding is often a concern in the area during springtime when snow begins to melt, although a flood control system, including levees and a diversion channel, was constructed during the late 1950s to early 1960s to reduce the flood threat within the city limits and to divert water from the Big Sioux River and Skunk Creek around the city (Bair, 1992 and City of Sioux Falls, 2011).

The climate of Custer is considered semi-arid continental; annual precipitation is generally light. Warm, pleasant summers and relatively mild winters are characteristic of this area, due in part to the Black Hills, which allow winters to be milder in comparison to the rest of the state. Winds blow out of the north-northwest on average (Bair, 1992).

The climate near Sioux City is generally continental in nature, with warm summers and cold, relatively dry winters. Precipitation is concentrated in the spring and summer months. Wind direction varies with season, with southeasterly to southerly winds in the spring and summer, and northwesterly winds in the autumn and winter (Bair, 1992).

26.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The three closest NWS weather stations are located at Custer County Airport (near CUSD), Joe Foss Field Airport (near SSSD), and Sioux Gateway Airport (near UCSD), WBAN 94032, 14944, and 14943, respectively. Additional information about these weather stations is provided in Table 26-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 26-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 26-3 is the 95 percent confidence interval for each parameter. As shown in Table 26-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout the years at all three sites.

Table 26-3. Average Meteorological Conditions near the South Dakota Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Custer, South Dakota - CUSD										
Custer County Airport 94032 (43.73, -103.63)	3.20 miles 224° (SW)	2008	Sample Day	50.7 ± 5.0	40.3 ± 4.7	25.5 ± 4.4	34.0 ± 4.1	59.6 ± 3.7	1014.0 ± 2.2	5.9 ± 0.5
			All Year	51.5 ± 2.0	41.4 ± 1.8	25.8 ± 1.7	34.6 ± 1.5	58.5 ± 1.5	1014.2 ± 0.8	5.9 ± 0.3
Sioux Falls, South Dakota - SSSD										
Joe Foss Field Airport 14944 (43.58, -96.75)	3.21 miles 309° (NW)	2008	Sample Day	52.6 ± 6.6	43.1 ± 6.3	32.3 ± 5.8	38.1 ± 5.7	68.5 ± 2.6	1015.5 ± 2.2	9.3 ± 1.2
			All Year	54.8 ± 2.5	45.0 ± 2.4	33.9 ± 2.2	39.7 ± 2.1	68.2 ± 1.1	1015.8 ± 0.8	8.3 ± 0.4
		2009	Sample Day	56.8 ± 5.7	47.0 ± 5.3	36.7 ± 5.0	42.1 ± 4.8	69.9 ± 2.5	1016.1 ± 1.6	8.2 ± 1.0
			All Year	54.9 ± 2.3	45.4 ± 2.2	35.6 ± 2.1	40.8 ± 2.0	71.2 ± 1.1	1016.5 ± 0.8	7.9 ± 0.4
Union County, South Dakota - UCSD										
Sioux Gateway/Col. Bud Day Field Airport 14943 (42.39, -96.38)	25.06 miles 86° (E)	2009	Sample Day	60.1 ± 5.5	49.6 ± 5.1	39.1 ± 4.8	44.5 ± 4.6	70.4 ± 3.1	1016.9 ± 1.7	8.3 ± 1.1
			All Year	58.2 ± 2.3	47.8 ± 2.1	37.6 ± 2.0	42.9 ± 2.0	70.7 ± 1.2	1017.0 ± 0.8	8.2 ± 0.4

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

26.2.3 Back Trajectory Analysis

Figure 26-7 is the composite back trajectory map for days on which samples were collected at the CUSD monitoring site in 2008. Figure 26-8 is the cluster analysis for 2008. Figures 26-9 and 26-10 are the composite back trajectory maps for days on which samples were collected at the SSSD monitoring site in 2008 and 2009, respectively. Figure 26-11 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Finally, Figure 26-12 is the composite back trajectory map for days on which samples were collected at the UCSD monitoring site in 2009 and Figure 26-13 is the cluster analysis for 2009. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 26-7 through 26-13 represents 100 miles.

Figure 26-7. 2008 Composite Back Trajectory Map for CUSD

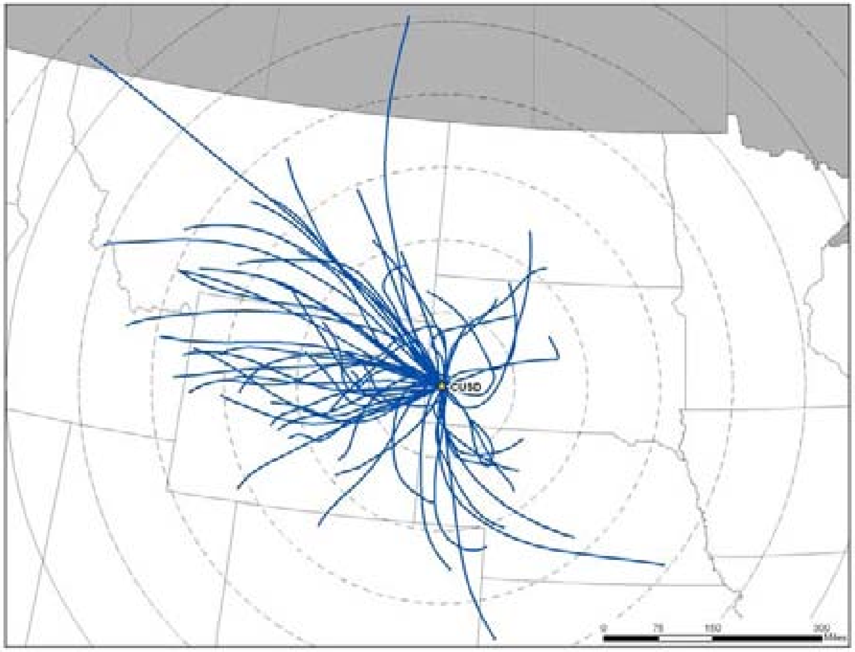


Figure 26-8. 2008 Back Trajectory Cluster Map for CUSD

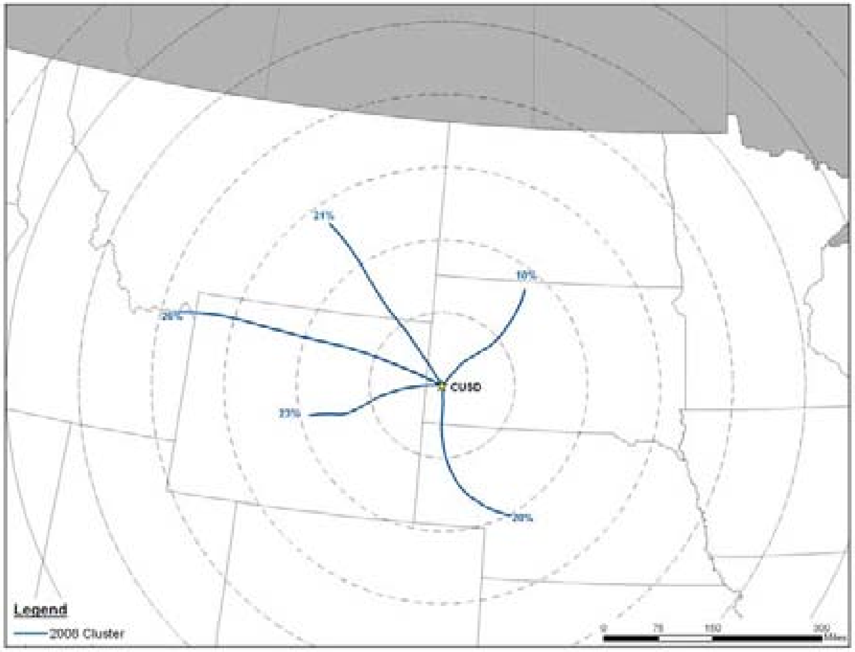


Figure 26-9. 2008 Composite Back Trajectory Map for SSSD

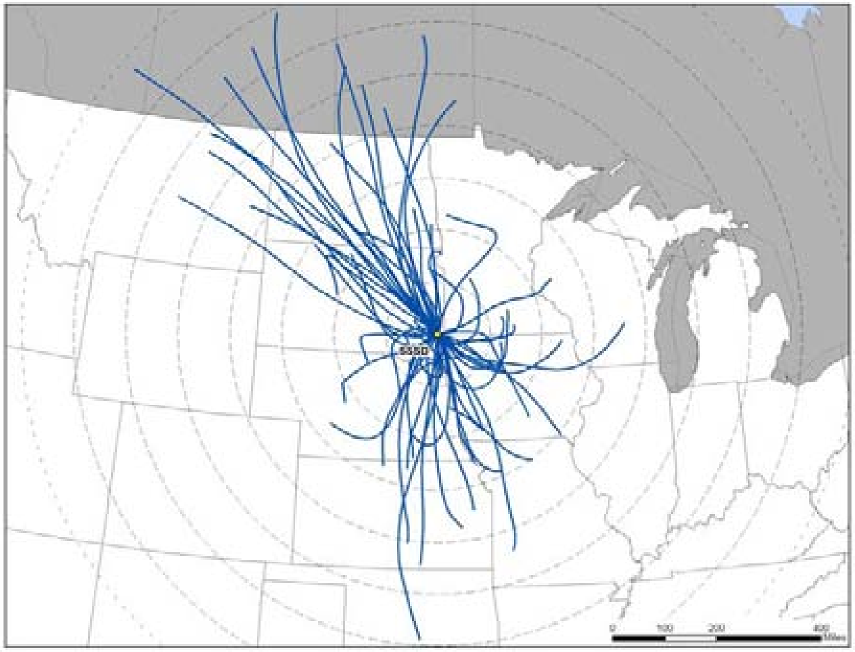


Figure 26-10. 2009 Composite Back Trajectory Map for SSSD

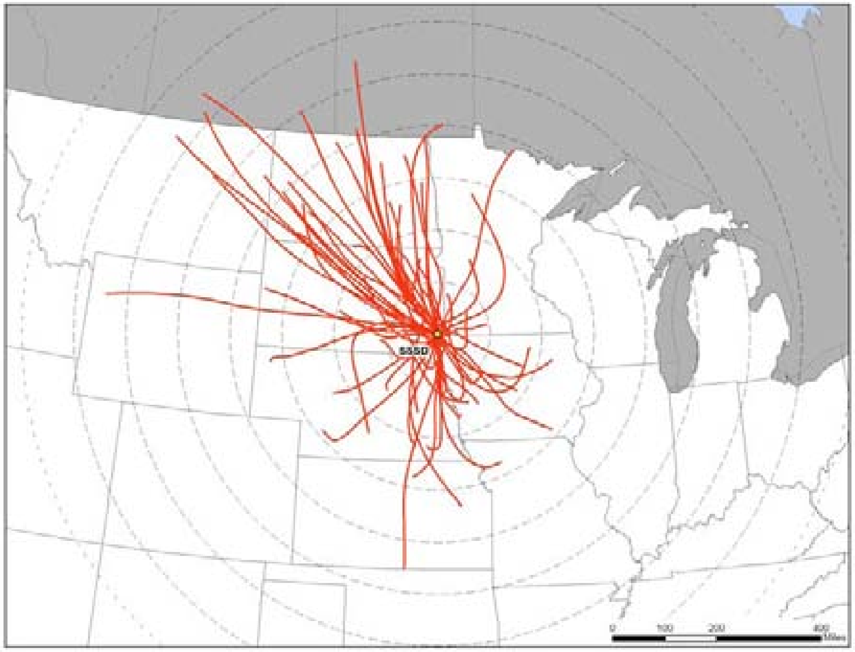


Figure 26-11. Back Trajectory Cluster Map for SSSD

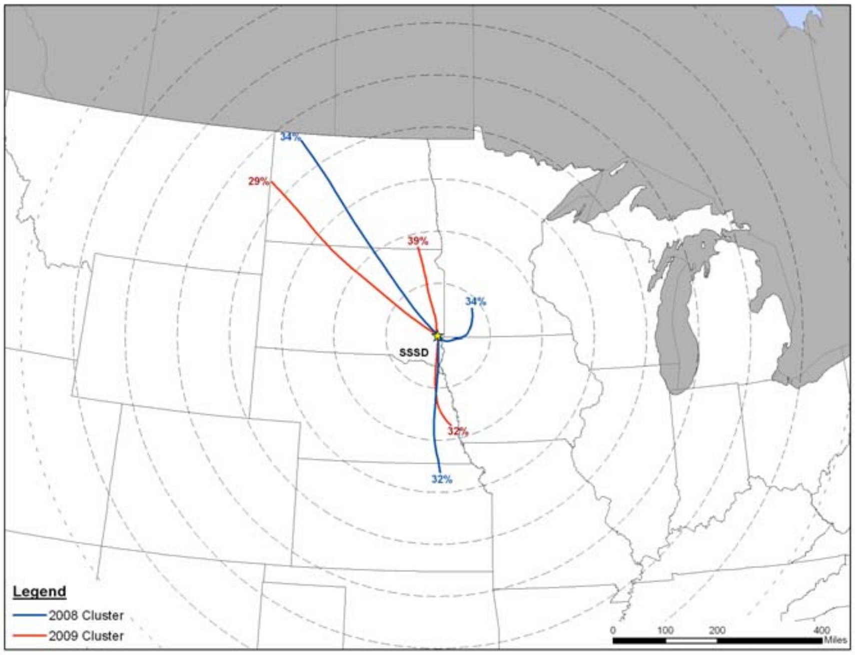


Figure 26-12. 2009 Composite Back Trajectory Map for UCSD

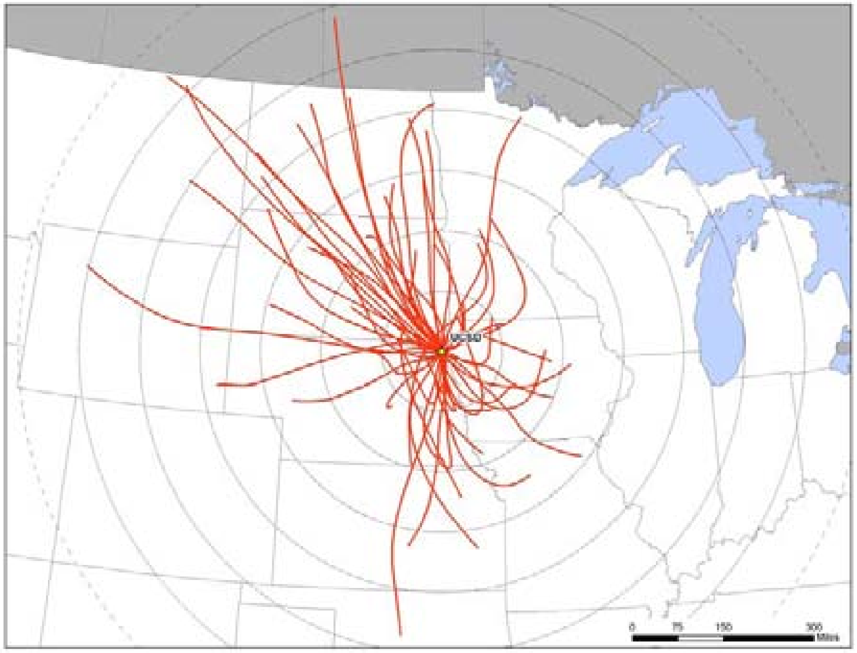
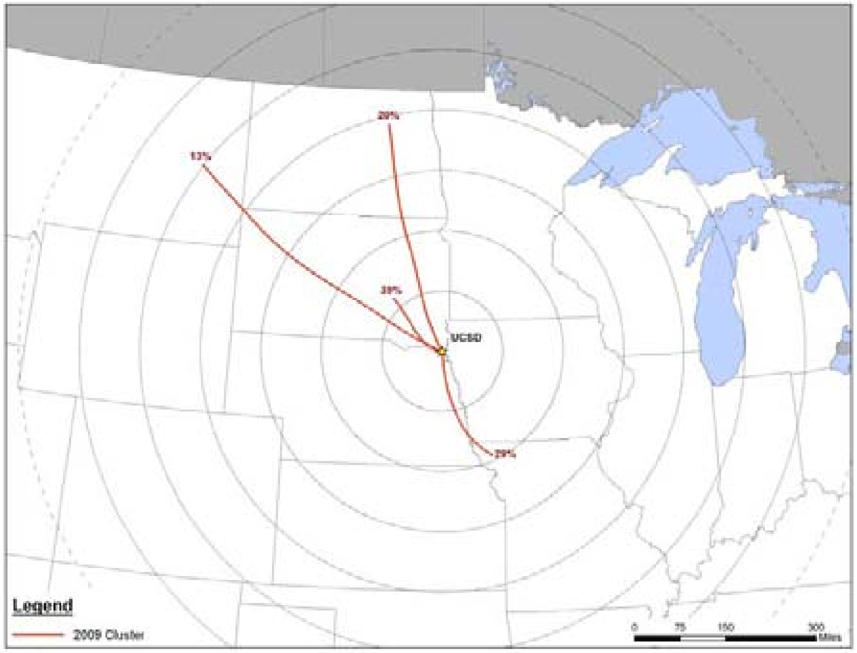


Figure 26-13. 2009 Back Trajectory Cluster Map for UCSD



Observations from Figures 26-7 and 26-8 for CUSD include the following:

- Back trajectories originated from a variety of directions at the CUSD monitoring site, although most trajectories originated from the southwest, west or northwest.

- The 24-hour air shed domain for CUSD was somewhat larger in size compared to other NMP monitoring sites. The farthest away a trajectory originated was southeast British Columbia, Canada, or nearly 700 miles away. However, the average trajectory length was 269 miles and over 90 percent of the trajectories originated within 400 miles of the site.

- The cluster analysis for CUSD shows that 70 percent of trajectories originated from the northwest, west, or southwest of the site. Twenty percent of trajectories originated from the south and south-southeast of the site and another 10 percent originated to the northeast of the site.

Observations from Figures 26-9 through 26-11 for SSSD include the following:

- Back trajectories originated from a variety of directions at the SSSD site, although primarily from the northwest and south.

- The 24-hour air shed domain for SSSD was one of the larger air sheds compared to the other NMP monitoring sites. The farthest away a trajectory originated was southeast Alberta, Canada, or nearly 800 miles away. However, the average trajectory length was approximately 300 miles and 85 percent of the trajectories originated within 500 miles of the site.

- The cluster analysis confirms that trajectories originating from the northwest and south were most common for SSSD. The shorter clusters originating to the northeast (2008) or north (2009) of SSSD represent trajectories originating to the north, northeast, and east of the site, as well as a few from other directions but within 100 miles or so of the site.

Observations from Figures 26-12 and 26-13 for UCSD include the following:

- Back trajectories originated from a variety of directions at the UCSD monitoring site.

- The 24-hour air shed domain for UCSD was somewhat larger in size compared to other NMP monitoring sites. The farthest away a trajectory originated was north-central Montana, or nearly 650 miles away. However, the average trajectory length was 280 miles and over 85 percent of the trajectories originated within 450 miles of the site.

- The cluster analysis for UCSD shows that over 30 percent of trajectories originated from the northwest and north-northwest of the site. Another roughly 30 percent originated to the south and southeast of the site. Similar to SSSD's cluster analysis, the shorter cluster originating to the northwest (39 percent) of UCSD represents trajectories originating from various directions but within 100-200 miles of the site.

26.2.4 Wind Rose Comparison

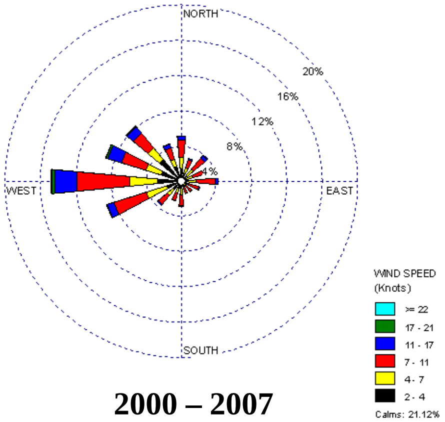
Hourly wind data from the NWS weather stations at Custer County (for CUSD), Joe Foss Field (for SSSD), and Sioux Gateway (for UCSD) Airports were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 26-14 presents three different wind roses for the CUSD monitoring site. First, a historical wind rose representing 2000 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year is presented. Lastly, a wind rose representing days on which samples were collected in 2008 is presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 26-15 presents five different wind roses for the SSSD monitoring site (including a full-year and sample day wind rose for both years) and Figure 26-16 presents three different wind roses for the UCSD monitoring site (including a full-year and sample day wind rose for 2009).

Observations from Figure 26-14 for CUSD include the following:

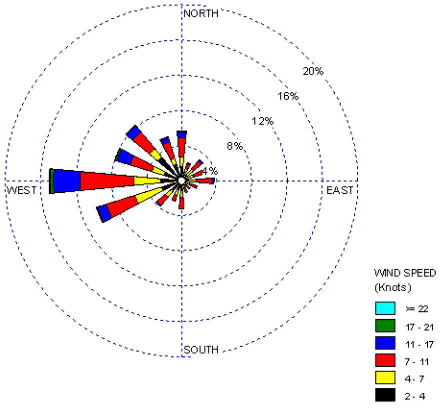
- The historical wind rose shows that west-southwesterly to northwesterly winds prevailed near CUSD. Calm winds (≤2 knots) were observed for approximately 21 percent of the observations.
- The wind patterns shown on the 2008 wind rose are nearly identical to those shown on the historical wind rose, indicating that conditions in 2008 were similar to those experienced historically.
- The 2008 sample day wind rose exhibits a little more fluctuation in the percentages, but still shows that winds from the west-southwest to northwest prevailed on sample days.

Figure 26-14. Wind Roses for the Custer County Airport Weather Station near CUSD

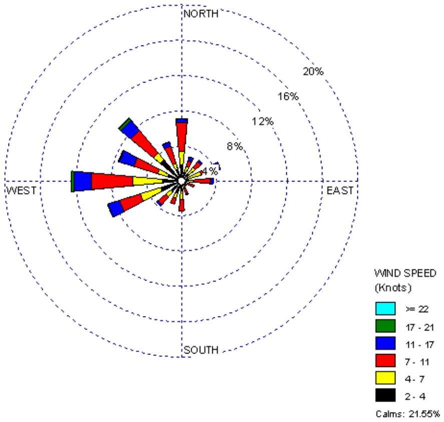


2000 – 2007

Historical Wind Rose

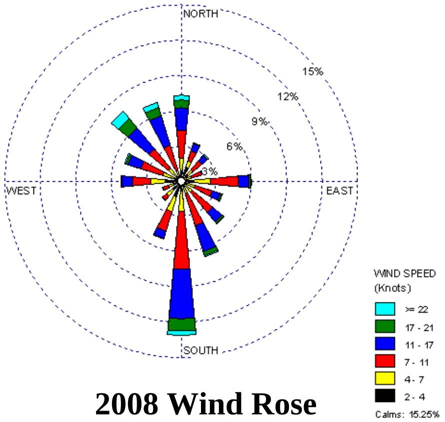


2008 Wind Rose

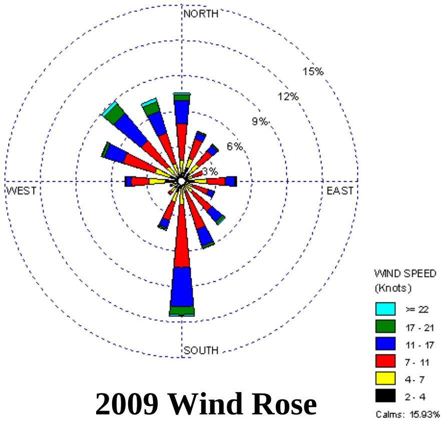


2008 Sample Day Wind Rose

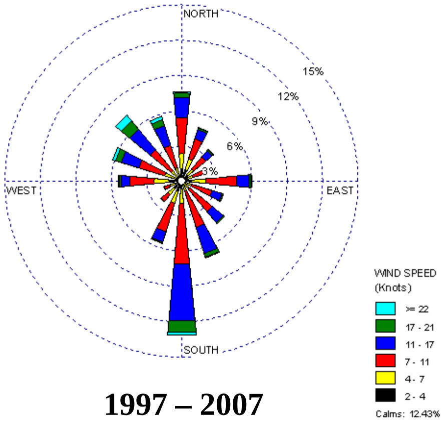
Figure 26-15. Wind Roses for the Joe Foss Field Airport Weather Station near SSSD



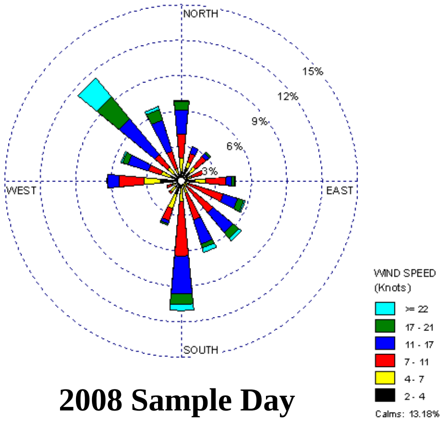
2008 Wind Rose



2009 Wind Rose

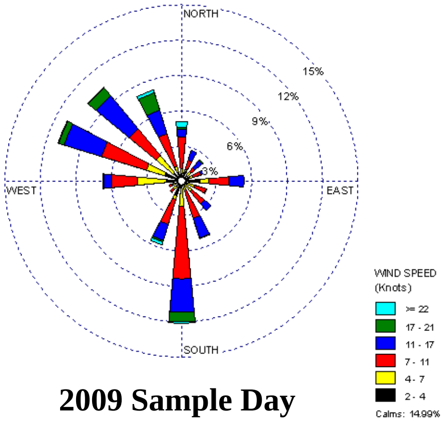


1997 – 2007
Historical Wind Rose



2008 Sample Day

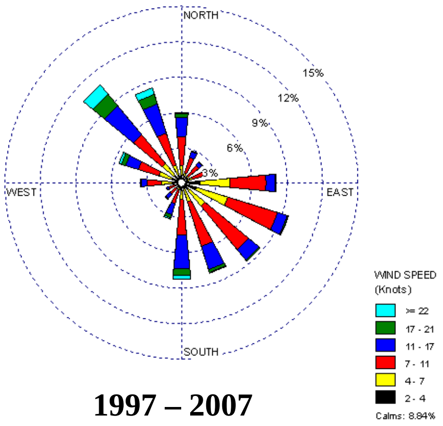
Wind Rose



2009 Sample Day

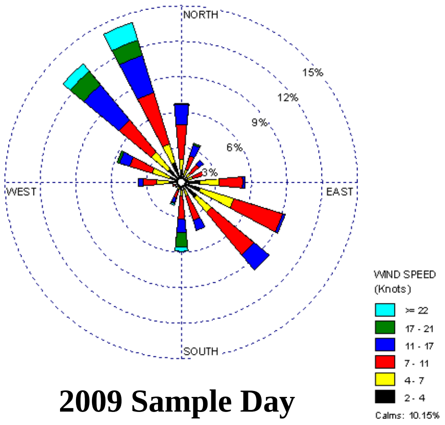
Wind Rose

Figure 26-16. Wind Roses for the Sioux Gateway Airport Weather Station near UCSD



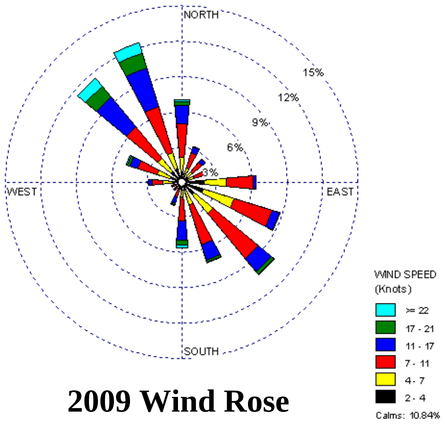
1997 – 2007

Historical Wind Rose



2009 Sample Day

Wind Rose



2009 Wind Rose

Observations from Figure 26-15 for SSSD include the following:

- The historical wind rose shows that winds from a variety of directions were observed near SSSD, although winds from the south were observed the most (13 percent), and southwesterly and south-southwesterly winds observed the least (less than 3 percent). Calm winds were observed for approximately 12 percent of the observations. The strongest winds tend to be from the south or the northwest quadrant.

- The 2008 and 2009 wind patterns are very similar to the historical wind patterns, although a slightly higher percentage of calm winds were observed during these years.

- The 2008 and 2009 sample day wind roses resemble the historical and full-year wind roses, but do show some differences. Both sample day wind roses have a higher percentage of northwesterly (and west-northwesterly for 2008) winds.

Observations from Figure 26-16 for UCSD include the following:

- The historical wind rose shows that winds from the southeasterly and northwesterly quadrants were observed the most near UCSD. Calm winds were observed for less than nine percent of the observations. The strongest winds tend to be from the south or the northwest quadrant.

- The 2009 wind patterns are similar to the historical wind patterns, although there are a few differences such as a higher percentage of northwesterly and north-northwesterly wind observations and fewer observations from the southeast quadrant.

- The 2009 sample day wind patterns resemble the full-year wind patterns, but have an even higher percentage of northwesterly and north-northwesterly wind observations and slightly less observations from the southeast quadrant.

26.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the South Dakota monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 26-4 presents the pollutants of interest for the three South Dakota monitoring sites. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. CUSD, SSSD, and UCSD sampled for VOC, SNMOC, and carbonyl compounds.

Table 26-4. Risk Screening Results for the South Dakota Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Custer, South Dakota - CUSD						
Benzene	0.13	60	60	100.00	20.83	20.83
Formaldehyde	0.077	60	60	100.00	20.83	41.67
Acetaldehyde	0.45	59	60	98.33	20.49	62.15
Carbon Tetrachloride	0.17	59	60	98.33	20.49	82.64
1,3-Butadiene	0.033	32	51	62.75	11.11	93.75
Acrylonitrile	0.015	6	6	100.00	2.08	95.83
p-Dichlorobenzene	0.091	3	11	27.27	1.04	96.88
Ethylbenzene	0.4	3	59	5.08	1.04	97.92
Dichloromethane	2.1	2	60	3.33	0.69	98.61
Tetrachloroethylene	0.17	2	38	5.26	0.69	99.31
n-Hexane	70	1	60	1.67	0.35	99.65
Xylenes	10	1	59	1.69	0.35	100.00
Total		288	584	49.32	100.00	

Table 26-4. Risk Screening Results for the South Dakota Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Sioux Falls, South Dakota - SSSD						
Benzene	0.13	120	120	100.00	20.73	20.73
Carbon Tetrachloride	0.17	118	120	98.33	20.38	41.11
Acetaldehyde	0.45	114	114	100.00	19.69	60.79
Formaldehyde	0.077	114	114	100.00	19.69	80.48
1,3-Butadiene	0.033	54	116	46.55	9.33	89.81
Acrylonitrile	0.015	23	23	100.00	3.97	93.78
Tetrachloroethylene	0.17	16	99	16.16	2.76	96.55
Ethylbenzene	0.4	9	120	7.50	1.55	98.10
1,2-Dichloroethane	0.038	4	4	100.00	0.69	98.79
p-Dichlorobenzene	0.091	3	49	6.12	0.52	99.31
Dichloromethane	2.1	2	120	1.67	0.35	99.65
Propionaldehyde	0.8	2	114	1.75	0.35	100.00
Total		579	1,113	52.02	100.00	
Union County, South Dakota - UCSD						
Acetaldehyde	0.45	52	52	100.00	20.00	20.00
Formaldehyde	0.077	52	52	100.00	20.00	40.00
Benzene	0.13	48	49	97.96	18.46	58.46
Carbon Tetrachloride	0.17	48	49	97.96	18.46	76.92
Acrylonitrile	0.015	22	22	100.00	8.46	85.38
Ethylbenzene	0.4	12	49	24.49	4.62	90.00
Trichloroethylene	0.5	11	24	45.83	4.23	94.23
1,3-Butadiene	0.033	4	33	12.12	1.54	95.77
Propionaldehyde	0.8	4	52	7.69	1.54	97.31
1,2-Dichloroethane	0.038	3	3	100.00	1.15	98.46
Dichloromethane	2.1	2	49	4.08	0.77	99.23
p-Dichlorobenzene	0.091	1	13	7.69	0.38	99.62
Tetrachloroethylene	0.17	1	24	4.17	0.38	100.00
Total		260	471	55.20	100.00	

Observations from Table 26-4 include the following:

- Twelve pollutants failed at least one screen for CUSD and SSSD; of these, six are NATTS MQO Core Analytes (for both sites). Thirteen pollutants failed screens for UCSD, of which seven are also NATTS MQO Core Analytes.

- The percent of the measured detections that failed screens (of the pollutants that failed at least one screen) ranged from 49 percent for CUSD to 55 percent for UCSD. Note that CUSD sampled in 2008 only, SSSD sampled over the 2-year period, and UCSD sampled in 2009 only. This explains why the percentage of measured detections is so much higher for SSSD.

- For CUSD, six pollutants (of which five are NATTS MQO Core Analytes) were identified as pollutants of interest by the risk screening process. Tetrachloroethylene was added to CUSD's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. In addition, vinyl chloride, trichloroethylene, and chloroform were also added because they are NATTS MQO Core Analytes, even though they did not fail any screens. These three pollutants are not shown in Table 26-4.

- For SSSD, seven pollutants (of which six are NATTS MQO Core Analytes) were identified as pollutants of interest by the risk screening process. Vinyl chloride, trichloroethylene, and chloroform were added to SSSD's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These three pollutants are also not shown in Table 26-4.

- For UCSD, nine pollutants (of which six are NATTS MQO Core Analytes) were identified as pollutants of interest by the risk screening process. Tetrachloroethylene was added to UCSD's pollutants of interest because it's a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. Vinyl chloride and chloroform were added to UCSD's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are also not shown in Table 26-4.

- Of the 10 pollutants of interest in common among the three sites, formaldehyde and acrylonitrile failed 100 percent screens for each site. However, note the difference in the number of measured detections between these two pollutants: formaldehyde was detected in 100 percent of samples collected at each site while the percent of detections of acrylonitrile ranged from 12 (CUSD) to 44 (UCSD) percent.

- Recall from Section 3.2 that if a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used for the risk screening process. As all three of the South Dakota sites sampled both VOC (TO-15) and SNMOC, the TO-15 results were used for the 12 pollutants these methods have in common.

26.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the South Dakota monitoring sites. Concentration averages are provided for the pollutants of interest for each site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the sites, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

26.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each South Dakota site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages for the South Dakota monitoring sites are presented in Table 26-5, where applicable.

Observations for CUSD from Table 26-5 include the following:

- The pollutants with the highest daily average concentrations by mass were formaldehyde (1.98 ± 0.24 $\mu g/m^3$), acetaldehyde (1.74 ± 0.27 $\mu g/m^3$), and carbon tetrachloride (0.73 ± 0.06 $\mu g/m^3$), although the benzene concentration (0.72 ± 0.13 $\mu g/m^3$) was very similar to the carbon tetrachloride concentration.

- Most of the quarterly average concentrations of the pollutants of interest did not vary significantly across the calendar quarters.

- Although benzene's third quarter 2008 average was not much different than the average concentration for the other quarters, the large confidence interval indicates that this concentration is influenced by outliers. On September 27, 2008, the benzene concentration (TO-15) was 3.46 $\mu g/m^3$ or nearly twice the next highest concentration (1.67 $\mu g/m^3$ measured on January 7, 2008). Note that only the TO-15 concentrations were included in this analysis for benzene. The highest benzene concentration for CUSD from SNMOC was also measured on September 27, 2008.

- Quarterly and annual averages could not be calculated for acrylonitrile, vinyl chloride, or trichloroethylene because these pollutants were not detected frequently enough.

Table 26-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the South Dakota Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Custer, South Dakota - CUSD												
Acetaldehyde	1.75 ± 0.27	1.59 ± 0.38	1.49 ± 0.49	2.41 ± 0.84	1.56 ± 0.42	1.75 ± 0.27	NR	NR	NR	NR	NR	NR
Acrylonitrile	0.37 ± 0.11	NA	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
Benzene	0.72 ± 0.13	0.81 ± 0.21	0.48 ± 0.07	0.81 ± 0.45	0.80 ± 0.22	0.72 ± 0.13	NR	NR	NR	NR	NR	NR
1,3-Butadiene	0.06 ± 0.01	0.07 ± 0.03	0.03 ± 0.01	0.04 ± 0.02	0.07 ± 0.03	0.05 ± 0.01	NR	NR	NR	NR	NR	NR
Carbon Tetrachloride	0.73 ± 0.06	0.66 ± 0.09	0.74 ± 0.14	0.76 ± 0.11	0.78 ± 0.15	0.73 ± 0.06	NR	NR	NR	NR	NR	NR
Chloroform	0.08 ± 0.01	0.07 ± 0.01	0.06 ± 0.02	NA	0.08 ± 0.01	0.07 ± 0.01	NR	NR	NR	NR	NR	NR
Formaldehyde	1.98 ± 0.24	2.03 ± 0.42	1.80 ± 0.47	2.34 ± 0.66	1.77 ± 0.42	1.98 ± 0.24	NR	NR	NR	NR	NR	NR
Tetrachloroethylene	0.09 ± 0.04	0.05 ± 0.02	0.04 ± 0.02	0.12 ± 0.13	NA	0.06 ± 0.03	NR	NR	NR	NR	NR	NR
Trichloroethylene	0.11 ± 0.14	NA	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR
Vinyl Chloride	0.01 ± 0.01	NA	NA	NA	NA	NA	NR	NR	NR	NR	NR	NR

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Table 26-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the South Dakota Monitoring Sites (Continued)

	2008						2009					
Pollutant	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**	**Daily Average (µg/m^3)**	**1st Quarter Average (µg/m^3)**	**2nd Quarter Average (µg/m^3)**	**3rd Quarter Average (µg/m^3)**	**4th Quarter Average (µg/m^3)**	**Annual Average (µg/m^3)**
Sioux Falls, South Dakota - SSSD												
Acetaldehyde	2.01 ± 0.40	3.06 ± 1.12	1.59 ± 0.24	1.55 ± 0.26	1.45 ± 0.65	2.01 ± 0.40	2.38 ± 0.45	2.89 ± 1.96	1.94 ± 0.52	2.30 ± 0.55	2.63 ± 1.05	2.38 ± 0.45
Acrylonitrile	0.16 ± 0.16	NA	NA	NA	NA	NA	0.07 ± 0.01	0.04 ± 0.02	0.04 ± 0.02	NA	NA	NA
Benzene	0.72 ± 0.10	0.85 ± 0.26	0.60 ± 0.16	0.75 ± 0.14	0.66 ± 0.20	0.72 ± 0.10	0.67 ± 0.10	0.86 ± 0.20	0.65 ± 0.23	0.63 ± 0.20	0.58 ± 0.15	0.67 ± 0.10
1,3-Butadiene	0.05 ± 0.01	0.06 ± 0.03	0.02 ± 0.01	0.05 ± 0.02	0.05 ± 0.04	0.05 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.04 ± 0.02	0.04 ± 0.02	0.04 ± 0.01
Carbon Tetrachloride	0.73 ± 0.05	0.65 ± 0.08	0.73 ± 0.09	0.77 ± 0.13	0.80 ± 0.12	0.73 ± 0.05	0.67 ± 0.05	0.57 ± 0.12	0.62 ± 0.06	0.83 ± 0.07	0.61 ± 0.15	0.67 ± 0.05
Chloroform	0.10 ± 0.01	0.07 ± 0.03	0.08 ± 0.02	0.09 ± 0.04	0.10 ± 0.01	0.08 ± 0.01	0.10 ± 0.01	0.07 ± 0.01	0.08 ± 0.01	0.12 ± 0.02	0.07 ± 0.02	0.09 ± 0.01
Formaldehyde	2.95 ± 0.25	2.86 ± 0.64	3.10 ± 0.42	3.05 ± 0.40	2.69 ± 0.58	2.95 ± 0.25	2.27 ± 0.24	2.61 ± 0.79	2.48 ± 0.55	2.28 ± 0.31	1.79 ± 0.35	2.27 ± 0.24
Tetrachloroethylene	0.12 ± 0.02	0.10 ± 0.04	0.07 ± 0.03	0.14 ± 0.07	0.10 ± 0.05	0.10 ± 0.02	0.09 ± 0.01	0.07 ± 0.03	0.07 ± 0.02	0.09 ± 0.04	0.06 ± 0.03	0.07 ± 0.02
Trichloroethylene	0.10 ± 0.08	NA	NA	NA	NA	NA	0.09 ± 0.06	NA	NA	NA	NA	NA
Vinyl Chloride	0.01 ± <0.01	NA	NA	NA	NA	NA	0.01 ± 0.01	NA	NA	NA	NA	NA

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Table 26-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the South Dakota Monitoring Sites (Continued)

	2008						2009					
Pollutant	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Daily Average ($\mu g/m^3$)	1st Quarter Average ($\mu g/m^3$)	2nd Quarter Average ($\mu g/m^3$)	3rd Quarter Average ($\mu g/m^3$)	4th Quarter Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
Union County, South Dakota - UCSD												
Acetaldehyde	NR	NR	NR	NR	NR	NR	2.75 ± 0.97	1.94 ± 0.95	3.43 ± 2.86	1.81 ± 0.87	3.35 ± 1.47	2.75 ± 0.97
Acrylonitrile	NR	NR	NR	NR	NR	NR	0.52 ± 0.55	NA	0.07 ± 0.04	0.11 ± 0.11	NA	NA
Benzene	NR	NR	NR	NR	NR	NR	0.38 ± 0.06	NA	0.43 ± 0.12	0.25 ± 0.03	0.31 ± 0.07	0.38 ± 0.06
1,3-Butadiene	NR	NR	NR	NR	NR	NR	0.02 ± <0.01	NA	0.01 ± <.0.01	0.01 ± <.0.01	NA	NA
Carbon Tetrachloride	NR	NR	NR	NR	NR	NR	0.68 ± 0.05	NA	0.63 ± 0.03	0.85 ± 0.04	0.63 ± 0.11	0.68 ± 0.05
Chloroform	NR	NR	NR	NR	NR	NR	0.09 ± 0.01	NA	0.08 ± 0.02	0.11 ± 0.01	0.08 ± 0.02	0.09 ± 0.01
Ethylbenzene	NR	NR	NR	NR	NR	NR	0.61 ± 0.31	NA	0.96 ± 0.80	0.23 ± 0.27	0.06 ± 0.02	0.61 ± 0.31
Formaldehyde	NR	NR	NR	NR	NR	NR	5.97 ± 5.20	1.32 ± 0.56	14.34 ± 16.96	3.08 ± 0.93	2.08 ± 1.29	5.97 ± 5.20
Propionaldehyde	NR	NR	NR	NR	NR	NR	0.44 ± 0.30	0.24 ± 0.09	0.85 ± 0.96	0.35 ± 0.26	0.20 ± 0.14	0.44 ± 0.30
Tetrachloroethylene	NR	NR	NR	NR	NR	NR	0.06 ± 0.02	NA	0.03 ± 0.02	NA	NA	NA
Trichloroethylene	NR	NR	NR	NR	NR	NR	3.51 ± 1.92	NA	2.85 ± 2.71	NA	NA	NA
Vinyl Chloride	NR	NR	NR	NR	NR	NR	0.01 ± 0.01	NA	NA	NA	NA	NA

NR = Not reportable because sampling was not conducted during this time period.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for SSSD from Table 26-5 include the following:

- The pollutants with the highest 2008 daily average concentrations by mass were formaldehyde (2.95 ± 0.25 µg/m^3), acetaldehyde (2.01 ± 0.40 µg/m^3), carbon tetrachloride (0.73 ± 0.05 µg/m^3), and benzene (0.72 ± 0.10 µg/m^3). The pollutants with the highest 2009 daily average concentrations by mass were acetaldehyde (2.38 ± 0.45 µg/m^3), formaldehyde (2.27 ± 0.24 µg/m^3), benzene (0.67 ± 0.10 µg/m^3), and carbon tetrachloride (0.67 ± 0.05 µg/m^3).

- Acetaldehyde concentrations appear highest during the colder months of the year. Yet, the high confidence intervals indicate that these concentrations are likely influenced by outliers. The highest acetaldehyde concentration was measured on February 6, 2009 (11.0 µg/m^3). A similar acetaldehyde concentration was measured on January 19, 2008 (10.6 µg/m^3). These concentrations were nearly twice the next highest concentration (6.57 µg/m^3 on December 21, 2009). Note that of the 20 acetaldehyde concentrations greater than 3 µg/m^3 measured at SSSD, 13 were measured during the first or fourth quarters of the year.

- The 2008 daily average concentration of acrylonitrile is twice as high as the 2009 daily average concentration of this pollutant. Further, the confidence interval for the 2008 daily average is relatively high, indicating that this daily average is influenced by outliers. The highest concentration of acrylonitrile was measured on September 3, 2008 (0.346 µg/m^3) and was more than twice the next highest concentration (0.167 µg/m^3 measured on December 2, 2008). Of the 23 measured detections of this pollutant across both years, only seven were greater than 0.1 µg/m^3.

- Quarterly and annual averages could not be calculated for acrylonitrile, vinyl chloride, or trichloroethylene because these pollutants were not detected frequently enough.

Observations for UCSD from Table 26-5 include the following:

- Similar to the other two sites, the pollutants with the highest daily average concentrations by mass were formaldehyde (5.97 ± 5.20 µg/m^3), acetaldehyde (2.75 ± 0.97 µg/m^3), and carbon tetrachloride (0.68 ± 0.05 µg/m^3). UCSD's daily average benzene concentration was nearly half the daily average concentrations for CUSD and SSSD. UCSD's daily average benzene concentration was the second lowest among all NMP sites sampling this pollutant (behind only UNVT).

- For the carbonyl compounds (acetaldehyde, formaldehyde, and propionaldehyde), each has a relatively high second quarter 2009 average, as well as associated large confidence intervals, especially formaldehyde. A review of the data shows that the highest concentration of each pollutant was measured on April 1, 2009. In the case of formaldehyde, this concentration (138 µg/m^3) was more than 10 times higher than the next highest concentration (11.9 µg/m^3 measured on May 1, 2009). This explains why the second quarter average formaldehyde concentration has such a large confidence interval, as well as the daily and annual average. The April 1, 2009 formaldehyde concentration was the eleventh highest measurement of this pollutant among all NMP sites sampling carbonyl compounds (the first 10 were measured at INDEM). For acetaldehyde, the April 1, 2009 concentration (24.2 µg/m^3) was nearly three times the next highest concentration (8.465 µg/m^3 measured on December 21, 2009) and the highest concentration measured for this pollutant among all NMP sites sampling carbonyl compounds. For propionaldehyde, the April 1, 2009 concentration (7.83 µg/m^3) was more than four times the next highest concentration (1.84 µg/m^3 measured on August 26, 2009) and also the highest concentration measured for this pollutant among all sites sampling carbonyl compounds.

- First quarter 2009 averages are not available for the VOC due to a late January 2009 start date combined with several invalid samples early in the year.

- Several VOC, notably ethylbenzene and trichloroethylene, have relatively high second quarter 2009 averages, as well as large confidence intervals, indicating the presence of outliers. As review of the data shows that high concentrations of these two pollutants were measured on April 1, 2009; April 7, 2009; and April 19, 2009, as well as a few other dates. For ethylbenzene, the April 19, 2009 concentration (4.08 µg/m^3) and the April 7, 2009 concentration (3.92 µg/m^3) were the fifth and sixth highest concentrations measured among all NMP sites sampling this pollutant. For trichloroethylene, of the 12 highest trichloroethylene concentrations measured among NMP sites, 10 were measured at UCSD (the other two were measured at SPIL). These two sites evenly split the 22 highest trichloroethylene concentrations (those greater than 1.3 µg/m^3).

- The confidence interval for the 2009 daily average concentration of acrylonitrile indicates that this daily average is influenced by outliers. The highest concentration of acrylonitrile was measured on January 31, 2009 (6.15 µg/m^3), the first day of sampling at this site. This concentration was nearly eight times the next highest concentration (0.824 µg/m^3 measured on August 5, 2009) and the third highest concentration measured for this pollutant among all sites sampling VOC.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for CUSD, SSSD, and UCSD from those tables include the following:

- None of the daily average concentrations of the pollutants of interest for CUSD appear in Tables 4-9 through 4-12. However, CUSD had the second highest daily average concentration of *p*-dichlorobenzene among NMP sites sampling VOC (this pollutant failed screens for CUSD but was not identified as a pollutant of interest). Note that the highest concentration of *p*-dichlorobenzene was measured on September 3, 2008 (2.19 µg/m^3) and was an order of magnitude higher than the next highest concentration (0.301 µg/m^3), which explains the high confidence interval associated with this daily average.

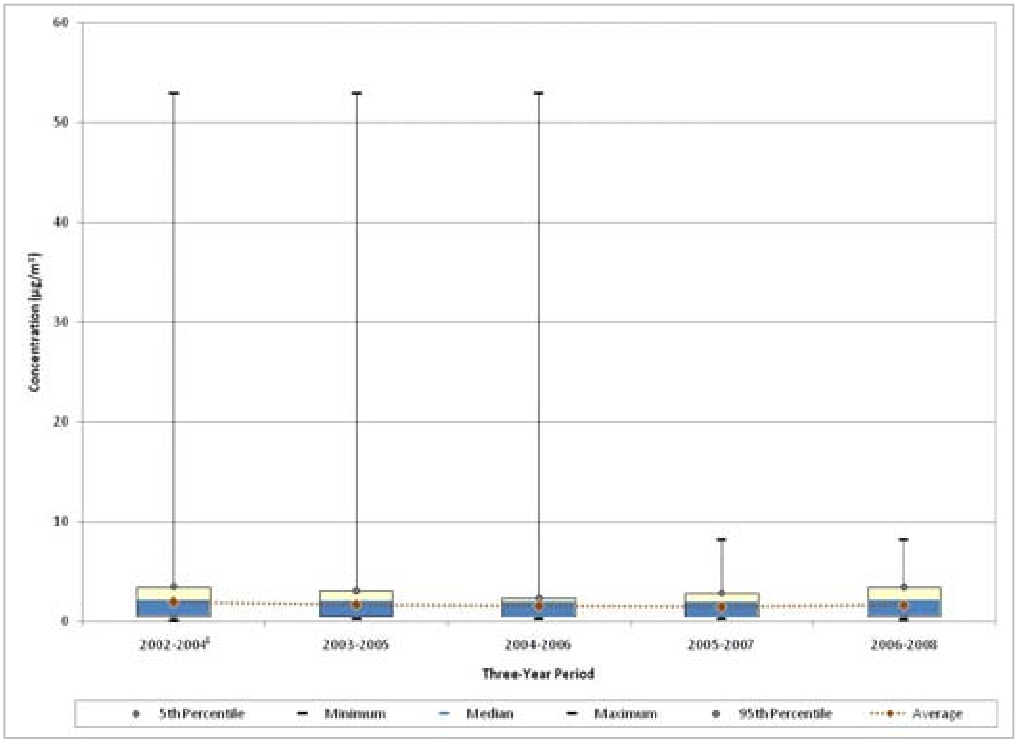
- None of the daily average concentrations of the pollutants of interest for SSSD appear in Tables 4-9 through 4-12.

- Daily average concentrations of the pollutants of interest for UCSD appear in Tables 4-9 through 4-12 several times. UCSD had the highest concentration of trichloroethylene and eighth highest ethylbenzene concentration among NMP sites sampling VOC, as shown in Table 4-9. UCSD had the fourth highest concentration of formaldehyde and seventh highest acetaldehyde concentration among NMP sites sampling carbonyl compounds, as shown in Table 4-10.

26.4.2 Concentration Trends

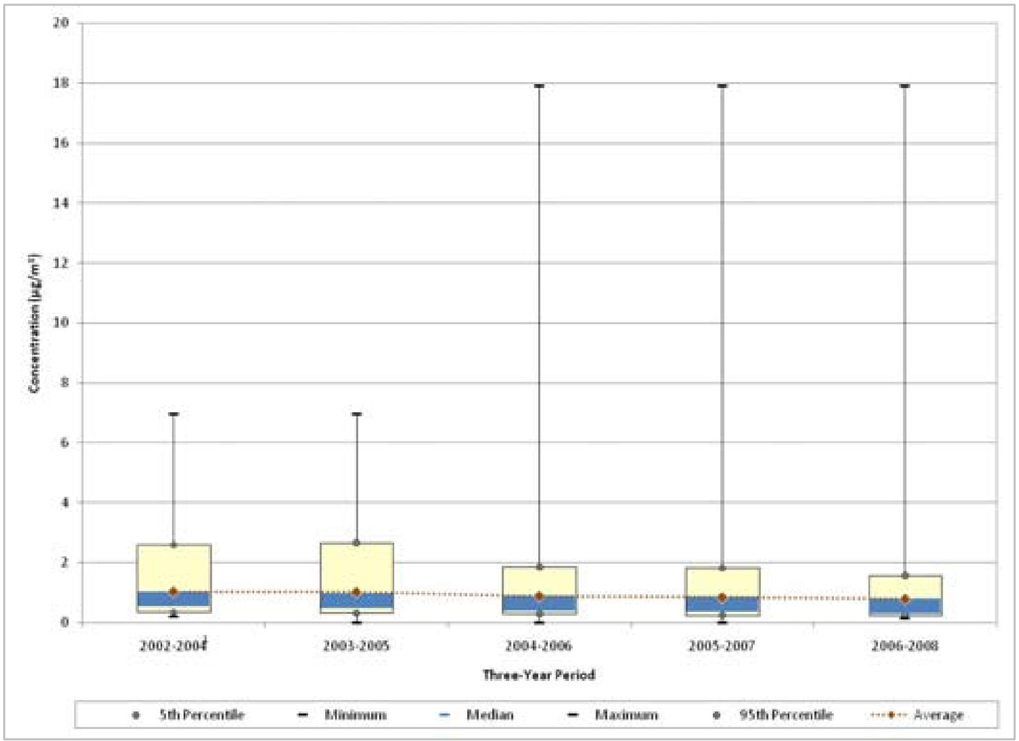
A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. CUSD sampled VOC, SNMOC, and carbonyl compounds from 2002 through 2008. Thus, Figures 26-17 through 26-20 present the 3-year rolling statistical metrics for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde for the CUSD monitoring site. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. Sampling at SSSD began at the beginning of 2008 and UCSD at the beginning of 2009; thus, a trends analysis was not conducted for these sites.

Figure 26-17. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at CUSD



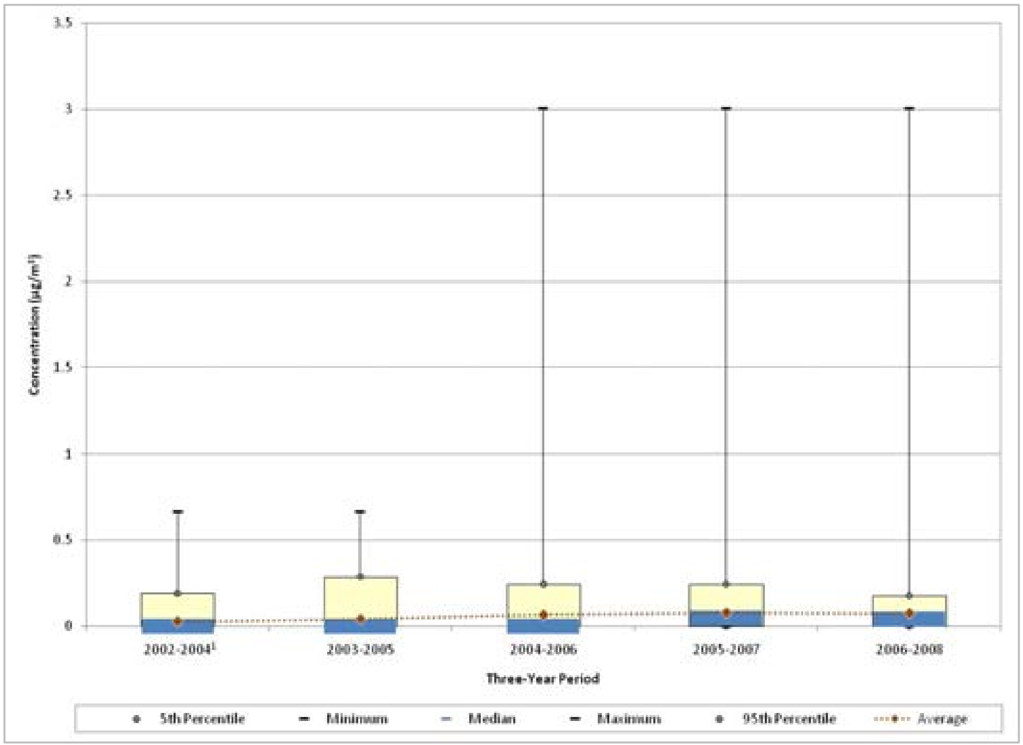
[1] Carbonyl compound sampling at CUSD began in March 2002.

Figure 26-18. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at CUSD



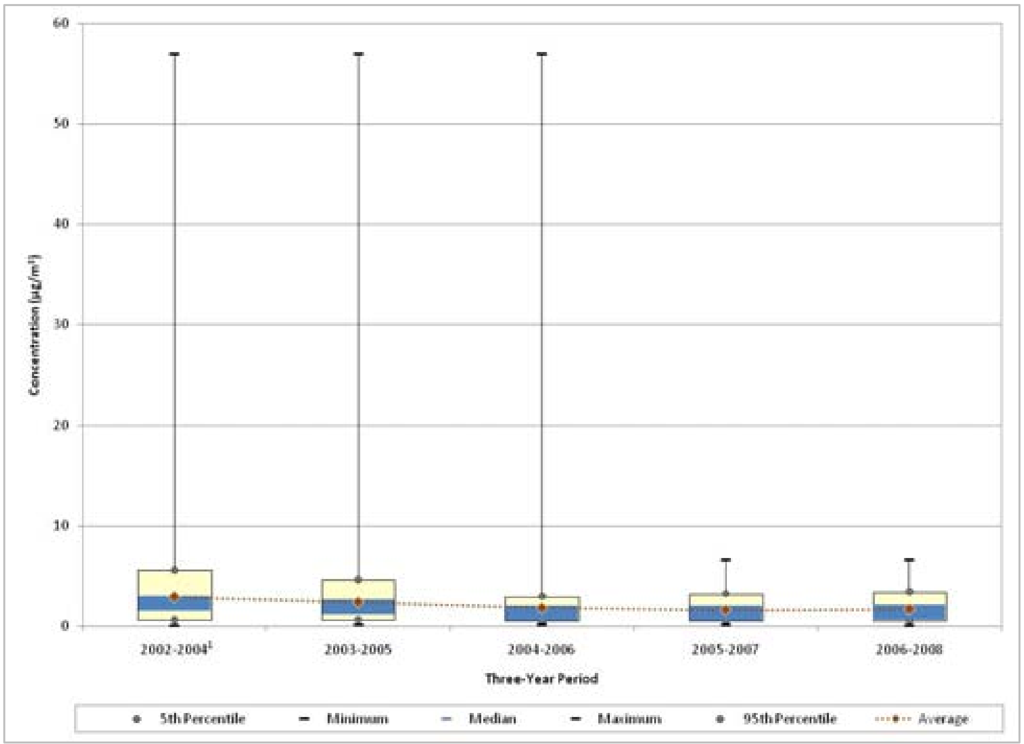
[1] VOC sampling at CUSD began in March 2002.

Figure 26-19. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at CUSD



[1] VOC sampling at CUSD began in March 2002.

Figure 26-20. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at CUSD



[1] Carbonyl compound sampling at CUSD began in March 2002.

Observations from Figure 26-17 for acetaldehyde measurements at CUSD include the following:

- Carbonyl compound sampling at CUSD began in March 2002, as denoted in Figure 26-17.

- The maximum acetaldehyde concentration was measured in 2004. This concentration was more than six times the next highest concentration (measured in 2007).

- Although difficult to discern in Figure 26-17, the rolling average concentrations decreased slightly through the first four time periods then increased slightly for the final 3-year period. However, the calculation of confidence intervals indicates that these changes are not statistically significant. As similar pattern is shown for the medians, except that the increase in the median begins during the 2005-2007 time frame.

- The rolling average and the median concentrations became more similar to each other over the time periods shown. This indicates decreasing variability in the central tendency of acetaldehyde concentrations measured over the periods shown in Figure 26-17.

Observations from Figures 26-18 for benzene measurements at CUSD include the following:

- VOC sampling at CUSD began in March 2002, as denoted in Figure 26-18.

- The maximum concentration was measured in 2006 and was nearly three times the next highest concentration, which was measured in 2003.

- Over the time periods shown, the difference between the 5th and 95th percentiles has decreased, indicating a decrease in the spread of the majority of concentrations measured.

- The rolling average concentrations have a slight decreasing trend over the time periods shown, although the difference is not statistically significant, based on the calculation of confidence intervals.

Observations from Figure 26-19 for 1,3-butadiene measurements at CUSD include the following:

- The maximum concentration of 1,3-butadiene was measured in 2006 and was nearly five times the next highest measurement (measured in 2003). The maximum concentrations of benzene and 1,3-butadiene were both measured on November 13, 2006.

- The plot for 1,3-butadiene measurements shows an increasing trend in the rolling average through 2005-2007. The calculation of confidence intervals for the rolling 1,3-butadiene average concentrations shows that the apparent increases shown in Figure 26-19 are not statistically significant, primarily because the confidence intervals for each year are so large, particularly for the time frames affected by the maximum concentration measured in 2006.

- The minimum and 5th percentiles for every 3-year period are zero, indicating the presence of non-detects. For the first three 3-year periods, the median is also zero, indicating that at least 50 percent of the samples yielded non-detects. The number of non-detects ranged from as high as 92 percent in 2002 and 2004 to as low as 12 percent in 2007.

Observations from Figure 26-20 for formaldehyde measurements at CUSD include the following:

- The maximum formaldehyde concentration shown was measured in 2004, on the same day as the highest acetaldehyde concentration. This formaldehyde concentration was nearly six times the next highest concentration (measured in 2002). The second, third, fourth, and fifth highest concentrations were all measured in 2002.

- Although difficult to discern in Figure 26-20, the difference between the rolling averages and the median values decreased through the 2005-2007 time frame, then was static for the final time period. This indicates decreasing variability in the central tendency of formaldehyde concentrations measured over the periods shown.

- Similar to acetaldehyde, the rolling average concentrations appear to decrease through the first four time periods then increase slightly for the final 3-year period. The calculation of confidence intervals indicates that these changes are not statistically significant. As similar pattern is shown for the medians, except that the increase in the median begins during the 2005-2007 time frame.

26.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each South Dakota monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

26.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the South Dakota monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. The results of this risk screening are summarized in Table 26-6. Where a quarterly or annual average exceeds the applicable MRL, the concentration is bolded.

Observations from Table 26-6 include the following:

- Formaldehyde was the only pollutant of interest where a preprocessed daily measurement and/or time-period average was greater than one or more of the MRL health risk benchmarks.

- One preprocessed daily measurement of formaldehyde for UCSD (out of 52 measured detections) was greater than the acute MRL. This measurement was discussed in Section 26.4.1 and is one of 14 instances where a preprocessed formaldehyde measurement was greater than the acute MRL among all NMP sites sampling this pollutant.

- None of the quarterly averages of formaldehyde came close to the intermediate MRL; the 2009 annual average of formaldehyde was not greater than the chronic MRL.

For the pollutants whose concentrations were greater than their respective ATSDR acute MRL noncancer health risk benchmark, the concentrations were further examined by developing pollution roses for these pollutants. A pollution rose is a plot of concentration vs. wind speed and wind direction, as described in Section 3.5.4.1. Figure 26-21 is the formaldehyde pollution rose for UCSD.

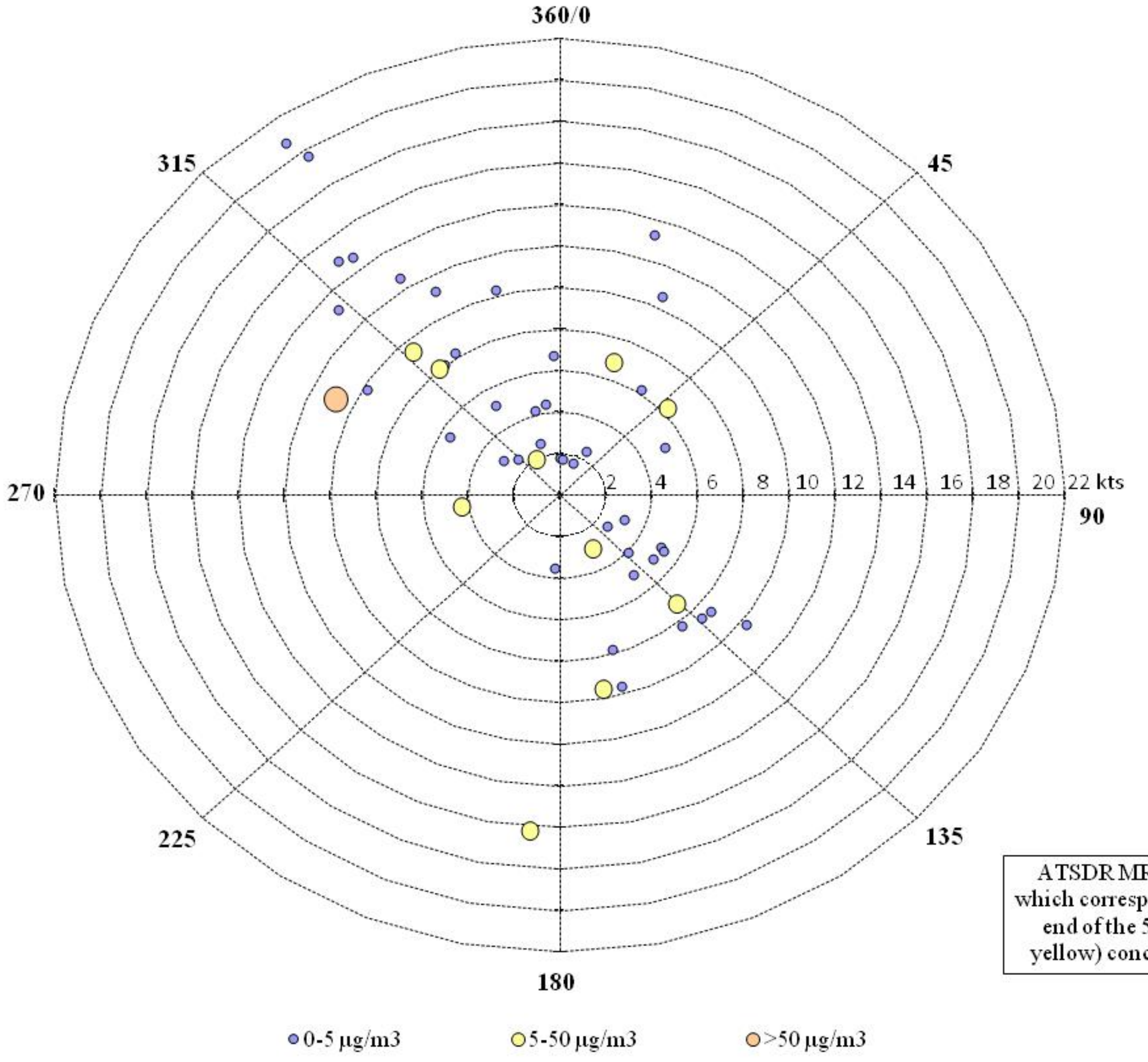
Table 26-6. MRL Risk Screening Assessment Summary for the South Dakota Monitoring Sites

		Acute			Intermediate					Chronic	
Pollutant	Year	ATSDR Short MRL[1] (µg/m³)	# of Concentrations > MRL	# of Measured Detections	ATSDR Intermediate MRL[1] (µg/m³)	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	ATSDR Chronic MRL[1] (µg/m³)	Annual Average (µg/m³)
Union County, South Dakota - UCSD											
Formaldehyde	2009	50	1	52	40	1.32 ± 0.56	14.34 ± 16.96	3.08 ± 0.93	2.08 ± 1.29	10	5.97 ± 5.20

Bolded = a quarterly or annual average concentration is greater than the intermediate or chronic MRLs.

[1] Reflects the use of one significant digit for MRL.

Figure 26-21. Formaldehyde Pollution Rose for UCSD



ATSDR MRL = 50 µg/m^3, which corresponds to the upper end of the 5-50 µg/m^3 (or yellow) concentration range

Observations from Figure 26-21 for formaldehyde concentrations include the following:

- The concentration that was greater than the ATSDR acute MRL for formaldehyde at UCSD (shown in orange) was measured on a day with winds blowing from the northwest. The second highest concentration was also measured on a day with northwesterly winds. However, concentrations less than the acute MRL but higher than 5 µg/m^3 (shown in yellow) were measured on days with different average wind directions.

- Figure 26-21 shows that many of the measurements are aligned northwest to southeast, indicating that those concentrations were measured with the average daily wind direction from that direction. Recall from Figure 26-14 from Section 26.2.4 that winds near UCSD were from the northwest a majority of the time, including days with the highest wind speed measurements. Figure 26-14 also shows that winds rarely come from the southwest or northeast, which also correlates fairly well with the pollution rose.

26.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the South Dakota monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 26-7, where applicable.

Observations from Table 26-7 for CUSD include the following:

- The pollutants with the highest annual average concentrations for CUSD in 2008 were formaldehyde, acetaldehyde, and carbon tetrachloride.

- The pollutants with the highest cancer surrogate risk approximations were formaldehyde (25.75 in-a-million), benzene (5.65 in-a-million), and carbon tetrachloride (4.40 in-a-million).

- None of the noncancer surrogate risk approximations were greater than an HQ of 1.0 for CUSD.

Table 26-7. Cancer and Noncancer Surrogate Risk Approximations for the South Dakota Monitoring Sites

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/ Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/ Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Custer, South Dakota - CUSD										
Acetaldehyde	0.0000022	0.009	60/4	1.75 ± 0.27	3.85	0.19	NR	NR	NR	NR
Acrylonitrile	0.000068	0.002	6/0	NA	NA	NA	NR	NR	NR	NR
Benzene	0.0000078	0.03	60/4	0.72 ± 0.13	5.65	0.02	NR	NR	NR	NR
1,3-Butadiene	0.00003	0.002	51/4	0.05 ± 0.01	1.55	0.03	NR	NR	NR	NR
Carbon Tetrachloride	0.000006	0.1	60/4	0.73 ± 0.06	4.40	0.01	NR	NR	NR	NR
Chloroform	--	0.098	48/3	0.07 ± 0.01	--	<0.01	NR	NR	NR	NR
Formaldehyde	0.000013	0.0098	60/4	1.98 ± 0.24	25.75	0.20	NR	NR	NR	NR
Tetrachloroethylene	0.0000059	0.27	38/3	0.06 ± 0.03	0.34	<0.01	NR	NR	NR	NR
Trichloroethylene	0.000002	0.6	3/0	NA	NA	NA	NR	NR	NR	NR
Vinyl Chloride	0.0000088	0.1	5/0	NA	NA	NA	NR	NR	NR	NR

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

NR = Not reportable because sampling was not conducted during this time period.

Table 26-7. Cancer and Noncancer Surrogate Risk Approximations for the South Dakota Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
Sioux Falls, South Dakota - SSSD										
Acetaldehyde	0.0000022	0.009	55/4	2.01 ± 0.40	4.42	0.22	59/4	2.38 ± 0.45	5.23	0.26
Acrylonitrile	0.000068	0.002	4/0	NA	NA	NA	19/2	NA	NA	NA
Benzene	0.0000078	0.03	60/4	0.72 ± 0.10	5.60	0.02	60/4	0.67 ± 0.10	5.25	0.02
1,3-Butadiene	0.00003	0.002	58/4	0.05 ± 0.01	1.44	0.02	58/4	0.04 ± 0.01	1.05	0.02
Carbon Tetrachloride	0.000006	0.1	60/4	0.73 ± 0.05	4.40	0.01	60/4	0.67 ± 0.05	4.00	0.01
Chloroform	--	0.098	51/4	0.08 ± 0.01	--	<0.01	55/4	0.09 ± 0.01	--	<0.01
Formaldehyde	0.000013	0.0098	55/4	2.95 ± 0.25	38.30	0.30	59/4	2.27 ± 0.24	29.50	0.23
Tetrachloroethylene	0.0000059	0.27	51/4	0.10 ± 0.02	0.60	<0.01	48/4	0.07 ± 0.02	0.43	<0.01
Trichloroethylene	0.000002	0.6	7/0	NA	NA	NA	4/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	9/0	NA	NA	NA	4/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

NR = Not reportable because sampling was not conducted during this time period.

Table 26-7. Cancer and Noncancer Surrogate Risk Approximations for the South Dakota Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/ Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Union County, South Dakota - UCSD										
Acetaldehyde	0.0000022	0.009	NR	NR	NR	NR	52/4	2.75 ± 0.97	6.04	0.31
Acrylonitrile	0.000068	0.002	NR	NR	NR	NR	22/2	NA	NA	NA
Benzene	0.0000078	0.03	NR	NR	NR	NR	49/3	0.38 ± 0.06	2.94	0.01
1,3-Butadiene	0.00003	0.002	NR	NR	NR	NR	33/2	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	NR	NR	NR	NR	49/3	0.68 ± 0.05	4.08	0.01
Chloroform	--	0.098	NR	NR	NR	NR	47/3	0.09 ± 0.01	--	<0.01
Ethylbenzene	0.0000025	1	NR	NR	NR	NR	49/3	0.61 ± 0.31	1.52	<0.01
Formaldehyde	0.000013	0.0098	NR	NR	NR	NR	52/4	5.97 ± 5.20	77.63	0.61
Propionaldehyde	--	0.008	NR	NR	NR	NR	52/4	0.44 ± 0.30	--	0.06
Tetrachloroethylene	0.0000059	0.27	NR	NR	NR	NR	24/1	NA	NA	NA
Trichloroethylene	0.000002	0.6	NR	NR	NR	NR	24/1	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	NR	NR	NR	NR	4/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
NR = Not reportable because sampling was not conducted during this time period.

Observations from Table 26-7 for SSSD include the following:

- The pollutants with the highest annual average concentrations for SSSD were formaldehyde, acetaldehyde, benzene, and carbon tetrachloride for both years.
- These same four pollutants also had the highest cancer risk approximations among this site's pollutants of interest, although formaldehyde's cancer risk approximations were an order of magnitude higher than the cancer risk approximations for the other pollutants.
- None of the noncancer surrogate risk approximations were greater than an HQ of 1.0.

Observations from Table 26-7 for UCSD include the following:

- The pollutants with the highest annual average concentrations for UCSD in 2009 were formaldehyde, acetaldehyde, and carbon tetrachloride.
- Formaldehyde had the highest cancer risk approximation for UCSD at 77.63 in-a-million. This cancer risk approximation was the fourth highest among all sites sampling formaldehyde (behind INDEM, PROK, and ININ).
- None of the noncancer surrogate risk approximations for UCSD's pollutants of interest were greater than an HQ of 1.0.

26.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 26-8 and 26-9 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 26-8 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 26-9 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 26-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the South Dakota 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Custer, South Dakota (Custer County) - CUSD					
Formaldehyde	44.91	Formaldehyde	5.61E-04	Formaldehyde	25.75
Benzene	29.26	1,3-Butadiene	2.31E-04	Benzene	5.65
Acetaldehyde	10.10	Benzene	2.28E-04	Carbon Tetrachloride	4.40
1,3-Butadiene	7.71	POM, Group 2	9.40E-05	Acetaldehyde	3.85
POM, Group 2	1.71	POM, Group 5	2.79E-05	1,3-Butadiene	1.55
Tetrachloroethylene	1.57	Naphthalene	2.70E-05	Tetrachloroethylene	0.34
Naphthalene	0.79	Acetaldehyde	2.22E-05		
Dichloromethane	0.55	POM, Group 6	2.08E-05		
POM, Group 6	0.21	POM, Group 3	1.02E-05		
p-Dichlorobenzene	0.15	Tetrachloroethylene	9.29E-06		
Sioux Falls, South Dakota (Minnehaha County) - SSSD					
Benzene	112.02	Formaldehyde	9.06E-04	Formaldehyde	38.30
Formaldehyde	72.47	Benzene	8.74E-04	Formaldehyde	29.50
Acetaldehyde	45.29	1,3-Butadiene	5.26E-04	Benzene	5.60
1,3-Butadiene	17.53	Hexavalent Chromium, PM	3.11E-04	Benzene	5.25
Dichloromethane	11.96	Naphthalene	2.75E-04	Acetaldehyde	5.23
Naphthalene	8.08	POM, Group 2	1.90E-04	Acetaldehyde	4.42
Tetrachloroethylene	6.03	Arsenic, PM	1.57E-04	Carbon Tetrachloride	4.40
POM, Group 2	3.45	Acetaldehyde	9.96E-05	Carbon Tetrachloride	4.00
p-Dichlorobenzene	3.27	POM, Group 3	8.08E-05	1,3-Butadiene	1.44
Trichloroethylene	1.03	Ethylene oxide	3.69E-05	1,3-Butadiene	1.05

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 26-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the South Dakota 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Union County, South Dakota (Union County) - UCSD					
Benzene	17.07	Formaldehyde	1.90E-04	Formaldehyde	77.63
Formaldehyde	15.20	Benzene	1.33E-04	Acetaldehyde	6.04
Acetaldehyde	7.78	Arsenic, PM	7.95E-05	Carbon Tetrachloride	4.08
1,3-Butadiene	2.54	1,3-Butadiene	7.62E-05	Benzene	2.94
Naphthalene	1.32	Hexavalent Chromium, PM	4.57E-05	Ethylbenzene	1.52
Dichloromethane	0.94	Naphthalene	4.48E-05		
POM, Group 2	0.77	POM, Group 2	4.22E-05		
p-Dichlorobenzene	0.27	POM, Group 3	1.73E-05		
Trichloroethylene	0.23	Acetaldehyde	1.71E-05		
POM, Group 6	0.05	POM, Group 5	9.62E-06		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 26-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the South Dakota 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Custer, South Dakota (Custer County) - CUSD					
Formaldehyde	44.91	Acrolein	335,592.73	Formaldehyde	0.20
Toluene	43.10	Formaldehyde	4,583.06	Acetaldehyde	0.19
Xylenes	30.04	1,3-Butadiene	3,854.91	1,3-Butadiene	0.03
Benzene	29.26	Acetaldehyde	1,122.03	Benzene	0.02
Acetaldehyde	10.10	Benzene	975.34	Carbon Tetrachloride	0.01
1,3-Butadiene	7.71	Xylenes	300.44	Chloroform	<0.01
Acrolein	6.71	Cyanide Compounds, gas	291.96	Tetrachloroethylene	<0.01
Ethylbenzene	6.23	Naphthalene	264.57		
Hexane	5.33	Toluene	107.75		
Methanol	2.60	Lead, PM	40.50		
Sioux Falls, South Dakota (Minnehaha County) - SSSD					
Toluene	291.50	Acrolein	228,670.18	Formaldehyde	0.30
Xylenes	211.60	1,3-Butadiene	8,763.37	Acetaldehyde	0.26
Benzene	112.02	Formaldehyde	7,394.72	Formaldehyde	0.23
Methanol	86.16	Acetaldehyde	5,031.93	Acetaldehyde	0.22
Formaldehyde	72.47	Benzene	3,734.16	1,3-Butadiene	0.02
Hydrochloric acid	63.22	Hydrochloric acid	3,161.14	Benzene	0.02
Acetaldehyde	45.29	Naphthalene	2,691.88	Benzene	0.02
Ethylbenzene	42.33	Xylenes	2,115.97	1,3-Butadiene	0.02
Hexane	37.32	Cyanide Compounds, gas	1,874.27	Carbon Tetrachloride	0.01
Styrene	33.43	Nickel, PM	1,364.70	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 26-9. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the South Dakota 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Union County, South Dakota (Union County) - UCSD					
Toluene	43.53	Acrolein	41,161.08	Formaldehyde	0.61
Hydrochloric acid	35.14	Manganese, PM	5,146.73	Acetaldehyde	0.31
Xylenes	33.90	Hydrochloric acid	1,756.97	Propionaldehyde	0.06
Benzene	17.07	Formaldehyde	1,550.96	Benzene	0.01
Formaldehyde	15.20	1,3-Butadiene	1,270.01	Carbon Tetrachloride	0.01
Acetaldehyde	7.78	Acetaldehyde	864.25	Chloroform	<0.01
Ethylbenzene	6.47	Arsenic, PM	616.24	Ethylbenzene	<0.01
Hexane	5.95	Nickel, PM	586.78		
Methanol	4.71	Benzene	569.06		
Hydrofluoric acid	4.31	Naphthalene	439.66		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 26.3, CUSD, SSSD, and UCSD sampled for VOC, SNMOC, and carbonyl compounds. In addition, the cancer and noncancer risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 26-8 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Custer, Minnehaha, and Union Counties (although not necessarily in that order). The emissions were higher in Minnehaha County than in Custer or Union Counties; however, all three counties had some of the lowest emissions among counties with NMP sites.

- Formaldehyde was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for all three counties.

- Eight of the highest emitted pollutants also had the highest toxicity-weighted emissions for Custer County; six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Minnehaha County; and six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Union County.

- Formaldehyde was the pollutant with the highest cancer surrogate risk approximations for all three sites; this pollutant also appeared on both emissions-based lists. This was also true for benzene and acetaldehyde. Conversely, carbon tetrachloride appeared on neither emissions-based list but was among the pollutants with the highest cancer risk approximations for all three sites.

Observations from Table 26-9 include the following:

- Formaldehyde, toluene, and xylenes were the highest emitted pollutants with noncancer RfCs in Custer County; toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Minnehaha County; and toluene, hydrochloric acid, and xylenes were the highest emitted pollutants with noncancer RfCs in Union County. The emissions of these pollutants were higher in Minnehaha County than Custer and Union Counties.

- Acrolein was the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all three counties. Although acrolein was sampled for at CUSD, SSSD, and UCSD, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Custer County; five of the highest emitted pollutants also had the highest toxicity-weighted emissions for Minnehaha County; and four of the highest emitted pollutants also had the highest toxicity-weighted emissions for Union County.

- Formaldehyde and acetaldehyde, which had the highest noncancer risk approximations for all three sites, appear on both emissions-based lists for all three sites. Benzene also appeared on all three lists for each South Dakota monitoring site.

26.6 Summary of the 2008-2009 Monitoring Data for the South Dakota Sites

Results from several of the treatments described in this section include the following:

- ❖ *Twelve pollutants failed at least one screen for CUSD and SSSD, and 13 pollutants failed at least one screen for UCSD.*

- ❖ *Formaldehyde had the highest daily average concentration for CUSD in 2008 and for UCSD in 2009. Formaldehyde also had the highest daily average concentration for SSSD in 2008 while acetaldehyde had the highest daily average concentration in 2009.*

- ❖ *One preprocessed daily measurement of formaldehyde was greater than the acute MRL health risk benchmark (for UCSD). All of the quarterly and annual average concentrations of the pollutants of interest, where they could be calculated, were less than their associated MRL noncancer health risk benchmarks.*

27.0 Sites in Tennessee

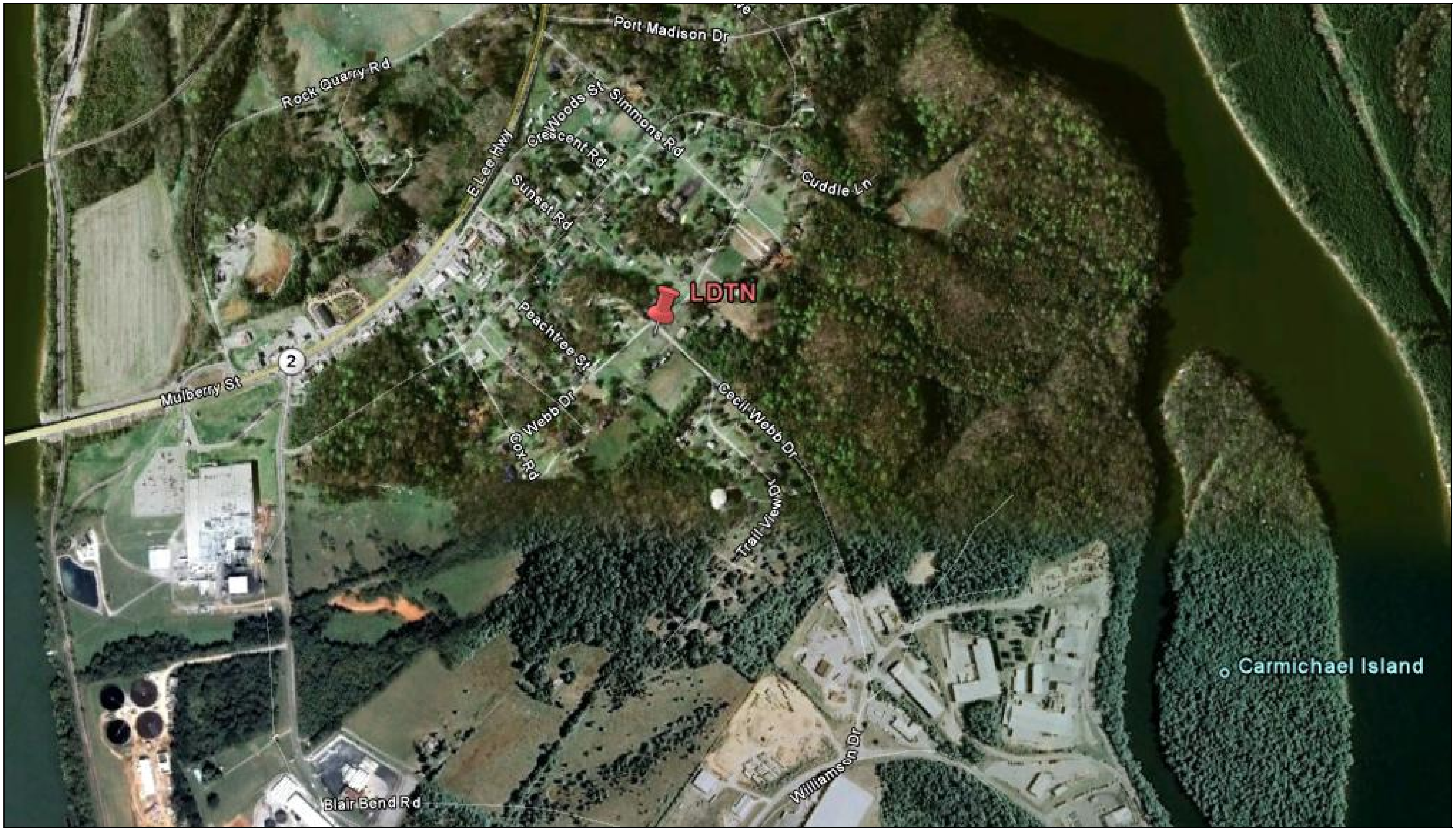
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP sites in Tennessee, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

27.1 Site Characterization

This section characterizes the Tennessee monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

Two monitoring sites are located in the town of Loudon and a third is located in Memphis. Figures 27-1 through 27-3 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban and rural locations. Figures 27-4 and 27-5 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 27-4 and 27-5. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 27-1 describes the area surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

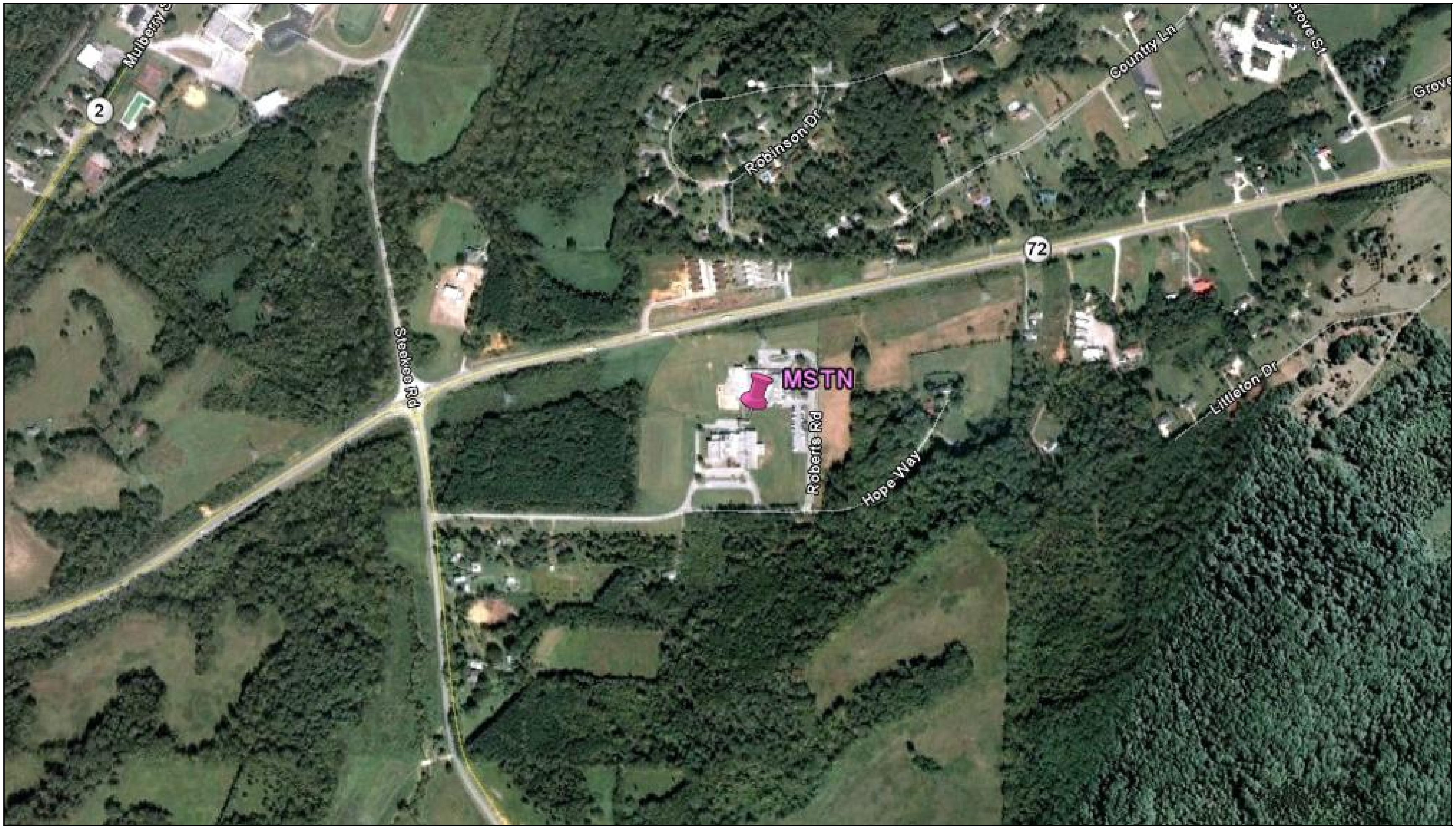
Figure 27-1. Loudon, Tennessee (LDTN) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 2,314 feet

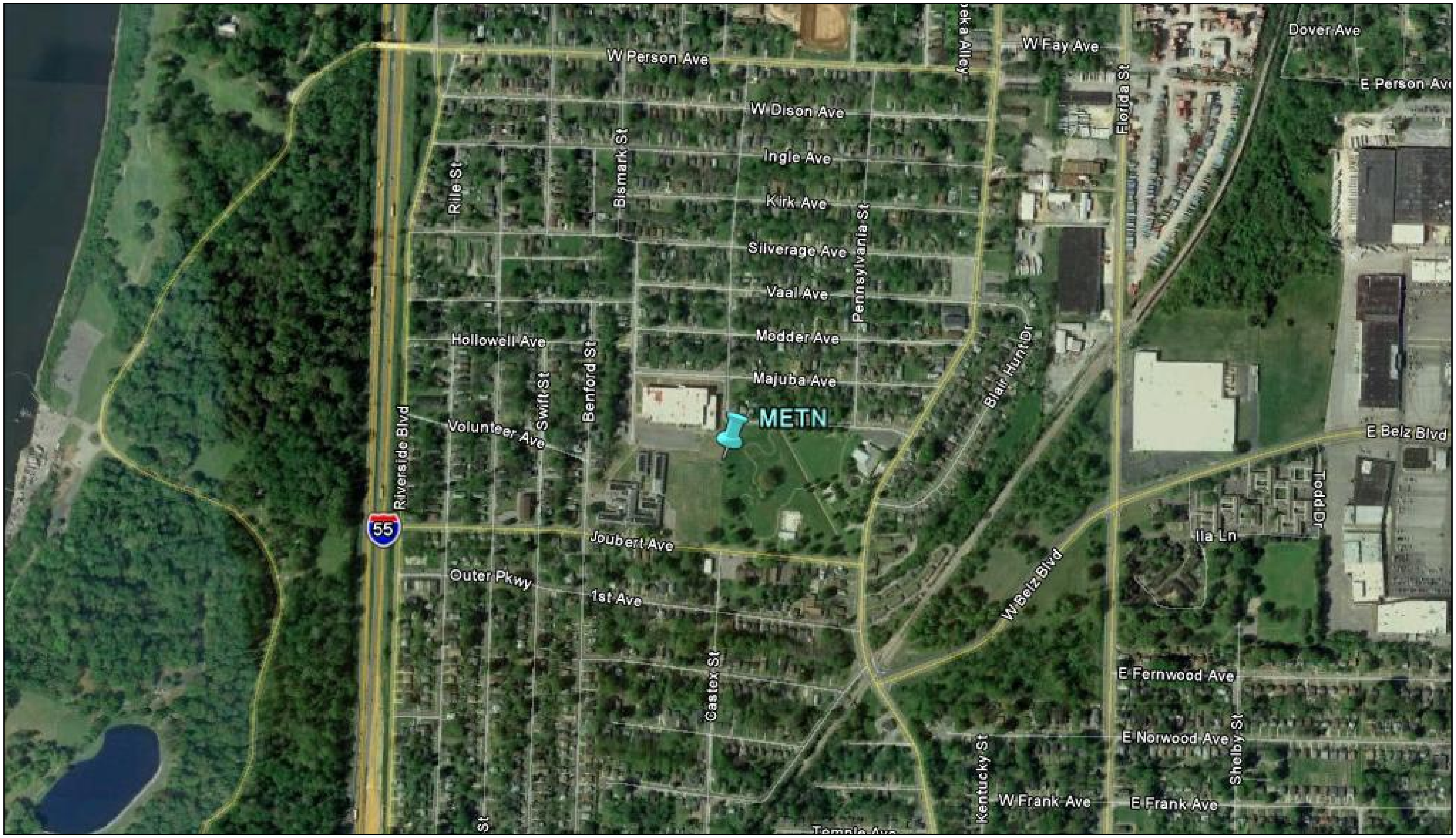
Figure 27-2. Loudon Middle School, Loudon, Tennessee (MSTN) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 2,005 feet

Figure 27-3. Memphis, Tennessee (METN) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 2,189 feet

Figure 27-4. NEI Point Sources Located Within 10 Miles of LDTN and MSTN

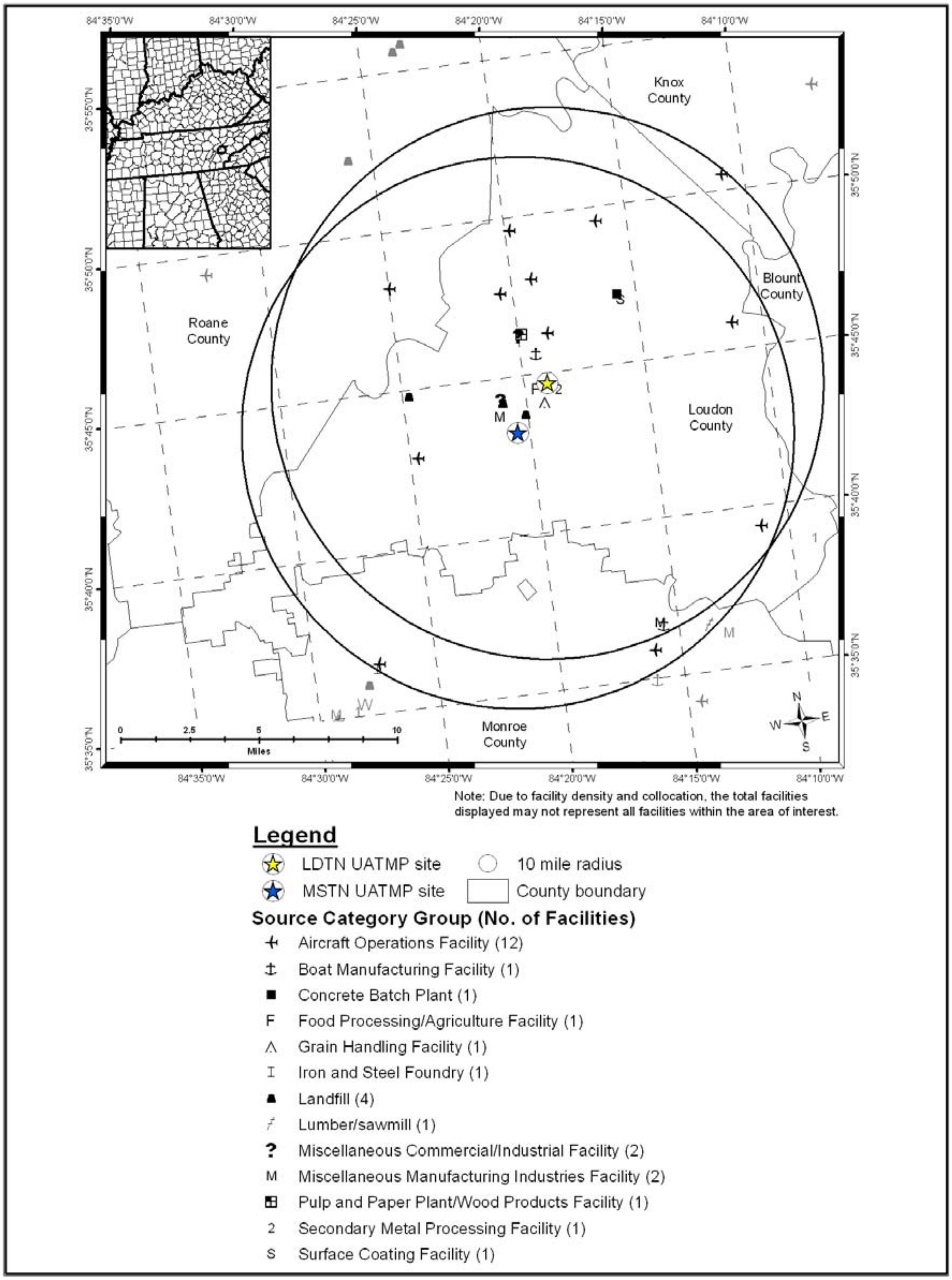
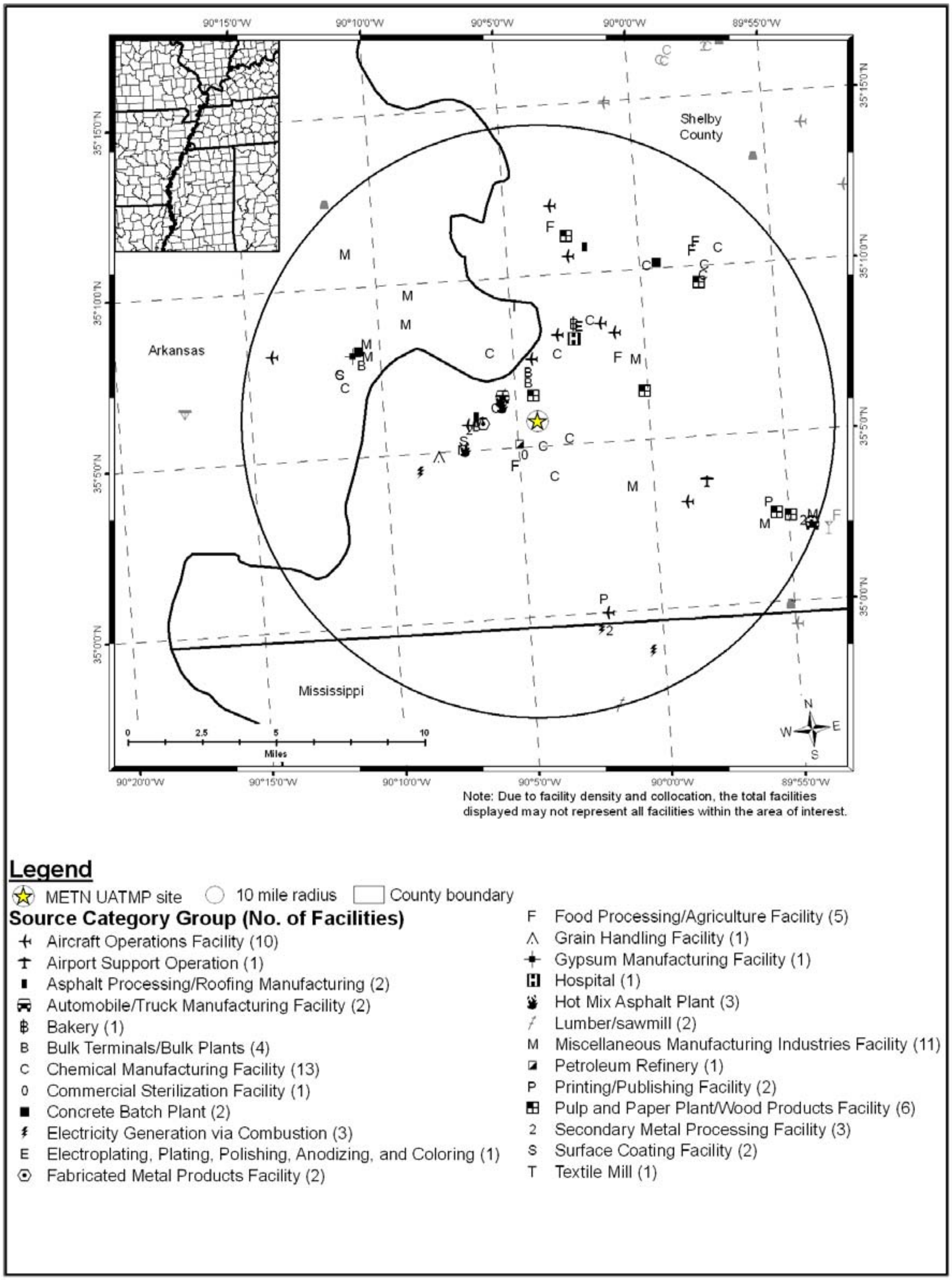

84°35'0"W
84°30'0"W
84°25'0"W
84°20'0"W
84°15'0"W
84°10'0"W
35°55'0"N
35°50'0"N
35°45'0"N
35°40'0"N
35°35'0"N
Knox County
Blount County
Roane County
Loudon County
Monroe County
0 2.5 5 10
Miles
N
W
E
S
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
LDTN UATMP site
MSTN UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (12)
Boat Manufacturing Facility (1)
Concrete Batch Plant (1)
Food Processing/Agriculture Facility (1)
Grain Handling Facility (1)
Iron and Steel Foundry (1)
Landfill (4)
Lumber/sawmill (1)
Miscellaneous Commercial/Industrial Facility (2)
Miscellaneous Manufacturing Industries Facility (2)
Pulp and Paper Plant/Wood Products Facility (1)
Secondary Metal Processing Facility (1)
Surface Coating Facility (1)

Figure 27-5. NEI Point Sources Located Within 10 Miles of METN


90°15'0"W
90°10'0"W
90°5'0"W
90°0'0"W
89°55'0"W
90°20'0"W
35°15'0"N
35°10'0"N
35°5'0"N
35°0'0"N
Shelby County
Arkansas
Mississippi
0
2.5
5
10
Miles
N
E
S
W
Legend
METN UATMP site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (10)
Airport Support Operation (1)
Asphalt Processing/Roofing Manufacturing (2)
Automobile/Truck Manufacturing Facility (2)
Bakery (1)
B Bulk Terminals/Bulk Plants (4)
C Chemical Manufacturing Facility (13)
0 Commercial Sterilization Facility (1)
Concrete Batch Plant (2)
Electricity Generation via Combustion (3)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (1)
Fabricated Metal Products Facility (2)
F Food Processing/Agriculture Facility (5)
Grain Handling Facility (1)
Gypsum Manufacturing Facility (1)
Hospital (1)
Hot Mix Asphalt Plant (3)
Lumber/sawmill (2)
M Miscellaneous Manufacturing Industries Facility (11)
Petroleum Refinery (1)
P Printing/Publishing Facility (2)
Pulp and Paper Plant/Wood Products Facility (6)
2 Secondary Metal Processing Facility (3)
S Surface Coating Facility (2)
T Textile Mill (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 27-1. Geographical Information for the Tennessee Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
LDTN	47-105-0108	Loudon	Loudon	Knoxville, TN	35.744799, -84.317313	Residential	Suburban	Meteorological parameters and $PM_{2.5}$.
MSTN	47-105-0109	Loudon	Loudon	Knoxville, TN	35.720833, -84.341667	Residential	Suburban	O_3.
METN	47-157-0010	Memphis	Shelby	Memphis, TN-AR-MS	35.09583, -90.07006	Residential	Suburban	None.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The town of Loudon is located approximately 20 miles southwest of Knoxville, TN. A branch of the Tennessee River, Watts Bar Lake, winds through the town. The LDTN monitoring site is located on a peninsula where the river is less than 3/4 mile to the east, 1 mile to the south, and 3/4 mile to the west. The site is located in a primarily residential area on Webb Drive, a few blocks from State Road 2/Highway 11, as shown in Figure 27-1. However, several industrial businesses lie along the river on Blair Bend Drive, less than 1/2 mile south of the site. The site was established to measure emissions from the nearby industrial sources.

MSTN is located on the property of Loudon Middle School, between Highway 74 and Roberts Road. Although a residential subdivision is located immediately across the street from the middle school, as shown in Figure 27-2, mixed land use areas lie to the north and northeast while rural and forested areas lie to the south. This site was also established to measure emissions from nearby industrial sources. Interstate-75, which runs northeast-southwest through eastern Tennessee, is approximately 2.5 miles west of either site.

Figure 27-4 shows that the two Loudon monitoring sites are approximately 2 miles apart. Although the source category with the highest number of sources is the aircraft operations category, which includes airports as well as small runways, heliports, or landing pads, most of these emissions sources are located to the north of the sites. Several other types of sources are located between these sites. In the business park immediately south of LDTN is a grain handling facility, a secondary metal processing facility, and a food processing/agriculture facility. A landfill is located about halfway between LDTN and MSTN. Another cluster of sources is located to the northwest of MSTN.

METN is located in Memphis, in the southwest corner of Tennessee. The site is located just east of I-55, on the property of Riverview Elementary School and south of Riverview Middle School. The elementary school is surrounded by residential areas and is adjacent to Riverview Park and Pool, as shown in Figure 27-3. Riverside Golf Club lies just to the west of I-55. Immediately south of the golf club is the Valero Oil Refinery, which is approximately 1 mile southwest of the site. West of the golf club lies President's Island, a highly industrialized area that is part of the Port of Memphis. The monitoring site is located about 2 miles from the President's Island industrial area. Figure 27-5 shows that METN is surrounded by a number of point sources, mostly to the west and north of the site. Although aircraft operations and chemical manufacturing are the source categories with the highest number of sources within 10 miles of METN, a pulp and paper plant/wood products facility, a petroleum refinery, and a chemical manufacturing facility are the closest sources (within 1 mile) surrounding the site.

Table 27-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Tennessee monitoring sites. Information provided in Table 27-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Loudon and Shelby Counties were obtained from the Tennessee Department of Revenue (TN DOR, 2010) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 27-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 27-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 27-2 presents the daily VMT for the Knoxville and Memphis urban areas.

Table 27-2. Population, Motor Vehicle, and Traffic Information for the Tennessee Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
LDTN	46,725	57,565	1.23	50,501	62,217	12,560	15,741
MSTN	46,725	57,565	1.23	50,501	62,217	7,691	15,741
METN	920,232	682,581	0.74	412,435	305,923	57,872	25,974

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2010 data from the Tennessee Department of Revenue (TN DOR, 2010).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Tennessee DOT (TN DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).

Observations from Table 27-2 include the following:

- Loudon County's population is significantly lower than Shelby County's population. While the Shelby County population was in the mid to upper end of the range compared to other counties with NMP sites, the population for Loudon County was on the low end. The difference in population decreases somewhat for the 10-mile populations.

- The county-level vehicle registrations are in line with the county populations, with Shelby County in the middle of the range compared to other counties with NMP sites and Loudon County on the low end. Similar to the populations, the difference in vehicle ownership decreases somewhat at the 10-mile level.

- The vehicle-per-person ratios for the Loudon sites were greater than one vehicle per person, and were among some of the higher ratios compared to other NMP sites. By contrast, the ratio for METN was in the bottom third compared to other NMP sites.

- METN experienced a higher daily traffic volume than the two Loudon sites. The traffic volume near METN was in the middle of the range compared to other NMP sites. LDTN experienced a higher average daily traffic volume than MSTN, although both traffic volumes were in the lower-third compared to other program sites. LDTN traffic data were obtained from Highway 11 before it crosses the river (TN DOT station 056); traffic data for MSTN were obtained from Highway 11, near the intersection with State Road 72 (TN DOT station 122); and traffic data for METN were obtained from I-55 between McLemore Avenue and South Parkway (TN DOT Station 611).

- The Knoxville urban area VMT was among the lowest for urban areas with NMP sites. (Although the Loudon area is predominantly rural in nature, Loudon County is part of the Knoxville MSA.) The Memphis area VMT was on the mid to low end among other areas with NMP sites, although it was higher than the Knoxville VMT.

27.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Tennessee on sample days, as well as over the course of each year.

27.2.1 Climate Summary

Loudon is located to the southwest of Knoxville in the Great Valley of east Tennessee. Loudon is located in a valley, which is divided from the rest of the state by the Cumberland Plateau. The Appalachian and Great Smoky Mountains lie to the east and the Cumberland and Crab Orchard Mountains lie to the northwest. The Tennessee River meanders through the town of Loudon. These topographic influences affect the area’s weather by moderating temperatures and affecting wind patterns. The area has ample rainfall year-round and experiences all four seasons (Bair, 1992 and UT, 2011).

The Mississippi River is the western border of Tennessee. In the extreme southwest corner of the state lies the city of Memphis, in the state’s lowlands. Frontal systems track across the state most frequently in winter and spring, while afternoon thunderstorms are the principle rain-makers during summer and fall. Summers tend to be warmer and winters milder in the western part of the state compared to the eastern portion, due to elevation differences. This allows the Memphis area to have one of the longest growing seasons in the state. Southerly winds prevail in Memphis (Bair, 1992 and UT, 2011).

27.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to both Loudon sites is located at McGhee Tyson Airport (WBAN 13891); the closest station to METN is located at Memphis International Airport (WBAN 13893). Additional information about these weather stations is provided in Table 27-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 27-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 27-3 is the 95 percent confidence interval for each parameter.

Table 27-3. Average Meteorological Conditions near the Tennessee Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Loudon, Tennessee - LDTN										
McGhee Tyson Airport 13891 (35.82, -83.99)	18.29 miles 67° (ENE)	2008	Sample Day	69.1 ± 3.8	59.1 ± 3.7	46.0 ± 3.8	52.3 ± 3.4	65.2 ± 3.0	1016.7 ± 1.5	5.2 ± 0.9
			All Year	68.8 ± 1.7	58.9 ± 1.6	46.0 ± 1.6	52.1 ± 1.5	65.5 ± 1.2	1017.7 ± 0.6	5.0 ± 0.3
		2009	Sample Day	70.1 ± 4.4	61.2 ± 4.4	50.1 ± 4.9	55.3 ± 4.3	69.7 ± 3.4	1015.9 ± 1.9	5.7 ± 0.9
			All Year	67.6 ± 1.6	58.4 ± 1.6	48.2 ± 1.7	53.1 ± 1.5	71.7 ± 1.3	1017.3 ± 0.6	5.0 ± 0.3
Loudon Middle School, Loudon, Tennessee - MSTN										
McGhee Tyson Airport 13891 (35.82, -83.99)	20.03 miles 63° (ENE)	2008	Sample Day	68.9 ± 3.9	59.0 ± 3.8	46.3 ± 3.9	52.4 ± 3.5	66.1 ± 3.2	1016.8 ± 1.5	5.1 ± 0.9
			All Year	68.8 ± 1.7	58.9 ± 1.6	46.0 ± 1.6	52.1 ± 1.5	65.5 ± 1.2	1017.7 ± 0.6	5.0 ± 0.3
		2009	Sample Day	70.7 ± 4.5	61.9 ± 4.4	50.8 ± 4.9	56.0 ± 4.2	70.0 ± 3.6	1015.7 ± 1.7	5.8 ± 0.9
			All Year	67.6 ± 1.6	58.4 ± 1.6	48.2 ± 1.7	53.1 ± 1.5	71.7 ± 1.3	1017.3 ± 0.6	5.0 ± 0.3
Memphis, Tennessee – METN										
Memphis International Airport 13893 (35.06, -89.99)	5.15 miles 114° (ESE)	2008	Sample Day	74.8 ± 5.3	66.1 ± 5.2	53.8 ± 5.3	59.1 ± 4.7	67.0 ± 3.8	1017.2 ± 1.5	6.9 ± 1.1
			All Year	71.4 ± 1.7	62.5 ± 1.7	49.5 ± 1.8	55.5 ± 1.6	65.1 ± 1.2	1017.5 ± 0.6	7.2 ± 0.3
		2009	Sample Day	71.3 ± 4.0	62.8 ± 4.1	50.0 ± 4.5	56.0 ± 3.8	65.6 ± 3.2	1016.5 ± 1.4	6.8 ± 0.7
			All Year	70.7 ± 1.7	62.5 ± 1.7	50.2 ± 1.8	55.9 ± 1.5	66.7 ± 1.3	1017.0 ± 0.6	6.8 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

Observations from Table 27-3 include the following:

- Average meteorological conditions on 2008 sample days near LDTN and MSTN were fairly representative of average weather conditions experienced throughout 2008. Average meteorological conditions on 2009 sample days appear slightly warmer, more humid, and windier than average weather conditions throughout 2009. This is likely because sampling was concluded in early October 2009, thereby missing some of the cooler months of the year.

- Average meteorological conditions on 2008 sample days for METN appear slightly warmer, more humid, and less windy than average weather conditions throughout the year. This is because sampling did not begin until June 2008, thereby missing the coldest months of the year. Average meteorological conditions on 2009 sample days near METN were fairly representative of average weather conditions experienced throughout 2009.

27.2.3 Back Trajectory Analysis

Figure 27-6 and Figure 27-7 are the composite back trajectory maps for days on which samples were collected at the LDTN monitoring site in 2008 and 2009, respectively. Figure 27-8 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. Figures 27-9 through 27-11 are the composite back trajectory and cluster analysis maps for days on which samples were collected at the MSTN monitoring site and Figures 27-12 through 27-14 are the composite back trajectory and cluster analysis maps for days on which samples were collected at the METN monitoring site. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the sites in Figures 27-6 through 27-14 represents 100 miles.

Figure 27-6. 2008 Composite Back Trajectory Map for LDTN

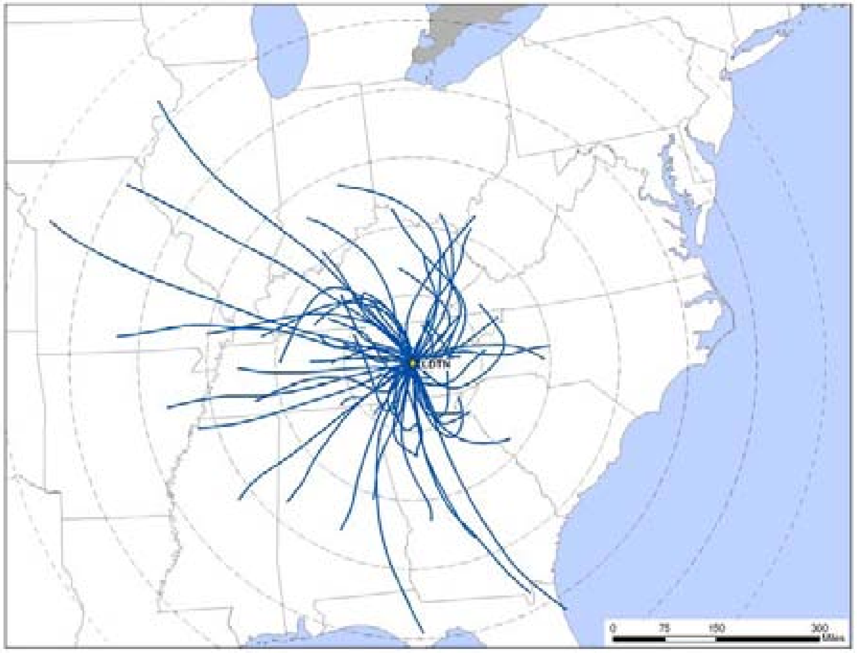


Figure 27-7. 2009 Composite Back Trajectory Map for LDTN

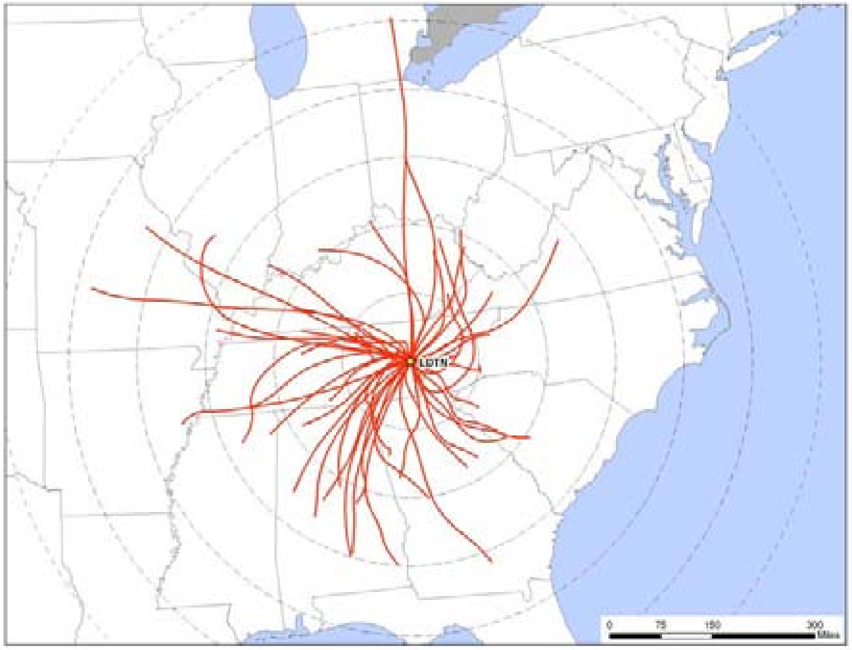


Figure 27-8. Back Trajectory Cluster Map for LDTN

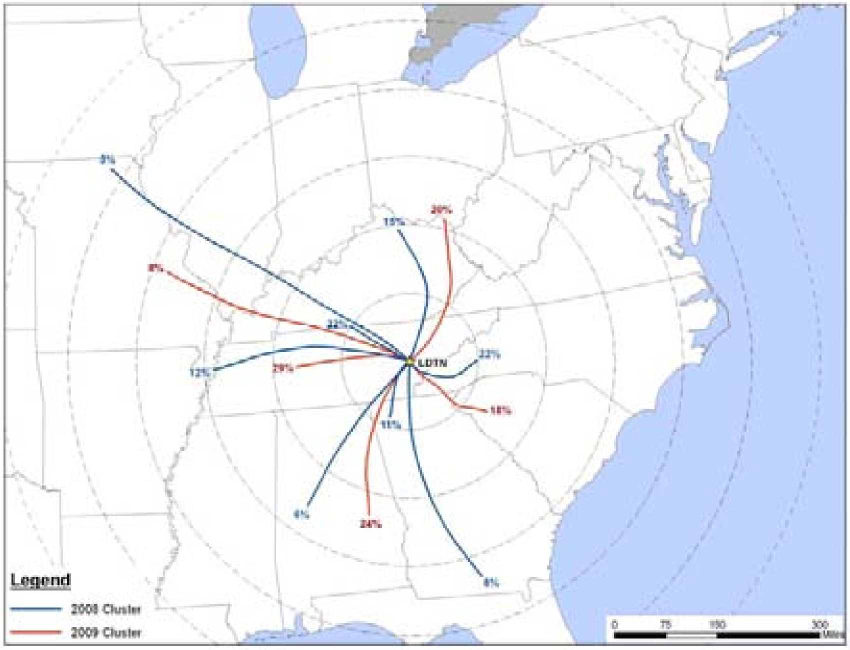


Figure 27-9. 2008 Composite Back Trajectory Map for MSTN

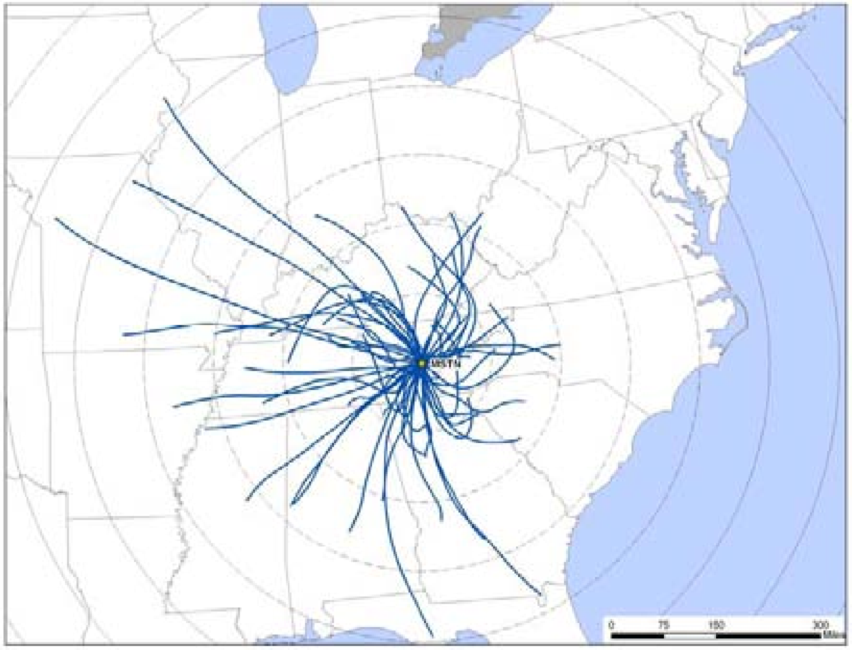


Figure 27-10. 2009 Composite Back Trajectory Map for MSTN

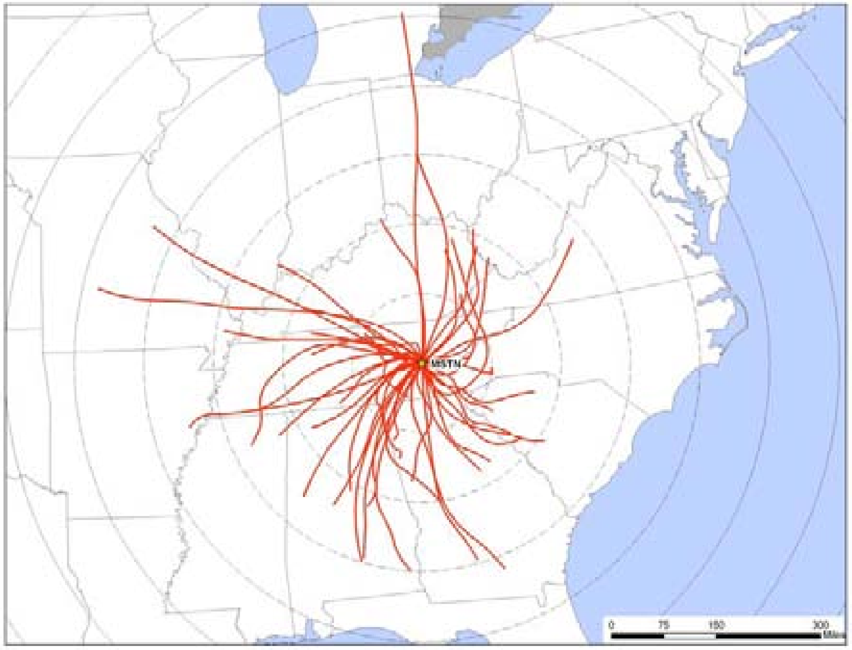


Figure 27-11. Back Trajectory Cluster Map for MSTN

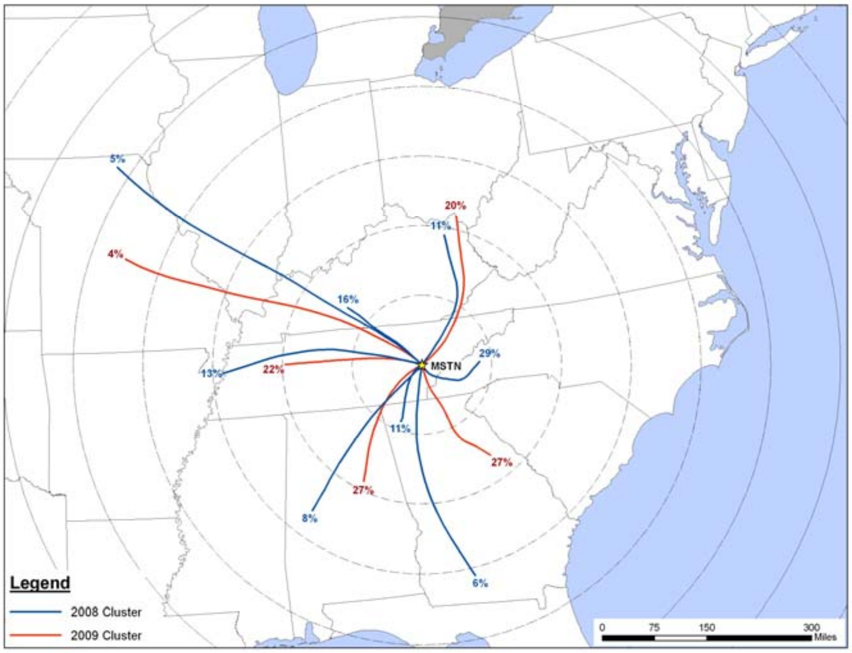


Figure 27-12. 2008 Composite Back Trajectory Map for METN

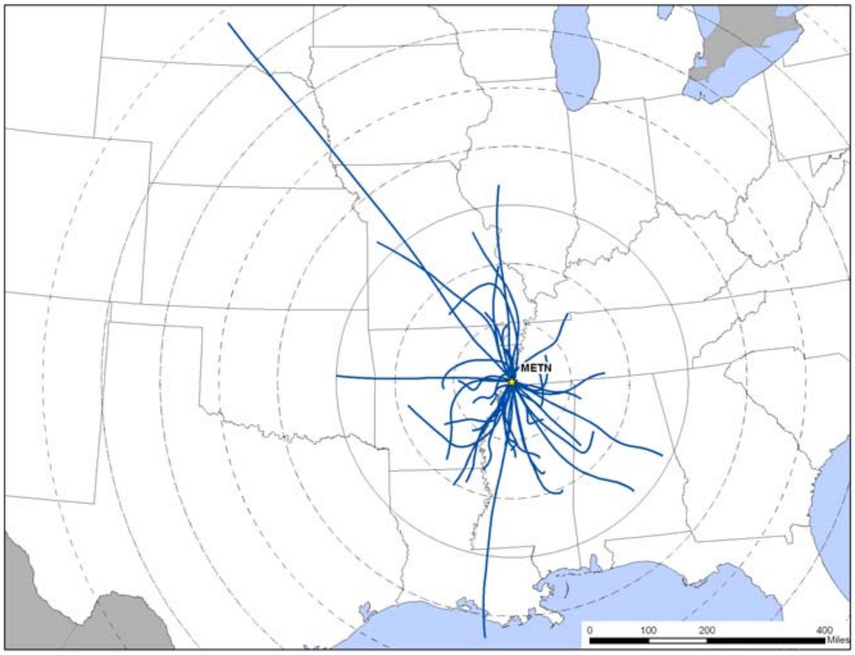


Figure 27-13. 2009 Composite Back Trajectory Map for METN

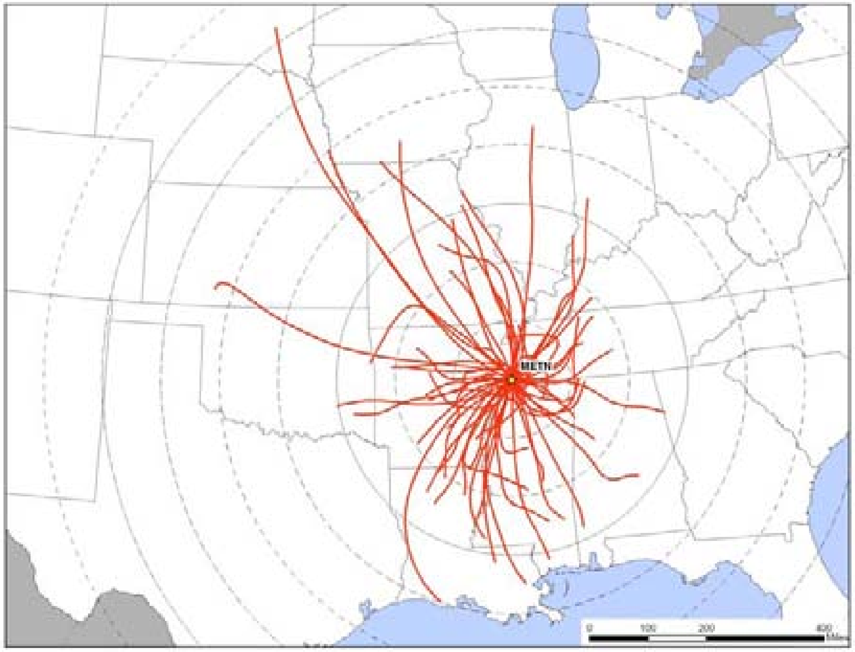
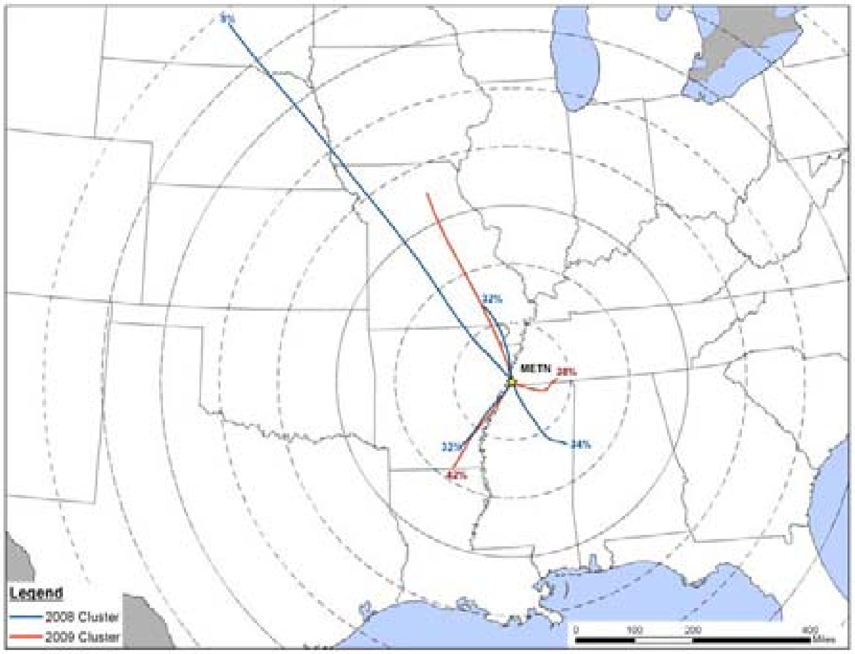


Figure 27-14. Back Trajectory Cluster Map for METN



Observations for the Loudon sites from Figures 27-6 through 27-11 include the following:

- The back trajectory and cluster maps for LDTN and MSTN exhibit a similar trajectory distribution, which is expected, given their close proximity to each other.

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

- The 24-hour air shed domains for these sites were similar in size other NMP monitoring sites. The farthest away a trajectory originated was near Kansas City, Missouri, or less than 575 miles away. However, the average trajectory length for both sites was just over 200 miles and most of the trajectories (roughly 85 percent) originated within 300 miles of the sites.

- The cluster trajectories for the Loudon sites are similar to each other and confirm that trajectories indeed originate from just about every direction. The cluster analyses show that the highest percentage of trajectories originated to the west to northwest; another cluster of trajectories originated to the southeast to southwest; trajectories often originated to the northeast to southeast and usually within 100-200 miles of the sites; and trajectories also originated to the north.

Observations for METN from Figures 27-12 through 27-14 include the following:

- Back trajectories originated from a variety of directions at the METN site. Note that sampling at METN did not begin until June 2008, thus Figure 27-12 for 2008 has roughly half the trajectories as Figure 27-13 for 2009.

- The 24-hour air shed domain for this site appears larger in size compared to other NMP monitoring sites. The farthest away a trajectory originated was central South Dakota, or nearly 800 miles away (in 2008). A trajectory of similar origin is also shown in Figure 27-13 for 2009. However, the average trajectory length was 211 miles and most (82 percent) of the trajectories originated within 300 miles of the site.

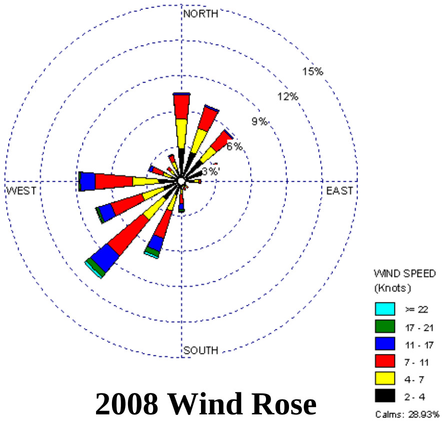
- The cluster map shows that trajectories were fairly evenly split between three directions: one-third originated to the northwest and north, one-third to the southwest, and one-third to the southeast. Note that the cluster trajectories originating to the east and southeast also represent shorter trajectories (usually 100-200 miles in length or less) originating generally from the northeast to southeast, but occasionally other directions as well.

27.2.4 Wind Rose Comparison

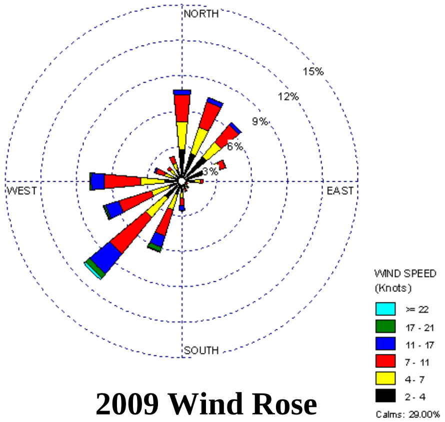
Hourly wind data from the NWS weather stations at the McGhee Tyson Airport (for LDTN and MSTN) and Memphis International Airport (for METN) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using “petals” positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 27-15 presents five different wind roses for the LDTN monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 27-16 and 27-17 present the five different wind roses for the MSTN and METN monitoring sites, respectively.

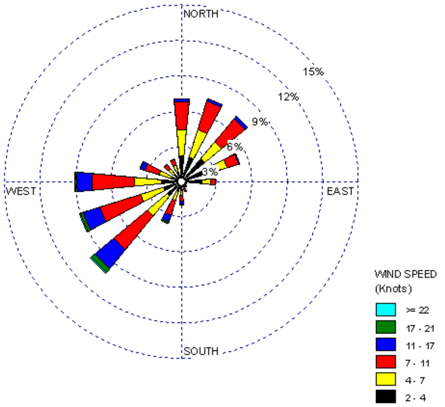
Figure 27-15. Wind Roses for the McGhee Tyson Airport Weather Station near LDTN



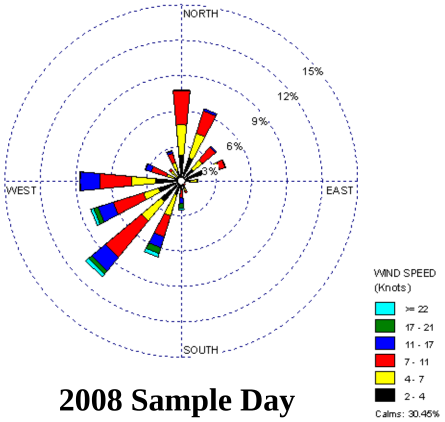
2008 Wind Rose



2009 Wind Rose

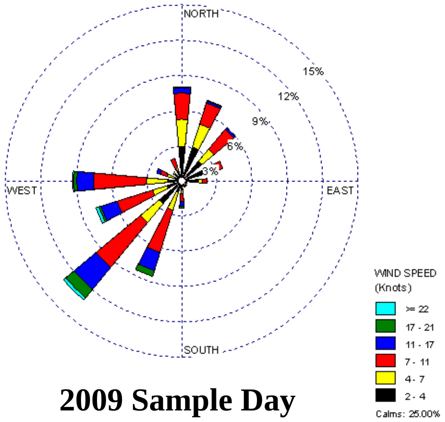


1997 – 2007
Historical Wind Rose



2008 Sample Day

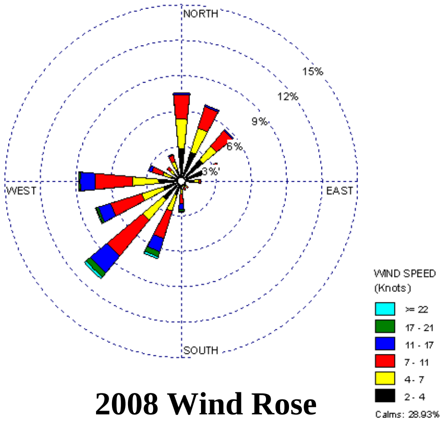
Wind Rose



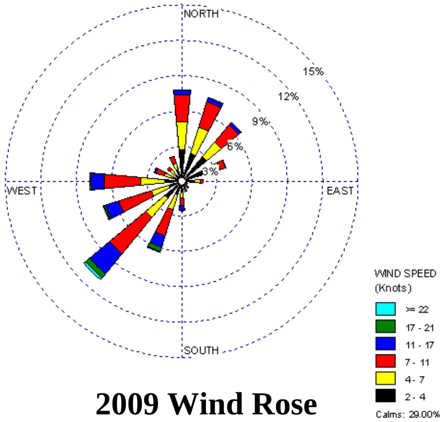
2009 Sample Day

Wind Rose

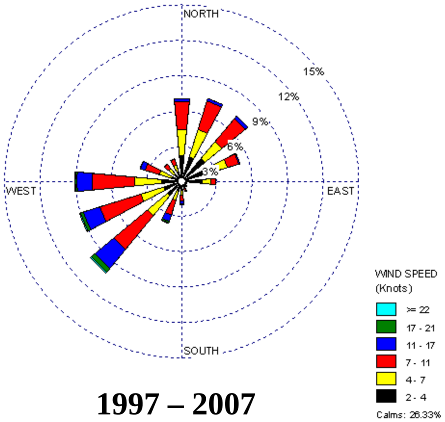
Figure 27-16. Wind Roses for the McGhee Tyson Airport Weather Station near MSTN



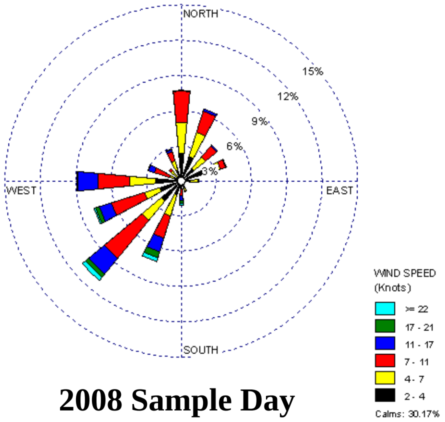
2008 Wind Rose



2009 Wind Rose

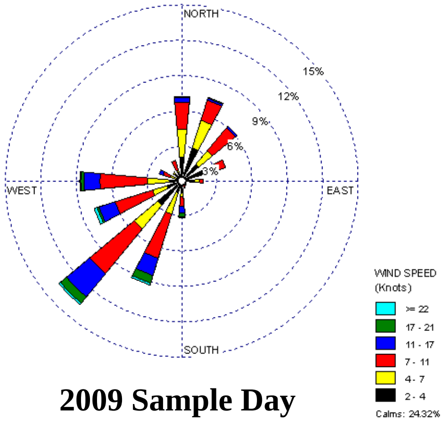


1997 – 2007
Historical Wind Rose



2008 Sample Day

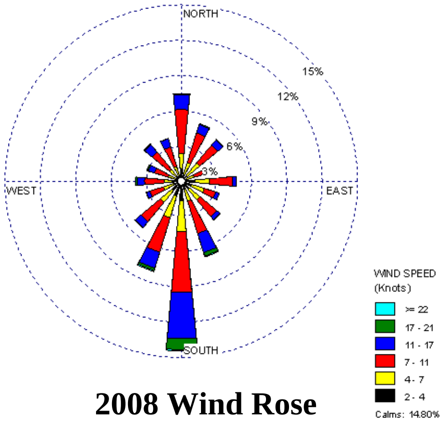
Wind Rose



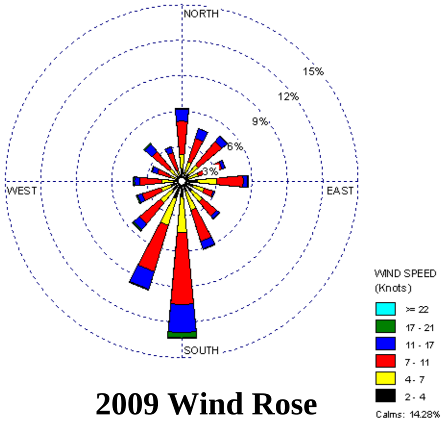
2009 Sample Day

Wind Rose

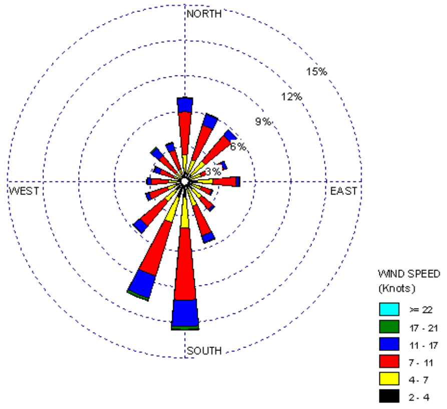
Figure 27-17. Wind Roses for the Memphis International Airport Weather Station near METN



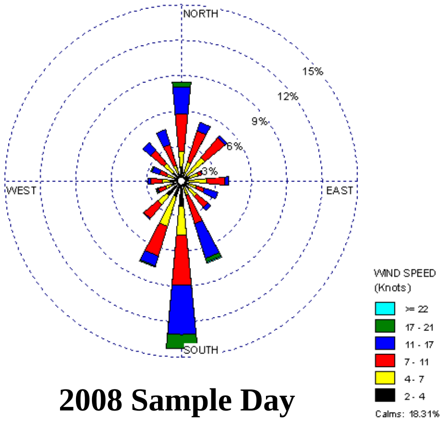
2008 Wind Rose



2009 Wind Rose

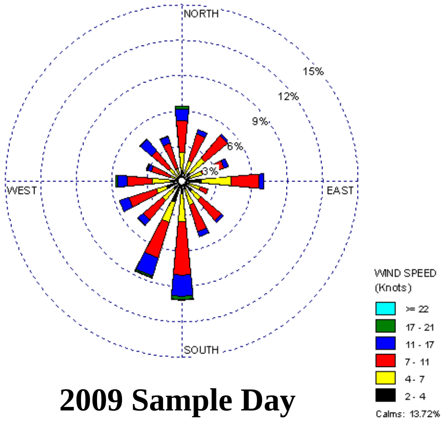


2000 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figures 27-15 and 27-16 for the Loudon sites include the following:

- The historical wind roses for LDTN and MSTN are identical to each other. This is expected, as the wind data are from the same weather station.

- The historical wind roses show that calm winds (≤ 2 knots) were observed for over one quarter of the hourly measurements. For winds greater than 2 knots, southwesterly to westerly winds and northerly to northeasterly winds were prevalent. The strongest winds were generally out of the southwest.

- For both sites, the wind patterns shown on the 2008 wind roses are similar to the historical wind patterns, although there were slightly more calm winds. There was also an increase in winds from the south-southwest and slightly fewer from the west-southwest and west. The 2008 sample day wind patterns are similar the 2008 full-year wind patterns, indicating that wind conditions on sample days were representative of conditions over the entire year.

- For both sites, the 2009 wind patterns are also similar to the historical wind patterns, although there were slightly more calm winds. There was also an increase in winds from the south-southwest and southwest and slightly fewer from the west-southwest and west. The 2009 sample day wind patterns are similar the 2009 full-year wind patterns, although there were fewer calm winds and slightly more winds from the southwest quadrant. Note that sampling at these sites stopped in early October 2009, which could account for some of these differences.

Observations from Figure 27-17 for METN include the following:

- The historical wind rose shows that winds from a variety of directions are observed near METN, although southerly and south-southwesterly winds are observed the most. Winds from the south-southeast to the southwest together account for approximately 36 percent of the wind measurements near this site. Winds from the north to northeast are also common. Calm winds account for 15 percent of the hourly measurements.

- The wind patterns shown on the 2008 wind rose are fairly similar to the historical wind patterns, although southerly winds account for even more of the hourly measurements. The 2008 sample day wind patterns resemble the full-year wind patterns, but with slightly more (and stronger) northerly winds.

- The wind patterns shown on the 2009 wind rose are similar to the historical wind patterns. The 2009 sample day wind patterns resemble the full-year wind patterns, although the predominance of southerly winds is reduced.

27.3 Pollutants of Interest

Site- specific “pollutants of interest” were determined for the Tennessee monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 27-4 presents the pollutants of interest for each Tennessee monitoring site. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. All three sites sampled for VOC and carbonyl compounds.

Table 27-4. Risk Screening Results for the Tennessee Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Loudon, Tennessee - LDTN						
Benzene	0.13	108	108	100.00	20.07	20.07
Formaldehyde	0.077	107	107	100.00	19.89	39.96
Acetaldehyde	0.45	106	107	99.07	19.70	59.67
Carbon Tetrachloride	0.17	106	108	98.15	19.70	79.37
1,3-Butadiene	0.033	61	101	60.40	11.34	90.71
Carbon Disulfide	70	21	108	19.44	3.90	94.61
Acrylonitrile	0.015	11	11	100.00	2.04	96.65
Tetrachloroethylene	0.17	5	88	5.68	0.93	97.58
p-Dichlorobenzene	0.091	3	87	3.45	0.56	98.14
1,2-Dichloroethane	0.038	3	3	100.00	0.56	98.70
Dichloromethane	2.1	2	107	1.87	0.37	99.07
Hexachloro-1,3-butadiene	0.045	2	2	100.00	0.37	99.44
Ethylbenzene	0.4	1	108	0.93	0.19	99.63
1,1,2,2-Tetrachloroethane	0.017	1	2	50.00	0.19	99.81
Vinyl chloride	0.11	1	14	7.14	0.19	100.00
Total		538	1,061	50.71		
Loudon Middle School, Loudon, Tennessee - MSTN						
Formaldehyde	0.077	109	109	100.00	21.12	21.12
Acetaldehyde	0.45	108	109	99.08	20.93	42.05
Benzene	0.13	105	105	100.00	20.35	62.40
Carbon Tetrachloride	0.17	105	105	100.00	20.35	82.75
1,3-Butadiene	0.033	61	103	59.22	11.82	94.57
Acrylonitrile	0.015	12	12	100.00	2.33	96.90
Tetrachloroethylene	0.17	6	85	7.06	1.16	98.06
p-Dichlorobenzene	0.091	3	72	4.17	0.58	98.64
1,2-Dichloroethane	0.038	3	3	100.00	0.58	99.22
Ethylbenzene	0.4	2	105	1.90	0.39	99.61
Hexachloro-1,3-butadiene	0.045	2	3	66.67	0.39	100.00
Total		516	811	63.63		

Table 27-4. Risk Screening Results for the Tennessee Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Memphis, Tennessee - METN						
Formaldehyde	0.077	98	98	100.00	16.33	16.33
Acetaldehyde	0.45	97	98	98.98	16.17	32.50
Benzene	0.13	91	91	100.00	15.17	47.67
Carbon Tetrachloride	0.17	90	91	98.90	15.00	62.67
1,3-Butadiene	0.033	81	90	90.00	13.50	76.17
p-Dichlorobenzene	0.091	40	86	46.51	6.67	82.83
Acrylonitrile	0.015	35	35	100.00	5.83	88.67
Ethylbenzene	0.4	30	91	32.97	5.00	93.67
Tetrachloroethylene	0.17	17	78	21.79	2.83	96.50
1,2-Dichloroethane	0.038	8	8	100.00	1.33	97.83
Dichloromethane	2.1	8	91	8.79	1.33	99.17
Propionaldehyde	0.8	4	98	4.08	0.67	99.83
1,2-Dibromoethane	0.0017	1	1	100.00	0.17	100.00
Total		600	956	62.76		

Observations from Table 27-4 include the following:

- Fifteen pollutants failed at least one screen for LDTN, of which seven were NATTS MQO Core Analytes; 11 pollutants failed at least one screen for MSTN, of which six were NATTS MQO Core Analytes; and 13 pollutants failed at least one screen for METN, of which six were NATTS MQO Core Analytes. Ten pollutants failed at least one screen for all three sites.

- The risk screening process identified seven pollutants of interest for LDTN, of which five are NATTS MQO Core Analytes. Tetrachloroethylene and vinyl chloride were added to LDTN's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of LDTN's total failed screens. Two pollutants (trichloroethylene and chloroform) were also added to LDTN's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are not shown in Table 27-4.

- The risk screening process identified six pollutants of interest for MSTN, of which five are NATTS MQO Core Analytes. Tetrachloroethylene was also added to MSTN's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of MSTN's total failed screens. Vinyl chloride, trichloroethylene, and chloroform were added to MSTN's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These three pollutants are not shown in Table 27-4.

- The risk screening process identified nine pollutants of interest for METN, of which six are NATTS MQO Core Analytes. Three pollutants (vinyl chloride, trichloroethylene, and chloroform) were added to METN's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These three pollutants are not shown in Table 27-4.

- The failure rate (of pollutants failing at least one screen) ranged from 50.71 percent for LDTN to 63.63 percent for MSTN.

- For each site, 100 percent of the measured detections of formaldehyde, benzene, acrylonitrile, and 1,2-dichloroethane failed screens. Note that the latter two pollutants were detected infrequently while the former two pollutants were detected in 100 percent of samples collected.

- Carbon disulfide failed 21 screens for LDTN. Of this pollutant's 22 failed screens across all NMP sites, 21 were for LDTN (the other was for SPAZ). Note the relatively high screening value (70 µg/m^3) for this pollutant. Of the 61 measurements of carbon disulfide greater than 35 µg/m^3 measured across all NMP sites, 48 were measured at LDTN.

27.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Tennessee monitoring sites. Concentration averages are provided for the pollutants of interest for each site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

27.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for each Tennessee site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 27-5, where applicable.

Observations for LDTN from Table 27-5 include the following:

- For both years, the pollutants with the highest daily average concentrations by mass were carbon disulfide, formaldehyde, and acetaldehyde.

- The daily, quarterly, and annual average concentrations of carbon disulfide are significantly higher than the averages for the other pollutants of interest. Each of these carbon disulfide averages has a relatively large confidence interval. This is due to the large range of measurements collected for this pollutant; the concentrations ranged from 0.0468 $\mu g/m^3$ to 165 $\mu g/m^3$, with a median of 27.55 $\mu g/m^3$. The median represents the 50th percentile, or the value at which 50 percent of the concentration are less than and 50 percent are greater than. This relatively high median indicates that there are not just a couple of outliers influencing the average concentrations.

- Acetaldehyde concentrations appear to be higher during the second quarter of both years. A review of the confidence intervals for the quarterly averages indicates that the difference is not statistically significant.

- Benzene concentrations appear to be higher at LDTN from the fourth quarter of 2008 through the second quarter of 2009. Of the 24 concentrations of benzene greater than 1 $\mu g/m^3$, 19 of them were measured during this time frame.

- Formaldehyde concentrations at LDTN were higher during the warmer months (second and third quarters) of both years. Because sampling at LDTN stopped in October 2009, a fourth quarter 2009 average could not be calculated.

- The confidence interval for the third quarter 2009 tetrachloroethylene concentration is greater than the concentration itself, indicating the presence of outliers. The maximum concentration measured at LDTN was 1.05 $\mu g/m^3$. The measurements excluding this concentration ranged from 0.0272 to 0.326 $\mu g/m^3$. This tetrachloroethylene concentration falls into the top one percent of measurements of this pollutant among all NMP sites.

- The confidence interval for the 2009 daily average vinyl chloride concentration is greater than the concentration itself, also indicating the presence of outliers. The vinyl chloride concentration measured at LDTN on March 20, 2009 was 0.176 $\mu g/m^3$, which is an order of magnitude higher than the next highest concentration (0.0154 $\mu g/m^3$) and the highest concentration of this pollutant among all NMP sites sampling VOC. This pollutant was detected in only 14 of 108 samples collected at this monitoring site (note that no quarterly averages could be calculated).

Table 27-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Tennessee Monitoring Sites

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Loudon, Tennessee – LDTN												
Acetaldehyde	1.89 ± 0.32	1.90 ± 0.77	2.22 ± 0.93	1.81 ± 0.36	1.66 ± 0.51	1.89 ± 0.32	1.82 ± 0.37	1.65 ± 0.60	2.43 ± 0.76	1.23 ± 0.22	NA	1.82 ± 0.37
Acrylonitrile	0.23 ± <0.01	NA	NA	NA	NA	NA	0.07 ± 0.03	NA	NA	NA	NA	NA
Benzene	0.85 ± 0.08	0.75 ± 0.11	0.80 ± 0.16	0.74 ± 0.10	1.10 ± 0.21	0.85 ± 0.08	0.94 ± 0.25	1.22 ± 0.41	1.11 ± 0.57	0.52 ± 0.09	NA	0.94 ± 0.25
1,3-Butadiene	0.05 ± 0.01	0.05 ± 0.02	0.04 ± 0.01	0.03 ± 0.01	0.08 ± 0.03	0.05 ± 0.01	0.04 ± 0.01	0.06 ± 0.03	0.04 ± 0.01	0.02 ± 0.01	NA	0.04 ± 0.01
Carbon Disulfide	45.53 ± 11.68	28.04 ± 19.98	53.82 ± 25.58	33.92 ± 14.90	65.06 ± 29.66	45.53 ± 11.68	35.67 ± 9.62	27.01 ± 17.56	38.64 ± 16.64	38.33 ± 18.60	NA	35.67 ± 9.62
Carbon Tetrachloride	0.76 ± 0.06	0.67 ± 0.09	0.79 ± 0.10	0.85 ± 0.14	0.75 ± 0.11	0.76 ± 0.06	0.70 ± 0.07	0.55 ± 0.14	0.65 ± 0.03	0.91 ± 0.13	NA	0.70 ± 0.07
Chloroform	0.40 ± 0.09	0.26 ± 0.16	0.42 ± 0.20	0.50 ± 0.16	0.43 ± 0.19	0.40 ± 0.09	0.29 ± 0.05	0.19 ± 0.06	0.28 ± 0.08	0.38 ± 0.11	NA	0.29 ± 0.05
Formaldehyde	2.40 ± 0.32	1.67 ± 0.32	2.82 ± 0.62	3.69 ± 0.60	1.46 ± 0.33	2.40 ± 0.32	2.44 ± 0.32	1.73 ± 0.41	3.00 ± 0.62	2.48 ± 0.31	NA	2.44 ± 0.32
Tetrachloroethylene	0.08 ± 0.01	0.07 ± 0.02	0.07 ± 0.02	0.06 ± 0.02	0.06 ± 0.03	0.07 ± 0.01	0.10 ± 0.06	0.07 ± 0.05	0.06 ± 0.01	0.12 ± 0.14	NA	0.08 ± 0.05
Trichloroethylene	0.04 ± 0.01	0.02 ± 0.01	NA	NA	NA	NA	0.05 ± 0.04	NA	NA	NA	NA	NA
Vinyl Chloride	0.01 ± <0.01	NA	NA	NA	NA	NA	0.03 ± 0.05	NA	NA	NA	NA	NA

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not available because sampling was not conducted during this time period.

Table 27-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Tennessee Monitoring Sites (Continued)

	2008						2009					
Pollutant	**Daily Average (µg/m³)**	**1st Quarter Average (µg/m³)**	**2nd Quarter Average (µg/m³)**	**3rd Quarter Average (µg/m³)**	**4th Quarter Average (µg/m³)**	**Annual Average (µg/m³)**	**Daily Average (µg/m³)**	**1st Quarter Average (µg/m³)**	**2nd Quarter Average (µg/m³)**	**3rd Quarter Average (µg/m³)**	**4th Quarter Average (µg/m³)**	**Annual Average (µg/m³)**
Loudon Middle School, Loudon, Tennessee – MSTN												
Acetaldehyde	1.19 ± 0.12	1.02 ± 0.21	1.27 ± 0.25	1.33 ± 0.22	1.16 ± 0.27	1.19 ± 0.12	0.97 ± 0.12	0.98 ± 0.20	1.15 ± 0.24	0.76 ± 0.11	NA	0.97 ± 0.12
Acrylonitrile	1.45 ± 3.17	NA	NA	NA	NA	NA	0.08 ± 0.07	NA	NA	NA	NA	NA
Benzene	1.13 ± 0.10	1.32 ± 0.27	1.27 ± 0.20	0.95 ± 0.11	0.99 ± 0.15	1.13 ± 0.10	0.85 ± 0.19	1.15 ± 0.51	0.85 ± 0.23	0.53 ± 0.07	NA	0.85 ± 0.19
1,3-Butadiene	0.06 ± 0.01	0.06 ± 0.02	0.04 ± 0.02	0.04 ± 0.01	0.09 ± 0.02	0.06 ± 0.01	0.04 ± 0.01	0.05 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	NA	0.04 ± 0.01
Carbon Tetrachloride	0.67 ± 0.04	0.57 ± 0.06	0.68 ± 0.05	0.76 ± 0.12	0.67 ± 0.11	0.67 ± 0.04	0.70 ± 0.06	0.57 ± 0.11	0.70 ± 0.07	0.83 ± 0.09	NA	0.70 ± 0.06
Chloroform	0.18 ± 0.03	0.10 ± 0.04	0.09 ± 0.04	0.20 ± 0.09	0.19 ± 0.05	0.14 ± 0.03	0.17 ± 0.04	0.10 ± 0.02	0.21 ± 0.09	0.16 ± 0.06	NA	0.16 ± 0.04
Formaldehyde	2.05 ± 0.25	1.40 ± 0.23	2.50 ± 0.43	3.05 ± 0.46	1.32 ± 0.32	2.05 ± 0.25	1.82 ± 0.21	1.24 ± 0.20	2.29 ± 0.38	1.89 ± 0.28	NA	1.82 ± 0.21
Tetrachloroethylene	0.13 ± 0.06	0.13 ± 0.11	0.15 ± 0.19	0.06 ± 0.03	0.09 ± 0.03	0.11 ± 0.05	0.10 ± 0.08	0.14 ± 0.19	0.05 ± 0.02	0.04 ± 0.03	NA	0.08 ± 0.06
Trichloroethylene	0.08 ± 0.05	NA	NA	NA	NA	NA	0.07 ± 0.04	NA	NA	NA	NA	NA
Vinyl Chloride	0.01 ± 0.01	NA	NA	NA	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not available because sampling was not conducted during this time period.

Table 27-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Tennessee Monitoring Sites (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Memphis, Tennessee – METN												
Acetaldehyde	3.17 ± 0.72	NR	NA	3.26 ± 0.92	2.35 ± 0.89	NA	1.83 ± 0.24	1.37 ± 0.27	2.03 ± 0.35	1.52 ± 0.44	2.35 ± 0.71	1.83 ± 0.24
Acrylonitrile	1.89 ± 3.93	NR	NA	NA	NA	NA	0.24 ± 0.06	0.27 ± 0.15	0.12 ± 0.08	NA	NA	NA
Benzene	1.75 ± 0.47	NR	NA	1.83 ± 0.78	1.74 ± 0.73	NA	1.45 ± 0.23	1.59 ± 0.54	1.63 ± 0.58	1.21 ± 0.34	1.41 ± 0.49	1.45 ± 0.23
1,3-Butadiene	0.11 ± 0.04	NR	NA	0.08 ± 0.03	0.14 ± 0.07	NA	0.09 ± 0.02	0.08 ± 0.05	0.08 ± 0.03	0.07 ± 0.02	0.12 ± 0.05	0.09 ± 0.02
Carbon Tetrachloride	0.67 ± 0.09	NR	NA	0.80 ± 0.17	0.54 ± 0.09	NA	0.64 ± 0.06	0.46 ± 0.10	0.62 ± 0.06	0.82 ± 0.15	0.63 ± 0.07	0.64 ± 0.06
Chloroform	0.18 ± 0.04	NR	NA	0.23 ± 0.12	0.14 ± 0.03	NA	0.14 ± 0.01	0.11 ± 0.02	0.15 ± 0.03	0.16 ± 0.04	0.14 ± 0.02	0.14 ± 0.01
p-Dichlorobenzene	0.19 ± 0.08	NR	NA	0.26 ± 0.17	0.17 ± 0.09	NA	0.12 ± 0.03	0.08 ± 0.05	0.12 ± 0.06	0.13 ± 0.07	0.10 ± 0.05	0.11 ± 0.03
Ethylbenzene	0.46 ± 0.11	NR	NA	0.45 ± 0.16	0.54 ± 0.19	NA	0.37 ± 0.08	0.59 ± 0.29	0.36 ± 0.09	0.31 ± 0.13	0.29 ± 0.11	0.37 ± 0.08
Formaldehyde	3.53 ± 0.86	NR	NA	4.30 ± 1.43	2.01 ± 0.54	NA	2.69 ± 0.41	1.76 ± 0.42	3.55 ± 0.88	2.75 ± 0.63	2.58 ± 1.10	2.69 ± 0.41
Tetrachloroethylene	0.15 ± 0.06	NR	NA	0.17 ± 0.10	0.12 ± 0.07	NA	0.13 ± 0.02	0.10 ± 0.02	0.12 ± 0.05	0.09 ± 0.05	0.13 ± 0.07	0.11 ± 0.02
Trichloroethylene	0.11 ± 0.05	NR	NA	NA	NA	NA	0.08 ± 0.02	NA	NA	NA	NA	NA
Vinyl Chloride	0.02 ± <0.01	NR	NA	0.01 ± 0.01	NA	NA	0.02 ± <0.01	0.01 ± 0.01	0.01 ± <0.01	NA	NA	NA

NA = Not available due to the criteria for calculating a quarterly and/or annual average.
NR = Not available because sampling was not conducted during this time period.

Observations for MSTN from Table 27-5 include the following:

- The pollutants with the highest daily average concentrations by mass for 2008 were formaldehyde, acrylonitrile, and acetaldehyde. The pollutants with the highest daily average concentrations by mass for 2009 were formaldehyde, acetaldehyde, and benzene.

- The confidence interval for the 2008 daily average acrylonitrile concentration is greater than the concentration itself, indicating the presence of outliers. A review of the data shows that the highest concentration of this pollutant was measured on April 12, 2008. This concentration (6.86 µg/m^3) was an order of magnitude higher than the next highest concentration (0.281 µg/m^3), measured on May 31, 2009 and was the second highest acrylonitrile concentration measured among all NMP sites sampling VOC (behind only METN). The 2009 daily average concentration of this pollutant is much lower. Acrylonitrile did not have enough measured detections for a single quarterly average to be calculated for this site.

- Formaldehyde concentrations at MSTN were higher during the warmer months (second and third quarters) of both years, similar to LDTN. Because sampling at MSTN stopped in October 2009, a fourth quarter 2009 average could not be calculated.

- The confidence intervals for the second quarter 2008 and the first quarter 2009 tetrachloroethylene concentrations are greater than the concentrations themselves, indicating the presence of outliers. The maximum concentrations measured at MSTN were measured on April 24, 2008 (1.43 µg/m^3) and January 25, 2009 (1.30 µg/m^3). The measurements, excluding these concentrations, ranged from 0.0272 to 0.897 µg/m^3. These tetrachloroethylene concentrations fall into the top one percent of measurements of this pollutant among all NMP sites.

- Although carbon disulfide was not a pollutant of interest for MSTN, the daily average concentration of carbon disulfide was 5.37 ± 1.62 µg/m^3 in 2008 and 3.00 ± 1.34 µg/m^3 in 2009, which are both an order of magnitude lower than the averages for LDTN. The large disparity between the concentrations of this pollutant for LDTN and MSTN may suggest that MSTN is upwind from a carbon disulfide source while LDTN is downwind.

Observations for METN from Table 27-5 include the following:

- The pollutants with the highest daily average concentrations by mass for 2008 were formaldehyde, acetaldehyde, and acrylonitrile. The pollutants with the highest daily average concentrations by mass for 2009 were formaldehyde, acetaldehyde, and benzene.

- Because sampling did not begin until June 2008, first and second quarter averages for 2008 are not available for METN; thus, annual averages for 2008 could not be calculated either.

- Formaldehyde concentrations appear to be higher during the warmer months of the year, although a high confidence interval for the fourth quarter of 2009 throws this observation off. Of the 22 concentrations of formaldehyde greater than 4 µg/m^3, seven of these were measured during the third quarter of 2008; five during the second quarter of 2009; four during the second quarter of 2008; two in the fourth quarter of 2009; and one in the fourth quarter of 2008. The two measured during the fourth quarter of 2009 drive up the confidence interval for concentrations that are usually lower than those measured during the warmer months of the year (which explains the lower average but higher confidence interval).

- The confidence interval for the 2008 daily average acrylonitrile concentration is greater than the concentration itself, indicating the presence of outliers. A review of the data shows that the highest concentration of this pollutant was measured on August 28, 2008. This concentration (8.72 µg/m^3) was an order of magnitude higher than the next highest concentration (0.857 µg/m^3), measured on March 14, 2009 and was the highest acrylonitrile concentrations measured among all NMP sites sampling VOC. The 2009 daily average concentration of this pollutant is much lower. Acrylonitrile had enough measured detections for two quarterly averages to be calculated for this site (first and second quarter of 2009).

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Tennessee sites from those tables include the following:

- Both METN and MSTN's 2008 daily average concentrations of acrylonitrile appear in Table 4-9; METN ranked fifth and MSTN ranked seventh.

- As shown in Table 4-9, of the program-level pollutants of interest, LDTN had the seventh (2008) and ninth (2009) highest daily average concentrations of chloroform.

- As shown in Table 4-10, METN has the second highest daily average concentration of acetaldehyde (2008), behind only INDEM, and the tenth highest formaldehyde concentration (2008). Neither of the Loudon sites appears in Table 4-10.

27.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. The LDTN site has sampled VOC and carbonyl compounds as part of the NMP since 2003. Thus, Figures 27-18 through 27-21 present the 3-year rolling statistical metrics for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde for LDTN. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. Because VOC and carbonyl compound sampling did not begin until November 2003, 2003 data were excluded from this analysis because two months of sampling is not enough to be representative of an entire year.

Observations from Figure 27-18 for acetaldehyde measurements include the following:

- The maximum acetaldehyde concentration shown was measured on August 16, 2007.
- The rolling average concentrations decreased slightly over the periods shown; however, the calculation of confidence intervals indicates that this decrease is not statistically significant. The median concentrations exhibit a similar decreasing trend.

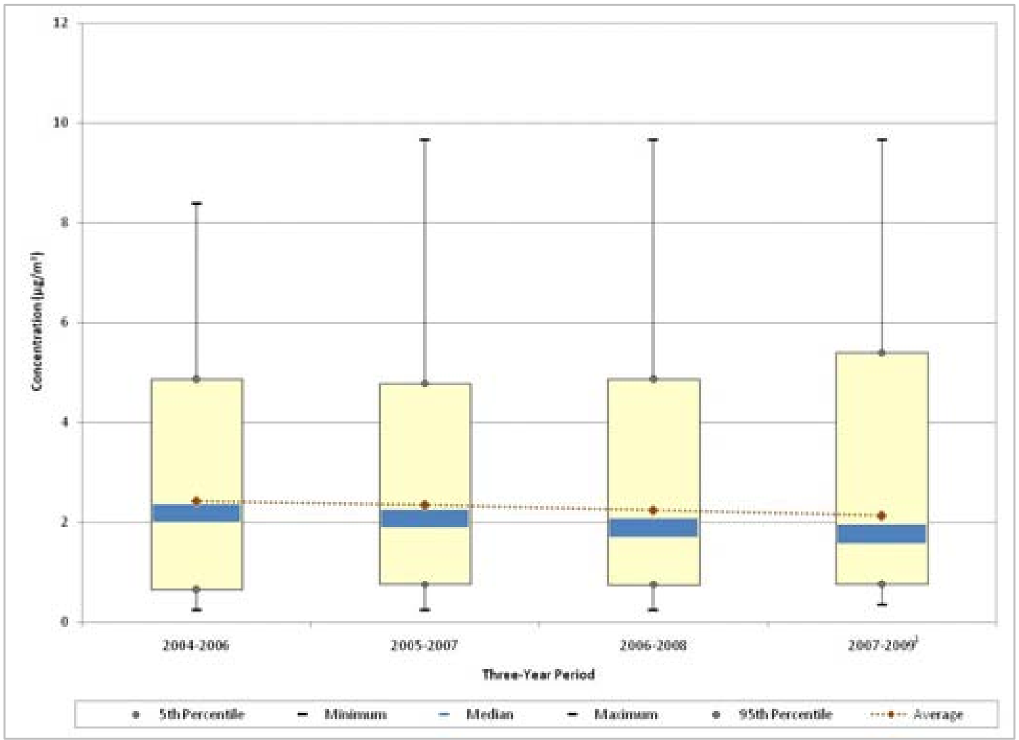
Observations from Figure 27-19 for benzene measurements include the following:

- The maximum benzene concentration shown was measured on April 19, 2009; similar concentrations were also measured on April 13, 2009 and June 8, 2004.
- The rolling average and median concentrations have a decreasing trend through the 2006-2008 time period, then level off for the final time frame.

Observations from Figure 27-20 for 1,3-butadiene measurements include the following:

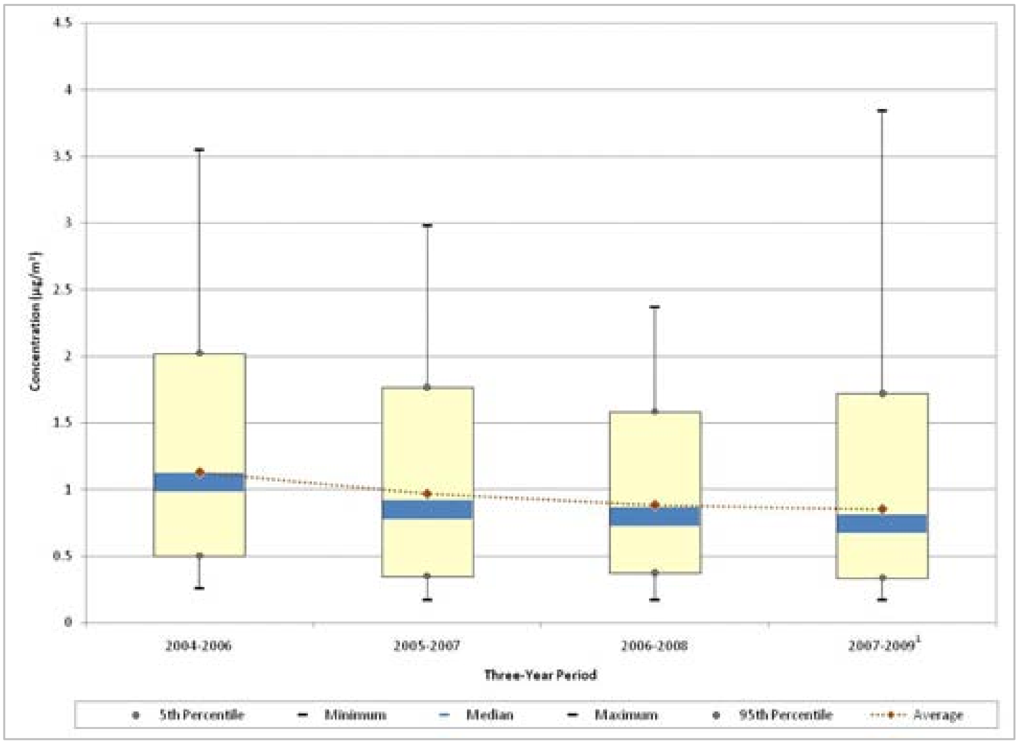
- The maximum concentration of 1,3-butadiene was measured on July 21, 2005.
- The rolling average concentration increased slightly from 2004-2006 to 2005-2007, then decreased slightly for 2006-2008 and returned to the original levels for 2007-2009. Confidence intervals indicate that none of these changes were statistically significant. The median concentrations exhibited a similar pattern, although again, the changes were slight.
- Note that the difference between the 5th and 95th percentiles changed little over the period of sampling, indicating little change in the majority of concentrations measured.

Figure 27-18. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at LDTN



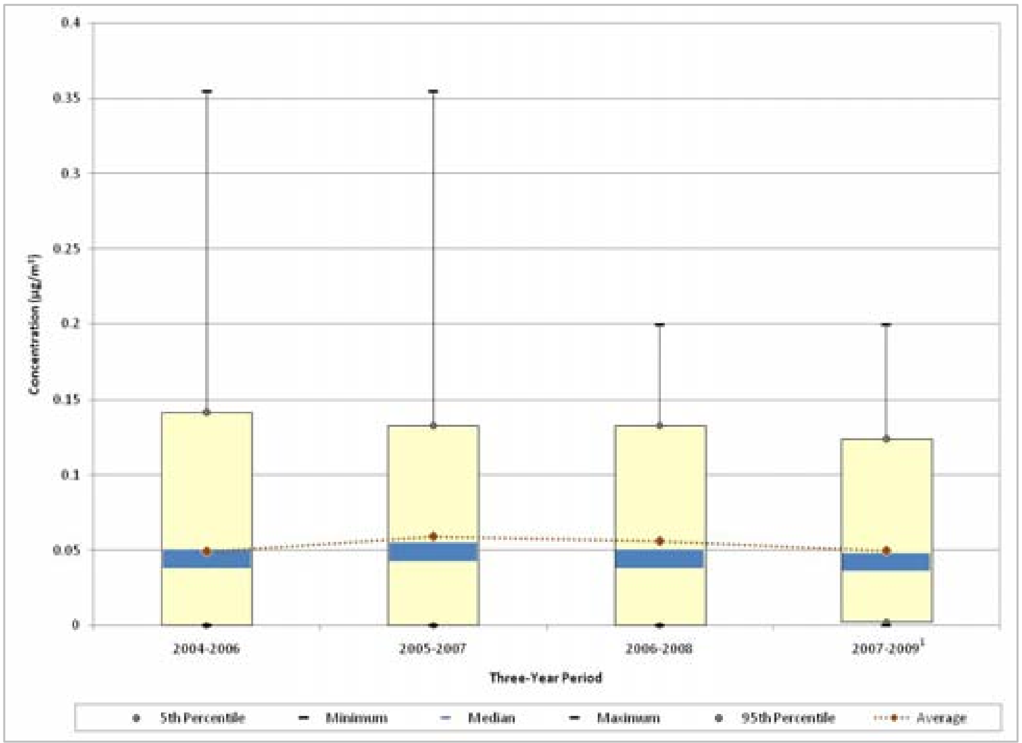
[1] Sampling for carbonyl compounds ended in October 2009.

Figure 27-19. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at LDTN



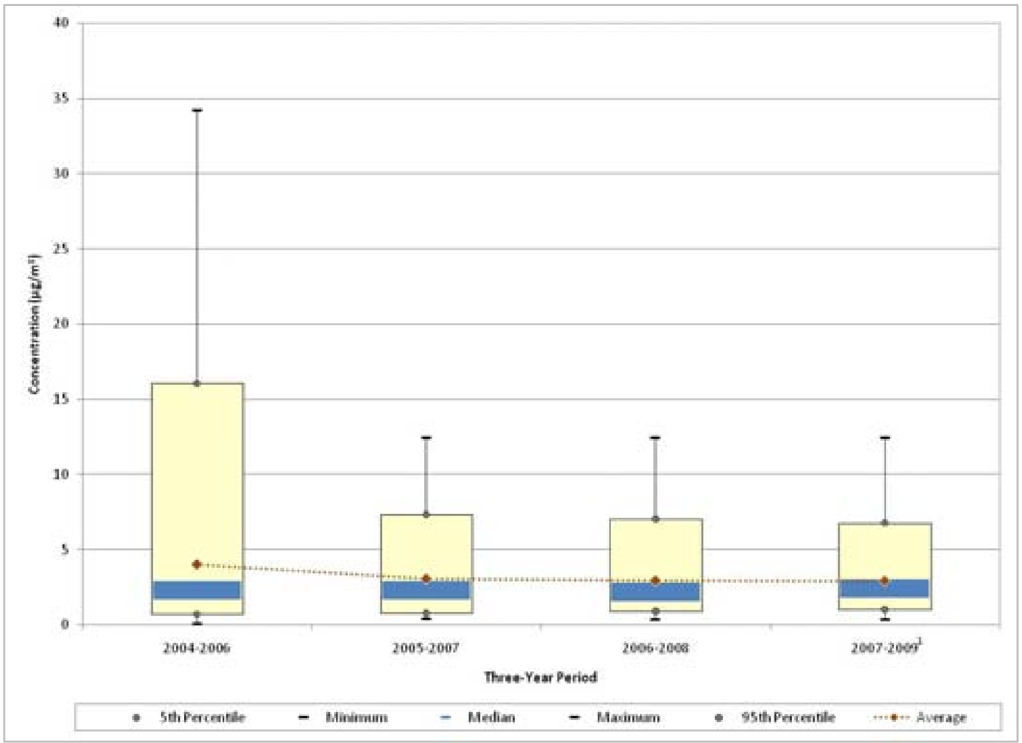
[1] Sampling for VOC ended in October 2009.

Figure 27-20. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at LDTN



[1] Sampling for VOC ended in October 2009.

Figure 27-21. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at LDTN



[1] Sampling for carbonyl compounds ended in October 2009.

Observations from Figure 27-21 for formaldehyde measurements include the following:

- The maximum formaldehyde concentration shown was measured in January 2004. Although not shown in Figure 27-21, two higher concentrations were also measured in late 2003. Further, of 15 formaldehyde concentrations greater than 10 $\mu g/m^3$ measured at LDTN, 13 were measured in 2003 and 2004.

- The rolling average concentration decreased from 2004-2006 to 2005-2007, after which it has been static.

- The rolling average and median concentrations became more similar to each other for each time frame, indicating decreasing variability in central tendency since sampling began. This is also evident by the decreasing difference between the 5th and 95th percentiles.

27.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at each Tennessee monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

27.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Tennessee monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Tennessee monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

27.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Tennessee monitoring sites and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 27-6, where applicable.

Observations for LDTN from Table 27-6 include the following:

- The pollutants with the highest annual averages were carbon disulfide, formaldehyde, and acetaldehyde for both years, yet the pollutants with the highest cancer risk approximations were formaldehyde, benzene, and carbon tetrachloride for both years. The cancer risk approximations for formaldehyde were at least an order of magnitude higher than the cancer risk approximations for the other pollutants of interest (approximately 31 in-a-million for both years).

- There were no pollutants with noncancer risk approximations greater than 1.0, the level of concern, based on the annual averages.

- Even with carbon disulfide’s rather high annual averages, its noncancer risk approximations were still very low, indicating that noncancer risks associated with this pollutant are negligible. Carbon disulfide has no cancer URE.

Observations for MSTN from Table 27-6 include the following:

- The pollutants with the highest annual averages are formaldehyde, acetaldehyde, and benzene, for both years (although each of the 2009 annual averages is lower than its corresponding 2008 annual average).

- The pollutant with the highest cancer risk approximation was formaldehyde, followed by benzene and carbon tetrachloride, for both years.

- There were no pollutants with noncancer risk approximations greater than 1.0 based on the annual averages.

Table 27-6. Cancer and Noncancer Surrogate Risk Approximations for the Tennessee Monitoring Sites

Pollutant	Cancer URE (µg/m^3)$^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (µg/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Loudon, Tennessee – LDTN										
Acetaldehyde	0.0000022	0.009	61/4	1.89 ± 0.32	4.16	0.21	46/3	1.82 ± 0.37	3.99	0.20
Acrylonitrile	0.000068	0.002	1/0	NA	NA	NA	10/0	NA	NA	NA
Benzene	0.0000078	0.03	61/4	0.85 ± 0.08	6.64	0.03	47/3	0.94 ± 0.25	7.35	0.03
1,3-Butadiene	0.00003	0.002	58/4	0.05 ± 0.01	1.52	0.03	43/3	0.04 ± 0.01	1.15	0.02
Carbon Disulfide	--	0.7	61/4	45.53 ± 11.68	--	0.07	47/3	35.67 ± 9.62	--	0.05
Carbon Tetrachloride	0.000006	0.1	61/4	0.76 ± 0.06	4.58	0.01	47/3	0.70 ± 0.07	4.23	0.01
Chloroform	--	0.098	61/4	0.40 ± 0.09	--	<0.01	47/3	0.29 ± 0.05	--	<0.01
Formaldehyde	0.000013	0.0098	61/4	2.40 ± 0.32	31.15	0.24	46/3	2.44 ± 0.32	31.75	0.25
Tetrachloroethylene	0.0000059	0.27	51/4	0.07 ± 0.01	0.39	<0.01	37/3	0.08 ± 0.05	0.49	<0.01
Trichloroethylene	0.000002	0.6	14/1	NA	NA	NA	6/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	6/0	NA	NA	NA	8/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.

Table 27-6. Cancer and Noncancer Surrogate Risk Approximations for the Tennessee Monitoring Sites (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average (µg/m^3)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Loudon Middle School, Loudon, Tennessee - MSTN										
Acetaldehyde	0.0000022	0.009	62/4	1.19 ± 0.12	2.62	0.13	47/3	0.97 ± 0.12	2.13	0.11
Acrylonitrile	0.000068	0.002	5/0	NA	NA	NA	7/0	NA	NA	NA
Benzene	0.0000078	0.03	61/4	1.13 ± 0.10	8.84	0.04	44/3	0.85 ± 0.19	6.65	0.03
1,3-Butadiene	0.00003	0.002	60/4	0.06 ± 0.01	1.73	0.03	43/3	0.04 ± 0.01	1.06	0.02
Carbon Tetrachloride	0.000006	0.1	61/4	0.67 ± 0.04	4.00	0.01	44/3	0.70 ± 0.06	4.20	0.01
Chloroform	--	0.098	49/4	0.14 ± 0.03	--	<0.01	42/3	0.16 ± 0.04	--	<0.01
Formaldehyde	0.000013	0.0098	62/4	2.05 ± 0.25	26.59	0.21	47/3	1.82 ± 0.21	23.70	0.19
Tetrachloroethylene	0.0000059	0.27	52/4	0.11 ± 0.05	0.63	<0.01	33/3	0.08 ± 0.06	0.46	<0.01
Trichloroethylene	0.000002	0.6	13/0	NA	NA	NA	5/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	7/0	NA	NA	NA	8/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

Table 27-6. Cancer and Noncancer Surrogate Risk Approximations for the Tennessee Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Memphis, Tennessee - METN										
Acetaldehyde	0.0000022	0.009	37/2	NA	NA	NA	61/4	1.83 ± 0.24	4.02	0.20
Acrylonitrile	0.000068	0.002	5/0	NA	NA	NA	30/2	NA	NA	NA
Benzene	0.0000078	0.03	34/2	NA	NA	NA	57/4	1.45 ± 0.23	11.29	0.05
1,3-Butadiene	0.00003	0.002	34/2	NA	NA	NA	56/4	0.09 ± 0.02	2.66	0.04
Carbon Tetrachloride	0.000006	0.1	34/2	NA	NA	NA	57/4	0.64 ± 0.06	3.86	0.01
Chloroform	--	0.098	31/2	NA	NA	NA	57/4	0.14 ± 0.01	--	<0.01
p-Dichlorobenzene	0.000011	0.8	33/2	NA	NA	NA	53/4	0.11 ± 0.03	1.21	<0.01
Ethylbenzene	0.0000025	1	34/2	NA	NA	NA	57/4	0.37 ± 0.08	0.93	<0.01
Formaldehyde	0.000013	0.0098	37/2	NA	NA	NA	61/4	2.69 ± 0.41	35.00	0.27
Tetrachloroethylene	0.0000059	0.27	29/2	NA	NA	NA	49/4	0.11 ± 0.02	0.64	<0.01
Trichloroethylene	0.000002	0.6	8/0	NA	NA	NA	20/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	12/1	NA	NA	NA	24/2	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

Observations for METN from Table 27-6 include the following:

- The pollutants with the highest annual averages are formaldehyde, acetaldehyde, and benzene (2009 only).
- The pollutants with the highest cancer risk approximations were formaldehyde, benzene, and acetaldehyde.
- There were no pollutants with noncancer risk approximations greater than 1.0 based on the 2009 annual averages.

27.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 27-7 and 27-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 27-8 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 27-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risks based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 27.3, all three Tennessee sites sampled for VOC and carbonyl compounds. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. The Loudon monitoring sites sampled each pollutant group mentioned above through October 2009, while sampling did not begin at METN until June 2008. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 27-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Tennessee 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Loudon, Tennessee (Loudon County) - LDTN					
Benzene	63.23	Arsenic, PM	5.19E-04	Formaldehyde	31.75
Acetaldehyde	52.26	Benzene	4.93E-04	Formaldehyde	31.15
Formaldehyde	36.59	Formaldehyde	4.57E-04	Benzene	7.35
1,3-Butadiene	7.73	1,3-Butadiene	2.32E-04	Benzene	6.64
Dichloromethane	3.94	Acetaldehyde	1.15E-04	Carbon Tetrachloride	4.58
Naphthalene	2.81	Naphthalene	9.54E-05	Carbon Tetrachloride	4.23
Tetrachloroethylene	2.06	Hexavalent Chromium, PM	9.43E-05	Acetaldehyde	4.16
POM, Group 2	1.59	POM, Group 2	8.75E-05	Acetaldehyde	3.99
p-Dichlorobenzene	0.88	Nickel, PM	4.00E-05	1,3-Butadiene	1.52
Trichloroethylene	0.50	POM, Group 3	3.42E-05	1,3-Butadiene	1.15
Loudon Middle School, Loudon, Tennessee (Loudon County) - MSTN					
Benzene	63.23	Arsenic, PM	5.19E-04	Formaldehyde	26.59
Acetaldehyde	52.26	Benzene	4.93E-04	Formaldehyde	23.70
Formaldehyde	36.59	Formaldehyde	4.57E-04	Benzene	8.84
1,3-Butadiene	7.73	1,3-Butadiene	2.32E-04	Benzene	6.65
Dichloromethane	3.94	Acetaldehyde	1.15E-04	Carbon Tetrachloride	4.20
Naphthalene	2.81	Naphthalene	9.54E-05	Carbon Tetrachloride	4.00
Tetrachloroethylene	2.06	Hexavalent Chromium, PM	9.43E-05	Acetaldehyde	2.62
POM, Group 2	1.59	POM, Group 2	8.75E-05	Acetaldehyde	2.13
p-Dichlorobenzene	0.88	Nickel, PM	4.00E-05	1,3-Butadiene	1.73
Trichloroethylene	0.50	POM, Group 3	3.42E-05	1,3-Butadiene	1.06

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 27-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Tennessee 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Memphis, Tennessee (Shelby County) - METN					
Benzene	618.51	Benzene	4.82E-03	Formaldehyde	35.00
Formaldehyde	380.33	Formaldehyde	4.75E-03	Benzene	11.29
Acetaldehyde	242.58	1,3-Butadiene	2.53E-03	Acetaldehyde	4.02
Tetrachloroethylene	102.95	Hexavalent Chromium, PM	2.05E-03	Carbon Tetrachloride	3.86
1,3-Butadiene	84.39	Arsenic, PM	1.20E-03	1,3-Butadiene	2.66
Dichloromethane	44.76	Naphthalene	1.04E-03	*p*-Dichlorobenzene	1.21
Naphthalene	30.65	Tetrachloroethylene	6.07E-04	Ethylbenzene	0.93
Trichloroethylene	28.79	POM, Group 2	6.05E-04	Tetrachloroethylene	0.64
p-Dichlorobenzene	19.43	Acetaldehyde	5.34E-04		
POM, Group 2	11.00	Beryllium, PM	3.45E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 27-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Tennessee 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Loudon, Tennessee (Loudon County) - LDTN					
Carbon disulfide	1,042.67	Acrolein	204,722.45	Formaldehyde	0.25
Toluene	203.35	Manganese, PM	19,198.51	Formaldehyde	0.24
Xylenes	141.38	Acetaldehyde	5,806.56	Acetaldehyde	0.21
Styrene	135.00	Hydrochloric acid	4,875.64	Acetaldehyde	0.20
Hydrochloric acid	97.51	Arsenic, PM	4,023.83	Carbon Disulfide	0.07
Benzene	63.23	1,3-Butadiene	3,863.89	Carbon Disulfide	0.05
Acetaldehyde	52.26	Nickel, PM	3,842.92	Benzene	0.03
Hexane	37.33	Formaldehyde	3,733.58	Benzene	0.03
Formaldehyde	36.59	Benzene	2,107.62	1,3-Butadiene	0.03
Ethylbenzene	34.69	Carbon disulfide	1,489.53	1,3-Butadiene	0.02
Loudon Middle School, Loudon, Tennessee (Loudon County) - MSTN					
Carbon disulfide	1,042.67	Acrolein	204,722.45	Formaldehyde	0.21
Toluene	203.35	Manganese, PM	19,198.51	Formaldehyde	0.19
Xylenes	141.38	Acetaldehyde	5,806.56	Acetaldehyde	0.13
Styrene	135.00	Hydrochloric acid	4,875.64	Acetaldehyde	0.11
Hydrochloric acid	97.51	Arsenic, PM	4,023.83	Benzene	0.04
Benzene	63.23	1,3-Butadiene	3,863.89	1,3-Butadiene	0.03
Acetaldehyde	52.26	Nickel, PM	3,842.92	Benzene	0.03
Hexane	37.33	Formaldehyde	3,733.58	1,3-Butadiene	0.02
Formaldehyde	36.59	Benzene	2,107.62	Carbon Tetrachloride	0.01
Ethylbenzene	34.69	Carbon disulfide	1,489.53	Carbon Tetrachloride	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 27-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Tennessee 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 Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Memphis, Tennessee (Shelby County) - METN					
Toluene	2,167.89	Acrolein	1,481,100.43	Formaldehyde	0.27
Xylenes	1,192.83	Manganese, PM	67,586.47	Acetaldehyde	0.20
Methanol	974.03	1,3-Butadiene	42,193.04	Benzene	0.05
Benzene	618.51	Formaldehyde	38,809.53	1,3-Butadiene	0.04
Hexane	531.12	Cyanide Compounds, gas	33,205.04	Carbon Tetrachloride	0.01
Hydrochloric acid	414.69	Acetaldehyde	26,953.58	Chloroform	<0.01
Formaldehyde	380.33	Hydrochloric acid	20,734.32	Tetrachloroethylene	<0.01
Ethylene glycol	305.19	Benzene	20,617.01	Ethylbenzene	<0.01
Ethylbenzene	297.51	Xylenes	11,928.34	*p*-Dichlorobenzene	<0.01
Acetaldehyde	242.58	Naphthalene	10,218.16		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations for LDTN and MSTN from Table 27-7 include the following:

- Benzene, acetaldehyde, and formaldehyde were the highest emitted pollutants with cancer UREs in Loudon County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Loudon County were arsenic, benzene, and formaldehyde.
- Six of the highest emitted pollutants in Loudon County also had the highest toxicity-weighted emissions.
- For both monitoring sites, formaldehyde, benzene, carbon tetrachloride, acetaldehyde, and 1,3-butadiene had the highest cancer surrogate risk approximations. Four of these pollutants appear on both emissions-based lists, while carbon tetrachloride did not appear on either emissions-based list.

Observations for METN from Table 27-7 include the following:

- Similar to Loudon County, benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Shelby County, although the quantity of emissions was much higher for Shelby County than Loudon County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Shelby County were benzene, formaldehyde, and 1,3-butadiene.
- Seven of the highest emitted pollutants in Shelby County also had the highest toxicity-weighted emissions.
- Formaldehyde, benzene, acetaldehyde, and carbon tetrachloride had the highest cancer surrogate risk approximations for METN. Carbon tetrachloride did not appear on either emissions-based list, while benzene, formaldehyde, and acetaldehyde appeared on both. Tetrachloroethylene and 1,3-butadiene also appear on all three lists in Table 27-7.

Observations for LDTN and MSTN from Table 27-8 include the following:

- Carbon disulfide, toluene, and xylenes were the highest emitted pollutants with noncancer RfCs in Loudon County. The emissions of carbon disulfide (1,043 tpy) were nearly five times the quantity of the next highest emitted pollutant (toluene at 203 tpy). This is the only county with an NMP site for which this pollutant was among the 10 highest emitted pollutants.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Loudon County were acrolein, manganese, and acetaldehyde. Carbon disulfide ranked tenth highest for toxicity-weighted emissions. This is the

only county with an NMP site for which this pollutant appears on the list of highest toxicity-weighted emissions.

- Although acrolein was sampled for at LDTN and MSTN, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions for Loudon County.

- Formaldehyde, acetaldehyde, carbon disulfide, and benzene had the highest noncancer risk approximations for LDTN. All four of these pollutants appear on both emissions-based lists. 1,3-Butadiene was also among the pollutants with the highest risk approximations for LDTN. While this pollutant was among the pollutants with the highest toxicity-weighted emissions, this pollutant's total emissions did not rank among the top 10.

- Formaldehyde, acetaldehyde, and benzene had the highest noncancer risk approximations for MSTN. All three of these pollutants appear on both emissions-based lists. Carbon tetrachloride and 1,3-butadiene were also among the pollutants with the highest risk approximations for MSTN. While 1,3-butadiene was among the pollutants with the highest toxicity-weighted emissions, this pollutant's total emissions did not rank among the top 10. Carbon tetrachloride does not appear on either emissions-based list.

Observations for METN from Table 27-8 include the following:

- Toluene, xylenes, and methanol were the highest emitted pollutants with noncancer RfCs in Shelby County. The quantity of emissions of the pollutants in common was generally an order of magnitude higher for Shelby County than Loudon County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Shelby County were acrolein, manganese, and 1,3-butadiene. Although acrolein was sampled for at METN, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions for Shelby County.

- The pollutants with the highest noncancer risk approximations were formaldehyde, acetaldehyde, and benzene. These pollutants appeared on both emissions-based lists.

27.6 Summary of the 2008-2008 Monitoring Data for the Tennessee Sites

Results from several of the treatments described in this section include the following:

- *Fifteen pollutants failed at least one screen for LDTN; 11 pollutants failed at least one screen for MSTN; and 13 pollutants failed at least one screen for METN.*

- *While carbon disulfide had the highest daily average concentrations for LDTN, formaldehyde had the highest daily average concentrations for METN and MSTN.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

28.0 Site in Texas

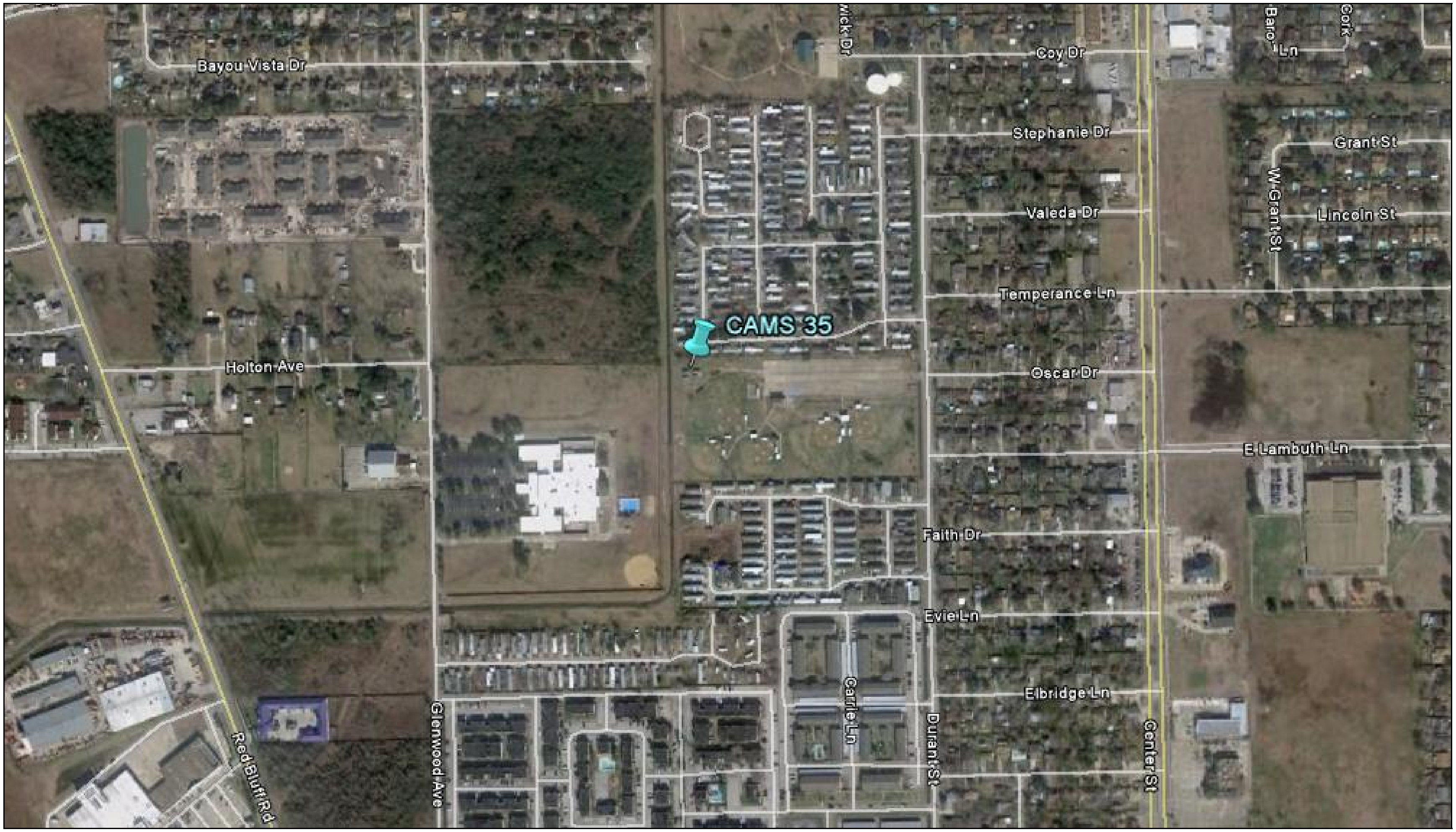
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Texas, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

28.1 Site Characterization

This section characterizes the CAMS 35 monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

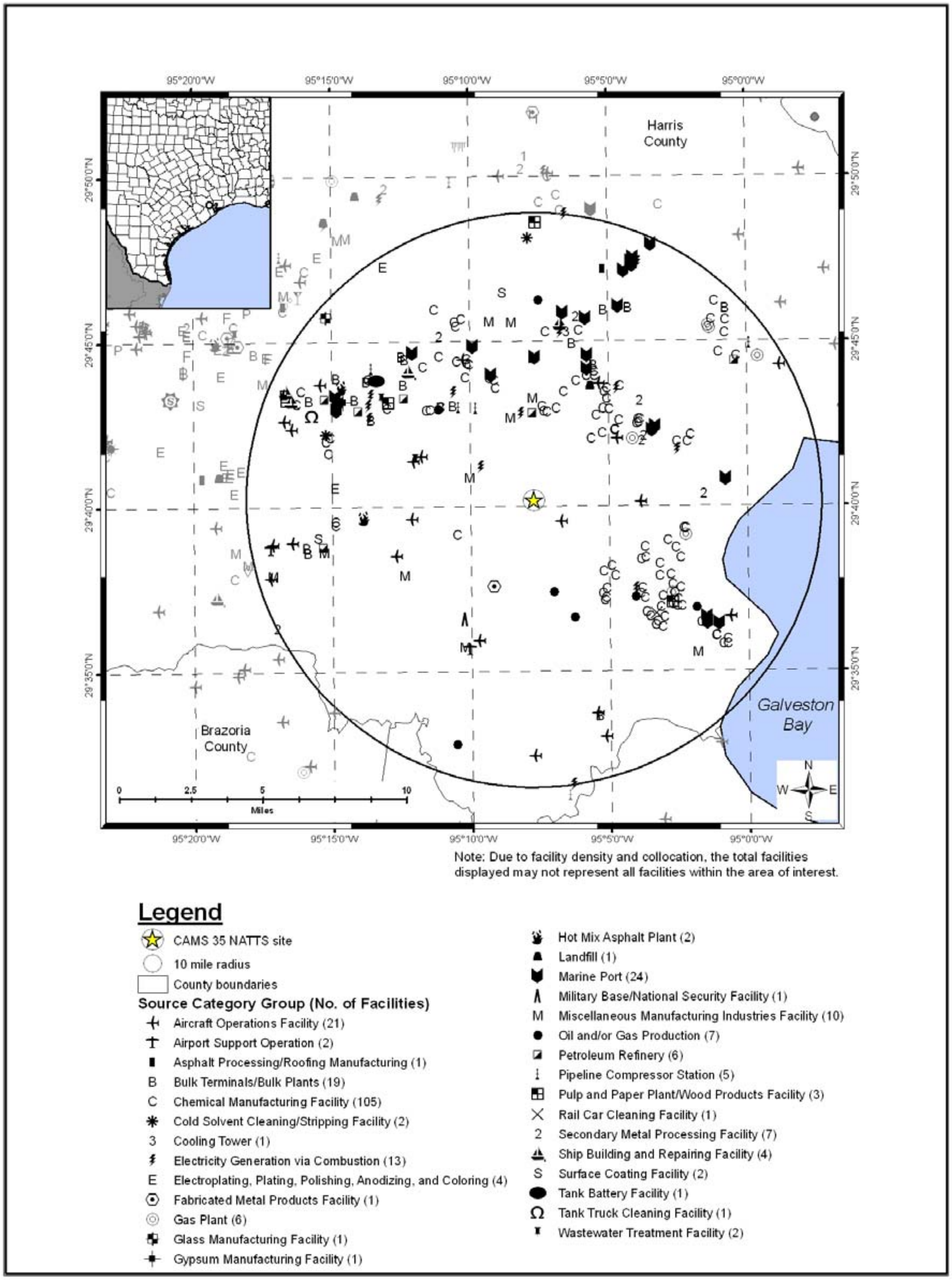
The CAMS 35 monitoring site is located in the Houston-Sugarland-Baytown, Texas MSA. Figure 28-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 28-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 28-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 28-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 28-1. Deer Park, Texas (CAMS 35) Monitoring Site



©2010 Google Earth, accessed 11/10/2010 Scale: 2 inches = 1,505 feet

Figure 28-2. NEI Point Sources Located Within 10 Miles of CAMS 35


95°20'0"W
95°15'0"W
95°10'0"W
95°5'0"W
95°0'0"W
29°50'0"N
29°45'0"N
29°40'0"N
29°35'0"N
Harris County
Brazoria County
Galveston Bay
N
S
E
W
0
2.5
5
10
Miles
Legend
CAMS 35 NATTS site
10 mile radius
County boundaries
Source Category Group (No. of Facilities)
Aircraft Operations Facility (21)
Airport Support Operation (2)
Asphalt Processing/Roofing Manufacturing (1)
B Bulk Terminals/Bulk Plants (19)
C Chemical Manufacturing Facility (105)
Cold Solvent Cleaning/Stripping Facility (2)
3 Cooling Tower (1)
Electricity Generation via Combustion (13)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (4)
Fabricated Metal Products Facility (1)
Gas Plant (6)
Glass Manufacturing Facility (1)
Gypsum Manufacturing Facility (1)
Hot Mix Asphalt Plant (2)
Landfill (1)
Marine Port (24)
Military Base/National Security Facility (1)
M Miscellaneous Manufacturing Industries Facility (10)
Oil and/or Gas Production (7)
Petroleum Refinery (6)
Pipeline Compressor Station (5)
Pulp and Paper Plant/Wood Products Facility (3)
Rail Car Cleaning Facility (1)
2 Secondary Metal Processing Facility (7)
Ship Building and Repairing Facility (4)
S Surface Coating Facility (2)
Tank Battery Facility (1)
Ω Tank Truck Cleaning Facility (1)
Wastewater Treatment Facility (2)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 28-1. Geographical Information for the Texas Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
CAMS 35	48-201-1039	Deer Park	Harris	Houston-Sugarland-Baytown, TX MSA	29.670046, -95.128485	Residential	Suburban	Haze, CO, NOy, NO, NO_2, NOx, PAMS, NMOC, VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM Coarse, PM_{10} Speciation, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The CAMS 35 monitoring site is located in Deer Park, southeast of Houston, in east Texas. The site is located at Brown Memorial Park, in a primarily residential area, as shown in Figure 28-1. Major thoroughfares are near the site, including Beltway 8 (1.5 miles) and Highway 225 (nearly 3 miles). Galveston Bay is located to the east and southeast and the Houston Ship Channel, which runs from the Bay westward towards downtown Houston, is located to the north on the other side of Highway 225. The east side of Houston has significant industry, including several oil refineries. As Figure 28-2 shows, the point source located closest to the CAMS 35 monitoring site is a heliport at San Jacinto College in Pasadena. However, a large number of emissions sources are located roughly along a line that runs east to west just north of the site (or along the Houston Ship Channel). A second cluster of emissions sources is located to the southeast of the monitoring site. The source category with the largest number of sources (105) surrounding CAMS 35 is chemical manufacturing. Other source categories with a number of sources around CAMS 35 include marine ports; aircraft operations, which include airports as well as small runways, heliports, or landing pads; and bulk terminals and bulk plants.

Table 28-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Texas monitoring site. Information provided in Table 28-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Harris County were obtained from the Harris County Public Infrastructure Department (HCPID, 2004) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 28-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person). An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 28-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 28-2 presents the daily VMT for the Houston area.

Table 28-2. Population, Motor Vehicle, and Traffic Information for the Texas Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
CAMS 35	4,070,989	2,982,632	0.73	741,262	543,090	31,043	106,872

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Texas DOT (TX DOT, 2010).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2004 data from the Harris County Public Infrastructure Department (HCPID, 2004).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 28-2 include the following:

- Compared to other counties with NMP monitoring sites, Harris County was among the highest for both county-level population and vehicle ownership.

- The 10-mile population for CAMS 35 does not reflect the magnitude of the county population, indicating that the site is not located near the center of highest population density. The 10-mile population for CAMS 35 was in the middle of the range compared to other NMP sites.

- The vehicle-per-person ratio for CAMS 35 was in the lower third compared to other NMP sites.

- The traffic volume passing CAMS 35 was in the middle of the range compared to other program sites. Traffic data for CAMS 35 were obtained for Spencer Highway between Red Bluff Road and Underwood Road.

- The Houston area was among the urban areas (with NMP monitoring sites) with the highest VMT.

28.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Texas on sample days, as well as over the course of each year.

28.2.1 Climate Summary

The eastern third of Texas is characterized by a subtropical humid climate, with the climate becoming more continental in nature farther north and west. The proximity to the Gulf of

Mexico acts as a moderating influence as temperatures soar in the summer or dip in the winter. Areas closer to the coast, such as Houston, remain slightly cooler in the summer than neighboring areas to the north. The reverse is also true, as coastal areas are warmer in the winter than areas farther inland, although East Texas winters are relatively mild. The onshore flow from the Gulf of Mexico also allows humidity levels to remain higher near the coast. The winds flow out of the Gulf of Mexico a majority of the year, with the winter months being the exception, as frontal systems allow colder air to filter in from the north. Abundant rainfall is also typical of the region, again due in part to the nearness to the Gulf of Mexico (Bair, 1992 and TAMU, 2011).

28.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to CAMS 35 is located at William P. Hobby Airport, WBAN 12918. Additional information about the Hobby Airport weather station is provided in Table 28-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 28-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 28-3 is the 95 percent confidence interval for each parameter. As shown in Table 28-3, average meteorological conditions on sample days were fairly representative of average weather conditions throughout the year for both years.

Table 28-3. Average Meteorological Conditions near the Texas Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Deer Park, Texas - CAMS 35										
William P. Hobby Airport 12918 (29.65, -95.28)	8.86 miles 285° (WNW)	2008	Sample Day	80.3 ± 2.9	71.4 ± 3.0	59.0 ± 3.6	64.1 ± 2.9	68.2 ± 3.1	1016.4 ± 1.2	6.9 ± 0.9
			All Year	79.7 ± 1.2	70.7 ± 1.2	58.7 ± 1.4	63.7 ± 1.2	68.7 ± 1.2	1016.8 ± 0.6	6.8 ± 0.4
		2009	Sample Day	79.3 ± 3.2	70.2 ± 3.2	57.9 ± 3.8	63.1 ± 3.1	68.2 ± 3.2	1016.2 ± 1.3	6.7 ± 0.7
			All Year	79.6 ± 1.3	70.5 ± 1.3	58.9 ± 1.5	63.7 ± 1.2	69.7 ± 1.2	1016.5 ± 0.5	6.7 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

28.2.3 Back Trajectory Analysis

Figure 28-3 and Figure 28-4 are the composite back trajectory maps for days on which samples were collected at the CAMS 35 monitoring site in 2008 and 2009, respectively. Figure 28-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 28-3 through 28-5 represents 100 miles.

Observations from Figures 28-3 through 28-5 for CAMS 35 include the following:

- Back trajectories originated from a variety of directions at the CAMS 35 monitoring site, although a majority of trajectories originated over the Gulf of Mexico.

- The 24-hour air shed domain for CAMS 35 was similar in size to other NMP monitoring sites. Two trajectories originated approximately 610 miles away, one to the north over central Kansas, and the other to the southeast over the Gulf of Mexico. However, the average trajectory length was 273 miles and nearly 90 percent of trajectories originated within 450 miles of the site.

- The cluster analysis for 2008 is similar in trajectory distribution to the cluster analysis for 2009. Both show that the majority of trajectories originated over the Gulf of Mexico (although somewhat more in 2008). Another common trajectory origin is from the northwest to north (11 percent in 2008 and 17 percent in 2009). The two short trajectories representing relatively short 2009 trajectories from the west (16 percent) and east (16 percent) are represented by a single trajectory originating to the north for 2008 (20 percent). Recall that both direction and distance from the monitoring site factor into the cluster analysis.

Figure 28-3. 2008 Composite Back Trajectory Map for CAMS 35

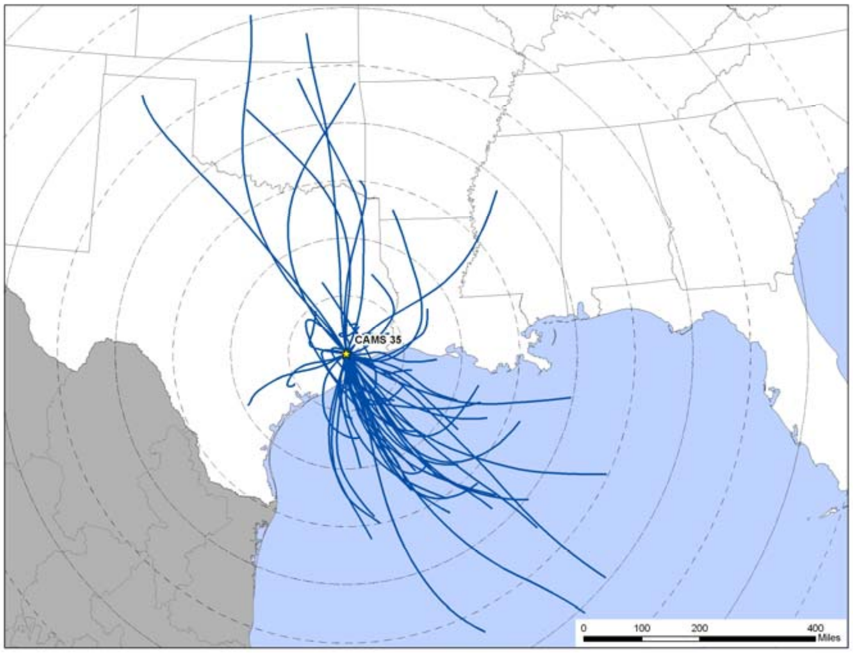


Figure 28-4. 2009 Composite Back Trajectory Map for CAMS 35

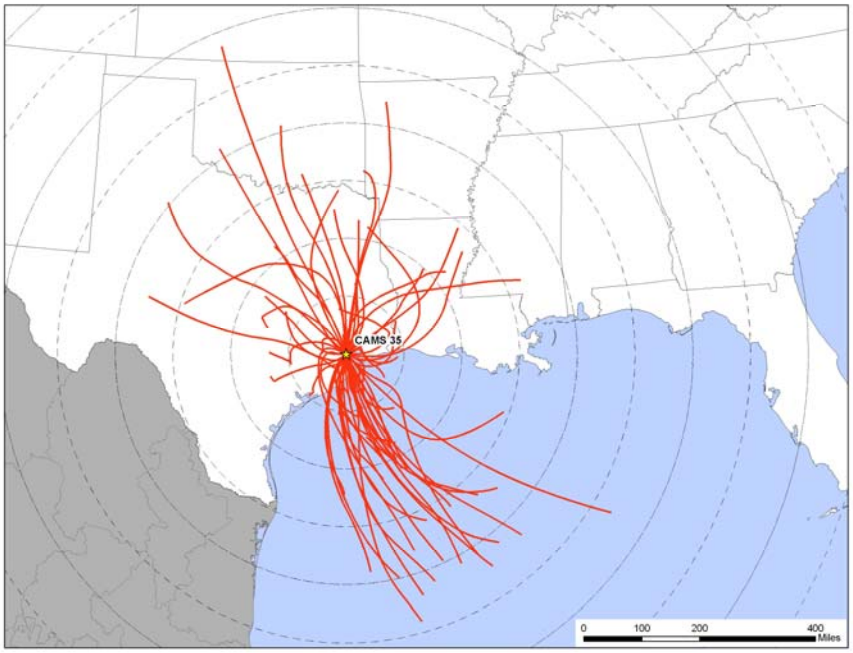
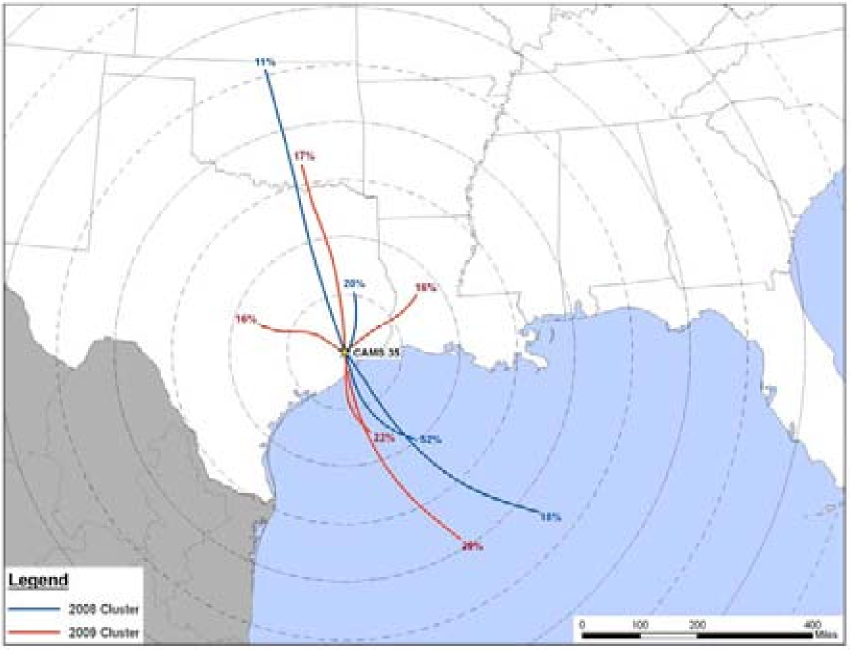


Figure 28-5. Back Trajectory Cluster Map for CAMS 35

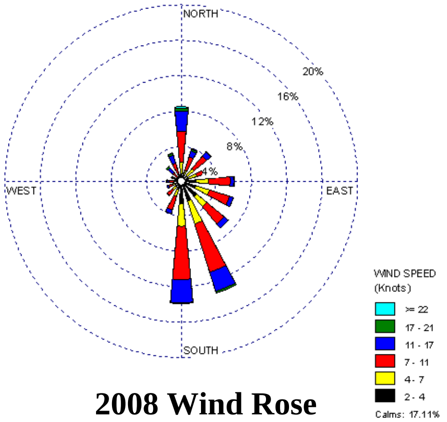


28.2.4 Wind Rose Comparison

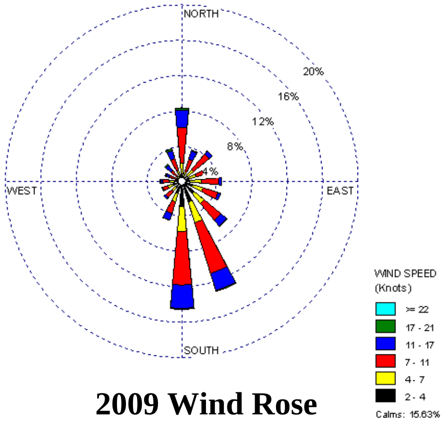
Hourly wind data from the NWS weather station at Hobby Airport near CAMS 35 were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 28-6 presents five different wind roses for the CAMS 35 monitoring site. First, a historical wind rose representing 1999 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

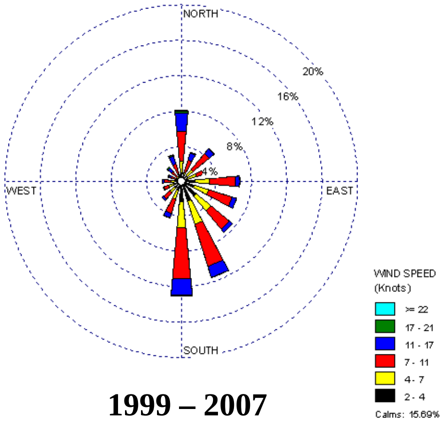
Figure 28-6. Wind Roses for the William P. Hobby Airport Weather Station near CAMS 35



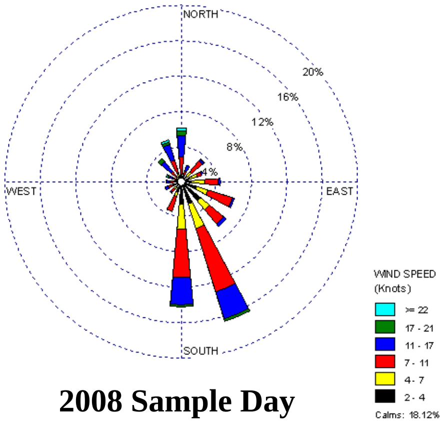
2008 Wind Rose



2009 Wind Rose

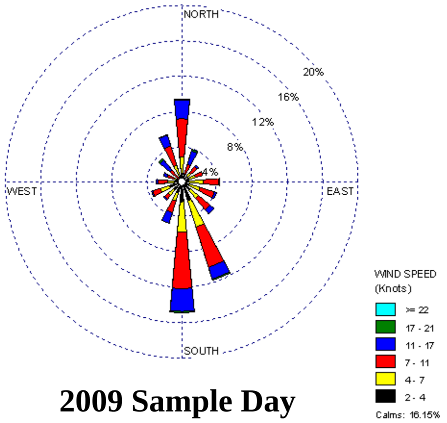


1999 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 28-6 for CAMS 35 include the following:

- The historical wind rose shows that winds from the southeasterly quadrant, including both easterly and southerly winds, prevailed near the CAMS 35 site. Northerly winds were also observed often. Calm winds (≤2 knots) were observed for nearly 16 percent of the wind measurements.

- The wind patterns shown on the 2008 and 2009 wind roses are very similar to the historical wind patterns, indicating that conditions during sample years were similar to conditions observed in past years.

- The 2008 and 2009 sample day wind patterns generally resemble the full-year and historical wind patterns with a few exceptions. The 2008 sample day wind rose has fewer northerly wind observations and more north-northwesterly observations. There were also more south-southeasterly observations but fewer easterly observations shown on the 2008 sample day wind rose.

28.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the CAMS 35 monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 28-4 presents CAMS 35's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. As such, pollutants of interest are shaded and/or bolded. CAMS 35 sampled for PAH only.

Table 28-4. Risk Screening Results for the Texas Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Deer Park, Texas - CAMS 35						
Naphthalene	0.029	100	114	87.72	99.01	99.01
Benzo(a)pyrene	0.00091	1	58	1.72	0.99	100.00
Total		101	172	58.72		

Observations from Table 28-4 include the following:

- Two pollutants failed at least one screen for CAMS 35. They are both PAH NATTS MQO Core Analytes, naphthalene and benzo(a)pyrene.
- Naphthalene contributed to 99 percent of the total number of failed screens for CAMS 35. Nearly 88 percent of naphthalene's measured detections failed screens while less than two percent of benzo(a)pyrene's measured detections failed screens.

28.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Texas monitoring site. Concentration averages are provided for the pollutants of interest for CAMS 35, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

28.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for CAMS 35, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 28-5, where applicable. The averages presented in Table 28-5 are shown in ng/m^3 for ease of viewing.

Observations from Table 28-5 include the following:

- Naphthalene's daily, quarterly, and annual averages were all significantly higher than the averages for benzo(a)pyrene.

- The first quarter 2009 naphthalene average is the highest of the quarterly averages for CAMS 35 and has a large confidence interval associated with it, suggesting that outliers may be affecting this average. The highest concentration of naphthalene was measured at CAMS 35 on January 13, 2009 (854 ng/m^3). This concentration is among the highest one percent of naphthalene measurements among all NMP sites sampling naphthalene. However, naphthalene concentrations appear to be higher during the second half of the year. Of the 25 naphthalene concentrations greater than 125 ng/m^3 measured at CAMS 35, eight were measured during third quarter months and eleven were measured during fourth quarter months.

- Benzo(a)pyrene was detected in roughly half the samples collected at CAMS 35; thus, some quarterly averages could not be calculated. The confidence interval for fourth quarter 2008 average is higher than its respective average, indicating that outliers may also be affecting this average. On October 21, 2008, an unusually high concentration was measured (1.27 ng/m^3). This concentration is an order of magnitude higher than the next highest concentration (0.237 ng/m^3) and is among the higher measurements of this pollutant among all NMP sites sampling PAH. Benzo(a)pyrene measurements from CAMS 35 ranged from 0.0112 to 1.27 ng/m^3, with a median concentration of 0.04 ng/m^3.

- None of the daily average concentrations of the pollutants of interest for CAMS 35 were among the highest daily averages of the PAH, as shown in Table 4-11.

28.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. The Texas monitoring site has not sampled PAH continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

Table 28-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Texas Monitoring Site

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Deer Park, Texas - CAMS 35												
Benzo(a)pyrene	0.08 ± 0.10	0.02 ± 0.01	0.01 ± 0.01	NA	0.12 ± 0.18	0.04 ± 0.05	0.06 ± 0.02	0.05 ± 0.03	NA	0.02 ± 0.01	0.06 ± 0.04	0.03 ± 0.01
Naphthalene	88.52 ± 20.06	64.31 ± 16.78	54.40 ± 27.40	96.02 ± 39.04	138.15 ± 56.38	88.52 ± 20.06	106.23 ± 29.61	160.87 ± 124.83	71.08 ± 22.28	96.14 ± 27.26	109.71 ± 45.61	106.23 ± 29.61

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

28.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the CAMS 35 monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

28.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Texas monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the CAMS 35 monitoring site were higher than their respective MRL noncancer health risk benchmarks.

28.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Texas monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 28-6, where applicable.

Table 28-6. Cancer and Noncancer Surrogate Risk Approximations for the Texas Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Deer Park, Texas - CAMS 35										
Benzo(a)pyrene	0.001	--	26/3	0.04 ± 0.05	0.04	--	32/3	0.03 ± 0.01	0.03	--
Naphthalene	0.000034	0.003	54/4	88.52 ± 20.06	3.01	0.03	60/4	106.23 ± 29.61	3.61	0.04

-- = a Cancer URE or Noncancer RfC is not available.

Observations for CAMS 35 from Table 28-6 include the following:

- Naphthalene's cancer risk approximation was 3.01 in-a-million for 2008 and 3.61 in-a-million for 2009, based on the annual averages. Naphthalene's noncancer risk approximations were well below the level of concern, an HQ of 1.0.

- Benzo(a)pyrene's cancer risk approximations were both low (both approximations were below 0.05 in-a-million). Benzo(a)pyrene does not have a noncancer RfC, thus noncancer risk approximations could not be calculated.

28.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 28-7 and 28-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 28-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 28-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 28.3, the Texas monitoring site sampled for PAH only. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 28-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Texas Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Deer Park, Texas (Harris County) - CAMS 35					
Benzene	2,116.48	1,3-Butadiene	1.92E-02	Naphthalene	3.61
Formaldehyde	1,348.24	Formaldehyde	1.69E-02	Naphthalene	3.01
1,3-Butadiene	641.55	Benzene	1.65E-02	Benzo(a)pyrene	0.04
Acetaldehyde	517.31	Hexavalent Chromium, PM	9.38E-03	Benzo(a)pyrene	0.03
Dichloromethane	490.27	Benzidine, gas	6.96E-03		
Tetrachloroethylene	439.24	Naphthalene	5.35E-03		
1,3-Dichloropropene	284.92	Arsenic, PM	3.63E-03		
Naphthalene	157.37	Tetrachloroethylene	2.59E-03		
p-Dichlorobenzene	90.25	POM, Group 2	1.91E-03		
Trichloroethylene	90.20	Ethylene oxide	1.78E-03		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 28-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Texas Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Deer Park, Texas (Harris County) - CAMS 35					
Methyl *tert*-butyl ether	5,253.70	Acrolein	3,374,296.63	Naphthalene	0.04
Toluene	4,973.48	Chlorine	1,125,108.32	Naphthalene	0.03
Xylenes	3,180.95	Hexamethylene-1,6-diisocyanate, gas	518,170.00		
Hexane	3,011.32	Manganese, PM	337,368.31		
Benzene	2,116.48	1,3-Butadiene	320,776.21		
Methanol	1,906.63	Formaldehyde	137,575.21		
Formaldehyde	1,348.24	Nickel, PM	77,425.48		
Hydrochloric acid	1,321.33	Benzene	70,549.23		
1,1,1-Trichloroethane	814.96	Hydrochloric acid	66,066.46		
Ethylbenzene	724.78	Acetaldehyde	57,478.61		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 28-7 include the following:

- Benzene, formaldehyde, and 1,3-butadiene were the highest emitted pollutants with cancer UREs in Harris County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Harris County were 1,3-butadiene, formaldehyde, and benzene.
- Five of the highest emitted pollutants in Harris County also had the highest toxicity-weighted emissions.
- Naphthalene is the only pollutant of interest that appears on both emissions-based lists.
- POM Group 2 was the ninth highest emitted "pollutant" in Harris County. POM Group 2 includes several PAH sampled for at CAMS 35 including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for CAMS 35.

Observations from Table 28-8 include the following:

- Methyl *tert*-butyl, toluene, and xylenes were the highest emitted pollutants with noncancer RfCs in Harris County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Harris County were acrolein, chlorine, and hexamethylene-1,6-diisocyanate gas.
- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions for Harris County.
- Neither of CAMS 35's pollutants of interest appear on the emissions-based lists for Harris County.

28.6 Summary of the 2008-2009 Monitoring Data for CAMS 35

Results from several of the treatments described in this section include the following:

- ❖ *Although naphthalene and benzo(a)pyrene both failed at least one screen, naphthalene accounted for 99 percent of the total failed screens for CAMS 35.*
- ❖ *Of the site-specific pollutants of the interest, naphthalene had the highest daily average concentration for CAMS 35 for both years.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

29.0 Site in Utah

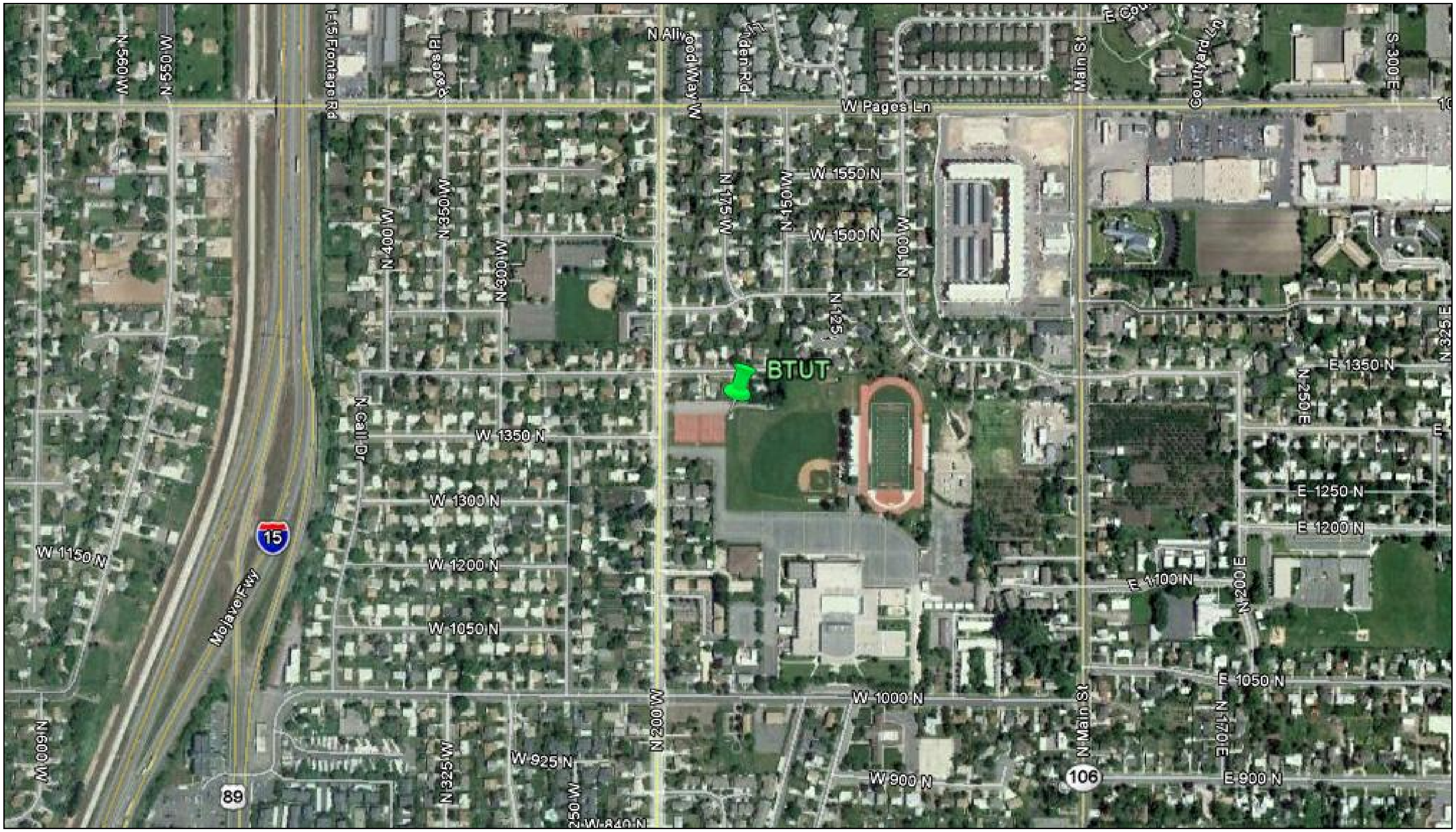
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Utah, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

29.1 Site Characterization

This section characterizes the BTUT monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

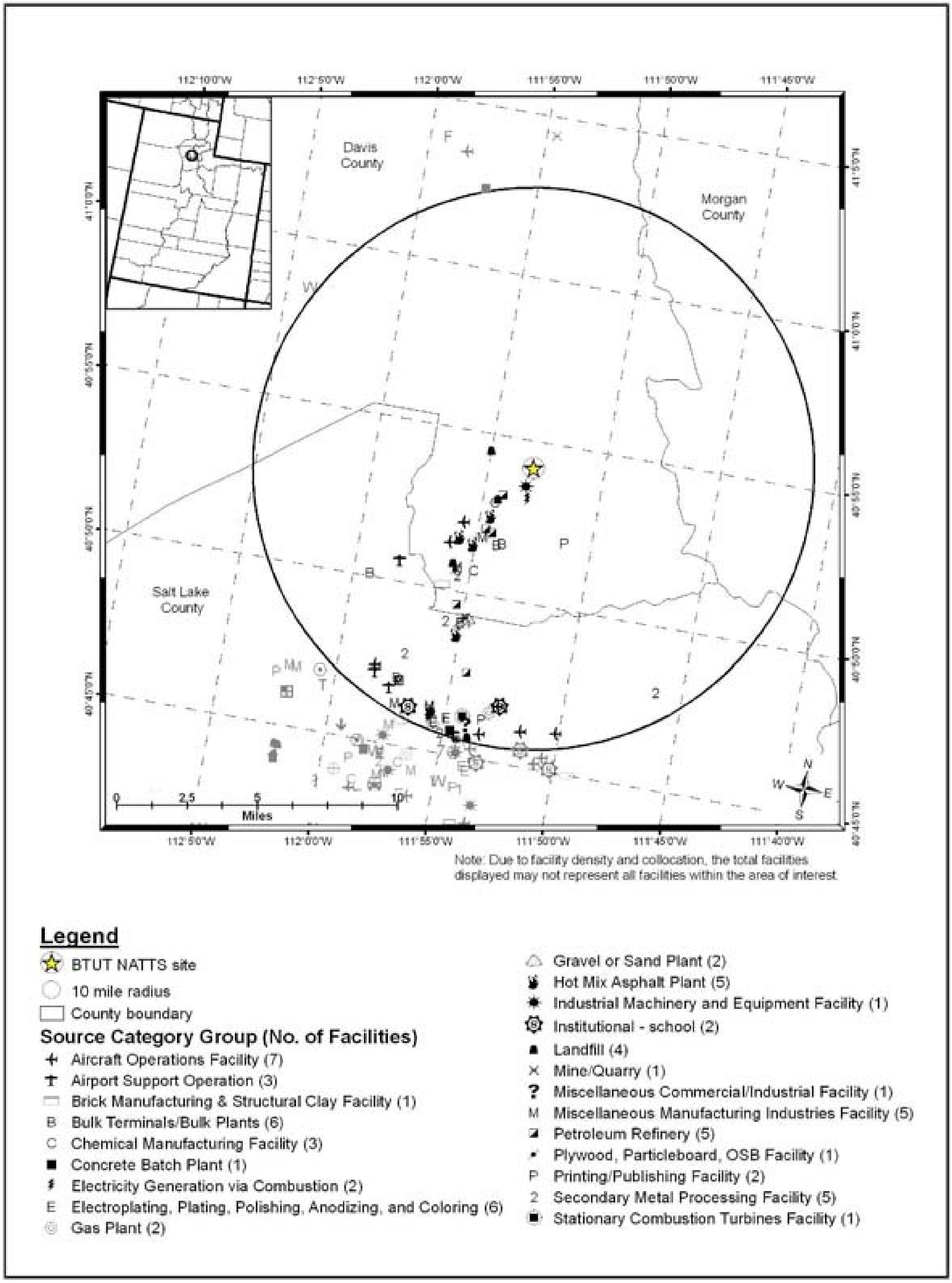
BTUT is located in Bountiful, in northern Utah. Figure 29-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 29-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 29-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 29-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 29-1. Bountiful, Utah (BTUT) Monitoring Site



©2010 Google Earth, accessed 11/11/2010 Scale: 2 inches = 1,724 feet

Figure 29-2. NEI Point Sources Located Within 10 Miles of BTUT



112°10'0"W
112°5'0"W
112°0'0"W
111°55'0"W
111°50'0"W
111°45'0"W
41°5'0"N
41°0'0"N
40°55'0"N
40°50'0"N
40°45'0"N
Davis County
Morgan County
Salt Lake County
0 2.5 5 10
Miles
N
S
E
W
Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.
Legend
BTUT NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (7)
Airport Support Operation (3)
Brick Manufacturing & Structural Clay Facility (1)
B Bulk Terminals/Bulk Plants (6)
C Chemical Manufacturing Facility (3)
Concrete Batch Plant (1)
Electricity Generation via Combustion (2)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (6)
Gas Plant (2)
Gravel or Sand Plant (2)
Hot Mix Asphalt Plant (5)
Industrial Machinery and Equipment Facility (1)
Institutional - school (2)
Landfill (4)
× Mine/Quarry (1)
? Miscellaneous Commercial/Industrial Facility (1)
M Miscellaneous Manufacturing Industries Facility (5)
Petroleum Refinery (5)
Plywood, Particleboard, OSB Facility (1)
P Printing/Publishing Facility (2)
2 Secondary Metal Processing Facility (5)
Stationary Combustion Turbines Facility (1)

Table 29-1. Geographical Information for the Utah Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
BTUT	49-011-0004	Bountiful	Davis	Ogden-Clearfield, UT	40.902967, -111.884467	Residential	Suburban	SO_2, NO, NO_2, NOx, PAMS, O_3, Meteorological parameters, PM_{10}, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

Bountiful is north of Salt Lake City, and is situated in a valley between the Great Salt Lake to the west and the Wasatch Mountains to the east. Figure 29-1 shows that BTUT is located on the property of Viewmont High School, in a primarily residential area. The site is located about one-third of a mile from I-15, which runs north-south through most of the surrounding urban area including Salt Lake City, Clearfield, and Ogden. Figure 29-2 shows that nearly all of the point sources near BTUT are located to the south of the site. The facilities surrounding BTUT are involved in a variety of industries, although the source categories with the highest number of point sources surrounding BTUT include aircraft operations, which include airports as well as small runways, heliports, or landing pads; bulk terminals and bulk plants; and electroplating, plating, polishing, anodizing, and coloring facilities. The source closest to BTUT is involved in industrial machinery and equipment.

Table 29-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Utah monitoring site. Information provided in Table 29-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Davis County were obtained from the Utah Tax Commission (UT TC, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 29-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 29-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 29-2 presents the daily VMT for the Ogden-Clearfield urban area.

Table 29-2. Population, Motor Vehicle, and Traffic Information for the Utah Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
BTUT	300,827	241,541	0.80	251,597	202,013	111,065	10,791

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Utah Tax Commission (UT TC, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Utah DOT (UT DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 29-2 include the following:

- Davis County's population was in the mid-to-low end of the range, as was its 10-mile population, compared to all counties with NMP sites. The county-level vehicle registration and 10-mile ownership estimate rankings were similar to the population rankings.

- The vehicle-per-person ratio (0.80) was in the bottom third of the range compared to other NMP sites.

- The traffic volume experienced near BTUT was in the top third compared to other NMP monitoring sites. The traffic estimate used came from the intersection of I-15 with US-89, just west of the site.

- The Ogden-Clearfield area VMT was among the lowest VMT for urban areas with NMP sites (less than the Knoxville, TN MSA but higher than the Gulfport, MS MSA and a few others).

29.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Utah on sample days, as well as over the course of each year.

29.2.1 Climate Summary

The Salt Lake City area's climate can be classified as semi-arid and continental in nature, and the city experiences large seasonal variations. Summers are hot and dry while winters are cold and snow is common. The area is generally dry, with spring as the wettest season, and sunshine prevails across the area during much of the year. Precipitation that does fall can be enhanced over the eastern parts of the valley as storm systems move up the side of the Wasatch Mountains, located to the east. Surrounding mountains protect the valley from winter storm systems moving in from the southwest or north, preventing cold air outbreaks. The Great Salt Lake tends to have a moderating influence on the area's temperature. Moderate winds flow out of the southeast on average, although there is a valley breeze/lake breeze system that affects the area. High pressure systems that occasionally settle over the area can result in stagnation episodes (Bair, 1992 and WRCC, 2011).

29.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station is located at Salt Lake City International Airport (WBAN 24127). Additional information about the Salt Lake City International Airport weather station is provided in Table 29-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 29-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 29-3 is the 95 percent confidence interval for each parameter. As shown in Table 29-3, average meteorological conditions on sample days were representative of average weather conditions throughout the year for both years.

Table 29-3. Average Meteorological Conditions near the Utah Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Bountiful, Utah - BTUT										
Salt Lake City International 24127 (40.79, -111.97)	9.00 miles 217° (SW)	2008	Sample Day	61.7 ± 5.3	51.5 ± 4.7	29.8 ± 2.2	40.8 ± 3.0	51.0 ± 4.5	1015.7 ± 1.8	7.1 ± 0.7
			All Year	62.5 ± 2.3	52.2 ± 2.0	30.1 ± 1.0	41.3 ± 1.3	50.5 ± 2.0	1015.7 ± 0.8	6.8 ± 0.3
		2009	Sample Day	62.4 ± 5.2	51.9 ± 4.6	32.6 ± 2.6	42.1 ± 3.1	54.6 ± 4.4	1016.4 ± 1.9	6.4 ± 0.7
			All Year	62.2 ± 2.2	52.1 ± 2.0	32.4 ± 1.1	42.1 ± 1.3	53.9 ± 1.9	1015.7 ± 0.8	6.5 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

29.2.3 Back Trajectory Analysis

Figure 29-3 and Figure 29-4 are the composite back trajectory maps for days on which samples were collected at the BTUT monitoring site in 2008 and 2009, respectively. Figure 29-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 29-3 through 29-5 represents 100 miles.

Observations from Figures 29-3 through 29-5 include the following:

- Back trajectories originated from a variety of directions at BTUT.
- Similar to other sites located in the inter-mountain west, the 24-hour air shed domain for BTUT was smaller in size compared to most other NMP monitoring sites. The farthest away a trajectory originated was over the Mojave Desert of California, just less than 450 miles away. However, most trajectories (87 percent) originated within 300 miles of the site.
- The red (2009) cluster trajectory that originates near BTUT and circles back around the site (49 percent) represents trajectories originating within close proximity to the site, generally within 100-150 miles of the site, and primarily to the southeast to southwest. For 2008, these back trajectories are represented by two cluster trajectories, the one originating to the south (34 percent) and the one originating to the east (10 percent). For both years, these back trajectories account for nearly 50 percent of the sample days. Back trajectories also originated to the west to northwest and south.

Figure 29-3. 2008 Composite Back Trajectory Map for BTUT

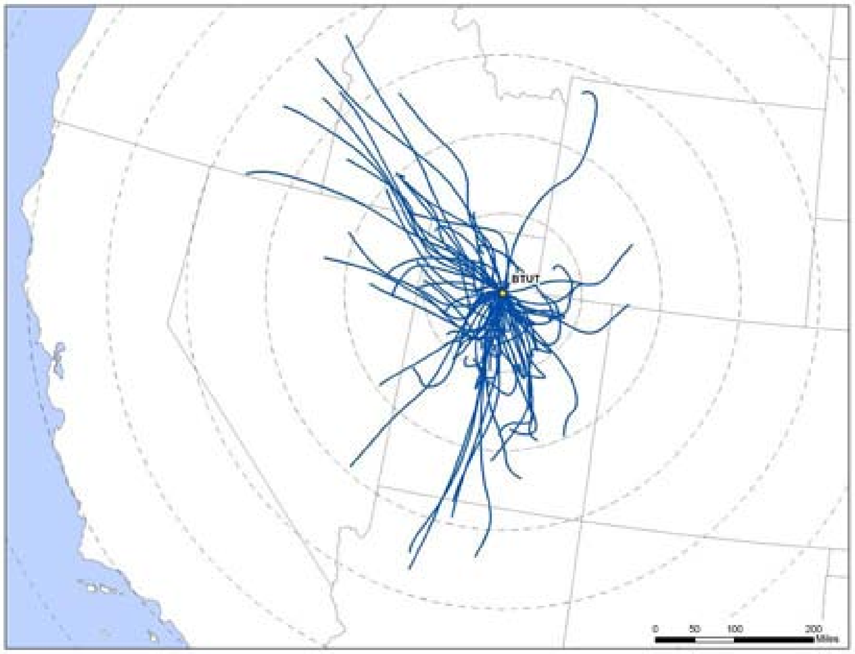


Figure 29-4. 2009 Composite Back Trajectory Map for BTUT

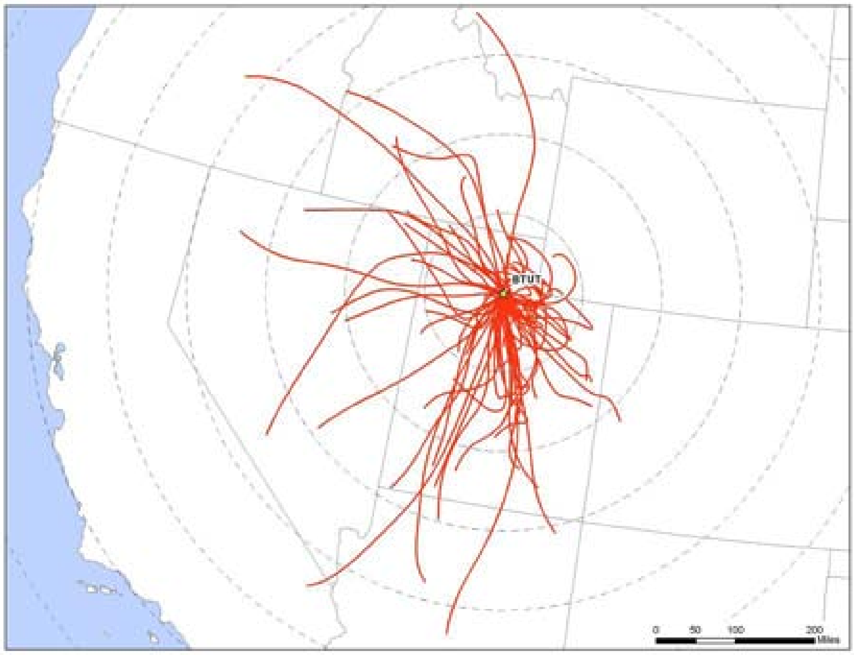
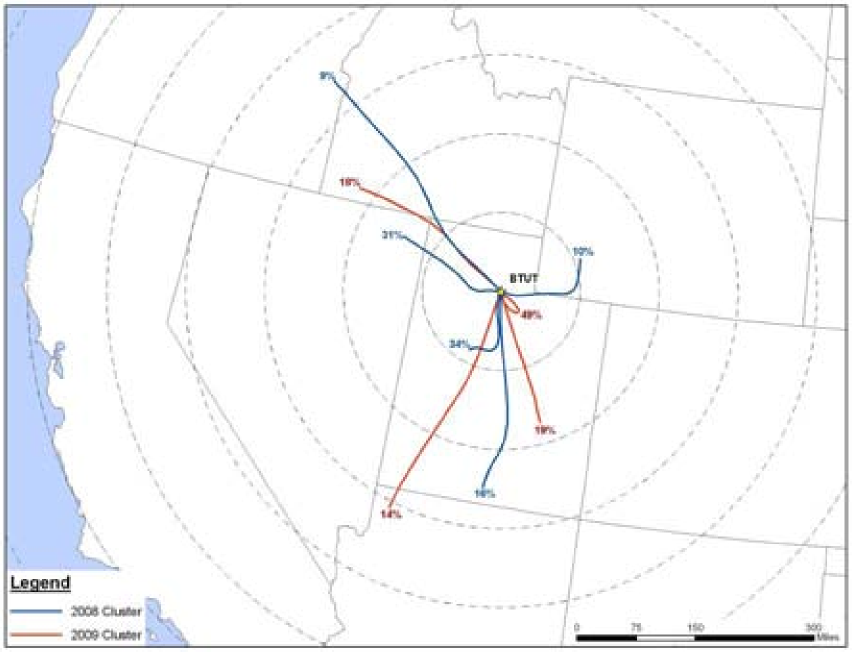


Figure 29-5. Back Trajectory Cluster Map for BTUT

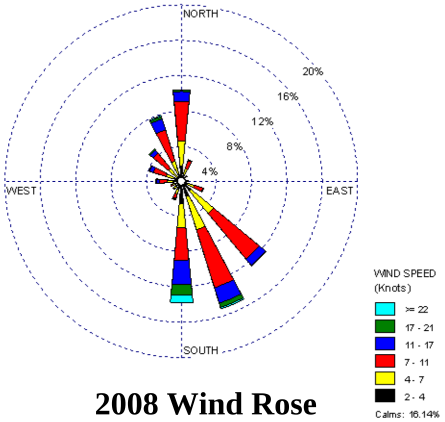


29.2.4 Wind Rose Comparison

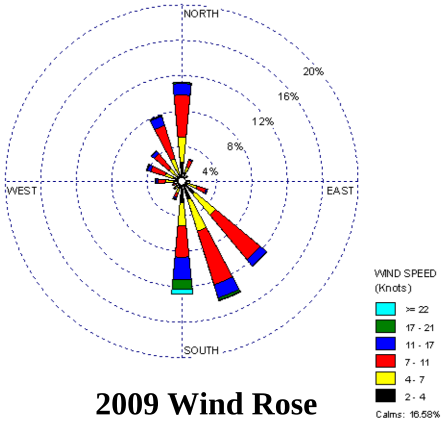
Hourly wind data from the NWS weather station at Salt Lake City International Airport near BTUT were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 29-6 presents five different wind roses for the BTUT monitoring site. First, a historical wind rose representing 1999 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

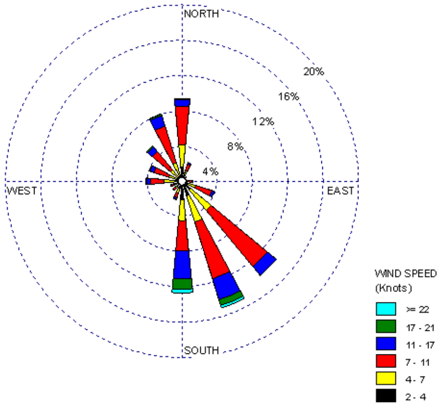
Figure 29-6. Wind Roses for the Salt Lake City International Airport Weather Station near BTUT



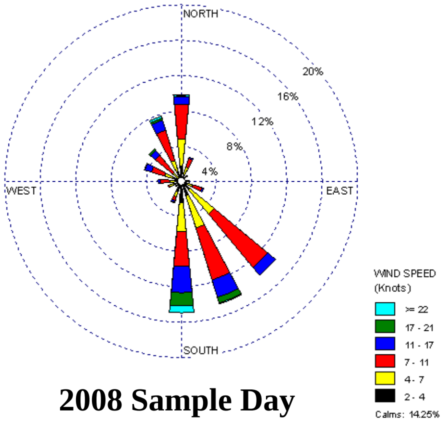
2008 Wind Rose



2009 Wind Rose

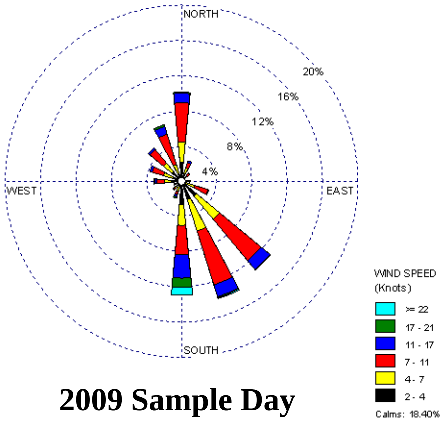


1999 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 29-6 for BTUT include the following:

- The historical wind rose shows that southeasterly, south-southeasterly, and southerly winds were prevalent near BTUT. Winds from the north-northwest to north were also common. Calm winds (≤2 knots) were observed for approximately 14 percent of the hourly measurements from 1999-2007. The strongest wind speeds were observed with south-southeasterly and southerly winds.

- The wind patterns shown on the 2008 and 2009 wind roses are similar to the historical wind patterns. Further, the wind patterns shown on the sample day wind roses for each year also resemble the historical wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

29.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the BTUT monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the BTUT monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 29-4 presents BTUT's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. BTUT sampled for VOC, carbonyl compounds, SNMOC, PAH, metals (PM_{10}), and hexavalent chromium.

Table 29-4. Risk Screening Results for the Utah Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bountiful, Utah - BTUT						
Benzene	0.13	128	128	100.00	11.76	11.76
Carbon Tetrachloride	0.17	128	128	100.00	11.76	23.53
Acetaldehyde	0.45	124	124	100.00	11.40	34.93
Formaldehyde	0.077	124	124	100.00	11.40	46.32
1,3-Butadiene	0.033	111	128	86.72	10.20	56.53
Arsenic (PM_{10})	0.00023	98	116	84.48	9.01	65.53
Manganese (PM_{10})	0.005	77	119	64.71	7.08	72.61
Naphthalene	0.029	66	74	89.19	6.07	78.68
Tetrachloroethylene	0.17	58	122	47.54	5.33	84.01
Dichloromethane	2.1	44	128	34.38	4.04	88.05
Ethylbenzene	0.4	41	128	32.03	3.77	91.82
p-Dichlorobenzene	0.091	38	109	34.86	3.49	95.31
Acrylonitrile	0.015	25	25	100.00	2.30	97.61
Hexavalent Chromium	0.000083	7	93	7.53	0.64	98.25
Cadmium (PM_{10})	0.00056	6	117	5.13	0.55	98.81
Propionaldehyde	0.8	5	124	4.03	0.46	99.26
1,2-Dichloroethane	0.038	2	2	100.00	0.18	99.45
Nickel (PM_{10})	0.009	2	119	1.68	0.18	99.63
1,2-Dibromoethane	0.0017	1	1	100.00	0.09	99.72
Hexachloro-1,3-butadiene	0.045	1	1	100.00	0.09	99.82
Lead (PM_{10})	0.015	1	119	0.84	0.09	99.91
Xylenes	10	1	128	0.78	0.09	100.00
Total		1,088	2,157	50.44		

Observations from Table 29-4 include the following:

- Twenty-two pollutants, of which 13 are NATTS MQO Core Analytes, failed at least one screen for BTUT.

- The risk screening process identified 12 pollutants of interest for BTUT, of which nine were NATTS MQO Core Analytes. Four additional pollutants (cadmium, hexavalent chromium, nickel, and lead) were added to BTUT's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. In addition, five more pollutants were added to BTUT's pollutants of interest because they are also NATTS MQO Core Analytes, even though they did not fail any screens: benzo(a)pyrene, beryllium, chloroform, trichloroethylene, and vinyl chloride. These five pollutants are not shown in Table 29-4. Although it seems like the list of added pollutants is long, BTUT is one of two NMP monitoring sites where the entire suite of pollutants is sampled for (NBIL is the other).

- Of the pollutants of interest, acetaldehyde, formaldehyde, benzene, and carbon tetrachloride failed 100 percent of screens.

- Fifty percent of measured detections failed screens (of the pollutants that failed at least one screen) for BTUT.

- As shown in Table 4-8 of Section 4.2, BTUT failed the third highest number of screens among all NMP sites (behind only PXSS and S4MO).

- Recall from Section 3.2 that if a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used for the risk screening process. As BTUT sampled both VOC (TO-15) and SNMOC, the TO-15 results were used for the 12 pollutants these methods have in common.

29.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Utah monitoring site. Concentration averages are provided for the pollutants of interest for the BTUT site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendix J through Appendix O.

29.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for BTUT, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 29-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium are presented in ng/m^3 for ease of viewing.

Table 29-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Utah Monitoring Site

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Bountiful, Utah - BTUT												
Acetaldehyde	2.10 ± 0.64	1.63 ± 0.39	1.48 ± 0.44	3.89 ± 2.81	1.71 ± 0.41	2.10 ± 0.64	1.97 ± 0.23	2.18 ± 0.46	1.38 ± 0.36	2.29 ± 0.42	1.99 ± 0.52	1.97 ± 0.23
Benzene	1.40 ± 0.17	1.56 ± 0.39	0.87 ± 0.21	1.60 ± 0.26	1.57 ± 0.34	1.40 ± 0.17	1.68 ± 0.34	2.84 ± 0.87	1.18 ± 0.46	1.02 ± 0.20	1.41 ± 0.41	1.68 ± 0.34
1,3-Butadiene	0.10 ± 0.02	0.13 ± 0.04	0.04 ± 0.01	0.07 ± 0.01	0.15 ± 0.04	0.10 ± 0.02	0.11 ± 0.02	0.20 ± 0.05	0.04 ± 0.01	0.05 ± 0.01	0.13 ± 0.04	0.11 ± 0.02
Carbon Tetrachloride	0.65 ± 0.05	0.55 ± 0.06	0.64 ± 0.09	0.67 ± 0.12	0.77 ± 0.10	0.65 ± 0.05	0.64 ± 0.04	0.59 ± 0.04	0.66 ± 0.07	0.67 ± 0.09	0.63 ± 0.09	0.64 ± 0.04
Chloroform	0.11 ± 0.01	0.08 ± 0.02	0.09 ± 0.02	0.12 ± 0.03	0.13 ± 0.02	0.10 ± 0.01	0.13 ± 0.01	0.10 ± 0.02	0.12 ± 0.03	0.16 ± 0.02	0.11 ± 0.02	0.12 ± 0.01
p-Dichlorobenzene	0.27 ± 0.29	0.06 ± 0.07	0.04 ± 0.02	0.76 ± 1.20	0.18 ± 0.15	0.23 ± 0.25	0.25 ± 0.15	0.45 ± 0.37	0.26 ± 0.30	0.05 ± 0.03	0.04 ± 0.04	0.22 ± 0.13
Dichloromethane	4.56 ± 6.55	0.60 ± 0.30	0.38 ± 0.07	0.66 ± 0.20	17.14 ± 27.73	4.56 ± 6.55	19.76 ± 14.99	8.03 ± 7.90	30.54 ± 51.61	35.16 ± 33.79	7.00 ± 2.88	19.76 ± 14.99
Ethylbenzene	0.38 ± 0.07	0.34 ± 0.11	0.21 ± 0.06	0.63 ± 0.19	0.39 ± 0.09	0.38 ± 0.07	0.39 ± 0.08	0.72 ± 0.20	0.26 ± 0.08	0.21 ± 0.04	0.31 ± 0.08	0.39 ± 0.08
Formaldehyde	2.47 ± 0.48	1.93 ± 0.37	1.81 ± 0.54	4.47 ± 1.75	2.00 ± 0.32	2.47 ± 0.48	2.96 ± 0.45	2.40 ± 0.33	2.66 ± 1.10	4.42 ± 1.19	2.36 ± 0.30	2.96 ± 0.45
Tetrachloroethylene	0.30 ± 0.14	0.22 ± 0.10	0.11 ± 0.02	0.61 ± 0.60	0.29 ± 0.11	0.29 ± 0.13	0.24 ± 0.06	0.42 ± 0.13	0.17 ± 0.09	0.13 ± 0.08	0.14 ± 0.04	0.23 ± 0.06
Trichloroethylene	0.08 ± 0.02	0.04 ± 0.02	NA	NA	NA	NA	0.08 ± 0.02	0.07 ± 0.03	NA	NA	NA	NA
Vinyl Chloride	0.02 ± 0.01	NA	NA	NA	NA	NA	0.02 ± 0.01	0.01 ± 0.01	NA	NA	NA	NA
Arsenic (PM$_{10}$)[a]	0.68 ± 0.16	0.48 ± 0.17	0.49 ± 0.16	0.76 ± 0.23	0.97 ± 0.55	0.67 ± 0.16	1.17 ± 0.43	1.87 ± 1.40	0.68 ± 0.26	0.55 ± 0.17	1.38 ± 0.83	1.13 ± 0.42

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not available because sampling was not conducted during this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 29-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Utah Monitoring Site (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Benzo(a)pyrene[a]	0.15 ± 0.10	NR	NA	NA	0.11 ± 0.09	NA	0.19 ± 0.06	0.17 ± 0.10	NA	NA	0.17 ± 0.08	NA
Beryllium (PM$_{10}$)[a]	0.01 ± <0.01	NA	0.01 ± 0.01	0.01 ± <0.01	<0.01 ± <0.01	0.01 ± <0.01	0.01 ± <0.01	NA	NA	0.01 ± <0.01	NA	NA
Cadmium (PM$_{10}$)[a]	0.20 ± 0.10	0.27 ± 0.23	0.08 ± 0.03	0.12 ± 0.07	0.31 ± 0.35	0.20 ± 0.10	0.13 ± 0.06	0.25 ± 0.21	0.06 ± 0.02	0.08 ± 0.04	0.12 ± 0.06	0.13 ± 0.06
Hexavalent Chromium[a]	0.04 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	0.05 ± 0.03	0.04 ± 0.03	0.04 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01
Lead (PM$_{10}$)[a]	3.24 ± 0.58	3.43 ± 1.12	2.33 ± 0.87	3.38 ± 0.49	3.82 ± 1.84	3.24 ± 0.58	3.60 ± 0.98	5.32 ± 3.10	1.99 ± 0.42	2.66 ± 0.54	4.31 ± 2.22	3.60 ± 0.98
Manganese (PM$_{10}$)[a]	8.68 ± 1.50	7.58 ± 2.84	8.42 ± 3.35	12.21 ± 2.89	6.83 ± 2.89	8.68 ± 1.50	7.01 ± 1.20	6.86 ± 2.91	7.60 ± 3.30	8.96 ± 1.71	4.66 ± 1.32	7.01 ± 1.20
Naphthalene[a]	70.14 ± 22.37	NR	NA	NA	71.33 ± 26.39	NA	84.19 ± 16.63	125.22 ± 55.82	44.77 ± 11.65	65.29 ± 12.87	102.96 ± 27.53	84.19 ± 16.63
Nickel (PM$_{10}$)[a]	2.75 ± 1.09	2.27 ± 0.70	5.76 ± 4.09	1.64 ± 0.56	1.28 ± 0.49	2.75 ± 1.09	1.00 ± 0.17	1.48 ± 0.34	0.79 ± 0.21	0.81 ± 0.17	0.89 ± 0.45	1.00 ± 0.17

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not available because sampling was not conducted during this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Observations for BTUT from Table 29-5 include the following:

- For both years, the pollutants with the highest daily average concentrations by mass were dichloromethane, formaldehyde, acetaldehyde, and benzene. The annual averages for these pollutants were the same as their respective daily averages, meaning these pollutants were detected in every sample collected.

- Some pollutants of interest have seasonal variations. For instance, 1,3-butadiene was highest during the colder months (first and fourth quarters of both years). Conversely, formaldehyde tended to be higher during the warmer months.

- Several pollutants appear to be higher in one quarter or another, but have very large confidence intervals associated them. For example, both carbonyl compounds have rather large confidence intervals for their third quarter 2008 averages, particularly acetaldehyde. The highest concentration of acetaldehyde was measured on July 17, 2008 (20.0 μg/m^3) and was nearly four times the next highest concentration measured on July 30, 2009 (4.69 μg/m^3). This was also the second highest acetaldehyde concentration measured among all NMP sites sampling carbonyl compounds.

- Another example of this is *p*-dichlorobenzene's third quarter 2008 average. The highest concentration of this pollutant was measured on September 27, 2008 (7.59 μg/m^3) and was more than twice the next highest concentration. This was also the highest concentration of this pollutant among all NMP sites sampling VOC. A closer inspection of this pollutant's other quarterly averages reveals that all of the quarterly averages between the third quarter of 2008 and the second quarter of 2009 had relatively high confidence intervals (based on the average itself). There were eight concentrations measured at BTUT that were greater than 0.75 μg/m^3 and these were spread across sample dates across this time frame. Of the 25 measurements of *p*-dichlorobenzene greater than 0.75 μg/m^3 for all NMP sites, nearly one-third of them belong to BTUT (another six belong to S4MO and two were measured at SPIL; the remainder were spread across nine additional sites).

- Dichloromethane had the highest daily and annual averages for BTUT, but also had several high quarterly averages with very large confidence intervals associated them. This indicates the presence of outliers. The concentrations of dichloromethane at BTUT ranged from 0.223 to 432 μg/m^3. There were five measurements of this pollutant that were greater than 100 μg/m^3 and a total of 17 greater than 10.0 μg/m^3. Compared to other NMP sites, BTUT had the most number of dichloromethane measurements greater than 10.0 μg/m^3 (GPCO had second highest at seven). Only one other NMP site had a dichloromethane measurement greater than 100 μg/m^3 (EQWA).

- The third quarter 2008 and first quarter 2009 averages of ethylbenzene are higher than the other quarters. A review of the data shows that there were six measurements of ethylbenzene greater than 1.0 μg/m^3. Four of these were measured in

January 2009, the other two were measured in July and September 2009. The September measurement was collected on September 27, 2008, the same day the high *p*-dichlorobenzene concentration was measured.

- The third quarter 2008 tetrachloroethylene quarterly average has a very large confidence interval associated with it. The first quarter 2009 average is also relatively high. A review of the data shows that the two highest concentrations of this pollutant were measured at BTUT on September 27, 2008 (3.97 µg/m^3), similar to *p*-dichlorobenzene, and July 2, 2008 (1.24 µg/m^3).

- Although PAH sampling began at BTUT in April 2008, complications with the sampler lead to a six-month lapse in sampling between the end of April 2008 and mid-October 2008.

- Concentrations of arsenic were higher during the last quarter of 2008, first quarter of 2009, and fourth quarter 2009. The highest concentration of arsenic was measured on January 19, 2009 (10.2 ng/m^3) and was more than twice the next highest concentration (4.95 ng/m^3, January 31, 2009), hence the large confidence interval. Of the 25 arsenic concentrations greater than 1.0 ng/m^3, six were measured in first quarter of 2009, six in the fourth quarter of 2009, and five in the fourth quarter of 2008.

- Both cadmium and lead appear to be higher during the colder months of the year (first and fourth quarters). The highest concentration of lead was measured on January 19, 2009 (23.1 ng/m^3), which is the same day the highest arsenic concentration was measured. Lead concentrations ranged from 0.0358 ng/m^3 to 23.1 ng/m^3, with a median of 2.66 ng/m^3. Of the 20 lead concentrations greater than 5.0 ng/m^3, four were measured in first quarter of 2008, four in the fourth quarter of 2008, five in the first quarter of 2009, and five in the fourth quarter of 2009. Only two were measured outside these quarters. Three concentrations of cadmium (out of 117) were greater than 1.0 ng/m^3. These were measured on November 26, 2008 (2.61 ng/m^3), February 12, 2008 (1.73 ng/m^3), and January 19, 2009 (1.54 ng/m^3). The median cadmium concentration was 0.07 ng/m^3. This explains the large confidence intervals for these calendar quarters.

- The second quarter 2008 nickel average concentration is higher than the other quarterly averages and has a large confidence interval associated with it. The two highest concentrations of nickel were measured on April 18, 2008 (26.9 ng/m^3) and April 12, 2008 (20.9 ng/m^3). These two concentrations are the highest measurements of nickel among all NMP sites sampling metals. The third highest nickel concentration was also measured during the second quarter of 2008 (May 6, 2008, 8.92 ng/m^3).

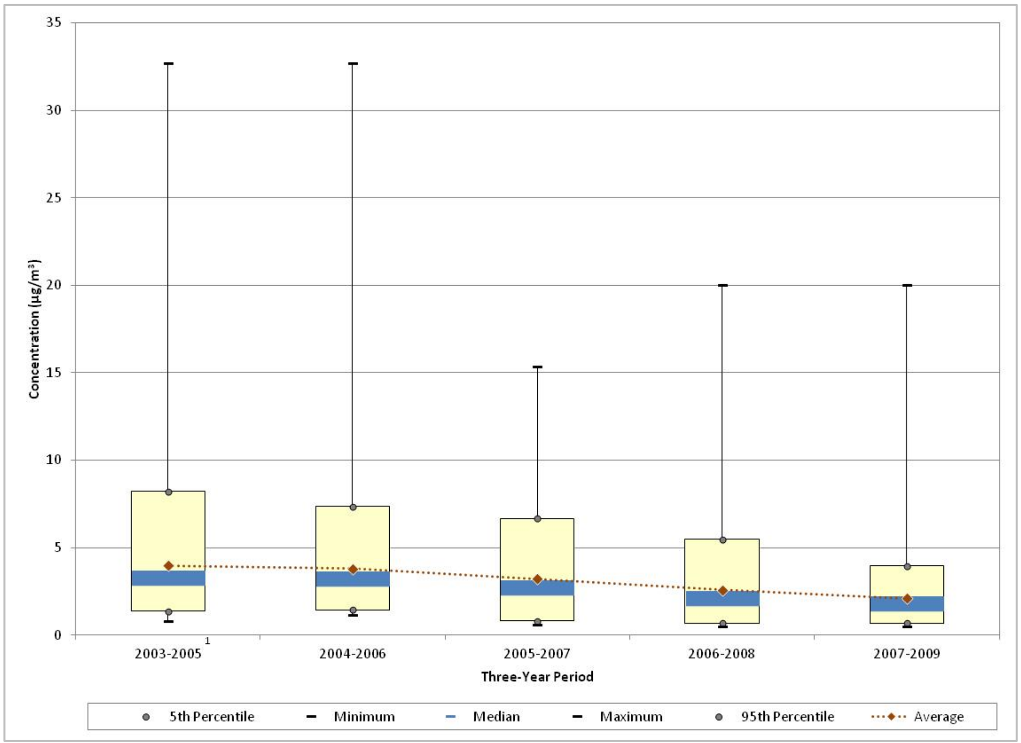
Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for BTUT from those tables include the following:

- BTUT has fourth highest daily average concentration of acrylonitrile (2008) as well as the third (2008) and sixth (2009) highest daily average concentrations of *p*-dichlorobenzene, as shown in Table 4-9.
- BTUT appears in Table 4-12 for every metal except lead. BTUT had the highest daily average concentration of nickel (2008 only), the second highest daily average concentration of arsenic (2009 only), the third (2009) and fourth (2008) highest daily average concentrations of beryllium, the seventh highest daily average concentration of cadmium (2008), the ninth highest daily average concentration of hexavalent chromium (2008), and the fifth (2008) and ninth (2009) highest daily average concentration of manganese.
- BTUT does not appear on either table for carbonyl compounds or PAH.

29.4.2 Concentration Trends

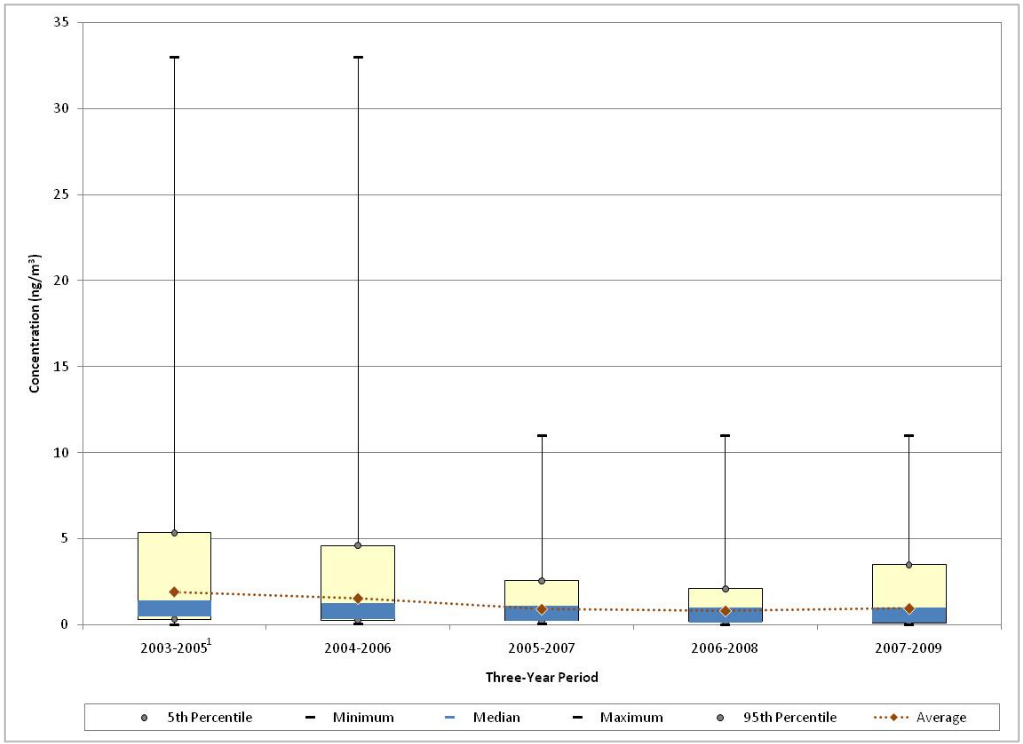
A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. BTUT has sampled carbonyl compounds, VOC, metals, and SNMOC as part of the NMP since July 2003. BTUT has also sampled hexavalent chromium since 2005. Thus, Figures 29-7 through 29-13 present the 3-year rolling statistical metrics for acetaldehyde, arsenic, benzene, 1,3-butadiene, formaldehyde, hexavalent chromium, and manganese for BTUT, respectively. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 29-7. Three-Year Rolling Statistical Metrics for Acetaldehyde Concentrations Measured at BTUT



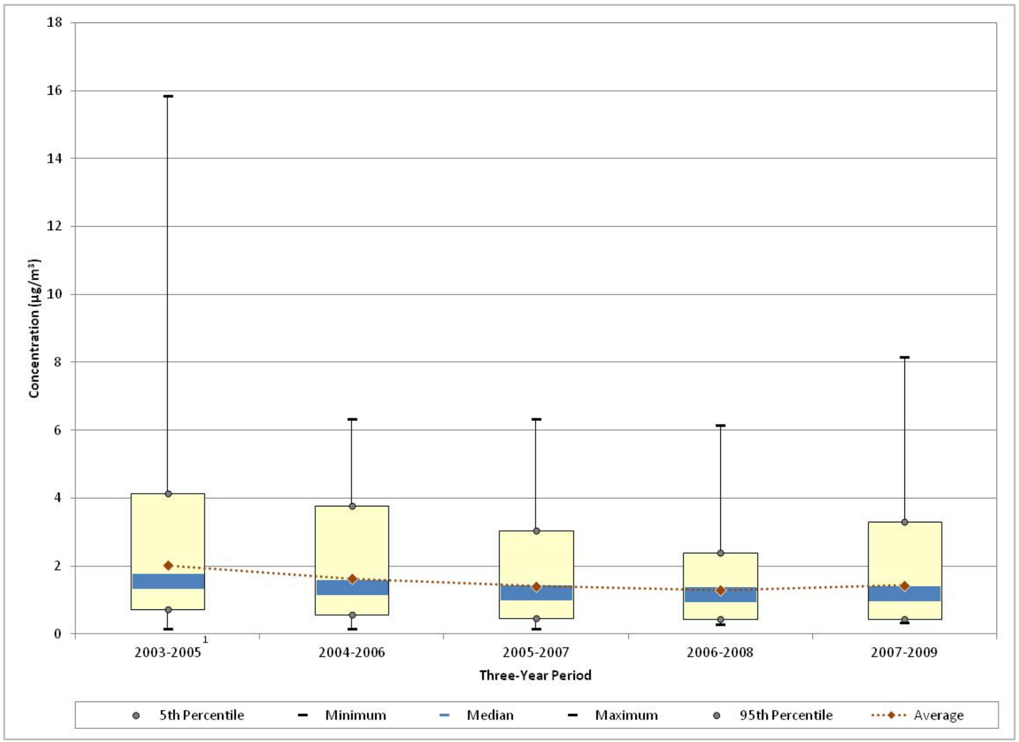
[1]Sampling for carbonyl compounds began in July 2003.

Figure 29-8. Three-Year Rolling Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BTUT



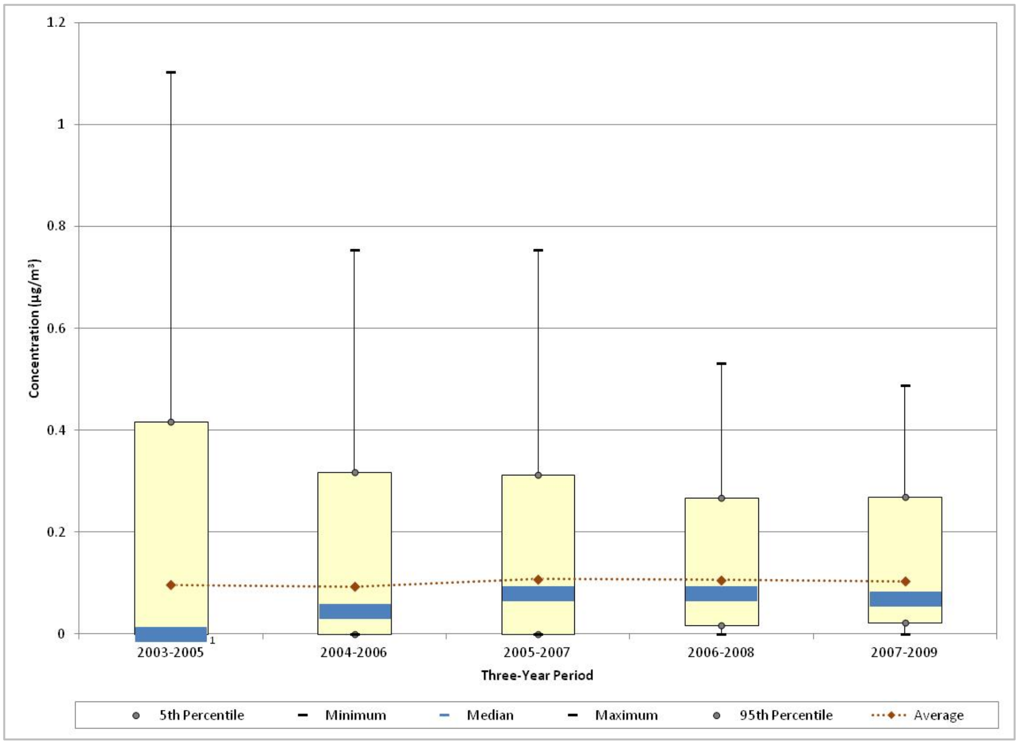
[1]Sampling for PM_{10} metals began in July 2003.

Figure 29-9. Three-Year Rolling Statistical Metrics for Benzene Concentrations Measured at BTUT



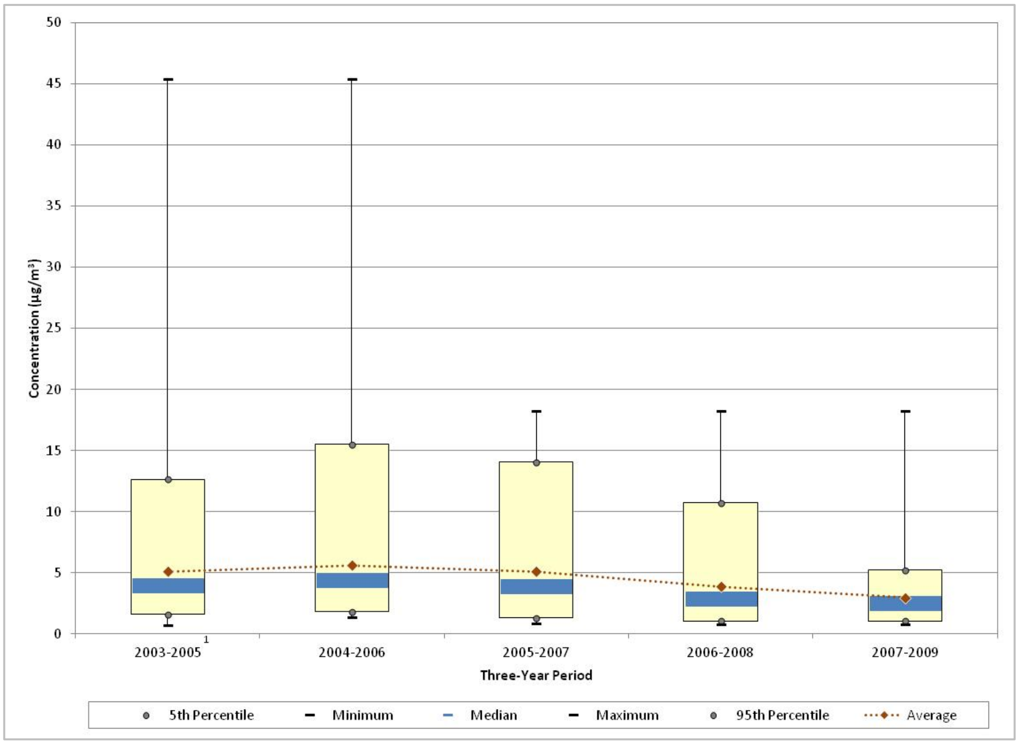
[1] Sampling for VOC began in July 2003.

Figure 29-10. Three-Year Rolling Statistical Metrics for 1,3-Butadiene Concentrations Measured at BTUT



[1] Sampling for VOC began in July 2003.

Figure 29-11. Three-Year Rolling Statistical Metrics for Formaldehyde Concentrations Measured at BTUT



[1]Sampling for carbonyl compounds began in July 2003.

Figure 29-12. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at BTUT

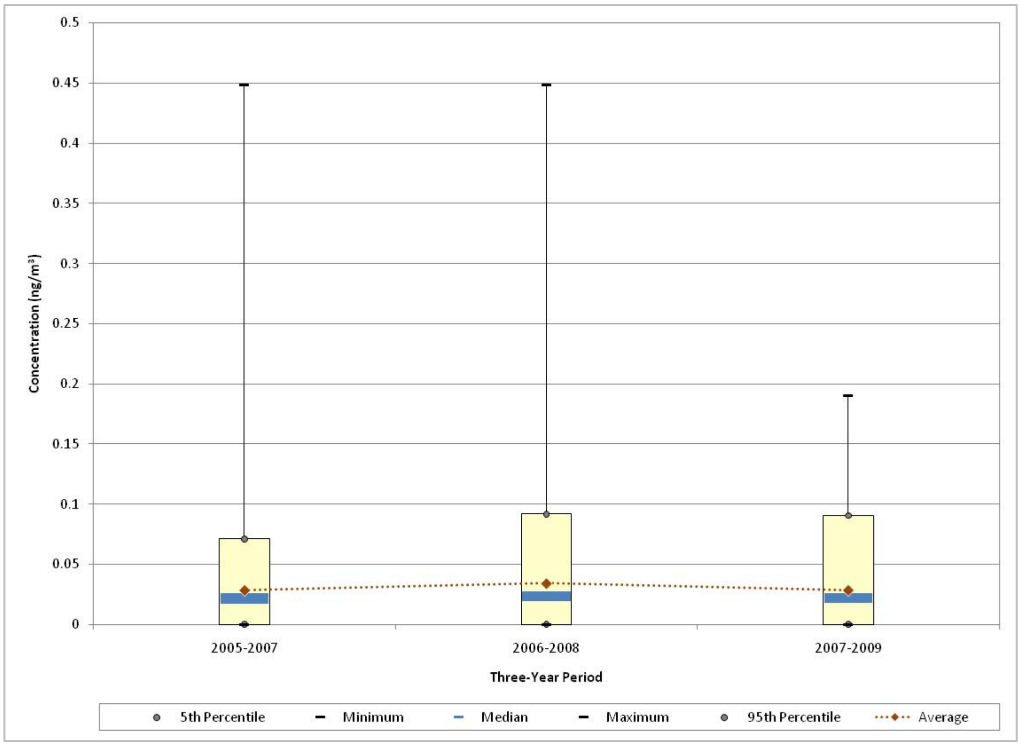
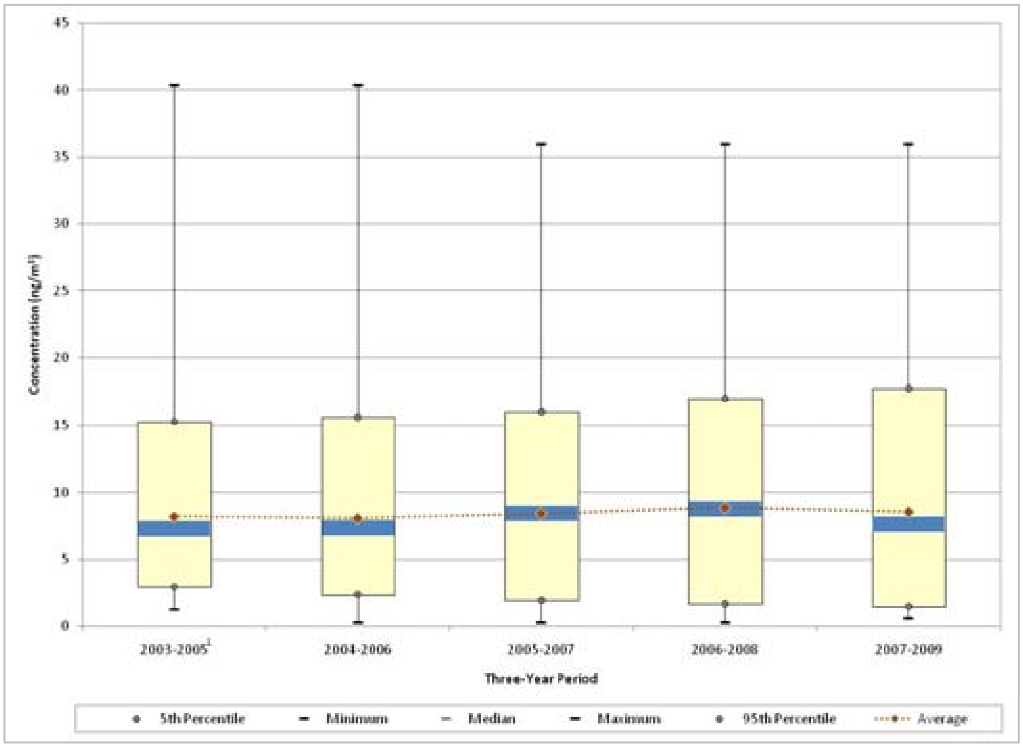


Figure 29-13. Three-Year Rolling Statistical Metrics for Manganese (PM_{10}) Concentrations Measured at BTUT



[1]Sampling for PM_{10} metals began in July 2003.

Observations from Figure 29-7 for acetaldehyde measurements include the following:

- The maximum acetaldehyde concentration was measured in 2004 (32.7 µg/m^3). The second highest concentration of acetaldehyde measured at BTUT was the maximum shown for 2008 (20.0 µg/m^3).
- Both the rolling average and median concentrations exhibit a steady decrease over the periods shown. The range of the majority of concentrations measured has also decreased, as indicated by the decreasing spread between the 5th and 95th percentiles.

Observations from Figure 29-8 for arsenic measurements include the following:

- The maximum arsenic concentration was measured in 2004. The maximum concentration measured (33.0 ng/m^3) was nearly twice the next highest concentration (16.8 ng/m^3), also measured in 2004. The three highest measurements since sampling began in 2003 were all measured in 2004; further, eight of the 12 highest concentrations of arsenic (those greater than 5 ng/m^3) were measured in 2004. Of these 12, eight were measured in the first quarter of the calendar year and four were measured during the fourth quarter of the calendar year, supporting the tendency discussed in Section 29.4.1.

- Although difficult to discern in Figure 29-8, the rolling average concentrations of arsenic decreased through the 2006-2008 time period, but increased just slightly for the final time frame shown. The median has decreased as well, but was static during the final time frame. The 95th percentile has decreased through most of the time frames too, but increased somewhat in the final time frame.

- The difference between the median and the average concentrations decreased over the periods shown, indicating decreasing variability in the central tendency of arsenic measurements.

Observations from Figures 29-9 for benzene include the following:

- The maximum concentration of benzene was measured in 2003 (15.84 $\mu g/m^3$). The next highest concentration (9.44 $\mu g/m^3$) was also measured in 2003.

- The rolling average, median, and 95th percentiles have a decreasing trend through the 2006-2008 time frame, after which a slight increase is shown.

Observations from Figures 29-10 for 1,3-butadiene include the following:

- The maximum concentration of 1,3-butadiene was measured in October 2003. The maximum concentration for every 3-year period afterward is lower than this measurement.

- The minimum, 5th percentile, and median concentrations are all zero for the 2003-2005 time frame, indicating that at least 50 percent of the measurements were non-detects. The detection rate of 1,3-butadiene has increased for every year of sampling, up to a 100 percent detection rate for 2008 and 2009.

- Figure 29-10 shows that the rolling average concentration has changed little over the years of sampling.

Observations from Figure 29-11 for formaldehyde measurements include the following:

- The maximum formaldehyde concentration was measured in 2004 (45 $\mu g/m^3$), on the same day as the highest acetaldehyde concentration, August 31, 2004. This measurement is more than twice the next highest concentration (18.21 $\mu g/m^3$), measured in 2007. Concentrations of similar magnitude were also measured on additional days in 2004 and 2007.

- The rolling average concentration increased slightly from 2003-2005 to 2004-2006, then decreased through 2007-2009. This is also true of the median concentration and the 95th percentile.

- The difference between the median and the average concentrations decreased over most of the periods shown, indicating decreasing variability in the central tendency of formaldehyde measurements.

Observations from Figure 29-12 for hexavalent chromium measurements include the following:

- The maximum hexavalent chromium concentration was measured on July 4, 2006. The next highest concentration was measured in December 2008 and was roughly half as high.

- Both the rolling average and median concentrations increased slightly during the second 3-year period then returned to 2005-2007 levels for the third 3-year period. These changes, however, were not statistically significant.

- The minimum and 5th percentile are both zero for each time frame, indicating the presence of non-detects. The number of non-detects was 33 percent during the first year of sampling, dropped to around 10 percent for the next 3 years, and was highest in 2009 (38 percent).

Observations from Figure 29-13 for manganese measurements include the following:

- The maximum manganese concentration was measured in 2004, although the next highest concentration, measured in 2007, was not that much lower.

- The rolling average concentration increased slightly in 2005-2007 and 2006-2008 from 2004-2006 levels. However, the calculation of confidence intervals shows that this slight increase is not statistically significant.

- The difference between the 5th and 95th percentiles increased over the periods shown, indicating an increasing spread in the measurements of manganese, and thus increasing variability, since the onset of sampling.

29.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the BTUT monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

29.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Utah monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Utah monitoring site were higher than their respective MRL noncancer health risk benchmarks.

29.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Utah monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 29-6, where applicable.

Observations for BTUT from Table 29-6 include the following:

- The pollutants with the highest annual averages were dichloromethane, formaldehyde, acetaldehyde, and benzene for both years. Note that the dichloromethane average for 2009 was considerably higher than the average for 2008.
- The pollutants with the highest cancer risk approximations for 2008 were formaldehyde, benzene, and acetaldehyde. For 2009, the pollutants with the highest cancer risk approximations were formaldehyde, benzene, and dichloromethane.
- There were no pollutants of interest with a noncancer risk approximation greater than 1.0.

Table 29-6. Cancer and Noncancer Surrogate Risk Approximations for the Utah Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Bountiful, Utah - BTUT										
Acetaldehyde	0.0000022	0.009	60/4	2.10 ± 0.64	4.62	0.23	64/4	1.97 ± 0.23	4.33	0.22
Arsenic (PM_{10})[a]	0.0043	0.000015	59/4	<0.01 ± <0.01	2.88	0.04	57/4	<0.01 ± <0.01	4.84	0.08
Benzene	0.0000078	0.03	62/4	1.40 ± 0.17	10.94	0.05	66/4	1.68 ± 0.34	13.07	0.06
Benzo(a)pyrene[a]	0.001	--	9/1	NA	NA	NA	27/2	NA	NA	NA
Beryllium (PM_{10})[a]	0.0024	0.00002	43/3	<0.01 ± <0.01	0.02	<0.01	19/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	62/4	0.10 ± 0.02	2.98	0.05	66/4	0.11 ± 0.02	3.24	0.05
Cadmium (PM_{10})[a]	0.0018	0.00001	60/4	<0.01 ± <0.01	0.36	0.02	57/4	<0.01 ± <0.01	0.23	0.01
Carbon Tetrachloride	0.000006	0.1	62/4	0.65 ± 0.05	3.89	0.01	66/4	0.64 ± 0.04	3.82	0.01
Chloroform	--	0.098	57/4	0.10 ± 0.01	--	<0.01	64/4	0.12 ± 0.01	--	<0.01
p-Dichlorobenzene	0.000011	0.8	53/4	0.23 ± 0.25	2.57	<0.01	56/4	0.22 ± 0.13	2.38	<0.01
Dichloromethane	4.7E-07	1	62/4	4.56 ± 6.55	2.14	<0.01	66/4	19.76 ± 14.99	9.29	0.02
Ethylbenzene	0.0000025	1	62/4	0.38 ± 0.07	0.96	<0.01	66/4	0.39 ± 0.08	0.98	<0.01
Formaldehyde	0.000013	0.0098	60/4	2.47 ± 0.48	32.06	0.25	64/4	2.96 ± 0.45	38.51	0.30

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 29-5.

Table 29-6. Cancer and Noncancer Surrogate Risk Approximations for the Utah Monitoring Site (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Hexavalent Chromium [a]	0.012	0.0001	55/4	<0.01 ± <0.01	0.44	<0.01	38/4	<0.01 ± <0.01	0.23	<0.01
Lead (PM$_{10}$) [a]	--	0.00015	60/4	<0.01 ± <0.01	--	0.02	59/4	<0.01 ± <0.01	--	0.02
Manganese (PM$_{10}$) [a]	--	0.00005	60/4	0.01 ± <0.01	--	0.17	59/4	0.01 ± <0.01	--	0.14
Naphthalene [a]	0.000034	0.003	14/1	NA	NA	NA	60/4	0.08 ± 0.02	2.86	0.03
Nickel (PM$_{10}$) [a]	0.000312	0.00009	60/4	<0.01 ± <0.01	0.86	0.03	59/4	<0.01 ± <0.01	0.31	0.01
Tetrachloroethylene	0.0000059	0.27	60/4	0.29 ± 0.13	1.73	<0.01	62/4	0.23 ± 0.06	1.33	<0.01
Trichloroethylene	0.000002	0.6	16/1	NA	NA	NA	22/1	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	7/0	NA	NA	NA	19/1	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 29-5.

29.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 29-7 and 29-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 29-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 29-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer tables. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 29.3, BTUT sampled for VOC, carbonyl compounds, SNMOC, metals (PM_{10}), PAH, and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 29-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Utah Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Bountiful, Utah (Davis County) - BTUT					
Benzene	212.53	Benzene	1.66E-03	Formaldehyde	38.51
Formaldehyde	77.29	Formaldehyde	9.66E-04	Formaldehyde	32.06
Dichloromethane	44.71	1,3-Butadiene	7.08E-04	Benzene	13.07
Acetaldehyde	31.87	Naphthalene	3.49E-04	Benzene	10.94
1,3-Butadiene	23.61	Hexavalent Chromium, PM	3.06E-04	Dichloromethane	9.29
Tetrachloroethylene	12.98	POM, Group 2	1.45E-04	Arsenic (PM$_{10}$)	4.84
Naphthalene	10.25	Tetrachloroethylene	7.66E-05	Acetaldehyde	4.62
p-Dichlorobenzene	5.34	Acetaldehyde	7.01E-05	Acetaldehyde	4.33
Trichloroethylene	2.76	*p*-Dichlorobenzene	5.88E-05	Carbon Tetrachloride	3.89
POM, Group 2	2.64	Cadmium, PM	4.93E-05	Carbon Tetrachloride	3.82

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 29-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Utah Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Bountiful, Utah (Davis County) - BTUT					
Toluene	614.86	Acrolein	288,490.75	Formaldehyde	0.30
Xylenes	454.93	Hexamethylene-1,6-diisocyanate, gas	12,765.00	Formaldehyde	0.25
Benzene	212.53	1,3-Butadiene	11,805.93	Acetaldehyde	0.23
Hexane	103.66	Manganese, PM	9,742.63	Acetaldehyde	0.22
Ethylbenzene	96.69	Formaldehyde	7,887.09	Manganese (PM_{10})	0.17
Methanol	94.50	Benzene	7,084.50	Manganese (PM_{10})	0.14
Methyl isobutyl ketone	89.07	Chlorine	4,710.00	Arsenic (PM_{10})	0.08
Formaldehyde	77.29	Xylenes	4,549.25	Benzene	0.06
1,1,1-Trichloroethane	51.67	Cyanide Compounds, gas	3,913.33	1,3-Butadiene	0.05
Dichloromethane	44.71	Acetaldehyde	3,540.64	1,3-Butadiene	0.05

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 29-7 include the following:

- Benzene, formaldehyde, and dichloromethane were the highest emitted pollutants with cancer UREs in Davis County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were benzene, formaldehyde, 1,3-butadiene.

- Eight of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Formaldehyde and benzene topped all three lists for BTUT.

- POM Group 2 was the tenth highest emitted "pollutant" in Davis County and ranked sixth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at BTUT including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for BTUT.

- Some of the highest concentrations measured at BTUT were for dichloromethane. Although this pollutant had the third highest emissions of the pollutants with UREs, it was not one of the pollutants with the highest toxicity-weighted emissions. Its cancer risk approximation was the fifth highest of those calculated for BTUT.

Observations from Table 29-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Davis County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, hexamethylene-1,6-diisocyanate (gas), and 1,3-butadiene. Although acrolein was sampled for at BTUT, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Three of the highest emitted pollutants also had the highest toxicity-weighted emissions.

- Although less than the level of concern, formaldehyde, acetaldehyde, and manganese had the highest noncancer risk approximations for BTUT. These pollutants ranked fifth, tenth, and fourth (respectively) for toxicity-weighted emissions. Of these three pollutants, only formaldehyde was among the highest emitted pollutants.

29.6 Summary of the 2008-2009 Monitoring Data for BTUT

Results from several of the treatments described in this section include the following:

- *Twenty-two pollutants failed at least one screen for BTUT; of these, 13 were NATTS MQO Core Analytes.*
- *Dichloromethane had the highest daily average concentrations among the pollutants of interest for BTUT, followed by formaldehyde and acetaldehyde. The 2008 daily average concentration of nickel for BTUT was the highest among all NMP sites sampling PM_{10} metals (the 2009 daily average was much lower).*
- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

30.0 Site in Vermont

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Vermont, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

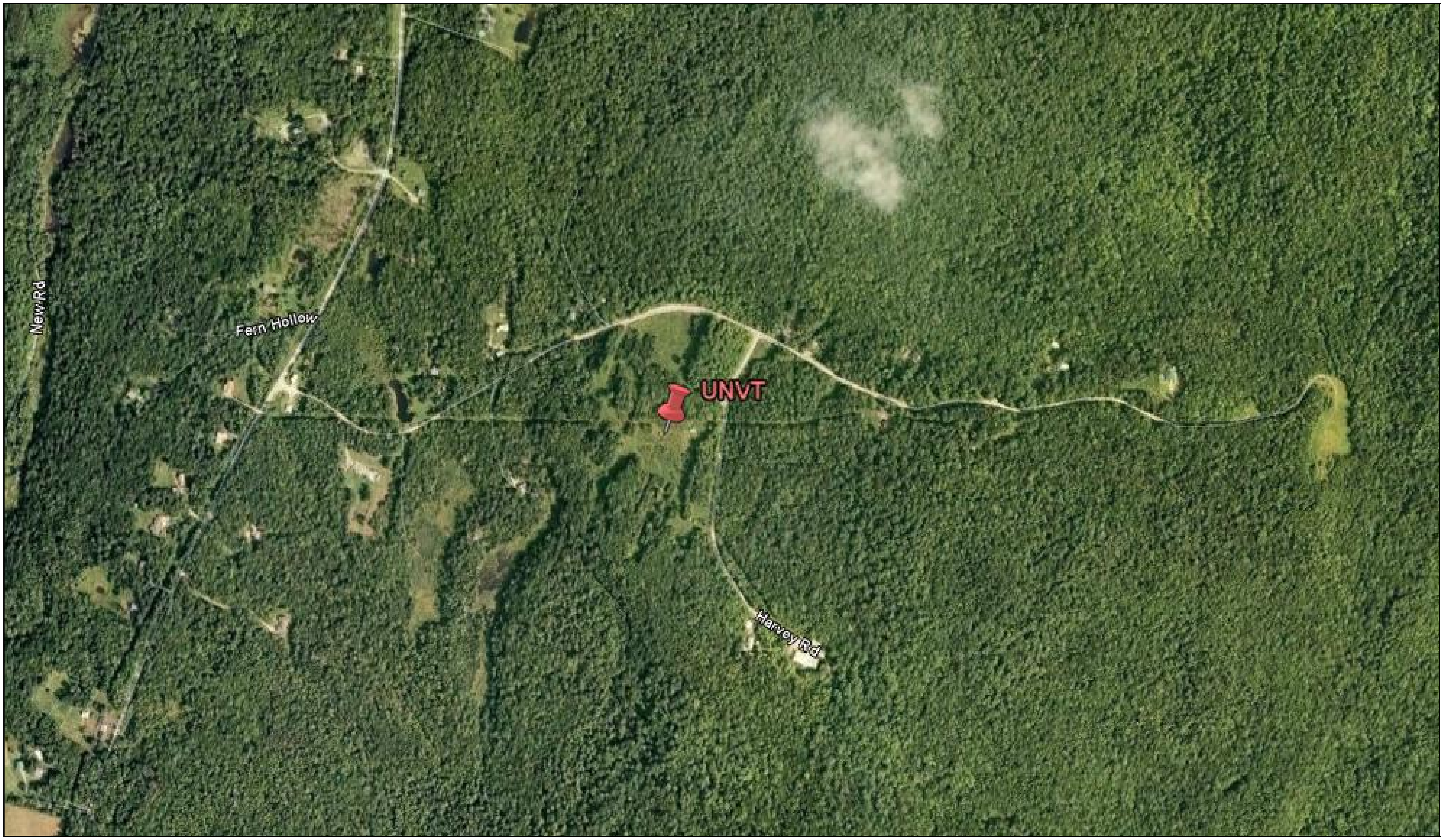
At the request of the Vermont Air Pollution Control Division, the results of the data analyses for the two UATMP sites in Burlington and Rutland (BURVT and RUVT) have been removed from this section. The data analyses for the Underhill NATTS site (UNVT) have been retained. Note that data from all three sites were incorporated into the introductory Sections 1-4.

30.1 Site Characterization

This section characterizes the Vermont NATTS site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

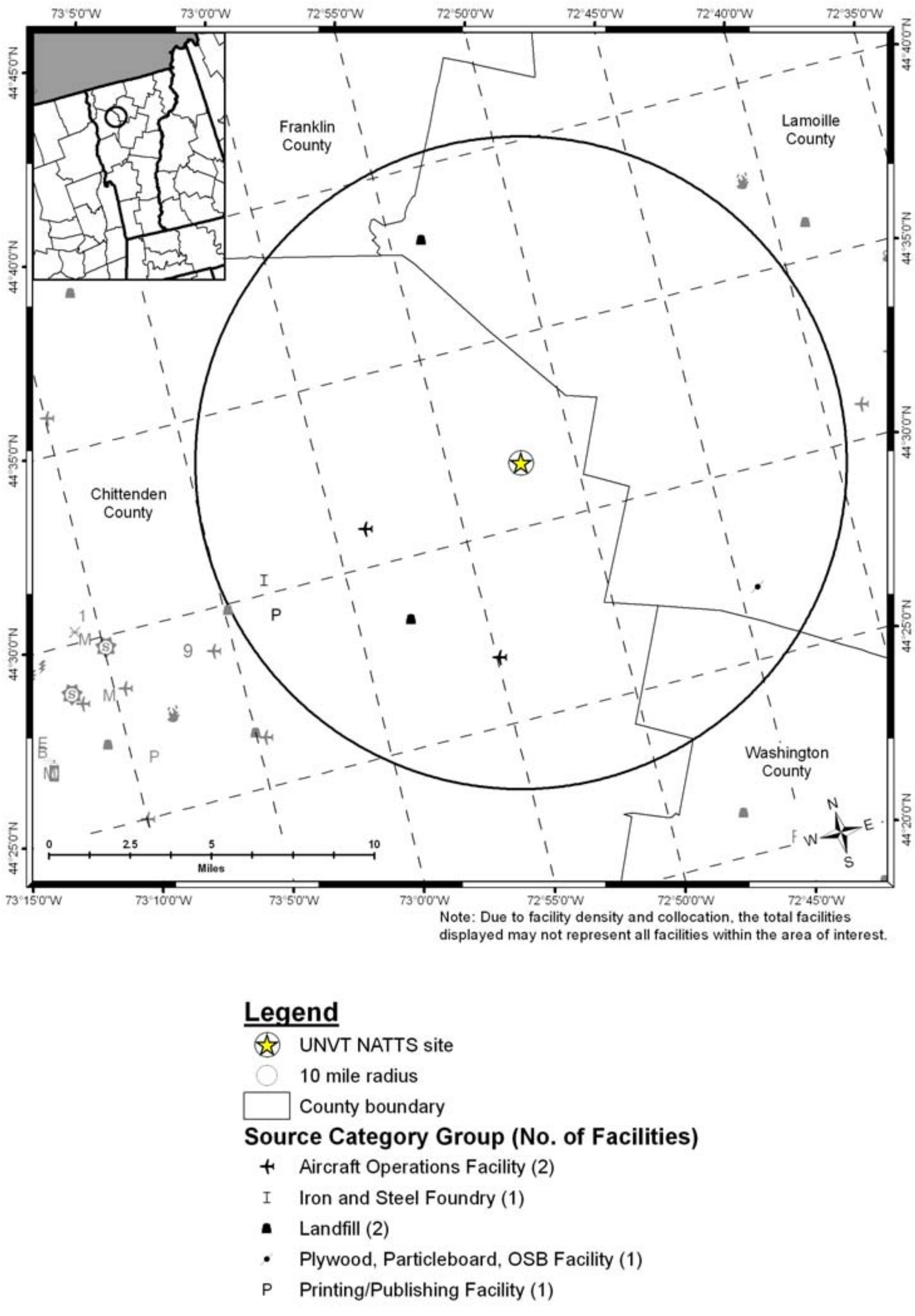
The Vermont NATTS site (UNVT) is located in the Burlington-South Burlington, VT MSA. Figure 30-1 is the composite satellite image retrieved from Google™ Earth showing the monitoring site in its rural location. Figure 30-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 30-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 30-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 30-1. Underhill, Vermont (UNVT) Monitoring Site



©2010 Google Earth, accessed 11/11/2010 Scale: 2 inches = 2,195 feet

Figure 30-2. NEI Point Sources Located Within 10 Miles of UNVT



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 30-1. Geographical Information for the Vermont NATTS Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
UNVT	50-007-0007	Underhill	Chittenden	Burlington-South Burlington, VT	44.52839, -72.86884	Forest	Rural	Haze, Sulfate, SO_2, VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM Coarse, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The UNVT monitoring site is located on the Proctor Maple Research Farm in Underhill, Vermont, east of the Burlington area. Mount Mansfield, the highest peak in Vermont, lies to the east in Underhill State Park, less than 3 miles away. The Underhill Artillery Range is a few miles to the south. Figure 30-1 shows that the area surrounding the site is rural in nature and heavily forested. This site is intended to serve as a background site for the region for trends assessment, standards compliance, and long-range transport assessment.

As Figure 30-2 shows, most of the emissions sources within 10 miles of UNVT are located to the southwest of the site and closer to the Burlington area. There are seven emissions sources located within 10 miles of UNVT, the closest of which are in the landfill source category and the aircraft operations source category, which includes airports as well as small runways, heliports, or landing pads.

Table 30-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Vermont NATTS site. Information provided in Table 30-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Chittenden County were obtained from the Vermont Department of Motor Vehicles Commissioners Office (VT DMV, 2010) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 30-2 also includes a vehicle registration-to-county population ratio (vehicles-per-person) for the site. In addition, the population within 10 miles of the site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 30-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 30-2 presents the daily VMT for the Burlington urban area.

Table 30-2. Population, Motor Vehicle, and Traffic Information for the Vermont NATTS Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
UNVT	152,313	223,316	1.47	14,408	21,125	1,200	3,236

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2010 data from the Vermont DMV (VT DMV, 2010).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2005 data from Chittenden County Regional Planning Commission (CCRPC, 2005).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 30-2 include the following:

- Chittenden County's population was in the bottom third compared on other counties with NMP sites. UNVT's 10-mile population is among the lowest compared to other NMP sites. Similar patterns are shown in the vehicle ownership data.

- UNVT has one of the highest vehicle-per-person ratios among all NMP sites (1.47), indicating that many people own more than one vehicle.

- The traffic volume experienced near UNVT was among the lower traffic counts for NMP sites. The traffic estimate for UNVT was for Pleasant Valley Road, north of Harvey Road.

- VMT for the Burlington area ranked among the lowest compared to other urban areas with NMP monitoring sites.

30.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the Vermont NATTS site on sample days, as well as over the course of each year.

30.2.1 Climate Summary

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 in winter than it could be given its New England location. The town of Underhill is located to the east of Burlington but still within the Burlington MSA. The state of Vermont is affected by frequent storm systems that track across the country, producing variable weather and often cloudy skies.

Summers in Vermont are pleasant, with warm days and cool nights, escaping much of the heat and humidity typical of the East Coast summer. Winters are warmer in the Champlain Valley region than in other portions of the state but snow is common state-wide. Precipitation is evenly distributed throughout the year. Average annual winds parallel the valleys, generally from the south ahead of advancing weather systems, or from the north behind these systems. These storm systems tend to be moderated somewhat due to the Adirondacks to the west and Green Mountains to the east (Bair, 1992; VGA, 2011; NCDC, 2011).

30.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest the Vermont NATTS site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station to UNVT is located at Morrisville-Stowe State Airport (WBAN 54771). Additional information about this weather station is provided in Table 30-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 30-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 30-3 is the 95 percent confidence interval for each parameter. As shown in Table 30-3, average meteorological conditions on sample days at UNVT were fairly representative of average weather conditions throughout the year for both years.

Table 30-3. Average Meteorological Conditions near the Vermont NATTS Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Underhill, Vermont - UNVT										
Morrisville-Stowe State Airport 54771 (44.53, -72.61)	11.84 miles 73° (ENE)	2008	Sample Day	54.1 ± 5.3	43.8 ± 5.0	34.2 ± 5.1	39.6 ± 4.7	72.0 ± 3.0	1016.4 ± 2.1	2.5 ± 0.5
			All Year	53.9 ± 2.1	43.7 ± 2.0	34.0 ± 2.0	39.5 ± 1.8	71.8 ± 1.1	1016.3 ± 0.9	2.9 ± 0.2
		2009	Sample Day	55.0 ± 5.1	45.0 ± 4.9	36.1 ± 5.0	41.0 ± 4.6	74.2 ± 2.9	1014.1 ± 2.2	3.0 ± 0.5
			All Year	53.3 ± 2.1	43.2 ± 2.0	34.1 ± 2.1	39.2 ± 1.9	72.9 ± 1.1	1016.7 ± 0.9	2.9 ± 0.2

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

30.2.3 Back Trajectory Analysis

Figure 30-3 and Figure 30-4 are the composite back trajectory maps for days on which samples were collected at the UNVT monitoring site in 2008 and 2009, respectively. Figure 30-5 is the cluster analysis for both years for UNVT, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 30-3 through 30-5 represents 100 miles.

Figure 30-3. 2008 Composite Back Trajectory Map for UNVT

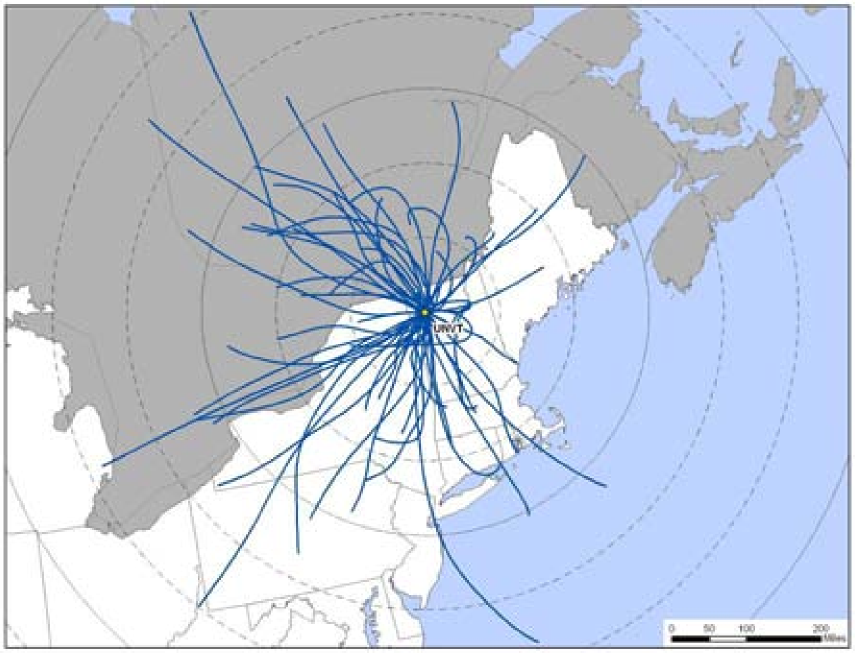


Figure 30-4. 2009 Composite Back Trajectory Map for UNVT

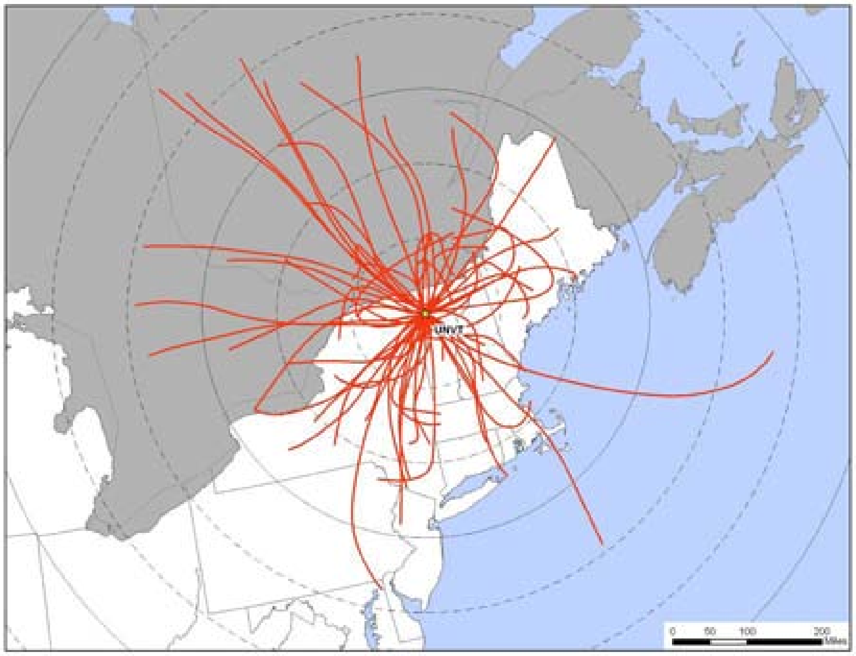
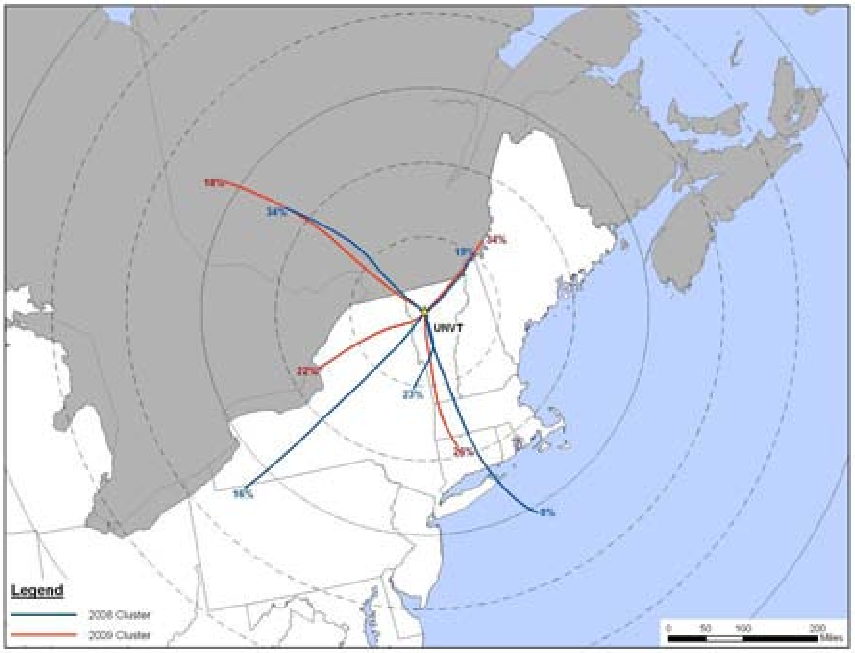


Figure 30-5. Back Trajectory Cluster Map for UNVT



Observations from Figures 30-3 through 30-5 for UNVT include the following:

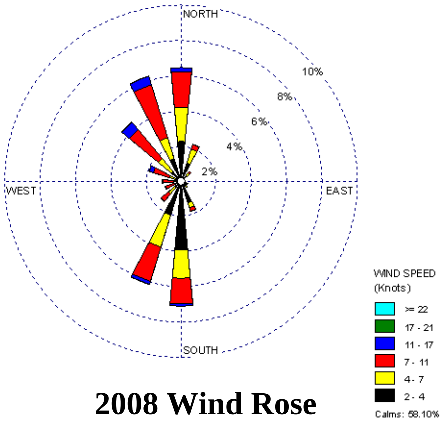
- Back trajectories originated from a variety of directions at UNVT.
- The farthest away a trajectory originated was near the bottom of James Bay in west-central Quebec, Canada, or over 500 miles away. However, the average trajectory length was 216 miles long and most trajectories (85 percent) originated within 350 miles of the site.
- Directionally, the cluster analysis for 2008 (blue) is very similar to the cluster analysis for 2009 (red). The cluster analyses show that trajectories originated from the west-northwest to north-northwest (34 percent in 2008, 18 percent in 2009); from the north to east and generally of shorter distance (19 percent in 2008, 18 percent in 2009); from the southeast to southwest (31 percent in 2008, 26 percent in 2009); and from the southwest to west or northwest and a shorter distance (16 percent in 2008, 22 percent in 2009).

30.2.4 Wind Rose Comparison

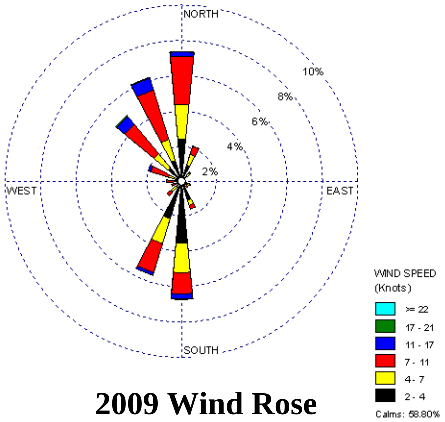
Hourly wind data from the NWS weather station at the Morrisville-Stowe State Airport near UNVT were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 30-6 presents five different wind roses for the UNVT monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

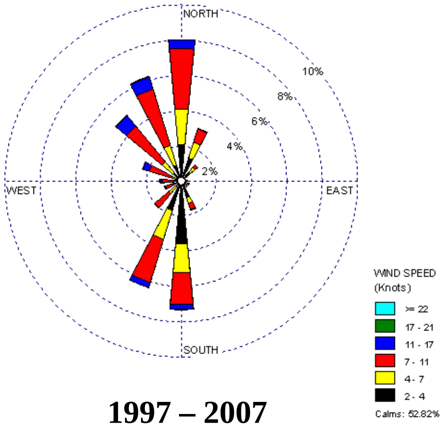
Figure 30-6. Wind Roses for the Morrisville-Stowe State Airport Weather Station near UNVT



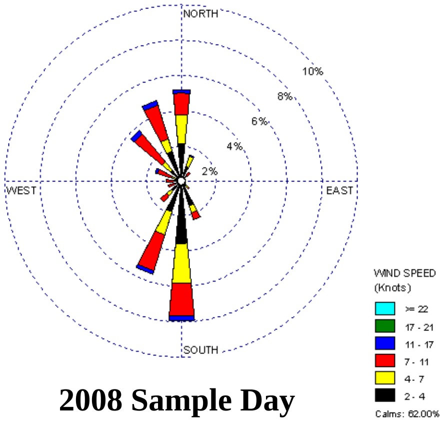
2008 Wind Rose



2009 Wind Rose

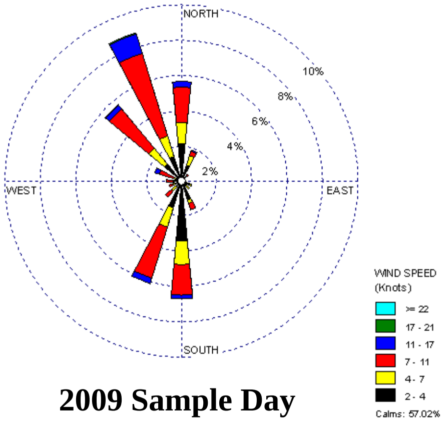


1997 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 30-6 for UNVT include the following:

- The historical wind rose shows that calm winds were prevalent near UNVT, as calm winds were observed for over one-half of the hourly measurements. Winds from the northwest to north account for nearly 20 percent of the wind observations greater than two knots and winds from the south to south-southwest account for another 13 percent of observations.

- The wind patterns shown on the 2008 and 2009 wind roses are similar to the historical wind patterns, indicating that conditions during these years were similar to wind conditions experienced historically.

- The 2008 sample day wind rose shows that a slightly lower percentage of the prevailing wind directions were measured on sample days compared to the full-year wind rose. Also, a slightly higher percentage of calm winds were observed on sample days.

- For 2009 sample days, a higher percentage of north-northwesterly winds and a lower percentage of northerly winds were observed compared to observations over the entire year.

30.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Vermont NATTS site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 30-4 presents the pollutants of interest for the Vermont NATTS site. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. UNVT sampled for VOC, carbonyl compounds, hexavalent chromium, PAH, and metals (PM_{10}).

Table 30-4. Risk Screening Results for the Vermont NATTS Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Underhill, Vermont - UNVT						
Arsenic (PM_{10})	0.00023	55	119	46.22	25.35	25.35
Carbon Tetrachloride	0.17	51	51	100.00	23.50	48.85
Benzene	0.13	49	51	96.08	22.58	71.43
Formaldehyde	0.077	26	26	100.00	11.98	83.41
Acetaldehyde	0.45	22	26	84.62	10.14	93.55
Naphthalene	0.029	7	90	7.78	3.23	96.77
1,2-Dichloroethane	0.038	3	3	100.00	1.38	98.16
Acrylonitrile	0.015	2	2	100.00	0.92	99.08
Benzo(a)pyrene	0.00091	1	21	4.76	0.46	99.54
Manganese (PM_{10})	0.005	1	119	0.84	0.46	100.00
Total		217	508	42.72		

Observations from Table 30-4 for UNVT include the following:

- Ten pollutants, of which eight are NATTS MQO Core Analytes, failed screens for UNVT.

- The preliminary risk screening identified six pollutants of interest: arsenic, benzene, carbon tetrachloride, formaldehyde, acetaldehyde, and naphthalene. Benzo(a)pyrene and manganese were added as pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of the total failed screens. Nine additional pollutants (four VOC, four metals, and hexavalent chromium) were added as pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. Trichloroethylene was not added because this pollutant was not detected at this site.

- Four pollutants (benzene, carbon tetrachloride, acrylonitrile, and 1,2-dichloroethane) failed 100 percent of screens for UNVT. Note the difference in detection rates among these pollutants (nearly 100 percent for benzene and carbon tetrachloride vs. four and six percent for acrylonitrile and 1,2-dichloroethane, respectively).

- Unlike other NMP sites sampling PM_{10} metals, the state of Vermont blank-corrects their metals data for UNVT. This involved averaging a set of lot blanks and subtracting this average concentration from the reported concentration for each pollutant, which results in slightly lower reported concentrations. Vermont maintains that by not blank-correcting their sample data, most of the concentrations reported would have been the result of background contamination on the filters rather than representing the actual concentration of each metal in the ambient air.

30.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Vermont NATTS site. Concentration averages are provided for the pollutants of interest, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries for UNVT are provided in Appendices J through O.

30.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for the Vermont NATTS site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 30-5, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium for UNVT are presented in ng/m^3 for ease of viewing.

Table 30-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Vermont NATTS Site

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Underhill, Vermont - UNVT												
Acetaldehyde	NR	NR	NR	NR	NR	NR	0.67 ± 0.12	NR	NR	0.59 ± 0.12	0.74 ± 0.19	NA
Benzene	NR	NR	NR	NR	NR	NR	0.30 ± 0.04	0.44 ± 0.09	0.34 ± 0.08	0.19 ± 0.03	0.29 ± 0.05	0.30 ± 0.04
1,3-Butadiene	NR	NR	NR	NR	NR	NR	0.01 ± <0.01	NA	NA	NA	NA	NA
Carbon Tetrachloride	NR	NR	NR	NR	NR	NR	0.75 ± 0.05	0.64 ± 0.05	0.70 ± 0.07	0.92 ± 0.10	0.70 ± 0.08	0.75 ± 0.05
Chloroform	NR	NR	NR	NR	NR	NR	0.10 ± 0.02	0.07 ± 0.02	0.08 ± 0.01	0.10 ± 0.01	0.13 ± 0.06	0.10 ± 0.02
Formaldehyde	NR	NR	NR	NR	NR	NR	1.23 ± 0.24	NR	NR	1.20 ± 0.30	1.26 ± 0.39	NA
Tetrachloroethylene	NR	NR	NR	NR	NR	NR	0.06 ± 0.01	NA	0.05 ± 0.02	NA	NA	NA
Vinyl Chloride	NR	NR	NR	NR	NR	NR	0.04 ± <0.01	NA	NA	NA	NA	NA
Arsenic (PM_{10})[a]	0.24 ± 0.04	0.23 ± 0.08	0.26 ± 0.11	0.26 ± 0.06	0.23 ± 0.07	0.24 ± 0.04	0.24 ± 0.04	0.24 ± 0.05	0.23 ± 0.07	0.26 ± 0.11	0.23 ± 0.11	0.24 ± 0.04
Benzo(a)pyrene[a]	0.28 ± 0.45	NR	NA	NA	NA	NA	0.07 ± 0.03	0.07 ± 0.04	NA	NA	NA	NA
Beryllium (PM_{10})[a]	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	NA	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	NA	NA	NA	NA
Cadmium (PM_{10})[a]	0.07 ± 0.01	0.07 ± 0.02	0.07 ± 0.03	0.05 ± 0.01	0.07 ± 0.03	0.07 ± 0.01	0.06 ± 0.01	0.07 ± 0.02	0.05 ± 0.01	0.06 ± 0.02	0.06 ± 0.02	0.06 ± 0.01

NR = Not available because sampling was not conducted by ERG during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 30-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Vermont NATTS Site (Continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Hexavalent Chromium [a]	0.01 ± <0.01	NA	NA	NA	NA	NA	0.02 ± 0.02	NA	NA	NA	NA	NA
Lead (PM$_{10}$) [a]	1.30 ± 0.23	1.49 ± 0.43	1.48 ± 0.65	0.99 ± 0.46	1.26 ± 0.34	1.30 ± 0.23	1.20 ± 0.16	1.38 ± 0.28	1.15 ± 0.36	1.08 ± 0.33	1.20 ± 0.40	1.20 ± 0.16
Manganese (PM$_{10}$) [a]	1.01 ± 0.28	0.82 ± 0.24	1.67 ± 1.07	0.94 ± 0.43	0.70 ± 0.31	1.01 ± 0.28	0.89 ± 0.15	0.89 ± 0.29	1.12 ± 0.36	0.85 ± 0.28	0.68 ± 0.28	0.89 ± 0.15
Naphthalene [a]	10.85 ± 4.32	NR	NA	5.85 ± 0.86	15.69 ± 7.77	NA	16.38 ± 6.21	33.05 ± 25.09	8.49 ± 2.11	9.38 ± 5.42	16.71 ± 5.54	16.38 ± 6.21
Nickel (PM$_{10}$) [a]	0.18 ± 0.10	0.09 ± 0.06	NA	NA	NA	NA	0.18 ± 0.04	0.19 ± 0.13	0.12 ± 0.04	0.11 ± 0.05	0.18 ± 0.07	0.15 ± 0.04

NR = Not available because sampling was not conducted by ERG during this time period.

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Observations for UNVT from Table 30-5 include the following:

- Metals and hexavalent chromium were sampled year-round at UNVT for 2008 and 2009. PAH sampling began in June 2008. VOC sampling at UNVT (with analysis by ERG) began in February 2009. Carbonyl compound sampling (with analysis by ERG) began in July 2009. These various start dates explain why some pollutants do not have quarterly or annual averages for some time frames.

- The pollutants with the highest daily average concentrations for UNVT are formaldehyde (1.23 ± 0.24 ng/m^3), carbon tetrachloride (0.75 ± 0.05 ng/m^3), and acetaldehyde (0.67 ± 0.12 ng/m^3). Note that each of these daily averages is for 2009.

- For metals and PAH, most of the daily average concentrations did not vary significantly from 2008 to 2009. One exception is naphthalene, which is higher for 2009 but also has a relatively high confidence interval. Table 30-5 shows that the first quarter 2009 average naphthalene concentration is higher than the other quarterly averages and has a relatively large confidence interval associated with it, indicating the presence of outliers. A review of the data shows that the naphthalene concentration for February 6, 2009 (182 ng/m^3) was more than twice the next highest concentration measured on January 19, 2009 (68.8 ng/m^3). Of the 12 concentrations of naphthalene greater than 20 ng/m^3, five were measured during the first quarter of 2009, two during the fourth quarter of 2008, and four during the fourth quarter of 2009. This suggests a quarterly variation in naphthalene concentrations (higher during colder months).

- The daily average concentration of benzo(a)pyrene for 2008 was much higher than the daily average concentration for 2009. In addition, the confidence interval for this average is higher than the average itself, which indicates that outliers are affecting this average concentration. The highest concentration was measured on November 26, 2008 (1.05 ng/m^3) and was nearly four times higher than the next highest concentration (0.269 ng/m^3) measured on January 19, 2009.

- Manganese had a relatively high second quarter 2008 average concentration and associated confidence interval. The two highest concentrations of this pollutant were both measured during this quarter, on April 18, 2008 and May 18, 2008. The manganese concentrations on these days were 6.74 ng/m^3 and 4.35 ng/m^3, respectively. Of the 119 measured detections of manganese, the median (50th percentile) was 0.73 ng/m^3 and the third quartile (75th percentile) was 1.16 ng/m^3.

- About half of UNVT's pollutants of interest do not have annual averages. This is due to several reasons: 1) sampling began late in the year, as was the case with PAH in 2008; 2) sampling was conducted on a 1-in-12 day sampling schedule, such as the case with carbonyl compounds; 3) the pollutant was not detected frequently enough, as is the case with hexavalent chromium; 4) or a combination of sampling schedule, duration, and a low detection rate.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Vermont NATTS site from those tables include the following:

- Compared to other sites sampling PM_{10} metals, UNVT had some of the lowest daily average concentrations for each of the program-wide PM_{10} metals pollutants of interest. This site also had some of the lowest daily average naphthalene concentrations among sites sampling PAH.

- Table 4-11 shows that UNVT had the eighth highest daily average concentration of benzo(a)pyrene among NMP sites sampling PAH (2008). As discussed above, this daily average concentration is being driven by an outlier. The daily average concentration of this pollutant for 2009 was much lower.

30.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. UNVT has sampled hexavalent chromium under the NMP since 2005. Thus, Figure 30-7 presents the 3-year rolling statistical metrics for hexavalent chromium for UNVT. The statistical metrics presented for calculating trends include the substitution of zeros for non-detects.

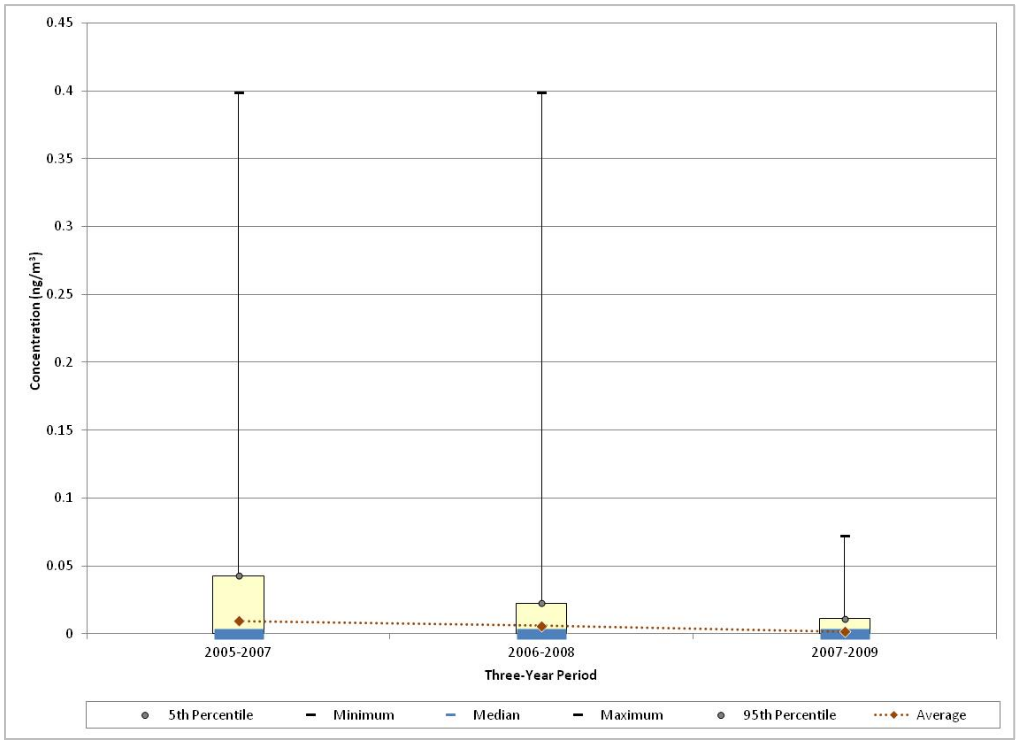
Observations from Figure 30-7 for hexavalent chromium measurements at UNVT include the following:

- The maximum hexavalent chromium concentration was measured at UNVT on June 16, 2006 (0.399 ng/m^3). The next highest hexavalent chromium concentration was measured on April 22, 2005 (0.101 ng/m^3). All other measurements of this pollutant were less than 0.1 ng/m^3.

- The rolling average concentration has decreased since the onset of sampling. However, the confidence intervals calculated for the first two 3-year periods are very large due to the presence of outliers. The 95th percentile exhibits a similar decrease as the rolling average.

- For all three time frames shown, the minimum, 5th percentile, and median concentrations are zero, indicating that at least 50 percent of the measurements are non-detects. The number of non-detects has varied over the years of sampling, from as low as 56 percent in 2005 to as high as 95 percent in 2009.

Figure 30-7. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at UNVT



30.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the Vermont NATTS site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

30.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Vermont NATTS site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the UNVT monitoring site were higher than their respective MRL noncancer health risk benchmarks.

30.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Vermont NATTS site and where the *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 30-6, where applicable.

Observations from Table 30-6 include the following:

- For 2008, the only pollutants of interest for UNVT for which annual average concentrations could be calculated were the metals. All annual averages for these pollutants are less than 0.01 $\mu g/m^3$. Arsenic is the only pollutant with a cancer surrogate risk approximation greater than 1.0 in-a-million (1.05 in-a-million). However, several of the PM_{10} metals do not have cancer UREs. The noncancer risk approximations for these pollutants are well below the level of concern, indicating virtually no noncancer health risks attributable to these metals.

- For 2009, the number of pollutants of interest for UNVT for which annual average concentrations could be calculated increased. Carbon tetrachloride, benzene, and arsenic have cancer surrogate risk approximations greater than 1.0 in-a-million (4.52, 2.34, and 1.02 in-a-million, respectively). Similar to 2008, the noncancer risk approximations for the pollutants where annual average concentrations could be calculated are well below the level of concern.

Table 30-6. Cancer and Noncancer Surrogate Risk Approximations for the Vermont NATTS Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Underhill, Vermont - UNVT										
Acetaldehyde	0.0000022	0.009	NR	NR	NR	NR	26/2	NA	NA	NA
Arsenic (PM_{10})[a]	0.0043	0.000015	59/4	<0.01 ± <0.01	1.05	0.02	60/4	<0.01 ± <0.01	1.02	0.02
Benzene	0.0000078	0.03	NR	NR	NR	NR	51/4	0.30 ± 0.04	2.34	0.01
Benzo(a)pyrene[a]	0.001	--	5/0	NA	NA	NA	16/1	NA	NA	NA
Beryllium (PM_{10})[a]	0.0024	0.00002	29/3	<0.01 ± <0.01	<0.01	<0.01	11/1	NA	NA	NA
1,3-Butadiene	0.00003	0.002	NR	NR	NR	NR	13/0	NA	NA	NA
Cadmium (PM_{10})[a]	0.0018	0.00001	59/4	<0.01 ± <0.01	0.12	0.01	60/4	<0.01 ± <0.01	0.11	0.01
Carbon Tetrachloride	0.000006	0.1	NR	NR	NR	NR	51/4	0.75 ± 0.05	4.52	0.01
Chloroform	--	0.098	NR	NR	NR	NR	51/4	0.10 ± 0.02	--	<0.01
Formaldehyde	0.000013	0.0098	NR	NR	NR	NR	26/2	NA	NA	NA
Hexavalent Chromium[a]	0.012	0.0001	4/0	NA	NA	NA	3/0	NA	NA	NA
Lead (PM_{10})[a]	--	0.00015	59/4	<0.01 ± <0.01	--	0.01	60/4	<0.01 ± <0.01	--	0.01
Manganese (PM_{10})[a]	--	0.00005	59/4	<0.01 ± <0.01	--	0.02	60/4	<0.01 ± <0.01	--	0.02

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

NR = Not reportable because sampling was not conducted by ERG during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 30-5.

Table 30-6. Cancer and Noncancer Surrogate Risk Approximations for the Vermont NATTS Site (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Naphthalene [a]	0.000034	0.003	29/2	NA	NA	NA	61/4	0.02 ± 0.01	0.56	0.01
Nickel (PM$_{10}$) [a]	0.000312	0.00009	23/1	NA	NA	NA	52/4	<0.01 ± <0.01	0.05	<0.01
Tetrachloroethylene	0.0000059	0.27	NR	NR	NR	NR	25/1	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	NR	NR	NR	NR	1/0	NA	NA	NA

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

NR = Not reportable because sampling was not conducted by ERG during this time period.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 30-5.

30.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 30-7 and 30-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 30-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million) for the Vermont NATTS site, as calculated from the annual averages. Table 30-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on the site's annual averages are limited to those pollutants for which each respective site sampled, as discussed in Section 30.3. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 30-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Vermont NATTS Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Underhill, Vermont (Chittenden County) - UNVT					
Benzene	143.23	Benzene	1.12E-03	Carbon Tetrachloride	4.52
Formaldehyde	80.56	Formaldehyde	1.01E-03	Benzene	2.34
Acetaldehyde	31.84	1,3-Butadiene	5.98E-04	Arsenic (PM_{10})	1.05
1,3-Butadiene	19.93	Naphthalene	2.78E-04	Arsenic (PM_{10})	1.02
Dichloromethane	14.65	POM, Group 2	2.38E-04	Naphthalene	0.56
Naphthalene	8.18	Arsenic, PM	2.29E-04	Cadmium (PM_{10})	0.12
Tetrachloroethylene	7.60	Hexavalent Chromium, PM	1.73E-04	Cadmium (PM_{10})	0.11
POM, Group 2	4.33	POM, Group 5	1.06E-04	Nickel (PM_{10})	0.05
p-Dichlorobenzene	3.19	Acetaldehyde	7.00E-05	Beryllium (PM_{10})	<0.01
Trichloroethylene	1.71	Tetrachloroethylene	4.48E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 30-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Vermont NATTS Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Underhill, Vermont (Chittenden County) - UNVT					
Toluene	445.75	Acrolein	630,526.02	Manganese (PM_{10})	0.02
Xylenes	330.13	Manganese, PM	51,923.36	Manganese (PM_{10})	0.02
Benzene	143.23	1,3-Butadiene	9,965.33	Arsenic (PM_{10})	0.02
Methanol	94.79	Formaldehyde	8,220.73	Arsenic (PM_{10})	0.02
Formaldehyde	80.56	Chlorine	6,351.91	Benzene	0.01
Ethylbenzene	74.17	Benzene	4,774.43	Lead (PM_{10})	0.01
Hexane	52.97	Acetaldehyde	3,537.72	Lead (PM_{10})	0.01
Hydrochloric acid	32.27	Xylenes	3,301.32	Carbon Tetrachloride	0.01
Acetaldehyde	31.84	Naphthalene	2,727.64	Cadmium (PM_{10})	0.01
Ethylene glycol	29.17	Nickel, PM	1,881.37	Cadmium (PM_{10})	0.01

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 30-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Chittenden County.

- Benzene was also the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by formaldehyde and 1,3-butadiene.

- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for Chittenden County.

- Benzene and carbon tetrachloride had the highest cancer risk approximations for UNVT. Benzene topped both emissions-based lists, while carbon tetrachloride appeared on neither emissions-based list.

- Arsenic, which had the third (2008) and fourth (2009) highest cancer risk approximations for UNVT, had the sixth highest toxicity-weighted emissions for Chittenden County. This pollutant did not appear on the list of highest emitted pollutants.

- POM Group 2 was the eighth highest emitted "pollutant" in Chittenden County and ranked fifth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at UNVT including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for UNVT. Benzo(a)pyrene is part of POM Group 5, which ranked eighth for toxicity-weighted emissions for Chittenden County.

Observations from Table 30-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Chittenden County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Chittenden County were acrolein, manganese, and 1,3-butadiene.

- Four of the highest emitted pollutants for Chittenden County also had the highest toxicity-weighted emissions.

- Although very low, manganese (both years) had the two highest noncancer risk approximations for UNVT. Manganese ranked second among the 10 pollutants with the highest toxicity-weighted emissions, but is not among the 10 highest emitted pollutants with noncancer RfCs.

- Benzene and carbon tetrachloride were the only non-metals among UNVT's highest noncancer risk approximations. Benzene appears on both emissions-based lists for

Chittenden County, while carbon tetrachloride appears on neither emissions-based list.

30.6 Summary of the 2008-2009 Monitoring Data for the Vermont NATTS Site

Results from several of the treatments described in this section include the following:

- *At the request of the Vermont Air Pollution Control Division, the results of the data analyses for BURVT and RUVT have been removed from this section.*

- *Ten pollutants failed screens for UNVT.*

- *Formaldehyde had the highest daily average concentration among the pollutants of interest for UNVT; this formaldehyde concentration was the only daily average concentration greater than 1.0 µg/m^3 among UNVT's daily average concentrations.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest for the UNVT monitoring site, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

31.0 Site in Virginia

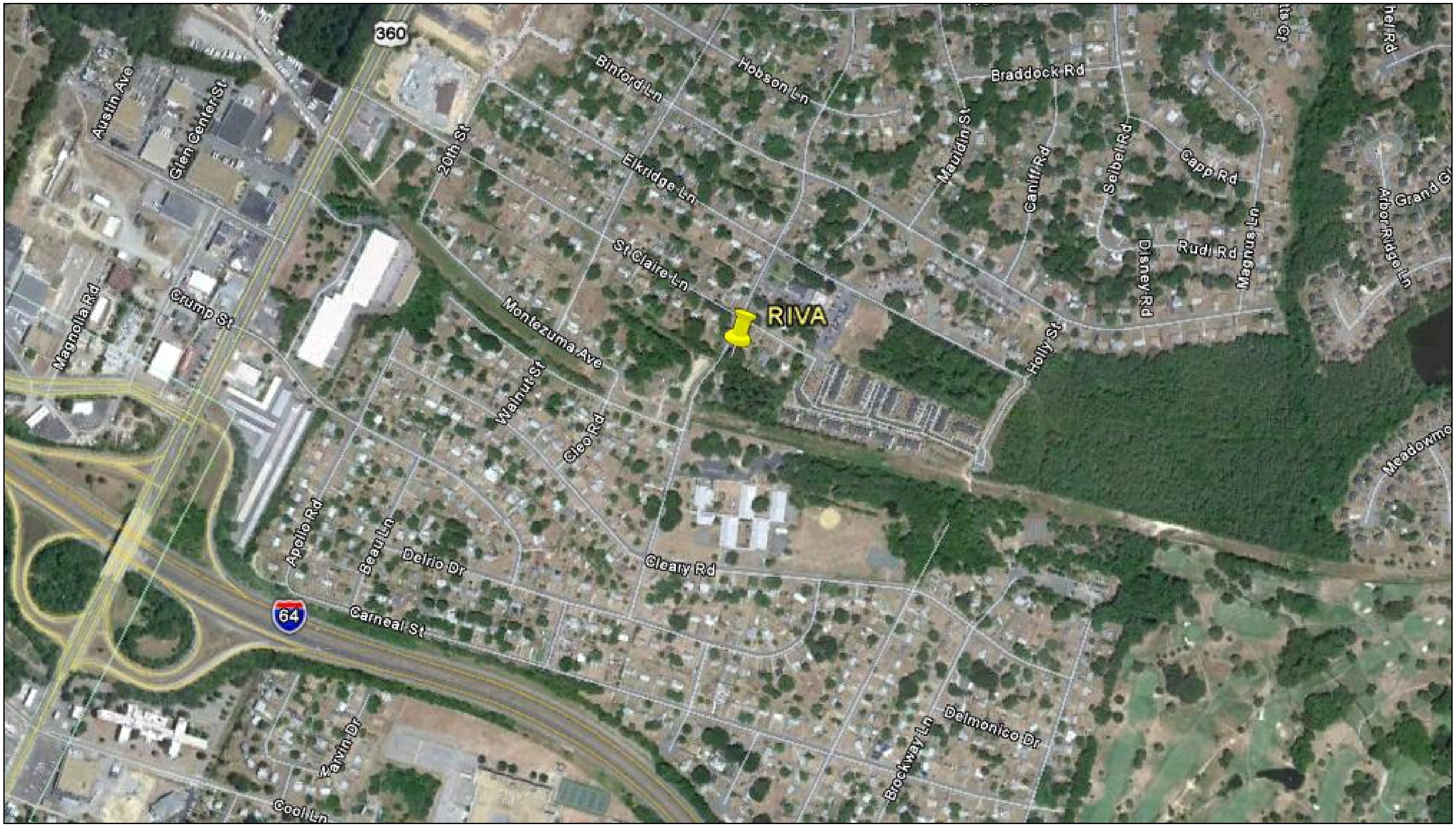
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Virginia, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

31.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The RIVA monitoring site is located just outside the Richmond, Virginia city limits. Figure 31-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its urban location. Figure 31-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 31-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 31-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

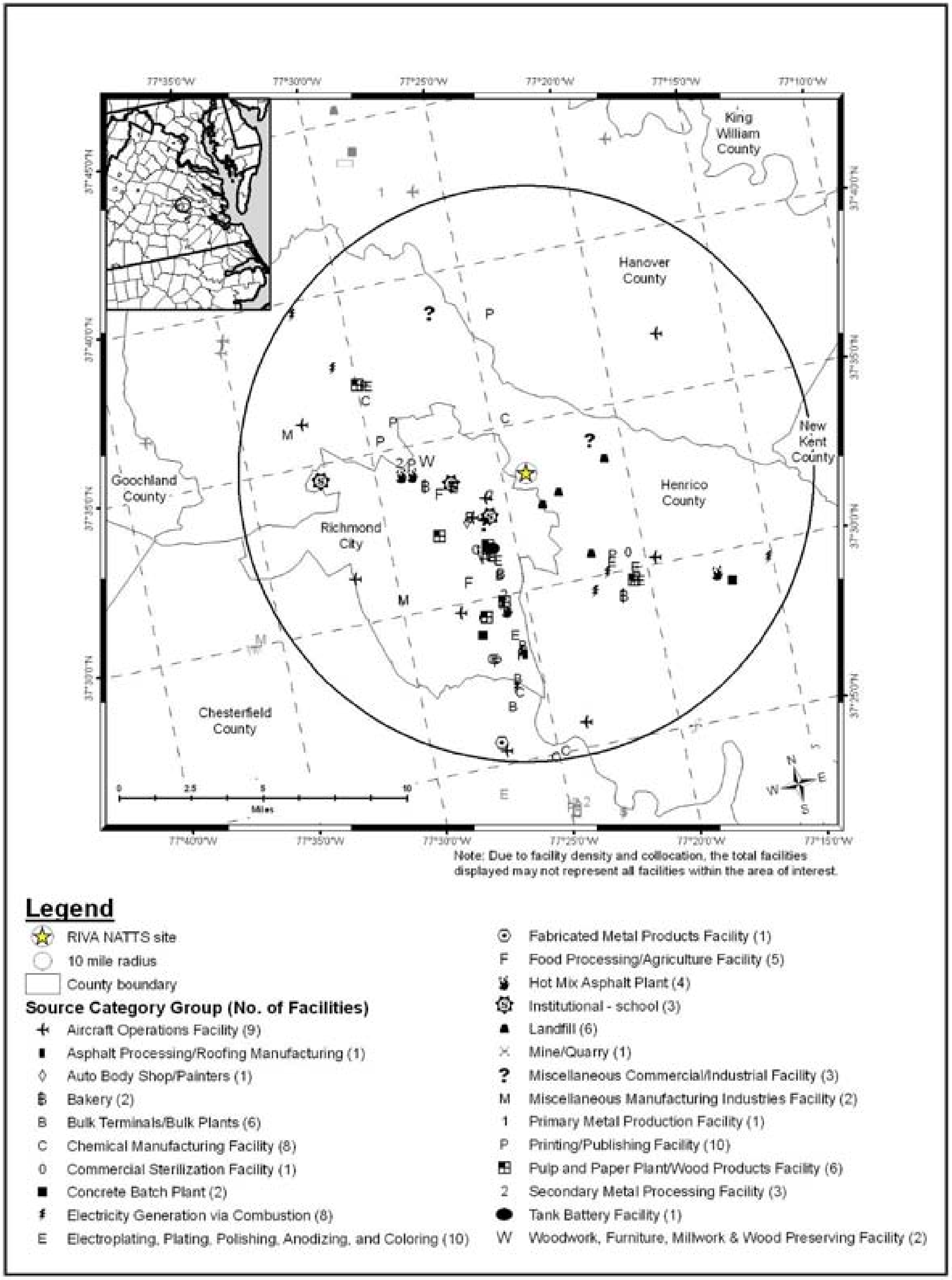
Figure 31-1. Richmond, Virginia (RIVA) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 1,864 feet

Figure 31-2. NEI Point Sources Located Within 10 Miles of RIVA


77°35'0"W
77°30'0"W
77°25'0"W
77°20'0"W
77°15'0"W
77°10'0"W
77°40'0"W
77°35'0"W
77°30'0"W
77°25'0"W
77°20'0"W
77°15'0"W
37°45'0"N
37°40'0"N
37°35'0"N
37°30'0"N
37°40'0"N
37°35'0"N
37°30'0"N
37°25'0"N
King William County
Hanover County
New Kent County
Goochland County
Richmond City
Henrico County
Chesterfield County
0
2.5
5
10
Miles
N
E
S
W
Legend
RIVA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (9)
Asphalt Processing/Roofing Manufacturing (1)
Auto Body Shop/Painters (1)
Bakery (2)
Bulk Terminals/Bulk Plants (6)
Chemical Manufacturing Facility (8)
Commercial Sterilization Facility (1)
Concrete Batch Plant (2)
Electricity Generation via Combustion (8)
Electroplating, Plating, Polishing, Anodizing, and Coloring (10)
Fabricated Metal Products Facility (1)
Food Processing/Agriculture Facility (5)
Hot Mix Asphalt Plant (4)
Institutional - school (3)
Landfill (6)
Mine/Quarry (1)
Miscellaneous Commercial/Industrial Facility (3)
Miscellaneous Manufacturing Industries Facility (2)
Primary Metal Production Facility (1)
Printing/Publishing Facility (10)
Pulp and Paper Plant/Wood Products Facility (6)
Secondary Metal Processing Facility (3)
Tank Battery Facility (1)
Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 31-1. Geographical Information for the Virginia Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
RIVA	51-087-0014	Not in a City	Henrico	Richmond-Petersburg, VA	37.558333, -77.400278	Residential	Suburban	TSP Metals, SO_2, NOy, NO, NO_2, NOx, PAMS, NMOC, VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM_{10} Metals, PM Coarse, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The RIVA monitoring site is located just northeast of the capital city of Richmond, in east-central Virginia. The site is located at the MathScience Innovation Center in a residential area less than 1/4 mile from I-64. The I-64 interchange with Mechanicsville Turnpike (360) is less than 1/2 mile southwest of the site. Figure 31-1 shows that beyond the residential areas surrounding the school property are a golf course to the southeast, a high school to the south, and commercial areas to the west. As Figure 31-2 shows, RIVA is located near several point sources, most of which are located in the city of Richmond. The sources closest to RIVA are landfills, a secondary metal processing facility, and a heliport at the Medical College of Virginia. The source categories with the highest number of emissions sources within 10 miles of RIVA are printing and publishing facilities; electroplating, plating, polishing, anodizing, and coloring facilities; aircraft operations, which include airports as well as small runways, heliports, or landing pads; electricity generation via combustion; and chemical manufacturers.

Table 31-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Virginia monitoring site. Information provided in Table 31-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Henrico County were obtained from the Revenue Division of Henrico County (Henrico County, 2010) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 31-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 31-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 31-2 presents the daily VMT for the Richmond area.

Table 31-2. Population, Motor Vehicle, and Traffic Information for the Virginia Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
RIVA	296,415	347,913	1.17	477,486	560,443	74,000	26,709

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Henrico County Revenue Department (Henrico County, 2010).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Virginia DOT (VA DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 31-2 include the following:

- RIVA's county-level population was in the lower third compared to other counties with NMP sites. The 10-mile population was in the middle of the range among NMP sites.
- The county-level vehicle ownership and 10-mile vehicle ownership were in the middle of the ranged compared to other NMP sites.
- The vehicle-per-person ratio was among the higher ratios compared to other NMP sites.
- The traffic volume experienced near RIVA was in the mid to upper end of the range compared to other NMP monitoring sites. The traffic estimate used came from the interchange of US-360 (Mechanicsville Turnpike) and I-64.
- The Richmond area VMT was in the middle of the range compared to other urban areas with NMP sites.

31.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Virginia on sample days, as well as over the course of each year.

31.2.1 Climate Summary

The city of Richmond is located in east-central Virginia, east of the Blue Ridge Mountains and west of the Chesapeake Bay. The James River flows through the west, center, and south parts of town. Richmond has a modified continental climate. Winters tend to be mild, as the mountains act as a barrier to cold air and the proximity to the Atlantic Ocean prevents temperatures from plummeting too low. Conversely, summers are warm and humid, also due to these influences. Precipitation is well distributed throughout the year (Bair, 1992).

31.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station is located at Richmond International Airport (WBAN 13740). Additional information about the Richmond International Airport weather station is provided in Table 31-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 31-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 31-3 is the 95 percent confidence interval for each parameter. As shown in Table 31-3, average meteorological conditions on 2008 sample days appear cooler, drier, and less windy than the average weather conditions throughout 2008. This is because sampling at RIVA did not begin until October 2008, thereby missing the warmest months of the year. Average meteorological conditions on 2009 sample days were fairly representative of average weather conditions throughout 2009.

Table 31-3. Average Meteorological Conditions near the Virginia Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Richmond, Virginia - RIVA										
Richmond International Airport 13740 (37.51, -77.32)	5.16 miles 117° (ESE)	2008	Sample Day	59.9 ± 6.7	49.8 ± 5.9	38.3 ± 7.5	44.7 ± 6.0	67.2 ± 6.7	1020.1 ± 3.9	4.7 ± 1.1
			All Year	69.9 ± 1.7	59.7 ± 1.6	45.9 ± 1.8	52.7 ± 1.5	64.2 ± 1.4	1017.9 ± 0.7	6.4 ± 0.3
		2009	Sample Day	69.4 ± 4.4	59.3 ± 4.2	46.3 ± 4.4	52.6 ± 3.8	65.6 ± 3.2	1016.3 ± 1.9	6.2 ± 0.7
			All Year	68.2 ± 1.8	58.6 ± 1.7	46.1 ± 1.9	52.3 ± 1.6	66.8 ± 1.5	1017.7 ± 0.7	6.2 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

31.2.3 Back Trajectory Analysis

Figure 31-3 and Figure 31-4 are the composite back trajectory maps for days on which samples were collected at the RIVA monitoring site in 2008 and 2009, respectively. Figure 31-5 is the cluster analysis for 2009. A cluster analysis could not be conducted for RIVA for 2008 because there were fewer than 30 sample days for this year. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analysis, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 31-3 through 31-5 represents 100 miles.

Figure 31-3. 2008 Composite Back Trajectory Map for RIVA

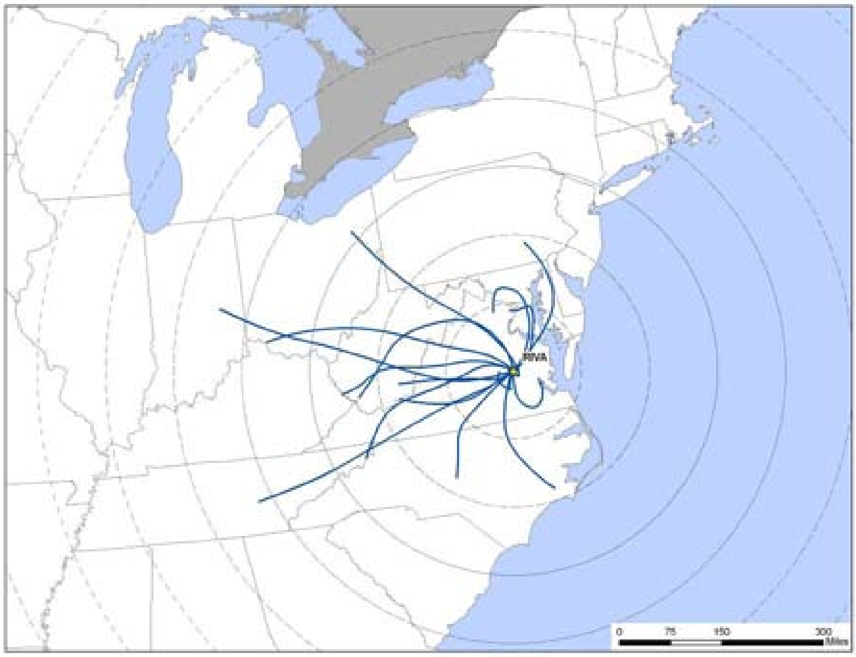


Figure 31-4. 2009 Composite Back Trajectory Map for RIVA

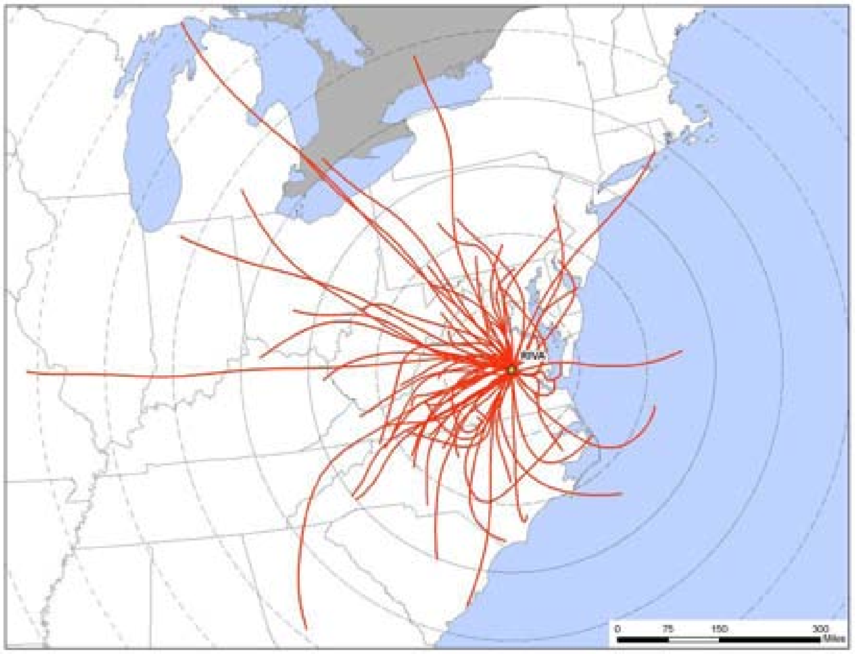
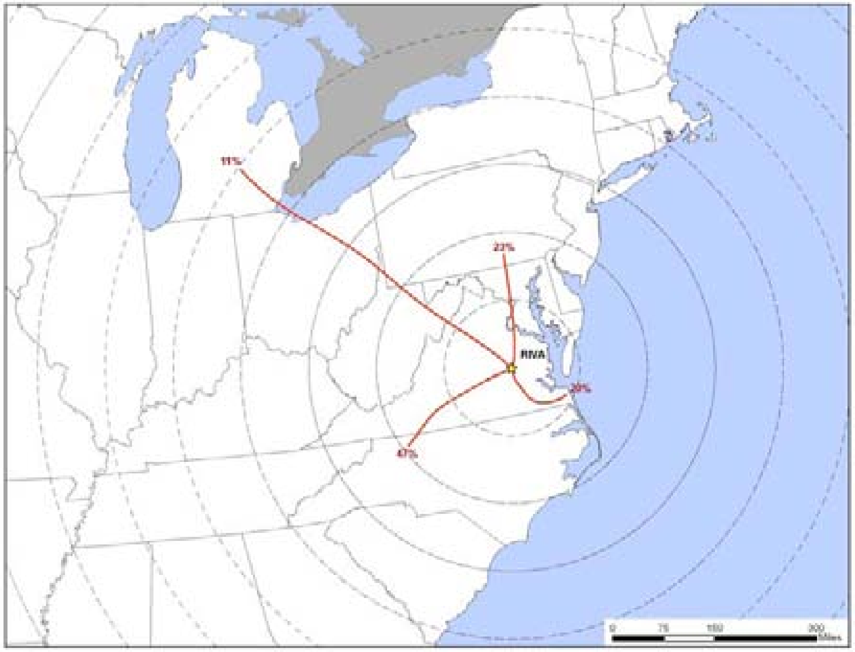


Figure 31-5. 2009 Back Trajectory Cluster Map for RIVA



Observations from Figures 31-3 through Figure 31-5 for RIVA include the following:

- The 24-hour air shed domain for RIVA was similar in size to many other NMP monitoring sites. The farthest away a trajectory originated was west of St. Louis, Missouri, or over 700 miles away. However, the average trajectory distance is 225 miles and most (88 percent) trajectories originated within 400 miles of the site.

- Back trajectories originated primarily to the southwest, west, and northwest of RIVA.

- Figure 31-3 includes only three months of sampling (October to December 2008). A composite back trajectory map incorporating the entire year's worth of sample day trajectories would exhibit a different trajectory distribution.

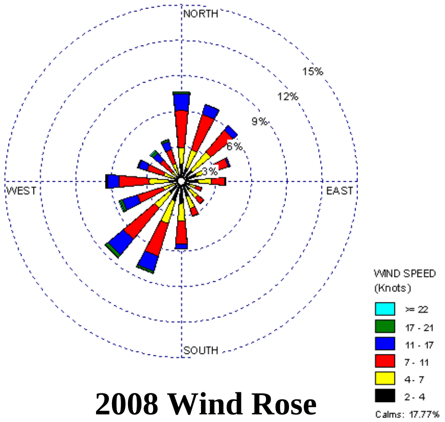
- The cluster analysis for 2009 shows that the majority of trajectories originated to the southwest, west, and northwest (as shown by the trajectory denoted by 47 percent). A majority of these trajectories were 200-300 miles in length. Eleven percent of trajectories originated to the west and northwest, and these trajectories tended to be longer in length, generally 300-500 miles long, which is why they are represented separately from the shorter cluster trajectory originating to the southwest of RIVA. The short trajectory originating and curving to the southeast (20 percent) represents trajectories originating to the southeast and east, but also several trajectories originating within 100 or so miles of the site. Another 23 percent of trajectories originated from the northwest to northeast.

31.2.4 Wind Rose Comparison

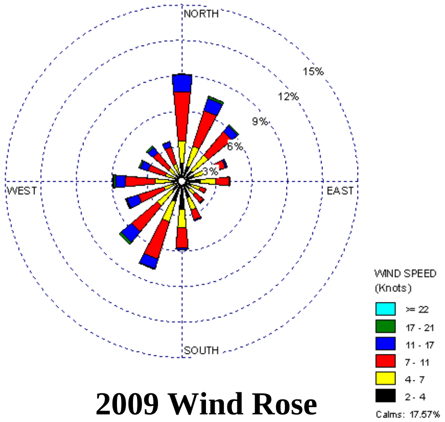
Hourly wind data from the NWS weather station at Richmond International Airport near RIVA were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 31-6 presents five different wind roses for the RIVA monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

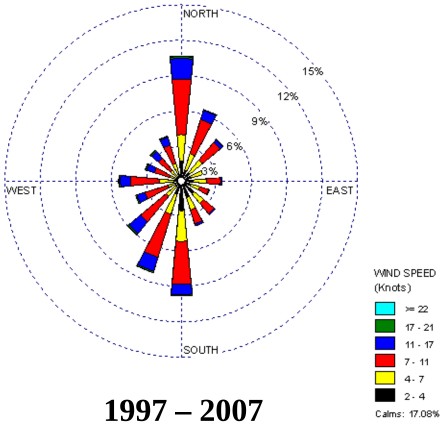
Figure 31-6. Wind Roses for the Richmond International Airport Weather Station near RIVA



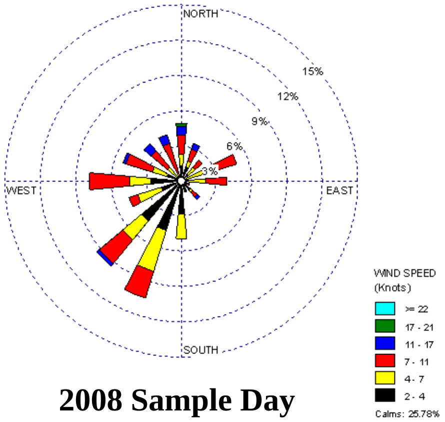
2008 Wind Rose



2009 Wind Rose

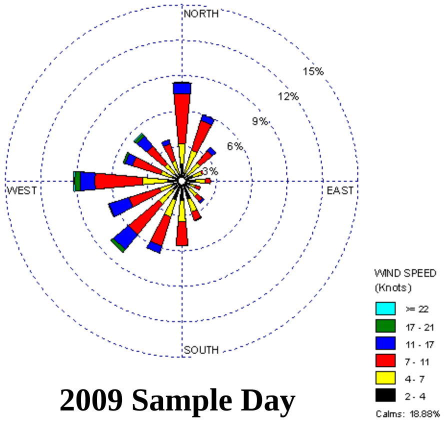


1997 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

Observations from Figure 31-6 for RIVA include the following:

- The historical wind rose shows that the most commonly observed wind direction is north, although winds from the north-northeast, south, south-southwest, and southwest were also frequently observed. Calm winds (≤ 2 knots) were observed for approximately 17 percent of the hourly wind measurements.

- The 2008 and 2009 wind roses resemble each other but show deviations from the historical observations. Rather than showing a northerly prominence, the 2008 and 2009 wind roses more evenly spread winds across the north, north-northeast, and northeast. The 2008 and 2009 wind roses also have a higher percentage of south-southwesterly and southwesterly winds and a decreased percentage of southerly winds. The calm rates for the 2008 and 2009 wind roses are very similar to the historical wind rose.

- The 2008 sample day wind rose exhibits a higher percentage of winds from the southwest quadrant and a lower percentage of northerly or northeasterly winds than the full-year wind rose. The 2008 sample day wind rose also shows lighter winds, as the calm rate is nearly 26 percent; there is also a higher percentage of black and yellow colors on the wind rose petals indicating a higher percentage of lighter wind speeds. Recall that sampling at RIVA did not begin until October 2008, which could explain these differences.

- The 2009 sample day wind patterns are more like the full-year wind patterns, but show a higher percentage of westerly winds and a lower percentage of north-northeasterly to northeasterly winds as well as fewer south-southwesterly winds.

31.3 Pollutants of Interest

Site- specific “pollutants of interest” were determined for the Virginia monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 31-4 presents RIVA's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. RIVA sampled for PAH and hexavalent chromium.

Table 31-4. Risk Screening Results for the Virginia Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Richmond, Virginia - RIVA						
Naphthalene	0.029	72	74	97.30	100.00	100.00
Total		72	74	97.30		

Observations from Table 31-4 include the following:

- Naphthalene was the only pollutant to fail at least one screen for RIVA. This pollutant was detected in every valid sample collected and failed 97 percent of its screens. Naphthalene is a NATTS MQO Core Analyte.

- While the risk screening process identified naphthalene as RIVA's only pollutant of interest, benzo(a)pyrene and hexavalent chromium were also added to this site's pollutants of interest. These two pollutants were added because they are NATTS MQO Core Analytes, even though they did not fail any screens. These two pollutants are not shown in Table 31-4.

31.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Virginia monitoring site. Concentration averages are provided for the pollutants of interest for the RIVA monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

31.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for RIVA, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated.

The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 31-5, where applicable. The averages presented in Table 31-5 are shown in ng/m^3 for ease of viewing.

Observations for RIVA from Table 31-5 include the following:

- The daily average concentrations of naphthalene are significantly higher than the daily average concentrations of hexavalent chromium and benzo(a)pyrene.

- Because sampling of PAH did not begin until October 2008, RIVA does not have first through third quarter averages or annual averages for 2008 for naphthalene. The fourth quarter average concentrations of naphthalene for both years have rather large confidence intervals, which indicate that these averages are likely influenced by outliers. The highest concentration of naphthalene was measured on October 4, 2009 (498 ng/m^3); similar concentrations were also measured on October 15, 2008 and November 9, 2009 (478 ng/m^3 and 476 ng/m^3, respectively). Of the fifteen naphthalene concentrations greater than 150 ng/m^3, eight were measured during the fourth quarter of 2009 and four during the fourth quarter of 2008. Two more were measured during the first quarter or 2009. This may indicate a seasonal trend in naphthalene concentrations, i.e. naphthalene concentrations tend to be higher during the colder months of the year.

- The 2008 daily average concentration of naphthalene for RIVA was the fifth highest daily average concentration of this pollutant among all NMP sites sampling PAH, as shown in Table 4-11. The 2009 daily average concentration of naphthalene ranked 21st.

- The quarterly and annual averages of benzo(a)pyrene, where they could be calculated, are fairly similar to each other. The fourth quarter average for 2009 has a relatively large confidence interval associated with it. The highest concentration of this pollutant was measured on December 9, 2009 (0.792 ng/m^3) and was twice the next highest concentration (0.396 ng/m^3, measured on February 6, 2009). Although difficult to discern from Table 31-5, benzo(a)pyrene concentrations also show some seasonal tendencies, as all but one of the 23 concentrations of this pollutant greater than 0.1 ng/m^3 were measured during the colder months of the years (first and fourth quarters).

- Hexavalent chromium was not detected enough for a single quarterly average concentration to be calculated. This pollutant was detected in 14 out of 76 valid samples.

Table 31-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Virginia Monitoring Site

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Richmond, Virginia - RIVA												
Benzo(a)pyrene	0.13 ± 0.05	NR	NR	NR	0.11 ± 0.05	NA	0.13 ± 0.05	0.13 ± 0.06	NA	NA	0.15 ± 0.10	NA
Hexavalent Chromium	0.01 ± <0.01	NR	NR	NR	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA
Naphthalene	149.52 ± 63.83	NR	NR	NR	149.52 ± 63.83	NA	113.47 ± 24.96	70.88 ± 23.57	77.91 ± 16.77	96.12 ± 14.60	201.87 ± 78.78	113.47 ± 24.96

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

NR = Not available because sampling was not conducted during this time period.

31.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. RIVA has not sampled continuously for 5 years as part of the NMP; therefore, the trends analysis was not conducted.

31.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the RIVA monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

31.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Virginia monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the RIVA monitoring site were higher than their respective MRL noncancer health risk benchmarks.

31.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Virginia monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 31-6, where applicable.

Table 31-6. Cancer and Noncancer Surrogate Risk Approximations for the Virginia Monitoring Site

			2008				2009			
			# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation	
Pollutant	**Cancer URE (µg/m^3)$^{-1}$**	**Noncancer RfC (mg/m^3)**			**Cancer (in-a-million)**	**Noncancer (HQ)**			**Cancer (in-a-million)**	**Noncancer (HQ)**
Richmond, Virginia - RIVA										
Benzo(a)pyrene	0.001	--	11/1	NA	NA	NA	36/2	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	3/0	NA	NA	NA	11/0	NA	NA	NA
Naphthalene	0.000034	0.003	13/1	NA	NA	NA	61/4	113.47 ± 24.96	3.86	0.04

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

Observations for RIVA from Table 31-6 include the following:

- Because PAH sampling did not begin until October 2008, annual averages (and therefore cancer and noncancer risk approximations) could not be calculated for the PAH for 2008.
- For 2009, annual averages (and therefore cancer and noncancer risk approximations) could not be calculated for benzo(a)pyrene because this pollutant did not meet the quarterly average criteria. Hexavalent chromium was not detected frequently enough in both years for annual averages to be calculated.
- The 2009 cancer surrogate risk approximation for naphthalene was 3.86 in-a-million. The 2009 noncancer risk approximation for naphthalene (0.04) was well below than the level of concern for noncancer, which is an HQ of 1.0.

31.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 31-7 and 31-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 31-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer surrogate risk approximations (in-a-million), as calculated from the annual averages. Table 31-8 presents similar information, but identifies the 10 pollutants with the highest noncancer surrogate risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 31.3, RIVA sampled for PAH and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 31-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Virginia Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Richmond, Virginia (Henrico County) - RIVA					
Benzene	183.14	Arsenic, PM	2.60E-03	Naphthalene	3.86
Formaldehyde	122.26	Hexavalent Chromium, PM	1.76E-03		
Acetaldehyde	45.76	Formaldehyde	1.53E-03		
1,3-Butadiene	32.34	Benzene	1.43E-03		
Dichloromethane	26.17	1,3-Butadiene	9.70E-04		
Tetrachloroethylene	19.00	Naphthalene	4.30E-04		
Naphthalene	12.64	Ethylene oxide	3.44E-04		
Ethylene oxide	3.91	POM, Group 2	1.60E-04		
POM, Group 2	2.90	Cadmium, PM	1.47E-04		
Trichloroethylene	1.59	Tetrachloroethylene	1.12E-04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 31-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Virginia Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Richmond, Virginia (Henrico County) - RIVA					
Toluene	1,125.69	Acrolein	347,813.75	Naphthalene	0.04
Methyl *tert*-butyl ether	339.99	Arsenic, PM	20,191.43		
Xylenes	308.58	1,3-Butadiene	16,170.73		
Hydrofluoric acid	222.25	Formaldehyde	12,475.38		
Benzene	183.14	Hydrofluoric acid	7,408.27		
Hydrochloric acid	130.82	Hydrochloric acid	6,540.84		
Formaldehyde	122.26	Benzene	6,104.78		
Ethylbenzene	70.05	Acetaldehyde	5,084.79		
Methyl isobutyl ketone	63.97	Naphthalene	4,213.07		
Hexane	57.15	Cadmium, PM	4,072.04		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Observations from Table 31-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Henrico County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) were arsenic, hexavalent chromium, and formaldehyde.
- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henrico County.
- Naphthalene, which was the only pollutant with a cancer risk approximation for RIVA, has the seventh highest emissions and the sixth highest toxicity-weighted emissions for Henrico County.
- Neither hexavalent chromium nor benzo(a)pyrene, the other pollutants of interest for RIVA, appear among the highest emitted pollutants. The same is also true for the toxicity-weighted emissions.
- POM Group 2 was the ninth highest emitted “pollutant” in Henrico County and ranked eighth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at RIVA including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for RIVA.

Observations from Table 31-8 include the following:

- Toluene, methyl *tert*-butyl ether, and xylenes were the highest emitted pollutants with noncancer RfCs in Henrico County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, arsenic, and 1,3-butadiene. Note that arsenic was at or near the top of the toxicity-weighted emissions for pollutants with cancer UREs and noncancer RfCs.
- Four of the highest emitted pollutants in Henrico County also have the highest toxicity-weighted emissions.
- Naphthalene, which was the only pollutant with a noncancer risk approximation for RIVA, has the ninth highest toxicity-weighted emissions for Henrico County. Naphthalene is not among the highest emitted pollutants with a noncancer toxicity factor in Henrico County.

31.6 Summary of the 2008-2009 Monitoring Data for RIVA

Results from several of the treatments described in this section include the following:

- *Naphthalene was the only pollutant to fail screens for RIVA. Two pollutants, hexavalent chromium and benzo(a)pyrene, were added to RIVA's pollutants of interest because they are NATTS MQO Core Analytes.*

- *The daily average concentrations of naphthalene were significantly higher than the daily average concentrations of the other two pollutants of interest. Naphthalene and benzo(a)pyrene concentrations appear to be higher during the colder months of the year.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

32.0 Sites in Washington

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and CSATAM sites in Washington, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

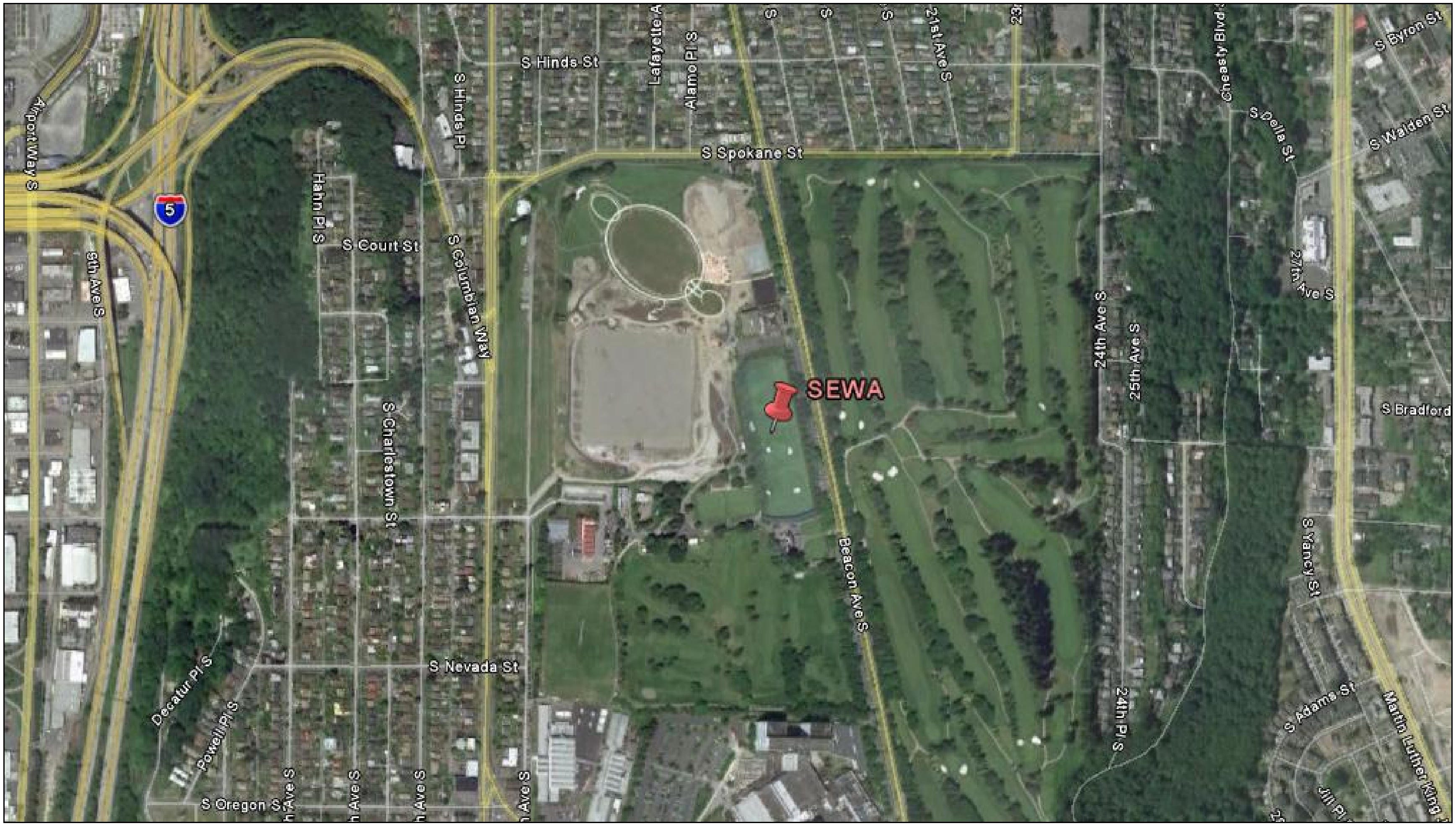
32.1 Site Characterization

This section characterizes the monitoring sites by providing geographical and physical information about the locations of the sites and the surrounding areas. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

There are five NMP sites located within the Seattle-Tacoma-Bellevue, WA MSA. One site (SEWA) is a NATTS site, while the other four are CSATAM sites (CEWA, EQWA, ESWA, and EYWA). These four sites are often referred to as the "Puget Sound sites" throughout Section 32, as these sites were part of a community air toxics study run by the Puget Sound Clean Air Agency.

Figures 32-1 through 32-5 are composite satellite images retrieved from Google™ Earth showing the monitoring sites in their urban locations. Figures 32-6 and 32-7 identify point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the sites are included in the facility counts provided below the maps in Figures 32-6 and 32-7. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the maps to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring sites; further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Table 32-1 describes the areas surrounding each monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

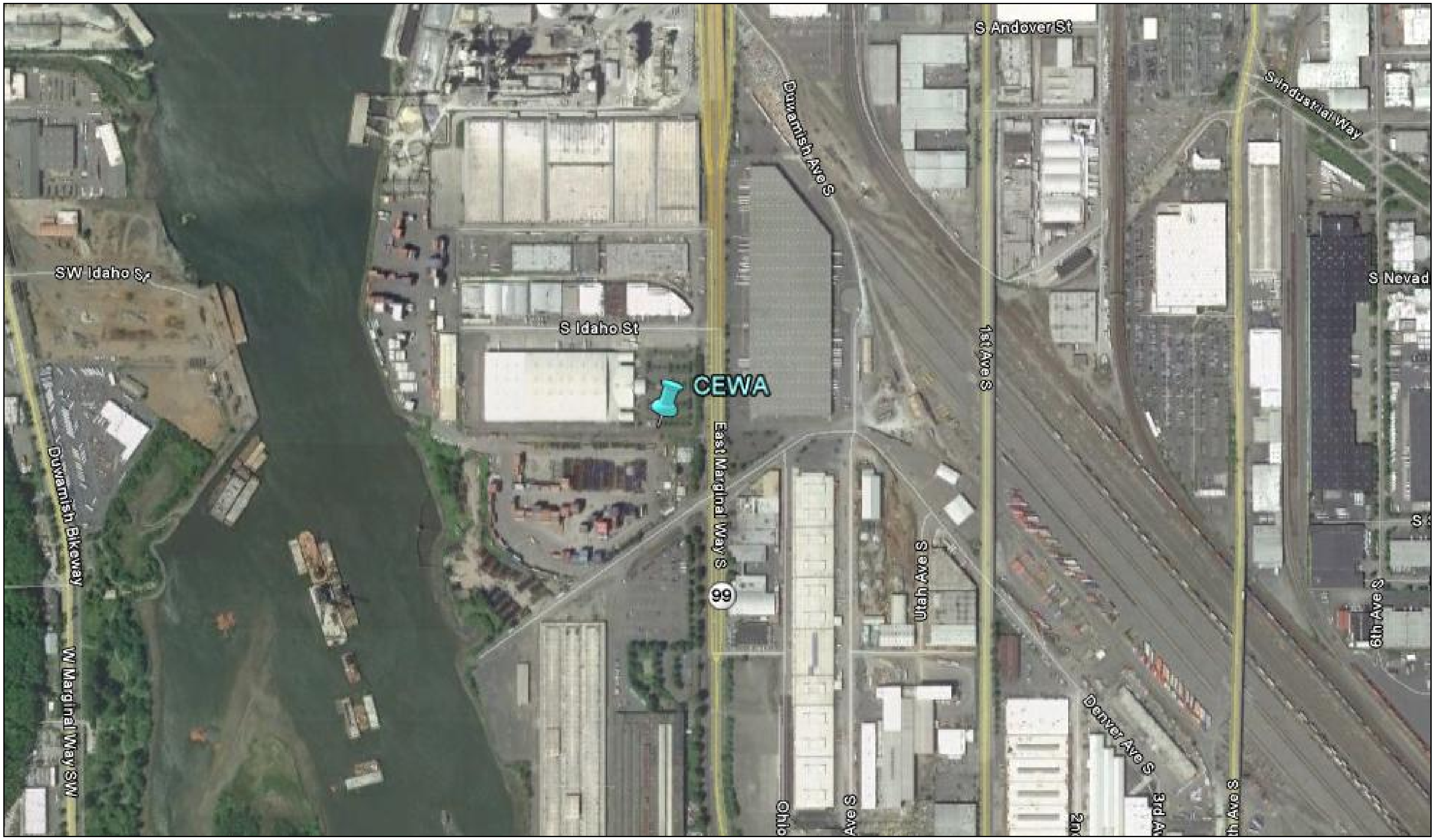
Figure 32-1. Seattle, Washington (SEWA) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 1,995 feet

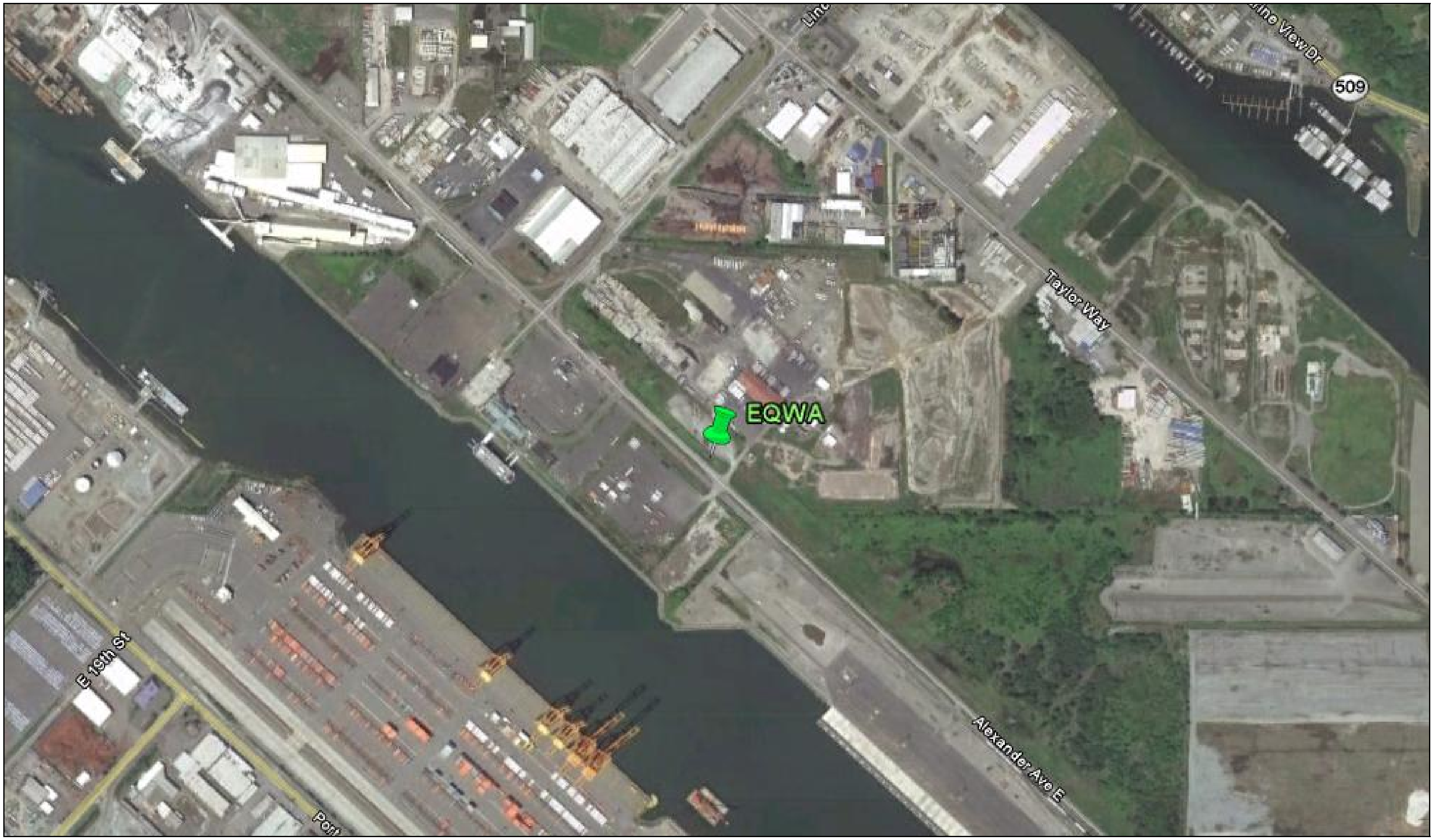
Figure 32-2. Duwamish, Seattle, Washington (CEWA) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 1,832 feet

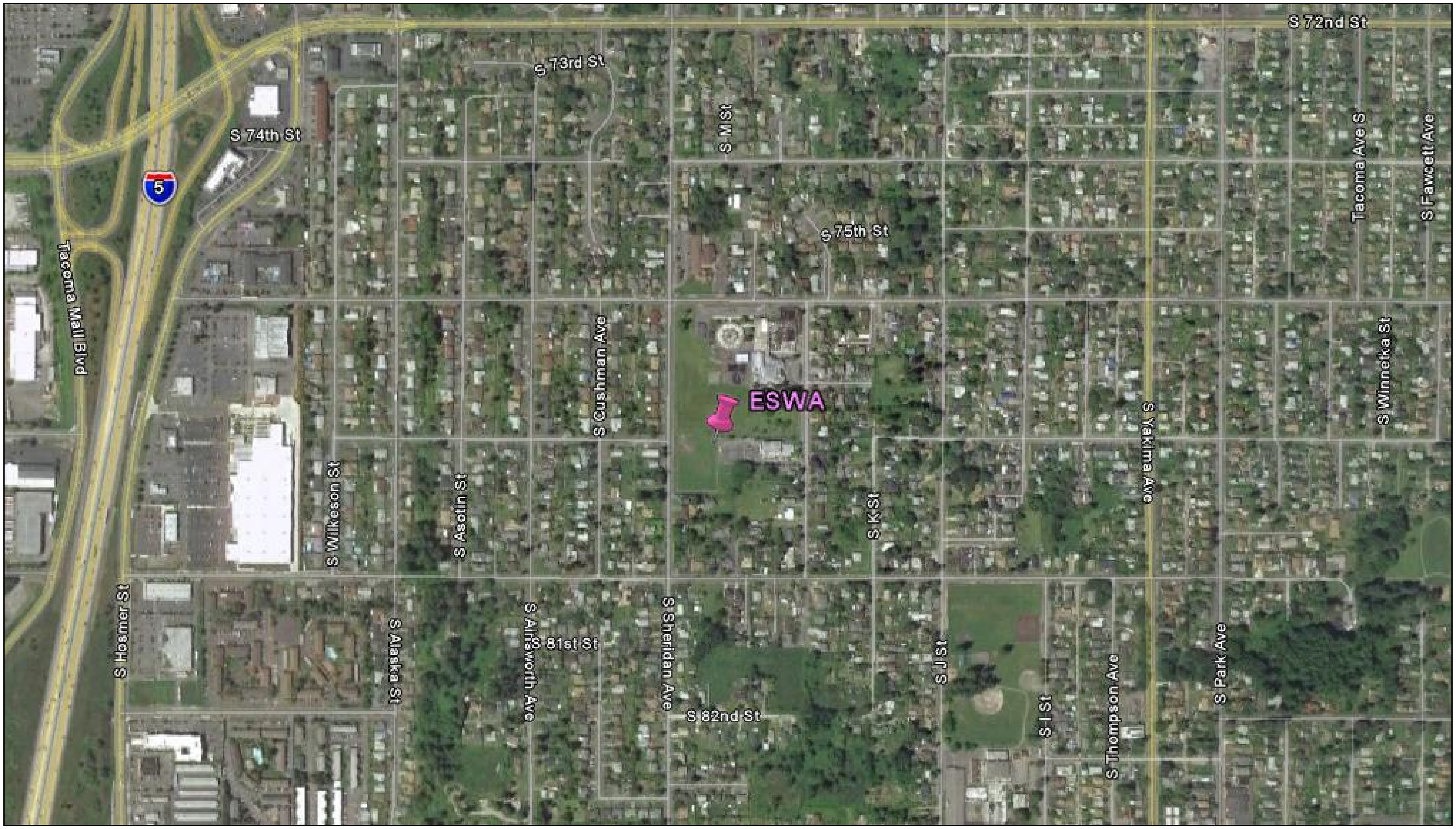
Figure 32-3. Tideflats, Tacoma, Washington (EQWA) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 2,009 feet

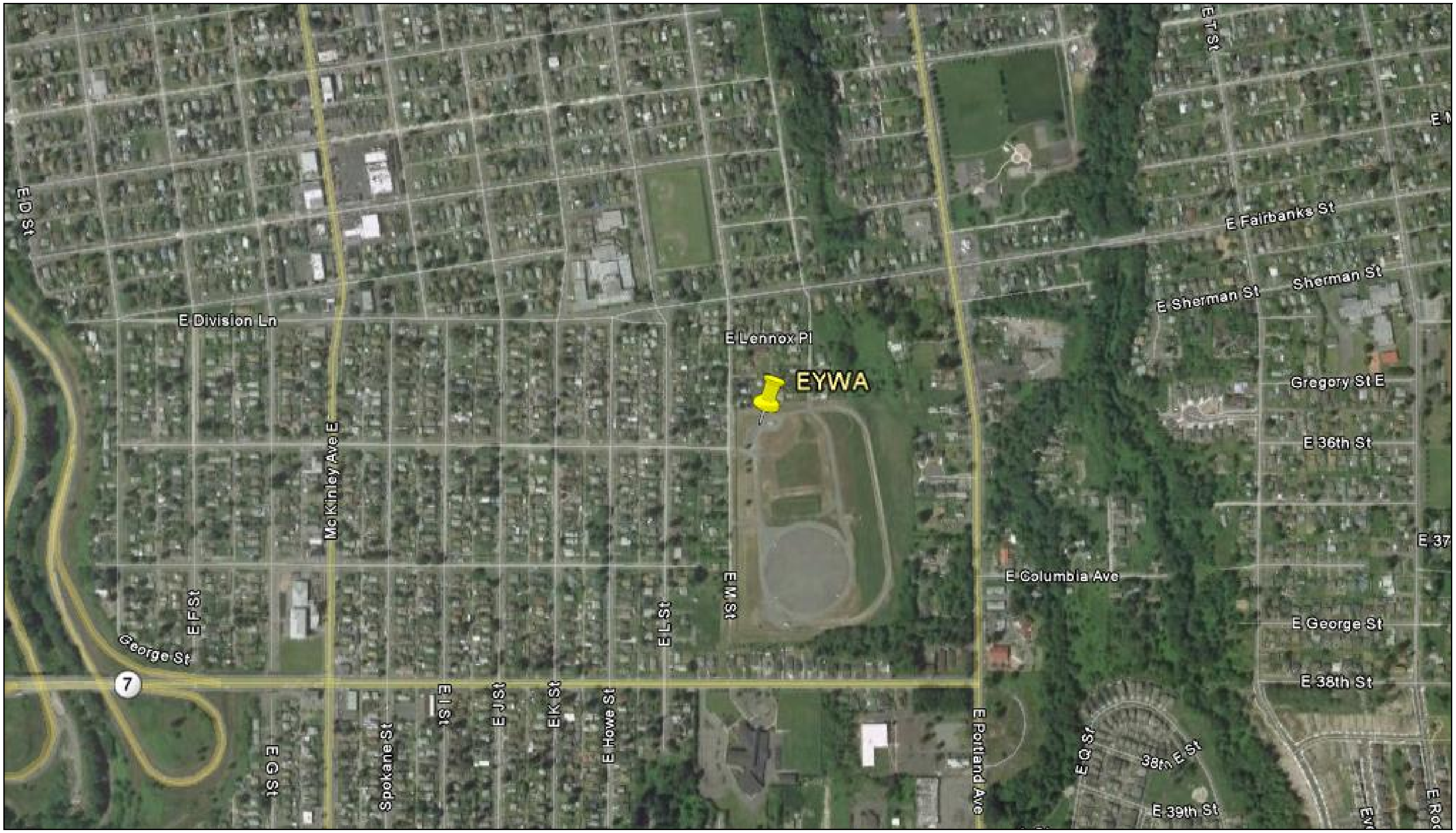
Figure 32-4. South Tacoma, Washington (ESWA) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

Scale: 2 inches = 1,904 feet

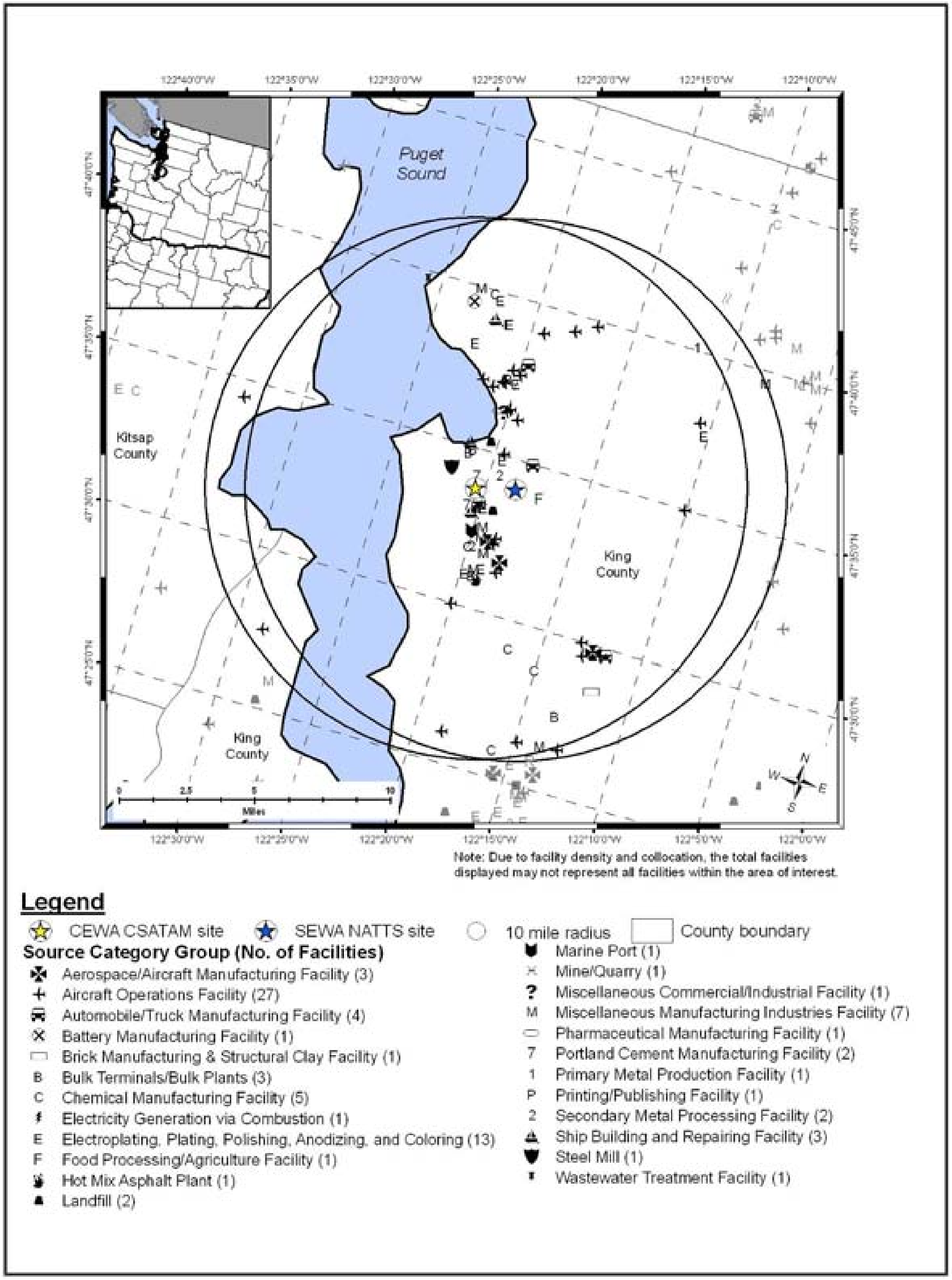
Figure 32-5. Portland Avenue Reservoir, Tacoma, Washington (EYWA) Monitoring Site



©2010 Google Earth, accessed 11/11/2010

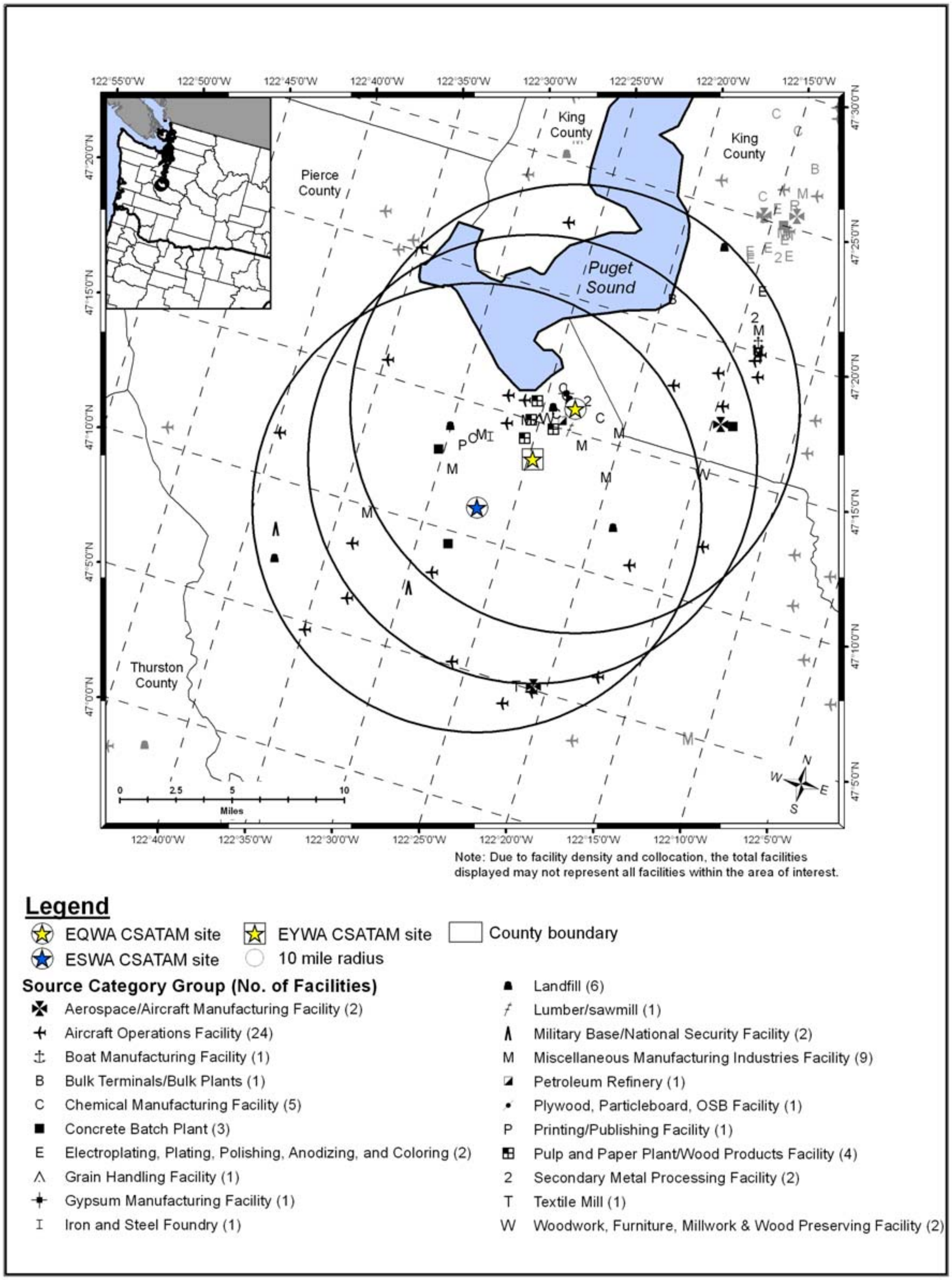
Scale: 2 inches = 1,996 feet

Figure 32-6. NEI Point Sources Located Within 10 Miles of SEWA and CEWA


Puget Sound
Kitsap County
King County
King County
0
2.5
5
10
Miles
Legend
CEWA CSATAM site
SEWA NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (3)
Aircraft Operations Facility (27)
Automobile/Truck Manufacturing Facility (4)
Battery Manufacturing Facility (1)
Brick Manufacturing & Structural Clay Facility (1)
B Bulk Terminals/Bulk Plants (3)
C Chemical Manufacturing Facility (5)
Electricity Generation via Combustion (1)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (13)
F Food Processing/Agriculture Facility (1)
Hot Mix Asphalt Plant (1)
Landfill (2)
Marine Port (1)
Mine/Quarry (1)
? Miscellaneous Commercial/Industrial Facility (1)
M Miscellaneous Manufacturing Industries Facility (7)
Pharmaceutical Manufacturing Facility (1)
7 Portland Cement Manufacturing Facility (2)
1 Primary Metal Production Facility (1)
P Printing/Publishing Facility (1)
2 Secondary Metal Processing Facility (2)
Ship Building and Repairing Facility (3)
Steel Mill (1)
Wastewater Treatment Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Figure 32-7. NEI Point Sources Located Within 10 Miles of EQWA, ESWA, and EYWA


122°55'0"W
122°50'0"W
122°45'0"W
122°40'0"W
122°35'0"W
122°30'0"W
122°25'0"W
122°20'0"W
122°15'0"W
47°30'0"N
47°25'0"N
47°20'0"N
47°15'0"N
47°10'0"N
47°5'0"N
47°0'0"N
King County
King County
Pierce County
Puget Sound
Thurston County
0
2.5
5
10
Miles
N
W
E
S
122°40'0"W
122°35'0"W
122°30'0"W
122°25'0"W
122°20'0"W
122°15'0"W
122°10'0"W
122°5'0"W
Legend
EQWA CSATAM site
EYWA CSATAM site
County boundary
ESWA CSATAM site
10 mile radius
Source Category Group (No. of Facilities)
Aerospace/Aircraft Manufacturing Facility (2)
Aircraft Operations Facility (24)
Boat Manufacturing Facility (1)
B Bulk Terminals/Bulk Plants (1)
C Chemical Manufacturing Facility (5)
Concrete Batch Plant (3)
E Electroplating, Plating, Polishing, Anodizing, and Coloring (2)
Grain Handling Facility (1)
Gypsum Manufacturing Facility (1)
I Iron and Steel Foundry (1)
Landfill (6)
Lumber/sawmill (1)
Military Base/National Security Facility (2)
M Miscellaneous Manufacturing Industries Facility (9)
Petroleum Refinery (1)
Plywood, Particleboard, OSB Facility (1)
P Printing/Publishing Facility (1)
Pulp and Paper Plant/Wood Products Facility (4)
2 Secondary Metal Processing Facility (2)
T Textile Mill (1)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (2)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 32-1. Geographical Information for the Washington Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
SEWA	53-033-0080	Seattle	King	Seattle-Tacoma-Bellevue, WA	47.568333, -122.308056	Industrial	Suburban	Haze, CO, SO_2, NOy, NO, O_3, Meteorological parameters, PM Coarse, PM_{10}, PM_{10} Speciated, Black Carbon, $PM_{2.5}$, $PM_{2.5}$ Speciation.
CEWA	53-033-0057	Seattle	King	Seattle-Tacoma-Bellevue, WA	47.5632, -122.3405	Industrial	Suburban	CO, SNMOC, Meteorological parameters, Black Carbon, $PM_{2.5}$, $PM_{2.5}$ Speciation.
EQWA	53-053-0031	Tacoma	Pierce	Seattle-Tacoma-Bellevue, WA	47.2656, -122.3858	Industrial	Suburban	CO, Meteorological parameters, Black Carbon, $PM_{2.5}$ Speciation.
ESWA	53-053-0029	Tacoma	Pierce	Seattle-Tacoma-Bellevue, WA	47.1864, -122.4517	Commercial	Suburban	Meteorological parameters, $PM_{2.5}$, Black Carbon, $PM_{2.5}$ Speciation.
EYWA	53-053-0034	Tacoma	Pierce	Seattle-Tacoma-Bellevue, WA	47.226666, -122.412166	Residential	Suburban	Meteorological parameters, Black Carbon, $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

The SEWA monitoring site is located in Seattle, at the southeast corner of the Beacon Hill Reservoir. The reservoir and the Jefferson Park Golf Course to the east are separated by Beacon Avenue. The reservoir, golf course, a middle school, and the VA Puget Sound Health Care System, located to the south, are surrounded by residential neighborhoods, as shown in Figure 32-1. Interstate-5, which runs north-south through Seattle, is less than 1 mile to the west and intersects with I-90 farther north. Interstate-90 runs east-west across Seattle, a couple of miles to the northwest of the site. The area to the west of I-5 is industrial while the area to the east is primarily residential.

The CEWA monitoring site is located near the Duwamish Waterway in the Industrial District of Seattle. This area is south of downtown and southeast of the Port of Seattle. This area experiences heavy traffic, with SR-99 running north-south (through the center of Figure 32-2) close to the monitoring site and intersecting with Spokane Street and the Seattle Bridge to the north. In addition, I-5 runs roughly parallel with SR-99 approximately 3/4 mile to the east of the site.

Figure 32-6 shows the proximity of the two Seattle monitoring sites to each other. CEWA is located approximately 1.5 miles west of the SEWA monitoring site. Most of the point sources surrounding these sites are located along a line running north-south and bisecting the 10-mile radii. A cluster of sources is located directly south of CEWA. Although the emissions sources within 10 miles of the sites are involved in a variety of activities, the aircraft operations (which include airports, as well as small runways, heliports, or landing pads) and electroplating, plating, polishing, anodizing, and coloring categories have the highest number of sources. The point source located closest to SEWA is involved in secondary metal processing while the point source closest to CEWA is involved in Portland cement manufacturing.

Figures 32-3 through 32-5 are the composite satellite images for the three monitoring sites in Tacoma. The EQWA monitoring site is located in the tidal flats of the Port of Tacoma, which is located off Commencement Bay at the southern end of Pudget Sound. This monitoring site is also in a heavily industrialized area, as shown in Figure 32-3. Just across the Blair

Waterway are a cargo yard, petroleum refinery, and railyard. The ESWA monitoring site is located in a South Tacoma residential area, as shown in Figure 32-4, behind Birney Elementary School. The site is located approximately 1/2 mile to the east of I-5. The EYWA monitoring site is located on the northwest corner of the Portland Avenue Reservoir in Tacoma. Residential areas surround the reservoir property, as shown in Figure 32-5. Interstate-5 is approximately 3/4 mile to the north of the site.

Figure 32-7 shows that the three Tacoma sites are located along a diagonal line running north-south through the city, south of Puget Sound. A cluster of point sources is located between EQWA and EYWA. These sources are primarily located at the Port of Tacoma. Similar to the Seattle sites, the emissions sources within 10 miles of the sites are involved in a variety of activities, and the aircraft operations source category has the highest number of sources. Locations with airport activity within 10 miles of the Tacoma sites include bigger airports such as Tacoma Narrows, military bases such as McCord Air Force Base, several smaller municipal airports (Shady Acres, Spanaway, Peirce County), as well as hospitals (Mary Bridge Children’s Hospital and St. Joseph’s Hospital).

Table 32-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the areas surrounding the Washington monitoring sites. Information provided in Table 32-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for King and Peirce Counties were obtained from the Washington State Department of Licensing (WA DOL, 2009) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 32-2 also includes vehicle registration-to-county population ratios (vehicles-per-person) for each site. In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding each monitoring site. Table 32-2 also contains annual average daily traffic information as well as the year of the traffic data estimate and the source from which it was obtained. Finally, Table 32-2 presents the daily VMT for the Seattle urban area.

Table 32-2. Population, Motor Vehicle, and Traffic Information for the Washington Monitoring Sites

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
CEWA	1,916,441	1,772,343	0.92	860,890	796,159	47,000	69,801
EQWA	796,836	757,027	0.95	641,623	609,568	21,000	69,801
ESWA	796,836	757,027	0.95	627,789	596,425	154,000	69,801
EYWA	796,836	757,027	0.95	694,266	659,581	196,000	69,801
SEWA	1,916,441	1,772,343	0.92	912,020	843,445	236,000	69,801

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2009 data from the Washington DOL (WA DOL, 2009).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2009 data from the Washington DOT (WA DOT, 2009).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
BOLD = EPA-designated NATTS Site.

Observations from Table 32-2 include the following:

- King County has more than twice the population as Pierce County and is among the most populous counties with NMP sites. By comparison, Pierce County was in the mid-to-upper range compared to other counties with NMP sites. The difference in population between the two is less at the 10-mile level.

- King County has more than twice the number of vehicles as Pierce County and is among the counties with the highest vehicle registrations. By comparison, Pierce County is in the mid-to-upper range among other counties with NMP sites. The difference in vehicle ownership is also less at the 10-mile level.

- The vehicle-per-person ratios were about the same for both counties and were in the middle of the range compared to other NMP sites.

- The traffic volume experienced near SEWA was the third highest compared to other NMP monitoring sites. The traffic estimate used came from I-5 near Spokane Street. Traffic near EYWA and ESWA were also among the highest traffic counts and came from I-5 near Portland Avenue, just past I-705, and I-5 at exit 129, respectively. The traffic volumes near the other sites were considerably lower and came from the following: SR-99 at Spokane Street for CEWA and SR-509 at Norpoint Way for EQWA.

- The Seattle area VMT was in the mid-to-upper range among urban areas with NMP sites.

32.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring sites in Washington on sample days, as well as over the course of each year for SEWA and over the study period for the remaining sites.

32.2.1 Climate Summary

The city of Seattle is located between Puget Sound and Lake Washington, and the city of Tacoma is located farther south along the bottom of the Sound. The entire urban area is situated between the Olympic Mountains to the west and the Cascades to the east. The area 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 temperature extremes. Although the city is known for its cloudy, rainy conditions, the actual precipitation totals tend to be lower compared to many locations east of the Rocky Mountains. The winter months are the wettest and the summer months the driest. Prevailing winds are out of the southwest (Bair, 1992).

32.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather stations nearest these sites were retrieved for all of 2008 and 2009 for SEWA and for the November 2008 to October 2009 study period for the Puget Sound sites (NCDC, 2008 and 2009). The closest NWS weather station to CEWA and SEWA is located at Boeing Field/King County International Airport (WBAN 24234). The closest NWS weather station to the three Tacoma sites is located at the Tacoma Narrows Airport (WBAN 94274). Additional information about these weather stations is provided in Table 32-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the years of sampling and over the study period.

Table 32-3. Average Meteorological Conditions near the Washington Monitoring Sites

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Seattle, Washington - SEWA										
Boeing Field/ King County Intl Airport 24234 (47.53, -122.30)	2.67 miles 190° (S)	2008	Sample Day	57.5 ± 3.3	51.1 ± 2.8	41.3 ± 2.3	46.3 ± 2.3	71.7 ± 2.7	1018.5 ± 1.7	4.6 ± 0.6
			All Year	58.1 ± 1.3	51.4 ± 1.1	42.0 ± 0.9	46.7 ± 0.9	72.5 ± 1.1	1017.8 ± 0.7	4.5 ± 0.2
		2009	Sample Day	59.1 ± 3.1	51.9 ± 2.8	41.9 ± 2.5	47.0 ± 2.4	71.6 ± 2.9	1017.0 ± 1.5	4.5 ± 0.6
			All Year	60.1 ± 1.4	52.7 ± 1.2	42.6 ± 1.0	47.6 ± 1.0	71.5 ± 1.2	1017.5 ± 0.7	4.3 ± 0.2
Duwamish, Seattle, Washington - CEWA										
Boeing Field/ King County Intl Airport 24234 (47.53, -122.30)	2.88 miles 159° (SSE)	Nov 2008-Oct 2009	Sample Day	59.2 ± 3.6	52.6 ± 3.0	43.3 ± 2.4	47.9 ± 2.5	73.6 ± 3.3	1017.2 ± 1.7	4.7 ± 0.6
			All Days	59.9 ± 1.5	52.7 ± 1.2	43.0 ± 0.9	47.8 ± 1.0	72.6 ± 1.3	1017.5 ± 0.7	4.3 ± 0.2
Tideflats, Tacoma, Washington - EQWA										
Tacoma Narrows Airport 94274 (47.27, -122.58)	8.44 miles 288° (WNW)	Nov 2008-Oct 2009	Sample Day	57.8 ± 3.4	51.1 ± 2.7	42.5 ± 2.3	46.8 ± 2.3	75.1 ± 3.1	1017.2 ± 1.7	5.0 ± 0.8
			All Days	58.2 ± 1.4	51.0 ± 1.2	42.1 ± 1.0	46.6 ± 0.9	74.1 ± 1.3	1017.6 ± 0.7	4.7 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full-year averages.

Table 32-3. Average Meteorological Conditions near the Washington Monitoring Sites (Continued)

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Birney Elementary School, Tacoma, Washington - ESWA										
Tacoma Narrows Airport 94274 (47.27, -122.58)	7.89 miles 332° (NNW)	Nov 2008-Oct 2009	Sample Day	57.5 ± 3.5	50.9 ± 2.7	42.3 ± 2.4	46.7 ± 2.3	75.3 ± 3.2	1017.3 ± 1.7	4.9 ± 0.8
			All Days	58.2 ± 1.4	51.0 ± 1.2	42.1 ± 1.0	46.6 ± 0.9	74.1 ± 1.3	1017.6 ± 0.7	4.7 ± 0.3
Portland Avenue Reservoir, Tacoma, Washington - EYWA										
Tacoma Narrows Airport 94274 (47.27, -122.58)	7.81 miles 308° (NW)	Nov 2008-Oct 2009	Sample Day	57.6 ± 3.5	51.0 ± 2.8	42.3 ± 2.4	46.7 ± 2.4	75.0 ± 3.2	1017.4 ± 1.7	4.9 ± 0.8
			All Days	58.3 ± 1.5	51.0 ± 1.2	42.1 ± 1.0	46.6 ± 1.0	74.0 ± 1.3	1017.7 ± 0.7	4.7 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full-year averages.

Table 32-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009 for SEWA. Similar information is presented for the Puget Sound sites for days samples were collected and for the entire study period. Also included in Table 32-3 is the 95 percent confidence interval for each parameter. As shown in Table 32-3, average meteorological conditions on sample days near SEWA were representative of average weather conditions throughout the year for both years. Average meteorological conditions on sample days near the Puget Sound sites were representative of average weather conditions throughout the study period. Note that the study period averages for EYWA are different than EQWA and ESWA, even though the data are from the same weather station. EYWA began sampling on November 8, 2008 while the other sites began sampling on November 2, 2008; thus, six less days are incorporated into EYWA’s meteorological averages.

32.2.3 Back Trajectory Analysis

Figure 32-8 and Figure 32-9 are the composite back trajectory maps for days on which samples were collected at the SEWA monitoring site in 2008 and 2009, respectively. Figure 32-10 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. The back trajectory figures for the Puget Sound sites are a little different. Figure 32-11 is the composite back trajectory map for days on which samples were collected at the CEWA monitoring site over the sample period from November 2008 to October 2009 (note that 2008 sample day trajectories are shown in blue and 2009 sample day trajectories are shown in red). Figure 32-12 is the cluster analysis based on back trajectories over the entire study period. Thus, there is one less figure for each Puget Sound site. Figures 32-13 through 32-18 are the composite back trajectory maps for the three Tacoma monitoring sites and the associated cluster analyses for the study period. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1.

Figure 32-8. 2008 Composite Back Trajectory Map for SEWA

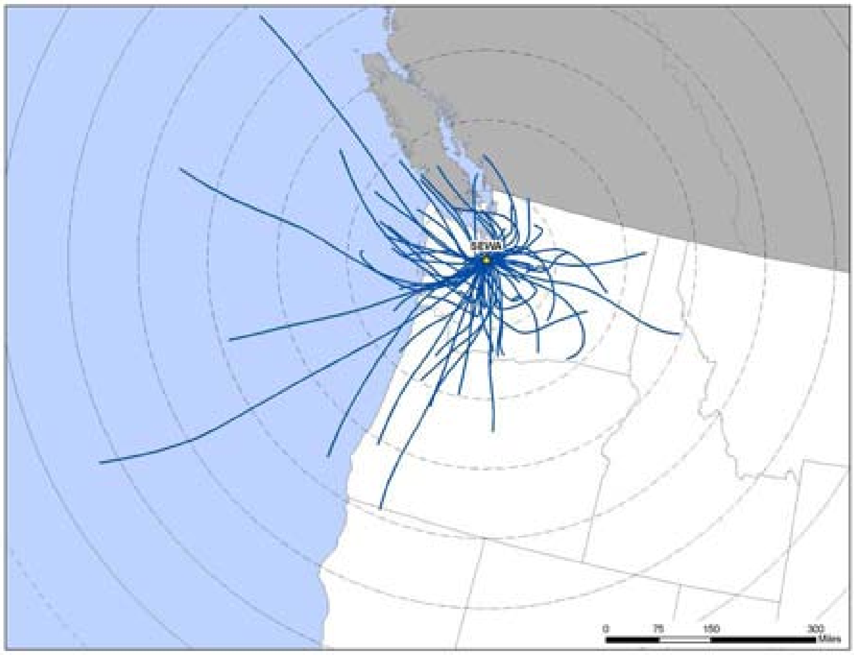


Figure 32-9. 2009 Composite Back Trajectory Map for SEWA

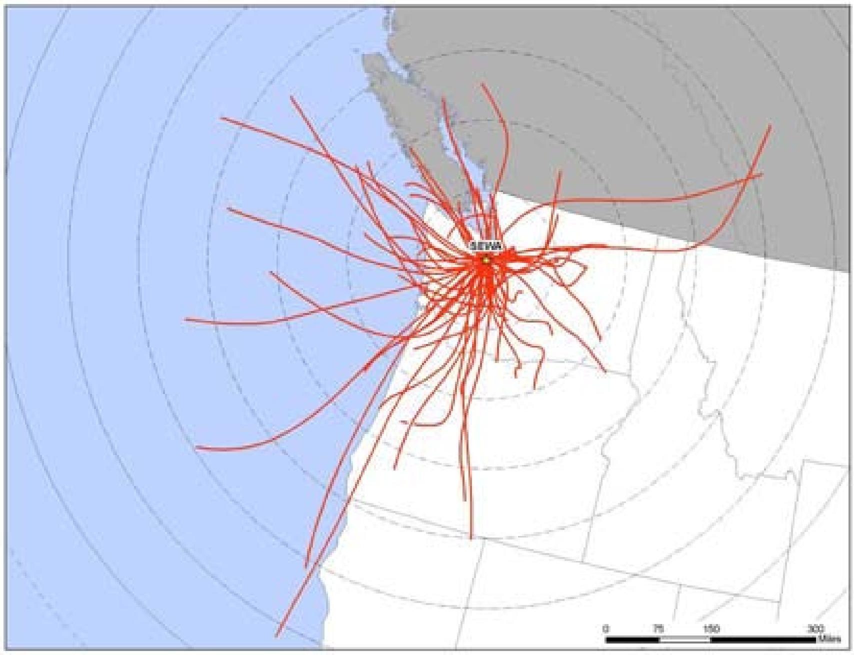


Figure 32-10. Back Trajectory Cluster Map for SEWA

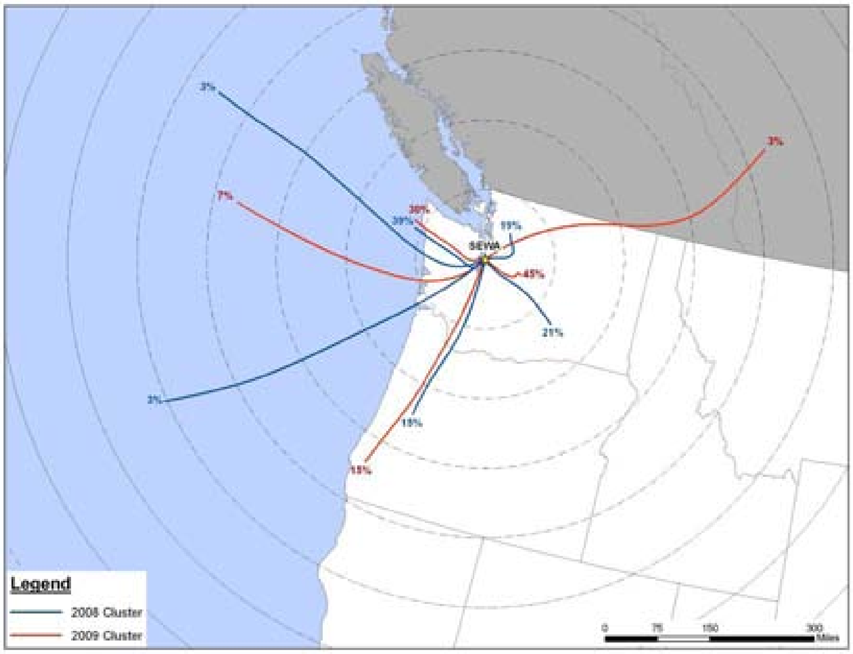


Figure 32-11. 2008-2009 Composite Back Trajectory Map for CEWA

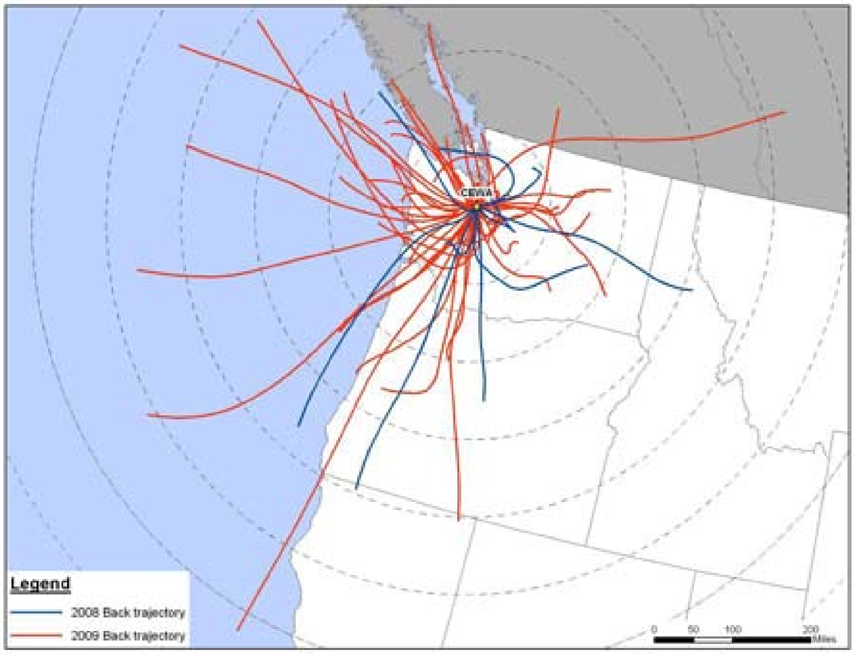


Figure 32-12. Back Trajectory Cluster Map for CEWA

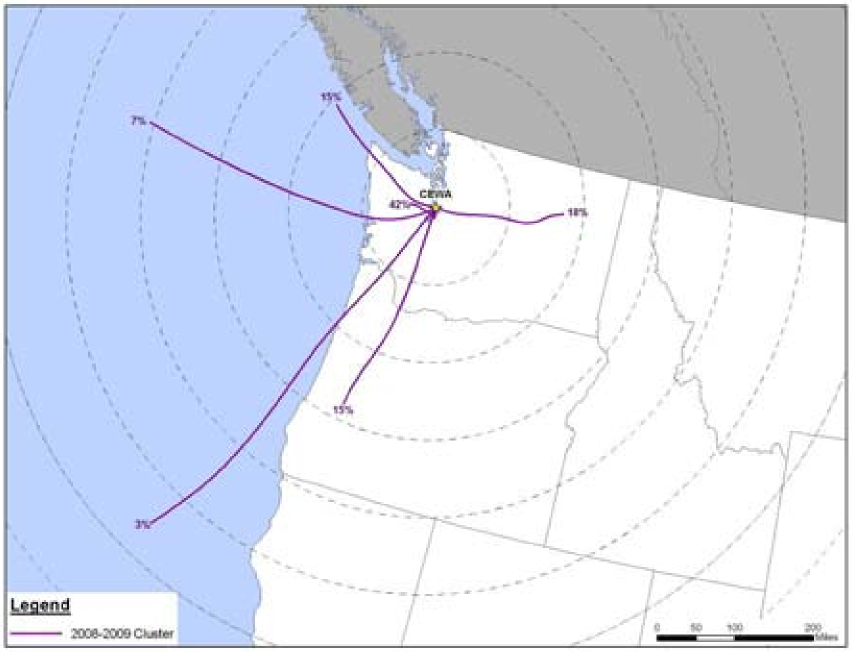


Figure 32-13. 2008-2009 Composite Back Trajectory Map for EQWA

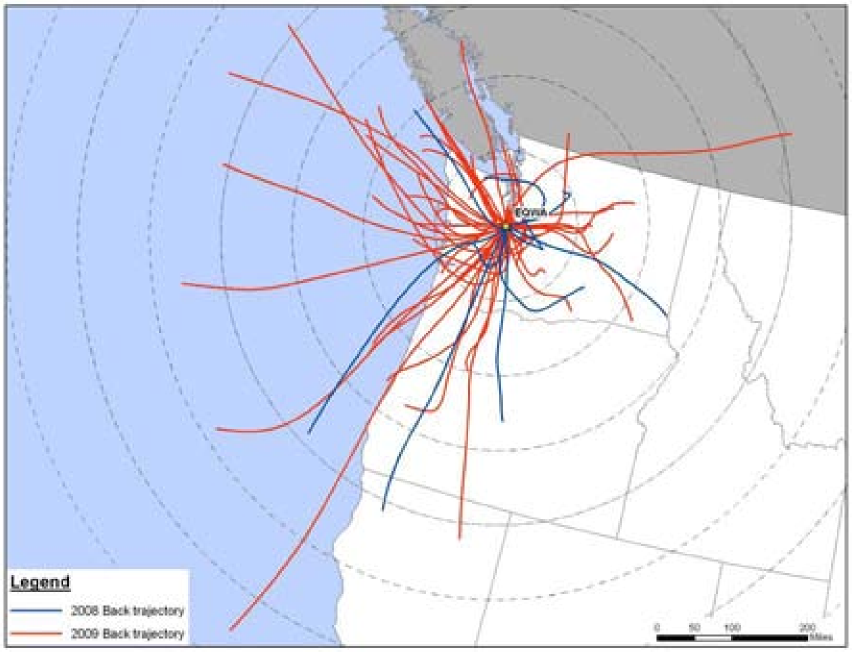


Figure 32-14. Back Trajectory Cluster Map for EQWA

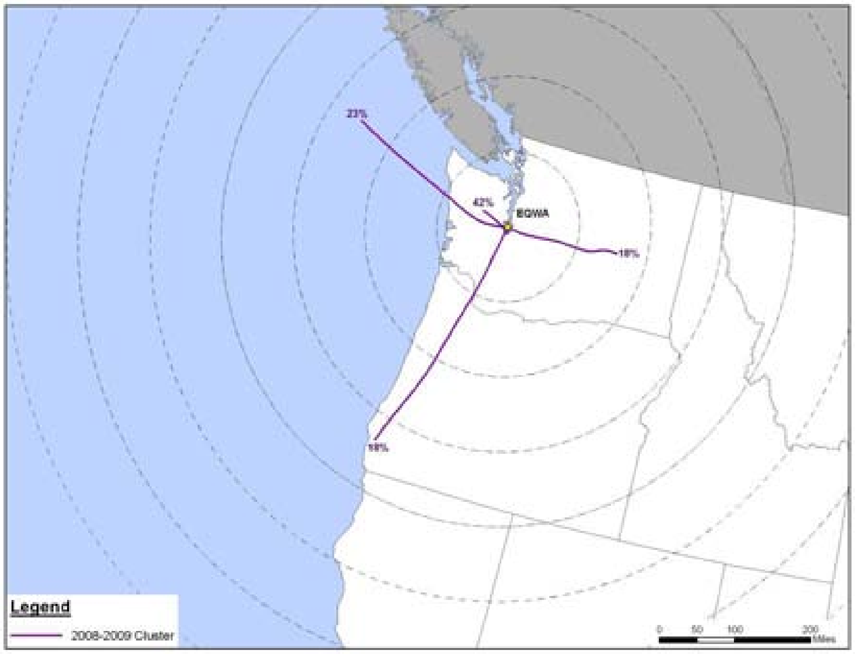


Figure 32-15. 2008-2009 Composite Back Trajectory Map for ESWA

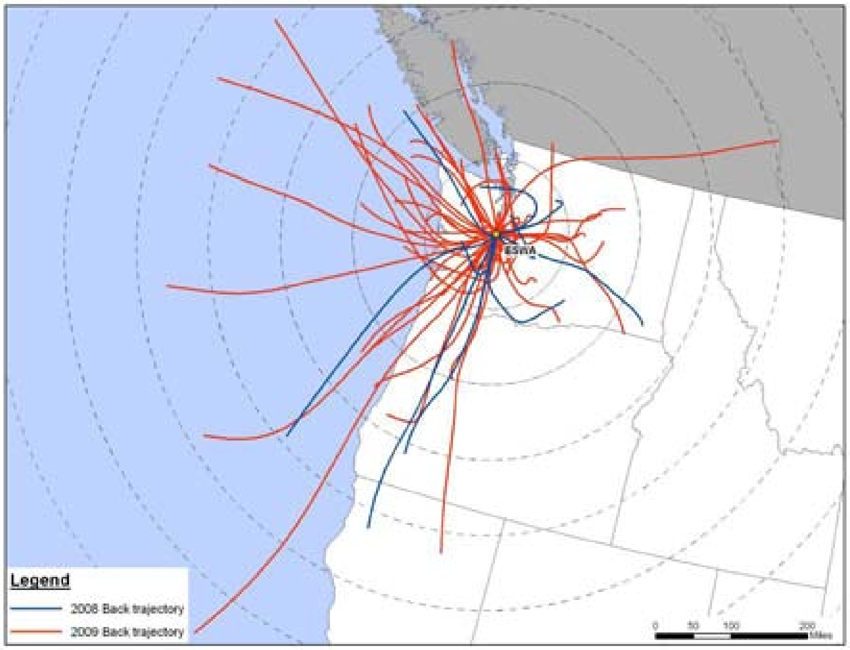


Figure 32-16. Back Trajectory Cluster Map for ESWA

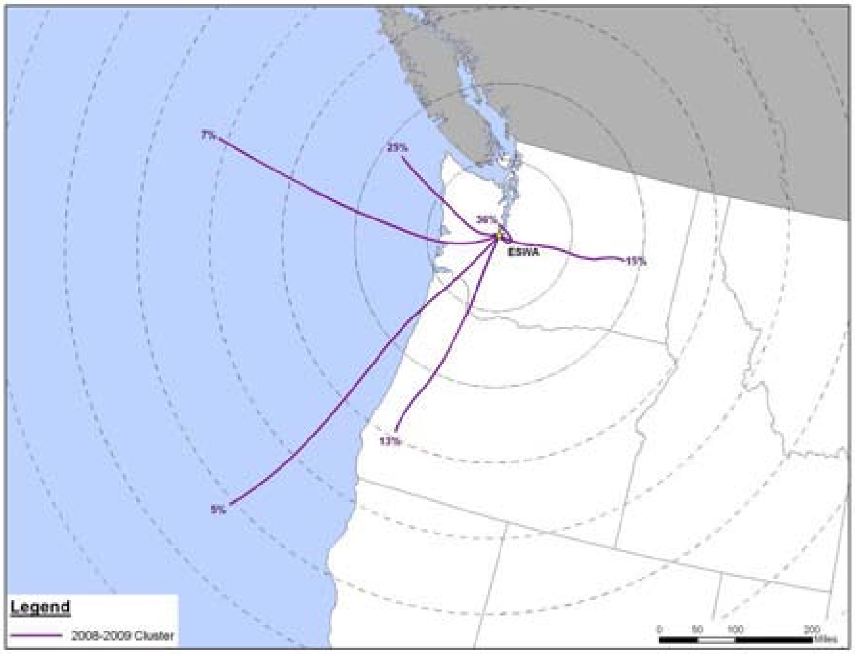


Figure 32-17. 2008-2009 Composite Back Trajectory Map for EYWA

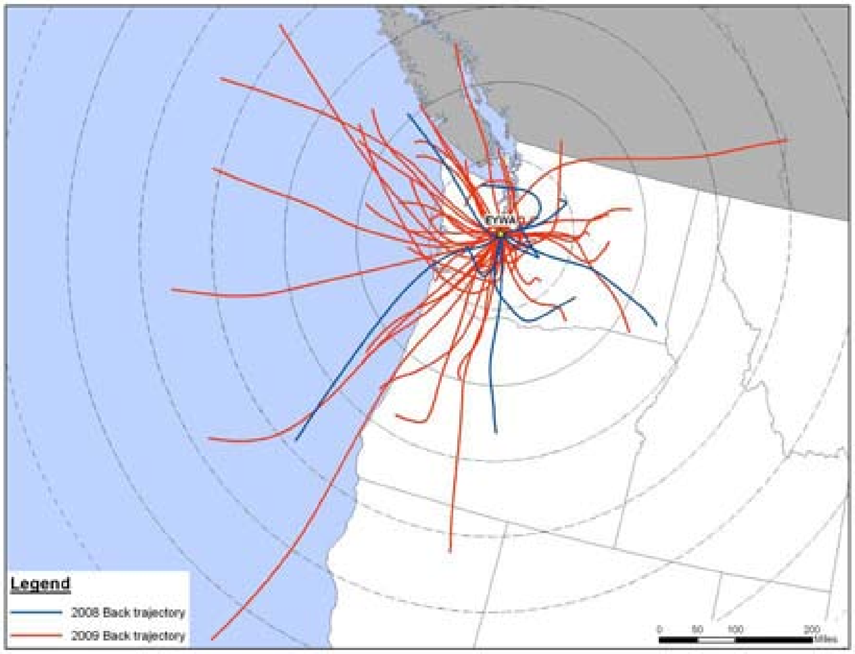
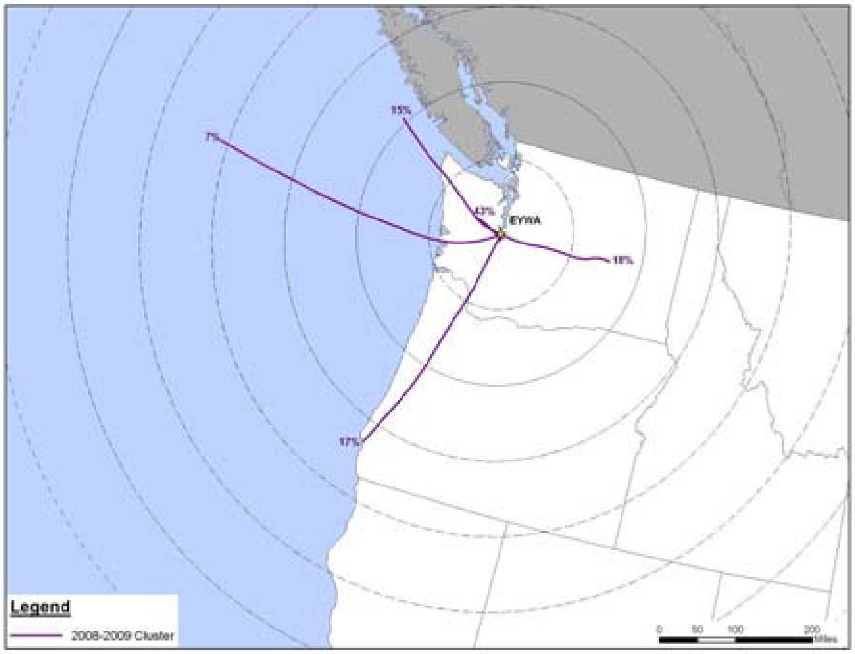


Figure 32-18. Back Trajectory Cluster Map for EYWA



For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For both maps, each concentric circle around the sites in Figures 32-8 through 32-18 represents 100 miles.

Observations from Figures 32-8 through 32-10 for SEWA include the following:

- Back trajectories originated from a variety of directions from SEWA.
- The 24-hour air shed domain for SEWA is somewhat smaller than other NMP sites. Although the longest trajectories originated along the northern California coastline and was greater than 600 miles in length, the average trajectory length was 175 miles and 85 percent of trajectories originated within 300 miles of the site.
- Directionally, the cluster analysis for 2008 (blue) is very similar to the cluster analysis for 2009 (red). The cluster map for SEWA shows that between 30 (2009) and 40 (2008) percent of trajectories originated just off the Washington coast. In 2008, 19 percent of trajectories originated from the north to east and within 200 miles of the site. Another 21 percent originated from the east to south and within 200 miles of the site. For 2009, the HYSPLIT model combined these trajectories, as represented by the short cluster trajectory accounting for 45 percent of the back trajectories. Fifteen percent of back trajectories originated to the south for both years. Note that the longer

cluster trajectories (> 400 miles) accounted for only a few trajectories each year (six percent for 2008 and 10 percent for 2009).

Observations from Figures 32-11 through 32-18 for the Puget Sound sites include the following:

- The back trajectory maps for CEWA, EYWA, ESWA, and EQWA are fairly similar in back trajectory distribution to each other, which is expected, given their proximity to each other.

- Back trajectories originated from a variety of directions at these sites. Trajectories often originated from off the Washington coast, over the eastern portion of the state, and to the south along the Pacific coastline.

- The 24-hour air shed domains for these sites were similar in size to SEWA and generally smaller in size compared to most other NMP monitoring sites. The farthest away a trajectory originated from each site was greater than 600 miles and off the northern California coast. However, the average trajectory length for each site was between 180 (EYWA) and 185 (ESWA) miles.

- The cluster trajectory distributions shown on the cluster analyses for these sites are very similar to each other and similar to the cluster analysis for SEWA. Each one shows that back trajectories originating within a 100 or so miles of the sites account of one-third or more of the trajectories. While many of these trajectories originated to the west, recall that distance is also a factor in the cluster analysis, and that trajectories originating from other directions may also be represented by these clusters. This is evident in ESWA's shortest cluster trajectory. Unlike the other sites, this cluster trajectory is curved, indicating that trajectories originating from directions other than west factored into this cluster.

32.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather stations at Boeing Field/King County International Airport (for CEWA and SEWA) and Tacoma Narrows Airport (for EQWA, ESWA, and EYWA) were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

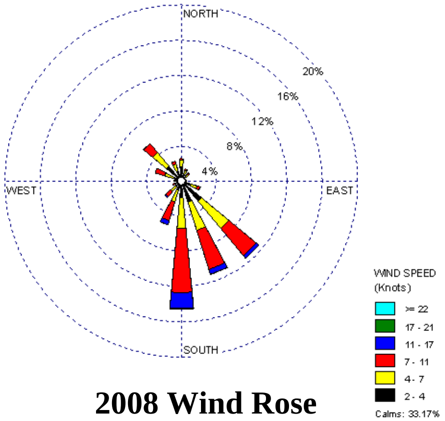
Figure 32-19 presents five different wind roses for the SEWA monitoring site. First, a historical wind rose representing 1997 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 32-20 through 32-23 present the different wind roses for the Puget Sound monitoring sites, but these figures have only three wind roses: a historical wind rose; a wind rose representing wind observations for the entire November 2008 to October 2009 study period; and wind rose representing the days on which samples were collected over the study period.

Observations from Figure 32-19 for SEWA include the following:

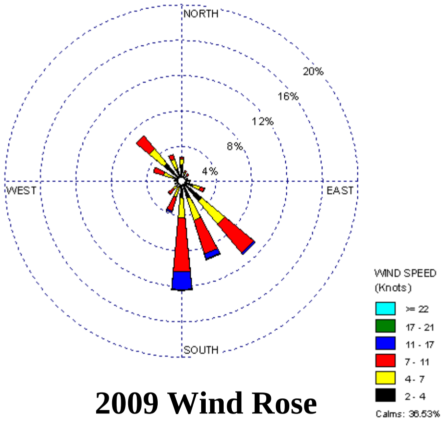
- The historical wind rose shows that southeasterly, south-southeasterly, and southerly winds were frequently observed, accounting for more than one-third of observations. Calm winds (≤ 2 knots) account for another one-third of wind observations near SEWA. The strongest wind speeds were associated with winds with a southerly component.

- The wind patterns shown on the 2008 and 2009 wind roses are similar to the historical wind patterns. Further, the wind patterns shown on the sample day wind roses for each year also resemble the historical wind patterns, indicating that conditions on sample days were representative of those experienced over the entire year and historically.

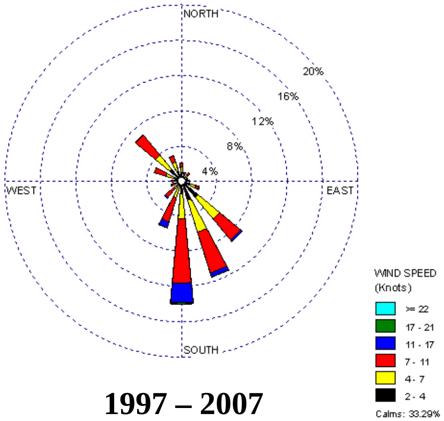
Figure 32-19. Wind Roses for the Boeing Field/King County International Airport Weather Station near SEWA



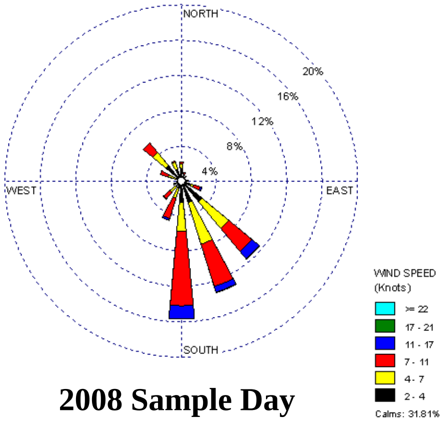
2008 Wind Rose



2009 Wind Rose

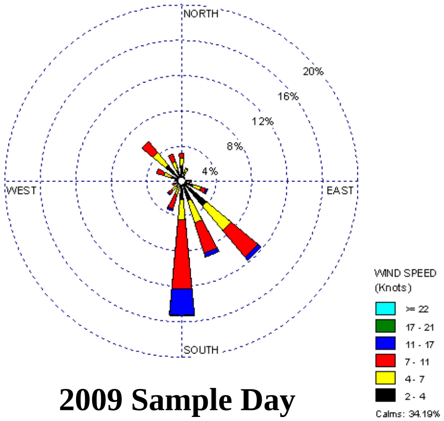


1997 – 2007
Historical Wind Rose



2008 Sample Day

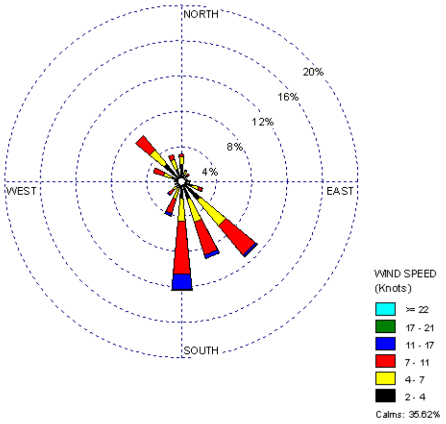
Wind Rose



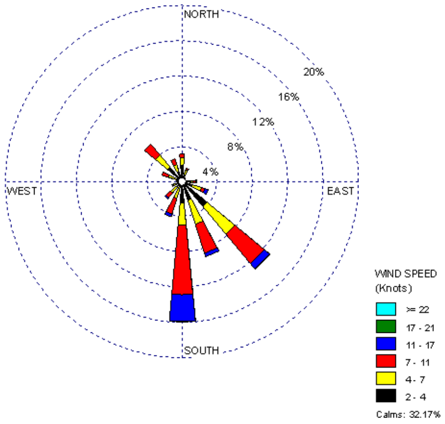
2009 Sample Day

Wind Rose

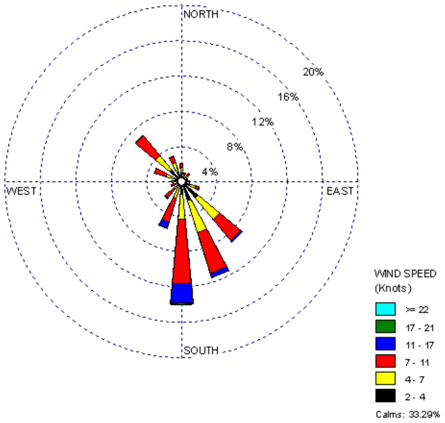
Figure 32-20. Wind Roses for the Boeing Field/King County International Airport Weather Station near CEWA



2008 – 2009 Sample Period
Wind Rose

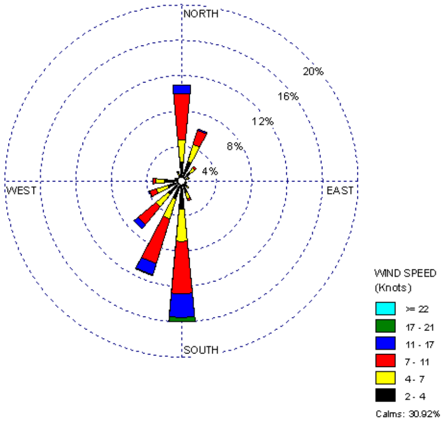


2008 – 2009 Sample Day
Wind Rose

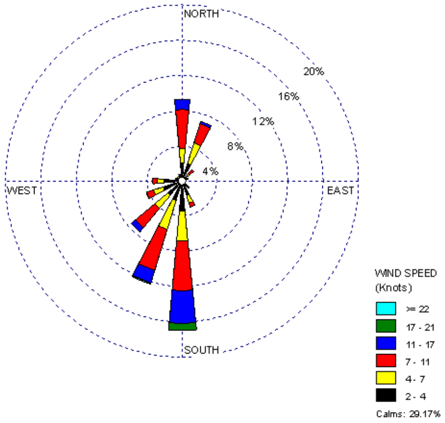


1997 – 2007 Historical
Wind Rose

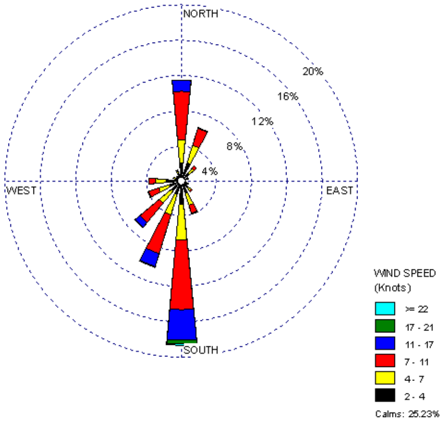
Figure 32-21. Wind Roses for the Tacoma Narrows Airport Weather Station near EQWA



2008 – 2009 Sample Period
Wind Rose

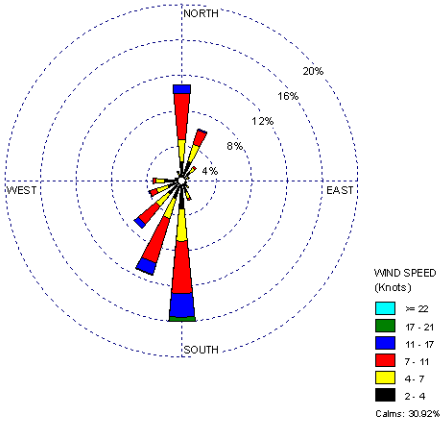


2008 - 20009 Sample Day
Wind Rose

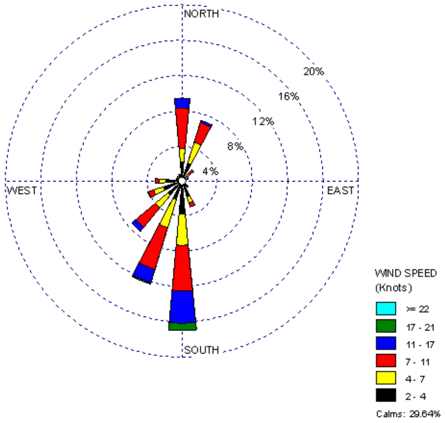


1999 – 2007 Historical
Wind Rose

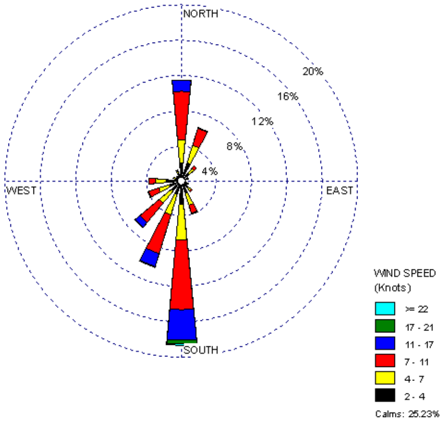
Figure 32-22. Wind Roses for the Tacoma Narrows Airport Weather Station near ESWA



2008 – 2009 Sample Period
Wind Rose

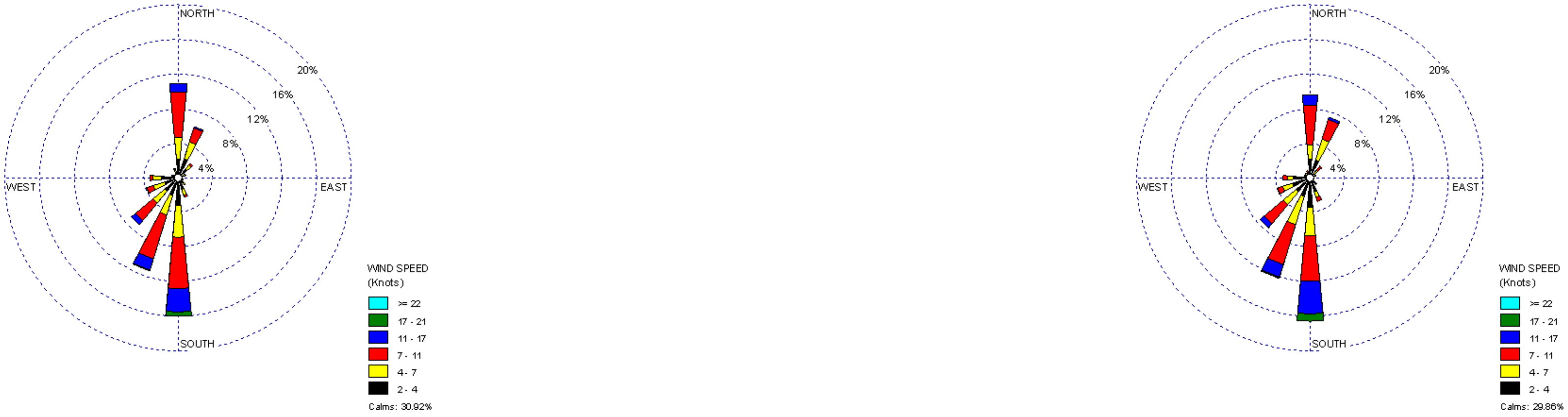


2008 – 2009 Sample Day
Wind Rose



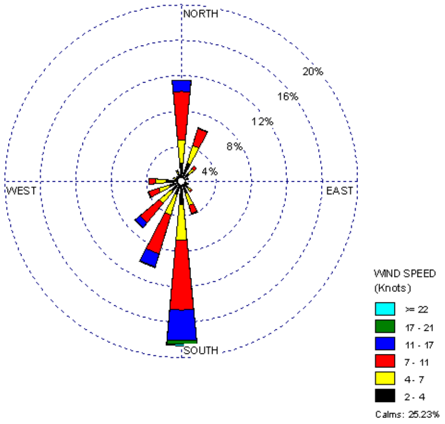
1999 – 2007 Historical
Wind Rose

Figure 32-23. Wind Roses for the Tacoma Narrows Airport Weather Station near EYWA



2008 – 2009 Sample Period
Wind Rose

2008 – 2009 Sample Day
Wind Rose



1999 – 2007 Historical

Wind Rose

Observations from Figure 32-20 for CEWA include the following:

- The historical wind rose for CEWA is identical to the historical wind rose for SEWA, as the Boeing Field/King County International Airport weather station is the closest one to both sites.
- The wind patterns shown on the sample period wind rose are similar to the historical wind patterns, indicating that conditions during the sample period were similar to those experienced historically.
- The sample day wind rose shows the same prevalence of southeasterly to southerly winds as well as calm winds as the sample period wind rose, indicating that conditions on sample days were representative of those experienced over the entire sample period.

Observations from Figures 32-21 through 32-23 for the Tacoma sites include the following:

- The historical wind roses for these three sites are identical as the Tacoma Narrows Airport weather station is the closest one to all three sites.
- The historical wind roses show that winds from the south and the southwest quadrant were commonly observed. Winds from due north and the north-northeast were also frequently observed. Calm winds accounted for one quarter of the observations.
- The sample period wind patterns are similar to the historical wind patterns for each site, indicating that conditions during the sample period were similar to those experienced historically.
- The sample day wind patterns show the same prominence of these wind directions and calm winds as the sample period wind patterns and the historical wind patterns, indicating that conditions on sample days were representative of those experienced over the entire sample period and historically.

32.3 Pollutants of Interest

Site-specific “pollutants of interest” were determined for the Washington monitoring sites in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” Pollutants of interest are those for which the individual pollutant’s total failed screens contribute to the top 95 percent of the site’s total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by each monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 32-4 presents the Washington monitoring sites' pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for each monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. EYWA sampled for carbonyl compounds and VOC; CEWA, EQWA, and ESWA sampled for PAH in addition to these pollutant groups; and SEWA sampled for PM_{10} metals and hexavalent chromium in addition to these three pollutant groups.

Table 32-4. Risk Screening Results for the Washington Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Seattle, Washington - SEWA						
Formaldehyde	0.077	125	126	99.21	13.53	13.53
Carbon Tetrachloride	0.17	123	123	100.00	13.31	26.84
Benzene	0.13	122	123	99.19	13.20	40.04
Arsenic (PM_{10})	0.00023	107	119	89.92	11.58	51.62
Acetaldehyde	0.45	105	126	83.33	11.36	62.99
1,3-Butadiene	0.033	95	119	79.83	10.28	73.27
Naphthalene	0.029	91	108	84.26	9.85	83.12
Manganese (PM_{10})	0.005	65	119	54.62	7.03	90.15
Tetrachloroethylene	0.17	32	111	28.83	3.46	93.61
Ethylbenzene	0.4	21	123	17.07	2.27	95.89
Hexavalent Chromium	0.000083	13	99	13.13	1.41	97.29
Acrylonitrile	0.015	6	6	100.00	0.65	97.94
1,2-Dichloroethane	0.038	5	5	100.00	0.54	98.48
Dichloromethane	2.1	4	123	3.25	0.43	98.92
p-Dichlorobenzene	0.091	3	72	4.17	0.32	99.24
Nickel (PM_{10})	0.009	3	119	2.52	0.32	99.57
Lead (PM_{10})	0.015	2	119	1.68	0.22	99.78
Cadmium (PM_{10})	0.00056	1	119	0.84	0.11	99.89
Hexachloro-1,3-butadiene	0.045	1	4	25.00	0.11	100.00
Total		924	1,863	49.60		

Table 32-4. Risk Screening Results for the Washington Monitoring Sites (Continued)

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Duwamish, Seattle, Washington - CEWA						
Benzene	0.13	59	59	100.00	15.65	15.65
Carbon Tetrachloride	0.17	59	59	100.00	15.65	31.30
Naphthalene	0.029	59	59	100.00	15.65	46.95
Acetaldehyde	0.45	57	57	100.00	15.12	62.07
Formaldehyde	0.077	57	57	100.00	15.12	77.19
1,3-Butadiene	0.033	46	59	77.97	12.20	89.39
Tetrachloroethylene	0.17	17	56	30.36	4.51	93.90
Ethylbenzene	0.4	13	59	22.03	3.45	97.35
Acrylonitrile	0.015	2	2	100.00	0.53	97.88
Benzo(a)pyrene	0.00091	2	41	4.88	0.53	98.41
Dichloromethane	2.1	2	59	3.39	0.53	98.94
p-Dichlorobenzene	0.091	1	41	2.44	0.27	99.20
1,2-Dichloroethane	0.038	1	1	100.00	0.27	99.47
1,2-Dichloropropane	0.053	1	1	100.00	0.27	99.73
1,1,2,2-Tetrachloroethane	0.017	1	1	100.00	0.27	100.00
Total		377	611	61.70		
Tideflats, Tacoma, Washington - EQWA						
Acetaldehyde	0.45	59	59	100.00	15.17	15.17
Formaldehyde	0.077	59	59	100.00	15.17	30.33
Naphthalene	0.029	59	61	96.72	15.17	45.50
Benzene	0.13	58	58	100.00	14.91	60.41
Carbon Tetrachloride	0.17	58	58	100.00	14.91	75.32
1,3-Butadiene	0.033	40	58	68.97	10.28	85.60
Tetrachloroethylene	0.17	25	56	44.64	6.43	92.03
Ethylbenzene	0.4	13	58	22.41	3.34	95.37
Dichloromethane	2.1	9	58	15.52	2.31	97.69
p-Dichlorobenzene	0.091	3	40	7.50	0.77	98.46
Acrylonitrile	0.015	2	2	100.00	0.51	98.97
Bromomethane	0.5	1	58	1.72	0.26	99.23
1,2-Dibromoethane	0.0017	1	1	100.00	0.26	99.49
1,2-Dichloroethane	0.038	1	1	100.00	0.26	99.74
Trichloroethylene	0.5	1	34	2.94	0.26	100.00
Total		389	661	58.85		

Table 32-4. Risk Screening Results for the Washington Monitoring Sites (Continued)

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
South Tacoma, Washington - ESWA						
Formaldehyde	0.077	59	59	100.00	15.82	15.82
Benzene	0.13	58	58	100.00	15.55	31.37
Carbon Tetrachloride	0.17	58	58	100.00	15.55	46.92
Naphthalene	0.029	54	60	90.00	14.48	61.39
Acetaldehyde	0.45	51	59	86.44	13.67	75.07
1,3-Butadiene	0.033	42	57	73.68	11.26	86.33
Ethylbenzene	0.4	17	58	29.31	4.56	90.88
Tetrachloroethylene	0.17	16	45	35.56	4.29	95.17
Benzo(a)pyrene	0.00091	9	39	23.08	2.41	97.59
p-Dichlorobenzene	0.091	5	39	12.82	1.34	98.93
Acrylonitrile	0.015	1	2	50.00	0.27	99.20
1,2-Dichloroethane	0.038	1	1	100.00	0.27	99.46
Dichloromethane	2.1	1	58	1.72	0.27	99.73
Xylenes	10	1	58	1.72	0.27	100.00
Total		373	651	57.30		
Reservoir, Tacoma, Washington - EYWA						
Benzene	0.13	58	58	100.00	27.10	27.10
Carbon Tetrachloride	0.17	58	58	100.00	27.10	54.21
1,3-Butadiene	0.033	44	58	75.86	20.56	74.77
Ethylbenzene	0.4	27	58	46.55	12.62	87.38
Tetrachloroethylene	0.17	15	54	27.78	7.01	94.39
Acrylonitrile	0.015	8	8	100.00	3.74	98.13
p-Dichlorobenzene	0.091	2	36	5.56	0.93	99.07
1,2-Dichloroethane	0.038	1	1	100.00	0.47	99.53
Vinyl chloride	0.11	1	5	20.00	0.47	100.00
Total		214	336	63.69		

Observations from Table 32-4 for SEWA include the following:

- Nineteen pollutants failed at least one screen for SEWA.
- The risk screening process identified 10 pollutants of interest, of which all but one are NATTS MQO Core Analytes. Hexavalent chromium, nickel, cadmium, and lead were added to SEWA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not contribute to 95 percent of SEWA's total failed screens. Five additional pollutants were added to SEWA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens (benzo(a)pyrene, beryllium, chloroform, trichloroethylene, and vinyl

chloride). These five pollutants are not shown in Table 32-4 but are shown in subsequent tables in the following sections.

- The percentage of measured detections failing screens (of the pollutants with at least one failed screen) for SEWA was nearly 50 percent.

- Carbon tetrachloride, acrylonitrile, and 1,2-dichloroethane failed 100 percent of screens for SEWA. But the latter two pollutants were detected in only a few of the total sampled collected, while carbon tetrachloride was detected in all 123 VOC samples collected.

Observations from Table 32-4 for the Puget Sound sites include the following:

- Fifteen pollutants failed at least one screen for CEWA. The risk screening process identified eight pollutants of interest, of which all but one are NATTS MQO Core Analytes. Benzo(a)pyrene was added to CEWA's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of CEWA's total failed screens. Three additional pollutants (chloroform, trichloroethylene, and vinyl chloride) were added to CEWA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These pollutants are not shown in Table 32-4.

- Fifteen pollutants failed at least one screen for EQWA. The risk screening process identified eight pollutants of interest, of which all but one are NATTS MQO Core Analytes. Trichloroethylene was added to EQWA's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of EQWA's total failed screens. Three additional pollutants (chloroform, benzo(a)pyrene, and vinyl chloride) were added to EQWA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These pollutants are not shown in Table 32-4.

- Fourteen pollutants failed at least one screen for ESWA. The risk screening process identified eight pollutants of interest, of which all but one are NATTS MQO Core Analytes. Benzo(a)pyrene was added to ESWA's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of ESWA's total failed screens. Three additional pollutants (chloroform, trichloroethylene, and vinyl chloride) were added to ESWA's pollutants of interest because they are NATTS MQO Core Analytes, even though they did not fail any screens. These pollutants are not shown in Table 32-4.

- The same eight pollutants failed the most screens for CEWA, EQWA, and ESWA. These same eight pollutants were also the same initial eight pollutants of interest identified by the risk screening process for each site. Ethylbenzene is the one non-NATTS MQO Core Analyte in the list of pollutants of interest for each of these sites.

- The failure rate is around 60 percent for each of these three sites. Formaldehyde, benzene, and carbon tetrachloride were detected in every valid sample collected and each failed 100 percent of their total failed screens for each site.

- As discussed in Section 2.4, the Puget Sound Clean Air Authority discovered a leak in the instrument probe and invalidated all carbonyl compound samples for EYWA. In addition, selected individual pollutant results from VOC samples were also invalidated or flagged, at the agency's discretion. As a result, all carbonyl compounds and some VOC are excluded from this (and subsequent) analyses. The VOC for which the analytical results were invalidated are:
    - Acetonitrile
    - Acrolein
    - Chloroethane
    - Chloroform
    - Methyl Ethyl Ketone
    - Styrene
    - Trichlorofluoromethane
    - Trichlorotrifluoroethane

- Nine pollutants failed at least one screen for EYWA. The risk screening process identified six pollutants of interest, of which four are NATTS MQO Core Analytes. Vinyl chloride was added to EYWA's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of EYWA's total failed screens. One additional pollutant (trichloroethylene) was added to EYWA's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not fail any screens. Trichloroethylene is not shown in Table 32-4. Note that chloroform is also a NATTS MQO Core Analyte but was one of the pollutants for which all data were invalidated, and thus has been excluded from this analysis. Note that EYWA did not measured PAH like the other Puget Sound sites.

- Benzene, carbon tetrachloride, acrylonitrile, and 1,2-dichloroethane failed 100 percent of screens for EYWA. But the latter two pollutants were detected in only a few of the total sampled collected, while carbon tetrachloride and benzene were detected in all 58 VOC samples collected.

32.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Washington monitoring sites. Concentration averages are provided for the pollutants of interest for each site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at each site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

32.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for the pollutants of interest for the SEWA monitoring site, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual average concentrations are presented in Table 32-5a, where applicable. Note that concentrations of the PAH, metals, and hexavalent chromium are presented in ng/m^3 for ease of viewing.

Daily, quarterly, and study concentration averages were calculated for the pollutants of interest for the four Puget Sound monitoring sites. In lieu of an annual average, the *study* average for a pollutant includes all measured detections and substituted zeros for non-detects over the period of sampling. Study averages were calculated for monitoring sites that sampled for a 1-year period that overlapped 2008 and 2009, provided that at least three quarterly averages could be calculated and method completeness was greater than or equal to 85 percent, as described in Section 3.1.1. The study averages for the four Puget Sound sites represent the sample period from November 2008 to October 2009. Daily, quarterly, and study averages are presented in Table 32-5b, where applicable. Note that concentrations of the PAH are presented in ng/m^3 for ease of viewing.

Table 32-5a. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the SEWA Monitoring Site

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Seattle, Washington - SEWA												
Acetaldehyde	0.82 ± 0.13	0.72 ± 0.32	0.61 ± 0.17	1.07 ± 0.28	0.87 ± 0.28	0.82 ± 0.13	0.98 ± 0.15	0.80 ± 0.36	0.80 ± 0.19	1.23 ± 0.36	1.05 ± 0.29	0.98 ± 0.15
Benzene	0.76 ± 0.08	0.88 ± 0.18	0.54 ± 0.09	0.66 ± 0.14	0.98 ± 0.17	0.76 ± 0.08	0.81 ± 0.18	1.22 ± 0.71	0.71 ± 0.17	0.57 ± 0.18	0.78 ± 0.22	0.81 ± 0.18
1,3-Butadiene	0.07 ± 0.01	0.08 ± 0.03	0.03 ± 0.01	0.05 ± 0.02	0.08 ± 0.02	0.06 ± 0.01	0.08 ± 0.03	0.13 ± 0.12	0.04 ± 0.01	0.04 ± 0.01	0.09 ± 0.04	0.07 ± 0.03
Carbon Tetrachloride	0.84 ± 0.04	0.83 ± 0.07	0.84 ± 0.09	0.83 ± 0.10	0.83 ± 0.11	0.84 ± 0.04	0.77 ± 0.04	0.67 ± 0.05	0.79 ± 0.07	0.90 ± 0.08	0.70 ± 0.08	0.77 ± 0.04
Chloroform	0.14 ± 0.01	0.13 ± 0.01	0.14 ± 0.01	0.16 ± 0.02	0.15 ± 0.02	0.14 ± 0.01	0.15 ± 0.01	0.11 ± 0.02	0.16 ± 0.03	0.17 ± 0.02	0.13 ± 0.01	0.15 ± 0.01
Ethylbenzene	0.27 ± 0.05	0.23 ± 0.08	0.28 ± 0.12	0.30 ± 0.08	0.28 ± 0.11	0.27 ± 0.05	0.21 ± 0.07	0.32 ± 0.29	0.18 ± 0.05	0.17 ± 0.06	0.19 ± 0.07	0.21 ± 0.07
Formaldehyde	0.75 ± 0.12	0.73 ± 0.27	0.53 ± 0.15	0.95 ± 0.26	0.78 ± 0.24	0.75 ± 0.12	1.04 ± 0.51	1.62 ± 2.22	0.63 ± 0.14	1.10 ± 0.39	0.83 ± 0.25	1.04 ± 0.51
Tetrachloroethylene	0.14 ± 0.02	0.13 ± 0.04	0.11 ± 0.04	0.13 ± 0.05	0.16 ± 0.05	0.13 ± 0.02	0.14 ± 0.03	0.14 ± 0.09	0.10 ± 0.03	0.12 ± 0.05	0.13 ± 0.05	0.12 ± 0.03
Trichloroethylene	0.07 ± 0.01	NA	NA	NA	NA	NA	0.07 ± 0.02	NA	NA	NA	NA	NA
Vinyl Chloride	0.01 ± <0.01	NA	NA	NA	NA	NA	0.01 ± <0.01	NA	NA	NA	NA	NA
Arsenic (PM_{10})[a]	0.69 ± 0.11	0.91 ± 0.30	0.68 ± 0.20	0.48 ± 0.17	0.70 ± 0.19	0.69 ± 0.11	0.71 ± 0.13	0.70 ± 0.36	0.66 ± 0.36	0.60 ± 0.15	0.86 ± 0.25	0.71 ± 0.13
Benzo(a)pyrene[a]	0.05 ± 0.02	NA	NA	NA	0.06 ± 0.03	NA	0.13 ± 0.06	0.06 ± 0.05	NA	NA	0.17 ± 0.10	NA

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 32-5a. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the SEWA Monitoring Site (continued)

Pollutant	2008						2009					
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Annual Average (µg/m^3)
Beryllium (PM_{10}) [a]	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01	<0.01 ± <0.01
Cadmium (PM_{10}) [a]	0.12 ± 0.03	0.15 ± 0.06	0.10 ± 0.02	0.14 ± 0.07	0.10 ± 0.04	0.12 ± 0.03	0.10 ± 0.03	0.08 ± 0.04	0.08 ± 0.03	0.11 ± 0.05	0.13 ± 0.09	0.10 ± 0.03
Hexavalent Chromium [a]	0.04 ± 0.01	0.04 ± 0.02	0.03 ± 0.01	0.03 ± 0.02	0.03 ± 0.02	0.04 ± 0.01	0.04 ± 0.01	0.05 ± 0.03	0.02 ± 0.01	0.03 ± 0.02	0.03 ± 0.01	0.03 ± 0.01
Lead (PM_{10}) [a]	4.07 ± 1.08	6.17 ± 3.73	3.39 ± 0.84	3.37 ± 1.27	3.13 ± 0.91	4.07 ± 1.08	3.64 ± 0.73	3.36 ± 2.08	2.92 ± 0.80	4.08 ± 1.36	3.92 ± 1.34	3.64 ± 0.73
Manganese (PM_{10}) [a]	11.03 ± 2.61	11.20 ± 5.75	11.51 ± 4.56	12.68 ± 6.47	8.56 ± 4.87	11.03 ± 2.61	7.15 ± 1.85	9.51 ± 5.61	6.28 ± 4.10	8.32 ± 2.32	4.29 ± 2.63	7.15 ± 1.85
Naphthalene [a]	60.92 ± 10.69	NA	44.10 ± 18.48	66.35 ± 20.21	74.4 ± 20.13	60.92 ± 10.69	78.67 ± 12.84	65.02 ± 31.18	56.85 ± 20.16	86.76 ± 27.17	98.99 ± 23.44	78.67 ± 12.84
Nickel (PM_{10}) [a]	2.19 ± 0.48	1.54 ± 0.62	3.04 ± 1.39	2.81 ± 1.00	1.37 ± 0.51	2.19 ± 0.48	2.61 ± 0.67	2.15 ± 1.48	3.08 ± 1.88	3.82 ± 1.18	1.45 ± 0.88	2.61 ± 0.67

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 32-5b. Daily, Quarterly, and Study Average Concentrations of the Pollutants of Interest for the Puget Sound Monitoring Sites

Pollutant	2008					2009					Study Average (µg/m^3)
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	
Duwamish, Seattle, Washington - CEWA											
Acetaldehyde	1.39 ± 0.28	NR	NR	NR	1.39 ± 0.28	1.44 ± 0.18	1.39 ± 0.44	1.26 ± 0.26	1.40 ± 0.30	NA	1.43 ± 0.16
Benzene	1.34 ± 0.37	NR	NR	NR	1.34 ± 0.37	0.86 ± 0.21	1.31 ± 0.59	0.60 ± 0.18	0.55 ± 0.16	NA	0.92 ± 0.19
1,3-Butadiene	0.16 ± 0.05	NR	NR	NR	0.16 ± 0.05	0.09 ± 0.03	0.16 ± 0.10	0.05 ± 0.01	0.04 ± 0.01	NA	0.10 ± 0.03
Carbon Tetrachloride	0.73 ± 0.20	NR	NR	NR	0.73 ± 0.20	0.76 ± 0.05	0.71 ± 0.10	0.71 ± 0.06	0.87 ± 0.08	NA	0.76 ± 0.05
Chloroform	0.11 ± 0.01	NR	NR	NR	0.11 ± 0.01	0.11 ± 0.01	0.09 ± 0.01	0.10 ± 0.01	0.13 ± 0.02	NA	0.11 ± 0.01
Ethylbenzene	0.51 ± 0.28	NR	NR	NR	0.51 ± 0.28	0.33 ± 0.11	0.50 ± 0.33	0.21 ± 0.06	0.20 ± 0.07	NA	0.35 ± 0.10
Formaldehyde	2.72 ± 0.91	NR	NR	NR	2.72 ± 0.91	2.82 ± 0.29	2.36 ± 0.67	2.89 ± 0.47	2.97 ± 0.53	NA	2.80 ± 0.28
Tetrachloroethylene	0.43 ± 0.42	NR	NR	NR	0.43 ± 0.42	0.17 ± 0.06	0.24 ± 0.17	0.09 ± 0.03	0.11 ± 0.04	NA	0.20 ± 0.07
Trichloroethylene	0.10 ± 0.02	NR	NR	NR	NA	0.15 ± 0.04	0.11 ± 0.08	0.04 ± 0.02	0.08 ± 0.06	NA	0.08 ± 0.03
Vinyl Chloride	ND	NR	NR	NR	ND	0.02 ± 0.02	NA	NA	NA	NA	NA
Benzo(a)pyrene[a]	0.14 ± 0.08	NR	NR	NR	0.13 ± 0.08	0.27 ± 0.26	0.28 ± 0.40	0.02 ± 0.02	0.25 ± 0.47	NA	0.17 ± 0.14
Naphthalene[a]	119.42 ± 35.29	NR	NR	NR	119.42 ± 35.29	122.29 ± 24.97	126.52 ± 75.69	87.77 ± 21.14	129.75 ± 34.91	NA	121.81 ± 21.34

NA = Not available due to the criteria for calculating a quarterly and/or study average.
NR = Not available because sampling was not conducted during this time period.
ND = Not detected during sampling for this time period.
[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 32-5b. Daily, Quarterly, and Study Average Concentrations of the Pollutants of Interest for the Puget Sound Monitoring Sites (Continued)

Pollutant	2008					2009					Study Average (µg/m^3)
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	
Tideflats, Tacoma, Washington - EQWA											
Acetaldehyde	1.15 ± 0.22	NR	NR	NR	1.15 ± 0.22	1.41 ± 0.18	1.06 ± 0.21	1.26 ± 0.30	1.81 ± 0.40	NA	1.37 ± 0.15
Benzene	1.51 ± 0.77	NR	NR	NR	1.51 ± 0.77	0.91 ± 0.23	1.36 ± 0.65	0.69 ± 0.20	0.57 ± 0.17	NA	1.00 ± 0.23
1,3-Butadiene	0.15 ± 0.10	NR	NR	NR	0.15 ± 0.10	0.08 ± 0.03	0.13 ± 0.09	0.04 ± 0.02	0.04 ± 0.02	NA	0.09 ± 0.03
Carbon Tetrachloride	0.77 ± 0.17	NR	NR	NR	0.77 ± 0.17	0.76 ± 0.05	0.72 ± 0.10	0.71 ± 0.05	0.89 ± 0.11	NA	0.76 ± 0.05
Chloroform	0.11 ± 0.01	NR	NR	NR	0.11 ± 0.01	0.12 ± 0.01	0.10 ± 0.02	0.10 ± 0.01	0.15 ± 0.03	NA	0.11 ± 0.01
Ethylbenzene	0.47 ± 0.29	NR	NR	NR	0.47 ± 0.29	0.30 ± 0.10	0.43 ± 0.27	0.22 ± 0.09	0.20 ± 0.10	NA	0.33 ± 0.09
Formaldehyde	1.83 ± 0.51	NR	NR	NR	1.83 ± 0.51	1.99 ± 0.35	1.08 ± 0.27	1.57 ± 0.40	3.19 ± 0.72	NA	1.97 ± 0.30
Tetrachloroethylene	0.23 ± 0.12	NR	NR	NR	0.23 ± 0.12	0.34 ± 0.20	0.23 ± 0.11	0.14 ± 0.07	0.59 ± 0.75	NA	0.31 ± 0.17
Trichloroethylene	0.13 ± 0.10	NR	NR	NR	NA	0.17 ± 0.05	0.06 ± 0.06	0.08 ± 0.05	0.16 ± 0.12	NA	0.10 ± 0.04
Vinyl Chloride	0.01 ± <0.01	NR	NR	NR	NA	0.02 ± 0.01	NA	0.01 ± <0.01	NA	NA	NA
Benzo(a)pyrene[a]	0.23 ± 0.19	NR	NR	NR	0.21 ± 0.17	0.19 ± 0.08	0.20 ± 0.14	0.03 ± 0.02	NA	NA	0.12 ± 0.05
Naphthalene[a]	119.89 ± 50.68	NR	NR	NR	119.89 ± 50.68	118.69 ± 23.84	98.32 ± 36.06	87.72 ± 30.03	147.71 ± 59.57	NA	118.89 ± 21.21

NA = Not available due to the criteria for calculating a quarterly and/or study average.
NR = Not available because sampling was not conducted during this time period.
ND = Not detected during sampling for this time period.
[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 32-5b. Daily, Quarterly, and Study Average Concentrations of the Pollutants of Interest for the Puget Sound Monitoring Sites (Continued)

Pollutant	2008					2009					Study Average (µg/m^3)
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	
South Tacoma, Washington - ESWA											
Acetaldehyde	0.95 ± 0.27	NR	NR	NR	0.95 ± 0.27	0.98 ± 0.17	0.73 ± 0.22	0.90 ± 0.32	1.21 ± 0.42	NA	0.98 ± 0.15
Benzene	1.13 ± 0.44	NR	NR	NR	1.13 ± 0.44	1.32 ± 0.37	1.89 ± 1.06	1.01 ± 0.46	0.91 ± 0.39	NA	1.30 ± 0.32
1,3-Butadiene	0.12 ± 0.07	NR	NR	NR	0.12 ± 0.07	0.13 ± 0.06	0.23 ± 0.18	0.06 ± 0.03	0.06 ± 0.03	NA	0.13 ± 0.05
Carbon Tetrachloride	0.72 ± 0.17	NR	NR	NR	0.72 ± 0.17	0.78 ± 0.05	0.72 ± 0.11	0.72 ± 0.06	0.89 ± 0.09	NA	0.77 ± 0.05
Chloroform	0.09 ± 0.02	NR	NR	NR	0.09 ± 0.02	0.12 ± 0.01	0.10 ± 0.02	0.10 ± 0.01	0.15 ± 0.03	NA	0.11 ± 0.01
Ethylbenzene	0.37 ± 0.20	NR	NR	NR	0.37 ± 0.20	0.38 ± 0.12	0.53 ± 0.37	0.29 ± 0.13	0.28 ± 0.14	NA	0.38 ± 0.11
Formaldehyde	1.69 ± 0.66	NR	NR	NR	1.69 ± 0.66	1.42 ± 0.19	1.03 ± 0.23	1.30 ± 0.34	1.88 ± 0.43	NA	1.47 ± 0.19
Tetrachloroethylene	0.15 ± 0.11	NR	NR	NR	NA	0.18 ± 0.05	0.15 ± 0.10	0.09 ± 0.05	0.13 ± 0.11	NA	0.13 ± 0.04
Trichloroethylene	0.15 ± 0.26	NR	NR	NR	NA	0.07 ± 0.02	NA	NA	NA	NA	NA
Vinyl Chloride	ND	NR	NR	NR	ND	0.03 ± 0.07	NA	NA	NA	NA	NA
Benzo(a)pyrene[a]	0.69 ± 0.52	NR	NR	NR	0.69 ± 0.52	0.39 ± 0.18	0.47 ± 0.31	NA	NA	NA	NA
Naphthalene[a]	143.81 ± 61.07	NR	NR	NR	143.81 ± 61.07	122.9 ± 31.47	152.25 ± 78.89	81.4 ± 39.29	99.49 ± 40.80	NA	126.39 ± 27.74

NA = Not available due to the criteria for calculating a quarterly and/or study average.

NR = Not available because sampling was not conducted during this time period.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing.

Table 32-5b. Daily, Quarterly, and Study Average Concentrations of the Pollutants of Interest for the Puget Sound Monitoring Sites (Continued)

Pollutant	2008					2009					Study Average (µg/m^3)
	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	Daily Average (µg/m^3)	1st Quarter Average (µg/m^3)	2nd Quarter Average (µg/m^3)	3rd Quarter Average (µg/m^3)	4th Quarter Average (µg/m^3)	
Reservoir, Tacoma, Washington - EYWA											
Acrylonitrile	0.23 ± <0.01	NR	NR	NR	NA	0.08 ± 0.09	NA	NA	NA	NA	NA
Benzene	1.78 ± 0.78	NR	NR	NR	1.78 ± 0.78	1.07 ± 0.22	1.46 ± 0.56	0.83 ± 0.28	0.82 ± 0.31	NA	1.17 ± 0.22
1,3-Butadiene	0.18 ± 0.12	NR	NR	NR	0.18 ± 0.12	0.10 ± 0.03	0.16 ± 0.08	0.05 ± 0.02	0.06 ± 0.03	NA	0.11 ± 0.03
Carbon Tetrachloride	0.73 ± 0.19	NR	NR	NR	0.73 ± 0.19	0.74 ± 0.04	0.69 ± 0.11	0.70 ± 0.06	0.83 ± 0.07	NA	0.74 ± 0.04
Ethylbenzene	0.75 ± 0.38	NR	NR	NR	0.75 ± 0.38	0.47 ± 0.09	0.56 ± 0.21	0.47 ± 0.17	0.37 ± 0.12	NA	0.51 ± 0.09
Tetrachloroethylene	0.31 ± 0.28	NR	NR	NR	0.27 ± 0.25	0.13 ± 0.03	0.15 ± 0.08	0.10 ± 0.05	0.10 ± 0.04	NA	0.14 ± 0.04
Trichloroethylene	0.12 ± 0.05	NR	NR	NR	NA	0.10 ± 0.01	0.08 ± 0.02	0.07 ± 0.02	0.08 ± 0.03	NA	0.08 ± 0.01
Vinyl Chloride	0.12 ± <0.01	NR	NR	NR	NA	0.02 ± 0.02	NA	NA	NA	NA	NA

NA = Not available due to the criteria for calculating a quarterly and/or study average.

NR = Not available because sampling was not conducted during this time period.

ND = Not detected during sampling for this time period.

[a] Average concentrations provided for the pollutants below the black line are presented in ng/m^3 for ease of viewing

Observations for the SEWA monitoring site from Table 32-5a include the following:

- The daily average concentrations for all of SEWA's pollutants of interest were less than 1.0 µg/m^3 for 2008. The pollutants with the highest daily average concentrations by mass were carbon tetrachloride (0.84 ± 0.04 µg/m^3), acetaldehyde (0.82 ± 0.13 µg/m^3), benzene (0.76 ± 0.08 µg/m^3), and formaldehyde (0.75 ± 0.12 µg/m^3).

- For 2009, only formaldehyde's daily average concentration was greater than 1.0 µg/m^3 (1.04 ± 0.51 µg/m^3). Behind formaldehyde, the pollutants with the highest daily average concentrations by mass were acetaldehyde (0.98 ± 0.15 µg/m^3), benzene (0.81 ± 0.18 µg/m^3) and carbon tetrachloride (0.77 ± 0.04 µg/m^3) for 2009.

- Table 32-5a shows that the quarterly average concentrations of most of the pollutants of interest for SEWA did not vary significantly across the quarters.

- Formaldehyde's first quarter 2009 concentration average is higher than all of the other quarterly averages; further, its confidence interval is very large, even higher than the average itself, indicating the presence of outliers. A review of the data shows that the highest formaldehyde concentration was measured on January 13, 2009 (16.6 µg/m^3) and that this concentration is four times the next highest concentration (3.62 µg/m^3, measured on September 22, 2009). These are the only two formaldehyde measurements greater than 3.0 µg/m^3 for this site and the median concentration was 0.594 µg/m^3.

- The first quarter 2009 average for 1,3-butadiene also appears to be influenced by outliers. A review of the data shows that the highest 1,3-butadiene concentration was measured on January 19, 2009 (0.891 µg/m^3) and that this concentration is more than three times the next highest concentration (0.288 µg/m^3, measured on December 3, 2009). This January concentration is the seventh highest 1,3-butadiene measurement among all NMP sites sampling this pollutant. Concentrations of 1,3-butadiene ranged from 0.0111 to 0.891 µg/m^3 for this site and the median concentration was 0.0532 µg/m^3.

- Several of the quarterly averages of lead appear to be influenced by outliers, particularly the first quarters of each year. A review of the data shows that the highest lead concentration was measured on February 24, 2008 (31.7 ng/m^3) and that this concentration is nearly twice the next highest concentration (16.2 ng/m^3), measured on January 19, 2009). There were only four measurements of lead greater than 10 ng/m^3 measured at this site and the median concentration was 2.99 ng/m^3.

Observations for the Puget Sound sites from Table 32-5b include the following:

- The pollutants with the highest study average concentrations by mass were formaldehyde, acetaldehyde, and benzene for CEWA, EQWA, and ESWA. For EYWA, benzene, carbon tetrachloride, and ethylbenzene had the highest study average concentrations by mass. Recall that all carbonyl compound data were invalidated for EYWA.

- None of these sites have first, second, or third quarterly averages for 2008 because they did not begin sampling until November 2008. Fourth quarter 2009 averages are also unavailable because sampling stopped in October 2009.

- Several of the VOC concentrations were higher during the colder months of the year for these four sites, as shown by the fourth quarter 2008 and first quarter 2009 averages of 1,3-butadiene, benzene, and ethylbenzene.

- Several of CEWA's VOC have relatively large confidence intervals for the first quarter of 2009. The highest concentrations of several of these pollutants were measured on January 19, 2009, including benzene, ethylbenzene, trichloroethylene, and 1,3-butadiene. This is also true for EQWA and ESWA. In addition, the highest concentrations of naphthalene at CEWA and ESWA were also measured on January 19, 2009, but not at EQWA (and EYWA did not measure PAH).

- In addition to the first quarter of 2009, tetrachloroethylene also has a high fourth quarter 2008 average (and a large confidence interval) for CEWA. The two highest concentrations of this pollutant were measured on November 26, 2008 (1.76 $\mu g/m^3$) and January 19, 2009 (1.20 $\mu g/m^3$). All other concentrations of this pollutant were less than 0.75 $\mu g/m^3$ and the median concentration was 0.122 $\mu g/m^3$.

- Both trichloroethylene and, in particular, tetrachloroethylene have high third quarter 2009 average concentrations (and large confidence intervals) for EQWA. The highest concentrations of these pollutants were measured on September 22, 2009. The tetrachloroethylene concentration from this date (4.76 $\mu g/m^3$) was the highest concentration among all NMP sites measuring this pollutant.

- Tetrachloroethylene also has a high fourth quarter 2008 average concentration (and large confidence interval) for EYWA. The highest concentration of this pollutant was measured on November 14, 2008 (1.02 $\mu g/m^3$). Although several other higher concentrations were also measured during this quarter, all other concentrations of this pollutant were less than 0.60 $\mu g/m^3$ and the median concentration was 0.099 $\mu g/m^3$.

- For CEWA, the first and third quarter averages of benzo(a)pyrene for 2009 have confidence intervals larger than the averages themselves, indicating the presence of outliers. The highest concentrations of this pollutant at CEWA were measured on September 22, 2009 (3.46 ng/m^3) and January 19, 2009 (2.58 ng/m^3). These are the only two concentrations of this pollutant greater than 0.5 ng/m^3 and were the second and seventh highest concentrations of benzo(a)pyrene among all NMP sites measuring PAH.

- For ESWA, the only two quarters for which a quarterly average concentration could be calculated for benzo(a)pyrene were the fourth quarter of 2008 and the first quarter 2009. Note that these averages have relatively large confidence intervals associated with them, indicating the presence of outliers. The highest concentrations of this pollutant at ESWA were measured on November 14, 2008 (2.29 ng/m^3) and February 18, 2009 (2.01 ng/m^3) and were the eighth and tenth highest concentrations of benzo(a)pyrene among all NMP sites measuring PAH. However, several additional concentrations of this pollutant greater than 1.0 ng/m^3 were measured throughout these quarters.

Tables 4-9 through 4-12 present the sites with the 10 highest daily average concentrations for each of the program-level pollutants of interest. Observations for the Washington sites from those tables include the following:

- As shown in Tables 4-9, 4-10, and 4-11, the Washington sites appear among the 10 highest site-specific daily average concentrations for the program-level pollutants of interest a total of 26 times.

- ESWA had the second (2008) and fifth (2009) highest daily average concentrations of benzo(a)pyrene and the sixth (2008) highest daily average concentration of naphthalene among sites sampling PAH.

- All five sites appear among the sites with the highest daily average concentrations of VOC. The Washington sites account for six of the 10 highest daily average concentrations of carbon tetrachloride. Although EYWA had the highest daily average concentration of vinyl chloride (2008) among sites sampling VOC, this pollutant was detected only twice, illustrating the limitation of calculating averages based on only a few measured detections.

- None of the Washington sites sampling carbonyl compounds appear in Table 4-10 for carbonyl compounds.

- Although SEWA appears in Tables 4-9 through 4-13 a total of 9 times, all but two were for metals (including hexavalent chromium). SEWA had the second (2009) and third (2008) highest daily average concentrations of nickel; the fourth (2008) and seventh (2009) highest daily average concentrations of manganese; and seventh (2008) and eighth (2009) highest daily average concentrations of hexavalent chromium.

32.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. Although SEWA has sampled hexavalent chromium since 2005, sampling was discontinued for an eight-month period in 2006 from March through October. Because four months is not considered enough to be representative of an entire year, and this year would factor into two of the three 3-year periods, the trends analysis was not conducted.

32.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the Washington monitoring sites. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

32.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data for the Washington monitoring sites to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest for each site were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual and/or study averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the Washington monitoring sites were higher than their respective MRL noncancer health risk benchmarks.

32.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Washington monitoring sites and where *annual* or *study average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual and study averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations for SEWA are presented in Table 32-6a, where applicable. Study averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations for the Puget Sound sites are presented in Table 32-6b, where applicable.

Observations from Table 32-6a for SEWA include the following:

- The pollutants with the highest 2008 annual averages for SEWA were carbon tetrachloride, acetaldehyde, benzene, and formaldehyde. These pollutants also had the highest annual averages for 2009, but the order was different, with formaldehyde and carbon tetrachloride trading positions.

- The pollutants with the highest cancer surrogate risk approximations were formaldehyde, benzene, and carbon tetrachloride for both years.

- All noncancer surrogate risk approximations for SEWA were less than 1.0.

Observations from Table 32-6b for the Puget Sound sites include the following:

- The pollutants with the highest study averages for CEWA, EQWA, and ESWA were formaldehyde, acetaldehyde, and benzene (although not necessarily in that order). The pollutants with the highest study averages for EYWA were benzene, carbon tetrachloride, and ethylbenzene.

- The pollutants with the highest cancer surrogate risk approximations for CEWA, EQWA, and ESWA were formaldehyde, benzene, and carbon tetrachloride. The pollutants with the highest cancer surrogate risk approximations for EYWA were benzene, carbon tetrachloride, and 1,3-butadiene.

- All noncancer surrogate risk approximations for the Puget Sound monitoring sites were less than 1.0.

Table 32-6a. Cancer and Noncancer Surrogate Risk Approximations for the SEWA Monitoring Site in Washington

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)	# of Measured Detections/Valid Quarterly Averages	Annual Average $(\mu g/m^3)$	Cancer (in-a-million)	Noncancer (HQ)
Seattle, Washington - SEWA										
Acetaldehyde	0.0000022	0.009	62/4	0.82 ± 0.13	1.79	0.09	64/4	0.98 ± 0.15	2.15	0.11
Arsenic (PM_{10})[a]	0.0043	0.000015	60/4	<0.01 ± <0.01	2.99	0.05	59/4	<0.01 ± <0.01	3.05	0.05
Benzene	0.0000078	0.03	61/4	0.76 ± 0.08	5.96	0.03	62/4	0.81 ± 0.18	6.31	0.03
Benzo(a)pyrene [a]	0.001	--	22/1	NA	NA	NA	30/2	NA	NA	NA
Beryllium (PM_{10}) [a]	0.0024	0.00002	47/4	<0.01 ± <0.01	0.01	<0.01	49/4	<0.01 ± <0.01	0.01	<0.01
1,3-Butadiene	0.00003	0.002	59/4	0.06 ± 0.01	1.92	0.03	60/4	0.07 ± 0.03	2.18	0.04
Cadmium (PM_{10}) [a]	0.0018	0.00001	60/4	<0.01 ± <0.01	0.22	0.01	59/4	<0.01 ± <0.01	0.19	0.01
Carbon Tetrachloride	0.000006	0.1	61/4	0.84 ± 0.04	5.01	0.01	62/4	0.77 ± 0.04	4.62	0.01
Chloroform	--	0.098	61/4	0.14 ± 0.01	--	<0.01	62/4	0.15 ± 0.01	--	<0.01
Ethylbenzene	0.0000025	1	61/4	0.27 ± 0.05	0.67	<0.01	62/4	0.21 ± 0.07	0.53	<0.01
Formaldehyde	0.000013	0.0098	62/4	0.75 ± 0.12	9.70	0.08	64/4	1.04 ± 0.51	13.53	0.11
Hexavalent Chromium [a]	0.012	0.0001	51/4	<0.01 ± <0.01	0.43	<0.01	48/4	<0.01 ± <0.01	0.39	<0.01
Lead (PM_{10}) [a]	--	0.00015	60/4	<0.01 ± <0.01	--	0.03	59/4	<0.01 ± <0.01	--	0.02

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 32-5a.

Table 32-6a. Cancer and Noncancer Surrogate Risk Approximations for the SEWA Monitoring Site in Washington (Continued)

			2008				2009			
					Risk Approximation				Risk Approximation	
Pollutant	**Cancer URE ($\mu g/m^3$)$^{-1}$**	**Noncancer RfC (mg/m^3)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average ($\mu g/m^3$)**	**Cancer (in-a-million)**	**Noncancer (HQ)**	**# of Measured Detections/Valid Quarterly Averages**	**Annual Average ($\mu g/m^3$)**	**Cancer (in-a-million)**	**Noncancer (HQ)**
Manganese (PM_{10}) [a]	--	0.00005	60/4	0.01 ± <0.01	--	0.22	59/4	0.01 ± <0.01	--	0.14
Naphthalene [a]	0.000034	0.003	47/3	0.06 ± 0.01	2.07	0.02	61/4	0.08 ± 0.01	2.67	0.03
Nickel (PM_{10}) [a]	0.000312	0.00009	60/4	<0.01 ± <0.01	0.68	0.02	59/4	<0.01 ± <0.01	0.82	0.03
Tetrachloroethylene	0.0000059	0.27	57/4	0.13 ± 0.02	0.79	<0.01	54/4	0.12 ± 0.03	0.72	<0.01
Trichloroethylene	0.000002	0.6	16/0	NA	NA	NA	13/0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	2/0	NA	NA	NA	3/0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating an annual average.

[a] For the annual average concentration of this pollutant in ng/m^3, refer back to Table 32-5a.

Table 32-6b. Cancer and Noncancer Surrogate Risk Approximations for the Puget Sound Monitoring Sites in Washington

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections	# of Quarterly Averages	Study Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Duwamish, Seattle, Washington - CEWA							
Acetaldehyde	0.0000022	0.009	57	4	1.43 ± 0.16	3.15	0.16
Benzene	0.0000078	0.03	59	4	0.92 ± 0.19	7.19	0.03
Benzo(a)pyrene[a]	0.001	--	41	4	<0.01 ± <0.01	0.17	--
1,3-Butadiene	0.00003	0.002	59	4	0.10 ± 0.03	2.97	0.05
Carbon Tetrachloride	0.000006	0.1	59	4	0.76 ± 0.05	4.56	0.01
Chloroform	--	0.098	59	4	0.11 ± 0.01	--	<0.01
Ethylbenzene	0.0000025	1	59	4	0.35 ± 0.10	0.88	<0.01
Formaldehyde	0.000013	0.0098	57	4	2.80 ± 0.28	36.42	0.29
Naphthalene[a]	0.000034	0.003	59	4	0.12 ± 0.02	4.14	0.04
Tetrachloroethylene	0.0000059	0.27	56	4	0.20 ± 0.07	1.17	<0.01
Trichloroethylene	0.000002	0.6	33	3	0.08 ± 0.03	0.16	<0.01
Vinyl Chloride	0.0000088	0.1	5	0	NA	NA	NA
Tideflats, Tacoma, Washington - EQWA							
Acetaldehyde	0.0000022	0.009	59	4	1.37 ± 0.15	3.01	0.15

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating a study average.

[a] For the study average concentration of this pollutant in ng/m^3, refer back to Table 32-5b.

Table 32-6b. Cancer and Noncancer Surrogate Risk Approximations for the Puget Sound Monitoring Sites in Washington (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections	# of Quarterly Averages	Study Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Benzene	0.0000078	0.03	58	4	1.00 ± 0.23	7.82	0.03
Benzo(a)pyrene[a]	0.001	--	38	3	<0.01 ± <0.01	0.12	--
1,3-Butadiene	0.00003	0.002	58	4	0.09 ± 0.03	2.71	0.05
Carbon Tetrachloride	0.000006	0.1	58	4	0.76 ± 0.05	4.59	0.01
Chloroform	--	0.098	58	4	0.11 ± 0.01	--	<0.01
Ethylbenzene	0.0000025	1	58	4	0.33 ± 0.09	0.81	<0.01
Formaldehyde	0.000013	0.0098	59	4	1.97 ± 0.30	25.56	0.20
Naphthalene[a]	0.000034	0.003	61	4	0.12 ± 0.02	4.04	0.04
Tetrachloroethylene	0.0000059	0.27	56	4	0.31 ± 0.17	1.84	<0.01
Trichloroethylene	0.000002	0.6	34	3	0.10 ± 0.04	0.19	<0.01
Vinyl Chloride	0.0000088	0.1	20	1	NA	NA	NA
South Tacoma, Washington - ESWA							
Acetaldehyde	0.0000022	0.009	59	4	0.98 ± 0.15	2.15	0.11
Benzene	0.0000078	0.03	58	4	1.30 ± 0.32	10.12	0.04

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating a study average.

[a] For the study average concentration of this pollutant in ng/m^3, refer back to Table 32-5b.

Table 32-6b. Cancer and Noncancer Surrogate Risk Approximations for the Puget Sound Monitoring Sites in Washington (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections	# of Quarterly Averages	Study Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Benzo(a)pyrene[a]	0.001	--	39	2	NA	NA	NA
1,3-Butadiene	0.00003	0.002	57	4	0.13 ± 0.05	3.88	0.06
Carbon Tetrachloride	0.000006	0.1	58	4	0.77 ± 0.05	4.62	0.01
Chloroform	--	0.098	58	4	0.11 ± 0.01	--	<0.01
Ethylbenzene	0.0000025	1	58	4	0.38 ± 0.11	0.94	<0.01
Formaldehyde	0.000013	0.0098	59	4	1.47 ± 0.19	19.05	0.15
Naphthalene[a]	0.000034	0.003	60	4	0.13 ± 0.03	4.30	0.04
Tetrachloroethylene	0.0000059	0.27	45	3	0.13 ± 0.04	0.79	<0.01
Trichloroethylene	0.000002	0.6	10	0	NA	NA	NA
Vinyl Chloride	0.0000088	0.1	2	0	NA	NA	NA
Reservoir, Tacoma, Washington - EYWA							
Acrylonitrile	0.000068	0.002	8	0	NA	NA	NA
Benzene	0.0000078	0.03	58	4	1.17 ± 0.22	9.13	0.04
1,3-Butadiene	0.00003	0.002	58	4	0.11 ± 0.03	3.22	0.05

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating a study average.

[a] For the study average concentration of this pollutant in ng/m^3, refer back to Table 32-5b.

Table 32-6b. Cancer and Noncancer Surrogate Risk Approximations for the Puget Sound Monitoring Sites in Washington (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections	# of Quarterly Averages	Study Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Risk Approximation (HQ)
Carbon Tetrachloride	0.000006	0.1	58	4	0.74 ± 0.04	4.46	0.01
Chloroform	--	0.098	0	0	NA	NA	NA
Ethylbenzene	0.0000025	1	58	4	0.51 ± 0.09	1.28	<0.01
Tetrachloroethylene	0.0000059	0.27	54	4	0.14 ± 0.04	0.85	<0.01
Trichloroethylene	0.000002	0.6	45	3	0.08 ± 0.01	0.16	<0.01
Vinyl Chloride	0.0000088	0.1	5	0	NA	NA	NA

-- = a Cancer URE or Noncancer RfC is not available.

NA = Not available due to the criteria for calculating a study average.

[a] For the study average concentration of this pollutant in ng/m^3, refer back to Table 32-5b.

32.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 32-7a through 32-8b present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 32-7a presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million) for SEWA, as calculated from the annual averages. Table 32-7b presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million) for the Puget Sound sites, as calculated from the study averages. Tables 32-8a and 32-8b present similar information, but identify the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual or study averages, for SEWA and the Puget Sound sites (respectively). For SEWA, risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in Tables 32-7a and 32-8a.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual or study averages are limited to those pollutants for which each respective site sampled. As discussed in section 32.3, SEWA sampled for VOC, PAH, carbonyl compounds, metals (PM_{10}), and hexavalent chromium; CEWA, EQWA, and ESWA sampled for VOC, PAH, and carbonyl compounds; and EYWA sampled for VOC and carbonyl compounds (although all carbonyl compound data was invalidated). In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual or study averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Table 32-7a. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the SEWA Monitoring Site in Washington

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Seattle, Washington (King County) - SEWA					
Benzene	1,631.22	Benzene	1.27E-02	Formaldehyde	13.53
Formaldehyde	846.25	Formaldehyde	1.06E-02	Formaldehyde	9.70
Acetaldehyde	338.36	1,3-Butadiene	5.79E-03	Benzene	6.31
1,3-Butadiene	192.95	Naphthalene	2.89E-03	Benzene	5.96
Tetrachloroethylene	137.51	Hexavalent Chromium, PM	2.31E-03	Carbon Tetrachloride	5.01
Dichloromethane	115.51	POM, Group 2	2.18E-03	Carbon Tetrachloride	4.62
Naphthalene	85.03	POM, Group 3	9.27E-04	Arsenic (PM_{10})	3.05
Trichloroethylene	50.69	Tetrachloroethylene	8.11E-04	Arsenic (PM_{10})	2.99
POM, Group 2	39.66	Acetaldehyde	7.44E-04	Naphthalene	2.67
p-Dichlorobenzene	37.68	Arsenic, PM	5.53E-04	1,3-Butadiene	2.18

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 32-7b. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Puget Sound Monitoring Sites in Washington

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Duwamish, Seattle, Washington (King County) - CEWA					
Benzene	1,631.22	Benzene	1.27E-02	Formaldehyde	36.42
Formaldehyde	846.25	Formaldehyde	1.06E-02	Benzene	7.19
Acetaldehyde	338.36	1,3-Butadiene	5.79E-03	Carbon Tetrachloride	4.56
1,3-Butadiene	192.95	Naphthalene	2.89E-03	Naphthalene	4.14
Tetrachloroethylene	137.51	Hexavalent Chromium, PM	2.31E-03	Acetaldehyde	3.15
Dichloromethane	115.51	POM, Group 2	2.18E-03	1,3-Butadiene	2.97
Naphthalene	85.03	POM, Group 3	9.27E-04	Tetrachloroethylene	1.17
Trichloroethylene	50.69	Tetrachloroethylene	8.11E-04	Ethylbenzene	0.88
POM, Group 2	39.66	Acetaldehyde	7.44E-04	Benzo(a)pyrene	0.17
p-Dichlorobenzene	37.68	Arsenic, PM	5.53E-04	Trichloroethylene	0.16
Tideflats, Tacoma, Washington (Pierce County) - EQWA					
Benzene	754.12	Formaldehyde	7.61E-03	Formaldehyde	25.56
Formaldehyde	608.92	Benzene	5.88E-03	Benzene	7.82
Acetaldehyde	216.78	1,3-Butadiene	3.44E-03	Carbon Tetrachloride	4.59
1,3-Butadiene	114.58	POM, Group 2	1.09E-03	Naphthalene	4.04
Dichloromethane	87.50	Naphthalene	9.82E-04	Acetaldehyde	3.01
Tetrachloroethylene	38.71	Acetaldehyde	4.77E-04	1,3-Butadiene	2.71
Naphthalene	28.89	Hexavalent Chromium, PM	3.87E-04	Tetrachloroethylene	1.84
POM, Group 2	19.81	POM, Group 3	3.82E-04	Ethylbenzene	0.81
p-Dichlorobenzene	15.66	POM, Group 1	2.56E-04	Trichloroethylene	0.19
POM, Group 1	4.65	Tetrachloroethylene	2.28E-04	Benzo(a)pyrene	0.12

[1] These cancer risk approximations are based on the study averages.

Table 32-7b. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Puget Sound Monitoring Sites in Washington (Continued)

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
South Tacoma, Washington (Pierce County) - ESWA					
Benzene	754.12	Formaldehyde	7.61E-03	Formaldehyde	19.05
Formaldehyde	608.92	Benzene	5.88E-03	Benzene	10.12
Acetaldehyde	216.78	1,3-Butadiene	3.44E-03	Carbon Tetrachloride	4.62
1,3-Butadiene	114.58	POM, Group 2	1.09E-03	Naphthalene	4.30
Dichloromethane	87.50	Naphthalene	9.82E-04	1,3-Butadiene	3.88
Tetrachloroethylene	38.71	Acetaldehyde	4.77E-04	Acetaldehyde	2.15
Naphthalene	28.89	Hexavalent Chromium, PM	3.87E-04	Ethylbenzene	0.94
POM, Group 2	19.81	POM, Group 3	3.82E-04	Tetrachloroethylene	0.79
p-Dichlorobenzene	15.66	POM, Group 1	2.56E-04	Benzo(a)pyrene	0.30
POM, Group 1	4.65	Tetrachloroethylene	2.28E-04	Trichloroethylene	0.03
Reservoir, Tacoma, Washington (Pierce County) - EYWA					
Benzene	754.12	Formaldehyde	7.61E-03	Benzene	9.13
Formaldehyde	608.92	Benzene	5.88E-03	Carbon Tetrachloride	4.46
Acetaldehyde	216.78	1,3-Butadiene	3.44E-03	1,3-Butadiene	3.22
1,3-Butadiene	114.58	POM, Group 2	1.09E-03	Ethylbenzene	1.28
Dichloromethane	87.50	Naphthalene	9.82E-04	Acrylonitrile	0.89
Tetrachloroethylene	38.71	Acetaldehyde	4.77E-04	Tetrachloroethylene	0.85
Naphthalene	28.89	Hexavalent Chromium, PM	3.87E-04	Trichloroethylene	0.16
POM, Group 2	19.81	POM, Group 3	3.82E-04	Vinyl Chloride	0.03
p-Dichlorobenzene	15.66	POM, Group 1	2.56E-04		
POM, Group 1	4.65	Tetrachloroethylene	2.28E-04		

[1] These cancer risk approximations are based on the study averages.

Table 32-8a. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the SEWA Monitoring Site in Washington

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Seattle, Washington (King County) - SEWA					
Toluene	4,893.78	Acrolein	2,853,660.18	Manganese (PM_{10})	0.22
Xylenes	3,269.20	1,3-Butadiene	96,475.61	Manganese (PM_{10})	0.14
Benzene	1,631.22	Formaldehyde	86,351.95	Acetaldehyde	0.11
Methanol	947.08	Benzene	54,374.01	Formaldehyde	0.11
Hexane	848.59	Acetaldehyde	37,595.20	Acetaldehyde	0.09
Formaldehyde	846.25	Xylenes	32,692.01	Formaldehyde	0.08
Ethylbenzene	758.85	Naphthalene	28,344.12	Arsenic (PM_{10})	0.05
Acetaldehyde	338.36	Manganese, PM	16,654.97	Arsenic (PM_{10})	0.05
Ethylene glycol	323.95	Hexamethylene-1,6-diisocyanate	13,200.00	1,3-Butadiene	0.04
Methyl isobutyl ketone	276.67	Toluene	12,234.44	1,3-Butadiene	0.03

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 32-8b. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Puget Sound Monitoring Sites in Washington

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Duwamish, Seattle, Washington (King County) - CEWA					
Toluene	4,893.78	Acrolein	2,853,660.18	Formaldehyde	0.29
Xylenes	3,269.20	1,3-Butadiene	96,475.61	Acetaldehyde	0.16
Benzene	1,631.22	Formaldehyde	86,351.95	1,3-Butadiene	0.05
Methanol	947.08	Benzene	54,374.01	Naphthalene	0.04
Hexane	848.59	Acetaldehyde	37,595.20	Benzene	0.03
Formaldehyde	846.25	Xylenes	32,692.01	Carbon Tetrachloride	0.01
Ethylbenzene	758.85	Naphthalene	28,344.12	Chloroform	<0.01
Acetaldehyde	338.36	Manganese, PM	16,654.97	Tetrachloroethylene	<0.01
Ethylene glycol	323.95	Hexamethylene-1,6-diisocyanate	13,200.00	Ethylbenzene	<0.01
Methyl isobutyl ketone	276.67	Toluene	12,234.44	Trichloroethylene	<0.01
Tideflats, Tacoma, Washington (Pierce County) - EQWA					
Toluene	1,871.52	Acrolein	3,199,942.87	Formaldehyde	0.20
Xylenes	1,245.92	Formaldehyde	62,134.94	Acetaldehyde	0.15
Methanol	882.28	1,3-Butadiene	57,289.71	1,3-Butadiene	0.05
Benzene	754.12	Benzene	25,137.39	Naphthalene	0.04
Formaldehyde	608.92	Acetaldehyde	24,086.29	Benzene	0.03
Hexane	418.95	Xylenes	12,459.15	Carbon Tetrachloride	0.01
Ethylbenzene	287.07	Naphthalene	9,631.08	Chloroform	<0.01
Acetaldehyde	216.78	Hydrochloric acid	8,855.52	Tetrachloroethylene	<0.01
Hydrochloric acid	177.11	Nickel, PM	7,468.39	Ethylbenzene	<0.01
1,3-Butadiene	114.58	Manganese, PM	5,520.24	Trichloroethylene	<0.01

[1] These cancer risk approximations are based on the study averages.

Table 32-8b. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Puget Sound Monitoring Sites in Washington (Continued)

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Risk Approximations Based on Study Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
South Tacoma, Washington (Pierce County) - ESWA					
Toluene	1,871.52	Acrolein	3,199,942.87	Formaldehyde	0.15
Xylenes	1,245.92	Formaldehyde	62,134.94	Acetaldehyde	0.11
Methanol	882.28	1,3-Butadiene	57,289.71	1,3-Butadiene	0.06
Benzene	754.12	Benzene	25,137.39	Benzene	0.04
Formaldehyde	608.92	Acetaldehyde	24,086.29	Naphthalene	0.04
Hexane	418.95	Xylenes	12,459.15	Carbon Tetrachloride	0.01
Ethylbenzene	287.07	Naphthalene	9,631.08	Chloroform	<0.01
Acetaldehyde	216.78	Hydrochloric acid	8,855.52	Tetrachloroethylene	<0.01
Hydrochloric acid	177.11	Nickel, PM	7,468.39	Ethylbenzene	<0.01
1,3-Butadiene	114.58	Manganese, PM	5,520.24	Trichloroethylene	<0.01
Reservoir, Tacoma, Washington (Pierce County) - EYWA					
Toluene	1,871.52	Acrolein	3,199,942.87	1,3-Butadiene	0.05
Xylenes	1,245.92	Formaldehyde	62,134.94	Benzene	0.04
Methanol	882.28	1,3-Butadiene	57,289.71	Carbon Tetrachloride	0.01
Benzene	754.12	Benzene	25,137.39	Acrylonitrile	0.01
Formaldehyde	608.92	Acetaldehyde	24,086.29	Tetrachloroethylene	<0.01
Hexane	418.95	Xylenes	12,459.15	Ethylbenzene	<0.01
Ethylbenzene	287.07	Naphthalene	9,631.08	Trichloroethylene	<0.01
Acetaldehyde	216.78	Hydrochloric acid	8,855.52	Vinyl Chloride	<0.01
Hydrochloric acid	177.11	Nickel, PM	7,468.39		
1,3-Butadiene	114.58	Manganese, PM	5,520.24		

[1] These cancer risk approximations are based on the study averages.

Observations from Table 32-7a for SEWA and Table 32-7b for CEWA include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in King County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for King County were benzene, formaldehyde, and 1,3-butadiene.
- Seven of the highest emitted pollutants also had the highest toxicity-weighted emissions for King County.
- Formaldehyde and benzene topped both sites' highest cancer risk approximations list. Carbon tetrachloride, which was the third-ranked pollutant for both sites' cancer risk approximations, did not appear on either emissions-based list.
- POM Group 2 was the ninth highest emitted "pollutant" in King County and ranked sixth for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at SEWA and CEWA including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for these sites.
- POM Group 3 ranked seventh for toxicity-weighted emissions for King County. POM Group 3 does not include any pollutants sampled at these sites.

Observations from Table 32-7b for the Tacoma sites include the following:

- Benzene, formaldehyde, and acetaldehyde were also the highest emitted pollutants with cancer UREs in Pierce County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Pierce County were formaldehyde, benzene, and 1,3-butadiene.
- Eight of the highest emitted pollutants also had the highest toxicity-weighted emissions for Pierce County.
- Formaldehyde, benzene, and carbon tetrachloride had the highest cancer risk approximations for EQWA and ESWA. Carbon tetrachloride did not appear on either emissions-based list for Pierce County while the other two pollutants appear on both emissions-based lists.
- For EYWA, benzene, carbon tetrachloride, and 1,3-butadiene had the highest cancer risk approximations. 1,3-Butadiene ranked fourth in total emissions and third for toxicity-weighted emissions for Pierce County.

- POM Groups 1 and 2 were among the 10 highest emitted "pollutants" in Pierce County and also ranked among the 10 highest for toxicity-weighted emissions. POM Group 1 includes unspeciated polycyclic organic matter. POM Group 2 includes several PAH sampled for at EQWA and EYWA including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for these sites. POM Group 3 ranked eighth for toxicity-weighted emissions for Pierce County. POM Group 3 does not include any pollutants sampled at these sites.

Observations from Table 32-8a for SEWA and Table 32-8b for CEWA include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in King County.

- Acrolein was the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for King County, followed by 1,3-butadiene and formaldehyde. Although acrolein was sampled for at CEWA and SEWA, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Five of the highest emitted pollutants also had the highest toxicity-weighted emissions for King County.

- Manganese, which had the highest noncancer risk approximations for SEWA, had the eighth highest toxicity-weighted emissions, but did not appear among the 10 highest emitted pollutants for King County.

- Formaldehyde and acetaldehyde appear on all three lists for SEWA and CEWA.

Observations from Table 32-8b for the Tacoma sites include the following:

- Toluene, xylenes, and methanol were the highest emitted pollutants with noncancer RfCs in Pierce County.

- Acrolein was the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Pierce County, followed by formaldehyde and 1,3-butadiene. Although acrolein was sampled for at EQWA, ESWA, and EYWA, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Six of the highest emitted pollutants also had the highest toxicity-weighted emissions for Pierce County.

- Formaldehyde, acetaldehyde, and 1,3-butadiene had the highest noncancer risk approximations for EQWA and ESWA (albeit low); these three pollutants also appear on both emissions-based lists for Pierce County. Benzene also appears on both emissions-based lists for both sites.

- For EYWA, 1,3-butadiene, benzene, and carbon tetrachloride had the highest noncancer risk approximations (albeit low). While benzene and 1,3-butadiene appear on both emissions-based lists for Pierce County, carbon tetrachloride appears on neither.

32.6 Summary of the 2008-2009 Monitoring Data for the Washington Sites

Results from several of the treatments described in this section include the following:

- ❖ *Between nine and 15 pollutants failed screens for CEWA, EQWA, ESWA, and EYWA; 19 failed screens for SEWA.*

- ❖ *Formaldehyde had the highest daily average concentration for SEWA, CEWA, EQWA, and ESWA. For EYWA, benzene had the highest daily average concentration; note that carbonyl compound data was invalidated for this site.*

- ❖ *None of the preprocessed daily measurements and none of the quarterly, annual or study average concentrations of the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

33.0 Site in Wisconsin

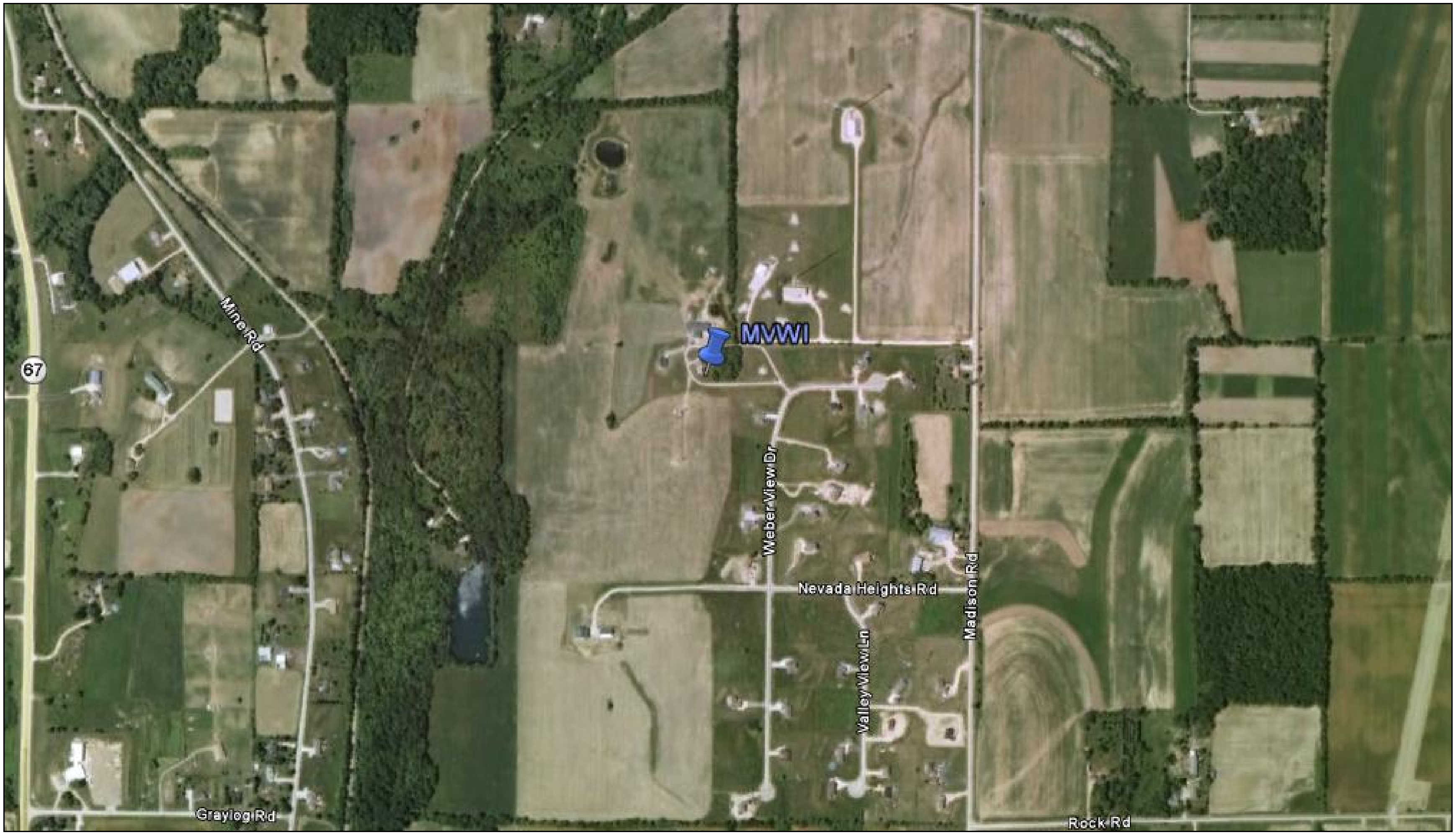
This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site in Wisconsin, and integrates these concentrations with emissions, meteorological, and risk information. Data generated by sources other than ERG are not included in the data analyses contained in this report. Readers are encouraged to refer back to Sections 1 through 4 for detailed discussions on the various data analyses presented below.

33.1 Site Characterization

This section characterizes the monitoring site by providing geographical and physical information about the location of the site and the surrounding area. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

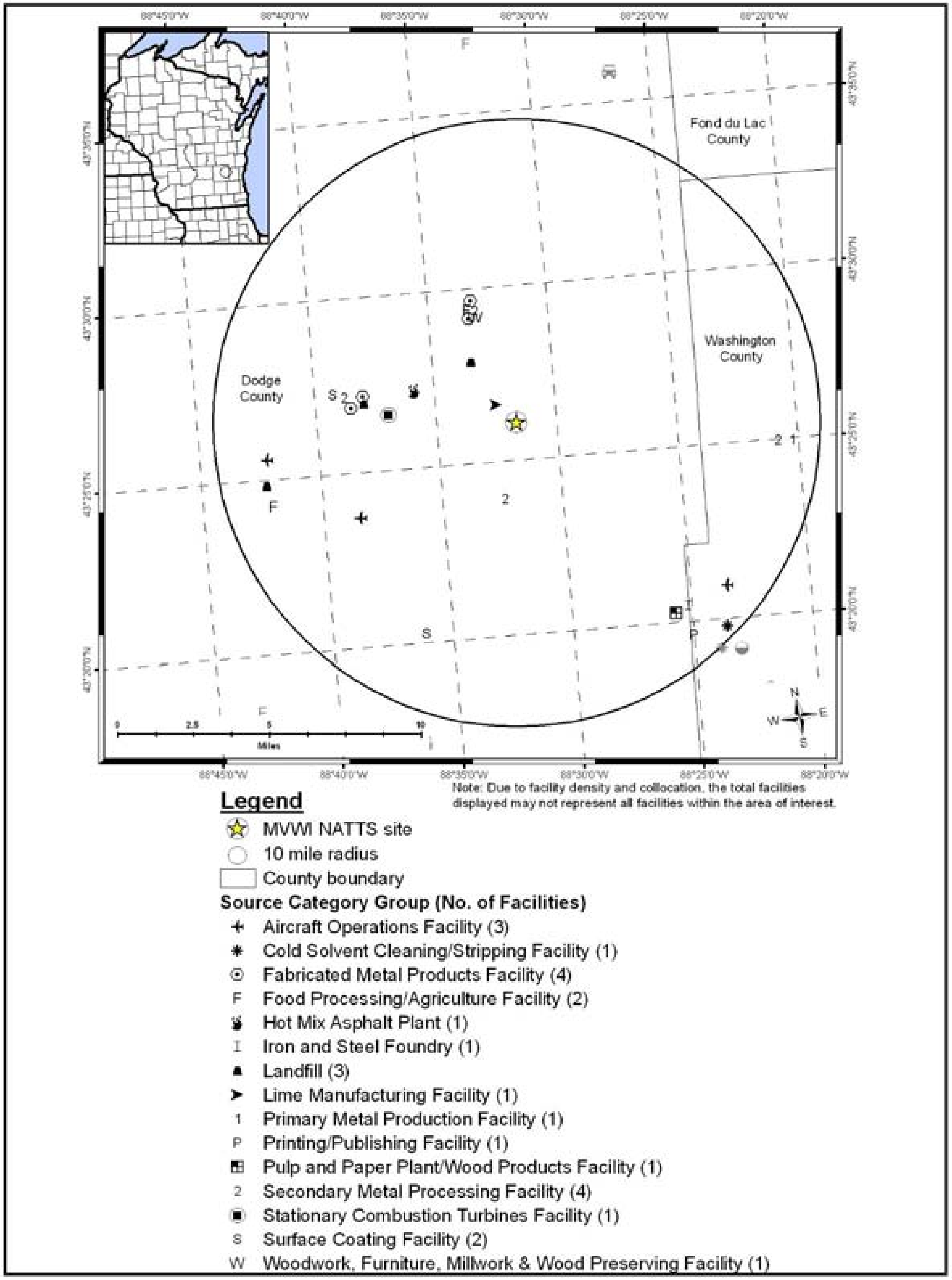
The MVWI monitoring site is located in Mayville, Wisconsin. Figure 33-1 is a composite satellite image retrieved from Google™ Earth showing the monitoring site in its rural location. Figure 33-2 identifies point source emissions locations by source category, as reported in the 2005 NEI for point sources. Note that only sources within 10 miles of the site are included in the facility counts provided below the map in Figure 33-2. Thus, sources outside the 10-mile radius have been grayed out, but are visible on the map to show emissions sources outside the 10-mile boundary. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have an immediate impact on the air quality at the monitoring site; further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Table 33-1 describes the area surrounding the monitoring site by providing supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 33-1. Mayville, Wisconsin (MVWI) Monitoring Site



©2010 Google Earth, accessed 11/11/2010 Scale: 2 inches = 2,257 feet

Figure 33-2. NEI Point Sources Located Within 10 Miles of MVWI


88°45'0"W
88°40'0"W
88°35'0"W
88°30'0"W
88°25'0"W
88°20'0"W
43°35'0"N
43°30'0"N
43°25'0"N
43°20'0"N
Fond du Lac County
Washington County
Dodge County
N
E
S
W
0
2.5
5
10
Miles
Legend
MVWI NATTS site
10 mile radius
County boundary
Source Category Group (No. of Facilities)
Aircraft Operations Facility (3)
Cold Solvent Cleaning/Stripping Facility (1)
Fabricated Metal Products Facility (4)
F Food Processing/Agriculture Facility (2)
Hot Mix Asphalt Plant (1)
I Iron and Steel Foundry (1)
Landfill (3)
Lime Manufacturing Facility (1)
1 Primary Metal Production Facility (1)
P Printing/Publishing Facility (1)
Pulp and Paper Plant/Wood Products Facility (1)
2 Secondary Metal Processing Facility (4)
Stationary Combustion Turbines Facility (1)
S Surface Coating Facility (2)
W Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Table 33-1. Geographical Information for the Wisconsin Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Additional Ambient Monitoring Information[1]
MVWI	55-027-0007	Mayville	Dodge	Beaver Dam, WI	43.435, -88.527778	Agricultural	Rural	CO, SO_2, NOy, NO, VOC, Carbonyl compounds, O_3, Meteorological parameters, PM_{10}, PM_{10} Metals, $PM_{2.5}$, and $PM_{2.5}$ Speciation.

BOLD = EPA-designated NATTS Site.

[1] Information in this column was obtained from AQS, represents active monitors for the 2008-2009 time frame, and excludes ambient monitoring covered in this report (EPA, 2011j).

MVWI is located about 30 miles northwest of Milwaukee and roughly 40 miles northeast of Madison, and to the east of Horicon National Wildlife Refuge. The surrounding area is rural and agricultural in nature. The MVWI monitoring site serves as a rural background site. However, the area is impacted by nearby urban areas, and thus, could show the impacts on the wildlife sanctuary. Highway 33 to the north and Highway 67 to the west (which can be seen on the left-hand side of Figure 33-1) intersect less than 1 mile northwest of the site. Figure 33-2 shows that most of the point sources surrounding MVWI are located to the west and northwest of the site. The source categories with the highest number of emissions sources are fabricated metal products facilities; secondary metal processing facilities; aircraft operations, which include airports as well as small runways, heliports, and landing pads; and landfills. However, the facility closest to MVWI is involved in lime manufacturing.

Table 33-2 presents information related to mobile source activity, such as population, traffic, VMT, and estimated vehicle ownership information for the area surrounding the Wisconsin monitoring site. Information provided in Table 33-2 represents the most recent year of sampling (2009), unless otherwise indicated. County-level vehicle registration and population data for Dodge County were obtained from the Wisconsin Department of Transportation (WI DOT, 2008) and the U.S. Census Bureau (Census Bureau, 2010), respectively. Table 33-2 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 estimate of 10-mile vehicle ownership was calculated by applying the county-level vehicle registration-to-population ratio to the 10-mile population surrounding the monitoring site. Table 33-2 also contains annual average daily traffic information, as well as the year of the traffic data estimate and the source from which it was obtained. VMT was not available for the MVWI monitoring site due to the rural nature of the surrounding area.

Table 33-2. Population, Motor Vehicle, and Traffic Information for the Wisconsin Monitoring Site

Site	Estimated County Population[1]	Number of Vehicles Registered[2]	Vehicles per Person (Registration: Population)	Population Within 10 Miles[3]	Estimated 10-Mile Vehicle Ownership	Annual Average Daily Traffic[4]	VMT[5] (thousands)
MVWI	87,335	93,219	1.07	24,804	26,475	3,500	NA

[1] Reference: Census Bureau, 2010.
[2] County-level vehicle registration reflects 2008 data from the Wisconsin DOT (WI DOT, 2008).
[3] Reference: http://xionetic.com/zipfinddeluxe.aspx
[4] Annual Average Daily Traffic reflects 2004 data from the Wisconsin DOT (WI DOT, 2004).
[5] VMT reflects 2008 data from the Federal Highway Administration (FHWA, 2009b).
NA = Data unavailable.
BOLD = EPA-designated NATTS Site.

Observations from Table 33-2 include the following:

- Dodge County's population was on the low end compared to other counties with NMP sites. This is also true of its 10-mile population.
- The county-level vehicle registration was also on the low end compared to other counties with NMP sites. This is also true of its estimated 10-mile vehicle ownership.
- The vehicle-per-person ratio was slightly greater than one vehicle per person. This ratio ranked among the higher ratios for NMP sites.
- The traffic volume experienced near MVWI was also on the low end compared to other NMP monitoring sites. The traffic estimate used was for the intersection of Highway 33 and Highway 67.

33.2 Meteorological Characterization

The following sections characterize the meteorological conditions near the monitoring site in Wisconsin on sample days, as well as over the course of each year.

33.2.1 Climate Summary

The town of Mayville is located about halfway between Madison and Milwaukee. This area experiences a highly variable, continental climate as weather systems frequently track across the region. Precipitation falls predominantly in the spring and summer months. Winters are cold and predominantly dry, although wintertime temperature extremes can be moderated somewhat by the proximity to Lake Michigan (although this effect is felt more often closer to the lake). Lake effect snows can occur with winds with an easterly component. Summers tend to be mild, although southerly winds out of the Gulf of Mexico can occasionally advect warm, humid air into the area (Bair, 1992).

33.2.2 Meteorological Conditions in 2008-2009

Hourly meteorological data from the NWS weather station nearest this site were retrieved for all of 2008 and 2009 (NCDC, 2008 and 2009). The closest NWS weather station is located at West Bend Municipal Airport (WBAN 04875). Additional information about the West Bend weather station is provided in Table 33-3. These data were used to determine how meteorological conditions on sample days vary from normal conditions throughout the year(s).

Table 33-3 presents average temperature (average maximum and average daily), moisture (average dew point temperature, average wet bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind (average scalar wind speed) information for days samples were collected and for the entire year for both 2008 and 2009. Also included in Table 33-3 is the 95 percent confidence interval for each parameter. As shown in Table 33-3, average meteorological conditions on sample days were representative of average weather conditions throughout the year for both years. Sea level pressure was not recorded at the West Bend Municipal Airport.

33.2.3 Back Trajectory Analysis

Figure 33-3 and Figure 33-4 are the composite back trajectory maps for days on which samples were collected at the MVWI monitoring site in 2008 and 2009, respectively. Figure 33-5 is the cluster analysis for both years, with 2008 clusters in blue and 2009 clusters in red. An in-depth description of these maps and how they were generated is presented in Section 3.5.2.1. For the composite maps, each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a given sample day. For the cluster analyses, each line corresponds to a back trajectory representative of a given cluster of trajectories. For all maps, each concentric circle around the site in Figures 33-3 through 33-5 represents 100 miles.

Table 33-3. Average Meteorological Conditions near the Wisconsin Monitoring Site

Closest NWS Station (WBAN and Coordinates)	Distance and Direction from Site	Year	Average Type[1]	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)
Mayville, Wisconsin - MVWI										
West Bend Municipal Airport 04875 (43.42, -88.12)	19.39 miles 88° (E)	2008	Sample Day	53.3 ± 5.4	45.3 ± 5.0	38.2 ± 5.0	42.0 ± 4.7	78.3 ± 2.9	NA	5.5 ± 0.7
			All Year	52.8 ± 2.3	44.7 ± 2.2	37.2 ± 2.1	41.2 ± 2.0	77.0 ± 1.1	NA	5.5 ± 0.3
		2009	Sample Day	54.1 ± 5.0	45.7 ± 4.8	35.9 ± 4.6	41.2 ± 4.3	71.8 ± 3.4	NA	6.2 ± 0.8
			All Year	53.9 ± 2.2	45.4 ± 2.0	35.6 ± 1.9	40.9 ± 1.8	71.9 ± 1.4	NA	5.7 ± 0.3

[1] Sample day averages are highlighted in orange to help differentiate the sample day averages from the full year averages.

NA = Sea level pressure was not recorded at the West Bend Municipal Airport.

Figure 33-3. 2008 Composite Back Trajectory Map for MVWI

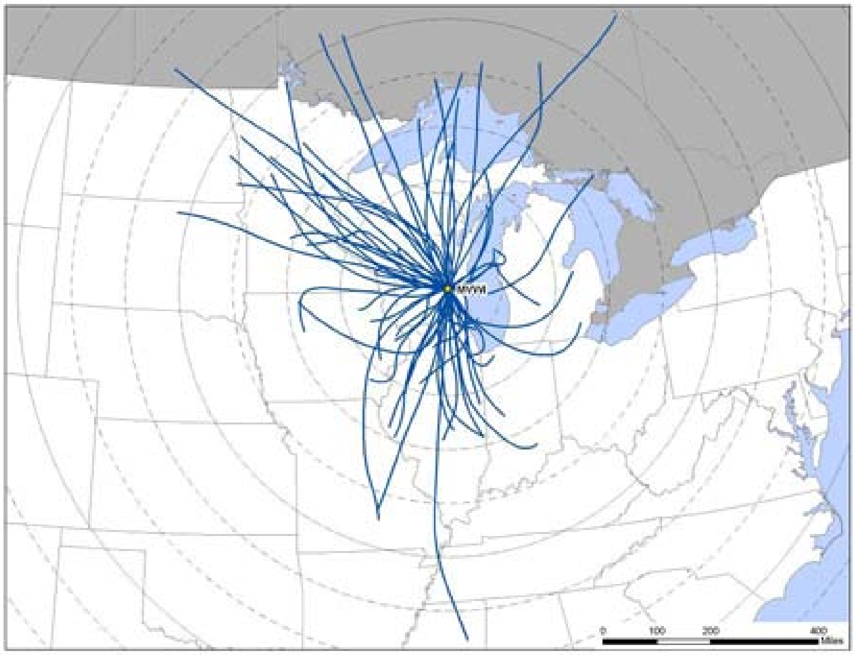


Figure 33-4. 2009 Composite Back Trajectory Map for MVWI

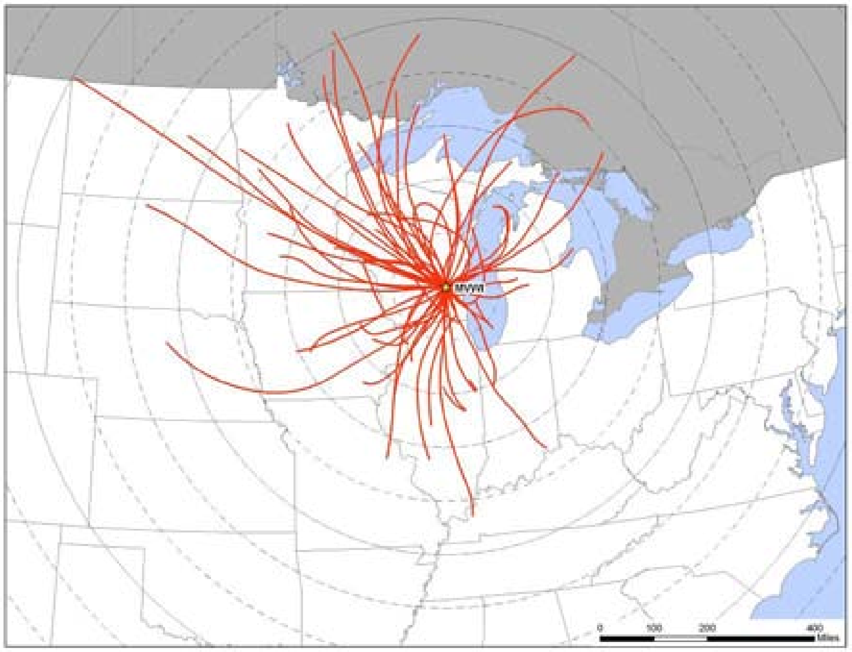
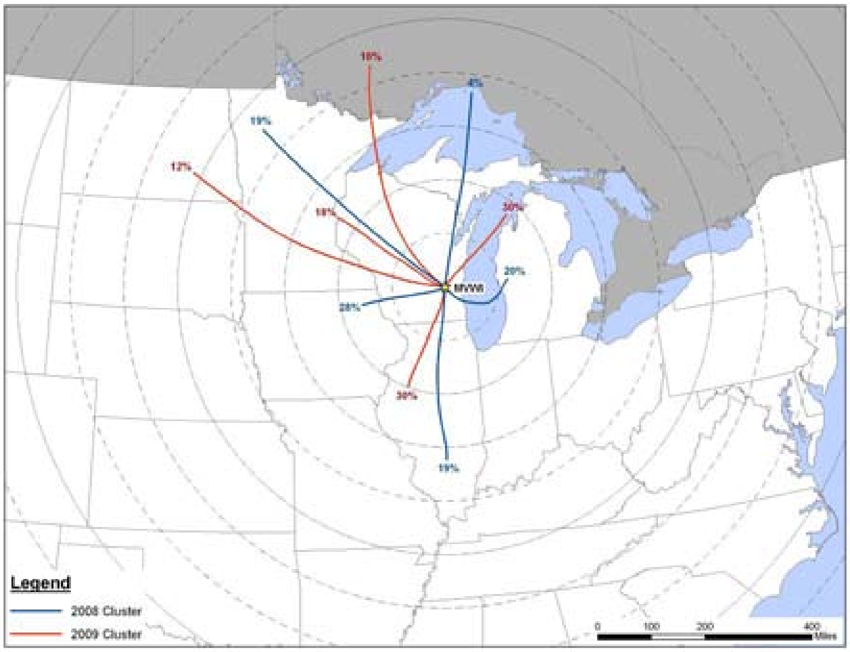


Figure 33-5. Back Trajectory Cluster Map for MVWI



Observations from Figures 33-3 through 33-5 for MVWI include the following:

- Back trajectories originated from a variety of directions at MVWI, although less frequently from the east.

- The 24-hour air shed domain for MVWI was larger in size compared to many other NMP monitoring sites. The farthest away a trajectory originated was just beyond the northwest North Dakota border, or approximately 800 miles away. However, the average trajectory length was 288 miles and most trajectories (83 percent) originated within 450 miles of the site.

- The cluster map shows that 28 percent of the 2008 back trajectories are represented by the short trajectory originating to the west of the site. The individual back trajectories represented by this cluster trajectory originated from within 250 miles of the site and originated from the northwest, west, and southwest. Longer trajectories originating to the west and northwest account for another 19 percent of the 2008 trajectories. Thus, nearly 50 percent of 2008 trajectories originated from a direction with a westerly component. For 2009, these directions accounted for fewer trajectory origins, about 30 percent. Shorter trajectories originating from the northeast to southeast accounted for 20 percent of trajectories in 2008 and 30 percent in 2009. Trajectories originating to the south-southeast to south-southwest of the site accounted for 19 percent of the trajectories in 2008 and 30 percent in 2009. Back trajectories originating to the north-northwest to north-northeast accounted for four percent in 2008 and 10 percent in 2009.

33.2.4 Wind Rose Comparison

Hourly wind data from the NWS weather station at West Bend Municipal Airport near MVWI were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.5.2.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds.

Figure 33-6 presents five different wind roses for the MVWI monitoring site. First, a historical wind rose representing 2003 to 2007 is presented, which shows the predominant surface wind speed and direction over an extended period of time. Second, a wind rose for 2008 representing wind observations for the entire year and a wind rose representing days on which samples were collected in 2008 are presented. Finally, a wind rose representing all of 2009 and a wind rose for days that samples were collected in 2009 are presented. These can be used to determine if wind observations on sample days were representative of conditions experienced over the entire year.

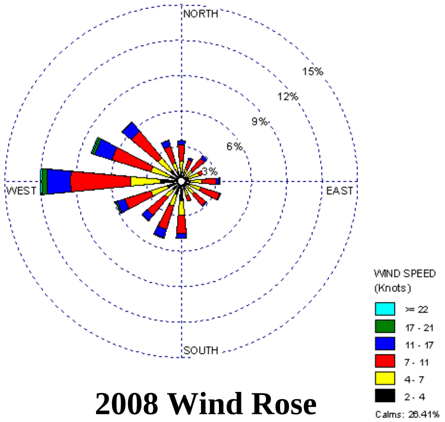
Observations from Figure 33-6 for MVWI include the following:

- The historical wind rose shows that calm winds (≤2 knots) were prevalent near MVWI, as calm winds were observed for nearly 28 percent of the hourly measurements. For winds greater than 2 knots, winds with a westerly component were observed the most, particularly westerly and west-northwesterly winds. The strongest wind speeds were associated with these two wind directions.

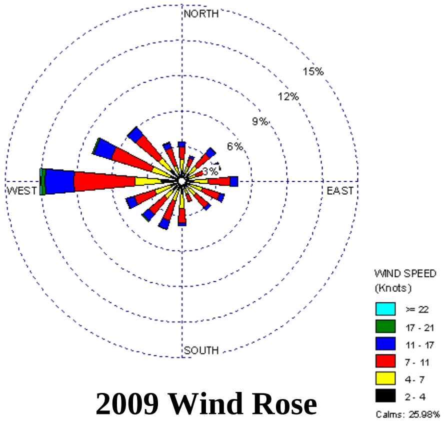
- The wind patterns shown on the 2008 wind rose resemble the historical wind patterns, although winds from the west, west-northwest, and northwest were each observed slightly more frequently. The 2008 sample day wind rose shows that fewer winds from the southwest quadrant were observed while an increased percentage of winds from the northwest quadrant (including north) were observed. Westerly winds were still observed the most of any wind direction and calm winds still accounted for more than a quarter of the observations.

- The wind patterns shown on the 2009 wind rose resemble the historical wind patterns, but westerly, west-northwesterly, and northwesterly winds were each observed slightly more frequently than the historical wind rose. The 2009 sample day wind rose has an even higher percentage of westerly, west-northwesterly, and northwesterly winds, and fewer calm wind observations.

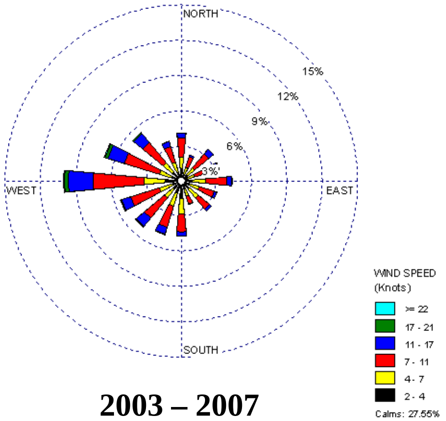
Figure 33-6. Wind Roses for the West Bend Municipal Airport Weather Station near MVWI



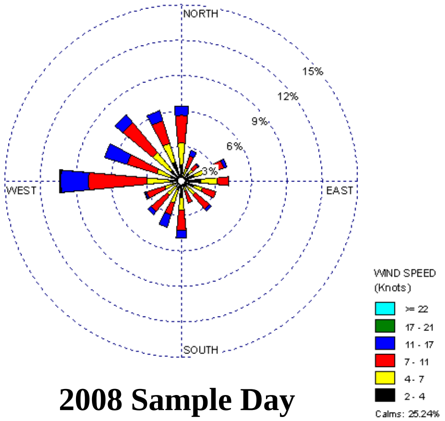
2008 Wind Rose



2009 Wind Rose

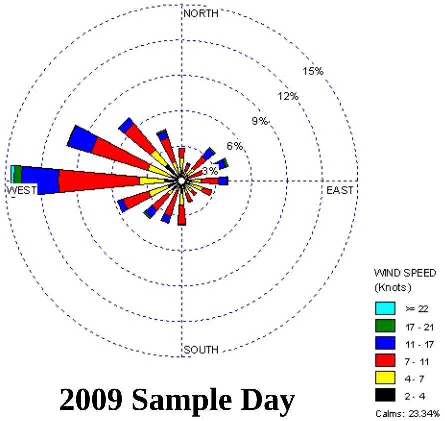


2003 – 2007
Historical Wind Rose



2008 Sample Day

Wind Rose



2009 Sample Day

Wind Rose

33.3 Pollutants of Interest

Site-specific "pollutants of interest" were determined for the Wisconsin monitoring site in order to allow analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens. In addition, if any of the NATTS MQO Core Analytes measured by the monitoring site did not meet the pollutant of interest criteria based on the preliminary risk screening, that pollutant was added to the list of site-specific pollutants of interest. A more in-depth description of the risk screening process is presented in Section 3.2.

Table 33-4 presents MVWI's pollutants of interest. The pollutants that failed at least one screen and contributed to 95 percent of the total failed screens for the monitoring site are shaded. NATTS MQO Core Analytes are bolded. Thus, pollutants of interest are shaded and/or bolded. MVWI sampled for PAH and hexavalent chromium.

Table 33-4. Risk Screening Results for the Wisconsin Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Mayville, Wisconsin - MVWI						
Naphthalene	0.029	33	103	32.04	97.06	97.06
Hexavalent Chromium	0.000083	1	50	2.00	2.94	100.00
Total		34	153	22.22		

Observations from Table 33-4 include the following:

- Both naphthalene and hexavalent chromium failed screens for MVWI; however, all but one of those failures were for naphthalene.
- Hexavalent chromium was detected in fewer than 50 percent of samples collected (50 out of 120 valid samples) while naphthalene was detected in every sample collected (103). Note that sampling for PAH did not begin until March 2008, thus fewer total samples were collected.

- Naphthalene was identified as the pollutant of interest for MVWI, based on the risk screening process. However, hexavalent chromium was added to MVWI's pollutants of interest because it is a NATTS MQO Core Analyte, even though it did not contribute to 95 percent of the total failed screens. Benzo(a)pyrene was added to MVWI's pollutants of interest because it is also a NATTS MQO Core Analyte, even though it did not fail any screens. This pollutant is not shown in Table 33-4.

33.4 Concentrations

This section presents various concentration averages used to characterize pollution levels at the Wisconsin monitoring site. Concentration averages are provided for the pollutants of interest for the MVWI monitoring site, where applicable. In addition, concentration averages for select pollutants are presented from previous years of sampling in order to characterize concentration trends at the site, where applicable. Additional site-specific statistical summaries are provided in Appendices J through O.

33.4.1 2008-2009 Concentration Averages

Daily, quarterly, and annual concentration averages were calculated for MVWI's pollutants of interest, as described in Section 3.1.1. 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 given calendar quarter, then a *quarterly* average was calculated. The quarterly average calculations include the substitution of zeros for all non-detects. Finally, the *annual* average includes all measured detections and substituted zeros for non-detects. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent. Daily, quarterly, and annual averages are presented in Table 33-5, where applicable. The averages presented in Table 33-5 are shown in ng/m^3 for ease of viewing.

Table 33-5. Daily, Quarterly, and Annual Average Concentrations of the Pollutants of Interest for the Wisconsin Monitoring Site

Pollutant	2008						2009					
	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)	Daily Average (ng/m^3)	1st Quarter Average (ng/m^3)	2nd Quarter Average (ng/m^3)	3rd Quarter Average (ng/m^3)	4th Quarter Average (ng/m^3)	Annual Average (ng/m^3)
Mayville, Wisconsin - MVWI												
Benzo(a)pyrene	0.06 ± 0.03	NA	0.02 ± 0.01	NA	0.05 ± 0.04	NA	0.11 ± 0.06	0.17 ± 0.11	NA	NA	0.07 ± 0.03	NA
Hexavalent Chromium	0.02 ± 0.01	0.01 ± <0.01	0.02 ± 0.01	0.02 ± 0.01	NA	0.01 ± <0.01	0.02 ± 0.01	NA	NA	NA	NA	NA
Naphthalene	25.55 ± 8.98	NA	15.29 ± 4.15	15.40 ± 4.17	44.45 ± 25.80	25.55 ± 8.98	32.02 ± 6.19	45.26 ± 13.03	32.73 ± 15.20	20.48 ± 7.93	27.01 ± 6.89	32.02 ± 6.19

NA = Not available due to the criteria for calculating a quarterly and/or annual average.

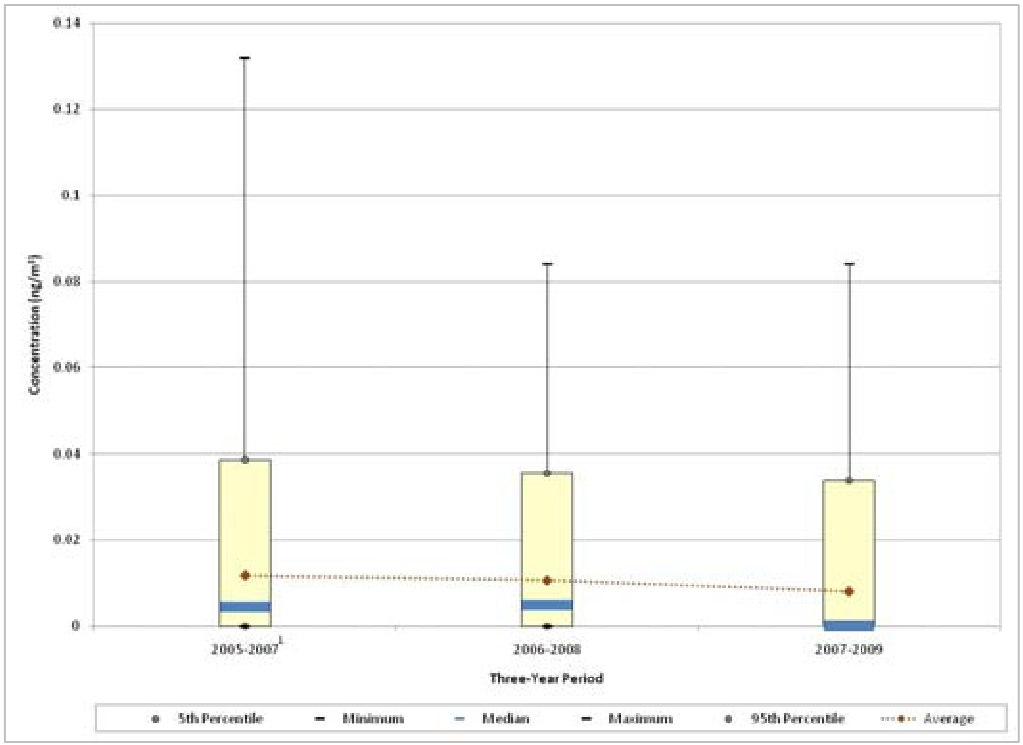
Observations for MVWI from Table 33-5 include the following:

- The daily average concentrations of naphthalene were significantly higher than the daily average concentrations of hexavalent chromium and benzo(a)pyrene.
- MVWI began sampling PAH in March 2008, so neither of these pollutants has a first quarter 2008 average concentration. Additionally, benzo(a)pyrene and hexavalent chromium did not have enough measured detections for several quarterly averages (and annual averages in some cases) to be calculated.
- Although the fourth quarter 2008 and first quarter 2009 average concentrations for naphthalene appear higher than the other seasons, the confidence intervals for these averages are relatively high, suggesting the influence of outliers. The second quarter average of 2009 also has a relatively high confidence interval. Three of the five concentrations of naphthalene greater than 100 ng/m^3 were measured during the fourth quarter of 2008, and one each in the first and second quarter of 2009. Naphthalene measurements ranged from 4.18 ng/m^3 to 167 ng/m^3, with a median of 19.4 ng/m^3.
- Measurements of hexavalent chromium ranged from 0.0017 to 0.0841 ng/m^3, with a median concentration of 0.0151 ng/m^3. The highest concentrations (0.0841 and 0.0766 ng/m^3) were measured on May 6, 2008 and July 5, 2008.

33.4.2 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the selected NATTS MQO Core Analytes for 5 consecutive years or longer, as described in Section 3.5.3. MVWI has sampled hexavalent chromium under the NMP since 2005. Thus, Figure 33-7 presents the 3-year rolling statistical metrics for hexavalent chromium for MVWI. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects.

Figure 33-7. Three-Year Rolling Statistical Metrics for Hexavalent Chromium Concentrations Measured at MVWI



[1] Hexavalent chromium sampling at MWVI began in March 2005.

Observations from Figure 33-7 for hexavalent chromium measurements at MVWI include the following:

- Sampling for hexavalent chromium at MVWI began in March 2005.

- The maximum hexavalent chromium concentration was measured at MVWI on July 3, 2005. The next two highest concentrations were measured in 2008 and were discussed in the previous section. Note that one of these concentrations was also measured around the July 4th holiday on July 5, 2008. The eighth highest hexavalent chromium concentration was measured on July 4, 2006. This supports the correlation between higher hexavalent chromium concentrations and fireworks discussed in Section 4.1.2.

- The rolling average concentration has decreased slightly since the onset of sampling. However, confidence intervals calculated for these averages indicate that the decrease is not statistically significant. The 95th percentile exhibits a similar decreasing trend.

- The minimum and 5th percentile are both zero for the first two 3-year periods, indicating the presence of non-detects. For the third 3-year period, the minimum, 5th percentile, and median concentrations are zero, indicating that at least 50 percent of the measurements are non-detects. The number of non-detects has varied over the years of sampling, from as low as 38 percent in 2006 to as high as 75 percent in 2009.

33.5 Additional Risk Screening Evaluations

The following risk screening evaluations were conducted to characterize risk at the Wisconsin monitoring site. Refer to Sections 3.3, 3.5.4.2, and 3.5.4.3 for definitions and explanations regarding the various risk factors, time frames, and calculations associated with these risk screenings.

33.5.1 Risk Screening Assessment Using MRLs

A noncancer risk screening was conducted by comparing the concentration data from the Wisconsin monitoring site to the ATSDR acute, intermediate, and chronic MRLs, where available. As described in Section 3.3, acute risk results from exposures of 1 to 14 days; intermediate risk results from exposures of 15 to 364 days; and chronic risk results from exposures of 1 year or greater. The preprocessed daily measurements of the pollutants of interest were compared to the acute MRL; the quarterly averages were compared to the intermediate MRL; and the annual averages were compared to the chronic MRL. None of the measured detections or time-period average concentrations of the pollutants of interest for the MVWI monitoring site were higher than their respective MRL noncancer health risk benchmarks.

33.5.2 Cancer and Noncancer Surrogate Risk Approximations

For the pollutants of interest for the Wisconsin monitoring site and where *annual average* concentrations could be calculated, risk was further examined by calculating cancer and noncancer surrogate risk approximations (refer to Section 3.5.4.2 regarding the criteria for annual averages and how cancer and noncancer surrogate risk approximations are calculated). Annual averages, cancer UREs and/or noncancer RfCs, and cancer and noncancer surrogate risk approximations are presented in Table 33-6, where applicable.

Table 33-6. Cancer and Noncancer Surrogate Risk Approximations for the Wisconsin Monitoring Site

			2008				2009			
Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation		# of Measured Detections/Valid Quarterly Averages	Annual Average (ng/m^3)	Risk Approximation	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Mayville, Wisconsin - MVWI										
Benzo(a)pyrene	0.001	--	20/2	NA	NA	NA	31/2	NA	NA	NA
Hexavalent Chromium	0.012	0.0001	35/3	0.01 ± <0.01	0.14	<0.01	15/0	NA	NA	NA
Naphthalene	0.000034	0.003	47/3	25.55 ± 8.98	0.87	0.01	56/4	32.02 ± 6.19	1.09	0.01

NA = Not available due to the criteria for calculating an annual average.

-- = a Cancer URE or Noncancer RfC is not available.

Observations for MVWI from Table 33-6 include the following:

- For 2008, cancer risk approximations based on annual averages for naphthalene and hexavalent chromium were both less than 1.0 in-a-million. For 2009, an annual average could only be calculated for naphthalene. The 2009 cancer risk approximation for naphthalene was higher than its respective 2008 cancer risk approximation (1.09 in-a-million, vs. 0.87 in-a-million for 2008).

- All noncancer risk approximations, where they could be calculated, were well below the level of concern (an HQ of 1.0).

- Annual averages, and therefore cancer and noncancer risk approximations, could not be calculated for benzo(a)pyrene.

33.5.3 Risk-Based Emissions Assessment

In addition to the risk screenings discussed above, Tables 33-7 and 33-8 present a risk-based evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 33-7 presents the 10 pollutants with the highest emissions from the 2005 NEI, the 10 pollutants with the highest toxicity-weighted emissions, and the 10 pollutants with the highest cancer risk approximations (in-a-million), as calculated from the annual averages. Table 33-8 presents similar information, but identifies the 10 pollutants with the highest noncancer risk approximations (HQ), also calculated from annual averages. Risk approximations in green were calculated from 2008 annual averages while risk approximations in white were calculated from 2009 annual averages, as denoted in the tables.

Table 33-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Wisconsin Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer Risk Factors (County-Level)		**Top 10 Cancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Mayville, Wisconsin (Dodge County) - MVWI					
Benzene	87.63	Formaldehyde	7.22E-04	Naphthalene	1.09
Formaldehyde	57.76	Benzene	6.84E-04	Naphthalene	0.87
Acetaldehyde	28.25	1,3-Butadiene	3.82E-04	Hexavalent Chromium	0.14
Dichloromethane	14.98	POM, Group 3	2.86E-04		
Tetrachloroethylene	14.87	Hexavalent Chromium, PM	2.39E-04		
1,3-Butadiene	12.74	Naphthalene	2.29E-04		
Naphthalene	6.74	POM, Group 2	1.54E-04		
1,3-Dichloropropene	6.31	Tetrachloroethylene	8.77E-05		
Trichloroethylene	4.54	Arsenic, PM	6.46E-05		
p-Dichlorobenzene	3.28	Acetaldehyde	6.22E-05		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

Table 33-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Risk Approximations for Pollutants with Noncancer RfCs for the Wisconsin Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer Risk Factors (County-Level)		**Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)**		**Top 10 Noncancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]**	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Risk Approximation (HQ)**
Mayville, Wisconsin (Dodge County) - MVWI					
Toluene	330.90	Acrolein	217,294.60	Naphthalene	0.01
Xylenes	176.66	1,3-Butadiene	6,371.09	Naphthalene	0.01
Benzene	87.63	Formaldehyde	5,893.84	Hexavalent Chromium	<0.01
Formaldehyde	57.76	Manganese, PM	5,092.78		
1,1,1-Trichloroethane	52.19	Acetaldehyde	3,139.05		
Methanol	37.68	Benzene	2,921.07		
Hexane	36.60	Naphthalene	2,247.46		
Ethylbenzene	34.77	Xylenes	1,766.63		
Ethylene glycol	33.09	Bromomethane	1,760.75		
Acetaldehyde	28.25	Cyanide Compounds, gas	1,384.47		

[1] Green shading represents a 2008 risk approximation; white shading represents a 2009 risk approximation.

The pollutants in these tables are limited to those that have cancer and noncancer risk factors, respectively. As a result, although the actual value of the emissions is the same, the highest emitted pollutants in the cancer table may be different from the noncancer table. The cancer and noncancer surrogate risk approximations based on each site's annual averages are limited to those pollutants for which each respective site sampled. As discussed in Section 33.3, MVWI sampled for PAH and hexavalent chromium. In addition, the cancer and noncancer surrogate risk approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.5.4.3.

Observations from Table 33-7 include the following:

- Benzene, formaldehyde, and acetaldehyde were the highest emitted pollutants with cancer UREs in Dodge County.
- Formaldehyde was the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by benzene and 1,3-butadiene.
- Six of the highest emitted pollutants in Dodge County also had the highest toxicity-weighted emissions.
- Naphthalene, which was the pollutant with the highest cancer risk approximations for MVWI (albeit low), had the seventh highest emissions and the sixth highest toxicity-weighted emissions for Dodge County. Benzo(a)pyrene does not appear on either emissions-based list, while hexavalent chromium ranked fifth among the toxicity-weighted emissions.
- POM Group 2 ranked seventh for toxicity-weighted emissions. POM Group 2 includes several PAH sampled for at MVWI including acenapthylene, fluoranthene, perylene, and phenanthrene. None of the PAH included in POM Group 2 were identified as pollutants of interest for MVWI. POM Group 3 ranked fourth for toxicity-weighted emissions. POM Group 3 does not include any pollutants sampled at MVWI.

Observations from Table 33-8 include the following:

- Toluene, xylenes, and benzene were the highest emitted pollutants with noncancer RfCs in Dodge County.
- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) were acrolein, 1,3-butadiene, and formaldehyde.

- Four of the highest emitted pollutants in Dodge County also had the highest toxicity-weighted emissions.

- None of MVWI's pollutants of interest appear on among the highest emitted pollutants (with noncancer RfCs) in Dodge County. Naphthalene, however, ranked seventh for toxicity-weighted emissions.

33.6 Summary of the 2008-2009 Monitoring Data for MVWI

Results from several of the treatments described in this section include the following:

- *Naphthalene and hexavalent chromium both failed at least one screen, although naphthalene accounted for all but one of the failed screens. Both pollutants were identified as pollutants of interest for MVWI. Benzo(a)pyrene was added to the pollutants of interest because it is also a NATTS MQO Core Analyte.*

- *Naphthalene had the highest daily average concentrations among MVWI's pollutants of interest.*

- *None of the preprocessed daily measurements and none of the quarterly or annual average concentrations for the pollutants of interest, where they could be calculated, were higher than their associated MRL noncancer health risk benchmarks.*

34.0 Data Quality

This section discusses the data quality of the ambient air measurements comprising the 2008 and 2009 NMP dataset. In accordance with the Data Quality Objectives (DQOs) presented in ERG's EPA-approved QAPP (ERG, 2008 and 2009), the following data quality indicators were assessed: completeness, precision, and accuracy (also called bias).

The quality assessments presented in this section show that the 2008 and 2009 monitoring data are of a known and high quality. As indicators of the reliability and representativeness of experimental measurements, both precision and accuracy are considered when interpreting ambient air monitoring data. The method precision for collocated and duplicate analyses met the precision DQOs for some methods, but not for all. The analytical precision level for replicate analyses met the DQOs. Audit samples show that ERG is meeting the accuracy requirements of the NATTS TAD (EPA, 2009b).

34.1 Completeness

Completeness refers to the number of valid samples collected and analyzed compared to the number of total samples attempted. The DQO for completeness based on the EPA-approved QAPP specifies that at least 85 percent of samples collected at a given monitoring site must be analyzed successfully to be considered sufficient for data trends analysis (ERG, 2008 and 2009). Completeness statistics are presented in Section 2.4. The goal of 85 percent completeness was met by all but 10 site-method combinations (out of 291).

34.2 Method Precision

Precision defines the level of agreement realized between independent measurements performed according to identical protocols and procedures. Method precision, which includes s*ampling and analytical precision,* quantifies random errors associated with collecting ambient air samples and analyzing the samples in the laboratory. Method precision is evaluated by comparing concentrations measured in duplicate or collocated samples. 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 (intra-system assessment).
- Analysis of collocated samples provides information on the potential for variability (or precision) expected between different collection systems (inter-system assessment).

During the 2008 and 2009 sampling years, duplicate and collocated samples were collected on at least 10 percent of the scheduled sample days, as outlined in the QAPP. Most of these samples were analyzed in replicate. Collocated systems were not provided under the national contract for sites sampling PAH and were the responsibility of the participating agency. Thus, duplicate/collocated samples were not collected for most PAH sites because there were few collocated samplers and the samplers used were not equipped to collect duplicate samples. Therefore, the method precision data for PAH is based on only eight sites for 2008 and 2009, as they were the only sites with collocated systems.

Method precision was calculated by comparing the concentrations of the duplicates/collocates for each compound. Three parameters were used 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 2008 and 2009 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 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
$\overline{X}$ is the arithmetic mean of X_1 and X_2.

As this equation shows, duplicate or collocated analyses with low variability have lower RPDs (and better precision), and duplicate or collocated 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 duplicate or collocated samples was calculated for each pollutant and each site.

The following approach was employed to estimate how precisely samples were collected and analyzed:

- 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/collocated analyses, non-detects were replaced with 1/2 MDL. Sites with two or less sets of valid duplicate or collocated samples were not included in these calculations.

- 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.

For each of the above calculations used to assess method precision, the substitution of 1/2 MDL was made for all cases where one sample yielded a measurement and the other yielded a non-detect. This substitution often resulted in higher CVs and RPDs. Duplicate or collocated pairs that were both non-detect were not considered in the calculations.

Table 34-1 presents the 2008 and 2009 NMP average method precision for VOC, SNMOC, carbonyl compounds, metals, hexavalent chromium, and PAH, presented as CV and RPD. The overall carbonyl compounds and metals method precision (the average for all sites) met the program DQOs, which are 15 percent CV and 25 percent RPD. The overall VOC, SNMOC, hexavalent chromium, and PAH method precision were above the program DQOs. The CVs and RPDs that exceed the program DQOs were driven largely by the following factors:

- the inclusion of measurements below the MDL,
- the substitution of 1/2 MDLs for non-detects, and
- concentration differences for very small concentrations may yield large CVs and RPDs (i.e., the concentration difference between 0.001 ng/m^3 and 0.002 ng/m^3 is 100 percent).

Table 34-1. Method Precision by Analytical Method

Method	**Average Coefficient of Variation (%)**	**Average Relative Percent Difference (%)**
VOC	**18.78**	**34.69**
SNMOC	**19.85**	**31.58**
Carbonyl Compounds	8.52	11.53
Metals	12.72	11.44
Hexavalent Chromium	**23.27**	**32.93**
PAH	**19.39**	**29.06**
DQO	15.00	25.00

Tables 34-2 through 34-5, 34-7 through 34-10, 34-12 through 34-15, 34-17 through 34-18, 34-20, and 34-21 through 34-22 present average concentration differences, RPDs, and CVs as estimates of method precision for VOC, SNMOC, carbonyl compounds, metals, hexavalent chromium, and PAH, respectively. Tables 34-6, 34-11, 34-16, 34-19, and 34-23 present the average CVs per pollutant, per site, and per method. Pollutants exceeding the 15 percent control limit for CV and/or the 25 percent control limit for RPD are bolded in each table.

34.2.1 VOC Method Precision

Table 34-2 presents the method precision for all duplicate and collocated VOC samples. The average concentration differences observed for duplicate and collocated analyses of VOC ranged from less than 0.01 ppbv (several compounds) to 18.72 ppbv (acetonitrile). Twenty-eight out of 60 VOC showed greater variation than the target CV of 15 percent.

Table 34-2. VOC Method Precision: 498 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	476	**53.58**	18.72	**37.89**
Acetylene	498	9.57	0.08	6.77
Acrolein	485	**49.10**	0.24	**34.72**
Acrylonitrile	39	**109.22**	0.12	**77.23**
tert-Amyl Methyl Ether	9	**57.84**	<0.01	**40.90**
Benzene	498	14.64	0.06	10.36
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	26	**25.34**	0.01	**17.92**
Bromoform	11	**31.69**	<0.01	**22.41**
Bromomethane	469	16.92	<0.01	11.97
1,3-Butadiene	469	18.39	0.01	13.00
Carbon Disulfide	494	**33.95**	0.20	**24.01**
Carbon Tetrachloride	496	18.76	0.02	13.27
Chlorobenzene	14	19.22	0.01	13.59
Chloroethane	421	**47.17**	0.01	**33.35**
Chloroform	478	19.75	0.01	13.96
Chloromethane	498	7.14	0.05	5.05
Chloromethylbenzene	1	**93.33**	<0.01	**66.00**
Chloroprene	0	NA	NA	NA
Dibromochloromethane	32	**36.27**	<0.01	**25.65**
1,2-Dibromoethane	1	**169.23**	0.01	**119.66**
m-Dichlorobenzene	1	0.00	<0.01	0.00
o-Dichlorobenzene	1	0.00	<0.01	0.00
p-Dichlorobenzene	372	**28.18**	0.01	**19.93**
Dichlorodifluoromethane	498	5.96	0.04	4.22
1,1-Dichloroethane	7	**64.19**	0.01	**45.39**
1,2-Dichloroethane	15	**45.70**	0.01	**32.31**
1,1-Dichloroethene	2	**149.25**	0.04	**105.53**
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	12	**34.65**	<0.01	**24.50**
Dichloromethane	498	**26.46**	0.12	**18.71**

Table 34-2. VOC Method Precision: 498 Duplicate and Collocated Samples (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	498	11.79	<0.01	8.33
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	498	14.55	0.01	10.29
Hexachloro-1,3-butadiene	4	**50.64**	<0.01	**35.81**
Methyl Ethyl Ketone	497	**33.86**	0.12	**23.94**
Methyl Isobutyl Ketone	439	**35.05**	0.01	**24.79**
Methyl Methacrylate	34	**31.15**	0.03	**22.03**
Methyl *tert*-Butyl Ether	52	20.55	0.01	14.53
n-Octane	449	23.71	0.01	**16.77**
Propylene	498	15.02	0.07	10.62
Styrene	444	**29.63**	0.01	**20.95**
1,1,2,2-Tetrachloroethane	1	**158.62**	0.01	**112.16**
Tetrachloroethylene	453	18.41	0.01	13.02
Toluene	498	15.65	0.08	11.07
1,2,4-Trichlorobenzene	1	13.33	<0.01	9.43
1,1,1-Trichloroethane	498	11.89	<0.01	8.41
1,1,2-Trichloroethane	7	**65.98**	<0.01	**46.65**
Trichloroethylene	154	**44.76**	0.01	**31.65**
Trichlorofluoromethane	497	7.19	0.02	5.08
Trichlorotrifluoroethane	498	7.07	0.01	5.00
1,2,4-Trimethylbenzene	490	19.93	0.01	14.09
1,3,5-Trimethylbenzene	463	21.29	0.01	**15.06**
Vinyl chloride	72	**60.09**	<0.01	**42.49**
m,p-Xylene	498	17.23	0.03	12.18
o-Xylene	498	14.86	0.01	10.51
Total & Averages	*14,862*	***34.69***	*0.60*	***24.53***

The VOC method precision for all collocated samples is presented in Table 34-3. The range of variability was 0.0 percent (*m*-dichlorobenzene and *o*-dichlorobenzene) to 114.53 percent (acrylonitrile). The average variability was 23.99 percent.

Table 34-3. VOC Method Precision: 262 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	251	**75.00**	36.53	**53.04**
Acetylene	262	9.05	0.08	6.40
Acrolein	254	**47.15**	0.19	**33.34**
Acrylonitrile	9	**161.97**	0.17	**114.53**
tert-Amyl Methyl Ether	4	**72.14**	<0.01	**51.01**
Benzene	262	16.26	0.07	11.50
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	26	**25.34**	0.01	**17.92**
Bromoform	7	**50.59**	<0.01	**35.77**
Bromomethane	247	15.13	<0.01	10.70
1,3-Butadiene	248	20.17	0.01	14.26
Carbon Disulfide	258	**46.60**	0.30	**32.95**
Carbon Tetrachloride	261	16.53	0.01	11.68
Chlorobenzene	12	4.16	<0.01	2.94
Chloroethane	226	**50.31**	0.01	**35.58**
Chloroform	250	23.95	0.01	**16.94**
Chloromethane	262	7.16	0.05	5.06
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	32	**36.27**	<0.01	**25.65**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	1	0.00	<0.01	0.00
o-Dichlorobenzene	1	0.00	<0.01	0.00
p-Dichlorobenzene	208	**36.45**	0.01	**25.78**
Dichlorodifluoromethane	262	6.21	0.04	4.39
1,1-Dichloroethane	1	18.18	<0.01	12.86
1,2-Dichloroethane	7	**33.60**	<0.01	**23.76**
1,1-Dichloroethene	1	**120.00**	<0.01	**84.85**
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	4	**28.23**	<0.01	**19.96**
Dichloromethane	262	**35.03**	0.12	**24.77**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	262	14.51	<0.01	10.26
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	262	16.82	0.01	11.89
Hexachloro-1,3-butadiene	1	18.18	<0.01	12.86
Methyl Ethyl Ketone	262	**34.36**	0.12	**24.30**
Methyl Isobutyl Ketone	236	**38.72**	0.02	**27.38**
Methyl Methacrylate	12	**38.05**	0.01	**26.90**
Methyl *tert*-Butyl Ether	8	20.44	0.01	14.45
n-Octane	240	**26.94**	0.01	**19.05**
Propylene	262	16.53	0.07	11.69
Styrene	230	**27.58**	0.01	**19.50**

Table 34-3. VOC Method Precision: 262 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1,2,2-Tetrachloroethane	1	**158.62**	0.01	**112.16**
Tetrachloroethylene	240	23.87	0.01	**16.88**
Toluene	262	18.46	0.09	13.05
1,2,4-Trichlorobenzene	1	13.33	<0.01	9.43
1,1,1-Trichloroethane	262	12.61	<0.01	8.91
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	77	**47.71**	0.01	**33.73**
Trichlorofluoromethane	262	7.30	0.02	5.16
Trichlorotrifluoroethane	262	7.87	0.01	5.57
1,2,4-Trimethylbenzene	261	22.70	0.02	**16.05**
1,3,5-Trimethylbenzene	247	23.91	0.01	**16.91**
Vinyl chloride	22	**82.36**	<0.01	**58.24**
m,p-Xylene	262	19.15	0.04	13.54
o-Xylene	262	16.57	0.01	11.71
Total & Averages	*7,814*	***33.92***	*1.08*	***23.99***

Table 34-4 presents the method precision results for all duplicate analyses for VOC. The variability ranged from 4.04 percent (dichlorodifluoromethane) to 126.21 percent (1,1-dichloroethene). The average variability was 25.08 percent.

Table 34-4. VOC Method Precision: 236 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	225	**32.16**	0.91	**22.74**
Acetylene	236	10.08	0.08	7.13
Acrolein	231	**51.05**	0.29	**36.10**
Acrylonitrile	30	**56.47**	0.08	**39.93**
tert-Amyl Methyl Ether	5	**43.55**	<0.01	**30.79**
Benzene	236	13.03	0.05	9.21
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	4	12.79	<0.01	9.05
Bromomethane	222	18.72	<0.01	13.23
1,3-Butadiene	221	16.61	0.01	11.74
Carbon Disulfide	236	21.30	0.11	**15.06**
Carbon Tetrachloride	235	21.00	0.02	14.85
Chlorobenzene	2	**34.29**	0.01	**24.24**
Chloroethane	195	**44.02**	0.01	**31.13**
Chloroform	228	15.54	<0.01	10.99
Chloromethane	236	7.13	0.06	5.04

Table 34-4. VOC Method Precision: 236 Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Chloromethylbenzene	1	**93.33**	<0.01	**66.00**
Chloroprene	0	NA	NA	NA
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	1	**169.23**	0.01	**119.66**
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	164	19.91	<0.01	14.08
Dichlorodifluoromethane	236	5.71	0.03	4.04
1,1-Dichloroethane	6	**110.19**	0.01	**77.92**
1,2-Dichloroethane	8	**57.79**	0.01	**40.87**
1,1-Dichloroethene	1	**178.49**	0.04	**126.21**
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	8	**41.08**	<0.01	**29.05**
Dichloromethane	236	17.90	0.11	12.66
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	236	9.06	<0.01	6.41
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
Ethylbenzene	236	12.28	0.01	8.68
Hexachloro-1,3-butadiene	3	**83.10**	<0.01	**58.76**
Methyl Ethyl Ketone	235	**33.36**	0.12	**23.59**
Methyl Isobutyl Ketone	203	**31.38**	0.01	**22.19**
Methyl Methacrylate	22	24.26	0.05	**17.15**
Methyl *tert*-Butyl Ether	44	20.66	<0.01	14.61
n-Octane	209	20.49	<0.01	14.49
Propylene	236	13.50	0.08	9.55
Styrene	214	**31.69**	0.01	**22.41**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	213	12.95	<0.01	9.15
Toluene	236	12.85	0.07	9.08
1,2,4-Trichlorobenzene	0	NA	NA	NA
1,1,1-Trichloroethane	236	11.17	<0.01	7.90
1,1,2-Trichloroethane	7	**65.98**	<0.01	**46.65**
Trichloroethylene	77	**41.82**	0.01	**29.57**
Trichlorofluoromethane	235	7.07	0.02	5.00
Trichlorotrifluoroethane	236	6.27	0.01	4.44
1,2,4-Trimethylbenzene	229	17.15	0.01	12.13
1,3,5-Trimethylbenzene	216	18.68	<0.01	13.21
Vinyl chloride	50	**37.81**	<0.01	**26.73**
m,p-Xylene	236	15.30	0.02	10.82
o-Xylene	236	13.16	0.01	9.30
Total & Averages	*7,048*	***35.46***	*0.07*	***25.08***

Due to the focus on QA for the NATTS program in the NATTS TAD, Table 34-5 presents the average VOC method precision results for duplicate and collocated samples for all of the NATTS sites that sampled VOC (BTUT, DEMI, GPCO, NBIL, PXSS, S4MO, and SEWA). Shaded rows present results for the NATTS MQO Core Analytes, as identified in Section 3.2. Variability ranged from less than 0.01 percent (1,2-dichloroethane) to 71.74 percent (1,1-dichloroethene), with an average variability of 19.58 percent.

Table 34-5. VOC Method Precision: 150 Duplicate and Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	139	**43.95**	1.21	**31.08**
Acetylene	150	11.54	0.11	8.16
Acrolein	141	**41.65**	0.15	**29.45**
Acrylonitrile	16	**68.78**	0.09	**48.64**
tert-Amyl Methyl Ether	1	20.69	<0.01	14.63
Benzene	150	11.31	0.05	8.00
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	26	24.60	0.01	**17.39**
Bromoform	5	**67.45**	<0.01	**47.70**
Bromomethane	145	16.89	<0.01	11.94
1,3-Butadiene	144	20.10	0.01	14.21
Carbon Disulfide	148	**29.73**	0.12	**21.03**
Carbon Tetrachloride	149	16.35	0.01	11.56
Chlorobenzene	12	4.16	<0.01	2.94
Chloroethane	135	**50.45**	0.01	**35.67**
Chloroform	148	23.76	0.02	**16.80**
Chloromethane	150	7.83	0.05	5.54
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	0	NA	NA	NA
Dibromochloromethane	28	**27.04**	<0.01	**19.12**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	120	21.96	<0.01	**15.53**
Dichlorodifluoromethane	150	6.65	0.04	4.70
1,1-Dichloroethane	3	**101.46**	0.02	**71.74**
1,2-Dichloroethane	2	<0.01	<0.01	<0.01
1,1-Dichloroethene	1	13.33	<0.01	9.43
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	6	21.85	<0.01	**15.45**
Dichloromethane	150	**32.80**	0.17	**23.19**
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA

Table 34-5. VOC Method Precision: 150 Duplicate and Collocated Samples for the NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Dichlorotetrafluoroethane	148	19.55	0.01	13.82
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	2	8.96	<0.01	6.33
Ethylbenzene	148	11.25	0.01	7.95
Hexachloro-1,3-butadiene	4	**28.89**	<0.01	**20.43**
Methyl Ethyl Ketone	150	**33.73**	0.11	**23.85**
Methyl Isobutyl Ketone	140	**25.14**	0.01	**17.77**
Methyl Methacrylate	17	**46.45**	0.04	**32.84**
Methyl *tert*-Butyl Ether	2	**50.00**	0.02	**35.36**
n-Octane	142	20.72	0.01	14.65
Propylene	150	14.72	0.07	10.41
Styrene	140	**28.47**	0.01	**20.13**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	147	14.57	0.01	10.30
Toluene	150	11.19	0.07	7.92
1,2,4-Trichlorobenzene	1	13.33	<0.01	9.43
1,1,1-Trichloroethane	150	11.38	<0.01	8.05
1,1,2-Trichloroethane	3	**97.44**	<0.01	**68.90**
Trichloroethylene	64	**39.94**	0.01	**28.24**
Trichlorofluoromethane	149	8.47	0.02	5.99
Trichlorotrifluoroethane	148	5.91	0.01	4.18
1,2,4-Trimethylbenzene	149	14.01	0.01	9.91
1,3,5-Trimethylbenzene	145	17.96	<0.01	12.70
Vinyl chloride	15	**71.52**	<0.01	**50.57**
m,p-Xylene	150	11.54	0.02	8.16
o-Xylene	150	12.29	0.01	8.69
Total & Averages	*4,583*	***27.70***	*0.05*	***19.58***

Table 34-6 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all NMP sites sampling VOC. The average pollutant-specific CV ranged from 0 percent for a few compounds for several sites to 139.28 percent (acetonitrile for PROK). The overall average was 18.78 percent.

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	Average (%)	Anchorage, AK (ANAK)	Bountiful, UT (BTUT)	Burlington, VT (BURVT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Pryor, OK (CNEP)	Custer, SD (CUSD)	Dearborn, MI (DEMI)
Acetonitrile	**41.82**	**16.31**	**24.40**	**26.49**	7.31	**18.97**	12.35	**32.24**	**24.74**
Acetylene	7.03	**18.10**	8.72	6.38	3.64	6.85	**15.20**	3.79	3.58
Acrolein	**33.08**	**23.04**	**47.03**	**26.68**	**22.39**	**28.88**	**19.19**	**28.95**	**32.83**
Acrylonitrile	**70.42**	7.96	**49.17**	NA	NA	**81.43**	NA	**128.76**	NA
tert-Amyl Methyl Ether	**43.95**	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	10.66	12.09	6.38	7.47	**17.02**	11.67	**27.57**	7.68	5.53
Bromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	**17.39**	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	**18.91**	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	11.22	**21.93**	**22.33**	10.31	**17.10**	10.34	**15.01**	6.61	12.69
1,3-Butadiene	12.75	**26.10**	6.34	**24.07**	11.56	**25.17**	**27.00**	8.70	8.97
Carbon Disulfide	**24.17**	**30.52**	11.94	**23.26**	12.42	**20.40**	8.80	2.98	**26.00**
Carbon Tetrachloride	12.90	**15.24**	13.78	7.18	9.02	11.35	6.89	**16.58**	3.30
Chlorobenzene	13.59	NA	NA	NA	NA	**24.24**	NA	NA	2.94
Chloroethane	**30.00**	**54.71**	**27.68**	**28.46**	**22.23**	**28.05**	8.64	**23.35**	12.62
Chloroform	14.01	11.52	**17.12**	8.04	**34.05**	9.33	9.04	**34.50**	**29.22**
Chloromethane	4.69	10.54	5.27	5.55	5.42	4.59	3.47	1.85	4.67
Chloromethylbenzene	**66.00**	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	**37.76**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	**119.66**	NA	NA	NA	NA	**119.66**	NA	NA	NA
m-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**23.23**	11.63	**22.59**	**23.14**	6.91	**17.11**	**31.43**	**35.36**	13.16
Dichlorodifluoromethane	3.86	4.18	4.53	6.54	3.91	4.48	4.37	1.64	3.00
1,1-Dichloroethane	**47.14**	NA	9.43	**84.85**	NA	NA	NA	NA	NA
1,2-Dichloroethane	**36.44**	NA	NA	7.86	NA	12.86	NA	NA	NA

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Anchorage, AK (ANAK)**	**Bountiful, UT (BTUT)**	**Burlington, VT (BURVT)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**
1,1-Dichloroethene	**78.49**	NA	**126.21**	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**27.37**	**20.94**	NA	NA	NA	NA	NA	NA	NA
Dichloromethane	**18.47**	**21.02**	12.33	**17.70**	8.40	**30.55**	7.95	6.58	8.52
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	8.56	2.62	7.58	6.40	4.60	7.59	10.68	2.93	4.29
Ethyl Acrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	5.42	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	10.54	9.71	7.76	7.86	8.06	12.59	**30.81**	7.10	5.79
Hexachloro-1,3-butadiene	**30.75**	NA	**41.59**	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	**23.03**	**16.57**	14.36	**19.29**	**17.82**	**18.59**	**36.89**	**25.66**	**19.08**
Methyl Isobutyl Ketone	**26.89**	14.97	**18.36**	**32.96**	9.43	**26.90**	**44.88**	**23.62**	12.36
Methyl Methacrylate	**31.73**	NA	NA	NA	NA	12.86	NA	NA	**62.23**
Methyl *tert*-Butyl Ether	**18.71**	NA	NA	NA	11.16	**15.90**	NA	NA	NA
n-Octane	**17.10**	7.68	7.66	13.95	7.12	**21.70**	**24.53**	**24.77**	9.25
Propylene	10.59	11.43	10.10	12.14	6.18	10.39	**29.56**	5.37	9.97
Styrene	**22.21**	14.41	**23.10**	**18.68**	**32.23**	**28.62**	**48.08**	**25.46**	**24.76**
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	**15.55**	12.50	10.20	**15.15**	8.54	11.63	10.10	5.03	12.29
Toluene	12.34	10.05	9.68	6.68	5.05	11.60	**31.43**	4.73	5.34
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	8.36	7.33	7.06	6.95	7.88	7.96	6.84	7.11	3.66
1,1,2-Trichloroethane	**48.27**	NA	NA	NA	NA	NA	**23.57**	NA	NA
Trichloroethylene	**41.91**	**17.68**	**60.40**	**115.71**	7.44	**62.27**	**78.57**	NA	12.57
Trichlorofluoromethane	4.41	4.29	4.70	5.30	3.82	3.97	3.86	2.58	1.99

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Anchorage, AK (ANAK)**	**Bountiful, UT (BTUT)**	**Burlington, VT (BURVT)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**
Trichlorotrifluoroethane	4.98	4.99	4.92	4.67	3.93	5.24	5.77	3.88	1.82
1,2,4-Trimethylbenzene	**16.76**	7.49	8.21	**16.81**	**23.65**	**20.82**	**36.98**	10.59	4.23
1,3,5-Trimethylbenzene	**16.20**	8.24	8.84	**19.45**	**36.30**	**19.38**	**25.71**	14.56	5.00
Vinyl chloride	**41.42**	12.86	**35.36**	**111.96**	**19.64**	10.88	**15.71**	NA	**40.41**
m,p-Xylene	12.72	9.84	5.40	8.42	10.32	**21.49**	**52.84**	**18.67**	6.19
o-Xylene	11.13	7.89	7.33	7.45	7.37	**15.45**	**36.58**	11.35	5.09
Average	***18.78***	*14.30*	***19.66***	***21.88***	*12.48*	***21.36***	***22.74***	***17.19***	*12.89*

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average (%)	Elizabeth, NJ (ELNJ)	Tacoma, WA (EQWA)	Davie, FL (FLFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Loudon, TN (LDTN)	Memphis, TN (METN)	Loudon, TN (MSTN)
Acetonitrile	**41.82**	**25.43**	**61.99**	**41.43**	**23.47**	**30.59**	**23.56**	**23.77**	**24.26**
Acetylene	7.03	7.36	3.40	7.16	3.86	1.12	**17.03**	6.92	6.60
Acrolein	**33.08**	**35.98**	**41.98**	**66.05**	**21.76**	13.19	**26.99**	**52.18**	**26.54**
Acrylonitrile	**70.42**	**33.43**	NA	NA	**20.20**	NA	**122.32**	**18.30**	**68.69**
tert-Amyl Methyl Ether	**43.95**	**33.67**	NA	NA	NA	NA	**24.96**	NA	**63.49**
Benzene	10.66	7.64	6.58	12.15	8.90	4.93	8.94	8.14	**18.25**
Bromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	**17.39**	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	**18.91**	NA	NA	9.05	NA	NA	NA	NA	NA
Bromomethane	11.22	13.55	7.55	**15.21**	8.35	5.66	10.64	10.32	14.67
1,3-Butadiene	12.75	8.66	6.07	**22.16**	7.06	6.15	14.90	6.80	**18.00**
Carbon Disulfide	**24.17**	9.74	**42.73**	**50.44**	12.52	5.11	**15.57**	9.13	**19.68**
Carbon Tetrachloride	12.90	**16.70**	3.16	**27.29**	14.00	13.11	**21.80**	**22.54**	**19.22**
Chlorobenzene	13.59	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	**30.00**	**27.97**	**53.06**	14.44	**35.40**	NA	**38.14**	**21.22**	**42.78**
Chloroform	14.01	7.96	7.64	**15.69**	7.56	**16.97**	**26.10**	10.87	**17.02**
Chloromethane	4.69	5.49	5.16	10.21	3.98	2.65	5.58	7.74	5.14
Chloromethylbenzene	**66.00**	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	**37.76**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	**119.66**	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**23.23**	11.25	**19.48**	13.68	13.85	12.86	**36.09**	**16.02**	**19.15**
Dichlorodifluoromethane	3.86	4.66	2.32	4.75	4.26	0.29	5.33	6.75	2.95
1,1-Dichloroethane	**47.14**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	**36.44**	7.86	NA	NA	NA	NA	NA	NA	**79.33**

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average (%)	Elizabeth, NJ (ELNJ)	Tacoma, WA (EQWA)	Davie, FL (FLFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Loudon, TN (LDTN)	Memphis, TN (METN)	Loudon, TN (MSTN)
1,1-Dichloroethene	**78.49**	NA	NA	NA	**76.15**	NA	NA	**47.14**	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**27.37**	NA	NA	NA	6.43	NA	NA	NA	NA
Dichloromethane	**18.47**	12.95	11.37	**18.81**	4.91	2.67	**35.40**	**17.97**	**23.52**
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	8.56	7.56	3.71	4.24	5.91	9.43	6.85	7.73	6.56
Ethyl Acrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	5.42	NA	NA	NA	NA	NA	5.66	NA	NA
Ethylbenzene	10.54	8.25	6.65	12.61	5.38	4.04	**18.97**	11.09	**20.56**
Hexachloro-1,3-butadiene	**30.75**	**87.55**	NA	NA	NA	NA	**16.97**	NA	NA
Methyl Ethyl Ketone	**23.03**	**34.65**	**24.23**	**47.92**	14.79	9.79	**25.00**	**24.77**	14.55
Methyl Isobutyl Ketone	**26.89**	14.18	10.66	**32.63**	8.99	NA	**32.13**	13.41	**35.22**
Methyl Methacrylate	**31.73**	**21.84**	NA	NA	13.33	NA	**57.17**	NA	NA
Methyl *tert*-Butyl Ether	**18.71**	11.52	7.48	**28.28**	NA	NA	NA	NA	NA
n-Octane	**17.10**	13.88	11.70	**20.17**	8.52	6.15	**18.07**	**20.71**	**20.74**
Propylene	10.59	6.59	7.42	**31.29**	5.01	10.96	7.96	3.81	**21.49**
Styrene	**22.21**	14.68	10.75	**34.76**	6.62	NA	**26.95**	**17.42**	9.02
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	**112.16**	NA	NA
Tetrachloroethylene	**15.55**	8.20	4.97	**21.61**	3.51	**64.28**	**34.97**	3.53	**35.76**
Toluene	12.34	7.26	5.27	10.80	6.83	3.79	13.85	9.09	**27.84**
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	8.36	10.65	10.54	4.29	8.54	3.82	10.61	12.09	9.24
1,1,2-Trichloroethane	**48.27**	NA	NA	**15.71**	**76.15**	NA	NA	**64.28**	NA
Trichloroethylene	**41.91**	**20.92**	**17.16**	**124.59**	13.42	NA	6.73	NA	NA
Trichlorofluoromethane	4.41	4.52	2.10	3.91	3.91	0.58	4.62	5.81	**16.16**

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Elizabeth, NJ (ELNJ)**	**Tacoma, WA (EQWA)**	**Davie, FL (FLFL)**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Memphis, TN (METN)**	**Loudon, TN (MSTN)**
Trichlorotrifluoroethane	4.98	4.65	**26.02**	4.66	4.22	4.56	6.21	6.57	4.08
1,2,4-Trimethylbenzene	**16.76**	7.04	5.36	10.05	5.50	**58.23**	**25.52**	**29.18**	**19.53**
1,3,5-Trimethylbenzene	**16.20**	10.72	4.74	13.67	6.52	**32.64**	**20.81**	**19.43**	**20.09**
Vinyl chloride	**41.42**	**45.41**	**17.94**	14.28	12.86	12.86	NA	7.41	**59.38**
m,p-Xylene	12.72	9.19	5.95	8.37	5.89	8.73	**23.47**	12.55	**21.52**
o-Xylene	11.13	8.12	6.54	7.23	5.62	8.84	14.98	11.01	**20.09**
Average	***18.78***	***16.52***	*13.99*	***22.27***	*13.36*	*12.64*	***24.95***	***16.64***	***24.44***

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average (%)	Midwest City, OK (MWOK)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Oklahoma City, OK (OCOK)	Pryor Creek, OK (PROK)	Phoenix, AZ (PXSS)	St. Louis, MO (S4MO)	Seattle, WA (SEWA)
Acetonitrile	**41.82**	**47.66**	**51.71**	13.39	**119.66**	**139.28**	**53.15**	**23.17**	**16.91**
Acetylene	7.03	3.26	**21.32**	7.61	0.68	4.59	6.12	10.85	2.68
Acrolein	**33.08**	**30.57**	**23.94**	**36.56**	10.30	**46.14**	**16.85**	**31.20**	**32.53**
Acrylonitrile	**70.42**	NA	NA	NA	NA	**126.43**	**114.31**	10.86	NA
tert-Amyl Methyl Ether	**43.95**	NA	NA	**74.87**	NA	**52.10**	NA	14.63	NA
Benzene	10.66	11.94	9.79	8.49	2.58	**15.16**	12.03	6.94	6.42
Bromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	**17.39**	NA	**24.17**	NA	NA	NA	10.61	NA	NA
Bromoform	**18.91**	NA	NA	NA	NA	NA	**47.70**	NA	NA
Bromomethane	11.22	7.26	14.97	13.05	6.73	10.49	8.73	9.18	7.33
1,3-Butadiene	12.75	5.66	**45.07**	7.08	5.24	7.86	7.23	**20.16**	4.69
Carbon Disulfide	**24.17**	**22.43**	**21.02**	11.98	14.43	**87.01**	**55.94**	2.73	**17.02**
Carbon Tetrachloride	12.90	9.55	6.72	13.37	2.07	**15.09**	9.31	**16.01**	**17.82**
Chlorobenzene	13.59	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	**30.00**	14.35	**43.67**	12.33	**32.64**	**19.96**	**29.90**	**42.65**	**57.77**
Chloroform	14.01	7.00	**26.66**	6.32	4.29	7.92	**16.29**	5.41	**15.32**
Chloromethane	4.69	2.75	11.46	3.45	2.52	3.52	5.70	3.94	3.76
Chloromethylbenzene	**66.00**	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	**37.76**	NA	13.54	NA	NA	NA	**24.69**	NA	NA
1,2-Dibromoethane	**119.66**	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**23.23**	**20.43**	**37.46**	14.36	**34.40**	**29.16**	6.78	4.87	9.96
Dichlorodifluoromethane	3.86	3.25	9.44	4.86	0.98	3.61	5.38	2.98	3.35
1,1-Dichloroethane	**47.14**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	**36.44**	NA	0.00	NA	NA	NA	NA	NA	NA

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Midwest City, OK (MWOK)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Oklahoma City, OK (OCOK)**	**Pryor Creek, OK (PROK)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**
1,1-Dichloroethene	**78.49**	NA	NA	NA	NA	NA	12.86	NA	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**27.37**	NA	NA	NA	NA	NA	**35.36**	NA	4.56
Dichloromethane	**18.47**	6.39	**60.37**	6.98	**19.48**	13.32	**30.59**	9.43	**36.21**
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	8.56	6.43	**17.59**	5.17	8.32	9.34	7.42	8.43	**45.55**
Ethyl Acrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	5.42	NA	NA	4.29	NA	NA	NA	6.33	NA
Ethylbenzene	10.54	7.45	**19.46**	6.07	NA	10.62	6.05	5.94	5.30
Hexachloro-1,3-butadiene	**30.75**	NA	12.86	2.32	NA	NA	NA	6.83	NA
Methyl Ethyl Ketone	**23.03**	**24.80**	**39.58**	12.64	6.82	**16.96**	**27.08**	**35.39**	**16.65**
Methyl Isobutyl Ketone	**26.89**	**19.53**	**28.84**	**29.93**	**51.63**	**23.66**	**23.74**	**25.80**	6.32
Methyl Methacrylate	**31.73**	NA	NA	NA	NA	NA	**22.98**	NA	NA
Methyl *tert*-Butyl Ether	**18.71**	NA	NA	**15.02**	NA	NA	**35.36**	NA	NA
n-Octane	**17.10**	12.16	**44.05**	9.76	2.28	**28.70**	10.14	10.95	11.98
Propylene	10.59	12.61	**22.29**	6.21	2.12	10.20	8.99	8.10	8.42
Styrene	**22.21**	**26.14**	**36.70**	**24.00**	**15.71**	14.08	8.97	**18.53**	**22.22**
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	**15.55**	5.76	**29.29**	6.85	**38.57**	**26.62**	5.97	4.65	6.20
Toluene	12.34	9.60	**15.02**	12.41	10.80	**19.48**	7.87	6.05	4.63
1,2,4-Trichlorobenzene	NA	NA	9.43	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	8.36	2.72	8.33	4.21	NA	**18.82**	13.12	9.38	6.22
1,1,2-Trichloroethane	**48.27**	NA	NA	NA	NA	NA	NA	**61.65**	NA
Trichloroethylene	**41.91**	**70.71**	**37.68**	5.13	NA	NA	**25.74**	7.01	**40.86**
Trichlorofluoromethane	4.41	3.14	8.65	4.29	1.36	2.81	5.05	14.49	3.12

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Midwest City, OK (MWOK)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Oklahoma City, OK (OCOK)**	**Pryor Creek, OK (PROK)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**
Trichlorotrifluoroethane	4.98	4.17	5.55	3.79	1.52	3.90	5.53	3.62	3.58
1,2,4-Trimethylbenzene	**16.76**	12.68	**29.89**	7.58	12.12	**23.92**	6.12	8.79	6.63
1,3,5-Trimethylbenzene	**16.20**	11.50	**39.52**	10.63	4.88	**15.32**	7.82	11.47	9.74
Vinyl chloride	**41.42**	NA	**79.93**	12.15	NA	NA	**84.85**	**67.96**	**32.64**
m,p-Xylene	12.72	8.07	**23.52**	5.37	2.59	**26.92**	4.61	5.60	5.90
o-Xylene	11.13	9.21	**21.48**	8.09	2.53	12.64	6.01	7.12	8.19
Average	***18.78***	*14.17*	***25.70***	*11.96*	*14.90*	***26.43***	***20.82***	*14.84*	*14.56*

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average (%)	Schiller Park, IL (SPIL)	Sioux Falls, SD (SSSD)	Tulsa, OK (TMOK)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tupelo, MS (TUMS)	Tulsa, OK (TUOK)	Union County, SD (UCSD)
Acetonitrile	**41.82**	**71.74**	**20.86**	**55.68**	**119.07**	**113.05**	**20.08**	**45.82**	9.72
Acetylene	7.03	4.93	2.88	2.91	6.74	8.96	2.97	5.31	13.47
Acrolein	**33.08**	**59.26**	**44.64**	7.44	**34.80**	**40.21**	**44.33**	**41.11**	**45.17**
Acrylonitrile	**70.42**	NA	NA	NA	NA	**133.54**	NA	NA	NA
tert-Amyl Methyl Ether	**43.95**	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	10.66	**22.85**	4.90	5.27	**18.79**	**20.29**	6.50	7.50	10.61
Bromochloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	**17.39**	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	**18.91**	0.00	NA	NA	NA	NA	NA	NA	NA
Bromomethane	11.22	**21.74**	**18.82**	6.73	9.79	7.24	0.00	4.24	10.56
1,3-Butadiene	12.75	**17.06**	7.44	2.77	12.50	10.62	7.71	10.96	8.35
Carbon Disulfide	**24.17**	**73.08**	**23.46**	7.86	**42.73**	**46.01**	2.92	**30.13**	13.42
Carbon Tetrachloride	12.90	**17.94**	11.18	2.80	9.95	12.78	**23.80**	11.05	12.28
Chlorobenzene	13.59	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	**30.00**	**42.15**	**62.21**	0.00	**34.99**	**29.28**	**30.30**	**22.43**	**16.71**
Chloroform	14.01	**17.86**	8.79	7.44	**18.17**	7.96	9.43	**22.38**	4.35
Chloromethane	4.69	2.36	3.35	0.82	3.68	5.13	0.70	2.82	6.78
Chloromethylbenzene	**66.00**	NA	**66.00**	NA	NA	NA	NA	NA	NA
Chloroprene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	**37.76**	**33.25**	NA	NA	NA	NA	NA	**79.55**	NA
1,2-Dibromoethane	**119.66**	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**23.23**	**27.71**	9.70	**56.26**	**42.17**	**50.03**	NA	**49.95**	NA
Dichlorodifluoromethane	3.86	2.69	2.65	3.11	3.49	7.06	0.29	2.93	3.58
1,1-Dichloroethane	**47.14**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	**36.44**	NA	**87.26**	NA	NA	NA	**76.15**	NA	**20.20**

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Schiller Park, IL (SPIL)**	**Sioux Falls, SD (SSSD)**	**Tulsa, OK (TMOK)**	**Tulsa, OK (TOOK)**	**Tulsa, OK (TSOK)**	**Tupelo, MS (TUMS)**	**Tulsa, OK (TUOK)**	**Union County, SD (UCSD)**
1,1-Dichloroethene	**78.49**	NA	**98.57**	NA	NA	NA	**109.99**	NA	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**27.37**	NA	**32.64**	NA	NA	NA	NA	NA	**64.28**
Dichloromethane	**18.47**	**44.02**	3.75	**35.48**	**26.77**	12.76	**19.18**	**16.93**	8.91
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	8.56	11.23	3.91	NA	4.06	**17.80**	9.43	4.16	7.78
Ethyl Acrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	5.42	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	10.54	12.70	6.40	3.01	**16.66**	**28.09**	9.43	5.86	6.34
Hexachloro-1,3-butadiene	**30.75**	NA	**47.14**	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	**23.03**	**32.48**	**20.32**	6.05	**32.69**	**22.89**	12.04	**43.06**	**23.53**
Methyl Isobutyl Ketone	**26.89**	**20.61**	**24.99**	**66.00**	**28.24**	**35.62**	NA	**57.31**	**33.77**
Methyl Methacrylate	**31.73**	NA	NA	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	**18.71**	NA	**24.96**	NA	NA	NA	NA	NA	NA
n-Octane	**17.10**	**29.96**	14.23	**19.55**	**29.21**	**29.79**	NA	4.36	**36.30**
Propylene	10.59	13.51	8.23	3.34	12.08	9.00	1.77	9.75	12.45
Styrene	**22.21**	**28.93**	**28.51**	NA	13.44	**37.39**	14.63	7.80	**33.59**
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	**15.55**	**23.28**	4.50	5.24	**18.22**	10.01	7.44	6.86	**35.74**
Toluene	12.34	14.40	6.33	**29.69**	**20.66**	**35.66**	6.01	**17.62**	9.40
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	8.36	5.48	6.96	10.88	7.20	10.02	9.43	12.49	9.36
1,1,2-Trichloroethane	**48.27**	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	**41.91**	**41.69**	NA	NA	**32.69**	**27.63**	NA	**21.52**	**115.71**
Trichlorofluoromethane	4.41	3.17	2.83	3.05	2.78	7.48	0.29	3.56	3.01

Table 34-6. VOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Schiller Park, IL (SPIL)**	**Sioux Falls, SD (SSSD)**	**Tulsa, OK (TMOK)**	**Tulsa, OK (TOOK)**	**Tulsa, OK (TSOK)**	**Tupelo, MS (TUMS)**	**Tulsa, OK (TUOK)**	**Union County, SD (UCSD)**
Trichlorotrifluoroethane	4.98	2.02	2.95	5.89	4.42	5.99	2.93	3.27	4.10
1,2,4-Trimethylbenzene	**16.76**	**17.21**	7.24	**15.17**	**19.60**	**42.62**	8.66	**17.72**	11.31
1,3,5-Trimethylbenzene	**16.20**	**15.29**	8.37	10.25	**20.50**	**41.67**	8.32	**17.70**	**19.19**
Vinyl chloride	**41.42**	**47.14**	**58.23**	NA	NA	**111.33**	NA	NA	NA
m,p-Xylene	12.72	11.98	6.73	4.02	**16.87**	**31.58**	9.96	6.98	7.64
o-Xylene	11.13	**15.44**	5.21	5.78	**15.17**	**27.95**	11.22	11.26	7.96
Average	***18.78***	***23.68***	***21.54***	*13.66*	***21.87***	***31.44***	***16.07***	***18.89***	***19.55***

34.2.2 SNMOC Method Precision

The SNMOC method precision for duplicate and collocated samples is presented in Table 34-7. The average concentration differences observed for duplicate and collocated sample analysis ranged from 0.02 ppbC (1,3-butadiene) to 29.99 ppbC (TNMOC). The variation ranged from 5.63 percent (ethane) to 54.24 percent (1-undecene).

Table 34-7. SNMOC Method Precision: 102 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	102	9.05	0.15	6.40
Benzene	100	14.62	0.27	10.34
1,3-Butadiene	37	16.65	0.02	11.77
n-Butane	102	10.58	1.14	7.48
cis-2-Butene	77	15.79	0.03	11.17
trans-2-Butene	82	**30.30**	0.07	**21.42**
Cyclohexane	96	22.18	0.34	**15.68**
Cyclopentane	96	**26.94**	0.09	**19.05**
Cyclopentene	69	**65.29**	0.24	**46.17**
n-Decane	97	**33.58**	0.27	**23.74**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	38	**38.45**	0.08	**27.19**
p-Diethylbenzene	27	**39.24**	0.09	**27.75**
2,2-Dimethylbutane	95	21.30	0.08	**15.06**
2,3-Dimethylbutane	99	17.86	0.11	12.63
2,3-Dimethylpentane	97	16.36	0.08	11.57
2,4-Dimethylpentane	93	19.14	0.05	13.54
n-Dodecane	95	**63.53**	0.90	**44.92**
1-Dodecene	29	**62.59**	0.97	**44.26**
Ethane	102	7.96	3.42	5.63
Ethylbenzene	101	19.18	0.07	13.56
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	102	12.20	0.26	8.63
m-Ethyltoluene	90	22.26	0.06	**15.74**
o-Ethyltoluene	74	**32.43**	0.07	**22.93**
p-Ethyltoluene	75	**31.49**	0.09	**22.27**
n-Heptane	101	14.92	0.20	10.55
1-Heptene	61	**29.54**	0.10	**20.89**
n-Hexane	102	17.63	0.47	12.47
1-Hexene	69	**34.54**	0.06	**24.42**
cis-2-Hexene	17	24.01	0.03	**16.98**
trans-2-Hexene	7	**41.01**	0.05	**29.00**
Isobutane	102	11.76	0.99	8.31
Isobutene/1-Butene	87	**35.46**	0.74	**25.07**
Isopentane	99	**26.48**	3.25	**18.72**
Isoprene	81	**25.49**	0.09	**18.02**

Table 34-7. SNMOC Method Precision: 102 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isopropylbenzene	31	**40.51**	0.04	**28.64**
2-Methyl-1-butene	65	**40.37**	0.22	**28.54**
2-Methyl-2-butene	72	**25.68**	0.05	**18.16**
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	88	18.76	0.41	13.26
Methylcyclopentane	102	14.88	0.22	10.52
2-Methylheptane	64	**27.60**	0.12	**19.51**
3-Methylheptane	66	23.66	0.07	**16.73**
2-Methylhexane	94	24.24	0.19	**17.14**
3-Methylhexane	87	**29.37**	0.18	**20.77**
3-Methylpentane	102	18.12	0.24	12.81
2-Methylpentane	102	23.25	0.69	**16.44**
4-Methyl-1-pentene	12	**54.50**	0.27	**38.54**
2-Methyl-1-pentene	7	**45.89**	0.06	**32.45**
n-Nonane	92	21.66	0.10	**15.32**
1-Nonene	30	**49.79**	0.08	**35.21**
n-Octane	98	22.30	0.17	**15.77**
1-Octene	27	**31.72**	0.03	**22.43**
n-Pentane	102	17.98	2.97	12.71
1-Pentene	100	22.30	0.22	**15.77**
cis-2-Pentene	54	18.73	0.16	13.24
trans-2-Pentene	82	13.80	0.03	9.76
a-Pinene	66	**51.29**	0.17	**36.27**
b-Pinene	11	**53.25**	0.18	**37.65**
Propane	102	11.16	2.67	7.89
n-Propylbenzene	65	**29.05**	0.05	**20.54**
Propylene	102	14.68	0.14	10.38
Propyne	0	NA	NA	NA
Styrene	25	**70.57**	0.21	**49.90**
SNMOC	102	12.14	17.63	8.58
TNMOC (w/unknowns)	102	15.77	29.99	11.15
Toluene	102	16.39	0.50	11.59
n-Tridecane	25	**62.87**	0.20	**44.45**
1-Tridecene	9	**66.86**	0.22	**47.28**
1,2,3-Trimethylbenzene	53	23.60	0.04	**16.69**
1,2,4-Trimethylbenzene	99	**28.77**	0.37	**20.34**
1,3,5-Trimethylbenzene	60	**26.46**	0.09	**18.71**
2,2,3-Trimethylpentane	45	**26.09**	0.05	**18.45**
2,2,4-Trimethylpentane	92	20.64	0.08	14.59
2,3,4-Trimethylpentane	91	18.95	0.04	13.40
n-Undecane	100	**56.61**	0.96	**40.03**
1-Undecene	23	**76.71**	0.38	**54.24**
m-Xylene/*p*-Xylene	101	19.16	0.27	13.55
o-Xylene	100	18.56	0.08	13.12
Total & Averages	*2,530*	***31.58***	*1.66*	***22.33***

Table 34-8 presents the method precision for duplicate SNMOC samples. The variation ranged from 1.22 percent (ethane) to 53.71 percent (*trans*-2-hexene), with an average CV of 20.81 percent.

Table 34-8. SNMOC Method Precision: 64 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	64	5.08	0.06	3.59
Benzene	62	15.73	0.27	11.12
1,3-Butadiene	23	13.51	0.02	9.55
n-Butane	64	3.59	0.15	2.54
cis-2-Butene	53	18.21	0.03	12.88
trans-2-Butene	55	**31.56**	0.06	**22.32**
Cyclohexane	59	18.12	0.24	12.81
Cyclopentane	60	19.77	0.04	13.98
Cyclopentene	49	**62.60**	0.23	**44.27**
n-Decane	59	**34.22**	0.20	**24.20**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	22	**39.42**	0.07	**27.87**
p-Diethylbenzene	15	**41.75**	0.12	**29.52**
2,2-Dimethylbutane	60	23.48	0.06	**16.60**
2,3-Dimethylbutane	62	17.20	0.04	12.16
2,3-Dimethylpentane	60	12.03	0.05	8.51
2,4-Dimethylpentane	58	20.13	0.04	14.23
n-Dodecane	57	**54.87**	0.74	**38.80**
1-Dodecene	13	**45.75**	0.12	**32.35**
Ethane	64	1.73	0.11	1.22
Ethylbenzene	63	14.21	0.05	10.05
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	64	6.99	0.14	4.94
m-Ethyltoluene	52	18.70	0.05	13.22
o-Ethyltoluene	44	**33.31**	0.07	**23.55**
p-Ethyltoluene	47	24.94	0.05	**17.63**
n-Heptane	64	9.79	0.03	6.92
1-Heptene	33	**33.75**	0.07	**23.86**
n-Hexane	64	11.24	0.12	7.95
1-Hexene	48	**32.74**	0.06	**23.15**
cis-2-Hexene	9	15.08	0.02	10.66
trans-2-Hexene	3	**75.96**	0.10	**53.71**
Isobutane	64	6.53	0.13	4.62
Isobutene/1-Butene	54	**29.40**	0.71	**20.79**
Isopentane	63	23.09	2.22	**16.33**
Isoprene	56	23.34	0.10	**16.50**
Isopropylbenzene	18	**37.00**	0.04	**26.17**
2-Methyl-1-butene	44	**27.64**	0.15	**19.54**
2-Methyl-2-butene	49	**27.72**	0.05	**19.60**
3-Methyl-1-butene	0	NA	NA	NA

Table 34-8. SNMOC Method Precision: 64 Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Methylcyclohexane	51	16.17	0.06	11.43
Methylcyclopentane	64	10.12	0.05	7.16
2-Methylheptane	35	21.08	0.06	14.91
3-Methylheptane	37	19.92	0.03	14.09
2-Methylhexane	56	**29.31**	0.15	**20.72**
3-Methylhexane	54	23.78	0.12	**16.82**
3-Methylpentane	64	10.93	0.06	7.73
2-Methylpentane	64	16.70	0.25	11.81
4-Methyl-1-pentene	6	**49.36**	0.26	**34.90**
2-Methyl-1-pentene	5	**71.30**	0.09	**50.42**
n-Nonane	54	18.75	0.04	13.26
1-Nonene	15	**40.95**	0.05	**28.95**
n-Octane	62	18.34	0.05	12.97
1-Octene	16	**32.87**	0.04	**23.25**
n-Pentane	64	15.24	4.26	10.77
1-Pentene	62	**27.20**	0.38	**19.23**
cis-2-Pentene	35	19.35	0.29	13.68
trans-2-Pentene	56	13.13	0.02	9.29
a-Pinene	34	**58.06**	0.19	**41.06**
b-Pinene	9	**39.51**	0.20	**27.93**
Propane	64	3.75	0.43	2.65
n-Propylbenzene	40	**25.66**	0.04	**18.14**
Propylene	64	7.37	0.06	5.21
Propyne	0	NA	NA	NA
Styrene	19	**65.11**	0.27	**46.04**
SNMOC	64	7.72	7.26	5.46
TNMOC (w/unknowns)	64	15.69	23.16	11.09
Toluene	64	11.81	0.28	8.35
n-Tridecane	13	**66.95**	0.19	**47.34**
1-Tridecene	4	**72.98**	0.32	**51.60**
1,2,3-Trimethylbenzene	31	20.17	0.02	14.26
1,2,4-Trimethylbenzene	61	**26.68**	0.09	**18.87**
1,3,5-Trimethylbenzene	36	**29.28**	0.07	**20.71**
2,2,3-Trimethylpentane	23	24.25	0.04	**17.15**
2,2,4-Trimethylpentane	63	13.27	0.07	9.39
2,3,4-Trimethylpentane	57	18.73	0.04	13.25
n-Undecane	62	**56.24**	0.87	**39.77**
1-Undecene	13	**63.02**	0.25	**44.56**
m-Xylene/*p*-Xylene	63	12.88	0.12	9.11
o-Xylene	62	13.31	0.05	9.41
Total & Averages	*1,560*	***29.43***	*1.07*	***20.81***

Table 34-9 presents the method precision for collocated SNMOC samples. For SNMOC, there was only one collocated site, NBIL. The variation ranged from 3.41 percent (3-methyl-1-butene) to 63.92 percent (1-undecene), with an average CV of 23.85 percent.

Table 34-9. SNMOC Method Precision: 38 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	38	13.01	0.24	9.20
Benzene	38	13.51	0.27	9.55
1,3-Butadiene	14	19.79	0.03	13.99
n-Butane	38	17.58	2.14	12.43
cis-2-Butene	24	13.37	0.03	9.46
trans-2-Butene	27	**29.03**	0.08	**20.53**
Cyclohexane	37	**26.23**	0.43	**18.55**
Cyclopentane	36	**34.12**	0.13	**24.13**
Cyclopentene	20	**67.98**	0.26	**48.07**
n-Decane	38	**32.93**	0.34	**23.29**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	16	**37.48**	0.10	**26.50**
p-Diethylbenzene	12	**36.74**	0.06	**25.98**
2,2-Dimethylbutane	35	19.12	0.10	13.52
2,3-Dimethylbutane	37	18.53	0.18	13.11
2,3-Dimethylpentane	37	20.70	0.11	14.64
2,4-Dimethylpentane	35	18.16	0.06	12.84
n-Dodecane	38	**72.18**	1.06	**51.04**
1-Dodecene	16	**79.43**	1.83	**56.17**
Ethane	38	14.20	6.72	10.04
Ethylbenzene	38	24.15	0.09	**17.07**
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	38	17.41	0.39	12.31
m-Ethyltoluene	38	**25.82**	0.08	**18.26**
o-Ethyltoluene	30	**31.55**	0.06	**22.31**
p-Ethyltoluene	28	**38.05**	0.13	**26.90**
n-Heptane	37	20.05	0.36	14.17
1-Heptene	28	**25.33**	0.14	**17.91**
n-Hexane	38	24.02	0.81	**16.98**
1-Hexene	21	**36.33**	0.06	**25.69**
cis-2-Hexene	8	**32.95**	0.04	**23.30**
trans-2-Hexene	4	6.06	0.01	4.29
Isobutane	38	16.98	1.85	12.01
Isobutene/1-Butene	33	**41.51**	0.77	**29.35**
Isopentane	36	**29.86**	4.28	**21.12**
Isoprene	25	**27.64**	0.08	**19.55**
Isopropylbenzene	13	**44.01**	0.05	**31.12**
2-Methyl-1-butene	21	**53.09**	0.28	**37.54**
2-Methyl-2-butene	23	23.63	0.05	**16.71**
3-Methyl-1-butene	6	4.83	0.02	3.41

Table 34-9. SNMOC Method Precision: 38 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Methylcyclohexane	37	21.35	0.76	**15.10**
Methylcyclopentane	38	19.64	0.39	13.89
2-Methylheptane	29	**34.11**	0.18	**24.12**
3-Methylheptane	29	**27.40**	0.12	**19.37**
2-Methylhexane	38	19.17	0.24	13.55
3-Methylhexane	33	**34.96**	0.25	**24.72**
3-Methylpentane	38	**25.31**	0.42	**17.89**
2-Methylpentane	38	**29.80**	1.13	**21.07**
4-Methyl-1-pentene	6	**59.64**	0.28	**42.17**
2-Methyl-1-pentene	2	20.49	0.02	14.49
n-Nonane	38	24.57	0.16	**17.38**
1-Nonene	15	**58.63**	0.11	**41.46**
n-Octane	36	**26.25**	0.30	**18.56**
1-Octene	11	**30.56**	0.03	**21.61**
n-Pentane	38	20.71	1.69	14.65
1-Pentene	38	17.40	0.05	12.30
cis-2-Pentene	19	18.11	0.02	12.80
trans-2-Pentene	26	14.47	0.03	10.23
a-Pinene	32	**44.52**	0.16	**31.48**
b-Pinene	2	**66.99**	0.15	**47.37**
Propane	38	18.56	4.92	13.12
n-Propylbenzene	25	**32.44**	0.06	**22.94**
Propylene	38	21.99	0.22	**15.55**
Propyne	0	NA	NA	NA
Styrene	6	**76.02**	0.15	**53.76**
SNMOC	38	16.56	28.00	11.71
TNMOC (w/unknowns)	38	15.85	36.83	11.21
Toluene	38	20.97	0.73	14.83
n-Tridecane	12	**58.78**	0.21	**41.56**
1-Tridecene	5	**60.75**	0.13	**42.96**
1,2,3-Trimethylbenzene	22	**27.03**	0.05	**19.12**
1,2,4-Trimethylbenzene	38	**30.86**	0.66	**21.82**
1,3,5-Trimethylbenzene	24	23.64	0.11	**16.72**
2,2,3-Trimethylpentane	22	**27.92**	0.07	**19.74**
2,2,4-Trimethylpentane	29	**28.01**	0.10	**19.80**
2,3,4-Trimethylpentane	34	19.17	0.03	13.56
n-Undecane	38	**56.99**	1.05	**40.29**
1-Undecene	10	**90.40**	0.50	**63.92**
m-Xylene/*p*-Xylene	38	**25.44**	0.42	**17.99**
o-Xylene	38	23.80	0.11	**16.83**
Total & Averages	*970*	***33.73***	*1.87*	***23.85***

Due to the focus on QA for the NATTS program, Table 34-10 presents the SNMOC average method precision for duplicate and collocated samples for the NATTS sites (BTUT and NBIL). Table 34-10 shows that the SNMOC variation for the duplicate and collocated samples at the NATTS sites ranged from 0.80 percent (*cis*-2-hexene) to 53.92 percent (4-methyl-1-pentene). The average CV was 22.16 percent.

Table 34-10. SNMOC Method Precision: 34 Duplicate and Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	34	8.70	0.11	6.16
Benzene	32	19.23	0.40	13.59
1,3-Butadiene	16	16.05	0.02	11.35
n-Butane	34	12.44	0.45	8.80
cis-2-Butene	21	15.71	0.03	11.11
trans-2-Butene	24	**27.60**	0.04	**19.51**
Cyclohexane	33	**30.36**	0.41	**21.46**
Cyclopentane	32	**32.98**	0.07	**23.32**
Cyclopentene	21	**60.12**	0.12	**42.51**
n-Decane	34	**31.91**	0.28	**22.56**
1-Decene	0	NA	NA	NA
m-Diethylbenzene	13	22.46	0.04	**15.88**
p-Diethylbenzene	12	**42.49**	0.15	**30.04**
2,2-Dimethylbutane	31	19.29	0.06	13.64
2,3-Dimethylbutane	33	11.90	0.04	8.41
2,3-Dimethylpentane	33	16.77	0.08	11.86
2,4-Dimethylpentane	31	17.29	0.05	12.22
n-Dodecane	34	**58.33**	0.71	**41.24**
1-Dodecene	12	20.19	0.05	14.28
Ethane	34	8.13	0.75	5.75
Ethylbenzene	34	19.40	0.06	13.72
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	34	12.45	0.23	8.81
m-Ethyltoluene	34	21.63	0.04	**15.29**
o-Ethyltoluene	28	**36.09**	0.06	**25.52**
p-Ethyltoluene	25	**31.66**	0.06	**22.39**
n-Heptane	33	14.91	0.06	10.54
1-Heptene	23	**36.94**	0.06	**26.12**
n-Hexane	34	20.56	0.27	14.54
1-Hexene	20	**41.86**	0.05	**29.60**
cis-2-Hexene	2	1.13	0.00	0.80
trans-2-Hexene	3	**75.96**	0.10	**53.71**
Isobutane	34	12.29	0.26	8.69
Isobutene/1-Butene	32	**49.83**	1.04	**35.23**
Isopentane	32	**27.97**	2.99	**19.78**
Isoprene	25	**41.32**	0.18	**29.22**

Table 34-10. SNMOC Method Precision: 34 Duplicate and Collocated Samples for the NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isopropylbenzene	13	**68.71**	0.07	**48.59**
2-Methyl-1-butene	23	**43.17**	0.21	**30.52**
2-Methyl-2-butene	20	**39.12**	0.07	**27.66**
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	33	20.38	0.09	14.41
Methylcyclopentane	34	14.18	0.08	10.03
2-Methylheptane	25	**42.45**	0.07	**30.01**
3-Methylheptane	25	**33.39**	0.05	**23.61**
2-Methylhexane	34	18.30	0.12	12.94
3-Methylhexane	31	**33.97**	0.14	**24.02**
3-Methylpentane	34	21.09	0.12	14.91
2-Methylpentane	34	**25.81**	0.61	**18.25**
4-Methyl-1-pentene	4	**76.26**	0.42	**53.92**
2-Methyl-1-pentene	4	**68.96**	0.08	**48.76**
n-Nonane	34	24.61	0.08	**17.40**
1-Nonene	8	**52.76**	0.06	**37.31**
n-Octane	32	22.57	0.10	**15.96**
1-Octene	11	**30.96**	0.03	**21.89**
n-Pentane	34	24.21	7.36	**17.12**
1-Pentene	32	**33.60**	0.46	**23.76**
cis-2-Pentene	15	24.05	0.38	**17.01**
trans-2-Pentene	22	16.87	0.03	11.93
a-Pinene	27	**55.44**	0.18	**39.20**
b-Pinene	2	11.53	0.04	8.15
Propane	34	14.55	0.99	10.29
n-Propylbenzene	23	**35.45**	0.04	**25.07**
Propylene	34	14.45	0.11	10.22
Propyne	0	NA	NA	NA
Styrene	12	**69.98**	0.24	**49.48**
SNMOC	34	14.70	12.74	10.39
TNMOC (w/unknowns)	34	15.12	21.34	10.69
Toluene	34	17.42	0.43	12.32
n-Tridecane	7	**38.80**	0.08	**27.43**
1-Tridecene	4	**72.98**	0.32	**51.60**
1,2,3-Trimethylbenzene	19	**28.11**	0.03	**19.88**
1,2,4-Trimethylbenzene	34	20.91	0.08	14.79
1,3,5-Trimethylbenzene	22	19.11	0.03	13.51
2,2,3-Trimethylpentane	33	19.48	0.06	13.77
2,2,4-Trimethylpentane	17	22.29	0.04	**15.76**
2,3,4-Trimethylpentane	34	21.03	0.12	14.87
n-Undecane	34	**52.72**	1.12	**37.28**
1-Undecene	12	**36.54**	0.18	**25.84**
m-Xylene/*p*-Xylene	34	20.57	0.17	14.54
o-Xylene	34	19.60	0.07	13.86
Total & Averages	*872*	***31.34***	*1.35*	***22.16***

Table 34-11 presents the average CV per pollutant, per pollutant per site, per site, and the overall CV for all NMP sites sampling SNMOC. The results from duplicate and collocated samples show low- to high-level variability among pollutants per sites, ranging from an average CV of 0 percent (*n*-butane and *n*-pentane for GPMS) to 118.24 percent (1-undecene for UCSD), with an overall average of 19.85 percent.

Table 34-11. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	Average (%)	Silt, CO (BRCO)	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Rifle, CO (MOCO)	Northbrook, IL (NBIL)
Acetylene	6.36	9.41	3.35	3.11	1.42	8.01	8.96
Benzene	9.41	7.58	**16.15**	7.86	2.81	8.60	11.04
1,3-Butadiene	12.41	**15.40**	9.21	**15.85**	NA	NA	13.49
n-Butane	7.98	12.81	3.07	1.97	0.00	**21.80**	14.52
cis-2-Butene	11.20	**16.92**	8.30	**16.49**	**16.50**	3.82	13.92
trans-2-Butene	**20.68**	**29.49**	10.59	**20.35**	**21.80**	0.84	**28.44**
Cyclohexane	14.78	**16.40**	**15.55**	11.31	7.30	**27.28**	**27.38**
Cyclopentane	**16.35**	13.73	9.39	5.98	5.59	13.31	**37.25**
Cyclopentene	**40.47**	0.63	**42.79**	**28.03**	11.33	**54.12**	**42.24**
n-Decane	**24.71**	**20.88**	**20.57**	**18.78**	**41.12**	**36.64**	**24.55**
1-Decene	NA	NA	NA	NA	NA	NA	NA
m-Diethylbenzene	**29.01**	**25.24**	**27.24**	14.75	**45.40**	NA	4.52
p-Diethylbenzene	**27.39**	**16.37**	**30.04**	NA	NA	NA	NA
2,2-Dimethylbutane	14.51	12.06	10.47	**20.24**	12.52	11.54	**16.81**
2,3-Dimethylbutane	13.45	13.53	5.63	12.63	5.24	**20.04**	11.20
2,3-Dimethylpentane	11.60	13.91	5.78	10.15	8.32	12.86	**17.94**
2,4-Dimethylpentane	**15.82**	13.44	7.30	14.58	**47.14**	10.22	**17.15**
n-Dodecane	**44.80**	**29.77**	**31.29**	**39.94**	**51.43**	**62.62**	**51.20**
1-Dodecene	**48.02**	**50.40**	**22.32**	**52.47**	NA	NA	6.23
Ethane	7.22	11.94	1.41	1.01	0.48	**30.35**	10.08
Ethylbenzene	14.45	**15.09**	6.76	9.68	**21.48**	**26.22**	**20.68**
2-Ethyl-1-butene	NA	NA	NA	NA	NA	NA	NA
Ethylene	7.93	10.65	5.16	4.97	4.94	2.62	12.45
m-Ethyltoluene	**18.59**	13.57	7.82	8.60	**31.13**	8.64	**22.77**
o-Ethyltoluene	**26.13**	11.63	**15.69**	8.54	**61.61**	NA	**35.35**
p-Ethyltoluene	**24.34**	**17.72**	**18.50**	**25.18**	**35.83**	**35.15**	**26.28**
n-Heptane	10.80	**15.51**	4.65	6.74	0.74	**29.05**	**16.44**
1-Heptene	**22.13**	11.94	**20.60**	**53.42**	**19.41**	**26.16**	**31.64**
n-Hexane	12.13	14.67	6.85	8.56	4.89	**24.15**	**22.23**
1-Hexene	**23.40**	**29.38**	**24.21**	**32.08**	10.88	**27.50**	**35.00**
cis-2-Hexene	**15.15**	**26.82**	0.80	NA	NA	NA	NA

Table 34-11. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average (%)	Silt, CO (BRCO)	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Rifle, CO (MOCO)	Northbrook, IL (NBIL)
trans-2-Hexene	**29.00**	NA	**53.71**	NA	NA	NA	NA
Isobutane	8.91	12.94	3.84	7.82	1.95	**23.11**	13.55
Isobutene/1-Butene	**22.88**	11.60	**25.79**	5.00	11.05	**21.53**	**44.68**
Isopentane	**16.57**	13.63	**15.29**	**27.55**	11.48	11.86	**24.27**
Isoprene	**17.73**	1.42	**22.91**	9.57	NA	**21.88**	**35.53**
Isopropylbenzene	**34.19**	**37.49**	**19.82**	NA	NA	NA	**77.35**
2-Methyl-1-butene	**30.86**	NA	**26.22**	7.61	**17.74**	14.33	**34.83**
2-Methyl-2-butene	**19.40**	13.36	14.01	**23.58**	8.66	**18.99**	**41.32**
3-Methyl-1-butene	3.41	NA	NA	NA	NA	1.16	NA
Methylcyclohexane	14.02	**15.50**	9.87	**15.25**	**20.10**	**27.13**	**18.95**
Methylcyclopentane	12.25	**16.00**	5.02	12.96	**18.40**	**25.38**	**15.04**
2-Methylheptane	**19.90**	**16.58**	9.48	**16.66**	3.11	**30.48**	**50.55**
3-Methylheptane	**18.00**	14.70	7.69	10.36	8.32	**22.94**	**39.54**
2-Methylhexane	**15.56**	**16.16**	9.41	**24.52**	1.78	**26.41**	**16.46**
3-Methylhexane	**23.03**	12.77	8.15	**21.75**	**20.99**	**36.21**	**39.89**
3-Methylpentane	11.92	13.56	5.38	10.97	5.35	**19.09**	**24.45**
2-Methylpentane	**16.12**	**15.65**	7.57	11.09	**17.12**	**25.61**	**28.93**
4-Methyl-1-pentene	**39.96**	NA	**79.11**	**28.57**	NA	13.13	**28.74**
2-Methyl-1-pentene	**39.54**	NA	**48.76**	**55.38**	NA	NA	NA
n-Nonane	14.29	13.20	10.11	**19.97**	8.61	**33.11**	**24.69**
1-Nonene	**31.97**	13.23	**28.31**	0.88	NA	NA	**46.31**
n-Octane	14.96	14.75	5.50	**18.42**	12.73	**28.22**	**26.41**
1-Octene	**20.06**	**41.24**	**20.23**	NA	NA	NA	**23.54**
n-Pentane	12.21	**15.33**	**20.93**	9.92	0.00	**23.65**	13.31
1-Pentene	14.06	6.84	**37.62**	**20.52**	11.85	4.37	9.90
cis-2-Pentene	**15.93**	**15.26**	14.96	**25.43**	NA	9.05	**19.06**
trans-2-Pentene	9.99	3.20	6.35	9.40	8.60	9.30	**17.51**
a-Pinene	**36.71**	10.40	**35.56**	**60.97**	**107.94**	NA	**42.84**
b-Pinene	**35.48**	**24.74**	8.15	11.15	NA	NA	NA
Propane	8.54	11.64	4.80	2.11	0.70	**27.82**	**15.78**
n-Propylbenzene	**24.19**	5.44	12.60	**16.21**	**50.51**	NA	**37.53**
Propylene	9.05	4.38	3.87	3.54	0.44	12.06	**16.56**
Propyne	NA	NA	NA	NA	NA	NA	NA
Styrene	**42.70**	NA	**44.03**	**44.64**	**50.78**	NA	**16.88**
SNMOC	9.20	11.73	7.39	5.43	2.22	**24.42**	13.39
TNMOC (w/unknowns)	11.89	10.54	10.66	7.01	10.24	**26.12**	10.72
Toluene	12.45	**15.20**	8.34	6.43	7.55	**31.48**	**16.30**
n-Tridecane	**44.59**	**36.28**	**40.09**	**61.48**	NA	NA	14.78
1-Tridecene	**43.89**	**71.93**	**51.60**	NA	NA	NA	NA
1,2,3-Trimethylbenzene	**20.55**	9.02	9.64	**23.02**	NA	NA	30.11
1,2,4-Trimethylbenzene	**24.45**	14.90	11.63	**18.21**	**72.07**	5.93	**17.94**

Table 34-11. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Silt, CO (BRCO)**	**Bountiful, UT (BTUT)**	**Custer, SD (CUSD)**	**Gulfport, MS (GPMS)**	**Rifle, CO (MOCO)**	**Northbrook, IL (NBIL)**
1,3,5-Trimethylbenzene	**20.09**	14.28	12.62	**46.98**	NA	NA	14.41
2,2,3-Trimethylpentane	**16.19**	11.28	11.24	11.41	**31.13**	NA	**16.30**
2,2,4-Trimethylpentane	**18.93**	14.15	11.08	**15.89**	**27.20**	NA	**20.45**
2,3,4-Trimethylpentane	14.72	6.49	7.15	5.93	**17.62**	**32.39**	**22.59**
n-Undecane	**40.20**	**34.77**	**33.05**	**42.53**	**45.64**	**68.73**	**41.50**
1-Undecene	**67.29**	**59.85**	**24.26**	NA	**52.46**	**106.73**	**27.42**
m-Xylene/*p*-Xylene	14.85	**17.81**	6.99	2.87	**20.93**	**24.53**	**22.10**
o-Xylene	13.51	**16.57**	6.98	10.45	**21.34**	**18.68**	**20.74**
Average	***19.85***	***17.36***	***16.70***	***18.01***	***19.93***	***23.70***	***24.47***

Table 34-11. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Parachute, CO (PACO)**	**Rifle, CO (RICO)**	**Rulison, CO (RUCO)**	**Sioux Falls, SD (SSSD)**	**Union County, SD (UCSD)**
Acetylene	6.36	4.87	**17.98**	2.89	2.50	7.44
Benzene	9.41	7.62	11.08	5.63	6.61	**18.57**
1,3-Butadiene	12.41	10.88	**15.07**	NA	7.01	NA
n-Butane	7.98	6.88	12.36	7.97	1.66	4.67
cis-2-Butene	11.20	7.73	7.07	5.29	**15.61**	11.60
trans-2-Butene	**20.68**	**26.96**	6.52	6.93	**17.37**	**58.14**
Cyclohexane	14.78	7.51	11.91	7.56	9.75	**20.65**
Cyclopentane	**16.35**	10.31	**21.92**	12.63	**15.46**	**34.33**
Cyclopentene	**40.47**	**72.48**	**49.66**	NA	**56.45**	**46.93**
n-Decane	**24.71**	**27.64**	**15.35**	11.04	**26.99**	**28.26**
1-Decene	NA	NA	NA	NA	NA	NA
m-Diethylbenzene	**29.01**	**40.97**	13.26	**56.09**	13.41	**49.25**
p-Diethylbenzene	**27.39**	**51.03**	10.53	NA	**27.27**	**29.07**
2,2-Dimethylbutane	14.51	10.64	14.07	5.28	14.67	**31.26**
2,3-Dimethylbutane	13.45	12.20	**18.36**	8.39	8.99	**31.71**
2,3-Dimethylpentane	11.60	12.05	12.62	7.81	5.39	**20.81**
2,4-Dimethylpentane	**15.82**	8.07	9.15	9.98	13.30	**23.72**
n-Dodecane	**44.80**	**67.33**	**46.91**	**27.89**	**42.25**	**42.22**
1-Dodecene	**48.02**	**83.05**	**78.28**	**64.82**	**29.26**	**45.36**

Table 34-11. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	**Average (%)**	**Parachute, CO (PACO)**	**Rifle, CO (RICO)**	**Rulison, CO (RUCO)**	**Sioux Falls, SD (SSSD)**	**Union County, SD (UCSD)**
Ethane	7.22	5.88	8.43	7.04	0.98	1.83
Ethylbenzene	14.45	13.63	14.12	5.74	8.89	**16.67**
2-Ethyl-1-butene	NA	NA	NA	NA	NA	NA
Ethylene	7.93	**15.74**	13.54	6.83	4.22	6.10
m-Ethyltoluene	**18.59**	10.82	**21.74**	**20.47**	11.83	**47.11**
o-Ethyltoluene	**26.13**	10.50	**19.84**	7.06	**24.26**	**66.79**
p-Ethyltoluene	**24.34**	**31.64**	**26.93**	**21.11**	11.29	**18.09**
n-Heptane	10.80	9.31	11.05	7.35	8.10	9.87
1-Heptene	**22.13**	12.71	10.56	9.56	11.55	**35.86**
n-Hexane	12.13	8.36	**16.85**	7.40	6.55	12.89
1-Hexene	**23.40**	**26.46**	**19.32**	14.71	**21.56**	**16.26**
cis-2-Hexene	**15.15**	**23.71**	**15.43**	NA	14.87	9.29
trans-2-Hexene	**29.00**	NA	4.29	NA	NA	NA
Isobutane	8.91	7.83	10.63	7.62	3.46	5.27
Isobutene/1-Butene	**22.88**	**17.64**	11.70	**20.43**	9.60	**72.65**
Isopentane	**16.57**	**33.89**	8.84	9.01	12.64	13.80
Isoprene	**17.73**	10.44	8.87	**39.89**	**18.15**	8.61
Isopropylbenzene	**34.19**	12.25	14.90	**42.34**	**36.48**	**32.91**
2-Methyl-1-butene	**30.86**	**45.41**	**38.84**	NA	12.08	**80.73**
2-Methyl-2-butene	**19.40**	11.74	3.19	**18.83**	**19.03**	**40.72**
3-Methyl-1-butene	3.41	3.86	5.23	NA	NA	NA
Methylcyclohexane	14.02	10.17	9.47	8.02	9.83	9.89
Methylcyclopentane	12.25	7.23	**16.91**	6.48	5.15	6.22
2-Methylheptane	**19.90**	12.41	12.46	8.93	**15.11**	**43.07**
3-Methylheptane	**18.00**	8.91	11.81	9.03	**21.70**	**42.96**
2-Methylhexane	**15.56**	8.70	8.50	6.77	**30.37**	**22.07**
3-Methylhexane	**23.03**	8.26	10.33	NA	7.42	**64.50**
3-Methylpentane	11.92	9.08	**18.35**	6.86	6.22	11.84
2-Methylpentane	**16.12**	13.18	**17.17**	7.76	9.96	**23.30**
4-Methyl-1-pentene	**39.96**	**92.58**	**34.24**	NA	3.37	NA
2-Methyl-1-pentene	**39.54**	NA	14.49	NA	NA	NA
n-Nonane	14.29	10.52	8.24	6.30	14.11	8.28
1-Nonene	**31.97**	**55.66**	**21.06**	**51.81**	**31.70**	**38.78**
n-Octane	14.96	9.61	12.51	7.71	**16.45**	12.26
1-Octene	**20.06**	14.35	2.18	5.16	**23.51**	**30.26**
n-Pentane	12.21	10.84	**22.06**	7.97	7.54	2.79
1-Pentene	14.06	**23.35**	11.09	9.87	10.71	8.50
cis-2-Pentene	**15.93**	5.97	11.33	**39.60**	5.75	12.85
trans-2-Pentene	9.99	9.37	9.23	9.87	7.62	**19.42**
a-Pinene	**36.71**	**37.28**	13.76	**24.15**	**30.13**	4.07
b-Pinene	**35.48**	**70.00**	NA	NA	**21.52**	**77.34**

Table 34-11. SNMOC Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site (Continued)

Pollutant	Average (%)	Parachute, CO (PACO)	Rifle, CO (RICO)	Rulison, CO (RUCO)	Sioux Falls, SD (SSSD)	Union County, SD (UCSD)
Propane	8.54	6.20	13.21	7.54	1.28	2.86
n-Propylbenzene	**24.19**	**18.90**	**16.67**	**34.54**	**19.40**	**30.05**
Propylene	9.05	**21.94**	**15.52**	7.72	7.13	6.39
Propyne	NA	NA	NA	NA	NA	NA
Styrene	**42.70**	NA	**49.06**	NA	**50.78**	NA
SNMOC	9.20	10.74	8.76	7.60	4.24	5.32
TNMOC (w/unknowns)	11.89	12.03	8.49	6.36	12.34	**16.22**
Toluene	12.45	8.22	16.10	8.25	6.61	12.48
n-Tridecane	**44.59**	**38.23**	**80.39**	**53.45**	**51.98**	**24.68**
1-Tridecene	**43.89**	**47.87**	4.16	NA	NA	NA
1,2,3-Trimethylbenzene	**20.55**	**20.35**	**20.71**	7.60	13.74	**50.73**
1,2,4-Trimethylbenzene	**24.45**	**36.55**	**21.06**	**25.98**	**15.62**	**29.04**
1,3,5-Trimethylbenzene	**20.09**	**15.18**	**18.79**	**28.46**	**21.59**	8.54
2,2,3-Trimethylpentane	**16.19**	7.78	10.29	**29.12**	12.07	**21.28**
2,2,4-Trimethylpentane	**18.93**	**18.71**	**31.38**	8.95	**31.06**	10.39
2,3,4-Trimethylpentane	14.72	14.96	**15.85**	NA	10.27	13.94
n-Undecane	**40.20**	**48.75**	**29.83**	10.81	**40.24**	**46.31**
1-Undecene	**67.29**	**110.35**	NA	**51.75**	**54.53**	**118.24**
m-Xylene/*p*-Xylene	14.85	12.14	**15.44**	9.89	6.18	**24.47**
o-Xylene	13.51	12.20	**15.43**	6.90	9.66	9.65
Average	***19.85***	***22.41***	***17.50***	***15.98***	***16.39***	***26.69***

34.2.3 Carbonyl Compound Method Precision

Table 34-12 presents the method precision for duplicate and collocated carbonyl compound samples. The average concentration difference ranged from <0.01 ppbv for isovaleraldehyde to 0.17 ppbv for formaldehyde.

Table 34-12. Carbonyl Compound Method Precision: 728 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	728	7.12	0.07	5.03
Acetone	728	9.42	0.10	6.66
Benzaldehyde	704	12.90	0.01	9.12

Table 34-12. Carbonyl Compound Method Precision: 728 Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Butyraldehyde	725	10.39	0.01	7.35
Crotonaldehyde	711	10.21	0.01	7.22
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	728	7.53	0.17	5.33
Hexaldehyde	705	13.58	0.01	9.60
Isovaleraldehyde	127	15.91	<0.01	11.25
Propionaldehyde	728	8.24	0.01	5.83
Tolualdehydes	702	16.92	0.01	11.96
Valeraldehyde	691	14.63	0.01	10.35
Total & Averages	*7,277*	*11.53*	*0.04*	*8.15*

The carbonyl compound method precision results for the 374 collocated samples are presented in Table 34-13. The CV for carbonyl compounds ranged from 5.33 percent (formaldehyde) to 11.12 percent (tolualdehydes).

Table 34-13. Carbonyl Compound Method Precision: 374 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	374	8.02	0.07	5.67
Acetone	374	8.10	0.08	5.73
Benzaldehyde	360	15.58	0.01	11.02
Butyraldehyde	373	11.58	0.01	8.19
Crotonaldehyde	359	11.34	0.01	8.02
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	374	7.53	0.17	5.33
Hexaldehyde	367	12.45	0.01	8.81
Isovaleraldehyde	52	9.60	<0.01	6.79
Propionaldehyde	374	8.54	0.01	6.04
Tolualdehydes	365	15.73	0.01	11.12
Valeraldehyde	360	14.81	<0.01	10.47
Total & Averages	*3,732*	*11.21*	*0.03*	*7.93*

Table 34-14 presents method precision results from the 354 duplicate carbonyl compound samples. The data show a low- to mid-level variability, ranging from 4.39 percent (acetaldehyde) to 15.72 percent (isovaleraldehyde), with an average of 8.38 percent.

Table 34-14. Carbonyl Compound Method Precision: 354 Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	354	6.21	0.07	4.39
Acetone	354	10.74	0.12	7.59
Benzaldehyde	344	10.21	<0.01	7.22
Butyraldehyde	352	9.20	0.01	6.51
Crotonaldehyde	352	9.07	0.01	6.41
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	354	7.54	0.17	5.33
Hexaldehyde	338	14.70	0.01	10.40
Isovaleraldehyde	75	22.22	<0.01	**15.72**
Propionaldehyde	354	7.95	0.01	5.62
Tolualdehydes	337	18.10	0.01	12.80
Valeraldehyde	331	14.45	0.01	10.22
Total & Averages	*3,545*	*11.85*	*0.04*	*8.38*

Due to the focus on QA for the NATTS program, Table 34-15 presents average carbonyl compound method precision data for the NATTS sites sampling for carbonyl compounds (BTUT, DEMI, GPCO, NBIL, PXSS, S4MO, SEWA, SKFL, and SYFL). Shaded rows present results for NATTS MQO Core Analytes, as identified in Section 3.2. The carbonyl compound variation for the duplicate and collocated samples at NATTS sites ranged from 5.39 percent (acetaldehyde) to 14.46 percent (isovaleraldehyde), with an average of 9.54 percent.

Table 34-15. Carbonyl Compound Method Precision: 216 Duplicate and Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	216	7.62	0.06	5.39
Acetone	216	10.35	0.09	7.32
Benzaldehyde	215	14.76	<0.01	10.44
Butyraldehyde	215	12.84	0.01	9.08
Crotonaldehyde	211	12.87	0.01	9.10
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	216	8.85	0.13	6.26
Hexaldehyde	213	17.99	0.01	12.72
Isovaleraldehyde	38	20.45	0.01	14.46
Propionaldehyde	216	8.65	0.01	6.11
Tolualdehydes	211	17.13	0.01	12.11
Valeraldehyde	212	16.96	0.01	11.99
Total & Averages	*2,179*	*13.50*	*0.03*	*9.54*

Table 34-16 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all NMP sites sampling carbonyl compounds. The duplicate and collocated sample results show low- to high-level variability among the sites, ranging from an average CV of 0.41 percent for crotonaldehyde for TMOK to 124.78 percent for isovaleraldehyde for CHNJ. This high percentage is based on one isovaleraldehyde measured detection compared to 1/2 MDL. The overall average CV was 8.52 percent.

Table 34-16. Carbonyl Compound Method Precision: Coefficient of Variation for all Duplicate and Collocated Samples by Site

Pollutant	Average (%)	St. Petersburg, FL (AZFL)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Seattle, WA (CEWA)	Chester, NJ (CHNJ)	Columbus, OH (COOH)	Custer, SD (CUSD)	Dearborn, MI (DEMI)	Elizabeth, NJ (ELNJ)	Tacoma, WA (EQWA)
Acetaldehyde	4.99	12.13	7.03	7.17	0.85	3.85	2.69	3.10	3.48	7.32	0.54
Acetone	6.19	8.08	5.99	11.80	1.22	5.23	4.78	3.13	3.58	11.27	0.85
Benzaldehyde	9.74	6.69	10.20	9.60	5.26	5.97	3.97	6.68	9.73	9.32	4.04
Butyraldehyde	7.79	4.36	8.48	8.42	3.94	8.63	4.32	5.24	13.66	8.61	3.34
Crotonaldehyde	7.07	3.17	9.96	5.47	6.23	9.01	4.35	5.88	2.92	10.44	<0.01
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	5.25	8.22	11.08	6.92	1.12	4.99	4.75	2.18	6.29	8.96	4.22
Hexaldehyde	9.75	14.65	**23.16**	8.88	3.80	11.12	3.11	9.32	11.49	13.89	<0.01
Isovaleraldehyde	14.86	7.44	7.62	**17.97**	NA	**124.78**	0.51	**15.71**	12.91	8.97	NA
Propionaldehyde	6.62	5.51	7.44	9.01	1.78	6.12	3.10	5.74	6.53	8.53	1.27
Tolualdehydes	12.34	9.36	14.73	13.72	7.22	8.42	12.31	**42.43**	10.22	**23.06**	4.04
Valeraldehyde	10.89	8.92	9.93	11.81	5.34	7.30	11.41	11.32	**15.85**	12.84	<0.01
Average	*8.52*	*8.05*	*10.51*	*10.07*	*3.68*	***17.77***	*5.03*	*10.07*	*8.79*	*11.20*	*2.61*

Table 34-16. Carbonyl Compound Method Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average (%)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Indianapolis, IN (IDIN)	Gary, IN (INDEM)	Indianapolis, IN (ININ)	Loudon, TN (LDTN)	Memphis, TN (METN)	Loudon TN (MSTN)	Midwest City, OK (MWOK)
Acetaldehyde	4.99	3.69	1.31	0.83	3.43	6.60	10.72	0.68	2.86	1.72	0.86
Acetone	6.19	12.56	3.51	2.03	1.66	7.87	7.67	2.17	4.84	2.68	1.07
Benzaldehyde	9.74	9.62	5.91	3.82	8.46	9.24	9.92	3.11	6.20	4.36	7.44
Butyraldehyde	7.79	10.80	3.70	2.53	4.82	6.39	10.36	1.52	4.08	4.14	8.14
Crotonaldehyde	7.07	8.27	4.04	3.14	5.26	7.42	10.74	2.65	5.21	3.10	1.88
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	5.25	4.05	2.04	2.71	3.87	7.43	8.77	1.15	3.19	1.16	1.35
Hexaldehyde	9.75	9.30	8.66	13.69	8.64	5.00	11.02	2.71	12.83	2.77	3.94
Isovaleraldehyde	14.86	10.10	8.31	3.63	NA	<0.01	10.88	0.70	**45.51**	<0.01	7.44
Propionaldehyde	6.62	7.94	2.36	2.32	3.80	6.13	9.04	1.94	4.30	2.21	3.40
Tolualdehydes	12.34	9.15	5.33	**28.28**	**15.56**	10.43	11.22	7.92	5.77	9.47	6.55
Valeraldehyde	10.89	9.25	5.81	9.43	7.00	4.59	11.13	3.42	12.97	8.26	5.01
Average	*8.52*	*8.61*	*4.63*	*6.58*	*6.25*	*7.11*	*10.13*	*2.54*	*9.80*	*3.99*	*4.28*

Table 34-16. Carbonyl Compound Method Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average (%)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Oklahoma City, OK (OCOK)	Winter Park, FL (ORFL)	Parachute, CO (PACO)	Pryor Creek, OK (PROK)	Phoenix, AZ (PXSS)	Rifle, CO (RICO)	St. Louis, MO (S4MO)	Seattle, WA (SEWA)
Acetaldehyde	4.99	12.45	3.96	0.60	4.25	3.62	1.35	5.47	6.74	2.07	8.60
Acetone	6.19	14.47	4.99	5.05	12.24	3.48	2.16	2.50	5.70	6.65	11.35
Benzaldehyde	9.74	**17.40**	7.18	5.56	7.68	**41.34**	5.36	8.40	11.04	8.53	**19.22**
Butyraldehyde	7.79	10.38	5.12	5.72	5.40	**19.51**	3.39	10.34	**15.65**	6.46	13.12
Crotonaldehyde	7.07	**21.46**	4.58	0.95	4.38	6.53	1.39	5.89	9.83	8.61	**18.06**
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	5.25	11.38	5.14	0.84	4.21	2.65	2.00	3.75	5.87	5.20	7.29
Hexaldehyde	9.75	12.77	9.26	5.32	8.42	14.14	4.15	**19.82**	**16.31**	10.80	13.38
Isovaleraldehyde	14.86	NA	**16.29**	5.05	**18.94**	NA	4.16	**24.60**	8.32	10.88	NA
Propionaldehyde	6.62	10.11	5.22	3.17	5.08	**32.32**	3.16	8.81	**25.15**	6.33	3.88
Tolualdehydes	12.34	12.87	11.66	6.96	11.98	**18.68**	8.33	**16.70**	5.66	8.70	**15.67**
Valeraldehyde	10.89	12.67	8.55	4.67	**15.99**	<0.01	2.57	**15.30**	**19.53**	9.81	**15.11**
Average	*8.52*	*13.59*	*7.45*	*3.99*	*8.96*	***15.81***	*3.46*	*11.05*	*11.80*	*7.64*	*12.57*

Table 34-16. Carbonyl Compound Method Precision: Coefficient of Variation for all Duplicate and Collocated Analyses by Site (Continued)

Pollutant	Average (%)	Pinellas Park, FL (SKFL)	Schiller Park, IL (SPIL)	Sioux Falls, SD (SSSD)	Plant City, FL (SYFL)	Tulsa, OK (TMOK)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)	Union County, SD (UCSD)	Indianapolis, IN (WPIN)
Acetaldehyde	4.99	3.42	**33.73**	3.11	2.57	1.37	1.13	**15.58**	2.93	1.41	4.02	5.39
Acetone	6.19	6.12	8.45	5.04	11.06	1.44	4.34	12.89	10.72	<0.01	13.57	3.28
Benzaldehyde	9.74	4.02	**47.27**	7.45	7.28	5.76	14.23	**17.03**	9.92	3.82	4.90	6.26
Butyraldehyde	7.79	7.66	**31.58**	5.37	5.12	3.40	4.53	**17.40**	4.11	4.04	8.33	7.18
Crotonaldehyde	7.07	4.63	**29.59**	7.10	3.37	0.41	8.53	13.06	2.65	12.30	5.84	4.32
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	5.25	3.19	**32.93**	3.60	5.17	1.38	1.20	10.25	3.17	4.29	3.40	4.04
Hexaldehyde	9.75	9.32	**24.16**	6.31	3.48	2.11	6.30	14.88	8.33	6.15	10.73	5.80
Isovaleraldehyde	14.86	NA	NA	**22.33**	13.88	4.04	5.80	8.32	4.71	NA	4.88	11.20
Propionaldehyde	6.62	4.21	**15.23**	3.66	4.14	1.82	2.24	**18.24**	4.17	1.13	8.50	6.31
Tolualdehydes	12.34	12.20	**28.71**	12.37	10.83	2.43	9.40	**19.33**	9.20	14.43	7.22	7.50
Valeraldehyde	10.89	12.88	**33.67**	6.73	7.81	5.64	7.16	**29.56**	5.81	13.69	11.97	14.20
Average	*8.52*	*6.77*	***28.53***	*7.55*	*6.79*	*2.71*	*5.90*	***16.05***	*5.98*	*6.81*	*7.58*	*6.86*

34.2.4 Metals Method Precision

The method precision for all collocated metals samples are presented in Table 34-17. All samples evaluated in this section are collocated samples. The average CV values, as well as the average RPD values, show low- to high-level variability. Average CVs ranged from 2.93 percent for arsenic to 41.32 percent for mercury, with an overall average of 10.58 percent.

Table 34-17. Metals Method Precision: 480 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	480	8.78	0.05	6.21
Arsenic	478	4.14	0.03	2.93
Beryllium	435	**27.21**	<0.01	**19.24**
Cadmium	478	14.99	0.03	10.60
Chromium	478	6.88	0.15	4.87
Cobalt	478	10.43	0.04	7.37
Lead	480	6.08	0.35	4.30
Manganese	480	4.85	0.56	3.43
Mercury	451	**58.44**	0.07	**41.32**
Nickel	480	16.89	0.09	11.94
Selenium	478	5.84	0.04	4.13
Total & Averages	*5,196*	*14.96*	*0.13*	*10.58*

Due to the focus on QA for the NATTS program, Table 34-18 presents the average method precision results from collocated metals for the NATTS sites sampling metals (BOMA, BTUT, NBIL, S4MO, and UNVT). Shaded rows present results for NATTS MQO Core Analytes, as identified in Section 3.2. Variability ranged from 4.58 percent for chromium to 49.51 percent for mercury, with an overall average CV of 14.17 percent.

Table 34-18. Metals Method Precision: 240 Collocated Samples for the NATTS Sites

Pollutant	**Number of Observations**	**Average RPD (%)**	**Average Concentration Difference (ng/m^3)**	**Coefficient of Variation (%)**
Antimony	240	6.75	0.06	4.78
Arsenic	237	11.94	0.04	8.45
Beryllium	204	**42.31**	<0.01	**29.92**
Cadmium	238	14.74	0.05	10.42
Chromium	238	6.48	0.10	4.58
Cobalt	238	18.56	0.03	13.13
Lead	240	8.77	0.33	6.20
Manganese	240	10.09	0.36	7.14
Mercury	212	**70.02**	0.17	**49.51**
Nickel	240	23.56	0.21	**16.66**
Selenium	238	7.20	0.03	5.09
Total & Averages	*2,565*	*20.04*	*0.13*	*14.17*

Table 34-19 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all NMP sites sampling metals. The results from collocated samples show low- to high-level variability among sites, ranging from 0.71 percent for arsenic at UNVT to 78.76 percent for mercury at BTUT, with an overall method average of 12.72 percent.

Table 34-19. Metals Method Precision: Coefficient of Variation for all Collocated Samples by Site

Pollutant	**Average (%)**	**Boston, MA (BOMA)**	**Bountiful, UT (BTUT)**	**Pryor, OK (CNEP)**	**Northbrook, IL (NBIL)**	**St. Louis, MO (S4MO)**	**Tulsa, OK (TOOK)**	**Underhill, VT (UNVT)**
Antimony	5.70	2.93	6.86	2.46	6.95	3.26	13.54	3.87
Arsenic	7.28	2.26	**26.18**	2.59	9.87	3.21	6.15	0.71
Beryllium	**23.02**	**31.57**	**47.90**	7.96	**27.12**	13.08	10.47	NA
Cadmium	11.64	**16.74**	1.31	7.76	**18.25**	12.77	**21.59**	3.06
Chromium	4.94	2.55	5.78	5.24	4.33	5.66	6.09	NA
Cobalt	11.38	6.01	7.92	3.23	**33.09**	**15.84**	10.80	2.77
Lead	6.35	4.83	8.82	4.58	11.66	4.64	8.83	1.06
Manganese	6.50	4.14	**16.44**	3.54	8.70	5.32	6.27	1.07
Mercury	**48.18**	**47.94**	**78.76**	**53.76**	**27.61**	**43.72**	**37.27**	NA

Table 34-19. Metals Method Precision: Coefficient of Variation for all Collocated Samples by Site (Continued)

Pollutant	Average (%)	Boston, MA (BOMA)	Bountiful, UT (BTUT)	Pryor, OK (CNEP)	Northbrook, IL (NBIL)	St. Louis, MO (S4MO)	Tulsa, OK (TOOK)	Underhill, VT (UNVT)
Nickel	**15.01**	4.78	**29.23**	13.43	**17.87**	**17.62**	8.35	13.80
Selenium	5.38	3.65	9.20	4.98	6.79	3.45	7.20	2.36
Average	*12.72*	*11.58*	***21.67***	*9.96*	***15.66***	*11.69*	*12.42*	*3.59*

34.2.5 Hexavalent Chromium Method Precision

The hexavalent chromium method precision results are shown in Table 34-20. Hexavalent chromium is a NATTS MQO Core Analyte and all the sites shown are collocated NATTS sites. The average RPD was higher than the program DQO specified 25 percent, with an overall average RPD of 32.93 percent. The RPD ranged from 10.90 percent for GLKY to 66.79 percent for ROCH. The CV ranged from 7.71 percent for GLKY to 47.22 percent for ROCH, with an overall average of 23.27 percent.

Table 34-20. Hexavalent Chromium Method Precision: Collocated Samples

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
BOMA	15	**32.56**	0.01	**23.02**
BTUT	32	16.62	0.01	11.42
BXNY	21	22.40	<0.01	**15.84**
CHSC	12	**41.54**	0.01	**29.37**
DEMI	22	14.67	0.01	10.37
GLKY	4	10.90	<0.01	7.71
GPCO	13	**44.32**	0.01	**31.34**
HAKY	4	**61.42**	0.01	**43.43**
MVWI	9	**41.23**	0.01	**29.15**
NBIL	19	**36.78**	0.01	**26.01**
PRRI	13	**60.30**	0.01	**42.64**
PXSS	26	13.42	0.01	9.49
RIVA	5	**45.99**	<0.01	**32.52**

Table 34-20. Hexavalent Chromium Method Precision: Collocated Samples (Continued)

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
ROCH	9	**66.79**	0.01	**47.22**
S4MO	21	**28.08**	<0.01	**19.86**
SDGA	16	**35.47**	<0.01	**25.08**
SEWA	19	**28.93**	0.01	**20.46**
SKFL	10	11.97	<0.01	8.46
SYFL	11	**44.75**	<0.01	**31.64**
UNVT	5	17.11	<0.01	12.10
WADC	11	16.31	<0.01	11.54
Total & Averages	*297*	***32.93***	*0.01*	***23.27***

34.2.6 PAH Method Precision

The method precision results for the collocated PAH samples are shown in Table 34-21. The average concentration differences observed for PAH ranged from 0.02 ng/m^3 for several pollutants to 9.48 ng/m^3 for naphthalene. The average CV ranged from 10.94 percent for fluoranthene to 41.04 percent for perylene, with an overall average of 20.55 percent.

Table 34-21. PAH Method Precision: 268 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	268	21.71	0.71	**15.35**
Acenaphthylene	136	**40.76**	0.26	**28.82**
Anthracene	107	**40.08**	0.22	**28.34**
Benzo(a)anthracene	203	**32.58**	0.03	**23.04**
Benzo(a)pyrene	120	**36.27**	0.03	**25.65**
Benzo(b)fluoranthene	251	22.16	0.04	**15.67**
Benzo(e)pyrene	207	24.48	0.02	**17.31**
Benzo(g,h,i)perylene	188	24.94	0.03	**17.64**
Benzo(k)fluoranthene	182	**38.57**	0.02	**27.27**
Chrysene	264	**30.03**	0.05	**21.23**
Coronene	109	**32.98**	0.03	**23.32**
Cyclopenta[cd]pyrene	27	**45.41**	0.04	**32.11**
Dibenz(a,h)anthracene	16	**28.53**	0.02	**20.17**

Table 34-21. PAH Method Precision: 268 Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Fluoranthene	276	15.47	0.24	10.94
Fluorene	271	17.68	0.64	12.50
9-Fluorenone	246	18.91	0.20	13.37
Indeno(1,2,3-cd)pyrene	116	**27.28**	0.03	**19.29**
Naphthalene	276	17.29	9.48	12.23
Perylene	40	**58.04**	0.03	**41.04**
Phenanthrene	275	17.62	1.11	12.46
Pyrene	274	20.69	0.20	14.63
Retene	251	**27.84**	0.23	**19.69**
Total & Averages	*4,103*	***29.06***	*0.62*	***20.55***

Due to the focus on QA for the NATTS program, Table 34-22 presents the average method precision results from collocated samples for the NATTS sites (DEMI, PLOR, RUCA, SEWA, SDGA, and SYFL). Shaded rows present results for NATTS MQO Core Analytes, as identified in Section 3.2. The average CV ranged from 10.68 percent for fluoranthene to 50.84 percent for perylene, with an overall average of 19.02 percent.

Table 34-22. PAH Method Precision: 216 Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	216	16.16	0.52	11.43
Acenaphthylene	96	**29.05**	0.26	**20.54**
Anthracene	74	**35.01**	0.12	**24.75**
Benzo(a)anthracene	155	**27.57**	0.03	**19.50**
Benzo(a)pyrene	87	**34.36**	0.02	**24.30**
Benzo(b)fluoranthene	198	19.25	0.03	13.61
Benzo(e)pyrene	156	21.86	0.02	**15.46**
Benzo(g,h,i)perylene	138	19.49	0.02	13.78
Benzo(k)fluoranthene	139	**31.02**	0.02	**21.93**
Chrysene	211	24.79	0.04	**17.53**
Coronene	71	**26.73**	0.02	**18.90**
Cyclopenta[cd]pyrene	23	**39.21**	0.03	**27.73**
Dibenz(a,h)anthracene	13	**26.22**	0.02	**18.54**
Fluoranthene	220	15.11	0.24	10.68

Table 34-22. PAH Method Precision: 216 Collocated Samples for the NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Fluorene	217	17.54	0.64	12.40
9-Fluorenone	193	16.16	0.20	11.43
Indeno(1,2,3-cd)pyrene	78	**25.46**	0.03	**18.01**
Naphthalene	220	17.37	11.04	12.28
Perylene	32	**71.90**	0.05	**50.84**
Phenanthrene	219	18.90	1.17	13.37
Pyrene	218	20.33	0.17	14.37
Retene	195	**38.24**	0.14	**27.04**
Total & Averages	*3,169*	***26.90***	***0.67***	***19.02***

Table 34-23 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all sites sampling PAH. The results from collocated samples show low- to high-level average variability among sites, ranging from 4.04 percent for DEMI (cyclopenta[c,d]pyrene) to 139.92 percent for ANAK (anthracene). The variability for anthracene for ANAK was based on only two measured detections of anthracene for this site for 2008-2009. The overall average for all sites was 19.39 percent.

Table 34-23. PAH Method Precision: Coefficient of Variation for all Collocated Samples by Site

Pollutant	**Average (%)**	**Anchorage, AK (ANAK)**	**Dearborn, MI (DEMI)**	**Tacoma, WA (EQWA)**	**Portland, OR (PLOR)**	**Rubidoux, CA (RUCA)**	**Decatur, GA (SDGA)**	**Seattle, WA (SEWA)**	**Plant City, FL (SYFL)**
Acenaphthene	**15.80**	**47.77**	4.91	10.07	12.62	**20.63**	7.35	7.60	**15.47**
Acenaphthylene	**26.95**	**25.03**	**16.43**	**67.30**	8.31	**25.57**	**36.08**	8.14	**28.74**
Anthracene	**39.04**	**139.92**	8.70	**23.85**	**49.09**	**36.94**	6.84	9.37	**37.60**
Benzo(a)anthracene	**18.70**	**20.85**	11.16	11.78	10.44	**16.98**	**31.78**	**18.65**	**27.96**
Benzo(a)pyrene	**22.68**	**20.24**	**16.11**	**15.40**	**33.79**	**18.47**	**23.30**	**17.50**	**36.61**
Benzo(b)fluoranthene	13.14	13.57	10.76	9.94	13.46	**20.33**	12.07	7.06	**17.97**
Benzo(e)pyrene	13.88	4.44	10.93	13.88	**16.13**	**21.04**	**17.65**	5.28	**21.71**
Benzo(g,h,i)perylene	14.82	**22.72**	12.04	13.13	**17.39**	14.62	9.21	6.79	**22.64**
Benzo(k)fluoranthene	**22.47**	**27.46**	**22.00**	**20.74**	**16.00**	**23.09**	**25.41**	11.74	**33.36**
Chrysene	**17.09**	**22.50**	14.50	9.04	**19.47**	**17.57**	**17.32**	9.74	**26.60**
Coronene	**19.25**	**30.77**	14.22	9.81	**20.68**	**29.94**	9.34	6.34	**32.89**
Cyclopenta[cd]pyrene	**27.25**	**23.83**	4.04	**28.26**	NA	**22.36**	**23.13**	**39.66**	**49.45**
Dibenz(a,h)anthracene	**20.29**	NA	14.91	**25.53**	NA	**24.50**	NA	NA	**16.20**
Fluoranthene	10.48	12.43	6.24	7.33	8.71	**20.61**	8.90	9.20	10.44
Fluorene	11.67	11.52	9.92	7.41	11.51	**23.88**	8.15	8.54	12.43
9-Fluorenone	12.98	**25.50**	4.14	9.75	8.16	11.88	**19.27**	11.47	13.64
Indeno(1,2,3-cd)pyrene	**17.93**	**24.35**	12.45	11.02	**24.70**	**18.95**	7.58	**20.82**	**23.53**
Naphthalene	10.99	6.96	4.62	7.32	14.59	**24.73**	7.27	9.66	12.80
Perylene	**44.47**	**17.68**	**22.80**	**39.38**	NA	**15.92**	**57.17**	**94.92**	**63.41**
Phenanthrene	12.48	10.17	**19.44**	9.47	9.55	**23.58**	6.79	9.60	11.24
Pyrene	14.15	**18.08**	7.27	8.87	13.00	**28.47**	14.01	9.54	13.94
Retene	**24.74**	**18.45**	**56.04**	**17.28**	**18.67**	**29.98**	**24.59**	**18.28**	14.66
Average	***19.39***	***25.92***	*13.80*	***17.12***	***17.17***	***22.27***	***17.77***	***16.19***	***24.70***

34.3 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 analyses of ambient air samples. The number of observations from Tables 34-24 through 34-45, in comparison to the respective tables listed for duplicate or collocated analyses in Tables 34-2 through 34-23, 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 SNMOC, carbonyl compounds, metals, hexavalent chromium, and PAH indicate that the analytical precision level is within the program DQOs. The analytical precision level for VOC was just above the program DQO.

34.3.1 VOC Analytical Precision

In Table 34-24, the analytical precision results from 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 analytical precision of the VOC analytical method, in terms of average concentration difference, ranged from <0.01 ppbv for several pollutants to 1.01 ppbv for acetonitrile. In terms of CV, the overall average variability was 21.02 percent and the median CV was 10.44 percent. The low median CV indicates that most of the pollutant variabilities were low. The relatively high average variability was likely due to the substitution of non-detects with 1/2 MDLs.

Table 34-24. VOC Analytical Precision: 1,002 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	959	13.02	1.01	9.21
Acetylene	1,002	6.71	0.07	4.74
Acrolein	977	13.95	0.03	9.86
Acrylonitrile	79	**65.69**	0.05	**46.45**
tert-Amyl Methyl Ether	15	**83.51**	<0.01	**59.05**
Benzene	1,002	7.76	0.03	5.49
Bromochloromethane	1	**104.76**	0.01	**74.08**

Table 34-24. VOC Analytical Precision: 1,002 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Bromodichloromethane	52	13.30	<0.01	9.41
Bromoform	24	**27.67**	<0.01	**19.56**
Bromomethane	944	12.18	<0.01	8.62
1,3-Butadiene	951	10.12	<0.01	7.16
Carbon Disulfide	994	8.00	0.05	5.65
Carbon Tetrachloride	1,000	7.80	0.01	5.52
Chlorobenzene	29	3.67	<0.01	2.60
Chloroethane	854	23.01	<0.01	**16.27**
Chloroform	966	13.50	<0.01	9.54
Chloromethane	1,002	5.14	0.03	3.64
Chloromethylbenzene	1	**93.33**	<0.01	**66.00**
Chloroprene	3	**74.90**	0.01	**52.96**
Dibromochloromethane	62	**39.26**	<0.01	**27.76**
1,2-Dibromoethane	1	**120.00**	<0.01	**84.85**
m-Dichlorobenzene	3	**83.33**	<0.01	**58.93**
o-Dichlorobenzene	2	**50.00**	<0.01	**35.36**
p-Dichlorobenzene	754	14.34	<0.01	10.14
Dichlorodifluoromethane	1,002	5.05	0.03	3.57
1,1-Dichloroethane	12	**43.98**	0.01	**31.10**
1,2-Dichloroethane	25	**66.64**	0.01	**47.12**
1,1-Dichloroethene	3	**154.96**	0.04	**109.57**
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	25	**31.16**	<0.01	**22.03**
Dichloromethane	1,002	7.07	0.02	5.00
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	1	**35.29**	<0.01	**24.96**
Dichlorotetrafluoroethane	1,002	8.20	<0.01	5.80
Ethyl Acrylate	1	**80.00**	<0.01	**56.57**
Ethyl *tert*-Butyl Ether	3	**30.30**	<0.01	**21.43**
Ethylbenzene	1,001	7.61	0.01	5.38
Hexachloro-1,3-butadiene	7	**46.37**	<0.01	**32.79**
Methyl Ethyl Ketone	994	14.84	0.04	10.49
Methyl Isobutyl Ketone	883	14.75	<0.01	10.43
Methyl Methacrylate	65	23.46	0.02	**16.59**
Methyl *tert*-Butyl Ether	106	21.30	<0.01	**15.06**
n-Octane	903	16.88	<0.01	11.94
Propylene	1,002	6.74	0.04	4.76
Styrene	898	14.76	0.01	10.44
1,1,2,2-Tetrachloroethane	1	**158.62**	0.01	**112.16**
Tetrachloroethylene	908	11.55	<0.01	8.16
Toluene	1,002	6.52	0.04	4.61
1,2,4-Trichlorobenzene	2	**64.56**	0.01	**45.65**
1,1,1-Trichloroethane	1,002	10.20	<0.01	7.21
1,1,2-Trichloroethane	11	**62.81**	<0.01	**44.41**
Trichloroethylene	314	22.46	<0.01	**15.88**

Table 34-24. VOC Analytical Precision: 1,002 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Trichlorofluoromethane	1,000	6.33	0.02	4.47
Trichlorotrifluoroethane	999	6.31	0.01	4.46
1,2,4-Trimethylbenzene	987	8.49	<0.01	6.01
1,3,5-Trimethylbenzene	941	11.00	<0.01	7.78
Vinyl chloride	155	**34.17**	0.01	**24.17**
m,p-Xylene	1,002	9.34	0.02	6.61
o-Xylene	1,002	7.65	0.01	5.41
Total & Averages	*29,938*	***29.73***	*0.05*	***21.02***

Table 34-25 shows the analytical precision results from replicate analyses of all collocated VOC samples. The replicate results from collocated samples show variation for the pollutants ranging from <0.01 percent (several compounds) to 1.58 percent (acetonitrile), as indicated by average concentration differences. The overall average variability was 20.22 percent.

Table 34-25. VOC Analytical Precision: 528 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	506	12.36	1.58	8.74
Acetylene	528	5.76	0.05	4.07
Acrolein	512	14.48	0.03	10.24
Acrylonitrile	18	**81.01**	0.05	**57.28**
tert-Amyl Methyl Ether	5	**72.14**	<0.01	**51.01**
Benzene	528	7.25	0.03	5.12
Bromochloromethane	1	**104.76**	0.01	**74.08**
Bromodichloromethane	52	13.30	<0.01	9.41
Bromoform	12	**39.02**	<0.01	**27.59**
Bromomethane	499	11.20	<0.01	7.92
1,3-Butadiene	502	10.53	<0.01	7.45
Carbon Disulfide	520	7.70	0.04	5.44
Carbon Tetrachloride	527	7.71	0.01	5.45
Chlorobenzene	24	4.62	<0.01	3.27
Chloroethane	457	**26.74**	<0.01	**18.91**
Chloroform	506	13.32	<0.01	9.42
Chloromethane	528	5.04	0.03	3.56
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	2	**83.13**	0.01	**58.78**

Table 34-25. VOC Analytical Precision: 528 Replicate Analyses for all Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Dibromochloromethane	59	**25.18**	<0.01	**17.81**
1,2-Dibromoethane	0	NA	NA	NA
m-Dichlorobenzene	3	**83.33**	<0.01	**58.93**
o-Dichlorobenzene	2	**50.00**	<0.01	**35.36**
p-Dichlorobenzene	420	14.34	<0.01	10.14
Dichlorodifluoromethane	528	4.94	0.03	3.50
1,1-Dichloroethane	2	18.18	<0.01	12.86
1,2-Dichloroethane	13	24.85	<0.01	**17.57**
1,1-Dichloroethene	2	**131.43**	<0.01	**92.93**
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	10	**35.19**	<0.01	**24.88**
Dichloromethane	528	7.05	0.01	4.98
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	1	**35.29**	<0.01	**24.96**
Dichlorotetrafluoroethane	528	8.38	<0.01	5.93
Ethyl Acrylate	1	**80.00**	<0.01	**56.57**
Ethyl *tert*-Butyl Ether	2	**38.38**	<0.01	**27.14**
Ethylbenzene	527	6.95	<0.01	4.91
Hexachloro-1,3-butadiene	2	**29.09**	<0.01	**20.57**
Methyl Ethyl Ketone	524	13.08	0.04	9.25
Methyl Isobutyl Ketone	474	13.65	<0.01	9.65
Methyl Methacrylate	22	**28.25**	0.01	**19.98**
Methyl *tert*-Butyl Ether	18	**29.71**	<0.01	**21.01**
n-Octane	480	17.42	<0.01	12.32
Propylene	528	6.21	0.03	4.39
Styrene	464	13.69	<0.01	9.68
1,1,2,2-Tetrachloroethane	1	**158.62**	0.01	**112.16**
Tetrachloroethylene	479	12.32	<0.01	8.71
Toluene	528	5.89	0.03	4.17
1,2,4-Trichlorobenzene	1	13.33	<0.01	9.43
1,1,1-Trichloroethane	528	10.25	<0.01	7.25
1,1,2-Trichloroethane	0	NA	NA	NA
Trichloroethylene	155	24.75	<0.01	**17.50**
Trichlorofluoromethane	527	5.50	0.01	3.89
Trichlorotrifluoroethane	526	6.28	0.01	4.44
1,2,4-Trimethylbenzene	527	7.43	<0.01	5.26
1,3,5-Trimethylbenzene	499	10.42	<0.01	7.37
Vinyl chloride	49	**40.07**	0.01	**28.34**
m,p-Xylene	528	7.70	0.01	5.44
o-Xylene	528	6.54	<0.01	4.62
Total & Averages	*15,741*	***28.59***	*0.06*	***20.22***

Table 34-26 shows the analytical precision results from replicate analyses of all duplicate VOC samples. The variation for the replicate results from the duplicate samples ranged from 1.92 percent (chlorobenzene) to 126.21 percent (1,1-dichloroethene), as represented by the CV. The overall average variability was 21.83 percent.

Table 34-26. VOC Analytical Precision: 474 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	453	13.68	0.44	9.67
Acetylene	474	7.65	0.08	5.41
Acrolein	465	13.42	0.04	9.49
Acrylonitrile	61	**50.38**	0.06	**35.62**
tert-Amyl Methyl Ether	10	**94.88**	<0.01	**67.09**
Benzene	474	8.27	0.03	5.85
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Bromoform	12	16.31	<0.01	11.54
Bromomethane	445	13.16	<0.01	9.31
1,3-Butadiene	449	9.71	<0.01	6.87
Carbon Disulfide	474	8.29	0.06	5.86
Carbon Tetrachloride	473	7.89	0.01	5.58
Chlorobenzene	5	2.72	<0.01	1.92
Chloroethane	397	19.28	<0.01	13.63
Chloroform	460	13.67	<0.01	9.67
Chloromethane	474	5.25	0.04	3.71
Chloromethylbenzene	1	**93.33**	<0.01	**66.00**
Chloroprene	1	**66.67**	<0.01	**47.14**
Dibromochloromethane	3	**53.33**	<0.01	**37.71**
1,2-Dibromoethane	1	**120.00**	<0.01	**84.85**
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	334	14.34	<0.01	10.14
Dichlorodifluoromethane	474	5.15	0.03	3.64
1,1-Dichloroethane	10	**69.77**	0.01	**49.34**
1,2-Dichloroethane	12	**108.42**	0.01	**76.67**
1,1-Dichloroethene	1	**178.49**	0.04	**126.21**
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	15	**27.13**	<0.01	**19.19**
Dichloromethane	474	7.09	0.03	5.01
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	474	8.02	<0.01	5.67
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	1	22.22	<0.01	**15.71**

Table 34-26. VOC Analytical Precision: 474 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Ethylbenzene	474	8.28	0.01	5.85
Hexachloro-1,3-butadiene	5	**63.66**	<0.01	**45.01**
Methyl Ethyl Ketone	470	16.59	0.04	11.73
Methyl Isobutyl Ketone	409	15.84	<0.01	11.20
Methyl Methacrylate	43	18.68	0.02	13.21
Methyl *tert*-Butyl Ether	88	12.88	<0.01	9.11
n-Octane	423	16.34	<0.01	11.55
Propylene	474	7.26	0.04	5.13
Styrene	434	15.83	0.01	11.20
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	429	10.77	<0.01	7.62
Toluene	474	7.15	0.06	5.05
1,2,4-Trichlorobenzene	1	**115.79**	0.01	**81.88**
1,1,1-Trichloroethane	474	10.15	<0.01	7.18
1,1,2-Trichloroethane	11	**62.81**	<0.01	**44.41**
Trichloroethylene	159	20.17	<0.01	14.26
Trichlorofluoromethane	473	7.15	0.03	5.05
Trichlorotrifluoroethane	473	6.35	0.01	4.49
1,2,4-Trimethylbenzene	460	9.55	<0.01	6.76
1,3,5-Trimethylbenzene	442	11.58	<0.01	8.19
Vinyl chloride	106	**28.27**	<0.01	**19.99**
m,p-Xylene	474	10.99	0.02	7.77
o-Xylene	474	8.75	0.01	6.19
Total & Averages	*14,197*	***30.87***	*0.03*	***21.83***

Due to the focus on QA for the NATTS program, Table 34-27 presents the analytical precision results from VOC replicate analyses for all the duplicate and collocated samples collected at NATTS sites (BTUT, DEMI, GPCO, NBIL, PXSS, S4MO, and SEWA). Shaded rows present results for the NATTS MQO Core Analytes, as identified in Section 3.2. These results show low- to high-level variability among the sites, as represented by CV, ranging from 1.63 percent (chlorobenzene) to 84.85 percent (1,2-dibromoethane), with an average of 15.89 percent.

Table 34-27. VOC Analytical Precision: 162 Replicate Analyses for Duplicate and Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetonitrile	272	13.73	0.62	9.71
Acetylene	294	5.84	0.07	4.13
Acrolein	276	9.17	0.03	6.49
Acrylonitrile	34	**56.05**	0.08	**39.63**
tert-Amyl Methyl Ether	3	**79.37**	<0.01	**56.12**
Benzene	294	7.50	0.03	5.31
Bromochloromethane	0	NA	NA	NA
Bromodichloromethane	52	13.23	<0.01	9.36
Bromoform	9	**26.63**	<0.01	**18.83**
Bromomethane	285	13.53	<0.01	9.57
1,3-Butadiene	284	11.86	0.01	8.38
Carbon Disulfide	290	6.60	0.04	4.66
Carbon Tetrachloride	293	8.49	0.01	6.00
Chlorobenzene	25	2.31	<0.01	1.63
Chloroethane	268	21.88	<0.01	**15.47**
Chloroform	290	12.38	0.01	8.75
Chloromethane	294	5.11	0.03	3.61
Chloromethylbenzene	0	NA	NA	NA
Chloroprene	1	**78.26**	<0.01	**55.34**
Dibromochloromethane	55	**36.66**	<0.01	**25.92**
1,2-Dibromoethane	1	**120.00**	<0.01	**84.85**
m-Dichlorobenzene	0	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
p-Dichlorobenzene	235	15.14	<0.01	10.71
Dichlorodifluoromethane	294	4.92	0.03	3.48
1,1-Dichloroethane	5	**103.02**	0.01	**72.84**
1,2-Dichloroethane	4	16.35	<0.01	11.56
1,1-Dichloroethene	1	13.33	<0.01	9.43
cis-1,2-Dichloroethylene	0	NA	NA	NA
trans-1,2-Dichloroethylene	13	20.16	<0.01	14.25
Dichloromethane	294	5.99	0.05	4.23
1,2-Dichloropropane	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
Dichlorotetrafluoroethane	290	7.93	<0.01	5.61
Ethyl Acrylate	0	NA	NA	NA
Ethyl *tert*-Butyl Ether	4	4.32	<0.01	3.05
Ethylbenzene	290	6.84	0.01	4.84
Hexachloro-1,3-butadiene	6	**26.13**	<0.01	**18.47**
Methyl Ethyl Ketone	293	10.83	0.03	7.66
Methyl Isobutyl Ketone	272	12.09	<0.01	8.55
Methyl Methacrylate	31	**41.00**	0.02	**28.99**
Methyl *tert*-Butyl Ether	5	**72.70**	0.01	**51.41**
n-Octane	277	14.35	<0.01	10.14
Propylene	294	6.07	0.04	4.29
Styrene	270	14.11	0.01	9.98

Table 34-27. VOC Analytical Precision: 162 Replicate Analyses for Duplicate and Collocated Samples for the NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
Tetrachloroethylene	288	8.11	<0.01	5.74
Toluene	294	6.01	0.04	4.25
1,2,4-Trichlorobenzene	1	13.33	<0.01	9.43
1,1,1-Trichloroethane	294	10.19	<0.01	7.20
1,1,2-Trichloroethane	5	**58.12**	<0.01	**41.10**
Trichloroethylene	128	19.10	<0.01	13.50
Trichlorofluoromethane	293	6.02	0.02	4.26
Trichlorotrifluoroethane	290	4.98	<0.01	3.52
1,2,4-Trimethylbenzene	293	7.07	<0.01	5.00
1,3,5-Trimethylbenzene	285	10.93	<0.01	7.73
Vinyl chloride	32	**41.81**	<0.01	**29.57**
m,p-Xylene	294	6.72	0.02	4.75
o-Xylene	294	7.05	0.01	4.99
Total & Averages	*8,989*	*22.47*	*0.03*	***15.89***

Table 34-28 shows the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all NMP sites sampling VOC. The average site CV ranged from 0 percent for several pollutants and several sites to 136.88 percent for LDTN (vinyl chloride). The overall program average CV of 11.91 percent.

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average (%)	Anchorage, AK (ANAK)	Bountiful, UT (BTUT)	Burlington, VT (BURVT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Pryor, OK (CNEP)	Custer, SD (CUSD)	Dearborn, MI (DEMI)
Acetonitrile	8.78	10.71	10.40	8.92	5.26	**17.15**	10.01	**16.03**	7.05
Acetylene	4.66	3.83	3.02	5.88	6.77	12.59	2.40	3.48	2.87
Acrolein	10.77	8.18	5.57	7.19	8.46	9.82	5.68	9.06	5.93
Acrylonitrile	**52.77**	6.53	**70.95**	NA	NA	**44.57**	NA	**127.65**	**66.04**
tert-Amyl Methyl Ether	**56.43**	NA	**78.57**	**38.57**	**74.87**	NA	NA	NA	NA
Benzene	5.05	4.51	4.35	4.71	7.02	13.11	5.35	3.07	4.54
Bromochloromethane	**74.08**	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	9.36	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	**23.69**	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	8.42	**15.64**	12.24	7.40	9.36	7.04	13.06	7.02	10.60
1,3-Butadiene	7.20	5.68	4.52	9.98	8.75	7.13	9.69	5.10	6.70
Carbon Disulfide	5.34	7.96	3.89	7.63	7.22	13.26	7.55	2.41	4.68
Carbon Tetrachloride	5.61	5.07	3.11	4.84	6.80	4.82	4.40	4.76	3.36
Chlorobenzene	2.05	NA	0.00	NA	NA	2.88	NA	NA	3.27
Chloroethane	**17.66**	**17.62**	**15.61**	**16.72**	7.60	**25.76**	11.29	8.65	5.57
Chloroform	10.09	6.80	11.67	6.57	**33.79**	9.68	7.74	13.71	4.64
Chloromethane	3.41	3.66	2.96	4.49	7.06	3.72	2.64	2.83	3.15
Chloromethylbenzene	**66.00**	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	**54.90**	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	**33.89**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	**84.85**	NA	**84.85**	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	**58.93**	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	**70.71**	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	10.29	7.35	7.79	12.87	5.17	**15.98**	**22.73**	NA	8.91
Dichlorodifluoromethane	3.39	3.71	3.12	5.02	5.77	2.85	2.21	2.51	2.54
1,1-Dichloroethane	**57.69**	**70.71**	9.43	**92.93**	NA	NA	NA	NA	NA
1,2-Dichloroethane	**65.37**	NA	NA	5.14	NA	**125.14**	NA	NA	NA

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Anchorage, AK (ANAK)**	**Bountiful, UT (BTUT)**	**Burlington, VT (BURVT)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**
1,1-Dichloroethene	**59.04**	NA	**126.21**	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**30.88**	6.54	NA	NA	NA	NA	NA	NA	NA
Dichloromethane	4.83	3.75	3.40	5.14	7.73	8.74	4.18	5.19	3.00
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	**24.96**	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	5.48	4.31	4.39	4.60	7.98	5.47	5.35	7.76	4.42
Ethyl Acrylate	**56.57**	NA	NA	**56.57**	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	14.92	NA	NA	**38.57**	NA	**15.71**	NA	NA	NA
Ethylbenzene	5.02	3.77	3.69	4.01	5.24	14.65	9.31	5.99	3.86
Hexachloro-1,3-butadiene	**29.67**	NA	**41.59**	**28.28**	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	11.63	**16.34**	3.68	6.47	7.92	6.34	4.60	14.70	7.46
Methyl Isobutyl Ketone	10.37	6.28	9.06	13.83	7.63	**17.45**	4.85	**20.81**	5.90
Methyl Methacrylate	**22.25**	NA	NA	NA	NA	5.44	NA	NA	**62.23**
Methyl *tert*-Butyl Ether	**22.84**	NA	NA	NA	13.03	8.59	NA	NA	NA
n-Octane	11.78	9.87	3.04	**15.48**	6.11	**30.73**	6.42	7.82	8.85
Propylene	4.33	4.03	3.62	5.75	7.02	14.06	4.78	2.72	4.59
Styrene	10.15	5.18	6.56	11.01	8.75	**23.87**	**17.94**	12.47	8.12
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	9.06	3.77	5.80	12.71	7.74	7.99	5.08	**18.37**	4.68
Toluene	4.39	3.66	3.74	4.34	6.10	13.43	4.91	2.15	4.25
1,2,4-Trichlorobenzene	**45.65**	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	7.30	6.72	5.16	4.59	8.07	4.67	6.73	10.24	5.54
1,1,2-Trichloroethane	**46.05**	NA	**15.71**	NA	NA	NA	**23.57**	NA	NA
Trichloroethylene	**23.22**	3.72	**31.36**	**83.87**	8.59	9.51	10.88	NA	12.20
Trichlorofluoromethane	4.06	3.81	2.76	4.19	7.42	9.97	2.27	2.46	2.47

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Anchorage, AK (ANAK)**	**Bountiful, UT (BTUT)**	**Burlington, VT (BURVT)**	**Camden, NJ (CANJ)**	**Chester, NJ (CHNJ)**	**Pryor, OK (CNEP)**	**Custer, SD (CUSD)**	**Dearborn, MI (DEMI)**
Trichlorotrifluoroethane	4.12	4.60	3.57	4.39	6.00	3.53	3.24	3.33	2.60
1,2,4-Trimethylbenzene	5.86	4.53	3.78	4.27	5.12	**18.40**	6.53	7.49	3.67
1,3,5-Trimethylbenzene	9.21	4.76	4.27	6.55	9.30	8.12	**17.64**	4.37	7.89
Vinyl chloride	**32.92**	10.10	**32.27**	**64.36**	**16.90**	NA	**15.71**	**47.14**	NA
m,*p*-Xylene	6.50	4.15	3.64	4.67	5.90	**23.73**	**23.03**	10.42	4.45
o-Xylene	5.32	4.46	3.77	4.89	4.20	14.19	5.66	9.27	3.58
Average	*11.91*	*8.35*	***16.33***	***16.51***	*10.31*	***15.68***	*8.71*	*12.87*	*8.81*

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Elizabeth, NJ (ELNJ)**	**Tacoma, WA (EQWA)**	**Davie, FL (FLFL)**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Memphis, TN (METN)**	**Loudon, TN (MSTN)**
Acetonitrile	8.78	8.89	4.22	**16.07**	7.40	4.03	6.13	3.61	10.14
Acetylene	4.66	5.12	2.96	4.32	5.30	4.96	10.10	3.38	3.52
Acrolein	10.77	12.28	7.21	5.91	6.60	**69.65**	10.68	**16.40**	11.47
Acrylonitrile	**52.77**	7.79	NA	NA	**44.20**	NA	**122.32**	**50.76**	**97.29**
tert-Amyl Methyl Ether	**56.43**	**66.74**	NA	NA	NA	NA	**24.96**	NA	**63.49**
Benzene	5.05	4.29	3.28	8.12	7.78	3.87	6.27	3.57	4.38
Bromochloromethane	**74.08**	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	9.36	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	**23.69**	NA	NA	10.70	NA	NA	NA	NA	NA
Bromomethane	8.42	8.31	5.62	11.55	10.48	12.32	5.34	6.71	11.01
1,3-Butadiene	7.20	5.34	4.89	13.65	4.84	6.44	5.32	5.07	5.02
Carbon Disulfide	5.34	3.87	5.45	6.03	5.13	1.83	3.42	2.98	4.27
Carbon Tetrachloride	5.61	4.37	3.52	**16.54**	8.67	7.26	6.96	6.37	3.94
Chlorobenzene	2.05	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	**17.66**	8.57	13.34	**20.23**	12.46	**101.02**	**27.07**	6.44	**36.97**
Chloroform	10.09	6.84	6.79	7.02	9.95	**17.72**	9.43	7.66	**20.54**
Chloromethane	3.41	4.16	2.71	4.19	5.33	2.12	3.55	3.57	3.35
Chloromethylbenzene	**66.00**	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	**54.90**	NA	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	**33.89**	NA	NA	NA	**47.14**	NA	NA	NA	NA
1,2-Dibromoethane	**84.85**	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	**58.93**	NA	NA	NA	NA	NA	**47.14**	NA	NA
o-Dichlorobenzene	**70.71**	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	10.29	5.38	10.17	9.41	17.55	12.86	10.12	12.27	10.02
Dichlorodifluoromethane	3.39	4.18	2.64	5.21	5.20	2.98	3.93	4.26	3.28
1,1-Dichloroethane	**57.69**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	**65.37**	7.19	NA	NA	NA	NA	NA	**124.78**	**79.33**

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Elizabeth, NJ (ELNJ)**	**Tacoma, WA (EQWA)**	**Davie, FL (FLFL)**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Memphis, TN (METN)**	**Loudon, TN (MSTN)**
1,1-Dichloroethene	**59.04**	NA	NA	NA	**76.15**	NA	NA	**47.14**	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**30.88**	**32.64**	NA	NA	8.47	NA	NA	NA	NA
Dichloromethane	4.83	4.65	2.75	6.45	5.74	1.33	10.16	3.94	4.82
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	**24.96**	NA	NA	NA	NA	NA	NA	NA	**24.96**
Dichlorotetrafluoroethane	5.48	7.67	3.69	6.13	4.87	7.15	6.05	5.44	10.24
Ethyl Acrylate	**56.57**	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	14.92	NA	NA	NA	NA	NA	12.55	NA	NA
Ethylbenzene	5.02	5.00	3.89	5.57	5.62	2.14	3.94	2.86	9.08
Hexachloro-1,3-butadiene	**29.67**	**87.55**	NA	NA	NA	NA	7.79	NA	NA
Methyl Ethyl Ketone	11.63	**15.89**	4.92	13.58	5.58	4.00	**15.24**	14.97	4.75
Methyl Isobutyl Ketone	10.37	8.53	9.14	7.76	10.59	NA	13.98	**18.52**	8.45
Methyl Methacrylate	**22.25**	**19.00**	NA	NA	7.85	NA	**57.17**	NA	NA
Methyl *tert*-Butyl Ether	**22.84**	7.76	7.03	NA	NA	NA	NA	NA	NA
n-Octane	11.78	6.22	5.95	10.49	7.90	**17.59**	14.16	**17.92**	11.13
Propylene	4.33	4.20	4.00	4.31	5.11	4.51	3.59	3.12	3.74
Styrene	10.15	8.54	6.26	**15.64**	5.95	NA	9.16	**16.33**	9.43
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	**112.16**	NA	NA
Tetrachloroethylene	9.06	5.63	5.20	8.39	7.71	**28.28**	13.93	4.44	**17.31**
Toluene	4.39	4.25	3.52	3.37	5.36	5.91	4.72	3.12	4.32
1,2,4-Trichlorobenzene	**45.65**	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	7.30	8.83	6.97	10.27	7.50	9.37	7.28	5.06	6.57
1,1,2-Trichloroethane	**46.05**	**76.15**	NA	**35.05**	**45.93**	NA	NA	**64.28**	NA
Trichloroethylene	**23.22**	14.64	**20.89**	10.69	8.35	NA	6.73	**94.28**	NA
Trichlorofluoromethane	4.06	3.94	2.83	4.86	5.43	2.84	3.62	3.76	9.44

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Elizabeth, NJ (ELNJ)**	**Tacoma, WA (EQWA)**	**Davie, FL (FLFL)**	**Grand Junction, CO (GPCO)**	**Gulfport, MS (GPMS)**	**Loudon, TN (LDTN)**	**Memphis, TN (METN)**	**Loudon, TN (MSTN)**
Trichlorotrifluoroethane	4.12	3.79	10.99	4.01	5.61	4.94	10.73	4.62	3.87
1,2,4-Trimethylbenzene	5.86	4.40	3.84	4.97	5.49	14.28	8.05	9.03	6.20
1,3,5-Trimethylbenzene	9.21	6.52	3.86	8.66	7.43	**50.28**	6.26	13.19	9.09
Vinyl chloride	**32.92**	**19.59**	10.96	9.52	**62.93**	**36.97**	**136.88**	10.08	**19.61**
m,p-Xylene	6.50	4.99	3.65	4.69	5.77	10.19	4.68	3.24	10.00
o-Xylene	5.32	4.11	4.29	3.19	5.88	6.84	4.99	5.62	4.59
Average	*11.91*	*13.19*	*5.98*	*9.31*	*13.56*	***15.65***	***19.91***	***16.91***	***15.59***

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Midwest City, OK (MWOK)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Oklahoma City, OK (OCOK)	Pryor Creek, OK (PROK)	Phoenix, AZ (PXSS)	St. Louis, MO (S4MO)	Seattle, WA (SEWA)
Acetonitrile	8.78	8.38	9.70	6.23	6.83	2.80	7.34	6.83	**19.22**
Acetylene	4.66	4.18	4.25	4.36	1.49	2.56	4.84	5.43	3.19
Acrolein	10.77	5.04	6.02	11.73	8.29	5.41	6.38	7.49	7.40
Acrylonitrile	**52.77**	NA	NA	**41.20**	NA	4.91	6.87	10.11	NA
tert-Amyl Methyl Ether	**56.43**	NA	NA	**74.87**	NA	**52.10**	NA	**33.67**	NA
Benzene	5.05	4.22	5.78	4.81	1.03	2.73	4.04	4.86	5.79
Bromochloromethane	**74.08**	**74.08**	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	9.36	NA	9.68	NA	NA	NA	9.04	NA	NA
Bromoform	**23.69**	NA	NA	**15.71**	NA	NA	**18.83**	NA	NA
Bromomethane	8.42	13.07	6.32	6.99	3.37	9.35	9.42	9.30	8.64
1,3-Butadiene	7.20	5.82	**18.30**	6.51	2.62	4.51	5.13	12.31	6.90
Carbon Disulfide	5.34	9.18	5.52	3.55	2.93	5.72	5.97	4.23	3.22
Carbon Tetrachloride	5.61	5.35	4.31	3.40	2.16	3.52	5.70	5.53	11.33
Chlorobenzene	2.05	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	**17.66**	9.85	**15.74**	7.31	**19.64**	13.88	**19.79**	**16.60**	**22.51**
Chloroform	10.09	7.03	5.44	6.70	9.99	3.81	11.21	11.16	7.19
Chloromethane	3.41	3.87	1.95	3.01	1.64	2.25	4.66	4.50	2.72
Chloromethylbenzene	**66.00**	NA	NA	NA	NA	NA	NA	NA	NA
Chloroprene	**54.90**	NA	NA	NA	NA	NA	NA	NA	**55.34**
Dibromochloromethane	**33.89**	NA	13.28	**28.28**	NA	NA	**17.35**	NA	NA
1,2-Dibromoethane	**84.85**	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	**58.93**	NA	NA	NA	**70.71**	NA	NA	NA	NA
o-Dichlorobenzene	**70.71**	**70.71**	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	10.29	**18.19**	**20.70**	8.35	NA	3.39	6.72	5.27	8.01
Dichlorodifluoromethane	3.39	3.92	1.88	3.33	1.22	2.52	4.51	4.33	2.76
1,1-Dichloroethane	**57.69**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	**65.37**	NA	11.56	**127.28**	NA	NA	NA	NA	NA

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Midwest City, OK (MWOK)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Oklahoma City, OK (OCOK)**	**Pryor Creek, OK (PROK)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**
1,1-Dichloroethene	**59.04**	NA	NA	NA	NA	NA	12.86	**76.15**	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**30.88**	**84.85**	**32.64**	NA	NA	NA	13.47	NA	2.44
Dichloromethane	4.83	4.72	3.82	3.70	3.26	4.92	4.79	4.84	4.04
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	**24.96**	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	5.48	6.85	6.17	3.40	2.14	6.25	9.29	6.65	3.47
Ethyl Acrylate	**56.57**	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	14.92	NA	NA	3.93	NA	NA	NA	3.05	NA
Ethylbenzene	5.02	5.49	7.45	5.22	1.33	5.47	3.84	4.83	4.54
Hexachloro-1,3-butadiene	**29.67**	NA	12.86	7.44	NA	NA	NA	0.97	NA
Methyl Ethyl Ketone	11.63	4.08	11.38	**15.43**	5.26	**20.24**	5.78	14.50	5.25
Methyl Isobutyl Ketone	10.37	8.94	10.39	8.21	3.37	4.43	5.05	7.96	10.89
Methyl Methacrylate	**22.25**	NA	NA	NA	NA	NA	**16.91**	NA	NA
Methyl *tert*-Butyl Ether	**22.84**	NA	**84.85**	11.35	NA	NA	**17.96**	NA	NA
n-Octane	11.78	5.25	**27.17**	7.33	2.92	**26.50**	6.22	6.78	11.06
Propylene	4.33	4.82	4.14	3.34	0.46	5.06	4.67	4.89	3.00
Styrene	10.15	12.78	**20.67**	11.67	2.83	10.63	10.24	11.78	6.55
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	9.06	1.60	9.62	5.91	13.30	13.86	3.98	4.57	3.80
Toluene	4.39	3.87	4.49	3.92	0.56	4.75	3.95	3.95	4.00
1,2,4-Trichlorobenzene	**45.65**	NA	9.43	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	7.30	6.86	6.33	4.42	3.07	12.07	10.63	8.27	6.99
1,1,2-Trichloroethane	**46.05**	NA	NA	NA	NA	NA	NA	**61.65**	NA
Trichloroethylene	**23.22**	10.10	10.91	6.75	NA	NA	**17.78**	7.82	6.11
Trichlorofluoromethane	4.06	4.22	1.92	3.46	1.08	2.68	4.25	10.08	2.89
Trichlorotrifluoroethane	4.12	4.08	1.80	3.26	1.13	1.76	3.96	4.22	2.91

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Midwest City, OK (MWOK)**	**Northbrook, IL (NBIL)**	**New Brunswick, NJ (NBNJ)**	**Oklahoma City, OK (OCOK)**	**Pryor Creek, OK (PROK)**	**Phoenix, AZ (PXSS)**	**St. Louis, MO (S4MO)**	**Seattle, WA (SEWA)**
1,2,4-Trimethylbenzene	5.86	4.48	6.70	4.98	1.91	6.81	5.12	5.19	5.04
1,3,5-Trimethylbenzene	9.21	12.38	14.48	8.88	NA	5.00	6.85	7.90	5.30
Vinyl chloride	**32.92**	NA	**40.41**	12.92	NA	NA	**20.20**	**18.52**	**32.64**
m,p-Xylene	6.50	3.99	6.33	6.93	1.03	14.43	4.15	3.85	5.06
o-Xylene	5.32	3.59	8.19	4.81	3.21	4.84	3.98	4.72	4.78
Average	*11.91*	*12.82*	*12.37*	*12.77*	*6.16*	*8.41*	*8.59*	*11.18*	*8.68*

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Schiller Park, IL (SPIL)	Sioux Falls, SD (SSSD)	Tulsa, OK (TMOK)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tupelo, MS (TUMS)	Tulsa, OK (TUOK)	Union County, SD (UCSD)
Acetonitrile	8.78	7.97	4.05	8.38	5.68	6.32	6.46	**20.69**	7.97
Acetylene	4.66	3.94	2.40	1.20	3.55	4.92	4.78	4.88	12.50
Acrolein	10.77	**20.68**	9.35	7.60	**16.84**	5.48	3.71	**18.86**	4.15
Acrylonitrile	**52.77**	NA	**72.62**	NA	NA	**70.49**	NA	NA	NA
tert-Amyl Methyl Ether	**56.43**	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	5.05	5.76	3.37	0.74	8.12	5.57	7.69	4.85	3.87
Bromochloromethane	**74.08**	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	9.36	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	**23.69**	**49.50**	NA	NA	NA	NA	NA	NA	NA
Bromomethane	8.42	5.38	11.53	4.73	7.51	2.43	6.73	8.34	2.49
1,3-Butadiene	7.20	5.90	8.26	4.79	8.08	7.92	3.86	7.03	14.34
Carbon Disulfide	5.34	5.51	7.06	2.50	4.91	4.51	3.60	6.90	7.98
Carbon Tetrachloride	5.61	4.07	3.07	3.89	7.57	5.70	10.84	4.25	4.16
Chlorobenzene	2.05	NA	NA	NA	NA	NA	NA	NA	NA
Chloroethane	**17.66**	**19.88**	12.24	4.52	9.31	**22.38**	12.14	**18.46**	5.94
Chloroform	10.09	7.85	8.61	3.37	**19.98**	8.99	12.75	**15.54**	2.59
Chloromethane	3.41	3.37	2.33	1.36	4.07	4.29	3.87	3.73	2.01
Chloromethylbenzene	**66.00**	NA	**66.00**	NA	NA	NA	NA	NA	NA
Chloroprene	**54.90**	NA	NA	NA	NA	NA	**47.14**	**62.23**	NA
Dibromochloromethane	**33.89**	**17.75**	NA	NA	NA	NA	NA	**79.55**	NA
1,2-Dibromoethane	**84.85**	NA	NA	NA	NA	NA	NA	NA	NA
m-Dichlorobenzene	**58.93**	NA	NA	NA	NA	NA	NA	NA	NA
o-Dichlorobenzene	**70.71**	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	10.29	14.12	**15.77**	1.79	8.04	4.40	10.10	5.14	NA
Dichlorodifluoromethane	3.39	2.86	2.03	1.69	4.12	4.29	4.00	3.55	2.13
1,1-Dichloroethane	**57.69**	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	**65.37**	NA	**87.26**	NA	NA	NA	**76.15**	NA	9.87

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Schiller Park, IL (SPIL)	Sioux Falls, SD (SSSD)	Tulsa, OK (TMOK)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tupelo, MS (TUMS)	Tulsa, OK (TUOK)	Union County, SD (UCSD)
1,1-Dichloroethene	**59.04**	NA	NA	NA	NA	NA	**15.71**	NA	NA
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethylene	**30.88**	NA	**32.64**	NA	NA	NA	NA	NA	**64.28**
Dichloromethane	4.83	5.19	3.01	1.23	6.26	5.77	8.25	5.06	4.73
1,2-Dichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	**24.96**	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorotetrafluoroethane	5.48	3.75	5.60	1.35	6.31	5.05	4.71	4.86	3.84
Ethyl Acrylate	**56.57**	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl *tert*-Butyl Ether	14.92	NA	NA	NA	**15.71**	NA	NA	NA	NA
Ethylbenzene	5.02	5.31	3.70	1.60	4.07	3.77	8.43	3.41	3.60
Hexachloro-1,3-butadiene	**29.67**	NA	NA	NA	NA	NA	**50.91**	NA	NA
Methyl Ethyl Ketone	11.63	4.72	14.92	7.17	**19.65**	**18.93**	**62.30**	13.43	2.64
Methyl Isobutyl Ketone	10.37	5.52	12.39	5.05	7.67	6.69	**28.28**	13.42	**20.28**
Methyl Methacrylate	**22.25**	NA	NA	NA	NA	9.43	NA	0.00	NA
Methyl *tert*-Butyl Ether	**22.84**	NA	7.86	NA	NA	**47.14**	NA	NA	NA
n-Octane	11.78	9.76	13.35	2.74	10.53	12.49	**15.71**	5.64	**33.90**
Propylene	4.33	4.95	3.17	1.86	4.20	3.75	3.51	4.51	3.01
Styrene	10.15	10.04	6.56	3.63	9.88	12.60	5.89	5.14	8.62
1,1,2,2-Tetrachloroethane	**112.16**	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	9.06	5.20	7.35	4.29	12.24	4.75	3.72	6.00	**32.80**
Toluene	4.39	5.92	3.19	0.54	4.30	4.36	8.23	2.74	4.64
1,2,4-Trichlorobenzene	**45.65**	NA	NA	NA	NA	NA	**81.88**	NA	NA
1,1,1-Trichloroethane	7.30	5.73	7.65	5.03	9.95	6.32	12.07	5.58	9.04
1,1,2-Trichloroethane	**46.05**	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	**23.22**	**16.81**	NA	NA	**21.79**	5.62	NA	**22.17**	**115.71**
Trichlorofluoromethane	4.06	3.20	2.29	1.33	3.96	4.54	6.14	3.36	2.45
Trichlorotrifluoroethane	4.12	3.05	3.10	1.41	4.53	4.44	6.86	2.40	2.96

Table 34-28. VOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Schiller Park., IL (SPIL)	Sioux Falls, SD (SSSD)	Tulsa, OK (TMOK)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tupelo, MS (TUMS)	Tulsa, OK (TUOK)	Union County, SD (UCSD)
1,2,4-Trimethylbenzene	5.86	5.84	3.97	1.14	6.95	2.63	4.33	4.11	8.38
1,3,5-Trimethylbenzene	9.21	8.80	6.39	3.89	4.80	9.28	8.87	3.96	10.61
Vinyl chloride	**32.92**	**47.14**	**58.23**	12.86	NA	7.07	NA	**47.14**	NA
m,p-Xylene	6.50	5.74	4.28	0.40	4.25	3.40	7.09	3.18	6.68
o-Xylene	5.32	3.95	3.75	0.54	4.67	3.86	7.97	4.74	13.12
Average	*11.91*	*9.86*	*14.43*	*3.31*	*8.42*	*9.70*	***16.13***	*12.14*	*13.48*

34.3.2 SNMOC Analytical Precision

Table 34-29 presents analytical precision results from replicate analyses of all duplicate and collocated SNMOC samples. The average concentration differences observed for replicate analyses of SNMOC ranged from 0.02 for several pollutants to 4.72 ppbC (TNMOC). For most of the pollutants, the CV was less than 15 percent. The overall average variability was 9.77 percent.

Table 34-29. SNMOC Analytical Precision: 202 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	202	2.76	0.04	1.95
Benzene	198	5.66	0.12	4.00
1,3-Butadiene	73	13.61	0.03	9.62
n-Butane	202	1.80	0.34	1.27
cis-2-Butene	153	12.23	0.02	8.64
trans-2-Butene	165	9.70	0.02	6.86
Cyclohexane	193	7.51	0.08	5.31
Cyclopentane	193	16.00	0.04	11.32
Cyclopentene	136	13.26	0.04	9.38
n-Decane	192	7.74	0.05	5.47
1-Decene	0	NA	NA	NA
m-Diethylbenzene	77	16.88	0.03	11.93
p-Diethylbenzene	50	19.41	0.05	13.73
2,2-Dimethylbutane	190	11.97	0.04	8.46
2,3-Dimethylbutane	197	8.44	0.04	5.97
2,3-Dimethylpentane	193	8.54	0.04	6.04
2,4-Dimethylpentane	186	10.09	0.03	7.13
n-Dodecane	188	13.72	0.09	9.70
1-Dodecene	56	18.73	0.07	13.24
Ethane	202	0.53	0.18	0.38
Ethylbenzene	199	10.20	0.04	7.21
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	202	2.59	0.05	1.83
m-Ethyltoluene	177	12.45	0.03	8.80
o-Ethyltoluene	147	17.35	0.04	12.27
p-Ethyltoluene	152	11.06	0.02	7.82
n-Heptane	201	7.95	0.12	5.62
1-Heptene	119	10.56	0.04	7.47
n-Hexane	202	4.33	0.17	3.06
1-Hexene	146	**25.03**	0.04	**17.70**
cis-2-Hexene	32	22.49	0.05	**15.90**
trans-2-Hexene	16	**43.64**	0.05	**30.86**
Isobutane	202	2.85	0.43	2.01
Isobutene/1-Butene	172	5.64	0.12	3.99

Table 34-29. SNMOC Analytical Precision: 202 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Isopentane	196	4.46	0.58	3.15
Isoprene	164	11.87	0.03	8.39
Isopropylbenzene	64	**28.00**	0.05	**19.80**
2-Methyl-1-butene	132	19.04	0.10	13.46
2-Methyl-2-butene	143	13.89	0.03	9.82
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	175	10.90	0.17	7.71
Methylcyclopentane	202	6.75	0.08	4.78
2-Methylheptane	128	13.15	0.06	9.30
3-Methylheptane	133	11.86	0.04	8.39
2-Methylhexane	187	11.07	0.09	7.83
3-Methylhexane	175	11.69	0.08	8.27
3-Methylpentane	202	7.43	0.08	5.26
2-Methylpentane	202	7.60	0.22	5.38
4-Methyl-1-pentene	24	10.81	0.05	7.64
2-Methyl-1-pentene	16	**55.03**	0.06	**38.91**
n-Nonane	179	9.20	0.05	6.50
1-Nonene	60	14.92	0.02	10.55
n-Octane	196	9.91	0.08	7.01
1-Octene	49	**28.61**	0.03	**20.23**
n-Pentane	202	2.21	0.12	1.56
1-Pentene	198	10.48	0.03	7.41
cis-2-Pentene	106	12.69	0.04	8.97
trans-2-Pentene	166	11.39	0.02	8.05
a-Pinene	131	15.74	0.04	11.13
b-Pinene	22	**31.25**	0.04	**22.10**
Propane	202	0.88	0.30	0.62
n-Propylbenzene	133	16.98	0.02	12.00
Propylene	202	3.46	0.03	2.45
Propyne	0	NA	NA	NA
Styrene	47	**37.78**	0.16	**26.71**
SNMOC	202	2.22	3.28	1.57
TNMOC (w/unknowns)	202	2.16	4.72	1.53
Toluene	202	5.56	0.22	3.93
n-Tridecane	48	20.73	0.07	14.65
1-Tridecene	18	17.75	0.05	12.55
1,2,3-Trimethylbenzene	108	13.49	0.02	9.54
1,2,4-Trimethylbenzene	197	9.34	0.04	6.60
1,3,5-Trimethylbenzene	122	15.04	0.04	10.63
2,2,3-Trimethylpentane	89	18.08	0.04	12.78
2,2,4-Trimethylpentane	182	10.01	0.04	7.08
2,3,4-Trimethylpentane	178	10.50	0.02	7.42
n-Undecane	198	7.60	0.06	5.37
1-Undecene	41	**26.66**	0.07	**18.85**

Table 34-29. SNMOC Analytical Precision: 202 Replicate Analyses for all Duplicate and Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
m-Xylene/*p*-Xylene	199	7.73	0.12	5.46
o-Xylene	197	9.33	0.04	6.60
Total & Averages	*5,015*	*13.81*	*0.29*	*9.77*

Table 34-30 presents analytical precision results from SNMOC replicate analyses for all duplicate samples. These results show low- to high-level variability, ranging from 0.38 percent (ethane) to 49.56 percent (*trans*-2-hexene). The overall average variability was 9.69 percent.

Table 34-30. SNMOC Analytical Precision: 126 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	126	3.03	0.04	2.14
Benzene	122	4.39	0.05	3.11
1,3-Butadiene	45	7.76	0.01	5.49
n-Butane	126	1.42	0.06	1.01
cis-2-Butene	106	15.90	0.03	11.25
trans-2-Butene	110	8.78	0.02	6.21
Cyclohexane	118	8.37	0.02	5.92
Cyclopentane	119	15.84	0.03	11.20
Cyclopentene	95	17.39	0.05	12.30
n-Decane	116	7.99	0.04	5.65
1-Decene	0	NA	NA	NA
m-Diethylbenzene	44	19.12	0.03	13.52
p-Diethylbenzene	26	20.80	0.07	14.71
2,2-Dimethylbutane	118	13.00	0.03	9.19
2,3-Dimethylbutane	122	10.99	0.03	7.77
2,3-Dimethylpentane	119	9.72	0.03	6.87
2,4-Dimethylpentane	115	11.84	0.02	8.37
n-Dodecane	112	15.04	0.13	10.64
1-Dodecene	24	15.77	0.03	11.15
Ethane	126	0.54	0.03	0.38
Ethylbenzene	123	10.43	0.03	7.37
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	126	2.17	0.04	1.53
m-Ethyltoluene	102	11.63	0.03	8.22
o-Ethyltoluene	87	19.69	0.03	13.93
p-Ethyltoluene	94	12.33	0.02	8.72
n-Heptane	126	8.96	0.03	6.34

Table 34-30. SNMOC Analytical Precision: 126 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
1-Heptene	63	14.87	0.03	10.51
n-Hexane	126	4.53	0.05	3.20
1-Hexene	99	24.05	0.04	**17.01**
cis-2-Hexene	16	20.23	0.05	14.31
trans-2-Hexene	8	**70.09**	0.08	**49.56**
Isobutane	126	2.60	0.04	1.84
Isobutene/1-Butene	106	5.28	0.12	3.73
Isopentane	124	2.74	0.26	1.94
Isoprene	113	9.14	0.03	6.46
Isopropylbenzene	37	23.08	0.03	**16.32**
2-Methyl-1-butene	89	12.59	0.09	8.90
2-Methyl-2-butene	97	13.97	0.03	9.88
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	100	12.74	0.04	9.01
Methylcyclopentane	126	8.58	0.04	6.07
2-Methylheptane	68	13.12	0.03	9.28
3-Methylheptane	74	13.43	0.02	9.49
2-Methylhexane	111	13.48	0.07	9.53
3-Methylhexane	108	11.64	0.05	8.23
3-Methylpentane	126	7.56	0.04	5.34
2-Methylpentane	126	5.66	0.07	4.01
4-Methyl-1-pentene	12	14.13	0.06	9.99
2-Methyl-1-pentene	11	**68.99**	0.08	**48.78**
n-Nonane	103	10.72	0.02	7.58
1-Nonene	30	22.51	0.03	**15.92**
n-Octane	123	12.14	0.03	8.58
1-Octene	28	24.54	0.03	**17.35**
n-Pentane	126	1.77	0.05	1.25
1-Pentene	122	8.57	0.03	6.06
cis-2-Pentene	67	12.73	0.06	9.00
trans-2-Pentene	111	11.36	0.02	8.03
a-Pinene	67	14.99	0.04	10.60
b-Pinene	17	16.53	0.03	11.69
Propane	126	0.99	0.08	0.70
n-Propylbenzene	82	18.27	0.02	12.92
Propylene	126	3.59	0.03	2.54
Propyne	0	NA	NA	NA
Styrene	37	**46.66**	0.27	**32.99**
SNMOC	126	1.79	1.09	1.27
TNMOC (w/unknowns)	126	2.08	2.72	1.47
Toluene	126	5.40	0.12	3.82
n-Tridecane	24	**27.50**	0.11	**19.45**
1-Tridecene	8	8.84	0.05	6.25
1,2,3-Trimethylbenzene	63	18.67	0.02	13.20
1,2,4-Trimethylbenzene	121	9.51	0.03	6.72
1,3,5-Trimethylbenzene	73	14.70	0.02	10.39

Table 34-30. SNMOC Analytical Precision: 126 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
2,2,3-Trimethylpentane	46	21.07	0.03	14.90
2,2,4-Trimethylpentane	124	6.14	0.03	4.34
2,3,4-Trimethylpentane	111	11.12	0.03	7.86
n-Undecane	122	8.90	0.06	6.30
1-Undecene	21	**37.48**	0.11	**26.50**
m-Xylene/*p*-Xylene	123	8.09	0.07	5.72
o-Xylene	121	9.14	0.03	6.46
Total & Averages	*3,068*	*13.70*	*0.10*	*9.69*

Table 34-31 presents analytical precision results from SNMOC replicate analyses for collocated samples. The variability ranged from 0.38 percent for ethane to 32.51 percent for *b*-pinene, with an average variability of 8.77 percent.

Table 34-31. SNMOC Analytical Precision: 76 Replicate Analyses for Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	76	2.49	0.04	1.76
Benzene	76	6.92	0.18	4.89
1,3-Butadiene	28	19.46	0.05	13.76
n-Butane	76	2.18	0.63	1.54
cis-2-Butene	47	8.55	0.02	6.04
trans-2-Butene	55	10.62	0.02	7.51
Cyclohexane	75	6.65	0.13	4.70
Cyclopentane	74	16.17	0.04	11.43
Cyclopentene	41	9.13	0.02	6.46
n-Decane	76	7.48	0.07	5.29
1-Decene	0	NA	NA	NA
m-Diethylbenzene	33	14.64	0.03	10.35
p-Diethylbenzene	24	18.03	0.03	12.75
2,2-Dimethylbutane	72	10.94	0.04	7.73
2,3-Dimethylbutane	75	5.89	0.05	4.17
2,3-Dimethylpentane	74	7.37	0.05	5.21
2,4-Dimethylpentane	71	8.33	0.03	5.89
n-Dodecane	76	12.39	0.06	8.76
1-Dodecene	32	21.69	0.11	**15.34**
Ethane	76	0.53	0.34	0.38
Ethylbenzene	76	9.97	0.04	7.05
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	76	3.02	0.06	2.13

Table 34-31. SNMOC Analytical Precision: 76 Replicate Analyses for Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
m-Ethyltoluene	75	13.28	0.03	9.39
o-Ethyltoluene	60	15.00	0.04	10.61
p-Ethyltoluene	58	9.79	0.02	6.92
n-Heptane	75	6.94	0.21	4.91
1-Heptene	56	6.26	0.06	4.42
n-Hexane	76	4.14	0.29	2.93
1-Hexene	47	**26.02**	0.04	**18.40**
cis-2-Hexene	16	24.74	0.05	**17.49**
trans-2-Hexene	8	17.18	0.02	12.15
Isobutane	76	3.10	0.82	2.19
Isobutene/1-Butene	66	6.00	0.13	4.24
Isopentane	72	6.18	0.90	4.37
Isoprene	51	14.60	0.03	10.32
Isopropylbenzene	27	**32.92**	0.07	**23.28**
2-Methyl-1-butene	43	**25.48**	0.12	**18.02**
2-Methyl-2-butene	46	13.80	0.03	9.76
3-Methyl-1-butene	11	**36.19**	0.07	**25.59**
Methylcyclohexane	75	9.07	0.31	6.41
Methylcyclopentane	76	4.93	0.12	3.48
2-Methylheptane	60	13.18	0.09	9.32
3-Methylheptane	59	10.30	0.06	7.28
2-Methylhexane	76	8.66	0.12	6.12
3-Methylhexane	67	11.74	0.12	8.30
3-Methylpentane	76	7.31	0.12	5.17
2-Methylpentane	76	9.54	0.36	6.75
4-Methyl-1-pentene	12	7.49	0.03	5.29
2-Methyl-1-pentene	5	**41.07**	0.04	**29.04**
n-Nonane	76	7.67	0.08	5.42
1-Nonene	30	7.32	0.02	5.18
n-Octane	73	7.68	0.13	5.43
1-Octene	21	**32.68**	0.04	**23.11**
n-Pentane	76	2.64	0.18	1.87
1-Pentene	76	12.39	0.03	8.76
cis-2-Pentene	39	12.64	0.02	8.94
trans-2-Pentene	55	11.42	0.02	8.08
a-Pinene	64	16.50	0.05	11.66
b-Pinene	5	**45.98**	0.06	**32.51**
Propane	76	0.77	0.52	0.54
n-Propylbenzene	51	15.68	0.03	11.09
Propylene	76	3.33	0.03	2.36
Propyne	0	NA	NA	NA
Styrene	10	**28.89**	0.05	**20.43**
SNMOC	76	2.66	5.47	1.88
TNMOC (w/unknowns)	76	2.24	6.71	1.59
Toluene	76	5.72	0.32	4.05
n-Tridecane	24	13.95	0.03	9.86

Table 34-31. SNMOC Analytical Precision: 76 Replicate Analyses for Collocated Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
1-Tridecene	10	**26.66**	0.05	**18.85**
1,2,3-Trimethylbenzene	45	8.30	0.01	5.87
1,2,4-Trimethylbenzene	76	9.17	0.05	6.48
1,3,5-Trimethylbenzene	49	15.38	0.06	10.88
2,2,3-Trimethylpentane	43	15.09	0.04	10.67
2,2,4-Trimethylpentane	58	13.88	0.05	9.81
2,3,4-Trimethylpentane	67	9.88	0.02	6.99
n-Undecane	76	6.30	0.05	4.45
1-Undecene	20	15.85	0.03	11.21
m-Xylene/*p*-Xylene	76	7.36	0.17	5.21
o-Xylene	76	9.52	0.05	6.74
Total & Averages	*1,947*	*12.40*	*0.27*	*8.77*

Due to the focus on QA for the NATTS program, Table 34-32 presents the average analytical precision results from SNMOC replicate analyses for all the duplicate and collocated samples at NATTS sites sampling SNMOC (BTUT and NBIL). These results show low- to high-level variability at these sites, as represented by CV, ranging from 0.39 percent (ethane) to 48.43 percent (*trans*-2-hexene), with an average of 10.37 percent.

Table 34-32. SNMOC Analytical Precision: 68 Replicate Analyses for NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
Acetylene	68	1.78	0.03	1.26
Benzene	64	5.85	0.07	4.13
1,3-Butadiene	32	**27.85**	0.08	**19.69**
n-Butane	68	1.50	0.08	1.06
cis-2-Butene	41	18.68	0.03	13.21
trans-2-Butene	48	15.40	0.02	10.89
Cyclohexane	67	7.23	0.03	5.12
Cyclopentane	66	19.31	0.04	13.65
Cyclopentene	41	14.77	0.03	10.44
n-Decane	68	8.11	0.05	5.73
1-Decene	0	NA	NA	NA
m-Diethylbenzene	28	17.32	0.03	12.25
p-Diethylbenzene	23	16.87	0.07	11.93
2,2-Dimethylbutane	64	13.49	0.03	9.54
2,3-Dimethylbutane	67	5.88	0.02	4.15

Table 34-32. SNMOC Analytical Precision: 68 Replicate Analyses for NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
2,3-Dimethylpentane	66	5.94	0.02	4.20
2,4-Dimethylpentane	63	7.56	0.02	5.35
n-Dodecane	68	13.34	0.08	9.43
1-Dodecene	22	12.29	0.03	8.69
Ethane	68	0.55	0.05	0.39
Ethylbenzene	68	10.36	0.04	7.33
2-Ethyl-1-butene	0	NA	NA	NA
Ethylene	68	2.33	0.05	1.64
m-Ethyltoluene	67	14.84	0.03	10.49
o-Ethyltoluene	56	15.36	0.02	10.86
p-Ethyltoluene	51	10.99	0.02	7.77
n-Heptane	67	6.88	0.03	4.86
1-Heptene	46	12.04	0.02	8.52
n-Hexane	68	3.49	0.05	2.47
1-Hexene	42	**30.14**	0.04	**21.31**
cis-2-Hexene	6	**28.56**	0.08	**20.20**
trans-2-Hexene	7	**68.50**	0.08	**48.43**
Isobutane	68	2.06	0.04	1.46
Isobutene/1-Butene	64	5.29	0.08	3.74
Isopentane	64	3.48	0.33	2.46
Isoprene	50	8.40	0.03	5.94
Isopropylbenzene	27	19.00	0.02	13.44
2-Methyl-1-butene	47	**29.21**	0.13	**20.65**
2-Methyl-2-butene	40	17.65	0.04	12.48
3-Methyl-1-butene	0	NA	NA	NA
Methylcyclohexane	67	10.71	0.04	7.58
Methylcyclopentane	68	5.47	0.04	3.87
2-Methylheptane	52	18.40	0.03	13.01
3-Methylheptane	51	14.35	0.02	10.14
2-Methylhexane	68	11.86	0.06	8.38
3-Methylhexane	63	12.42	0.05	8.78
3-Methylpentane	68	7.83	0.05	5.53
2-Methylpentane	68	9.52	0.20	6.73
4-Methyl-1-pentene	8	13.89	0.05	9.82
2-Methyl-1-pentene	10	**67.65**	0.08	**47.84**
n-Nonane	68	7.43	0.02	5.26
1-Nonene	17	15.37	0.02	10.87
n-Octane	65	8.23	0.02	5.82
1-Octene	21	**32.35**	0.04	**22.87**
n-Pentane	68	2.27	0.07	1.60
1-Pentene	64	11.26	0.04	7.96
cis-2-Pentene	32	17.39	0.08	12.30
trans-2-Pentene	47	11.29	0.02	7.98
a-Pinene	55	12.81	0.04	9.06
b-Pinene	5	**60.45**	0.05	**42.74**
Propane	68	0.64	0.07	0.45

Table 34-32. SNMOC Analytical Precision: 68 Replicate Analyses for NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbC)	Coefficient of Variation (%)
n-Propylbenzene	47	18.69	0.02	13.21
Propylene	68	3.45	0.03	2.44
Propyne	0	NA	NA	NA
Styrene	21	**36.10**	0.15	**25.53**
SNMOC	68	2.68	1.33	1.90
TNMOC (w/unknowns)	68	2.31	2.65	1.63
Toluene	68	5.14	0.14	3.63
n-Tridecane	14	13.25	0.03	9.37
1-Tridecene	8	8.84	0.05	6.25
1,2,3-Trimethylbenzene	40	11.69	0.02	8.27
1,2,4-Trimethylbenzene	68	9.67	0.03	6.84
1,3,5-Trimethylbenzene	45	20.79	0.03	14.70
2,2,3-Trimethylpentane	66	12.63	0.04	8.93
2,2,4-Trimethylpentane	35	11.87	0.02	8.40
2,3,4-Trimethylpentane	68	9.58	0.05	6.78
n-Undecane	68	6.20	0.06	4.38
1-Undecene	23	21.29	0.07	**15.06**
m-Xylene/*p*-Xylene	68	7.36	0.08	5.21
o-Xylene	68	9.61	0.03	6.79
Total & Averages	*1,757*	*14.67*	*0.16*	*10.37*

Table 34-33 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all NMP sites sampling SNMOC. The average CV ranged from 0 percent for *n*-butane for MOCO and isobutane for RUCO to 119.19 percent for styrene for UCSD. This large CV was due to only one measured detection for styrene being compared to 1/2 MDL. The overall program average CV was 8.71 percent.

Table 34-33. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average (%)	Silt, CO (BRCO)	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulfport, MS (GPMS)	Rifle, CO (MOCO)	Northbrook, IL (NBIL)
Acetylene	2.16	1.51	1.18	2.06	0.47	6.57	1.34
Benzene	4.21	10.25	3.72	2.64	1.27	4.15	4.55
1,3-Butadiene	8.95	3.65	6.05	9.29	NA	NA	**33.33**
n-Butane	1.25	4.75	0.64	0.74	0.45	0.00	1.48
cis-2-Butene	9.29	2.86	6.65	9.89	**19.77**	2.03	**19.76**
trans-2-Butene	6.39	9.30	4.14	8.51	5.43	1.34	**17.63**
Cyclohexane	4.90	4.97	2.08	5.95	7.15	1.20	8.15
Cyclopentane	8.73	2.83	5.03	**15.84**	7.10	1.20	**22.28**
Cyclopentene	8.61	2.69	12.69	7.24	9.45	1.25	8.19
n-Decane	5.43	5.19	5.19	5.15	2.58	9.44	6.28
1-Decene	NA	NA	NA	NA	NA	NA	NA
m-Diethylbenzene	13.27	5.71	12.41	12.59	8.94	NA	12.09
p-Diethylbenzene	**18.82**	14.82	11.93	NA	NA	NA	NA
2,2-Dimethylbutane	6.80	2.53	5.26	**15.76**	5.30	2.74	13.81
2,3-Dimethylbutane	5.25	2.92	2.20	7.61	1.31	1.03	6.11
2,3-Dimethylpentane	7.07	5.15	2.35	5.71	12.10	8.94	6.05
2,4-Dimethylpentane	8.28	6.24	3.40	12.81	**16.02**	**15.50**	7.29
n-Dodecane	8.71	6.03	6.98	8.22	1.46	12.49	11.89
1-Dodecene	**17.13**	10.96	10.71	10.21	NA	NA	6.67
Ethane	0.37	0.57	0.37	0.42	0.24	0.36	0.42
Ethylbenzene	6.76	7.69	5.77	6.92	3.03	7.64	8.89
2-Ethyl-1-butene	NA	NA	NA	NA	NA	NA	NA
Ethylene	1.85	3.39	1.05	1.82	0.74	1.87	2.23
m-Ethyltoluene	8.03	8.40	5.72	9.04	9.44	5.69	**15.26**
o-Ethyltoluene	11.87	7.67	6.38	**22.25**	**18.20**	NA	**15.34**
p-Ethyltoluene	10.08	5.23	6.70	12.70	9.69	**19.28**	8.84
n-Heptane	5.72	7.46	3.58	6.84	9.10	2.24	6.15
1-Heptene	6.87	5.40	10.55	11.54	14.80	2.67	6.48
n-Hexane	3.49	7.66	2.68	4.18	2.62	2.72	2.25
1-Hexene	**17.46**	10.44	7.95	**31.79**	8.22	**30.73**	**34.67**
cis-2-Hexene	**15.79**	9.35	2.05	NA	NA	NA	**38.35**
trans-2-Hexene	**38.60**	NA	**48.43**	NA	NA	NA	NA
Isobutane	1.97	6.98	0.66	1.21	1.17	0.36	2.26
Isobutene/1-Butene	3.94	8.70	2.99	2.57	1.06	5.51	4.50
Isopentane	2.66	2.58	1.71	2.07	1.39	1.13	3.22
Isoprene	11.62	**22.53**	4.30	7.67	NA	8.29	7.58
Isopropylbenzene	**20.12**	**24.72**	14.31	NA	NA	NA	12.57
2-Methyl-1-butene	*11.59*	NA	5.56	**19.07**	13.56	5.94	**35.74**
2-Methyl-2-butene	*10.80*	11.77	10.42	10.43	7.37	14.34	14.55
3-Methyl-1-butene	***26.74***	NA	NA	NA	NA	8.48	NA
Methylcyclohexane	*7.76*	5.04	3.80	9.44	**18.58**	2.61	11.36

Table 34-33. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	**Average (%)**	**Silt, CO (BRCO)**	**Bountiful, UT (BTUT)**	**Custer, SD (CUSD)**	**Gulfport, MS (GPMS)**	**Rifle, CO (MOCO)**	**Northbrook, IL (NBIL)**
Methylcyclopentane	4.90	5.58	3.19	5.44	8.82	1.59	4.56
2-Methylheptane	8.38	7.28	7.81	9.34	6.25	2.52	**18.21**
3-Methylheptane	11.39	7.13	6.31	8.27	**21.82**	4.05	13.98
2-Methylhexane	6.77	6.75	6.75	**19.41**	2.62	2.16	10.02
3-Methylhexane	7.35	6.76	3.41	**16.96**	8.47	1.70	14.16
3-Methylpentane	4.53	4.95	2.59	6.47	0.89	2.29	8.48
2-Methylpentane	4.19	5.26	2.58	3.42	1.91	0.37	10.88
4-Methyl-1-pentene	7.13	NA	13.71	7.66	NA	0.27	5.94
2-Methyl-1-pentene	**44.41**	NA	**47.84**	**55.38**	NA	NA	NA
n-Nonane	6.75	6.30	4.46	10.34	9.66	7.51	6.05
1-Nonene	8.57	3.41	**16.95**	12.86	NA	NA	4.79
n-Octane	6.50	7.00	3.87	12.75	4.26	1.71	7.77
1-Octene	**18.94**	**29.04**	**24.04**	NA	NA	NA	**21.70**
n-Pentane	1.48	1.76	0.91	1.47	1.70	0.47	2.30
1-Pentene	7.22	5.14	5.06	3.62	4.74	**18.63**	10.87
cis-2-Pentene	9.69	3.61	5.66	**16.40**	NA	11.14	**18.94**
trans-2-Pentene	8.11	11.17	5.62	8.40	8.77	6.85	10.34
a-Pinene	12.72	10.87	10.12	7.95	**38.13**	NA	8.00
b-Pinene	**20.23**	4.09	3.14	**17.64**	NA	NA	**82.35**
Propane	0.61	1.36	0.42	0.40	0.35	0.61	0.48
n-Propylbenzene	13.34	8.63	7.91	**20.07**	**31.05**	8.40	**18.51**
Propylene	2.46	1.77	1.76	1.78	2.85	4.31	3.12
Propyne	NA	NA	NA	NA	NA	NA	NA
Styrene	**36.17**	NA	**29.92**	**34.31**	**23.25**	NA	4.23
SNMOC	1.40	2.49	0.94	0.84	0.65	0.84	2.85
TNMOC (w/unknowns)	1.42	2.51	1.18	0.74	1.10	0.28	2.09
Toluene	4.28	8.07	3.67	2.73	2.74	1.78	3.59
n-Tridecane	**16.66**	7.28	13.48	**16.90**	NA	NA	5.26
1-Tridecene	14.65	11.40	6.25	NA	NA	NA	NA
1,2,3-Trimethylbenzene	**18.24**	5.76	7.15	**23.88**	**92.51**	NA	9.38
1,2,4-Trimethylbenzene	7.09	5.99	4.01	9.74	14.08	8.54	9.66
1,3,5-Trimethylbenzene	10.52	8.66	7.30	**25.94**	NA	NA	**22.10**
2,2,3-Trimethylpentane	7.55	6.51	8.73	4.98	3.79	NA	9.13
2,2,4-Trimethylpentane	12.83	8.28	8.22	**25.01**	1.36	NA	8.57
2,3,4-Trimethylpentane	7.50	1.39	2.72	6.56	4.50	**20.20**	10.83
n-Undecane	5.36	4.44	3.49	2.70	0.42	14.87	5.28
1-Undecene	**28.30**	1.01	10.26	NA	**52.46**	1.38	**19.85**
m-Xylene/*p*-Xylene	5.71	7.92	4.12	5.01	3.34	4.28	6.29
o-Xylene	6.85	7.34	4.34	8.11	9.38	7.43	9.25
Average	*8.71*	*6.83*	*7.20*	*10.34*	*9.66*	*5.65*	*11.49*

Table 34-33. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Parachute, CO (PACO)	Rifle, CO (RICO)	Rulison, CO (RUCO)	Sioux Falls, SD (SSSD)	Union County, SD (UCSD)
Acetylene	2.16	1.91	1.15	2.07	2.94	2.58
Benzene	4.21	2.44	5.47	5.74	3.18	2.89
1,3-Butadiene	8.95	2.53	4.57	NA	3.21	NA
n-Butane	1.25	0.26	2.24	0.24	1.15	1.86
cis-2-Butene	9.29	5.36	3.17	5.59	**15.20**	11.92
trans-2-Butene	6.39	4.62	1.86	3.13	7.04	7.24
Cyclohexane	4.90	0.61	3.08	1.31	7.23	12.19
Cyclopentane	8.73	2.59	6.94	0.98	11.29	**19.99**
Cyclopentene	8.61	5.59	6.83	NA	9.61	**22.53**
n-Decane	5.43	4.51	2.75	4.17	5.20	9.28
1-Decene	NA	NA	NA	NA	NA	NA
m-Diethylbenzene	13.27	14.99	4.23	**22.10**	13.55	**26.12**
p-Diethylbenzene	**18.82**	11.07	12.35	NA	**18.08**	**44.63**
2,2-Dimethylbutane	6.80	3.89	4.00	1.05	8.64	11.83
2,3-Dimethylbutane	5.25	1.53	5.62	0.49	8.35	**20.53**
2,3-Dimethylpentane	7.07	2.37	6.02	4.17	7.34	**17.54**
2,4-Dimethylpentane	8.28	3.78	2.72	3.04	8.91	11.40
n-Dodecane	8.71	5.49	5.63	7.94	14.28	**15.45**
1-Dodecene	**17.13**	**17.15**	5.99	**64.82**	**26.10**	1.59
Ethane	0.37	0.20	0.38	0.34	0.40	0.35
Ethylbenzene	6.76	5.03	3.92	7.89	8.84	8.72
2-Ethyl-1-butene	NA	NA	NA	NA	NA	NA
Ethylene	1.85	0.87	3.20	0.94	1.24	2.99
m-Ethyltoluene	8.03	4.48	3.45	5.59	9.60	11.61
o-Ethyltoluene	11.87	11.40	4.16	4.25	**18.65**	10.35
p-Ethyltoluene	10.08	3.77	6.19	5.09	6.87	**26.54**
n-Heptane	5.72	2.34	3.62	6.68	7.75	7.10
1-Heptene	6.87	3.15	4.37	2.26	10.54	3.80
n-Hexane	3.49	1.57	3.17	3.74	2.11	5.74
1-Hexene	**17.46**	9.92	**17.72**	8.74	**19.40**	12.45
cis-2-Hexene	**15.79**	**23.71**	6.70	NA	**18.86**	11.50
trans-2-Hexene	**38.60**	NA	12.15	NA	NA	**55.21**
Isobutane	1.97	0.31	2.66	0.00	2.53	3.50
Isobutene/1-Butene	3.94	5.02	2.08	0.78	4.92	5.25
Isopentane	2.66	10.89	1.96	0.33	2.18	1.77
Isoprene	11.62	3.00	5.78	**42.89**	7.81	6.30
Isopropylbenzene	**20.12**	**31.95**	14.98	**25.02**	**22.51**	14.92
2-Methyl-1-butene	11.59	5.00	10.23	NA	5.63	3.57
2-Methyl-2-butene	10.80	7.69	5.56	4.86	7.40	**24.41**
3-Methyl-1-butene	**26.74**	**53.00**	**18.72**	NA	NA	NA
Methylcyclohexane	7.76	1.51	3.25	2.47	11.51	**15.83**

Table 34-33. SNMOC Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Parachute, CO (PACO)	Rifle, CO (RICO)	Rulison, CO (RUCO)	Sioux Falls, SD (SSSD)	Union County, SD (UCSD)
Methylcyclopentane	4.90	1.45	3.01	2.20	6.11	11.95
2-Methylheptane	8.38	6.07	2.71	8.62	12.88	10.45
3-Methylheptane	11.39	3.66	3.19	7.41	10.44	**39.08**
2-Methylhexane	6.77	1.59	3.61	3.30	7.08	11.20
3-Methylhexane	7.35	2.66	4.41	NA	8.00	7.01
3-Methylpentane	4.53	1.04	4.18	1.51	4.16	13.23
2-Methylpentane	4.19	3.53	4.86	1.53	4.29	7.42
4-Methyl-1-pentene	7.13	5.92	6.84	NA	9.58	NA
2-Methyl-1-pentene	**44.41**	NA	12.69	**61.73**	NA	NA
n-Nonane	6.75	3.83	3.67	8.18	9.19	5.03
1-Nonene	8.57	7.59	5.28	1.77	**18.53**	6.00
n-Octane	6.50	2.52	2.54	7.63	9.31	12.12
1-Octene	**18.94**	**24.63**	**28.48**	9.42	10.96	3.25
n-Pentane	1.48	0.54	3.52	0.42	0.99	2.18
1-Pentene	7.22	8.14	4.55	4.38	8.22	6.10
cis-2-Pentene	9.69	7.75	6.85	6.02	8.42	12.12
trans-2-Pentene	8.11	9.72	3.54	2.23	7.16	**15.45**
a-Pinene	12.72	**19.83**	9.62	10.51	8.51	3.69
b-Pinene	**20.23**	11.10	NA	NA	**17.02**	6.29
Propane	0.61	0.33	0.56	0.10	0.98	1.06
n-Propylbenzene	13.34	13.58	3.53	4.11	13.29	**17.68**
Propylene	2.46	1.13	1.98	1.47	3.05	3.81
Propyne	NA	NA	NA	NA	NA	NA
Styrene	**36.17**	NA	**19.01**	NA	**23.25**	**119.19**
SNMOC	1.40	1.30	0.74	1.01	1.37	2.37
TNMOC (w/unknowns)	1.42	1.08	0.89	1.14	1.57	3.02
Toluene	4.28	3.14	3.56	7.00	3.12	7.67
n-Tridecane	**16.66**	9.02	9.75	**29.15**	**42.46**	NA
1-Tridecene	14.65	**20.97**	**19.97**	NA	NA	NA
1,2,3-Trimethylbenzene	**18.24**	5.19	4.49	5.94	12.42	**15.71**
1,2,4-Trimethylbenzene	7.09	2.44	3.76	4.33	5.64	9.80
1,3,5-Trimethylbenzene	10.52	11.16	5.60	1.92	9.36	2.64
2,2,3-Trimethylpentane	7.55	5.93	2.32	9.56	7.25	**17.26**
2,2,4-Trimethylpentane	12.83	10.43	**18.89**	6.12	**24.11**	**17.27**
2,3,4-Trimethylpentane	7.50	10.34	7.81	NA	3.35	7.33
n-Undecane	5.36	2.38	2.49	1.64	7.69	13.54
1-Undecene	**28.30**	4.91	NA	**19.66**	**54.53**	**90.61**
m-Xylene/*p*-Xylene	5.71	2.68	3.36	7.71	4.91	13.21
o-Xylene	6.85	3.26	3.98	6.89	6.14	9.27
Average	*8.71*	*6.84*	*5.93*	*7.71*	*9.94*	*14.02*

34.3.3 Carbonyl Compound Analytical Precision

Table 34-34 presents the analytical precision results from replicate analyses of duplicate and collocated carbonyl compound samples. The overall average variability was 2.65 percent, which is within the control limits of 15 percent CV. In terms of average concentration difference, the carbonyl compound precision ranged from <0.01 ppbv for several pollutants to 0.02 ppbv for formaldehyde.

Table 34-34. Carbonyl Compound Analytical Precision: 1,468 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	1,468	1.31	0.01	0.92
Acetone	1,468	1.23	0.01	0.87
Benzaldehyde	1,419	4.81	<0.01	3.40
Butyraldehyde	1,462	3.75	<0.01	2.65
Crotonaldehyde	1,434	3.42	<0.01	2.42
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	1,468	1.30	0.02	0.92
Hexaldehyde	1,420	4.96	<0.01	3.51
Isovaleraldehyde	255	5.63	<0.01	3.98
Propionaldehyde	1,468	3.34	<0.01	2.36
Tolualdehydes	1,415	6.49	<0.01	4.59
Valeraldehyde	1,394	5.01	<0.01	3.54
Total & Averages	*14,671*	*3.75*	*0.01*	*2.65*

Table 34-35 shows analytical precision results from replicate analyses of all collocated carbonyl compound samples collected at DEMI, IDIN, INDEM, ININ, LDTN, MSTN, NBIL, PXSS, SEWA, TOOK, TSOK, TUOK, and WPIN. The analytical precision results from collocated samples show variation for the pollutants ranging from 0.44 percent (acetone) to 3.74 percent (tolualdehydes). The overall average variability was 2.18 percent.

Table 34-35. Carbonyl Compound Analytical Precision: 758 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	758	0.83	0.01	0.59
Acetone	758	0.63	0.01	0.44
Benzaldehyde	730	4.26	<0.01	3.01
Butyraldehyde	756	3.30	<0.01	2.33
Crotonaldehyde	728	3.11	<0.01	2.20
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	758	0.72	0.02	0.51
Hexaldehyde	743	4.47	<0.01	3.16
Isovaleraldehyde	104	4.08	<0.01	2.88
Propionaldehyde	758	2.79	<0.01	1.97
Tolualdehydes	740	5.29	<0.01	3.74
Valeraldehyde	730	4.37	<0.01	3.09
Total & Averages	*7,563*	*3.08*	*<0.01*	*2.18*

Table 34-36 shows the analytical precision results from replicate analyses of all duplicate carbonyl compound samples. The analytical precision results from duplicate samples show variation ranging from 1.26 percent (acetaldehyde) to 5.44 percent (tolualdehydes). The overall average variability was 3.13 percent.

Table 34-36. Carbonyl Compound Analytical Precision: 710 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	710	1.78	0.01	1.26
Acetone	710	1.84	0.01	1.30
Benzaldehyde	689	5.35	<0.01	3.79
Butyraldehyde	706	4.19	<0.01	2.96
Crotonaldehyde	706	3.72	<0.01	2.63
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	710	1.88	0.03	1.33
Hexaldehyde	677	5.46	<0.01	3.86
Isovaleraldehyde	151	7.18	<0.01	5.08

Table 34-36. Carbonyl Compound Analytical Precision: 710 Replicate Analyses for all Duplicate Samples (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Propionaldehyde	710	3.90	<0.01	2.76
Tolualdehydes	675	7.69	<0.01	5.44
Valeraldehyde	664	5.65	<0.01	3.99
Total & Averages	*7,108*	*4.42*	*0.01*	*3.13*

Due to the focus on QA for the NATTS program, Table 34-37 presents the analytical precision results from carbonyl compound replicate analyses of duplicate and collocated samples at NATTS sites (BTUT, DEMI, GPCO, NBIL, PXSS, S4MO, SEWA, SKFL, and SYFL). Shaded rows present results for the NATTS MQO Core Analytes, as identified in Section 3.2. The analytical precision results from the NATTS replicate samples show low-level variability among the sites, ranging from 0.46 percent for acetone to 4.25 percent for tolualdehydes. The average CV was 2.28 percent.

Table 34-37. Carbonyl Compound Analytical Precision: 442 Replicate Analyses for Duplicate and Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ppbv)	Coefficient of Variation (%)
Acetaldehyde	442	0.74	0.01	0.53
Acetone	442	0.65	0.01	0.46
Benzaldehyde	440	4.17	<0.01	2.95
Butyraldehyde	440	2.79	<0.01	1.97
Crotonaldehyde	432	2.89	<0.01	2.04
2,5-Dimethylbenzaldehyde	0	NA	NA	NA
Formaldehyde	442	0.71	0.01	0.50
Hexaldehyde	436	4.08	<0.01	2.88
Isovaleraldehyde	78	5.97	<0.01	4.22
Propionaldehyde	442	2.92	<0.01	2.07
Tolualdehydes	431	6.01	<0.01	4.25
Valeraldehyde	434	4.58	<0.01	3.24
Total & Averages	*4,459*	*3.23*	*<0.01*	*2.28*

Table 34-38 presents the average CV per pollutant, per pollutant per site, per site, and the overall CV for all NMP sites sampling carbonyl compounds. The replicate results from duplicate and collocated samples show low- to high-level variability among the sites, ranging from an average CV of 0.13 percent for acetone for EQWA and GPMS to 124.78 percent for isovaleraldehyde for CHNJ. The high percent CV is due to only one isovaleraldehyde measured detection compared to 1/2 MDL. The average CV was 3.01 percent.

Table 34-38. Carbonyl Compound Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average (%)	St. Petersburg, FL (AZFL)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Seattle, WA (CEWA)	Chester, NJ (CHNJ)	Columbus, OH (COOH)	Custer, SD (CUSD)	Dearborn, MI (DEMI)	Elizabeth, NJ (ELNJ)	Tacoma, WA (EQWA)
Acetaldehyde	0.91	0.56	0.35	0.99	0.66	0.48	0.95	0.55	0.35	0.50	0.33
Acetone	0.86	0.67	0.23	1.12	0.44	0.40	0.79	0.30	0.54	0.34	0.13
Benzaldehyde	3.42	2.54	2.85	1.43	3.00	2.00	2.67	9.91	3.57	1.84	2.14
Butyraldehyde	2.72	2.44	1.57	1.92	2.20	2.10	2.81	4.07	1.86	1.99	1.12
Crotonaldehyde	2.73	1.81	1.94	1.76	3.15	2.42	1.72	3.07	1.13	1.64	2.44
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	0.92	0.88	0.45	1.20	0.54	0.46	0.63	0.58	0.41	0.53	0.37
Hexaldehyde	3.70	3.14	2.31	2.44	2.69	3.69	2.35	1.16	1.83	1.88	<0.01
Isovaleraldehyde	7.95	3.37	2.74	4.38	NA	**124.78**	5.15	4.01	3.88	4.82	NA
Propionaldehyde	2.55	2.61	1.57	2.44	1.97	2.00	1.79	1.90	1.78	1.46	1.29
Tolualdehydes	5.16	3.71	3.44	3.14	2.85	5.93	3.40	5.88	3.12	3.69	2.02
Valeraldehyde	3.83	2.49	3.28	3.69	2.67	2.14	4.99	1.86	3.43	2.99	1.64
Average	*3.01*	*2.20*	*1.88*	*2.23*	*2.02*	*13.31*	*2.48*	*3.03*	*1.99*	*1.97*	*1.28*

Table 34-38. Carbonyl Compound Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Indianapolis, IN (IDIN)	Gary, IN (INDEM)	Indianapolis, IN (ININ)	Loudon, TN (LDTN)	Memphis, TN (METN)	Loudon TN (MSTN)	Midwest City, OK (MWOK)
Acetaldehyde	0.91	0.50	0.34	0.42	0.76	0.58	0.73	0.40	**16.01**	0.53	0.40
Acetone	0.86	0.93	0.26	0.13	0.41	0.45	0.60	0.34	**16.00**	0.46	0.28
Benzaldehyde	3.42	3.19	1.46	1.91	2.91	2.85	2.47	3.13	**16.95**	3.30	0.82
Butyraldehyde	2.72	2.62	1.40	0.64	2.44	2.50	2.20	1.83	**16.91**	1.56	3.86
Crotonaldehyde	2.73	1.65	1.78	3.22	1.75	2.99	1.64	2.61	**16.28**	1.20	1.93
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	0.92	0.92	0.49	0.57	0.63	0.53	0.66	0.45	**16.11**	0.48	0.44
Hexaldehyde	3.70	10.45	2.92	4.58	11.26	2.73	3.01	1.86	**16.80**	2.90	2.27
Isovaleraldehyde	7.95	<0.01	3.79	1.91	NA	2.11	5.27	1.25	2.33	2.77	<0.01
Propionaldehyde	2.55	2.89	1.86	4.80	3.37	2.38	2.19	1.35	**16.57**	1.77	1.40
Tolualdehydes	5.16	5.03	9.70	**17.88**	4.25	4.41	4.35	4.01	**17.49**	4.10	2.02
Valeraldehyde	3.83	6.05	3.32	4.72	3.31	3.58	3.74	2.91	**16.50**	3.26	4.01
Average	*3.01*	*3.42*	*2.48*	*3.71*	*3.11*	*2.28*	*2.44*	*1.83*	***15.27***	*2.03*	*1.74*

Table 34-38. Carbonyl Compound Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Northbrook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Oklahoma City, OK (OCOK)	Winter Park, FL (ORFL)	Parachute, CO (PACO)	Pryor Creek, OK (PROK)	Phoenix, AZ (PXSS)	Rifle, CO (RICO)	St. Louis, MO (S4MO)	Seattle, WA (SEWA)
Acetaldehyde	0.91	0.58	0.25	0.33	0.38	0.14	0.39	0.61	0.87	0.38	0.97
Acetone	0.86	0.54	0.38	0.56	0.95	<0.01	0.32	0.23	0.92	0.38	0.57
Benzaldehyde	3.42	2.91	4.17	3.09	2.80	3.80	2.28	3.58	2.48	3.49	2.64
Butyraldehyde	2.72	1.94	2.42	4.34	2.71	6.02	2.66	2.29	1.70	2.20	2.22
Crotonaldehyde	2.73	4.10	2.20	1.30	0.86	3.23	1.79	2.17	2.37	1.59	2.80
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	0.92	0.65	0.55	0.43	0.33	0.19	0.35	0.40	0.90	0.37	0.72
Hexaldehyde	3.70	4.08	4.09	2.95	2.46	8.84	1.36	2.94	2.29	3.29	3.29
Isovaleraldehyde	7.95	NA	0.96	2.83	<0.01	NA	4.21	3.33	4.16	8.50	NA
Propionaldehyde	2.55	2.60	2.14	3.16	1.88	0.66	1.53	1.74	3.13	1.84	3.08
Tolualdehydes	5.16	3.85	5.57	2.66	4.34	12.38	3.17	3.31	3.54	4.94	3.58
Valeraldehyde	3.83	2.31	2.58	2.04	3.87	5.45	2.34	3.58	3.94	3.75	2.95
Average	*3.01*	*2.36*	*2.30*	*2.15*	*2.06*	*4.52*	*1.86*	*2.20*	*2.39*	*2.79*	*2.28*

Table 34-38. Carbonyl Compound Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site (Continued)

Pollutant	Average (%)	Pinellas Park, FL (SKFL)	Schiller Park, IL (SPIL)	Sioux Falls, SD (SSSD)	Plant City, FL (SYFL)	Tulsa, OK (TMOK)	Tulsa, OK (TOOK)	Tulsa, OK (TSOK)	Tulsa, OK (TUOK)	Tupelo, MS (TUMS)	Union County, SD (UCSD)	Indianapolis, IN (WPIN)
Acetaldehyde	0.91	0.55	0.24	0.36	0.72	0.60	0.78	0.30	0.75	0.55	0.24	0.36
Acetone	0.86	0.80	0.28	0.35	0.45	0.53	0.47	0.16	0.47	0.80	0.28	0.35
Benzaldehyde	3.42	2.84	3.11	3.79	1.75	3.43	7.09	3.74	3.64	2.84	3.11	3.79
Butyraldehyde	2.72	1.77	2.36	2.11	2.67	2.27	1.36	2.50	2.72	1.77	2.36	2.11
Crotonaldehyde	2.73	1.08	0.85	1.11	1.43	2.06	14.01	3.67	1.98	1.08	0.85	1.11
2,5-Dimethylbenzaldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	0.92	0.42	0.32	0.30	0.49	0.80	0.85	0.18	0.42	0.42	0.32	0.30
Hexaldehyde	3.70	2.17	3.31	2.63	3.99	2.87	3.07	2.07	4.08	2.17	3.31	2.63
Isovaleraldehyde	7.95	4.34	2.02	2.18	<0.01	3.32	NA	2.44	3.75	4.34	2.02	2.18
Propionaldehyde	2.55	1.78	0.68	1.25	1.75	1.34	9.80	1.37	1.72	1.78	0.68	1.25
Tolualdehydes	5.16	3.60	2.01	3.96	4.13	4.12	**17.51**	3.65	4.24	3.60	2.01	3.96
Valeraldehyde	3.83	4.38	3.33	2.76	3.68	2.53	14.87	1.45	3.16	4.38	3.33	2.76
Average	*3.01*	*2.16*	*1.68*	*1.89*	*2.11*	*2.17*	*6.98*	*1.96*	*2.45*	*2.16*	*1.68*	*1.89*

34.3.4 Metals Analytical Precision

The analytical precision results for all collocated metals samples are presented in Table 34-39. The average CV, as well as the average RPD, show low- to high-level variability among the sites. Average CVs ranged from 0.88 percent for arsenic to 30.57 percent for beryllium, with an overall average of 7.18 percent.

Table 34-39. Metals Analytical Precision: 954 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	954	2.22	0.01	1.57
Arsenic	950	1.25	<0.01	0.88
Beryllium	865	**43.24**	<0.01	**30.57**
Cadmium	950	7.70	<0.01	5.45
Chromium	950	1.77	0.03	1.25
Cobalt	950	10.52	<0.01	7.44
Lead	954	4.98	0.09	3.52
Manganese	954	1.51	0.14	1.06
Mercury	898	**29.36**	0.03	**20.76**
Nickel	952	6.88	0.01	4.86
Selenium	949	3.57	0.01	2.52
Total & Averages	*10,326*	*10.16*	*0.01*	*7.18*

Due to the focus on QA for the NATTS program, Table 34-40 presents the analytical precision results from collocated metals samples collected at the NATTS sites (BOMA, BTUT, NBIL, S4MO, and UNVT). Shaded rows present results for the NATTS MQO Core Analytes, as identified in Section 3.2. The variability ranged from 1.31 percent (antimony) to 34.15 percent (beryllium), with an overall CV of 7.93 percent.

Table 34-40. Metals Analytical Precision: 474 Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Antimony	474	1.85	0.01	1.31
Arsenic	468	2.87	0.01	2.03
Beryllium	403	**48.30**	<0.01	**34.15**

Table 34-40. Metals Analytical Precision: 474 Collocated Samples for the NATTS Sites (Continued)

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Cadmium	470	4.01	<0.01	2.83
Chromium	470	2.28	0.04	1.61
Cobalt	470	7.66	<0.01	5.42
Lead	474	3.46	0.11	2.44
Manganese	474	2.93	0.12	2.07
Mercury	421	**38.38**	0.06	**27.14**
Nickel	472	5.20	0.03	3.67
Selenium	469	6.39	0.02	4.52
Total & Averages	*5,065*	*11.21*	*0.05*	*7.93*

Table 34-41 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all NMP sites sampling metals. The results from collocated samples show low- to high-level variability among sites, ranging from an average CV of 0.45 percent for cadmium for S4MO to 67.22 percent for beryllium for BTUT, with an overall average of 6.63 percent.

Table 34-41. Metals Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	Average (%)	Boston, MA (BOMA)	Bountiful, UT (BTUT)	Pryor, OK (CNEP)	Northbrook, IL (NBIL)	St. Louis, MO (S4MO)	Tulsa, OK (TOOK)	Underhill, VT (UNVT)
Antimony	1.29	0.67	2.36	1.61	0.54	0.67	0.85	2.32
Arsenic	1.81	0.86	6.71	1.80	0.92	0.88	0.73	0.78
Beryllium	**25.68**	**29.60**	**67.22**	4.76	11.53	**15.26**	4.24	**47.14**
Cadmium	2.65	1.59	0.62	3.41	1.86	0.45	0.99	9.65
Chromium	1.44	0.89	2.56	0.86	0.90	2.08	1.33	NA
Cobalt	4.51	1.09	9.89	3.14	1.79	1.02	1.31	13.30
Lead	2.13	0.53	4.35	1.51	0.61	0.71	1.20	6.03
Manganese	2.02	0.96	6.75	2.40	0.65	1.10	1.37	0.90
Mercury	**25.99**	**30.32**	**49.74**	**30.90**	4.14	**24.35**	**16.49**	NA
Nickel	3.61	0.78	6.81	5.88	1.51	0.78	0.99	8.49
Selenium	3.81	3.06	13.28	2.59	1.67	1.95	1.46	2.65
Average	*6.63*	*6.40*	***15.48***	*5.35*	*2.37*	*4.48*	*2.81*	*10.14*

34.3.5 Hexavalent Chromium Analytical Precision

Table 34-42 presents the hexavalent chromium analytical precision results. Hexavalent chromium is a NATTS MQO Core Analyte and all the sites shown are NATTS sites. The range of variability for hexavalent chromium was 3.04 percent (SEWA) to 20.51 percent (HAKY), with the overall average CV of 10.69 percent.

Table 34-42. Hexavalent Chromium Analytical Precision: Replicate Analyses for Collocated Samples

Site	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
BOMA	30	15.69	0.01	11.09
BTUT	63	12.51	0.01	8.85
BXNY	46	8.85	<0.01	6.26
CHSC	24	19.80	<0.01	14.00
DEMI	44	7.11	<0.01	5.03
GLKY	8	8.80	<0.01	6.23
GPCO	26	11.84	<0.01	8.37
HAKY	7	**29.01**	<0.01	**20.51**
MVWI	16	**27.52**	0.01	**19.46**
NBIL	34	11.75	<0.01	8.31
PRRI	26	18.00	<0.01	12.73
PXSS	52	5.65	0.01	4.00
RIVA	11	21.30	<0.01	**15.06**
ROCH	19	18.26	0.01	12.91
S4MO	45	20.46	<0.01	14.47
SDGA	32	18.48	<0.01	13.07
SEWA	36	4.30	<0.01	3.04
SKFL	20	9.00	<0.01	6.36
SYFL	22	21.60	<0.01	**15.28**
UNVT	10	19.64	<0.01	13.89
WADC	20	7.77	<0.01	5.49
Total & Averages	*591*	*15.11*	*<0.01*	*10.69*

34.3.6 PAH Analytical Precision

The analytical precision results for the replicate analyses of the collocated PAH samples are shown in Table 34-43. The average concentration differences observed for PAH ranged from 0.01 ng/m^3 for several pollutants to 1.66 ng/m^3 for naphthalene. The average CV ranged from 1.63 percent for fluorene to 23.73 percent for anthracene, with an overall average of 8.37 percent.

Table 34-43. PAH Analytical Precision: 554 Collocated Samples

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	554	4.09	0.11	2.89
Acenaphthylene	279	23.20	0.12	**16.41**
Anthracene	227	**33.55**	0.40	**23.73**
Benzo(a)anthracene	429	14.32	0.01	10.12
Benzo(a)pyrene	252	10.91	0.01	7.72
Benzo(b)fluoranthene	524	5.65	0.01	3.99
Benzo(e)pyrene	425	10.12	0.01	7.15
Benzo(g,h,i)perylene	395	7.37	0.01	5.21
Benzo(k)fluoranthene	393	19.33	0.01	13.67
Chrysene	550	5.75	0.01	4.06
Coronene	224	13.34	0.01	9.43
Cyclopenta[cd]pyrene	60	**33.40**	0.02	**23.62**
Dibenz(a,h)anthracene	33	13.16	0.01	9.30
Fluoranthene	572	2.41	0.04	1.70
Fluorene	563	2.30	0.10	1.63
9-Fluorenone	512	6.09	0.04	4.30
Indeno(1,2,3-cd)pyrene	249	9.06	0.01	6.41
Naphthalene	572	2.65	1.66	1.88
Perylene	83	**30.77**	0.02	**21.76**
Phenanthrene	571	2.59	0.24	1.83
Pyrene	569	3.25	0.03	2.30
Retene	523	7.18	0.03	5.08
Total & Averages	*8,559*	*11.84*	*0.13*	*8.37*

Due to the focus on QA for the NATTS program, Table 34-44 presents the average analytical precision results from the NATTS sites (DEMI, PLOR, RUCA, SEWA, SDGA, and SYFL). Shaded rows present results for NATTS MQO Core Analytes, as identified in

Section 3.2. The average CV ranged from 1.47 percent for fluoranthrene to 27.90 percent for perylene, with an overall average of 8.22 percent.

Table 34-44. PAH Analytical Precision: 449 Collocated Samples for the NATTS Sites

Pollutant	Number of Observations	Average RPD (%)	Average Concentration Difference (ng/m^3)	Coefficient of Variation (%)
Acenaphthene	449	2.73	0.08	1.93
Acenaphthylene	199	18.24	0.06	12.90
Anthracene	156	**29.99**	0.20	**21.21**
Benzo(a) anthracene	328	11.13	0.01	7.87
Benzo(a)pyrene	184	14.73	0.01	10.41
Benzo(b)fluoranthene	416	5.22	0.01	3.69
Benzo(e)pyrene	324	11.39	0.01	8.05
Benzo(g,h,i)perylene	292	4.98	<0.01	3.52
Benzo(k)fluoranthene	306	14.96	0.01	10.58
Chrysene	441	4.96	0.01	3.51
Coronene	149	11.07	0.01	7.83
Cyclopenta[cd]pyrene	50	**28.99**	0.02	**20.50**
Dibenz(a,h)anthracene	25	19.02	0.01	13.45
Fluoranthene	458	2.07	0.04	1.47
Fluorene	453	2.53	0.10	1.79
9-Fluorenone	405	3.98	0.04	2.81
Indeno(1,2,3-cd)pyrene	172	10.75	0.01	7.60
Naphthalene	458	2.67	1.97	1.89
Perylene	68	**39.45**	0.02	**27.90**
Phenanthrene	455	3.00	0.17	2.12
Pyrene	455	3.11	0.03	2.20
Retene	411	10.73	0.02	7.59
Total & Averages	*6,654*	*11.62*	*0.13*	*8.22*

Table 34-45 presents the average CV per pollutant, per pollutant per site, per site, and the overall average CV for all sites sampling PAH. The results from replicate analysis of collocated samples show low- to high-level variability among sites, ranging from 0.15 percent for PLOR (9-fluorenone) to 81.79 percent for ANAK (anthracene). This high CV is based on just three measured detections. The overall average for all sites was 8.13 percent.

Table 34-45. PAH Analytical Precision: Coefficient of Variation for all Replicate Analyses by Site

Pollutant	**Average %**	**Anchorage, AK (ANAK)**	**Dearborn, MI (DEMI)**	**Tacoma, WA (EQWA)**	**Portland, OR (PLOR)**	**Rubidoux, CA (RUCA)**	**Decatur, GA (SDGA)**	**Seattle, WA (SEWA)**	**Plant City, FL (SYFL)**
Acenaphthene	3.85	**17.57**	1.11	1.66	0.69	2.42	2.60	2.13	2.65
Acenaphthylene	14.05	**17.34**	**21.37**	**17.69**	2.35	11.78	12.94	8.69	**20.29**
Anthracene	**29.71**	**81.79**	**17.63**	**28.68**	**28.98**	12.24	**21.89**	**17.10**	**29.38**
Benzo(a)anthracene	7.62	9.48	7.99	4.26	1.01	9.49	9.39	6.73	12.63
Benzo(a)pyrene	8.98	4.00	2.36	5.39	**15.04**	5.51	**19.75**	10.36	9.46
Benzo(b)fluoranthene	3.50	3.10	3.30	2.70	2.96	7.54	2.21	2.02	4.13
Benzo(e)pyrene	7.03	5.43	1.64	2.50	**15.28**	7.79	9.49	5.38	8.74
Benzo(g,h,i)perylene	3.48	2.18	2.44	4.57	2.31	2.08	3.77	2.12	8.42
Benzo(k)fluoranthene	10.85	12.45	6.61	10.85	9.92	13.01	7.88	9.80	**16.26**
Chrysene	4.16	10.69	1.11	1.51	1.85	2.25	9.35	1.73	4.76
Coronene	8.06	12.07	3.60	5.47	6.64	12.92	5.42	3.57	14.83
Cyclopenta[cd]pyrene	**18.06**	7.45	**29.07**	**16.47**	NA	3.57	7.76	**21.17**	**40.92**
Dibenz(a,h)anthracene	12.22	NA	10.90	8.56	NA	3.98	NA	NA	**25.47**
Fluoranthene	1.99	5.48	1.65	1.63	1.02	1.68	1.32	1.67	1.46
Fluorene	1.95	2.85	1.72	1.99	2.68	1.79	1.41	1.70	1.42
9-Fluorenone	4.20	**15.11**	1.40	1.61	0.15	1.86	7.01	1.86	4.61
Indeno(1,2,3-cd)pyrene	6.38	2.08	3.41	3.33	12.41	3.70	4.56	13.16	8.38
Naphthalene	1.86	1.59	1.09	1.96	2.51	2.41	1.70	1.69	1.91
Perylene	**24.96**	7.08	12.02	**28.14**	NA	14.27	**57.78**	**22.03**	**33.39**
Phenanthrene	2.61	7.39	7.78	0.80	0.79	0.96	1.04	1.00	1.13
Pyrene	2.28	3.32	1.82	1.72	0.55	5.30	1.69	1.89	1.94
Retene	6.41	1.90	6.81	3.86	1.48	12.55	13.58	8.18	2.93
Average	*8.13*	*10.97*	*6.67*	*7.06*	*5.72*	*6.32*	*9.64*	*6.86*	*11.60*

34.4 Accuracy

Laboratories typically evaluate their accuracy (or bias) by analyzing external audit samples and comparing the measured concentrations obtained to the known concentrations of those audit samples. Accuracy, or bias, indicates the extent to which experimental measurements represent their corresponding "true" or "actual" values.

Laboratories participating in the NATTS program are provided with proficiency test (PT) audit samples for VOC, carbonyl compounds, metals, and PAH which are used to quantitatively measure analytical accuracy. Tables 34-46 through 34-49 present ERG's results from the 2008 and 2009 NATTS PT audit samples for VOC, carbonyl compounds, metals, and PAH, respectively. Table 34-50 shows ERG's result for the 2009 PT audit sample received from EPA for hexavalent chromium. 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 values outside the program DQOs for metals, manganese is the only analyte to exceed the DQO over multiple audits. Shaded rows present results for NATTS MQO Core Analytes.

Table 34-46. VOC NATTS PT Audit Samples-Percent Difference from True Value

Pollutant	March, 2008	March, 2009	June, 2009
Acrolein	10	-11	-18.5
Benzene	-1.5	7.6	4.7
1,3-Butadiene	7.8	-11.4	10.4
Carbon Tetrachloride	16.5	0.0	3.7
Chloroform	4.3	6.4	4.5
1,2-Dibromoethane	4.4	-2.1	-0.9
1,2-Dichloroethane	6.3	2.0	3.4
Dichloromethane	11.1	7.9	3.4
1,2-Dichloropropane	3.0	0.0	-4.4
cis-1,3-Dichloropropene	6.6	3.3	0.0
trans-1,3-Dichloropropene	8.3	-3.1	-4.9
1,1,2,2-tetrachloroethane	-4.3	-8.2	-6.3
Tetrachloroethylene	0.0	2.2	0.0
Trichloroethylene	5.3	6.2	-0.8
Vinyl Chloride	-14.1	1.1	-1.2

Table 34-47. Carbonyl Compound NATTS PT Audit Samples-Percent Difference from True Value

Pollutant	January, 2009	May, 2009
Formaldehyde	-6.3	-9.3
Acetaldehyde	-2.4	-17.7

Table 34-48. Metals NATTS PT Audit Samples-Percent Difference from True Value

Pollutant	May, 2008	February, 2009
Antimony	-8.7	NA
Arsenic	8.4	-14.8
Beryllium	4.8	-5.5
Cadmium	5.1	-16.2
Lead	4.7	**-30.6**
Manganese	**-25.3**	**-37.7**
Nickel	8.6	**-28.9**

Table 34-49. PAH NATTS PT Audit Samples-Percent Difference from True Value

Pollutant	August, 2008	October, 2008	February, 2009
Acenaphthene	-1.0	-1.0	-10.9
Anthracene	10.7	-2.6	-0.8
Benzo(a)pyrene	17.2	7.0	-1.7
Fluoranthene	10.3	5.9	3.7
Fluorene	4.9	-5.2	-5.4
Naphthalene	-11.1	-13.2	-7.7
Phenanthrene	-1.3	-4.1	-2.7
Pyrene	8.1	-0.9	7.6

Table 34-50. Hexavalent Chromium PT Audit Samples-Percent Difference from True Value

Pollutant	July, 2009
Hexavalent Chromium	2.32

The accuracy of the 2008 and 2009 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 2008 and 2009 monitoring effort have been approved by EPA for accurately measuring ambient levels of various pollutants—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 are required to strictly adhere to quality control and quality assurance guidelines detailed in the respective monitoring methods. This strict adherence to the well-documented sampling and analytical methods suggests that the 2008 and 2009 monitoring data accurately represent ambient air quality.

35.0 Results, Conclusions, and Recommendations

The following discussion summarizes the results of the data analyses contained in this report and presents recommendations applicable to future air monitoring efforts. As demonstrated by the results of the data analyses discussed throughout this report, NMP monitoring data offer a wealth of information for assessing air quality by evaluating trends, patterns, correlations, and the potential for health risk and should ultimately assist a wide range of audiences understand the complex nature of air pollution.

35.1 Summary of Results

Analyses of the 2008 and 2009 monitoring data identified the following notable results, observations, trends, and patterns in the program-level and state- and site-specific air pollution data.

35.1.1 National-level Summary

- *Number of participating NATTS sites.* Twenty-six of the 73 sites are EPA-designated NATTS sites (BOMA, BTUT, BXNY, CAMS 35, CELA, CHSC, DEMI, GLKY, GPCO, HAKY, MVWI, NBIL, PLOR, PRRI, PXSS, ROCH, RIVA, RUCA, S4MO, SDGA, SEWA, SJJCA, SKFL, SYFL, UNVT, and WADC).

- *Total number of samples collected and analyzed.* Over 18,000 samples were collected yielding over 462,400 valid measurements of air toxics.

- *Detects.* The detection of a given pollutant is subject to the analytical methods used and the limitations of the instruments. Simply stated, a method detection limit is the lowest concentration of a substance that can be measured and reported with 99 percent confidence that the pollutant concentration is greater than zero. Every pollutant was detected at least once during the 2008 and 2009 monitoring efforts. Approximately 57 percent of the reported measurements were above the associated MDLs.

- *Program-level Pollutants of Interest.* The pollutants of interest at the program-level are based on the number of exceedances, or “failures,” of the preliminary risk screening values. In addition, 18 NATTS MQO Core Analytes (excluding acrolein) are classified as pollutants of interest. Only two NATTS MQO Core Analytes (beryllium and chloroform) did not fail any screens.

- *Risk Screening using ATSDR MRLs*. Fourteen preprocessed daily measurements (measured at INDEM, PROK, and UCSD), two quarterly averages (calculated for INDEM, 2008), and one annual average (calculated for INDEM, 2008) of formaldehyde were higher than the associated ATSDR acute, intermediate, and chronic MRLs, respectively. One preprocessed daily benzene measurement (measured at ELNJ) exceeded the ATSDR acute MRL.

- *Cancer Surrogate Risk Approximations.* The cancer surrogate risk approximation calculated for INDEM for formaldehyde's 2008 annual average (976.72 in-a-million) was the highest of all annual average-based cancer risk approximations. Five additional sites exhibited cancer risk approximations greater than 50 in-a-million (SPAZ 2009, PROK 2009, ININ 2008, UCSD 2009, and GPCO 2008). With the exception of acrylonitrile for SPAZ, the remaining cancer risk approximations were for formaldehyde.

- *Noncancer Surrogate Risk Approximations.* The noncancer surrogate risk approximation calculated for INDEM for formaldehyde's 2008 annual average (an HQ of 7.67) was the highest of all annual average-based noncancer risk approximations. No other site had noncancer risk approximations greater than 1.0.

- *Emissions and Toxicity Weighted Emissions.* Benzene tended to have the highest county-level emissions for most participating counties (of those with a cancer URE). Both benzene and formaldehyde tended to have the highest toxicity-weighted emissions. Toluene was often the highest emitted pollutant with a noncancer risk factor, although it rarely had top 10 toxicity-weighted emissions. Acrolein tended to have the highest toxicity-weighted emissions of pollutants with noncancer RfCs, although it was rarely emitted in high enough quantities to rank in the top 10 emissions for the participating counties.

35.1.2 State-level Summary

Alaska.

- The Alaska monitoring site is located in Anchorage, Alaska. ANAK is a UATMP site that sampled from October 2008 to October 2009.

- Back trajectories originated primarily from the northeast, east and southeast of ANAK. The air shed domain was among the smallest of all the NMP monitoring sites, with the longest trajectory originating about 450 miles from ANAK.

- The wind roses for ANAK show that calm winds are prevalent near ANAK; for winds speeds greater than 2 knots, northerly to northeasterly winds were most common.

- ANAK sampled for VOC and PAH.

- Thirteen pollutants failed screens for ANAK, including seven NATTS MQO Core Analytes.

- Of the pollutants of interest for ANAK, benzene had the highest daily averages for both 2008 and 2009.

- None of the measured detections or time-period average concentrations of the pollutants of interest were higher than their respective ATSDR MRL noncancer health risk benchmarks for ANAK.

- Benzene, 1,3-butadiene, and carbon tetrachloride had the highest cancer risk approximations for ANAK. None of the pollutants of interest for ANAK had a noncancer risk approximation greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in the Anchorage Borough, 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 for the Anchorage Borough.

Arizona.

- The Arizona monitoring sites are located in Phoenix. PXSS is a NATTS site; SPAZ is a UATMP site.

- Back trajectories originated from a variety of directions at PXSS and SPAZ, though many are from the southwest and west. Their air shed domains were somewhat smaller in size compared to other NMP monitoring sites, as nearly all trajectories originated within 250 miles of the sites.

- The wind roses show that calm, easterly, westerly and east-southeasterly winds were prevalent near PXSS and SPAZ for both 2008 and 2009.

- PXSS sampled for VOC, carbonyl compounds, PAH, metals (PM_{10}), and hexavalent chromium. SPAZ sampled for VOC only.

- Twenty-three pollutants, of which 13 are NATTS MQO Core Analytes, failed screens for PXSS. PXSS failed the highest number of screens among all NMP sites.

- Ten pollutants failed screens for SPAZ, of which four are NATTS MQO Core Analytes. Carbon tetrachloride and acrylonitrile failed 100 percent of screens for both sites.

- Of the pollutants of interest for PXSS, formaldehyde had the highest daily average concentration both years. PXSS had the highest daily average concentration of hexavalent chromium and beryllium (PM_{10}) among all NMP sites sampling these pollutants for 2008 and 2009.

- Of the pollutants of interest for SPAZ, acrylonitrile and benzene had the highest daily average concentrations for both years. SPAZ had the second (2009) and third (2008) highest daily average concentrations of acrylonitrile compared to all NMP sites that sampled this pollutant.

- None of the measured detections or time-period average concentrations of the pollutants of interest were higher than their respective ATSDR MRL noncancer health risk benchmarks for either of the two Arizona monitoring sites.

- Formaldehyde and benzene had the highest cancer risk approximations for PXSS both years. None of the pollutants of interest for PXSS had a noncancer risk approximation greater than 1.0.

- Not enough data were available to calculate annual averages for 2008 for SPAZ, therefore, cancer and noncancer surrogate risk approximations could not be calculated. For 2009, acrylonitrile and benzene had the highest cancer risk approximations, with the acrylonitrile cancer risk approximation being the second highest cancer risk approximation calculated among any of the NMP site-specific pollutants of interest. None of the pollutants of interest for SPAZ had noncancer risk approximations greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Maricopa County, while toluene was the highest emitted pollutant with a noncancer risk factor. Formaldehyde had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions for Maricopa County.

California.

- The three California monitoring sites are located in Los Angeles (CELA), Rubidoux (RUCA), and San Jose (SJJCA). All three are NATTS sites.

- Back trajectories for CELA and RUCA primarily originated from the northwest, with a secondary cluster originating from the northeast. Their air shed domains were somewhat smaller in size compared to other NMP monitoring sites as nearly all trajectories originated within 300 miles of the sites. The back trajectories for SJJCA primarily originated from the northwest and north. The air shed domain for SJJCA is larger than the other two California sites; nearly all trajectories originated within 400 miles of the site.

- CELA experienced primarily calm winds, although those greater than 2 knots were predominantly from the west. The wind roses show that westerly winds were prevalent near RUCA. SJJCA experienced predominantly northwesterly and north-northwesterly winds.

- CELA and RUCA sampled for PAH only. SJJCA sampled for PAH and metals (PM_{10}).

- Naphthalene and benzo(a)pyrene failed screens for CELA and RUCA, both of which are NATTS MQO Core Analytes. Five pollutants (arsenic, naphthalene, manganese, lead, and cadmium) failed screens for SJJCA, all of which are NATTS MQO Core Analytes.

- Naphthalene had the highest daily average concentration for each site. The daily average concentrations of naphthalene were similar for RUCA and SJJCA, while the daily average concentration of naphthalene for CELA was nearly double that of RUCA and SJJCA. All three sites exhibited similar average concentrations of benzo(a)pyrene.

- None of the measured detections or time-period average concentrations of the pollutants of interest were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Of the pollutants of interest for each site, naphthalene exhibited the highest cancer risk approximation for all three California sites in 2008 and 2009. The noncancer surrogate risk approximations were less than 1.0 for all three sites.

- Formaldehyde was the highest emitted pollutant with a cancer risk factor in Los Angeles, Riverside, and Santa Clara Counties; formaldehyde also had the highest cancer toxicity-weighted emissions for all three counties.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Los Angeles, Riverside, and Santa Clara Counties, while acrolein had the highest noncancer toxicity-weighted emissions for all three counties.

Colorado.

- The NATTS site in Colorado is located in Grand Junction (GPCO). There are also five CSATAM sites located north of Grand Junction in Garfield County. The sites are located in the towns of Silt (BRCO), Rifle (MOCO and RICO), Rulison (RUCO), and Parachute (PACO).

- Back trajectories originated from a variety of directions at GPCO, though almost all had a westerly component. The 24-hour air shed domain GPCO was somewhat smaller in size than other NMP monitoring sites, with most back trajectories originating less than 200 miles from the site. The Garfield County sites had air shed domains of similar size to GPCO, which is expected given the close proximity of these sites to GPCO.

- Both the 2008 and 2009 wind roses for GPCO show that easterly, east-southeasterly, and southeasterly winds were prevalent near the site. Westerly and southerly winds were prevalent for the Garfield County sites.

- GPCO sampled for VOC, carbonyl compounds, PAH, and hexavalent chromium. The Garfield County sites sampled for SNMOC and carbonyl compounds.

- Sixteen pollutants failed at least one screen for GPCO, of which nine are NATTS MQO Core Analytes. The number of pollutants that failed screens for the Garfield County sites ranged from five (MOCO and RUCO) to six (BRCO, PACO, and

RICO). For all six Colorado sites, benzene and formaldehyde failed 100 percent of all screens.

- Of the pollutants of interest for GPCO, formaldehyde had the highest daily average concentration, followed by acetaldehyde. Benzene had the highest daily average concentration for each of the Garfield County sites. Benzene concentrations measured at these sites account for five of the 10 highest daily average concentrations for sites that sampled benzene.

- Sampling has occurred at GPCO for at least five consecutive years; thus, a trends analysis was conducted for acetaldehyde, benzene, 1,3-butadiene, formaldehyde, and hexavalent chromium. Hexavalent chromium and 1,3-butadiene exhibited a slight decreasing trend; formaldehyde exhibited an increasing trend; benzene had a decreasing trend but increased for the final time frame; and acetaldehyde showed little change.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Colorado sites were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- For sites where annual averages of formaldehyde could be calculated (GPCO, BRCO 2008, and RICO), formaldehyde had the highest cancer risk approximations. The cancer risk approximations for benzene were greater than 10 in-a-million for all sites except MOCO. All noncancer risk approximations were less than 1.0 for all six Colorado sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in Mesa and Garfield Counties. Benzene also had the highest cancer toxicity-weighted emissions for Mesa County, while formaldehyde had the highest cancer toxicity-weighted emissions for Garfield County.

- While toluene was the highest emitted pollutant with a noncancer risk factor for both counties, acrolein had the highest noncancer toxicity-emissions.

District of Columbia

- The Washington, D.C. monitoring site is a NATTS site.

- Back trajectories originated from a variety of directions at WADC. The 24-hour air shed domain for WADC was similar in size to many other NMP sites, with the longest trajectories originating more than 700 miles from the site.

- The wind roses show that southerly and south-southwesterly winds were prevalent near WADC.

- WADC sampled for hexavalent chromium and PAH. The only pollutant to fail screens for WADC was naphthalene, with 83 out of 86 measured detections failing screens.

- The pollutant with the highest daily average concentrations for WADC was naphthalene (for both years).

- Hexavalent chromium sampling has occurred at WADC for at least five consecutive years; thus, a trends analysis was conducted. Hexavalent chromium exhibited a slight decreasing trend, though more years of sampling may be required to verify this trend.

- None of the measured detections or time-period average concentrations of the pollutants of interest for WADC were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Naphthalene had the highest cancer risk approximation for WADC, where cancer risk approximations could be calculated.

- 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. Formaldehyde had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions in the District.

Florida.

- Four of the Florida monitoring sites are located in the Tampa-St. Petersburg-Clearwater MSA (GAFL, SYFL, AZFL, and SKFL); two are located in the Orlando-Kissimmee MSA (ORFL and PAFL); and two are located in the Miami-Ft. Lauderdale-Pompano Beach MSA (CCFL and FLFL). Two monitoring sites in the Tampa/St. Petersburg area are NATTS sites (SKFL and SYFL).

- Back trajectories originated from a variety of directions at the Tampa/St. Petersburg and Orlando sites. Easterly and northeasterly back trajectories were prevalent for both CCFL and FLFL. Most back trajectories originated within 400 miles of the Tampa/St. Petersburg and Orlando sites, while most back trajectories originated within 500 miles of the CCFL and FLFL.

- Winds from a variety of directions were observed near the Tampa/St. Petersburg and Orlando sites. East-northeasterly to southeasterly winds were prevalent near the CCFL and FLFL sites.

- AZFL, GAFL, and ORFL sampled for carbonyl compounds only. SKFL and SYFL sampled for hexavalent chromium and PAH in addition to carbonyl compounds. PAFL sampled only PM_{10} metals and CCFL and FLFL sampled only VOC.

- Acetaldehyde and formaldehyde were the only pollutants to fail screens for AZFL, GAFL, and ORFL. These two pollutants and naphthalene also failed screens for SKFL and SYFL; hexavalent chromium and benzo(a)pyrene also failed screens for SKFL; and propionaldehyde also failed screens for SYFL. Thirteen VOC failed screens for CCFL and nine failed screens for FLFL, four of which are NATTS MQO Core Analytes for both sites. Four metals failed screens for PAFL, all of which are NATTS MQO Core Analytes.

- Formaldehyde and acetaldehyde had the highest daily average concentrations for the sites sampling carbonyl compounds. Benzene had the highest daily average concentration of the pollutants of interest for CCFL and FLFL. Lead had the highest 2008 and 2009 daily average concentration for PAFL.

- Carbonyl compound sampling has been conducted at AZFL, GAFL, ORFL, SKFL, and SYFL for at least five consecutive years; thus a trends analysis was conducted for acetaldehyde and formaldehyde. Rolling acetaldehyde concentration trends varied for each of the five Florida sites. Acetaldehyde concentrations at AZFL exhibited an increasing trend through 2003-2005, decreased through 2006-2008, then increased for 2007-2009. GAFL's rolling average acetaldehyde concentrations did not change significantly over the time period. Acetaldehyde concentrations at ORFL exhibited a slight decreasing trend after 2005-2007 time frame. The rolling average concentrations of acetaldehyde at SFKL began to increase after the 2006-2008 time frame. At SYFL, rolling acetaldehyde concentrations increased through the 2005-2007 time period, after which there has been little change.

- Formaldehyde concentrations have varied for each of the five Florida sites. For AZFL, formaldehyde concentrations have fluctuated over time. High measurements resulted in increases over the years of sampling for GAFL, although a decrease is noted for the most recent time frame. Concentrations of formaldehyde have increased at SYFL, while concentrations have decreased at ORFL and SKFL.

- Hevavalent chromium sampling has occured at SYFL since 2005; thus a trends analysis was conducted. Rolling average and median concentrations show a decreasing trend since the onset of hexavalent chromium sampling.

- None of the measured detections or time-period average concentrations of the pollutants of interest for any of the Florida monitoring sites were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- For sites sampling carbonyl compounds, formaldehyde had the highest cancer surrogate risk approximations. Arsenic had the highest cancer risk approximation for the site sampling metals (PAFL). All noncancer risk approximations for the Florida sites' pollutants of interest were less than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in all four Florida counties. Benzene also had the highest cancer toxicity-weighted emissions for all four counties.

- Toluene was the highest emitted pollutant with a noncancer risk factor in three of the four counties (hydrochloric acid was highest in Hillsborough County). Acrolein had the highest noncancer toxicity-weighted emissions for all four counties.

Georgia.

- The SDGA monitoring site located in Decatur, south of Atlanta, is a NATTS site.

- Back trajectories originated from a variety of directions at SDGA. The 24-hour air shed domain for SDGA was somewhat smaller in size compared to other NMP sites, with most trajectories originating within 300 miles of the site.

- The wind roses show that winds from the west to north-northwest were prevalent near SDGA. Easterly winds were also common.

- SDGA sampled for PAH and hexavalent chromium. Naphthalene and hexavalent chromium failed screens for SDGA, with naphthalene accounting for over 99 percent of the total failed screens and hexavalent chromium failing only one screen.

- Of the pollutants of interest for SDGA, naphthalene had the highest daily average concentrations for both years.

- Hexavalent chromium sampling has occurred at SDGA for at least five consecutive years; thus, a trends analysis was conducted. Hexavalent chromium exhibited a decreasing trend, though method completeness for 2008 was below 85 percent.

- None of the measured detections or time-period average concentrations of the pollutants of interest for SDGA were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Naphthalene was the only pollutant with a cancer risk approximation greater than 1.0 in-a-million. Naphthalene's noncancer risk approximation was less than 1.0. Annual averages could not be calculated for hexavalent chromium or benzo(a)pyrene; therefore, cancer and noncancer surrogate risk approximations could not be calculated.

- Benzene was the highest emitted pollutant with a cancer risk factor in DeKalb County, 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 DeKalb County.

Illinois.

- The Illinois monitoring sites are located near Chicago. NBIL is a NATTS site located in Northbrook and SPIL is a UATMP site located in Schiller Park.

- Back trajectories originated from a variety of directions at the sites, although back trajectories primarily originated from the south, southwest, west and northwest. The air shed domains were larger in size compared to other NMP sites, as the farthest away a back trajectory originated was over 850 miles from the sites.

- The wind roses show that winds from a variety of directions were observed near the monitoring sites, although southeasterly winds were rarely observed.

- Both Illinois sites sampled for VOC and carbonyl compounds. NBIL also sampled for SNMOC, PAH, hexavalent chromium and metals (PM_{10}).

- Nineteen pollutants failed screens for NBIL, of which 12 are NATTS MQO Core Analytes. Fifteen pollutants failed screens for SPIL, of which seven are NATTS MQO Core Analytes.

- Of the pollutants of interest for NBIL, acetaldehyde had the highest 2008 daily average concentration while formaldehyde had the highest daily average concentration for 2009. NBIL had the two highest concentrations of chloroform measured among all NMP sites sampling this pollutant. Of the pollutants of interest for SPIL, formaldehyde had the highest daily average concentration both years.

- VOC and carbonyl compounds sampling have been conducted at NBIL and SPIL for at least five years; thus, a trends analysis was conducted for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde for both sites. Both sites exhibited a decreasing trend in rolling average concentrations for acetaldehyde, benzene, and formaldehyde. For 1,3-butadiene, the rolling average concentrations exhibited a slight decreasing trend in the later years of sampling.

- PM_{10} metals and hexavalent chromium sampling have been conducted at NBIL for at least five consecutive years; thus, a trends analysis was conducted for arsenic, hexavalent chromium, and manganese. Rolling average concentrations exhibited little change over the period of sampling for arsenic. A decreasing trend is shown for hexavalent chromium. The rolling average concentrations of manganese decreased into the 2006-2008 time frame, then leveled out during the final time frame.

- None of the measured detections or time-period average concentrations of the pollutants of interest for NBIL and SPIL were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Formaldehyde had the highest cancer risk approximations for both sites for both years. In general, the cancer surrogate risk approximations for SPIL were higher than for NBIL.

- All noncancer risk approximations for the Illinois sites' pollutants of interest were less than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Cook County, while formaldehyde 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 for Cook County.

Indiana.

- Three Indiana monitoring sites are located in Indianapolis (IDIN, ININ, WPIN), and a fourth is located in Gary, near Chicago (INDEM). All four are UATMP sites.

- Back trajectories originated from a variety of directions at the Indiana sites, with the least predominant direction of trajectory origin from the southeast. The air shed domain for INDEM was the largest in size compared to the other Indiana monitoring sites, although the majority of trajectories originated within 450 miles of the sites.

- The wind roses show that southerly, southwesterly, and westerly winds were observed most frequently near the Indianapolis sites. Winds from the south, south-southwest, and west were observed most frequently near INDEM.

- ININ and IDIN sampled for carbonyl compounds and metals (PM_{10}); WPIN and INDEM sampled for carbonyl compounds only.

- Eight and seven pollutants failed screens for IDIN and ININ, respectively. Six of these pollutants for each site are NATTS MQO Core Analytes. Two pollutants, formaldehyde and acetaldehyde, failed screens for both INDEM and WPIN and propionaldehyde also failed screens for INDEM.

- Of the pollutants of interest, formaldehyde had the highest daily average concentrations for all four sites. The concentrations of formaldehyde for INDEM have historically been the highest among all NMP monitoring sites; however a sampler change in 2009 has resulted in a significant decrease in formaldehyde measurements.

- Carbonyl compound sampling has been conducted at INDEM for at least five consecutive years; thus, a trends analysis was conducted for acetaldehyde and formaldehyde. Statistical parameters show an increasing trend in acetaldehyde concentrations through the 2006-2008 time frame, followed by a significant decrease for the final time frame. Formaldehyde concentration trends show little change through the 2006-2008 time frame, followed by a decrease for the final time frame.

- Several measured detections and time-period averages of formaldehyde for 2008 for INDEM were higher than the ATSDR acute, intermediate, and chronic MRL noncancer health risk benchmarks. No measured detections or time-period averages of formaldehyde for 2009 were higher than any of the ATSDR MRLs. The annual average concentration of formaldehyde for 2008 for INDEM was the only annual average to exceed a chronic MRL noncancer health risk benchmark among all NMP sites.

- Formaldehyde had the highest cancer risk approximations for all four Indiana sites, followed by acetaldehyde and arsenic (for sites sampling PM_{10} metals). INDEM's cancer risk approximation for formaldehyde for 2008 was the highest among all cancer risk approximations program-wide. INDEM's 2008 formaldehyde noncancer risk approximation was the only noncancer HQ greater than 1.0 for any of the NMP sites.

- Benzene and formaldehyde were the highest emitted pollutants with cancer risk factors in Marion and Lake Counties, while coke oven emissions (PM) had the highest cancer toxicity-weighted emissions for both counties.

- Hydrochloric acid was the highest emitted pollutant with a noncancer risk factor in Lake County, while toluene was the highest emitted pollutant with a noncancer risk factor in Marion County. Acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Kentucky.

- The HAKY monitoring site is near Hazard, Kentucky. In June 2008, the HAKY NATTS site was moved to Grayson, Kentucky (GLKY). GLKY is also considered a NATTS site.

- Back trajectories originated from a variety of directions for both sites. The 24-hour air shed domain for HAKY was smaller in size than GLKY, although for both sites, the majority of trajectories originated with 400 miles of the sites.

- The wind roses show that calm winds were prevalent near both HAKY and GLKY, with winds from the south to southwest most frequently observed.

- Both sites sampled for hexavalent chromium and PAH. The only pollutant to fail screens for either Kentucky site was naphthalene.

- Of the pollutants of interest, naphthalene had the highest daily average concentration for both sites. Hexavalent chromium was detected infrequently enough that most quarterly averages and annual averages could not be calculated.

- None of the measured detections or time-period average concentrations of the pollutants of interest for HAKY or GLKY were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Annual averages could not be calculated for HAKY, and therefore, cancer and noncancer surrogate risk approximations could not be calculated. None of the pollutants of interest for GLKY had cancer or noncancer risk approximations greater than their respective levels of concern.

- Formaldehyde was the highest emitted pollutant with a cancer risk factor in Perry County and had the highest cancer toxicity-weighted emissions. Formaldehyde was also the highest emitted pollutant with a noncancer risk factor, while acrolein had the highest noncancer toxicity-weighted emissions for Perry County.

- Benzene was the highest emitted pollutant with a cancer risk factor in Carter County, while formaldehyde 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.

Massachusetts.

- The Massachusetts monitoring site (BOMA) is a NATTS site in Boston.

- Back trajectories originated from a variety of directions at BOMA. The 24-hour air shed domain for BOMA was similar in size to other NMP monitoring sites, with most trajectories originating within 400 miles of the monitoring site.

- The wind roses show that southwesterly, westerly, and west-northwesterly winds were prevalent near BOMA.

- BOMA sampled for metals (PM_{10}), PAH, and hexavalent chromium. Seven pollutants failed screens for BOMA, all of which are NATTS MQO Core Analytes.

- Of the pollutants of interest, naphthalene had the highest daily average concentration both years. BOMA had the third and fourth highest daily average concentrations of hexavalent chromium (2008 and 2009, respectively) among all NMP monitoring sites sampling this pollutant. BOMA also had some of the highest concentrations of lead, cadmium, and nickel among sites sampling PM_{10} metals.

- Metals sampling has been conducted at BOMA for at least five consecutive years; thus, a trends analysis was conducted for arsenic, hexavalent chromium, and manganese. Arsenic concentrations have changed little; manganese concentrations have decreased; and hexavalent chromium concentrations have decreased slightly over the periods of sampling at BOMA.

- None of the measured detections or time-period average concentrations of the pollutants of interest for BOMA were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- The only pollutants with cancer risk approximations greater than 1.0 in-a-million for both years were arsenic and naphthalene. None of the pollutants of interest for BOMA had noncancer risk approximations greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Suffolk County, while formaldehyde had the highest cancer toxicity-weighted emissions. Toluene was the highest emitted pollutant with a noncancer risk factor in Suffolk County, while acrolein had the highest noncancer toxicity-weighted emissions.

Michigan.

- DEMI is a NATTS site located in Dearborn, near Detroit. ITCMI is a UATMP site located in Sault St. Marie and is operated by the Intertribal Council of Michigan. ITCMI stopped sampling in February 2008.

- Back trajectories originated from a variety of directions at DEMI, although less frequently from the east. The 24-hour air shed domain for DEMI was larger in size than many other NMP monitoring sites, with the farthest trajectory originating nearly 800 miles away. Because so few trajectories were available for ITCMI, it is difficult to determine a trajectory pattern for this site.

- The wind roses for DEMI show that winds from a variety of directions were observed near the monitoring site, although winds from the southeast quadrant were observed the least. West-northwesterly and northwesterly winds were observed most frequently near ITCMI.

- DEMI sampled for VOC, PAH, carbonyl compounds, and hexavalent chromium, while ITCMI sampled for PAH only.

- Fifteen pollutants failed screens for DEMI, of which eight are NATTS MQO Core Analytes. Naphthalene was the only pollutant to fail screens for ITCMI.

- Formaldehyde and acetaldehyde had the highest daily average concentrations for DEMI both years. Compared to other NMP sites, DEMI had the first and third highest daily average concentrations of chloroform for 2008 and 2009, respectively. DEMI also had the fifth and sixth highest daily average concentrations of hexavalent chromium (2009 and 2008, respectively), and the seventh highest daily average concentration of naphthalene (2008).

- Three months of carbonyl compound data measured during 2008 were invalidated for DEMI because a leak was found in the sample line.

- Hexavalent chromium and VOC sampling has been conducted at DEMI for at least five consecutive years; thus, a trends analysis was conducted for benzene, 1,3-butadiene, and hexavalent chromium. A decreasing trend in concentrations is exhibited for benzene. A decrease in concentrations is also shown for 1,3-butadiene and hexavalent chromium, but neither decrease is statistically significant for these two pollutants.

- None of the measured detections or time-period average concentrations of the pollutants of interest for DEMI or ITCMI were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Benzene, naphthalene, and carbon tetrachloride had the highest cancer surrogate risk approximations for DEMI for 2008. Formaldehyde, benzene, and carbon tetrachloride had the highest cancer surrogate risk approximations for 2009. None of the pollutants of interest for DEMI had a noncancer risk approximation greater than 1.0. Surrogate risk approximations could not be calculated for carbonyl compounds for 2008 for DEMI because the completeness criteria were not met. Because ITCMI stopped sampling in February 2008, annual averages, and therefore cancer and noncancer surrogate risk approximations, could not be calculated.

- Benzene was the highest emitted pollutant with a cancer risk factor in Wayne and Chippewa Counties. Benzene also had the highest toxicity-weighted emissions in Chippewa County, while coke oven emissions had the highest cancer toxicity-weighted emissions for Wayne County.

- Toluene was the highest emitted pollutant with a noncancer risk factor in both counties, while acrolein had the highest noncancer toxicity-weighted emissions.

Mississippi.

- The two UATMP sites in Mississippi are located in Gulfport (GPMS) and Tupelo (TUMS). Both sites ended sampling in March 2008.

- Back trajectories originated from a variety of directions at the Mississippi sites. The 24-hour air shed domain for GPMS was smaller than the air shed domain for TUMS and most other NMP monitoring sites. Composite back trajectory maps included only three months of sample days.

- The wind roses for GPMS show that northerly winds and winds from the southeastern quadrant were the most common wind directions near this site. Northerly to north-northeasterly and south-southeasterly to southerly winds were most common near TUMS.

- GPMS and TUMS both sampled for VOC and carbonyl compounds. GPMS also sampled SNMOC.

- Eight pollutants failed screens for both sites. Of these eight pollutants, six are NATTS MQO Core Analytes.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for both sites. TUMS and GPMS had the third and fifth highest daily average concentrations of vinyl chloride among all sites monitoring this pollutant.

- None of the measured detections or first quarter 2008 average concentrations of the pollutants of interest for GPMS and TUMS were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Annual averages, and therefore cancer and noncancer surrogate risk approximations, could not be calculated because sampling was discontinued in March 2008.

- Benzene was the highest emitted pollutant with a cancer risk factor in Harrison County, while hexavalent chromium had the highest cancer toxicity-weighted emissions. Dichloromethane was the highest emitted pollutant with a cancer risk factor in Lee County, while formaldehyde had the highest cancer toxicity-weighted emissions.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Lee County, while total xylenes was the highest emitted pollutant with a noncancer risk factor in Harrison County. Acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Missouri.

- The NATTS site in Missouri is located in St. Louis.

- Back trajectories originated from a variety of directions at S4MO. The 24-hour air shed domain was similar in size to other monitoring sites, as most back trajectories originated within 400 miles of the site.

- The wind roses for S4MO show that southeasterly, south-southeasterly and southerly winds were observed most frequently near this site.

- S4MO sampled for VOC, PAH, carbonyl compounds, metals (PM_{10}), and hexavalent chromium.

- Twenty-three pollutants failed at least one screen for S4MO, of which 15 are NATTS MQO Core Analytes. Six pollutants (benzene, acetaldehyde, formaldehyde, acrylonitrile, 1,2-dichloroethane, and 1,2-dibromoethane) failed 100 percent of screens for S4MO. S4MO failed the second highest number of screens among all NMP sites.

- Of the pollutants of interest, formaldehyde and acetaldehyde had the highest daily average concentrations for S4MO both years. S4MO had the highest daily average concentration of arsenic (2009), cadmium, lead, manganese (2008), and *p*-dichlorobenzene (2008) among all NMP sites sampling those pollutants.

- Carbonyl compounds, VOC, metals, and hexavalent chromium sampling have been conducted at S4MO for at least five consecutive years; thus, a trends analysis was conducted for acetaldehyde, arsenic, benzene, 1,3-butadiene, formaldehyde, hexavalent chromium, and manganese. No significant change in concentrations is shown for acetaldehyde, arsenic, 1,3-butadiene, hexavalent chromium, and manganese while benzene and formaldehyde exhibit decreasing trends.

- None of the measured detections or time-period average concentrations of the pollutants of interest for S4MO were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Formaldehyde had the highest cancer risk approximation for S4MO for both years. None of the pollutants of interest for S4MO had a noncancer risk approximation greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in St. Louis (city), 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 (city).

New Jersey.

- The four UATMP sites in New Jersey are located in Camden (CANJ), Chester (CHNJ), Elizabeth (ELNJ), and New Brunswick (NBNJ). CANJ, the UATMP's longest running monitoring site, stopped sampling in October 2008.

- Due to the close proximity of the New Jersey sites, the composite back trajectories exhibit similar patterns across the four sites. The 24-hour air shed domains for the New Jersey sites were comparable in size to other NMP monitoring sites. Back trajectories originated from a variety of directions, though less frequently from the east, with average trajectory lengths less than 250 miles for each site.

- The wind roses for the New Jersey sites show that winds from a variety of directions were observed near CANJ and ELNJ, although few southeasterly wind observations were recorded near these sites. Calm winds were observed for more than 50 percent of observations near CHNJ and NBNJ.

- All four New Jersey sites sampled for VOC and carbonyl compounds.

- For CANJ and CHNJ, 15 pollutants failed at least one screen. Seventeen pollutants failed screens for ELNJ and 14 failed screens for NBNJ. Formaldehyde and benzene failed 100 percent of screens for all four sites.

- Of the pollutants of interest, formaldehyde had the highest daily average concentration for CANJ, CHNJ, and ELNJ in 2008 and all four sites in 2009. Acetaldehyde had the highest daily average concentration for NBNJ in 2008.

- Compared to other NMP sites, CANJ had the highest daily average concentration of tetrachloroethylene among sites sampling VOC.

- Carbonyl compound sampling has been conducted at each of the New Jersey sites for at least five consecutive years; thus, a trends analysis was conducted for acetaldehyde and formaldehyde. The rolling average concentrations of acetaldehyde showed a decreasing trend for all four sites, though averages for CANJ in the final time frames were slightly higher than previous years. Formaldehyde exhibited a similar trend.

- VOC sampling has been conducted at each of the New Jersey sites for at least five consecutive years; thus, a trends analysis was conducted for benzene and 1,3-butadiene. Benzene has shown a decreasing trend in recent years of sampling for all four sites. The rolling average concentrations of 1,3-butadiene have decreased overall for CANJ and ELNJ. CHNJ exhibited an increasing trend for 1,3-butadiene through the 2006-2008 time frame, after which a decreasing trend is noted. Rolling average concentrations for NBNJ have remained relatively constant over the sampling period for 1,3-butadiene.

- One preprocessed daily measurement of benzene for ELNJ was higher than the acute ATSDR MRL noncancer health risk benchmark. This is the only instance where a benzene measurement was higher than an ATSDR MRL noncancer health risk benchmark among all NMP monitoring sites sampling this pollutant.

- Cancer and noncancer risk approximations could not be calculated for CANJ because this site did not meet the method completeness criteria. Formaldehyde had the highest cancer risk approximations for CHNJ, ELNJ, and NBNJ for both years. None of the pollutants of interest for any of the New Jersey sites had noncancer risk approximations greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer URE in Union, Middlesex, Morris, and Camden Counties. Benzene also had the highest toxicity-weighted emissions for each county.

- Toluene was the highest emitted pollutant with a noncancer risk factor in all four counties, while acrolein had the highest noncancer toxicity-weighted emissions for each county.

New York.

- Two New York monitoring sites, located in Rochester (ROCH) and New York City (BXNY), are NATTS sites. The third New York monitoring site is located north of Buffalo in Tonawanda (TONY).

- Back trajectories originated from a variety of directions at each of the New York sites, though less frequently from the east. The 24-hour air shed domains for all three sites were comparable in size to other NMP monitoring sites, with the majority of back trajectories originating within 400 miles of the sites.

- Winds from a variety of directions were observed near BXNY, although northwesterly and southerly winds were observed the most. Winds from the south to southwest to west were observed more frequently than winds from other directions near ROCH and TONY.

- All three New York sites sampled PAH. BXNY and ROCH also sampled for hexavalent chromium.

- Three pollutants, all of which are NATTS MQO Core Analytes, failed screens for BXNY. Naphthalene and hexavalent chromium failed screens for ROCH. Four PAH, of which two are NATTS MQO Core Analytes, failed screens for TONY. Naphthalene failed the majority of screens for all three New York sites.

- Naphthalene had the highest daily average concentration of all the pollutants of interest for each of the New York sites. The daily average concentration of naphthalene for TONY was significantly higher than BXNY and ROCH, as well as all other NMP sites sampling PAH. TONY also had the highest daily average concentration of benzo(a)pyrene among sites sampling PAH.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the New York sites were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Naphthalene had the highest cancer risk approximation for all three sites (in 2009). None of the pollutants of interest had a noncancer risk approximation greater than 1.0.

- Tetrachloroethylene was the highest emitted pollutant with a cancer risk factor in Bronx County, while naphthalene had the highest cancer toxicity-weighted emissions for that county. Benzene was the highest emitted pollutant with a cancer risk factor and had the highest cancer toxicity-weighted emissions for both Monroe and Erie Counties.

- Toluene was the highest emitted pollutant with a noncancer risk factor in Bronx, Monroe, and Erie Counties, while acrolein had the highest noncancer toxicity-weighted emissions for all three counties.

Ohio.

- The Ohio monitoring site (COOH) located in Columbus is a UATMP monitoring site that collected samples between December 2007 and December 2008.

- Back trajectories originated from a variety of directions at COOH. The 24-hour air shed domain for COOH was comparable in size to other NMP sites, with majority of trajectories originating within 400 miles of the site.

- The wind roses show that southerly, westerly, and northerly winds were the most frequently observed wind directions near COOH.

- The Ohio site sampled for carbonyl compounds only.

- Acetaldehyde, formaldehyde, and propionaldehyde were the only pollutants to fail screens for COOH and are the only carbonyl compounds with risk screening values. Acetaldehyde and formaldehyde each failed 100 percent of screens, while propionaldehyde failed fewer than 5 percent.

- The daily average concentrations of acetaldehyde and formaldehyde are similar to each other. The daily average concentration of acetaldehyde was the 10th highest among NMP sites sampling carbonyl compounds.

- None of the measured detections or time-period average concentrations of the pollutants of interest for COOH were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Both formaldehyde and acetaldehyde had cancer risk approximations greater than 1.0 in-a-million, although the cancer risk approximation for formaldehyde was an order of magnitude higher than for acetaldehyde. Neither pollutant had a noncancer risk approximation greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Franklin County; benzene also had the highest toxicity-weighted emissions. Toluene was the highest emitted pollutant with a noncancer risk factor in Franklin County, while acrolein had the highest toxicity-weighted emissions.

Oklahoma.

- Three Oklahoma monitoring sites were initially located Tulsa (TOOK, TSOK, TUOK) and one was located outside Tulsa in Pryor Creek (CNEP). The instrumentation at TSOK was moved in October 2008 to Pryor Creek (PROK), north of the CNEP site. The instrumentation at TUOK moved to a new location in Tulsa at the end of March 2009 (TMOK). The MWOK site is located in Midwest City and OCOK is located in Oklahoma City. All eight are UATMP sites.

- The back trajectory maps for the Tulsa, Pryor Creek and Oklahoma City sites are similar in trajectory distribution, with a strong tendency for back trajectories to originate from the south-southeast to south-southwest and from the northwest to northeast of the sites.

- The wind roses show that southerly winds prevailed near each monitoring site.

- The four Tulsa sites, PROK, OCOK, and MWOK sampled for VOC, carbonyl compounds, and metals (TSP); CNEP sampled for VOC in the first quarter of 2008 and metals (TSP) in the first half of 2009.

- Six pollutants failed at least one screen for CNEP; 12 pollutants failed screens for MWOK; 13 pollutants failed screens for OCOK and TSOK; 14 pollutants failed screens for PROK; 17 pollutants failed at least one screen for TUOK and TMOK; and 20 pollutants failed screens for TOOK. Benzene failed 100 percent of screens for all eight monitoring sites and formaldehyde failed 100 percent of screens for all Oklahoma sites sampling carbonyl compounds.

- Of the pollutants of interest, formaldehyde and acetaldehyde generally had the highest daily average concentrations for each Oklahoma site. The exception is for CNEP, which did not sample carbonyl compounds; at CNEP, benzene had the highest daily average concentration.

- Formaldehyde was the only pollutant of interest with a preprocessed daily measurement that was higher than the acute ATSDR MRL noncancer health risk benchmark. Two of the measured detections for PROK in 2009 exceeded the ASTDR acute MRL for formaldehyde.

- Formaldehyde and benzene had the highest cancer risk approximations, where they could be calculated, for all of the Oklahoma monitoring sites. Arsenic had the highest cancer risk approximations among the metals. None of the pollutants of interest for the Oklahoma sites had a noncancer risk approximation greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Mayes, Oklahoma, and Tulsa Counties. Arsenic had the highest cancer toxicity-weighted emissions for Mayes County, benzene had the highest cancer toxicity-weighted emissions for Oklahoma County, and hexavalent chromium had the highest cancer toxicity-weighted emissions for Tulsa County.

- Toluene was the highest emitted pollutant with a noncancer risk factor in all three counties, while acrolein had the highest noncancer toxicity-weighted emissions.

Oregon.

- The Oregon monitoring site in Portland is a NATTS site. PAH samples from PLOR were analyzed by ERG from March to June 2008 only, after which the State of Oregon began analyzing their own samples.

- Back trajectories at PLOR originated primarily from the west and northwest. The 24-hour air shed domain is smaller in size than other NMP monitoring sites, with most trajectories originating within 250 miles of the site.

- The wind roses show that winds from the northwest quadrant were prevalent near PLOR, though winds from the east-southeast were also commonly observed.

- PLOR sampled for PAH only. Naphthalene failed 100 percent of screens in the 16 valid samples that were collected.

- Of the two pollutants of interest for PLOR, naphthalene had the highest daily average concentration.

- None of the measured detections or second quarter 2008 average concentrations of the pollutants of interest for PLOR were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Annual averages could not be calculated for PLOR; thus, cancer and noncancer surrogate risk approximations could not be calculated.

- Dichloromethane was the highest emitted pollutant with a cancer risk factor in Multnomah County, while POM Group 1 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 for Multnomah County.

Rhode Island.

- The Rhode Island monitoring site is located in Providence and is a NATTS site.

- Back trajectories originated from a variety of directions at PRRI. The 24-hour air shed domain for PRRI was similar in size to other NMP monitoring sites, with more than 85 percent of trajectories originating within 450 miles of the site.

- The wind roses show that winds from the north, south, or with a westerly component were prevalent near PRRI.

- PRRI sampled for PAH and hexavalent chromium.

- Naphthalene, benzo(a)pyrene, and hexavalent chromium failed screens for PRRI; 97 percent of failed screens are attributed to naphthalene.

- The daily average concentrations of naphthalene were significantly higher than that of the other two pollutants of interest for both years.

- Hexavalent chromium sampling has been conducted at PRRI for at least five consecutive years; thus, a trends analysis was conducted. Hexavalent chromium exhibited a slight decreasing trend, though confidence intervals indicate that the decrease is not statistically significant.

- None of the measured detections or time-period average concentrations of the pollutants of interest for PRRI were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- The cancer and noncancer risk approximations for hexavalent chromium were both low for 2008 and could not be calculated for 2009. Annual averages for the PAH could not be calculated in 2008. For 2009, naphthalene had a cancer risk approximation greater than 1.0 in-a-million for PRRI; the noncancer risk approximation for naphthalene was less than an HQ of 1.0. For 2009, benzo(a)pyrene had a cancer risk approximation well below 1.0 in-a-million; a noncancer risk factor is not available for this pollutant.

- Benzene was the highest emitted pollutant with a cancer risk factor in Providence County, 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 for Providence County.

South Carolina.

- The South Carolina monitoring site is located near Chesterfield and is a NATTS site.

- Back trajectories originated from a variety of directions at CHSC, though many originated from southwesterly and westerly directions. The 24-hour air shed domain for CHSC was similar in size to other NMP monitoring sites, with the average trajectory length just over 200 miles from the site.

- The wind roses show that calm winds, southwesterly winds, and northeasterly winds were prevalent near CHSC.

- CHSC sampled for hexavalent chromium and PAH.

- Naphthalene was the only pollutant to fail screens for CHSC (9 of 102 measured detections). CHSC had the third lowest number of failed screens among all NMP sites.

- The daily average concentrations of naphthalene were significantly higher than the daily average concentrations of the other two pollutants of interest. Compared to other program sites sampling PAH and hexavalent chromium, CHSC had some of the lowest daily average concentrations.

- Hexavalent chromium sampling has been conducted at CHSC for at least five consecutive years; thus, a trends analysis was conducted. Hexavalent chromium exhibited a decreasing trend over the period of sampling.

- None of the measured detections or time-period average concentrations of the pollutants of interest for CHSC were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Naphthalene was the only pollutant for which annual average concentrations could be calculated. Both the cancer and noncancer risk approximations were less than the levels of concern for CHSC.

- Formaldehyde was the highest emitted pollutant with a cancer risk factor in Chesterfield County, while toluene was the highest emitted pollutant with a noncancer risk factor. Formaldehyde had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

South Dakota.

- In 2008, the UATMP sites in South Dakota were located in Sioux Falls (SSSD) and Custer (CUSD). Sampling was completed at CUSD at the end of 2008 and the instrumentation at the site was moved to Union County (UCSD) for 2009.

- Back trajectories originated from a variety of directions at the South Dakota sites. The air shed domains for the South Dakota sites were some of the larger domains compared to other NMP monitoring sites.

- The wind roses for CUSD show that west-southwesterly to northwesterly winds accounted for more than 40 percent of the wind measurements near this site. Winds from a variety of directions were observed near SSSD, although southerly winds were the most common wind direction. Winds from the southeast and northwest quadrants were the most frequently observed wind directions near UCSD.

- All three South Dakota sites sampled for VOC, SNMOC, and carbonyl compounds.

- Twelve pollutants failed screens for CUSD and SSSD, of which six were NATTS MQO Core Analytes for each site. Thirteen pollutants failed screens for UCSD, of which seven are also NATTS MQO Core Analytes. Formaldehyde and acrylonitrile failed 100 percent of screens for each site.

- Formaldehyde had the highest daily average concentration for CUSD and SSSD in 2008 and UCSD in 2009. Acetaldehyde had the highest daily average concentration for SSSD in 2009. UCSD had the highest concentration of trichloroethylene and eighth highest ethylbenzene concentration among all NMP sites sampling VOC, as well as the fourth highest concentration of formaldehyde and seventh highest acetaldehyde concentration.

- Carbonyl compound and VOC sampling has been conducted at CUSD for seven consecutive years; thus, a trends analysis was conducted for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Decreasing trends in the rolling average concentrations of acetaldehyde, benzene, and formaldehyde were not statistically significant. The slight increasing trend for 1,3-butadiene was also not statistically significant.

- One formaldehyde measurement from UCSD was greater than the acute ATSDR MRL noncancer health risk benchmark for formaldehyde, while none of the quarterly or annual average concentrations for the pollutants of interest for the South Dakota sites were greater than their respective intermediate or chronic MRLs.

- Formaldehyde had the highest cancer risk approximations for all three sites. None of the pollutants of interest for any of the South Dakota sites had a noncancer risk approximation greater than 1.0.

- Formaldehyde was the highest emitted pollutant with a cancer risk factor in Custer County, while benzene was the highest emitted pollutant with a cancer risk factor in Minnehaha and Union Counties. Formaldehyde had the highest toxicity-weighted emissions for all three counties.

- Formaldehyde was also the highest emitted pollutant with a noncancer risk factor in Custer County, while toluene was the highest emitted pollutant with a noncancer risk factor in Minnehaha and Union Counties. Acrolein had the highest noncancer toxicity-weighted emissions for all three counties.

Tennessee.

- Two Tennessee monitoring sites (LDTN and MSTN) are UATMP sites located in Loudon, southwest of Knoxville. A third UATMP site (METN) is located in Memphis, Tennessee.

- Back trajectories originated from a variety of directions at all three Tennessee sites. The air shed domains for the Tennessee sites were similar in size compared to other NMP monitoring sites, with average trajectory lengths just over 200 miles.

- The wind roses show that calm winds account for one quarter of the observations near the Loudon monitoring sites, and that southwesterly to westerly winds were observed the most for winds greater than 2 knots. Southerly and south-southwesterly winds were the most prevalent wind directions near METN.

- All three Tennessee sites sampled for VOC and carbonyl compounds.

- Fifteen pollutants failed screens for LDTN, 13 failed screens for METN, and 11 failed screens for MSTN. Seven pollutants that failed screens for LDTN are NATTS MQO Core Analytes, while six pollutants that failed screens for METN and MSTN are NATTS MQO Core Analytes. Formaldehyde, benzene, acrylonitrile, and 1,2-dichloroethane failed 100 percent of screens for each of the Tennessee sites.

- Of the pollutants of interest for LDTN, carbon disulfide had the highest daily average concentration both years. Formaldehyde had the highest daily average concentration for both METN and MSTN for 2008 and 2009. Of the NMP sites sampling VOC, LDTN had the seventh and ninth highest daily average concentrations of chloroform. METN had the second highest daily average concentration of acetaldehyde among all NMP sites sampling carbonyl compounds.

- Carbonyl compound and VOC sampling has been conducted at LDTN for at least five consecutive years; thus, a trends analysis was conducted for acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Concentrations of benzene have a decreasing trend over the sampling periods; changes in concentrations of acetaldehyde, formaldehyde, and 1,3-butadiene were not statistically significant.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Tennessee sites were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Formaldehyde had the highest cancer risk approximations for all three sites. None of the pollutants of interest had a noncancer risk approximation greater than 1.0 for any of the Tennessee sites.

- Benzene was the highest emitted pollutant with a cancer risk factor in both Loudon and Shelby Counties. Benzene also had the highest cancer toxicity-weighted emissions for Shelby County, while arsenic had the highest cancer toxicity-weighted emissions for Loudon County.

- Carbon disulfide was the highest emitted pollutant with a noncancer risk factor in Loudon County, while toluene was the highest emitted pollutant with a noncancer risk factory in Shelby County. Acrolein had the highest noncancer toxicity-weighted emissions for both Loudon and Shelby Counties.

Texas.

- The Texas monitoring site is located in Deer Park (CAMS 35) and is a NATTS site.
- Back trajectories originated from a variety of directions at the Texas monitoring site, although most trajectories originated to the southeast over the Gulf of Mexico.
- The wind roses show that winds from the southeasterly quadrant (including easterly and southerly winds) were the most commonly observed wind directions near CAMS 35.
- The CAMS 35 site sampled for PAH only.
- Naphthalene and benzo(a)pyrene failed screens for CAMS 35, both of which are NATTS MQO Core Analytes, although naphthalene failed the bulk of the screens.
- Of the pollutants of interest, naphthalene had the highest daily average concentrations for both years and tended to be higher during the second half of the year.
- None of the measured detections or time-period average concentrations of the pollutants of interest for the Texas site were higher than their respective ATSDR MRL noncancer health risk benchmarks.
- Naphthalene had the highest cancer risk approximations among the pollutants of interest for CAMS 35. None of naphthalene's noncancer risk approximations were higher than 1.0.
- Benzene was the highest emitted pollutant with a cancer risk factor in Harris County, while methyl *tert*-butyl ether was the highest emitted pollutant with a noncancer risk factor. 1,3-Butadiene had the highest cancer toxicity-weighted emissions for Harris County, while acrolein had the highest noncancer toxicity-weighted emissions.

Utah.

- The NATTS site in Utah is located in Bountiful, north of Salt Lake City.
- The majority of back trajectories originated within 150 mile of BTUT. The 24-hour air shed domain for BTUT was smaller in size compared to other NMP monitoring sites.
- The wind roses show that southeasterly, south-southeasterly, and southerly winds were prevalent near BTUT.
- BTUT sampled for VOC, carbonyl compounds, SNMOC, PAH, metals (PM_{10}), and hexavalent chromium.

- Twenty-two pollutants failed screens for BTUT, of which 13 are NATTS MQO Core Analytes. Acetaldehyde, benzene, carbon tetrachloride, and formaldehyde failed 100 percent of screens for BTUT. BTUT failed the third highest number of screens among all NMP sites.

- Of the pollutants of interest, dichloromethane had the highest daily average concentration for BTUT, followed by formaldehyde, acetaldehyde and benzene for both years. BTUT had the fourth highest daily average concentration of acrylonitrile (2008) and the third (2008) and sixth (2009) highest daily average concentrations of *p*-dichlorobenzene among all NMP sites sampling VOC. BTUT also had the highest daily average concentration of nickel (2008), the second highest daily average concentration of arsenic (2009), and the third and fourth highest daily average concentrations of beryllium (2008 and 2009, respectively) among all NMP sites sampling metals (PM_{10}).

- Carbonyl compounds, VOC, SNMOC, metals (PM_{10}), and hexavalent chromium sampling have been conducted at BTUT for at least five consecutive years; thus, a trends analysis was conducted for acetaldehyde, arsenic, benzene, 1,3-butadiene, formaldehyde, hexavalent chromium, and manganese. Concentrations of acetaldehyde, arsenic, benzene, and formaldehyde have decreased since the onset of sampling while concentrations of 1,3-butadiene, manganese, and hexavalent chromium have not changed over the period of sampling.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Utah site were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- The pollutant with the highest cancer surrogate risk approximations for BTUT was formaldehyde for both years. None of the pollutants of interest had a noncancer risk approximation greater than 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Davis County and 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 for Davis County.

Vermont.

- Two Vermont monitoring sites are located in or near Burlington (UNVT and BURVT); a third monitoring site is located in Rutland (RUVT). However, at the request of the Vermont Air Pollution Control Division, the results of the data analyses for BURVT and RUVT have been removed from the Vermont state section. The data analyses for the Underhill NATTS site (UNVT) have been retained and are summarized below.

- Back trajectories originated from a variety of directions at the Vermont NATTS site. The 24-hour air shed domain for the Vermont NATTS site was smaller in size than many other NMP monitoring sites, with the average trajectory length approximately 215 miles in length.

- The wind roses for the Vermont NATTS site show that calm winds were prevalent near UNVT.

- UNVT sampled for VOC, carbonyl compounds, hexavalent chromium, PAH, and metals (PM_{10}).

- Ten pollutants failed screens for UNVT, of which eight are NATTS MQO Core Analytes. Formaldehyde, carbon tetrachloride, 1,2-dichloroethane, and acrylonitrile failed 100 percent of screens for UNVT.

- The state of Vermont blank-corrected their metals data for UNVT.

- Formaldehyde had the highest daily average concentration for UNVT. Measured concentrations of the PM_{10} metals pollutants of interest for UNVT were among the lowest compared to NMP sites sampling these pollutants.

- UNVT has sampled hexavalent chromium for at least five consecutive years; thus, a trends analysis was conducted for hexavalent chromium. A decreasing trend is shown for hexavalent chromium over the period of sampling. At least 50 percent of the measurements were non-detects for each 3-year period.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Vermont NATTS site were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- For 2008, arsenic had the highest cancer risk approximation for UNVT. For 2009, carbon tetrachloride had the highest cancer risk approximation for UNVT, but recall that VOC and carbonyl compounds sampling (with analysis performed by ERG) began at UNVT in 2009. None of the noncancer risk approximations, where they could be calculated, were greater than an HQ of 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Chittenden County and also had the highest cancer toxicity-weighted emissions. Toluene was the highest emitted pollutant with a noncancer risk factor in Chittenden County, while acrolein had the highest noncancer toxicity-weighted emissions.

Virginia.

- The NATTS site in Virginia is located near Richmond and began sampling in October 2008.

- Back trajectories originated primarily from the southwest, west, and northwest at RIVA. The 24-hour air shed domain is similar in size to other NMP sites, with an average trajectory length of 225 miles.

- The historical wind rose shows that northerly to north-northeasterly winds and southerly to southwesterly winds were the most commonly observed wind directions near RIVA. The 2008 and 2009 wind roses exhibit a lower percentage of northerly and southerly winds.

- RIVA sampled for PAH and hexavalent chromium.

- Naphthalene, which is a NATTS MQO Core Analyte, was the only pollutant to fail screens for RIVA. This pollutant failed 100 percent of its screens.

- Of the pollutants of interest, naphthalene had the highest daily average concentrations. RIVA's 2008 daily average naphthalene concentration was the fifth highest daily average of naphthalene among all sites sampling PAH, while the 2009 daily average concentration of naphthalene was ranked much lower.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Virginia site were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- Because sampling did not begin at RIVA until October 2008, annual averages, and thus cancer and noncancer risk approximations, could not be calculated for that year. For 2009, surrogate risk approximations could only be calculated for naphthalene. The cancer risk approximation was 3.86 in-a-million, while the noncancer risk approximation was well below an HQ of 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Henrico County, while arsenic had the highest cancer toxicity-weighted emissions. Toluene was the highest emitted pollutant with a noncancer risk factor in Henrico County, while acrolein had the highest noncancer toxicity-weighted emissions.

Washington.

- The NATTS site in Washington is located in Seattle (SEWA). The four CSATAM sites in Washington are located in Seattle (CEWA) and Tacoma (EQWA, ESWA, and EYWA) and began sampling in November 2008 and ended sampling in October 2009.

- Back trajectories for the Washington sites originated from a variety of directions. The 24-hour air shed domains for the Washington sites were smaller than most other NMP monitoring sites, with average trajectories between 175 and 185 miles in length.

- The wind roses show that southeasterly to southerly winds were prevalent near the Seattle sites. Winds from the south were prevalent near the Tacoma sites as well, but south-southwesterly, northerly, and north-northeasterly winds were also commonly observed.

- EYWA sampled for carbonyl compounds and VOC; CEWA, EQWA, and ESWA sampled for PAH, carbonyl compounds, and VOC; SEWA sampled for PAH, carbonyl compounds, VOC, PM_{10} metals, and hexavalent chromium.

- The Puget Sound Clean Air Authority discovered a leak in the instrument probe and invalidated all carbonyl compound samples for EYWA. In addition, selected individual pollutant results from VOC samples were also invalidated or flagged, at the agency's discretion. As a result, all carbonyl compounds and some VOC are excluded from the analyses contained in this report.

- Nineteen pollutants failed screens for SEWA, of which 13 are NATTS MQO Core Analytes. Fifteen pollutants failed at least one screen for CEWA and EQWA; 14 pollutants failed screens for ESWA; and nine pollutants failed screens for EYWA. Carbon tetrachloride failed 100 percent of screens for each Washington monitoring site.

- Of the pollutants of interest for SEWA, carbon tetrachloride had the highest daily average concentration for 2008, while formaldehyde was highest for 2009.

- Formaldehyde had the highest study average concentrations for CEWA, EQWA, and ESWA; benzene had the highest study average concentration for EYWA.

- The Washington sites account for six of the 10 highest daily average concentrations of carbon tetrachloride. SEWA had the second (2009) and third (2008) highest daily average concentrations of nickel; the fourth (2008) and seventh (2009) highest daily average concentrations of manganese; and the seventh (2008) and eighth (2009) highest daily average concentrations of hexavalent chromium. The ESWA site had the second (2008) and fifth (2009) highest daily average concentrations of benzo(a)pyrene and sixth (2008) highest daily average concentration of naphthalene.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Washington sites were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- For the sites sampling carbonyl compounds, formaldehyde had the highest cancer surrogate risk approximations. Benzene had the highest cancer risk approximation for

EYWA. All of the noncancer risk approximations for the pollutants of interest for the Washington sites were less than an HQ of 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in King and Pierce Counties, while toluene was the highest emitted pollutant with a noncancer risk factor for both counties. Benzene had the highest cancer toxicity-weighted emissions for King County, while formaldehyde had the highest cancer toxicity-weighted emissions for Pierce County. Acrolein had the highest noncancer toxicity-weighted emissions for both counties.

Wisconsin.

- The Wisconsin monitoring site is located in Mayville and is a NATTS site.

- Back trajectories originated from a variety of directions at MVWI, although less frequently from the east. The 24-hour air shed domain for MVWI was larger in size compared to other NMP monitoring sites, with an average trajectory length just less than 300 miles.

- The wind roses show that calm winds accounted for approximately one quarter of the wind observations near MVWI. For winds greater than 2 knots, westerly and west-northwesterly winds were observed most frequently.

- MVWI sampled for PAH and hexavalent chromium.

- Naphthalene and hexavalent chromium failed screens for MVWI, though all but one of those failures were for naphthalene.

- The daily average concentrations of naphthalene were significantly higher than the other pollutants of interest.

- Hexavalent chromium has been sampled at MVWI for at least five consecutive years; thus, a trends analysis was conducted for hexavalent chromium. Although rolling average concentrations show a slight decreasing trend, this trend is not statistically significant.

- None of the measured detections or time-period average concentrations of the pollutants of interest for the Wisconsin site were higher than their respective ATSDR MRL noncancer health risk benchmarks.

- The cancer surrogate risk approximations for naphthalene and hexavalent chromium were both less than 1.0 in-a-million for 2008. For 2009, the cancer risk approximation for naphthalene was just over 1.0 in-a-million, while cancer risk approximations could not be calculated for hexavalent chromium or benzo(a)pyrene. All of the noncancer surrogate risk approximations for the pollutants of interest, where they could be calculated, were less than an HQ of 1.0.

- Benzene was the highest emitted pollutant with a cancer risk factor in Dodge County, while toluene was the highest emitted pollutant with a noncancer risk factor. Formaldehyde had the highest cancer toxicity-weighted emissions, while acrolein had the highest noncancer toxicity-weighted emissions.

35.1.3 Composite Site-level Summary

- Twenty-four pollutants were identified as site-specific pollutants of interest, based on the risk screening process. Acetaldehyde and formaldehyde were the two most common pollutants of interest among the monitoring sites. All sites (46) that sampled carbonyl compounds had acetaldehyde and formaldehyde as pollutants of interest (note that EYWA is excluded here). Benzene, 1,3-butadiene, and carbon tetrachloride were the most common VOC pollutants of interest. Every site that sampled benzene (44) had this as a pollutant of interest. Every site that sampled PAH (32) had naphthalene as a pollutant of interest.

- Among the site-specific pollutants of interest, formaldehyde frequently had the highest daily average concentration among the monitoring sites; formaldehyde had the highest daily average concentration for 58 site and sample year combinations. Naphthalene had the next highest at 34 site and sample year combinations.

- The toxicity factor for formaldehyde used in the preliminary risk screening process, the cancer risk approximation calculations, and the toxicity-weighting of emissions decreased substantially since the 2007 report. This translated to a much higher toxicity potential for formaldehyde, leading to more failed screens, higher cancer risk approximations, and relatively higher toxicity-weighted emissions values for the 2008-2009 report than in previous reports.

- Carbon tetrachloride often had relatively high cancer risk approximations based on annual or study averages among the monitoring sites, but tended to have relatively low emissions and toxicity-weighted emissions according to the NEI. 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 30 years due to its role as an ozone depleting substance, it has a relatively long atmospheric lifetime.

- Acrolein emissions were relatively low when compared to other pollutants. However, due to the high toxicity of this pollutant, even low emissions translated into high noncancer toxicity-weighted emissions; the toxicity-weighted value was often several orders of magnitude higher than other pollutants. Acrolein is a national noncancer risk driver according to NATA.

35.1.4 Data Quality Summary

Method precision and analytical precision was determined for the 2008-2009 NMP monitoring efforts using RPD, CV, and average concentration difference calculations based on duplicate, collocated, and replicate samples. The overall method precision for some methods was well within data quality objective specifications and monitoring method guidelines (TO-11A and IO-3.5), while other methods exceeded the data quality objective specifications (TO-15/SNMOC, TO-13A, and hexavalent chromium). Sampling and analytical method accuracy is ensured by using proven methods, as demonstrated by third-party analysis of proficiency test audit samples, and following strict quality control and quality assurance guidelines.

Ambient air concentration data sets generally met data quality objectives for completeness. Completeness, or the number of valid samples collected compared to the number expected from a 1-in-6 or 1-in-12 day sampling schedule, measures the reliability of the sampling and analytical equipment as well as the efficiency of the program. Typically, a completeness of 85-100 percent is desired for a complete data set. Only 10 out of 291 data sets failed to comply with the data quality objective of 85 percent completeness. One hundred seventeen data sets achieved 100 percent completeness.

35.2 Conclusions

Conclusions resulting from the data analyses of the data generated from the 2008-2009 NMP monitoring efforts are presented below.

- There are a large number of concentrations that are greater than their respective preliminary risk screening values, particularly for many of the NATTS MQO Core Analytes. However, there are few instances where the preprocessed daily measurements or time-period average concentrations were greater than the ATSDR MRL noncancer health risk benchmarks.

- Where annual averages could be calculated and for those pollutants with available cancer UREs, three of the cancer surrogate risk approximations were greater than 100-in-a-million (two for formaldehyde and one for acrylonitrile); 83 were greater than 10-in-a-million (59 for formaldehyde, 22 for benzene, and one each for acrylonitrile and naphthalene); and, over half were greater than 1.0 in-a-million.

- Where annual averages could be calculated and for those pollutants with available noncancer RfCs, only one of the noncancer surrogate risk approximations was greater than an HQ of 1.0. This noncancer surrogate risk approximation was based on INDEM's 2008 formaldehyde annual average concentration.

- When comparing the highest emitted pollutants for a specific county to the pollutants with the highest toxicity-weighted emissions, the listed pollutants were more similar for the pollutants with cancer UREs than for pollutants with noncancer RfCs. This indicates that pollutants with cancer UREs that are emitted in higher quantities are often more toxic than pollutants emitted in lower quantities; conversely, the highest emitted pollutants with noncancer RfCs are not necessarily the most toxic. For example, toluene is the noncancer pollutant that was emitted in the highest quantities for many NMP counties, yet was rarely one of the pollutants with highest toxicity-weighted emissions. Further, while acrolein had the highest noncancer toxicity-weighted emissions for every NMP county, it was rarely among the highest emitted pollutants.

- While the number of states and sites participating in the NMP has increased (as it has in previous years), many of the data analyses utilized here require data from year-round (or nearly year-round) sampling. Of the 73 sites whose data are including in the 2008-2009 report, 31 sampled for an abbreviated duration (due to site/method initialization and/or site closure/relocation) for one or more years. As a result, time-period averages and subsequent risk-based analyses could not be calculated for nearly one-third of participating sites. While these gaps have ramifications for the results contained in this report, they also inhibit the potential determination of trends.

- Of the 73 sites participating in the 2008-2009 NMP, only two sampled for all six available analytical methods under the national program. Another four sites sampled all five methods required for NATTS sites through the national program. The wide range of methods/pollutants sampled among the sites makes it difficult to draw definitive conclusions regarding air toxics in ambient air in a global manner.

- This report strives to utilize the best laboratory and data analysis techniques available (which includes the improvement of MDLs and the incorporation of updated values for various risk factors, for example). This often leads to adjusting the focus of the report to concentrate on the air quality issues of highest concern. Thus, the NMP report is dynamic in nature and scope; yet this approach may prevent the direct comparison of the current report to past reports.

35.3 Recommendations

Based on the conclusions from the 2008-2009 NMP, a number of recommendations for future ambient air monitoring efforts are presented below.

- *Continue participation in the National Monitoring Programs.* Ongoing ambient air monitoring at fixed locations can provide insight into long-term trends in air quality and the potential for air pollution to cause adverse health effects among the general population. Therefore, state and local agencies should be encouraged to either 1) develop and implement their own ambient air monitoring programs based on proven, consistent sampling and analysis methods and EPA technical and quality assurance guidance, or 2) consider participation in the NMP.

- *Participate in the National Monitoring Programs year-round.* Many of the analyses presented in the 2008-2009 report 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 encouraged to implement year-long ambient air monitoring programs in addition to participating in future monitoring efforts.

- *Monitor for additional pollutant groups based on the results of data analyses in the annual report.* The risk-based analysis where county-level emissions are weighted based on toxicity identifies those pollutants whose emissions may result in adverse health effects in a specific area. If a site is not sampling for a pollutant or pollutant group identified as particularly hazardous in a given area, the agency responsible for that site should consider sampling for those compounds.

- *Strive to develop standard conventions for interpreting air monitoring data.* The lack of consistent approaches to present and summarize ambient air monitoring data complicates direct comparisons between different studies. Thought should be given to the feasibility of establishing standard approaches for analyzing and reporting air monitoring data for programs with similar objectives.

- *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 the measurement of ambient air concentrations of 11 pollutants that were not measured during previous programs. This improvement provides sponsoring agencies and a variety of interested parties with important information about air quality within their area. Further research is encouraged to identify other method improvements that would allow for the characterization of an even wider range of components in air pollution and enhance the ability of the methods to quantify all cancer and noncancer pollutants to at least their levels of concern (risk screening concentrations).

- *Require consistency in sampling and analytical methods.* The development of the NATTS program has shown that there are inconsistencies in collection and analytical methods that make data comparison difficult across agencies. Requiring agencies to use specified and accepted measurement methods is integral to the identification of trends and the impacts of regulation.

- *Establish and apply tiered DQOs for analytical precision that reflect the impact of concentration level.* There are two primary reasons that select analytical methods encompassed in the NMP do not meet the established DQO for precision. First, although the MDLs have been driven down to the lowest levels that can be supported by the current procedures, a large volume of the data being considered reflects very low concentrations, which are often below the established MDLs. Second, when the paired concentrations used to determine precision are low, very small differences in concentrations manifest very large percent differences between them. These large percent differences falsely portray analytical imprecision. A tired approach that considers multiple precision objectives reflecting different concentrations levels, such as below the MDL, at or above the MDL, and at the risk screening level, would allow analytical precision to be more realistically appraised.

- *Perform case studies based on findings from the annual report.* Often, the annual report identifies an interesting tendency or trend, or highlights an event at a particular site(s). For example, the 2006 annual report included observations of high hexavalent chromium concentrations on July 4, 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.

- *Consider more rigorous study of the impact of automobile emissions on ambient air quality using multiple years of data.* Because many NMP sites have generated years of continuous data, a real opportunity exists to evaluate the importance and impact of automobile emissions on ambient air quality. Suggested areas of study include additional signature compound assessments and parking lot characterizations.

- *Develop and/or verify HAP and VOC emissions inventories.* State/local/tribal agencies should use the data collected from the NMP sites to develop and validate emissions inventories, or at the very least, identify and/or verify emissions sources of concern. Ideally, state/local/tribal agencies would compare the ambient monitoring results with an emissions inventory for source category completeness. The emissions inventory could then be used to develop modeled concentrations useful to compare against ambient monitoring data.

- *Promulgate ambient air standards for HAPs.* Several of the pollutants sampled during the 2008-2009 program years were higher than risk screening factors developed by various government agencies. One way to reduce the risk to human health would be to develop standards similar to the NAAQS for pollutants that frequently exceed published risk screening levels.

- *Incorporate/Update Risk in State Implementation Plans (SIPs).* Use risk calculations to design State Implementation Plans to implement policies that reduce the potential for human health risk. This would be easier to enforce if ambient standards for certain HAPs were developed (refer to above recommendation).

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