2014 National Monitoring Programs Annual Report (UATMP, NATTS, and CSATAM)

Final Report
EPA Contract No. EP-D-09-048 and EP-D-14-030

Prepared for:

Jeff Yane and David Shelow
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

February 2017

DISCLAIMER

Through its Office of Air Quality Planning and Standards, the U.S. Environmental Protection Agency funded and managed the research described in this report under EPA Contract No. EP-D-09-048 and EP-D-14-030 to Eastern Research Group, Inc. This report has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products in this report does not constitute endorsement or recommendation for their use.

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)

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)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF ACRONYMS

AADT	Annual Average Daily Traffic
AQS	Air Quality System
ASE	Accelerated Solvent Extractor
CBSA	Core-Based Statistical Area(s)
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
COC	Chain of Custody
CSATAM	Community-Scale Air Toxics Ambient Monitoring
CV	Coefficient of Variation
DNPH	2,4-Dinitrophenylhydrazine
DQI	Data Quality Indicator(s)
DQO	Data Quality Objective(s)
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
F	Fahrenheit
FAC	Federal Advisory Committee
FEM	Federal Equivalent Method
GC/MS-FID	Gas Chromatography/Mass Spectrometry and Flame Ionization Detection
HAP	Hazardous Air Pollutant(s)
HPLC	High-Performance Liquid Chromatography
HQ	Hazard Quotient
IC	Ion Chromatography
ICP-MS	Inductively Coupled Plasma/Mass Spectrometry
In Hg	Inches of Mercury
kt	Knots
MDL	Method Detection Limit
mg/m^3	Milligrams per cubic meter
mL	Milliliter
MQO	Measurement Quality Objective(s)
NAAQS	National Ambient Air Quality Standard
NATA	National-Scale Air Toxics Assessment
NATTS	National Air Toxics Trends Stations
NCDC	National Climatic Data Center
ND	Non-detect
NEI	National Emissions Inventory
ng/m^3	Nanograms per cubic meter
NMOC	Non-Methane Organic Compound(s)
NMP	National Monitoring Programs
NWS	National Weather Service
PAH	Polycyclic Aromatic Hydrocarbon(s)
PAMS	Photochemical Assessment Monitoring Stations
PM	Particulate Matter

LIST OF ACRONYMS (Continued)

PM_{10}	Particulate Matter less than 10 microns
POM	Polycyclic Organic Matter
ppbC	Parts per billion carbon
ppbv	Parts per billion by volume
PT	Proficiency Test
PUF	Polyurethane Foam
QAPP	Quality Assurance Project Plan
RfC	Reference Concentration(s)
SATMP	School Air Toxics Monitoring Program
SIM	Selected Ion Monitoring
SIP	State Implementation Plan(s)
SNMOC	Speciated Nonmethane Organic Compound(s)
TAD	Technical Assistance Document
TNMOC	Total Nonmethane Organic Compound(s)
tpy	Tons per year
TSP	Total Suspended Particulate
UATMP	Urban Air Toxics Monitoring Program
$\mu g/m^3$	Micrograms per cubic meter
µL	Microliter
URE	Unit Risk Estimate(s)
UV	Ultraviolet
VOC	Volatile Organic Compound(s)
WBAN	Weather Bureau/Army/Navy ID

Abstract

This report presents the results and conclusions from the ambient air monitoring conducted as part of the 2014 National Monitoring Programs (NATTS, UATMP, and CSATAM) - three individual programs with different goals, but together result in a better understanding and appreciation of the nature and extent of toxic air pollution. The 2014 NMP includes data from samples collected at 51 monitoring sites that collected 24-hour air samples, typically on a 1-in-6 or 1-in-12 day schedule, and analyzed by the national contract laboratory. Twenty-seven sites sampled for 59 volatile organic compounds (VOCs); 32 sites sampled for 15 carbonyl compounds; seven sites sampled for 80 speciated nonmethane organic compounds (SNMOCs); 19 sites sampled for 22 polycyclic aromatic hydrocarbons (PAHs); 21 sites sampled for 11 metals; and 2 sites sampled for hexavalent chromium. Nearly 225,000 ambient air concentrations were measured during the 2014 NMP under the national contract. 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 from city-to-city and from season-to-season.

The ambient air monitoring data collected during the 2014 NMP under the national contract serve a wide range of purposes. Not only do these data allow for the characterization of the nature and extent of air pollution close to the 51 individual monitoring sites participating in these programs, but they also exhibit trends and patterns that may be common to 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 contains many components that originate from a wide range of stationary, mobile, and natural emissions sources. Because some of these components include air toxics that are known or suspected to have the potential for negative human health effects, 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 (NMOCs). The UATMP, the NATTS, and the CSATAM programs include longer-term monitoring efforts (durations of one year or more) at specific locations. These programs have the following program-specific objectives (EPA, 2009a/EPA, 2014):

- The primary technical objective of the UATMP is to characterize the composition and magnitude of air toxics pollution through ambient air monitoring. http://www.epa.gov/ttnamti1/uatm.html

- The primary technical objective 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. http://www.epa.gov/ttnamti1/natts.html

- The primary technical objective of the CSATAM Program is to conduct local-scale investigative ambient air toxics monitoring projects. http://www.epa.gov/ttnamti1/local.html

1.1 Background

The UATMP was initiated by EPA to meet the increasing need for information on air toxics. Over the years, the program has grown in both participation and targeted pollutants (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 10-City Pilot Program (LADCO, 2003) 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 from fixed sites that remain active over an extended period of time such that concentration trends (i.e., any substantial increase or decrease over a period of time) may 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, 2016a). The initial site locations were based on existing infrastructure of monitoring site locations (e.g., $PM_{2.5}$ network) and results from preliminary air toxics programs such as the 1996 National-Scale 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 and to assess impacts to non-urban areas (EPA, 2009b). Currently, 27 NATTS sites are strategically placed across the country (EPA, 2016a).

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. The objectives of the CSATAM Program include identifying and profiling air toxics sources; developing and evaluating emerging measurement methods; characterizing the degree and extent of local air toxics problems; and tracking progress of air toxics reduction activities (EPA, 2009a).

1.2 The Report

Many environmental and health agencies have participated in these programs to assess the sources, effects, and changes in air pollution within their jurisdictions. This report summarizes and interprets measurements collected at monitoring sites participating in the UATMP, NATTS, and CSATAM programs in 2014. Included in this report are data from sites whose operating agencies have opted to have their samples analyzed by EPA's national contract laboratory, Eastern Research Group, Inc. (ERG). Agencies operating sites under the NMP 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 laboratories. In these cases, data are generated by sources other than ERG and are not included in this report. In addition, a state, local, or tribal agency may opt to contract with ERG for a special air toxics

monitoring study in which their data are included in the report as well. The purpose of this report is to summarize those data generated by the contract laboratory over the 2014 sampling effort.

In past reports, measurements from UATMP, NATTS, and CSATAM monitoring sites have been presented together and referred to as "UATMP sites." In more recent reports, a distinction has been made among the three programs due to the increasing number of sites covered under each program. Thus, 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 one another.

Included in this report are data collected at 51 monitoring sites around the country. The 51 sites whose data are included in this report are located in or near 29 urban or rural locations in 18 states and the District of Columbia, including 28 metropolitan or micropolitan statistical areas (collectively referred to as core-based statistical areas or CBSAs).

This report provides both a qualitative overview of air toxics pollution at participating urban and rural locations and a quantitative data analysis of the factors that appear to most significantly affect the behavior of air toxics in urban and rural areas. This report also focuses on data characterizations for each of the 51 different air monitoring 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. Much of the data analysis and interpretation contained in this report focuses on pollutant-specific risk potential.

This report offers participating agencies relevant information and insight 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 could 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 (or increased despite regulation)?

- 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 each participating UATMP, NATTS, 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 2014 UATMP, NATTS, 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 EPA's Air Quality System (AQS) (EPA, 2016b).

This report is organized into 26 sections and 18 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 associated data analyses without having to read the entire report, it is recommended that Sections 1 through 4 (Introduction, Monitoring Programs Network overview, Data Treatments and Methods, and Summary of NMP Data) and Sections 24 and 25 (Data Quality and Results, Conclusions, 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 2014 National Monitoring Programs Report

Report Section	Section Title	Overview of Contents
1	Introduction	This section serves as an introduction to the background, objectives, and scope of the NMP (specifically, the UATMP, NATTS, and CSATAM Programs).
2	The 2014 National Monitoring Programs Network	This section provides an overview on the 2014 NMP monitoring effort, including: • Monitoring locations • Pollutants selected for monitoring • Sampling and analytical methods • Sampling schedules • Completeness of the air monitoring programs.

Table 1-1. Organization of the 2014 National Monitoring Programs Report (Continued)

Report Section	Section Title	Overview of Contents
3	Summary of the 2014 National Monitoring Programs Data Treatments and Methods	This section presents and discusses the data treatments applied to the 2014 NMP 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 human health risk.
4	Summary of the 2014 National Monitoring Programs Data	This section presents and discusses the results of the data treatments from the 2014 NMP data.
5	Sites in Arizona	Monitoring results for the sites in the Phoenix-Mesa-Scottsdale, AZ CBSA (PXSS and SPAZ)
6	Sites in California	Monitoring results for the sites in the Los Angeles-Long Beach-Anaheim, CA CBSA (CELA), the Riverside-San Bernardino-Ontario, CA CBSA (RUCA), and the San Jose-Sunnyvale-Santa Clara, CA CBSA (SJJCA)
7	Sites in Colorado	Monitoring results for the sites in the Grand Junction, CO CBSA (GPCO) and the Glenwood Springs, CO CBSA (BMCO, BRCO, PACO, RFCO, and RICO)
8	Site in the District of Columbia	Monitoring results for the site in the Washington-Arlington-Alexandria, DC-VA-MD-WV CBSA (WADC)
9	Sites in Florida	Monitoring results for the sites in the Orlando-Kissimmee-Sanford, FL CBSA (ORFL and PAFL) and the Tampa-St. Petersburg-Clearwater, FL CBSA (AZFL, SKFL, and SYFL)
10	Sites in Illinois	Monitoring results for the sites in the Chicago-Naperville-Elgin, IL-IN-WI CBSA (NBIL and SPIL) and the St. Louis, MO-IL CBSA (ROIL)
11	Sites in Indiana	Monitoring results for the sites in the Chicago- Naperville-Elgin, IL-IN-WI CBSA (INDEM) and the Indianapolis-Carmel-Anderson, IN CBSA (WPIN)
12	Sites in Kentucky	Monitoring results for the sites in the Huntington-Ashland, WV-KY-OH CBSA (ASKY and ASKY-M), the Lexington-Fayette, KY CBSA (LEKY), the Evansville, IN-KY CBSA (BAKY), the Paducah, KY-IL CBSA (BLKY), and the sites in Marshall County (ATKY, CCKY, LAKY, and TVKY) and Carter County (GLKY)
13	Site in Massachusetts	Monitoring results for the site in the Boston-Cambridge-Newton, MA-NH CBSA (BOMA)
14	Site in Michigan	Monitoring results for the site in the Detroit-Warren-Dearborn, MI CBSA (DEMI)
15	Site in Missouri	Monitoring results for the site in the St. Louis, MO-IL CBSA (S4MO)
16	Sites in New Jersey	Monitoring results for the sites in the New York-Newark-Jersey City, NY-NJ-PA CBSA (CHNJ, ELNJ, and NBNJ) and the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD CBSA (CSNJ)
17	Sites in New York	Monitoring results for the sites in the New York-Newark-Jersey City, NY-NJ-PA CBSA (BXNY) and the Rochester, NY CBSA (ROCH)
18	Sites in Oklahoma	Monitoring results for the sites in the Tulsa, OK CBSA (TOOK, TMOK, and TROK), and the Oklahoma City, OK CBSA (OCOK and YUOK)
19	Site in Rhode Island	Monitoring results for the site in the Providence-Warwick, RI-MA CBSA (PRRI)

Table 1-1. Organization of the 2014 National Monitoring Programs Report (Continued)

Report Section	Section Title	Overview of Contents
20	Site in Utah	Monitoring results for the site in the Ogden-Clearfield, UT CBSA (BTUT)
21	Site in Vermont	Monitoring results for the site in the Burlington-South Burlington, VT CBSA (UNVT)
22	Site in Virginia	Monitoring results for the site in the Richmond, VA CBSA (RIVA)
23	Site in Washington	Monitoring results for the site in the Seattle-Tacoma-Bellevue, WA CBSA (SEWA)
24	Data Quality	This section defines and discusses the general concepts of precision and accuracy. Based on quantitative and qualitative analyses, this section comments on the specific precision and accuracy of the 2014 NMP ambient air monitoring data.
25	Results, Conclusions, and Recommendations	This section summarizes the most significant findings of the report and makes several recommendations for future projects that involve ambient air monitoring.
26	References	This section lists the references cited throughout the report.

2.0 The 2014 National Monitoring Programs Network

Agencies operating UATMP, NATTS, or CSATAM sites may choose to have their samples analyzed by EPA's contract laboratory, ERG, in Morrisville, North Carolina. Data from 51 monitoring sites that collected 24-hour integrated ambient air samples for up to 12 months, at 1-in-6 or 1-in-12 day sampling intervals, and sent them to ERG for analysis are included in this report. Samples were analyzed for concentrations of the following suites of pollutants:

- selected hydrocarbons, halogenated hydrocarbons, and polar compounds from canister samples for Speciated Non-methane Organic Compounds (SNMOCs) and/or Volatile Organic Compounds (VOCs) using EPA Compendium Method TO-15,
- carbonyl compounds from sorbent cartridge samples using EPA Compendium Method TO-11A,
- polycyclic aromatic hydrocarbons (PAHs) from polyurethane foam (PUF) and XAD-2® resin samples using EPA Compendium Method TO-13A,
- trace metals from filters using EPA Compendium Method IO-3.5/Federal Equivalency Methods (FEM) EQL-0512-201 or EQL-0512-202, and
- hexavalent chromium from sodium bicarbonate-coated filters using ASTM D7614.

Agencies operating sites under the NMP are not required to have their samples analyzed by ERG. They may have samples for only select methods analyzed by ERG, as they may have their own laboratory capabilities for other methods. In these cases, data are generated by sources other than ERG and are therefore not included in this report.

Section 2.2 provides additional information regarding each of the sampling methodologies used to collect and analyze samples.

The following sections review the monitoring locations, pollutants selected for monitoring, sampling and analytical methods, collection schedules, and completeness of the 2014 NMP dataset.

2.1 Monitoring Locations

For the NATTS network, monitor siting is based on the need to assess population exposure and/or 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 these programs, monitors were placed in urban areas near the centers of heavily populated cities (e.g., Chicago, Illinois and Phoenix, Arizona), while others were placed in moderately or sparsely populated rural areas (e.g., Grayson, Kentucky and Underhill, Vermont).

Figure 2-1 shows the locations of the 51 monitoring sites participating in the 2014 programs under the national contract, which encompass 29 different urban and rural areas. Outlined in Figure 2-1 are the associated CBSAs, as designated by the U.S. Census Bureau, where each site is located (Census Bureau, 2013a). A CBSA refers to either a metropolitan (an urban area with 50,000 or more people) or micropolitan (an urban area with at least 10,000 people but less than 50,000 people) statistical area (Census Bureau, 2013b). Table 2-1 lists the respective monitoring program and the years of program participation under the national contract for the 51 monitoring sites. Each of the 51 monitoring sites has been included in at least one previous NMP annual report.

As Figure 2-1 and Table 2-1 show, the 2014 NMP sites are widely distributed across the country. Detailed information about the monitoring sites is provided in Table 2-2, Appendix A, and the individual state sections (Sections 5 through 23). 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 programs. Table 2-2 shows that the locations of the monitoring sites vary significantly, depending on the individual program technical objectives. These sites are located in areas of differing 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 monitoring results. For reference, each site's AQS site code is provided in Table 2-2.

Figure 2-1. Locations of the 2014 National Monitoring Programs Monitoring Sites[1]

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-1. 2014 National Monitoring Programs Sites and Past Program Participation[1]

Monitoring Location and Site Name	Program	2003 and Earlier	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ashland, KY (ASKY)	UATMP										✓	✓
Ashland, KY (ASKY-M)	UATMP										✓	✓
Baskett, KY (BAKY)	UATMP										✓	✓
Battlement Mesa, CO (BMCO)	UATMP								✓	✓	✓	✓
Boston, MA ***(BOMA)***	NATTS	2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bountiful, UT ***(BTUT)***	NATTS	2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Calvert City, KY (ATKY)	UATMP										✓	✓
Calvert City, KY (CCKY)	UATMP										✓	✓
Calvert City, KY (LAKY)	UATMP										✓	✓
Calvert City, KY (TVKY)	UATMP										✓	✓
Camden, NJ (CSNJ)	UATMP											✓
Carbondale, CO (RFCO)	UATMP										✓	✓
Chester, NJ (CHNJ)	UATMP	2001- 2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dearborn, MI ***(DEMI)***	NATTS	2001- 2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
East Highland Park, VA (***RIVA***)	NATTS						✓	✓	✓	✓	✓	✓
Elizabeth, NJ (ELNJ)	UATMP	1999-2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gary, IN (INDEM)	UATMP		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-1. 2014 National Monitoring Programs Sites and Past Program Participation[1] (Continued)

Monitoring Location and Site Name	Program	2003 and Earlier	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Grand Junction, CO ***(GPCO)***	NATTS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grayson, KY ***(GLKY)***	NATTS						✓	✓	✓	✓	✓	✓
Indianapolis, IN (WPIN)	UATMP				✓	✓	✓	✓	✓	✓	✓	✓
Lexington, KY (LEKY)	UATMP										✓	✓
Los Angeles, CA (***CELA***)	NATTS					✓	✓	✓	✓	✓	✓	✓
New York, NY (***BXNY***)	NATTS				✓	✓	✓	✓	✓		✓	✓
North Brunswick, NJ (NBNJ)	UATMP	2001- 2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Northbrook, IL (***NBIL***)	NATTS	2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oklahoma City, OK (OCOK)	UATMP							✓	✓	✓	✓	✓
Orlando, FL (PAFL)	UATMP						✓	✓	✓	✓	✓	✓
Parachute, CO (PACO)	UATMP						✓	✓	✓	✓	✓	✓
Phoenix, AZ (***PXSS***)	NATTS	2001- 2003	✓		✓	✓	✓	✓	✓	✓	✓	✓
Phoenix, AZ (SPAZ)	UATMP	2001				✓	✓	✓	✓	✓	✓	✓
Pinellas Park, FL (***SKFL***)	NATTS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Providence, RI (***PRRI***)	NATTS			✓	✓	✓	✓	✓	✓	✓	✓	✓
Rifle, CO (RICO)	UATMP						✓	✓	✓	✓	✓	✓
Rochester, NY (***ROCH***)	NATTS				✓	✓	✓	✓	✓	✓	✓	✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-1. 2014 National Monitoring Programs Sites and Past Program Participation[1] (Continued)

Monitoring Location and Site Name	Program	2003 and Earlier	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Roxana, IL (ROIL)	Special Study										✓	✓
Rubidoux, CA (***RUCA***)	NATTS					✓	✓	✓	✓	✓	✓	✓
San Jose, CA (***SJJCA***)	NATTS						✓	✓	✓	✓	✓	✓
Schiller Park, IL (SPIL)	UATMP	2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Seattle, WA (***SEWA***)	NATTS			✓	✓	✓	✓	✓	✓	✓	✓	✓
Silt, CO (BRCO)	UATMP						✓	✓	✓	✓	✓	✓
Smithland, KY (BLKY)	UATMP										✓	✓
St. Louis, MO (***S4MO***)	NATTS	2002, 2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
St. Petersburg, FL (AZFL)	UATMP	1991-1992, 2001-2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tulsa, OK (TMOK)	UATMP							✓	✓	✓	✓	✓
Tulsa, OK (TOOK)	UATMP				✓	✓	✓	✓	✓	✓	✓	✓
Tulsa, OK (TROK)	UATMP											✓
Underhill, VT (***UNVT***)	NATTS	2002		✓	✓	✓	✓	✓	✓	✓	✓	✓
Valrico, FL (***SYFL***)	NATTS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Washington, D.C. (***WADC***)	NATTS			✓	✓	✓	✓	✓	✓	✓	✓	✓
Winter Park, FL (ORFL)	UATMP	1990-1991, 2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yukon, OK (YUOK)	UATMP											✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-2. Site Characterizing Information for the 2014 National Monitoring Programs Sites

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
ASKY	21-019-0017	Ashland, KY	Residential	Suburban	5,934 (2014)	262.71	172.53
ASKY-M	21-019-0002	Ashland, KY	Industrial	Urban/City Center	12,842 (2012)	262.71	172.53
ATKY	21-157-0016	Calvert City, KY	Industrial	Suburban	3,262 (2012)	1,119.74	476.37
AZFL	12-103-0018	St. Petersburg, FL	Residential	Suburban	40,000 (2014)	2,132.17	3,217.48
BAKY	21-101-0014	Baskett, KY	Commercial	Rural	922 (2012)	397.98	268.40
BLKY	21-139-0004	Smithland, KY	Agricultural	Rural	2,510 (2013)	32.24	136.07
BMCO	08-045-0019	Battlement Mesa, CO	Commercial	Suburban	1,880 (2014)	3,787.70	327.61
BOMA	25-025-0042	Boston, MA	Commercial	Urban/City Center	27,654 (2010)	851.81	1,015.72
BRCO	08-045-0009	Silt, CO	Agricultural	Rural	1,182 (2014)	3,787.70	327.61
BTUT	49-011-0004	Bountiful, UT	Residential	Suburban	130,950 (2013)	1,163.85	930.74
BXNY	36-005-0110	New York, NY	Residential	Urban/City Center	98,298 (2013)	3,796.74	840.39
CCKY	21-157-0018	Calvert City, KY	Residential	Suburban	4,050 (2013)	1,119.74	476.37
CELA	06-037-1103	Los Angeles, CA	Residential	Urban/City Center	230,000 (2014)	21,804.55	14,773.30
CHNJ	34-027-3001	Chester, NJ	Agricultural	Rural	11,215 (2012)	680.93	1,278.46
CSNJ	34-007-0002	Camden, NJ	Industrial	Urban/City Center	3,231 (2012)	577.27	953.66

BOLD ITALICS = EPA-designated NATTS site

[a]Individual references provided in each state section.

[b] Reference: 2011 NEI version 2 (EPA, 2015a)

[c]GPCO's metals sampler is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's county-level emissions are city-level data.

Table 2-2. Site Characterizing Information for the 2014 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
DEMI	26-163-0033	Dearborn, MI	Industrial	Suburban	96,870 (2014)	7,118.74	4,563.35
ELNJ	34-039-0004	Elizabeth, NJ	Industrial	Suburban	250,000 (2006)	814.19	1,017.46
GLKY	21-043-0500	Grayson, KY	Residential	Rural	303 (2012)	75.96	145.24
GPCO[c]	08-077-0017 08-077-0018	Grand Junction, CO	Commercial	Urban/City Center	12,000 (2014)	659.65	664.73
INDEM	18-089-0022	Gary, IN	Industrial	Urban/City Center	34,754 (2011)	1,603.10	1,607.33
LAKY	21-157-0019	Calvert City, KY	Residential	Suburban	1,189 (2012)	1,119.74	476.37
LEKY	21-067-0012	Lexington, KY	Residential	Suburban	18,993 (2014)	764.77	1,116.04
NBIL	17-031-4201	Northbrook, IL	Residential	Suburban	115,100 (2014)	15,663.06	8,882.46
NBNJ	34-023-0006	North Brunswick, NJ	Agricultural	Rural	114,322 (2010)	1,038.26	1,577.17
OCOK	40-109-1037	Oklahoma City, OK	Residential	Suburban	52,400 (2014)	2,156.08	3,425.17
ORFL	12-095-2002	Winter Park, FL	Commercial	Urban/City Center	31,500 (2014)	2,774.25	4,121.46
PACO	08-045-0005	Parachute, CO	Residential	Urban/City Center	16,000 (2014)	3,787.70	327.61
PAFL	12-095-1004	Orlando, FL	Commercial	Suburban	49,000 (2013)	2,774.25	4,121.46
PRRI	44-007-0022	Providence, RI	Residential	Urban/City Center	136,800 (2009)	1,362.28	1,350.29
PXSS	04-013-9997	Phoenix, AZ	Residential	Urban/City Center	35,103 (2010)	7,792.15	9,915.84

BOLD ITALICS = EPA-designated NATTS site

[a]Individual references provided in each state section.

[b] Reference: 2011 NEI version 2 (EPA, 2015a)

[c]GPCO's metals sampler is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's county-level emissions are city-level data.

Table 2-2. Site Characterizing Information for the 2014 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
RFCO	08-045-0018	Carbondale, CO	Residential	Rural	16,000 (2014)	3,787.70	327.61
RICO	08-045-0007	Rifle, CO	Commercial	Urban/City Center	17,000 (2014)	3,787.70	327.61
RIVA	51-087-0014	East Highland Park, VA	Residential	Suburban	72,000 (2013)	888.54	746.37
ROCH	36-055-1007	Rochester, NY	Residential	Urban/City Center	85,417 (2013)	2,959.44	1,742.27
ROIL	17-119-9010	Roxana, IL	Industrial	Suburban	7,750 (2013)	1,359.86	815.08
RUCA	06-065-8001	Rubidoux, CA	Residential	Suburban	158,000 (2014)	3,826.19	3,244.32
S4MO	29-510-0085	St. Louis, MO	Residential	Urban/City Center	100,179 (2013)	939.84[d]	611.09 [d]
SEWA	53-033-0080	Seattle, WA	Residential	Urban/City Center	178,000 (2014)	7,310.24	6,890.17
SJJCA	06-085-0005	San Jose, CA	Commercial	Urban/City Center	124,000 (2014)	4,177.14	3,634.86
SKFL	12-103-0026	Pinellas Park, FL	Residential	Suburban	36,500 (2014)	2,132.17	3,217.48
SPAZ	04-013-4003	Phoenix, AZ	Residential	Urban/City Center	25,952 (2011)	7,792.15	9,915.84
SPIL	17-031-3103	Schiller Park, IL	Mobile	Suburban	193,800 (2013)	15,663.06	8,882.46
SYFL	12-057-3002	Valrico, FL	Residential	Rural	3,800 (2014)	3,155.70	4,260.15
TMOK	40-143-1127	Tulsa, OK	Residential	Urban/City Center	4,200 (2014)	1,902.81	4,149.89
TOOK	40-143-0235	Tulsa, OK	Industrial	Urban/City Center	65,800 (2014)	1,902.81	4,149.89

BOLD ITALICS = EPA-designated NATTS site

[a]Individual references provided in each state section.

[b] Reference: 2011 NEI version 2 (EPA, 2015a)

[c]GPCO's metals sampler is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's county-level emissions are city-level data.

Table 2-2. Site Characterizing Information for the 2014 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
TROK	40-143-0179	Tulsa, OK	Industrial	Urban/City Center	53,300 (2014)	1,902.81	4,149.89
TVKY	21-157-0014	Calvert City, KY	Industrial	Suburban	1,458 (2014)	1,119.74	476.37
UNVT	50-007-0007	Underhill, VT	Forest	Rural	1,100 (2011)	432.40	477.55
WADC	11-001-0043	Washington, D.C.	Commercial	Urban/City Center	8,700 (2013)	933.45	829.76
WPIN	18-097-0078	Indianapolis, IN	Residential	Suburban	24,661 (2011)	2,627.90	4,042.65
YUOK	40-017-0101	Yukon, OK	Commercial	Suburban	41,000 (2014)	680.10	447.57

BOLD ITALICS = EPA-designated NATTS site

[a]Individual references provided in each state section.

[b] Reference: 2011 NEI version 2 (EPA, 2015a)

[c]GPCO's metals sampler is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's county-level emissions are city-level data.

The proximity of the monitoring sites 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:

- The number of vehicles passing the nearest available representative roadway to the monitoring site, generally expressed as annual average daily traffic (AADT).

- Stationary and mobile source hazardous air pollutant (HAP) emissions for the monitoring site's residing county, according to version 2 of the 2011 National Emissions Inventory (NEI). (The 2014 NEI was published near the end of the production of the 2014 NMP report and will be utilized in the 2015 NMP report.)

This information is discussed in further detail in the individual state sections.

2.2 Analytical Methods and Pollutants Targeted for Monitoring

Air pollution typically contains hundreds of components, including, but not limited to, VOCs, metals, and particulate matter (PM). 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 at the laboratory using methods based on the EPA-approved methods, as listed below:

- *Compendium Method TO-15* was used to measure ambient air concentrations of 59 VOCs.

- *EPA-approved SNMOC Method* was used to measure 80 ozone precursors plus total NMOC. This method was can be performed 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 PAHs.

- A combination of *Compendium Method IO-3.5* and EPA *Federal Equivalency Methods (FEM) EQL-0512-201 or EQL-0512-202* was used to measure ambient air concentrations of 11 metals.

- *ASTM Method D7614* was used to measure ambient air concentrations of hexavalent chromium.

The target pollutants and methods utilized varied from monitoring site to monitoring site. The sample collection equipment at each site 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 feet 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 pollutant's concentration in ambient air is below the method sensitivity (as gauged by the MDL), the analytical method might not differentiate the pollutant from other pollutants in the sample or from the random "noise" inherent in the analyses. While quantification below the MDL is possible, the measurement reliability is lower. Therefore, when pollutants are present at concentrations 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, 1986) in accordance with the specifications presented in the NATTS Technical Assistance Document (TAD) (EPA, 2009b). This procedure involves analyzing at least seven replicate standards spiked onto the appropriate sampling media and extracted (per analytical method). Instrument-specific detection limits (replicate analysis of standards in solution) are not determined because sampling media background and preparation variability would not be considered.

MDLs for metals samples were calculated using the procedure described by "Appendix D: DQ FAC Single Laboratory Procedure v2.4" (FAC, 2007), with the exception of the arsenic MDL for Teflon® filters. The Federal Advisory Committee (FAC) MDL procedure involves using historical blank filter data to calculate MDLs for each pollutant. For arsenic, the procedure

described in 40 CFR was used to calculate the MDL rather than the FAC procedure because this metal is not present at a high enough level in the background on the filters.

Tables 2-3 through 2-8 identify the specific target pollutants for each analytical method and their corresponding MDLs, as determined for 2014. For the VOC and SNMOC analyses, the experimentally determined MDLs do not change within a given year unless the sample was diluted. The 2014 VOC and SNMOC MDLs are presented in Tables 2-3 and 2-4, respectively. For the rest of the analytical methods, 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 MDL is presented for each pollutant in Tables 2-5 through 2-8, based on valid samples. If the MDLs presented in Tables 2-5 through 2-8 include an MDL for a diluted sample, the MDL may appear elevated. Dilutions cause the MDL to increase by a factor of the dilution; MDLs affected by dilution are denoted in the tables. ERG's published 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 2012a; ASTM, 2012; ASTM, 2013).

2.2.1 VOC and SNMOC Concurrent Sampling and Analytical Methods

VOC and SNMOC sampling and analysis can be performed concurrently using a combined methodology based on 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), respectively. When referring to SNMOC analysis, this report may refer to this method as the "concurrent SNMOC method" or "concurrent SNMOC analysis" because both methods can be employed at the same time to analyze the same sample. Ambient air samples for VOC and/or 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 flowed into the canisters automatically once an associated

system solenoid valve was opened. A mass flow controller on the sampling device inlet ensured that ambient air entered the canister at an integrated constant rate across the collection period. At the end of the 24-hour sampling period, the solenoid valve automatically closed and stopped ambient air from flowing into the canister. Site operators recovered and returned the canisters, along with the Chain of Custody (COC) forms and all associated documentation, to the ERG laboratory for analysis.

By analyzing each sample with gas chromatography incorporating mass spectrometry (operating in the Selected Ion Monitoring (SIM) mode) and flame ionization detection (GC/MS-FID), laboratory staff determined ambient air concentrations of 59 VOCs and/or 80 SNMOCs, and calculated the total non-methane organic compounds (TNMOC) concentration. TNMOC is the sum of all hydrocarbon concentrations within the sample. Because *m*-xylene and *p*-xylene elute from the GC column at the same time, both the VOC and SNMOC analytical methods report only the sum concentration for these two isomers, and not the separate concentration for each isomer. Raw data for both methods are presented in Appendices C and D.

Table 2-3 presents the MDLs for the laboratory analysis of VOC samples with Method TO-15 and Table 2-4 presents the MDLs for the analysis of SNMOC samples. The MDL for every VOC is less than or equal to 0.095 parts per billion by volume (ppbv). SNMOC detection limits are expressed in parts per billion Carbon (ppbC). All SNMOC MDLs are less than or equal to 1.58 ppbC.

Table 2-3. 2014 VOC Method Detection Limits

Pollutant	2014 MDL (ppbv)	Pollutant	2014 MDL (ppbv)
Acetonitrile	0.045	Dichloromethane	0.014
Acetylene	0.013	1,2-Dichloropropane	0.015
Acrolein	0.094	*cis*-1,3-Dichloropropene	0.018
Acrylonitrile	0.016	*trans*-1,3-Dichloropropene	0.020
tert-Amyl Methyl Ether	0.011	Dichlorotetrafluoroethane	0.013
Benzene	0.015	Ethyl Acrylate	0.018
Bromochloromethane	0.015	Ethyl *tert*-Butyl Ether	0.016
Bromodichloromethane	0.017	Ethylbenzene	0.013
Bromoform	0.013	Hexachloro-1,3-Butadiene	0.027
Bromomethane	0.012	Methyl Isobutyl Ketone	0.019
1,3-Butadiene	0.013	Methyl Methacrylate	0.018
Carbon Disulfide	0.013	Methyl *tert*-Butyl Ether	0.018
Carbon Tetrachloride	0.017	*n*-Octane	0.012
Chlorobenzene	0.015	Propylene	0.030
Chloroethane	0.015	Styrene	0.014
Chloroform	0.015	1,1,2,2-Tetrachloroethane	0.014
Chloromethane	0.014	Tetrachloroethylene	0.013
Chloroprene	0.016	Toluene	0.013
Dibromochloromethane	0.014	1,2,4-Trichlorobenzene	0.050
1,2-Dibromoethane	0.013	1,1,1-Trichloroethane	0.015
m-Dichlorobenzene	0.014	1,1,2-Trichloroethane	0.018
o-Dichlorobenzene	0.015	Trichloroethylene	0.017
p-Dichlorobenzene	0.015	Trichlorofluoromethane	0.015
Dichlorodifluoromethane	0.014	Trichlorotrifluoroethane	0.016
1,1-Dichloroethane	0.018	1,2,4-Trimethylbenzene	0.018
1,2-Dichloroethane	0.014	1,3,5-Trimethylbenzene	0.017
1,1-Dichloroethene	0.014	Vinyl Chloride	0.012
cis-1,2-Dichloroethylene	0.014	*m,p*-Xylene[1]	0.023
trans-1,2-Dichloroethylene	0.012	*o*-Xylene	0.012

[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. 2014 SNMOC Method Detection Limits

Pollutant	2014 MDL (ppbC)[1]	Pollutant	2014 MDL (ppbC)[1]	Pollutant	2014 MDL (ppbC)[1]
Acetylene	0.12	1-Heptene	0.26	1-Pentene	0.16
Benzene	0.23	*n*-Hexane	0.35	*cis*-2-Pentene	0.13
1,3-Butadiene	0.19	1-Hexene	0.25	*trans*-2-Pentene	0.13
n-Butane	0.25	*cis*-2-Hexene	0.21	*a*-Pinene	0.27
1-Butene	0.35	*trans*-2-Hexene	0.23	*b*-Pinene	0.82
cis-2-Butene	0.08	Isobutane	0.15	Propane	0.57
trans-2-Butene	0.09	Isobutylene	0.15	*n*-Propylbenzene	0.29
Cyclohexane	0.23	Isopentane	0.17	Propylene	0.11
Cyclopentane	0.15	Isoprene	0.14	Propyne	0.06
Cyclopentene	0.88	Isopropylbenzene	0.20	Styrene	0.36
n-Decane	0.39	2-Methyl-1-Butene	0.13	Toluene	0.30
1-Decene	1.07	3-Methyl-1-Butene	0.18	*n*-Tridecane	0.65
m-Diethylbenzene	0.67	2-Methyl-1-Pentene	0.21	1-Tridecene	0.91
p-Diethylbenzene	0.43	4-Methyl-1-Pentene	0.15	1,2,3-Trimethylbenzene	0.23
2,2-Dimethylbutane	0.21	2-Methyl-2-Butene	0.20	1,2,4-Trimethylbenzene	1.07
2,3-Dimethylbutane	0.18	Methylcyclohexane	0.24	1,3,5-Trimethylbenzene	0.37
2,3-Dimethylpentane	0.25	Methylcyclopentane	0.19	2,2,3-Trimethylpentane	0.29
2,4-Dimethylpentane	0.25	2-Methylheptane	0.36	2,2,4-Trimethylpentane	0.28
n-Dodecane	0.91	3-Methylheptane	0.33	2,3,4-Trimethylpentane	0.28
1-Dodecene	1.57	2-Methylhexane	0.23	*n*-Undecane	0.75
Ethane	1.52	3-Methylhexane	0.37	1-Undecene	1.20
2-Ethyl-1-butene	0.34	2-Methylpentane	0.36	*m*-Xylene/*p*-Xylene[2]	0.45
Ethylbenzene	0.24	3-Methylpentane	0.16	*o*-Xylene	0.23
Ethylene	0.21	*n*-Nonane	0.26	Sum of Knowns	NA
m-Ethyltoluene	0.38	1-Nonene	0.31	Sum of Unknowns	NA
o-Ethyltoluene	0.38	*n*-Octane	0.36	TNMOC	NA
p-Ethyltoluene	0.28	1-Octene	0.33		
n-Heptane	0.24	*n*-Pentane	0.18		

[1] Concentration in ppbC = concentration in ppbv * number of carbon atoms in the compound.

[2] Because *m*-xylene and *p*-xylene elute from the GC column at the same time, the SNMOC analytical method reports the sum concentration for these two isomers and not concentrations of the individual isomers.

NA = Not applicable

2.2.2 Carbonyl Compound Sampling and Analytical Method

Sampling and analysis for carbonyl compounds was performed using methodology based on 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 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 the cartridges and returned them, along with the COC forms and all associated documentation, to the ERG laboratory for analysis.

To quantify concentrations of carbonyl compounds in the sampled ambient air, laboratory analysts extracted the exposed DNPH cartridges with acetonitrile. High-performance liquid chromatography (HPLC) analysis and ultraviolet (UV) detection of these solutions determined the relative amounts of individual carbonyl compounds present in the original air sample. Because the three tolualdehyde isomers elute from the HPLC column at the same time, the carbonyl compound analytical method reports only the sum concentration for these isomers and not the separate concentrations for each isomer. Raw data for Method TO-11A 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 sample-to-sample due to different volumes pulled through the samples, the average detection limit for valid samples reported by the ERG laboratory for every carbonyl compound is less than or equal to 0.016 ppbv.

Table 2-5. 2014 Carbonyl Compound Method Detection Limits

Pollutant	Minimum MDL (ppbv)	Maximum MDL[2] (ppbv)	Average MDL (ppbv)
Acetaldehyde	0.003	0.014	0.008
Acetone	0.010	0.040[2]	0.016
Benzaldehyde	0.001	0.006	0.003
2-Butanone	0.001	0.006	0.002
Butyraldehyde	0.001	0.006	0.003
Crotonaldehyde	0.003	0.011	0.004
2,5-Dimethylbenzaldehyde	0.001	0.006	0.002
Formaldehyde	0.007	0.179[2]	0.013
Hexaldehyde	0.001	0.003	0.002
Isovaleraldehyde	0.001	0.006	0.002
Propionaldehyde	0.001	0.006	0.004
Tolualdehydes[1]	0.002	0.009	0.004
Valeraldehyde	0.001	0.006	0.003

[1] The three tolualdehyde isomers elute from the HPLC column at the same time; thus, the analytical method reports only the sum concentration for these three isomers and not the individual concentrations.
[2] Indicates that sample dilution was required to perform analysis.

2.2.3 PAH Sampling and Analytical Method

PAH sampling and analysis was performed using methodology based on EPA Compendium Method TO-13A (EPA, 1999c) and ASTM D6209 (ASTM, 2013). 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 glass fiber filter are installed in a high volume sampler by the site operators and allowed to sample for 24 hours. Sample collection modules, COC forms, and all associated documentation were returned 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 0.6 microliter (µL) is injected into the GC/MS operating in the SIM mode to analyze for 22 PAHs. Raw data for Method TO-13A are presented in Appendix F.

Table 2-6 lists the MDLs for the 22 PAH target pollutants. PAH detection limits are expressed in nanograms per cubic meter (ng/m^3). Although the sensitivity varies from pollutant-to-pollutant and from sample-to-sample due to the different volumes pulled through the samples,

the average detection limit for valid samples reported by the ERG laboratory for every PAH is less than 0.485 ng/m^3.

Table 2-6. 2014 PAH Method Detection Limits

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL[1] (ng/m^3)	Average MDL (ng/m^3)
Acenaphthene	0.068	0.414	0.128
Acenaphthylene	0.010	0.063	0.019
Anthracene	0.033	0.202	0.062
Benzo(a)anthracene	0.014	0.083	0.026
Benzo(a)pyrene	0.020	0.120	0.037
Benzo(b)fluoranthene	0.019	0.116	0.036
Benzo(e)pyrene	0.019	0.115	0.035
Benzo(g,h,i)perylene	0.018	0.107	0.033
Benzo(k)fluoranthene	0.021	0.128	0.039
Chrysene	0.017	0.101	0.031
Coronene	0.017	0.105	0.032
Cyclopenta[cd]pyrene	0.025	0.148	0.046
Dibenz(a,h)anthracene	0.018	0.111	0.034
Fluoranthene	0.017	0.105	0.032
Fluorene	0.053	0.321	0.099
9-Fluorenone	0.018	0.111	0.034
Indeno(1,2,3-cd)pyrene	0.020	0.121	0.037
Naphthalene	0.255	4.410	0.484
Perylene	0.024	0.145	0.045
Phenanthrene	0.044	0.263	0.081
Pyrene	0.017	0.102	0.032
Retene	0.013	0.081	0.025

[1] A single sample required a dilution for all pollutants listed.

2.2.4 Metals Sampling and Analytical Method

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. EPA provided the filters to the monitoring sites. Sites sampled for either particulate matter less than 10 microns (PM_{10}) or total suspended particulate (TSP). Particulates in ambient air were collected on the filters and, after a 24-hour sampling period, site operators recovered and returned the filters, along with the COC forms and all associated documentation, to the ERG laboratory for analysis.

Extraction and analysis for the determination of speciated metals in or on particulate matter was performed using a combination of EPA Compendium Method IO-3.5 and EPA FEM Methods EQL-0512-201 and EQL-0512-202 (EPA, 1999d; EPA, 2012a). Upon receipt at the laboratory, the whole filters (47mm Teflon®) or filter strips (8" x 10" quartz) were digested using a dilute nitric acid, hydrochloric acid, and/or hydrofluoric acid (Teflon® only) 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. Raw data for speciated metals are presented in Appendix G.

Table 2-7 lists the MDLs for the analysis of metals samples. Due to the difference in sample volume/filter collection media, there are two sets of MDLs listed in Table 2-7, one for each filter type. Although the sensitivity varies from pollutant-to-pollutant and from sample-to-sample due to the different volumes pulled through the samples, the average detection limit for valid samples reported by the ERG laboratory for every metal is less than 2.25 ng/m^3 for the quartz filters and less than or equal to 14.0 ng/m^3 for the Teflon® filters.

Table 2-7. 2014 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	0.009	0.015	0.012	Antimony	0.090	0.120	0.101
Arsenic	0.042	0.074	0.057	Arsenic	0.190	0.260	0.221
Beryllium	0.001	0.003	0.002	Beryllium	0.010	0.020	0.020
Cadmium	0.003	0.005	0.004	Cadmium	0.010	0.010	0.010
Chromium	1.65	2.91	2.24	Chromium	12.1	16.5	14.0
Cobalt	0.017	0.029	0.022	Cobalt	0.010	0.020	0.020
Lead	0.054	0.933[1]	0.076	Lead	0.030	0.040	0.040
Manganese	0.144	0.253	0.194	Manganese	0.120	0.170	0.141
Mercury	0.004	0.062[1]	0.005	Mercury	0.030	0.040	0.031
Nickel	0.515	0.907	0.696	Nickel	0.160	0.220	0.181
Selenium	0.019	0.033	0.025	Selenium	0.250	0.350	0.292

[1]Indicates that sample dilution was required to perform analysis.

2.2.5 Hexavalent Chromium Sampling and Analytical Method

Hexavalent chromium was measured using the method described in ASTM D7614 (ASTM, 2012). Ambient air samples of hexavalent chromium from TSP were collected by passing ambient air through sodium bicarbonate impregnated acid-washed cellulose filters. ERG prepared and distributed the filters secured in Teflon® cartridges or in petri dishes, per the specific sampler used at each site, to the monitoring sites prior to each scheduled sample collection event. Site operators connected the cartridges (or installed the filters) to the air sampling equipment. After a 24-hour sampling period, site operators recovered the cartridges (or filters) and returned them, along with the COC forms and all associated documentation, to the ERG laboratory for analysis. Upon receipt at the laboratory, the filters were extracted using a sodium bicarbonate solution. Ion chromatography (IC) analysis using visible detection of the extracts determined the amount of hexavalent chromium present in each sample. Raw data for the hexavalent chromium method are presented in Appendix H.

Although the sensitivity varies due to the different volumes pulled through the samples, Table 2-8 presents the range and average detection limit (0.0035 ng/m^3) for valid hexavalent chromium samples reported by the ERG laboratory across the program.

Table 2-8. 2014 Hexavalent Chromium Method Detection Limit

Pollutant	Minimum MDL (ng/m^3)	Maximum MDL (ng/m^3)	Average MDL (ng/m^3)
Hexavalent Chromium	0.0031	0.0036	0.0035

2.3 Sample Collection Schedules

Table 2-9 presents the first and last date upon which sample collection occurred for each monitoring site sampling under the NMP in 2014. The first sample date for each site is generally at the beginning of January and sampling continued through the end of December, although there was an exception. Sampling at CCKY was discontinued at the beginning of October 2014. The metals sampler at CCKY was redeployed at BLKY, where metals sampling reconvened at the end of October 2014.

According to the NMP schedule, 24-hour integrated samples were collected at each monitoring site on a 1-in-6 day schedule and sample collection began and ended at midnight, local standard time. However, there were some exceptions, as some sites collected samples on a 1-in-12 day schedule, dependent upon location and monitoring objectives:

- SNMOC samples were collected on a 1-in-6 day schedule while carbonyl compounds were collected on a 1-in-12 day schedule at BMCO, BRCO, PACO, and RICO. Sampling at RFCO was conducted on a 1-in-12 day schedule for both methods.

- The South Phoenix, Arizona site (SPAZ) collected VOC samples on a 1-in-12 day schedule.

- The Orlando, Florida site (PAFL) collected metals samples on a 1-in-12 day schedule.

Table 2-9 shows the following:

- 27 sites collected VOC samples.

- 32 sites collected carbonyl compound samples.

- 7 sites collected SNMOC samples.

- 19 sites collected PAH samples.

- 21 sites collected metals samples.

- 2 sites collected hexavalent chromium samples.

As part of the sampling schedule, site operators were instructed to collect duplicate (or collocated) samples on roughly 10 percent of the sample days for select methods when duplicate (or collocated) samplers were available. Field blanks were collected once a month for carbonyl compounds, hexavalent chromium, metals, and PAHs. 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 on a given scheduled sample day, site operators were instructed to reschedule or "make up" samples on other days. This practice explains why some monitoring locations periodically strayed from the 1-in-6 or 1-in-12 day sampling schedule.

Table 2-9. 2014 Sampling Schedules and Completeness Rates

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
ASKY	1/5/14	12/31/14	61	61	100	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
ASKY-M	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	59	61	97	--	--	--	--	--	--
ATKY	1/7/14	12/31/14	--	--	--	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
AZFL	1/5/14	12/31/14	56	61	92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BAKY	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	58	61	95	--	--	--	--	--	--
BLKY	1/7/14	12/31/14	--	--	--	60	61	98	--	--	--	12	13	92	--	--	--	--	--	--
BMCO	1/5/14	12/31/14	27	31	87[2]	--	--	--	--	--	--	--	--	--	51	61	84	--	--	--
BOMA	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	58	61	95	--	--	--	57	61	93
BRCO	1/5/14	12/31/14	25	31	81[2]	--	--	--	--	--	--	--	--	--	50	51	82	--	--	--
BTUT	1/5/14	12/31/14	58	61	95	55	61	90	--	--	--	57	61	93	55	61	90	58	61	95
BXNY	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	57	61	93
CCKY	1/5/14	10/2/14	--	--	--	46	46	100	--	--	--	41	46	89	--	--	--	--	--	--
CELA	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	56	61	92
CHNJ	1/11/14	12/31/14	60	61	98	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
CSNJ	1/8/14	12/31/14	60	61	98	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2014 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is below the MQO of 85 percent.

Table 2-9. 2014 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
DEMI	1/5/14	12/31/14	61	61	100	60	61	98	--	--	--	--	--	--	--	--	--	60	61	98
ELNJ	1/8/14	12/31/14	61	61	100	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--
GLKY	1/5/14	12/31/14	61	61	100	56	61	92	--	--	--	59	61	97	--	--	--	58	61	95
GPCO	1/5/14	12/31/14	58	61	95	57	61	93	--	--	--	59	61	97	--	--	--	60	61	98
INDEM	1/5/14	12/31/14	57	61	93	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LAKY	1/7/14	12/31/14	--	--	--	56	61	92	--	--	--	--	--	--	--	--	--	--	--	--
LEKY	1/5/14	12/31/14	55	61	90	58	61	95	--	--	--	56	61	92	--	--	--	--	--	--
NBIL	1/5/14	12/31/14	55	61	90	56	61	92	--	--	--	53	61	87	56	61	92	55	61	90
NBNJ	1/8/14	12/31/14	20	61	33	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--
OCOK	1/5/14	12/31/14	60	61	98	60	61	98	--	--	--	59	61	97	--	--	--	--	--	--
ORFL	1/5/14	12/31/14	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PACO	1/5/14	12/31/14	25	31	81[2]	--	--	--	--	--	--	--	--	--	57	61	93	--	--	--
PAFL[2]	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	30	31	97	--	--	--	--	--	--
PRRI	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	58	61	95
PXSS	1/5/14	12/31/14	61	61	100	61	61	100	--	--	--	60	61	98	--	--	--	59	61	97

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2014 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is below the MQO of 85 percent.

Table 2-9. 2014 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
RFCO[2]	1/5/14	12/31/14	26	31	84	--	--	--	--	--	--	--	--	--	28	31	90	--	--	--
RICO	1/5/14	12/31/14	27	31	87[2]	--	--	--	--	--	--	--	--	--	54	61	89	--	--	--
RIVA	1/5/14	12/31/14	--	--	--	--	--	--	61	61	100	--	--	--	--	--	--	57	61	93
ROCH	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	57	61	93
ROIL	1/5/14	12/31/14	60	61	98	58	61	95	--	--	--	--	--	--	--	--	--	--	--	--
RUCA	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	59	61	97
S4MO	1/5/14	12/31/14	60	61	98	59	61	97	31	31	100	61	61	100	--	--	--	57	61	93
SEWA	1/5/14	12/31/14	61	61	100	60	61	98	--	--	--	60	61	98	--	--	--	61	61	100
SJJCA	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	61	61	100	--	--	--	59	61	97
SKFL	1/5/14	12/31/14	50	61	82	--	--	--	--	--	--	--	--	--	--	--	--	58	61	95
SPAZ[2]	1/11/14	12/25/14	--	--	--	30	30	100	--	--	--	--	--	--	--	--	--	--	--	--
SPIL	1/5/14	12/31/14	59	61	97	55	61	90	--	--	--	--	--	--	--	--	--	--	--	--
SYFL	1/5/14	12/25/14	55	61	90	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TMOK	1/5/14	12/31/14	62	61	>100	62	61	>100	--	--	--	58	61	95	--	--	--	--	--	--
TOOK	1/5/14	12/31/14	61	61	100	61	61	100	--	--	--	62	61	102	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2014 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is below the MQO of 85 percent.

Table 2-9. 2014 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
TROK	1/5/14	12/31/14	61	61	100	61	61	100	--	--	--	59	61	97	--	--	--	--	--	--
TVKY	1/7/14	12/31/14	--	--	--	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
UNVT	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	61	61	100	--	--	--	59	61	97
WADC	1/5/14	12/31/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	61	98
WPIN	1/5/14	12/31/14	54	61	89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YUOK	1/5/14	12/31/14	61	61	100	61	61	100	--	--	--	61	61	100	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2014 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is below the MQO of 85 percent.

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 as well as a measure of the efficiency with which the program is managed. The completeness for each monitoring site and method sampled is presented in Table 2-9.

The measurement quality objective (MQO) 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, 2013). The data in Table 2-9 show that seven datasets from a total of 108 datasets from the 2014 NMP monitoring effort did not meet this MQO (orange shaded cells in Table 2-9):

- BMCO – SNMOC
- BRCO – carbonyl compounds and SNMOC
- NBNJ – carbonyl compounds
- PACO – carbonyl compounds
- RFCO – carbonyl compounds
- SKFL – carbonyl compounds

The percent completeness for each of these datasets is just less than the MQO of 85 percent (between 80 percent and 85 percent for each), with the exception of NBNJ.

Appendix I identifies samples that were invalidated and lists the reason for invalidation, based on the applied AQS null code. A defective sampler was discovered at SKFL and resulted in the invalidation of carbonyl compound samples collected between July 22, 2014 and September 20, 2014. A new sampler was installed on September 26, 2014 and sampling resumed on September 27, 2014. Similarly, carbonyl compound results were invalidated between May 5, 2014 and December 31, 2014 for NBNJ, after which a new sampler was installed.

Also of note, chromium and nickel concentrations measured at UNVT after July 4, 2014 were invalidated after the Vermont Department of Environmental Conservation determined that the filters were contaminated by a new weighing and equilibration chamber at their laboratory. As this affected only two of the 11 metals for which measurements were collected at this site, this invalidation is not reflected in Table 2-9.

Table 2-10 presents method-specific completeness. Method-specific completeness was greater than 85 percent for all methods performed under the 2014 NMP and ranged from 88 percent for SNMOCs to 100 percent for hexavalent chromium.

Table 2-10. Method Completeness Rates for 2014

Method	# of Valid Samples	# of Samples Scheduled	Method Completeness (%)	Minimum Site-Specific Completeness (%)	Maximum Site-Specific Completeness (%)
VOCs	1,556	1,601	97.2	90 (2 sites)	>100 (TMOK)
SNMOCs	351	397	88.4	82 (BRCO)	93 (PACO)
Carbonyl Compounds	1,678	1,802	93.1	33 (NBNJ)	>100 (TMOK)
PAHs	1,105	1,159	95.3	90 (***NBIL***)	100 (***SEWA***)
Metals Analysis	1,144	1,188	96.3	87 (***NBIL***)	>100 (2 sites)
Hexavalent Chromium[1]	92	92	100	100 (***RIVA*** and ***S4MO***)	

BOLD ITALICS = EPA-designated NATTS site.

[1] Hexavalent chromium was sampled for at only two sites in 2014.

3.0 Summary of the 2014 National Monitoring Programs Data Treatment and Methods for Data Analysis

This section summarizes the data treatment employed and approaches used to analyze the data generated from samples collected during the 2014 NMP sampling year. These data were analyzed on a program-wide basis as well as a site-specific basis.

Results from the program-wide data analyses are presented in Section 4 while results from the site-specific data analyses are presented in the individual state sections, Sections 5 through 23.

A total of 224,685 valid air toxics concentrations (including non-detects, duplicate analyses, replicate analyses, and analyses for collocated samples) were produced from 7,819 valid samples collected at 51 monitoring sites during the 2014 reporting year. A tabular presentation of the raw data and statistical summaries are found in Appendices C through O, as presented in Table 3-1. Appendix P serves as the glossary for the NMP report and many of the terms discussed and defined throughout the report are provided there.

Table 3-1. Overview and Layout of Data Presented

Pollutant Group	Number of Sites	Appendix	
		Raw Data	Statistical Summary
VOCs	27	C	J
SNMOCs	7	D	K
Carbonyl Compounds	32	E	L
PAHs	19	F	M
Metals	21	G	N
Hexavalent Chromium	2	H	O

3.1 Approach to Data Treatment

This section examines the various statistical tools employed to characterize and analyze the data collected during the 2014 sampling year. 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 concentration data for data analysis.

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

Concentrations of *m,p*-xylene and *o*-xylene were summed together and are referred to as "total xylenes," 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 4-2, which are the method-specific statistics for VOCs and SNMOCs, respectively, present the xylenes results retained as *m,p*-xylene and *o*-xylene species. Data for the isomers are also presented individually in the Data Quality section (Section 24).

For the 2014 NMP, where statistical parameters are calculated based on the preprocessed daily measurements, zeros have been substituted for non-detect results. This approach is consistent with how data are loaded into AQS per the NATTS TAD **(**EPA, 2009b) as well as other EPA air toxics monitoring programs, such as the School Air Toxics Monitoring Program (SATMP) (EPA, 2011a), and other associated reports, including the NATTS Network Assessment (EPA, 2012b). The substitution of zeros for non-detects results in lower average concentrations of pollutants that are rarely measured at or above the associated MDL and/or have a relatively high MDL.

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 unit of measure associated with the particular sampling method. Thus, it is important to pay close attention to the unit of measure associated with each data analysis discussed in this and subsequent sections of the report.

In addition, this report presents various time-based averages to summarize the measurements for a specific site. Where applicable, quarterly and annual averages were calculated for each site. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly averages include the substitution of zeros for all non-detects. Quarterly averages for the first quarter in the calendar year include measurements collected in January, February, and March; the second quarter includes April, May, and June samples; the third quarter includes July, August, and September samples; and the fourth quarter includes October, November, and December samples. A minimum of 75 percent of the total number of samples possible within a given calendar quarter must be valid to have a quarterly average presented. For sites sampling on a 1-in-6 day sampling schedule, 12 samples meet the 75 percent criteria; for sites sampling on a 1-in-12 day schedule, six samples meet the 75 percent criteria. Sites that do not meet this minimum requirement do not have a quarterly average concentration presented. Sites may not meet this minimum requirement due to invalidated or missed samples or because of a shortened sampling duration.

An *annual average concentration* includes all measured detections and substituted zeros for non-detects for a given calendar year (2014). Annual average concentrations were calculated for monitoring sites where three quarterly averages could be calculated and where method completeness, as presented in Section 2.4, is greater than or equal to 85 percent. Sites that do not meet these requirements do not have an annual average concentration presented.

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 (EPA, 2011a). For example, an average concentration may be written as 1.25 ± 0.25 µg/m^3; thus, the interval over which the true average would be expected to fall would be between 1.00 µg/m^3 to 1.50 µg/m^3.

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. Health risk-based calculations have been used to identify "pollutants of interest" for several years, including the 2014 NMP report. The following paragraphs provide an overview of health risk terms and concepts and outline how the pollutants of interest are determined 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, 2015b). Human health risk can be further 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, 2010a). Health risk is also route-specific; that is, risk varies depending 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 effects" (EPA, 2016c).

Health risks are typically divided into cancer and noncancer effects when referring to human health risk. Cancer risk is defined as the likelihood of developing cancer as a result of exposure to a given concentration over a 70-year period, and is presented as the number of people at risk for developing cancer per million people. Noncancer health effects include conditions such as asthma; noncancer health risks are presented as a hazard quotient, the value below which no adverse health effects are expected (EPA, 2015b). Cancer risk is presented as a probability while the hazard quotient is a ratio and thus, a unitless value.

In order to assess health risk, EPA and other agencies develop toxicity factors, 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-based screening approach for performing an initial screen of ambient air toxics monitoring datasets (EPA, 2010a). The *preliminary risk-based screening process* provided in this report is an

adaption of that approach and is a risk-based methodology for analysts and interested parties to identify which pollutants may pose a health risk in their area. For this process, cancer UREs and noncancer RfCs are converted into screening values. The cancer screening value is the cancer URE converted to µg/m^3 and divided by one million. The noncancer screening value is one-tenth of the noncancer RfC and converted from milligram per cubic meter (mg/m^3) to µg/m^3. The final screening value used in this report is the lower of the two screening values. Not all pollutants analyzed under the NMP have screening values; of the pollutants sampled under the NMP, 71 pollutants have screening values. The screening values used in this analysis are presented in Appendix Q[1].

The 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-based 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 for each sample day.

2. Each preprocessed daily measurement was compared to its associated risk screening value. Concentrations that are greater than the risk 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.

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 nickel 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 of the program-wide risk-based screening process are provided in Section 4.2.

[1] The risk-based screening process used in this report is an adaption of guidance 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 have since been updated (EPA, 2015c, 2015d).

A note regarding measurements of acetonitrile, acrylonitrile, carbon disulfide, and acrolein: Laboratory analysts have indicated that acetonitrile concentrations 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. Similarly, laboratory analysts have also indicated that acrylonitrile and carbon disulfide concentrations may also be artificially high due to potential contamination of the samplers using Method TO-15. Additionally, questions about the consistency and reliability of acrolein measurements have been raised during other monitoring projects, such as SAMP (EPA, 2010b). The inclusion of acetonitrile, acrylonitrile, carbon disulfide, and acrolein in data analyses must be determined on a site-specific basis by the agency responsible for the site. Thus, results for these pollutants are also excluded from program-wide and site-specific data analyses related to risk.

The NATTS TAD (EPA, 2009b) identifies 19 pollutants ("MQO Core Analytes") that participating sites are required to sample and analyze for under the NATTS program. Table 3-2 presents these 19 NATTS MQO Core Analytes. Monitoring for these pollutants is required because they are major health risk drivers according to EPA (EPA, 2009b). Many of the pollutants listed in Table 3-2 are identified as pollutants of interest via the risk-based screening process. Note that beginning in July 2013, hexavalent chromium was removed from the list of required pollutants for which to sample under the NATTS program. As a result, many NATTS sites discontinued sampling hexavalent chromium. In 2014, two NATTS sites sampled for this pollutant, RIVA and S4MO, although S4MO also discontinued sampling in July 2014.

The "pollutants of interest" designation is reserved for pollutants targeted for sampling through the NMP that meet the identified criteria. As discussed in Section 2.0, agencies operating monitoring sites that participate under the UATMP, NATTS, or CSATAM programs are not required to have their samples analyzed by ERG or may measure pollutants 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-based screening process or any other data analysis contained in this report.

Table 3-2. NATTS MQO Core Analytes

Pollutant	Class/Method
Acrolein	VOCs/TO-15
Benzene	
1,3-Butadiene	
Carbon Tetrachloride	
Chloroform	
Tetrachloroethylene	
Trichloroethylene	
Vinyl Chloride	
Acetaldehyde	Carbonyl Compounds/ TO-11A
Formaldehyde	
Naphthalene	PAHs/ TO-13A
Benzo(a)pyrene	
Arsenic	Metals/ IO-3.5 and EQL-0512-201/202
Beryllium	
Cadmium	
Manganese	
Lead	
Nickel	
Hexavalent chromium[1]	Metals/ASTM D7614

[1] Hexavalent chromium was removed from the Core Analytes list in July 2013, although a few NATTS sites continued to sample for it in 2014.

3.3 Additional Program-Level Analyses of the 2014 National Monitoring Programs Dataset

This section summarizes additional analyses performed on the 2014 NMP dataset at the program level. Additional program-level analyses include a review of how concentrations vary among the sites themselves and from quarter-to-quarter. The results of these analyses are presented in Section 4.2.

Variability refers to the degree of difference among values in a dataset. Two types of variability are analyzed for this report. The first type of variability assessed in this report is inter-site variability. For this analysis, the annual average concentration for each site is plotted in the form of a bar graph for each program-wide pollutant of interest. The criteria for calculating an annual average concentration are discussed in Section 3.1 and sites that do not meet these requirements do not have an annual average concentration presented. This assessment allows the reader to visualize how concentrations varied across the sites for a particular pollutant of interest.

In order to further this analysis, the program-level average concentrations, as presented in Section 4.1 in Tables 4-1 through 4-6, are plotted against the site-specific annual averages. This allows the reader to see how the site-specific annual averages compare to the program-level average for each pollutant. Note that the average concentrations shown for VOCs, SNMOCs, and carbonyl compounds in Tables 4-1 through 4-3 are presented in method-specific units, but have been converted to a common unit of measurement ($\mu g/m^3$) for the purposes of this analysis.

Quarterly variability is the second type of variability assessed in this report. The concentration data for each site were divided into the four quarters of the year, as described in Section 3.1. The completeness criteria, also described in Section 3.1, are maintained here as well. The site-specific quarterly average concentrations are illustrated by bar graphs for each program-level pollutant of interest. This analysis allows for the potential determination of a quarterly (or seasonal) correlation with the magnitude of concentrations for a specific pollutant.

3.4 Additional Site-Specific Analyses

In addition to 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 23).

3.4.1 Site Characterization

For each site participating in the 2014 NMP, a site characterization was performed. This characterization includes a review of the nearby area surrounding the monitoring site; plotting of emissions sources surrounding the monitoring site; and obtaining traffic data and other characterizing information. For the 2014 NMP report, the locations of point sources located near the monitoring sites were obtained from Version 2 of the 2011 NEI (EPA, 2015a). Sources for other site-characterizing data are provided in the individual state sections.

3.4.2 Meteorological Analysis

Several site-specific meteorological analyses were performed in order to help readers determine which meteorological factors may play a role in a given site's air quality. First, the average (or mean) for several meteorological parameters (such as temperature, pressure, and wind speed) are provided. Two averages are presented for each parameter, one average representing all of 2014 and one average representing sample days only. These two averages provide an indication of how meteorological conditions on sample days varied from typical conditions experienced throughout the year.

The way in which these meteorological parameters were developed is different for the 2014 report compared to previous reports. Previously, these averages were 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). Beginning with the 2014 report, where meteorological data collected at each monitoring site are available in AQS, these data were used to calculate the full-year and sample day averages. This change was made to better represent the meteorological conditions at the individual monitoring sites. Where no site-specific data were available, or where data is missing from AQS, NWS data was substituted.

Wind roses were constructed for each site in order to further characterize the meteorology at or near each monitoring site. A wind rose shows the frequency at which a given wind speed and direction are measured near the monitoring site, capturing day-to-day fluctuations at the surface while allowing the predominant direction from which the wind blows to be identified. Thus, 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. 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 obtained from either data collected at the individual monitoring site, where possible, or the nearest NWS weather station, into a wind rose software program, WRPLOT (Lakes, 2011). For each site, two wind roses were constructed. First, 2014 data were used to construct a wind rose presenting wind data for the entire calendar year; then, a wind rose was constructed to present wind data for sample days only. These wind roses are used to determine if

the meteorological conditions on sample days were representative of conditions experienced throughout the sampling year near each site.

The NWS defines calm winds as those less than 3 mph; thus, after converting and formatting for the WRPLOT program, wind speeds of 0 knots to 2 knots are considered "calm" (NOAA, 1998). But wind speed data collected at the individual sites is often reported at levels less than this threshold. As such, the threshold has been lowered to 1 knot for the wind roses.

3.4.3 Preliminary Risk-Based Screening and Pollutants of Interest

The preliminary risk-based 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, the time-period averages (quarterly and annual) described in Section 3.1 were calculated for each site and were used for various data analyses at the site-specific level, as described below:

- Comparison to the program-level average concentrations
- Trends analysis
- The calculation of cancer risk and noncancer hazard approximations in relation to cancer and noncancer health effects, including the emission tracer analysis
- Risk-based emissions assessment.

3.4.3.1 Site-Specific Comparison to Program-level Average Concentrations

To better understand how an individual site's measurements compare to the program-level results, as presented in Section 4.1 in Tables 4-1 through 4-6, the site-specific and program-level concentrations are presented together graphically for each site-specific pollutant of interest identified via the risk-based screening process. This analysis is an extension of the analysis discussed in Section 3.3 and utilizes box and whisker plots, or simply box plots, to visually show this comparison. These box plots were created in Microsoft Excel, using the Peltier Tech Charts for Excel 3.0 utility (Peltier, 2016). Note that for sites sampling VOCs (or SNMOCs), pollutants are shown only in comparison to other sites sampling VOCs (or SNMOCs) to match the program-level averages presented in Section 4.1 in Tables 4-1 and 4-2.

The box plots used in this analysis overlay the site-specific minimum, annual average, and maximum concentrations over several program-level statistical metrics. For the program-level statistics, the first, second (median), third, and fourth (maximum) quartiles are shown as colored segments on a "bar" where the color changes correspond to the exact numerical value of the quartile. The thin vertical line represents the program-level average concentration. The site-specific annual average is shown as a white circle plotted on top of the bar and the horizontal lines extending outward from the white circle represent the minimum and maximum concentration measured at the site. An example of this figure is shown in Figure 5-6. Note that the program-level average concentrations shown for VOCs, SNMOCs, and carbonyl compounds in Tables 4-1 through 4-3 are presented in method-specific units, but have been converted to a common unit of measurement ($\mu g/m^3$) for the purposes of this analysis. These graphs are presented in Sections 5 through 23, and are grouped by pollutant within each state section. This allows for both a "site vs. program" comparison as well as an inter-site comparison for sites within a given state.

3.4.3.2 Site Trends Analysis

Table 2-1 presents current monitoring sites that have participated in the NMP in previous years. A site-specific trends analysis was conducted for sites with at least 5 consecutive years of method-specific data analyzed under the NMP. The trends analysis was conducted for each of the site-specific pollutants of interest identified via the risk-based screening process. Thirty-five of the 51 sites have sampled at least one pollutant group long enough for the trends analysis to be conducted. The approach to this trends analysis is described below and the results are presented in the individual state sections (Sections 5 through 23).

The trends figures and analyses are presented as 1-year statistical metrics. The following criteria were used to calculate valid statistical metrics:

- Analysis must have been performed under the NMP by the contract laboratory.
- There must be a minimum of at least 5 years of consecutive data.

Five individual statistical metrics were calculated for this analysis and are presented as box and whisker plots, an example of which can be seen in Figure 5-17. The statistical metrics shown include the minimum and maximum concentration measured during each year of

sampling (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 of the box, the blue line, and top of the box, respectively); and the average (or mean) concentration (as denoted by the orange diamond). Each of the five statistical metrics incorporates all measurements collected during that 1-year period. For each 1-year period, there must be a minimum of 85 percent completeness, which corresponds to roughly 51 valid samples or approximately 10 months of sampling (for a site sampling on a 1-in-6 day sampling schedule) for an average concentration to be presented. For cases where sampling began mid-year, a minimum of 6 months of sampling is required. In these cases, a 1-year average is not provided but the concentration range and quartiles are still presented.

Historical data used in this analysis were downloaded from EPA's AQS database (EPA, 2016b) in order to ensure the use of the most up-to-date data available. Recall that 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.

In NMP reports prior to 2014, results from sample days with precision data (duplicates, collocates, and/or replicates) were averaged together to allow for the determination of a single concentration per pollutant for each site, reflecting the data treatment described in Section 3.1. For 2014, duplicate and replicate data were not downloaded from AQS due to a change in the availability of this data in AQS. However, for collocated results, the averaging schema was retained.

3.4.3.3 Cancer Risk and Noncancer Hazard Approximations

Risk was further examined by calculating cancer risk and noncancer hazard 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 to a given pollutant 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, 2009c). The noncancer hazard approximation is presented as the Noncancer Hazard Quotient (HQ), which is a unitless value. According to EPA, "A hazard quotient less than or

equal to one indicates that adverse noncancer effects are not likely to occur, and thus can be considered to have negligible hazard." (EPA, 2015b).

The toxicity factors applied to calculate the cancer risk and noncancer hazard approximations are typically UREs (for cancer) or RfCs (for noncancer), which are developed by EPA. However, UREs and RfCs are not available for all pollutants. In the absence of EPA values, toxicity factors developed by agencies with credible methods and that are similar in scope and definition were used (EPA, 2015c/2015d). Cancer URE and noncancer RfC toxicity factors can be applied to the annual average concentrations to approximate risk based on ambient monitoring data. While the cancer risk and noncancer hazard 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 averages, and corresponding annual average-based cancer risk and noncancer hazard approximations are presented in each state section (Sections 5 through 23).

To further this analysis, pollution roses were created for each of the site-specific pollutants of interest that have cancer risk approximations greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. This analysis is performed 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.

There are, however, limitations to this analysis. Wind data are hourly observations while concentrations from this report are 24-hour measurements. Thus, the wind data must be averaged for comparison to the concentrations data. Wind speed and direction can fluctuate throughout a given day or change dramatically if a frontal system moves through. Thus, the average calculated wind data may not be completely representative of a given day. This can be investigated more thoroughly if the need arises.

3.4.3.4 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 toxicity factors, as discussed in previous sections, 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 10 pollutants with the highest 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 *relative 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 greater than or equal to 1.0). The pollutants exhibiting the 10 highest annual average-based risk approximations for cancer and noncancer effects 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 and whether or not these pollutants are already being monitoring or perhaps should be monitored in the future.

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

1. Obtain HAP emissions data for all anthropogenic sectors (nonpoint, point, onroad, and nonroad) from the NEI. For point sources, sum the process-level emissions to the county-level. Biogenic emissions are not included in this analysis.

2. Apply the mass extraction speciation profiles to extract metal and cyanide mass.

3. Apply weight to the emissions derived from the steps above based on their toxicity. The results of the toxicity-weighting process are unitless.
    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 PAHs and/or phenols 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 PAHs are grouped into POM Groups in order to assess risk attributable to these pollutants. Thus, emissions data and toxicity-weighted emissions for many of the PAHs are presented by POM Groups for this analysis. Table 3-3 presents the 22 PAHs measured by Method TO-13A and their associated POM Groups, if applicable.

Table 3-3. POM Groups for PAHs[1]

Pollutant	POM Group	POM Subgroup	New POM Grouping
Acenaphthene	Group 2	Group 2b	PAH_880E5
Acenaphthylene	Group 2	Group 2b	PAH_880E5
Anthracene	NA		PAH_000E0
Benzo(a)anthracene	Group 6		PAH_176E4
Benzo(a)pyrene	Group 5	Group5a	PAH_176E3
Benzo(b)fluoranthene	Group 6		PAH_176E4
Benzo(e)pyrene	Group 2	Group 2b	PAH_880E5
Benzo(g,h,i)perylene	Group 2	Group 2b	PAH_880E5
Benzo(k)fluoranthene	Group 6		PAH_176E4
Chrysene	Group 7		PAH_176E5
Coronene	NA		
Cyclopenta[cd]pyrene	NA		
Dibenz(a,h)anthracene	Group 5	Group5b	PAH_192E3
Fluoranthene	Group 2	Group 2b	PAH_880E5
Fluorene	Group 2	Group 2b	PAH_880E5
9-Fluorenone	NA		
Indeno(1,2,3-cd)pyrene	Group 6		PAH_176E4
Naphthalene*	NA		
Perylene	Group 2	Group 2b	PAH_880E5
Phenanthrene	NA		PAH_000E0
Pyrene	NA		PAH_000E0
Retene	NA		

* Emissions for these pollutants are reported to the NEI individually; therefore, they are not included in one of the POM Groups.

[1] Reference = EPA 2015c

NA = no POM Group assigned.

The POM groups are sub-grouped in Table 3-3 because toxicity research has led to the refining of UREs for certain PAHs. With the release of the 2011 NATA, the POM Groups have been renamed, although the grouping is still based on the same risk levels. For simplicity's sake, the original names are provided in the analysis, but both names are provided in Table 3-3. Note the following in regards to Table 3-3:

- naphthalene emissions are reported to the NEI individually; therefore, it is not included in one of the POM Groups;
- four pollutants analyzed by Method TO-13A and listed in Table 3-3 do not have assigned POM Groups;
- anthracene, phenanthrene, and pyrene used to be part of POM Group 2 (2d), but have been removed.

4.0 Summary of the 2014 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 the target pollutants of each analytical method: 1) detection rates, 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

There is an experimentally determined MDL for every target pollutant, 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. 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 each target pollutant was detected out of the number of valid samples collected and analyzed. Approximately 55 percent of the reported measurements (based on the preprocessed daily measurements) were equal to or greater than the MDLs across the program. The following list provides the percentage of measurements that were above the MDLs for each of the target pollutant groups:

- 43 percent for VOCs
- 42 percent for SNMOCs
- 83 percent for carbonyl compounds
- 73 percent for PAHs
- 79 percent for metals

- 53 percent for hexavalent chromium.

Some pollutants were detected in every valid sample collected while others were infrequently detected or not detected at all. Among the carbonyl compounds, formaldehyde and acetaldehyde had the greatest number of measured detections (1,678), based on the preprocessed daily measurements. These pollutants were reported in every valid carbonyl compound sample collected (1,678). Eleven VOCs (acetylene, benzene, carbon tetrachloride, chloromethane, dichlorodifluoromethane, dichlorotetrafluoroethane, ethylbenzene, *m,p*-xylene, propylene, toluene, and trichlorofluoromethane) were detected in every valid VOC sample collected (1,556). Eleven pollutants (acetylene, *n*-butane, ethane, ethylene, *n*-hexane, isobutene, 2-methylpentane, *n*-pentane, propane, propylene, and toluene) were detected in every valid SNMOC sample collected (351). 9-Fluorenone, fluoranthene, naphthalene, phenanthrene, and pyrene were detected in every valid PAH sample collected (1,105). Antimony, cadmium, cobalt, lead, and manganese were detected in every valid speciated metals sample collected (1,144). Hexavalent chromium was detected in 49 samples (out of 92 valid samples collected).

BTUT and NBIL have the greatest number of measured detections by a considerable margin (6,712 for BTUT and 6,174 for NBIL). They are two of only three NMP sites that collected samples for at least five analytical methods/pollutant groups and the only two NMP site to sample both VOCs and SNMOCs. However, the detection rates for these sites (67 percent and 62 percent, respectively) 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 be expected to have higher detection rates. PAFL's detection rate is 100 percent. Conversely, VOCs had one of the lowest percentages of concentrations greater than the MDLs (43 percent). A site measuring only VOCs would be expected to have lower detection rates, such as SPAZ (49 percent).

Table 4-1. Statistical Summaries of the VOC Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Acetonitrile[3]	13	1,537	16	0.035	542	15.7	0.360	0.156	2.58	58.5
Acetylene	0	1,556	0	0.093	37.9	1.13	0.573	0.365	0.975	2.53
Acrolein	189	1,367	54	0.038	3.55	0.339	0.293	0.146	0.486	0.261
Acrylonitrile[3]	1,183	373	0	0.016	1.03	0.044	0	0	0	0.105
tert-Amyl Methyl Ether	1,539	17	14	0.005	0.012	<0.001	0	0	0	0.001
Benzene	0	1,556	0	0.041	3.88	0.232	0.191	0.138	0.270	0.185
Bromochloromethane	1,556	0	0	Not Detected						
Bromodichloromethane	1,365	191	133	0.005	1.73	0.005	0	0	0	0.055
Bromoform	1,373	183	163	0.004	0.046	0.001	0	0	0	0.003
Bromomethane	304	1,252	470	0.006	47.7	0.046	0.012	0.009	0.014	1.22
1,3-Butadiene	121	1,435	66	0.005	2.66	0.046	0.029	0.019	0.047	0.107
Carbon Disulfide	5	1,551	435	0.004	12.1	0.467	0.022	0.012	0.110	1.30
Carbon Tetrachloride	0	1,556	3	0.006	0.486	0.102	0.101	0.094	0.108	0.026
Chlorobenzene	1,469	87	44	0.005	0.039	0.001	0	0	0	0.005
Chloroethane	1,023	533	4	0.013	0.377	0.012	0	0	0.021	0.024
Chloroform	148	1,408	1	0.013	3.61	0.043	0.025	0.020	0.035	0.130
Chloromethane	0	1,556	0	0.379	2.87	0.595	0.578	0.539	0.623	0.125
Chloroprene	1,554	2	0	0.040	0.055	<0.001	0	0	0	0.002
Dibromochloromethane	742	814	782	0.001	0.812	0.004	0.003	0	0.006	0.023
1,2-Dibromoethane	1,516	40	37	0.007	0.015	<0.001	0	0	0	0.002
m-Dichlorobenzene	1,446	110	107	0.005	0.015	0.001	0	0	0	0.002
o-Dichlorobenzene	1,409	147	147	0.004	0.013	0.001	0	0	0	0.002
p-Dichlorobenzene	875	681	468	0.005	0.190	0.007	0	0	0.010	0.013
Dichlorodifluoromethane	0	1,556	0	0.336	0.672	0.504	0.505	0.480	0.523	0.034
1,1-Dichloroethane	1,495	61	28	0.007	0.254	0.001	0	0	0	0.008
1,2-Dichloroethane	115	1,441	38	0.010	6.75	0.075	0.020	0.017	0.025	0.380

[1] Out of 1,556 valid samples

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 1,556 for some compounds where no value could be reported due to co-elution.

Table 4-1. Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
1,1-Dichloroethene	1,450	106	98	0.004	0.040	0.001	0	0	0	0.002
cis-1,2-Dichloroethylene	1,553	3	0	0.019	0.073	<0.001	0	0	0	0.002
trans-1,2-Dichloroethylene	1,484	72	15	0.005	1.41	0.004	0	0	0	0.056
Dichloromethane[3]	0	1,504	0	0.056	2,420	4.037	0.127	0.094	0.262	66.8
1,2-Dichloropropane	1,553	3	3	0.013	0.015	<0.001	0	0	0	0.001
cis-1,3-Dichloropropene	1,548	8	7	0.008	0.030	<0.001	0	0	0	0.001
trans-1,3-Dichloropropene	1,555	1	0	0.021		Single Detect				
Dichlorotetrafluoroethane	0	1,556	3	0.011	0.032	0.017	0.017	0.015	0.019	0.003
Ethyl Acrylate	1,550	6	1	0.014	0.045	<0.001	0	0	0	0.002
Ethyl *tert*-Butyl Ether	1,228	328	43	0.005	0.211	0.008	0	0	0	0.019
Ethylbenzene	0	1,556	83	0.005	0.771	0.058	0.041	0.024	0.072	0.057
Hexachloro-1,3-butadiene	1,197	359	358	0.003	0.057	0.002	0	0	0	0.004
Methyl Isobutyl Ketone	153	1,403	238	0.008	3.37	0.042	0.031	0.018	0.048	0.097
Methyl Methacrylate	1,444	112	63	0.005	0.866	0.002	0	0	0	0.026
Methyl *tert*-Butyl Ether	1,174	382	128	0.007	0.337	0.007	0	0	0	0.018
n-Octane	71	1,485	57	0.007	1.77	0.050	0.032	0.019	0.054	0.087
Propylene	0	1,556	0	0.091	25.9	0.582	0.344	0.245	0.545	1.24
Styrene	279	1,277	276	0.006	3.91	0.070	0.018	0.010	0.035	0.258
1,1,2,2-Tetrachloroethane	1,314	242	204	0.005	0.091	0.002	0	0	0	0.007
Tetrachloroethylene	284	1,272	539	0.005	0.622	0.024	0.012	0.008	0.020	0.053
Toluene	0	1,556	0	0.029	14.4	0.414	0.266	0.144	0.507	0.570
1,2,4-Trichlorobenzene	1,473	83	83	0.004	0.032	0.001	0	0	0	0.002
1,1,1-Trichloroethane	553	1,003	980	0.004	0.110	0.006	0.006	0	0.009	0.005
1,1,2-Trichloroethane	1,528	28	8	0.011	0.111	<0.001	0	0	0	0.004
Trichloroethylene	1,241	315	215	0.007	0.598	0.006	0	0	0	0.032
Trichlorofluoromethane	0	1,556	0	0.150	1.07	0.244	0.233	0.223	0.247	0.056
Trichlorotrifluoroethane	1	1,555	0	0.054	0.112	0.080	0.080	0.077	0.084	0.006

[1] Out of 1,556 valid samples

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 1,556 for some compounds where no value could be reported due to co-elution.

Table 4-1. Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
1,2,4-Trimethylbenzene	30	1,526	299	0.004	0.828	0.055	0.037	0.020	0.068	0.062
1,3,5-Trimethylbenzene	177	1,379	683	0.003	0.283	0.020	0.015	0.008	0.026	0.021
Vinyl chloride	1,308	248	70	0.003	8.95	0.028	0	0	0	0.272
m,p-Xylene	0	1,556	65	0.008	3.21	0.154	0.100	0.053	0.190	0.181
o-Xylene	4	1,552	78	0.005	1.16	0.063	0.043	0.024	0.080	0.069

[1] Out of 1,556 valid samples

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 1,556 for some compounds where no value could be reported due to co-elution.

Table 4-2. Statistical Summaries of the SNMOC Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
Acetylene	0	351	0	0.157	7.04	1.24	0.958	0.573	1.55	0.994
Benzene[3]	0	341	0	0.231	5.49	1.62	1.37	0.865	2.16	0.979
1,3-Butadiene	266	85	36	0.042	0.822	0.062	0	0	0	0.134
n-Butane	0	351	0	0.545	63.8	11.2	8.17	4.07	13.8	10.4
1-Butene[3]	2	1	0	20.0		Single Detect				
cis-2-Butene	215	136	12	0.053	1.13	0.086	0	0	0.131	0.151
trans-2-Butene	209	142	5	0.065	2.02	0.151	0	0	0.257	0.259
Cyclohexane	13	338	35	0.094	10.3	2.18	1.80	0.467	3.18	1.97
Cyclopentane[3]	74	275	8	0.087	1.78	0.419	0.400	0.196	0.567	0.337
Cyclopentene	307	44	41	0.081	1.34	0.039	0	0	0	0.140
n-Decane	49	302	116	0.100	4.86	0.532	0.418	0.212	0.702	0.530
1-Decene	348	3	2	0.131	0.554	0.003	0	0	0	0.033
m-Diethylbenzene	341	10	7	0.149	5.98	0.032	0	0	0	0.345
p-Diethylbenzene	337	14	8	0.162	1.53	0.019	0	0	0	0.115
2,2-Dimethylbutane[3]	68	282	60	0.075	1.37	0.340	0.310	0.138	0.472	0.282
2,3-Dimethylbutane	12	339	46	0.071	2.84	0.658	0.574	0.254	0.840	0.531
2,3-Dimethylpentane	10	341	52	0.075	6.32	0.573	0.457	0.307	0.680	0.516
2,4-Dimethylpentane	32	319	99	0.067	4.02	0.379	0.330	0.183	0.490	0.340
n-Dodecane	83	268	244	0.080	70.1	0.501	0.177	0.096	0.333	3.75
1-Dodecene	347	4	3	0.992	1.98	0.015	0	0	0	0.145
Ethane	0	351	2	1.11	250	43.5	27.9	10.1	64.2	42.9
2-Ethyl-1-butene	351	0	0	Not Detected						
Ethylbenzene	68	283	91	0.081	2.14	0.334	0.265	0.135	0.453	0.322
Ethylene	0	351	0	0.897	21.7	2.72	2.39	1.81	3.14	1.66
m-Ethyltoluene	87	264	74	0.134	2.92	0.570	0.423	0.138	0.804	0.593
o-Ethyltoluene	240	111	58	0.140	1.53	0.147	0	0	0.246	0.270

[1] Out of 351 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 351 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-2. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
p-Ethyltoluene	144	207	70	0.125	1.73	0.281	0.208	0	0.430	0.337
n-Heptane	1	350	25	0.089	10.5	1.94	1.69	0.611	2.68	1.60
1-Heptene	348	3	1	0.147	12.4	0.037	0	0	0	0.661
n-Hexane	0	351	12	0.225	20.9	3.67	3.14	1.24	4.82	3.12
1-Hexene	229	122	106	0.068	17.3	0.110	0	0	0.116	0.924
cis-2-Hexene	343	8	7	0.092	0.208	0.003	0	0	0	0.019
trans-2-Hexene	334	17	15	0.079	0.292	0.008	0	0	0	0.036
Isobutane	0	351	0	0.287	58.1	9.52	7.02	2.14	12.3	9.65
Isobutylene[3]	2	3	0	0.294	0.627	0.249	0.294	0	0.325	0.234
Isopentane[3]	9	102	0	0.633	38.3	8.03	7.10	1.89	11.1	7.42
Isoprene	133	218	47	0.055	10.2	0.553	0.133	0	0.690	1.05
Isopropylbenzene	318	33	29	0.083	0.251	0.014	0	0	0	0.046
2-Methyl-1-butene[3]	186	164	8	0.087	1.06	0.145	0	0	0.266	0.188
3-Methyl-1-butene[3]	346	4	0	0.220	0.761	0.006	0	0	0	0.057
2-Methyl-1-pentene	346	5	5	0.111	0.147	0.002	0	0	0	0.015
4-Methyl-1-pentene	350	1	0	0.368		Single Detect				
2-Methyl-2-butene	223	128	17	0.094	1.90	0.143	0	0	0.258	0.241
Methylcyclohexane[3]	33	314	15	0.112	25.7	3.98	2.80	0.659	6.20	3.97
Methylcyclopentane	2	349	1	0.164	8.23	2.07	1.83	0.732	2.84	1.61
2-Methylheptane	83	268	60	0.095	4.28	0.574	0.500	0.129	0.845	0.561
3-Methylheptane	64	287	101	0.091	3.18	0.446	0.364	0.149	0.636	0.419
2-Methylhexane	2	349	0	0.248	6.32	1.76	1.54	0.980	2.34	1.09
3-Methylhexane[3]	101	146	0	0.402	4.89	1.10	1.03	0	1.90	1.15
2-Methylpentane	0	351	1	0.250	12.4	3.23	2.84	1.40	4.25	2.32
3-Methylpentane	2	349	4	0.119	6.64	1.57	1.38	0.620	1.97	1.25
n-Nonane	20	331	83	0.092	4.92	0.597	0.449	0.221	0.797	0.579

[1] Out of 351 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 351 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-2. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
1-Nonene	173	178	150	0.081	11.4	0.142	0.098	0	0.179	0.618
n-Octane	3	348	71	0.106	10.9	1.41	1.10	0.449	1.98	1.31
1-Octene	89	262	179	0.097	12.0	0.273	0.215	0	0.324	0.663
n-Pentane	0	351	0	0.359	78.2	6.36	4.90	2.42	7.52	6.59
1-Pentene	51	300	141	0.071	19.0	0.258	0.149	0.100	0.250	1.03
cis-2-Pentene	273	78	42	0.042	0.476	0.030	0	0	0	0.066
trans-2-Pentene	161	190	74	0.058	1.01	0.107	0.076	0	0.163	0.145
a-Pinene	222	129	22	0.104	9.38	0.312	0	0	0.338	0.845
b-Pinene	347	4	0	1.87	4.82	0.041	0	0	0	0.402
Propane	0	351	0	1.65	167	27.1	18.4	7.78	35.4	26.0
n-Propylbenzene	185	166	87	0.081	3.77	0.163	0	0	0.264	0.280
Propylene	0	351	0	0.417	19.2	1.19	1.01	0.719	1.31	1.12
Propyne	351	0	0	Not Detected						
Styrene[3]	183	70	5	0.141	22.6	1.63	0	0	0.463	3.96
Toluene	0	351	0	0.558	67.0	5.37	4.08	2.64	6.59	5.30
n-Tridecane	215	136	125	0.087	22.3	0.180	0	0	0.151	1.21
1-Tridecene	351	0	0	Not Detected						
1,2,3-Trimethylbenzene	184	167	72	0.100	1.16	0.141	0	0	0.242	0.188
1,2,4-Trimethylbenzene	7	344	132	0.120	8.90	0.899	0.678	0.407	1.13	0.807
1,3,5-Trimethylbenzene	139	212	114	0.097	1.54	0.244	0.190	0	0.414	0.274
2,2,3-Trimethylpentane	291	60	31	0.086	1.81	0.058	0	0	0	0.162
2,2,4-Trimethylpentane[3]	174	175	39	0.107	12.1	0.452	0.107	0	0.527	0.981
2,3,4-Trimethylpentane	97	254	140	0.068	3.21	0.281	0.181	0	0.354	0.368
n-Undecane	47	304	282	0.087	21.1	0.373	0.240	0.147	0.401	1.15
1-Undecene	328	23	23	0.086	0.718	0.017	0	0	0	0.075
m-Xylene/*p*-Xylene	4	347	27	0.201	11.4	1.74	1.41	0.751	2.37	1.37

[1] Out of 351 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 351 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-2. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
o-Xylene	16	335	37	0.096	3.20	0.557	0.455	0.281	0.698	0.429
SNMOC (Sum of Knowns)	NA	NA	NA	16.8	724	150	124	59.5	191	117
Sum of Unknowns	NA	NA	NA	16.3	2,790	148	89.6	56.4	157	232
TNMOC	NA	NA	NA	41.1	2,930	297	251	153	368	256

[1] Out of 351 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 351 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-3. Statistical Summaries of the Carbonyl Compound Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Acetaldehyde	0	1,678	0	0.010	5.08	0.974	0.860	0.545	1.24	0.618
Acetone[3]	0	1,677	0	0.031	6.46	1.12	0.974	0.591	1.44	0.787
Benzaldehyde[3]	13	1,622	0	0.002	1.30	0.027	0.022	0.014	0.032	0.037
2-Butanone[3]	2	1,618	0	0.007	1.82	0.184	0.142	0.089	0.236	0.155
Butyraldehyde[3]	7	1,663	0	0.004	0.746	0.094	0.078	0.049	0.119	0.068
Crotonaldehyde[3]	12	1,656	1	0.004	1.45	0.107	0.043	0.023	0.129	0.152
2,5-Dimethylbenzaldehyde	1,678	0	0	Not Detected						
Formaldehyde	0	1,678	0	0.010	21.0	2.25	1.96	1.14	2.94	1.66
Hexaldehyde[3]	23	1,653	0	0.002	0.560	0.032	0.022	0.012	0.037	0.048
Isovaleraldehyde	1,677	1	0	0.003		Single Detect				
Propionaldehyde[3]	7	1,668	1	0.0015	0.691	0.122	0.105	0.065	0.162	0.081
Tolualdehydes[3]	134	1,377	3	0.002	0.241	0.022	0.018	0.011	0.027	0.020
Valeraldehyde[3]	45	1,572	0	0.002	0.372	0.030	0.022	0.013	0.037	0.032

[1] Out of 1,678 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 1,678 for some compounds in samples where no value could be reported due to co-elution.

Table 4-4. Statistical Summaries of the PAH Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
Acenaphthene	66	1,039	3	0.071	198	4.89	2.12	0.984	4.45	11.409
Acenaphthylene	519	586	0	0.031	14.0	0.521	0.098	0	0.464	1.208
Anthracene	222	883	21	0.032	21.1	0.407	0.219	0.081	0.469	0.916
Benzo(a)anthracene	183	922	108	0.009	3.53	0.109	0.051	0.024	0.114	0.231
Benzo(a)pyrene	254	851	148	0.005	3.19	0.114	0.058	0.021	0.133	0.209
Benzo(b)fluoranthene	41	1,064	94	0.012	4.45	0.258	0.142	0.062	0.313	0.365
Benzo(e)pyrene	91	1,014	173	0.012	2.03	0.141	0.081	0.038	0.173	0.184
Benzo(g,h,i)perylene	61	1,044	130	0.014	9.49	0.169	0.091	0.044	0.191	0.349
Benzo(k)fluoranthene	335	770	193	0.011	1.46	0.073	0.040	0	0.089	0.118
Chrysene	15	1,090	42	0.014	3.77	0.237	0.149	0.084	0.284	0.297
Coronene	227	878	168	0.010	5.94	0.083	0.046	0.021	0.092	0.207
Cyclopenta[cd]pyrene	796	309	136	0.002	1.57	0.023	0	0	0.019	0.072
Dibenz(a,h)anthracene	791	314	119	0.006	0.432	0.014	0	0	0.019	0.034
Fluoranthene	0	1,105	1	0.043	36.8	2.32	1.35	0.760	2.51	3.184
Fluorene	291	814	0	0.552	161	4.45	2.66	0	5.06	8.453
9-Fluorenone	0	1,105	1	0.040	13.6	1.49	1.12	0.623	1.92	1.341
Indeno(1,2,3-cd)pyrene	148	957	108	0.013	2.48	0.152	0.086	0.040	0.185	0.216
Naphthalene	0	1,105	0	0.780	568	66.5	50.7	28.9	84.1	56.649
Perylene	701	404	265	0.004	0.844	0.018	0	0	0.024	0.047
Phenanthrene	0	1,105	0	0.390	216	9.51	5.39	3.04	10.0	14.677
Pyrene	0	1,105	1	0.023	38.3	1.36	0.838	0.488	1.54	1.932
Retene	40	1,065	5	0.021	5.95	0.259	0.124	0.076	0.227	0.447

[1] Out of 1,105 valid samples.
[2] Excludes zeros for non-detects.

Table 4-5. Statistical Summaries of the Metals Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
PM_{10} Metals										
Antimony	0	845	12	0.040	24.3	1.34	0.833	0.490	1.56	1.71
Arsenic	33	812	133	0.003	10.1	0.605	0.450	0.260	0.769	0.636
Beryllium	122	723	395	0.00002	0.310	0.013	0.009	0.003	0.020	0.017
Cadmium	0	845	12	0.004	70.7	0.197	0.070	0.045	0.115	2.43
Chromium	11	803	778	0.002	26.3	4.86	4.29	2.34	6.78	3.27
Cobalt	0	845	31	0.004	2.21	0.136	0.090	0.048	0.165	0.166
Lead	0	845	0	0.140	27.5	2.93	1.94	1.20	3.25	3.15
Manganese	0	845	0	0.270	136	8.02	5.35	2.86	9.70	9.10
Mercury	96	749	476	0.0003	0.334	0.019	0.019	0.007	0.030	0.020
Nickel	7	807	82	0.021	9.73	1.11	0.760	0.460	1.30	1.16
Selenium	55	790	263	0.005	10.6	0.558	0.373	0.170	0.750	0.660
TSP Metals										
Antimony	0	299	0	0.118	4.05	0.630	0.544	0.341	0.770	0.434
Arsenic	0	299	0	0.125	2.22	0.625	0.539	0.406	0.779	0.350
Beryllium	0	299	0	0.002	0.116	0.019	0.016	0.009	0.023	0.014
Cadmium	0	299	0	0.027	1.89	0.183	0.141	0.091	0.219	0.159
Chromium	0	299	92	1.40	17.7	2.79	2.41	1.97	3.06	1.47
Cobalt	0	299	0	0.053	4.01	0.462	0.295	0.183	0.498	0.555
Lead	0	299	0	0.791	29.0	3.37	2.67	1.87	4.08	2.77
Manganese	0	299	0	2.59	53.9	17.7	15.6	10.3	23.2	9.94
Mercury	0	299	6	0.0009	0.078	0.016	0.014	0.011	0.019	0.010
Nickel	0	299	23	0.357	7.82	1.47	1.26	0.916	1.78	0.897
Selenium	0	299	0	0.065	2.88	0.656	0.616	0.344	0.862	0.419

[1] For PM_{10}, out of 845 valid samples; for TSP, out of 299 valid samples.
[2] Excludes zeros for non-detects.

Table 4-6. Statistical Summary of the Hexavalent Chromium Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
Hexavalent Chromium	43	49	0	0.0036	0.640	0.020	0.005	0.000	0.018	0.069

[1] Out of 92 valid samples.
[2] Excludes zeros for non-detects.

4.1.2 Concentration Range and Data Distribution

The concentrations measured during the 2014 NMP exhibit a wide range of variability. The minimum and maximum concentration measured (excluding zeros substituted for non-detects) for each target pollutant are presented in Tables 4-1 through 4-6 (in respective pollutant group units). Some pollutants, such as dichloromethane, had a wide range of concentrations measured, while other pollutants, such as dichlorotetrafluoroethane, did not, even though they were both detected frequently. For each method-specific pollutant group, the pollutant with the largest range in measured concentrations is as follows:

- For VOCs, dichloromethane (0.056 ppbv to 2,420 ppbv)
- For SNMOCs, ethane (1.11 ppbC to 250 ppbC)
- For carbonyl compounds, formaldehyde (0.010 ppbv to 21.0 ppbv)
- For PAHs, naphthalene (0.780 ng/m^3 to 568 ng/m^3)
- For metals in PM_{10}, manganese (0.270 ng/m^3 to 136 ng/m^3)
- For metals in TSP, manganese (2.59 ng/m^3 to 53.9 ng/m^3)
- For hexavalent chromium, 0.0036 ng/m^3 to 0.640 ng/m^3.

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 or average, median, first and third quartiles, and standard deviation) for each of the pollutants sampled during the 2014 NMP, in respective pollutant group units. A multitude of observations can be made from these tables. The pollutants with the three highest average concentrations for each method-specific pollutant group are provided below, with respective confidence intervals (the 95 percent confidence intervals are not provided in the tables).

The three VOCs with the highest average concentrations, as presented in Table 4-1, are:

- Acetonitrile (15.7 ± 2.91 ppbv)
- Dichloromethane (4.04 ± 3.38 ppbv).
- Acetylene (1.13 ± 0.13 ppbv)

The three SNMOCs with the highest average concentrations, as presented in Table 4-2, are:

- Ethane (43.5 ± 4.50 ppbC)
- Propane (27.1 ± 2.73 ppbC)
- *n*-Butane (11.2 ± 1.09 ppbC).

The three carbonyl compounds with the highest average concentrations, as presented in Table 4-3, are:

- Formaldehyde (2.25 ± 0.08 ppbv)
- Acetone (1.12 ± 0.04 ppbv).
- Acetaldehyde (0.974 ± 0.030 ppbv).

The three PAHs with the highest average concentrations, as presented in Tables 4-4, are:

- Naphthalene (66.5 ± 3.34 ng/m^3)
- Phenanthrene (9.51 ± 0.866 ng/m^3)
- Acenaphthene (4.89 ± 0.673 ng/m^3).

The three metals with the highest average concentrations for both PM_{10} and TSP fractions, as presented in Table 4-5, are;

- Manganese (PM_{10} = 8.02 ± 0.61 ng/m^3, TSP = 17.7 ± 1.13 ng/m^3)
- Total chromium (PM_{10} = 4.86 ± 0.22 ng/m^3, TSP = 2.79 ± 0.17 ng/m^3)
- Lead (PM_{10} = 2.93 ± 0.21 ng/m^3, TSP = 3.37 ± 0.32 ng/m^3).

The average concentration of hexavalent chromium, as presented in Table 4-6, is 0.020 ± 0.014 ng/m^3.

Appendices J through O present statistical calculations on a site-specific basis, similar to those presented in Tables 4-1 through 4-6.

4.2 Preliminary Risk-Based Screening and Pollutants of Interest

Based on the preliminary risk-based screening process 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.

The results in Table 4-7 are listed in descending order by number of screens failed. Table 4-7 shows that benzene failed the greatest number of screens (1,794), although carbon tetrachloride, formaldehyde, acetaldehyde, 1,2-dichloroethane, and 1,3-butadiene each failed greater than 1,000 screens. These pollutants were also among those with the greatest number of measured detections among pollutants shown in Table 4-7. Conversely, three pollutants listed in Table 4-7 failed only one screen each (1,1-dichloroethane, antimony, and tetrachloroethylene). The number of measured detections for these pollutants varied significantly. Antimony and tetrachloroethylene were detected in greater than 1,000 samples each, while 1,1-dichloroethane was detected infrequently (61 out of 1,556 valid samples). Four pollutants exhibited a failure rate of 100 percent (benzene, 1,2-dichloroethane, 1,2-dibromoethane, and chloroprene). Benzene and 1,2-dichloroetahne were detected in 100 percent and 93 percent of samples, respectively, while 1,2-dibromoethane and chloroprene were detected in 3 percent and less than 1 percent of samples collected, respectively. 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 preliminary risk-based screening process.

Table 4-7. Results of the Program-Level Preliminary Risk-Based Screening Process

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Failed Screens	% of Total Failures	Cumulative % Contribution
Benzene	0.13	1,794	1,794	100.00	14.05	14.05
Formaldehyde	0.077	1,674	1,678	99.76	13.11	27.15
Acetaldehyde	0.45	1,592	1,678	94.87	12.46	39.62
Carbon Tetrachloride	0.17	1,551	1,556	99.68	12.14	51.76
1,2-Dichloroethane	0.038	1,441	1,441	100.00	11.28	63.04
1,3-Butadiene	0.03	1,412	1,492	94.64	11.06	74.10
Arsenic	0.00023	934	1,111	84.07	7.31	81.41
Naphthalene	0.029	826	1,105	74.75	6.47	87.88
Hexachloro-1,3-butadiene	0.045	339	359	94.43	2.65	90.53
Ethylbenzene	0.4	275	1,759	15.63	2.15	92.69
p-Dichlorobenzene	0.091	197	681	28.93	1.54	94.23
Nickel	0.0021	126	1,106	11.39	0.99	95.22
Vinyl chloride	0.11	102	248	41.13	0.80	96.01
Acenaphthene	0.011	96	1,039	9.24	0.75	96.77
Fluorene	0.011	82	814	10.07	0.64	97.41
Manganese	0.03	63	1,144	5.51	0.49	97.90
1,2-Dibromoethane	0.0017	40	40	100.00	0.31	98.21
Trichloroethylene	0.2	30	315	9.52	0.23	98.45
Benzo(a)pyrene	0.00057	29	851	3.41	0.23	98.68
Cadmium	0.00056	29	1,144	2.53	0.23	98.90
Dichloromethane	60	28	1,504	1.86	0.22	99.12
Propionaldehyde	0.8	27	1,668	1.62	0.21	99.33
1,1,2-Trichloroethane	0.0625	26	28	92.86	0.20	99.54
Fluoranthene	0.011	26	1,105	2.35	0.20	99.74
Lead	0.015	15	1,144	1.31	0.12	99.86
Bromomethane	0.5	4	1,252	0.32	0.03	99.89
Hexavalent Chromium	0.000083	3	49	6.12	0.02	99.91
Acenaphthylene	0.011	2	586	0.34	0.02	99.93
Chloroform	9.8	2	1,408	0.14	0.02	99.95
Chloroprene	0.0021	2	2	100.00	0.02	99.96
Xylenes	10	2	1,796	0.11	0.02	99.98
1,1-Dichloroethane	0.625	1	61	1.64	0.01	99.98
Antimony	0.02	1	1,144	0.09	0.01	99.99
Tetrachloroethylene	3.8	1	1,272	0.08	0.01	100.00
Total		12,772	34,374	37.16		

The program-level pollutants of interest, as indicated by the shading in Table 4-7, are identified as follows:

- Acetaldehyde
- Arsenic
- Benzene
- 1,3-Butadiene
- Carbon Tetrachloride
- *p*-Dichlorobenzene
- 1,2-Dichloroethane
- Ethylbenzene
- Formaldehyde
- Hexachloro-1,3-butadiene
- Naphthalene
- Nickel.

The pollutants of interest identified via the preliminary risk-based screening approach for 2014 are similar to the pollutants identified in previous years. Acenaphthene is the only pollutant that was a program-wide pollutant of interest for 2013 but is not on the list for 2014. Acenaphthene is the second pollutant, behind vinyl chloride, just outside the 95 percent criteria, as shown in Table 4-7, and therefore is not a pollutant of interest for 2014.

Of the 71 pollutants sampled for under the NMP that have corresponding screening values, concentrations of 34 pollutants failed at least one screen. Of these, a total of 12,772 concentrations out of 34,374 concentrations (or 37 percent) failed screens. If all pollutants with screening values are considered (including those that did not fail any screens), the percentage of concentrations failing screens is less (12,772 of 56,119, or nearly 23 percent). Note that these percentages exclude acrolein, acetonitrile, acrylonitrile, and carbon disulfide measurements per the explanations provided in Section 3.2; these pollutants are excluded from all risk-related analyses contained in the report from this point forward.

Table 4-8 presents the total number of failed screens per site, in descending order, as a means of comparing the results of the preliminary risk-based screening process across the sites. 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-Based Screening Comparison

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
PXSS	563	2,482	22.68	4
S4MO	561	2,655	21.13	5
TOOK	537	1,764	30.44	3
GPCO	502	2,514	19.97	4
BTUT	497	2,387	20.82	5
NBIL	495	2,473	20.02	5
TROK	489	1,704	28.70	3
TMOK	482	1,727	27.91	3
DEMI	473	2,024	23.37	3
SEWA	436	2,279	19.13	4
YUOK	421	1,660	25.36	3
ELNJ	409	1,213	33.72	2
LEKY	407	1,561	26.07	3
CSNJ	400	1,213	32.98	2
OCOK	400	1,613	24.80	3
SPIL	388	1,124	34.52	2
CHNJ	376	1,185	31.73	2
ROIL	373	1,060	35.19	2
ASKY	363	1,055	34.41	2
GLKY	360	2,009	17.92	4
NBNJ	315	1,068	29.49	2
TVKY	306	1,076	28.44	1
ATKY	279	1,001	27.87	1
BLKY	260	1,032	25.19	2
LAKY	252	893	28.22	1
CCKY	233	1,127	20.67	2
SPAZ	153	450	34.00	1
SKFL	143	901	15.87	2
RICO	142	418	33.97	2
ORFL	120	180	66.67	1
INDEM	113	171	66.08	1
PACO	113	402	28.11	2
AZFL	111	168	66.07	1
SYFL	110	165	66.67	1

[1]Total number of measured detections for all pollutants with screening values, not just those failing screens. Also excludes acrolein, acetonitrile, acrylonitrile, and carbon disulfide results.
BOLD ITALICS = EPA-designated NATTS Site

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

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
WPIN	108	162	66.67	1
SJJCA	102	1,251	8.15	2
BOMA	98	1,367	7.17	2
ASKY-M	94	575	16.35	1
BRCO	92	311	29.58	2
BMCO	87	329	26.44	2
ROCH	86	813	10.58	1
RFCO	78	229	34.06	2
BXNY	77	833	9.24	1
WADC	57	751	7.59	1
BAKY	56	568	9.86	1
CELA	56	701	7.99	1
RIVA	50	668	7.49	2
RUCA	50	689	7.26	1
PRRI	46	833	5.52	1
PAFL	29	300	9.67	1
UNVT	24	985	2.44	2
Total	12,772	56,119	22.76	

[1]Total number of measured detections for all pollutants with screening values, not just those failing screens. Also excludes acrolein, acetonitrile, acrylonitrile, and carbon disulfide results.
BOLD ITALICS = EPA-designated NATTS Site

As shown, PXSS has the largest number of failed screens (563), followed by S4MO (561) and TOOK (537); conversely, PRRI, PAFL, and UNVT failed relatively few screens each. Every NMP site had at least one failed screen. The total number of screens and the number of pollutant groups measured by each site must be considered when interpreting the results in Table 4-8. For example, sites sampling four or five pollutant groups tended to have a higher number of failed screens due to the large number of pollutants sampled. For sites sampling only one or two pollutant groups, it depends on the pollutant group sampled as the number of compounds analyzed varies from one (hexavalent chromium) to 80 (SNMOCs). Although ORFL, SYFL, and WPIN have the highest failure rates (67 percent each), 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 tend to 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 GLKY and SEWA. These sites both

sampled four pollutant groups and have a failure rate just less than 20 percent. Of course, the magnitude of concentrations measured greatly factors into this as well.

The following sections from this point forward focus primarily 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 annual average concentrations and 95 percent confidence intervals by site for each of the program-level pollutants of interest (for VOC/SNMOCs, carbonyl compounds, PAHs, and metals, respectively). As described in Section 3.1, an annual average is the average concentration of all measured detections and zeros substituted for non-detects for a given year. Further, an annual average is only calculated where at least three quarterly averages could be calculated and where the site-specific method completeness is at least 85 percent. The annual average concentrations in Tables 4-9 and 4-10, for VOC/SNMOCs and carbonyl compounds, respectively, are reported in $\mu g/m^3$ while the annual average concentrations for PAHs and metals, in Tables 4-11 and 4-12, respectively, are reported in ng/m^3 for ease of viewing. Note that not all sites sampled each pollutant group; thus, the list of possible sites presented in Tables 4-9 through 4-12 is limited to those sites sampling each pollutant. For instance, only five sites sampled TSP metals; thus, these would be the only sites to appear in Table 4-12 for each metal (TSP) pollutant of interest shown.

Table 4-9. Annual Average Concentration Comparison of the VOC/SNMOC Pollutants of Interest

Rank	Benzene (µg/m³)	1,3-Butadiene (µg/m³)	Carbon Tetrachloride (µg/m³)	*p*-Dichlorobenzene (µg/m³)	1,2-Dichloroethane (µg/m³)	Ethylbenzene (µg/m³)	Hexachloro-1,3-Butadiene (µg/m³)
1	PACO 1.49 ± 0.14	TVKY 0.38 ± 0.22	TVKY 0.87 ± 0.13	SPAZ 0.21 ± 0.05	TVKY 3.54 ± 1.66	SPAZ 0.60 ± 0.13	***BTUT*** 0.05 ± 0.01
2	ROIL 1.22 ± 0.21	***PXSS*** 0.20 ± 0.05	BLKY 0.73 ± 0.09	***PXSS*** 0.17 ± 0.03	LAKY 0.97 ± 0.47	***PXSS*** 0.57 ± 0.10	TVKY 0.03 ± 0.01
3	RICO 1.09 ± 0.14	SPAZ 0.19 ± 0.06	LAKY 0.71 ± 0.06	***S4MO*** 0.13 ± 0.05	BLKY 0.81 ± 0.43	***GPCO*** 0.45 ± 0.06	TOOK 0.03 ± 0.01
4	SPAZ 1.09 ± 0.24	BLKY 0.17 ± 0.16	CCKY 0.70 ± 0.03	TOOK 0.07 ± 0.01	ATKY 0.58 ± 0.22	TOOK 0.39 ± 0.06	ELNJ 0.02 ± 0.01
5	***PXSS*** 1.05 ± 0.20	***GPCO*** 0.17 ± 0.03	ATKY 0.68 ± 0.03	TMOK 0.07 ± 0.01	CCKY 0.49 ± 0.16	TROK 0.37 ± 0.05	TROK 0.02 ± 0.01
6	TVKY 1.04 ± 0.35	SPIL 0.13 ± 0.02	***SEWA*** 0.67 ± 0.02	TROK 0.06 ± 0.01	***BTUT*** 0.11 ± 0.01	***DEMI*** 0.37 ± 0.09	LAKY 0.02 ± 0.01
7	TOOK 1.03 ± 0.11	ELNJ 0.12 ± 0.01	***DEMI*** 0.67 ± 0.02	***BTUT*** 0.05 ± 0.04	TOOK 0.09 ± 0.01	ELNJ 0.36 ± 0.05	NBNJ 0.02 ± 0.01
8	***GPCO*** 0.99 ± 0.12	LAKY 0.11 ± 0.04	ASKY 0.65 ± 0.02	ELNJ 0.04 ± 0.01	ELNJ 0.09 ± 0.01	TMOK 0.34 ± 0.05	CHNJ 0.02 ± 0.01
9	ASKY 0.87 ± 0.39	RICO 0.10 ± 0.03	YUOK 0.63 ± 0.02	CSNJ 0.04 ± 0.01	TMOK 0.08 ± 0.01	CSNJ 0.33 ± 0.11	***NBIL*** 0.02 ± 0.01
10	TMOK 0.81 ± 0.08	***DEMI*** 0.10 ± 0.02	NBNJ 0.63 ± 0.02	LEKY 0.03 ± 0.01	***S4MO*** 0.08 ± 0.01	ROIL 0.32 ± 0.10	TMOK 0.02 ± 0.01

BOLD ITALICS = EPA-designated NATTS Site

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

Rank	Acetaldehyde (µg/m^3)	Formaldehyde (µg/m^3)
1	***BTUT*** 3.33 ± 0.34	***BTUT*** 5.92 ± 0.73
2	***GPCO*** 2.80 ± 0.25	CSNJ 4.48 ± 0.52
3	ELNJ 2.78 ± 0.21	ELNJ 4.44 ± 0.52
4	SPIL 2.52 ± 0.50	***GPCO*** 3.90 ± 0.35
5	***PXSS*** 2.52 ± 0.29	***PXSS*** 3.46 ± 0.24
6	CSNJ 2.49 ± 0.22	***S4MO*** 3.45 ± 0.48
7	***NBIL*** 2.36 ± 0.45	TMOK 3.41 ± 0.39
8	***S4MO*** 2.08 ± 0.22	***DEMI*** 3.25 ± 0.35
9	ORFL 2.01 ± 0.25	LEKY 3.15 ± 0.90
10	TOOK 1.97 ± 0.22	SPIL 3.12 ± 0.35

BOLD ITALICS = EPA-designated NATTS Site

Table 4-11. Annual Average Concentration Comparison of the PAH Pollutant of Interest

Rank	Naphthalene (ng/m^3)
1	***DEMI*** 116.80 ± 18.59
2	***NBIL*** 109.13 ± 28.14
3	***BXNY*** 101.09 ± 10.72
4	***GPCO*** 100.03 ± 13.48
5	***CELA*** 88.54 ± 13.86
6	***S4MO*** 81.79 ± 12.61
7	***PXSS*** 78.25 ± 15.71
8	***RUCA*** 75.23 ± 15.07
9	***WADC*** 67.34 ± 10.18
10	***RIVA*** 62.57 ± 8.89

BOLD ITALICS = EPA-designated NATTS Site

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

Rank	Arsenic (PM_{10}) (ng/m^3)	Arsenic (TSP) (ng/m^3)	Nickel (PM_{10}) (ng/m^3)	Nickel (TSP) (ng/m^3)
1	ASKY-M 1.14 ± 0.36	TROK 0.77 ± 0.12	ASKY-M 2.19 ± 0.56	TOOK 2.25 ± 0.31
2	***S4MO*** 0.90 ± 0.15	TOOK 0.76 ± 0.08	***BOMA*** 1.99 ± 0.42	TROK 1.70 ± 0.21
3	BAKY 0.85 ± 0.17	TMOK 0.67 ± 0.09	***SEWA*** 1.74 ± 0.40	TMOK 1.52 ± 0.14
4	PAFL 0.81 ± 0.16	OCOK 0.48 ± 0.07	***PXSS*** 1.42 ± 0.21	YUOK 0.96 ± 0.10
5	***BTUT*** 0.79 ± 0.26	YUOK 0.44 ± 0.05	***SJJCA*** 1.42 ± 0.34	OCOK 0.91 ± 0.09
6	LEKY 0.67 ± 0.11		***BTUT*** 1.38 ± 0.24	
7	***SEWA*** 0.60 ± 0.11		***S4MO*** 1.00 ± 0.18	
8	***PXSS*** 0.55 ± 0.11		PAFL 0.97 ± 0.10	
9	CCKY 0.55 ± 0.12		BAKY 0.72 ± 0.12	
10	***SJJCA*** 0.44 ± 0.07		LEKY 0.58 ± 0.08	

BOLD ITALICS = EPA-designated NATTS Site

Observations from Tables 4-9 through 4-12 include the following:

- The highest annual average concentration among the program-wide pollutants of interest was calculated for formaldehyde for BTUT (5.92 ± 0.73 µg/m^3). This was also true for BTUT in 2012 and 2013, although the concentration for 2014 is considerably less than it was for 2013. Formaldehyde accounts for 10 of the 12 annual average concentrations greater than 3.0 µg/m^3 shown in Tables 4-9 through 4-12 (with acetaldehyde and 1,2-dichloroethane each accounting for one).

- Among the VOCs shown in Table 4-9, the highest annual average concentration was calculated for 1,2-dichloroethane for TVKY (3.54 ± 1.66 µg/m^3). However, no other NMP site sampling this pollutant has an annual average concentration greater than 1 µg/m^3. The range of annual average concentrations shown for 1,2-dichloroethane varies considerably, spreading across two orders of magnitude. While the Calvert City, Kentucky sites (ATKY, BLKY, CCKY, LAKY, and TVKY) account for the five highest annual average concentrations of this pollutant in Table 4-9, their averages are also rather variable.

- Seven of the 10 annual average concentrations of benzene shown in Table 4-9 are greater than 1 µg/m^3. PACO has the highest annual average benzene concentration (1.49 ± 0.14 µg/m^3) among sites sampling benzene, with three of the six Colorado sites ranking among the 10 highest. Other sites ranking among the highest annual average benzene concentrations include ROIL, the two Phoenix sites (SPAZ and PXSS), TVKY, and. TOOK. Note that the sites with the largest confidence intervals shown in Table 4-9 were calculated for TVKY and ASKY. The two highest benzene

concentrations measured across the program were measured at ASKY (12.4 µg/m^3) and TVKY (9.92 µg/m^3).

- The highest annual average concentration of 1,3-butadiene (0.38 ± 0.22 µg/m^3) was calculated for TVKY for 2014. No other site has an annual average concentration of 1,3-butadiene greater than 0.20 µg/m^3. Three of the five Calvert City, Kentucky sites appear among those with the highest annual average concentrations of 1,3-butadiene (TVKY, BLKY, and LAKY). Note the relatively large confidence intervals associated with the annual averages for TVKY and BLKY. These two sites have the highest measurements of 1,3-butadiene across the program; of the six 1,3-butadiene concentrations greater than 1 µg/m^3 measured across the program, five were measured at TVKY and one at BLKY. The two Phoenix, Arizona sites rank second and third for their annual average concentrations of 1,3-butadiene and have similar concentrations (PXSS, 0.20 ± 0.05 µg/m^3 and SPAZ, 0.19 ± 0.06 µg/m^3).

- Calvert City, Kentucky sites account for five of the 10 highest annual average concentrations of carbon tetrachloride. Most of the annual average concentrations of carbon tetrachloride do not vary significantly across the sites; less than 0.10 µg/m^3 separates most of the annual average carbon tetrachloride concentrations. Only annual average concentrations calculated for the Calvert City, Kentucky sites are greater than or equal to 0.70 µg/m^3 (ATKY being the exception). Measurements of carbon tetrachloride collected at Calvert City sites account for 23 of the 25 highest carbon tetrachloride concentrations measured across the program, including 16 of the 17 measurements greater than 1 µg/m^3.

- Similar to previous years, the two Phoenix, Arizona sites have the two highest annual averages concentrations of *p*-dichlorobenzene among NMP sites and account for two of the three annual average concentrations greater than 0.1 µg/m^3 shown in Table 4-9 (SPAZ - 0.21 ± 0.05 µg/m^3 and PXSS - 0.17 ± 0.03 µg/m^3). S4MO is the other NMP site with an annual average concentration greater than 0.1 µg/m^3 (0.13 ± 0.05 µg/m^3). Note the relatively large confidence interval shown for BTUT, which has the seventh highest annual average concentration (0.05 ± 0.04 µg/m^3). Only two concentrations of *p*-dichlorobenzene greater than 1 µg/m^3 were measured at NMP sites in 2014, one at S4MO (1.14 µg/m^3) and one at BTUT (1.03 µg/m^3); all other measurements are less than 0.60 µg/m^3.

- The Calvert City, Kentucky sites also account for the five highest annual average concentrations of 1,2-dichloroethane, although the averages vary significantly among them, ranging from 3.54 ± 1.66 µg/m^3 for TVKY to 0.49 ± 0.16 µg/m^3 for CCKY. These five sites account for the highest 125 measurements of 1,2-dichloroethane measured across the program, ranging from 0.304 µg/m^3 to 27.4 µg/m^3, with the top seven (those greater than 12 µg/m^3) measured at TVKY. All other NMP sites have annual averages are less than 0.10 µg/m^3 (except BTUT, whose annual average concentration is 0.11 ± 0.01 µg/m^3).

- The Phoenix, Arizona sites also have the two highest annual average concentrations of ethylbenzene (SPAZ, 0.60 ± 0.13 µg/m^3 and PXSS, 0.57 ± 0.10 µg/m^3) across the program, followed by GPCO (0.45 ± 0.06 µg/m^3); all other annual average

concentrations shown in Table 4-9 are less than 0.4 μg/m^3. Note that the confidence intervals for the sites with the ninth and tenth highest annual averages (CSNJ and ROIL) are similar to the sites with the highest annual average ethylbenzene concentrations shown in Table 4-9. CSNJ and ROIL are the only NMP sites at which ethylbenzene concentrations greater than 3 μg/m^3 were measured.

- Hexachloro-1,3-butadiene is the only VOC in Table 4-9 that does not have at least one annual average concentration greater than 0.1 μg/m^3. BTUT has the highest annual average concentration of this pollutant (0.05 ± 0.01 μg/m^3), although the range of annual average concentrations for hexachloro-1,3-butadiene is relatively small, varying by 0.03 μg/m^3 across the sites shown and by 0.05 μg/m^3 across all NMP sites.

- TVKY, TOOK, TMOK, and ELNJ each appear in Table 4-9 a total of five times and PXSS, SPAZ, and LAKY each appear four times. All three Tulsa, Oklahoma sites appear in Table 4-9 for their annual average concentrations of *p*-dichlorobenzene, ethylbenzene, and hexachloro-1,3-butadiene. Both Phoenix, Arizona sites appear in Table 4-9 for their annual average concentrations of benzene, 1,3-butadiene, *p*-dichlorobenzene, and ethylbenzene.

- BTUT has the highest annual average concentrations of both acetaldehyde and formaldehyde shown in Table 4-10. Seven of the NMP sites shown appear for both pollutants (BTUT, GPCO, ELNJ, SPIL, PXSS, CSNJ, and S4MO), although their order varies.

- Annual average acetaldehyde concentrations shown in Table 4-10 vary from 3.33 ± 0.34 μg/m^3 for BTUT to 1.97 ± 0.221 μg/m^3 for TOOK. The maximum acetaldehyde concentration was measured at NBIL (9.17 μg/m^3), which ranks seventh for its annual average concentration, although a similar concentration was also measured at BTUT (9.15 μg/m^3). Twenty-four additional acetaldehyde concentrations greater than 5 μg/m^3 were measured across the program, with the most measured at SPIL (8), which ranks fourth for its annual average acetaldehyde concentration.

- As shown in Table 4-10, three NMP sites have annual average formaldehyde concentrations greater than 4 μg/m^3 (BTUT, CSNJ, and ELNJ) and all 10 sites shown in Table 4-10 have annual average concentrations of formaldehyde greater than 3 μg/m^3.

- Although BTUT has the highest annual average concentration of formaldehyde (5.92 ± 0.73 μg/m^3), the highest concentrations measured across the program were measured at other sites. The maximum concentration of formaldehyde was measured at LEKY (25.9 μg/m^3), which ranks ninth for its annual average concentration (and has the largest confidence interval associated with its annual average). Other higher formaldehyde concentrations were measured at NBNJ and AZFL, in addition to sites shown in Table 4-10. Of the 20 formaldehyde concentrations greater than 10 μg/m^3 measured across the program, nine were measured at BTUT, five at NBNJ, two at ELNJ, and one each at ROIL, LEKY, CSNJ, and AZFL.

- Naphthalene is the only PAH program-wide pollutant of interest. Table 4-11 shows that the range of the 10 highest annual average concentrations of naphthalene vary considerably, from 116.80 ± 18.59 ng/m^3 for DEMI to 62.57 ± 8.89 ng/m^3 for RIVA, with four NMP sites having annual averages greater than 100 ng/m^3. The maximum naphthalene concentration was measured at NBIL (568 ng/m^3), and is the only measurement of this pollutant greater than 400 ng/m^3. Two additional concentrations greater than 300 ng/m^3 were also measured NBIL; two were also measured at DEMI and one was measured at PXSS. With the exception of RIVA, which ranks 10th in Table 4-11, each of the NMP sites shown in Table 4-11 measured at least one naphthalene concentration greater than 200 ng/m^3 (with the most measured at NBIL, 10).

- ASKY-M has the highest annual average concentration for both of the program-wide PM_{10} metals pollutants of interest, similar to 2013. Four of the five Kentucky sites sampling PM_{10} metals (and where annual average concentrations could be calculated) appear in Table 4-12 for arsenic (GLKY is the exception) while three appear in Table 4-12 for nickel. S4MO, PAFL, and BTUT round out the top five for arsenic. Annual averages of arsenic for S4MO consistently rank among the highest in past annual reports. Aside from ASKY-M, NATTS sites have the highest ranking annual averages for nickel. For the last several years, the annual average nickel concentration for SEWA has been at or near the top.

- The maximum arsenic concentration was measured at ASKY-M (10.1 ng/m^3), with the next highest arsenic concentration nearly half as high (5.04 ng/m^3, measured at BTUT). Arsenic concentrations greater than 2 ng/m^3 were measured at seven NMP sampling PM_{10} metals; ASKY-M has the greatest number of arsenic concentrations greater than 2 ng/m^3 (6), followed by BTUT (4), S4MO and BAKY (3), and NBIL (2), with PXSS and PAFL each measuring one.

- Among the Oklahoma sites sampling TSP metals, TROK has the highest annual average concentration of arsenic (0.77 ± 0.12 ng/m^3), similar to 2013, although the annual average concentration for TOOK is similar (0.76 ± 0.08 ng/m^3). The other Tulsa site, TMOK, ranks third (0.67 ± 0.09 ng/m^3) while the OCOK and YUOK sites have significantly lower annual average concentrations of arsenic (0.48 ± 0.07 ng/m^3 and 0.44 ± 0.05 ng/m^3, respectively).

- The range of annual average concentrations for nickel is relatively large, ranging from 2.19 ± 0.56 ng/m^3 for ASKY-M to 0.58 ± 0.08 ng/m^3 for LEKY. Three nickel concentrations greater than 9 ng/m^3 were measured in 2014, each at a different site (SJJCA, ASKY-M, and BOMA); these sites rank fifth, first, and second for their annual average nickel concentrations, respectively, as shown in Table 4-12. ASKY-M has the greatest number of nickel concentrations greater than 5 ng/m^3 among NMP sampling PM_{10} metals (7), followed by SEWA (4), and BOMA (3), with SJJCA and BTUT each measuring one.

- Among the Oklahoma sites sampling TSP metals, the three Tulsa sites ranked highest for nickel while the Oklahoma City sites have significantly lower annual average concentrations of nickel. All but one of TOOK's 62 nickel concentrations are greater

than 1 ng/m^3 (with the exception at 0.989 ng/m^3), with slightly fewer measured at the other Tulsa sites (TMOK at 51 and TROK at 50). The number of nickel concentrations greater than 1 ng/m^3 measured at the two Oklahoma City sites is considerably less (YUOK, 23 and OCOK, 20).

- PXSS appears on the top 10 list for nine of the 12 program-level pollutants of interest shown in Tables 4-9 through 4-12; TOOK and TMOK appear in these tables for eight of the 12 program-level pollutants of interest; ELNJ, S4MO, and BTUT appear in the tables for seven of the 12 program-level pollutants of interest; and GPCO appears in the tables six times.

4.2.2 Variability Analysis for the Pollutants of Interest

This section presents the results of the two variability analyses described in Section 3.3.

4.2.2.1 Inter-site Variability

Figures 4-1 through 4-12 are bar graphs depicting the site-specific annual averages (in gray) overlain on the program-level averages (indicated by the solid shading), as presented in Section 4.1. For each program-level pollutant of interest, the inter-site variability graphs allow the reader to see how the individual site-specific annual average concentrations feed into the program-level averages (i.e., if a specific site(s) is driving the program average). In addition, the confidence intervals provided on the inter-site variability graphs are an indication of the amount of variability contained within the site-specific dataset and thus, annual average concentrations. The published MDL from the ERG laboratory is also plotted on the graph as an indication of the how the data fall in relation to the MDL. The preliminary risk-based screening values are also plotted on the graphs.

Several items to note about these figures: Some sites do not have annual average concentrations presented on the inter-site variability graphs because they did not meet the criteria for the calculation of annual averages specified in Section 3.1. For the sites sampling metals, the program-level average for sites collecting PM_{10} samples is presented in green while the program-level average for sites collecting TSP samples is presented in pink. For benzene, 1,3-butadiene, and ethylbenzene, the three pollutants sampled and analyzed by two methods (VOC and SNMOC) and identified as program-level pollutants of interest, two graphs are presented, one for each method. Note that while the Garfield County, Colorado sites have their canister samples analyzed using the SNMOC method, BTUT and NBIL have their canister samples analyzed

using both methods. While both results are shown in this section, only the VOCs results are discussed throughout the remainder of this report, as described in Section 3.2.

Observations from Figures 4-1 through 4-12 include the following:

- The program-level average concentration of acetaldehyde is 1.76 µg/m^3, as shown in purple in Figure 4-1. Site-specific annual average concentrations range from 0.42 µg/m^3 (BMCO) to 3.33 µg/m^3 (BTUT). The annual average concentration for BTUT is nearly twice the program-level average concentration for acetaldehyde. Other sites with annual average concentrations greater than the program-level average include CSNJ, DEMI, ELNJ, GPCO, NBIL, ORFL, PXSS, ROIL, S4MO, SPIL, TMOK, TOOK, and YUOK. SPIL and NBIL have the most variability associated with their measurements, as indicated by the confidence intervals shown. Sites with relatively low annual average concentrations (less than 1 µg/m^3) other than BMCO include GLKY, RICO, and SEWA. Annual averages could not be calculated for BRCO, NBNJ, PACO, RFCO, and SKFL.

- Figure 4-2 presents the inter-site variability graph for arsenic, which also includes a comparison of PM_{10} results and TSP results. Note that only sites from Oklahoma are using TSP samplers. The program-level average concentration of arsenic in PM_{10} is similar to the program average concentration of arsenic in TSP, with a PM_{10} average of 0.61 ng/m^3 and a TSP average of 0.63 ng/m^3. There is more variability across the program associated with the PM_{10} measurements than the TSP measurements, as indicated by the range of annual average concentrations as well as confidence intervals shown. Site-specific annual average arsenic concentrations range from 0.21 ng/m^3 (UNVT) to 1.14 ng/m^3 (ASKY-M) for PM_{10} and 0.44 ng/m^3 (YUOK) to 0.77 ng/m^3 (TROK) for TSP. Annual averages could not be calculated for BLKY and NBIL. ASKY-M has the most variability in the PM_{10} measurements, while TROK has the most variability in the TSP measurements, although the confidence intervals calculated for ASKY-M are three times larger than those for TROK.

- Figure 4-3a is the inter-site variability graph for benzene, as measured with Method TO-15. The program-level average concentration of benzene is 0.74 µg/m^3. Site-specific annual average concentrations range from 0.42 µg/m^3 (GLKY) to 1.22 µg/m^3 (ROIL). Other sites with annual average concentrations greater than 1 µg/m^3 include PXSS, SPAZ, TOOK, and TVKY. Sites with relatively low annual average concentrations (less than 0.5 µg/m^3) other than GLKY include CHNJ and NBIL. ASKY and TVKY have the most variability associated with the measurements collected, as indicated by the confidence intervals shown in Figure 4-3a.

- Figure 4-3b is the inter-site variability graph for benzene, as measured with the concurrent SNMOC method. Canister samples collected at seven sites are analyzed with this method. The program-level average concentration of benzene (SNMOC only) is 0.86 µg/m^3. Site-specific annual average concentrations range from 0.46 µg/m^3 (RFCO) to 1.49 µg/m^3 (PACO). The annual average concentrations for PACO and RICO are greater than the program-level average; the annual average concentrations for BTUT, NBIL, and RFCO are less than the program-level average;

and annual average concentrations for BMCO and BRCO could not be calculated. Note that canisters from BTUT and NBIL are analyzed using both methods and their annual average benzene concentrations are similar although slightly higher using the VOC method.

- Figure 4-4a is the inter-site variability graph for 1,3-butadiene, as measured with Method TO-15. The program-level average concentration of 1,3-butadiene is 0.10 µg/m^3. Site-specific annual average concentrations span an order of magnitude, ranging from 0.037 µg/m^3 (GLKY) to 0.38 µg/m^3 (TVKY). While many sites' annual average concentrations are less than the program-level average, including some whose annual averages are just greater than the MDL, the annual average concentrations for BLKY, ELNJ, GPCO, LAKY, PXSS, SPAZ, SPIL, and TVKY are greater than the program-level average concentration. The sites with the most variability associated with the measurements collected are TVKY and BLKY, as indicated by the confidence intervals shown in Figure 4-4a.

- Figure 4-4b is the inter-site variability graph for 1,3-butadiene, as measured with the concurrent SNMOC method. Canister samples collected at seven sites are analyzed with this method. The program-level average concentration of 1,3-butadiene (SNMOC only) is 0.035 µg/m^3. Site-specific annual average concentrations range from 0.015 µg/m^3 (NBIL) to 0.103 µg/m^3 (RICO). The annual average concentrations for BTUT and RICO are greater than the program-level average, with the annual average for RICO three times the program-level average concentration, while the remaining annual average concentrations are less than the program-level average concentration (where they could be calculated). Note that the annual average concentrations for NBIL, PACO, and RFCO are less than the MDL for 1,3-butadiene with the SNMOC method. This means that the annual average concentrations shown incorporate data containing many zeroes substituted for non-detects, many concentrations that are less than the MDL, or a combination of both. The MDL for 1,3-butadiene is considerably higher for the SNMOC method (0.121 µg/m^3) than the TO-15 Method (0.029 µg/m^3). Because so many of the results are less than the MDL or non-detects, there is less certainty associated with the SNMOC results for this pollutant.

- The program-level average concentration of carbon tetrachloride is 0.64 µg/m^3, as shown in blue in Figure 4-5. For most sites, the annual average concentration is either slightly less or slightly more than the program-level average concentration and the associated confidence intervals are relatively small. This indicates that there is little variability in the carbon tetrachloride concentrations measured across the program. This uniformity is not unexpected. 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 by the Montreal Protocol (EPA, 2016d). This pollutant has a long lifetime in the atmosphere, but slowly degrades over time. Today, its concentration in ambient air is fairly ubiquitous regardless of where it is measured. The annual average carbon tetrachloride concentrations for several of the Calvert City, Kentucky sites are greater than annual averages for the remaining sites, particularly for TVKY. Most of the annual average concentrations of carbon tetrachloride range from 0.58 µg/m^3 to 0.68 µg/m^3, with only Calvert City sites

falling outside this range. In addition, the confidence intervals shown for these sites are larger than most sites, particularly for TVKY, indicating a higher level of variability in the measurements compared to other NMP sites.

- Figure 4-6 presents the program-level and annual average concentrations of *p*-dichlorobenzene. This figure shows that the program-level average concentration (0.041 µg/m^3) and most of the site-specific annual average concentrations are less than the MDL for this pollutant (0.088 µg/m^3), as indicated by the dashed blue line. This indicates that many of the measurements are either non-detects or less than the detection limit. Table 4-1 shows that more than half of the 2014 measurements of *p*-dichlorobenzene are non-detects and of the measured detections, nearly 70 percent were less than the MDL. Only three NMP sites have annual average concentrations greater than the MDL for this pollutant: PXSS, SPAZ, and S4MO. PXSS has the greatest number of *p*-dichlorobenzene measurements greater than the MDL (46), with 25 each for SPAZ and S4MO (as well as TOOK). The two Arizona sites have had the two highest annual average concentrations of this pollutant for the last several NMP reports. Other sites with a higher number of measurements greater than the MDL include TMOK (19), TROK (12), and ELNJ (11). The highest *p*-dichlorobenzene concentrations measured across the program were measured at S4MO (1.14 µg/m^3) and BTUT (1.03 µg/m^3). These concentrations are roughly twice the third highest concentration measured in 2014 and helps explain, at least partially, why the confidence intervals are so large for these sites.

- Figure 4-7 shows that the annual average concentrations of 1,2-dichloroethane calculated for the Calvert City, Kentucky sites are significantly higher than the annual averages for other NMP sites. Excluding the Calvert City sites, annual average concentrations of 1,2-dichloroethane range from 0.06 µg/m^3 (SPAZ) to 0.11 µg/m^3 (BTUT), which are all similar to or just greater than the MDL for this pollutant (0.056 µg/m^3). The annual average concentrations of 1,2-dichloroethane for the five Calvert City sites range from 0.49 µg/m^3 (CCKY) to 3.54 µg/m^3 (TVKY). The confidence intervals for these annual average concentrations are relatively large, indicating there is considerable variability in the measurements collected at these sites. Concentrations measured at these sites are driving the program-level average concentration (0.31 µg/m^3), which was a similar finding in the 2012 and 2013 NMP reports. Without the Calvert City sites, the program-level average concentration would be 0.08 µg/m^3.

- Figure 4-8a is the inter-site variability graph for ethylbenzene, as measured with Method TO-15. The program-level average concentration of ethylbenzene is 0.25 µg/m^3. Site-specific annual average concentrations range from 0.08 µg/m^3 (BLKY) to 0.60 µg/m^3 (SPAZ). PXSS is the only other NMP site with an annual average concentration of ethylbenzene greater than 0.5 µg/m^3. Sites with relatively low annual average ethylbenzene concentrations (less than 0.15 µg/m^3) other than BLKY include ATKY, CCKY, CHNJ, GLKY, and TVKY.

- Figure 4-8b is the inter-site variability graph for ethylbenzene, as measured with the concurrent SNMOC method. Canister samples collected at seven sites are analyzed with this method. The program-level average concentration of ethylbenzene (SNMOC

only) is 0.18 µg/m^3. Site-specific annual average concentrations range from 0.11 µg/m^3 (RFCO) to 0.32 µg/m^3 (RICO). The annual average concentrations for BTUT and RICO are greater than the program-level average; the annual average concentrations for PACO is similar to the program-level average; and the annual average concentrations for remaining sites are less than the program-level average concentration (where they could be calculated). Note that canister samples collected at BTUT and NBIL are analyzed using both methods and their annual averages are very similar between the two methods.

- The program-level average concentration of formaldehyde is 2.77 µg/m^3, as shown in purple in Figure 4-9. Site-specific annual average concentrations of formaldehyde range from 0.60 µg/m^3 (SEWA) to 5.92 µg/m^3 (BTUT). This is the fourth year in a row that BTUT has had the highest annual average concentration of formaldehyde among NMP sites. The annual average concentration for BTUT is more twice the program-level average for formaldehyde, with all other NMP sites having annual average concentrations less than 4.5 µg/m^3 (although the annual averages for CSNJ and ELNJ are 4.48 µg/m^3 and 4.44 µg/m^3, respectively). Sites with relatively low annual average concentrations (less than 1 µg/m^3) other than SEWA include BMCO and RICO. Annual averages could not be calculated for BRCO, NBNJ, PACO, RFCO, and SKFL.

- Figure 4-10 presents the program-level and site-specific annual average concentrations of hexachloro-1,3-butadiene. This figure shows that the program-level average concentration (0.018 µg/m^3) and all of the site-specific annual average concentrations are considerably less than the MDL for this pollutant (0.29 µg/m^3), as indicated by the dashed blue line. Only one of the hexachloro-1,3-butadiene measurements collected in 2014 is greater than the detection limit, as indicated in Table 4-1. Of the 1,556 valid VOC samples collected, only 359 (or 23 percent) included measured detections of hexachloro-1,3-butadiene. This indicates that a large number of substituted zeroes are included in the program-level and annual average concentrations shown in Figure 4-10, which generally pull the averages down. The maximum hexachloro-1,3-butadiene concentration measured across the program (and the single concentration greater than the MDL) was measured at OCOK (0.61 µg/m^3), explaining the large confidence interval shown for this site.

- Figure 4-11 presents the program-level and site-specific annual average concentrations of naphthalene. The program-level average concentration (66.46 ng/m^3), as well as all of the annual average concentrations, where they could be calculated, are considerably greater than the MDL for this pollutant. The site-specific annual averages varied considerably, from 9.58 ng/m^3 (UNVT) to 116.80 ng/m^3 (DEMI). Sites with annual average concentrations greater than 100 ng/m^3 besides DEMI include NBIL, BXNY, and GPCO; sites with annual average concentrations less than 50 ng/m^3 besides UNVT includes SEWA, BOMA, BTUT, and GLKY. The site with the most variability in the measurements, as indicated by the magnitude of the confidence intervals, is NBIL. Concentrations measured at NBIL range from 17.5 ng/m^3 to 568 ng/m^3.

- Figure 4-12 shows the inter-site variability graph for nickel, which also includes a comparison of PM_{10} results and TSP results. Note that only sites from Oklahoma are using TSP samplers. The program-level average concentration of nickel (PM_{10}) is 1.11 ng/m^3, while the program-level average concentration of nickel (TSP) is 1.47 ng/m^3. Site-specific annual average nickel concentrations range from 0.40 ng/m^3 (GLKY) to 2.19 ng/m^3 (ASKY-M) for PM_{10} and 0.91 ng/m^3 (OCOK) to 2.25 ng/m^3 (TOOK) for TSP. Similar observations were made in the 2013 NMP report. Annual averages could not be calculated for BLKY and NBIL. ASKY-M has the most variability in the nickel measurements collected, with concentrations of nickel ranging from 0.26 ng/m^3 to 9.64 ng/m^3, although other sites, such as BOMA, SEWA, SJJCA, and TOOK also have relatively large confidence intervals.

Figure 4-1. Inter-Site Variability for Acetaldehyde

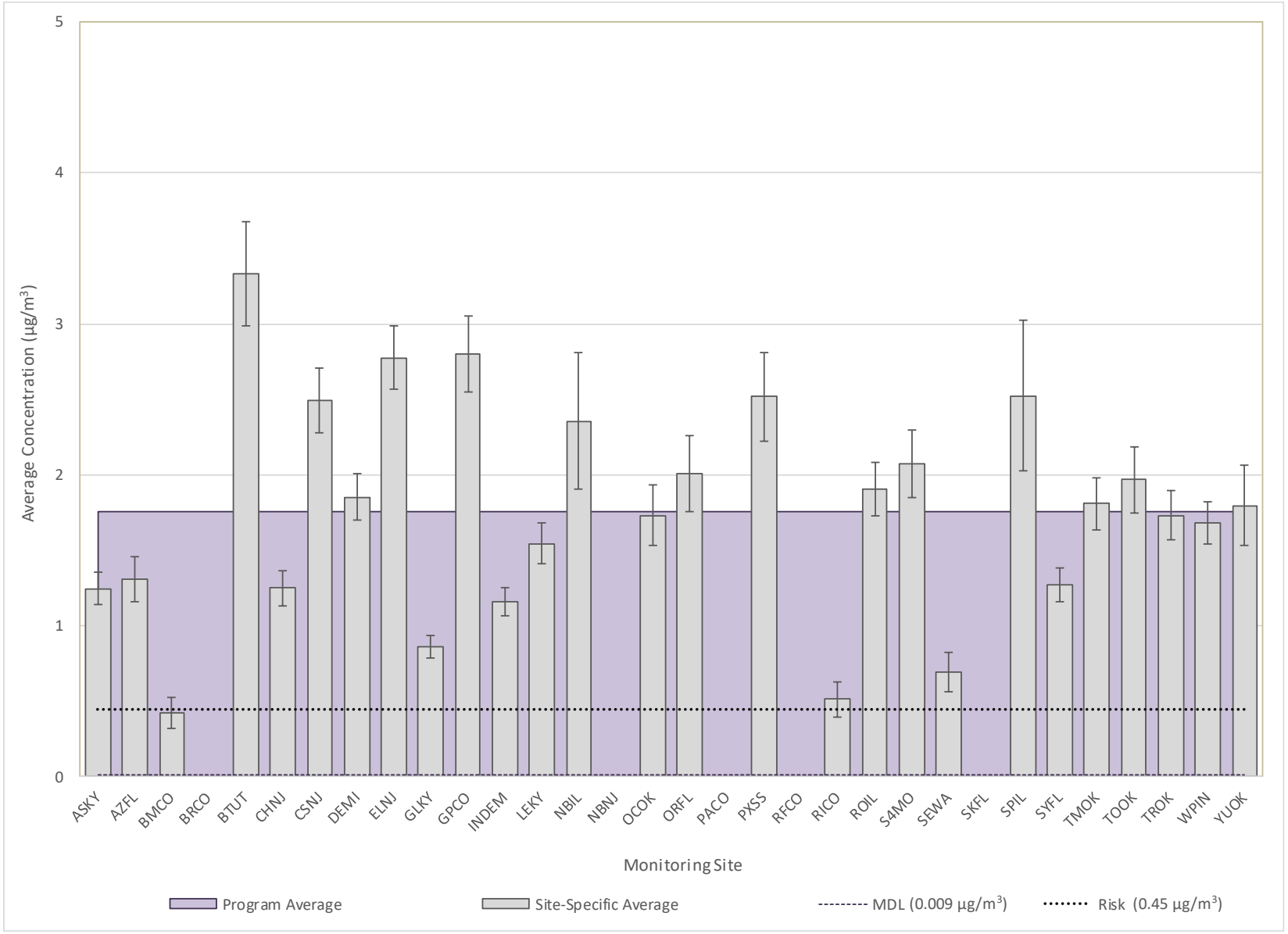


Figure 4-2. Inter-Site Variability for Arsenic

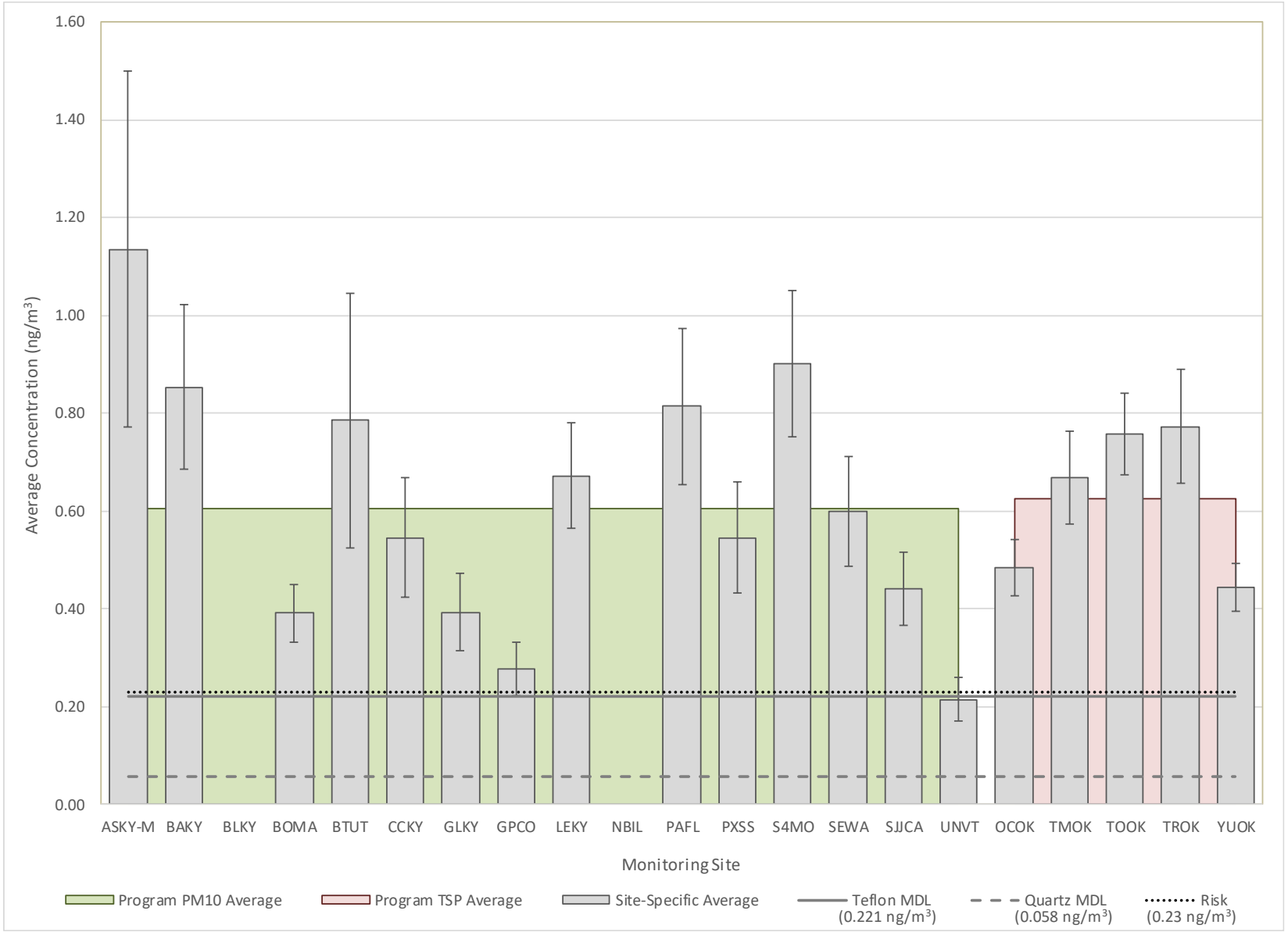


Figure 4-3a. Inter-Site Variability for Benzene – Method TO-15

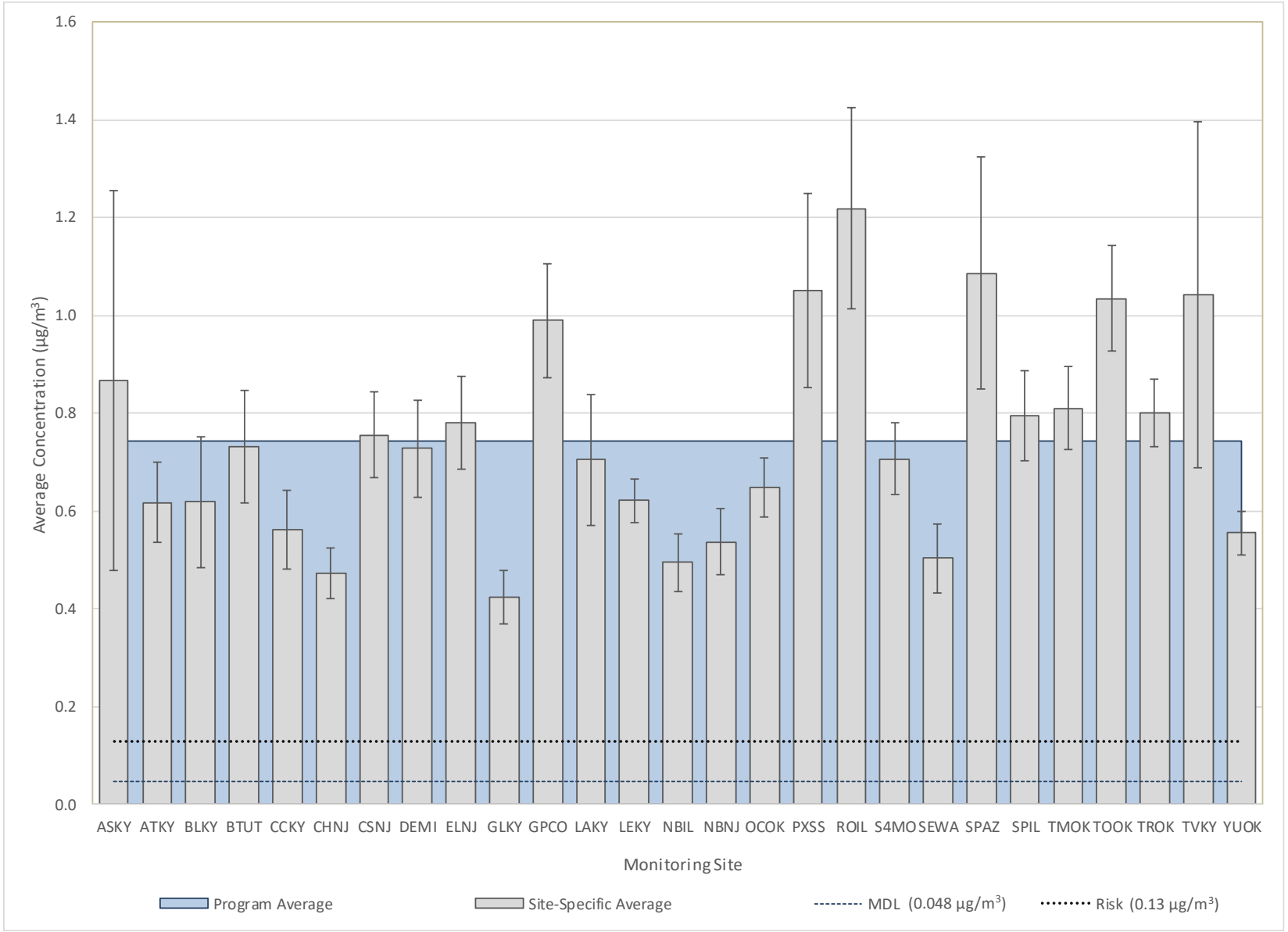


Figure 4-3b. Inter-Site Variability for Benzene – SNMOC

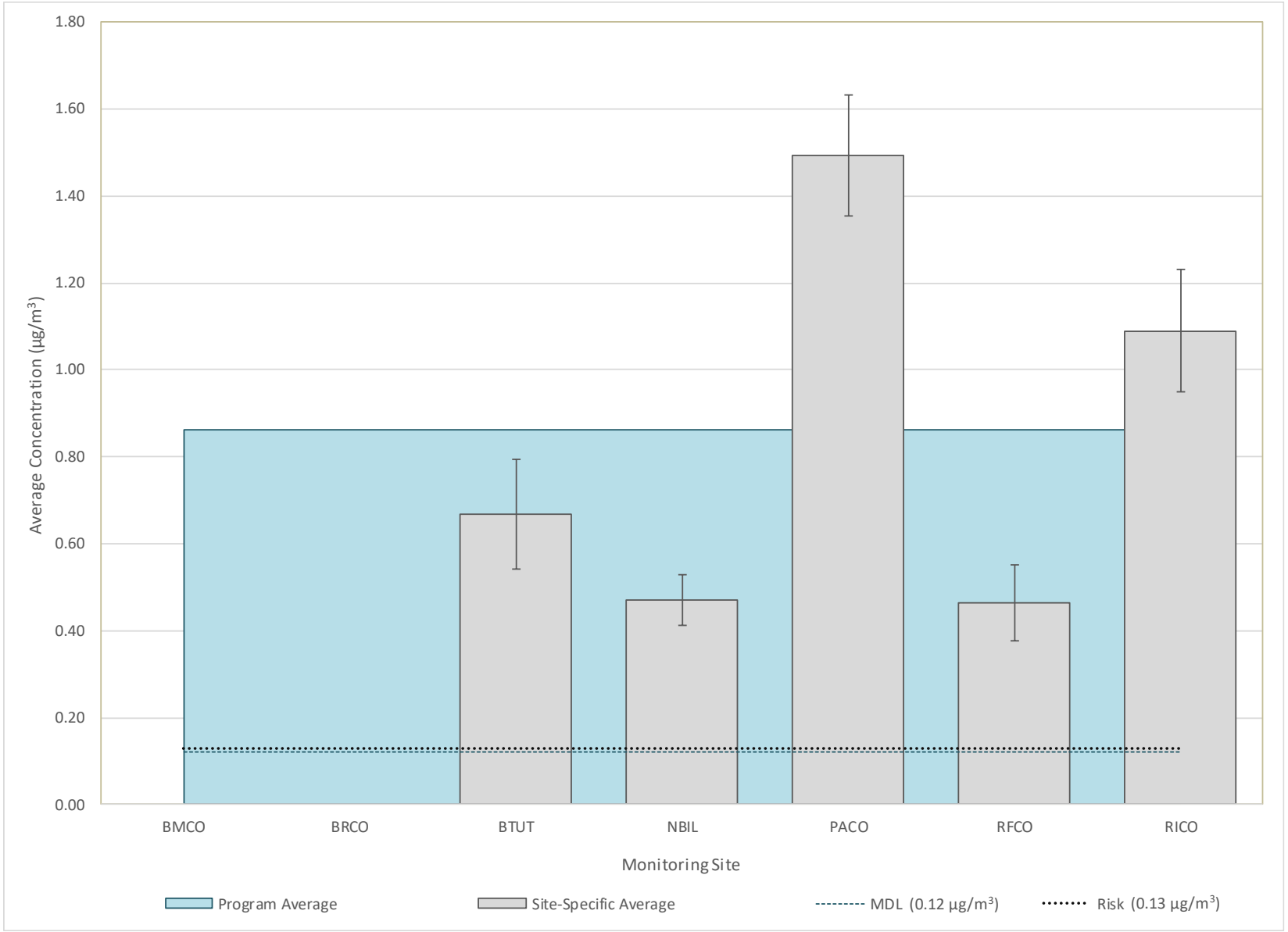


Figure 4-4a. Inter-Site Variability for 1,3-Butadiene – Method TO-15

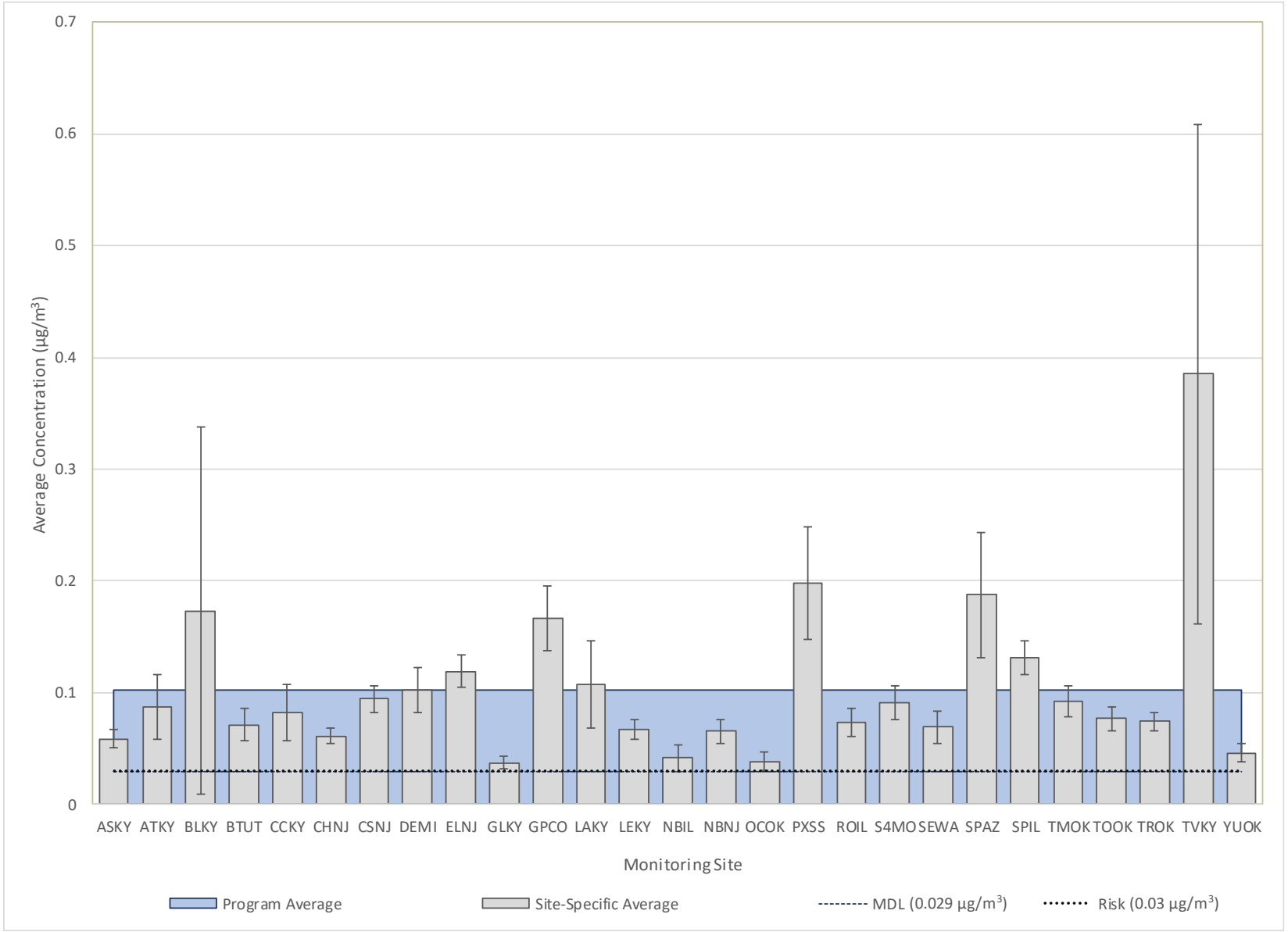


Figure 4-4b. Inter-Site Variability for 1,3-Butadiene – SNMOC

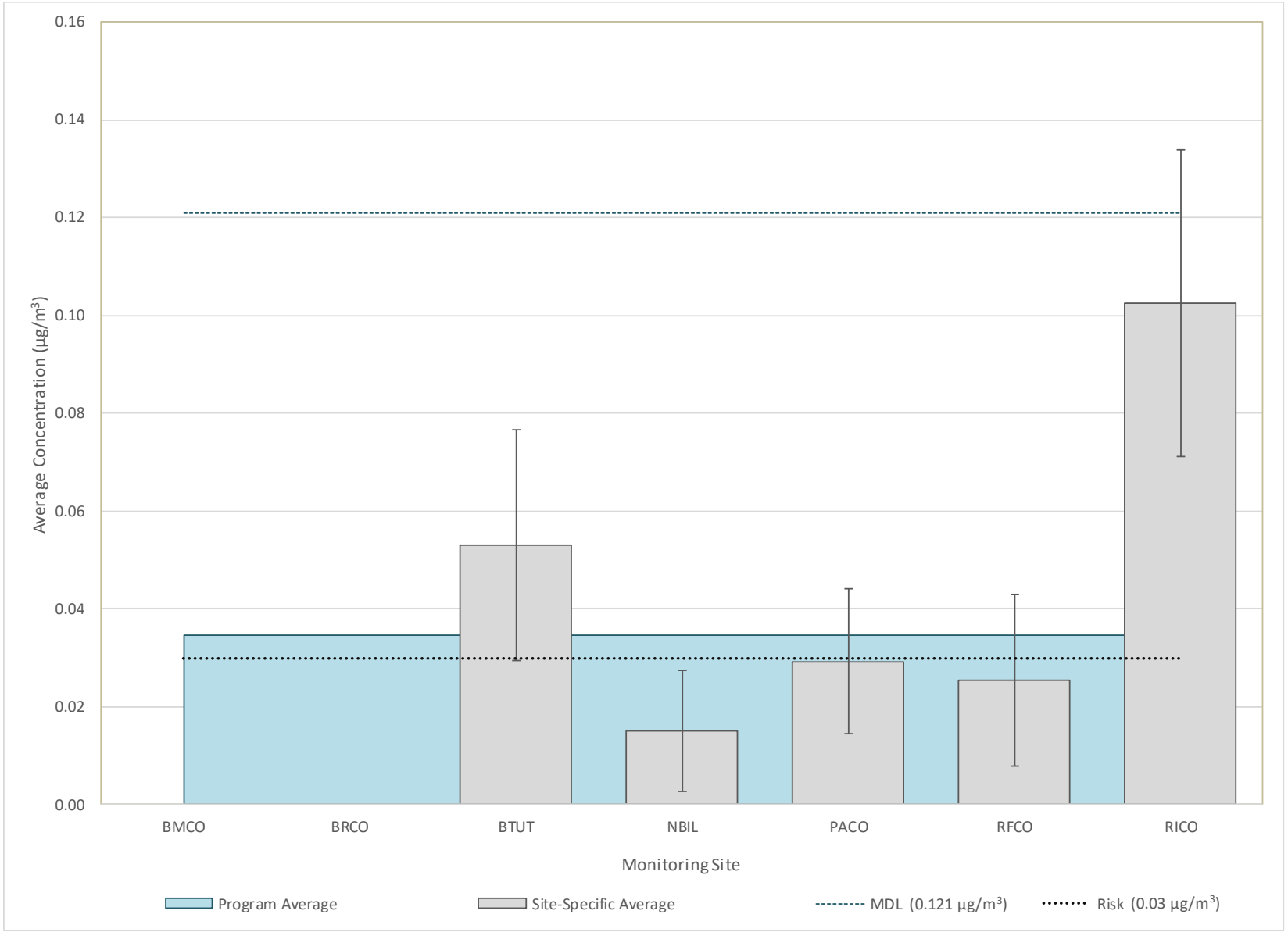


Figure 4-5. Inter-Site Variability for Carbon Tetrachloride

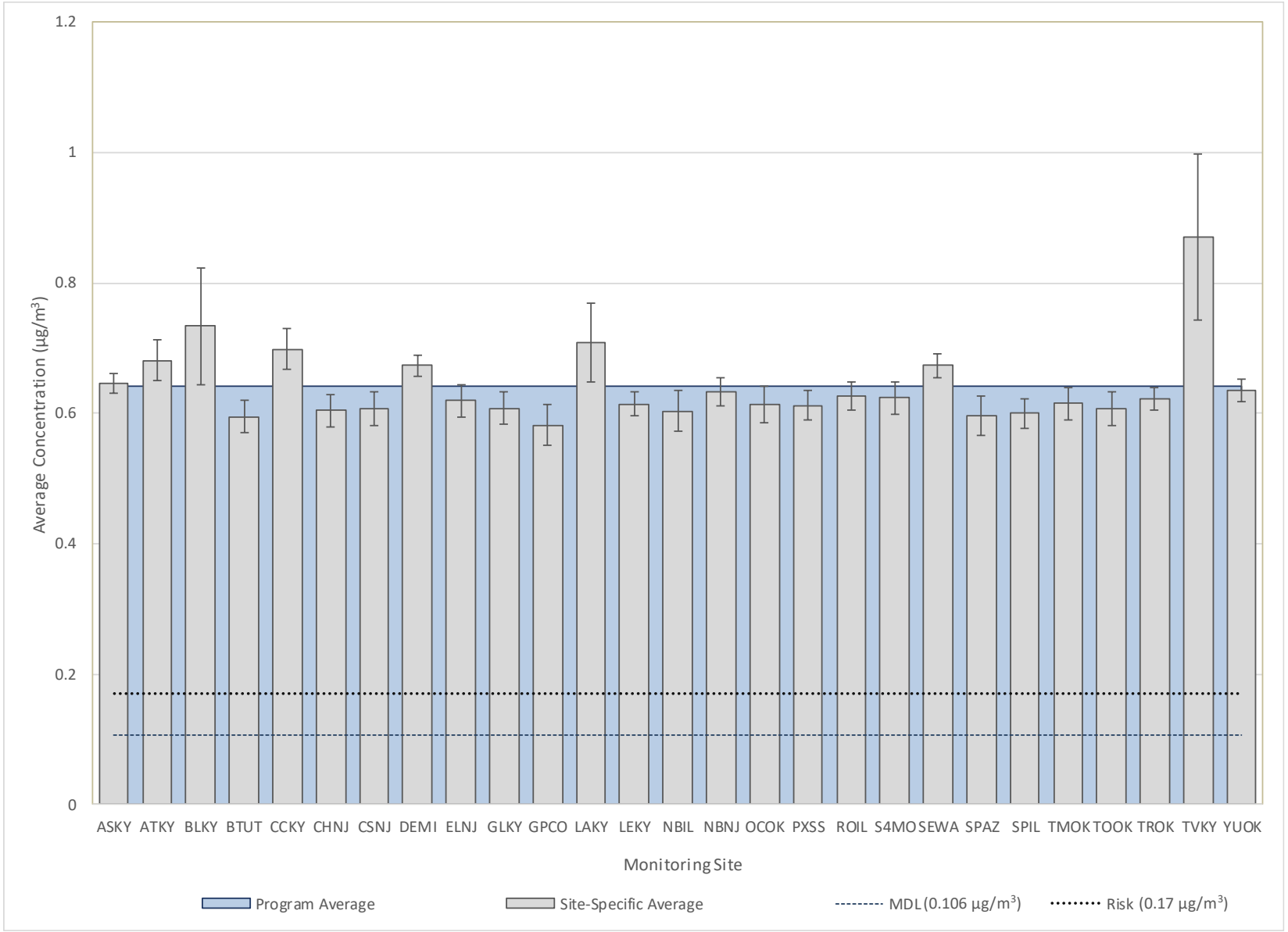


Figure 4-6. Inter-Site Variability for *p*-Dichlorobenzene

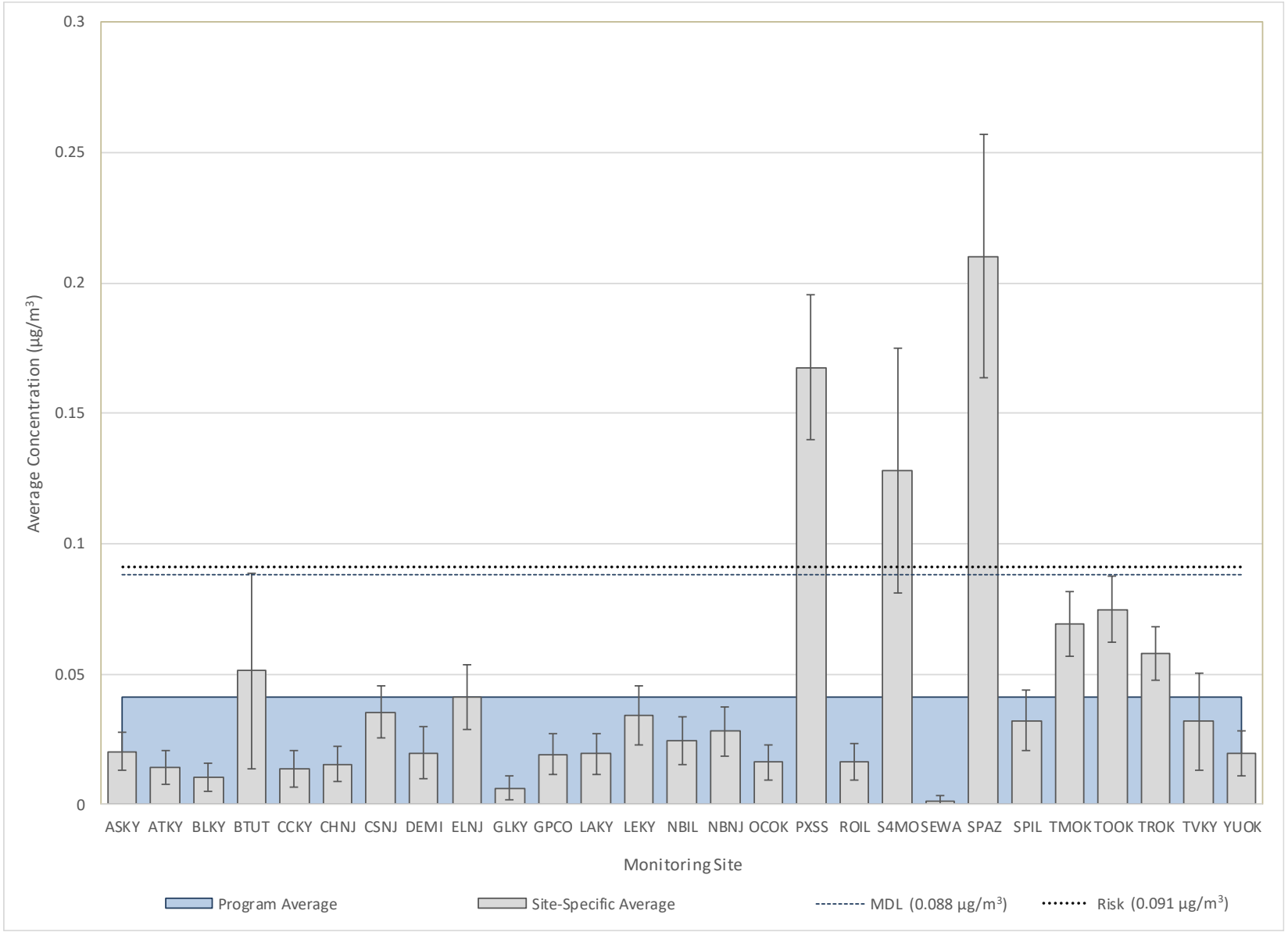


Figure 4-7. Inter-Site Variability for 1,2-Dichloroethane

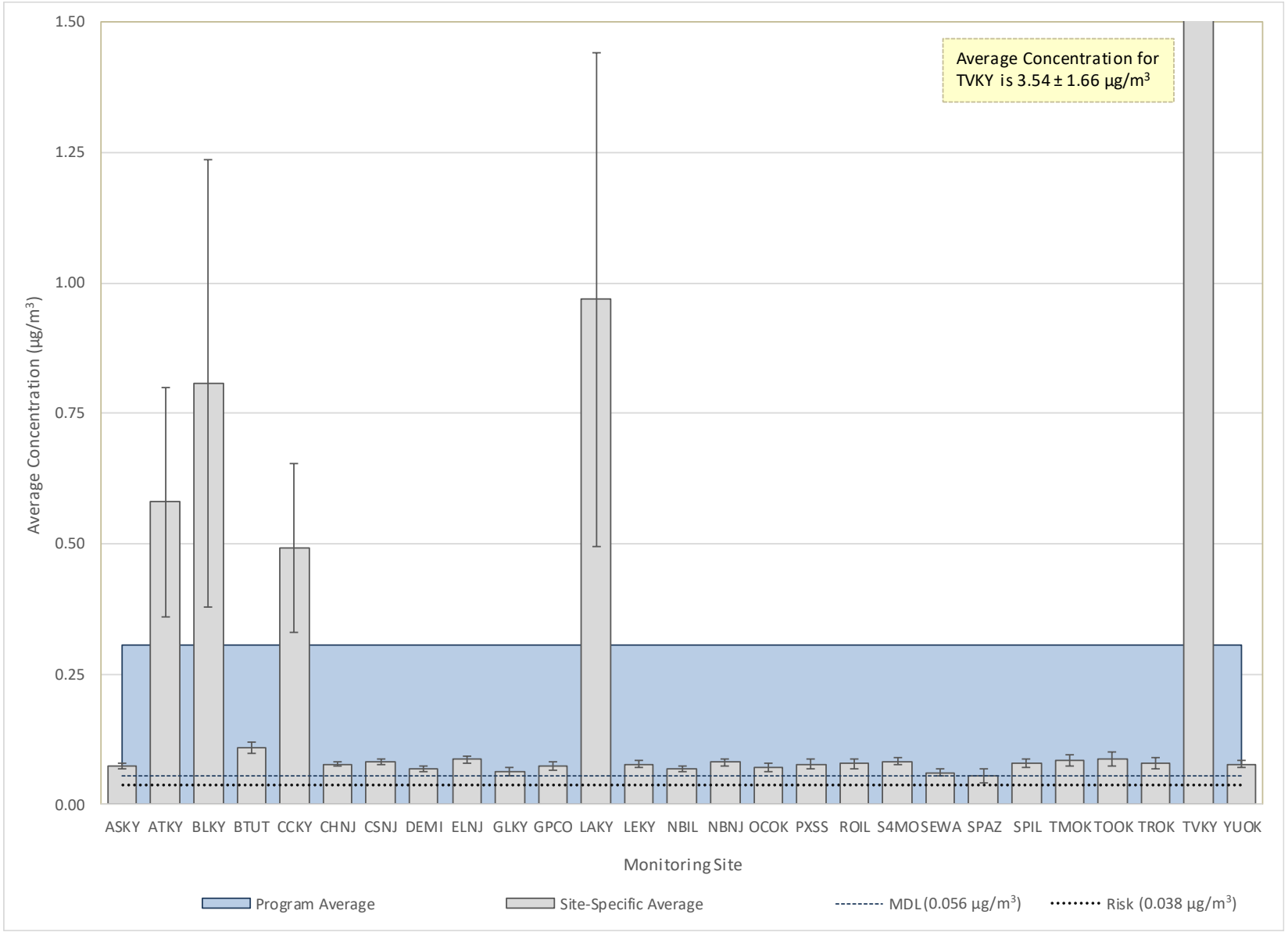


Figure 4-8a. Inter-Site Variability for Ethylbenzene – Method TO-15

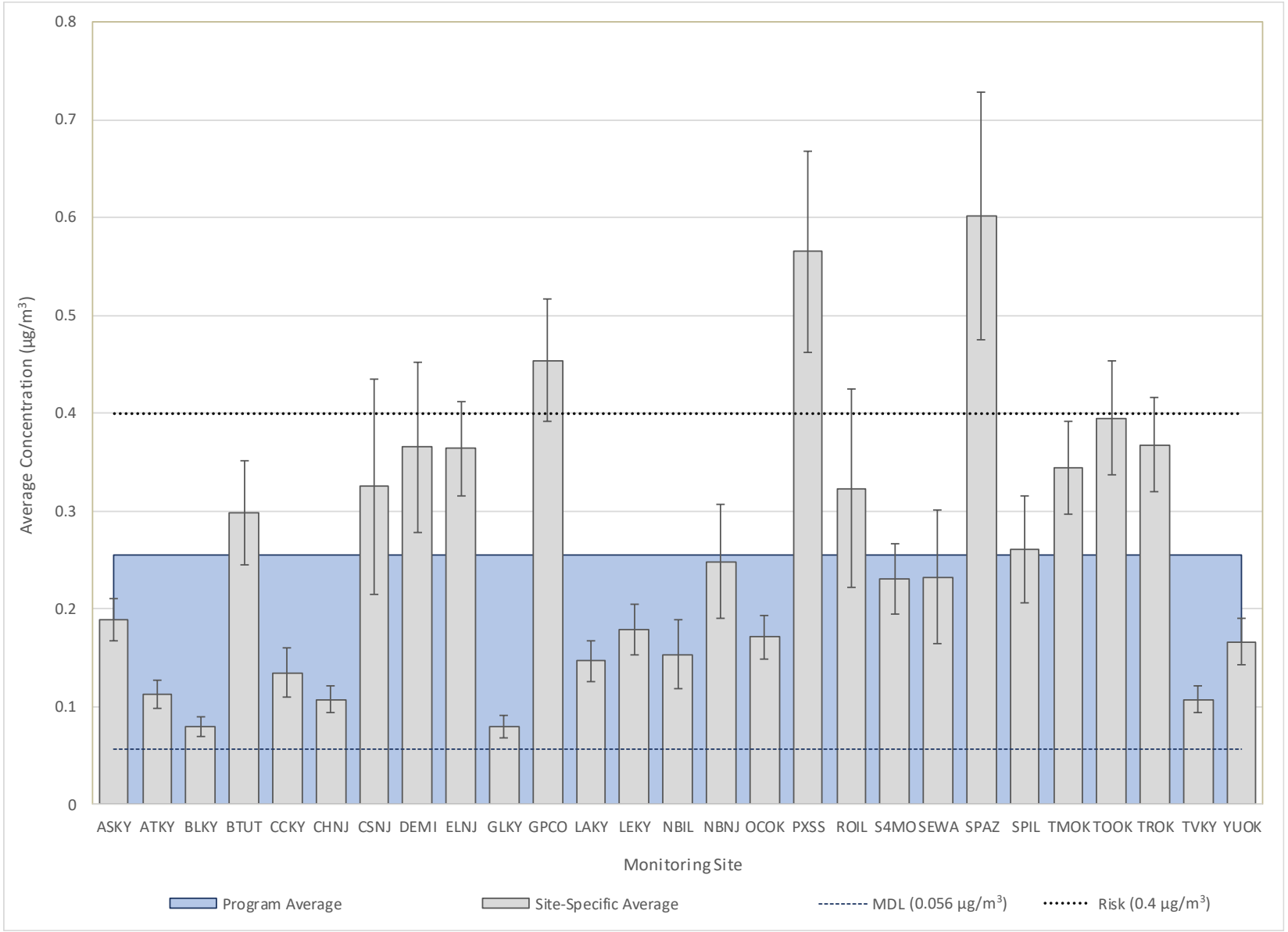


Figure 4-8b. Inter-Site Variability for Ethylbenzene – SNMOC

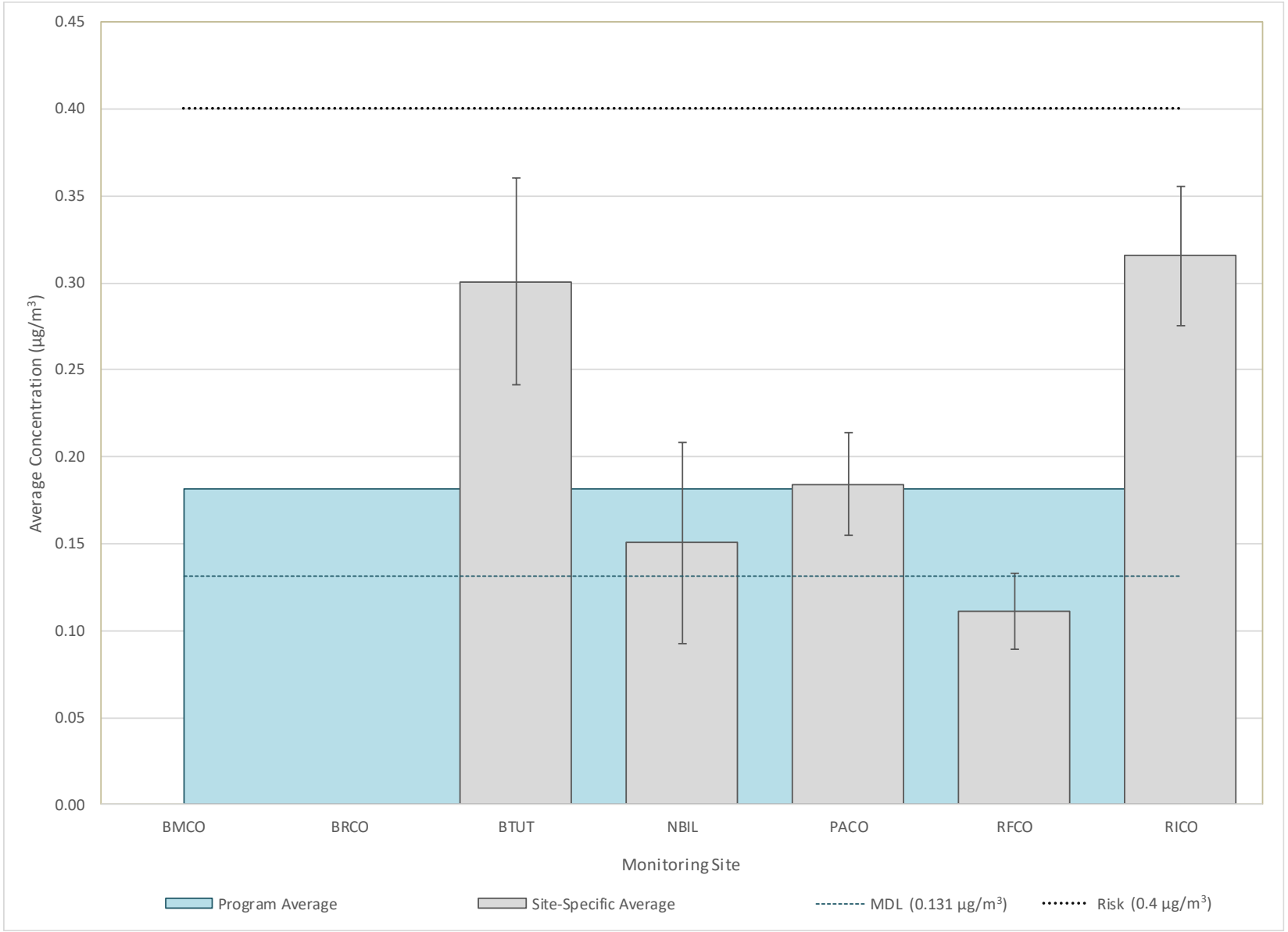


Figure 4-9. Inter-Site Variability for Formaldehyde

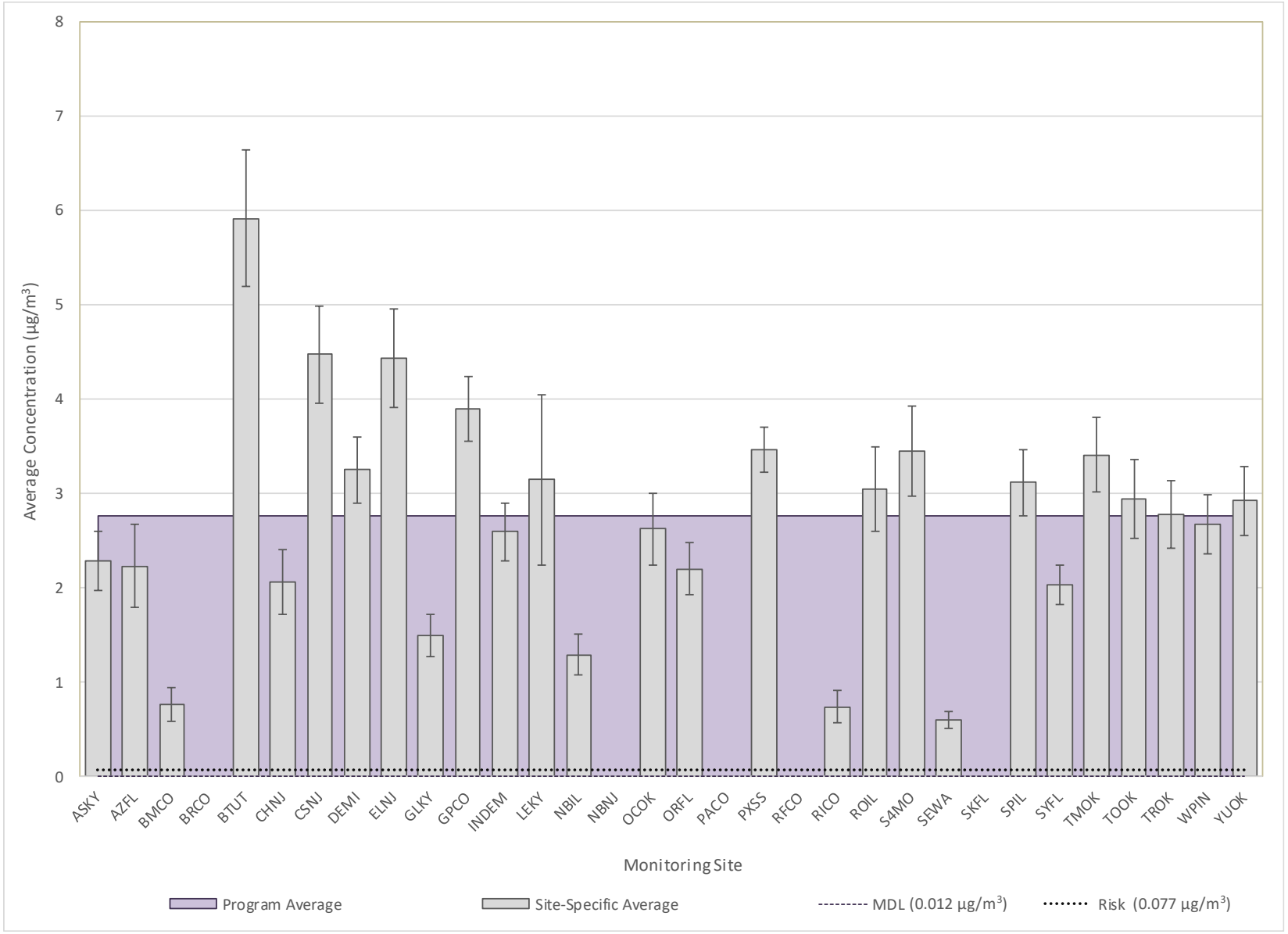


Figure 4-10. Inter-Site Variability for Hexachloro-1,3-butadiene

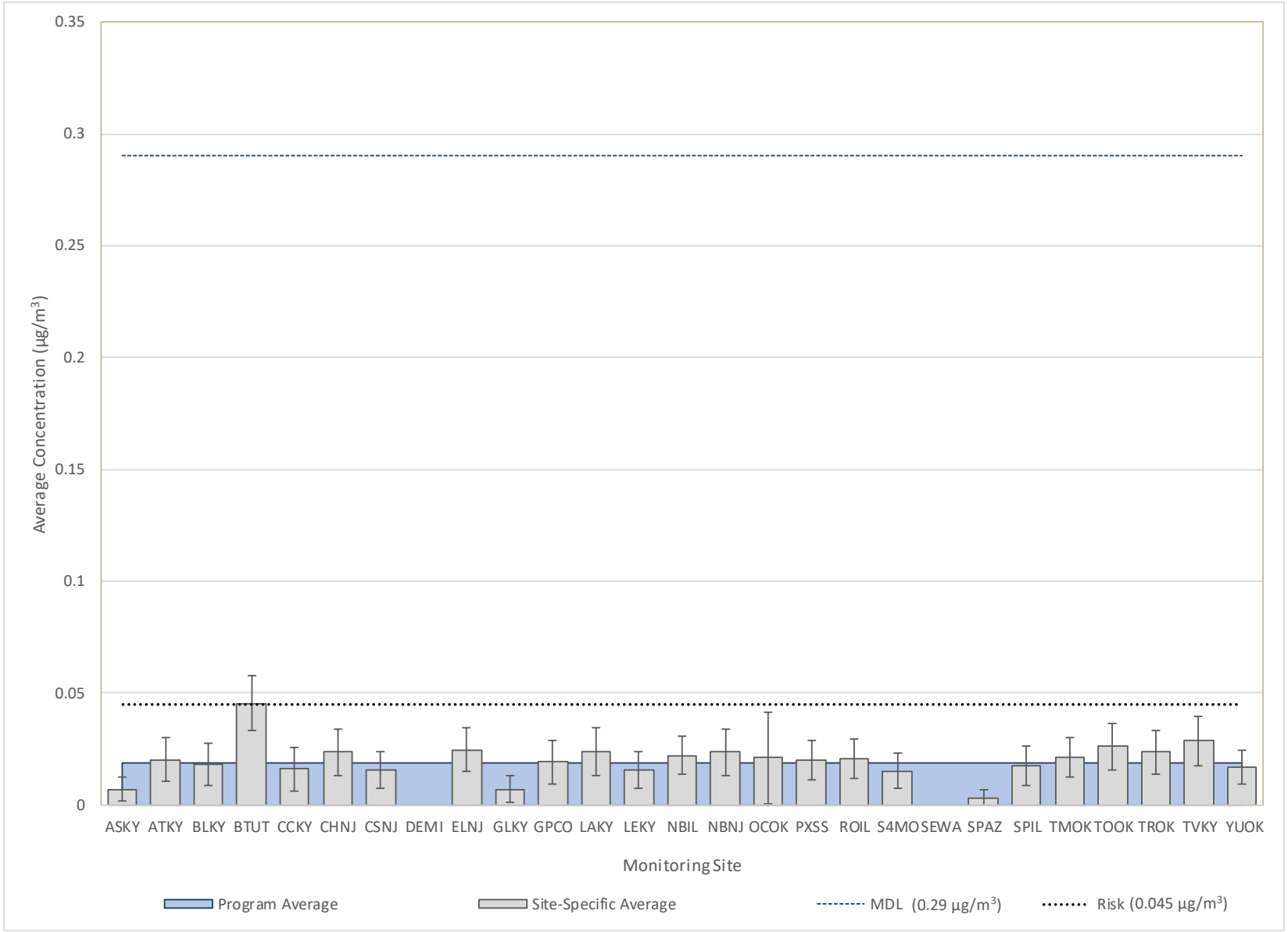


Figure 4-11. Inter-Site Variability for Naphthalene

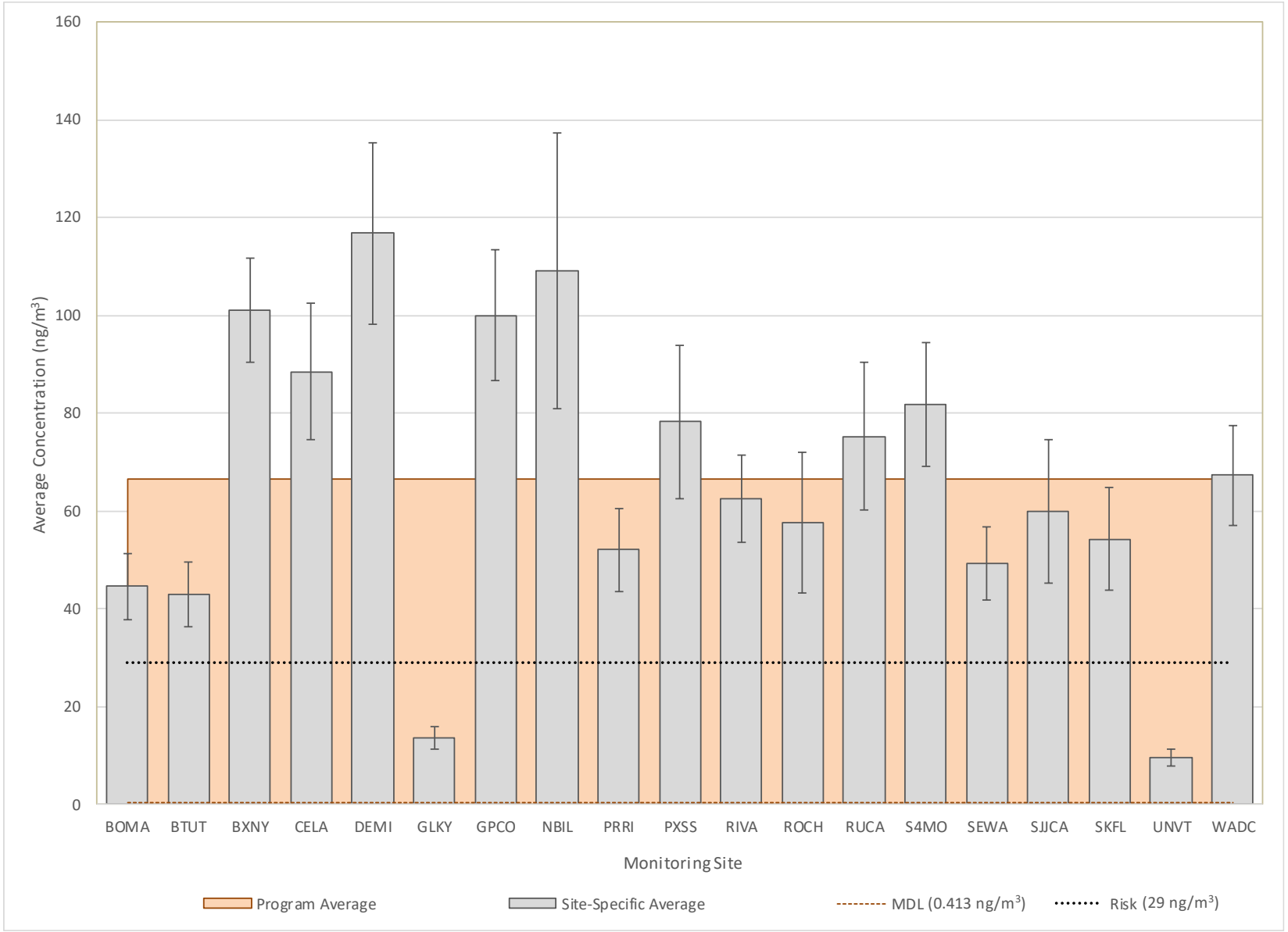
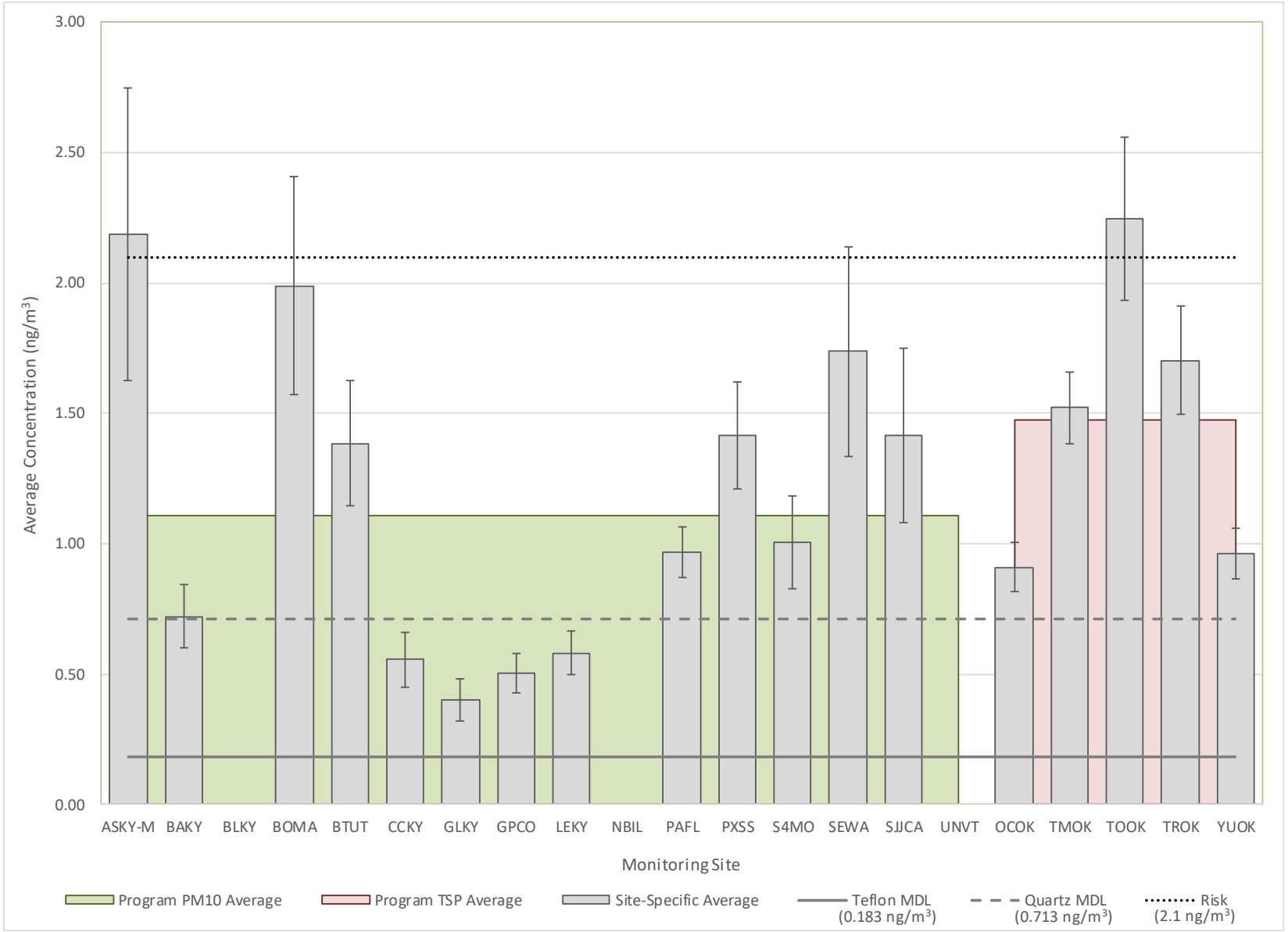


Figure 4-12. Inter-Site Variability for Nickel



4.2.2.2 Quarterly Variability Analysis

Figures 4-13 through 4-24b provide a graphical display of the site-specific quarterly average concentrations for each of the program-level pollutants of interest. Quarterly average concentrations are calculated based on the criteria specified in Section 3.1. The published MDL from the ERG laboratory is also plotted on each graph, similar to the inter-site variability graphs. For each metal pollutant of interest, there are two graphs, one for PM_{10} and one for TSP, the scales for which are the same. The same is also true for the air toxics measured by both Method TO-15 and the concurrent SNMOC method.

"Missing" quarterly average concentrations in the figures for the pollutants of interest can be attributed to several reasons. First, some of the program-wide pollutants of interest were infrequently detected in some quarters and may have a quarterly average concentration of zero, as a result of the substitution of zeros for non-detects. Thus, the quarterly average concentration is not missing but rather not visible on the graph. Another reason for missing quarterly averages in the figures is due to the sampling duration of each site. Some sites started late or ended early in the year, which may result in a lack of quarterly averages. Lastly, the criteria specified in Section 3.1 require a site to have 75 percent of the possible samples within a given calendar quarter (12 for a site sampling on a 1-in-6 day schedule) for a quarterly average concentration to be calculated. A quarterly average concentration is not presented for sites that did not meet this criterion.

Most of the program-level pollutants of interest were detected year-round. Few were detected less frequently. For example, hexachloro-1,3-butadiene was not detected at every site, as shown in Figure 4-22. This pollutant was not detected at DEMI or SEWA, and was detected in only two quarters at GLKY and SPAZ. However, comparing the quarterly average concentrations for sites with four valid quarterly averages in a year may reveal a temporal trend for other pollutants, such as formaldehyde, the quarterly averages for which tend to be highest for the summer months, based on this and previous reports. Trends in quarterly average concentrations are discussed below and in more detail in the state sections (Sections 5 through 23).

The quarterly average concentration 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. The quarterly average graphs may also reveal if concentrations measured at a particular site are significantly lower than other sites. These graphs may also reveal when there is very little variability in the quarterly averages across other sites. Inter-state trends may also be revealed.

Observations from Figures 4-13 through 4-24b include the following:

- Figure 4-13 presents the site-specific quarterly average concentrations of acetaldehyde. Twenty-five of the 32 sites sampling this pollutant have four quarterly average concentrations available. For many of these sites, the quarterly average concentrations for the second (7) and third (9) quarters are higher than the other quarterly averages. These can be seen by the red and green bars extending higher in Figure 4-13 than the others; examples include CSNJ, ELNJ, GPCO, and the Tulsa, Oklahoma sites. This figure also shows that the highest quarterly average concentrations were calculated for BTUT (fourth quarter) and SPIL (first quarter). Other sites with quarterly average acetaldehyde concentrations greater than 3.0 $\mu g/m^3$ include ELNJ, GPCO, NBIL, NBNJ, and PXSS. Note that three of BTUT's four quarterly average concentrations are greater than 3 $\mu g/m^3$. Sites with quarterly average acetaldehyde concentrations less than 0.5 $\mu g/m^3$ include BMCO, BRCO, PACO, RFCO, RICO, and SEWA; five of these sites are located in Garfield County, Colorado.

- Figures 4-14a and 4-14b present the quarterly average concentrations of arsenic for sites sampling speciated metals, first for PM_{10} then for TSP. Figure 4-14b shows that for each of the five sites sampling TSP metals, the third quarter average concentration was the highest quarterly average concentration for this pollutant. A similar observation can be made from Figure 4-14a for the sites sampling PM_{10} metals, but to a lesser extent. Of the 16 sites shown, 13 have four quarterly average concentrations of arsenic available. For seven of these 13 sites, the third quarter average concentration was the highest quarterly average concentration. These figures show that ASKY-M's third quarter average concentration (1.91 ng/m^3) is considerably higher than most of the others shown; only five other sites have quarterly average arsenic concentrations greater than 1 ng/m^3 (BAKY, NBIL, PAFL, S4MO, and TROK).

- Figures 4-15a and 4-15b present the quarterly average concentrations for sites sampling benzene, first for Method TO-15 then for SNMOC. Of the 32 sites sampling benzene with these methods, 24 have four quarterly average concentrations available. The first quarter average is mostly commonly the highest quarterly average concentration among the sites, followed by the third quarter average concentration. TVKY's third quarter average concentration (1.87 $\mu g/m^3$) is the highest quarterly average concentration shown, although PXSS, SPAZ, and PACO each have at least one quarterly average concentration greater than 1.5 $\mu g/m^3$.

- Figures 4-16a and 4-16b present the quarterly average concentrations for sites sampling 1,3-butadiene, first for Method TO-15 then for SNMOC. For sites sampling this pollutant with the SNMOC method, there are few quarterly average concentrations shown; some of these are due non-detects (and substituted zeros) rather than not being able to calculated them. For example, PACO is the only site with four quarterly averages of 1,3-butadiene, but two of them are zero due to non-detects. For sites sampling with Method TO-15, there are no zero quarterly averages, only a few sites for which quarterly averages could not be calculated (such as CCKY for the fourth quarter). Note, though, the MDLs between the two methods are quite different (0.029 µg/m^3 for TO-15 and 0.105 µg/m^3 for SNMOC). Of the 24 sites for which four quarterly average concentrations of 1,3-butadiene could be calculated, the third quarter average is mostly commonly the highest quarterly average concentration among the sites (11). This is a little different from previous reports, where 1,3-butadiene tended to be higher during the colder months of the year. For 2014, just as many sites have their highest quarterly average 1,3-butadiene concentration for the first or fourth quarters (12) as they do the second or third quarters (12) of the year. Yet for most sites, the differences among the quarterly averages are relatively small (less than 0.1 µg/m^3). The site with the highest quarterly average concentration of 1,3-butadiene is TVKY (0.86 µg/m^3, for the third quarter). No other sites have quarterly average concentrations of this pollutant greater than 0.5 µg/m^3 and only a few sites have quarterly averages greater than 0.25 µg/m^3.

- Concentrations of some pollutants had a tendency to be higher in one quarter over the others but the differences among the quarters were so small, it makes little difference. For instance, Figure 4-17 shows that the second and third quarter average concentrations are highest for most of the sites sampling carbon tetrachloride. Of the 23 sites with four available quarterly average concentrations of carbon tetrachloride, 21 have their highest quarterly average concentration calculated for either the second or third quarters of 2014 (with only two highest for the first quarter, LAKY and TVKY, and none highest for the fourth quarter). However, the quarterly average concentrations for most monitoring sites vary by less than 0.15 µg/m^3. The site with the largest difference in its quarterly average concentrations of carbon tetrachloride is BLKY, as its second quarter average concentration is considerably higher than the others (0.90 µg/m^3). Only two other NMP sites have quarterly average concentrations greater 0.75 µg/m^3 (LAKY and TVKY); all four of TVKY's quarterly average concentrations of carbon tetrachloride are greater than 0.75 µg/m^3.

- Figure 4-18 presents the quarterly average concentrations for *p*-dichlorobenzene. Note that most of the quarterly average concentrations shown are well below the MDL shown in the figure. Recall from the previous section that the detection rate for this pollutant is relatively low, around 44 percent, and most of the measured detections are less than the MDL. Only five sites have at least one quarterly average concentration greater than the MDL. For BTUT and TOOK, the third quarter average is greater than the MDL. For the other three sites (S4MO, PXSS, and SPAZ), all four quarterly average concentrations are well above the MDL. Of the 23 sites for which four quarterly average concentrations could be calculated, the averages for the third quarter are most frequently the highest (10), but of varying degrees of difference. For example, LEKY's third quarter average concentration of *p*-dichlorobenzene is more

than twice its next highest quarterly average, while the quarterly averages vary by very little for ATKY.

- As shown in Figure 4-19, most of the quarterly average concentrations for NMP sites measuring 1,2-dichloroethane are similar to the MDL for this pollutant (0.056 µg/m^3). The exceptions to this are all for the Calvert City, Kentucky sites. For the Calvert City sites, most of the quarterly average concentrations of 1,2-dichloroethane fall between 0.25 µg/m^3 and 1.25 µg/m^3, while all but one of TVKY's are greater than this range, particularly the first quarter average concentration (6.81 µg/m^3).

- Figures 4-20a and 4-20b present the quarterly average concentrations for sites sampling ethylbenzene, first for Method TO-15 then for SNMOC. Of the 24 sites for which four quarterly average concentrations could be calculated, the third quarter averages were the highest quarterly average for 15 of them. The sites with the highest quarterly average concentrations of ethylbenzene are PXSS and SPAZ, the only two sites with quarterly averages greater than 0.75 µg/m^3 (for the first and fourth quarters of 2014 for both sites). Only four additional sites (DEMI, GPCO, TOOK, and TROK) have at least one quarterly average concentration greater than 0.5 µg/m^3. All of the quarterly average concentrations shown for sites sampling with Method TO-15 are greater than the MDL for this pollutant while several of the quarterly averages shown for sites sampling with the SNMOC method are less than the MDL. Note, however, that the MDL for the SNMOC method (0.131 µg/m^3) is more than twice the MDL for Method TO-15 (0.056 µg/m^3).

- Figure 4-21 presents the quarterly average concentrations of formaldehyde. Quarterly average concentrations of formaldehyde tend to be highest for the summer months, based on previous reports. Figure 4-21 shows that 25 of the 32 sites sampling formaldehyde have four quarterly average concentrations available. Of these, 17 exhibited the highest quarterly average concentration for the third quarter (which includes samples collected from July through September, and is shown in green). Another five sites exhibited their highest quarterly formaldehyde average for the second quarter (from April through June), which is shown in red. Thus, it appears that formaldehyde concentrations tended to be highest during the warmer months of 2014 too, although there are exceptions. Several sites have quarterly average concentrations greater than 5 µg/m^3, although BTUT is the only site with more than one (second, third, and fourth quarters).

- Figure 4-22 presents the quarterly average concentrations of hexachloro-1,3-butadiene. The MDL for this pollutant is 0.29 µg/m^3 and all quarterly average concentrations shown are less than 0.06 µg/m^3. Recall from the previous section that only one concentration of hexachloro-1,3-butadiene measured in 2014 is greater than the detection limit and that the detection rate is 23 percent. This indicates that a large number of substituted zeroes are included in the quarterly average calculations, including some sites where this pollutant was not detected at all (DEMI and SEWA).

- Of the 19 sites sampling PAHs, four quarterly average concentrations of naphthalene could be calculated for 15 of them. Of these, the first quarter average concentration tended to be the highest (10 sites). However, the highest quarterly average

concentrations shown in Figure 4-23 were calculated for DEMI's and NBIL's third quarter average concentrations (203.35 ng/m^3 and 164.80 ng/m^3, respectively). The quarterly average naphthalene concentrations shown vary considerably, from UNVT's third quarter average concentration (4.49 ng/m^3) to NBIL's third quarter average concentration (203.35 ng/m^3). GLKY and UNVT are the only two sites with quarterly averages less than 25 ng/m^3 while NBIL and DEMI are the only two with quarterly averages greater than 150 ng/m^3. Note that several NMP sites do not have a second quarter average concentration for naphthalene shown in Figure 4-23. This is a result of the invalidation of several PAH samples in April and early May resulting from laboratory equipment issues. While this issue affected all sites that sampled naphthalene, some sites had enough valid samples for the second quarter to still meet the minimum criteria for calculating a quarterly average concentration while others did not. The number of samples affected varies from two samples to four samples.

- Figures 4-24a and 4-24b present the quarterly average concentrations of nickel for sites sampling speciated metals, first for PM_{10} then for TSP. The quarterly average concentrations of nickel do not exhibit an identifiable seasonal trend. Some sites' quarterly average concentrations vary considerably (SEWA) while others do not (OCOK). SEWA is the only site with a quarterly average concentration of nickel greater than 3 ng/m^3, although three additional sites have quarterly averages greater than 2.5 ng/m^3 (ASKY-M, BOMA, and TOOK). Several sites have quarterly average concentrations less than 0.5 ng/m^3, although all of these are sampling PM_{10} metals.

Figure 4-13. Comparison of Average Quarterly Acetaldehyde Concentrations

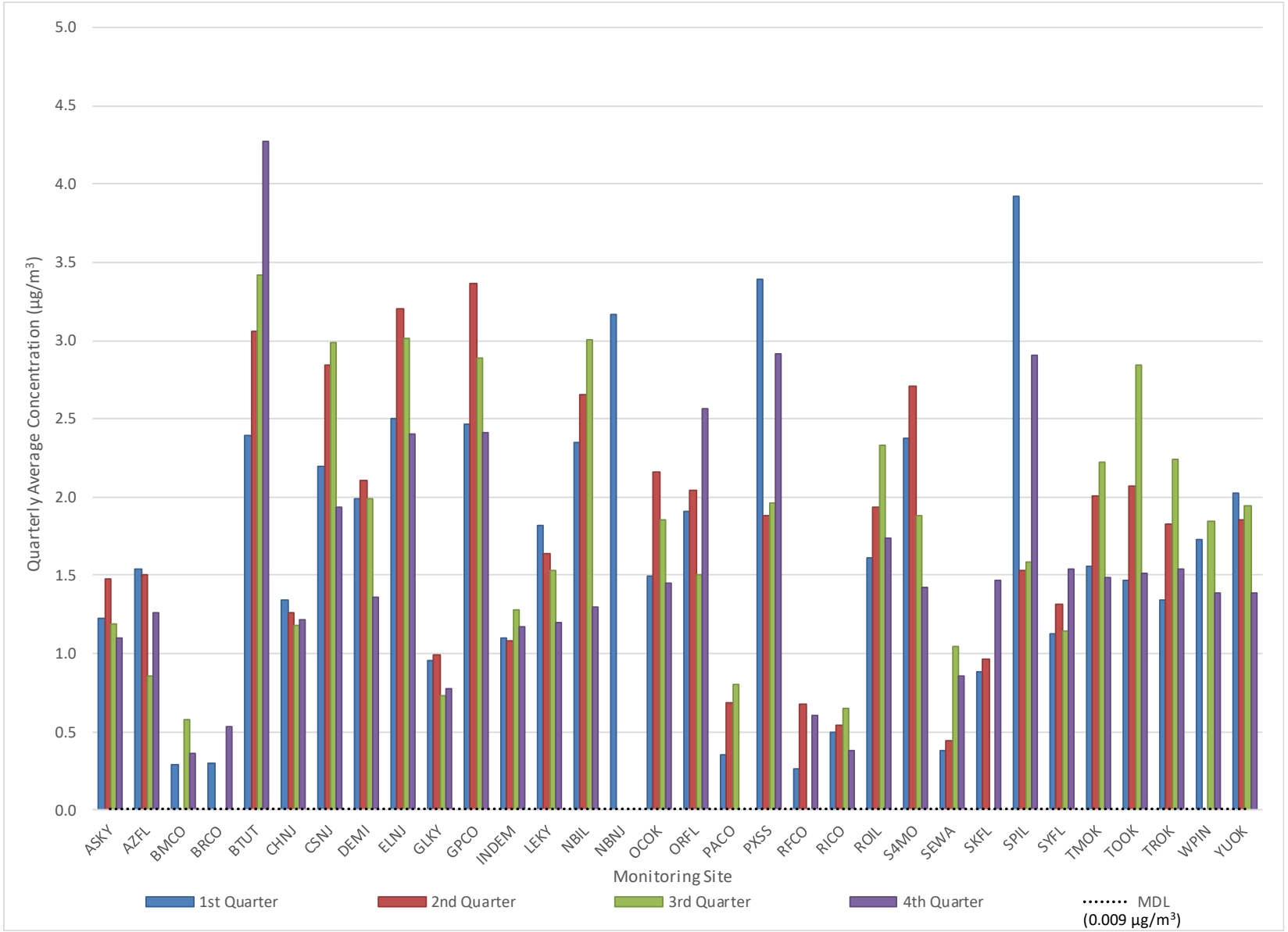


Figure 4-14a. Comparison of Average Quarterly Arsenic (PM_{10}) Concentrations

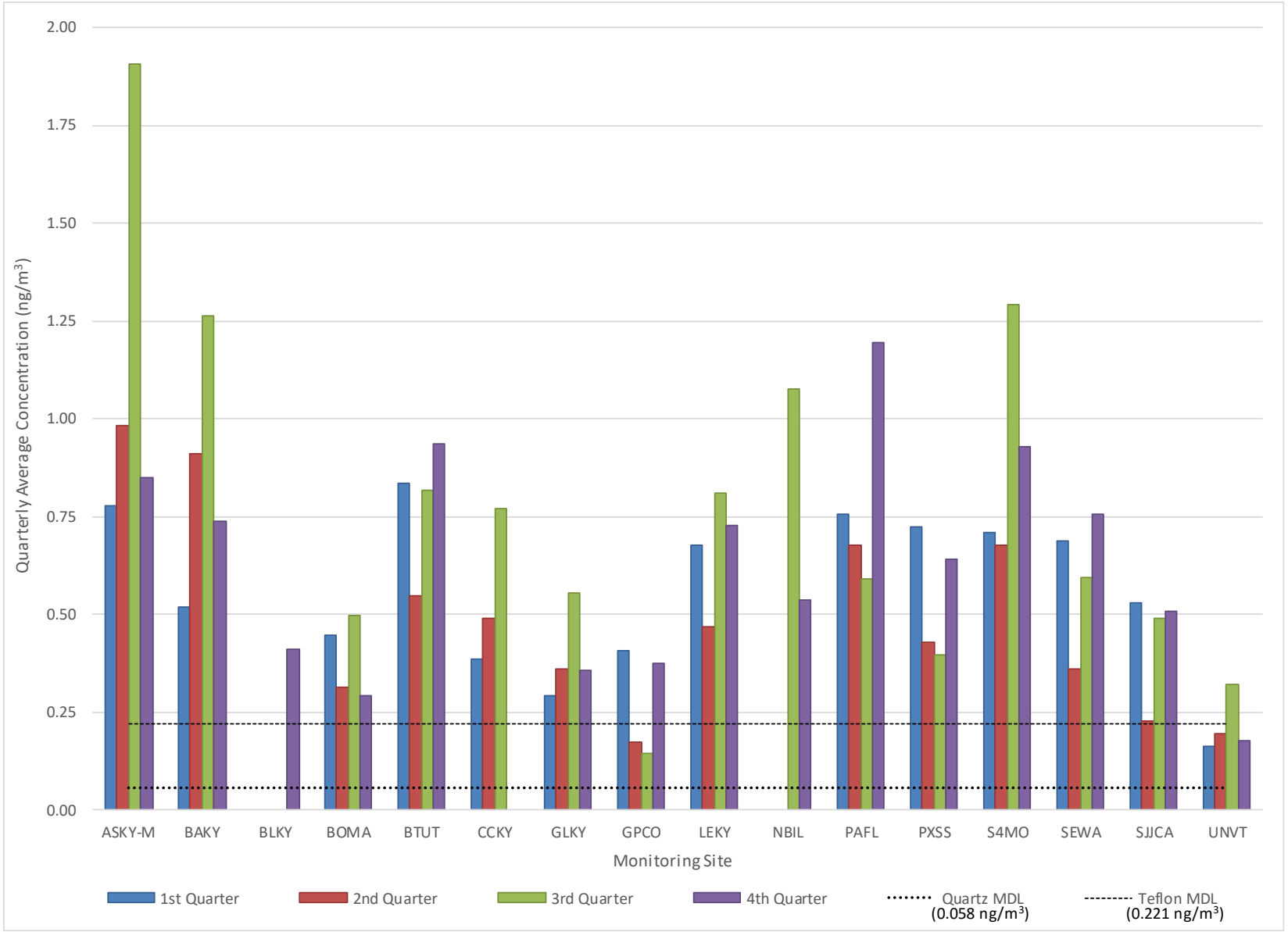


Figure 4-14b. Comparison of Average Quarterly Arsenic (TSP) Concentrations

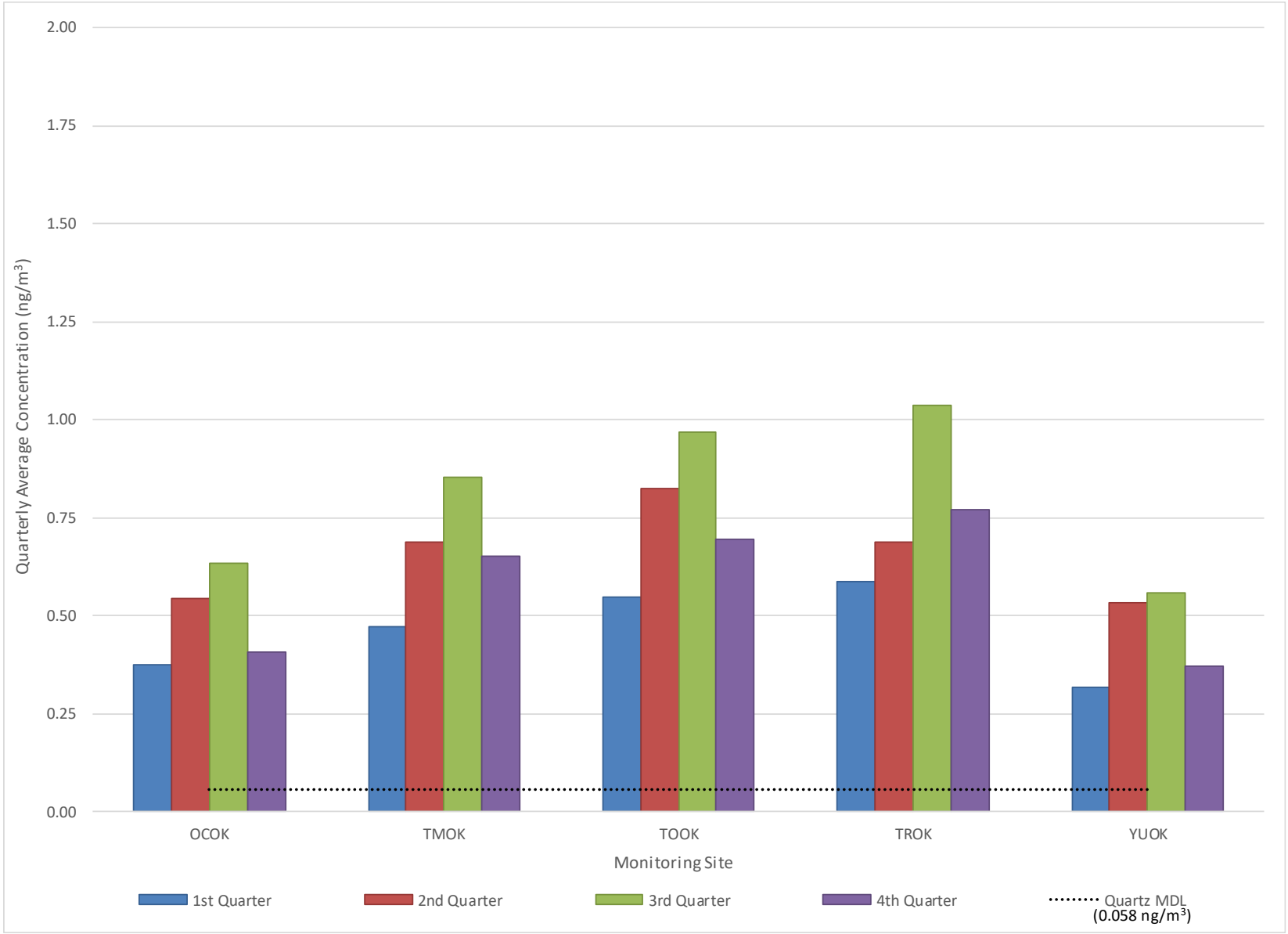


Figure 4-15a. Comparison of Average Quarterly Benzene (Method TO-15) Concentrations

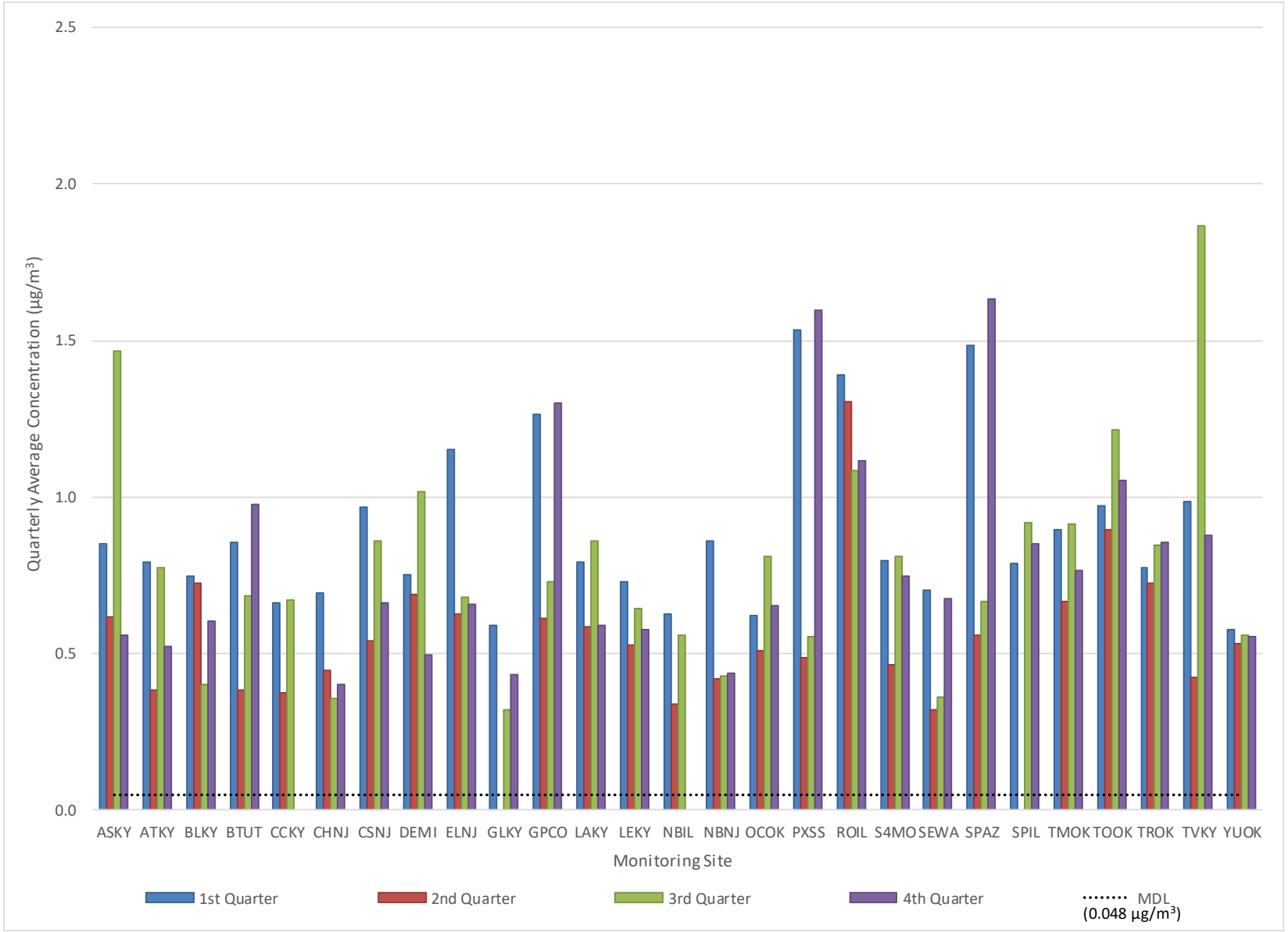


Figure 4-15b. Comparison of Average Quarterly Benzene (SNMOC) Concentrations

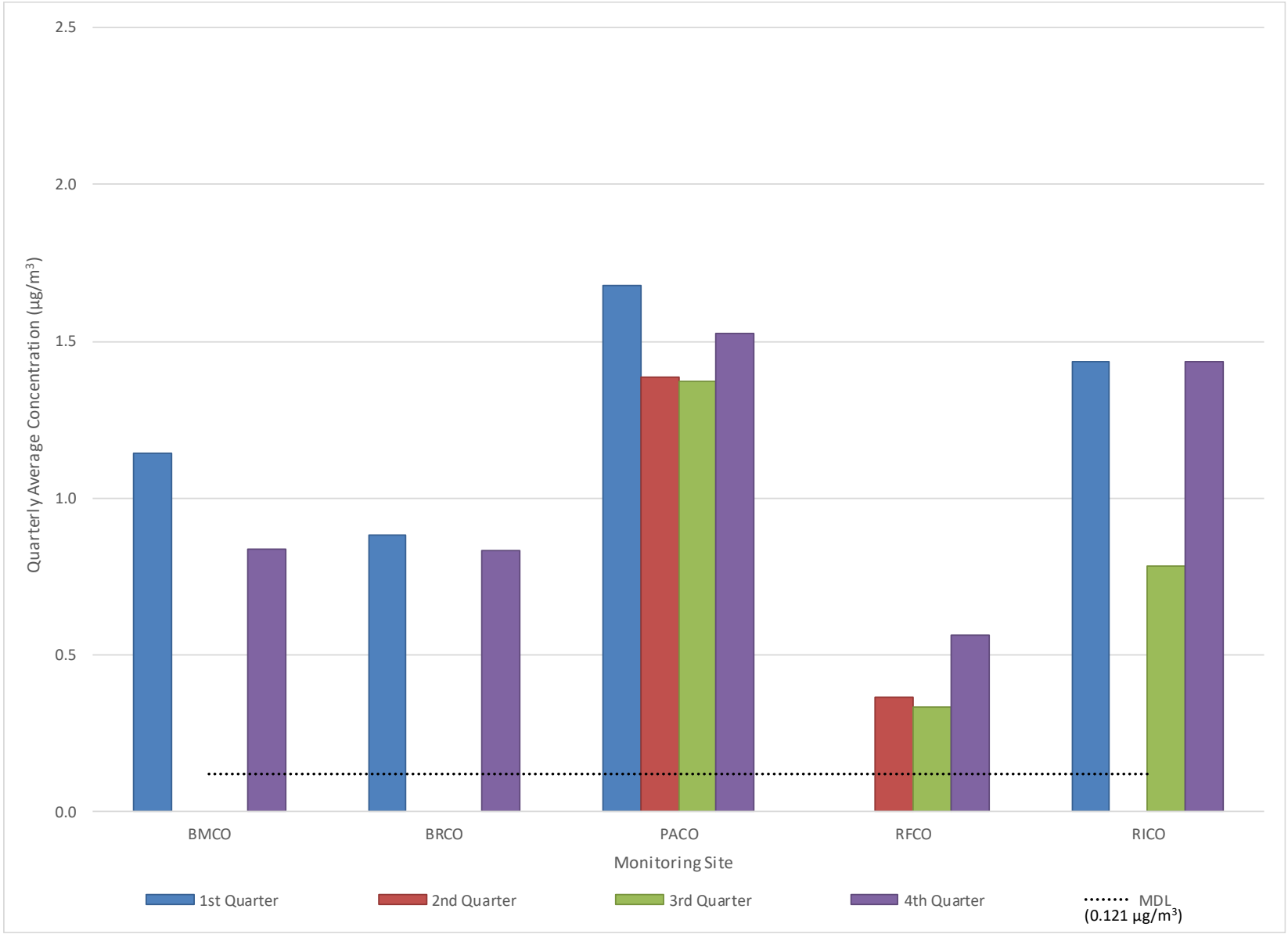


Figure 4-16a. Comparison of Average Quarterly 1,3-Butadiene (Method TO-15) Concentrations

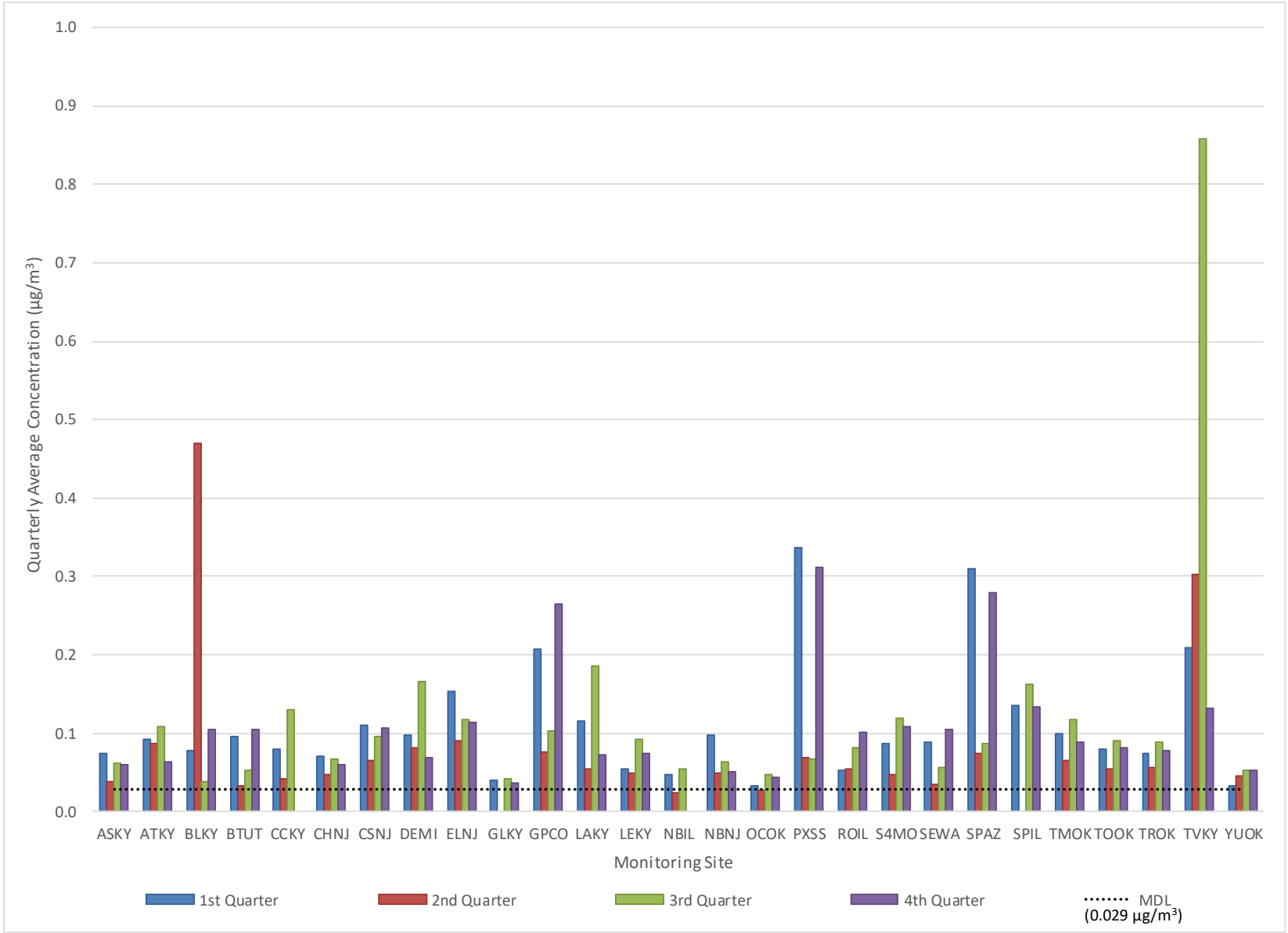


Figure 4-16b. Comparison of Average Quarterly 1,3-Butadiene (SNMOC) Concentrations

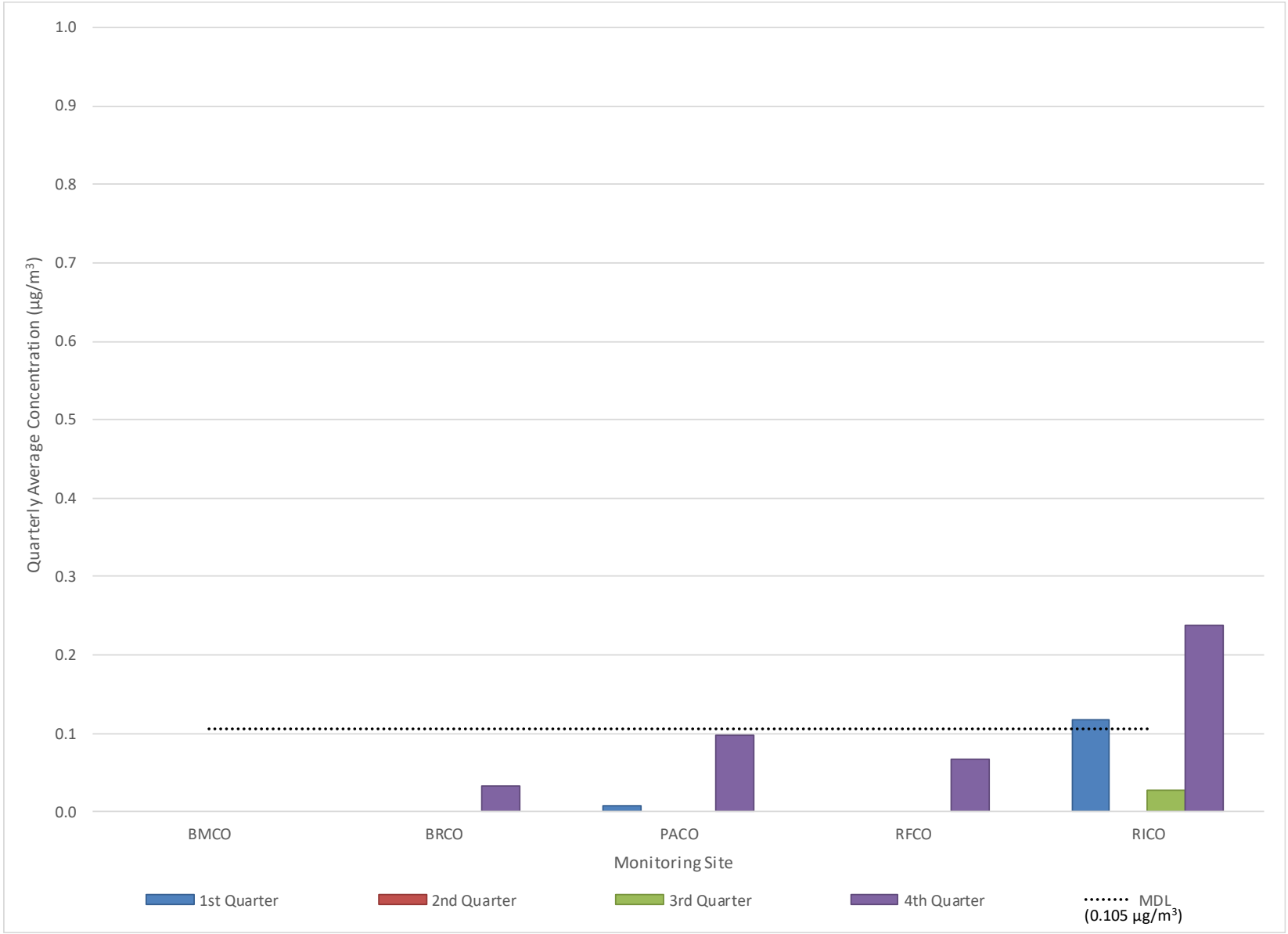


Figure 4-17. Comparison of Average Quarterly Carbon Tetrachloride Concentrations

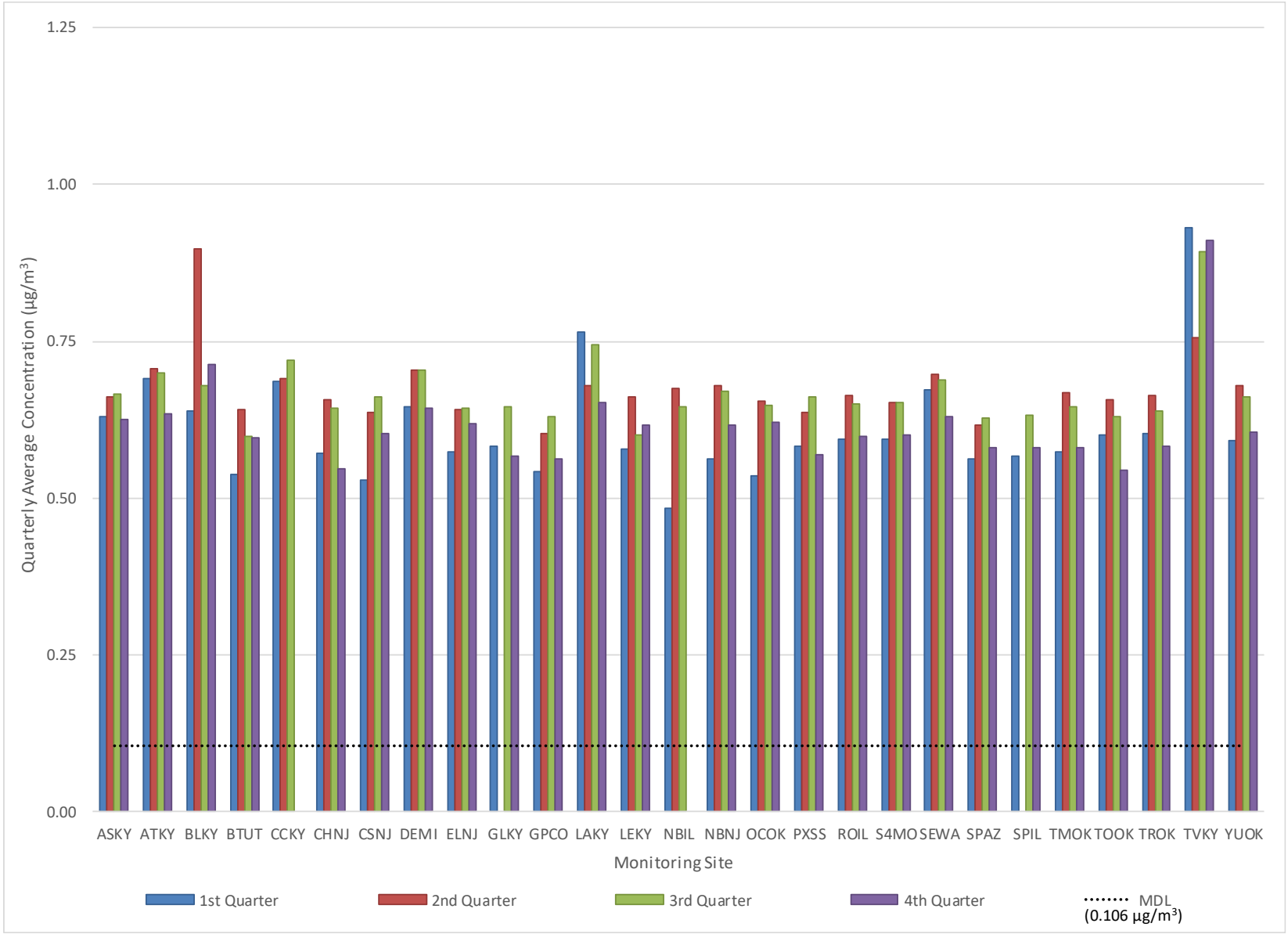


Figure 4-18. Comparison of Average Quarterly *p*-Dichlorobenzene Concentrations

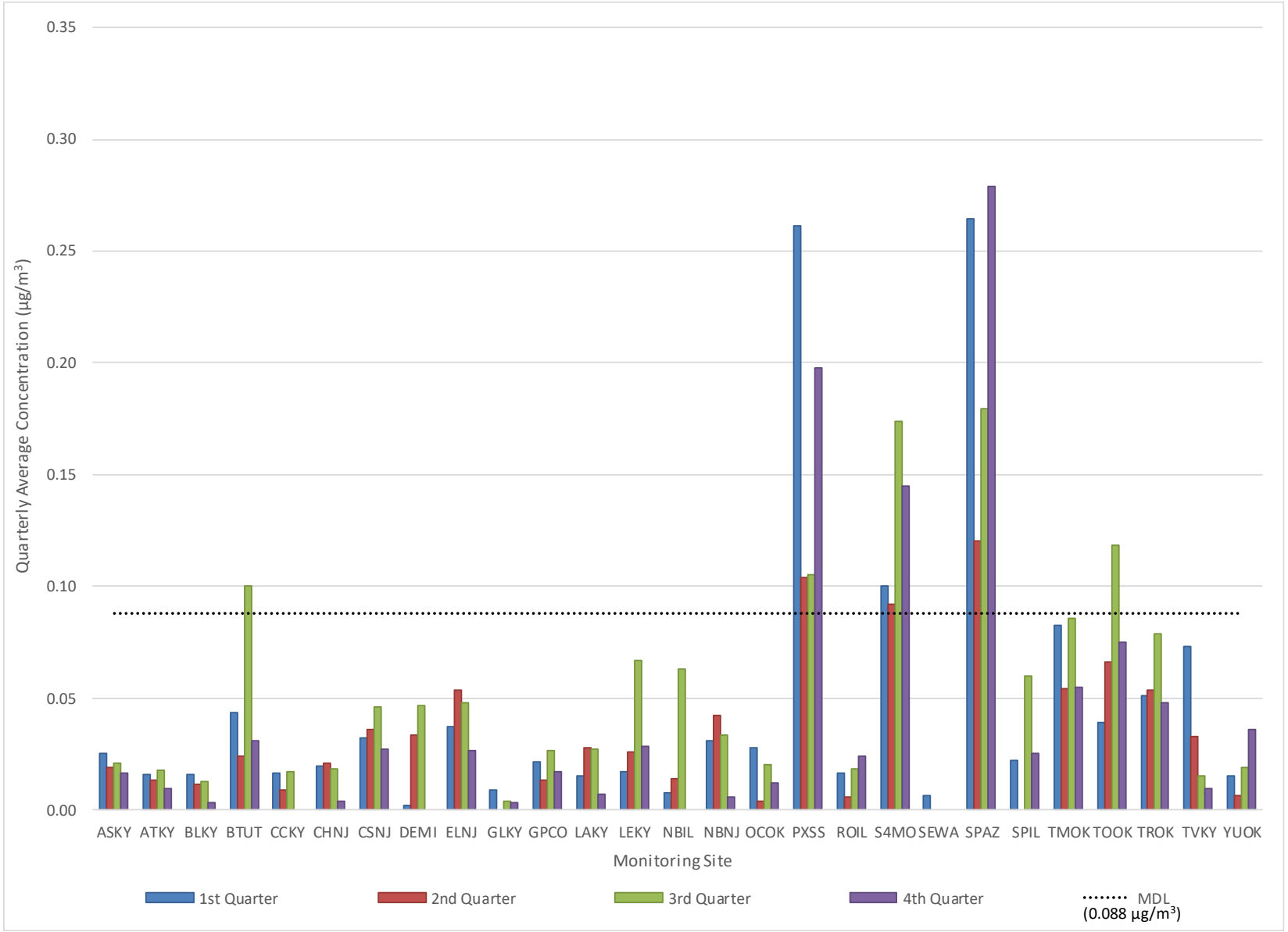


Figure 4-19. Comparison of Average Quarterly 1,2-Dichloroethane Concentrations

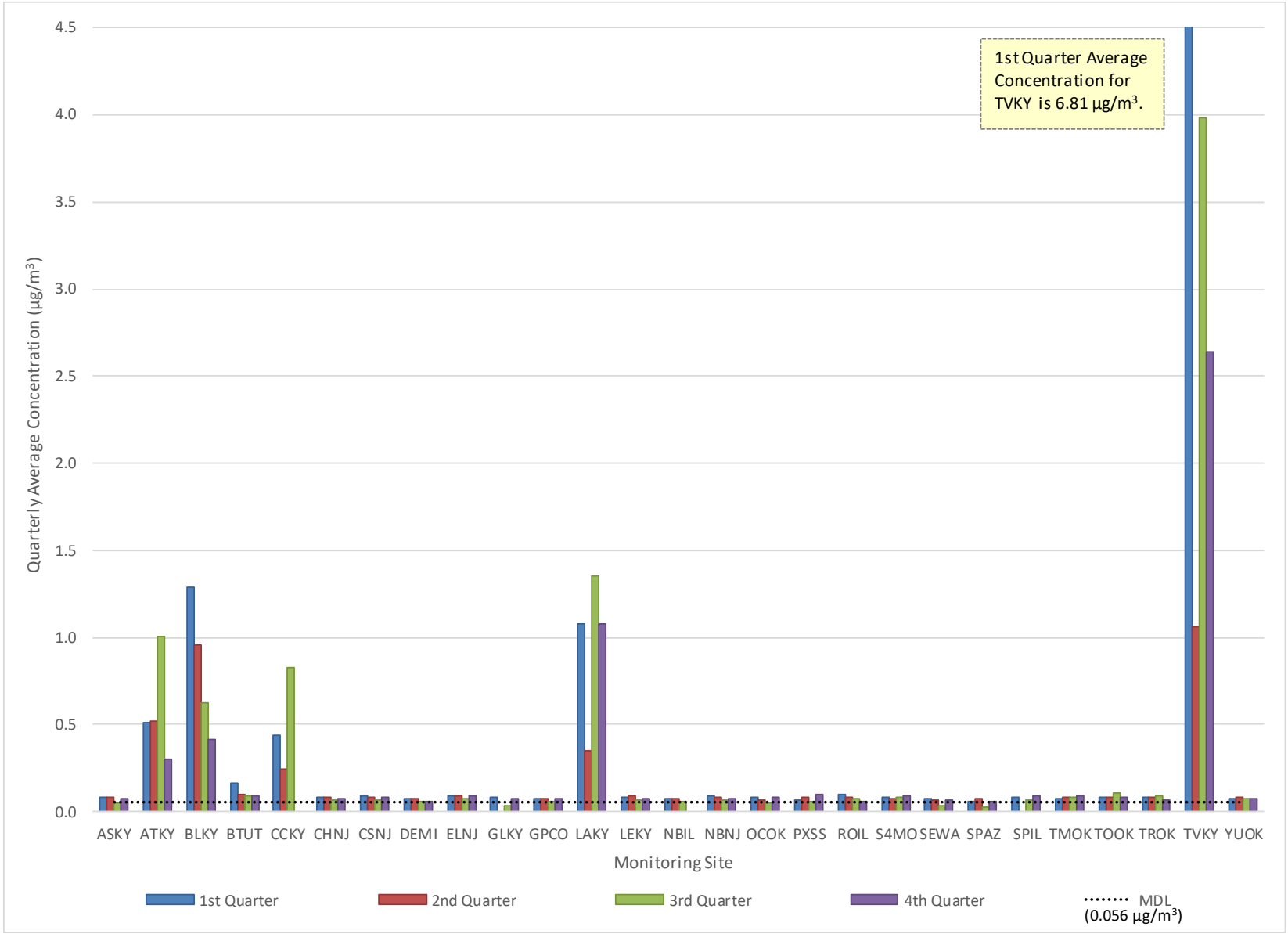


Figure 4-20a. Comparison of Average Quarterly Ethylbenzene (Method TO-15) Concentrations

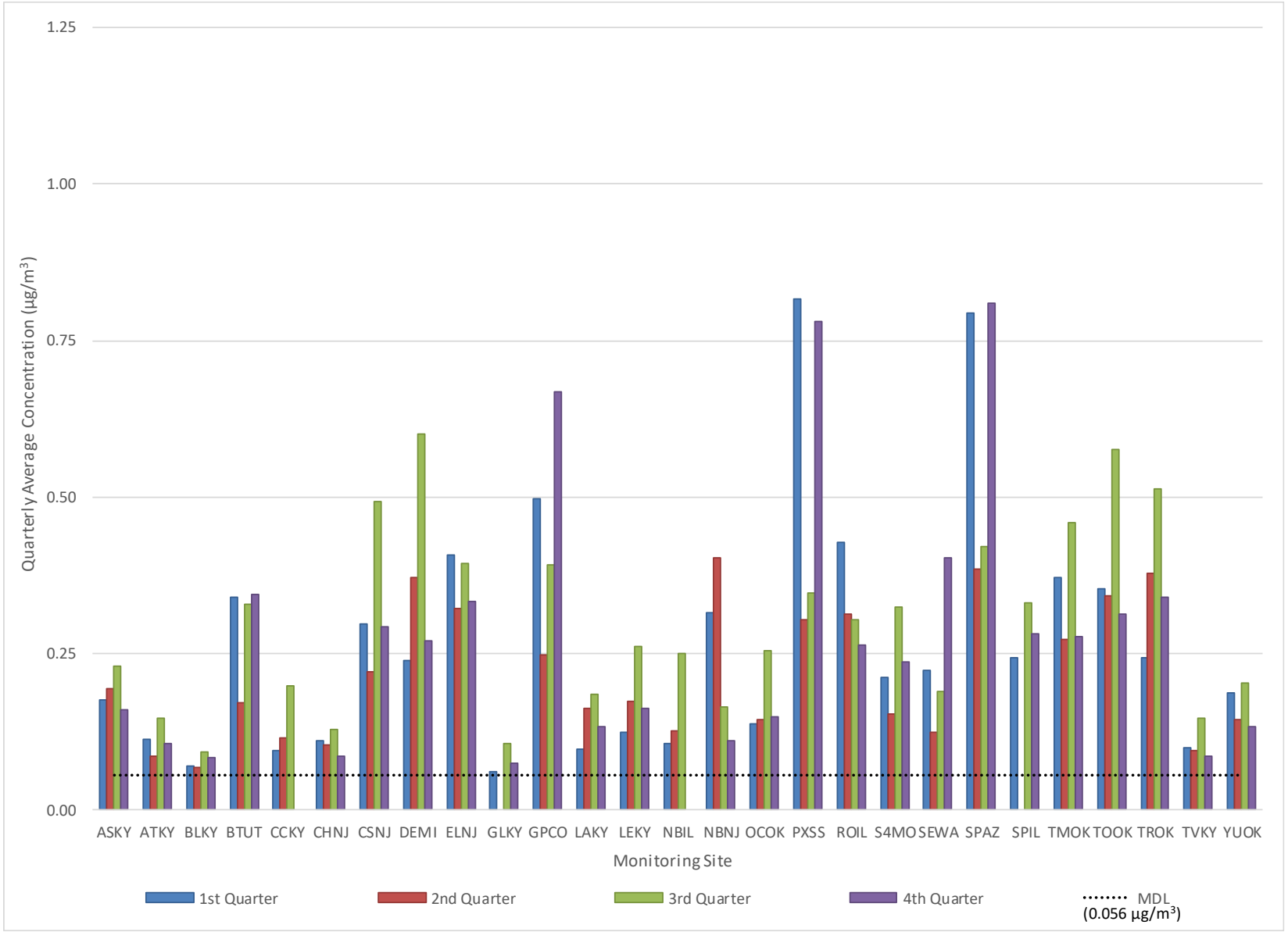


Figure 4-20b. Comparison of Average Quarterly Ethylbenzene (SNMOC) Concentrations

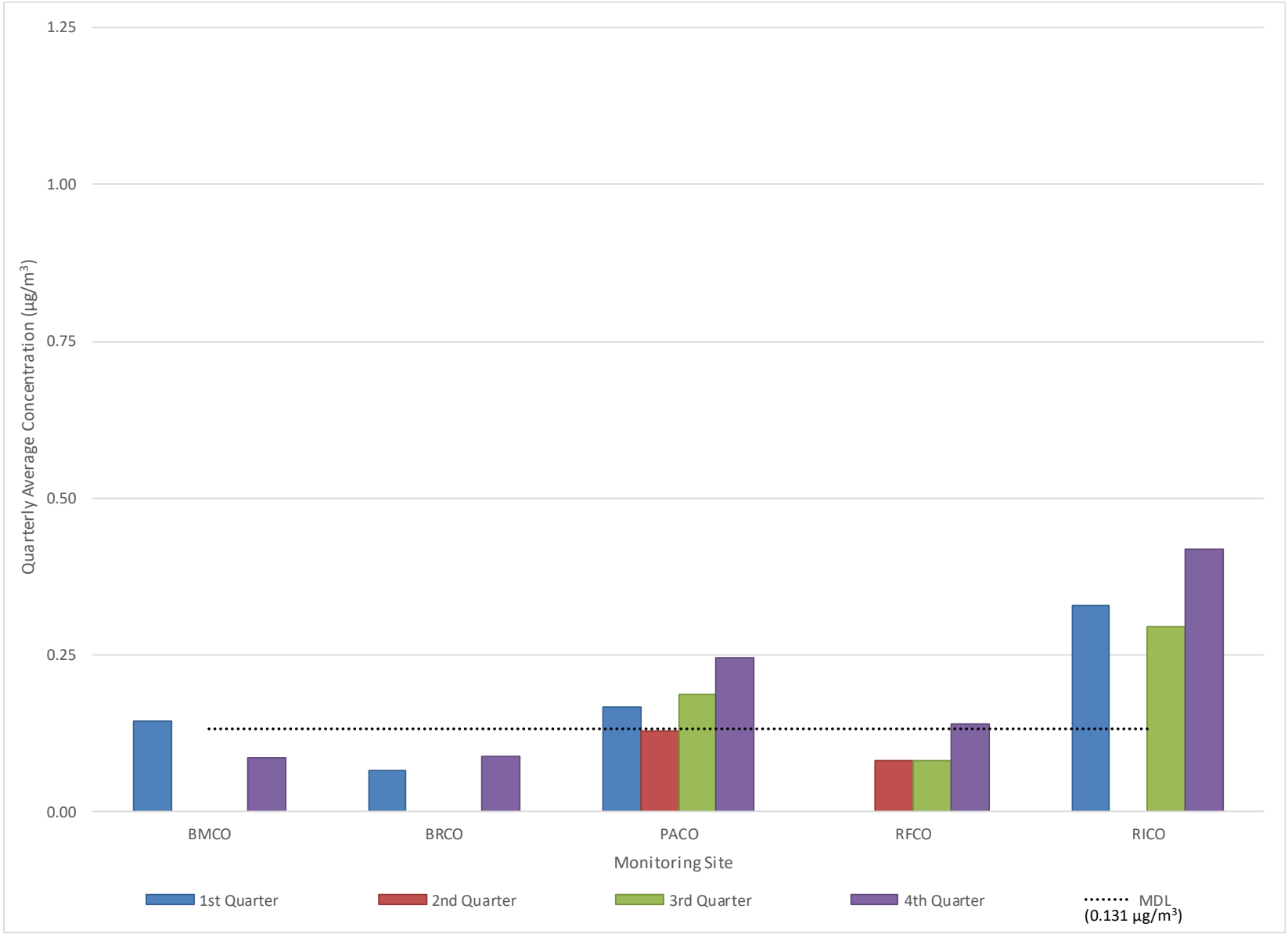


Figure 4-21. Comparison of Average Quarterly Formaldehyde Concentrations

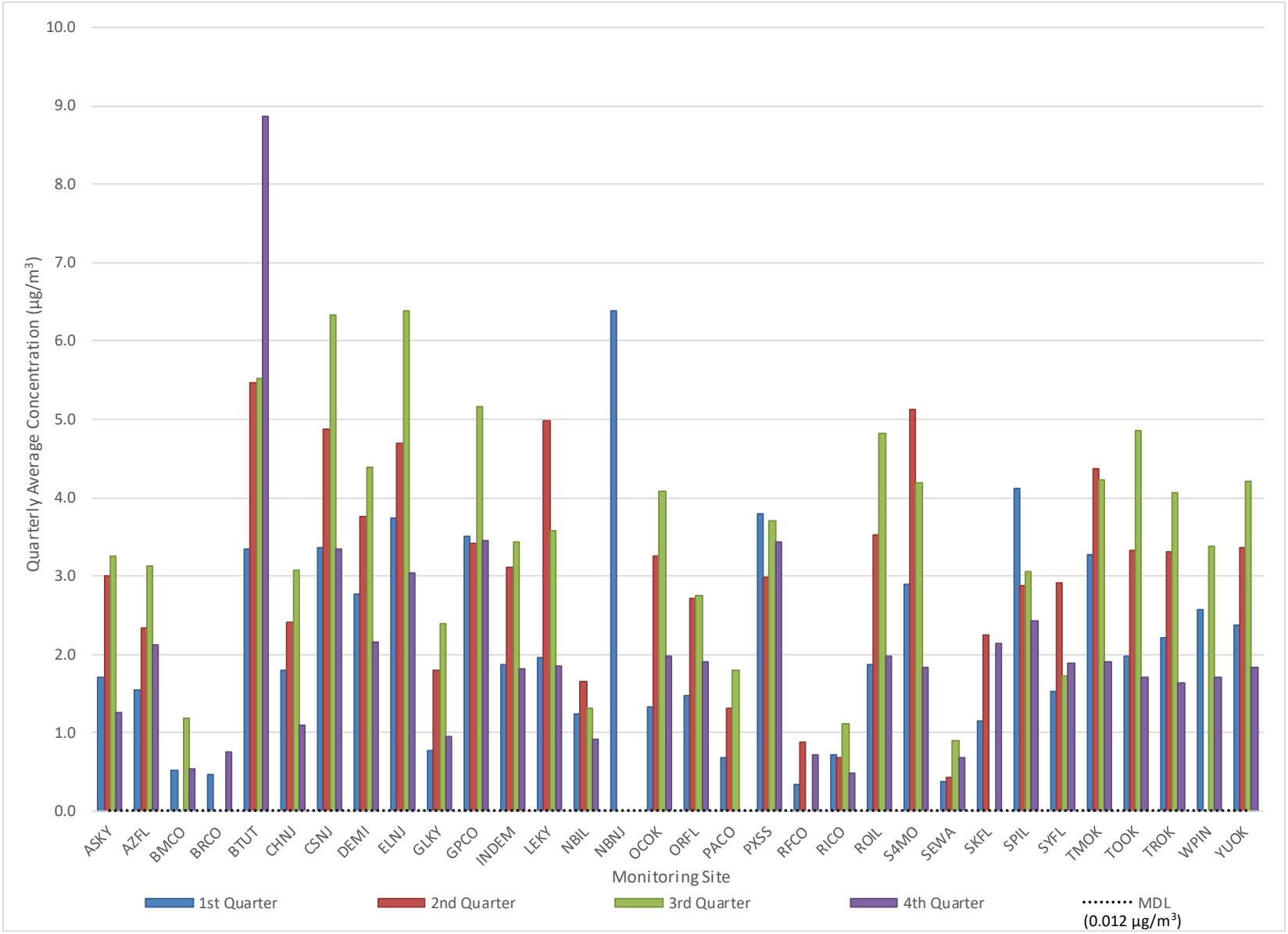


Figure 4-22. Comparison of Average Quarterly Hexachloro-1,3-butadiene Concentrations

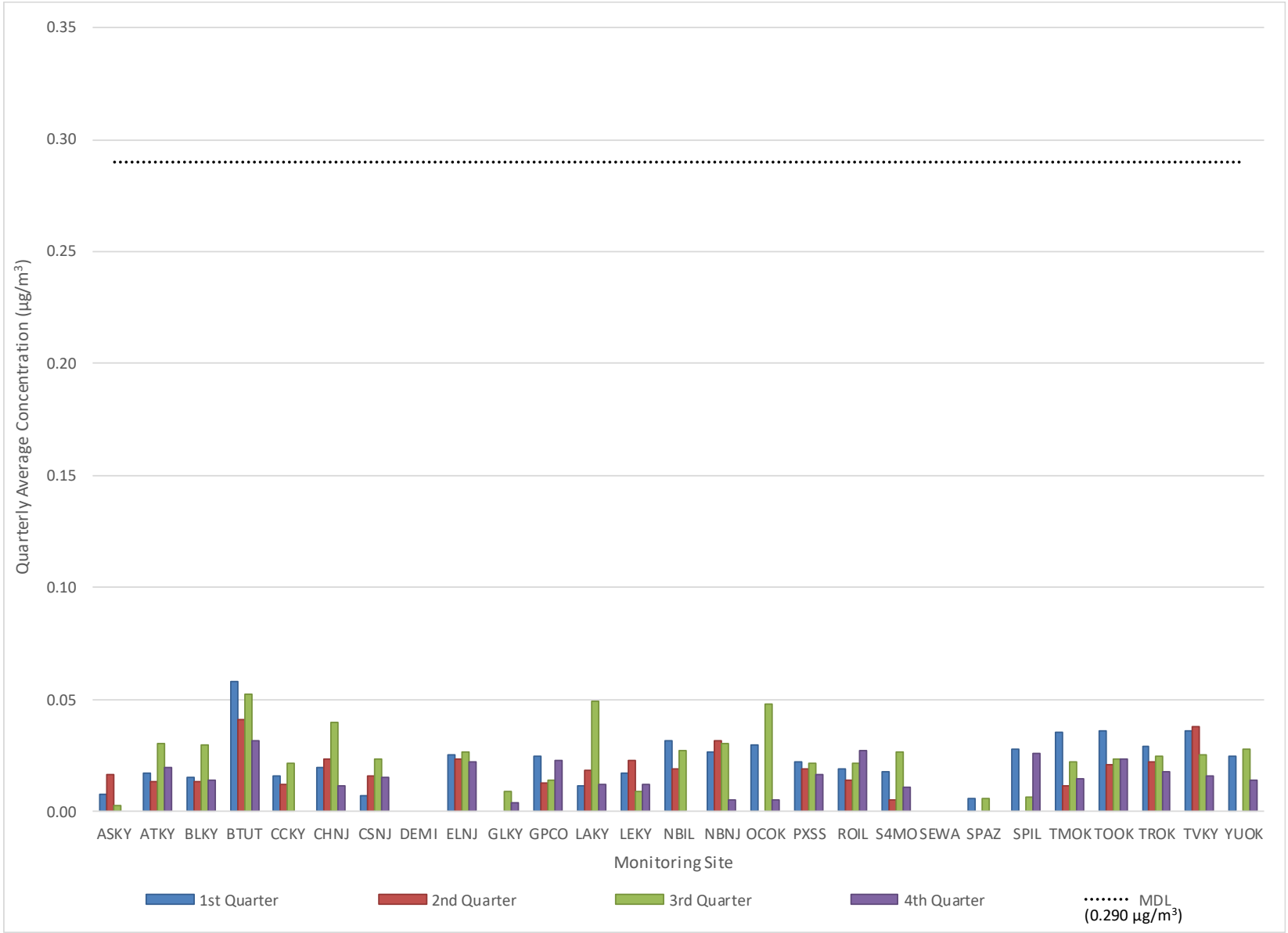


Figure 4-23. Comparison of Average Quarterly Naphthalene Concentrations

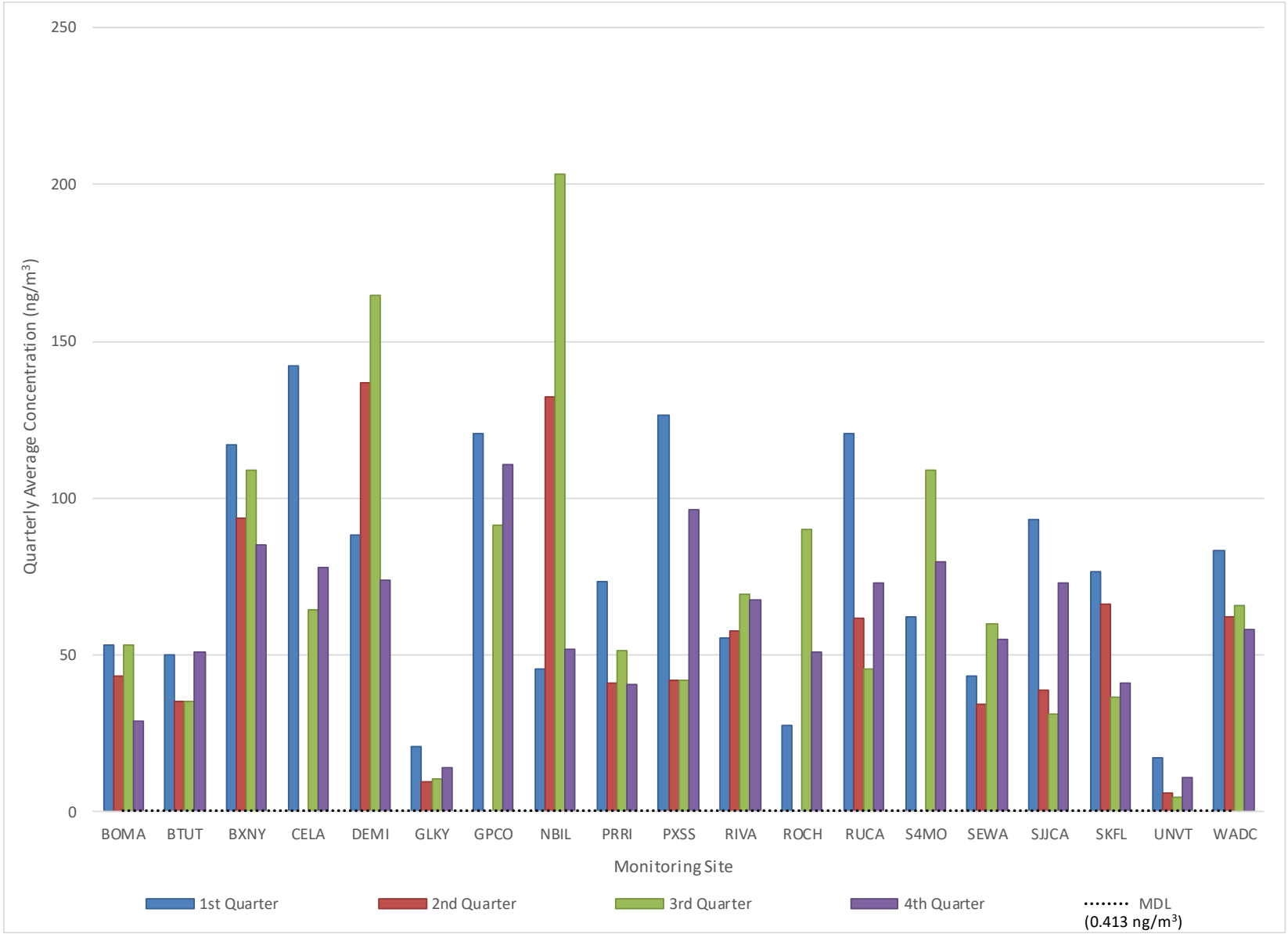


Figure 4-24a. Comparison of Average Quarterly Nickel (PM_{10}) Concentrations

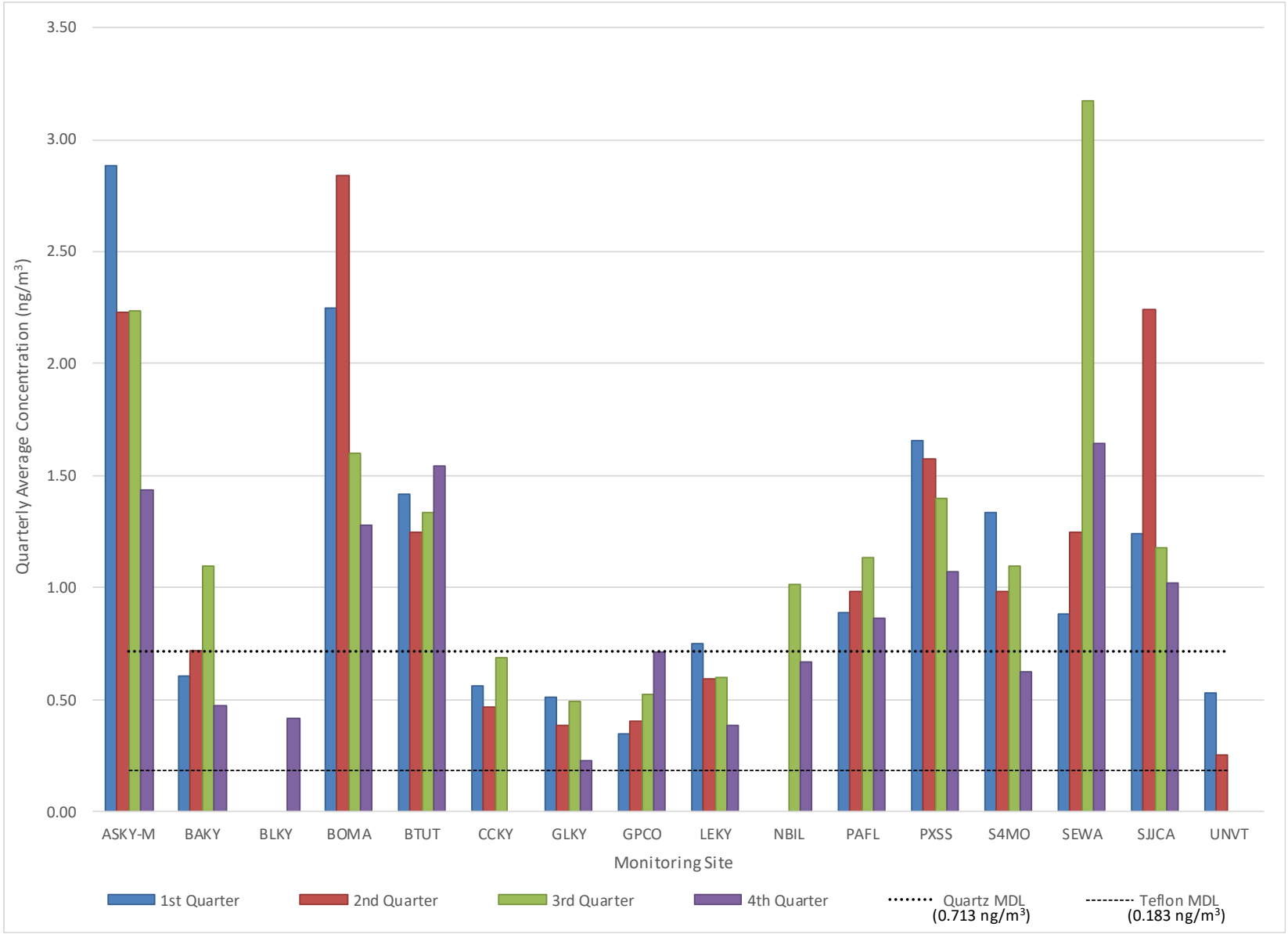
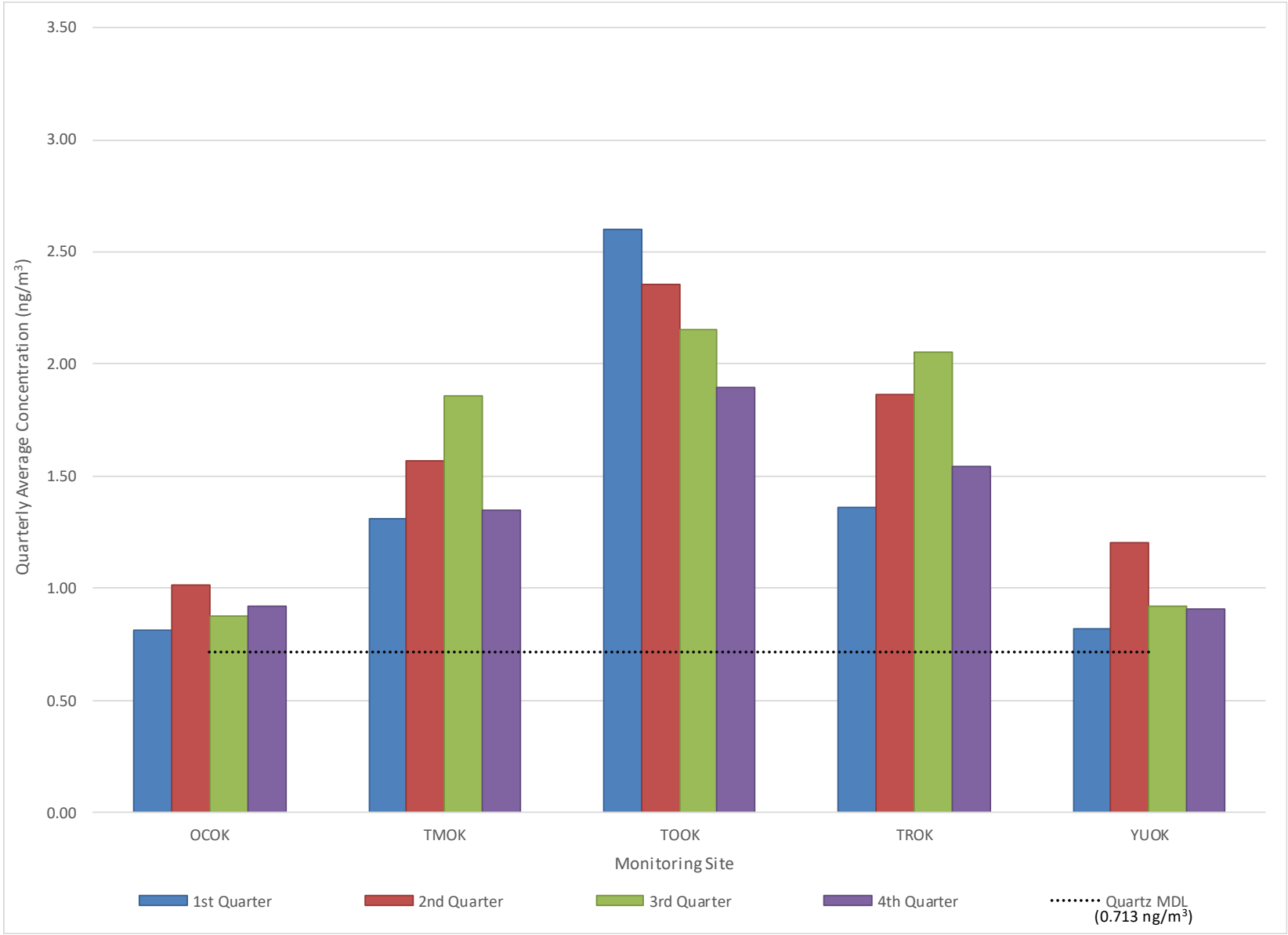


Figure 4-24b. Comparison of Average Quarterly Nickel (TSP) Concentrations



5.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

5.1 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 5-1 and 5-2 are composite satellite images retrieved from ArcGIS Explorer showing the monitoring sites and their immediate surroundings. Figure 5-3 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 5-3. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundaries are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 5-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

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

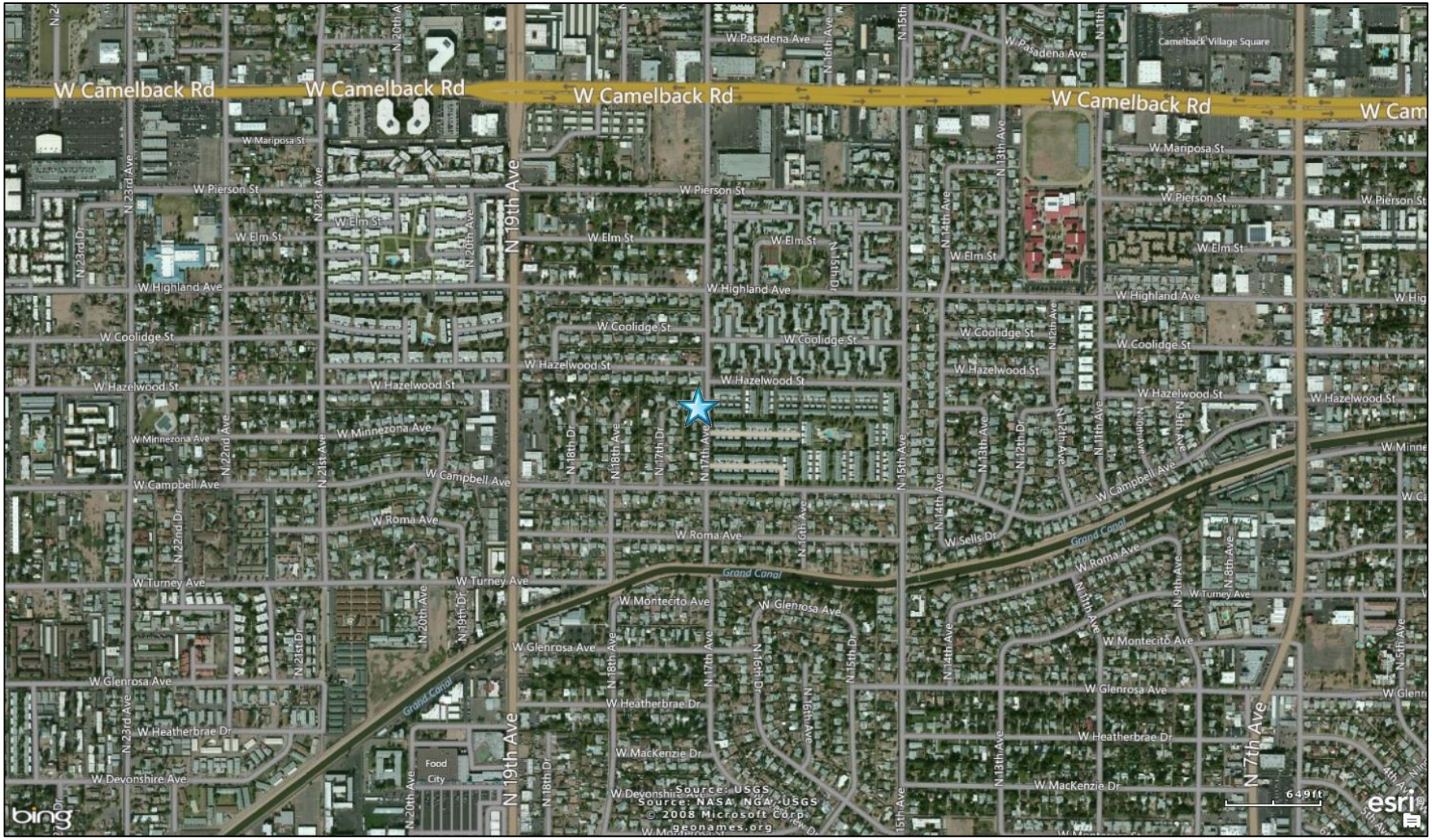


Figure 5-2. South Phoenix, Arizona (SPAZ) Monitoring Site

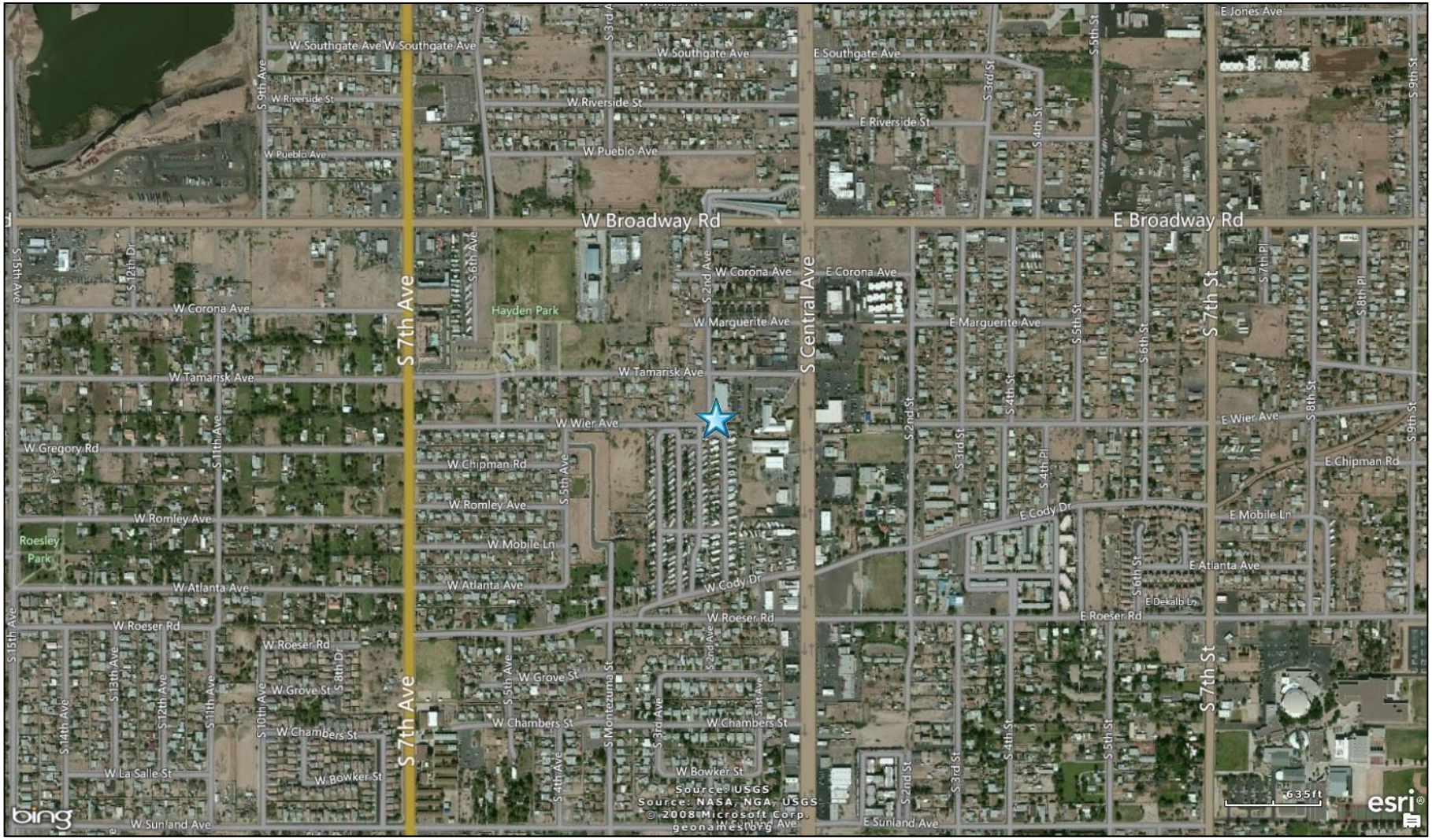


Figure 5-3. NEI Point Sources Located Within 10 Miles of PXSS and SPAZ

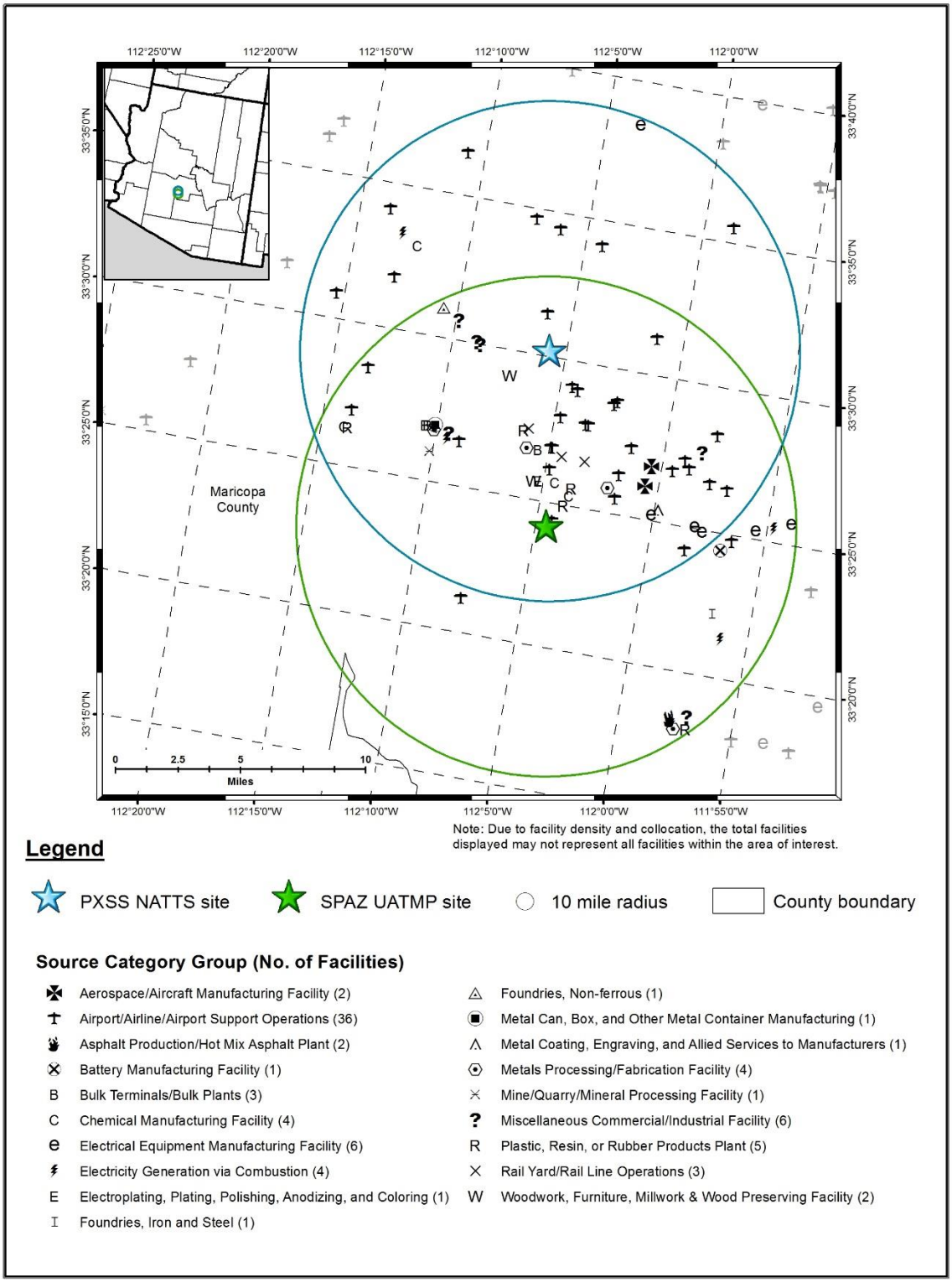


Table 5-1. Geographical Information for the Arizona Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
PXSS	04-013-9997	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ	33.503833, -112.095767	Residential	Urban/City Center	35,103	W Camelback Rd, on either side of N 19th Ave
SPAZ	04-013-4003	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ	33.403160 -112.075330	Residential	Urban/City Center	25,952	Central Ave, south of W Tamarisk Ave

[1]AADT reflects 2010 data for PXSS and 2011 data for SPAZ (AZ DOT, 2016)
BOLD ITALICS = EPA-designated NATTS Site

PXSS is located in central Phoenix. Figure 5-1 shows that PXSS is located in a highly residential area on North 17th Avenue. The Grand Canal is shown along the bottom of Figure 5-1. The monitoring site is approximately three-quarters of a mile east of I-17 and 2 miles north of I-10. Figure 5-2 shows that SPAZ is located in South Phoenix near the intersection of West Tamarisk Avenue and South Central Avenue. SPAZ is surrounded by residential properties to the west and south and commercial properties to the east. SPAZ is located approximately 1 mile south of I-17/I-10.

PXSS is located approximately 7 miles north of SPAZ. The majority of emissions sources are located between the sites, to the south of PXSS and north of SPAZ, as shown in Figure 5-3. The source category with the greatest number of emissions sources near these monitoring sites is the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. The emissions source nearest PXSS is a hospital heliport while the source nearest SPAZ is a heliport at a police station.

In addition to providing city, county, CBSA, and land use/location setting information, Table 5-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. PXSS experiences a higher traffic volume compared to SPAZ, although the traffic volumes near both of these sites rank in the middle of the range compared to traffic volumes near other NMP sites. These traffic volumes were obtained for roadways fairly close to the monitoring sites (West Camelback Road and Central Avenue).

5.2 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 the year.

5.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed.

Weather data collected from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Arizona sites, site-specific data were available for some, but not all, of the parameters in Table 5-2. For PXSS, pressure, humidity, and wind information was available in AQS; for SPAZ, only wind data was available. Data from the NWS weather station at Phoenix Sky Harbor International Airport (WBAN 23183) was used for the remaining parameters. The Phoenix Sky Harbor weather station is located 7.5 miles southeast of PXSS and 4.5 miles east-northeast of SPAZ. A map showing the distance between each Arizona monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 5-2. Average Meteorological Conditions near the Arizona Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Phoenix, Arizona – PXSS[2]							
Sample Days (72)	74.8 ± 0.8	37.0 ± 0.8	35.2 ± 1.0	29.86 ± 0.01	28.73 ± 0.01	WSW	2.7 ± 0.1
2014	75.3 ± 0.4	37.9 ± 0.3	35.4 ± 0.4	29.87 ± <0.01	28.74 ± <0.01	WSW	2.5 ± <0.1
South Phoenix, Arizona – SPAZ[3]							
Sample Days (30)	76.8 ± 1.1	38.0 ± 1.3	31.2 ± 1.6	29.85 ± 0.01	28.67 ± 0.01	W	2.4 ± 0.1
2014	77.2 ± 0.3	37.9 ± 0.3	30.0 ± 0.4	29.87 ± <0.01	28.74 ± <0.01	W	2.2 ± <0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, and wind parameters were measured at PXSS. The remaining information was obtained from the closest NWS weather station located at Sky Harbor International Airport, WBAN 23183.
[3]Only wind parameters were measured at SPAZ. The remaining information was obtained from the closest NWS weather station located at Sky Harbor International Airport, WBAN 23183.

Table 5-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 5-2 is the 95 percent confidence interval for each parameter. As shown in Table 5-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year at each site. The greatest difference between the sample day and full-year averages was calculated for average relative humidity for SPAZ, although the difference is not statistically significant.

The number of sample days for each site is provided in Table 5-2. Samples were collected on a 1-in-6 day schedule at PXSS while samples were collected on a 1-in-12 day schedule at SPAZ, yielding roughly half the number of collection events; thus, the number of observations included in each sample day calculation for SPAZ is less. The difference in the number of sample days is reflected in the larger confidence intervals for SPAZ (the fewer observations, generally the larger the confidence intervals).

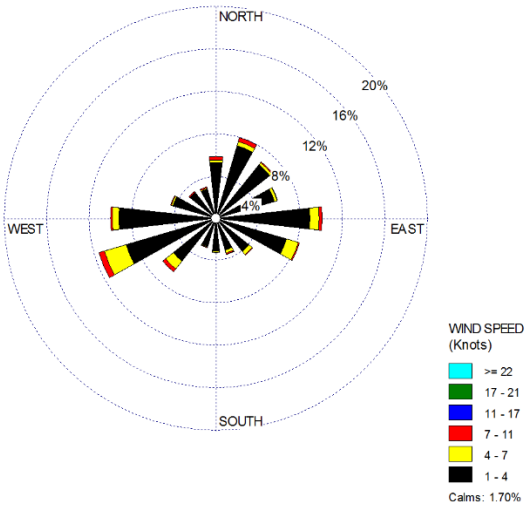
These sites experienced the warmest temperatures among NMP sites in 2014, based on both the full-year and sample day average temperatures. These sites also experienced the lowest relative humidity levels among all NMP sites in 2014, based on both the full-year and sample day average relative humidity levels.

5.2.2 Wind Rose Comparison

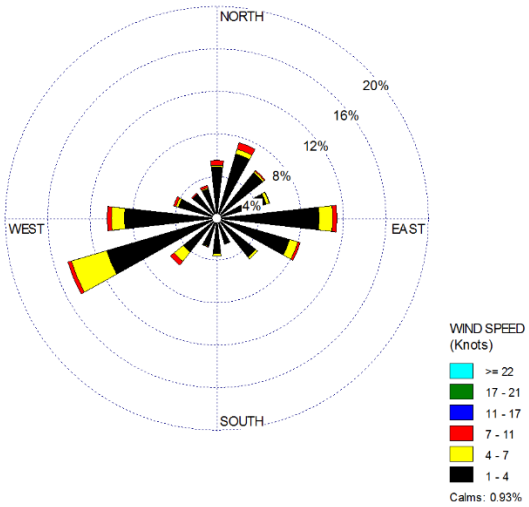
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 5-4 presents two wind roses for the PXSS monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 5-5 presents the full-year and sample day wind roses for SPAZ.

Figure 5-4. Wind Roses for the Wind Data Collected at PXSS

2014 Wind Rose



Sample Day Wind Rose



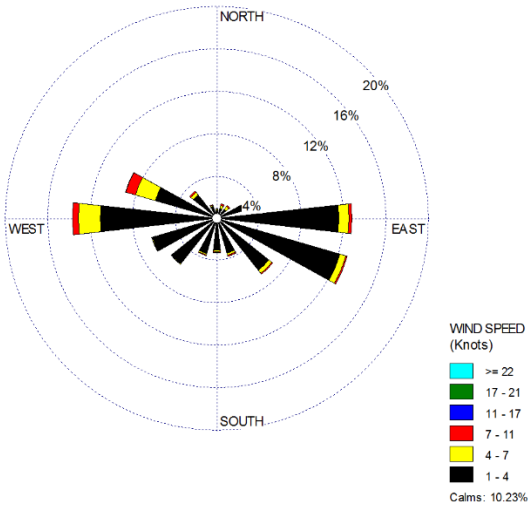
Observations from Figure 5-4 for PXSS include the following:

- The 2014 wind rose shows that wind speeds were generally light near PXSS, with wind speeds mostly in the 1 knot to 4 knot range, although the calm rate was less than 2 percent. West-southwesterly winds were the most commonly observed wind direction at PXSS, although easterly and westerly winds were also observed frequently. Winds from the northwest quadrant and those with from the south-southeast to south-southwest were infrequently observed near PXSS.

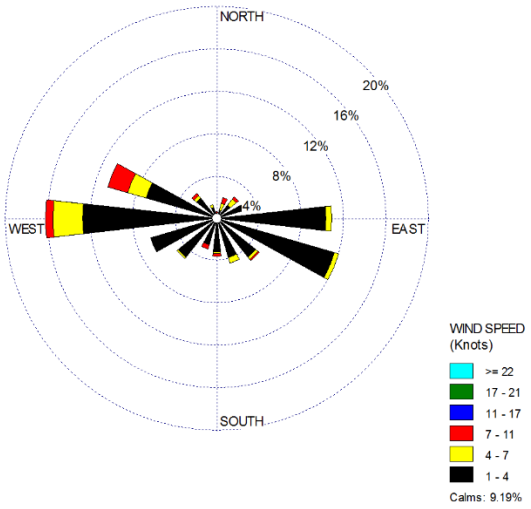
- The sample day wind rose resembles the full-year wind rose, exhibiting both light winds and a similar wind direction pattern, indicating that winds on sample days were representative of those observed throughout the year near PXSS, even though west-southwesterly winds were observed even more frequently on sample days.

Figure 5-5. Wind Roses for Wind Data Collected at SPAZ

2014 Wind Rose



Sample Day Wind Rose



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

- The 2014 wind rose shows that wind speeds were generally light near SPAZ, with a calm rate was of 10 percent. West winds were the most commonly observed wind direction, although easterly and east-southeasterly winds were also observed frequently. Conversely, winds with a northerly component were infrequently observed near SPAZ.

- The sample day wind rose resembles the full-year wind rose, exhibiting both light winds and a similar wind direction pattern, indicating that winds on sample days were representative of those observed throughout the year near SPAZ.

5.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Arizona monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 5-3. 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 and are shaded in gray in Table 5-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at PXSS; VOCs were the only pollutants sampled for at SPAZ.

Observations from Table 5-3 include the following:

- The number of pollutants failing screens varied significantly between the two monitoring sites, which is expected given the difference in pollutants measured at each site.

- Concentrations of 15 pollutants failed at least one screen for PXSS; 72 percent of concentrations for these 15 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 11 pollutants contributed to 95 percent of failed screens for PXSS and therefore were identified as pollutants of interest for PXSS. These 11 include two carbonyl compounds, seven VOCs, one PM_{10} metal, and one PAH.

- PXSS failed the highest number of screens (563) among all NMP sites (refer to Table 4-8 of Section 4.2). However, the failure rate for PXSS, when incorporating all pollutants with screening values, is relatively low, at 23 percent. This is due primarily to the relatively high number of pollutants sampled for at this site, as discussed in Section 4.2 and above.

- Concentrations of six pollutants failed screens for SPAZ; approximately 91 percent of concentrations for these six pollutants were greater than their associated risk screening value (or failed screens). This percentage is greater than the percentage for PXSS. However, nearly all of the measured detections for the pollutants listed for SPAZ failed screens, ranging from a 60 percent failure rate for ethylbenzene to a 100 percent failure rate for four pollutants; for PXSS, the percentage of screens failed for each individual pollutant is more varied, ranging from 4 percent for benzo(a)pyrene to 100 percent for four pollutants.

- All six pollutants that failed screens for SPAZ contributed to 95 percent of failed screens for SPAZ and therefore were identified as pollutants of interest for this site.

- Of the VOCs measured at these sites, benzene was detected in all valid samples and failed 100 percent of screens for each site. Other VOCs, such as carbon tetrachloride, 1,2-dichloroethane, and 1,3-butadiene were detected frequently and also failed the majority of screens. Formaldehyde was detected in all of the valid samples collected at PXSS and also failed 100 percent of screens for this site. Acetaldehyde was also detected in all carbonyl compound samples collected and failed all but one screen.

Table 5-3. Risk-Based 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						
Benzene	0.13	61	61	100.00	10.83	10.83
Formaldehyde	0.077	61	61	100.00	10.83	21.67
Acetaldehyde	0.45	60	61	98.36	10.66	32.33
Carbon Tetrachloride	0.17	60	61	98.36	10.66	42.98
1,3-Butadiene	0.03	59	60	98.33	10.48	53.46
1,2-Dichloroethane	0.038	53	53	100.00	9.41	62.88
Naphthalene	0.029	53	59	89.83	9.41	72.29
Arsenic (PM_{10})	0.00023	50	60	83.33	8.88	81.17
p-Dichlorobenzene	0.091	42	57	73.68	7.46	88.63
Ethylbenzene	0.4	29	61	47.54	5.15	93.78
Hexachloro-1,3-butadiene	0.045	16	17	94.12	2.84	96.63
Nickel (PM_{10})	0.0021	11	60	18.33	1.95	98.58
Manganese (PM_{10})	0.03	5	60	8.33	0.89	99.47
Benzo(a)pyrene	0.00057	2	46	4.35	0.36	99.82
1,2-Dibromoethane	0.0017	1	1	100.00	0.18	100.00
Total		563	778	72.37		
South Phoenix, Arizona - SPAZ						
Benzene	0.13	30	30	100.00	19.61	19.61
Carbon Tetrachloride	0.17	30	30	100.00	19.61	39.22
1,3-Butadiene	0.03	29	29	100.00	18.95	58.17
p-Dichlorobenzene	0.091	25	28	89.29	16.34	74.51
1,2-Dichloroethane	0.038	21	21	100.00	13.73	88.24
Ethylbenzene	0.4	18	30	60.00	11.76	100.00
Total		153	168	91.07		

5.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Arizona monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at PXSS and SPAZ are provided in Appendices J, L, M, and N.

5.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each Arizona monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Arizona monitoring sites are presented in Table 5-4, where applicable. Note that concentrations of the PAHs and metals for PXSS are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 5-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	Total # of Samples	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)
Phoenix, Arizona - PXSS							
Acetaldehyde	61/61	61	3.39 ± 0.67	1.88 ± 0.38	1.96 ± 0.49	2.91 ± 0.54	2.52 ± 0.29
Benzene	61/61	61	1.53 ± 0.40	0.49 ± 0.11	0.55 ± 0.16	1.60 ± 0.42	1.05 ± 0.20
1,3-Butadiene	60/59	61	0.34 ± 0.12	0.07 ± 0.02	0.07 ± 0.02	0.31 ± 0.10	0.20 ± 0.05
Carbon Tetrachloride	61/61	61	0.58 ± 0.04	0.64 ± 0.04	0.66 ± 0.03	0.57 ± 0.06	0.61 ± 0.02
p-Dichlorobenzene	57/46	61	0.26 ± 0.07	0.10 ± 0.03	0.11 ± 0.04	0.20 ± 0.05	0.17 ± 0.03
1,2-Dichloroethane	53/48	61	0.07 ± 0.03	0.09 ± 0.01	0.05 ± 0.01	0.10 ± 0.02	0.08 ± 0.01
Ethylbenzene	61/60	61	0.82 ± 0.25	0.30 ± 0.09	0.35 ± 0.11	0.78 ± 0.20	0.57 ± 0.10
Formaldehyde	61/61	61	3.80 ± 0.57	2.99 ± 0.39	3.70 ± 0.43	3.43 ± 0.49	3.46 ± 0.24
Hexachloro-1,3-butadiene	17/0	61	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Arsenic (PM_{10})[a]	60/52	60	0.72 ± 0.28	0.43 ± 0.25	0.40 ± 0.10	0.64 ± 0.25	0.55 ± 0.11
Naphthalene[a]	59/59	59	126.33 ± 44.42	42.09 ± 11.79	42.08 ± 11.24	96.46 ± 22.50	78.25 ± 15.71
South Phoenix, Arizona - SPAZ							
Benzene	30/30	30	1.49 ± 0.54	0.56 ± 0.21	0.67 ± 0.26	1.63 ± 0.36	1.09 ± 0.24
1,3-Butadiene	29/29	30	0.31 ± 0.17	0.08 ± 0.04	0.09 ± 0.04	0.28 ± 0.08	0.19 ± 0.06
Carbon Tetrachloride	30/30	30	0.56 ± 0.11	0.62 ± 0.04	0.63 ± 0.05	0.58 ± 0.06	0.60 ± 0.03
p-Dichlorobenzene	28/25	30	0.26 ± 0.10	0.12 ± 0.07	0.18 ± 0.12	0.28 ± 0.08	0.21 ± 0.05
1,2-Dichloroethane	21/19	30	0.06 ± 0.04	0.07 ± 0.01	0.02 ± 0.02	0.06 ± 0.04	0.06 ± 0.01
Ethylbenzene	30/30	30	0.79 ± 0.30	0.39 ± 0.22	0.42 ± 0.17	0.81 ± 0.23	0.60 ± 0.13

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

Observations for PXSS from Table 5-4 include the following:

- The pollutants of interest with the highest annual average concentrations for PXSS are formaldehyde (3.46 ± 0.24 µg/m^3), acetaldehyde (2.52 ± 0.29 µg/m^3), and benzene (1.05 ± 0.20 µg/m^3). These are the only pollutants of interest with annual average concentrations greater than 1 µg/m^3 for this site.

- The first and fourth quarter average concentrations for benzene and 1,3-butadiene are significantly greater than the second and third quarter average concentrations, indicating that there is a seasonal tendency in these measurements, with higher concentrations measured during the cooler months of the year. A similar observation was made in the 2013 NMP report. A review of the benzene data shows that of the 14 benzene concentrations greater than 1.50 µg/m^3 measured at PXSS, all 14 were measured during the first or fourth quarters of 2014 and the five benzene concentrations greater than 2.50 µg/m^3 were measured at PXSS in either January or December. For 1,3-butadiene, the 22 highest concentrations were measured during the first or fourth quarters of 2014, with the four highest measured at PXSS in either January or December.

- The quarterly averages for *p*-dichlorobenzene and ethylbenzene exhibit a similar seasonal tendency. Acetaldehyde's quarterly average concentrations reflect a similar tendency, although the differences are less significant.

- The quarterly average concentrations of hexachloro-1,3-butadiene appear to be the same across Table 5-4 (0.02 ± 0.02 µg/m^3). Increasing the number of decimal places shows these quarterly averages vary between 0.017 µg/m^3 and 0.022 µg/m^3. Note however, that the number of measured detections is only 17 out of 61 valid samples and that none of these are greater than the MDL for this pollutant.

- Concentrations of naphthalene are similar to several of the VOCs in that the concentrations measured are higher during the first and fourth quarters of 2014, as shown by the quarterly average concentrations in Table 5-4. All but one of the 13 naphthalene concentrations greater than 100 ng/m^3 were measured at PXSS during the first or fourth quarters of 2014; conversely, all but three of the 26 naphthalene concentrations less than 50 ng/m^3, all but three were measured during the second and third quarters of 2014.

- Arsenic is the only metal pollutant of interest for PXSS. The first and fourth quarter average concentrations of arsenic are greater than the other two quarterly average concentrations, although not significantly so. Of the seven concentrations of arsenic greater than 1 ng/m^3 measured at PXSS, only one was not measured in either January or December (a measurement tied for second highest was measured in May).

Observations for SPAZ from Table 5-4 include the following:

- The pollutant of interest with the highest annual average concentration for SPAZ is benzene (1.09 ± 0.24 µg/m^3), which is the only pollutant of interest with an annual average concentration greater than 1 µg/m^3. The annual average concentration of benzene for SPAZ is similar to the annual average benzene concentration for PXSS.

- Similar to PXSS, benzene and 1,3-butadiene concentrations were highest during the first and fourth quarters of 2014 at SPAZ. This is also true for ethylbenzene and *p*-dichlorobenzene. However, the confidence intervals calculated for these averages indicate that the difference in the quarterly averages are not significant.

- The first quarter average concentration for most of the pollutants of interest for SPAZ have relatively large confidence intervals, indicating measurements of these pollutants were more variable during the first three months of 2014. The maximum concentrations of benzene, 1,3-butadiene, ethylbenzene, and 1,2-dichloroethane were all measured on January 11, 2014. The maximum *p*-dichlorobenzene concentration was measured at SPAZ on February 16, 2014, along with the second highest ethylbenzene and 1,3-butadiene concentrations and the third highest benzene concentration.

- Table 5-4 shows that of the 30 valid VOC samples collected at SPAZ, 1,2-dichloroethane was detected 21 times, of which 19 were greater than the MDL for this pollutant, and non-detects were reported for nine samples. Seven of these non-detects were for consecutive sample days between August 15, 2014 and October 26, 2014.

Tables 4-9 through 4-12 present the NMP sites with the 10 highest annual 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 13 times.

- SPAZ and PXSS have the highest annual average concentrations of *p*-dichlorobenzene among all NMP sites sampling VOCs, similar to previous years. These annual average concentrations of *p*-dichlorobenzene are roughly twice the next highest concentration shown in Table 4-9. While the highest concentrations of *p*-dichlorobenzene were not measured at these two sites, SPAZ and PXSS do account for 24 of the 34 highest concentrations measured across the program (those greater than 0.25 µg/m^3), with each site measuring 12 each. By comparison, the next highest site had eight (S4MO) and TVKY and BTUT each measured one.

- These two sites also have the highest and second highest annual average concentration of ethylbenzene among NMP sites. Similarly, the highest concentrations of ethylbenzene across the program were not measured at SPAZ or PXSS, but these sites have the highest number of ethylbenzene measurements greater than 1 µg/m^3, 12 for PXSS and 6 for SPAZ, while no other site measured more than three and most NMP sites measured none.

- These two sites also have the second and third highest annual average concentrations of 1,3-butadiene and the fourth and fifth highest annual average concentrations of benzene among NMP sites sampling these pollutants.

- PXSS has the fifth highest annual average concentrations of acetaldehyde and formaldehyde among NMP sites sampling carbonyl compounds.

- The annual average concentration of naphthalene for PXSS ranks seventh among NMP sites sampling PAHs, similar to 2013.

- PXSS ranks fourth for its annual average concentration of nickel and eighth for its annual average concentration of arsenic among NMP sites sampling PM_{10} metals.

5.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in in Table 5-4 for PXSS and SPAZ. Figures 5-6 through 5-16 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 5-6. Program vs. Site-Specific Average Acetaldehyde Concentration

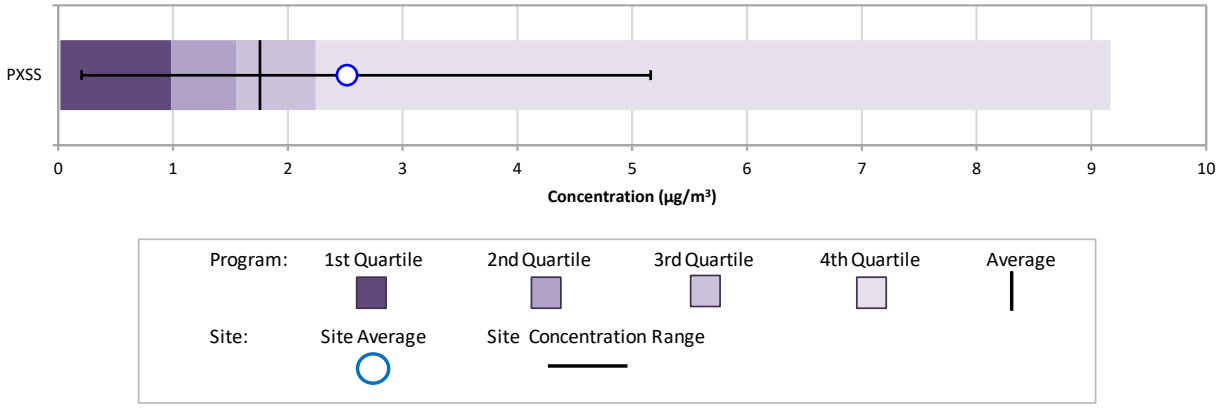


Figure 5-6 presents the box plot for acetaldehyde for PXSS and shows the following:

- PXSS's annual average concentration is greater than the program-level average concentration as well as the program-level third quartile. Recall from the previous section that PXSS has the fifth highest annual average acetaldehyde concentration among 27 NMP sites sampling this pollutant and where annual average concentrations could be calculated. Acetaldehyde concentrations measured at PXSS range from 0.113 ng/m^3 to 5.16 ng/m^3.

Figure 5-7. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

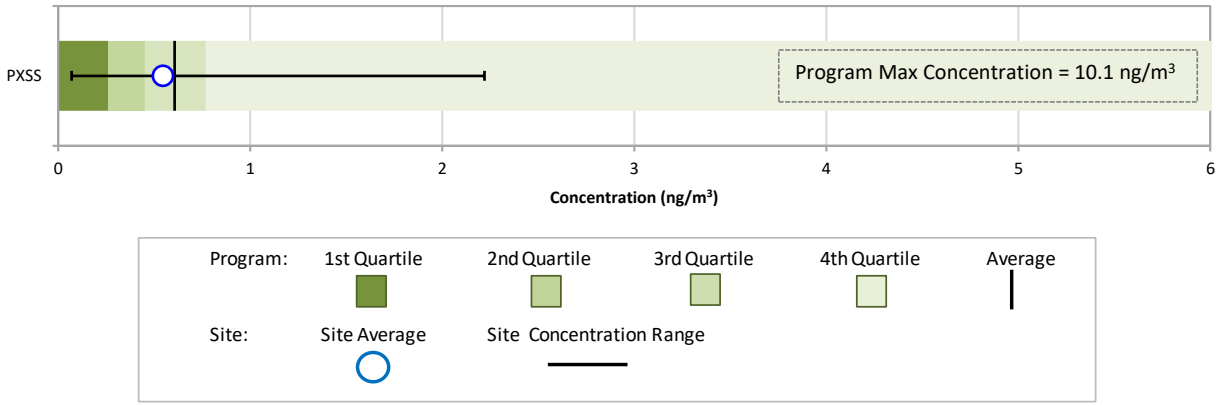


Figure 5-7 presents the box plot for arsenic for PXSS and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 5-7 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The annual average arsenic (PM_{10}) concentration for PXSS falls between the program-level average concentration and the program-level median concentration. Arsenic concentrations measured at PXSS in 2014 range from 0.07 ng/m^3 to 2.22 ng/m^3.

Figure 5-8. Program vs. Site-Specific Average Benzene Concentrations

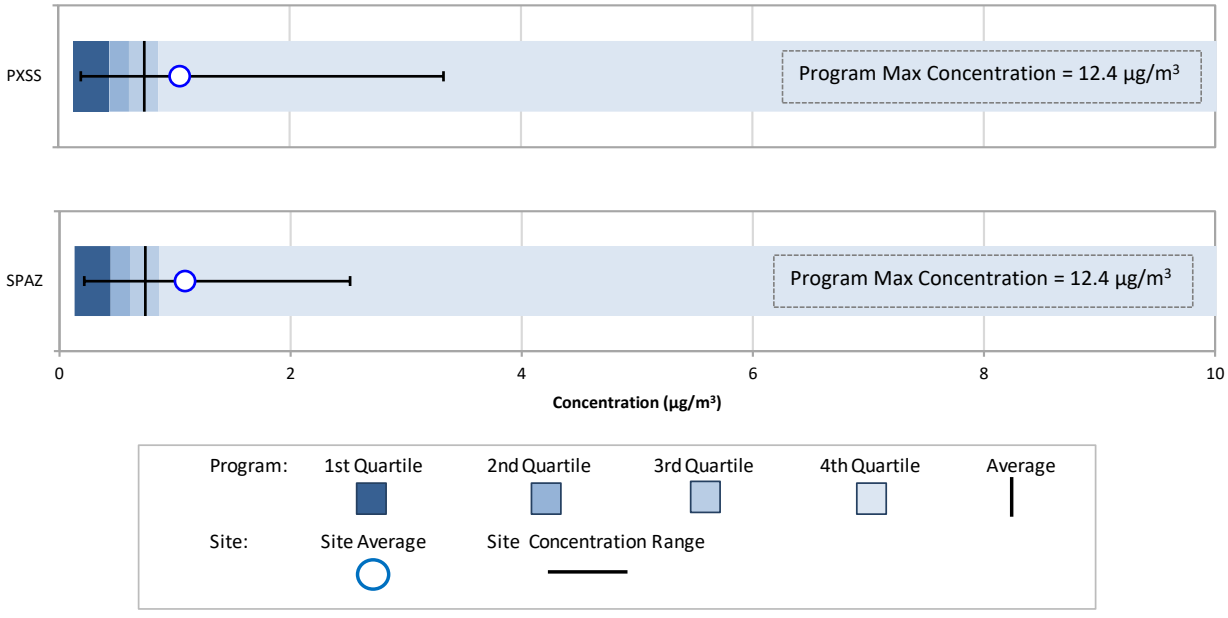


Figure 5-8 presents the box plots for benzene for both sites and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plots in Figure 5-8 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- Although the maximum benzene concentration measured at each Arizona site is considerably less than the maximum benzene concentration measured across the program, both sites' annual averages are greater than the program-level average concentration and third quartile. Recall from the previous section that SPAZ and PXSS have the fourth and fifth highest annual average concentrations of benzene among the 30 NMP sites sampling this pollutant and where annual average concentrations could be calculated. The annual average benzene concentrations for these sites are similar to each other, although the range of measurements is slightly greater for PXSS.

Figure 5-9. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

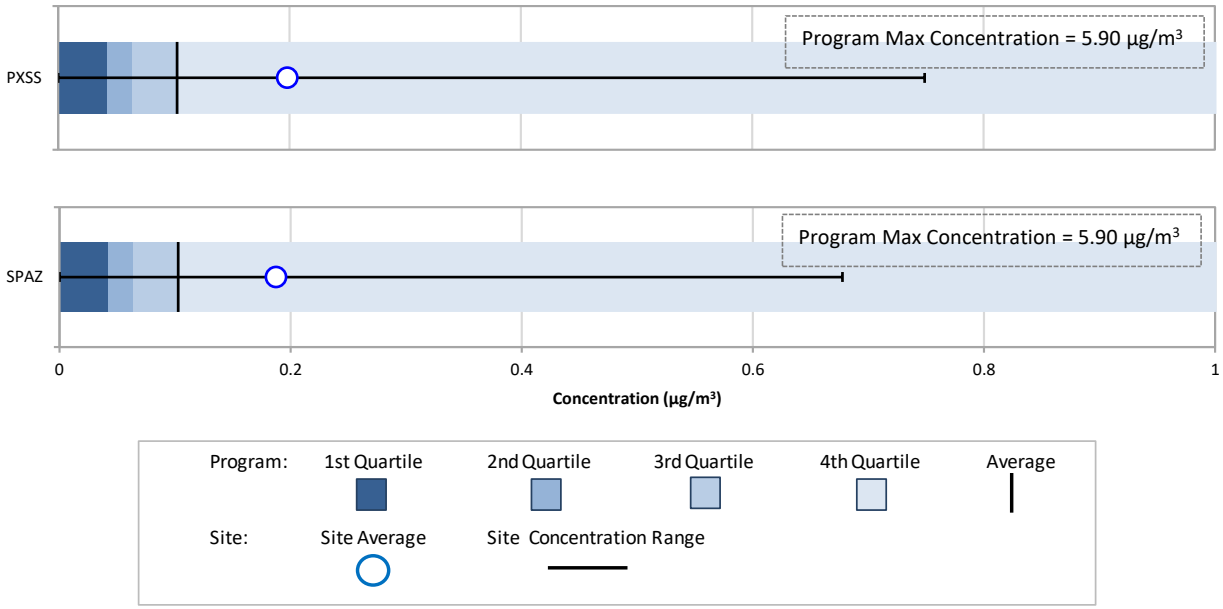


Figure 5-9 presents the box plots for 1,3-butadiene for both sites and shows the following:

- Similar to benzene, the program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plots in Figure 5-9 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced to 1 µg/m^3.

- The maximum 1,3-butadiene concentration measured at PXSS is slightly higher than the maximum concentration measured at SPAZ, although both are an order of magnitude less than the maximum concentration measured across the program.

- The annual average concentrations for these two sites are similar to each other, and both are greater than the program-level average concentration.

- A single non-detect of 1,3-butadiene was measured at each Arizona monitoring site.

Figure 5-10. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

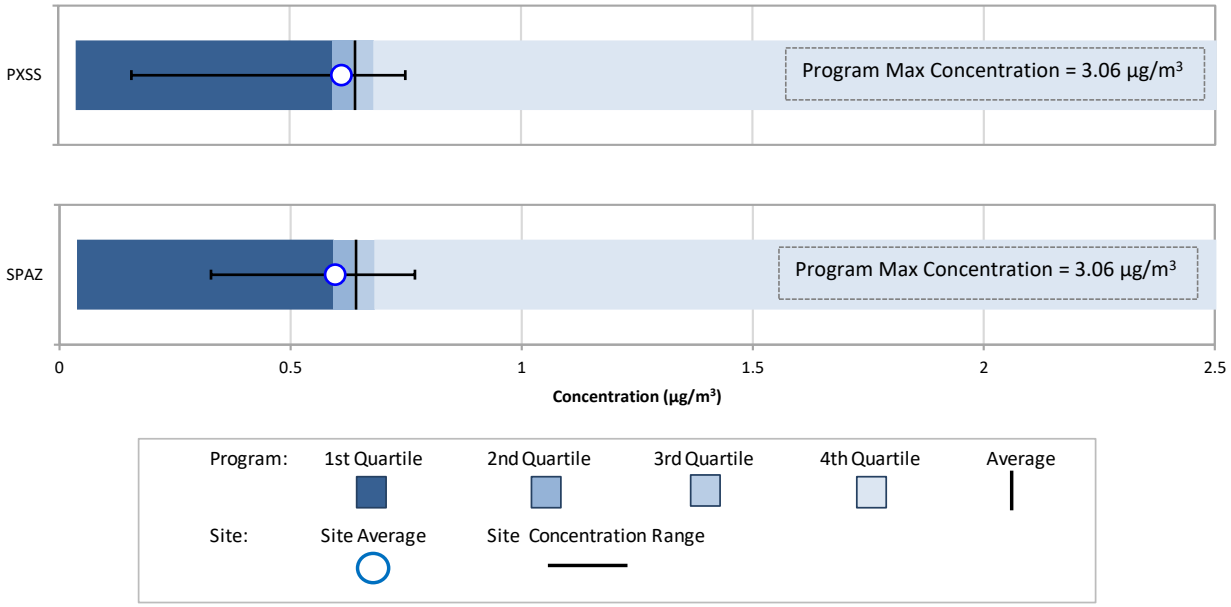


Figure 5-10 presents the box plots for carbon tetrachloride for both sites and shows the following:

- The scale of the box plots in Figure 5-10 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- The maximum carbon tetrachloride concentrations measured at these sites are similar to each other, while the minimum concentrations are more variable.

- The annual average concentrations of carbon tetrachloride for the Arizona sites are also similar to each other and both are just less than the program-level average concentration of 0.64 µg/m^3.

Figure 5-11. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

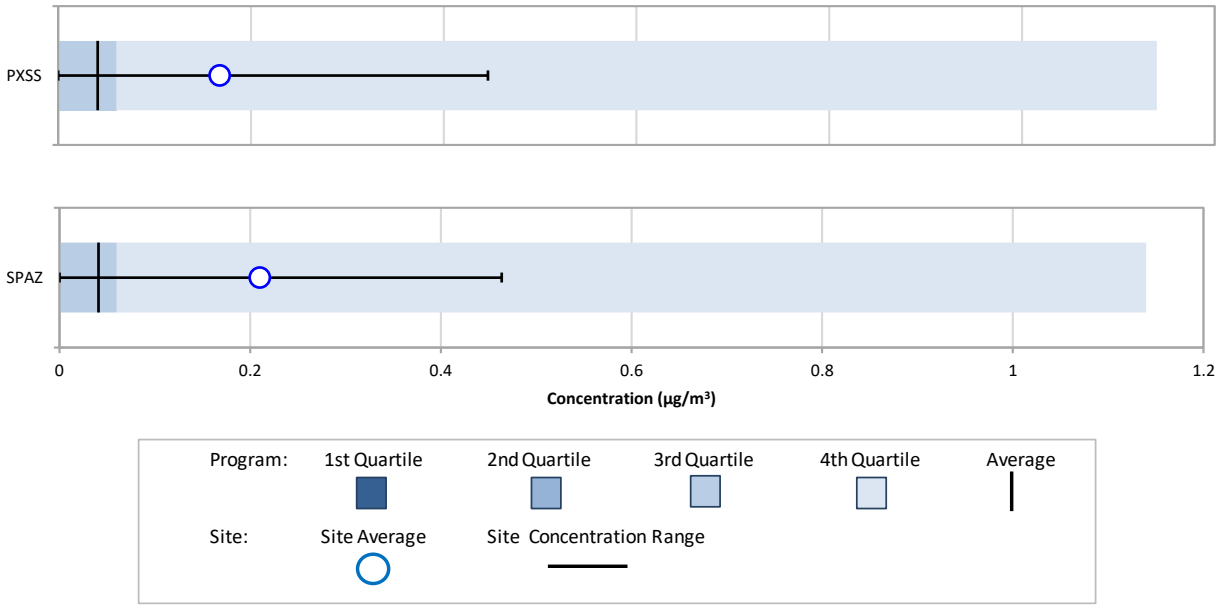


Figure 5-11 presents the box plots for *p*-dichlorobenzene for both sites and shows the following:

- The program-level first and second quartiles are both zero and therefore not visible on the box plots.

- SPAZ and PXSS have the highest annual average concentrations of *p*-dichlorobenzene among the 27 NMP sites sampling VOCs. The annual average concentrations for SPAZ and PXSS are roughly four and five times the program-level average concentration (0.04 µg/m^3), respectively.

- Although the maximum concentrations measured at these sites are considerably less than the maximum concentration measured across the program, these two sites account for four of the 10 highest concentrations measured across the program.

- Two non-detects of *p*-dichlorobenzene were measured at SPAZ while four non-detects were measured at PXSS; no other NMP sites has fewer than 10 non-detects of this pollutant.

Figure 5-12. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

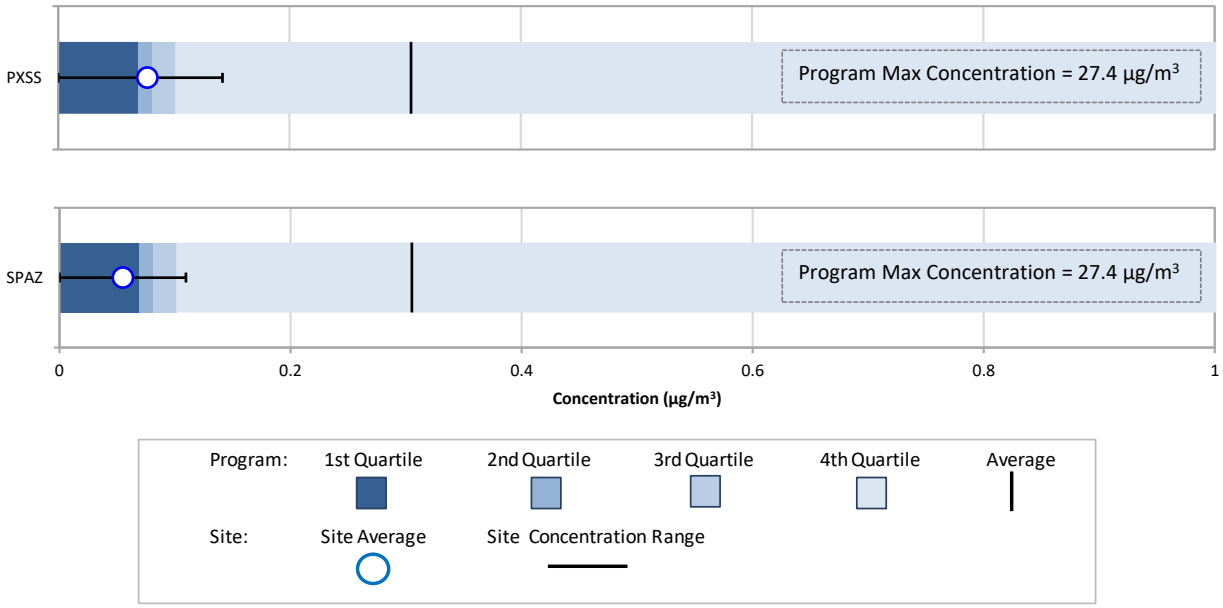


Figure 5-12 presents the box plots for 1,2-dichloroethane for both sites and shows the following:

- The scale of the box plots in Figure 5-12 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- All of the concentrations of 1,2-dichloroethane measured at PXSS and SPAZ are less than the program-level average concentration of 0.31 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- The annual average concentration for PXSS is similar to the program-level median concentration (0.081 µg/m^3) while the annual average concentration for SPAZ is less than the program-level first quartile (0.069 µg/m^3).

Figure 5-13. Program vs. Site-Specific Average Ethylbenzene Concentrations

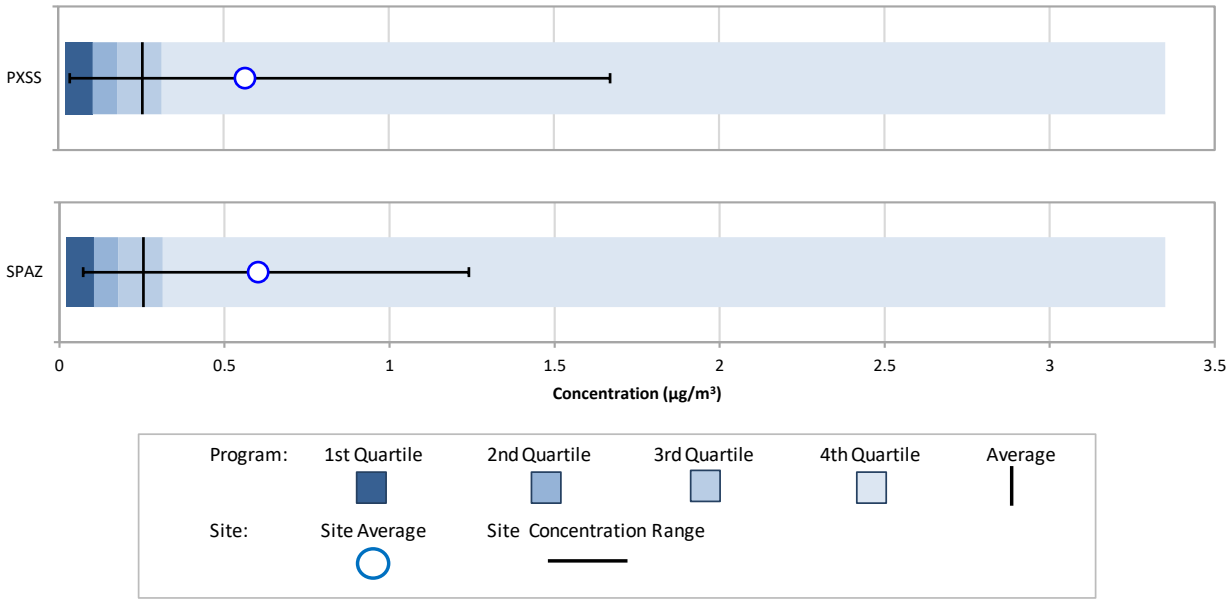


Figure 5-13 presents the box plots for ethylbenzene for both sites and shows the following:

- The range of ethylbenzene concentrations measured at PXSS is greater than the range of concentrations measured at SPAZ. While the maximum concentration measured at PXSS is roughly half the maximum concentration measured across the program, PXSS accounts for four of the 10 highest ethylbenzene concentrations measured across the program.

- The annual average concentrations of ethylbenzene for these two sites are both more than twice the program-level average; recall from the previous section that these sites have the two highest annual average concentrations of ethylbenzene among NMP sites sampling this pollutant.

Figure 5-14. Program vs. Site-Specific Average Formaldehyde Concentration

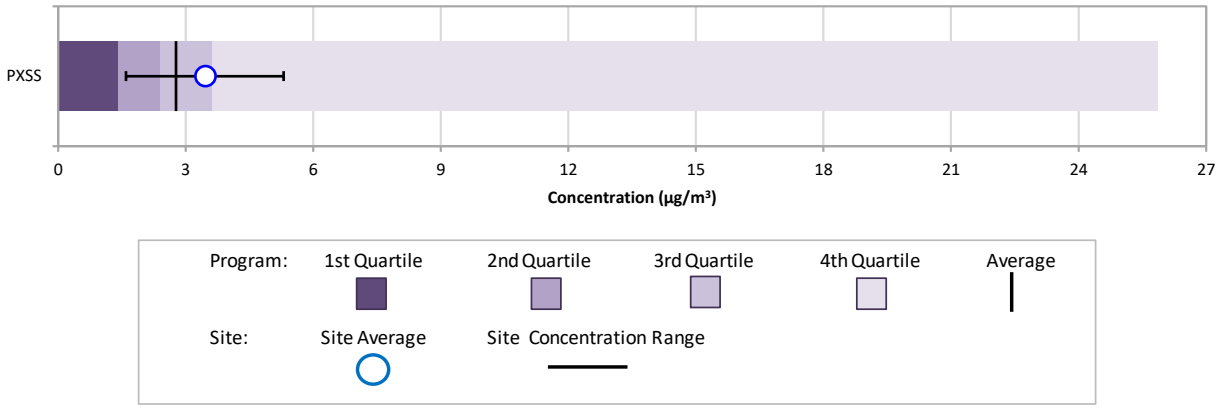


Figure 5-14 presents the box plot for formaldehyde for PXSS and shows the following:

- The range of formaldehyde concentrations measured at PXSS falls within a relatively small range (1.59 µg/m^3 to 5.30 µg/m^3) compared to the range of concentrations measured across the program. Yet, the annual average concentration for PXSS is greater than the program-level average concentration and similar to the program-level third quartile. Recall from the previous section that this site has the fifth highest annual average concentration of formaldehyde among NMP sites sampling carbonyl compounds.

- The minimum formaldehyde concentration measured at PXSS is greater than the program-level first quartile and is among the highest minimum concentrations measured at a given site.

Figure 5-15. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentration

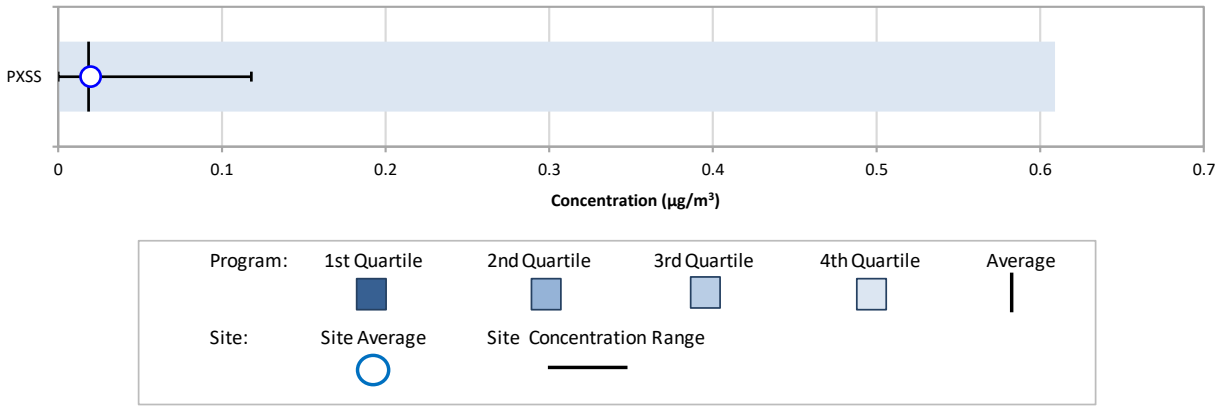


Figure 5-15 presents the box plot for hexachloro-1,3-butadiene for PXSS and shows the following:

- The program-level first, second, and third quartiles for hexachloro-1,3-butadiene are zero and therefore not visible on the box plot.

- The annual average concentration of hexachloro-1,3-butadiene for PXSS is similar to the program-level average concentration (0.018 µg/m^3). While the maximum concentration measured at PXSS (0.118 µg/m^3) is considerably less than the maximum concentration measured across the program (0.609 µg/m^3), it is the fourth highest measurement of this pollutant (although concentrations of the same magnitude were measured at several other sites). Forty-four non-detects of hexachloro-1,3-butadiene were measured at PXSS and none of the measurements were greater than the MDL for this pollutant.

Figure 5-16. Program vs. Site-Specific Average Naphthalene Concentration

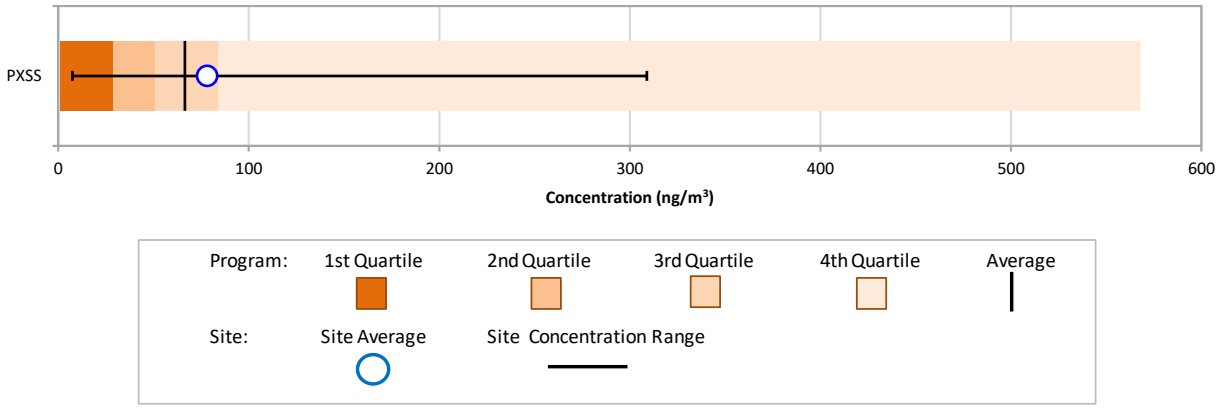


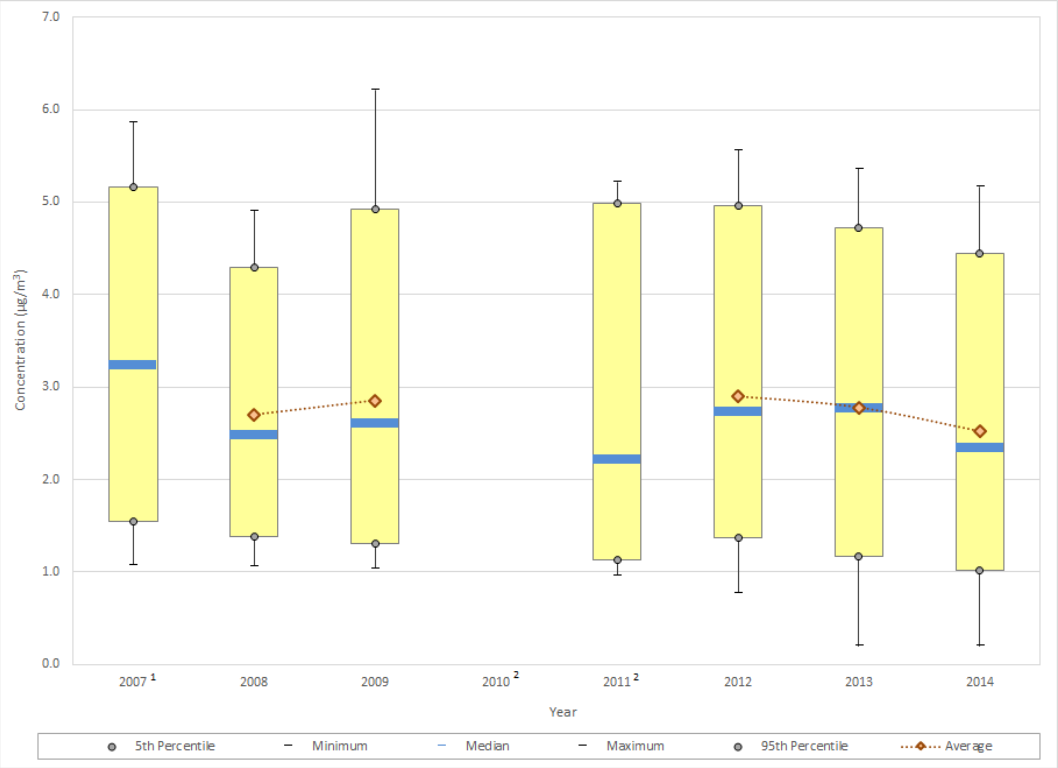
Figure 5-16 presents the box plot for naphthalene for PXSS and shows the following:

- The annual average naphthalene concentration for PXSS falls between the program-level average concentration (66.46 ng/m^3) and the program-level third quartile (84.10 ng/m^3).
- The range of naphthalene concentrations measured at PXSS is among the larger ranges measured and PXSS is one of only three NMP sites at which a naphthalene concentration greater than 300 ng/m^3 was measured (DEMI and NBIL are the other two).

5.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. PXSS has sampled PM_{10} metals under the NMP since 2006; in addition, SPAZ began sampling VOCs and PXSS began sampling VOCs, carbonyl compounds, and PAHs under the NMP in 2007. Thus, Figures 5-17 through 5-32 present the 1-year statistical metrics for each of the pollutants of interest first for PXSS, then for SPAZ. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 5-17. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.
[2] Some statistical metrics are not presented because data from Feb 2010 to Mar 2011 was invalidated.

Observations from Figure 5-17 for acetaldehyde concentrations measured at PXSS include the following:

- PXSS began sampling acetaldehyde under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided. In addition, much of the data between February 2010 and March 2011 was invalidated due to sampler maintenance issues on the primary sampler. No statistical metrics are provided for 2010 due to the low number of valid measurements. The range of measurements is provided for 2011, although a 1-year average is not provided.

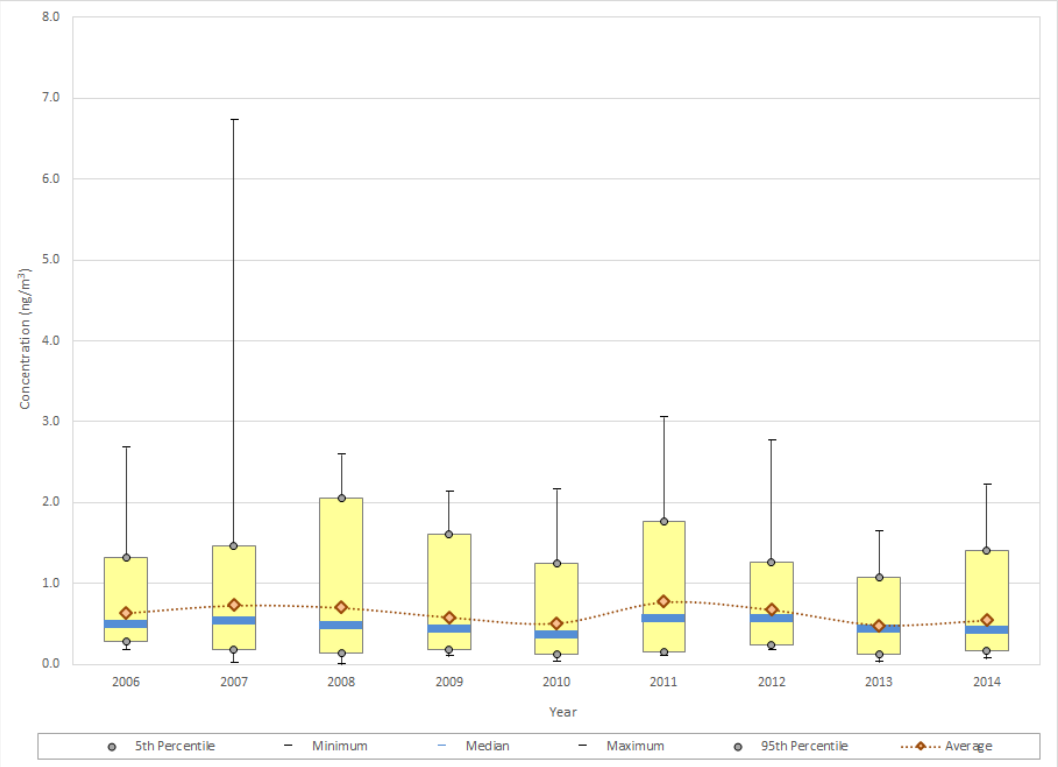
- The maximum acetaldehyde concentration (6.21 µg/m^3) was measured on January 1, 2009, although this measurement is not significantly higher than the maximum concentrations measured in other years. Acetaldehyde concentrations greater than 5 µg/m^3 have been measured every year except 2008 (and 2010, for which no data is provided).

- A distinct trend is hard to identify because several of the 1-year average concentrations could not be calculated. However, 1-year averages shown vary by less than 0.5 µg/m^3, ranging from 2.52 µg/m^3 (2014) to 2.90 µg/m^3 (2012).

- The minimum concentration has decreased slightly every year through 2013, particularly from 2012 to 2013. This minimum acetaldehyde concentration

(0.20 µg/m^3) was measured on July 21, 2013 and is unusually low for PXSS. Only seven acetaldehyde concentrations less than 1 µg/m^3 have been measured at PXSS, all of which were measured in 2011 or later. The minimum concentration for 2014 is similar to the minimum concentration measured in 2013, and 2014 has the most acetaldehyde concentrations less than 1 µg/m^3 of any year (three).

Figure 5-18. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at PXSS



Observations from Figure 5-18 for arsenic concentrations measured at PXSS include the following:

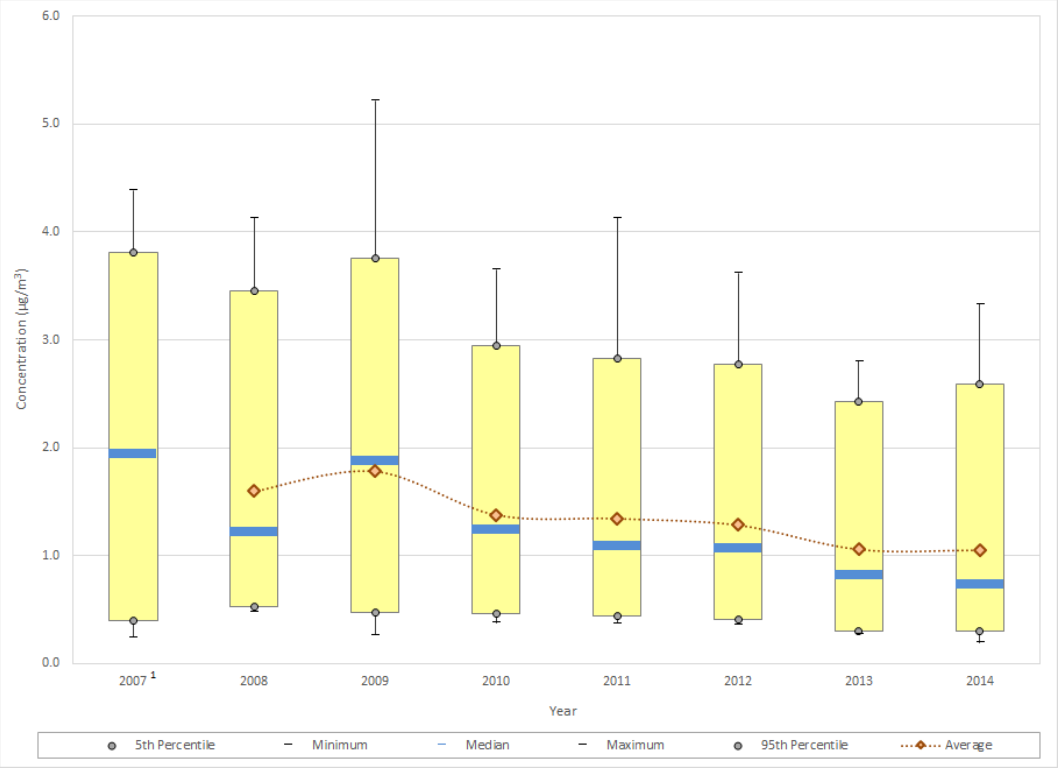
- PXSS began sampling arsenic under the NMP in January 2006.

- The maximum arsenic concentration (6.73 ng/m^3) was measured on December 26, 2007 and is more than twice the next highest concentration (3.05 ng/m^3), measured on August 19, 2011. In total, 16 arsenic measurements greater than or equal to 2 ng/m^3 have been measured at PXSS, with at least one measured each year of sampling except 2013 and the most measured in 2008 (four).

- After several years of decreasing slightly, the 1-year average concentration increased significantly from 2010 to 2011, after which additional decreasing is shown through 2013. The 1-year average concentration is at a minimum for 2013 (0.49 ng/m^3). The maximum concentration and 95th percentile are also at a minimum for 2013.

- With the exception of the median concentration, all of the statistical metrics increased at least slightly from 2013 to 2014. The median concentration changed very little between the two years (from 0.43 ng/m^3 to 0.42 ng/m^3).

Figure 5-19. Yearly Statistical Metrics for Benzene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-19 for benzene concentrations measured at PXSS include the following:

- PXSS began sampling VOCs under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided.

- The maximum benzene concentration shown was measured on January 1, 2009 (5.21 µg/m^3). Four additional measurements greater than 4 µg/m^3 have been measured at this site (during 2007, 2008, 2009, and 2011).

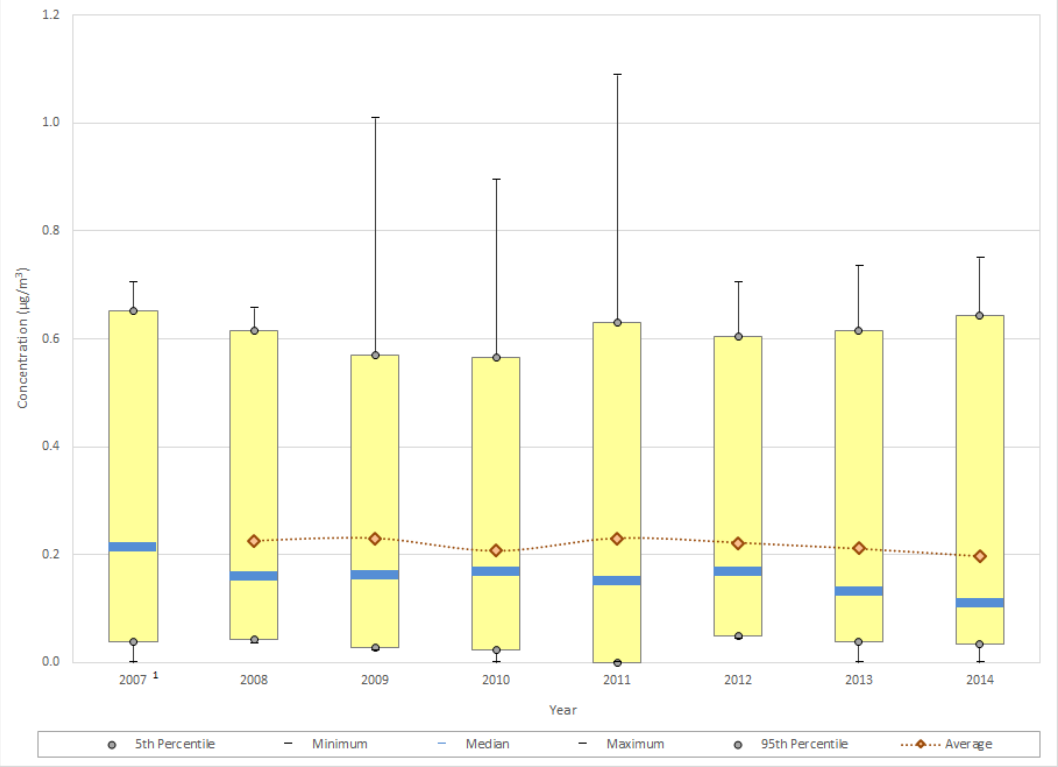
- The 15 highest benzene concentrations (those greater than 3.5 µg/m^3) were all measured during the first or fourth quarter of any given year. Further, of the 110 benzene concentrations greater than or equal to 2 µg/m^3, all but 10 were measured during the first or fourth quarters of a given year; those other 10 were all measured in either April or September, or just outside the first or fourth quarters.

- The median concentration increased significantly from 2008 to 2009 and is greater than the 1-year average concentration for 2009. A review of the data shows that the

number of concentrations greater than 2 µg/m^3 increased from 15 in 2008 to 24 in 2009. After the increase from 2008 to 2009, the median benzene concentration has a decreasing trend, with the largest change shown from 2009 to 2010. For 2010, the number of benzene concentrations greater than 2 µg/m^3 decreased to 12, with the number ranging from nine (2013) to 14 (2011) for each of the remaining years.

- The 1-year average concentration exhibits a similar pattern as the median concentration, with the 1-year average concentration (1.05 µg/m^3) at a minimum for 2014, although there is relatively little change from 2013 to 2014. The median concentration is also at a minimum for 2014 (0.74 µg/m^3).

Figure 5-20. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-20 for 1,3-butadiene concentrations measured at PXSS include the following:

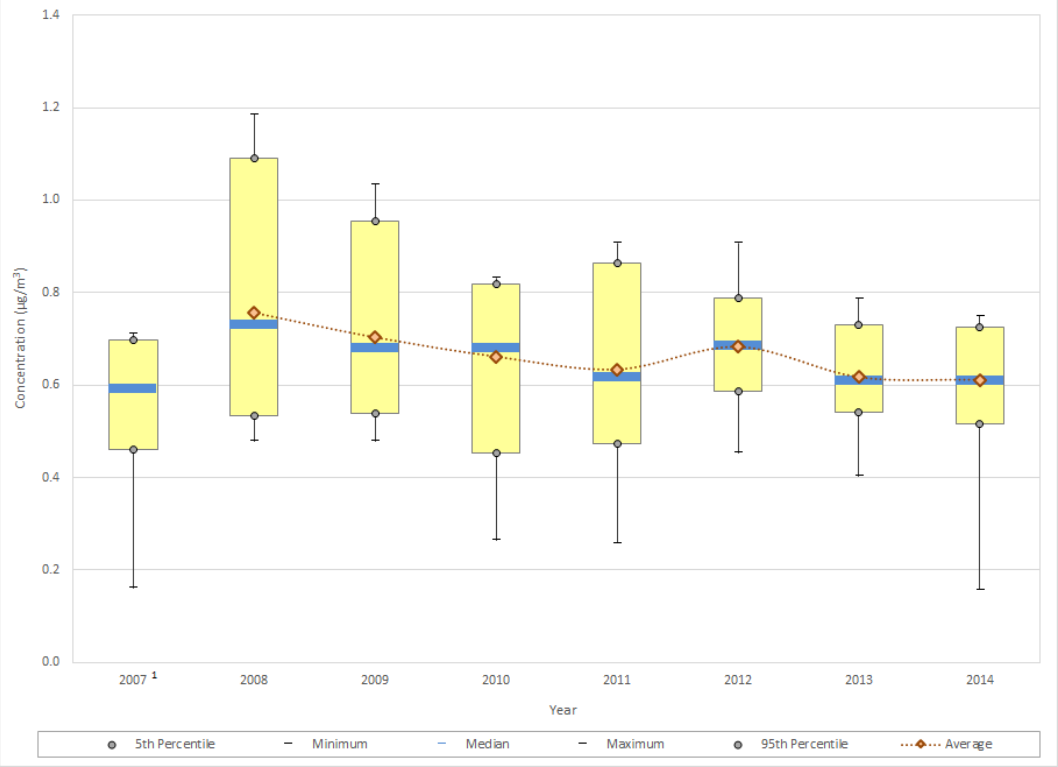
- The maximum 1,3-butadiene concentration (1.09 µg/m^3) was measured on December 11, 2011. The only other concentration greater than 1.0 µg/m^3 was measured at PXSS on January 1, 2009, the same day that the maximum benzene concentration was measured. All but two of the 115 1,3-butadiene concentrations greater than 0.30 µg/m^3 were measured during the first or fourth quarters. The two not measured during the first or fourth quarters were measured in September.

- The 1-year average 1,3-butadiene concentration exhibits relatively little change over the period shown, ranging from 0.20 µg/m^3 (2014) to 0.23 µg/m^3 (both 2009 and

2011). The median concentration varies between 0.15 µg/m^3 and 0.17 µg/m^3 for the years between 2008 and 2012, then fell to 0.13 µg/m^3 and 0.011 µg/m^3 for 2013 and 2014, respectively.

- There have been 10 non-detects of 1,3-butadiene measured at PXSS since the onset of VOC sampling at PXSS under the NMP. Five of these were measured in 2011, with one each measured in 2007, 2013, and 2014, and two measured in 2010. For 2011, the minimum and 5th percentile were both equal to zero. None of the 10 non-detects of 1,3-butadiene were measured during the first or fourth quarters of any given year.

Figure 5-21. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-21 for carbon tetrachloride concentrations measured at PXSS include the following:

- Seven concentrations of carbon tetrachloride greater than 1.0 µg/m^3 have been measured at PXSS since the onset of sampling in 2007, with five measured in 2008 and two measured in 2009.

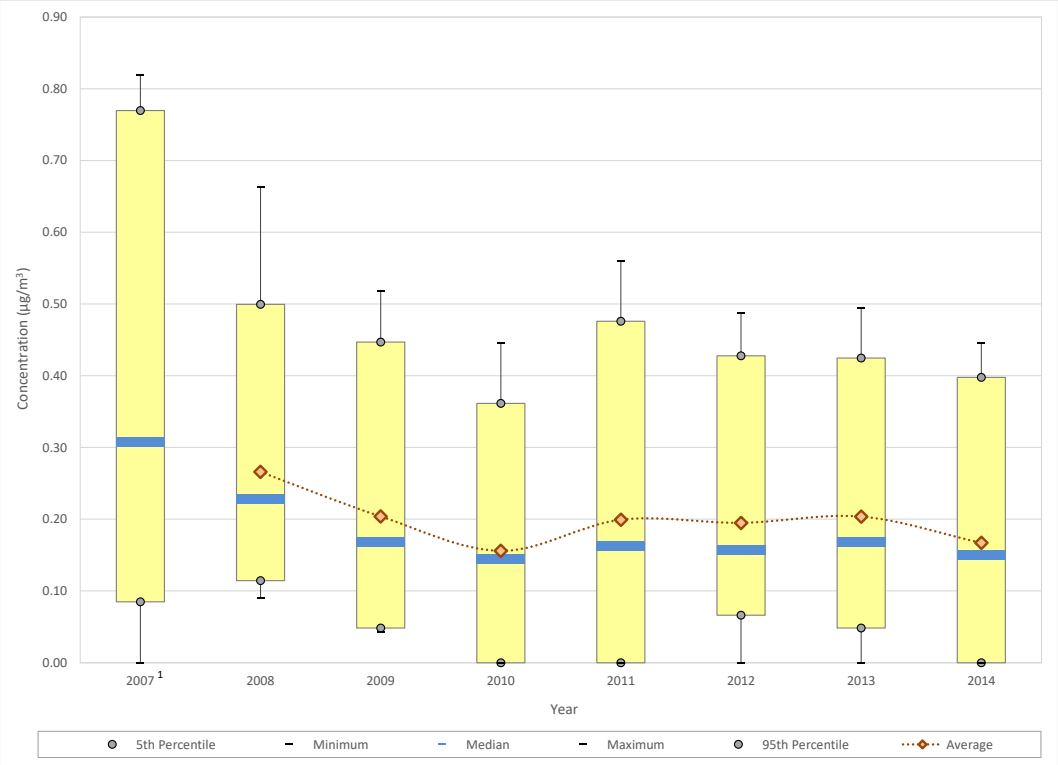
- For 2007, 2010, 2011, and 2014, the box and whisker plots for this pollutant appear "inverted," with the minimum concentration extending farther away from the majority of the measurements rather than the maximum concentration, which is more common (see benzene or 1,3-butadiene as examples).

- All of the carbon tetrachloride measurements from 2007 are less than the 1-year average and median concentrations calculated for 2008. However, the concentrations measured in 2007 represent only one-half of the year.

- The 1-year average concentration exhibits a decreasing trend between 2008 and 2011. Although the range of concentrations measured decreased for 2012, an increase is shown for the 1-year average and median concentrations for 2012. This is mostly a result of a change at the lower end of the concentration range. The number of concentrations less than 0.6 µg/m^3 in 2011 is 23; the number of concentrations less than 0.6 µg/m^3 in 2012 is five.

- All of the statistical parameters for carbon tetrachloride exhibit a decrease for 2013. This is also true for 2014, with the exception of the median concentration, which did not change between the two years. The 1-year average concentration also changed little between 2013 and 2014.

Figure 5-22. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

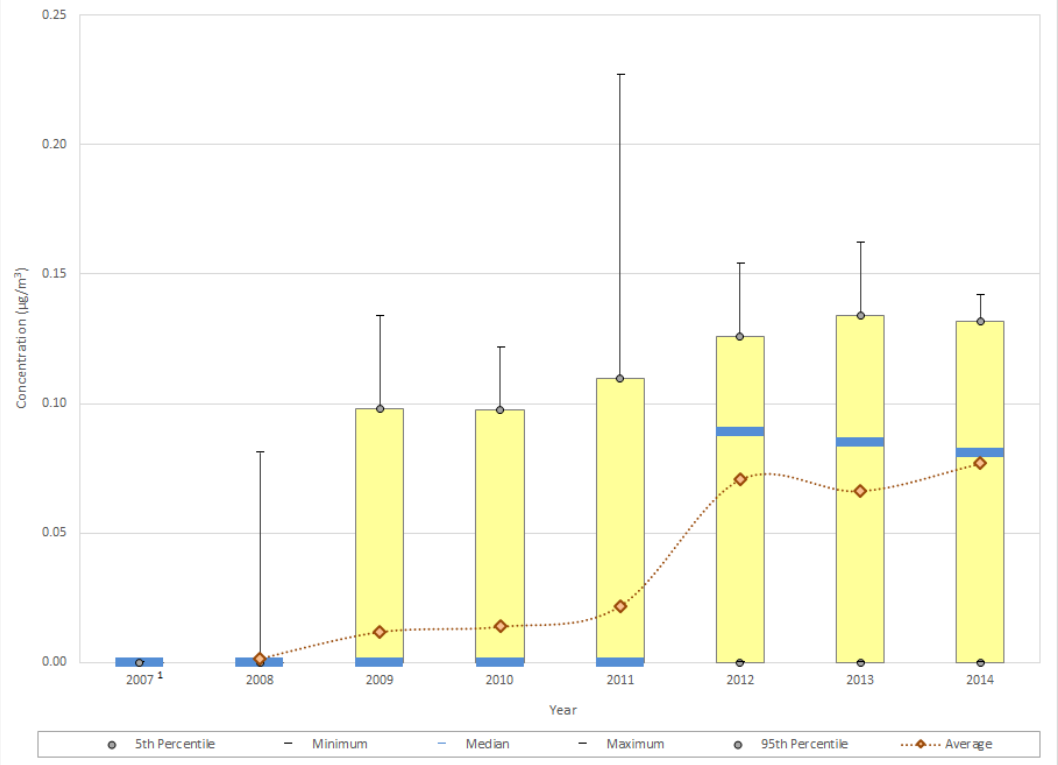
Observations from Figure 5-22 for *p*-dichlorobenzene concentrations measured at PXSS include the following:

- The three highest concentrations of *p*-dichlorobenzene were all measured in November 2007 and are the only ones greater than 0.75 µg/m^3 measured at PXSS.

- The maximum, 95th percentile, 1-year average, and median concentrations all exhibit a significant decreasing trend through 2010. Even the minimum concentration and 5th percentile decreased each year from 2008 through 2010. Each of the statistical parameters increased for 2011, with the exception of the minimum and 5th percentile, as several non-detects were measured in both years. Although the range within which the majority of the concentrations fall tightened up for 2012 and 2013, little change is shown for the 1-year average or median concentrations between 2011 and 2013. Each of the statistical parameters decreased at least slightly for 2014, except the minimum concentration, which has remained constant since 2010.

- Prior to 2010, a single non-detect was measured; for 2010, nine non-detects were measured, explaining the decrease in the minimum and 5th percentile shown from 2009 to 2010. The number of non-detects has varied between one (2012) and six (2011) in the years following 2010.

Figure 5-23. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-23 for 1,2-dichloroethane concentrations measured at PXSS include the following:

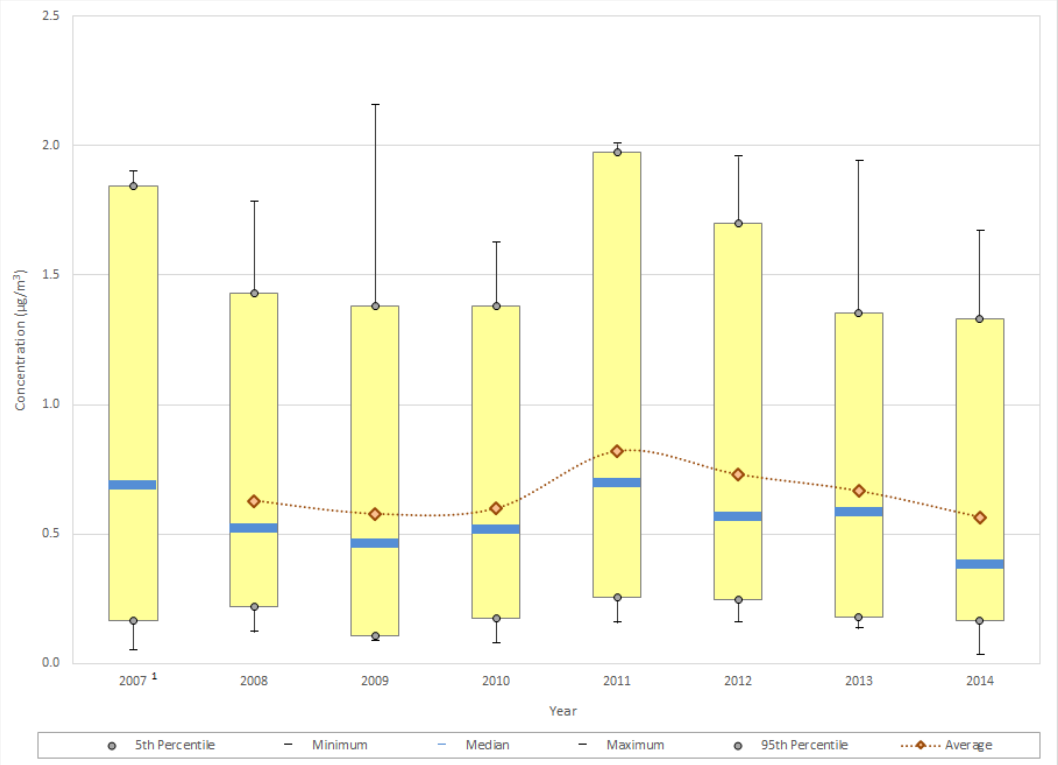
- There were no measured detections of 1,2-dichloroethane in 2007, one measured detection in 2008, seven in 2009, nine in 2010, 12 in 2011, 47 in 2012, 38 in 2013, and 53 in 2014.

- The median concentration is zero for each year until 2012, indicating that at least 50 percent of the measurements were non-detects for the first 5 years of sampling.

- The number of measured detections increased markedly for 2012, and the median and 1-year average concentrations increased correspondingly. The median concentration is greater than the 1-year average concentration for each year between 2012 and 2014. This is because there were still many non-detects (or zeros) factoring into the 1-year average concentration for 2012 (14), 2013 (23), and 2014 (8), which pull the 1-year average concentrations down in the same manner that a maximum or outlier concentration can drive the average up.

- The difference between the 1-year average and median concentration for 2014 is at its lowest since 2008, when there was only one measured detection.

Figure 5-24. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-24 for ethylbenzene concentrations measured at PXSS include the following:

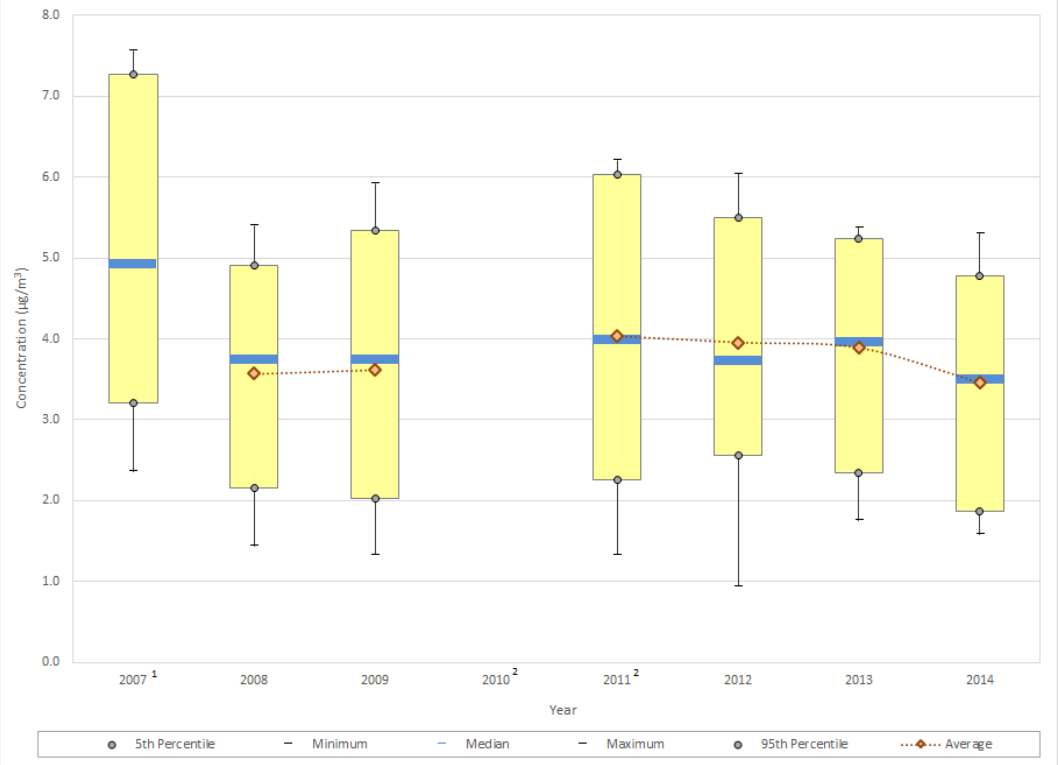
- The maximum concentration of ethylbenzene measured at PXSS (2.16 µg/m^3) was measured on January 1, 2009, the same day that the maximum benzene concentration was measured at this site. The next four highest concentrations were all measured in November 2011, including the only other concentration greater than 2 µg/m^3 measured at PXSS (2.01 µg/m^3).

- Similar to benzene and 1,3-butadiene, the highest ethylbenzene concentrations were measured most often during the first and fourth quarters of the years. Ninety of the 100 highest concentrations (those greater than 1.0 µg/m^3) were measured between January and March or October and December of any given year. The exceptions were measured April (1), May (1), July (1), and September (7).

- The median ethylbenzene concentration has a decreasing trend through 2009, then returns to 2008 levels for 2010, and returns to 2007 levels for 2011. All of the statistical parameters shown increased from 2010 to 2011. Nearly twice the number of measurements greater than 1 µg/m^3 were measured in 2011 (20) than the previous years, which vary between nine (2008) and 11 (both 2007 and 2010).

- A significant decreasing trend in the 1-year average concentration is shown between 2011 and 2014, with the 1-year average concentration at a minimum for 2014 (0.57 µg/m^3). The median concentration is also at a minimum for 2014 (0.38 µg/m^3), as are the minimum concentration and the 95th percentile.

Figure 5-25. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.
[2] Some statistical metrics are not presented because data from Feb 2010 to Mar 2011 was invalidated.

Observations from Figure 5-25 for formaldehyde concentrations measured at PXSS include the following:

- PXSS began sampling formaldehyde under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average for 2007 is not presented,

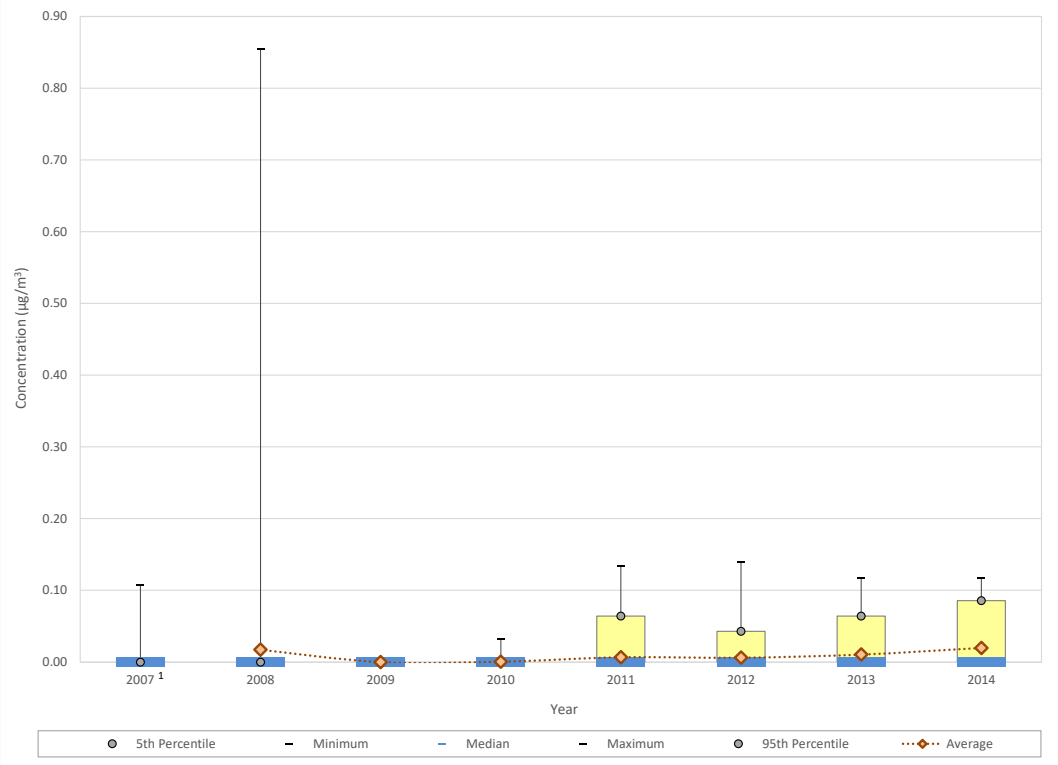
although the range of measurements is provided. In addition, much of the data between February 2010 and March 2011 was invalidated due to sampler maintenance issues on the primary sampler. No statistical metrics are provided for 2010 due to the low number of valid measurements. The range of measurements is provided for 2011, although a 1-year average concentration is not provided.

- The five highest formaldehyde concentrations (ranging from 6.28 µg/m^3 to 7.56 µg/m^3) were all measured at PXSS in 2007 and all but one of the 11 formaldehyde concentrations greater than 6 µg/m^3 were measured in either 2007 or 2011 at PXSS (with the exception measured in 2012).

- The median concentration for 2007 is nearly 5 µg/m^3. The median concentration for the years that follow are all less than 4 µg/m^3.

- Only one formaldehyde concentration less than 1 µg/m^3 has been measured at PXSS (2012) and only 18 less than 2 µg/m^3 have been measured at PXSS since 2007. One-third of these were measured in 2014 (6) and no other year has more than three.

Figure 5-26. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at PXSS



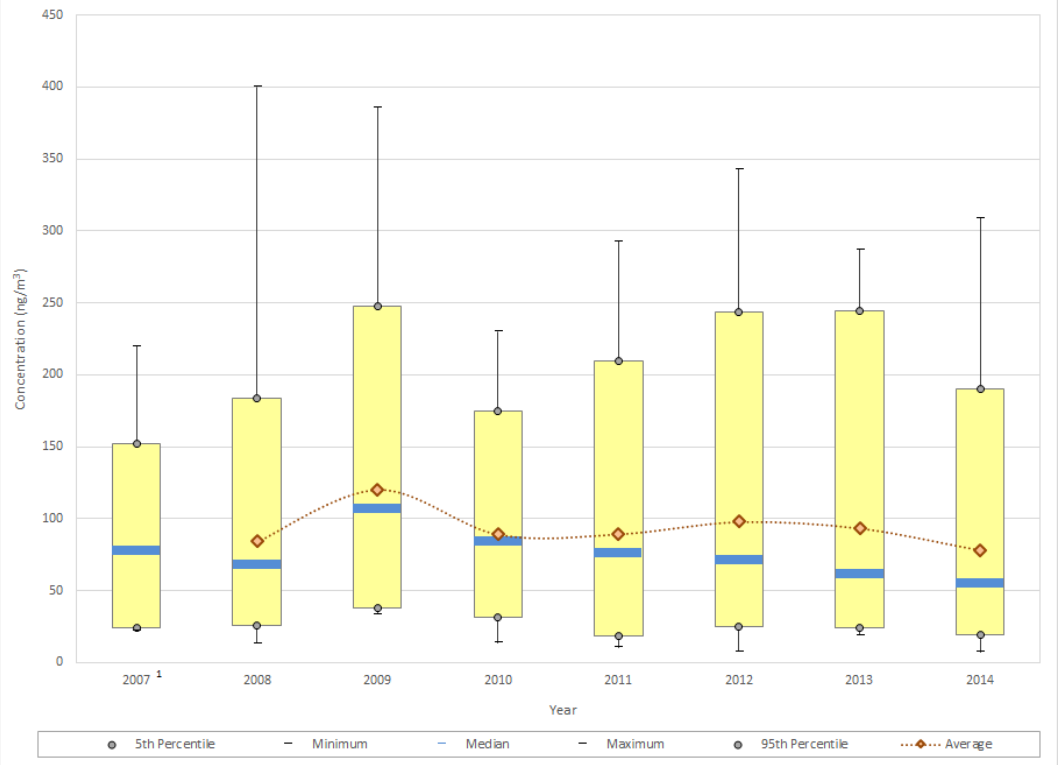
[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-26 for hexachloro-1,3-butadiene concentrations measured at PXSS include the following:

- The maximum concentration of hexachloro-1,3-butadiene was measured on September 3, 2008 (0.85 µg/m^3). No other concentration greater than 0.15 µg/m^3 has been measured at PXSS.

- The median concentration for each year shown is zero, indicating that at least 50 percent of the measurements are non-detects for each year. The percentage of non-detects was greater than 90 percent for each of the first six years of sampling, including 2009, when the percentage was 100 percent. The percentage of non-detects decreased to 87 percent for 2013 when eight measured detections were measured. The percentage of non-detects is at a minimum for 2014 (72 percent), when the number of measured detections more than doubled to 17.

Figure 5-27. Yearly Statistical Metrics for Naphthalene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

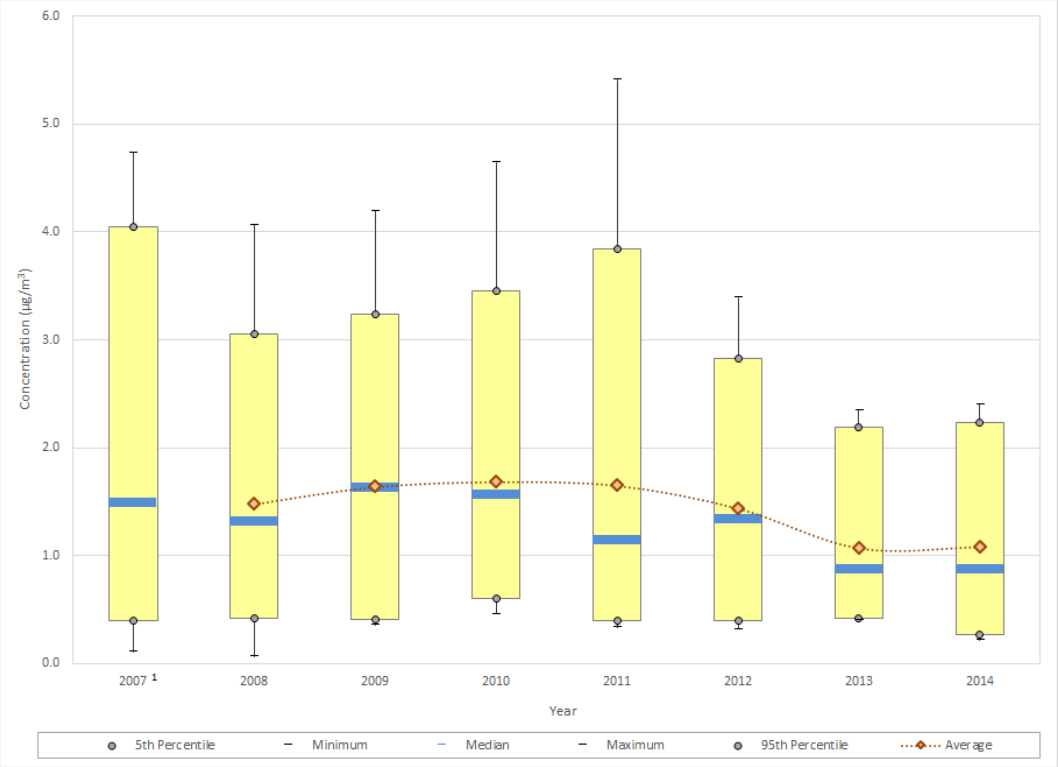
Observations from Figure 5-27 for naphthalene concentrations measured at PXSS include the following:

- PXSS began sampling PAHs under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average for 2007 is not presented, although the range of measurements is provided.

- The maximum naphthalene concentration was measured on December 20, 2008 (400 ng/m^3), with a similar concentration measured 12 days later on January 1, 2009 (386 ng/m^3). Two additional measurements greater than 300 ng/m^3 have been measured at PXSS, one in December 2012 and one in January 2014.

- Many of the statistical parameters are at a maximum for 2009. The median, or midpoint, for 2009 is 107 ng/m^3. The median concentrations for the other years are less than 100 ng/m^3, ranging from 55.30 ng/m^3 (2014) to 84.1 ng/m^3 (2010), and have a steady decreasing trend after 2009. The 1-year average concentration is also at a maximum for 2009 (120.17 ng/m^3) and at a minimum for 2014 (78.25 ng/m^3), varying between roughly 90 ng/m^3 and 100 ng/m^3 in between.

Figure 5-28. Yearly Statistical Metrics for Benzene Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-28 for benzene concentrations measured at SPAZ include the following:

- SPAZ also began sampling VOCs under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of concentrations measured is provided.

- The maximum benzene concentration shown was measured on January 27, 2011 (5.41 µg/m^3) and is the only benzene concentration greater than 5 µg/m^3 measured at SPAZ. Five additional measurements greater than 4 µg/m^3 have been measured at this site (one for each year of sampling prior to 2012).

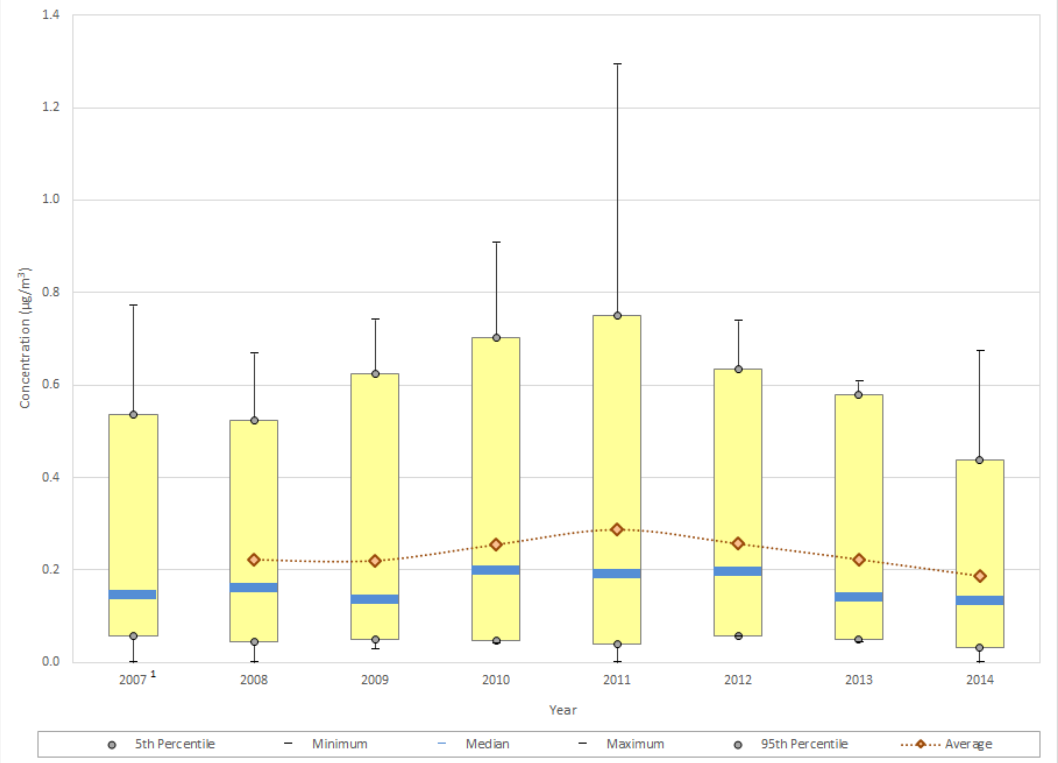
- Similar to PXSS, 52 of the 56 benzene concentrations greater than 2 µg/m^3 were measured at SPAZ during the first or fourth quarters of any given year.

- The 1-year average and median concentrations are fairly similar to each other for all years except 2011, when more than 0.5 µg/m^3 separates them. The largest range of benzene concentrations was measured in 2011, spanning more than 5 µg/m^3, and the maximum concentration for the period shown was measured in 2011. This year has the highest number of benzene concentrations greater than 3 µg/m^3 (5) but also the highest number of benzene concentrations less than 1.25 µg/m^3 (16) for the years prior to 2013.

- After several years of increasing, both the maximum and 95th percentile decreased considerably for 2012 and again for 2013, with little change shown for 2014. The range of benzene concentrations measured is at a minimum for 2013, spanning less than 2 µg/m^3.

- The 1-year average concentrations changed little between 2009 and 2011, then decreased from 2011 to 2012 and again for 2013, with little change for 2014. The median concentration exhibits more variability during this time frame.

Figure 5-29. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-29 for 1,3-butadiene concentrations measured at SPAZ include the following:

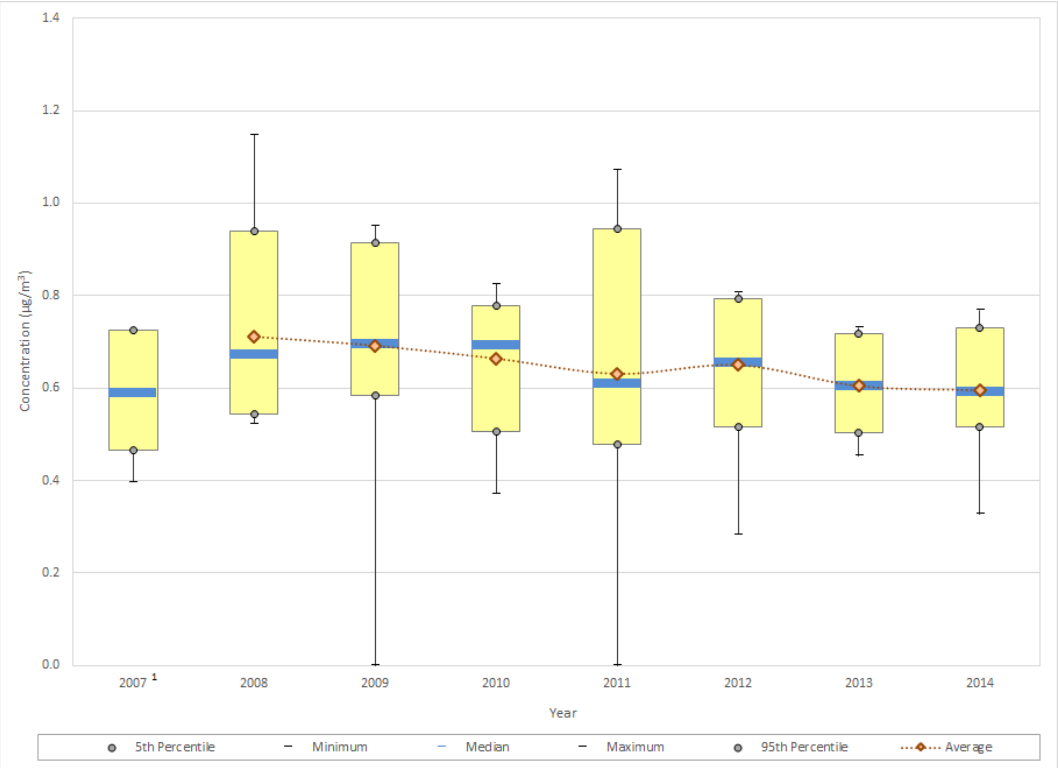
- The only 1,3-butadiene concentration greater than 1 µg/m^3 was measured at SPAZ on January 27, 2011 (1.29 µg/m^3). Four additional 1,3-butadiene concentrations greater than 0.75 µg/m^3 have been measured at SPAZ, one in 2007, two in 2010, and one in 2011.

- Seventy-three of the 77 concentrations greater than 0.25 µg/m^3 were measured at SPAZ during the first or fourth quarters of any given year, similar to the trend seen in PXSS 1,3-butadiene measurements.

- The maximum concentration and 95th percentile increased each year after 2008 through 2011, while the 5th percentile remained fairly static. This indicates that more of the concentrations measured were on the higher end of the concentration range for each of these years. For 2012, the maximum concentration and 95th percentiles are lower, with the maximum concentration for 2012 less than the 95th percentile for 2011. This is also true for 2013, where the maximum concentration is less than the 95th percentile for the preceding year. The 95th percentile continued its decrease for 2014, although the maximum concentration measured increased. The majority of concentrations measured in 2014, as indicated by the 5th and 95th percentiles, falls into the tightest range among the years shown.

- The 1-year average concentration increases steadily between 2009 and 2011, then decreases through 2014, with the 1-year average concentration falling to less than 0.2 µg/m^3 for the first time in 2014. However, the 1-year average concentrations vary by only 0.1 µg/m^3, ranging from 0.19 µg/m^3 (2014) to 0.29 µg/m^3 (2011), and confidence intervals calculated indicate these changes are not statistically significant.

Figure 5-30. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-30 for carbon tetrachloride concentrations measured at SPAZ include the following:

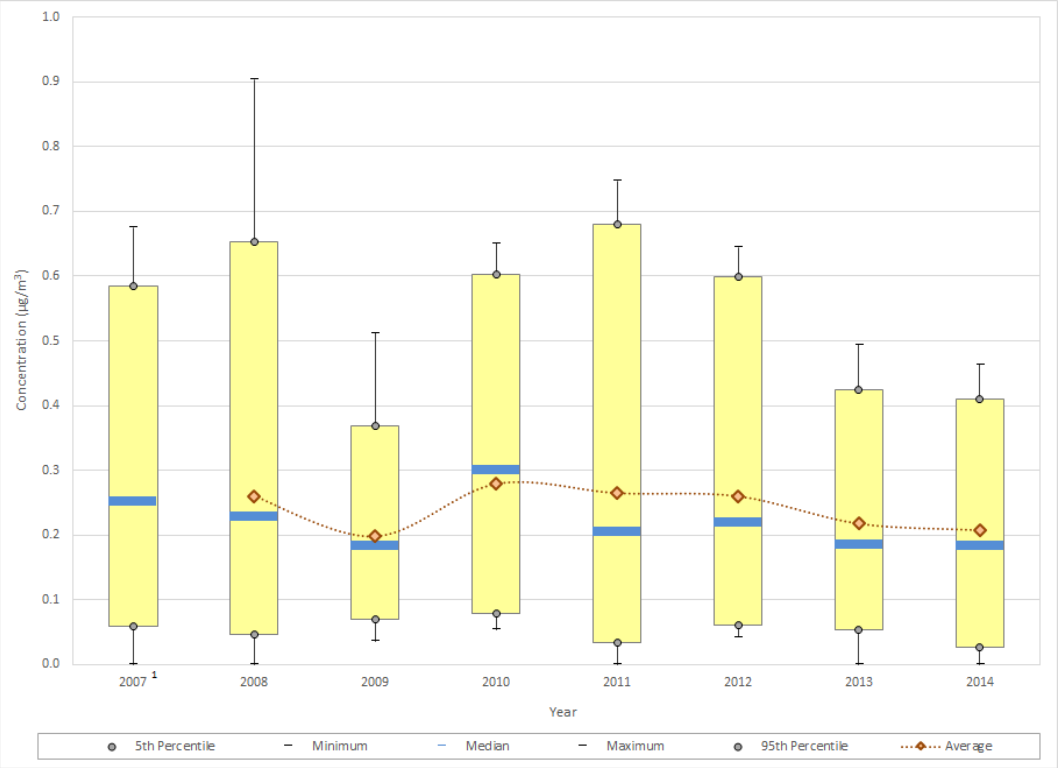
- Two concentrations of carbon tetrachloride greater than 1.0 µg/m^3 have been measured at SPAZ since the onset of sampling. One was measured in 2008 and one was measured in 2011 (although another concentration just less than 1 µg/m^3 was measured in 2011). Conversely, two non-detects of carbon tetrachloride have been measured at SPAZ, one in 2009 and one in 2011.

- The box and whisker plots for this pollutant appear "inverted" for several years, with the minimum concentration extending farther away from the majority of the measurements for several years rather than the maximum (see benzene or 1,3-butadiene as examples), which is more common.

- With the exception of 2012, the 1-year average concentration exhibits a slight decreasing trend over the years shown, reaching a minimum for 2014 (0.61 µg/m^3). However, the differences represent an overall change of less than 0.12 µg/m^3.

- The range of concentrations measured is at a minimum for 2013, as is the difference between the 1-year average and median for 2013 (0.001 µg/m^3), indicating the least amount of variability in the measurements compared to other years. However, the difference between the 1-year average and median concentrations is relatively low for every year, with the difference for 2008 being the largest (0.04 µg/m^3).

Figure 5-31. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at SPAZ



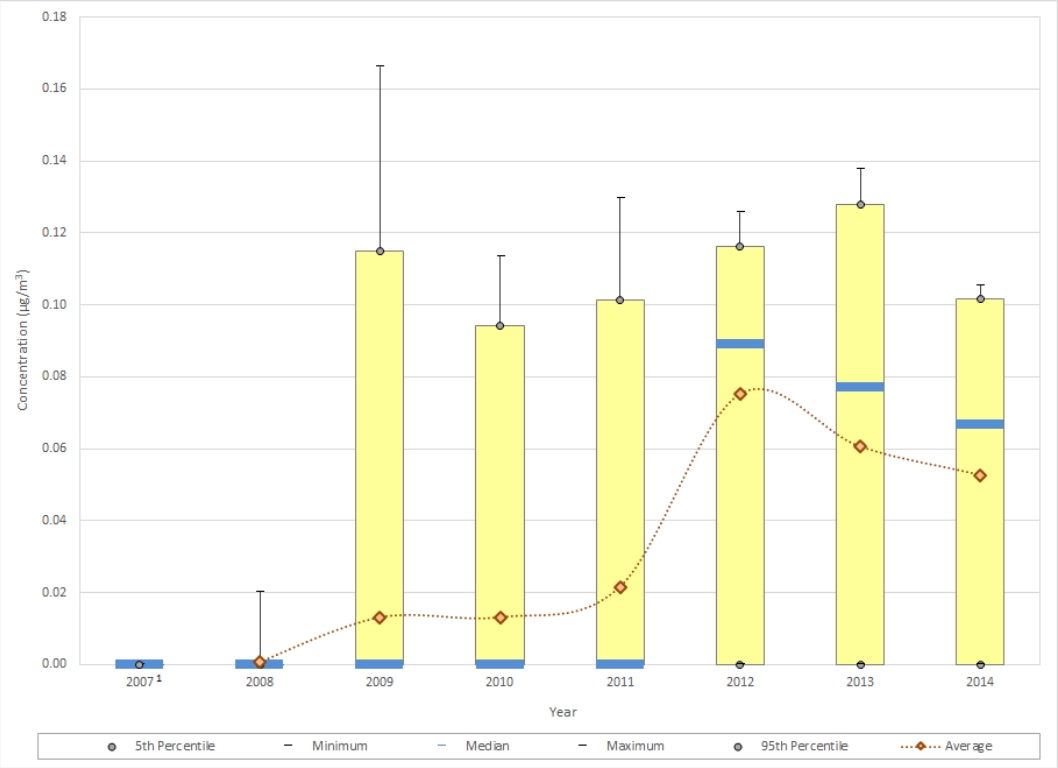
[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-31 for *p*-dichlorobenzene concentrations measured at SPAZ include the following:

- The widest range of *p*-dichlorobenzene concentrations measured is shown for 2008 (non-detect to 0.90 µg/m^3), while the range of concentrations measured the following year is roughly half as wide. A review of the data shows that the number of *p*-dichlorobenzene concentrations greater than 0.3 µg/m^3 decreased by half from 2008 (8) to 2009 (4). All of the statistical metric exhibit increases from 2009 to 2010, with the number of *p*-dichlorobenzene concentrations greater than 0.3 µg/m^3 increasing nearly four-fold (15).

- The 1-year average concentration decreased from 2008 to 2009, increased for 2010, then decreased slightly each year between 2011 and 2014. However, confidence intervals calculated for these averages indicate that the changes are not statistically significant. The median concentrations exhibit larger fluctuations than the 1-year average concentrations.

Figure 5-32. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-32 for 1,2-dichloroethane concentrations measured at SPAZ include the following:

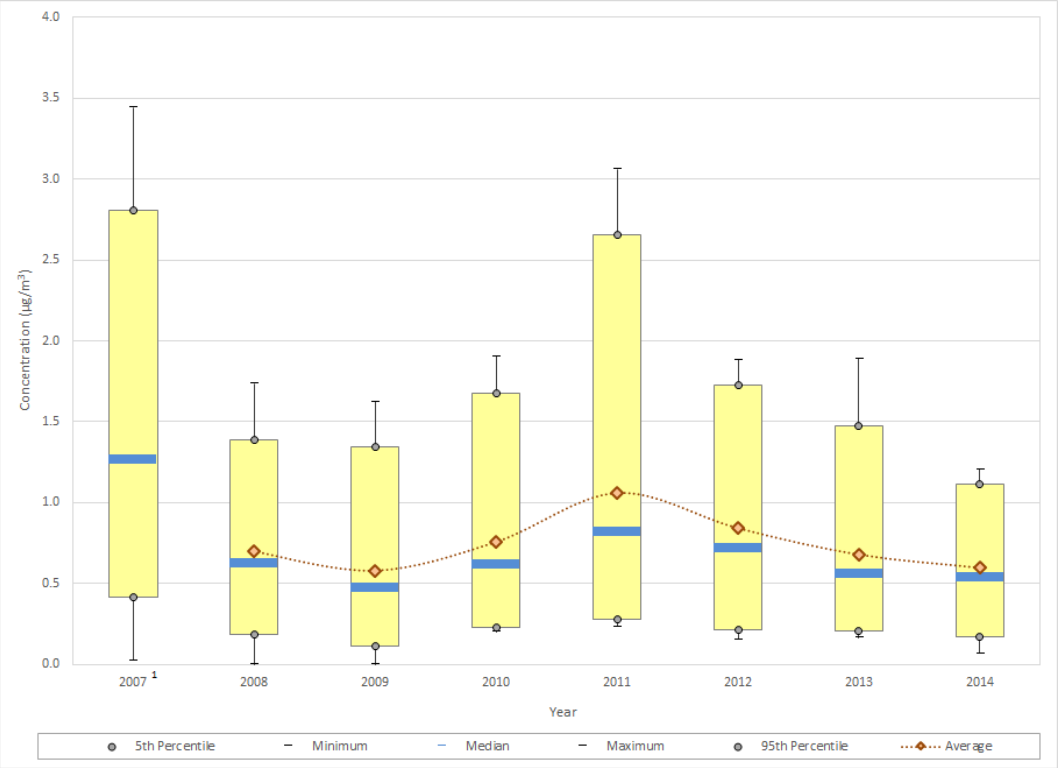
- There were no measured detections of 1,2-dichloroethane in 2007, one measured detection in 2008, three in 2009, four in 2010, seven in 2011, 26 in 2012, 19 in 2013, and 20 in 2014.

- The median concentration is zero for all years until 2012, indicating that at least 50 percent of the measurements were non-detects. As the number of measured detections increase, so do the corresponding central tendency statistics shown in Figure 5-32.

- The median concentration is greater than the 1-year average concentration for 2012, 2013, and 2014. This is because the non-detects (or zeros) factored into each 1-year average concentration are pulling the average down in the same manner that a maximum or outlier concentration can drive the average upward.

- Confidence intervals calculated for the last three years of sampling indicate that the steady decrease in the 1-year average and median concentrations shown is not statistically significant due to the variability in the concentrations measured.

Figure 5-33. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-33 for ethylbenzene concentrations measured at SPAZ include the following:

- The maximum concentration of ethylbenzene measured at SPAZ (3.44 µg/m^3) was measured in 2007. The only other concentration greater than 3.0 µg/m^3 was measured at SPAZ on January 27, 2011 (3.06 µg/m^3). All eight concentrations between 2.0 µg/m^3 and 3.0 µg/m^3 were measured in either 2007 (four) or 2011 (four).

- The median concentration is at a maximum for 2007, after which the median decreases by half. Recall that 2007 includes only half a year's worth of samples. The downward trend continues through 2009, followed by an increase that continues through 2011. The median decreases somewhat for 2012, with additional decreases for 2013 and 2014. The 1-year average concentration has a similar pattern, although no 1-year average concentration is presented for 2007. These patterns are similar to the patterns shown for 1,3-butadiene in Figure 5-29 and the patterns shown in Figure 5-24 for PXSS's ethylbenzene concentrations.

- The only non-detects of ethylbenzene were measured during the first two full-years of sampling at SPAZ.

5.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each Arizona monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

5.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Arizona monitoring sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 5-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 5-5. Risk Approximations for the Arizona Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Phoenix, Arizona - PXSS						
Acetaldehyde	0.0000022	0.009	61/61	2.52 ± 0.29	5.54	0.28
Benzene	0.0000078	0.03	61/61	1.05 ± 0.20	8.20	0.04
1,3-Butadiene	0.00003	0.002	60/61	0.20 ± 0.05	5.94	0.10
Carbon Tetrachloride	0.000006	0.1	61/61	0.61 ± 0.02	3.67	0.01
p-Dichlorobenzene	0.000011	0.8	57/61	0.17 ± 0.03	1.84	<0.01
1,2-Dichloroethane	0.000026	2.4	53/61	0.08 ± 0.01	2.00	<0.01
Ethylbenzene	0.0000025	1	61/61	0.57 ± 0.10	1.41	<0.01
Formaldehyde	0.000013	0.0098	61/61	3.46 ± 0.24	45.04	0.35
Hexachloro-1,3-butadiene	0.000022	0.09	17/61	0.02 ± 0.01	0.44	<0.01
Arsenic (PM_{10})[a]	0.0043	0.000015	60/60	0.55 ± 0.11	2.35	0.04
Naphthalene[a]	0.000034	0.003	59/59	78.25 ± 15.71	2.66	0.03
South Phoenix, Arizona - SPAZ						
Benzene	0.0000078	0.03	30/30	1.09 ± 0.24	8.48	0.04
1,3-Butadiene	0.00003	0.002	29/30	0.19 ± 0.06	5.62	0.09
Carbon Tetrachloride	0.000006	0.1	30/30	0.60 ± 0.03	3.58	0.01
p-Dichlorobenzene	0.000011	0.8	28/30	0.21 ± 0.05	2.31	<0.01
1,2-Dichloroethane	0.000026	2.4	21/30	0.06 ± 0.01	1.43	<0.01
Ethylbenzene	0.0000025	1	30/30	0.60 ± 0.13	1.51	<0.01

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

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

- The pollutants of interest with the highest annual average concentrations are formaldehyde, acetaldehyde, and benzene, and are the only pollutants of interest with annual average concentrations greater than 1 $\mu g/m^3$.

- Based on the annual averages and cancer UREs, formaldehyde has the highest cancer risk approximation (45.04 in-a-million), followed by benzene (8.20 in-a-million), 1,3-butadiene (5.94 in-a-million), and acetaldehyde (5.54 in-a-million).

- Formaldehyde's cancer risk approximation for PXSS is the sixth highest cancer risk approximation among the site-specific pollutants of interest across the program.

- None of the pollutants of interest for PXSS have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation for PXSS is formaldehyde (0.35). This noncancer hazard approximation is the seventh highest noncancer hazard approximation among all site-specific pollutants of interest.

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

- The pollutants with the highest annual average concentrations for SPAZ are benzene, ethylbenzene, and carbon tetrachloride. Only benzene has an annual average concentration greater than 1 $\mu g/m^3$.

- Based on the annual averages and cancer UREs, benzene has the highest cancer risk approximation for SPAZ (8.48 in-a-million), followed by 1,3-butadiene (5.62 in-a-million), and carbon tetrachloride (3.58 in-a-million). These cancer risk approximations are similar to the approximations calculated for these same pollutants for PXSS.

- None of the pollutants of interest for SPAZ have noncancer hazard approximations greater than 1.0, indicating no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation for SPAZ is 1,3-butadiene (0.09).

5.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 5-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 5-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 5-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 5-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 5-6. Table 5-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Table 5-6. 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 UREs (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)**
Phoenix, Arizona (Maricopa County) – PXSS					
Benzene	1,313.94	Formaldehyde	1.48E-02	Formaldehyde	45.04
Formaldehyde	1,141.02	Benzene	1.02E-02	Benzene	8.20
Ethylbenzene	862.37	1,3-Butadiene	5.42E-03	1,3-Butadiene	5.94
Acetaldehyde	576.27	Naphthalene	3.02E-03	Acetaldehyde	5.54
1,3-Butadiene	180.82	Ethylbenzene	2.16E-03	Carbon Tetrachloride	3.67
Tetrachloroethylene	95.59	POM, Group 2b	1.48E-03	Naphthalene	2.66
Naphthalene	88.77	Acetaldehyde	1.27E-03	Arsenic (PM_{10})	2.35
POM, Group 2b	16.83	POM, Group 2d	1.19E-03	1,2-Dichloroethane	2.00
POM, Group 2d	13.53	Arsenic, PM	1.03E-03	*p*-Dichlorobenzene	1.84
Dichloromethane	12.34	POM, Group 5a	7.15E-04	Ethylbenzene	1.41
South Phoenix, Arizona (Maricopa County) – SPAZ					
Benzene	1,313.94	Formaldehyde	1.48E-02	Benzene	8.48
Formaldehyde	1,141.02	Benzene	1.02E-02	1,3-Butadiene	5.62
Ethylbenzene	862.37	1,3-Butadiene	5.42E-03	Carbon Tetrachloride	3.58
Acetaldehyde	576.27	Naphthalene	3.02E-03	*p*-Dichlorobenzene	2.31
1,3-Butadiene	180.82	Ethylbenzene	2.16E-03	Ethylbenzene	1.51
Tetrachloroethylene	95.59	POM, Group 2b	1.48E-03	1,2-Dichloroethane	1.43
Naphthalene	88.77	Acetaldehyde	1.27E-03		
POM, Group 2b	16.83	POM, Group 2d	1.19E-03		
POM, Group 2d	13.53	Arsenic, PM	1.03E-03		
Dichloromethane	12.34	POM, Group 5a	7.15E-04		

Table 5-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Arizona Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Phoenix, Arizona (Maricopa County) – PXSS					
Toluene	5,233.19	Acrolein	2,932,324.18	Formaldehyde	0.35
Xylenes	3,296.34	Formaldehyde	116,431.08	Acetaldehyde	0.28
Hexane	2,752.67	1,3-Butadiene	90,410.71	1,3-Butadiene	0.10
Methanol	2,399.14	Acetaldehyde	64,030.43	Arsenic	0.04
Benzene	1,313.94	Benzene	43,798.12	Benzene	0.04
Formaldehyde	1,141.02	Lead, PM	34,426.96	Naphthalene	0.03
Ethylene glycol	880.96	Xylenes	32,963.37	Carbon Tetrachloride	0.01
Ethylbenzene	862.37	Naphthalene	29,589.71	Ethylbenzene	<0.01
Acetaldehyde	576.27	Arsenic, PM	16,021.47	Hexachloro-1,3-butadiene	<0.01
Methyl isobutyl ketone	326.41	Propionaldehyde	10,771.78	*p*-Dichlorobenzene	<0.01
South Phoenix, Arizona (Maricopa County) – SPAZ					
Toluene	5,233.19	Acrolein	2,932,324.18	1,3-Butadiene	0.09
Xylenes	3,296.34	Formaldehyde	116,431.08	Benzene	0.04
Hexane	2,752.67	1,3-Butadiene	90,410.71	Carbon Tetrachloride	0.01
Methanol	2,399.14	Acetaldehyde	64,030.43	Ethylbenzene	<0.01
Benzene	1,313.94	Benzene	43,798.12	*p*-Dichlorobenzene	<0.01
Formaldehyde	1,141.02	Lead, PM	34,426.96	1,2-Dichloroethane	<0.01
Ethylene glycol	880.96	Xylenes	32,963.37		
Ethylbenzene	862.37	Naphthalene	29,589.71		
Acetaldehyde	576.27	Arsenic, PM	16,021.47		
Methyl isobutyl ketone	326.41	Propionaldehyde	10,771.78		

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 5.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 5-6 include the following:

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

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

- Eight of the highest emitted pollutants in Maricopa County also have the highest toxicity-weighted emissions.

- Formaldehyde has the highest cancer risk approximation for PXSS; carbonyl compounds were not sampled for at SPAZ, thus, a cancer risk approximation is not available for this pollutant for SPAZ. Formaldehyde has the second highest emissions and the highest toxicity-weighted emissions for Maricopa County. Acetaldehyde, which has the fourth highest cancer risk approximation for PXSS, also appears on both emissions-based list for Maricopa County.

- Among the VOCs, benzene, 1,3-butadiene, and carbon tetrachloride have highest cancer risk approximations for PXSS and SPAZ. The cancer risk approximations for these pollutants are similar between the two sites. While benzene and 1,3-butadiene both appear among the pollutants with the highest emissions and highest toxicity-weighted emissions for Maricopa County, carbon tetrachloride does not appear on either list, ranking 23rd for quantity emitted and 28th for it toxicity-weighted emissions.

- Naphthalene is among the highest emitted pollutants (seventh), has one of the highest toxicity-weighted emissions (fourth), and has one of the highest cancer risk approximations for PXSS (sixth). POM, Group 2b is the eighth highest emitted "pollutant" in Maricopa County and ranks sixth for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at PXSS including acenaphthene, benzo(e)pyrene, fluoranthene, and perylene. None of the PAHs included in POM, Group 2b were identified as pollutants of interest for PXSS (or failed any screens). POM, Group 5a ranks tenth for its toxicity-weighted emissions for Maricopa County.

This POM group includes benzo(a)pyrene, which failed two screens for PXSS but was not identified as a pollutant of interest for this site.

- Arsenic has the seventh highest cancer risk approximation among the pollutants of interest for PXSS. This pollutant ranks ninth for its toxicity-weighted emissions but does not appear among the highest emitted pollutants in Maricopa County (it ranks 20th).

Observations from Table 5-7 include the following:

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

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

- Four of the highest emitted pollutants also have the highest toxicity-weighted emissions for Maricopa County.

- Acrolein has the highest toxicity-weighted emissions 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-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. The emissions for acrolein rank 16th for Maricopa County.

- Formaldehyde and acetaldehyde have the highest noncancer hazard approximations for PXSS (although considerably less than an HQ of 1.0), both of which appear among those with the highest emissions and toxicity-weighted emissions for Maricopa County.

- 1,3-Butadiene and benzene have the highest noncancer hazard approximations among the VOCs for both PXSS and SPAZ and are similar in magnitude between the two sites. Benzene ranks fifth for both its emissions and its toxicity-weighted emissions. 1,3-Butadiene has the third highest toxicity-weighted emissions for Maricopa County but is not one of the highest emitted pollutants in Maricopa County (with a noncancer RfC), as it ranks 11th.

- Arsenic has the fourth highest noncancer hazard approximation for PXSS. Arsenic has the ninth highest toxicity-weighted emissions for Maricopa County but is not one of the highest emitted pollutants in Maricopa County (with a noncancer RfC), as it ranks 40th.

- Naphthalene is another pollutant of interest for PXSS that appears among the pollutants with the highest toxicity-weighted emissions for Maricopa County but whose actual emissions rank outside the top 10 emitted pollutants, ranking 13th.

5.6 Summary of the 2014 Monitoring Data for PXSS and SPAZ

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

- *Fifteen pollutants failed screens for PXSS; six pollutants failed screens for SPAZ. The six pollutants that failed screens for SPAZ also failed screens for PXSS.*

- *Of the site-specific pollutants of interest for PXSS, formaldehyde had the highest annual average concentration. For SPAZ, benzene had the highest annual average concentration among this site's pollutants of interest.*

- *Concentrations of several VOCs, particularly benzene and 1,3-butadiene, tended to be higher during the colder months of the year. This was also reflected in the concentration data from previous years of sampling.*

- *SPAZ and PXSS have the highest and second highest annual average concentrations of p-dichlorobenzene and ethylbenzene among NMP sites sampling VOCs. These sites also rank second and third highest for 1,3-butadiene.*

- *Concentrations of benzene and ethylbenzene appear to be decreasing at the Arizona sites. The detection rate of 1,2-dichloroethane increased significantly during the later years of sampling.*

- *Formaldehyde has the highest cancer risk approximation of the pollutants of interest for PXSS; benzene has the highest cancer risk approximation of the pollutants of interest for SPAZ. None of the pollutants of interest for either site have noncancer hazard approximations greater than an HQ of 1.0.*

6.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

6.1 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.

Three NATTS monitoring sites are located in California. Two are located in Southern California, in Los Angeles (CELA) and Rubidoux (RUCA), and a third monitoring site is located in Northern California, in San Jose (SJJCA). Figure 6-1 is the composite satellite image retrieved from ArcGIS Explorer showing the Los Angeles monitoring site and its immediate surroundings. Figure 6-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of CELA are included in the facility counts provided in Figure 6-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Figures 6-3 through 6-6 are the composite satellite images and emissions maps for the Rubidoux and San Jose monitoring sites. Table 6-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 6-1. Los Angeles, California (CELA) Monitoring Site

Figure 6-2. NEI Point Sources Located Within 10 Miles of CELA

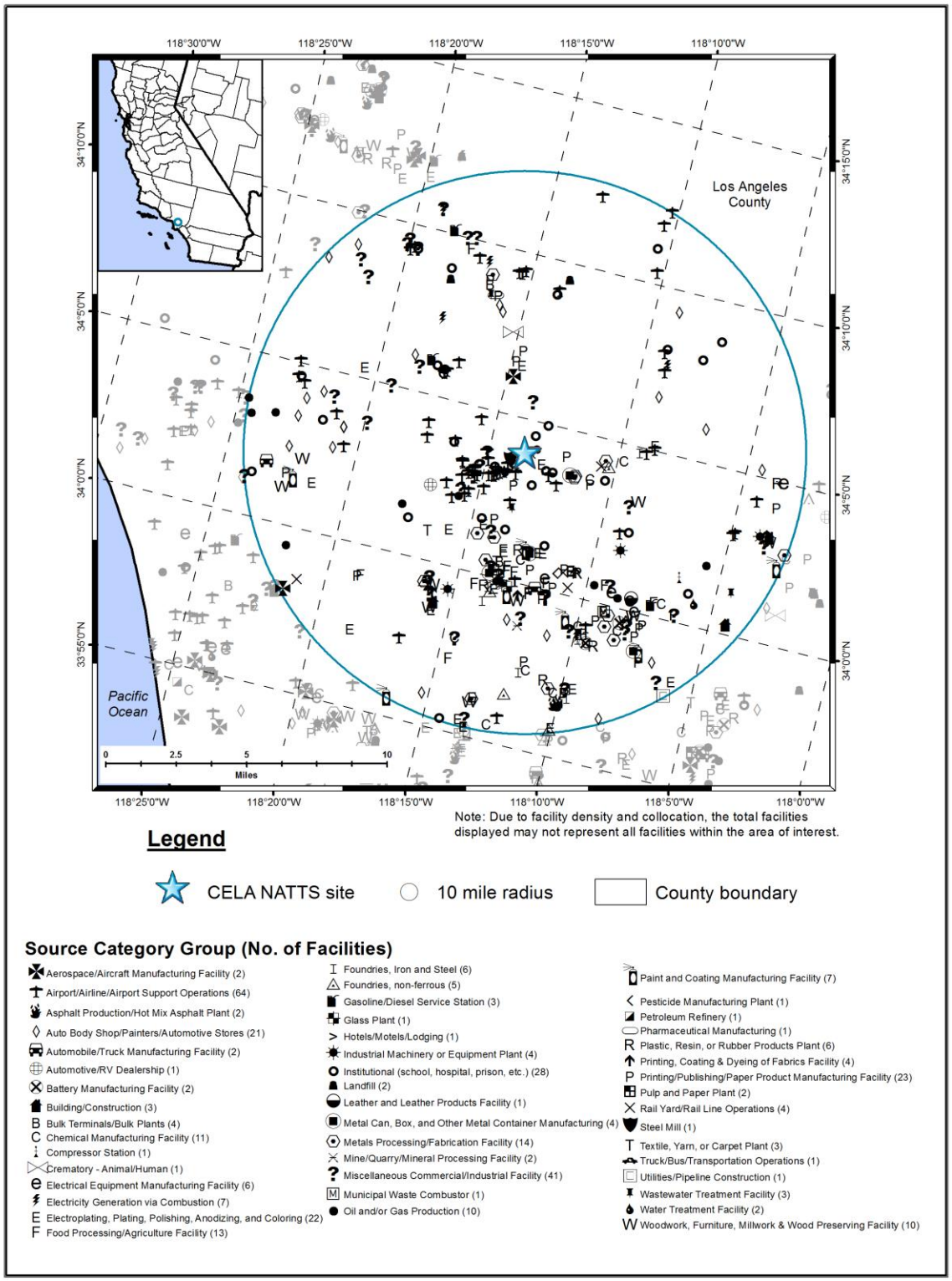


Figure 6-3. Rubidoux, California (RUCA) Monitoring Site

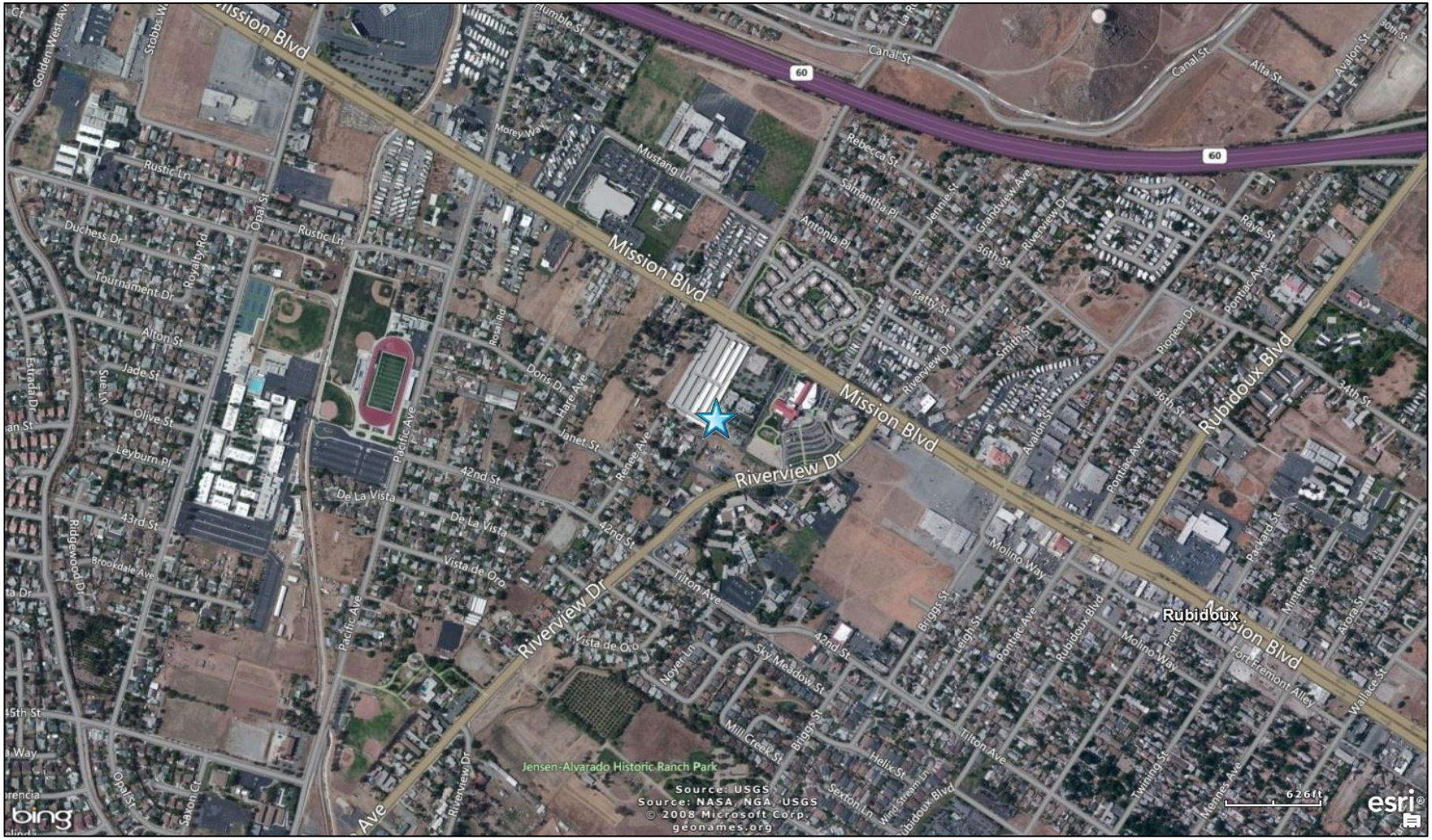


Figure 6-4. NEI Point Sources Located Within 10 Miles of RUCA

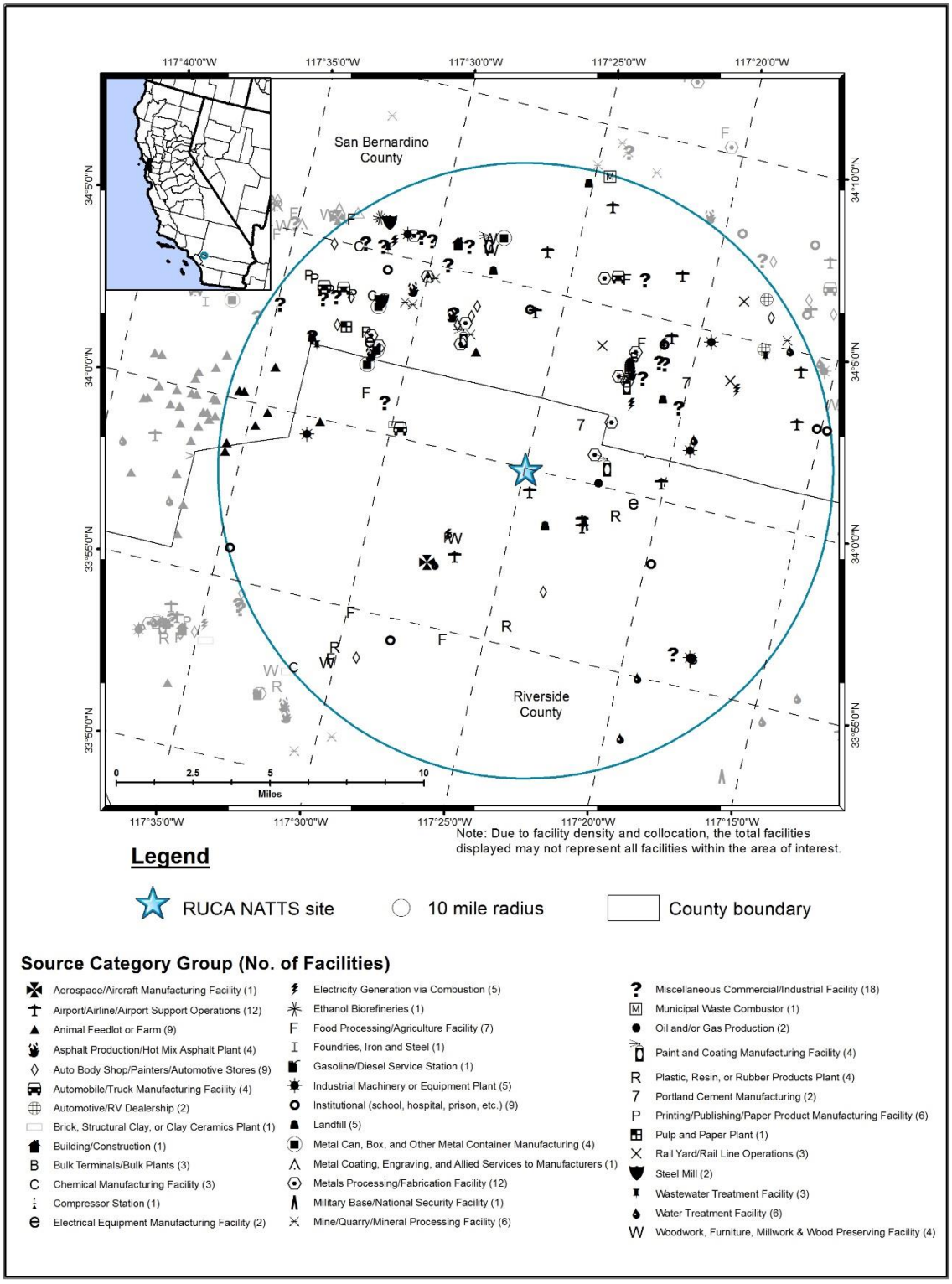


Figure 6-5. San Jose, California (SJJCA) Monitoring Site

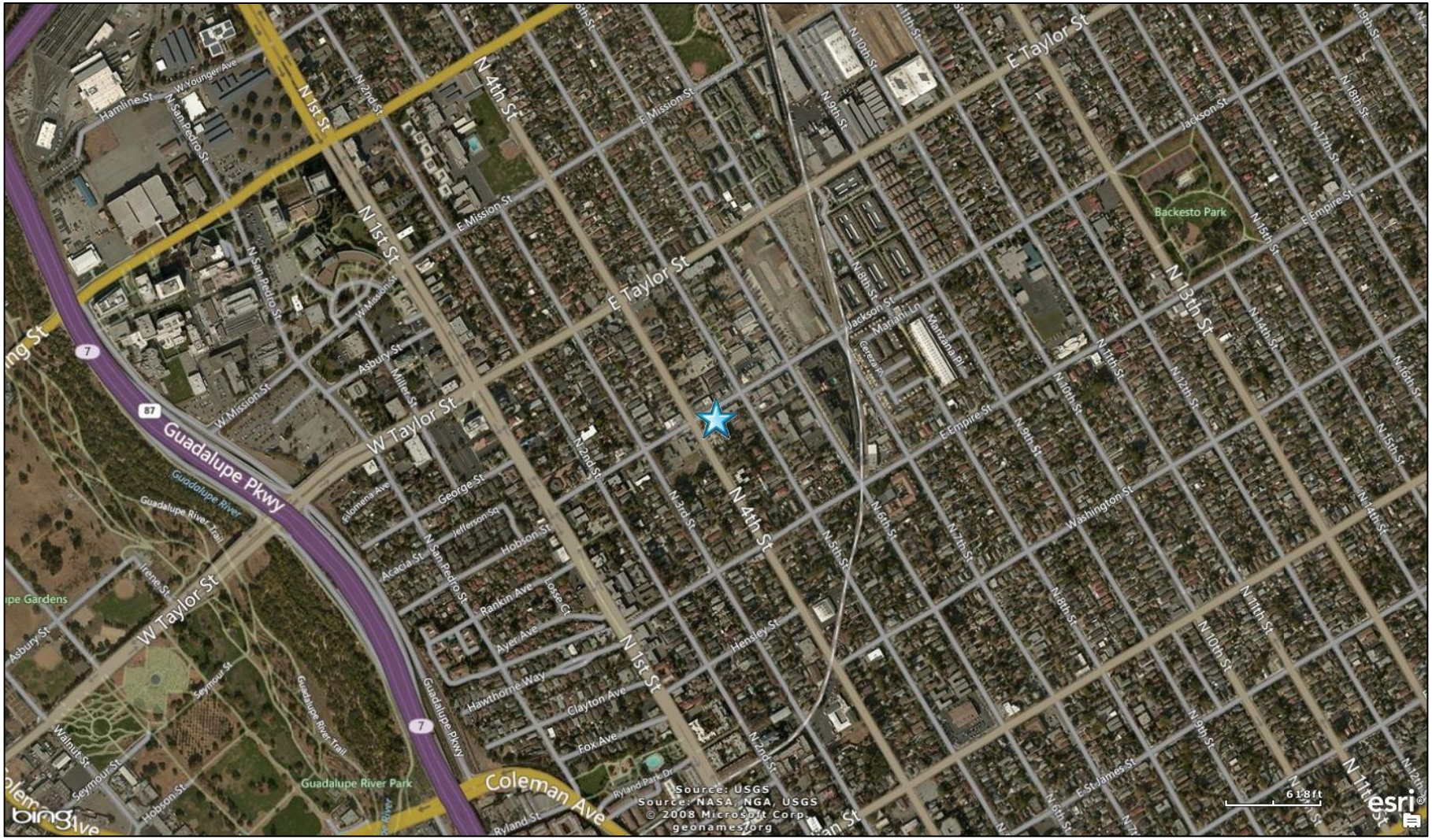


Figure 6-6. NEI Point Sources Located Within 10 Miles of SJJCA

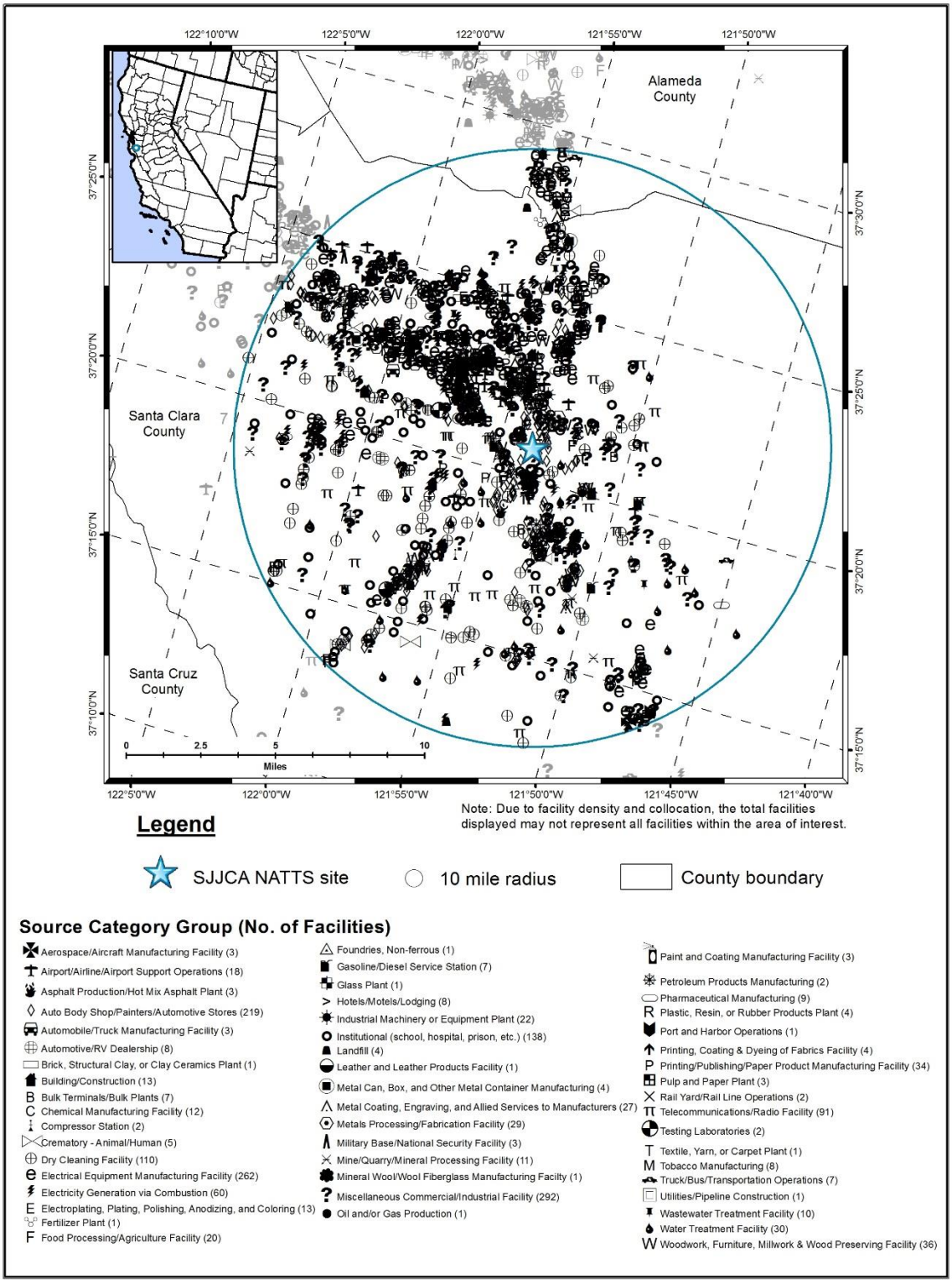


Table 6-1. Geographical Information for the California Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
CELA	06-037-1103	Los Angeles	Los Angeles	Los Angeles-Long Beach-Anaheim, CA	34.066590, -118.226880	Residential	Urban/City Center	230,000	I-5 between Main St. and Broadway (exit 136 and 137)
RUCA	06-065-8001	Rubidoux	Riverside	Riverside-San Bernardino-Ontario, CA	33.999580, -117.416010	Residential	Suburban	158,000	Rte 60 (Mission Blvd) between Rubidoux Blvd and Valley Way
SJJCA	06-085-0005	San Jose	Santa Clara	San Jose-Sunnyvale-Santa Clara, CA	37.348497, -121.894898	Commercial	Urban/City Center	124,000	Rte 87 (Guadalupe Pkwy) between Julian St and W Taylor St

[1]AADT reflects 2014 data (CA DOT, 2014)
BOLD ITALICS = EPA-designated NATTS Site

CELA is located on the rooftop of a two-story building northeast of downtown Los Angeles, just southeast of Dodgers' Stadium and Los Angeles State Historic Park, which are prominent features in Figure 6-1. CELA is surrounded by major freeways, including I-5 and Route 110. Highway 101 is located farther south. 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 monitoring site.

Figure 6-2 shows that CELA is situated among numerous point sources. The source category with the greatest number of emissions sources near this monitoring site is the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Other source categories with a large number of emissions sources within 10 miles of CELA include institutions such as schools, hospitals, and/or prisons; auto body shops, painters, and automotive stores; printing, publishing, and paper product manufacturing; and electroplating, plating, polishing, anodizing, and coloring facilities. A high-density cluster of emissions sources is located just to the west and southwest of CELA. The sources closest to CELA are a mineral processing facility, a carpet plant, a facility involved in oil/gas production, and a heliport at a detention center.

RUCA is located just north of Riverside, in a residential area in the town of Rubidoux. RUCA is adjacent to a power substation next to a storage facility and apartment building near the intersection of Mission Boulevard and Riverview Drive. Residential areas surround RUCA, including three schools: a middle school north of Mission Boulevard, an elementary school south of Riverview Drive, and a high school to the west of Pacific Avenue, the football and baseball fields of which are prominent features in Figure 6-3. Highway 60 runs east-west to the north of the site. Flabob Airport is located approximately three-quarters of a mile to the southeast of the site. RUCA is located approximately 44 miles east of CELA.

Figure 6-4 shows that fewer emissions sources surround RUCA than CELA. Most of the emissions sources are located to the northeast and northwest of the site, in San Bernardino County. The point source located closest to RUCA is Flabob Airport. Although the emissions source categories are varied, the emissions source categories with the greatest number of sources within 10 miles of RUCA include airport operations; metals processing and fabrication; auto

body shops, painters, and automotive stores; animal feedlots or farms; and institutions such as schools, hospitals, and/or prisons.

SJJCA is located in central San Jose. Figure 6-5 shows that SJJCA is located in a commercial area surrounded by residential areas. A railroad is shown east of the monitoring site, running north-south in Figure 6-5. Guadalupe Parkway (Route 87) 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. The Guadalupe River runs along the eastern boundary of the airport and runs parallel to the Guadalupe Parkway, as does the Guadalupe River Park and Gardens, a park and trail system which can be seen on the bottom left of Figure 6-5. Figure 6-6 shows that the density of point sources is significantly higher near SJJCA than the other California monitoring sites. The emissions source categories with the greatest number of sources surrounding SJJCA are electrical equipment manufacturing; auto body, paint, and automotive shops; institutions such as schools, hospitals, and/or prisons; dry cleaning; and telecommunications. Sources closest to SJJCA include a food processing facility and several auto body shops.

In addition to providing city, county, CBSA, and land use/location setting information, Table 6-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. CELA experiences a higher traffic volume compared to the other California sites, although the traffic volumes near these sites are all greater than 100,000. Compared to other NMP sites, CELA has the second highest traffic volume, RUCA ranks fifth, and SJJCA ranks eighth highest. These traffic volumes for CELA, RUCA and SJJCA were obtained from heavily traveled highways.

6.2 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 the year.

6.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the California sites, site-specific data were available for some, but not all, of the parameters in Table 6-2. For CELA, data from the NWS weather station at Downtown L.A./USC Campus (WBAN 93134) were used for meteorological parameters without data and/or as surrogates for parameters without complete observation records. The Downtown L.A./USC Campus weather station is located 4.7 miles southwest of CELA. For RUCA, data from the NWS weather station at Riverside Municipal Airport (WBAN 03171) were used, where needed; the Riverside Municipal Airport weather station is located 3.5 miles south-southwest of RUCA. For SJJCA, data from the NWS weather station at San Jose International Airport (WBAN 23293) were used as needed; the weather station at the San Jose International Airport is located 1.8 miles west-northwest of SJJCA. A map showing the distance between each California monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 6-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 6-2 is the 95 percent confidence interval for each parameter. As shown in Table 6-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year at each site. The differences between the sample day and full-year averages were greatest for relative humidity, although the difference is not statistically significant.

Table 6-2. Average Meteorological Conditions near the California Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Los Angeles, California – CELA[2]							
Sample Days (63)	67.0 ± 0.5	51.4 ± 0.6	60.4 ± 1.1	29.95 ± 0.01	29.69 ± 0.01	NE	3.9 ± 0.1
2014	67.0 ± 0.2	51.1 ± 0.2	59.7 ± 0.4	29.96 ± <0.01	29.69 ± <0.01	NE	3.9 ± <0.1
Rubidoux, California – RUCA[3]							
Sample Days (63)	68.5 ± 0.6	45.1 ± 0.8	51.1 ± 1.3	29.93 ± 0.01	29.12 ± 0.01	W	3.2 ± 0.1
2014	68.2 ± 0.3	45.1 ± 0.3	51.3 ± 0.5	29.93 ± <0.01	29.12 ± <0.01	W	3.0 ± 0.1
San Jose, California – SJJCA[4]							
Sample Days (64)	61.0 ± 0.5	47.7 ± 0.5	66.0 ± 1.0	30.01 ± 0.01	29.96 ± 0.01	WNW	5.8 ± 0.2
2014	61.1 ± 0.2	48.3 ± 0.2	66.9 ± 0.4	30.01 ± <0.01	29.96 ± <0.01	WNW	5.6 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Wind parameters, relative humidity, temperature, and station pressure were measured at CELA for part of the year. The remaining portion was obtained from the closest NWS weather station located at Downtown L.A./USC Campus, WBAN 93134, and used as a surrogate. Data for the remaining parameters are from the NWS station.
[3]Dew point temperature and sea level pressure were not measured at RUCA. This information was obtained from the closest NWS weather station located at Riverside Municipal Airport, WBAN 03171.
[4]Pressure was not measured at SJJCA. This information was obtained from the NWS weather station located at San Jose International Airport, WBAN 23293. Wind parameters and temperature were measured year-round at SJJCA. Dew point and relative humidity measurements were also collected at SJJCA, but were less complete; thus, the remaining portion was obtained from the NWS weather station and used as a surrogate.

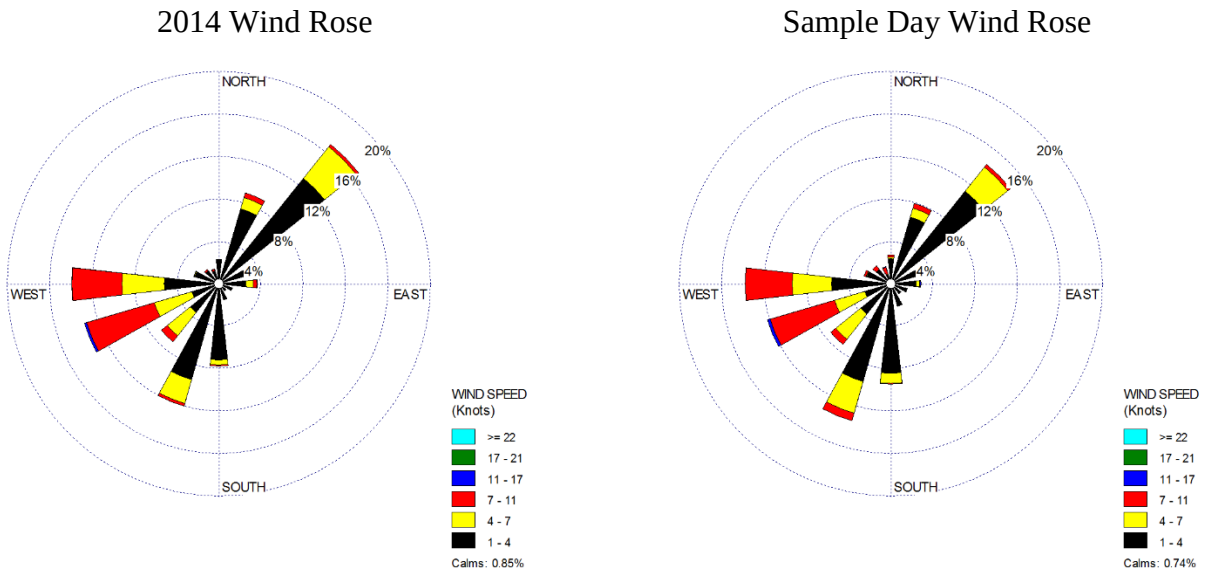
As expected, conditions in 2014 were cooler near SJJCA than near the two sites located farther south. For the two southern California sites, average temperatures tended to be slightly higher for RUCA, which is farther inland than CELA. Wind speeds tended to be higher at SJJCA than the other two sites.

6.2.2 Wind Rose Comparison

Hourly surface wind data were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 6-7 presents two wind roses for the CELA monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose

representing wind observations for days on which samples were collected in 2014. These can be used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 6-8 and 6-9 present the full-year and sample day wind roses for RUCA and SJJCA. The wind roses for the NATTS sites in California represent wind observations collected at each site, as available in AQS.

Figure 6-7. Wind Roses for the Wind Data Collected at CELA



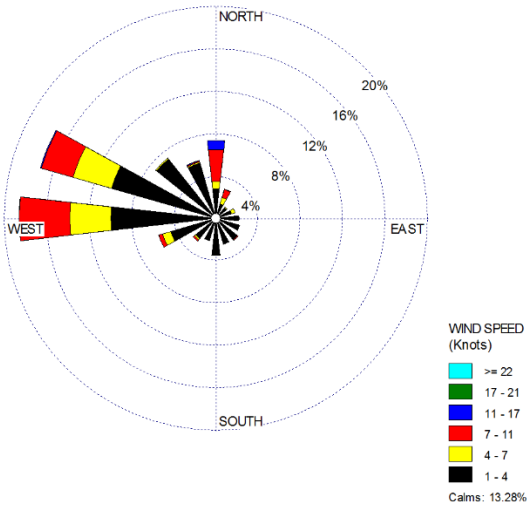
Observations from Figure 6-7 for CELA include the following:

- The 2014 wind rose shows that northeasterly winds were observed the most over the course of the year. However, winds from the south-southwest, west-southwest, and west were also observed frequently. Calm winds were infrequently observed as were wind speeds greater than 11 knots. Higher wind speeds were most often observed with a west-southwesterly wind direction.

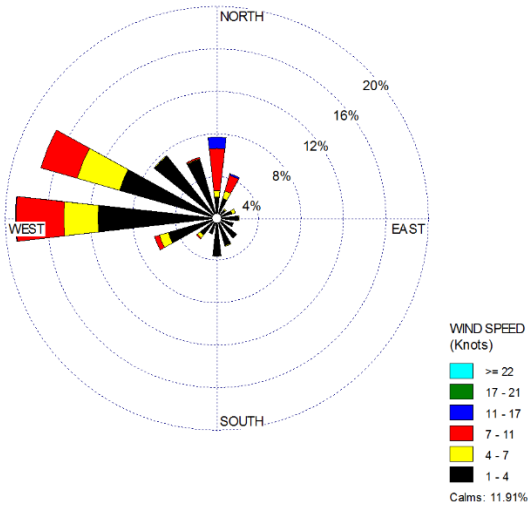
- The sample day wind rose resembles the full-year wind rose, exhibiting similar wind speed and direction patterns, indicating that wind conditions on sample days were representative of those observed throughout the year near CELA.

Figure 6-8. Wind Roses for the Wind Data Collected at RUCA

2014 Wind Rose



Sample Day Wind Rose



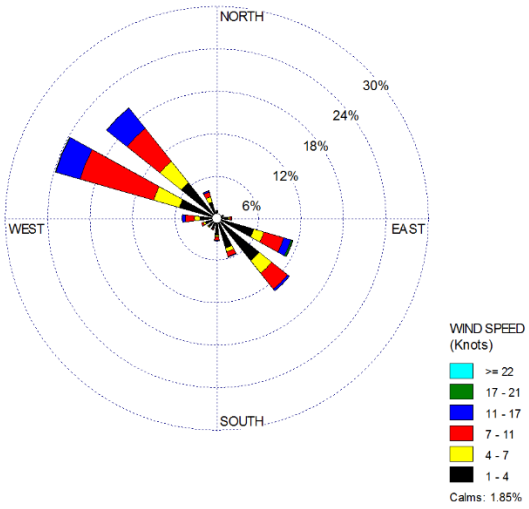
Observations from Figure 6-8 for RUCA include the following:

- The 2014 wind rose shows that westerly and west-northwesterly winds were observed the most at RUCA over the course of the year. Winds from the west to northwest to north account for the majority of the wind observations near RUCA while winds from the northeast, southeast, and southwest quadrants were infrequently observed. Calm winds accounted for 13 percent of the observations while wind speeds greater than 11 knots accounted for few observations. Higher wind speeds were most often observed with a northerly wind direction.

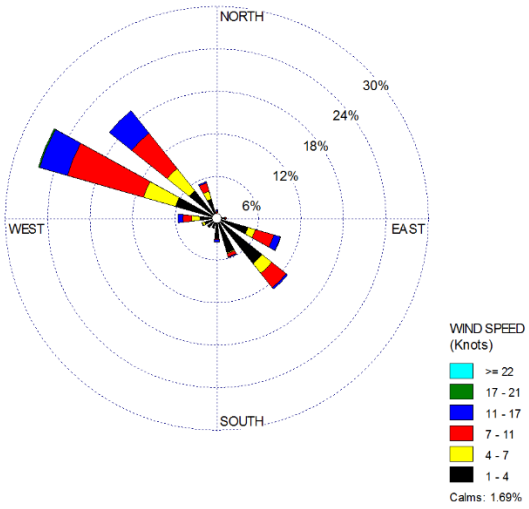
- The sample day wind rose resembles the full-year wind rose, exhibiting similar wind speed and direction patterns, indicating that winds on sample days were representative of those observed throughout the year near RUCA.

Figure 6-9. Wind Roses for the Wind Data Collected at SJJCA

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 6-9 for SJJCA include the following:

- Winds from the west-northwest and northwest account for more than 40 percent of wind observations near SJJCA. Winds from the east-southeast and southeast make up one quarter of wind observations. Winds from the northeast and southwest quadrants were rarely observed. Calm winds account for less than 2 percent of the observations.

- The wind patterns shown on the sample day wind rose resemble the wind patterns shown on the full-year wind rose, indicating that conditions on sample days were representative of those experienced over the entire year.

6.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each California monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 6-3. 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 and are shaded in gray in Table 6-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at all three California sites; in addition, metals (PM_{10}) were also sampled for at SJJCA.

Table 6-3. Risk-Based 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	55	56	98.21	98.21	98.21
Benzo(a)pyrene	0.00057	1	41	2.44	1.79	100.00
Total		56	97	57.73		
Rubidoux, California - RUCA						
Naphthalene	0.029	50	59	84.75	100.00	100.00
Total		50	59	84.75		
San Jose, California - SJJCA						
Arsenic (PM_{10})	0.00023	48	57	84.21	47.06	47.06
Naphthalene	0.029	42	59	71.19	41.18	88.24
Nickel (PM_{10})	0.0021	6	61	9.84	5.88	94.12
Benzo(a)pyrene	0.00057	4	25	16.00	3.92	98.04
Acenaphthene	0.011	1	58	1.72	0.98	99.02
Fluorene	0.011	1	45	2.22	0.98	100.00
Total		102	305	33.44		

Observations from Table 6-3 include the following:

- Concentrations of naphthalene failed the majority of screens for CELA, accounting for 55 of the 56 failed screens for this site, while benzo(a)pyrene concentrations failed a single screen. Thus, naphthalene is the only pollutant identified as a pollutant of interest for CELA.

- Naphthalene was the only PAH to fail screens for RUCA; thus, naphthalene is the only pollutant of interest for this site. Naphthalene was detected in all 59 valid PAH samples collected at RUCA and failed screens for 50 of these, representing an 85 percent failure rate.

- SJJCA is the only site that sampled metals (PM_{10}) in addition to PAHs. For SJJCA, concentrations of arsenic account for the majority of failed screens for the site (48), although naphthalene concentrations also contributed to a large number of the total failed screens (42). Together, these two pollutants account for 88 percent of SJJCA's total failed screens. Nickel accounts for another 6 percent of the total failed screens for this site and benzo(a)pyrene accounts for another 4 percent. These four pollutants contributed to more than 95 percent of failed screens for SJJCA and were therefore identified as pollutants of interest for this site. Acenaphthene and fluorene also failed a single screen each for SJCCA but were not identified as pollutants of interest.

6.4 Concentrations

This section presents various concentration averages used to characterize air toxics pollution levels at the California monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the California monitoring sites are provided in Appendices M and N.

6.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each California site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be

calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the California monitoring sites are presented in Table 6-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 6-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the California Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	Total # of Samples	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							
Naphthalene	56/56	56	142.32 ± 43.53	NA	64.55 ± 11.78	78.08 ± 15.58	88.54 ± 13.86
Rubidoux, California - RUCA							
Naphthalene	59/59	59	120.46 ± 47.44	61.57 ± 27.32	45.56 ± 10.36	72.74 ± 13.41	75.23 ± 15.07
San Jose, California - SJJCA							
Arsenic (PM_{10})	57/52	61	0.53 ± 0.18	0.23 ± 0.10	0.49 ± 0.17	0.51 ± 0.11	0.44 ± 0.07
Benzo(a)pyrene	25/20	59	0.16 ± 0.13	0.20 ± 0.30	<0.01 ± 0.01	0.08 ± 0.07	0.11 ± 0.07
Naphthalene	59/59	59	93.33 ± 48.41	38.59 ± 10.34	31.03 ± 7.72	72.96 ± 20.62	59.91 ± 14.59
Nickel (PM_{10})	61/60	61	1.24 ± 0.57	2.24 ± 1.16	1.18 ± 0.17	1.02 ± 0.36	1.42 ± 0.34

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

Observations for the California monitoring sites from Table 6-4 include the following:

- Naphthalene was identified as a pollutant of interest for all three sites. The annual average concentration of naphthalene is highest for CELA and lowest for SJJCA.

- For each site, naphthalene concentrations appear highest during the first quarter of 2014, based on the quarterly averages, and lowest during the third quarter. However, the confidence intervals calculated for each of the first quarter averages are relatively large, indicating that there is considerable variability in the measurements.

- Note that CELA does not have a second quarter average concentration for naphthalene shown in Table 6-4. This is a result of the invalidation of several PAH

samples in April and early May resulting from laboratory equipment issues, as discussed in Section 4.2.2. While this issue affected all sites that sampled naphthalene, some sites had enough valid samples for the second quarter to still meet the minimum criteria for calculating a quarterly average concentration while others did not. The number of samples affected varies from three samples (RUCA and SJJCA) to four samples (CELA).

- Naphthalene concentrations measured at CELA range from 18.1 ng/m^3 to 254 ng/m^3 with a median concentration of 73.40 ng/m^3. All six of CELA's naphthalene concentrations greater than 150 ng/m^3 were measured in either January or February. However, three of the concentrations measured in March are among the lowest 10 concentrations measured at CELA. This helps explain the large confidence interval shown for CELA's first quarter naphthalene concentration.

- Naphthalene concentrations measured at RUCA range from 16.3 ng/m^3 to 281 ng/m^3 with a median concentration of 64.10 ng/m^3. The maximum naphthalene concentration measured at RUCA is the eighth highest concentration of naphthalene among NMP sites sampling this pollutant. All five of RUCA's naphthalene concentrations greater than 150 ng/m^3 were measured in either January or February. However, the minimum concentration was also collected during the first quarter (March) as was the third-lowest concentration measured at RUCA. This helps explain the large confidence interval shown for RUCA's first quarter average naphthalene concentration. Of the 25 naphthalene concentrations less than 50 ng/m^3 measured at RUCA, the third quarter has the most (10) and the fourth quarter has the fewest (3). Only three concentrations greater than the median naphthalene concentration were measured during the third quarter at RUCA.

- Naphthalene concentrations measured at SJJCA range from 14.7 ng/m^3 to 279 ng/m^3; the maximum naphthalene concentration measured at SJJCA is the 10th highest concentration of naphthalene among NMP sites sampling this pollutant. Yet, the median naphthalene concentration of 38.40 ng/m^3 is roughly half the median concentration of the other two sites. Four of the five naphthalene concentrations greater than 150 ng/m^3 were measured at SJJCA in January 2014. These four were measured on the first four sample days of 2014, after which another naphthalene concentration greater than 100 ng/m^3 was not measured again until October. This is reflected in SJJCA's quarterly average concentrations.

- Benzo(a)pyrene is also a pollutant of interest for SJJCA. The quarterly average concentrations exhibit considerably variability, both in the magnitude of the averages as well as the confidence intervals shown. Of the 59 valid concentrations measured at SJJCA, 34 of them were non-detects. The number of non-detects measured during each quarter varies from five (fourth quarter) to 14 (third quarter), with only one measured detection for the third quarter of 2014, explaining why the third quarter average concentration is so low compared to the other quarterly averages. The measured detections of benzo(a)pyrene measured at SJJCA range from 0.021 ng/m^3 to 1.76 ng/m^3, which is the third highest measurement across NMP sites sampling this pollutant. Both the minimum and maximum measured detections of benzo(a)pyrene were measured during the second quarter of 2014, along with nine non-detects,

explaining the relatively large confidence interval calculated for the second quarter average concentration.

- Arsenic and nickel are also pollutants of interest for SJJCA. There were four non-detects of arsenic measured at SJJCA, with the remaining concentrations ranging from 0.08 ng/m^3 to 1.47 ng/m^3. All four non-detects were measured during the second quarter of 2014. In addition, six of the 10 arsenic concentrations less than 0.25 ng/m^3 were measured during the second quarter, including the minimum concentration (although a measurement of the same magnitude was also measured at the end of February). This explains the relatively low average shown for the second quarter compared to the other quarterly average concentrations of this pollutant.

- Concentrations of nickel measured at SJJCA range from 0.17 ng/m^3 to 9.73 ng/m^3, which is the maximum nickel concentration measured across NMP sites sampling this pollutant. The median nickel concentration for SJJCA is 1.19 ng/m^3. A review of the quarterly average concentrations shows that the second quarter average is considerably higher than the others and has a relatively high confidence interval associated with it. Six of the 10 highest nickel concentrations measured at SJJCA were measured during the second quarter, including the maximum concentration. Also, of the 24 nickel concentrations less than 1 ng/m^3 measured at SJJCA, only one was measured during the second quarter of 2014.

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

- CELA and RUCA both appear in Table 4-11 for naphthalene, ranking fifth and eighth, respectively.

- SJJCA appears twice in Table 4-12 for PM_{10} metals. SJJCA has the fifth highest annual average concentration of nickel and tenth highest annual average concentration of arsenic among NMP sites sampling PM_{10} metals.

6.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 6-4 for CELA, RUCA, and SJJCA. Figures 6-10 through 6-13 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 6-10. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

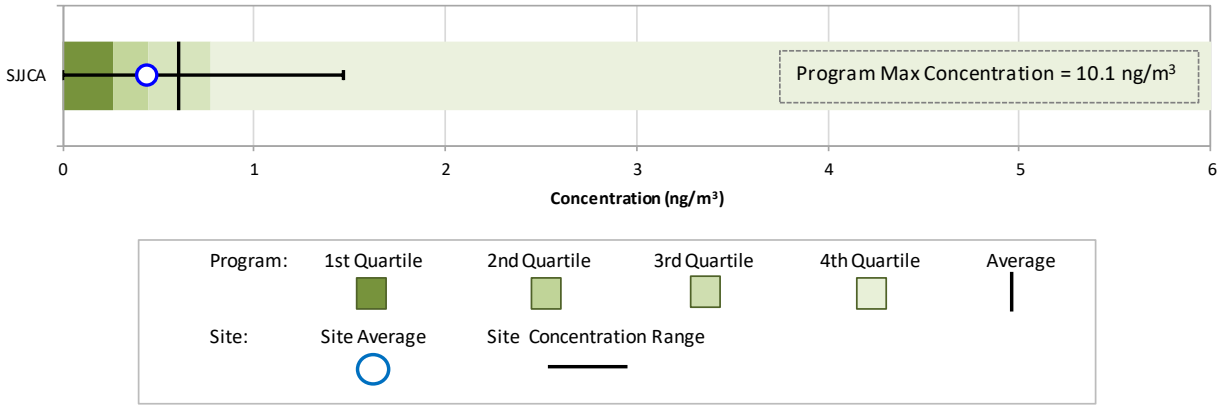


Figure 6-10 presents the box plot for arsenic (PM_{10}) for SJJCA and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 6-10 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The maximum arsenic concentration measured at SJJCA is an order of magnitude less than the maximum concentration measured across the program.

- The annual average arsenic concentration for SJJCA is less than the program-level average concentration and similar to the program-level median concentration of arsenic.

- The minimum concentration measured at SJJCA is zero, indicating that at least one non-detect of arsenic was measured at SJJCA. Four non-detects of arsenic were measured at SJJCA.

Figure 6-11. Program vs. Site-Specific Average Benzo(a)pyrene Concentration

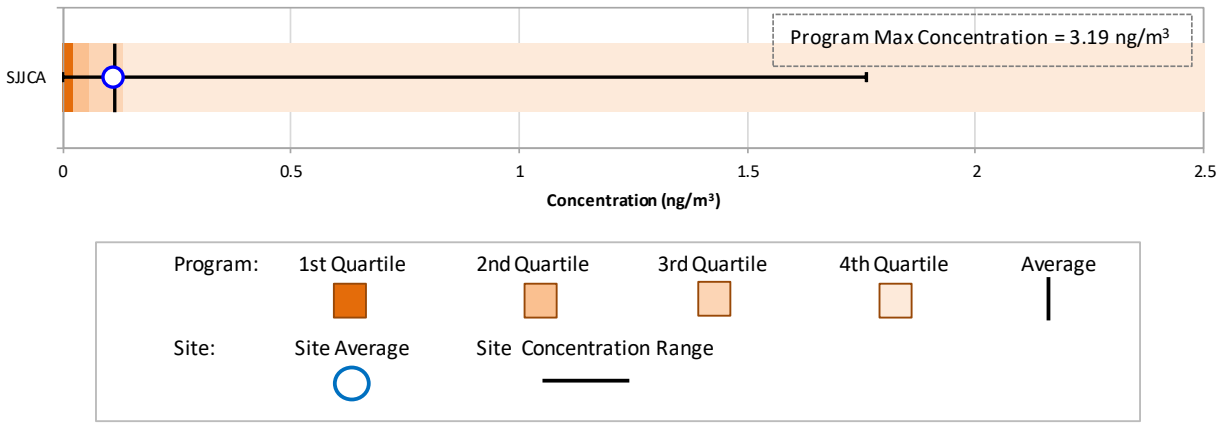


Figure 6-11 presents the box plot for benzo(a)pyrene for SJJCA and shows the following:

- Similar to arsenic, the scale of the box plot in Figure 6-11 has also been reduced to allow for the observation of data points at the lower end of the concentration range.

- While the maximum benzo(a)pyrene concentration measured at SJJCA is roughly half the maximum concentration measured across the program, it is the third highest measurement of this pollutant across the program.

- The annual average benzo(a)pyrene concentration for SJJCA is similar to the program-level average concentration. Note that the majority of the benzo(a)pyrene concentrations measured across the program, as indicated by the first, second (median), and third quartiles, fall into a relatively small range of measurements (less than or equal to 0.133 ng/m^3). SJJCA is one of only two NMP sites for which benzo(a)pyrene is a pollutant of interest (BXNY is the other).

- The minimum concentration measured at SJJCA is zero, indicating that at least one non-detect was measured at SJJCA; 34 non-detects of benzo(a)pyrene were measured at SJJCA.

Figure 6-12. Program vs. Site-Specific Average Naphthalene Concentrations

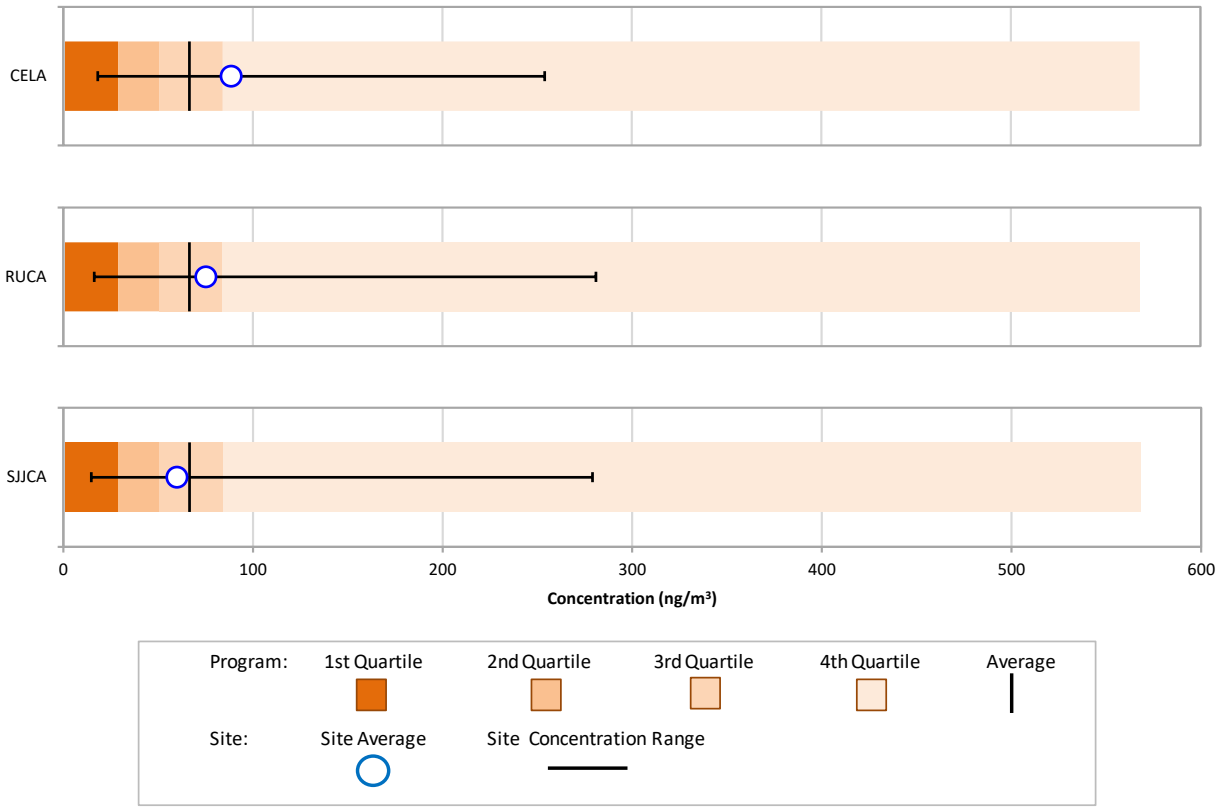


Figure 6-12 presents the box plots for naphthalene for all three sites and shows the following:

- The range of naphthalene measurements is similar across the California monitoring sites.

- The annual average concentration is highest for CELA, followed by RUCA and then SJJCA. The annual average naphthalene concentration for CELA is greater than the program-level average concentration and just greater than the program-level third quartile. RUCA's annual average is greater than the program-level average concentration while SJJCA's annual average is less than the program-level average concentration.

- There were no non-detects of naphthalene measured at CELA, RUCA, SJJCA, or across the program.

Figure 6-13. Program vs. Site-Specific Average Nickel (PM_{10}) Concentration

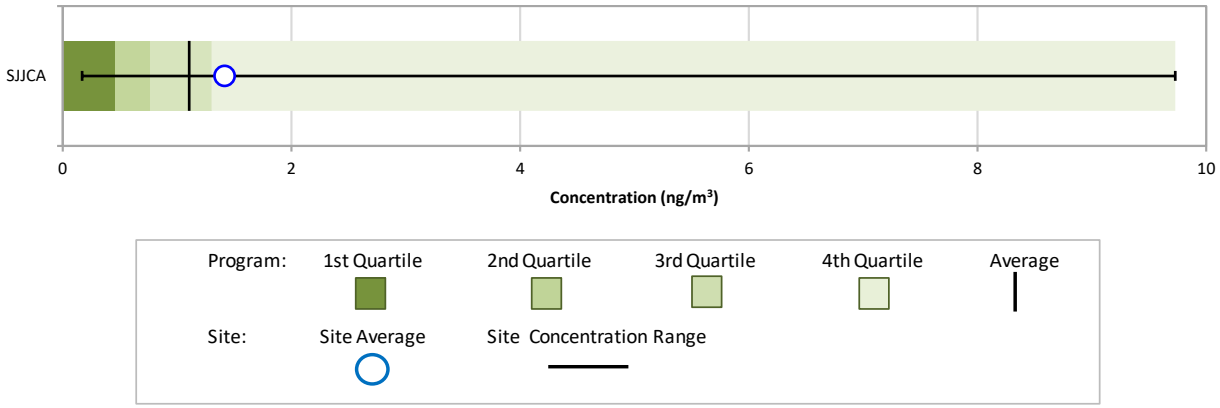


Figure 6-13 presents the box plot for nickel for SJJCA and shows the following:

- The maximum nickel concentration measured across the program was measured at SJJCA.

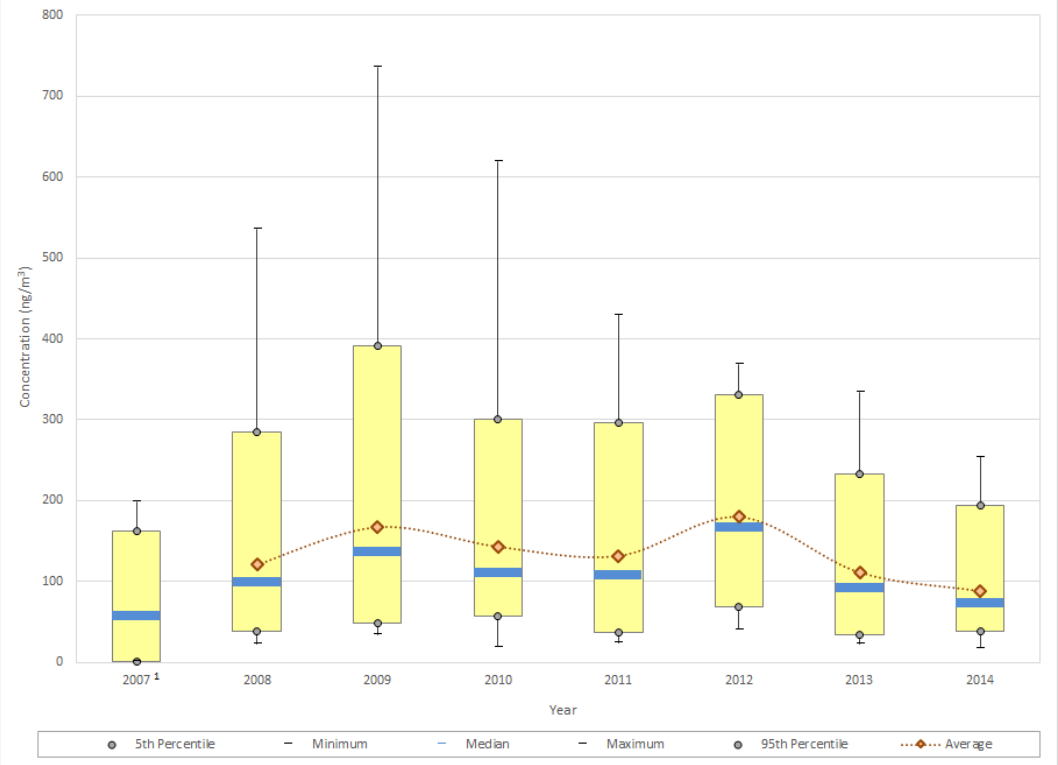
- SJJCA's annual average nickel concentration is greater than the program-level average concentration and just greater than the program-level third quartile. Recall from the previous section that SJJCA has the fifth highest annual average concentration of nickel among NMP sites sampling PM_{10} metals.

- There were no non-detects of nickel measured at SJJCA.

6.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. Both CELA and RUCA began sampling PAHs under the NMP in 2007. SJJCA began sampling PAHs and metals under the NMP in 2008. Thus, Figures 6-14 through 6-20 present the 1-year statistical metrics for each of the pollutants of interest first for CELA, then for RUCA, and finally for SJJCA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 6-14. Yearly Statistical Metrics for Naphthalene Concentrations Measured at CELA



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2007.

Observations from Figure 6-14 for naphthalene concentrations measured at CELA include the following:

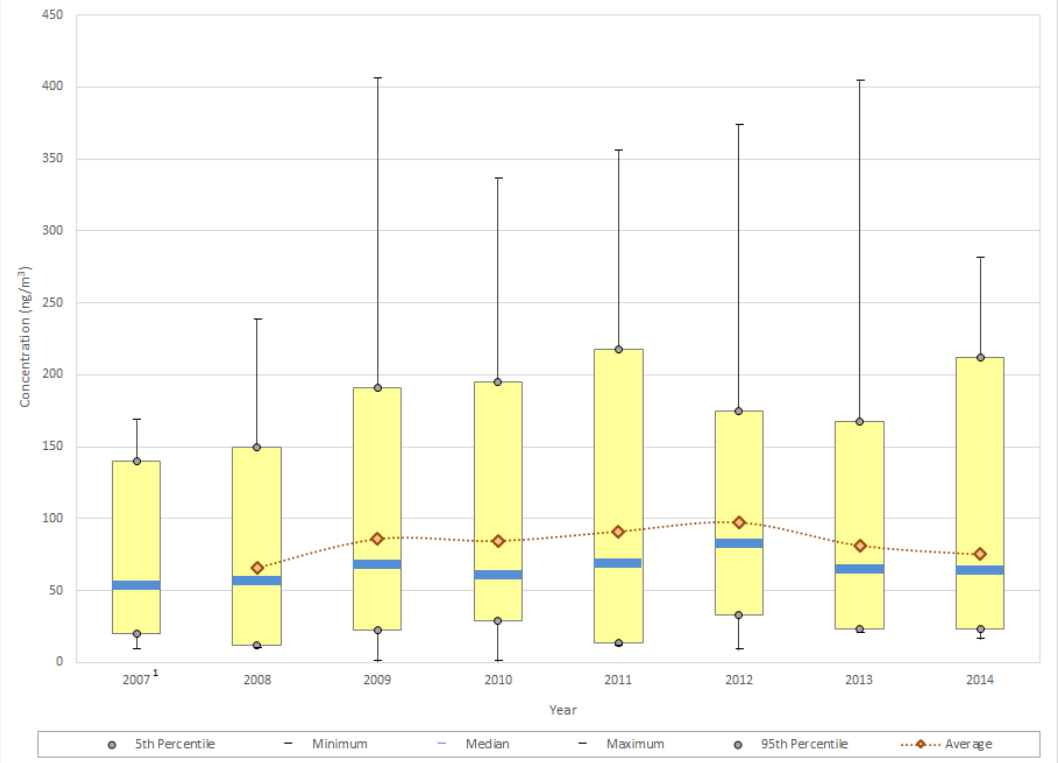
- CELA began sampling PAHs under the NMP in April 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided.

- The smallest range of concentrations was measured in 2007, although the statistical metrics do not represent a full year of sampling. The minimum concentration measured at CELA was measured in 2007 (1.30 ng/m^3); in addition, 2007 is the only year in which a concentration less than 15 ng/m^3 was measured (there were five in total). The range of naphthalene measurements increased considerably in 2008 and again in 2009, when the maximum naphthalene concentration was measured (736 ng/m^3 on October 16, 2009). Concentrations greater than 500 ng/m^3 were also measured in 2008 and 2010. The maximum, 95th percentile, 1-year average, and median concentrations decrease from 2009 to 2010 and again for 2011.

- All of the statistical parameters shown in Figure 6-14 exhibit an increase from 2011 to 2012 except the maximum concentration. The increase in the 1-year average concentration from 2011 to 2012 is significant, even though the range of concentrations measured in 2012 is the smallest since the initial year of sampling. The number of naphthalene concentrations greater than 200 ng/m^3 increased from nine in 2011 to 24 for 2012, which is the most for any year of sampling at CELA.

- Each of the statistical metrics exhibits a decrease from 2012 to 2013 and, with the exception of the 5th percentile, are at a minimum for 2014 since the first full year of sampling. 2014 is the first year that the 1-year average concentration is less than 100 ng/m^3.

Figure 6-15. Yearly Statistical Metrics for Naphthalene Concentrations Measured at RUCA



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2007.

Observations from Figure 6-15 for naphthalene concentrations measured at RUCA include the following:

- RUCA began sampling PAHs under the NMP in May 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided.

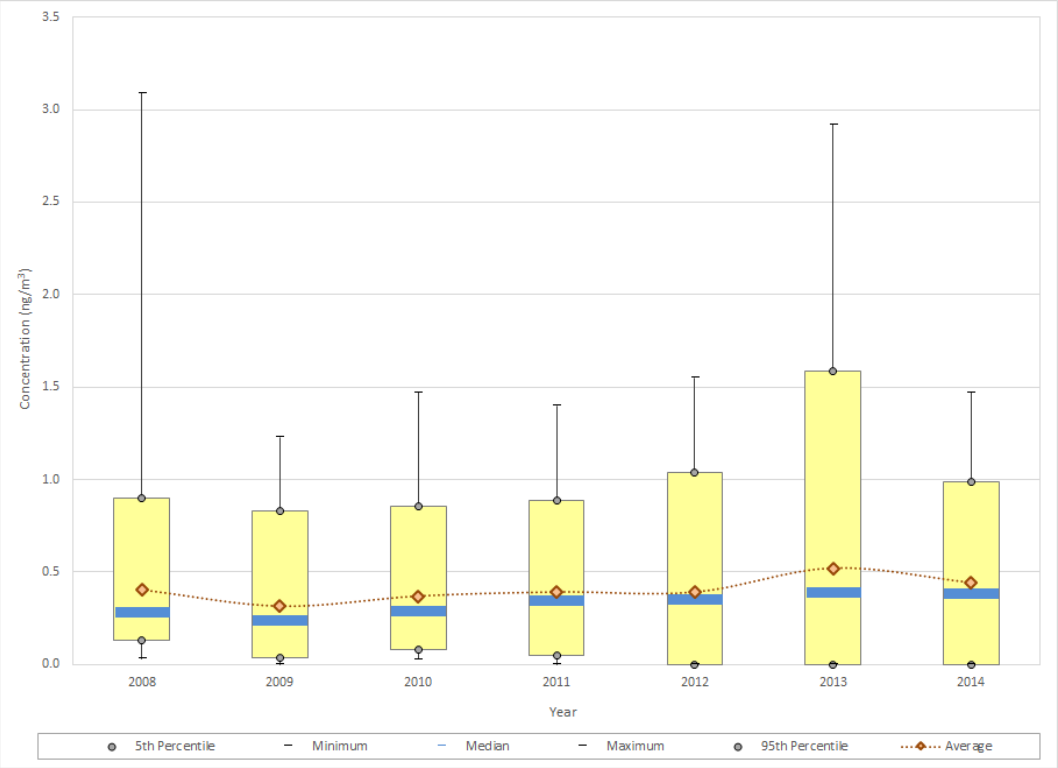
- The smallest range of measurements was collected in 2007, similar to the observation made for CELA, although the statistical metrics do not represent a full year of sampling.

- The maximum naphthalene concentration was measured at RUCA in 2009 (406 ng/m^3), although another concentration of similar magnitude was also measured at RUCA in 2013. Naphthalene concentrations greater than 300 ng/m^3 have been measured at least once every year since 2009 until 2014.

- The 1-year average concentration has an increasing trend through 2012, although 2010 was down slightly. The median concentration has a similar pattern. After 2012, these parameters decrease somewhat. The 1-year average concentration for 2014 is the lowest it has been since 2008.

- The range of concentrations measured at RUCA reflects a relatively high level of variability in the concentrations measured. For 2009, 2012, and 2013, the maximum concentration is twice the 95th percentile. For these years, more than 100 ng/m^3 separates the maximum concentration and the next highest concentration measured.

Figure 6-16. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at SJJCA



Observations from Figure 6-16 for arsenic concentrations measured at SJJCA include the following:

- The maximum concentration of arsenic (3.09 n/gm^3) was measured on the first day of sampling at SJJCA (January 1, 2008). The only other arsenic concentration greater than 2 ng/m^3 was measured in 2013. All but one of the seven arsenic concentrations greater than 1.5 ng/m^3 were measured in 2008 (two) or 2013 (four).

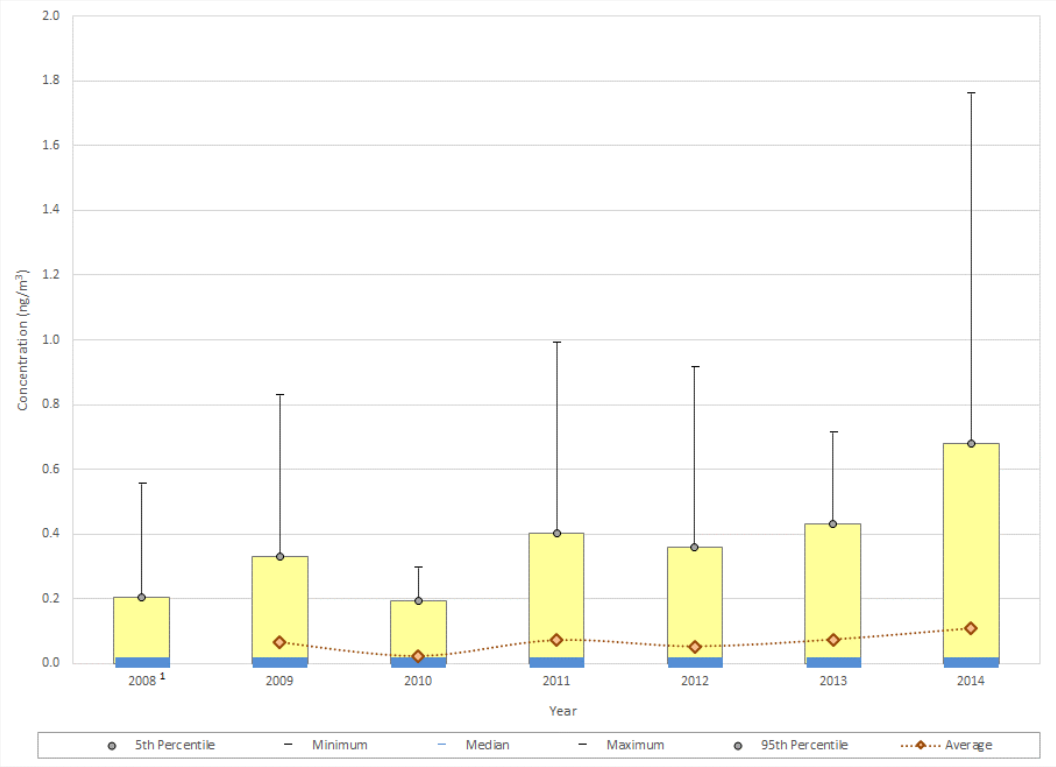
- The 1-year average arsenic concentration decreased from 2008 to 2009. Although this is due in part to the maximum concentration measured in 2008, all of the statistical parameters exhibit a decrease from 2008 to 2009, indicating that the decrease is not only due to the difference in the maximum concentrations. The number of concentrations at the lower end of the concentration range increased for 2009. In 2009, two non-detects were measured at SJJCA, compared to none in 2008. In addition, seven arsenic concentrations less than 0.1 ng/m^3 were measured in 2009 compared to only two in 2008.

- Between 2010 and 2012, the range of concentrations measured changed little and the 1-year average arsenic concentration varied between 0.37 ng/m^3 for 2010 to 0.39 ng/m^3 for 2011 and 2012. With the exception of the minimum and 5th percentile (which did not change), all of the statistical metrics exhibit an increase for 2013, with the 1-year average concentration increasing to 0.52 ng/m^3. Along with the second and third highest concentration measured since the onset of sampling, the number of arsenic concentrations greater than 0.75 ng/m^3 measured at SJJCA increased to 16 for

2013, the most for any year of sampling (none of the previous years had more than six).

- For 2014, the range of arsenic concentrations measured returned to previous levels, with a 1-year average concentration that falls between 2012 and 2013 levels (0.44 ng/m^3).

Figure 6-17. Yearly Statistical Metrics for Benzo(a)pyrene Concentrations Measured at SJJCA



Observations from Figure 6-17 for benzo(a)pyrene concentrations measured at SJJCA include the following:

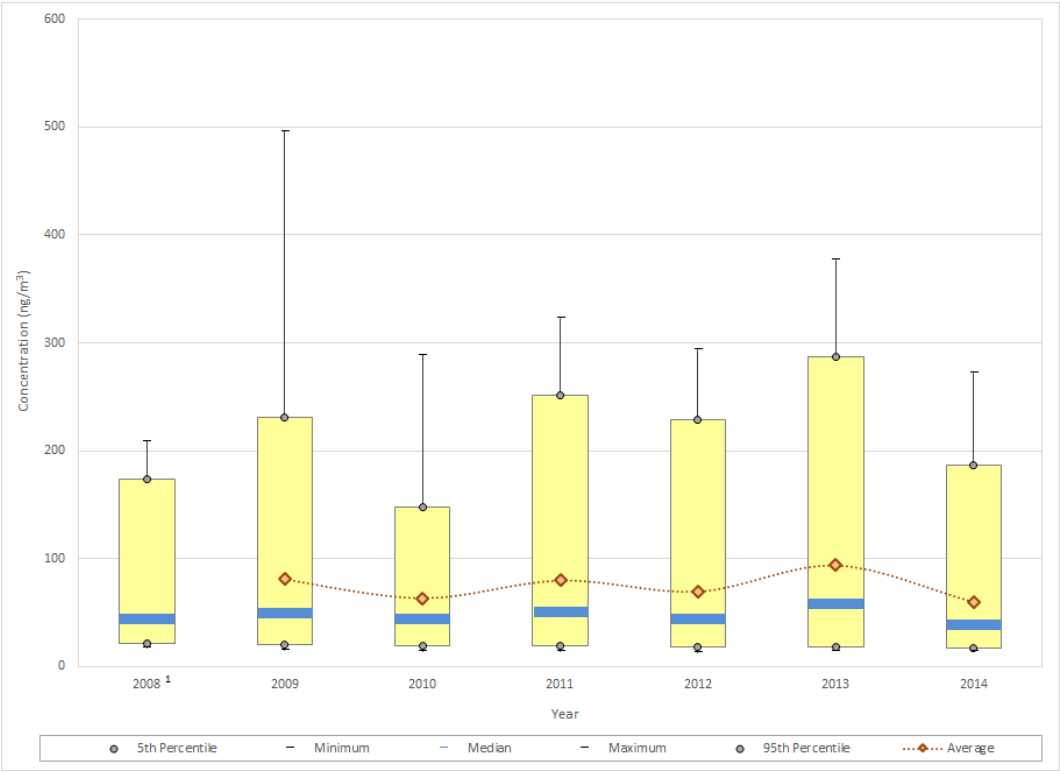
- SJJCA began sampling PAHs under the NMP in May 2008. Because a full year's worth of data is not available, a 1-year average concentration for 2008 is not presented, although the range of measurements is provided.

- The median benzo(a)pyrene concentration is zero for all years of PAH sampling at SJJCA, indicating that at least half of the measurements were non-detects. The percentage of non-detects has ranged from 58 percent (2013 and 2014) to 83 percent (2010).

- The maximum benzo(a)pyrene concentration measured in 2014 (1.76 ng/m^3) is the maximum concentration measured since the onset of sampling at SJJCA. No other concentration greater than 1 ng/m^3 has been measured at this site, although one has come close. 2014 has the highest number of concentrations greater than 0.5 ng/m^3

(five) compared to previous years, with three in 2011 and one each in all other years except 2010, when none were measured.

Figure 6-18. Yearly Statistical Metrics for Naphthalene Concentrations Measured at SJJCA



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2008.

Observations from Figure 6-18 for naphthalene concentrations measured at SJJCA include the following:

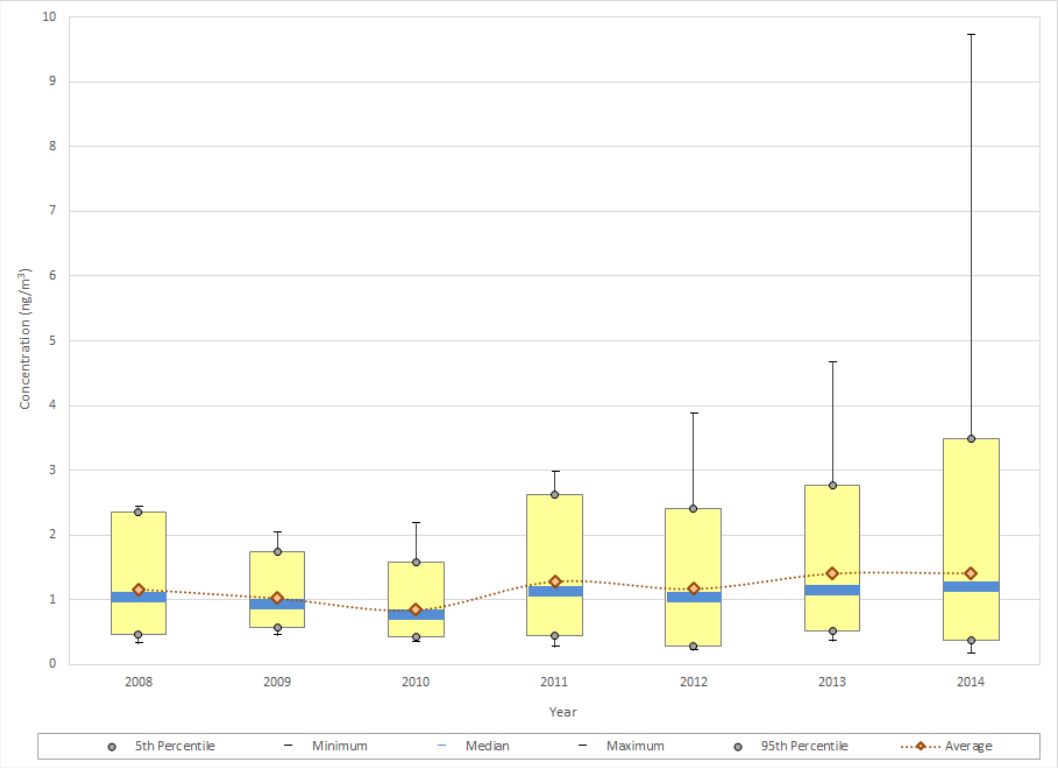
- The maximum concentration of naphthalene was measured at SJJCA in 2009 (496 ng/m^3). No additional naphthalene concentrations greater than 400 ng/m^3 have been measured at SJJCA.

- There is very little change among the minimum concentrations and 5th percentiles across the years of sampling while there are considerable fluctuations in the statistical parameters representing the upper end of the concentration range.

- The median concentration has changed little over the years through 2012, ranging from 43.00 ng/m^3 (2010) to 49.90 ng/m^3 (2011); 2013 is the first year with a median concentration greater than 50 ng/m^3 (57.70 ng/m^3). The 1-year average concentration exhibits more variability, having an undulating pattern from year-to-year, ranging from 63.44 ng/m^3 (2010) to 81.04 ng/m^3 (2009) through 2012, then increasing to 94.13 ng/m^3 for 2013.

- Both the 1-year average and median concentrations are at a minimum for 2014.

Figure 6-19. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at SJJCA



Observations from Figure 6-19 for nickel concentrations measured at SJJCA include the following:

- The maximum concentration of nickel was measured at SJJCA on April 17, 2014 (9.73 ng/m^3) and is more than twice the next highest nickel concentration measured at this site (4.66 ng/m^3 measured in 2013). The maximum concentration of nickel has a steady increasing trend between 2009 and 2014.

- Both the 1-year average and median concentrations have a decreasing trend between 2008 and 2010, when both statistical parameters are at a minimum for the period of sampling. This is followed by a significant increase for 2011. The concentrations measured in 2011 were higher than the preceding year as the number of nickel concentrations greater than 1 ng/m^3 more than doubled, accounting for more than half of the measurements in 2011 (compared to a quarter of the measurements in 2010).

- The changes in the 1-year average and median concentrations have been more subtle in more recent years. After a slight decrease for 2012, both central tendency parameters increased for 2013. Despite the continued increase in the maximum concentration and 95th percentile, little change is shown for 2014.

6.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each California monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

6.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the California monitoring sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 6-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for the California sites from Table 6-5 include the following:

- Naphthalene has the highest (or only) annual average concentration for each of the California monitoring sites among the site-specific pollutants of interest, as discussed in the previous section. The annual average concentration for CELA is the highest of the three annual averages for naphthalene, followed by the annual average for RUCA and then SJJCA.

- Naphthalene also has the highest cancer risk approximation among the site-specific pollutants of interest for the California monitoring sites. The cancer risk approximations for naphthalene range from 2.04 in-a-million for SJJCA to 3.01 in-a-million for CELA.

- SJJCA is the only site with pollutants of interest other than naphthalene. Among the remaining pollutants, arsenic is the only other pollutant of interest for SJJCA with a cancer risk approximation greater than 1 in-a-million (1.89 in-a-million).

- All of the noncancer hazard approximations for the pollutants of interest for the California monitoring sites are less than 1.0, where noncancer RfCs are available, indicating that no adverse noncancer health effects are expected from these individual pollutants.

Table 6-5. Risk Approximations for the California Monitoring Sites

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Los Angeles, California - CELA						
Naphthalene	0.000034	0.003	56/56	88.54 ± 13.86	3.01	0.03
Rubidoux, California - RUCA						
Naphthalene	0.000034	0.003	59/59	75.23 ± 15.07	2.56	0.03
San Jose, California - SJJCA						
Arsenic (PM_{10})	0.0043	0.000015	57/61	0.44 ± 0.07	1.89	0.03
Benzo(a)pyrene	0.00176	--	25/59	0.11 ± 0.07	0.19	--
Naphthalene	0.000034	0.003	59/59	59.91 ± 14.59	2.04	0.02
Nickel (PM_{10})	0.00048	0.00009	61/61	1.42 ± 0.34	0.68	0.02

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

6.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 6-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 6-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 6-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 6-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 6-6. Table 6-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and

noncancer hazard approximations provided in Section 6.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 6-6 include the following:

- Formaldehyde and benzene are the highest emitted pollutants with cancer UREs in Los Angeles and Riverside Counties while benzene is emitted in slightly higher quantities than formaldehyde in Santa Clara County. The quantity of emissions is considerably greater for Los Angeles County than Riverside and Santa Clara Counties.

- Formaldehyde has the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for all three counties. POM, Group 1a, benzene, and 1,3-butadiene rank behind formaldehyde for Los Angeles County; benzene, hexavalent chromium, and POM, Group 1a rank behind formaldehyde for Riverside County; and benzene, POM, Group 2b, and hexavalent chromium rank behind formaldehyde for Santa Clara County.

- Six of the highest emitted pollutants also have the highest toxicity-weighted emissions for Los Angeles County, while there are five in common for Riverside and Santa Clara Counties.

- Naphthalene has the highest (or only) cancer risk approximation for all three California sites. Naphthalene appears on both emissions-based lists for all three counties.

- Arsenic and nickel do not appear on either emissions-based list for Santa Clara County (they rank lower than tenth). Hexavalent chromium is the only metal shown for Santa Clara County, ranking fourth highest for its toxicity-weighted emissions.

- Several POM Groups appear among the pollutants with the highest toxicity-weighted emissions for each county. POM, Group 2b includes acenaphthene and fluorene, both of which failed screens for SJJCA but were not identified as pollutants of interest. POM, Group 5a includes benzo(a)pyrene, which failed one screen for CELA and was identified as a pollutant of interest for SJJCA. POM, Group 5a ranks fifth for its toxicity-weighted emissions but is not among the highest emitted in Santa Clara County. POM, Group 1a, which appears among each county's toxicity-weighted emissions, includes unspeciated compounds.

Table 6-6. 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 UREs (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)**
Los Angeles, California (Los Angeles County) - CELA					
Formaldehyde	2,221.45	Formaldehyde	2.89E-02	Naphthalene	3.01
Benzene	1,913.13	POM, Group 1a	1.49E-02		
Dichloromethane	1,682.67	Benzene	1.49E-02		
Ethylbenzene	1,101.33	1,3-Butadiene	9.87E-03		
Tetrachloroethylene	1,076.88	POM, Group 2b	7.27E-03		
Acetaldehyde	962.00	POM, Group 5a	6.02E-03		
p-Dichlorobenzene	339.36	POM, Group 2d	5.84E-03		
1,3-Butadiene	328.83	Naphthalene	5.27E-03		
POM, Group 1a	169.60	*p*-Dichlorobenzene	3.73E-03		
Naphthalene	154.91	Hexavalent Chromium	3.03E-03		
Rubidoux, California (Riverside County) - RUCA					
Formaldehyde	418.81	Formaldehyde	5.44E-03	Naphthalene	2.56
Benzene	317.30	Benzene	2.47E-03		
Tetrachloroethylene	214.39	Hexavalent Chromium	2.04E-03		
Dichloromethane	200.68	POM, Group 1a	1.88E-03		
Acetaldehyde	197.01	1,3-Butadiene	1.47E-03		
Ethylbenzene	191.03	POM, Group 2b	1.45E-03		
p-Dichlorobenzene	70.48	POM, Group 5a	1.20E-03		
1,3-Butadiene	48.84	Naphthalene	1.19E-03		
Naphthalene	34.99	POM, Group 2d	1.09E-03		
1,3-Dichloropropene	29.57	*p*-Dichlorobenzene	7.75E-04		

Table 6-6. 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 UREs (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)**
San Jose, California (Santa Clara County) - SJJCA					
Benzene	356.17	Formaldehyde	4.46E-03	Naphthalene	2.04
Formaldehyde	342.81	Benzene	2.78E-03	Arsenic	1.89
Ethylbenzene	232.74	POM, Group 2b	1.73E-03	Nickel	0.68
Dichloromethane	191.47	Hexavalent Chromium	1.67E-03	Benzo(a)pyrene	0.19
Acetaldehyde	171.62	POM, Group 5a	1.63E-03		
Tetrachloroethylene	110.40	1,3-Butadiene	1.35E-03		
p-Dichlorobenzene	60.37	POM, Group 2d	1.32E-03		
1,3-Butadiene	45.07	Naphthalene	1.26E-03		
Naphthalene	37.18	POM, Group 1a	1.21E-03		
Trichloroethylene	29.51	*p*-Dichlorobenzene	6.64E-04		

Table 6-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the California Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Los Angeles, California (Los Angeles County) - CELA					
Toluene	8,265.39	Acrolein	6,797,409.70	Naphthalene	0.03
1,1,1-Trichloroethane	6,903.37	Chlorine	230,010.81		
Xylenes	4,970.97	Formaldehyde	226,678.82		
Hexane	4,520.90	1,3-Butadiene	164,416.69		
Formaldehyde	2,221.45	Acetaldehyde	106,888.65		
Benzene	1,913.13	Benzene	63,771.13		
Dichloromethane	1,682.67	Cyanide Compounds, PM	63,440.92		
Ethylene glycol	1,465.20	Trichloroethylene	56,352.54		
Methanol	1,338.85	Naphthalene	51,636.02		
Ethylbenzene	1,101.33	Xylenes	49,709.73		
Rubidoux, California (Riverside County) - RUCA					
Toluene	1,541.54	Acrolein	1,151,923.43	Naphthalene	0.03
Xylenes	1,037.06	Chlorine	71,489.03		
Hexane	1,034.89	Formaldehyde	42,736.21		
1,1,1-Trichloroethane	617.84	1,3-Butadiene	24,417.60		
Formaldehyde	418.81	Acetaldehyde	21,889.50		
Benzene	317.30	Bromomethane	13,246.82		
Ethylene glycol	241.17	Naphthalene	11,663.14		
Methanol	218.85	Lead, PM	11,143.30		
Tetrachloroethylene	214.39	Benzene	10,576.82		
Dichloromethane	200.68	Trichloroethylene	10,486.48		

Table 6-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the California Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
San Jose, California (Santa Clara County) - SJJCA					
Toluene	1,762.28	Acrolein	1,804,553.18	Arsenic	0.03
1,1,1-Trichloroethane	1,289.63	Chlorine	91,338.84	Naphthalene	0.02
Hexane	1,014.84	Formaldehyde	34,980.53	Nickel	0.02
Xylenes	987.31	1,3-Butadiene	22,537.16		
Benzene	356.17	Acetaldehyde	19,068.78		
Formaldehyde	342.81	Trichloroethylene	14,754.18		
Ethylene glycol	280.57	Naphthalene	12,392.06		
Ethylbenzene	232.74	Benzene	11,872.49		
Methanol	216.21	Xylenes	9,873.13		
Dichloromethane	191.47	Lead, PM	9,571.88		

Observations from Table 6-7 include the following:

- Toluene is the highest emitted pollutant with a noncancer RfC in all three California counties. The quantity emitted is significantly higher for Los Angeles County than Riverside and Santa Clara Counties. 1,1,1-Trichloroethane is the second highest emitted pollutant in Los Angeles and Santa Clara Counties but ranks fourth for Riverside County. Xylenes are the second highest emitted pollutant in Riverside County but ranks third and fourth for Los Angeles and Santa Clara Counties, respectively. Hexane is also among the top four emitted pollutants in each of these counties.

- Acrolein, chlorine, formaldehyde, 1,3-butadiene, and acetaldehyde are the five pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all three counties. Although acrolein and chlorine rank highest for toxicity-weighted emissions for each county, neither pollutant appears among the highest emitted. This is also true for acetaldehyde and 1,3-butadiene. Conversely, formaldehyde has the fifth highest emissions for Los Angeles and Riverside Counties and ranks sixth for Santa Clara County.

- Three of the highest emitted pollutants also have the highest toxicity-weighted emissions for Los Angeles and Santa Clara Counties, while only two of the highest emitted pollutants also have the highest toxicity-weighted emissions for Riverside County.

- Naphthalene is the only pollutant of interest for all three sites. Naphthalene does not appear among the highest emitted pollutants (of those with a noncancer RfC) for any of the three counties. Naphthalene ranks seventh for its toxicity-weighted emissions for Riverside and Santa Clara Counties and ninth for its toxicity-weighted emissions for Los Angeles County.

- Arsenic and nickel are the only other pollutants of interest for SJJCA for which noncancer hazard approximations could be calculated. Lead is the only metal that appears on either emissions-based list for Santa Clara County in Table 6-7. Concentrations of lead did not fail screens for SJJCA.

6.6 Summary of the 2014 Monitoring Data for the California Monitoring Sites

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

❖ *Naphthalene failed screens for all three California sites. One additional PAH failed screens for CELA and three additional PAHs and two PM_{10} metals failed screens for SJJCA. Naphthalene was identified as a pollutant of interest for all three sites.*

❖ *Naphthalene had the highest annual average concentration among the site-specific pollutants of interest for each of the California monitoring sites. CELA has the fifth highest annual average concentration of naphthalene among NMP sites sampling PAHs. The highest concentrations of naphthalene were measured at these sites in January and/or February.*

- *The maximum nickel concentration across the program was measured at SJJCA.*

- *Naphthalene concentrations have a decreasing trend at CELA in recent years. Progressively higher nickel concentrations have been measured at SJJCA over the last several years of sampling.*

- *Naphthalene has the highest cancer risk approximation of the pollutants of interest for each site. None of the pollutants of interest for the California sites have noncancer hazard approximations greater than an HQ of 1.0.*

7.0 Sites in Colorado

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

7.1 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 in Colorado is located in Grand Junction (GPCO) while the five UATMP sites are located in neighboring Garfield County, in the towns of Battlement Mesa (BMCO), Silt (BRCO), Parachute (PACO), Carbondale (RFCO), and Rifle (RICO). Figure 7-1 for GPCO is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 7-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of GPCO are included in the facility counts provided in Figure 7-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Figures 7-3 through 7-9 are the composite satellite maps and emissions sources maps for the Garfield County sites. Table 7-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 7-1. Grand Junction, Colorado (GPCO) Monitoring Site

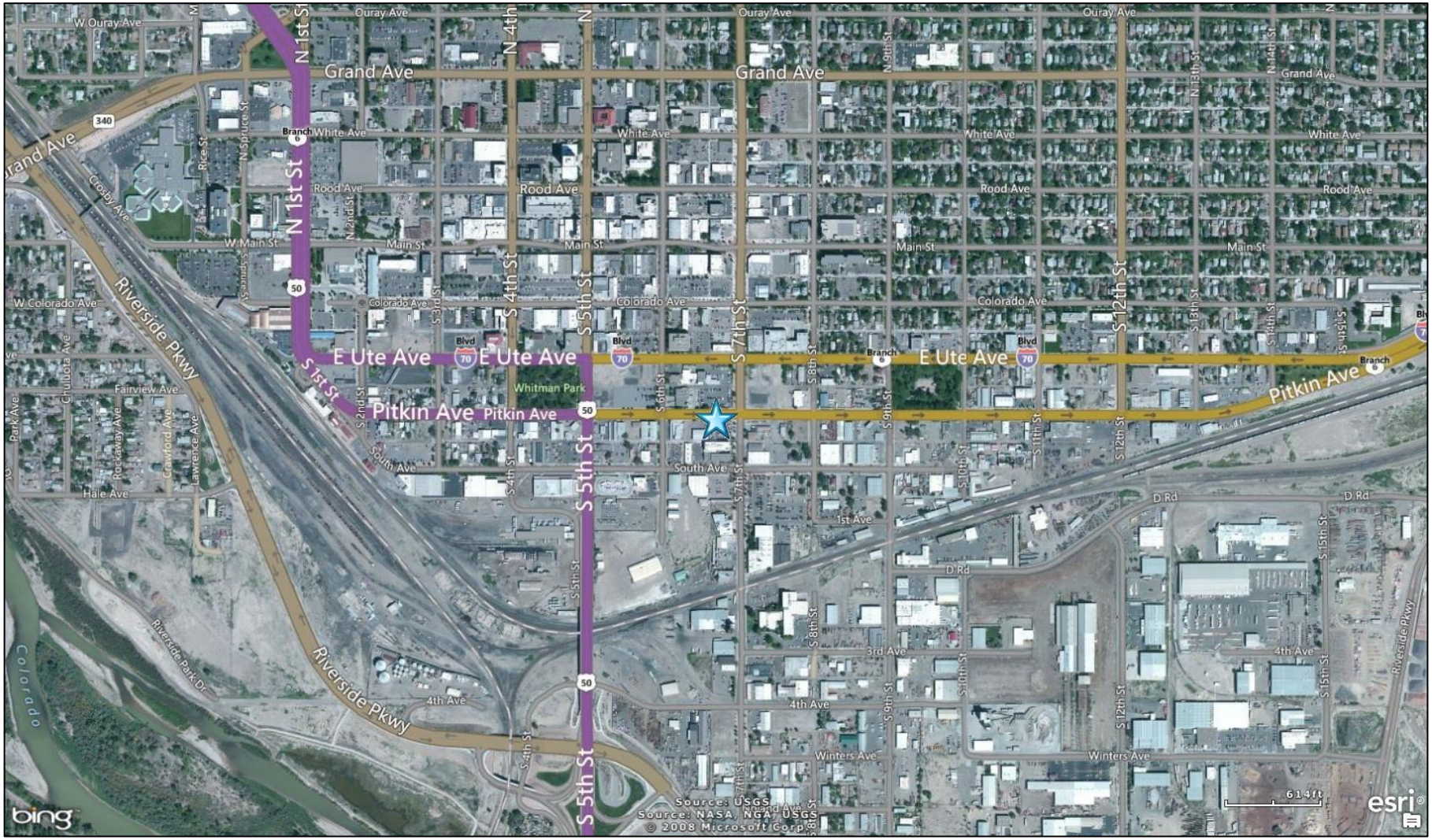


Figure 7-2. NEI Point Sources Located Within 10 Miles of GPCO

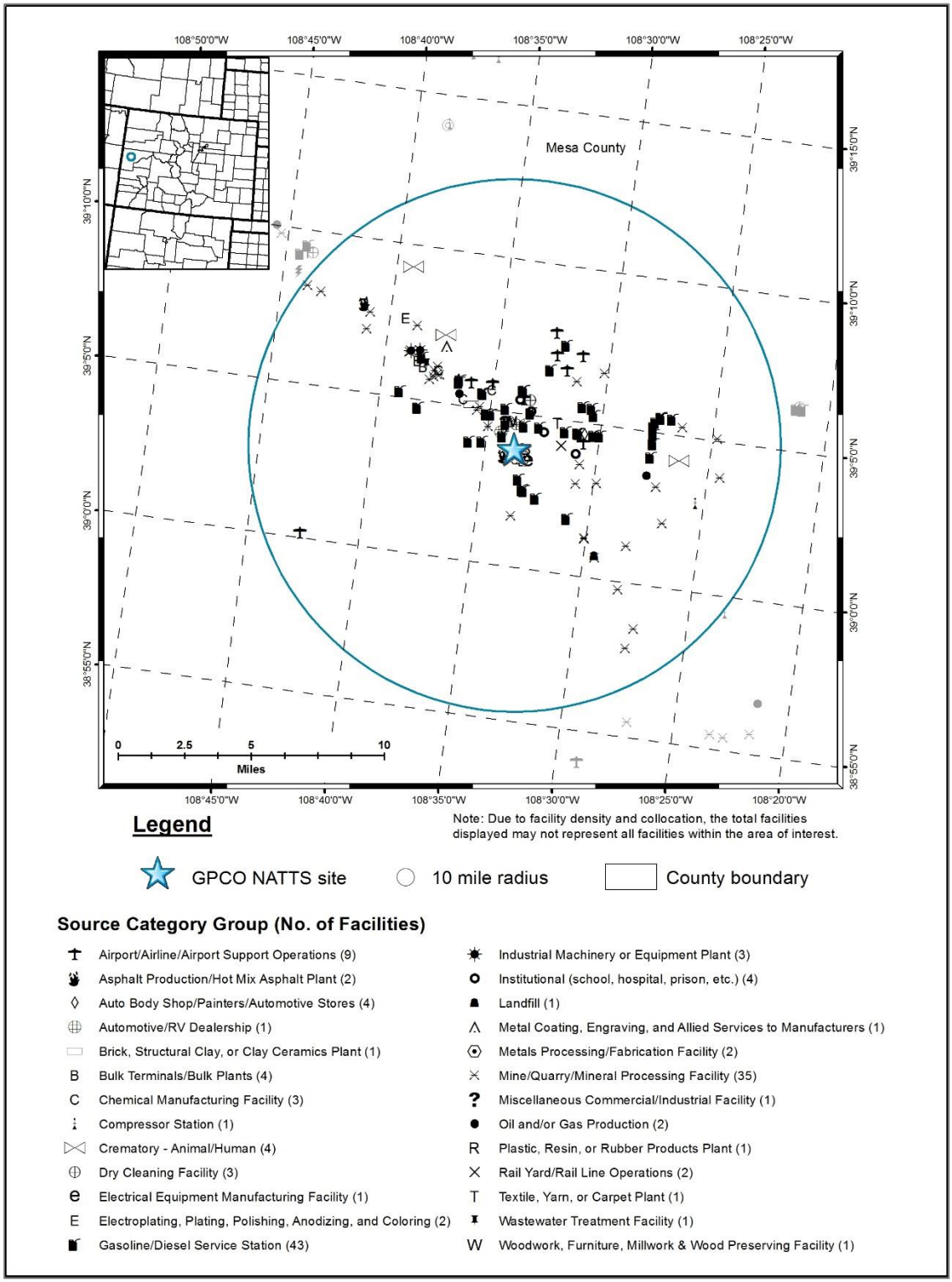


Figure 7-3. Battlement Mesa, Colorado (BMCO) Monitoring Site

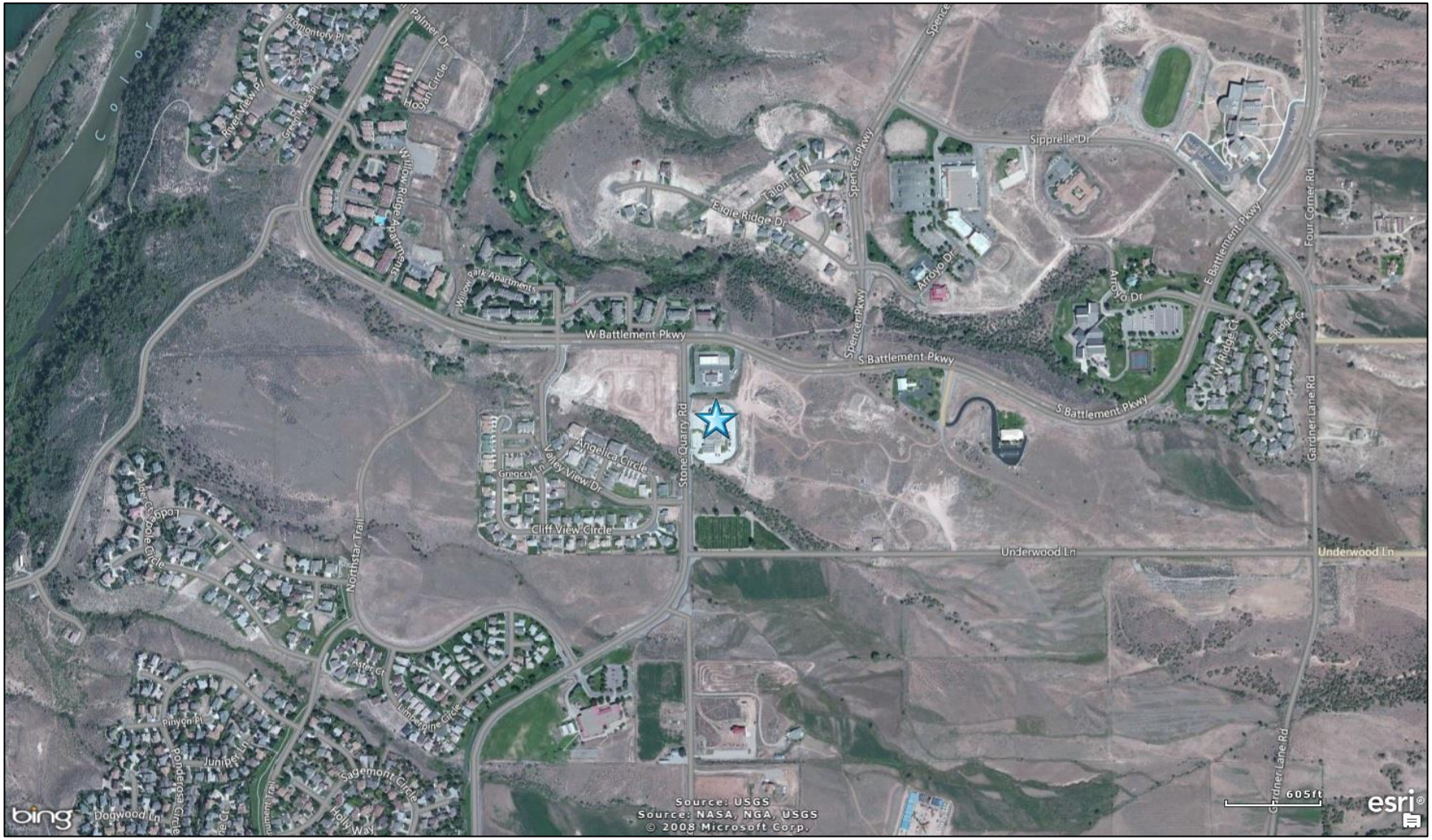


Figure 7-4. Silt, Colorado (BRCO) Monitoring Site

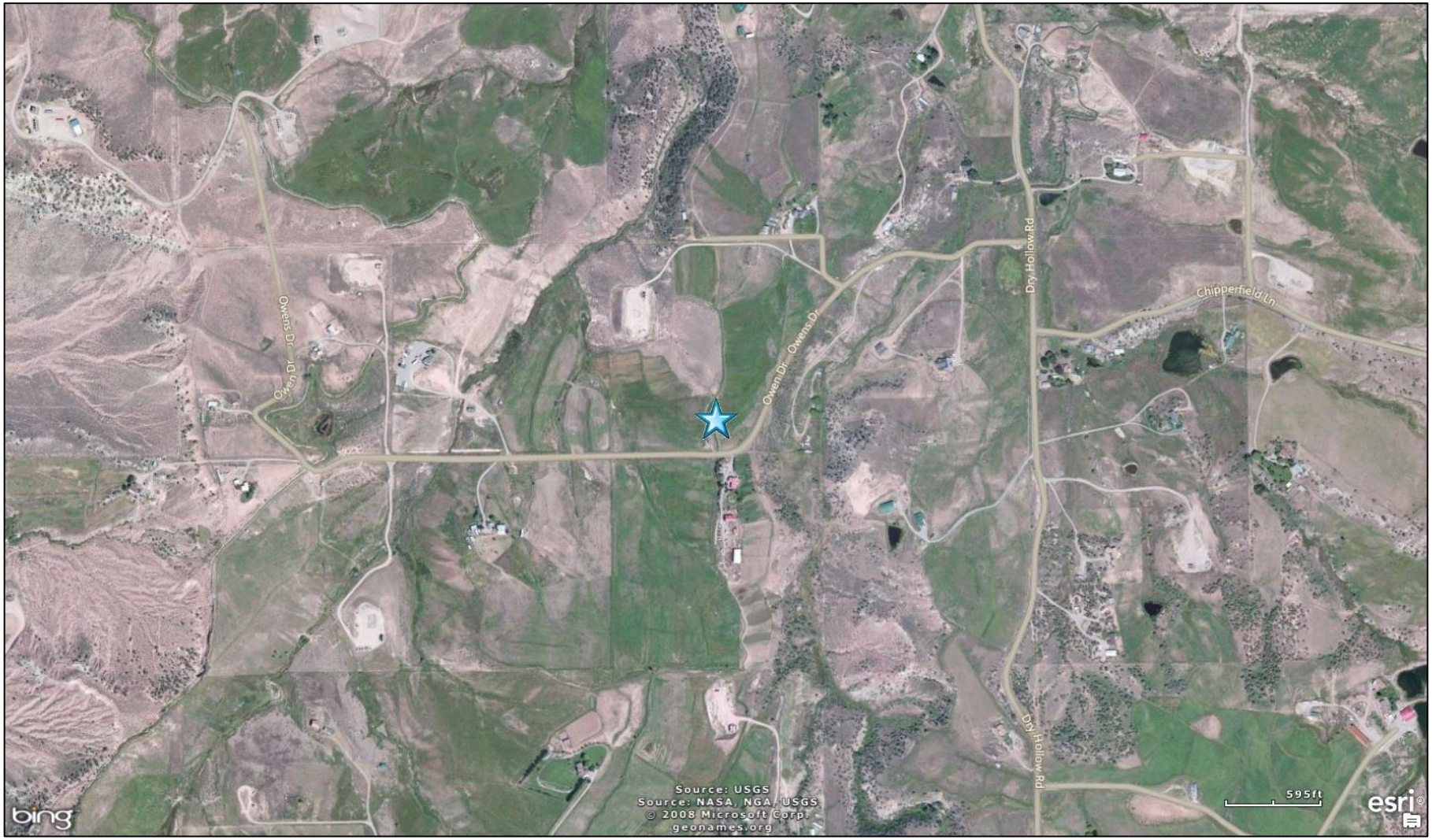


Figure 7-5. Parachute, Colorado (PACO) Monitoring Site

Figure 7-6. Rifle, Colorado (RICO) Monitoring Site

Figure 7-7. NEI Point Sources Located Within 10 Miles of BMCO, BRCO, PACO, and RICO

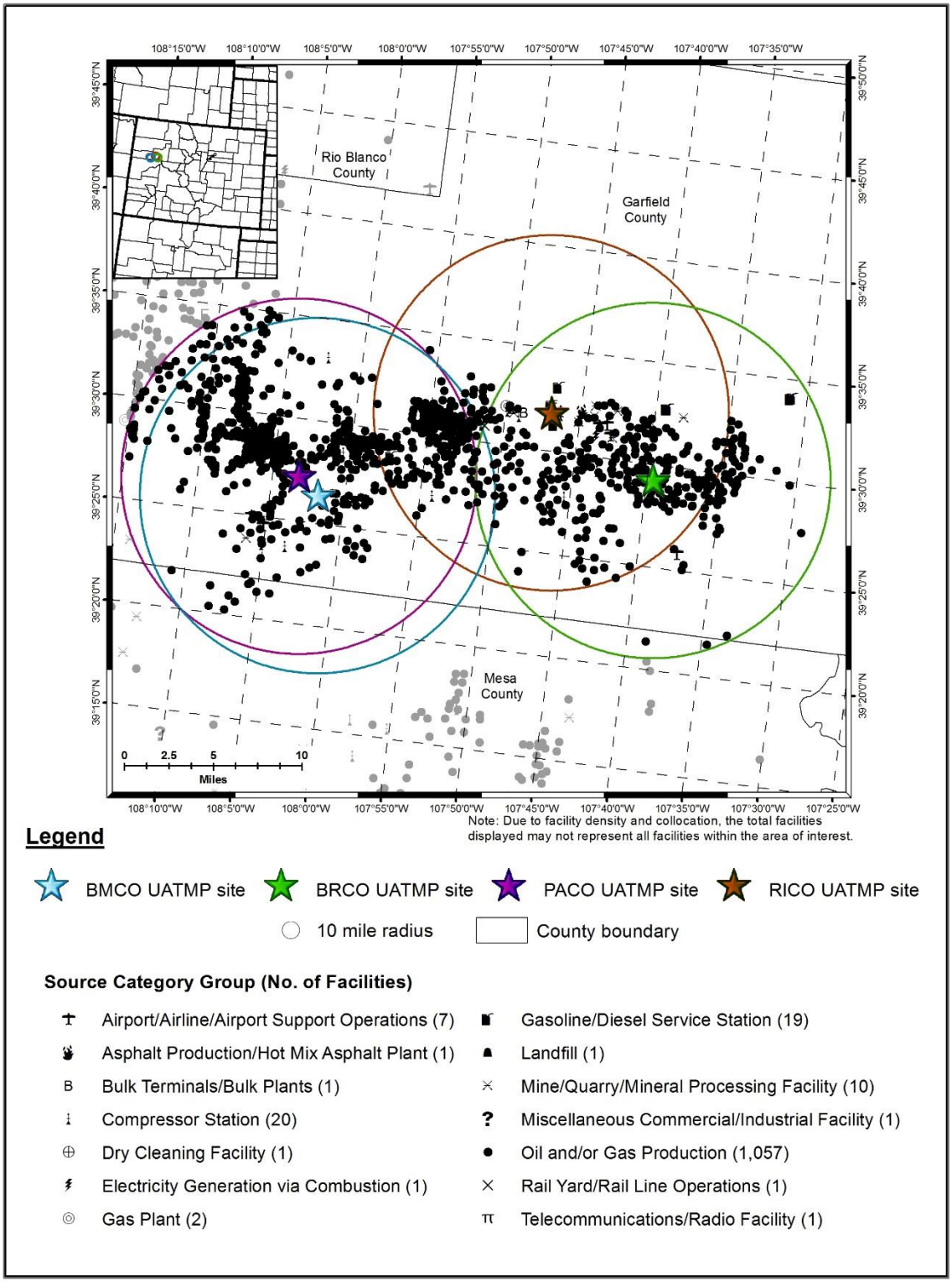


Figure 7-8. Carbondale, Colorado (RFCO) Monitoring Site

Figure 7-9. NEI Point Sources Located Within 10 Miles of RFCO

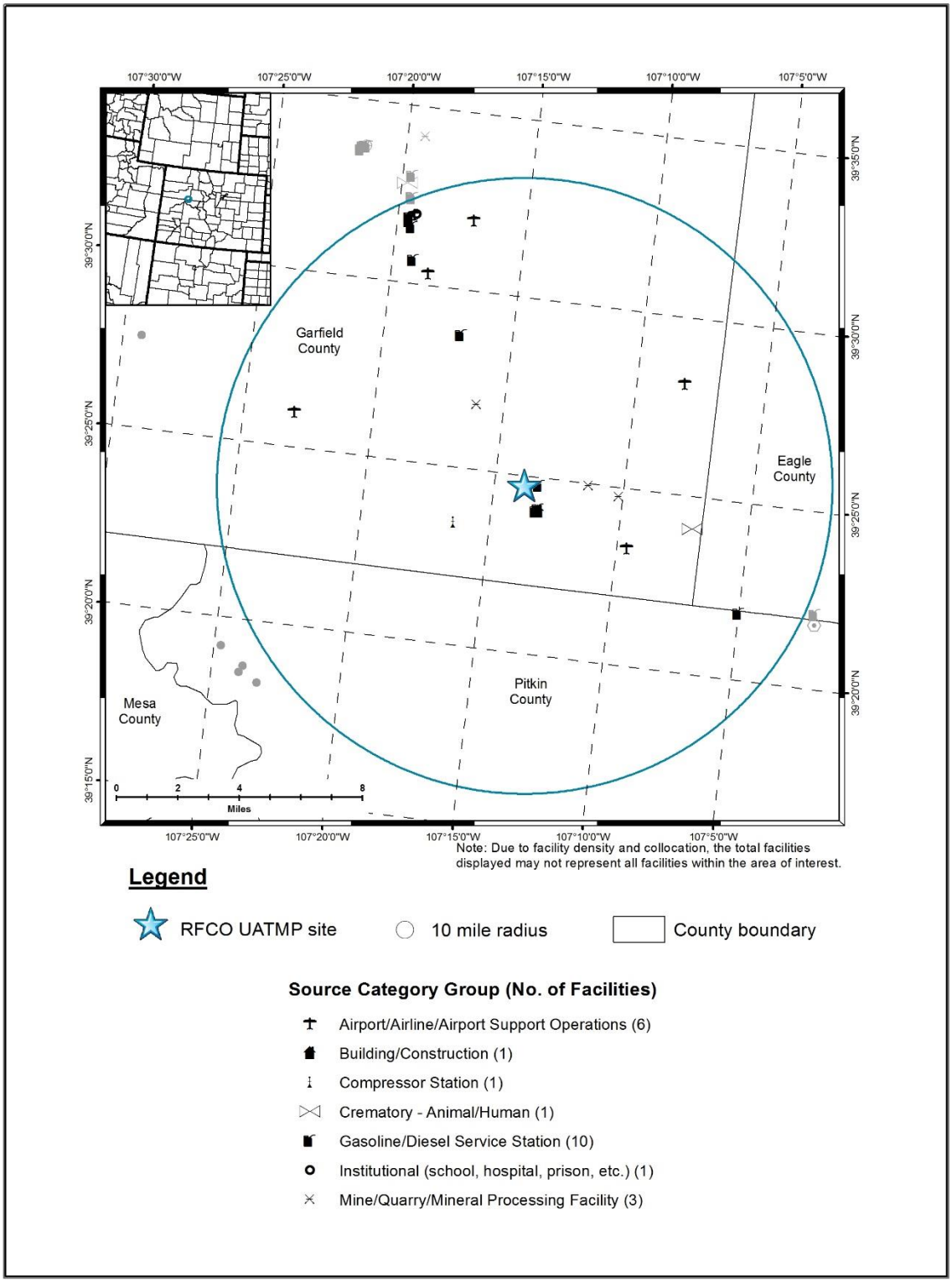


Table 7-1. Geographical Information for the Colorado Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
GPCO	08-077-0017 08-077-0018	Grand Junction	Mesa	Grand Junction, CO	39.064289, -108.561550	Commercial	Urban/City Center	12,000	Bus-70 (Pitkin Ave) just E of 7th St
BMCO	08-045-0019	Battlement Mesa	Garfield	Glenwood Springs, CO	39.438060, -108.026110	Commercial	Suburban	1,880	S Battlement Pkwy
BRCO	08-045-0009	Silt	Garfield	Glenwood Springs, CO	39.487755, -107.659685	Agricultural	Rural	1,182	Dry Hollow Rd
PACO	08-045-0005	Parachute	Garfield	Glenwood Springs, CO	39.453654, -108.053259	Residential	Urban/City Center	16,000	I-70 near exit 75
RICO	08-045-0007	Rifle	Garfield	Glenwood Springs, CO	39.531813, -107.782298	Commercial	Urban/City Center	17,000	Rte 13 connecting US-6 and I-70
RFCO	08-045-0018	Carbondale	Garfield	Glenwood Springs, CO	39.412278, -107.230397	Residential	Rural	16,000	Rte 133 just south of Hwy 82

[1]AADT reflects 2014 data for GPCO, PACO, RFCO, and RICO (CO DOT, 2014) and 2014 data for BMCO and BRCO (GCRBD, 2014)
BOLD ITALICS = EPA-designated NATTS Site

The GPCO monitoring site is comprised of two locations. The first location 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, which is on the roof of an adjacent 2-story building, is comprised of the metals samplers. As a result, two AQS codes are provided in Table 7-1. Figure 7-1 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. This site's location is next to a major east-west roadway (I-70 Business) in central Grand Junction. A rail line runs roughly east-west a few blocks to the south of the GPCO monitoring site, and merges with another rail line to the southwest of the site. The Colorado River can be seen in the bottom left-hand corner of Figure 7-1 near the junction with the Gunnison River. Grand Junction is located in the Grand Valley, which lies north and northeast of the Colorado National Monument.

As Figure 7-2 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 and oriented along the mountain valley. Many of the point sources near GPCO fall into the gasoline/diesel service station or the mine/quarry/mineral processing source categories. The sources closest to GPCO are an industrial machinery/equipment plant, a bulk terminal/bulk plant, a gasoline/diesel service station, and an auto body shop.

Four of the five Garfield County monitoring sites are situated in towns located along a river valley along the Colorado River and paralleling I-70. The BMCO monitoring site is located in Battlement Mesa, a rural community located to the southeast of Parachute. The monitoring site is located on the roof of the Grand Valley Fire Protection District facility, near the intersection of Stone Quarry Road and West Battlement Parkway, as shown in Figure 7-3. The site is surrounded primarily by residential subdivisions. A gas station is located immediately to the north of the site and a cemetery is located to the south.

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 7-4, the closest major roadway is County Road 331, Dry Hollow Road.

PACO is located on the roof of the old Parachute High School building, which is presently operating as an early education facility. This location is in the center of the town of Parachute. The surrounding area is considered residential. Interstate-70 is less than a quarter of a mile from the monitoring site, as shown in Figure 7-5. PACO is located 1.6 miles from BMCO; these are the two Garfield County sites that are the closest to each other.

RICO is located on the roof of the Henry Annex Building in downtown Rifle. This location is near the crossroads of several major roadways through town, as shown in Figure 7-6. Highway 13 and US-6/24 intersect just south of the site and I-70 is just over a half-mile south of the monitoring site, across the Colorado River. The surrounding area is commercial in nature.

These four Garfield County sites are located along a line running roughly east-west and spanning approximately 20 miles; hence, they are shown together in Figure 7-7. There are more than 1,000 petroleum or natural gas wells (collectively shown as the oil and/or gas production source category) within 10 miles of these sites. Garfield County is collecting SNMOC samples to characterize the effects these wells may have on the air quality in the surrounding areas (GCPH, 2015).

The RFCO monitoring site is the only site in Garfield County not located along the I-70 corridor. This site is located in the southeast corner of Garfield County in Carbondale. The town of Carbondale resides in a valley between the Roaring Fork and Crystal Rivers, north of Mt. Sopris (Carbondale, 2016). The RFCO monitoring site is located near the boathouse of the Rocky Mountain School on the bank of the Crystal River in the northern part of town. The surrounding area is residential and rural in nature. Highway 82, which runs southward from Glenwood Springs and separates Carbondale from the base of Red Hill, is just over one-third of a mile north of RFCO and is visible in the top right-hand corner of Figure 7-8.

Because RFCO is 24 miles from the next closest Garfield County monitoring site, the emissions sources surrounding RFCO are provided in a separate map in Figure 7-9. This figure shows that the few emissions sources within 10 miles of RFCO are primarily gasoline and/or diesel service stations. There is also a building/construction company, a compressor station, three mine/quarry/mineral processing facilities, and an airport within a few miles of this site.

In addition to providing city, county, CBSA, and land use/location setting information, Table 7-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volumes near RICO, RFCO, PACO, and GPCO are considerably higher than the traffic volumes near BMCO and BRCO. Yet, the traffic volumes for all six Colorado sites rank in the bottom half compared to the traffic volumes for other NMP sites. The traffic volume for BRCO is one of the lowest among all NMP sites. However, this monitoring site is located in the most rural of settings compared to the other Colorado sites.

7.2 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 the year.

7.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Colorado sites, site-specific data were available from GPCO and BMCO for some, but not all, of the site-specific parameters in Table 7-2. For GPCO, data from the NWS weather station at Walker Field/Grand Junction Regional Airport (WBAN 23066) were used for meteorological parameters without data and/or as a surrogate for parameters without complete observation records. The Walker Field/Grand Junction Regional Airport weather station is located 5 miles north-northeast of GPCO. For BMCO, data from the NWS weather station at Garfield County Regional Airport (WBAN 03016) were used where needed; the Garfield County Regional Airport Regional Airport weather station is located 17.7 miles east-northeast of BMCO. Meteorological observations were not available in AQS for the remaining Garfield County sites, and therefore, weather data from the closest NWS station were used and included in Table 7-2. A map showing the distance between the Colorado monitoring sites and the closest NWS weather

station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 7-2. Average Meteorological Conditions near the Colorado Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Grand Junction, Colorado – GPCO[2]							
Sample Days (75)	56.5 ± 0.9	29.1 ± 0.6	45.3 ± 1.2	29.97 ± 0.01	25.16 ± 0.01	E	3.1 ± 0.1
2014	54.5 ± 0.4	28.5 ± 0.3	47.4 ± 0.5	30.00 ± 0.01	25.17 ± <0.01	ESE	3.1 ± <0.1
Battlement Mesa, Colorado – BMCO[3]							
Sample Days (59)	50.2 ± 1.0	27.8 ± 0.7	47.4 ± 1.2	30.03 ± 0.01	24.54 ± 0.01	WSW	3.4 ± 0.1
2014	50.5 ± 0.4	28.8 ± 0.3	48.5 ± 0.5	30.03 ± <0.01	24.55 ± <0.01	WSW	3.4 ± 0.1
Garfield County Regional Airport[4]							
BRCO (62)	48.9 ± 1.1	27.6 ± 0.7	52.5 ± 1.3	30.02 ± 0.01	24.53 ± 0.01	W	4.6 ± 0.3
PACO (60)	48.5 ± 1.0	28.4 ± 0.7	53.7 ± 1.3	30.03 ± 0.01	24.54 ± 0.01	W	4.6 ± 0.3
RICO (61)	48.5 ± 1.1	28.3 ± 0.7	53.8 ± 1.3	30.03 ± <0.01	24.53 ± 0.01	W	4.5 ± 0.3
2014	48.4 ± 0.4	28.8 ± 0.3	55.1 ± 0.5	30.03 ± <0.01	24.54 ± <0.01	W	4.4 ± 0.1
Aspen-Pitkin County Regional Airport[5]							
RFCO (35)	42.9 ± 1.3	24.8 ± 0.9	54.7 ± 1.5	29.97 ± 0.01	22.62 ± 0.01	SSW	5.2 ± 0.3
2014	42.4 ± 0.4	25.2 ± 0.3	57.0 ± 0.5	29.98 ± <0.01	22.62 ± <0.01	SSW	5.0 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature and wind parameters were measured at GPCO, along with relative humidity measurements for part of the year. The remaining portion was obtained from the closest NWS weather station located at Walker Field/Grand Junction Regional Airport, WBAN 23066, and used as a surrogate. Data for the remaining parameters are from the NWS station.
[3]Dew point temperature and sea level pressure were not measured at BMCO. This information was obtained from the closest NWS weather station located at Garfield County Regional Airport, WBAN 03016.
[4]Meteorological data for BRCO, PACO, and RICO were not available in AQS. This information was obtained from the NWS weather station located at Garfield County Regional Airport, WBAN 03016.
[5]Meteorological data for RFCO were not available in AQS. This information was obtained from the NWS weather station located at Aspen-Pitkin County Airport, WBAN 93073.

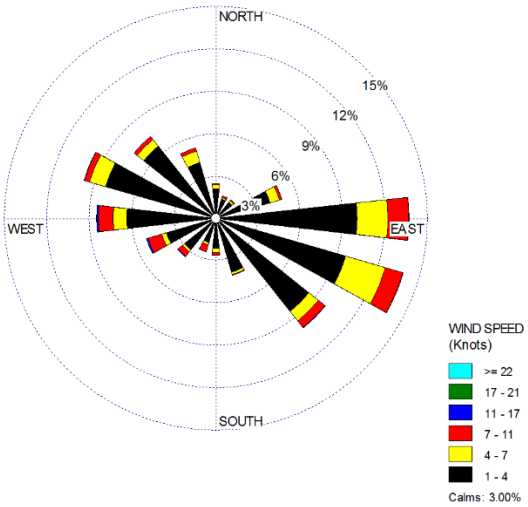
Table 7-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 7-2 is the 95 percent confidence interval for each parameter. As shown in Table 7-2, average meteorological conditions on sample days were generally representative of average weather conditions experienced throughout the year at each site. For GPCO, the greatest difference between the sample day and full-year averages was calculated for average relative humidity, although average temperature has a similar difference. A number of make-up samples were collected at GPCO in 2014, particularly for PAHs. These were collected primarily during the warmer months of the year, between April and September, and may account for the differences shown for these parameters. Among the Garfield County sites, the greatest differences between the sample day and full-year averages were also calculated for relative humidity.

7.2.2 Wind Rose Comparison

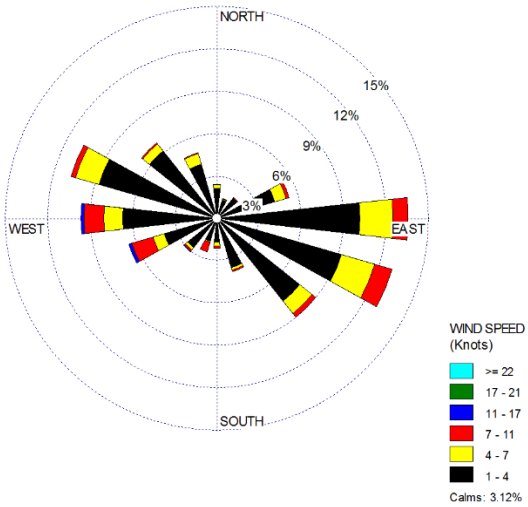
Hourly surface wind data were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 7-10 presents two wind roses for the GPCO monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These can be used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 7-11 through 7-13 presents the full-year and sample day wind roses for the Garfield County sites.

Figure 7-10. Wind Roses for the Wind Data Collected at GPCO

2014 Wind Rose



Sample Day Wind Rose



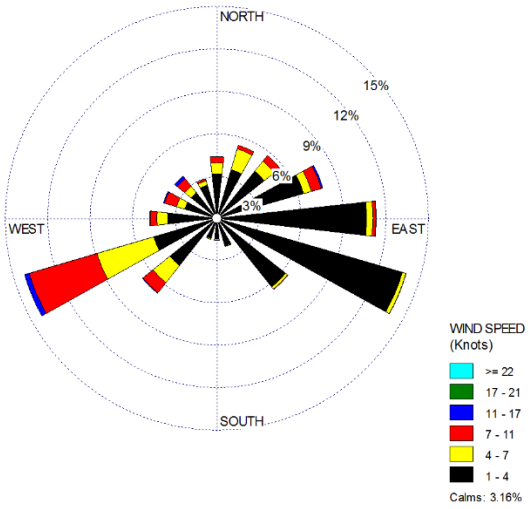
Observations from Figure 7-10 for GPCO include the following:

- The 2014 wind rose shows that winds from the east to southeast are the most frequently observed wind directions at GPCO, together accounting for more than one-third of observations. Winds from the west to northwest make up a secondary wind grouping. Winds from the northeast and southwest quadrants were infrequently observed. Wind speeds greater than 11 knots were rarely observed near GPCO, and calm winds account for 3 percent of observations.

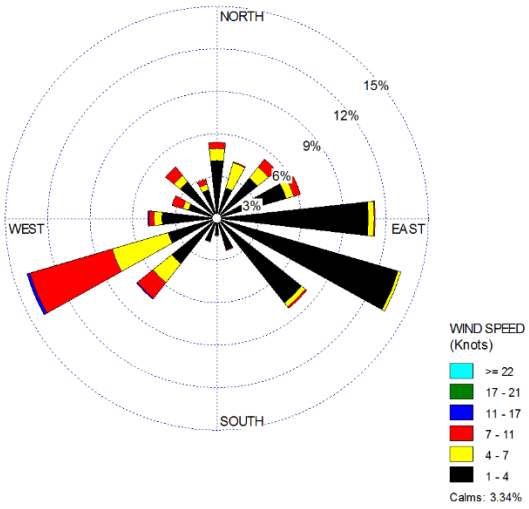
- The sample day wind patterns at GPCO resemble the full-year wind patterns, indicating that wind conditions on sample days were representative of those experienced over the entire year.

Figure 7-11. Wind Roses for the Wind Data Collected at BMCO

2014 Wind Rose



Sample Day Wind Rose



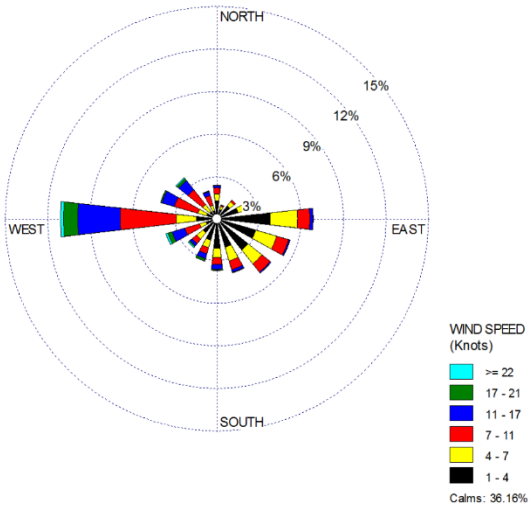
Observations from Figure 7-11 for BMCO include the following:

- The 2014 wind rose for BMCO shows that west-southwesterly winds were the most frequently observed wind direction near BMCO (14.2 percent), although winds from the east-southeast were observed nearly as frequently (13.9 percent). Winds from the western quadrants were not observed as frequently as those from the eastern quadrants, with winds from the south observed the least. Yet winds from the eastern quadrants tended to be lighter than those from the western quadrants. Calm winds accounted for about 3 percent of wind observations.

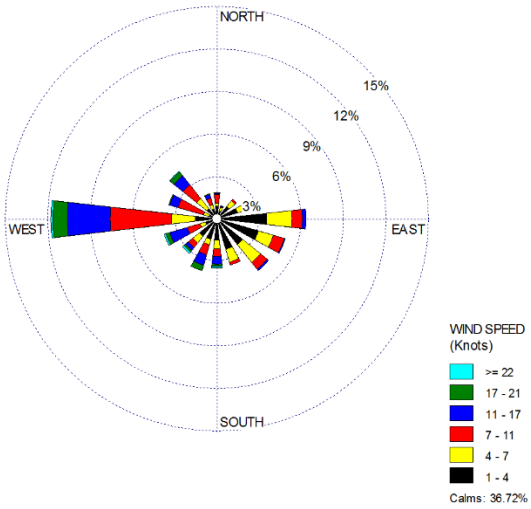
- The sample day wind patterns at BMCO resemble the full-year wind patterns, indicating that wind conditions on sample days were representative of those experienced over the entire year.

Figure 7-12. Wind Roses for the Wind Data Collected at the Garfield County Regional Airport Weather Station

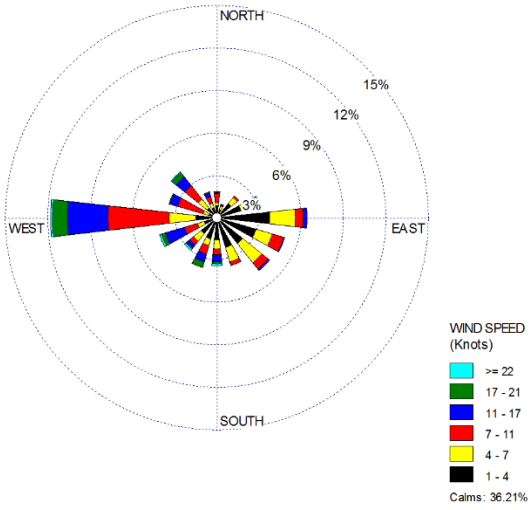
2014 Wind Rose



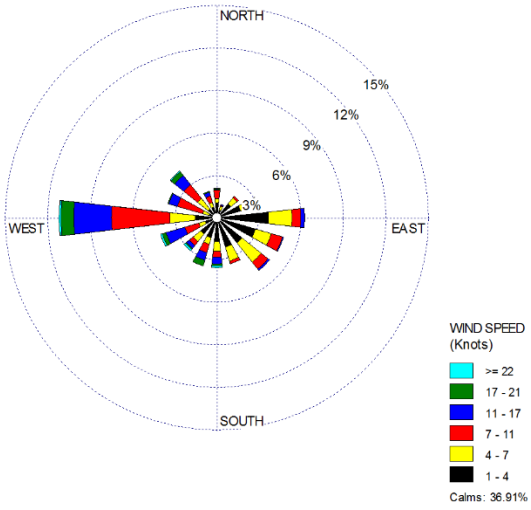
BRCO Sample Day Wind Rose



PACO Sample Day Wind Rose



RICO Sample Day Wind Rose



Observations from Figure 7-12 for BRCO, PACO, and RICO include the following:

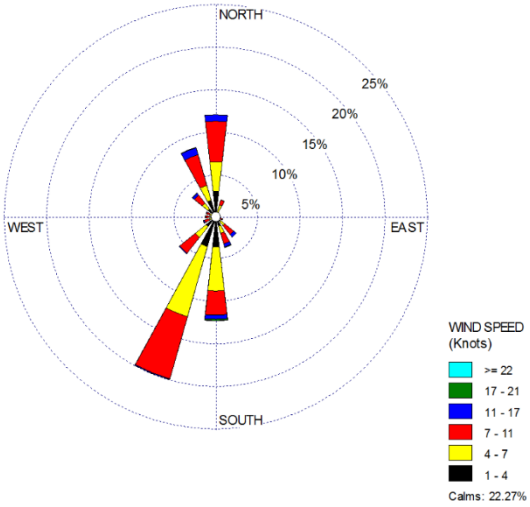
- Wind data was not collected at BRCO, PACO, and RICO (or were not available in AQS); thus, Figure 7-12 presents the 2014 full-year wind rose for the weather station located at the Garfield County Regional Airport and sample day wind roses based these sites' individual sample days.

- The 2014 wind rose shows that westerly winds were the most frequently observed wind direction at the Garfield County Airport. Winds from the east to south to west to northwest were also observed, while northerly to northeasterly winds were infrequently observed. Calm winds accounted for more than one-third of the observations while the strongest winds tended to be those from the western quadrants.

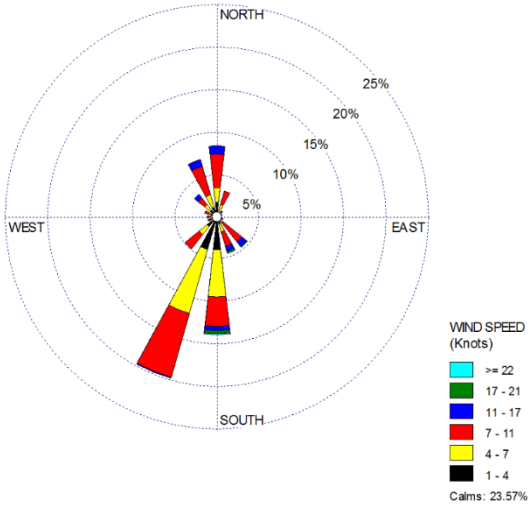
- The sample day wind patterns based on each sites' sample days resemble the full-year wind patterns, indicating that wind conditions on sample days were representative of those experienced over the entire year.

Figure 7-13. Wind Roses for the Wind Data Collected at the Aspen-Pitkin County Airport Weather Station near RFCO

2014 Wind Rose



Sample Day Wind Rose



Observations from Figures 7-13 for RFCO include the following:

- Wind data was not collected at RFCO (or were not available in AQS); thus, Figure 7-13 presents the 2014 full-year wind rose for the weather station located at the Aspen-Pitkin County Airport and the sample day wind roses based this site's individual sample days.

- The 2014 wind rose shows that south-southwesterly winds were the most frequently observed wind direction at the weather station closest to RFCO (20 percent), with winds from the south and north each accounting for more than 12 percent of the observations. Winds from the east or west were rarely observed. Calm winds accounted for about 22 percent of wind observations while winds greater than 17 knots were rarely observed.

- The sample day wind patterns near RFCO generally resemble the full-year wind patterns, although winds from the north and north-northwest were observed less often and winds from the southeast to south were observed more often.

7.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Colorado monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 7-3. 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 and are shaded in gray in Table 7-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, PM_{10} metals, and PAHs were sampled for at GPCO while SNMOCs and carbonyl compounds were sampled for at the Garfield County sites.

Table 7-3. Risk-Based 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
Grand Junction, Colorado - GPCO						
Acetaldehyde	0.45	58	58	100.00	11.55	11.55
Formaldehyde	0.077	58	58	100.00	11.55	23.11
Naphthalene	0.029	58	60	96.67	11.55	34.66
Benzene	0.13	57	57	100.00	11.35	46.02
1,3-Butadiene	0.03	57	57	100.00	11.35	57.37
Carbon Tetrachloride	0.17	57	57	100.00	11.35	68.73
1,2-Dichloroethane	0.038	50	50	100.00	9.96	78.69
Arsenic (PM_{10})	0.00023	33	50	66.00	6.57	85.26
Ethylbenzene	0.4	31	57	54.39	6.18	91.43
Acenaphthene	0.011	12	60	20.00	2.39	93.82
Hexachloro-1,3-butadiene	0.045	12	13	92.31	2.39	96.22
Benzo(a)pyrene	0.00057	7	50	14.00	1.39	97.61
Dichloromethane	60	7	57	12.28	1.39	99.00
1,2-Dibromoethane	0.0017	2	2	100.00	0.40	99.40
Fluorene	0.011	2	55	3.64	0.40	99.80
p-Dichlorobenzene	0.091	1	19	5.26	0.20	100.00
Total		502	760	66.05		

Table 7-3. Risk-Based 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
Battlement Mesa, Colorado - BMCO						
Benzene	0.13	51	51	100.00	58.62	58.62
Formaldehyde	0.077	25	27	92.59	28.74	87.36
Acetaldehyde	0.45	11	27	40.74	12.64	100.00
Total		87	105	82.86		
Silt, Colorado - BRCO						
Benzene	0.13	49	49	100.00	53.26	53.26
Formaldehyde	0.077	24	25	96.00	26.09	79.35
Acetaldehyde	0.45	16	25	64.00	17.39	96.74
1,3-Butadiene	0.03	3	3	100.00	3.26	100.00
Total		92	102	90.20		
Parachute, Colorado - PACO						
Benzene	0.13	57	57	100.00	50.44	50.44
Formaldehyde	0.077	25	25	100.00	22.12	72.57
Acetaldehyde	0.45	14	25	56.00	12.39	84.96
1,3-Butadiene	0.03	14	14	100.00	12.39	97.35
Ethylbenzene	0.4	3	55	5.45	2.65	100.00
Total		113	176	64.20		
Carbondale, Colorado - RFCO						
Benzene	0.13	27	27	100.00	34.62	34.62
Formaldehyde	0.077	26	26	100.00	33.33	67.95
Acetaldehyde	0.45	18	26	69.23	23.08	91.03
1,3-Butadiene	0.03	7	7	100.00	8.97	100.00
Total		78	86	90.70		
Rifle, Colorado - RICO						
Benzene	0.13	54	54	100.00	38.03	38.03
1,3-Butadiene	0.03	33	33	100.00	23.24	61.27
Formaldehyde	0.077	26	27	96.30	18.31	79.58
Acetaldehyde	0.45	16	27	59.26	11.27	90.85
Ethylbenzene	0.4	13	52	25.00	9.15	100.00
Total		142	193	73.58		

Observations from Table 7-3 include the following:

- The number of pollutants failing screens varied significantly between GPCO and the Garfield County monitoring sites; this is expected given the difference in pollutants measured at the sites.

- Concentrations of 16 pollutants failed at least one screen for GPCO; 66 percent of the concentrations for these 16 pollutants were greater than their associated risk screening value (or failed screens).

- Eleven pollutants contributed to 95 percent of failed screens for GPCO and therefore were identified as pollutants of interest for GPCO. These 11 include two carbonyl compounds, six VOCs, two PAHs, and one PM_{10} metal.

- The number of pollutants failing screens for the Garfield County sites range from three (BMCO) to five (PACO and RICO). The same three pollutants (benzene, formaldehyde, and acetaldehyde) failed screens for each Garfield County site. 1,3-Butadiene also failed screens at four of the five sites and ethylbenzene also failed screens for PACO and RICO.

- Benzene, formaldehyde, and acetaldehyde were identified as pollutants of interest for all five Garfield County sites. 1,3-Butadiene was also identified as a pollutant of interest for PACO, RFCO, and RICO. Ethylbenzene was also identified as a pollutant of interest for RICO.

- Benzene failed 100 percent of screens for all six Colorado sites.

- Carbonyl compound samples were collected on a 1-in-12 day sampling schedule at BMCO, BRCO, PACO, and RICO, while SNMOC samples were collected on a 1-in-6 day sampling schedule; thus, the number of carbonyl compound samples collected at these sites were often less than half the number of SNMOC samples collected. Both carbonyl compound and SNMOC samples were collected on a 1-in-12 day sampling schedule at RFCO.

7.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Colorado monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the Colorado monitoring sites are provided in Appendices J through N.

7.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each Colorado monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Colorado monitoring sites are presented in Table 7-4, where applicable. Note that concentrations of the PAHs and metals for GPCO are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 7-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Grand Junction, Colorado - GPCO							
Acetaldehyde	58/58	58	2.47 ± 0.37	3.36 ± 0.56	2.89 ± 0.51	2.41 ± 0.51	2.80 ± 0.25
Benzene	57/57	57	1.26 ± 0.23	0.61 ± 0.09	0.73 ± 0.10	1.30 ± 0.21	0.99 ± 0.12
1,3-Butadiene	57/57	57	0.21 ± 0.06	0.08 ± 0.02	0.10 ± 0.02	0.26 ± 0.06	0.17 ± 0.03
Carbon Tetrachloride	57/57	57	0.54 ± 0.09	0.60 ± 0.05	0.63 ± 0.02	0.56 ± 0.05	0.58 ± 0.03
1,2-Dichloroethane	50/49	57	0.08 ± 0.02	0.08 ± 0.01	0.06 ± 0.02	0.08 ± 0.02	0.07 ± 0.01
Ethylbenzene	57/57	57	0.50 ± 0.10	0.25 ± 0.05	0.39 ± 0.07	0.67 ± 0.14	0.45 ± 0.06
Formaldehyde	58/58	58	3.50 ± 0.39	3.42 ± 0.51	5.16 ± 0.82	3.45 ± 0.63	3.90 ± 0.35
Hexachloro-1,3-butadiene	13/0	57	0.02 ± 0.02	0.01 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Acenaphthene[a]	60/60	60	3.59 ± 0.55	NA	11.68 ± 1.94	5.27 ± 1.53	7.17 ± 1.20
Arsenic (PM_{10})[a]	50/33	59	0.41 ± 0.11	0.17 ± 0.10	0.15 ± 0.07	0.38 ± 0.11	0.28 ± 0.06
Naphthalene[a]	60/60	60	120.56 ± 39.18	NA	91.59 ± 13.36	110.83 ± 26.63	100.03 ± 13.48
Battlement Mesa, Colorado - BMCO							
Acetaldehyde	27/27	27	0.29 ± 0.08	NA	0.58 ± 0.30	0.36 ± 0.19	0.42 ± 0.11
Benzene	51/51	51	1.14 ± 0.21	NA	NA	0.84 ± 0.11	NA
Formaldehyde	27/27	27	0.52 ± 0.11	NA	1.18 ± 0.47	0.54 ± 0.25	0.77 ± 0.18
Silt, Colorado - BRCO							
Acetaldehyde	25/25	25	0.30 ± 0.18	NA	NA	0.53 ± 0.16	NA
Benzene	49/49	50	0.88 ± 0.17	NA	NA	0.83 ± 0.13	NA
Formaldehyde	25/25	25	0.46 ± 0.26	NA	NA	0.75 ± 0.19	NA
Parachute, Colorado - PACO							
Acetaldehyde	25/25	25	0.35 ± 0.18	0.68 ± 0.23	0.80 ± 0.26	NA	NA
Benzene	57/57	57	1.68 ± 0.36	1.39 ± 0.28	1.37 ± 0.28	1.52 ± 0.23	1.49 ± 0.14
1,3-Butadiene	14/8	57	0.01 ± 0.01	0	0	0.10 ± 0.04	0.03 ± 0.01
Formaldehyde	25/25	25	0.67 ± 0.34	1.31 ± 0.41	1.80 ± 0.34	NA	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 blue line for GPCO are presented in ng/m³ for ease of viewing.

Table 7-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Carbondale, Colorado - RFCO							
Acetaldehyde	26/26	26	0.26 ± 0.15	0.67 ± 0.26	NA	0.60 ± 0.10	NA
Benzene	27/27	28	NA	0.37 ± 0.09	0.33 ± 0.09	0.56 ± 0.20	0.46 ± 0.09
1,3-Butadiene	7/3	28	NA	0	0	0.07 ± 0.05	0.03 ± 0.02
Formaldehyde	26/26	26	0.33 ± 0.16	0.89 ± 0.26	NA	0.72 ± 0.10	NA
Rifle, Colorado - RICO							
Acetaldehyde	27/27	27	0.49 ± 0.21	0.54 ± 0.30	0.65 ± 0.27	0.38 ± 0.24	0.52 ± 0.12
Benzene	54/54	54	1.43 ± 0.34	NA	0.78 ± 0.09	1.43 ± 0.19	1.09 ± 0.14
1,3-Butadiene	33/20	54	0.12 ± 0.04	NA	0.03 ± 0.03	0.24 ± 0.06	0.10 ± 0.03
Ethylbenzene	52/51	54	0.33 ± 0.07	NA	0.30 ± 0.04	0.42 ± 0.10	0.32 ± 0.04
Formaldehyde	27/27	27	0.71 ± 0.32	0.69 ± 0.32	1.12 ± 0.41	0.48 ± 0.36	0.74 ± 0.17

NA = Not available due to the criteria for calculating a quarterly and/or annual average.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Observations for GPCO from Table 7-4 include the following:

- The pollutants with the highest annual average concentrations for GPCO are formaldehyde (3.90 ± 0.35 µg/m^3) and acetaldehyde (2.80 ± 0.25 µg/m^3). These are also the only pollutants with annual average concentrations greater than 1 µg/m^3, although benzene is very close (0.99 ± 0.12 µg/m^3). The annual average concentrations for these carbonyl compounds are considerably lower for 2014 than they were for 2013.

- The third quarter average concentration for formaldehyde is significantly higher than the other quarterly averages and has a relatively large confidence interval associated with it. A review of the data shows that all but 10 formaldehyde concentrations greater than 5 µg/m^3 were measured in samples collected at GPCO during the third quarter of 2014, including all five samples collected in July, two from August, and three from September. These measurements range from 5.08 µg/m^3 to 7.38 µg/m^3.

- The second quarter average concentration for acetaldehyde appears considerably higher than the other quarterly averages. A review of the data shows that five of the seven acetaldehyde concentrations greater than 4 µg/m^3 were measured in samples collected at GPCO between April and June (with the other two in early July). The second quarter also has the fewest concentrations on the lower end of the range; of the 12 acetaldehyde concentrations less than 2 µg/m^3, only one was measured at

GPCO during the second quarter while three to four were measured in each of the other calendar quarters.

- Concentrations of benzene and 1,3-butadiene appear highest during the colder months of the year, based on the quarterly averages shown in Table 7-4. A review of the data shows that 22 of GPCO's 23 benzene concentrations greater than 1 $\mu g/m^3$ were measured during the first or fourth quarters of 2014 (and the one exception was in late September). Conversely, the 10 lowest benzene concentrations were measured between April and August, during the second or third quarters of 2014. Similarly, all 22 of GPCO's 1,3-butadiene concentrations greater than 0.15 $\mu g/m^3$ were measured during the first or fourth quarters of 2014 while 10 of the 11 lowest concentrations were measured between April and August. Ethylbenzene concentrations also appear to exhibit this tendency, with the second quarter average significantly lower than the other quarterly average concentrations. The highest ethylbenzene concentration measured during the second quarter of 2014 is lower than the average concentration for the year and all but one of the seven ethylbenzene concentrations less than 0.2 $\mu g/m^3$ were measured at GPCO during the second quarter.

- Second quarter average concentrations for acenaphthene and naphthalene are not provided in Table 7-4. Several PAH samples collected in April were invalidated as a result of laboratory equipment issues. In addition, the site experienced sampler issues in June. Thus, the criteria for calculating a quarterly average concentration was not met.

- Concentrations of acenaphthene appear considerably higher during the warmer months of the year, based on the quarterly averages shown in Table 7-4. A review of the data shows that of 16 acenaphthene concentrations greater than 10 ng/m^3, all but two were measured between July and September. In addition, none of the 17 acenaphthene concentrations less than 4 ng/m^3 were measured during the third quarter while between three (second quarter) and nine (first quarter) were measured during the other calendar quarters.

- GPCO is one of only four NMP sites with an annual average concentration of naphthalene greater than 100 ng/m^3 (100.03 ± 13.48 ng/m^3). Concentrations of naphthalene measured at GPCO range from 26.6 ng/m^3 to 245 ng/m^3 with all three of GPCO's naphthalene concentrations greater than 200 ng/m^3 measured in January 2014. Twenty-five naphthalene concentrations measured at GPCO are greater than 100 ng/m^3; only DEMI (29) has more individual naphthalene measurements greater than 100 ng/m^3 than GPCO, although BXNY ties GPCO with 25.

Observations for the Garfield County sites from Table 7-4 include the following:

- Although acetaldehyde and formaldehyde are pollutants of interest for each Garfield County site, annual average concentrations of these carbonyl compounds could not be calculated for BRCO, PACO, or RFCO because the completeness criteria for this method is less than 85 percent for each site, as discussed in Section 2.4. In addition, BMCO does not have a second quarter average concentration for these pollutants because there were too few valid samples collected during this calendar quarter. Thus,

RICO is the only Garfield County site with four quarterly averages and an annual average presented in Table 7-4 for formaldehyde and acetaldehyde.

- The annual average concentrations of acetaldehyde and formaldehyde for BMCO and RICO are fairly similar to each other and significantly less than the annual averages for GPCO. In fact, RICO and BMCO have the two lowest annual average concentrations of acetaldehyde and second and third lowest annual average concentrations of formaldehyde among NMP sites sampling carbonyl compounds.

- BMCO and BRCO are missing several quarterly average benzene concentrations and do not have an annual average concentration for benzene presented. These are a result of summertime sampling issues at BMCO and a series of invalid samples in May and August at BRCO. Among the other three Garfield County sites, the annual average benzene concentration ranges from 0.46 ± 0.09 $\mu g/m^3$ (RFCO) to 1.49 ± 0.14 $\mu g/m^3$ (PACO). The annual average benzene concentration for PACO is the highest among all NMP sites sampling this pollutant, with RICO's annual average ranking third (1.09 ± 0.14 $\mu g/m^3$). A review of the data shows that PACO has the highest number of benzene concentrations greater than 1 $\mu g/m^3$ among all NMP sites sampling benzene (49, or 86 percent of samples collected, with the next highest site at 33). Conversely, RFCO is tied for lowest, with only one benzene concentration greater than 1 $\mu g/m^3$. This site has the second lowest annual average concentration of benzene among NMP sites. The quarterly average concentrations of benzene reflect a similar pattern in the magnitude of the benzene measurements. Note that the first and fourth quarter average concentrations of benzene for RICO are significantly higher than the third quarter average concentration (and a quarterly average concentration could not be calculated for the second quarter of 2014). A review of this site's data shows that all of the benzene concentrations measured between March and August 2014 are less than 1 $\mu g/m^3$, ranging from 0.289 $\mu g/m^3$ to 0.944 $\mu g/m^3$. Conversely, most of the concentrations measured during the rest of 2014 are greater than 1 $\mu g/m^3$, and range from 0.72 $\mu g/m^3$ to 2.51 $\mu g/m^3$.

- 1,3-Butadiene is also a pollutant of interest for PACO, RFCO, and RICO. The annual average concentration for RICO is three times greater than the annual averages calculated for PACO and RFCO. Note that the second and third quarter average concentrations for 1,3-butadiene for PACO and RICO are both 0, indicating that this pollutant was not detected at these sites during these two calendar quarters. 1,3-Butadiene was detected in only seven samples collected at RFCO and in 14 samples collected at PACO, compared to 33 samples collected at RICO. Only one non-detect of 1,3-butadiene was measured at RICO during the first and fourth quarters of 2014 while few measured detections were measured during the second and third quarters of 2014. In fact, there were no measured detections of 1,3-butadiene measured at RICO between mid-May and early September and only six measured during the second and third quarters. Concentrations of 1,3-butadiene measured at these three sites were highest during the fourth quarter and is reflected in the fourth quarter average concentrations.

- The only other pollutant of interest shown in Table 7-4 is ethylbenzene for RICO. Concentrations of ethylbenzene also appear highest during the fourth quarter of 2014 at RICO, although the difference is not significant.

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

- Annual average concentrations for the Colorado sites appear in Tables 4-9 through 4-12 a total of nine times, with GPCO appearing the most (6).

- PACO has the highest annual average concentration of benzene among all NMP sites sampling this pollutant, as indicated above, with RICO (third highest) and GPCO (eighth highest) also appearing in Table 4-9.

- GPCO and RICO have the fifth and ninth highest annual average concentrations of 1,3-butadiene, respectively, among NMP sites sampling this pollutant.

- GPCO also ranks third for its annual average concentration of ethylbenzene.

- GPCO's annual average concentration of acetaldehyde ranks second highest among NMP sites sampling carbonyl compounds, as shown in Table 4-10. GPCO also ranks fourth for its annual average concentration of formaldehyde.

- GPCO has the fourth highest annual concentration of naphthalene among NMP sites sampling PAHs, as shown in Table 4-11.

7.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for each of the pollutants listed in Table 7-4 for each site. Note that the box plots for benzene, 1,3-butadiene, and ethylbenzene were split into separate figures, one for samples collected and analyzed with Method TO-15 (GPCO) and one for samples collected and analyzed with the SNMOC method (the Garfield County sites), where annual averages could be calculated. Figures 7-14 through 7-24 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 7-14. Program vs. Site-Specific Average Acenaphthene Concentration

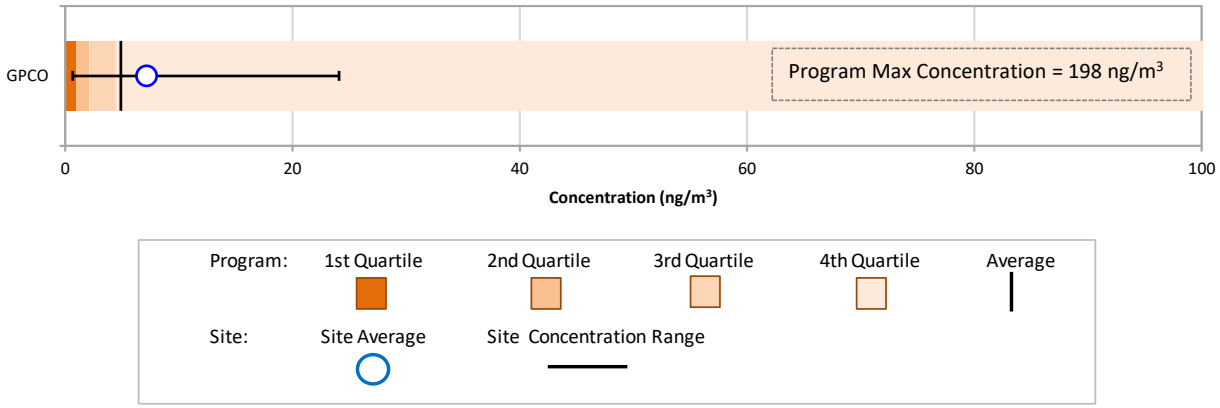


Figure 7-14 presents the box plot for acenaphthene for GPCO and shows the following:

- The program-level maximum acenaphthene concentration (198 ng/m^3) is not shown directly on the box plot in Figure 7-14 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced to 100 ng/m^3.

- GPCO's annual average concentration of acenaphthene is greater than the program-level average concentration as well as the program-level third quartile. This site has the fourth highest annual average concentration of acenaphthene among NMP sites sampling PAHs. Yet, the range of concentrations shown in Figure 7-14 appears relatively small as the maximum concentration measured at GPCO is considerably less than the maximum concentration measured across the program. A review of the data shows that all 35 acenaphthene measurements greater than GPCO's maximum acenaphthene concentration were measured at only three other NMP sites (NBIL, ROCH, and DEMI). Concentrations of acenaphthene measured at GPCO range from 0.66 ng/m^3 to 24.1 ng/m^3, with a median concentration of 5.98 ng/m^3, which is the third-highest median concentration among sites sampling this pollutant.

Figure 7-15. Program vs. Site-Specific Average Acetaldehyde Concentrations

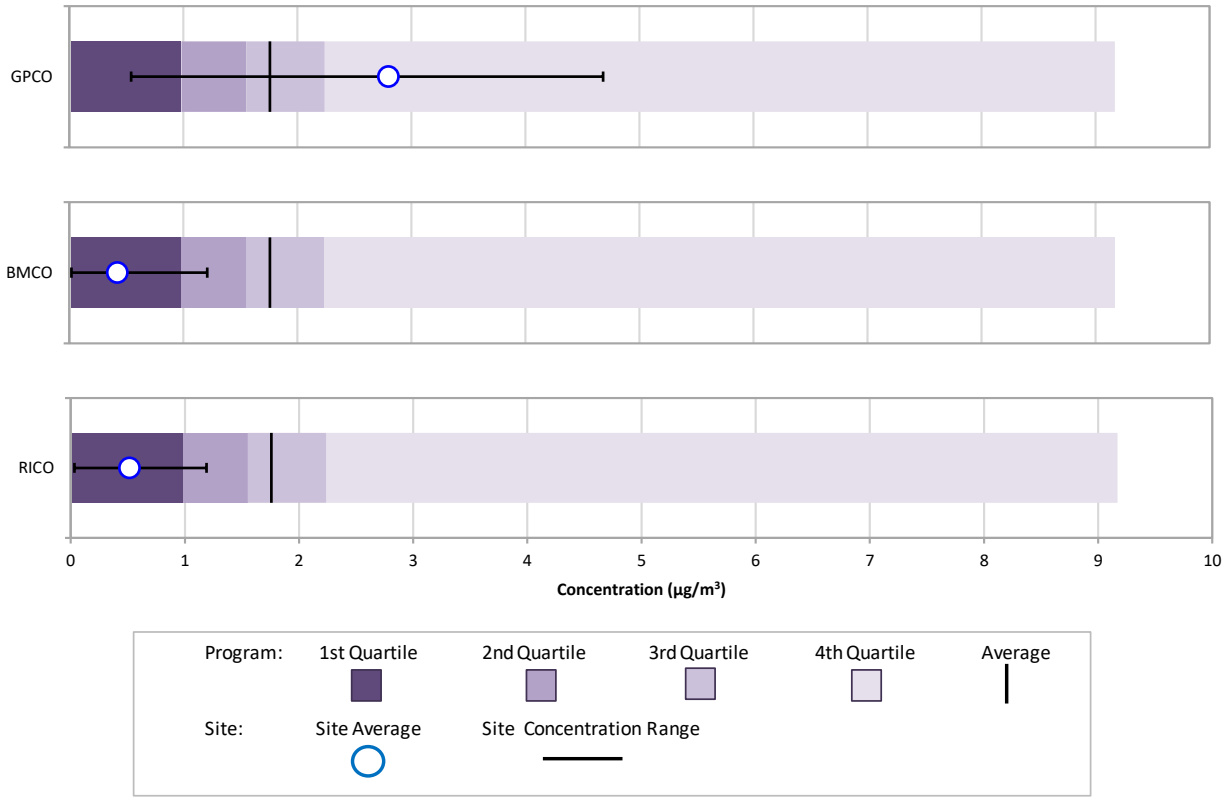


Figure 7-15 presents the box plots for acetaldehyde and shows the following:

- Figure 7-15 presents the box plots for GPCO, BMCO, and RICO, the three Colorado sites for which annual average concentrations for acetaldehyde could be calculated.

- The box plots show that the range of acetaldehyde concentrations measured at GPCO is considerably larger than the range of concentrations measured at the two Garfield County sites shown. GPCO has the highest annual average acetaldehyde concentration among the Colorado sites, where they could be calculated. The annual average concentration for GPCO is more than five times greater than the annual average acetaldehyde concentrations for BMCO and RICO, and is the second highest annual average among NMP sites sampling carbonyl compounds. The minimum acetaldehyde concentration measured at GPCO is greater than the annual average concentrations for BMCO and RICO, an observation that was also made in the 2013 and 2012 NMP reports. The entire range of acetaldehyde concentrations measured at BMCO and RICO is less than the program-level average and median concentrations. Recall from the previous section that these two sites have the lowest annual average acetaldehyde concentrations among NMP sites sampling carbonyl compounds.

Figure 7-16. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

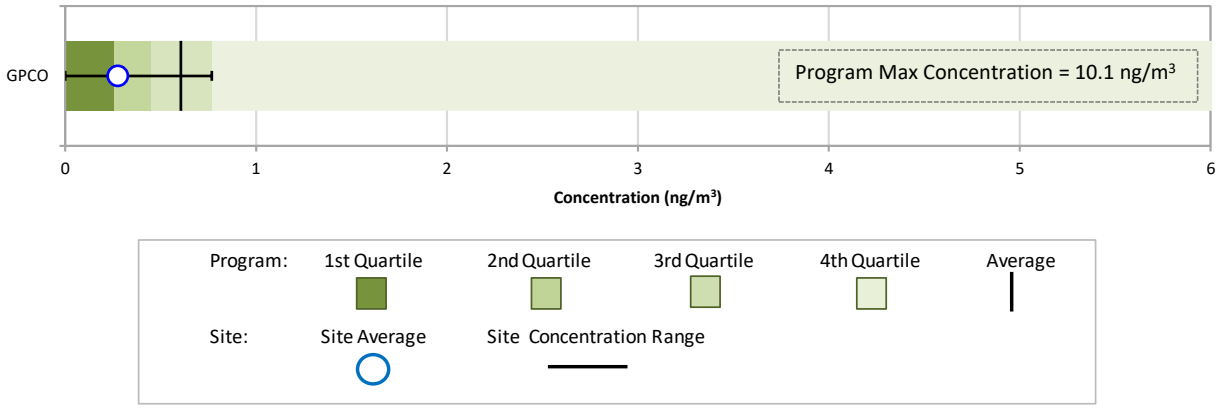


Figure 7-16 presents the box plot for arsenic for GPCO and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot because the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range.

- GPCO's maximum arsenic concentration is similar to the program-level third quartile, and is the lowest maximum concentration among NMP sites sampling this pollutant. The annual average concentration of arsenic for GPCO is just greater than the program-level first quartile. This site has the second-lowest annual average concentration of arsenic among NMP sites sampling arsenic.

Figure 7-17a. Program vs. Site-Specific Average Benzene (Method TO-15) Concentration

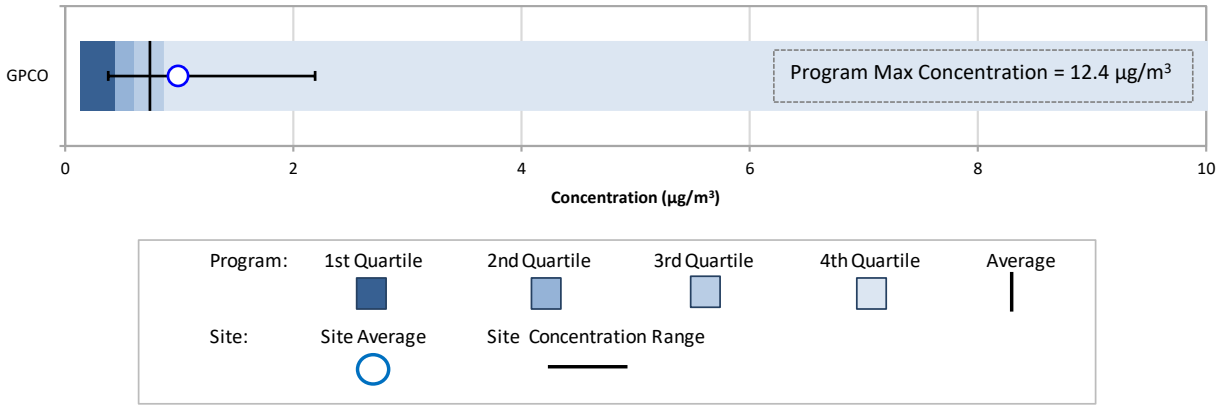
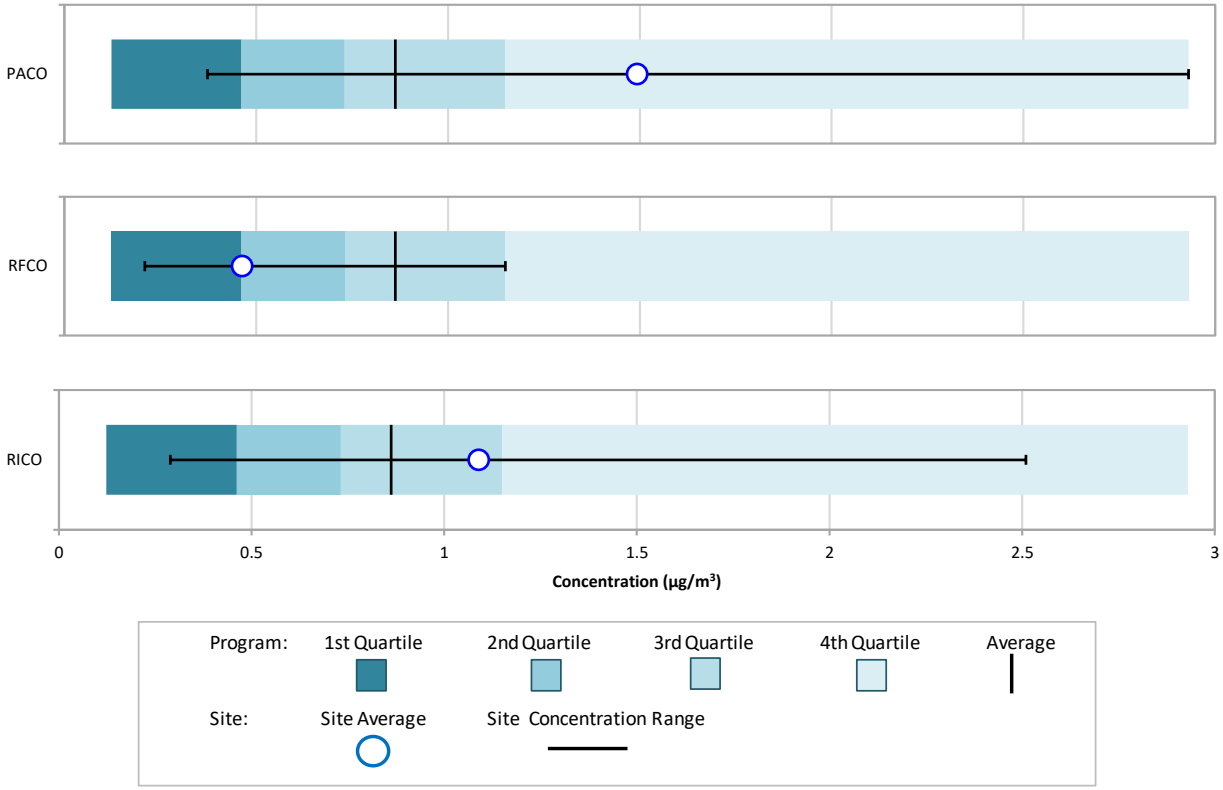


Figure 7-17b. Program vs. Site-Specific Average Benzene (SNMOC) Concentrations



Figures 7-17a and 7-17b present the box plots for benzene and show the following:

- Figure 7-17a presents the minimum, maximum, and annual average concentration of benzene for GPCO compared to the benzene concentrations measured across the program for NMP sites sampling VOCs with Method TO-15; Figure 7-17b presents the minimum, maximum, and annual average benzene concentrations for the Garfield County sites compared to the benzene concentrations measured across the program for NMP sites sampling SNMOCs. Note that the scales are not the same in the figures.

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plot in Figure 7-17a because the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range.

- Figure 7-17a shows that the annual average benzene concentration for GPCO is higher than the program-level average concentration and the program-level third quartile. The maximum benzene concentration measured at GPCO is considerably less than the maximum benzene concentration measured across the program. Even though the range of benzene concentrations for GPCO appears relatively small, this site has the sixth highest annual average benzene concentration among NMP sites sampling benzene with Method TO-15.

- Figure 7-17b includes a box plot for three of the five Garfield County sites. The maximum benzene concentration measured at PACO is the maximum benzene concentration measured among the seven NMP sites sampling SNMOCs (2.93 µg/m^3). Of the Garfield County sites, PACO has the highest annual average concentration of benzene, followed by RICO and RFCO. The range of benzene concentrations measured at RFCO is considerably smaller than the ranges shown for the other Garfield County sites. This site's annual average benzene concentration is equivalent to the program-level first quartile.

Figure 7-18a. Program vs. Site-Specific Average 1,3-Butadiene (Method TO-15) Concentration

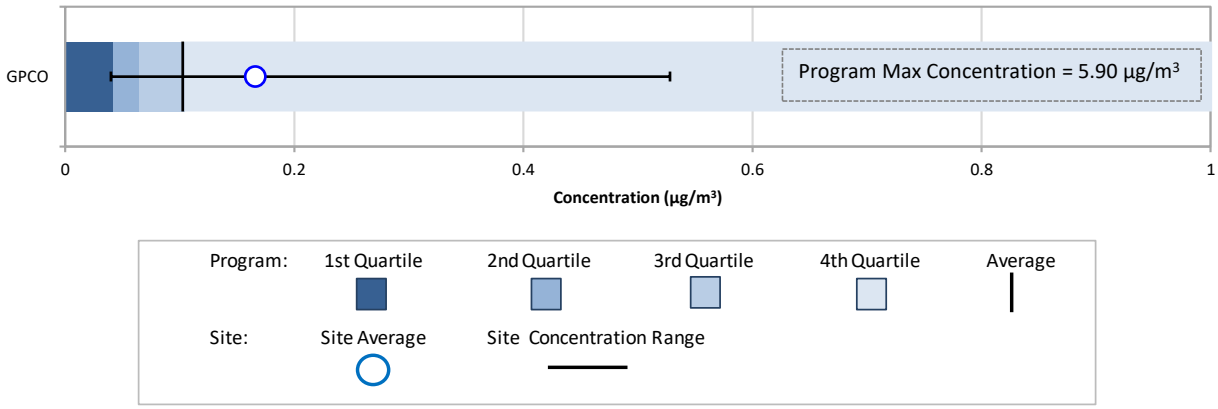
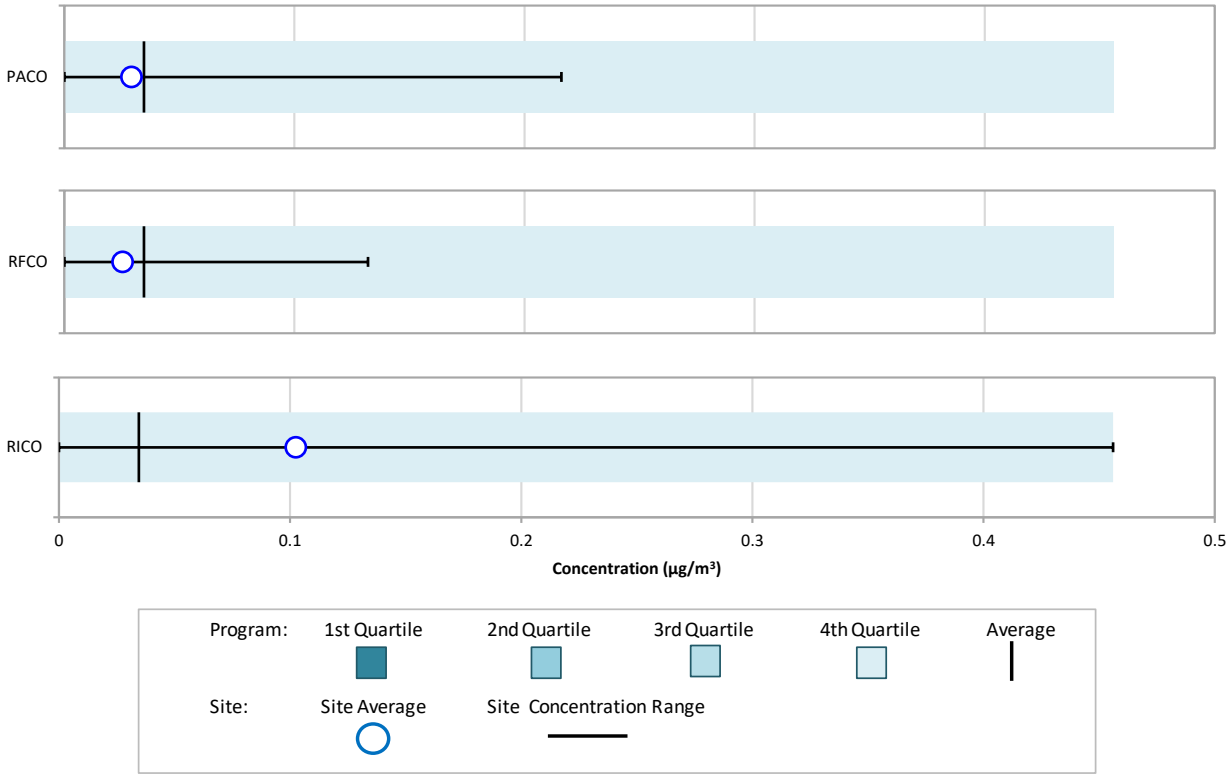


Figure 7-18b. Program vs. Site-Specific Average 1,3-Butadiene (SNMOC) Concentrations



Figures 7-18a and 7-18b present the box plots for 1,3-butadiene and show the following:

- Similar to the box plots for benzene, Figure 7-18a presents the minimum, maximum, and annual average concentration of 1,3-butadiene for GPCO compared to the 1,3-butadiene concentrations measured across the program for NMP sites sampling VOCs with Method TO-15; Figure 7-18b presents the minimum, maximum, and annual average 1,3-butadiene concentrations for the Garfield County sites compared to the 1,3-butadiene concentrations measured across the program for NMP sites sampling SNMOCs. Note that the scales are not the same in the figures.

- The program-level maximum 1,3-butadiene concentration (5.90 $\mu g/m^3$) is not shown directly on the box plot in Figure 7-18a because the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range.

- Figure 7-18a shows that the maximum 1,3-butadiene concentration measured at GPCO is an order of magnitude less than the program-level maximum concentration. GPCO's annual average concentration of 1,3-butadiene is greater than the program-level average concentration and the program-level third quartile and is the fifth highest annual average concentration among NMP sites sampling 1,3-butadiene with Method TO-15. The minimum concentration of 1,3-butadiene measured at GPCO is similar to the program-level first quartile.

- Figure 7-18b includes a box plot for PACO, RFCO, and RICO, the Garfield County sites for which 1,3-butadiene is a pollutant of interest. The program-level first, second, and third quartiles are zero, and thus, not visible in Figure 7-18b, indicating that at least half of the 1,3-butadiene concentrations measured by sites sampling SNMOCs were non-detects. The box plots show that non-detects were measured at each of the Garfield County sites shown. The maximum 1,3-butadiene concentration measured at RICO (0.460 $\mu g/m^3$) is at least twice the maximum concentration measured among the remaining Garfield County sites. Of the Garfield County sites shown, RICO has the highest annual average concentration of 1,3-butadiene, followed by PACO and RFCO. The annual average concentrations for PACO and RFCO are less the program-level average concentration while RICO's annual average is three times the program-level average concentration (among sites sampling SNMOCs).

Figure 7-19. Program vs. Site-Specific Average Carbon Tetrachloride Concentration

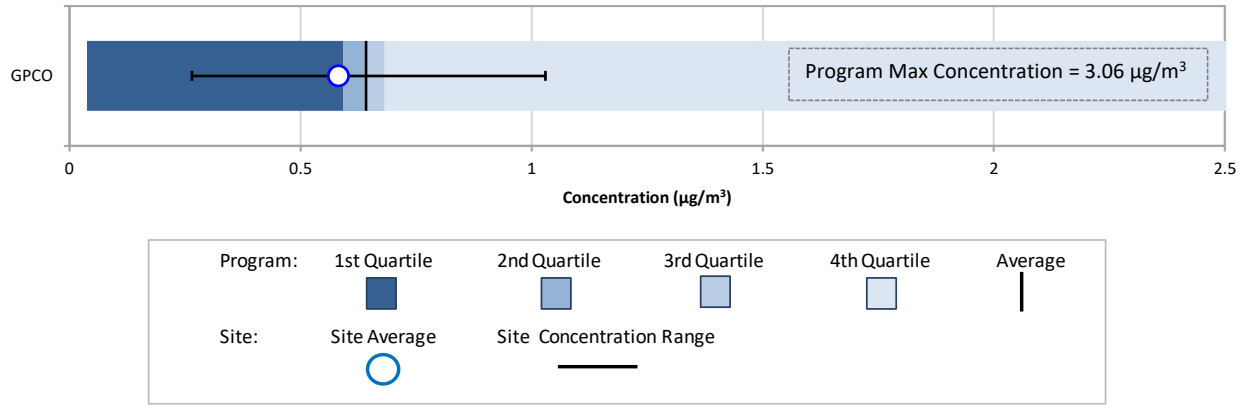


Figure 7-19 presents the box plot for carbon tetrachloride for GPCO and shows the following:

- The program-level maximum carbon tetrachloride concentration (3.06 µg/m^3) is not shown directly on the box plot in Figure 7-19 because the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range.

- The maximum carbon tetrachloride concentration measured at GPCO is considerably less than the program-level maximum concentration. The annual average carbon tetrachloride concentration for GPCO is just less than the program-level first quartile. The annual average carbon tetrachloride concentration for GPCO is the lowest annual average among NMP sites sampling this pollutant. However, the variability in the annual averages among NMP sites is rather small, with less than 0.1 µg/m^3 separating most sites' annual averages.

Figure 7-20. Program vs. Site-Specific Average 1,2-Dichloroethane Concentration

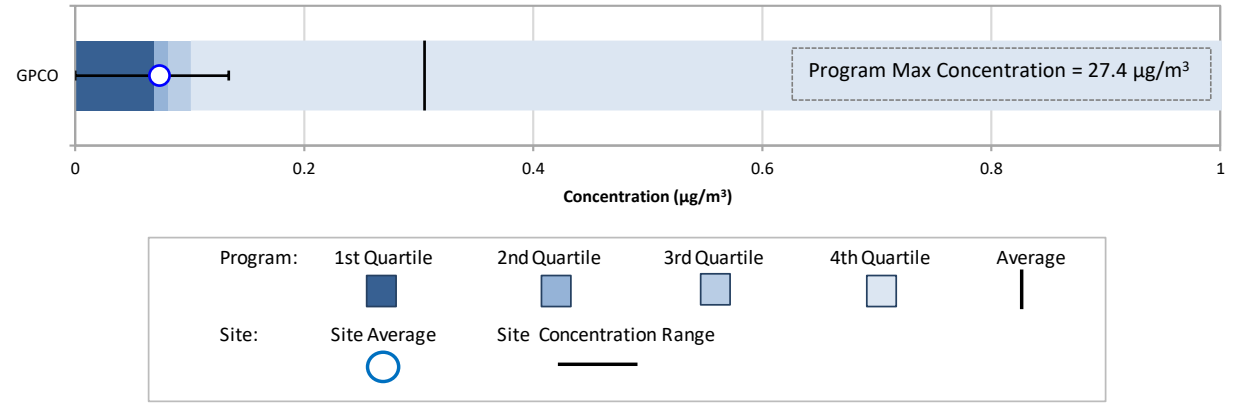


Figure 7-20 presents the box plot for 1,2-dichloroethane for GPCO and shows the following:

- The program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is not shown directly on the box plot in Figure 7-20 as the program-level maximum concentration is considerably greater than the majority of concentrations measured across the program.

- All of the concentrations of 1,2-dichloroethane measured at GPCO are less than the program-level average concentration of 0.31 µg/m^3 and GPCO's maximum concentration is half the magnitude of the program-level average concentration. The annual average concentration for GPCO falls between program-level first quartile and median concentration. Note that the program-level average concentration is being driven by the measurements at the upper end of the concentration range.

Figure 7-21a. Program vs. Site-Specific Average Ethylbenzene (Method TO-15) Concentration

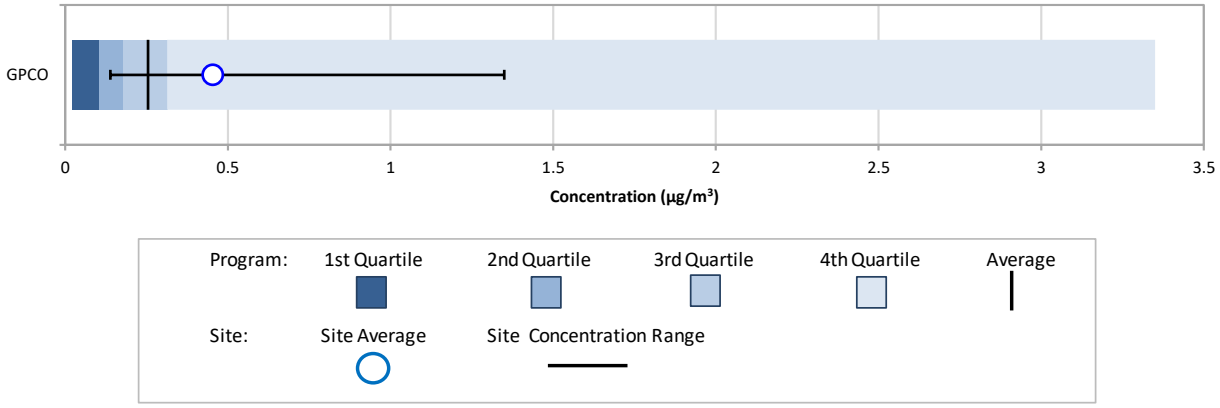
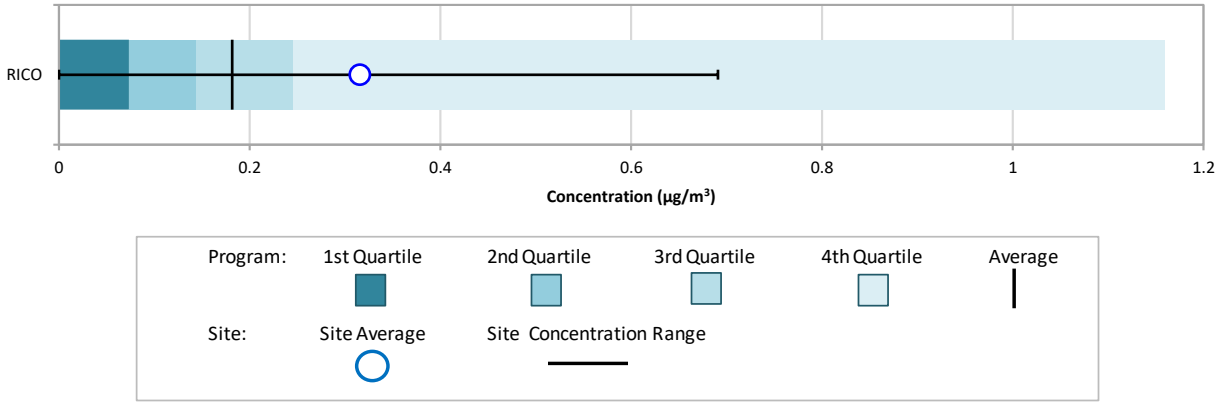


Figure 7-21b. Program vs. Site-Specific Average Ethylbenzene (SNMOC) Concentration



Figures 7-21a and 7-21b present the box plots for ethylbenzene and show the following:

- Ethylbenzene is a pollutant of interest for GPCO and RICO; thus, Figure 7-21a presents the minimum, maximum, and annual average concentration of ethylbenzene for GPCO compared to the ethylbenzene concentrations measured across the program

for NMP sites sampling VOCs with Method TO-15 while Figure 7-21b presents the minimum, maximum, and annual average 1,3-butadiene concentrations for RICO compared to the ethylbenzene concentrations measured across the program for NMP sites sampling SNMOCs. Note that the scales are not the same in the figures.

- Figure 7-21a shows that the maximum ethylbenzene concentration measured at GPCO is less than half the magnitude of the program-level maximum concentration. GPCO's annual average concentration of ethylbenzene is greater than the program-level average concentration and the program-level third quartile. GPCO has the third highest annual average concentration among NMP sites sampling ethylbenzene. The minimum concentration of ethylbenzene measured at GPCO is greater than the program-level first quartile.

- Figure 7-21b shows that the annual average ethylbenzene concentration for RICO is greater than the program-level average concentration and the program-level third quartile for sites sampling SNMOCs. The range of ethylbenzene concentrations measured at RICO ranges from 0.125 µg/m^3 to 0.691 µg/m^3, as well as two non-detects.

Figure 7-22. Program vs. Site-Specific Average Formaldehyde Concentrations

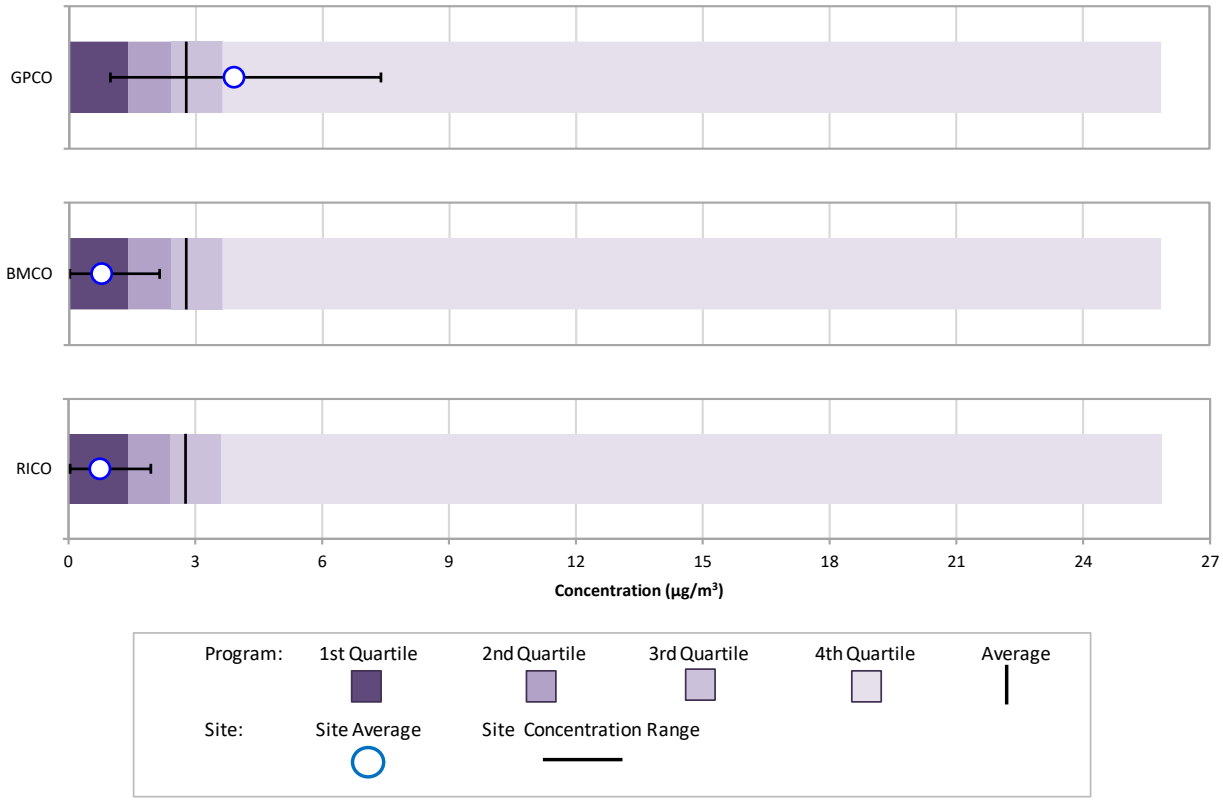


Figure 7-22 presents the box plots for formaldehyde and shows the following:

- Figure 7-22 presents the box plots for GPCO, BMCO, and RICO, the three Colorado sites for which annual average concentrations could be calculated. The box plots for

formaldehyde exhibit similar concentration patterns to those shown in the box plots for acetaldehyde in Figure 7-15.

- The box plots show that the range of formaldehyde concentrations measured at GPCO is considerably larger than the range of concentrations measured at the two Garfield County sites shown. GPCO has the highest annual average formaldehyde concentration among the Colorado sites, where they could be calculated. The annual average concentration for GPCO is nearly four times greater than the annual average formaldehyde concentrations for BMCO and RICO, and is the fourth highest annual average among NMP sites sampling formaldehyde. The minimum formaldehyde concentration measured at GPCO is greater than the annual average concentrations calculated for BMCO and RICO, an observation that was also made in the 2013 and 2012 NMP reports. The entire range of formaldehyde concentrations measured at BMCO and RICO is less than the program-level average and median concentrations for 2014. Recall from the previous section that these two sites have some of the lowest annual average formaldehyde concentrations among NMP sites sampling carbonyl compounds.

Figure 7-23. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentration

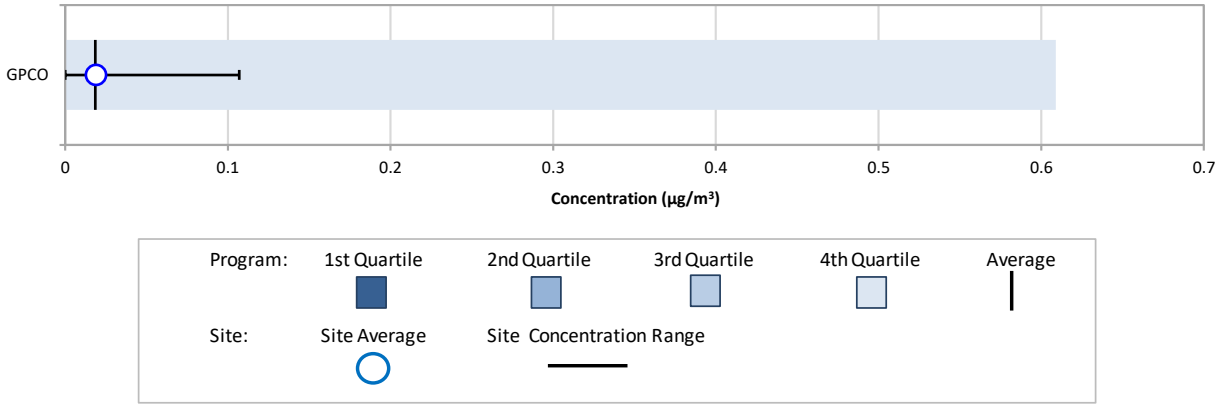


Figure 7-23 presents the box plot for hexachloro-1,3-butadiene for GPCO and shows the following:

- The program-level first, second (median), and third quartiles are all zero for hexachloro-1,3-butadiene and therefore not visible on the box plot. This is due to the large number of non-detects of this pollutant across the program (77 percent). Fifty-seven valid VOC samples were collected at GPCO and of these, hexachloro-1,3-butadiene was detected in only 13 of them. Thus, many zeroes are substituted into the annual average concentration of this pollutant.

- The maximum hexachloro-1,3-butadiene concentration measured at GPCO is about one-sixth the magnitude of the maximum hexachloro-1,3-butadiene concentration measured across the program. The annual average concentration for GPCO is similar to the program-level average concentration of hexachloro-1,3-butadiene.

Figure 7-24. Program vs. Site-Specific Average Naphthalene Concentration

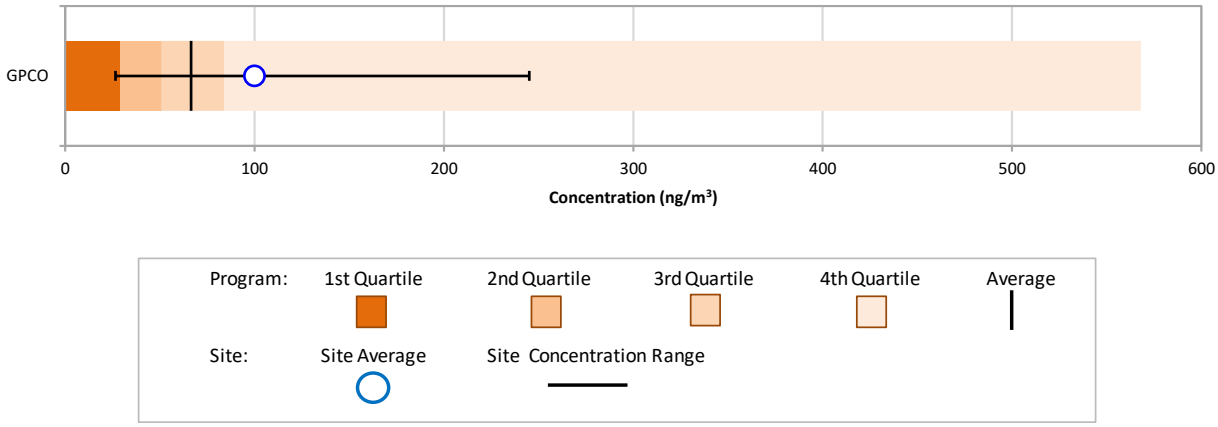


Figure 7-24 presents the box plot for naphthalene for GPCO and shows the following:

- GPCO is one of four NMP sites sampling naphthalene with an annual average concentration greater than 100 ng/m^3. Recall from the previous section that GPCO has the fourth highest annual average naphthalene concentration among NMP sites sampling PAHs. The annual average naphthalene concentration for GPCO is greater than the program-level average concentration and the program-level third quartile. The minimum concentration of naphthalene measured at GPCO is just less than the program-level first quartile.

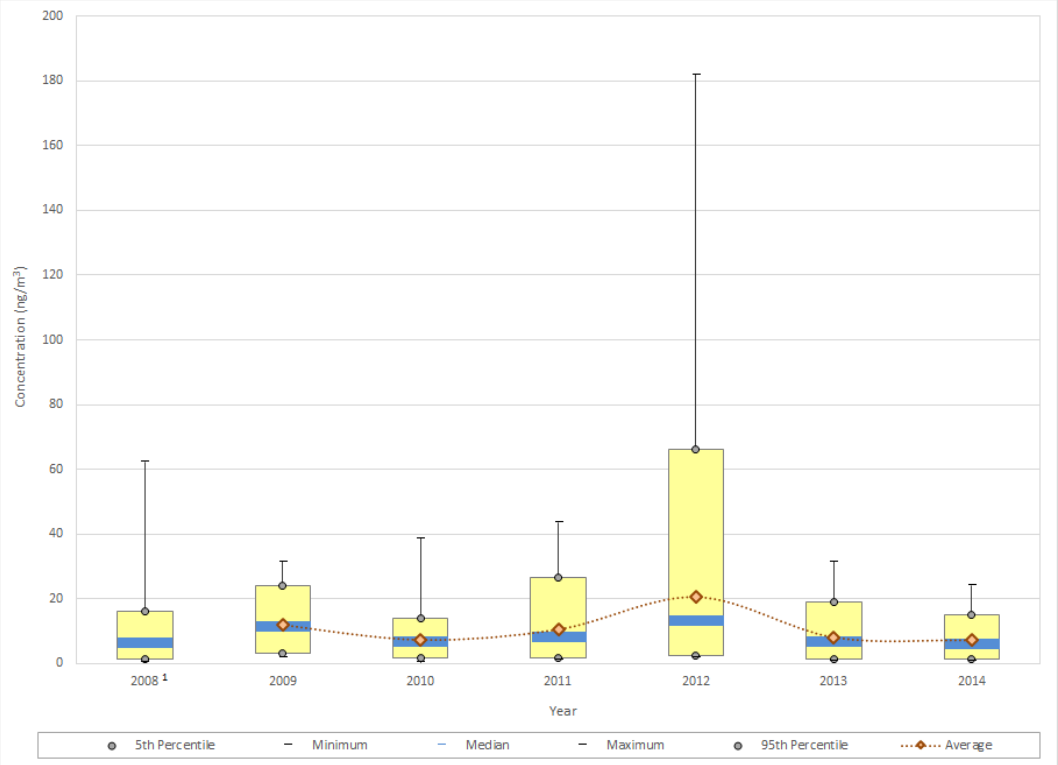
7.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. GPCO has sampled carbonyl compounds and VOCs under the NMP since 2004, PAHs since 2008, and metals since 2014; thus, Figures 7-25 through 7-34 present the 1-year statistical metrics for each of the pollutants of interest for GPCO except arsenic, since metals have not been sampled at this site for the minimum of 5 consecutive years. BRCO, PACO, and RICO began sampling SNMOCs and carbonyl compounds under the NMP in 2008, thus, Figures 7-35 through 7-46 present the 1-year statistical metrics for each of the pollutants of interest for these three sites.

The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. While BMCO began sampling SNMOCs and carbonyl compounds under the NMP in 2010, sampling did not begin until September 2010,

which is less than the 6-month requirement; thus, the trends analysis was not conducted for this site. RFCO began sampling in 2012, which is less than 5 years of sampling, excluding this site from trends analysis as well.

Figure 7-25. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at GPCO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 7-25 for acenaphthene concentrations measured at GPCO include the following:

- Sampling for PAHs at GPCO began under the NMP in April 2008. Because a full year's worth of data is not available for 2008, a 1-year average is not presented, although the range of measurements is provided.

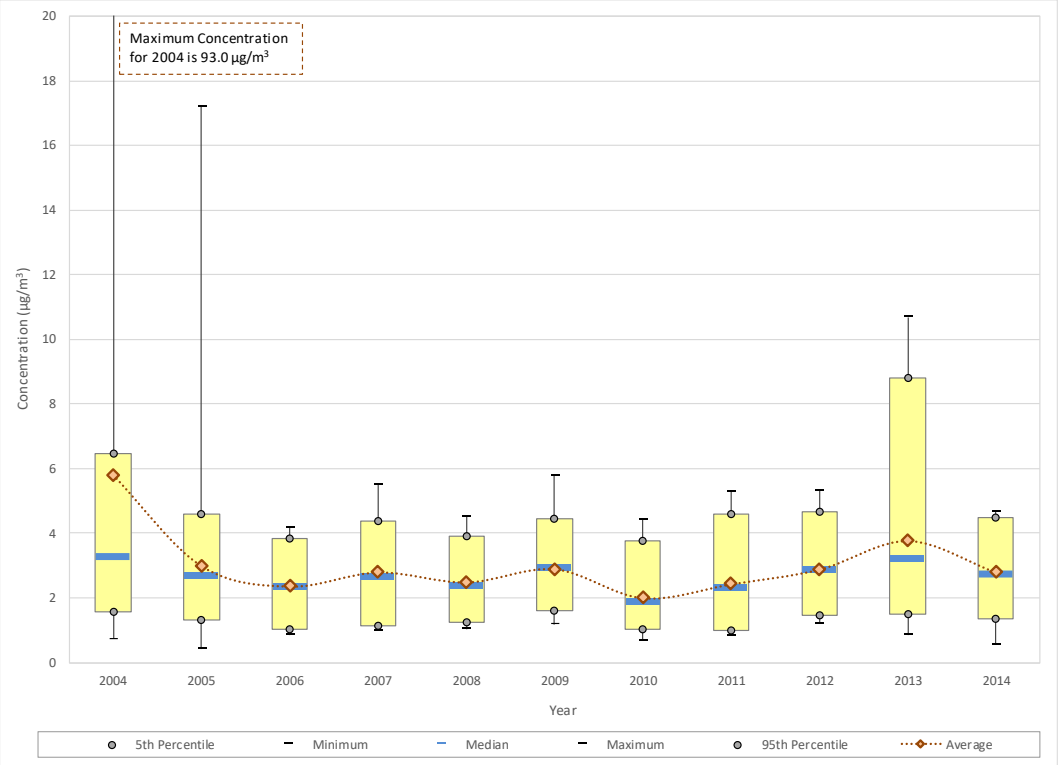
- Five of the six highest concentrations of acenaphthene were measured at GPCO during the spring of 2012 and ranged from 53.7 ng/m^3 to 182 ng/m^3. The only other measurement greater than 50 ng/m^3 collected at GPCO was measured in November 2008 (62.2 ng/m^3).

- Concentrations of acenaphthene decreased significantly from 2009 to 2010, based on the 1-year averages, after which a steady increasing trend is shown through 2012. Concentrations measured in 2012 were higher overall compared to other years; for example, nine of the 16 acenaphthene concentrations greater than 30 ng/m^3 were measured in 2012 while only one or two were measured in each of the other years of sampling (except 2014 when none were measured). Even if the two highest

concentrations measured in 2012 were removed from the dataset, the 1-year average concentration for acenaphthene for 2012 would still represent more than a 50 percent increase from 2011.

- All of the statistical metrics shown in Figure 7-25 exhibit a decrease for 2013. Both the 1-year average and median concentrations decreased by more than half from 2012 to 2013. Each of the statistical parameters exhibit additional decreases for 2014; the 1-year average, median, and maximum concentrations are at a minimum for 2014.

Figure 7-26. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at GPCO



Observations from Figure 7-26 for acetaldehyde concentrations measured at GPCO include the following:

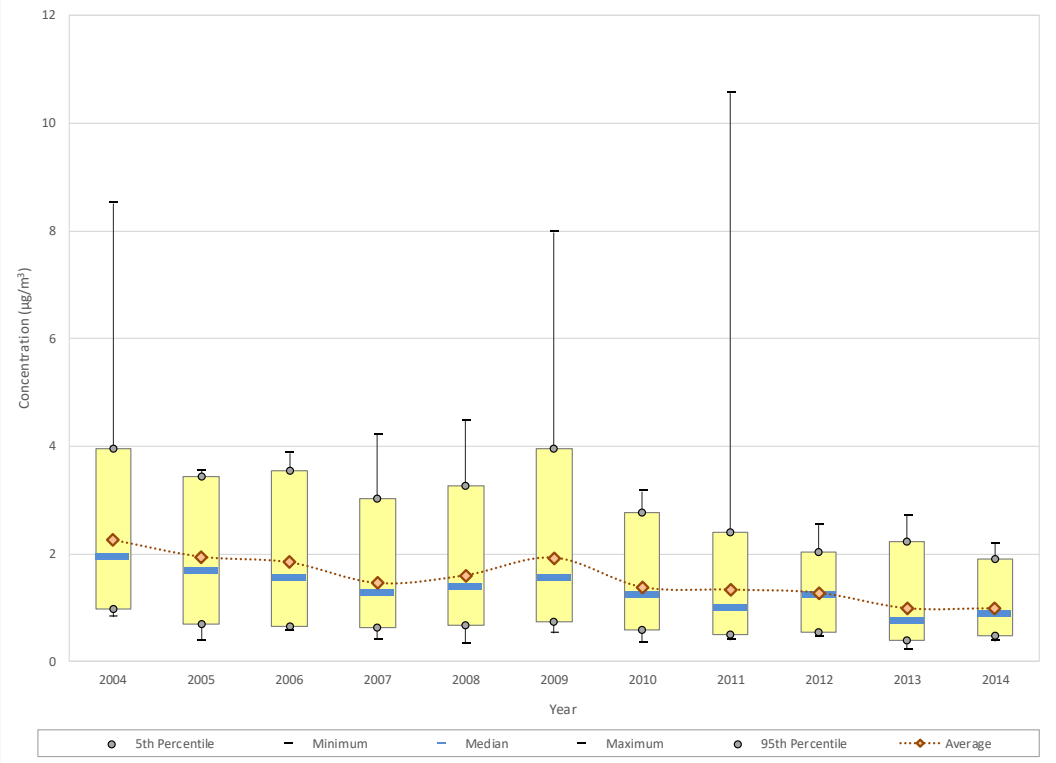
- The maximum acetaldehyde concentration was measured at GPCO in 2004. The two highest acetaldehyde concentrations (93.0 µg/m^3 and 54.9 µg/m^3) were both measured in 2004. The maximum concentrations measured in subsequent years were significantly lower as no additional concentrations greater than 20 µg/m^3 were measured. The third highest acetaldehyde concentration (17.2 µg/m^3) was measured in 2005 after which acetaldehyde concentrations greater than 7 µg/m^3 were not measured again until 2013. In 2013, seven concentrations ranging from 7.00 µg/m^3 to 10.7 µg/m^3 were measured.

- Between 2005 and 2012, the 1-year average concentrations vary by less than 1 µg/m^3, ranging from 2.00 µg/m^3 (2010) to 3.00 µg/m^3 (2005). The 1-year average and median concentrations are both at a minimum for 2010, representing a statistically

significant decrease from 2009. The 1-year average concentration increases steadily between 2010 and 2013, with the 1-year average at a maximum since 2004. The median concentration exhibits a similar pattern.

- Concentrations measured in 2014 return to levels near those shown for 2012, although both the minimum and maximum concentrations for 2014 are among the lowest measured at GPCO for each year shown.

Figure 7-27. Yearly Statistical Metrics for Benzene Concentrations Measured at GPCO



Observations from Figure 7-27 for benzene concentrations measured at GPCO include the following:

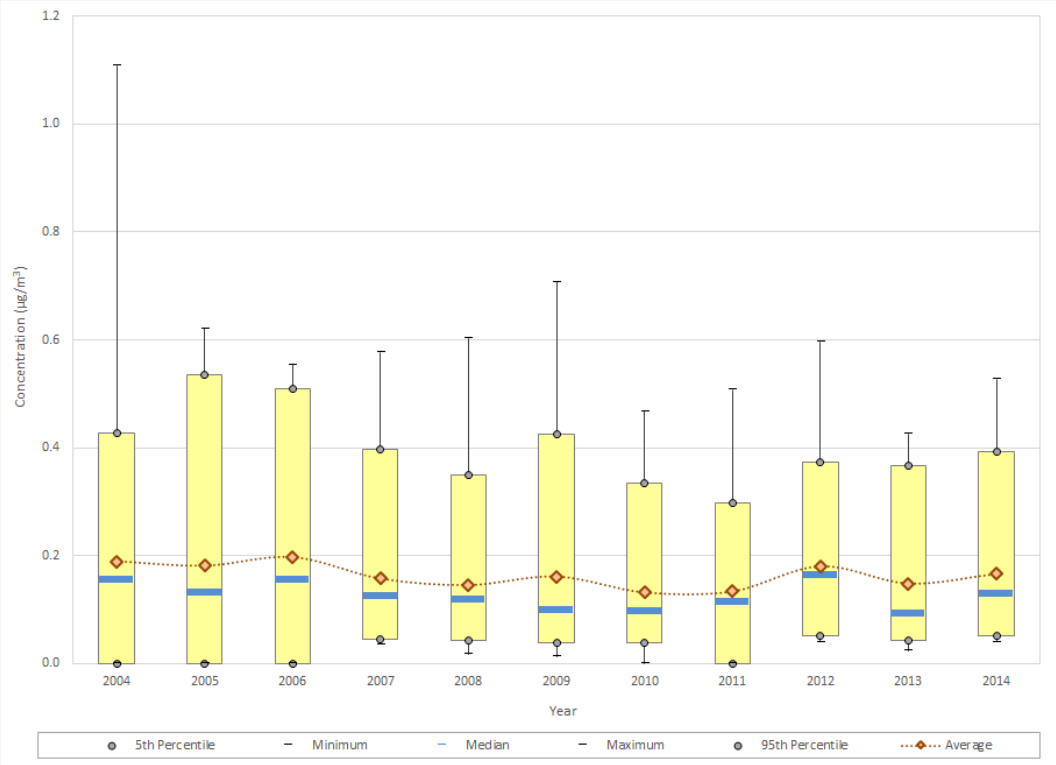
- The maximum benzene concentration (10.6 µg/m^3) was measured on June 8, 2011. Only three additional benzene concentrations greater than 5 µg/m^3 have been measured at GPCO, two in 2004 and one in 2009.

- Concentrations of benzene have a decreasing trend between 2004 and 2007, based on the 1-year average and median concentrations. After a period of increasing for 2008 and 2009, a significant decrease is shown for 2010. This decreasing trend continues through 2014, when several of the statistical metrics are at a minimum. This is also true for the median concentration, except that the median increases slightly for 2014.

- The range of benzene concentrations measured is at a minimum for 2014, with less than 2 µg/m^3 separating the minimum and maximum concentrations, and the 1-year average, 95th percentile, and maximum concentrations are at a minimum for the years

shown. Yet, the median concentration exhibits a slight increase from 2013 to 2014. The number of benzene concentrations falling between 1 µg/m^3 and 2 µg/m^3 doubled from 2013 (10) to 2014 (20), accounting for more than one-third of the concentrations measured in 2014.

Figure 7-28. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at GPCO



Observations from Figure 7-28 for 1,3-butadiene concentrations measured at GPCO include the following:

- The only 1,3-butadiene concentration greater than 1 µg/m^3 measured at GPCO was measured on December 11, 2004. The second highest concentration was also measured in 2004 (0.75 µg/m^3), although a similar concentration was measured in 2009 (0.71 µg/m^3).

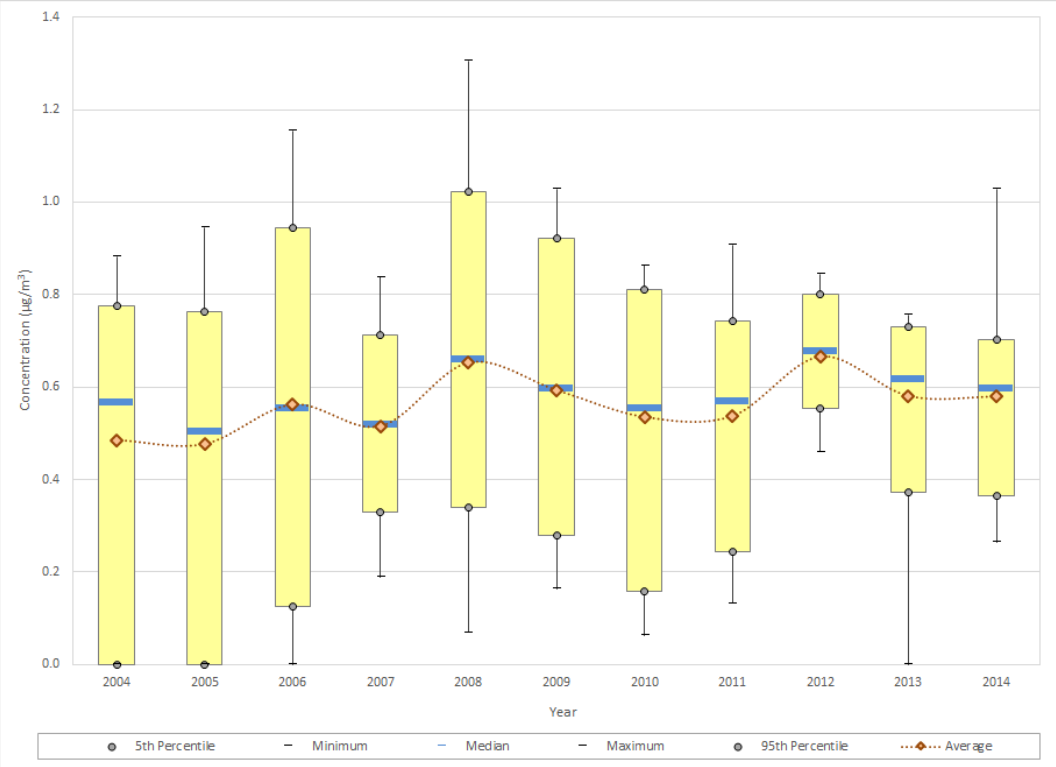
- The 1-year average concentrations have an undulating pattern and vary by less than 0.07 µg/m^3 over the years of sampling, ranging from 0.132 µg/m^3 (2010) to 0.197 µg/m^3 (2006).

- The increase in the 1-year average concentration from 2011 to 2012 represents the largest year-to-year change (approximately 0.05 µg/m^3). The median also increased by this much from 2011 to 2012. Not only are the measurements at the upper end of the concentration range higher for 2012 compared to 2011, but there were also no non-detects reported for 2012, while there were seven reported for 2011.

- The largest year-to-year change in the median concentration is the decrease shown from 2012 to 2013. Although non-detects were not measured in either year, the number of 1,3-butadiene measurements less than 0.1 µg/m^3 nearly doubled from 2012 (17) to 2013 (31), thus, representing half of the measurements for 2013.

- Each of the statistical parameters exhibits a slight increase from 2013 to 2014.

Figure 7-29. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at GPCO



Observations from Figure 7-29 for carbon tetrachloride concentrations measured at GPCO include the following:

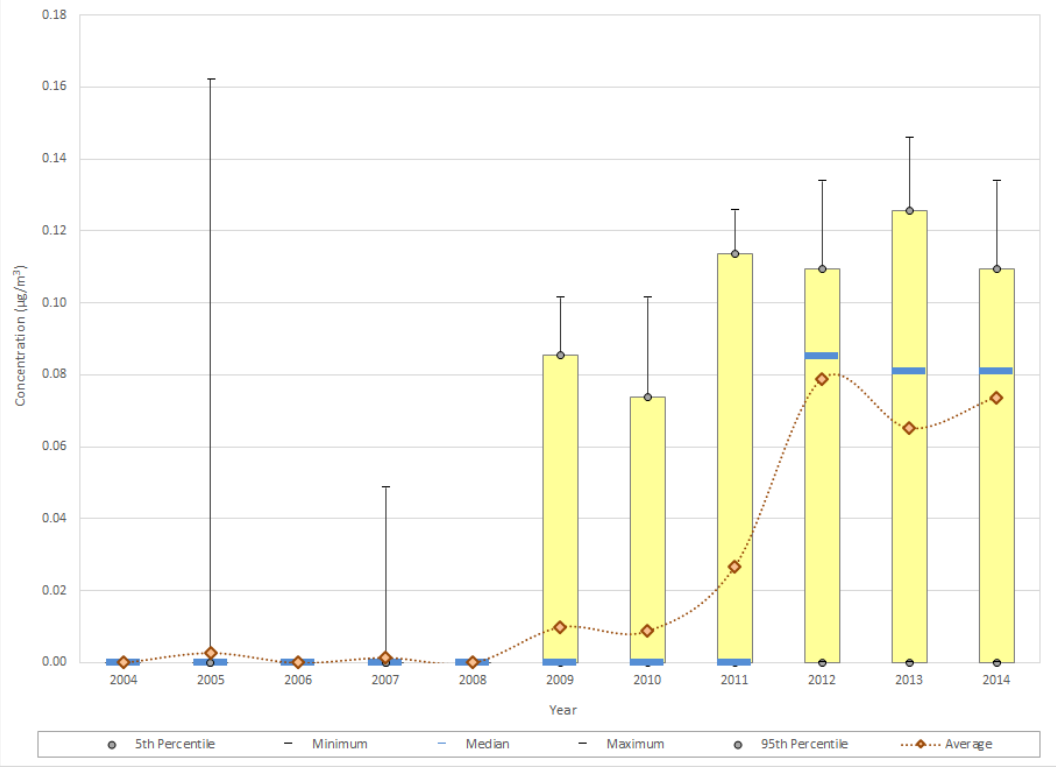
- Seven concentrations of carbon tetrachloride greater than 1 µg/m^3 have been measured at GPCO (four in 2008, and one each in 2006, 2009, and 2014). Conversely, 16 non-detects have been measured (nine in 2004, five in 2005, and one each in 2006 and 2013).

- The year with the least variability is 2012, with a difference of 0.38 µg/m^3 between the minimum and maximum concentrations and a difference of 0.24 µg/m^3 between the 5th and 95th percentiles. However, the year with the highest 1-year average and median concentrations (0.67 µg/m^3 and 0.68 µg/m^3, respectively) is also 2012. Note the difference between the minimum and 5th percentile for 2012 compared to other years (where the 1-year average and/or median concentrations for a given year are less than the 5th percentile for 2012).

- For most of the years of sampling, the median concentration is slightly higher than the 1-year average concentration. This indicates that the concentrations at the lower end of the concentration range are pulling down the 1-year average in the same manner than an outlier can drive an average upward. However, the difference between the 1-year average and median concentrations for most years is less than 0.05 µg/m^3.

- There is a significant increase in the 1-year average concentrations from 2007 to 2008 as the range of concentrations measured doubled from one year to the next. After 2008, a steady decreasing trend is shown through 2010, with little change in the measurements from 2010 to 2011. These statistical parameters increased significantly from 2011 to 2012, and are at a maximum for the period of sampling. All of the statistical metrics exhibit a decrease from 2012 to 2013, primarily as a result of the higher number of concentrations at the lower end of the concentration range. The number of carbon tetrachloride concentrations less than 0.5 µg/m^3 increased from one in 2012 to 12 in 2013. While the central tendency statistics changed little for 2014, the minimum concentration appears to have increased considerably. The lowest concentration measured actually varies little, the difference is a result of a non-detect.

Figure 7-30. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at GPCO



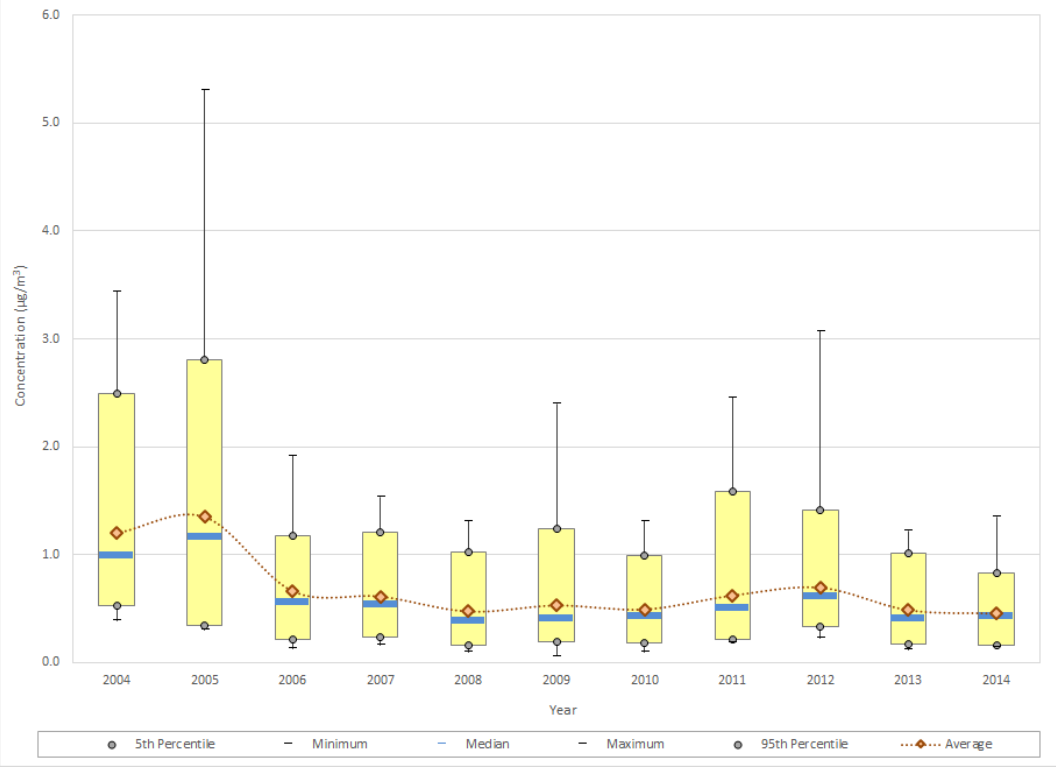
Observations from Figure 7-30 for 1,2-dichloroethane concentrations measured at GPCO include the following:

- Between 2004 and 2008, there were only three measured detections of 1,2-dichloroethane measured at GPCO. The median concentration is zero for all years through 2011, indicating that at least 50 percent of the measurements were non-detects prior to 2012. The number of measured detections began to increase in 2009, from 12 percent for 2009 and 2010, to 27 percent in 2011, and 90 percent for 2012. The percentage of measured detections decreased slightly for 2013 (74 percent) but approached 90 percent again for 2014.

- As the number of measured detections increases, so do each of the corresponding statistical metrics shown in Figure 7-30. The percentage of measured detections increased by 63 percent from 2011 to 2012, thus, the 1-year average and median concentrations exhibit considerable increases.

- The median concentration is greater than the 1-year average concentration for 2012, 2013, and 2014. This is because there were still non-detects (or zeros) factoring into the 1-year average concentration for each year, which tend to pull the average down. Excluding non-detects, the minimum concentration for 2012 would be 0.04 µg/m^3, with a difference between the minimum and maximum concentrations measured for 2012 of less than 0.1 µg/m^3. This is also true for 2013 and 2014.

Figure 7-31. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at GPCO



Observations from Figure 7-31 for ethylbenzene concentrations measured at GPCO include the following:

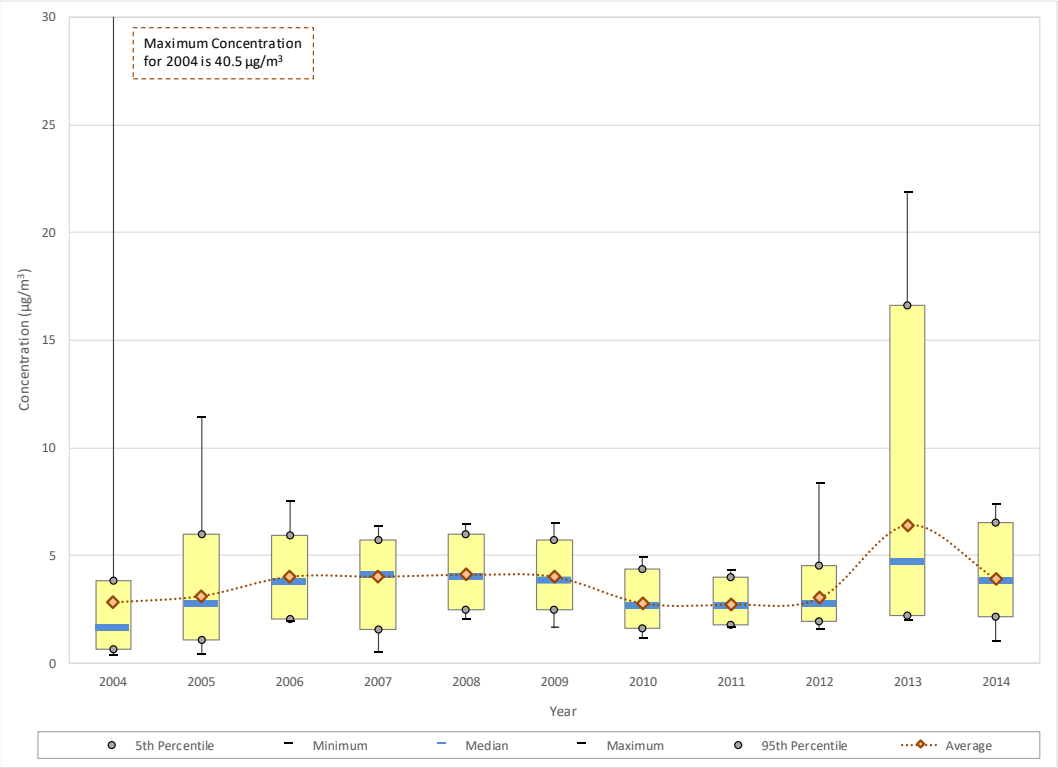
- The maximum ethylbenzene concentration was measured at GPCO in 2005 (5.31 µg/m^3), as was the second highest concentration (3.96 µg/m^3). Three additional concentrations greater than 3 µg/m^3 have been measured at GPCO, two in 2004 and one in 2012. All but two of the 18 ethylbenzene measurements greater than 2 µg/m^3 were measured during these three years.

- The 1-year average concentration increased from 2004 to 2005, although there is a relatively high level of variability in the measurements. A significant decrease in all of the statistical parameters is shown from 2005 to 2006, with a slight decreasing trend continuing through 2008.

- Although the maximum concentration measured increased by more than 1 µg/m^3 from 2008 to 2009, only a slight change in the 1-year and median concentrations is exhibited for 2009. The range of concentrations measured in 2010 is similar to the range of concentrations measured in 2008. An increasing trend in the 1-year average concentration is shown from 2010 through 2012. The median concentration exhibits a slight increasing trend beginning with 2009 and continuing through 2012.

- All of the statistical parameters exhibit a decrease from 2012 to 2013. The maximum ethylbenzene concentration measured in 2013 is the lowest maximum concentration for any given year of sampling shown in Figure 7-31. Although the range of ethylbenzene concentrations measured increased just slightly for 2014, the 1-year average concentration is at a minimum across the years of sampling (as is the 95th percentile).

Figure 7-32. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at GPCO



Observations from Figure 7-32 for formaldehyde concentrations measured at GPCO include the following:

- The trends graph for formaldehyde resembles the trends graph for acetaldehyde in that the maximum formaldehyde concentration (40.5 µg/m^3) was measured in 2004 and is significantly higher than the maximum concentrations measured in subsequent years. The second highest concentration was also measured in 2004 (23.5 µg/m^3); these two concentrations of formaldehyde were measured on the same days in 2004 as the two highest acetaldehyde concentrations. The next eight highest formaldehyde concentrations were measured at GPCO in 2013 and range from 13.9 µg/m^3 to 21.9 µg/m^3.

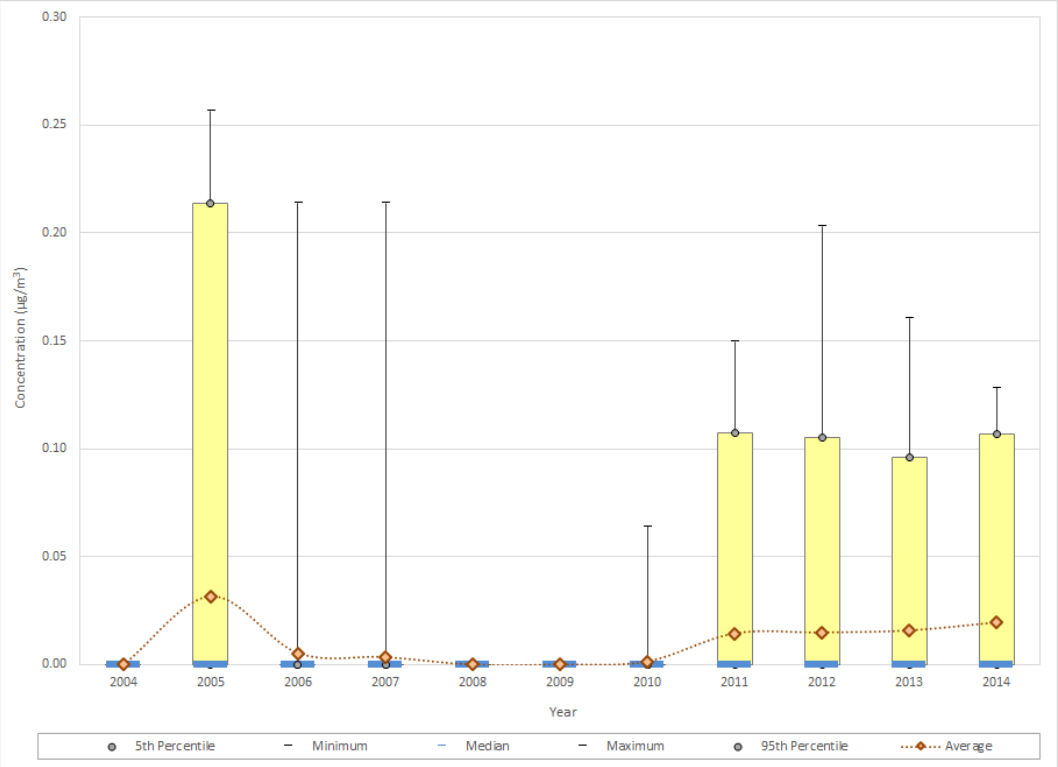
- Even with decreasing maximum concentrations, the 1-year average concentrations have an increasing trend through 2006. The 1-year average concentration is approximately 4 µg/m^3 for each year between 2006 and 2009. A significant decrease in all of the statistical metrics is shown for 2010. Although an even smaller range of concentrations was measured in 2011, there is little change in the 1-year average concentration between 2010 and 2011. With a few higher concentrations measured in 2012, the 1-year average calculated for 2012 is slightly higher than the 1-year average concentrations for the previous two years, although the increase is not statistically significant.

- All of the statistical parameters exhibit increases for 2013, particularly those representing concentrations at the upper end of the concentration range. The 1-year average concentration for 2013 is greater than the maximum concentrations measured

in several of the previous years and is greater than the 95th percentile for each of the previous years. Even the median concentration, which is less affected by outlier concentrations, increased by more than 70 percent from 2012 to 2013.

- All of the statistical metrics for 2014 exhibit a decrease from 2013 levels, although the 1-year average and median concentrations are still higher than they were in the three years prior to 2013.

Figure 7-33. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at GPCO



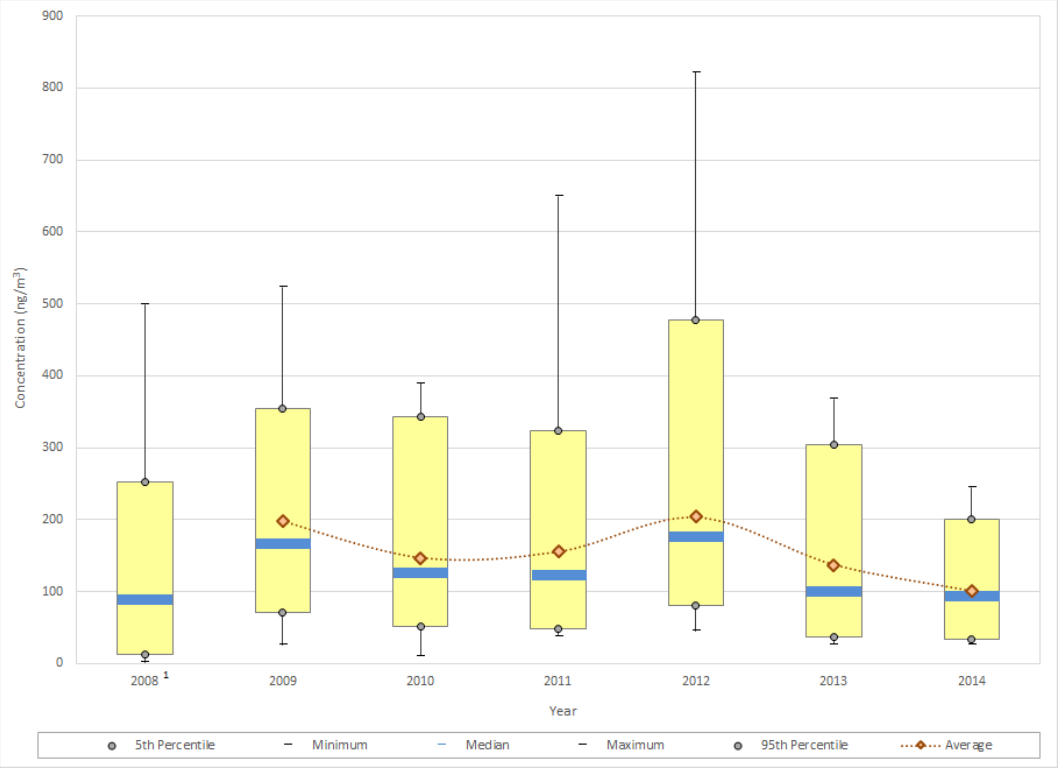
Observations from Figure 7-33 for hexachloro-1,3-butadiene concentrations measured at GPCO include the following:

- The number of measured detections of hexachloro-1,3-butadiene for each year is very low, from zero measured detections in 2004, 2008, and 2009 to 13 (or 23 percent) for 2014. This explains why the minimum, 5th percentile, and median concentrations (and in some cases, the 1-year averages) are all zero for each year of sampling. The detection rate has increased slightly over the last few years. Additional years of sampling are needed to determine if this trend continues.

- The maximum hexachloro-1,3-butadiene concentration was measured in 2005 (0.26 µg/m^3). Although nine additional measurements greater than 0.20 µg/m^3 have been measured at GPCO, all but one of these were measured between 2005 and 2007.

- The large number of non-detects, and thus zeroes substituted into the calculations, combined with few measured detections results in relatively low 1-year average concentrations with relatively large confidence intervals.

Figure 7-34. Yearly Statistical Metrics for Naphthalene Concentrations Measured at GPCO



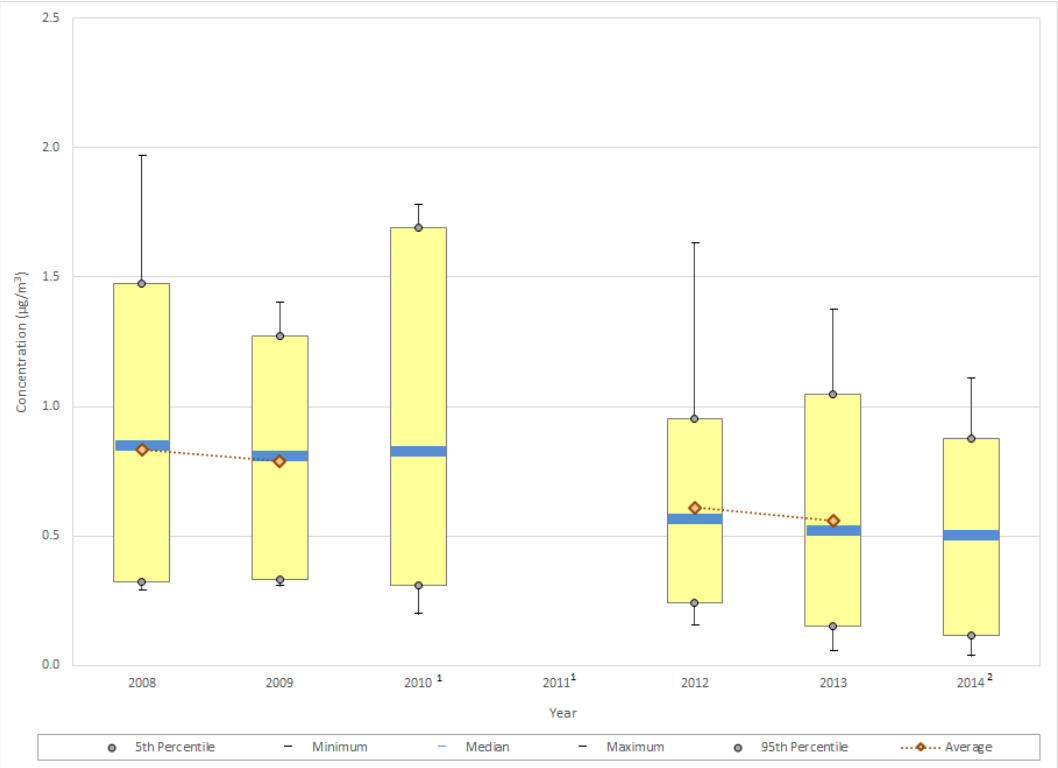
[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 7-34 for naphthalene concentrations measured at GPCO include the following:

- The maximum naphthalene concentration measured at GPCO was measured in 2012 (822 ng/m^3). Concentrations of 400 ng/m^3 or higher have been measured in four of the seven years of sampling and concentrations greater than 250 ng/m^3 have been measured in all years of sampling except 2014.

- The trends graph for naphthalene resembles the trends graphs for acenaphthene shown in Figure 7-25. The 1-year average concentration for naphthalene decreased significantly from 2009 to 2010. A slight increase from 2010 to 2011 is followed by an additional increase for 2012. All of the statistical parameters increased from 2011 to 2012 and are at a maximum across the years of sampling. This was followed by a decrease in 2013 to levels less than those shown for 2011. The smallest range of naphthalene concentrations was measured in 2014, with all of the statistical parameters exhibiting decreases from 2013 to 2014. The 1-year average concentration, the 95th percentile, and the maximum concentration for 2014 are at a minimum across the years of sampling.

Figure 7-35. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at BRCO



[1] There was a gap in sampling between October 2010 and September 2011.
[2] A 1-year average is not presented due to low method completeness in 2014.

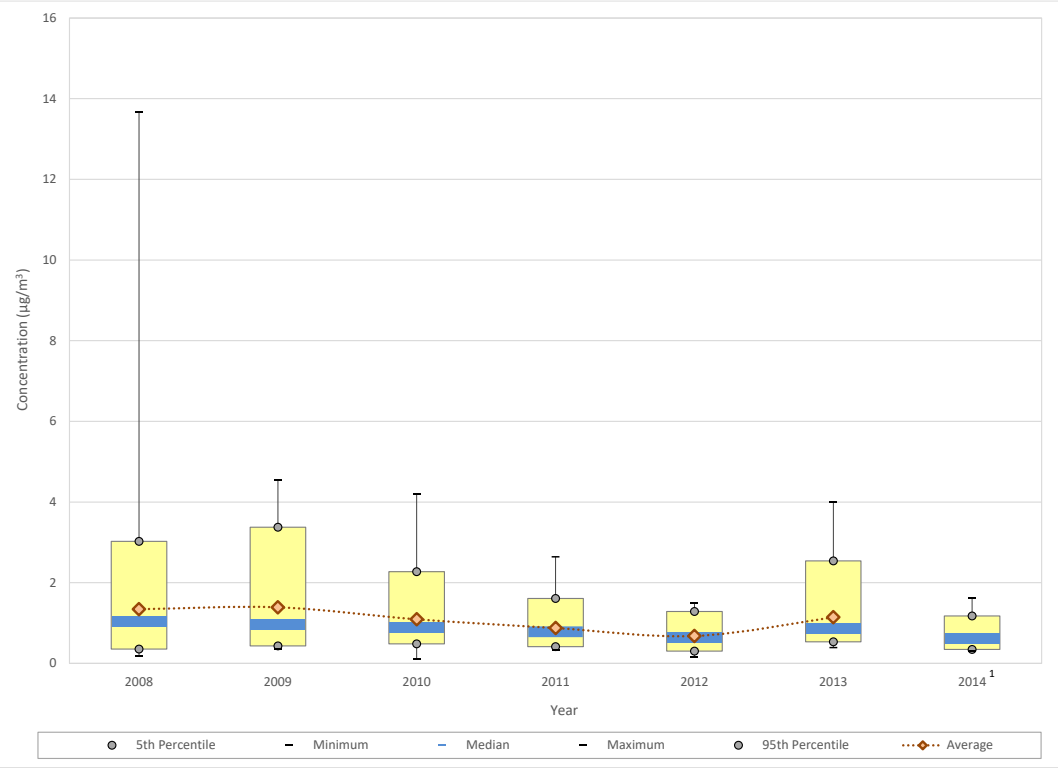
Observations from Figure 7-35 for acetaldehyde concentrations measured at BRCO include the following:

- BRCO began sampling carbonyl compounds under the NMP in February 2008. A 1-year average concentration is not presented for 2010 and statistical metrics are not provided for 2011. This is because sampling was discontinued in October 2010 and did not begin again until September 2011. In addition, the completeness criteria was not met for 2014, and thus, a 1-year average concentration is not provided for 2014. Note that carbonyl compounds are sampled on a 1-in-12 sampling schedule at BRCO.

- The maximum acetaldehyde concentration (1.97 µg/m^3) was measured on the second day of sampling, February 12, 2008. In total, only 27 acetaldehyde concentrations greater than 1 µg/m^3 have been measured at BRCO since the onset of sampling.

- Concentrations of acetaldehyde measured at BRCO have a decreasing trend across the years of sampling, and nearly all of the statistical parameters at a minimum for 2014.

Figure 7-36. Yearly Statistical Metrics for Benzene Concentrations Measured at BRCO



[1] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-36 for benzene concentrations measured at BRCO include the following:

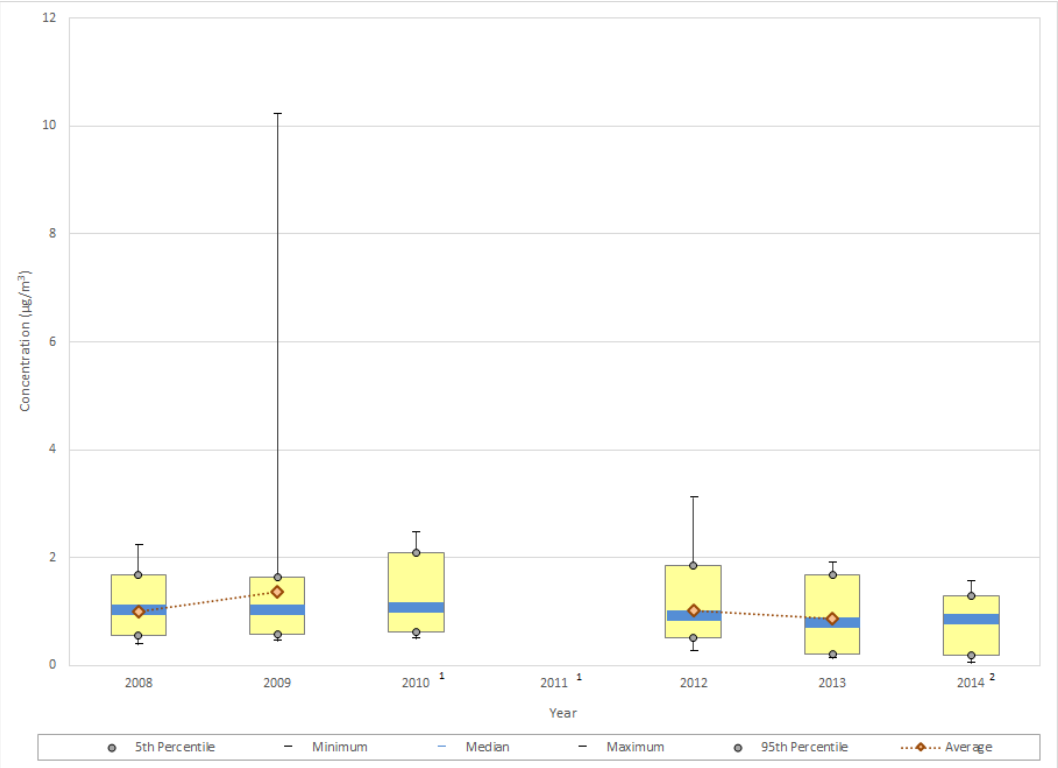
- BRCO began sampling benzene under the NMP in January 2008. Similar to acetaldehyde, a 1-year average concentration is not provided for benzene for 2014 as the completeness criteria was not met.

- The maximum benzene concentration (13.7 µg/m^3) was measured on July 29, 2008 and is three times greater than the next highest concentration (4.55 µg/m^3, measured on January 7, 2009). Two additional benzene concentrations greater than 4 µg/m^3 have been measured at BRCO, another in 2009 and one in 2010.

- The statistical parameters for benzene exhibit a steady decreasing trend over the years of sampling at BRCO between 2009 and 2012. Prior to 2013, the 1-year average concentration decreased by roughly half, from a maximum of 1.39 µg/m^3 in 2009 to a minimum of 0.68 µg/m^3 in 2012. The median concentration also decreased, from 1.05 µg/m^3 in 2008 to 0.65 µg/m^3 in 2012.

- All of the statistical metrics exhibit an increase from 2012 to 2013, returning to concentration levels similar to 2010. This is followed by a return to 2012 levels for 2014, based on the available statistical metrics.

Figure 7-37. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at BRCO



[1] There was a gap in sampling between October 2010 and September 2011.
[2] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-37 for formaldehyde concentrations measured at BRCO include the following:

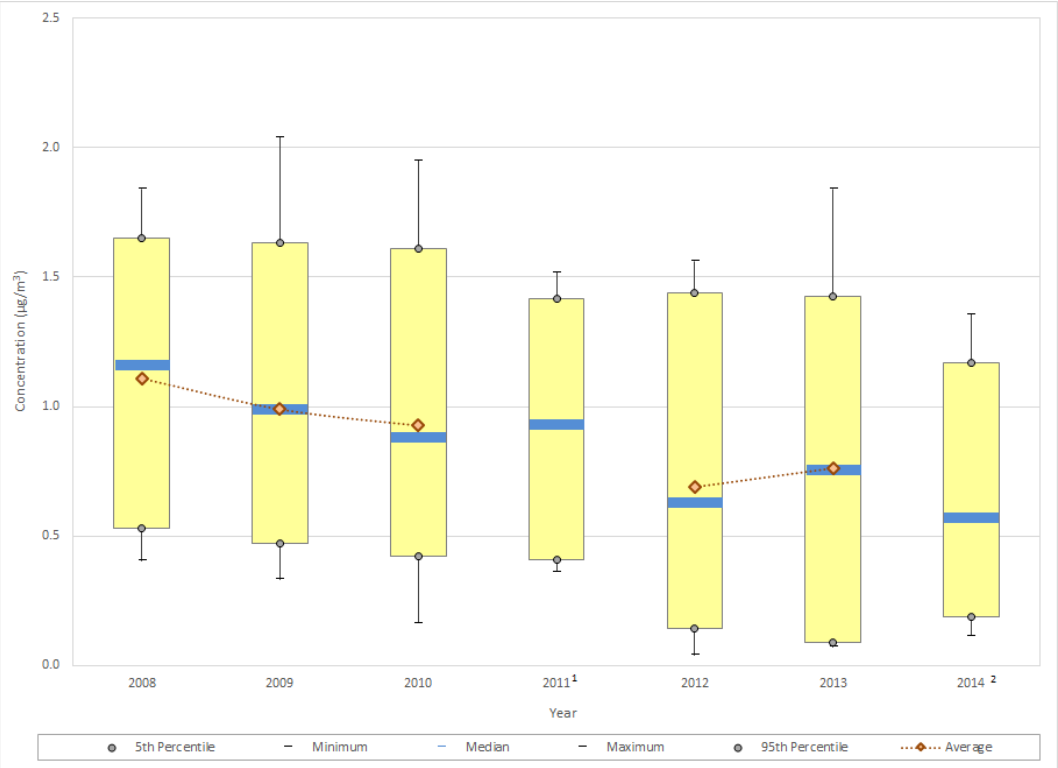
- The maximum formaldehyde concentration (10.2 µg/m^3) was measured at BRCO on January 7, 2009, the same day as the second highest benzene concentration. This formaldehyde measurement is three times higher than the next highest concentration measured at this site (3.11 µg/m^3, measured on August 31, 2012). Only three additional formaldehyde concentrations greater than 2.0 µg/m^3 have been measured at BRCO.

- The increase in the 1-year average concentration shown from 2008 to 2009 results primarily from the maximum concentration measured in 2009. The median concentrations are similar to each other for these two years (1.02 µg/m^3 and 1.03 µg/m^3) and, if the maximum concentration for 2009 was removed from the dataset, the 1-year average concentrations would also be similar to each other.

- Several of the statistical parameters exhibit increases for 2010, although these do not include measurements for an entire year.

- Several statistical parameters exhibit a decreasing trend between 2012 and 2014, including the maximum concentration, the 95th percentile, the 5th percentile, and the minimum concentration.

Figure 7-38. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2011.
[2] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-38 for acetaldehyde concentrations measured at PACO include the following:

- PACO began sampling acetaldehyde under the NMP in February 2008. A 1-year average concentration is not presented for 2011 due to low method completeness. This is also true for 2014. Note that carbonyl compounds are sampled on a 1-in-12 sampling schedule at PACO.

- The maximum acetaldehyde concentration (2.04 µg/m^3) was measured at PACO on January 13, 2009 and is the only acetaldehyde concentration greater than 2 µg/m^3 measured at this site.

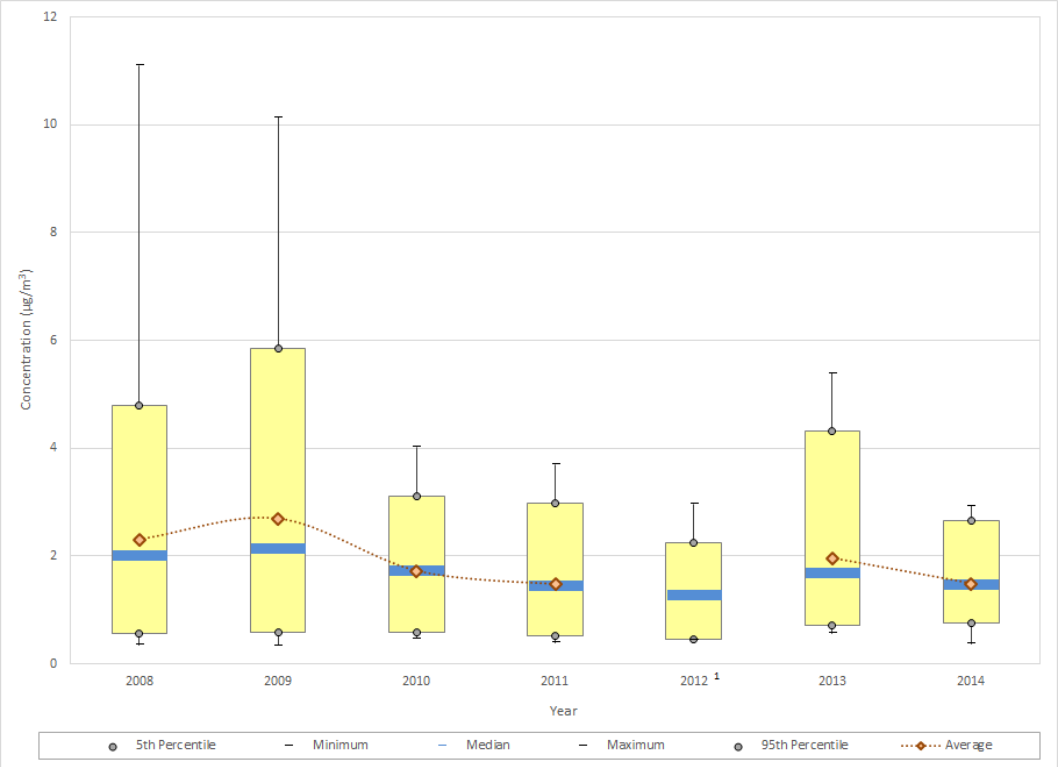
- Acetaldehyde concentrations measured at PACO have an overall decreasing trend across the years of sampling (although two of the seven years do not follow this pattern, and are discussed in the bullets that follow). Several of the statistical parameters are at a minimum for 2014, including the median, 95th percentile, and maximum concentrations. Those not a minimum for 2014 are at a minimum for either 2012 or 2013.

- For 2011, fewer valid samples were collected but those greater than 1 µg/m^3 make up a higher percentage of the measurements, resulting in a higher median concentration.

In addition, there minimum concentration measured in 2011 was higher the others years of sampling, with fewest concentrations less than 0.5 µg/m^3 since 2008.

- For 2013, both the 1-year average and median concentrations exhibit an increase. The range within which the majority of the measurements fall, indicated by the 5th and 95th percentiles, is at a maximum for 2013 over the years of sampling, indicating an increase in the variability of the measurements.

Figure 7-39. Yearly Statistical Metrics for Benzene Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2012.

Observations from Figure 7-39 for benzene concentrations measured at PACO include the following:

- PACO began sampling SNMOCs under the NMP in January 2008. A 1-year average concentration is not presented for 2012 due to low method completeness resulting from sampler issues.

- The maximum benzene concentration (11.1 µg/m^3) was measured at PACO on October 15, 2008. The next highest measurement (10.1 µg/m^3) was measured 3 months later on January 7, 2009. The third highest concentration was measured on the next sample day in 2009 but was less (7.52 µg/m^3). In total, 12 benzene concentrations greater than 5.0 µg/m^3 have been measured at PACO, with three measured in 2008, eight measured in 2009, and one in 2013.

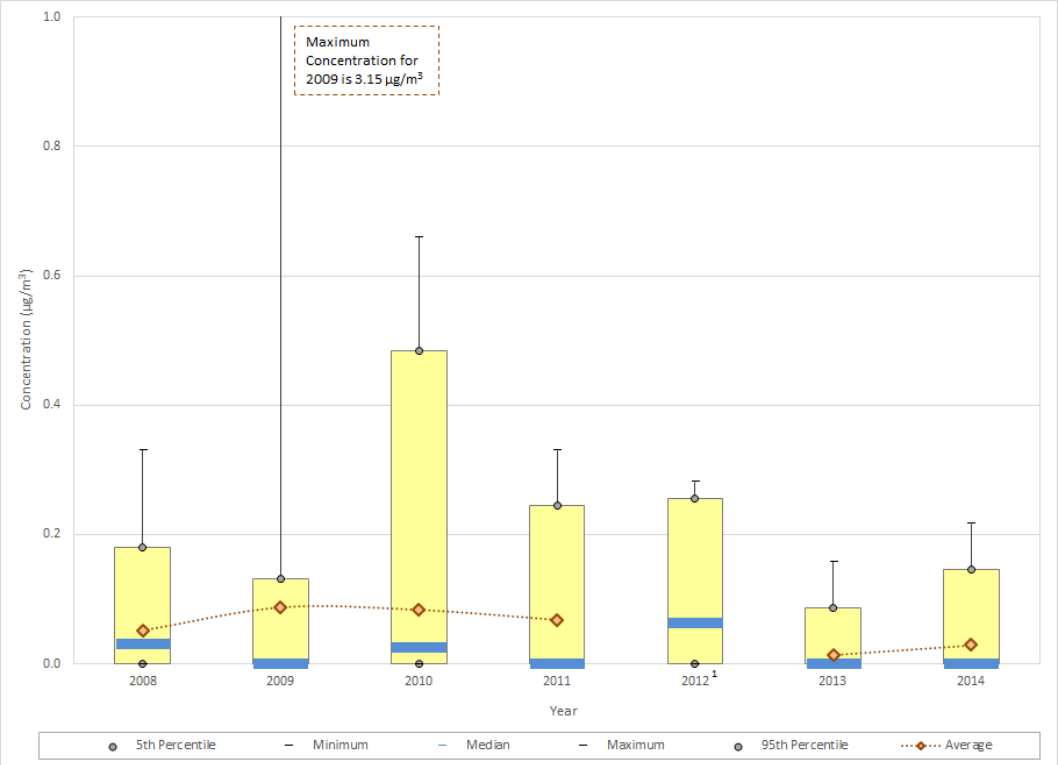
- Even though the maximum concentration decreased some from 2008 to 2009, benzene concentrations increased overall from 2008 to 2009, as indicated by the increases in the 1-year average, median, and 95th percentile. The number of benzene concentrations greater than 3 µg/m^3 increased from six in 2008 to 15 in 2009, accounting for more than a quarter of the measurements in 2009.

- Concentrations of benzene exhibit a significant decreasing trend between 2009 and 2010, when the maximum and 95th percentile decreased by nearly half. This decreasing trend continued into 2011 and 2012. Although a 1-year average concentration could not be calculated for 2012, the maximum, 95th percentile, and median concentrations are at a minimum for 2012. Benzene concentrations greater than 3 µg/m^3 were not measured in 2012.

- All of the statistical parameters shown increased considerably from 2012 to 2013. The range within which the majority of the measurements fall, indicated by the 5th and 95th percentiles, more than doubled and is at its largest since 2009. Nine benzene concentrations greater than the maximum concentration for 2012 (2.97 µg/m^3) were measured in 2013.

- The increases shown for 2013 were followed by significant decreases for 2014, although not quite returning to levels shown for 2012.

Figure 7-40. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2012.

Observations from Figure 7-40 for 1,3-butadiene concentrations measured at PACO include the following:

- The maximum 1,3-butadiene concentration (3.15 µg/m^3) was measured on December 27, 2009 and is the only 1,3-butadiene measurement greater than 1 µg/m^3 measured at this site.

- The increase in the 1-year average concentration from 2008 to 2009 is a result of this outlier concentration measured in 2009. The second highest concentration measured in 2009 is substantially less (0.19 µg/m^3). Excluding the maximum concentration for 2009 would result is a 1-year average concentration of only 0.028 µg/m^3 (rather than 0.88 µg/m^3), and thus a decrease in the 1-year average concentration by almost half from 2008 to 2009. Note that the median 1,3-butadiene concentration for 2009 is zero, indicating that at least half of the measurements for 2009 are non-detects.

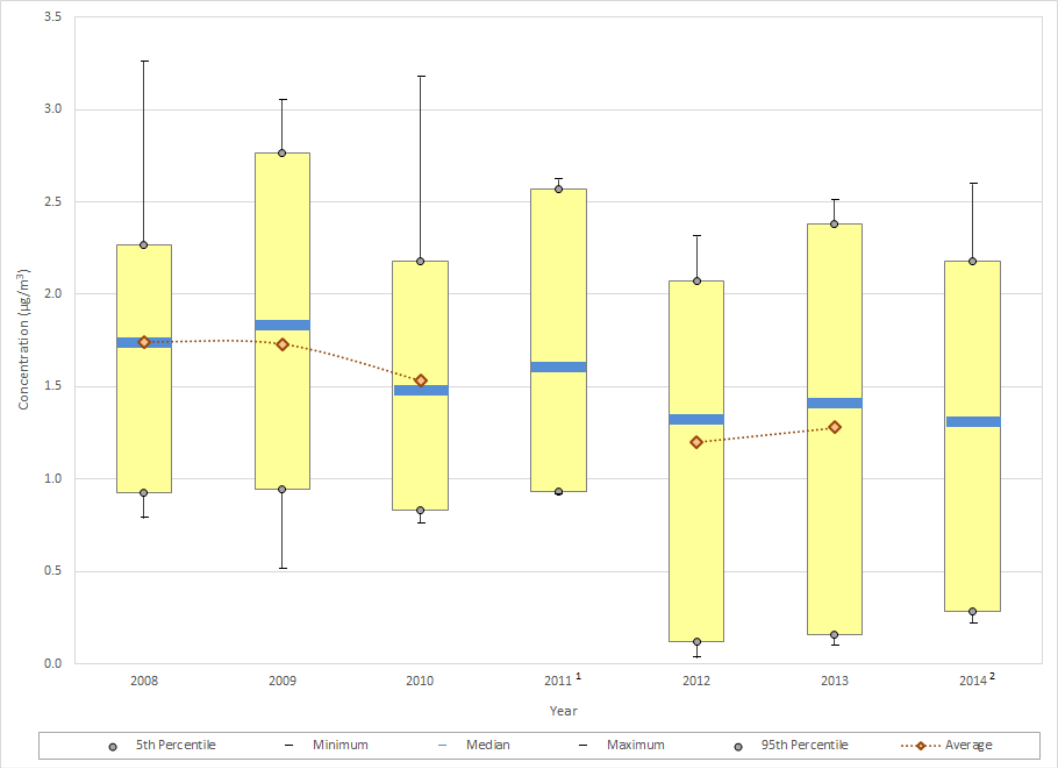
- The second, third, fourth, and fifth highest 1,3-butadiene concentrations measured at PACO were all measured in December 2010 and range from 0.39 µg/m^3 to 0.66 µg/m^3. The next highest concentration for this year was also measured in December but was considerably less (0.16 µg/m^3). The 95th percentile for 2010 is greater than the maximum concentration measured for all other years except 2009 and more than tripled from 2009 to 2010. Even though half of the measurements in 2010 were non-detects, the December measurements for 2010 are driving the top-end statistical parameters upward.

- Nearly all of the statistical parameters decreased from 2010 to 2011, except the minimum and 5th percentile, which are both zero for these years.

- Prior to 2012, the percentage of non-detects measured at PACO ranged from 47 percent (2008) to 58 percent (2009 and 2011). This explains why the median concentration is at or near zero for these years. For 2012, the number of non-detects is at a minimum (29 percent) and explains why the median increased considerably, although the range of measurements did not change much from 2011 and 2012.

- For 2013, the median concentration returned to zero as the number of non-detects increased from 29 percent in 2012 to 83 percent for 2013. The maximum and 95th percentile decreased considerably for 2013 and are at a minimum for the period of sampling, as is the 1-year average concentration. Although slightly higher concentrations were measured in 2014, non-detects still account for 75 percent of the concentrations measured.

Figure 7-41. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2011.
[2] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-41 for formaldehyde concentrations measured at PACO include the following:

- Only four formaldehyde concentrations greater than 3 µg/m^3 have been measured at PACO (one is 2008, two in 2009, and one in 2010).

- The 1-year average concentration changed little between 2008 and 2009. The decreases in the minimum and maximum concentrations for 2009 are countered by an increase in the number of measurements at the higher end of the concentration range, as indicated by the increases in the median and 95th percentile.

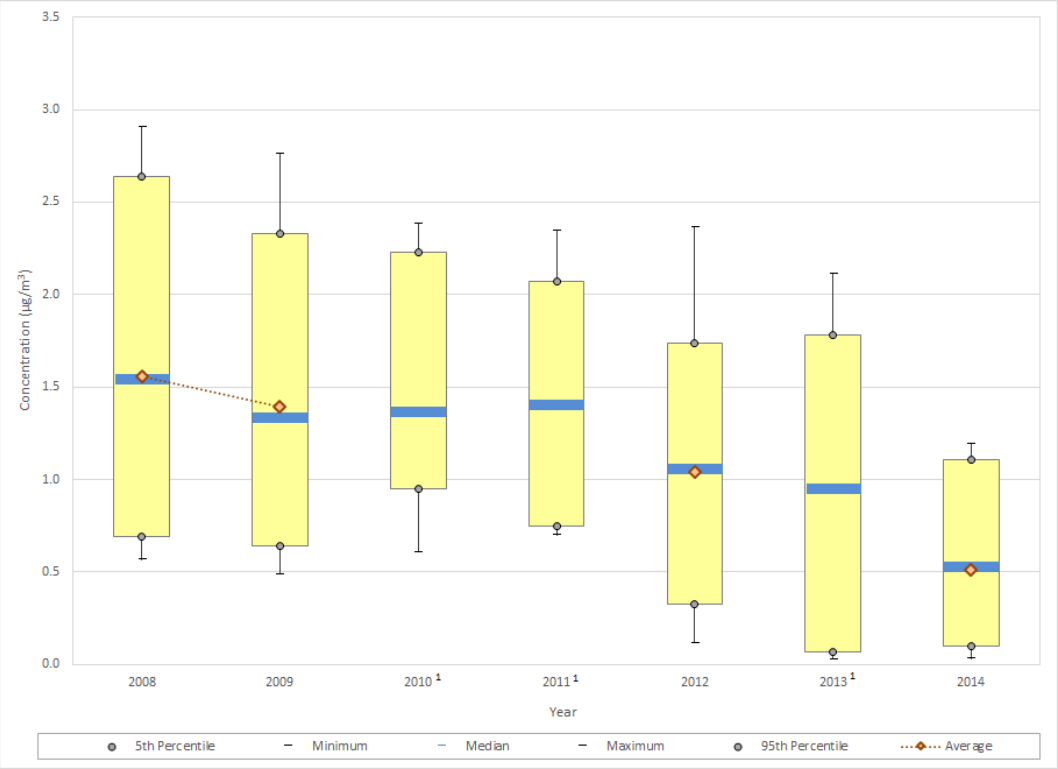
- The data distribution statistics for 2010 resemble those for 2008, although the 1-year average and median concentrations both exhibit decreases. The number of formaldehyde concentrations greater than 2 µg/m^3 decreased by half from 2009 to 2010, while the number of concentrations less than 1 µg/m^3 more than doubled.

- Although the maximum concentration decreased for 2011, all of the other statistical parameters that could be calculated exhibit increases from 2010 to 2011.

- All of the statistical parameters exhibit decreases from 2011 to 2012, particularly at the lower end of the concentration range, as the 5th percentile decreased from just less than 1 µg/m^3 to just greater than 0.1 µg/m^3. Nine formaldehyde measurements less than 1 µg/m^3 were measured in 2012, accounting for one-third of concentrations

measured in 2012. However, lower concentrations (those less than 1 µg/m^3) continued to be measured in subsequent years, with seven measured in 2013 and 11 measured in 2014, the most of any year shown. All 14 formaldehyde concentrations less than 0.5 µg/m^3 measured at PACO were measured in 2012 (5), 2013 (4), or 2014 (5).

Figure 7-42. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at RICO



[1] A 1-year average is not presented due to low method completeness in 2010, 2011, and 2013.

Observations from Figure 7-42 for acetaldehyde concentrations measured at RICO include the following:

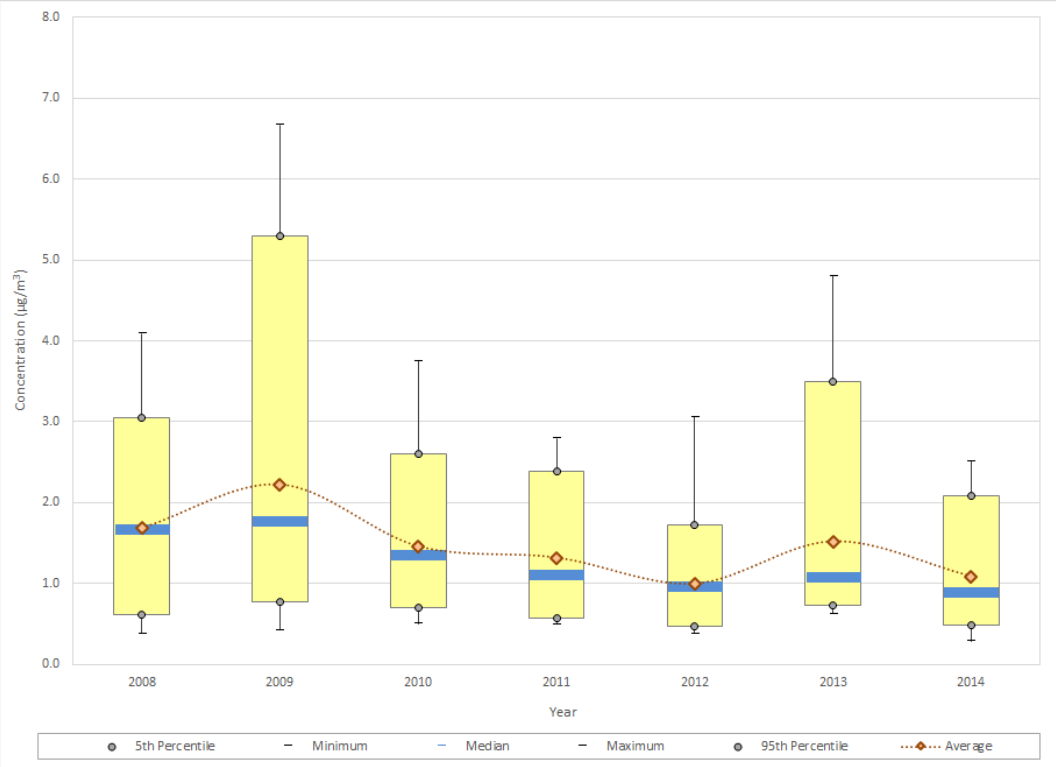
- RICO began sampling carbonyl compounds under the NMP in February 2008. A 1-year average concentration is not presented for 2010, 2011, or 2013 due to low method completeness. However, the range of measurements is provided for each of these years.

- The maximum acetaldehyde concentration (2.91 µg/m^3) was measured at RICO in July 2008, although a similar concentration was also measured on the sample day prior.

- Few 1-year average concentrations could be calculated for RICO. However, the measurements have an overall decreasing trend, based on the decreases shown for nearly all of the other statistical parameters. Acetaldehyde concentrations greater than 2.5 µg/m^3 were not measured after 2009 and concentrations greater than 2 µg/m^3 were not measured in 2014.

- The minimum concentration and 5th percentile decreased considerably from 2011 to 2012, with additional decreases for 2013. Concentrations measured 2012 and later account for 22 of the 23 concentrations less than 0.5 µg/m^3 measured at RICO (four were measured in 2012, six in 2013, and 12 in 2014).

Figure 7-43. Yearly Statistical Metrics for Benzene Concentrations Measured at RICO



Observations from Figure 7-43 for benzene concentrations measured at RICO include the following:

- RICO began sampling SNMOCs under the NMP in January 2008.

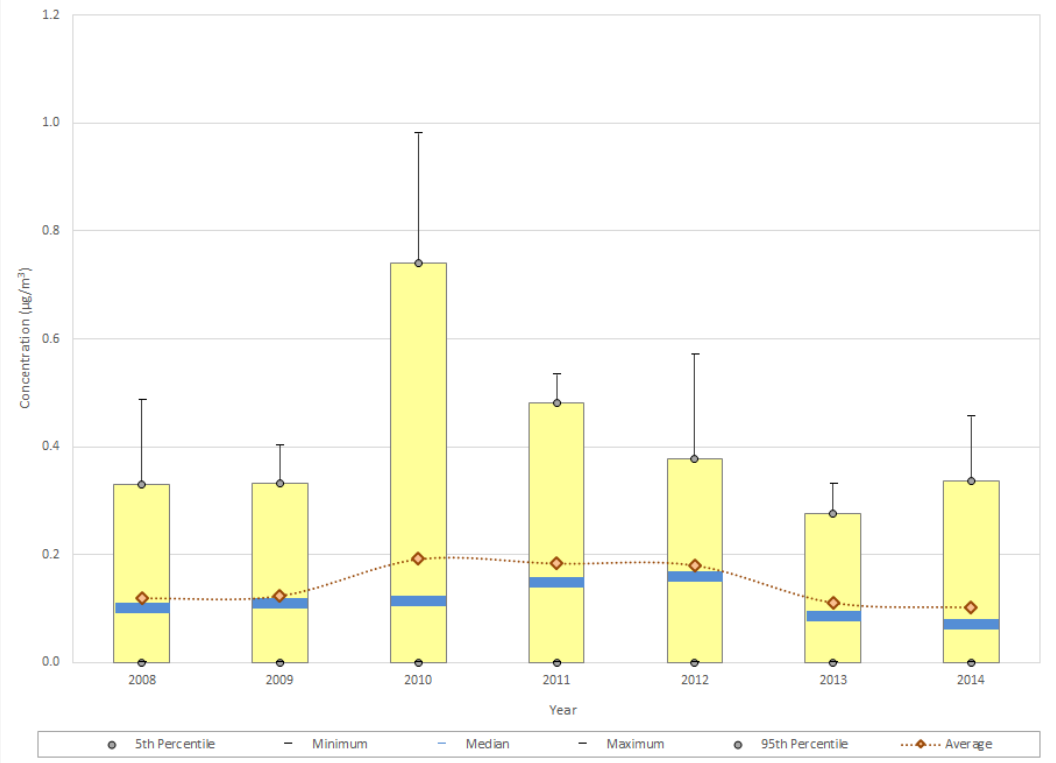
- The maximum benzene concentration (6.67 µg/m^3) was measured in January 2009. The four highest benzene concentrations measured at RICO were all measured in January 2009, with the next two highest also measured in 2009, but in different months.

- All of the statistical metrics exhibit increases from 2008 to 2009, particularly the maximum concentration and the 95th percentile, after which a steady decreasing trend is shown through 2012. The number of measurements greater than 2 µg/m^3 increased from 19 to 25 from 2008 to 2009, then decreased by half for 2010 and continued to decrease, reaching a minimum of two for 2012. This explains the increase in the statistical parameters shown from 2008 to 2009 as well as the subsequent decreases in the years that follow. The median concentration is 0.96 µg/m^3 for 2012, indicating that at least half of the measurements are less than 1 µg/m^3. The 1-year average concentration is also less than 1 µg/m^3 for 2012.

- All of the statistical parameters exhibit increases for 2013 as benzene concentrations were higher overall in 2013. The number of concentrations greater than 2 µg/m^3 increased six-fold from 2012 to 2013. Five concentrations measured in 2013 are greater than the maximum concentration measured in 2012, while 11 concentrations measured in 2012 are less than the minimum concentration measured in 2013.

- The increases shown for 2013 were followed by significant decreases for 2014, although not quite returning to levels shown for 2012. The statistical metrics shown for RICO's benzene concentrations resemble the ones shown for benzene concentrations measured at PACO (and to a lesser extent BRCO), as all three sites exhibit a decreasing trend through 2012 followed by a considerable increase for 2013 and additional decreases for 2014.

Figure 7-44. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at RICO



Observations from Figure 7-44 for 1,3-butadiene concentrations measured at RICO include the following:

- The five highest 1,3-butadiene concentrations were all measured at RICO in December 2010 and ranged from 0.57 µg/m^3 to 0.98 µg/m^3 (although a measurement of 0.57 µg/m^3 was also measured in 2012). Higher 1,3-butadiene concentrations were also measured at PACO during December 2010.

- The minimum concentration and 5th percentile are zero for each year of sampling; this indicates that at least 5 percent of the measurements were non-detects for each

year. The percentage of non-detects has varied from 7 percent (2012) to 39 percent (2014).

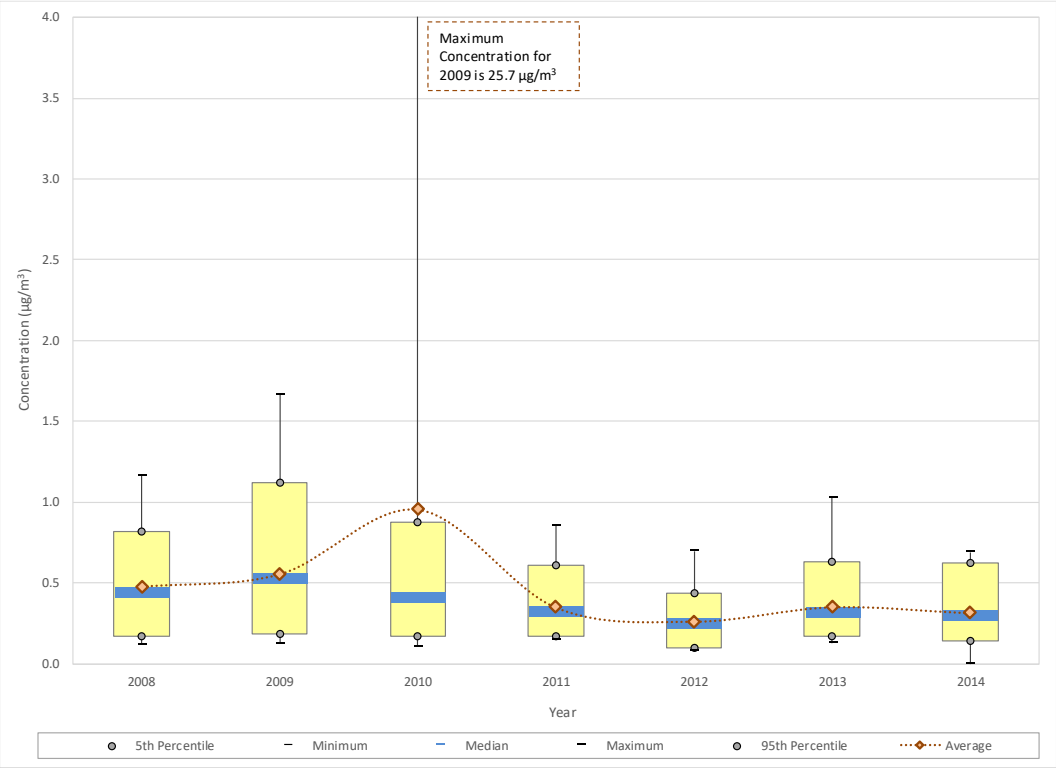
- With the exception of the maximum concentration, the range of concentrations measured in 2008 and 2009 were similar to each other, as indicated by most of the statistical parameters shown. This was followed by an increase in the magnitude of the concentrations measured in 2010. Even though the maximum concentration and 95th percentile more than doubled and the 1-year average concentration increased by more than 50 percent, the median concentration changed very little for 2010. This indicates that there are roughly the same number of measurements at the lower end of the concentration range while the measurements at the higher end of the concentration range are driving the 1-year average concentration upward.

- Although the range of concentrations measured varies between 2010 and 2012, the 1-year average concentration decreases only slightly while the median concentration increases steadily.

- Most of the statistical parameters exhibit decreases from 2012 to 2013 (the minimum and 5th percentile both stay the same), with the median concentration decreasing by half. Overall, the 1,3-butadiene concentrations measured were lower in 2013. The number of concentrations greater than 0.25 $\mu g/m^3$ decreased from 17 in 2012 to five in 2013; further, the number of concentrations less than 0.1 $\mu g/m^3$ (including non-detects) increased from 15 in 2012 to 32 in 2013, accounting for more than half of the concentrations measured in 2013.

- Although little change is shown in the 1-year average concentration for 2014, five concentrations measured in 2014 are greater than the maximum concentration measured in 2013. On the lower end of the scale, the number of non-detects increased four-fold, from five in 2013 to 21 in 2014.

Figure 7-45. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at RICO



Observations from Figure 7-45 for ethylbenzene concentrations measured at RICO include the following:

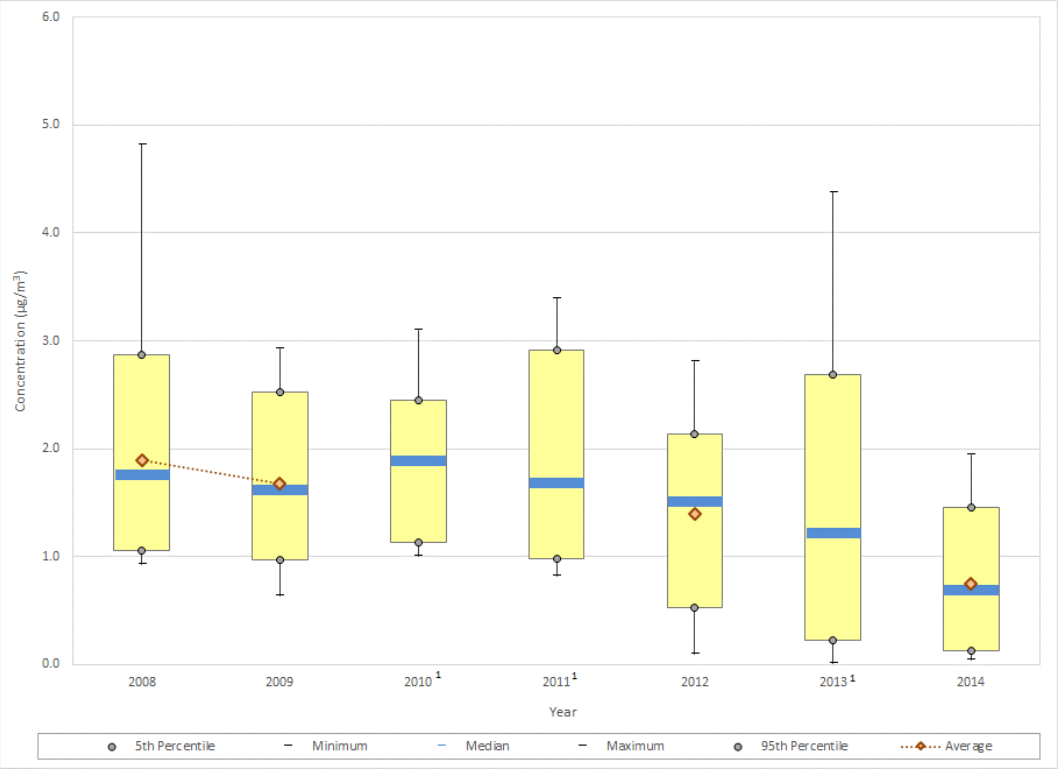
- The maximum ethylbenzene concentration measured at RICO was measured on August 18, 2010 (25.7 µg/m^3). The next highest concentration was also measured in 2010 but is considerably less (6.86 µg/m^3). No other ethylbenzene concentrations greater than 2 µg/m^3 have been measured at RICO and only nine concentrations greater than 1 µg/m^3 have been measured at this site. This explains why the 1-year average concentration is greater than the 95th percentile for 2010, it is skewed by the outlier. Excluding the maximum concentration measured at RICO from the 1-year average calculation for 2010 would result in a 1-year average concentration similar to that shown for 2009.

- Excluding the outlier, there is a decreasing trend in most of the statistical parameters shown between 2009 and 2012, with most of the statistical parameters at a minimum for 2012.

- Each of the statistical metrics shown in Figure 7-45 increased from 2012 to 2013, with several of them returning to levels similar to those calculated for 2011.

- The only two non-detects of ethylbenzene measured at RICO were both measured in 2014.

Figure 7-46. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at RICO



[1] A 1-year average is not presented due to low method completeness in 2010, 2011, and 2013.

Observations from Figure 7-46 for formaldehyde concentrations measured at RICO include the following:

- The maximum formaldehyde concentration (4.82 µg/m^3) was measured at RICO in November 2008. The only other formaldehyde concentration greater than 4 µg/m^3 was measured on August 26, 2013 (4.38 µg/m^3). Only three additional formaldehyde concentrations measured at RICO are greater than 3 µg/m^3 (one each in 2008, 2010, and 2011).

- Few 1-year average concentrations could be calculated for RICO; however, the measurements appear to have an overall decreasing trend after 2010, despite a few higher concentrations measured, based on the decreases shown for several of the other statistical parameters.

- The minimum and 5th percentile decreased considerably from 2011 to 2012 and continued into 2013 and 2014, similar to acetaldehyde. Twenty-four of the 25 measurements less than 0.75 µg/m^3 collected at RICO were measured between 2012 and 2014, with 2014 having the most (15).

7.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each Colorado monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

7.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Colorado monitoring sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 7-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 7-5. Risk Approximations for the Colorado Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Grand Junction, Colorado - GPCO						
Acetaldehyde	0.0000022	0.009	58/58	2.80 ± 0.25	6.16	0.31
Benzene	0.0000078	0.03	57/57	0.99 ± 0.12	7.72	0.03
1,3-Butadiene	0.00003	0.002	57/57	0.17 ± 0.03	4.98	0.08
Carbon Tetrachloride	0.000006	0.1	57/57	0.58 ± 0.03	3.49	0.01
1,2-Dichloroethane	0.000026	2.4	50/57	0.07 ± 0.01	1.92	<0.01
Ethylbenzene	0.0000025	1	57/57	0.45 ± 0.06	1.14	<0.01
Formaldehyde	0.000013	0.0098	58/58	3.90 ± 0.35	50.68	0.40
Hexachloro-1,3-butadiene	0.000022	0.09	13/57	0.02 ± 0.01	0.42	<0.01
Acenaphthene[a]	0.000088	--	60/60	7.17 ± 1.20	0.63	--
Arsenic (PM_{10})[a]	0.0043	0.000015	50/59	0.28 ± 0.06	1.19	0.02
Naphthalene[a]	0.000034	0.003	60/60	100.03 ± 13.48	3.40	0.03
Battlement Mesa, Colorado - BMCO						
Acetaldehyde	0.0000022	0.009	27/27	0.42 ± 0.11	0.93	0.05
Benzene	0.0000078	0.03	51/51	NA	NA	NA
Formaldehyde	0.000013	0.0098	27/27	0.77 ± 0.18	9.95	0.08
Silt, Colorado - BRCO						
Acetaldehyde	0.0000022	0.009	25/25	NA	NA	NA
Benzene	0.0000078	0.03	49/50	NA	NA	NA
Formaldehyde	0.000013	0.0098	25/25	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] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Table 7-5. Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Parachute, Colorado - PACO						
Acetaldehyde	0.0000022	0.009	25/25	NA	NA	NA
Benzene	0.0000078	0.03	57/57	1.49 ± 0.14	11.65	0.05
1,3-Butadiene	0.00003	0.002	14/57	0.03 ± 0.01	0.88	0.01
Formaldehyde	0.000013	0.0098	25/25	NA	NA	NA
Carbondale, Colorado - RFCO						
Acetaldehyde	0.0000022	0.009	26/26	NA	NA	NA
Benzene	0.0000078	0.03	27/28	0.46 ± 0.09	3.62	0.02
1,3-Butadiene	0.00003	0.002	7/28	0.03 ± 0.02	0.76	0.01
Formaldehyde	0.000013	0.0098	26/26	NA	NA	NA
Rifle, Colorado - RICO						
Acetaldehyde	0.0000022	0.009	27/27	0.52 ± 0.12	1.13	0.06
Benzene	0.0000078	0.03	54/54	1.09 ± 0.14	8.50	0.04
1,3-Butadiene	0.00003	0.002	33/54	0.10 ± 0.03	3.08	0.05
Ethylbenzene	0.0000025	1	52/54	0.32 ± 0.04	0.79	<0.01
Formaldehyde	0.000013	0.0098	27/27	0.74 ± 0.17	9.66	0.08

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Observations for GPCO from Table 7-5 include the following:

- Formaldehyde, acetaldehyde, and benzene have the highest annual average concentrations among GPCO's pollutants of interest.

- Formaldehyde has the highest cancer risk approximation for this site (50.68 in-a-million), followed by benzene (7.72 in-a-million), acetaldehyde (6.16 in-a-million), and 1,3-butadiene (4.98 in-a-million). GPCO's cancer risk approximation for formaldehyde is the fifth highest cancer risk approximation calculated across the program for 2014 and the fourth highest cancer risk approximation calculated for formaldehyde.

- None of the pollutants of interest for GPCO have a noncancer hazard approximation greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. Acetaldehyde and formaldehyde have the highest noncancer hazard approximations (0.40 and 0.31, respectively) among the pollutants of interest for GPCO. The noncancer hazard approximation for formaldehyde for GPCO is the fifth highest noncancer hazard approximation calculated across the program for 2014 and the fourth highest noncancer hazard approximation calculated for formaldehyde.

Observations for the Garfield County sites from Table 7-5 include the following:

- Benzene, acetaldehyde, and formaldehyde were identified as pollutants of interest for each Garfield County site.

- Annual average benzene concentrations could be calculated for three of these sites (PACO, RFCO, and RICO). Among these sites, the annual average concentrations of benzene range from 0.46 ± 0.09 $\mu g/m^3$ (RFCO) to 1.49 ± 0.14 $\mu g/m^3$ (PACO). The cancer risk approximations for benzene for these sites range from 3.62 in-a-million (RFCO) to 11.65 in-a-million (PACO). The noncancer hazard approximations calculated for benzene for the Garfield County sites with available annual average concentrations of benzene are considerably less than 1.0 (all are 0.05 or less). This indicates that no adverse noncancer health effects are expected from this individual pollutant.

- Annual average formaldehyde concentrations could only be calculated for BMCO and RICO; the annual averages for these two sites are similar to each other (0.74 ± 0.17 $\mu g/m^3$ for RICO and 0.77 ± 0.18 $\mu g/m^3$ for BMCO). The cancer risk approximations for these sites are also similar to each other (9.66 in-a-million for RICO and 9.95 in-a-million for BMCO) as are the noncancer hazard approximations (both are 0.08).

- Similarly, annual average concentrations of acetaldehyde could only be calculated for BMCO and RICO. The annual average acetaldehyde concentrations calculated for BMCO and RICO are 0.42 ± 0.11 $\mu g/m^3$ and 0.52 ± 0.12 $\mu g/m^3$, respectively. The cancer risk approximations for these sites are both around 1 in-a-million (1.13 in-a-million for RICO and 0.93 in-a-million for BMCO). The noncancer hazard approximation for BMCO is 0.05 and for RICO is 0.06, both considerably less than the level of concern (1.0).

- 1,3-Butadiene was identified as a pollutant of interest for PACO, RFCO, and RICO; the annual average concentrations of 1,3-butadiene for these sites range from 0.03 ± 0.01 $\mu g/m^3$ for PACO to 0.10 ± 0.03 $\mu g/m^3$ for RICO. The cancer risk approximations for these sites for 1,3-butadiene range from 0.76 in-a-million (RFCO) to 3.08 in-a-million (RICO). The noncancer hazard approximations calculated for 1,3-butadiene for these Garfield County sites are 0.05 or less.

7.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 7-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 7-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 7-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 7-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 7-6. Table 7-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 7.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 7-6. 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 UREs (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)**
Grand Junction, Colorado (Mesa County) - GPCO					
Benzene	166.34	Formaldehyde	1.72E-03	Formaldehyde	50.68
Formaldehyde	131.94	Benzene	1.30E-03	Benzene	7.72
Ethylbenzene	55.92	1,3-Butadiene	4.48E-04	Acetaldehyde	6.16
Acetaldehyde	49.20	Naphthalene	2.34E-04	1,3-Butadiene	4.98
1,3-Butadiene	14.93	POM, Group 2b	1.55E-04	Carbon Tetrachloride	3.49
Naphthalene	6.89	Ethylbenzene	1.40E-04	Naphthalene	3.40
Dichloromethane	5.44	Acetaldehyde	1.08E-04	1,2-Dichloroethane	1.92
Tetrachloroethylene	1.86	POM, Group 2d	1.00E-04	Arsenic (PM_{10})	1.19
POM, Group 2b	1.76	POM, Group 5a	6.90E-05	Ethylbenzene	1.14
POM, Group 2d	1.14	Arsenic, PM	3.36E-05	Acenaphthene	0.63
Battlement Mesa, Colorado (Garfield County) - BMCO					
Benzene	652.88	Formaldehyde	7.96E-03	Formaldehyde	9.95
Formaldehyde	612.56	Benzene	5.09E-03	Acetaldehyde	0.93
Acetaldehyde	112.59	1,3-Butadiene	3.78E-04		
Ethylbenzene	67.74	Acetaldehyde	2.48E-04		
1,3-Butadiene	12.62	Ethylbenzene	1.69E-04		
Naphthalene	4.78	Naphthalene	1.62E-04		
Tetrachloroethylene	1.01	POM, Group 2b	7.72E-05		
POM, Group 2b	0.88	POM, Group 2d	5.42E-05		
POM, Group 2d	0.62	POM, Group 5a	3.89E-05		
Dichloromethane	0.25	Arsenic, PM	3.28E-05		

Table 7-6. 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 UREs (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)**
Silt, Colorado (Garfield County) - BRCO					
Benzene	652.88	Formaldehyde	7.96E-03		
Formaldehyde	612.56	Benzene	5.09E-03		
Acetaldehyde	112.59	1,3-Butadiene	3.78E-04		
Ethylbenzene	67.74	Acetaldehyde	2.48E-04		
1,3-Butadiene	12.62	Ethylbenzene	1.69E-04		
Naphthalene	4.78	Naphthalene	1.62E-04		
Tetrachloroethylene	1.01	POM, Group 2b	7.72E-05		
POM, Group 2b	0.88	POM, Group 2d	5.42E-05		
POM, Group 2d	0.62	POM, Group 5a	3.89E-05		
Dichloromethane	0.25	Arsenic, PM	3.28E-05		
Parachute, Colorado (Garfield County) - PACO					
Benzene	652.88	Formaldehyde	7.96E-03	Benzene	11.65
Formaldehyde	612.56	Benzene	5.09E-03	1,3-Butadiene	0.88
Acetaldehyde	112.59	1,3-Butadiene	3.78E-04		
Ethylbenzene	67.74	Acetaldehyde	2.48E-04		
1,3-Butadiene	12.62	Ethylbenzene	1.69E-04		
Naphthalene	4.78	Naphthalene	1.62E-04		
Tetrachloroethylene	1.01	POM, Group 2b	7.72E-05		
POM, Group 2b	0.88	POM, Group 2d	5.42E-05		
POM, Group 2d	0.62	POM, Group 5a	3.89E-05		
Dichloromethane	0.25	Arsenic, PM	3.28E-05		

Table 7-6. 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 UREs (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)**
Carbondale, Colorado (Garfield County) - RFCO					
Benzene	652.88	Formaldehyde	7.96E-03	Benzene	3.62
Formaldehyde	612.56	Benzene	5.09E-03	1,3-Butadiene	0.76
Acetaldehyde	112.59	1,3-Butadiene	3.78E-04		
Ethylbenzene	67.74	Acetaldehyde	2.48E-04		
1,3-Butadiene	12.62	Ethylbenzene	1.69E-04		
Naphthalene	4.78	Naphthalene	1.62E-04		
Tetrachloroethylene	1.01	POM, Group 2b	7.72E-05		
POM, Group 2b	0.88	POM, Group 2d	5.42E-05		
POM, Group 2d	0.62	POM, Group 5a	3.89E-05		
Dichloromethane	0.25	Arsenic, PM	3.28E-05		
Rifle, Colorado (Garfield County) - RICO					
Benzene	652.88	Formaldehyde	7.96E-03	Formaldehyde	9.66
Formaldehyde	612.56	Benzene	5.09E-03	Benzene	8.50
Acetaldehyde	112.59	1,3-Butadiene	3.78E-04	1,3-Butadiene	3.08
Ethylbenzene	67.74	Acetaldehyde	2.48E-04	Acetaldehyde	1.13
1,3-Butadiene	12.62	Ethylbenzene	1.69E-04	Ethylbenzene	0.79
Naphthalene	4.78	Naphthalene	1.62E-04		
Tetrachloroethylene	1.01	POM, Group 2b	7.72E-05		
POM, Group 2b	0.88	POM, Group 2d	5.42E-05		
POM, Group 2d	0.62	POM, Group 5a	3.89E-05		
Dichloromethane	0.25	Arsenic, PM	3.28E-05		

Table 7-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Grand Junction, Colorado (Mesa County) - GPCO					
Toluene	381.86	Acrolein	550,555.59	Formaldehyde	0.40
Xylenes	274.58	Formaldehyde	13,463.29	Acetaldehyde	0.31
Benzene	166.34	1,3-Butadiene	7,464.46	1,3-Butadiene	0.08
Formaldehyde	131.94	Benzene	5,544.61	Naphthalene	0.03
Hexane	120.83	Acetaldehyde	5,466.88	Benzene	0.03
Methanol	102.01	Xylenes	2,745.81	Arsenic	0.02
Ethylbenzene	55.92	Naphthalene	2,298.28	Carbon Tetrachloride	0.01
Acetaldehyde	49.20	Antimony, PM	1,050.63	Ethylbenzene	<0.01
Ethylene glycol	29.13	Lead, PM	767.25	Hexachloro-1,3-butadiene	<0.01
1,3-Butadiene	14.93	Arsenic, PM	521.58	1,2-Dichloroethane	<0.01
Battlement Mesa, Colorado (Garfield County) - BMCO					
Toluene	1,190.11	Acrolein	3,464,518.24	Formaldehyde	0.08
Xylenes	730.99	Formaldehyde	62,505.94	Acetaldehyde	0.05
Benzene	652.88	Benzene	21,762.81		
Methanol	623.52	Acetaldehyde	12,509.99		
Formaldehyde	612.56	Xylenes	7,309.95		
Hexane	169.35	1,3-Butadiene	6,308.09		
Acetaldehyde	112.59	Naphthalene	1,592.72		
Acrolein	69.29	Propionaldehyde	567.82		
Ethylbenzene	67.74	Cadmium, PM	526.47		
1,3-Butadiene	12.62	Arsenic, PM	508.98		

Table 7-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Silt, Colorado (Garfield County) - BRCO					
Toluene	1,190.11	Acrolein	3,464,518.24		
Xylenes	730.99	Formaldehyde	62,505.94		
Benzene	652.88	Benzene	21,762.81		
Methanol	623.52	Acetaldehyde	12,509.99		
Formaldehyde	612.56	Xylenes	7,309.95		
Hexane	169.35	1,3-Butadiene	6,308.09		
Acetaldehyde	112.59	Naphthalene	1,592.72		
Acrolein	69.29	Propionaldehyde	567.82		
Ethylbenzene	67.74	Cadmium, PM	526.47		
1,3-Butadiene	12.62	Arsenic, PM	508.98		
Parachute, Colorado (Garfield County) - PACO					
Toluene	1,190.11	Acrolein	3,464,518.24	Benzene	0.05
Xylenes	730.99	Formaldehyde	62,505.94	1,3-Butadiene	0.01
Benzene	652.88	Benzene	21,762.81		
Methanol	623.52	Acetaldehyde	12,509.99		
Formaldehyde	612.56	Xylenes	7,309.95		
Hexane	169.35	1,3-Butadiene	6,308.09		
Acetaldehyde	112.59	Naphthalene	1,592.72		
Acrolein	69.29	Propionaldehyde	567.82		
Ethylbenzene	67.74	Cadmium, PM	526.47		
1,3-Butadiene	12.62	Arsenic, PM	508.98		

Table 7-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Carbondale, Colorado (Garfield County) - RFCO					
Toluene	1,190.11	Acrolein	3,464,518.24	Benzene	0.02
Xylenes	730.99	Formaldehyde	62,505.94	1,3-Butadiene	0.01
Benzene	652.88	Benzene	21,762.81		
Methanol	623.52	Acetaldehyde	12,509.99		
Formaldehyde	612.56	Xylenes	7,309.95		
Hexane	169.35	1,3-Butadiene	6,308.09		
Acetaldehyde	112.59	Naphthalene	1,592.72		
Acrolein	69.29	Propionaldehyde	567.82		
Ethylbenzene	67.74	Cadmium, PM	526.47		
1,3-Butadiene	12.62	Arsenic, PM	508.98		
Rifle, Colorado (Garfield County) - RICO					
Toluene	1,190.11	Acrolein	3,464,518.24	Formaldehyde	0.08
Xylenes	730.99	Formaldehyde	62,505.94	Acetaldehyde	0.06
Benzene	652.88	Benzene	21,762.81	1,3-Butadiene	0.05
Methanol	623.52	Acetaldehyde	12,509.99	Benzene	0.04
Formaldehyde	612.56	Xylenes	7,309.95	Ethylbenzene	<0.01
Hexane	169.35	1,3-Butadiene	6,308.09		
Acetaldehyde	112.59	Naphthalene	1,592.72		
Acrolein	69.29	Propionaldehyde	567.82		
Ethylbenzene	67.74	Cadmium, PM	526.47		
1,3-Butadiene	12.62	Arsenic, PM	508.98		

Observations from Table 7-6 include the following:

- The 10 highest emitted pollutants with cancer UREs in Mesa County are the highest emitted pollutants in Garfield County, although not necessarily in the same order. Benzene and formaldehyde top both lists, although the emissions are more than three times higher for Garfield County than Mesa County.

- The two pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde and benzene for both Mesa and Garfield Counties. These two counties have the same pollutants listed for the pollutants with the highest toxicity-weighted emissions.

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Mesa County; the same eight pollutants have the highest emitted pollutants and highest toxicity-weighted emissions for Garfield County.

- For GPCO, eight of the 10 pollutants with the highest cancer risk approximations also appear among the pollutants with the highest toxicity-weighted emissions for Mesa County (the exceptions are carbon tetrachloride and 1,2-dichloroethane). Note that POM, Group 2b, which ranks fifth for toxicity-weighted emissions, includes several PAHs sampled for at GPCO including acenaphthene.

- Each of the pollutants of interest identified for the Garfield County sites appear on both emissions-based lists in Table 7-6.

Observations from Table 7-7 include the following:

- Toluene is the highest emitted pollutant with a noncancer RfC in both Mesa and Garfield Counties, although the emissions are considerably higher in Garfield County. These two counties have an additional eight pollutants in common on their lists of highest emitted pollutants with noncancer RfCs.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties is acrolein. Although acrolein was sampled for at GPCO, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein is not a target analyte for the SNMOC method. Although acrolein has the highest toxicity-weighted emissions for all but one county with an NMP site, rarely does it appear among the highest emitted pollutants. Garfield County is one of only two counties with an NMP site for which acrolein ranks among the 10 highest emitted. The acrolein emissions for Garfield County are the third highest among counties with NMP sites. A similar observation was made in previous NMP reports.

- Five of the highest emitted pollutants in Mesa County also have the highest toxicity-weighted emissions. Six of the 10 highest emitted pollutants in Garfield County (including acrolein) also have the highest toxicity-weighted emissions. Toluene, the highest emitted pollutant for both counties, is not among those pollutants with the

highest toxicity-weighted emissions. Several metals appear near the bottom of each toxicity-weighted emissions list but do not appear among the highest emitted.

- Formaldehyde, acetaldehyde, benzene, and 1,3-butadiene are pollutants of interest for GPCO that appear on all three lists in Table 7-7. Naphthalene appears among the pollutants with the highest noncancer hazard approximations and highest toxicity-weighted emissions, but is not among the highest emitted pollutants with a noncancer RfC in Mesa County. This is also true for arsenic. Ethylbenzene appears among the pollutants with the highest noncancer hazard approximations for GPCO and highest emissions in Mesa County, but is not among those with the highest toxicity-weighted emissions.

- Each of the pollutants of interest identified for the Garfield County sites appear on both emissions-based lists in Table 7-7, with one exception. Ethylbenzene is a pollutant of interest for RICO. Ethylbenzene appears among the pollutants with the highest emissions in Garfield County, but is not among those with the 10 highest toxicity-weighted emissions.

7.6 Summary of the 2014 Monitoring Data for the Colorado Monitoring Sites

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

- ❖ *Sixteen pollutants failed screens for GPCO. The number of pollutants failing screens for the Garfield County sites ranged from three to five.*

- ❖ *Formaldehyde and acetaldehyde have highest annual average concentrations for GPCO; these were the only pollutants with annual average concentrations greater than 1 µg/m^3.*

- ❖ *RICO was the only Garfield County site for which annual average concentrations could be calculated for each of its pollutants of interest.*

- ❖ *PACO and RICO have the highest and third-highest annual average concentrations of benzene among NMP sites, while GPCO's annual average concentration of ethylbenzene ranks third-highest. GPCO also has the second highest annual average concentration of acetaldehyde and the fourth highest annual average concentrations of formaldehyde and naphthalene among all NMP sites sampling these pollutants.*

- ❖ *GPCO and three Garfield County sites have sampled under the NMP for at least 5 years. Notable trends for these sites include: Benzene concentrations at GPCO have an overall decreasing trend across the years of sampling while concentrations of naphthalene have decreased in recent years. In addition, the detection rate of 1,2-dichloroethane at GPCO has increased during the last few years of sampling. Concentrations of acetaldehyde and formaldehyde appear to have a decreasing trend at RICO.*

- ❖ *Formaldehyde has the highest cancer risk approximation of the pollutants of interest for GPCO. Benzene and formaldehyde have the highest cancer risk approximations for the five Garfield County sites, depending upon whether annual average*

concentrations could be calculated. None of the pollutants of interest for the Colorado monitoring sites have noncancer hazard approximations greater than an HQ of 1.0.

8.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

8.1 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 8-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 8-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 8-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 8-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 8-1. Washington, D.C. (WADC) Monitoring Site

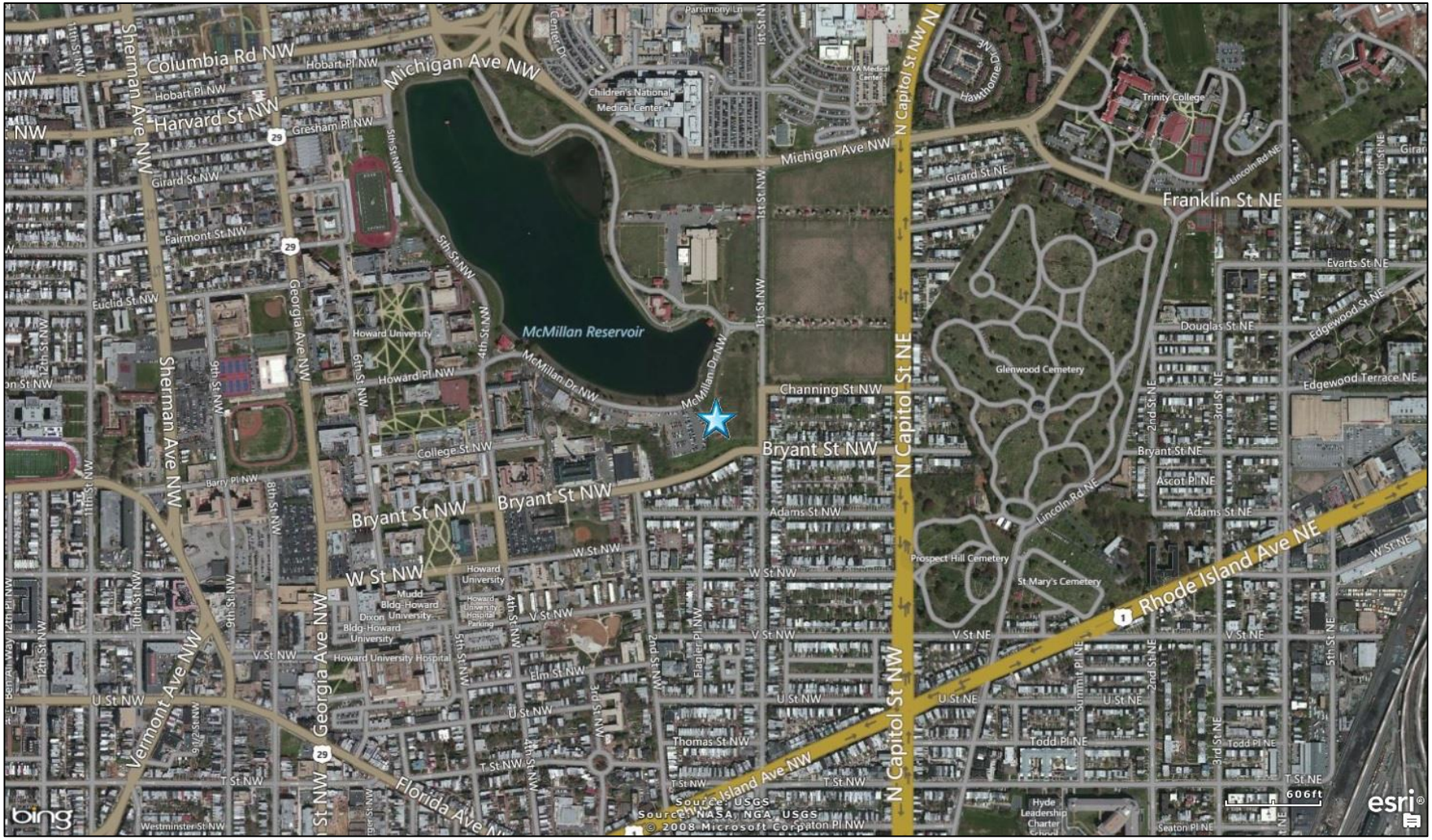
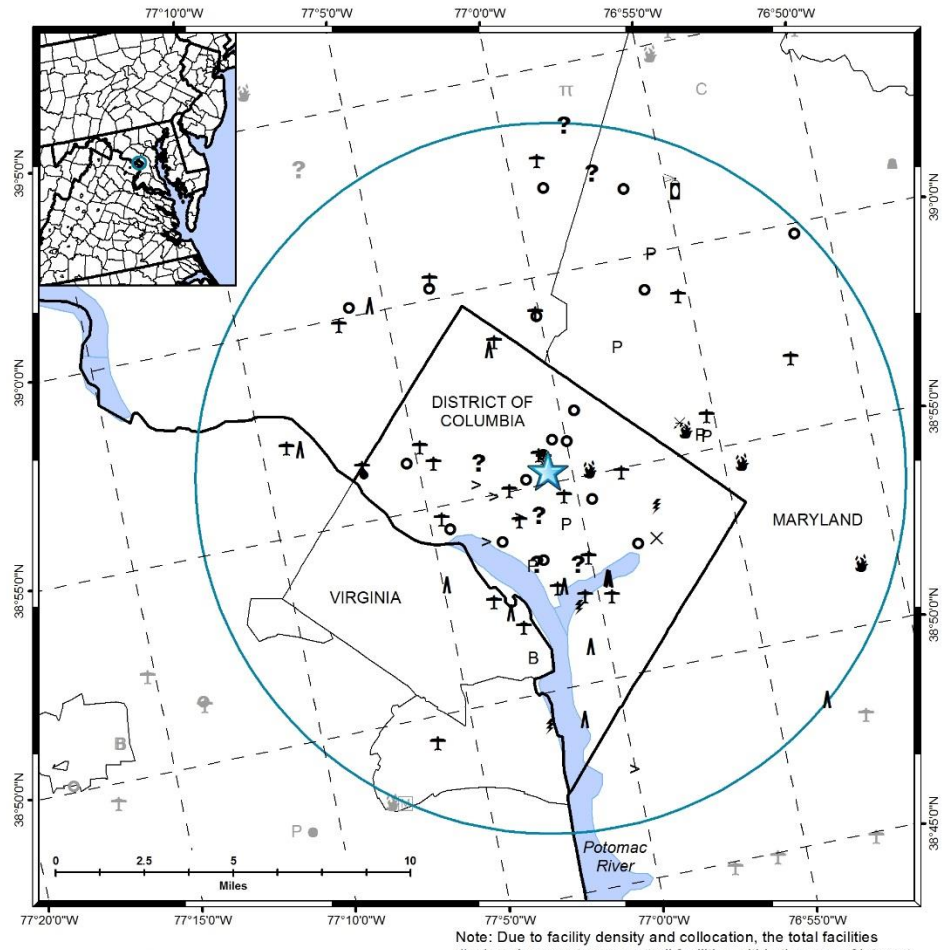


Figure 8-2. NEI Point Sources Located Within 10 Miles of WADC



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)

- Airport/Airline/Airport Support Operations (26)
- Asphalt Production/Hot Mix Asphalt Plant (5)
- B Bulk Terminals/Bulk Plants (1)
- Electricity Generation via Combustion (3)
- > Hotels/Motels/Lodging (5)
- Institutional (school, hospital, prison, etc.) (19)
- Military Base/National Security Facility (11)
- Mine/Quarry/Mineral Processing Facility (1)
- ? Miscellaneous Commercial/Industrial Facility (6)
- Paint and Coating Manufacturing Facility (1)
- P Printing/Publishing/Paper Product Manufacturing Facility (6)
- × Rail Yard/Rail Line Operations (1)
- Water Treatment Facility (2)

Table 8-1. 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	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
WADC	11-001-0043	Washington	District Of Columbia	Washington-Arlington-Alexandria, DC-VA-MD-WV	38.921847, -77.013178	Commercial	Urban/City Center	8,700	First St between W St and V St

[1]AADT reflects 2013 data (DC DOT, 2014)
BOLD ITALICS = EPA-designated NATTS Site

Figure 8-1 shows that the WADC monitoring site is located in an open field at the southeast end of the McMillan Water Reservoir in Washington, D.C. It is also located within a short distance of several heavily traveled roadways. The site is located in a commercial area, and is surrounded by a hospital, a cemetery, and a university. Just to the northeast, a construction project has commenced, which is part of the First Street Tunnel Project (DC WSA, 2016). As Figure 8-2 shows, WADC is surrounded by a number of emissions sources, many of which are included in three sources categories: 1) the airport and airport support operations source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or televisions stations; 2) the institutions source category, which includes hospitals, schools, and prisons, etc.; and 3) the military bases and national security facilities source category. The closest sources to WADC are a wastewater treatment facility, hospitals, and heliports at hospitals.

In addition to providing city, county, CBSA, and land use/location setting information, Table 8-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near WADC is less than 9,000 vehicles and is in the bottom third compared to other NMP sites. The traffic volume provided is for First Street, the closest roadway east of the monitoring site, between W Street and V Street, three to four blocks south of the site. Ongoing construction may affect typical traffic patterns in the area.

8.2 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 the year.

8.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2.

For WADC, site-specific data were available for all the meteorological parameters except dew point temperature and sea level pressure. Data for these parameters were obtained from the NWS weather station at Ronald Reagan Washington National Airport (WBAN 13743). The Reagan National weather station is located 5.2 miles south-southwest of WADC. A map showing the distance between the WADC monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 8-2. Average Meteorological Conditions near the Washington, D.C. Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Washington, D.C. – WADC[2]							
Sample Days (63)	56.7 ± 0.9	42.3 ± 1.0	58.8 ± 1.0	30.06 ± 0.01	29.91 ± 0.01	NW	7.4 ± 0.2
2014	56.9 ± 0.4	42.5 ± 0.4	58.7 ± 0.4	30.05 ± <0.01	29.90 ± <0.01	NW	6.9 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure and wind parameters were measured at WADC. The remaining information was obtained from the closest NWS weather station located at Reagan National Airport, WBAN 13743.

Table 8-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 8-2 is the 95 percent confidence interval for each parameter. As shown in Table 8-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year near WADC.

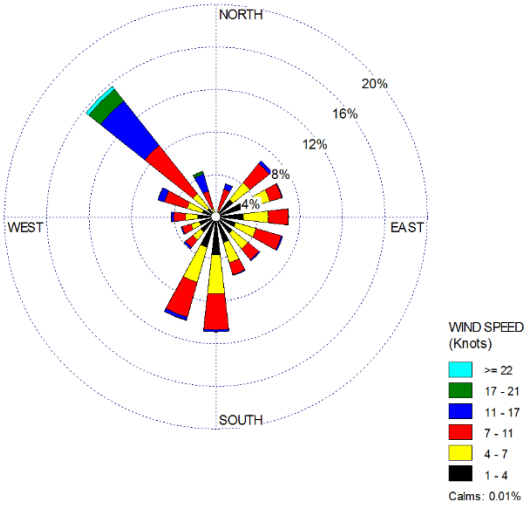
8.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 8-3 presents two wind roses for the WADC monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are

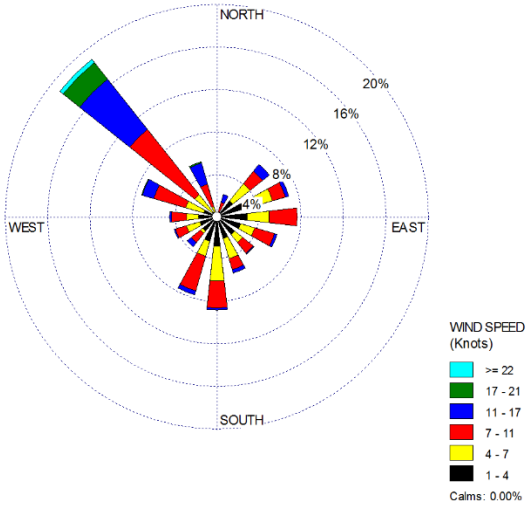
used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 8-3. Wind Roses for the Wind Data Collected at WADC

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 8-3 for WADC include the following:

- In 2014, winds from the northwest accounted for the largest percentage of wind observations at WADC. The strongest winds were observed with this wind direction. Winds from the south to south-southwest together account for approximately one-fifth percent of wind observations near WADC, while winds from due north were not observed at WADC in 2014. Winds with an easterly component were observed more often than those with a westerly component, excluding the primary directions already discussed. Calm winds were rarely observed at WADC.

- The sample day wind patterns resemble those on the full-year wind rose, although there are some differences. Northwesterly winds account for an even higher percentage of wind observations on sample days in 2014 while winds from the south and south-southwest accounted for fewer observations on sample days.

8.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the Washington, D.C. monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 8-3. 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 and are shaded in gray in Table 8-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Only PAHs were sampled for at WADC in 2014.

Table 8-3. Risk-Based 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	55	60	91.67	96.49	96.49
Benzo(a)pyrene	0.00057	1	52	1.92	1.75	98.25
Fluorene	0.011	1	41	2.44	1.75	100.00
Total		57	153	37.25		

Observations from Table 8-3 include the following:

- Concentrations of three pollutants failed screens for WADC: naphthalene, benzo(a)pyrene, and fluorene.
- Concentrations of naphthalene failed 92 percent of screens, while concentrations of benzo(a)pyrene and fluorene failed a single screen each.
- Naphthalene accounted for more than 96 percent of the total failed screens for WADC; thus, naphthalene is WADC's only pollutant of interest.

8.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Washington, D.C. monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each site.
- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at WADC are provided in Appendix M.

8.4.1 2014 Concentration Averages

Quarterly and annual average concentrations were calculated for the pollutants of interest for the Washington, D.C. monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire year of sampling. Annual average concentrations were calculated for pollutants where three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutant of interest for WADC are presented in Table 8-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 8-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Washington, D.C. Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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							
Naphthalene	60/60	60	83.50 ± 29.50	61.99 ± 20.29	65.94 ± 16.12	57.92 ± 16.09	67.34 ± 10.18

Observations for WADC from Table 8-4 include the following:

- Naphthalene was detected in every valid PAH sample collected at WADC.
- Concentrations of naphthalene measured at WADC range from 19.4 ng/m^3 to 208 ng/m^3.
- The first quarter average concentration of naphthalene is higher than the other quarterly averages shown in Table 8-4, and the associated confidence intervals indicate that there is considerably variability in the measurements, particularly for those measured during the first quarter. The two highest concentrations of naphthalene measured at WADC, 208 ng/m^3 and 172 ng/m^3, were both measured in January 2014. The first quarter has the highest number of naphthalene concentrations greater than 100 ng/m^3 (four) and is the only quarter with a concentration greater than 200 ng/m^3. Yet, the number of naphthalene concentrations less than 50 ng/m^3 measured at WADC is fairly similar across the quarters (between five and seven were measured during each quarter). Concentrations measured during the first quarter span the largest concentration range.
- As shown in Table 4-11, WADC has the ninth highest annual average concentration of naphthalene compared to other NMP sites sampling PAHs.

8.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for the site-specific pollutants of interest, where applicable. Thus, a box plot was created for naphthalene for WADC. Figure 8-4 overlays the site's minimum, annual average, and maximum naphthalene concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 8-4. Program vs. Site-Specific Average Naphthalene Concentration

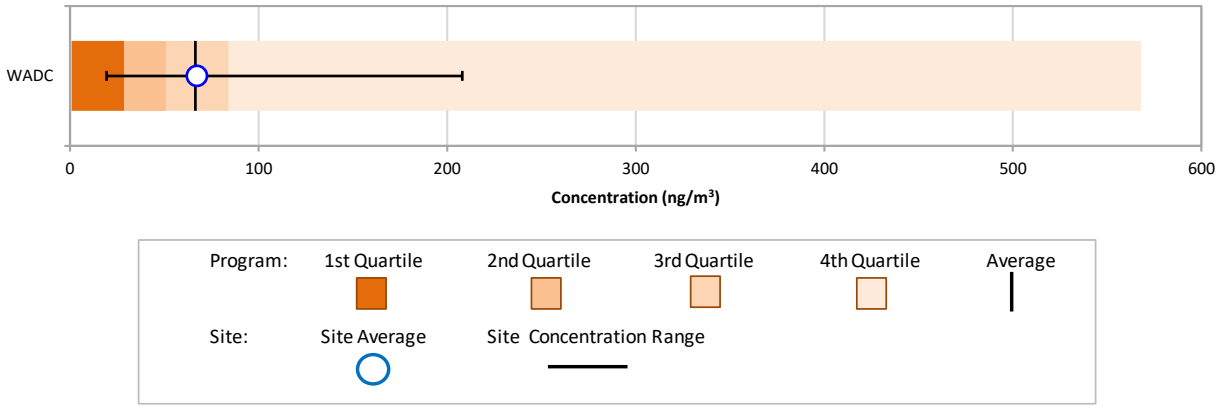


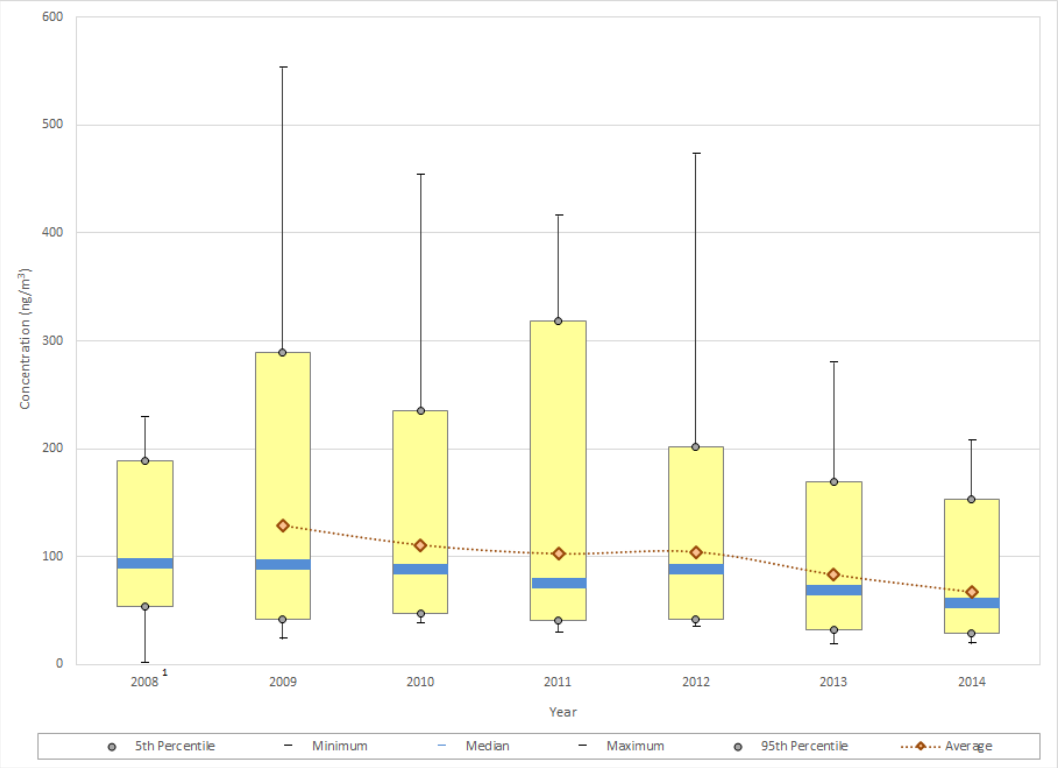
Figure 8-4 presents the box plot for naphthalene for WADC and shows the following:

- The maximum naphthalene concentration measured at WADC is considerably less than the program-level maximum concentration (568 ng/m^3).
- The annual average concentration of naphthalene for WADC (67.34 ± 10.18 ng/m^3) is similar to the program-level average concentration (66.5 ng/m^3).
- There were no non-detects of naphthalene measured at WADC, or across the program.

8.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. WADC has sampled PAHs under the NMP since mid-2008. Thus, Figure 8-5 presents the 1-year statistical metrics for naphthalene for WADC. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 8-5. Yearly Statistical Metrics for Naphthalene Concentrations Measured at WADC



[1] A 1-year average is not presented because sampling under the NMP did not begin until late June 2008.

Observations from Figure 8-5 for naphthalene concentrations measured at WADC include the following:

- WADC began sampling PAHs under the NMP in late June 2008.

- The maximum naphthalene concentration shown was measured in 2009 and is the only concentration greater than 500 ng/m^3 measured at this site (553 ng/m^3). Concentrations greater than 400 ng/m^3 have been measured in each year of sampling except 2008 (which included only half a year's worth of samples), 2013 and 2014.

- The 1-year average concentrations exhibit an overall decreasing trend between 2009 and 2014. The 1-year average concentration is less than 100 ng/m^3 for the first time in 2013. The 1-year average concentration has decreased by nearly half since 2009.

- The median concentration also has an overall decreasing trend, although the median increased from 2011 to 2012 before exhibiting further decreases from 2012 to 2013 and again in 2014. (While the 1-year average also increased slightly during this time, the difference is less than 2 ng/m^3.) The median concentration is less than 100 ng/m^3 for each year shown in Figure 8-5, and is at a minimum for 2014 (57.0 ng/m^3).

- The difference between the 5th and 95th percentiles is at a minimum for 2014, indicating that the majority of concentrations measured fell within a tighter range of measurements than the previous years. With the exception of 2011, this is true for each year following 2009.

8.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the WADC monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

8.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for WADC and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 8-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 8-5. Risk Approximations for the Washington, D.C. Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Washington, D.C. - WADC						
Naphthalene	0.000034	0.003	60/60	67.34 ± 10.18	2.29	0.02

Observations for WADC from Table 8-5 include the following:

- As discussed in Section 8.4.1, the annual average concentration of naphthalene for WADC is the ninth highest annual average concentration compared to other NMP sites sampling this pollutant.

- The cancer risk approximation for naphthalene is greater than 1.0 in-a-million (2.29 in-a-million).

- The noncancer hazard approximation for naphthalene is significantly less than 1.0, indicating that no adverse noncancer health effects are expected from this individual pollutant.

8.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, Tables 8-6 and 8-7 present an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 8-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 8-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 8-6 provides the cancer risk approximation (in-a-million) for the pollutant of interest for WADC, as presented in Table 8-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 8-6. Table 8-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 8.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 8-6. 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 UREs (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)**
Washington, D.C. (District of Columbia) - WADC					
Benzene	110.18	Formaldehyde	1.21E-03	Naphthalene	2.29
Formaldehyde	92.82	Benzene	8.59E-04		
Acetaldehyde	52.06	1,3-Butadiene	5.06E-04		
Ethylbenzene	51.75	Naphthalene	2.78E-04		
Tetrachloroethylene	18.70	POM, Group 2b	2.21E-04		
1,3-Butadiene	16.86	Nickel, PM	1.51E-04		
Naphthalene	8.18	POM, Group 2d	1.50E-04		
POM, Group 2b	2.51	Ethylbenzene	1.29E-04		
POM, Group 2d	1.71	Acetaldehyde	1.15E-04		
Dichloromethane	0.82	POM, Group 5a	1.11E-04		

Table 8-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Washington, D.C. Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Washington, D.C. (District of Columbia) - WADC					
Toluene	363.94	Acrolein	229,665.41	Naphthalene	0.02
Methanol	352.82	Formaldehyde	9,471.05		
Hexane	217.66	1,3-Butadiene	8,432.47		
Xylenes	213.36	Acetaldehyde	5,784.35		
Ethylene glycol	123.11	Benzene	3,672.70		
Benzene	110.18	Nickel, PM	3,505.21		
Formaldehyde	92.82	Chlorine	3,176.67		
Acetaldehyde	52.06	Naphthalene	2,725.10		
Ethylbenzene	51.75	Xylenes	2,133.58		
Methyl isobutyl ketone	26.88	Arsenic, PM	1,691.85		

Observations from Table 8-6 include the following:

- Benzene and formaldehyde are the highest emitted pollutants with cancer UREs in the District of Columbia. Formaldehyde and benzene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs).

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

- Naphthalene is the only pollutant of interest for WADC. This pollutant appears on both emissions-based lists. Naphthalene is the seventh highest emitted pollutant with a cancer URE in the District of Columbia and has the fourth highest toxicity-weighted emissions (of the pollutants with cancer UREs).

- Several POM Groups are among the highest emitted "pollutants" in the District and/or rank among the pollutants with the highest toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at WADC including fluorene, which failed a single screen for WADC. POM, Group 2d does not include any PAHs sampled for at WADC. POM, Group 5a includes benzo(a)pyrene, which also failed a single screen.

Observations from Table 8-7 include the following:

- Toluene and methanol are 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) are acrolein, formaldehyde, and 1,3-butadiene.

- Four of the highest emitted pollutants in the District of Columbia also have the highest toxicity-weighted emissions.

- Naphthalene has the eighth highest toxicity-weighted emissions but is not one of the 10 highest emitted pollutants (of the pollutants with noncancer RfCs).

- None of the other pollutants sampled for at WADC under the NMP appear in Table 8-7.

8.6 Summary of the 2014 Monitoring Data for WADC

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

❖ *Although concentrations of three PAHs failed screens, naphthalene failed the majority of screens and was therefore the only pollutant of interest identified via the risk screening process.*

❖ *The annual average concentration of naphthalene for WADC ranks ninth highest among NMP sites sampling this pollutant.*

- *Concentrations of naphthalene have an overall decreasing trend at WADC and are at a minimum for 2014.*

9.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

9.1 Site Characterization

This section characterizes the Florida 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 five Florida sites are located in two separate urban areas. Three sites (AZFL, SKFL, and SYFL) are located in the Tampa-St. Petersburg-Clearwater, Florida CBSA. ORFL and PAFL are located in the Orlando-Kissimmee-Sanford, Florida CBSA. Figures 9-1 and 9-2 are composite satellite images retrieved from ArcGIS Explorer showing the St. Petersburg area monitoring sites and their immediate surroundings. Figure 9-3 identifies nearby point source emissions locations that surround these two sites by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 9-3. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundaries are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundaries. Figures 9-4 through 9-8 are the composite satellite images and emissions sources maps for the Tampa site and the two sites in the Orlando area. Table 9-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 9-1. St. Petersburg, Florida (AZFL) Monitoring Site

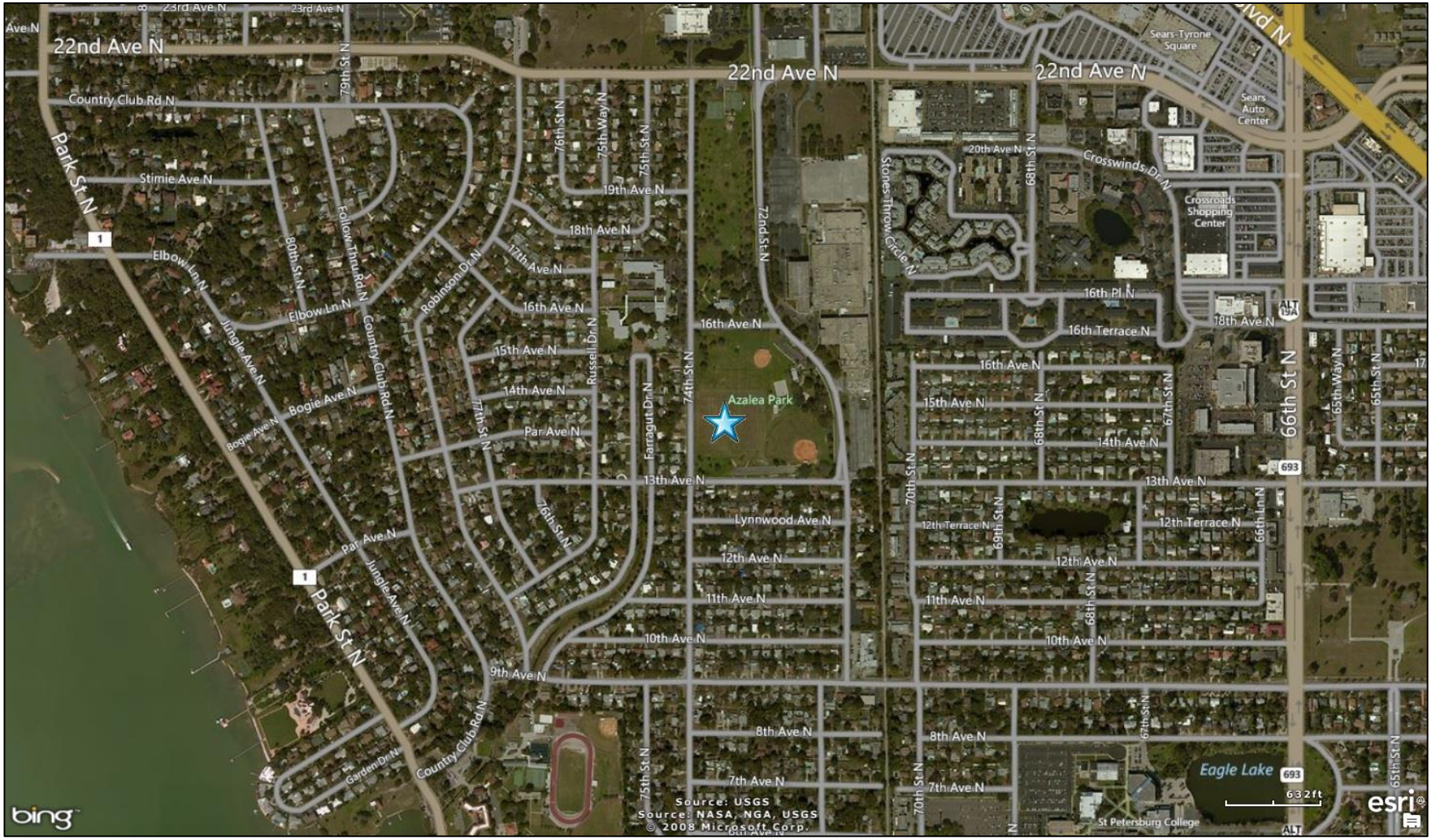


Figure 9-2. Pinellas Park, Florida (SKFL) Monitoring Site

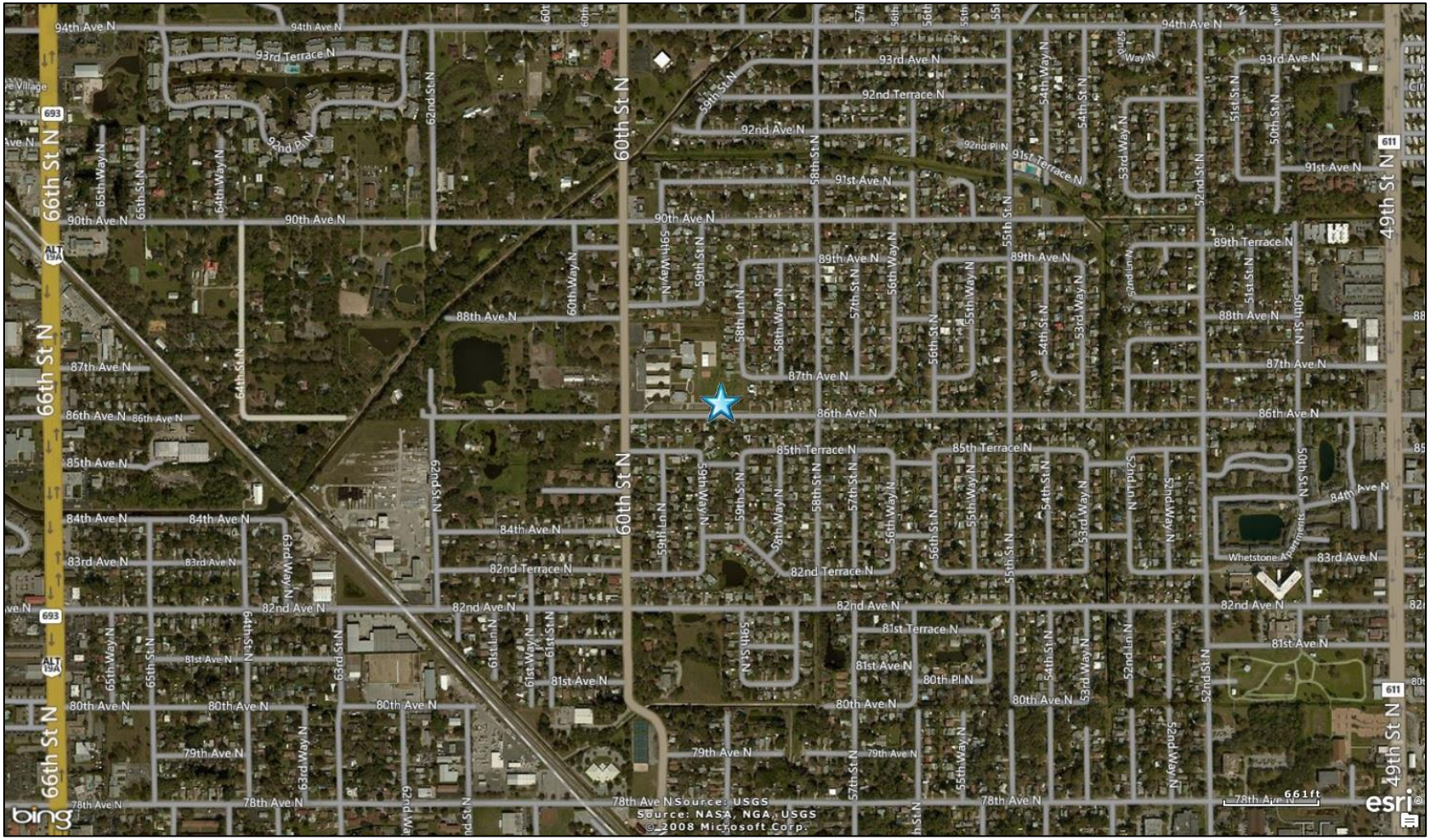


Figure 9-3. NEI Point Sources Located Within 10 Miles of AZFL and SKFL

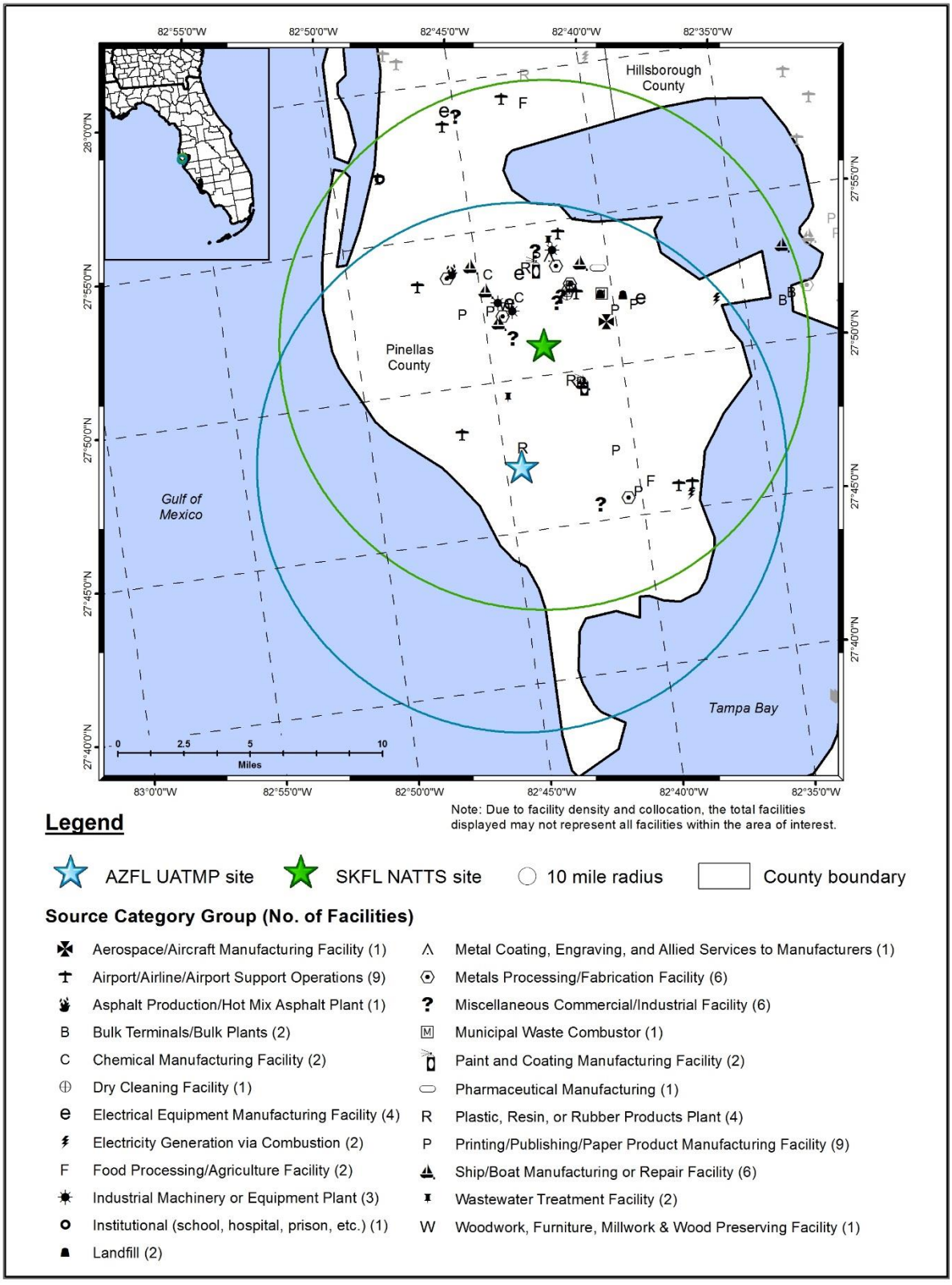


Figure 9-4. Valrico, Florida (SYFL) Monitoring Site

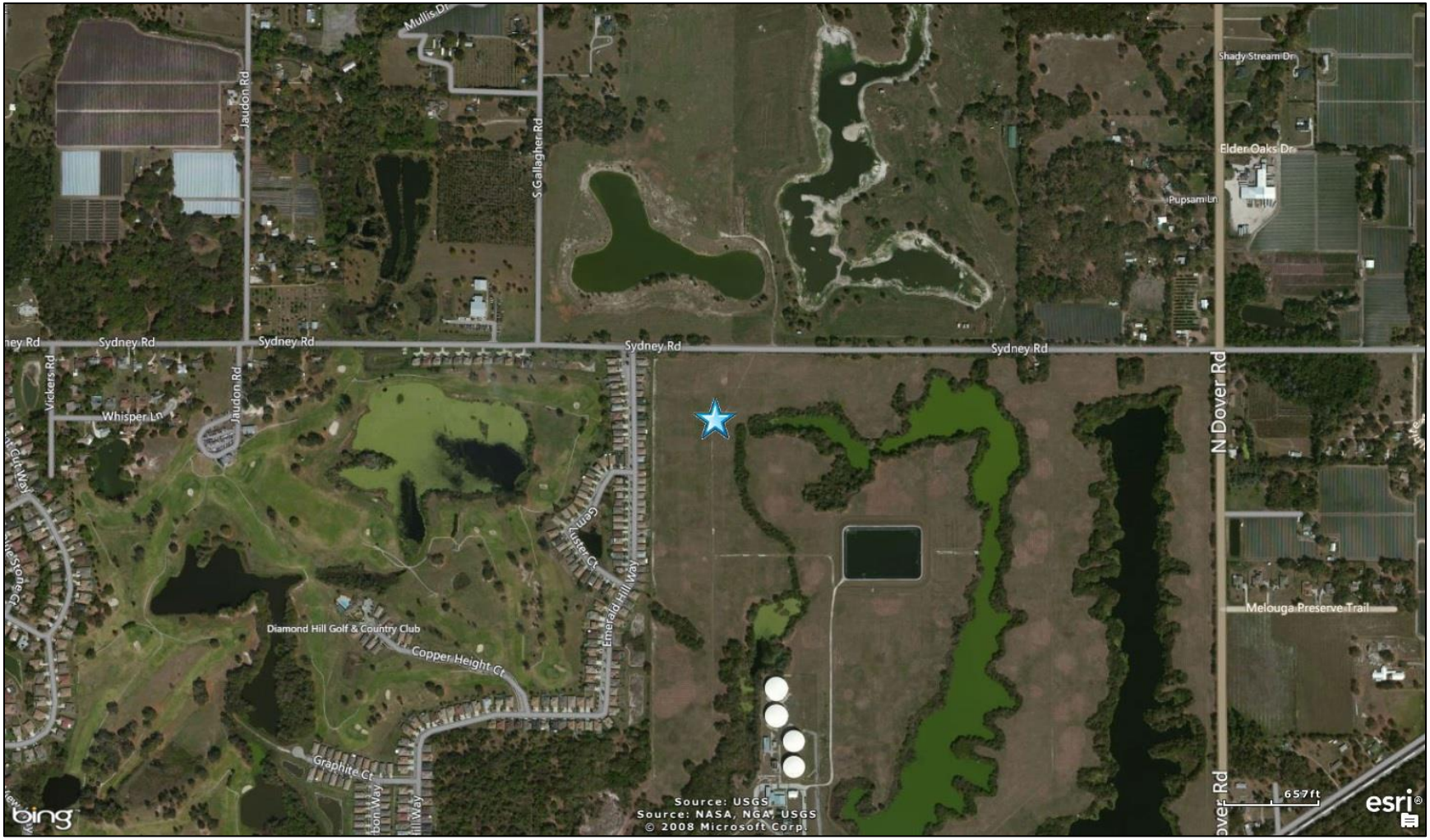
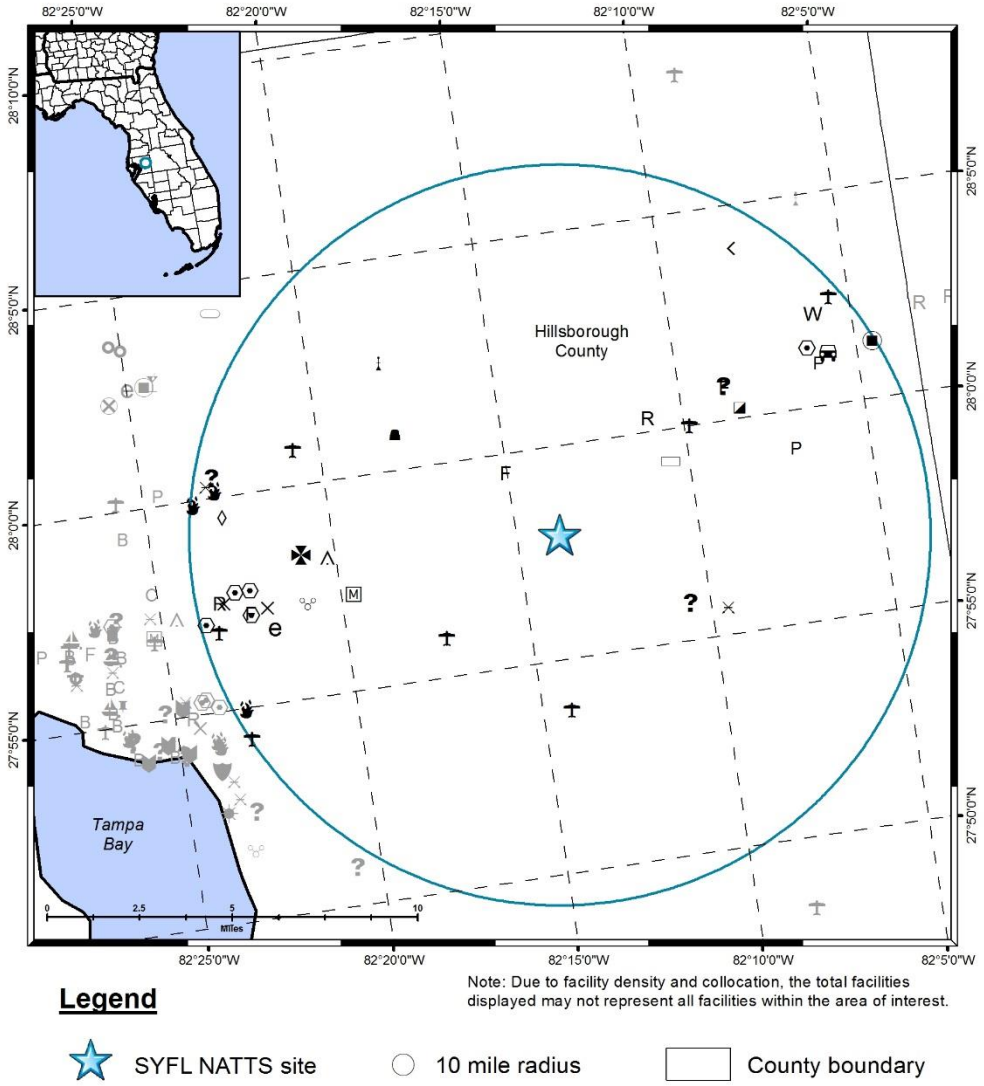


Figure 9-5. NEI Point Sources Located Within 10 Miles of SYFL



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

Legend

SYFL NATTS site | 10 mile radius | County boundary

Source Category Group (No. of Facilities)

- Aerospace/Aircraft Manufacturing Facility (1)
- Airport/Airline/Airport Support Operations (7)
- Asphalt Production/Hot Mix Asphalt Plant (3)
- Auto Body Shop/Painters/Automotive Stores (1)
- Automobile/Truck Manufacturing Facility (1)
- Brick, Structural Clay, or Clay Ceramics Plant (1)
- Compressor Station (1)
- Electrical Equipment Manufacturing Facility (1)
- Fertilizer Plant (1)
- Food Processing/Agriculture Facility (3)
- Landfill (1)
- Metal Can, Box, and Other Metal Container Manufacturing (1)
- Metal Coating, Engraving, and Allied Services to Manufacturers (1)
- Metals Processing/Fabrication Facility (5)
- Mine/Quarry/Mineral Processing Facility (2)
- Miscellaneous Commercial/Industrial Facility (3)
- Municipal Waste Combustor (1)
- Pesticide Manufacturing Plant (1)
- Petroleum Refinery (1)
- Plastic, Resin, or Rubber Products Plant (2)
- Printing/Publishing/Paper Product Manufacturing Facility (2)
- Rail Yard/Rail Line Operations (2)
- Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Figure 9-6. Winter Park, Florida (ORFL) Monitoring Site

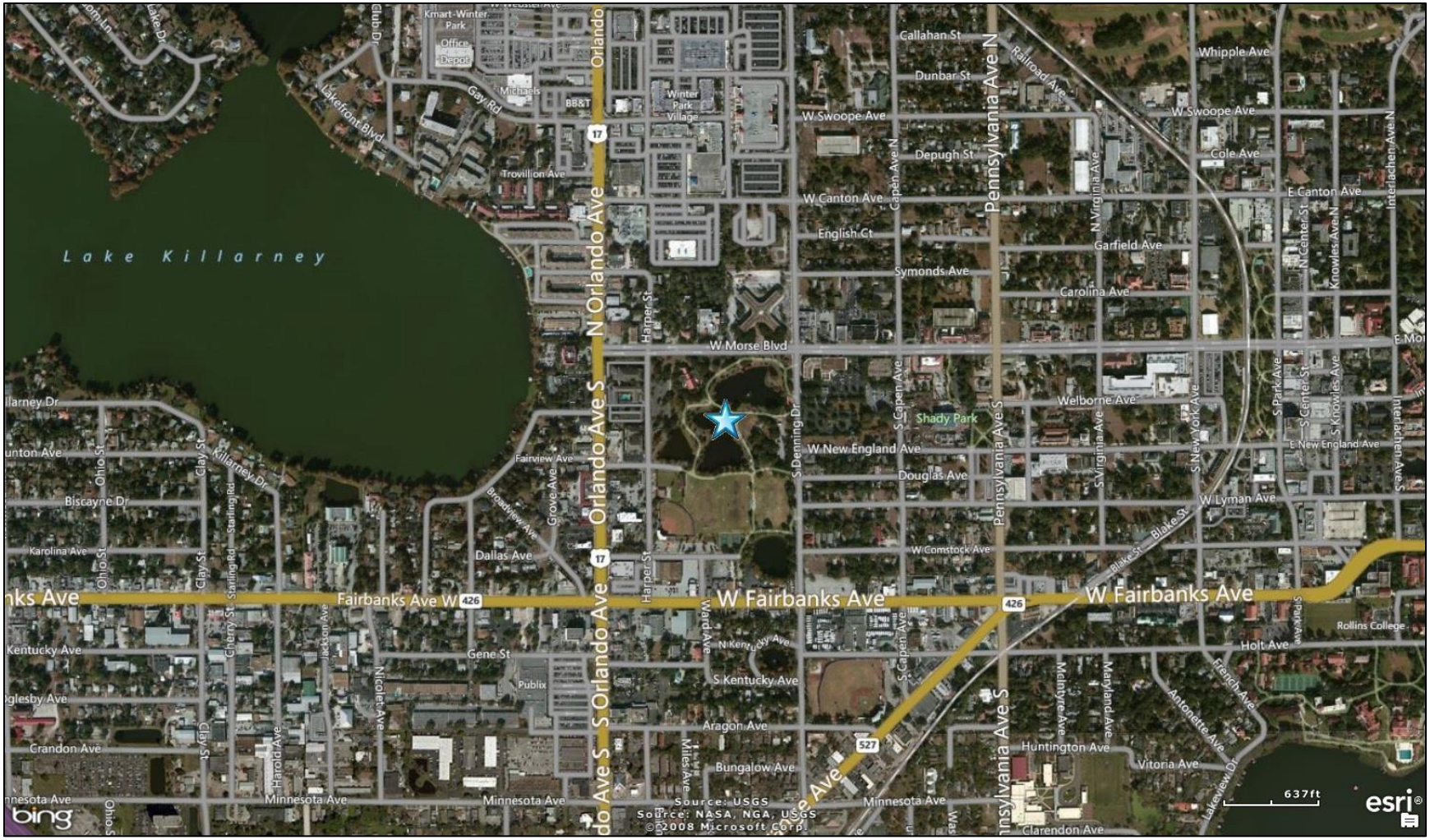


Figure 9-7. Orlando, Florida (PAFL) Monitoring Site

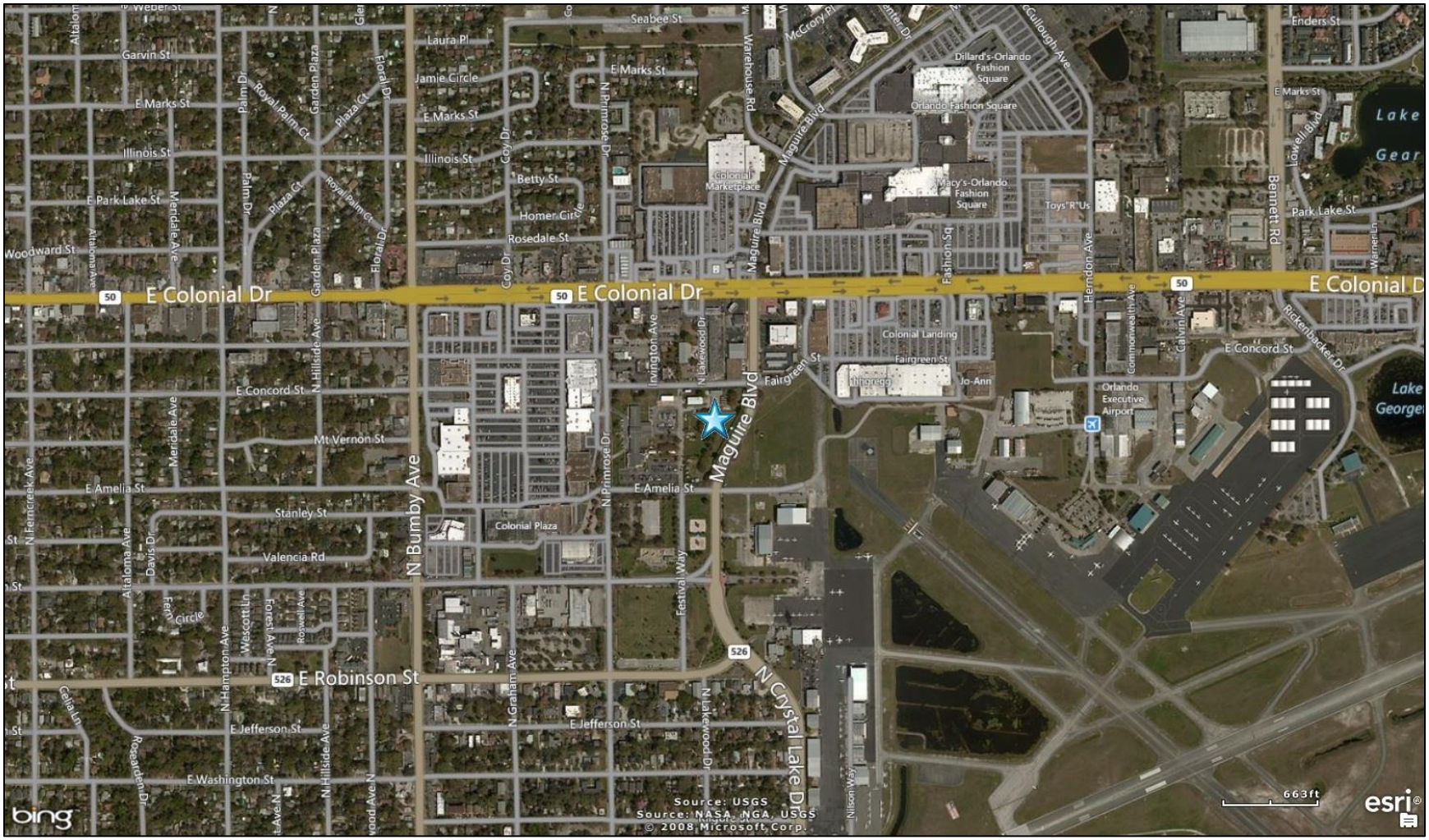


Figure 9-8. NEI Point Sources Located Within 10 Miles of ORFL and PAFL

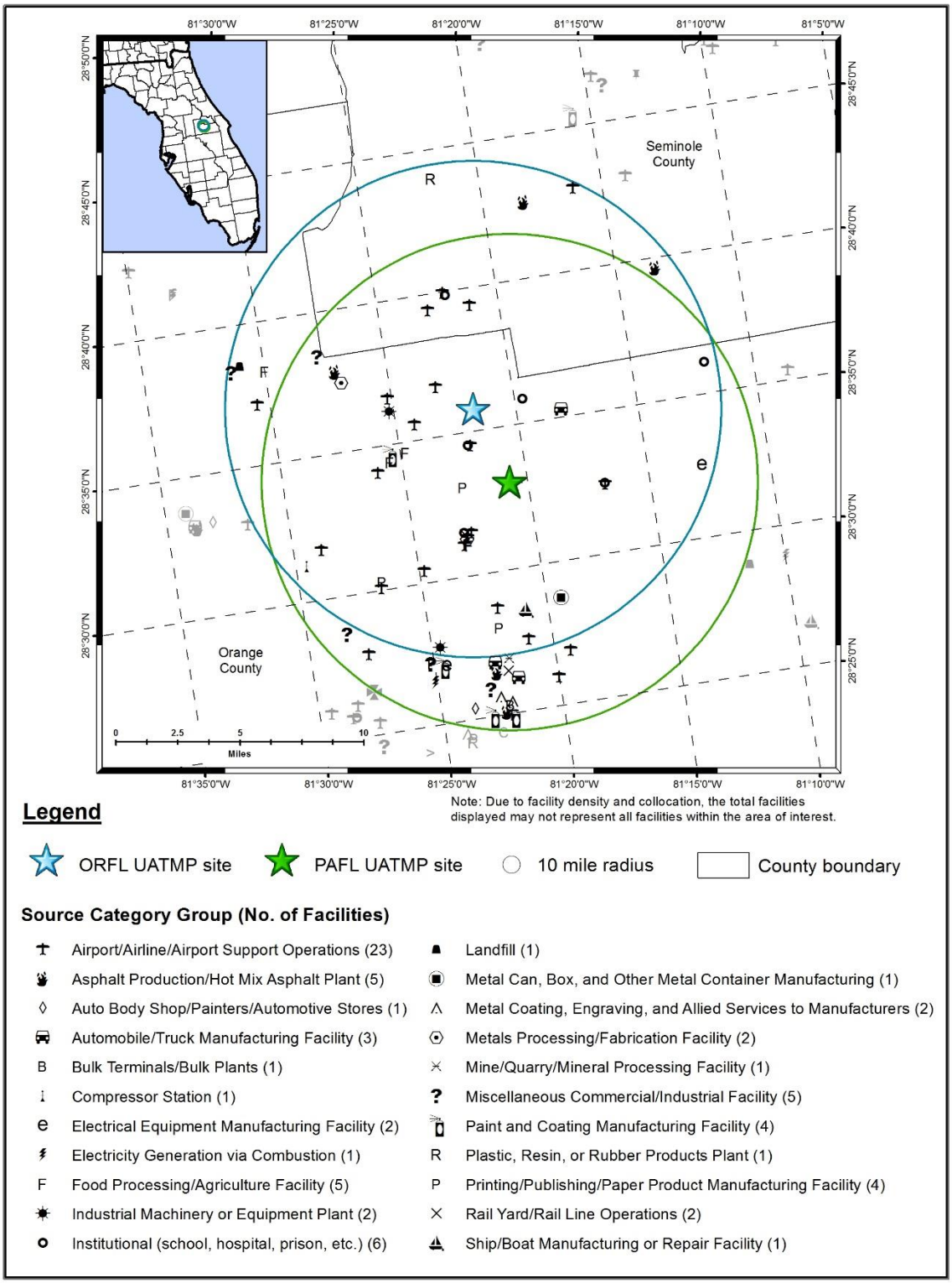


Table 9-1. Geographical Information for the Florida Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
AZFL	12-103-0018	St. Petersburg	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.785866, -82.739875	Residential	Suburban	40,000	66th St N, N of 9th St
SKFL	12-103-0026	Pinellas Park	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.850348, -82.714465	Residential	Suburban	36,500	66th St N, S of 102 Ave N
SYFL	12-057-3002	Valrico	Hillsborough	Tampa-St. Petersburg-Clearwater, FL	27.965650, -82.230400	Residential	Rural	3,800	Sydney Road, W of S Forbes Rd
ORFL	12-095-2002	Winter Park	Orange	Orlando-Kissimmee-Sanford, FL	28.596389, -81.362500	Commercial	Urban/City Center	31,500	Orlando Ave, N of Morse Blvd
PAFL	12-095-1004	Orlando	Orange	Orlando-Kissimmee-Sanford, FL	28.550833, -81.345556	Commercial	Suburban	49,000	Colonial/MLK Blvd, b/w Primrose Rd & Bumby Ave

[1]AADT reflects 2013 data for PAFL and 2014 data for AZFL, SKFL, SYFL, and ORFL (FL DOT, 2014)

BOLD ITALICS = EPA-designated NATTS Site

AZFL is located at Azalea Park in St. Petersburg. Figure 9-1 shows that the area surrounding AZFL consists of mixed land use, including residential, commercial, and industrial properties. The industrial property separated from Azalea Park by 72nd Street North is a former electronics manufacturer and a permanently closed facility, and was purchased in 2015 by a commercial redevelopment company (Girardi, 2015). Heavily traveled roadways are located less than 1 mile from the monitoring site. AZFL is located less than 1 mile east of Boca Ciega Bay, the edge of which can be seen in the bottom-left corner of Figure 9-1.

SKFL is located in Pinellas Park, north of St. Petersburg. This site is located on the property of Skyview Elementary School, at the corner of 86th Avenue North and 60th Street North. Figure 9-2 shows that SKFL is located in a primarily residential area. A rail line intersects the Pinellas Park Ditch near a construction company on the left-hand side of Figure 9-2. Population exposure is the purpose behind monitoring at this location. This site is the Pinellas County NATTS site.

Figure 9-3 shows the location of the St. Petersburg sites in relation to each other. AZFL is located approximately 5 miles south-southwest of SKFL. Most of the emissions sources on the Tampa Bay Peninsula are located north of SKFL. A small cluster of point sources is also located southeast of SKFL. The airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; printing, publishing, and paper product manufacturing; metals processing and fabrication; and ship/boat manufacturing or repair are the source categories with the greatest number of emissions sources in the St. Petersburg area (based on the areas covered by the 10-mile radii). The emissions source closest to AZFL is a plastic, resin, or rubber products plant. While the emissions source closest to SKFL falls into the miscellaneous commercial/industrial facility source category, a plastic, resin, or rubber products plant, a metals processing/fabrication facility, and a ship/boat manufacturing or repair facility are also located within 2 miles of SKFL.

SYFL is located in Valrico, which is also part of the Tampa-St. Petersburg-Clearwater, Florida CBSA, although it is on the eastern outskirts of the area. The SYFL monitoring site is located in a rural area, although, as Figure 9-4 shows, a residential community and country club lie just to the west of the site. Located to the south of the site (and shown in the bottom-center portion of Figure 9-4) are tanks that are part of the local water treatment facility. This site serves

as a background site, although the effects of increased development in the area are likely being captured by the monitoring site. This site is the Tampa NATTS site.

Figure 9-5 shows that most of the emissions sources surrounding SYFL are greater than 5 miles away from the site. The point sources shown include a number of sources categories. The airport source category and metals processing and fabrication are the source categories with the greatest number of emissions sources near SYFL. The closest source to SYFL with reportable air emissions in the 2011 NEI is a food processing facility.

ORFL is located in Winter Park, north of Orlando. Figure 9-6 shows that ORFL is located near Lake Mendsen, just behind Community Playground. The site is east of Lake Killarney and south of Winter Park Village. This site lies in a commercial area and is a population exposure site.

PAFL is located in northeast Orlando, on the northwestern edge of the Orlando Executive Airport property, as shown in Figure 9-7. The area is commercial in nature 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 (although not shown in Figure 9-7). A large shopping complex is located to the northeast of the site, just north of the airport, between Colonial Drive and Maguire Boulevard. Interstate-4 runs north-south approximately 2 miles to the west of the monitoring site.

ORFL is located 3.3 miles north-northwest of PAFL. Most of the point sources surrounding these sites are located on the western side of the 10-mile radii, as shown in Figure 9-8. Although the emissions sources surrounding ORFL and PAFL are involved in a variety of industries and processes, the airport and airport support operations source category has the greatest number of emissions sources within 10 miles of these sites. The closest emissions source to PAFL is Orlando Executive Airport, which is located under the star symbol for PAFL in Figure 9-8. The closest emissions source to ORFL is a hospital, which falls into the institutions category, and the heliport located at the hospital, which falls into the airport source category.

In addition to providing city, county, CBSA, and land use/location setting information, Table 9-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume is lowest near SYFL and highest near PAFL, among the Florida sites, with the traffic volumes for four of the five sites are greater than 30,000 vehicles. The traffic volume for PAFL ranks 19th highest among other NMP sites, with the traffic volumes for AZFL, SKFL, and ORFL in the middle of the range compared to other NMP sites (ranking 21st, 22nd, and 25th, respectively). The traffic volume near SYFL is considerably less than the other Florida sites and is in the bottom third compared to other NMP sites.

9.2 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 the year.

9.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. Limited site-specific data were available in AQS for the Florida sites. For SYFL, site-specific wind information was available in AQS and is presented in Table 9-2. For the remaining sites and parameters, data from the closest NWS weather stations are presented. A map showing the distance between each Florida monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 9-2. Average Meteorological Conditions near the Florida Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
St. Petersburg, Florida – AZFL[2]							
Sample Days (61)	73.3 ± 0.5	64.2 ± 0.5	74.6 ± 0.7	30.04 ± 0.01	30.03 ± 0.01	N	7.1 ± 0.2
2014	73.4 ± 0.2	64.4 ± 0.2	74.9 ± 0.3	30.04 ± <0.01	30.03 ± <0.01	N	7.1 ± 0.1
Pinellas Park, Florida – SKFL[3]							
Sample Days (66)	71.9 ± 0.5	62.7 ± 0.6	74.7 ± 0.8	30.05 ± 0.01	30.05 ± 0.01	ENE	6.6 ± 0.2
2014	72.4 ± 0.2	63.3 ± 0.2	74.9 ± 0.3	30.05 ± <0.01	30.04 ± <0.01	N	6.5 ± 0.1
Valrico, Florida – SYFL[4]							
Sample Days (60)	71.2 ± 0.7	60.5 ± 0.7	72.3 ± 1.1	NA	30.03 ± 0.01	N	4.9 ± 0.2
2014	71.1 ± 0.3	60.5 ± 0.3	72.3 ± 0.4	NA	30.04 ± <0.01	NW	5.1 ± 0.1
Winter Park, Florida – ORFL[5]							
Sample Days (60)	71.9 ± 0.6	61.4 ± 0.7	72.5 ± 1.0	30.06 ± 0.01	29.93 ± 0.01	N	5.7 ± 0.2
2014	72.3 ± 0.2	62.3 ± 0.3	73.3 ± 0.4	30.06 ± <0.01	29.94 ± <0.01	N	5.7 ± 0.1
Orlando, Florida – PAFL[6]							
Sample Days (30)	71.6 ± 0.8	61.3 ± 0.9	73.2 ± 1.4	30.06 ± 0.01	29.93 ± 0.01	N	5.6 ± 0.3
2014	72.3 ± 0.2	62.3 ± 0.3	73.3 ± 0.4	30.06 ± <0.01	29.94 ± <0.01	N	5.7 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Information was obtained from the closest NWS weather station located at St.Petersburg/Whitted Airport, WBAN 92806.
[3]Information was obtained from the closest NWS weather station located at St.Petersburg/Clearwater International Airport, WBAN 12873.
[4]Only wind parameters were measured at SYFL year-round. The remaining information was obtained from the closest NWS weather station located at Tampa Executive Airport (formerly Vandenburg Airport), WBAN 92816. Data completeness at this station was between 84% and 90% for each parameter.
[5,6]Information was obtained from the closest NWS weather station located at Orlando Executive Airport, WBAN 12841.
NA= Sea level pressure was not recorded at the Vandenberg Airport.

Table 9-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 9-2 is the 95 percent confidence interval for each parameter. As shown in Table 9-2, average meteorological conditions at the Florida monitoring sites on sample days in 2014 were representative of average weather conditions experienced throughout the entire year. The largest difference between the 2014 averages and the sample day averages is shown for PAFL for dew point temperature.

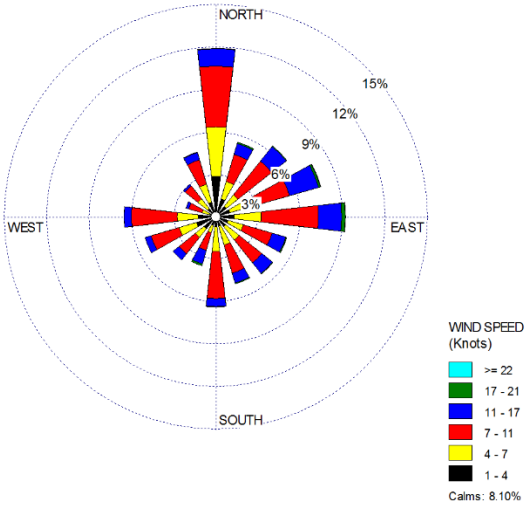
The Florida sites have some of the highest daily average temperatures among the NMP sites, behind only the Arizona sites. The highest average dew point temperatures among NMP sites were calculated for the Florida monitoring sites. The Florida sites also experienced some of the highest relative humidity levels among NMP sites.

9.2.2 Wind Rose Comparison

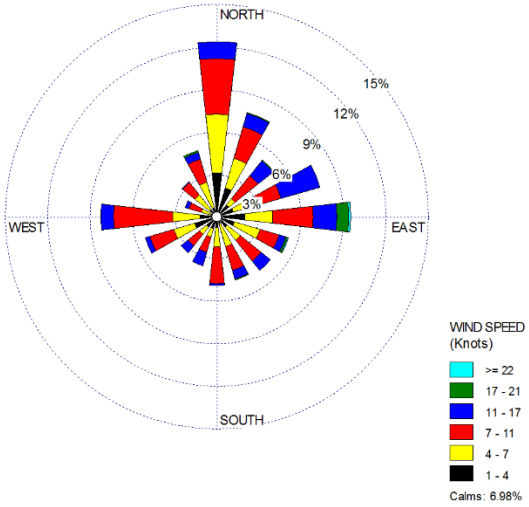
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 9-9 presents two wind roses for the AZFL monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 9-10 through 9-13 present the full-year and sample day wind roses for the remaining Florida monitoring sites.

Figure 9-9. Wind Roses for the St. Petersburg/Whitted Airport Weather Station near AZFL

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 9-9 for AZFL include the following:

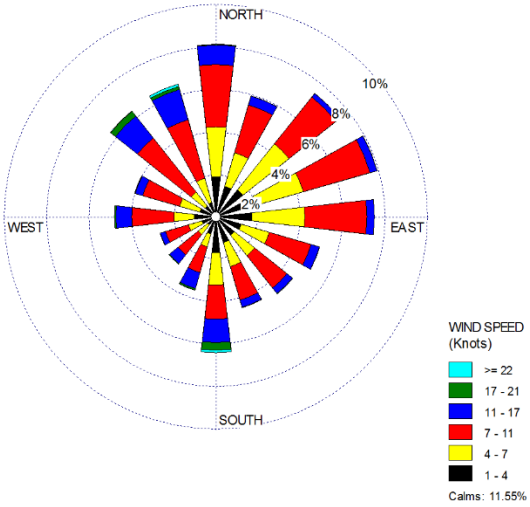
- The weather station at St. Petersburg/Whitted Airport is located 7.1 miles east-southeast of AZFL. Between them is most of the city of St. Petersburg. Note that the Whitted Airport is located on the Tampa Bay coast while AZFL is on the west side of the peninsula near the Boca Ciega Bay.

- The full-year wind rose shows that winds from the north, northeast quadrant, and east were the most commonly observed wind directions near AZFL, accounting for more than 40 percent of observations. Winds from the western quadrants were observed less frequently than winds from the eastern quadrants. Calm winds account for roughly 8 percent of the hourly wind measurements.

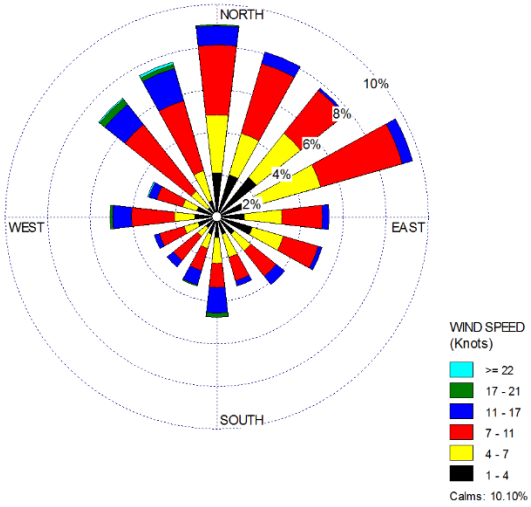
- The sample day wind patterns resemble the full-year wind patterns, with northerly winds observed the most, along with those from the northeast quadrant and east. The strongest winds on sample days were observed with easterly wind observations. A lower percentage of calm winds were observed on sample days.

Figure 9-10. Wind Roses for the St. Petersburg/Clearwater International Airport Weather Station near SKFL

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 9-10 for SKFL include the following:

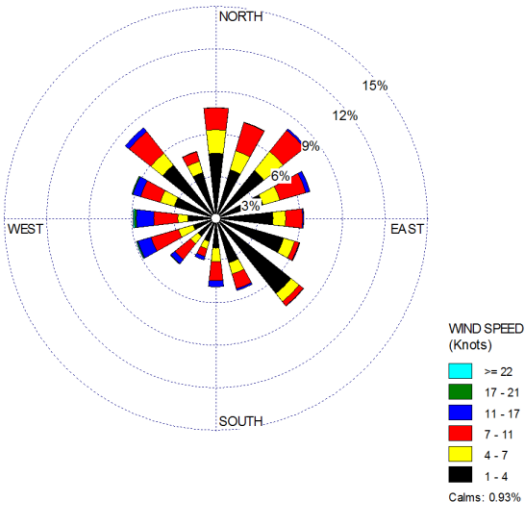
- The weather station at St. Petersburg/Clearwater International Airport is located 4.5 miles north-northeast of SKFL. The St. Petersburg/Clearwater Airport is located on Old Tampa Bay while SKFL is located farther inland.

- The full-year wind rose shows that winds from a variety of directions were observed near SKFL. Winds from the northwest to north and northeast to east were the most commonly observed wind directions while winds from the southwest quadrant were observed the least. Calm winds accounted for less than 12 percent of the hourly wind measurements.

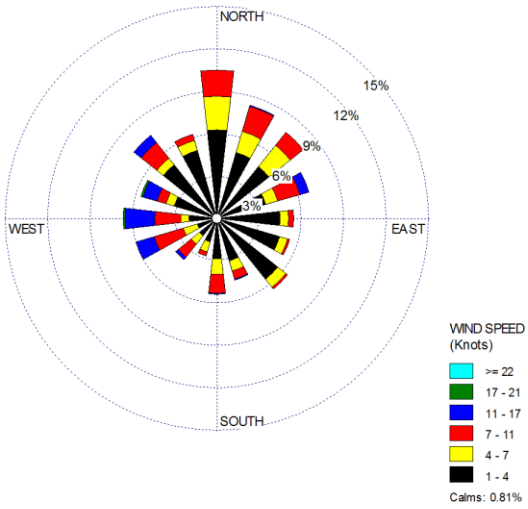
- Winds from the northwest to north to east-northeast were frequently observed near SKFL on sample days, with each of these wind directions accounting for a slightly higher percentage of observations on sample days than in 2014 as a whole. Thus, fewer winds with a southerly component were observed on sample days.

Figure 9-11. Wind Roses for the Wind Data Collected at SYFL

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 9-11 for SYFL include the following:

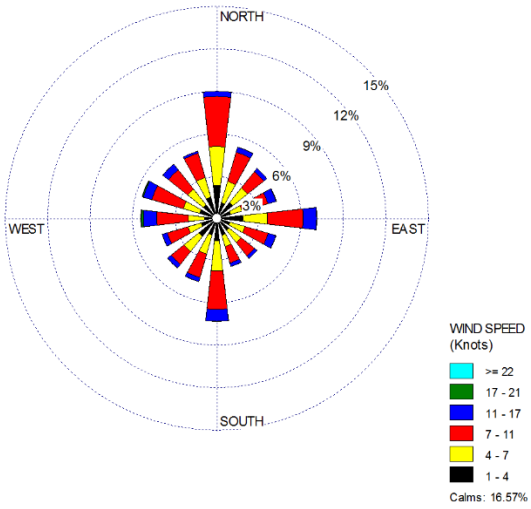
- SYFL is the only Florida monitoring site in which wind observations from the site were available in AQS.

- The full-year wind rose shows that winds from all directions were observed at SYFL, with winds from the northwest and southeast observed slightly more often than winds from other directions. Winds greater than 11 knots were observed most often with winds from the southwest and northwest quadrants than with winds from other directions. Calm winds account for less than 1 percent of observations collected at SYFL in 2014.

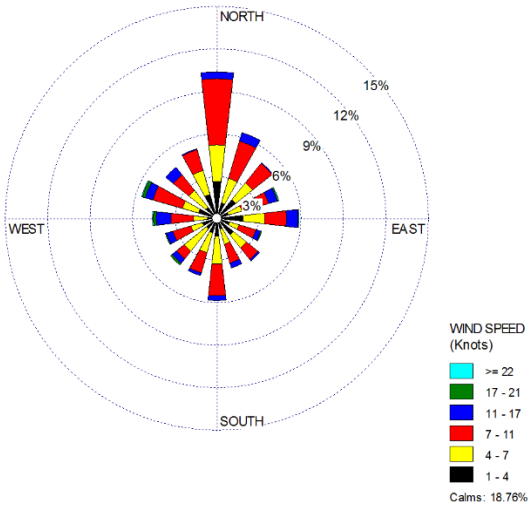
- Winds from the north were observed most frequently at SYFL on sample days, with winds from the north to northeast accounting for the directions with the most observations. The highest wind speeds on sample days were observed with winds from the southwest and northwest quadrants. Calm winds account for a similar percentage of observations on sample days as the full-year.

Figure 9-12. Wind Roses for the Orlando Executive Airport Weather Station near ORFL

2014 Wind Rose



Sample Day Wind Rose



Observations from Figures 9-12 for ORFL include the following: Karla to revise for calms

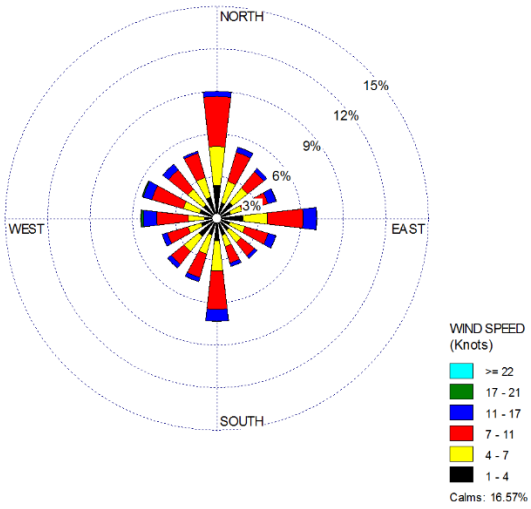
- The closest weather station to both ORFL and PAFL is the one located at the Orlando Executive Airport. The weather station is located 4 miles south-southeast of ORFL and less than 1 mile east-southeast of PAFL. Thus, the full-year wind roses presented for these sites are identical.

- Although winds from all directions were observed near these sites, northerly winds were the most frequently observed near ORFL and PAFL in 2014, accounting for nine percent of observations. Winds from the east and south each also accounted for more than 6 percent of observations. Calm winds accounted for approximately 17 percent of observations in 2014.

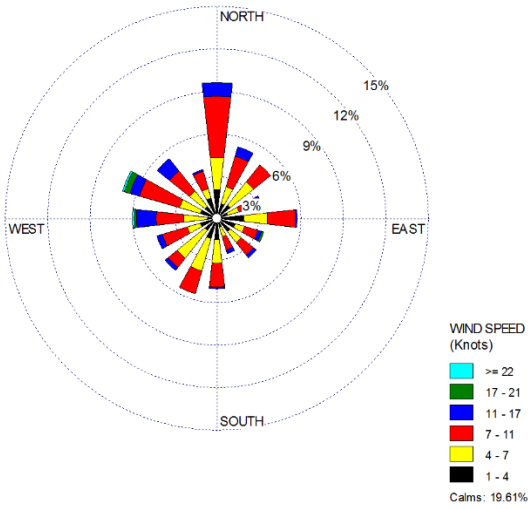
- The sample day wind rose for ORFL shows that winds from the north prevailed, accounting for more than 10 percent of wind observations. Winds from the north-northeast, east, and south each accounted for more than 6 percent of observations. Calm winds accounted for approximately 19 percent of observations on sample days.

Figure 9-13. Wind Roses for the Orlando Executive Airport Weather Station near PAFL

2014 Wind Rose



Sample Day Wind Rose



Observations from Figures 9-13 for PAFL include the following:

- The closest weather station to both ORFL and PAFL is the one located at the Orlando Executive Airport. The weather station is located less than 1 mile east-southeast of PAFL, as PAFL is located on the edge of the Orlando Executive Airport property. The distance between PAFL and the weather station at Orlando Executive Airport is the shortest distance calculated between a weather station and an NMP site. The full-year wind rose presented for PAFL is identical to the one presented for ORFL in Figure 9-12.

- Although winds from all directions were observed near these sites, northerly winds were the most frequently observed near ORFL and PAFL in 2014, accounting for nine percent of observations. Winds from the east and south each also accounted for more than 6 percent of observations. Calm winds accounted for approximately 17 percent of observations in 2014.

- The sample day wind rose for PAFL shares the northerly prominence of ORFL's sample day wind rose but has a higher percentage of wind observations from the west-northwest and west. The strongest winds were observed with these directions. Note that although the sample days are fairly standardized, samples are collected at PAFL on a 1-in-12 day sampling schedule, leading to roughly half the sample days included in the sample day wind rose as ORFL.

9.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Florida monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 9-3. 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 and are shaded in gray in Table 9-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Only carbonyl compounds were sampled for at AZFL, SYFL, and ORFL. PAHs were sampled for in addition to carbonyl compounds at SKFL. Only PM_{10} metals were sampled for at PAFL.

Table 9-3. Risk-Based Screening Results for the Florida Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Petersburg, Florida – AZFL						
Formaldehyde	0.077	56	56	100.00	50.45	50.45
Acetaldehyde	0.45	55	56	98.21	49.55	100.00
Total		111	112	99.11		
Pinellas Park, Florida – SKFL						
Acetaldehyde	0.45	50	50	100.00	34.97	34.97
Formaldehyde	0.077	50	50	100.00	34.97	69.93
Naphthalene	0.029	43	58	74.14	30.07	100.00
Total		143	158	90.51		
Valrico, Florida – SYFL						
Acetaldehyde	0.45	55	55	100.00	50.00	50.00
Formaldehyde	0.077	55	55	100.00	50.00	100.00
Total		110	110	100.00		
Winter Park, Florida – ORFL						
Acetaldehyde	0.45	60	60	100.00	50.00	50.00
Formaldehyde	0.077	60	60	100.00	50.00	100.00
Total		120	120	100.00		
Orlando, Florida – PAFL						
Arsenic (PM_{10})	0.00023	29	30	96.67	100.00	100.00
Total		29	30	96.67		

Observations from Table 9-3 include the following:

- For AZFL, SYFL, and ORFL, the sites sampling only carbonyl compounds, acetaldehyde and formaldehyde were the only two pollutants to fail screens. Among the carbonyl compounds, only acetaldehyde, formaldehyde, and propionaldehyde have risk screening values. Propionaldehyde did not fail any screens for these three sites.

- For SYFL and ORFL, formaldehyde and acetaldehyde failed the same number of screens and contributed equally to the total number of failed screens. For AZFL, acetaldehyde failed one less screen than formaldehyde. For all three sites, formaldehyde failed 100 percent of screens.

- Three pollutants failed at least one screen for SKFL (acetaldehyde, formaldehyde, and naphthalene). Acetaldehyde and formaldehyde failed the same number of screens and contributed equally to the total number of failed screens, with both failing 100 percent of screens. Naphthalene failed a few less screens, but was still identified as a pollutant of interest for this site.

- Arsenic is the only PM_{10} metal to fail screens for PAFL. This pollutant was detected in every metals sample collected at PAFL and failed all but one screen.

9.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Florida monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the Florida monitoring sites are provided in Appendices L, M, and N.

9.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each Florida monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Florida monitoring sites are presented in Table 9-4, where applicable. Note that concentrations of the PAHs and metals for SKFL and PAFL are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 9-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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	56/56	56	1.54 ± 0.29	1.51 ± 0.27	0.86 ± 0.17	1.26 ± 0.32	1.31 ± 0.15
Formaldehyde	56/56	56	1.54 ± 0.20	2.34 ± 0.32	3.13 ± 1.98	2.12 ± 0.40	2.24 ± 0.44
Pinellas Park, Florida – SKFL							
Acetaldehyde	50/50	50	0.89 ± 0.17	0.96 ± 0.11	NA	1.47 ± 0.32	NA
Formaldehyde	50/50	50	1.15 ± 0.14	2.25 ± 0.29	NA	2.14 ± 0.37	NA
Naphthalene[a]	58/58	58	76.65 ± 30.40	66.38 ± 23.61	36.58 ± 7.73	40.88 ± 12.31	54.29 ± 10.42
Valrico, Florida – SYFL							
Acetaldehyde	55/55	55	1.13 ± 0.15	1.31 ± 0.15	1.14 ± 0.24	1.54 ± 0.37	1.27 ± 0.12
Formaldehyde	55/55	55	1.53 ± 0.17	2.91 ± 0.39	1.73 ± 0.33	1.88 ± 0.40	2.03 ± 0.22
Winter Park, Florida – ORFL							
Acetaldehyde	60/60	60	1.91 ± 0.48	2.04 ± 0.41	1.50 ± 0.19	2.56 ± 0.69	2.01 ± 0.25
Formaldehyde	60/60	60	1.48 ± 0.23	2.72 ± 0.78	2.75 ± 0.46	1.91 ± 0.46	2.20 ± 0.28
Orlando, Florida – PAFL							
Arsenic (PM_{10})[a]	30/30	30	0.76 ± 0.27	0.68 ± 0.23	0.59 ± 0.18	1.19 ± 0.42	0.81 ± 0.16

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

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

Observations for AZFL from Table 9-4 include the following:

- The first quarter average concentrations of acetaldehyde and formaldehyde for AZFL are equivalent; yet, the quarterly average concentrations of acetaldehyde decrease during the warmer months of the year at AZFL while the quarterly average concentrations of formaldehyde increase. The third quarter average acetaldehyde concentration is roughly half the concentration shown for the first quarter while the third quarter average concentration of formaldehyde is twice the first quarter average concentration.

- Concentrations of acetaldehyde measured at AZFL range from 0.441 µg/m^3 to 2.74 µg/m^3. A review of the acetaldehyde data collected at AZFL shows that acetaldehyde concentrations greater than 2 µg/m^3 were measured during each calendar quarter except the third and the number of acetaldehyde concentrations less

than 1 µg/m^3 measured during the third quarter is two to three times greater than the number measured during the other calendar quarters.

- Concentrations of formaldehyde measured at AZFL range from 1.02 µg/m^3 to 13.4 µg/m^3. The confidence interval shown for the third quarter average formaldehyde concentration is large and may indicate that the increase shown across the calendar quarters is attributable, at least in part, to outlier(s). The maximum formaldehyde concentration measured at AZFL is 13.4 µg/m^3, which is nearly four times greater than the next highest concentration measured at this site (3.52 µg/m^3). This concentration is also the fourth highest formaldehyde concentration measured at an NMP site in 2014. If the maximum concentration was removed from the calculation, the quarterly average concentration for the third quarter would fall between the second and fourth quarter average concentrations.

Observations for SKFL from Table 9-4 include the following:

- Due to a defective sampler, carbonyl compound samples collected between July 22, 2014 and September 20, 2014 were invalidated. Thus, third quarter and annual average concentrations for the carbonyl compounds could not be calculated for SKFL.

- Concentrations of acetaldehyde measured at SKFL range from 0.473 µg/m^3 to 3.05 µg/m^3. Looking at the quarterly averages, it appears that higher acetaldehyde concentrations were measured after sampling resumed in September. All seven acetaldehyde concentrations greater than 1.5 µg/m^3 were measured during the fourth quarter of 2014. Of the 23 acetaldehyde concentrations greater than 1 µg/m^3 measured at SKFL, 11 were measured between January and June and the additional 12 were measured after sampling resumed at the end of September.

- Concentrations of formaldehyde do not follow this trend. Concentrations of formaldehyde measured at SKFL range from 0.663 µg/m^3 to 3.20 µg/m^3, with all five formaldehyde concentrations less than 1 µg/m^3 measured between January and March. All of the formaldehyde concentrations measured during the first quarter are less than 1.75 µg/m^3, with few concentrations less than 1.75 µg/m^3 measured during the remaining calendar quarters (two each during the second and third quarter and five measured during the fourth quarter). The first quarter formaldehyde average concentration for SKFL is the lowest quarterly average concentration for this pollutant among the Florida sites.

- Concentrations of naphthalene measured at SKFL range from 11.9 ng/m^3 to 191 ng/m^3. The first and second quarterly average concentrations of naphthalene are greater than the third and fourth quarter averages and have larger confidence intervals associated with them. All six naphthalene concentrations greater than 100 ng/m^3 were measured at SKFL during the first and second quarters of the year. Of the 25 naphthalene concentrations greater than 50 ng/m^3 measured at SKFL, 17 were measured between January and June 2014. Conversely, nine of the 13 lowest concentrations (those less than 25 ng/m^3) were measured during the second half of 2014.

Observations for SYFL from Table 9-4 include the following:

- Concentrations of formaldehyde were higher than concentrations of acetaldehyde measured at SYFL, based on the quarterly and annual average concentrations.

- Concentrations of acetaldehyde measured at SYFL range from 0.518 µg/m^3 to 2.55 µg/m^3. The quarterly average concentrations vary relatively little, with the fourth quarter average the highest and exhibiting the most variability. Both the minimum and maximum acetaldehyde concentrations were measured at SYFL during the fourth quarter of 2014, as were three of the four acetaldehyde concentrations greater than 2 µg/m^3.

- Concentrations of formaldehyde measured at SYFL range from 0.752 µg/m^3 to 4.25 µg/m^3, with all six concentrations greater than 3 µg/m^3 measured in May or June. This explains why, at least in part, the second quarter average concentration is more than 1 µg/m^3 greater than the other quarterly averages for formaldehyde. The number of formaldehyde concentrations greater than 2 µg/m^3 measured at SYFL during the second quarter (14) is considerably greater than the number measured during the other calendar quarters (zero during the first quarter, and five each during the third and fourth quarters).

Observations for ORFL from Table 9-4 include the following:

- Concentrations of acetaldehyde measured at ORFL range from 0.756 µg/m^3 to 5.45 µg/m^3. ORFL has the highest annual average concentration of acetaldehyde among the Florida sites (with available annual averages). Based on the quarterly average concentrations, acetaldehyde concentrations were lowest at ORFL during the third quarter of the year and highest (and most variable) during the fourth quarter. Four of the five highest acetaldehyde concentrations were measured at ORFL between October and December (those greater than 3.5 µg/m^3). Only one acetaldehyde concentration greater than 2 µg/m^3 was measured at ORFL during the third quarter, while six or more were measured during each of the other calendar quarters (with nine measured during the fourth quarter).

- Concentrations of formaldehyde measured at ORFL range from 0.756 µg/m^3 to 6.54 µg/m^3, the maximum of which is the second highest formaldehyde concentration measured at a Florida site in 2014. Although the second and third quarter average concentrations are similar to each other, the confidence interval for the second quarter is nearly twice the confidence interval for the third quarter average. Three of the four highest formaldehyde concentrations measured at ORFL were measured in May or June, with eight of the 10 concentrations greater than 3 µg/m^3 measured during the second or third quarters of 2014.

Observations for PAFL from Table 9-4 include the following:

- PAFL is the only Florida monitoring site that did not sample carbonyl compounds.

- PM_{10} metals were sampled for at PAFL on a 1-in-12 day schedule, while the other Florida sites sampled on a 1-in-6 day schedule, thus, yielding roughly half the number of samples as the remaining sites.

- Arsenic is the only pollutant identified as a pollutant of interest for this site. Concentrations of arsenic measured at PAFL span an order of magnitude, ranging from 0.223 ng/m^3 to 2.11 ng/m^3.

- Concentrations of arsenic appear highest during the fourth quarter and lowest during the third quarter, based on the quarterly average concentrations, as the fourth quarter average is twice the third quarter average concentration. The four highest arsenic concentrations measured at PAFL were measured between October and December. The fourth quarter has the greatest number of arsenic measurements greater than 1 ng/m^3 (five, including the only measurement greater than 2 ng/m^3), while none were measured between April and September and three were measured during the first quarter. In addition, arsenic concentrations less than 0.5 ng/m^3 were not measured during the fourth quarter, while between two and three were measured during the other calendar quarters.

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

- None of the Florida monitoring sites appear in Table 4-10 for formaldehyde. ORFL is the only Florida site with an annual average concentration of acetaldehyde greater than 2 µg/m^3 and ranks ninth among NMP sites sampling this pollutant.

- SKFL does not appear among the sites with the highest annual average concentration of naphthalene among NMP sites sampling this pollutant.

- The annual average concentration of arsenic for PAFL ranks fourth highest among NMP sites sampling PM_{10} metals.

9.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 9-4 for each of the Florida monitoring sites. Figures 9-14 through 9-17 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first

quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 9-14. Program vs. Site-Specific Average Acetaldehyde Concentrations

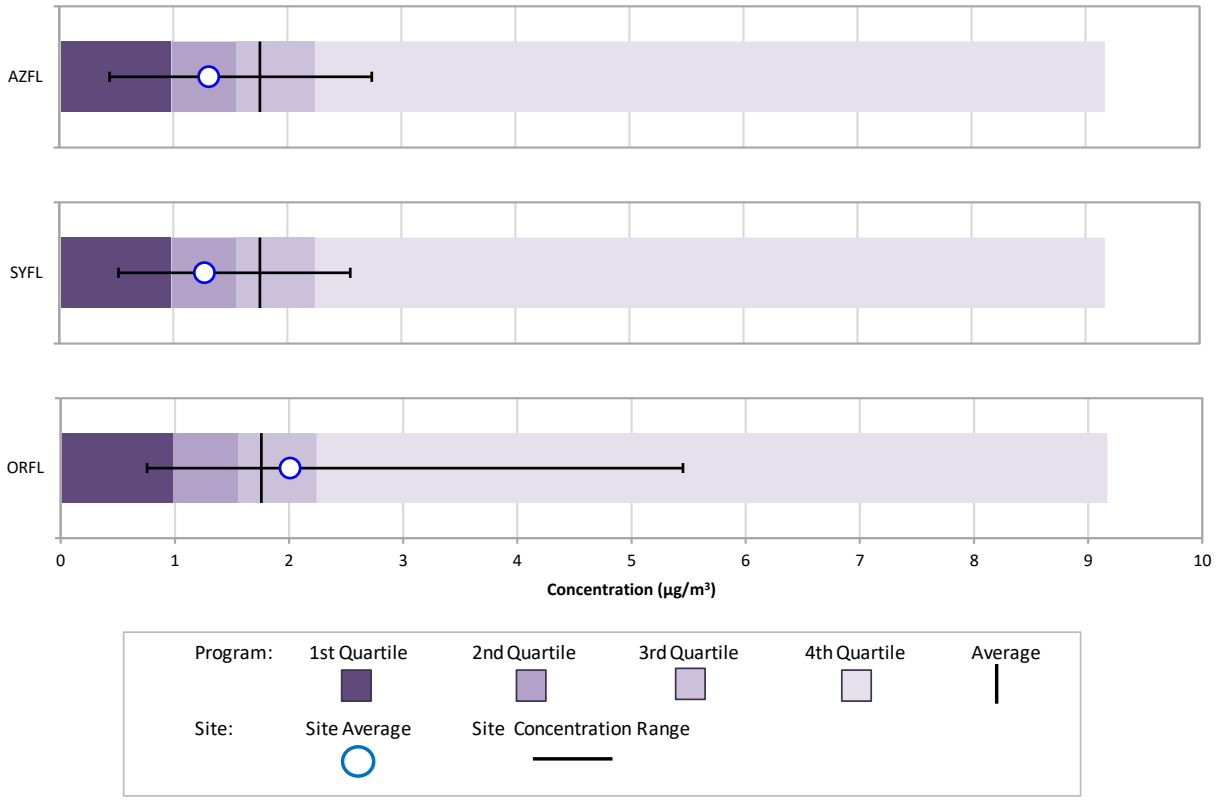


Figure 9-14 presents the box plots for acetaldehyde for AZFL, SYFL, and ORFL and shows the following:

- The box plots show that the range of acetaldehyde concentrations measured is smallest for SYFL and largest for ORFL. The maximum acetaldehyde concentration measured at ORFL is twice the maximum concentrations measured at AZFL and SYFL. The six highest acetaldehyde concentrations among the Florida sites were measured at ORFL.

- The annual average concentrations calculated for AZFL and SYFL are similar to each other and are less than both the program-level average and median concentrations. The annual average for ORFL is greater than the program-level median and average concentrations.

- A box plot was not created for SKFL because this site does not have an annual average concentration.

Figure 9-15. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

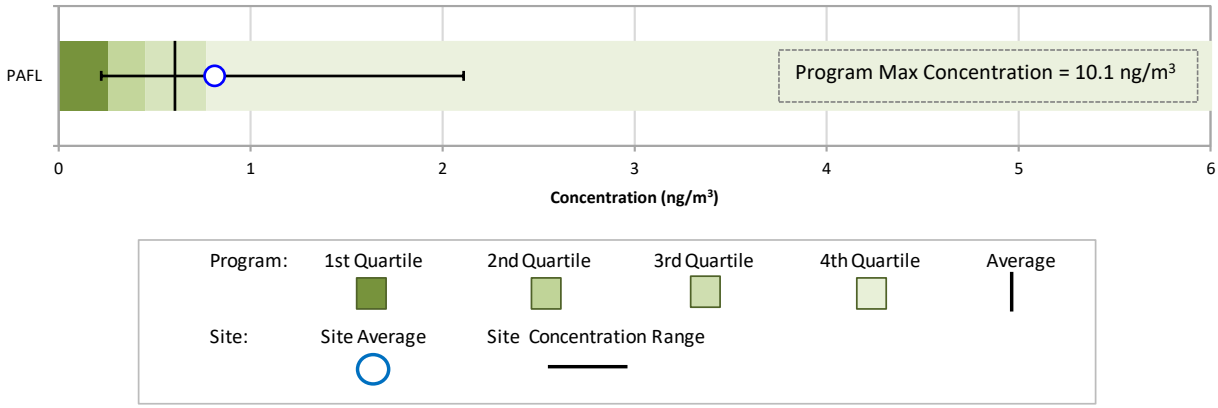


Figure 9-15 presents the box plot for arsenic for PAFL and shows the following:

- The program-level maximum arsenic (PM_{10}) concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 9-15 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The maximum arsenic concentration measured at PAFL is roughly one-fifth the maximum arsenic (PM_{10}) concentration measured across the program. The minimum concentration of arsenic measured at PAFL is just less than the program-level first quartile and is the highest minimum arsenic concentration among NMP sites sampling arsenic (PM_{10}) metals. These observations were also made in the 2013 NMP report.

- The annual average concentration of arsenic for PAFL is greater than the program-level average concentration (0.61 ng/m^3) and similar to the program-level third quartile (0.80 ng/m^3). There were no non-detects of arsenic measured at PAFL.

Figure 9-16. Program vs. Site-Specific Average Formaldehyde Concentrations

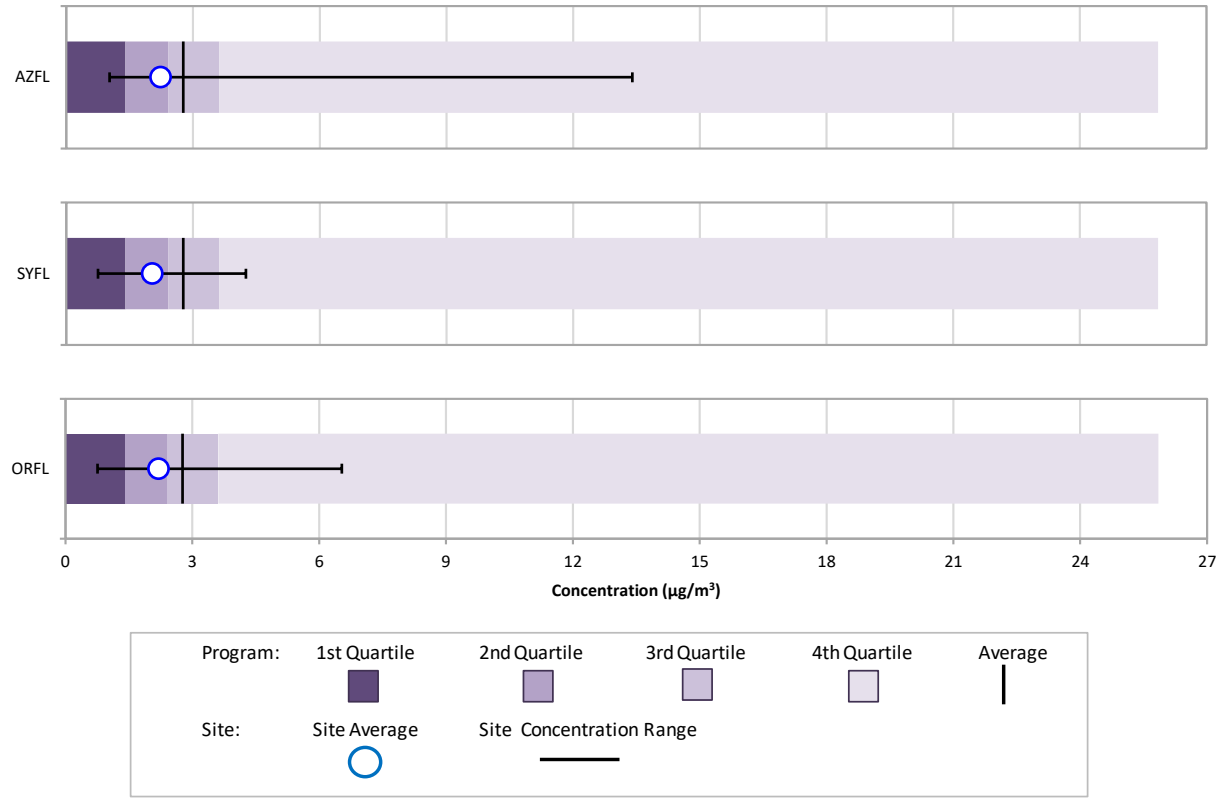


Figure 9-16 presents the box plots for formaldehyde for AZFL, SYFL, and ORFL and shows the following:

- The box plots show that the range of formaldehyde concentrations measured is smallest for SYFL and largest for AZFL. The maximum formaldehyde concentration measured at AZFL is twice the maximum formaldehyde concentration measured at ORFL and three times the maximum concentration measured at SYFL.

- All of the annual average concentrations of formaldehyde calculated for the Florida sites (for which an annual average could be calculated) are less than the program-level average concentration (2.77 µg/m^3) and just less than the program-level median concentration (2.41 µg/m^3).

- A box plot was not created for SKFL because this site does not have an annual average concentration.

Figure 9-17. Program vs. Site-Specific Average Naphthalene Concentration

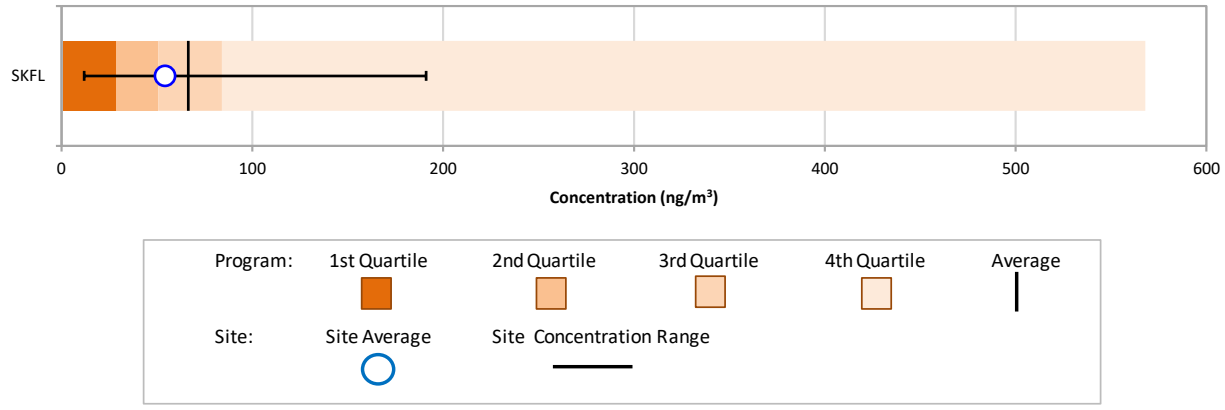


Figure 9-17 presents the box plot for naphthalene for SKFL and shows the following:

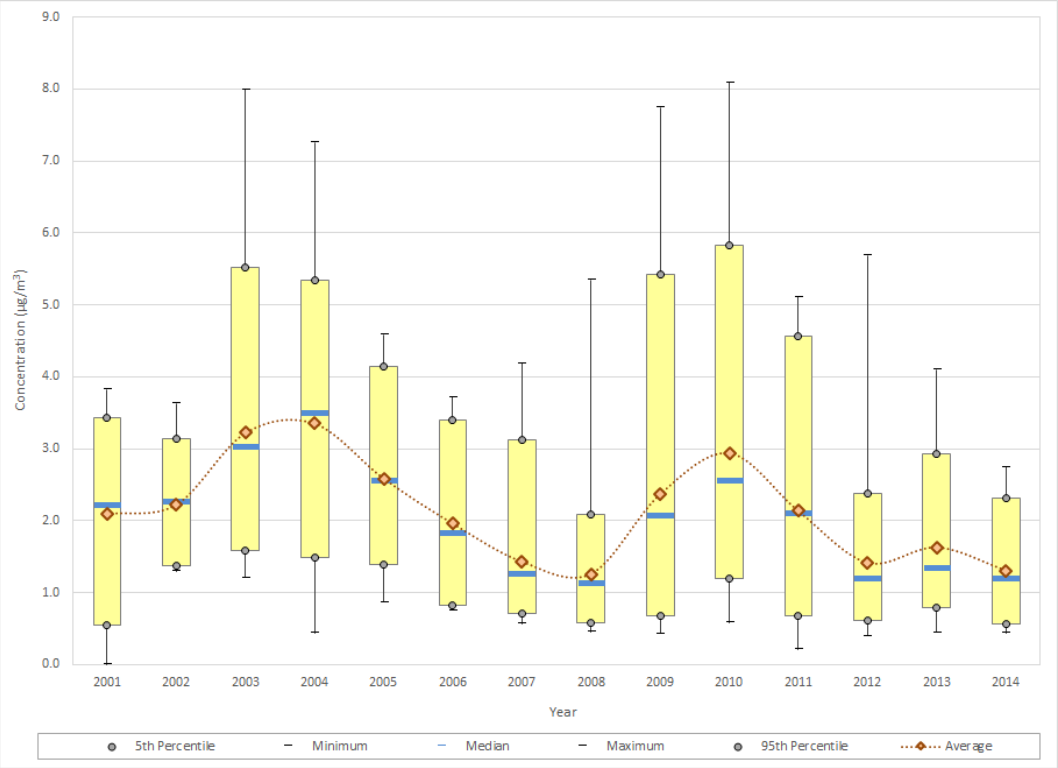
- The maximum arsenic concentration measured at SKFL (191 ng/m^3) is considerably less than the maximum concentration measured across the program (568 ng/m^3).

- The annual average concentration of naphthalene for SKFL is less than the program-level average concentration (66.5 ng/m^3) and just greater than the program-level median concentration (50.7 ng/m^3).

9.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. AZFL, ORFL, SKFL, and SYFL have sampled carbonyl compounds under the NMP for at least 5 consecutive years; in addition, sampling for PAHs at SKFL and PM_{10} metals at PAFL began in 2008. Thus, Figures 9-18 through 9-27 present the 1-year statistical metrics for each of the pollutants of interest for each of these Florida monitoring sites. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 9-18. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at AZFL



Observations from Figure 9-18 for acetaldehyde concentrations measured at AZFL include the following:

- Carbonyl compounds have been measured at AZFL under the NMP since 2001, making this site one of the longest running NMP sites.

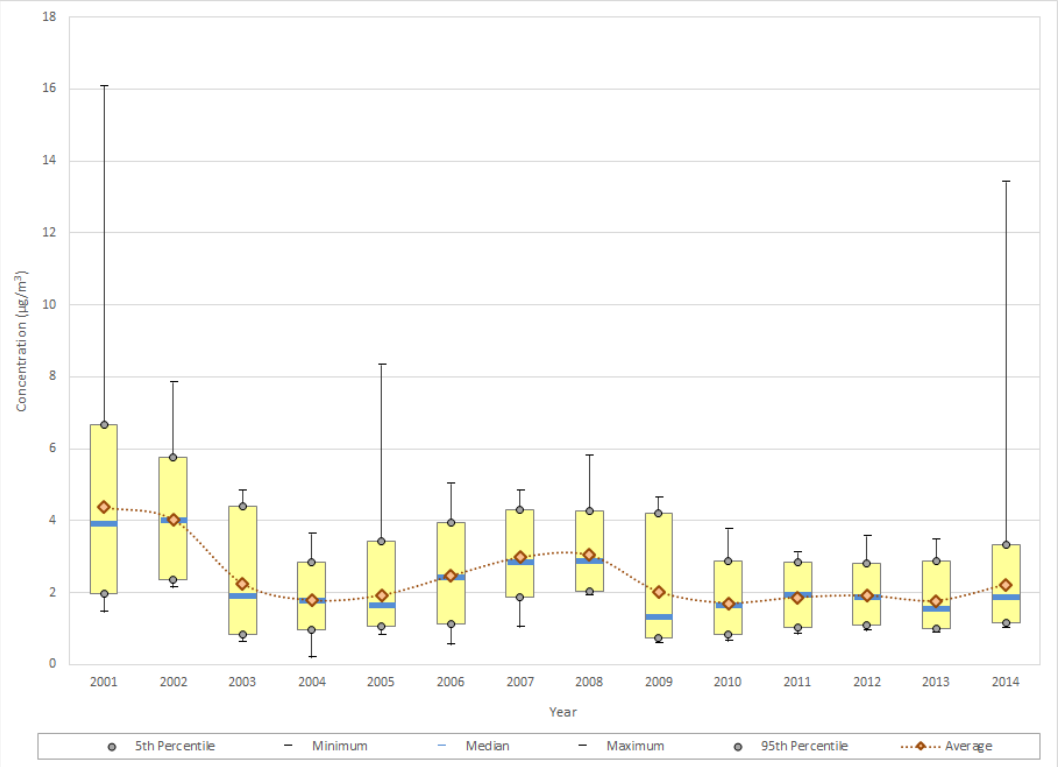
- The maximum acetaldehyde concentration was measured in 2010 (8.09 µg/m^3), although similar concentrations were also measured in 2003 (8.00 µg/m^3) and 2009 (7.74 µg/m^3).

- The 1-year average and median concentrations did not change significantly during the first 2 years of sampling, although the range of measurements is twice as large for 2001 compared to 2002. The 1-year average and median concentrations increased significantly from 2002 to 2003, remained elevated through 2004, then began to decrease significantly, a trend that continued through 2008.

- The 1-year average and median concentrations began to increase again in 2009. This increase cannot be attributed to an outlier here or there because nearly all of the statistical metrics exhibit this increase and the trend continued into 2010. The 95th percentile more than doubled from 2008 to 2009, and the 1-year average and median concentrations exhibit increases slightly less in magnitude. A significant decrease is shown for 2011 and continued into 2012, despite the increase in the maximum concentration measured in 2012. Slight increases in the central tendency statistics are shown for 2013, with a return to 2012 levels for 2014. The 1-year average and

median concentrations shown for 2014 are the second lowest since sampling began, behind only those calculated for 2008.

Figure 9-19. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at AZFL



Observations from Figure 9-19 for formaldehyde concentrations measured at AZFL include the following:

- The maximum formaldehyde concentration (16.1 µg/m^3) was measured in 2001, after which the highest concentration measured in any given year decreased by nearly half, until 2014. The maximum concentration measured in 2014 (13.4 µg/m^3) is just less than the maximum concentration measured in 2001.

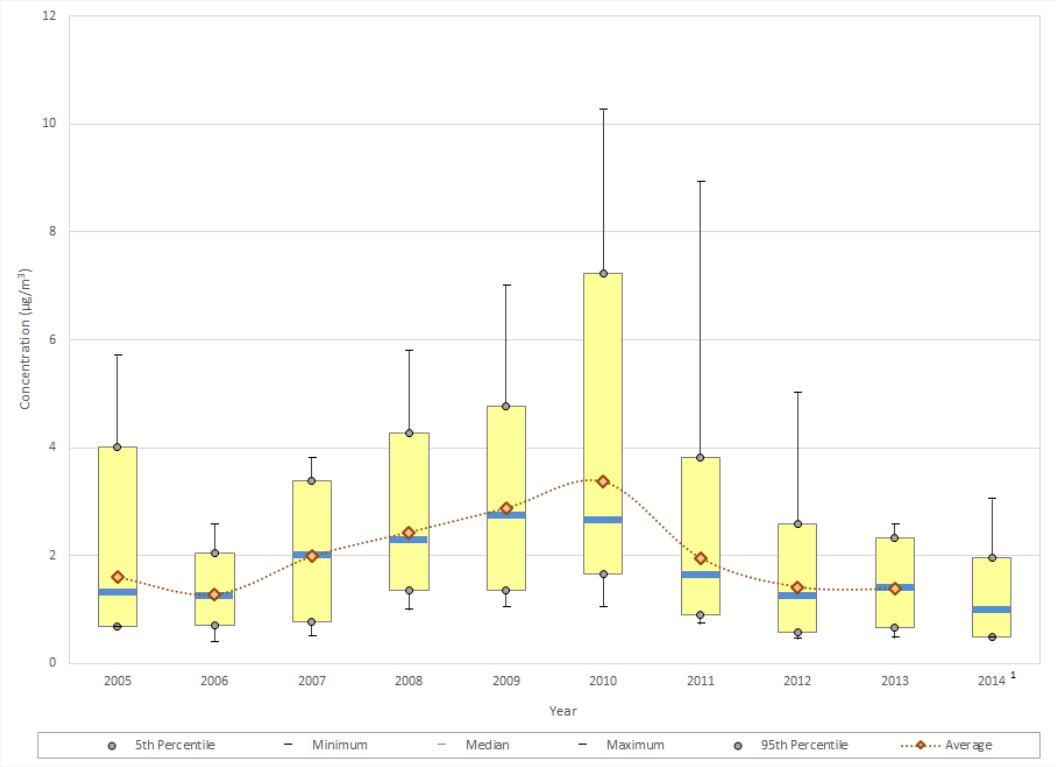
- The 1-year average and median formaldehyde concentrations decreased significantly from 2002 to 2003. The decreasing trend continued through 2004, after which an increasing trend is shown, which lasted through 2008. A second significant decrease is shown from 2008 to 2009 and into 2010 (although the median concentration increased for 2010). Little change is shown for the next 3 years of sampling.

- Although the increase in the maximum concentration measured in 2014 is apparent in Figure 9-19, each of the statistical parameters also exhibits at least a slight increase from 2013 to 2014. If the outlier was removed from the calculation, the 1-year average concentration would decrease only slightly, and the other parameters would change little. Five concentrations less than the minimum concentration measured in 2014 were measured in 2013. On the other end of the concentration range, the number of formaldehyde concentrations greater than 2.5 µg/m^3 doubled from 2013 (8) to

2014 (16). Thus, the slight increases shown for 2014 were not solely attributable to the outlier concentration.

- The trends shown for formaldehyde in Figure 9-19 are almost the opposite of the trends shown for acetaldehyde in Figure 9-18, particularly for the period between 2004 through 2008.

Figure 9-20. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SKFL



Observations from Figure 9-20 for acetaldehyde concentrations measured at SKFL include the following:

- Sampling for carbonyl compounds under the NMP began at SKFL in late July 2004. Because this represents less than half of the sampling year, Figure 9-20 excludes data from 2004.

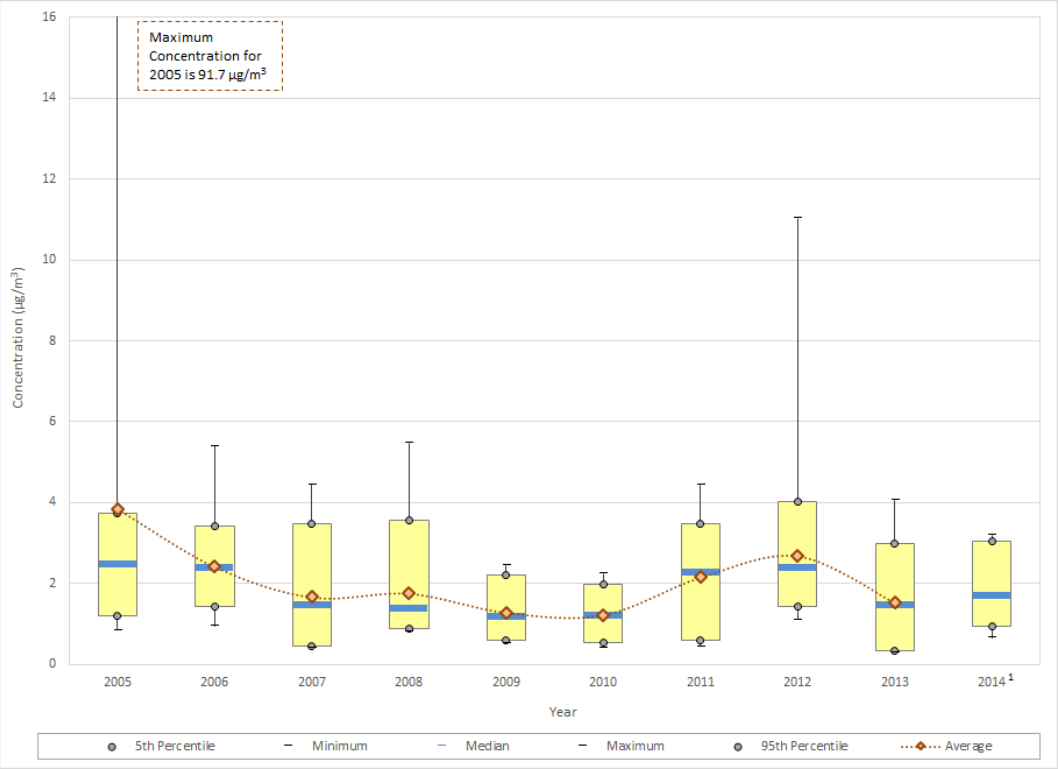
- The maximum acetaldehyde concentration shown was measured at SKFL in 2010 (10.3 µg/m^3), as were the third, fourth, and fifth highest concentrations of acetaldehyde. Of the 18 acetaldehyde concentrations greater than 5 µg/m^3, 11 were measured in 2010.

- Even though the range of concentrations measured decreased by half from 2005 to 2006, the change in the 1-year average concentration is not statistically significant. After 2006, the 1-year average acetaldehyde concentration increased steadily, reaching a maximum in 2010. A significant decrease is shown for 2011 and continued

into 2012. Although the range of concentrations measured decreased by half for 2013, the 1-year average concentration changed little.

- The majority of acetaldehyde concentrations measured at SKFL in 2014, as determined by the difference between the 5th and 95th percentiles, are within the smallest range since 2006. Although an annual average concentration could not be calculated for 2014, the median concentrations is shown for all years of sampling. The median concentration is at a minimum for 2014, and is less than 1 µg/m^3 for the first time since the first full year of sampling.

Figure 9-21. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SKFL



Observations from Figure 9-21 for formaldehyde concentrations measured at SKFL include the following:

- The maximum formaldehyde concentration was measured at SKFL on July 9, 2005 (91.7 µg/m^3). The second highest formaldehyde concentration was measured at SKFL in 2012, and is considerably less (11.4 µg/m^3). No other formaldehyde concentrations greater than 6 µg/m^3 have been measured at SKFL.

- For 2005, the 1-year average concentration is greater than the 95th percentile, reflecting the effect that an outlier can have on statistical measurements. The second highest concentration measured in 2005 was 4.07 µg/m^3.

- The 1-year average and median concentrations exhibit an overall decreasing trend through 2010. The range of measurements is at a minimum for 2010 and the 1-year

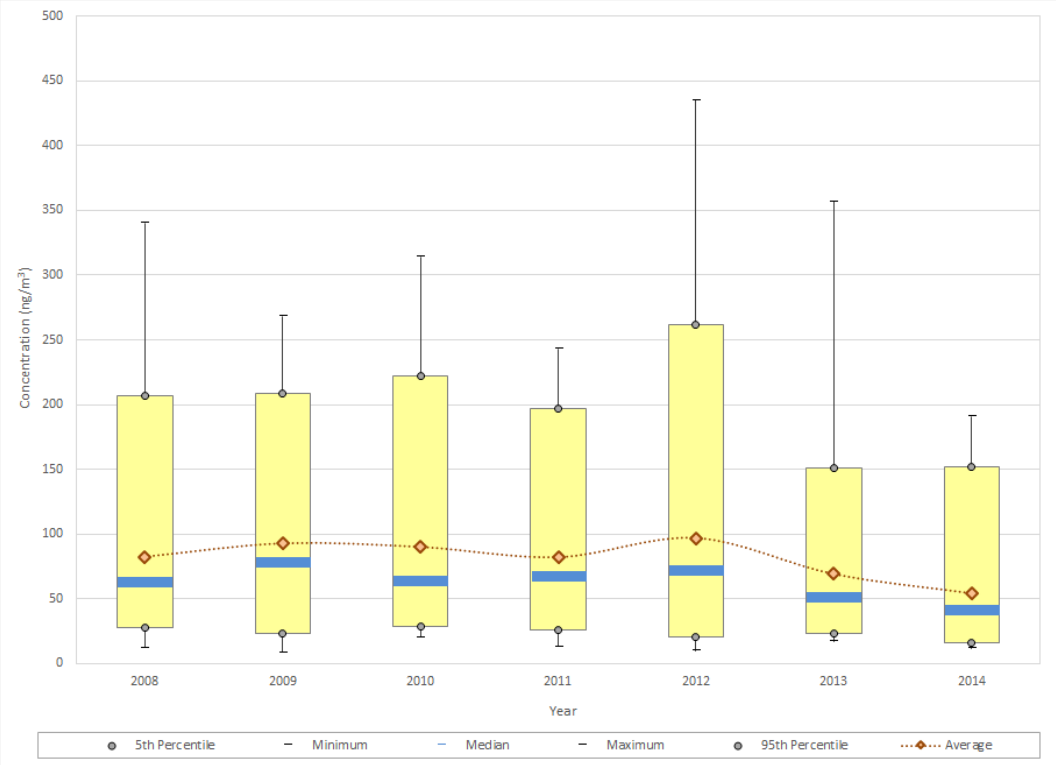
average and median concentrations are nearly equivalent, reflecting little variability in the measurements.

- All of the statistical parameters increased from 2010 to 2011 and again for 2012, indicating that concentrations of formaldehyde were higher overall at SKFL for 2012. The 5th percentile for 2012 is greater than several of the central tendency statistics for several of the previous years.

- All of the statistical parameters exhibit a decrease for 2013. Both the minimum and 5th percentile are at a minimum for 2013.

- The median concentration exhibits a slight increase for 2014, despite the smaller range of formaldehyde measurements measured in 2014.

Figure 9-22. Yearly Statistical Metrics for Naphthalene Concentrations Measured at SKFL



Observations from Figure 9-22 for naphthalene concentrations measured at SKFL include the following:

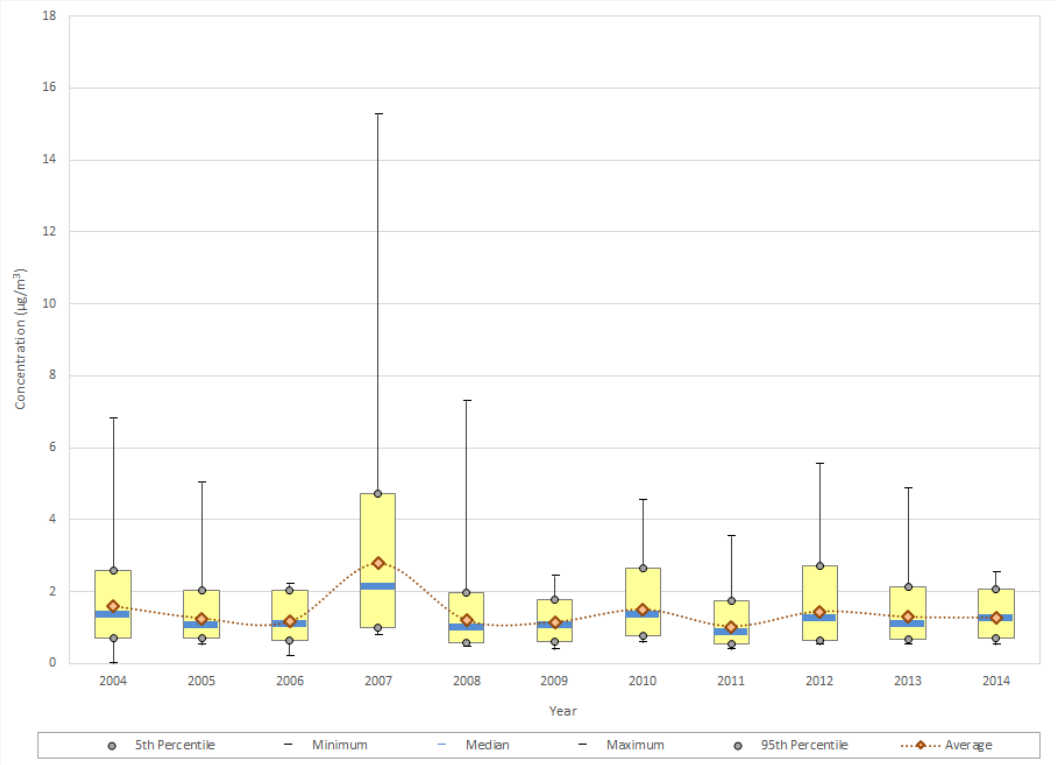
- Sampling for PAHs began at SKFL under the NMP on March 1, 2008.

- The maximum naphthalene concentration was measured at SKFL in 2012 (435 ng/m^3). Three additional measurements greater than 300 ng/m^3 have been measured at SKFL (one each in 2008, 2010, and 2013).

- The range within which the majority of naphthalene concentrations fall changed little through 2011. There is an increase shown for 2012 as this year has the greatest number of measurements greater than 200 ng/m^3 (seven). This increase is followed by a considerable decrease for 2013, which has the fewest measurements greater than 200 ng/m^3 (one) through 2013.

- A decreasing trend in naphthalene concentrations is shown after 2012, with both the 1-year average and median concentrations at a minimum for 2014; this is the first year in which concentrations of naphthalene greater than 200 ng/m^3 were not measured at SKFL.

Figure 9-23. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SYFL



Observations from Figure 9-23 for acetaldehyde concentrations measured at SYFL include the following:

- Carbonyl compounds have been measured at SYFL under the NMP since January 2004.

- Two acetaldehyde concentrations greater than 10 µg/m^3 were measured at SYFL in January 2007 (15.3 µg/m^3 and 12.6 µg/m^3). The next highest concentration, measured in 2008, is roughly half as high (7.29 µg/m^3). Only one additional acetaldehyde concentration greater than 6 µg/m^3 has been measured at SYFL (2004).

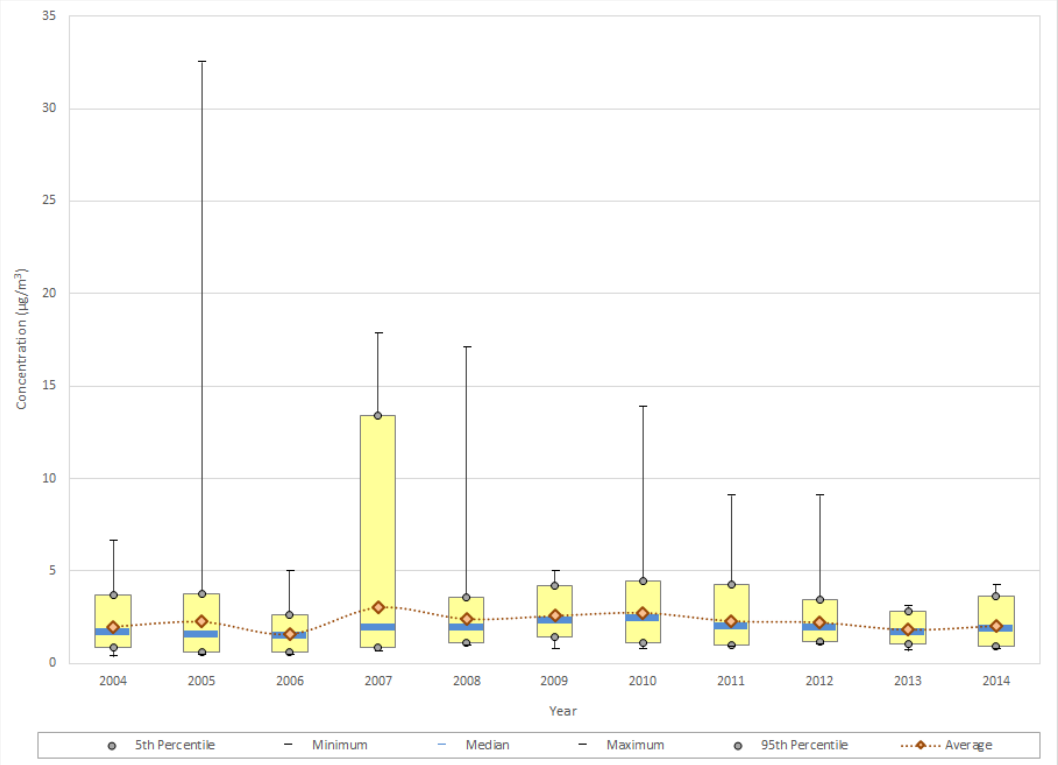
- After a decreasing trend through 2006, all of the statistical parameters increased for 2007. Even if the two measurements of acetaldehyde discussed above were removed

from the calculation, the 1-year average concentration for 2007 would still be nearly twice the next highest 1-year average concentration. While every other year of sampling has three or less, 2007 has the greatest number of acetaldehyde concentrations greater than 3 µg/m^3 (16). Thus, it is not just the two highest measurements driving this 1-year average concentration.

- With the exception of 2007, the 1-year average concentrations of acetaldehyde have fluctuated between 1.03 µg/m^3 (2011) and 1.60 µg/m^3 (2004). Confidence intervals calculated for the 1-year averages between 2009 and 2012 indicate that the year-to-year changes are statistically significant, although the undulating pattern indicates no specific trend.

- Little change is shown from 2013 to 2014, despite the decrease in the maximum concentration measured. The difference between the 1-year average concentrations for these two years is less than 0.025 µg/m^3.

Figure 9-24. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SYFL



Observations from Figure 9-24 for formaldehyde concentrations measured at SYFL include the following:

- The maximum formaldehyde concentration was measured at SYFL in 2005 (32.5 µg/m^3) and is nearly twice the next highest concentrations (17.8 µg/m^3, measured in 2007, and 17.1 µg/m^3, measured in 2008). In all, seven formaldehyde concentrations greater than 10 µg/m^3 have been measured at SYFL, four in 2007 and one each in 2005, 2008, and 2010.

- Even though the maximum concentration was measured in 2005, the second highest concentration measured that year is considerably less (4.17 µg/m^3). The 1-year average concentration exhibits a slight increase from 2004 to 2005 while the median concentration decreased slightly; if the outlier was excluded from the calculation, the 1-year average concentration would exhibit a decrease for 2005 while the median would change little.

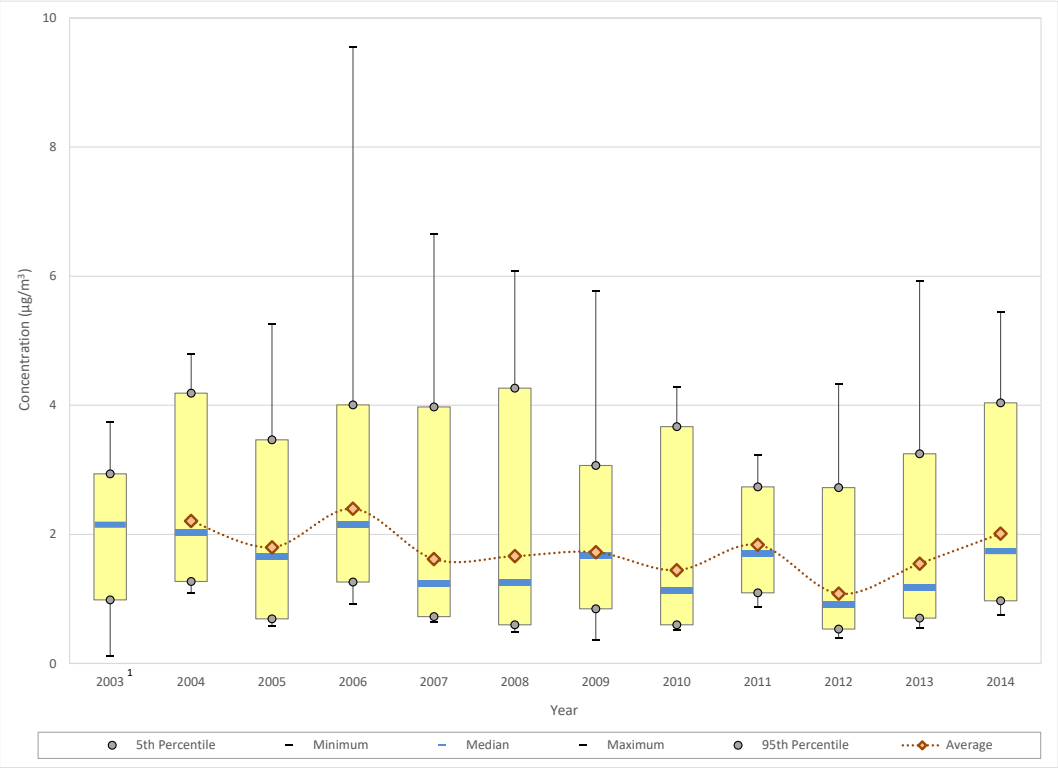
- Although the maximum concentration for 2007 is considerably less than the maximum measured in 2005, the other statistical parameters exhibit significant increases for 2007. In particular, the 95th percentile increased five-fold and the 1-year average doubled from 2006 to 2007. These statistical parameters indicate that the concentrations measured in 2007 were higher overall compared to other years. The number of formaldehyde concentrations greater than 5 µg/m^3 is highest for 2007 (six), while every other year of sampling has two or less.

- The 1-year average concentrations of formaldehyde vary little during the five years between 2008 and 2012, ranging from 2.23 µg/m^3 (2012) to 2.75 µg/m^3 (2010).

- The 1-year average concentration for 2013 is the lowest since 2006 and has the smallest range of measurements of any year shown.

- Slight increases are shown for most of the parameters for 2014.

Figure 9-25. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at ORFL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 9-25 for acetaldehyde concentrations measured at ORFL include the following:

- Sampling for carbonyl compounds under the NMP began at ORFL in April 2003. A 1-year average concentration is not presented for 2003 because a full year's worth of data is not available, although the range of measurements is provided.

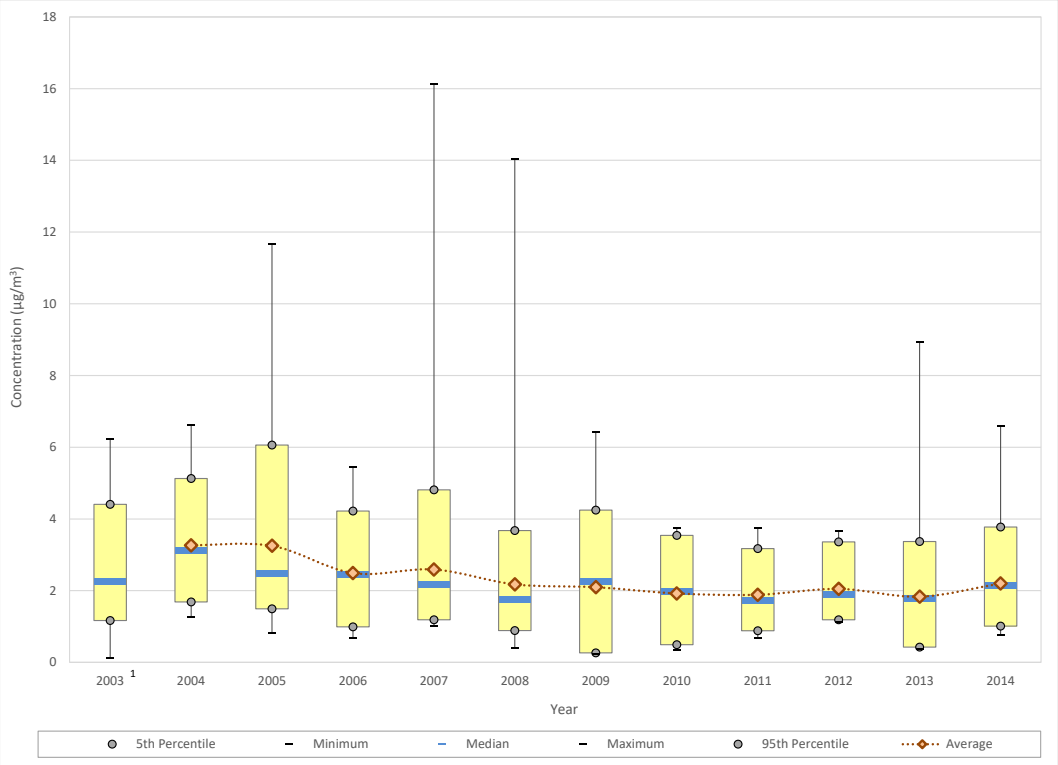
- The maximum acetaldehyde concentration was measured in 2006 (9.55 µg/m^3). Concentrations of at least 5 µg/m^3 have been measured most years of sampling, although this wasn't the case between 2010 and 2012.

- Between 2004 and 2007, the 1-year average concentrations have an undulating pattern, with a higher year followed by a lower year. Between 2007 and 2009, little change is shown in the 1-year average concentrations, when these averages varied by only 0.1 µg/m^3, despite the considerable increase in the median shown for 2009. The undulating pattern returns between 2009 and 2012.

- The 1-year average concentration is at a minimum for 2012 (1.08 µg/m^3) and represents a significant decrease from 2011 and most of the previous years. The median concentration decreased by almost half from 2011 to 2012. Only one concentration less than 1 µg/m^3 was measured in 2011 compared to 38 for 2012.

- All of the statistical metrics exhibit increases for 2013, with most exhibiting additional increases for 2014. The 1-year average concentration shown for 2014 is the highest average since 2006, when the maximum concentration was measured.

Figure 9-26. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at ORFL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

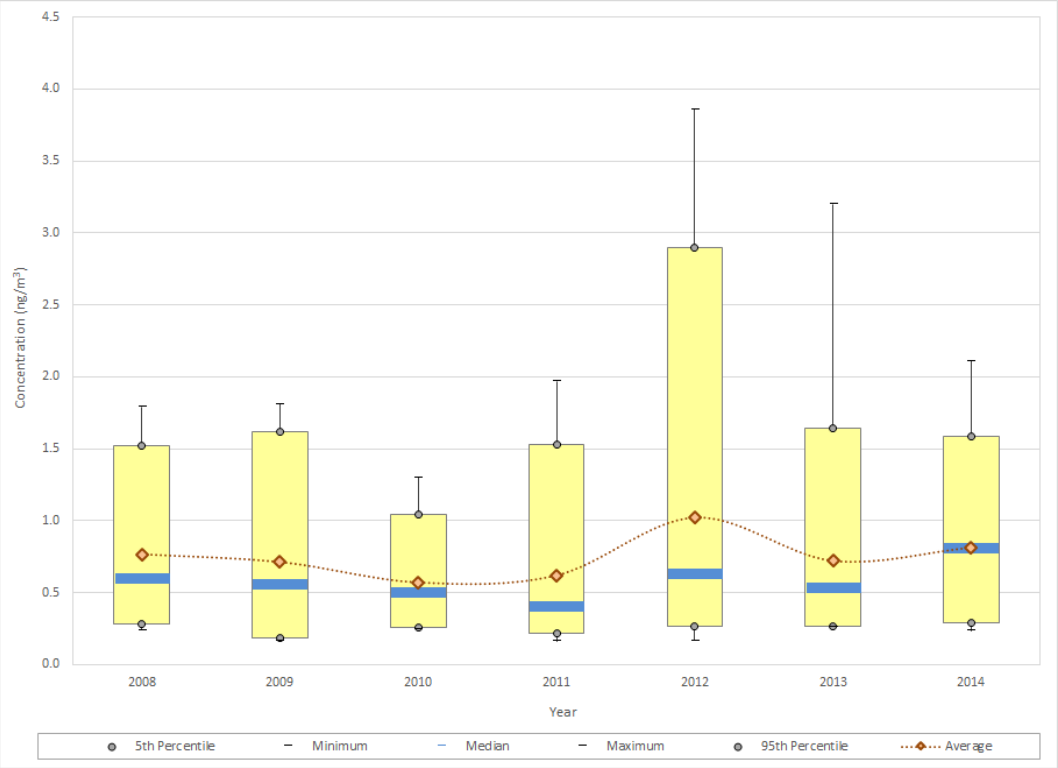
Observations from Figure 9-26 for formaldehyde concentrations measured at ORFL include the following:

- The maximum formaldehyde concentration was measured in 2007 (16.1 µg/m^3), on the same day as the second highest acetaldehyde concentration (September 21, 2007). Formaldehyde concentrations greater than 10 µg/m^3 were also measured in 2005 (two) and 2008 (one).

- The 1-year average concentrations exhibit an overall decreasing trend through 2011, starting at 3.26 µg/m^3 for 2004 and reaching a minimum of 1.89 µg/m^3 for 2011. The statistical metrics for 2007 are the exception to this. However, if the maximum concentration measured in 2007 was excluded from the calculation, the 1-year average concentration would exhibit a constant decreasing trend across the years through 2011. The median concentrations have decreased as well, but exhibited a considerable increase in 2009, with additional decreases through 2011.

- The central tendency statistics for formaldehyde hover around 2 µg/m^3 for the last several years of sampling at ORFL.

Figure 9-27. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at PAFL



Observations from Figure 9-27 for arsenic concentrations measured at PAFL include the following:

- Sampling for PM_{10} metals under the NMP began at PAFL in January 2008; metals sampling occurred on a 1-in-12 day sampling schedule.

- Four of the six arsenic concentrations greater than 2 ng/m^3 were measured at PAFL in 2012, and ranged from 2.08 ng/m^3 to 3.86 ng/m^3. The others were measured in 2013 and 2014.

- The range of arsenic concentrations measured is at a minimum for 2010, increases for 2011, then doubles for 2012. The range within which the majority of concentrations fall, as indicated by the difference between the 5th and 95th percentiles, nearly doubles from 2010 to 2011 and again for 2012.

- The 1-year average concentration decreases slightly through 2010. After a slight increase for 2011, the 1-year average increases substantially for 2012. This is the first time the 1-year average concentration is greater than 1 ng/m^3. The median concentration exhibits a decreasing trend through 2011, even though the range of measurements increases for 2011, then also increases for 2012. The number of concentrations greater than 1 ng/m^3 increased from two in 2010 to five in 2011 to nine in 2012. 2012 is the first year arsenic concentrations greater than 2 ng/m^3 were measured at PAFL.

- Most of the statistical parameters exhibit a decrease from 2012 to 2013, with the 95th percentile decreasing by almost half from 2012 to 2013. The number of arsenic measurements greater than 1 ng/m^3 returned to five in 2013.

- Despite little change in the majority of arsenic concentrations measured, both the 1-year average and median concentrations exhibit increases for 2014, particularly the median concentration. Arsenic concentrations greater than 0.5 ng/m^3 account for just over half of the measurements in 2013 and nearly three-quarters of the measurements in 2014. Thus, the median concentration is at a maximum for 2014.

9.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each Florida monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

9.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Florida sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 9-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 9-5. Risk Approximations for the Florida Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
St. Petersburg, Florida - AZFL						
Acetaldehyde	0.0000022	0.009	56/56	1.31 ± 0.15	2.88	0.15
Formaldehyde	0.000013	0.0098	56/56	2.24 ± 0.44	29.06	0.23
Pinellas Park, Florida - SKFL						
Acetaldehyde	0.0000022	0.009	50/50	NA	NA	NA
Formaldehyde	0.000013	0.0098	50/50	NA	NA	NA
Naphthalene[a]	0.000034	0.003	58/58	54.29 ± 10.42	1.85	0.02
Valrico, Florida - SYFL						
Acetaldehyde	0.0000022	0.009	55/55	1.27 ± 0.12	2.80	0.14
Formaldehyde	0.000013	0.0098	55/55	2.03 ± 0.22	26.45	0.21
Winter Park, Florida - ORFL						
Acetaldehyde	0.0000022	0.009	60/60	2.01 ± 0.25	4.42	0.22
Formaldehyde	0.000013	0.0098	60/60	2.20 ± 0.28	28.61	0.22
Orlando, Florida - PAFL						
Arsenic (PM_{10})[a]	0.0043	0.000015	30/30	0.81 ± 0.16	3.50	0.05

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Observations for the Florida sites from Table 9-5 include the following:

- Formaldehyde has the highest cancer risk approximations among the various pollutants of interest for the Florida sites (where they could be calculated). These cancer risk approximations span a relatively small range (26.45 in-a-million for SYFL to 29.06 in-a-million for AZFL).

- The cancer risk approximations for acetaldehyde are an order of magnitude less than the cancer risk approximations for formaldehyde, ranging from 2.80 in-a-million for SKFL to 4.42 in-a-million for ORFL.

- For SKFL, naphthalene has a cancer risk approximation of 1.85 in-a-million.

- For PAFL, arsenic has a cancer risk approximation of 3.50 in-a-million.

- All of the noncancer hazard approximations for the site-specific pollutants of interest are less than 1.0, indicating that no adverse noncancer health effects are expected

from these individual pollutants. The highest noncancer hazard approximation was calculated for formaldehyde (0.23), based on the annual average concentration for AZFL, although similar noncancer hazard approximations were also calculated for ORFL and SYFL as well as ORFL's annual average concentration of acetaldehyde.

9.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, Tables 9-6 and 9-7 present an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 9-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 9-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 9-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 9-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 9-6. Table 9-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 9.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 9-6. 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 UREs (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)**
St. Petersburg, Florida (Pinellas County) – AZFL					
Benzene	423.95	Benzene	3.31E-03	Formaldehyde	29.06
Ethylbenzene	262.81	Formaldehyde	2.68E-03	Acetaldehyde	2.88
Formaldehyde	206.42	1,3-Butadiene	1.77E-03		
Acetaldehyde	133.62	Naphthalene	6.91E-04		
1,3-Butadiene	58.94	Ethylbenzene	6.57E-04		
Naphthalene	20.33	POM, Group 2b	3.19E-04		
Dichloromethane	3.85	Acetaldehyde	2.94E-04		
POM, Group 2b	3.63	POM, Group 2d	2.68E-04		
POM, Group 2d	3.04	Arsenic, PM	2.28E-04		
Tetrachloroethylene	1.67	Nickel, PM	1.48E-04		
Pinellas Park, Florida (Pinellas County) – SKFL					
Benzene	423.95	Benzene	3.31E-03	Naphthalene	1.85
Ethylbenzene	262.81	Formaldehyde	2.68E-03		
Formaldehyde	206.42	1,3-Butadiene	1.77E-03		
Acetaldehyde	133.62	Naphthalene	6.91E-04		
1,3-Butadiene	58.94	Ethylbenzene	6.57E-04		
Naphthalene	20.33	POM, Group 2b	3.19E-04		
Dichloromethane	3.85	Acetaldehyde	2.94E-04		
POM, Group 2b	3.63	POM, Group 2d	2.68E-04		
POM, Group 2d	3.04	Arsenic, PM	2.28E-04		
Tetrachloroethylene	1.67	Nickel, PM	1.48E-04		

Table 9-6. 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 UREs (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)**
Valrico, Florida (Hillsborough County) – SYFL					
Benzene	439.99	Formaldehyde	3.47E-03	Formaldehyde	26.45
Ethylbenzene	294.34	Benzene	3.43E-03	Acetaldehyde	2.80
Formaldehyde	266.66	1,3-Butadiene	1.89E-03		
Acetaldehyde	166.39	Nickel, PM	1.47E-03		
1,3-Butadiene	63.16	Cadmium, PM	1.37E-03		
Naphthalene	27.75	Arsenic, PM	1.23E-03		
Methyl *tert*-butyl ether	7.67	Naphthalene	9.43E-04		
POM, Group 2b	5.34	Ethylbenzene	7.36E-04		
POM, Group 2d	4.24	Hexavalent Chromium	6.15E-04		
Nickel, PM	3.07	POM, Group 2b	4.70E-04		
Winter Park, Florida (Orange County) – ORFL					
Benzene	557.93	Hexavalent Chromium	5.22E-03	Formaldehyde	28.61
Formaldehyde	373.01	Formaldehyde	4.85E-03	Acetaldehyde	4.42
Ethylbenzene	343.02	Benzene	4.35E-03		
Acetaldehyde	198.71	1,3-Butadiene	2.41E-03		
1,3-Butadiene	80.46	Naphthalene	1.03E-03		
Naphthalene	30.26	Ethylbenzene	8.58E-04		
POM, Group 2b	6.43	POM, Group 2b	5.65E-04		
POM, Group 2d	4.63	Acetaldehyde	4.37E-04		
Tetrachloroethylene	2.91	POM, Group 2d	4.08E-04		
Dichloromethane	1.09	Arsenic, PM	3.86E-04		

Table 9-6. 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 UREs (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)**
Orlando, Florida (Orange County) – PAFL					
Benzene	557.93	Hexavalent Chromium	5.22E-03	Arsenic	3.50
Formaldehyde	373.01	Formaldehyde	4.85E-03		
Ethylbenzene	343.02	Benzene	4.35E-03		
Acetaldehyde	198.71	1,3-Butadiene	2.41E-03		
1,3-Butadiene	80.46	Naphthalene	1.03E-03		
Naphthalene	30.26	Ethylbenzene	8.58E-04		
POM, Group 2b	6.43	POM, Group 2b	5.65E-04		
POM, Group 2d	4.63	Acetaldehyde	4.37E-04		
Tetrachloroethylene	2.91	POM, Group 2d	4.08E-04		
Dichloromethane	1.09	Arsenic, PM	3.86E-04		

Table 9-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Florida Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
St. Petersburg, Florida (Pinellas County) – AZFL					
Toluene	1,691.40	Acrolein	529,170.22	Formaldehyde	0.23
Xylenes	1,112.81	1,3-Butadiene	29,468.37	Acetaldehyde	0.15
Hexane	837.02	Formaldehyde	21,063.17		
Methanol	533.81	Acetaldehyde	14,846.98		
Benzene	423.95	Benzene	14,131.55		
Ethylbenzene	262.81	Xylenes	11,128.12		
Formaldehyde	206.42	Naphthalene	6,776.34		
Ethylene glycol	183.89	Lead, PM	4,834.15		
Acetaldehyde	133.62	Arsenic, PM	3,541.06		
Methyl isobutyl ketone	85.23	Nickel, PM	3,431.37		
Pinellas Park, Florida (Pinellas County) – SKFL					
Toluene	1,691.40	Acrolein	529,170.22	Naphthalene	0.02
Xylenes	1,112.81	1,3-Butadiene	29,468.37		
Hexane	837.02	Formaldehyde	21,063.17		
Methanol	533.81	Acetaldehyde	14,846.98		
Benzene	423.95	Benzene	14,131.55		
Ethylbenzene	262.81	Xylenes	11,128.12		
Formaldehyde	206.42	Naphthalene	6,776.34		
Ethylene glycol	183.89	Lead, PM	4,834.15		
Acetaldehyde	133.62	Arsenic, PM	3,541.06		
Methyl isobutyl ketone	85.23	Nickel, PM	3,431.37		

Table 9-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Valrico, Florida (Hillsborough County) – SYFL					
Toluene	1,908.71	Acrolein	839,881.94	Formaldehyde	0.21
Xylenes	1,141.28	Cadmium, PM	76,216.14	Acetaldehyde	0.14
Hexane	974.23	Nickel, PM	34,087.06		
Methanol	723.09	1,3-Butadiene	31,578.65		
Benzene	439.99	Formaldehyde	27,210.45		
Hydrochloric acid	356.26	Arsenic, PM	19,144.38		
Ethylbenzene	294.34	Acetaldehyde	18,488.27		
Ethylene glycol	287.12	Hydrochloric acid	17,813.03		
Formaldehyde	266.66	Benzene	14,666.49		
Acetaldehyde	166.39	Xylenes	11,412.81		
Winter Park, Florida (Orange County) – ORFL					
Toluene	2,144.16	Acrolein	1,048,114.49	Formaldehyde	0.22
Xylenes	1,437.17	1,3-Butadiene	40,232.28	Acetaldehyde	0.22
Hexane	985.39	Formaldehyde	38,061.79		
Methanol	678.41	Hexamethylene-1,6-diisocyanate, gas	30,043.31		
Benzene	557.93	Acetaldehyde	22,079.12		
Formaldehyde	373.01	Benzene	18,597.79		
Ethylbenzene	343.02	Xylenes	14,371.73		
Ethylene glycol	268.80	Naphthalene	10,085.90		
Acetaldehyde	198.71	Arsenic, PM	5,985.06		
Styrene	101.41	Hydrochloric acid	4,682.79		

Table 9-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Orlando, Florida (Orange County) – PAFL					
Toluene	2,144.16	Acrolein	1,048,114.49	Arsenic	0.05
Xylenes	1,437.17	1,3-Butadiene	40,232.28		
Hexane	985.39	Formaldehyde	38,061.79		
Methanol	678.41	Hexamethylene-1,6-diisocyanate, gas	30,043.31		
Benzene	557.93	Acetaldehyde	22,079.12		
Formaldehyde	373.01	Benzene	18,597.79		
Ethylbenzene	343.02	Xylenes	14,371.73		
Ethylene glycol	268.80	Naphthalene	10,085.90		
Acetaldehyde	198.71	Arsenic, PM	5,985.06		
Styrene	101.41	Hydrochloric acid	4,682.79		

Observations from Table 9-6 include the following:

- Benzene, ethylbenzene, formaldehyde, and acetaldehyde are the highest emitted pollutants with cancer UREs in Pinellas, Hillsborough, and Orange Counties, although not necessarily in that order.

- Benzene, formaldehyde, and 1,3-butadiene have the highest toxicity-weighted emissions for Pinellas County. The same three pollutants have the highest toxicity-weighted emissions for Hillsborough County but the order is different. Hexavalent chromium has the highest toxicity-weighted emissions for Orange County, followed by the other three pollutants.

- Eight of the highest emitted pollutants in Pinellas and Orange Counties also have the highest toxicity-weighted emissions while seven of the highest emitted pollutants in Hillsborough County also have the highest toxicity-weighted emissions.

- Formaldehyde, which has the highest cancer risk approximations for the sites sampling carbonyl compounds and where annual averages could be calculated, is one of the highest emitted pollutants in each county and has one of the highest toxicity-weighted emissions for each county. This is also true for acetaldehyde for Pinellas and Orange Counties, but acetaldehyde does not appear among those pollutants with the highest toxicity-weighted emissions for Hillsborough County (it ranks 12th).

- Naphthalene, which is a pollutant of interest for SFKL, is one of the highest emitted pollutants in all three counties and has one of the highest toxicity-weighted emissions for each county.

- POM, Groups 2b and 2d are also among the highest emitted "pollutants" in Pinellas County and appear among the pollutants with the highest toxicity-weighted emissions. POM, Groups 2b and 2d include several PAHs sampled for at SKFL, none of which failed screens for these sites.

- Arsenic is the only pollutant of interest for PAFL. Arsenic ranks 10th for toxicity-weighted emissions for Orange County, but is not among the highest emitted pollutants, ranking 23rd for quantity emitted. This indicates that even a "low" quantity of emissions may translate to a relatively "high" toxicity level. Arsenic also appears among those with the highest toxicity-weighted emissions for the other two Florida counties with NMP sites. Several metals appear among those with the highest toxicity-weighted emissions for Pinellas and Hillsborough Counties, but metals were not sampled there under the NMP.

Observations from Table 9-7 include the following:

- Toluene, xylenes, and hexane are the highest emitted pollutants with noncancer RfCs in these three Florida counties.

- Acrolein has the highest toxicity-weighted emissions of the pollutants with noncancer RfCs for each county, but is not among the highest emitted pollutants in the three Florida counties. None of the Florida sites sampled VOCs under the NMP.

- Four of the highest emitted pollutants in Pinellas and Orange Counties also have the highest toxicity-weighted emissions. Five of the highest emitted pollutants in Hillsborough County also have the highest toxicity-weighted emissions. Four of these pollutants are in common amongst the counties: formaldehyde, acetaldehyde, benzene, and xylenes.

- Formaldehyde and acetaldehyde appear on both emissions-based lists for each county.

- Naphthalene is among the pollutants with the highest toxicity-weighted emissions for each county, except Hillsborough County, but is not among the highest emitted pollutants (with a noncancer RfC) in any of these counties.

- Arsenic ranks ninth for toxicity-weighted emissions for Orange County, but is not among the highest emitted pollutants, ranking 46th for quantity emitted. Arsenic is the only metal that appears among the pollutants with the highest toxicity-weighted emissions for Orange County. Several metals appear among those with the highest toxicity-weighted emissions for Pinellas and Hillsborough Counties, ranking highest for Hillsborough County, but none of these metals are among the highest emitted. Metals were sampled for only at PAFL under the NMP.

9.6 Summary of the 2014 Monitoring Data for the Florida Monitoring Sites

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

- ❖ *Acetaldehyde and formaldehyde failed screens for AZFL, SYFL, and ORFL, where only carbonyl compounds were sampled. Formaldehyde, acetaldehyde, and naphthalene failed screens for SKFL. Arsenic failed screens for PAFL.*

- ❖ *Among the Florida sites, ORFL has the highest annual average acetaldehyde concentration while concentrations of formaldehyde did not vary significantly among these sites. Note that annual averages could not be calculated for SKFL for the carbonyl compounds. Arsenic was the only metal identified as a pollutant of interest for PAFL; its annual average ranked fourth highest among NMP sites sampling PM_{10} metals. PAHs were sampled for at SKFL and naphthalene was the only PAH identified as a pollutant of interest for this site. Concentrations of naphthalene measured at this site were on the lower end compared to other sites sampling this pollutant.*

- ❖ *Concentrations of acetaldehyde and naphthalene have a decreasing trend at SKFL while concentrations of acetaldehyde at ORFL have an increasing trend.*

- *Formaldehyde has the highest cancer risk approximation among the pollutants of interest for each Florida site, where carbonyl compounds were sampled and annual averages could be calculated. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

10.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

10.1 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.

Two monitoring sites are located in northwestern suburbs of Greater Chicago. NBIL is located in Northbrook and SPIL is located in Schiller Park. The third site (ROIL) is located in Roxana, just north of the St. Louis CBSA. Figures 10-1 and 10-2 are composite satellite images retrieved from ArcGIS Explorer showing the Chicago monitoring sites and their immediate surroundings. Figure 10-3 identifies the nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2, for NBIL and SPIL. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 10-3. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundaries are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundaries. Figures 10-4 and 10-5 present the composite satellite image and facility map for ROIL, respectively. Table 10-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for each site.

Figure 10-1. Northbrook, Illinois (NBIL) Monitoring Site

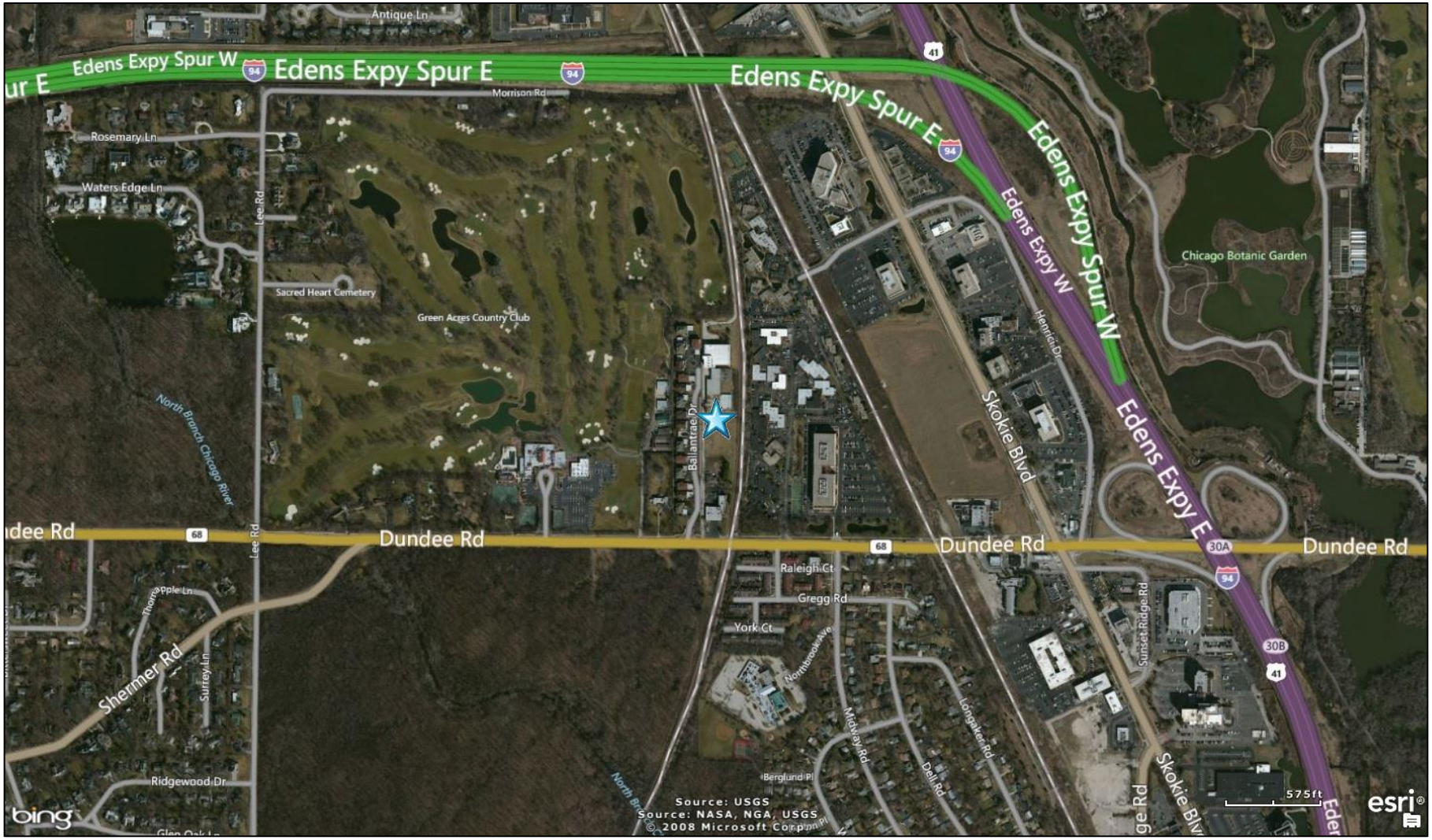


Figure 10-2. Schiller Park, Illinois (SPIL) Monitoring Site

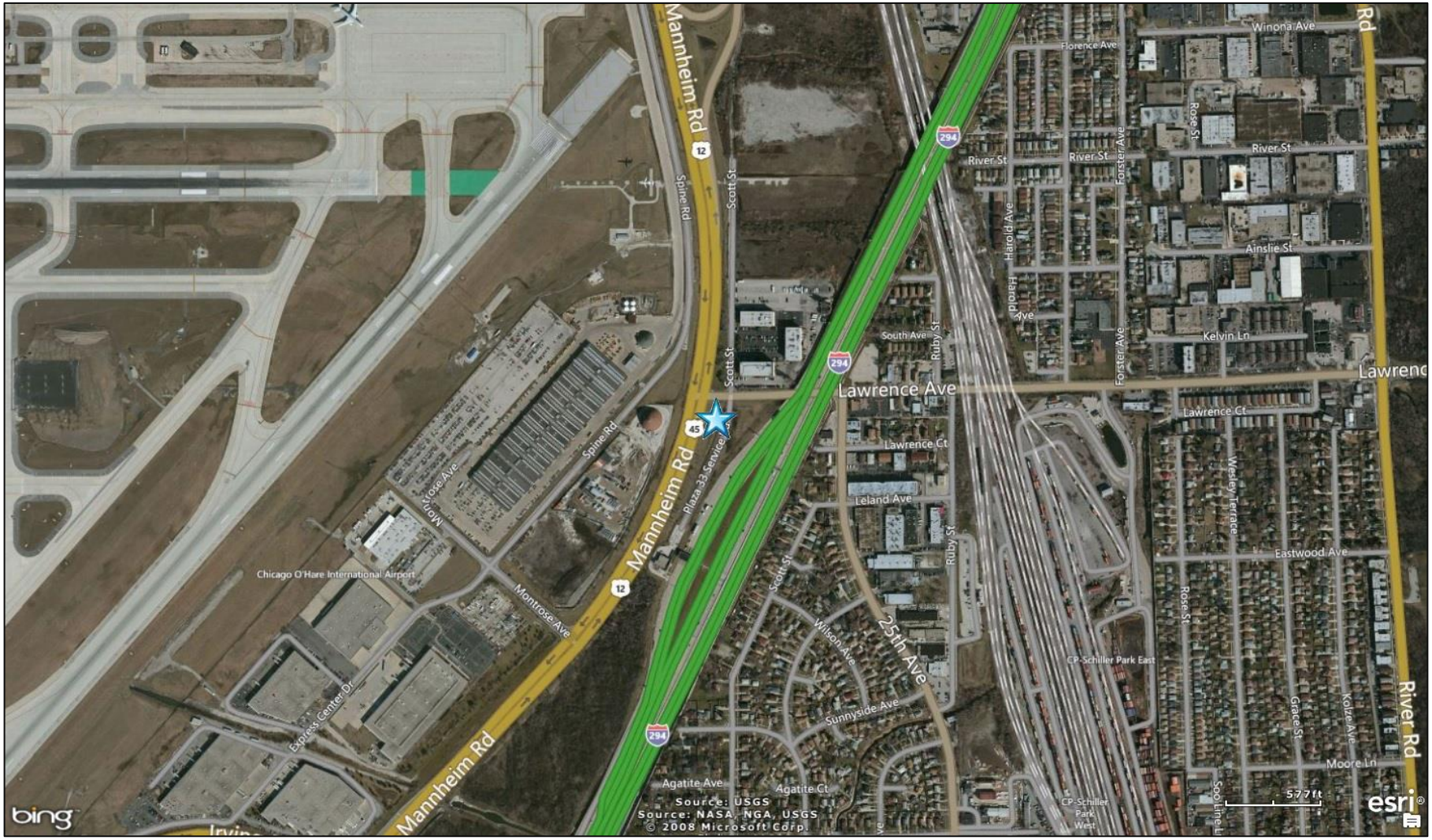


Figure 10-3. NEI Point Sources Located Within 10 Miles of NBIL and SPIL

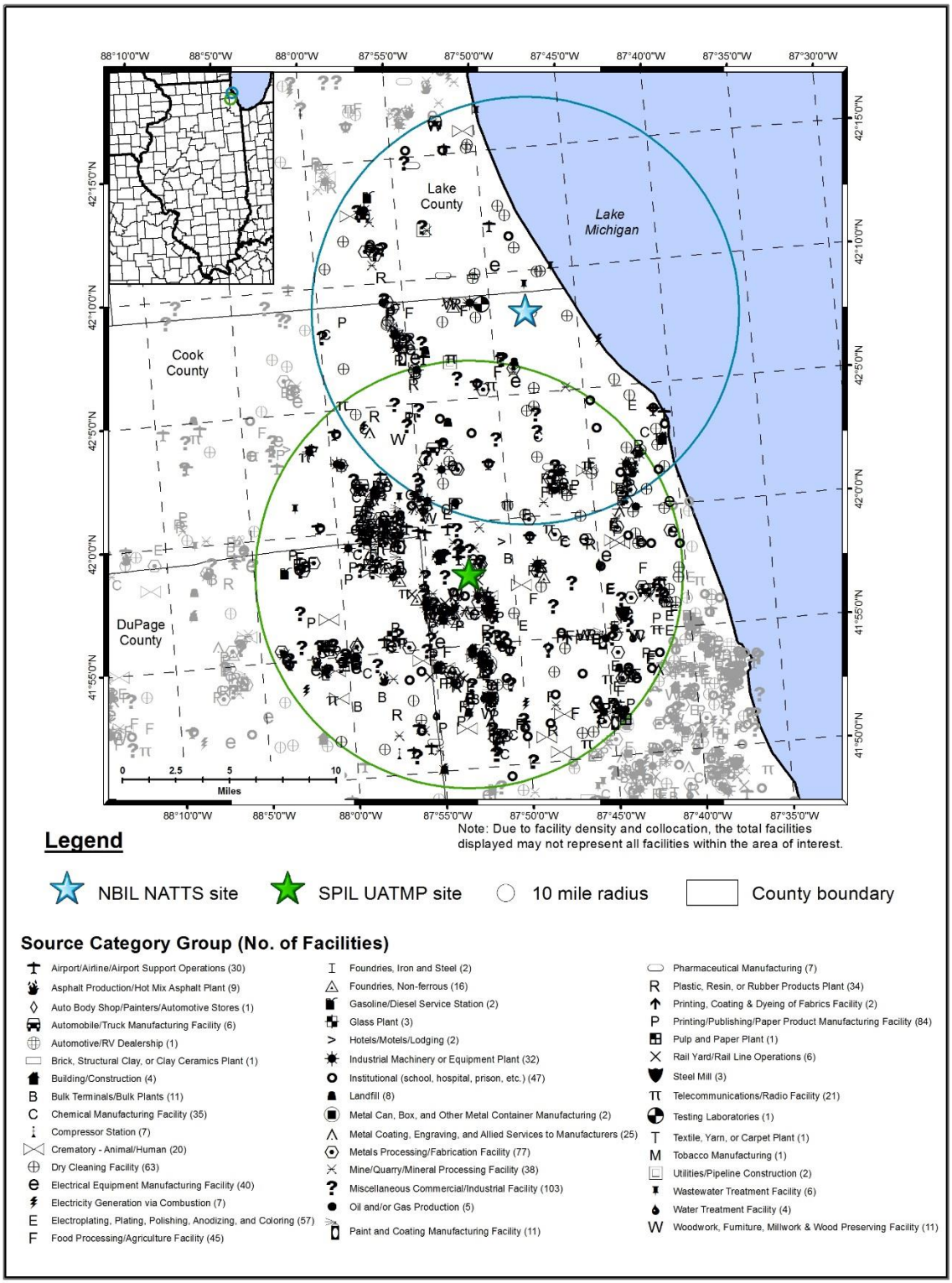


Figure 10-4. Roxana, Illinois (ROIL) Monitoring Site

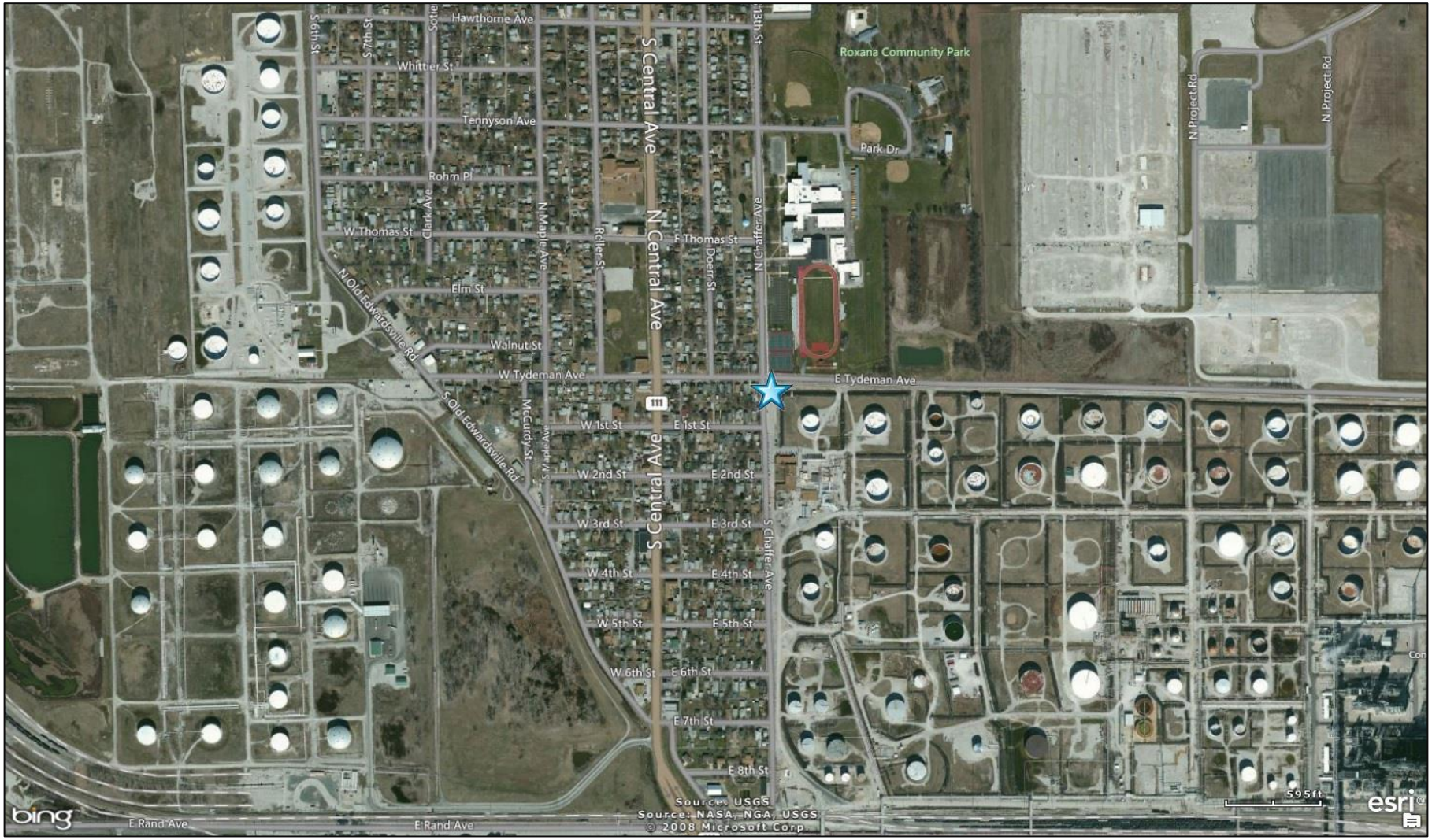


Figure 10-5. NEI Point Sources Located Within 10 Miles of ROIL

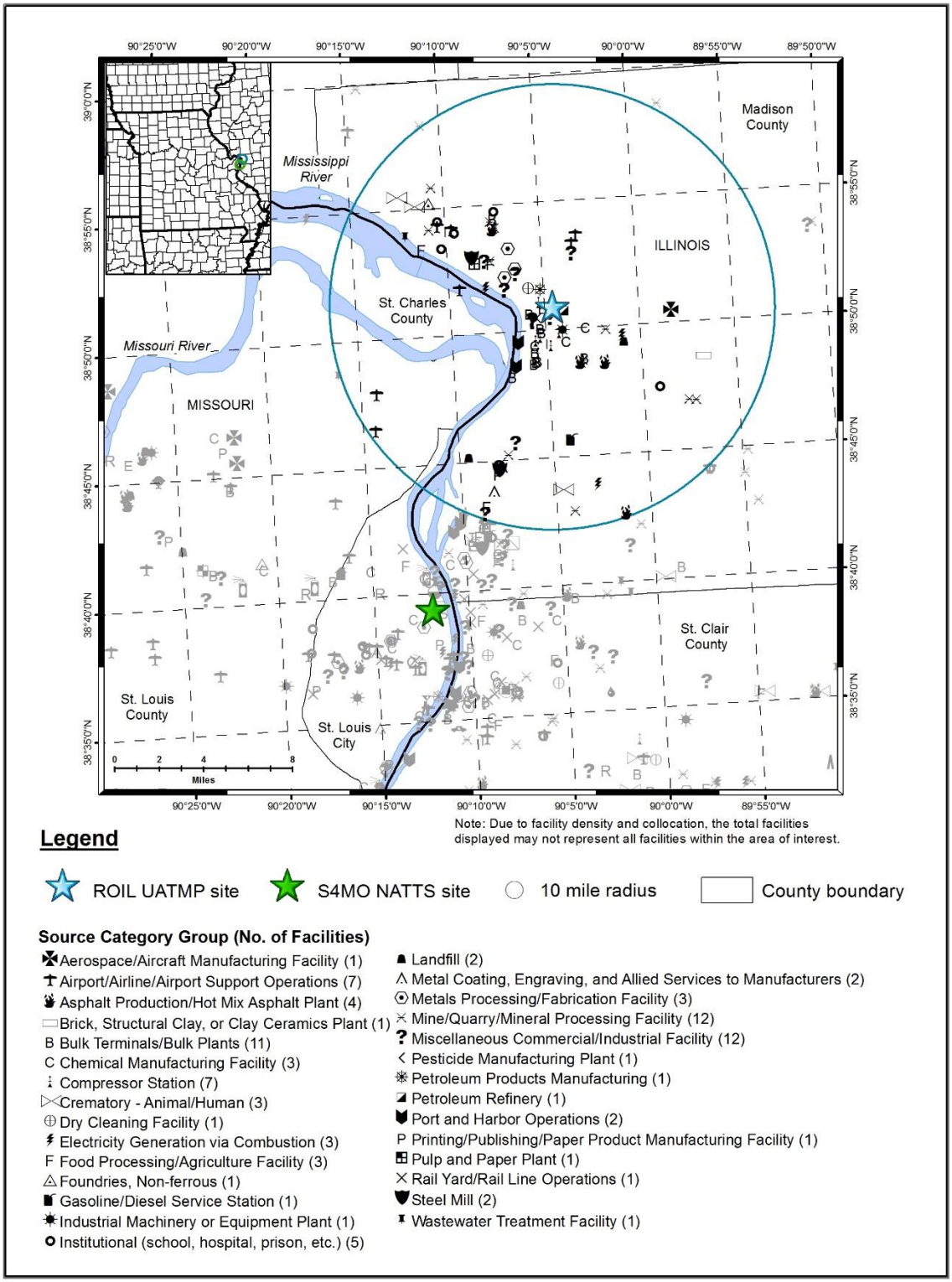


Table 10-1. Geographical Information for the Illinois Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
NBIL	17-031-4201	Northbrook	Cook	Chicago-Naperville-Elgin IL-IN-WI	42.139996, -87.799227	Residential	Suburban	115,100	I-94 north of intersection with Dundee Rd
SPIL	17-031-3103	Schiller Park	Cook	Chicago-Naperville-Elgin IL-IN-WI	41.965193, -87.876265	Mobile	Suburban	193,800	I-294, just south of Lawrence Ave
ROIL	17-119-9010	Roxana	Madison	St. Louis, MO-IL	38.848382, -90.076413	Industrial	Suburban	7,750	S Central Ave at Hawthorne Ave

[1] AADT reflects 2013 data for SPIL and ROIL and 2014 data for NBIL (IL DOT, 2013/2014)

BOLD ITALICS = EPA-designated NATTS Site

NBIL is located on the property of the Northbrook Water Filtration Station. Figure 10-1 shows that NBIL is located off State Highway 68 (Dundee Road), near Exit 30 on I-94. A rail line runs north-south next to the water filtration station, separating the municipal buildings and nearby residential subdivision from a business complex to the east, and intersects Dundee Road just south of the monitoring site. The surrounding area is suburban and residential. Commercial, residential, and forested areas surround the site, along with a country club and golf course. The NBIL monitoring site is the Chicago NATTS site.

SPIL is located on the eastern edge of the Chicago-O'Hare International Airport, between Mannheim Road and I-294, just north of the toll plaza. The nearest runway is less than one-half mile from the site. The surrounding area is classified as suburban and mobile. Commercial and residential areas are located to the east of the airport and I-294. The rail yard located to the east of I-294 is an intermodal terminal/facility that has been closed (Podmolik, 2015).

NBIL and SPIL are located within 13 miles of each other. Each site is located within 10 miles of numerous point sources, although the quantity of emissions sources is higher near SPIL than NBIL, as shown in Figure 10-3. The source categories with the largest number of sources within 10 miles of NBIL and SPIL are printing/publishing/paper product manufacturing; metals processing/fabrication; dry cleaning; electroplating, plating, polishing, anodizing, and coloring; institutions (schools, hospitals, prisons, etc.); and food processing/agriculture. 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 plotted under the symbol for the site in Figure 10-3; this source is a dry cleaning facility. Besides the airport and related operations, the closest point source to SPIL is involved in electroplating, plating, polishing, anodizing, and coloring.

The ROIL monitoring site in Roxana is located at the fence line of a petroleum refinery. Although this area is industrial, residential areas are wedged between the industrial properties, as Figure 10-4 shows. Just north of the monitoring site are a junior high school and a high school, whose track and tennis courts are shown across the street from the monitoring site. North of the schools is a community park. Ambient monitoring data from this location will be used to assess near-field concentrations in the neighboring community, with emphasis on comparing and contrasting these data to the St. Louis NATTS site (S4MO), which is also pictured in Figure 10-5

(WUSTL, 2013 and 2016). The Mississippi River, which is the border between Missouri and Illinois, is just over a mile and a half west of the ROIL monitoring site.

In addition to showing the ROIL monitoring site's location relative to the S4MO monitoring site, Figure 10-5 also shows the point sources within 10 miles of each site (although only the facilities within 10 miles of ROIL are included in the facility counts below the map). There are numerous emissions sources surrounding ROIL, most of which are located to the south and northwest of the site. Many of the sources within 2 miles of ROIL are involved in or related to the petroleum industry. A petroleum refinery, multiple compressor stations, and several bulk terminals surround this site. Other nearby sources include a rail yard, an industrial machinery/equipment facility, and several chemical manufacturers.

In addition to providing city, county, CBSA, and land use/location setting information, Table 10-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. SPIL experiences a higher traffic volume compared to NBIL, although the traffic volumes near these sites are both significantly greater than the traffic volume near ROIL. SPIL's traffic volume is the third highest among all NMP sites. The traffic volume for NBIL ranks ninth among NMP sites while traffic volume near ROIL is in the bottom third. Note that the traffic volumes presented for NBIL and SPIL are from interstate highways while the traffic volume for ROIL is not.

10.2 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 the year.

10.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for

the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Illinois sites, site-specific data were available for some, but not all, of the parameters in Table 10-2. For NBIL, many of the meteorological instruments were down in 2014 and only pressure information was available in AQS; for SPIL, only wind information was available in AQS; weather data were not available in AQS for ROIL. Data from the closest NWS weather station was used for the remaining parameters. The Chicago Executive Airport weather station is located 5.6 miles west-southwest of NBIL; the O'Hare International Airport weather station is located 3.6 miles northwest of SPIL; and the Lambert/St. Louis International Airport weather station is located 17.4 miles west-southwest of ROIL. A map showing the distance between each Illinois monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 10-2. Average Meteorological Conditions near the Illinois Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Northbrook, Illinois - NBIL[2]							
Sample Days (62)	46.3 ± 1.1	34.3 ± 1.1	65.3 ± 0.8	30.08 ± 0.01	29.45 ± 0.01	W	6.5 ± 0.2
2014	47.8 ± 0.5	36.6 ± 0.4	67.5 ± 0.3	30.03 ± <0.01	29.39 ± <0.01	S	7.0 ± 0.1
Schiller Park, Illinois - SPIL[3]							
Sample Days (61)	47.0 ± 1.2	33.7 ± 1.1	62.1 ± 0.8	30.06 ± 0.01	29.33 ± 0.01	SW	6.2 ± 0.2
2014	47.9 ± 0.5	35.4 ± 0.4	64.2 ± 0.3	30.01 ± <0.01	29.28 ± <0.01	SW	6.9 ± 0.1
Roxana, Illinois - ROIL[4]							
Sample Days (62)	54.3 ± 1.1	40.2 ± 1.1	61.4 ± 0.8	30.09 ± 0.01	29.32 ± 0.01	ESE	6.9 ± 0.2
2014	55.9 ± 0.5	42.2 ± 0.4	62.6 ± 0.4	30.04 ± <0.01	29.28 ± <0.01	S	7.4 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Only station pressure was measured at NBIL in 2014. The remaining information was obtained from the closest NWS weather station located at Chicago Executive Airport, WBAN 04838.
[3]Only wind parameters were measured at SPIL. The remaining information was obtained from the closest NWS weather station located at O'Hare International Airport, WBAN 94846.
[4]This information was obtained from the NWS weather station located at Lambert/St. Louis International Airport, WBAN 13994.

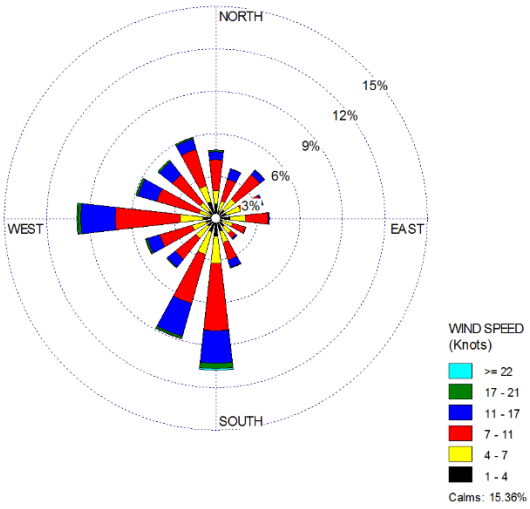
Table 10-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 10-2 is the 95 percent confidence interval for each parameter. As shown in Table 10-2, average meteorological conditions on sample days near NBIL, SPIL, and ROIL were generally representative of average weather conditions experienced throughout the year near these sites. The largest difference shown in Table 10-2 is for NBIL and the dew point temperature, although dew point and/or relative humidity have the largest differences for each site. Note the difference in the temperature parameters between the Chicago sites and ROIL. These differences are expected, given the roughly 250 mile distance between these sites.

10.2.2 Wind Rose Comparison

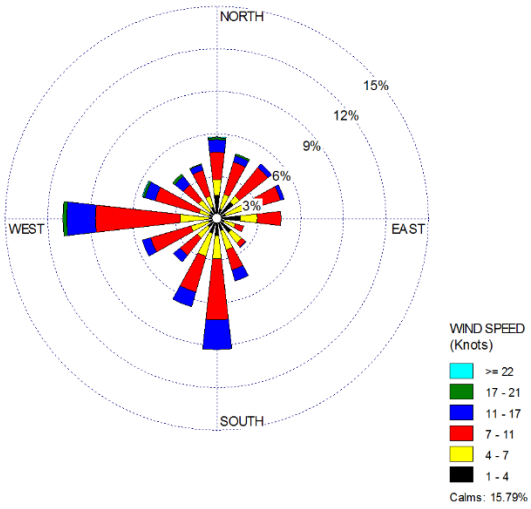
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 10-6 presents two wind roses for the NBIL monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 10-7 and 10-8 present the full-year and sample day wind roses for SPIL and ROIL.

Figure 10-6. Wind Roses for the Chicago Executive Airport Weather Station near NBIL

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 10-6 for NBIL include the following:

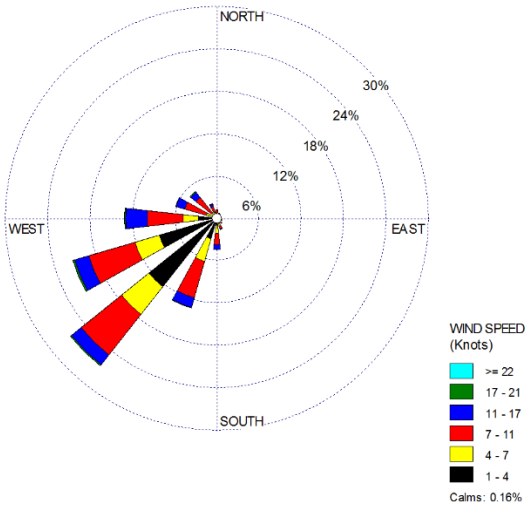
- The wind instruments at NBIL were down in 2014, so the wind data provided here is from the Chicago Executive Airport weather station, which is located 5.6 miles west-southwest of NBIL, and about four times as far from Lake Michigan as NBIL.

- The full-year wind rose shows that winds from a variety of directions were observed near NBIL. Winds from the south, south-southwest, and west together account for nearly one-third of wind observations while winds from the east-southeast and southeast were observed the least. Calm were observed for 15 percent of the hourly measurements while the strongest winds were most often out of the south.

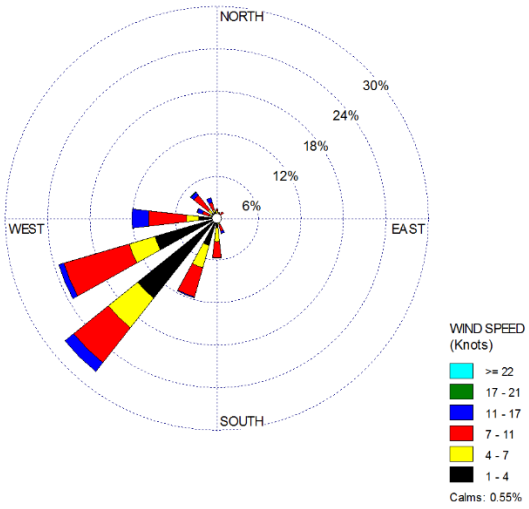
- The sample day wind patterns generally resemble the full-year wind patterns in that winds from the south, south-southwest, and west were observed the most and winds from the east-southeast and southeast were observed the least. Westerly winds accounted for a higher percentage of observations on sample days while fewer southerly and south-southwesterly winds were observed compared to the full-year wind rose. Fewer winds from the northwest quadrant were observed on sample days while a greater percentage of winds from the northeast quadrant were observed. Also, winds appear lighter on sample days; winds speeds greater than 11 knots account for a fewer percentage of observations on sample days than throughout the year.

Figure 10-7. Wind Roses for the Wind Data Collected at SPIL

2014 Wind Rose



Sample Day Wind Rose



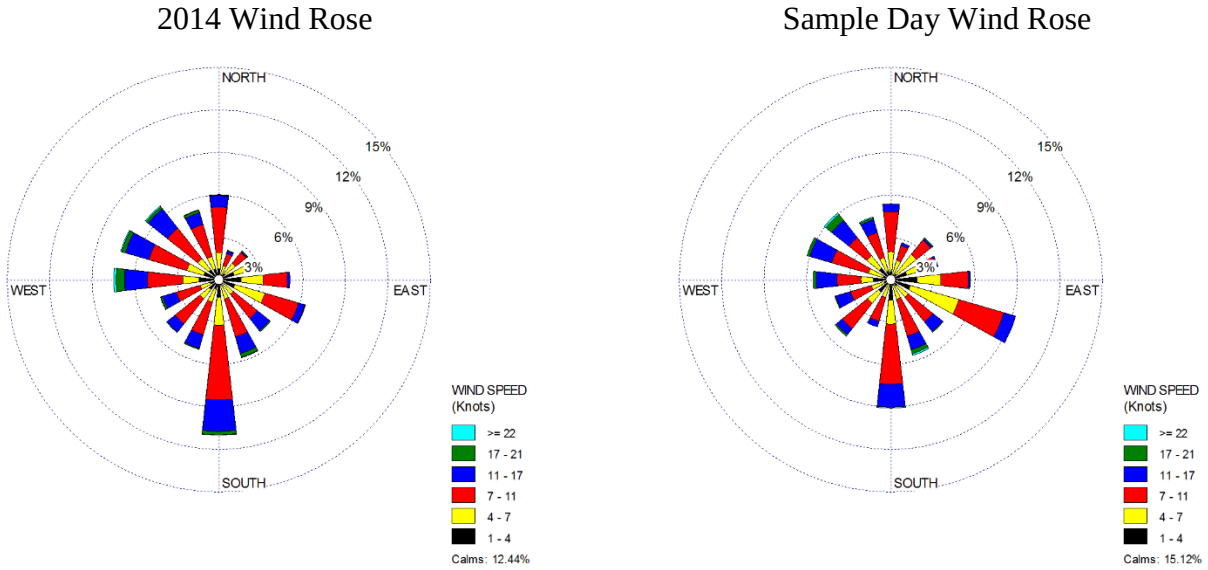
Observations from Figure 10-7 for SPIL include the following:

- SPIL is the only NMP site in Illinois for which 2014 wind data were available in AQS.

- The 2014 wind rose shows that winds from the southwest quadrant account for the majority of wind observations collected at SPIL in 2014, with very few wind observations from the eastern quadrants. Few calm winds were observed at SPIL in 2014.

- The sample day wind patterns resemble those of the full-year wind rose, with the winds from the south to southwest to west accounting for the majority of observations and a calm rate less than 1 percent.

Figure 10-8. Wind Roses for the Lambert/St. Louis International Airport Weather Station near ROIL



Observations from Figure 10-8 for ROIL include the following:

- The Lambert/St. Louis International Airport weather station is located 17.4 miles west-southwest of ROIL. The airport lies on the northwest side of St. Louis and is south of the Missouri River.

- The 2014 wind rose shows that winds from a variety of directions were observed near ROIL, although winds from the northeast quadrant were rarely observed. Winds from the south were observed the most in 2014, with winds from the west to northwest also commonly observed. Calm winds were observed for 12 percent of the hourly measurements while the strongest winds were most often observed with winds with a westerly component.

- Winds from the south and east-southeast were nearly equally observed near ROIL on sample days. The remaining wind directions accounted for 6 percent of observations or fewer. Winds from the west to northwest were observed slightly less on sample days compared to the full year. The calm rate on sample days is higher (15 percent) than for the full year's worth of observations (12 percent).

10.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Illinois monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 10-3. 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 and are shaded in gray in Table 10-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, SNMOCs, metals (PM_{10}), and PAHs were sampled for at NBIL, while only VOCs and carbonyl compounds were sampled for at SPIL and ROIL.

Table 10-3. Risk-Based 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	56	56	100.00	11.31	11.31
Carbon Tetrachloride	0.17	55	56	98.21	11.11	22.42
Formaldehyde	0.077	55	55	100.00	11.11	33.54
1,2-Dichloroethane	0.038	54	54	100.00	10.91	44.44
Acetaldehyde	0.45	53	55	96.36	10.71	55.15
Naphthalene	0.029	46	55	83.64	9.29	64.44
Arsenic (PM_{10})	0.00023	45	53	84.91	9.09	73.54
1,3-Butadiene	0.03	35	43	81.40	7.07	80.61
Acenaphthene	0.011	27	55	49.09	5.45	86.06
Fluorene	0.011	25	49	51.02	5.05	91.11
Fluoranthene	0.011	18	55	32.73	3.64	94.75
Hexachloro-1,3-butadiene	0.045	17	19	89.47	3.43	98.18
Chloroform	9.8	2	56	3.57	0.40	98.59
p-Dichlorobenzene	0.091	2	22	9.09	0.40	98.99
Ethylbenzene	0.4	2	56	3.57	0.40	99.39
Benzo(a)pyrene	0.00057	1	55	1.82	0.20	99.60
Cadmium (PM_{10})	0.00056	1	53	1.89	0.20	99.80
Dichloromethane	60	1	55	1.82	0.20	100.00
Total		495	902	54.88		

Table 10-3. Risk-Based Screening Results for the Illinois Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Schiller Park, Illinois - SPIL						
Acetaldehyde	0.45	59	59	100.00	15.21	15.21
Formaldehyde	0.077	59	59	100.00	15.21	30.41
Benzene	0.13	55	55	100.00	14.18	44.59
1,3-Butadiene	0.03	55	55	100.00	14.18	58.76
Carbon Tetrachloride	0.17	55	55	100.00	14.18	72.94
1,2-Dichloroethane	0.038	52	52	100.00	13.40	86.34
Trichloroethylene	0.2	24	49	48.98	6.19	92.53
Hexachloro-1,3-butadiene	0.045	12	13	92.31	3.09	95.62
Ethylbenzene	0.4	7	55	12.73	1.80	97.42
p-Dichlorobenzene	0.091	4	25	16.00	1.03	98.45
Propionaldehyde	0.8	3	59	5.08	0.77	99.23
1,2-Dibromoethane	0.0017	2	2	100.00	0.52	99.74
Tetrachloroethylene	3.8	1	55	1.82	0.26	100.00
Total		388	593	65.43		
Roxana, Illinois - ROIL						
Acetaldehyde	0.45	60	60	100.00	16.09	16.09
Formaldehyde	0.077	60	60	100.00	16.09	32.17
Benzene	0.13	58	58	100.00	15.55	47.72
Carbon Tetrachloride	0.17	58	58	100.00	15.55	63.27
1,3-Butadiene	0.03	51	55	92.73	13.67	76.94
1,2-Dichloroethane	0.038	51	51	100.00	13.67	90.62
Hexachloro-1,3-butadiene	0.045	16	17	94.12	4.29	94.91
Ethylbenzene	0.4	14	58	24.14	3.75	98.66
1,2-Dibromoethane	0.0017	2	2	100.00	0.54	99.20
p-Dichlorobenzene	0.091	1	17	5.88	0.27	99.46
Propionaldehyde	0.8	1	60	1.67	0.27	99.73
Xylenes	10	1	58	1.72	0.27	100.00
Total		373	554	67.33		

Observations from Table 10-3 include the following:

- The number of pollutants failing screens for NBIL is higher than the other two monitoring sites; this is expected given the difference in pollutants measured at each site.

- Eighteen pollutants failed at least one screen for NBIL; 55 percent of concentrations for these 18 pollutants were greater than their associated risk screening value (or failed screens).

- Twelve pollutants contributed to 95 percent of failed screens for NBIL and therefore were identified as pollutants of interest for this site. These 12 include two carbonyl compounds, five VOCs, one PM_{10} metal, and four PAHs.

- NBIL failed the sixth highest number of screens (495) among NMP sites, as shown in Table 4-8 of Section 4.2, and had the third highest number of pollutants whose concentrations failed screens (18). However, the failure rate for NBIL, when incorporating all pollutants with screening values, is relatively low, at 20 percent. This is due primarily to the relatively high number of pollutants sampled for at this site. NBIL is one of only three NMP sites sampling five pollutant groups and one of only two sites to sample with both the TO-15 and SNMOC methods. 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-based screening process. As NBIL sampled both VOCs (TO-15) and SNMOCs, the TO-15 results were used for the 12 pollutants these methods have in common.

- Thirteen pollutants failed screens for SPIL; approximately 65 percent of concentrations for these 13 pollutants were greater than their associated risk screening value (or failed screens).

- Eight pollutants contributed to 95 percent of failed screens for SPIL and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs. SPIL is the only NMP site with trichloroethylene as a pollutant of interest.

- Twelve pollutants failed screens for ROIL; approximately 67 percent of concentrations for these 12 pollutants were greater than their associated risk screening value (or failed screens).

- Eight pollutants contributed to 95 percent of failed screens for ROIL and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs.

- The Illinois monitoring sites have seven pollutants of interest in common: two carbonyl compounds (acetaldehyde and formaldehyde) and five VOCs (benzene, 1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane, and hexachloro-1,3-butadiene). Of these, benzene, formaldehyde, and 1,2-dichloroethane failed 100 percent of screens for each site.

10.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Illinois monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at NBIL, SPIL, and ROIL are provided in Appendices J through N.

10.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each Illinois site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Illinois monitoring sites are presented in Table 10-4, where applicable. Note that concentrations of the PAHs and metals for NBIL are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 10-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	1st Quarter Average (µg/m³)	2nd Quarter Average (µg/m³)	3rd Quarter Average (µg/m³)	4th Quarter Average (µg/m³)	Annual Average (µg/m³)
Northbrook, Illinois - NBIL							
Acetaldehyde	55/55	55	2.35 ± 0.74	2.65 ± 1.10	3.00 ± 0.76	1.29 ± 0.90	2.36 ± 0.45
Benzene	56/56	56	0.63 ± 0.09	0.34 ± 0.05	0.56 ± 0.16	NA	0.49 ± 0.06
1,3-Butadiene	43/36	56	0.05 ± 0.04	0.02 ± 0.01	0.05 ± 0.02	NA	0.04 ± 0.01
Carbon Tetrachloride	56/55	56	0.48 ± 0.09	0.67 ± 0.02	0.65 ± 0.03	NA	0.60 ± 0.03
1,2-Dichloroethane	54/52	56	0.07 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	NA	0.07 ± <0.01
Formaldehyde	55/55	55	1.23 ± 0.39	1.65 ± 0.55	1.31 ± 0.36	0.91 ± 0.34	1.29 ± 0.21
Hexachloro-1,3-butadiene	19/0	56	0.03 ± 0.02	0.02 ± 0.02	0.03 ± 0.02	NA	0.02 ± 0.01
Acenaphthene[a]	55/55	55	2.75 ± 1.61	26.05 ± 10.69	46.31 ± 24.01	6.31 ± 4.68	20.62 ± 8.20
Arsenic (PM_{10})[a]	53/53	53	NA	NA	1.07 ± 0.33	0.54 ± 0.17	NA
Fluoranthene[a]	55/55	55	1.74 ± 0.69	11.38 ± 4.59	16.58 ± 5.12	2.65 ± 1.51	8.12 ± 2.37
Fluorene[a]	49/49	55	2.31 ± 1.50	21.66 ± 8.73	38.81 ± 19.27	5.78 ± 4.05	17.37 ± 6.69
Naphthalene[a]	55/55	55	45.44 ± 19.67	132.42 ± 44.09	203.35 ± 70.64	51.91 ± 27.25	109.13 ± 28.14
Schiller Park, Illinois - SPIL							
Acetaldehyde	59/59	59	3.92 ± 1.30	1.53 ± 0.43	1.58 ± 0.22	2.91 ± 1.09	2.52 ± 0.50
Benzene	55/55	55	0.79 ± 0.11	NA	0.92 ± 0.21	0.85 ± 0.24	0.79 ± 0.09
1,3-Butadiene	55/55	55	0.14 ± 0.03	NA	0.16 ± 0.03	0.13 ± 0.03	0.13 ± 0.02
Carbon Tetrachloride	55/55	55	0.57 ± 0.05	NA	0.63 ± 0.02	0.58 ± 0.07	0.60 ± 0.02
1,2-Dichloroethane	52/52	55	0.08 ± 0.01	NA	0.06 ± 0.02	0.09 ± 0.02	0.08 ± 0.01
Formaldehyde	59/59	59	4.11 ± 0.80	2.87 ± 0.86	3.06 ± 0.43	2.43 ± 0.51	3.12 ± 0.35
Hexachloro-1,3-butadiene	13/0	55	0.03 ± 0.02	NA	0.01 ± 0.01	0.03 ± 0.02	0.02 ± 0.01
Trichloroethylene	49/37	55	0.34 ± 0.34	NA	0.72 ± 0.42	0.36 ± 0.38	0.44 ± 0.17

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Table 10-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Roxana, Illinois - ROIL							
Acetaldehyde	60/60	60	1.61 ± 0.30	1.94 ± 0.23	2.33 ± 0.41	1.74 ± 0.39	1.91 ± 0.18
Benzene	58/58	58	1.39 ± 0.78	1.30 ± 0.30	1.09 ± 0.29	1.11 ± 0.28	1.22 ± 0.21
1,3-Butadiene	55/51	58	0.05 ± 0.02	0.06 ± 0.01	0.08 ± 0.02	0.10 ± 0.04	0.07 ± 0.01
Carbon Tetrachloride	58/58	58	0.59 ± 0.06	0.66 ± 0.03	0.65 ± 0.03	0.60 ± 0.05	0.63 ± 0.02
1,2-Dichloroethane	51/51	58	0.10 ± 0.02	0.09 ± <0.01	0.07 ± 0.02	0.06 ± 0.02	0.08 ± 0.01
Ethylbenzene	58/58	58	0.43 ± 0.45	0.31 ± 0.06	0.30 ± 0.08	0.26 ± 0.10	0.32 ± 0.10
Formaldehyde	60/60	60	1.87 ± 0.29	3.52 ± 0.65	4.82 ± 1.11	1.98 ± 0.41	3.05 ± 0.45
Hexachloro-1,3-butadiene	17/0	58	0.02 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	0.03 ± 0.02	0.02 ± 0.01

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for NBIL from Table 10-4 include the following:

- The pollutants with the highest annual average concentrations are acetaldehyde (2.36 ± 0.45 µg/m^3) and formaldehyde (1.29 ± 0.21 µg/m^3). NBIL is one of only two sites for which the annual average concentration of acetaldehyde is greater than the annual average concentration of formaldehyde (SEWA is the other). A similar observation was made in the 2013 NMP report. The annual average concentrations for the remaining pollutants of interest are less than 1 µg/m^3, with carbon tetrachloride as the next highest (0.60 ± 0.03 µg/m^3).

- Acetaldehyde concentrations measured at NBIL range from 0.159 µg/m^3 to 9.17 µg/m^3. The maximum acetaldehyde concentration measured at NBIL is the maximum acetaldehyde concentration measured across the program. An acetaldehyde concentration greater than 5 µg/m^3 was measured at NBIL during each calendar quarter in 2014. The fourth quarter average acetaldehyde concentration is roughly half the magnitude of the other quarter averages and has a relatively large confidence interval associated with it. A review of the data shows that at least seven acetaldehyde concentrations greater than 2 µg/m^3 were measured during each quarter except the fourth quarter, when only one was measured. On the other end of the concentration range, the number of acetaldehyde concentrations less than 1 µg/m^3 measured at NBIL during the fourth quarter of 2014 (seven) is more than twice the number measured throughout the rest of the year (three), including the only two less than 0.5 µg/m^3.

- The quarterly average concentrations of formaldehyde exhibit a similar pattern as the quarterly averages of acetaldehyde. A review of the data shows that formaldehyde concentrations measured at NBIL range from 0.108 µg/m^3 to 4.74 µg/m^3, with the maximum concentration measured on the same day as the maximum acetaldehyde concentration (April 11, 2014). The documentation indicated that there may have been timer issues for this sample. At least two formaldehyde concentrations greater than 2 µg/m^3 were measured during each calendar quarter except the fourth quarter, when none were measured. On the other end of the concentration range, the number of formaldehyde concentrations less than 0.5 µg/m^3 measured at NBIL during the fourth quarter of 2014 (three) is more than the number measured throughout the rest of the year (one), and includes the only two less than 0.25 µg/m^3.

- Fourth quarter average concentrations for the VOCs in Table 10-4 could not be calculated because there were too many invalid samples during this quarter to meet the 75 percent criteria. Of the VOCs shown, carbon tetrachloride and benzene have the only annual average concentrations greater than 0.1 µg/m^3.

- The first quarter average concentration of carbon tetrachloride is significantly less than the other available quarterly averages. A review of the data shows that all six carbon tetrachloride measurements less than 0.5 µg/m^3 were measured during the first quarter, including one less than 0.1 µg/m^3. The first quarter is the only calendar quarter during which a concentration greater than 0.7 µg/m^3 was not measured.

- The second quarter average concentration of benzene is significantly less than the other available quarterly averages. A review of the data shows that benzene concentrations measured at NBIL span an order of magnitude, ranging from 0.189 µg/m^3 to 1.39 µg/m^3. There were 23 benzene concentrations greater than 0.5 µg/m^3 measured at NBIL; of these, only one was measured during the second quarter of 2014, compared to 11, seven, and four measured during the first, third, and fourth quarters, respectively.

- There were a number of invalid metals samples during the first and second quarters of 2014, resulting in these quarters not meeting the 75 percent criteria for quarterly averages to be calculated and thus, no annual average is provided either. However, a site-specific statistical summary for arsenic is provided in Appendix N. Arsenic concentrations measured at NBIL in 2014 range from 0.117 ng/m^3 to 2.16 ng/m^3. Table 10-4 shows that the third quarter average concentration of arsenic is twice the fourth quarter average. Of the 10 arsenic concentrations greater than 1 ng/m^3 measured at NBIL, seven were measured during the third quarter (compared to one measured during the second quarter and two measured during the fourth quarter of 2014). Comparing just the two quarters with available quarterly average concentrations, six concentrations were measured during the third quarter that are greater than the maximum concentration measuring during the fourth quarter. On the other end of the concentration range, the number of arsenic concentrations less than 0.5 ng/m^3 measured during the fourth quarter (10) is five times greater than the number measured during the third quarter of 2014 (two).

- Of the PAHs shown, naphthalene has the highest annual average concentration (109.13 ± 28.14 ng/m^3). Concentrations of each of the PAH pollutants of interest were significantly higher during the warmer months of the year and exhibit a relatively large amount of variability, based on the confidence intervals. Concentrations of naphthalene measured at NBIL range from 17.5 ng/m^3 to 568 ng/m^3. The maximum concentration measured at NBIL is the highest naphthalene concentration measured across the program in 2014. This was also true in 2013. Only two of the 22 naphthalene concentrations greater than 100 ng/m^3 measured at NBIL were measured outside the second and third quarters of the year; conversely, all but two of the 21 measurements less than 50 ng/m^3 were measured during the first or fourth quarters of 2014.

- Some of the highest concentrations of acenaphthene, fluorene, and fluoranthene measured across the program were also measured at NBIL. Concentrations of acenaphthene measured at NBIL range from 0.491 ng/m^3 to 198 ng/m^3, accounting for six of the 10 highest acenaphthene measurements across the program (those greater than 50 ng/m^3). Concentrations of fluorene measured at NBIL range from 0.782 ng/m^3 to 161 ng/m^3, including the maximum fluorene measurement across the program. Concentrations of fluoranthene range from 0.514 ng/m^3 to 36.8 ng/m^3, with all six fluoranthene concentrations greater than 20 ng/m^3 across the program measured at NBIL. Many of the higher PAH concentrations were measured on the same days. For instance, the highest naphthalene, acenaphthene, and fluorene concentrations were measured at NBIL on August 9, 2014, along with the second highest fluoranthene concentration.

Observations for SPIL from Table 10-4 include the following:

- The pollutants with the highest annual average concentrations are formaldehyde (3.12 ± 0.35 µg/m^3) and acetaldehyde (2.52 ± 0.50 µg/m^3). These are the only pollutants of interest with annual average concentrations greater than 1 µg/m^3. Of the VOCs, benzene (0.79 ± 0.09 µg/m^3) and carbon tetrachloride (0.60 ± 0.02 µg/m^3) have the highest annual average concentrations for SPIL.

- Concentrations of formaldehyde measured at SPIL appear highest during the first quarter of 2014, based on the quarterly average concentrations. Five of the seven formaldehyde concentrations greater than or equal to 5 µg/m^3 were measured at SPIL between January and March, while none of the 10 formaldehyde concentrations less than 2 µg/m^3 were measured during the first quarter.

- Concentrations of acetaldehyde measured at SPIL span an order of magnitude, ranging from 0.849 µg/m^3 to 8.99 µg/m^3. The maximum acetaldehyde concentration measured at SPIL is the third highest acetaldehyde concentration measured across the program. SPIL has the highest number of acetaldehyde concentrations greater than 5 µg/m^3 (eight) of any other NMP site (NBIL has four). The first and fourth quarter average concentrations for SPIL are considerably higher than the other quarterly averages, and the confidence intervals indicate that there is considerable variability associated with these averages. All 12 acetaldehyde concentrations greater than 4 µg/m^3 were measured at SPIL during the first (seven) or fourth (five) quarters of

2014. All but one of the acetaldehyde concentrations measured during the first quarter are greater than the averages calculated for the second and third quarters of the year.

- Second quarter average concentrations for the VOCs in Table 10-4 could not be calculated for SPIL because there were too many invalid samples during this quarter to meet the 75 percent criteria.

- SPIL has a significantly higher annual average concentration of 1,3-butadiene than NBIL. The maximum 1,3-butadiene concentration for each Chicago site was measured on the same day, January 23, 2014 (0.308 µg/m^3 for NBIL and 0.288 µg/m^3 for SPIL). After these two measurements, concentrations measured at SPIL account for the next 23 highest 1,3-butadiene concentrations measured at these two sites. Of the 37 1,3-butadiene concentrations greater than 0.1 µg/m^3 measured at these two sites, 35 were measured at SPIL. Benzene concentrations were also higher than SPIL than NBIL. All but one of the 13 benzene concentrations greater than 1 µg/m^3 measured at these two sites were measured at SPIL.

- The first and fourth quarter average concentrations of trichloroethylene have confidence intervals greater than or equal to the averages themselves. The second quarter average concentration also has a relatively large confidence interval associated with it. A review of the data shows that trichloroethylene was detected in 89 percent of the samples collected at SPIL, with measured detections ranging from 0.0485 µg/m^3 to 3.09 µg/m^3. Seven of the nine trichloroethylene concentrations greater than 1 µg/m^3 measured across the program were measured at SPIL; further, 22 of the 25 highest trichloroethylene concentrations (those greater than 0.25 µg/m^3) were measured at SPIL. SPIL is the only NMP site for which trichloroethylene is a pollutant of interest. Similar observations were also made in the 2011, 2012, and 2013 NMP reports.

Observations for ROIL from Table 10-4 include the following:

- The pollutants with the highest annual average concentrations are formaldehyde (3.05 ± 0.45 µg/m^3), acetaldehyde (1.91 ± 0.18 µg/m^3), and benzene (1.22 ± 0.21 µg/m^3). These are the only pollutants of interest with annual average concentrations greater than 1 µg/m^3. ROIL's annual average concentration of benzene is significantly higher than the annual average concentrations of benzene for the Chicago sites.

- The second and third quarter average concentrations for formaldehyde are significantly higher than the first and fourth quarter averages. A review of the data shows that formaldehyde concentrations measured at ROIL range from 1.11 µg/m^3 to 10.5 µg/m^3. ROIL is one of seven NMP sites at which formaldehyde concentrations greater than 10 µg/m^3 were measured. All but one of the 24 formaldehyde concentrations greater than 3 µg/m^3 measured at ROIL were measured between April and September. At the other end of the concentration range, all but one of the 18 formaldehyde concentrations less than 2 µg/m^3 were measured during the first and fourth quarters of 2014.

- Concentrations of acetaldehyde also appear higher during the second and third quarter of the year, although the difference among the quarterly averages is considerably less. While acetaldehyde concentrations greater than 2 $\mu g/m^3$ were measured during each calendar quarter, the majority of them (17 of 23) were measured between April and September. Conversely, nine of the 10 lowest acetaldehyde concentrations were measured at ROIL during the first or fourth quarters, primarily in January and December.

- The confidence interval for the first quarter average concentration of benzene is two to three times larger than the confidence intervals shown for the other quarterly averages shown for ROIL. Benzene concentrations measured at ROIL range from 0.301 $\mu g/m^3$ to 5.25 $\mu g/m^3$, which is the third highest benzene concentration measured at an NMP site in 2014. The two highest benzene concentrations measured at ROIL were both from samples collected during the first quarter (5.25 $\mu g/m^3$ on February 28, 2014 and 3.13 $\mu g/m^3$ on March 18, 2014). ROIL is one of only five NMP sites at which benzene concentrations greater than 3 $\mu g/m^3$ were measured.

- Ethylbenzene is the only pollutant of interest for ROIL that is not a pollutant of interest for each of the Chicago sites. The confidence interval for the first quarter average concentration of ethylbenzene is greater than the quarterly average itself, indicating the likely influence of outliers. Ethylbenzene concentrations measured at ROIL range from 0.065 $\mu g/m^3$ to 3.01 $\mu g/m^3$. This maximum ethylbenzene concentration was measured at ROIL on the same day as the maximum benzene concentration, and is the second highest ethylbenzene concentration measured across the program in 2014. All other ethylbenzene concentrations measured at ROIL in 2014 are less than 0.85 $\mu g/m^3$ and all other ethylbenzene concentrations measured during the first quarter at this site are less than 0.5 $\mu g/m^3$, explaining the large confidence interval associated with the first quarter average concentration.

Tables 4-9 through 4-12 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for NBIL, SPIL, and ROIL from those tables include the following:

- The Illinois monitoring sites appear in Tables 4-9 through 4-12 a total of eight times, with NBIL appearing three times, SPIL appearing three times, and ROIL appearing twice.

- Table 4-9 shows that ROIL has the second highest annual average concentration of benzene among NMP sites sampling this pollutant, with neither Chicago site appearing in this table for benzene. ROIL also appears for ethylbenzene, ranking tenth. SPIL's annual average concentration of 1,3-butadiene ranks sixth and NBIL's annual average concentration of hexachloro-1,3-butadiene ranks ninth among NMP sites sampling these pollutants.

- SPIL and NBIL both appear in Table 4-10 for their annual average concentrations of acetaldehyde, ranking fourth and seventh, respectively (ROIL's annual average is just outside the top 10, ranking 11th.) Note that the annual averages for SPIL and NBIL

have the largest confidence intervals among the sites shown. SPIL ranks tenth for its annual average concentration of formaldehyde, with ROIL again just outside the top 10. In contrast to the other sites, the annual average concentration of formaldehyde for NBIL is one of the lowest among NMP sites sampling carbonyl compounds.

- NBIL ranks second for its annual average concentration of naphthalene among NMP sites sampling PAHs, as shown in Table 4-11. The confidence interval associated with NBIL's annual average is the largest among the averages shown, a reflection of the variability within the measurements.

10.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 10-4 for NBIL, SPIL, and ROIL. Figures 10-9 through 10-21 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below. Because an annual average concentration could not be calculated for arsenic, a box plot is not presented for NBIL.

Figure 10-9. Program vs. Site-Specific Average Acenaphthene Concentration

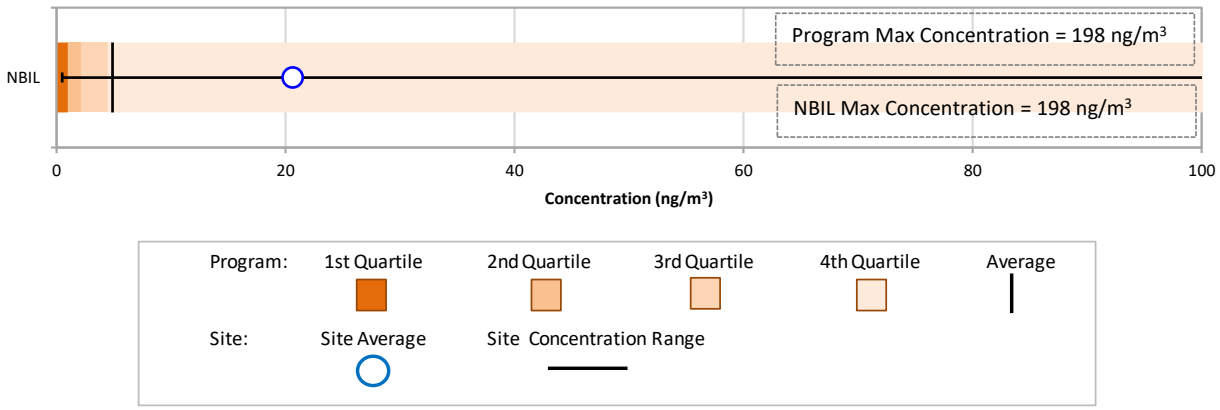


Figure 10-9 presents the box plot for acenaphthene for NBIL and shows the following:

- NBIL is the only Illinois site to sample PAHs under the NMP is 2014. The program-level maximum concentration (198 ng/m^3) of acenaphthene is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced to 100 ng/m^3.

- The maximum acenaphthene concentration measured at NBIL is the maximum concentration measured across the program, although the next highest concentration measured at NBIL is roughly one-third the magnitude (63.6 ng/m^3). Only NBIL and one other NMP site have individual acenaphthene concentrations greater than 40 ng/m^3.

- NBIL's annual average acenaphthene concentration is more than four times the program-level average concentration, with more than half of NBIL's acenaphthene measurements greater than the program-level average concentration. Note that the program-level average is greater than the program-level third quartile, an indication that the measurements at the upper end of the concentration range are driving the program-level average upward.

Figure 10-10. Program vs. Site-Specific Average Acetaldehyde Concentrations

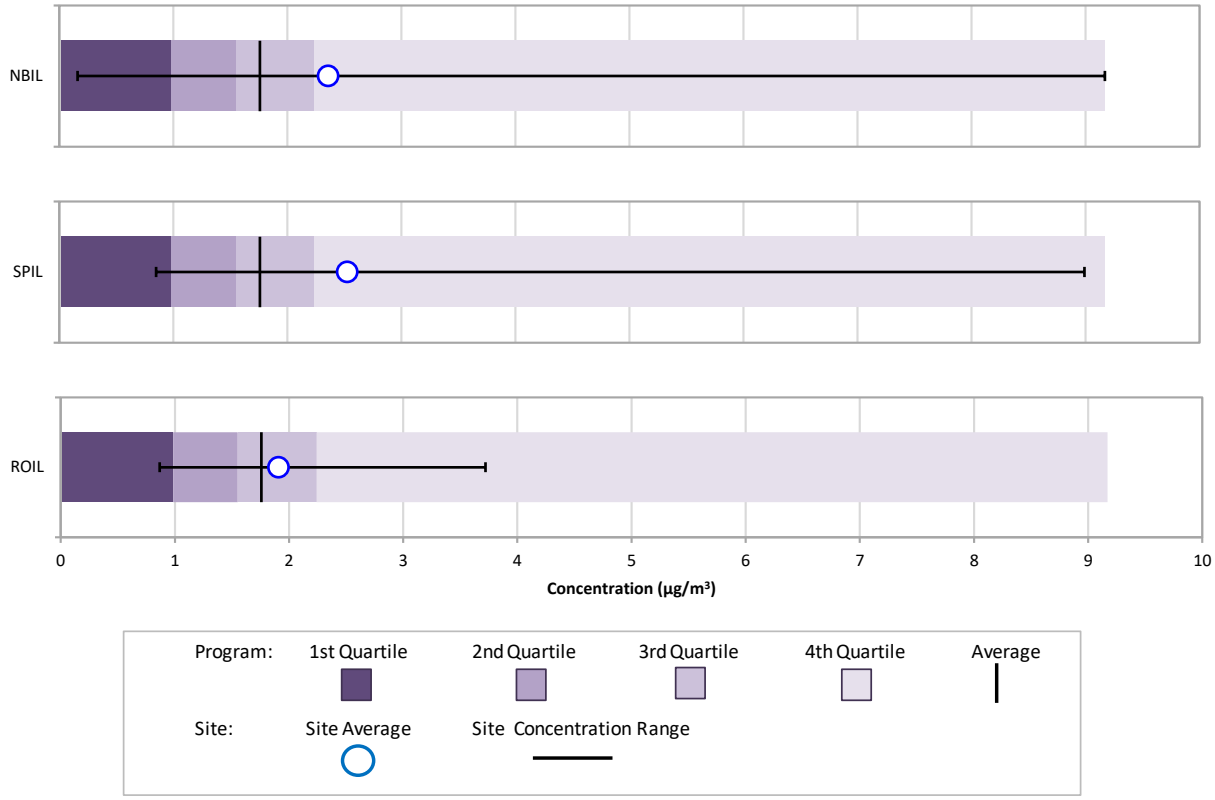


Figure 10-10 presents the box plots for acetaldehyde for all three sites and shows the following:

- The range of acetaldehyde concentrations measured is largest for NBIL and smallest for ROIL. The program-level maximum concentration of acetaldehyde was measured at NBIL, although a similar concentration was also measured at SPIL.

- The annual average concentration of acetaldehyde for each Illinois monitoring site is greater than the program-level average concentration, with the annual averages for NBIL and SPIL also greater than the program-level third quartile

- The minimum acetaldehyde concentration measured at NBIL is among the lowest measured across the program.

Figure 10-11. Program vs. Site-Specific Average Benzene Concentrations

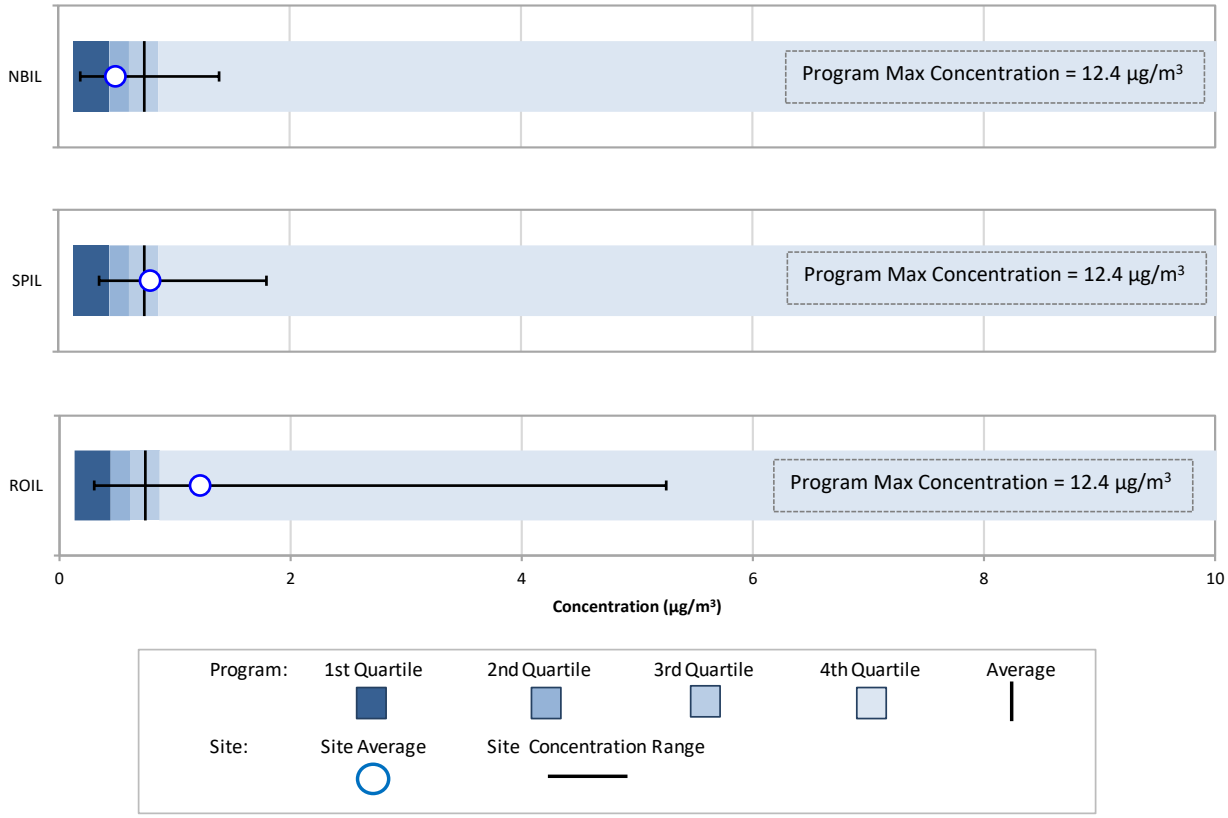


Figure 10-11 presents the box plots for benzene for all three sites and shows the following:

- Similar to the box plot for acenaphthene, the program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plots as the scale has been reduced to allow for the observation of data points at the lower end of the concentration range.

- The range of concentrations measured at these sites is smallest for NBIL and largest for ROIL. Benzene concentrations greater than 2 µg/m^3 were not measured at NBIL or SPIL while several were measured at ROIL.

- NBIL's annual average benzene concentration is less than the program-level median concentration and is the fourth lowest among NMP sites sampling this pollutant. SPIL's annual average benzene concentration is just greater than the program-level average concentration while ROIL's annual average is greater than the program-level average concentration and third quartile. Among NMP sites sampling benzene, ROIL's annual average concentration ranks second.

Figure 10-12. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

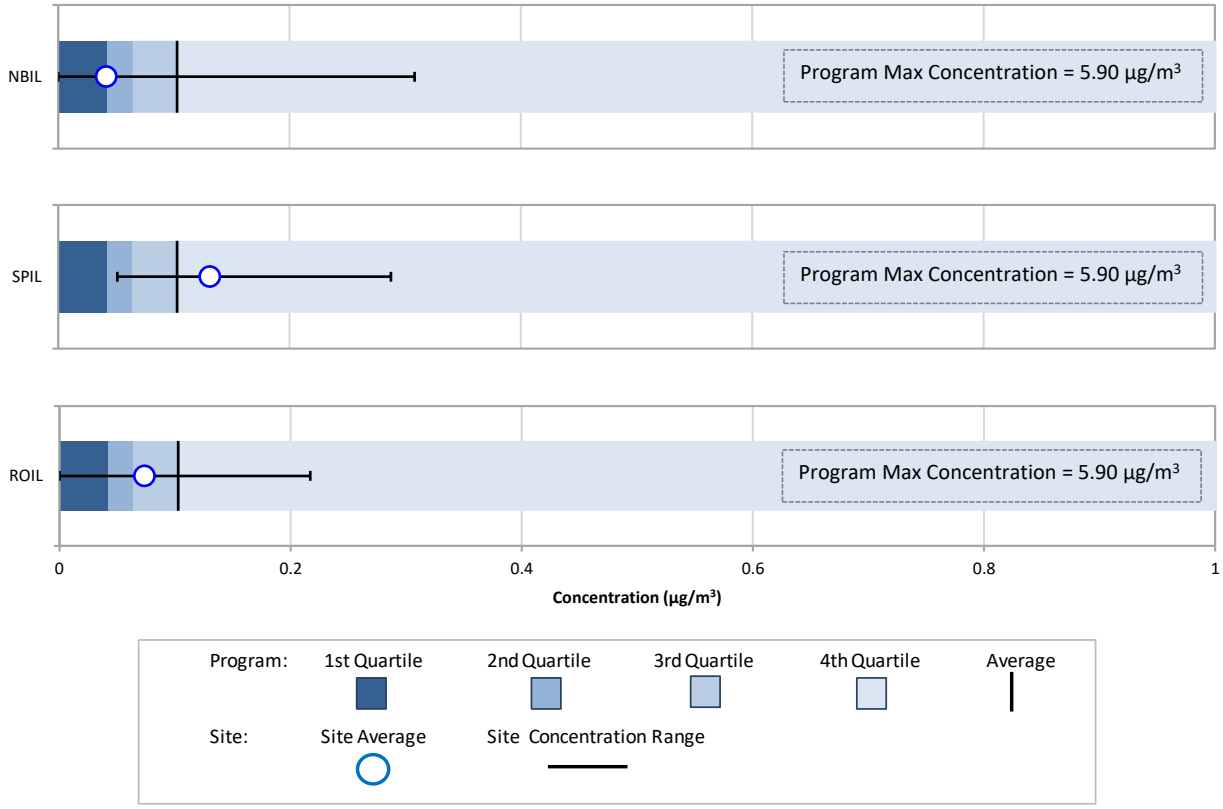


Figure 10-12 presents the box plots for 1,3-butadiene for all three sites and shows the following:

- The program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plots as the scale has been reduced to 1.0 µg/m^3 to allow for the observation of data points at the lower end of the concentration range.

- The range of 1,3-butadiene concentrations is largest for NBIL and smallest for ROIL. While non-detects of this pollutant were measured at NBIL and ROIL, the minimum concentration measured at SPIL is greater than the program-level first quartile.

- The annual average concentration of 1,3-butadiene for NBIL is similar to the program-level first quartile; ROIL's annual average concentration just greater than the program-level median concentration; and SPIL's annual average is greater than the program-level average concentration and third quartile.

Figure 10-13. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

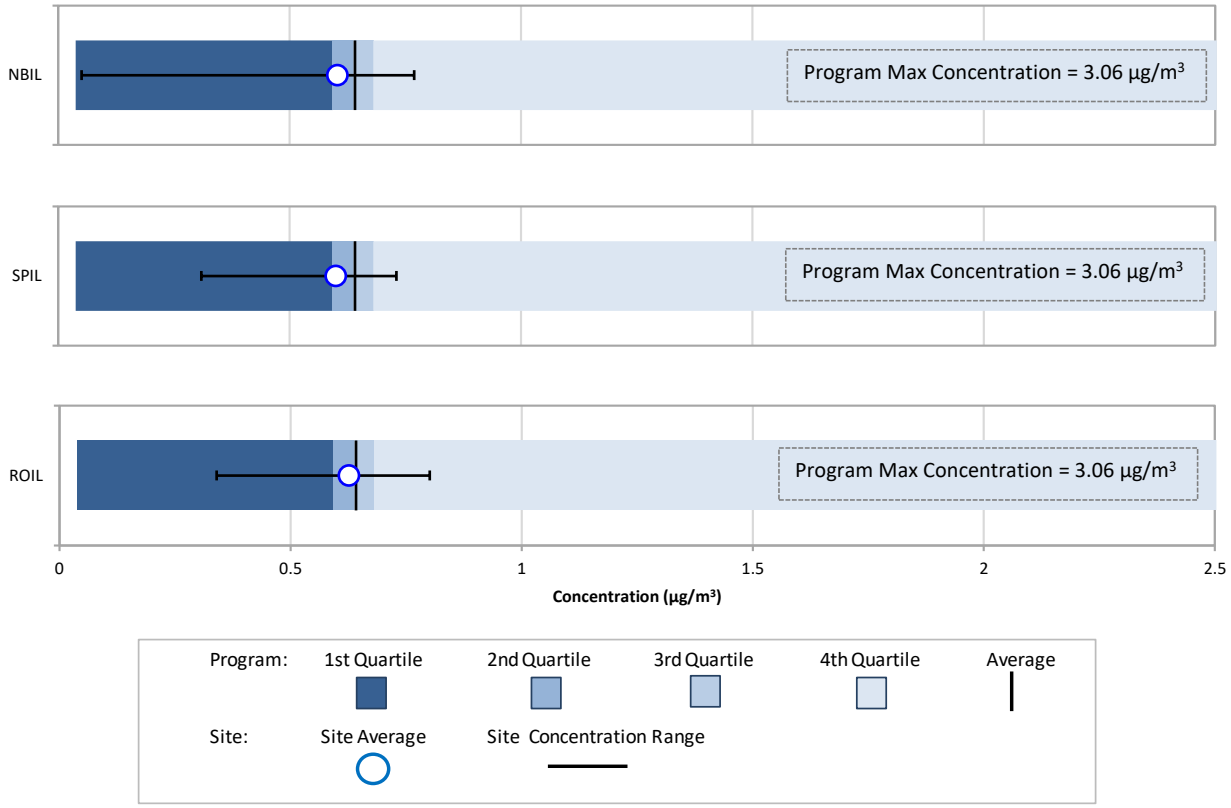


Figure 10-13 presents the box plots for carbon tetrachloride for all three sites and shows the following:

- The scale of these box plots have also been reduced to allow for the observation of data points at the lower end of the concentration range.

- The maximum carbon tetrachloride concentrations measured at the Illinois sites are relatively similar and considerably less than the program-level maximum concentration. The minimum concentrations measured at ROIL and SPIL are fairly similar to each other while the minimum concentration measured at NBIL is an order of magnitude less (and the second lowest concentration of this pollutant across the program).

- The annual average carbon tetrachloride concentrations for these three sites fall between the program-level median and average concentrations, with the annual average for ROIL just slightly greater than the annual averages for NBIL and SPIL.

Figure 10-14. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

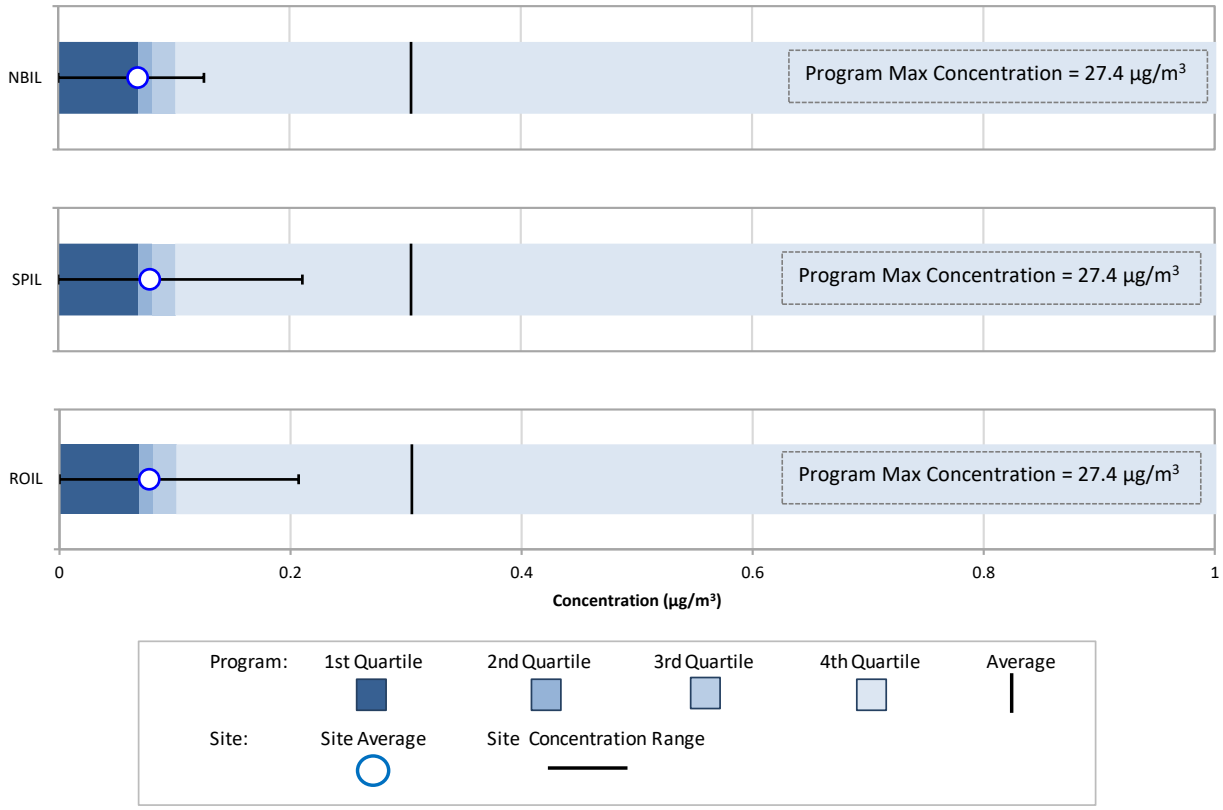


Figure 10-14 presents the box plots for 1,2-dichloroethane for all three sites and shows the following:

- The scale of the box plots for 1,2-dichloroethane has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements. This is another example of measurements at the upper end of the concentration range driving the program-level average concentration, as the program-level average is three times the program-level third quartile.

- All of the concentrations of 1,2-dichloroethane measured at the Illinois sites are less than the program-level average concentration of 0.31 µg/m^3.

- The annual average concentrations for SPIL and ROIL are similar to each other, and both are just less than the program-level median concentration, with NBIL's annual average concentration similar to the program-level first quartile.

Figure 10-15. Program vs. Site-Specific Average Ethylbenzene Concentration

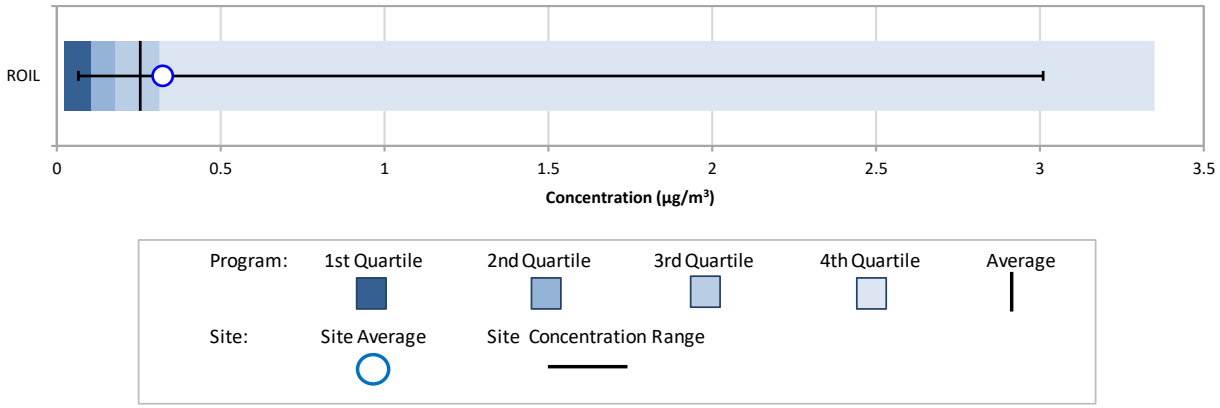


Figure 10-15 presents the box plot for ethylbenzene for ROIL and shows the following:

- ROIL is the only Illinois site for which ethylbenzene is a pollutant of interest.
- The second highest ethylbenzene concentration measured across the program was measured at ROIL (3.01 µg/m^3). However, the next highest concentration measured at ROIL is considerably less (0.835 µg/m^3) and only one other ethylbenzene concentration is greater than 0.5 µg/m^3.
- The annual average concentration of ethylbenzene for ROIL is greater than the program-level average concentration and just greater than the program-level third quartile.

Figure 10-16. Program vs. Site-Specific Average Fluoranthene Concentration

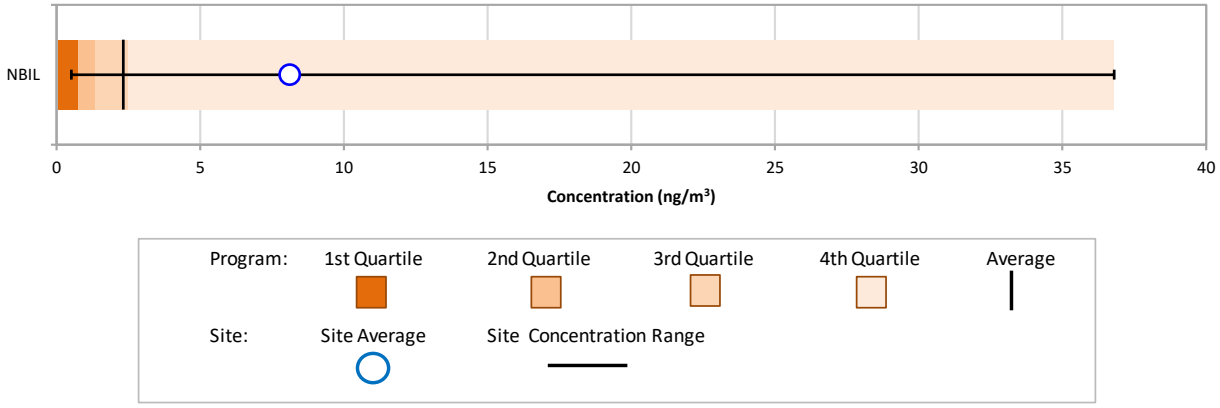


Figure 10-16 presents the box plot for fluoranthene for NBIL and shows the following:

- NBIL is the only Illinois site to sample PAHs under the NMP is 2014.
- The maximum fluoranthene concentration measured at NBIL is the maximum concentration measured across the program, with the six highest fluoranthene concentrations across the program measured at NBIL.

- NBIL's annual average fluoranthene concentration is more than three times the program-level average concentration. More than half of NBIL's fluoranthene measurements are greater than the program-level average concentration.

Figure 10-17. Program vs. Site-Specific Average Fluorene Concentration

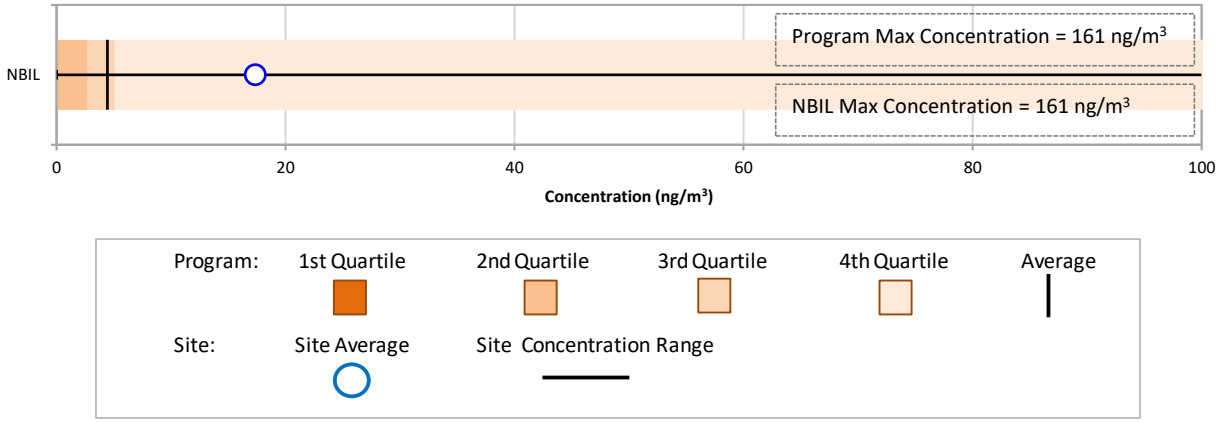


Figure 10-17 presents the box plot for flourene for NBIL and shows the following:

- Fluorene is another PAH pollutant of interest for NBIL. The program-level maximum concentration (161 ng/m^3) of fluorene is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced to 100 ng/m^3. Note that the program-level first quartile is zero and thus, not visible on the box plot.

- The maximum fluorene concentration measured at NBIL is the maximum fluorene concentration measured across the program. Only NBIL and one other NMP site (ROCH) have individual fluorene concentrations greater than 100 ng/m^3. All other fluorene concentrations measured at NBIL are less than 50 ng/m^3.

- NBIL's annual average fluorene concentration is nearly four times the program-level average concentration; more than half of NBIL's fluorene measurements greater than the program-level average concentration.

Figure 10-18. Program vs. Site-Specific Average Formaldehyde Concentrations

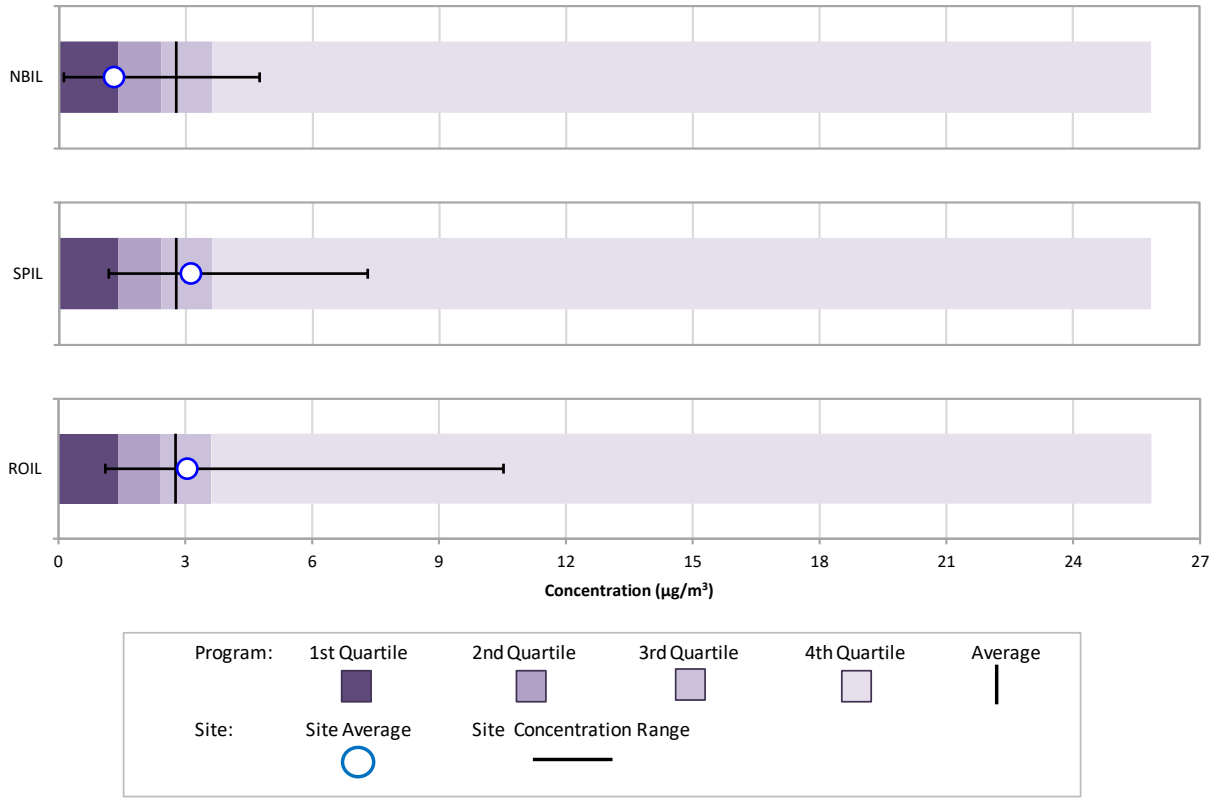


Figure 10-18 presents the box plots for formaldehyde for all three sites and shows the following:

- The range of formaldehyde concentrations measured at these sites is smallest for NBIL and largest for ROIL.

- The annual average concentrations of formaldehyde for SPIL and ROIL are similar to each other and more than twice the annual average concentration for NBIL. The annual average concentrations of formaldehyde for SPIL and ROIL are greater than the program-level average concentration while NBIL's annual average is just less than the program-level first quartile.

- The minimum concentration measured at NBIL is among the lowest measured across the program and is an order of magnitude less than the minimum concentrations for the other two Illinois sites.

Figure 10-19. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

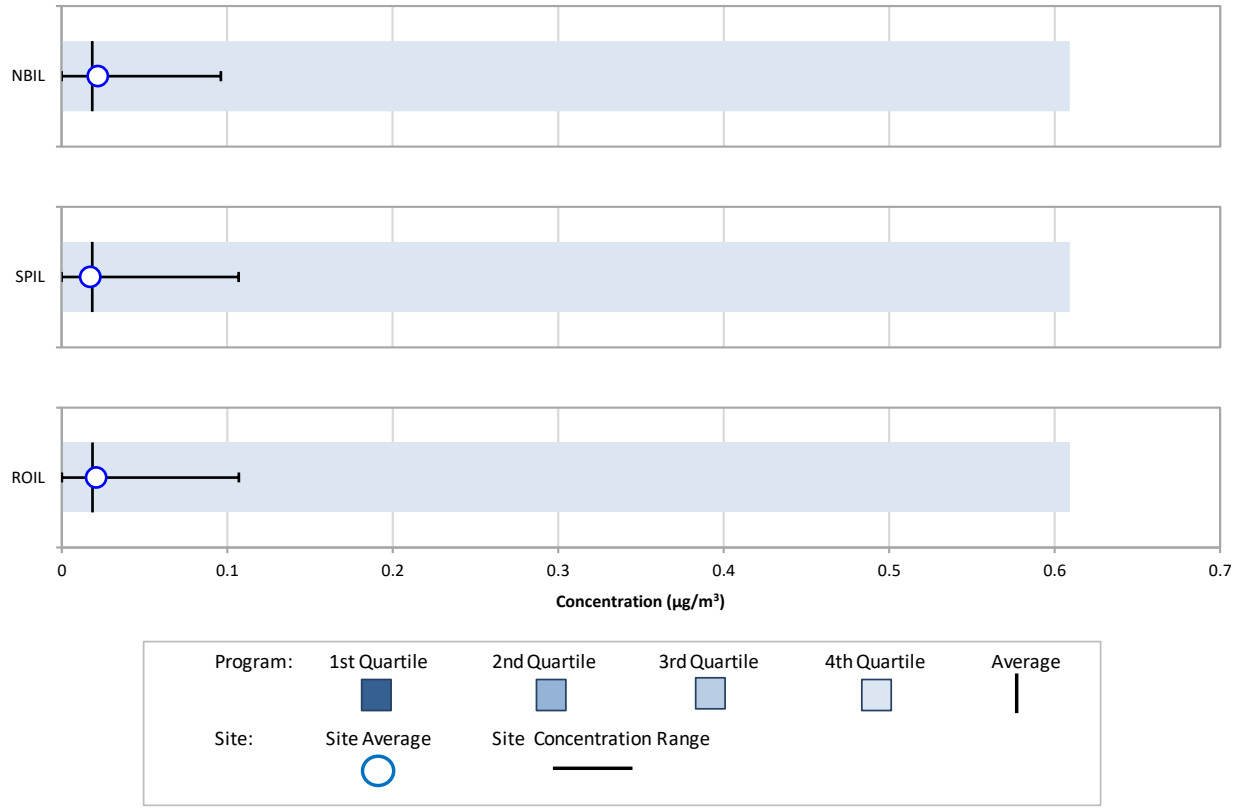


Figure 10-19 presents the box plots for hexachloro-1,3-butadiene for all three sites and shows the following:

- The program-level first, second (median), and third quartiles are all zero and therefore not visible on the box plot. This is due to the large number of non-detects of this pollutant across the program (77 percent).

- Between 55 and 60 valid VOC samples were collected at each of the Illinois sites; of these, fewer than 20 measured detections were measured at each site. Thus, many zeroes are substituted into the annual average concentrations for this pollutant. The range of concentrations measured and the annual average concentrations are fairly similar across the Illinois monitoring sites.

Figure 10-20. Program vs. Site-Specific Average Naphthalene Concentration

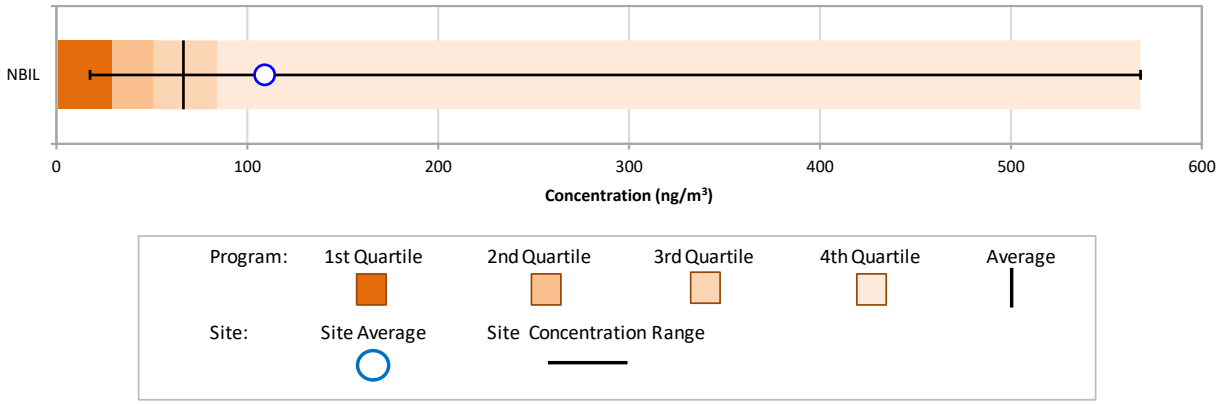


Figure 10-20 presents the box plot for naphthalene for NBIL and shows the following:

- The maximum naphthalene concentration measured at NBIL is the maximum concentration measured across the program. This was also true in 2013. NBIL is the only NMP site at which a naphthalene concentration greater than 400 ng/m^3 was measured.

- NBIL's annual average naphthalene concentration is greater than the program-level average concentration and program-level third quartile. Recall from the previous section that NBIL's annual average is the second highest annual average concentration of naphthalene among NMP sites sampling PAHs in 2014.

Figure 10-21. Program vs. Site-Specific Average Trichloroethylene Concentration

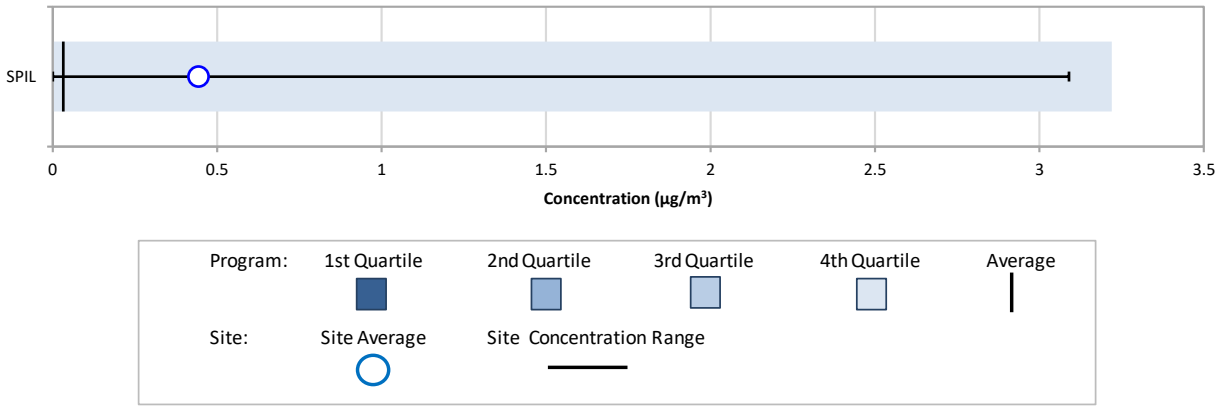


Figure 10-21 presents the box plot for trichloroethylene for SPIL and shows the following:

- SPIL is the only NMP site for which trichloroethylene is a pollutant of interest.

- The first, second, and third quartiles for trichloroethylene are all zero due to the large number of non-detects; thus, only the fourth quartile is visible in Figure 10-21.

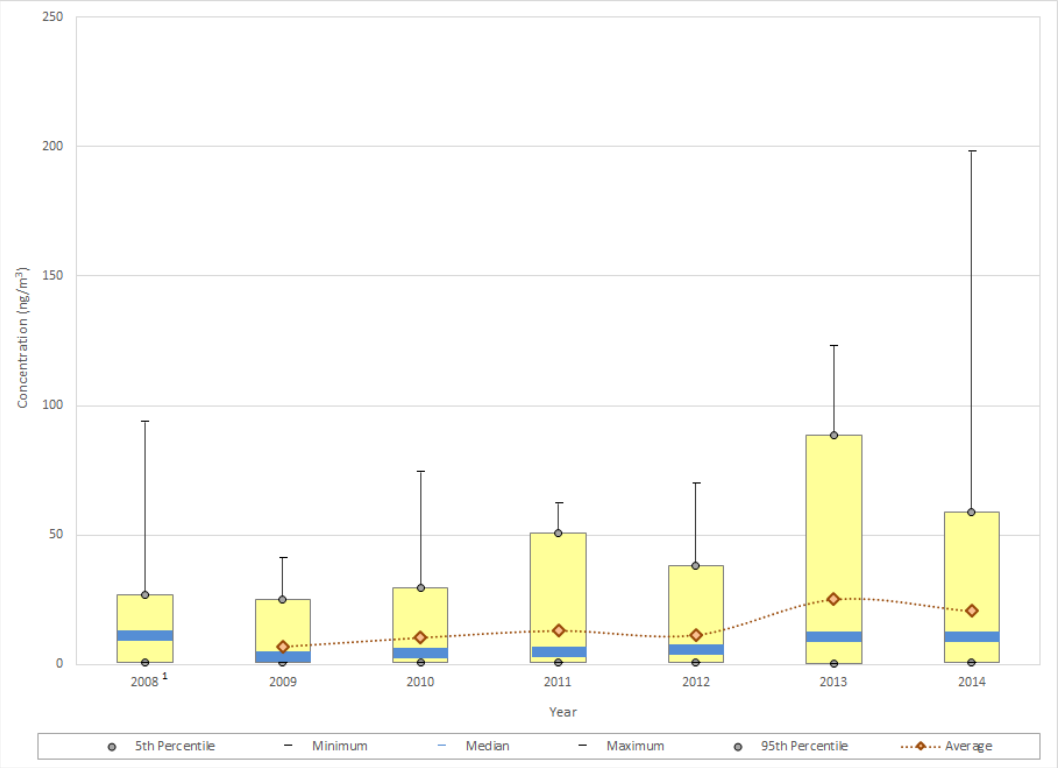
- Although the maximum concentration of trichloroethylene across the program was not measured at SPIL, a concentration of similar magnitude was measured at SPIL. Among NMP sites sampling this pollutant, SPIL has the greatest number of measured detections (49), with the next closest site at 22 (CSNJ). Concentrations measured at SPIL account for nearly half (33) of the trichloroethylene measurements greater than 0.1 $\mu g/m^3$ measured across the program (75).

- The annual average concentration for SPIL (0.44 $\mu g/m^3$) is considerably higher than the program-level average concentration (0.032 $\mu g/m^3$).

10.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. NBIL and SPIL have both sampled VOCs under the NMP since 2003. Both sites have also sampled carbonyl compounds since 2005. NBIL has also sampled PM_{10} metals since 2005 and began sampling PAHs under the NMP in 2008. Thus, Figures 10-22 through 10-41 present the 1-year statistical metrics for each of the pollutants of interest first for NBIL, then for SPIL. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. Because sampling at ROIL began in 2012, a trends analysis was not performed.

Figure 10-22. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 10-22 for acenaphthene concentrations measured at NBIL include the following:

- Although PAH sampling under the NMP began at NBIL in 2008, sampling did not begin until June; because a full year's worth of data is not available for 2008, a 1-year average is not presented, although the range of measurements is provided.

- The maximum acenaphthene concentration was measured at NBIL on August 9, 2014 (198 ng/m^3), with two additional acenaphthene concentrations greater than 100 ng/m^3 measured at NBIL in 2013. Five of the seven acenaphthene concentrations greater than 75 ng/m^3 were measured at NBIL in 2013.

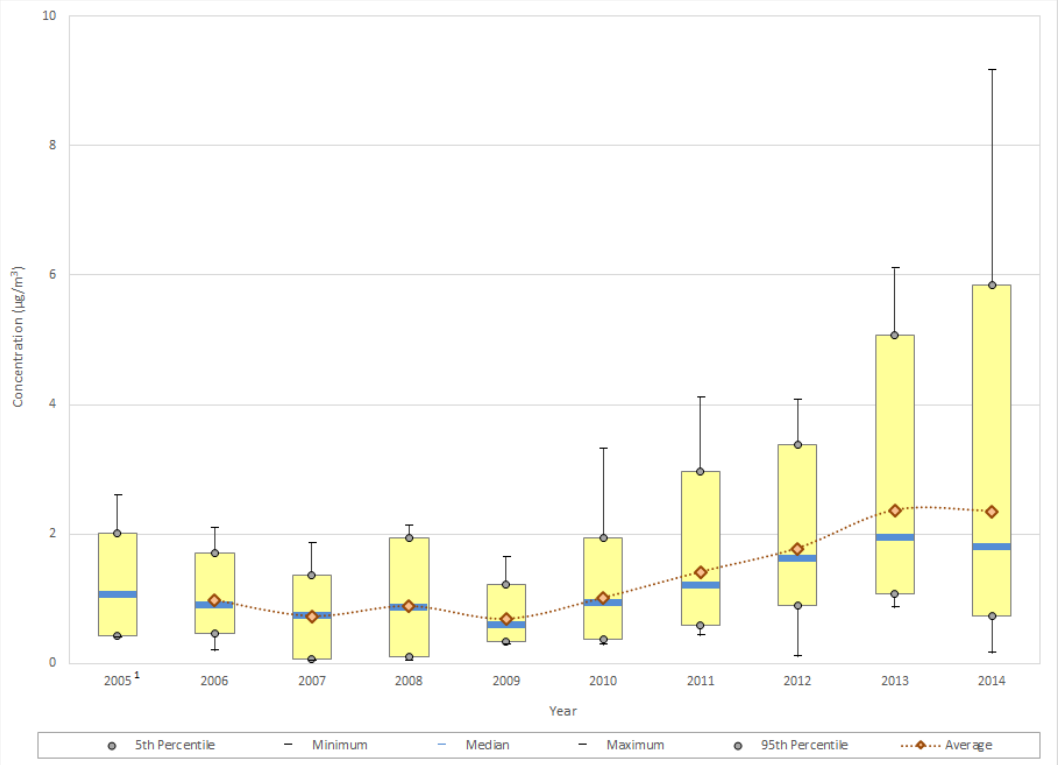
- The median concentration decreased significantly from 2008 to 2009. This is because there are a greater number of concentrations at the lower end of the concentration range in 2009. Recall, however, that 2008 does not include a full year's worth of sampling. The median concentration increases steadily between 2009 and 2012, after which the median doubles for 2013, and changes little for 2014.

- The 1-year average concentration increases between 2009 and 2011, nearly doubling over this time frame. However, confidence intervals calculated for these averages indicate that the increase is not statistically significant due to the relatively large amount of variability in the measurements. The 1-year average decreased slightly for 2012, although the median continued to increase. For 2013, the 1-year average concentration more than doubled, with similar increases for the median, 95th

percentile, and maximum concentration. Five acenaphthene concentrations measured in 2013 are greater than the maximum concentrations measured in 2012. Also, the number of acenaphthene concentrations greater than 50 ng/m^3 measured at NBIL increased from one in 2012 to 11 in 2013, with no more than four measured in any of the previous years.

- Even though the maximum concentration measured approached 200 ng/m^3 in 2014, the 95th percentile decreased considerably and the 1-year average exhibits a decrease as well. Yet the median concentration exhibits little change, indicating that the changes shown are due to the measurements at the upper end of the concentration range, as mentioned in previous bullets.

Figure 10-23. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2005.

Observations from Figure 10-23 for acetaldehyde concentrations measured at NBIL include the following:

- Carbonyl compound sampling at NBIL under the NMP began in March 2005; because a full year's worth of data is not available for 2005, a 1-year average concentration is not presented, although the range of measurements is provided.

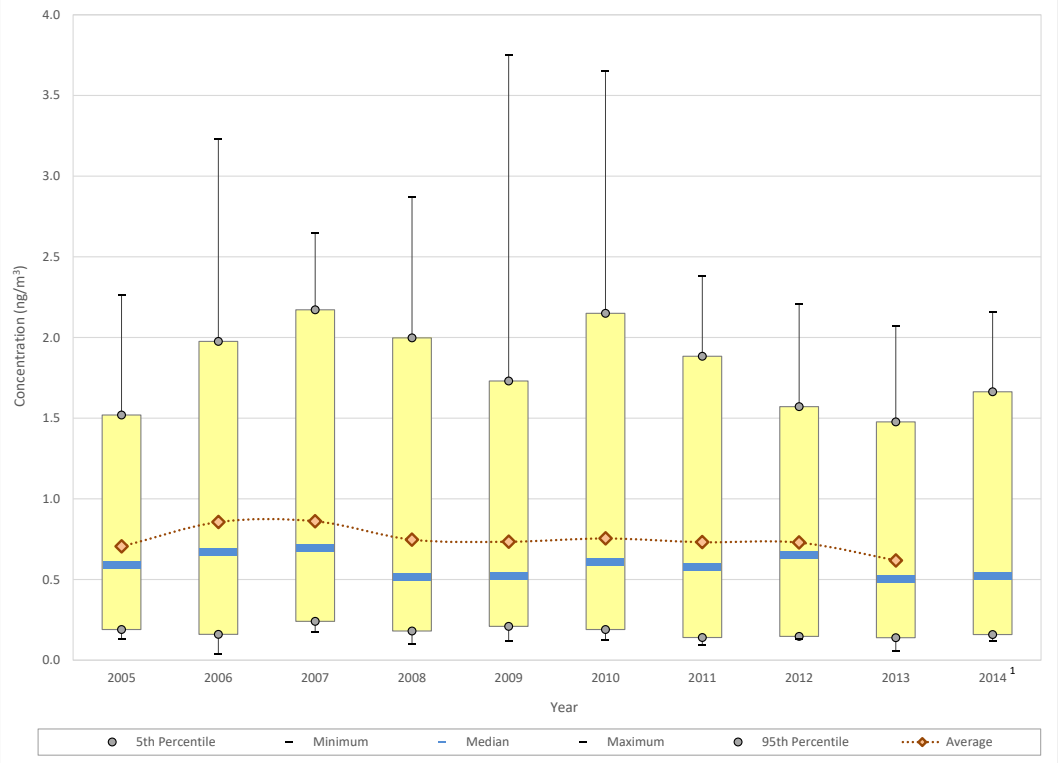
- The maximum acetaldehyde concentration measured at NBIL (9.17 µg/m^3) was measured in 2014, along with four of the five highest concentrations since the onset of sampling. The 14 highest acetaldehyde concentrations were measured in 2013 and 2014 and all 40 acetaldehyde concentrations greater than 3 µg/m^3 measured at NBIL

were measured after 2009 (one in 2010, three in 2011, six in 2012, and 15 were measured in 2013 and again in 2014).

- Prior to 2010, the 1-year average concentrations were all less than 1 µg/m^3, fluctuating between 0.69 µg/m^3 (2009) and 0.98 µg/m^3 (2006). After 2009, acetaldehyde concentrations measured at NBIL increase significantly as nearly all of the statistical metrics exhibit an increase from 2009 to 2010 and again for each year afterward. The 1-year average concentration for 2013 is greater than the maximum concentrations measured for several of the early years of sampling and the 5th percentile for 2013 is greater than the 1-year average concentrations for each of the earlier years of sampling. The increase in the 1-year average concentration of acetaldehyde between 2009 and 2013 represents a 243 percent increase.

- The range of acetaldehyde concentrations measured at NBIL expanded in 2014. Two acetaldehyde concentrations greater than the maximum concentration for 2013 were measured in 2014 while seven concentrations less than the minimum concentration for 2013 were measured in 2014. Yet, little difference is shown in the 1-year average concentration between these two years. The median concentration decreased slightly for 2014, but is still greater than the 1-year average and median concentrations shown for all years prior to 2013.

Figure 10-24. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at NBIL



[1] A 1-year average is not presented because the criteria for an annual average was not met in 2014.

Observations from Figure 10-24 for arsenic (PM_{10}) concentrations measured at NBIL include the following:

- Metals sampling under the NMP began at NBIL in January 2005.

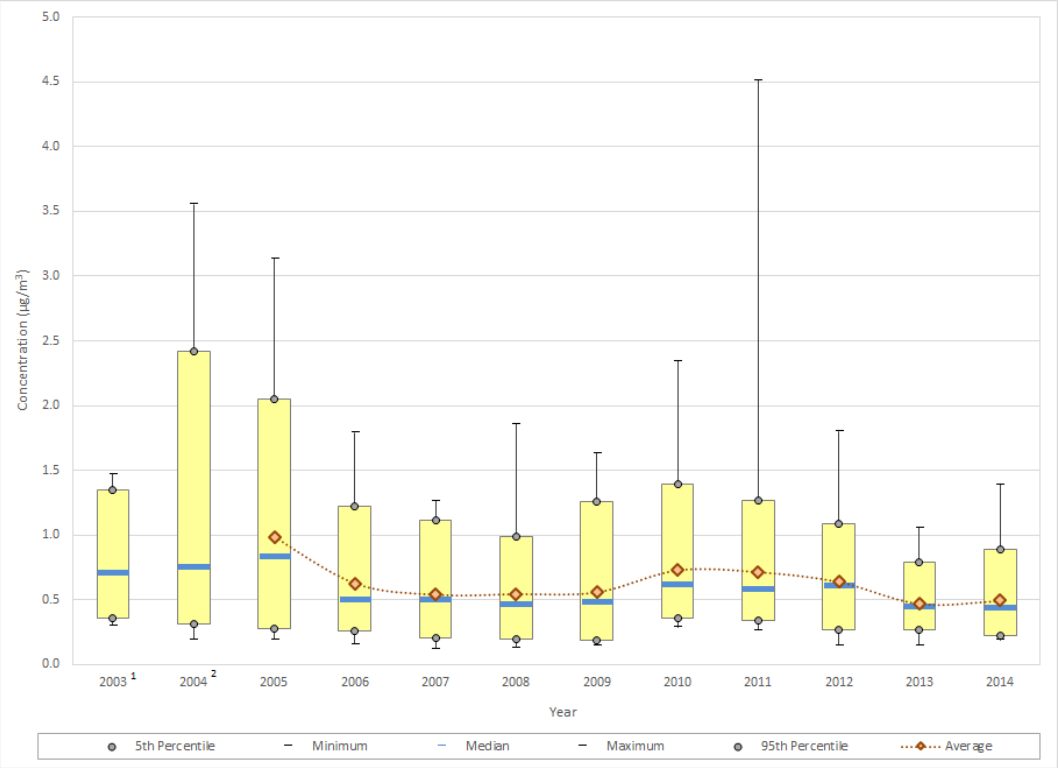
- The maximum arsenic concentration was measured at NBIL on July 12, 2009, although a similar concentration was also measured in 2010. Only four concentrations greater than 3 ng/m^3 have been measured at NBIL (one in 2006, one in 2009, and two in 2010).

- Although the statistical parameters representing the upper end of the concentration range have fluctuated somewhat each year, the 1-year average concentrations exhibit relatively little significant change over the course of sampling. The 1-year average concentration increased from 2005 to 2006, changed little for 2007, decreased slightly for 2008, after which the 1-year average concentration remained steady through 2012, hovering around 0.75 ng/m^3.

- Most of the statistical parameters are at a minimum for 2013, with the 1-year average concentration (0.62 ng/m^3) at its lowest since the first year of sampling.

- Slight increases in the statistical parameters presented are shown for 2014, although a 1-year average concentration is not provided because a number of metals samples were invalid during the first and second quarters of 2014, and the criteria for an annual average to be calculated was not met.

Figure 10-25. Yearly Statistical Metrics for Benzene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 until late December 2004.

Observations from Figure 10-25 for benzene concentrations measured at NBIL include the following:

- Although sampling for VOCs at NBIL began in 2003, sampling under the NMP did not begin until April; because a full year's worth of data is not available for 2003, a 1-year average is not presented, although the range of measurements is provided. In addition, sampling for VOCs was discontinued in October 2004 through the end of the year. Thus, a 1-year average is not presented for 2004 either.

- The maximum benzene concentration (4.51 µg/m^3) was measured on January 9, 2011 and is the only benzene measurement greater than 4 µg/m^3 measured at NBIL. Three additional benzene concentrations greater than 3 µg/m^3 were measured in 2004 and 2005 and most of the measurements greater than 2 µg/m^3 were measured in 2004.

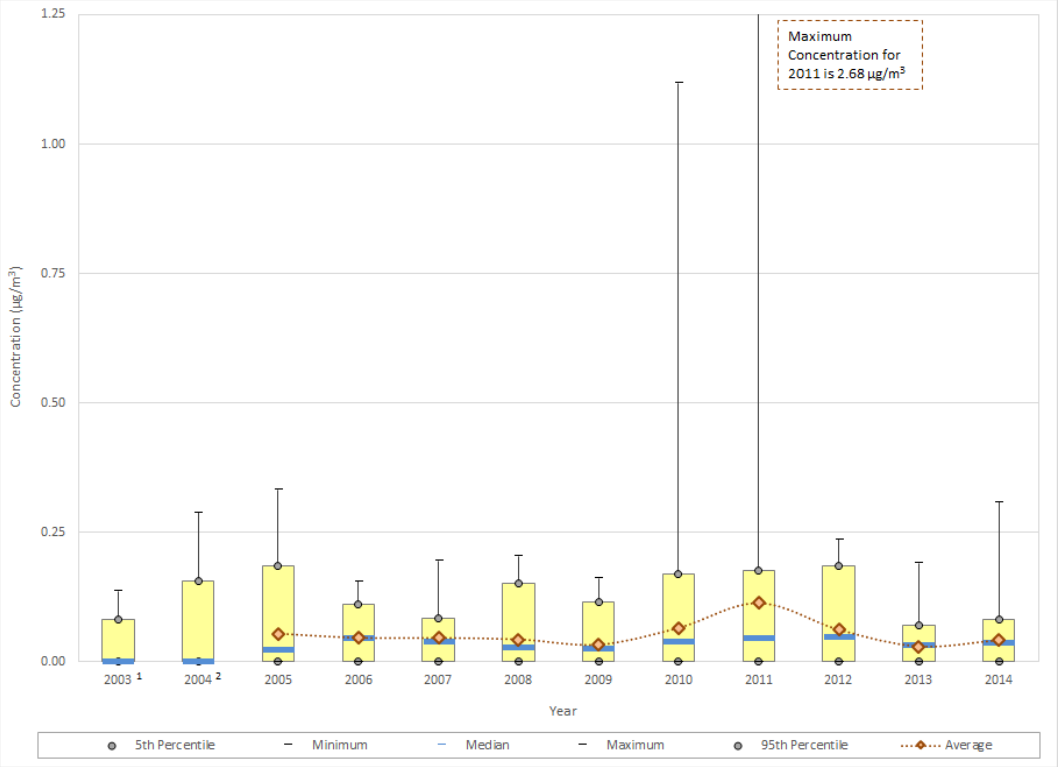
- A decreasing trend in the concentrations of benzene is shown through 2007, as the 1-year average concentration decreased significantly from 2005 to 2006, with slight decreases for 2007, after which the 1-year average remained steady through 2009.

- All of the statistical parameters exhibit increases from 2009 to 2010. Although the maximum concentration nearly doubled from 2010 to 2011, the rest of the statistical parameters decreased for 2011. This decreasing continued into 2012 (although the median concentration actually increased slightly) and 2013. Several of the statistical

parameters are at a minimum for 2013, which is the first year the 1-year average concentration is less than 0.5 µg/m^3.

- Although a few additional higher benzene concentrations were measured in 2014 compared to 2013, relatively little change in the statistical parameters is shown for 2014, with the 1-year average concentration still less than 0.5 µg/m^3.

Figure 10-26. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 until late December 2004.

Observations from Figure 10-26 for 1,3-butadiene concentrations measured at NBIL include the following:

- The maximum 1,3-butadiene concentration was measured on the same day as the maximum benzene concentration, January 9, 2011 (2.68 µg/m^3). Only three 1,3-butadiene concentrations greater than 1 µg/m^3 have been measured at NBIL (two in 2011 and one in 2010). All other concentrations of 1,3-butadiene measured at NBIL are less than 0.35 µg/m^3.

- For each year shown, the minimum and 5th percentile are zero, indicating the presence of non-detects (at least 5 percent of the measurements). For the first 2 years of sampling, the median concentration is also zero, indicating that at least half of the measurements were non-detects. The percentage of non-detects reported has fluctuated over the years of sampling, from as high as 88 percent (2004) to as low as 7 percent (2007), although the percentage of non-detects has been increasing slightly

each year since, reaching 38 percent of measurements for 2013. This percentage decreased somewhat for 2014 (23 percent).

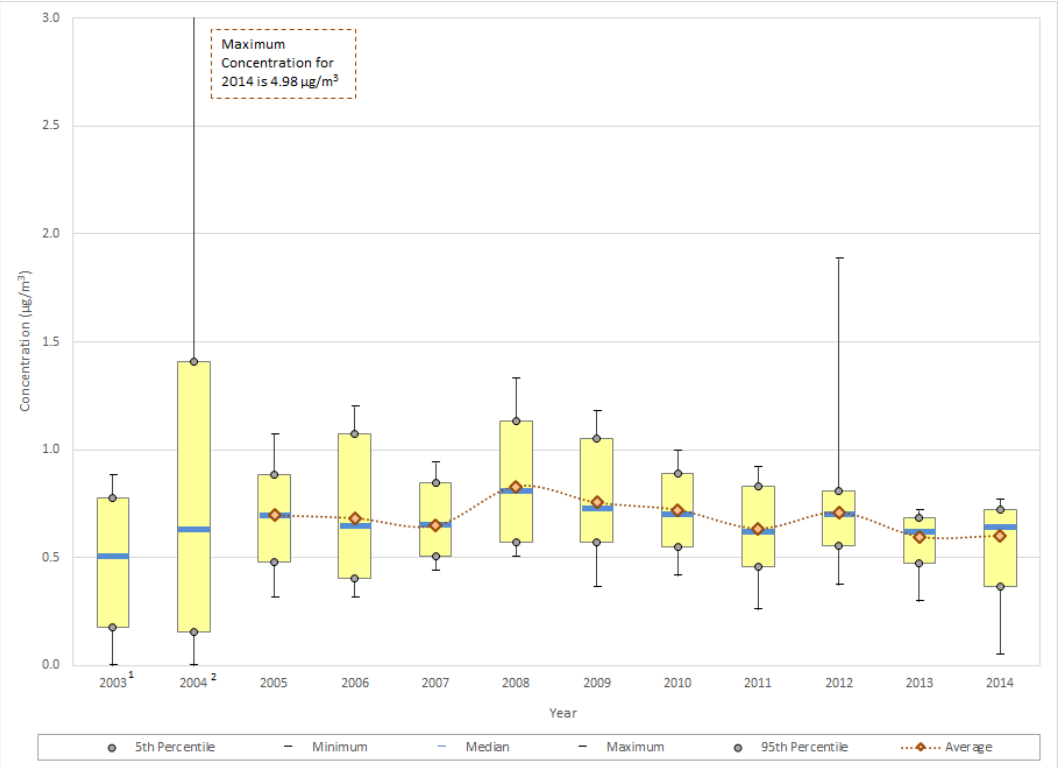
- The 1-year average concentration decreased slightly between 2005 and 2009, although the changes are not significant. From 2009 to 2010, the 1-year average doubled, and then nearly doubled again for 2011. However, there is a significant amount of variability associated with these measurements, based on the confidence intervals. Even with the relatively high concentrations measured in 2010 and 2011, the 95th percentile changed only slightly, indicating that the majority of the measurements were within the same range. If the three outlier concentrations measured in 2010 and 2011 were excluded from the calculations, the 1-year average concentrations for these years would still be greater than the 1-year average for 2009, but they would be similar to the averages shown for years prior.

- Excluding the two years with outliers, the 1-year average and median concentrations are highest for 2012. Although the range of concentrations measured is similar to other years, 2012 has the highest number of 1,3-butadiene concentrations (13) greater than 0.1 $\mu g/m^3$ than any other year of sampling.

- The range within which the majority of concentrations fall, as determined by the 5th and 95th percentiles, is at a minimum for 2013, as is the 1-year average concentration, which decreased significantly from 2012 to 2013.

- Slight increases are shown for most of the statistical parameters from 2013 to 2014, although the majority of concentrations fell within the second smallest range since 2005, the first year with a full year's worth of samples.

Figure 10-27. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 until late December 2004.

Observations from Figure 10-27 for carbon tetrachloride concentrations measured at NBIL include the following:

- The maximum concentration of carbon tetrachloride was measured in 2004 (4.98 µg/m^3). Only one additional measurement greater than 1.5 µg/m^3 has been measured at NBIL (1.88 µg/m^3 in 2012).

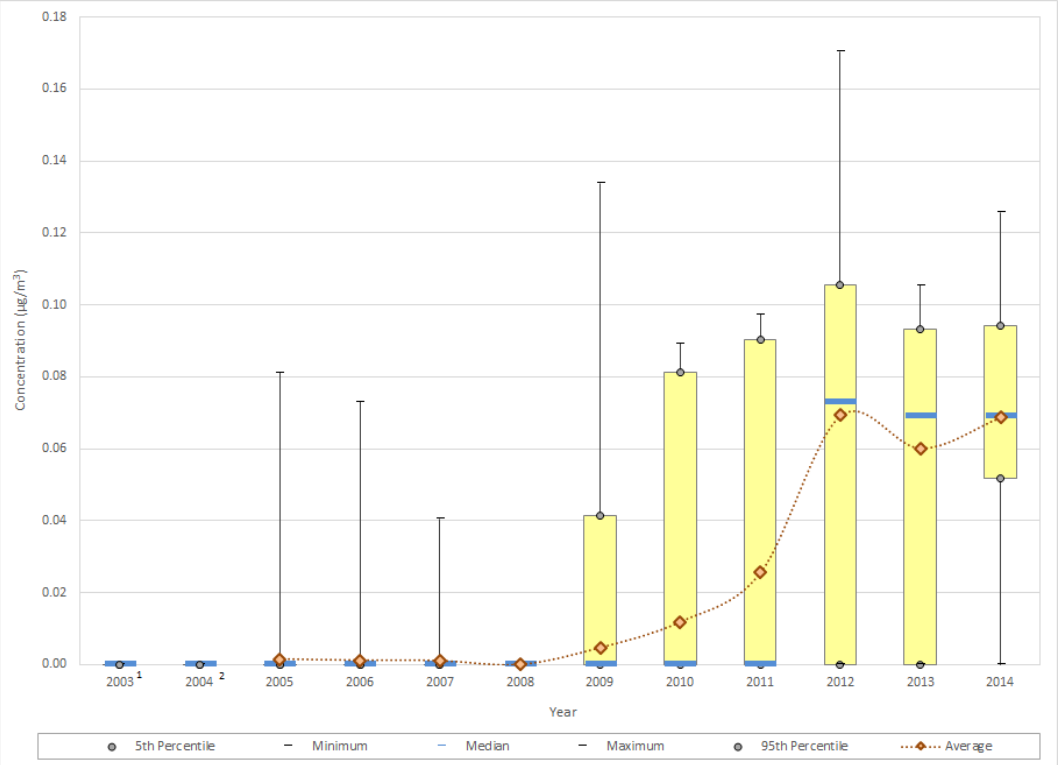
- Five non-detects of carbon tetrachloride have been measured at NBIL. All of these were measured during the first 2 years of sampling (two in 2003 and three in 2004).

- The statistical parameters for 2003 and 2004 have a different appearance than the parameters shown for the years afterward, particularly for 2004, when the range of measurements is at its largest and several non-detects were measured.

- After decreasing slightly between 2005 and 2007, the 1-year average concentration increased significantly for 2008. The 1-year average concentration exhibits a significant decreasing trend after 2008 that continued through 2011, when the 1-year average returned to 2007 levels. After exhibiting an increase for 2012, the 1-year average concentration is at a minimum for 2013 (0.60 µg/m^3), with a negligible change for 2014. The 1-year average concentrations presented range from 0.60 µg/m^3

(2013 and 2014) to 0.83 µg/m^3 (2008). The median concentration exhibits a similar pattern.

Figure 10-28. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 until late December 2004.

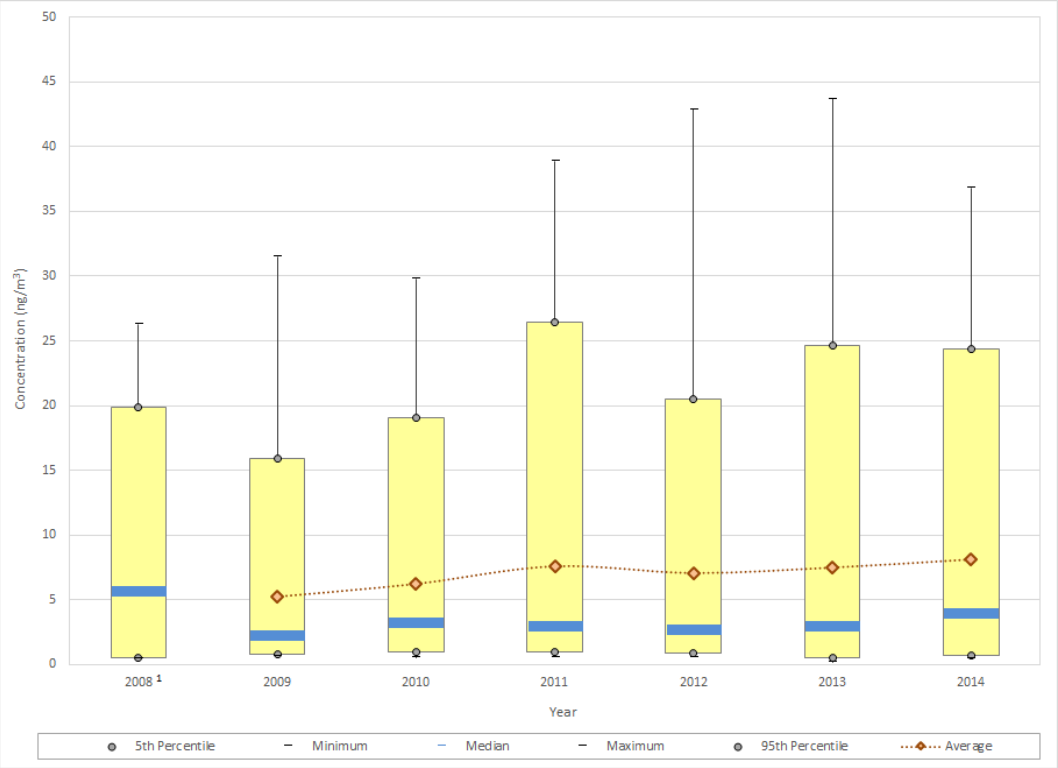
Observations from Figure 10-28 for 1,2-dichloroethane concentrations measured at NBIL include the following:

- There were no measured detections of 1,2-dichloroethane in 2003, 2004, or 2008. The number of non-detects between 2005 and 2007 was greater than 95 percent. Thus, the minimum, 5th percentile, median, and in some cases the 1-year average concentrations, were zero between 2003 and 2008. The median concentration is zero through 2011, indicating that at least half of the measurements are non-detects.

- The number of non-detects began to decrease starting with 2009 and continued through 2012. The median concentration is greater than zero for the first time for 2012 and is also greater than the 1-year average concentration. This is because the eight non-detects (or zeros) factored into the 1-year average concentration are pulling the average down (in the same manner that a maximum or outlier concentration can drive the average up) but are not contributing to the majority of measurements for the first time. This is also true for 2013, although the number of non-detects increased slightly (10).

- The 5th percentile is greater than zero for the first time for 2014, when only two non-detects of 1,2-dichloroethane were measured at NBIL.

Figure 10-29. Yearly Statistical Metrics for Fluoranthene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

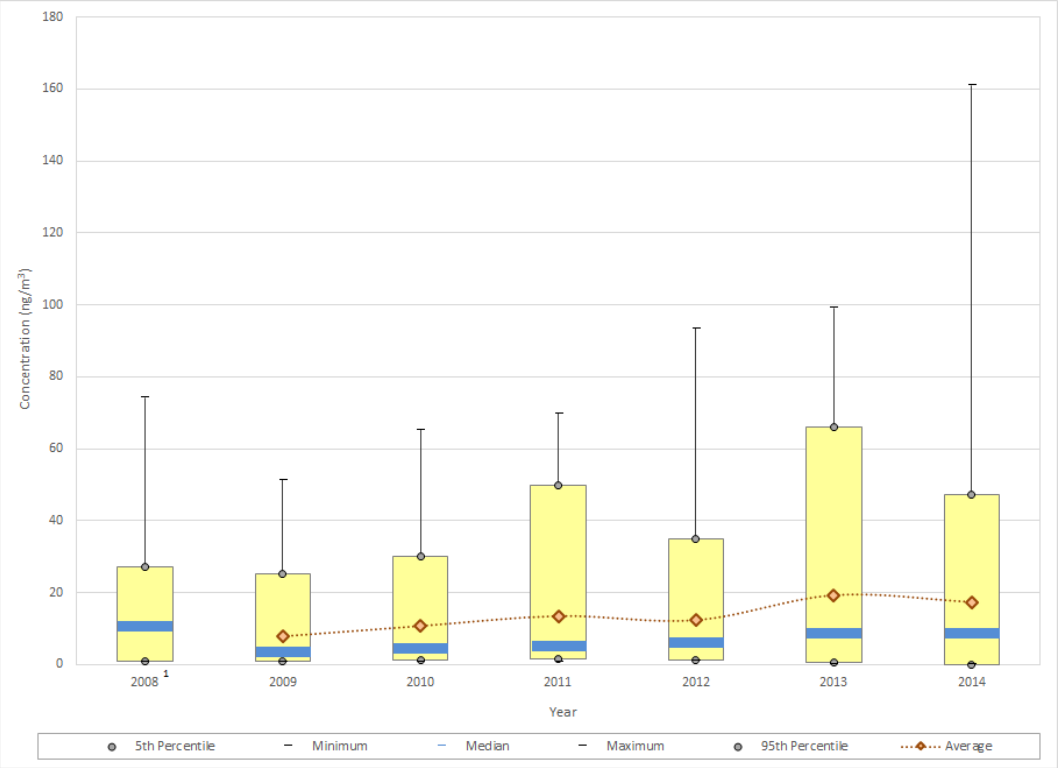
Observations from Figure 10-29 for fluoranthene concentrations measured at NBIL include the following:

- The maximum fluoranthene concentration was measured at NBIL on July 21, 2013 (43.7 ng/m^3), although a similar concentration was also measured earlier in July as well as in 2012, also in July. The maximum fluoranthene concentration measured each year from 2011 forward were all measured during the first week of July.

- The median concentration decreased by more than half from 2008 to 2009. This is because there is a greater number of fluoranthene concentrations at the lower end of the concentration range for 2009. The number of measurements less than 2 ng/m^3 tripled from 2008 to 2009, increasing from nine in 2008 to 27 in 2009. Recall, however, that 2008 does not include a full year's worth of sampling. The median fluoranthene concentrations shown after 2009 vary little.

- The 1-year average concentration of fluoranthene increases between 2009 and 2011, decreases slightly for 2012, then increases slightly for 2013 and 2014. Both the 1-year average and median concentrations are at a maximum for 2014.However, confidence intervals calculated for these averages indicate that the changes are not statistically significant due to the relatively large amount of variability in the measurements.

Figure 10-30. Yearly Statistical Metrics for Fluorene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 10-30 for fluorene concentrations measured at NBIL include the following:

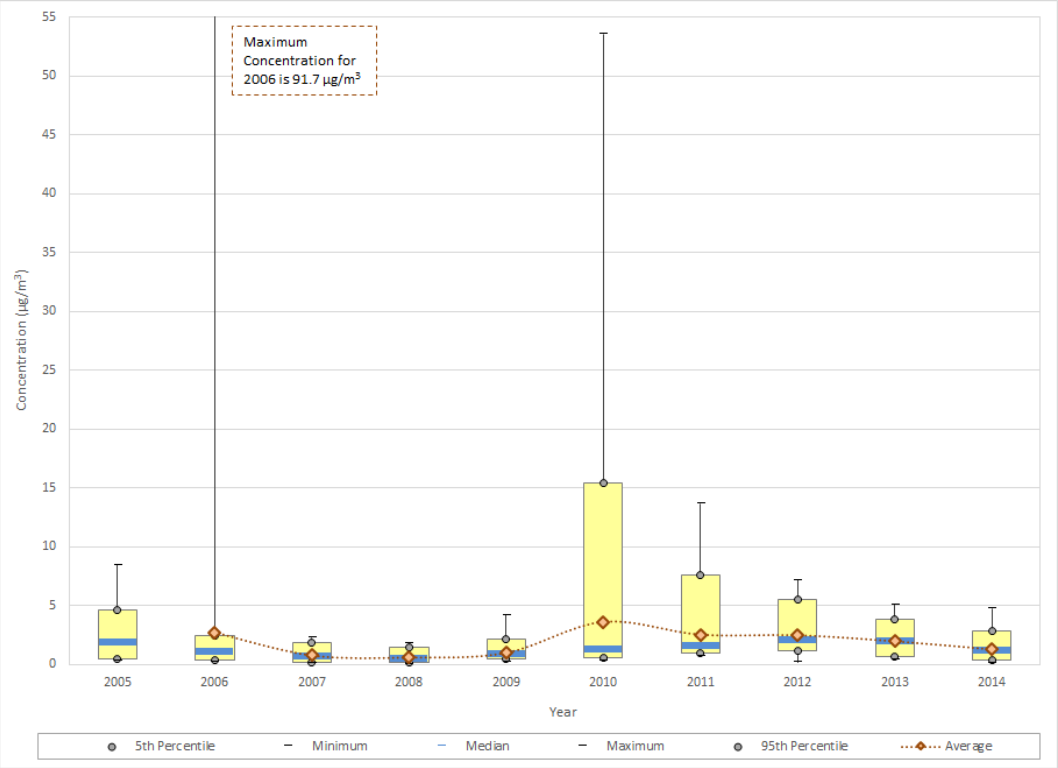
- The statistical patterns for fluorene resemble the statistical patterns shown on the trends graph for acenaphthene and, to a lesser extent, fluoranthene.

- The median concentration of fluorene also decreased significantly from 2008 to 2009 due to the number of fluorene concentrations at the lower end of the concentration range for 2009. The number of measurements less than 3 ng/m^3 increased three-fold from 2008 to 2009, increasing from eight in 2008 to 29 in 2009. Recall, however, that 2008 does not include a full year's worth of sampling. A steady increase in the median concentration is shown after 2009.

- Like acenaphthene, the 1-year average concentration of fluorene increases between 2009 and 2011, then decreases slightly for 2012. The 1-year average concentration then increases considerably for 2013, after which a slight decrease is exhibited for 2014. Confidence intervals calculated for these averages indicate that there is a relatively large amount of variability in these measurements. The range of fluorene measurements spans two orders of magnitude for each year. For example, the minimum and maximum concentrations for 2012 are 0.93 ng/m^3 and 93.4 ng/m^3, respectively.

- The maximum concentration of fluorene measured at NBIL has increased each year since 2009, more than doubling in magnitude, and exceeding 100 ng/m^3 in 2014.

Figure 10-31. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2005.

Observations from Figure 10-31 for formaldehyde concentrations measured at NBIL include the following:

- The maximum formaldehyde concentration was measured on January 5, 2006 (91.7 µg/m^3). The next five highest concentrations, ranging from 14.4 µg/m^3 to 53.5 µg/m^3, were all measured in 2010. The only other formaldehyde concentration greater than 10 µg/m^3 was measured in 2011 (13.7 µg/m^3).

- The maximum concentration measured in 2006 is 20 times higher than the next highest concentration measured that year (4.46 µg/m^3). The magnitude of this outlier explains why the 1-year average concentration is greater than the 95th percentile for 2006.

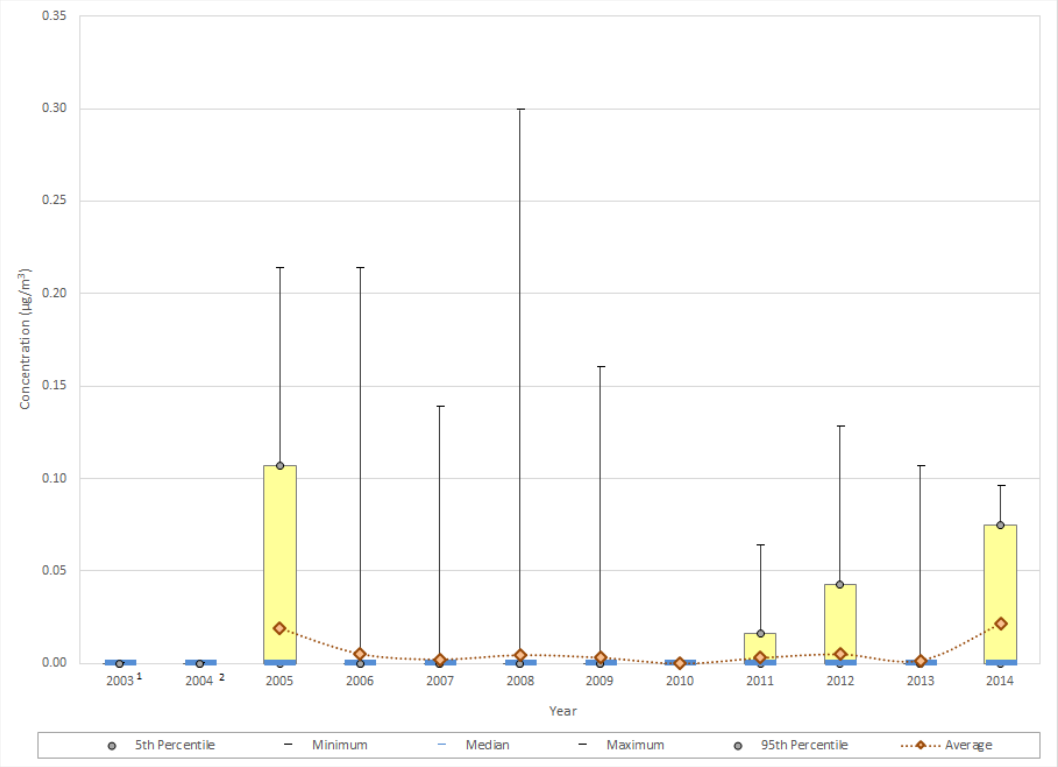
- The statistical metrics for 2010 are also affected by the higher concentrations; however, concentrations measured this year are higher overall, as indicated by seven-fold increase in the 95th percentile. Although difficult to discern in Figure 10-31, the 1-year average concentration more than tripled from 2009 to 2010 and the median increased by 50 percent. The concentrations measured in 2011 were less than those measured in 2010, although still greater than most years.

- Although the maximum concentration measured in 2012 is less than the 95th percentile for 2011, the 1-year average concentration did not change significantly for 2012 and the median concentration increased. This is because the number of concentrations in the middle of the concentration range increased. The number of

measurements between 2 µg/m^3 and 4 µg/m^3 nearly doubled from 2011 (15) to 2012 (29).

- The range of formaldehyde concentrations measured at NBIL after 2010 has a decreasing trend and, for 2014, is at its smallest in five years. There is a significant decrease in the 1-year average concentrations between 2010 and 2014, although the 1-year averages prior to 2010 are still lower.

Figure 10-32. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 until late December 2004.

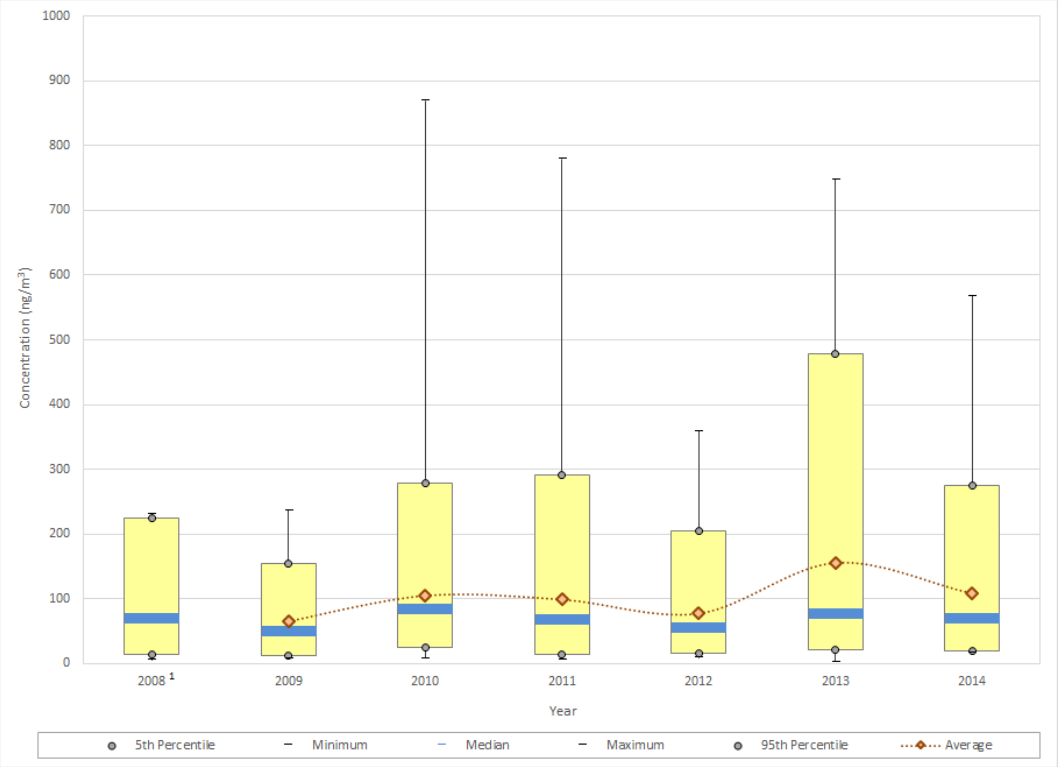
Observations from Figure 10-32 for hexachloro-1,3-butadiene concentrations measured at NBIL include the following:

- There were no measured detections of hexachloro-1,3-butadiene measured at NBIL during the first 2 years of sampling. Non-detects made up 85 percent of measurements in 2005, and between 2006 and 2013, the percentage of non-detects was greater than 90 percent each year, including 2010, when again no measured detections were measured.

- The number of non-detects fell to 66 percent for 2014. The number of measured detections for 2014 is at 19, which is nearly greater than the number of measured detections across the previous years of sampling combined (22). This explains the increase in the 1-year average concentration shown for 2014.

- The maximum hexachloro-1,3-butadiene concentration measured at NBIL was measured on July 5, 2008 (0.299 µg/m^3) and is the only measurement of this pollutant greater than 0.25 µg/m^3. Only 41 total measured detections have been measured at NBIL since the onset of sampling. The effect of the non-detects (zeros) factored into the statistical calculations can be seen in the scale of the trends graph and by noting that none of the 1-year average concentrations shown are greater than 0.025 µg/m^3.

Figure 10-33. Yearly Statistical Metrics for Naphthalene Concentrations Measured at NBIL



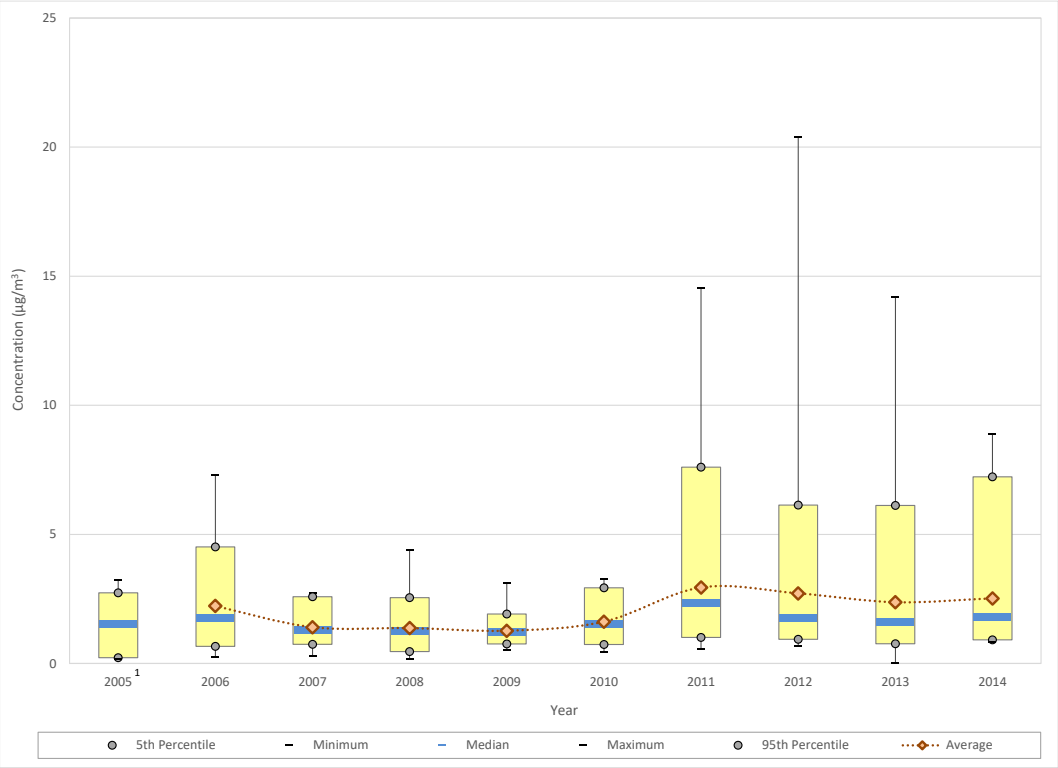
[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 10-33 for naphthalene concentrations measured at NBIL include the following:

- The maximum naphthalene concentration was measured on September 23, 2010 (869 ng/m^3). Five additional naphthalene concentrations greater than 500 ng/m^3 have been measured at NBIL (one in 2011, three in 2013, and one in 2014).

- The 1-year average concentration of naphthalene increases from 2009 to 2010 then decreases slightly for 2011 and 2012. The 1-year average concentration then doubles for 2013, after which a slight decrease is exhibited for 2014. The median concentration exhibits a similar pattern. The central tendency parameters for naphthalene exhibit a similar pattern of changes as those shown on the trends graphs for the other PAH pollutants of interest for NBIL.

Figure 10-34. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SPIL



[1] A 1-year average is not presented because consistent sampling did not begin until March 2005.

Observations from Figure 10-34 for acetaldehyde concentrations measured at SPIL include the following:

- Although the first carbonyl compound sample was collected at SPIL in February 2005, consistent sampling did not begin until March 2005; because a full year's worth of data is not available for 2005, a 1-year average is not presented, although the range of measurements is provided.

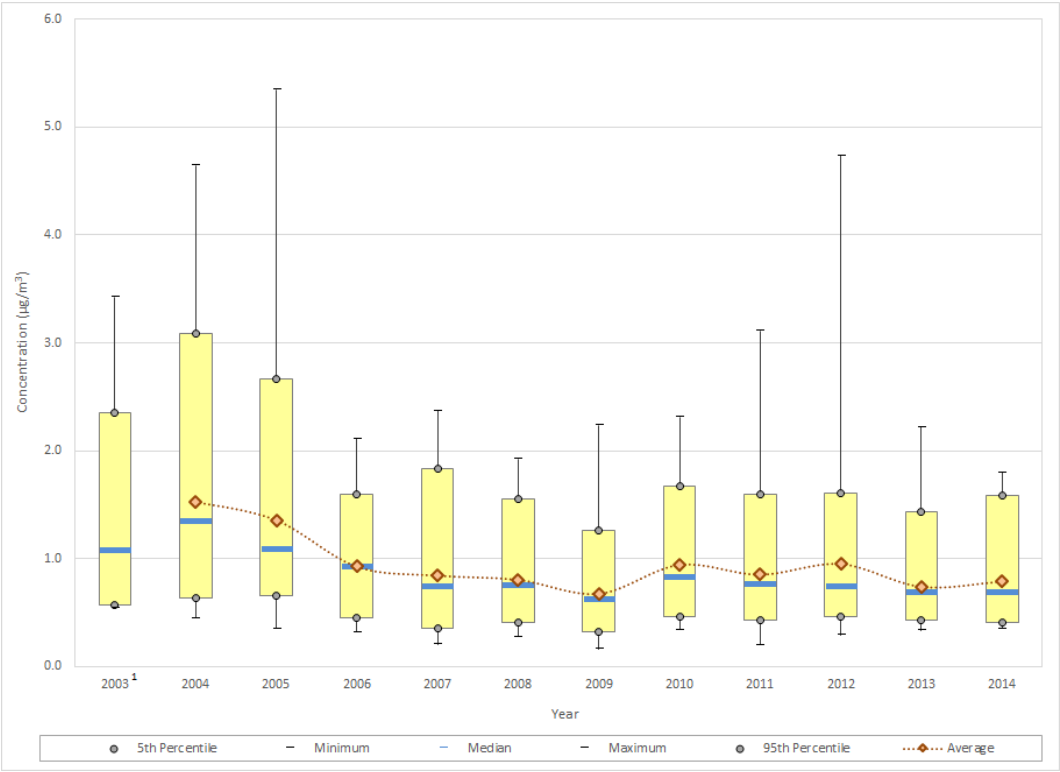
- The maximum acetaldehyde concentration was measured at SPIL on November 17, 2012 (20.4 µg/m^3). Thirty-one of the 33 concentrations of acetaldehyde greater than 5 µg/m^3 were measured after 2010 (eight in 2011, eight in 2012, seven in 2013, and eight in 2014), with the other two measured in 2006.

- The 1-year average concentration decreased significantly from 2006 to 2007, as did most of the other statistical parameters. Between 2007 and 2009, the 1-year average concentration changed little, hovering between 1.25 µg/m^3 and 1.45 µg/m^3. The 1-year average concentration increased in 2010 then increased significantly in 2011. All of the statistical metrics increased for 2011, particularly the maximum and 95th percentile, indicating that the increases shown are not attributable to a few of outliers. As an illustration, the number of measurements greater than 2 µg/m^3 increased from three in 2009 to 15 for 2010 to 40 in 2011.

- The profiles of acetaldehyde concentrations measured at SPIL in 2012, 2013, and 2014 are more similar to 2011 than other years of sampling. Yet, these measurements

reflect considerable variability, based on the range of concentrations measured and spread of the central tendency statistics.

Figure 10-35. Yearly Statistical Metrics for Benzene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-35 for benzene concentrations measured at SPIL include the following:

- Sampling for VOCs at SPIL under the NMP began in April 2003; because a full year's worth of data is not available for 2003, a 1-year average is not presented, although the range of measurements is provided.

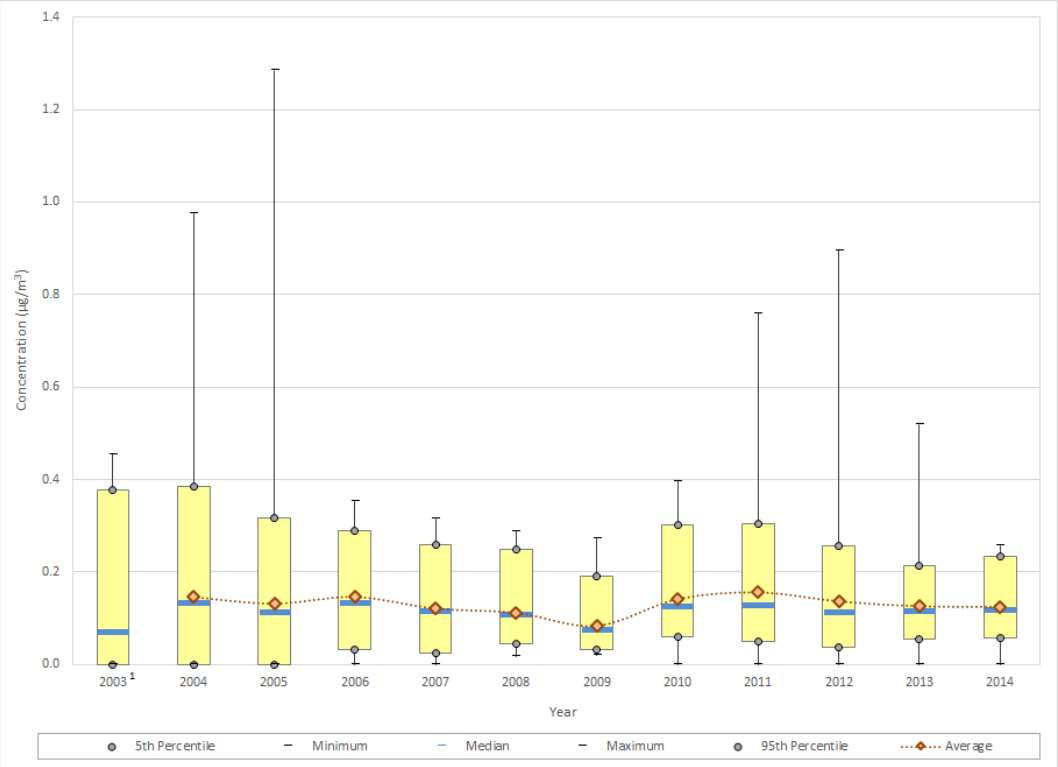
- The only two concentrations of benzene greater than 5 µg/m^3 were both measured in 2005.

- The 1-year average benzene concentration has a significant decreasing trend over the years between 2004 and 2009. The 1-year average concentration increased significantly from 2009 to 2010, after which the 1-year average benzene concentration has an undulating pattern, varying between 0.74 µg/m^3 (2013) and 0.95 µg/m^3 (2012). The median concentration has a similar pattern through 2010 but has a steady decreasing in the years that follow.

- The majority of benzene concentrations measured at SPIL, as indicated by the 5th and 95th percentiles, fell within roughly the same range between 2010 and 2014, with the

exception of 2013, when the range of benzene concentrations is slightly smaller than other recent years.

Figure 10-36. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-36 for 1,3-butadiene measurements at SPIL include the following:

- The maximum concentration of 1,3-butadiene was measured on February 3, 2005 (1.29 µg/m^3) and is the only measurement greater than 1 µg/m^3 measured at SPIL. In total, only seven concentrations greater than 0.5 µg/m^3 have been measured at SPIL, one in 2004, two in 2005, two in 2011, and one each in 2012 and 2013.

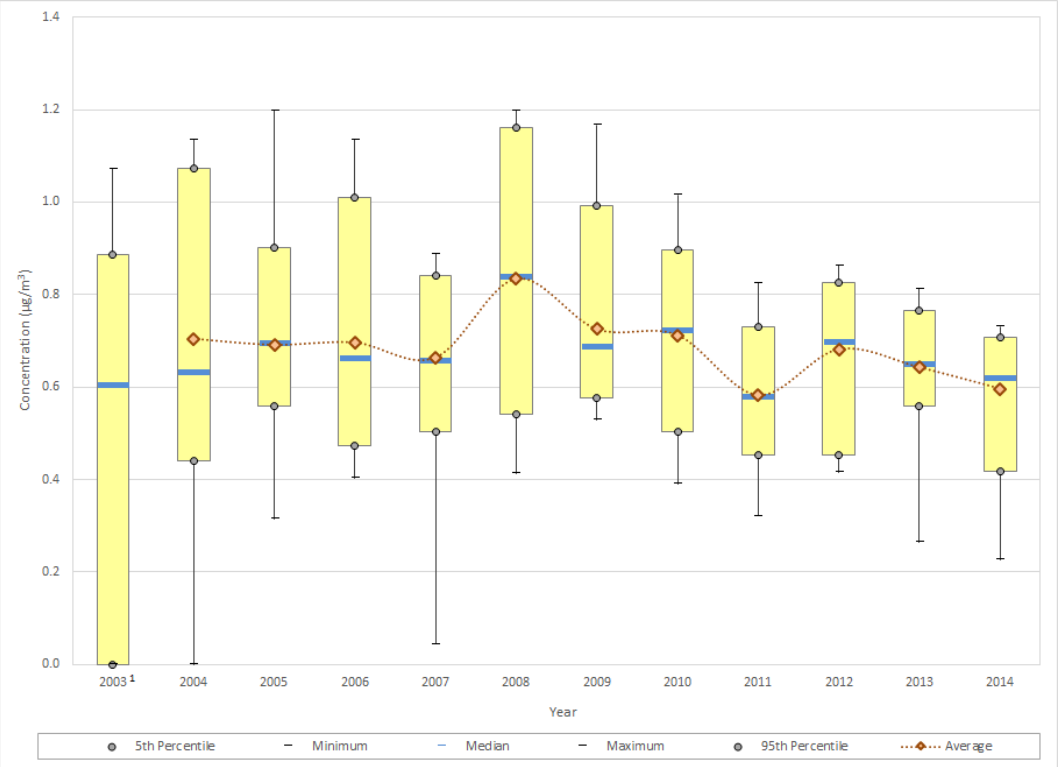
- The detection rate for 1,3-butadiene has increased over time, increasing from approximately 55 percent measured detections in 2003 and 2004 to a 100 percent detection rate in 2008 and 2009. A single non-detect has been measured in each of the following years after 2009.

- The 1-year average concentrations of 1,3-butadiene changed little between 2004 and 2006, then decreased between 2006 and 2009. The significant increase in the 1-year average concentration from 2009 to 2010 represents a 67 percent increase and a return to 2006 levels. A slight decreasing trend in the 1-year average concentration is shown after 2011. Despite these changes, most of the 1-year average concentrations

shown fall between 0.10 µg/m^3 and 0.15 µg/m^3, with only the minimum (0.08 µg/m^3 for 2009) and maximum (0.16 µg/m^3 for 2011) falling outside this range.

- The 5th and 95th percentiles indicate the range within which the majority of concentrations fall. This range decreased considerably between 2004 and 2009, increased for 2010 and 2011, then began to decrease again. The difference between these two parameters is at a minimum for 2013, with just a slight increase shown for 2014.

Figure 10-37. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-37 for carbon tetrachloride concentrations measured at SPIL include the following:

- The maximum concentration of carbon tetrachloride was measured three times, once in 2005 and twice in 2008 (1.20 µg/m^3).

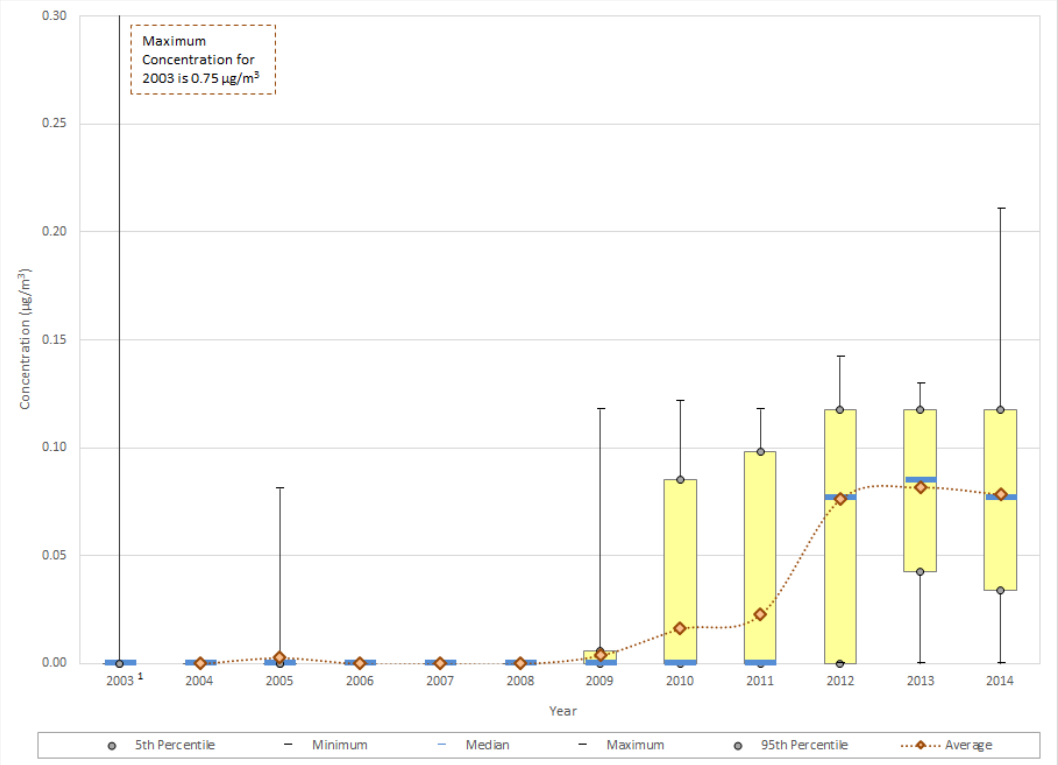
- Six non-detects of carbon tetrachloride have been measured at SPIL. All of these were measured during the first 2 years of sampling (four in 2003 and two in 2004).

- The 1-year average concentration changed very little between 2004 and 2007, varying between 0.65 µg/m^3 and 0.70 µg/m^3. The 1-year average then increased significantly for 2008 (0.84 µg/m^3). The 1-year average concentration exhibits a decreasing trend after 2008 that continued through 2011, when the 1-year average is at a minimum

(0.58 µg/m^3). The increase shown for 2012 brings the 1-year average carbon tetrachloride concentration back to near 2010 levels.

- With the exception of the 5th percentile, most of the statistical parameters exhibit a decrease for 2013 and all of them exhibit decreases for 2014.

Figure 10-38. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-38 for 1,2-dichloroethane concentrations measured at SPIL include the following:

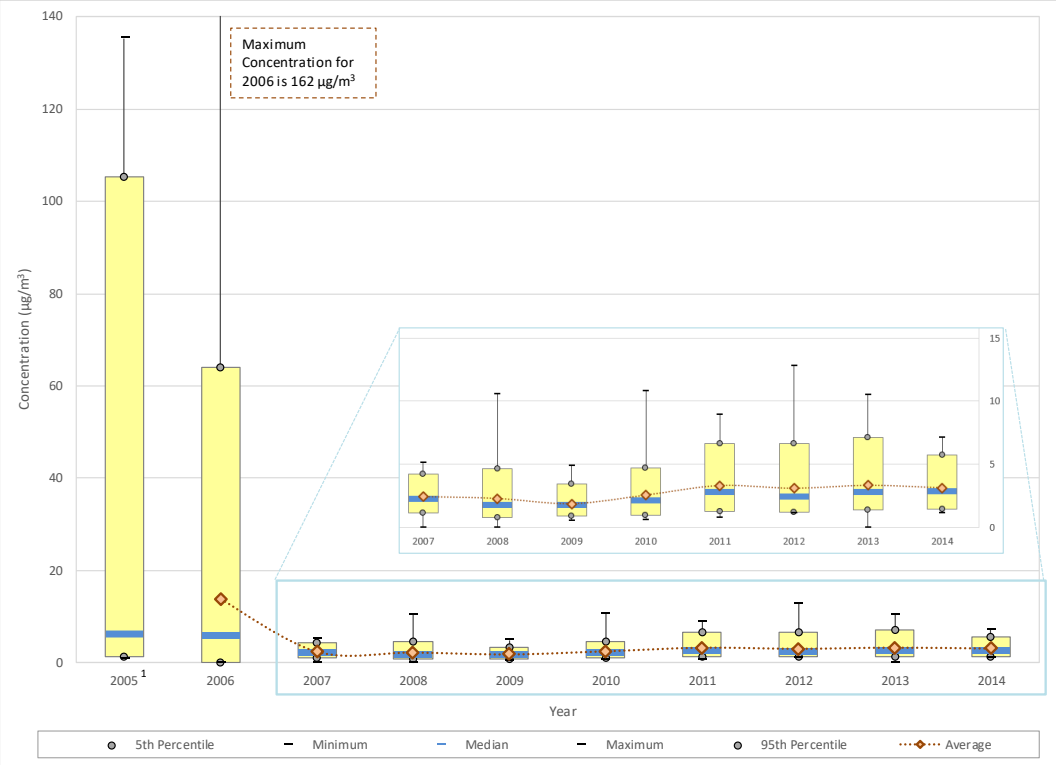
- There were no measured detections of 1,2-dichloroethane in 2004, 2006, 2007, or 2008. For 2003, 2005, and 2009, the percentage of non-detects was 95 percent or greater. Thus, the minimum, 5th percentile, median, and in some cases, the 1-year average concentrations are zero through 2009. The median concentration is also zero for 2010 and 2011, indicating that at least half the measurements are non-detects. The percentage of non-detects decreased to 80 percent for 2010 and 73 percent for 2011. For 2012, the percentage of non-detects decreased to 8 percent of samples collected and was at a minimum of 5 percent for 2013, which is the first year that the 5th percentile is greater than zero. The percentage of non-detects for 2014 is also 5 percent.

- The maximum concentration of 1,2-dichloroethane was measured at SPIL in 2003 (0.75 µg/m^3). This is the only measured detection for 2003 as all other measurements

were non-detects. Only one other 1,2-dichloroethane concentration greater than 0.15 µg/m^3 has been measured at SPIL (0.21 µg/m^3, which was measured on December 25, 2014).

- As the number of non-detects decreased and the number of measured detections increased, the statistical parameters began to increase correspondingly. The median concentration is greater than zero for the first time for 2012. The sharp decrease in the number of non-detects from 73 percent to 8 percent from 2011 to 2012 results in a sharp increase in the 1-year average concentration shown for 2012. The 1-year average concentrations vary by less than 0.01 µg/m^3 between 2012 and 2014.

Figure 10-39. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SPIL



[1] A 1-year average is not presented because consistent sampling did not begin until March 2005.

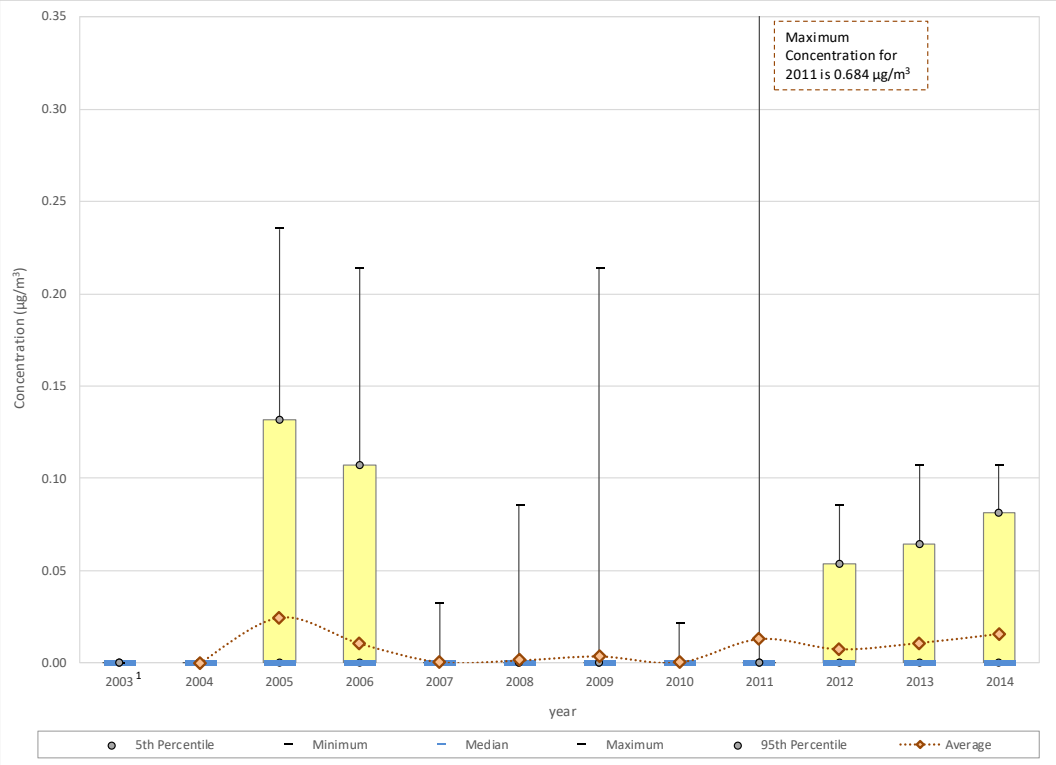
Observations from Figure 10-39 for formaldehyde concentrations measured at SPIL include the following:

- The maximum formaldehyde concentration (162 µg/m^3) was measured at SPIL on May 29, 2006 and is more than 10 times the maximum concentration for any of the other years shown in Figure 10-39 other than 2005. Of the 29 formaldehyde concentrations greater than 15 µg/m^3, 12 were measured at SPIL in 2005, 17 were measured in 2006, and none were measured in the years that followed.

- The 1-year average concentration for 2006 is 13.76 µg/m^3. After 2006, the 1-year average concentration decreased each year, reaching a minimum of 1.85 µg/m^3 for

2009. There is an increasing trend in the 1-year average concentration between 2009 and 2011, after which little change is shown. Between 2011 and 2014, the 1-year average concentrations varied between 3.07 µg/m^3 (2012) and 3.31 µg/m^3 (2013).

Figure 10-40. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-40 for hexachloro-1,3-butadiene concentrations measured at SPIL include the following:

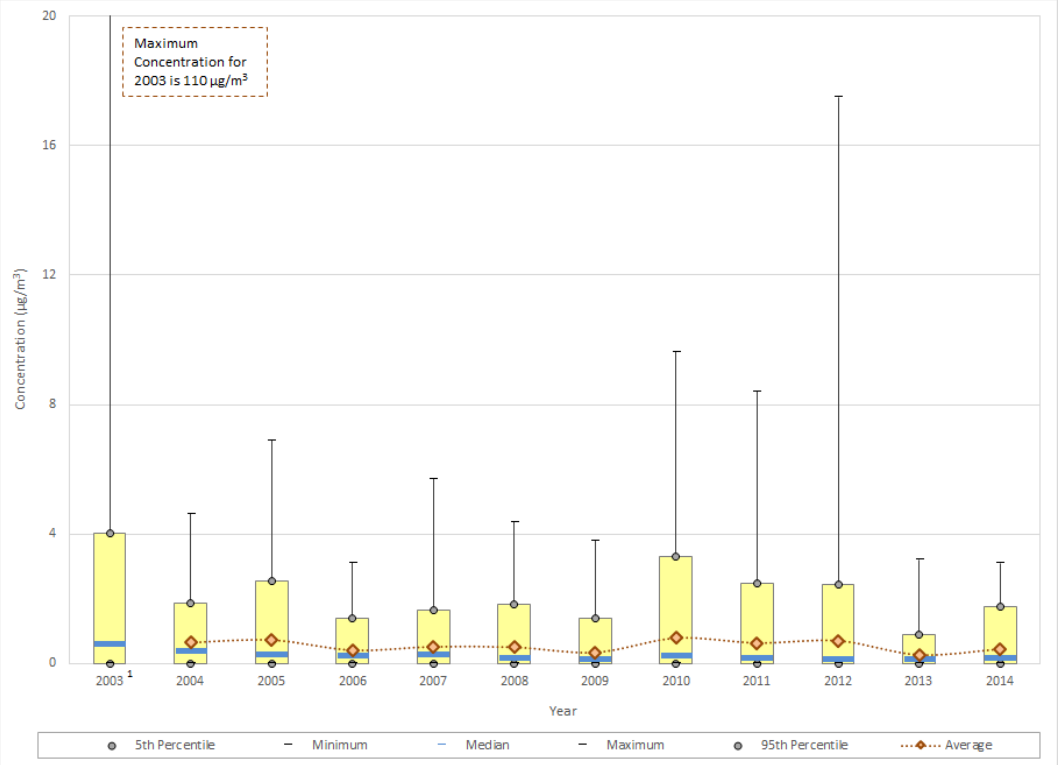
- The trends graph for hexachloro-1,3-butadiene measurements resembles the trends graph for 1,2-dichloroethane in that the statistical parameters reflect that non-detects make up the majority of measurements of this pollutant.

- There were no measured detections of hexachloro-1,3-butadiene measured at SPIL during the first 2 years of sampling. Non-detects made up 83 percent of measurements in 2005 and 93 percent in 2006. Between 2007 and 2010, the percentage of non-detects was constant at 98 percent, with only a single measured detection for each year. After 2010, the percentage of non-detects began to fall slightly each year, reaching a minimum of 78 percent for 2014.

- The maximum hexachloro-1,3-butadiene concentration measured at SPIL was measured on December 11, 2011 (0.684 µg/m^3) and is the only measurement of this pollutant greater than 0.25 µg/m^3. Only 51 total measured detections have been measured at SPIL since the onset of sampling. The effect of the non-detects (zeros)

factored into the statistical calculations can be seen in the scale of the trends graph and by noting that none of the 1-year average concentrations shown are greater than 0.025 µg/m^3.

Figure 10-41. Yearly Statistical Metrics for Trichloroethylene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-41 for trichloroethylene concentrations measured at SPIL include the following:

- The minimum and 5th percentile are both zero for all years of sampling, indicating that at least 5 percent of the measurements were non-detects for each year since sampling began at SPIL. The percentage of non-detects has ranged from 13 percent (2014) to 39 percent (2004).

- The maximum concentration of trichloroethylene (110 µg/m^3) was measured at SPIL in 2003 and is an order of magnitude greater than the next highest concentration (17.5 µg/m^3), which was measured in 2012. No other trichloroethylene concentrations greater than 10 µg/m^3 have been measured at SPIL.

- The concentrations of trichloroethylene exhibit considerable variability, as indicated by confidence intervals calculated for the 1-year average concentrations, particularly for 2012, when the maximum concentration was nearly four times the next highest concentration measured that year and non-detects made up about one-fifth of the measurements.

- The 1-year average concentrations have fluctuated between 0.26 µg/m^3 (2013) and 0.79 µg/m^3 (2010), with no distinct trend in the concentrations.

10.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each Illinois monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

10.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Illinois sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 10-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for the Illinois sites from Table 10-5 include the following:

- Formaldehyde and acetaldehyde are the pollutants with the highest annual average concentrations for all three sites.

- Formaldehyde has the highest cancer risk approximation for all three sites, ranging from 16.82 in-a-million for NBIL to 40.52 in-a-million for SPIL. There were no other pollutants for which a cancer risk approximation greater than 10 in-a-million was calculated, although ROIL's benzene is close (9.50 in-a-million).

- None of the pollutants of interest for NBIL, SPIL, or ROIL have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation among the pollutants of interest for the Illinois sites is formaldehyde (0.32 for SPIL).

Table 10-5. Risk Approximations for the Illinois Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Northbrook, Illinois - NBIL						
Acetaldehyde	0.0000022	0.009	55/55	2.36 ± 0.45	5.18	0.26
Benzene	0.0000078	0.03	56/56	0.49 ± 0.06	3.86	0.02
1,3-Butadiene	0.00003	0.002	43/56	0.04 ± 0.01	1.25	0.02
Carbon Tetrachloride	0.000006	0.1	56/56	0.60 ± 0.03	3.62	0.01
1,2-Dichloroethane	0.000026	2.4	54/56	0.07 ± <0.01	1.79	<0.01
Formaldehyde	0.000013	0.0098	55/55	1.29 ± 0.21	16.82	0.13
Hexachloro-1,3-butadiene	0.000022	0.09	19/56	0.02 ± 0.01	0.48	<0.01
Acenaphthene[a]	0.000088	--	55/55	20.62 ± 8.20	1.81	--
Arsenic (PM_{10})[a]	0.0043	0.000015	53/53	NA	NA	NA
Fluoranthene[a]	0.000088	--	55/55	8.12 ± 2.37	0.71	--
Fluorene[a]	0.000088	--	49/55	17.37 ± 6.69	1.53	--
Naphthalene[a]	0.000034	0.003	55/55	109.13 ± 28.14	3.71	0.04
Schiller Park, Illinois - SPIL						
Acetaldehyde	0.0000022	0.009	59/59	2.52 ± 0.50	5.55	0.28
Benzene	0.0000078	0.03	55/55	0.79 ± 0.09	6.20	0.03
1,3-Butadiene	0.00003	0.002	55/55	0.13 ± 0.02	3.93	0.07
Carbon Tetrachloride	0.000006	0.1	55/55	0.60 ± 0.02	3.60	0.01
1,2-Dichloroethane	0.000026	2.4	52/55	0.08 ± 0.01	2.06	<0.01
Formaldehyde	0.000013	0.0098	59/59	3.12 ± 0.35	40.52	0.32
Hexachloro-1,3-butadiene	0.000022	0.09	13/55	0.02 ± 0.01	0.38	<0.01
Trichloroethylene	0.0000048	0.002	49/55	0.44 ± 0.17	2.13	0.22

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Table 10-5. Risk Approximations for the Illinois Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Roxana, Illinois - ROIL						
Acetaldehyde	0.0000022	0.009	60/60	1.91 ± 0.18	4.20	0.21
Benzene	0.0000078	0.03	58/58	1.22 ± 0.21	9.50	0.04
1,3-Butadiene	0.00003	0.002	55/58	0.07 ± 0.01	2.21	0.04
Carbon Tetrachloride	0.000006	0.1	58/58	0.63 ± 0.02	3.76	0.01
1,2-Dichloroethane	0.000026	2.4	51/58	0.08 ± 0.01	2.02	<0.01
Ethylbenzene	0.0000025	1	58/58	0.32 ± 0.10	0.81	<0.01
Formaldehyde	0.000013	0.0098	60/60	3.05 ± 0.45	39.63	0.31
Hexachloro-1,3-butadiene	0.000022	0.09	17/58	0.02 ± 0.01	0.46	<0.01

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

10.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 10-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 10-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 10-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for each Illinois site, as presented in Table 10-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 10-6. Table 10-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 10.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 10-6. 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 UREs (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)**
Northbrook, Illinois (Cook County) - NBIL					
Benzene	1,391.32	Formaldehyde	1.48E-02	Formaldehyde	16.82
Formaldehyde	1,135.39	Benzene	1.09E-02	Acetaldehyde	5.18
Ethylbenzene	756.81	1,3-Butadiene	6.47E-03	Benzene	3.86
Acetaldehyde	623.34	Hexavalent Chromium	4.02E-03	Naphthalene	3.71
1,3-Butadiene	215.66	Naphthalene	3.60E-03	Carbon Tetrachloride	3.62
Tetrachloroethylene	187.87	Arsenic, PM	2.64E-03	Acenaphthene	1.81
Naphthalene	105.84	Ethylbenzene	1.89E-03	1,2-Dichloroethane	1.79
Trichloroethylene	99.56	POM, Group 2b	1.81E-03	Fluorene	1.53
Dichloromethane	35.41	Acetaldehyde	1.37E-03	1,3-Butadiene	1.25
POM, Group 2b	20.53	POM, Group 2d	1.19E-03	Fluoranthene	0.71
Schiller Park, Illinois (Cook County) - SPIL					
Benzene	1,391.32	Formaldehyde	1.48E-02	Formaldehyde	40.52
Formaldehyde	1,135.39	Benzene	1.09E-02	Benzene	6.20
Ethylbenzene	756.81	1,3-Butadiene	6.47E-03	Acetaldehyde	5.55
Acetaldehyde	623.34	Hexavalent Chromium	4.02E-03	1,3-Butadiene	3.93
1,3-Butadiene	215.66	Naphthalene	3.60E-03	Carbon Tetrachloride	3.60
Tetrachloroethylene	187.87	Arsenic, PM	2.64E-03	Trichloroethylene	2.13
Naphthalene	105.84	Ethylbenzene	1.89E-03	1,2-Dichloroethane	2.06
Trichloroethylene	99.56	POM, Group 2b	1.81E-03	Hexachloro-1,3-butadiene	0.38
Dichloromethane	35.41	Acetaldehyde	1.37E-03		
POM, Group 2b	20.53	POM, Group 2d	1.19E-03		

Table 10-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Illinois Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Roxana, Illinois (Madison County) - ROIL					
Formaldehyde	117.39	Coke Oven Emissions, PM	1.58E-02	Formaldehyde	39.63
Benzene	116.81	Formaldehyde	1.53E-03	Benzene	9.50
Ethylbenzene	56.77	Hexavalent Chromium	1.29E-03	Acetaldehyde	4.20
Acetaldehyde	50.30	Arsenic, PM	1.03E-03	Carbon Tetrachloride	3.76
Coke Oven Emissions, PM	15.95	Benzene	9.11E-04	1,3-Butadiene	2.21
Naphthalene	14.00	Naphthalene	4.76E-04	1,2-Dichloroethane	2.02
1,3-Butadiene	12.69	1,3-Butadiene	3.81E-04	Ethylbenzene	0.81
Dichloromethane	12.11	Nickel, PM	3.20E-04	Hexachloro-1,3-butadiene	0.46
Tetrachloroethylene	3.60	POM, Group 5a	2.42E-04		
POM, Group 2b	1.85	POM, Group 2b	1.63E-04		

Table 10-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Illinois Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Northbrook, Illinois (Cook County) - NBIL					
Toluene	10,461.60	Acrolein	4,043,182.36	Acetaldehyde	0.26
Xylenes	3,369.01	Formaldehyde	115,856.06	Formaldehyde	0.13
Methanol	3,041.83	1,3-Butadiene	107,829.46	Naphthalene	0.04
Hexane	2,784.74	Cyanide Compounds, gas	86,974.16	1,3-Butadiene	0.02
Benzene	1,391.32	Acetaldehyde	69,259.50	Benzene	0.02
Formaldehyde	1,135.39	Trichloroethylene	49,780.32	Carbon Tetrachloride	0.01
Ethylene glycol	1,052.17	Benzene	46,377.32	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	756.81	Arsenic, PM	40,902.71	1,2-Dichloroethane	<0.01
Acetaldehyde	623.34	Naphthalene	35,279.80		
Methyl isobutyl ketone	342.65	Xylenes	33,690.12		
Schiller Park, Illinois (Cook County) - SPIL					
Toluene	10,461.60	Acrolein	4,043,182.36	Formaldehyde	0.32
Xylenes	3,369.01	Formaldehyde	115,856.06	Acetaldehyde	0.28
Methanol	3,041.83	1,3-Butadiene	107,829.46	Trichloroethylene	0.22
Hexane	2,784.74	Cyanide Compounds, gas	86,974.16	1,3-Butadiene	0.07
Benzene	1,391.32	Acetaldehyde	69,259.50	Benzene	0.03
Formaldehyde	1,135.39	Trichloroethylene	49,780.32	Carbon Tetrachloride	0.01
Ethylene glycol	1,052.17	Benzene	46,377.32	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	756.81	Arsenic, PM	40,902.71	1,2-Dichloroethane	<0.01
Acetaldehyde	623.34	Naphthalene	35,279.80		
Methyl isobutyl ketone	342.65	Xylenes	33,690.12		

Table 10-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Illinois Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Roxana, Illinois (Madison County) – ROIL					
Toluene	635.77	Acrolein	274,415.42	Formaldehyde	0.31
Xylenes	208.66	Chlorine	95,420.68	Acetaldehyde	0.21
Hexane	195.81	Hexamethylene-1,6-diisocyanate, gas	25,000.00	Benzene	0.04
Methanol	178.11	Manganese, PM	16,632.19	1,3-Butadiene	0.04
Hydrochloric acid	128.20	Arsenic, PM	16,022.05	Carbon Tetrachloride	0.01
Formaldehyde	117.39	Lead, PM	14,477.27	Ethylbenzene	<0.01
Benzene	116.81	Formaldehyde	11,978.64	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	56.77	Cyanide Compounds, gas	7,490.07	1,2-Dichloroethane	<0.01
Ethylene glycol	53.93	Nickel, PM	7,414.81		
Acetaldehyde	50.30	Hydrochloric acid	6,410.24		

Observations from Table 10-6 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Cook County. These same pollutants are the highest emitted pollutants with cancer UREs in Madison County, although the order differs. The quantity of emissions is considerably different between the two counties, with the emissions for Cook County an order of magnitude greater than Madison County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Cook County are formaldehyde, benzene, and 1,3-butadiene. Coke oven emissions top Madison County's toxicity-weighted emissions, followed by formaldehyde and hexavalent chromium.

- Seven of the highest emitted pollutants in Cook County also have the highest toxicity-weighted emissions while six of the highest emitted pollutants in Madison County also have the highest toxicity-weighted emissions.

- For NBIL and SPIL, formaldehyde is the pollutant with the highest cancer risk approximation. This pollutant also has the highest toxicity-weighted emissions and ranks second for quantity emitted in Cook County. Benzene, acetaldehyde, and 1,3-butadiene also appear on all three lists for both sites. For ROIL, formaldehyde is also the pollutant with the highest cancer risk approximation. This pollutant also has the highest emissions in Madison County and the second highest toxicity-weighted emissions. Benzene and 1,3-butadiene also appear on all three lists for ROIL.

- Carbon tetrachloride, which has the fifth highest cancer risk approximation for NBIL and SPIL and the fourth highest cancer risk approximation for ROIL, does not appear on either county's emissions-based list. Similarly, 1,2-dichloroethane appears on neither emissions-based list, though it ranks among the pollutants with the highest cancer risk approximations for all three sites.

- Naphthalene has the fourth highest cancer risk approximation for NBIL. This pollutant also has the fifth highest toxicity-weighted emissions for Cook County and ranks seventh for quantity emitted. POM, Group 2b ranks 10th for quantity emitted and eighth for toxicity-weighted emissions in Cook County. POM, Group 2b includes acenaphthene, fluorene, and fluoranthene, all three of which are pollutants of interest for NBIL. Arsenic, which is a pollutant of interest for NBIL but for which an annual average concentration could not be calculated, is also among those with the highest toxicity-weighted emissions for Cook County.

- Trichloroethylene has the sixth highest cancer risk approximation for SPIL and is the eighth highest emitted pollutant in Cook County, but does not appear among the pollutants with the highest toxicity-weighted emissions (this pollutant ranks 13th).

- Ethylbenzene is a pollutant of interest for ROIL and ranks seventh for its cancer risk approximation. This pollutant is the third highest emitted pollutant in Madison County but does not appear among those with the highest toxicity-weighted emissions (it ranks 11th).

Observations from Table 10-7 include the following:

- Toluene and xylenes are the highest emitted pollutants with noncancer RfCs in both Cook and Madison Counties, although the quantity emitted is significantly higher in Cook County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties is acrolein. Although acrolein was sampled for at all three sites, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Only four of the highest emitted pollutants also have the highest toxicity-weighted emissions for Cook County (formaldehyde, benzene, xylenes, and acetaldehyde). The highest emitted pollutants and the pollutants with the highest toxicity-weighted emissions for Madison County have only two pollutants in common (formaldehyde and hydrochloric acid). This speaks to the relative toxicity of a pollutant; a pollutant does not have to be emitted in high quantities to be hazardous to human health.

- Formaldehyde and acetaldehyde have the highest noncancer hazard approximations for the Chicago sites (albeit less than an HQ of 1.0). These two pollutants appear on both emissions-based lists for Cook County. Benzene is another pollutant of interest for these sites and appears on both emissions-based lists for Cook County. These three pollutants are also pollutants of interest for ROIL but only formaldehyde appears on both emissions-based lists (acetaldehyde and benzene only appear among the highest emitted, ranking 12th and 15th, respectively, for their toxicity-weighted emissions).

- Naphthalene and 1,3-butadiene are also pollutants of interest for NBIL and are among those with the highest toxicity-weighted emissions in Cook County but are not among the highest emitted. This is also true for arsenic. Trichloroethylene and 1,3-butadiene are pollutants of interest for SPIL and are among those with the highest toxicity-weighted emissions but are not among the highest emitted in Cook County.

- Formaldehyde is the pollutant of interest with the highest noncancer hazard approximation for ROIL (albeit less than an HQ of 1.0). Formaldehyde ranks sixth for the quantity emitted in Madison County and seventh for its toxicity-weighted emissions. This is the only pollutant to appear on all three lists on Table 10-7. Acetaldehyde, benzene, and ethylbenzene are pollutants of interest for ROIL that are among the highest emitted but none of these appear among those with the highest toxicity-weighted emissions.

- Several metals appear among the pollutants with the highest toxicity-weighted emissions in Madison County, although none are among the highest emitted. Metals were not sampled for at ROIL under the NMP.

10.6 Summary of the 2014 Monitoring Data for NBIL, SPIL, and ROIL

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

- *Eighteen pollutants (two carbonyl compounds, nine VOCs, five PAHs, and two speciated metals) failed screens for NBIL; 13 pollutants (three carbonyl compounds and 10 VOCs) failed screens for SPIL; and 12 pollutants (three carbonyl compounds and nine VOCs) failed screens for ROIL.*

- *Formaldehyde had the highest annual average concentration among the pollutants of interest for SPIL and ROIL, while acetaldehyde had the highest annual average concentration among the pollutants of interest for NBIL.*

- *The maximum concentrations of several pollutants across the program were measured at NBIL (acetaldehyde, acenaphthene, fluoranthene, fluorene, and naphthalene).*

- *Concentrations of acetaldehyde have been increasing significantly in recent years at NBIL, although little change is shown between 2013 and 2014, while concentrations of formaldehyde have a decreasing trend in recent years. Like many NMP sites, a significant decrease in the number of non-detects reported for 1,2-dichloroethane has occurred at both Chicago sites.*

- *Formaldehyde has the highest cancer risk approximation among the pollutants of interest for all three sites. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

11.0 Sites in Indiana

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the UATMP 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

11.1 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.

One Indiana monitoring site (INDEM) is located in the Chicago-Naperville-Elgin, IL-IN-WI CBSA, and another site (WPIN) is located in the Indianapolis-Carmel-Anderson, IN CBSA. Figures 11-1 and 11-3 are composite satellite images retrieved from ArcGIS Explorer showing the monitoring sites and their immediate surroundings. Figures 11-2 and 11-4 identify nearby point source emissions locations by source category near INDEM and WPIN, respectively, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figures 11-2 and 11-4. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on each map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 11-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 11-1. Gary, Indiana (INDEM) Monitoring Site

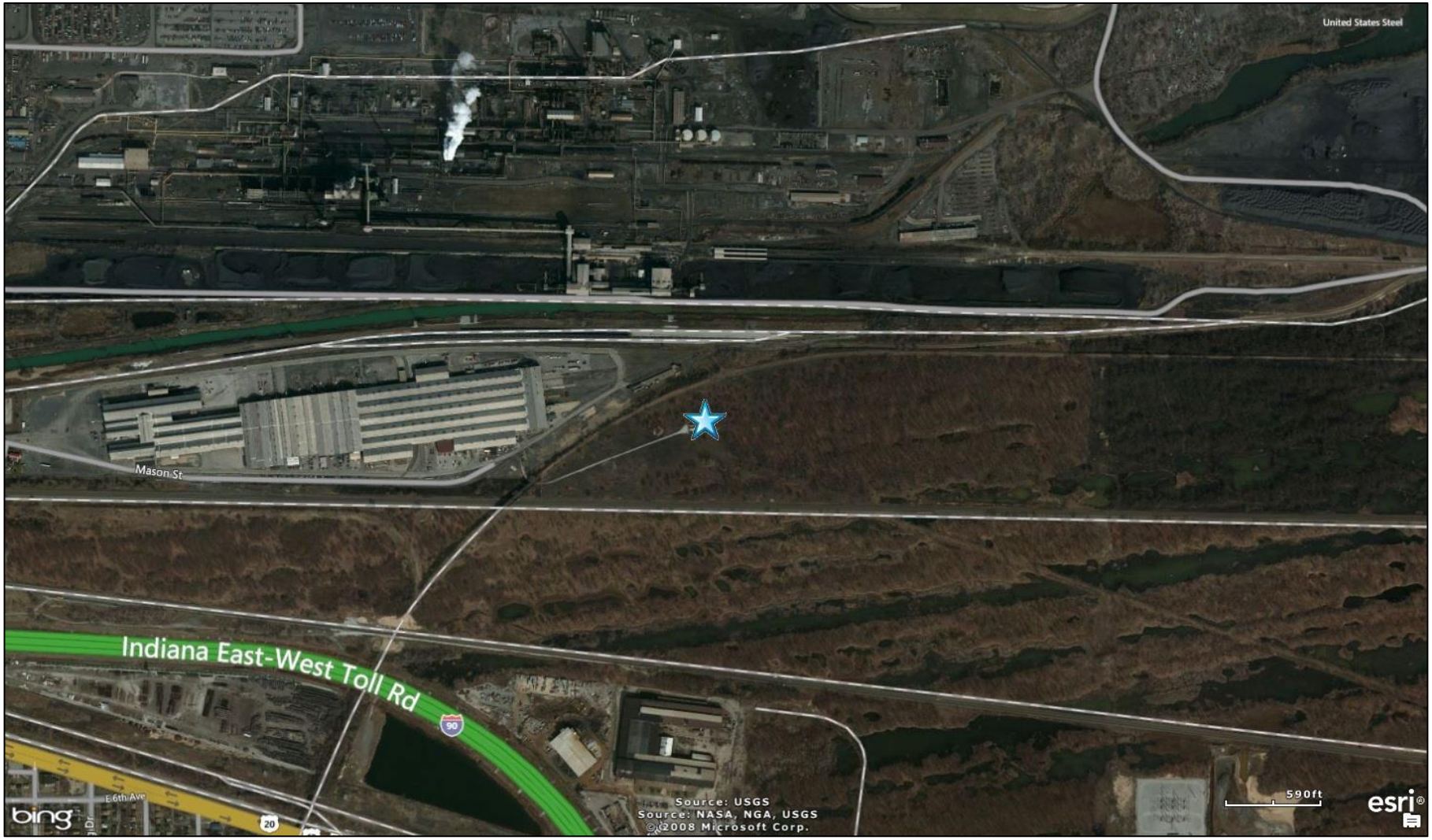


Figure 11-2. NEI Point Sources Located Within 10 Miles of INDEM

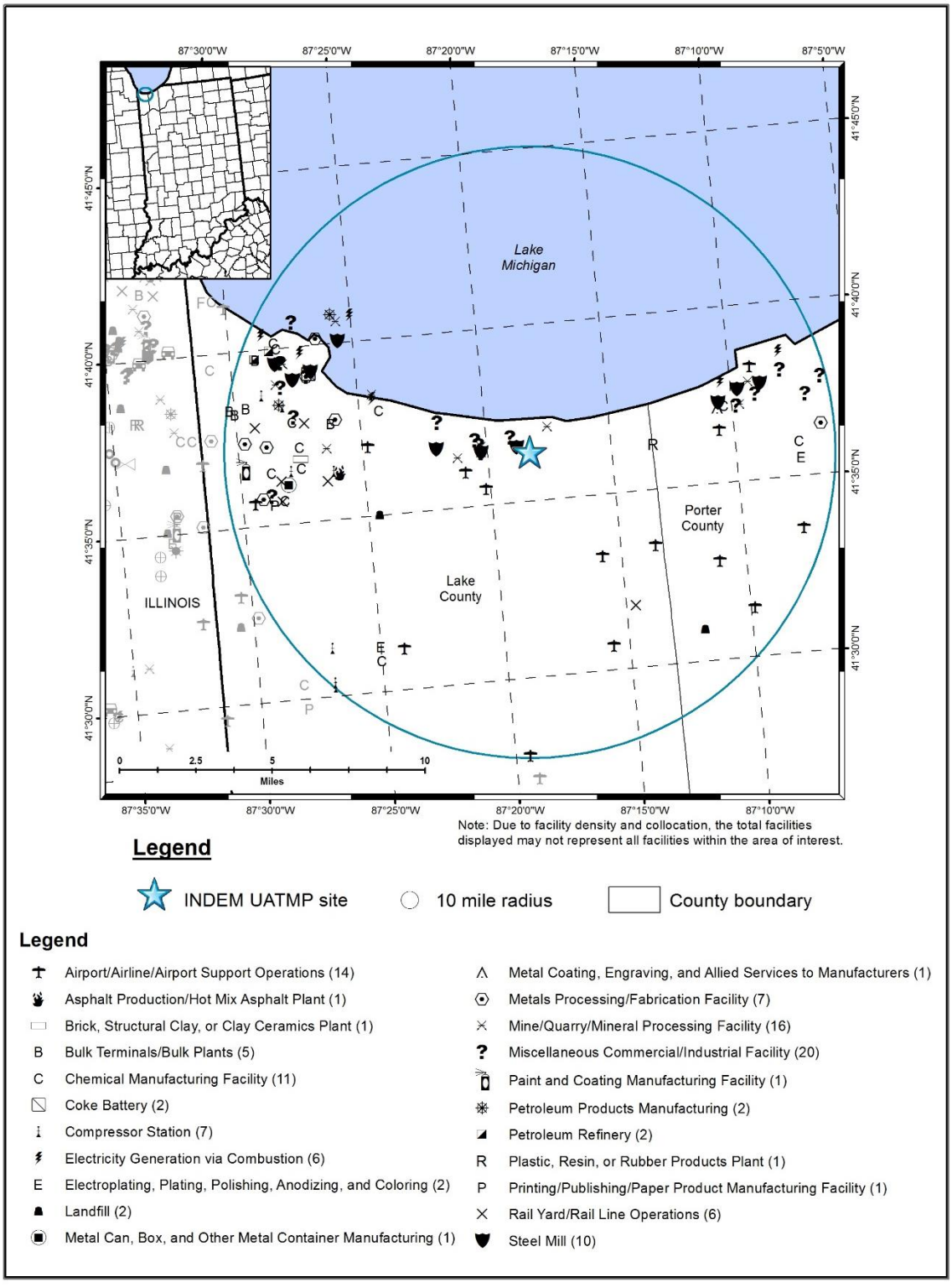


Figure 11-3. Indianapolis, Indiana (WPIN) Monitoring Site

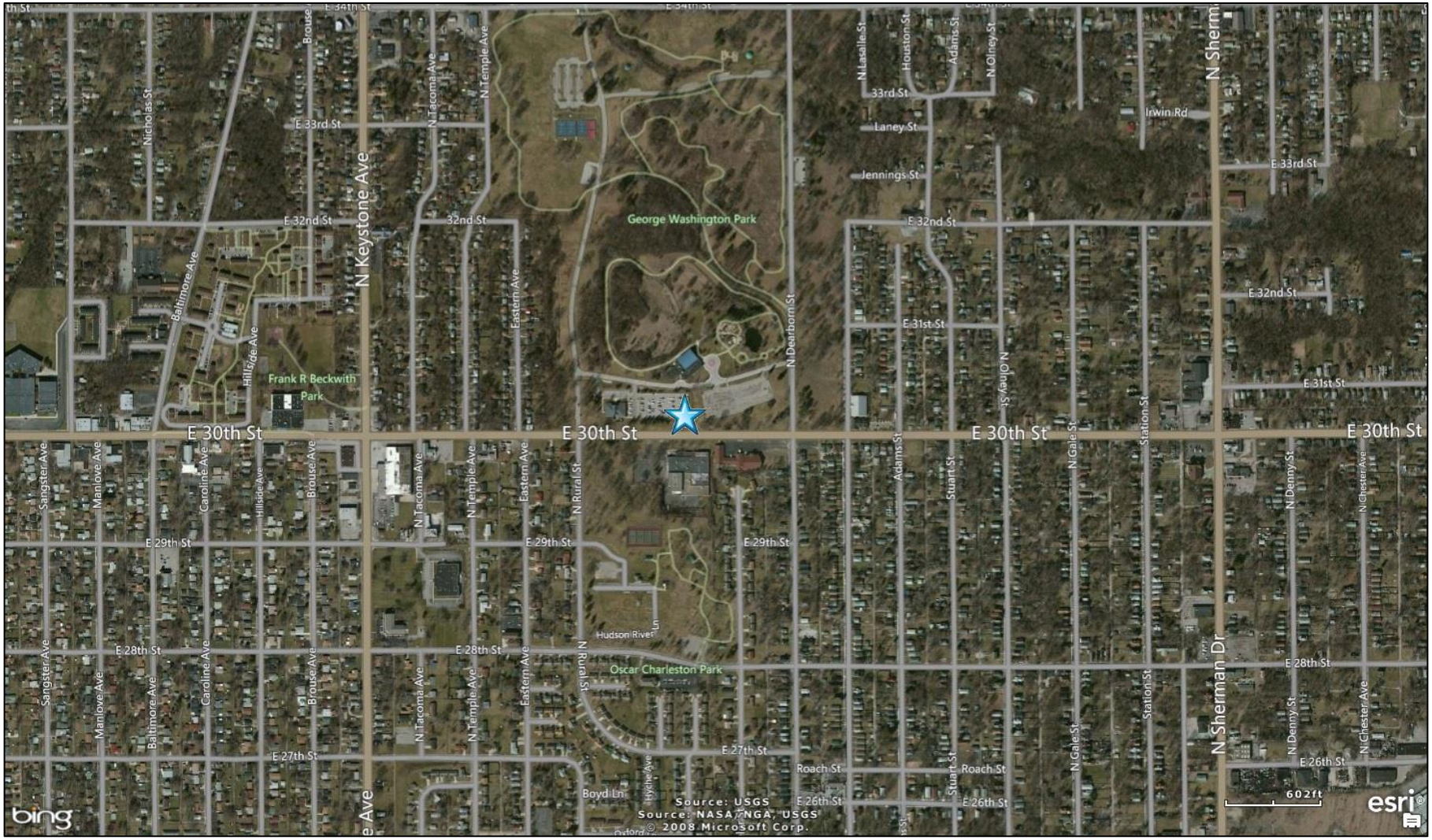


Figure 11-4. NEI Point Sources Located Within 10 Miles of WPIN

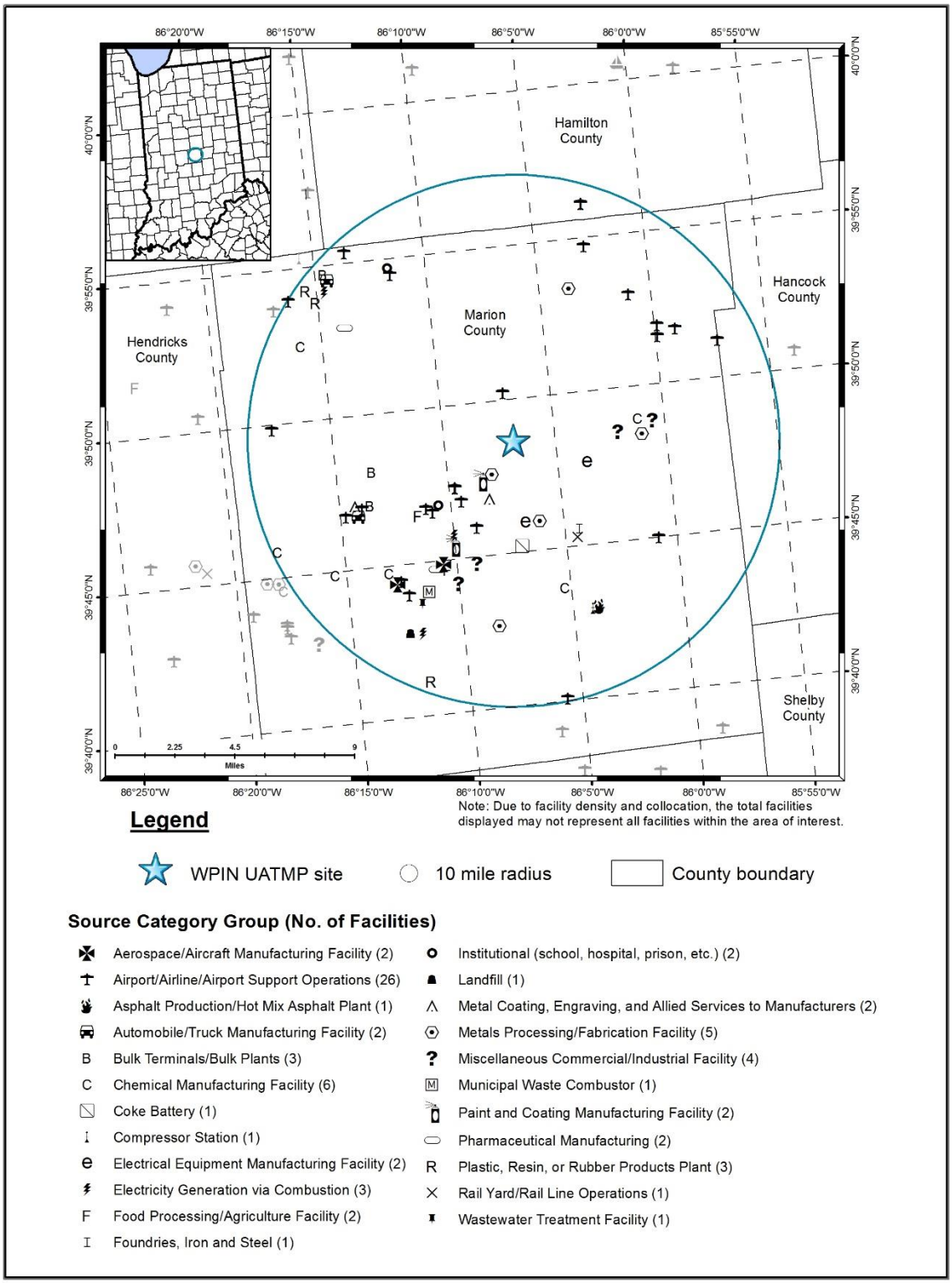


Table 11-1. Geographical Information for the Indiana Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
INDEM	18-089-0022	Gary	Lake	Chicago- Naperville-Elgin, IL-IN-WI	41.606680, -87.304729	Industrial	Urban/City Center	34,754	I-90 N of I-65 Interchange
WPIN	18-097-0078	Indianapolis	Marion	Indianapolis-Carmel-Anderson, IN	39.811097, -86.114469	Residential	Suburban	24,611	Keystone Ave at 30th St

[1]AADT reflects 2011 data (IN DOT, 2011)

INDEM is located in Gary, Indiana, approximately 11 miles east of the Indiana-Illinois border and 25 miles southeast of Chicago. Gary is located on the southernmost bank of Lake Michigan. The site is located just north of I-65 and I-90, the edge of which can be seen in the bottom left portion of Figure 11-1. Although INDEM resides on the Indiana Dunes National Lakeshore, about 1 mile south of the Lake Michigan shoreline, the surrounding area is highly industrialized, as shown in Figure 11-1, and several rail lines transverse the area. Figure 11-2 shows that the majority of point sources within 10 miles of INDEM are located to the west of the site. There is also a second cluster of facilities located to the east of INDEM in Porter County. The emissions source categories with the highest number of sources within 10 miles of INDEM include steel mills; aircraft operations, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or TV stations; chemical manufacturing; and mine/quarry/mineral processing. The sources closest to INDEM include a steel mill; an industrial complex that includes several facilities that fall into the miscellaneous commercial/industrial category as well as two mines/quarries and another steel mill; and a heliport at a police station and a hospital.

WPIN is located in the parking lot of a police station across from George Washington Park, near East 30th Street in northeast Indianapolis. Figure 11-3 shows that the area surrounding WPIN is suburban and residential, with little industry in close proximity. A church and a charitable organization are located across the street from Washington Park, as is Oscar Charleston Park. Figure 11-4 shows that the majority of point sources are located to the south and southwest of WPIN, towards the center of Marion County. The source category with the highest number of sources near WPIN is the airport operations source category. The sources closest to WPIN are a painting and coating manufacturer, a metals processing/fabrication facility, and a heliport. Each of these facilities is located within 2 miles of WPIN.

In addition to providing city, county, CBSA, and land use/location setting information, Table 11-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. INDEM experiences a higher traffic volume than WPIN, although the traffic volumes near these sites rank in the middle of the range compared to traffic volumes near other NMP sites. These

traffic volumes were obtained for roadways fairly close to the monitoring sites (I-90 near 1-65 for INDEM and North Keystone Avenue at East 30th Street for WPIN).

11.2 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 the year.

11.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For INDEM, site-specific data were available for all of the parameters in Table 11-2 except sea level pressure. For WPIN, AQS data were available but the instrumentation was down occasionally, with a longer outage from mid-May through early July; thus, data from the NWS weather station at Eagle Creek Airpark (WBAN 53842) were used as surrogates for missing data. The Eagle Creek Airpark weather station is located 9.7 miles west of WPIN. A map showing the distance between each monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 11-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 11-2 is the 95 percent confidence interval for each parameter. As shown in Table 11-2, average meteorological conditions on sample days at INDEM were generally representative of average weather conditions experienced throughout the year at this site. The greatest difference between the sample day and full-year averages was calculated for average dew point temperature. The difference in several parameters may be attributable, at least in part, to extra samples collected in December. For WPIN, the greatest difference was calculated for average relative humidity, although relatively large differences were also

calculated for average temperature and average dew point. A number of make-up samples were collected throughout out the year, primarily in March, which may contribute to these differences.

Table 11-2. Average Meteorological Conditions near the Indiana Monitoring Sites

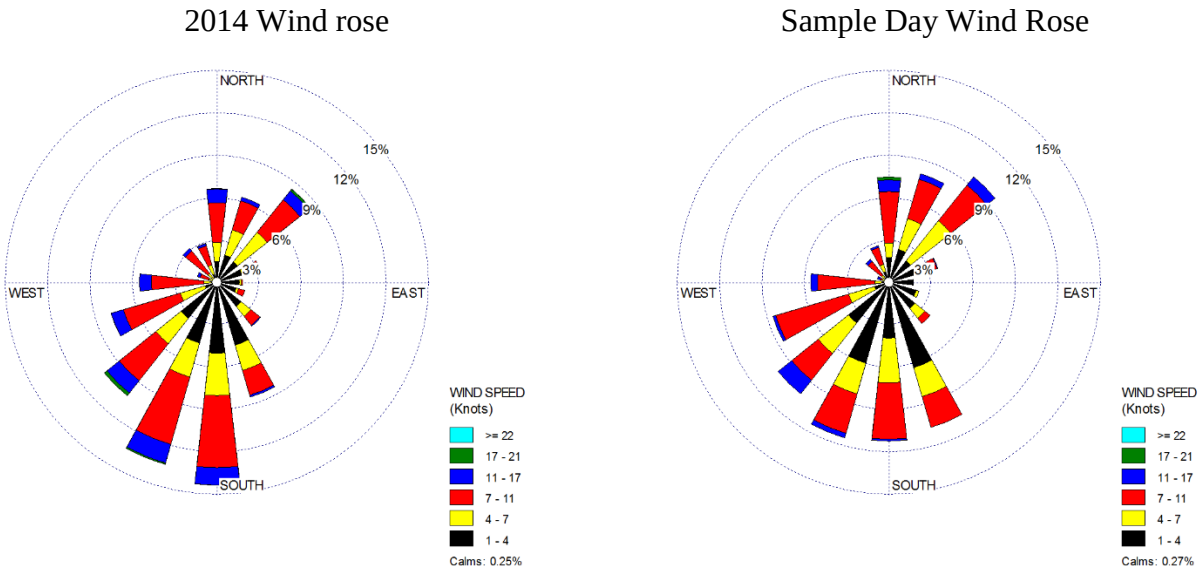
Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Gary, Indiana – INDEM[2]							
Sample Days (62)	45.7 ± 1.1	35.7 ± 1.1	70.6 ± 0.9	NA	29.44 ± 0.01	SSW	6.0 ± 0.2
2014	46.9 ± 0.4	37.3 ± 0.4	71.9 ± 0.4	NA	29.39 ± <0.01	S	6.5 ± 0.1
Indianapolis, Indiana – WPIN[3]							
Sample Days (68)	49.1 ± 1.1	37.3 ± 1.0	66.3 ± 0.9	30.07 ± 0.01	29.23 ± 0.01	WNW	4.3 ± 0.1
2014	50.8 ± 0.4	39.8 ± 0.4	69.0 ± 0.4	30.04 ± <0.01	29.20 ± <0.01	WNW	4.4 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]All parameters except sea level pressure were measured at INDEM. Sea level pressure was not collected at INDEM or the closest NWS weather station and thus, is not presented here.
[3]All parameters except sea level pressure were measured at WPIN; however, the meteorological instruments were down part of the year, so data from the closest NWS weather station located at Eagle Creek Airpark, WBAN 53842, were used as a surrogate.
NA= Sea level pressure was not recorded at the Lansing Municipal Airport.

11.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 11-5 presents two wind roses for the INDEM monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figure 11-6 presents the full-year and sample day wind roses for WPIN.

Figure 11-5. Wind Roses for the Wind Data Collected at INDEM



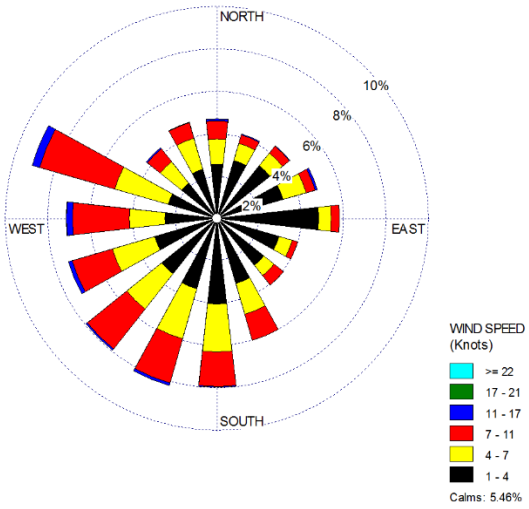
Observations from Figure 11-5 for INDEM include the following:

- The 2014 wind rose shows that light winds were infrequent and calm winds account for less than 1 percent of the wind observations. Winds from the south-southeast to west-southwest were commonly observed, together accounting for more than half of wind observations. Winds from the north to northeast make up a secondary wind grouping. Winds from the east-northeast to east-southeast were infrequently observed, as were winds from the west-northwest to northwest.

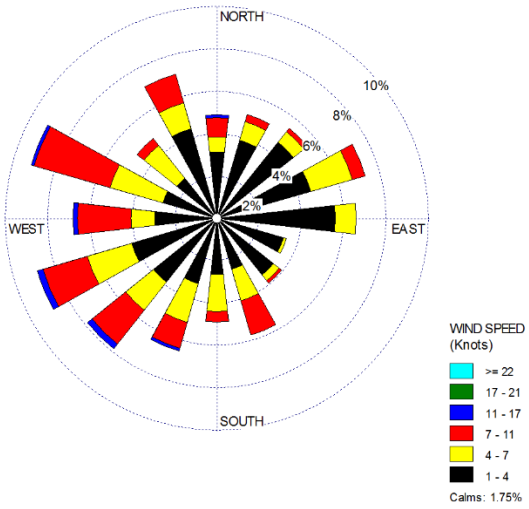
- The sample day wind rose resembles the full-year wind rose, exhibiting similar wind speeds and direction observation patterns. While winds from the south-southeast to west-southwest still accounted for the majority of observations on sample days, the percentage of observations was more evenly distributed on sample days than over the course of the year.

Figure 11-6. Wind Roses for the Wind Data Collected at WPIN

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 11-6 for WPIN include the following:

- Winds from the south-southeast, south, the southwestern quadrant, west, and west-northwest account for the majority (nearly 55 percent) of wind observations at WPIN in 2014. With the exception of east winds, winds from each of the remaining directions accounted for less than 5 percent of observations. Calm winds were observed for roughly 5 percent of observations. Winds greater than 17 knots were rarely observed at WPIN.

- The wind patterns on the sample day wind rose exhibit more variability than the full-year wind rose. Winds from the south-southeast to west-northwest still account for the majority of wind observations, but winds from the north-northwest and northeast to east accounted for a higher percentage of the observations on sample days. The calm rate was lower on sample days as well, with less than 2 percent of the observations falling into this category.

- Recall from the previous section that wind sensors were down at WPIN for a portion of 2014 and NWS data were used as a surrogate for missing data.

11.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Indiana monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 11-3. 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 and are shaded in gray in Table 11-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Carbonyl compounds were sampled for at both INDEM and WPIN.

Table 11-3. Risk-Based Screening Results for the Indiana Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Gary, Indiana - INDEM						
Formaldehyde	0.077	57	57	100.00	50.44	50.44
Acetaldehyde	0.45	56	57	98.25	49.56	100.00
Total		113	114	99.12		
Indianapolis, Indiana - WPIN						
Acetaldehyde	0.45	54	54	100.00	50.00	50.00
Formaldehyde	0.077	54	54	100.00	50.00	100.00
Total		108	108	100.00		

Observations from Table 11-3 include the following:

- Acetaldehyde and formaldehyde are the only pollutants to fail screens for INDEM and WPIN.
- Formaldehyde failed 100 percent of screens for both sites. Acetaldehyde failed 100 percent of screens for WPIN and 98 percent of screens for INDEM.
- Both pollutants were identified as pollutants of interest for each site, contributing equally or nearly equally to the number of failed screens for each site.
- Note that only three carbonyl compounds have risk screening values (formaldehyde, acetaldehyde, and propionaldehyde).

11.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Indiana monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the Indiana sites are provided in Appendix L.

11.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each Indiana monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Indiana monitoring sites are presented in Table 11-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 11-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Indiana Monitoring Sites

Pollutant	# of Measured Detections vs. # of Samples	Total # of Samples	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)
Gary, Indiana - INDEM							
Acetaldehyde	57/57	57	1.10 ± 0.19	1.08 ± 0.16	1.28 ± 0.22	1.17 ± 0.23	1.16 ± 0.10
Formaldehyde	57/57	57	1.86 ± 0.31	3.11 ± 0.53	3.43 ± 0.64	1.81 ± 0.46	2.59 ± 0.30
Indianapolis, Indiana - WPIN							
Acetaldehyde	54/54	54	1.73 ± 0.18	NA	1.85 ± 0.26	1.39 ± 0.28	1.68 ± 0.14
Formaldehyde	54/54	54	2.58 ± 0.33	NA	3.38 ± 0.51	1.71 ± 0.51	2.68 ± 0.32

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

Observations for the Indiana sites from Table 11-4 include the following:

- For both sites, acetaldehyde and formaldehyde were detected in all of the valid carbonyl compound samples collected.

- The annual average formaldehyde concentrations for these two sites are similar to each other. The annual average concentration of formaldehyde for INDEM is more than twice this site's annual average concentration of acetaldehyde. While the annual average formaldehyde concentration for WPIN is also greater than this site's annual average acetaldehyde concentration, the difference is less.

- The second and third quarter average concentrations of formaldehyde are significantly higher than the first and fourth quarter averages for INDEM. A review of the data shows that all but one of the 17 highest formaldehyde concentrations (those greater than 3 µg/m^3) were measured between April and September and ranged from 3.09 µg/m^3 to 6.37 µg/m^3; conversely, all but two of the 19 lowest concentrations (those less than 2 µg/m^3) were measured between January and March or October and December. This supports the trend identified in Section 4.4.2 indicating that formaldehyde concentrations tended to be higher during the warmer months of the year. Acetaldehyde concentrations measured at INDEM do not exhibit this trend. The quarterly average concentrations of acetaldehyde vary by only 0.2 µg/m^3.

- Power supply issues at WPIN resulted in samples not being collected between mid-May and late June. As a result, no quarterly average concentrations could be calculated for the second quarter.

- Even though the average formaldehyde concentration for the third quarter is twice the average concentration for the fourth quarter, their confidence intervals are the same, indicating more variability in the fourth quarter measurements at WPIN.

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

- INDEM does not appear in Table 4-10. Its annual average concentration of formaldehyde ranks 17th and its annual average concentration of acetaldehyde ranks 23rd among NMP sites sampling carbonyl compounds.

- WPIN does not appear in Table 4-10 either. Its annual average concentration of formaldehyde ranks 15th and its annual average concentration of acetaldehyde ranks 17th among NMP sites sampling carbonyl compounds.

- This is the first time in several years that WPIN does not appear in this table for formaldehyde.

11.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 11-4 for INDEM and WPIN. Figures 11-7 and 11-8 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 11-7. Program vs. Site-Specific Average Acetaldehyde Concentrations

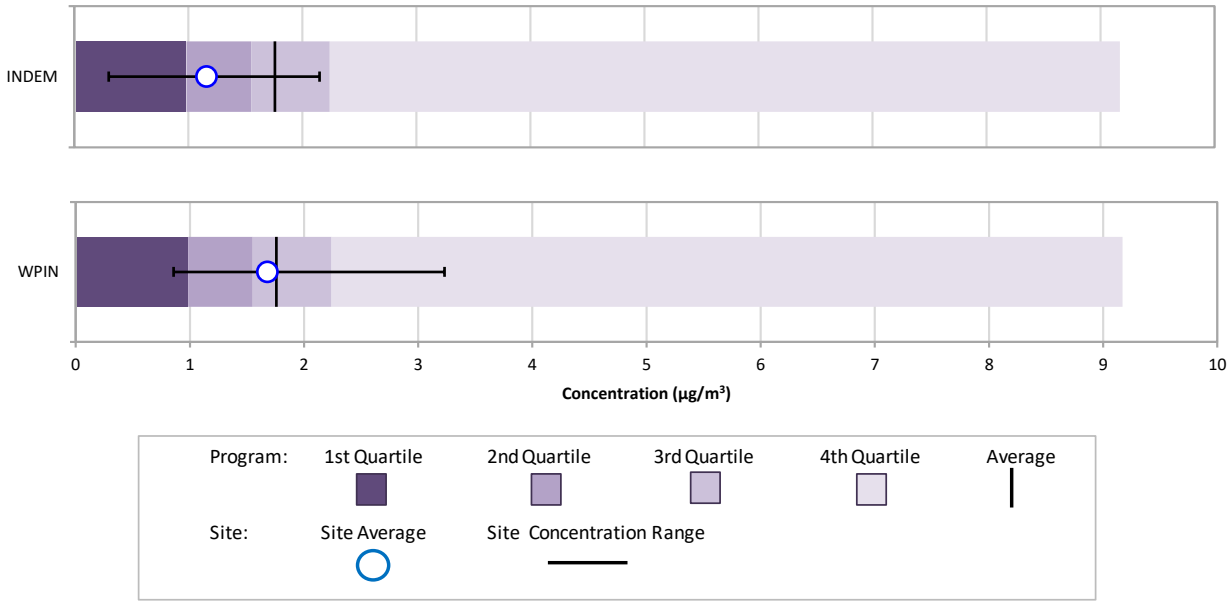


Figure 11-7 presents the box plots for acetaldehyde for both sites and shows the following:

- The maximum concentration of acetaldehyde measured at INDEM is less than the program-level third quartile. The annual average concentration for INDEM is less than both the program-level average and median concentrations.

- Acetaldehyde concentrations measured at WPIN are higher than those measured at INDEM. WPIN's annual average concentration is just less than the program-level average concentration and just greater than the program-level median concentration. The minimum concentration measured at WPIN is just less than the program-level first quartile.

Figure 11-8. Program vs. Site-Specific Average Formaldehyde Concentrations

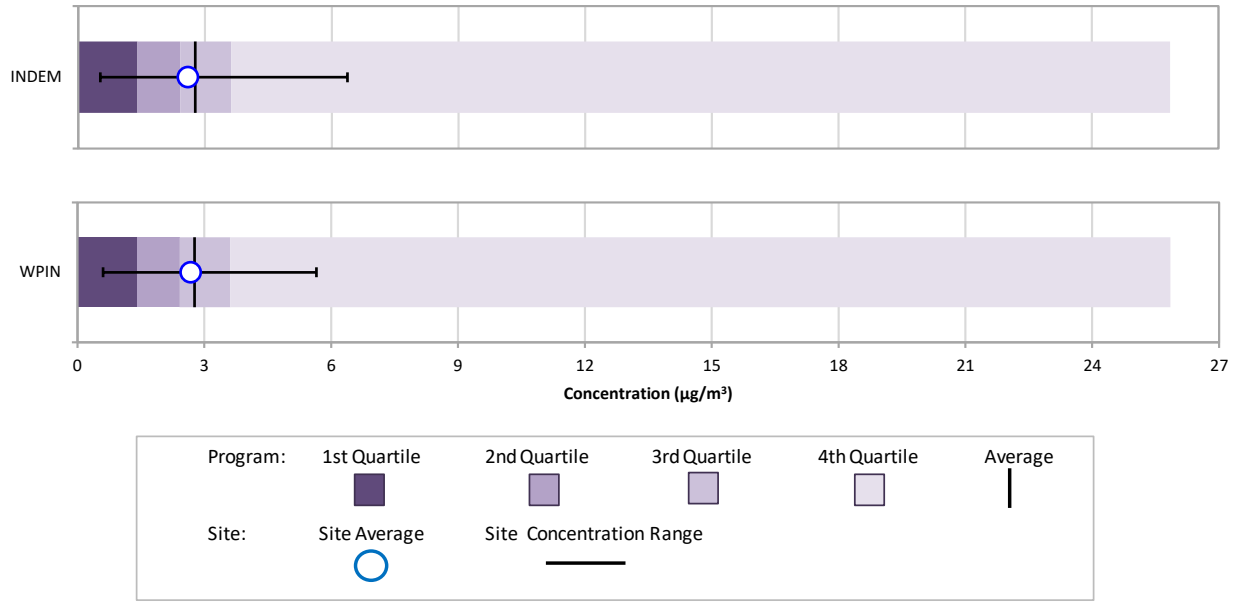


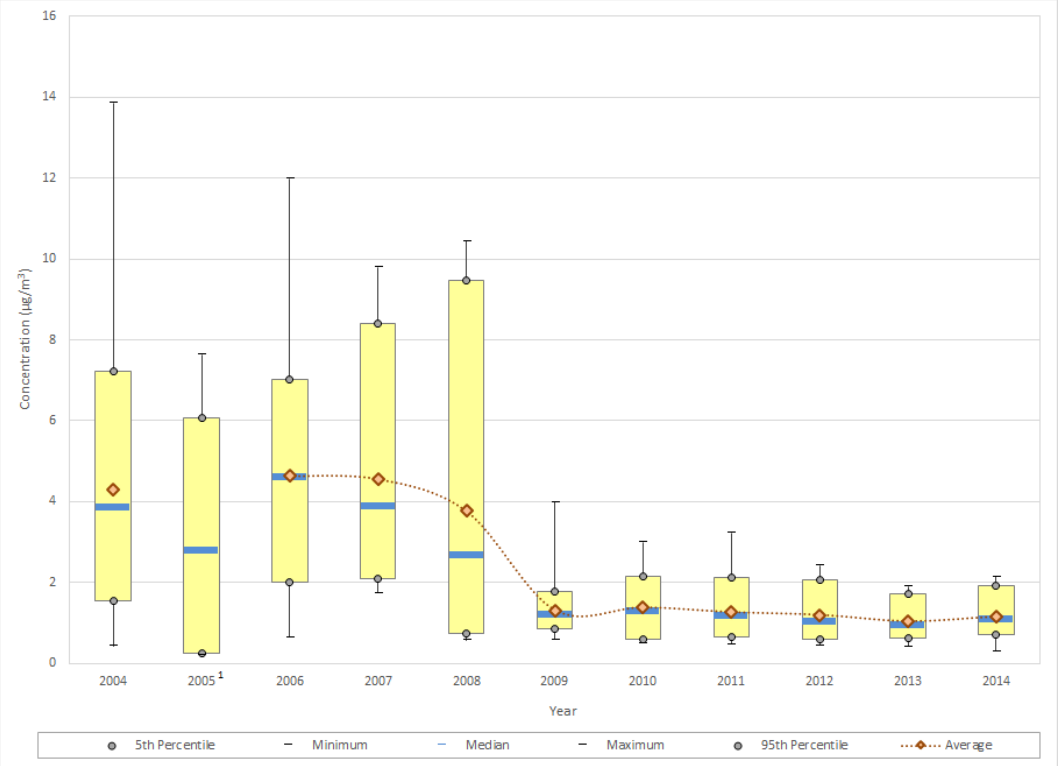
Figure 11-8 presents the box plots for formaldehyde for both sites and shows the following:

- The range of formaldehyde concentrations measured at INDEM is slightly larger than the range measured at WPIN.
- The annual average concentrations for these two sites are similar to each other. Both annual averages fall between the program-level average and program-level median concentrations.

11.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. INDEM and WPIN have sampled carbonyl compounds under the NMP since 2004 and 2007, respectively. Thus, Figures 11-9 through 11-12 present the 1-year statistical metrics for each of the pollutants of interest first for INDEM, then for WPIN. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 11-9. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at INDEM



[1] A 1-year average is not presented due to a gap in sampling between September 2005 and November 2005.

Observations from Figure 11-9 for acetaldehyde concentrations measured at INDEM include the following:

- Although carbonyl compound sampling under the NMP began in 2003, samples were only collected for 3 months. Carbonyl compound sampling began in earnest at INDEM at the beginning of 2004; thus, Figure 11-9 begins with 2004. However, a 1-year average concentration is not presented for 2005 due to a break in sampling between September and November 2005, although the range of measurements is provided.

- The maximum acetaldehyde concentration shown (13.8 µg/m^3) was measured at INDEM on June 14, 2004. Four additional concentrations greater than 10 µg/m^3 have been measured at INDEM (one in 2006 and three in 2008).

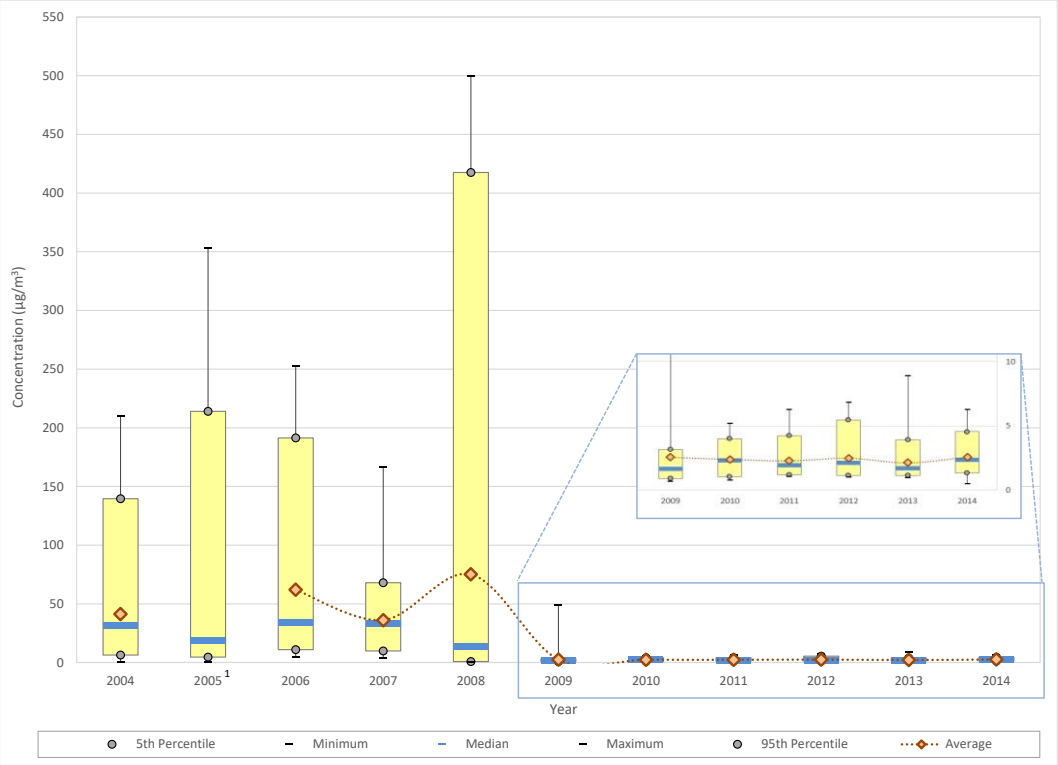
- Although the maximum and 95th percentile increased from 2007 to 2008, the 1-year average, median, 5th percentile, and minimum concentrations of acetaldehyde all exhibit decreases from 2007 to 2008. Although three concentrations greater than 10 µg/m^3 were measured in 2008 (compared to zero in 2007), the number of measurements at the lower end of the concentration range increased significantly. The number of acetaldehyde concentrations less than 2 µg/m^3 increased seven-fold (from three in 2007 to 21 for 2008).

- With the exception of the minimum and 5th percentile, the statistical parameters decreased significantly from 2008 to 2009. The 1-year average and median concentrations decreased by more than half and the 95th percentile decreased by more than 80 percent during this time. The carbonyl compound samplers were switched out in 2009, which seems to have had a significant effect on the concentrations measured, particularly with respect to formaldehyde, which is discussed in more detail below.

- Most of the statistical parameters exhibit a slight decreasing trend between 2010 and 2013, with many of them at a minimum for 2013. The median concentration for 2013 is less than 1.00 µg/m^3 and the 1-year average concentration is similar.

- With the exception of the minimum concentration, each of the statistical parameters increased slightly for 2014 compared to 2013, but are still in line with those shown for recent years.

Figure 11-10. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at INDEM



[1] A 1-year average is not presented due to a break in sampling between September 2005 and November 2005.

Observations from Figure 11-10 for formaldehyde concentrations measured at INDEM include the following:

- Five formaldehyde concentrations greater than 400 µg/m^3 were measured in the summer of 2008 (ranging from 414 µg/m^3 to 500 µg/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 11-10. There have been 38 concentrations of formaldehyde greater than 100 µg/m^3 measured at INDEM.

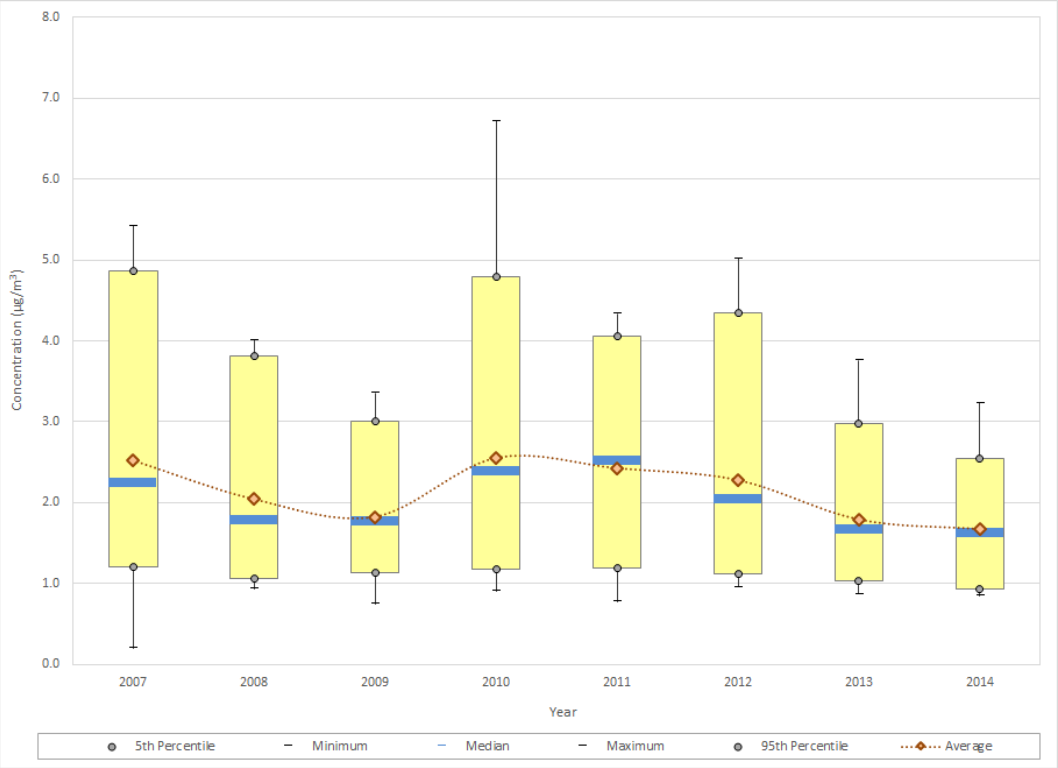
- Prior to 2009, the maximum concentration for each year is greater than 150 µg/m^3. The median concentrations for 2004, 2006, and 2007 are greater than 30 µg/m^3, indicating that at least half of the concentrations were greater than 30 µg/m^3 for these years; the median concentration for 2005 and 2008 are both greater than 10 µg/m^3.

- Although the 1-year average concentration doubled from 2007 to 2008, the median concentration decreased by more than half. This means that although the magnitude of those higher measurements is driving the 1-year average concentration upward, there were also a larger number of concentrations at the lower end of the concentration range. There were 24 formaldehyde concentrations measured in 2008 that were less than the minimum concentration measured in 2007; those 24 measurements represent 40 percent of the concentrations measured in 2008. The last "high" concentration was measured on August 4, 2008, after which no formaldehyde concentrations greater than 4 µg/m^3 were measured that year.

- All the statistical metrics decreased significantly for 2009 and the years that follow, with the 1-year average concentrations ranging from 2.14 µg/m^3 (2013) to 2.59 µg/m^3 (2014). The number of formaldehyde measurements greater than 4 µg/m^3 ranged from two to nine for each year between 2009 and 2014 (with the most measured in 2014), compared to more than half of the measurements in each of the previous years.

- INDEM's formaldehyde concentrations have historically been higher than any other NMP site sampling carbonyl compounds. During the summer PAMS season, which begins on June 1, a state-owned multi-channel collection system was 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 and their formaldehyde concentrations decreased substantially (as did their acetaldehyde concentrations, but the difference is less dramatic). Given that the elevated concentrations of formaldehyde were typically measured during the summer, this sampler change could account for the differences in the concentrations measured before and after 2009. Thus, the elevated concentrations from previous years were likely related to the multi-channel collection equipment and may not reflect the actual levels in ambient air. However, concentrations in the earlier years of sampling must have still been higher based on the median concentrations shown before and after 2009, as discussed in the previous bullets.

Figure 11-11. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at WPIN



Observations from Figure 11-11 for acetaldehyde concentrations measured at WPIN include the following:

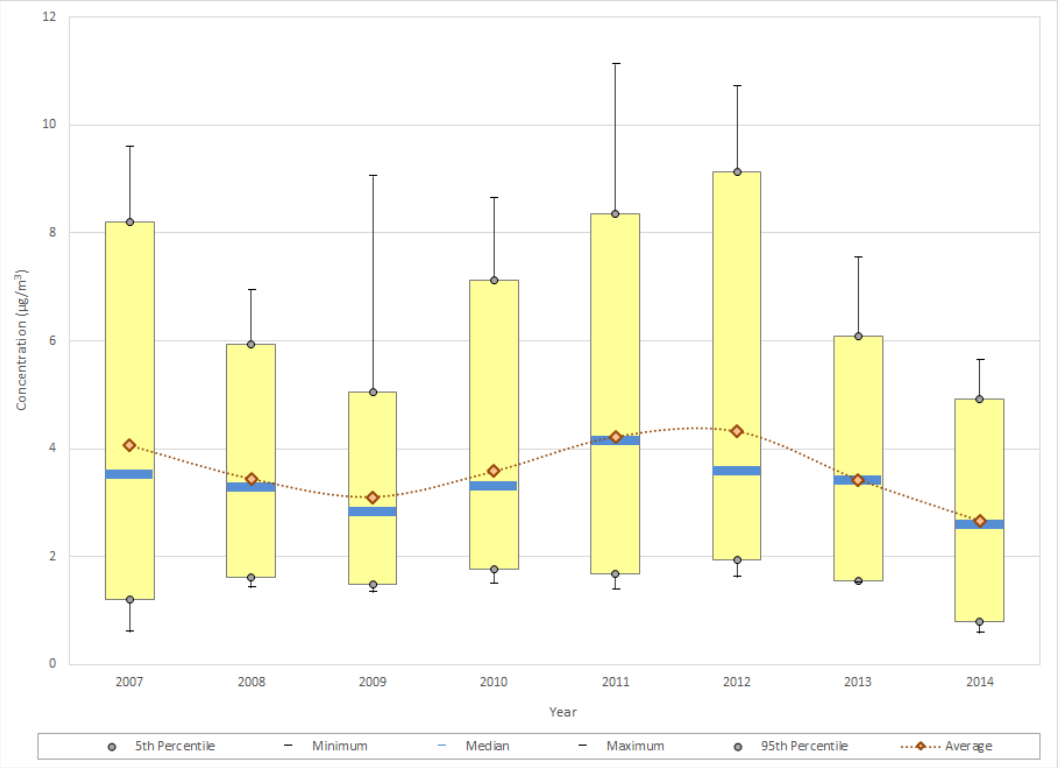
- Although carbonyl compound sampling under the NMP began in 2006, samples were collected intermittently. Carbonyl compound sampling began in earnest at WPIN at the beginning of 2007; thus, Figure 11-11 begins with 2007.

- The three highest acetaldehyde concentrations were measured at WPIN in 2010 and ranged from 5.96 µg/m^3 to 6.72 µg/m^3. Three additional concentrations greater than 5 µg/m^3 have been measured at WPIN (two in 2007 and one in 2012).

- The 1-year average concentration has a decreasing trend through 2009, after which a significant increase is shown for 2010. All of the statistical parameters exhibit an increase for 2010, particularly the maximum concentration (which doubled) and the 95th percentile (which increased by nearly 60 percent). The number of concentrations greater than 3 µg/m^3 increased five-fold, from three measured in 2009 to 15 measured in 2010.

- The 1-year average concentration has a decreasing trend again 2010, with all of the statistical parameters at a minimum for 2014 over the years of sampling, with the exception of the minimum concentration.

Figure 11-12. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at WPIN



Observations from Figure 11-12 for formaldehyde concentrations measured at WPIN include the following:

- The maximum concentration of formaldehyde measured at WPIN was measured in 2011 (11.1 µg/m^3). The next three highest concentrations were measured at WPIN in 2012 and ranged from 9.87 µg/m^3 to 10.7 µg/m^3, although additional formaldehyde concentrations greater than 9 µg/m^3 were also measured in 2007, 2009, and 2011.

- The 1-year average concentration has a decreasing trend through 2009, similar to acetaldehyde, after which an increasing trend is shown through 2012. Although the 1-year average concentration did not change significantly between 2011 and 2012, the median concentration for 2012 decreased considerably. While the range of concentrations did not change much between the two years, the data for 2011 and 2012 show that the number of concentrations in the 2 µg/m^3 to 4 µg/m^3 range increased from 21 in 2011 to 29 in 2012 while the number of concentrations in the 4 µg/m^3 to 6 µg/m^3 range decreased by nearly half (from 20 in 2011 to 11 in 2012). These changes explain the change in the median concentration while a few additional measurements in the upper end of the concentration range explain the increase in the 95th percentile.

- Nearly all of the statistical parameters exhibit decreases for 2013, with additional decreases shown for 2014. Each of the statistical parameters are at a minimum for 2014, with the 1-year average concentration less than 3 µg/m^3 for the first time.

11.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each Indiana monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.3 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

11.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Indiana sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 11-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 11-5. Risk Approximations for the Indiana Monitoring Sites

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Gary, Indiana - INDEM						
Acetaldehyde	0.0000022	0.009	57/57	1.16 ± 0.10	2.55	0.13
Formaldehyde	0.000013	0.0098	57/57	2.59 ± 0.30	33.73	0.26
Indianapolis, Indiana - WPIN						
Acetaldehyde	0.0000022	0.009	54/54	1.68 ± 0.14	3.69	0.19
Formaldehyde	0.000013	0.0098	54/54	2.68 ± 0.32	34.81	0.27

Observations for the Indiana sites from Table 11-5 include the following:

- For both sites, the annual average concentration of formaldehyde is greater than the annual average concentration of acetaldehyde. The annual average acetaldehyde

concentration for WPIN is greater than the annual average for INDEM. While this is also true for the annual averages of formaldehyde, the difference is less.

- The cancer risk approximation for formaldehyde is an order of magnitude higher than the cancer risk approximation for acetaldehyde for both sites.

- The cancer risk approximation for formaldehyde for WPIN (34.81 in-a-million) is similar to the cancer risk approximation for formaldehyde for INDEM (33.73 in-a-million). There is a similar difference between the cancer risk approximations for acetaldehyde (3.69 in-a-million for WPIN and 2.55 in-a-million for INDEM).

- Neither pollutant of interest for INDEM or WPIN has a noncancer hazard approximation greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants.

11.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 11-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 11-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 11-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 11-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 11-6. Table 11-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 11.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 11-6. 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 UREs (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)**
Gary, Indiana (Lake County) - INDEM					
Benzene	177.07	Coke Oven Emissions, PM	2.38E-03	Formaldehyde	33.73
Formaldehyde	145.37	POM, Group 1b	1.92E-03	Acetaldehyde	2.55
Ethylbenzene	94.06	Formaldehyde	1.89E-03		
Acetaldehyde	84.11	Benzene	1.38E-03		
1,3-Butadiene	27.28	Hexavalent Chromium	9.67E-04		
POM, Group 1b	21.84	1,3-Butadiene	8.18E-04		
Naphthalene	13.35	Arsenic, PM	6.53E-04		
Tetrachloroethylene	9.35	Naphthalene	4.54E-04		
POM, Group 2b	2.78	POM, Group 2b	2.45E-04		
POM, Group 2d	2.68	Nickel, PM	2.38E-04		
Indianapolis, Indiana (Marion County) - WPIN					
Benzene	421.74	Formaldehyde	4.14E-03	Formaldehyde	34.81
Formaldehyde	318.24	Benzene	3.29E-03	Acetaldehyde	3.69
Ethylbenzene	268.73	1,3-Butadiene	1.87E-03		
Acetaldehyde	189.64	Naphthalene	1.11E-03		
1,3-Butadiene	62.21	Arsenic, PM	1.05E-03		
Tetrachloroethylene	33.59	Ethylbenzene	6.72E-04		
Naphthalene	32.73	POM, Group 2b	6.51E-04		
POM, Group 2b	7.40	Nickel, PM	5.08E-04		
POM, Group 2d	5.22	POM, Group 2d	4.60E-04		
Propylene oxide	4.72	Hexavalent Chromium	4.20E-04		

Table 11-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Indiana Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Gary, Indiana (Lake County) - INDEM					
Toluene	669.66	Acrolein	476,219.32	Formaldehyde	0.26
Xylenes	436.89	Lead, PM	52,690.40	Acetaldehyde	0.13
Hexane	427.58	Manganese, PM	22,492.64		
Methanol	328.00	Hydrochloric acid	16,187.23		
Hydrochloric acid	323.74	Formaldehyde	14,834.03		
Benzene	177.07	1,3-Butadiene	13,641.59		
Formaldehyde	145.37	Chlorine	12,016.67		
Ethylene glycol	98.80	Arsenic, PM	10,126.34		
Ethylbenzene	94.06	Acetaldehyde	9,345.56		
Acetaldehyde	84.11	Benzene	5,902.45		
Indianapolis, Indiana (Marion County) - WPIN					
Toluene	1,660.99	Acrolein	1,224,556.10	Formaldehyde	0.27
Xylenes	1,008.89	Formaldehyde	32,473.78	Acetaldehyde	0.19
Hexane	773.82	1,3-Butadiene	31,104.81		
Methanol	532.81	Hydrochloric acid	23,337.36		
Hydrochloric acid	466.75	Acetaldehyde	21,070.71		
Benzene	421.74	Arsenic, PM	16,282.89		
Formaldehyde	318.24	Benzene	14,057.94		
Ethylbenzene	268.73	Lead, PM	13,691.58		
Ethylene glycol	203.01	Nickel, PM	11,766.86		
Acetaldehyde	189.64	Naphthalene	10,909.09		

Observations from Table 11-6 include the following:

- Benzene, formaldehyde, and ethylbenzene are the three highest emitted pollutants with cancer UREs in both Marion and Lake County, although the quantity emitted is higher in Marion County.

- Coke oven emissions is the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Lake County, followed by POM, Group 1b and formaldehyde. Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions for Marion County.

- Six of the highest emitted pollutants in Lake County also have the highest toxicity-weighted emissions; seven of the highest emitted pollutants in Marion County also have the highest toxicity-weighted emissions.

- Acetaldehyde and formaldehyde are the only pollutants of interest for INDEM and WPIN. Acetaldehyde and formaldehyde appear among the highest emitted pollutants for both counties, with only formaldehyde appearing among the pollutants with the highest toxicity-weighted emissions for each county. Formaldehyde has the highest toxicity-weighted emissions in Marion County and ranks third highest for Lake County.

- While several metals (arsenic, nickel, and hexavalent chromium) are among the pollutants with the highest toxicity-weighted emissions for both counties, none of these are among the highest emitted pollutants for either county. This demonstrates that a pollutant does not have to be emitted in large quantities to be a health hazard.

- Several POM Groups and naphthalene appear among the highest emitted pollutants and the pollutants with the highest toxicity-weighted emissions for both counties. Neither site sampled PAHs under the NMP.

Observations from Table 11-7 include the following:

- Toluene, xylenes, and hexane are the three highest emitted pollutants with noncancer RfCs in both Marion and Lake County, although the quantity emitted is higher in Marion County. The same 10 pollutants appear on each county's list of highest emitted pollutants.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties. Lead and manganese rank second and third for Lake County, while formaldehyde and 1,3-butadiene rank second and third for Marion County.

- Four of the highest emitted pollutants in Lake County also have the highest toxicity-weighted emissions (formaldehyde, acetaldehyde, benzene, and hydrochloric acid). The same four pollutants appear on both emissions-based lists for Marion County.

- Several metals are among the pollutants with the highest toxicity-weighted emissions for Lake and Marion Counties, although none of these appear among the highest emitted pollutants.

- Formaldehyde and acetaldehyde appear in all three columns in Table 11-7 for both sites.

11.6 Summary of the 2014 Monitoring Data for INDEM and WPIN

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

❖ *Carbonyl compounds were sampled for at INDEM and WPIN in 2014. Acetaldehyde and formaldehyde failed screens for each site and were identified as pollutants of interest for each site.*

❖ *The annual average concentration of formaldehyde is greater than the annual average concentration of acetaldehyde for both sites. Concentrations of formaldehyde exhibit a seasonal trend, with higher concentrations measured during the warmer months of the year.*

❖ *Concentrations of formaldehyde and acetaldehyde decreased significantly at INDEM from 2008 to 2009; these changes may be at least partially explained by a sampler replacement. Concentrations of formaldehyde and acetaldehyde both exhibit a decreasing trend at WPIN in the last few years.*

12.0 Sites in Kentucky

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS and UATMP 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

12.1 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.

Data from 10 monitoring sites in Kentucky are included in this section, one NATTS site and nine predominantly "source-oriented" sites. Three monitoring sites are located in northeast Kentucky, two in Ashland and one near Grayson Lake. One monitoring site is located south of Evansville, Indiana in the town of Baskett. Five monitoring sites are located in or near the Calvert City area, east of Paducah, Kentucky. The final monitoring site is located in Lexington, in north-central Kentucky. A composite satellite image and facility map is provided for each site in Figures 12-1 through 12-15. The composite satellite images were retrieved from ArcGIS Explorer and show each monitoring site in its respective location. The facility maps identify nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of each site are included in the facility counts provided. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at each monitoring site. Further, this boundary provides both the proximity of emissions sources to each monitoring site as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundaries are still visible on the maps for reference, but have been grayed out in order to emphasize emissions sources within the boundaries. Table 12-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for each site.

Figure 12-1. Ashland, Kentucky (ASKY) Monitoring Site

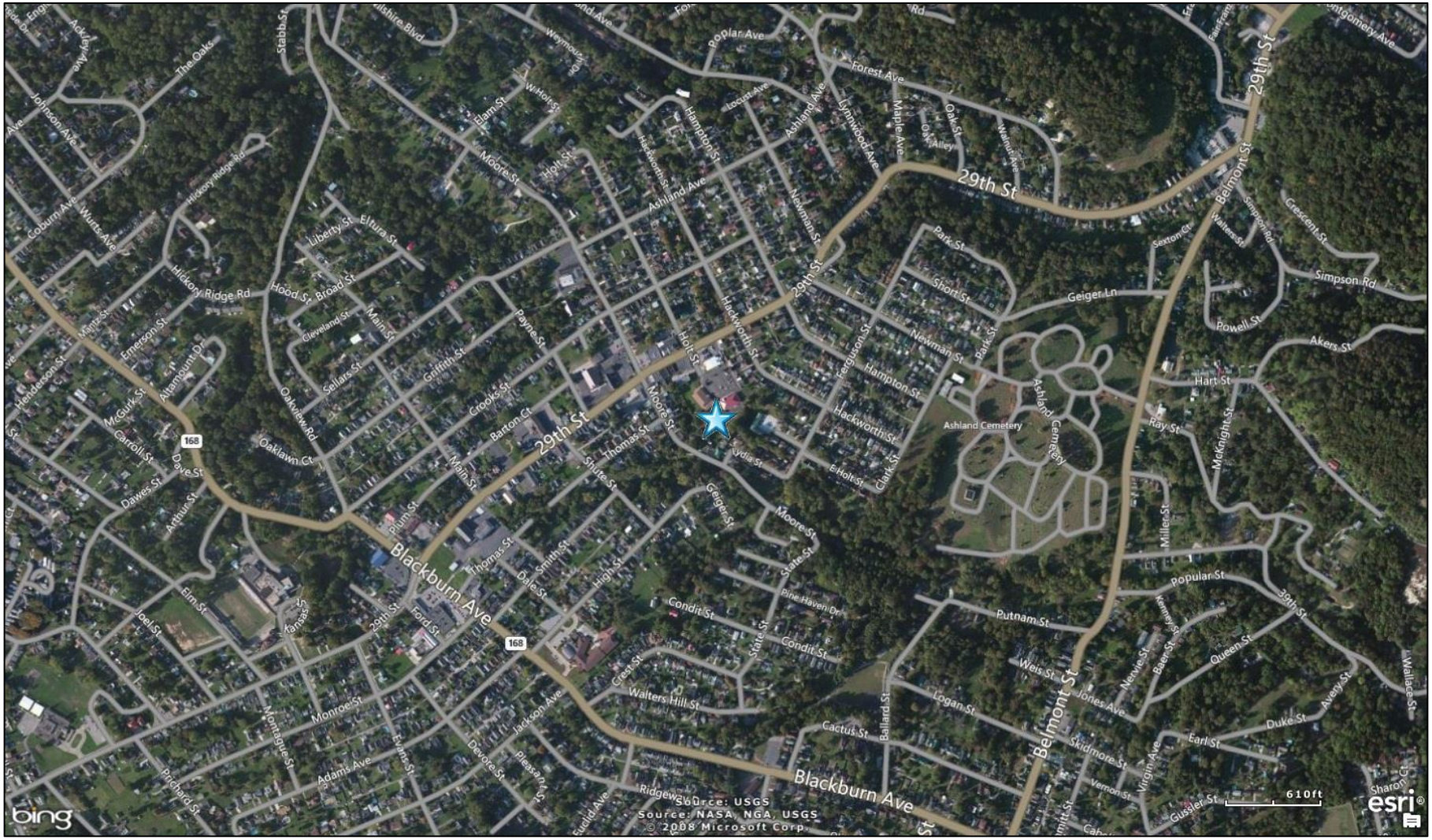


Figure 12-2. Ashland, Kentucky (ASKY-M) Monitoring Site

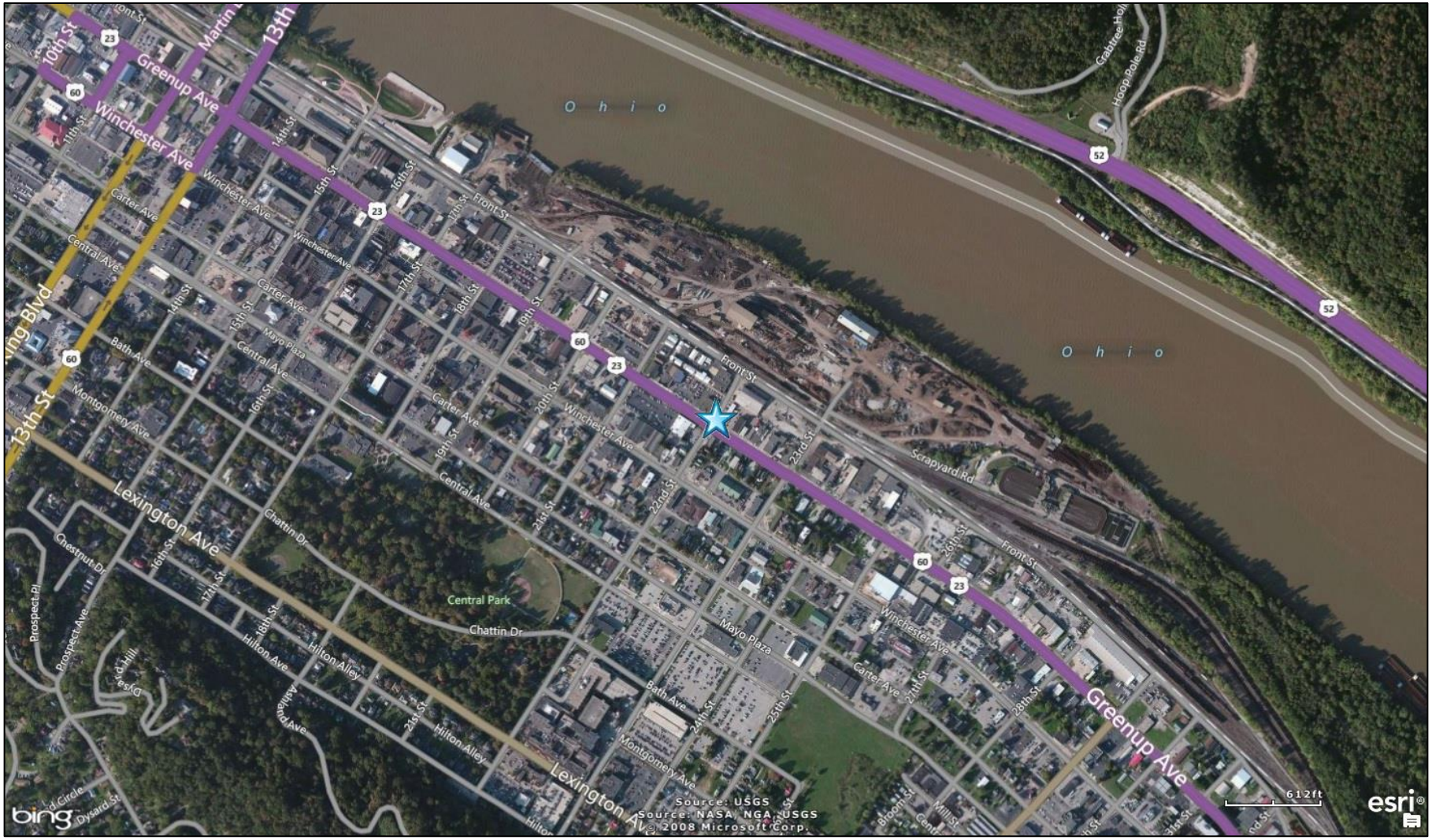


Figure 12-3. NEI Point Sources Located Within 10 Miles of ASKY and ASKY-M

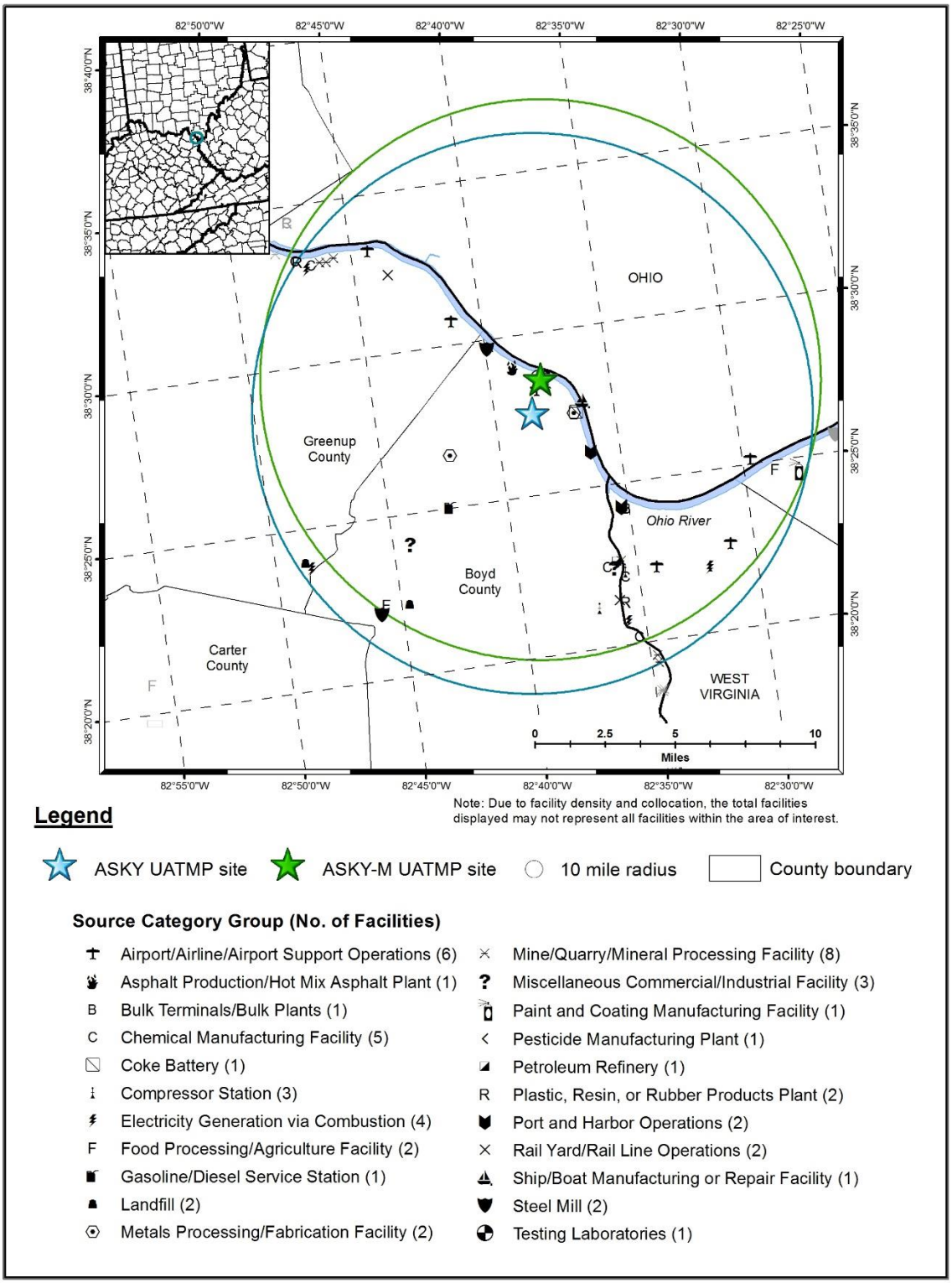


Figure 12-4. Grayson, Kentucky (GLKY) Monitoring Site

Figure 12-5. NEI Point Sources Located Within 10 Miles of GLKY

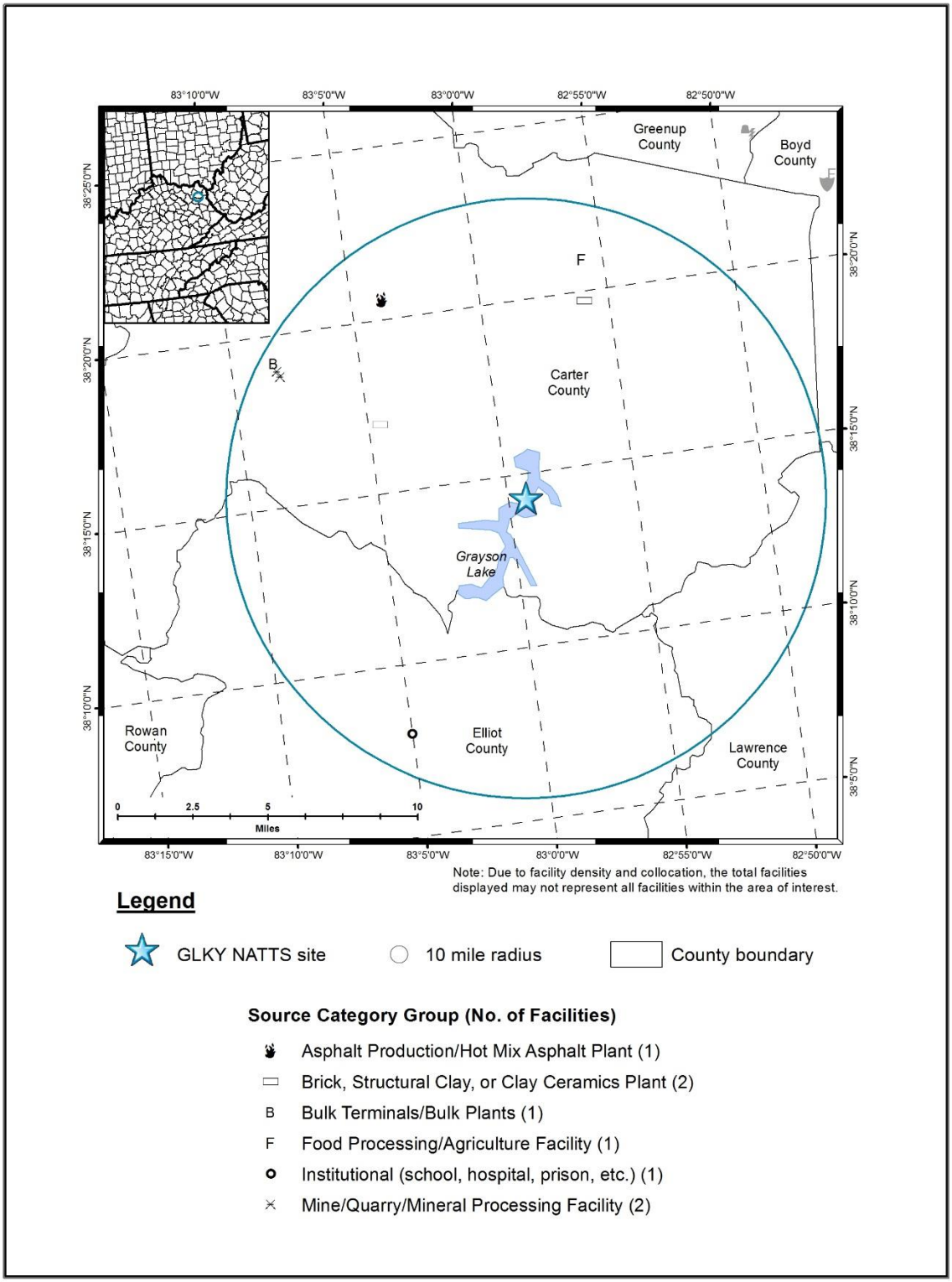


Figure 12-6. Baskett, Kentucky (BAKY) Monitoring Site

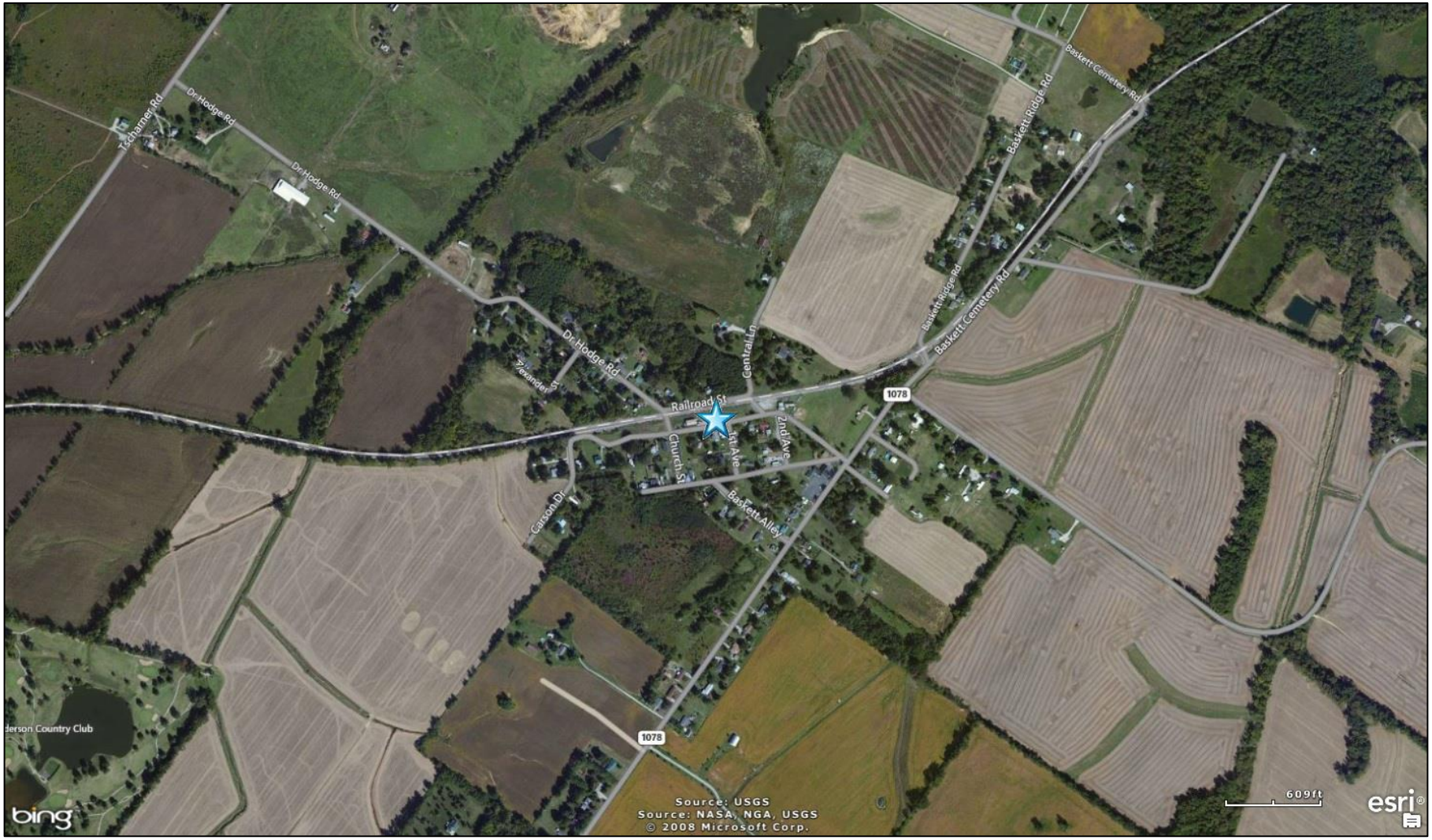


Figure 12-7. NEI Point Sources Located Within 10 Miles of BAKY

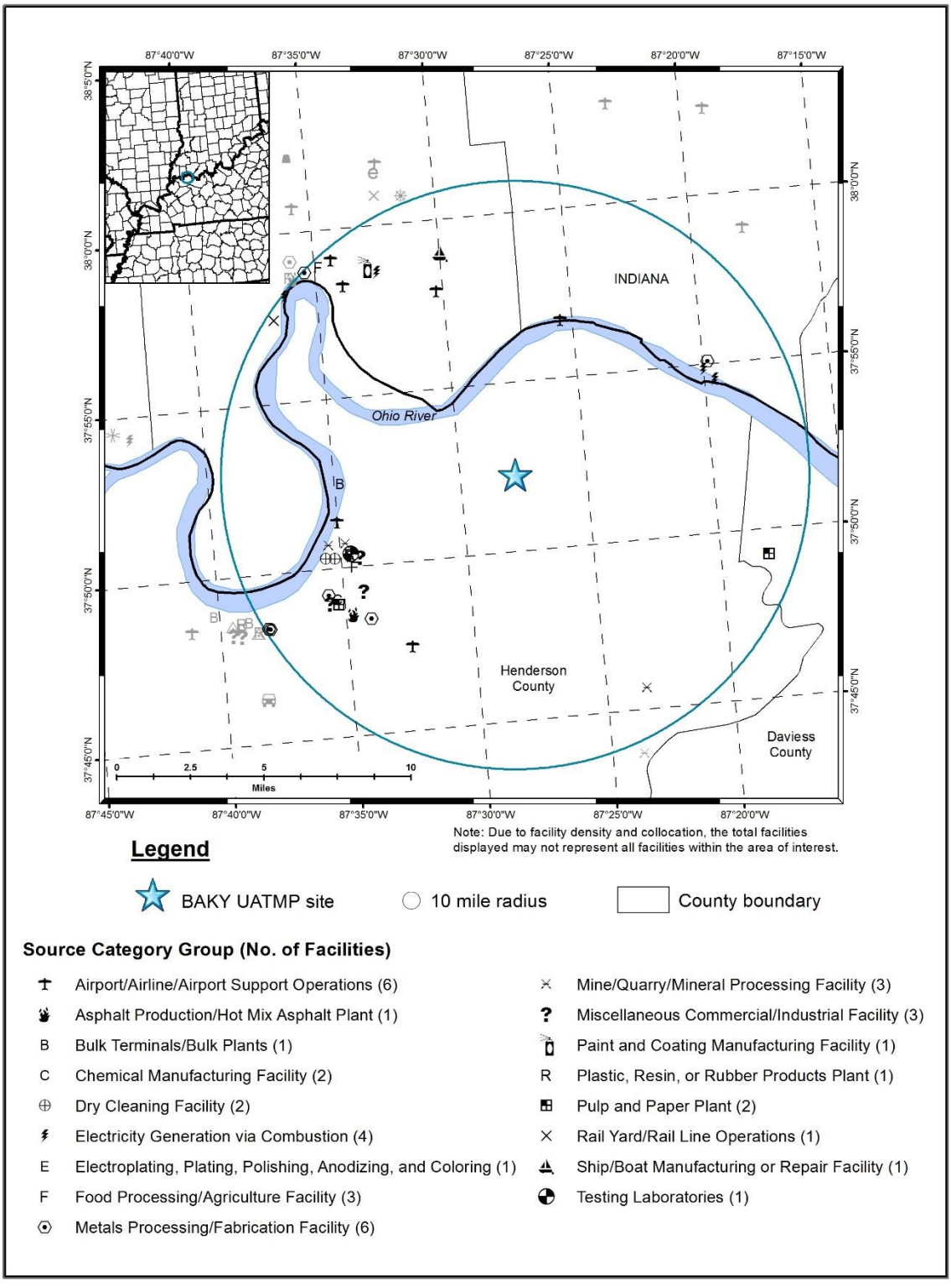


Figure 12-8. Calvert City, Kentucky (ATKY) Monitoring Site

Figure 12-9. Smithland, Kentucky (BLKY) Monitoring Site

Figure 12-10. Calvert City, Kentucky (CCKY) Monitoring Site

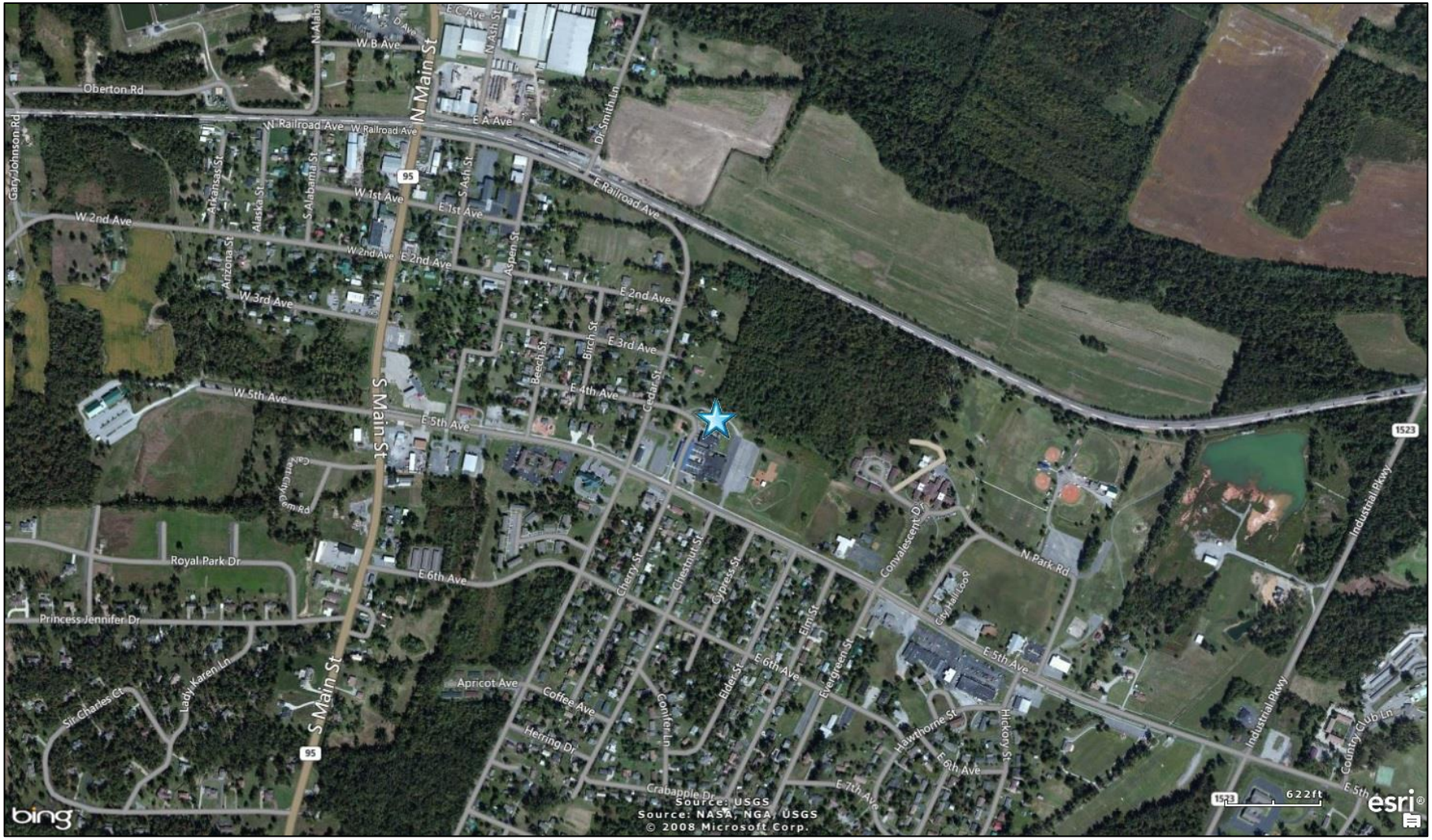


Figure 12-11. Calvert City, Kentucky (LAKY) Monitoring Site

Figure 12-12. Calvert City, Kentucky (TVKY) Monitoring Site

Figure 12-13. NEI Point Sources Located Within 10 Miles of ATKY, BLKY, CCKY, LAKY, and TVKY

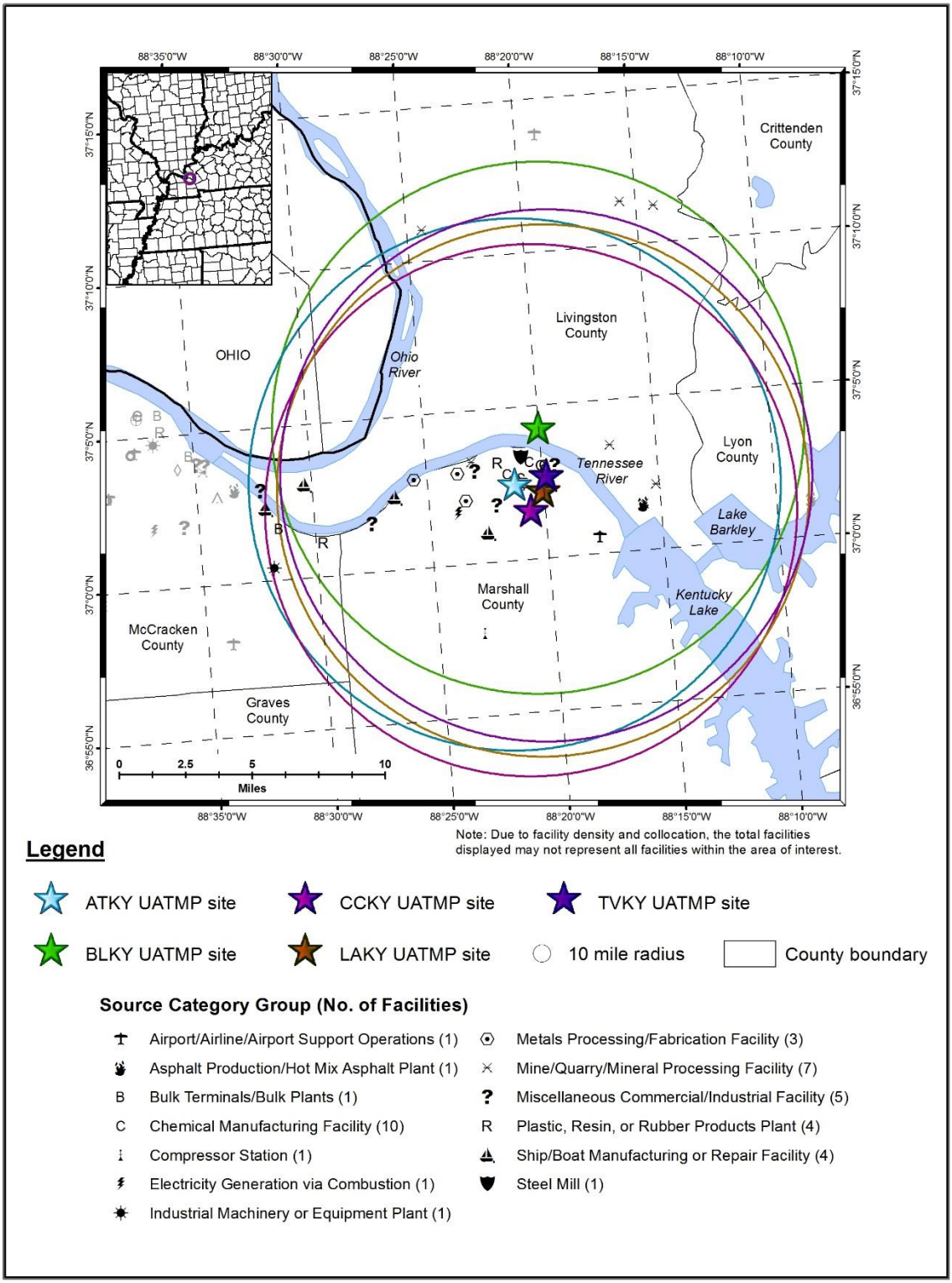


Figure 12-14. Lexington, Kentucky (LEKY) Monitoring Site

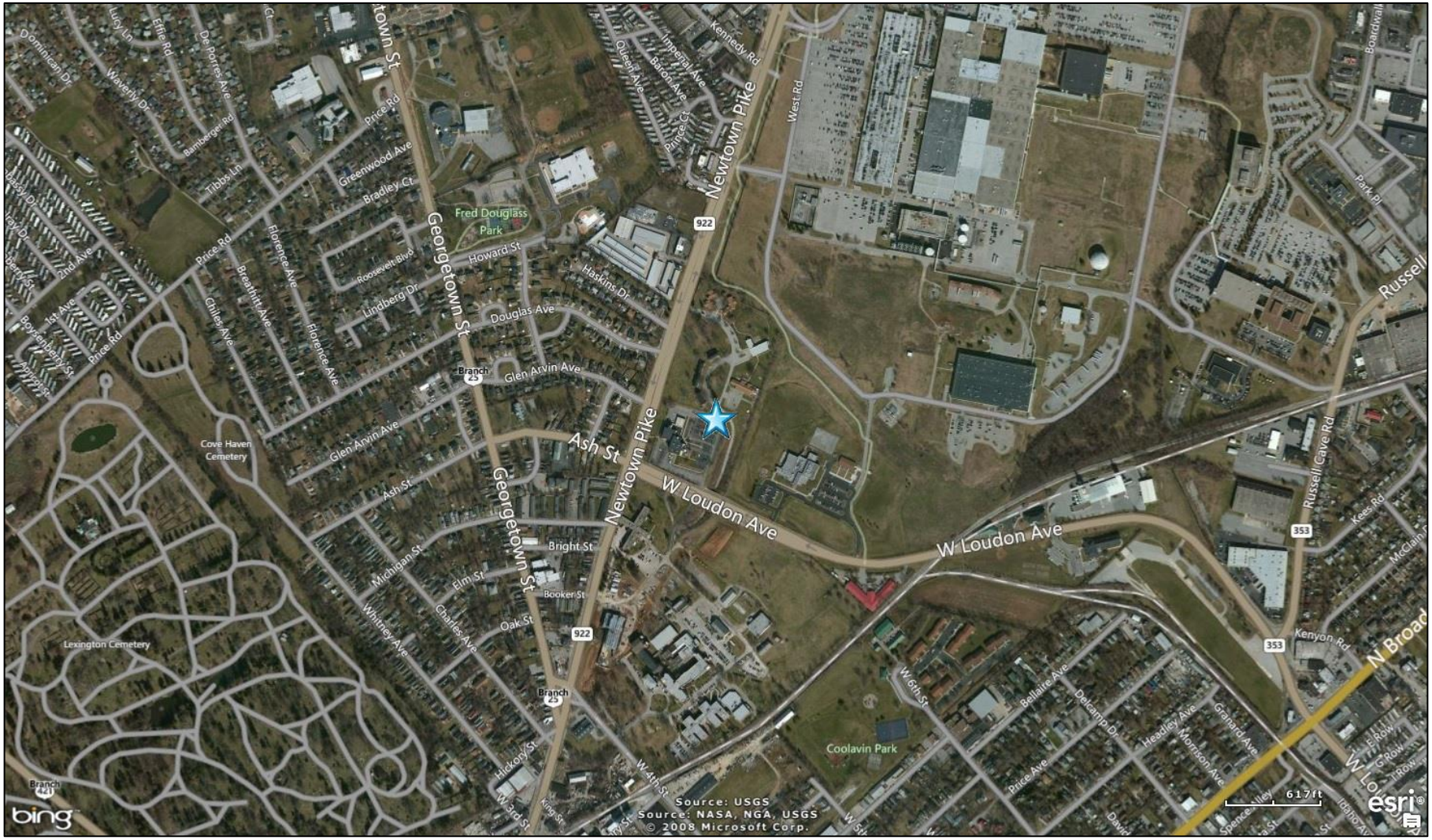


Figure 12-15. NEI Point Sources Located Within 10 Miles of LEKY

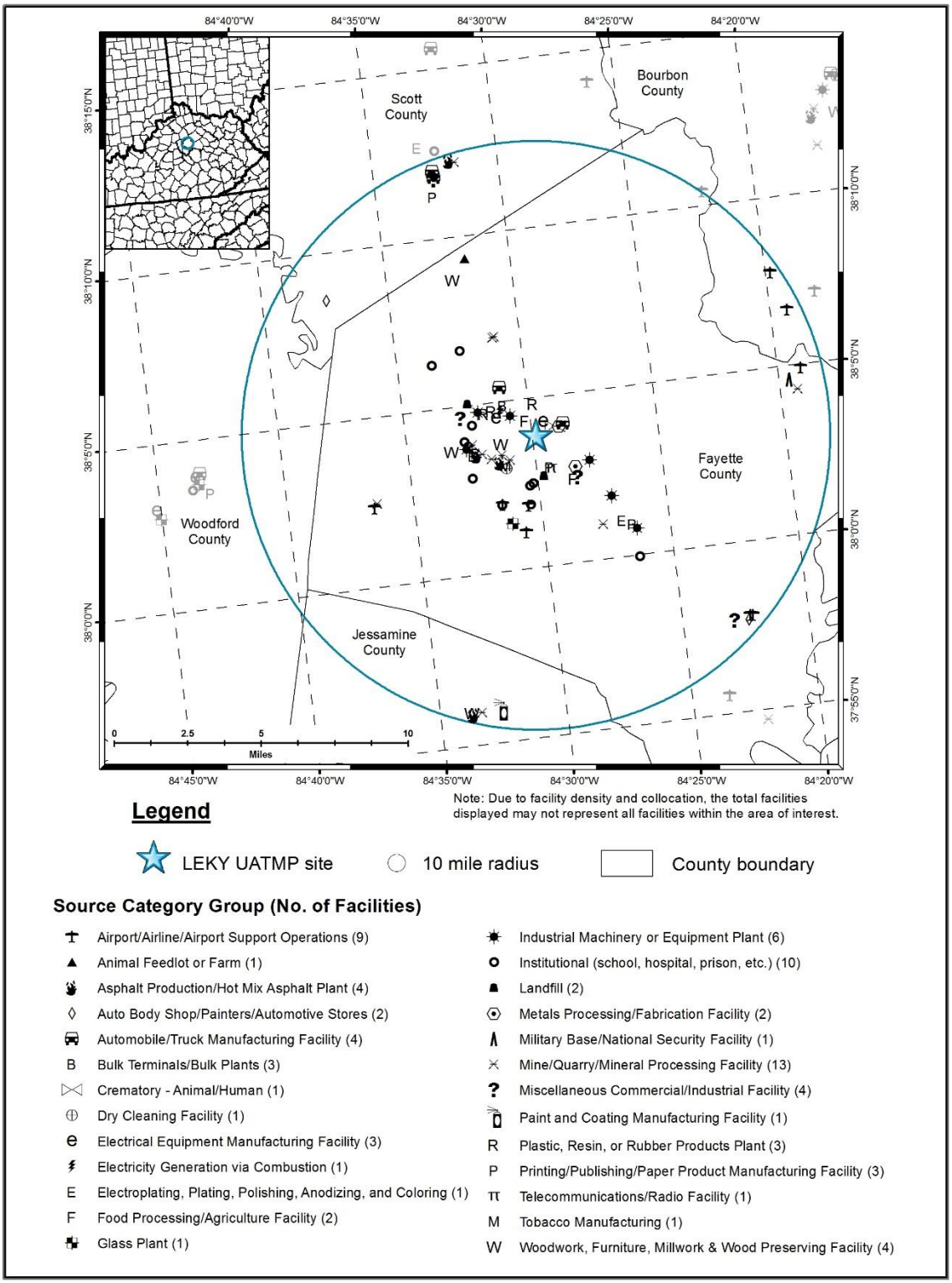


Table 12-1. Geographical Information for the Kentucky Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
ASKY	21-019-0017	Ashland	Boyd	Huntington-Ashland, WV-KY-OH	38.459340, -82.640410	Residential	Suburban	5,934	29th St between Newman St and Lynwood Ave
ASKY-M	21-019-0002	Ashland	Boyd	Huntington-Ashland, WV-KY-OH	38.476000, -82.631370	Industrial	Urban/City Center	12,842	Greenup (23rd) between 16th St and 17th St
GLKY	21-043-0500	Grayson	Carter	None	38.238870, -82.988100	Residential	Rural	303	Rd 1496, S of Camp Webb Rd
BAKY	21-101-0014	Baskett	Henderson	Evansville, IN-KY	37.871200, -87.463750	Commercial	Rural	922	Rte 1078 N of Hwy 60
ATKY	21-157-0016	Calvert City	Marshall	None	37.041760, -88.354070	Industrial	Suburban	3,262	Main St (Rte 95), S of Johnson Riley Rd
BLKY	21-139-0004	Smithland	Livingston	Paducah, KY-IL	37.071510, -88.333890	Agricultural	Rural	2,510	Rte 93/453, E of Bloodworth Rd
CCKY	21-157-0018	Calvert City	Marshall	None	37.027020, -88.343870	Residential	Suburban	4,050	Industrial Pkwy, S of E 5th Ave
LAKY	21-157-0019	Calvert City	Marshall	None	37.037180, -88.334110	Residential	Suburban	1,189	Rte 282 (Gilbertsville Hwy), E of Industrial Lane
TVKY	21-157-0014	Calvert City	Marshall	None	37.045200, -88.330870	Industrial	Suburban	1,458	Industrial Pkwy (Rte 1523), E of Plant Cut-off Rd
LEKY	21-067-0012	Lexington	Fayette	Lexington-Fayette, KY	38.065030, -84.497610	Residential	Suburban	18,993	Newton Pike, N of W Loudon Ave

[1]AADT reflects 2014 data for ASKY, LEKY & TVKY; 2012 data for ASKY-M, GLKY, BAKY, ATKY, and LAKY; and 2013 data for BLKY and CCKY (KYTC, 2014)
BOLD ITALICS = EPA-designated NATTS Site

There are two Kentucky monitoring sites in the town of Ashland. Ashland is located on the Ohio River, just north of where the borders of Kentucky, West Virginia, and Ohio meet, and is part of the Huntington-Ashland, WV-KY-OH CBSA. The ASKY site is located behind the county health department, in a residential area in the center of town, as shown in Figure 12-1. The ASKY-M site is located on the roof of an oil company complex in the north-central part of Ashland, which is more industrial. The monitoring site is located less than one-quarter mile from the Ohio River, as shown in Figure 12-2, and a rail yard, a scrap yard, and other industries are located between ASKY-M and the river.

ASKY and ASKY-M are approximately 1.25 miles apart, as shown in Figure 12-3. Most of the emissions sources near these sites are located along the Ohio River and its tributary to the south, the Big Sandy River. These emissions sources reflect a variety of industries including asphalt production, chemical manufacturing, food processing, metals processing/fabrication, pesticide manufacturing, petroleum refining, and ship/boat manufacturing, to name a few. A cluster of emissions sources is located very close to ASKY-M, within a half-mile, such that the symbol for the site hides the symbols for the facilities. This cluster includes a testing laboratory, a miscellaneous commercial/industrial facility, a mine/quarry, and a heliport at a hospital. There are no emissions sources within a half-mile of ASKY. The closest sources to ASKY are the same ones under the symbol for ASKY-M, although a metals processing/fabrication facility and coke battery are located a little farther to the east of ASKY.

Grayson Lake is located in northeast Kentucky, south of the town of Grayson, and southwest of the Huntington-Ashland, WV-KY-OH CBSA. 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, 2016; ACE, 2016). The closest road to the monitoring site is a service road feeding into Camp Grayson, as shown in Figure 12-4. This site serves as the Grayson Lake NATTS site. Figure 12-5 shows that few point sources surround GLKY and that most of them are on the outer periphery of the 10-mile boundary around GLKY. This is not surprising given the rural nature of the area and that Grayson Lake is located roughly in the center of the 10-mile radius in Figure 12-5. Sources within 10 miles of GLKY are involved in asphalt production, brick/structural clay/clay ceramics manufacturing, food processing, and mining, among others.

The BAKY monitoring site is located at the Baskett Fire Department in Baskett, a small rural town in northwest Kentucky. Baskett is northeast of Henderson and south of Evansville, Indiana. The Ohio River is the border between Kentucky and Indiana and meanders through the area, with the Green River, a tributary of the Ohio River, just over 1 mile north of the site at the closest point. The fire department property backs up to a rail line that runs through town. Open fields surround the town, as shown in Figure 12-6, and there are no emissions sources within a few miles of BAKY, as shown in Figure 12-7. The cluster of emissions sources to the southwest of BAKY are located in or near Henderson, while the sources to the northwest are located in Evansville.

There are five monitoring sites in and around the Calvert City area. Calvert City is located on the Tennessee River, east of the Paducah metro area, approximately 6 miles southeast of the Ohio River and the Kentucky/Illinois border. The northern half of the city is highly industrialized while the southern half is primarily residential, with a rail line that transverses the area acting as a pseudo-dividing line. The city is home to some 16 industrial plants, including metal, steel, and chemical plants (Calvert City, 2016).

The ATKY monitoring site is located off Main Street (State Road 95), just south of the entrance to a chemical manufacturing plant. The majority of the city's industry lies north and east of ATKY. Approximately 1 mile east-southeast down Gilbertsville Highway is the LAKY monitoring site. LAKY is located behind a mobile home park. Although located in a residential area, industrial areas are located to the west, northwest, and north. Just over one-half mile north of LAKY is the TVKY monitoring site. This monitoring site is located at a power substation just south of another chemical manufacturing plant. The fourth monitoring site in Calvert City is located at Calvert City Elementary School. The CCKY site is located behind the school, which backs up to a forested area just south of the aforementioned rail line and to the south of most of the industry. The BLKY site is located across the Tennessee River, north of Calvert City, in Smithland. The site is located on a residential property in an agricultural area. This site is potentially downwind of the Calvert City industrial area. The composite satellite images for these sites are provided in alphabetical order by site in Figures 12-8 through 12-12.

Figure 12-13 is the facility map for the Calvert City sites and provides an indication of how close these sites are to one another. Most of the emissions sources in Calvert City are

located between ATKY, LAKY, and the Tennessee River. Many of the emissions sources closest to the Calvert City sites are in the chemical manufacturing source category. There are also several plastic, resin, or rubber product plants located between these sites. Industries located farther away from the sites but within 10 miles include ship/boat manufacturing or repair; mine, quarry, or mineral processing; a steel mill; metals processing/fabrication, and an asphalt production/hot mix asphalt plant.

The LEKY monitoring site is located in the city of Lexington in north-central Kentucky. The site is located on the property of the county health department in a primarily residential area of northern Lexington. A YMCA is located adjacent to the health department along W. Loudon Avenue and a community college is located immediately to the south. The mental health facility formerly located on the property has been demolished after relocating. Although the area is residential and suburban, most of the residences are located to the west of Newtown Pike (922). An electrical equipment and ink manufacturer is located to the northeast of the site, as shown in Figure 12-14. LEKY is located just over a half-mile south of New Circle Road (4/421), a loop encircling the city of Lexington. Figure 12-15 shows that most of the emissions sources within 10 miles of LEKY are within a few miles of the site. Emissions sources within 1 mile of LEKY include a food processing plant, the aforementioned electrical equipment manufacturing plant, a crematory, a metals processing and fabrication facility, and an automobile/truck manufacturing facility.

In addition to providing city, county, CBSA, and land use/location setting information, Table 12-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. Among these sites, traffic volume is highest near LEKY and ASKY-M and lowest near GLKY and BAKY. Traffic counts for all of the Kentucky sites are in the bottom half of the range compared to other NMP sites, with the traffic near GLKY the lowest among all NMP sites.

12.2 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 the year.

12.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Kentucky sites, site-specific data were available for some, but not all, of the parameters in Table 12-2 for half of the monitoring sites. Temperature and wind data were collected at ASKY, BLKY, and CCKY; at GLKY, temperature, pressure, dew point, relative humidity, and wind data were collected. For the remaining sites, meteorological observations were not available in AQS. Weather data from the closest NWS station were used for meteorological parameters without data and/or as a surrogate for parameters without complete observation records. A map showing the distance between each Kentucky monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 12-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 12-2 is the 95 percent confidence interval for each parameter. As shown in Table 12-2, average meteorological conditions on sample days were generally representative of average weather conditions experienced throughout the year at each site. GLKY is the site with the smallest differences between the sample day averages and the full-year averages, while the Calvert City sites have the largest, particularly for dew point. It should be noted that even though sample days are generally standardized, the need for making up invalid samples leads to additional sample days. This is why although the data are from the same weather station, the sample day averages are often different from each other, such is the case with ATKY, LAKY, and TVKY.

Table 12-2. Average Meteorological Conditions near the Kentucky Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Health Department, Ashland, Kentucky - ASKY [2]							
Sample Days (62)	55.1 ± 1.0	41.4 ± 1.1	71.4 ± 1.1	30.08 ± 0.01	29.18 ± 0.01	NW	1.4 ± 0.1
2014	56.9 ± 0.4	43.0 ± 0.4	71.1 ± 0.4	30.05 ± <0.01	29.15 ± <0.01	NW	1.3 ± <0.1
21st and Greenup, Ashland, Kentucky - ASKY-M [3]							
Sample Days (62)	51.8 ± 1.0	41.8 ± 1.0	71.7 ± 1.0	30.07 ± 0.01	29.18 ± 0.01	SSW	4.5 ± 0.2
2014	53.5 ± 0.4	43.0 ± 0.4	71.1 ± 0.4	30.05 ± <0.01	29.15 ± <0.01	SSW	4.6 ± 0.1
Grayson, Kentucky – GLKY[4]							
Sample Days (73)	52.6 ± 0.9	43.5 ± 0.9	74.3 ± 1.0	30.06 ± 0.01	29.14 ± 0.03	SW	2.5 ± 0.1
2014	53.6 ± 0.4	44.1 ± 0.4	73.7 ± 0.4	30.05 ± <0.01	29.14 ± 0.01	SW	2.6 ± 0.1
Baskett, Kentucky – BAKY[5]							
Sample Days (64)	53.2 ± 1.1	41.4 ± 1.0	66.8 ± 0.8	30.10 ± 0.01	29.68 ± 0.01	SSW	5.5 ± 0.2
2014	55.3 ± 0.4	43.9 ± 0.4	68.0 ± 0.4	30.06 ± <0.01	29.64 ± <0.01	SSW	5.9 ± 0.1
Calvert City, Kentucky – CCKY[6]							
Sample Days (50)	57.8 ± 1.3	46.1 ± 1.3	65.2 ± 1.0	30.05 ± 0.01	29.61 ± 0.01	SW	2.7 ± 0.1
Jan-Oct 2014	59.5 ± 0.5	48.2 ± 0.5	66.9 ± 0.4	30.03 ± <0.01	29.59 ± <0.01	SE	2.8 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature and wind parameters were measured at ASKY. Data for the remaining parameters were obtained from the closest NWS weather station located at Tri-State/M.J. Ferguson Field Airport, WBAN 03860.
[3]Meteorological data for ASKY-M were not available in AQS. This information was obtained from the NWS weather station located at Tri-State/M.J. Ferguson Field Airport, WBAN 03860.
[4]All meteorological parameters except sea level pressure were measured at GLKY. Data for sea level pressure were obtained from the closest NWS weather station located at Tri-State/M.J. Ferguson Field Airport, WBAN 03860.
[5]Meteorological data for BAKY were not available in AQS. This information was obtained from the NWS weather station located at Evansville Regional Airport, WBAN 93817.
[6]Temperature and wind parameters were measured at CCKY through the end of the sampling period. Data for the remaining parameters were obtained from the closest NWS weather station located at Barkley Regional Airport, WBAN 03816.
[7]Temperature and wind parameters were measured at BLKY. Data for the remaining parameters were obtained from the closest NWS weather station located at Barkley Regional Airport, WBAN 03816.
[8]Meteorological data for ATKY, LAKY, and TVKY were not available in AQS. This information was obtained from the NWS weather station located at Barkley Regional Airport, WBAN 03816.
[9]Meteorological data for LEKY were not available in AQS. This information was obtained from the NWS weather station located at Blue Grass Airport, WBAN 93820.

Table 12-2. Average Meteorological Conditions near the Kentucky Monitoring Sites (Continued)

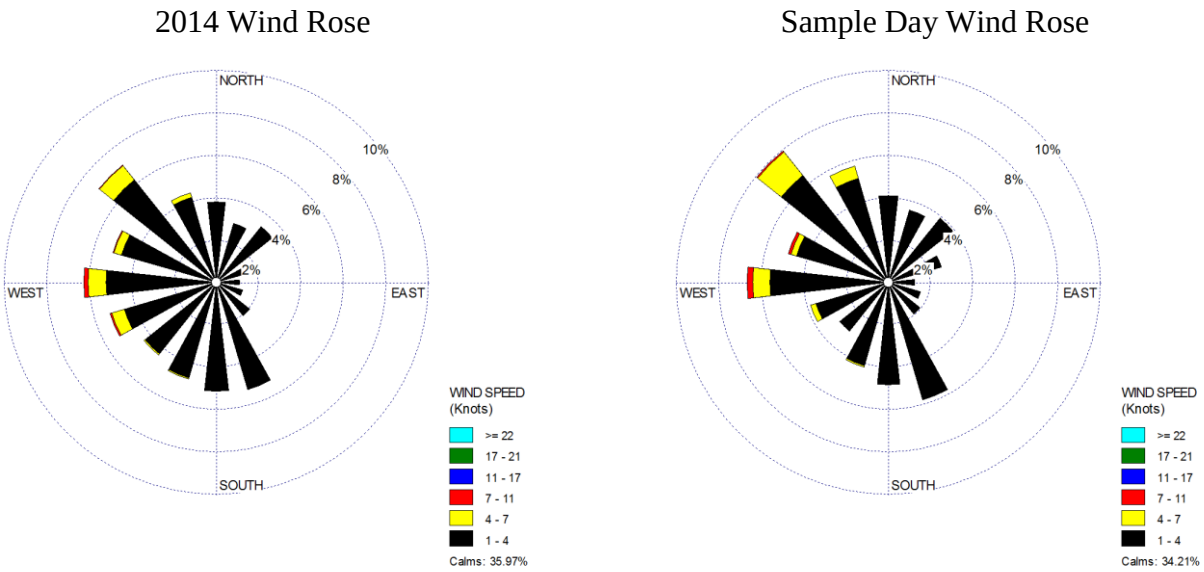
Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Smithland, Kentucky – BLKY[7]							
Sample Days (62)	54.2 ± 1.1	43.5 ± 1.1	66.3 ± 0.9	30.09 ± <0.01	29.64 ± <0.01	SSW	3.3 ± 0.1
2014	55.7 ± 0.4	45.9 ± 0.4	69.0 ± 0.4	30.05 ± <0.01	29.61 ± <0.01	S	3.3 ± 0.1
Barkley Regional Airport[8]							
ATKY (61)	55.7 ± 1.1	43.7 ± 1.1	66.4 ± 0.9	30.09 ± 0.01	29.64 ± 0.01	S	5.4 ± 0.2
LAKY (62)	55.6 ± 1.1	43.6 ± 1.1	66.7 ± 0.9	30.09 ± 0.01	29.65 ± 0.01	S	5.3 ± 0.2
TVKY (63)	56.3 ± 1.1	44.4 ± 1.1	66.8 ± 0.9	30.08 ± 0.01	29.63 ± 0.01	S	5.4 ± 0.2
2014	57.1 ± 0.4	45.9 ± 0.4	69.0 ± 0.4	30.05 ± <0.01	29.61 ± <0.01	S	5.8 ± 0.1
Lexington, Kentucky – LEKY[9]							
LEKY (67)	53.6 ± 1.0	42.0 ± 1.0	67.4 ± 0.8	30.08 ± 0.01	29.03 ± 0.01	S	6.7 ± 0.2
2014	54.7 ± 0.4	43.6 ± 0.4	68.5 ± 0.4	30.05 ± <0.01	29.00 ± <0.01	S	7.1 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature and wind parameters were measured at ASKY. Data for the remaining parameters were obtained from the closest NWS weather station located at Tri-State/M.J. Ferguson Field Airport, WBAN 03860.
[3]Meteorological data for ASKY-M were not available in AQS. This information was obtained from the NWS weather station located at Tri-State/M.J. Ferguson Field Airport, WBAN 03860.
[4]All meteorological parameters except sea level pressure were measured at GLKY. Data for sea level pressure were obtained from the closest NWS weather station located at Tri-State/M.J. Ferguson Field Airport, WBAN 03860.
[5]Meteorological data for BAKY were not available in AQS. This information was obtained from the NWS weather station located at Evansville Regional Airport, WBAN 93817.
[6]Temperature and wind parameters were measured at CCKY through the end of the sampling period. Data for the remaining parameters were obtained from the closest NWS weather station located at Barkley Regional Airport, WBAN 03816.
[7]Temperature and wind parameters were measured at BLKY. Data for the remaining parameters were obtained from the closest NWS weather station located at Barkley Regional Airport, WBAN 03816.
[8]Meteorological data for ATKY, LAKY, and TVKY were not available in AQS. This information was obtained from the NWS weather station located at Barkley Regional Airport, WBAN 03816.
[9]Meteorological data for LEKY were not available in AQS. This information was obtained from the NWS weather station located at Blue Grass Airport, WBAN 93820.

12.2.2 Wind Rose Comparison

Hourly surface wind data were uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 12-16 presents two wind roses for the ASKY monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These can be used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 12-17 through 12-23 present the full-year and sample day wind roses for the remaining Kentucky sites.

Figure 12-16. Wind Roses for the Wind Data Collected at ASKY

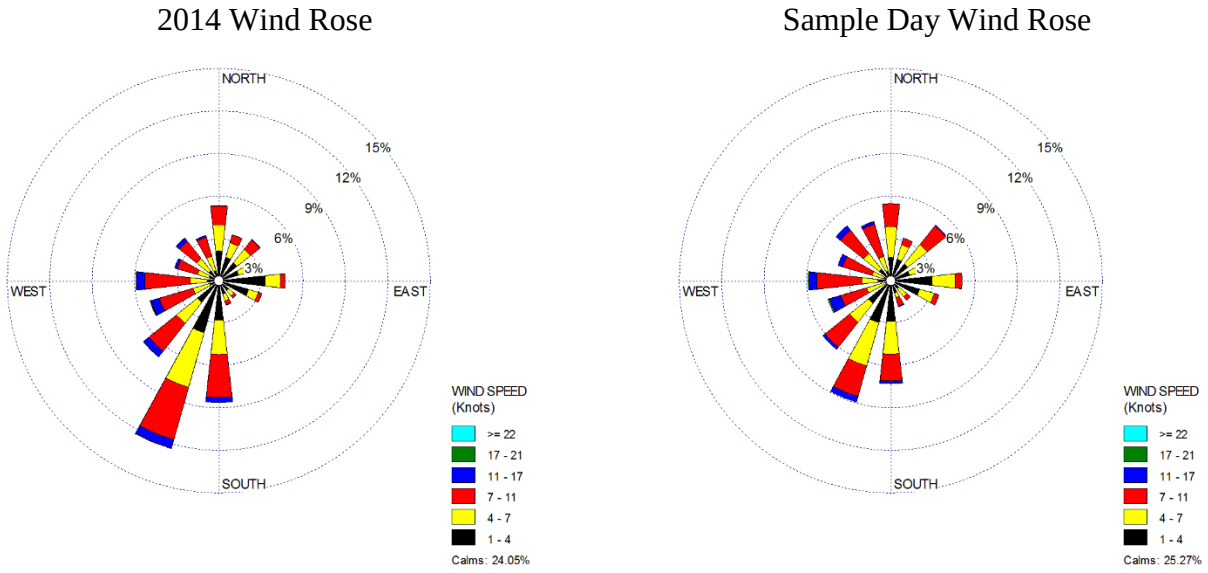


Observations from Figure 12-16 for ASKY include the following:

- The 2014 wind rose shows that calm winds accounted for more than one-third of observations at ASKY. Winds from the western quadrants were more frequently observed than those from the eastern quadrants. Northwesterly winds were observed the most, although winds from the south-southeast to north-northwest each accounted for more than 4 percent of the observations. Wind speeds less than 4 knots were frequently observed near ASKY, while winds greater than 11 knots were rarely observed, but most often observed with westerly winds.

- The sample day wind rose also exhibits light wind patterns. Northwesterly winds were also prevalent on samples days. Fewer winds from the southwest quadrant were observed on samples days while a higher percentage of winds from the northwest quadrant were observed.

Figure 12-17. Wind Roses for the Tri-State/M.J. Ferguson Field Airport Weather Station near ASKY-M



Observations from Figure 12-17 for ASKY-M include the following:

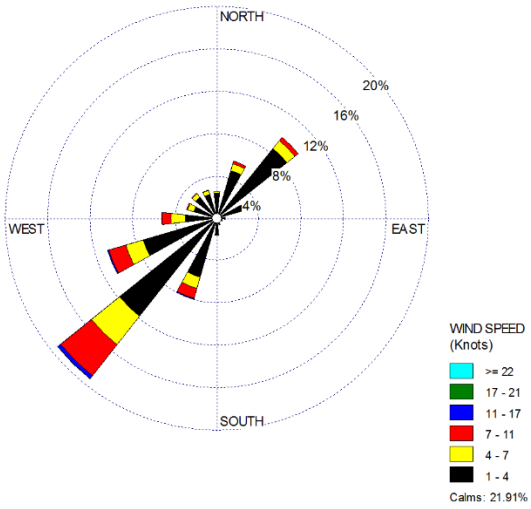
- The Tri-State/M.J. Ferguson Field weather station is the closest weather station to ASKY-M. The weather station is located 8.7 miles south-southeast of ASKY-M. This weather station is located in West Virginia, south of the Ohio River and east of the Big Sandy River.

- The full-year wind rose shows that south-southwesterly winds were the most frequently observed winds near ASKY-M. Winds from the southwest quadrant, including winds from the south, accounted for the majority of observations. Calm winds were observed for about one-quarter of the observations, and wind speeds greater than 11 knots were more commonly observed with winds from the western quadrants than the eastern quadrants.

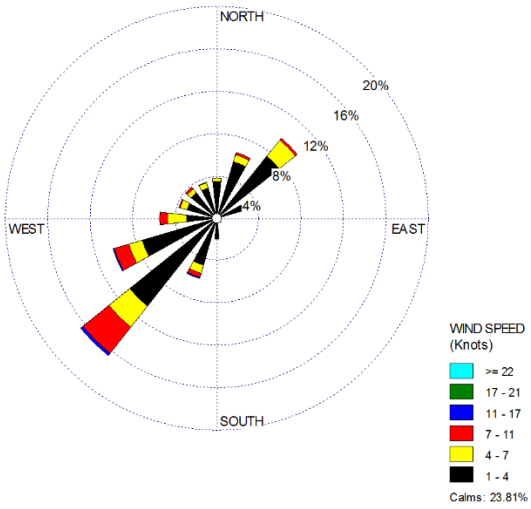
- While south-southwesterly winds were also prevalent on sample days, they accounted for fewer observations. Compared to the full-year, winds from the south to southwest accounted for fewer observations on sample days while winds from the west-northwest to north-northwest and northeast accounted for additional observations.

Figure 12-18. Wind Roses for the Wind Data Collected at GLKY

2014 Wind Rose



Sample Day Wind Rose



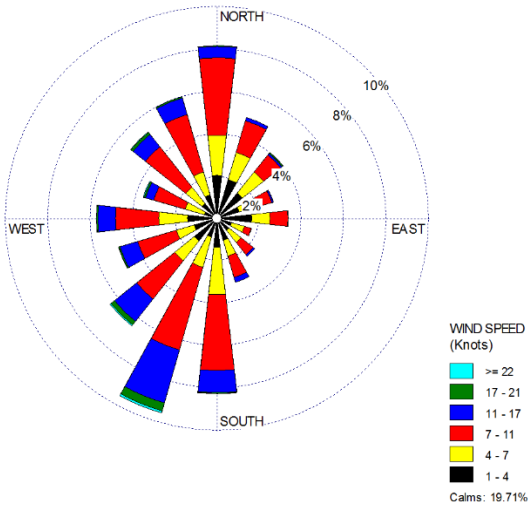
Observations from Figure 12-18 for GLKY include the following:

- The full-year wind rose for GLKY shows that southwesterly winds were prevalent at GLKY, accounting for nearly 20 percent of the observations collected at this site. Together, winds from the south-southwest to west-southwest account nearly 40 percent of observations. Winds from the north-northeast and northeast represent a secondary group of wind observations. Winds from the northwest quadrant were infrequently observed and winds from the southeast quadrant were rarely observed. Calm winds accounted for nearly 22 percent of the wind observations and wind speeds greater than 11 knots were observed most often with southwesterly winds.

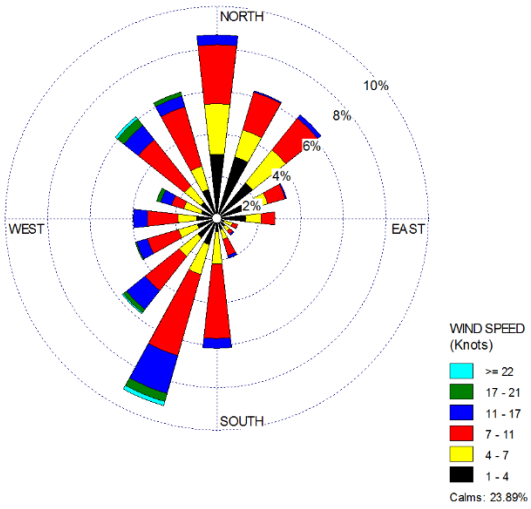
- The wind patterns on the sample day wind rose generally resemble those on the full-year wind rose, although there are a few differences. Fewer winds from the southwest quadrant were observed on sample days, while a higher percentage of winds from the northwest quadrant were observed (although still representing a relatively small percentage of the observations).

Figure 12-19. Wind Roses for the Evansville Regional Airport Weather Station near BAKY

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 12-19 for BAKY include the following:

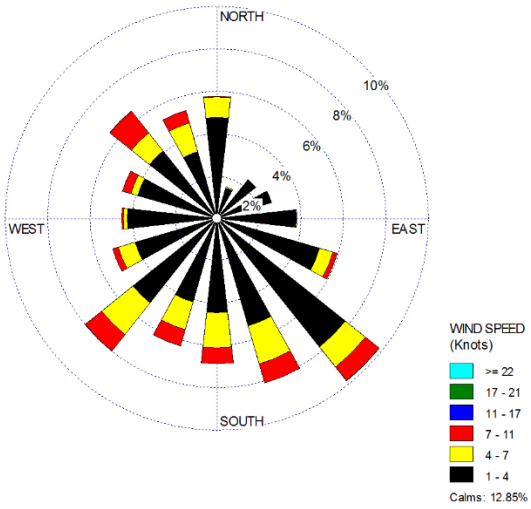
- The Evansville Regional Airport weather station is located approximately 12 miles north-northwest of BAKY. This weather station is in Ohio, with most of the city of Evansville between the site and the station.

- The 2014 wind rose shows that winds from a variety of directions were observed near BAKY, although winds from the western quadrants and due north and due south were observed most often while winds from the eastern quadrants were observed less often. Calm winds account for just less than 20 percent of the observations.

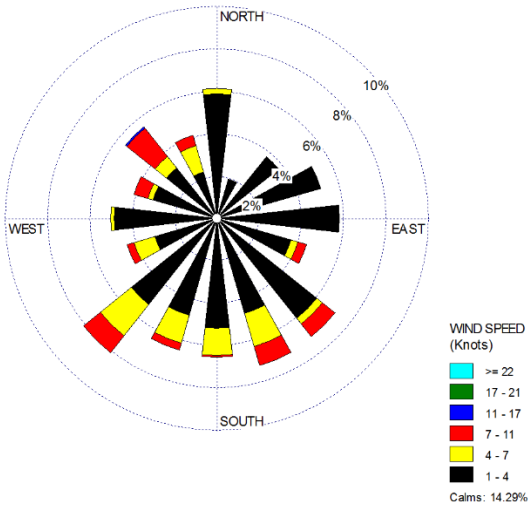
- The sample day wind rose for BAKY shares some similarities with the full-year wind rose, but exhibits some differences as well. Although south-southwesterly winds were still prevalent, northerly winds were observed nearly as often. In addition, winds from the northwest to northeast accounted for a higher percentage of observations on sample days while winds from the south and southwest to west were observed less often. Calm winds accounted for nearly 24 percent of observations on sample days.

Figure 12-20. Wind Roses for the Wind Data Collected at CCKY

Jan – Oct 2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 12-20 for CCKY include the following:

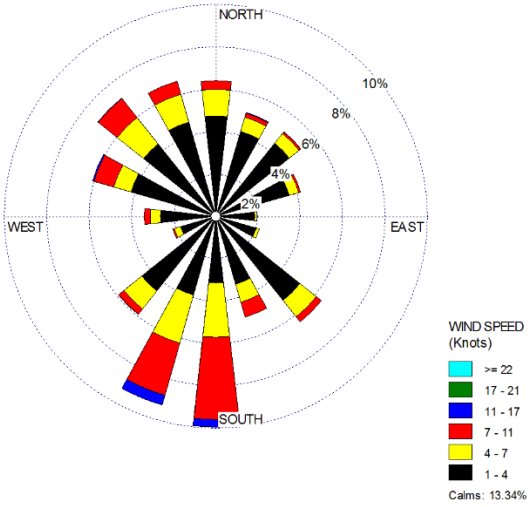
- The full-year wind rose for CCKY shows that winds from the southern quadrants were observed more often at this site than those from the northern quadrants. Southeasterly winds prevailed near CCKY, and along with winds from the south-southeast to southwest, account for 40 percent of the wind observations. Conversely, winds from the north-northeast to east were infrequently observed. Calm winds accounted for just less than 13 percent of observations at CCKY.

- The sample day wind rose resembles the full-year wind rose in that winds from the southern quadrants were observed more often than those from the northern quadrants. However, winds from the southeast to southwest were more evenly distributed, and winds from the southwest account for slightly higher percentage of observations on sample days. In addition, a higher percentage of winds from the northeast to east is shown on the sample day wind rose, while fewer winds from the northwest were observed.

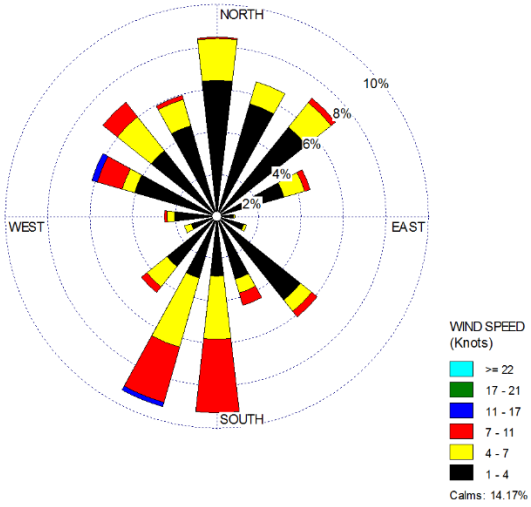
- Recall that sampling was discontinued at CCKY in October, thus, the wind roses presented here include wind observations through the end of the sampling period only.

Figure 12-21. Wind Roses for the Wind Data Collected at BLKY

2014 Wind Rose



Sample Day Wind Rose



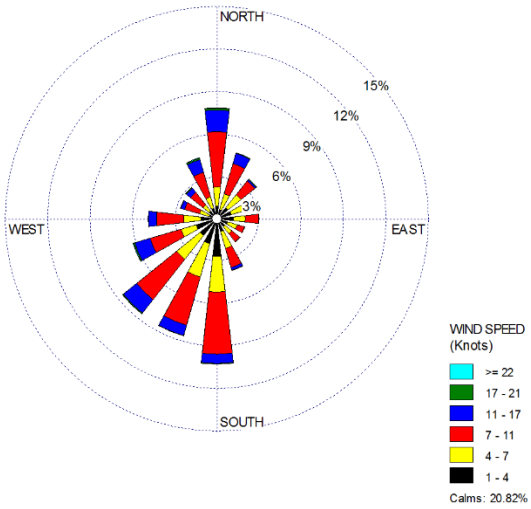
Observations from Figure 12-21 for BLKY include the following:

- The full-year wind rose shows that winds from all directions were observed at BLKY, with winds from the south and south-southwest observed most often, accounting for 10 percent and 9 percent of observations, respectively. Winds from the northwest quadrant, including north, were also commonly observed, each direction accounting for at least 6 percent of observations. This is also true for southeasterly and southwesterly winds. Winds from the east and east-southeast and south-southwest and west were observed least often. Calm winds account for 13 percent of the hourly measurements while the strongest winds were observed with winds from the south and south-southwest.

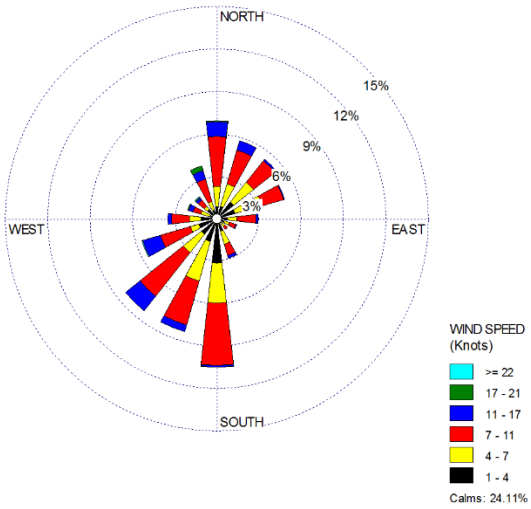
- The wind patterns on the sample day wind rose generally resemble those on the full-year wind rose, although there are some differences. For instance, winds from the north to east-northeast account for a higher percentage of observations on sample days.

Figure 12-22. Wind Roses for the Barkley Regional Airport Weather Station near ATKY, LAKY, and TVKY

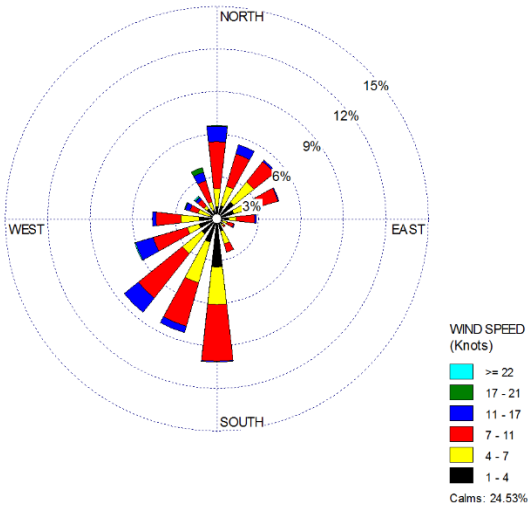
2014 Wind Rose



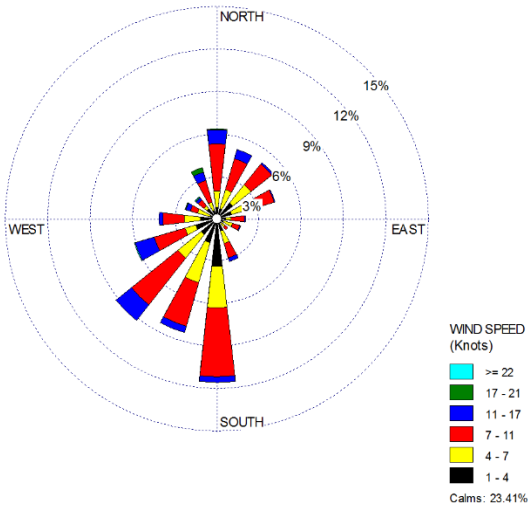
Sample Day Wind Rose for ATKY



Sample Day Wind Rose for LAKY



Sample Day Wind Rose for TVKY



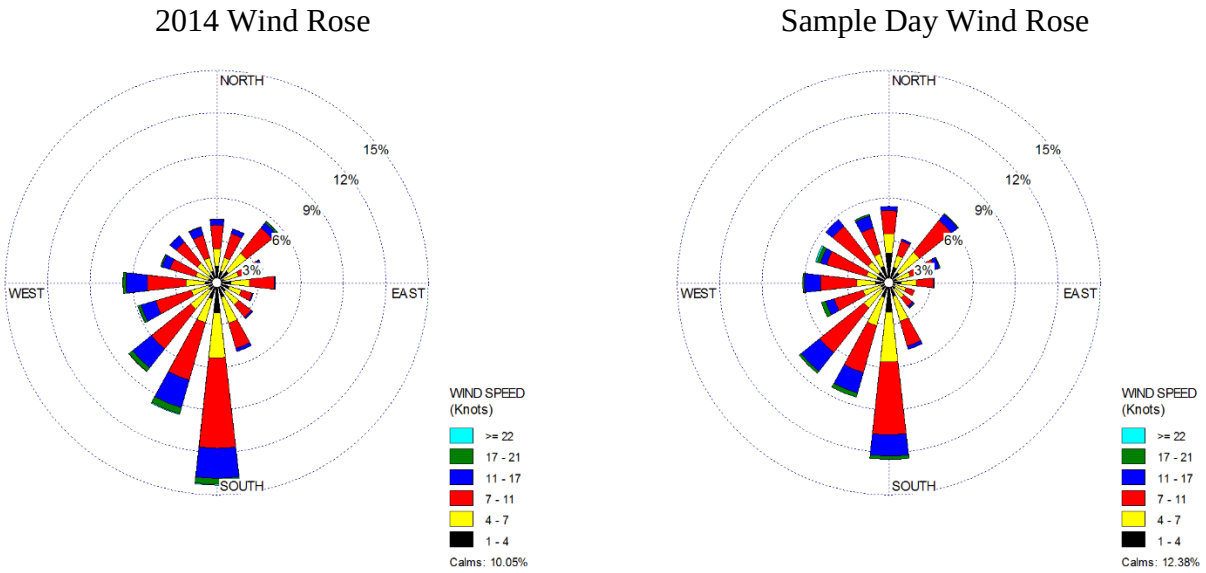
Observations from Figure 12-22 for ATKY, LAKY, and TVKY include the following:

- The Barkley Regional Airport weather station is the closest weather station to the sites in and near Calvert City. The weather station is located between 23 miles and 25 miles west of the Calvert City monitoring sites and just west of the Paducah metro area.

- The full-year wind rose shows that winds from the south, southwest quadrant, and north account for the majority of wind observations near these sites, although calm winds account for nearly 21 percent of the hourly measurements.

- The sample day wind roses for ATKY, LAKY, and TVKY resemble each other as well as the full-year wind rose. For each site, the sample day wind rose shows that southerly winds were prevalent on sample days near each site, with winds from the south, southwest quadrant, and north accounting for the highest percentage of wind observations. Calm winds accounted for 23 percent to 25 percent of the wind observations on sample days near each site while the strongest winds were most often observed with winds from the northwest quadrant.

Figure 12-23. Wind Roses for the Blue Grass Airport Weather Station near LEKY



Observations from Figure 12-23 for LEKY include the following:

- The Blue Grass Airport weather station is located approximately 6 miles west-southwest of the LEKY monitoring site. The airport is located on the western edge of the Lexington metro area.

- The full-year wind rose shows that winds from the south, southwest quadrant, and west account for the majority of wind observations near LEKY, particularly winds from the south, which account for approximately 14 percent of observations. Winds from most of the other directions account for roughly 5 percent of wind observations or less each. Calm winds accounted for 10 percent of the hourly measurements in 2014.

- The wind patterns on the sample day wind rose for LEKY resemble the wind patterns shown on the full-year wind rose, although there are some differences. Winds from the south and south-southwest accounted for fewer observations on sample days while winds from the northwest quadrant and northeast accounted for a higher percentage of observations.

12.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Kentucky monitoring site in order to identify site-specific "pollutants of interest," which allows 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.

It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Table 12-3 provides an overview of which pollutant groups were sampled for at each site. The site-specific results of the risk-based screening process are presented in Table 12-4, with the pollutants of interest for each site shaded in gray.

Table 12-3. Overview of Pollutant Groups Sampled for at the Kentucky Monitoring Sites

Site	VOCs	Carbonyl Compounds	PAHs	PM_{10} Metals
ASKY	✓	✓	--	--
ASKY-M	--	--	--	✓
GLKY	✓	✓	✓	✓
BAKY	--	--	--	✓
ATKY	✓	--	--	--
BLKY[1]	✓	--	--	✓
CCKY[1]	✓	--	--	✓
LAKY	✓	--	--	--
TVKY	✓	--	--	--
LEKY	✓	✓	--	✓

-- = This pollutant group was not sampled for at this site.
BOLD ITALICS = EPA-designated NATTS Site
[1] Sampling at CCKY was discontinued in October 2014 and the metals instrumentation moved to BLKY, where sampling resumed.

Observations from Table 12-3 include the following:

- Carbonyl compounds, VOCs, PAHs, and PM_{10} metals were sampled for at GLKY throughout 2014.
- Additional sites sampling PM_{10} metals include ASKY-M, BAKY, BLKY, CCKY, and LEKY.
- Additional sites sampling VOCs include ASKY, ATKY, BLKY, CCKY, LAKY, TVKY, and LEKY.
- Additional sites sampling carbonyl compounds include ASKY and LEKY.
- No additional sites sampled PAHs.
- Sampling at the CCKY site was discontinued in early October 2014 and the metals instrumentation was moved to BLKY site. The first metals sample was collected at BLKY on October 20, 2014.

Table 12-4. Risk-Based Screening Results for the Kentucky Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Health Department, Ashland, Kentucky - ASKY						
Acetaldehyde	0.45	61	61	100.00	16.80	16.80
Benzene	0.13	61	61	100.00	16.80	33.61
Carbon Tetrachloride	0.17	61	61	100.00	16.80	50.41
Formaldehyde	0.077	61	61	100.00	16.80	67.22
1,2-Dichloroethane	0.038	58	58	100.00	15.98	83.20
1,3-Butadiene	0.03	53	56	94.64	14.60	97.80
Hexachloro-1,3-butadiene	0.045	5	6	83.33	1.38	99.17
p-Dichlorobenzene	0.091	2	23	8.70	0.55	99.72
Ethylbenzene	0.4	1	61	1.64	0.28	100.00
Total		363	448	81.03		
21st and Greenup, Ashland, Kentucky - ASKY-M						
Arsenic (PM_{10})	0.00023	55	58	94.83	58.51	58.51
Nickel (PM_{10})	0.0021	18	59	30.51	19.15	77.66
Manganese (PM_{10})	0.03	12	59	20.34	12.77	90.43
Cadmium (PM_{10})	0.00056	5	59	8.47	5.32	95.74
Lead (PM_{10})	0.015	4	59	6.78	4.26	100.00
Total		94	294	31.97		
Grayson, Kentucky - GLKY						
Formaldehyde	0.077	61	61	100.00	16.94	16.94
Acetaldehyde	0.45	58	61	95.08	16.11	33.06
Benzene	0.13	56	56	100.00	15.56	48.61
Carbon Tetrachloride	0.17	56	56	100.00	15.56	64.17
1,2-Dichloroethane	0.038	48	48	100.00	13.33	77.50
1,3-Butadiene	0.03	38	47	80.85	10.56	88.06
Arsenic (PM_{10})	0.00023	36	55	65.45	10.00	98.06
Hexachloro-1,3-butadiene	0.045	4	5	80.00	1.11	99.17
Naphthalene	0.029	3	58	5.17	0.83	100.00
Total		360	447	80.54		
Baskett, Kentucky - BAKY						
Arsenic (PM_{10})	0.00023	54	57	94.74	96.43	96.43
Nickel (PM_{10})	0.0021	2	57	3.51	3.57	100.00
Total		56	114	49.12		

Table 12-4. Risk-Based Screening Results for the Kentucky Monitoring Sites (Continued)

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Atmos Energy, Calvert City, Kentucky - ATKY						
Benzene	0.13	61	61	100.00	21.86	21.86
Carbon Tetrachloride	0.17	61	61	100.00	21.86	43.73
1,2-Dichloroethane	0.038	60	60	100.00	21.51	65.23
1,3-Butadiene	0.03	49	53	92.45	17.56	82.80
Vinyl chloride	0.11	28	36	77.78	10.04	92.83
Hexachloro-1,3-butadiene	0.045	14	14	100.00	5.02	97.85
1,1,2-Trichloroethane	0.0625	3	3	100.00	1.08	98.92
1,2-Dibromoethane	0.0017	2	2	100.00	0.72	99.64
Trichloroethylene	0.2	1	17	5.88	0.36	100.00
Total		279	307	90.88		
Smithland, Kentucky - BLKY						
Benzene	0.13	60	60	100.00	23.08	23.08
Carbon Tetrachloride	0.17	59	60	98.33	22.69	45.77
1,2-Dichloroethane	0.038	57	57	100.00	21.92	67.69
1,3-Butadiene	0.03	39	47	82.98	15.00	82.69
Vinyl chloride	0.11	19	33	57.58	7.31	90.00
Hexachloro-1,3-butadiene	0.045	13	13	100.00	5.00	95.00
Arsenic (PM_{10})	0.00023	8	11	72.73	3.08	98.08
1,1,2-Trichloroethane	0.0625	4	4	100.00	1.54	99.62
1,2-Dibromoethane	0.0017	1	1	100.00	0.38	100.00
Total		260	286	90.91		
Calvert City Elementary School, Calvert City, Kentucky - CCKY						
Benzene	0.13	46	46	100.00	19.74	19.74
Carbon Tetrachloride	0.17	46	46	100.00	19.74	39.48
1,2-Dichloroethane	0.038	46	46	100.00	19.74	59.23
1,3-Butadiene	0.03	38	41	92.68	16.31	75.54
Arsenic (PM_{10})	0.00023	35	39	89.74	15.02	90.56
Vinyl chloride	0.11	10	27	37.04	4.29	94.85
Hexachloro-1,3-butadiene	0.045	9	9	100.00	3.86	98.71
1,2-Dibromoethane	0.0017	1	1	100.00	0.43	99.14
Ethylbenzene	0.4	1	46	2.17	0.43	99.57
1,1,2-Trichloroethane	0.0625	1	1	100.00	0.43	100.00
Total		233	302	77.15		

Table 12-4. Risk-Based Screening Results for the Kentucky Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Lazy Daze, Calvert City, Kentucky - LAKY						
Benzene	0.13	56	56	100.00	22.22	22.22
Carbon Tetrachloride	0.17	56	56	100.00	22.22	44.44
1,2-Dichloroethane	0.038	56	56	100.00	22.22	66.67
1,3-Butadiene	0.03	47	49	95.92	18.65	85.32
Vinyl chloride	0.11	16	33	48.48	6.35	91.67
Hexachloro-1,3-butadiene	0.045	15	15	100.00	5.95	97.62
1,1,2-Trichloroethane	0.0625	3	4	75.00	1.19	98.81
1,2-Dibromoethane	0.0017	2	2	100.00	0.79	99.60
p-Dichlorobenzene	0.091	1	19	5.26	0.40	100.00
Total		252	290	86.90		
TVA Substation, Calvert City, Kentucky - TVKY						
Benzene	0.13	61	61	100.00	19.93	19.93
Carbon Tetrachloride	0.17	61	61	100.00	19.93	39.87
1,2-Dichloroethane	0.038	61	61	100.00	19.93	59.80
1,3-Butadiene	0.03	53	55	96.36	17.32	77.12
Vinyl chloride	0.11	28	42	66.67	9.15	86.27
Hexachloro-1,3-butadiene	0.045	19	20	95.00	6.21	92.48
1,1,2-Trichloroethane	0.0625	15	15	100.00	4.90	97.39
1,2-Dibromoethane	0.0017	4	4	100.00	1.31	98.69
p-Dichlorobenzene	0.091	2	25	8.00	0.65	99.35
1,1-Dichloroethane	0.625	1	15	6.67	0.33	99.67
Trichloroethylene	0.2	1	18	5.56	0.33	100.00
Total		306	377	81.17		
Lexington, Kentucky - LEKY						
Benzene	0.13	58	58	100.00	14.25	14.25
Carbon Tetrachloride	0.17	58	58	100.00	14.25	28.50
1,2-Dichloroethane	0.038	57	57	100.00	14.00	42.51
Acetaldehyde	0.45	55	55	100.00	13.51	56.02
Formaldehyde	0.077	55	55	100.00	13.51	69.53
1,3-Butadiene	0.03	54	56	96.43	13.27	82.80
Arsenic (PM_{10})	0.00023	50	56	89.29	12.29	95.09
Hexachloro-1,3-butadiene	0.045	12	12	100.00	2.95	98.03
p-Dichlorobenzene	0.091	4	26	15.38	0.98	99.02
Ethylbenzene	0.4	3	58	5.17	0.74	99.75
Propionaldehyde	0.8	1	55	1.82	0.25	100.00
Total		407	546	74.54		

Observations for the Ashland sites from Table 12-4 include the following:

- The number of pollutants failing screens varied significantly among the monitoring sites; this is expected given the different pollutants measured at each site, as shown in Table 12-3. VOCs and carbonyl compounds were sampled for at ASKY while PM_{10} metals were sampled for at ASKY-M.

- Concentrations of nine pollutants failed at least one screen for ASKY, with 81 percent of concentrations for these nine pollutants greater than their associated risk screening value (or failing screens).

- Six pollutants contributed to 95 percent of failed screens for ASKY and therefore were identified as pollutants of interest. These six include two carbonyl compounds and four VOCs.

- Concentrations of five metals failed at least one screen for ASKY-M, with 32 percent of concentrations for these five pollutants greater than their associated risk screening value (or failing screens).

- Four metals contributed to 95 percent of failed screens for ASKY-M and therefore were identified as pollutants of interest. ASKY-M is one of only two NMP sites with manganese as a pollutant of interest (TOOK is the other). This is also true for cadmium (S4MO is the other site).

Observations for GLKY from Table 12-4 include the following:

- All four pollutant groups shown in Table 12-3 were sampled for at GLKY.

- Concentrations of nine pollutants failed at least one screen for GLKY, with nearly 81 percent of concentrations for these nine pollutants greater than their associated risk screening value (or failing screens).

- Seven pollutants contributed to 95 percent of failed screens for GLKY and therefore were identified as pollutants of interest. These include two carbonyl compounds, four VOCs, and one metal.

Observations for BAKY from Table 12-4 include the following:

- BAKY sampled for PM_{10} metals only.

- Concentrations of arsenic and nickel failed at least one screen for BAKY, with 49 percent of concentrations for these two pollutants greater than their associated risk screening value (or failing screens).

- Arsenic contributed to 96 percent of the failed screens for BAKY and therefore was identified as BAKY's sole pollutant of interest.

Observations for the Calvert City sites from Table 12-4 include the following:

- VOCs were sampled for at all five Calvert City sites. PM_{10} metals were also sampled for at CCKY until October and then at BLKY afterwards.

- The number of pollutants whose concentrations were greater than their associated risk screening value varied from nine (3 sites) to 11 (TVKY).

- Concentrations of nine VOCs failed screens for ATKY, and six of these contributed to 95 percent of failed screens for ATKY and thus, were identified as pollutants of interest for this site.

- Concentrations of nine pollutants failed screens for BLKY, with six of the VOCs contributed to 95 percent of failed screens for BLKY and thus, were identified as pollutants of interest for this site.

- Concentrations of 10 pollutants failed screens for CCKY, and six VOCs and arsenic contributing to 95 percent of failed screens for CCKY; thus, these seven pollutant were identified as pollutants of interest for this site.

- Concentrations of nine VOCs failed screens for LAKY, and six of these contributed to 95 percent of failed screens for LAKY and thus, were identified as pollutants of interest for this site.

- Concentrations of 11 VOCs failed screens for TVKY, and seven of these contributed to 95 percent of failed screens for TVKY and thus, were identified as pollutants of interest for this site.

- Benzene, carbon tetrachloride, 1,2-dichloroethane, 1,3-butadiene, vinyl chloride, and hexachloro-1,3-butadiene were identified as pollutants of interest for all five Calvert City sites. These sites are the only NMP sites with vinyl chloride as a pollutant of interest.

Observations for LEKY from Table 12-4 include the following:

- Carbonyl compounds, VOCs, and PM_{10} metals were sampled for at LEKY.

- Concentrations of 11 pollutants failed at least one screen for LEKY, with nearly 75 percent of concentrations of these 11 pollutants greater than their associated risk screening value (or failing screens).

- Seven pollutants contributed to 95 percent of failed screens for LEKY and therefore were identified as pollutants of interest. These include two carbonyl compounds, four VOCs, and one metal.

12.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Kentucky monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the Kentucky monitoring sites are provided in Appendices J, L, M, and N.

12.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for the Kentucky sites, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Kentucky monitoring sites are presented in Table 12-5, where applicable. Note that concentrations of the PAHs and metals are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 12-5. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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 ($\mu g/m^3$)
Health Department, Ashland, Kentucky - ASKY							
Acetaldehyde	61/61	61	1.23 ± 0.17	1.48 ± 0.27	1.19 ± 0.21	1.10 ± 0.19	1.25 ± 0.11
Benzene	61/61	61	0.85 ± 0.15	0.62 ± 0.15	1.47 ± 1.62	0.56 ± 0.10	0.87 ± 0.39
1,3-Butadiene	56/53	61	0.07 ± 0.02	0.04 ± 0.02	0.06 ± 0.02	0.06 ± 0.01	0.06 ± 0.01
Carbon Tetrachloride	61/61	61	0.63 ± 0.05	0.66 ± 0.03	0.67 ± 0.02	0.62 ± 0.03	0.65 ± 0.02
1,2-Dichloroethane	58/58	61	0.08 ± 0.01	0.08 ± 0.01	0.05 ± 0.02	0.08 ± 0.01	0.07 ± 0.01
Formaldehyde	61/61	61	1.71 ± 0.24	3.00 ± 0.63	3.26 ± 0.67	1.26 ± 0.23	2.29 ± 0.31
21st and Greenup, Ashland, Kentucky - ASKY-M							
Arsenic (PM_{10})[a]	58/55	59	0.78 ± 0.20	0.98 ± 0.38	1.91 ± 1.29	0.85 ± 0.49	1.14 ± 0.36
Cadmium (PM_{10})[a]	59/59	59	0.22 ± 0.06	0.26 ± 0.08	0.33 ± 0.13	0.13 ± 0.05	0.24 ± 0.04
Manganese (PM_{10})[a]	59/59	59	15.73 ± 5.92	18.04 ± 5.98	23.42 ± 9.30	15.52 ± 7.32	18.22 ± 3.53
Nickel (PM_{10})[a]	59/59	59	2.89 ± 1.69	2.23 ± 0.89	2.23 ± 0.69	1.44 ± 1.22	2.19 ± 0.56
Grayson, Kentucky - GLKY							
Acetaldehyde	61/61	61	0.96 ± 0.18	0.99 ± 0.16	0.73 ± 0.10	0.77 ± 0.15	0.86 ± 0.08
Benzene	56/56	56	0.59 ± 0.08	NA	0.32 ± 0.04	0.43 ± 0.15	0.42 ± 0.05
1,3-Butadiene	47/40	56	0.04 ± 0.01	NA	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
Carbon Tetrachloride	56/56	56	0.58 ± 0.07	NA	0.65 ± 0.02	0.57 ± 0.04	0.61 ± 0.02
1,2-Dichloroethane	48/45	56	0.08 ± <0.01	NA	0.03 ± 0.02	0.07 ± 0.01	0.06 ± 0.01
Formaldehyde	61/61	61	0.77 ± 0.15	1.79 ± 0.35	2.39 ± 0.45	0.95 ± 0.18	1.49 ± 0.22
Arsenic (PM_{10})[a]	55/36	59	0.29 ± 0.13	0.36 ± 0.14	0.56 ± 0.21	0.36 ± 0.16	0.39 ± 0.08
Baskett, Kentucky - BAKY							
Arsenic (PM_{10})[a]	57/54	58	0.52 ± 0.14	0.91 ± 0.33	1.26 ± 0.33	0.74 ± 0.45	0.85 ± 0.17

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

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

Table 12-5. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Atmos Energy, Calvert City, Kentucky - ATKY							
Benzene	61/61	61	0.79 ± 0.21	0.38 ± 0.09	0.78 ± 0.17	0.52 ± 0.08	0.62 ± 0.08
1,3-Butadiene	53/49	61	0.09 ± 0.09	0.09 ± 0.07	0.11 ± 0.05	0.06 ± 0.02	0.09 ± 0.03
Carbon Tetrachloride	61/61	61	0.69 ± 0.10	0.71 ± 0.08	0.70 ± 0.03	0.63 ± 0.02	0.68 ± 0.03
1,2-Dichloroethane	60/59	61	0.51 ± 0.60	0.52 ± 0.32	1.01 ± 0.52	0.30 ± 0.27	0.58 ± 0.22
Hexachloro-1,3-butadiene	14/0	61	0.02 ± 0.02	0.01 ± 0.02	0.03 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Vinyl chloride	36/33	61	0.64 ± 0.74	1.29 ± 1.36	0.72 ± 0.51	0.44 ± 0.49	0.77 ± 0.40
Smithland, Kentucky - BLKY							
Benzene	60/60	60	0.75 ± 0.24	0.73 ± 0.44	0.40 ± 0.10	0.60 ± 0.22	0.62 ± 0.13
1,3-Butadiene	47/41	60	0.08 ± 0.07	0.47 ± 0.67	0.04 ± 0.02	0.10 ± 0.08	0.17 ± 0.16
Carbon Tetrachloride	60/60	60	0.64 ± 0.08	0.90 ± 0.31	0.68 ± 0.03	0.71 ± 0.16	0.73 ± 0.09
1,2-Dichloroethane	57/57	60	1.29 ± 1.61	0.96 ± 0.61	0.62 ± 0.74	0.42 ± 0.27	0.81 ± 0.43
Hexachloro-1,3-butadiene	13/0	60	0.02 ± 0.02	0.01 ± 0.02	0.03 ± 0.03	0.01 ± 0.02	0.02 ± 0.01
Vinyl chloride	33/32	60	0.27 ± 0.28	0.16 ± 0.08	0.05 ± 0.05	0.10 ± 0.06	0.14 ± 0.07
Calvert City Elementary School, Calvert City, Kentucky - CCKY							
Benzene	46/46	46	0.66 ± 0.11	0.37 ± 0.08	0.67 ± 0.17	NA	0.56 ± 0.08
1,3-Butadiene	41/38	46	0.08 ± 0.03	0.04 ± 0.02	0.13 ± 0.06	NA	0.08 ± 0.03
Carbon Tetrachloride	46/46	46	0.69 ± 0.07	0.69 ± 0.03	0.72 ± 0.06	NA	0.70 ± 0.03
1,2-Dichloroethane	46/45	46	0.44 ± 0.28	0.24 ± 0.14	0.83 ± 0.34	NA	0.49 ± 0.16
Hexachloro-1,3-butadiene	9/0	46	0.02 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	NA	0.02 ± 0.01
Vinyl chloride	27/26	46	0.09 ± 0.08	0.03 ± 0.03	0.12 ± 0.08	NA	0.08 ± 0.04
Arsenic (PM_{10})[a]	39/35	41	0.38 ± 0.16	0.49 ± 0.23	0.77 ± 0.21	NA	0.55 ± 0.12

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

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

Table 12-5. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Lazy Daze, Calvert City, Kentucky - LAKY							
Benzene	56/56	56	0.79 ± 0.32	0.59 ± 0.40	0.86 ± 0.22	0.59 ± 0.11	0.70 ± 0.13
1,3-Butadiene	49/48	56	0.12 ± 0.10	0.05 ± 0.03	0.19 ± 0.12	0.07 ± 0.02	0.11 ± 0.04
Carbon Tetrachloride	56/56	56	0.77 ± 0.27	0.68 ± 0.05	0.74 ± 0.10	0.65 ± 0.02	0.71 ± 0.06
1,2-Dichloroethane	56/55	56	1.08 ± 1.09	0.35 ± 0.26	1.35 ± 0.53	1.08 ± 1.52	0.97 ± 0.47
Hexachloro-1,3-butadiene	15/0	56	0.01 ± 0.02	0.02 ± 0.02	0.05 ± 0.03	0.01 ± 0.02	0.02 ± 0.01
Vinyl chloride	33/31	56	0.28 ± 0.28	0.04 ± 0.04	0.16 ± 0.08	0.06 ± 0.05	0.13 ± 0.07
TVA Substation, Calvert City, Kentucky - TVKY							
Benzene	61/61	61	0.98 ± 0.35	0.42 ± 0.12	1.87 ± 1.21	0.88 ± 0.44	1.04 ± 0.35
1,3-Butadiene	55/53	61	0.21 ± 0.15	0.30 ± 0.36	0.86 ± 0.76	0.13 ± 0.09	0.38 ± 0.22
Carbon Tetrachloride	61/61	61	0.93 ± 0.32	0.76 ± 0.08	0.89 ± 0.27	0.91 ± 0.35	0.87 ± 0.13
1,2-Dichloroethane	61/61	61	6.81 ± 5.83	1.06 ± 1.09	3.98 ± 2.93	2.64 ± 2.38	3.54 ± 1.66
Hexachloro-1,3-butadiene	20/0	61	0.04 ± 0.02	0.04 ± 0.03	0.03 ± 0.02	0.02 ± 0.02	0.03 ± 0.01
1,1,2-Trichloroethane	15/13	61	0.03 ± 0.03	0.01 ± 0.02	0.05 ± 0.03	0.02 ± 0.03	0.03 ± 0.01
Vinyl chloride	42/41	61	0.66 ± 0.81	1.57 ± 2.93	0.32 ± 0.17	0.17 ± 0.14	0.69 ± 0.76
Lexington, Kentucky - LEKY							
Acetaldehyde	55/55	55	1.82 ± 0.27	1.64 ± 0.23	1.53 ± 0.26	1.20 ± 0.26	1.55 ± 0.13
Benzene	58/58	58	0.73 ± 0.08	0.53 ± 0.08	0.64 ± 0.11	0.58 ± 0.06	0.62 ± 0.04
1,3-Butadiene	56/55	58	0.05 ± 0.02	0.05 ± 0.01	0.09 ± 0.01	0.07 ± 0.02	0.07 ± 0.01
Carbon Tetrachloride	58/58	58	0.58 ± 0.05	0.66 ± 0.03	0.60 ± 0.03	0.62 ± 0.02	0.61 ± 0.02
1,2-Dichloroethane	57/54	58	0.08 ± <0.01	0.09 ± 0.02	0.07 ± 0.01	0.08 ± 0.01	0.08 ± 0.01
Formaldehyde	55/55	55	1.96 ± 0.44	4.98 ± 3.37	3.58 ± 0.59	1.86 ± 0.61	3.15 ± 0.90
Arsenic (PM_{10})[a]	56/51	56	0.68 ± 0.15	0.47 ± 0.21	0.81 ± 0.26	0.73 ± 0.24	0.67 ± 0.11

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

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

Observations for the Ashland sites from Table 12-5 include the following:

- VOCs and carbonyl compounds were sampled for at ASKY and PM_{10} metals were sampled for at ASKY-M. Thus, these sites have no pollutants of interest in common.

- With the exception of 1,3-butadiene and 1,2-dichloroethane, each of the pollutants of interest for ASKY was detected in all the valid VOC samples collected. However, even these two pollutants were detected in a majority of the samples collected.

- The pollutants of interest with the highest annual average concentrations for ASKY are formaldehyde (2.29 ± 0.31 µg/m^3), acetaldehyde (1.25 ± 0.11 µg/m^3), and benzene (0.87 ± 0.39 µg/m^3). The annual average concentrations for the two carbonyl compounds are similar to the annual averages for 2013 while the annual average concentration of benzene for 2014 is approximately half of its 2013 annual average. Note the relatively high confidence interval for the annual average concentration of benzene.

- The second and third quarter average concentrations of formaldehyde are significantly higher than the other quarterly averages for this pollutant for ASKY. A review of the data shows that all 15 formaldehyde concentrations greater than or equal to 3 µg/m^3 were measured at ASKY during the second and third quarters of 2014 while all but one of the 17 concentrations less than 1.5 µg/m^3 were all measured during the first or fourth quarters of 2014 (and the exception was measured on the first sample day in April).

- The third quarter average benzene concentration is two to three times greater than the other quarterly averages and has a confidence interval greater than the average itself. This indicates that outliers may be affecting this quarterly average. A review of the data shows that the maximum benzene concentration was measured at ASKY on July 22, 2014 (12.4 µg/m^3) and is the maximum concentration of benzene measured across the program. The maximum benzene concentration for 2013 was also measured at this site. This measurement is more than seven times greater than the next highest benzene concentrations measured at this site (1.74 µg/m^3), which was also measured during the third quarter. Only one other benzene concentration measured at ASKY during the third quarter is greater than 1.0 µg/m^3, with the remaining concentrations ranging from 0.295 µg/m^3 to 1.01 µg/m^3 and a median concentration of 0.679 µg/m^3 for the quarter. This explains the large confidence interval associated with this quarterly average concentration.

- Table 4-9 presents the NMP sites with the 10 highest annual average concentrations for each of the program-level VOC pollutants of interest. This table shows that ASKY has the ninth highest annual average concentration of benzene calculated across the program. This site has the largest confidence interval among the sites shown, indicating that this annual average is influenced by outliers while most of the other annual averages likely run higher on a more consistent basis. Excluding the maximum concentration from the calculation would result in an annual average concentration for ASKY in the middle of the site-specific annual average concentrations of benzene and a much smaller confidence interval.

- With the exception of arsenic, the metal pollutants of interest were detected in all of the valid samples collected at ASKY-M. Arsenic was detected in all but one of samples collected.

- The pollutant of interest with the highest annual average concentration for ASKY-M is manganese (18.22 ± 3.53 ng/m^3), followed by nickel (2.19 ± 0.56 ng/m^3) and arsenic (1.14 ± 0.36 ng/m^3), with the annual average concentration of cadmium considerably lower (0.24 ± 0.04 ng/m^3).

- Several of the quarterly average concentrations for the pollutants of interest for ASKY-M have relatively large confidence intervals, indicating the concentrations measured at ASKY-M are highly variable. Concentrations of nickel range from 0.260 ng/m^3 to 9.64 ng/m^3, with a median concentration of 1.41 ng/m^3, considerably less than the annual average concentration. Both the first and fourth quarter averages of nickel have relatively large confidence intervals associated with them. All but one of the samples collected at ASKY-M during the fourth quarter were less than 2 ng/m^3, yet the maximum nickel concentration (9.64 ng/m^3) was also measured during the fourth quarter. This explains the relatively large confidence interval shown for the fourth quarter. The first quarter average concentration has the second highest number of nickel concentrations less than 1 ng/m^3, but the second, third, and fourth highest concentrations, each falling between 7 ng/m^3 and 9 ng/m^3, were also measured during the first quarter of 2014.

- Concentrations of manganese measured at ASKY-M range from 1.77 ng/m^3 to 67.5 ng/m^3, with a median concentration of 14.8 ng/m^3. Several of the highest manganese concentrations across the program were measured at ASKY-M, including two measurements greater than 50 ng/m^3, which were measured on back-to-back sample days (September 26, 2014 and October 2, 2014; note that construction was noted near the monitoring site on September 26, 2014). Several manganese concentrations greater than 25 ng/m^3 were measured at ASKY-M during each of the calendar quarters, from two measured during the fourth quarter, three measured during the first quarter, and five each measured during the second and third quarters. Conversely, at least one manganese concentration less than 5 ng/m^3 was also measured during each calendar quarter. This explains the relatively large confidence intervals shown for each quarterly average of manganese in Table 12-5.

- Concentrations of arsenic measured at ASKY-M span two orders of magnitude, ranging from 0.14 ng/m^3 to 10.1 ng/m^3 plus one non-detect, with a median concentration of 0.71 ng/m^3. The maximum arsenic concentration measured at ASKY-M is the maximum arsenic concentration measured across the program and is roughly three times higher than the second highest concentration measured at this site (3.58 ng/m^3). ASKY-M has the highest number of arsenic measurements greater than 2 ng/m^3 compared to any other NMP site (6). The third quarter average concentration of arsenic is considerably higher than the other quarterly averages and has a relatively large confidence interval associated with it. Of the 20 arsenic concentrations greater than 1 ng/m^3, nine were measured during the third quarter, including three of the four highest arsenic concentrations measured at this site.

- Concentrations of cadmium measured at ASKY-M range from 0.010 ng/m^3 to 0.79 ng/m^3, with a median concentration of 0.175 ng/m^3. The third quarter average concentration of cadmium is greater than the other quarterly averages and the associated confidence interval is the highest of the four. A review of the data shows that four of the five highest cadmium concentrations (those greater than 0.5 ng/m^3) were measured at ASKY-M during the third quarter of 2014.

- It should be noted that the COCs for samples collected from mid-May through mid-July at ASKY-M denoted that the samples were potentially influenced by a nearby source, as indicated by the request to apply the "NS" flag to the data when uploaded into AQS.

- Table 4-12 presents the NMP sites with the 10 highest annual average concentrations for each of the program-level metal pollutants of interest. This table shows that the highest annual average concentrations for arsenic and nickel across the program were calculated for ASKY-M. A similar observation was made in the 2013 report.

Observations for GLKY from Table 12-5 include the following:

- GLKY sampled VOCs, carbonyl compounds, metals (PM_{10}), and PAHs.

- The only pollutant of interest with an annual average concentration greater than 1 µg/m^3 is formaldehyde (1.49 ± 0.22 µg/m^3). However, this is one of the lowest annual averages of formaldehyde calculated among NMP sites sampling carbonyl compounds.

- Concentrations of formaldehyde were higher during the warmer months of the year, based on the quarterly averages. All but one of the 24 formaldehyde concentrations greater than 1.50 µg/m^3 were measured during the second or third quarters of 2014. Conversely, all but one of the 24 concentrations less than 1.0 µg/m^3 were measured during the first or fourth quarters of the year.

- Concentrations of acetaldehyde do not exhibit the same tendency as formaldehyde. Concentrations of this pollutant were highest during the first and second quarters. Of the 16 acetaldehyde concentrations greater than 1 µg/m^3, 12 were measured during the first and second quarters, with only one measured during the third quarter and three during the fourth quarter.

- A number of VOC samples collected between mid-May and mid-June were invalidated due to a sampler issue; as a result, no second quarter average concentrations are shown in Table 12-5 for GLKY.

- Based on the quarterly average concentrations shown, benzene concentrations appear highest during the first quarter of 2014, yet the fourth quarter average has the highest associated confidence interval. A review of the data shows that the maximum benzene concentration was measured on November 22, 2014 (1.47 µg/m^3), and is the only benzene concentration greater than 1 µg/m^3 measured at GLKY. The next eight highest benzene concentrations were all measured at GLKY during the first quarter of

the year. Benzene concentrations measured during the fourth quarter but before the maximum concentration was measured were less than or equal to the median benzene concentration for GLKY; all but one of the concentrations measured after the maximum concentration was measured were greater than the median concentration.

- All of GLKY's 1,3-butadiene concentrations are less than 0.1 µg/m^3 and range from 0.020 µg/m^3 to 0.075 µg/m^3, including nine non-detects. There is little variability in the quarterly average concentrations shown for this pollutant.

- The third quarter average concentration of 1,2-dichloroethane is less than the other quarterly averages shown and has the most variability associated with it. All eight non-detects of 1,2-dichloroethane were measured at GLKY during the third quarter of 2014. In addition, all measured detections from the third quarter were less than or equal to the median 1,2-dichloroethane concentration.

- Arsenic is the only other pollutant of interest for GLKY that is not a VOC or carbonyl compound. Concentrations of arsenic measured at GLKY range from 0.04 ng/m^3 to 1.53 ng/m^3, plus four non-detects. The four highest arsenic concentrations measured at GLKY were measured on consecutive sample days between September 14, 2014 and October 2, 2014.

- GLKY is not listed in Tables 4-9 through 4-12, which present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. The annual average concentrations for GLKY's pollutants of interest are among some of the lowest across the program. GLKY's annual average benzene concentration is the lowest among all NMP sites sampling this pollutant.

Observations for BAKY from Table 12-5 include the following:

- Only speciated metals were sampled for at BAKY; only arsenic was identified as a pollutant of interest for BAKY.

- Arsenic was measured in all but one of the 58 valid metals samples collected at BAKY.

- Arsenic concentrations measured at BAKY range from 0.06 ng/m^3 to 3.36 ng/m^3, plus the one non-detect, with a median concentration of 0.755 ng/m^3. The maximum arsenic concentration was measured on October 26, 2014 and is among the highest arsenic concentrations measured across the program. Yet, this measurement is the only arsenic concentration greater than 1 ng/m^3 measured during the fourth quarter of 2014, explaining the variability shown by the confidence interval for the fourth quarter average concentration. Most of the 15 arsenic concentrations greater than 1 ng/m^3 were measured at BAKY during the third quarter of the year (nine).

- Among NMP sites sampling PM_{10} metals, BAKY has the third highest annual average concentration of arsenic, as shown in Table 4-12. A similar observation was made in the 2013 NMP report.

Observations for the Calvert City monitoring sites from Table 12-5 include the following:

- VOC samples were collected at all five Calvert City sites; PM_{10} metals were sampled for in addition to VOCs at CCKY through October 2, 2014, after which sampling at this location was discontinued. Thus, fourth quarter average concentrations are not available in table 12-5.

- Some of the highest concentrations of VOCs were measured at the Calvert City sites and these data are reviewed in the bullets that follow.

- Vinyl chloride is an infrequently detected pollutant under the NMP in typical urban atmospheres. Across the program, this pollutant was detected in 16 percent of the total samples collected. Together, the five Calvert City sites account for nearly 70 percent of the 248 measured detections of this pollutant. The Calvert City sites account for all 56 concentrations of vinyl chloride greater than 0.30 $\mu g/m^3$ measured across the program, including the 19 measurements greater than 1 $\mu g/m^3$. The maximum concentration of vinyl chloride across the program was measured at TVKY (22.95 $\mu g/m^3$), although additional measurements greater than 5 $\mu g/m^3$ were also measured at ATKY. A vinyl chloride concentration greater than 1 $\mu g/m^3$ was measured at least once at four of the five Calvert City sites in 2014 (CCKY is the exception).

- Vinyl chloride is a pollutant of interest for all five Calvert City sites. As shown in Table 12-5, annual average concentrations for these sites range from 0.08 ± 0.04 $\mu g/m^3$ for CCKY to 0.77 ± 0.40 $\mu g/m^3$ for ATKY. All of the annual average and quarterly average concentrations of vinyl chloride for these sites have relatively large confidence intervals, indicating the relatively large amount of variability associated with these measurements, including substitutions for non-detects. The number of non-detects measured at each site range from 19 (TVKY and CCKY) to 27 (BLKY).

- Another pollutant for which the highest concentrations program-wide were measured at the Calvert City sites is 1,2-dichloroethane. The 124 highest concentrations of 1,2-dichloroethane across the program were measured at the Calvert City sites. This includes all 78 measurements greater than 1 $\mu g/m^3$ and the nine greater than 10 $\mu g/m^3$.

- 1,2-Dichloroethane is a pollutant of interest for all five Calvert City sites. Annual average concentrations for these sites range from 0.49 ± 0.16 $\mu g/m^3$ for CCKY to 3.54 ± 1.66 $\mu g/m^3$ for TVKY. All of the sites except CCKY have at least one quarterly average concentration of 1,2-dichloroethane with an associated confidence interval greater than the average itself, indicating the relatively large amount of variability associated with these measurements.

- Some of the highest measurements of carbon tetrachloride were also measured at the Calvert City sites. Of the 17 carbon tetrachloride concentrations greater than or equal to 1 $\mu g/m^3$ measured across the program, 16 were measured at the Calvert City sites (seven at TVKY, three at BLKY, and two each at ATKY, CCKY, and LAKY). The maximum carbon tetrachloride concentration measured at TVKY on

November 13, 2014 (3.06 µg/m^3), although a concentration of similar magnitude (2.86 µg/m^3) was also measured at TVKY in September.

- Carbon tetrachloride is a pollutant of interest for all five Calvert City sites. Annual average concentrations range from 0.68 ± 0.03 µg/m^3 for ATKY to 0.87 ± 0.13 µg/m^3 for TVKY. Quarterly average concentrations for TVKY exhibit the most variability, ranging from 0.76 ± 0.08 µg/m^3 for the second quarter of 2014 to 0.93 ± 0.32 µg/m^3 for the first quarter. Most of the quarterly average concentrations calculated for NMP sites sampling carbon tetrachloride in 2014 fall between 0.55 µg/m^3 and 0.75 µg/m^3; all four of TVKY's quarterly averages, BLKY's second quarter average, and LAKY's first quarter are outside this range.

- All 10 1,3-butadiene concentrations greater than 0.75 µg/m^3 measured across the program were measured at the Calvert City sites (seven at TVKY, two at BLKY, and one at LAKY). Concentrations of 1,3-butadiene greater than 0.5 µg/m^3 were measured at only seven NMP sites in 2014, and concentrations measured at TVKY, BLKY, LAKY, and ATKY account for 18 out of 28 of them. Annual average concentrations of 1,3-butadiene range from 0.08 ± 0.03 µg/m^3 for CCKY to 0.38 ± 0.22 µg/m^3 for TVKY.

- The concentrations of 1,3-butadiene for the Calvert City sites exhibit considerable variability, particularly for TVKY, with quarterly average concentrations that range from 0.13 ± 0.09 µg/m^3 for the fourth quarter of 2014 to 0.86 ± 0.76 µg/m^3 for the third quarter. Many of the quarterly average concentrations for the Calvert City sites have relatively large confidence intervals associated with them, a few of which are greater than the average itself.

- Hexachloro-1,3-butadiene is another infrequently detected pollutant that is a pollutant of interest for all five Calvert City sites. Concentrations measured at the Calvert City sites account for roughly one-fifth of the 359 measured detections of this pollutant across the program. The number of times hexachloro-1,3-butadiene was detected in samples collected at these sites ranges from nine (CCKY) to 20 (TVKY); thus, zeros substituted for non-detects make up the majority of the measurements incorporated into the quarterly and annual averages shown in Table 12-5. As a result, the annual averages are not significantly different across the sites, ranging from 0.016 ± 0.010 µg/m^3 for CCKY to 0.029 ± 0.011 µg/m^3 for TVKY.

- Benzene is the only other VOC that is a pollutant of interest across the Calvert City sites. Annual average concentrations of benzene range from 0.56 ± 0.08 µg/m^3 for CCKY to 1.04 ± 0.35 µg/m^3 for TVKY. Benzene concentrations measured at TVKY exhibit the most variability, ranging from 0.20 µg/m^3 to 9.92 µg/m^3. The maximum benzene concentration was measured at TVKY on July 28, 2014 and is the second highest benzene concentration measured across the program, second only to the maximum concentration measured at ASKY. Concentrations measured at TVKY account for three of the eight benzene measurements greater than 3 µg/m^3 measured across the program with LAKY accounting for a fourth. TVKY's third quarter average concentration is the highest quarterly average concentration of benzene

calculated for NMP sites sampling this pollutant. All but one of TVKY's benzene concentrations measured in July and August are greater than 1 µg/m^3.

- 1,1,2-Trichloroethane is a pollutant of interest for TVKY and is the only NMP site for which this is true. This pollutant was detected in 28 samples collected across the program in 2014, with measurements from the Calvert City sites accounting for 27 of them. This pollutant was detected 15 times at TVKY, four times each at BLKY and LAKY, three times at ATKY, and once at CCKY. The program-level maximum concentration of this pollutant (0.607 µg/m^3) was measured at LAKY on December 1, 2014 and concentrations of 1,1,2-trichloroethane greater than 0.2 µg/m^3 were not measured at any other NMP site in 2014.

- Table 4-9 presents the NMP sites with the 10 highest annual average concentrations for each of the program-level VOC pollutants of interest. This table shows that the Calvert City sites account for the five highest annual average concentrations of carbon tetrachloride and 1,2-dichloroethane across the program, with TVKY ranking highest for each. Calvert City sites account for three of the five highest annual average concentrations of 1,3-butadiene across the program (with ATKY and CCKY as the exceptions). TVKY has the sixth highest annual average benzene concentration among sites sampling this pollutant. TVKY and LAKY rank second and sixth highest, respectively, among NMP sites for their annual average concentrations of hexachloro-1,3-butadiene.

- Arsenic is the only non-VOC pollutant of interest for CCKY. Concentrations of arsenic measured at CCKY range from 0.10 ng/m^3 to 1.75 ng/m^3, plus two non-detects, with a median concentration of 0.43 ng/m^3. Concentrations measured in 2014 appear highest during the warmer months of the year and lowest during the colder months, based on the available quarterly average concentrations. The number of arsenic concentrations greater than 0.5 ng/m^3 measured at CCKY increases from three during the first quarter to four during the second quarter to 10 during the third quarter. Conversely, the number of arsenic concentrations less than 0.3 ng/m^3 measured at CCKY decreases from five during the first quarter to three during the second quarter to one during the third quarter. This site has the ninth highest annual average concentration of arsenic among NMP sites sampling PM_{10} metals, as shown in Table 4-12. A similar observation was made in the 2013 NMP report.

- It should be noted that during the first four months of 2014, construction was occurring near the TVKY monitoring site.

Observations for LEKY from Table 12-5 include the following:

- VOC, carbonyl compound, and speciated metals samples were collected at LEKY in 2014.

- The annual average concentration for formaldehyde (3.15 ± 0.90 µg/m^3) is twice the annual average concentration of acetaldehyde (1.55 ± 0.13 µg/m^3), the two carbonyl compound pollutants of interest for LEKY and the only two pollutants with annual average concentrations greater than 1 µg/m^3.

- The second and third quarter average concentrations of formaldehyde are considerably higher than the first and fourth quarter averages, indicating that formaldehyde concentrations tended to be higher during the warmer months of the year at this site. However, the confidence interval for the second quarter average is five time larger than the confidence interval for the third quarter average, indicating the presence of outliers. Concentrations of formaldehyde measured at LEKY range from 0.766 µg/m^3 to 25.85 µg/m^3, with the maximum concentration measured on May 23, 2014. This measurement is the maximum formaldehyde concentration measured across the program. The next highest formaldehyde concentration measured at LEKY (5.73 µg/m^3) is one-fifth the magnitude of the maximum concentration. If the maximum formaldehyde concentration was excluded from the second quarter average concentration, it would be similar to the third quarter average concentration.

- While not significantly different, the quarterly average concentrations of acetaldehyde exhibit a decreasing trend across the year. The highest acetaldehyde concentrations were measured on the last sample day of January and first sample day of February while the lowest concentrations were measured in December. Of the 12 acetaldehyde concentrations greater than 2 µg/m^3, four were measured during the first and second quarters, three were measured during the third quarter, and only one was measured during the fourth quarter. Looking at the lower end of the concentration range, acetaldehyde concentrations less than 1 µg/m^3 were not measured during the first and second quarters, while two were measured during the third quarter and five were measured during the fourth quarter of 2014.

- Among the VOC pollutants of interest for LEKY, benzene has the highest annual average concentration (0.62 ± 0.04 µg/m^3), although the annual average concentration of carbon tetrachloride is very similar (0.61 ± 0.02 µg/m^3).

- Concentrations of arsenic measured at LEKY range from 0.10 ng/m^3 to 1.88 ng/m^3, with a median concentration of 0.63 ng/m^3, including 13 measurements greater than 1 ng/m^3. Among NMP sites sampling PM_{10} metals, LEKY has the sixth highest annual average concentration of arsenic, as shown in Table 4-12.

- It should be noted that during the first quarter of 2014, demolition of a nearby building was occurring near the monitoring site. Also, in June, paving and construction were noted adjacent to the site.

12.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where annual averages are available. Thus, box plots were created for the pollutants of interest for each of the Kentucky monitoring sites. Figures 12-24 through 12-36 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as

described in Section 3.4.3.1. Figures 12-24 through 12-36 and their associated observations are discussed below.

Figure 12-24. Program vs. Site-Specific Average Acetaldehyde Concentrations

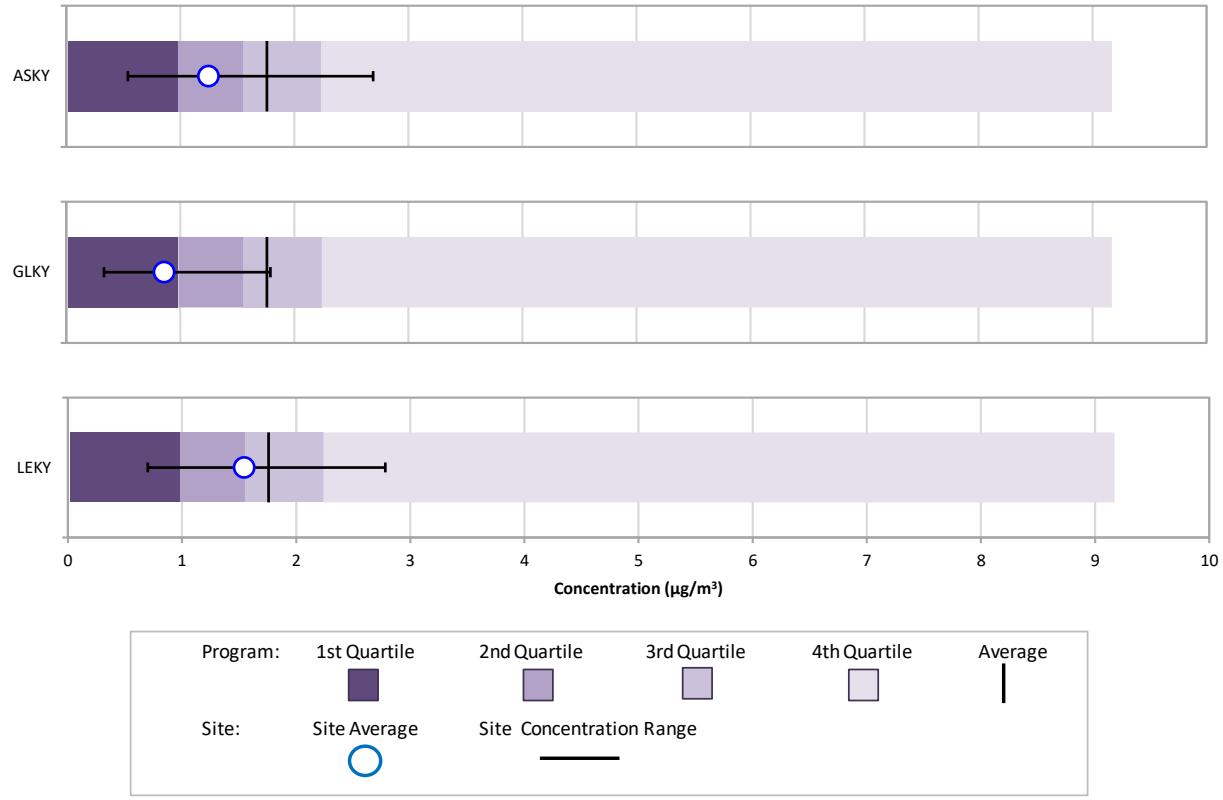


Figure 12-24 presents the box plots for acetaldehyde for ASKY, GLKY, and LEKY and shows the following:

- The range of acetaldehyde concentrations measured at ASKY is similar to the range measured at LEKY. For GLKY, all but one of the acetaldehyde concentrations measured are less than the program-level average concentration.

- Among these three sites, GLKY has the lowest annual average concentration, which is less than the program-level first quartile; LEKY has the highest of the three, with an annual average similar to the program-level median concentration; ASKY's annual average is between the two, although the annual average concentrations for all three sites are less than the program-level average concentration.

Figure 12-25. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

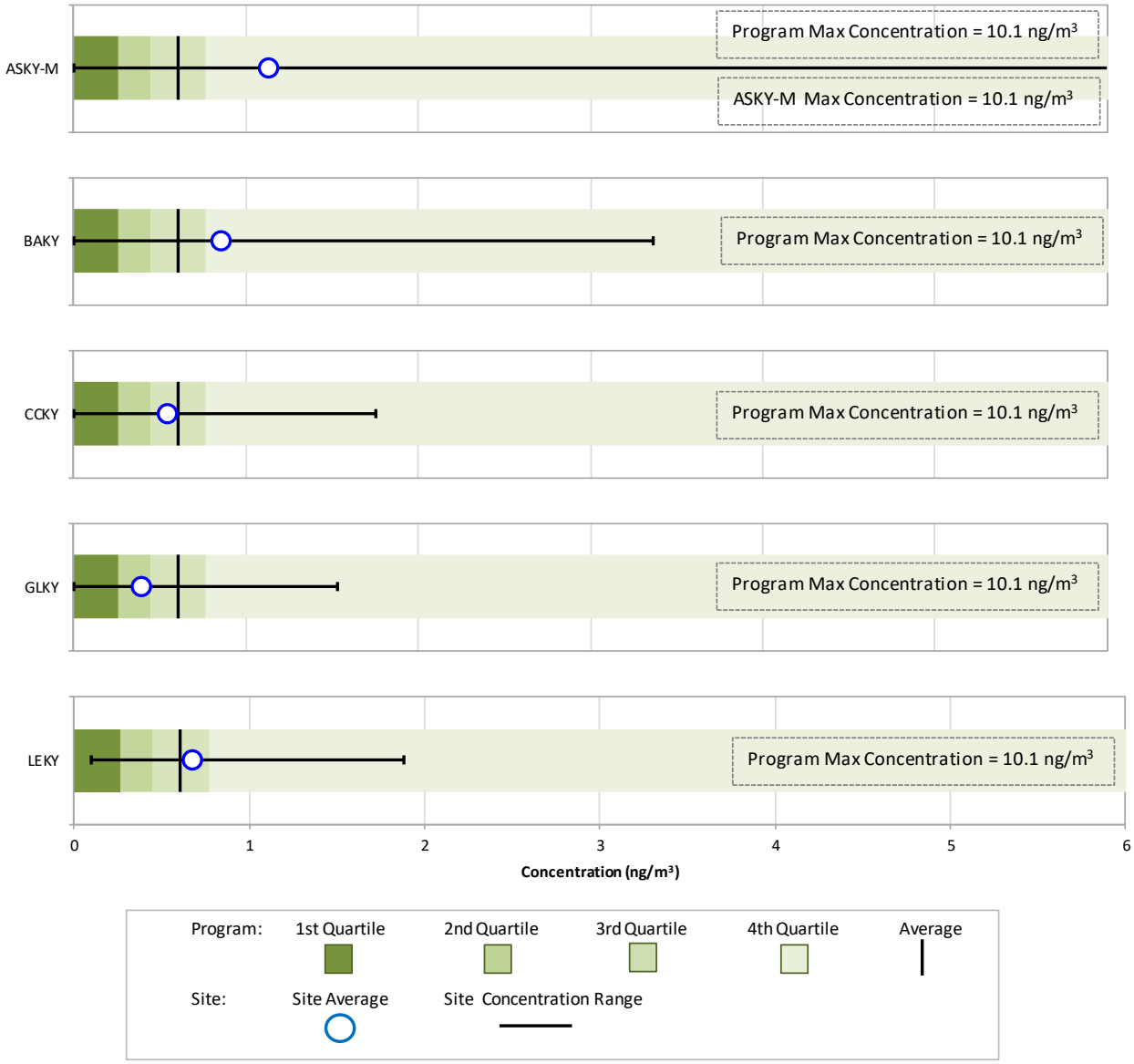


Figure 12-25 presents the box plots for arsenic for the five Kentucky sites sampling PM_{10} metals and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plots in Figure 12-25 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The box plots show that the range of arsenic concentrations measured is smallest for GLKY and largest for ASKY-M and that the maximum arsenic concentration measured across the program was measured at ASKY-M.

- The annual average concentrations of arsenic for ASKY-M, BAKY, and LEKY are greater than the program-level average concentration while the annual average concentrations for CCKY and GLKY are less than the program-level average concentration. The annual average concentration for GLKY is also less than the program-level median concentration.

- At least one non-detect of arsenic was measured at each site shown except LEKY.

Figure 12-26. Program vs. Site-Specific Average Benzene Concentrations

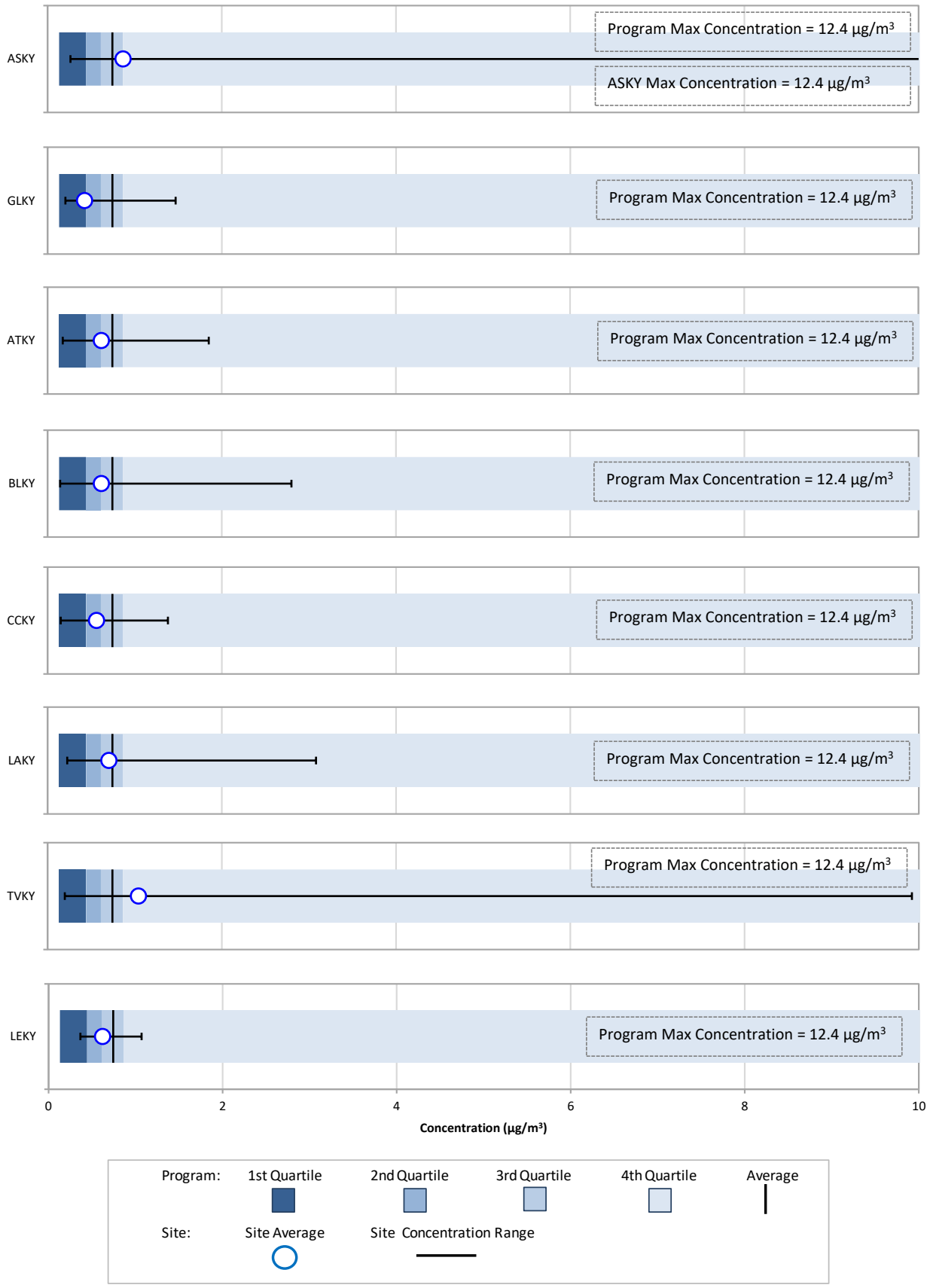


Figure 12-26 presents the box plots for benzene for the eight Kentucky sites sampling VOCs and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plots in Figure 12-26 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The box plots show that the maximum benzene concentration measured across the program was measured at ASKY. While all other benzene concentrations measured at the Kentucky sites fall within the range of benzene concentrations shown on the box plots, the second highest benzene concentration across the program was measured at TVKY. The range of benzene concentrations measured at the remaining sites are considerably smaller, with the smallest range of measurements shown for LEKY.

- The annual average concentrations of benzene across the Kentucky sites range from 0.42 ± 0.05 µg/m^3 (GLKY) to 1.04 ± 0.35 µg/m^3 (TVKY); the annual averages for ASKY and TVKY are greater than the program-level average concentration.

Figure 12-27. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

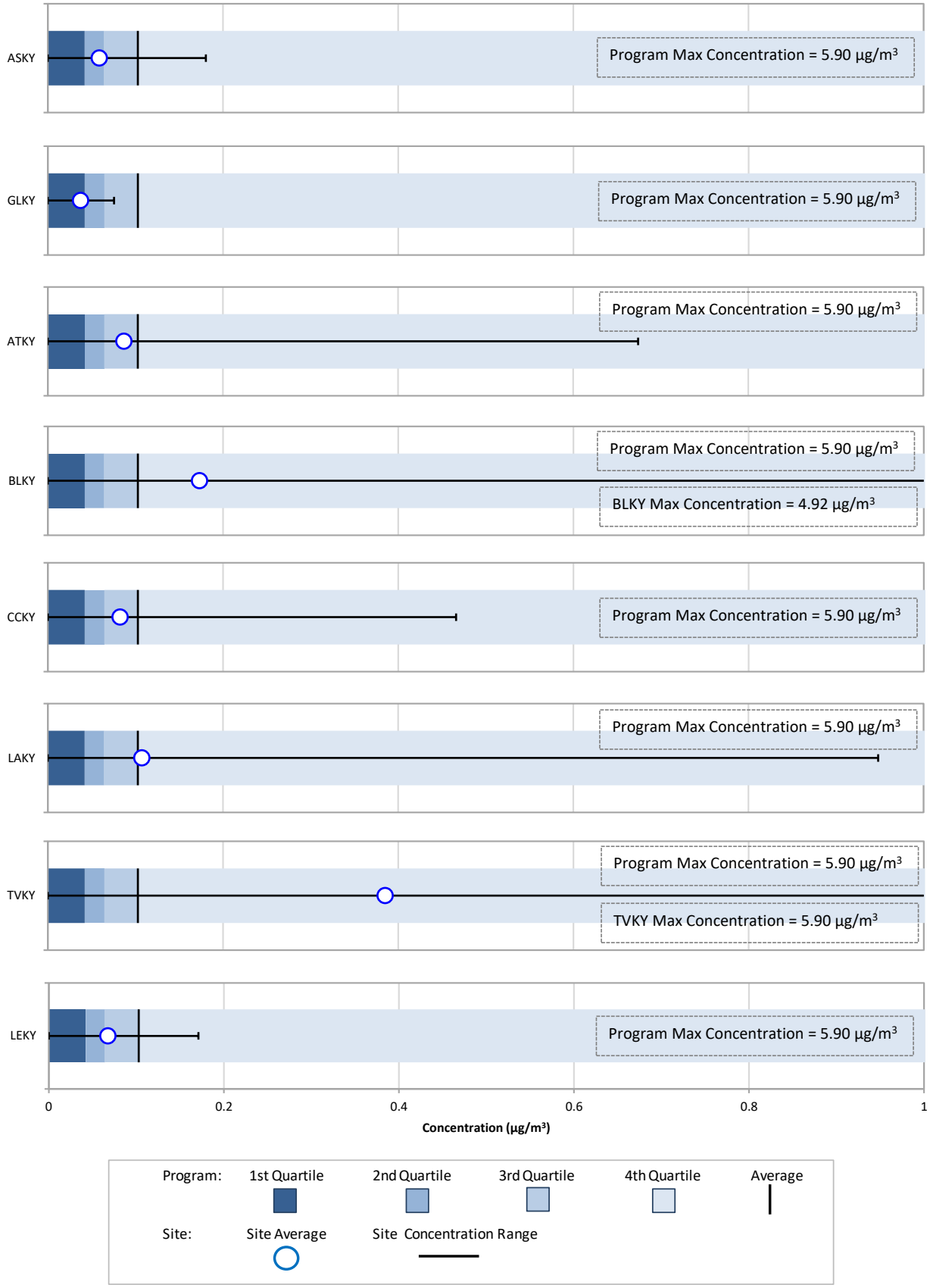


Figure 12-27 presents the box plots for 1,3-butadiene for the eight Kentucky sites sampling VOCs and shows the following:

- The program-level maximum concentration (5.90 µg/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 1 µg/m^3. Also, since the maximum 1,3-butadiene concentration for several sites is greater than the scale of the box plots, the site-specific maximum concentrations are labeled for these sites.

- The maximum 1,3-butadiene concentration measured across the program was measured at TVKY, although the maximum concentration measured at BLKY is also greater than the scale of the box plot.

- The annual average concentration of 1,3-butadiene for TVKY is more than three times the program-level average concentration; the annual average concentrations for BLKY and LAKY are also greater than the program-level average. The annual average concentrations for ATKY, CCKY, and LEKY fall between the program-level median and average concentrations. The annual average concentration for ASKY is just less than the program-level median concentration and the annual average for GLKY is just less than the program-level first quartile. Note that the program-level average concentration is similar to the third quartile, indicating that the 1,3-butadiene concentrations on the upper end of the concentration range are driving the program-level average upward.

Figure 12-28. Program vs. Site-Specific Average Cadmium Concentration

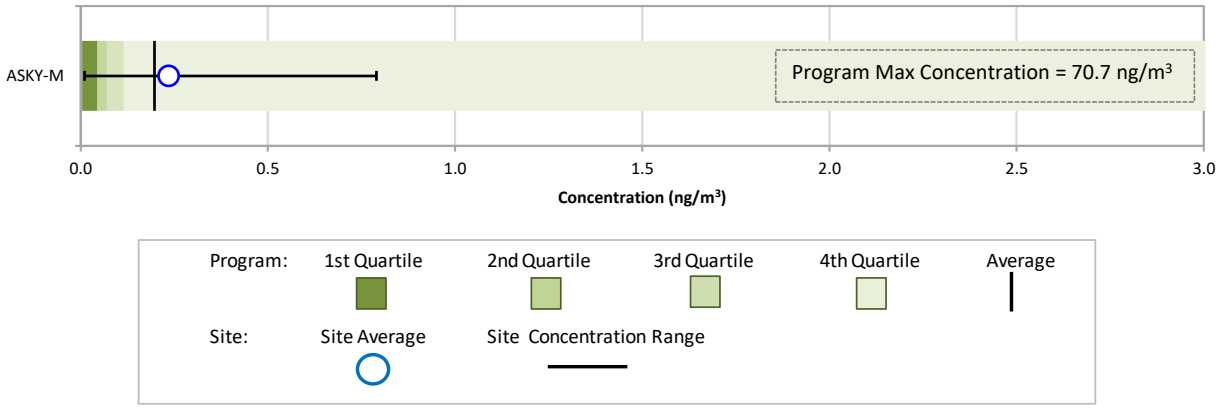


Figure 12-28 presents the box plot for cadmium for ASKY-M and shows the following:

- Similar to other pollutants, the program-level maximum cadmium concentration (70.7 ng/m^3) is not shown directly on the box plot as the scale of the box plot has been reduced to 3 ng/m^3 in order to allow for the observation of data points at the lower end of the concentration range.

- The maximum concentration measured at ASKY-M (0.79 ng/m^3) is an order of magnitude less than the maximum concentration measured across the program. However, the maximum concentration measured this site is among the higher measurements (ninth highest).

- The annual average concentration of cadmium for ASKY-M is just greater than the program-level average concentration. Note that the program-level average cadmium concentration is nearly two times the third quartile and nearly three times the program-level median concentration, indicating that the cadmium concentrations on the upper end of the concentration range, particularly the maximum program-level concentration, are driving the program-level average concentration upward, as the second highest cadmium concentration measured across the program falls within the scale of the box plot. ASKY-M is one of only two NMP sites sampling PM_{10} metals for which cadmium is a pollutant of interest.

Figure 12-29. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

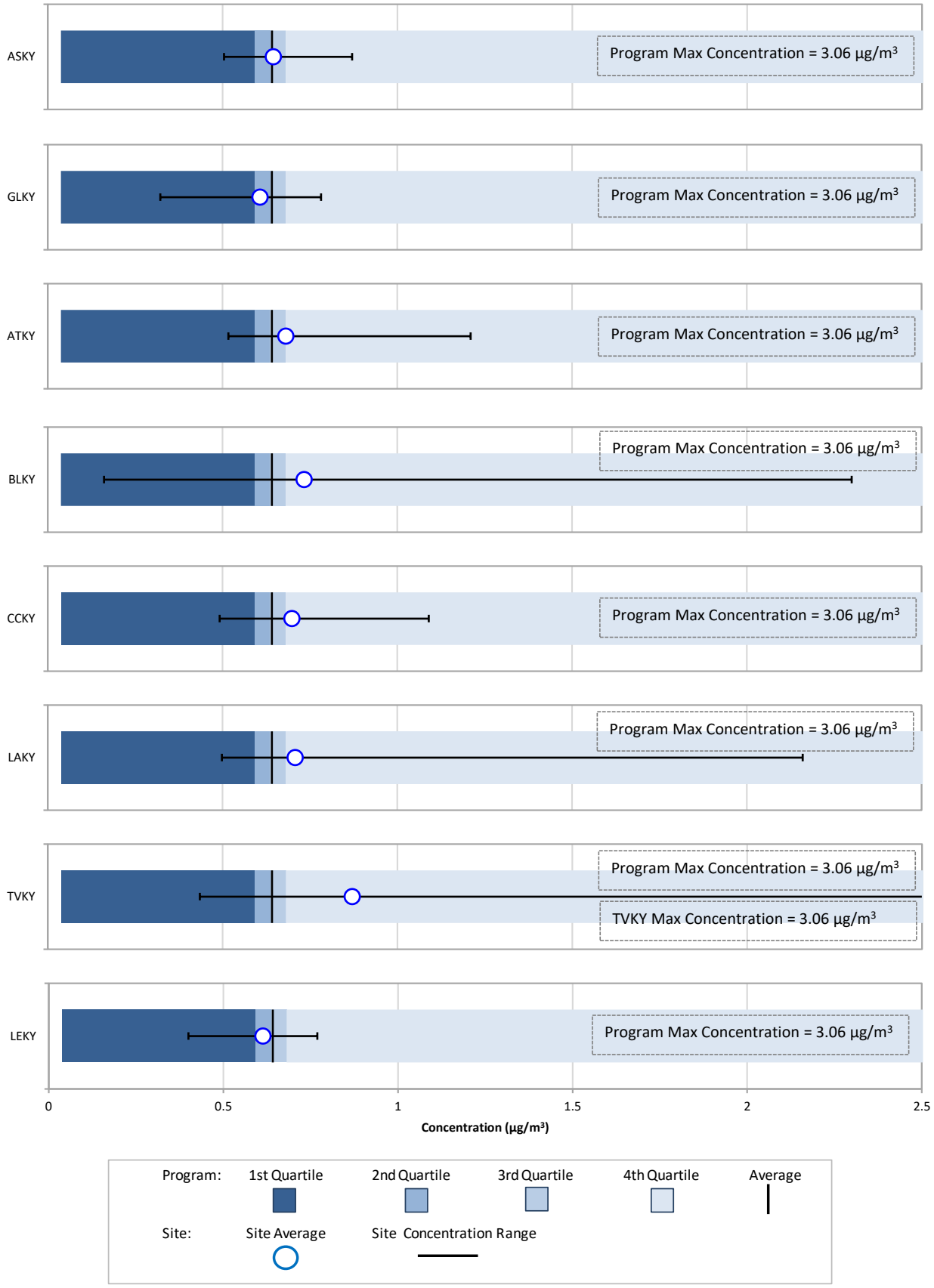


Figure 12-29 presents the box plots for carbon tetrachloride for the eight Kentucky sites sampling VOCs and shows the following:

- The program-level maximum carbon tetrachloride concentration (3.06 µg/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- The two highest carbon tetrachloride concentrations measured across the program were measured at TVKY, although concentrations greater than 1 µg/m^3 were also measured at BLKY, LAKY, and ATKY (and one other NMP site, GPCO).

- The annual average concentrations for the five Calvert City sites are greater than the program-level average and greater than or similar to the program-level third quartile. For the remaining Kentucky sites sampling carbon tetrachloride, the annual average concentration for ASKY is similar to the program-level average while the annual averages for GLKY and LEKY fall between the program-level first quartile and program-level median and average concentration.

Figure 12-30. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

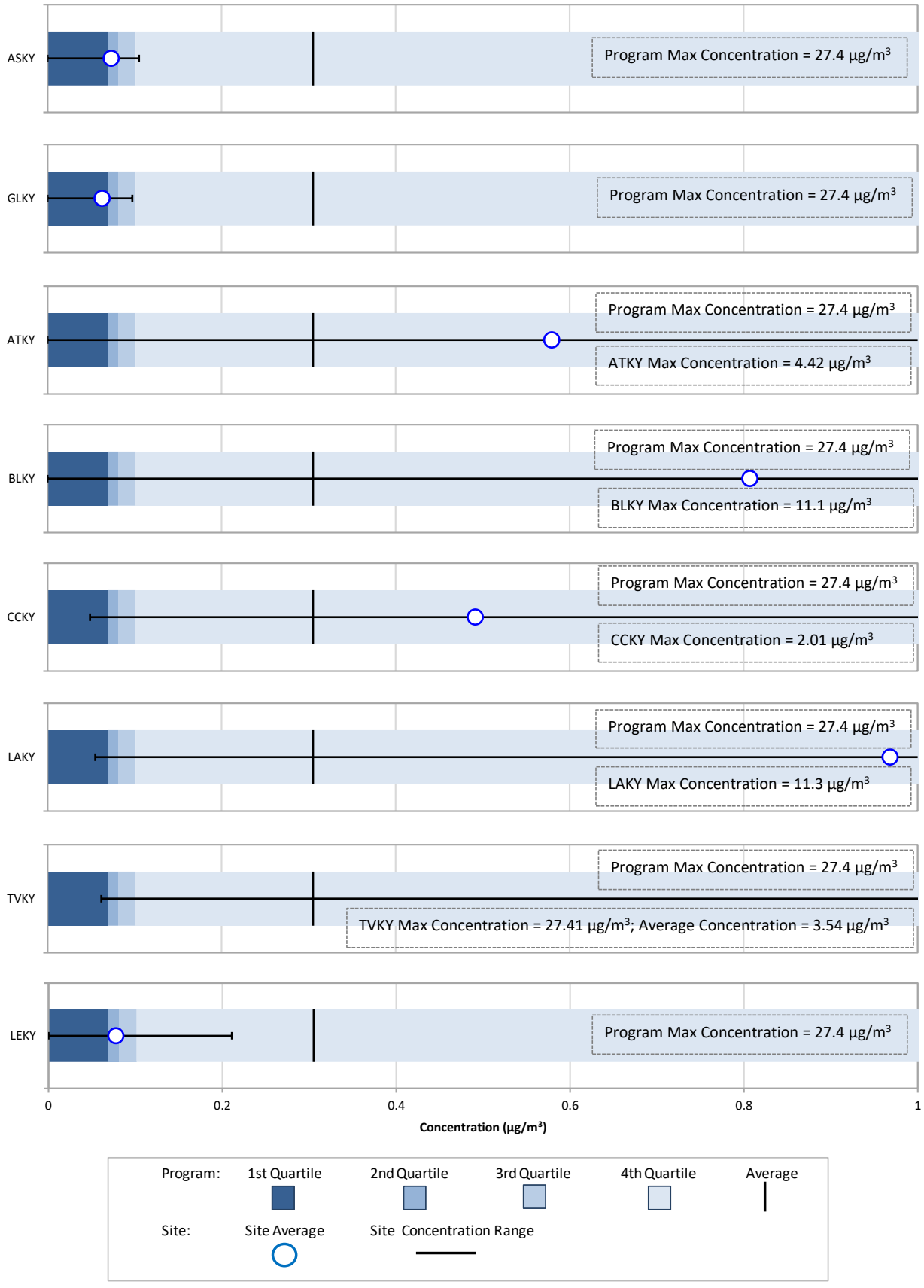


Figure 12-30 presents the box plots for 1,2-dichloroethane for the eight Kentucky sites sampling VOCs and shows the following:

- Similar to other pollutants, the program-level maximum concentration (27.4 µg/m^3) is not shown directly on the box plots for 1,2-dichloroethane as the scale of the box plots has been reduced to 1 µg/m^3 in order to allow for the observations data points at the lower end of the concentration range. Also, since the maximum 1,2-dichloroethane concentration measured at several sites is greater than the scale of the box plots, the site-specific maximum concentrations are labeled for these sites. Note that the program-level average concentration is three times greater than the third quartile, indicating that the 1,2-dichloroethane concentrations on the upper end of the concentration range are driving the program-level average upward.

- 1,2-Dichloroethane concentrations measured at ASKY, GLKY, and LEKY are all less than the program-level average concentration, with all of GLKY's measurements less the program-level third quartile. By comparison, the maximum concentration measured at each of the Calvert City sites exceeds the scale of the box plots, including TVKY's annual average concentration.

- Recall from the previous section that the annual average concentrations for the Calvert City sites account for the five highest annual average concentrations of 1,2-dichloroethane among NMP sites sampling VOCs. Among the Calvert City sites, CCKY has the lowest annual average concentration of 1,2-dichloroethane, although it is still more than four times the annual average for the NMP monitoring site with the next highest annual average (BTUT), as shown in Table 4-9.

Figure 12-31. Program vs. Site-Specific Average Formaldehyde Concentrations

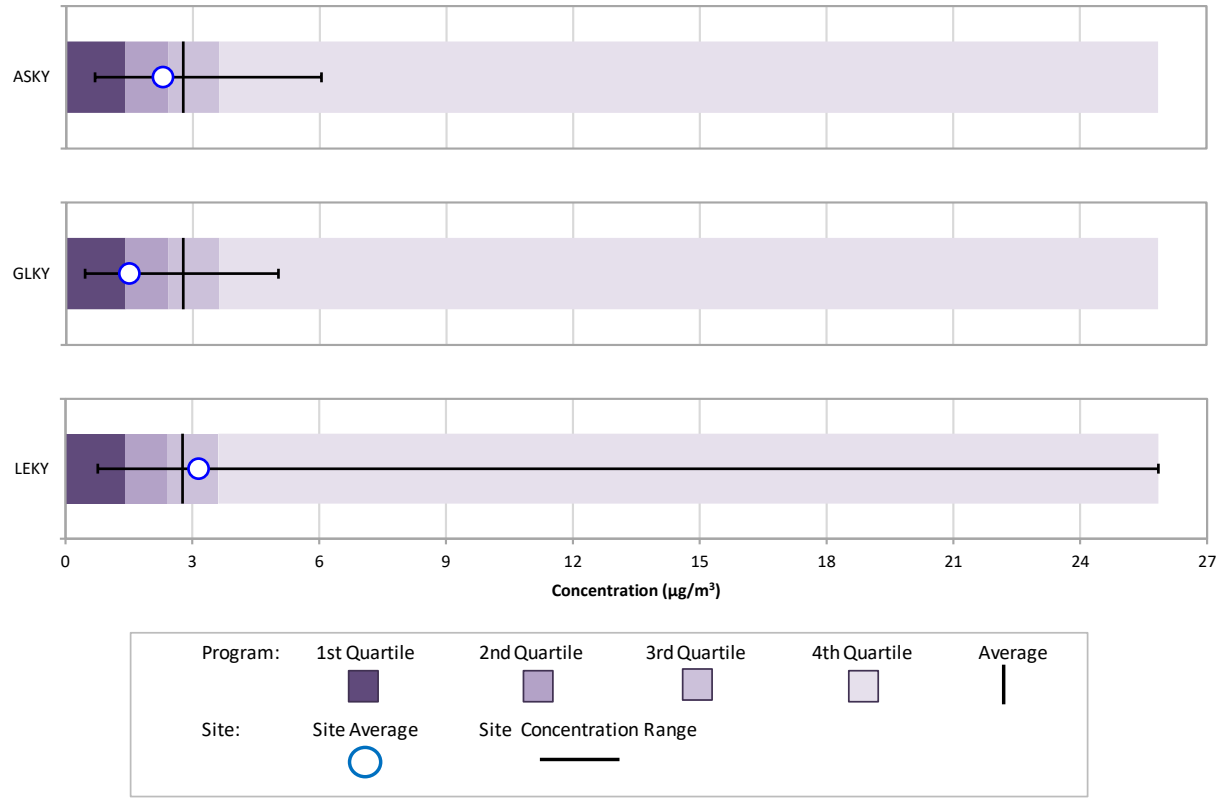


Figure 12-31 presents the box plots for formaldehyde for ASKY, GLKY, and LEKY and shows the following:

- The range of formaldehyde concentrations measured was smallest for GLKY and largest for LEKY, where the program-level maximum formaldehyde concentration was measured.

- Among these three sites, GLKY has the lowest annual average concentration while LEKY has the highest. LEKY's annual average concentration is just greater than the program-level average concentration; ASKY's annual average is just less the program-level median concentration; and GLKY's annual average is just greater than to the program-level first quartile.

Figure 12-32. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

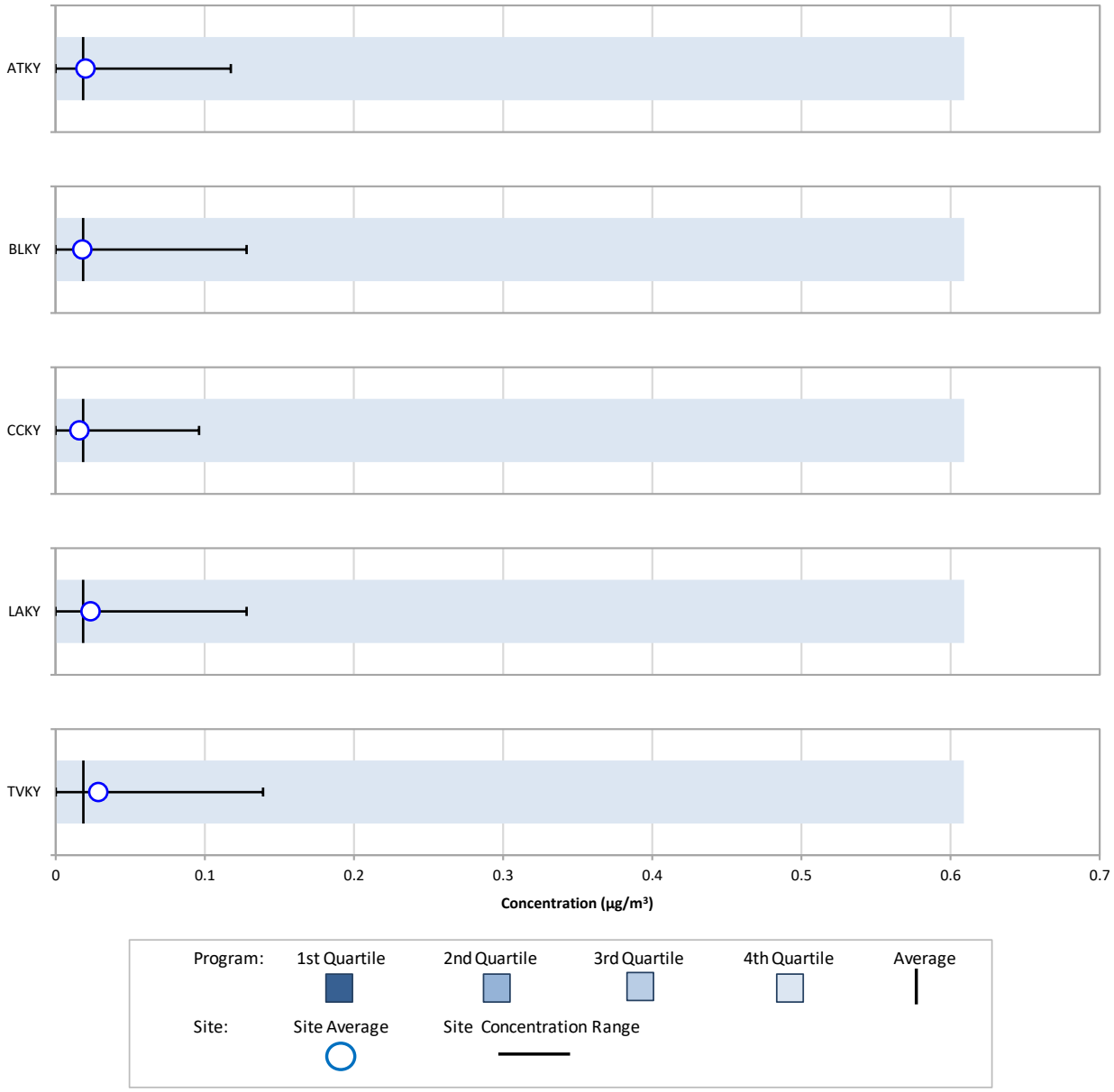


Figure 12-32 presents the box plots for hexachloro-1,3-butadiene for the five Kentucky sites for which this pollutant was identified as a pollutant of interest and shows the following:

- The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plots.

- The Kentucky sites for which hexachloro-1,3-butadiene was identified as a pollutant of interest are all Calvert City sites. The maximum hexachloro-1,3-butadiene concentrations measured at these sites are fairly similar to each other, with less than 0.05 µg/m^3 separating them. The number of measured detections of this pollutant for these sites ranged from nine (CCKY) to 20 (TVKY), and thus, hexachloro-1,3-butadiene was detected in fewer than one-third of valid samples for these sites.

- Even though the annual average hexachloro-1,3-butadiene concentrations for all of the sites shown are similar to the program-level average concentration, the annual averages of this pollutant for all NMP sites sampling VOCs fall within a relatively tight range across the program (spanning 0.05 µg/m^3 for all NMP sites sampling VOCs, including several sites at which hexachloro-1,3-butadiene was not detected).

Figure 12-33. Program vs. Site-Specific Average Manganese (PM_{10}) Concentration

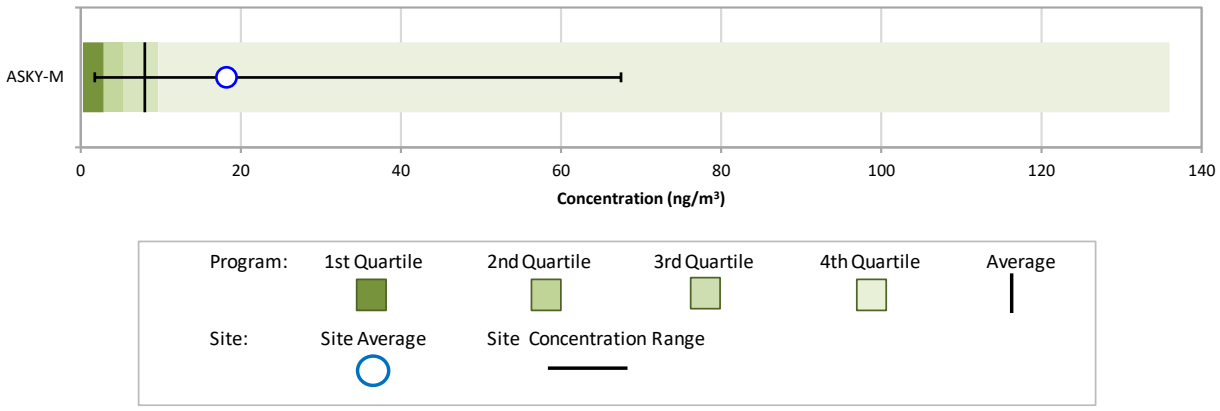


Figure 12-33 presents the box plot for manganese for ASKY-M and shows the following:

- Although the maximum manganese concentration across the program was not measured at ASKY-M, this site does have one of the higher measurements, including two greater than 50 ng/m^3.

- The annual average concentration of manganese for ASKY-M is more than twice the program-level average concentration. Note that ASKY-M is the only NMP site sampling PM_{10} metals for which manganese is a pollutant of interest (and one of only two NMP sites if the sites sampling TSP metals are included).

Figure 12-34. Program vs. Site-Specific Average Nickel (PM_{10}) Concentration

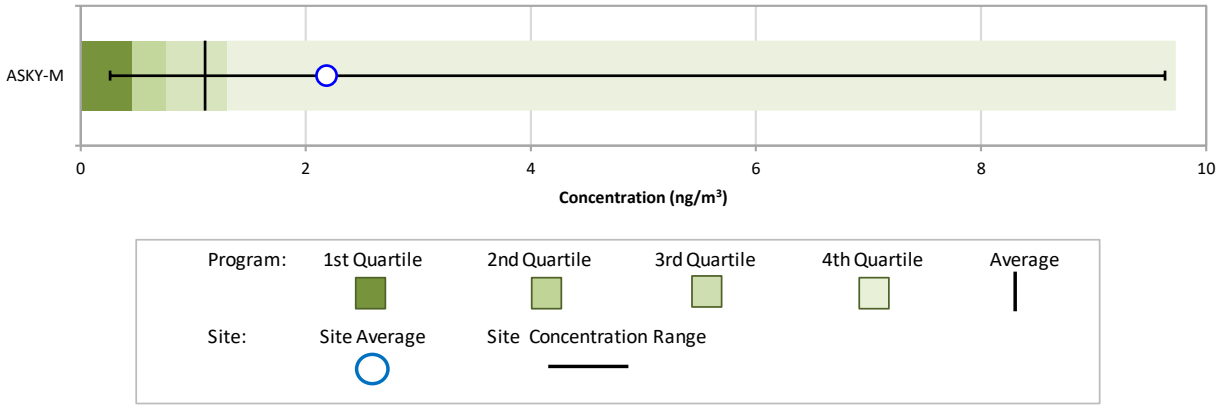


Figure 12-34 presents the box plot for nickel for ASKY-M and shows the following:

- Although the maximum nickel concentration measured across the program was not measured at ASKY-M, ASKY-M's maximum concentration does rank second highest, with a difference less than 0.1 ng/m^3.

- The annual average concentration of nickel for ASKY-M is nearly two times greater than the program-level average concentration and is the highest annual average concentration of nickel calculated among NMP sites sampling PM_{10} metals.

Figure 12-35. Program vs. Site-Specific Average 1,1,2-Trichloroethane Concentration

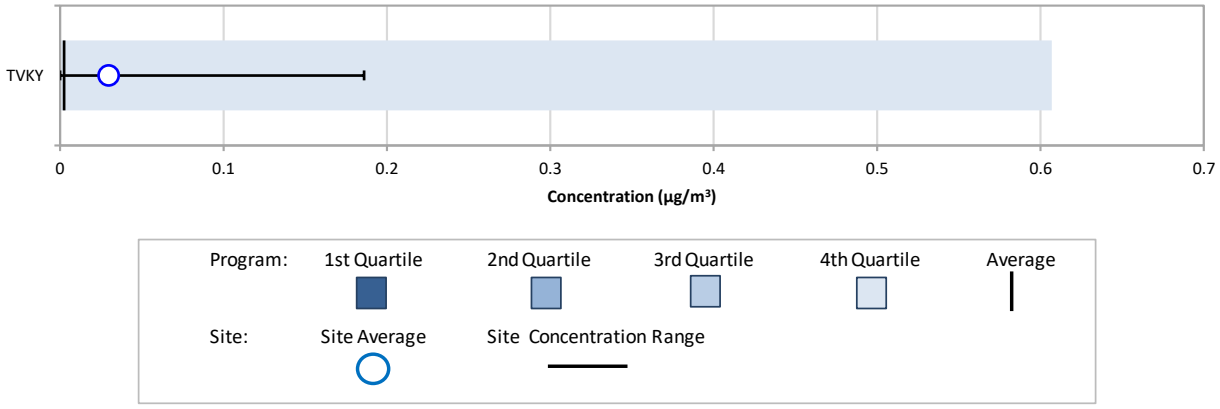


Figure 12-35 presents the box plot for 1,1,2-trichloroethane for TVKY, the only site for which this pollutant was identified as a pollutant of interest, and shows the following:

- The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plot.

- The maximum 1,1,2-trichloroethane concentration across the program was measured at LAKY and not at TVKY, and although the next two highest 1,1,2-trichloroethane concentrations were measured at TVKY, they were considerably less. This pollutant was detected 15 times at TVKY, or in less than a quarter of the samples collected at this site, despite having the highest detection rate among NMP sites sampling VOCs. TVKY is the only NMP site with 1,1,2-trichloroethane as a pollutant of interest.

Figure 12-36. Program vs. Site-Specific Average Vinyl Chloride Concentrations

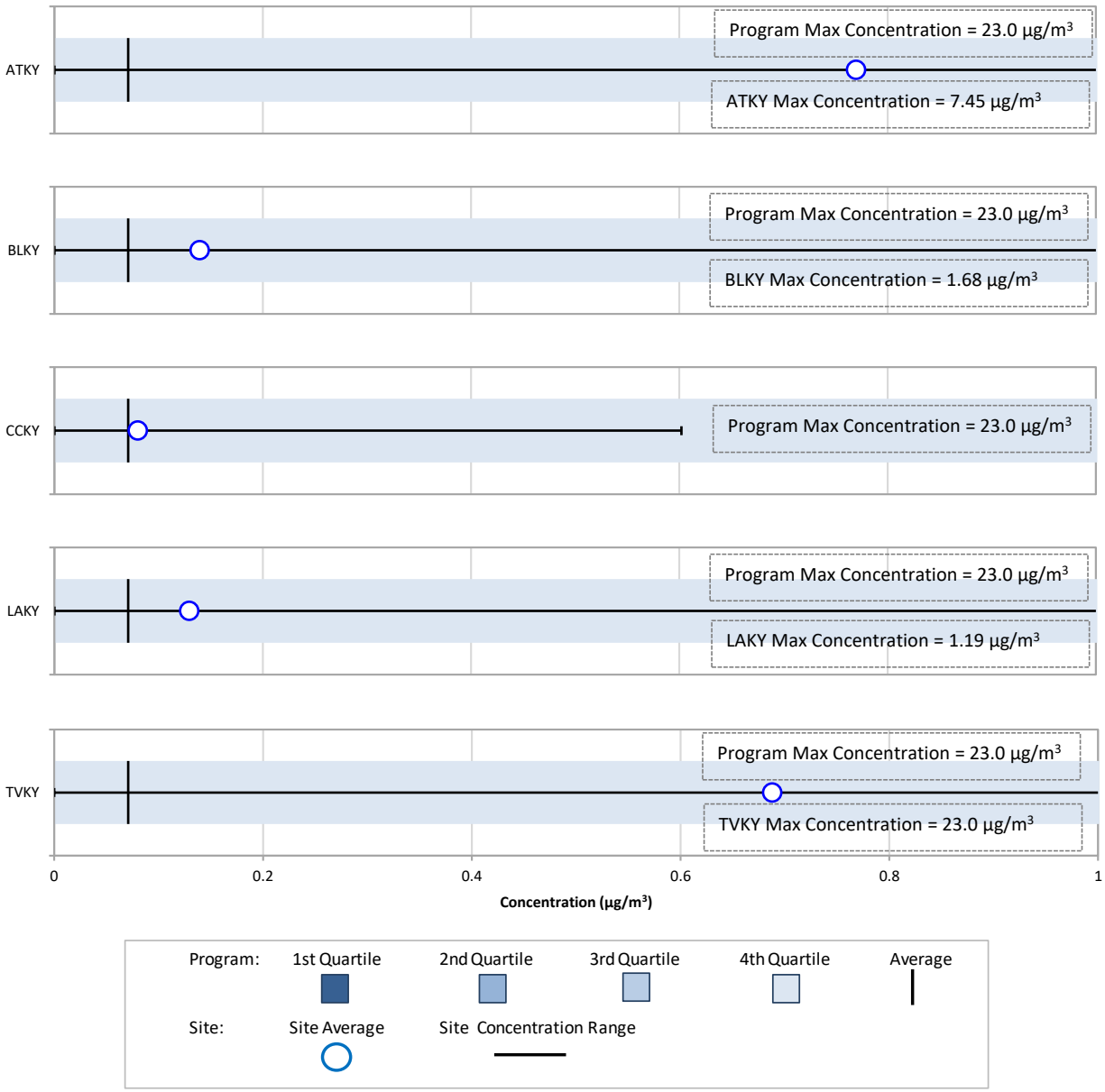


Figure 12-36 presents the box plots for vinyl chloride for the five Kentucky sites for which this pollutant was identified as a pollutant of interest and shows the following:

- The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plots.

- Similar to other pollutants, the program-level maximum concentration (23.0 µg/m^3) is not shown directly on the box plots for vinyl chloride as the scale of the box plots has been reduced. Also, since the maximum vinyl chloride concentration for several sites is greater than the scale of the box plots, the site-specific maximum concentrations are labeled for these sites.

- The maximum vinyl chloride concentration measured at TVKY is the maximum concentration measured across the program, although several concentrations greater than the scale of the box plots were measured at four of the five Calvert City sites.

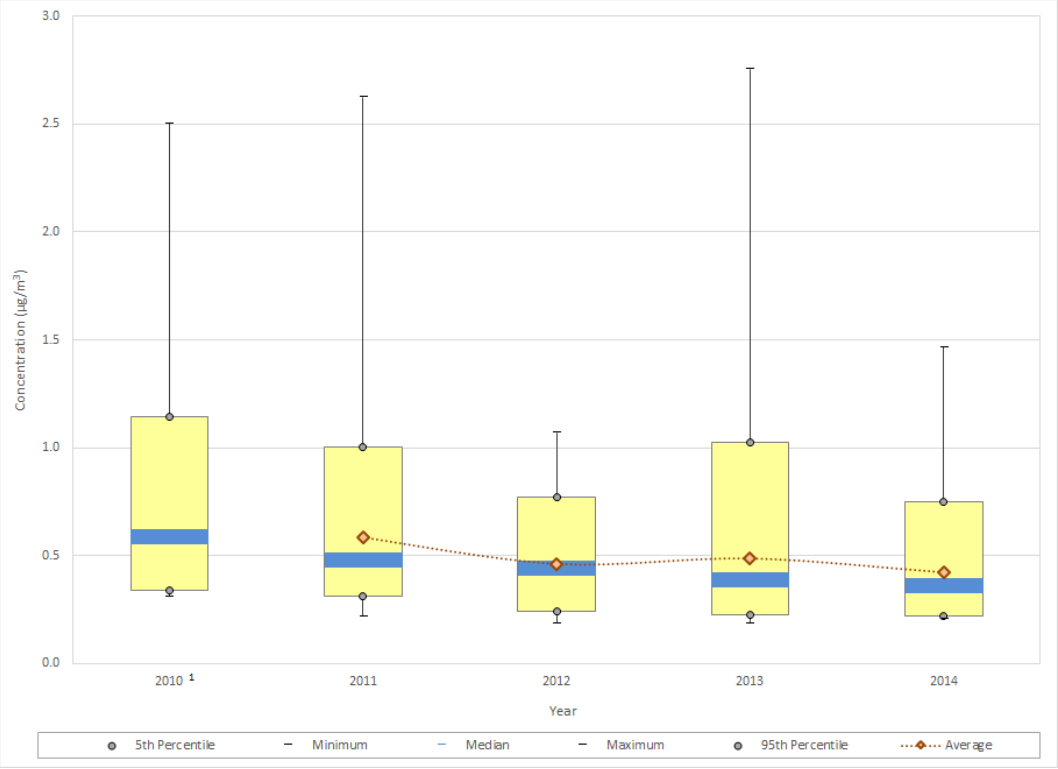
- The annual average vinyl chloride concentrations for these sites range from 0.08 ± 0.04 µg/m^3 for CCKY to 0.77 ± 0.40 µg/m^3 for ATKY, all of which are greater than the program-level average concentration of 0.07 µg/m^3. Note that the annual averages for ATKY and TVKY are more than five times greater than the annual averages for the remaining three sites.

- The number of measured detections ranges from 27 for CCKY to 42 for TVKY, with no other NMP site measuring more than eight measured detections of this pollutant.

12.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. The only pollutant groups for which GLKY has sampled under the NMP since at least 2010 is VOCs and PAHs (carbonyl compounds and PM_{10} metals sampling began in 2011). Thus, Figures 12-37 through 12-40 present the 1-year statistical metrics for each of the VOC pollutants of interest for GLKY (no PAHs were identified as pollutants of interest for this site). The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. The remaining Kentucky sites did not begin sampling under the NMP until 2012, and thus, no trends analysis was performed.

Figure 12-37. Yearly Statistical Metrics for Benzene Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

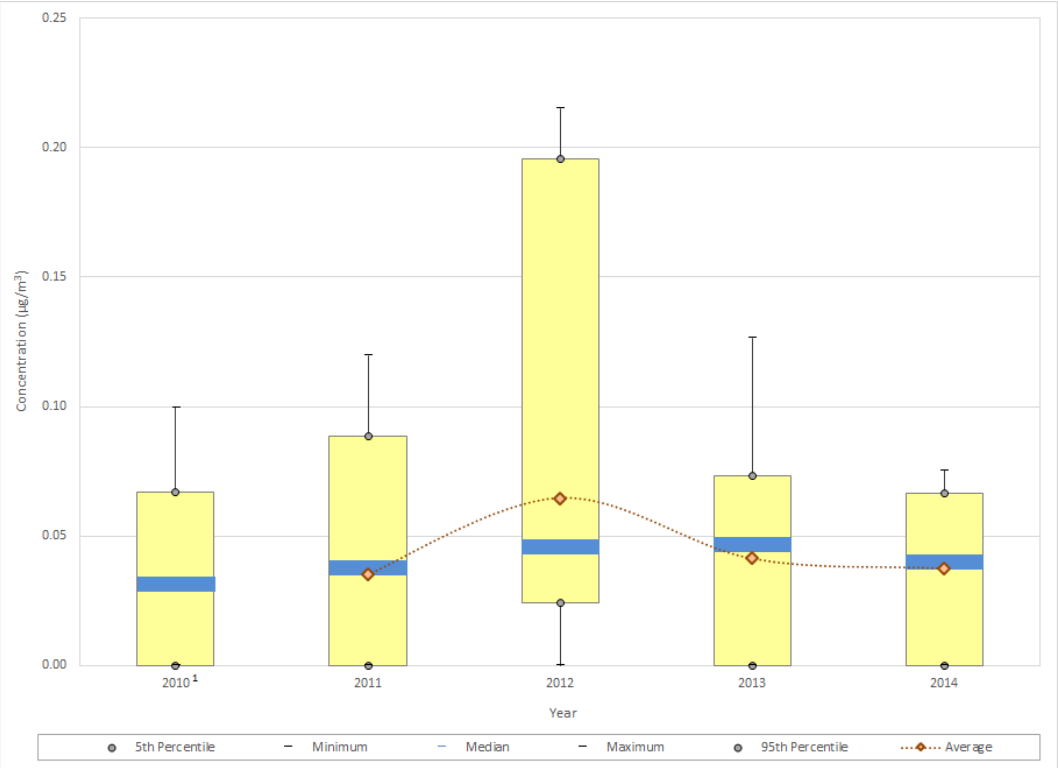
Observations from Figure 12-37 for benzene concentrations measured at GLKY include the following:

- GLKY began sampling VOCs under the NMP in June 2010. Because a full year's worth of data is not available, a 1-year average concentration for 2010 is not presented, although the range of measurements is provided.

- The maximum benzene concentration was measured at GLKY in August 2013 (2.75 µg/m^3), and is one of only three benzene concentrations greater than 2 µg/m^3 measured at this site.

- The 1-year median benzene concentration exhibits a steady decreasing trend at this site, decreasing from 0.59 µg/m^3 for 2010 to 0.36 µg/m^3 for 2014. The 1- year average concentration decreases from 0.58 µg/m^3 to 0.42 µg/m^3 between 2011 and 2014, with a slight increase shown from 2012 to 2013. If the maximum concentration measured in 2013 was excluded from the dataset, the 1-year average would exhibit a pattern similar to the 1-year median concentration.

Figure 12-38. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

Observations from Figure 12-38 for 1,3-butadiene concentrations measured at GLKY include the following:

- The eight highest 1,3-butadiene concentrations were measured at GLKY in 2012 and account for all of the measurements greater than 0.15 µg/m^3.

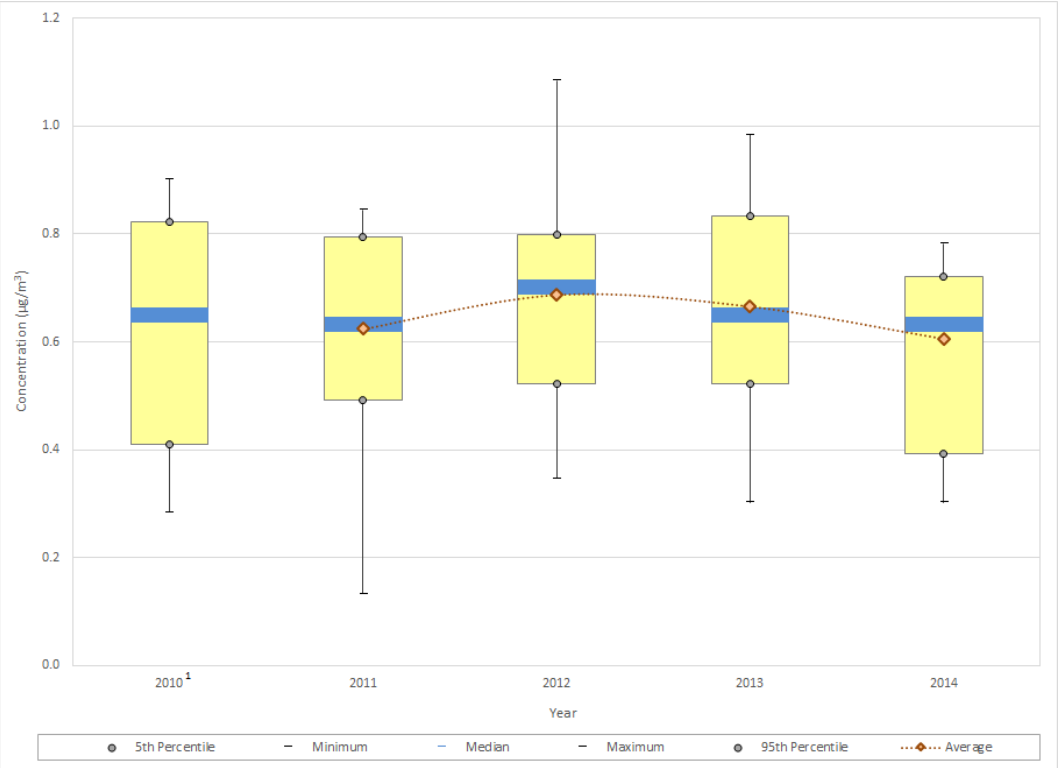
- In addition to having the concentrations of highest magnitude, 2012 is also the year with the fewest non-detects; only two non-detects were measured in 2012, compared to between nine (2014) and 18 (2011) for the remaining years.

- The 1-year average concentration nearly doubled from 2011 to 2012, as a result of the higher concentrations and reduced number of non-detects. The median also exhibits an increase.

- Despite the decreases shown in the statistical parameters from 2012 to 2013, the median concentration exhibited an additional increase, albeit slight. The actual number of concentrations greater than 0.05 µg/m^3 changed very little between these two years, with the number of measurements between 0.05 µg/m^3 and 0.075 µg/m^3 increasing from 12 in 2012 to 19 in 2013.

- Each of the statistical parameters exhibits a slight decrease from 2013 to 2014, with the exception of the minimum and 5th percentile, which remained zero.

Figure 12-39. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

Observations from Figure 12-39 for carbon tetrachloride concentrations measured at GLKY include the following:

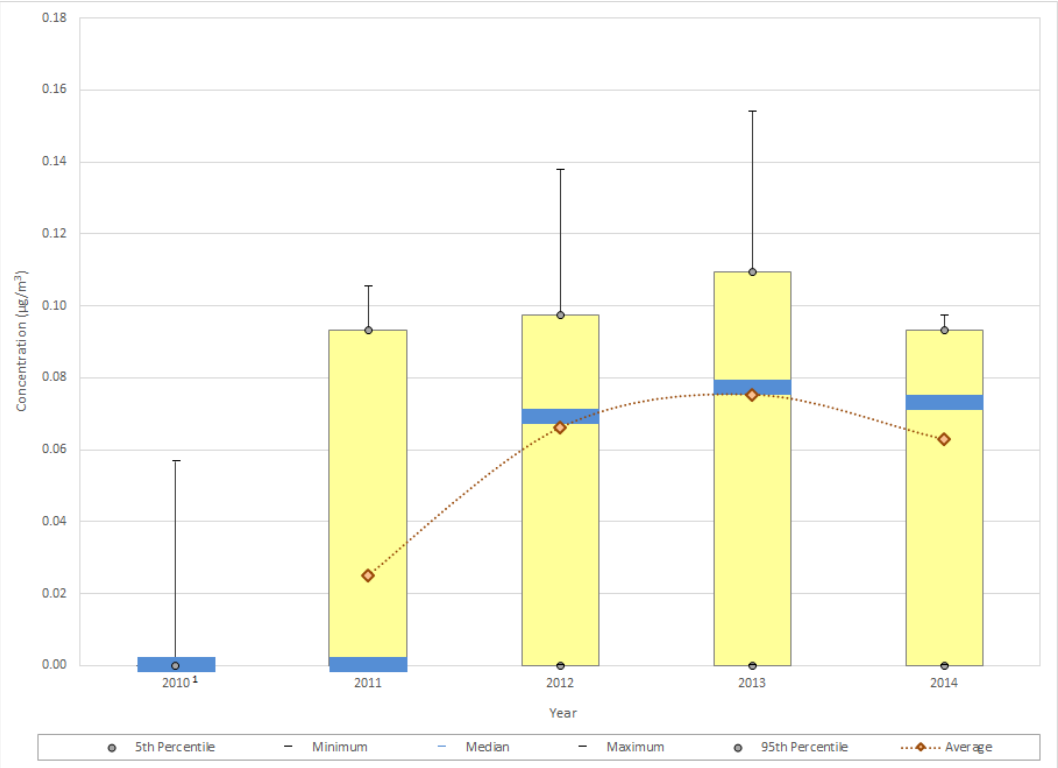
- Only one carbon tetrachloride concentration greater than 1 µg/m^3 has been measured at GLKY (March 2012).

- All of the statistical parameters exhibit an increase from 2011 to 2012, although the majority of concentrations, as indicated by the 5th and 95th percentiles, fell into a similar range. The number of carbon tetrachloride measurements between 0.7 µg/m^3 and 0.8 µg/m^3 more than doubled, from 11 measured in 2011 to 25 in 2012.

- Decreases in the 1-year average concentration are shown from 2012 to 2013 as the number of carbon tetrachloride measurements between 0.7 µg/m^3 and 0.8 µg/m^3 accounts for fewer measurements (falling to 14 from 25).

- Most of the statistical parameters exhibit decreases from 2013 to 2014, with the exception of the minimum concentration, with several parameters at a minimum for 2014, which is the first year without a measurement greater than 0.8 µg/m^3.

Figure 12-40. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

Observations from Figure 12-40 for 1,2-dichloroethane concentrations measured at GLKY include the following:

- There was one measured detection of 1,2-dichloroethane in 2010. The number of measured detections increased to 19 for 2011, 54 in 2012, peaked in 2013 with 56, then fell slightly to 48 in 2014.

- As the number of non-detects decreased and measured detections increased, the 1-year average and median concentrations increased correspondingly. The median concentration is greater than the 1-year average concentration for each year between 2012 and 2014. This is because there were still several non-detects (or zeros) factoring into the 1-year average concentration for each year: 2012 (6), 2013 (5), and 2014 (8), which drive the 1-year average concentrations down in the same manner that a maximum or outlier concentration can drive the average up.

- The maximum concentration, 95th percentile, median, and average concentrations for 2014 exhibit decreases from 2013. Eleven concentrations measured in 2013 are greater than the maximum concentration measured in 2014. Further, the number of concentrations greater than 0.8 µg/m^3 fell from 27 measured in 2013 to 14 in 2014.

12.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the Kentucky monitoring sites. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

12.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Kentucky monitoring sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 12-6, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 12-6. Risk Approximations for the Kentucky Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Health Department, Ashland, Kentucky - ASKY						
Acetaldehyde	0.0000022	0.009	61/61	1.25 ± 0.11	2.74	0.14
Benzene	0.0000078	0.03	61/61	0.87 ± 0.39	6.77	0.03
1,3-Butadiene	0.00003	0.002	56/61	0.06 ± 0.01	1.76	0.03
Carbon Tetrachloride	0.000006	0.1	61/61	0.65 ± 0.02	3.87	0.01
1,2-Dichloroethane	0.000026	2.4	58/61	0.07 ± 0.01	1.90	<0.01
Formaldehyde	0.000013	0.0098	61/61	2.29 ± 0.31	29.75	0.23

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
-- = A Cancer URE or Noncancer RfC is not available.

Table 12-6. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
21st and Greenup, Ashland, Kentucky - ASKY-M						
Arsenic (PM_{10})[a]	0.0043	0.000015	58/59	1.14 ± 0.36	4.88	0.08
Cadmium (PM_{10})[a]	0.0018	0.00001	59/59	0.24 ± 0.04	0.42	0.02
Manganese (PM_{10})[a]	--	0.0003	59/59	18.22 ± 3.53	--	0.06
Nickel (PM_{10})[a]	0.00048	0.00009	59/59	2.19 ± 0.56	1.05	0.02
Grayson, Kentucky - GLKY						
Acetaldehyde	0.0000022	0.009	61/61	0.86 ± 0.08	1.89	0.10
Benzene	0.0000078	0.03	56/56	0.42 ± 0.05	3.31	0.01
1,3-Butadiene	0.00003	0.002	47/56	0.04 ± 0.01	1.12	0.02
Carbon Tetrachloride	0.000006	0.1	56/56	0.61 ± 0.02	3.64	0.01
1,2-Dichloroethane	0.000026	2.4	48/56	0.06 ± 0.01	1.63	<0.01
Formaldehyde	0.000013	0.0098	61/61	1.49 ± 0.22	19.41	0.15
Arsenic (PM_{10})[a]	0.0043	0.000015	55/59	0.39 ± 0.08	1.69	0.03
Baskett, Kentucky - BAKY						
Arsenic (PM_{10})[a]	0.0043	0.000015	57/58	0.85 ± 0.17	3.67	0.06
Atmos Energy, Calvert City, Kentucky - ATKY						
Benzene	0.0000078	0.03	61/61	0.62 ± 0.08	4.82	0.02
1,3-Butadiene	0.00003	0.002	53/61	0.09 ± 0.03	2.61	0.04
Carbon Tetrachloride	0.000006	0.1	61/61	0.68 ± 0.03	4.09	0.01
1,2-Dichloroethane	0.000026	2.4	60/61	0.58 ± 0.22	15.06	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	14/61	0.02 ± 0.01	0.44	<0.01
Vinyl chloride	0.0000088	0.1	36/61	0.77 ± 0.40	6.77	0.01

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
-- = A Cancer URE or Noncancer RfC is not available.

Table 12-6. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Smithland, Kentucky - BLKY						
Benzene	0.0000078	0.03	60/60	0.62 ± 0.13	4.82	0.02
1,3-Butadiene	0.00003	0.002	47/60	0.17 ± 0.16	5.20	0.09
Carbon Tetrachloride	0.000006	0.1	60/60	0.73 ± 0.09	4.40	0.01
1,2-Dichloroethane	0.000026	2.4	57/60	0.81 ± 0.43	20.98	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	13/60	0.02 ± 0.01	0.40	<0.01
Vinyl chloride	0.0000088	0.1	33/60	0.14 ± 0.07	1.23	<0.01
Calvert City Elementary School, Calvert City, Kentucky - CCKY						
Benzene	0.0000078	0.03	46/46	0.56 ± 0.08	4.39	0.02
1,3-Butadiene	0.00003	0.002	41/46	0.08 ± 0.03	2.48	0.04
Carbon Tetrachloride	0.000006	0.1	46/46	0.70 ± 0.03	4.19	0.01
1,2-Dichloroethane	0.000026	2.4	46/46	0.49 ± 0.16	12.78	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	9/46	0.02 ± 0.01	0.35	<0.01
Vinyl chloride	0.0000088	0.1	27/46	0.08 ± 0.04	0.70	<0.01
Arsenic (PM_{10})[a]	0.0043	0.000015	39/41	0.55 ± 0.12	2.34	0.04
Lazy Daze, Calvert City, Kentucky - LAKY						
Benzene	0.0000078	0.03	56/56	0.70 ± 0.13	5.50	0.02
1,3-Butadiene	0.00003	0.002	49/56	0.11 ± 0.04	3.22	0.05
Carbon Tetrachloride	0.000006	0.1	56/56	0.71 ± 0.06	4.25	0.01
1,2-Dichloroethane	0.000026	2.4	56/56	0.97 ± 0.47	25.17	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	15/56	0.02 ± 0.01	0.52	<0.01
Vinyl chloride	0.0000088	0.1	33/56	0.13 ± 0.07	1.14	<0.01

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
-- = A Cancer URE or Noncancer RfC is not available.

Table 12-6. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
TVA Substation, Calvert City, Kentucky - TVKY						
Benzene	0.0000078	0.03	61/61	1.04 ± 0.35	8.13	0.03
1,3-Butadiene	0.00003	0.002	55/61	0.38 ± 0.22	11.55	0.19
Carbon Tetrachloride	0.000006	0.1	61/61	0.87 ± 0.13	5.22	0.01
1,2-Dichloroethane	0.000026	2.4	61/61	3.54 ± 1.66	91.92	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	20/61	0.03 ± 0.01	0.63	<0.01
1,1,2-Trichloroethane	0.000016	0.4	15/61	0.03 ± 0.01	0.48	<0.01
Vinyl chloride	0.0000088	0.1	42/61	0.69 ± 0.76	6.05	0.01
Lexington, Kentucky - LEKY						
Acetaldehyde	0.0000022	0.009	55/55	1.55 ± 0.13	3.40	0.17
Benzene	0.0000078	0.03	58/58	0.62 ± 0.04	4.84	0.02
1,3-Butadiene	0.00003	0.002	56/58	0.07 ± 0.01	2.02	0.03
Carbon Tetrachloride	0.000006	0.1	58/58	0.61 ± 0.02	3.68	0.01
1,2-Dichloroethane	0.000026	2.4	57/58	0.08 ± 0.01	2.02	<0.01
Formaldehyde	0.000013	0.0098	55/55	3.15 ± 0.90	40.92	0.32
Arsenic (PM_{10})[a]	0.0043	0.000015	56/56	0.67 ± 0.11	2.89	0.04

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
-- = A Cancer URE or Noncancer RfC is not available.

Observations for the Kentucky monitoring sites from Table 12-6 include the following:

- The pollutants with the highest annual average concentrations for ASKY are formaldehyde, acetaldehyde, and benzene. Formaldehyde and benzene are the pollutants with the highest cancer risk approximations for ASKY (29.75 in-a-million and 6.77 in-a-million, respectively). All of the noncancer hazard approximations for the pollutants of interest for ASKY are considerably less than an HQ of 1.0 (0.23 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- The pollutant of interest with the highest annual average concentration for ASKY-M is manganese. Arsenic has the highest cancer risk approximation among ASKY-M's pollutants of interest (4.88 in-a-million). All of the noncancer hazard approximations for the pollutants of interest for ASKY-M are considerably less than an HQ of 1.0 (0.08 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- Formaldehyde is the only pollutant of interest for GLKY with an annual average concentration greater than 1 $\mu g/m^3$. This pollutant also has the only cancer risk approximation greater than 10 in-a-million for GLKY (19.41 in-a-million). All of the noncancer hazard approximations for the pollutants of interest for GLKY are considerably less than an HQ of 1.0 (0.15 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- Arsenic is the only pollutant of interest for BAKY. Arsenic has a cancer risk approximation greater than 1 in-a-million for BAKY (3.67 in-a-million). The noncancer hazard approximation for arsenic for BAKY is considerably less than an HQ of 1.0 (0.06), indicating that no adverse noncancer health effects are expected from this individual pollutant.

- 1,2-Dichloroethane has the highest cancer risk approximations among the pollutants of interest for the Calvert City sites, each one greater than 10 in-a-million and ranging from 12.78 in-a-million (CCKY) to 91.92 in-a-million (TVKY). This cancer risk approximation for TVKY is the highest one calculated in the 2014 NMP report. The cancer risk approximation for 1,3-butadiene for TVKY is also greater than 10 in-a-million (11.55 in-a-million), which is the highest approximation calculated for this pollutant across the program. With the exception of CCKY, each Calvert City site has at least one additional pollutant for which a cancer risk approximation greater than 5 in-a-million was calculated.

- All of the noncancer hazard approximations for the pollutants of interest for the Calvert City sites are less than an HQ of 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. For each of these sites, the pollutant with the highest noncancer hazard approximation is 1,3-butadiene, which ranged from 0.04 for ATKY and CCKY to 0.19 for TVKY. (Note that the noncancer hazard approximation for arsenic for CCKY is the same as the one calculated for 1,3-butadiene.)

- Formaldehyde and acetaldehyde are the only pollutants of interest for LEKY with an annual average concentration greater than 1 $\mu g/m^3$. The cancer risk approximation for LEKY for formaldehyde (40.92 in-a-million) is an order of magnitude greater than the cancer risk approximation for the pollutant with the next highest cancer risk approximation for this site (benzene, 4.84 in-a-million). All of the noncancer hazard approximations for the pollutants of interest for LEKY are considerably less than an HQ of 1.0 (0.32 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

As an extension of this analysis, pollution roses were created for each of the site-specific pollutants of interest that have a cancer risk approximation greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. Thus, a pollution rose was created for TVKY's 1,2-dichloroethane measurements. A pollution rose is a plot of the ambient concentration versus the wind speed and direction; the magnitude of the concentration is indicated using different colored dots and are shown in relation to the average wind direction oriented about a 16-point compass, similar to the wind roses presented in Section 12.2.3. Thus, high concentrations may be shown in relation to the direction of potential emissions sources. Hourly NWS wind observations from the Barkley Regional Airport used in this analysis were averaged (using vector averaging techniques) to compute daily wind direction averages for comparison to the 24-hour concentration data. This analysis is intended to help identify the geographical area where the emissions sources of these pollutants may have originated. Additional information regarding this analysis is also presented in Section 3.4.3.3.

Figure 12-41 presents the pollution rose for all 61 1,2-dichloroethane concentrations measured at TVKY. However, the magnitude of the higher concentrations is such that all of the lower concentrations are plotted nearly on top of each other. As a result, two pollution roses were created for TVKY, one that shows 1,2-dichloroethane measurements greater than 1 $\mu g/m^3$ (27 measurements) and one that shows 1,2-dichloroethane measurements less than 1 $\mu g/m^3$ (34 measurements).

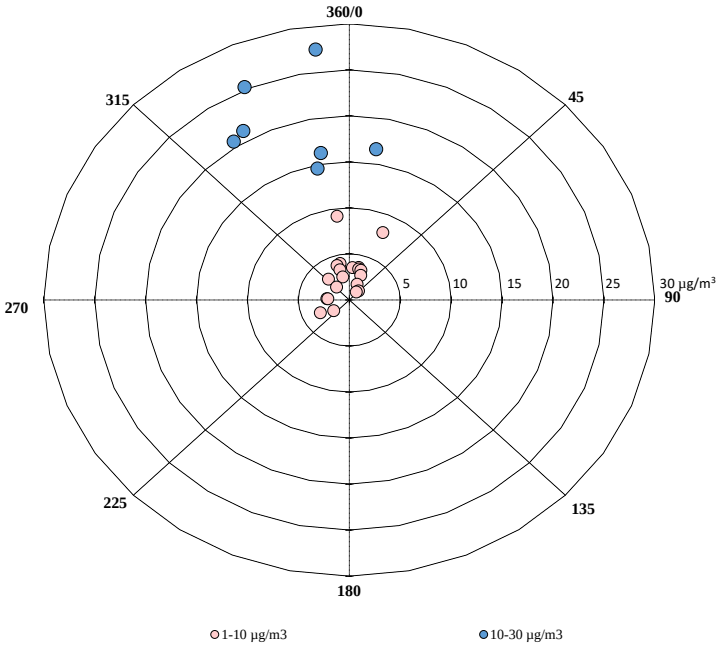
Observations for Figure 12-41 include the following:

- Concentrations greater than 1 $\mu g/m^3$ are plotted on the first pollution rose in two colors, with pink representing concentrations between 1 $\mu g/m^3$ and 10 $\mu g/m^3$ and blue representing concentrations between 10 $\mu g/m^3$ and 30 $\mu g/m^3$. The pollution rose shows that the concentrations greater than 10 $\mu g/m^3$ tended to be measured at TVKY on days with an average wind direction between 315° (northwest) and 360° (north). Concentrations between 1 $\mu g/m^3$ and 10 $\mu g/m^3$ tended to be measured on sample days with an average wind direction between 315° (northwest) and 45° (northeast).

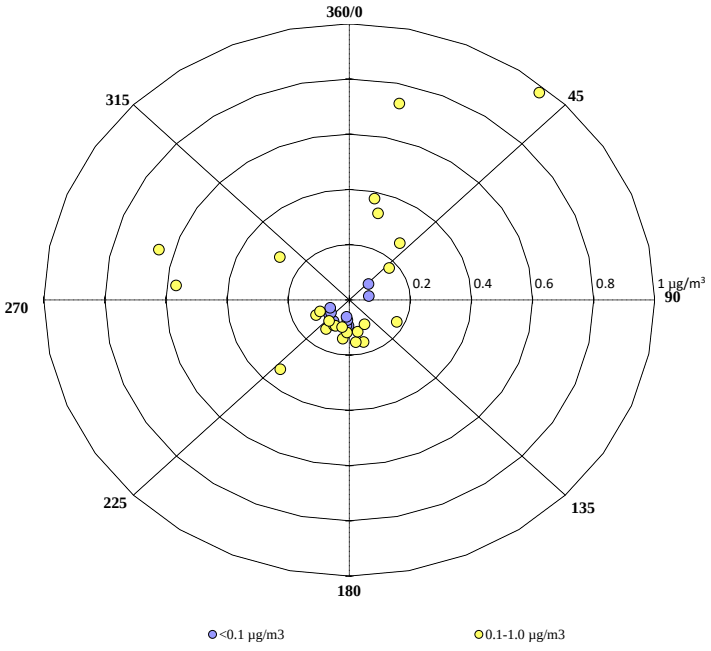
- Concentrations less than 1 $\mu g/m^3$ are plotted on the second pollution rose in two colors, with yellow representing concentrations between 0.1 $\mu g/m^3$ and 1 $\mu g/m^3$ and purple representing concentrations less than 0.1 $\mu g/m^3$. This pollution rose shows that 1,2-dichloroethane concentrations less than 1 $\mu g/m^3$ were measured at TVKY on sample days with a variety of average wind directions, although these lower concentrations were measured most often on days with an average wind direction from the southwest quadrant, between 180° (south) and 270° (west).

Figure 12-41. Pollution Roses for 1,2-Dichloroethane Concentrations Measured at TVKY

Measurements greater than 1 µg/m^3



Measurements less than 1 µg/m^3



12.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, Tables 12-7 and 12-8 present an 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 2011 NEI (version 2) that have cancer toxicity factors. Table 12-7 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 12-7 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 12-6. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 12-7. Table 12-8 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 12.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 12-7. 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 UREs (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)**
Health Department, Ashland, Kentucky (Boyd County) - ASKY					
Benzene	61.79	Coke Oven Emissions, PM	7.25E-03	Formaldehyde	29.75
Formaldehyde	20.35	Hexavalent Chromium	9.84E-04	Benzene	6.77
Ethylbenzene	13.36	Nickel, PM	6.71E-04	Carbon Tetrachloride	3.87
Acetaldehyde	11.59	Benzene	4.82E-04	Acetaldehyde	2.74
Coke Oven Emissions, PM	7.32	Formaldehyde	2.64E-04	1,2-Dichloroethane	1.90
1,3-Butadiene	3.65	2,4-Dinitrotoluene	1.96E-04	1,3-Butadiene	1.76
2,4-Dinitrotoluene	2.20	1,3-Butadiene	1.10E-04		
Tetrachloroethylene	2.00	Naphthalene	6.77E-05		
Naphthalene	1.99	Cadmium, PM	5.96E-05		
Nickel, PM	1.40	POM, Group 2b	4.51E-05		
21st and Greenup, Ashland, Kentucky (Boyd County) - ASKY-M					
Benzene	61.79	Coke Oven Emissions, PM	7.25E-03	Arsenic (PM_{10})	4.88
Formaldehyde	20.35	Hexavalent Chromium	9.84E-04	Nickel (PM_{10})	1.05
Ethylbenzene	13.36	Nickel, PM	6.71E-04	Cadmium (PM_{10})	0.42
Acetaldehyde	11.59	Benzene	4.82E-04		
Coke Oven Emissions, PM	7.32	Formaldehyde	2.64E-04		
1,3-Butadiene	3.65	2,4-Dinitrotoluene	1.96E-04		
2,4-Dinitrotoluene	2.20	1,3-Butadiene	1.10E-04		
Tetrachloroethylene	2.00	Naphthalene	6.77E-05		
Naphthalene	1.99	Cadmium, PM	5.96E-05		
Nickel, PM	1.40	POM, Group 2b	4.51E-05		

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Grayson, Kentucky (Carter County) - GLKY					
Benzene	20.12	Formaldehyde	1.78E-04	Formaldehyde	19.41
Formaldehyde	13.70	Benzene	1.57E-04	Carbon Tetrachloride	3.64
Acetaldehyde	9.15	1,3-Butadiene	6.86E-05	Benzene	3.31
Ethylbenzene	9.14	Naphthalene	5.57E-05	Acetaldehyde	1.89
1,3-Butadiene	2.29	POM, Group 2b	3.60E-05	Arsenic (PM_{10})	1.69
Naphthalene	1.64	POM, Group 2d	2.66E-05	1,2-Dichloroethane	1.63
POM, Group 2b	0.41	Ethylbenzene	2.29E-05	1,3-Butadiene	1.12
POM, Group 2d	0.30	POM, Group 5a	2.23E-05		
POM, Group 6	0.04	Acetaldehyde	2.01E-05		
Trichloroethylene	0.03	POM, Group 6	7.36E-06		
Baskett, Kentucky (Henderson County) - BAKY					
Formaldehyde	52.75	Formaldehyde	6.86E-04	Arsenic (PM_{10})	3.67
Benzene	42.14	Naphthalene	5.72E-04		
Acetaldehyde	27.10	POM, Group 2d	3.74E-04		
Naphthalene	16.81	Benzene	3.29E-04		
Ethylbenzene	16.17	Hexavalent Chromium	2.83E-04		
Tetrachloroethylene	6.71	Nickel, PM	2.73E-04		
1,3-Butadiene	6.59	POM, Group 2b	2.52E-04		
POM, Group 2d	4.25	1,3-Butadiene	1.98E-04		
POM, Group 2b	2.87	Acetaldehyde	5.96E-05		
Dichloromethane	0.83	Cadmium, PM	5.03E-05		

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Atmos Energy, Calvert City, Kentucky (Marshall County) - ATKY					
Benzene	139.16	Benzene	1.09E-03	1,2-Dichloroethane	15.06
Ethylbenzene	100.03	Hexavalent Chromium	6.36E-04	Vinyl chloride	6.77
Formaldehyde	36.34	Formaldehyde	4.72E-04	Benzene	4.82
Acetaldehyde	33.61	1,3-Butadiene	4.26E-04	Carbon Tetrachloride	4.09
Vinyl chloride	30.93	Vinyl chloride	2.72E-04	1,3-Butadiene	2.61
1,3-Butadiene	14.20	Ethylbenzene	2.50E-04	Hexachloro-1,3-butadiene	0.44
1,2-Dichloroethane	9.25	1,2-Dichloroethane	2.41E-04		
Naphthalene	3.45	POM, Group 1a	2.34E-04		
POM, Group 1a	2.66	Naphthalene	1.17E-04		
Carbon Tetrachloride	2.32	Nickel, PM	7.66E-05		
Calvert City Elementary School, Calvert City, Kentucky (Marshall County) - CCKY					
Benzene	139.16	Benzene	1.09E-03	1,2-Dichloroethane	12.78
Ethylbenzene	100.03	Hexavalent Chromium	6.36E-04	Benzene	4.39
Formaldehyde	36.34	Formaldehyde	4.72E-04	Carbon Tetrachloride	4.19
Acetaldehyde	33.61	1,3-Butadiene	4.26E-04	1,3-Butadiene	2.48
Vinyl chloride	30.93	Vinyl chloride	2.72E-04	Arsenic (PM_{10})	2.34
1,3-Butadiene	14.20	Ethylbenzene	2.50E-04	Vinyl chloride	0.70
1,2-Dichloroethane	9.25	1,2-Dichloroethane	2.41E-04	Hexachloro-1,3-butadiene	0.35
Naphthalene	3.45	POM, Group 1a	2.34E-04		
POM, Group 1a	2.66	Naphthalene	1.17E-04		
Carbon Tetrachloride	2.32	Nickel, PM	7.66E-05		

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Lazy Daze, Calvert City, Kentucky (Marshall County) - LAKY					
Benzene	139.16	Benzene	1.09E-03	1,2-Dichloroethane	25.17
Ethylbenzene	100.03	Hexavalent Chromium	6.36E-04	Benzene	5.50
Formaldehyde	36.34	Formaldehyde	4.72E-04	Carbon Tetrachloride	4.25
Acetaldehyde	33.61	1,3-Butadiene	4.26E-04	1,3-Butadiene	3.22
Vinyl chloride	30.93	Vinyl chloride	2.72E-04	Vinyl chloride	1.14
1,3-Butadiene	14.20	Ethylbenzene	2.50E-04	Hexachloro-1,3-butadiene	0.52
1,2-Dichloroethane	9.25	1,2-Dichloroethane	2.41E-04		
Naphthalene	3.45	POM, Group 1a	2.34E-04		
POM, Group 1a	2.66	Naphthalene	1.17E-04		
Carbon Tetrachloride	2.32	Nickel, PM	7.66E-05		
TVA Substation, Calvert City, Kentucky (Marshall County) - TVKY					
Benzene	139.16	Benzene	1.09E-03	1,2-Dichloroethane	91.92
Ethylbenzene	100.03	Hexavalent Chromium	6.36E-04	1,3-Butadiene	11.55
Formaldehyde	36.34	Formaldehyde	4.72E-04	Benzene	8.13
Acetaldehyde	33.61	1,3-Butadiene	4.26E-04	Vinyl chloride	6.05
Vinyl chloride	30.93	Vinyl chloride	2.72E-04	Carbon Tetrachloride	5.22
1,3-Butadiene	14.20	Ethylbenzene	2.50E-04	Hexachloro-1,3-butadiene	0.63
1,2-Dichloroethane	9.25	1,2-Dichloroethane	2.41E-04	1,1,2-Trichloroethane	0.48
Naphthalene	3.45	POM, Group 1a	2.34E-04		
POM, Group 1a	2.66	Naphthalene	1.17E-04		
Carbon Tetrachloride	2.32	Nickel, PM	7.66E-05		

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Smithland, Kentucky (Livingston County) - BLKY					
Benzene	14.04	Formaldehyde	1.50E-04	1,2-Dichloroethane	20.98
Formaldehyde	11.52	Benzene	1.09E-04	1,3-Butadiene	5.20
Acetaldehyde	6.66	1,3-Butadiene	5.45E-05	Benzene	4.82
Ethylbenzene	5.39	Naphthalene	2.27E-05	Carbon Tetrachloride	4.40
1,3-Butadiene	1.82	POM, Group 2b	1.63E-05	Vinyl chloride	1.23
Naphthalene	0.67	Acetaldehyde	1.47E-05	Hexachloro-1,3-butadiene	0.40
POM, Group 2b	0.18	Ethylbenzene	1.35E-05		
POM, Group 2d	0.15	POM, Group 2d	1.31E-05		
POM, Group 6	0.03	Nickel, PM	1.16E-05		
Trichloroethylene	0.03	POM, Group 5a	1.14E-05		
Lexington, Kentucky (Fayette County) - LEKY					
Benzene	135.46	Formaldehyde	1.20E-03	Formaldehyde	40.92
Formaldehyde	92.28	Benzene	1.06E-03	Benzene	4.84
Ethylbenzene	82.26	1,3-Butadiene	5.57E-04	Carbon Tetrachloride	3.68
Acetaldehyde	54.60	Naphthalene	3.50E-04	Acetaldehyde	3.40
1,3-Butadiene	18.57	POM, Group 2b	2.32E-04	Arsenic	2.89
Tetrachloroethylene	13.04	Ethylbenzene	2.06E-04	1,3-Butadiene	2.02
Naphthalene	10.31	POM, Group 2d	1.52E-04	1,2-Dichloroethane	2.02
POM, Group 2b	2.63	Hexavalent Chromium	1.34E-04		
Trichloroethylene	1.94	Arsenic, PM	1.28E-04		
POM, Group 2d	1.73	Acetaldehyde	1.20E-04		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Health Department, Ashland, Kentucky (Boyd County) - ASKY					
Toluene	89.31	Acrolein	63,687.70	Formaldehyde	0.23
Benzene	61.79	Chlorine	45,169.74	Acetaldehyde	0.14
Xylenes	52.93	Manganese, PM	33,849.17	1,3-Butadiene	0.03
Hexane	49.05	Nickel, PM	15,539.17	Benzene	0.03
Methanol	39.10	Lead, PM	11,227.89	Carbon Tetrachloride	0.01
Hydrochloric acid	27.65	Cadmium, PM	3,311.70	1,2-Dichloroethane	<0.01
Formaldehyde	20.35	Formaldehyde	2,076.07		
Ethylbenzene	13.36	Benzene	2,059.62		
Acetaldehyde	11.59	1,3-Butadiene	1,826.21		
Manganese, PM	10.15	Hydrochloric acid	1,382.51		
21st and Greenup, Ashland, Kentucky (Boyd County) - ASKY-M					
Toluene	89.31	Acrolein	63,687.70	Arsenic (PM_{10})	0.08
Benzene	61.79	Chlorine	45,169.74	Manganese (PM_{10})	0.06
Xylenes	52.93	Manganese, PM	33,849.17	Nickel (PM_{10})	0.02
Hexane	49.05	Nickel, PM	15,539.17	Cadmium (PM_{10})	0.02
Methanol	39.10	Lead, PM	11,227.89		
Hydrochloric acid	27.65	Cadmium, PM	3,311.70		
Formaldehyde	20.35	Formaldehyde	2,076.07		
Ethylbenzene	13.36	Benzene	2,059.62		
Acetaldehyde	11.59	1,3-Butadiene	1,826.21		
Manganese, PM	10.15	Hydrochloric acid	1,382.51		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Grayson, Kentucky (Carter County) - GLKY					
Toluene	58.15	Acrolein	45,189.54	Formaldehyde	0.15
Xylenes	35.59	Formaldehyde	1,397.58	Acetaldehyde	0.10
Hexane	25.95	Cyanide Compounds, gas	1,278.36	Arsenic (PM_{10})	0.03
Benzene	20.12	1,3-Butadiene	1,144.01	1,3-Butadiene	0.02
Methanol	15.68	Acetaldehyde	1,016.31	Benzene	0.01
Formaldehyde	13.70	Benzene	670.52	Carbon Tetrachloride	0.01
Acetaldehyde	9.15	Naphthalene	545.72	1,2-Dichloroethane	<0.01
Ethylbenzene	9.14	Xylenes	355.95		
Ethylene glycol	5.50	Arsenic, PM	91.58		
1,3-Butadiene	2.29	Propionaldehyde	84.60		
Baskett, Kentucky (Henderson County) - BAKY					
Carbonyl sulfide	128.78	Acrolein	76,864.06	Arsenic (PM_{10})	0.06
Toluene	112.00	Manganese, PM	7,205.03		
Xylenes	78.62	Nickel, PM	6,326.84		
Hexane	54.97	Naphthalene	5,604.26		
Formaldehyde	52.75	Formaldehyde	5,383.11		
Benzene	42.14	1,3-Butadiene	3,295.39		
Methanol	28.37	Chlorine	3,245.91		
Acetaldehyde	27.10	Acetaldehyde	3,010.82		
Naphthalene	16.81	Cadmium, PM	2,795.50		
Ethylbenzene	16.17	4,4'-Methylenediphenyl diisocyanate, gas	2,483.57		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Atmos Energy, Calvert City, Kentucky (Marshall County) - ATKY					
Methanol	677.58	Chlorine	210,803.93	1,3-Butadiene	0.04
Xylenes	522.49	Acrolein	125,961.44	Benzene	0.02
Toluene	480.91	1,3-Butadiene	7,098.77	Vinyl chloride	0.01
Benzene	139.16	Xylenes	5,224.89	Carbon Tetrachloride	0.01
Hexane	100.70	Benzene	4,638.60	1,2-Dichloroethane	<0.01
Ethylbenzene	100.03	Hydrochloric acid	4,173.99	Hexachloro-1,3-butadiene	<0.01
Hydrochloric acid	83.48	Acetaldehyde	3,734.64		
Vinyl acetate	73.28	Formaldehyde	3,708.16		
Formaldehyde	36.34	Acrylic acid	2,916.21		
Acetaldehyde	33.61	Nickel, PM	1,773.75		
Calvert City Elementary School, Calvert City, Kentucky (Marshall County) - CCKY					
Methanol	677.58	Chlorine	210,803.93	1,3-Butadiene	0.04
Xylenes	522.49	Acrolein	125,961.44	Arsenic (PM_{10})	0.04
Toluene	480.91	1,3-Butadiene	7,098.77	Benzene	0.02
Benzene	139.16	Xylenes	5,224.89	Carbon Tetrachloride	0.01
Hexane	100.70	Benzene	4,638.60	Vinyl chloride	<0.01
Ethylbenzene	100.03	Hydrochloric acid	4,173.99	1,2-Dichloroethane	<0.01
Hydrochloric acid	83.48	Acetaldehyde	3,734.64	Hexachloro-1,3-butadiene	<0.01
Vinyl acetate	73.28	Formaldehyde	3,708.16		
Formaldehyde	36.34	Acrylic acid	2,916.21		
Acetaldehyde	33.61	Nickel, PM	1,773.75		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Lazy Daze, Calvert City, Kentucky (Marshall County) - LAKY					
Methanol	677.58	Chlorine	210,803.93	1,3-Butadiene	0.05
Xylenes	522.49	Acrolein	125,961.44	Benzene	0.02
Toluene	480.91	1,3-Butadiene	7,098.77	Carbon Tetrachloride	0.01
Benzene	139.16	Xylenes	5,224.89	Vinyl chloride	<0.01
Hexane	100.70	Benzene	4,638.60	1,2-Dichloroethane	<0.01
Ethylbenzene	100.03	Hydrochloric acid	4,173.99	Hexachloro-1,3-butadiene	<0.01
Hydrochloric acid	83.48	Acetaldehyde	3,734.64		
Vinyl acetate	73.28	Formaldehyde	3,708.16		
Formaldehyde	36.34	Acrylic acid	2,916.21		
Acetaldehyde	33.61	Nickel, PM	1,773.75		
TVA Substation, Calvert City, Kentucky (Marshall County) - TVKY					
Methanol	677.58	Chlorine	210,803.93	1,3-Butadiene	0.19
Xylenes	522.49	Acrolein	125,961.44	Benzene	0.03
Toluene	480.91	1,3-Butadiene	7,098.77	Carbon Tetrachloride	0.01
Benzene	139.16	Xylenes	5,224.89	Vinyl chloride	0.01
Hexane	100.70	Benzene	4,638.60	1,2-Dichloroethane	<0.01
Ethylbenzene	100.03	Hydrochloric acid	4,173.99	Hexachloro-1,3-butadiene	<0.01
Hydrochloric acid	83.48	Acetaldehyde	3,734.64	1,1,2-Trichloroethane	<0.01
Vinyl acetate	73.28	Formaldehyde	3,708.16		
Formaldehyde	36.34	Acrylic acid	2,916.21		
Acetaldehyde	33.61	Nickel, PM	1,773.75		

Table 12-8. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Smithland, Kentucky (Livingston County) - BLKY					
Toluene	43.04	Acrolein	20,492.52	1,3-Butadiene	0.09
Xylenes	38.50	Formaldehyde	1,175.61	Benzene	0.02
Benzene	14.04	1,3-Butadiene	909.04	Carbon Tetrachloride	0.01
Hexane	12.08	Acetaldehyde	740.44	Vinyl chloride	<0.01
Formaldehyde	11.52	Cyanide Compounds, gas	527.46	1,2-Dichloroethane	<0.01
Acetaldehyde	6.66	Benzene	467.89	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	5.39	Xylenes	384.98		
Methanol	5.38	Nickel, PM	268.68		
Ethylene glycol	1.89	Naphthalene	222.51		
1,3-Butadiene	1.82	Manganese, PM	201.76		
Lexington, Kentucky (Fayette County) - LEKY					
Toluene	487.75	Acrolein	277,725.18	Formaldehyde	0.32
Xylenes	315.94	Formaldehyde	9,416.72	Acetaldehyde	0.17
Hexane	246.40	1,3-Butadiene	9,286.39	Arsenic (PM_{10})	0.04
Methanol	176.71	Acetaldehyde	6,066.40	1,3-Butadiene	0.03
Benzene	135.46	Benzene	4,515.24	Benzene	0.02
Formaldehyde	92.28	Naphthalene	3,436.18	Carbon Tetrachloride	0.01
Ethylbenzene	82.26	Xylenes	3,159.41	1,2-Dichloroethane	<0.01
Ethylene glycol	59.08	Hexamethylene-1,6-diisocyanate, gas	2,051.30		
Acetaldehyde	54.60	Arsenic, PM	1,982.63		
Methyl isobutyl ketone	29.90	4,4'-Methylenediphenyl diisocyanate, gas	1,757.48		

Observations from Table 12-7 include the following:

- Among the Kentucky counties with monitoring sites, emissions (for pollutants with cancer UREs) are highest in Fayette County (LEKY) and Marshall County (Calvert City) and lowest in Livingston County (BLKY) and Carter County (GLKY).

- Benzene, formaldehyde, ethylbenzene are the highest emitted pollutants with cancer UREs in Boyd County, where the Ashland sites are located. Coke oven emissions, hexavalent chromium, and nickel are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Boyd County. Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Boyd County.

- For ASKY, formaldehyde, benzene, and 1,3-butadiene are among the pollutants with the highest cancer risk approximations and appear on both emissions-based lists. Acetaldehyde, which has the fourth highest cancer risk approximation for ASKY, has the fourth highest emissions for Boyd County but is not among the pollutants with the highest toxicity-weighted emissions (acetaldehyde ranks 13th for toxicity-weighted emissions). Carbon tetrachloride and 1,2-dichloroethane, the other pollutants of interest for ASKY, appear on neither emissions-based list for Boyd County.

- Nickel is the only pollutant of interest for ASKY-M to appear on both emissions-based lists for Boyd County. While cadmium ranks ninth in Boyd County for its toxicity-weighted emissions, it is not among the highest emitted (ranking 18th). Arsenic, which has the highest cancer risk approximation for ASKY-M, appears on neither emissions-based list (ranking 24th for total emissions and 15th for toxicity-weighted emissions).

- Benzene, formaldehyde, acetaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Carter County, where GLKY is located. Formaldehyde, benzene, 1,3-butadiene, and naphthalene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Nine of the highest emitted pollutants also have the highest toxicity-weighted emissions for Carter County (all but one of which are sampled for at GLKY).

- Formaldehyde has the highest cancer risk approximation for GLKY, and ranks first for its toxicity-weighted emissions and second for its total emissions in Carter County, as shown in Table 12-7. Benzene, 1,3-butadiene, and acetaldehyde also appear on all three lists. The three remaining pollutants of interest appear on neither emissions-based list.

- Three POM Groups appear among the highest emitted pollutants in Carter County (POM, Groups 2b, 2d, and 6) and four POM Groups appear among the pollutants with the highest toxicity-weighted emissions (POM, Groups 2b, 2d, 5a, and 6). Many of the PAHs sampled using Method TO-13A are part of POM, Groups 2b, 5a, and 6. However, none of these pollutants failed screens for GLKY.

- Formaldehyde, benzene, and acetaldehyde are the highest emitted pollutants with cancer UREs in Henderson County, where BAKY is located. Formaldehyde,

naphthalene, and POM Group 2d are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henderson County.

- Arsenic is the only pollutant of interest for BAKY. Arsenic appears on neither emissions-based list for Henderson County (arsenic ranks 22nd for total emissions and 13th for toxicity-weighted emissions).

- Benzene, ethylbenzene, and formaldehyde are the highest emitted pollutants with cancer UREs in Marshall County, where four of the five Calvert City sites are located. Benzene, hexavalent chromium, and formaldehyde are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Marshall County.

- Marshall County is the only county with an NMP site for which vinyl chloride appears among the highest emitted pollutants. The quantity of vinyl chloride emitted in Marshall County (30.93 tpy) is the highest emissions for this pollutant among NMP counties and is considerably higher than the next highest emissions of this pollutant (1.77 tpy in Los Angeles County, California). Marshall County is also the only county with an NMP site for which carbon tetrachloride appears among the highest emitted pollutants. Marshall County is the only county with NMP site that has carbon tetrachloride emissions greater than 1 tpy (2.32 tpy). Marshall County is also the only county with an NMP site for which 1,2-dichloroethane appears among the highest emitted pollutants. The quantity of 1,2-dichloroethane emitted in Marshall County (9.25 tpy) again ranks highest for emissions, with Los Angeles County the next closest at 1.34 tpy.

- Marshall County is the only county with an NMP site for which vinyl chloride and 1,2-dichloroethane appear among the pollutants with the highest toxicity-weighted emissions.

- Most of the VOC pollutants of interest for the Calvert City sites in Marshall County appear on both emissions-based lists. Carbon tetrachloride is an exception, as this pollutant appears among the highest emitted but not those with the highest toxicity-weighted emissions (ranking 16th). Hexachloro-1,3-butadiene is a pollutant of interest for all four sites in Marshall County but does not appear on either emissions-based list. 1,1,2-Trichloroethane is a pollutant of interest for TVKY and appears on neither emissions-based list. Emissions of this pollutant are highest in Marshall County compared to other counties with NMP sites.

- Arsenic is the only pollutant of interest among the speciated metals sampled for at CCKY. Arsenic appears on neither emissions-based list for Marshall County (arsenic ranks 25th for total emissions and 13th for toxicity-weighted emissions).

- Benzene, formaldehyde, and acetaldehyde are the highest emitted pollutants with cancer UREs in Livingston County, where BLKY is located. Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Livingston County.

- Few of BLKY's pollutants of interest appear among the pollutants on the emissions-based lists for Livingston County (only 1,3-butadiene and benzene).

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Fayette County, where LEKY is located. Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Fayette County.

- Formaldehyde has the highest cancer risk approximation among LEKY's pollutants of interest. Formaldehyde, benzene, acetaldehyde, and 1,3-butadiene appear among the highest emitted pollutants in Fayette County and appear among those with the highest toxicity-weighted emissions. Arsenic, another pollutant of interest for LEKY, appears among those with the highest toxicity-weighted emissions but ranks 22nd for total emissions. The two remaining pollutants of interest, carbon tetrachloride and 1,2-dichloroethane, appear on neither emissions-based list.

Observations from Table 12-8 include the following:

- Among the Kentucky counties with monitoring sites, emissions (for pollutants with noncancer RfCs) are highest in Marshall County (Calvert City) and Fayette County (LEKY) and lowest in Carter County (GLKY) and Livingston County (BLKY).

- Toluene, benzene, and xylenes are the highest emitted pollutants with noncancer RfCs in Boyd County. Acrolein, chlorine, and manganese are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Boyd County. Four of the highest emitted pollutants also have the highest toxicity-weighted emissions for Boyd County.

- Although acrolein was sampled for at ASKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Boyd County's highest emitted pollutants.

- Of the pollutants of interest for ASKY, two (formaldehyde and benzene) also appear on both emissions-based lists. Acetaldehyde is among the highest emitted in Boyd County but is not among those with the highest toxicity-weighted emissions. 1,3-Butadiene is among those with the highest toxicity-weighted emissions but is not among the highest emitted. The remaining two pollutants of interest for ASKY appear on neither emissions-based list in Table 12-8.

- Manganese ranks tenth for its total emissions and has the third highest toxicity-weighted emissions for Boyd County. Nickel and cadmium also appear among those pollutants with the highest toxicity-weighted emissions in Boyd County, although they do not appear among the highest emitted in Boyd County. Arsenic is the only pollutant of interest for ASKY-M that does not appear in either emissions-based list.

- Toluene, xylenes, and hexane are the highest emitted pollutants with noncancer RfCs in Carter County. Acrolein, formaldehyde, and cyanide compounds (gaseous) are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Carter County. Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Carter County.

- Although acrolein was sampled for at GLKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Carter County's highest emitted pollutants.

- Formaldehyde, acetaldehyde, benzene, and 1,3-butadiene appear on all three lists for GLKY. Arsenic is among the pollutants with the highest toxicity-weighted emissions but is not among the highest emitted in Carter County (its emissions rank 32nd). Carbon tetrachloride and 1,2-dichloroethane, the remaining two pollutants of interest for GLKY, appear on neither emissions-based list for Carter County.

- Carbonyl sulfide, toluene, and xylenes are the highest emitted pollutants with noncancer RfCs in Henderson County. Henderson County is the only county with an NMP site for which carbonyl sulfide appears among the 10 highest emitted pollutants. Acrolein, manganese, and nickel are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Three of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henderson County.

- Arsenic is the only pollutant of interest for BAKY. Arsenic appears on neither emissions-based list (ranking 44th for total emissions and 18th for toxicity-weighted emissions). Several other metals, including manganese, nickel, and cadmium, which were sampled for at BAKY but were not identified as pollutants of interest, appear among those with the highest toxicity-weighted emissions for Henderson County (of those with noncancer RfCs).

- Methanol, xylenes, and toluene are the highest emitted pollutants with noncancer RfCs in Marshall County. Chlorine, acrolein, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. This is the only county with an NMP site for which acrolein was not the pollutant with the highest toxicity-weighted emissions. Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Marshall County.

- Benzene is the only pollutant of interest for the Calvert City sites to appear on all three lists. 1,3-Butadiene has the highest nonancer hazard approximation for all four

Calvert City sites located in Marshall County (as well as the one located in Livingston County). This pollutant has the third highest toxicity-weighted emissions but is not among the highest emitted (ranking 14th). None of the other VOC pollutants of interest for the Calvert City sites appear on either emissions-based list for Marshall County. This is also true for arsenic, a pollutant of interest for CCKY.

- Toluene, xylenes, and benzene are the highest emitted pollutants with noncancer RfCs in Livingston County. Acrolein, formaldehyde, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Livingston County.

- Although acrolein was sampled for at BLKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Livingston County's highest emitted pollutants.

- 1,3-Butadiene and benzene have the highest noncancer hazard approximations for BLKY. These pollutants appear on both emissions-based lists for Livingston County but are the only pollutants of interest for BLKY to do so.

- Toluene, xylenes, and hexane are the highest emitted pollutants with noncancer RfCs in Fayette County. Acrolein, formaldehyde, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Four of the highest emitted pollutants also have the highest toxicity-weighted emissions for Fayette County.

- Although acrolein was sampled for at LEKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Fayette County's highest emitted pollutants.

- Formaldehyde, acetaldehyde, and benzene appear on all three lists in Table 12-8 for LEKY. 1,3-Butadiene and arsenic rank third and ninth, respectively, for their toxicity-weighted emissions but are not among the highest emitted in Fayette County.

12.6 Summary of the 2014 Monitoring Data for the Kentucky Monitoring Sites

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

❖ *Eight monitoring sites sampled for VOCs; five monitoring sites sampled for PM_{10} metals; three monitoring sites sampled for carbonyl compounds; and PAHs were sampled for at GLKY. Sampling at the CCKY site was discontinued in October 2014 and the metals instrumentation was moved to BLKY, where sampling was initiated at the end of October.*

- *The number of pollutants failing screens for the Kentucky sites varies from two (BAKY) to 11 (TVKY and LEKY).*

- *ASKY-M has the highest annual average concentrations of arsenic and nickel among NMP sites sampling PM_{10} metals, similar to 2013. Three additional Kentucky sites (BAKY, LEKY, and CCKY) are among the NMP sites with the highest annual average concentrations of arsenic and BAKY and LEKY are also among the sites with the highest annual average concentrations of nickel.*

- *The two highest benzene concentrations measured across the program were measured at ASKY and TVKY, which have the ninth and sixth highest annual average concentration of benzene, respectively, among NMP sites sampling this pollutant.*

- *Some of the highest concentrations of VOCs were measured at the Calvert City sites, particularly vinyl chloride, carbon tetrachloride, 1,3-butadiene, and 1,2-dichloroethane. TVKY has the highest annual average concentration of 1,3-butadiene, carbon tetrachloride, and 1,2-dichloroethane among NMP sites sampling VOCs. Further, the annual averages for all five Calvert City sites rank in the top five among NMP sites for carbon tetrachloride and 1,2-dichloroethane.*

- *The maximum formaldehyde concentration measured across the program was measured at LEKY; this site ranks ninth highest for its annual average concentration compared to other NMP sites sampling carbonyl compounds.*

- *The cancer risk approximation for 1,2-dichloroethane for TVKY is the highest cancer risk approximation calculated among site-specific pollutants of interest.*

13.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

13.1 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. Figure 13-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 13-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 13-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 13-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 13-1. Boston, Massachusetts (BOMA) Monitoring Site

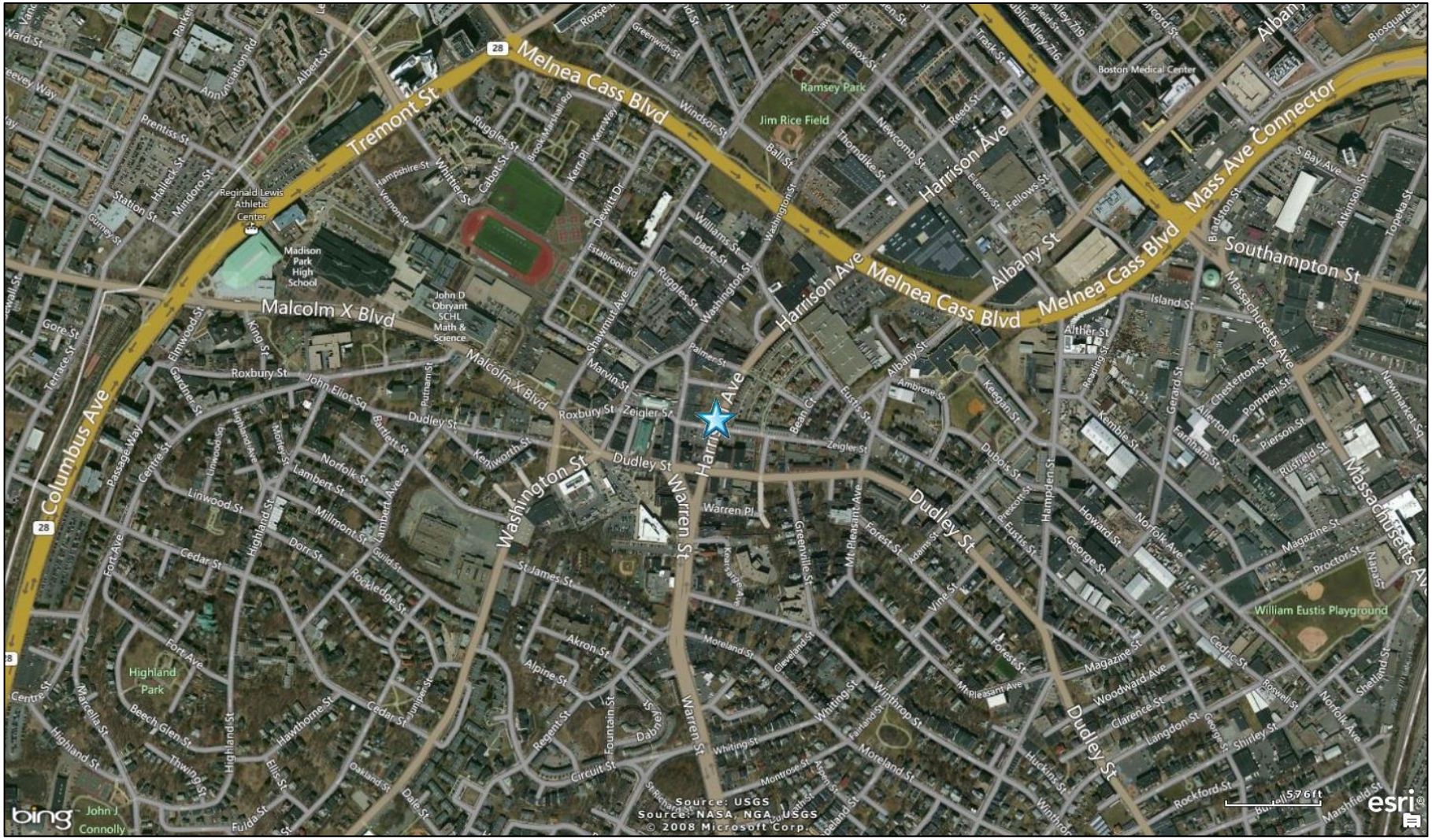


Figure 13-2. NEI Point Sources Located Within 10 Miles of BOMA

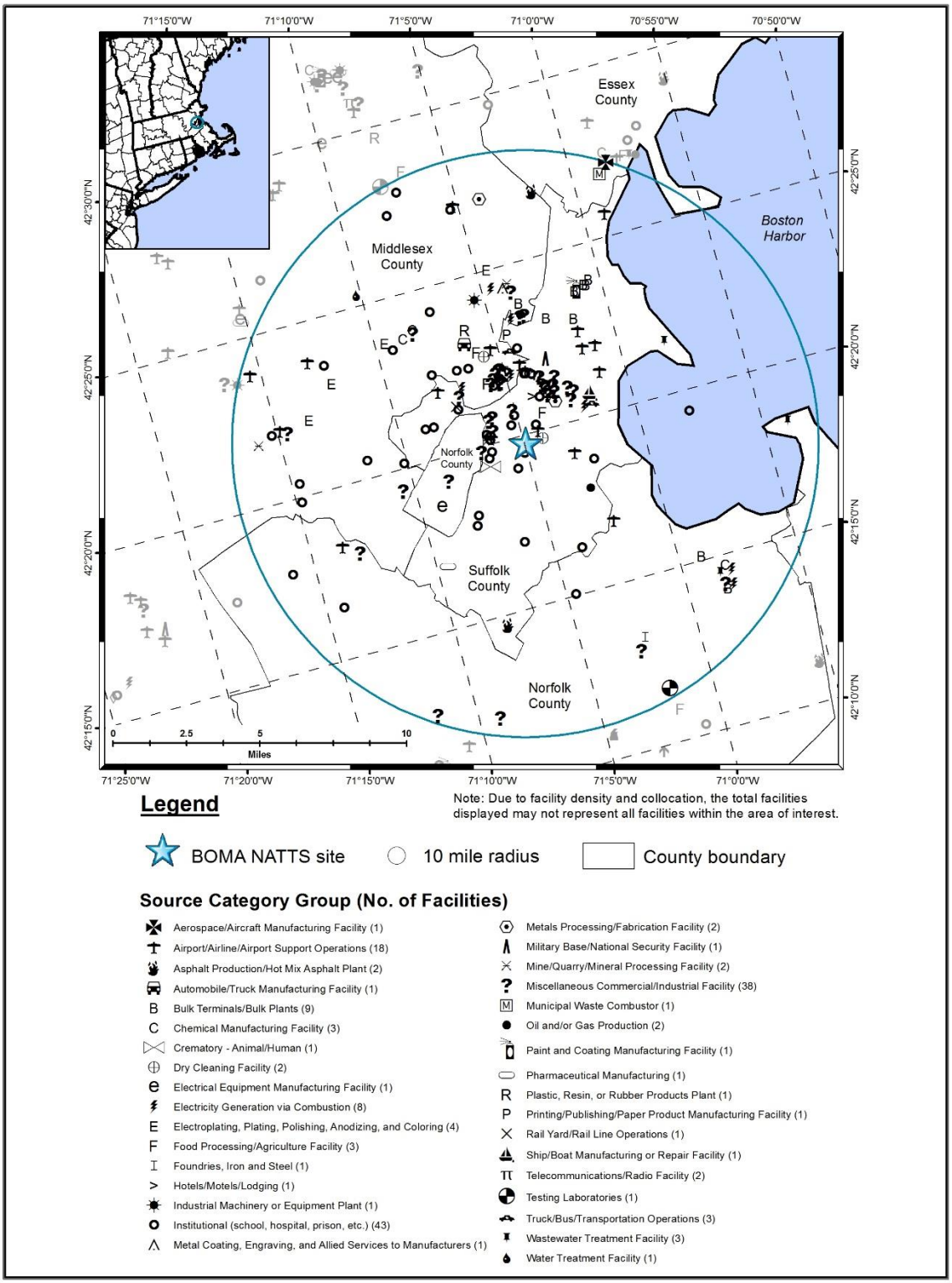


Table 13-1. Geographical Information for the Massachusetts Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
BOMA	25-025-0042	Boston	Suffolk	Boston-Cambridge-Newton, MA-NH	42.329500, -71.082600	Commercial	Urban/City Center	27,654	Melnea Cass Blvd near Shawmut Ave

[3]AADT reflects 2010 data (MA DOT, 2010)
BOLD ITALICS = EPA-designated NATTS Site

The BOMA monitoring site is located at Dudley Square in Roxbury, a southwest neighborhood of Boston and is the Roxbury NATTS site. The surrounding area is commercial as well as residential, as shown in Figure 13-1. Immediately to the east of the monitoring site are town homes, to the north is a parking lot and to the west are commercial properties. The original purpose for the location of this site was to measure population exposure to a city bus terminal located another block west of the monitoring site. In recent years, the buses servicing the area were converted to compressed natural gas (CNG). The monitoring site is 1.3 miles south of I-90 and 1 mile west of I-93. As Figure 13-2 shows, BOMA is located near a large number of point sources, with a high density of sources located a few miles to the west, northwest, and north of the site. The source category with the highest number of emissions sources surrounding BOMA is the institutions category, which includes schools, hospitals, and prisons. There are also numerous airport and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; bulk terminals and bulk plants; and electricity generating units (via combustion). Sources located within 1 mile of BOMA include several hospitals, a heliport at one of the hospitals, a university, and a dry cleaning facility. Figure 13-2 shows that BOMA is located less than 2 miles from the shoreline (Dorchester Bay).

In addition to providing city, county, CBSA, and land use/location setting information, Table 13-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near BOMA is greater than 27,000 and in the middle of the range compared to other NMP sites. The traffic estimate provided is for Melnea Cass Boulevard near Shawmut Avenue.

13.2 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 the year.

13.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For BOMA, site-specific data were available all of the parameters except dew point temperature and sea level pressure. Data for these parameters were obtained from the NWS weather station at Logan International Airport (WBAN 14739). The Logan Airport weather station is located 4.3 miles east-northeast of BOMA. A map showing the distance between the BOMA monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 13-2. Average Meteorological Conditions near the Massachusetts Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Boston, Massachusetts – BOMA[2]							
Sample Days (62)	50.9 ± 1.0	37.7 ± 1.1	58.0 ± 0.9	30.00 ± 0.01	29.94 ± 0.01	SW	4.6 ± 0.1
2014	51.4 ± 0.4	38.4 ± 0.4	58.6 ± 0.4	30.00 ± 0.01	29.94 ± 0.01	SW	4.5 ± <0.1

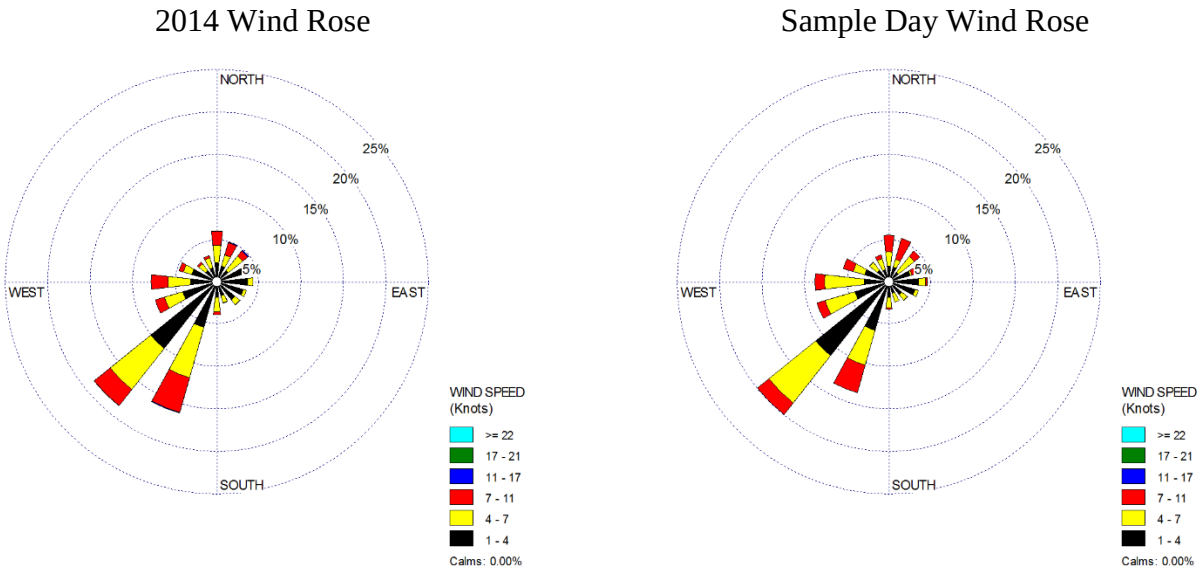
[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure and wind parameters were measured at BOMA. The remaining information was obtained from the closest NWS weather station located at Logan International Airport, WBAN 14739.

Table 13-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 13-2 is the 95 percent confidence interval for each parameter. As shown in Table 13-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year at BOMA.

13.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 13-3 presents two wind roses for the BOMA monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 13-3. Wind Roses for the Wind Data Collected at BOMA



Observations from Figure 13-3 for BOMA include the following:

- Winds from the south-southwest to southwest account for the majority (about one-third) of wind observations at BOMA in 2014. Winds from the southwest quadrant, including west, and winds from the north to northeast are the only wind directions accounting for more than 5 percent of observations. Calm winds were not measured at BOMA.

- The sample day wind patterns generally resemble the full-year wind patterns. Winds from the southwest to west account for an even higher percentage of winds observations on sample days at BOMA.

13.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the Massachusetts monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 13-3. 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 and are shaded in gray in Table 13-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PM_{10} metals and PAHs were sampled for at BOMA.

Table 13-3. Risk-Based Screening Results for the Massachusetts Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Boston, Massachusetts - BOMA						
Arsenic (PM_{10})	0.00023	42	57	73.68	42.86	42.86
Naphthalene	0.029	40	57	70.18	40.82	83.67
Nickel (PM_{10})	0.0021	15	58	25.86	15.31	98.98
Benzo(a)pyrene	0.00057	1	57	1.75	1.02	100.00
Total		98	229	42.79		

Observations from Table 13-3 include the following:

- Four pollutants failed at least one screen for BOMA; approximately 43 percent of concentrations for these four pollutants were greater than their associated risk screening value (or failed screens).

- Three pollutants contributed to 95 percent of failed screens for BOMA and therefore were identified as pollutants of interest for this site. These include two PM_{10} metals (arsenic and nickel) and one PAH (naphthalene).

- Naphthalene and arsenic each account for more than 40 percent of the total failed screens for BOMA while nickel accounts for 15 percent of the total failed screens.

13.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Massachusetts monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically to illustrate how each site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at the site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at BOMA are provided in Appendices M and N.

13.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for BOMA, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for BOMA are presented in Table 13-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 13-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Massachusetts Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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})	57/45	58	0.45 ± 0.14	0.32 ± 0.14	0.50 ± 0.09	0.29 ± 0.09	0.39 ± 0.06
Naphthalene	57/57	57	53.05 ± 19.45	43.18 ± 15.25	52.97 ± 9.22	28.70 ± 3.52	44.55 ± 6.72
Nickel (PM_{10})	58/58	58	2.25 ± 0.81	2.84 ± 1.34	1.60 ± 0.38	1.28 ± 0.48	1.99 ± 0.42

Observations for BOMA from Table 13-4 include the following:

- Naphthalene is the pollutant with the highest annual average concentration (44.55 ± 6.72 ng/m^3) among BOMA's pollutants of interest. The annual average concentrations for the remaining pollutants of interest are at least an order of magnitude lower.

- Concentrations of naphthalene measured at BOMA range from 13.8 ng/m^3 to 158 ng/m^3. The maximum naphthalene concentration measured at BOMA was measured on March 12, 2014 and is the only naphthalene concentration measured at this site that is greater than 100 ng/m^3.

- Concentrations of naphthalene appear more variable during the first half of the year, based on the confidence intervals calculated for the quarterly averages. Both the minimum and maximum concentrations were measured during the first half of the year, about one month apart. Nine naphthalene concentrations greater than 50 ng/m^3 were measured at BOMA during the first half of 2014, and nine were also measured during the second half. For the first half of the year, these measurements were spread out across the calendar quarters; for the second half of the year, all nine were measured during the third quarter of 2014 (none were measured during the fourth quarter).

- Concentrations of arsenic measured at BOMA in 2014 are all less than 1 ng/m^3, ranging from 0.007 ng/m^3 to 0.98 ng/m^3 and one non-detect. Both the maximum and minimum (non-detect) concentrations of arsenic were measured during the second quarter of 2014. The second and fourth quarter averages are more similar to each other and the first and third quarterly averages are more similar to each other, with confidence intervals that are rather large relative to the averages themselves. Only three concentrations greater than 0.5 ng/m^3 were measured during the second and fourth quarters, compared to 14 measured during the other two (six were measured during the first quarter and eight were measured during the third). In addition, all six arsenic concentrations less than 0.1 ng/m^3 were measured at BOMA during the second and fourth quarters (three measured during each calendar quarter). Arsenic

concentrations less than 0.1 ng/m^3 were not measured during the first and third quarters of 2014.

- Concentrations of nickel measured at BOMA range from 0.435 ng/m^3 to 9.00 ng/m^3. The first and second quarter average concentrations are higher than the other quarterly averages for 2014 and have more variability associated with their individual measurements, as their confidence intervals are two to three times higher than the confidence intervals for the third and fourth quarterly averages. The seven highest concentrations (those greater than 3.75 ng/m^3) were measured at BOMA between February and June, and 12 of the 16 measurements greater than or equal to 2 ng/m^3 were measured during the first half of the year. Several of the lowest nickel concentrations were measured at BOMA during the fourth quarter, with concentrations less than 1 ng/m^3 accounting for half (seven) of the 14 concentrations measured between October and December; no other quarter has more than three.

- Table 4-12 presents the NMP sites with the 10 highest annual average concentrations for each of the program-level speciated metals pollutants of interest. This table shows that BOMA has the second highest annual average concentration of nickel among NMP sites sampling PM_{10} metals (and does not appear in the table for arsenic).

13.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 13-4 for BOMA. Figures 13-4 through 13-6 overlay the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 13-4. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

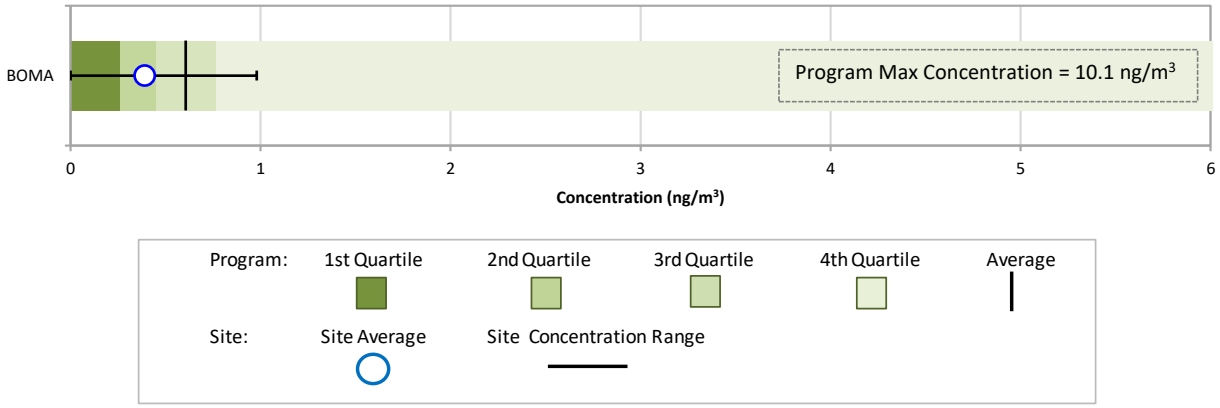


Figure 13-4 presents the box plot for arsenic for BOMA and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 13-4 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The maximum concentration of arsenic measured at BOMA is about an order of magnitude less than the maximum concentration of arsenic measured across the program.

- The annual average arsenic (PM_{10}) concentration for BOMA is less than the program-level average concentration (0.61 ng/m^3) and the program-level median concentration (0.45 ng/m^3).

Figure 13-5. Program vs. Site-Specific Average Naphthalene Concentration

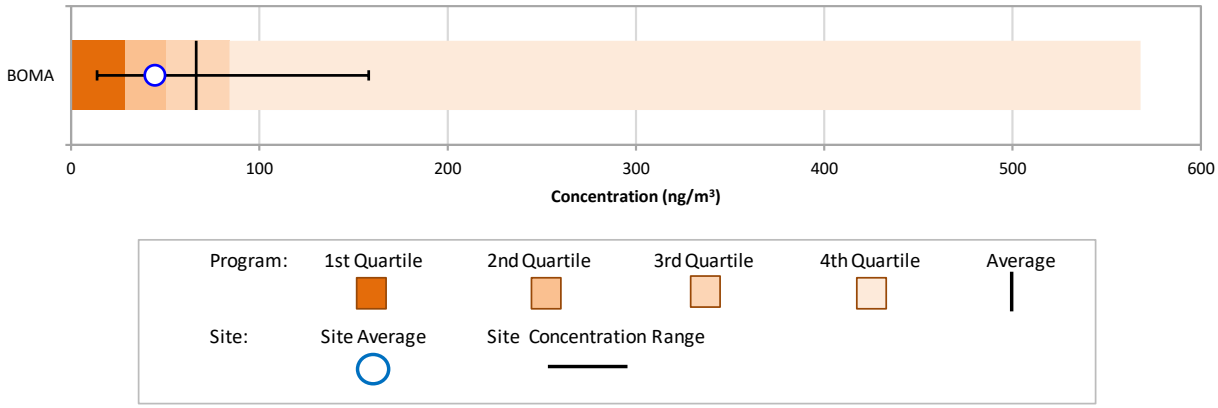


Figure 13-5 presents the box plot for naphthalene for BOMA and shows the following:

- The range of naphthalene concentrations measured at BOMA is much smaller than the range of concentrations measured across the program.

- The annual average naphthalene concentration for BOMA is less than the program-level average concentration (66.46 ng/m^3) and the program-level median concentration (50.70 ng/m^3).

Figure 13-6. Program vs. Site-Specific Average Nickel (PM_{10}) Concentration

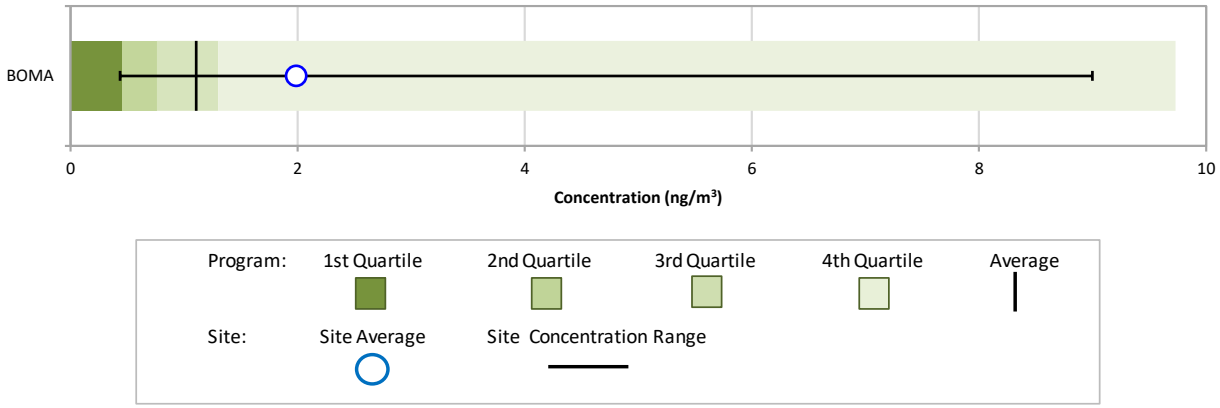


Figure 13-6 presents the box plot for nickel for BOMA and shows the following:

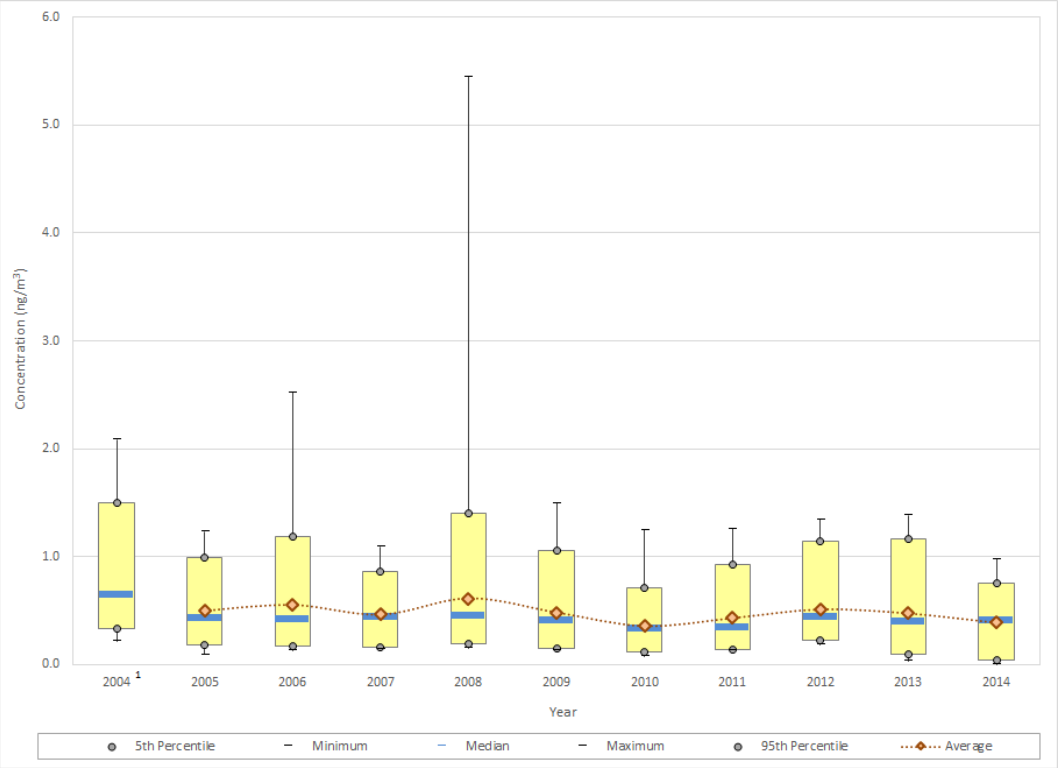
- BOMA's maximum nickel concentration of 9.00 ng/m^3 is the third highest nickel concentration measured across the program. The minimum nickel concentration measured at BOMA is just less than the program-level first quartile. Only two other NMP sites have minimum nickel concentrations greater than BOMA's.

- BOMA's annual average concentration of nickel is nearly twice the program-level average concentration and is also greater than the program-level third quartile. As discussed in the previous section, BOMA has the second highest annual average concentration of nickel, behind only ASKY-M.

13.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. BOMA has sampled PM_{10} metals under the NMP since 2003 and PAHs since 2008. Thus, Figures 13-7 through 13-9 present the 1-year statistical metrics for each of the pollutants of interest for BOMA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 13-7. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BOMA



[1] A 1-year average is not presented because there were breaks in sampling during portions of 2004.

Observations from Figure 13-7 for arsenic concentrations measured at BOMA include the following:

- Although sampling for PM_{10} metals under the NMP began in 2003, data from that year were excluded from this analysis because sampling did not begin until October. In addition, samples were not collected during portions of April, May, September, and October 2004. Because a full year's worth of data is not available for 2004, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum arsenic concentration shown was measured on July 5, 2008 (5.45 ng/m^3). Only two additional concentrations greater than 2 ng/m^3 have been measured at BOMA, one in 2004 and one in 2006. Arsenic concentrations greater than 1.5 ng/m^3 have not been measured after 2008.

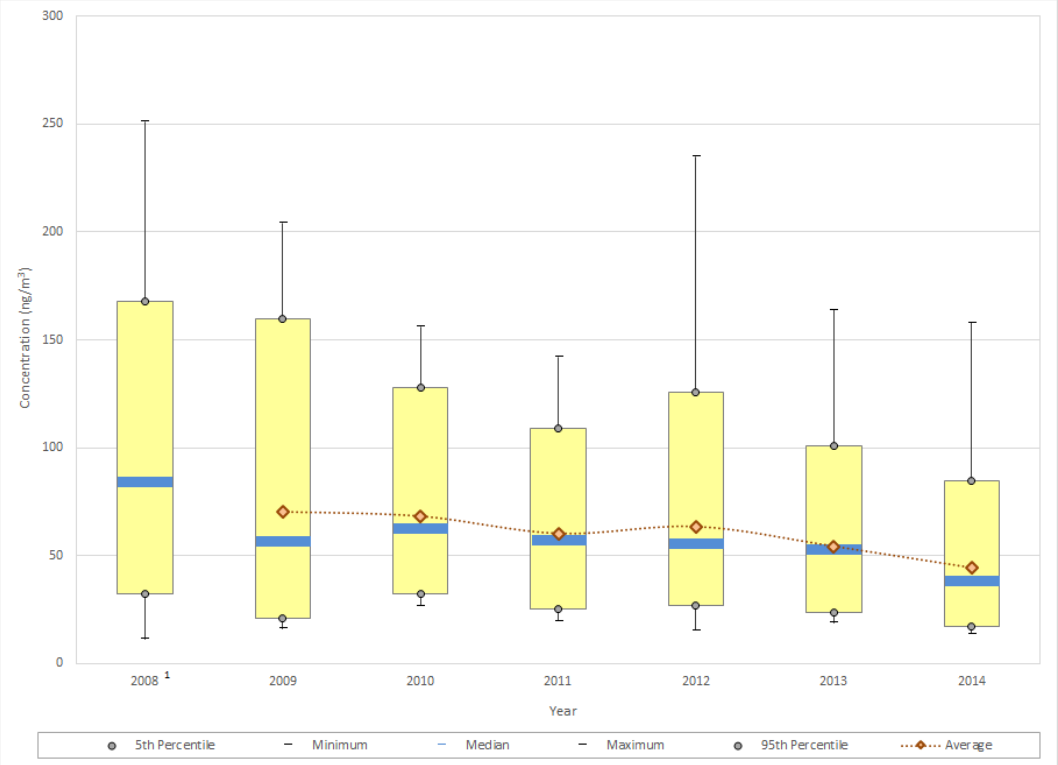
- The 1-year average concentrations of arsenic have fluctuated over the years, ranging from 0.36 ng/m^3 (2010) to 0.61 ng/m^3 (2008). For 2008, the maximum concentration is driving the 1-year average upward, which is evident from the median concentration, which hardly changed between 2007 and 2008, even though the smallest range of measurements was collected in 2007. If the maximum concentration for 2008 was removed from the dataset, the 1-year average concentration for 2008 would fall from 0.61 ng/m^3 to 0.53 ng/m^3, making the changes in the 1-year averages between 2007 and 2009 more subtle.

- All of the statistical metrics exhibit a decrease from 2008 to 2009 and again for 2010. Conversely, all of the statistical metrics exhibit an increase from 2010 to 2011 and again for 2012.

- For 2013, a higher number of concentrations at the lower end of the concentration range were measured while concentrations at the top of the range changed little. The number of arsenic concentrations less than 0.25 ng/m^3 increased from one in 2012 to 16 for 2013. This is explains the considerable decrease in the minimum and 5th percentile shown for 2013, as well as the slight decreases in the 1-year average and median concentrations.

- The number of arsenic concentrations less than 0.25 ng/m^3 continued to increase for 2014 (18) and a non-detect was measured for the first time. The maximum arsenic concentration measured in 2014 at BOMA is less than 1 ng/m^3 for the first time since the onset of sampling.

Figure 13-8. Yearly Statistical Metrics for Naphthalene Concentrations Measured at BOMA



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2008.

Observations from Figure 13-8 for naphthalene concentrations measured at BOMA include the following:

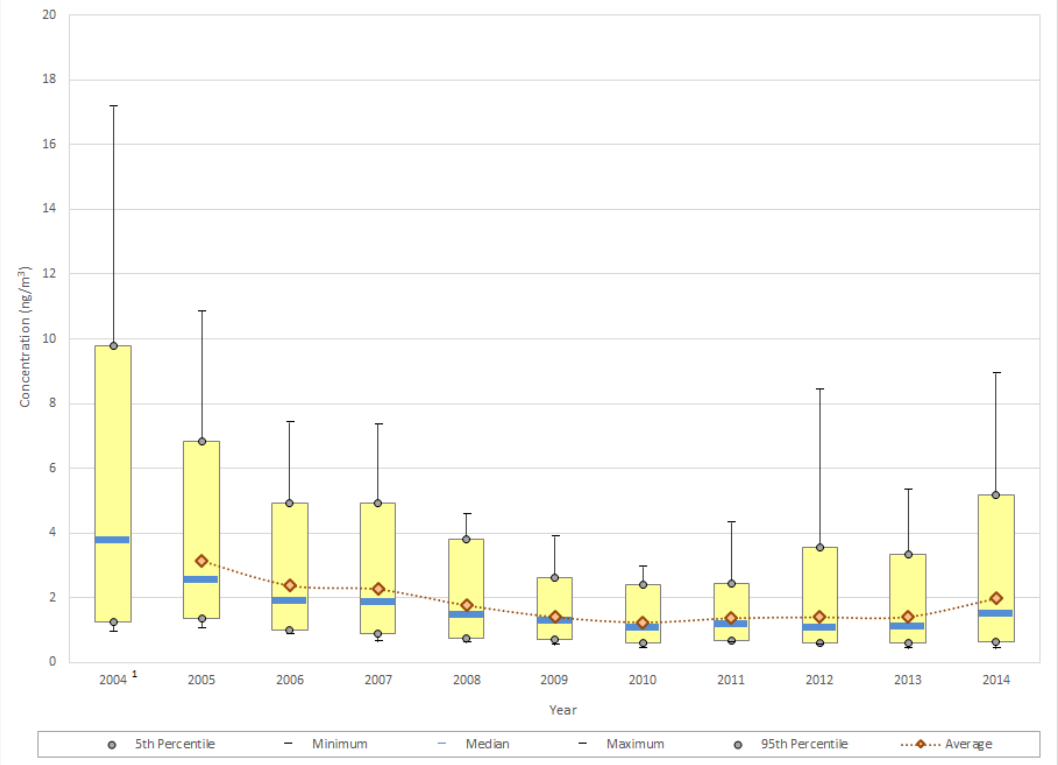
- BOMA began sampling PAHs under the NMP in May 2008. Because a full year's worth of data is not available for 2008, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum naphthalene concentration was measured at BOMA on the very first sample day (May 6, 2008), although a similar measurement was also collected in 2012. Only two additional concentrations greater than 200 ng/m^3 have been measured at BOMA (one each in 2008 and 2009).

- The difference between the 5th and 95th percentiles (the range of concentrations within which 90 percent of the measurements lie) decreased each year through 2011. The range increased somewhat for 2012, and is more similar to the range shown for 2010, before decreasing further for 2013 and reaching a minimum in 2014.

- With the exception of 2012, the 1-year average concentrations have a decreasing trend at BOMA, decreasing from 70.33 ng/m^3 for 2009 to 44.52 ng/m^3 for 2014, which is the first year the 1-year average is less than 50 ng/m^3. (If the maximum concentration measured in 2012 was excluded from the dataset, the 1-year average concentration would exhibit virtually no change from 2011 to 2012.) The median concentration also exhibits this decreasing trend after 2010.

Figure 13-9. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at BOMA



[1] A 1-year average is not presented because there were breaks in sampling during portions of 2004.

Observations from Figure 13-9 for nickel concentrations measured at BOMA include the following:

- The maximum nickel concentration was measured at BOMA in 2004 (17.2 ng/m^3). Nickel concentrations greater than 9 ng/m^3 have not been measured at BOMA since 2005.

- A steady decreasing trend in nickel concentrations measured at BOMA is shown through 2010. Concentrations for 2011 increased just slightly, returning to 2009 levels. Even with the higher concentrations measured in 2012 and 2013, the 1-year average concentration did not change significantly from 2011 (ranging from 1.38 ng/m^3 for 2011 to 1.42 ng/m^3 for 2013). Considerably increases, however, are shown for 2014, as all of the statistical parameters, except the minimum concentration, exhibit increases. The 1-year average concentration for 2014 is nearly 2 ng/m^3; the 1-year average concentration hasn't been greater than 2 ng/m^3 since 2007.

13.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the BOMA monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

13.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for BOMA and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air-monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 13-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for BOMA from Table 13-5 include the following:

- Among the pollutants of interest for BOMA, naphthalene has the highest annual average concentration while arsenic has the lowest annual average concentration.

- Although the annual average concentration for naphthalene is two orders of magnitude greater than the annual average concentration of arsenic, the cancer risk approximations for these two pollutants are fairly similar (1.68 in-a-million for arsenic and 1.51 in-a-million for naphthalene). This speaks to the relative toxicity of one pollutant compared to the other.

- None of the pollutants of interest for BOMA have noncancer hazard approximations greater than 1.0; in fact, none of the pollutants of interest have noncancer hazard approximations greater than 0.05. This indicates that adverse noncancer health effects are not expected due to these individual pollutants.

Table 13-5. Risk Approximations for the Massachusetts Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Boston, Massachusetts - BOMA						
Arsenic (PM_{10})	0.0043	0.000015	57/58	0.39 ± 0.06	1.68	0.03
Naphthalene	0.000034	0.003	57/57	44.55 ± 6.72	1.51	0.01
Nickel (PM_{10})	0.00048	0.00009	58/58	1.99 ± 0.42	0.95	0.02

13.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 13-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 13-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 13-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for BOMA, as presented in Table 13-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 13-6. Table 13-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 13.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 13-6. 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 UREs (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)**
Boston, Massachusetts (Suffolk County) - BOMA					
Formaldehyde	143.05	Formaldehyde	1.86E-03	Arsenic (PM_{10})	1.68
Benzene	137.55	Nickel, PM	1.22E-03	Naphthalene	1.51
Acetaldehyde	66.22	Benzene	1.07E-03	Nickel (PM_{10})	0.95
Ethylbenzene	64.30	1,3-Butadiene	7.34E-04		
1,3-Butadiene	24.47	Arsenic, PM	4.62E-04		
Tetrachloroethylene	19.26	Hexavalent Chromium	4.41E-04		
Naphthalene	10.82	Naphthalene	3.68E-04		
POM, Group 2b	3.41	POM, Group 2b	3.00E-04		
Nickel, PM	2.53	Ethylbenzene	1.61E-04		
POM, Group 2d	1.66	POM, Group 2d	1.46E-04		

Table 13-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Massachusetts Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Boston, Massachusetts (Suffolk County) - BOMA					
Toluene	511.53	Acrolein	501,247.48	Arsenic (PM_{10})	0.03
Hexane	399.62	Nickel, PM	28,149.17	Nickel (PM_{10})	0.02
Xylenes	271.73	Formaldehyde	14,596.91	Naphthalene	0.01
Formaldehyde	143.05	1,3-Butadiene	12,234.00		
Benzene	137.55	Acetaldehyde	7,357.30		
Acetaldehyde	66.22	Arsenic, PM	7,162.73		
Ethylbenzene	64.30	Benzene	4,584.90		
Methyl isobutyl ketone	55.81	Naphthalene	3,605.47		
1,3-Butadiene	24.47	Cadmium, PM	3,035.10		
Tetrachloroethylene	19.26	Xylenes	2,717.32		

Observations from Table 13-6 include the following:

- Formaldehyde, benzene, and acetaldehyde are the highest emitted pollutants with cancer UREs in Suffolk County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, nickel, and benzene.

- Eight of the highest emitted pollutants in Suffolk County also have the highest toxicity-weighted emissions.

- All three of BOMA's pollutants of interest appear among the pollutants with the highest toxicity-weighted emissions for Suffolk County. Nickel and naphthalene are also among those with the highest total emissions in Suffolk County while arsenic is not among the highest emitted (it ranks 16th).

- POM, Group 2b ranks eighth for both quantity emitted and its toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at BOMA including acenaphthene and fluorene, none of which failed a single screen. POM, Group 2d ranks tenth for both quantity emitted and its toxicity-weighted emissions. POM, Group 2d does not include any PAHs sampled for at BOMA.

Observations from Table 13-7 include the following:

- Toluene, hexane, and xylenes are the highest emitted pollutants with noncancer RfCs in Suffolk County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, nickel, and formaldehyde.

- Five of the highest emitted pollutants in Suffolk County also have the highest toxicity-weighted emissions.

- All three of BOMA's pollutants of interest appear among the pollutants with the highest toxicity-weighted emissions for Suffolk County, although none of these appear among the highest emitted pollutants (with noncancer RfCs). Cadmium, which was also sampled for at BOMA but did not fail any screens, also appears among the pollutants with the highest toxicity-weighted emissions for Suffolk County

13.6 Summary of the 2014 Monitoring Data for BOMA

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

- ❖ *Four pollutants failed screens for BOMA, with naphthalene and arsenic accounting for a majority of the failed screens.*

- ❖ *Naphthalene had the highest annual average concentration among the pollutants of interest for BOMA.*

- *BOMA has the second highest annual average concentration of nickel for 2014 among NMP sites sampling PM_{10} metals.*

- *Naphthalene concentrations have an overall decreasing trend at BOMA. Concentrations of nickel decreased significantly early on during sampling at BOMA, and, after a few years with little change, exhibited an increase for 2014.*

14.0 Site in Michigan

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

14.1 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 DEMI monitoring site is located in the Detroit-Warren-Dearborn, Michigan CBSA. Figure 14-1 is the composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 14-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 14-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize the emissions sources within the boundary. Table 14-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 14-1. Dearborn, Michigan (DEMI) Monitoring Site

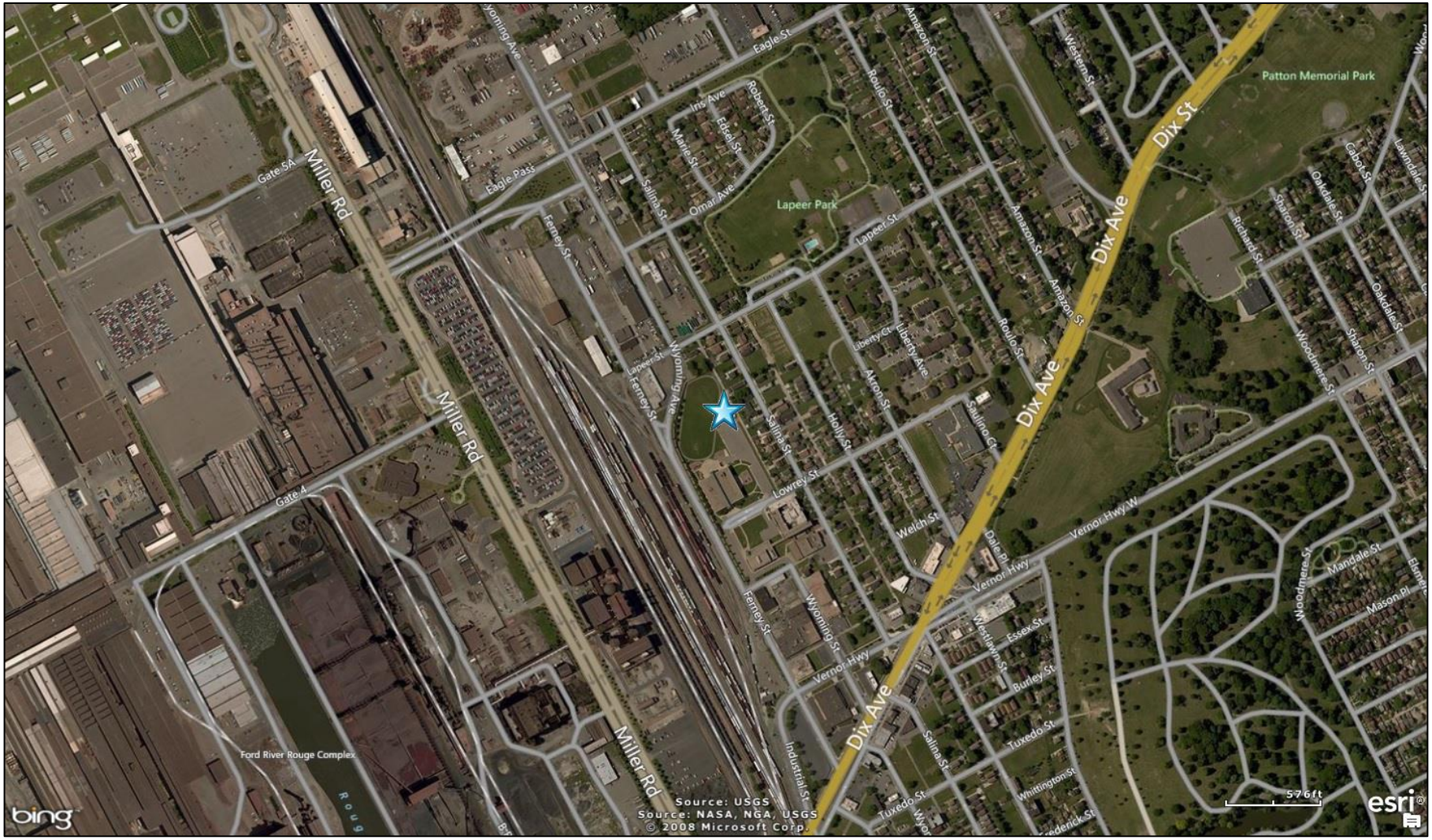


Figure 14-2. NEI Point Sources Located Within 10 Miles of DEMI

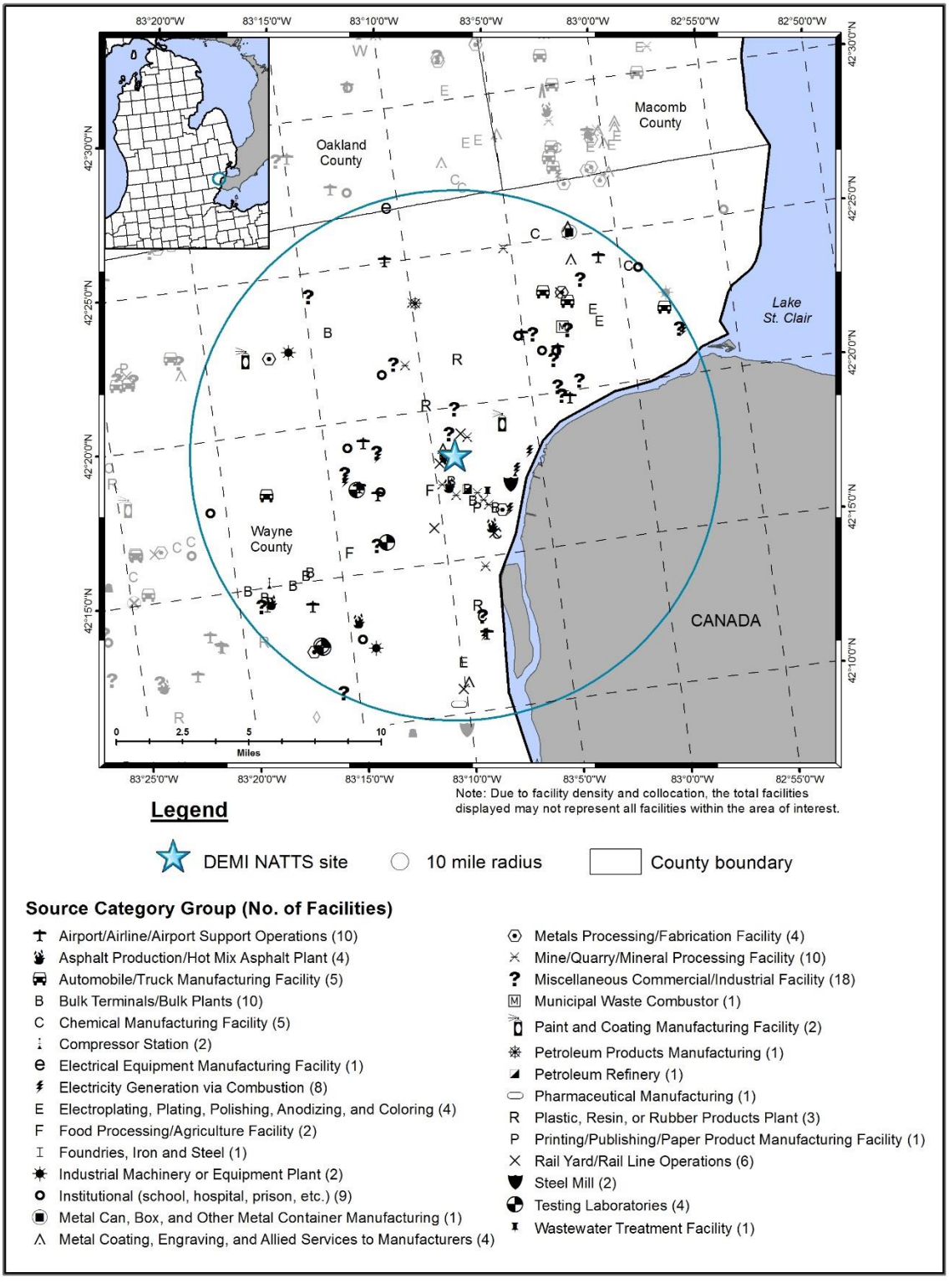


Table 14-1. Geographical Information for the Michigan Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
DEMI	26-163-0033	Dearborn	Wayne	Detroit-Warren-Dearborn, MI	42.306674, -83.148754	Industrial	Suburban	96,870	I-94 from Ford Plant to Rotunda Dr

[1]AADT reflects 2014 data (MI DOT, 2014)
BOLD ITALICS = EPA-designated NATTS Site

DEMI is located in the parking lot of Salina Elementary School in Dearborn, just southwest of Detroit, and is the Detroit NATTS site. The surrounding area is both suburban and industrial in nature. Figure 14-1 shows that a freight yard is located just west of the site and a residential neighborhood is located to the east. Industrial sources such as automobile and steel manufacturing facilities are also located in the vicinity. The monitoring site lies between two heavily traveled roadways, I-75 (1.4 miles to the east) and I-94 (1.2 miles to the west).

Figure 14-2 shows that DEMI is surrounded by numerous point sources. A cluster of sources is located just west of DEMI. Another cluster of sources is located farther south. The source categories with the most point sources within 10 miles of the site include the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; bulk terminals and bulk plants; mines, quarries, and mineral processing facilities; and institutional facilities (schools, prisons, and/or hospitals). Although difficult to discern in Figure 14-2, the closest sources to DEMI are just west of the site and include a steel mill and an automobile/truck manufacturing facility, part of which can be seen in the left hand side of Figure 14-1, as well as a facility generating electricity via combustion, a metal coatings facility, and a rail yard. Note that DEMI is located approximately 3 miles from the Canadian border, and that no emission sources information is provided for Canada.

In addition to providing city, county, CBSA, and land use/location setting information, Table 14-1 also contains traffic volume information for DEMI as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume near DEMI is nearly 100,000 and ranks 13th highest among NMP sites. Traffic for DEMI is provided for I-94, between the Ford Plant and Rotunda Drive.

14.2 Meteorological Characterization

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

14.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Michigan site, site-specific data were available for some, but not all, of the parameters in Table 14-2. For DEMI, temperature, pressure, humidity, and wind information was available in AQS. Data from the NWS weather station at Detroit City Airport (WBAN 14822) were used for the remaining parameters (sea level pressure and dew point temperature). The Detroit City Airport weather station is located 10 miles northeast of DEMI. A map showing the distance between the monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 14-2. Average Meteorological Conditions near the Michigan Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Dearborn, Michigan – DEMI[2]							
Sample Days (68)	48.6 ± 1.1	35.3 ± 1.0	65.3 ± 0.8	30.06 ± 0.01	29.27 ± 0.01	WNW	5.3 ± 0.1
2014	49.0 ± 0.4	36.4 ± 0.4	66.6 ± 0.3	30.02 ± 0.01	29.24 ± <0.01	WNW	5.5 ± 0.1

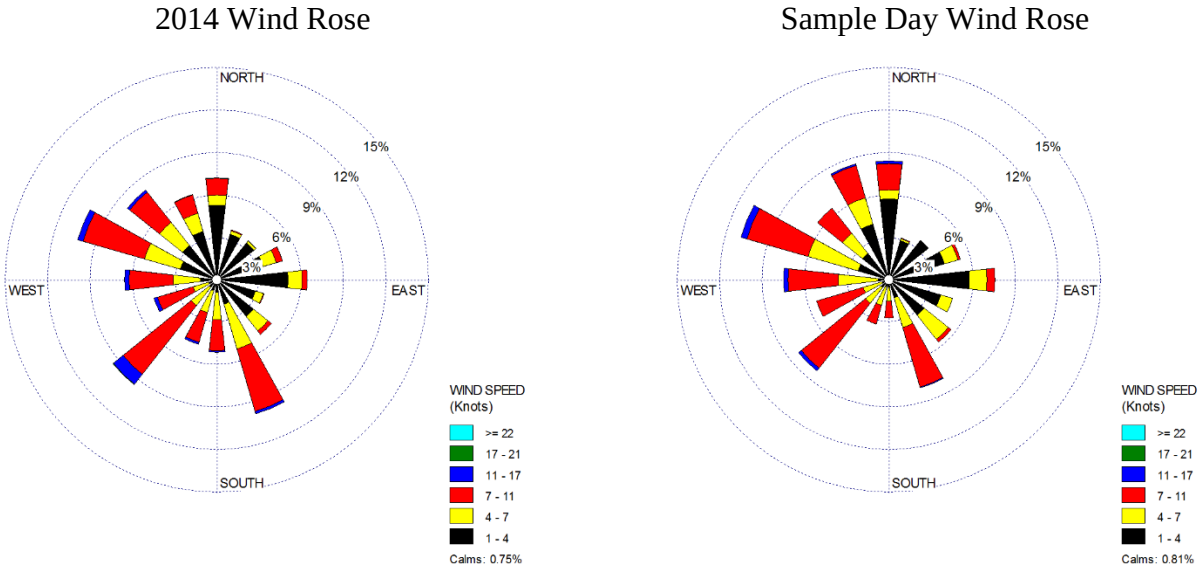
[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure and wind parameters were measured at DEMI. The remaining information was obtained from the closest NWS weather station located at Detroit City Airport, WBAN 14822.

Table 14-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 14-2 is the 95 percent confidence interval for each parameter. Average meteorological conditions on sample days near DEMI were fairly representative of average weather conditions experienced throughout the year. The largest difference between the parameters shown in Table 14-2 is for relative humidity.

14.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 14-3 presents two wind roses for the DEMI monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 14-3. Wind Roses for the Wind Data Collected at DEMI



Observations from Figure 14-3 include the following:

- The full-year wind rose shows that winds from a variety of directions were observed at DEMI, although winds from the south-southeast, southwest, and west-northwest each account for nearly 10 percent of the observations. Winds from the western quadrants were observed more often than those from the eastern quadrants. The strongest winds were most often observed with winds from the western quadrants. Calm winds were infrequently observed at DEMI in 2014.

- The sample day wind rose for DEMI bears some resemblance to the full-year wind rose, although there are also differences. Winds from the west-northwest account for a slightly greater number of observations on sample days while the number of south-southeasterly and southwesterly wind observations was fewer. Fewer northwesterly

winds were observed on sample days while the number of north-northwesterly and northerly wind observations was higher compared to the full-year wind rose. Similar to the full-year wind rose, winds from the western quadrants were observed more often on sample days than those from the eastern quadrants. The percentage of calm winds on the sample day wind rose is similar to the percentage shown on the full-year wind rose.

14.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for DEMI in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 14-3. 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 and are shaded in gray in Table 14-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, and PAHs were sampled for at DEMI.

Table 14-3. Risk-Based Screening Results for the Michigan Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Dearborn, Michigan - DEMI						
Acetaldehyde	0.45	61	61	100.00	12.90	12.90
Formaldehyde	0.077	61	61	100.00	12.90	25.79
Benzene	0.13	60	60	100.00	12.68	38.48
Carbon Tetrachloride	0.17	60	60	100.00	12.68	51.16
Naphthalene	0.029	60	60	100.00	12.68	63.85
1,3-Butadiene	0.03	59	60	98.33	12.47	76.32
1,2-Dichloroethane	0.038	56	56	100.00	11.84	88.16
Ethylbenzene	0.4	20	60	33.33	4.23	92.39
Fluorene	0.011	13	52	25.00	2.75	95.14
Acenaphthene	0.011	12	59	20.34	2.54	97.67
p-Dichlorobenzene	0.091	4	14	28.57	0.85	98.52
Fluoranthene	0.011	4	60	6.67	0.85	99.37
Benzo(a)pyrene	0.00057	3	60	5.00	0.63	100.00
Total		473	723	65.42		

Observations from Table 14-3 for DEMI include the following:

- Thirteen pollutants failed at least one screen for DEMI; 65 percent of concentrations for these 13 pollutants were greater than their associated risk screening value (or failed screens).

- Nine pollutants contributed to 95 percent of failed screens for DEMI and therefore were identified as pollutants of interest for this site. These nine include two carbonyl compounds, five VOCs, and two PAHs.

- The first five pollutants listed in Table 14-3 each failed 100 percent of screens, with each contributing to approximately 13 percent to the total number of failed screens; together these five pollutants account for nearly 65 of the total failed screens. One concentration of 1,3-butadiene was less than the screening value, and thus, this pollutant only failed 98 percent of its screens. Concentrations of 1,2-dichloroethane also failed 100 percent of screens. Thus, the first seven pollutants account for nearly 90 percent of the total failed screens. The failure rate was considerably lower for concentrations of the remaining pollutants.

14.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Michigan monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each data analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at DEMI are provided in Appendices J, L, and M.

14.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for the Michigan site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros

for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Michigan monitoring site are presented in Table 14-4, where applicable. Note that concentrations of the PAHs are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 14-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Michigan Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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 ($\mu g/m^3$)
Dearborn, Michigan – DEMI							
Acetaldehyde	61/61	61	1.99 ± 0.29	2.10 ± 0.27	1.99 ± 0.35	1.36 ± 0.20	1.85 ± 0.15
Benzene	60/60	60	0.75 ± 0.12	0.69 ± 0.16	1.02 ± 0.33	0.49 ± 0.07	0.73 ± 0.10
1,3-Butadiene	60/59	60	0.10 ± 0.03	0.08 ± 0.02	0.17 ± 0.07	0.07 ± 0.01	0.10 ± 0.02
Carbon Tetrachloride	60/60	60	0.64 ± 0.03	0.70 ± 0.03	0.71 ± 0.03	0.64 ± 0.03	0.67 ± 0.02
1,2-Dichloroethane	56/54	60	0.08 ± 0.01	0.08 ± 0.01	0.06 ± 0.02	0.06 ± 0.01	0.07 ± 0.01
Ethylbenzene	60/59	60	0.24 ± 0.07	0.37 ± 0.17	0.60 ± 0.22	0.27 ± 0.19	0.37 ± 0.09
Formaldehyde	61/61	61	2.77 ± 0.42	3.76 ± 0.78	4.40 ± 0.67	2.15 ± 0.39	3.25 ± 0.35
Fluorene[a]	52/52	60	1.37 ± 0.84	9.68 ± 4.43	12.60 ± 3.29	3.68 ± 1.14	6.93 ± 1.76
Naphthalene[a]	60/60	60	88.10 ± 21.92	136.94 ± 40.59	164.80 ± 42.51	73.64 ± 22.69	116.80 ± 18.59

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

Observations for DEMI from Table 14-4 include the following:

- The pollutants with the highest annual average concentrations are formaldehyde and acetaldehyde; all other annual average concentrations are less than 1.0 $\mu g/m^3$.

- Concentrations of acetaldehyde are significantly lower during the fourth quarter of 2014, compared to the rest of the year, based on the quarterly averages shown. Concentrations of acetaldehyde measured at DEMI range from 0.809 µg/m^3 to 3.29 µg/m^3. Only one acetaldehyde concentration greater than 2 µg/m^3 was measured at DEMI during the fourth quarter of 2014, compared to at least seven in each of the other calendar quarters. Acetaldehyde concentrations less than 1.5 µg/m^3 account for more than half of the samples collected between October and December (10), compared to only four measured throughout the rest of the year.

- The fourth quarter formaldehyde average is also the lowest of the four shown above, although the concentrations of formaldehyde are more variable. Concentrations of formaldehyde measured at DEMI range from 1.17 µg/m^3 to 6.93 µg/m^3. A review of the data shows that 14 of the 15 formaldehyde concentrations greater than 4 µg/m^3 were measured during the second and third quarters of the year, the majority of which were measured between June and August. At the other end of the concentration range, 12 of the 13 formaldehyde concentrations less than 2 µg/m^3 were measured at DEMI during the first or fourth quarters of 2014, predominantly in November and December.

- The third quarter average concentration of benzene is higher than the other quarterly averages and the associated confidence interval for it is two to three times higher than the others shown. Benzene concentrations measured at DEMI range from 0.282 µg/m^3 to 2.22 µg/m^3. The three highest concentrations of benzene, all greater than 1.5 µg/m^3, were measured in August and September. Of the nine benzene concentrations greater than 1 µg/m^3 measured at DEMI, five were measured during the third quarter, compared to one during the first quarter, three during the second, and none during the fourth. The fourth quarter average benzene concentration is less than half the third quarter average and has the smallest confidence interval among the averages. Benzene concentrations greater than 1 µg/m^3 were not measured at DEMI during the fourth quarter of 2014. Eighteen benzene concentrations greater than the maximum concentration measured during the fourth quarter (0.755 µg/m^3) were measured at DEMI throughout the rest of the year and are spread fairly evenly across the quarters. Ten benzene concentrations less than 0.5 µg/m^3 were measured at DEMI during the fourth quarter compared to six during the rest of the year.

- The quarterly average concentrations of 1,3-butadiene have a similar pattern as the quarterly average concentrations of benzene. The two highest 1,3-butadiene concentrations (0.430 µg/m^3 and 0.359 µg/m^3) were measured on the same days as the two highest benzene concentrations. In fact, the eight highest 1,3-butadiene concentrations were measured on the same days as the eight highest benzene concentrations, although the order varied a little.

- The third quarter average concentration of ethylbenzene is approximately twice the other quarterly averages and has the largest confidence interval associated with it. A review of the data shows that the maximum concentration of this pollutant was measured on December 13, 2014 (1.55 µg/m^3), although a similar concentration also measured on July 7, 2014 (1.54 µg/m^3). These are the fifth and sixth highest concentrations of ethylbenzene measured across the program. The number of

ethylbenzene concentrations greater than 0.5 µg/m^3 measured during the third quarter (8) is greater than the number measured during the rest of the year (6). In addition, no concentrations less than 0.1 µg/m^3 were measured during the third quarter, compared to 10 measured during other calendar quarters (three during the first quarter, one during the second, and six during the fourth).

- Concentrations of both PAHs appear higher during the warmer months of the year, although all of the quarterly average concentrations of naphthalene and fluorene have relatively large confidence intervals associated with them, indicating that the measurements are highly variable. Concentrations of naphthalene measured at DEMI span an order of magnitude, ranging from 36.1 ng/m^3 to 369 ng/m^3. Some of the highest naphthalene concentrations across the program were measured at DEMI, including the second and fourth highest concentrations. Seven naphthalene concentrations measured at DEMI are greater than 200 ng/m^3, the second highest among sites sampling PAHs. The two highest naphthalene concentrations were measured at DEMI on the same days as the two highest benzene and 1,3-butadiene concentrations (September 14th and September 26th). There is alignment among the sampling dates of several of the highest concentrations for each of these three compounds.

- Concentrations of fluorene measured at DEMI range from 1.63 ng/m^3 to 31.4 ng/m^3, and include eight non-detects. The second and third quarter average concentrations are significantly greater than the other quarterly average concentrations. The 10 highest fluorene concentrations measured at DEMI were measured between June and September. At the other end of the concentration range, 13 of the 15 fluorene concentrations less than 3 ng/m^3 were measured during the first or fourth quarters, with the other two measured in April. Further, all eight non-detects were measured during the first quarter of 2014.

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

- DEMI appears in Table 4-9 for VOCs three times. This site has the sixth highest annual average concentration of ethylbenzene and the tenth highest annual average concentration of 1,3-butadiene. This site also has the seventh highest annual average concentration of carbon tetrachloride; however, with the exception of TVKY, the difference among the annual average concentrations of this pollutant varies little.

- DEMI appears in Table 4-10 among the NMP sites with the highest annual average concentration of formaldehyde, ranking eighth highest.

- DEMI has the highest annual average concentration of naphthalene among NMP sites sampling PAHs, as shown in Table 4-11. DEMI has the most naphthalene concentrations greater than 100 ng/m^3 (29) among NMP sites sampling PAHs.

14.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 14-4. Figures 14-4 through 14-12 overlay the Michigan site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 14-4. Program vs. Site-Specific Average Acetaldehyde Concentration

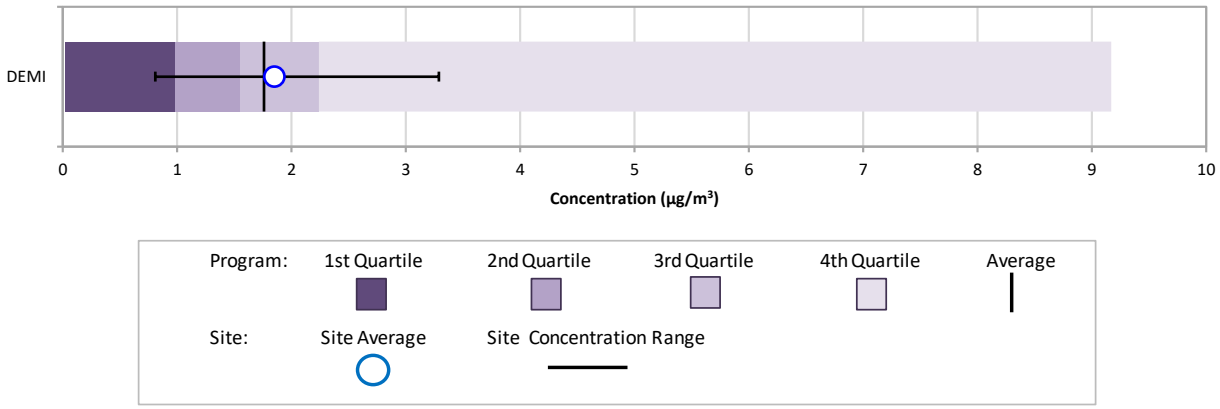


Figure 14-4 presents the box plot for acetaldehyde for DEMI and shows the following:

- The range of acetaldehyde concentrations measured at DEMI is relatively small compared to the range measured across the program.
- DEMI's annual average concentration of acetaldehyde is just greater than the program-level average concentration.

Figure 14-5. Program vs. Site-Specific Average Benzene Concentration

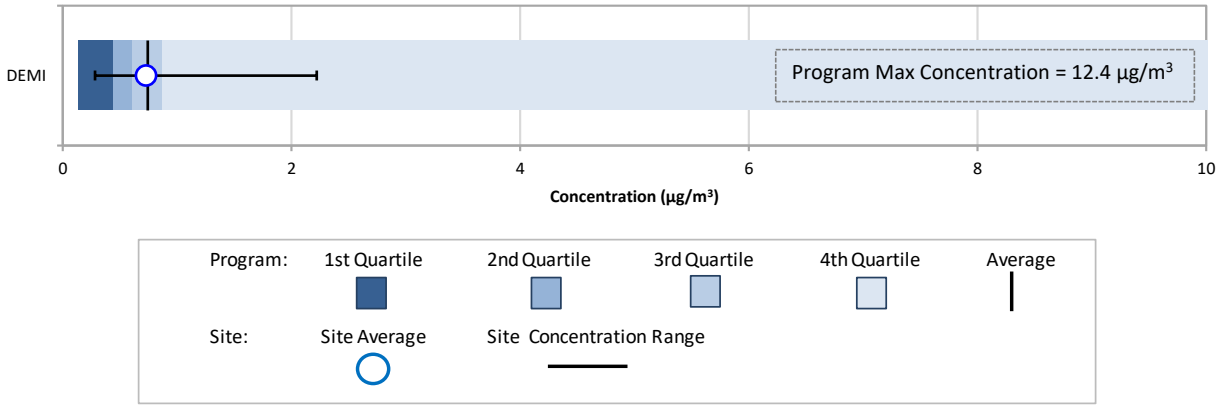


Figure 14-5 presents the box plot for benzene for DEMI and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plot in Figure 14-5 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The maximum benzene concentration measured at DEMI is considerably less than the maximum benzene concentration measured across the program.

- The annual average benzene concentration for this site is similar to the program-level average concentration.

Figure 14-6. Program vs. Site-Specific Average 1,3-Butadiene Concentration

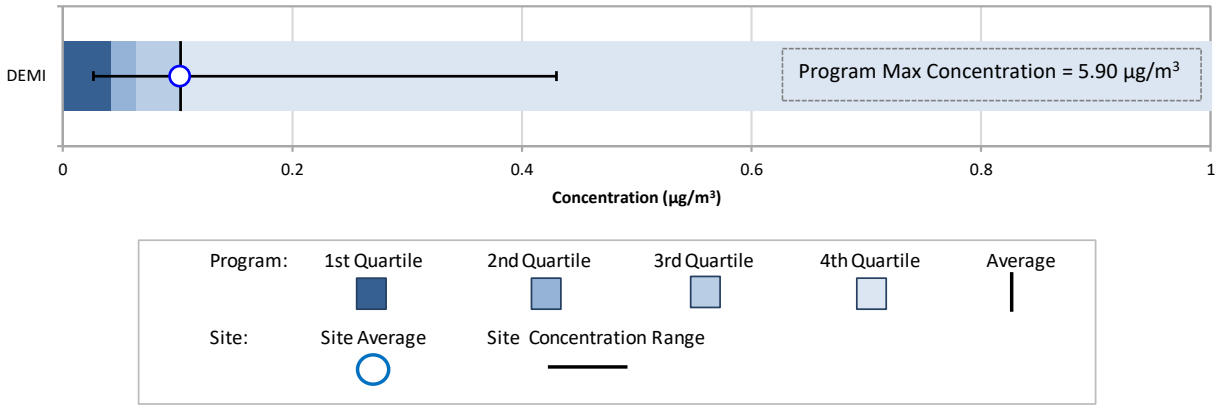


Figure 14-6 presents the box plot for 1,3-butadiene for DEMI and shows the following:

- Similar to benzene, the program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plot in Figure 14-6 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 1 µg/m^3.

- The maximum 1,3-butadiene concentration measured at DEMI is 0.43 µg/m^3, considerably less than the maximum concentration measured across the program. Yet, the annual average concentration for DEMI is similar to the program-level average concentration and both are similar to the program-level third quartile.

- Non-detects were not measured at the Michigan monitoring site.

Figure 14-7. Program vs. Site-Specific Average Carbon Tetrachloride Concentration

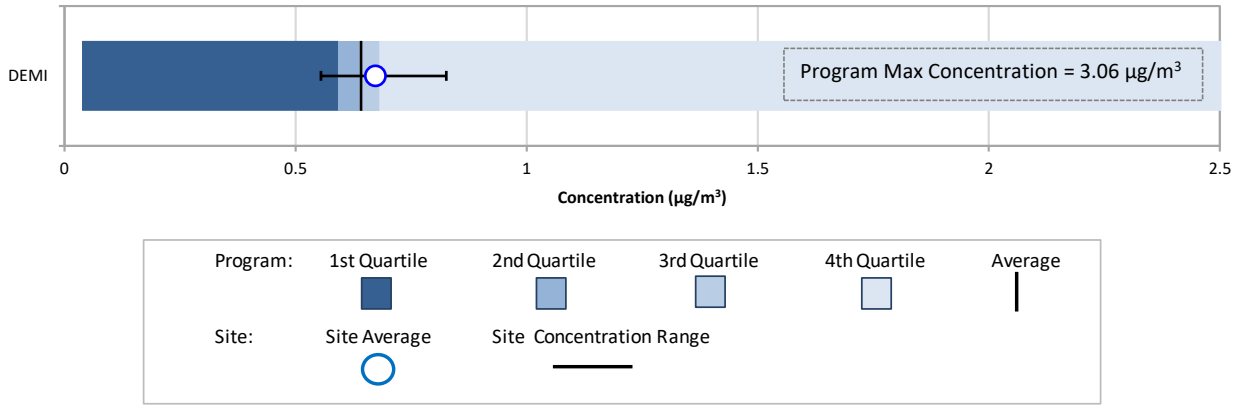


Figure 14-7 presents the box plot for carbon tetrachloride for DEMI and shows the following:

- The scale of the box plot in Figure 14-7 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- The range of carbon tetrachloride concentrations measured at DEMI is the smallest range for any NMP site sampling this pollutant.

- Despite this small range of measurements, the annual average concentration of carbon tetrachloride for DEMI is just greater than the program-level average concentration of 0.64 µg/m^3 (and just less than the program-level third quartile).

Figure 14-8. Program vs. Site-Specific Average 1,2-Dichloroethane Concentration

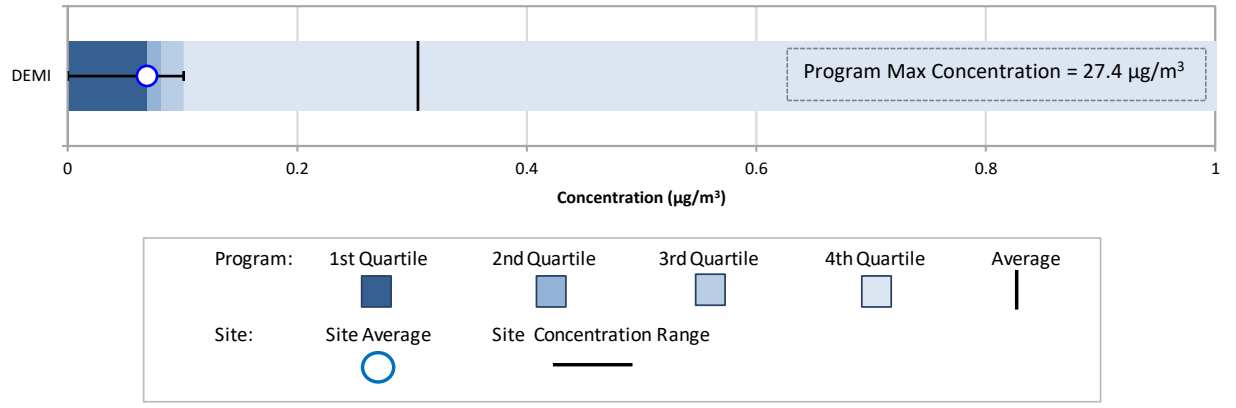


Figure 14-8 presents the box plot for 1,2-dichloroethane for DEMI and shows the following:

- The scale of the box plot in Figure 14-8 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the

program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- All of the concentrations of 1,2-dichloroethane measured at DEMI are less than the program-level average concentration of 0.31 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- The annual average concentration of 1,2-dichloroethane for DEMI is nearly equivalent to the program-level first quartile (0.069 µg/m^3).

Figure 14-9. Program vs. Site-Specific Average Ethylbenzene Concentration

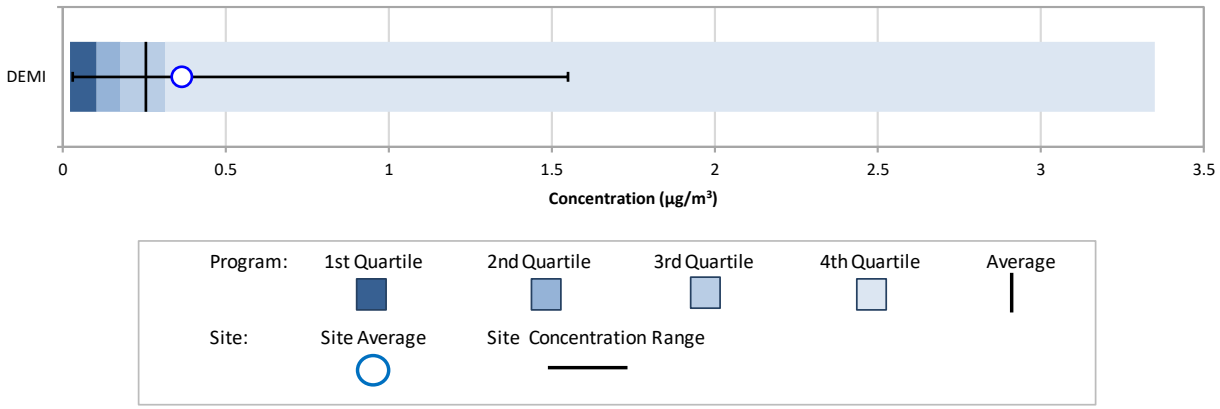


Figure 14-9 presents the box plot for ethylbenzene for DEMI and shows the following:

- The maximum ethylbenzene concentration measured at DEMI is approximately half the maximum concentration measured across the program, although DEMI's maximum concentration is the fifth highest measurement across the program.

- The annual average concentration of ethylbenzene for DEMI is greater than both the program-level average and third quartile; recall from the previous section that this site has the sixth highest annual average concentration of ethylbenzene among NMP sites sampling this pollutant.

Figure 14-10. Program vs. Site-Specific Average Fluorene Concentration

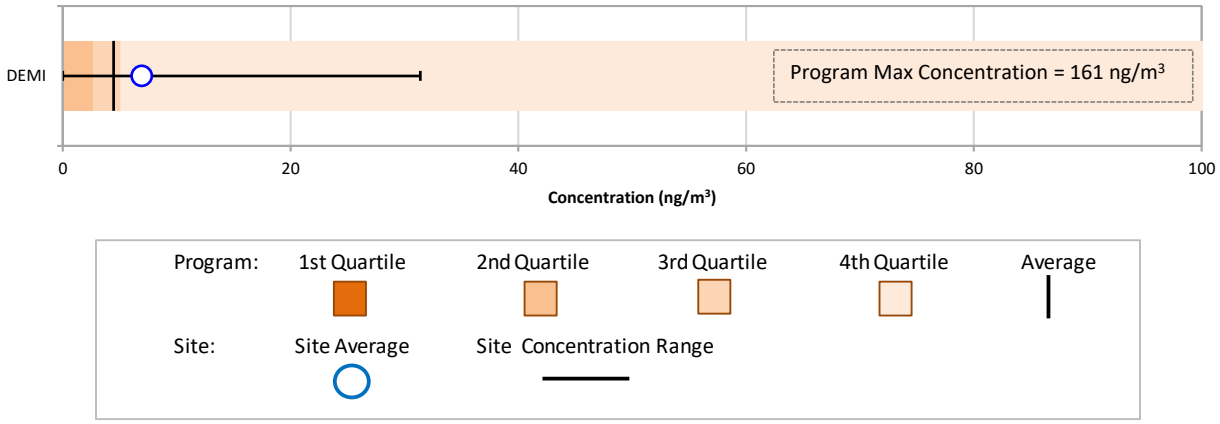


Figure 14-10 presents the box plot for fluorene for DEMI and shows the following:

- Like many other pollutants of interest, the scale of the box plot in Figure 14-10 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level first quartile is zero and therefore not visible on the box plot.

- The maximum fluorene concentration measured at DEMI is about one-fifth the maximum concentration measured across the program.

- The annual average fluorene concentration for DEMI is greater than the program-level average concentration (6.32 ng/m^3) and third quartile. DEMI's annual average is the third highest among NMP sites sampling PAHs.

Figure 14-11. Program vs. Site-Specific Average Formaldehyde Concentration

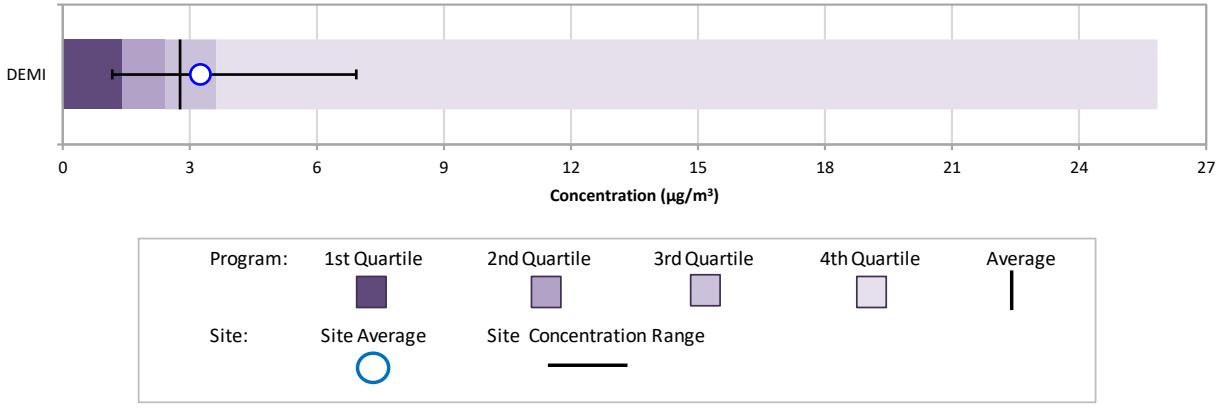


Figure 14-11 presents the box plot for formaldehyde for DEMI and shows the following:

- The range of formaldehyde concentrations measured at DEMI falls within a relatively small range (1.17 µg/m^3 to 6.93 µg/m^3) compared to the range of concentrations measured across the program. Yet, the annual average concentration for DEMI lies between the program-level average concentration and the program-level third

quartile. Recall from the previous section that this site has the eighth highest annual average concentration of formaldehyde among NMP sites sampling carbonyl compounds.

- The minimum formaldehyde concentration measured at DEMI is just less than the program-level first quartile. DEMI is among nine NMP sites where the minimum formaldehyde concentration measured is greater than 1 µg/m^3.

Figure 14-12. Program vs. Site-Specific Average Naphthalene Concentration

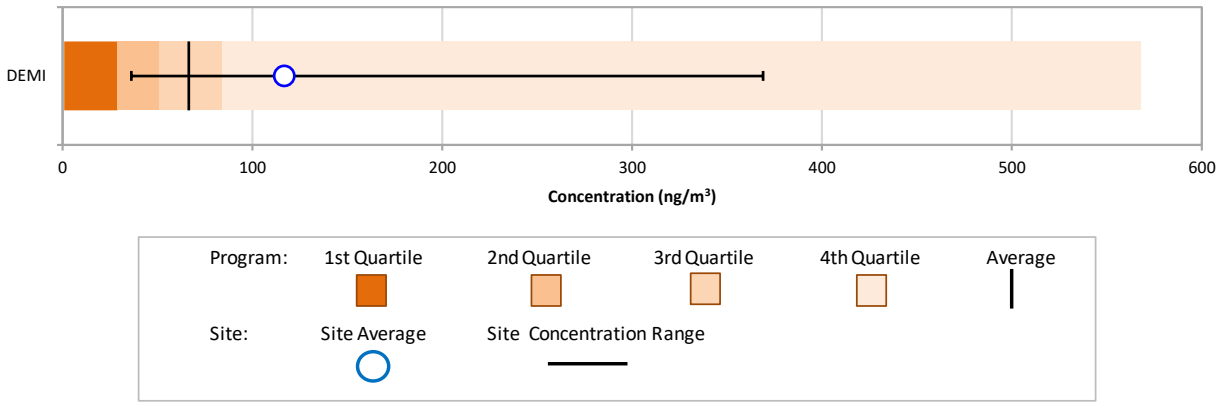


Figure 14-12 presents the box plot for naphthalene for DEMI and shows the following:

- DEMI's maximum naphthalene concentration is the second highest naphthalene measurement across the program.

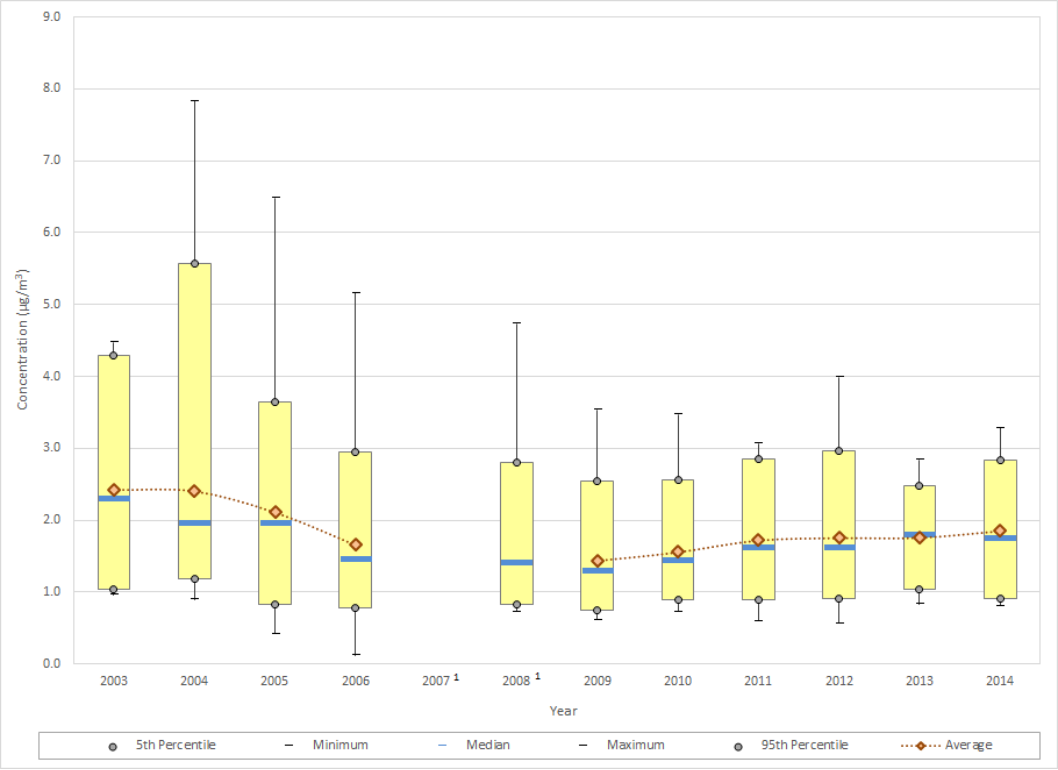
- The minimum concentration of naphthalene measured at DEMI is greater than the program-level first quartile. DEMI has the second highest minimum concentration among NMP sites sampling this pollutant.

- The annual average concentration of naphthalene for DEMI is just less than twice the program-level average concentration and is the highest annual average concentration among NMP sites sampling naphthalene.

14.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. DEMI has sampled VOCs and carbonyl compounds under the NMP since 2003 and PAHs since 2008. Thus, Figures 14-13 through 14-21 present the 1-year statistical metrics for each of the pollutants of interest for DEMI. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 14-13. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at DEMI



[1] A 1-year average is not presented because data from March 2007 to March 2008 was invalidated.

Observations from Figure 14-13 for acetaldehyde concentrations measured at DEMI include the following:

- Carbonyl compounds have been sampled continuously at DEMI under the NMP since 2003, beginning with a 1-in-12 day schedule in 2003 then changing to a 1-in-6 day schedule in the spring of 2004.

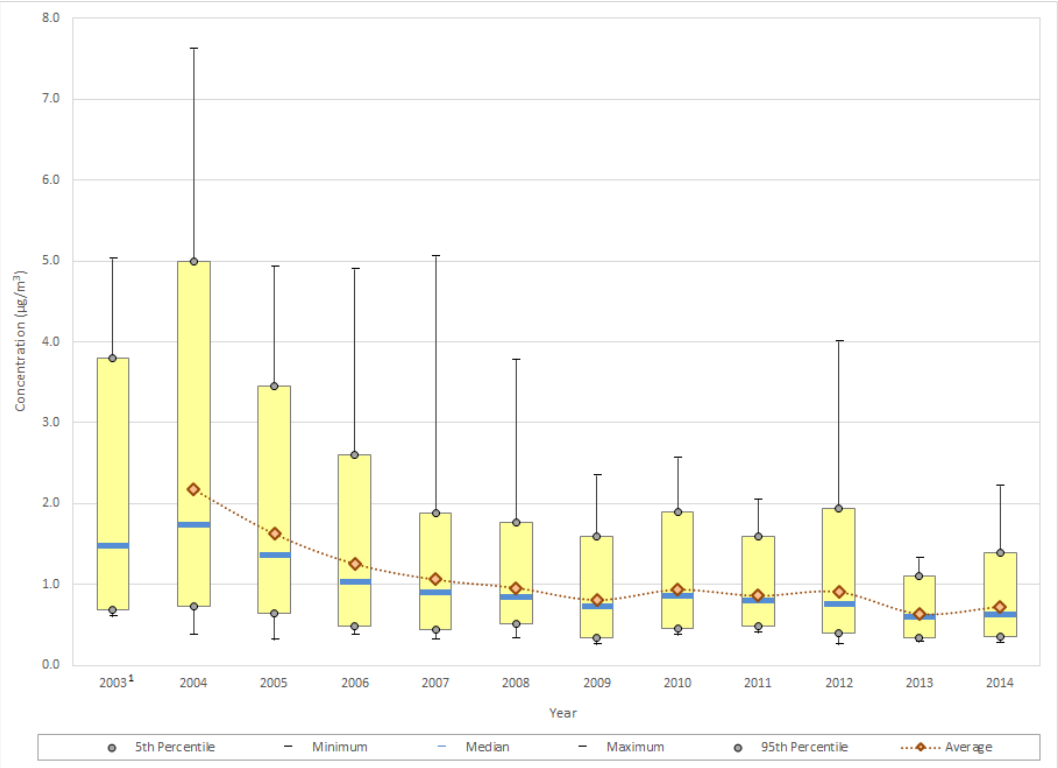
- Carbonyl compound samples from the primary sampler were invalidated between March 13, 2007 and March 25, 2008 by the state of Michigan due to a leak in the sample line. With only 12 valid samples in 2007, no statistical metrics are provided. Because less than 75 percent of the samples were valid in 2008, a 1-year average is not presented for 2008, although the range of measurements is provided.

- The maximum acetaldehyde concentration was measured at DEMI in 2004 (7.84 µg/m^3). Six concentrations greater than 5 µg/m^3 have been measured at DEMI, three in 2004, two in 2005, and one in 2006 (and none in the years that follow).

- The 1-year average concentration exhibits a decreasing trend after 2004 that continues through 2006. A 1-year average concentration is not available for 2007 or 2008, although the median concentration, which is available for 2008, changed little from 2006 to 2008, then decreased slightly for 2009. Both the 1-year average and median concentrations exhibit an increasing trend after 2009 that levels off for 2012, with additional increases shown for 2013 and 2014 (1-year average only).

- The 1-year average concentration for 2014 is at its highest since 2005.

Figure 14-14. Yearly Statistical Metrics for Benzene Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-14 for benzene concentrations measured at DEMI include the following:

- VOCs have been sampled continuously at DEMI under the NMP since 2003. However, the 1-in-12 day schedule combined with a number of invalid samples resulted in low completeness in 2003; as a result, a 1-year average concentration is not presented for 2003.

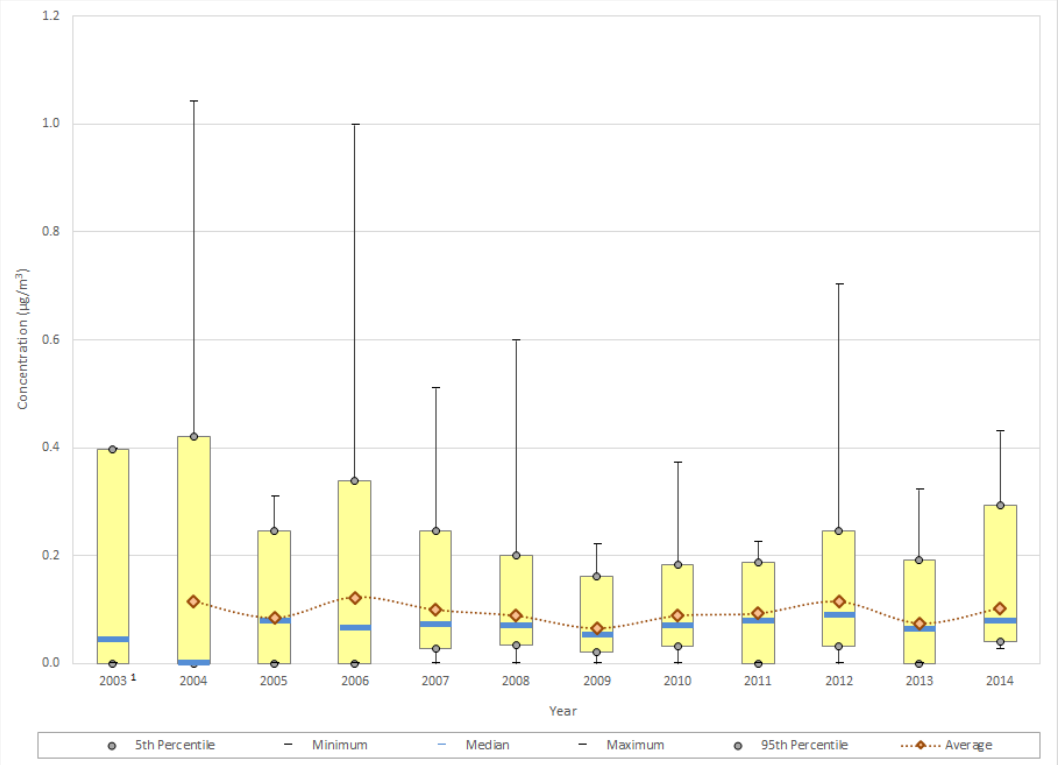
- The three highest benzene concentrations were measured at DEMI in 2004 and range from 5.44 µg/m^3 to 7.62 µg/m^3. Only two other concentrations greater than 5 µg/m^3 have been measured at DEMI, one in 2003 and one in 2007.

- Both the 1-year average and median concentrations exhibit a steady decreasing trend between 2004 and 2009. Between 2009 and 2012, the 1-year average concentration has an undulating pattern and fluctuated between 0.81 µg/m^3 (2009) and 0.94 µg/m^3 (2010).

- A significant decrease in benzene concentrations is shown for 2013, as the smallest range of benzene concentrations was measured at DEMI in 2013 and all of the statistical metrics decreased except the minimum concentration. Both the 1-year average and median concentrations are at a minimum for 2013.

- Nearly all of the statistical metrics exhibit an increase for 2014, although the 1-year average and median concentrations are both still less than these parameters for other year except 2013.

Figure 14-15. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-15 for 1,3-butadiene concentrations measured at DEMI include the following:

- The maximum 1,3-butadiene concentration (1.04 µg/m^3) was measured on October 18, 2004 and is the only 1,3-butadiene concentration greater than 1 µg/m^3 measured at DEMI, although concentrations greater than 0.90 µg/m^3 were measured in 2004 and 2006.

- For 2004, the minimum, 5th percentile, and median concentrations are all zero, indicating that at least half of the measurements were non-detects. Yet, two of the three highest concentrations were also measured at DEMI in 2004; in addition, the maximum 95th percentile was calculated for 2004. This indicates there is a high level of variability within these measurements.

- There were fewer non-detects in 2005 and 2006, as indicated by the increase in the median concentration, and even fewer in the years that follow, as indicated by the increase in the 5th percentile. The percentage of non-detects decreased from a high of 60 percent in 2004 to 2 percent in 2008, then fluctuated between 2 percent and

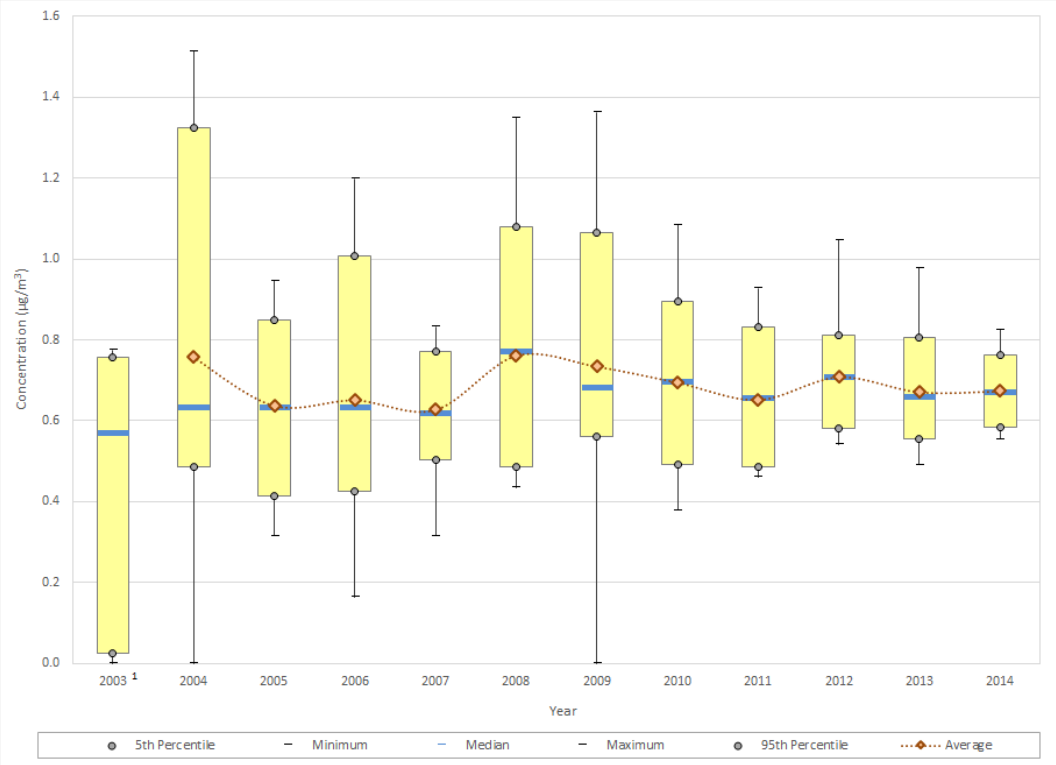
8 percent for the years that follow until 2014. There were no non-detects measured in 2014.

- Even as the number of non-detects decreased (and thus, the number of zeros factored into the calculated decreased), the 1-year average concentration decreased by almost half between 2006 and 2009. This was followed by an increasing trend between 2009 and 2012.

- The 1-year average concentration decreased significantly from 2012 to 2013, as did the median, both of which are at their lowest since 2009.

- All of the statistical metrics exhibit increases for 2014.

Figure 14-16. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-16 for carbon tetrachloride concentrations measured at DEMI include the following:

- In 2003, the measured detections ranged from 0.32 µg/m^3 to 0.76 µg/m^3, plus two non-detects. This is the only year of sampling for which nearly half the measurements were less than 0.5 µg/m^3.

- The range of concentrations measured in 2004 doubled from 2003 levels. The number of measurements greater than 1 µg/m^3 increased from none in 2003 to 12 for 2004.

- The 1-year average concentration decreased by more than 0.1 µg/m^3 from 2004 to 2005, as the range of concentrations measured decreased substantially. Little change in the 1-year average concentration is shown from 2005 to 2007, despite the differences in the ranges of concentrations measured.

- With the exception of the 5th percentile, all of the statistical metrics increased for 2008, with the 1-year average and median concentrations for 2008 similar to the 95th percentile for 2007.

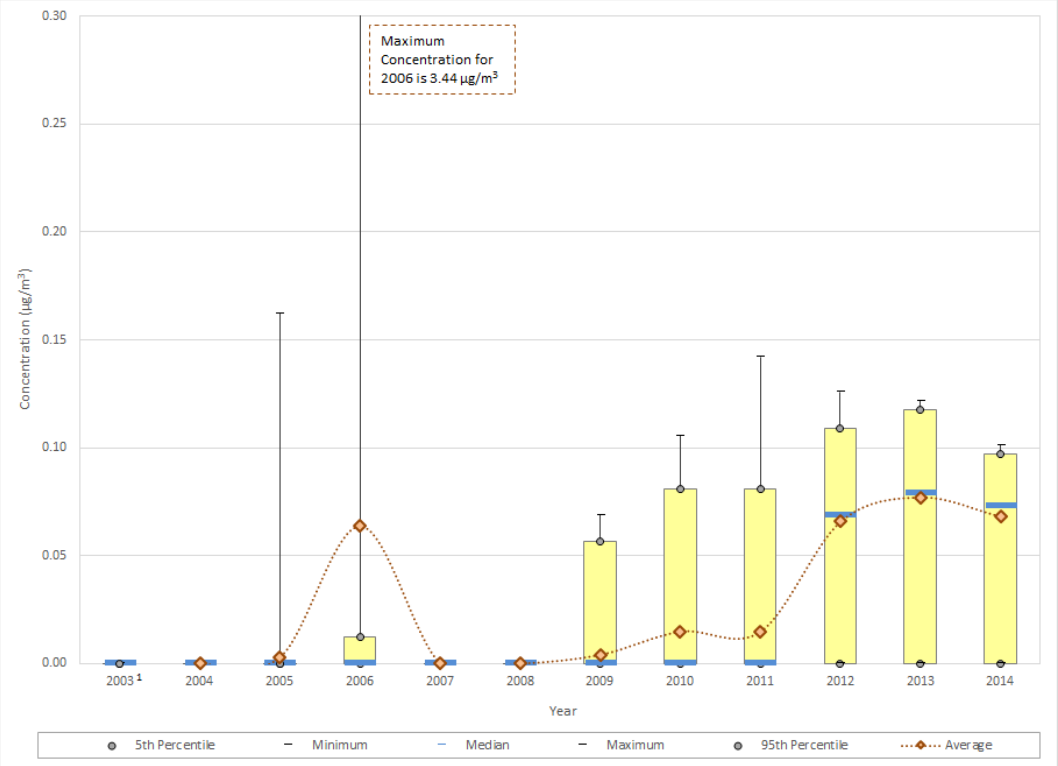
- A steady decreasing trend in the 1-year average concentration is shown between 2008 and 2011. Between these years, the majority of concentrations fell within a tighter concentration range, as indicated by the difference between the 5th and 95th percentiles.

- For 2012, the difference between the 5th and 95th percentiles is less than 0.25 µg/m^3, even though an increase in the 1-year average and median concentrations is shown. The number of carbon tetrachloride concentrations falling between 0.7 µg/m^3 and 0.9 µg/m^3 more than doubled from 2011 (13) to 2012 (32), accounting for more than half of the measurements for 2012.

- All of the statistical parameters exhibit a slight decrease from 2012 to 2013.

- The smallest range of carbon tetrachloride concentrations was measured in 2014, spanning just over 0.25 µg/m^3. In addition, the majority of concentrations measured in 2014 fall into the tightest range of concentrations measured. Despite this tightening of measurements, little change is shown in the central tendency statistics for 2014.

Figure 14-17. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

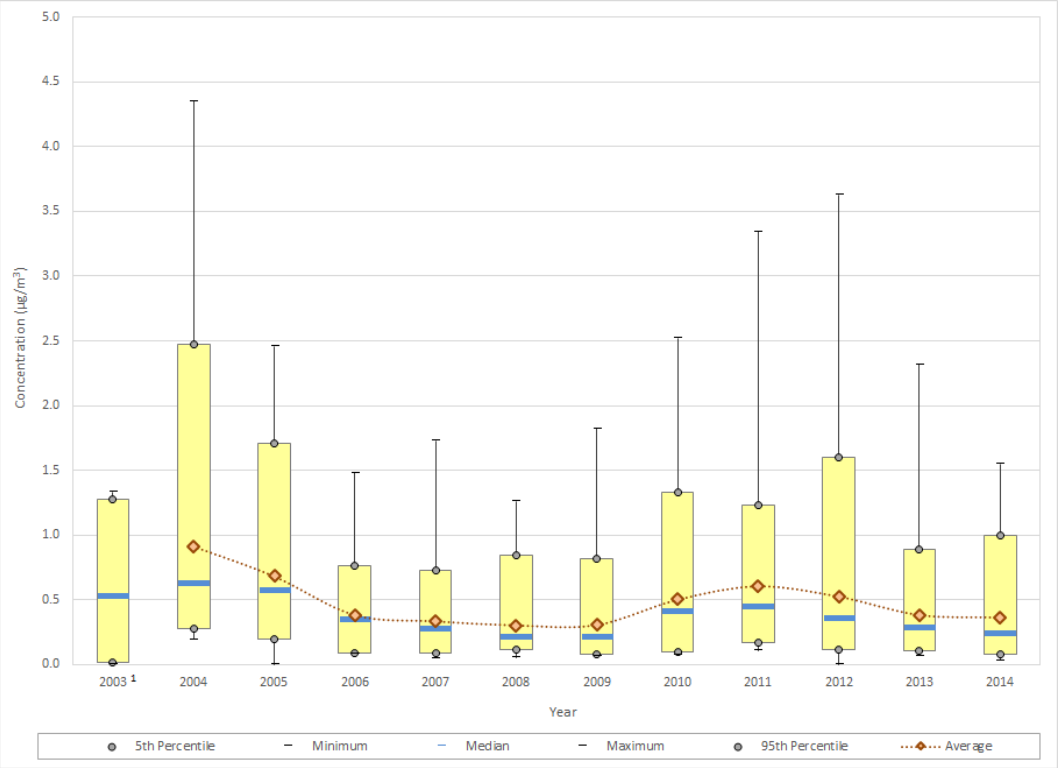
Observations from Figure 14-17 for 1,2-dichloroethane concentrations measured at DEMI include the following:

- There were no measured detections of 1,2-dichloroethane in 2003, 2004, 2007, or 2008. Through 2011, the median concentration is zero for all years, indicating that at least half of the measurements are non-detects: there was only one measured detection in 2005, three in 2006, four in 2009, 12 in 2010, and 11 in 2011. The number of measured detections increased by a factor of five for 2012, with a similar number for 2013 and 2014.

- As the number of measured detections increase, so do each of the corresponding statistical metrics shown in Figure 14-17.

- As the number of measured detections increased dramatically for 2012, and the years following, the 1-year average and median concentrations increased correspondingly. The median concentration is greater than the 1-year average concentration for each year from 2012 forward. This is because there were still several non-detects (or zeros) factoring into the 1-year average concentration for each year, which can pull down an average in the same manner an outlier can drive an average upward.

Figure 14-18. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-18 for ethylbenzene concentrations measured at DEMI include the following:

- The maximum ethylbenzene concentration was measured at DEMI in September 2004 (4.35 µg/m^3). Only two other ethylbenzene concentrations greater than 3 µg/m^3 have been measured at DEMI (one each in 2011 and 2012). Only 11 concentrations greater than 2 µg/m^3 have been measured at DEMI.

- A steady decreasing trend in the 1-year average concentration is shown after 2004, although the rate of decrease levels out after 2006, with the 1-year average reaching a minimum for 2008 (0.30 µg/m^3). Little change is shown for 2009.

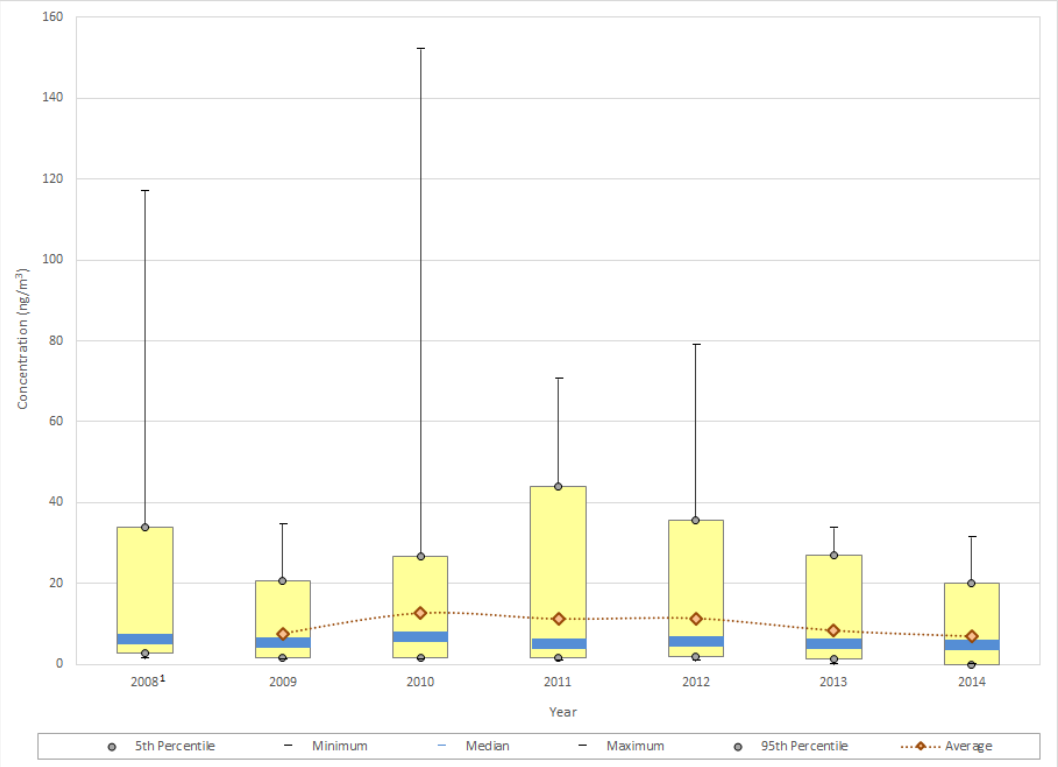
- The maximum concentration measured exhibits a steady increasing trend between 2008 and 2012, with all of the statistical parameters exhibiting increases for 2010, and most continuing this increase for 2011.

- While the maximum concentration increased for 2012, the minimum concentration decreased (and one non-detect was measured). The number of concentrations at the lower end of the concentration range (those less than 0.25 µg/m^3) nearly doubled from 2011 to 2012 (up from 11 to 19), resulting in the slight decreases shown in the central tendency statistics for 2012, despite a few higher concentrations measured.

- For 2013, all of the statistical metrics exhibit decreases, with the exception of the minimum concentration, as there were no non-detects measured in 2013.

Concentrations less than 0.25 µg/m^3 account for an even greater percentage of the measurements, accounting for 27 of the measurements (or more than 40 percent) for 2013. Additional decreases are shown for several of the parameters for 2014, with concentrations less than 0.25 µg/m^3 accounting for more than half of the measurements for the first time since 2009.

Figure 14-19. Yearly Statistical Metrics for Fluorene Concentrations Measured at DEMI



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 14-19 for fluorene concentrations measured at DEMI include the following:

- DEMI began sampling PAHs under the NMP in April 2008. Because a full year's worth of data is not available for 2008, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum fluorene concentration (152 ng/m^3) was measured at DEMI on August 18, 2010. Two additional measurements greater than 100 ng/m^3 have been measured at DEMI (one in August 2008 and another in August 2010). All eight concentrations greater than 50 ng/m^3 were measured in June, July, or August of a given year and all 40 concentrations greater than or equal to 20 ng/m^3 were measured at DEMI during the second or third quarters of the year (the warmer months of the year).

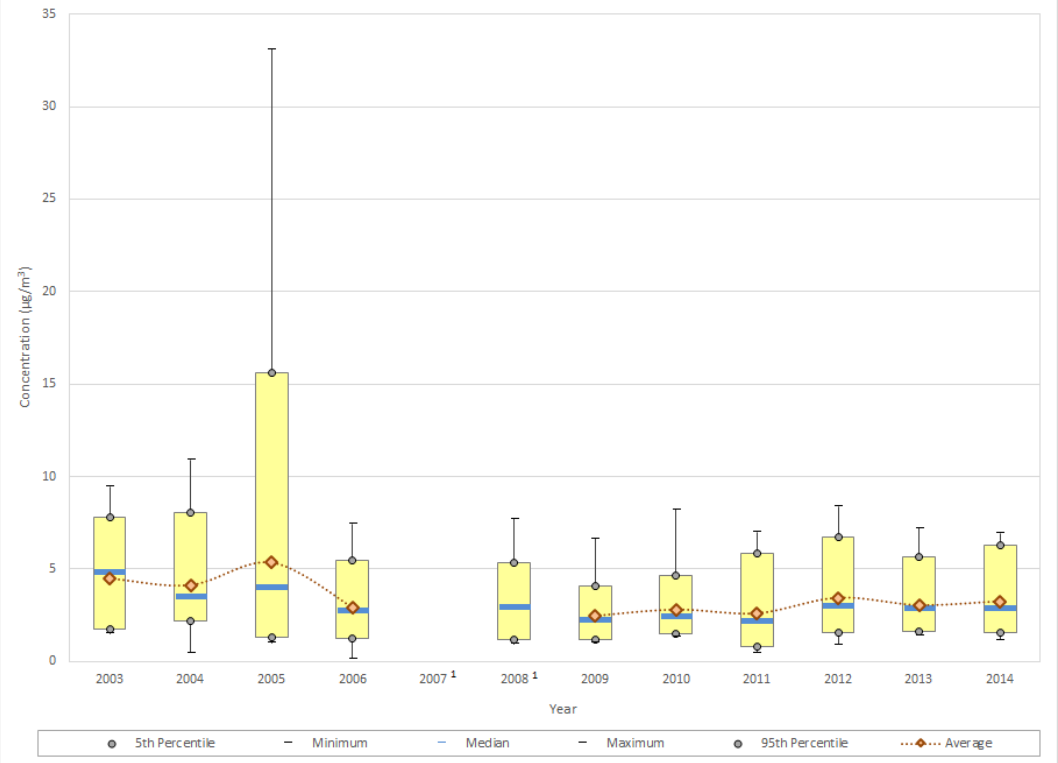
- Although all of the statistical metrics increased (at least slightly) from 2009 to 2010, the 1-year average concentration is being driven by the two highest concentrations

measured in 2010 (both greater than 100 ng/m^3). The next highest concentration measured in 2010 is considerably less (44.8 ng/m^3). If the two highest concentrations were excluded from the calculation, the 1-year average concentration for 2010 would decrease from 12.62 ng/m^3 to 8.40 ng/m^3.

- The 95th percentile increased steadily between 2009 and 2011. The number of concentrations greater than 25 ng/m^3 increased from one to three to seven during this period. There were also seven concentrations greater than 25 ng/m^3 measured in 2012, even though the 95th percentile exhibits a slight decrease.

- All of the statistical parameters exhibit decreases from 2012 to 2013 and again for 2014 (except the minimum concentration, which did not change). Both the 1-year average and median concentrations are at a minimum for 2014. The median concentrations have varied less than 2.25 ng/m^3 over the years, ranging from 4.58 ng/m^3 (2014) to 6.82 ng/m^3 (2010). The 1-year average concentrations exhibit more variability, ranging from 6.93 ng/m^3 (2014) to 12.62 ng/m^3 (2010).

Figure 14-20. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at DEMI



[1] A 1-year average is not presented because data from March 2007 to March 2008 was invalidated.

Observations from Figure 14-20 for formaldehyde concentrations measured at DEMI include the following:

- Recall that carbonyl compounds have been sampled continuously at DEMI under the NMP since 2003 but due to a leak in the sample line, samples collected between March 13, 2007 through March 25, 2008 were invalidated. With only 12 valid samples in 2007, no statistical metrics are provided. Because less than 75 percent of the samples were valid in 2008, a 1-year average concentration is not presented for 2008, although the range of measurements is provided.

- The five highest formaldehyde concentrations measured at DEMI were measured in 2005 and ranged from 13.3 $\mu g/m^3$ to 33.1 $\mu g/m^3$. All nine formaldehyde concentrations greater than 9 $\mu g/m^3$ were measured during the first 3 years of sampling.

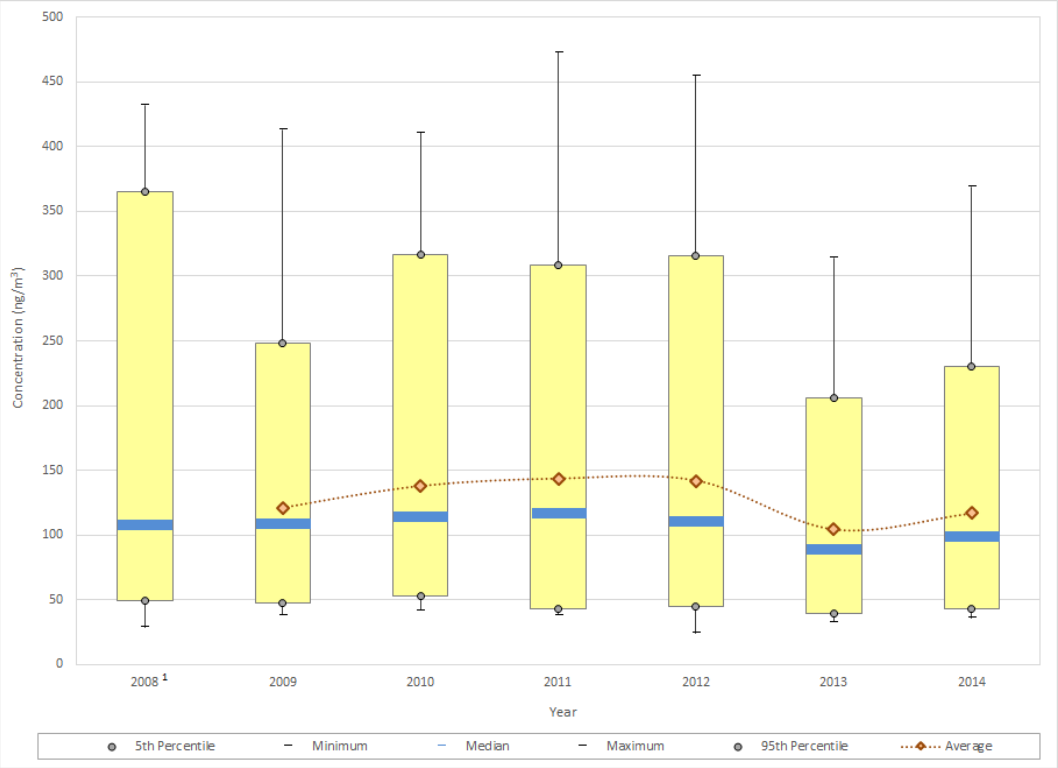
- The decrease in the 1-year average concentration shown between 2005 and 2006 is significant (from 5.35 $\mu g/m^3$ to 2.92 $\mu g/m^3$). The 1-year average concentrations for the years following 2006 (where they could be calculated) did not vary significantly through 2011.

- All of the statistical parameters exhibit increases for 2012. A review of the data shows that the concentrations measured in 2012 were higher in general compared to 2011. For instance, there were seven measurements less than 1 $\mu g/m^3$ in 2011 and only one in 2012. On the higher end of the concentration range, nine concentrations greater than 4 $\mu g/m^3$ were measured in 2011 compared to 21 in 2012.

- While most of the statistical parameters exhibit decreases for 2013, the minimum concentration measured in 2013 is at its highest in 10 years.

- Little change is shown in the statistical parameters for 2014.

Figure 14-21. Yearly Statistical Metrics for Naphthalene Concentrations Measured at DEMI



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 14-21 for naphthalene concentrations measured at DEMI include the following:

- The maximum naphthalene concentration was measured at DEMI in July 2011 (473 ng/m^3); five additional measurements greater than 400 ng/m^3 have been measured at DEMI (at least one in each year except 2013 and 2014).

- With the exception of the maximum concentration, all of the statistical parameters exhibit increases from 2009 to 2010. Little change is shown in the naphthalene concentrations measured at DEMI between 2010 and 2012.

- The smallest range of naphthalene concentrations was measured in 2013, with all of the statistical parameters exhibiting decreases except the minimum concentration. Both the 1-year average and median concentrations are at a minimum for 2013, with the median concentration less than 100 ng/m^3 for the first time.

- Although all of the statistical parameters exhibit increases for 2014, with the exception of the minimum concentration, each is at its second-lowest, behind only 2013.

14.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the Michigan monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

14.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Michigan site and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 14-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations from Table 14-5 include the following:

- Formaldehyde has the highest annual average concentration for DEMI, followed by acetaldehyde, benzene, and carbon tetrachloride.

- These four pollutants also have the highest cancer risk approximations for this site, although the order varies. Formaldehyde's cancer risk approximation is the highest (42.30 in-a-million), with all other cancer risk approximations an order of magnitude lower.

- None of the pollutants of interest for DEMI have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation for DEMI is formaldehyde (0.33).

Table 14-5. Risk Approximations for the Michigan Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Dearborn, Michigan - DEMI						
Acetaldehyde	0.0000022	0.009	61/61	1.85 ± 0.15	4.07	0.21
Benzene	0.0000078	0.03	60/60	0.73 ± 0.10	5.68	0.02
1,3-Butadiene	0.00003	0.002	60/60	0.10 ± 0.02	3.06	0.05
Carbon Tetrachloride	0.000006	0.1	60/60	0.67 ± 0.02	4.04	0.01
1,2-Dichloroethane	0.000026	2.4	56/60	0.07 ± 0.01	1.80	<0.01
Ethylbenzene	0.0000025	1	60/60	0.37 ± 0.09	0.91	<0.01
Formaldehyde	0.000013	0.0098	61/61	3.25 ± 0.35	42.30	0.33
Fluorene[a]	0.000088	--	52/60	6.93 ± 1.76	0.61	--
Naphthalene[a]	0.000034	0.003	60/60	116.80 ± 18.59	3.97	0.04

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

14.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 14-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 14-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 14-6 provides the 10 pollutants of interest with the highest cancer risk approximations (in-a-million) for DEMI, as presented in Table 14-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 14-6. Table 14-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Table 14-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Michigan Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Dearborn, Michigan (Wayne County) - DEMI					
Benzene	524.56	Coke Oven Emissions, PM	8.62E-03	Formaldehyde	42.30
Formaldehyde	438.33	Formaldehyde	5.70E-03	Benzene	5.68
Ethylbenzene	338.52	Benzene	4.09E-03	Acetaldehyde	4.07
Acetaldehyde	254.42	POM, Group 5a	3.22E-03	Carbon Tetrachloride	4.04
1,3-Butadiene	79.05	Hexavalent Chromium	2.53E-03	Naphthalene	3.97
Naphthalene	45.78	1,3-Butadiene	2.37E-03	1,3-Butadiene	3.06
Tetrachloroethylene	30.63	Arsenic, PM	2.06E-03	1,2-Dichloroethane	1.80
Trichloroethylene	17.05	Naphthalene	1.56E-03	Ethylbenzene	0.91
Dichloromethane	10.97	Nickel, PM	9.22E-04	Fluorene	0.61
POM, Group 2b	9.34	Ethylbenzene	8.46E-04		

Table 14-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Michigan Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Dearborn, Michigan (Wayne County) - DEMI					
Hydrochloric acid	3,022.43	Acrolein	1,456,276.15	Formaldehyde	0.33
Toluene	2,046.58	Hydrochloric acid	151,121.26	Acetaldehyde	0.21
Hexane	1,276.18	Formaldehyde	44,727.33	1,3-Butadiene	0.05
Xylenes	1,255.32	1,3-Butadiene	39,523.56	Naphthalene	0.04
Methanol	1,113.64	Arsenic, PM	31,862.61	Benzene	0.02
Benzene	524.56	Acetaldehyde	28,268.80	Carbon Tetrachloride	0.01
Formaldehyde	438.33	Nickel, PM	21,350.40	Ethylbenzene	<0.01
Ethylene glycol	384.08	Manganese, PM	21,158.92	1,2-Dichloroethane	<0.01
Ethylbenzene	338.52	Benzene	17,485.46		
Acetaldehyde	254.42	Naphthalene	15,259.58		

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 14.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 14-6 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Wayne County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Wayne County are coke oven emissions, formaldehyde, and benzene.

- Five of the highest emitted pollutants in Wayne County also have the highest toxicity-weighted emissions.

- Formaldehyde has the highest cancer risk approximation for DEMI. This pollutant also appears on both emissions-based lists, ranking second for both its quantity emitted and its toxicity-weighted emissions. Benzene, naphthalene, 1,3-butadiene, and ethylbenzene are also pollutants of interest that appear on both emissions-based lists.

- Acetaldehyde has the third highest cancer risk approximation for DEMI and is one of the highest emitted pollutants in Wayne County but does not appear among those with the highest toxicity-weighted emissions. This is also true for fluorene, which is included as part of POM, Group 2b in the NEI.

- Carbon tetrachloride and 1,2-dichloroethane, the two remaining pollutants of interest shown in Table 14-6, do not appear on either emissions-based list.

Observations from Table 14-7 include the following:

- Hydrochloric acid, toluene, and hexane are the highest emitted pollutants with noncancer RfCs in Wayne County. Wayne County is one of the few counties with an NMP site where toluene is the not the highest emitted pollutant in the noncancer table. The quantity of emissions for the highest ranking pollutants in Table 14-7 is an order of magnitude higher than the quantity of emissions for the highest ranking pollutants in Table 14-6.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Wayne County are acrolein, hydrochloric acid, and formaldehyde. Although acrolein was sampled for at DEMI, this pollutant was excluded from the pollutants of interest designation and thus, subsequent risk-based 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 Wayne County also have the highest toxicity-weighted emissions.

- Formaldehyde has the highest noncancer hazard approximation for DEMI (although none of the pollutants of interest have associated noncancer hazard approximations greater than 1.0). Formaldehyde emissions rank seventh highest for Wayne County while the toxicity-weighted emissions rank third (among the pollutants with noncancer RfCs). Acetaldehyde and benzene also appear on all three lists for DEMI.

- Several metals appear among the pollutants with the highest toxicity-weighted emissions for Wayne County. (This was also true for the pollutants with cancer UREs in Table 14-6.) Speciated metals were not sampled for under the NMP through the contract laboratory.

14.6 Summary of the 2014 Monitoring Data for DEMI

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

- ❖ *Thirteen pollutants failed screens for DEMI, including two carbonyl compounds, six VOCs, and five PAHs.*

- ❖ *Of the site-specific pollutants of interest, formaldehyde and acetaldehyde had the highest annual average concentrations for DEMI. None of the other site-specific pollutants of interest had annual average concentrations greater than 1 µg/m^3.*

- ❖ *DEMI has the highest annual average concentration of naphthalene among NMP sites sampling PAHs.*

- ❖ *A significant decrease in benzene concentrations occurred at DEMI for many years, although concentrations have leveled off in recent years. Concentrations of acetaldehyde have a slow, steady increasing trend over the last several years of sampling. The detection rate of 1,2-dichloroethane has increased significantly at DEMI during the last few years of sampling.*

- ❖ *Formaldehyde has the highest cancer risk approximation among the pollutants of interest for DEMI. None of the pollutants of interest for DEMI have noncancer hazard approximations greater than an HQ of 1.0.*

15.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

15.1 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 CBSA. Figure 15-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 15-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 15-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 15-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 15-1. St. Louis, Missouri (S4MO) Monitoring Site

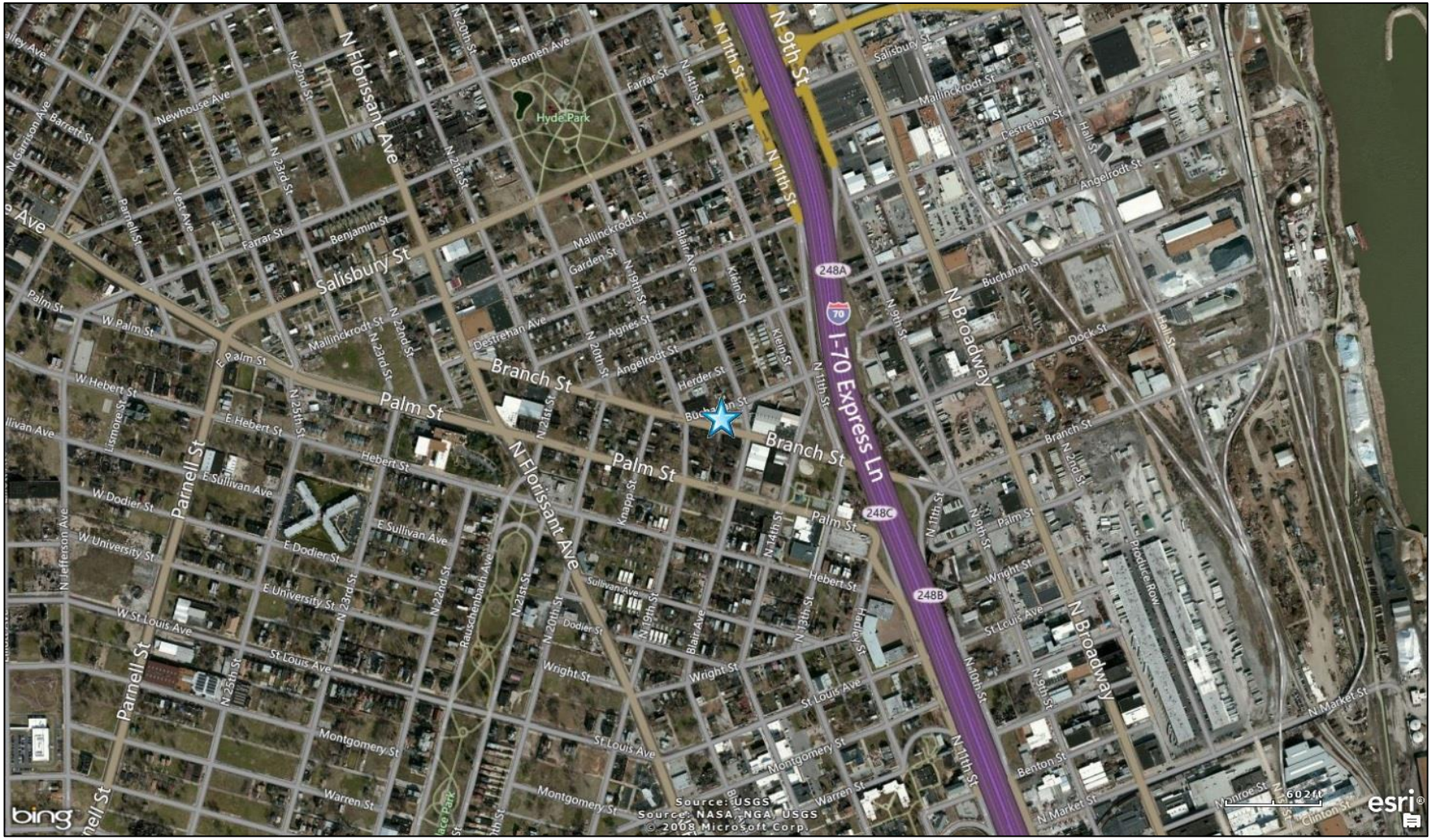


Figure 15-2. NEI Point Sources Located Within 10 Miles of S4MO

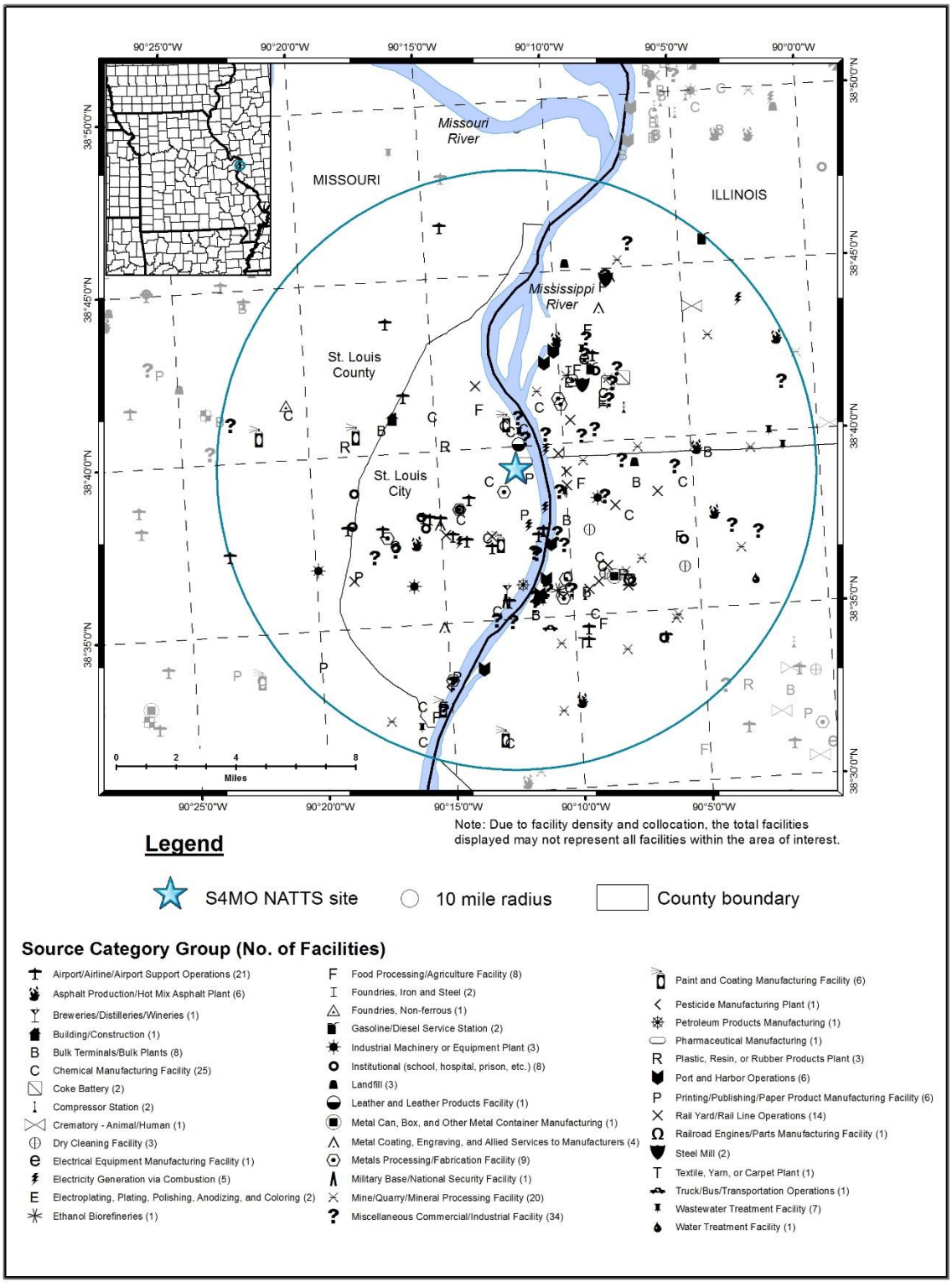


Table 15-1. Geographical Information for the Missouri Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
S4MO	29-510-0085	St. Louis	St. Louis City	St. Louis, MO-IL	38.656498, -90.198646	Residential	Urban/City Center	100,179	I-70 at I-44 split (at bridge)

[1]AADT reflects 2013 data (MO DOT, 2013)
BOLD ITALICS = EPA-designated NATTS Site

S4MO is located in central St. Louis. Figure 15-1 shows that the S4MO monitoring site is located less than one-quarter mile west of I-70. The Mississippi River, which separates Missouri and Illinois, is less than 1 mile east of the site. Although the area directly around the monitoring site is primarily residential, industrial facilities are located nearby, primarily just on the other side of I-70. Figure 15-2 shows that a large number of point sources are located within 10 miles of S4MO, particularly on the east side of the Missouri/Illinois border. The source categories with the greatest number of point sources surrounding S4MO include chemical manufacturing facilities; airport and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; mines, quarries, and mineral processing facilities; and rail yard/rail line operations. Within 1 mile of S4MO are a pharmaceutical manufacturing facility, a printing and publishing facility, a leather products facility, a metals processing/fabrication facility, and a chemical manufacturing facility.

In addition to providing city, county, CBSA, and land use/location setting information, Table 15-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near S4MO is just greater than 100,000 and ranks 11th highest among other NMP sites, which falls in the upper third of the range compared to other NMP sites. The traffic estimate provided is for I-70 near the split with I-44 (at the bridge).

15.2 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 the year.

15.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2.

For the Missouri site, site-specific data were available for some, but not all, of the parameters in Table 15-2. For S4MO, temperature, pressure, humidity, and wind information was available in AQS. Data from the NWS weather station at St. Louis Downtown Airport (WBAN 03960) were used for the remaining parameters (sea level pressure and dew point temperature). The St. Louis Downtown Airport weather station is located 6.3 miles south-southeast of S4MO. A map showing the distance between the monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 15-2. Average Meteorological Conditions near the Missouri Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
St. Louis, Missouri - S4MO [2]							
Sample Days (61)	54.9 ± 1.1	41.9 ± 1.1	65.8 ± 0.9	30.08 ± 0.01	29.55 ± 0.01	SE	3.1 ± 0.1
2014	56.1 ± 0.5	43.5 ± 0.4	67.4 ± 0.4	30.04 ± <0.01	29.51 ± <0.01	SE	3.2 ± <0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure, and wind parameters were measured at S4MO. The remaining information was obtained from the closest NWS weather station located at St. Louis Downtown Airport, WBAN 03960.

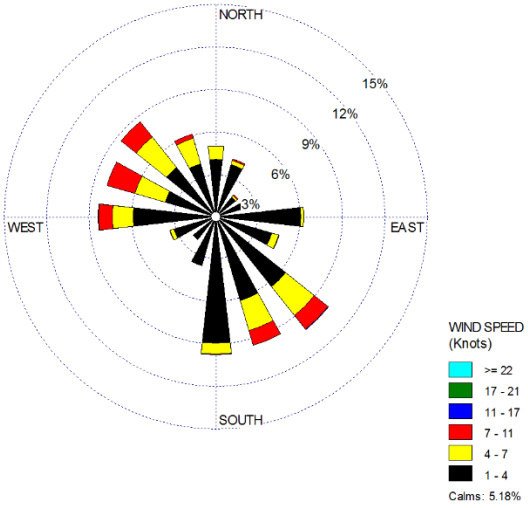
Table 15-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 15-2 is the 95 percent confidence interval for each parameter. Average meteorological conditions on sample days at S4MO were fairly representative of average weather conditions experienced throughout the year. The difference between the full-year averages and sample day averages is largest for relative humidity and dew point temperature, as shown in Table 15-2.

15.2.2 Wind Rose Comparison

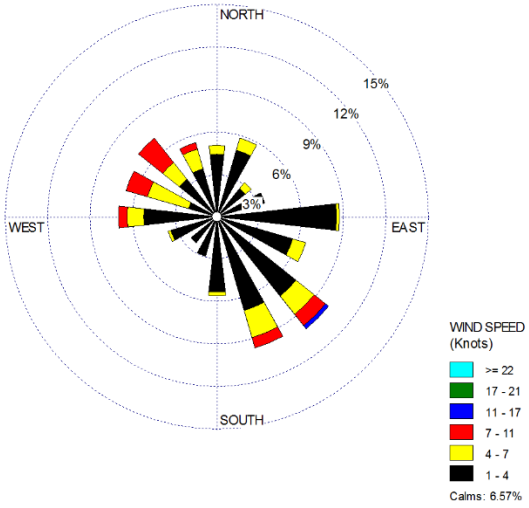
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 15-3 presents two wind roses for the S4MO monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 15-3. Wind Roses for the Wind Data Collected at S4MO

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 15-3 for S4MO include the following:

- The full-year wind rose shows that winds from the southeast to south and west to northwest were frequently observed at S4MO, with prevailing winds from the southeast. Winds from these directions account for more than 50 percent of observations. North-northwesterly winds and easterly winds are the only other winds accounting for at least 6 percent of observations. Calm winds were observed for approximately 5 percent of the hourly wind measurements. Wind speeds greater than 11 knots were rarely observed, but were out of the southeast or west when they were measured.

- The wind patterns on the sample day wind rose mostly resemble the wind patterns on the full-year wind rose, although there are a few differences. Fewer winds from the south and northwest quadrant, including west, were observed on sample days while winds from the north-northeast, east, and east-southeast were observed more frequently. The calm rate was slightly higher on sample days.

15.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the S4MO monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 15-3. 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 and are shaded in gray in Table 15-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, PAHs, carbonyl compounds, metals (PM_{10}), and hexavalent chromium were sampled for at S4MO. Hexavalent chromium sampling at S4MO was discontinued after July 4, 2014.

Table 15-3. Risk-Based Screening Results for the Missouri Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Louis, Missouri - S4MO						
Acetaldehyde	0.45	60	60	100.00	10.70	10.70
Formaldehyde	0.077	60	60	100.00	10.70	21.39
Benzene	0.13	59	59	100.00	10.52	31.91
Carbon Tetrachloride	0.17	59	59	100.00	10.52	42.42
1,2-Dichloroethane	0.038	58	58	100.00	10.34	52.76
Arsenic (PM_{10})	0.00023	57	61	93.44	10.16	62.92
1,3-Butadiene	0.03	57	58	98.28	10.16	73.08
Naphthalene	0.029	49	57	85.96	8.73	81.82
p-Dichlorobenzene	0.091	24	45	53.33	4.28	86.10
Acenaphthene	0.011	12	57	21.05	2.14	88.24
Cadmium (PM_{10})	0.00056	12	61	19.67	2.14	90.37
Fluorene	0.011	11	53	20.75	1.96	92.34
Hexachloro-1,3-butadiene	0.045	11	12	91.67	1.96	94.30
Ethylbenzene	0.4	8	59	13.56	1.43	95.72
Lead (PM_{10})	0.015	6	61	9.84	1.07	96.79
Manganese (PM_{10})	0.03	4	61	6.56	0.71	97.50
Nickel (PM_{10})	0.0021	4	60	6.67	0.71	98.22
Benzo(a)pyrene	0.00057	3	56	5.36	0.53	98.75
1,2-Dibromoethane	0.0017	2	2	100.00	0.36	99.11
Hexavalent Chromium	0.000083	2	25	8.00	0.36	99.47
Acenaphthylene	0.011	1	32	3.13	0.18	99.64
Antimony (PM_{10})	0.02	1	61	1.64	0.18	99.82
Propionaldehyde	0.8	1	60	1.67	0.18	100.00
Total		561	1,177	47.66		

Observations from Table 15-3 include the following:

- Concentrations of 23 pollutants failed at least one screen for S4MO; approximately 48 percent of concentrations for these 23 pollutants were greater than their associated risk screening value (or failed screens). S4MO has the highest number of individual pollutants failing screens.

- S4MO failed the second highest number of screens (561) among all NMP sites, behind only PXSS (refer to Table 4-8 of Section 4.2). Yet, the failure rate for S4MO, when incorporating all pollutants with screening values, is approximately 22 percent. This is due primarily to the relatively large number of pollutants sampled for at this site, as discussed in Section 4.2.

- Fourteen pollutants contributed to 95 percent of failed screens for S4MO and therefore were identified as pollutants of interest for this site. These 14 pollutants include two carbonyl compounds, seven VOCs, two PM_{10} metals, and three PAHs. S4MO has the greatest number of pollutants of interest among NMP sites.

- Acetaldehyde, formaldehyde, benzene, carbon tetrachloride, and 1,2-dichloroethane failed 100 percent of screens for S4MO and were detected in all or nearly all the samples collected. 1,2-Dibromoethane also failed 100 percent of screens but was detected in only two VOC samples collected and is not a pollutant of interest for S4MO.

- Cadmium was identified as a pollutant of interest for only two NMP sites sampling metals: S4MO and ASKY-M.

15.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Missouri monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at S4MO are provided in Appendices J, L, M, N, and O.

15.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for the Missouri site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted

zeros for non-detects for the entire year of sampling. Annual averages were calculated for pollutants where at least three valid quarterly averages could be calculated and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for S4MO are presented in Table 15-4, where applicable. Note that concentrations of the PAHs and metals are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 15-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Missouri Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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	60/60	60	2.38 ± 0.48	2.71 ± 0.47	1.88 ± 0.30	1.42 ± 0.31	2.08 ± 0.22
Benzene	59/59	59	0.80 ± 0.16	0.46 ± 0.06	0.81 ± 0.16	0.75 ± 0.13	0.71 ± 0.07
1,3-Butadiene	58/58	59	0.09 ± 0.03	0.05 ± 0.01	0.12 ± 0.03	0.11 ± 0.03	0.09 ± 0.02
Carbon Tetrachloride	59/59	59	0.59 ± 0.07	0.65 ± 0.03	0.65 ± 0.03	0.60 ± 0.06	0.62 ± 0.02
p-Dichlorobenzene	45/25	59	0.10 ± 0.09	0.09 ± 0.07	0.17 ± 0.05	0.15 ± 0.14	0.13 ± 0.05
1,2-Dichloroethane	58/58	59	0.08 ± 0.02	0.07 ± 0.01	0.08 ± 0.01	0.09 ± 0.01	0.08 ± 0.01
Ethylbenzene	59/59	59	0.21 ± 0.08	0.15 ± 0.04	0.32 ± 0.07	0.24 ± 0.07	0.23 ± 0.04
Formaldehyde	60/60	60	2.89 ± 0.49	5.13 ± 0.96	4.19 ± 1.02	1.83 ± 0.34	3.45 ± 0.48
Hexachloro-1,3-butadiene	12/0	59	0.02 ± 0.02	0.01 ± 0.01	0.03 ± 0.02	0.01 ± 0.02	0.02 ± 0.01
Acenaphthene[a]	57/56	57	1.75 ± 0.67	NA	12.55 ± 2.72	3.86 ± 2.06	6.43 ± 1.56
Arsenic (PM_{10})[a]	61/58	61	0.71 ± 0.27	0.68 ± 0.20	1.29 ± 0.39	0.93 ± 0.26	0.90 ± 0.15
Cadmium (PM_{10})[a]	61/61	61	0.31 ± 0.12	0.54 ± 0.32	0.33 ± 0.12	0.16 ± 0.05	0.33 ± 0.09
Fluorene[a]	53/53	57	2.47 ± 1.05	NA	12.10 ± 2.41	4.22 ± 1.64	6.65 ± 1.38
Naphthalene[a]	57/57	57	62.17 ± 22.87	NA	109.13 ± 26.39	79.80 ± 23.88	81.79 ± 12.61

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.
NA = Not available due to the criteria for calculating a quarterly and/or annual average.

Observations for S4MO from Table 15-4 include the following:

- The pollutants with the highest annual average concentrations are formaldehyde (3.45 ± 0.48 µg/m^3) and acetaldehyde (2.08 ± 0.22 µg/m^3). These are the only pollutants of interest with annual averages greater than 1 µg/m^3.

- Concentrations of formaldehyde measured at S4MO range from 0.715 µg/m^3 to 9.02 µg/m^3. The quarterly average concentrations of formaldehyde vary considerably, with the second quarter average nearly three times greater than the fourth quarter average, and two of the four have relatively large confidence intervals. Formaldehyde concentrations less than 2 µg/m^3 were not measured at S4MO during the second or third quarters while 10 were measured during the fourth quarter (and two were measured at S4MO during the first quarter). At the higher end of the concentration range, formaldehyde concentrations greater than 5 µg/m^3 were not measured at S4MO during the first or fourth quarters of the year while 11 were measured during the second and third quarters (seven during the second and four during the third).

- Concentrations of acetaldehyde measured during the second half of the year appear lower than those measured during the first half of the year, based on the quarterly average concentrations shown. A review of the data shows that nine acetaldehyde concentrations greater than 3 µg/m^3 were measured during the first half of 2014 compared to only 1 during the second half. At the other end of the concentration range, only one acetaldehyde concentration less than 1 µg/m^3 was measured during the first half of 2014 compared to six during the second half of the year.

- The second quarter average concentration of benzene is significantly less than the quarterly averages shown for the remaining quarterly averages. Concentrations of benzene measured at S4MO in 2014 range from 0.307 µg/m^3 to 1.47 µg/m^3. None of the nine benzene concentrations greater than or equal to 1 µg/m^3 were measured during the second quarter while three were measured during each of the other calendar quarters. In addition, the number of benzene concentrations less than 0.5 µg/m^3 measured at S4MO during the second quarter (8) is greater than the number measured throughout the rest of the year combined (5), with no more than two in any of the other calendar quarters.

- Concentrations of 1,3-butadiene follow a similar pattern as benzene in that the second quarter average is significantly lower than the other quarterly averages. A review of the data shows that none of the 18 1,3-butadiene concentrations greater than 0.1 µg/m^3 were measured during the second quarter of 2014, and were predominantly measured during the second half of the year (three were measured during the first quarter, eight during the third, and seven during the fourth). The number of concentrations measured each quarter that are greater than the maximum concentration measured during the second quarter (0.0709 µg/m^3) ranged from seven (first quarter) to 12 (third quarter). The one non-detect of 1,3-butadiene was measured at S4MO in April.

- The quarterly average concentrations of *p*-dichlorobenzene for the second half of 2014 are higher than those for the first half of the year, although the confidence intervals shown are relatively large, particularly for the fourth quarter of 2014.

Concentrations of *p*-dichlorobenzene measured at S4MO range from 0.0361 µg/m^3 to 1.14 µg/m^3 and include 14 non-detects. The maximum *p*-dichlorobenzene concentration measured at S4MO was measured in October and is the highest *p*-dichlorobenzene concentration measured across the program. The second highest *p*-dichlorobenzene concentration measured at S4MO was measured in March and is half as high. At least one non-detect was measured during each calendar quarter, although the number varies across the quarters (six during the first quarter, three during the second, one during the third, and four during the fourth).

- Concentrations of arsenic also appear higher during the second half of the year at S4MO, particularly the third quarter of 2014. A review of the data shows that arsenic concentrations measured at S4MO range from 0.133 ng/m^3 to 2.96 ng/m^3. Of the 23 arsenic concentrations greater than 1 ng/m^3 measured at S4MO, 17 were measured after July 1, including all three greater than 2 ng/m^3.

- The quarterly averages of cadmium exhibit considerably variability, with the second quarter average concentration more than three times greater than the fourth quarter average concentration. Concentrations of cadmium measured at S4MO span two orders of magnitude, ranging from 0.02 ng/m^3 to 1.98 ng/m^3. The second and fourth highest concentrations of cadmium across the program were both measured at S4MO in April. S4MO is one of only four NMP sites where cadmium concentrations greater than 1 ng/m^3 were measured. The maximum cadmium concentration measured during the fourth quarter is 0.305 ng/m^3; at least six cadmium concentrations greater than 0.305 ng/m^3 were measured during each of the other calendar quarters.

- Naphthalene has the highest annual average concentration among the PAHs identified as pollutants of interest for S4MO.

- Laboratory instrument issues combined with sampler issues at the site resulted in too many invalid samples for a quarterly average concentration to be calculated for the second quarter of 2014 for the PAHs.

- The quarterly average concentrations of naphthalene are highly variable, with the third quarter average more than twice the first quarter average, and each of the confidence intervals is relatively large. This indicates that the concentrations of naphthalene measured at S4MO exhibit considerable variability. Concentrations of naphthalene measured at S4MO range from 0.78 ng/m^3 to 214 ng/m^3. The minimum concentration measured at S4MO is the lowest naphthalene concentration measured at an NMP in 2014. It is the only measurement less than 7 ng/m^3 at a non-rural monitoring site and the only one less than 2 ng/m^3 at any NMP site sampling this pollutant. By comparison, the next lowest naphthalene concentration measured at S4MO is 18.55 ng/m^3. The number of naphthalene concentrations greater than 100 ng/m^3 measured at S4MO is greatest for the third quarter (nine) and two to three times greater than the number measured during each of the other calendar quarters (between three and five were measured during each). Conversely, the number of naphthalene concentrations less than 50 ng/m^3 is greatest for the first quarter (eight) and lowest for the third quarter (one), with the number for the remaining calendar quarters falling in-between.

- Concentrations of acenaphthene and fluorene appear to be highest during the third quarter, based on the available quarterly average concentrations, although each of the quarterly averages exhibits a considerable level of variability. A review of the data shows that the seven highest concentrations of each pollutant were measured on the same days at S4MO (although the exact order varies). Most of these days are in the third quarter. For example, of the 17 concentrations of acenaphthene greater than 10 ng/m^3, 11 were measured between July and September (with the others measured in May, June, or October). Conversely, all eight acenaphthene concentrations less than 1 ng/m^3 were measured during the colder months of the year (January, February November or December). Of the 15 fluorene concentrations greater than 10 ng/m^3, 10 were measured between July and September (with the others measured in May, June, or October). Conversely, all seven fluorene measurements less than 2 ng/m^3 were also measured during the colder months of the year (January, February November or December).

Tables 4-9 through 4-12 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for S4MO from those tables include the following:

- S4MO appears in Tables 4-9 through 4-12 a total of seven times, appearing in each table at least once.

- S4MO has the third highest annual average concentration of *p*-dichlorobenzene and the 10th highest annual average concentration of 1,2-dichloroethane among NMP sites sampling VOCs, as shown in Table 4-9.

- S4MO appears in Table 4-10 for both formaldehyde and acetaldehyde, ranking eighth and sixth, respectively, among NMP sites sampling carbonyl compounds.

- S4MO's annual average concentration of naphthalene ranks sixth highest among NMP sites sampling PAHs.

- S4MO has the second highest annual average concentration of arsenic and the seventh highest annual average concentration of nickel among NMP sites sampling PM_{10} metals.

15.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 15-4 for S4MO. Figures 15-4 through 15-17 overlay the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 15-4. Program vs. Site-Specific Average Acenaphthene Concentration

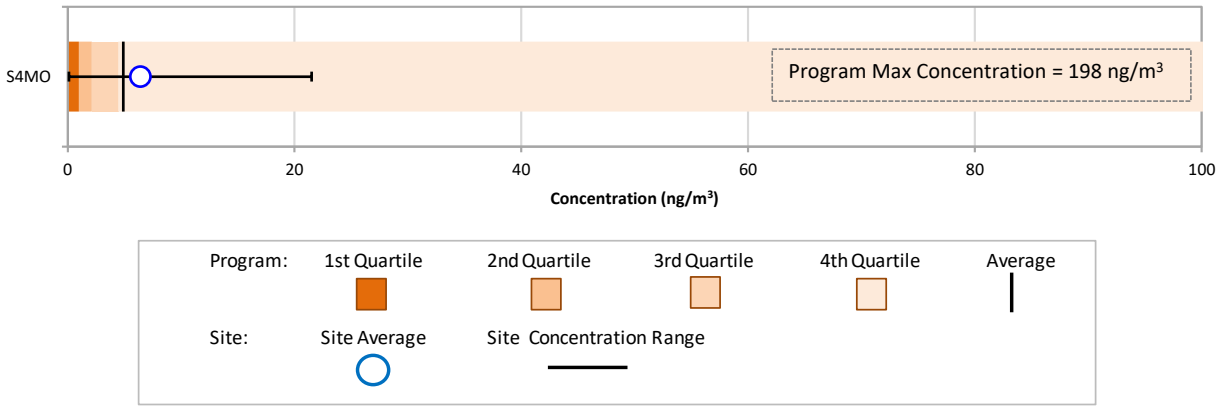


Figure 15-4 presents the box plot for acenaphthene for S4MO and shows the following:

- The program-level maximum acenaphthene concentration (198 ng/m^3) is not shown directly on the box plot in Figure 15-4 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced. Note that the program-level average concentration is being influenced by the measurements at the higher end of the concentration range, as the program-level average concentration is greater than the program-level third quartile.

- The maximum acenaphthene concentration measured at S4MO is considerably less than the maximum acenaphthene concentration measured across the program. Yet, the annual average acenaphthene concentration for this site is greater than the program-level average concentration.

- There were no non-detects of acenaphthene measured at S4MO while non-detects account for 6 percent of the measurements at the program level.

Figure 15-5. Program vs. Site-Specific Average Acetaldehyde Concentration

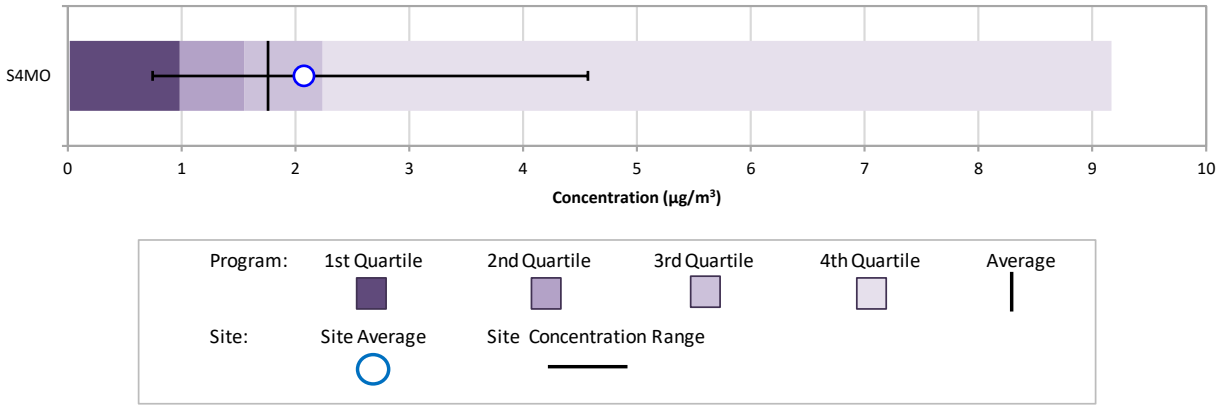


Figure 15-5 presents the box plot for acetaldehyde for S4MO and shows the following:

- The maximum acetaldehyde concentration measured at S4MO is roughly half the maximum concentration measured across the program.

- The annual average concentration of acetaldehyde for S4MO is greater than the program-level average concentration (1.76 µg/m^3) and less than the program-level third quartile.

Figure 15-6. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

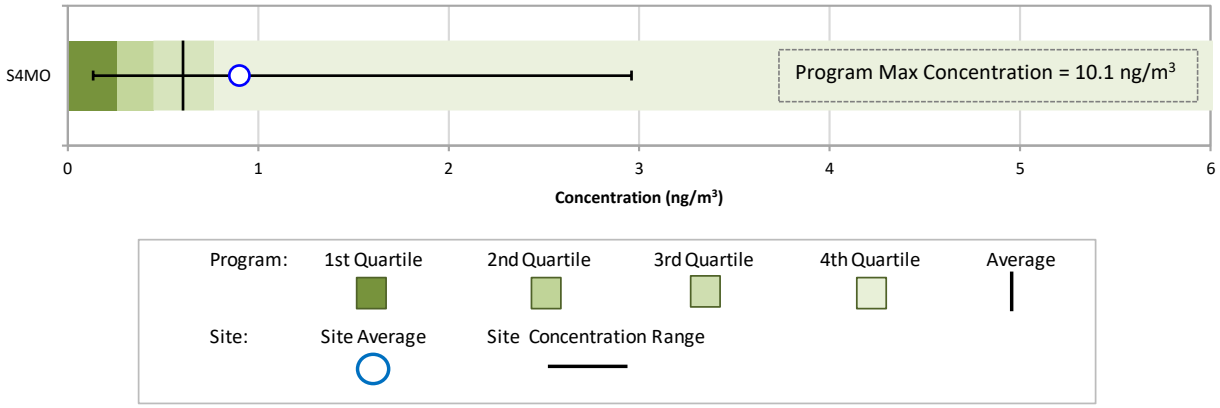


Figure 15-6 presents the box plot for arsenic (PM_{10}) for S4MO and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 15-6 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The maximum arsenic (PM_{10}) concentration measured at S4MO is about one-third the maximum concentration measured across the program. Yet, S4MO's annual average arsenic (PM_{10}) concentration is greater than both the program-level average concentration and third quartile. Recall from the previous section that this site has the second highest annual average arsenic concentration among NMP sites sampling

PM_{10} metals. S4MO has the highest number of arsenic concentrations greater than or equal to 1 ng/m^3 among all NMP sites sampling arsenic (23).

Figure 15-7. Program vs. Site-Specific Average Benzene Concentration

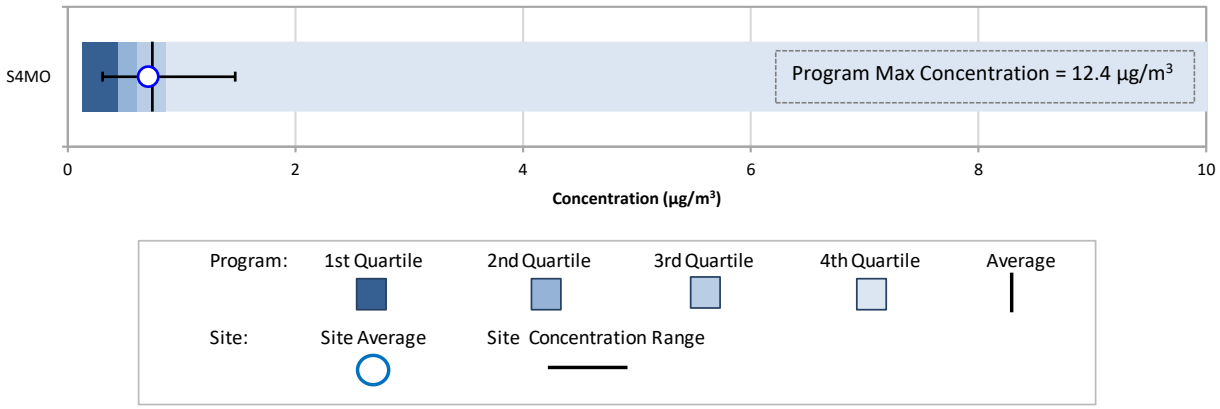


Figure 15-7 presents the box plot for benzene for S4MO and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plot in Figure 15-7 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The range of benzene concentrations measured at S4MO is relatively small compared to the range measured at the program-level. In fact, the range of benzene concentrations for S4MO is among the smallest compared to other NMP sites sampling benzene with Method TO-15.

- The annual average benzene concentration for S4MO is less than the program-level average concentration but greater than the program-level median concentration.

Figure 15-8. Program vs. Site-Specific Average 1,3-Butadiene Concentration

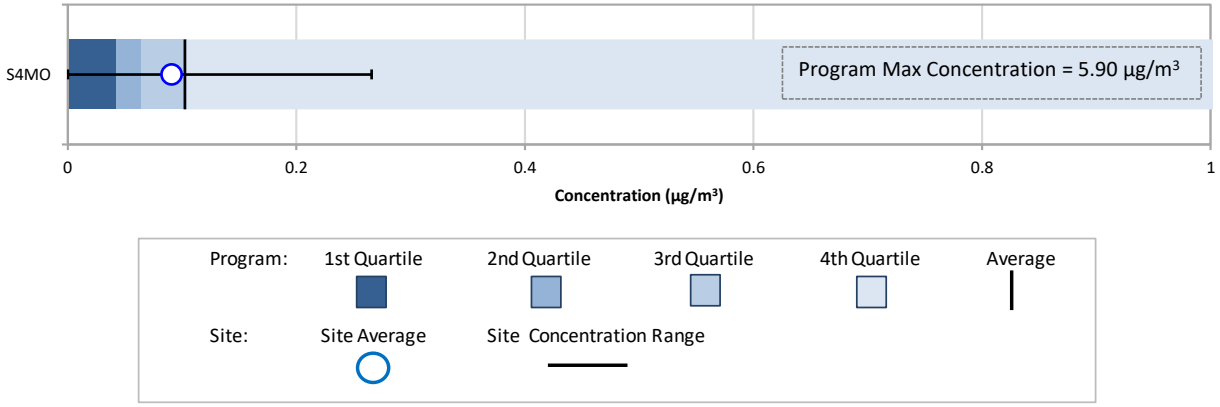


Figure 15-8 presents the box plot for 1,3-butadiene for S4MO and shows the following:

- Similar to other pollutants, the program-level maximum 1,3-butadiene concentration (5.905 µg/m^3) is not shown directly on the box plot as the scale has been reduced in to allow for the observation of data points at the lower end of the concentration range.

- The range of 1,3-butadiene concentrations measured at S4MO spans less than 0.3 µg/m^3 and includes a single non-detect.

- The annual average 1,3-butadiene concentration for S4MO is just less than the program-level average concentration.

Figure 15-9. Program vs. Site-Specific Average Cadmium (PM_{10}) Concentration

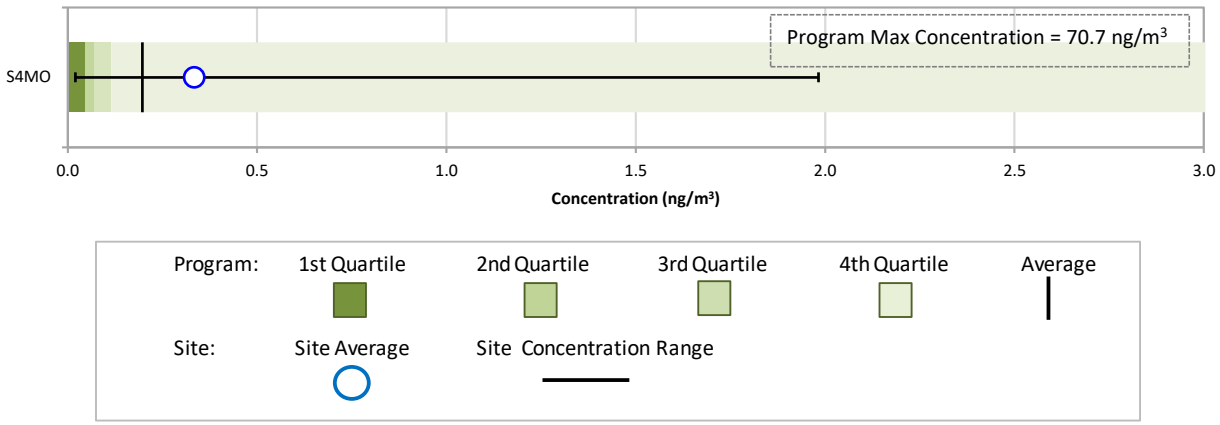


Figure 15-9 presents the box plot for cadmium (PM_{10}) for S4MO and shows the following:

- The program-level maximum cadmium concentration (70.7 ng/m^3) is not shown directly on the box plot in Figure 15-9 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced. Note that the second highest cadmium concentration measured across the program is the maximum cadmium concentration measured at S4MO (1.98 ng/m^3).

- The program-level average cadmium concentration is being driven by the outlier concentration measured at another site. The program-level average is higher than the program-level third quartile.

- S4MO's annual average cadmium (PM_{10}) concentration is greater than the program-level average concentration and is nearly three times greater than the program-level third quartile. S4MO has the highest number of cadmium concentrations greater than 0.5 ng/m^3 among all NMP sites sampling this pollutant (12, with the next highest site at five).

Figure 15-10. Program vs. Site-Specific Average Carbon Tetrachloride Concentration

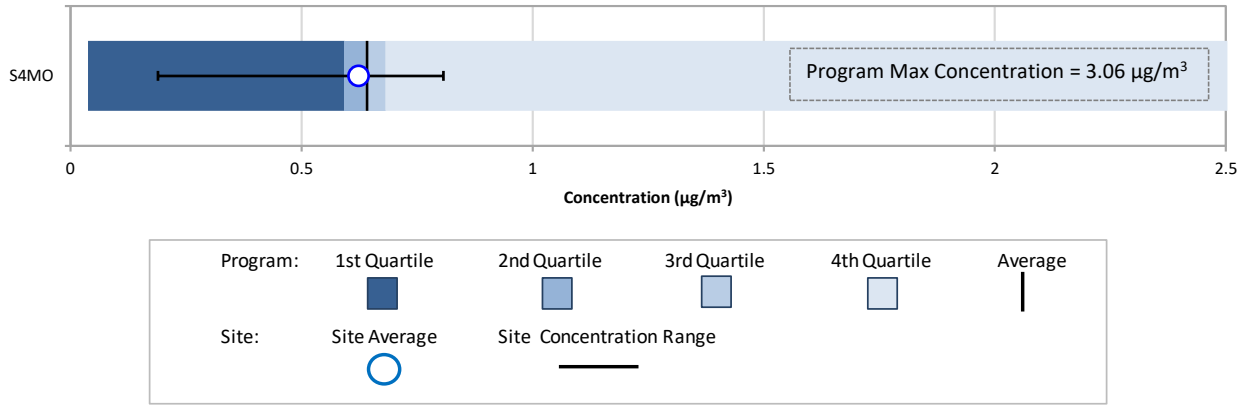


Figure 15-10 presents the box plot for carbon tetrachloride for S4MO and shows the following:

- The scale of the box plot in Figure 15-10 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- The majority of carbon tetrachloride concentrations measured at S4MO fall between 0.45 µg/m^3 and 0.75 µg/m^3; however, the minimum concentration measured at S4MO (0.189 µg/m^3) is among the lower carbon tetrachloride concentrations measured among NMP sites sampling this pollutant.

- The annual average concentration of carbon tetrachloride for S4MO is just less than both the program-level median and average concentrations, although less than 0.01 µg/m^3 separates these two parameters.

Figure 15-11. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentration

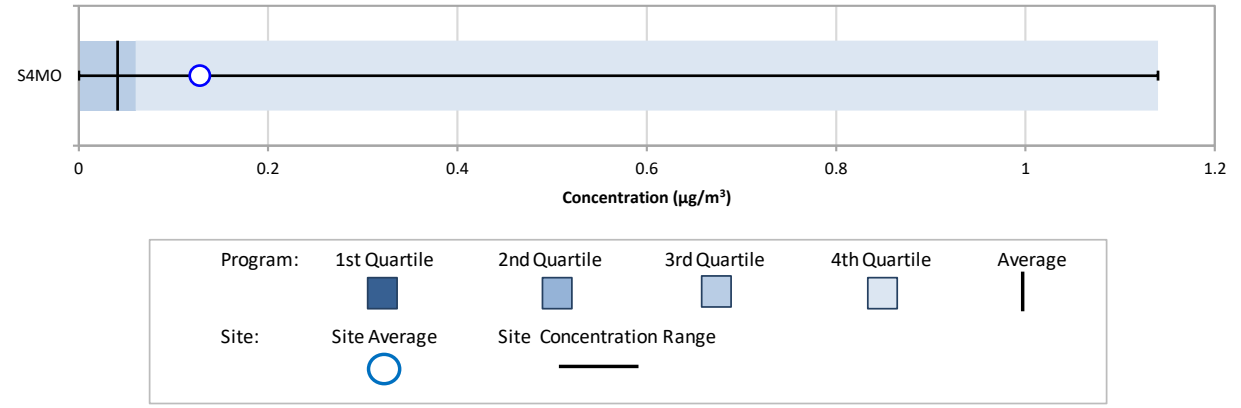


Figure 15-11 presents the box plot for *p*-dichlorobenzene for S4MO and shows the following:

- The first and second quartiles for *p*-dichlorobenzene are zero and therefore not visible on the graph due to the large number of non-detects for this pollutant (more than 50 percent of the measurements are non-detects for *p*-dichlorobenzene). Fourteen non-detects were measured at S4MO.

- The maximum *p*-dichloromethane concentration measured across the program was measured at S4MO (1.14 µg/m^3) and is one of only two *p*-dichlorobenzene concentrations greater than 1 µg/m^3 measured in 2014. Concentrations measured at S4MO account for three of the five highest *p*-dichlorobenzene concentrations measured in 2014. Recall from the previous section that this site has the third highest annual average concentration of *p*-dichlorobenzene among NMP sites sampling VOCs.

- S4MO is one of only three NMP sites with an annual average concentration of this pollutant greater than 0.1 µg/m^3. S4MO's annual average concentration is more than three times greater than the program-level average concentration.

Figure 15-12. Program vs. Site-Specific Average 1,2-Dichloroethane Concentration

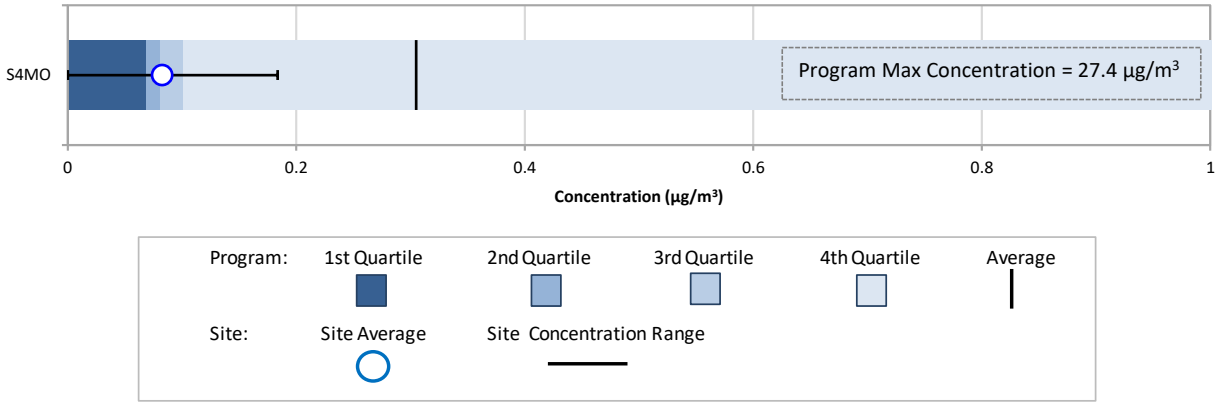


Figure 15-12 presents the box plot for 1,2-dichloroethane for S4MO and shows the following:

- The scale of the box plot in Figure 15-12 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- All the concentrations of 1,2-dichloroethane measured at S4MO are less than the program-level average concentration of 0.31 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- The annual average concentration for S4MO is similar to the program-level median concentration (0.081 µg/m^3).

Figure 15-13. Program vs. Site-Specific Average Ethylbenzene Concentration

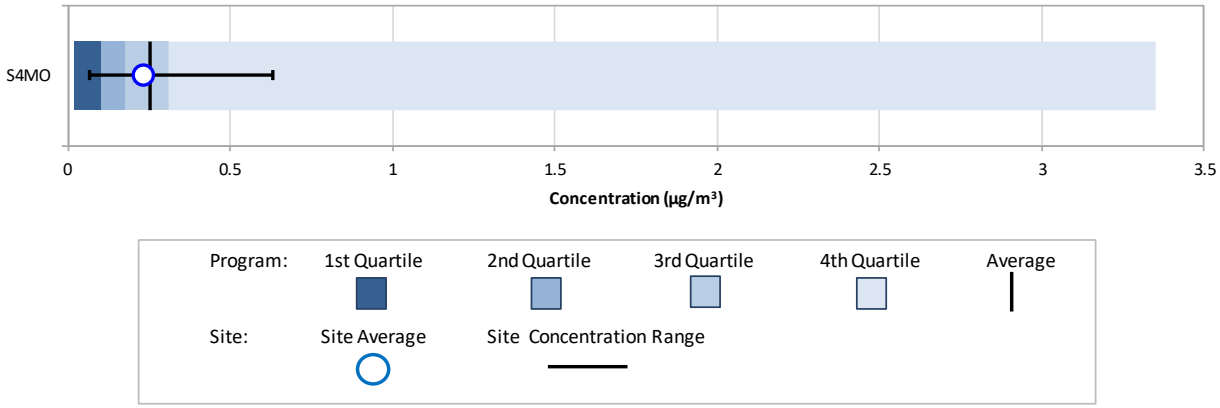


Figure 15-13 presents the box plot for ethylbenzene for S4MO and shows the following:

- The maximum ethylbenzene concentration measured at S4MO is roughly one-fifth the maximum concentration measured across the program.

- The annual average concentration of ethylbenzene for S4MO is just less than the program-level average concentration.

Figure 15-14. Program vs. Site-Specific Average Fluorene Concentration

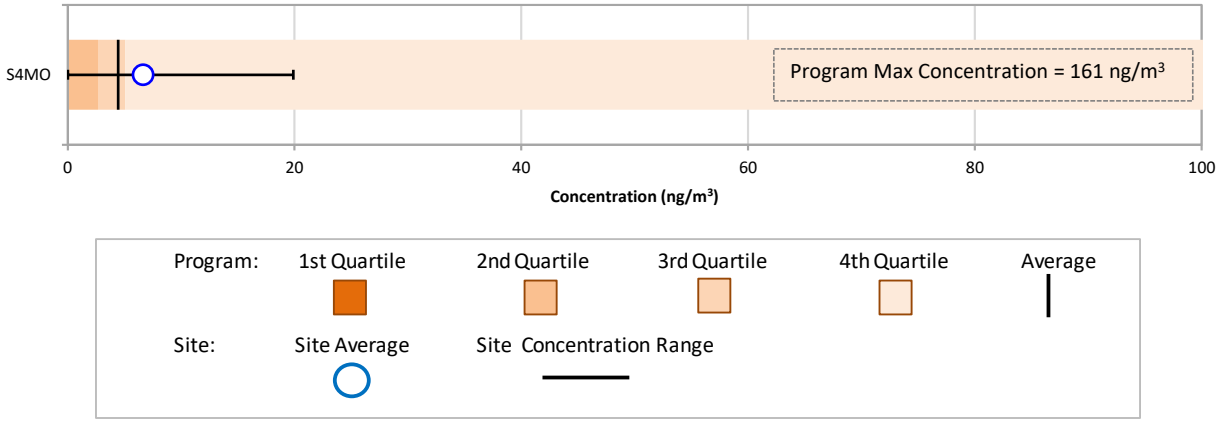


Figure 15-14 presents the box plot for fluorene for S4MO and shows the following:

- Similar to the box plot for acenaphthene, the program-level maximum fluorene concentration (161 ng/m^3) is not shown directly on the box plot in Figure 15-14 as the scale of the box plot has been reduced. Note that the first quartile is zero and therefore not visible on the graph for fluorene due to the number of non-detects.

- The maximum fluorene concentration measured at S4MO is considerably less than the maximum fluorene concentration measured across the program. Yet, the annual average fluorene concentration for this site is greater than both the program-level average concentration and third quartile.

- Four non-detects of fluorene were measured at S4MO while non-detects account for more than 25 percent of the measurements at the program-level.

Figure 15-15. Program vs. Site-Specific Average Formaldehyde Concentration

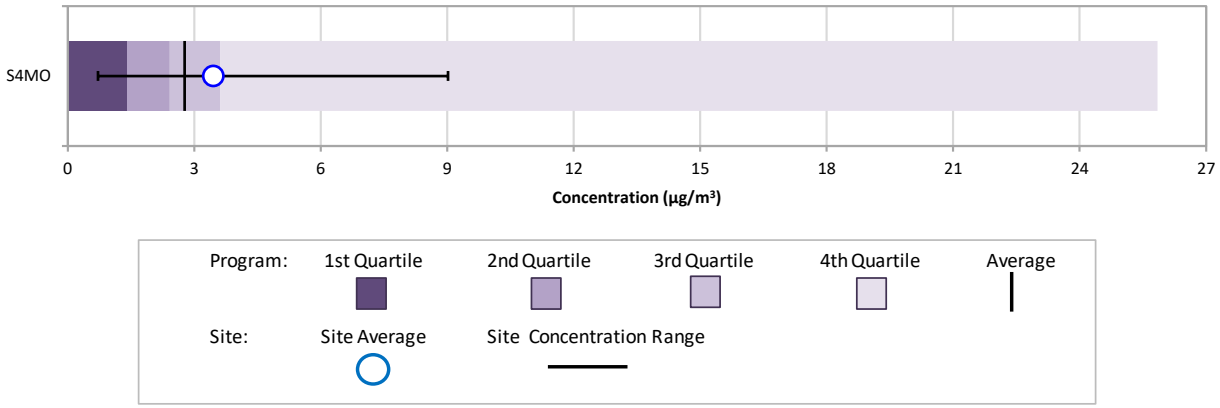


Figure 15-15 presents the box plot for formaldehyde for S4MO and shows the following:

- The maximum formaldehyde concentration measured at S4MO is roughly one-third the maximum concentration measured across the program.

- The annual average concentration for S4MO is greater than the program-level average concentration and just less than the program-level third quartile. Recall from the previous section that S4MO's annual average concentration ranks sixth highest among NMP sites sampling formaldehyde.

Figure 15-16. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentration

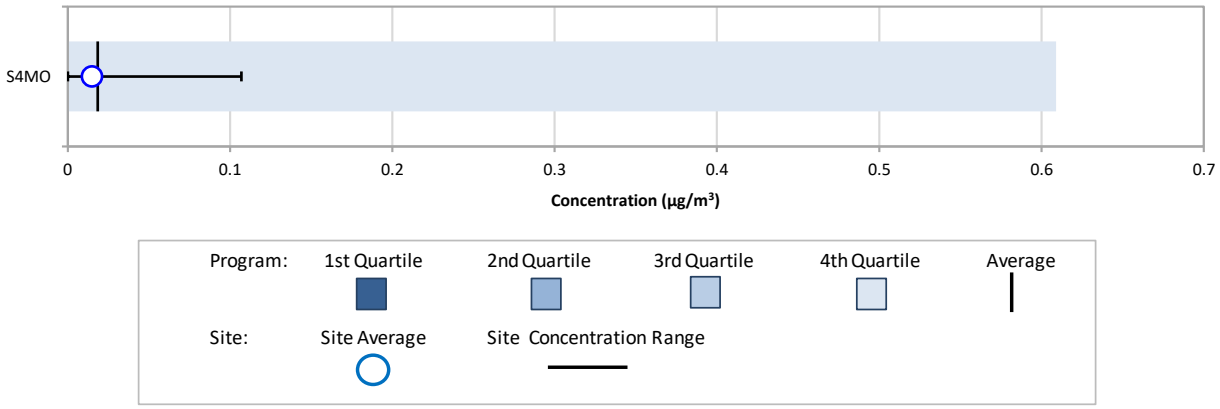


Figure 15-16 presents the box plot for hexachloro-1,3-butadiene for S4MO and shows the following:

- The first, second, and third quartiles for this pollutant are zero and thus, not visible on the box plot, due to the large number of non-detects (more than 76 percent of the measurements are non-detects for hexachloro-1,3-butadiene). Forty-seven non-detects were measured at S4MO, accounting for nearly 80 percent of the sample collected.

- The maximum concentration measured at S4MO is about one-sixth the program-level maximum concentration.

- The annual average concentration of hexachloro-1,3-butadiene for S4MO is just slightly less than the program-level average concentration, although most of the site-specific annual average concentrations of this pollutant vary little.

Figure 15-17. Program vs. Site-Specific Average Naphthalene Concentration

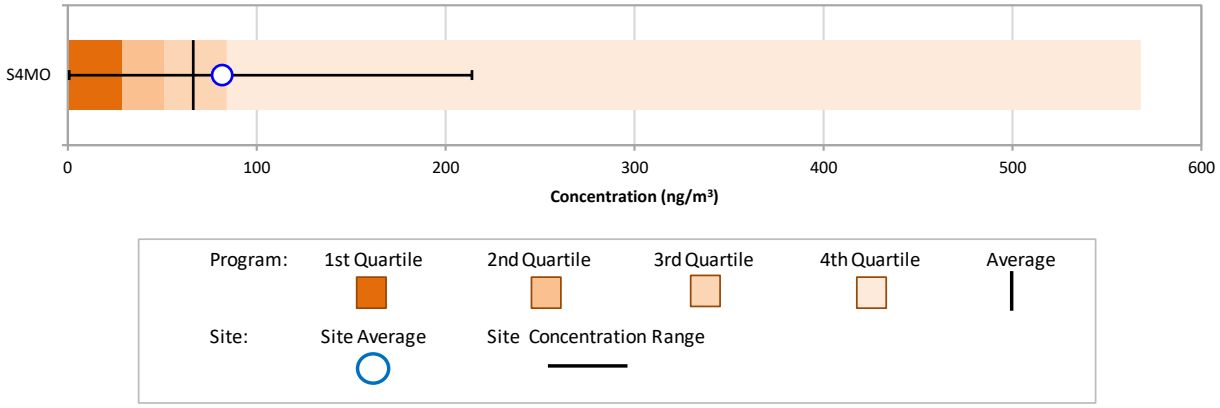


Figure 15-17 presents the box plot for naphthalene for S4MO and shows the following:

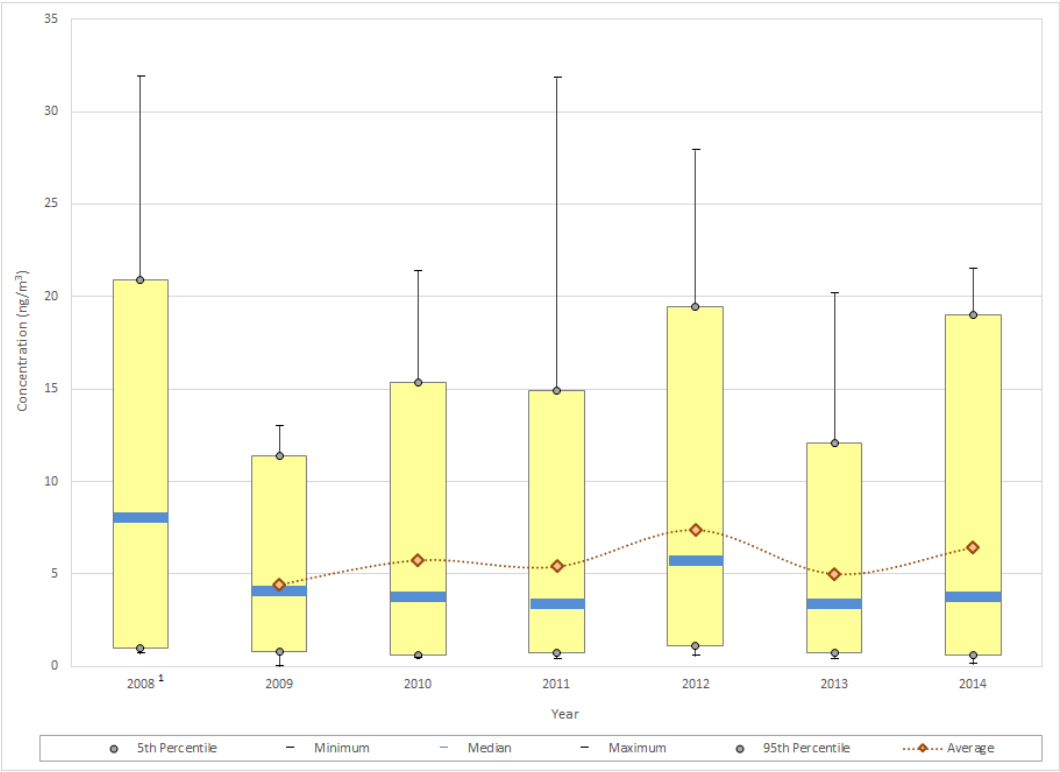
- Non-detects of naphthalene were not measured in 2014, across the program or at S4MO, despite the low minimum concentration shown on the box plot. As previously mentioned, the minimum concentration of naphthalene across the program was measured at S4MO and is an anomaly, for both this site and for the program. Since being added to the NATTS program only two lower concentrations of naphthalene have been measured at an NMP site.

- Despite the low minimum concentration, the annual average concentration of naphthalene for S4MO is greater than the program-level average concentration and just less than the program-level third quartile. Recall from the previous section that S4MO's annual average concentration ranks sixth highest among NMP sites sampling naphthalene.

15.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. S4MO has sampled VOCs and carbonyl compounds under the NMP since 2002, PM_{10} metals since 2003, and PAHs since 2008. Thus, Figures 15-18 through 15-31 present the 1-year statistical metrics for each of the pollutants of interest for S4MO. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 15-18. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 15-18 for acenaphthene concentrations measured at S4MO include the following:

- S4MO began sampling PAHs under the NMP in April 2008. Because a full year's worth of data is not available, a 1-year average concentration for 2008 is not presented, although the range of measurements is provided.

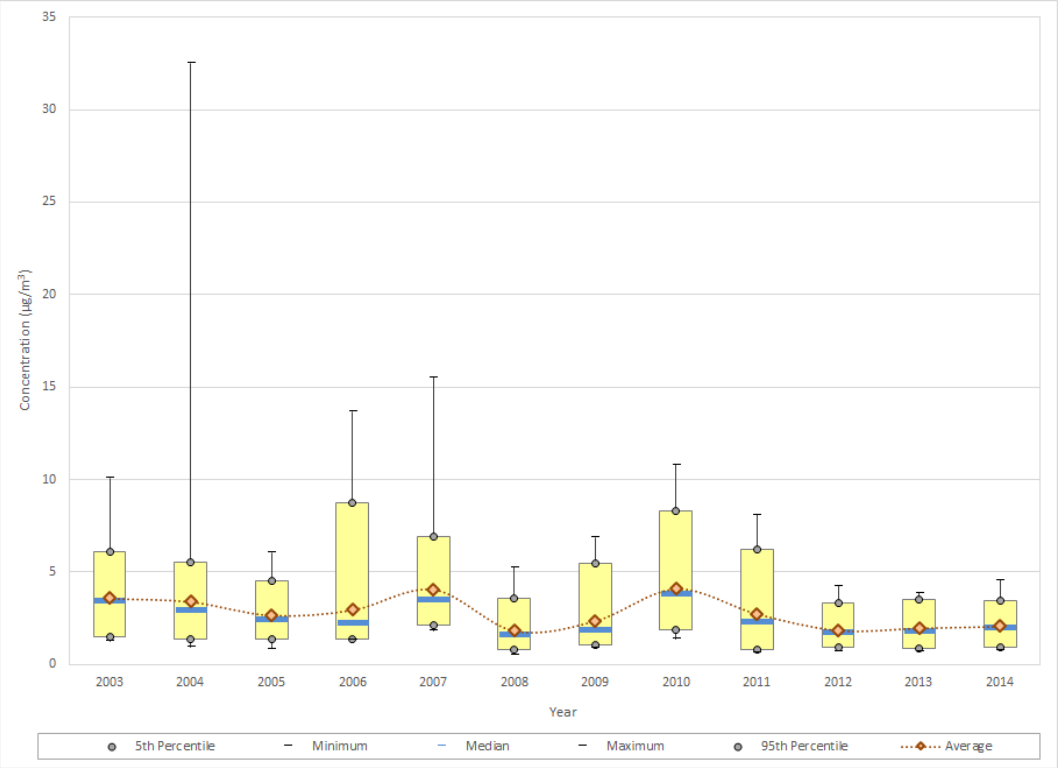
- Three measurements greater than 30 ng/m^3 were measured at S4MO, two in September 2008 and another in July 2011.

- All of the statistical parameters shown exhibit decreases from 2008 to 2009. In all, 13 concentrations measured in 2008 are greater than the maximum concentration measured in 2009. In addition, acenaphthene concentrations less than 5 ng/m^3 accounted for more than twice the percentage of samples collected in 2009 (64 percent) compared to 2008 (32 percent).

- Although the range of concentrations measured increased from 2009 to 2010 and again for 2011, the median concentration decreased slightly each year.

- Between 2011 and 2014, the 1-year average concentration has a fluctuating pattern, with years with lower averages alternating with years with higher averages. The median concentration has a similar pattern, although the increase shown for 2014 is smaller than the increase shown in the 1-year average concentration.

Figure 15-19. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at S4MO



Observations from Figure 15-19 for acetaldehyde concentrations measured at S4MO include the following:

- Because carbonyl compound sampling under the NMP did not begin at S4MO until December 2002, data from 2002 were excluded from this analysis.

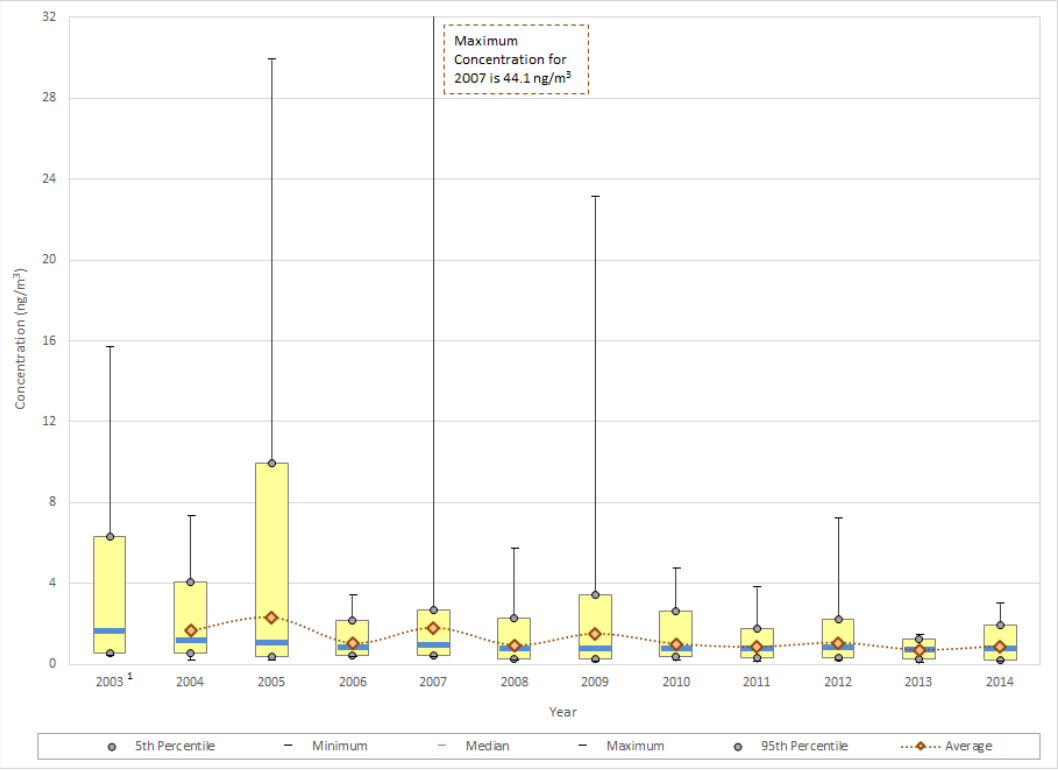
- The maximum acetaldehyde concentration was measured in 2004 (32.5 µg/m^3) and is more than twice the next highest concentration (15.5 µg/m^3, measured in 2007).

- Even with the maximum concentration measured in 2004, nearly all of the statistical metrics decreased from 2003 to 2004. The maximum concentration measured in 2004 is nearly six times higher than the next highest concentration measured that year (5.72 µg/m^3).

- The 1-year average concentrations have an undulating pattern, with a few years of a decreasing trend followed by a few years of an increasing trend. The 1-year average concentrations have ranged from 1.83 µg/m^3 (2008) and 4.10 µg/m^3 (2010).

- A significant decrease in the 1-year average concentration is shown from 2007 to 2008, which is followed by an increasing trend through 2010. A significant decrease is again shown from 2010 through 2012, after which more subtle changes are shown. A similar pattern is exhibited by the median concentrations. The concentrations measured during the 3-year period from 2012 to 2014 exhibit the least year-to-year variability in concentrations measured since the onset of sampling.

Figure 15-20. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2003.

Observations from Figure 15-20 for arsenic concentrations measured at S4MO include the following:

- S4MO began sampling metals under the NMP in July 2003. Because a full year's worth of data is not available, a 1-year average concentration is not presented, although the range of measurements is provided.

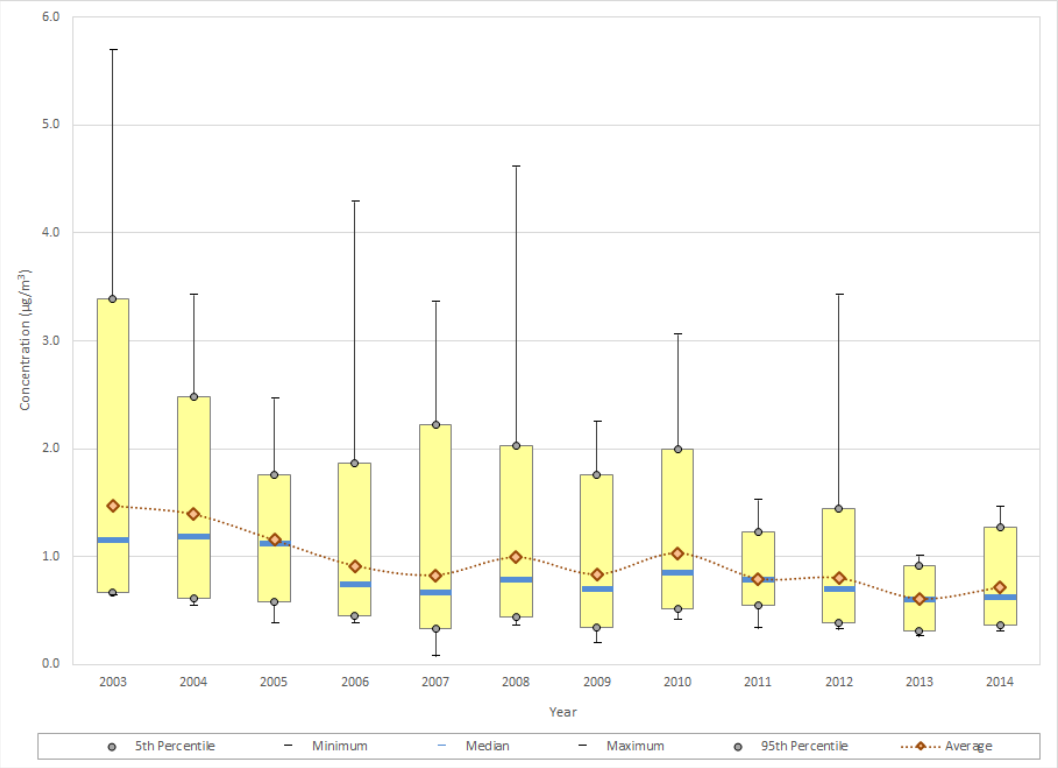
- The maximum arsenic concentration was measured at S4MO on December 26, 2007 (44.1 ng/m^3). Five additional arsenic concentrations greater than 10 ng/m^3 have been measured at S4MO (three in 2005 and one each in 2003 and 2009).

- This figure shows that years with little variability in the measurements seem to alternate with years with significant variability, particularly between 2004 and 2010. Less variability in the measurements is shown in the last few years of sampling.

- Most of the statistical parameters are at a minimum for 2013. The range of measurements, the difference between the 5th and 95th percentiles, and the difference between the median and 1-year average concentrations are all at a minimum for 2013.

- With the exception of the 5th percentile, increases are shown for each of the parameters for 2014, although some are slight (the median increased by less than 0.1 ng/m^3) while others are relatively large (the maximum concentration doubled from 2013 to 2014.

Figure 15-21. Yearly Statistical Metrics for Benzene Concentrations Measured at S4MO



Observations from Figure 15-21 for benzene concentrations measured at S4MO include the following:

- Because VOC sampling under the NMP did not begin at S4MO until December 2002, 2002 data was excluded from this analysis.

- Only one benzene concentration greater than 5 µg/m^3 has been measured at S4MO (2003). Three benzene concentrations greater than 4 µg/m^3 have also been measured (one each in 2003, 2006, and 2008).

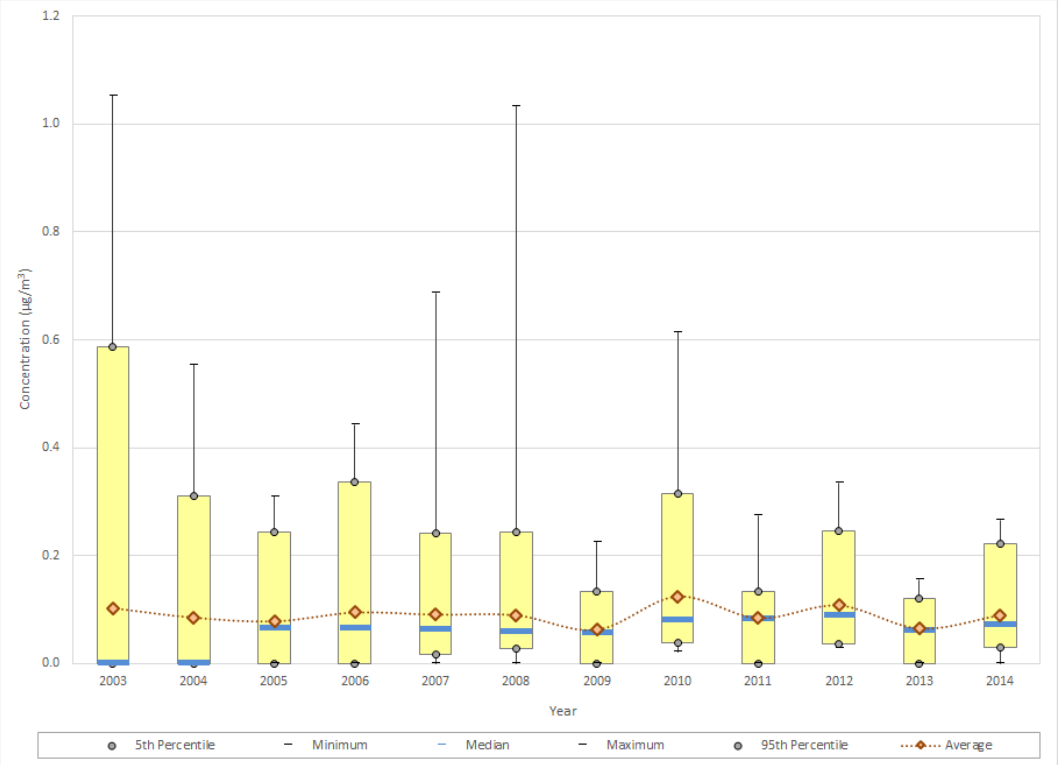
- The 1-year average concentrations exhibit a steady decreasing trend through 2007, representing a 44 percent decrease. In the years between 2007 and 2011, the 1-year average concentrations have a slight undulating pattern, with the 1-year average varying between 0.80 µg/m^3 (2011) and 1.03 µg/m^3 (2010).

- From 2011 to 2012, the statistical parameters representing the upper end of the concentration range (the maximum and 95th percentile) increased while the statistical parameters representing the lower end of the concentration range (the minimum and 5th percentile) decreased, indicating a widening of concentrations measured. Yet, the 1-year average concentration did not change and the median decreased. The number of concentrations greater than 1 µg/m^3 doubled (from six in 2011 to 12 in 2012) while the number of concentrations less than 0.5 µg/m^3 increased from two in 2011 to 12 in 2012.

- With the exception of the minimum concentration, all of the statistical parameters are at a minimum for 2013. The change between 2003 and 2013 represents nearly a 60 percent decrease in the 1-year average concentration and an 82 percent decrease in the median concentration.

- All of the statistical parameters exhibit slight increases for 2014.

Figure 15-22. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at S4MO



Observations from Figure 15-22 for 1,3-butadiene concentrations measured at S4MO include the following:

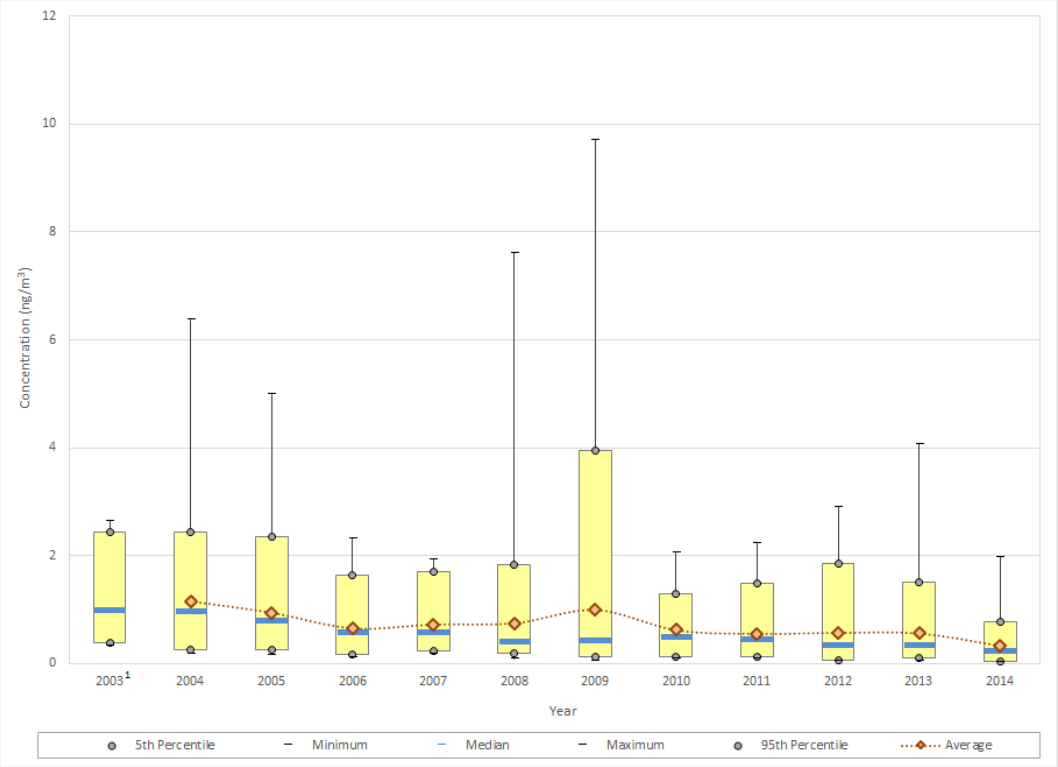
- The maximum 1,3-butadiene concentration was measured at S4MO in 2003, although a similar concentration was also measured in 2008. These are the only two 1,3-butadiene concentrations greater than 1.0 µg/m^3 that have been measured at S4MO.

- The minimum, 5th percentile, and median concentrations are all zero for 2003 and 2004, indicating that at least 50 percent of the measurements were non-detects. The number of non-detects decreased after 2004, from a maximum of 43 non-detects in 2004 to a minimum of zero in 2010 and 2012. After 2006, no more than five non-detects of 1,3-butadiene have been measured at S4MO for any given year.

- Between 2004 and 2008, the 1-year average concentration changed very little, ranging from 0.079 µg/m^3 (2005) to 0.095 µg/m^3 (2006). Greater fluctuations are shown in the years that follow. Years with a higher number of non-detects, as

indicated by a minimum and 5th percentile of zero, such as 2009 and 2011 and 2013, alternate with years without any non-detects (2010 and 2012) and concentrations that are higher in magnitude, as indicated by the 95th percentile and maximum concentration. This pattern ends with 2014, as two non-detects were measured in 2014.

Figure 15-23. Yearly Statistical Metrics for Cadmium (PM_{10}) Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2003.

Observations from Figure 15-23 for cadmium concentrations measured at S4MO include the following:

- The maximum cadmium concentration was measured in 2009 (9.71 ng/m^3). The four additional cadmium concentrations greater than 5 ng/m^3 were measured at S4MO in 2004 (one), 2008 (two), and 2009 (one).

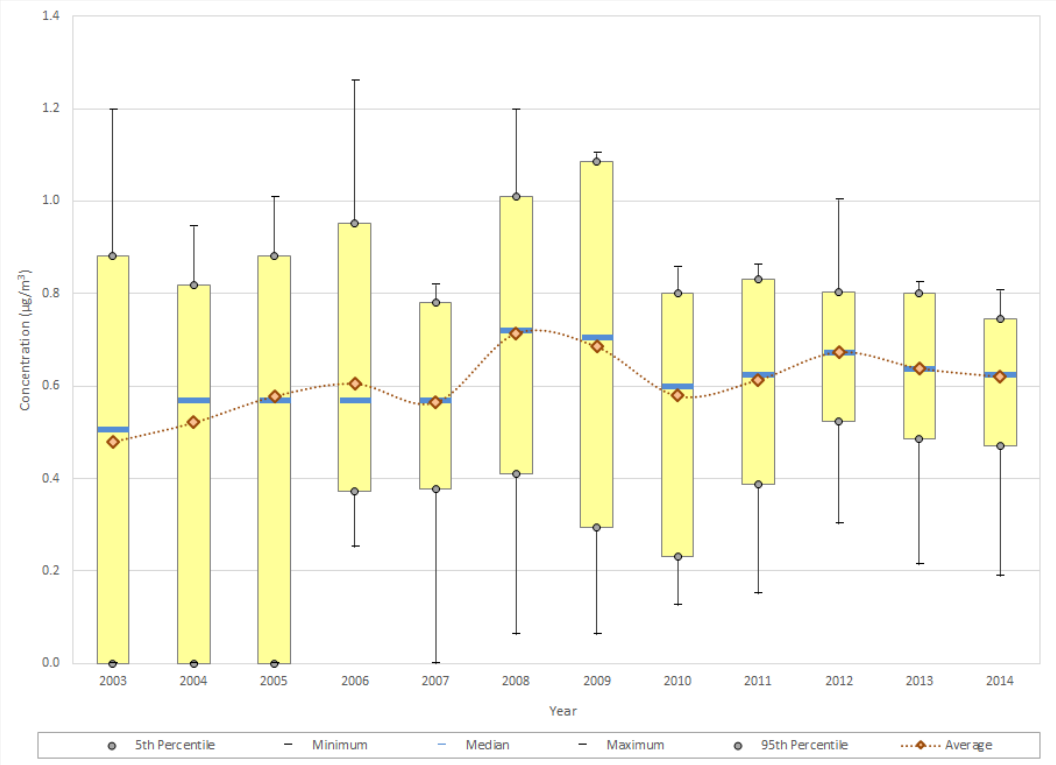
- A steady decreasing trend is shown in the 1-year average and median concentrations through 2006. Even though the 1-year average concentration exhibits an increasing trend between 2006 and 2009, the median concentration does not, and continued decreasing during most of this time. This indicates that concentrations at the upper end of the concentration range are driving the 1-year averages, particularly for 2008 and 2009, while the concentrations at the lower end of the concentration range are accounting for a higher percentage of measurements.

- The range of concentrations measured decreased significantly from 2009 to 2010.

- Even though the range of concentrations increased every year between 2010 and 2013, the 1-year average concentration changed little while the median exhibits a slight decreasing trend, before leveling out for 2013.

- Each of the statistical parameters is at a minimum for 2014, with the 1-year average concentration less than 0.5 ng/m^3 and the median concentration less than 0.25 ng/m^3 for the first time since the onset of sampling.

Figure 15-24. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at S4MO



Observations from Figure 15-24 for carbon tetrachloride concentrations measured at S4MO include the following:

- Twenty of the 21 non-detects of carbon tetrachloride were measured at S4MO in 2003, 2004, or 2005, with a single non-detect measured in 2007.

- A steady increasing trend in the 1-year average concentration is shown through 2006. Although the maximum concentration decreased substantially from 2006 to 2007 (and a non-detect was measured), the change in the 1-year average concentration is not statistically significant and the median concentration did not change at all. In fact, the median concentration is steady between 2005 and 2007.

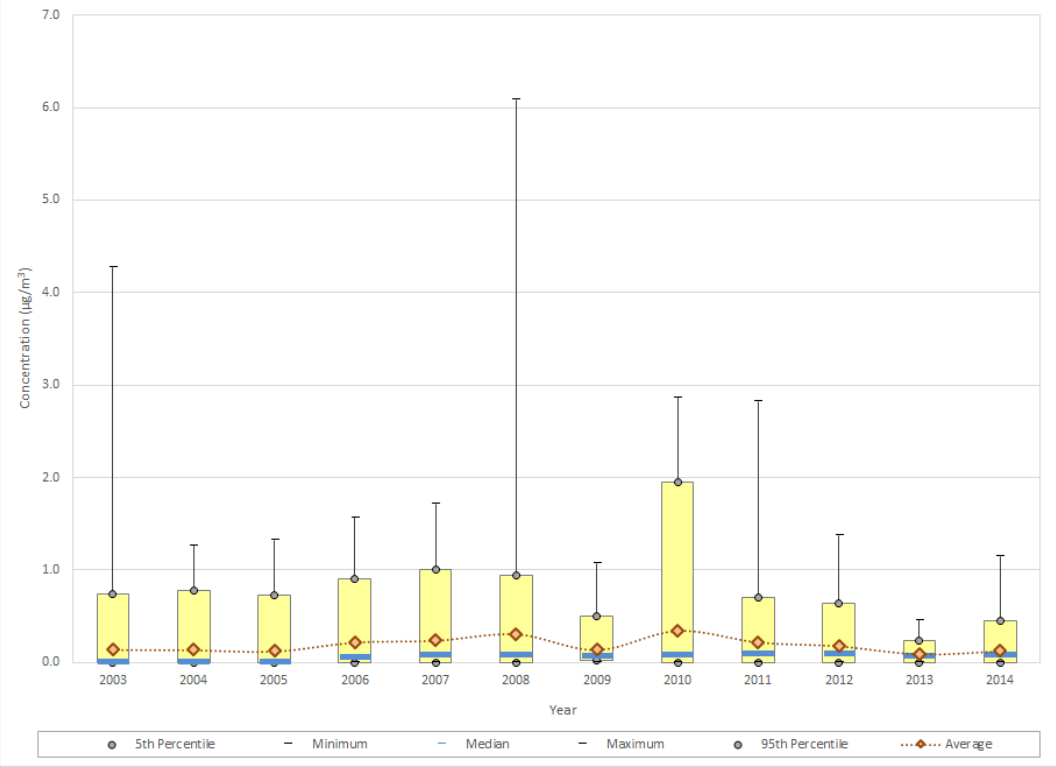
- All of the statistical parameters exhibit increases from 2007 to 2008. Twenty concentrations, or nearly one-third of the concentrations, measured in 2008 are greater than the maximum concentration measured in 2007.

- Both the median and 1-year average concentrations have a decreasing trend between 2008 and 2010, with the largest change shown for 2010.

- Between 2010 and 2012, the 1-year average concentrations have a significant increasing trend even as the majority of concentrations measured are falling into a tighter range, as indicated by the decreasing difference between the 5th and 95th percentiles for these years.

- Nearly all of the statistical parameters exhibit decreases for 2013 and again for 2014. A larger number of concentrations at the lower end of the concentration range was measured each year, while fewer concentrations at the upper end of the concentration range were measured. The number of concentrations less than 0.65 µg/m^3 increased between 2012 and 2014, from 20 in 2012 to 34 in 2013 and 35 in 2014. At the other end of the concentration range, fewer concentrations greater than 0.8 µg/m^3 have been measured each year, from 12 in 2012 to eight in 2013, and three in 2014.

Figure 15-25. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at S4MO



Observations from Figure 15-25 for *p*-dichlorobenzene concentrations measured at S4MO include the following:

- The minimum, 5th percentile, and median concentrations are all zero for 2003, 2004, and 2005, indicating that at least 50 percent of the measurements were non-detects. The percentage of non-detects was at a maximum in 2003 (90 percent), after which the percentage decreased, reaching a minimum of 5 percent for 2009. The percentage

of non-detects varies between 10 percent (2012) and 25 percent (2014) each year following 2009. The percentage of non-detects for 2014 is the highest percentage since 2005.

- After little change in the early years, the 1-year average and median concentrations exhibit a steady increasing trend between 2005 and 2008. However, the relatively large number of non-detects (zeros) combined with the range of measured detections result in a relatively high level of variability, based on the confidence intervals calculated for the 1-year averages. This is particularly true for 2008, when the maximum *p*-dichlorobenzene concentration was measured (6.18 $\mu g/m^3$). The difference between the median and 1-year average concentration is also an indicator of this variability. For 2008, the 1-year average concentration was more than three times greater than the median concentration.

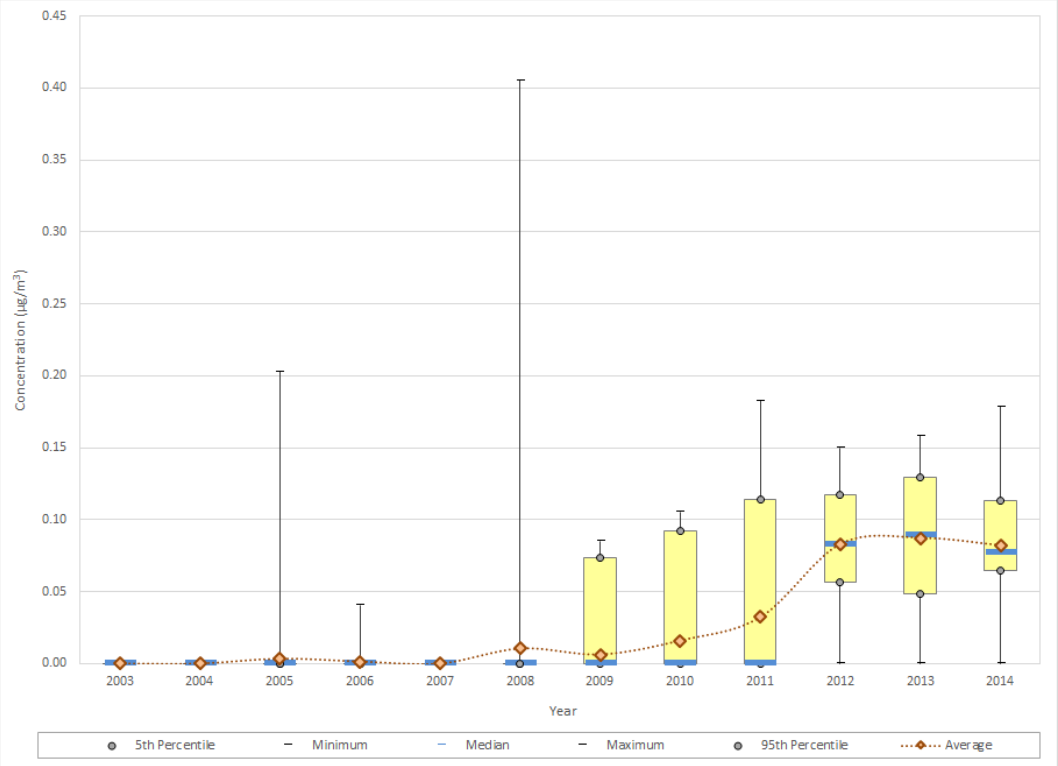
- The concentrations measured decreased considerably from 2008 to 2009 then increased again in 2010. Concentrations measured in 2010 were higher and more variable than those measured in 2009. Five concentrations measured in 2010 were greater than the maximum concentration measured in 2009 and the number of concentrations greater than 0.5 $\mu g/m^3$ more than doubled, from four in 2009 to 10 for 2010. At the same time, the number of non-detects increased from three in 2009 to eight in 2010.

- Although the range of concentrations measured in 2011 is similar to the range of concentrations measured in 2010, the 95th percentile and 1-year average concentration decreased considerably. Further decreases are shown for these parameters for 2012. While the 1-year average concentration exhibits a decrease during this time, the median concentration increased slightly for 2011 and then did not change for 2012.

- Several of the statistical parameters are at a minimum for 2013, including the 1-year average concentration, which is less than 0.1 $\mu g/m^3$ for the first time. This year has the smallest range of concentrations measured by a considerable margin.

- Most of the statistical parameters exhibit increases for 2014, even though more than a quarter of the measurements are non-detects.

Figure 15-26. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at S4MO



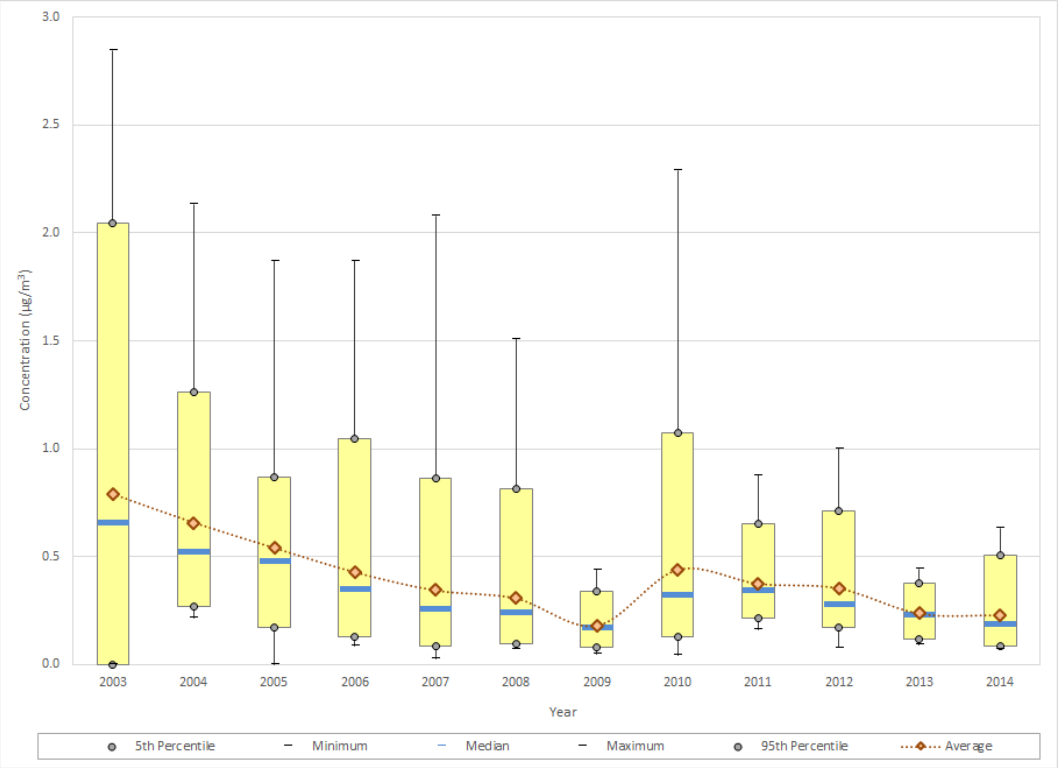
Observations from Figure 15-26 for 1,2-dichloroethane concentrations measured at S4MO include the following:

- With the exceptions of 2012, 2013, and 2014, the median concentration is zero for all years, indicating that at least 50 percent of the measurements were non-detects. There were no measured detections of 1,2-dichloroethane in 2003, 2004, or 2007, one measured detection in 2005, and two each in 2006 and 2008. Beginning in 2009, the number of measured detections increased steadily, from five in 2009, to 10 in 2010, 18 in 2011, 56 in 2012, and 58 in both 2013 and 2014.

- As the number of measured detections increased in the later years of sampling, each of the corresponding statistical metrics shown in Figure 15-26 also increased. The 5th percentile and median concentrations are greater than zero beginning with 2012, when measured detections accounted for a majority of the measurements for the first time.

- The 1-year average concentrations shown between 2012 and 2014 vary little, from 0.082 µg/m^3 for 2014 to 0.087 µg/m^3 for 2013.

Figure 15-27. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at S4MO



Observations from Figure 15-27 for ethylbenzene concentrations measured at S4MO include the following:

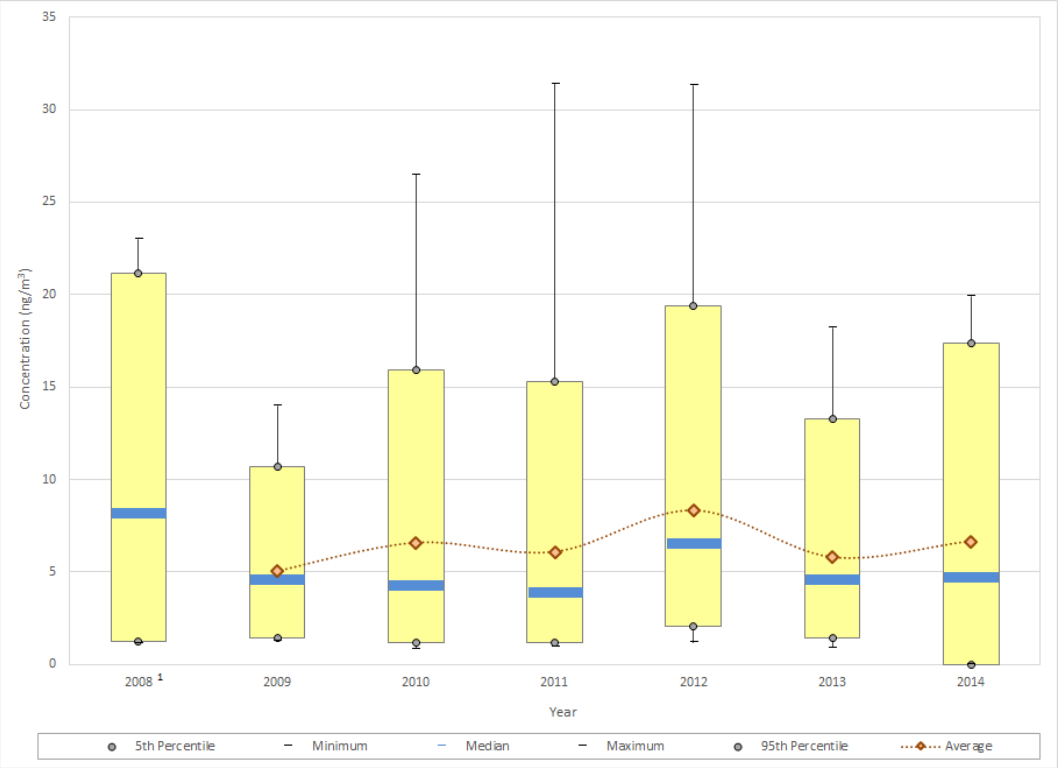
- The highest ethylbenzene concentrations were predominantly measured prior to 2008. Six of the seven ethylbenzene concentrations greater than 2 µg/m^3 were measured in 2007 or earlier, and four of these were measured in 2003. The exception was measured in 2010.

- Concentrations of ethylbenzene exhibit a significant decreasing trend between 2003 and 2009, when most of the statistical parameters are a minimum.

- With the exception of the minimum concentration, all of the statistical parameters exhibit increases for 2010, in some cases doubling (1-year average and median), tripling (95th percentile) or increasing by an even higher amount (maximum). Fifteen concentrations measured in 2010 are greater than the maximum concentration measured in 2009. The maximum concentration measured in 2009 in nearly equivalent to the 1-year average concentration for 2010.

- A steady decreasing trend in the ethylbenzene concentrations measured at S4MO is shown again for the years following 2010. Even though a few higher concentrations were measured in 2014, most of the statistical parameters exhibit additional decreases compared to 2013.

Figure 15-28. Yearly Statistical Metrics for Fluorene Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 15-28 for fluorene concentrations measured at S4MO include the following:

- The box and whisker plots for fluorene measurements resemble the plots for acenaphthene presented in Figure 15-18.

- Two measurements greater than 30 ng/m^3 have been measured at S4MO, one on July 2, 2011 (31.4 ng/m^3) and one on July 2, 2012 (31.3 ng/m^3). The highest fluorene concentrations tended to be measured during the warmer months of the year. Of the 35 fluorene concentrations greater than 15 ng/m^3, 27 were measured at S4MO between June and August of any given year and none were measured between December and March.

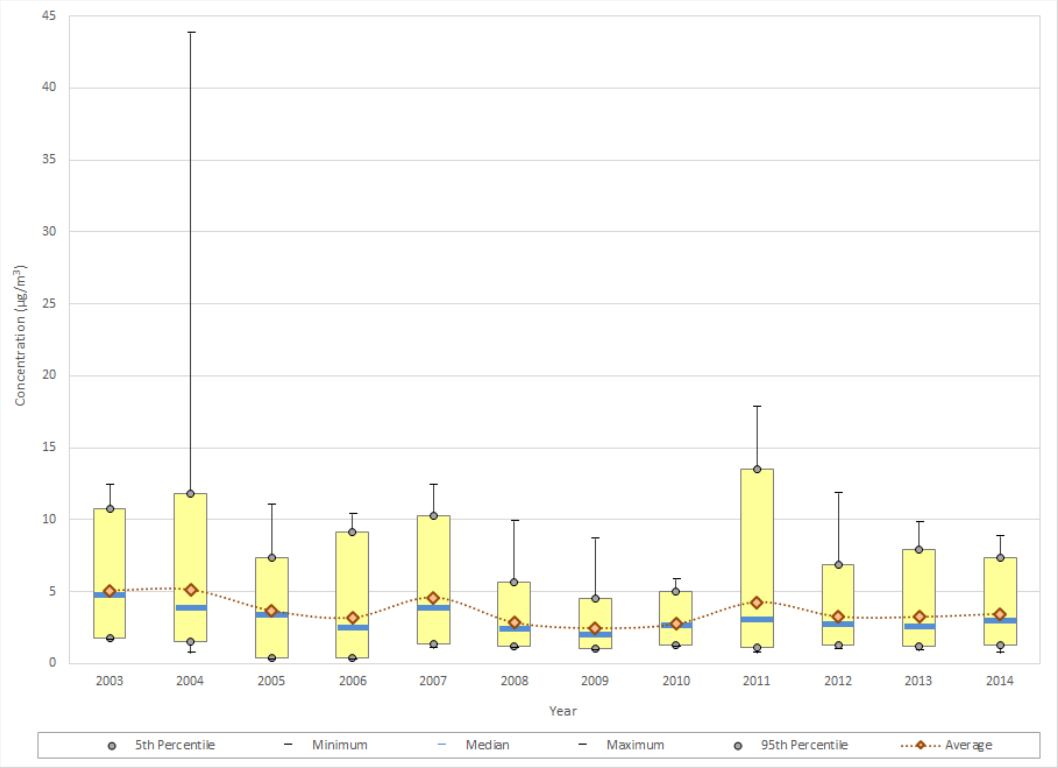
- Several of the statistical parameters shown exhibit decreases from 2008 to 2009. From 2009 to 2010, the range of concentrations measured increased considerably but the median concentration decreased, a trend that continued into 2011. A similar observation was made for acenaphthene.

- With the exception of the maximum concentration, the statistical parameters exhibit increases from 2011 to 2012. This is because the number of measurements at the upper end of the range increased while the number of measurements at the lower end of the concentration range decreased. The number of concentrations greater than 10 ng/m^3 increased from 13 to 22 from 2011 to 2012; conversely, the number of concentrations less than 2 ng/m^3 decreased from 11 to three from 2011 to 2012.

- All of the statistical parameters exhibit decreases for 2013.

- The first, and only, non-detects (four) of fluorene were measured at S4MO in 2014. Despite these non-detects, many of the statistical parameters exhibit slight increases for 2014.

Figure 15-29. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at S4MO



Observations from Figure 15-29 for formaldehyde concentrations measured at S4MO include the following:

- The maximum formaldehyde concentration (43.8 µg/m^3) was measured in 2004 on the same day that the maximum acetaldehyde concentration was measured (August 31, 2004). This concentration is more than twice the next highest concentration (17.8 µg/m^3), which was measured in 2011. The six highest concentrations of formaldehyde were all measured in 2004 (2) or 2011 (4).

- The 1-year average concentration has a decreasing trend between 2004 and 2006. After the increase shown for 2007, the decreasing trend resumed through 2009, when the 1-year average was at a minimum (2.46 µg/m^3).

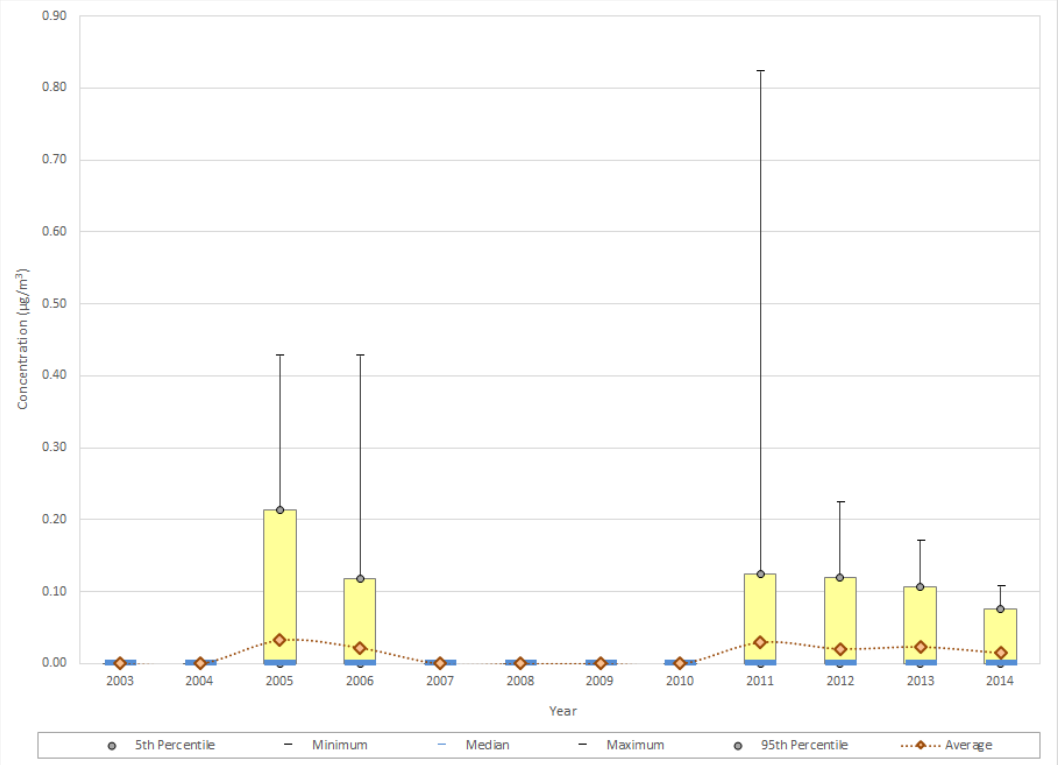
- The 1-year average concentration did not change significantly between 2009 and 2010, even though the smallest range of concentrations was measured in 2010.

- Most of the statistical parameters exhibit considerable increases from 2010 to 2011. Eleven concentrations of formaldehyde measured in 2011 are greater than the maximum concentration measured in 2010.

- Most of the statistical parameters exhibit decreases from 2011 to 2012.

- The central tendency statistics exhibit little change between 2012 and 2014.

Figure 15-30. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at S4MO



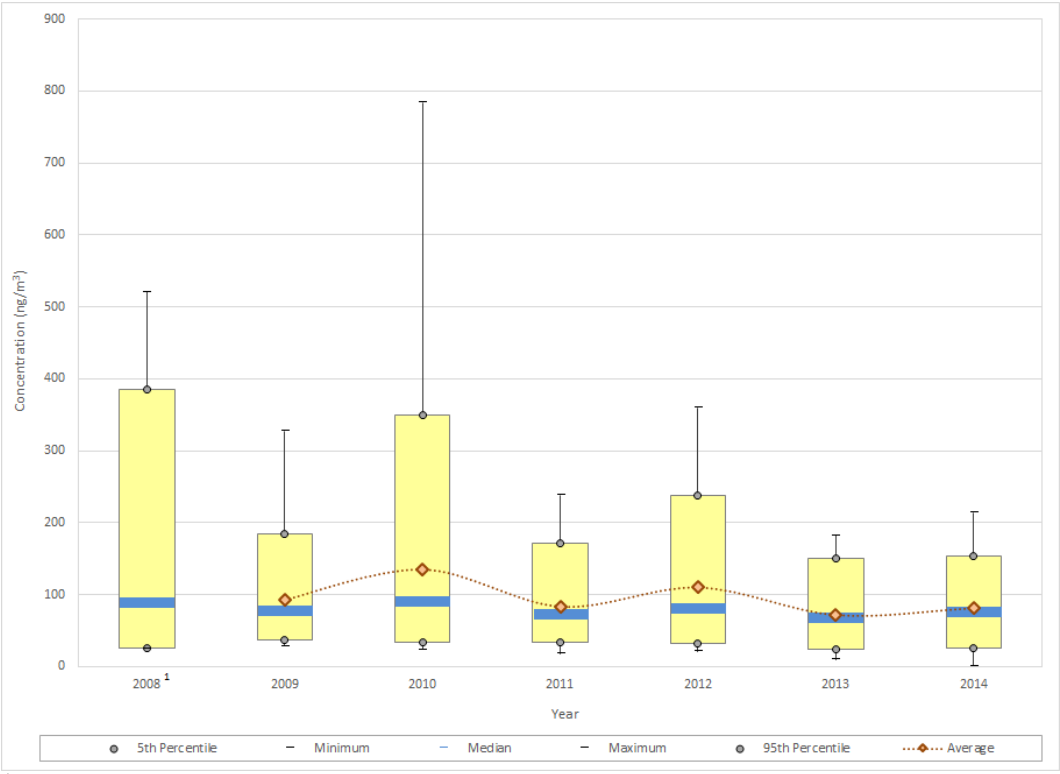
Observations from Figure 15-30 for hexachloro-1,3-butadiene concentrations measured at S4MO include the following:

- The median concentration of hexachloro-1,3-butadiene for each year of sampling is zero, indicating that at least 50 percent of the measurements were non-detects. For 2003, 2004, and 2007 through 2010, 100 percent of the measurements were non-detects.

- For 2005 and 2006, the percentage of measured detections was less than 15 percent. For 2011, measured detections accounted for 16 percent of the measurements. For 2012, that number increased to 22 percent and then up to 26 percent for 2013. The detection rate fell slightly in 2014 to 20 percent.

- Over the last 4 years of sampling, the 1-year average concentration has varied from 0.015 µg/m^3 (2014) to 0.029 µg/m^3 (2011).

Figure 15-31. Yearly Statistical Metrics for Naphthalene Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 15-31 for naphthalene concentrations measured at S4MO include the following:

- Naphthalene concentrations measured at S4MO exhibit considerable variability, spanning three orders of magnitude and ranging from 0.78 ng/m^3 (2014) to 784 ng/m^3 (2010).

- The 1-year average concentration has ranged from 72.07 ng/m^3 (2013) to 135 ng/m^3 (2010). The median varies less, ranging from 66.85 ng/m^3 (2013) to 89.85 ng/m^3 (2010). All of the statistical parameters, except the minimum concentration, are at a minimum for 2013.

- The years when relatively high concentrations were measured alternate with years when the highest concentrations are considerably less, resulting in the 1-year average (and median) concentrations having an undulating pattern. The difference decreases, though, in the later years of sampling

15.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the S4MO monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

15.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for S4MO and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 15-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for S4MO from Table 15-5 include the following:

- The pollutants with the highest annual average concentrations for S4MO are formaldehyde, acetaldehyde, and benzene.

- The same three pollutants have the highest cancer risk approximations for S4MO, although the order is different. Formaldehyde's cancer risk approximation for S4MO (44.91 in-a-million) is an order of magnitude higher than the cancer risk approximations for these two other pollutants.

- Benzene has the highest cancer risk approximation for S4MO among the VOCs (5.51 in-a-million); arsenic has the highest cancer risk approximation for S4MO among the metals (3.88 in-a-million); and naphthalene has the highest cancer risk approximation for S4MO among the PAHs (2.78 in-a-million).

- None of the pollutants of interest for S4MO have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation is formaldehyde (0.35).

Table 15-5. Risk Approximations for the Missouri Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
St. Louis, Missouri - S4MO						
Acetaldehyde	0.0000022	0.009	60/60	2.08 ± 0.22	4.57	0.23
Benzene	0.0000078	0.03	59/59	0.71 ± 0.07	5.51	0.02
1,3-Butadiene	0.00003	0.002	58/59	0.09 ± 0.02	2.73	0.05
Carbon Tetrachloride	0.000006	0.1	59/59	0.62 ± 0.02	3.74	0.01
p-Dichlorobenzene	0.000011	0.8	45/59	0.13 ± 0.05	1.41	<0.01
1,2-Dichloroethane	0.000026	2.4	58/59	0.08 ± 0.01	2.15	<0.01
Ethylbenzene	0.0000025	1	59/59	0.23 ± 0.04	0.58	<0.01
Formaldehyde	0.000013	0.0098	60/60	3.45 ± 0.48	44.91	0.35
Hexachloro-1,3-butadiene	0.000022	0.09	12/59	0.02 ± 0.01	0.33	<0.01
Acenaphthene[a]	0.000088	--	57/57	6.43 ± 1.56	0.57	--
Arsenic (PM_{10})[a]	0.0043	0.000015	61/61	0.90 ± 0.15	3.88	0.06
Cadmium (PM_{10})[a]	0.0018	0.00001	61/61	0.33 ± 0.09	0.60	0.03
Fluorene[a]	0.000088	--	53/57	6.65 ± 1.38	0.59	--
Naphthalene[a]	0.000034	0.003	57/57	81.79 ± 12.61	2.78	0.03

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

15.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 15-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 15-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 15-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for S4MO, as presented in Table 15-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 15-6. Table 15-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 15.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 15-6. 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 UREs (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)**
St. Louis, Missouri (St. Louis City) - S4MO					
Formaldehyde	86.19	Formaldehyde	1.12E-03	Formaldehyde	44.91
Benzene	85.02	Hexavalent Chromium	7.89E-04	Benzene	5.51
Ethylbenzene	48.46	Benzene	6.63E-04	Acetaldehyde	4.57
Acetaldehyde	46.53	1,3-Butadiene	3.78E-04	Arsenic (PM_{10})	3.88
Trichloroethylene	15.45	Naphthalene	3.26E-04	Carbon Tetrachloride	3.74
1,3-Butadiene	12.60	Arsenic, PM	2.49E-04	Naphthalene	2.78
Naphthalene	9.59	POM, Group 2b	1.80E-04	1,3-Butadiene	2.73
Tetrachloroethylene	5.83	POM, Group 2d	1.44E-04	1,2-Dichloroethane	2.15
Dichloromethane	3.65	Ethylbenzene	1.21E-04	*p*-Dichlorobenzene	1.41
POM, Group 2b	2.05	Acetaldehyde	1.02E-04	Cadmium (PM_{10})	0.60

Table 15-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Missouri Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
St. Louis, Missouri (St. Louis City) - S4MO					
Toluene	313.06	Acrolein	268,853.09	Formaldehyde	0.35
Hexane	226.91	Formaldehyde	8,795.13	Acetaldehyde	0.23
Methanol	208.08	Trichloroethylene	7,726.86	Arsenic (PM_{10})	0.06
Xylenes	196.63	1,3-Butadiene	6,302.24	1,3-Butadiene	0.05
Formaldehyde	86.19	Acetaldehyde	5,170.07	Cadmium (PM_{10})	0.03
Benzene	85.02	Arsenic, PM	3,864.62	Naphthalene	0.03
Hydrochloric acid	70.78	Hydrochloric acid	3,539.11	Benzene	0.02
Ethylene glycol	64.32	Cadmium, PM	3,474.08	Carbon Tetrachloride	0.01
Ethylbenzene	48.46	Lead, PM	3,349.14	Ethylbenzene	0.00
Acetaldehyde	46.53	Naphthalene	3,195.33	Hexachloro-1,3-butadiene	0.00

Observations from Table 15-6 include the following:

- Formaldehyde, benzene, and ethylbenzene are the highest emitted pollutants with cancer UREs in the city of St. Louis.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, hexavalent chromium, and benzene.

- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions.

- Formaldehyde tops all three lists, with the highest quantity emitted, the highest toxicity-weighted emissions, and the highest cancer risk approximation. Benzene, acetaldehyde, naphthalene, and 1,3-butadiene also appear on all three lists.

- Arsenic has the fourth highest cancer risk approximation for S4MO. While arsenic is not one of the highest emitted pollutants in the city of St. Louis, it ranks sixth for its toxicity-weighted emissions. Carbon tetrachloride, 1,2-dichloroethane, *p*-dichlorobenzene, and cadmium also appear among the pollutants of interest with the highest cancer risk approximations for S4MO but none of these appear on either emissions-based list.

- POM, Group 2b is the 10th highest emitted "pollutant" in the city of St. Louis and ranks seventh for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at S4MO including acenaphthene and fluorene, which are pollutants of interest for S4MO. These pollutants are not among those with the highest cancer risk approximations for S4MO.

Observations from Table 15-7 include the following:

- Toluene, hexane, and methanol are the highest emitted pollutants with noncancer RfCs in the city of St. Louis.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, formaldehyde, and trichloroethylene. Although acrolein was sampled for at S4MO, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based 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 the city of St. Louis also have the highest toxicity-weighted emissions.

- Formaldehyde, the pollutant with highest noncancer hazard approximation for S4MO, has the second highest toxicity-weighted emissions and the fifth highest total emissions (of the pollutants with noncancer RfCs). Acetaldehyde also appears on all three lists.

- Arsenic and cadmium, both pollutants of interest for S4MO, appear among the pollutants with the highest toxicity-weighted emissions, but are not among the highest emitted.

15.6 Summary of the 2014 Monitoring Data for S4MO

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

- ❖ *Twenty-three pollutants failed screens for S4MO. S4MO failed the second highest number of screens among all NMP sites.*

- ❖ *Formaldehyde and acetaldehyde have the highest annual average concentrations for S4MO. These are the only pollutants of interest with annual averages greater than 1 µg/m^3.*

- ❖ *S4MO has the second highest annual average concentration of arsenic among NMP sites sampling PM_{10} metals. S4MO also has the third highest annual average concentration of p-dichlorobenzene among NMP sites sampling VOCs.*

- ❖ *Concentrations of benzene, ethylbenzene, and cadmium have decreased significantly since sampling began at S4MO.*

- ❖ *Formaldehyde has the highest cancer risk approximation of the pollutants of interest for S4MO. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

16.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

16.1 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.

One New Jersey monitoring site (CSNJ) is located in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD CBSA while the other three New Jersey sites are located within the New York-Newark-Jersey City, NY-NJ-PA CBSA. Figure 16-1 is a composite satellite image retrieved from ArcGIS Explorer showing the CSNJ monitoring site and its immediate surroundings. Figure 16-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 16-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Figures 16-3 through 16-7 are the composite satellite maps and emissions source maps for CHNJ, ELNJ, and NBNJ. Table 16-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 16-1. Camden, New Jersey (CSNJ) Monitoring Site

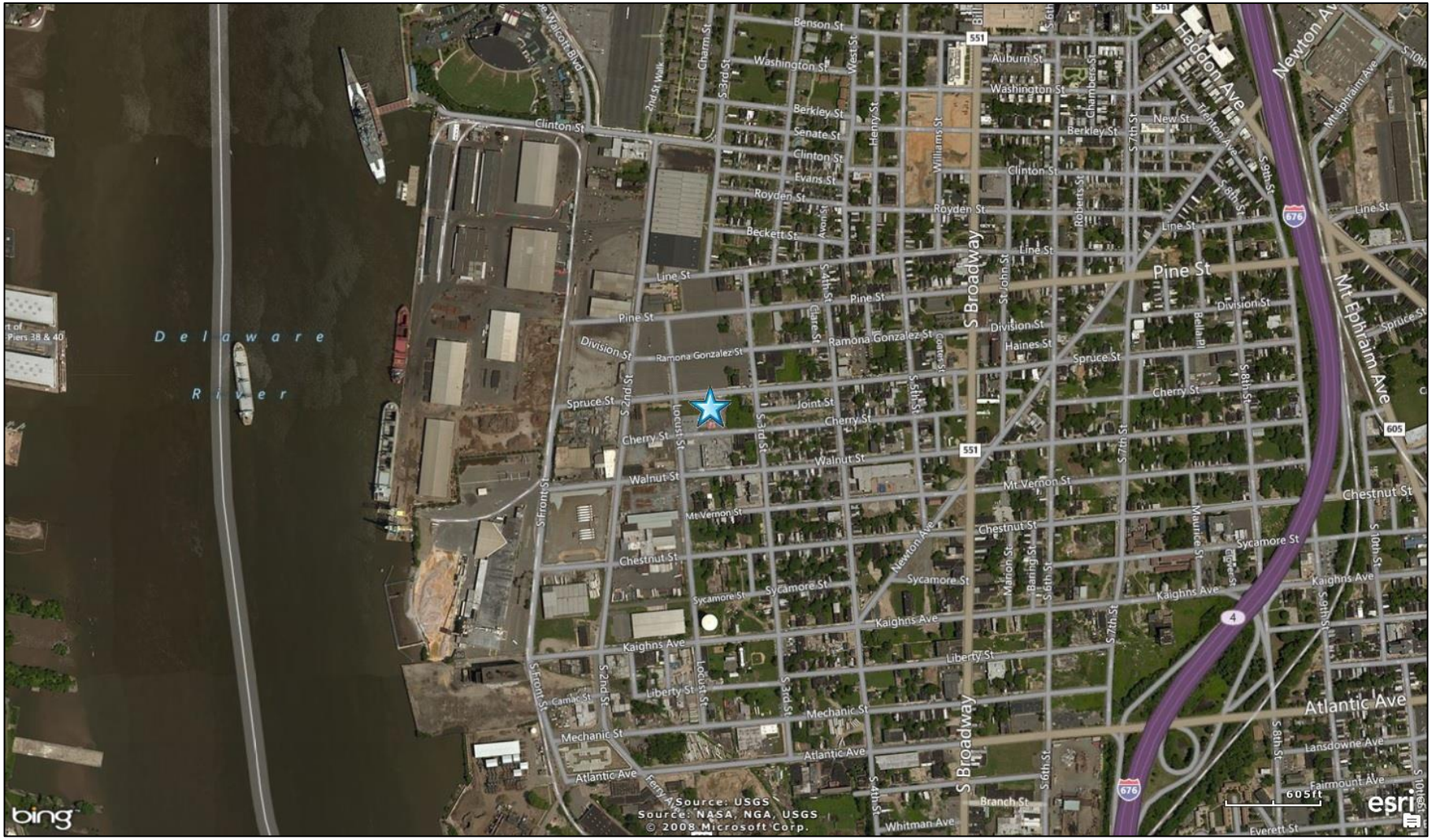


Figure 16-2. NEI Point Sources Located Within 10 Miles of CSNJ

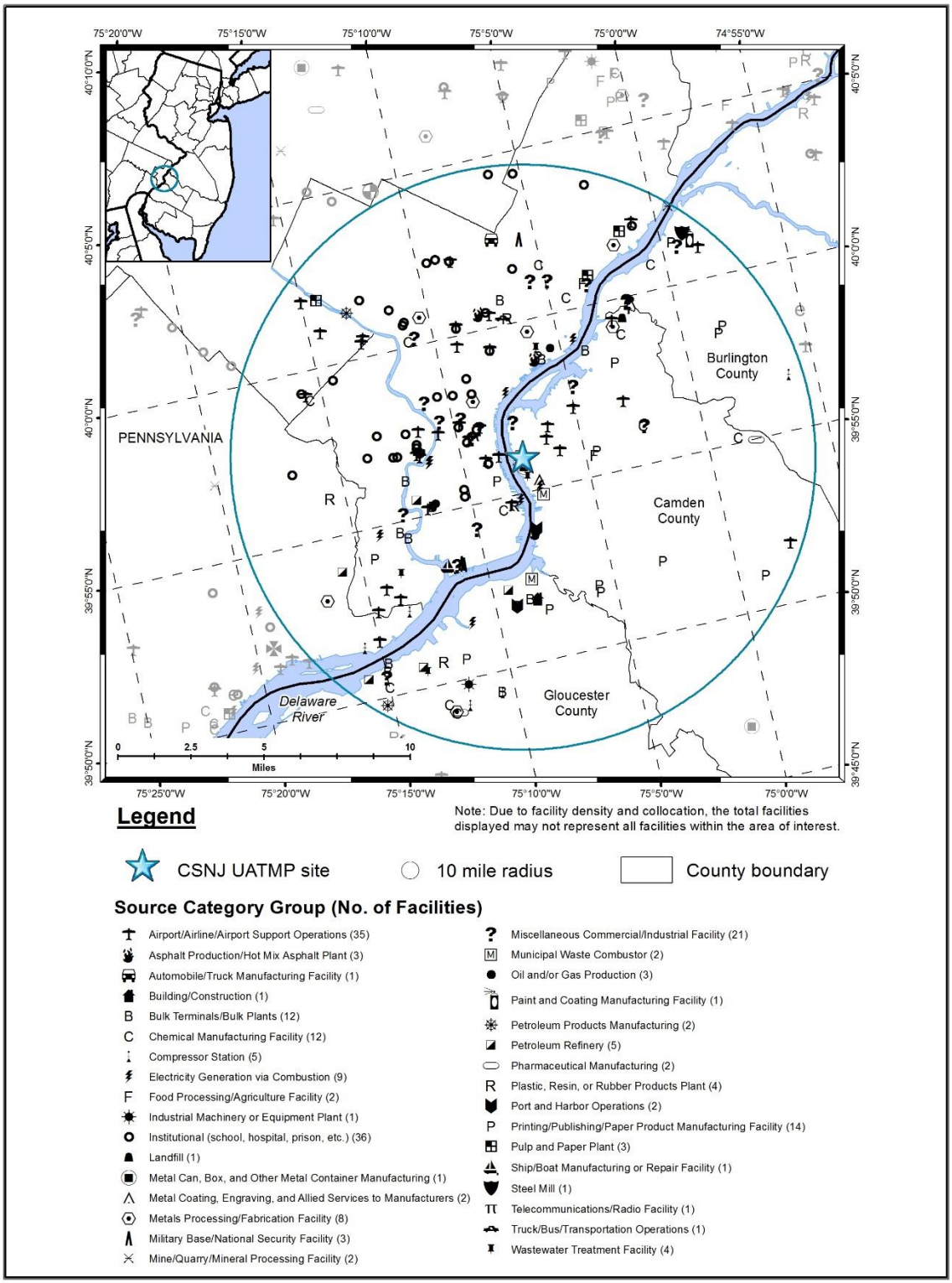


Figure 16-3. Chester, New Jersey (CHNJ) Monitoring Site

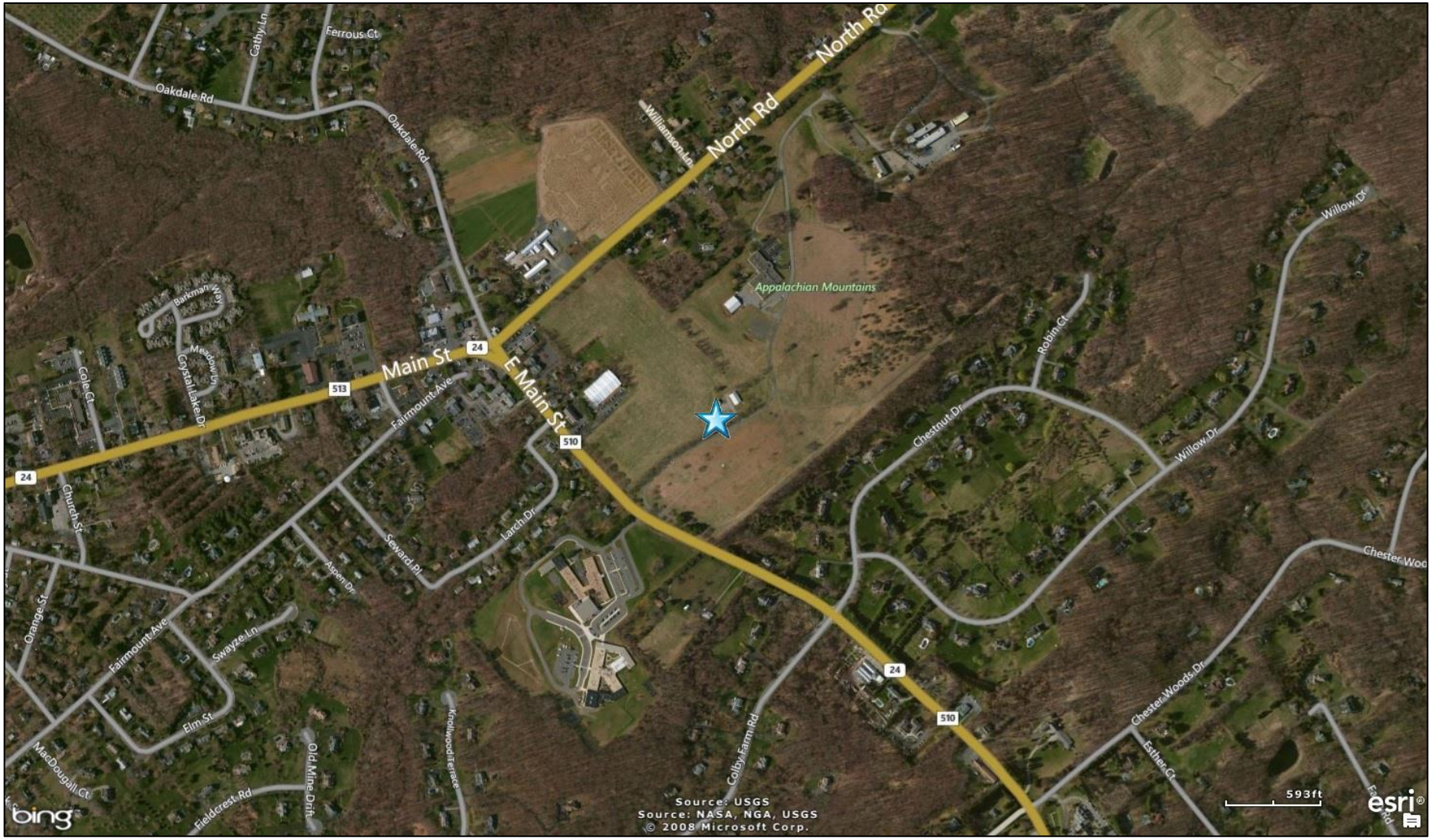


Figure 16-4. NEI Point Sources Located Within 10 Miles of CHNJ

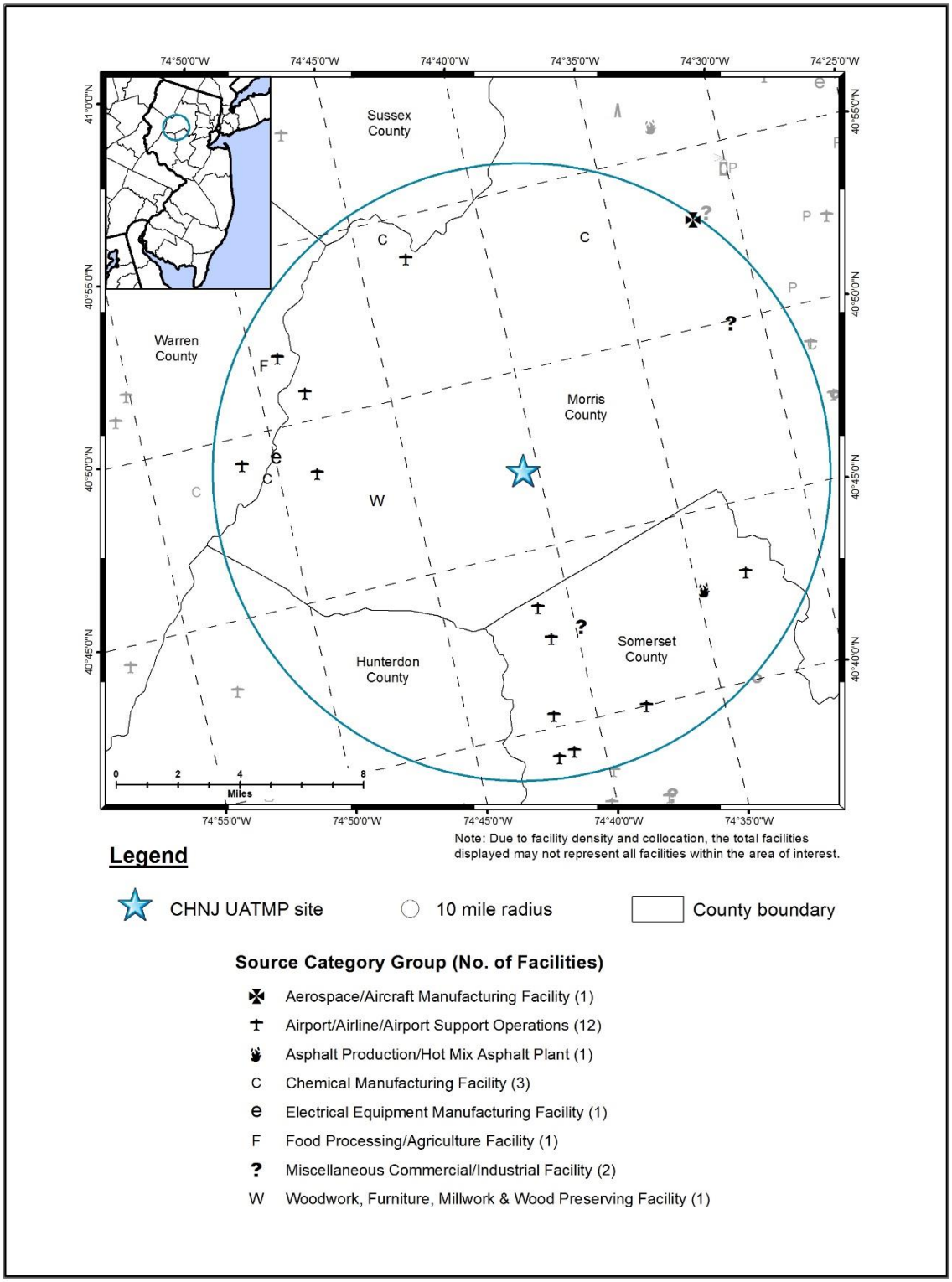


Figure 16-5. Elizabeth, New Jersey (ELNJ) Monitoring Site

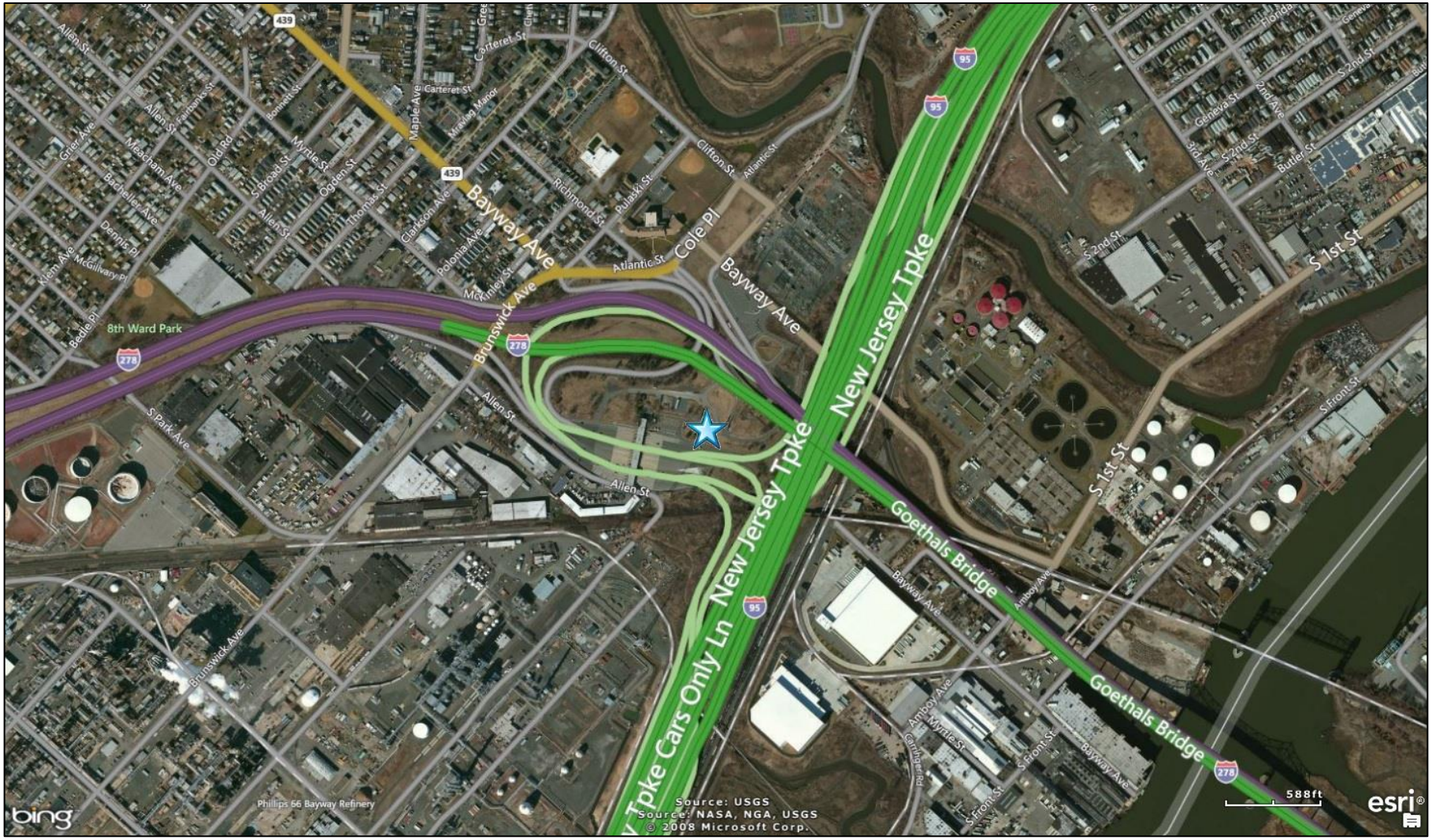


Figure 16-6. North Brunswick, New Jersey (NBNJ) Monitoring Site

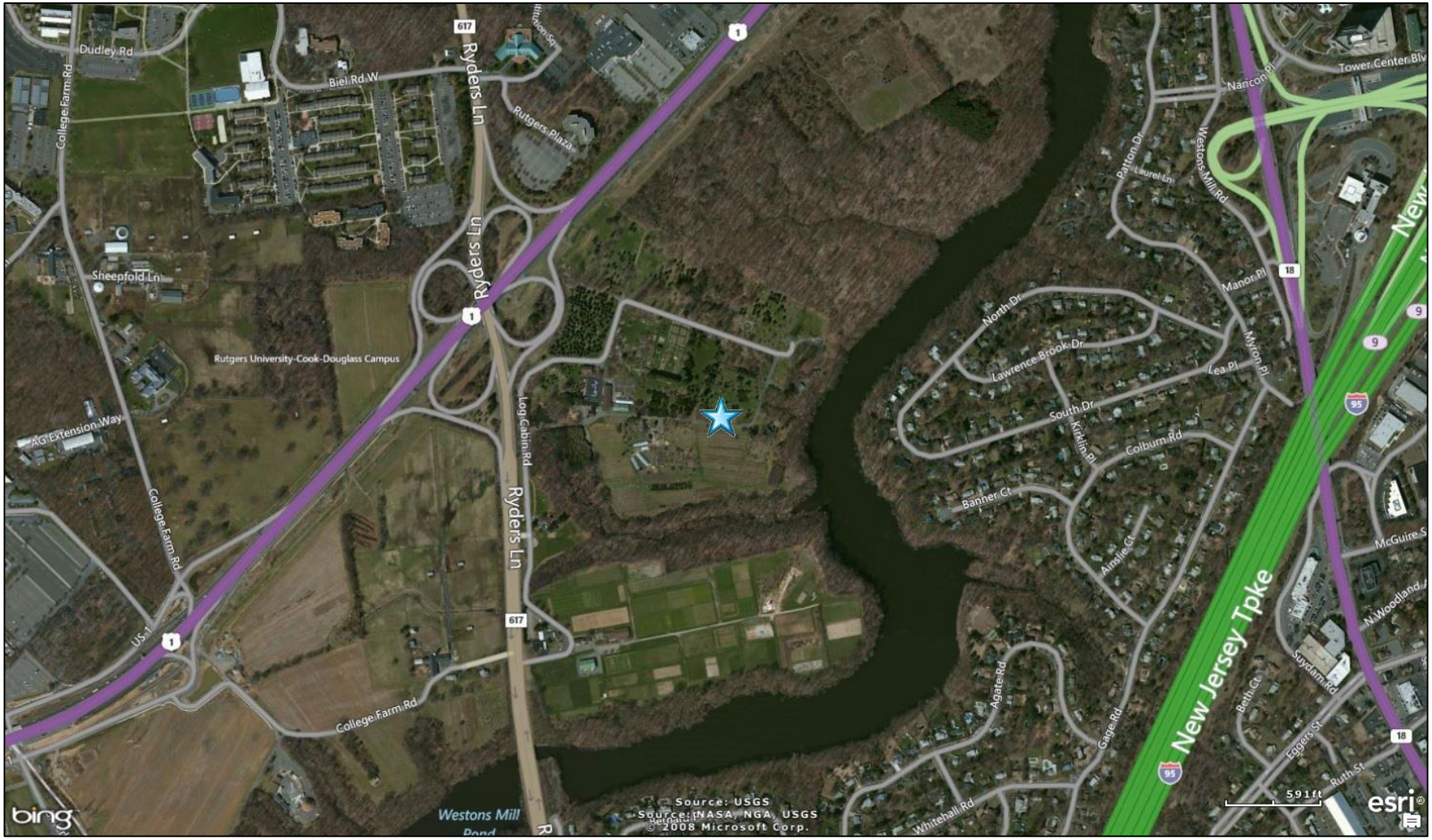


Figure 16-7. NEI Point Sources Located Within 10 Miles of ELNJ and NBNJ

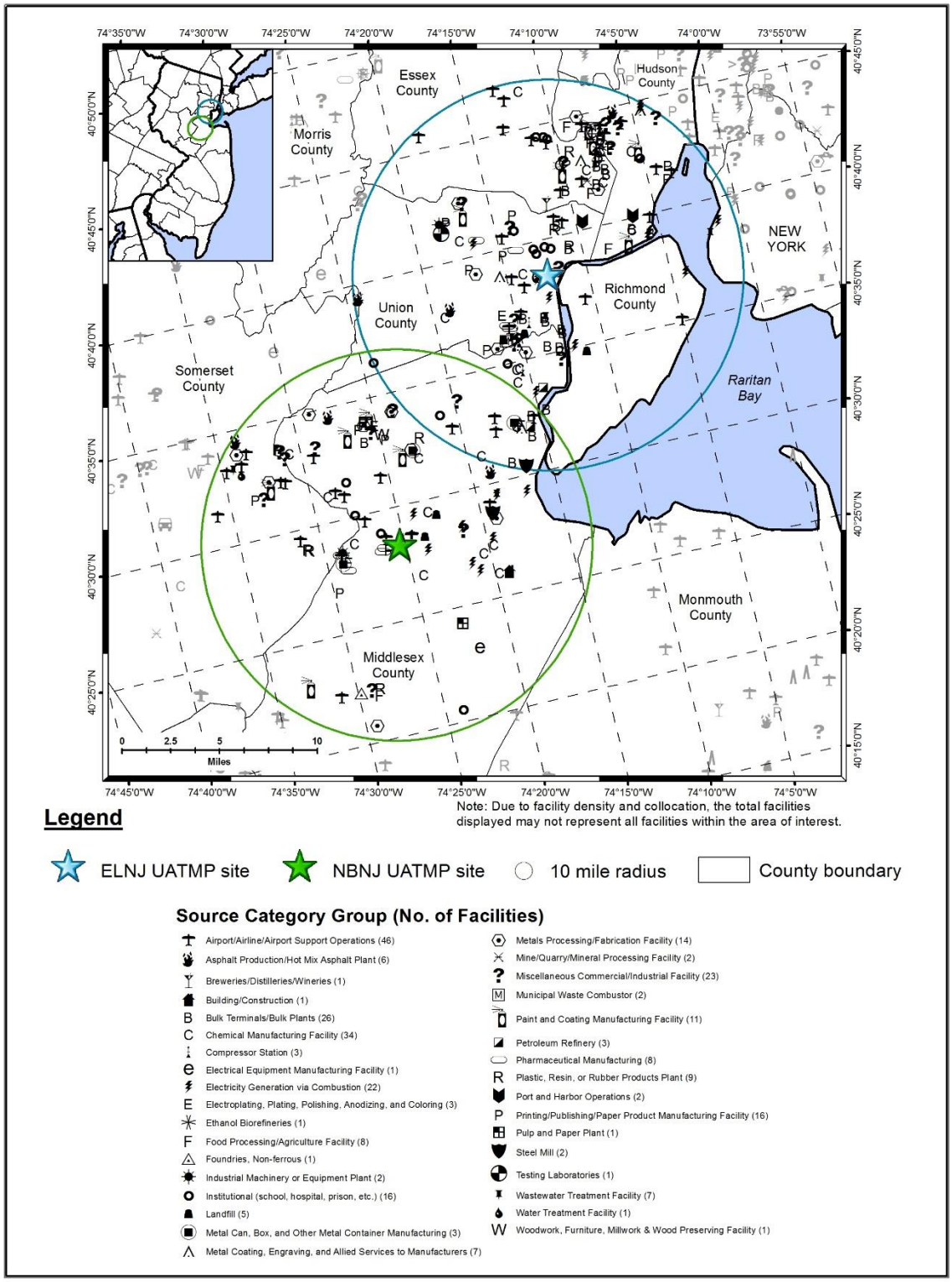


Table 16-1. Geographical Information for the New Jersey Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[3]	Intersection Used for Traffic Data
CSNJ	34-007-0002	Camden	Camden	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	39.934446, -75.125291	Industrial	Urban/City Center	3,231	S 2nd St. south of Walnut St.
CHNJ	34-027-3001	Chester	Morris	New York-Newark-Jersey City, NY-NJ-PA	40.787628, -74.676301	Agricultural	Rural	11,215	Mendham Rd (510/24) east of Fox Chase Rd
ELNJ	34-039-0004	Elizabeth	Union	New York-Newark-Jersey City, NY-NJ-PA	40.641440, -74.208365	Industrial	Suburban	250,000	Between Exits 13 & 13A on I-95
NBNJ	34-023-0006	North Brunswick	Middlesex	New York-Newark-Jersey City, NY-NJ-PA	40.472825, -74.422403	Agricultural	Rural	114,322	US-1, E of Ryders Lane/617

[3]AADT for ELNJ reflects 2006 data from NJ Department of Treasury (NJ DOTr, 2008); AADT reflects 2010 data for NBNJ and 2012 data for CSNJ and CHNJ from the NJ DOT (NJ DOT, 2014).

The CSNJ monitoring site is located just outside Philadelphia, across the state line, in the city of Camden in southwest New Jersey. The monitoring site is in an industrial area a few blocks east of the Delaware River, as shown in Figure 16-1. Residential areas are located to the east between the site and I-676. Figure 16-2 shows that the large number of point sources located within 10 miles of CSNJ are involved in a variety of industries. The source categories with the largest number of facilities include institutions (such as schools, hospitals, and prisons); airports and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; printing, publishing, and paper product manufacturing; chemical manufacturing; and bulk terminals and bulk plants. The sources closest to CSNJ include a metals processing and fabrication facility; a mine/quarry/minerals processing facility; an airport/airport operations facility; and a metal can, box, and other container manufacturing facility.

CHNJ is located in northern New Jersey, in the town of Chester, west of the New York City metropolitan area. Figure 16-3 shows that CHNJ is located in an open area near Building 1 of the Department of Public Works off Routes 513 (North Road) and 510 (Main Street). The surrounding area is rural and agricultural, with a rolling topography, but surrounded by small neighborhoods. Two schools are located on the other site of Route 510 to the south-southwest of CHNJ. Although the location is considered part of the New York City metro area, the site's location is outside most of the urbanized areas. Figure 16-4 shows that few sources are located within a few miles of CHNJ. The source category with the greatest number of emissions sources within 10 miles of CHNJ is the airport source category. The sources closest to CHNJ include a privately-owned heliport to the south and a woodwork, furniture, millwork, and wood preserving facility to the west.

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 16-5 shows, the monitoring site is located near the toll plaza just off Exit 13 of the New Jersey Turnpike (I-95). Interstate-278 intersects the Turnpike here as well. The surrounding area is highly industrialized, with an oil refinery located just southwest of the site. Additional industry is located to the southwest and west, as well as on the east side of the Turnpike, while residential neighborhoods are located to the north and northwest of ELNJ.

NBNJ is located in North Brunswick, approximately 16 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 16-6. County Road 617 (Ryders Lane) and US-1 intersect just west of the site and the New Jersey Turnpike/I-95 runs northeast-southwest less than 1 mile east of the site, part of which can be seen on the right-hand side of Figure 16-6.

Figure 16-7 shows that the outer portions of the 10-mile boundaries for ELNJ and NBNJ intersect; these sites are located approximately 17 miles apart. Many emissions sources surround these two sites. The majority 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 greatest number of emissions sources in the vicinity of these sites include airport operations, chemical manufacturing, bulk terminals and bulk plants, and electricity generation via combustion. The emissions sources in closest proximity to the ELNJ monitoring site are in the wastewater treatment, chemical manufacturing, bulk terminals/bulk plant, petroleum refining, and electricity generation via combustion source categories. The emissions sources in closest proximity to the NBNJ monitoring site are involved in plastic, resin, or rubber products manufacturing, airport and airport support operations, and pharmaceutical manufacturing.

In addition to providing city, county, CBSA, and land use/location setting information, Table 16-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. ELNJ and NBNJ experience a significantly higher traffic volume than CHNJ and CSNJ. Traffic data for ELNJ are provided for I-95, between Exit 13 and 13A; this is the highest traffic volume among all NMP sites. Traffic data for NBNJ are provided for US-1, east of State Road 617 (Ryders Lane); traffic data for CHNJ are provided for Route 510, east of Fox Chase Road; and traffic data for CSNJ are provided for South 2nd Street, south of Walnut Street.

16.2 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 the year.

16.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the New Jersey sites, not enough site-specific data were available in AQS for the parameters listed in Table 16-2; thus, data from the closest NWS weather station to each monitoring site was used for this analysis. A map showing the distance between each New Jersey monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 16-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 16-2 is the 95 percent confidence interval for each parameter. Note that the weather station at Somerville/Somerset Airport is the closest weather station to both CHNJ and NBNJ. Even though sample days are mostly standardized, missed and/or invalid samples and the need for "make-up" samples results in some differences in sample days among the sites; thus, the sample day averages are not the same for these two sites.

As shown in Table 16-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year near each site. The greatest difference between the sample day and full-year averages was calculated for average relative humidity for NBNJ.

Table 16-2. Average Meteorological Conditions near the New Jersey Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Camden, New Jersey – CSNJ[2]							
Sample Days (62)	54.0 ± 1.0	38.4 ± 1.1	58.1 ± 0.9	30.06 ± 0.01	30.04 ± 0.01	WNW	8.4 ± 0.2
2014	55.2 ± 0.4	40.3 ± 0.4	60.1 ± 0.4	30.04 ± <0.01	30.01 ± <0.01	SW	7.7 ± 0.1
Somerville, New Jersey/Somerset Airport[3]							
CHNJ (61)	51.0 ± 1.0	38.5 ± 1.1	65.6 ± 1.0	30.02 ± <0.01	29.91 ± <0.01	NW	3.5 ± 0.2
NBNJ (61)	51.1 ± 1.0	38.4 ± 1.1	64.9 ± 1.0	30.01 ± 0.01	29.91 ± 0.01	NW	3.5 ± 0.2
2014	51.3 ± 0.4	39.3 ± 0.4	67.2 ± 0.4	30.02 ± <0.01	29.91 ± <0.01	NW	3.1 ± 0.1
Elizabeth, New Jersey – ELNJ[4]							
Sample Days (61)	53.3 ± 1.0	38.6 ± 1.1	60.3 ± 0.9	30.04 ± 0.01	30.01 ± 0.01	W	8.4 ± 0.3
2014	54.2 ± 0.4	39.9 ± 0.4	61.7 ± 0.4	30.02 ± <0.01	30.00 ± <0.01	W	7.8 ± 0.1

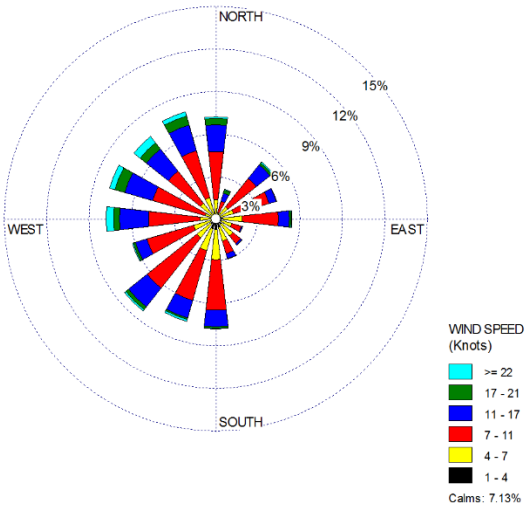
[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]This information was obtained from the NWS weather station located at Philadelphia International Airport, WBAN 13739.
[3]This information was obtained from the NWS weather station located at Somerville, New Jersey/Somerset Airport, WBAN 54785.
[4]This information was obtained from the NWS weather station located at Newark International Airport, WBAN 14734.

16.2.2 Wind Rose Comparison

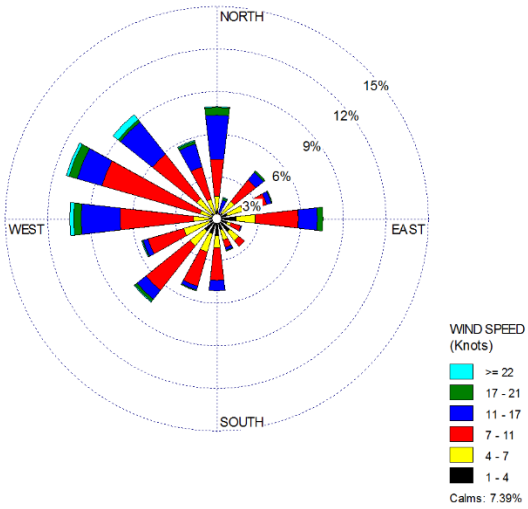
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 16-8 presents two wind roses for the CSNJ monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 16-9 and 16-10 present the full-year and sample day wind roses for CHNJ/NBNJ, and ELNJ.

Figure 16-8. Wind Roses for the Philadelphia International Airport Weather Station near CSNJ

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 16-8 for CSNJ include the following:

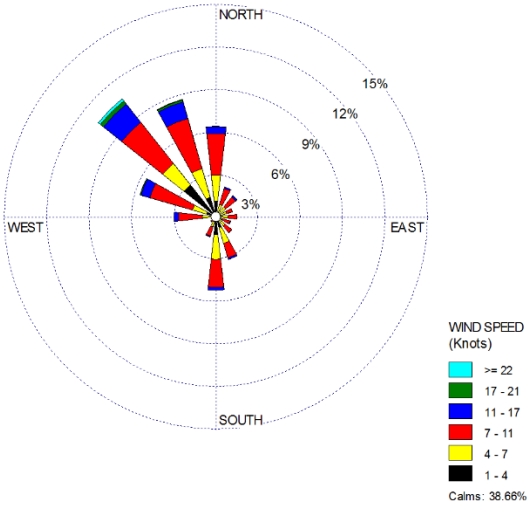
- The Philadelphia International Airport weather station is located 7.2 miles southwest of CSNJ. Both the site and the weather station are located near the Delaware River, which separates Pennsylvania from New Jersey, and runs along the east and south sides of Philadelphia.

- The full-year wind rose shows that winds from a variety of directions were observed near CSNJ, with winds from the southwestern and northwestern quadrants observed more frequently than those from the eastern quadrants. Winds from the western quadrants, and from due south and north account for approximately the same percentage of observations, with each individual direction accounting for between 6 percent and 8 percent of observations. Calm winds account for 7 percent of observations near CSNJ while the strongest winds were most often observed with westerly to north-northwesterly winds.

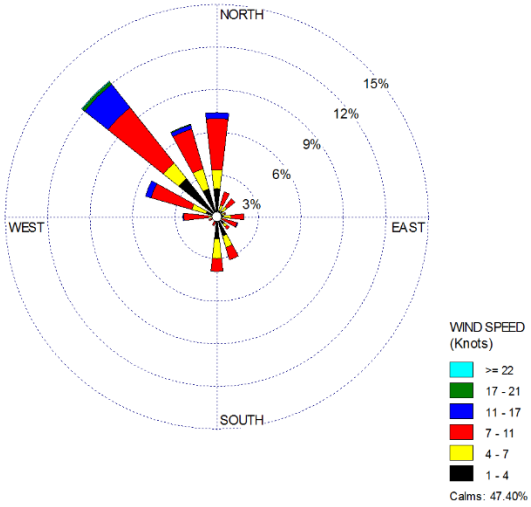
- The even distribution of winds from the western quadrants is not shown on the sample day wind rose. On sample days, winds from the west to northwest were prevalent, with fewer winds from the south, southwest quadrant, and north-northwest. East winds were also observed more frequently on sample days. The percentage of north-northeast winds, winds from the southeast quadrant, and calm winds shown on the sample day wind rose are similar to the percentages shown on the 2014 wind rose.

Figure 16-9. Wind Roses for the Somerville-Somerset Airport Weather Station near CHNJ and NBNJ

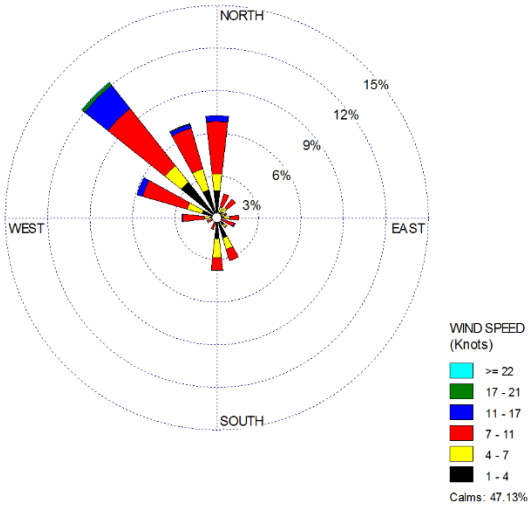
2014 Wind Rose



CHNJ Sample Day Wind Rose



NBNJ Sample Day Wind Rose



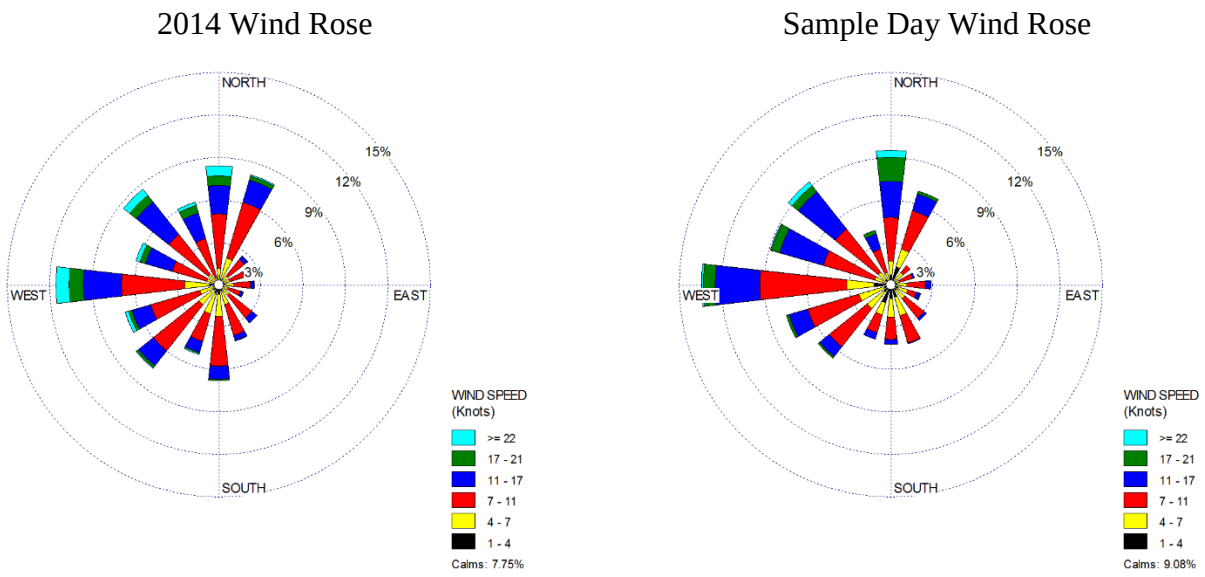
Observations from Figure 16-9 for CHNJ and NBNJ include the following:

- The weather station at Somerville/Somerset Airport is the closest weather station to both CHNJ and NBNJ. The Somerville/Somerset Airport weather station is located 11.3 miles south of CHNJ and 16.7 miles northwest of NBNJ.

- The full-year wind rose for these sites shows that calm winds account for nearly 40 percent of observations. For the remaining observations, northwesterly winds were observed most frequently, followed by winds from the north-northwest, north, and west-northwest, together accounting for nearly 20 percent of the observations. With the exception of south-southeasterly and southerly winds, winds from the other quadrants were infrequently observed.

- The sample day wind roses for CHNJ and NBNJ resemble each other. Both wind roses show that calm winds were prevalent near these sites, with calm winds accounting for 47 percent of the observations on sample days. For the remaining observations, northwesterly winds were prevalent on sample days, with winds from the west-northwest to north accounting for the majority of observations.

Figure 16-10. Wind Roses for the Newark International Airport Weather Station near ELNJ



Observations from Figure 16-10 for ELNJ include the following:

- The Newark International Airport weather station is located 3.5 miles northeast of ELNJ. Both the site and the weather station are located in close proximity to the New Jersey Turnpike.

- The full-year wind rose shows that winds from a variety of directions were observed near ELNJ, although winds from the northeast to east-southeast were observed infrequently. Westerly winds were observed the most, accounting for nearly 12 percent of observations. Calm winds accounted for nearly 8 percent of observations. The strongest winds were associated with west-southwesterly to northerly winds.

- Westerly winds were also prevalent on sample days, accounting for a slightly higher percentage of observations. Winds from the southwest to northwest, to north and north-northeast accounted for the majority of observations, similar to what is shown on the full-year wind rose. Calms winds accounted for 9 percent of observations on sample days.

16.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each New Jersey monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 16-3. 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 and are shaded in gray in Table 16-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs and carbonyl compounds were sampled for at all four New Jersey sites.

Table 16-3. Risk-Based 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 - CSNJ						
Benzene	0.13	61	61	100.00	15.25	15.25
1,3-Butadiene	0.03	61	61	100.00	15.25	30.50
Carbon Tetrachloride	0.17	61	61	100.00	15.25	45.75
Acetaldehyde	0.45	60	60	100.00	15.00	60.75
Formaldehyde	0.077	60	60	100.00	15.00	75.75
1,2-Dichloroethane	0.038	59	59	100.00	14.75	90.50
Hexachloro-1,3-butadiene	0.045	12	12	100.00	3.00	93.50
Ethylbenzene	0.4	11	61	18.03	2.75	96.25
p-Dichlorobenzene	0.091	6	30	20.00	1.50	97.75
Bromomethane	0.5	3	53	5.66	0.75	98.50
Propionaldehyde	0.8	2	60	3.33	0.50	99.00
Trichloroethylene	0.2	2	22	9.09	0.50	99.50
Vinyl chloride	0.11	1	8	12.50	0.25	99.75
Xylenes	10	1	61	1.64	0.25	100.00
Total		400	669	59.79		
Chester, New Jersey - CHNJ						
Benzene	0.13	61	61	100.00	16.22	16.22
Carbon Tetrachloride	0.17	61	61	100.00	16.22	32.45
Acetaldehyde	0.45	60	60	100.00	15.96	48.40
1,2-Dichloroethane	0.038	60	60	100.00	15.96	64.36
Formaldehyde	0.077	60	60	100.00	15.96	80.32
1,3-Butadiene	0.03	56	59	94.92	14.89	95.21
Hexachloro-1,3-butadiene	0.045	14	16	87.50	3.72	98.94
1,2-Dibromoethane	0.0017	3	3	100.00	0.80	99.73
p-Dichlorobenzene	0.091	1	16	6.25	0.27	100.00
Total		376	396	94.95		

Table 16-3. Risk-Based 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						
Acetaldehyde	0.45	61	61	100.00	14.91	14.91
Formaldehyde	0.077	61	61	100.00	14.91	29.83
Benzene	0.13	59	59	100.00	14.43	44.25
1,3-Butadiene	0.03	59	59	100.00	14.43	58.68
Carbon Tetrachloride	0.17	59	59	100.00	14.43	73.11
1,2-Dichloroethane	0.038	57	57	100.00	13.94	87.04
Ethylbenzene	0.4	19	59	32.20	4.65	91.69
Hexachloro-1,3-butadiene	0.045	18	18	100.00	4.40	96.09
p-Dichlorobenzene	0.091	10	30	33.33	2.44	98.53
Propionaldehyde	0.8	3	61	4.92	0.73	99.27
1,2-Dibromoethane	0.0017	2	2	100.00	0.49	99.76
Chloroprene	0.0021	1	1	100.00	0.24	100.00
Total		409	527	77.61		
North Brunswick, New Jersey - NBNJ						
Benzene	0.13	60	60	100.00	19.05	19.05
Carbon Tetrachloride	0.17	60	60	100.00	19.05	38.10
1,2-Dichloroethane	0.038	58	58	100.00	18.41	56.51
1,3-Butadiene	0.03	56	57	98.25	17.78	74.29
Acetaldehyde	0.45	20	20	100.00	6.35	80.63
Formaldehyde	0.077	20	20	100.00	6.35	86.98
Hexachloro-1,3-butadiene	0.045	16	17	94.12	5.08	92.06
Ethylbenzene	0.4	11	60	18.33	3.49	95.56
p-Dichlorobenzene	0.091	5	25	20.00	1.59	97.14
Propionaldehyde	0.8	5	20	25.00	1.59	98.73
1,2-Dibromoethane	0.0017	3	3	100.00	0.95	99.68
Bromomethane	0.5	1	50	2.00	0.32	100.00
Total		315	450	70.00		

Observations from Table 16-3 include the following:

- Fourteen pollutants failed at least one screen for CSNJ; 60 percent of concentrations for these 14 pollutants were greater than their associated risk screening value (or failed screens).

- Eight pollutants contributed to 95 percent of failed screens for CSNJ and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs.

- Nine pollutants failed at least one screen for CHNJ; 96 percent of concentrations for these nine pollutants were greater than their associated risk screening value (or failed screens).

- Six pollutants contributed to 95 percent of failed screens for CHNJ and therefore were identified as pollutants of interest for this site. These six include two carbonyl compounds and four VOCs.

- Twelve pollutants failed at least one screen for ELNJ, with nearly 78 percent of concentrations for these 12 pollutants greater than their associated risk screening value (or failing screens).

- Eight pollutants contributed to 95 percent of failed screens for ELNJ and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs.

- Twelve pollutants failed at least one screen for NBNJ, with 70 percent of concentrations for these 12 pollutants greater than their associated risk screening value (or failing screens).

- Eight pollutants contributed to 95 percent of failed screens for NBNJ and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs.

- The New Jersey sites have six pollutants of interest in common: acetaldehyde, formaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and 1,2-dichloroethane. If CHNJ is excluded, the New Jersey sites would also have ethylbenzene and hexachloro-1,3-butadiene in common.

16.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the New Jersey monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the New Jersey monitoring sites are provided in Appendices J and L.

16.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each New Jersey site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the New Jersey monitoring sites are presented in Table 16-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 16-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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 - CSNJ							
Acetaldehyde	60/60	60	2.20 ± 0.29	2.84 ± 0.44	2.99 ± 0.55	1.94 ± 0.20	2.49 ± 0.22
Benzene	61/61	61	0.97 ± 0.14	0.54 ± 0.09	0.86 ± 0.25	0.66 ± 0.14	0.76 ± 0.09
1,3-Butadiene	61/61	61	0.11 ± 0.03	0.06 ± 0.01	0.10 ± 0.02	0.11 ± 0.03	0.09 ± 0.01
Carbon Tetrachloride	61/61	61	0.53 ± 0.06	0.64 ± 0.03	0.66 ± 0.02	0.60 ± 0.06	0.61 ± 0.03
1,2-Dichloroethane	59/58	61	0.09 ± 0.01	0.08 ± 0.01	0.07 ± 0.02	0.08 ± 0.01	0.08 ± 0.01
Ethylbenzene	61/61	61	0.30 ± 0.11	0.22 ± 0.05	0.49 ± 0.43	0.29 ± 0.13	0.33 ± 0.11
Formaldehyde	60/60	60	3.36 ± 0.47	4.87 ± 1.17	6.33 ± 1.05	3.35 ± 0.53	4.48 ± 0.52
Hexachloro-1,3-butadiene	12/0	61	0.01 ± 0.01	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Chester, New Jersey - CHNJ							
Acetaldehyde	60/60	60	1.34 ± 0.34	1.27 ± 0.25	1.18 ± 0.17	1.22 ± 0.19	1.25 ± 0.12
Benzene	61/61	61	0.69 ± 0.06	0.44 ± 0.14	0.36 ± 0.05	0.40 ± 0.04	0.47 ± 0.05
1,3-Butadiene	59/57	61	0.07 ± 0.02	0.05 ± 0.01	0.07 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
Carbon Tetrachloride	61/61	61	0.57 ± 0.06	0.66 ± 0.03	0.64 ± 0.03	0.55 ± 0.05	0.60 ± 0.03
1,2-Dichloroethane	60/57	61	0.08 ± 0.01	0.08 ± 0.01	0.07 ± 0.01	0.08 ± 0.01	0.08 ± <0.01
Formaldehyde	60/60	60	1.80 ± 0.50	2.41 ± 0.82	3.07 ± 0.78	1.10 ± 0.22	2.06 ± 0.34

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

Table 16-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Elizabeth, New Jersey - ELNJ							
Acetaldehyde	61/61	61	2.50 ± 0.35	3.21 ± 0.50	3.02 ± 0.49	2.40 ± 0.25	2.78 ± 0.21
Benzene	59/59	59	1.15 ± 0.27	0.63 ± 0.12	0.68 ± 0.10	0.66 ± 0.08	0.78 ± 0.09
1,3-Butadiene	59/59	59	0.15 ± 0.04	0.09 ± 0.02	0.12 ± 0.02	0.11 ± 0.02	0.12 ± 0.01
Carbon Tetrachloride	59/59	59	0.57 ± 0.06	0.64 ± 0.03	0.64 ± 0.04	0.62 ± 0.06	0.62 ± 0.03
1,2-Dichloroethane	57/57	59	0.09 ± 0.02	0.09 ± 0.01	0.07 ± 0.01	0.09 ± 0.01	0.09 ± 0.01
Ethylbenzene	59/59	59	0.41 ± 0.13	0.32 ± 0.11	0.39 ± 0.06	0.33 ± 0.08	0.36 ± 0.05
Formaldehyde	61/61	61	3.74 ± 0.59	4.70 ± 0.98	6.38 ± 1.29	3.03 ± 0.46	4.44 ± 0.52
Hexachloro-1,3-butadiene	18/0	59	0.03 ± 0.02	0.02 ± 0.02	0.03 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
North Brunswick, New Jersey - NBNJ							
Acetaldehyde	20/20	20	3.17 ± 0.92	NA	NA	NA	NA
Benzene	60/60	60	0.86 ± 0.13	0.42 ± 0.06	0.43 ± 0.10	0.44 ± 0.08	0.54 ± 0.07
1,3-Butadiene	57/56	60	0.10 ± 0.03	0.05 ± 0.01	0.06 ± 0.01	0.05 ± 0.02	0.07 ± 0.01
Carbon Tetrachloride	60/60	60	0.56 ± 0.06	0.68 ± 0.03	0.67 ± 0.02	0.62 ± 0.03	0.63 ± 0.02
1,2-Dichloroethane	58/55	60	0.09 ± 0.01	0.09 ± 0.01	0.07 ± 0.02	0.08 ± 0.01	0.08 ± 0.01
Ethylbenzene	60/59	60	0.32 ± 0.14	0.40 ± 0.15	0.16 ± 0.02	0.11 ± 0.03	0.25 ± 0.06
Formaldehyde	20/20	20	6.39 ± 2.57	NA	NA	NA	NA
Hexachloro-1,3-butadiene	17/0	60	0.03 ± 0.02	0.03 ± 0.03	0.03 ± 0.03	<0.01 ± 0.01	0.02 ± 0.01

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

Observations for CSNJ from Table 16-4 include the following:

- The pollutants of interest with the highest annual average concentrations are formaldehyde (4.48 ± 0.52 µg/m^3) and acetaldehyde (2.49 ± 0.22 µg/m^3). These are the only two pollutants with annual average concentrations greater than 1 µg/m^3. Of the VOCs, benzene has the highest annual average concentration (0.76 ± 0.09 µg/m^3).

- Concentrations of formaldehyde appear highest during the second and third quarters of 2014, based on the quarterly averages shown. A review of the data shows that formaldehyde concentrations measured at CSNJ range from 2.01 µg/m^3 to 11.9 µg/m^3. All 12 formaldehyde concentrations greater than 6 µg/m^3 were measured at CSNJ between June and September and all but four of the 25 highest concentrations were measured during the second and third quarters (with those four measured in either March and October).

- Concentrations of acetaldehyde also appear highest during the second and third quarters of 2014, although the differences are less remarkable. Acetaldehyde concentrations measured at CSNJ range from 1.02 µg/m^3 to 6.30 µg/m^3, with the maximum concentration measured on the same day at CSNJ as the maximum formaldehyde concentration (August 27, 2014). All but one of the 15 acetaldehyde concentrations greater than 3 µg/m^3 were measured at CSNJ during the second and third quarters of 2014. Conversely, all but two of the 15 concentrations less than 2 µg/m^3 were measured at CSNJ during the first or fourth quarters of 2014 (with the two exceptions measured in April).

- The maximum concentration of benzene (2.12 µg/m^3) was also measured at CSNJ on August 27, 2014 and is the only benzene concentration greater than 2 µg/m^3 measured at this site. Of the 12 benzene concentrations greater than 1 µg/m^3 measured at CSNJ, six were measured during the first quarter, five were measured during the third quarter, one was measured during the fourth quarter, and none were measured during the second quarter of 2014. In addition, all 12 benzene concentrations less than 0.5 µg/m^3 were measured at CSNJ during the second or fourth quarters, with the four lowest concentration measured in April and May. This explains the differences shown in the quarterly average benzene concentrations, even though the differences are not statistically significant.

- The third quarter average concentration of ethylbenzene (0.49 ± 0.43 µg/m^3) is considerably higher than the other quarterly averages and has a confidence interval of nearly the same magnitude. This indicates the likely influence of outliers. The maximum ethylbenzene concentration (3.35 µg/m^3) was measured at CSNJ on September 26, 2014 and is the maximum ethylbenzene concentration measured across the program. The second highest concentration measured at CSNJ (1.07 µg/m^3) was measured in October and all other concentrations measured at CSNJ are less than 0.7 µg/m^3.

Observations for CHNJ from Table 16-4 include the following:

- The pollutants of interest with the highest annual average concentrations are formaldehyde (2.06 ± 0.34 µg/m^3) and acetaldehyde (1.25 ± 0.12 µg/m^3). These are the only two pollutants with annual average concentrations greater than 1 µg/m^3. Of the VOCs, carbon tetrachloride has the highest annual average concentration (0.60 ± 0.03 µg/m^3).

- Concentrations of formaldehyde appear highest during the second and third quarters of 2014, with the third quarter average concentration nearly three times higher than the fourth quarter average concentration. A review of the data shows that formaldehyde concentrations measured at CHNJ range from 0.588 µg/m^3 to 6.07 µg/m^3. Similar to CSNJ, the maximum concentration of formaldehyde was measured at CHNJ on August 27, 2014. All but one of the 12 formaldehyde concentrations greater than 3 µg/m^3 were measured at CHNJ between June and August, including the four concentrations greater than 5 µg/m^3. Conversely, the six lowest formaldehyde concentrations were measured at CHNJ between November and December. The quarterly average concentration for the fourth quarter is particularly low, as formaldehyde concentrations greater than 2 µg/m^3 were not measured at CHNJ during the fourth quarter, compared to five measured during the first quarter, six during the second quarter, and 11 during the third quarter.

- The first quarter average concentration of benzene is significantly higher than the other quarterly averages while there is little difference among the other quarterly averages. A review of the data shows that benzene concentrations measured at CHNJ range from 0.234 µg/m^3 to 1.32 µg/m^3. While the maximum benzene concentration was measured at CHNJ in April, the next six highest benzene concentrations were measured in either January or March. Of the 22 benzene concentrations greater than 0.5 µg/m^3 measured at CHNJ, 15 were measured during the first quarter, accounting for all of the concentrations measured that quarter. Benzene concentrations less than the annual average concentration were not measured during the first quarter of 2014.

Observations for ELNJ from Table 16-4 include the following:

- The pollutants of interest with the highest annual average concentrations are formaldehyde (4.44 ± 0.52 µg/m^3) and acetaldehyde (2.78 ± 0.21 µg/m^3). These are the only two pollutants with annual average concentrations greater than 1 µg/m^3. Of the VOCs, benzene has the highest annual average concentration (0.78 ± 0.09 µg/m^3).

- Similar to CSNJ and CHNJ, concentrations of formaldehyde measured at ELNJ tended to be higher during the warmer months of the year, as indicated by the second and third quarter average concentrations. A review of the data shows that formaldehyde concentrations measured at ELNJ range from 1.77 µg/m^3 to 11.6 µg/m^3, with the maximum concentration measured on August 27, 2014, the same day the maximum formaldehyde concentrations at CSNJ and CHNJ were measured. Of the 18 formaldehyde concentrations greater than 5 µg/m^3 measured at ELNJ, all but one was measured between April and September, with the five highest concentrations measured during the third quarter of 2014.

- Similar to CHNJ, the first quarter average concentration of benzene for ELNJ is significantly higher than the other quarterly averages while there is little difference among the other quarterly averages. A review of the data shows that benzene concentrations measured at ELNJ range from 0.371 µg/m^3 to 2.57 µg/m^3. The five highest benzene concentrations measured at ELNJ were measured between January and March; further, seven benzene concentrations greater than 1 µg/m^3 were measured during the first quarter of 2014 while no other calendar quarter has more than one.

Observations for NBNJ from Table 16-4 include the following:

- In regards to carbonyl compound sampling at NBNJ, a defective sampler was identified at the NBNJ site and the results between May 5, 2014 and December 31, 2014 were invalidated. A new sampler was installed in January 2015. As a result, only a first quarter average concentration could be calculated for this site.

- Even with this invalidation, some of the highest formaldehyde concentrations across the program were measured at NBNJ. Concentrations of formaldehyde measured at NBNJ between January and May 2014 span an order of magnitude, ranging from 2.15 µg/m^3 to 21.8 µg/m^3, including five formaldehyde concentrations greater than 10 µg/m^3 as well as the second and third highest formaldehyde concentrations measured across the program. Higher concentrations of acetaldehyde were also measured at NBNJ. Concentrations of acetaldehyde measured at NBNJ between January and May 2014 range from 2.02 µg/m^3 to 8.92 µg/m^3, which is the fourth highest acetaldehyde concentration measured across the program. The maximum acetaldehyde and maximum formaldehyde concentrations were both measured on January 11, 2014.

- The VOCs with the highest annual average concentrations for NBNJ are carbon tetrachloride (0.63 ± 0.02 µg/m^3) and benzene (0.54 ± 0.07 µg/m^3).

- Similar to CHNJ and ELNJ, the first quarter average concentration of benzene for NBNJ is significantly higher than the other quarterly averages while there is little difference among the other quarterly averages. A review of the data shows that benzene concentrations measured at NBNJ range from 0.234 µg/m^3 to 1.44 µg/m^3. The maximum benzene concentration was measured on the same day in January as the maximum acetaldehyde and formaldehyde concentrations. Four benzene concentrations greater than 1 µg/m^3 were measured at NBNJ between January and March, while only one was measured the rest of the year; further, benzene concentrations less than 0.5 µg/m^3 were not measured during the first quarter of 2014 while each other calendar quarter has more than 10.

- The quarterly average concentrations of 1,3-butadiene have a similar pattern as the quarterly average concentrations of benzene, although the differences are not significant. A review of the data shows that 1,3-butadiene concentrations measured at NBNJ range from 0.022 µg/m^3 to 0.279 µg/m^3, plus three non-detects. The maximum 1,3-butadiene concentration was also measured on January 11, 2014. Four 1,3-butadiene concentrations greater than 0.1 µg/m^3 were measured at NBNJ between

January and March, while only one was measured the rest of the year; further, the first quarter includes the fewest 1,3-butadiene concentrations less than 0.05 µg/m^3.

- The first and second quarter average concentrations of ethylbenzene appear higher than the other two quarterly averages and have larger confidence intervals associated with them. All 16 ethylbenzene concentrations greater than 0.25 µg/m^3 measured at NBNJ were measured between January and June. The maximum ethylbenzene concentration was measured at NBNJ on May 11, 2014 (1.18 µg/m^3), although a similar concentration was also measured on January 11, 2014 (1.10 µg/m^3). Conversely, all nine ethylbenzene concentrations less than 0.1 µg/m^3 were measured during the fourth quarter of 2014, which has the lowest quarterly average concentration.

Additional observations for the New Jersey sites from Table 16-4 include:

- Formaldehyde and acetaldehyde were the pollutants of interest with the highest annual average concentrations for each New Jersey site (with the exception of NBNJ, where annual averages could not be calculated). Concentrations of these pollutants were higher at CSNJ and ELNJ than CHNJ. Even though annual averages could not be calculated for NBNJ, some of the highest concentrations of formaldehyde and acetaldehyde across the program were measured at this site. Formaldehyde concentrations were higher during the warmer months of the year at each site, as indicated by the quarterly averages.

- Benzene and carbon tetrachloride have the highest annual average concentrations of the VOC pollutants of interest. Concentrations of benzene were also higher at CSNJ and ELNJ compared to CHNJ and NBNJ while concentrations of carbon tetrachloride varied little across the sites.

- The maximum concentrations of several pollutants of interest in common among the New Jersey sites were measured on the same sample day. For instance, the maximum concentrations of acetaldehyde, formaldehyde, benzene, 1,3-butadiene were all measured on the same day at NBNJ (January 11, 2014). Further, the maximum 1,3-butadiene concentrations for all four sites were measured on January 11, 2014. The maximum concentrations of formaldehyde measured at CSNJ, CHNJ, and ELNJ were all measured on August 27, 2014. The maximum acetaldehyde concentrations for CSNJ and ELNJ were also measured on this date in August.

Tables 4-9 through 4-12 present the NMP sites with the 10 highest annual 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 VOCs a total of 10 times (CSNJ, twice; CHNJ, once; ELNJ, five times; and NBNJ, twice).

- Three New Jersey sites appear in Table 4-9 for hexachloro-1,3-butadiene, with ELNJ, NBNJ, and CHNJ ranking fourth, seventh, and eighth, respectively, for this pollutant.

CSNJ's annual average concentration is similar to the other sites, although it ranks 20th among NMP sites sampling VOCs. Note that annual averages of this pollutant vary by only 0.05 µg/m^3 across the program.

- ELNJ and CSNJ both appear among those sites with the highest annual average concentrations of ethylbenzene and *p*-dichlorobenzene, neither of which rank higher than seventh.

- ELNJ also ranks seventh and eighth, respectively, for the annual average concentrations of 1,3-butadiene and 1,2-dichloroethane.

- NBNJ ranks tenth for its annual average concentration of carbon tetrachloride.

- CSNJ and ELNJ both appear in Table 4-10 for both carbonyl compounds. CSNJ has the second highest annual average concentration of formaldehyde and the sixth highest annual average concentration of acetaldehyde, among NMP sites sampling these pollutants. ELNJ has the third highest annual average concentrations of both acetaldehyde and formaldehyde among NMP sites sampling carbonyl compounds.

16.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 16-4 for each of the New Jersey sites. Figures 16-11 through 16-18 overlay the sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 16-11. Program vs. Site-Specific Average Acetaldehyde Concentrations

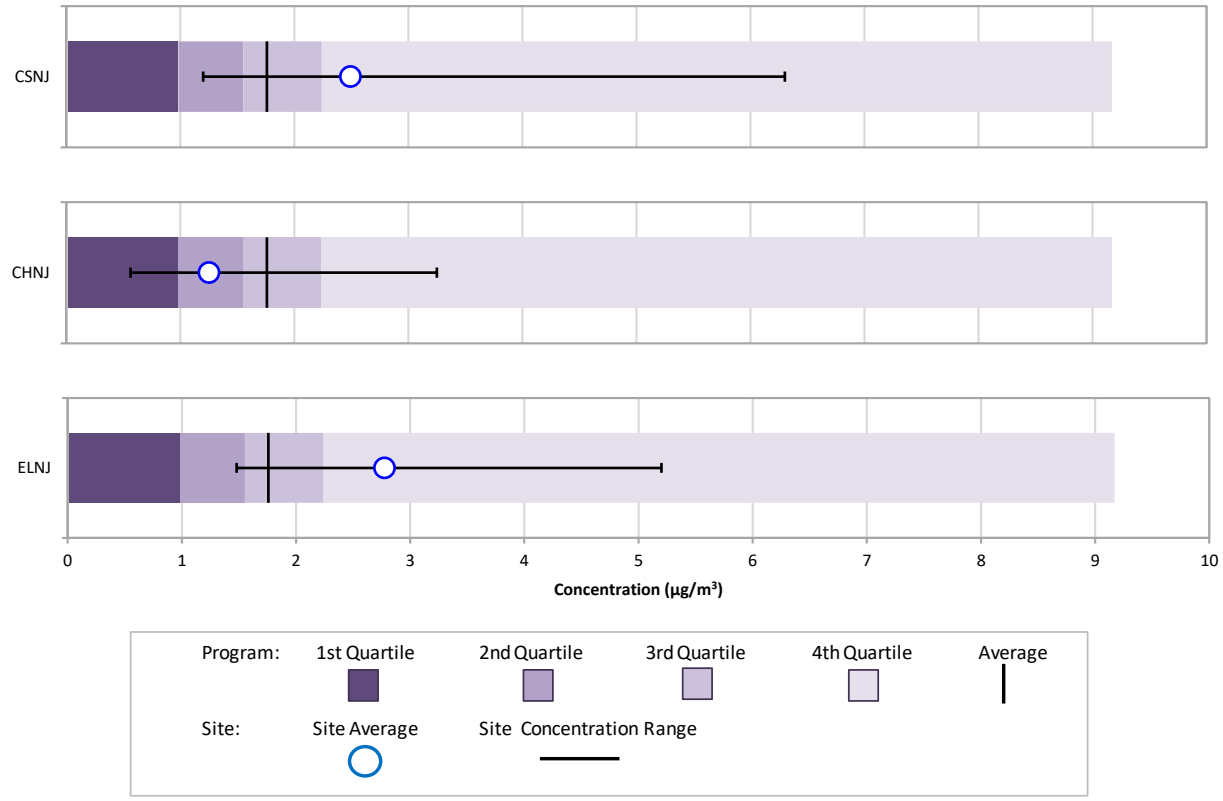


Figure 16-11 presents the box plots for acetaldehyde for the New Jersey sites and shows the following:

- This figure presents the boxplots for CSNJ, CHNJ, and ELNJ. Recall from the previous section that annual average concentrations for the carbonyl compounds could not be calculated for NBNJ, and thus, a box plot for this site is not provided.

- The range of acetaldehyde concentrations is largest for CSNJ and smallest for CHNJ. The minimum concentrations measured at CSNJ and ELNJ are greater than the program-level first quartile, with the minimum for ELNJ just less than the program-level median concentration.

- Among these sites, ELNJ's annual average concentration is just greater than the annual average concentration for CSNJ, both of which are twice the annual average concentration for CHNJ. The annual averages for CSNJ and ELNJ are both greater than the program-level average concentration as well as the program-level third quartile while the annual average for CHNJ is less than the program-level average and median concentrations. Recall from the previous section that ELNJ has the third highest annual average concentration among the NMP sites sampling this pollutant and CSNJ's annual average concentration ranks sixth.

Figure 16-12. Program vs. Site-Specific Average Benzene Concentrations

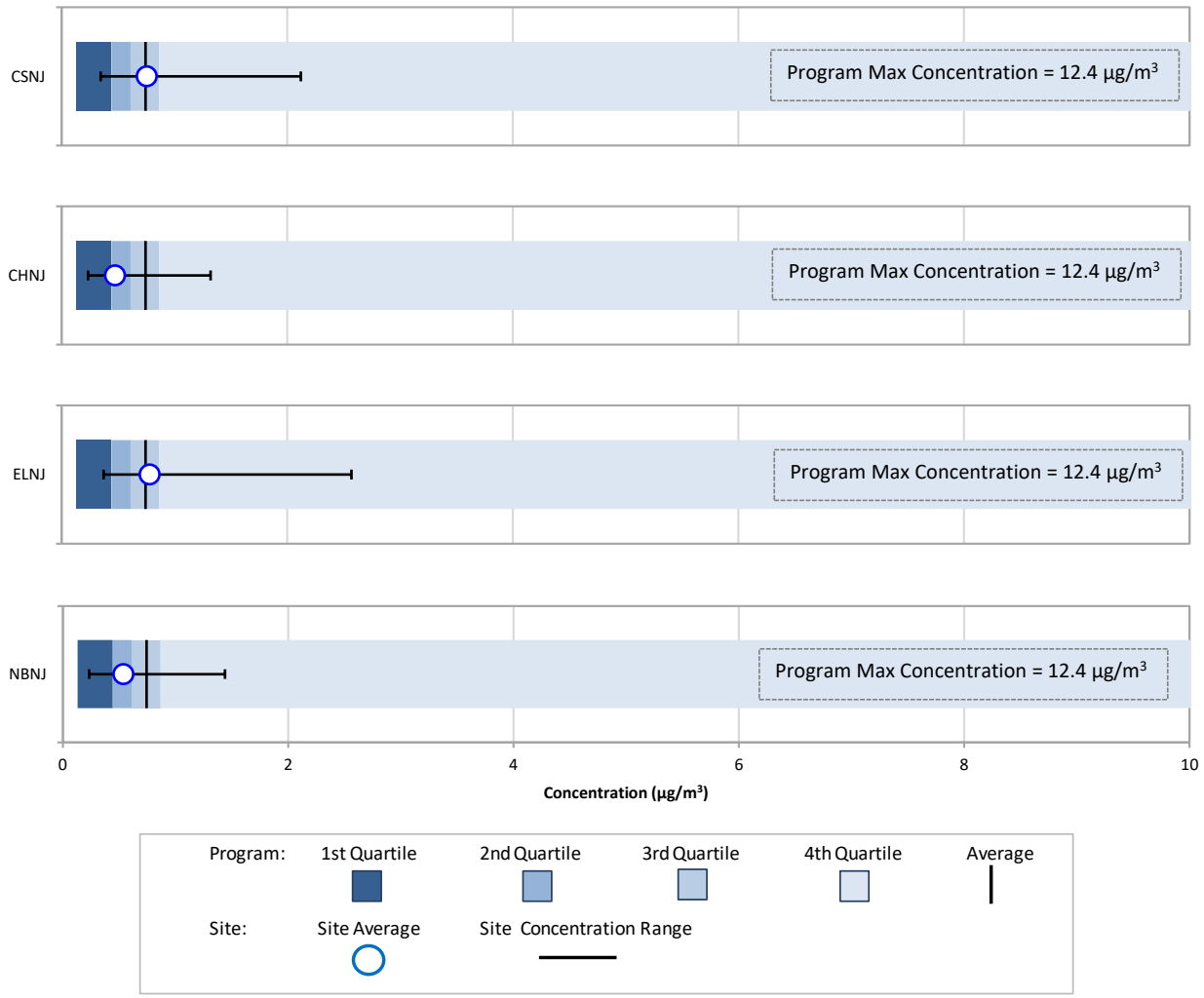


Figure 16-12 presents the box plots for benzene for the New Jersey sites and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plots in Figure 16-12 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- Compared to the maximum benzene concentration measured across the program, the maximum concentrations measured at each New Jersey site are considerably less (none were greater than 3 µg/m^3). The range of benzene concentrations measured was largest for ELNJ and CSNJ and smallest at CHNJ and NBNJ.

- The annual average concentrations of benzene for ELNJ and CSNJ are similar to the average concentration across the program, while the annual averages for CHNJ and NBNJ fall between the program-level first and second quartiles.

Figure 16-13. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

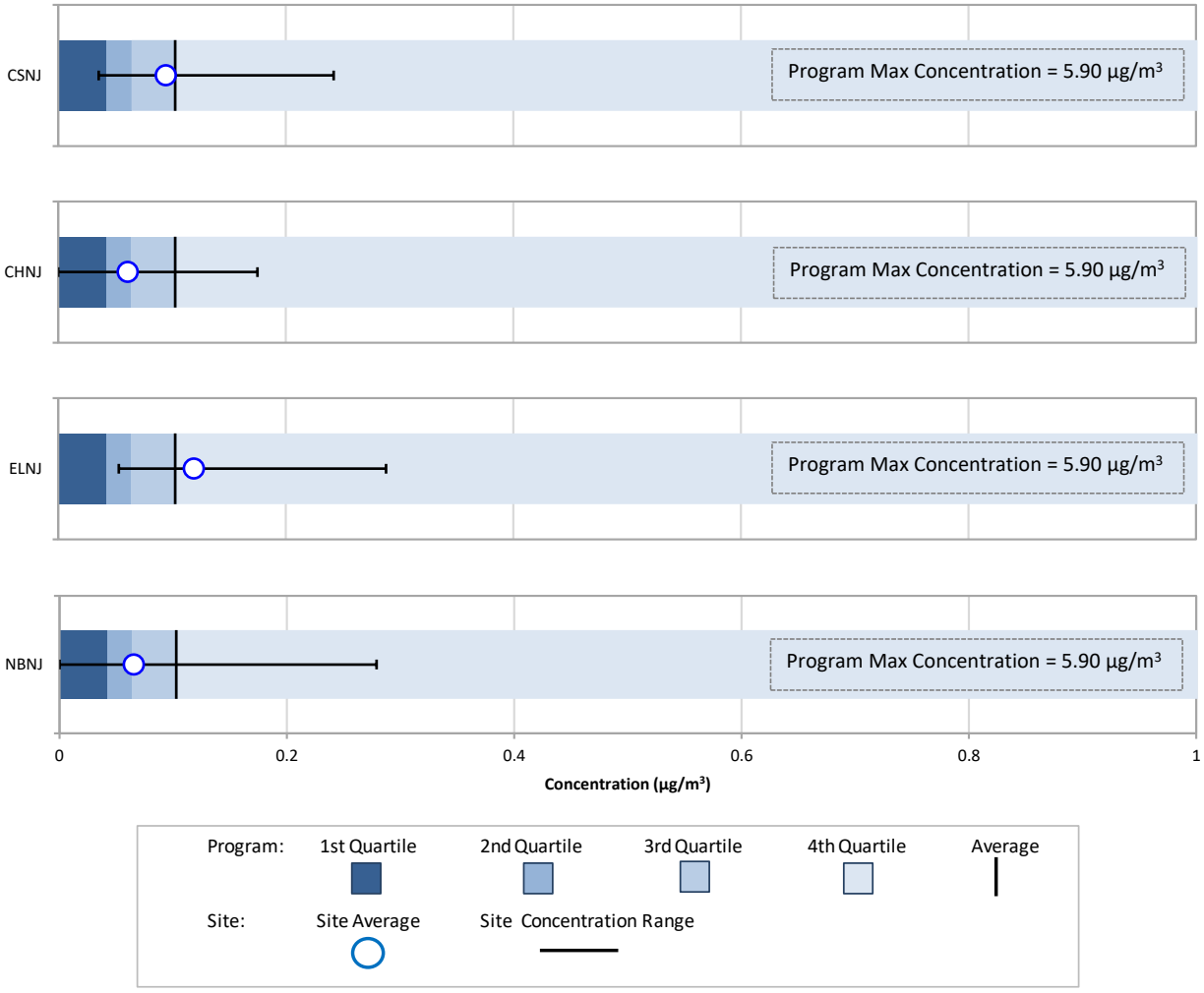


Figure 16-13 presents the box plots for 1,3-butadiene for the New Jersey sites and shows the following:

- Similar to benzene, the program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plots in Figure 16-13 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced to 1 µg/m^3.

- All of the 1,3-butadiene concentrations measured at the New Jersey sites are less than 0.3 µg/m^3. A few non-detects were measured at NBNJ and CHNJ while none were measured at the other two sites. The minimum concentration measured at ELNJ is greater than the program-level first quartile.

- The annual average concentrations of 1,3-butadiene for the New Jersey sites range from 0.06 ± 0.01 µg/m^3 (CHNJ) to 0.12 ± 0.01 µg/m^3 (ELNJ), with only ELNJ's annual average concentration greater than the program-level average.

Figure 16-14. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

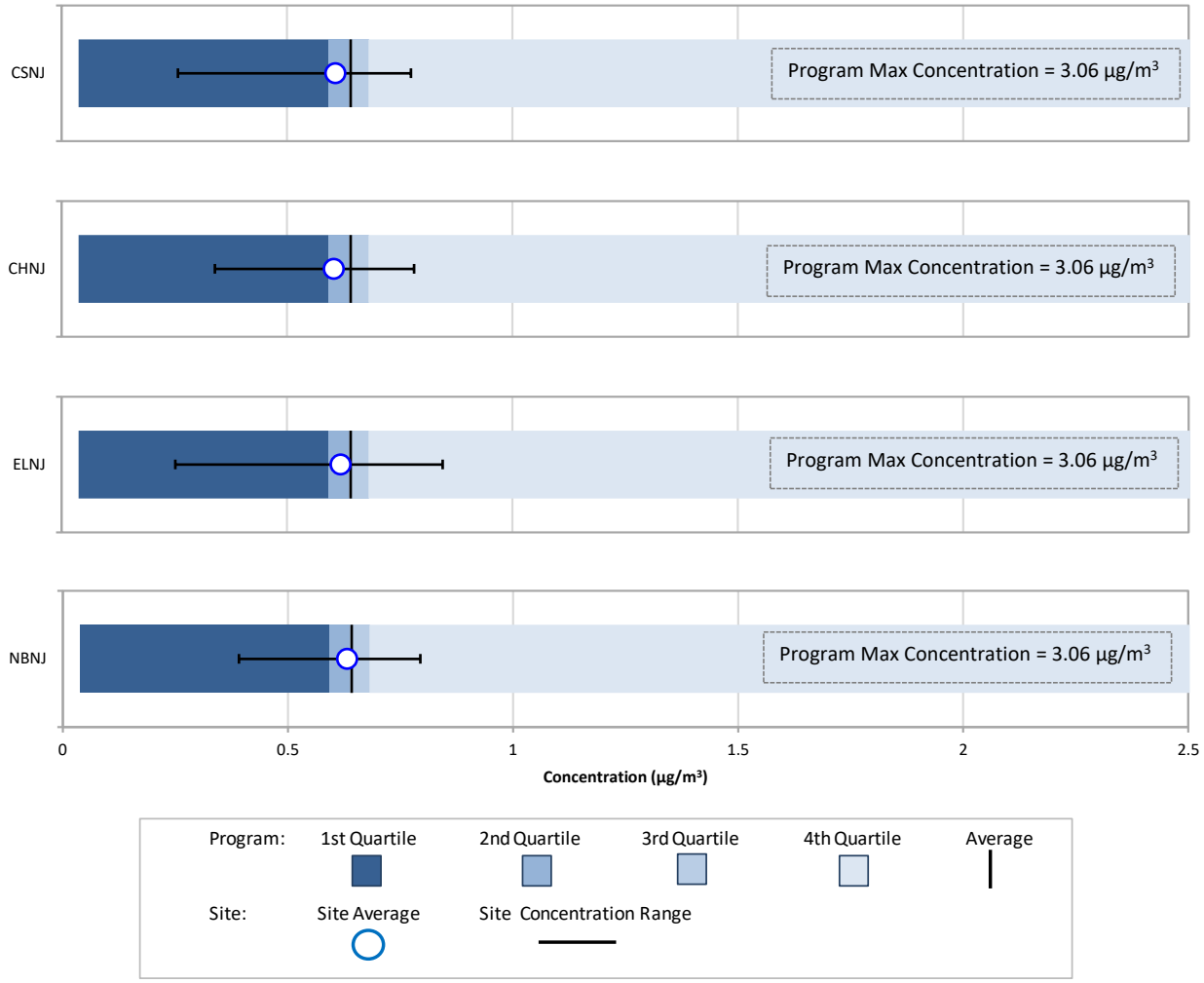


Figure 16-14 presents the box plots for carbon tetrachloride for the New Jersey sites and shows the following:

- The scale of the box plots in Figure 16-14 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- All of the carbon tetrachloride concentrations measured at these sites range from 0.25 µg/m^3 and 0.85 µg/m^3. The maximum concentrations measured at three of the sites are similar to each other, with the maximum for ELNJ slightly higher than the others. The minimum concentrations measured at each site are more variable.

- The annual average concentrations of carbon tetrachloride for the New Jersey sites are similar to each other, ranging from 0.60 µg/m^3 and 0.63 µg/m^3, with each just less than the program-level average concentration of 0.64 µg/m^3.

Figure 16-15. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

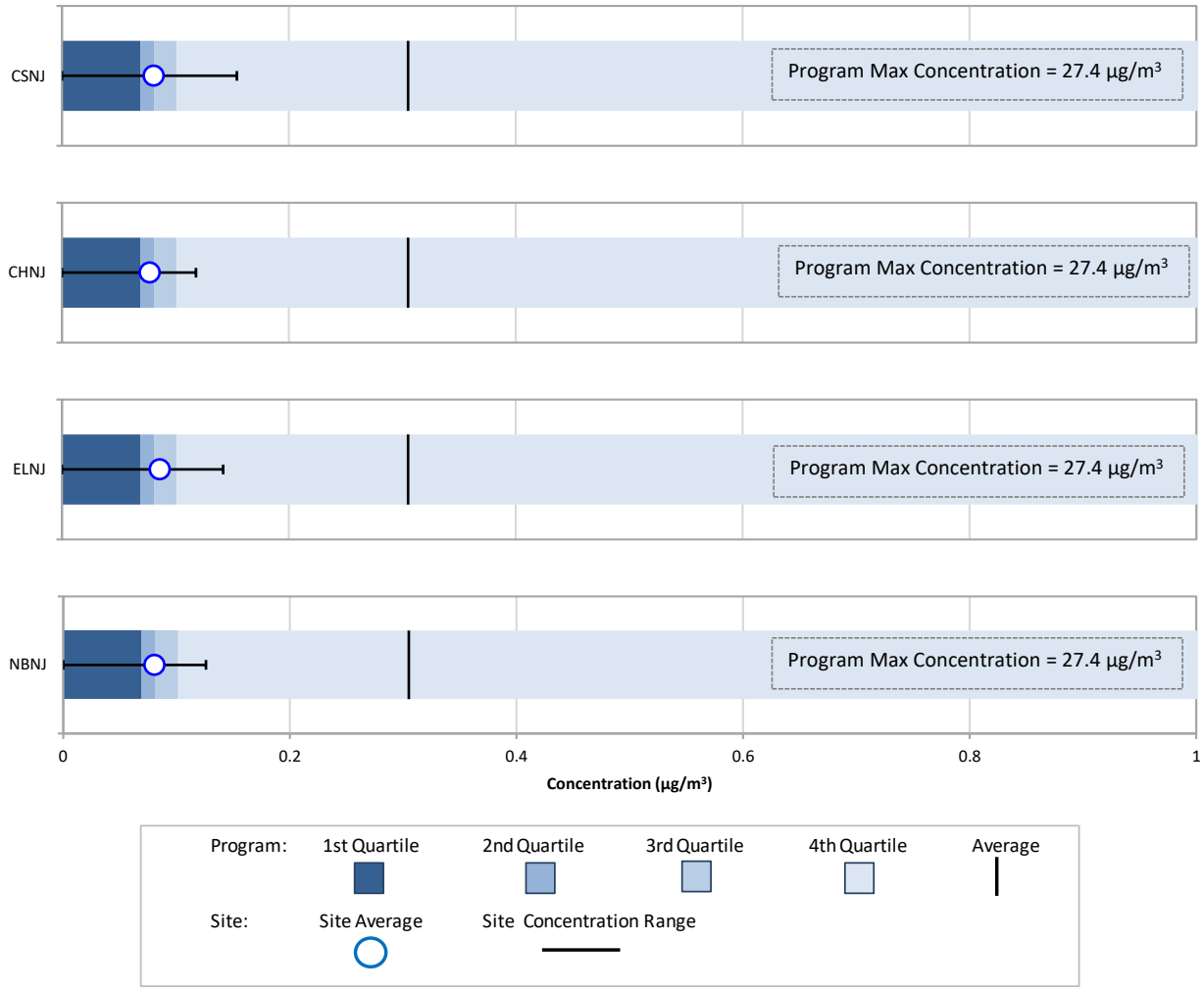


Figure 16-15 presents the box plots for 1,2-dichloroethane for the New Jersey sites and shows the following:

- The scale of the box plots in Figure 16-15 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- All of the concentrations of 1,2-dichloroethane measured at the New Jersey sites are less than the program-level average concentration of 0.31 µg/m^3, which is being driven by the measurements at the upper end of the concentration range. In fact, all of the concentrations measured at the New Jersey sites are less than half the program-level average concentration.

- The annual average concentrations for CSNJ, CHNJ, and NBNJ are similar to the program-level median concentration (0.081 µg/m^3) while the annual average concentration for ELNJ is just slightly higher (0.086 µg/m^3).

Figure 16-16. Program vs. Site-Specific Average Ethylbenzene Concentrations

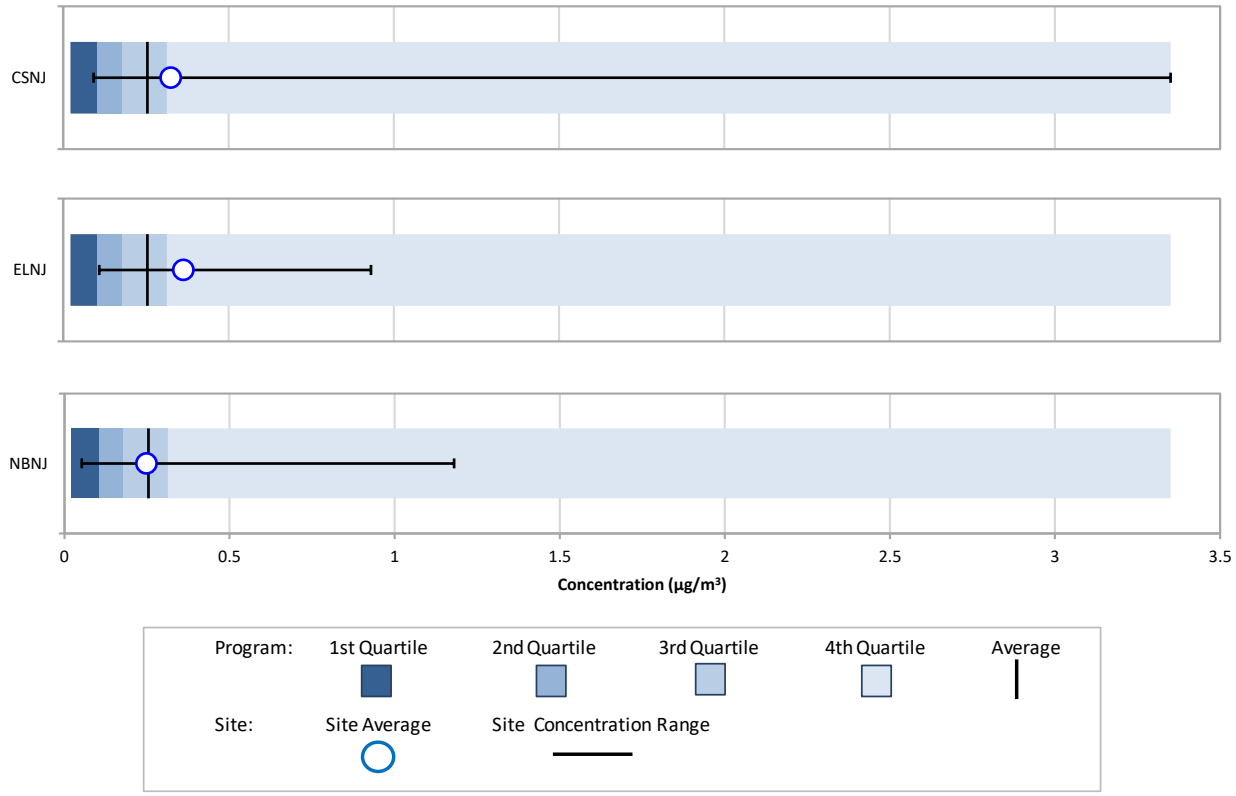


Figure 16-16 presents the box plots for ethylbenzene for the New Jersey sites and shows the following:

- This figure presents the box plots for CSNJ, ELNJ, and NBNJ. Ethylbenzene was not identified as a pollutant of interest for CHNJ and thus, a box plot is not presented for this site.

- The maximum ethylbenzene concentration measured across the program (3.35 µg/m^3) was measured at CSNJ; the next highest concentration measured at this site was considerably less (1.07 µg/m^3). Two ethylbenzene concentrations greater than 1 µg/m^3 were also measured at NBNJ. The range of ethylbenzene concentrations measured at ELNJ is smaller than the other sites, although the minimum concentration measured at ELNJ is greater than the program-level first quartile.

- The annual average concentration for NBNJ is similar to the program-level average concentration (0.25 µg/m^3) while the annual average concentrations for CSNJ and ELNJ are greater than the program-level average concentration.

Figure 16-17. Program vs. Site-Specific Average Formaldehyde Concentrations

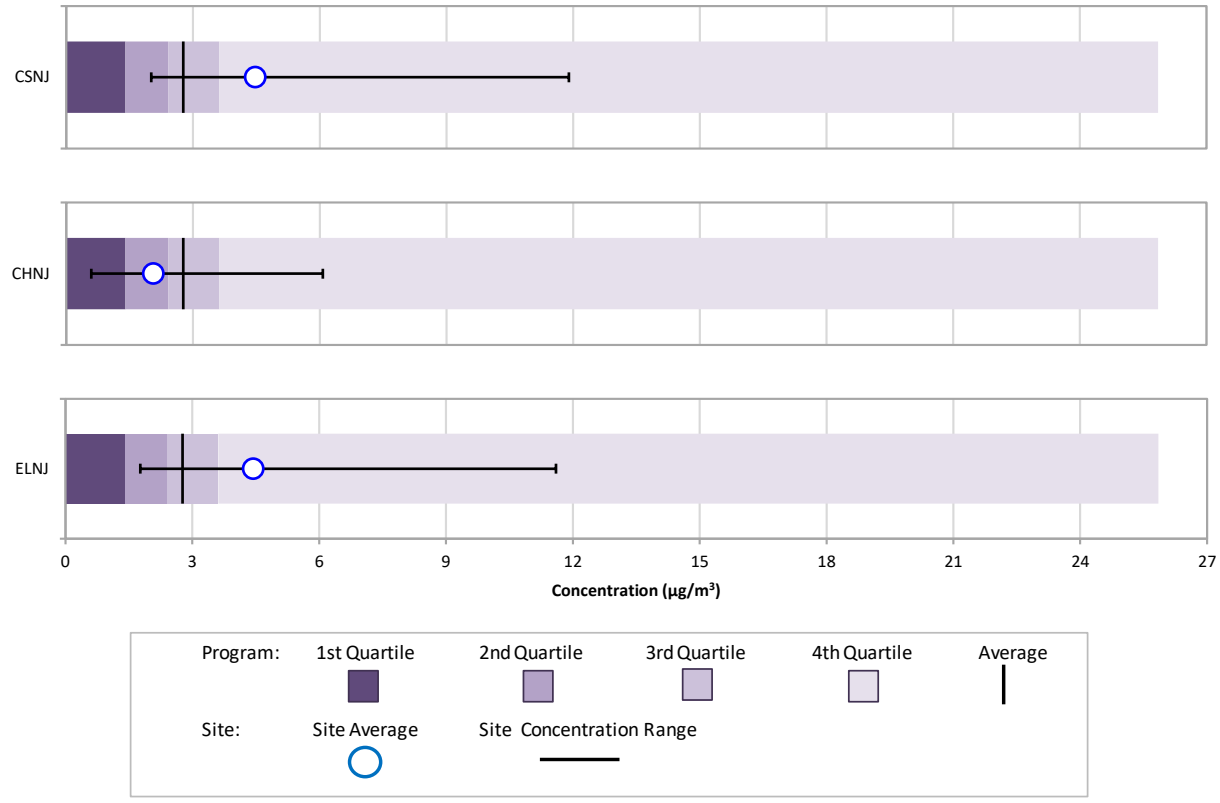


Figure 16-17 presents the box plots for formaldehyde for the New Jersey sites and shows the following:

- This figure presents the box plots for CSNJ, CHNJ, and ELNJ. Recall from the previous section that annual average concentrations for the carbonyl compounds could not be calculated for NBNJ, and thus, a box plot for this site is not provided.

- The range of formaldehyde concentrations measured at CSNJ is similar to the range measured at ELNJ, with the smallest range measured at CHNJ. Although all considerably less than the program-level maximum concentration, the maximum concentration measured at CHNJ is roughly half the maximum concentrations measured at CSNJ and ELNJ. The minimum concentrations measured at CSNJ and ELNJ are greater than the program-level first quartile.

- The annual average concentrations of formaldehyde for CSNJ and ELNJ are similar to each other and both are greater than the program-level average and third quartile. Recall from the previous section that CSNJ and ELNJ have the second and third highest annual average concentrations of formaldehyde, respectively, among the NMP sites sampling this pollutant. The annual average for CHNJ is less than the program-level average and median concentrations.

Figure 16-18. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

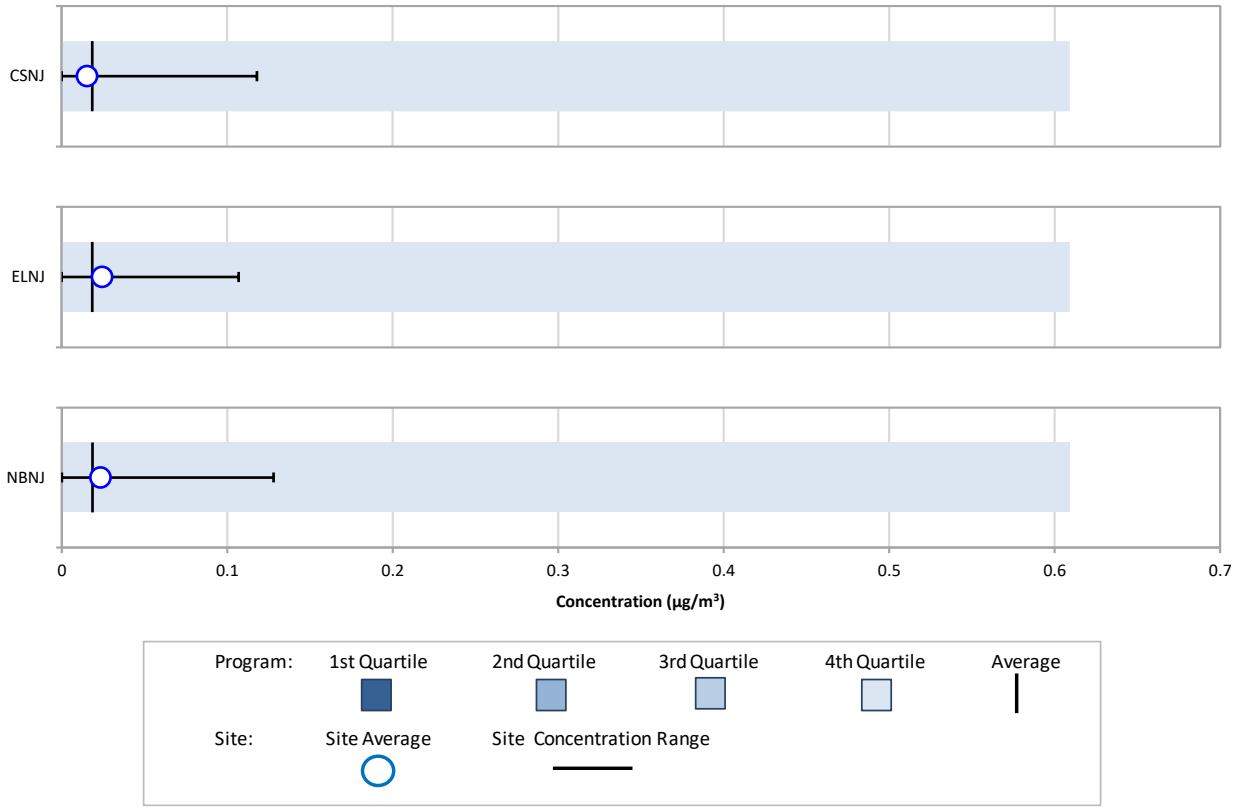


Figure 16-18 presents the box plots for hexchloro-1,3-butadiene for the New Jersey sites and shows the following:

- This figure presents the box plots for hexchloro-1,3-butadiene for CSNJ, ELNJ, and NBNJ, the three New Jersey sites for which this pollutant was identified as a pollutant of interest. Note that the first, second, and third quartiles for hexchloro-1,3-butadiene are zero at the program-level and therefore not visible on the box plots due to the large number of non-detects.

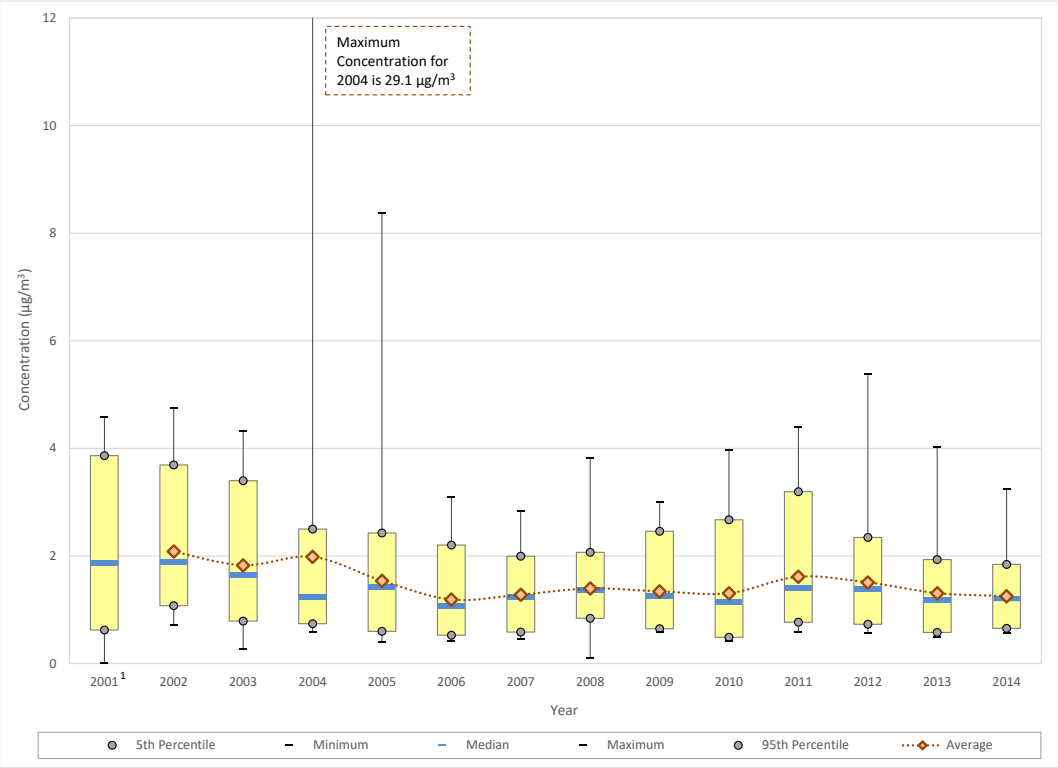
- The range of hexchloro-1,3-butadiene concentrations measured at these sites are similar to each other, with all measured detections less than 0.13 µg/m^3, and the number of measured detections ranging from 12 (CSNJ) to 18 (ELNJ), although none were greater than the MDL.

- The annual average hexchloro-1,3-butadiene concentrations for ELNJ and NBNJ are just greater than the program-level average concentration, though by only a small margin, while the annual average hexchloro-1,3-butadiene concentration for CSNJ is just less than the program-level average concentration.

16.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. CHNJ, ELNJ, and NBNJ have sampled VOCs and carbonyl compounds under the NMP for many years. ELNJ has sampled under the NMP since 2000 and CHNJ and NBNJ since 2001. Thus, Figures 16-19 through 16-40 present the 1-year statistical metrics for each of the pollutants of interest first for CHNJ, then for ELNJ and NBNJ. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. CSNJ began sampling under the NMP is 2013; thus, a trends analysis was not performed for this site.

Figure 16-19. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-19 for acetaldehyde concentrations measured at CHNJ include the following:

- Sampling for carbonyl compounds under the NMP began at CHNJ in May 2001. Because a full year's worth of data is not available for 2001, a 1-year average concentration is not presented, although the range of measurements is provided.

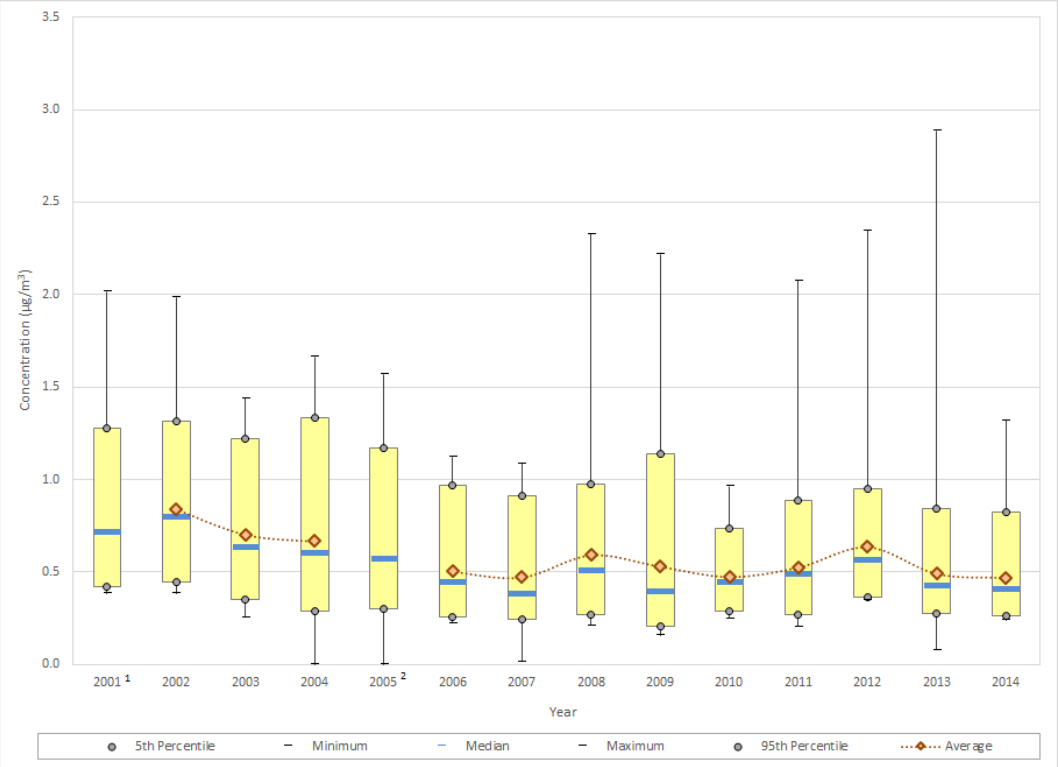
- The two highest acetaldehyde concentrations were measured at CHNJ in 2004 (29.1 µg/m^3 and 11.5 µg/m^3). All other concentrations measured in 2004 were less than 3 µg/m^3. Only two additional acetaldehyde concentrations greater than 5 µg/m^3 have been measured at CHNJ, one in 2005 (8.38 µg/m^3) and one in 2012 (5.38 µg/m^3).

- An overall decreasing trend in the 1-year average and median concentrations is shown though 2006, with the exception of 2004, when the maximum concentrations were measured. Between 2006 and 2010, the 1-year average and median concentrations changed little, with the 1-year average concentrations varying by less than 0.25 µg/m^3 over these years.

- All of the statistical metrics exhibit an increase from 2010 to 2011. Although the maximum concentration increased again for 2012, the 95th percentile decreased nearly 1 µg/m^3, indicating that fewer concentrations at the upper end of the range were measured in 2012. The second highest concentration measured in 2012 is half the magnitude of the maximum concentration for 2012. Additional decreases for all

of the statistical parameters are shown for 2013. The range of concentrations measured at CHNJ compressed even further for 2014, with the majority of the measurements falling into the smallest range since the onset of sampling.

Figure 16-20. Yearly Statistical Metrics for Benzene Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

Observations from Figure 16-20 for benzene concentrations measured at CHNJ include the following:

- Similar to carbonyl compounds, sampling for VOCs under the NMP began at CHNJ in May 2001. Because a full year's worth of data is not available, a 1-year average concentration is not presented, although the range of measurements is provided. In addition, a 1-year average concentration for 2005 is not provided due to low completeness.

- The maximum benzene concentration measured at CHNJ was measured on September 13, 2013 (2.88 µg/m^3). Only eight benzene concentrations greater than 2 µg/m^3 have been measured at CHNJ since the onset of sampling (one was measured in 2001, two in 2008, two in 2009, and one each in 2011, 2012, and 2013).

- The 1-year average and median concentrations exhibit a decreasing trend through 2007, although a 1-year average concentration is not provided for 2001 or 2005.

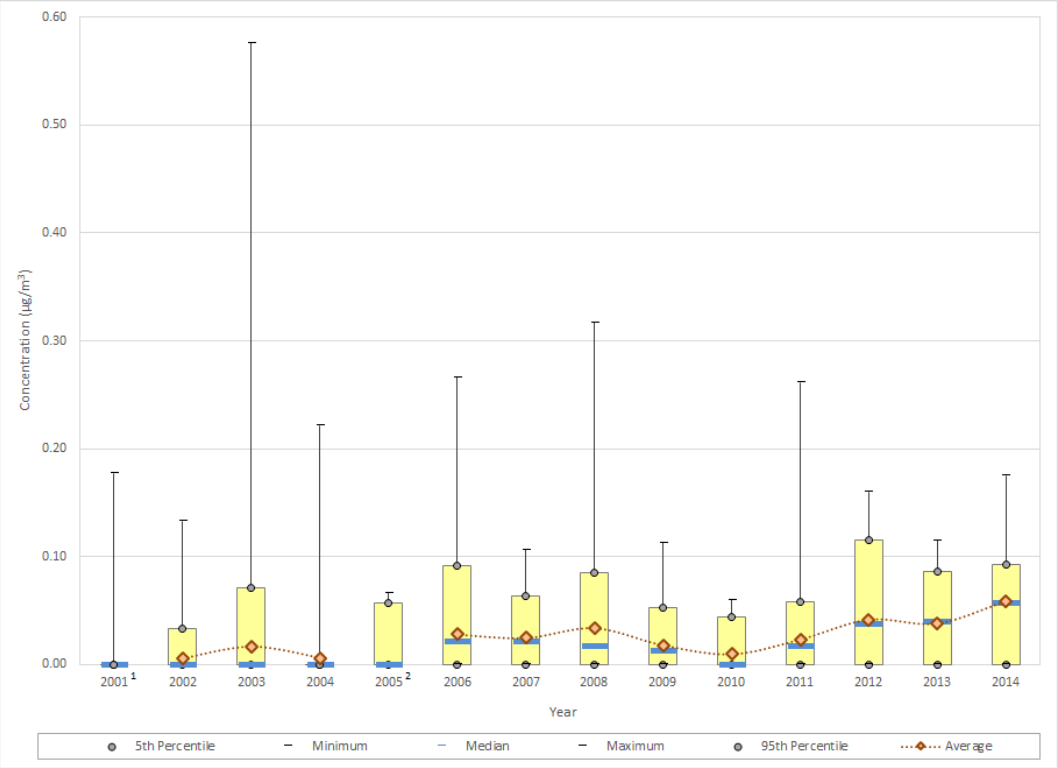
- Even though an increase in the 1-year average concentration is shown from 2007 to 2008, this increase is being driven less by the two measurements greater than 2 $\mu g/m^3$ and more by the measurements in the mid- to upper-end of the concentration range. This is evident from the increase shown in the median concentration. The number of concentrations between 0.5 $\mu g/m^3$ and 1 $\mu g/m^3$ nearly doubled from 2007 to 2008 (from 15 to 28).

- The difference between the 5th and 95th percentiles, or the range within which the majority of concentrations fall, increased from 2008 to 2009, indicating an increase in variability of the concentrations measured, despite the decreases shown in the 1-year average and median concentrations. Conversely, the difference between the 5th and 95th percentiles is at a minimum for the following year; 2010 has the smallest range of benzene measurements of any year of sampling.

- An increase in the 1-year average, median, 95th percentile, and maximum concentrations is shown from 2010 to 2011 and again for 2012. Although the range of concentrations measured is at a maximum for 2013, all of the statistical metrics exhibit decreases for 2013. Despite the differences in the minimum and maximum concentrations measured in 2013 and 2014, the 5th percentile, 95th percentile, 1-year average and median concentrations exhibit little change from 2013 to 2014.

- Despite the year-to-year increases or decreases shown in the 1-year average concentrations of benzene between 2006 and 2014, the averages have varied by less than 0.2 $\mu g/m^3$, ranging from 0.47 $\mu g/m^3$ (several years) to 0.64 $\mu g/m^3$ (2012).

Figure 16-21. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

Observations from Figure 16-21 for 1,3-butadiene concentrations measured at CHNJ include the following:

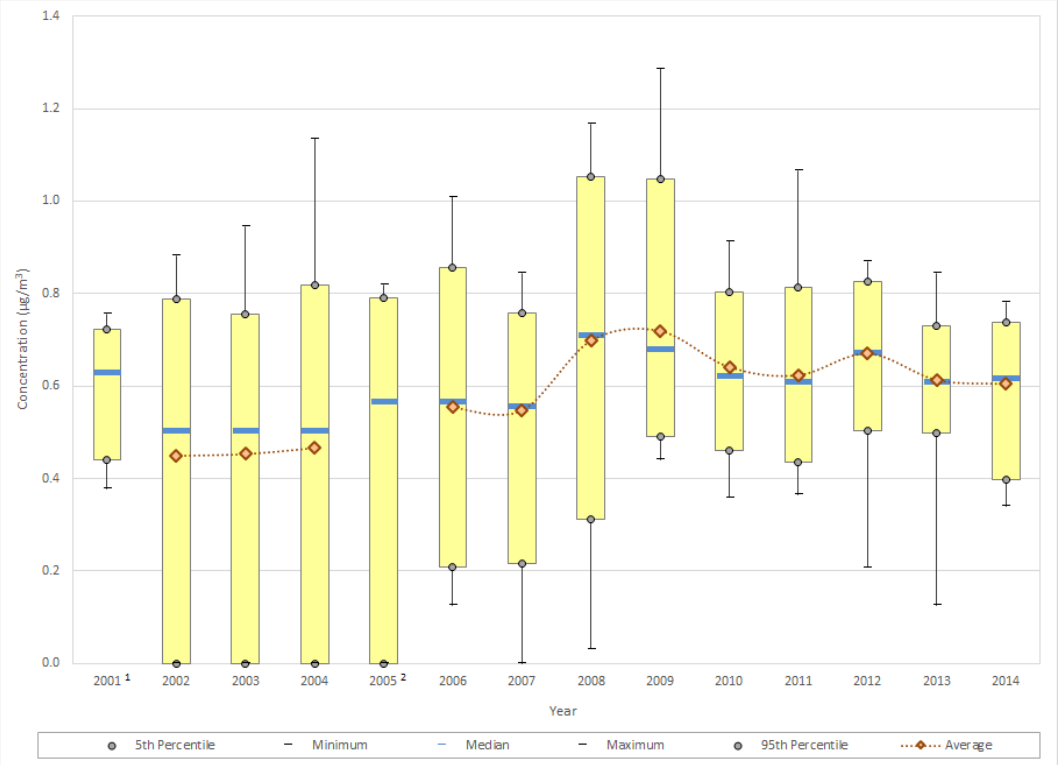
- The maximum 1,3-butadiene concentration was measured in 2003 (0.58 µg/m^3) and is the only concentration greater than 0.5 µg/m^3 measured at CHNJ. Only five 1,3-butadiene concentrations measured at CHNJ are greater than 0.2 µg/m^3.

- For 2001 and 2004, the minimum, 5th percentile, median, and 95th percentile are all zero. This is because the percentage of non-detects was greater than 95 percent for these years. More than 50 percent of the measurements were non-detects between 2001 and 2005 (as well as 2010), as indicated by the median concentration. The percentage of non-detects decreased steadily between 2004 (96 percent) and 2008 (17 percent). After 2008, the percentage of non-detects reported varies considerably, from fewer than 10 percent (2014) to greater than 70 percent (2010).

- The 1-year average and median concentrations have a decreasing trend from 2008 through 2010, which is followed by an increasing trend in the years that follow. While these changes do correspond with the changes in non-detects discussed above, the measurement of concentrations on the highest end of the concentration range became more frequent over the years, particularly in 2014. The number of 1,3-butadiene concentrations greater than 0.5 µg/m^3 ranged from five to 10 between 2006 and 2008, decreased to four for 2009 and two for 2010, then increased each year afterward, reaching a maximum of 40 in 2014, and accounting for more than half of

the measurements for the first time. Thus, the increasing trend in the 1-year average and median concentrations shown between 2008 and 2014 are only partially explained by changes in the number of non-detects from year-to-year.

Figure 16-22. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

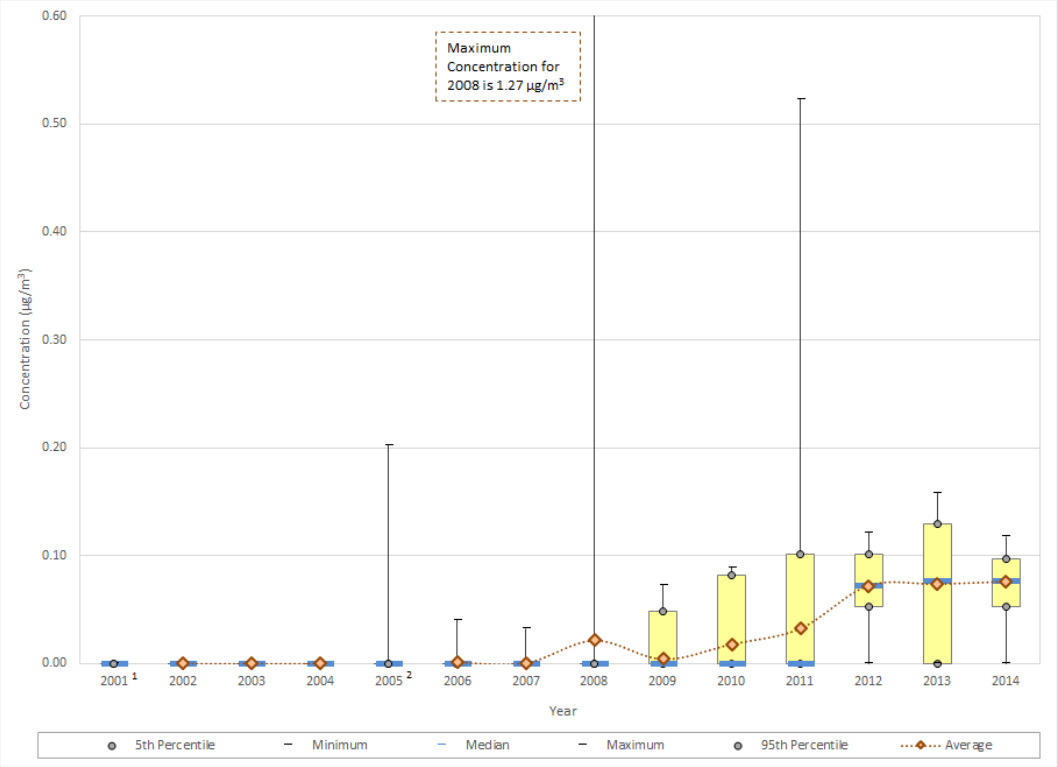
Observations from Figure 16-22 for carbon tetrachloride concentrations measured at CHNJ include the following:

- The range of carbon tetrachloride concentrations measured appears to increase significantly from 2001 to 2002, with fairly similar ranges measured between 2003 and 2005. While a larger range of concentrations was measured during these years compared to 2001, the measurement of a few non-detects each year during this period contributes to increase in the range shown. After 2005, only one non-detect was reported (2007).

- All of the statistical parameters exhibit an increase from 2007 to 2008. The 95th percentile for 2007 is just greater than the 1-year average and median concentrations calculated for 2008. Thirteen concentrations measured in 2008 were greater than the maximum concentration measured in 2007. The number of measurements greater than 0.6 µg/m^3 nearly doubled from 2007 (21) to 2008 (39). A similar number of concentrations greater than 0.6 µg/m^3 was measured in 2009 and the minimum concentration increased by an order of magnitude from 2008. Yet the 1-year average increased only slightly and the median concentration decreased slightly.

- All of the statistical parameters exhibit decreases from 2009 to 2010, with little change shown for 2011, except for the maximum concentration. Between 2010 and 2014, the majority of carbon tetrachloride concentrations measured fell between 0.4 µg/m^3 and 0.8 µg/m^3. The 1-year average concentrations for the years 2010 through 2014 vary by less than 0.10 µg/m^3.

Figure 16-23. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

Observations from Figure 16-23 for 1,2-dichloroethane concentrations measured at CHNJ include the following:

- There were no measured detections of 1,2-dichloroethane between 2001 and 2004. There were one or two measured detections each year between 2005 and 2008. After 2008, the percentage of measured detections increased significantly, from 7 percent in 2009, to 25 percent for 2010, 30 percent in 2011, and 95 percent for 2012. This explains the significant increase in the 1-year average concentrations shown for the later years of sampling. The number of measured detections decreased slightly for 2013 but still account for more than 85 percent of measurements. For, 2014, the percentage of measured detections is at a maximum of 97 percent.

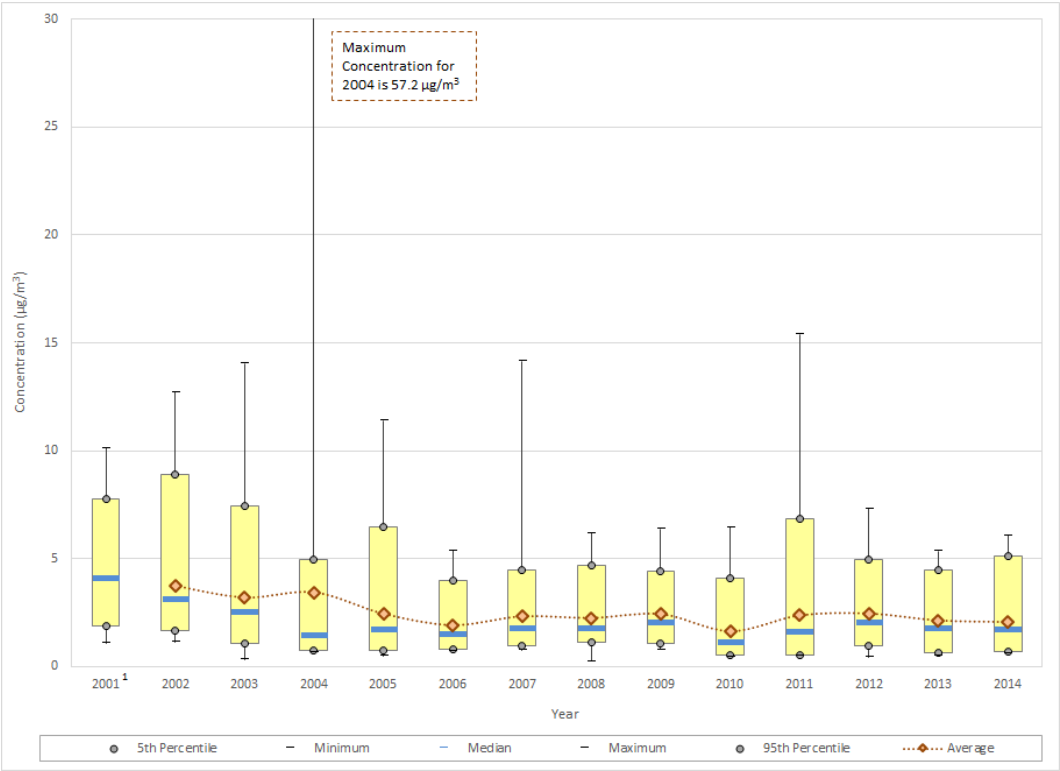
- 2012 is the first year that the median concentration and 5th percentile are greater than zero. Aside from the three non-detects, the range of concentrations measured in 2012 is relatively small, ranging from 0.053 µg/m^3 to 0.121 µg/m^3. The 1-year average and

median concentrations calculated for 2012 are less than 0.001 µg/m^3 apart, indicating little variability associated with the concentrations measured in 2012.

- The 5th percentile returned to zero for 2013, as six additional non-detects were measured in 2013. However, the 1-year average and median concentrations changed little. The effects of the additional non-detects are balanced by the additional concentrations measured at the upper end of the concentration range. The number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 increased from four in 2012 to 10 in 2013.

- The statistical metrics for 2014 resemble those shown for 2012, and for the second time, the 5th percentile is greater than zero.

Figure 16-24. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-24 for formaldehyde concentrations measured at CHNJ include the following:

- The two highest formaldehyde concentrations were measured on the same days in 2004 as the two highest concentrations of acetaldehyde. The maximum concentration of formaldehyde (57.2 µg/m^3) is nearly twice the second highest concentration (30.4 µg/m^3) and almost four times the maximum concentrations shown for other years.

- A decreasing trend in the 1-year average and median formaldehyde concentrations is shown though 2006. Slight increases in these parameters are shown for 2007, after which the 1-year average and median concentrations changed little through 2009. Less than 0.5 $\mu g/m^3$ separates the 1-year average concentrations calculated for the period between 2006 and 2009.

- The 1-year and median concentrations decreased significantly for 2010, when both statistical parameters are at a minimum. This is due primarily to the measurements at the lower end of the concentration range. The number of formaldehyde concentrations less than 1 $\mu g/m^3$ increased from two in 2009 to 21 in 2010.

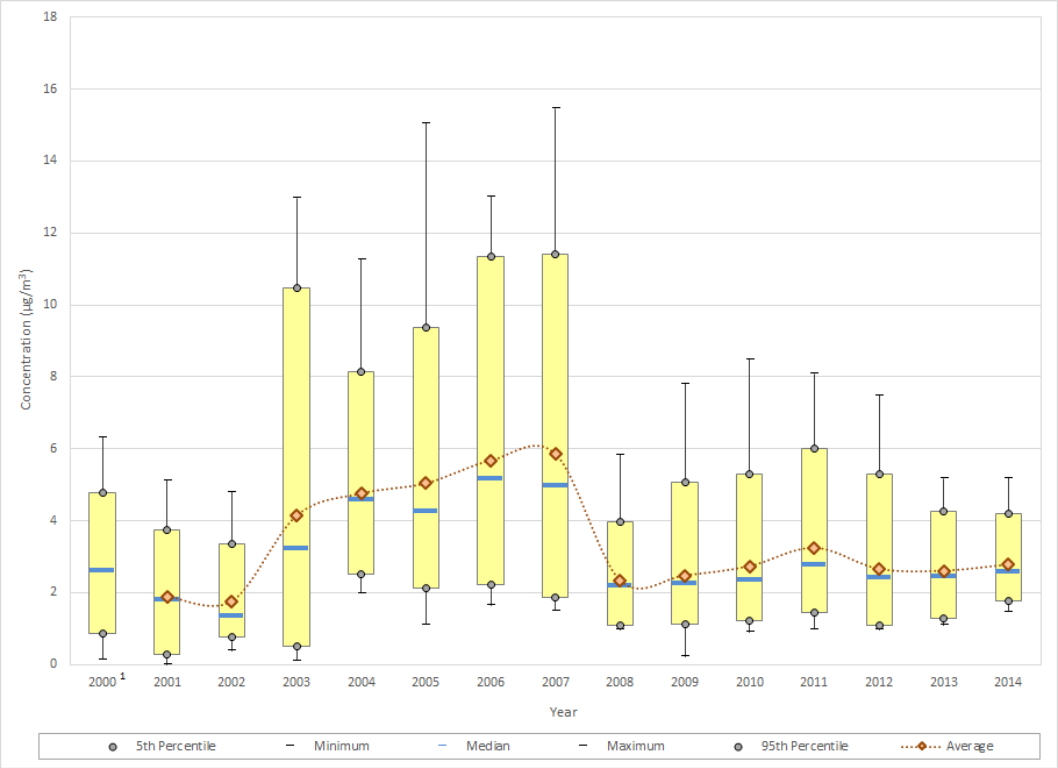
- Similar to acetaldehyde, all of the statistical metrics calculated for formaldehyde exhibit an increase from 2010 to 2011, including the 95th percentile, which is greater than the maximum concentration measured in 2010. Four formaldehyde concentrations measured in 2011 are greater than the maximum concentration measured in 2010 and the number of measurements greater than 2 $\mu g/m^3$ nearly doubled, from 13 in 2010 to 25 in 2011.

- Although the range of measurements decreased for 2012, little change is shown in the 1-year average concentration and the median continued to increase. This is primarily due to decreases in the number of concentrations at the lower end of the concentration range. The number of formaldehyde measurements less than 1 $\mu g/m^3$ fell from 19 in 2011 to five in 2012.

- With the exception of the minimum concentration, all of the statistical parameters exhibit decreases for 2013, albeit slight ones. The maximum formaldehyde concentration measured at CHNJ in 2013 is the lowest maximum concentration for any given year.

- Relatively little change is shown in the range of concentrations measured in 2014 compared to 2013 and the 1-year average concentrations for these two years vary by less than 0.1 $\mu g/m^3$.

Figure 16-25. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-25 for acetaldehyde concentrations measured at ELNJ include the following:

- ELNJ is the longest running NMP site. Carbonyl compound sampling under the NMP began at ELNJ in January 2000. However, sporadic sampling at the beginning of 2000 combined with a 1-in-12 day sampling schedule led to completeness less than 85 percent. Thus, a 1-year average concentration is not presented for 2000, although the range of measurements is provided.

- The maximum acetaldehyde concentration was measured at ELNJ in 2007 (15.5 µg/m^3), although a concentration of similar magnitude was also measured in 2005. In total, 22 acetaldehyde concentrations greater than 10 µg/m^3 have been measured at ELNJ, all of which were measured prior to 2008.

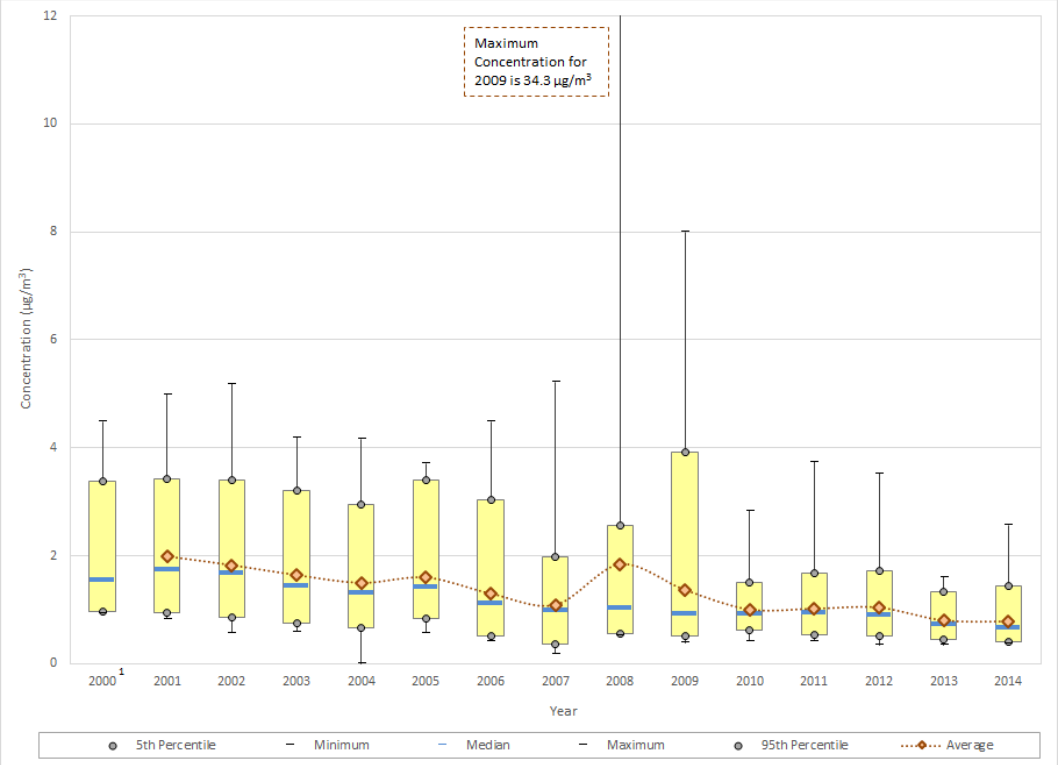
- The range of acetaldehyde concentrations measured between 2003 and 2007 is considerably higher than those collected during the first 3 years of sampling. The 1-year average concentration increased significantly from 2002 to 2003. This increasing trend continued through 2007, although the rate of change slowed over the years. A significant decrease in the measurements is shown from 2007 to 2008, where the maximum concentration measured in 2008 is less than the 1-year average calculated for 2007. The range of concentrations measured in 2008 is more similar to the range shown before 2003.

- Although an increasing trend is also shown between 2008 and 2011, the 1-year average concentrations are roughly half the magnitude of those shown before 2008.

- All of the statistical parameters exhibit decreases from 2011 to 2012, with additional decreases shown for some of the parameters for 2013.

- The range of concentrations measured in 2014 is the smallest since the onset of sampling at ELNJ. The slight increases in the 1-year average and median concentrations shown for 2014 result from a decrease in the number of concentrations at the lower end of the range. Nine concentrations measured in 2013 are less than the minimum concentration measured in 2014 (1.48 µg/m^3); further, the number of acetaldehyde concentrations less than 2 µg/m^3 decreased from 20 in 2013 to eight in 2014.

Figure 16-26. Yearly Statistical Metrics for Benzene Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-26 for benzene concentrations measured at ELNJ include the following:

- VOC sampling under the NMP also began at ELNJ in January 2000. However, a 1-year average concentration is not presented for 2000 due to low completeness, although the range of measurements is provided.

- The maximum benzene concentration (34.3 µg/m^3) was measured in 2008 and is more than four times higher than the next highest concentration (8.00 µg/m^3), which

was measured in 2009. The third highest concentration was also measured in 2009. In all, five benzene concentrations greater than 5 µg/m^3 have been measured at ELNJ.

- A fairly steady decreasing trend in the 1-year average and median concentrations is shown through 2007.

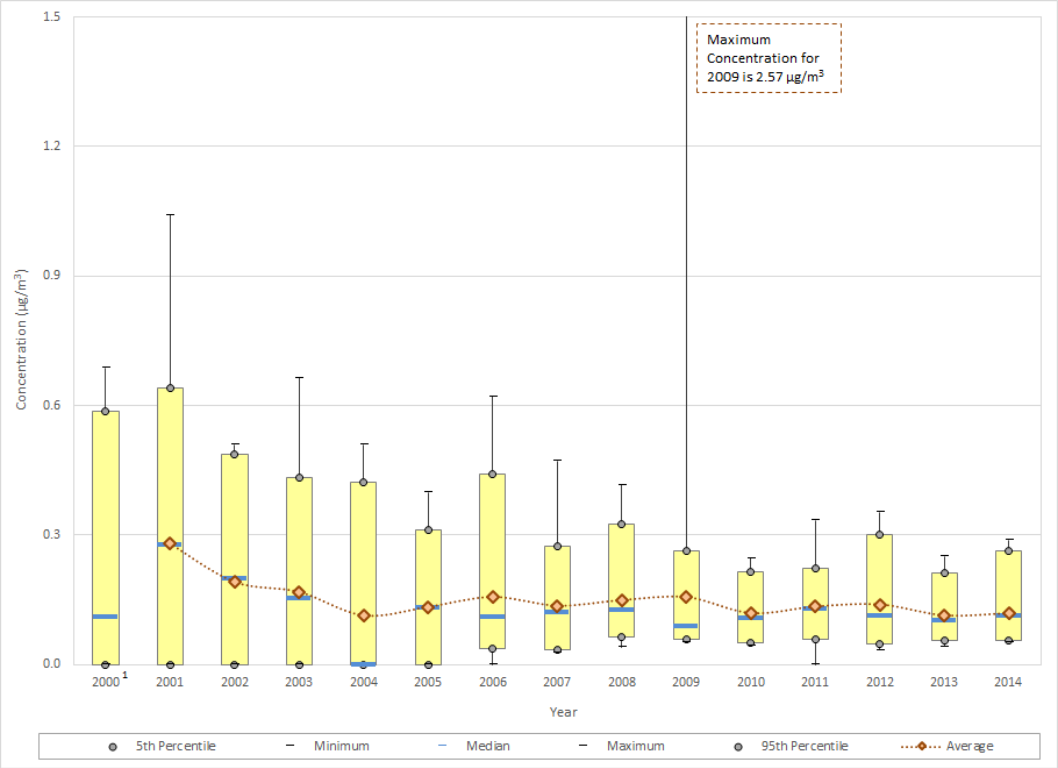
- All of the statistical parameters exhibit at least a slight increase for 2008. If the maximum concentration for 2008 was removed from the data set, the 1-year average concentration would exhibit only a slight increase for 2008. Thus, it is this single concentration that is primarily driving the change in the 1-year average concentration. The median concentration is influenced less by outliers, as this statistical parameter represents the midpoint of a data set. The median increased by less than 0.03 µg/m^3 between 2007 and 2008, further indicating that this outlier is the primary driver pulling the 1-year average concentration upward. However, the minimum concentration nearly tripled from 2007 to 2008, with eight concentrations measured in 2007 less than the minimum concentration measured in 2008; in addition, the 5th percentile increased as well, indicating that the outlier may not be the only factor.

- Even though two of the three highest benzene concentrations were measured at ELNJ in 2009, the 1-year average concentration decreased from 2008 to 2009, likely a result of the magnitude of the outlier affecting the 2008 calculations. If the maximum concentration measured in 2008 was removed from the dataset, the 1-year average concentrations would exhibit a slight increasing trend between 2007 and 2009, although 2009 would then have the largest confidence interval among the years shown.

- Benzene concentrations measured in 2010, 2011, and 2012 were fairly consistent. The difference in the 1-year average concentrations for these years is less than 0.04 µg/m^3.

- Additional decreases are shown for 2013, as no benzene concentrations greater than 2 µg/m^3 were measured in 2013, and the 1-year average concentration is less than 1 µg/m^3 for the first time. Although a few higher concentrations were measured in 2014 compared to 2013, the 1-year average benzene concentration is at a minimum for 2014 (0.78 µg/m^3).

Figure 16-27. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-27 for 1,3-butadiene concentrations measured at ELNJ include the following:

- The maximum concentration of 1,3-butadiene was measured at ELNJ in 2009 and is nearly two and a half times the next highest concentration (measured in 2001). These are the only concentrations of 1,3-butadiene measured at ELNJ that are greater than 1 µg/m^3 and only 16 concentrations measured at ELNJ are greater than 0.5 µg/m^3.

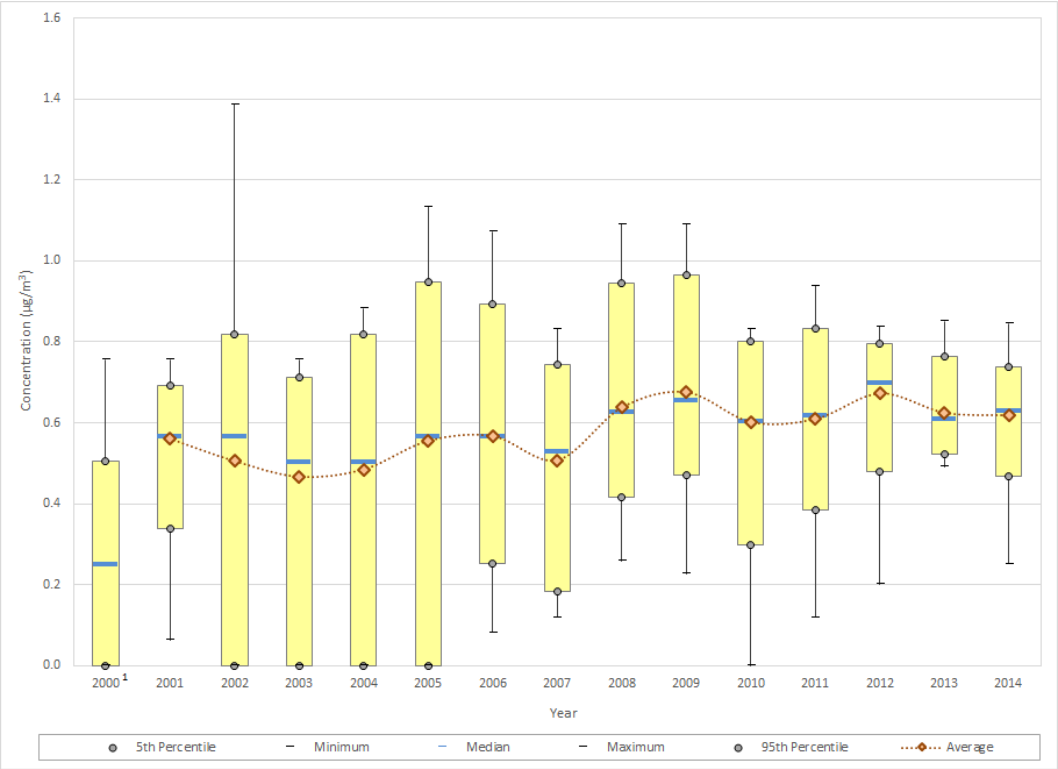
- The minimum and 5th percentile are zero for the first 6 years of sampling, indicating that at least 5 percent of the measurements were non-detects. For 2004, the median concentration is also zero, indicating that at least half of the measurements were non-detects. Between 2000 and 2005, the percentage of non-detects ranged from 10 percent (2001) to 57 percent (2004). After 2005, only five non-detects of 1,3-butadiene have been measured at ELNJ (three in 2006 and two in 2011).

- There is a decreasing trend in the 1-year average concentration through 2004, after which the 1-year average concentration remains fairly static. Even with the higher concentration measured in 2009, the 1-year average concentration for 2009 is similar to the 1-year average concentration for 2008. Between 2005 and 2014, the 1-year average concentration has ranged from 0.11 µg/m^3 (2013) to 0.16 µg/m^3 (2006 and 2009).

- Concentrations of 1,3-butadiene measured at ELNJ have become less variable in recent years, with concentrations measured in 2010, 2013, and 2014 exhibiting the

least variability. These years have the smallest range of concentrations measured and the smallest differences between the 5th and 95th percentiles (2010 and 2013 only), the range within which the majority of concentrations fall.

Figure 16-28. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

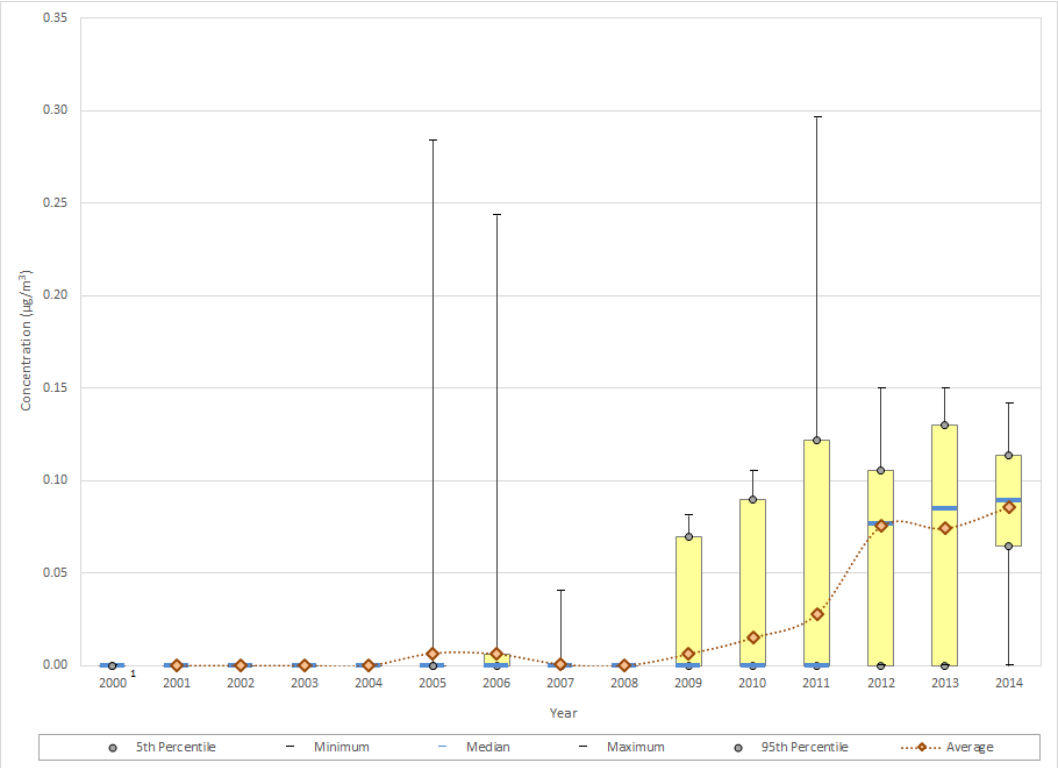
Observations from Figure 16-28 for carbon tetrachloride concentrations measured at ELNJ include the following:

- The minimum and 5th percentile are zero for five of the first 6 years of sampling, indicating that at least 5 percent of the measurements were non-detects (2001 being the exception). After 2005, only one non-detect has been reported (2010).

- The 1-year average carbon tetrachloride concentrations vary by approximately 0.1 µg/m^3 during the period from 2001 to 2007, even though the range of concentrations measured varies. All of the statistical parameters exhibit an increase in magnitude from 2007 to 2008, which is the first year that the 1-year average concentration is greater than 0.6 µg/m^3; all of the 1-year average concentrations between 2008 and 2014 are greater than 0.6 µg/m^3.

- The difference between the 5th percentile and 95th percentile, or the range within which the majority of measurements fall, has a decreasing trend after 2005 and is at a minimum for 2013. Less than 0.25 µg/m^3 separates these parameters for 2013. A slight widening of the range is shown for 2014.

Figure 16-29. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-29 for 1,2-dichloroethane concentrations measured at ELNJ include the following:

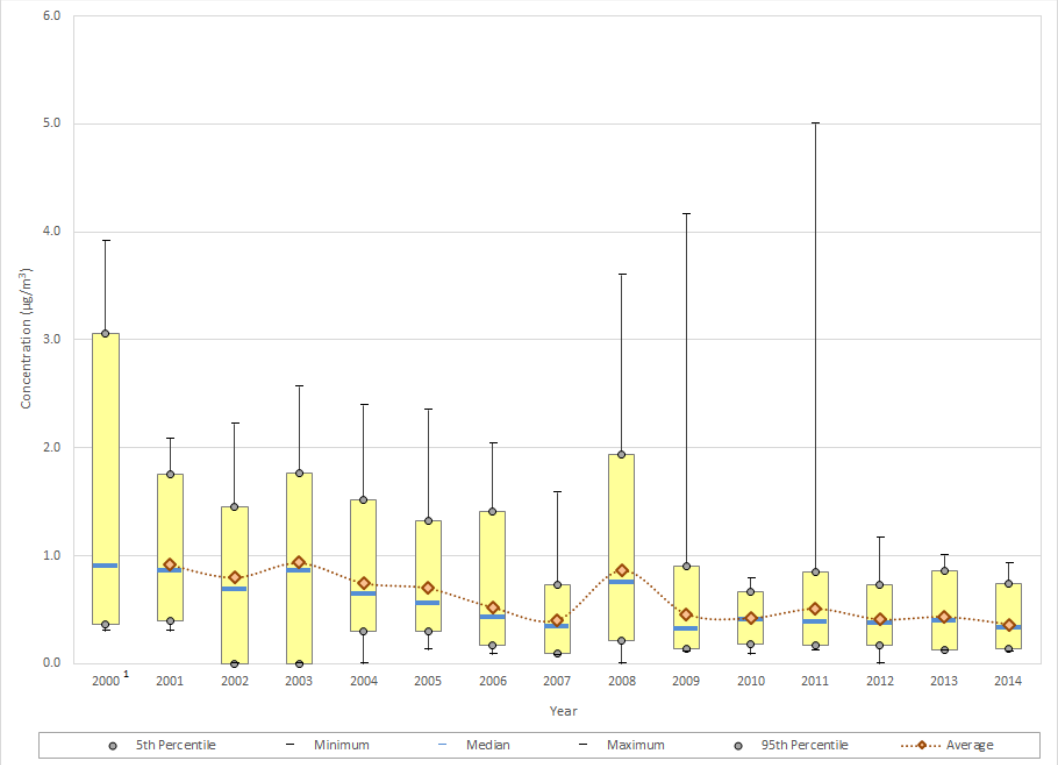
- There were no measured detections of 1,2-dichloroethane between 2000 and 2004. Between one and three measured detections were measured between 2005 and 2007, after which measured detections were not measured in 2008. After 2008, the number of measured detections increased significantly, from five in 2009, to 11 for 2010, 16 in 2011, and 55 for 2012. This explains the significant increase in the 1-year average concentrations shown for the later years of sampling.

- 2012 is the first year that the median concentration is greater than zero. Aside from the six non-detects, the range of concentrations measured in 2012 is relatively small, ranging from 0.061 µg/m^3 to 0.150 µg/m^3. The 1-year average and median concentrations calculated for 2012 are approximately 0.0015 µg/m^3 apart, indicating relatively little variability associated with the concentrations measured in 2012.

- For 2013, the number of non-detects more than doubled (from six in 2012 to 14 in 2013), accounting for nearly one-quarter of the concentrations measured. Yet, the 1-year average concentration changed little and the median concentration increased. Although the maximum concentration increased only slightly from 2012 to 2013, the number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 measured at ELNJ increased from eight in 2012 to 20 in 2013.

- Only two non-detects were measured at ELNJ in 2014 and thus, is the first year that the 5th percentile is greater than zero.

Figure 16-30. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-30 for ethylbenzene concentrations measured at ELNJ include the following:

- The trends graph for ELNJ's ethylbenzene concentrations resembles the trends graph for ELNJ's benzene concentrations.

- There is an overall decreasing trend in the 1-year average and median concentrations between 2001 and 2007.

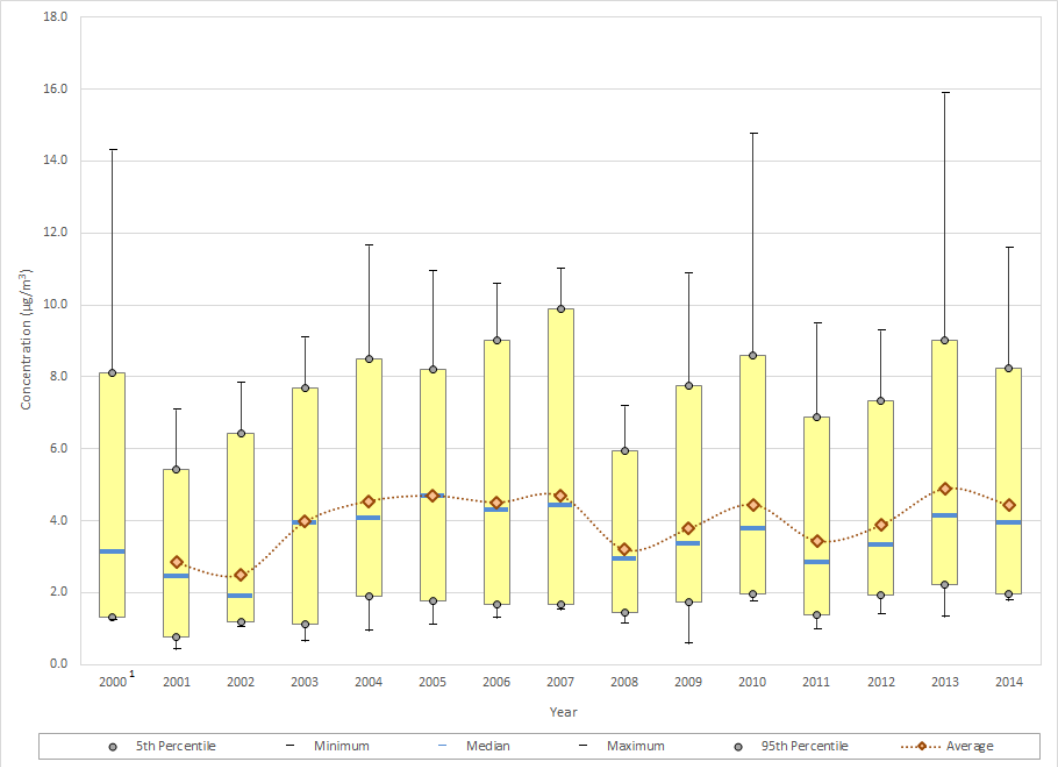
- A significant increase in the statistical parameters is shown for 2008. The maximum concentration measured in 2008 is more than twice the magnitude of the maximum concentration measured in 2007; further, 1-year average and median concentrations for 2008 are greater than the 95th percentile for 2007. The median concentration for 2008 is 0.76 µg/m^3, meaning that half of the concentrations measured at ELNJ in 2008 are greater than this concentration. By comparison, only three concentrations measured in 2007 are greater than the median for 2008.

- The concentrations measured in 2009 more closely resemble those collected in 2007 than 2008, with the exception of the maximum concentration measured.

- The smallest range of ethylbenzene concentrations was measured in 2010, with all concentrations measured spanning less than 0.75 µg/m^3.

- Between 2009 and 2014, the majority of concentrations fell within a fairly similar range and the 1-year average concentrations did not change significantly, ranging from 0.36 µg/m^3 (2014) to 0.51 µg/m^3 (2011).

Figure 16-31. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-31 for formaldehyde concentrations measured at ELNJ include the following:

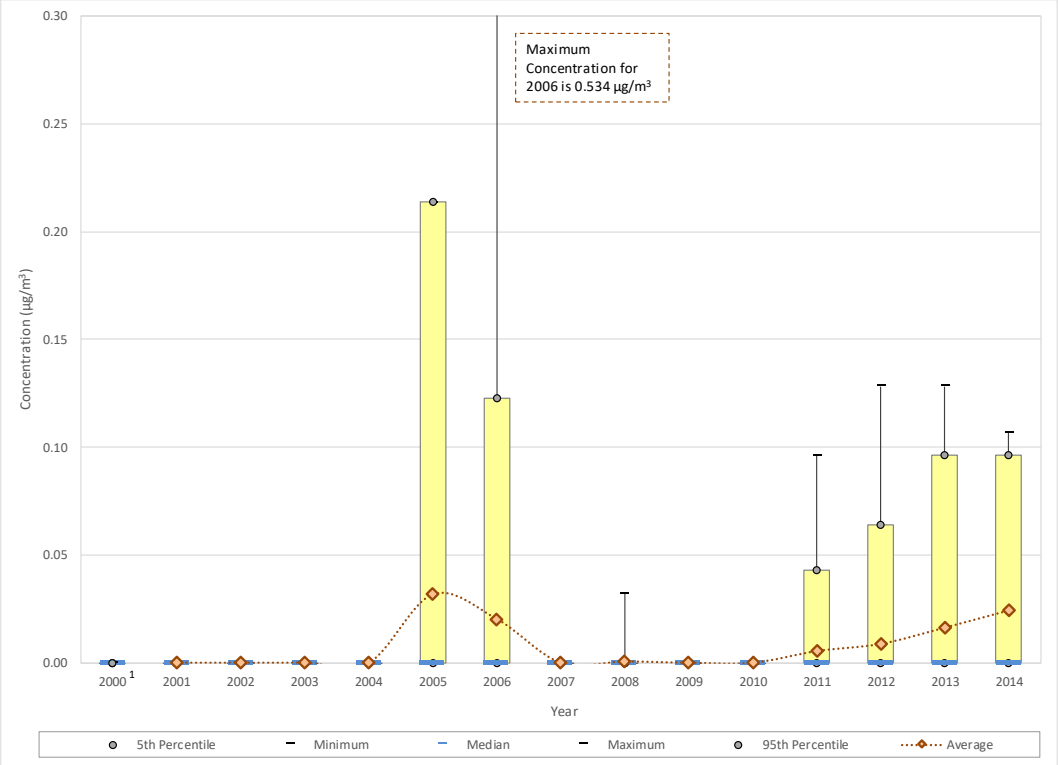
- The maximum formaldehyde concentration was measured at ELNJ in 2013 (15.88 µg/m^3). A total of 15 concentrations greater than 10 µg/m^3 have been measured at ELNJ, with the most measured in 2007 (three).

- After decreasing by more than 1 µg/m^3 from 2000 to 2002, the median concentration increased by more than 2 µg/m^3 for 2003. The 1-year average concentration also exhibits a significant increase during this time, with additional increases in both parameters shown for 2004 and 2005. The number of formaldehyde concentrations greater than 4 µg/m^3 nearly tripled from 2002 to 2003 (from 9 to 25), and continued increasing through 2005, with concentrations greater than 4 µg/m^3 accounting for at least half of the concentrations measured each year through 2007.

- Similar to acetaldehyde, the 1-year average and median concentrations of formaldehyde decreased significantly between 2007 and 2008, as the magnitude of concentrations measured decreased considerably. Afterward, an increasing trend is shown through 2010, followed by a decrease for 2011, then another round of increasing. The 1-year average concentration of formaldehyde for ELNJ for 2013 (4.90 µg/m^3) is the highest 1-year average calculated since the onset of sampling.

- A slight decrease is shown in all of the statistical parameters for 2014 except the minimum concentration (which is at a maximum for 2014).

Figure 16-32. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at ELNJ



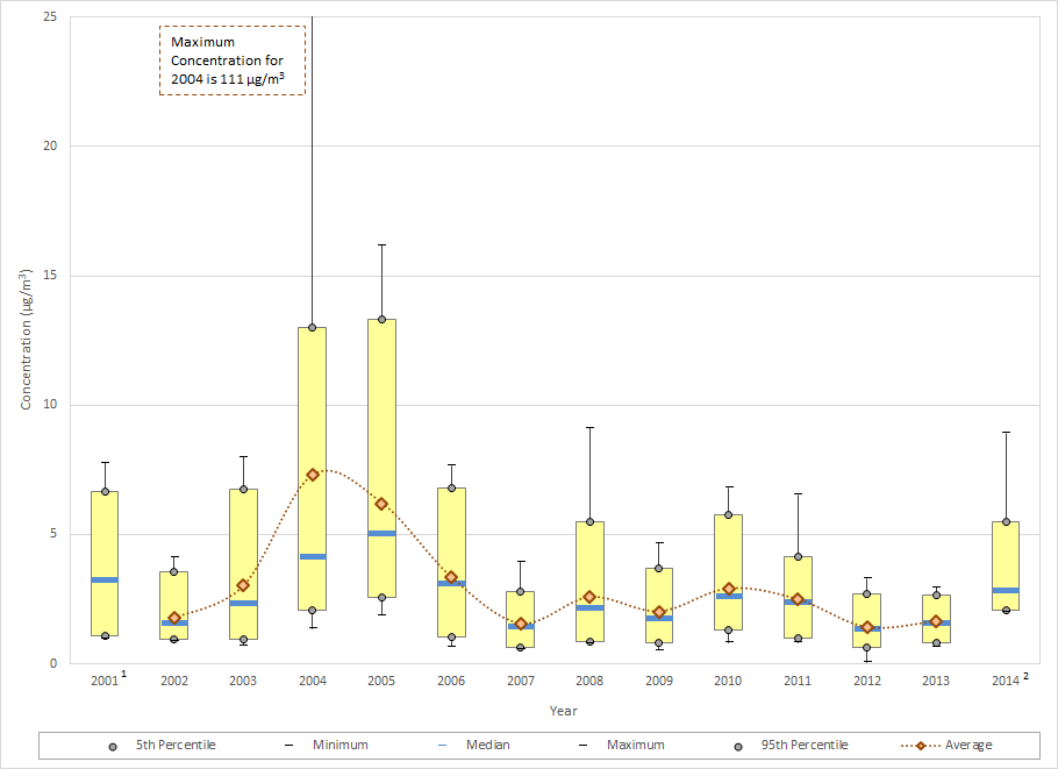
[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-32 for hexachloro-1,3-butadiene concentrations measured at ELNJ include the following:

- There were no measured detections of hexachloro-1,3-butadiene measured at ELNJ during the first 5 years of sampling.

- The number of measured detections increased to 13 for 2005, representing 22 percent of measurements, then decreased to five for 2006. Between 2007 and 2010, a single measured detection was measured (2008). Beginning in 2011, the number of measured detections began increasing, from five for 2011 to seven for 2012, 13 in 2013, and is at a maximum of 18 for 2014.

Figure 16-33. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-33 for acetaldehyde concentrations measured at NBNJ include the following:

- Sampling for carbonyl compounds under the NMP began at NBNJ in May 2001. Because a full year's worth of data is not available for 2001, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum acetaldehyde concentration was measured in 2004 (111 µg/m^3). This concentration is nearly seven times higher, and an order of magnitude higher, than the next highest concentration (16.2 µg/m^3, measured in 2005).

- Of the 30 concentrations greater than 8 µg/m^3 measured at NBNJ, 28 were measured at NBNJ in 2004 or 2005 (with one each measured in 2008 and 2014). This, along with the outlier concentration measured in 2004, explains the significant increase in the statistical metrics shown from 2003 to 2004. Even without an outlier for 2005, most of the statistical metrics for 2005 exhibit slight increases from 2004 levels. The 1-year average concentration, however, does not. If the outlier was removed from the data set for 2004, the 1-year average concentration for 2004 would be less than the 1-year average concentration for 2005.

- The 1-year average concentration decreases significantly between 2005 and 2007, as do all of the other statistical parameters. This is followed by a significant increase in the concentrations measured for 2008, with the range of concentrations measured doubling.

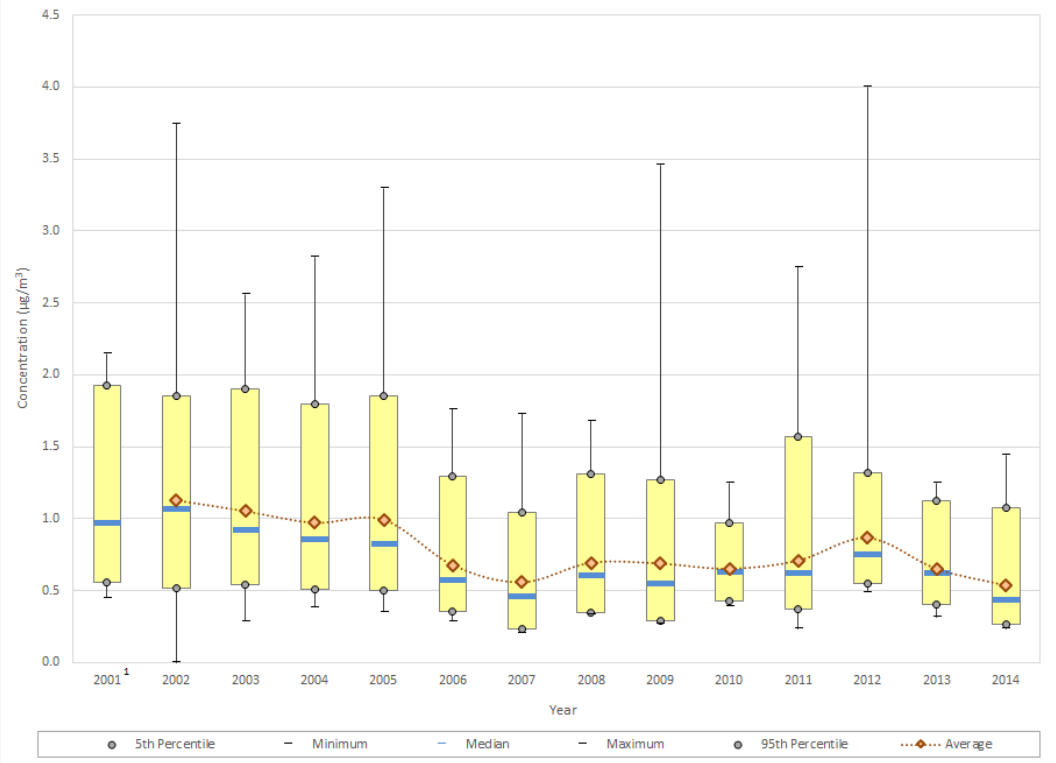
- Between 2008 and 2011, the 1-year average concentrations have an undulating pattern, fluctuating between 2 µg/m^3 and 3 µg/m^3.

- The acetaldehyde concentrations measured at NBNJ decreased significantly for 2012, with both the 1-year average and median concentrations at a minimum (1.41 µg/m^3 and 1.36 µg/m^3, respectively).

- The smallest range of acetaldehyde concentrations was measured at NBNJ in 2013, although slight increases are shown for the 1-year average and median concentrations.

- For 2014, a sampler issue resulted in the invalidation of carbonyl compound data from May 2014 through the end of the year. While a 1-year average concentration is not provided for 2014 in Figure 16-33, the range of concentrations is provided. The minimum concentration measured in 2014 is greater than the 1-year average concentration for 2013 and the median concentration for 2014 is similar to the maximum concentration measured in 2013.

Figure 16-34. Yearly Statistical Metrics for Benzene Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-34 for benzene concentrations measured at NBNJ include the following:

- Sampling for VOCs under the NMP also began at NBNJ in May 2001. Because a full year's worth of data is not available for 2001, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum benzene concentration was measured in 2012 (4.00 µg/m^3); aside from this measurement, only three additional concentrations of benzene greater than 3 µg/m^3 have been measured at NBNJ.

- Although a slight decreasing trend in the 1-year average concentration is shown between 2002 and 2004, a significant decrease is shown between 2005 and 2007. The median concentration is less than 0.5 µg/m^3 for the first time in 2007 since the onset of sampling.

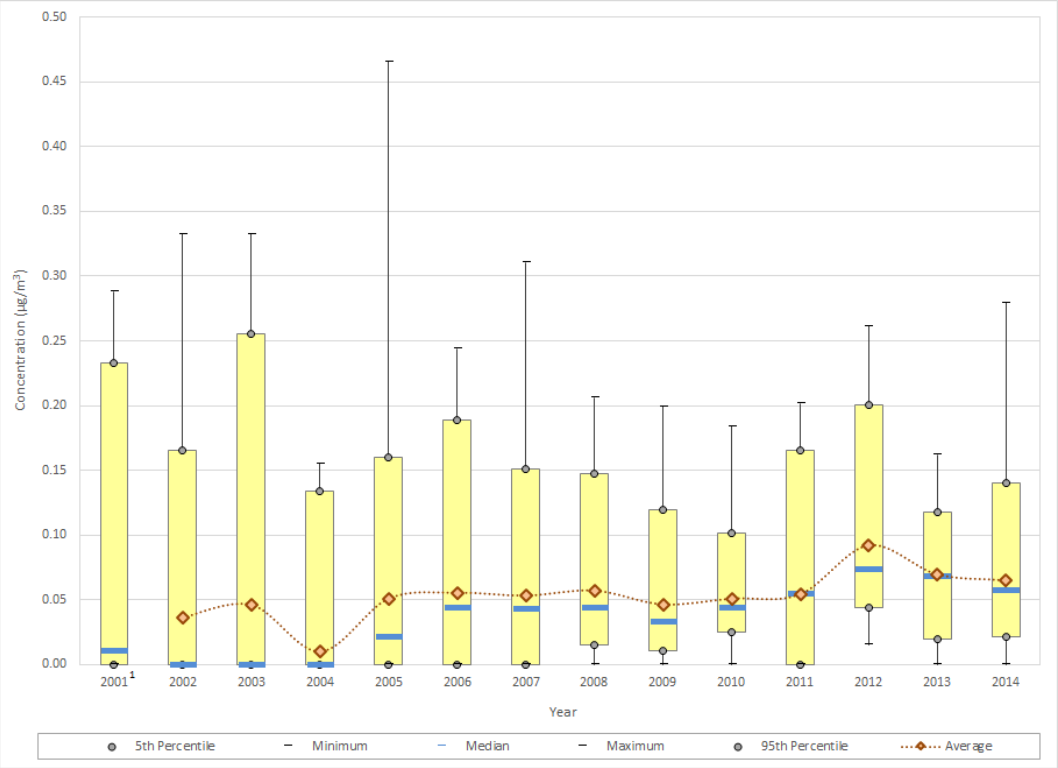
- With the exception of the maximum concentration, all of the statistical parameters exhibit an increase for 2008, representing a return to 2006 levels for most of the parameters.

- Between 2008 and 2011, the 1-year average concentration changes little, ranging from 0.65 µg/m^3 (2010) to 0.71 µg/m^3 (2011), even though there is fluctuation in the range of concentrations measured.

- The 1-year average benzene concentration exhibits an increase from 2011 to 2012, as did many of the statistical parameters, even though the majority of the measurements fell into a smaller range for 2012 than 2011. The minimum and 5th percentile increased considerably for 2012; there were 17 benzene concentrations measured in 2011 that are less than the minimum concentration measured in 2012 (0.49 µg/m^3). In addition, the number of measurements at the upper-end of the concentration range increased substantially for 2012. In addition to a higher maximum concentration, the number of benzene measurements greater than 0.75 µg/m^3 increased from 11 in 2011 to 31 in 2012, accounting for more than half of the concentrations measured in 2012.

- A significant decrease in the 1-year average and median concentrations is shown after 2012 and are both at a minimum for 2014 (and just slightly less than the 1-year average and median concentrations calculated for 2007).

Figure 16-35. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-35 for 1,3-butadiene concentrations measured at NBNJ include the following:

- The maximum 1,3-butadiene concentration was measured at NBNJ in 2005 (0.47 µg/m^3) and is the only measurement greater than 0.35 µg/m^3 measured at NBNJ.

- The minimum, 5th percentile, and median concentrations are zero for 2002 through 2004. This indicates that at least half of the measurements were non-detects for these years, and for 2004, non-detects accounted for all but four of the measurements. The median concentration increased from 2004 to 2005, with the number of non-detects decreasing by almost half. The minimum and 5th percentile are still zero for 2005 through 2007. Further decreases in the number of non-detects are indicated by the 5th percentile increasing for 2008 through 2010, when the number of non-detects ranged from one (2008) to three (2009). The number of non-detects increased considerably for 2011 (17), an increase that is evident from the return of the 5th percentile to zero. There were no non-detects measured in 2012, as indicating by the minimum concentration, which is greater than zero for the first time. Three non-detects were measured in 2013 and again in 2014.

- The 1-year average concentration of 1,3-butadiene decreased significantly from 2003 to 2004. This is primarily a result in the number of non-detects, which increased from 35 in 2003 to 56 in 2004. Thus, many zeros were substituted into this average. The increase in the 1-year average concentration shown from 2004 to 2005 results from a

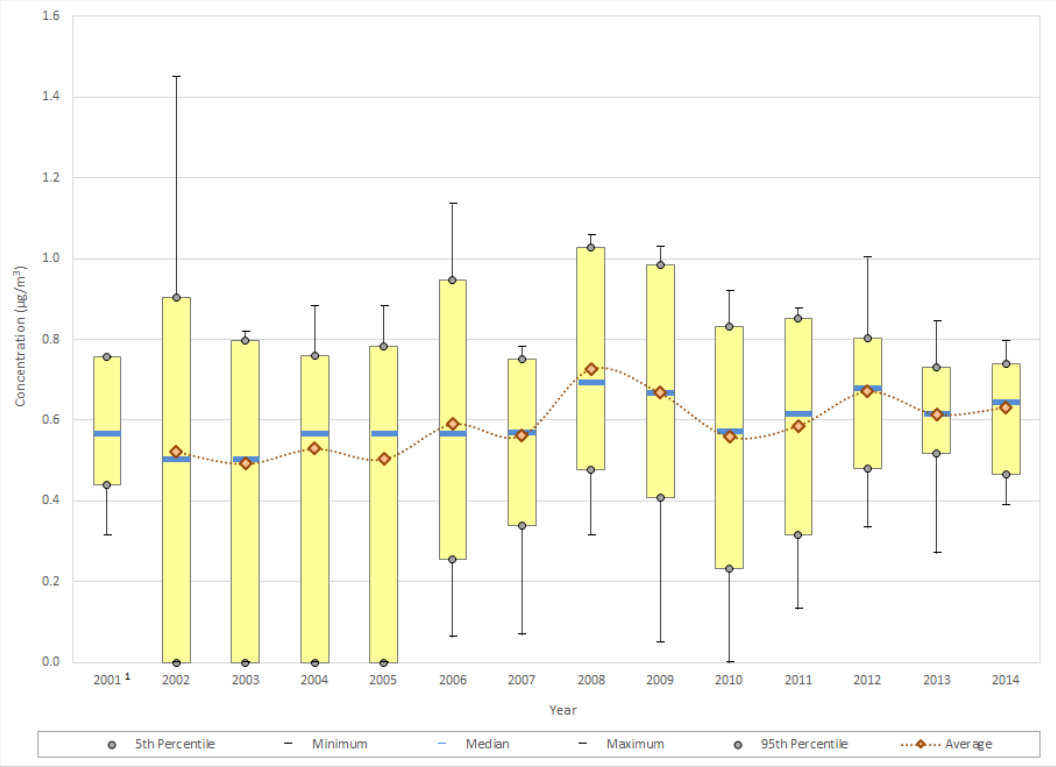
combination of fewer non-detects and a larger range of concentrations measured. The number of non-detects decreased to 27 for 2005, accounting for fewer than half of the measurements for the first time.

- The 1-year average concentration exhibits little change between 2005 and 2011, ranging from 0.047 µg/m^3 (2009) to 0.057 µg/m^3 (2008), even as the range within which the majority of the concentrations are measured tightened each year through 2010.

- The 1-year average concentration increases significantly from 2011 to 2012. Increases are also exhibited by each of the other statistical parameters. This is largely due to the decrease in non-detects (and thus, zeroes substituted for non-detects in the calculations) from 17 non-detects in 2011 to zero for 2012. The number of concentrations at the upper end of the concentration range increased as well; the number of measurements greater than 0.1 µg/m^3 more than doubled, increasing from eight in 2011 to 18 in 2012.

- The 1,3-butadiene concentrations measured in 2013 decreased from 2012 levels but were still higher than those measured in the previous years. Despite a few higher concentrations measured in 2014, slight decreases are also shown for the 1-year average and median concentrations for 2014.

Figure 16-36. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-36 for carbon tetrachloride concentrations measured at NBNJ include the following:

- The range of carbon tetrachloride concentrations measured in 2001 was considerably smaller than those collected in the years immediately following. The considerable decrease in the minimum concentration shown for 2002 to 2005 is due to non-detects, which account for at least 5 percent of the concentrations measured for each year during this time frame.

- The 1-year average concentration changed little between 2002 and 2005, ranging from 0.49 $\mu g/m^3$ to 0.53 $\mu g/m^3$. An increase in the 1-year average concentration is shown from 2005 to 2006, although the change is not statistically significant. This is a result of higher concentrations at both the lower and upper end of the concentration range. A slight decrease in the 1-year average is shown from 2006 to 2007, as the majority of measurements fell into a tighter concentration range. Between 2004 and 2007, the median concentration varied by only 0.003 $\mu g/m^3$.

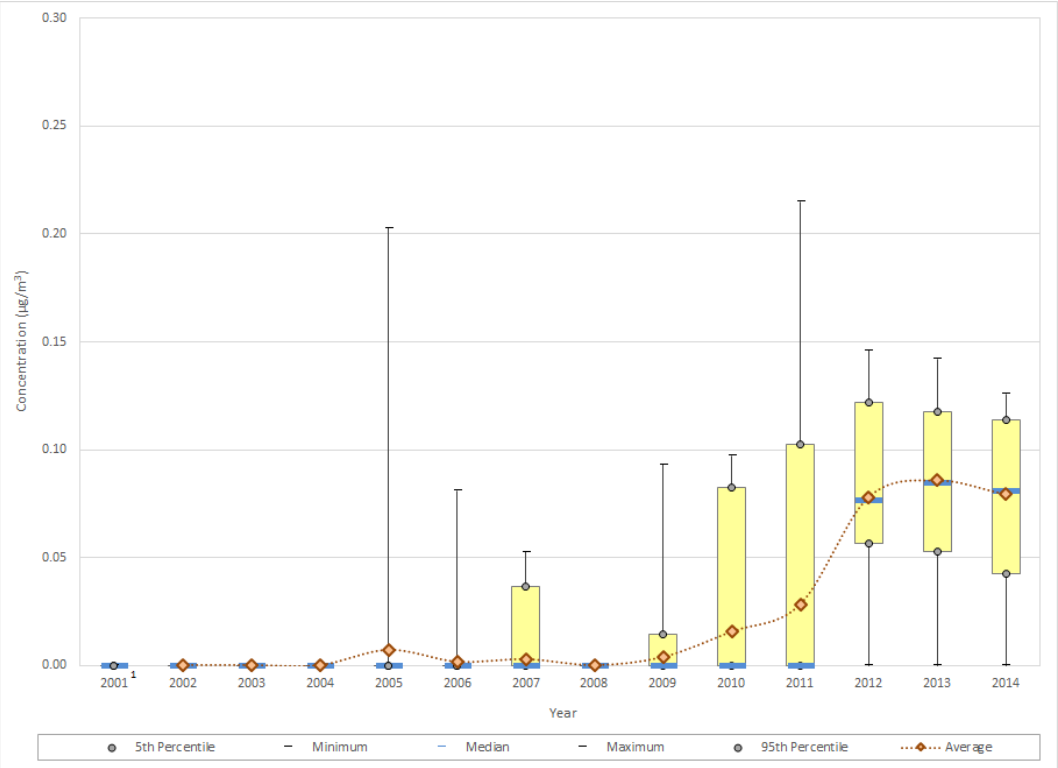
- All of the statistical parameters exhibit increases for 2008. The minimum concentration measured increased considerably from 2007 to 2008. In addition, 20 concentrations measured in 2008 were greater than the maximum concentration measured in 2007.

- Each of the statistical parameters exhibits a decrease after 2008 that continues through 2010. This is followed by an increase in most of the statistical parameters through 2012.

- Carbon tetrachloride concentrations measured in 2013 exhibit the least amount of variability in that the difference between the 5th and 95th percentiles is at a minimum and the difference between the 1-year average and median concentrations is less than 0.005 $\mu g/m^3$.

- The smallest of range of carbon tetrachloride concentrations was measured in 2014.

Figure 16-37. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at NBNJ



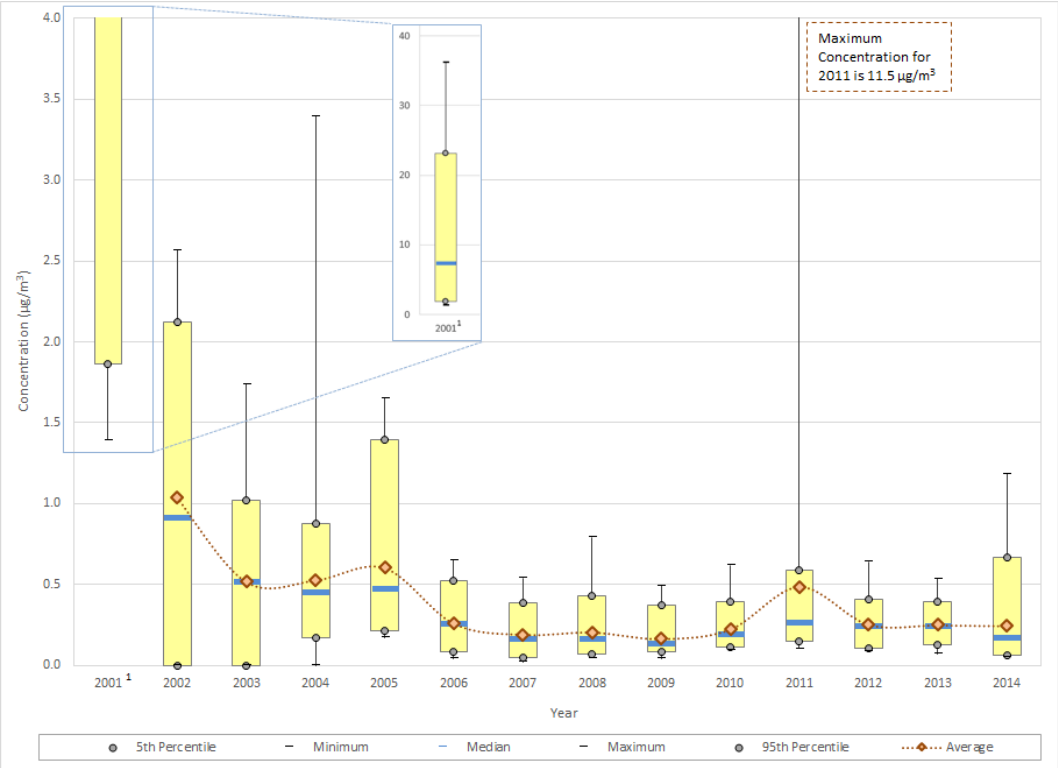
[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-37 for 1,2-dichloroethane concentrations measured at NBNJ include the following:

- There were no measured detections of 1,2-dichloroethane between 2001 and 2004. Between one and four measured detections were measured between 2005 and 2007, after which there were no measured detections in 2008. After 2008, the number of measured detections increased significantly, from a total of three in 2009, to 11 for 2010, 18 in 2011, 58 for 2012, 59 in 2013, and 57 in 2014. This increase in the number of measured detections is very similar to what was exhibited by the concentrations measured at CHNJ and ELNJ. This also explains the significant increase in the 1-year average concentrations shown, particularly for the later years of sampling.

- 2012 is the first year that the median concentration is greater than zero. Aside from the two non-detects, the range of concentrations measured in 2012 is relatively small, ranging from 0.053 µg/m^3 to 0.146 µg/m^3. The 1-year average and median concentrations calculated for 2012 are 0.001 µg/m^3 apart, indicating relatively little variability associated with the concentrations measured in 2012. Similar observations can be made for 2013 and 2014.

Figure 16-38. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-38 for ethylbenzene concentrations measured at NBNJ include the following:

- The maximum ethylbenzene concentration (36.3 µg/m^3) was measured at NBNJ on May 25, 2001. All but one of the 23 concentrations of ethylbenzene greater than 5 µg/m^3 were measured at NBNJ in 2001, and were measured on nearly consecutive sample days between May and October.

- All but five concentrations measured in 2001 are greater than the maximum concentration measured in 2002. As a result, each of the statistical parameters exhibit considerable decreases, with the median concentration decreasing from 7.29 µg/m^3 to 0.91 µg/m^3. Additional decreases shown for 2003.

- The slight increases shown in the 1-year average concentration between 2003 and 2005 is followed by a significant decrease for 2006. Between 2006 and 2010, the 1-year average concentration varied by less than 0.1 µg/m^3, ranging from 0.17 µg/m^3 (2009) to 0.26 µg/m^3 (2006). The concentrations measured during these years are considerably less than those prior to 2006.

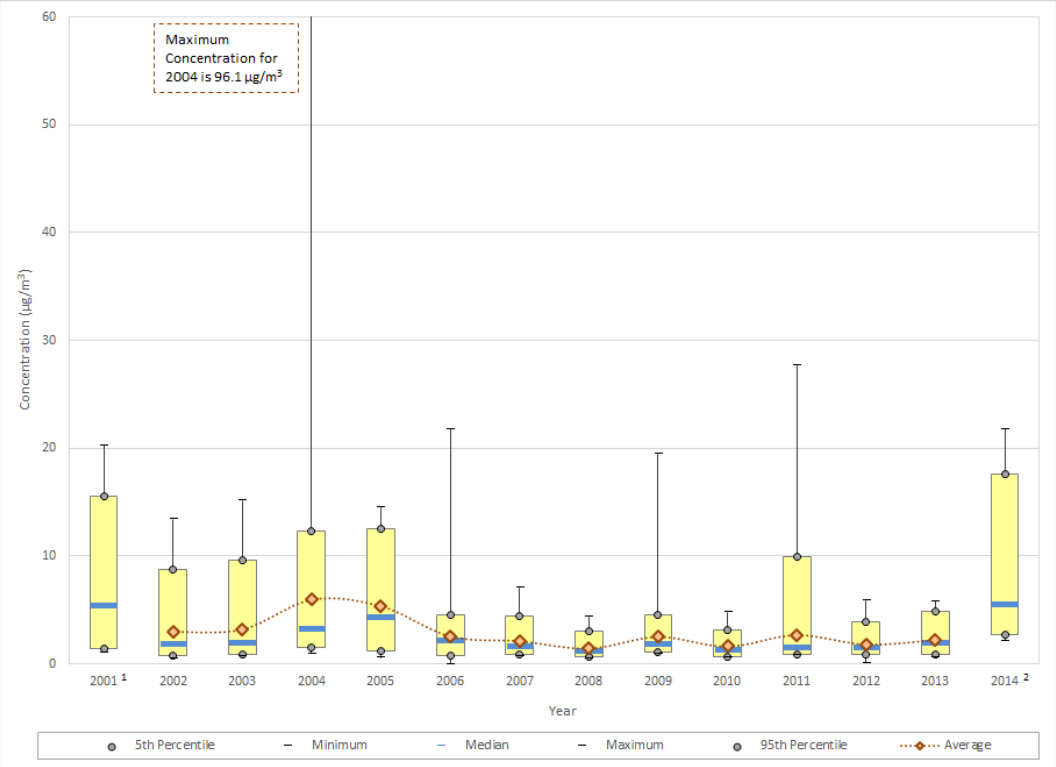
- While most of the ethylbenzene concentrations measured in 2011 fall into a similar range as the previous years, the maximum concentration measured in 2011 (11.5 µg/m^3) is an order of magnitude greater than the second highest concentration measured that year (1.01 µg/m^3). While this measurement is driving the 1-year

average concentration for 2011, the other statistical metrics exhibit increases as well, indicating concentrations were higher overall in 2011. The number of ethylbenzene concentrations greater than 0.25 µg/m^3 accounted for more than half of the concentrations measured at NBNJ in 2011, nearly doubling from 17 in 2010 to 33 in 2011.

- Ethylbenzene concentrations measured in 2012 and 2013 resemble those measured in 2010.

- Despite having similar 1-year average concentrations (all three are 0.25 µg/m^3), the ethylbenzene concentrations measured in 2014 exhibit more variability than the previous two years. The range of concentrations measured more than doubled, and the range within which the majority of concentrations fall is at its largest since 2005.

Figure 16-39. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-39 for formaldehyde concentrations measured at NBNJ include the following:

- The maximum formaldehyde concentration (96.1 µg/m^3) was measured at NBNJ on the same day in 2004 that the highest acetaldehyde concentration was measured (August 31, 2004). This concentration of formaldehyde is more than three times greater than the next highest concentration (27.7 µg/m^3, measured in 2011). In all,

concentrations greater than 20 µg/m^3 have been measured during five of the 14 years shown, including 2014.

- After little change between 2002 and 2003, each of the statistical metrics exhibit increases from 2003 to 2004. This is due in part to the outlying concentration measured in 2004; however, concentrations were higher overall in 2004 compared to 2003. If the maximum concentration was excluded from the calculations for 2004, the 1-year average concentration for 2004 would fall between those calculated for 2003 and 2005, exhibiting lesser increases, but an increase none the less. The number of formaldehyde concentrations greater than 3 µg/m^3 doubled from 2003 to 2004, from 16 to 34. Outlier aside, a similar range of concentration to 2004 was measured in 2005, with the median concentration exhibiting another 1 µg/m^3 increase.

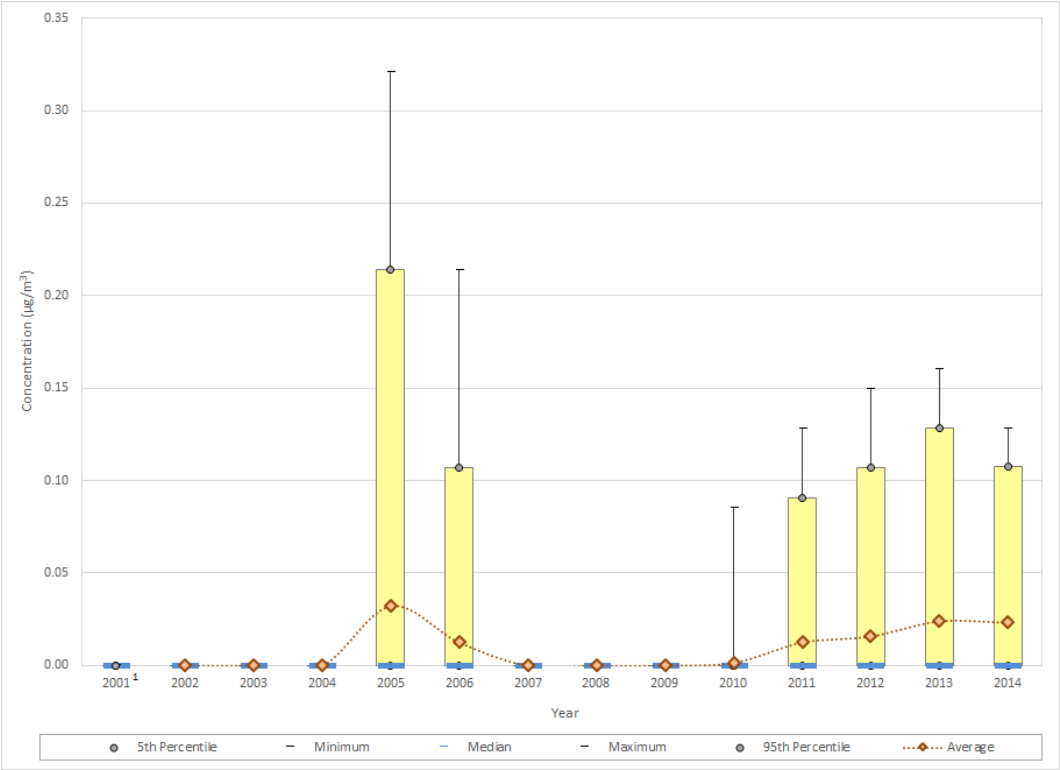
- After 2005, concentrations of formaldehyde measured at NBNJ decreased significantly, with the 1-year average and median concentrations decreasing each year and reaching a minimum for 2008. This year also has the smallest range of formaldehyde concentrations measured, although a similar range was also measured in 2010.

- Between 2008 and 2012, a year with more variability in the measurements alternates with a year with less variability. The measurements for 2011 exhibit a considerable amount of variability compared to the rest of the years within this period. The 95th percentile for 2011 is more than double the 95th percentile for the other years within this period. Yet, the median concentrations are nearly the same for 2011 and 2012.

- Several of the statistical parameters exhibit at least a slight increase for 2013. The number of formaldehyde concentrations greater than 2 µg/m^3 measured at NBNJ in 2013 increased considerably, from 18 in 2012 to 33 in 2013, accounting for more than half of the measurements in 2013.

- A 1-year average concentration is not provided in Figure 16-39 for 2014, as a sampler issue resulted in the invalidation of carbonyl compound data from May 2014 through the end of the year. The statistical metrics shown for formaldehyde for 2014 resemble those shown for acetaldehyde in Figure 16-33. Nine formaldehyde concentrations measured in 2014 are greater than the maximum concentration measured in 2013 and the median concentration for 2014 is greater than the 95th percentile shown for 2013.

Figure 16-40. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-40 for hexachloro-1,3-butadiene concentrations measured at NBNJ include the following:

- There were no measured detections of hexachloro-1,3-butadiene measured during the first 4 years of sampling at NBNJ.

- The number of measured detections increased to nine for 2005, representing 16 percent of measurements, then decreased to five for 2006. The number of measured detections returned to zero between 2007 and 2009. A single measured detection was reported for 2010, after which the number of measured detections has increased each year (eight for 2011, 11 for 2012, 16 for 2013, and 17 for 2014).

- Even though measured detections accounted for more than one-quarter of the concentrations measured during the last two years of sampling, none have been greater than the detection limit for this pollutant.

16.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each New Jersey monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

16.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the New Jersey sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 16-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 16-5. Risk Approximations for the New Jersey Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Camden, New Jersey - CSNJ						
Acetaldehyde	0.0000022	0.009	60/60	2.49 ± 0.22	5.48	0.28
Benzene	0.0000078	0.03	61/61	0.76 ± 0.09	5.90	0.03
1,3-Butadiene	0.00003	0.002	61/61	0.09 ± 0.01	2.84	0.05
Carbon Tetrachloride	0.000006	0.1	61/61	0.61 ± 0.03	3.64	0.01
1,2-Dichloroethane	0.000026	2.4	59/61	0.08 ± 0.01	2.10	<0.01
Ethylbenzene	0.0000025	1	61/61	0.33 ± 0.11	0.81	<0.01
Formaldehyde	0.000013	0.0098	60/60	4.48 ± 0.52	58.20	0.46
Hexachloro-1,3-butadiene	0.000022	0.09	12/61	0.02 ± 0.01	0.34	<0.01
Chester, New Jersey - CHNJ						
Acetaldehyde	0.0000022	0.009	60/60	1.25 ± 0.12	2.75	0.14
Benzene	0.0000078	0.03	61/61	0.47 ± 0.05	3.69	0.02
1,3-Butadiene	0.00003	0.002	59/61	0.06 ± 0.01	1.84	0.03
Carbon Tetrachloride	0.000006	0.1	61/61	0.60 ± 0.03	3.62	0.01
1,2-Dichloroethane	0.000026	2.4	60/61	0.08 ± <0.01	2.01	<0.01
Formaldehyde	0.000013	0.0098	60/60	2.06 ± 0.34	26.79	0.21

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average concentration.

Table 16-5. Risk Approximations for the New Jersey Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Elizabeth, New Jersey - ELNJ						
Acetaldehyde	0.0000022	0.009	61/61	2.78 ± 0.21	6.11	0.31
Benzene	0.0000078	0.03	59/59	0.78 ± 0.09	6.10	0.03
1,3-Butadiene	0.00003	0.002	59/59	0.12 ± 0.01	3.58	0.06
Carbon Tetrachloride	0.000006	0.1	59/59	0.62 ± 0.03	3.71	0.01
1,2-Dichloroethane	0.000026	2.4	57/59	0.09 ± 0.01	2.24	<0.01
Ethylbenzene	0.0000025	1	59/59	0.36 ± 0.05	0.91	<0.01
Formaldehyde	0.000013	0.0098	61/61	4.44 ± 0.52	57.73	0.45
Hexachloro-1,3-butadiene	0.000022	0.09	18/59	0.02 ± 0.01	0.54	<0.01
North Brunswick, New Jersey - NBNJ						
Acetaldehyde	0.0000022	0.009	20/20	NA	NA	NA
Benzene	0.0000078	0.03	60/60	0.54 ± 0.07	4.19	0.02
1,3-Butadiene	0.00003	0.002	57/60	0.07 ± 0.01	1.97	0.03
Carbon Tetrachloride	0.000006	0.1	60/60	0.63 ± 0.02	3.79	0.01
1,2-Dichloroethane	0.000026	2.4	58/60	0.08 ± 0.01	2.10	<0.01
Ethylbenzene	0.0000025	1	60/60	0.25 ± 0.06	0.62	<0.01
Formaldehyde	0.000013	0.0098	20/20	NA	NA	NA
Hexachloro-1,3-butadiene	0.000022	0.09	17/60	0.02 ± 0.01	0.51	<0.01

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

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

Observations from Table 16-5 include the following:

- For CSNJ, the pollutants of interest with the highest annual average concentrations are formaldehyde, acetaldehyde, and benzene. Formaldehyde has the highest cancer risk approximation for this site (58.20 in-a-million), followed by benzene and acetaldehyde. The cancer risk approximation for formaldehyde is at least an order of magnitude higher than the cancer risk approximations for the other pollutants of interest for CSNJ. CSNJ's cancer risk approximation for formaldehyde is the highest cancer risk approximation among the pollutants of interest for the New Jersey sites and the third highest among all NMP sites. None of the pollutants of interest for CSNJ have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximation for CSNJ (0.46).

- For CHNJ, the pollutants with the highest annual average concentrations are formaldehyde, acetaldehyde, and carbon tetrachloride. Formaldehyde has the highest cancer risk approximation for this site (26.79 in-a-million), followed by benzene and carbon tetrachloride. The cancer risk approximation for formaldehyde is at least an order of magnitude higher than the approximations for the other pollutants of interest for CHNJ. None of the pollutants of interest for CHNJ have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximation for CHNJ (0.21).

- For ELNJ, the pollutants with the highest annual average concentrations are formaldehyde, acetaldehyde, and benzene. These three pollutants also have the highest cancer risk approximations for this site, although the cancer risk approximation for benzene is similar to the cancer risk approximation for acetaldehyde. ELNJ's cancer risk approximation for formaldehyde (57.73 in-a-million) is similar to the cancer risk approximation calculated for CSNJ and is the fourth highest cancer risk approximation among all NMP sites. None of the pollutants of interest for ELNJ have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximation for ELNJ (0.45).

- For NBNJ, the pollutants with the highest annual average concentrations are carbon tetrachloride, benzene, and ethylbenzene. Recall, however, that annual average concentrations could not be calculated for the carbonyl compounds. Benzene has the highest cancer risk approximation for NBNJ (4.19 in-a-million), followed by carbon tetrachloride (3.79 in-a-million). None of the pollutants of interest for NBNJ have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. All of the noncancer hazard approximation calculated for NBNJ are less than 0.05.

16.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 16-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 16-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 16-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for each New Jersey site, as presented in Table 16-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 16-6. Table 16-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 16.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 16-6. 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 UREs (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)**
Camden, New Jersey (Camden County) - CSNJ					
Benzene	130.73	Formaldehyde	1.24E-03	Formaldehyde	58.20
Formaldehyde	95.20	Benzene	1.02E-03	Benzene	5.90
Ethylbenzene	64.14	1,3-Butadiene	6.27E-04	Acetaldehyde	5.48
Acetaldehyde	55.11	Naphthalene	3.58E-04	Carbon Tetrachloride	3.64
1,3-Butadiene	20.89	POM, Group 2b	2.36E-04	1,3-Butadiene	2.84
Tetrachloroethylene	11.72	Nickel, PM	2.02E-04	1,2-Dichloroethane	2.10
Naphthalene	10.52	POM, Group 2d	1.65E-04	Ethylbenzene	0.81
POM, Group 2b	2.68	Ethylbenzene	1.60E-04	Hexachloro-1,3-butadiene	0.34
POM, Group 2d	1.87	Arsenic, PM	1.38E-04		
Trichloroethylene	1.20	POM, Group 5a	1.23E-04		
Chester, New Jersey (Morris County) - CHNJ					
Benzene	161.55	Benzene	1.26E-03	Formaldehyde	26.79
Formaldehyde	95.57	Formaldehyde	1.24E-03	Benzene	3.69
Ethylbenzene	86.05	1,3-Butadiene	7.62E-04	Carbon Tetrachloride	3.62
Acetaldehyde	58.64	Naphthalene	3.43E-04	Acetaldehyde	2.75
1,3-Butadiene	25.41	Ethylbenzene	2.15E-04	1,2-Dichloroethane	2.01
Tetrachloroethylene	11.82	POM, Group 2b	2.05E-04	1,3-Butadiene	1.84
Naphthalene	10.09	Nickel, PM	1.97E-04		
Dichloromethane	5.27	POM, Group 2d	1.45E-04		
POM, Group 2b	2.33	POM, Group 5a	1.31E-04		
POM, Group 2d	1.64	Arsenic, PM	1.30E-04		

Table 16-6. 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 UREs (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)**
Elizabeth, New Jersey (Union County) - ELNJ					
Benzene	138.53	Formaldehyde	1.30E-03	Formaldehyde	57.73
Formaldehyde	99.64	Benzene	1.08E-03	Acetaldehyde	6.11
Ethylbenzene	74.03	1,3-Butadiene	6.29E-04	Benzene	6.10
Acetaldehyde	59.30	Nickel, PM	4.27E-04	Carbon Tetrachloride	3.71
1,3-Butadiene	20.96	Naphthalene	3.75E-04	1,3-Butadiene	3.58
Tetrachloroethylene	14.36	Arsenic, PM	2.03E-04	1,2-Dichloroethane	2.24
Naphthalene	11.04	Ethylbenzene	1.85E-04	Ethylbenzene	0.91
Dichloromethane	2.96	POM, Group 2b	1.84E-04	Hexachloro-1,3-butadiene	0.54
POM, Group 2b	2.09	Hexavalent Chromium	1.55E-04		
Trichloroethylene	1.77	POM, Group 2d	1.33E-04		
North Brunswick, New Jersey (Middlesex County) - NBNJ					
Benzene	213.63	Formaldehyde	1.81E-03	Benzene	4.19
Formaldehyde	139.48	Benzene	1.67E-03	Carbon Tetrachloride	3.79
Ethylbenzene	110.60	1,3-Butadiene	9.59E-04	1,2-Dichloroethane	2.10
Acetaldehyde	83.83	Naphthalene	5.42E-04	1,3-Butadiene	1.97
1,3-Butadiene	31.96	Hydrazine	4.38E-04	Ethylbenzene	0.62
Tetrachloroethylene	24.38	POM, Group 2b	2.82E-04	Hexachloro-1,3-butadiene	0.51
Naphthalene	15.95	Ethylbenzene	2.77E-04		
POM, Group 2b	3.20	POM, Group 2d	2.03E-04		
Trichloroethylene	3.19	Arsenic, PM	1.86E-04		
Dichloromethane	3.03	POM, Group 5a	1.85E-04		

Table 16-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New Jersey Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Camden, New Jersey (Camden County) - CSNJ					
Toluene	422.02	Acrolein	598,846.68	Formaldehyde	0.46
Hexane	272.19	1,3-Butadiene	10,445.69	Acetaldehyde	0.28
Xylenes	249.52	Formaldehyde	9,713.82	1,3-Butadiene	0.05
Benzene	130.73	Acetaldehyde	6,122.91	Benzene	0.03
Formaldehyde	95.20	Nickel, PM	4,680.35	Carbon Tetrachloride	0.01
Ethylbenzene	64.14	Benzene	4,357.53	Ethylbenzene	<0.01
Acetaldehyde	55.11	Naphthalene	3,506.47	Hexachloro-1,3-butadiene	<0.01
Methyl isobutyl ketone	32.86	Xylenes	2,495.17	1,2-Dichloroethane	<0.01
Hydrochloric acid	29.17	Arsenic, PM	2,139.62		
1,3-Butadiene	20.89	Cadmium, PM	1,996.78		
Chester, New Jersey (Morris County) - CHNJ					
Toluene	528.02	Acrolein	251,595.35	Formaldehyde	0.21
Xylenes	342.26	1,3-Butadiene	12,707.28	Acetaldehyde	0.14
Hexane	314.43	Formaldehyde	9,751.59	1,3-Butadiene	0.03
Benzene	161.55	Acetaldehyde	6,515.84	Benzene	0.02
Formaldehyde	95.57	Benzene	5,385.08	Carbon Tetrachloride	0.01
Ethylbenzene	86.05	Nickel, PM	4,561.47	1,2-Dichloroethane	<0.01
Ethylene glycol	81.36	Xylenes	3,422.56		
Acetaldehyde	58.64	Naphthalene	3,363.00		
Methyl isobutyl ketone	44.35	Lead, PM	2,402.90		
Methanol	38.69	Arsenic, PM	2,017.68		

Table 16-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New Jersey Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Elizabeth, New Jersey (Union County) - ELNJ					
Toluene	482.50	Acrolein	306,476.99	Formaldehyde	0.45
Hexane	351.57	Cyanide Compounds, PM	37,500.01	Acetaldehyde	0.31
Xylenes	279.98	1,3-Butadiene	10,478.70	1,3-Butadiene	0.06
Benzene	138.53	Formaldehyde	10,167.13	Benzene	0.03
Formaldehyde	99.64	Nickel, PM	9,894.58	Carbon Tetrachloride	0.01
Ethylbenzene	74.03	Acetaldehyde	6,588.93	Ethylbenzene	<0.01
Acetaldehyde	59.30	Benzene	4,617.66	Hexachloro-1,3-butadiene	<0.01
Ethylene glycol	45.18	Chlorine	4,370.00	1,2-Dichloroethane	<0.01
Methyl isobutyl ketone	44.98	Naphthalene	3,678.63		
Cyanide Compounds, PM	30.00	Lead, PM	3,167.18		
North Brunswick, New Jersey (Middlesex County) - NBNJ					
Toluene	721.66	Acrolein	424,778.44	1,3-Butadiene	0.03
Hexane	499.90	1,3-Butadiene	15,980.24	Benzene	0.02
Xylenes	432.41	Formaldehyde	14,232.86	Carbon Tetrachloride	0.01
Benzene	213.63	Acetaldehyde	9,314.11	Hexachloro-1,3-butadiene	<0.01
Formaldehyde	139.48	Benzene	7,120.91	Ethylbenzene	<0.01
Ethylbenzene	110.60	Naphthalene	5,317.45	1,2-Dichloroethane	<0.01
Acetaldehyde	83.83	Lead, PM	5,099.62		
Methyl isobutyl ketone	58.79	Titanium tetrachloride	4,535.00		
Ethylene glycol	35.26	Xylenes	4,324.07		
1,3-Butadiene	31.96	Arsenic, PM	2,886.75		

Observations from Table 16-6 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in all four New Jersey counties with NMP sites.

- Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for all four New Jersey counties, although the order is different for Morris County (CHNJ).

- Six of the 10 highest emitted pollutants in Union and Middlesex Counties also have the highest toxicity-weighted emissions. Seven of the highest emitted pollutants in Camden and Morris Counties also have the highest toxicity-weighted emissions.

- Formaldehyde, benzene, ethylbenzene, and 1,3-butadiene are among the pollutants with the highest cancer risk approximations for CSNJ and also appear on both emissions-based lists. Acetaldehyde is also among the pollutants with the highest cancer risk approximations for CSNJ; this pollutant appears among the highest emitted pollutants in Camden County but does not appear among those with the highest toxicity-weighted emissions. These observations are also true for ELNJ.

- Formaldehyde, benzene, and 1,3-butadiene are among the pollutants with the highest cancer risk approximations for CHNJ and also appear on both emissions-based lists. Acetaldehyde is also among the pollutants with the highest cancer risk approximations for CHNJ; this pollutant appears among the highest emitted pollutants in Morris County but does not appear among those with the highest toxicity-weighted emissions.

- Benzene, ethylbenzene, and 1,3-butadiene are among the pollutants with the highest cancer risk approximations for NBNJ and also appear on both emissions-based lists.

- Carbon tetrachloride, 1,2-dichloroethane, and hexachloro-1,3-butadiene are additional pollutants of interest for the New Jersey sites. These pollutants do not appear on either emissions-based list for any of the four counties.

- Arsenic, nickel, and several POM Groups appear among the pollutants with the highest toxicity-weighted emissions for the New Jersey counties with NMP sites. Neither speciated metals nor PAHs were sampled for at these sites under the NMP.

Observations from Table 16-7 include the following:

- Toluene, hexane, and xylenes are the highest emitted pollutants with noncancer RfCs in Camden, Union, and Middlesex Counties. In Morris County (CHNJ), toluene is also the highest emitted pollutant, but the xylenes emissions are greater than the hexane emissions.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all four New Jersey counties but is not among the highest emitted pollutants for any of the New Jersey counties (acrolein ranks between

11th and 17th for these counties). Although acrolein was sampled for at all four sites, this pollutant was excluded from the pollutant of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. 1,3-Butadiene and formaldehyde are the pollutants with the second and third highest toxicity-weighted emissions in three of the four counties. For Union County (ELNJ), cyanide compounds rank higher than 1,3-butadiene and formaldehyde for this county's toxicity-weighted emissions.

- Between four and five of the 10 highest emitted pollutants also have the highest toxicity-weighted emissions for each of the New Jersey counties.

- Formaldehyde, acetaldehyde, 1,3-butadiene, and benzene are pollutants of interest for CSNJ and each appears on both emissions-based lists for Camden County. Ethylbenzene is another pollutant of interest for CSNJ and appears among the highest emitted in Camden County but is not among those with the highest toxicity-weighted emissions.

- Formaldehyde, acetaldehyde, and benzene are pollutants of interest for CHNJ that appear on both emissions-based lists for Morris County. 1,3-Butadiene is another pollutant of interest for CHNJ and ranks second among those with the highest toxicity-weighted emissions, but is not among the highest emitted in Morris County.

- Formaldehyde, acetaldehyde, and benzene are pollutants of interest for ELNJ that appear on both emissions-based lists for Union County. 1,3-Butadiene is another pollutant of interest for ELNJ and ranks third among those with the highest toxicity-weighted emissions, but is not among the highest emitted in Union County. Ethylbenzene, also a pollutant of interest for ELNJ, appears among the highest emitted pollutants (with a noncancer RfC) but is not among those with the highest toxicity-weighted emissions.

- Benzene and 1,3-butadiene are pollutants of interest for NBNJ that appear on both emissions-based lists for Middlesex County. Ethylbenzene is also a pollutant of interest for NBNJ and appears among the highest emitted pollutants but is not among those with the highest toxicity-weighted emissions.

- Carbon tetrachloride, 1,2-dichloroethane, and hexachloro-1,3-butadiene are additional pollutants of interest for the New Jersey sites. These pollutants do not appear on either emissions-based list for any of the four counties.

- Several speciated metals and naphthalene appear among the pollutants with the highest toxicity-weighted emissions for each New Jersey county with an NMP site. Neither speciated metals nor PAHs were sampled for at the New Jersey sites under the NMP.

16.6 Summary of the 2014 Monitoring Data for the New Jersey Monitoring Sites

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

- *Concentrations of 14 pollutants failed at least one screen for CSNJ; nine failed screens for CHNJ; 12 failed screens for ELNJ; and 12 failed screens for NBNJ.*

- *Formaldehyde and acetaldehyde had the highest annual average concentrations for each of the New Jersey sites, where they could be calculated. Among the VOCs, benzene and carbon tetrachloride had the highest annual average concentrations for each site.*

- *CSNJ has the second highest annual average concentration of formaldehyde and the sixth highest annual average concentration of acetaldehyde among NMP sites sampling carbonyl compounds. ELNJ has the third highest annual average concentrations of both acetaldehyde and formaldehyde among sites sampling these pollutants.*

- *ELNJ is the longest running NMP site participating under the NMP. Concentrations of benzene have decreased significantly at this site since the onset of sampling. This is also true of ethylbenzene, although concentrations have leveled out in the last few years.*

- *The detection rates of 1,2-dichloroethane and hexachloro-1,3-butadiene at CHNJ, ELNJ, and NBNJ have been increasing steadily over the last few years of sampling. Concentrations of 1,3-butadiene have an increasing trend at CHNJ over recent years.*

- *Formaldehyde has the highest cancer risk approximation of the pollutants of interest for CSNJ, CHNJ, and ELNJ; benzene has the highest cancer risk approximation of the pollutants of interest for NBNJ (among those for which cancer risk approximations could be calculated). None of the pollutants of interest for these sites have noncancer hazard approximations greater than an HQ of 1.0.*

17.0 Sites in New York

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

17.1 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.

One New York monitoring site is located in New York City (BXNY) and one is located in Rochester (ROCH). Figure 17-1 is a composite satellite image retrieved from ArcGIS Explorer showing the New York City monitoring site and its immediate surroundings. Figure 17-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of BXNY are included in the facility counts provided in Figure 17-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Figures 17-3 and 17-4 are the composite satellite image and emissions sources map for ROCH. Table 17-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 17-1. New York City, New York (BXNY) Monitoring Site

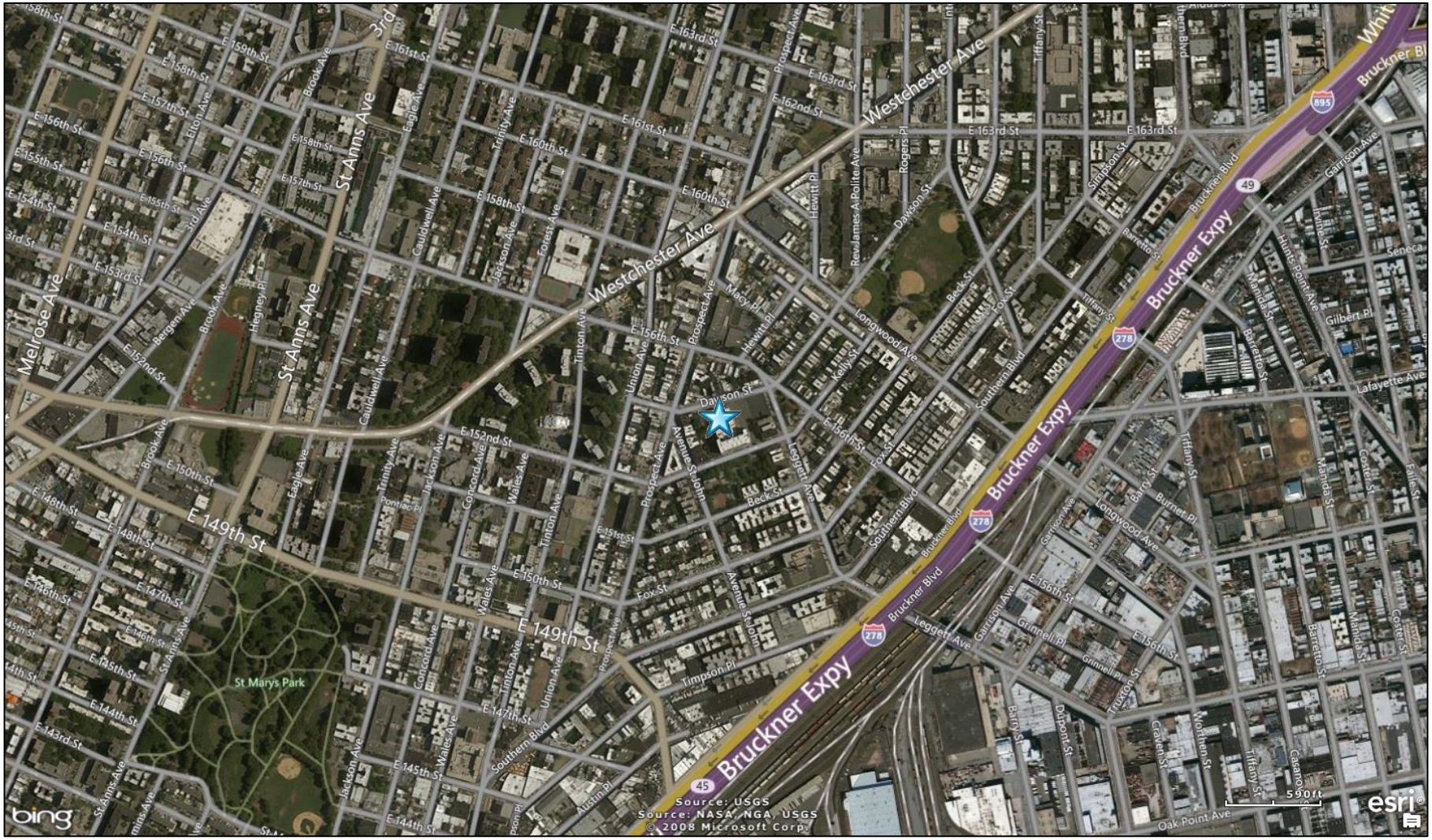


Figure 17-2. NEI Point Sources Located Within 10 Miles of BXNY

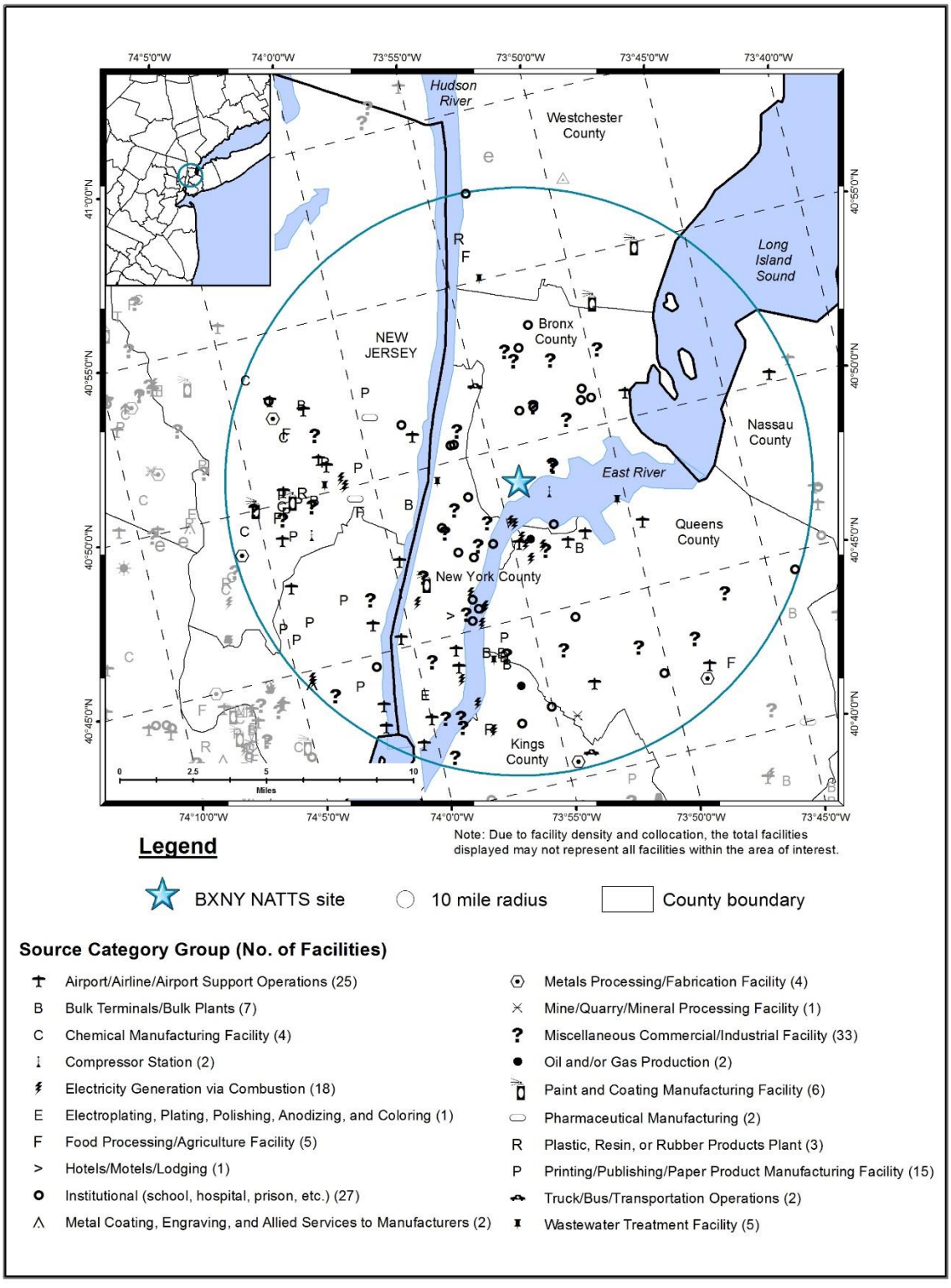


Figure 17-3. Rochester, New York (ROCH) Monitoring Site

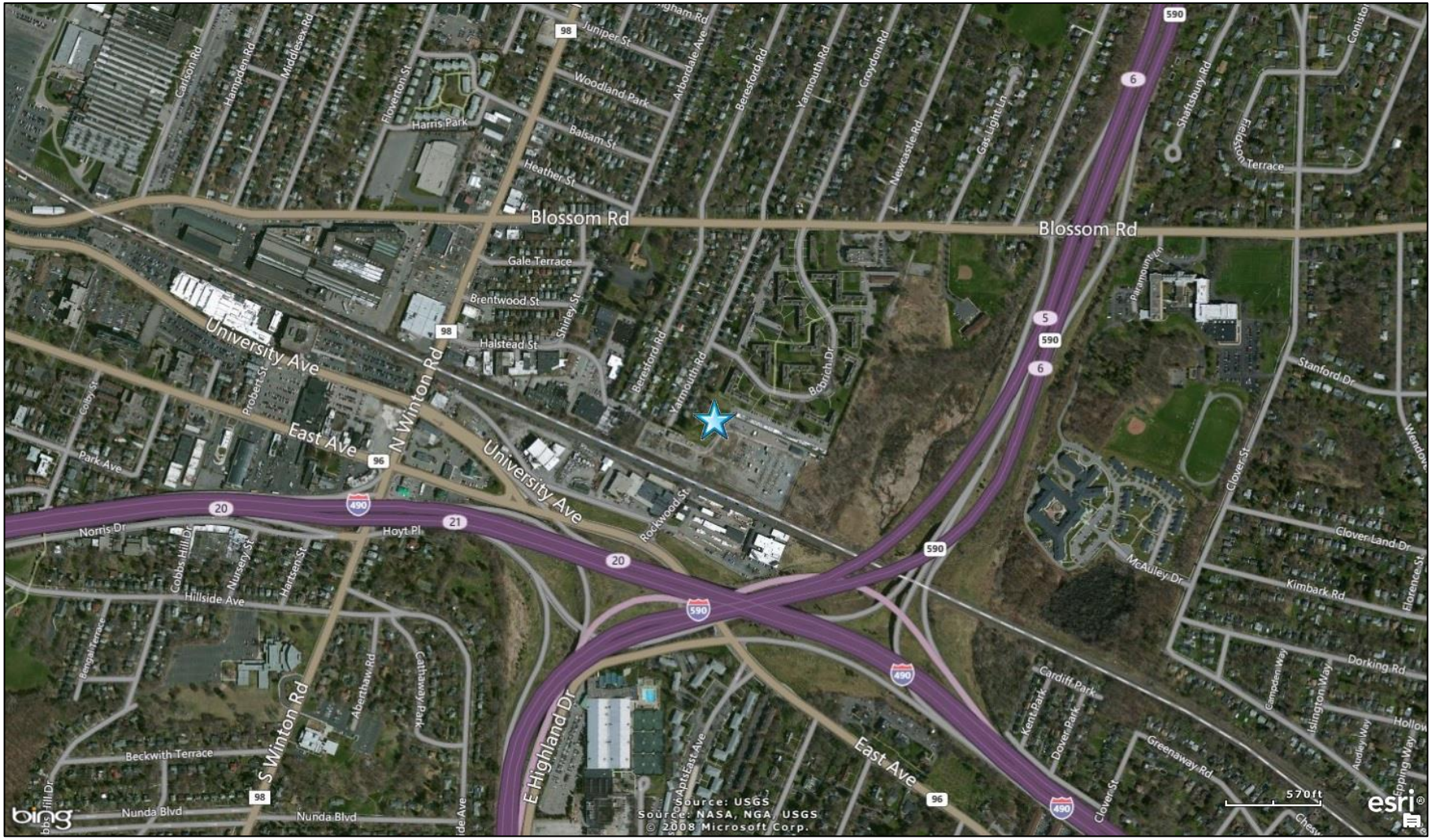


Figure 17-4. NEI Point Sources Located Within 10 Miles of ROCH

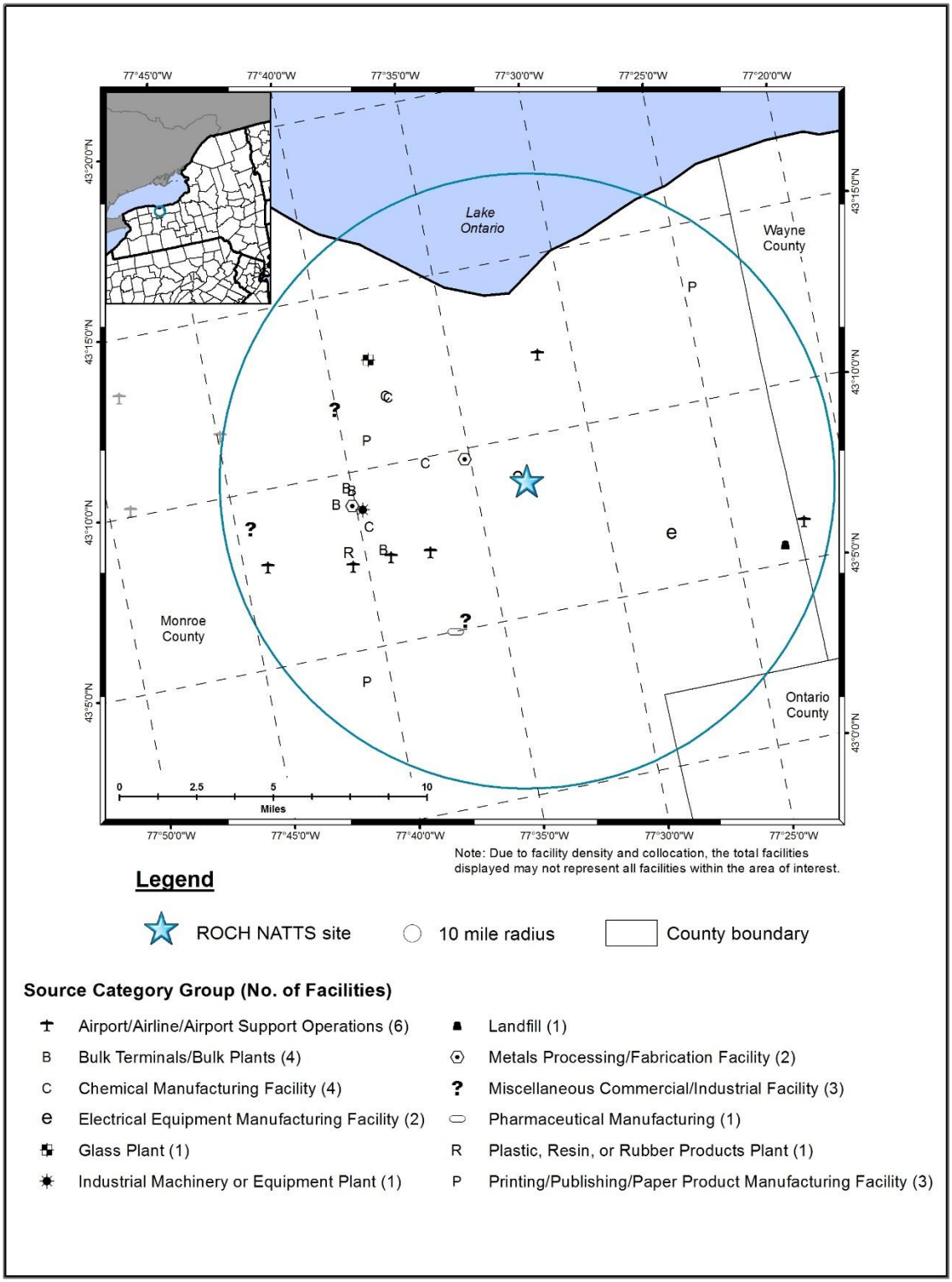


Table 17-1. Geographical Information for the New York Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
BXNY	36-005-0110	New York	Bronx	New York-Newark-Jersey City, NY-NJ-PA	40.816180, -73.902000	Residential	Urban/City Center	98,298	I-278 between I-87 & I-895
ROCH	36-055-1007	Rochester	Monroe	Rochester, NY	43.146180, -77.548170	Residential	Urban/City Center	85,417	I-490 at I-590

[1]AADT reflects 2013 data (NYS DOT, 2013)
BOLD ITALICS = EPA-designated NATTS Site

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 and is the Bronx (#1) NATTS site. The surrounding area is urban and residential, as shown in Figure 17-1. The Bruckner Expressway (I-278) is located a few blocks east of the monitoring site and other heavily traveled roadways are also located within a few miles of the site. A freight yard and other industries lie on the southeast and south side of I-278, part of which can be seen in the lower right-hand side of Figure 17-1. BXNY is less than one-half mile from the East River at its closest point.

Figure 17-2 shows the numerous point sources that are located within 10 miles of BXNY, with a majority of the emissions sources located to the south and west of the site. The source categories with the greatest number of emissions sources surrounding the site include institutions such as hospitals, schools, and prisons; airport and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; electricity generation via combustion; and printing, publishing, and paper product manufacturing. The point source closest to BXNY is a compressor station.

ROCH is located at a power substation on the east side of Rochester, in western New York. Rochester is approximately halfway between Syracuse and Buffalo, with Lake Ontario situated to the north. Although the area north and west of the site is primarily residential, as shown in Figure 17-3, a rail line transverses the area just south of the site, and I-590 and I-490 intersect farther south with commercial areas adjacent to this corridor. The site is used by researchers from several universities for short-term air monitoring studies and is the Rochester NATTS site. As Figure 17-4 shows, the relatively few point sources within 10 miles of ROCH are located primarily on the west side of the 10-mile boundary. The airport and airport support operations source category is the source category with the greatest number of emissions sources surrounding ROCH, although there are also bulk plants/bulk terminals, chemical manufacturers, metals processors/fabricators, and printing, publishing, and paper product manufacturers nearby, to name a few. The closest source to ROCH is an electrical equipment manufacturer.

In addition to providing city, county, CBSA, and land use/location setting information, Table 17-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. Traffic volume is higher near BXNY than ROCH, which rank 12th and 14th, respectively, among NMP sites, although both are in the upper third compared to other NMP sites. The traffic data for BXNY is for I-278 between I-87 and I-895; the traffic data for ROCH are provided for I-490 at I-590.

17.2 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 the year.

17.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For BXNY, site-specific data were not available; thus, data from the NWS weather station at La Guardia Airport (WBAN 14732) was used for the parameters in Table 17-2. For ROCH, temperature, pressure, humidity, and wind information was available in AQS while dew point temperature and sea level pressure data were obtained from the NWS weather station at Greater Rochester International Airport (WBAN 14768). Additionally, relative humidity observations for the first 3 months of 2014 were not available in AQS; thus, relative humidity data from the NWS station was used as a surrogate for the first part of the year for ROCH. A map showing the distance between each New York monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 17-2. Average Meteorological Conditions near the New York Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
New York City, New York - BXNY[2]							
Sample Days (61)	53.0 ± 1.0	38.0 ± 1.0	59.1 ± 0.9	30.03 ± 0.01	30.00 ± 0.01	NW	9.6 ± 0.3
2014	54.2 ± 0.4	39.0 ± 0.4	59.3 ± 0.4	30.02 ± <0.01	29.99 ± <0.01	NW	8.9 ± 0.1
Rochester, New York - ROCH[3]							
Sample Days (63)	49.5 ± 1.0	36.2 ± 1.0	66.1 ± 0.9	30.05 ± 0.01	29.44 ± 0.01	SSE	3.5 ± 0.1
2014	50.5 ± 0.4	37.3 ± 0.4	66.4 ± 0.4	30.02 ± <0.01	29.40 ± 0.01	SW	3.4 ± <0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Data for BXNY were obtained from the closest NWS weather station located at La Guardia Airport, WBAN 14732.
[3]Sea level pressure and dew point temperature observations were not available in AQS for ROCH and were obtained from the closest NWS weather station located at Greater Rochester International Airport, WBAN 14768. In addition, site-specific relative humidity data for the first 3 months of 2014 were not available in AQS; thus, NWS data was used as a surrogate where data were missing.

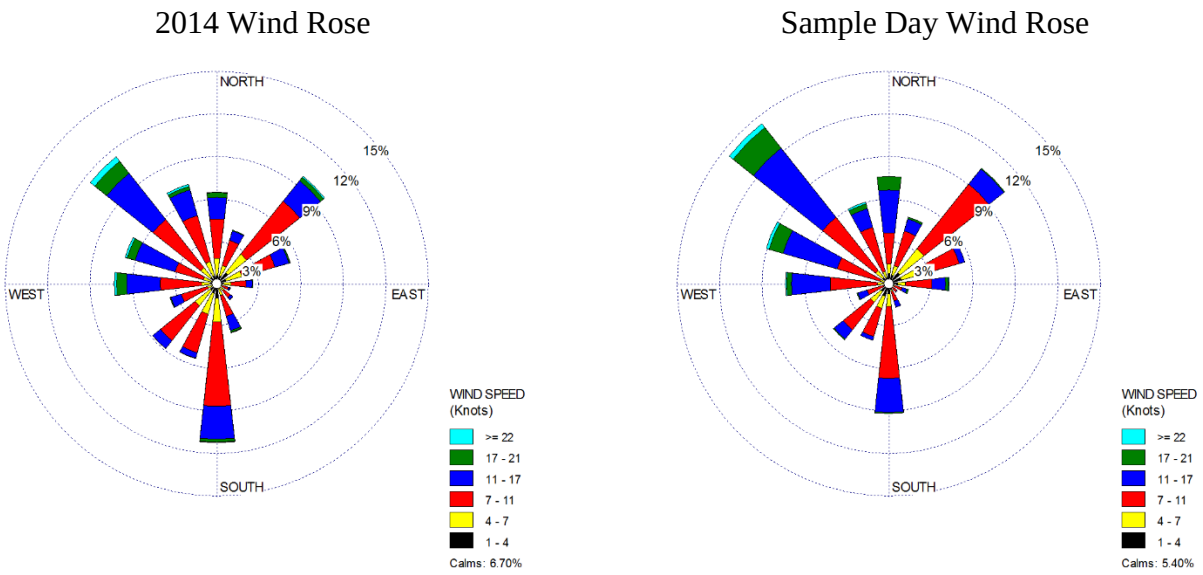
Table 17-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 17-2 is the 95 percent confidence interval for each parameter. As shown in Table 17-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year at each site. Although the difference between the sample day and full-year average wind speed for BXNY is statistically significant, these averages are the highest wind speed averages among NMP sites.

17.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 17-5 presents two wind roses for the BXNY monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind

observations on sample days were representative of conditions experienced over the entire year. Figure 17-6 presents the full-year and sample day wind roses for ROCH.

Figure 17-5. Wind Roses for the La Guardia Airport Weather Station near BXNY



Observations from Figure 17-5 for BXNY include the following:

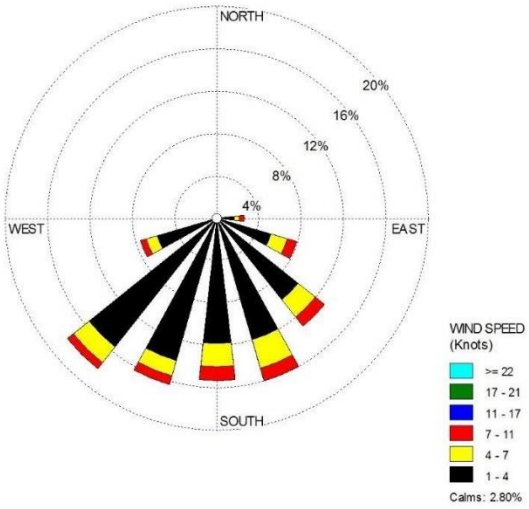
- The weather station at La Guardia Airport is located 2.8 miles south-southeast of BXNY. The East River and Rikers Island separate the site and the weather station.

- The full-year wind rose shows that winds from a variety of directions are observed near BXNY, although winds from the southeast quadrant were rarely observed. Winds from the west to northwest to north account for approximately 40 percent of the wind observations. Winds from the northeast account for another 10 percent of observations while winds from the south account for nearly 12 percent. Calm winds were observed for nearly 7 percent of the hourly measurements near BXNY.

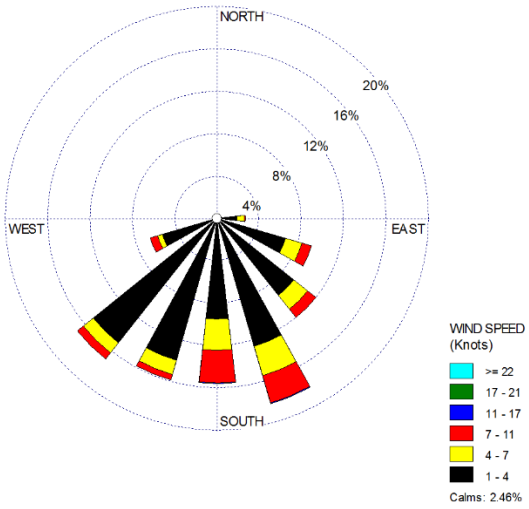
- The sample day wind rose shares many similarities with the full-year wind rose, such as the prominence of winds from the northwest quadrant and the lack of winds from the southeast quadrant. There are some differences, though. For example, winds from the northwest account for a higher percentage on wind observations on sample days while there were fewer southerly wind observations on sample days.

Figure 17-6. Wind Roses for the Wind Data Collected at ROCH

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 17-6 for ROCH include the following:

- The full-year wind rose shows that winds from the east-southeast to south-southwest were frequently observed, while winds from the northeast and northwest quadrants were not observed. Light winds account for the majority of wind observations at this site, although calm winds were observed for less than 3 percent of the hourly measurements. Few wind speeds greater than 11 knots were observed at ROCH in 2014.

- The wind patterns shown on the sample day wind rose are similar to the full-year wind patterns. The calm rate is also similar between the two wind roses. This indicates that wind observations on sample days were representative of those observed throughout the year at ROCH.

17.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each New York monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 17-3. 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 and are shaded in gray in Table 17-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at both New York sites.

Table 17-3. Risk-Based Screening Results for the New York Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
New York City, New York - BXNY						
Naphthalene	0.029	57	57	100.00	74.03	74.03
Acenaphthene	0.011	8	57	14.04	10.39	84.42
Fluorene	0.011	7	53	13.21	9.09	93.51
Benzo(a)pyrene	0.00057	2	57	3.51	2.60	96.10
Fluoranthene	0.011	2	57	3.51	2.60	98.70
Acenaphthylene	0.011	1	44	2.27	1.30	100.00
Total		77	325	23.69		
Rochester, New York - ROCH						
Naphthalene	0.029	39	57	68.42	45.35	45.35
Acenaphthene	0.011	23	57	40.35	26.74	72.09
Fluorene	0.011	22	50	44.00	25.58	97.67
Fluoranthene	0.011	2	57	3.51	2.33	100.00
Total		86	221	38.91		

Observations from Table 17-3 include the following:

- Concentrations of six pollutants failed screens for BXNY; 24 percent of concentrations for these six pollutants were greater than their associated risk screening value (or failed screens).

- Five of the six PAHs that failed screens were identified as pollutants of interest for BXNY. Although the 95 percent criteria is met with benzo(a)pyrene, fluoranthene is

also considered a pollutant of interest for BXNY because it failed the same number of screens as benzo(a)pyrene, per the steps described in Section 3.2.

- Concentrations of four pollutants failed screens for ROCH; 39 percent of concentrations for these four pollutants were greater than their associated risk screening value (or failed screens).

- Three of these four pollutants contributed to 95 percent of failed screens for ROCH and therefore were identified as pollutants of interest for this site.

- For both sites, naphthalene, acenaphthene, and fluorene were identified as pollutants of interest. Naphthalene failed the majority of screens for each site, accounting for 74 percent of failed screens for BXNY and 45 percent of failed screens for ROCH. Acenaphthene and fluorene together account for 15 failed screens for BXNY and 45 failed screens for ROCH. Thus, the number of failed screens of acenaphthene and fluorene is three times greater for ROCH than BXNY.

17.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the New York monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at BXNY and ROCH are provided in Appendix M.

17.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each New York site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the

total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the New York monitoring sites are presented in Table 17-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 17-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New York Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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							
Acenaphthene	57/57	57	2.83 ± 1.37	7.74 ± 2.25	11.98 ± 3.07	3.44 ± 0.88	6.28 ± 1.35
Benzo(a)pyrene	57/55	57	0.39 ± 0.30	0.11 ± 0.04	0.09 ± 0.02	0.22 ± 0.16	0.21 ± 0.09
Fluoranthene	57/57	57	3.82 ± 1.59	4.40 ± 1.23	5.88 ± 1.08	3.58 ± 1.62	4.38 ± 0.72
Fluorene	53/53	57	3.23 ± 1.50	7.73 ± 1.99	11.44 ± 2.58	3.69 ± 0.63	6.32 ± 1.21
Naphthalene	57/57	57	116.93 ± 33.58	93.45 ± 20.27	109.06 ± 10.84	84.98 ± 13.41	101.09 ± 10.72
Rochester, New York - ROCH							
Acenaphthene	57/57	57	1.81 ± 0.95	NA	35.57 ± 23.12	17.05 ± 13.08	18.17 ± 7.93
Fluorene	50/50	57	1.37 ± 0.95	NA	24.58 ± 12.55	10.97 ± 7.68	12.57 ± 4.64
Naphthalene	57/57	57	27.42 ± 7.54	NA	89.93 ± 35.78	51.11 ± 26.01	57.53 ± 14.40

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

Observations for BXNY from Table 17-4 include the following:

- Acenaphthene, benzo(a)pyrene, fluoranthene, and naphthalene were detected in all the valid PAH samples collected at BXNY, while four non-detects of fluorene were measured.

- Of the pollutants of interest for BXNY, naphthalene has the highest annual average concentration, benzo(a)pyrene has the lowest, and the annual averages for acenaphthene and fluorene are similar to each other.

- Concentrations of naphthalene measured at BXNY range from 37.2 ng/m^3 to 228 ng/m^3. Concentrations of naphthalene appear highest during the first quarter, although the quarterly averages of naphthalene are not significantly different from each other. A review of the data shows that the three highest naphthalene concentrations measured at BXNY were measured on back-to-back sample days in January, and all three are greater than 200 ng/m^3. Concentrations of naphthalene greater than 100 ng/m^3 were measured at BXNY during each calendar quarter, ranging from two measured during the fourth quarter to nine measured during the third quarter.

- Concentrations of benzo(a)pyrene measured at BXNY span two orders of magnitude, ranging from 0.0206 ng/m^3 to 2.37 ng/m^3. The maximum concentration measured at BXNY is the second highest benzo(a)pyrene concentration measured across the program. BXNY is one of only two NMP sites with more than one benzo(a)pyrene concentration greater than 1 ng/m^3. The first and fourth quarter average concentrations are higher than the other quarterly averages and have relatively large confidence intervals associated with them, particularly the first quarter average. A review of the data shows that all 10 benzo(a)pyrene concentrations greater than 0.25 ng/m^3 measured at BXNY were measured between January and March (eight) and November (2). The two highest concentrations were measured on February 22, 2014 (2.37 ng/m^3) and November 19, 2014 (1.31 ng/m^3).

- The annual average and quarterly average concentrations of acenaphthene and fluorene are similar to each other. Concentrations of acenaphthene range from 0.762 ng/m^3 to 23.4 ng/m^3 while concentrations of fluorene range from 1.57 ng/m^3 to 22.5 ng/m^3 plus four non-detects. For both pollutants, the second and third quarter average concentrations are significantly higher than the first and fourth quarter averages, indicating that concentrations tended to be higher during the warmer months of the year. For fluorene, all 13 concentrations greater than 10 ng/m^3 were measured between May and September and none of the 17 concentrations less than 3.5 ng/m^3 were measured during the second or third quarters of 2014. For acenaphthene, all but one of the 11 concentrations greater than 10 ng/m^3 were measured between May and September and none of the 18 concentrations less than 3.0 ng/m^3 were measured during the second or third quarters.

- Concentrations of fluoranthene measured at BXNY range from 1.22 ng/m^3 to 14.9 ng/m^3. Even though the third quarter average concentration is the highest of the four, this quarter average exhibits the least variability among the quarterly average concentrations. The first and fourth quarter averages exhibit the most variability despite being lower in magnitude compared to the other quarterly averages. Concentrations measured during the third quarter fall into the smallest range, with each concentration between 3 ng/m^3 and 9 ng/m^3. Concentrations measured during the fourth quarter have largest range, between 1 ng/m^3 and 15 ng/m^3.

Observations for ROCH from Table 17-4 include the following:

- Acenaphthene and naphthalene were detected in all 57 valid PAH samples collected at ROCH, while seven non-detects of fluorene were measured.

- Of the pollutants of interest for ROCH, naphthalene has the highest annual average concentration, followed by acenaphthene and fluorene.

- Laboratory instrument issues combined with a sampler issue resulted in too many invalid samples for quarterly average concentrations to be calculated for the second quarter of 2014. The same laboratory issue also affected BXNY samples, but quarterly average concentrations for the second quarter could still be calculated.

- Quarterly average concentrations of each of the pollutants of interest are highest for the third quarter; these quarterly averages also have the largest confidence intervals, indicating considerable variability.

- Concentrations of naphthalene measured at ROCH range from 10.0 ng/m^3 to 227 ng/m^3. The maximum naphthalene concentration was measured just at outside the third quarter on October 2, 2014, although a similar concentration (224 ng/m^3) was measured on the previous sample day, on September 26, 2014. Four of the six naphthalene concentrations greater than 100 ng/m^3 were measured at ROCH during the third quarter (with the exceptions measured in late June or early October). The number of naphthalene concentrations greater than 50 ng/m^3 measured during the third quarter (10) is greater than the number measured during the remaining calendar quarters combined (nine).

- Concentrations of acenaphthene range from 0.548 ng/m^3 to 188 ng/m^3 and concentrations of fluorene range from 0.909 ng/m^3 to 104 ng/m^3 plus the seven non-detects. The maximum concentration of each of these pollutants was measured on September 20, 2014 and each is the second highest concentration measured across the program among NMP sites sampling PAHs. For both pollutants, the next highest concentration measured at ROCH is considerably less, although concentrations measured at ROCH are among the highest across the program.

- The first quarter average concentrations of acenaphthene and fluorene are significantly less than the other quarterly averages shown in Table 17-4 for these pollutants.

- All six acenaphthene concentrations less than 1 ng/m^3 were measured during the first quarter of 2014. In addition, the number of acenaphthene concentrations less than 5 ng/m^3 measured during the first quarter (13) is more than the number measured during the other calendar quarters combined (10, with none measured during the third quarter). Conversely, acenaphthene concentrations greater than 25 ng/m^3 were measured during each calendar quarter except the first (with two each measured during the second and fourth quarters of 2014 and seven measured during the third).

- Six of the seven non-detects of fluorene were measured during the first quarter of 2014, with the exception measured in June. One fluorene concentration greater than 5 ng/m^3 was measured during the first quarter of 2014 while 30 were measured during the other calendar quarters (eight during the second quarter, 15 during the third, and seven during the fourth). Fluorene concentrations greater than 25 ng/m^3 were measured during each calendar quarter except the first (with two each measured during the second and fourth quarters of 2014 and five measured during the third).

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

- Naphthalene is the only PAH pollutant of interest at the program-level. BXNY has the third highest annual average concentration of naphthalene among NMP sites sampling PAHs, as shown in Table 4-11, and is one of only four NMP sites with an annual average naphthalene concentration greater than 100 ng/m^3.

- ROCH does not appear in Table 4-11 for naphthalene (it ranks 12th). The annual average naphthalene concentration for ROCH is approximately half the annual average concentration for BXNY.

17.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created each of the pollutants of interest for BXNY and ROCH. Figures 17-7 through 17-11 overlay the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations for each pollutant, as described in Section 3.4.3.1, and are discussed below.

Figure 17-7. Program vs. Site-Specific Average Acenaphthene Concentrations

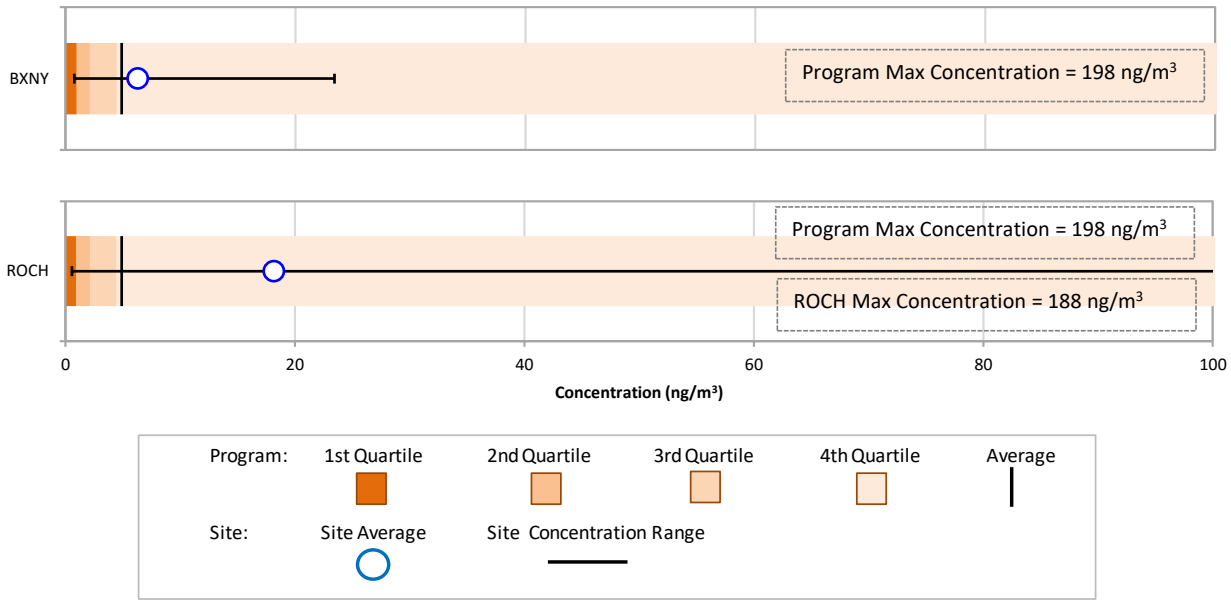


Figure 17-7 presents the box plots for acenaphthene for BXNY and ROCH and shows the following:

- The program-level maximum concentration (198 ng/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced to 100 ng/m^3. In addition, the maximum acenaphthene concentration measured at ROCH also exceeds the scale of the box plots and thus, has been denoted directly on ROCH's box plot.

- The maximum acenaphthene concentration measured at ROCH is eight times greater than the maximum concentration measured at BXNY and is the second highest concentration measured across the program.

- The annual average concentrations for both sites are greater than the program-level average concentration, although the annual average for ROCH is three times greater the annual average concentration for BXNY.

- ROCH has the second highest annual average concentration of acenaphthene among NMP sites sampling PAHs (behind only NBIL).

- Although non-detects of acenaphthene were measured at several NMP sites sampling PAHS, none were measured at BXNY or ROCH.

Figure 17-8. Program vs. Site-Specific Average Benzo(a)pyrene Concentration

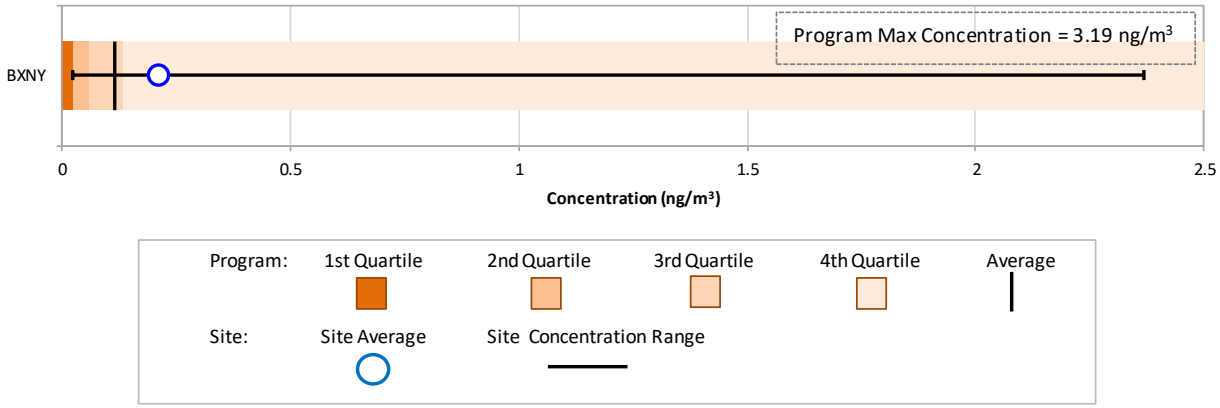


Figure 17-8 presents the box plot for benzo(a)pyrene for BXNY and shows the following:

- The program-level maximum concentration (3.19 ng/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced.

- BXNY is one of only two sites for which benzo(a)pyrene is a pollutant of interest (SJJCA is the other).

- The maximum benzo(a)pyrene concentration measured at BXNY is not the maximum concentration measured across the program, although it is the second highest.

- The minimum benzo(a)pyrene concentration measured at BXNY is greater than the program-level first quartile.

- The annual average concentration for BXNY is nearly twice the program-level average concentration; this site has the second highest annual average concentration of benzo(a)pyrene among NMP sites sampling PAHs.

Figure 17-9. Program vs. Site-Specific Average Fluoranthene Concentration

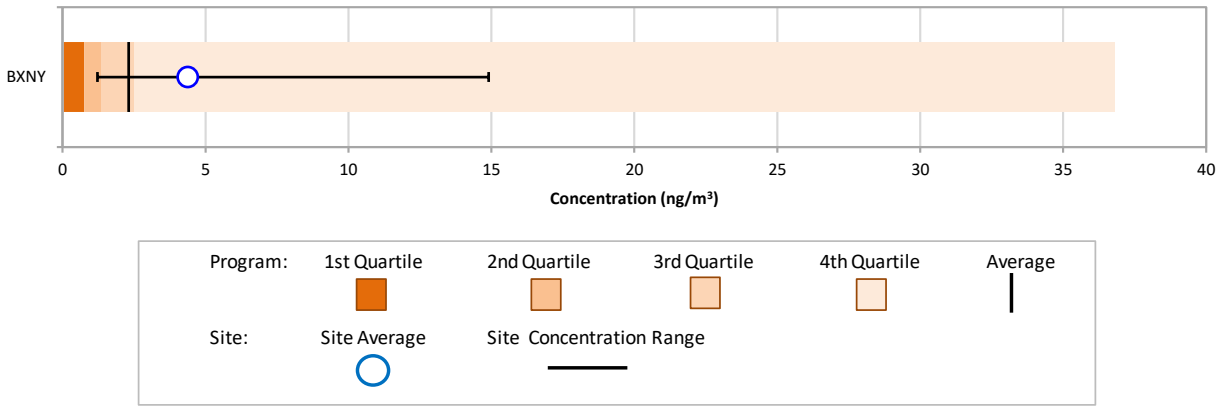


Figure 17-9 presents the box plot for fluoranthene for BXNY and shows the following:

- BXNY is one of only two sites for which fluoranthene is a pollutant of interest (NBIL is the other).
- The maximum fluoranthene concentration measured at BXNY is considerably less than the maximum concentration measured across the program.
- The minimum concentration measured at BXNY is just less than the program-level median concentration. This means that the minimum fluoranthene concentration measured at BXNY is greater than half of the concentrations measured across the program by NMP sites sampling PAHs.
- The annual average concentration for BXNY is nearly twice the program-level average concentration (2.32 ng/m^3).

Figure 17-10. Program vs. Site-Specific Average Fluorene Concentrations

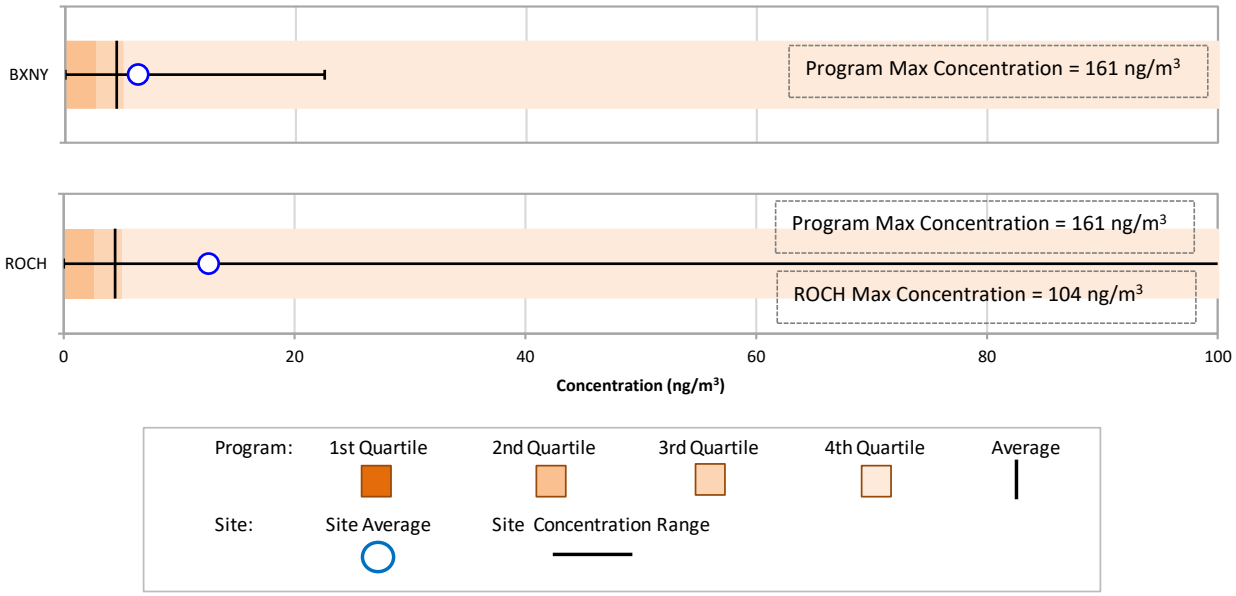


Figure 17-10 presents the box plots for fluorene for BXNY and ROCH and shows the following:

- The program-level maximum concentration (161 ng/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced to 100 ng/m^3. In addition, the maximum fluorene concentration measured at ROCH also exceeds the scale of the box plots and thus, has been denoted directly on ROCH's box plot.
- The maximum fluorene concentration measured at ROCH is nearly four times greater than the maximum concentration measured at BXNY and is the second highest concentration measured across the program.

- The annual average concentrations for both sites are greater than the program-level average concentration, although the annual average for ROCH is two times greater the annual average concentration for BXNY.

- ROCH has the second highest annual average concentration of fluorene among NMP sites sampling PAHs (behind only NBIL).

Figure 17-11. Program vs. Site-Specific Average Naphthalene Concentrations

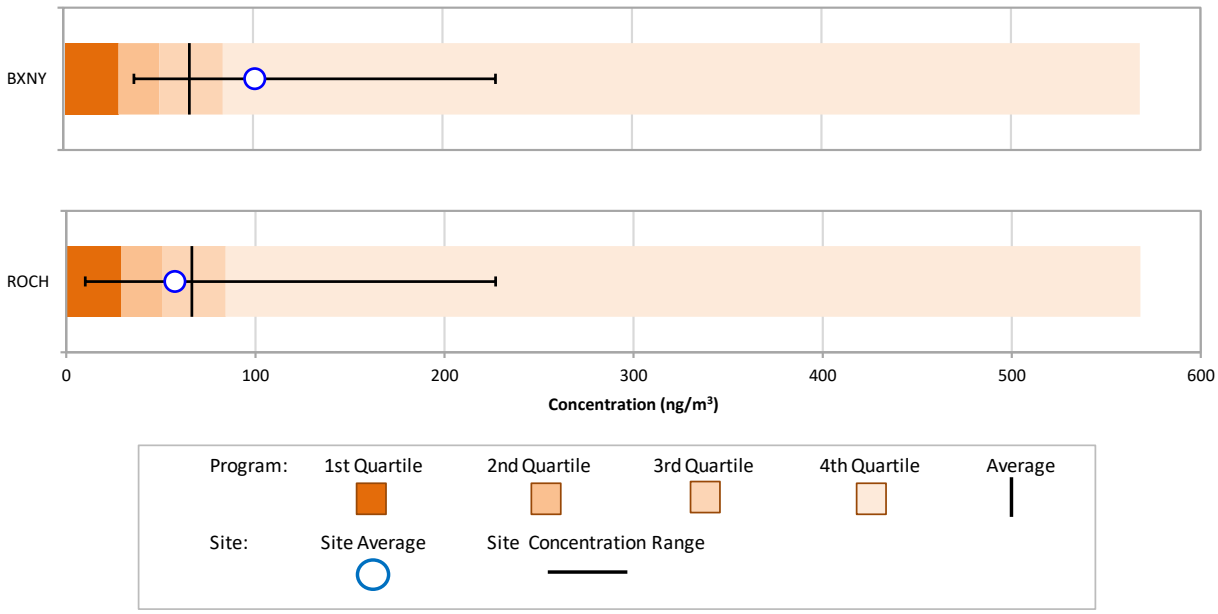


Figure 17-11 presents the box plots for naphthalene for BXNY and ROCH and shows the following:

- In contrast to the box plots for the other pollutants of interest in common for the New York sites, Figure 17-11 shows that the maximum naphthalene concentrations measured at these sites are similar to each other. Yet, the minimum concentrations measured at these sites are considerably different. The minimum concentration measured at BXNY is greater than the program-level first quartile and the highest minimum concentration measured among NMP sites sampling naphthalene. A similar observation was made in the 2013 NMP report.

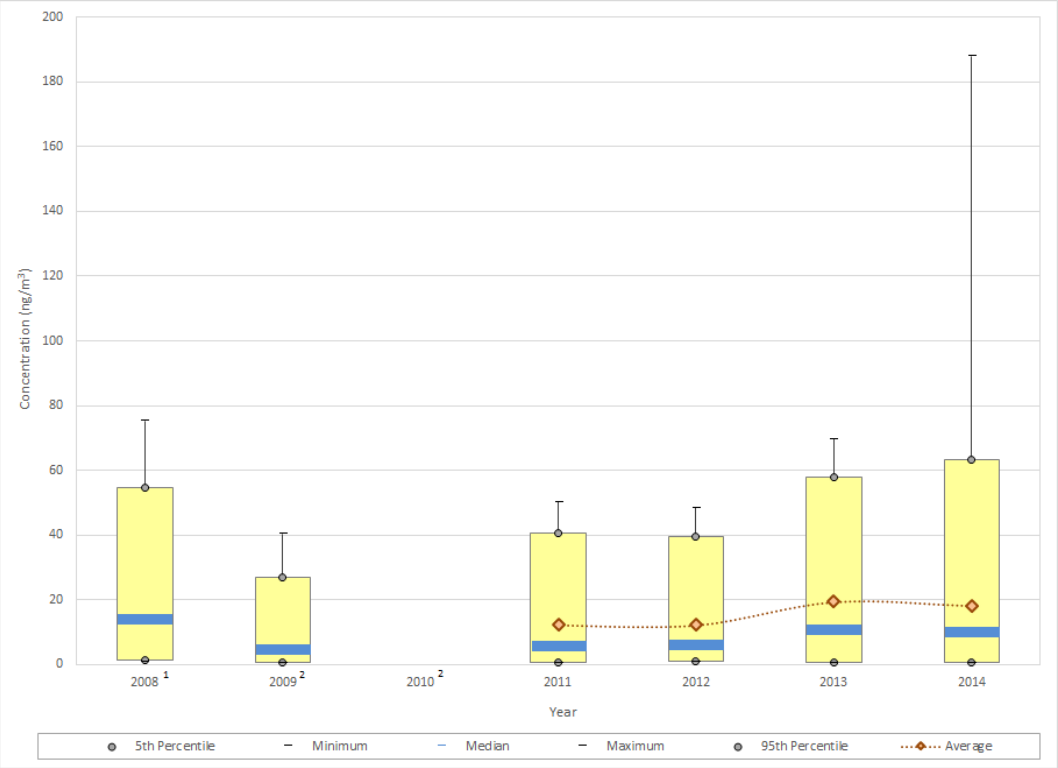
- The annual average naphthalene concentration for ROCH is nearly half the annual average for BXNY and is less than the program-level average concentration but greater than the program-level median concentration. The annual average concentration for BXNY is greater than the program-level average and third quartile. Recall that BXNY has the third highest annual average concentration of naphthalene among NMP sites sampling PAHs.

17.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. Sampling for PAHs at BXNY began in 2008. However, in June 2010, the monitoring instruments at BXNY were relocated to a new, temporary location due to roofing construction near the BXNY site. Two years later, the instrumentation was returned to the BXNY site and sampling resumed at this location in July 2012. A trends analysis was not performed for BXNY because sampling did not occur consecutively at the same location.

Sampling for PAHs at ROCH began in July 2008, so a trends analysis was performed for ROCH. However, due to the mid-year start, a 1-year average concentration for 2008 is not presented, although the range of measurements is provided. In addition, a collection error was discovered at the site, resulting in the invalidation of nearly one and one-half years' worth of samples between July 2009 and December 2010. Thus, the range of measurements is provided for 2009, although a 1-year average concentration is not provided and no statistical metrics are provided for 2010. This, combined with the mid-year start in 2008, results in the calculation of few 1-year average concentrations for the ROCH monitoring site. One-year average concentrations are provided in Figures 17-12 through 17-14 beginning in 2011.

Figure 17-12. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-12 for acenaphthene concentrations measured at ROCH include the following:

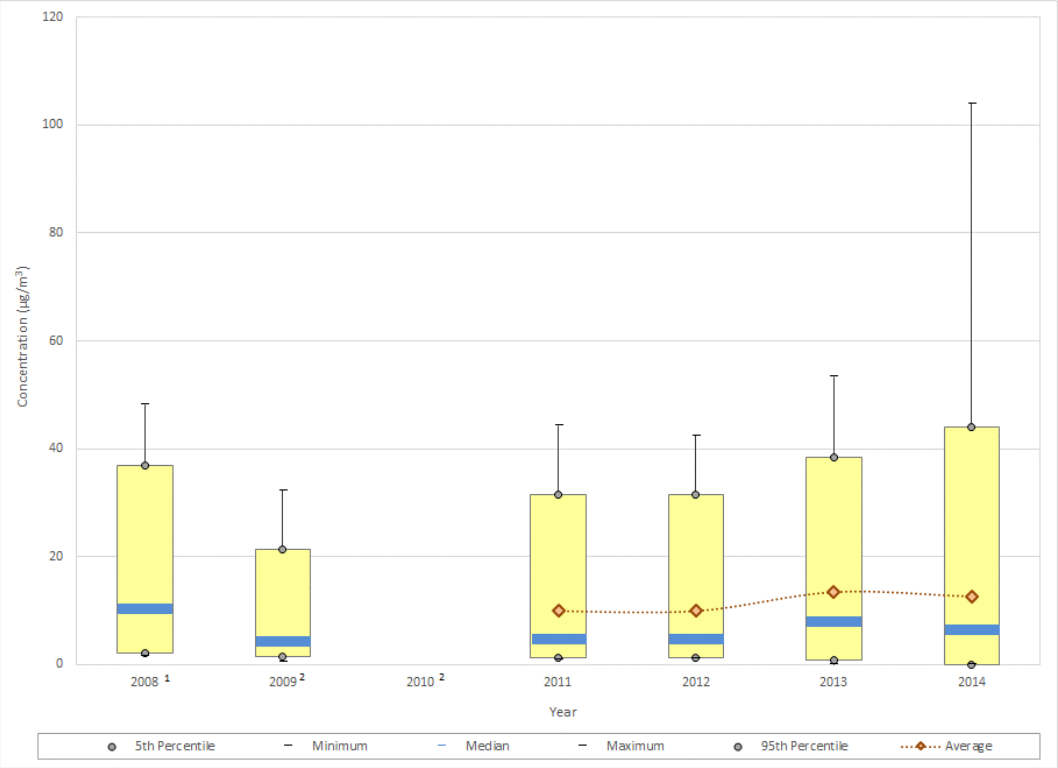
- The range of acenaphthene concentrations appears to have decreased by half from 2008 to 2009, although 2008 includes data from July through December while 2009 includes data from January through June.

- The concentrations measured in 2011 are similar to the concentrations measured in 2012.

- The range of concentrations increased from 2012 to 2013. The median concentration nearly doubled from 2012 to 2013 while the 1-year average concentration increased by 58 percent.

- The maximum concentration increased considerably for 2014, and in total, three acenaphthene concentrations measured in 2014 are greater than the maximum concentration measured in 2013. Despite these higher measurements, the median and average concentrations changed little.

Figure 17-13. Yearly Statistical Metrics for Fluorene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-13 for fluorene concentrations measured at ROCH include the following:

- The trends graph for fluorene resembles the trends graph for acenaphthene.

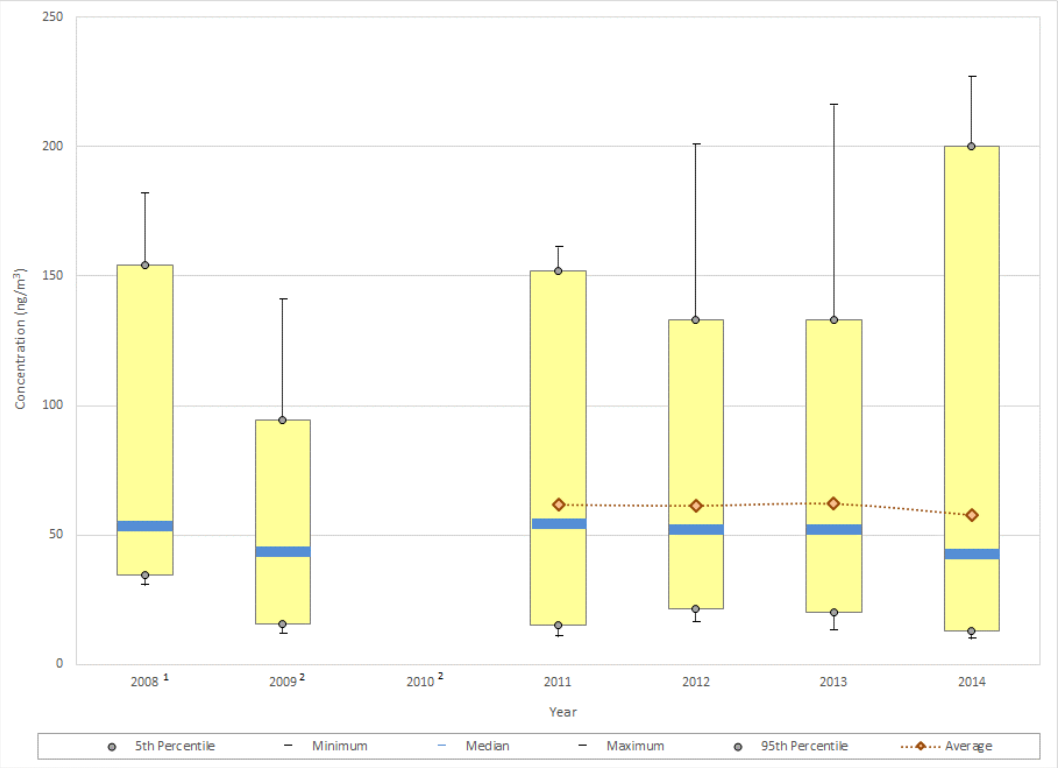
- The range of fluorene concentrations measured at ROCH decreased from 2008 to 2009 and the median concentration decreased by more than half during this time frame. Recall, though, that 2008 includes data from July through December and 2009 includes data from January through June.

- The concentrations measured in 2011 are similar to the concentrations measured in 2012.

- The median increased by 67 percent from 2012 to 2013 while the 1-year average concentration increased by about half that percentage as the range of concentrations increased from 2012 to 2013 (at both ends of the concentration range).

- The maximum concentration of fluorene measured at ROCH was measured in 2014 (104 ng/m^3). Only two other concentrations greater than 50 ng/m^3 have been measured at this site, one in 2013 (53.4 ng/m^3) and one in 2014 (51.4 ng/m^3). Despite the higher concentrations measured, slight decreases are shown in both the 1-year average and median concentrations. This is due primarily to the increase in non-detects measured in 2014 (seven). Non-detects have only been measured in 2013 (two) and 2014.

Figure 17-14. Yearly Statistical Metrics for Naphthalene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-14 for naphthalene concentrations measured at ROCH include the following:

- Similar to the other pollutants of interest, the range of naphthalene concentrations decreased from 2008 to 2009. However, each year's plot only includes half a year's worth of samples.

- Even though the maximum concentration has increased each year since 2011, the 1-year average naphthalene concentrations calculated for 2011, 2012, and 2013 exhibit little change, varying by less than 1 ng/m^3 across these years, and the 1-year average for 2014 decreased slightly. Several of the lowest naphthalene concentrations were measured in 2014, including the most concentrations less than 20 ng/m^3 (seven) since the onset of sampling.

17.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the New York monitoring sites. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

17.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the New York sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 17-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 17-5. Risk Approximations for the New York Monitoring Sites

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
New York City, New York - BXNY						
Acenaphthene	0.000088	--	57/57	6.28 ± 1.35	0.55	--
Benzo(a)pyrene	0.00176	--	57/57	0.21 ± 0.09	0.37	--
Fluoranthene	0.000088	--	57/57	4.38 ± 0.72	0.39	--
Fluorene	0.000088	--	53/57	6.32 ± 1.21	0.56	--
Naphthalene	0.000034	0.003	57/57	101.09 ± 10.72	3.44	0.03
Rochester, New York - ROCH						
Acenaphthene	0.000088	--	57/57	18.17 ± 7.93	1.60	--
Fluorene	0.000088	--	50/57	12.57 ± 4.64	1.11	--
Naphthalene	0.000034	0.003	57/57	57.53 ± 14.40	1.96	0.02

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

Observations for the New York sites from Table 17-5 include the following:

- Naphthalene has the highest annual average concentration among the pollutants of interest for each site. Although the annual average concentration for BXNY is nearly twice the annual average for ROCH, the confidence interval for ROCH's annual average concentration is larger than the confidence interval for BXNY's annual average.

- Naphthalene also has the highest cancer risk approximation for each site (3.44 in-a-million for BXNY and 1.96 in-a-million for ROCH). The cancer risk approximations for the other pollutants of interest for BXNY are all less than 1 in-a-million. For ROCH, the cancer risk approximations for each pollutant of interest is between 1 in-a-million and 2 in-a-million.

- Naphthalene is the only site-specific pollutant of interest that has a noncancer RfC. The noncancer hazard approximations for naphthalene for each site are both less than 0.05, considerably less than 1.0, indicating that no adverse noncancer health effects are expected from this individual pollutant.

17.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 17-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 17-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 17-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 17-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 17-6. Table 17-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 17.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 17-6. 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 UREs (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)**
New York City, New York (Bronx County) - BXNY					
Benzene	127.66	Formaldehyde	1.04E-03	Naphthalene	3.44
Ethylbenzene	92.28	Benzene	9.96E-04	Fluorene	0.56
Tetrachloroethylene	81.66	1,3-Butadiene	4.42E-04	Acenaphthene	0.55
Formaldehyde	80.26	Naphthalene	2.76E-04	Fluoranthene	0.39
Acetaldehyde	47.43	Ethylbenzene	2.31E-04	Benzo(a)pyrene	0.37
1,3-Butadiene	14.74	Arsenic, PM	2.19E-04		
Naphthalene	8.11	POM, Group 2b	1.53E-04		
POM, Group 2b	1.74	Nickel, PM	1.40E-04		
POM, Group 2d	1.53	POM, Group 2d	1.35E-04		
Trichloroethylene	1.05	POM, Group 5a	1.11E-04		
Rochester, New York (Monroe County) - ROCH					
Benzene	257.25	Formaldehyde	2.24E-03	Naphthalene	1.96
Formaldehyde	172.39	Benzene	2.01E-03	Acenaphthene	1.60
Ethylbenzene	140.93	1,3-Butadiene	1.24E-03	Fluorene	1.11
Acetaldehyde	98.59	Naphthalene	6.88E-04		
Dichloromethane	46.10	POM, Group 2b	5.08E-04		
1,3-Butadiene	41.31	Arsenic, PM	3.81E-04		
Tetrachloroethylene	24.16	Ethylbenzene	3.52E-04		
Naphthalene	20.23	POM, Group 2d	3.16E-04		
Trichloroethylene	6.40	Hexavalent Chromium	2.69E-04		
POM, Group 2b	5.77	POM, Group 5a	2.69E-04		

Table 17-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New York Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
New York City, New York (Bronx County) - BXNY					
Toluene	2,161.13	Acrolein	203,787.77	Naphthalene	0.03
Methanol	793.11	Formaldehyde	8,190.17		
Hexane	479.04	1,3-Butadiene	7,368.79		
Xylenes	293.26	Acetaldehyde	5,270.29		
Ethylene glycol	275.15	Benzene	4,255.29		
Benzene	127.66	Cadmium, PM	3,946.26		
Ethylbenzene	92.28	Arsenic, PM	3,399.31		
Tetrachloroethylene	81.66	Nickel, PM	3,238.72		
Formaldehyde	80.26	Xylenes	2,932.64		
Methyl isobutyl ketone	63.81	Naphthalene	2,702.28		
Rochester, New York (Monroe County) - ROCH					
Toluene	1,679.94	Acrolein	492,322.38	Naphthalene	0.02
Methanol	510.18	1,3-Butadiene	20,653.74		
Xylenes	507.26	Formaldehyde	17,591.01		
Hexane	498.21	Acetaldehyde	10,954.81		
Benzene	257.25	Hydrochloric acid	10,479.37		
Hydrochloric acid	209.59	Cadmium, PM	9,067.59		
Formaldehyde	172.39	Benzene	8,575.15		
Ethylene glycol	149.53	Naphthalene	6,742.12		
Ethylbenzene	140.93	Arsenic, PM	5,913.63		
Acetaldehyde	98.59	Nickel, PM	5,849.56		

Observations from Table 17-6 include the following:

- Benzene, ethylbenzene, and tetrachloroethylene are the highest emitted pollutants with cancer UREs in Bronx County while benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants in Monroe County.

- Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for both New York counties.

- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Bronx County; six of the highest emitted pollutants also have the highest toxicity-weighted emissions for Monroe County.

- Naphthalene, which is a pollutant of interest for both sites and has the highest cancer risk approximation for each site, appears on both emissions-based lists for Bronx and Monroe Counties.

- Emissions of several POM Groups rank among the highest emitted pollutants as well as the pollutants with the highest toxicity-weighted emissions for Bronx County. POM, Group 2b appears on both emissions-based lists for Bronx County and includes several PAHs sampled for at BXNY, including acenaphthene, fluoranthene, and fluorene. POM, Group 2d also appears on both emissions-based lists for Bronx County, although none of the PAHs sampled with Method TO-13A are included in this group. POM, Group 5a also appears among those with the highest toxicity-weighted emissions for Bronx County; this group includes benzo(a)pyrene, which is also a pollutant of interest for BXNY.

- POM, Groups 2b, 2d, and 5a also appear among the pollutants with the highest toxicity-weighted emissions for Monroe County while only POM, Group 2b appears among the highest emitted pollutants for Monroe County.

Observations from Table 17-7 include the following:

- Toluene and methanol are the highest emitted pollutants with noncancer RfCs in both Bronx and Monroe Counties. The emissions of toluene are considerably higher than the other pollutants listed for both Bronx and Monroe Counties.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) is acrolein for both counties. Formaldehyde and 1,3-butadiene round out the top three for both counties, although the order varies.

- Three of the highest emitted pollutants in Bronx County are also among the pollutants with the highest toxicity-weighted emissions; four of the highest emitted pollutants in Monroe County are also among the pollutants with the highest toxicity-weighted emissions.

- Naphthalene is the only pollutant of interest for each site for which a noncancer hazard approximation could be calculated. Naphthalene is among the pollutants with the highest toxicity-weighted emissions for each county, but is not among the highest emitted pollutants with a noncancer toxicity factor for either county.

17.6 Summary of the 2014 Monitoring Data for BXNY and ROCH

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

- ❖ *Six pollutants failed screens for BXNY, of which five were identified as pollutants of interest. Four pollutants failed screens for ROCH, of which three were identified as pollutants of interest. Naphthalene, acenaphthene, and fluorene were identified as pollutants of interest for both New York monitoring sites.*

- ❖ *Naphthalene has the highest annual average concentration for both sites, although the annual average for BXNY is nearly twice the annual average for ROCH.*

- ❖ *Concentrations of acenaphthene and fluorene for BXNY were highest during the warmer months of the year.*

- ❖ *BXNY has the third highest annual average concentration of naphthalene among NMP sites sampling PAHs. Some of the highest concentrations of acenaphthene and fluorene across the program were measured at ROCH.*

- ❖ *The highest concentrations of all three of ROCH's pollutants of interest, since the onset of sampling at this site, were measured in 2014*

- ❖ *Naphthalene has the highest cancer risk approximation among the pollutants of interest for both BXNY and ROCH. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

18.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

18.1 Site Characterization

This section characterizes the Oklahoma 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.

Five monitoring sites are located in Oklahoma. Three sites (TOOK, TMOK, and TROK) are located in Tulsa, Oklahoma. Another monitoring site is located in Oklahoma City and the final one is located in Yukon, Oklahoma, just west of Oklahoma City (YUOK).

Figures 18-1 through 18-3 are composite satellite images retrieved from ArcGIS Explorer showing the Tulsa monitoring sites and their immediate surroundings. Figure 18-4 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 18-4. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundaries are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundaries. Figures 18-5 through 18-7 are the composite satellite maps and emissions sources map for the Oklahoma City sites. Table 18-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for each site.

Figure 18-1. Public Works, Tulsa, Oklahoma (TOOK) Monitoring Site

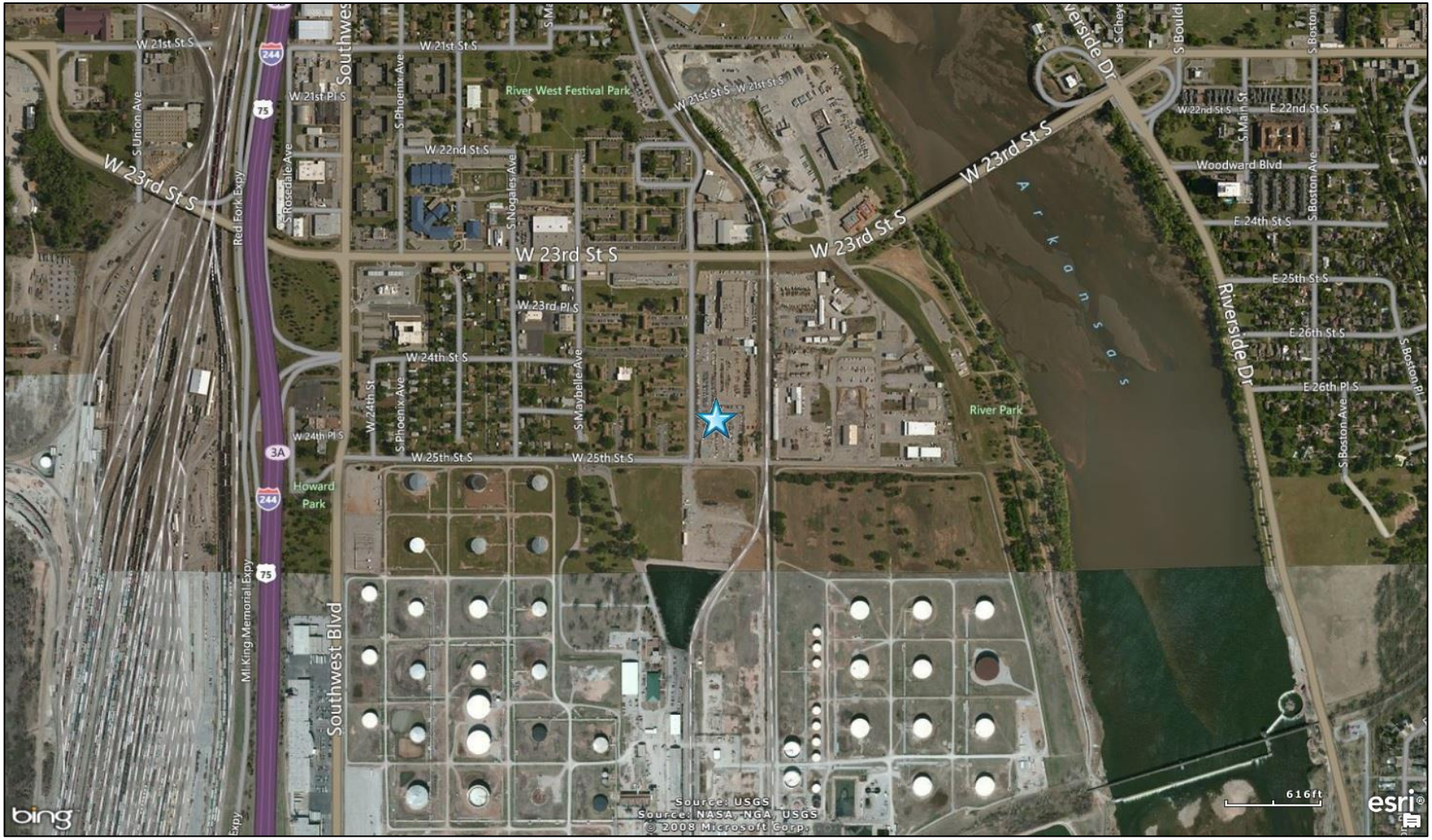


Figure 18-2. Fire Station, Tulsa, Oklahoma (TMOK) Monitoring Site

Figure 18-3. Riverside, Tulsa, Oklahoma (TROK) Monitoring Site

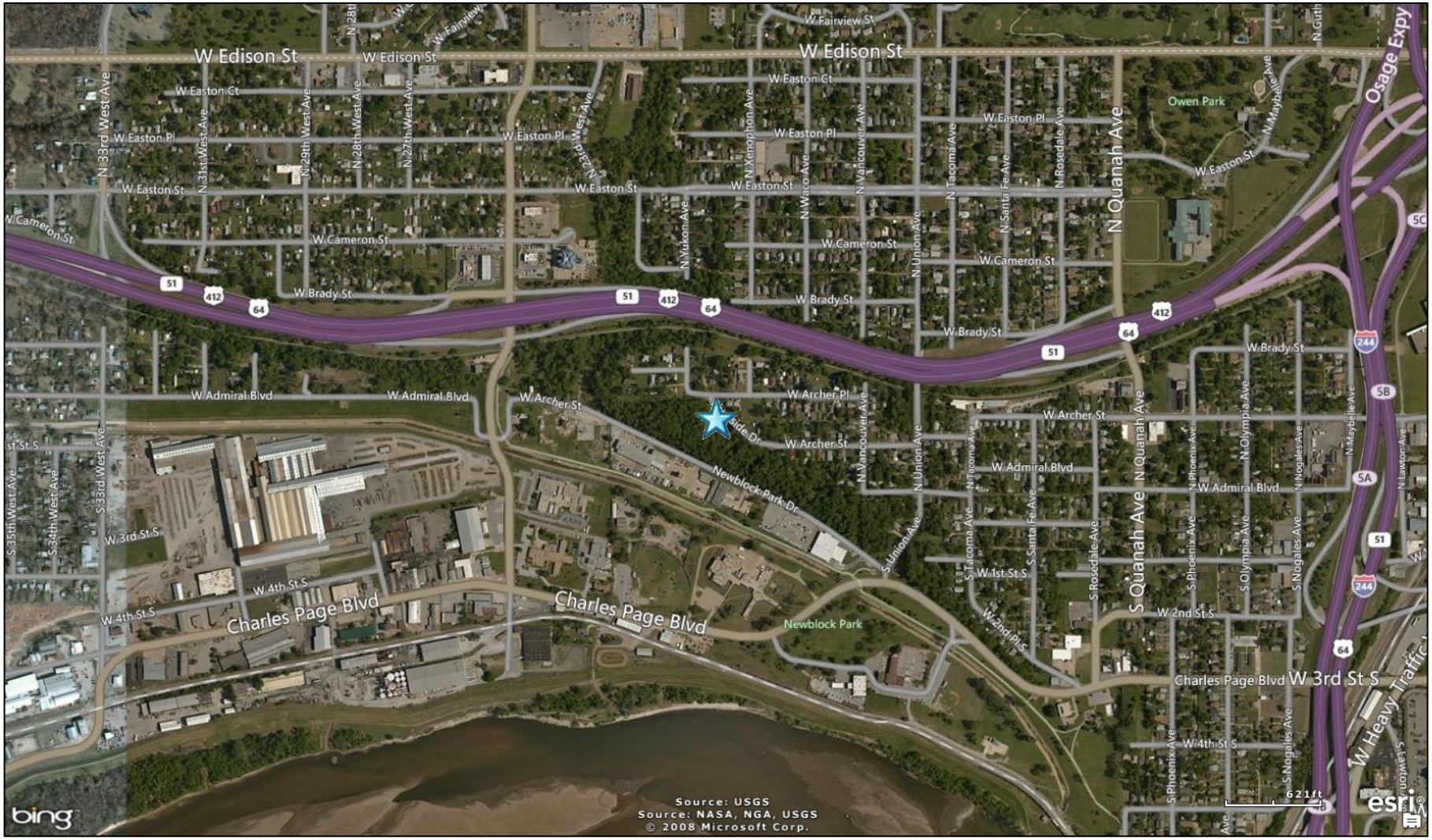


Figure 18-4. NEI Point Sources Located Within 10 Miles of TMOK, TOOK, and TROK

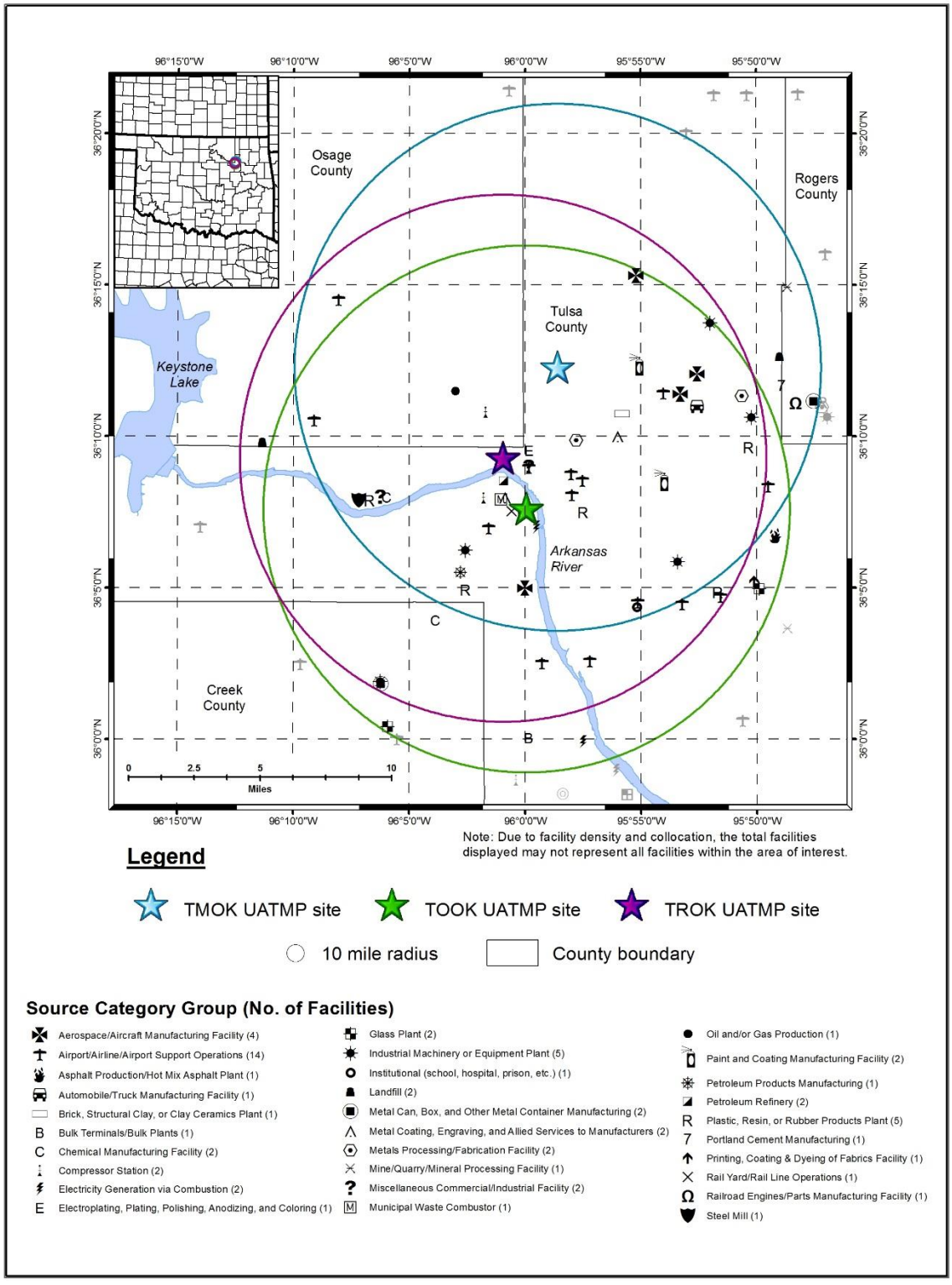


Figure 18-5. Oklahoma City, Oklahoma (OCOK) Monitoring Site

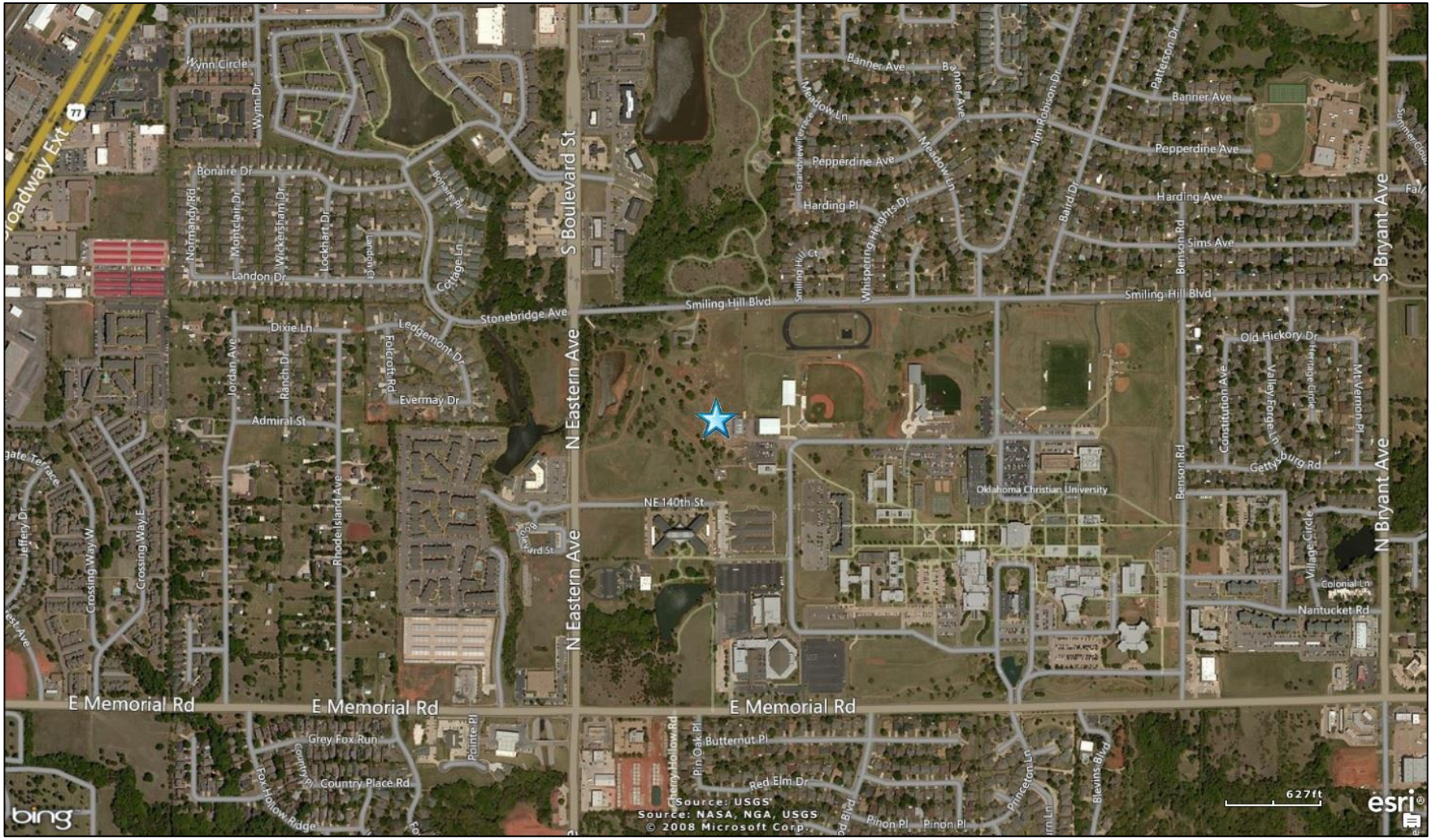


Figure 18-6. Yukon, Oklahoma (YUOK) Monitoring Site

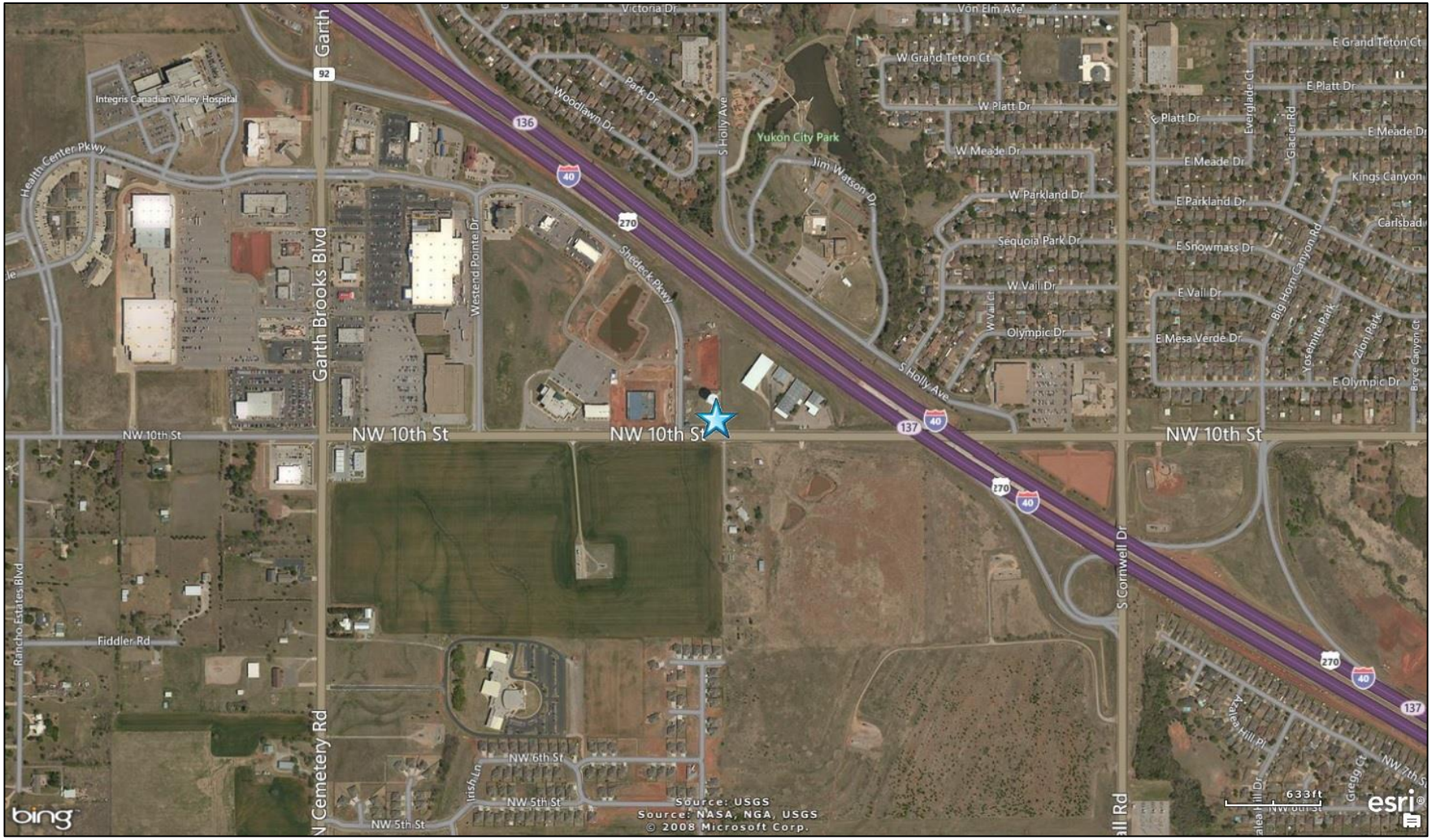


Figure 18-7. NEI Point Sources Located Within 10 Miles of OCOK and YUOK

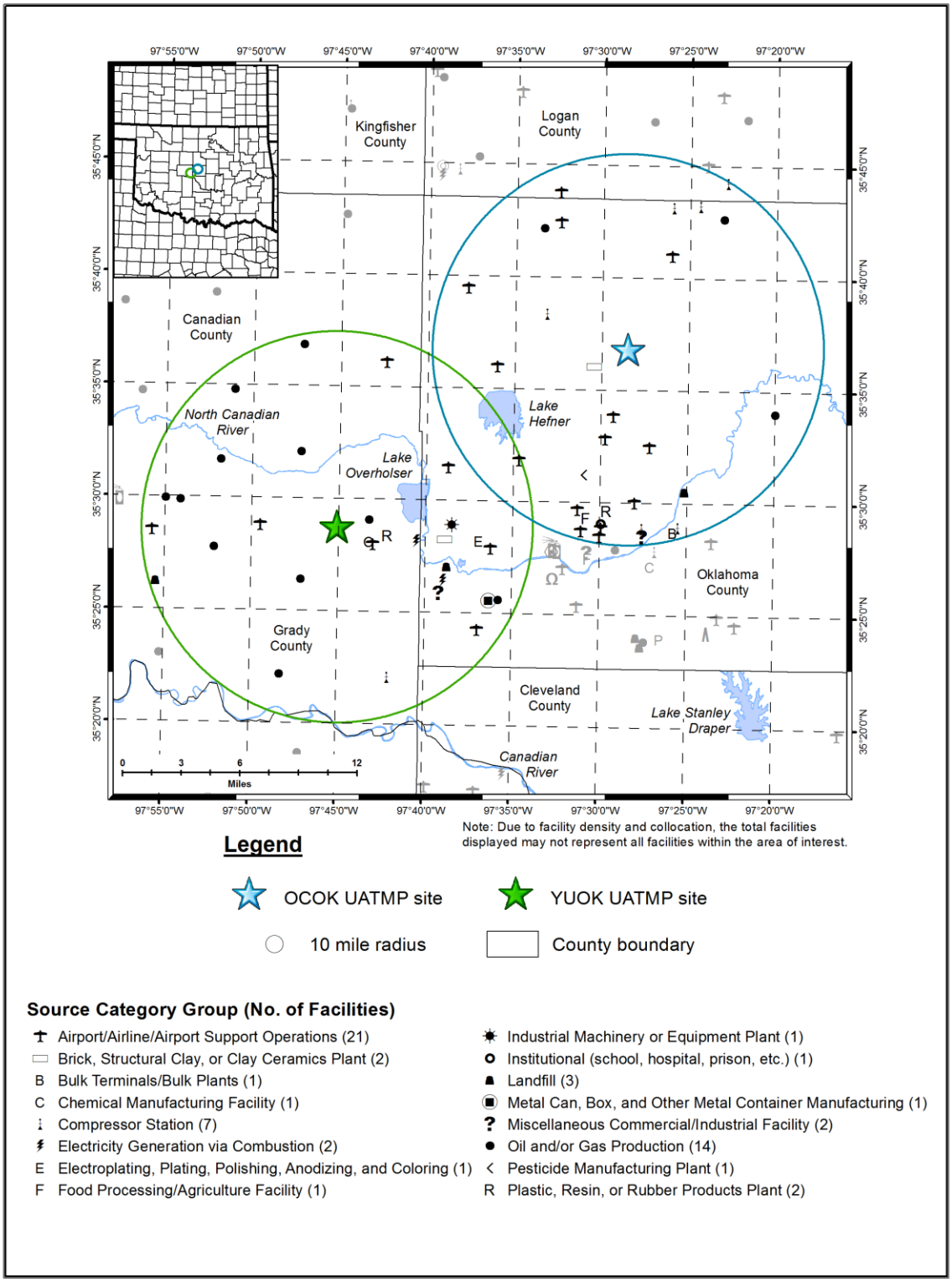


Table 18-1. Geographical Information for the Oklahoma Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
TOOK	40-143-0235	Tulsa	Tulsa	Tulsa, OK	36.126945, -95.998941	Industrial	Urban/City Center	65,800	I-244, south of Arkansas River
TMOK	40-143-1127	Tulsa	Tulsa	Tulsa, OK	36.204902, -95.976537	Residential	Urban/City Center	4,200	E 36th St N/11, west of US-75
TROK	40-143-0179	Tulsa	Tulsa	Tulsa, OK	36.154830, -96.015845	Industrial	Urban/City Center	53,300	64/51/412, west of I-244
OCOK	40-109-1037	Oklahoma City	Oklahoma	Oklahoma City, OK	35.614131, -97.475083	Residential	Suburban	52,433	US-77 north of 44 (Turnpike), before bend
YUOK	40-017-0101	Yukon	Canadian	Oklahoma City, OK	35.479215, -97.751503	Commercial	Suburban	41,000	I-40 west of Hwy 4 (east of Exit 132)

[1]AADT reflects 2014 data (OK DOT, 2014)

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. This location is between the Arkansas River and I-244, which runs parallel to Southwest Boulevard. The surrounding area is primarily industrial, although residential areas are located immediately west of the site. The site is located near the City of Tulsa West Maintenance Yard, which includes a public access CNG station. As shown in Figure 18-1, an oil refinery is located just south of West 25th Street South. Another refinery is located to the northwest of the site, on the other side of I-244. A rail yard is also located on the west side of I-244, which can be seen on left-hand side of Figure 18-1.

TMOK is located in north Tulsa on the property of Fire Station Number 24. As shown in Figure 18-2, the intersection of North Peoria Avenue (Highway 11) and East 36th Street North lies just to the northeast of the site. The surrounding area is primarily residential, with wooded areas just to the east, an early childhood education facility and an elementary school to the south, and a park to the west.

The TROK monitoring site is located west of downtown Tulsa, less than one-half mile north of the Arkansas River and north-northwest of the TOOK site. Although the area surrounding the TROK monitoring site is classified as “industrial”, the site is immediately adjacent to a residential dwelling, less than one-quarter mile south of Highway 412/51 (Sand Springs Expressway). The site is elevated above the river, and a wooded area separates the residential area from the industrial areas west of Newblock Park, as shown in Figure 18-3.

Figure 18-4 shows that the Tulsa sites are located approximately 5 miles apart, with TMOK farthest north and TOOK farthest south. Many of the emissions sources are clustered around TOOK, while there are no point sources within 2 miles of TMOK. There are a variety of industries in the area although the source category with the greatest number of sources surrounding the Tulsa sites is the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Point sources closest to TOOK include two petroleum refineries (including one directly under the star symbol for TOOK); a rail yard; a municipal waste combustor; a compressor station; a metal coating, engraving, and allied services to manufacturers facility; an airport/airport support operation; and a facility generating electricity via combustion. The closest point source to TROK is a refinery located on the other side of the Arkansas River, according to

Figure 18-4. However, several industrial facilities are located between the site and river but are not included in the NEI for point sources.

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 and I-44 to the east and John Kilpatrick Turnpike to the south are within a few miles of the site, although outside the boundaries of Figure 18-5.

The YUOK site is located in Yukon, a town to the west of Oklahoma City and in neighboring Canadian County. The monitoring site is located at the Integris water tower, just south of I-40. The site is located in a primarily commercial area, although the area north of I-40 is highly residential and the area to the south is of mixed usage. An oil well pump jack is located to the southwest of YUOK, which is shown in the middle of the green field to the southwest of YUOK in Figure 18-6. Yukon is a rapidly growing area, with both commercial and residential development.

Figure 18-7 shows that YUOK is located about 18 miles southwest of OCOK. Most of the point sources located within 10 miles of these sites are located in the center of Oklahoma City (south of OCOK and east of YUOK). The source categories with the greatest number of sources surrounding these sites are the airport source category and the oil and gas production category. The point source closest to OCOK is involved in brick, structural clay, or clay ceramics. The source closest to YUOK is an oil and gas production facility, although a chemical manufacturing facility is located roughly the same distance away.

In addition to providing city, county, CBSA, and land use/location setting information, Table 18-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. Among the Tulsa sites, the traffic volume passing the TMOK site is considerably less than the traffic volume near the other two Tulsa sites. For the Oklahoma City sites, the traffic volume near OCOK is higher than the traffic near YUOK. The traffic data for four of the five Oklahoma

sites rank between 16th and 20th highest among NMP sites, while the traffic data for TMOK are in the bottom third compared to other NMP sites.

18.2 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 the year.

18.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Oklahoma sites, site-specific data were available for some, but not all, of the parameters in Table 18-2. For each site, temperature, humidity, and wind information was available in AQS. For TOOK, meteorological data were not available for much of August and a few days in September and November; thus, data from the NWS weather station at Richard Lloyd Jones Jr. Airport (WBAN 53908) were used for meteorological parameters without data and/or as surrogates for parameters without complete observation records. The Richard Lloyd Jones Jr. Airport weather station is located 6.1 miles south of TOOK. For TMOK and TROK, data from the NWS weather station at Tulsa International Airport (WBAN 13968) were used where needed; the Tulsa International Airport weather station is located 5.0 miles east of TMOK and 7.8 miles east-northeast of TROK. RUCA. For OCOK and YUOK, data from the NWS weather station at Wiley Post Airport (WBAN 03954) were used as needed; the weather station at Wiley Post Airport is located 11.1 miles west-southwest of OCOK and 7.0 miles east-northeast of YUOK. A map showing the distance between each Oklahoma monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 18-2. Average Meteorological Conditions near the Oklahoma Monitoring Sites

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Public Works, Tulsa, Oklahoma - TOOK[2]							
Sample Days (62)	58.4 ± 1.0	45.3 ± 1.1	57.7 ± 1.0	30.07 ± 0.01	29.38 ± 0.01	SSE	5.4 ± 0.2
2014	58.6 ± 0.4	46.4 ± 0.4	59.6 ± 0.4	30.05 ± <0.01	29.36 ± <0.01	SSE	5.2 ± 0.1
Fire Station, Tulsa, Oklahoma - TMOK[3]							
Sample Days (64)	57.9 ± 1.1	44.1 ± 1.1	58.5 ± 1.1	30.04 ± <0.01	29.32 ± 0.01	S	4.8 ± 0.2
2014	59.2 ± 0.4	46.1 ± 0.4	60.6 ± 0.5	30.01 ± <0.01	29.30 ± <0.01	S	4.8 ± 0.1
Riverside, Tulsa, Oklahoma – TROK[3]							
Sample Days (63)	58.5 ± 1.1	44.4 ± 1.1	59.3 ± 1.1	30.05 ± 0.01	29.33 ± 0.01	SSW	1.4 ± 0.1
2014	59.7 ± 0.4	46.1 ± 0.4	60.8 ± 0.4	30.01 ± <0.01	29.30 ± <0.01	SSW	1.4 ± <0.1
Oklahoma City, Oklahoma – OCOK[4]							
Sample Days (62)	59.8 ± 1.1	45.1 ± 1.2	59.5 ± 1.0	30.04 ± 0.01	28.66 ± 0.01	SSE	5.1 ± 0.2
2014	60.2 ± 0.4	46.1 ± 0.4	60.7 ± 0.4	30.00 ± <0.01	28.64 ± <0.01	S	5.0 ± 0.1
Yukon, Oklahoma – YUOK[4]							
Sample Days (62)	57.3 ± 1.1	44.4 ± 1.2	57.8 ± 1.0	30.05 ± 0.01	28.67 ± 0.01	S	7.0 ± 0.2
2014	58.3 ± 0.4	46.1 ± 0.4	59.0 ± 0.4	30.00 ± <0.01	28.64 ± <0.01	S	6.8 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, and wind parameters were measured at TOOK. Where data are missing for these three parameters, or for the parameters for which observations were not collected, data was obtained from the closest NWS weather station located at Richard Lloyd Jones Jr. Airport, WBAN 53908.
[3]Temperature, humidity, and wind parameters were also measured at TMOK and TROK. The remaining information was obtained from the closest NWS weather station located at Tulsa International Airport, WBAN 13968.
[4]Temperature, humidity, and wind parameters were also measured at OCOK and YUOK. The remaining information was obtained from the closest NWS weather station located at Wiley Post Airport, WBAN 03954.

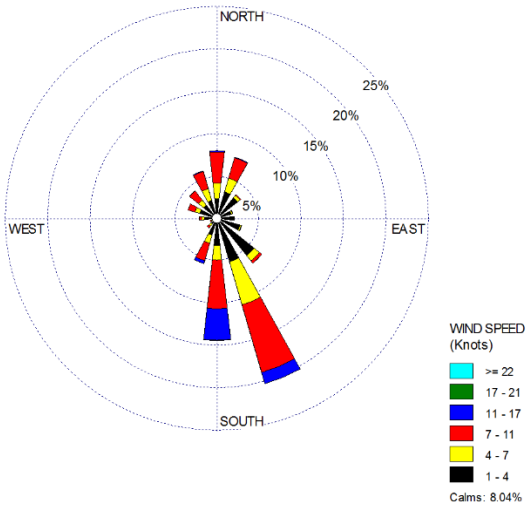
Table 18-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 18-2 is the 95 percent confidence interval for each parameter. As shown in Table 18-2, average meteorological conditions on sample days were generally representative of average weather conditions experienced throughout the year at each site. The greatest differences between the sample day and full-year averages for each site were for average dew point and average relative humidity, particularly for TMOK.

18.2.2 Wind Rose Comparison

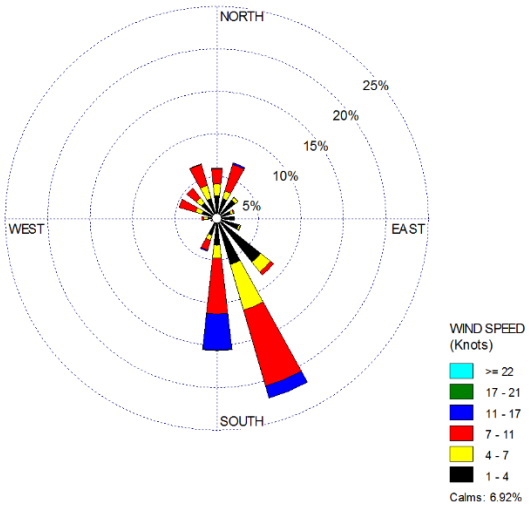
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 18-8 presents two wind roses for the TOOK monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year. Figures 18-9 through 18-12 present the full-year and sample day wind roses for the remaining Oklahoma monitoring sites.

Figure 18-8. Wind Roses for the Wind Data Collected at TOOK

2014 Wind Rose



Sample Day Wind Rose



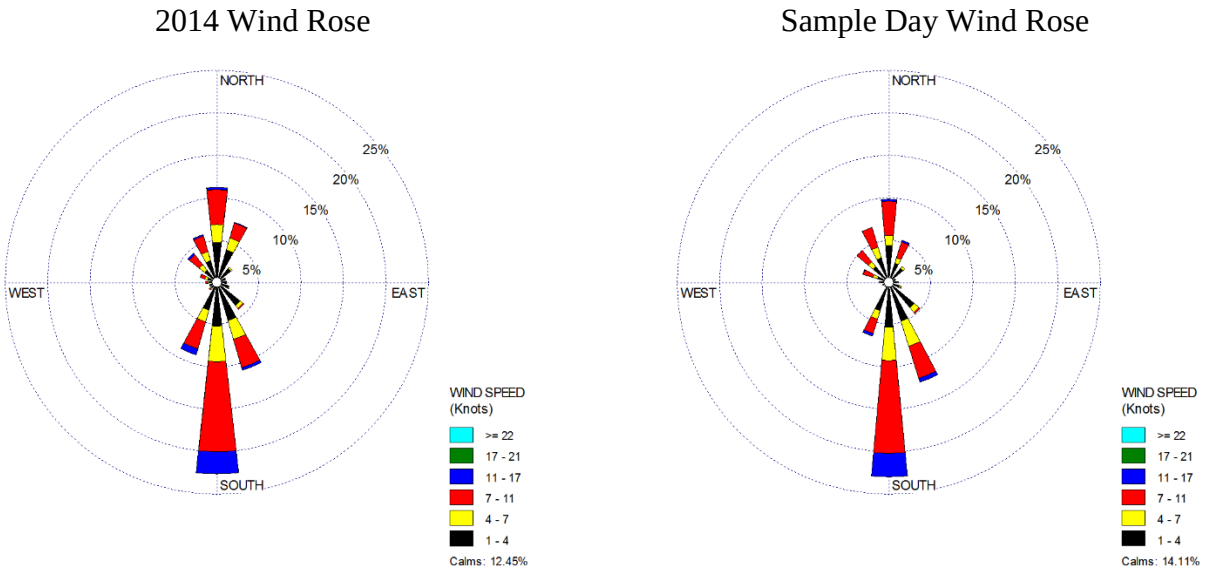
Observations from Figure 18-8 for TOOK include the following:

- The full-year wind rose shows that south-southeasterly winds were prevalent at TOOK in 2014, accounting for more than one-fifth of observations. Winds from the southeast to south-southwest together accounted for nearly 50 percent of observations. Winds from the north-northwest to north-northeast make up a secondary wind grouping. Winds from the east and west were rarely observed. Calm winds accounted for 8 percent of wind speed observations in 2014 while stronger winds were most often observed with south-southeasterly to southerly winds.

- The sample day wind rose for TOOK resembles the full-year wind rose, with winds from the southeast, south-southeast, and south accounting for the majority of observations on sample days.

- Recall from the previous section that wind data were not available at TOOK for a portion of 2014 (primarily during a 2-week stretch in August due to building/site repair, as indicated in AQS) and NWS data were used as a surrogate for missing data.

Figure 18-9. Wind Roses for the Wind Data Collected at TMOK



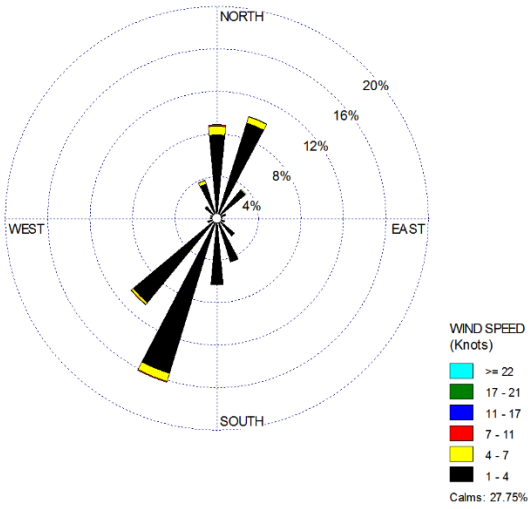
Observations from Figure 18-9 for TMOK include the following:

- The 2014 wind rose shows that winds from the south were prevalent on sample days at TMOK. Southerly winds accounted for more than 20 percent of observations in 2014, with winds from the south-southeast to south-southwest together accounting for more than 40 percent of observations. Winds from the north were observed for more than 10 percent of observations, with winds from the north-northwest to north-northeast together accounting for another one-quarter of observations. Winds from the east and west were rarely observed. Calm winds accounted for more than 12 percent of observations at TMOK in 2014.

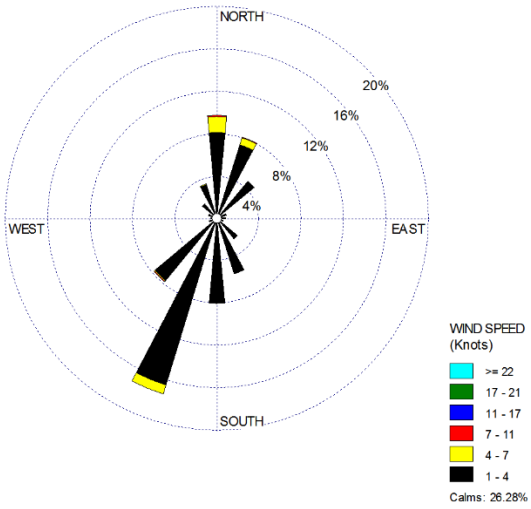
- The sample day wind rose for TMOK resembles the full-year wind rose, with winds from the south accounting for the highest percentage of wind observations on sample days.

Figure 18-10. Wind Roses for the Wind Data Collected at TROK

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 18-10 for TROK include the following:

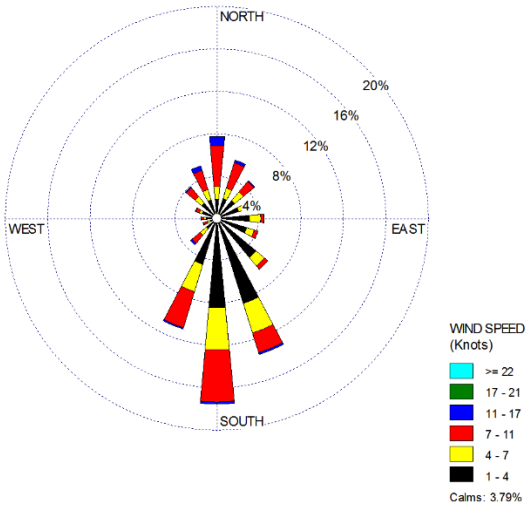
- TROK's wind roses show that winds were considerably lighter near TROK than at the other Tulsa sites. (This can also be seen in Table 18-2 in the wind speed column.) The largest percentage of wind speed observations fall into the 1 knot to 4 knots range, with very few observations exceeding 7 knots. Calm winds account for greater than one-quarter of observations, both on sample days and throughout the year.

- The 2014 wind rose shows that winds from the south-southwest were the most commonly observed, followed by southwesterly winds, north-northeasterly winds, and northerly winds.

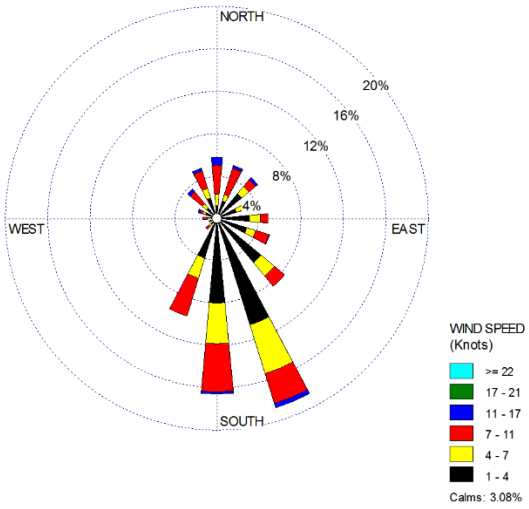
- South-southwesterly winds were also prevalent on sample days, while southerly and southwesterly winds accounted for a similar percentage of observations. Northerly winds accounted for a slightly higher percentage of winds on sample days than winds from the north-northeast (while the opposite is true for the full year wind rose).

Figure 18-11. Wind Roses for the Wind Data Collected at OCOK

2014 Wind Rose



Sample Day Wind Rose



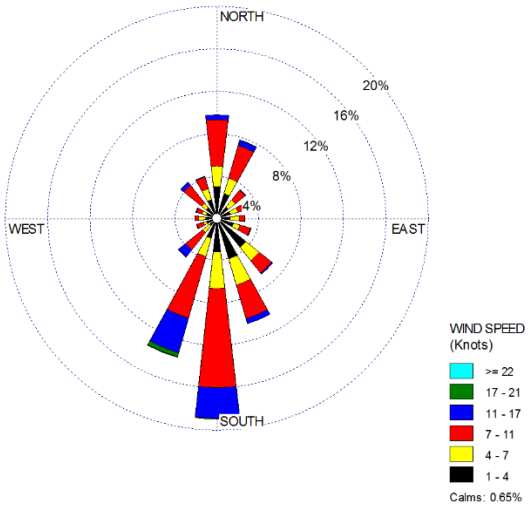
Observations from Figure 18-11 for OCOK include the following:

- The 2014 wind rose shows that winds from the southeast to south-southwest account for nearly 50 percent of observations at OCOK, with southerly winds observed the most. Winds from the north were the next most frequently observed wind direction, with all other wind directions accounting for fewer than 6 percent of observations. Calm winds were observed for less than 4 percent of observations while the strongest winds were most often observed with winds with a northerly component.

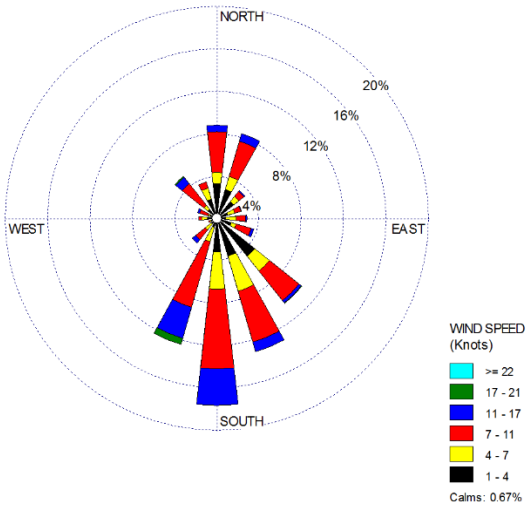
- The sample day wind rose for OCOK shows that winds from the southeast to south-southwest still account for the majority of observations, although south-southeasterly winds were observed the most often on sample days. Winds from the north-northwest to east-southeast are fairly evenly distributed on the sample day wind rose.

Figure 18-12. Wind Roses for the Wind Data Collected at YUOK

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 18-12 for YUOK include the following:

- The 2014 wind rose shows that southerly winds were prevalent at YUOK, with winds from the southeast to south-southwest together accounting for more than 40 percent of observations. Winds from the north and north-northeast also accounted for nearly 20 percent of observations in 2014. Less than 1 percent of wind observations for 2014 are classified as calm, the fewest of any Oklahoma monitoring site, while the strongest winds were most often observed with south-southwesterly winds.

- Winds from the southeast to south-southwest account for the majority of observations on sample days as well, although slightly fewer southerly and south-southwesterly winds are offset by additional southeasterly and south-southeasterly winds compared to the full-year wind rose. Winds from the north and north-northeast accounted for a similar percentage of observations on sample days. Cam winds accounted for a similar percentage of observations on sample days, and winds greater than 17 knots were most often observed with south-southwesterly winds at YUOK.

18.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Oklahoma monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 18-3. 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 and are shaded in gray in Table 18-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, and metals (TSP) were sampled for at each Oklahoma monitoring site.

Table 18-3. Risk-Based 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
Public Works, Tulsa, Oklahoma - TOOK						
Arsenic (TSP)	0.00023	62	62	100.00	11.55	11.55
Acetaldehyde	0.45	61	61	100.00	11.36	22.91
Benzene	0.13	61	61	100.00	11.36	34.26
Carbon Tetrachloride	0.17	61	61	100.00	11.36	45.62
Formaldehyde	0.077	61	61	100.00	11.36	56.98
1,3-Butadiene	0.03	57	59	96.61	10.61	67.60
1,2-Dichloroethane	0.038	50	50	100.00	9.31	76.91
p-Dichlorobenzene	0.091	24	51	47.06	4.47	81.38
Ethylbenzene	0.4	24	61	39.34	4.47	85.85
Nickel (TSP)	0.0021	24	62	38.71	4.47	90.32
Manganese (TSP)	0.03	23	62	37.10	4.28	94.60
Hexachloro-1,3-butadiene	0.045	18	19	94.74	3.35	97.95
1,2-Dibromoethane	0.0017	3	3	100.00	0.56	98.51
Lead (TSP)	0.015	3	62	4.84	0.56	99.07
Propionaldehyde	0.8	3	61	4.92	0.56	99.63
Cadmium (TSP)	0.00056	2	62	3.23	0.37	100.00
Total		537	858	62.59		

Table 18-3. Risk-Based 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
Fire Station, Tulsa, Oklahoma - TMOK						
Acetaldehyde	0.45	62	62	100.00	12.86	12.86
Benzene	0.13	62	62	100.00	12.86	25.73
Formaldehyde	0.077	62	62	100.00	12.86	38.59
Carbon Tetrachloride	0.17	61	62	98.39	12.66	51.24
Arsenic (TSP)	0.00023	56	58	96.55	11.62	62.86
1,3-Butadiene	0.03	56	58	96.55	11.62	74.48
1,2-Dichloroethane	0.038	54	54	100.00	11.20	85.68
p-Dichlorobenzene	0.091	19	49	38.78	3.94	89.63
Ethylbenzene	0.4	18	62	29.03	3.73	93.36
Hexachloro-1,3-butadiene	0.045	17	17	100.00	3.53	96.89
Nickel (TSP)	0.0021	9	58	15.52	1.87	98.76
Cadmium (TSP)	0.00056	2	58	3.45	0.41	99.17
Manganese (TSP)	0.03	2	58	3.45	0.41	99.59
1,2-Dibromoethane	0.0017	1	1	100.00	0.21	99.79
Propionaldehyde	0.8	1	62	1.61	0.21	100.00
Total		482	783	61.56		
Riverside, Tulsa, Oklahoma - TROK						
Acetaldehyde	0.45	61	61	100.00	12.47	12.47
Benzene	0.13	61	61	100.00	12.47	24.95
Carbon Tetrachloride	0.17	61	61	100.00	12.47	37.42
Formaldehyde	0.077	61	61	100.00	12.47	49.90
Arsenic (TSP)	0.00023	59	59	100.00	12.07	61.96
1,3-Butadiene	0.03	59	60	98.33	12.07	74.03
1,2-Dichloroethane	0.038	50	50	100.00	10.22	84.25
Ethylbenzene	0.4	24	61	39.34	4.91	89.16
Hexachloro-1,3-butadiene	0.045	17	18	94.44	3.48	92.64
p-Dichlorobenzene	0.091	12	47	25.53	2.45	95.09
Nickel (TSP)	0.0021	11	59	18.64	2.25	97.34
Manganese (TSP)	0.03	8	59	13.56	1.64	98.98
Cadmium (TSP)	0.00056	3	59	5.08	0.61	99.59
1,2-Dibromoethane	0.0017	2	2	100.00	0.41	100.00
Total		489	718	68.11		

Table 18-3. Risk-Based 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	60	60	100.00	15.00	15.00
Benzene	0.13	60	60	100.00	15.00	30.00
Formaldehyde	0.077	60	60	100.00	15.00	45.00
Carbon Tetrachloride	0.17	59	60	98.33	14.75	59.75
Arsenic (TSP)	0.00023	53	59	89.83	13.25	73.00
1,2-Dichloroethane	0.038	53	53	100.00	13.25	86.25
1,3-Butadiene	0.03	38	46	82.61	9.50	95.75
Hexachloro-1,3-butadiene	0.045	10	11	90.91	2.50	98.25
Trichloroethylene	0.2	2	6	33.33	0.50	98.75
Cadmium (TSP)	0.00056	1	59	1.69	0.25	99.00
1,2-Dibromoethane	0.0017	1	1	100.00	0.25	99.25
p-Dichlorobenzene	0.091	1	18	5.56	0.25	99.50
Ethylbenzene	0.4	1	60	1.67	0.25	99.75
Nickel (TSP)	0.0021	1	59	1.69	0.25	100.00
Total		400	612	65.36		
Yukon, Oklahoma - YUOK						
Acetaldehyde	0.45	61	61	100.00	14.49	14.49
Benzene	0.13	61	61	100.00	14.49	28.98
Carbon Tetrachloride	0.17	61	61	100.00	14.49	43.47
Formaldehyde	0.077	61	61	100.00	14.49	57.96
1,2-Dichloroethane	0.038	55	55	100.00	13.06	71.02
Arsenic (TSP)	0.00023	49	61	80.33	11.64	82.66
1,3-Butadiene	0.03	44	52	84.62	10.45	93.11
Hexachloro-1,3-butadiene	0.045	14	15	93.33	3.33	96.44
Manganese (TSP)	0.03	9	61	14.75	2.14	98.57
p-Dichlorobenzene	0.091	2	20	10.00	0.48	99.05
Propionaldehyde	0.8	2	61	3.28	0.48	99.52
Ethylbenzene	0.4	1	61	1.64	0.24	99.76
Nickel (TSP)	0.0021	1	61	1.64	0.24	100.00
Total		421	691	60.93		

Observations from Table 18-3 include the following:

- Concentrations of 16 pollutants failed at least one screen for TOOK; nearly 63 percent of concentrations for these 16 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 12 pollutants contributed to 95 percent of failed screens for TOOK and therefore were identified as pollutants of interest for this site. These 12 include

two carbonyl compounds, seven VOCs, and three TSP metals. TOOK is one of only two NMP sites for which manganese was identified as a pollutant of interest.

- Concentrations of 15 pollutants failed at least one screen for TMOK; nearly 62 percent of concentrations for these 15 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 10 pollutants contributed to 95 percent of failed screens for TMOK and therefore were identified as pollutants of interest for this site. These 10 include two carbonyl compounds, seven VOCs, and one TSP metal.

- Concentrations of 14 pollutants failed at least one screen for TROK; 68 percent of concentrations for these 14 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 10 pollutants contributed to 95 percent of failed screens for TROK and therefore were identified as pollutants of interest for this site. These 10 include two carbonyl compounds, seven VOCs, and one TSP metal.

- Concentrations of 14 pollutants failed at least one screen for OCOK; 65 percent of concentrations for these 14 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of seven pollutants contributed to 95 percent of failed screens for OCOK and therefore were identified as pollutants of interest for this site. These seven include two carbonyl compounds, four VOCs, and one TSP metal.

- Concentrations of 13 pollutants failed at least one screen for YUOK; nearly 61 percent of concentrations for these 13 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of eight pollutants contributed to 95 percent of failed screens for YUOK and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds, five VOCs, and one TSP metal.

- The number of pollutants identified as pollutants of interest range from seven to 12 among the Oklahoma sites. The Tulsa sites have 10 pollutants of interest in common: acetaldehyde and formaldehyde, arsenic, and seven VOCs. The only differences are for TOOK, which has two additional TSP metals (manganese and nickel) compared to the other two sites. The Oklahoma City sites have seven pollutants of interest in common: acetaldehyde, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane, and formaldehyde.

- Concentrations measured at TOOK failed the third highest number of screens among NMP sites, with other Oklahoma sites ranking seventh (TMOK), eighth (TROK), 11th (YUOK), and 15th (OCOK) as shown in Table 4-8.

18.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Oklahoma monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at the Oklahoma sites are provided in Appendices J, L, and N.

18.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for each Oklahoma site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Oklahoma monitoring sites are presented in Table 18-4, where applicable. Note that concentrations of the TSP metals are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 18-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Public Works, Tulsa, Oklahoma - TOOK							
Acetaldehyde	61/61	61	1.47 ± 0.24	2.07 ± 0.28	2.84 ± 0.50	1.52 ± 0.37	1.97 ± 0.22
Benzene	61/61	61	0.97 ± 0.16	0.89 ± 0.17	1.22 ± 0.20	1.05 ± 0.30	1.03 ± 0.11
1,3-Butadiene	59/57	61	0.08 ± 0.02	0.06 ± 0.01	0.09 ± 0.02	0.08 ± 0.03	0.08 ± 0.01
Carbon Tetrachloride	61/61	61	0.60 ± 0.05	0.66 ± 0.02	0.63 ± 0.03	0.55 ± 0.07	0.61 ± 0.03
p-Dichlorobenzene	51/25	61	0.04 ± 0.01	0.07 ± 0.03	0.12 ± 0.02	0.07 ± 0.02	0.07 ± 0.01
1,2-Dichloroethane	50/50	61	0.08 ± 0.02	0.08 ± 0.02	0.11 ± 0.02	0.08 ± 0.04	0.09 ± 0.01
Ethylbenzene	61/61	61	0.35 ± 0.09	0.34 ± 0.10	0.58 ± 0.16	0.31 ± 0.09	0.39 ± 0.06
Formaldehyde	61/61	61	1.97 ± 0.32	3.33 ± 0.51	4.85 ± 0.89	1.71 ± 0.47	2.95 ± 0.42
Hexachloro-1,3-butadiene	19/0	61	0.04 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.03 ± 0.01
Arsenic (TSP)	62/62	62	0.55 ± 0.09	0.83 ± 0.11	0.97 ± 0.20	0.69 ± 0.19	0.76 ± 0.08
Manganese (TSP)	62/62	62	24.67 ± 5.41	31.49 ± 5.28	26.48 ± 6.85	17.60 ± 4.65	25.04 ± 2.92
Nickel (TSP)	62/62	62	2.60 ± 1.16	2.36 ± 0.45	2.15 ± 0.38	1.89 ± 0.32	2.25 ± 0.31
Fire Station, Tulsa, Oklahoma - TMOK							
Acetaldehyde	62/62	62	1.56 ± 0.27	2.00 ± 0.33	2.22 ± 0.39	1.49 ± 0.31	1.81 ± 0.17
Benzene	62/62	62	0.89 ± 0.20	0.67 ± 0.18	0.91 ± 0.17	0.77 ± 0.13	0.81 ± 0.08
1,3-Butadiene	58/57	62	0.10 ± 0.04	0.06 ± 0.02	0.12 ± 0.02	0.09 ± 0.03	0.09 ± 0.01
Carbon Tetrachloride	62/61	62	0.57 ± 0.04	0.67 ± 0.03	0.65 ± 0.03	0.58 ± 0.08	0.62 ± 0.03
p-Dichlorobenzene	49/19	62	0.08 ± 0.02	0.05 ± 0.03	0.09 ± 0.02	0.05 ± 0.03	0.07 ± 0.01
1,2-Dichloroethane	54/53	62	0.08 ± 0.03	0.09 ± 0.02	0.08 ± 0.02	0.09 ± 0.02	0.08 ± 0.01
Ethylbenzene	62/62	62	0.37 ± 0.12	0.27 ± 0.07	0.46 ± 0.08	0.28 ± 0.08	0.34 ± 0.05
Formaldehyde	62/62	62	3.27 ± 0.47	4.37 ± 0.73	4.22 ± 0.85	1.90 ± 0.44	3.41 ± 0.39
Hexachloro-1,3-butadiene	17/0	62	0.04 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	0.01 ± 0.02	0.02 ± 0.01
Arsenic (TSP) [a]	58/58	58	0.47 ± 0.13	0.69 ± 0.12	0.85 ± 0.20	0.65 ± 0.23	0.67 ± 0.09

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

Table 18-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Riverside, Tulsa, Oklahoma - TROK							
Acetaldehyde	61/61	61	1.34 ± 0.26	1.82 ± 0.29	2.24 ± 0.30	1.54 ± 0.33	1.73 ± 0.16
Benzene	61/61	61	0.77 ± 0.09	0.73 ± 0.10	0.85 ± 0.13	0.85 ± 0.21	0.80 ± 0.07
1,3-Butadiene	60/59	61	0.07 ± 0.01	0.06 ± 0.02	0.09 ± 0.02	0.08 ± 0.02	0.07 ± 0.01
Carbon Tetrachloride	61/61	61	0.60 ± 0.04	0.66 ± 0.02	0.64 ± 0.04	0.58 ± 0.03	0.62 ± 0.02
p-Dichlorobenzene	47/12	61	0.05 ± 0.02	0.05 ± 0.02	0.08 ± 0.02	0.05 ± 0.02	0.06 ± 0.01
1,2-Dichloroethane	50/50	61	0.08 ± 0.02	0.08 ± 0.02	0.09 ± 0.02	0.07 ± 0.03	0.08 ± 0.01
Ethylbenzene	61/61	61	0.24 ± 0.05	0.38 ± 0.11	0.51 ± 0.10	0.34 ± 0.08	0.37 ± 0.05
Formaldehyde	61/61	61	2.20 ± 0.44	3.31 ± 0.55	4.07 ± 0.77	1.63 ± 0.45	2.78 ± 0.36
Hexachloro-1,3-butadiene	18/0	61	0.03 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Arsenic (TSP) [a]	59/59	59	0.59 ± 0.11	0.69 ± 0.16	1.04 ± 0.24	0.77 ± 0.33	0.77 ± 0.12
Oklahoma City, Oklahoma - OCOK							
Acetaldehyde	60/60	60	1.49 ± 0.28	2.16 ± 0.57	1.86 ± 0.34	1.45 ± 0.31	1.73 ± 0.20
Benzene	60/60	60	0.62 ± 0.09	0.51 ± 0.14	0.81 ± 0.11	0.65 ± 0.11	0.65 ± 0.06
1,3-Butadiene	46/38	60	0.03 ± 0.02	0.03 ± 0.02	0.05 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
Carbon Tetrachloride	60/59	60	0.54 ± 0.10	0.65 ± 0.03	0.65 ± 0.02	0.62 ± 0.03	0.61 ± 0.03
1,2-Dichloroethane	53/49	60	0.08 ± 0.01	0.07 ± 0.01	0.05 ± 0.02	0.08 ± 0.01	0.07 ± 0.01
Formaldehyde	60/60	60	1.33 ± 0.26	3.26 ± 0.79	4.08 ± 0.64	1.98 ± 0.40	2.63 ± 0.38
Arsenic (TSP) [a]	59/59	59	0.38 ± 0.08	0.54 ± 0.10	0.63 ± 0.15	0.41 ± 0.11	0.48 ± 0.06

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

Table 18-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Yukon, Oklahoma - YUOK							
Acetaldehyde	61/61	61	2.03 ± 0.94	1.86 ± 0.46	1.95 ± 0.26	1.39 ± 0.30	1.80 ± 0.27
Benzene	61/61	61	0.57 ± 0.08	0.53 ± 0.13	0.56 ± 0.08	0.55 ± 0.08	0.56 ± 0.04
1,3-Butadiene	52/44	61	0.03 ± 0.02	0.04 ± 0.02	0.05 ± 0.01	0.05 ± 0.02	0.05 ± 0.01
Carbon Tetrachloride	61/61	61	0.59 ± 0.04	0.68 ± 0.03	0.66 ± 0.02	0.61 ± 0.03	0.63 ± 0.02
1,2-Dichloroethane	55/54	61	0.07 ± 0.02	0.09 ± 0.01	0.07 ± 0.01	0.08 ± 0.02	0.08 ± 0.01
Formaldehyde	61/61	61	2.37 ± 0.62	3.37 ± 0.64	4.20 ± 0.63	1.83 ± 0.43	2.92 ± 0.36
Hexachloro-1,3-butadiene	15/0	61	0.02 ± 0.02	0	0.03 ± 0.02	0.01 ± 0.02	0.02 ± 0.01
Arsenic (TSP)[a]	61/61	61	0.32 ± 0.08	0.53 ± 0.06	0.56 ± 0.09	0.37 ± 0.10	0.44 ± 0.05

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

Observations for the Oklahoma sites from Table 18-4 include the following:

- Formaldehyde has the highest annual average concentration of the pollutants of interest for each site, followed by acetaldehyde and benzene (with one exception). With the exception of TOOK, acetaldehyde and formaldehyde were the only pollutants of interest with annual average concentrations greater than 1 µg/m^3 for each site. For TOOK, benzene also has an annual average concentration greater than 1 µg/m^3.

- Annual average concentrations of formaldehyde range from 2.63 ± 0.38 µg/m^3 for OCOK to 3.41 ± 0.39 µg/m^3 for TMOK. The annual average concentrations of acetaldehyde range from 1.73 ± 0.16 µg/m^3 for TROK to 1.97 ± 0.22 µg/m^3 for TOOK. The annual average concentrations of benzene range from 0.56 ± 0.04 µg/m^3 for YUOK to 1.03 ± 0.11 µg/m^3 for TOOK. TOOK has had the highest annual average benzene concentration among the Oklahoma sites for several years (and is usually one of the highest across the program), including 2014, although the difference is becoming less significant.

- Concentrations of the carbonyl compounds, formaldehyde in particular, tended to be highest in the warmer months and lowest in the cooler months.

- The rest of this section discusses concentrations measured at the individual monitoring sites in Oklahoma.

Observations for TOOK from Table 18-4 include the following:

- Formaldehyde concentrations measured at TOOK were highest during the warmer months of the year, as indicated by the quarterly average concentrations. All 18 formaldehyde concentrations greater than 3.5 $\mu g/m^3$ were measured at TOOK between May and September, with the six measurements between 5 $\mu g/m^3$ and 8 $\mu g/m^3$ measured in July and August. Conversely, all but one of the 13 formaldehyde concentrations less than 1.5 $\mu g/m^3$ were measured in January, February, November or December (including all six sample days in December).

- While the highest acetaldehyde concentrations were also measured at TOOK during July and August, there is more variability during the seasons in which the higher concentrations were measured. For instance, 13 acetaldehyde concentrations greater than 2.5 $\mu g/m^3$ were measured at TOOK in 2014: three were measured during the second quarter, eight were measured during the third quarter, and two were measured during the fourth quarter.

- Concentrations greater than 1 $\mu g/m^3$ account for just over half (32) of the benzene concentrations measured at TOOK in 2014 and only two NMP sites have more (PACO and ROIL). These measurements were spread throughout the year, with nine measured during the first quarter of 2014, six during the second quarter, 11 during the third quarter, and six during the fourth quarter (including the maximum concentration (2.84 $\mu g/m^3$), the only benzene concentration greater than 2 $\mu g/m^3$ measured at TOOK).

- Three ethylbenzene concentrations greater than 1 $\mu g/m^3$ were measured at TOOK in 2014, one each in July, August, and September, which is reflected in the third quarter average concentrations shown in Table 18-4.

- The third quarter average concentration for *p*-dichlorobenzene is greater than the other quarterly averages for TOOK. None of the 10 non-detects of this pollutant were measured during the third quarter. In addition, 13 of the 15 concentrations measured during the third quarter are greater than 0.1 $\mu g/m^3$, while the number for the remaining calendar quarters ranges from zero (first quarter) to six (second quarter).

- Concentrations of arsenic measured at TOOK appear highest during the third quarter and lowest during the first quarter, although the confidence intervals shown for the third and the fourth quarters are similar to each other and twice those shown for the other quarterly averages. The variability exhibited by the concentrations measured during each quarter can be evaluated by comparing the differences between the quarterly average and median concentration for each quarter. The differences between the quarterly average and median concentration for the first, second, and third quarters are less than 0.1 ng/m^3 (0.06 ng/m^3, 0.05 ng/m^3, and 0.01 ng/m^3, respectively) while the difference for the fourth quarter is 0.20 ng/m^3. Thus, this quarter exhibits the most variability. Four of the 10 highest arsenic concentrations measured at TOOK were measured during the fourth quarter while five of the 10 lowest arsenic concentrations measured at TOOK were also measured during the fourth quarter.

- The confidence interval for the first quarter average concentration of nickel is two to three times larger than the confidence intervals for the remaining quarterly average concentrations. Three of the four highest nickel concentrations were measured at TOOK during the first quarter, including two greater than 7 ng/m^3, which are among the 10 highest nickel concentrations measured at NMP sites sampling nickel. Three of the four lowest nickel concentrations measured at TOOK were measured during the first quarter of 2014, including the minimum concentration for this site (0.989 ng/m^3). Thus, nickel concentrations measured at TOOK during the first quarter exhibit the most variability.

Observations for TMOK from Table 18-4 include the following:

- Formaldehyde concentrations measured at TMOK were considerably lower during the fourth quarter compared to the rest of the year. Concentrations measured at TMOK range from 0.631 µg/m^3 to 8.01 µg/m^3, with nine of the 10 concentrations less than 2 µg/m^3 measured during the fourth quarter. Twenty-one formaldehyde concentrations greater than 4 µg/m^3 were measured at TMOK, all of which were measured between February and August.

- Concentrations of acetaldehyde appear higher during the warmer months of the year, based on the quarterly average concentrations, although the differences are not significant. All four acetaldehyde concentrations greater than 3 µg/m^3 were measured between May and August and 16 of the 25 concentrations greater than 2 µg/m^3 were measured during the second and third quarters of 2014. Conversely, 11 of the 12 lowest concentrations were measured during the first and fourth quarters.

- The quarterly average concentrations of several VOCs are highest for the first and third quarters of 2014 and lowest for the second and fourth quarters, although the difference is not significant. The highest concentrations of benzene, ethylbenzene, and 1,3-butadiene were all measured on the same days: February 16, 2014 and August 3, 2014. A review of each of these pollutants' 10 highest concentrations shows that more than half of these measurements were from samples collected during the first and third quarters.

- Concentrations of hexachloro-1,3-butadiene appear highest for the first quarter of 2014. This is mostly due to the number of measured detections of this pollutant. Hexachloro-1,3-butadiene was detected in 17 samples collected at TMOK; of these, eight were measured during the first quarter, which is at least twice the number for the other calendar quarters, which range from two (second quarter) to four (third quarter). While the maximum hexachloro-1,3-butadiene concentration was also measured during the first quarter (0.110 µg/m^3), so were several of the lowest concentrations measured at this site; note, however, that all of the measurements of this pollutant are less than the MDL.

- Arsenic concentrations appear highest during the third quarter and lowest for the first quarter. The number of arsenic concentrations greater than 1 ng/m^3 was highest for the third quarter (4) and the lowest during the first quarter (0), with the number between the two for the other calendar quarters. Conversely, only three arsenic

concentrations less than 0.5 ng/m^3 were measured at TMOK during the third quarter compared to eight for the first quarter, including the three lowest concentrations measured at this site. Note that the confidence interval is largest for the fourth quarter average concentration. The maximum arsenic concentration was measured at TMOK in December; December is also the most with the highest number of arsenic concentrations less than 0.5 ng/m^3 (9).

Observations for TROK from Table 18-4 include the following:

- The second and third quarter average concentrations of formaldehyde are significantly higher than the other quarterly averages for TROK. The maximum concentration of formaldehyde (6.39 µg/m^3) was measured on July 22, 2014 at TROK, the same day the maximum concentration was measured at TOOK and second highest concentration was measured at TMOK. The six concentrations of formaldehyde greater than 5 µg/m^3 were measured at TROK between May and August, and 20 of the 24 concentrations greater than 3 µg/m^3 were measured during the second and third quarters of 2014 (with two each in the first and fourth quarters). Conversely, all five concentrations of formaldehyde less than 1 µg/m^3 were measured in November and December and all but two of the 22 concentrations less than 2 µg/m^3 were measured during the first and fourth quarters of 2014.

- The quarterly average concentrations of acetaldehyde have a similar pattern as those for formaldehyde but to a lesser degree. Two of the three acetaldehyde concentrations greater than 3 µg/m^3 were measured in August (with the other measured in May) while none of the 21 concentrations less than 1.5 µg/m^3 were measured during the third quarter of 2014 (compared to nine, four, and eight for the first, second, and fourth quarters of the year).

- With the exception of two VOCs, the third quarter average concentration for each pollutant of interest for TMOK is the highest among the quarterly averages shown in Table 18-4 (although the statistical significance varies among the pollutants).

- The third and fourth quarter average benzene concentrations for TROK the same, although the fourth quarter average has a larger confidence interval associated with it. The two highest benzene concentrations were measured at TROK on December 25, 2014 (2.09 µg/m^3) and October 20, 2014 (1.33 µg/m^3), with two other benzene concentrations greater than 1 µg/m^3 also measured during the fourth quarter. Three benzene concentrations greater than 1 µg/m^3 were also measured during the third quarter, compared to one each during the first and second quarters.

- The third quarter average ethylbenzene concentration is the highest of the four quarterly averages and is twice the first quarter average shown in Table 18-4. A review of the data shows that there were no ethylbenzene concentrations greater than 0.5 µg/m^3 measured at TROK during the first quarter, compared to six measured during the third quarter (and the number ranging from two to four for the remaining calendar quarters). At the other end of the range, there were no ethylbenzene concentrations less than 0.25 µg/m^3 measured at TROK during the third quarter,

compared to nine measured during the first quarter (and the number ranging from three to six for the remaining calendar quarters).

- The third quarter average arsenic concentration is the highest of the four quarterly averages and is nearly twice the magnitude of the first quarter average concentration. A review of the data shows that there were no arsenic concentrations greater than 1 ng/m^3 measured at TROK during the first quarter, compared to seven measured during the third quarter (and the number ranging from one to three for the other two calendar quarters). Note that both the minimum (0.234 ng/m^3) and maximum (2.22 ng/m^3) arsenic concentrations were measured at TROK during the fourth quarter, explaining the relatively large confidence interval shown for this quarterly average.

Observations for OCOK from Table 18-4 include the following:

- Similar to the Tulsa sites, the second and third quarter average concentrations of formaldehyde are higher than the other quarterly averages for OCOK, and although the third quarter average concentration is the highest, the confidence interval is highest for the second quarter. A review of the data shows that all 16 formaldehyde concentrations greater than 3.5 µg/m^3 were measured at OCOK during the second (7) and third (9) quarters, with the maximum concentration measured on April 11, 2014 (6.90 µg/m^3). Formaldehyde concentrations less than 2 µg/m^3 were not measured between May and September and only two of these were measured outside the first and fourth quarters of 2014.

- The maximum acetaldehyde concentration was measured at OCOK on the same day as the maximum formaldehyde concentration (April 11, 2014). The second highest acetaldehyde concentration (3.18 µg/m^3) was also measured during the second quarter, along with six additional measurements greater than 2 µg/m^3 (the most of any calendar quarter).

- The maximum benzene and 1,3-butadiene concentrations were also measured at OCOK on April 11, 2014. The carbon tetrachloride and arsenic concentrations measured at OCOK on this date are not the maximums measured, but are among the higher concentrations measured, ranking fifth and sixth, respectively for each pollutant.

- The first quarter average concentration of carbon tetrachloride is the lowest of the four shown for OCOK and the lowest among quarterly averages of carbon tetrachloride calculated for the Oklahoma sites. A review of the data shows that the five concentrations of carbon tetrachloride less than 0.5 µg/m^3 were measured at OCOK during the first quarter of 2014, including the minimum concentration measured across the program (0.0378 µg/m^3). The next lowest carbon tetrachloride concentration measured at OCOK is an order of magnitude higher.

- Concentrations of arsenic measured at OCOK appear highest during the warmer months and lowest during the cooler months. The only arsenic concentration greater than 1 ng/m^3 was measured at OCOK on August 3, 2014 (1.19 ng/m^3), with the next two highest arsenic concentrations measured in July and August. Sixteen arsenic

concentrations greater than 0.5 ng/m^3 were measured at OCOK between April and September, compared to seven for the remainder of the year. On the other end of the concentration scale, arsenic concentrations less than 0.25 ng/m^3 were not measured at OCOK between April and September, compared to eight for the remainder of the year.

Observations for YUOK from Table 18-4 include the following:

- Although similar to the second and third quarter averages, the first quarter average concentration of acetaldehyde has a confidence interval two to three times larger than the other averages shown, indicating a high level of variability and/or potential outliers. The maximum acetaldehyde concentration was measured at YUOK on January 17, 2014 (7.80 µg/m^3) and is more than twice the next highest concentration measured during the first quarter (3.79 µg/m^3), with only one other measurement falling in between (4.28 µg/m^3, measured in April 11, 2014). YUOK is one of only five NMP sites with an acetaldehyde measurement greater than 7 µg/m^3. All other acetaldehyde concentrations measured at YUOK are less than 3 µg/m^3.

- Two formaldehyde concentrations of 6.15 µg/m^3 were measured at YUOK, one on April 11, 2014, the same day as the highest formaldehyde concentration was measured at OCOK, and one on August 15, 2014. Formaldehyde concentrations greater than 4 µg/m^3 were measured in the first (2), second (3), and third (8) quarters of 2014 while none were measured during the fourth quarter. Conversely, at least one concentration less than 2 µg/m^3 was measured during each calendar quarter (seven during the first quarter, two during the second quarter, one during the third quarter, and 10 during the fourth quarter).

- The second quarterly average concentration of hexachloro-1,3-butadiene is zero, indicating that all measurements were non-detects. Measured detections were not measured at YOUK between March and June. This is also true for December. There was at least one measured detection in all other months, ranging from one (January, July, September, and October) to five (February). However, none of these were greater than the MDL for this pollutant.

- The maximum arsenic concentration was measured on July 4, 2014 and is the only measurement greater than 1 ng/m^3 measured at this site (1.03 ng/m^3). Higher arsenic concentrations were measured more often during the warmer months of the year and lower concentrations measured more often during the cooler months of the year. For instance, arsenic concentrations greater than 0.5 ng/m^3 were measured during each calendar quarter, two during the first, 10 during the second, nine during the third, and three during the fourth. Conversely, arsenic concentration less than 0.25 ng/m^3 were not measured during the second and third calendar quarters, compared to seven during the first quarter and six during the fourth quarter.

Tables 4-9 through 4-12 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the Oklahoma sites include the following:

- The Oklahoma sites appear in Tables 4-9 through 4-12 a total of 26 times. However, because they are the only sites sampling TSP metals, each Oklahoma site appears for each metal, accounting for 10 of the appearances.

- All three Tulsa sites appear in Table 4-9 among the sites with the highest annual average concentrations of ethylbenzene, with TOOK ranking fourth, TROK ranking fifth, and TMOK ranking eighth. These annual averages vary by only 0.05 $\mu g/m^3$. The Tulsa sites also rank fourth through sixth for their annual averages of *p*-dichlorobenzene. These three sites also appear in Table 4-9 for their annual averages of hexachloro-1,3-butadiene.

- TOOK has the seventh highest annual average of concentration of benzene, with TMOK's annual average ranking 10th. These two sites also rank seventh and ninth, respectively, for their annual average concentrations of 1,2-dichloroethane.

- YUOK appears only once in Table 4-9: YUOK has the ninth highest annual average concentration of carbon tetrachloride among NMP sites sampling VOCs (although only 0.02 $\mu g/m^3$ separates the Oklahoma sites' annual average concentrations of this pollutant).

- OCOK does not appear in Table 4-9.

- The annual average concentration of acetaldehyde for TOOK ranks 10th among NMP sites sampling this pollutant. The annual average concentration of formaldehyde for TMOK ranks seventh among NMP sites. The remaining sites do not appear in Table 4-10 for carbonyl compounds.

- The Tulsa sites rank higher than OCOK and YUOK for the two TSP metals shown in Table 4-12 and there is a considerable decrease in the annual averages shown between the sites from the two metro areas. TROK has the highest annual average arsenic concentration among the Oklahoma sites while TOOK has the highest annual average nickel concentration among the Oklahoma sites. Similar observations were made in the 2013 NMP report.

18.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 18-4 for the five Oklahoma sites. Figures 18-13 through 18-24 overlay these sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first

quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 18-13. Program vs. Site-Specific Average Acetaldehyde Concentrations

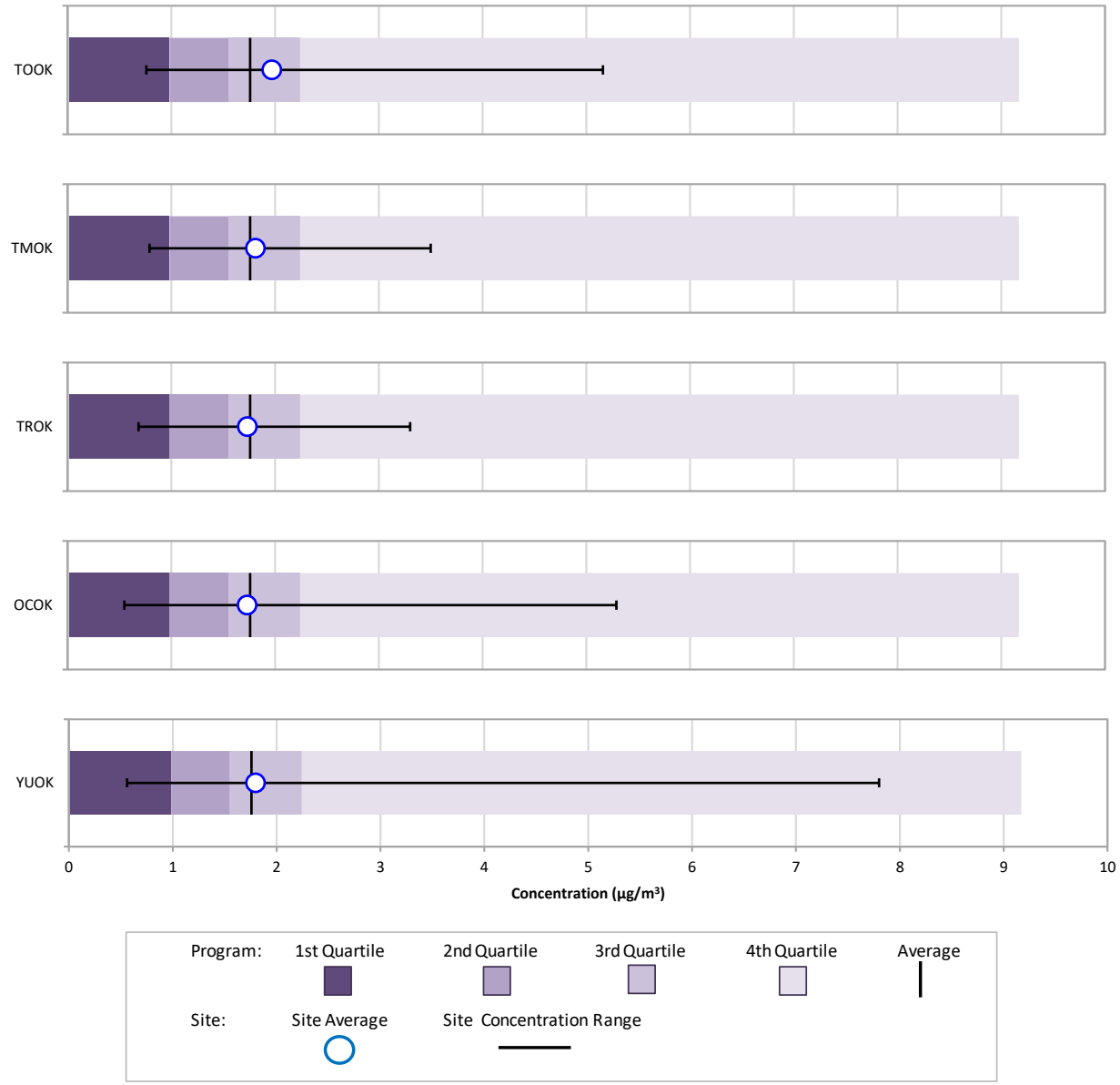


Figure 18-13 presents the box plots for acetaldehyde for all five sites and shows the following:

- The range of acetaldehyde concentrations measured was smallest for TROK and largest for YUOK, with the minimum concentrations measured similar across the sites but the maximum concentrations varying from 3.30 µg/m^3 to 7.80 µg/m^3.

- TOOK has the highest annual average concentration of acetaldehyde among the Oklahoma sites, which is greater than the program-level average concentration. The

annual average concentrations for the remaining sites vary by less than 0.08 µg/m^3, and are similar to the program-level average concentration.

Figure 18-14. Program vs. Site-Specific Average Arsenic (TSP) Concentrations

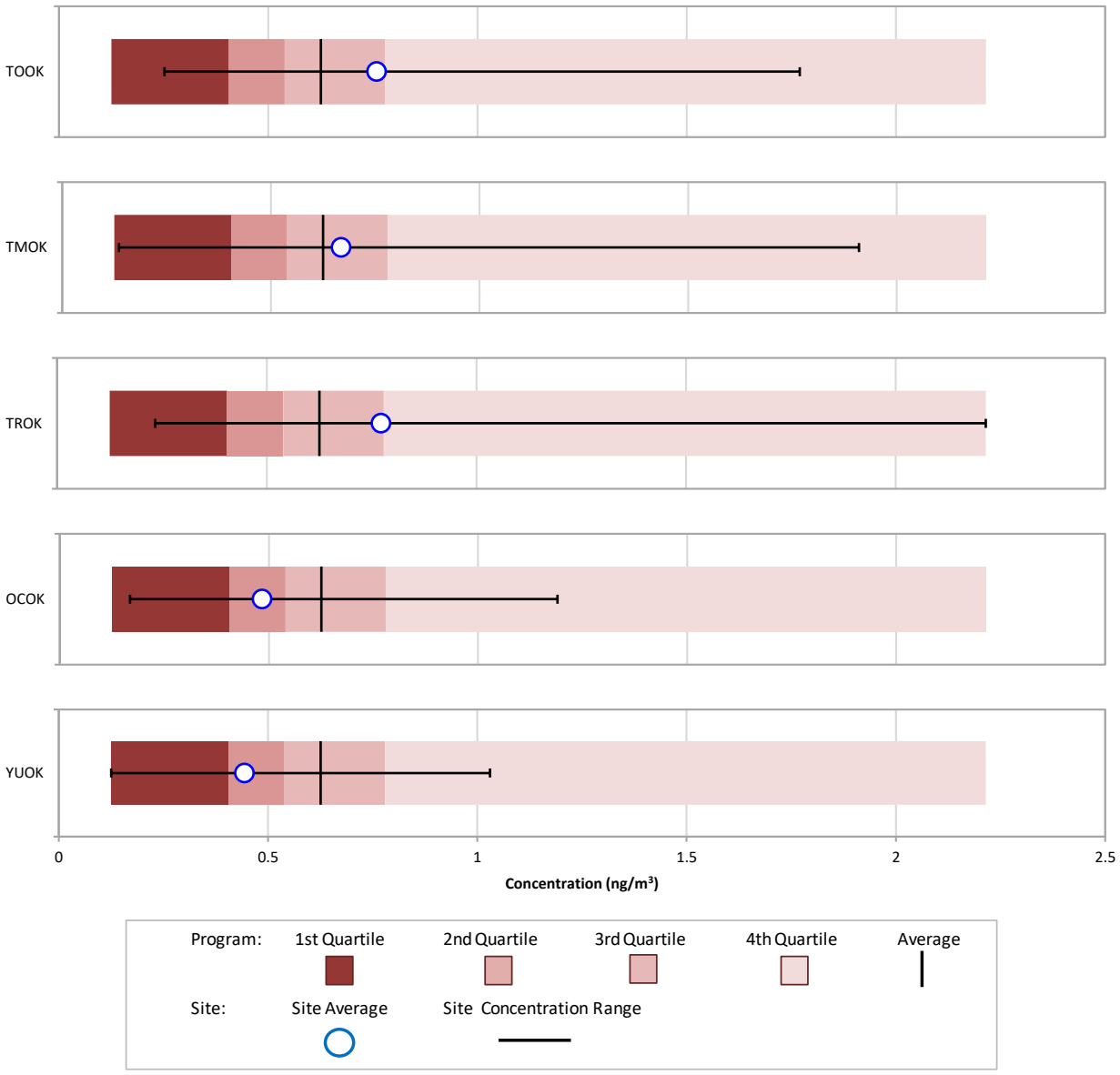


Figure 18-14 presents the box plots for arsenic for all five sites and shows the following:

- Because the Oklahoma sites are the only sites sampling TSP metals, Figure 18-14 compares each Oklahoma site's arsenic data against the combined Oklahoma data.

- The range of arsenic concentrations measured was smallest for YUOK and largest for TROK. Non-detects of arsenic were not measured at these sites.

- The annual average arsenic (TSP) concentration is greatest for TROK (although the annual average for TOOK is similar) and lowest for YUOK. This figure also shows

that arsenic concentrations were higher at the Tulsa sites, based on both the range of measurements as well as the annual average concentrations.

Figure 18-15. Program vs. Site-Specific Average Benzene Concentrations

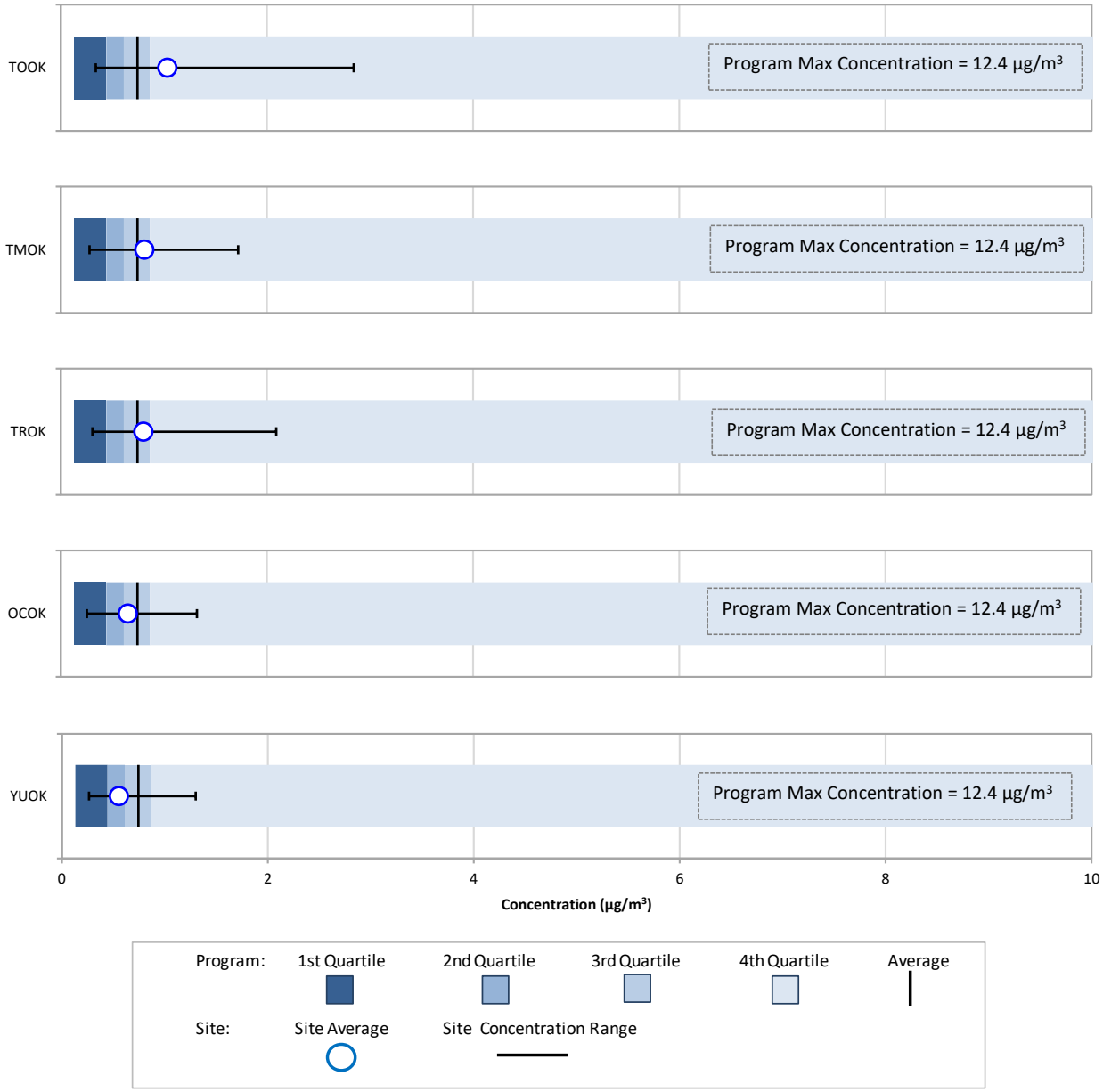


Figure 18-15 presents the box plots for benzene for all five sites and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plots in Figure 18-15 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The range of benzene concentrations was smaller at the Oklahoma City sites compared to the Tulsa sites.

- The annual average concentrations of benzene decrease across the sites as the Figure 18-15 is viewed from top to bottom, with the annual average for TOOK nearly twice the annual average for YUOK. TOOK's annual average concentration is greater than the program-level average concentration and third quartile; TMOK and TROK's annual average concentrations are similar to each other and fall between the program-level average concentration and third quartile; OCOK's annual average is between the program-level median and average concentrations; and YUOK's annual average is just less than the program-level median concentration.

Figure 18-16. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

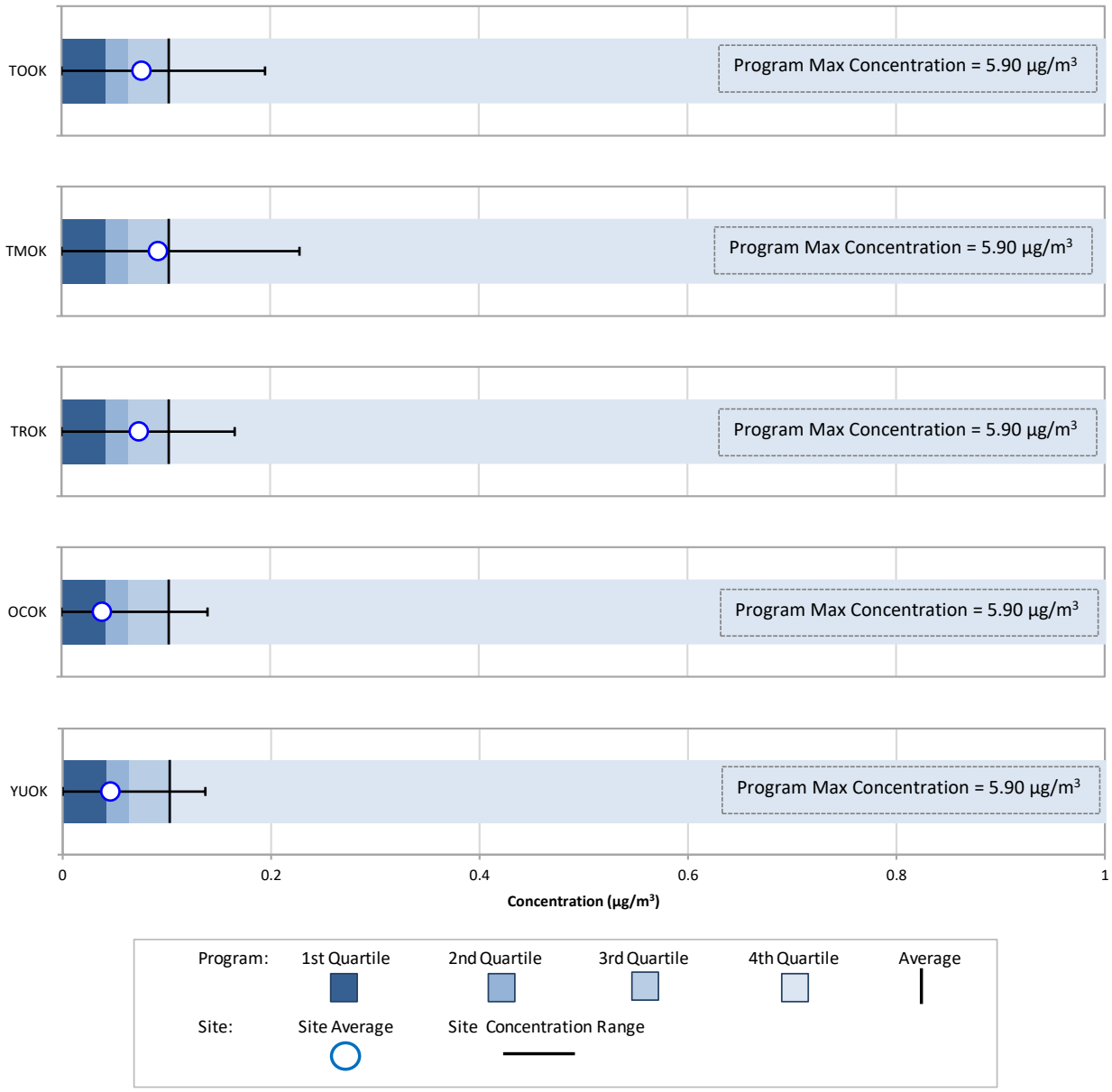


Figure 18-16 presents the box plot for 1,3-butadiene for all five sites and shows the following:

- Similar to benzene, the program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plots in Figure 18-16 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced to 1 µg/m^3.

- The range of 1,3-butadiene concentrations measured at the Oklahoma sites are considerably less than the range measured at the program-level, as all concentrations measured at these sites are less than 0.25 µg/m^3.

- All of the annual average concentrations of 1,3-butadiene for the Oklahoma sites are less than the program-level average concentration. The annual average concentration of 1,3-butadiene is highest for TMOK and lowest for OCOK with approximately 0.05 µg/m^3 separating them. The annual average concentrations for the Tulsa sites are greater than the annual averages for the Oklahoma City sites, with the annual averages for the Tulsa sites greater than the program-level median concentration and the annual averages for OCOK and YUOK less than the program-level median concentration.

Figure 18-17. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

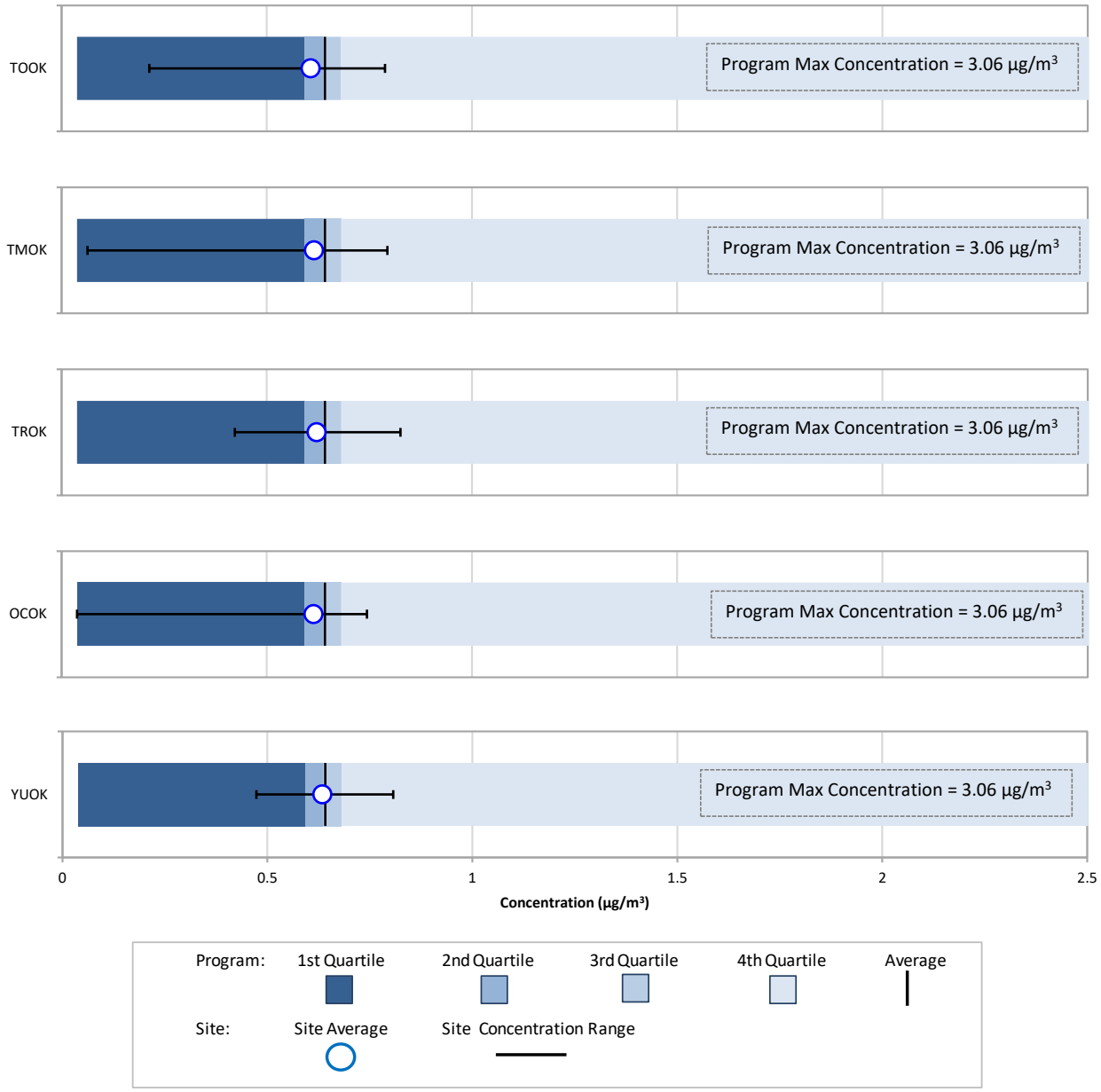


Figure 18-17 presents the box plots for carbon tetrachloride for all five sites and shows the following:

- The scale of the box plots in Figure 18-17 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- Several of the lowest carbon tetrachloride concentrations across the program were measured at Oklahoma sites, including the minimum concentration measured in 2014.

- The annual average concentrations for these five sites vary little, ranging from 0.61 µg/m^3 and 0.63 µg/m^3 for each site, all of which are just less than the program level average concentration of 0.64 µg/m^3.

Figure 18-18. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

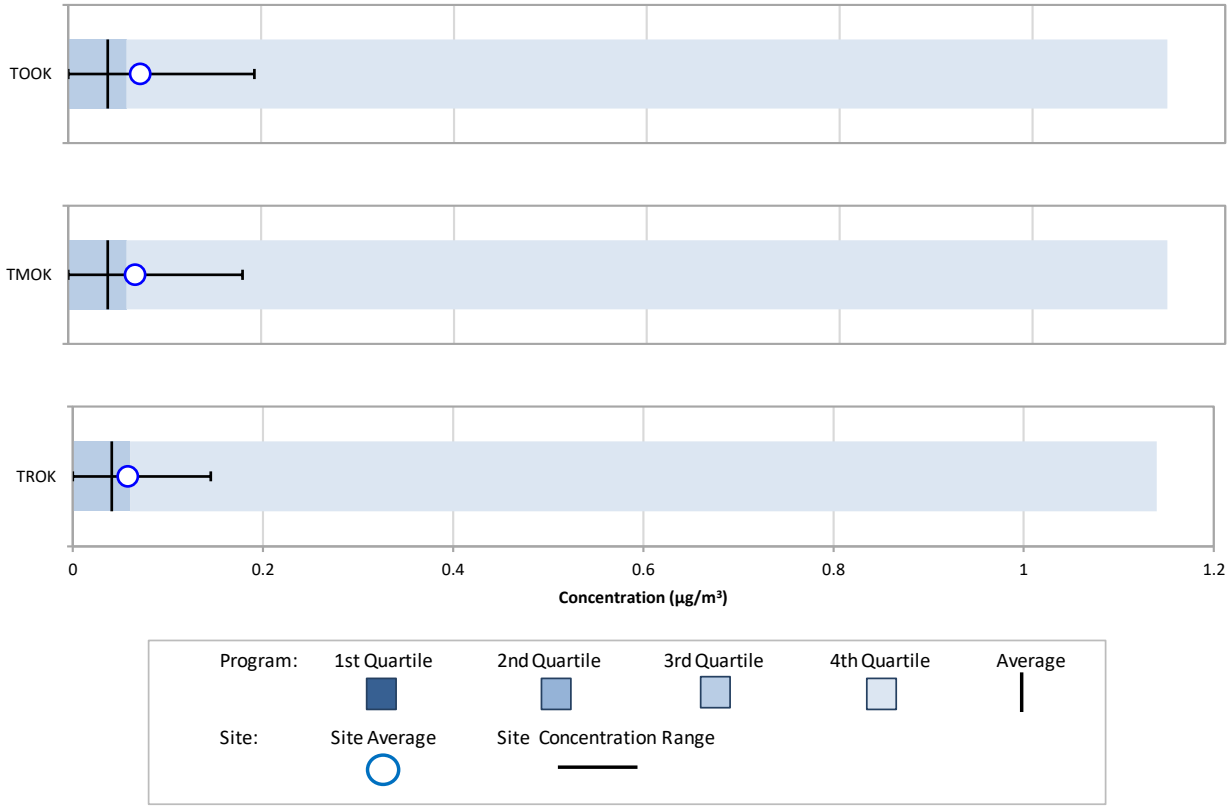


Figure 18-18 presents the box plots for *p*-dichlorobenzene for TOOK, TMOK, and TROK, and shows the following:

- *p*-Dichlorobenzene is a pollutant of interest for only the three Tulsa sites. Note that the program-level first and second quartiles are both zero and therefore not visible on the box plots.

- All *p*-dichlorobenzene concentrations measured at these sites are less than 0.2 µg/m^3, each an order of magnitude less than the maximum concentration measured across the program.

- The annual average *p*-dichlorobenzene concentration for each Tulsa site is greater than the program-level average concentration, with the annual averages for TOOK and TMOK also greater than the program-level third quartile (and the annual average for TROK similar to it).

- The number of non-detects measured at these sites ranges from 10 (TOOK) to 14 (TROK).

Figure 18-19. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

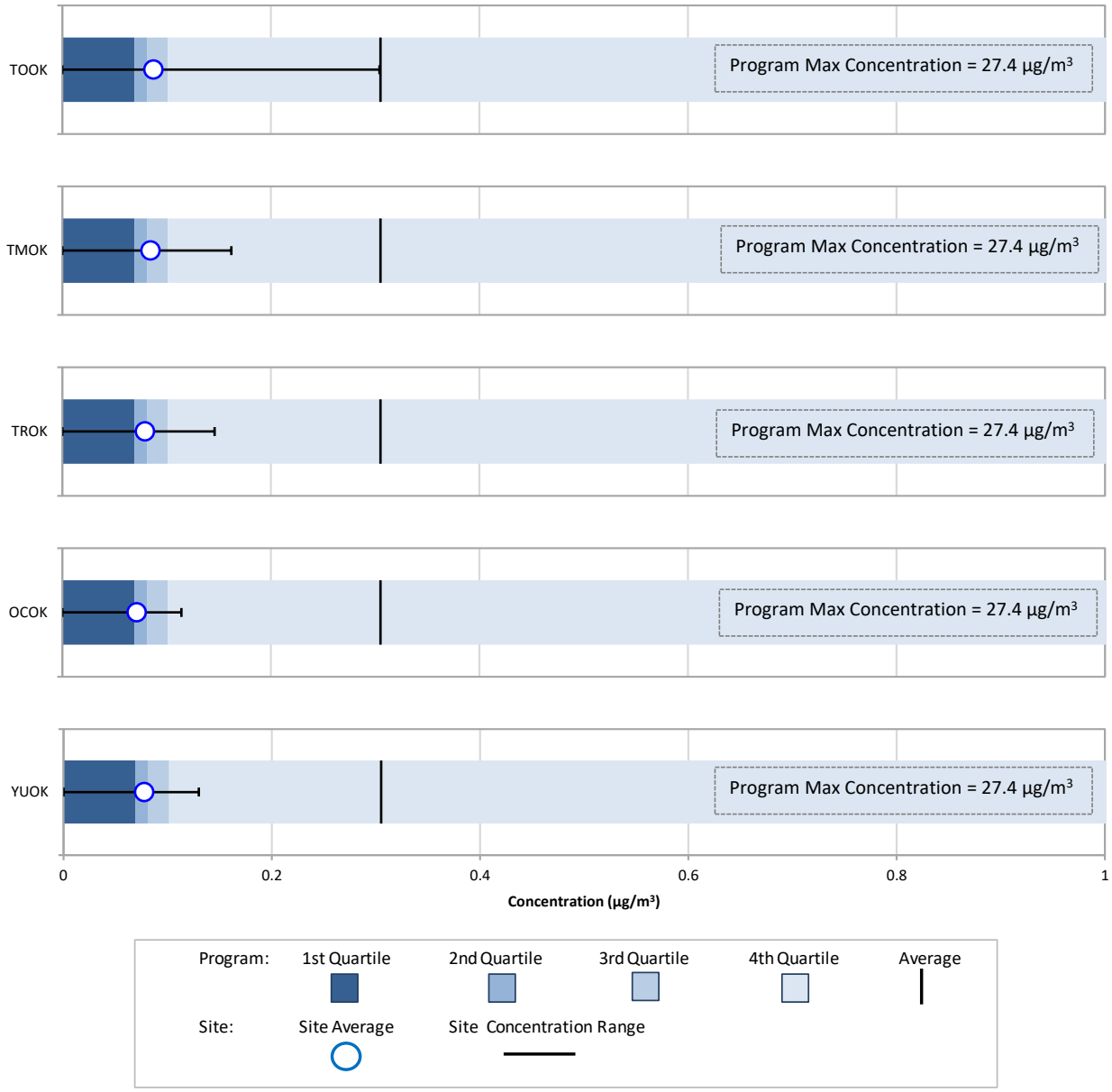


Figure 18-19 presents the box plots for 1,2-dichloroethane for all five sites and shows the following:

- The scale of the box plots in Figure 18-19 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- The program-level average concentration is being driven by the higher concentrations measured at a few monitoring sites. The entire range of 1,2-dichloroethane concentrations measured at the Oklahoma sites is less than the average concentration across the program (even the maximum concentration measured at TOOK, although difficult to discern in Figure 18-19).

- The annual average concentrations of 1,2-dichloroethane for these sites fall on either side of the program-level median concentration, with less than 0.02 µg/m^3 separating these sites' annual averages.

Figure 18-20. Program vs. Site-Specific Average Ethylbenzene Concentrations

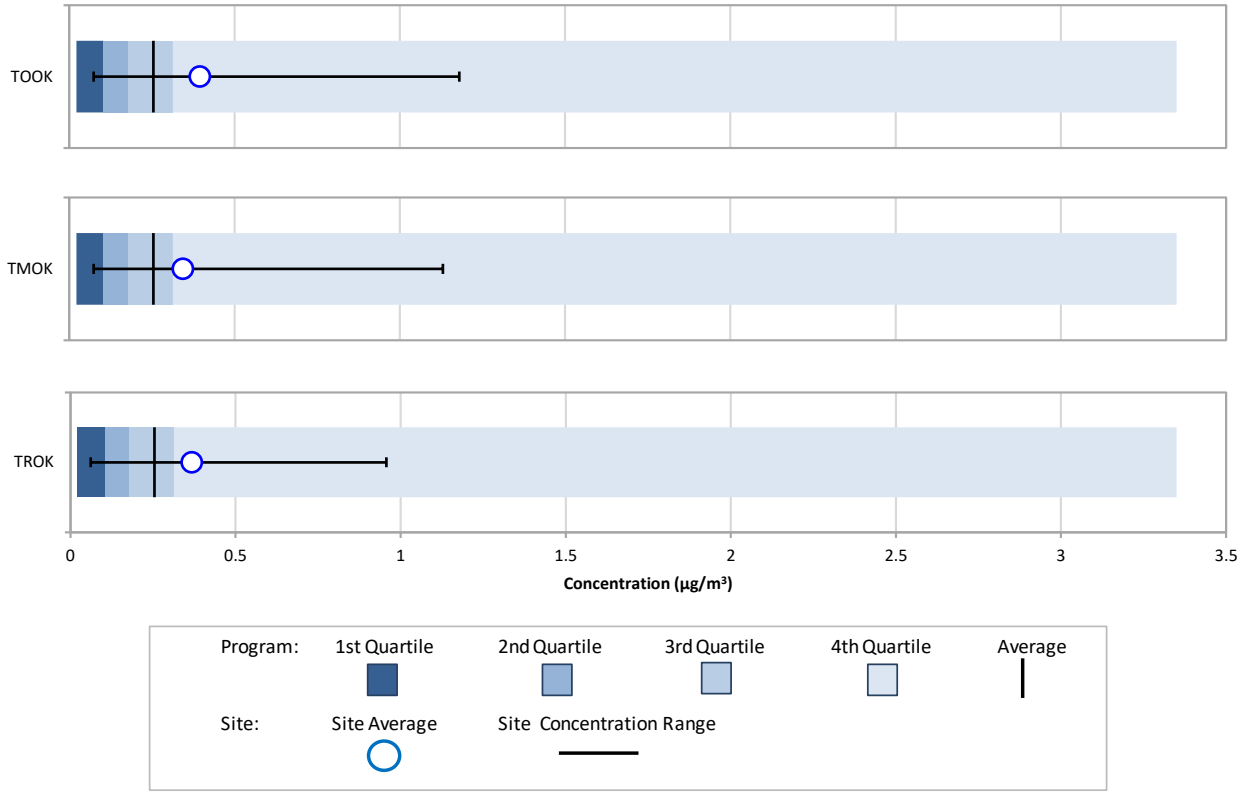


Figure 18-20 presents the box plots for ethylbenzene for TOOK, TMOK, and TROK, and shows the following:

- Ethylbenzene is a pollutant of interest for only the three Tulsa sites.

- The range of ethylbenzene concentrations measured is largest for TOOK and smallest for TROK.

- The annual average concentrations for each of the Tulsa sites are greater than the program-level average concentration and third quartile. Approximately 0.05 µg/m^3 separates the annual average concentrations of ethylbenzene for the Tulsa sites.

Figure 18-21. Program vs. Site-Specific Average Formaldehyde Concentrations

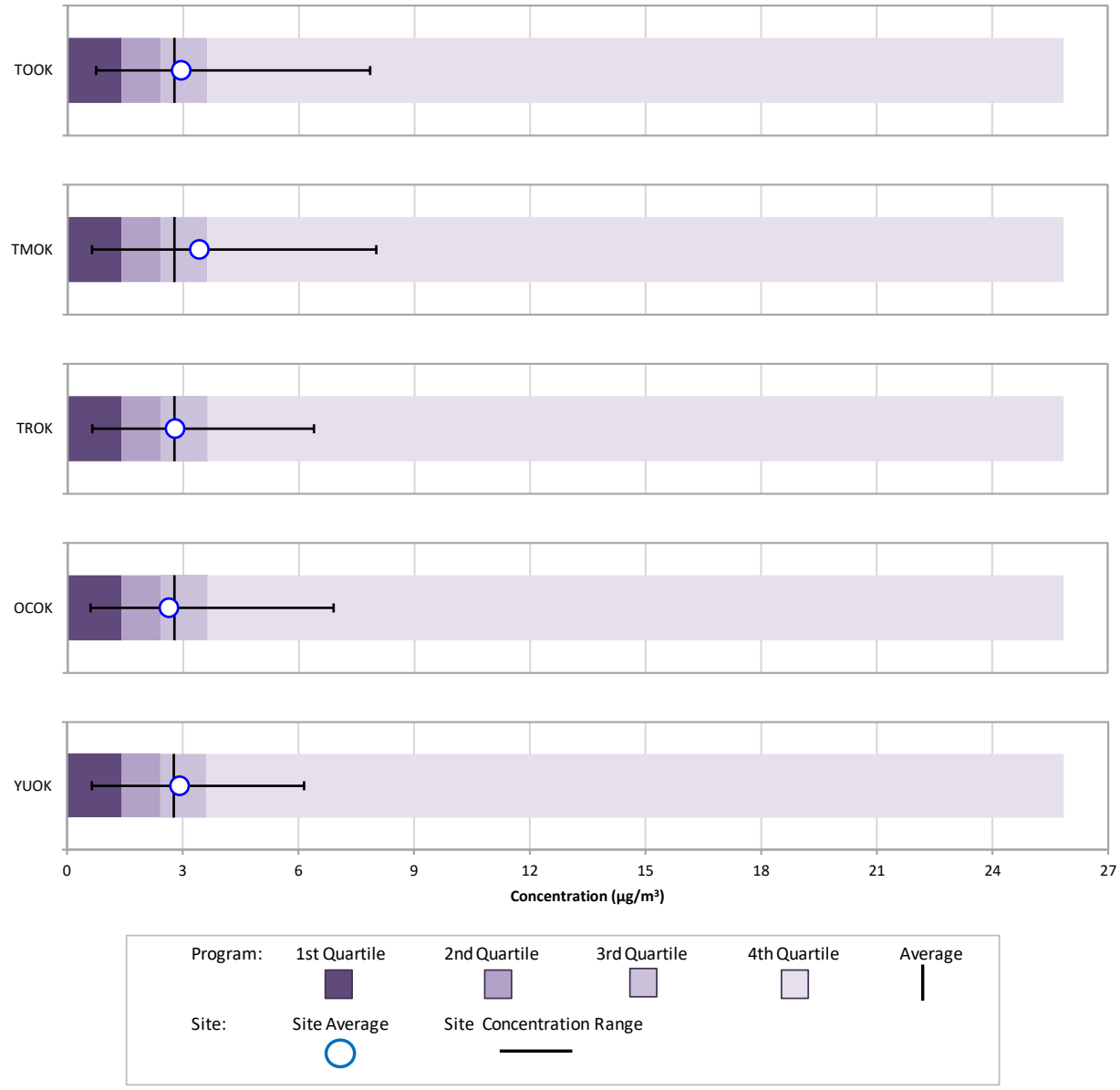


Figure 18-21 presents the box plots for formaldehyde for all five sites and shows the following:

- The maximum formaldehyde concentrations measured at these sites are all considerably less than the maximum concentration measured across the program, with the highest concentration among the Oklahoma sites measured at TMOK (although a similar concentration was also measured at TOOK).

- TMOK has the highest annual average concentration of formaldehyde among the Oklahoma sites, which is the only one greater than 3 µg/m^3. The annual averages for the Tulsa sites and YUOK are all greater than the program-level average concentration (although the difference for TROK is negligible).

Figure 18-22. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

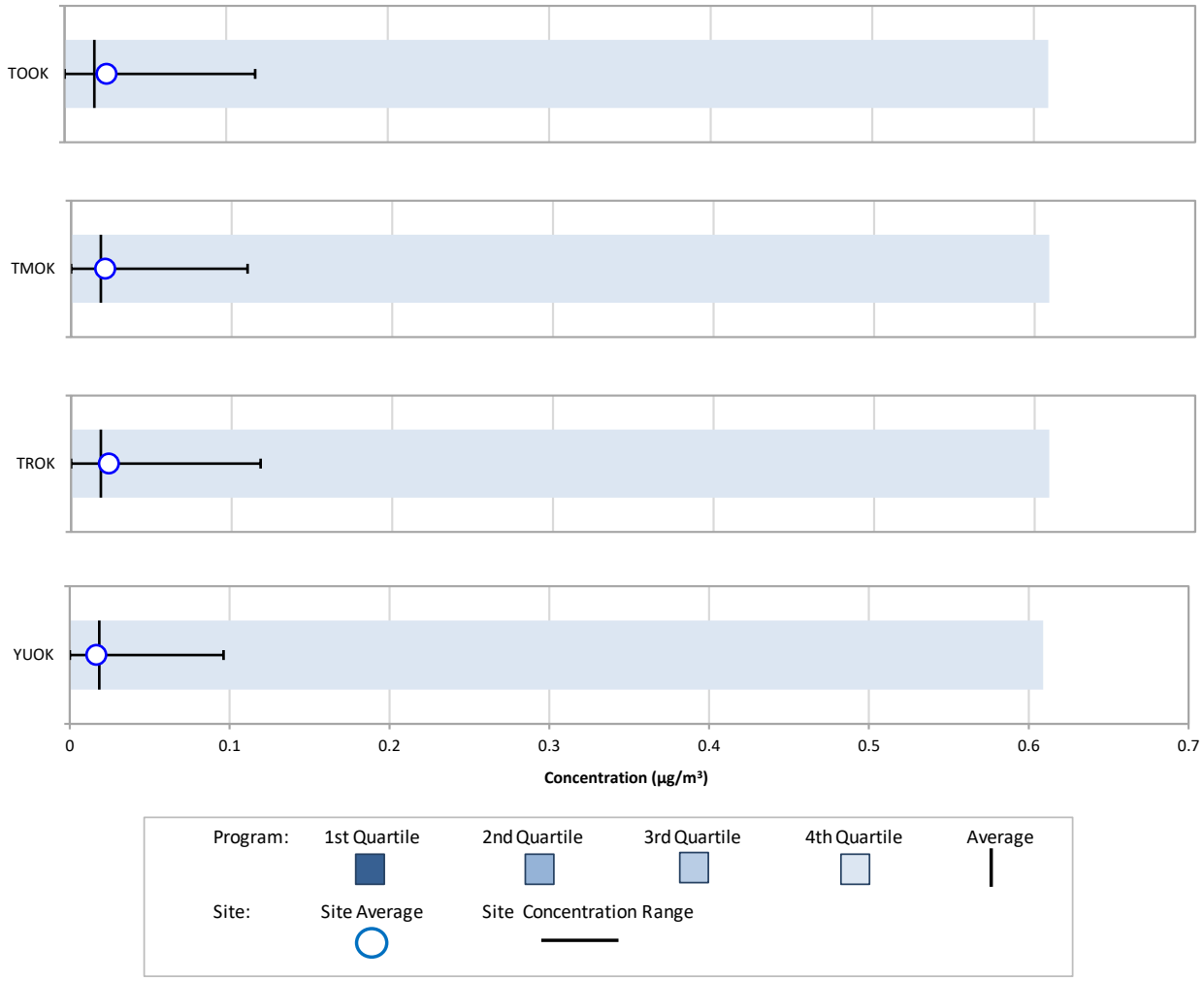


Figure 18-22 presents the box plots for hexachloro-1,3-butadiene for four of the five Oklahoma sites, and shows the following:

- Hexachloro-1,3-butadiene was not identified as a pollutant of interest for OCOK, and thus, this site has no box plot in Figure 18-22. Note that the program-level first, second, and third quartiles for hexachloro-1,3-butadiene are zero and therefore not visible on the box plot.

- The ranges of hexachloro-1,3-butadiene concentrations measured at the Tulsa sites are similar to each other, with a slightly smaller the range measured at YUOK. However, non-detects make up the majority of concentrations measured at these sites.

- The annual average concentrations of hexachloro-1,3-butadiene for the three Tulsa sites are just slightly greater than the program-level average concentration, with the annual average for YUOK just slightly less than the program-level average. Less than 0.01 µg/m^3 separates these annual averages.

Figure 18-23. Program vs. Site-Specific Average Manganese (TSP) Concentration

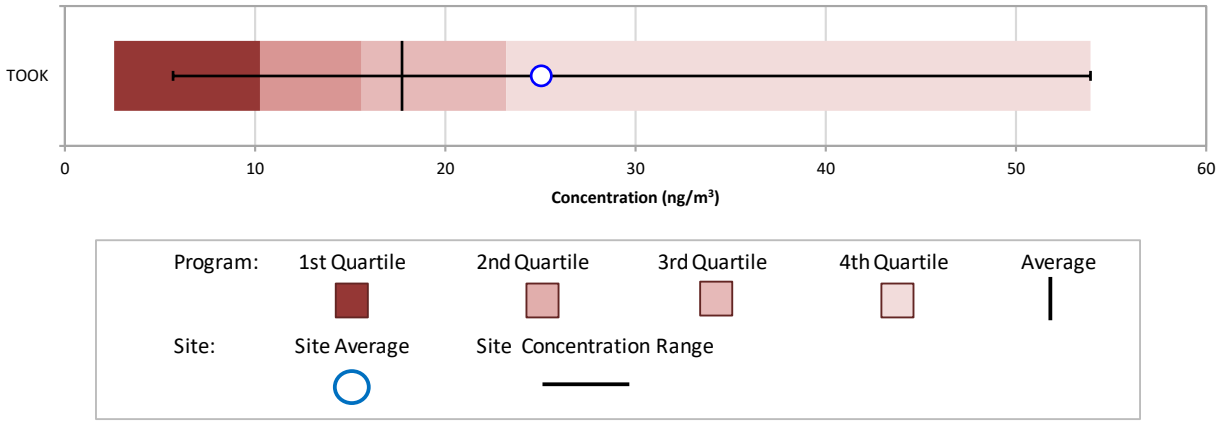


Figure 18-23 presents the box plot for manganese for TOOK and shows the following:

- TOOK is the only Oklahoma site for which manganese is a pollutant of interest. Because the Oklahoma sites are the only sites sampling TSP metals, Figure 18-23 compares the manganese concentrations measured at TOOK against the combined Oklahoma data.

- The maximum manganese concentration among the Oklahoma sites was measured at TOOK.

- The annual average manganese concentration for TOOK is greater than the program-level manganese concentration and third quartile (TSP only). A similar observations was made in the 2013 NMP report.

Figure 18-24. Program vs. Site-Specific Average Nickel (TSP) Concentrations

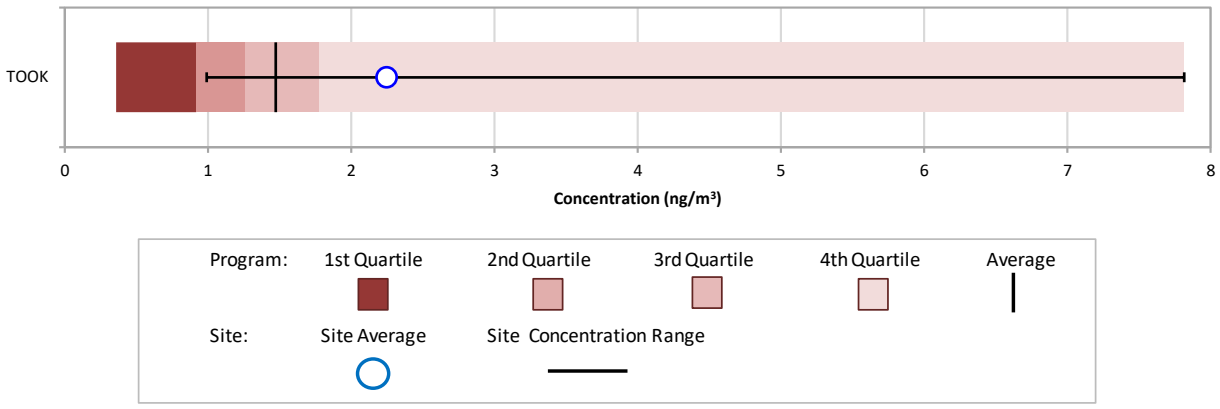


Figure 18-24 presents the box plot for nickel for TOOK and shows the following:

- Similar to manganese, TOOK is the only Oklahoma site for which nickel is a pollutant of interest. Because the Oklahoma sites are the only sites sampling TSP metals, Figure 18-24 compares the nickel concentrations measured at TOOK against the combined Oklahoma data. Note that the majority of concentrations

measured at the Oklahoma sites fall into a more compressed range for nickel than for manganese, as indicated by the first, second, and third quartiles in the box plot.

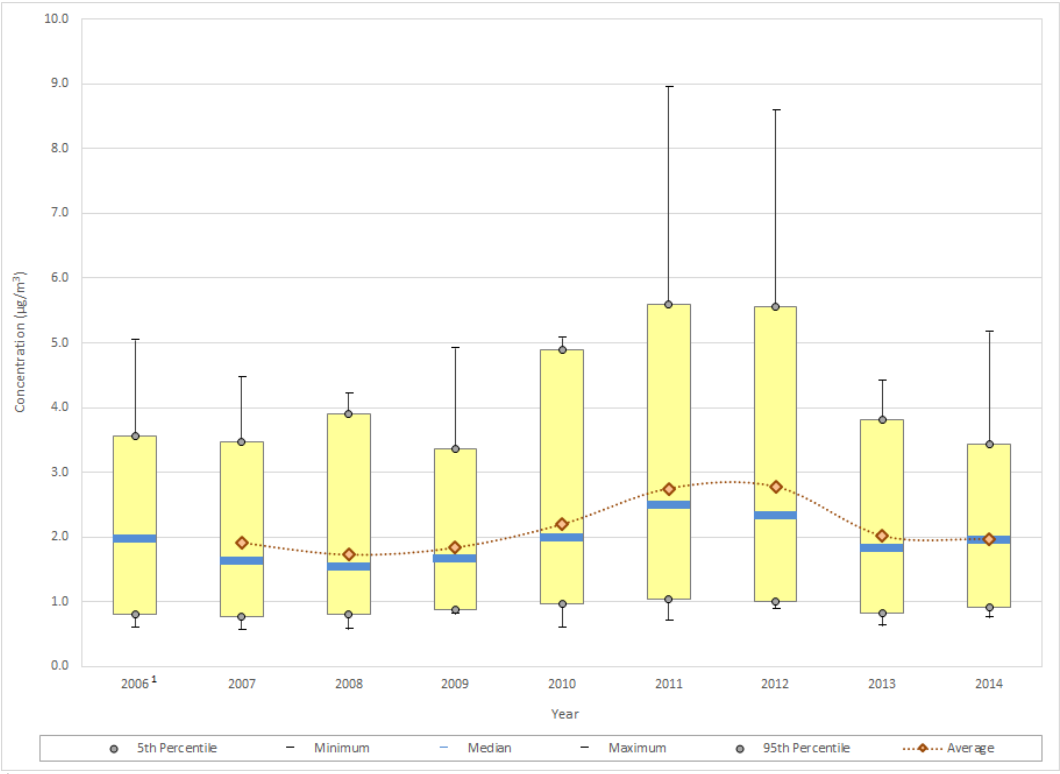
- The maximum nickel concentration among the Oklahoma sites was measured at TOOK. The minimum nickel concentration measured at TOOK is greater than the first quartile (TSP only).

- The annual average nickel concentration for TOOK is greater than the program-level nickel concentration and third quartile (TSP only).

18.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. TOOK has sampled TSP metals, carbonyl compounds, and VOCs under the NMP since 2006 and TMOK and OCOK have sampled these pollutants since 2009. Thus, Figures 18-25 through 18-53 present the 1-year statistical metrics for each of the pollutants of interest first for TOOK, followed by TMOK and OCOK. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 18-25. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-25 for acetaldehyde concentrations measured at TOOK include the following:

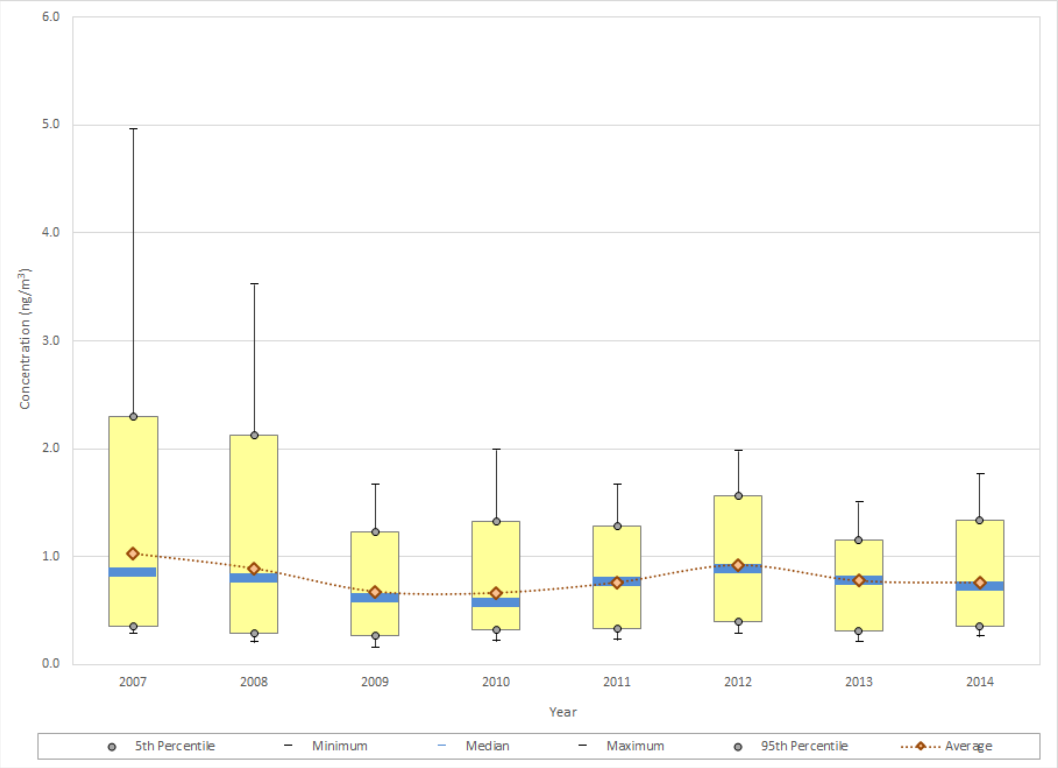
- Although TOOK began sampling carbonyl compounds under the NMP in January 2006, equipment complications at the onset of sampling resulted in a low completeness for 2006; thus, a 1-year average concentration is not presented for 2006, although the range of measurements is provided.

- The maximum concentration of acetaldehyde was measured in 2011 (8.95 µg/m^3), although a similar concentration was also measured in 2012 (8.59 µg/m^3). The 10 highest concentrations were all measured in 2011 or 2012. Of the 35 acetaldehyde concentrations greater than 4 µg/m^3 measured at TOOK, 12 were measured in 2012, eight were measured in 2011, five were measured in 2010, and three or fewer were measured in each of the other years.

- The statistical metrics exhibit an increasing trend between 2009 and 2011, with little change shown in the acetaldehyde measurements from 2011 to 2012. The 95th percentiles for 2011 and 2012 greater than the maximum concentrations measured prior to 2011. These are the only two years that the median acetaldehyde concentration is greater than 2 µg/m^3.

- A significant decrease in acetaldehyde concentrations is shown for 2013, with relatively little change in the central tendency shown for 2014.

Figure 18-26. Yearly Statistical Metrics for Arsenic (TSP) Concentrations Measured at TOOK



Observations from Figure 18-26 for arsenic (TSP) concentrations measured at TOOK include the following:

- Although TOOK began sampling TSP metals in 2006, sampling did not begin until October, which does not yield enough samples for the statistical metrics to be calculated; thus, Figure 18-26 excludes data from 2006 per the criteria specified in Section 3.4.3.2.

- The two highest concentrations of arsenic were measured at TOOK in September 2007 and are the only two concentrations greater than 4 ng/m^3 measured at TOOK. All eight concentrations of arsenic greater than 2 ng/m^3 were measured in either 2007 or 2008.

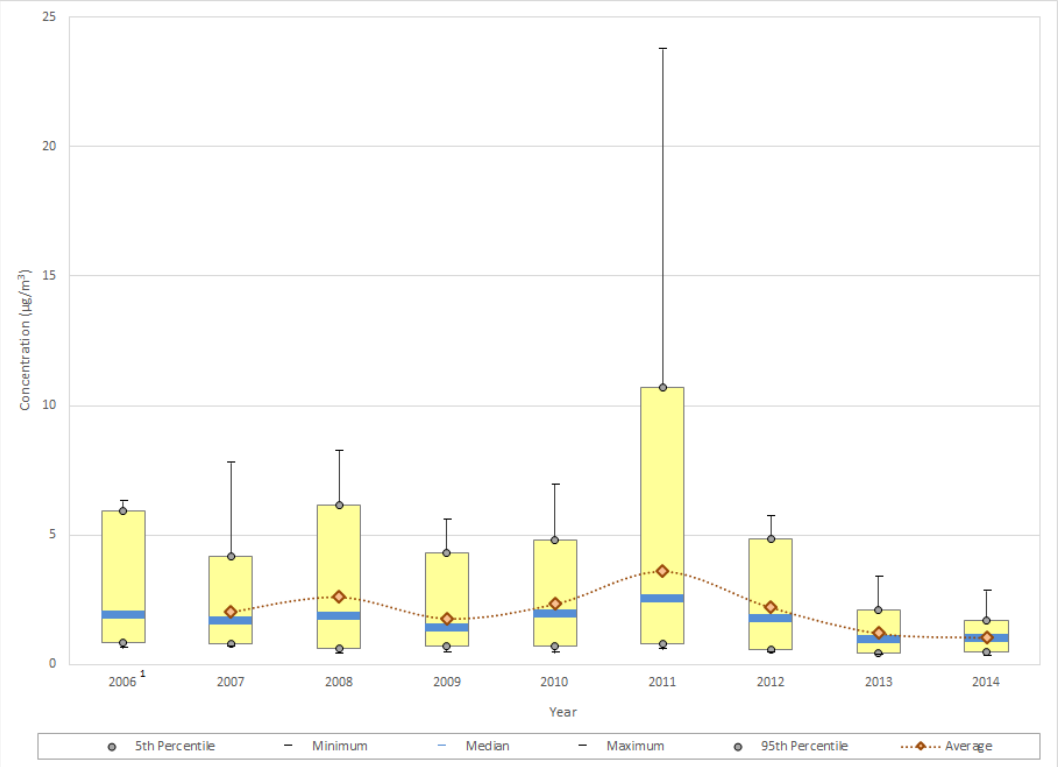
- The 1-year average and median concentrations exhibit a decreasing trend between 2007 and 2010, although the difference is relatively small between 2009 and 2010. The 1-year average and median concentrations increased for 2011, an increase that continued into 2012.

- All of the statistical parameters exhibit decreases from 2012 to 2013.

- Little change is shown in the central tendency statistics between 2013 and 2014 despite the higher concentrations measured in 2014. The additional concentrations at the upper end of the concentration range measured in 2014 (seven arsenic concentrations greater than 1.25 ng/m^3 were measured in 2014 compared to two in

2013) are countered by a higher number of measurements at the lower end of the concentration range (the number of arsenic concentrations less than 0.5 ng/m^3 doubled from 2013 (nine) to 2014 (18)).

Figure 18-27. Yearly Statistical Metrics for Benzene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-27 for benzene concentrations measured at TOOK include the following:

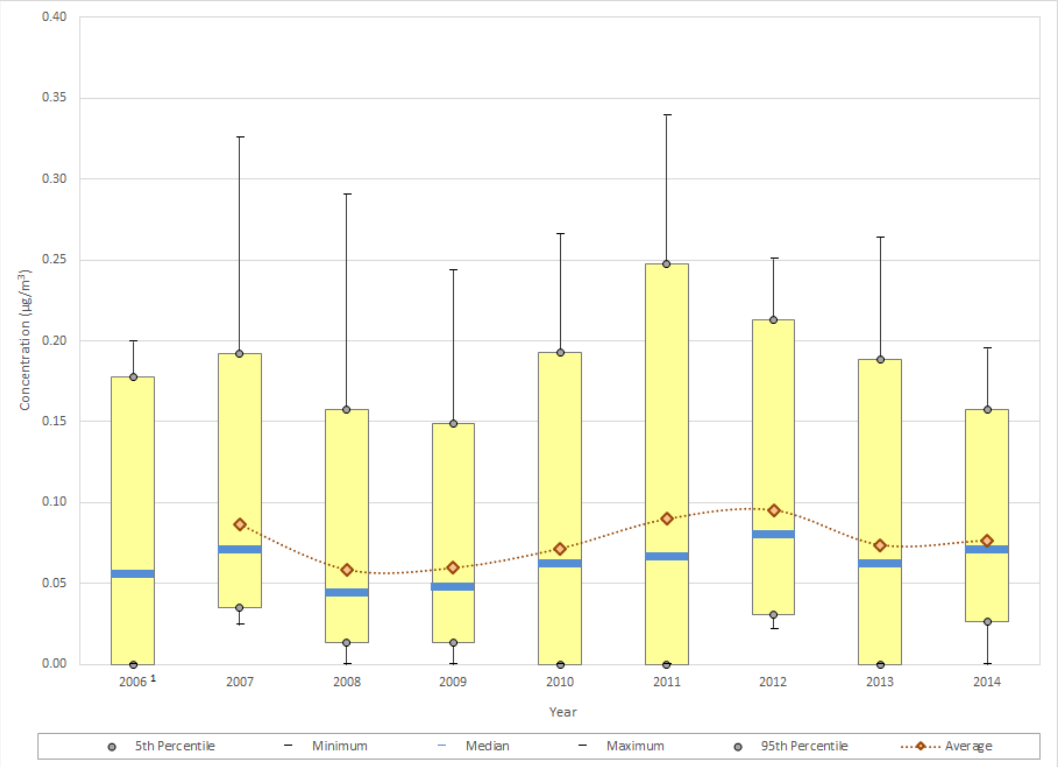
- Although TOOK began sampling VOCs under the NMP in January 2006, equipment complications at the onset of sampling resulted in a low completeness for 2006; thus, a 1-year average concentration is not presented for 2006, although the range of measurements is provided.

- The maximum concentration of benzene was measured at TOOK in 2011 (23.8 µg/m^3). All four of the benzene concentrations greater than 10 µg/m^3 were measured at TOOK in 2011. The 95th percentile for 2011 is greater than the maximum concentration for each of the other years shown.

- The 1-year average benzene concentration has fluctuated over the years. After a significant decrease from 2008 to 2009, an increasing trend through 2011 occurred. After 2011, a significant decrease trend in benzene concentrations is shown. Most of the statistical parameters are at a minimum for 2014 (with the exceptions calculated for 2013). The smallest range of benzene concentrations was measured in 2014, with

the maximum concentration measured in 2014 less than 3 µg/m^3 and the 95th percentile is less than 2 µg/m^3 for the first time since sampling began in 2006.

Figure 18-28. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-28 for 1,3-butadiene concentrations measured at TOOK include the following:

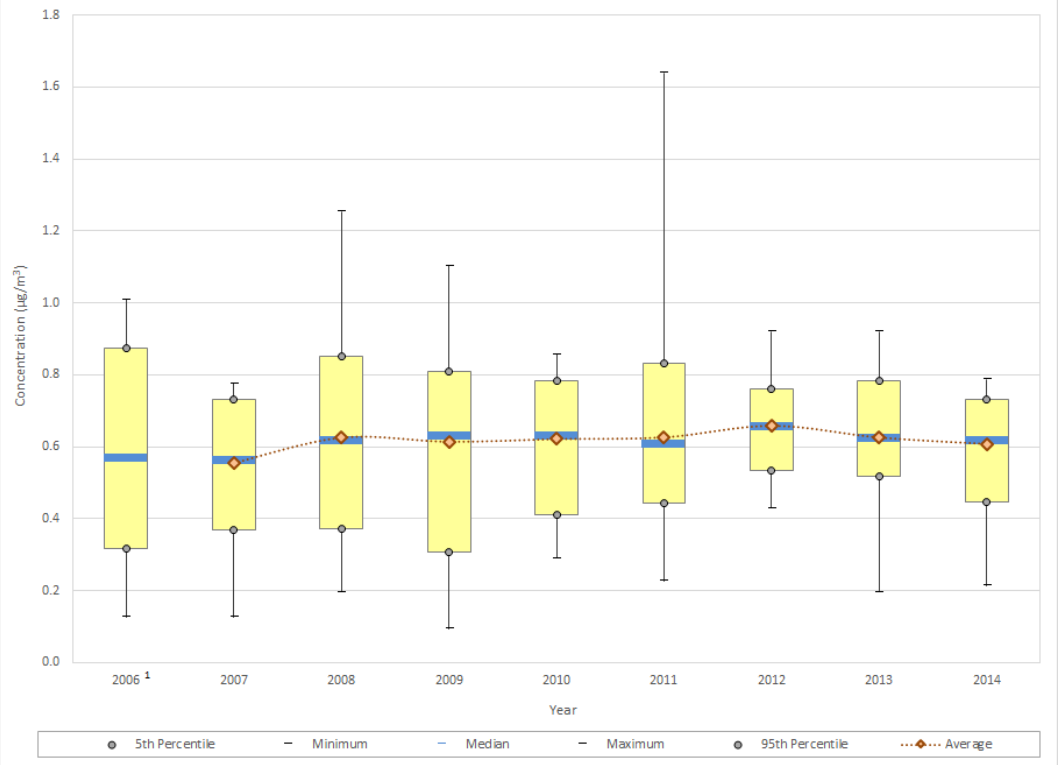
- The maximum concentration of 1,3-butadiene was measured in December 2011 (0.34 µg/m^3), although a similar concentration was also measured in 2007 (0.33 µg/m^3). Concentrations of 1,3-butadiene greater than 0.3 µg/m^3 have not been measured at TOOK.

- The minimum concentration for most years is zero, indicating the presence of non-detects. For 2006, 2010, 2011, and 2013, both the minimum concentration and 5th percentile are zero, indicating that more than one non-detect was measured during those years. The percentage of non-detects has ranged from zero (2007 and 2012) to 14 percent (2006).

- After an initial decrease from 2007 to 2008 and little change for 2009, the 1-year average concentration of 1,3-butadiene has an increasing trend through 2012. This is also true for the median concentration. Even though the maximum and 95th percentile decreased for 2012, both the 1-year average and median concentrations are at a maximum.

- With the exception of the maximum concentration, all of the statistical parameters exhibit decreases for 2013. Additional decreases are shown for 2014 for the statistical parameters representing the upper end of the concentration range while other statistical parameters exhibit increases.

Figure 18-29. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-29 for carbon tetrachloride concentrations measured at TOOK include the following:

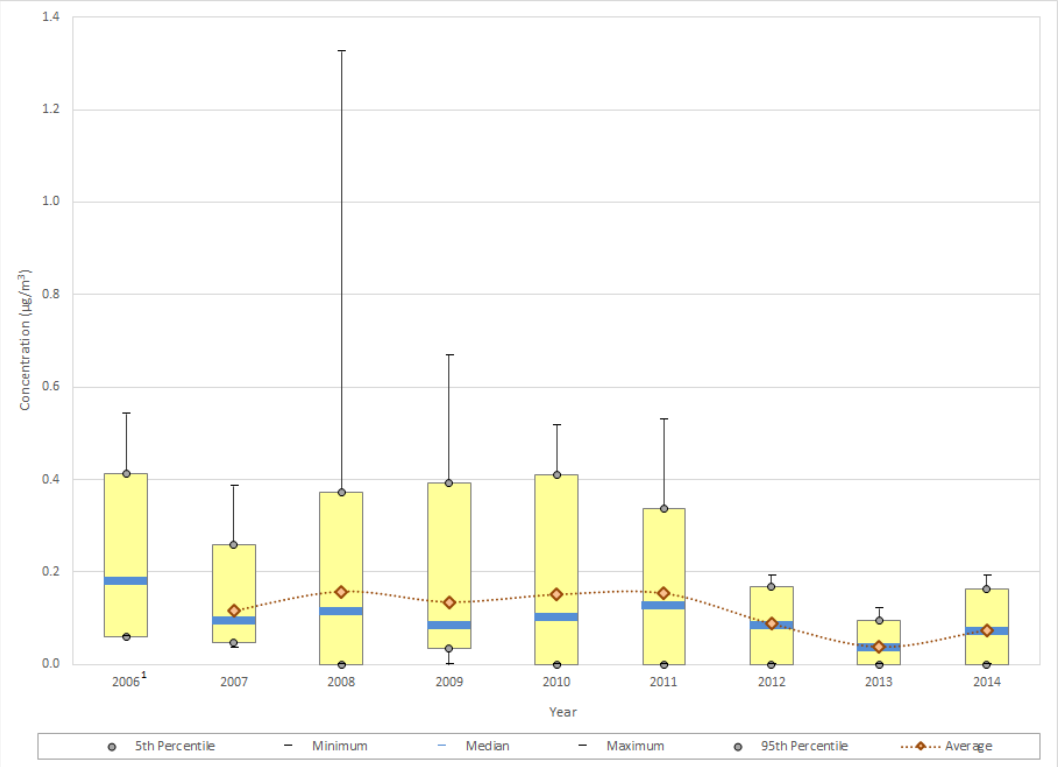
- Similar to other compounds, the maximum concentration of carbon tetrachloride was measured in 2011 (1.64 µg/m^3). Four additional concentrations greater than 1 µg/m^3 have been measured at TOOK.

- With the exception of 2011, the range of carbon tetrachloride measurements spans approximately 1 µg/m^3 or less. The range of measurements is at a minimum for 2012, when the difference between the minimum and maximum concentrations is less than 0.5 µg/m^3.

- The 1-year average concentration increased slightly from 2007 to 2008, after which little change is shown through 2011. Between 2008 and 2011, the 1-year average concentrations range from 0.61 µg/m^3 to 0.63 µg/m^3. A slight increase is shown for 2012 (0.66 µg/m^3), even though the measurements for this year exhibit the least variability. After 2012, the 1-year average concentration of carbon tetrachloride

returned to previous levels. Across the years of sampling, the 1-year average (and median concentrations) have varied by only about 0.10 µg/m^3.

Figure 18-30. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-30 for *p*-dichlorobenzene concentrations measured at TOOK include the following:

- The maximum *p*-dichlorobenzene concentration was measured at TOOK on October 9, 2008 (1.33 µg/m^3) and is twice the next highest concentration (0.669 µg/m^3, measured in 2009). Only four additional *p*-dichlorobenzene concentrations greater than 0.5 µg/m^3 have been measured at TOOK.

- The increase in the 1-year average concentration from 2007 to 2008 is not solely a result of the outlier concentration measured in 2008. The range within which the majority of concentrations lie expanded, nearly doubling from 2007 to 2008, with additional concentrations measured at the both ends of the concentration range.

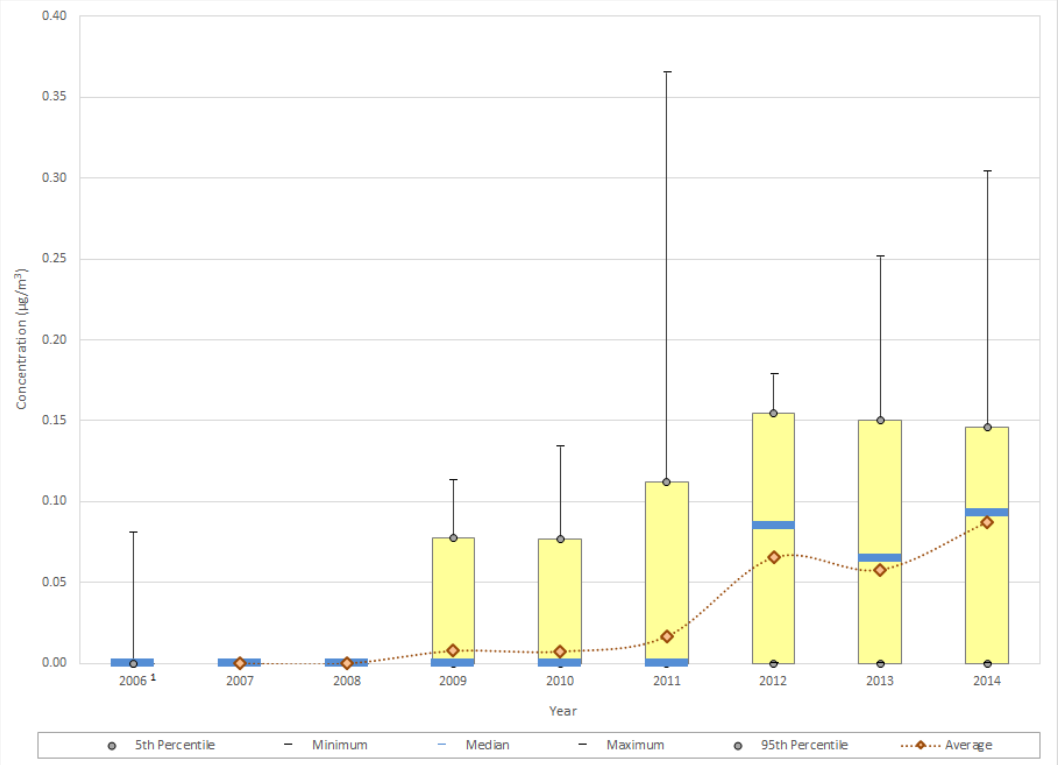
- Between 2008 and 2011, most of the concentrations measured at TOOK fell into a similar range and the 1-year average concentration did not vary significantly (although there is a little more variability in the median concentrations).

- After 2011, concentrations of *p*-dichlorobenzene decreased significantly. Concentrations greater than 0.2 µg/m^3 were not measured in 2012 or afterward. Aside

from the minimum and 5th percentile, all of the statistical metrics are at a minimum for 2013. There is relatively little difference in the *p*-dichlorobenzene concentrations measured in 2012 and 2014.

- There were no non-detects of *p*-dichlorobenzene measured in 2006 or 2007. The minimum concentration and 5th percentile are zero for most years after 2007, indicating the presence of non-detects. Between 2008 and 2012, the number of non-detects measured each year ranges from two (2009) to six (2010, 2011, and 2012). The number of non-detects increased four-fold for 2013 (24) then decreases to 11 for 2014.

Figure 18-31. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at TOOK



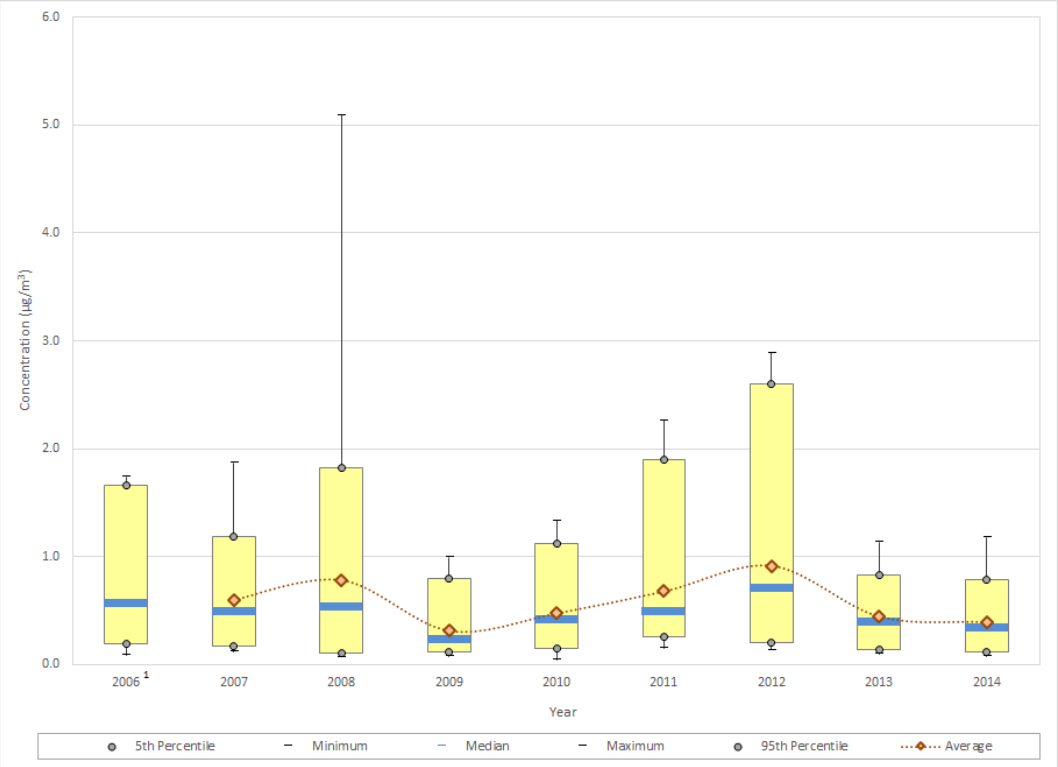
[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-31 for 1,2-dichloroethane concentrations measured at TOOK include the following:

- The median concentration for all years through 2011 is zero, indicating that at least half of the measurements were non-detects. In 2006, there was one measured detection of 1,2-dichloroethane. In 2007 and 2008, there were none. Between 2009 and 2011, the number of measured detections varied from five to six. The number of measured detections increased significantly for 2012, up from six in 2011 to 38 in 2012. Greater than 30 measured detections were measured in 2013, and in 2014, there were 50 measured detections, the most of any year since the onset of sampling.

- The 1-year average concentration for 2012 is less than the median concentration, which is a little unusual. The 1-year average concentration is more susceptible to outliers (on either end of the concentration range) than the median concentration, which represents the midpoint of a group of measurements. The 1-year average concentration for 2012 is less than the median, indicating that concentrations on the lower end of the concentration range (the many zeroes representing non-detects) are pulling the average down (just like a maximum or outlier concentration can drive the average upward). This is also true for 2013 and 2014, although the difference between the two statistical parameters is less.

Figure 18-32. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-32 for ethylbenzene concentrations measured at TOOK include the following:

- The two highest concentrations of ethylbenzene were both measured during the summer of 2008 (5.09 µg/m^3 and 4.57 µg/m^3). No other ethylbenzene concentrations greater than 3 µg/m^3 have been measured at TOOK since the onset of sampling. The next five highest concentrations, those between 2.50 µg/m^3 and 3 µg/m^3, were all measured at TOOK in 2012.

- The maximum, 95th percentile, and 1-year average concentrations exhibit increases from 2007 to 2008; the median also increased, although slightly. Even if the two highest concentrations measured in 2008 were excluded from the dataset, the 1-year average concentration would still exhibit a slight increase. A review of the data shows

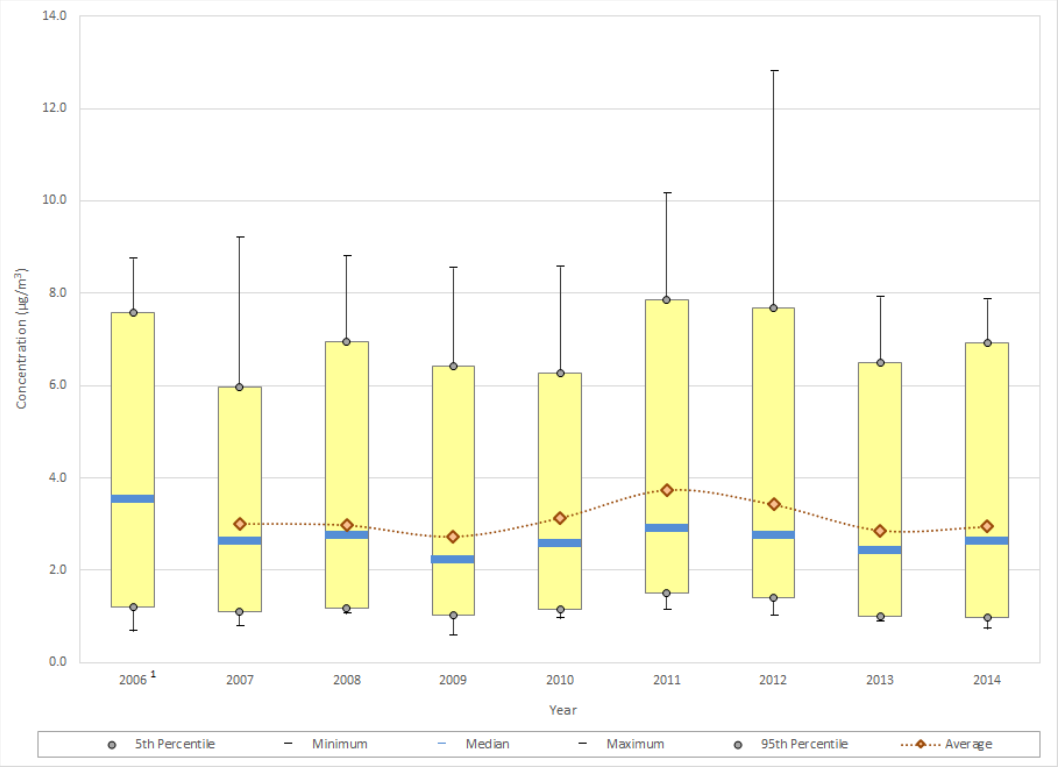
that the number of ethylbenzene concentrations greater than 1 µg/m^3 nearly doubled from 2007 (7) to 2008 (13).

- There were no ethylbenzene concentrations greater than 1 µg/m^3 measured at TOOK in 2009. Both the 1-year average and median concentrations are at a minimum for 2009, both decreasing by more than half from 2008 to 2009.

- After 2009, concentrations of ethylbenzene measured at TOOK exhibit a significant increasing trend through 2012. The 95th percentile, 1-year average concentration, and the median concentration are all at a maximum for 2012. The 95th percentile for 2012 is greater than the maximum concentration for all other years except 2008. The 1-year average concentration for 2012 is approaching 1 µg/m^3.

- Ethylbenzene concentrations measured in 2013 decreased significantly from 2012, with all of the statistical parameters exhibiting decreases, including the 1-year average concentration, which decreased by more than half. Most of the statistical parameters exhibit additional decreases for 2014, albeit slight decreases.

Figure 18-33. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-33 for formaldehyde concentrations measured at TOOK include the following:

- The maximum concentration of formaldehyde (12.8 µg/m^3) was measured at TOOK on June 26, 2012. Only one other measurement greater than 10 µg/m^3 has been measured at TOOK (10.2 µg/m^3 measured in 2011).

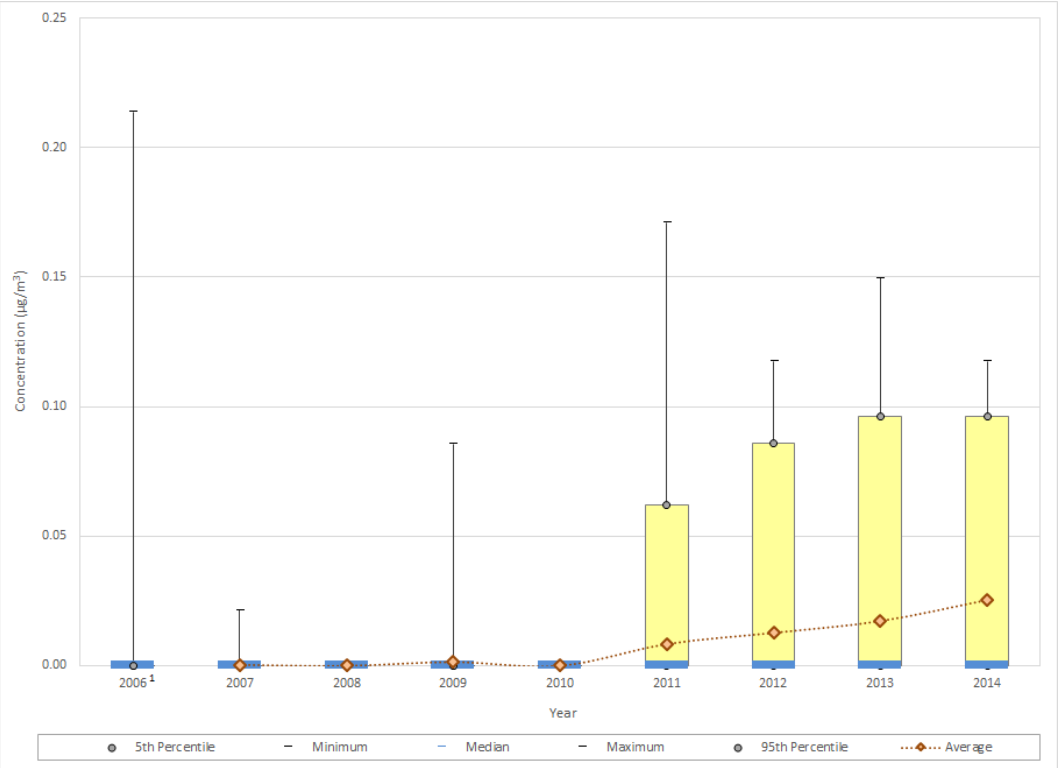
- All 84 formaldehyde concentrations greater than 5 µg/m^3 were measured at TOOK during the second and third quarters, particularly the period between June and August (accounting for 72 concentrations), regardless of year.

- The trends graph for formaldehyde resembles the graph for acetaldehyde, with an increasing trend in the 1-year average concentration shown for formaldehyde between 2009 and 2011. The 1-year average increased by 1 µg/m^3 over this period (with increases exhibited by the median concentration as well).

- Even though the maximum formaldehyde concentration was measured in 2012, all of the other statistical parameters exhibit slight decreases. Further decreases are shown for all of the statistical parameters for 2013.

- The range of formaldehyde concentrations measured at TOOK in 2014 is similar to those measured in 2013, with subtle changes in the 1-year average and median concentrations.

Figure 18-34. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at TOOK



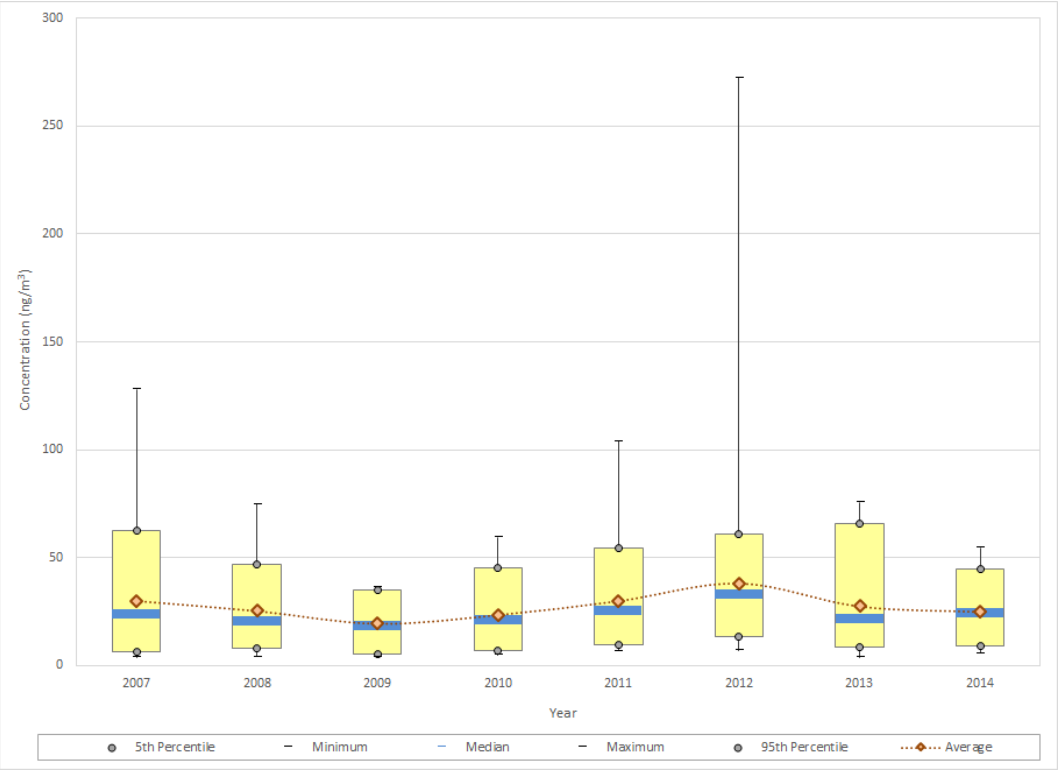
[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-34 for hexachloro-1,3-butadiene concentrations measured at TOOK include the following:

- The trends graphs for hexachloro-1,3-butadiene resembles the trends graph for 1,2-dichloroethane in that there were few measured detections in the first several years of sampling at TOOK.

- The median concentration is zero for all years of sampling, indicating that at least half of the measurements were non-detects for each year. Between 2006 and 2010, there were a total of four measured detections. In 2011, five measured detections were reported. This number doubled for 2012, increased to 13 for 2013, and is at a maximum for 2014 (19).

Figure 18-35. Yearly Statistical Metrics for Manganese (TSP) Concentrations Measured at TOOK



Observations from Figure 18-35 for manganese (TSP) concentrations measured at TOOK include the following:

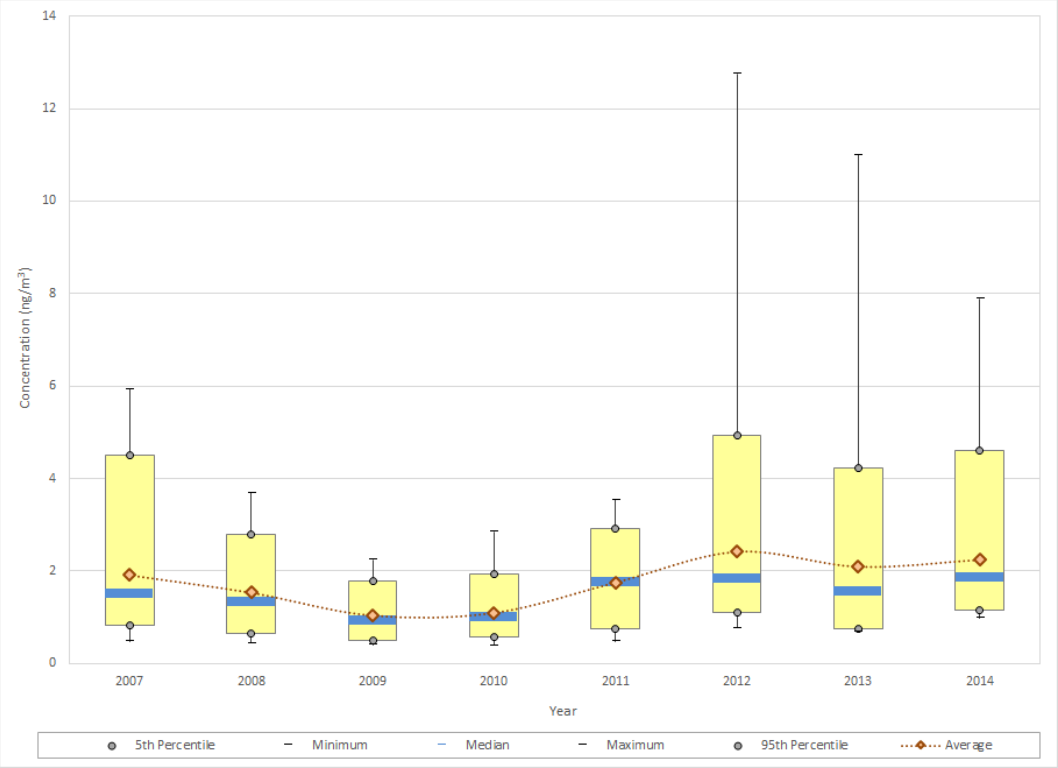
- The maximum concentration of manganese was measured in 2012 (273 ng/m^3), on the day of a dust storm (October 18, 2012). Measurements greater than 100 ng/m^3 were also measured in 2007 (128 ng/m^3) and 2011 (104 ng/m^3).

- A decreasing trend in the concentrations is shown through 2009, which was followed by an increasing trend through 2012. Even if the maximum concentration measured in 2012 was excluded from the calculations, the 1-year average and median concentrations would still exhibit an increasing trend for 2012. This is because there were more concentrations at the upper end of the concentration range for 2012 (the number of manganese measurements greater than 50 ng/m^3 increased from four in 2011 to 12 in 2012) as well as fewer concentrations at the lower end of the concentration range (the number of manganese measurements less than 20 ng/m^3 decreased from 17 in 2011 to 11 in 2012).

- With the exception of the 95th percentile, all of the statistical parameters exhibit decreases from 2012 to 2013. Both the 1-year average and median concentrations of manganese decreased by more than 10 ng/m^3 from 2012 to 2013.

- The range of concentrations measured in 2014 is among the smallest measured at TOOK. The 1-year average and median concentrations vary by less than 1 ng/m^3 for 2014, indicating less variability in the manganese concentrations measured in 2014.

Figure 18-36. Yearly Statistical Metrics for Nickel (TSP) Concentrations Measured at TOOK



Observations from Figure 18-36 for nickel (TSP) concentrations measured at TOOK include the following:

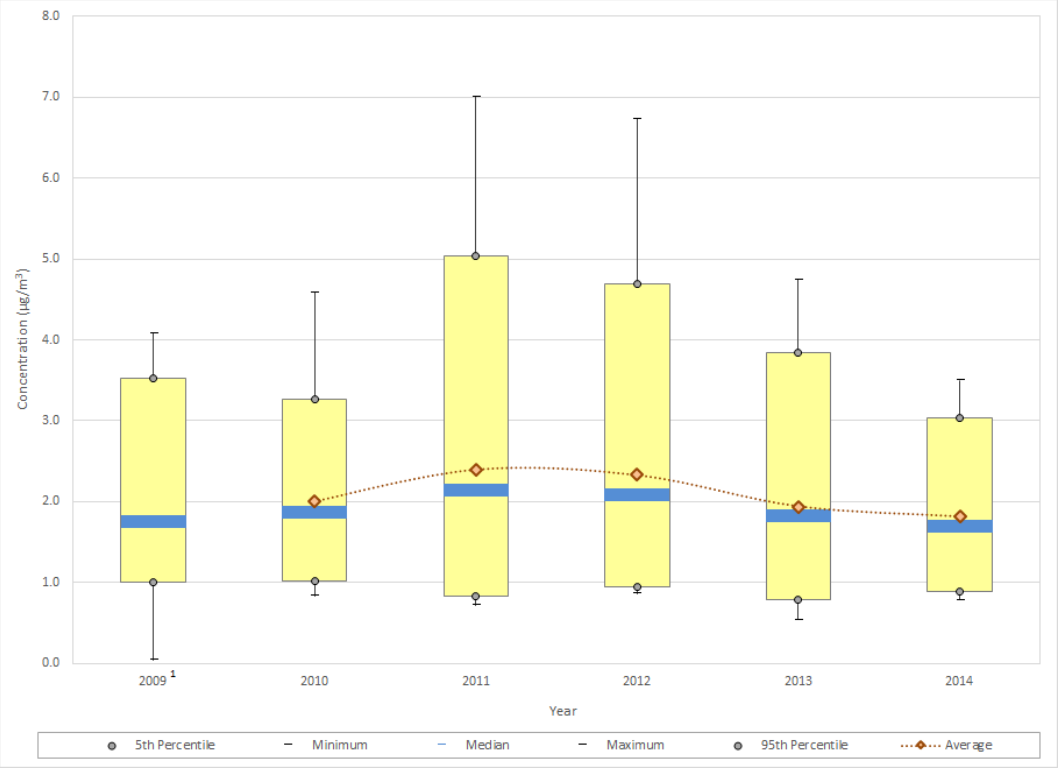
- The trends graph for nickel resembles the trends graph for manganese in several ways.

- The maximum concentration of nickel (12.8 ng/m^3) was measured at TOOK on the same day as the maximum concentration of manganese (October 18, 2012, the day of a dust storm). Only one additional nickel concentrations greater than 10 ng/m^3 has been measured at TOOK (11.0 ng/m^3 measured on July 3, 2013). Eight of the 10 nickel concentrations greater than 5 ng/m^3 were measured at TOOK in either 2012 or later (with the two exceptions measured in 2007).

- A significant decreasing trend in the nickel concentrations measured at TOOK is shown through 2009. A slight increase is shown for 2010, which was followed by significant increases for 2011 and 2012. The minimum concentration shown for 2012 is greater than the 5th percentile for the four previous years.

- With the exception of the maximum concentration, the statistical metrics shown for 2012 through 2014 more closely resemble those shown for 2007 than the years in-between.

Figure 18-37. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-37 for acetaldehyde concentrations measured at TMOK include the following:

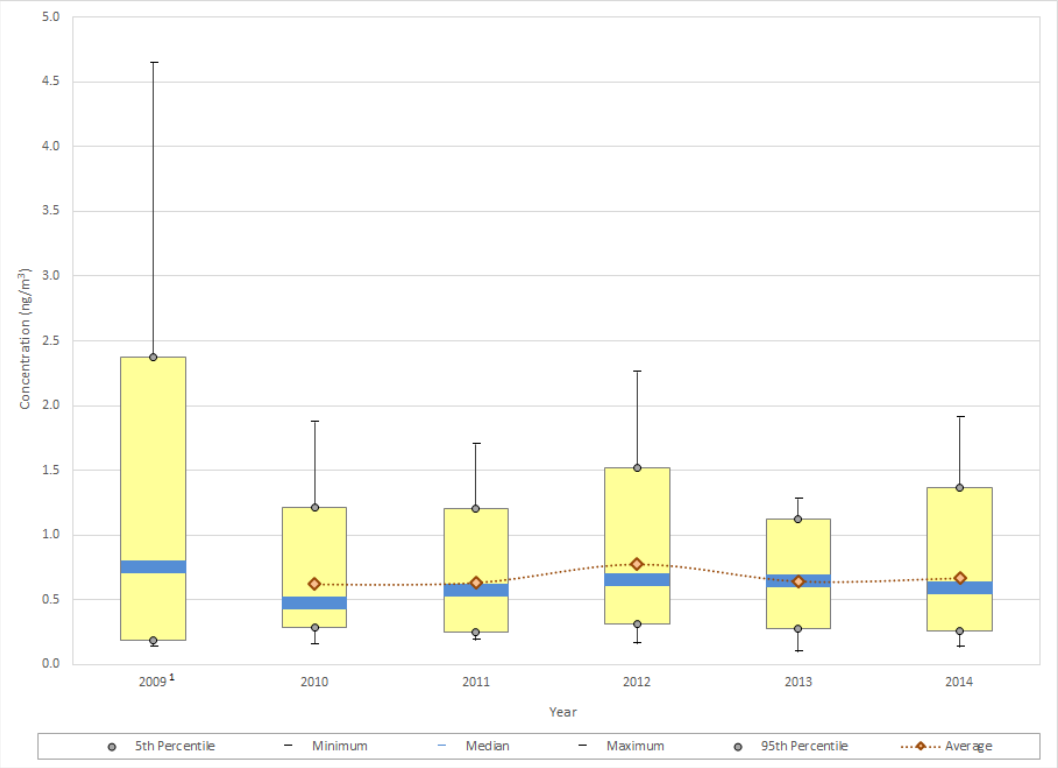
- Sampling for carbonyl compounds began at TMOK under the NMP in April 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum acetaldehyde concentration (7.00 µg/m^3) was measured at TMOK on August 19, 2011. All seven acetaldehyde concentrations greater than 5 µg/m^3 were measured in either 2011 or 2012.

- The range of acetaldehyde concentrations measured increased considerably from 2010 to 2011, after which the range of measurements has decreased each year.

- A decreasing trend is shown in the 1-year average and median concentrations between 2011 and 2014, with many of the statistical parameters at a minimum for 2014.

Figure 18-38. Yearly Statistical Metrics for Arsenic (TSP) Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-38 for arsenic (TSP) concentrations measured at TMOK include the following:

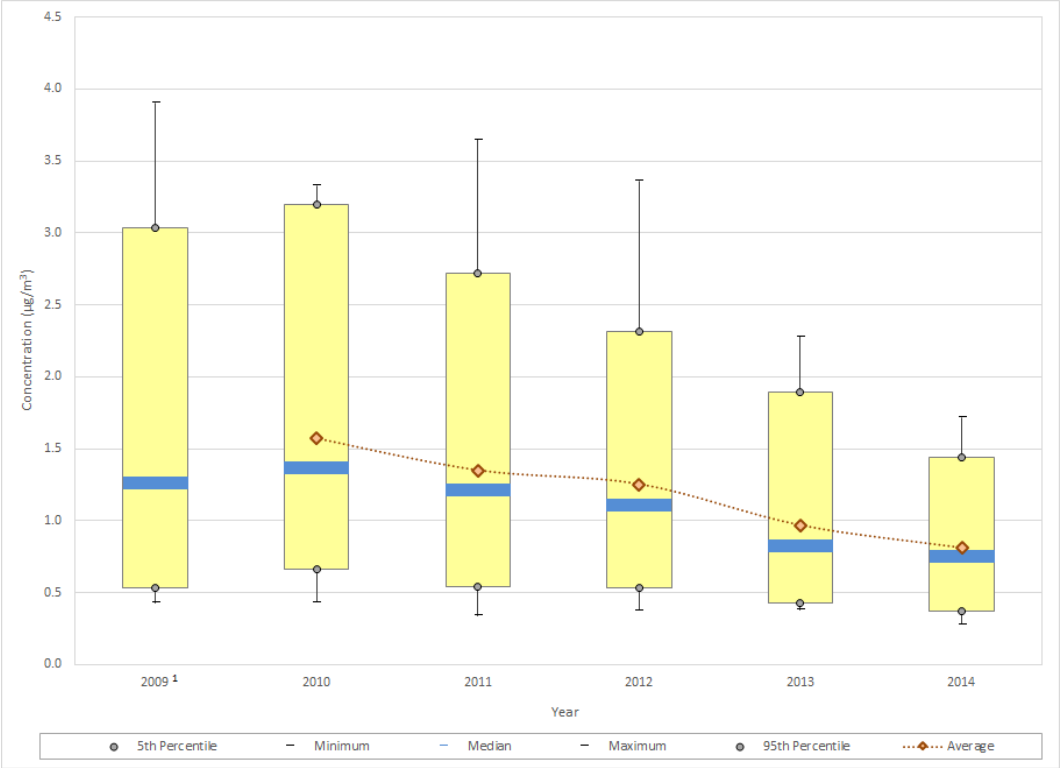
- Sampling for TSP metals began at TMOK under the NMP in April 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The three highest arsenic concentrations measured at TMOK were all measured in 2009, and all but one of the six arsenic concentrations greater than 2 ng/m^3 were measured in 2009. The entire range of concentrations measured in other years is less than the 95th percentile for 2009 and the median concentration is at a maximum for 2009.

- With the exception of 2012, the 1-year average concentrations vary between 0.6 ng/m^3 and 0.7 ng/m^3. Most of the statistical parameters exhibit increases for 2012 as the number of arsenic concentrations greater than 1 ng/m^3 in 2012 (15) is more than double the number measured in each of the previous years, with the exception of 2009 (16).

- Excluding 2009, the statistical metrics for arsenic concentrations measured at TMOK resemble those shown in Figure 18-26 for TOOK.

Figure 18-39. Yearly Statistical Metrics for Benzene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

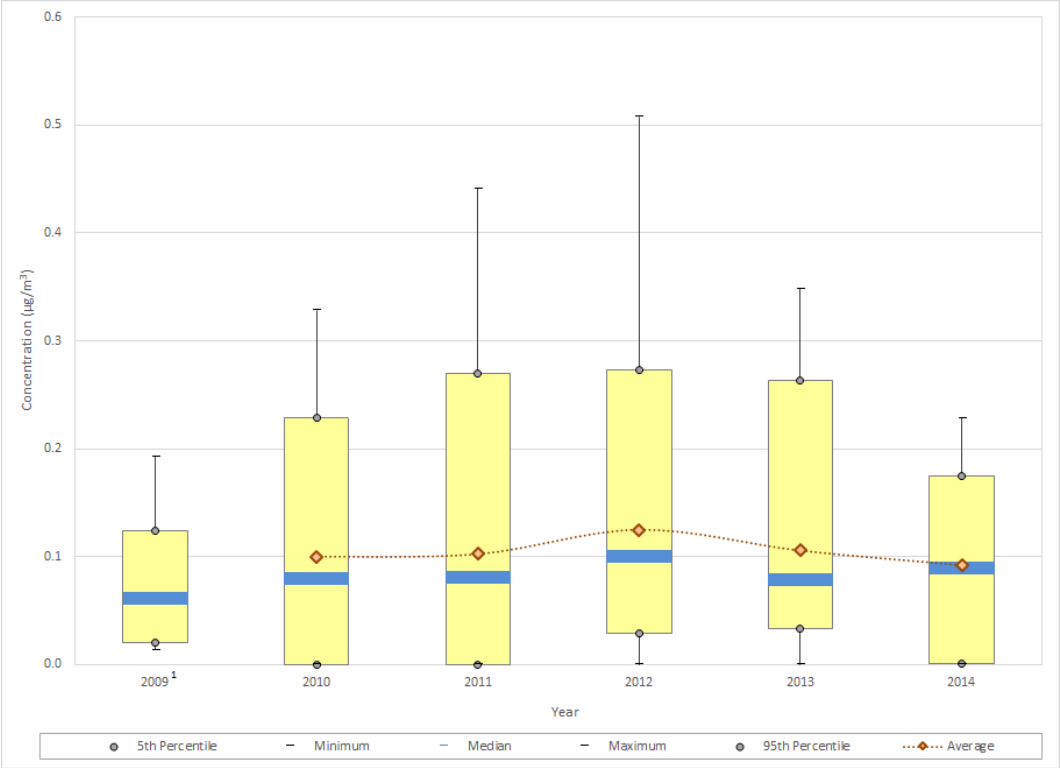
Observations from Figure 18-39 for benzene concentrations measured at TMOK include the following:

- Sampling for VOCs began at TMOK under the NMP in April 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum benzene concentration (3.91 µg/m^3) was measured at TMOK on May 7, 2009, although benzene concentrations greater than 3 µg/m^3 have been measured in all years of sampling prior to 2013.

- The 1-year average and median benzene concentrations have a significant decreasing trend between 2010 and 2014, with the largest decrease shown for 2013. The 1-year average and median concentrations have both decreased by half since the onset of sampling. The maximum concentration measured in 2014 is less than the 95th percentile for the previous year of sampling. This is also true for 2013.

Figure 18-40. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

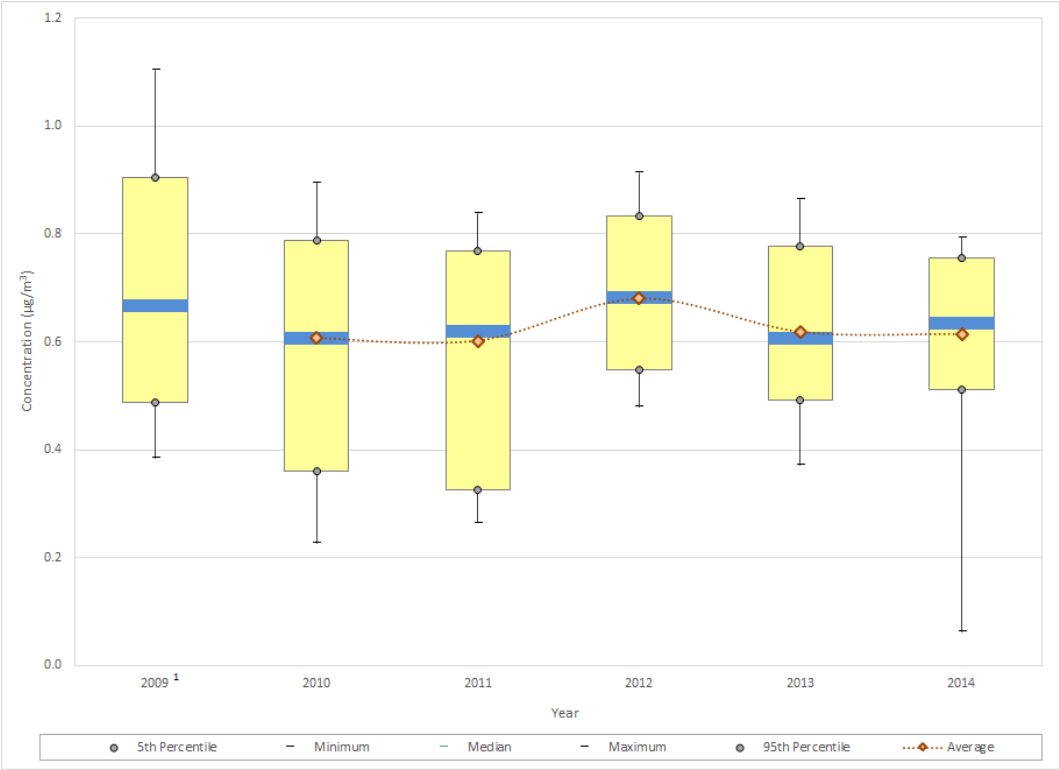
Observations from Figure 18-40 for 1,3-butadiene concentrations measured at TMOK include the following:

- The range of 1,3-butadiene concentrations measured at TMOK is at a minimum for 2009, with all concentrations measured spanning less than 0.2 µg/m^3, with the range of concentrations measured increasing each year through 2012. After 2012, the range of measurements decreases each year.

- Despite the differences in the concentrations measured, less than 0.04 µg/m^3 separates the 1-year average concentrations across the years shown, which range from 0.09 µg/m^3 (2014) to 0.13 µg/m^3 (2012).

- The number of non-detects has varied across the years of sampling, from a few as none (2009) to as many as nine (2011).

Figure 18-41. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-41 for carbon tetrachloride concentrations measured at TMOK include the following:

- The maximum carbon tetrachloride concentration was measured on August 17, 2009 and is the only concentration greater than 1 µg/m^3 measured at TMOK.

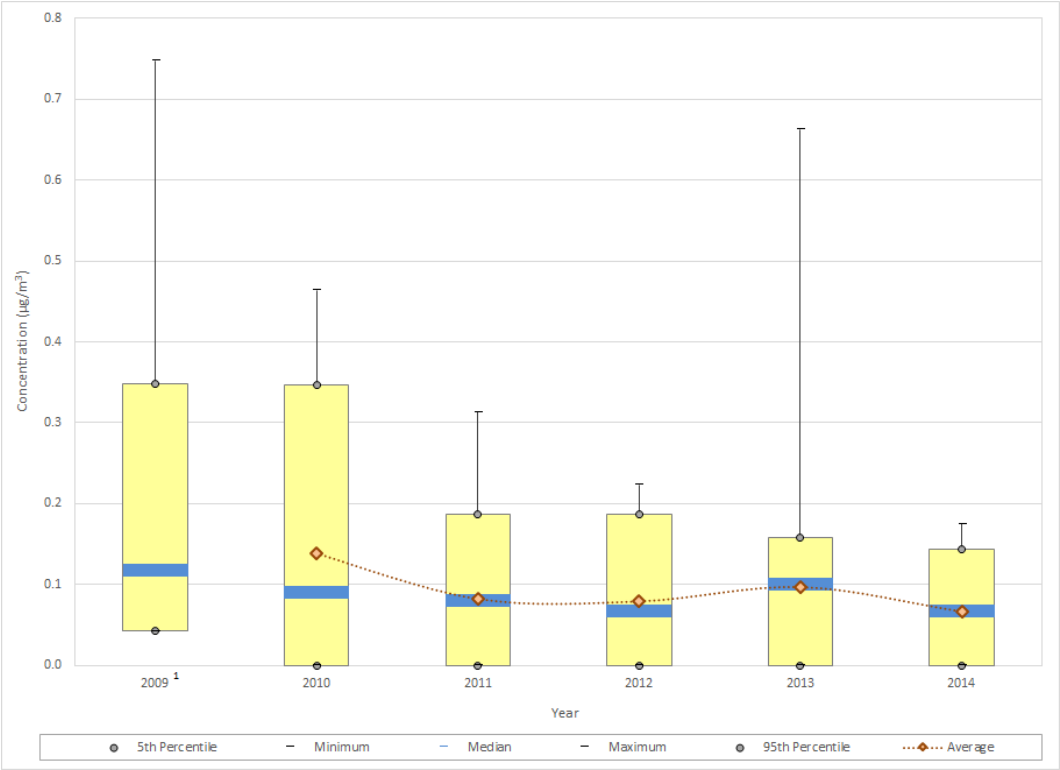
- All of the statistical parameters exhibit decreases from 2009 to 2010, with little change in the carbon tetrachloride measurements at TMOK shown from 2010 to 2011.

- All of the statistical parameters exhibit increases for 2012, despite the compressed range of concentrations measured. The highest number of carbon tetrachloride concentrations greater than 0.6 µg/m^3 was measured in 2012, accounting for 51 of the 61 measurements (compared to between 30 and 40 for each of the other years shown).

- All of the statistical parameters exhibit decreases from 2012 to 2013, with several parameters exhibiting additional decreases for 2014. The minimum concentration shown for 2014 is the third-lowest carbon tetrachloride concentration measured across the program in 2014.

- All of the 1-year average carbon tetrachloride concentrations shown fall between 0.60 µg/m^3 and 0.70 µg/m^3. This is also true for the median concentration.

Figure 18-42. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-42 for *p*-dichlorobenzene concentrations measured at TMOK include the following:

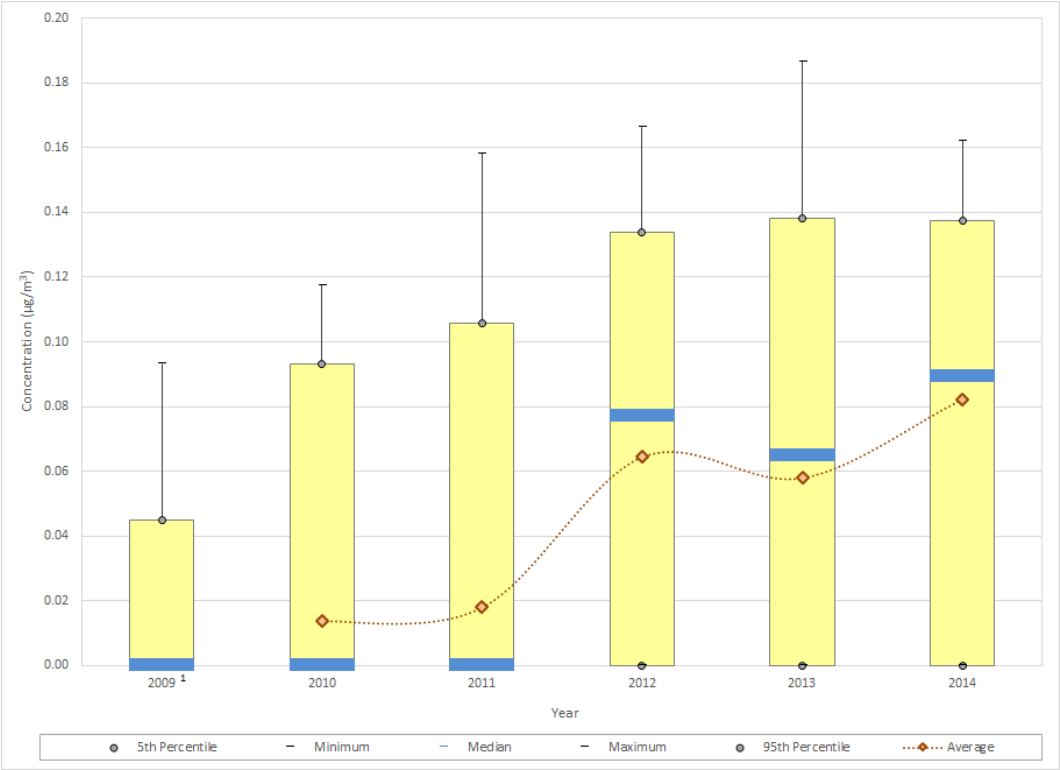
- The maximum *p*-dichlorobenzene concentration was measured on June 30, 2009 (0.747 µg/m^3). Only one additional concentration greater than 0.5 µg/m^3 has been measured at TMOK (0.663 µg/m^3, measured in 2013).

- A decreasing trend in the concentrations of *p*-dichlorobenzene is shown through 2012. The median decreases by almost half during this period and 1-year average concentration decreased significantly from 2010 to 2011 with little change shown from 2011 to 2012.

- The increase in the 1-year average concentration shown for 2013 is not solely attributable to the maximum concentration measured that year, as the median concentration, which is less influenced by outliers, exhibits a similar increase. The number of concentrations greater than 0.1 µg/m^3 nearly doubled from 2012 (16) to 2013 (30).

- The decreasing trend in *p*-dichlorobenzene concentrations measured at TMOK shown prior to 2013 resumes in 2014.

Figure 18-43. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at TMOK



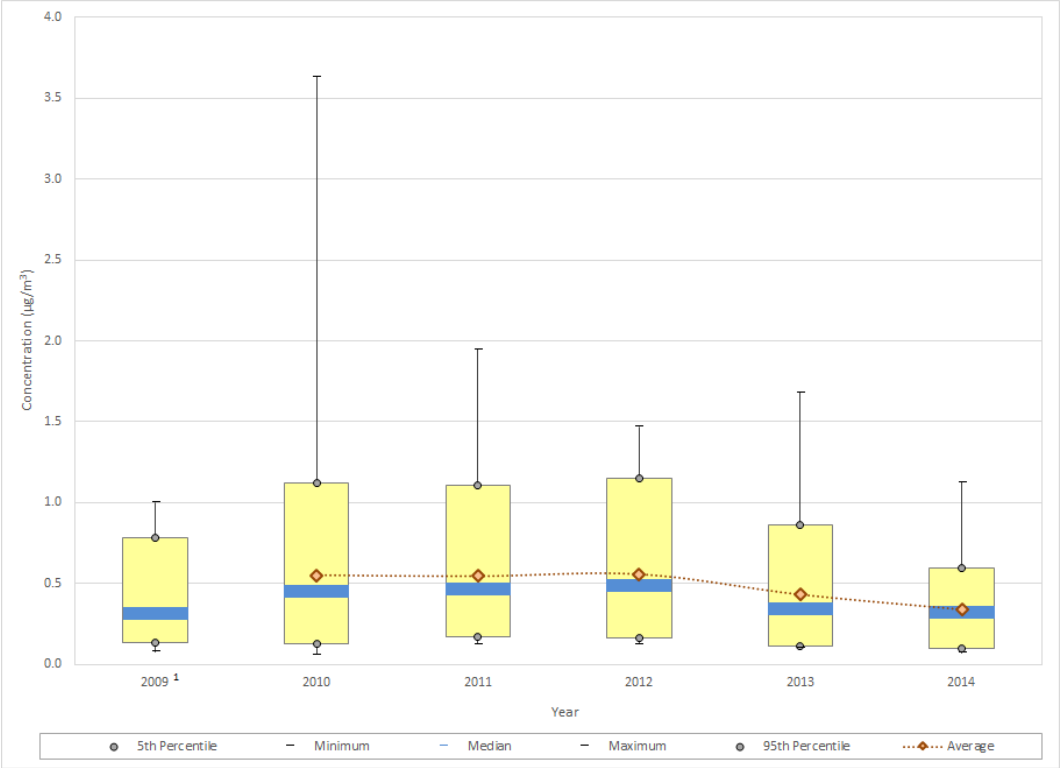
[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-43 for 1,2-dichloroethane concentrations measured at TMOK include the following:

- The minimum, 5th percentile, and median concentrations for 2009, 2010, and 2011 are zero, indicating that at least half of the measurements were non-detects. In 2009, there were three measured detections of 1,2-dichloroethane. In 2010 and 2011, there were 10 each year. For 2012, the number of measured detections increased by a factor of four and the median concentration is greater than zero for the first time. Measured detections also accounted for more than half of measurements in 2013. In 2014, measured detections account for 53 of the 62 valid samples collected, representing an 85 percent detection rate.

- The 1-year average concentration is more susceptible to outliers (on either end of the concentration range) than the median concentration. The 1-year average concentration for each year after 2012 is less than the median, indicating that concentrations on the lower end of the concentration range are pulling the 1-year average downward (just like a maximum or outlier concentration can drive the average upward).

Figure 18-44. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

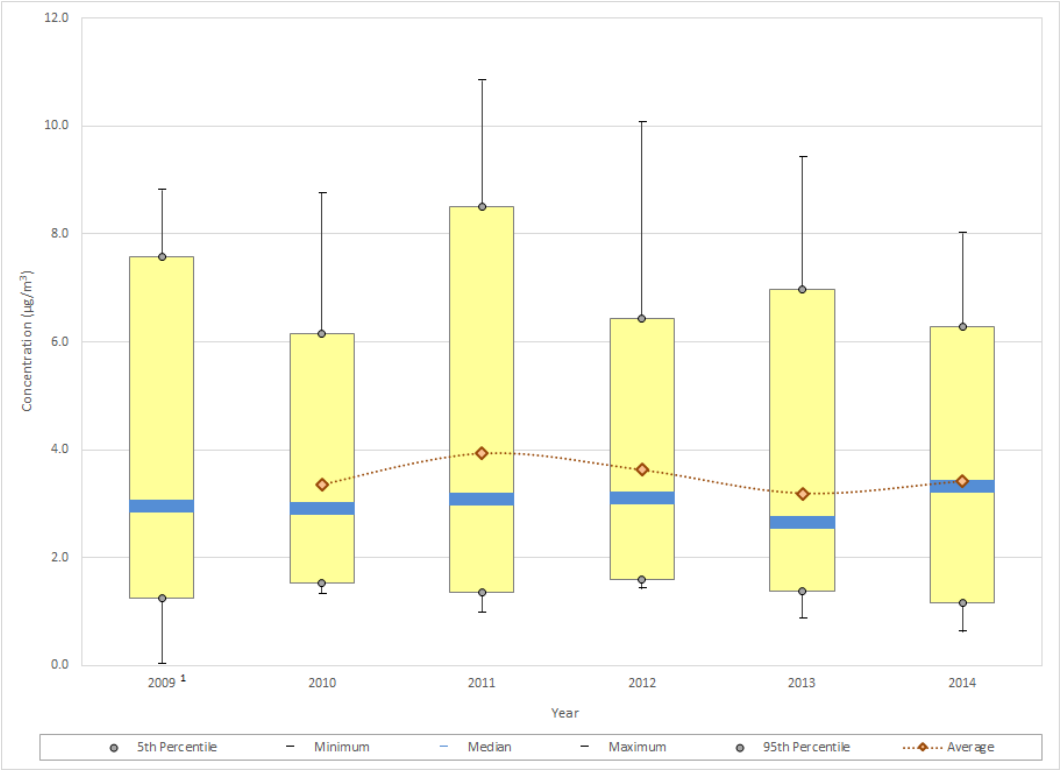
Observations from Figure 18-44 for ethylbenzene concentrations measured at TMOK include the following:

- The maximum ethylbenzene concentration was measured in 2010 (3.63 µg/m^3) and is the only measurement greater than 2 µg/m^3 measured at TMOK.

- Despite the decrease in the maximum concentrations shown between 2010 and 2012, little change is shown for most of the statistical parameters. Less than 0.05 µg/m^3 separates the median concentrations for these years and approximately 0.01 µg/m^3 separates the 1-year average concentrations during this period.

- With the exception of the maximum concentration, all of the statistical parameters exhibit decreases for 2013. These decreases continue into 2014, with the 1-year average concentration at a minimum (and less than 0.4 µg/m^3 for the first time).

Figure 18-45. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

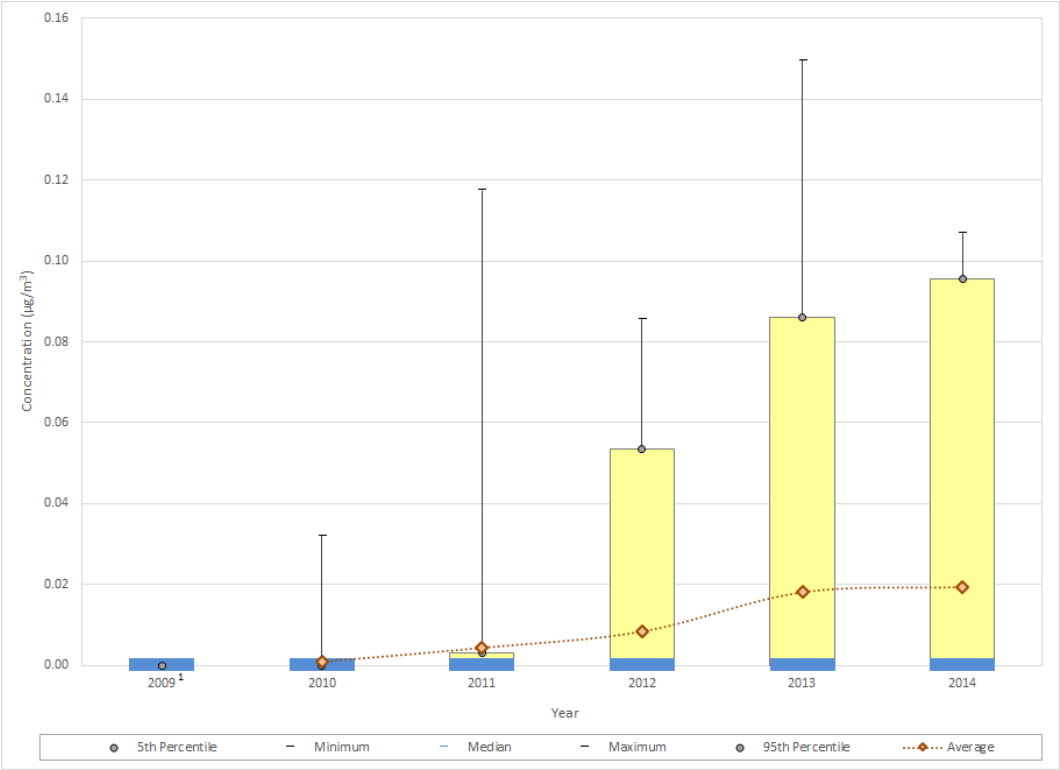
Observations from Figure 18-45 for formaldehyde concentrations measured at TMOK include the following:

- The maximum formaldehyde concentration was measured on August 19, 2011 (10.8 µg/m^3), the same date that the maximum acetaldehyde concentration was measured at TMOK. Two additional formaldehyde concentrations greater than 10 µg/m^3 were measured at TMOK in 2012.

- The 1-year average concentration increased from 2010 to 2011, then decreases each year through 2013, when the 1-year average is at a minimum. Slight increases are shown for 2014. However, these changes are not statistically significant. The 1-year average concentrations have ranged from 3.19 µg/m^3 (2013) to 3.94 µg/m^3 (2011). The median concentration is also at a minimum for 2013, ranging from 2.63 µg/m^3 (2013) to 3.30 µg/m^3 (2014) across the years of sampling.

- The 1-year average concentrations for formaldehyde exhibit a similar pattern as the 1-year average concentrations for acetaldehyde for TMOK shown through 2013. For 2014, the acetaldehyde concentrations continue to decrease while the formaldehyde concentrations exhibit a slight increase.

Figure 18-46. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at TMOK



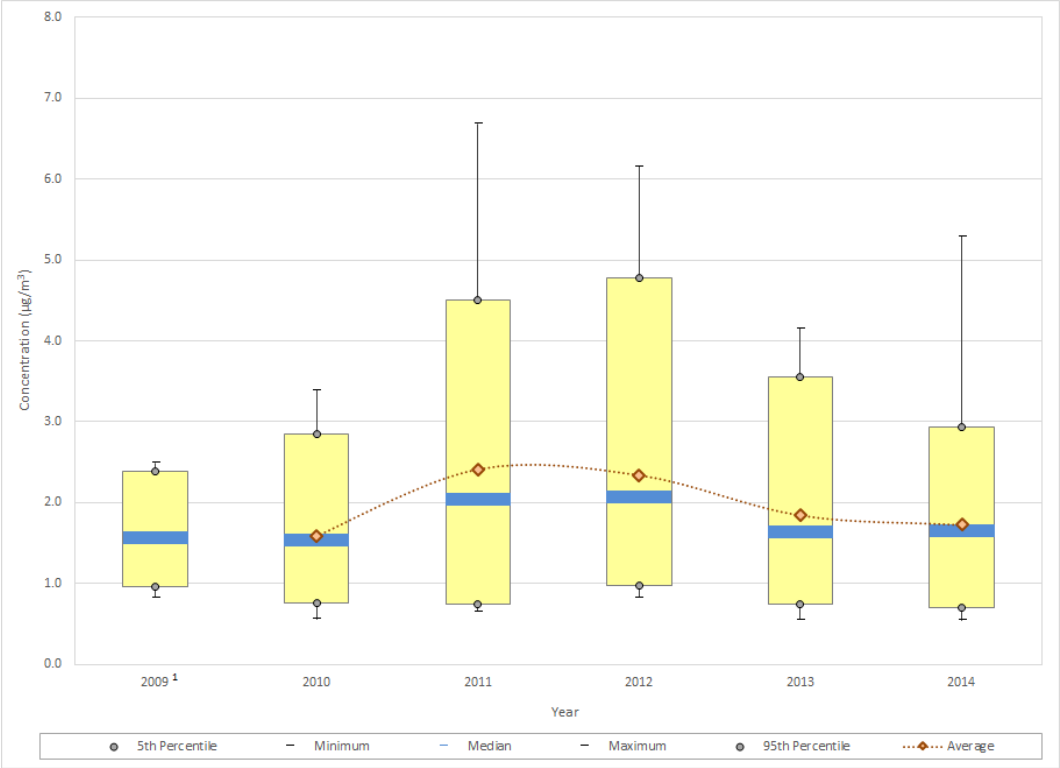
[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-46 for hexachloro-1,3-butadiene concentrations measured at TMOK include the following:

- There were few measured detections of hexachloro-1,3-butadiene in the first few years of sampling at TMOK. The median concentration is zero for all years of sampling, indicating that at least half of the measurements were non-detects for each year. There were no measured detections in 2009, two in 2010, three in 2011, nine in 2012, 14 in 2013, and 16 were measured in 2014.

- Although 2014 has the highest number of measured detections since the onset of sampling, all of the measured detections are less than the MDL. This is true for all years of sampling.

Figure 18-47. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-47 for acetaldehyde concentrations measured at OCOK include the following:

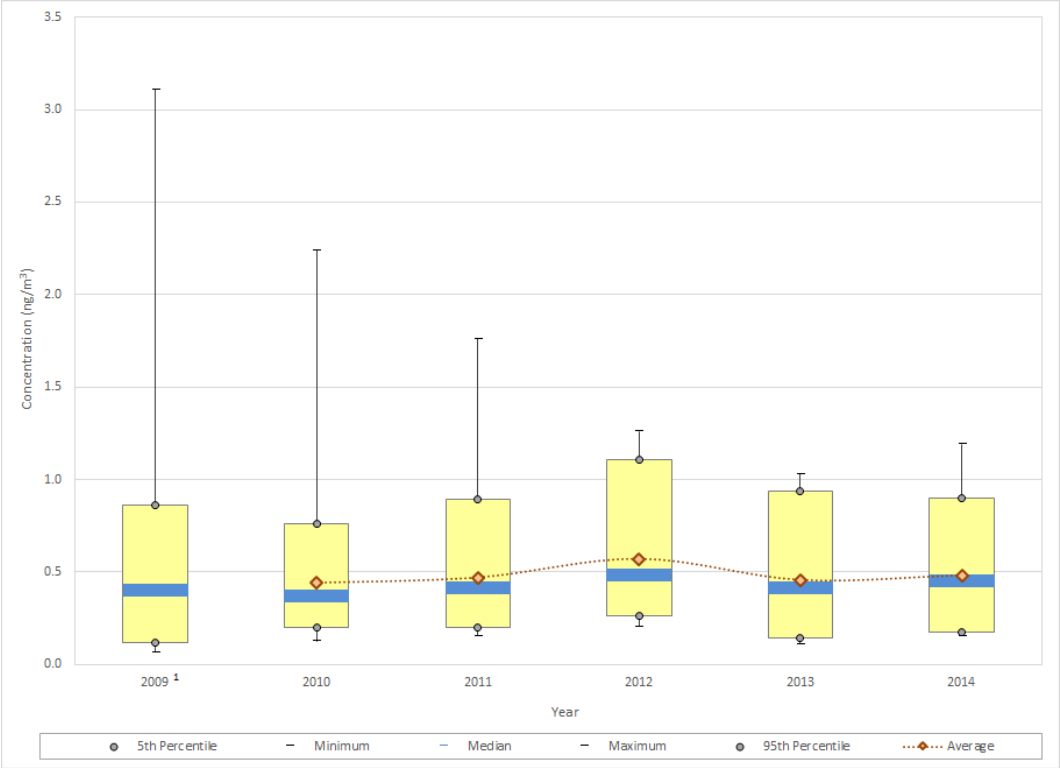
- Sampling for carbonyl compounds began at OCOK under the NMP in May 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum acetaldehyde concentration was measured on May 9, 2011 (6.68 µg/m^3). Only one additional acetaldehyde concentration greater than 6 µg/m^3 has been measured at OCOK (6.16 µg/m^3 in 2012).

- The smallest range of acetaldehyde concentrations was measured in 2009, after which the range of measurements increased considerably. The 1-year average concentration increased significantly from 2010 to 2011, with the median concentration exhibiting a similar increase. Fifteen concentrations measured in 2011 (or one-quarter of the measurements) are greater than the maximum concentration measured in 2010. Little change is shown from 2011 to 2012.

- All of the statistical parameters exhibit decreases from 2012 to 2013. Most of the statistical parameters exhibit at least slight decreases for 2014 as well.

Figure 18-48. Yearly Statistical Metrics for Arsenic (TSP) Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

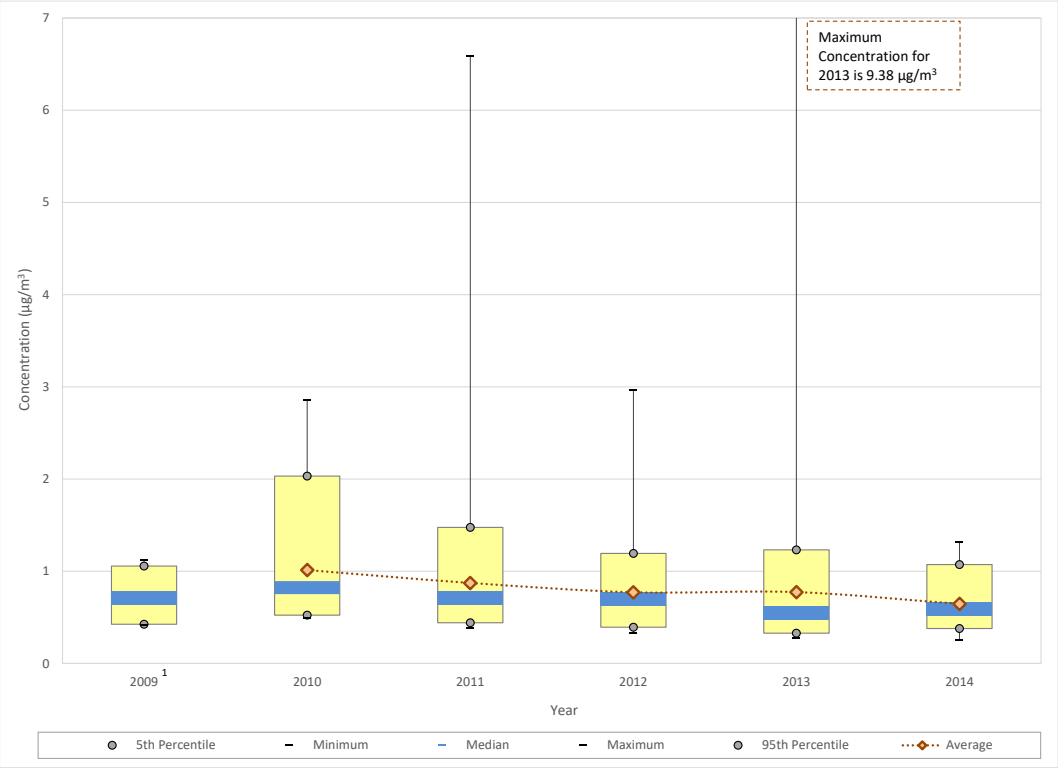
Observations from Figure 18-48 for arsenic (TSP) concentrations measured at OCOK include the following:

- Sampling for TSP metals began at OCOK under the NMP in May 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum concentration of arsenic was measured at OCOK in 2009 (3.11 ng/m^3). The maximum concentration measured each year after 2009 has been steadily decreasing, reaching a minimum for 2013 (1.03 ng/m^3), with 2014 the only year that does not follow this pattern. At the same time, the minimum concentration measured increased each year through 2012, reaching a maximum of 0.21 ng/m^3.

- Most of the 1-year average concentrations of arsenic fall between 0.40 ng/m^3 and 0.50 ng/m^3, with 2012 as the only exception (0.57 ng/m^3). Nearly as many arsenic concentrations greater than 1 ng/m^3 were measured in 2012 (7) as all other years put together (8).

Figure 18-49. Yearly Statistical Metrics for Benzene Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-49 for benzene concentrations measured at OCOK include the following:

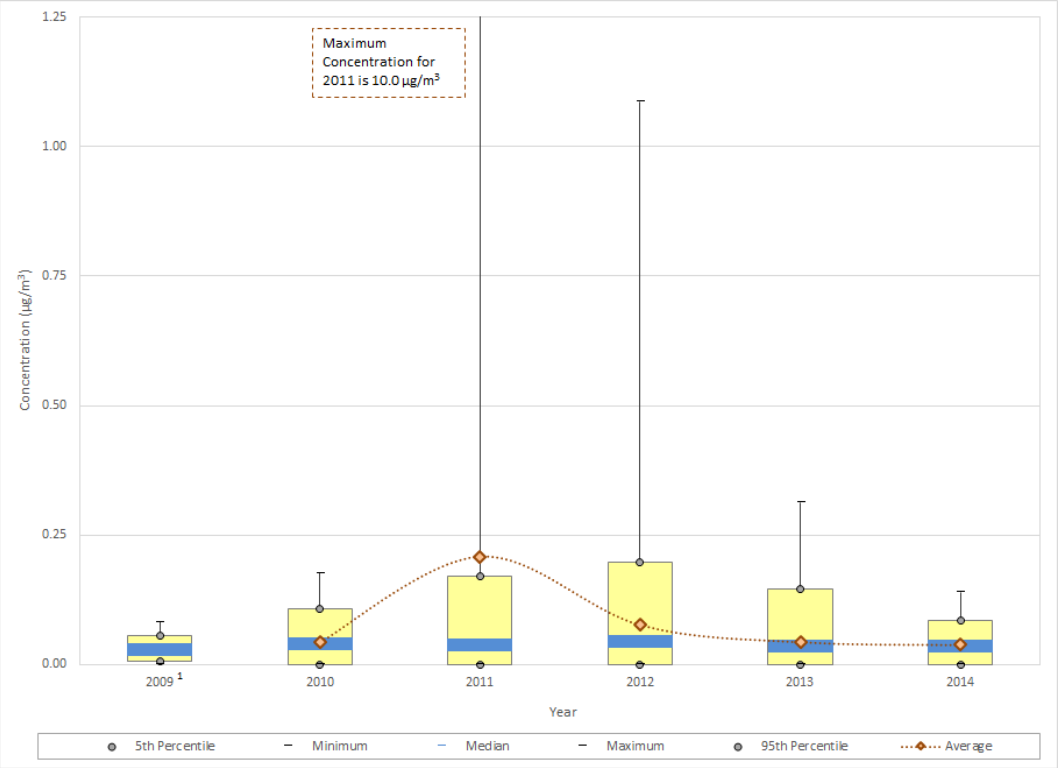
- Sampling for VOCs began at OCOK under the NMP in May 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum benzene concentration was measured at OCOK on November 6, 2013 (9.38 µg/m^3). The next highest concentration was measured on September 18, 2011 (6.80 µg/m^3). No other benzene concentrations greater than 3 µg/m^3 have been measured at OCOK.

- With the exception of 2013, the 1-year average concentration has a decreasing trend across the years of sampling. If the maximum concentration measured in 2013 was excluded from the calculation, as no other benzene concentrations greater than 2 µg/m^3 were measured in 2013, the 1-year average concentration would have a continuous decreasing trend through 2013, with virtually no change for 2014.

- Benzene concentrations measured at OCOK in 2014 exhibit the least amount of variability (excluding 2009, which does not include a full year's worth of sampling), as this year has the smallest range of measurements, the majority of concentrations fall into the smallest range, and the difference between the 1-year average and median concentrations is at a minimum.

Figure 18-50. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-50 for 1,3-butadiene concentrations measured at OCOK include the following:

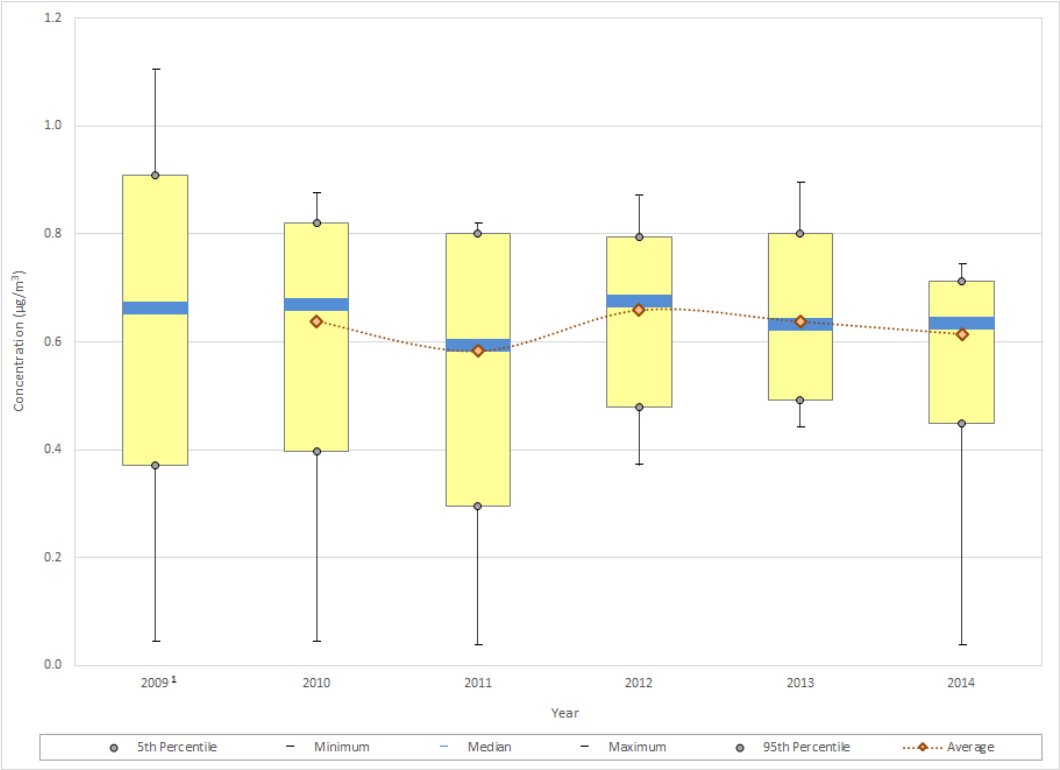
- The maximum 1,3-butadiene concentration was measured at OCOK on September 18, 2011 (10.0 µg/m^3), which is the same day the second highest benzene concentration was measured. The next highest concentration was measured in 2012 (1.09 µg/m^3). No other 1,3-butadiene concentrations greater than 0.35 µg/m^3 have been measured at OCOK.

- The 1-year average concentration for 2011 is being driven by the outlier, as the 1-year average is greater than the 95th percentile for 2011. If this measurement was excluded from the calculation, the 1-year average concentration would decrease from 0.21 µg/m^3 to 0.05 µg/m^3, resulting in a negligible change from 2010 levels.

- The median concentrations shown between 2010 and 2014 have varied by less than 0.01 µg/m^3 over the period, ranging from 0.035 µg/m^3 (2013, 2014) to 0.044 µg/m^3 (2012), despite the variation in the range of concentrations measured.

- The range within which the majority of concentrations fall, as indicated by the difference between the 5th and 95th percentiles, increased each year through 2012. This is followed by a decreasing of the range in 2013 and again in 2014.

Figure 18-51. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-51 for carbon tetrachloride concentrations measured at OCOK include the following:

- The two highest concentrations of carbon tetrachloride were measured at OCOK in 2009, including one greater than 1 µg/m^3 (1.10 µg/m^3). The maximum concentrations measured in other years are less than 0.90 µg/m^3.

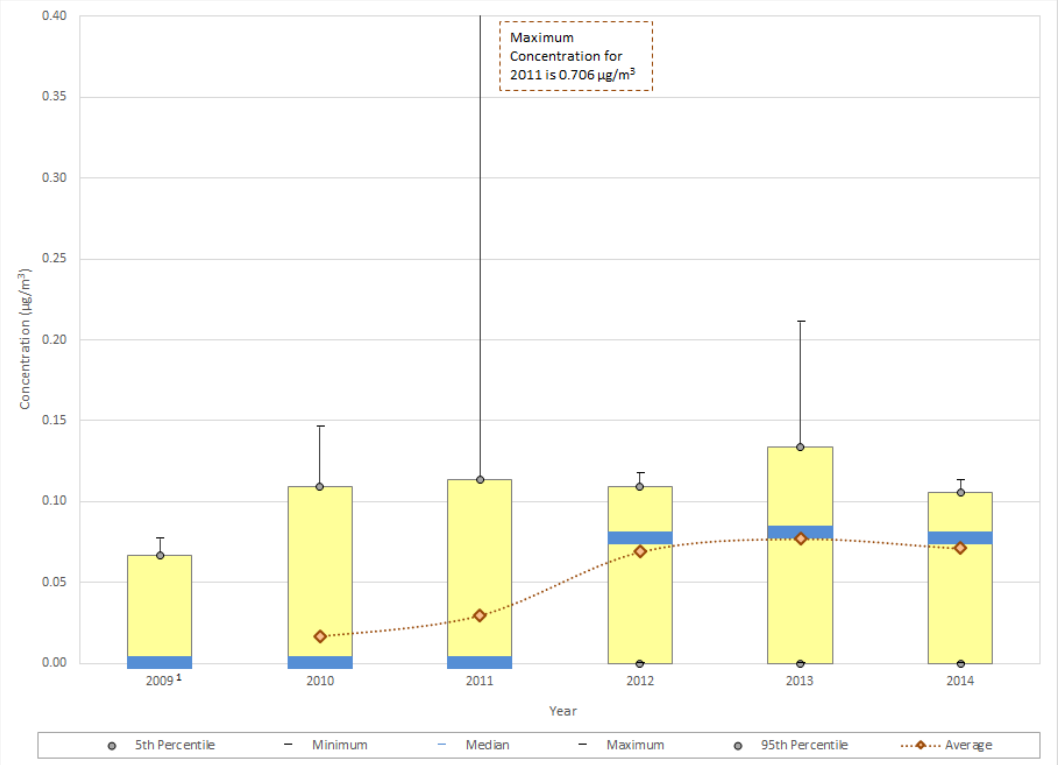
- The range of carbon tetrachloride concentrations measured at OCOK has decreased each year through 2013, when all carbon tetrachloride concentrations measured span less than 0.50 µg/m^3.

- The 1-year average concentrations of carbon tetrachloride have varied by less than 0.1 µg/m^3, ranging from 0.58 µg/m^3 (2011) to 0.66 µg/m^3 (2012). The median concentrations have a similar pattern, ranging from 0.59 µg/m^3 (2011) to 0.67 µg/m^3 (2012).

- With the exception of 2013, the median concentration is greater than the 1-year average concentration, which can be attributed to the few concentrations on the lower end of the concentration range, which can pull an average down in a similar manner to an outlying concentration driving the average up. In total, five carbon tetrachloride concentrations less than 0.1 µg/m^3 have been measured at OCOK, one each in 2009, 2010, and 2014, and two in 2011. This explains why the box and whisker plots for carbon tetrachloride appear "inverted" for several years, with the minimum

concentration extending farther away from the majority of the measurements rather than the maximum concentration, which is more common (see acetaldehyde as an example).

Figure 18-52. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

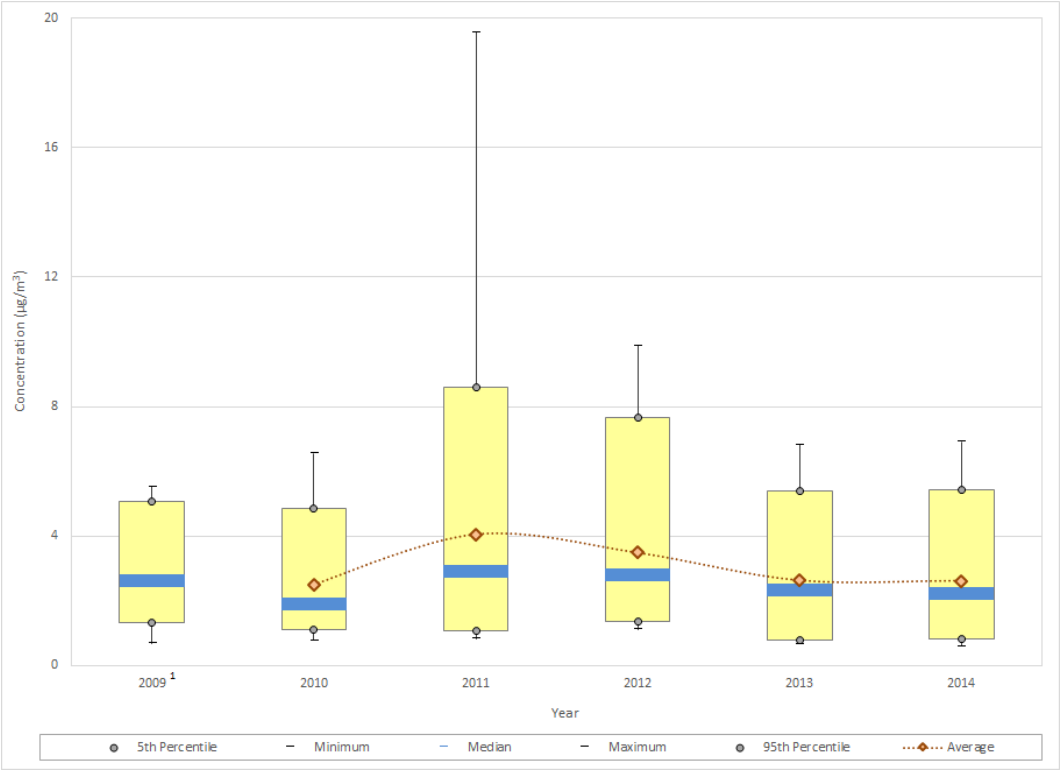
Observations from Figure 18-52 for 1,2-dichloroethane concentrations measured at OCOK include the following:

- The median concentration for 2009, 2010, and 2011 is zero, indicating that at least half of the measurements were non-detects. In 2009, there were four measured detections of 1,2-dichloroethane, which increased to 11 for 2010 and 13 for 2011. For 2012, the number of measured detections increased by a factor of four (up to 52). The number of measured detections is relatively constant for 2013 and 2014.

- The increase in the measured detections results in an increase in the 1-year average concentrations shown through 2012. Less than 0.01 µg/m^3 separates the 1-year average concentrations calculated for 2012, 2013, and 2014 and less than 0.005 µg/m^3 separates the median concentrations for these years.

- The range within which most of the concentrations fall, as indicated by the 5th and 95th percentiles, changed little between 2010 and 2014, even as a greater number of measured detections were measured.

Figure 18-53. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-53 for formaldehyde concentrations measured at OCOK include the following:

- The maximum formaldehyde concentration was measured at OCOK on May 9, 2011 (19.6 µg/m^3), the same day as the maximum acetaldehyde concentration was measured; the only other concentration greater than 10 µg/m^3 was also measured at OCOK in 2011 (10.6 µg/m^3). All 17 formaldehyde concentrations greater than 7 µg/m^3 were measured at OCOK in either 2011 or 2012.

- With the exception of the 5th percentile, all of the statistical parameters exhibit an increase from 2010 to 2011. This is not just a result of the two highest concentrations measured in 2011, as concentrations were higher overall. Twelve concentrations measured in 2011 were greater than the maximum concentration measured in 2010. The median concentration increased by more than 1 µg/m^3 and the 1-year average concentration increased by more than 60 percent for 2011.

- Formaldehyde concentrations measured after 2011 are lower, as the statistical parameters exhibit decreases in the years following 2011, particularly at the upper end of the concentration range. The concentrations measured in 2013 are similar to those measured in 2014 as the statistical parameters shown for these years exhibit little change.

18.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at each Oklahoma monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

18.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Oklahoma monitoring sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 18-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations from Table 18-5 include the following:

- Formaldehyde and acetaldehyde have the highest annual average concentrations for each site. Among the VOCs, benzene has the highest annual average concentration for four of the five sites (YUOK is the exception, where carbon tetrachloride has the highest annual average concentration among the VOCs). Arsenic is the only TSP metal that was identified as a pollutant of interest for all five of the Oklahoma sites. Annual average arsenic concentrations are all less than 1 ng/m^3.

- Formaldehyde and benzene have the highest cancer risk approximations among the pollutants of interest for each Oklahoma monitoring site. Cancer risk approximations for formaldehyde range from 34.18 in-a-million for OCOK to 44.38 in-a-million for TMOK. TMOK's cancer risk approximation for formaldehyde ranks eighth highest among all cancer risk approximations program-wide. Benzene cancer risk approximations for the Oklahoma monitoring sites range from 4.33 in-a-million for YUOK to 8.07 in-a-million for TOOK.

- For arsenic, the cancer risk approximations range from 1.91 in-a-million for YUOK to 3.32 in-a-million for TROK.

- None of the pollutants of interest have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The highest noncancer hazard approximation was calculated for formaldehyde for TMOK (0.35).

Table 18-5. Risk Approximations for the Oklahoma Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Public Works, Tulsa, Oklahoma - TOOK						
Acetaldehyde	0.0000022	0.009	61/61	1.97 ± 0.22	4.33	0.22
Benzene	0.0000078	0.03	61/61	1.03 ± 0.11	8.07	0.03
1,3-Butadiene	0.00003	0.002	59/61	0.08 ± 0.01	2.30	0.04
Carbon Tetrachloride	0.000006	0.1	61/61	0.61 ± 0.03	3.64	0.01
p-Dichlorobenzene	0.000011	0.8	51/61	0.07 ± 0.01	0.82	<0.01
1,2-Dichloroethane	0.000026	2.4	50/61	0.09 ± 0.01	2.27	<0.01
Ethylbenzene	0.0000025	1	61/61	0.39 ± 0.06	0.99	<0.01
Formaldehyde	0.000013	0.0098	61/61	2.95 ± 0.42	38.30	0.30
Hexachloro-1,3-butadiene	0.000022	0.09	19/61	0.03 ± 0.01	0.57	<0.01
Arsenic (TSP)[a]	0.0043	0.000015	62/62	0.76 ± 0.08	3.26	0.05
Manganese (TSP)[a]	--	0.0003	62/62	25.04 ± 2.92	--	0.08
Nickel (TSP)[a]	0.00048	0.00009	62/62	2.25 ± 0.31	1.08	0.02

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Table 18-5. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Fire Station, Tulsa, Oklahoma - TMOK						
Acetaldehyde	0.0000022	0.009	62/62	1.81 ± 0.17	3.98	0.20
Benzene	0.0000078	0.03	62/62	0.81 ± 0.08	6.32	0.03
1,3-Butadiene	0.00003	0.002	58/62	0.09 ± 0.01	2.77	0.05
Carbon Tetrachloride	0.000006	0.1	62/62	0.62 ± 0.03	3.69	0.01
p-Dichlorobenzene	0.000011	0.8	49/62	0.07 ± 0.01	0.76	<0.01
1,2-Dichloroethane	0.000026	2.4	54/62	0.08 ± 0.01	2.20	<0.01
Ethylbenzene	0.0000025	1	62/62	0.34 ± 0.05	0.86	<0.01
Formaldehyde	0.000013	0.0098	62/62	3.41 ± 0.39	44.38	0.35
Hexachloro-1,3-butadiene	0.000022	0.09	17/62	0.02 ± 0.01	0.47	<0.01
Arsenic (TSP)[a]	0.0043	0.000015	58/58	0.67 ± 0.09	2.87	0.04
Riverside, Tulsa, Oklahoma - TROK						
Acetaldehyde	0.0000022	0.009	61/61	1.73 ± 0.16	3.81	0.19
Benzene	0.0000078	0.03	61/61	0.80 ± 0.07	6.25	0.03
1,3-Butadiene	0.00003	0.002	60/61	0.07 ± 0.01	2.23	0.04
Carbon Tetrachloride	0.000006	0.1	61/61	0.62 ± 0.02	3.73	0.01
p-Dichlorobenzene	0.000011	0.8	47/61	0.06 ± 0.01	0.64	<0.01
1,2-Dichloroethane	0.000026	2.4	50/61	0.08 ± 0.01	2.06	<0.01
Ethylbenzene	0.0000025	1	61/61	0.37 ± 0.05	0.92	<0.01
Formaldehyde	0.000013	0.0098	61/61	2.78 ± 0.36	36.20	0.28
Hexachloro-1,3-butadiene	0.000022	0.09	18/61	0.02 ± 0.01	0.52	<0.01
Arsenic (TSP)[a]	0.0043	0.000015	59/59	0.77 ± 0.12	3.32	0.05

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Table 18-5. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Oklahoma City, Oklahoma - OCOK						
Acetaldehyde	0.0000022	0.009	60/60	1.73 ± 0.20	3.81	0.19
Benzene	0.0000078	0.03	60/60	0.65 ± 0.06	5.07	0.02
1,3-Butadiene	0.00003	0.002	46/60	0.04 ± 0.01	1.16	0.02
Carbon Tetrachloride	0.000006	0.1	60/60	0.61 ± 0.03	3.68	0.01
1,2-Dichloroethane	0.000026	2.4	53/60	0.07 ± 0.01	1.85	<0.01
Formaldehyde	0.000013	0.0098	60/60	2.63 ± 0.38	34.18	0.27
Arsenic (TSP)[a]	0.0043	0.000015	59/59	0.48 ± 0.06	2.08	0.03
Yukon, Oklahoma - YUOK						
Acetaldehyde	0.0000022	0.009	61/61	1.80 ± 0.27	3.95	0.20
Benzene	0.0000078	0.03	61/61	0.56 ± 0.04	4.33	0.02
1,3-Butadiene	0.00003	0.002	52/61	0.05 ± 0.01	1.38	0.02
Carbon Tetrachloride	0.000006	0.1	61/61	0.63 ± 0.02	3.81	0.01
1,2-Dichloroethane	0.000026	2.4	55/61	0.08 ± 0.01	2.02	<0.01
Formaldehyde	0.000013	0.0098	61/61	2.92 ± 0.36	38.00	0.30
Hexachloro-1,3-butadiene	0.000022	0.09	15/61	0.02 ± 0.01	0.37	<0.01
Arsenic (TSP)[a]	0.0043	0.000015	61/61	0.44 ± 0.05	1.91	0.03

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

18.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 18-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 18-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 18-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 18-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 18-6. Table 18-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 18.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 18-6. 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 UREs (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)**
Public Works, Tulsa, Oklahoma (Tulsa County) - TOOK					
Benzene	642.74	Benzene	5.01E-03	Formaldehyde	38.30
Ethylbenzene	397.71	Hexavalent Chromium	4.29E-03	Benzene	8.07
Formaldehyde	314.78	Formaldehyde	4.09E-03	Acetaldehyde	4.33
Acetaldehyde	183.16	1,3-Butadiene	2.69E-03	Carbon Tetrachloride	3.64
1,3-Butadiene	89.52	Naphthalene	1.08E-03	Arsenic (TSP)	3.26
Tetrachloroethylene	54.93	Ethylbenzene	9.94E-04	1,3-Butadiene	2.30
Naphthalene	31.71	POM, Group 2b	5.18E-04	1,2-Dichloroethane	2.27
Trichloroethylene	16.89	POM, Group 2d	4.29E-04	Nickel (TSP)	1.08
Dichloromethane	8.60	Acetaldehyde	4.03E-04	Ethylbenzene	0.99
POM, Group 2b	5.89	Nickel, PM	3.15E-04	*p*-Dichlorobenzene	0.82
Fire Station, Tulsa, Oklahoma (Tulsa County) - TMOK					
Benzene	642.74	Benzene	5.01E-03	Formaldehyde	44.38
Ethylbenzene	397.71	Hexavalent Chromium	4.29E-03	Benzene	6.32
Formaldehyde	314.78	Formaldehyde	4.09E-03	Acetaldehyde	3.98
Acetaldehyde	183.16	1,3-Butadiene	2.69E-03	Carbon Tetrachloride	3.69
1,3-Butadiene	89.52	Naphthalene	1.08E-03	Arsenic (TSP)	2.87
Tetrachloroethylene	54.93	Ethylbenzene	9.94E-04	1,3-Butadiene	2.77
Naphthalene	31.71	POM, Group 2b	5.18E-04	1,2-Dichloroethane	2.20
Trichloroethylene	16.89	POM, Group 2d	4.29E-04	Ethylbenzene	0.86
Dichloromethane	8.60	Acetaldehyde	4.03E-04	*p*-Dichlorobenzene	0.76
POM, Group 2b	5.89	Nickel, PM	3.15E-04	Hexachloro-1,3-butadiene	0.47

Table 18-6. 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 UREs (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)**
Riverside, Tulsa, Oklahoma (Tulsa County) - TROK					
Benzene	642.74	Benzene	5.01E-03	Formaldehyde	36.20
Ethylbenzene	397.71	Hexavalent Chromium	4.29E-03	Benzene	6.25
Formaldehyde	314.78	Formaldehyde	4.09E-03	Acetaldehyde	3.81
Acetaldehyde	183.16	1,3-Butadiene	2.69E-03	Carbon Tetrachloride	3.73
1,3-Butadiene	89.52	Naphthalene	1.08E-03	Arsenic (TSP)	3.32
Tetrachloroethylene	54.93	Ethylbenzene	9.94E-04	1,3-Butadiene	2.23
Naphthalene	31.71	POM, Group 2b	5.18E-04	1,2-Dichloroethane	2.06
Trichloroethylene	16.89	POM, Group 2d	4.29E-04	Ethylbenzene	0.92
Dichloromethane	8.60	Acetaldehyde	4.03E-04	*p*-Dichlorobenzene	0.64
POM, Group 2b	5.89	Nickel, PM	3.15E-04	Hexachloro-1,3-butadiene	0.52
Oklahoma City, Oklahoma (Oklahoma County) - OCOK					
Benzene	469.97	Benzene	3.67E-03	Formaldehyde	34.18
Ethylbenzene	297.38	Formaldehyde	3.63E-03	Benzene	5.07
Formaldehyde	279.17	1,3-Butadiene	1.78E-03	Acetaldehyde	3.81
Acetaldehyde	149.46	Hexavalent Chromium	9.52E-04	Carbon Tetrachloride	3.68
1,3-Butadiene	59.23	Naphthalene	8.47E-04	Arsenic (TSP)	2.08
Tetrachloroethylene	48.47	Ethylbenzene	7.43E-04	1,2-Dichloroethane	1.85
Naphthalene	24.91	POM, Group 2b	4.40E-04	1,3-Butadiene	1.16
Dichloromethane	14.77	POM, Group 2d	3.52E-04		
POM, Group 2b	5.01	Acetaldehyde	3.29E-04		
POM, Group 2d	3.99	Arsenic, PM	2.40E-04		

Table 18-6. 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 UREs (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)**
Yukon, Oklahoma (Canadian County) - YUOK					
Formaldehyde	153.30	Formaldehyde	1.99E-03	Formaldehyde	38.00
Benzene	69.83	Benzene	5.45E-04	Benzene	4.33
Acetaldehyde	50.89	1,3-Butadiene	3.53E-04	Acetaldehyde	3.95
Ethylbenzene	34.53	Naphthalene	1.61E-04	Carbon Tetrachloride	3.81
1,3-Butadiene	11.75	Acetaldehyde	1.12E-04	1,2-Dichloroethane	2.02
Naphthalene	4.72	Ethylbenzene	8.63E-05	Arsenic (TSP)	1.91
Tetrachloroethylene	2.35	POM, Group 2b	8.61E-05	1,3-Butadiene	1.38
POM, Group 2b	0.98	POM, Group 2d	7.69E-05	Hexachloro-1,3-butadiene	0.37
Dichloromethane	0.88	POM, Group 5a	5.54E-05		
POM, Group 2d	0.87	Arsenic, PM	2.78E-05		

Table 18-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Public Works, Tulsa, Oklahoma (Tulsa County) - TOOK					
Toluene	2,096.03	Acrolein	869,130.16	Formaldehyde	0.30
Xylenes	1,502.33	1,3-Butadiene	44,761.98	Acetaldehyde	0.22
Hexane	862.22	Formaldehyde	32,120.04	Manganese (TSP)	0.08
Benzene	642.74	Benzene	21,424.75	Arsenic (TSP)	0.05
Ethylbenzene	397.71	Acetaldehyde	20,350.75	1,3-Butadiene	0.04
Methanol	360.45	Xylenes	15,023.31	Benzene	0.03
Formaldehyde	314.78	Naphthalene	10,570.68	Nickel (TSP)	0.02
Acetaldehyde	183.16	Trichloroethylene	8,445.87	Carbon Tetrachloride	0.01
Ethylene glycol	120.05	Nickel, PM	7,292.24	Ethylbenzene	<0.01
1,3-Butadiene	89.52	Lead, PM	5,904.21	Hexachloro-1,3-butadiene	<0.01
Fire Station, Tulsa, Oklahoma (Tulsa County) - TMOK					
Toluene	2,096.03	Acrolein	869,130.16	Formaldehyde	0.35
Xylenes	1,502.33	1,3-Butadiene	44,761.98	Acetaldehyde	0.20
Hexane	862.22	Formaldehyde	32,120.04	1,3-Butadiene	0.05
Benzene	642.74	Benzene	21,424.75	Arsenic (TSP)	0.04
Ethylbenzene	397.71	Acetaldehyde	20,350.75	Benzene	0.03
Methanol	360.45	Xylenes	15,023.31	Carbon Tetrachloride	0.01
Formaldehyde	314.78	Naphthalene	10,570.68	Ethylbenzene	<0.01
Acetaldehyde	183.16	Trichloroethylene	8,445.87	Hexachloro-1,3-butadiene	<0.01
Ethylene glycol	120.05	Nickel, PM	7,292.24	*p*-Dichlorobenzene	<0.01
1,3-Butadiene	89.52	Lead, PM	5,904.21	1,2-Dichloroethane	<0.01

Table 18-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Riverside, Tulsa, Oklahoma (Tulsa County) - TROK					
Toluene	2,096.03	Acrolein	869,130.16	Formaldehyde	0.28
Xylenes	1,502.33	1,3-Butadiene	44,761.98	Acetaldehyde	0.19
Hexane	862.22	Formaldehyde	32,120.04	Arsenic (TSP)	0.05
Benzene	642.74	Benzene	21,424.75	1,3-Butadiene	0.04
Ethylbenzene	397.71	Acetaldehyde	20,350.75	Benzene	0.03
Methanol	360.45	Xylenes	15,023.31	Carbon Tetrachloride	0.01
Formaldehyde	314.78	Naphthalene	10,570.68	Ethylbenzene	<0.01
Acetaldehyde	183.16	Trichloroethylene	8,445.87	Hexachloro-1,3-butadiene	<0.01
Ethylene glycol	120.05	Nickel, PM	7,292.24	*p*-Dichlorobenzene	<0.01
1,3-Butadiene	89.52	Lead, PM	5,904.21	1,2-Dichloroethane	<0.01
Oklahoma City, Oklahoma (Oklahoma County) - OCOK					
Toluene	1,716.89	Acrolein	825,550.98	Formaldehyde	0.27
Xylenes	1,179.06	1,3-Butadiene	29,617.41	Acetaldehyde	0.19
Hexane	800.82	Formaldehyde	28,486.41	Arsenic (TSP)	0.03
Benzene	469.97	Acetaldehyde	16,606.84	Benzene	0.02
Methanol	444.71	Benzene	15,665.51	1,3-Butadiene	0.02
Ethylbenzene	297.38	Xylenes	11,790.55	Carbon Tetrachloride	0.01
Formaldehyde	279.17	Naphthalene	8,303.68	1,2-Dichloroethane	<0.01
Ethylene glycol	202.30	Arsenic, PM	3,725.81		
Acetaldehyde	149.46	Nickel, PM	3,115.38		
Methyl isobutyl ketone	71.17	Propionaldehyde	2,411.31		

Table 18-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Yukon, Oklahoma (Canadian County) - YUOK					
Xylenes	270.61	Acrolein	960,699.47	Formaldehyde	0.30
Toluene	218.04	Formaldehyde	15,642.59	Acetaldehyde	0.20
Formaldehyde	153.30	1,3-Butadiene	5,876.61	Arsenic (TSP)	0.03
Hexane	119.27	Acetaldehyde	5,654.44	1,3-Butadiene	0.02
Methanol	80.71	Xylenes	2,706.07	Benzene	0.02
Benzene	69.83	Benzene	2,327.52	Carbon Tetrachloride	0.01
Acetaldehyde	50.89	Naphthalene	1,574.09	Hexachloro-1,3-butadiene	<0.01
Ethylbenzene	34.53	Cyanide Compounds, gas	1,510.86	1,2-Dichloroethane	<0.01
Ethylene glycol	22.94	Lead, PM	1,020.34		
Acrolein	19.21	Arsenic, PM	430.77		

Observations from Table 18-6 include the following:

- Benzene is the highest emitted pollutant with a cancer URE in Tulsa and Oklahoma Counties, followed by ethylbenzene and formaldehyde. The highest emitted pollutants in Canadian County are formaldehyde, benzene, and acetaldehyde. The quantity of emissions is highest in Tulsa County and lowest in Canadian County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Tulsa County is benzene, followed by hexavalent chromium and formaldehyde. The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Oklahoma County is also benzene, followed by formaldehyde and 1,3-butadiene. The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Canadian County is formaldehyde, followed by benzene and 1,3-butadiene.

- Seven of the highest emitted pollutants in Tulsa County also have the highest toxicity-weighted emissions. Eight of the highest emitted pollutants in Oklahoma County also have the highest toxicity-weighted emissions. Eight of the highest emitted pollutants in Canadian County also have the highest toxicity-weighted emissions.

- Formaldehyde and benzene have the highest cancer risk approximations among the Oklahoma sites' pollutants of interest. Both of these pollutants appear at or near the top of both emissions-based lists for each county. Acetaldehyde and 1,3-butadiene also appear on all three lists for each site. Ethylbenzene is also a pollutant of interest for all three Tulsa sites and appears on both emissions-based lists.

- Nickel is a pollutant of interest for TOOK and has one of the higher cancer risk approximations for this site. Nickel has the 10th highest toxicity-weighted emissions for Tulsa County but is not among the highest emitted (its emissions rank 12th). Arsenic is a pollutant of interest for each Oklahoma site. Although this pollutant has one of the higher cancer risk approximations for TOOK, TMOK, and TROK, arsenic is not on either emissions-based list for Tulsa County (ranking 24th for its emissions and 11th for its toxicity-weighted emissions). For both Oklahoma and Canadian Counties, arsenic ranks 10th for its toxicity-weighted emissions, and 24th and 27th for its total emissions, respectively.

- Carbon tetrachloride and 1,2-dichloroethane are pollutants of interest for each site and have one of the higher cancer risk approximations for each site but do not appear on either emissions-based site. *p*-Dichlorobenzene is a pollutant of interest for all three Tulsa sites and appears on neither emissions-based list. Hexachloro-1,3-butadiene is another pollutant of interest for several sites but appears on neither emissions-based list.

- Naphthalene and several POM Groups appear in Table 18-6 for quantity emitted and toxicity-weighted emissions. PAHs were not sampled for under the NMP at the Oklahoma sites.

Observations from Table 18-7 include the following:

- Toluene and xylenes are the highest emitted pollutants with noncancer RfCs in Tulsa and Oklahoma Counties, while the order was reversed for Canadian County. Emissions were generally highest in Tulsa County and lowest in Canadian County.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all three counties. Acrolein has the highest toxicity-weighted emissions for almost all counties with NMP sites but appears among the highest emitted for only two. Canadian County is one of those counties, with acrolein ranking 10th among those with the highest emissions. Compared to other counties with NMP sites, Canadian County's acrolein emissions are not exceedingly high (19.21 tpy), but are the 11th highest for counties with NMP sites and are slightly higher than the emissions for Tulsa County (17.38 tpy) and Oklahoma County (16.51 tpy). 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-based 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 Oklahoma County also have the highest toxicity-weighted emissions; five of the highest emitted pollutants in Tulsa County and Canadian County also have the highest toxicity-weighted emissions. Although toluene is one of, if not the highest emitted pollutant in all three counties, this pollutant does not appear among those with the highest toxicity-weighted emissions.

- Formaldehyde and acetaldehyde have the highest noncancer hazard approximations among the Oklahoma sites. These pollutants appear on both emissions-based lists for each county. Benzene also appears on all three lists for each site. This is also true for 1,3-butadiene for the Tulsa sites. 1,3-Butadiene has one of the highest noncancer hazard approximations for OCOK and YUOK, and has some of the highest toxicity-weighted emissions for their counties, but is not one of the 10 highest emitted pollutants in either county (but is just outside the list at 11th highest for each county).

- Several metals appear among the pollutants with the highest toxicity-weighted emissions for each county but no metals are listed among the highest emitted pollutants for any of the three counties. This speaks to the relative toxicity of the speciated metals.

18.6 Summary of the 2014 Monitoring Data for the Oklahoma Monitoring Sites

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

- ❖ *Sixteen pollutants failed at least one screen for TOOK; 15 pollutants failed screens for TMOK; 14 pollutants failed screens for TROK; 14 pollutants failed screens for OCOK; and 13 pollutants failed screens for YUOK.*

- ❖ *Formaldehyde and acetaldehyde had the highest annual average concentrations for each site. Concentrations of formaldehyde tended to be higher during the warmer months of the year.*

- *After several years of increasing, concentrations of acetaldehyde, ethylbenzene, and manganese decreased at TOOK after 2012. Other pollutants exhibit this trend as well but the difference is less significant. Benzene concentrations measured at TOOK have been decreasing over the last few years. Benzene, acetaldehyde, and ethylbenzene concentrations have also been decreasing at TMOK and concentrations of the acetaldehyde and formaldehyde have been decreasing at OCOK. In addition, the detection rates of 1,2-dichloroethane and hexachloro-1,3-butadiene have been increasing at TOOK and TMOK over the last few years of sampling, particularly for 1,2-dichloroethane. This is also true for 1,2-dichloroethane measurements at OCOK.*

- *Formaldehyde has the highest cancer risk approximation among the site-specific pollutants of interest for each site. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

19.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

19.1 Site Characterization

This section characterizes the Rhode Island 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 19-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 19-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 19-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 19-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 19-1. Providence, Rhode Island (PRRI) Monitoring Site

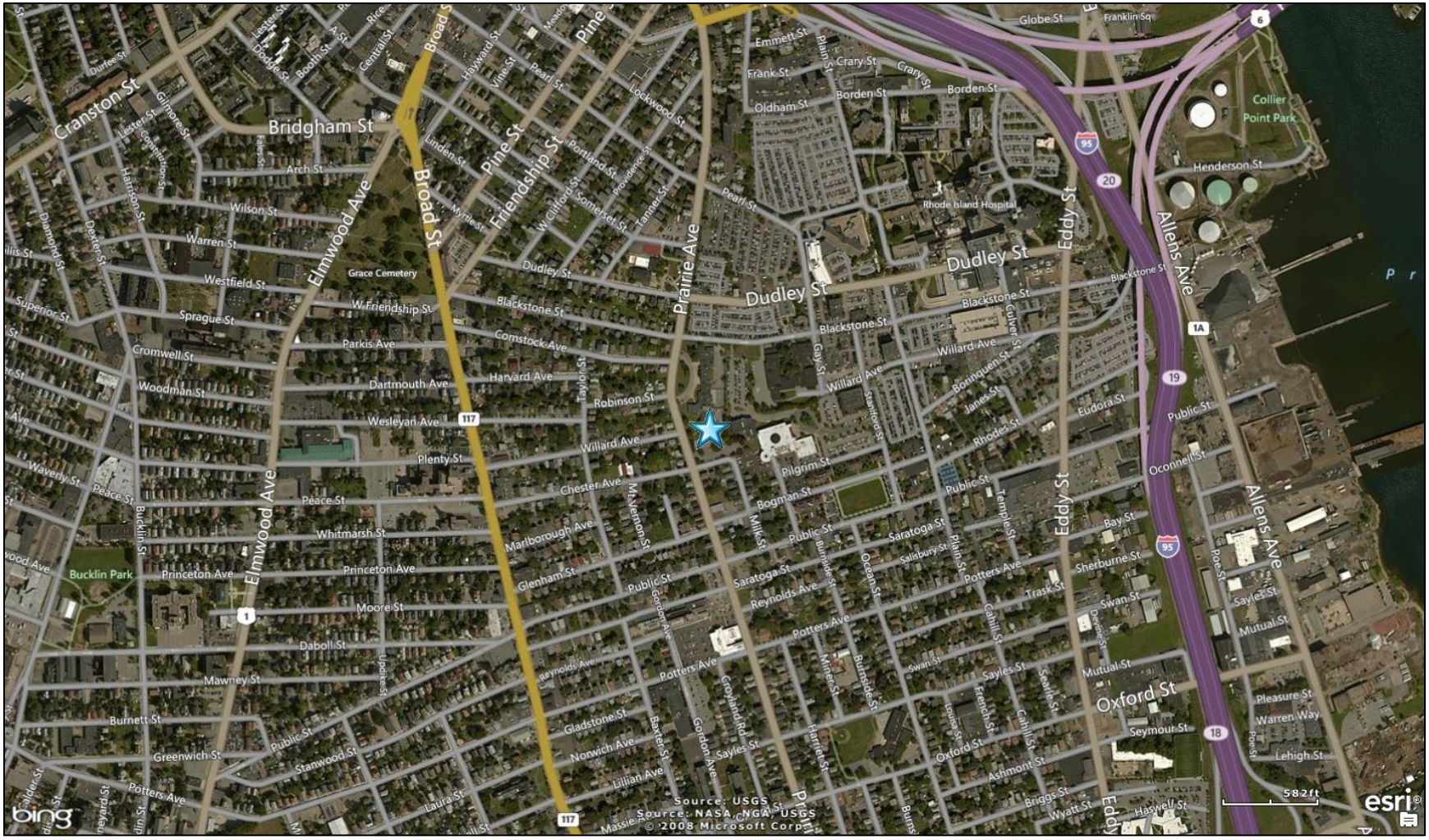


Figure 19-2. NEI Point Sources Located Within 10 Miles of PRRI

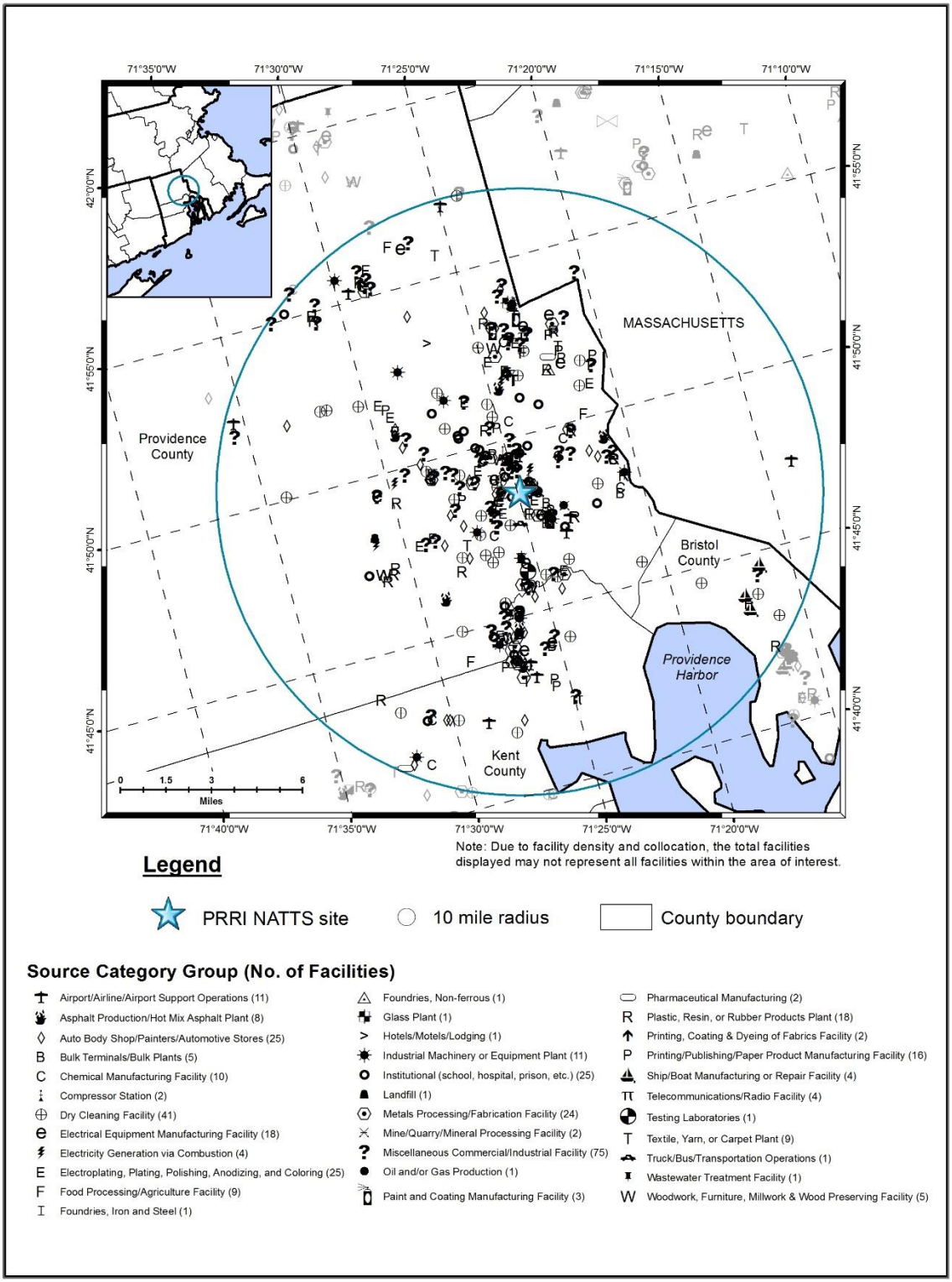


Table 19-1. Geographical Information for the Rhode Island Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
PRRI	44-007-0022	Providence	Providence	Providence-Warwick, RI-MA	41.807776, -71.415105	Residential	Urban/City Center	136,800	I-95 near I-195

[1] AADT reflects 2009 data (RI DOT, 2009)

BOLD ITALICS = EPA-designated NATTS Site

Figure 19-1 shows that the areas to the west and south of PRRI are primarily residential, but areas to the north and east are commercial. A hospital lies to the northeast of the site, just north of Dudley Street. Interstate-95 runs north-south about one-half mile to the east of the site, then turns northwestward, entering downtown Providence. The Providence Harbor is just on the other side of I-95 and can be seen on the right-hand side of Figure 19-1.

Figure 19-2 shows that a large number of point sources are located within 10 miles of PRRI, most of which are within about 5 miles of the site. The source categories with the greatest number of point sources within 10 miles of PRRI include dry cleaners; institutions (such as schools, prisons, and hospitals); metals processing and fabrication facilities; electroplating, plating, polishing, anodizing, and coloring facilities; and auto body shops, painters, and automotive stores. Sources within one-half mile of PRRI include several hospitals, a heliport at a hospital, a bulk terminal/bulk plant, an electroplating, plating, polishing, anodizing, and coloring facility, and a facility that falls into the miscellaneous commercial and industrial source category.

In addition to providing city, county, CBSA, and land use/location setting information, Table 19-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near PRRI is greater than 100,000 and is the sixth highest compared to traffic volumes near other NMP monitoring sites. The traffic estimate provided is for I-95 near the I-195 interchange.

19.2 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 the year.

19.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for

the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For PRRI**,** site-specific data were available all the parameters except dew point temperature and sea level pressure. Data for these parameters were obtained from the NWS weather station at T.F. Green Airport (WBAN 14765). The T.F. Green Airport weather station is located 6 miles south of PRRI. A map showing the distance between the PRRI monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 19-2. Average Meteorological Conditions near the Rhode Island Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Providence, Rhode Island - PRRI [2]							
Sample Days (62)	51.1 ± 1.0	38.9 ± 1.1	65.0 ± 1.0	30.01 ± 0.01	29.94 ± 0.01	NW	5.5 ± 0.1
2014	51.3 ± 0.4	39.1 ± 0.4	65.7 ± 0.4	30.01 ± <0.01	29.95 ± <0.01	NW	5.3 ± 0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, and wind parameters were measured at PRRI. The remaining information was obtained from the closest NWS weather station located at T.F. Green International Airport, WBAN 14765.

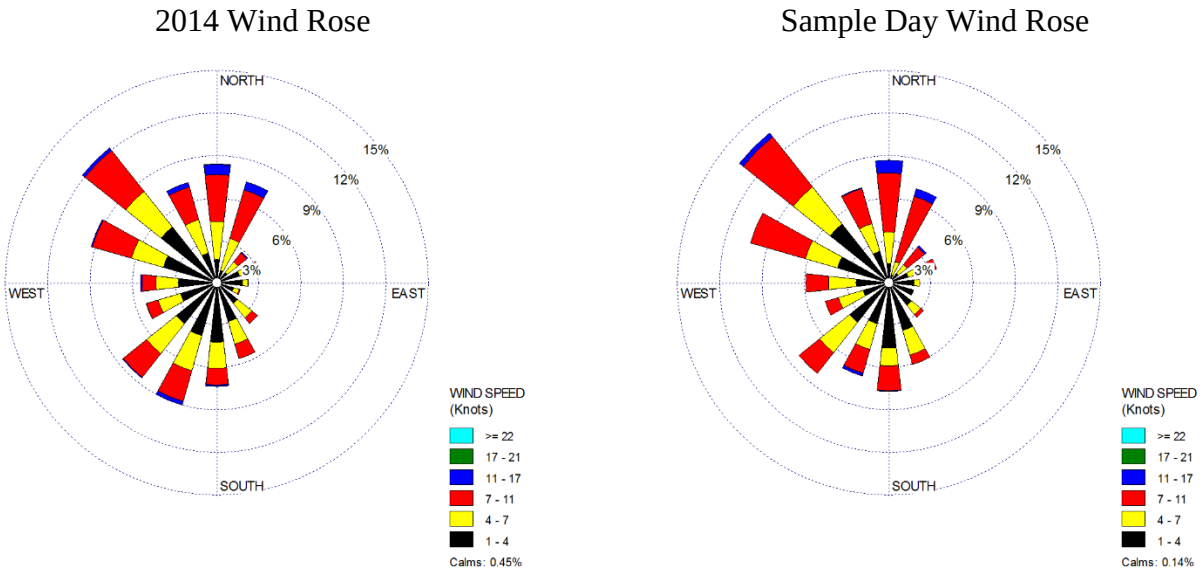
Table 19-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 19-2 is the 95 percent confidence interval for each parameter. As shown in Table 19-2, average meteorological conditions on sample days were representative of average weather conditions experienced throughout the year near PRRI.

19.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 19-3 presents two wind roses for the PRRI monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are

used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 19-3. Wind Roses for the Wind Data Collected at PRRI



Observations from Figure 19-3 for PRRI include the following:

- The full-year wind rose shows that northwesterly winds were observed most, accounting for 12 percent of observations. Winds from the western quadrants, including due north and due south, were often observed more frequently at PRRI than winds from the eastern quadrants. Calm winds account for less than 1 percent of the hourly measurements.

- The wind patterns shown on the sample day wind rose are similar to the full-year wind patterns, as winds from the northwest were observed the most and winds from the western quadrants were observed more often than those from the eastern quadrants. Fewer winds from the south-southwest and southwest were observed on sample days while a higher number of winds from the west-northwest and northwest were observed at PRRI on sample days.

19.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for PRRI in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 19-3. 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 and are shaded in gray in Table 19-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Only PAHs were sampled for at PRRI in 2014 under the NMP.

Table 19-3. Risk-Based 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	45	58	77.59	97.83	97.83
Benzo(a)pyrene	0.00057	1	58	1.72	2.17	100.00
Total		46	116	39.66		

Observations from Table 19-3 include the following:

- Concentrations of two PAHs failed at least one screen for PRRI: naphthalene and benzo(a)pyrene.
- Concentrations of naphthalene account for 45 of the 46 failed screens, with benzo(a)pyrene failing a single screen.
- Naphthalene accounts for 98 percent of the total failed screens for PRRI. Thus, naphthalene is the only pollutant of interest for PRRI.

19.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Rhode Island monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically to illustrate how each site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at PRRI are provided in Appendix M.

19.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for the Rhode Island site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for PRRI are presented in Table 19-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 19-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Rhode Island Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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							
Naphthalene	58/58	58	73.57 ± 25.32	41.11 ± 12.65	51.38 ± 12.29	40.75 ± 9.08	52.06 ± 8.40

Observations for PRRI from Table 19-4 include the following:

- Naphthalene was detected in all of the valid PAH samples collected at PRRI.
- Concentrations of naphthalene measured at PRRI span an order of magnitude, ranging from 14.7 ng/m^3 to 163 ng/m^3.
- The first quarter average concentration of naphthalene is greater than the other quarterly averages and has a confidence interval two to three times larger than the confidence intervals associated with the other quarterly average concentrations. This indicates considerably variability in the measurements. Four of the five naphthalene concentrations greater than 100 ng/m^3 were measured between January and March (the fifth was measured in September). The range of concentrations measured during the first quarter is nearly twice the range measured during the other calendar quarters. The median concentration for the first quarter measurements is approximately 57 ng/m^3. The difference between first quarter average concentration and the median concentration for this quarter is another indicator that the naphthalene concentrations measured during the first quarter are highly variable.

19.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, a box plot was created for the pollutant listed in Table 19-4 for PRRI. Figure 19-4 overlays PRRI's minimum, annual average, and maximum naphthalene concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 19-4. Program vs. Site-Specific Average Naphthalene Concentration

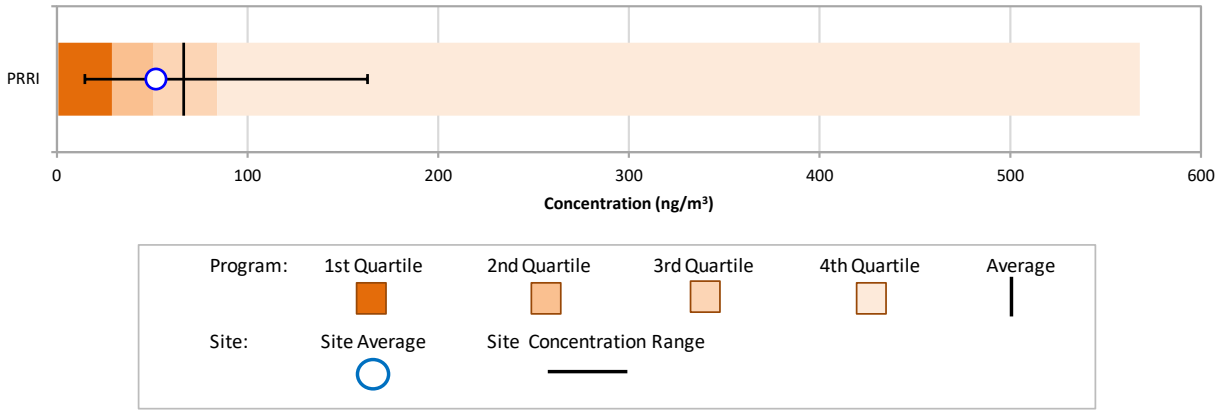


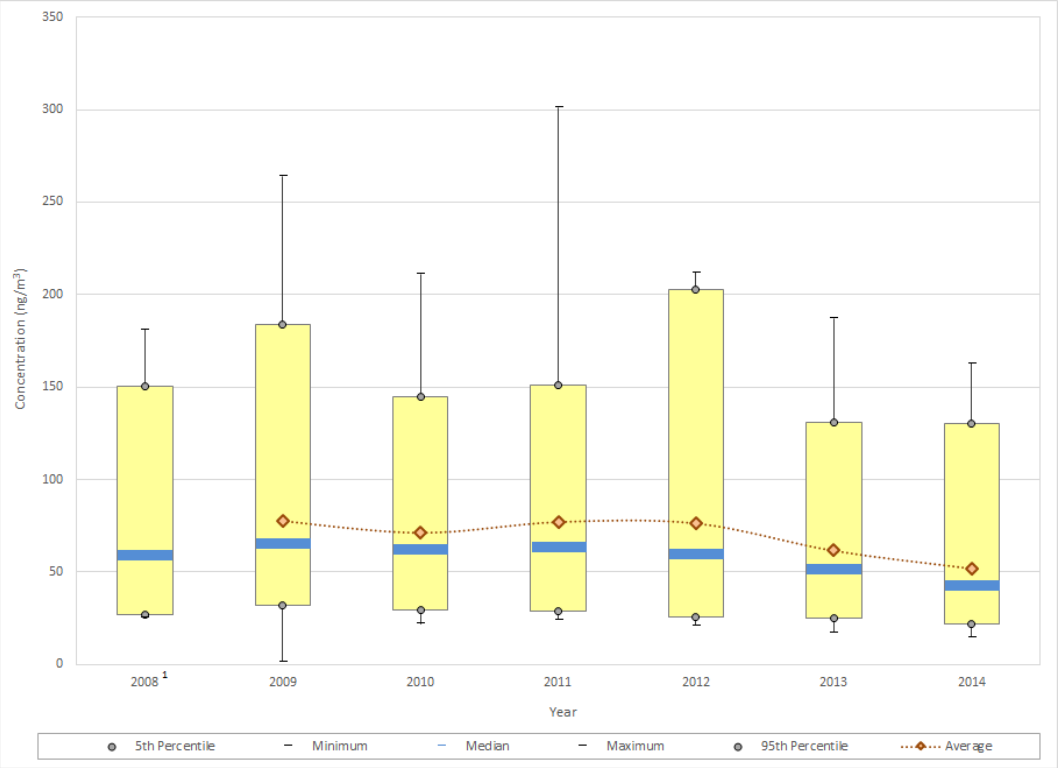
Figure 19-4 presents the box plot for naphthalene for PRRI and shows the following:

- The maximum naphthalene concentration measured at PRRI is about one-third the maximum concentration measured at the program-level.
- There were no non-detects of naphthalene measured at PRRI (or across the program).
- The annual average naphthalene concentration for PRRI is similar to the program-level median concentration. PRRI's annual average concentration of naphthalene is in the bottom-third of the range compared to other NMP sites sampling PAHs (ranking 14th).

19.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. PRRI has sampled PAHs under the NMP since 2008. Thus, Figure 19-5 presents the 1-year statistical metrics for the pollutant of interest for PRRI. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 19-5. Yearly Statistical Metrics for Naphthalene Concentrations Measured at PRRI



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.

Observations from Figure 19-5 for naphthalene concentrations measured at PRRI include the following:

- PRRI began sampling PAHs under the NMP in July 2008. Because a full year's worth of data is not available, a 1-year average concentration is not presented for 2008, although the range of measurements is provided.

- The maximum naphthalene concentration was measured at PRRI in 2011 (301 ng/m^3). In total, 10 naphthalene concentrations greater than 200 ng/m^3 have been measured at PRRI, of which seven were measured in November of any given year. In fact, the maximum concentration for all years between 2009 and 2013 was measured in November. Of the 25 naphthalene concentrations greater than 150 ng/m^3 measured at PRRI, more than half (17) were measured during the fourth quarter of any given year and 22 of these 25 were measured during the first or fourth quarters (or the colder months of the year).

- Although the range of concentrations measured has varied between 2009 and 2012, the 1-year average concentrations of naphthalene exhibit little variability, ranging from 71.39 ng/m^3 (2010) to 77.73 ng/m^3 (2009). This is also true for the median concentration, which, including 2008, ranges from 58.90 ng/m^3 (2008) to 64.80 ng/m^3 (2009).

- The concentrations of naphthalene measured at PRRI have a decreasing trend between 2012 and 2014. Several of the statistical parameters are at a minimum for 2014, including the 1-year average concentration and the median concentration (42.20 ng/m^3). The median concentration is less than 50 ng/m^3 for the first time since the onset of sampling.

19.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the PRRI monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

19.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Rhode Island monitoring site and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 19-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 19-5. Risk Approximations for the Rhode Island Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Providence, Rhode Island - PRRI						
Naphthalene	0.000034	0.003	58/58	52.06 ± 8.40	1.77	0.02

Observations for PRRI from Table 19-5 include the following:

- Naphthalene has both a cancer URE and a noncancer RfC.
- The cancer risk approximation for naphthalene is 1.77 in-a-million.
- The noncancer hazard approximation for naphthalene is negligible (0.02), indicating that no adverse noncancer health effects are expected from this individual pollutant.

19.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 19-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 19-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 19-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for PRRI, as presented in Table 19-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 19-6. Table 19-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on the site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 19.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 19-6. 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 UREs (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)**
Providence, Rhode Island (Providence County) - PRRI					
Benzene	196.93	Formaldehyde	1.89E-03	Naphthalene	1.77
Formaldehyde	145.48	Benzene	1.54E-03		
Ethylbenzene	94.74	1,3-Butadiene	9.40E-04		
Acetaldehyde	76.01	Naphthalene	5.27E-04		
1,3-Butadiene	31.32	POM, Group 2b	4.00E-04		
Tetrachloroethylene	17.48	POM, Group 2d	2.39E-04		
Naphthalene	15.50	Ethylbenzene	2.37E-04		
Trichloroethylene	6.49	POM, Group 5a	2.30E-04		
POM, Group 2b	4.54	Arsenic, PM	1.83E-04		
Dichloromethane	4.12	Acetaldehyde	1.67E-04		

Table 19-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Rhode Island Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Providence, Rhode Island (Providence County) - PRRI					
Toluene	636.76	Acrolein	336,121.99	Naphthalene	0.02
Xylenes	390.67	1,3-Butadiene	15,660.35		
Methanol	386.43	Formaldehyde	14,844.73		
Hexane	324.64	Acetaldehyde	8,445.40		
Benzene	196.93	Benzene	6,564.42		
Formaldehyde	145.48	Naphthalene	5,167.59		
Ethylene glycol	130.02	Xylenes	3,906.66		
Ethylbenzene	94.74	Nickel, PM	3,332.59		
Acetaldehyde	76.01	Trichloroethylene	3,243.04		
Methyl isobutyl ketone	41.59	Arsenic, PM	2,840.49		

Observations from Table 19-6 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Providence County.

- Formaldehyde is the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by benzene and 1,3-butadiene.

- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Providence County.

- Naphthalene, which is the only pollutant of interest for PRRI, has the seventh highest emissions and the fourth highest toxicity-weighted emissions for Providence County.

- Several POM Groups appear among the pollutants with the highest toxicity-weighted emissions for Providence County. POM, Groups 2b and 2d rank fifth and sixth for their toxicity-weighted emissions, respectively, and POM, Group 2b also ranks ninth for its quantity emitted. POM, Group 2b includes several PAHs sampled for at PRRI, although none of these pollutants failed screens.

- POM, Group 5a ranks eighth for toxicity-weighted emissions. POM, Group 5a includes benzo(a)pyrene, which failed a single screen for PRRI. POM, Group 5a is not among the highest emitted "pollutants" in Providence County.

Observations from Table 19-7 include the following:

- Toluene, xylenes, and methanol are the highest emitted pollutants with noncancer RfCs in Providence County.

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

- Four of the highest emitted pollutants in Providence County also have the highest toxicity-weighted emissions.

- Although naphthalene ranks sixth among the pollutants with the highest toxicity-weighted emissions, it is not one of the highest emitted pollutants (with a noncancer RfC) in Providence County (it ranks 15th).

19.6 Summary of the 2014 Monitoring Data for PRRI

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

- *Naphthalene and benzo(a)pyrene each failed at least one screen for PRRI, with concentrations of naphthalene accounting for 98 percent of the failed screens. As such, naphthalene is PRRI's only pollutant of interest.*

- *Concentrations of naphthalene measured at PRRI span an order of magnitude, ranging from 14.7 ng/m^3 to 163 ng/m^3.*

- *Concentrations of naphthalene measured at PRRI have a decreasing trend over the last two years.*

20.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

20.1 Site Characterization

This section characterizes the Utah 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 BTUT monitoring site is located in Bountiful, in northern Utah. Figure 20-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 20-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 20-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 20-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 20-1. Bountiful, Utah (BTUT) Monitoring Site

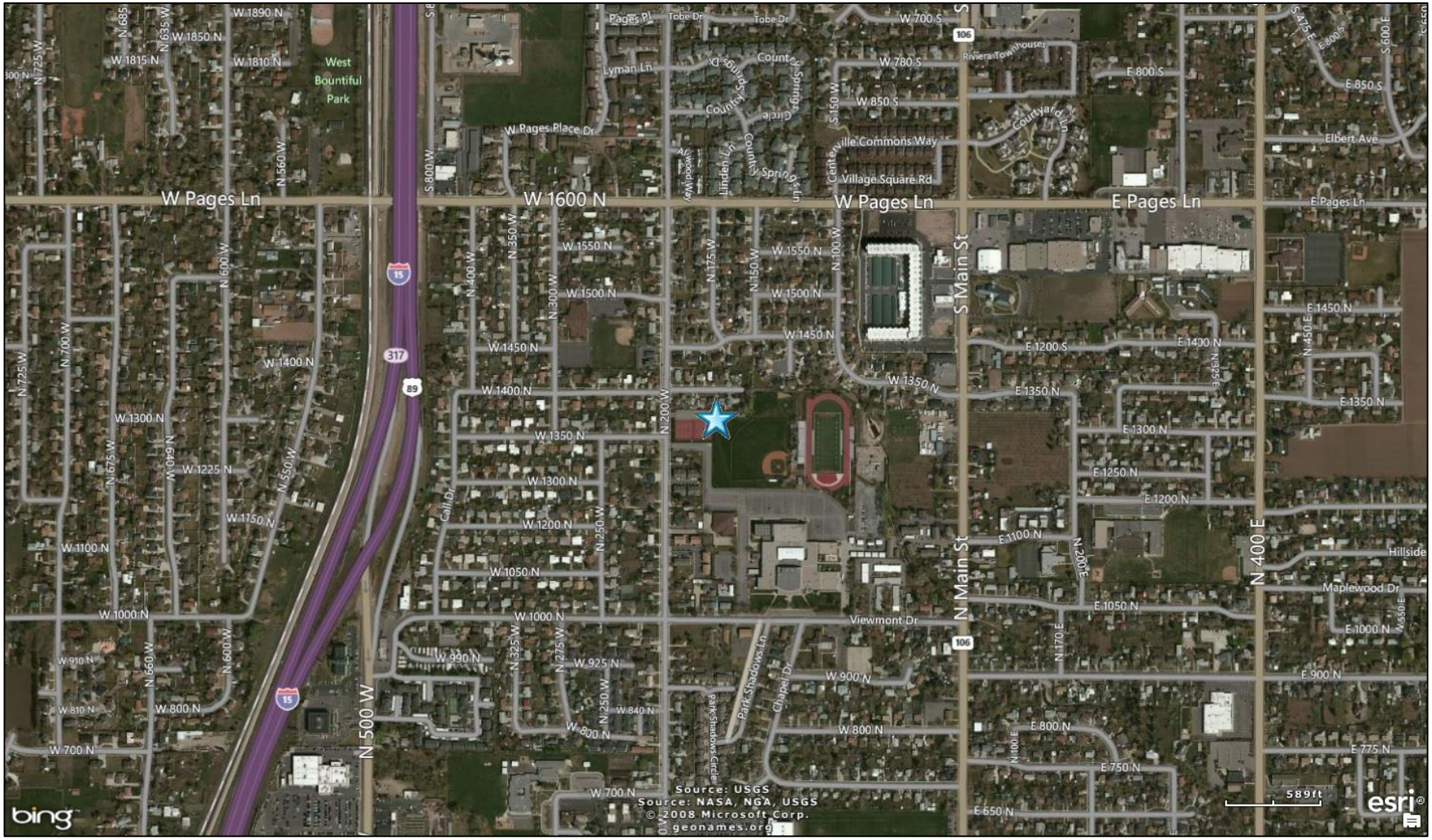
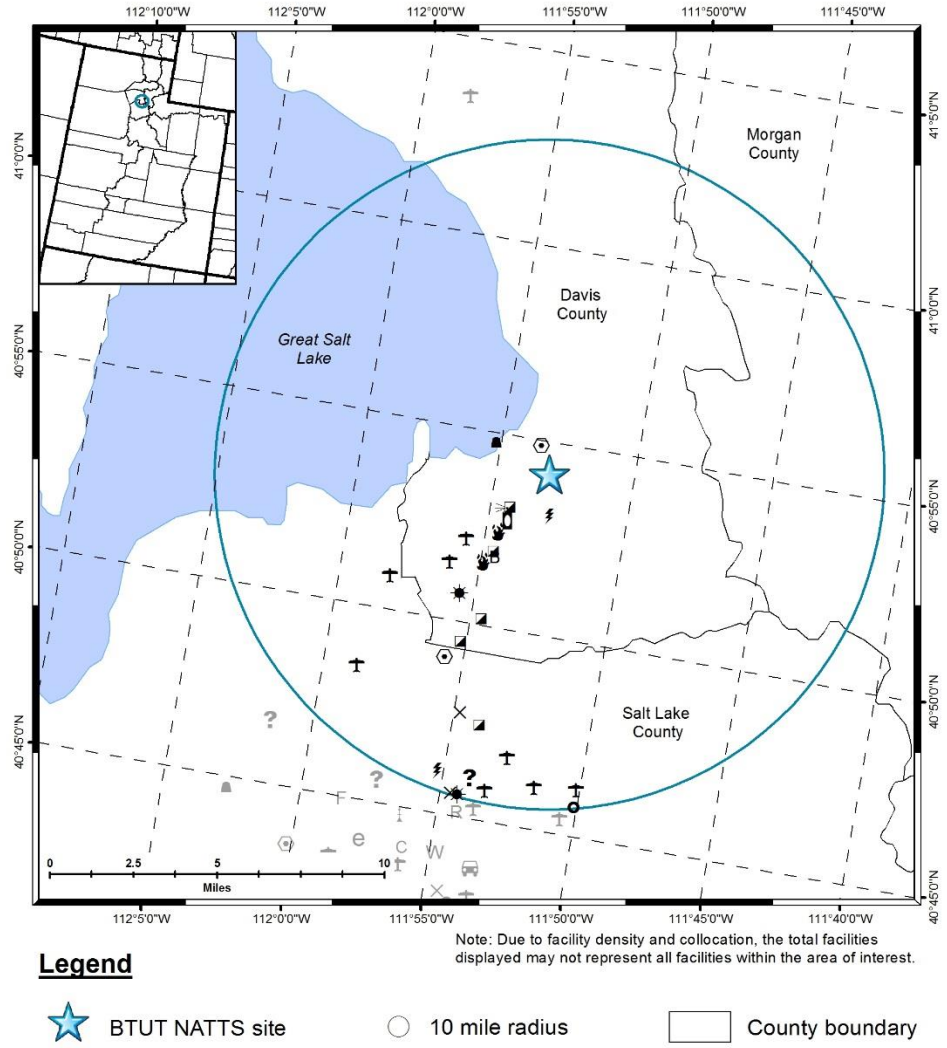


Figure 20-2. NEI Point Sources Located Within 10 Miles of BTUT



Legend

BTUT NATTS site | 10 mile radius | County boundary

Source Category Group (No. of Facilities)

- Airport/Airline/Airport Support Operations (8)
- Asphalt Production/Hot Mix Asphalt Plant (2)
- Bulk Terminals/Bulk Plants (1)
- Electricity Generation via Combustion (2)
- Industrial Machinery or Equipment Plant (2)
- Institutional (school, hospital, prison, etc.) (1)
- Landfill (1)
- Metals Processing/Fabrication Facility (2)
- Miscellaneous Commercial/Industrial Facility (1)
- Paint and Coating Manufacturing Facility (1)
- Petroleum Refinery (5)
- Rail Yard/Rail Line Operations (2)

Table 20-1. 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	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
BTUT	49-011-0004	Bountiful	Davis	Ogden-Clearfield, UT	40.902967, -111.884467	Residential	Suburban	130,950	I-15, North of Hwy 89 junction

[1]AADT reflects 2013 data (UT DOT, 2013)
BOLD ITALICS = EPA-designated NATTS Site

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 20-1 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 20-2 shows that most of the point sources near BTUT are located to the south of the site and run parallel to I-15. The facilities surrounding BTUT are involved in a variety of industries, although the source categories with the greatest number of point sources surrounding BTUT are the airport and airport support operations category and the petroleum refineries source category. The airport source category includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Point sources within 2 miles of BTUT include a metals processing/fabrication facility, a facility generating electricity via combustion, a petroleum refinery, a paint and coatings manufacturer, and a landfill.

In addition to providing city, county, CBSA, and land use/location setting information, Table 20-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near BTUT is nearly 131,000 and ranks in the top third compared to the traffic volumes for other NMP sites. The traffic estimate provided is for I-15, north of the Highway 89 junction, just west of the site.

20.2 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 the year.

20.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If

site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Utah site, site-specific data were available for some, but not all, of the parameters in Table 20-2. For BTUT, temperature, pressure, humidity, and wind information was available in AQS. Data from the NWS weather station at Salt Lake City International Airport (WBAN 24127) were used for the remaining parameters (sea level pressure and dew point temperature). The Salt Lake City International Airport weather station is located 9.7 miles south-southwest of BTUT. A map showing the distance between the monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 20-2. Average Meteorological Conditions near the Utah Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Bountiful, Utah - BTUT[2]							
Sample Days (71)	54.2 ± 0.9	33.7 ± 0.5	49.0 ± 1.0	29.96 ± 0.01	25.67 ± 0.01	SE	3.5 ± 0.1
2014	53.7 ± 0.4	33.3 ± 0.2	50.0 ± 0.5	29.98 ± <0.01	25.68 ± <0.01	SE	3.4 ± <0.1

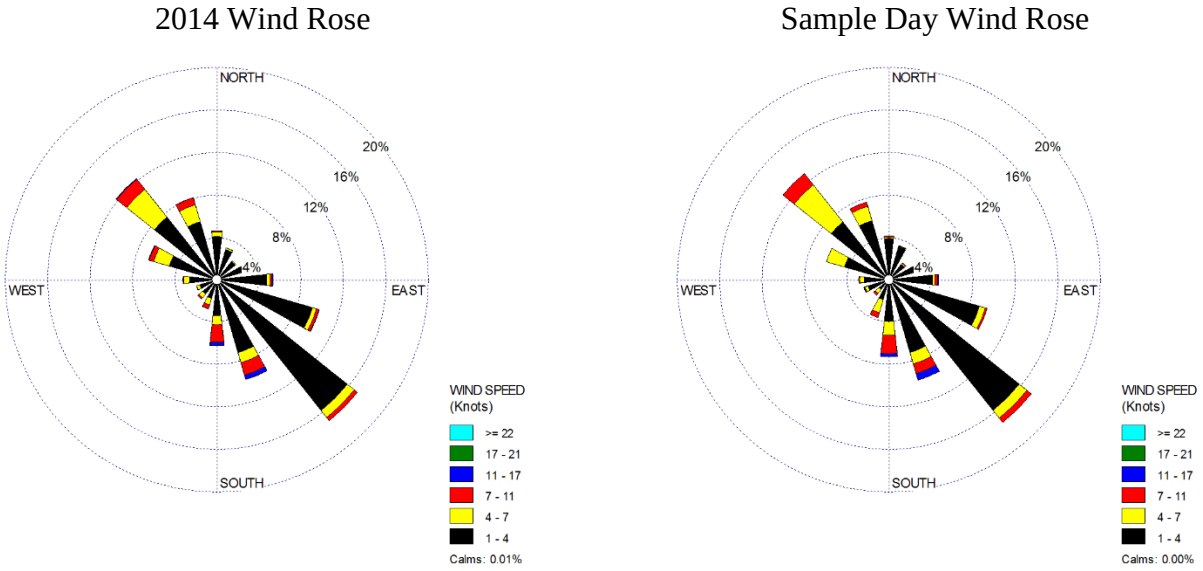
[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure, and wind parameters were measured at BTUT. The remaining information was obtained from the closest NWS weather station located at Salt Lake City International, WBAN 24127.

Table 20-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 20-2 is the 95 percent confidence interval for each parameter. Average meteorological conditions on sample days at BTUT were representative of average weather conditions experienced throughout the year.

20.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 20-3 presents two wind roses for the BTUT monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 20-3. Wind Roses for the Wind Data Collected at BTUT



Observations from Figure 20-3 for BTUT include the following:

- The full-year wind rose shows that winds from the southeast and northwest quadrants were prevalent at BTUT in 2014, with southeasterly winds observed the most. Winds from the northeast and southwest quadrants were infrequently observed. Winds were generally light at BTUT although calm winds were rarely observed. The strongest wind speeds were most often observed with south-southeasterly and southerly winds.

- The wind patterns shown on the sample day wind rose are similar to the full-year wind patterns, indicating that wind conditions in 2014 were similar to wind conditions experienced on sample days at BTUT.

20.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the Utah monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 20-3. 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 and are shaded in gray in Table 20-3. It is important to note which pollutants each site sampled for when reviewing the results of this analysis. VOCs, carbonyl compounds, SNMOCs, PAHs, and metals (PM_{10}) were sampled for at BTUT. BTUT is one of only three NMP sites sampling five suites of pollutants under the NMP and one of only two NMP sites sampling both SNMOC and VOCs (NBIL is the other).

Table 20-3. Risk-Based 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						
Acetaldehyde	0.45	58	58	100.00	11.67	11.67
Formaldehyde	0.077	58	58	100.00	11.67	23.34
Benzene	0.13	55	55	100.00	11.07	34.41
Carbon Tetrachloride	0.17	55	55	100.00	11.07	45.47
1,2-Dichloroethane	0.038	54	54	100.00	10.87	56.34
1,3-Butadiene	0.03	46	50	92.00	9.26	65.59
Arsenic (PM_{10})	0.00023	42	52	80.77	8.45	74.04
Naphthalene	0.029	41	58	70.69	8.25	82.29
Hexachloro-1,3-butadiene	0.045	28	29	96.55	5.63	87.93
Dichloromethane	60	20	55	36.36	4.02	91.95
Ethylbenzene	0.4	11	55	20.00	2.21	94.16
Nickel (PM_{10})	0.0021	8	57	14.04	1.61	95.77
1,2-Dibromoethane	0.0017	6	6	100.00	1.21	96.98
p-Dichlorobenzene	0.091	5	26	19.23	1.01	97.99
Propionaldehyde	0.8	5	58	8.62	1.01	98.99
Lead (PM_{10})	0.015	2	57	3.51	0.40	99.40
Benzo(a)pyrene	0.00057	1	24	4.17	0.20	99.60
Cadmium (PM_{10})	0.00056	1	57	1.75	0.20	99.80
Chloroprene	0.0021	1	1	100.00	0.20	100.00
Total		497	865	57.46		

Observations from Table 20-3 include the following:

- Concentrations of 19 pollutants failed at least one screen for BTUT; approximately 57 percent of concentrations for these 19 pollutants were greater than their associated risk screening value (or failed screens). BTUT has the second highest number of individual pollutants failing screens.

- Concentrations for 12 pollutants contributed to 95 percent of failed screens for BTUT and therefore were identified as pollutants of interest for this site. These 12 include two carbonyl compounds, seven VOCs, two PM_{10} metals, and one PAH.

- Acetaldehyde, formaldehyde, benzene and carbon tetrachloride were detected in every valid carbonyl compound and VOC sample collected at BTUT and failed 100 percent of screens. Other pollutants also failed 100 percent of screens but were detected less frequently.

- 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-based screening process. As BTUT sampled both VOCs (TO-15) and SNMOCs, the TO-15 results were used for the 12 pollutants these methods have in common.

20.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Utah monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at BTUT are provided in Appendix J through Appendix N.

20.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for BTUT, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the Utah monitoring site are presented in Table 20-4, where applicable. Note that concentrations of the PAHs and PM_{10} metals are presented in ng/m^3 in Table 20-4 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average concentration simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 20-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Utah Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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	58/58	58	2.39 ± 0.44	3.06 ± 0.30	3.42 ± 0.90	4.27 ± 0.56	3.33 ± 0.34
Benzene	55/55	55	0.86 ± 0.25	0.39 ± 0.12	0.68 ± 0.20	0.98 ± 0.24	0.73 ± 0.12
1,3-Butadiene	50/48	55	0.10 ± 0.03	0.03 ± 0.02	0.05 ± 0.01	0.10 ± 0.04	0.07 ± 0.01
Carbon Tetrachloride	55/55	55	0.54 ± 0.06	0.64 ± 0.03	0.60 ± 0.03	0.60 ± 0.07	0.60 ± 0.03
1,2-Dichloroethane	54/54	55	0.17 ± 0.02	0.10 ± 0.01	0.09 ± 0.01	0.09 ± 0.02	0.11 ± 0.01
Dichloromethane	55/55	55	830.76 ± 1442.97	493.12 ± 415.95	58.37 ± 55.20	1.81 ± 0.85	314.23 ± 316.90
Ethylbenzene	55/54	55	0.34 ± 0.13	0.17 ± 0.06	0.33 ± 0.12	0.35 ± 0.10	0.30 ± 0.05
Formaldehyde	58/58	58	3.35 ± 0.80	5.46 ± 0.55	5.51 ± 0.91	8.87 ± 1.72	5.92 ± 0.73
Hexachloro-1,3-butadiene	29/0	55	0.06 ± 0.03	0.04 ± 0.02	0.05 ± 0.02	0.03 ± 0.02	0.05 ± 0.01
Arsenic (PM_{10})[a]	52/42	57	0.84 ± 0.97	0.55 ± 0.19	0.82 ± 0.22	0.94 ± 0.48	0.79 ± 0.26
Naphthalene[a]	58/58	58	50.13 ± 21.23	35.34 ± 6.48	35.37 ± 5.65	51.07 ± 13.90	42.98 ± 6.51
Nickel (PM_{10})[a]	57/57	57	1.42 ± 0.84	1.25 ± 0.26	1.33 ± 0.29	1.54 ± 0.47	1.38 ± 0.24

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

Observations for BTUT from Table 20-4 include the following:

- The pollutants with the highest annual average concentrations are dichloromethane, formaldehyde, acetaldehyde, and benzene, consistent with the last several years of sampling.

- Dichloromethane has the highest annual average concentration for BTUT again for 2014, and is similar to its annual average calculated for 2013. The annual average concentration for 2014 has a very large confidence interval associated it, indicating the likely presence of outliers, as do the quarterly average concentrations. A review of the data shows that concentrations of dichloromethane measured at BTUT in 2014 range from 0.491 µg/m^3 to 8,423 µg/m^3. The maximum concentration of this pollutant was measured on March 30, 2014 and is one of four dichloromethane concentrations greater than 1,000 µg/m^3 measured at this site. Fifteen of the 21 dichloromethane concentrations greater than 100 µg/m^3 measured across the program were measured at BTUT (with the other six measured at GPCO). The median concentration of dichloromethane for BTUT is 21.10 µg/m^3, which is greater than all but one of the other NMP sites' annual average dichloromethane concentrations,

indicating that the statistics for this site are not being thrown off just by one or two outliers. The four highest dichloromethane concentrations measured at BTUT were measured between March 30, 2014 and May 11, 2014; concentrations greater than 250 µg/m^3 were not measured after July; and concentrations greater than 100 µg/m^3 were not measured after the third quarter of 2014. In fact, dichloromethane concentrations greater than 10 µg/m^3 were not measured during the fourth quarter of 2014, while between six and 13 were measured during each of the other calendar quarters. The quarterly average concentrations shown in Table 20-4 reflect these variations in concentrations measured each quarter.

- The quarterly average concentrations of formaldehyde show that concentrations of this pollutant were highest during the fourth quarter of 2014 and lowest during the first quarter of 2014. The fourth quarter average concentration is more than twice the first quarter average, with the second and third quarter averages in-between the two. Formaldehyde concentrations measured at BTUT in 2014 range from 2.01 µg/m^3 to 12.8 µg/m^3. All but one of the nine formaldehyde concentrations greater than 10 µg/m^3 were measured between November and December. Conversely, six of the seven lowest formaldehyde concentrations were measured at BTUT during the first quarter of 2014. Similar observations can be made for the quarterly average concentrations of acetaldehyde. Acetaldehyde concentrations measured at BTUT in 2014 range from 1.37 µg/m^3 to 9.15 µg/m^3. All but one of the 15 acetaldehyde concentrations greater than 4 µg/m^3 were measured during the second half of the year, with the majority measured during the fourth quarter (10).

- Concentrations of benzene appear lowest during the second quarter and highest during the fourth quarter, based on the quarterly average concentrations shown in Table 20-4. A review of the data shows that concentrations of benzene measured at BTUT range from 0.131 µg/m^3 to 2.05 µg/m^3, with all seven benzene measurements less than 0.3 µg/m^3 measured during the second quarter of 2014. In fact, benzene concentrations greater than 1 µg/m^3 were not measured during the second quarter, the only quarter for which this is true, with three measured during the first quarter, two during the third, and seven during the fourth. Concentrations of ethylbenzene also appear lowest during the second quarter of 2014. Ethylbenzene concentrations greater than 0.4 µg/m^3 were not measured at BTUT during the second quarter while at least three concentrations greater than 0.4 µg/m^3 were measured during each of the other calendar quarters. In addition, all four ethylbenzene measurements less than 0.1 µg/m^3 were measured at BTUT during the second quarter.

- Concentrations of 1,3-butadiene were higher during the first and fourth quarters of 2014, or during the colder months of the year, based on the quarterly averages shown in Table 20-4. All 14 1,3-butadiene concentrations greater than 0.1 µg/m^3 measured at BTUT were measured during the first or fourth quarters, specifically in January (2), February (4), October (1), November (4), or December (3). The maximum 1,3-butadiene concentration (0.266 µg/m^3) was measured on November 19, 2014, the same day as the maximum benzene concentration. Four of the five non-detects of 1,3-butadiene were measured during the second quarter, with the fifth measured in December.

- The first quarter average concentration of 1,2-dichloroethane is significantly greater than the other the three quarterly average concentrations of this pollutant. All seven 1,2-dichloroethane concentrations greater than 0.15 µg/m^3 were measured between January and March. In addition, only one measurement of this pollutant less than 0.1 µg/m^3 was measured during the first quarter compared to eight, 11, and nine measured during the following calendar quarters, respectively.

- The first quarter average arsenic concentration has a confidence interval larger than its associated quarterly average, indicating that concentrations measured during this quarter are highly variable. A review of the data shows that concentrations of arsenic measured at BTUT range from 0.03 ng/m^3 to 5.04 ng/m^3, and include five non-detects. Both the highest and lowest arsenic concentrations were measured at BTUT during the first quarter. All five non-detects were measured during the first quarter, with three measured in February and one each in January and March. Additionally, the two highest concentration (5.04 ng/m^3 and 4.86 ng/m^3) were measured in January. These two measurements are the second and third highest arsenic concentrations measured among NMP sites sampling metals. Three of the seven arsenic concentrations greater than 3 ng/m^3 measured across the program were measured at BTUT.

- Concentrations of nickel measured at BTUT range from 0.27 ng/m^3 to 5.76 ng/m^3, with the maximum concentration measured on the same day as the maximum arsenic concentration (January 17, 2014). BTUT is one of five NMP sites sampling PM_{10} metals with a nickel concentrations greater than 5 ng/m^3. Less than 0.3 ng/m^3 separates the quarterly average concentrations of nickel for BTUT but the first quarter average has a confidence interval that is two to three times greater than the confidence intervals for the other quarterly average concentrations. The range of concentrations measured during the first quarter is two to three times the range of concentrations measured during the other calendar quarters. Although the number of nickel concentrations greater than 1 ng/m^3 measured during the first quarter (6) is less than the number measured during each of the other quarters (between 9 and 11), the magnitude of the maximum concentration compared to the other concentrations is driving the average upward.

- Concentrations of naphthalene appear highest during the first and fourth quarters of the year, and exhibit more variability, based on the quarterly average concentrations shown in Table 20-4. Concentrations of naphthalene measured at BTUT range from 11.6 ng/m^3 to 147 ng/m^3, with the maximum concentration of naphthalene measured on January 17, 2014 (which is the same day as the maximum nickel and arsenic concentrations were measured). All 11 concentrations of naphthalene greater than 60 ng/m^3 were measured at BTUT in January (4), October (2), November (3), or December (2).

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

- BTUT appears in Table 4-9 through 4-12 a total of seven times for the program-level pollutants of interest.

- BTUT is listed for three of the program-level VOC pollutants of interest shown in Table 4-9. BTUT has the highest annual average concentration for hexachloro-1,3-butadiene among NMP sites sampling this pollutant. BTUT is the only NMP site for which more than half of the hexachloro-1,3-butadiene measurements were measured detections (as opposed to non-detects). BTUT also ranks sixth for 1,2-dichloroethane and seventh for *p*-dichlorobenzene.

- For the fourth year in a row, BTUT has the highest annual average concentration of formaldehyde among NMP sites sampling carbonyl compounds, as shown in Table 4-10, with a statistically significant difference shown between the first and second ranking monitoring sites. BTUT is the only site for which the annual average concentration is greater than 5 $\mu g/m^3$. For the second year in a row, BTUT also ranks highest for its annual average concentration of acetaldehyde, with the only annual average concentration greater than 3 $\mu g/m^3$ among NMP sites.

- BTUT does not appear in Table 4-11 for PAHs. This site's annual average concentration of the naphthalene is among the lower averages for sites sampling PAHs. A similar observation was made in the 2013 report.

- BTUT ranks fifth highest for its annual average concentration of arsenic (PM_{10}), as shown in Table 4-12. BTUT's annual average concentration ranks sixth highest for nickel.

20.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 20-4 for BTUT. Figures 20-4 through 20-15 overlay the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 20-4. Program vs. Site-Specific Average Acetaldehyde Concentration

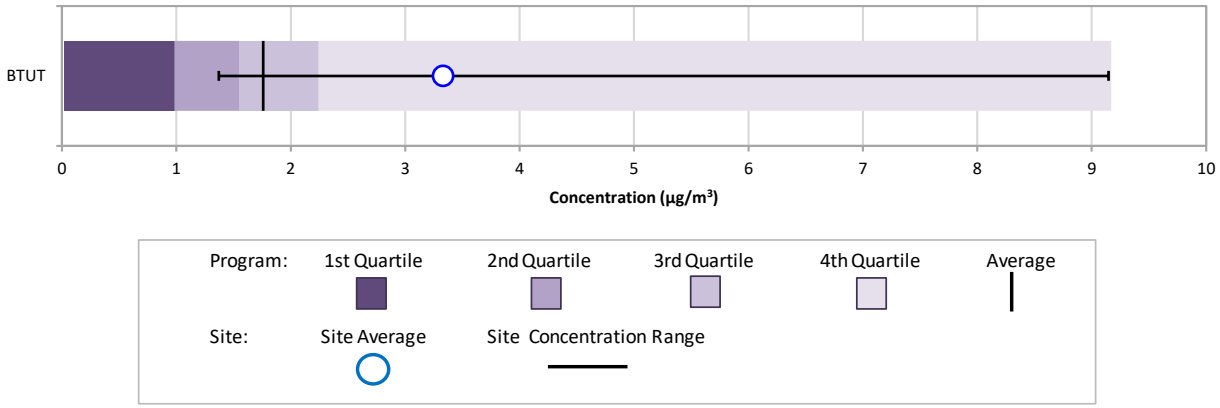


Figure 20-4 presents the box plot for acetaldehyde for BTUT and shows the following:

- The maximum acetaldehyde concentration measured at BTUT is also the maximum acetaldehyde concentration measured at the program-level.

- The minimum acetaldehyde concentration measured at BTUT (1.37 µg/m^3) is greater than the program-level first quartile but less than the program-level median concentration. BTUT is one of four NMP sites whose minimum acetaldehyde concentration is greater than 1 µg/m^3.

- The annual average acetaldehyde concentration for BTUT is nearly twice the program-level average concentration, is greater than the program-level third quartile, and is the highest annual average concentration among NMP sites sampling carbonyl compounds.

Figure 20-5. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

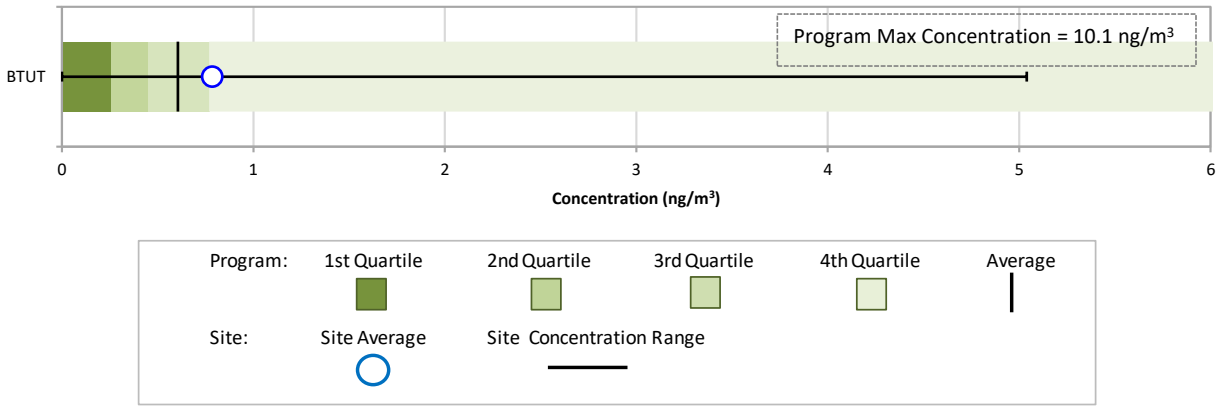


Figure 20-5 presents the box plot for arsenic (PM_{10}) for BTUT and shows the following:

- The program-level maximum arsenic (PM_{10}) concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 20-5 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 6 ng/m^3.

- Although BTUT's maximum arsenic concentration is not the maximum arsenic concentration measured at the program-level, it is the second highest arsenic concentration measured across the program.

- The annual average concentration of arsenic calculated for BTUT is greater than the program-level average concentration and is similar to the program-level third quartile. Recall from the previous section that BTUT has the fifth highest annual average concentration of arsenic among NMP sites sampling PM_{10} metals.

- Five non-detects of arsenic were measured at BTUT.

Figure 20-6. Program vs. Site-Specific Average Benzene Concentration

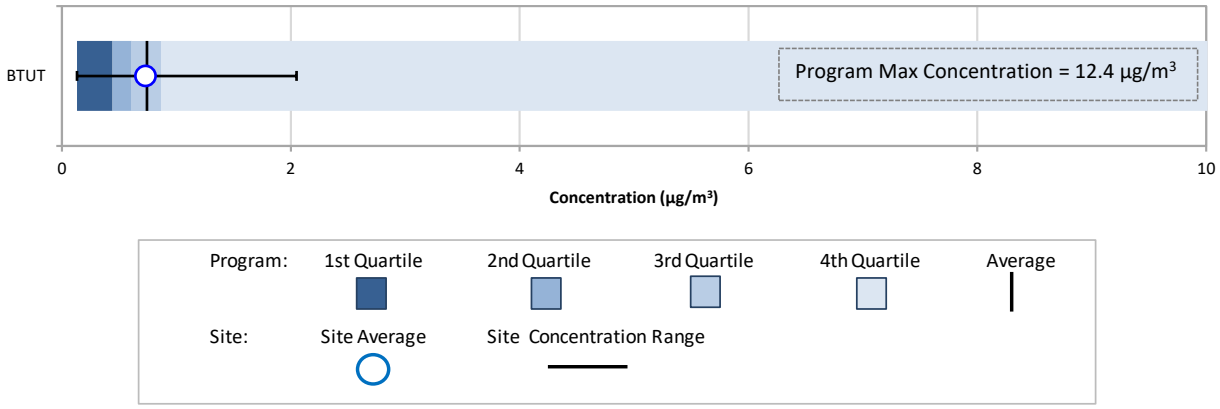


Figure 20-6 presents the box plot for benzene for BTUT and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The maximum benzene concentration measured at BTUT is about one-sixth the magnitude of the maximum benzene concentration measured across the program.

- The minimum benzene concentration measured across the program was measured at BTUT (0.131 µg/m^3).

- The annual average benzene concentration for BTUT is similar to the program-level average concentration (0.74 µg/m^3).

Figure 20-7. Program vs. Site-Specific Average 1,3-Butadiene Concentration

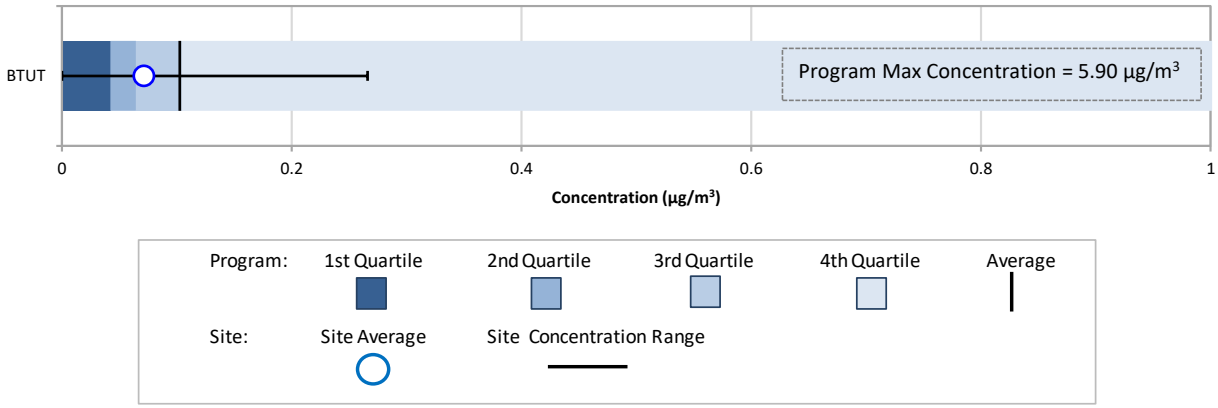


Figure 20-7 presents the box plot for 1,3-butadiene for BTUT and shows the following:

- Similar to benzene, the program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 1 µg/m^3.

- The maximum 1,3-butadiene concentration measured at BTUT is considerably less than the maximum concentration measured across the program.

- The annual average concentration of 1,3-butadiene for BTUT is just greater than the program-level median concentration.

- Five non-detects were measured at BTUT.

Figure 20-8. Program vs. Site-Specific Average Carbon Tetrachloride Concentration

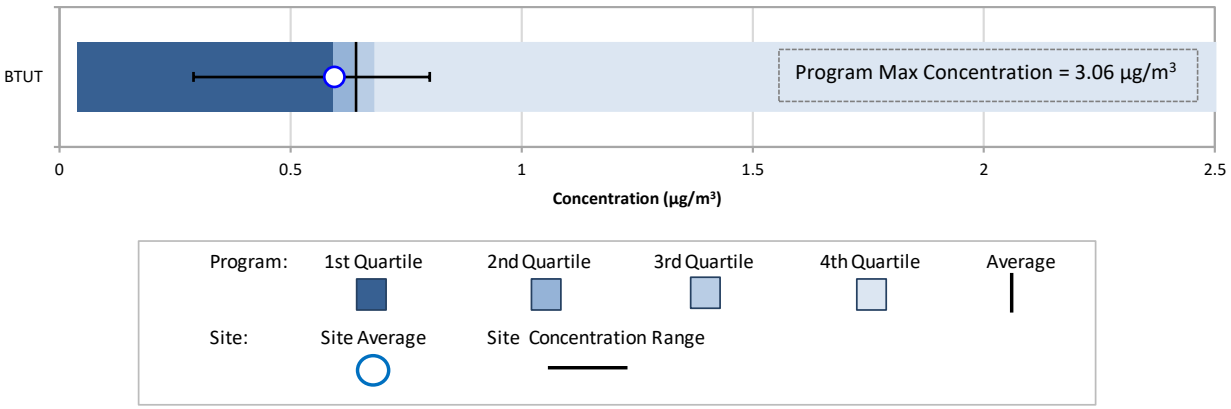


Figure 20-8 presents the box plot for carbon tetrachloride for BTUT and shows the following:

- The scale of the box plot for carbon tetrachloride has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that

the program-level median and average concentrations are similar and plotted nearly on top of each other.

- The range of carbon tetrachloride concentrations measured at BTUT span about 0.5 µg/m^3.

- The annual average concentration of carbon tetrachloride for BTUT is similar to the program-level first quartile and is the second-lowest annual average concentration among NMP sites sampling this pollutant, although the range of annual averages is relatively small for most of the sites.

Figure 20-9. Program vs. Site-Specific Average 1,2-Dichloroethane Concentration

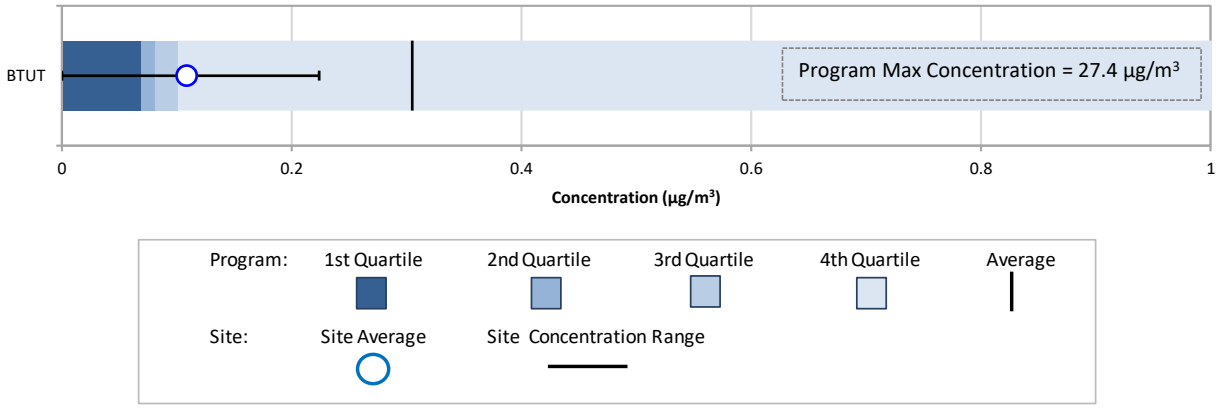


Figure 20-9 presents the box plot for 1,2-dichloroethane for BTUT and shows the following:

- The scale of the box plot in Figure 20-9 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- All of the concentrations of 1,2-dichloroethane measured at BTUT are less than the program-level average concentration of 0.31 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- The annual average concentration for BTUT is just greater than the program-level third quartile and ranks fifth highest among NMP sites sampling this pollutant. BTUT is the only non-Calvert City, Kentucky site for which the annual average concentration of 1,2-dichloroethane is greater than 0.1 µg/m^3, albeit only slightly.

- A single non-detect of 1,2-dichloroethane was measured at BTUT.

Figure 20-10. Program vs. Site-Specific Average Dichloromethane Concentration

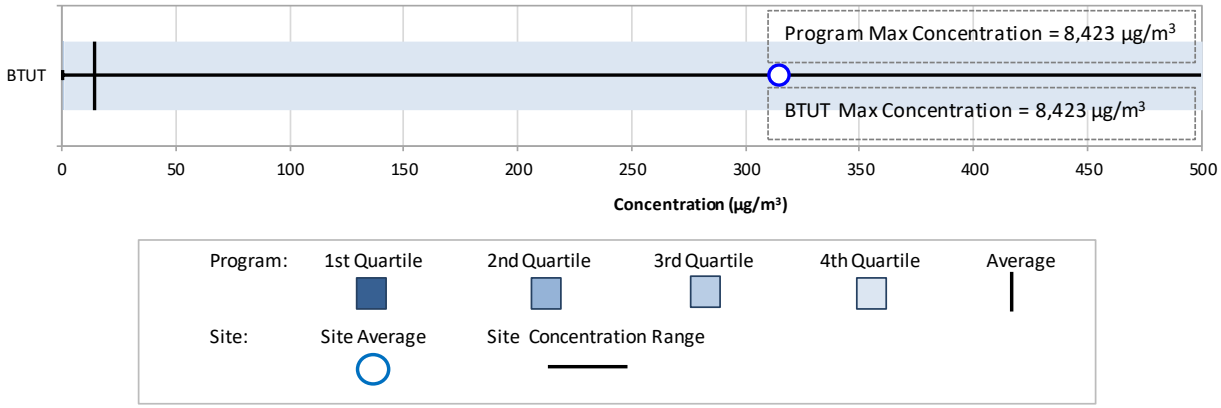


Figure 20-10 presents the box plot for dichloromethane for BTUT and shows the following:

- The maximum dichloromethane concentration across the program was measured at BTUT (8,423 µg/m^3) and is plotted on the box plot in Figure 20-10, as the box plot was reduced to 500 µg/m^3 in order to allow both the program-level average concentration and BTUT's annual average to appear on the figure. While the first, second, and third quartiles are still not visible on the box plot, this does indicate that a high percentage of the dichloromethane concentrations measured across the program fall below the concentration levels shown on the box plot and those measured at BTUT. The minimum dichloromethane concentration measured at BTUT (0.49 µg/m^3) is greater than the program-level median concentration (0.44 µg/m^3). As discussed in the previous section, dichloromethane concentrations measured at BTUT account for 15 of the 21 measurements greater than 100 µg/m^3 across the program. The maximum dichloromethane concentration measured at BTUT is more than 15 times greater than the next highest concentration measured at another NMP site. Concentrations of dichloromethane measured at BTUT typically run high compared to other NMP sites, but concentrations measured in 2014 are particularly high compared to past years. This was also true in 2013.

- The program-level average concentration (14.05 µg/m^3) is an order of magnitude greater than third quartile (0.91 µg/m^3), indicating that while most of the dichloromethane concentrations measured across the program are less than 1 µg/m^3, the concentrations at the upper end of the range are driving that program-level average. BTUT is the only site for which dichloromethane is a pollutant of interest and has the highest annual average concentration of dichloromethane among sites sampling this pollutant (the annual average concentration for BTUT is nearly eight times greater than the next highest annual average for an NMP sites sampling dichloromethane).

Figure 20-11. Program vs. Site-Specific Average Ethylbenzene Concentration

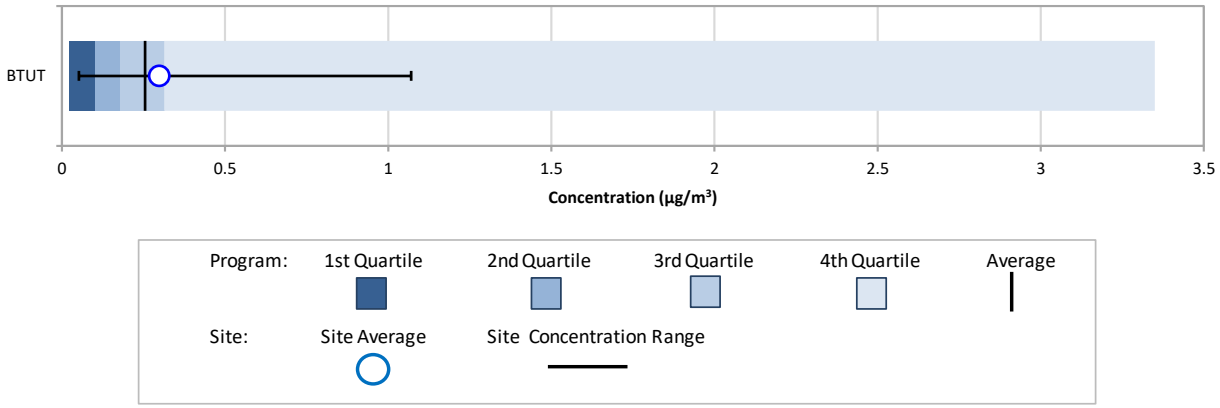


Figure 20-11 presents the box plot for ethylbenzene for BTUT and shows the following:

- Ethylbenzene concentrations measured at BTUT span about 1 µg/m^3.
- The annual average ethylbenzene concentration for BTUT lies between the program-level average concentration and the program-level third quartile.
- Non-detects of ethylbenzene were not measured at BTUT or at any of the NMP sites sampling this pollutant with Method TO-15.

Figure 20-12. Program vs. Site-Specific Average Formaldehyde Concentration

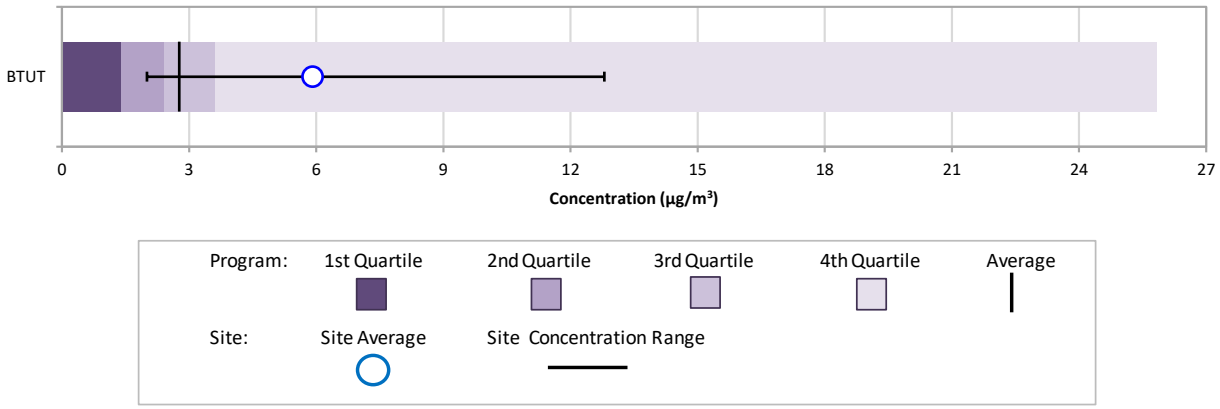


Figure 20-12 presents the box plot for formaldehyde for BTUT and shows the following:

- The minimum formaldehyde concentration measured at BTUT (2.01 µg/m^3) is greater than the program-level first quartile but less than the program-level median concentration. BTUT is one of only three NMP sites at which the minimum formaldehyde concentration measured is greater than 2 µg/m^3.

- The annual average formaldehyde concentration for BTUT is more than two times greater than the program-level average concentration and, as discussed in the previous section, is the highest annual average formaldehyde concentration among NMP sites sampling carbonyl compounds.

- Even though the maximum formaldehyde concentration was not measured at BTUT, this site has the greatest number of formaldehyde concentrations greater than 10 µg/m^3 among NMP sites sampling carbonyl compounds (nine, compared five for NBNJ and two or less for five additional sites).

Figure 20-13. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentration

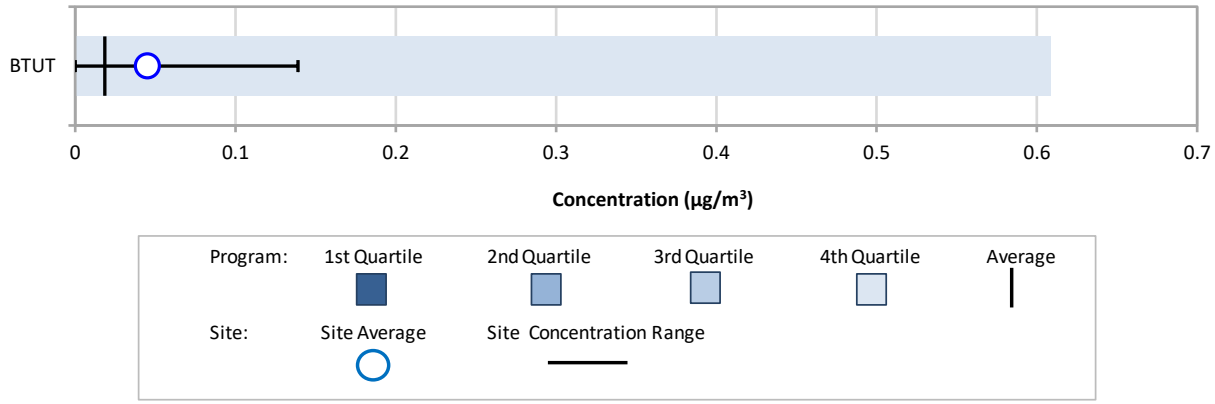


Figure 20-13 presents the box plot for hexachloro-1,3-butadiene for BTUT and shows the following:

- The program-level first, second, and third quartiles for hexachloro-1,3-butadiene are zero and therefore not visible on the box plot.

- Twenty-six non-detects of hexachloro-1,3-butadiene were measured at BTUT, which is the least number of non-detects among NMP sites sampling this pollutant. None of the remaining measurements were greater than the MDL for this pollutant.

- While the maximum concentration measured at BTUT (0.139 µg/m^3) is considerably less than the maximum concentration measured across the program (0.609 µg/m^3), it is the second highest measurement of this pollutant (although the same concentration was also measured at one other NMP site).

- The annual average concentration of hexachloro-1,3-butadiene for BTUT is nearly three times greater than the program-level average concentration (0.018 µg/m^3) and is the highest annual average concentration among NMP sites sampling this pollutant.

Figure 20-14. Program vs. Site-Specific Average Naphthalene Concentration

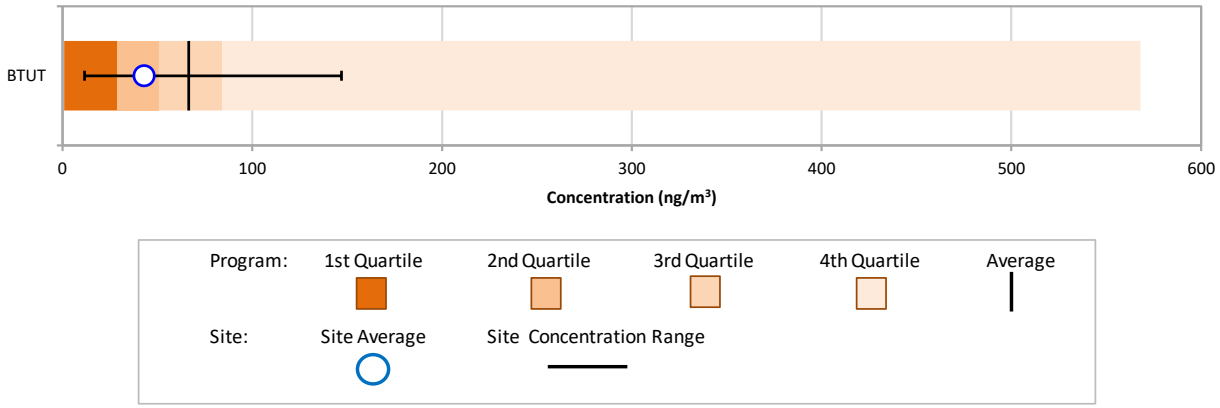


Figure 20-14 presents the box plot for naphthalene for BTUT and shows the following:

- The annual average naphthalene concentration for BTUT falls between the program-level first quartile (28.90 ng/m^3) and the program-level median concentration (50.70 ng/m^3).

- The annual average concentration of naphthalene for BTUT ranks 17th among the 19 sites sampling this pollutant.

Figure 20-15. Program vs. Site-Specific Average Nickel (PM_{10}) Concentration

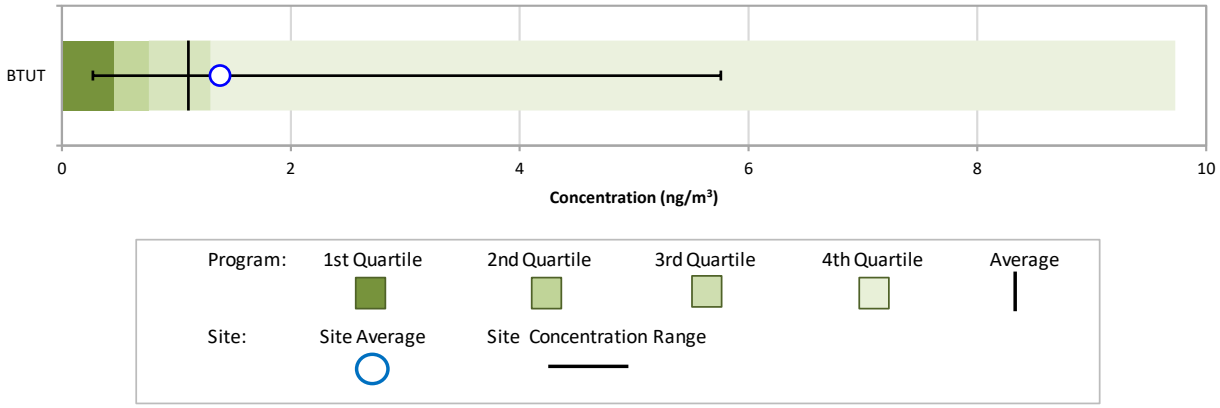


Figure 20-15 presents the box plot for nickel (PM_{10}) for BTUT and shows the following:

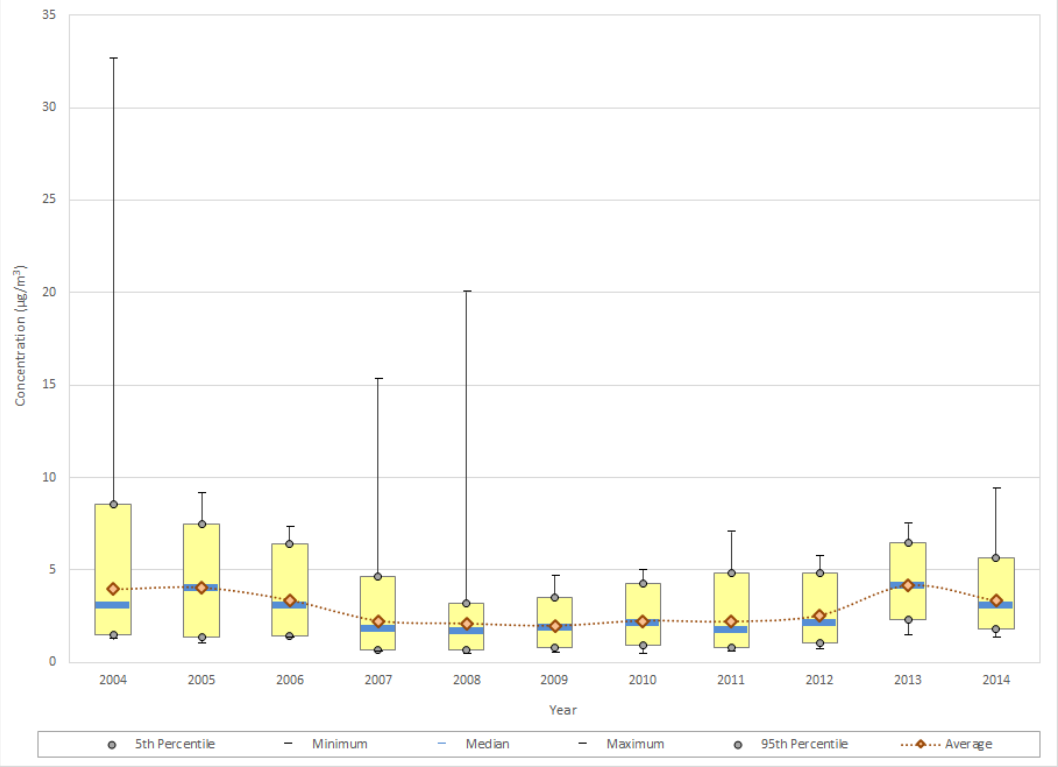
- The maximum concentration of nickel measured at BTUT is the 12th highest nickel concentration measured across the program.

- The annual average concentration of nickel for BTUT is greater than the program-level average concentration and just greater than the program-level third quartile. BTUT's annual average concentration ranks sixth among other NMP sites sampling PM_{10} metals.

20.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. BTUT has sampled carbonyl compounds, VOCs, metals, and SNMOCs under the NMP since 2003 and PAHs since 2008. Thus, Figures 20-16 through 20-28 present the 1-year statistical metrics for each of the pollutants of interest for BTUT. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 20-16. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at BTUT



Observations from Figure 20-16 for acetaldehyde concentrations measured at BTUT include the following:

- Sampling for carbonyl compounds under the NMP began at BTUT in late July 2003. Because this represents less than half of the sampling year, Figure 20-16 excludes data from 2003.

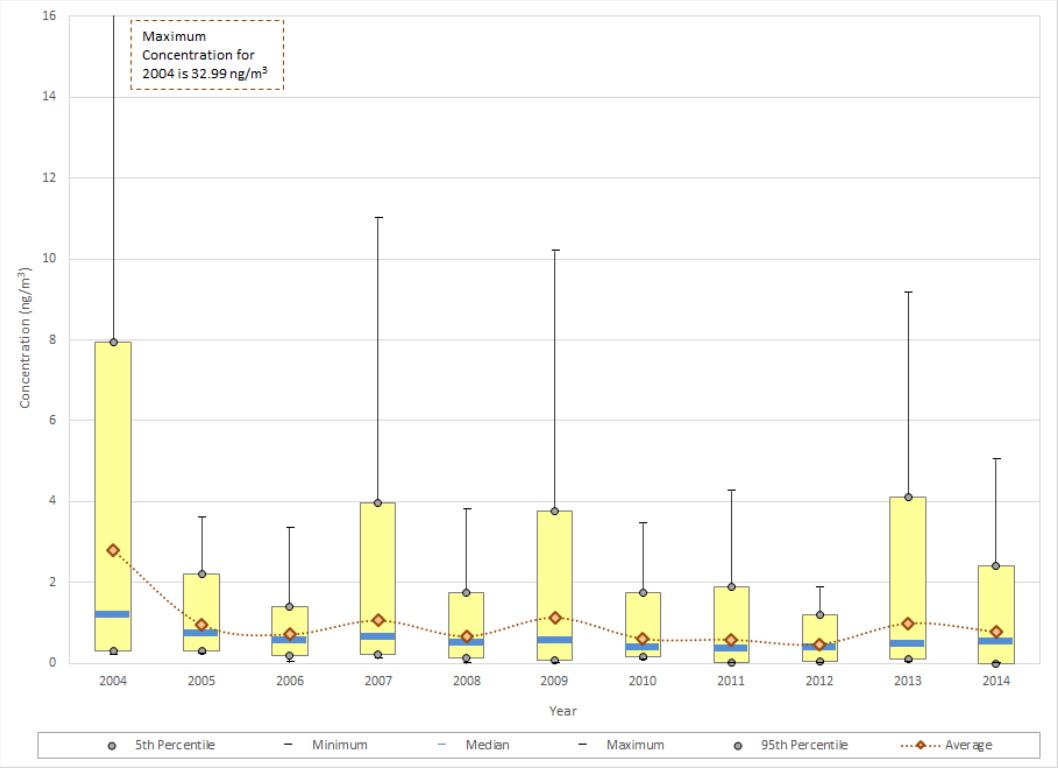
- The maximum acetaldehyde concentration was measured in 2004 (32.7 µg/m^3). Concentrations of acetaldehyde greater than 10 µg/m^3 were also measured at BTUT in 2008 (20.0 µg/m^3), 2007 (15.3 µg/m^3), and another in 2004 (10.8 µg/m^3). Acetaldehyde concentrations greater than 10 µg/m^3 have not been measured at BTUT since 2008.

- After 2005, the 1-year average concentration exhibits a steady decreasing trend through 2009, when the 1-year average concentration reaches a minimum (1.97 µg/m^3), although the most significant changes occurred between 2005 and 2007. Between 2007 and 2011, the 1-year average concentration varied by less than 0.3 µg/m^3, ranging from 1.97 µg/m^3 (2009) to 2.25 µg/m^3 (2010).

- Although the range of concentrations measured in 2012 is smaller than the range measured in 2011, a slight increase is shown in both the 1-year average and median concentrations for 2012. The slight increase for 2012 is followed by a significant increase for 2013, with both the 1-year average and median concentrations at a maximum for the period of sampling. The number of acetaldehyde concentrations greater than 4 µg/m^3 nearly tripled from 2012 (11) to 2013 (32). Additionally, 11 concentrations measured in 2012 are less than the minimum concentration measured in 2013.

- The significant increase shown by the central tendency statistics for 2013 is followed by a significant decrease in these same parameters for 2014. Although all of the parameters except the maximum concentration exhibit decreases for 2014, the parameters are still at higher levels than they have been at in several years.

Figure 20-17. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BTUT



Observations from Figure 20-17 for arsenic concentrations measured at BTUT include the following:

- Sampling for PM_{10} metals under the NMP began at BTUT in late July 2003. Because this represents less than half of the sampling year, Figure 20-17 excludes data from 2003.

- The maximum arsenic concentration was measured at BTUT in 2004 (32.99 ng/m^3) and is nearly twice the next highest concentration (16.84 ng/m^3), also measured in 2004. Eight of the 15 highest concentrations of arsenic (those greater than 5 ng/m^3) were measured in 2004.

- Of the 40 highest arsenic concentrations measured at BTUT (those greater than 3 ng/m^3), 36 were measured during the colder months of the year, with 18 measured during the first quarter of the calendar year and 18 measured during the fourth quarter of the calendar year, suggesting a seasonality in the measurements.

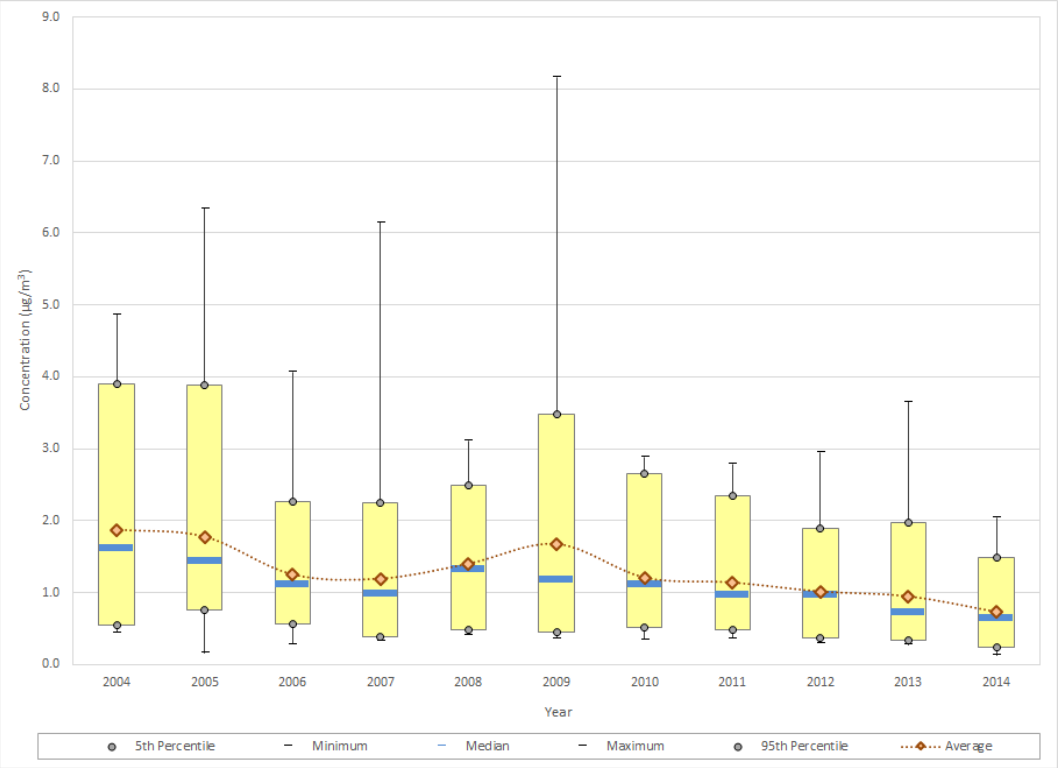
- The average concentration of arsenic decreased significantly from 2004 to 2005, with the 1-year average decreasing from 2.79 ng/m^3 to 0.96 ng/m^3. Between 2006 and 2010, there is an undulating pattern in the 1-year average concentrations, with years with higher concentrations followed by years with lower concentrations. During this period, the 1-year average arsenic concentration fluctuated between 0.61 ng/m^3 (2010) and 1.13 ng/m^3 (2009). However, the statistical parameters for 2007 and 2009 are being driven primarily by a single "high" measurement. If the maximum concentrations measured in 2007 and 2009 were removed from the data sets, the 1-year average concentrations for this period would all be less than 1 ng/m^3.

- Little change in the arsenic concentrations is shown between 2010 and 2011. The smallest range of arsenic concentrations was measured at BTUT in 2012, when all arsenic concentrations measured at BTUT were less than 2 ng/m^3. The 1-year average concentration, along with the 95th percentile and maximum concentration, are at a minimum for 2012.

- Concentrations of arsenic measured at BTUT increased significantly for 2013, as indicated by the increase shown in all of the statistical parameters. Although the 1-year average concentration doubled from 2012 to 2013, the increase in the median concentration is less dramatic.

- With the exception of the median concentration, each of the statistical parameters shown for 2014 exhibits a decrease from the previous year. Although difficult to discern in Figure 20-17, the median arsenic concentration has increased slightly each year since 2011.

Figure 20-18. Yearly Statistical Metrics for Benzene Concentrations Measured at BTUT



Observations from Figure 20-18 for benzene concentrations measured at BTUT include the following:

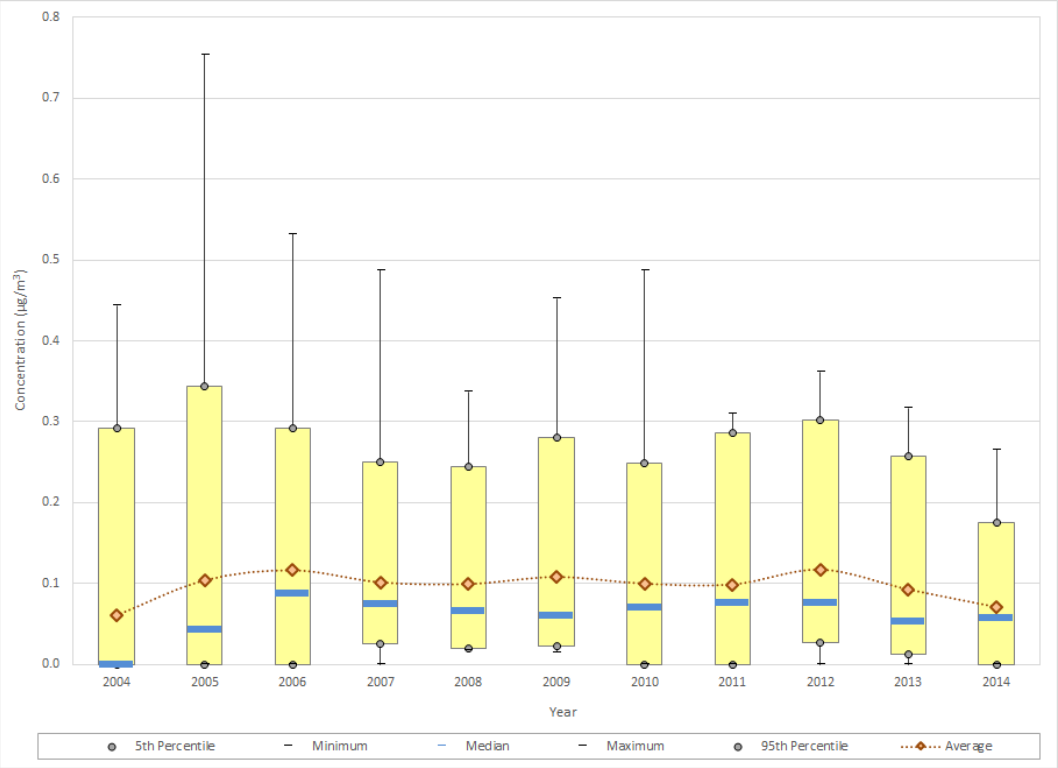
- Sampling for VOCs under the NMP began at BTUT in late July 2003. Because this represents less than half of the sampling year, Figure 20-18 excludes data from 2003.

- The maximum concentration of benzene shown was measured in 2009 (8.16 µg/m^3). The next highest concentration (6.56 µg/m^3) was also measured in 2009, although concentrations greater than 6 µg/m^3 were also measured in 2005 and 2007. Benzene concentrations greater than 4 µg/m^3 have not been measured at BTUT in recent years.

- Concentrations of benzene appear to be higher during the colder months of the year, as 50 of the 54 highest concentrations (those greater than 2.50 µg/m^3) were measured during the first (28) or fourth (22) quarters of the calendar year.

- The 1-year average and median benzene concentrations have a decreasing trend through 2007. An increasing trend in the 1-year average concentration is then shown through 2009, after which another decreasing trend follows. The 1-year average benzene concentration is at a minimum for 2014 (0.73 µg/m^3), the first year only one benzene concentration greater than 2 µg/m^3 was been measured. The median concentration is also at a minimum for 2014 (0.65 µg/m^3) and exhibits a similar trend as the 1-year average, except it did not exhibit the same increase for 2009 as the 1-year average concentration.

Figure 20-19. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at BTUT



Observations from Figure 20-19 for 1,3-butadiene concentrations measured at BTUT include the following:

- The maximum concentration of 1,3-butadiene shown was measured in 2005 (0.75 µg/m^3). The second highest concentration was also measured in 2005 (0.53 µg/m^3), although a similar concentration was also measured in 2006. These are the only concentrations of 1,3-butadiene greater than 0.5 µg/m^3 measured at BTUT.

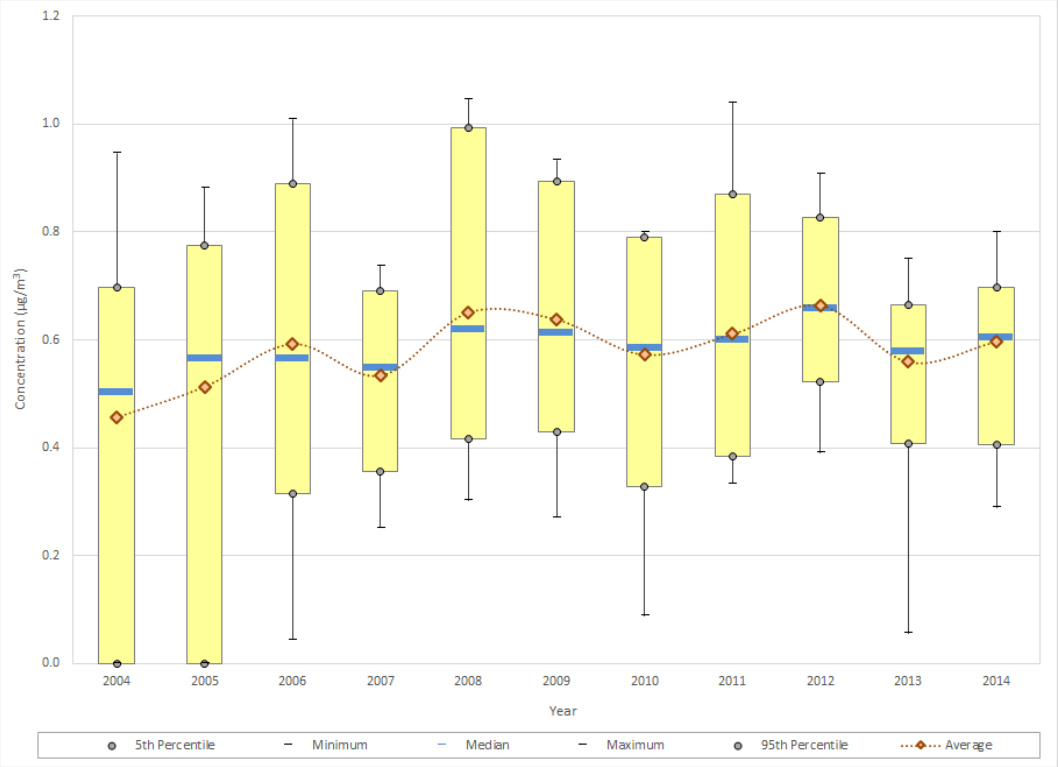
- The minimum, 5th percentile, and median concentrations are all zero for 2004, indicating that at least half of the measurements were non-detects. The detection rate of 1,3-butadiene increased after 2004, as indicated by the increase in the median concentrations for 2005 and 2006 and then the 5th percentile for 2007. The percentage of non-detects decreased from 75 percent for 2004 to 0 percent for 2008 and 2009. The percentage of non-detects increased to 7 percent for 2010 and 18 percent for 2011, explaining why the 5th percentile returned to zero. There was a single non-detect of this pollutant in 2012, three in 2013, and five in 2014.

- The 1-year average concentration increased from 0.061 µg/m^3 for 2004 to 0.104 µg/m^3 for 2005. This increase is likely due to the decrease in non-detects (and thus zeros substituted for them) as well as the higher concentrations measured in 2005, as discussed above. Between 2005 and 2011, the 1-year average concentration hovers around 0.1 µg/m^3, ranging from 0.099 µg/m^3 (2011) to 0.116 µg/m^3 (2006). The median concentration varies a little more, ranging from 0.044 µg/m^3 (2005) to 0.089 µg/m^3 (2006), although the median concentration varies less for the remaining years in this period.

- With the exception of the minimum concentration, all of the statistical parameters exhibit slight increases for 2012. Although not a significant change, the 1-year average concentration is at a maximum for 2012 (0.117 µg/m^3).

- A decreasing trend in the 1,3-butadiene concentrations measured at BTUT is shown between 2012 and 2014, the first year that measurements greater than 0.3 µg/m^3 were not measured and the 1-year average concentration is at a minimum.

Figure 20-20. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at BTUT



Observations from Figure 20-20 for carbon tetrachloride concentrations measured at BTUT include the following:

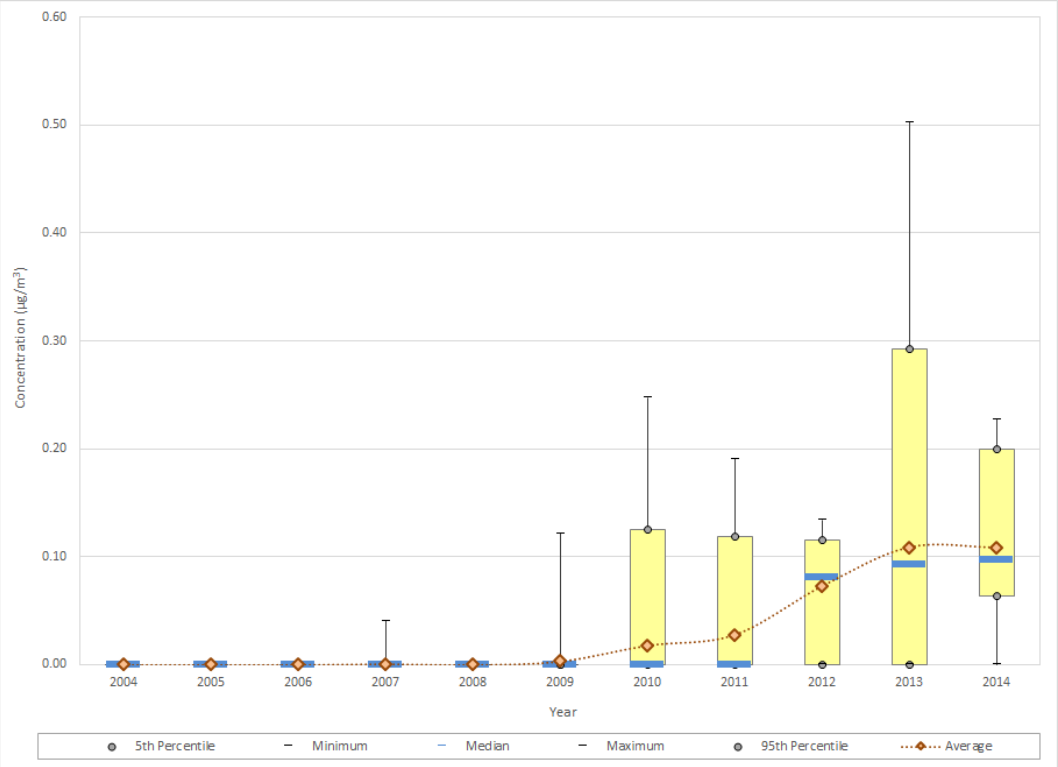
- Non-detects of carbon tetrachloride were measured only in 2004 (nine) and 2005 (five). Concentrations of carbon tetrachloride greater than 1 µg/m^3 were measured in 2006 (two), 2008 (three), and 2011 (one).

- A significant increasing trend is shown in the 1-year average concentrations between 2004 and 2008, with the exception of 2007. The range and magnitude of concentrations measured decreased substantially for 2007, which is reflected in the dip in the 1-year average concentration. After decreasing slightly between 2008 and 2010, an increasing trend in the carbon tetrachloride measurements is shown through 2012. Several of the statistical parameters, including the 1-year average and median concentrations, are at a maximum in 2012.

- A significant decrease in the 1-year average concentration, and the other statistical parameters, is shown for 2013. This year has the lowest maximum concentration since 2007 and the lowest minimum concentration since 2006. The difference between the 5th and 95th percentiles, or the range within which a majority of concentrations fall, is also at a minimum for 2013.

- Each of the statistical parameters exhibits a slight increase for 2014, with the exception of the 5th percentile, which did not change.

Figure 20-21. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at BTUT

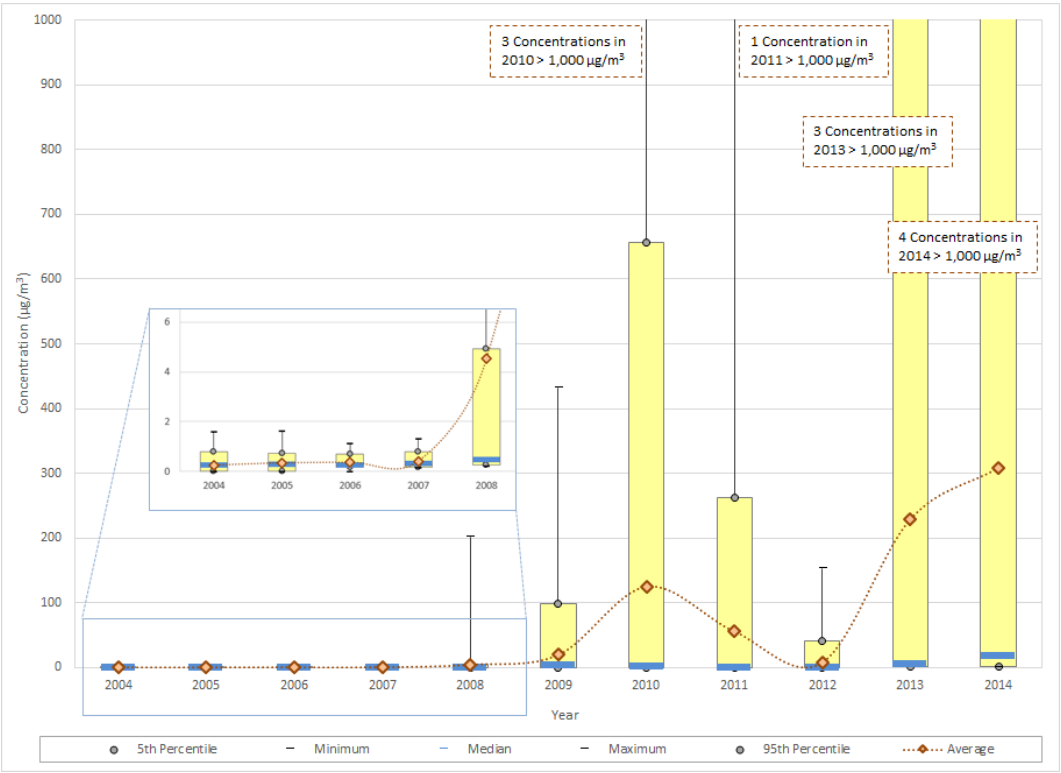


Observations from Figure 20-21 for 1,2-dichloroethane concentrations measured at BTUT include the following:

- For the first several years of sampling, all of the statistical parameters shown are zero, indicating that 1,2-dichloroethane was not detected. Between 2004 and 2008, there was a single measured detection of 1,2-dichloroethane, which was measured in 2007. Beginning with 2009, the number of measured detections began to increase; there were two in 2009, seven in 2010, 15 in 2011, 47 in 2012, 37 in 2013, and 54 in 2014. This explains the increases shown in the 1-year average concentrations (as well as other statistical parameters) for 2010 through 2014. The first year with a median concentration greater than zero is 2012. This indicates that there were more measured detections than non-detects for the first time since the onset of sampling.

- The range of concentrations measured in 2013 is considerably larger than the range of concentrations measured in previous years, as the 1-year average concentration for 2013 is similar to the 95th percentile shown for previous years. All seven 1,2-dichloroethane concentrations greater than 0.25 µg/m^3 measured at BTUT were measured in 2013. Concentrations measured in 2013 account for one-quarter of the 73 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 measured at BTUT since the onset of sampling. Little change is shown in the central tendency statistics for 2014, during which the largest number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 was measured at BTUT (accounting for the highest percentage thus far at nearly 40 percent).

Figure 20-22. Yearly Statistical Metrics for Dichloromethane Concentrations Measured at BTUT



Observations from Figure 20-22 for dichloromethane concentrations measured at BTUT include the following:

- Prior to 2008, the maximum concentration of dichloromethane measured at BTUT was 1.64 µg/m^3 (in 2005). The statistical parameters for the early years of sampling are provided in the inset in Figure 20-22.

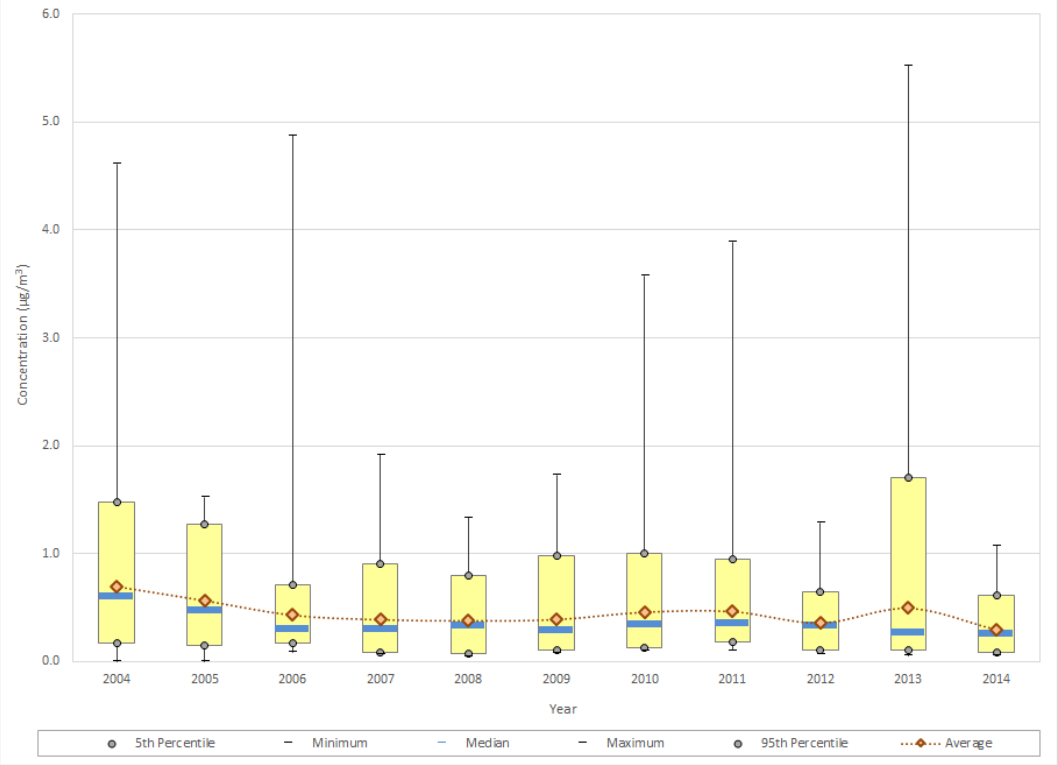
- Beginning in 2008, "higher" concentrations of dichloromethane began to be measured at BTUT. In 2008, the first concentration greater than 100 µg/m^3 was measured (202 µg/m^3). In 2009, four concentrations greater than 100 µg/m^3 were measured. In 2010, three dichloromethane concentrations greater than 1,000 µg/m^3 were measured, along with six more greater than 100 µg/m^3. For 2011, one concentration greater than

1,000 µg/m^3 was measured, along with four more greater than 100 µg/m^3. For 2012, only one concentration greater than 100 µg/m^3 was measured. For 2013, three concentrations greater than 1,000 µg/m^3 were measured, along with eight more greater than 100 µg/m^3. The maximum dichloromethane concentration was measured at BTUT in 2014 (8,423 µg/m^3) along with three others greater than 1,000 µg/m^3 and 10 others greater than 100 µg/m^3.

- There does not appear to be a pattern in the time of year that these higher concentrations are measured. Of the 45 concentrations measured at BTUT greater than 100 µg/m^3, at least one has been measured in each month of the year. January and September have with the greatest number of these higher measurements (7 each), with October having the fewest (1). Of the 11 concentrations measured at BTUT greater than 1,000 µg/m^3, five were measured during the spring months (April, May, or June), which is the most for any calendar quarter.

- Most of the statistical parameters are at a maximum for 2014. The largest range of concentrations was measured in 2014 and range from 0.49 µg/m^3 to 8,423 µg/m^3. The 1-year average concentration increased by 35 percent and the median concentration increased by a factor of three. This indicates that concentrations measured in 2014 were higher overall compared to previous years, as the median concentration is driven less by outliers than an average may be.

Figure 20-23. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at BTUT



Observations from Figure 20-23 for ethylbenzene concentrations measured at BTUT include the following:

- The maximum concentration of ethylbenzene measured at BTUT was measured in 2013 (5.53 µg/m^3) and is the only concentration greater than 5 µg/m^3 measured at this site. In total, only seven concentrations greater than 2 µg/m^3 have been measured at BTUT (of which three were measured in 2013).

- A steady decreasing trend in the 1-year average concentration is shown from 2004 through 2008, representing just less than a 50 percent decrease (from 0.70 µg/m^3 for 2004 to 0.38 µg/m^3 for 2008). However, most of the change is realized between 2004 and 2006.

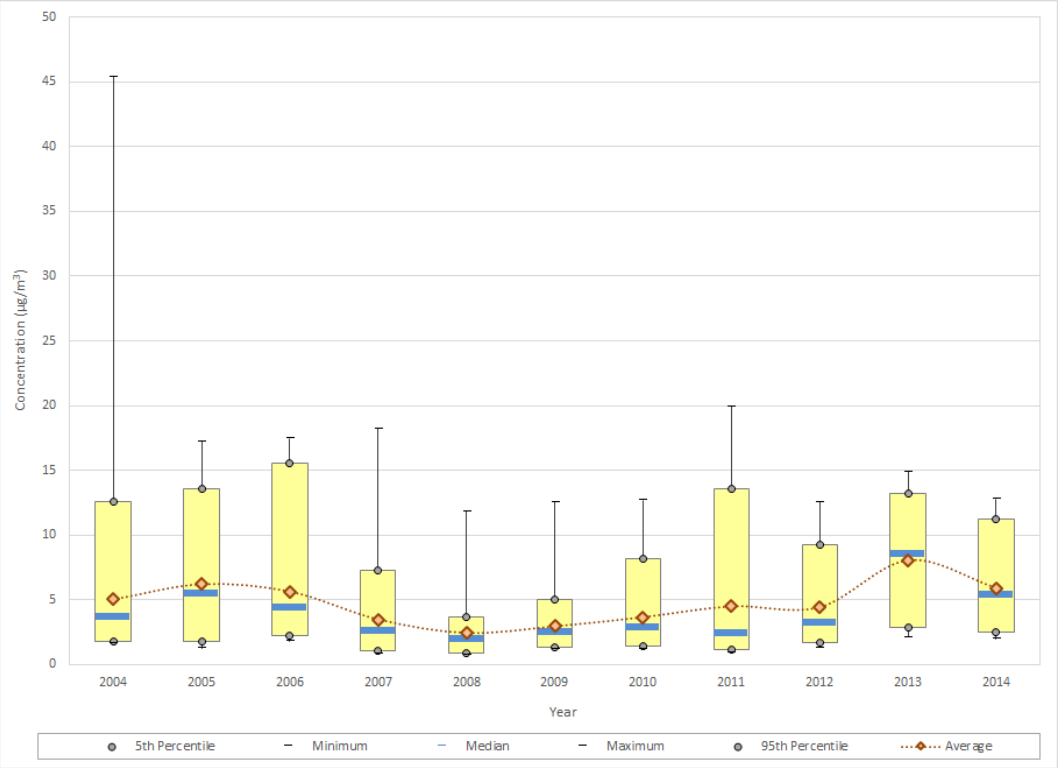
- Between 2007 and 2009, little change is shown in the concentrations measured, with the 1-year average concentrations varying by less than 0.012 µg/m^3.

- Nearly all of the statistical parameters exhibit increases for 2010, particularly the maximum concentration. However, removing the maximum concentration measured in 2010 from the data set would result in a 1-year average concentration similar to those shown for 2007 through 2009. This is also true for 2011.

- The range of ethylbenzene concentrations measured in 2012 is considerably smaller than the two preceding years, and is the smallest since the onset of sampling at BTUT. This is followed by the largest range of ethylbenzene concentrations measured in 2013, with the 1-year average concentration at its highest since 2005. The range within which the majority of concentrations fall, as indicated by the 5th and 95th percentiles is also at its largest for 2013, yet the median concentration is at its lowest since sampling began. Even with the higher concentrations measured, 2013 has the fewest number of measurements greater than 0.25 µg/m^3.

- The smallest range of ethylbenzene concentrations was measured at BTUT in 2014 and both the 1-year average and median concentrations are at a minimum since the onset of sampling.

Figure 20-24. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at BTUT



Observations from Figure 20-24 for formaldehyde concentrations measured at BTUT include the following:

- The maximum formaldehyde concentration (45.4 µg/m^3) was measured on August 31, 2004, on the same day as the highest acetaldehyde concentration. This measurement is more than twice the next highest concentration (19.9 µg/m^3), measured in 2011. Concentrations greater than 15 µg/m^3 were measured 12 times between 2004 and 2007, plus three additional times in 2011.

- Although the maximum concentration decreased significantly from 2004 to 2005, the other statistical metrics exhibit increases for 2005. The median increased by nearly 2 µg/m^3 from 2004 to 2005, indicating that concentrations ran higher in 2005 than 2004 (as opposed to being driven by an outlier, as in 2004). To illustrate, the number of concentrations greater than 5 µg/m^3 increased from 11 measured in 2004 to 31 measured in 2005.

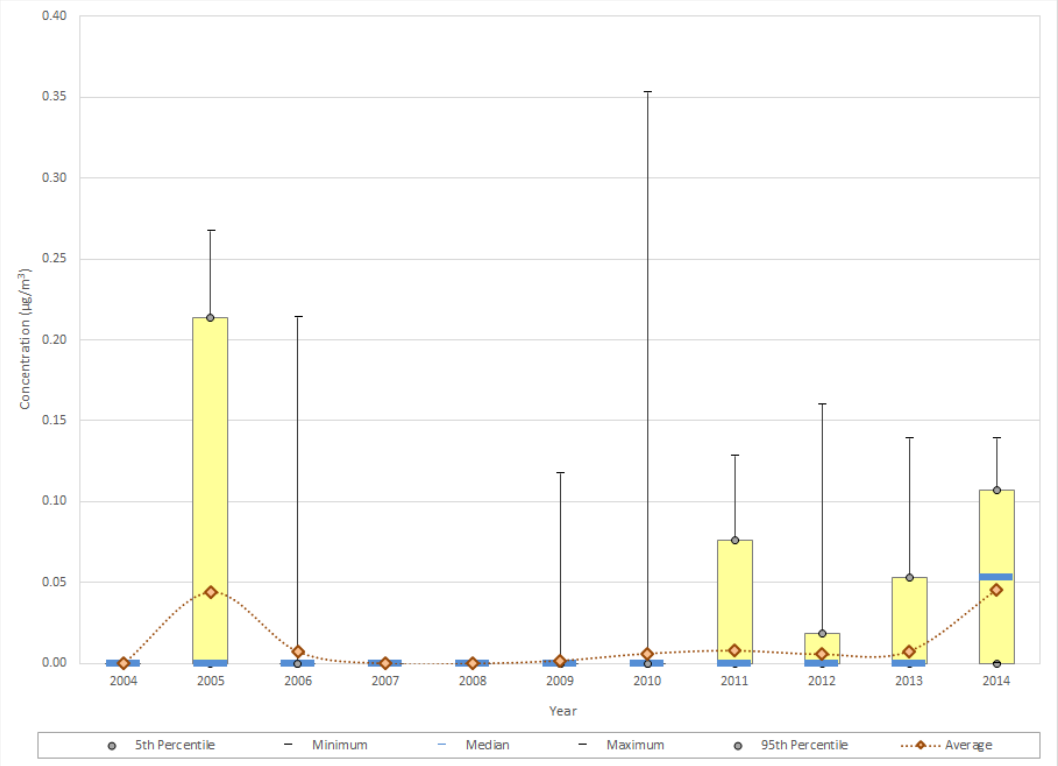
- After 2005, the 1-year average concentration began to decrease, reaching a minimum for 2008 (2.44 µg/m^3). In 2008, 95 percent of the concentrations measured were less than 4 µg/m^3, which is less than the 1-year average and/or median concentrations for several of the previous years. After 2008, a steady increasing trend is shown in the 1-year average formaldehyde concentrations, as well as most other statistical parameters, through 2011.

- Little change is shown in the 1-year average concentration between 2011 and 2012 and the range of concentrations measured is smaller for 2012, yet the median concentration exhibits an increase. The decrease in the concentrations at the upper end of the range from 2011 to 2012 is balanced by a higher number of measurements at the mid-to-upper part of the range. The number of measurements greater than 10 $\mu g/m^3$ decreased from nine to one from 2011 to 2012 while the number of measurements between 5 $\mu g/m^3$ and 10 $\mu g/m^3$ increased from six to 14 during the same period. Also, six concentrations measured in 2011 are less than the minimum concentration measured in 2012.

- Significant increases are shown for the central tendency statistics for 2013. The 1-year average concentration nearly doubled and the median concentration increased by 159 percent from 2012. The number of formaldehyde concentrations greater than 10 $\mu g/m^3$ is highest for 2013 (16) and concentrations greater than 5 $\mu g/m^3$ account for more than 75 percent of the measurements in 2013. This is also the only year for which a formaldehyde concentration less than 2 $\mu g/m^3$ was not measured.

- Significant decreases are shown for the central tendency statistics for 2014. Although the range of measurements did not change much, the 1-year average concentration decreased by more than 2 $\mu g/m^3$ and the median concentration decreased by more than 3 $\mu g/m^3$ from 2013. Fewer concentrations at the top of the concentration range were measured in 2014 (nine formaldehyde concentrations greater than 10 $\mu g/m^3$ were measured in 2014 compared to 16 in 2013). At the same time, the number of formaldehyde concentrations less than 5 $\mu g/m^3$ increased from 13 in 2013 to 24 in 2014. Yet, both the 1-year average and median concentrations for 2014 are still greater than 5 $\mu g/m^3$.

Figure 20-25. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at BTUT



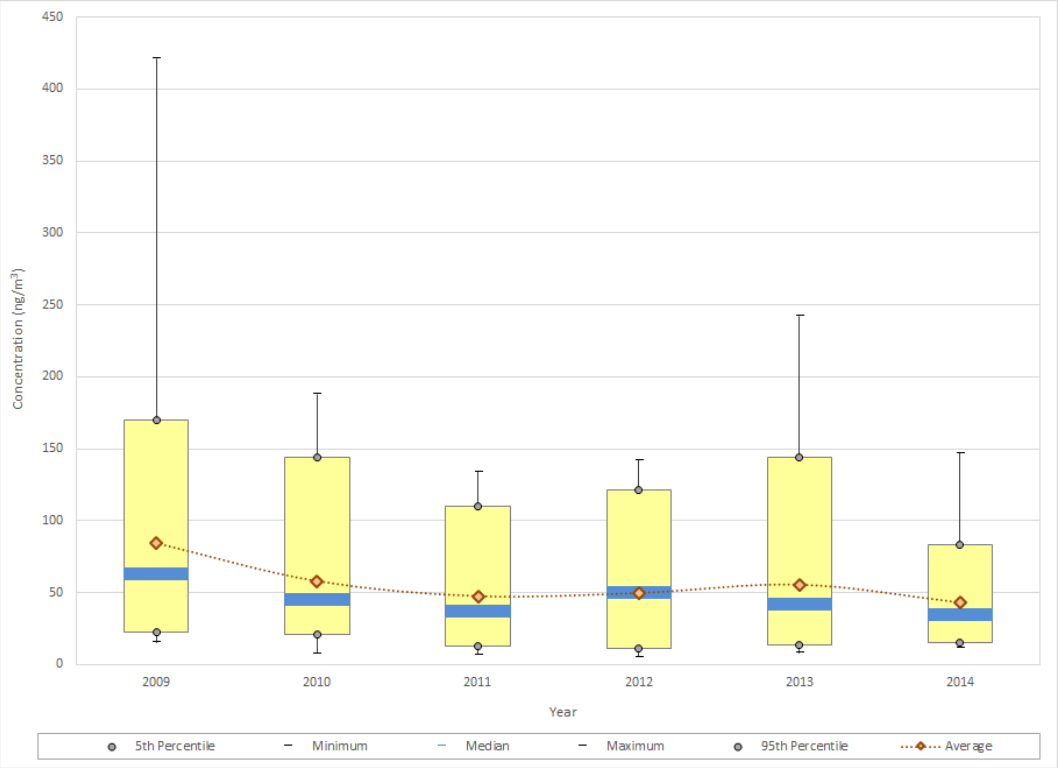
Observations from Figure 20-25 for hexachloro-1,3-butadiene concentrations measured at BTUT include the following:

- Two hexachloro-1,3-butadiene concentrations greater than 0.25 µg/m^3 have been measured at BTUT since the onset of sampling (0.36 µg/m^3 in 2010 and 0.27 µg/m^3 in 2005).

- The median concentration of hexachloro-1,3-butadiene is zero for all years of sampling except 2014, indicating that at least half of the measurements were non-detects each year. There were no measured detections of this pollutant in 2004, 2007, and 2008 and there were three or fewer measured detections in 2006, 2009, 2010, 2012, and 2013. Hexachloro-1,3-butadiene was detected 12 times in 2005 and 29 times in 2014.

- As 2014 is the first year that non-detects account for fewer than half of the measurements, a significant increase in the central tendency statistics is shown.

Figure 20-26. Yearly Statistical Metrics for Naphthalene Concentrations Measured at BTUT



Observations from Figure 20-26 for naphthalene concentrations measured at BTUT include the following:

- Although PAH sampling began at BTUT in April 2008, complications with the sampler lead to a 6-month lapse in sampling until mid-October. Thus, Figure 20-27 begins with 2009.

- The maximum naphthalene concentration (421 ng/m^3) was measured in 2009. The second highest naphthalene concentration (242 ng/m^3), measured in 2013, is the only other naphthalene measurement greater than 200 ng/m^3 measured at BTUT since the onset of PAH sampling.

- A steady decreasing trend in naphthalene concentrations measured at BTUT is shown through 2011. Although little change in the range of measurements or the 1-year average concentration shown for 2012, the median concentration exhibits an increase. The biggest change in concentrations between the two years occurs in the middle of the concentration range. The number of naphthalene concentrations measured at BTUT between 50 ng/m^3 and 75 ng/m^3 increased from 11 to 20 from 2011 to 2012.

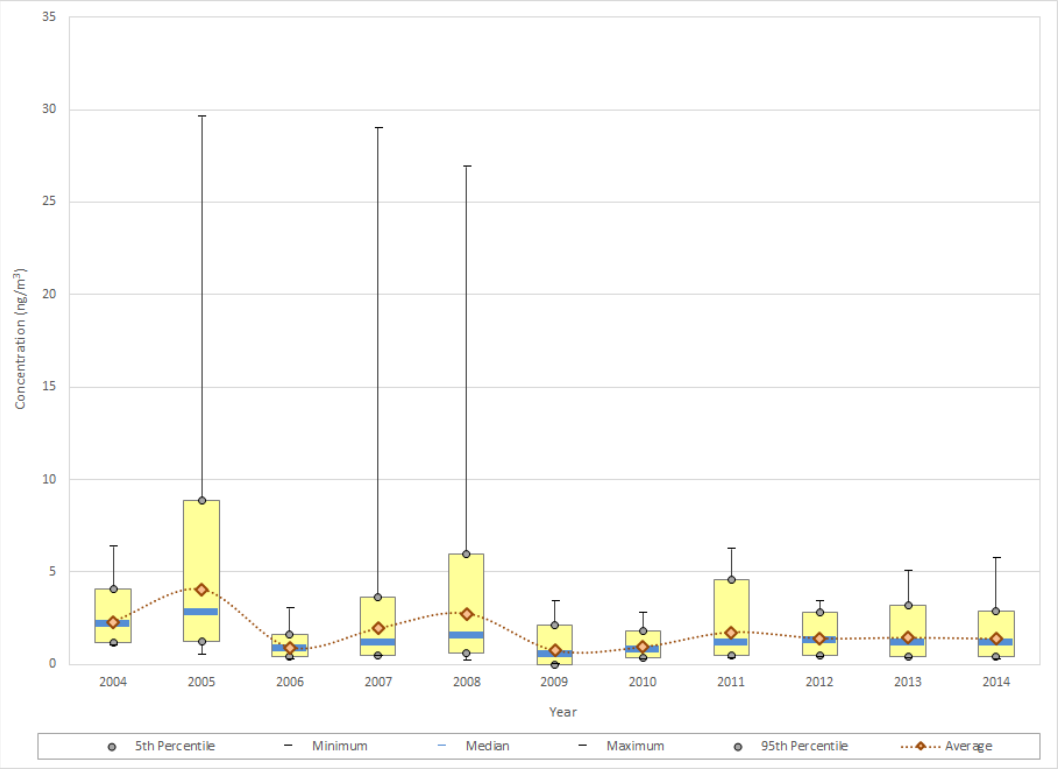
- Concentrations increased slightly for 2013, with the 95th percentile for 2013 greater than the maximum concentrations measured for the two previous years.

- The majority of naphthalene concentrations, as indicated by the 5th and 95th percentiles, fell into their smallest range in 2014, with the 95th percentile less than

100 ng/m^3 for the first time since sampling for this pollutant began at BTUT. Both the 1-year average and median concentrations are at a minimum for 2014.

- Concentrations of naphthalene exhibit seasonality. Of the 47 naphthalene concentrations greater than 100 ng/m^3 measured at BTUT since 2009, all but three were measured during the first or fourth quarters of any given year, or the colder months of the year, with the majority measured in January (16), November (11), or December (14). Naphthalene concentrations greater than 100 ng/m^3 have not been measured at BTUT between April and August.

Figure 20-27. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at BTUT



Observations from Figure 20-27 for nickel concentrations measured at BTUT include the following:

- The maximum nickel concentration was measured in 2005 (29.6 ng/m^3), although a similar concentration was also measured in 2007. Two additional nickel concentrations greater than 20 ng/m^3 were measured in 2008. Additional nickel concentrations greater than 10 ng/m^3 have not been measured at BTUT.

- All 24 non-detects of nickel were measured in 2009 and, with one exception, were measured on consecutive sample days between June and October.

- The range of nickel concentrations measured each year is highly variable, particularly through 2010. Concentrations measured over a given year have spanned a little as 2.6 ng/m^3 (2010) or up to nearly 30 ng/m^3 (2005). This variability is reflected in the

undulating pattern shown in the central tendency statistics, particularly in the years between 2004 and 2011. During this time period, the 1-year average concentrations ranged from 0.75 ng/m^3 (2009) to 4.05 ng/m^3 (2005).

- The concentrations measured between 2012 and 2014 exhibit less variability. The 1-year average concentrations calculated for each year during this period fall on either side of 1.4 ng/m^3, with less than 0.06 ng/m^3 separating the three of them. Less than 0.15 ng/m^3 separates the median concentrations calculated for each of these years.

20.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the BTUT monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

20.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for BTUT and where annual average concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 20-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 20-5. Risk Approximations for the Utah Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Bountiful, Utah - BTUT						
Acetaldehyde	0.0000022	0.009	58/58	3.33 ± 0.34	7.33	0.37
Benzene	0.0000078	0.03	55/55	0.73 ± 0.12	5.70	0.02
1,3-Butadiene	0.00003	0.002	50/55	0.07 ± 0.01	2.14	0.04
Carbon Tetrachloride	0.000006	0.1	55/55	0.60 ± 0.03	3.57	0.01
1,2-Dichloroethane	0.000026	2.4	54/55	0.11 ± 0.01	2.82	<0.01
Dichloromethane	0.000000016	0.6	55/55	314.23 ± 316.90	5.03	0.52
Ethylbenzene	0.0000025	1	55/55	0.30 ± 0.05	0.75	<0.01
Formaldehyde	0.000013	0.0098	58/58	5.92 ± 0.73	76.95	0.60
Hexachloro-1,3-butadiene	0.000022	0.09	29/55	0.05 ± 0.01	0.99	<0.01
Arsenic (PM_{10})[a]	0.0043	0.000015	52/57	0.79 ± 0.26	3.38	0.05
Naphthalene[a]	0.000034	0.003	58/58	42.98 ± 6.51	1.46	0.01
Nickel (PM_{10})[a]	0.00048	0.00009	57/57	1.38 ± 0.24	0.66	0.02

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

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Observations for BTUT from Table 20-5 include the following:

- The pollutants with the highest annual average concentrations are dichloromethane, formaldehyde, and acetaldehyde, as discussed in Section 20.4.1.

- The pollutants with the highest cancer risk approximations are formaldehyde, acetaldehyde, and benzene. The cancer risk approximation for formaldehyde for BTUT (76.95 in-a-million) is the second highest cancer risk approximation across the program, and the highest cancer risk approximation for formaldehyde. The remaining cancer risk approximations calculated for BTUT are all less than 10 in-a-million.

- There were no pollutants of interest with noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The highest noncancer hazard approximation was calculated for formaldehyde (0.60), which is the highest noncancer hazard approximation calculated among the site-specific pollutants of interest with noncancer toxicity factors.

- Dichloromethane's high annual average concentration for BTUT does not translate into high risk approximations. This is an indication of the toxicity potential of dichloromethane concentrations in ambient air.

As an extension of this analysis, pollution roses were created for each of the site-specific pollutants of interest that have a cancer risk approximation greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. Thus, a pollution rose was created for BTUT's formaldehyde measurements. A pollution rose is a plot of the ambient concentration versus the wind speed and direction; the magnitude of the concentration is indicated using different colored dots and are shown in relation to the average wind direction oriented about a 16-point compass, similar to the wind roses presented in Section 20.2.2. Thus, high concentrations may be shown in relation to the direction of potential emissions sources. Wind observations collected at BTUT and obtained from AQS are used in this analysis and were averaged (using vector averaging techniques) to compute daily wind direction averages for comparison to the 24-hour concentration data. This analysis is intended to help identify the geographical area where emissions sources of these pollutants may have originated. Additional information regarding this analysis is also presented in Section 3.4.3.3. Figure 20-28 presents the pollution rose for all 58 formaldehyde concentrations measured at BTUT.

Observations from Figure 20-28 include the following:

- Formaldehyde concentrations of varying magnitude are shown in relation to varying average wind directions.

- The majority of the formaldehyde concentrations are shown in relation to samples days with an average wind direction from the eastern quadrants. Of these, more measurements are associated with an average wind direction from the southeastern quadrant. Relatively few measurements were measured on sample days with an average wind direction from the southwest quadrant.

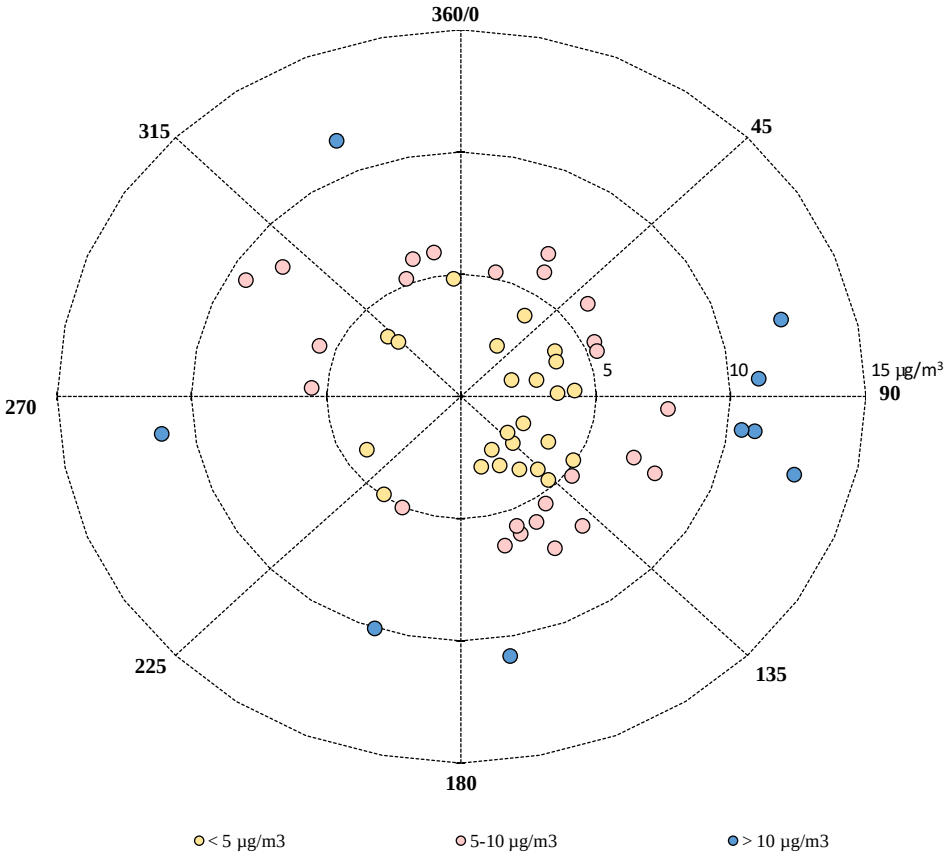
- For each concentration range shown on the pollution rose, the largest number of concentrations were associated with average winds from the southeast quadrant. Among the nine formaldehyde concentrations measured at BTUT greater than 10 $\mu g/m^3$ (as indicated by the cluster of blue dots), several were measured on a sample day with an average wind direction roughly from the east (including those between 75º and 115º).

- The facility map in Figure 20-2 shows that most of the point sources within 10 miles of BTUT are located to the south and southwest of the site, along the I-15 corridor and towards Salt Lake City.

- If the formaldehyde concentrations are *grouped* by average compass direction using an 8-point compass, the direction with the most concentrations is southeast followed by east. If the formaldehyde concentrations are *averaged* by compass direction using an 8-point compass, the highest average concentrations are calculated for west and east. However, the westerly direction only includes three formaldehyde concentrations while the easterly direction includes 13. Other wind directions, such as southeast, incorporate many concentrations of varying magnitude.

- The wind data for many of the sample days reflect a lake breeze/valley breeze system, one in which the wind direction in the morning is different from the afternoon/evening, switching directions with regularity due to daytime heating and geographic features such as the Great Salt Lake and the mountains on either side of the Salt Lake Valley (NHMU, 2017).

Figure 20-28. Pollution Rose for Formaldehyde Concentrations Measured at BTUT



20.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 20-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 20-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 20-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for BTUT, as presented in Table 20-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 20-6. Table 20-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 20.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 20-6. 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 UREs (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)**
Bountiful, Utah (Davis County) - BTUT					
Benzene	120.37	Benzene	9.39E-04	Formaldehyde	76.95
Formaldehyde	68.30	Formaldehyde	8.88E-04	Acetaldehyde	7.33
Ethylbenzene	67.10	Hexavalent Chromium	6.26E-04	Benzene	5.70
Dichloromethane	46.51	1,3-Butadiene	4.62E-04	Dichloromethane	5.03
Acetaldehyde	41.70	Naphthalene	2.84E-04	Carbon Tetrachloride	3.57
1,3-Butadiene	15.40	POM, Group 2b	1.79E-04	Arsenic (PM_{10})	3.38
Naphthalene	8.35	Ethylbenzene	1.68E-04	1,2-Dichloroethane	2.82
Tetrachloroethylene	6.26	POM, Group 2d	1.23E-04	1,3-Butadiene	2.14
POM, Group 2b	2.03	POM, Group 5a	9.95E-05	Naphthalene	1.46
POM, Group 2d	1.39	Acetaldehyde	9.17E-05	Hexachloro-1,3-butadiene	0.99

Table 20-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Utah Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Bountiful, Utah (Davis County) - BTUT					
Toluene	539.04	Acrolein	192,602.57	Formaldehyde	0.60
Hexane	370.73	1,3-Butadiene	7,700.14	Dichloromethane	0.52
Xylenes	286.60	Formaldehyde	6,969.87	Acetaldehyde	0.37
Methanol	205.85	Acetaldehyde	4,633.66	Arsenic (PM_{10})	0.05
Ethylene glycol	121.88	Benzene	4,012.18	1,3-Butadiene	0.04
Benzene	120.37	Xylenes	2,865.98	Benzene	0.02
Formaldehyde	68.30	Naphthalene	2,782.33	Nickel (PM_{10})	0.02
Ethylbenzene	67.10	Lead, PM	982.29	Naphthalene	0.01
Methyl isobutyl ketone	51.39	Arsenic, PM	703.33	Carbon Tetrachloride	0.01
Dichloromethane	46.51	Hexane	529.62	Hexachloro-1,3-butadiene	0.00

Observations from Table 20-6 include the following:

- Benzene, formaldehyde, ethylbenzene, and dichloromethane are the highest emitted pollutants with cancer UREs in Davis County.

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

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions in Davis County.

- Formaldehyde, which has the highest cancer risk approximation for BTUT, ranks second for both emissions-based lists, behind benzene. Acetaldehyde, 1,3-butadiene, naphthalene, and ethylbenzene also appear on all three lists in Table 20-6. Dichloromethane, which has the highest annual average concentration and the fourth highest cancer risk approximation for BTUT, ranks fourth for quantity of emissions in Davis County but is not among those with the highest toxicity-weighted emissions (it ranks 22nd). Arsenic, carbon tetrachloride, hexachloro-1,3-butadiene, and 1,2-dichloroethane, the remaining pollutants of interest listed for BTUT, appear on neither emissions-based list.

- POM, Group 2b is the ninth highest emitted "pollutant" in Davis County and ranks sixth for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at BTUT including acenaphthylene, fluoranthene, and perylene. None of the PAHs included in POM, Group 2b failed screens for BTUT. POM, Group 5a ranks ninth for its toxicity-weighted emissions. POM, Group 5a includes benzo(a)pyrene, which failed a single screen for BTUT.

Observations from Table 20-7 include the following:

- Toluene, hexane, and xylenes are the highest emitted pollutants with noncancer RfCs in Davis County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, 1,3-butadiene, and formaldehyde. Although acrolein was sampled for at BTUT, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based 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 have the highest toxicity-weighted emissions in Davis County.

- Formaldehyde, dichloromethane, and acetaldehyde have the highest noncancer hazard approximations for BTUT (although all are less than 1.0). Formaldehyde and benzene are the only listed pollutants of interest to appear on both emissions-based lists. Acetaldehyde, arsenic, 1,3-butadiene, and naphthalene are pollutants of interest for BTUT that rank among the pollutants with the highest toxicity-weighted emissions in Davis County but do not appear among those with the highest total emissions.

Dichloromethane ranks 10th for its quantity emitted in Davis County but does not appear among those highest toxicity-weighted emissions. Hexachloro-1,3-butadiene, nickel, and carbon tetrachloride are pollutants of interest for BTUT that do not appear on either emissions-based list in Table 20-7.

20.6 Summary of the 2014 Monitoring Data for BTUT

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

- *Nineteen pollutants failed at least one screen for BTUT.*

- *Dichloromethane had the highest annual average concentration among the pollutants of interest for BTUT, followed by formaldehyde and acetaldehyde.*

- *For the fourth year in a row, BTUT has the highest annual average formaldehyde concentration among NMP sites sampling this pollutant. BTUT also has the highest annual average concentrations of acetaldehyde and hexachloro-1,3-butadiene among other NMP sites.*

- *Concentrations of benzene have an overall decreasing trend at BTUT; the 1-year average concentration for 2014 is the lowest 1-year average concentration of benzene calculated since the onset of sampling at BTUT. Concentrations of 1,3-butadiene have also been decreasing in recent years. Concentrations of both acetaldehyde and formaldehyde increased significantly for 2013 then decreased for 2014. The detection rates of both 1,2-dichloroethane and hexachloro-1,3-butadiene is at a maximum for 2014.*

- *Formaldehyde has the highest cancer risk approximation among the pollutants of interest for BTUT (which is the second highest cancer risk approximation across the program). None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

21.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

21.1 Site Characterization

This section characterizes the Vermont 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 Vermont NATTS site (UNVT) is located in the town of Underhill, in northwest Vermont, in the Burlington-South Burlington, VT CBSA. Figure 21-1 is the composite satellite image retrieved from ArcGIS Explorer showing the Underhill monitoring site and its immediate surroundings. Figure 21-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 21-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 21-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for the site.

.

Figure 21-1. Underhill, Vermont (UNVT) Monitoring Site

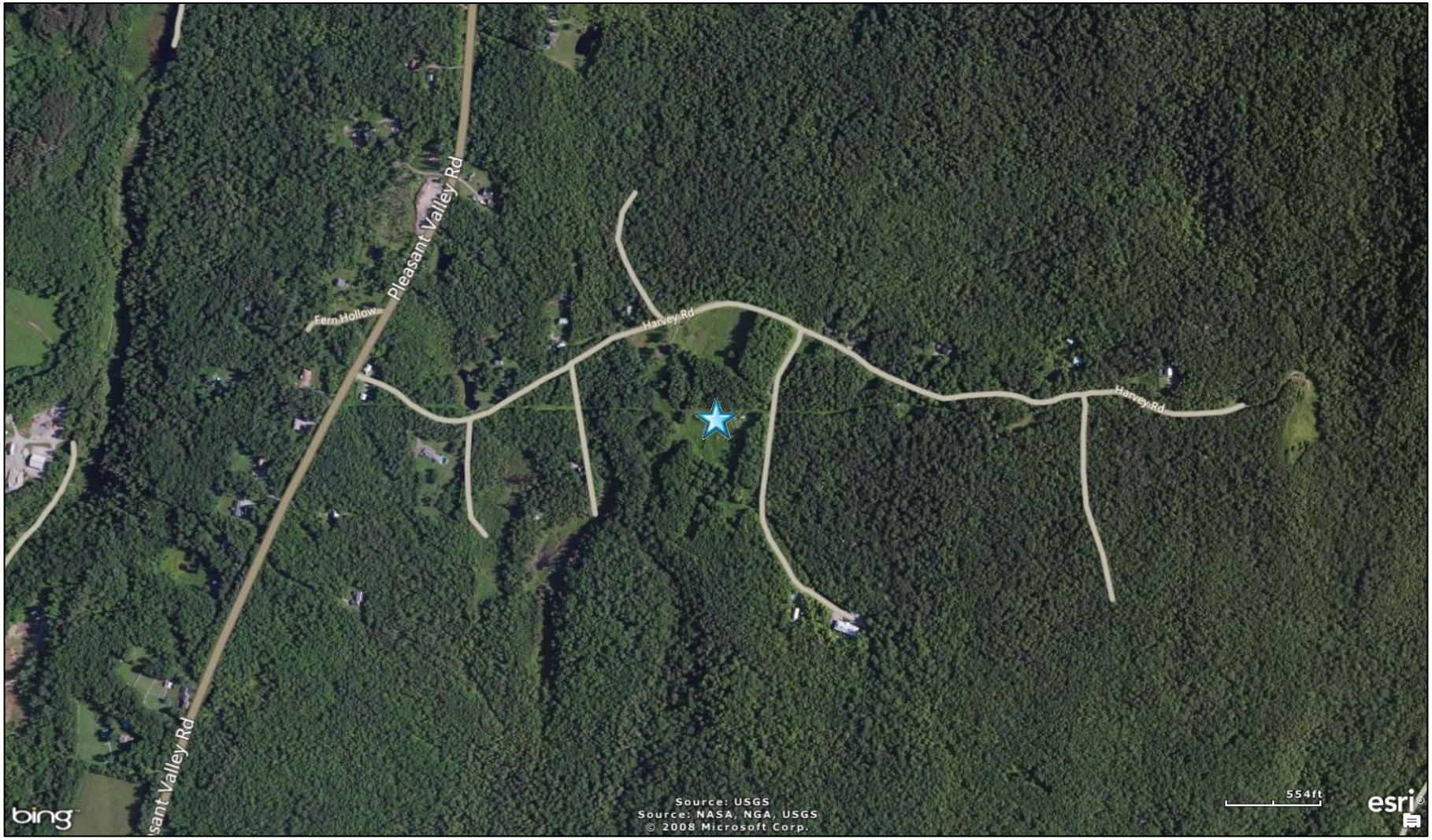


Figure 21-2. NEI Point Sources Located Within 10 Miles of UNVT

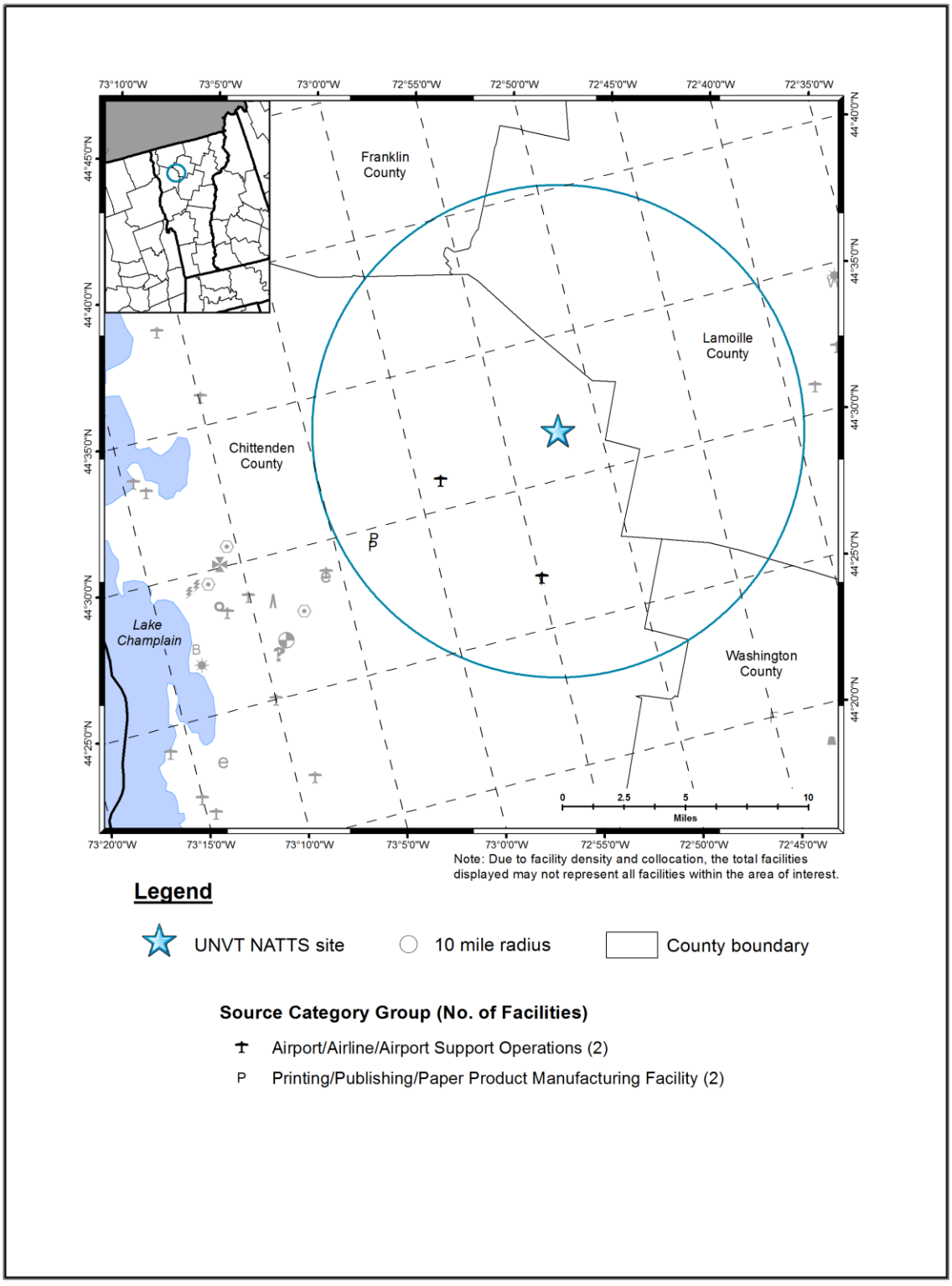


Table 21-1. Geographical Information for the Vermont Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
UNVT	50-007-0007	Underhill	Chittenden	Burlington-South Burlington, VT	44.528390, -72.868840	Forest	Rural	1,100	Pleasant Valley Rd, North of Harvey Rd

[1]AADT reflects 2011 data for UNVT (CCRPC, 2016)
BOLD ITALICS = EPA-designated NATTS Site

The UNVT monitoring site is located on the Proctor Maple Research Center in Underhill, Vermont, which is east of the Burlington area. This research station is part of the University of Vermont, with research focused on the sugar maple tree and sap collection methods (UVM, 2016). Figure 21-1 shows that the area surrounding the site is rural in nature and heavily forested. Mount Mansfield, the highest peak in Vermont, lies to the east in Underhill State Park, less than 3 miles away. This site is intended to serve as a background site for the region for trends assessment, standards compliance, and long-range transport assessment.

Most of the emissions sources near UNVT are located to the east and southeast of the monitoring site, primarily closer to the Burlington area. The closest sources to UNVT are both in the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. The two sources are private airports. Two sources in the printing and publishing source category are also located within 10 miles of UNVT.

In addition to providing city, county, CBSA, and land use/location setting information, Table 21-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume near UNVT is relatively light, with approximately 1,100 vehicles passing near UNVT on a daily basis. The traffic estimate near UNVT is the third lowest compared to other NMP sites. The traffic estimate for UNVT is provided for Pleasant Valley Road, north of Harvey Road.

21.2 Meteorological Characterization

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

21.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for

the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Vermont site, site-specific data were available for some, but not all, of the parameters in Table 21-2. For UNVT, temperature, pressure, humidity, and wind information was available in AQS. Data from the NWS weather station at Morrisville-Stowe State Airport (WBAN 54771) were used for the remaining parameters (sea level pressure and dew point temperature). The Morrisville-Stowe State Airport weather station is located 13 miles east of UNVT. In addition, the UNVT meteorological station was down for two weeks at the end of September through early October for repairs at the site and experienced a malfunction during the second half of December. Thus, NWS data was used as a surrogate here as well. A map showing the distance between the monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 21-2. Average Meteorological Conditions near the Vermont Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Underhill, Vermont - UNVT [2]							
Sample Days (69)	41.7 ± 1.1	31.8 ± 1.1	64.1 ± 0.8	30.01 ± 0.01	28.60 ± 0.01	NNW	2.2 ± 0.1
2014	43.7 ± 0.4	33.3 ± 0.5	63.5 ± 0.3	30.00 ±<0.01	28.59 ± 0.01	NNW	2.3 ± <0.1

[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure, and wind parameters were measured at UNVT. The remaining information was obtained from the closest NWS weather station located at Morrisville-Stowe State Airport, WBAN 54771. In addition, while the meteorological station at UNVT was down for parts of the year, NWS data was used as a surrogate.

Table 21-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 21-2 is the 95 percent confidence interval for each parameter. Average meteorological conditions on sample days at UNVT were fairly representative of average weather conditions experienced throughout the year, as shown in Table 21-2. The difference between a full-year average and sample day average is largest for average temperature**.** Compared to other NMP sites, the Vermont site experiences some of the coldest

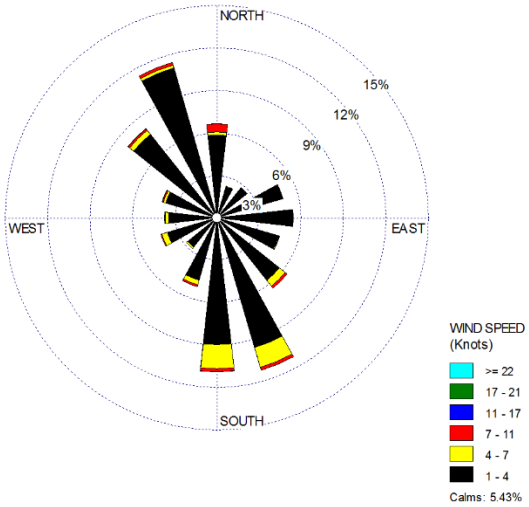
temperatures, as this site has the lowest average sample day temperature. UNVT also has the lowest average wind speed.

21.2.2 Wind Rose Comparison

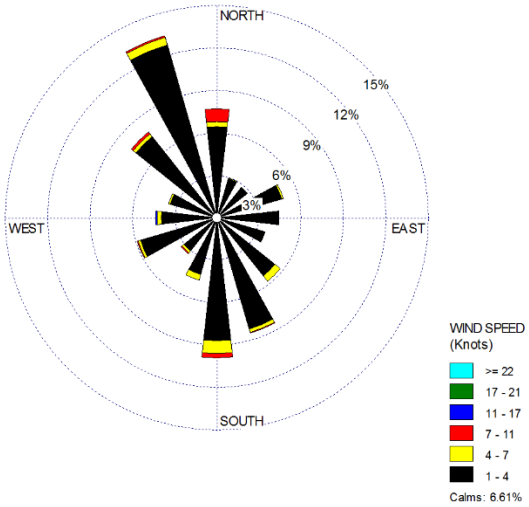
Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. A wind rose shows the frequency of wind directions using "petals" positioned around a 16-point compass, and uses different colors to represent wind speeds. Figure 21-3 presents two wind roses for the UNVT monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 21-3. Wind Roses for the Wind Data Collected at UNVT

2014 Wind Rose



Sample Day Wind Rose



Observations from Figure 21-3 for UNVT include the following:

- The full-year rose shows that light winds were prevalent near UNVT, as winds speeds greater than 4 knots were infrequently observed. Winds from the north-northwest were observed the most, although winds from the south-southeast and south account for a similar percentage of observations (each of these three wind directions were observed for approximately 11 percent of the wind observations). Winds from the northeast and southwest quadrants account for relatively few observations.

- The wind patterns shown on the sample day wind rose are similar to those shown on the full-year wind rose. Light winds prevailed and winds from the north-northwest account for the highest percentage of wind directions observed (greater than 13 percent). The increase in the percentage of north-northwesterly winds is offset by slightly fewer south-southwesterly and southerly wind observations on sample days.

- Recall from the previous section that wind sensors were down at UNVT for a portion of 2014 and NWS data were used as a surrogate for missing data.

21.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the UNVT monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 21-3. 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 and are shaded in gray in Table 21-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs and metals (PM_{10}) were sampled for under the NMP at UNVT in 2014.

Table 21-3. Risk-Based Screening Results for the Vermont Monitoring 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	24	56	42.86	100.00	100.00
Total		24	56	42.86		

Observations from Table 21-3 include the following:

- Arsenic is the only pollutant whose concentrations failed at least one screen for UNVT. Thus, arsenic is UNVT's only pollutant of interest.

- Approximately 43 percent of arsenic concentrations for were greater than their associated risk screening value (or failed screens).

- Concentrations of the remaining metals and PAHs sampled for at UNVT did not fail any screens. UNVT is the only NMP site sampling PAHs for which naphthalene did not fail any screens.

- It should be noted, however, that the Vermont Department of Environmental Conservation invalidated all of its nickel and total chromium concentrations for the second half of 2014. This is due to a contamination issue related to a new weighing and equilibration chamber at their laboratory, as discussed in Section 2.4.

21.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Vermont monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at UNVT are provided in Appendices M and N.

21.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for the UNVT site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the

total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the UNVT monitoring site are presented in Table 21-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 21-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Vermont Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
Underhill, Vermont - UNVT							
Arsenic (PM_{10})	56/25	61	0.16 ± 0.07	0.20 ± 0.06	0.32 ± 0.10	0.18 ± 0.11	0.21 ± 0.04

Observations from Table 21-4 include the following:

- Arsenic was detected in 56 of the 61 valid PM_{10} metals samples collected at UNVT in 2014. Of these, 25 were greater than the MDL associated with arsenic sampling.

- All of the arsenic concentrations measured at UNVT are less than 1 ng/m^3. Arsenic measurements range from 0.003 ng/m^3 to 0.83 ng/m^3 and include five non-detects. Non-detects of arsenic were measured during the first (2) and fourth (3) quarters of the year.

- Among NMP sites sampling arsenic, UNVT has the lowest annual average concentration of this pollutant (0.21 ± 0.04 ng/m^3).

- Based on the quarterly average concentrations of arsenic calculated for UNVT, concentrations appear highest during the third quarter. However, the differences are not statistically significant.

21.4.2 Concentration Comparison

In order to better illustrate how a site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 21-4 for UNVT. Figure 21-4 overlays the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 21-4. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

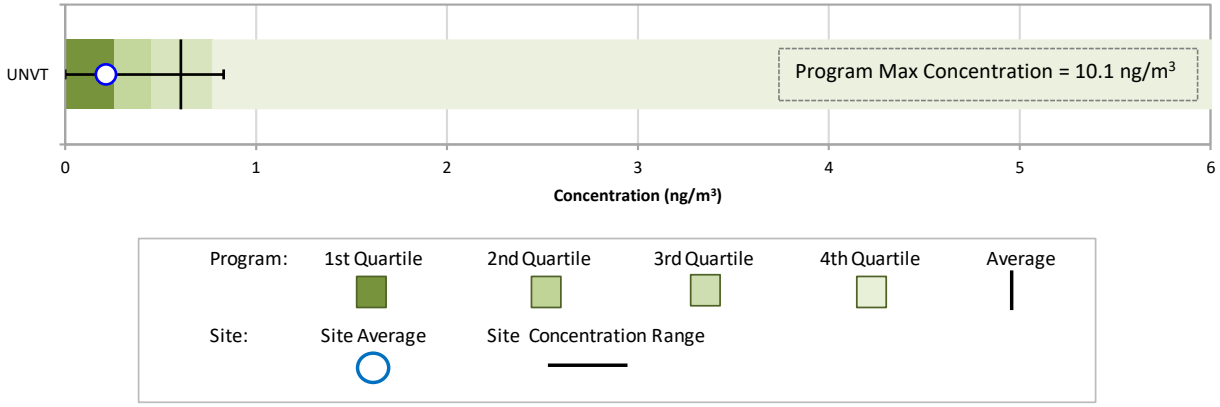


Figure 21-4 presents the box plot for arsenic for UNVT and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 21-4 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced.

- The maximum arsenic concentration measured at UNVT (0.83 ng/m^3) is just greater than the program-level third quartile (0.77 ng/m^3) and is the second-lowest site-specific maximum concentration among NMP sites sampling arsenic (PM_{10}).

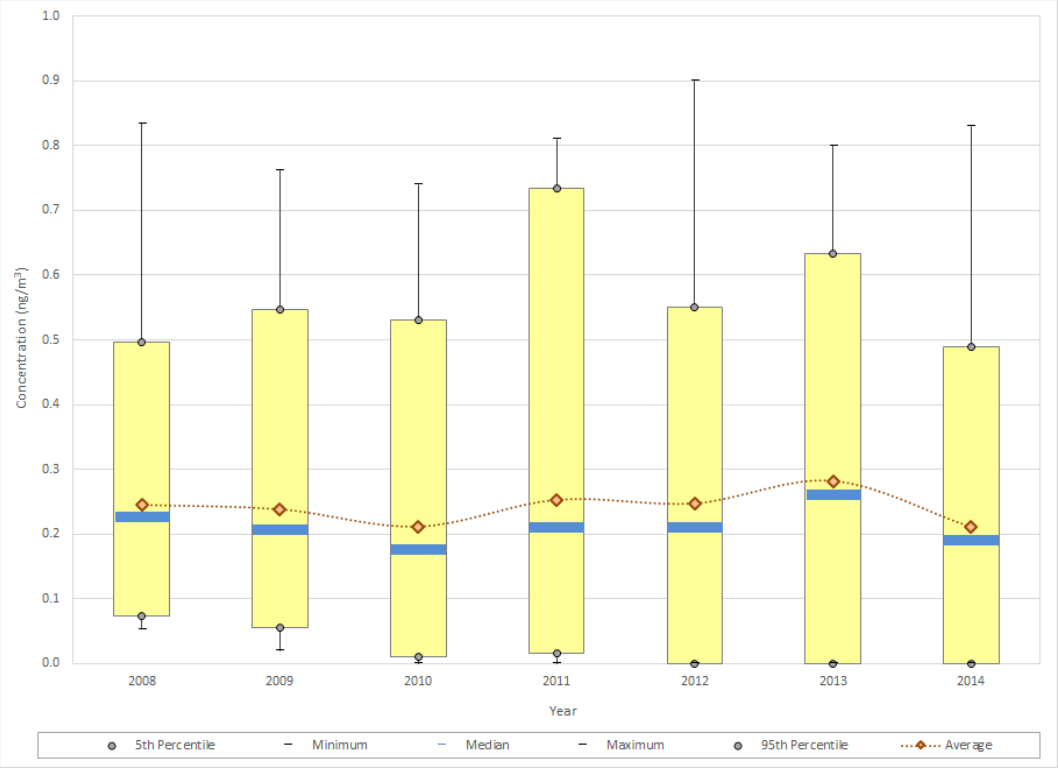
- The annual average arsenic concentration for UNVT is just less than the program-level first quartile (25th percentile). As discussed previously, the annual average concentration of arsenic for UNVT is the lowest annual average arsenic concentration among NMP sites sampling this pollutant.

- Five of the 33 non-detects of arsenic measured across the program were measured at UNVT.

21.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. UNVT has sampled PM_{10} metals under the NMP since 2008. Thus, Figure 21-5 presents the annual statistical metrics for the pollutant of interest for UNVT. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 21-5. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at UNVT



Observations from Figure 21-5 for arsenic concentrations measured at UNVT include the following:

- Arsenic concentrations greater than 1 ng/m^3 have not been measured at UNVT since the onset of sampling in 2008. The maximum arsenic concentration was measured at UNVT in 2012 (0.90 ng/m^3).

- With the exception of the 95th percentile, each of the statistical parameters exhibits a decrease from 2008 to 2009 and again for 2010. The minimum concentration

measured in 2008 is 0.05 ng/m^3, which decreased to 0.02 ng/m^3 for 2009, and the first non-detects were measured in 2010 (three). Between three and six non-detects were measured each year following 2010.

- Overall, a similar range of arsenic concentrations has been measured at UNVT from year-to-year. The 1-year average concentrations of arsenic for UNVT have changed little over the years of sampling, ranging from 0.21 ng/m^3 (2014) to 0.28 ng/m^3 (2013). Likewise, the median concentration has ranged from 0.18 ng/m^3 (2010) to 0.26 ng/m^3 (2013).

- The change in the 1-year average concentration is largest between 2013 and 2014. While not statistically significant, this difference can be primarily attributed to concentrations at the lower end of the concentration range. Concentrations less than 0.1 ng/m^3, excluding non-detects, account for only four measurements in 2013 compared to 13 in 2014. The number of non-detects of arsenic measured each year varied by only one (four in 2013 and five in 2014).

21.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the Vermont monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

21.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Vermont monitoring site and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 21-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 21-5. Risk Approximations for the Vermont Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Underhill, Vermont - UNVT						
Arsenic (PM_{10})	0.0043	0.000015	56/61	0.21 ± 0.04	0.92	0.01

Observations from Table 21-5 include the following:

- The annual average arsenic concentration for UNVT is the lowest annual average for this pollutant among NMP sites sampling metals.
- The cancer risk approximation for UNVT is less than 1 in-a-million and is the lowest cancer risk approximation for arsenic among NMP sites (0.92 in-a-million).
- The noncancer hazard approximation for arsenic for UNVT is considerably less than 1.0 (0.01), indicating that no adverse noncancer health effects are expected from this individual pollutant.

21.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screenings discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 21-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 21-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 21-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for UNVT, as presented in Table 21-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 21-6. Table 21-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Table 21-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Vermont Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Underhill, Vermont (Chittenden County) - UNVT					
Benzene	103.48	Formaldehyde	8.77E-04	Arsenic (PM_{10})	0.92
Formaldehyde	67.43	Benzene	8.07E-04		
Acetaldehyde	37.96	1,3-Butadiene	4.06E-04		
Ethylbenzene	37.92	Arsenic, PM	3.13E-04		
1,3-Butadiene	13.53	Naphthalene	2.29E-04		
Naphthalene	6.75	POM, Group 2b	1.52E-04		
Dichloromethane	2.55	Hexavalent Chromium	1.19E-04		
Tetrachloroethylene	2.22	POM, Group 5a	1.06E-04		
POM, Group 2b	1.73	Nickel, PM	9.73E-05		
POM, Group 2d	1.02	Ethylbenzene	9.48E-05		

Table 21-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Vermont Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Underhill, Vermont (Chittenden County) - UNVT					
Toluene	250.92	Acrolein	546,915.43	Arsenic (PM_{10})	0.01
Xylenes	174.70	Chlorine	12,098.33		
Hexane	106.23	Manganese, PM	9,934.56		
Benzene	103.48	Formaldehyde	6,880.35		
Methanol	90.73	1,3-Butadiene	6,767.01		
Formaldehyde	67.43	Arsenic, PM	4,859.91		
Acetaldehyde	37.96	Acetaldehyde	4,218.14		
Ethylbenzene	37.92	Benzene	3,449.29		
Hydrochloric acid	35.41	Cadmium, PM	2,474.68		
Ethylene glycol	31.16	Nickel, PM	2,252.18		

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 21.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 21-6 include the following:

- Benzene, formaldehyde, acetaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Chittenden County.

- Formaldehyde is the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) in Chittenden County, followed by benzene, 1,3-butadiene, and arsenic (PM).

- Six of the highest emitted pollutants also have the highest toxicity-weighted emissions for Chittenden County. Benzene and formaldehyde are at or near the top of the emissions-based lists.

- Arsenic is UNVT's only pollutant of interest for 2014. Arsenic has the fourth highest toxicity-weighted emissions, but is not one of the highest emitted in Chittenden County (it ranks 15th). Nickel also appears among the pollutants with the highest toxicity-weighted emissions, ranking ninth, while its quantity emitted in Chittenden County rank 12th. Nickel was sampled for at UNVT, but concentrations measured during the second half of the year were invalidated due to contamination of the filters.

Observations from Table 21-7 include the following:

- Toluene, xylenes, and hexane are the highest emitted pollutants with noncancer RfCs in Chittenden County.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Chittenden County, followed by chlorine and manganese (PM).

- Three of the highest emitted pollutants for Chittenden County also have the highest toxicity-weighted emissions.

- Four metals sampled for at UNVT appear among the pollutants with the highest toxicity-weighted emissions, including arsenic, although none appear among the

highest emitted (manganese ranks 19th and is the highest ranking among the four metals listed). This speaks to the relative toxicity potential of pollutants emitted in small quantities.

21.6 Summary of the 2014 Monitoring Data for the Vermont Monitoring Site

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

- *Metals (PM_{10}) and PAHs were sampled for at UNVT.*
- *Concentrations of nickel and total chromium sampled during the second half of 2014 were invalidated due to a filter contamination issue at the Vermont laboratory.*
- *Arsenic is the only pollutant of interest for UNVT. All of the arsenic concentrations measured at UNVT in 2014 are less than 1 $\mu g/m^3$.*
- *The annual average arsenic concentration for UNVT is the lowest annual average for this pollutant among NMP sites sampling metals.*

22.0 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

22.1 Site Characterization

This section characterizes the Virginia 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 in East Highland Park. Figure 22-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 22-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 22-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 22-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 22-1. East Highland Park, Virginia (RIVA) Monitoring Site

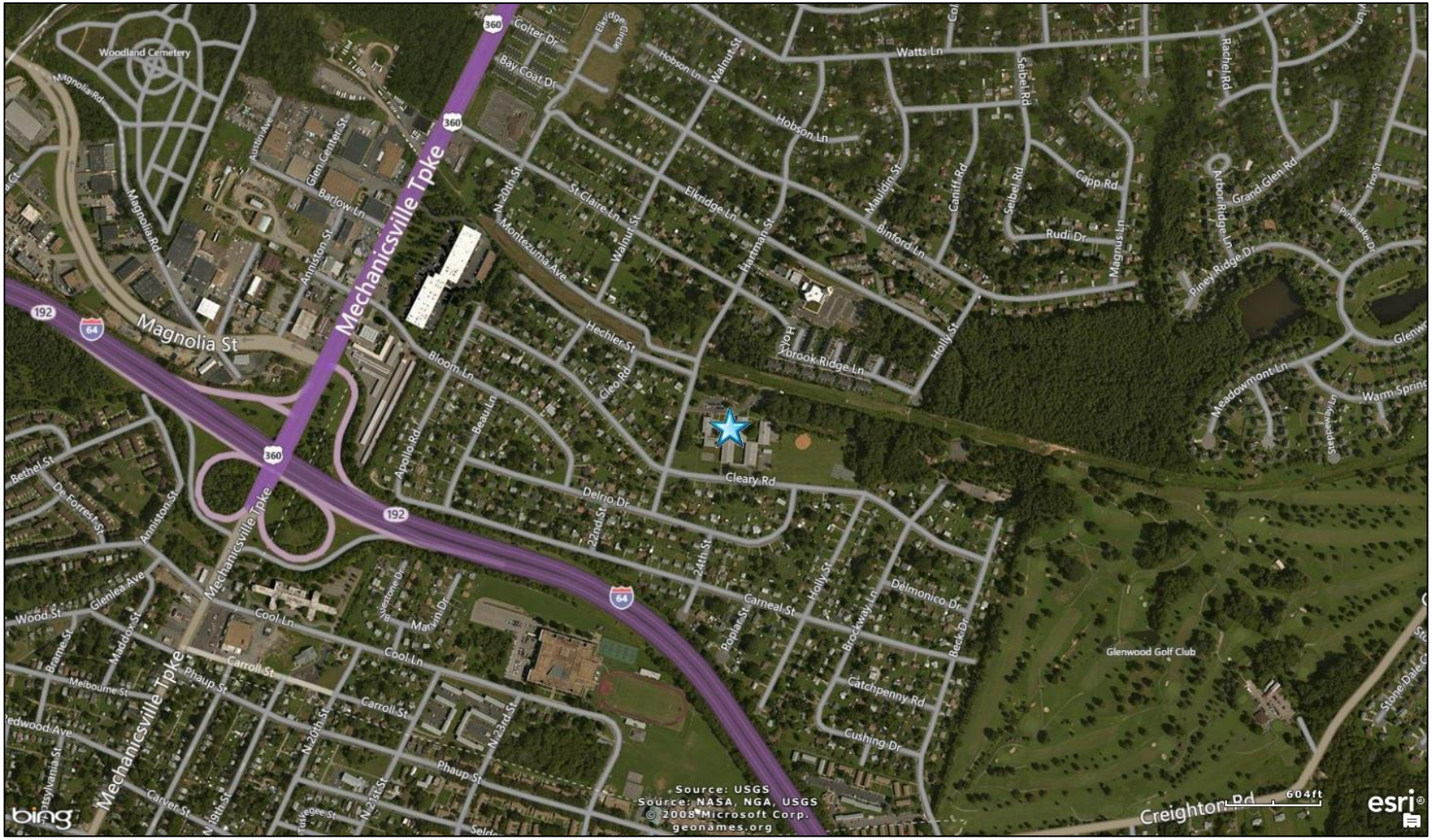
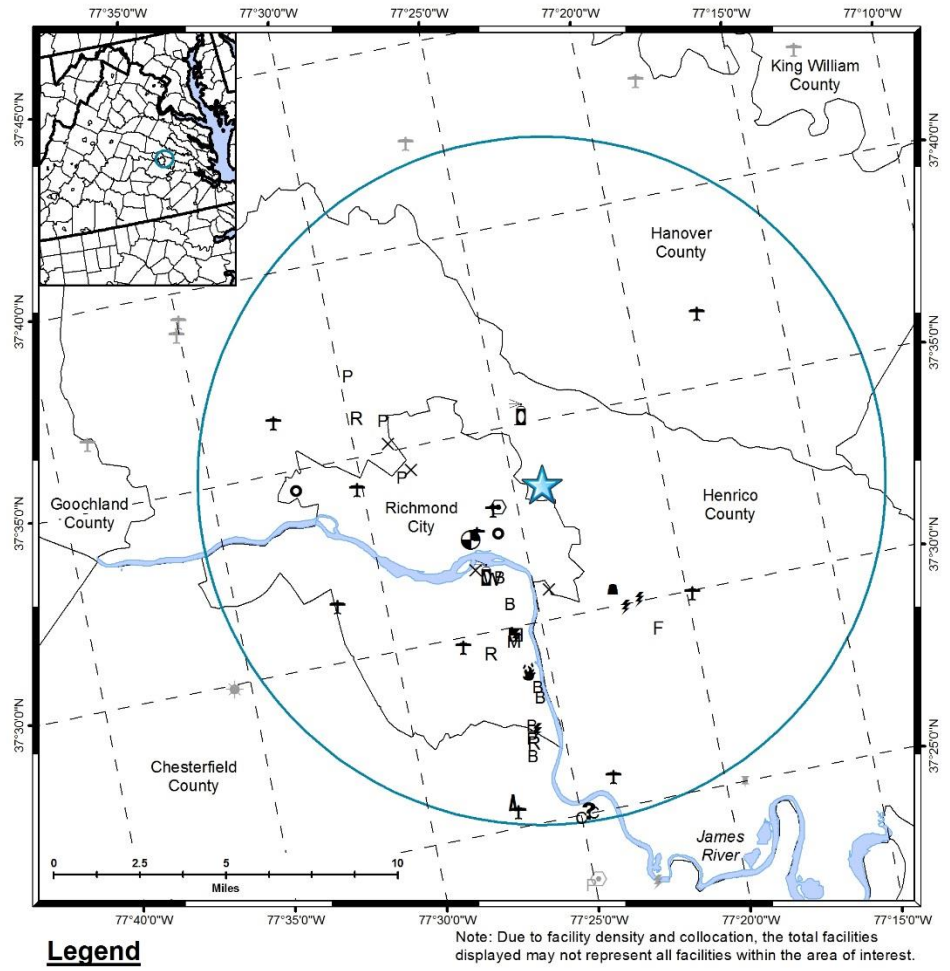


Figure 22-2. NEI Point Sources Located Within 10 Miles of RIVA



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

Legend

RIVA NATTS site | 10 mile radius | County boundary

Source Category Group (No. of Facilities)

- Airport/Airline/Airport Support Operations (10)
- Asphalt Production/Hot Mix Asphalt Plant (1)
- B Bulk Terminals/Bulk Plants (6)
- C Chemical Manufacturing Facility (2)
- Electricity Generation via Combustion (4)
- F Food Processing/Agriculture Facility (1)
- Institutional (school, hospital, prison, etc.) (2)
- Landfill (1)
- Metals Processing/Fabrication Facility (1)
- Military Base/National Security Facility (1)
- ? Miscellaneous Commercial/Industrial Facility (1)
- Paint and Coating Manufacturing Facility (2)
- R Plastic, Resin, or Rubber Products Plant (3)
- P Printing/Publishing/Paper Product Manufacturing Facility (4)
- Pulp and Paper Plant (1)
- × Rail Yard/Rail Line Operations (4)
- Testing Laboratories (1)
- M Tobacco Manufacturing (1)
- W Woodwork, Furniture, Millwork & Wood Preserving Facility (1)

Table 22-1. 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	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
RIVA	51-087-0014	East Highland Park	Henrico	Richmond, VA	37.556520, -77.400270	Residential	Suburban	72,000	I-64 at Mechanicsville Turnpike

[1]AADT reflects 2013 data (VA DOT, 2013)
BOLD ITALICS = EPA-designated NATTS Site

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 about one-quarter mile from I-64. The I-64 interchange with Mechanicsville Turnpike (US-360) is one-half mile west of the site, as shown in Figure 22-1. Beyond the residential areas surrounding the school property are a golf course to the southeast, a high school to the south (on the south side of I-64), and commercial areas to the west.

As Figure 22-2 shows, RIVA is located near several point sources, most of which are located to the south and southwest of the site and within the city of Richmond. The sources closest to RIVA are a metals processing and fabrication facility and a heliport at the Medical College of Virginia. The source categories with the greatest number of emissions sources within 10 miles of RIVA are the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; bulk terminals and bulk plants; printing, publishing, and paper product manufacturers; rail yard and rail line operations; and facilities generating electricity via combustion.

In addition to providing city, county, CBSA, and land use/location setting information, Table 22-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near RIVA is 72,000, which is in the top third of the range compared to other NMP monitoring sites, ranking 15th. The traffic volume provided is for I-64 at US-360 (Mechanicsville Turnpike).

22.2 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 the year.

22.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2. For the Virginia site, site-specific data were available for some, but not all, of the parameters in Table 22-2. For RIVA, temperature, pressure, and wind information was available in AQS. Data from the NWS weather station at Richmond International Airport (WBAN 13740) were used for the remaining parameters (relative humidity, sea level pressure, and dew point temperature). The Richmond International Airport weather station is located 5.7 miles southeast of RIVA. A map showing the distance between the monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 22-2. Average Meteorological Conditions near the Virginia Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
East Highland Park, Virginia - RIVA [2]							
Sample Days (67)	57.9 ± 0.9	44.9 ± 0.9	63.6 ± 1.0	30.06 ± 0.01	29.85 ± 0.01	S	3.4 ± 0.1
2014	57.9 ± 0.4	44.6 ± 0.4	63.2 ± 0.4	30.06 ± <0.01	29.85 ± <0.01	S	3.4 ± <0.1

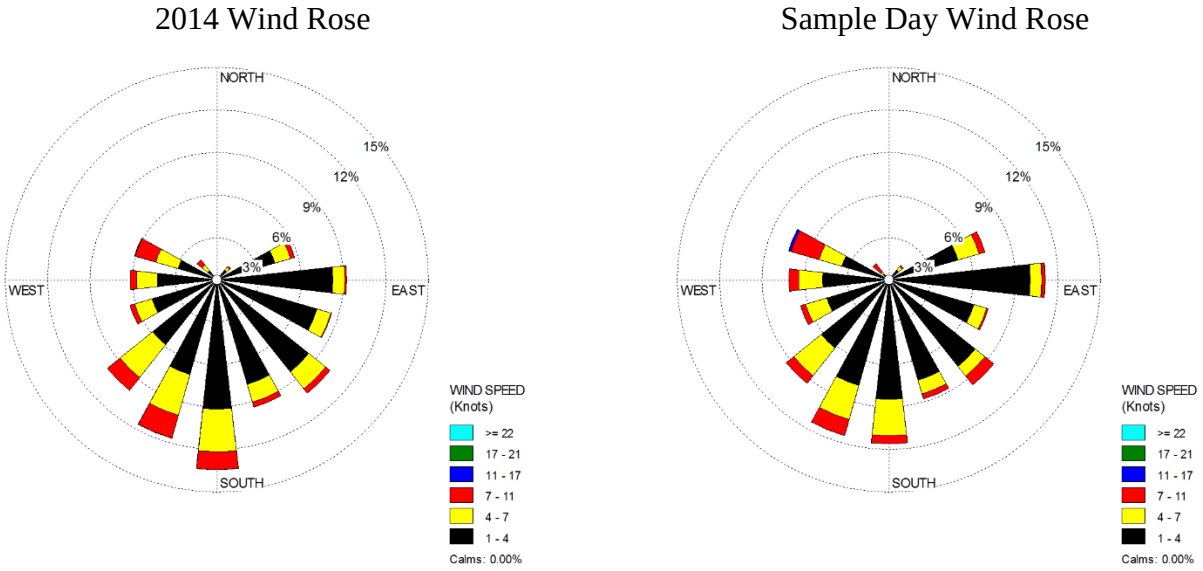
[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, station pressure, and wind parameters were measured at RIVA in 2014. The remaining information was obtained from the closest NWS weather station located at Richmond International Airport, WBAN 13740.

Table 22-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 22-2 is the 95 percent confidence interval for each parameter. As shown, average meteorological conditions on sample days at RIVA were representative of average weather conditions experienced throughout the year.

22.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 22-3 presents two wind roses for the RIVA monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 22-3. Wind Roses for the Wind Data Collected at RIVA



Observations from Figure 22-3 for RIVA include the following:

- The 2014 wind rose shows that wind blows predominantly from the southern quadrants at RIVA and rarely from the northern quadrants. Although winds from the south were observed the most (13 percent of observations), winds from the southeast to southwest account for majority of observations. Winds were light at RIVA, with winds greater than 17 knots not observed at this site, although calm winds were also not observed at RIVA. Wind speeds greater than 11 knots were most often observed with west-northwesterly winds.

- The wind patterns on the sample day wind rose resemble the wind patterns on the full-year wind rose, indicating that wind observations on sample days were representative of those observed throughout the year.

22.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the Virginia monitoring site in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 22-3. 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 and are shaded in gray in Table 22-3. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs and hexavalent chromium were sampled for year-round at RIVA. RIVA is the only NATTS site to sample hexavalent chromium year-round in 2014.

Table 22-3. Risk-Based Screening Results for the Virginia Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
East Highland Park, Virginia - RIVA						
Naphthalene	0.029	48	57	84.21	96.00	96.00
Benzo(a)pyrene	0.00057	1	36	2.78	2.00	98.00
Hexavalent Chromium	0.000083	1	24	4.17	2.00	100.00
Total		50	117	42.74		

Observations from Table 22-3 include the following:

- Concentrations of two PAHs, naphthalene and benzo(a)pyrene, and hexavalent chromium failed screens for RIVA.
- Concentrations of naphthalene failed 48 screens, which represents an 84 percent failure rate. Concentrations of the other two pollutants failed a single screen each.
- Concentrations of naphthalene account for 48 of the 50 failed screens for RIVA, accounting for 96 percent of failed screens. Thus, naphthalene is RIVA's only pollutant of interest.

22.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Virginia monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site.
- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at RIVA are provided in Appendices M and O.

22.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for RIVA, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutant of interest for the Virginia monitoring site are presented in Table 22-4, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 22-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Virginia Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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)
East Highland Park, Virginia - RIVA							
Naphthalene	57/57	57	55.57 ± 17.52	57.85 ± 10.28	69.26 ± 22.46	67.41 ± 20.81	62.57 ± 8.89

Observations for RIVA from Table 22-4 include the following:

- Concentrations of naphthalene measured at RIVA range from 21.3 ng/m^3 to 178 ng/m^3.

- The first quarter average concentration of naphthalene is the lowest and the third quarter average is the highest, although the differences among the quarterly averages are not statistically significant and each quarterly average concentration exhibits considerable variability, as indicated by the confidence intervals. Concentrations greater than 100 ng/m^3 were measured during each calendar quarter except the second quarter while concentrations less than 35 ng/m^3 were measured during each calendar quarter in 2014.

- Compared to other NMP sites sampling PAHs, RIVA has the 10th highest annual average concentration of naphthalene, as shown in Table 4-11 of Section 4.

22.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, a box plot was created for the pollutant listed in Table 22-4 for RIVA. Figure 22-4 overlays the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.3.1, and are discussed below.

Figure 22-4. Program vs. Site-Specific Average Naphthalene Concentration

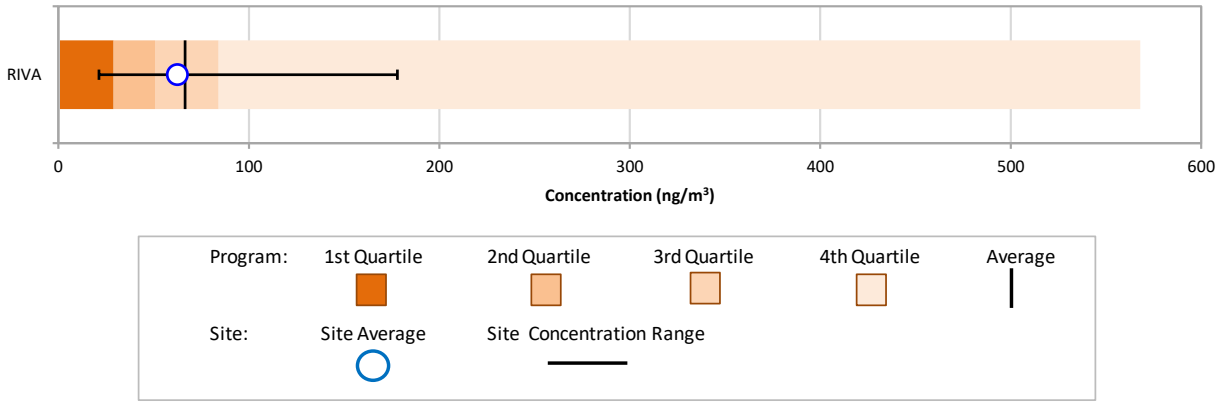


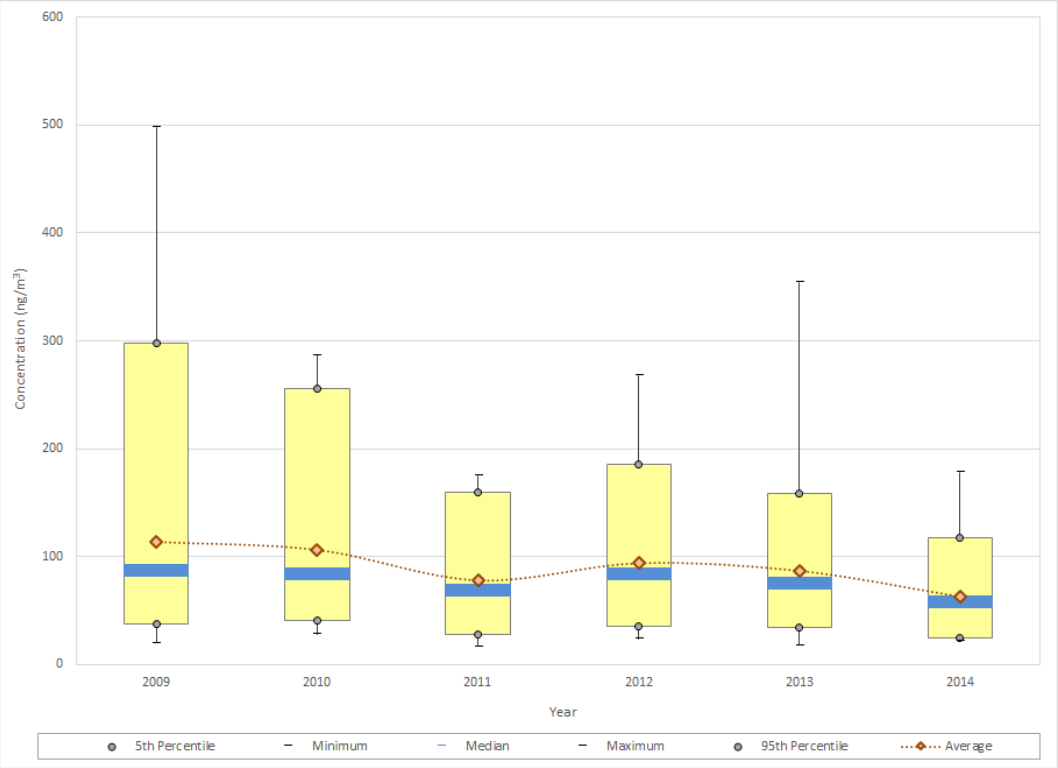
Figure 22-4 presents the box plot for naphthalene for RIVA and shows the following:

- The maximum naphthalene concentration measured at RIVA (178 ng/m^3) is roughly one-third the program-level maximum concentration (568 ng/m^3).
- There were no non-detects of naphthalene measured at RIVA, or across the program (although difficult to discern in Figure 22-4).
- The annual average concentration of naphthalene for RIVA (62.57 ng/m^3) is just less than the program-level average concentration (66.46 ng/m^3).

22.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. RIVA began sampling PAHs under the NMP in October 2008. Thus, Figure 22-5 presents the 1-year statistical metrics for the pollutant of interest for RIVA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 22-5. Yearly Statistical Metrics for Naphthalene Concentrations Measured at RIVA



Observations from Figure 22-5 for naphthalene concentrations measured at RIVA include the following:

- RIVA began sampling PAHs under the NMP in October 2008. Because less than 6 months of data are available for 2008, Figure 22-5 begins with 2009.

- The three naphthalene concentrations greater than 400 ng/m^3 were measured at RIVA during the fall of 2009. The next highest concentration was measured in 2013 (354 ng/m^3) and is the only other concentration greater than 300 ng/m^3 measured at RIVA.

- Most of the statistical parameters exhibit a decreasing trend through 2011, with the most significant change occurring between 2010 and 2011. All of the statistical parameters exhibit an increase for 2012 before decreasing slightly for 2013 (with the exception of the maximum concentration).

- Most of the statistical parameters are at a minimum for 2014. Since 2009, the median concentration decreased by 33 percent and the 1-year average concentration decreased by 44 percent.

22.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the RIVA monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

22.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for RIVA and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 22-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 22-5. Risk Approximations for the Virginia Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
East Highland Park, Virginia - RIVA						
Naphthalene	0.000034	0.003	57/57	62.57 ± 8.89	2.13	0.02

Observations for RIVA from Table 22-5 include the following:

- The annual average concentration of naphthalene for RIVA is 62.57 ± 8.89 ng/m^3.
- The cancer risk approximation for naphthalene based on RIVA's annual average concentration is 2.13 in-a-million.
- The noncancer hazard approximation for naphthalene is considerably less than 1.0 (0.02), indicating that no adverse noncancer health effects are expected from this individual pollutant.

22.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 22-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 22-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 22-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for RIVA, as presented in Table 22-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 22-6. Table 22-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual average concentrations to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 22.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 22-6. 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 UREs (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)**
East Highland Park, Virginia (Henrico County) - RIVA					
Benzene	102.27	Formaldehyde	1.12E-03	Naphthalene	2.13
Formaldehyde	86.37	Benzene	7.98E-04		
Acetaldehyde	50.16	1,3-Butadiene	5.48E-04		
Ethylbenzene	48.29	Naphthalene	2.84E-04		
1,3-Butadiene	18.27	POM, Group 2b	2.22E-04		
Tetrachloroethylene	17.17	POM, Group 2d	1.26E-04		
Naphthalene	8.35	Ethylbenzene	1.21E-04		
POM, Group 2b	2.52	Acetaldehyde	1.10E-04		
POM, Group 2d	1.43	POM, Group 5a	8.51E-05		
Trichloroethylene	0.85	Arsenic, PM	6.88E-05		

Table 22-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Virginia Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
East Highland Park, Virginia (Henrico County) - RIVA					
Toluene	542.35	Acrolein	276,867.54	Naphthalene	0.02
Hexane	196.44	1,3-Butadiene	9,132.57		
Xylenes	193.08	Formaldehyde	8,812.86		
Methanol	181.20	Acetaldehyde	5,572.79		
Benzene	102.27	Benzene	3,408.91		
Formaldehyde	86.37	Naphthalene	2,783.60		
Ethylene glycol	62.63	Xylenes	1,930.83		
Acetaldehyde	50.16	Arsenic, PM	1,067.34		
Ethylbenzene	48.29	Lead, PM	808.19		
Methyl isobutyl ketone	24.42	Propionaldehyde	556.24		

Observations from Table 22-6 include the following:

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

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

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henrico County.

- Naphthalene, the only pollutant of interest for RIVA, has the seventh highest emissions and the fourth highest toxicity-weighted emissions for Henrico County.

- POM, Group 2b is the eighth highest emitted "pollutant" in Henrico County and ranks fifth for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at RIVA, including fluorene, perylene, and acenaphthene. None of the PAHs sampled for at RIVA included in POM, Group 2b failed screens. POM, Group 2d also appears on both emissions-based lists for Henrico County but does not include any PAHs sampled for at RIVA. POM, Group 5a includes benzo(a)pyrene and ranks ninth for toxicity-weighted emissions but is not among the highest emitted. Benzo(a)pyrene failed a single screen for RIVA but was not identified as a pollutant of interest.

Observations from Table 22-7 include the following:

- Toluene, hexane, and xylenes are the highest emitted pollutants with noncancer RfCs in Henrico County.

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

- Four of the highest emitted pollutants in Henrico County also have the highest toxicity-weighted emissions.

- Naphthalene has the sixth highest toxicity-weighted emissions for Henrico County but is not among the highest emitted pollutants with a noncancer toxicity factor in Henrico County (it ranks 13th).

22.6 Summary of the 2014 Monitoring Data for RIVA

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

- ❖ *Concentrations of two PAHS and hexavalent chromium failed at least one screen, although naphthalene was the only pollutant identified as a pollutant of interest for RIVA.*

- ❖ *RIVA has the 10th highest annual average concentration of naphthalene among NMP sites sampling PAHs.*

- *Concentrations of naphthalene have a decreasing trend at RIVA since the onset of PAH sampling at this site.*

23.0 Site in Washington

This section examines the spatial and temporal characteristics of the ambient monitoring concentrations measured at the NATTS site 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 to Sections 1 through 4 and the glossary (Appendix P) for detailed discussions and definitions regarding the various data analyses presented below.

23.1 Site Characterization

This section characterizes the Washington 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 NATTS site in Washington is located in Seattle. Figure 23-1 is a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 23-2 identifies nearby point source emissions locations by source category, as reported in the 2011 NEI for point sources, version 2. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 23-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect 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. Sources outside the 10-mile boundary are still visible on the map for reference, but have been grayed out in order to emphasize emissions sources within the boundary. Table 23-1 provides supplemental geographical information such as land use, location setting, and locational coordinates.

Figure 23-1. Seattle, Washington (SEWA) Monitoring Site

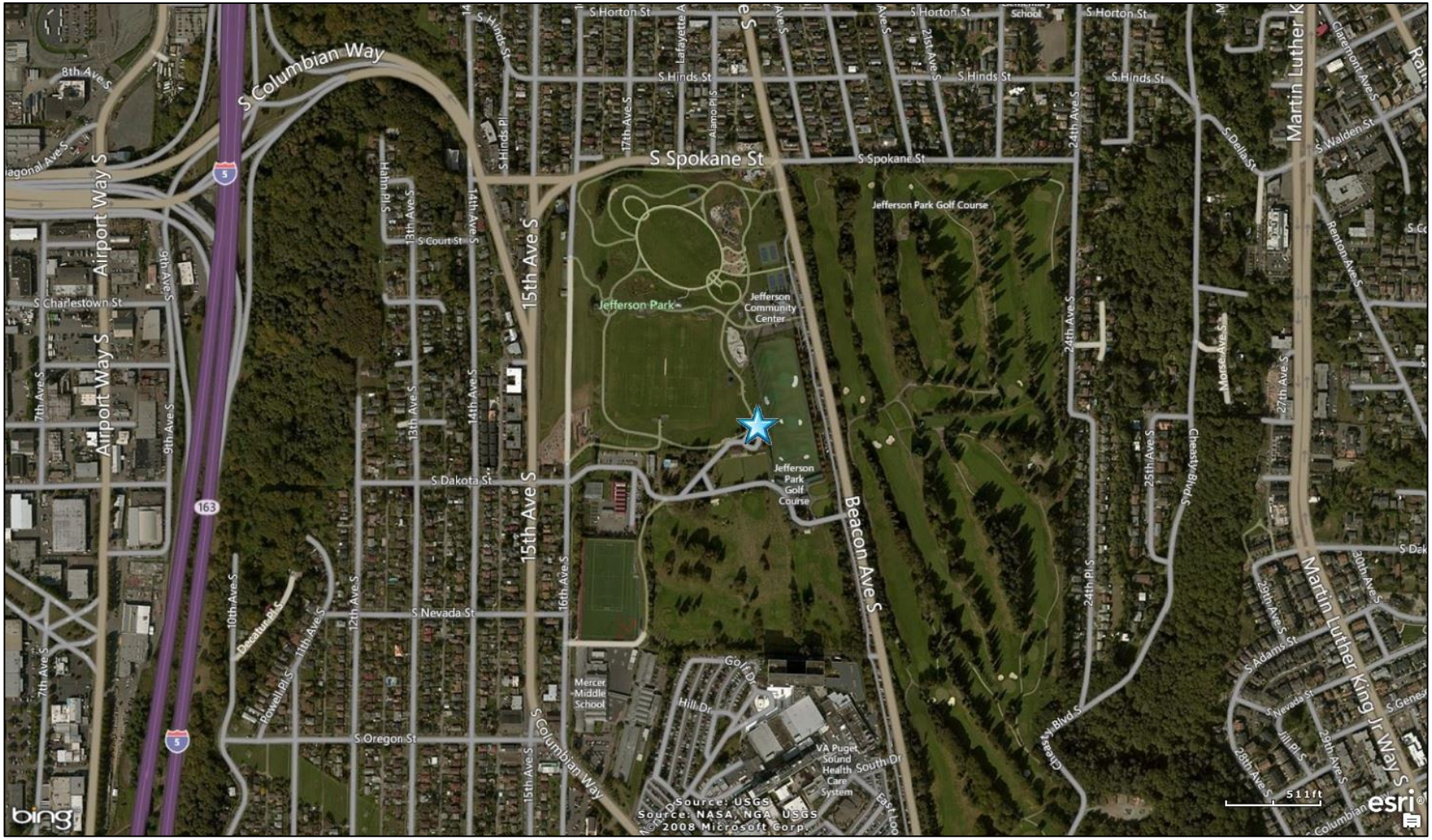


Figure 23-2. NEI Point Sources Located Within 10 Miles of SEWA

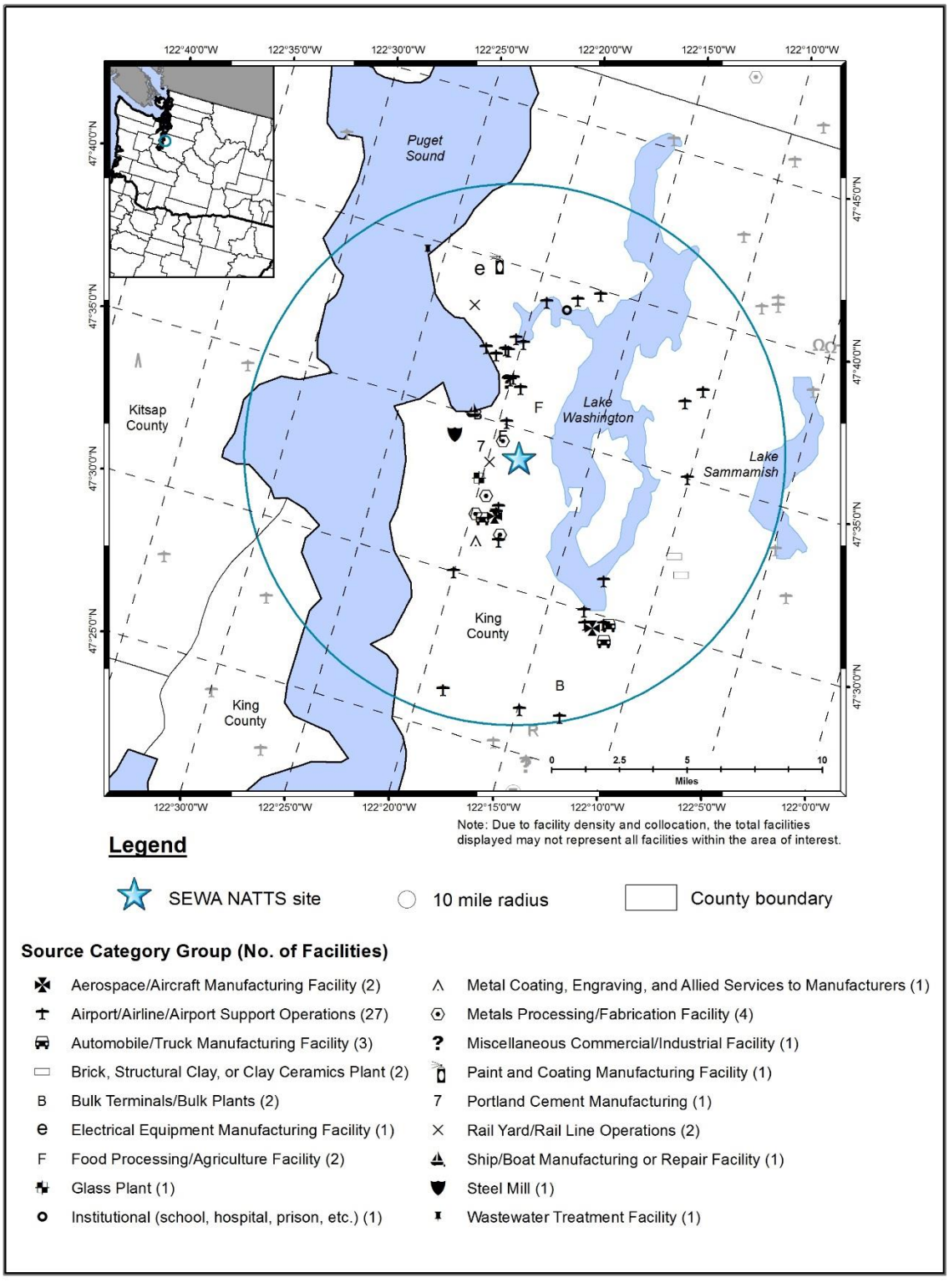


Table 23-1. Geographical Information for the Washington Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
SEWA	53-033-0080	Seattle	King	Seattle-Tacoma-Bellevue, WA	47.568236, -122.308628	Residential	Urban/City Center	178,000	I-5 S at Spokane St Viaduct

[1]AADT reflects 2014 data (WS DOT, 2014)
BOLD ITALICS = EPA-designated NATTS Site

The SEWA monitoring site is located in Seattle, at the southeast corner of the Beacon Hill Reservoir. With the reservoir covered, the entire area is part of Jefferson Park (Seattle, 2016). The reservoir and park are separated from the Jefferson Park Golf Course to the east by Beacon Avenue, as shown in Figure 23-1. A middle school and a hospital can be seen to the south of the site in the bottom-center portion of Figure 23-1. The site is surrounded by residential neighborhoods to the west, north, and east. Interstate-5, which runs north-south through Seattle, is less than 1 mile to the west of SEWA and intersects with I-90 a couple of miles farther north of the site. The area to the west of I-5 is highly industrial while the area to the east is primarily residential. Although the emissions sources within 10 miles of the site are involved in a variety of industries, the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations, has the greatest number of sources. The closest point sources to SEWA are a metals processing and fabrication facility and a food processing facility, as shown in Figure 23-2.

In addition to providing city, county, CBSA, and land use/location setting information, Table 23-1 also contains traffic volume information for SEWA as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly effect concentrations measured at a given monitoring site. The traffic volume experienced near SEWA is 178,000, which is the fourth highest compared to traffic volumes near other NMP monitoring sites. The traffic estimate provided is for I-5 at the Spokane Street Viaduct.

23.2 Meteorological Characterization

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

23.2.1 Meteorological Summary

In order to provide an overview of the meteorological conditions experienced at each monitoring site, hourly meteorological data for 2014 were retrieved and sample day and full-year averages developed for temperature, dew point, relative humidity, pressure, and wind speed. Weather data from the actual monitoring site(s) were obtained from AQS, where available. If site-specific weather data were not available in AQS, then data were obtained from NCDC for the NWS weather station located closest to the monitoring site(s), as described in Section 3.4.2.

For the Washington site, site-specific data were available for some, but not all, of the parameters in Table 23-2. For SEWA, temperature, station pressure, humidity, and wind information was available in AQS. Data from the NWS weather station at Boeing Field/King County International Airport (WBAN 24234) were used for the remaining parameters (sea level pressure and dew point temperature). The King County International Airport weather station is located 2.7 miles south of SEWA. In addition, pressure and humidity measurements at SEWA from May 2014 were not in AQS; thus, data from Seattle Airport was used as a surrogate. A map showing the distance between the monitoring site and the closest NWS weather station is provided in Appendix R. These data were used to determine how meteorological conditions on sample days vary from conditions experienced throughout the year.

Table 23-2. Average Meteorological Conditions near the Washington Monitoring Site

Average Type[1]	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (in Hg)	Average Station Pressure (in Hg)	Prevailing Wind Direction	Average Scalar Wind Speed (kt)
Seattle, Washington – SEWA[2]							
Sample Days (76)	52.6 ± 0.5	43.6 ± 0.5	77.6 ± 0.8	30.05 ± 0.01	29.72 ± 0.01	S	3.2 ± 0.1
2014	53.4 ± 0.2	44.4 ± 0.2	77.4 ± 0.4	30.03 ± <0.01	29.71 ± <0.01	S	3.2 ± <0.1

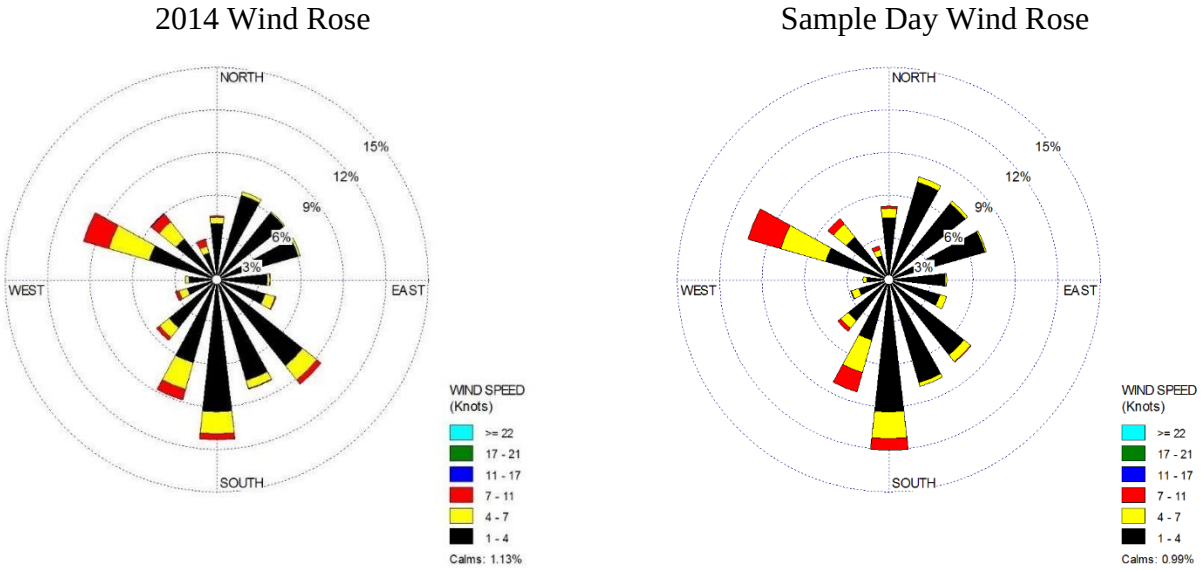
[1]Sample day averages are shaded in orange to help differentiate the sample day averages from the full-year averages.
[2]Temperature, humidity, station pressure, and wind parameters were measured at SEWA. The remaining information was obtained from the closest NWS weather station located at King County International Airport, WBAN 24234. In addition, station pressure and relative humidity data from the NWS station were used as a surrogate where meteorological data were not available in AQS.

Table 23-2 presents average temperature, average dew point temperature, average relative humidity, average station and sea level pressure, and wind information (average scalar wind speed and prevailing wind direction) for days on which samples were collected and for all of 2014. Also included in Table 23-2 is the 95 percent confidence interval for each parameter. Average meteorological conditions on sample days at SEWA were fairly representative of average weather conditions experienced throughout the year. The largest differences between the parameters shown in Table 23-2 are for average temperature and average dew point temperature.

23.2.2 Wind Rose Comparison

Hourly surface wind data were also uploaded into a wind rose software program to produce customized wind roses, as described in Section 3.4.2. 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 23-3 presents two wind roses for the SEWA monitoring site. The first is a wind rose representing wind observations for all of 2014 and the second is a wind rose representing wind observations for days on which samples were collected in 2014. These are used to identify the predominant wind speed and direction for 2014 and to determine if wind observations on sample days were representative of conditions experienced over the entire year.

Figure 23-3. Wind Roses for Wind Data Collected at SEWA



Observations from Figure 23-3 for SEWA include the following:

- The 2014 wind rose shows that light winds prevailed at SEWA. Winds from the southeast to south-southwest were observed the most, along with west-northwesterly winds, while winds from the west-southwest, west, and north-northwest were observed the least.

- The wind patterns shown on the sample day wind rose are similar to the wind patterns shown on the full-year wind rose, indicating that wind conditions in on sample days were representative of those experienced throughout the year.

23.3 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for SEWA in order to identify site-specific "pollutants of interest," which allows 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." The site-specific results of this risk-based screening process are presented in Table 23-3. 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 and are shaded in gray in Table 23-3. It is important to note which pollutants were sampled for at the site when reviewing the results of this analysis. PM_{10} metals, VOCs, PAHs, and carbonyl compounds were sampled for at SEWA.

Table 23-3. Risk-Based Screening Results for the Washington Monitoring Site

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	61	61	100.00	13.99	13.99
Benzene	0.13	60	60	100.00	13.76	27.75
Carbon Tetrachloride	0.17	60	60	100.00	13.76	41.51
1,2-Dichloroethane	0.038	53	53	100.00	12.16	53.67
1,3-Butadiene	0.03	50	53	94.34	11.47	65.14
Arsenic (PM_{10})	0.00023	47	60	78.33	10.78	75.92
Naphthalene	0.029	42	61	68.85	9.63	85.55
Acetaldehyde	0.45	38	61	62.30	8.72	94.27
Nickel (PM_{10})	0.0021	16	60	26.67	3.67	97.94
Ethylbenzene	0.4	5	60	8.33	1.15	99.08
Cadmium (PM_{10})	0.00056	2	60	3.33	0.46	99.54
Acenaphthene	0.011	1	60	1.67	0.23	99.77
Benzo(a)pyrene	0.00057	1	40	2.50	0.23	100.00
Total		436	749	58.21		

Observations from Table 23-3 for SEWA include the following:

- Concentrations of 13 pollutants failed at least one screen for SEWA; 58 percent of concentrations for these 13 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of nine pollutants contributed to 95 percent of failed screens for SEWA and therefore were identified as pollutants of interest for the site. These nine include two carbonyl compounds, four VOCs, two PM_{10} metals, and one PAH.

- Benzene, carbon tetrachloride, and formaldehyde were detected in every valid VOC or carbonyl compound sample collected at SEWA and failed 100 percent of screens. 1,2-Dichloroethane also failed 100 percent of screens, but was not detected in every sample collected.

23.4 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Washington monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each site.

- Annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics are presented from previous years of sampling in order to characterize concentration trends at each site.

Each analysis is performed where the data meet the applicable criteria specified in the appropriate sections discussed below. Site-specific statistical summaries for all pollutants sampled for at SEWA are provided in Appendices J, L, M, and N.

23.4.1 2014 Concentration Averages

Quarterly and annual concentration averages were calculated for the pollutants of interest for SEWA, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for the entire 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, as presented in Section 2.4. Quarterly and

annual average concentrations for the pollutants of interest for the Washington monitoring site are presented in Table 23-4, where applicable. Note that concentrations of the PAHs and PM_{10} metals are presented in ng/m^3 for ease of viewing. Also, note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 23-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Washington Monitoring Site

Pollutant	# of Measured Detections vs. # >MDL	# of Samples	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	61/61	61	0.38 ± 0.10	0.44 ± 0.10	1.04 ± 0.28	0.85 ± 0.31	0.69 ± 0.13
Benzene	60/60	60	0.70 ± 0.19	0.32 ± 0.05	0.36 ± 0.06	0.68 ± 0.14	0.50 ± 0.07
1,3-Butadiene	53/52	60	0.09 ± 0.05	0.03 ± 0.01	0.06 ± 0.02	0.10 ± 0.03	0.07 ± 0.01
Carbon Tetrachloride	60/60	60	0.67 ± 0.07	0.70 ± 0.02	0.69 ± 0.02	0.63 ± 0.02	0.67 ± 0.02
1,2-Dichloroethane	53/49	60	0.08 ± 0.01	0.07 ± <0.01	0.04 ± 0.01	0.07 ± 0.01	0.06 ± 0.01
Formaldehyde	61/61	61	0.38 ± 0.12	0.42 ± 0.07	0.89 ± 0.20	0.69 ± 0.22	0.60 ± 0.10
Arsenic (PM_{10})[a]	60/50	60	0.69 ± 0.29	0.36 ± 0.20	0.59 ± 0.15	0.76 ± 0.23	0.60 ± 0.11
Naphthalene[a]	61/61	61	43.11 ± 13.01	34.44 ± 13.74	59.70 ± 14.84	55.16 ± 16.48	49.25 ± 7.46
Nickel (PM_{10})[a]	60/59	60	0.88 ± 0.28	1.25 ± 0.50	3.17 ± 0.97	1.64 ± 0.85	1.74 ± 0.40

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

Observations from Table 23-4 include the following:

- The annual average concentrations for all of SEWA's pollutants of interest are less than 1.0 µg/m^3. The pollutants with the highest annual average concentrations are acetaldehyde (0.69 ± 0.13 µg/m^3), carbon tetrachloride (0.67 ± 0.02 µg/m^3), formaldehyde (0.60 ± 0.10 µg/m^3), and benzene (0.50 ± 0.07 µg/m^3). These are similar to the annual average concentrations calculated for 2012 and 2013.

- Even though acetaldehyde has the highest annual average concentration among SEWA's pollutants of interest, this annual average is one of the lowest among NMP sites sampling acetaldehyde. In addition, SEWA's annual average concentration of formaldehyde is the lowest among all NMP sites. Few NMP sites have annual average concentrations of these two pollutants less than 1 µg/m^3, and the annual

averages for both acetaldehyde and formaldehyde for SEWA are less than 1 µg/m^3. Similar observations were made in previous NMP reports.

- The quarterly average concentrations of acetaldehyde for the first and second quarters of the year are significantly lower than the quarterly average concentrations for the third and fourth quarters of the year. Only one acetaldehyde concentration greater than 1 µg/m^3 was measured at SEWA during the first half of 2014 while 13 were measured during the second half of the year. In addition, seven concentrations measured between January and June are less than the minimum concentration measured during the second half of the year. A similar observation can be made for formaldehyde, although the difference is less dramatic. Formaldehyde concentrations greater than 1 µg/m^3 were not measured at SEWA during the first half of 2014 while seven were measured during the second half of the year. In addition, seven of the nine formaldehyde concentrations less than 0.3 µg/m^3 were measured between January and June while only two were measured during the second half of the year. The three lowest concentrations of acetaldehyde and formaldehyde were measured at SEWA on the same days in January and February while the three highest concentrations of each pollutant were measured on the same days in November, September, and August.

- The first and fourth quarter average benzene concentrations shown in Table 23-4 are roughly twice the magnitude of the remaining quarterly average concentrations, indicating that concentrations of benzene tended to be higher during the colder months of the year at SEWA. A review of the data shows that benzene concentrations measured at SEWA range from 0.138 µg/m^3 to 1.71 µg/m^3 and that all 17 benzene concentrations greater than 0.6 µg/m^3 were measured at SEWA during the first (9) or fourth (8) quarters of 2014, including two greater than 1 µg/m^3 (January 5, 2014 and November 19, 2014). Conversely, none of the 17 concentrations of benzene less than 0.35 µg/m^3 were measured at SEWA during the first or fourth quarters of 2014. A similar observation can be made for 1,3-butadiene. All 10 1,3-butadiene concentrations greater than 0.1 µg/m^3 were measured in January, March, November, or December. The maximum concentrations of both benzene and 1,3-butadiene were measured on January 5, 2014. Several of the highest concentrations of these compounds were measured at SEWA on the same days.

- Concentrations of 1,2-dichloroethane measured during the third quarter appear lower than those measured during the rest of the year, based on the quarterly average concentrations shown in Table 23-4. A review of the data shows that six of the seven non-detects of this pollutant were measured between late July and early September. A similar observation was made in the 2013 NMP report.

- Concentrations of naphthalene appear higher during the second half of 2014, although the quarterly average concentrations of naphthalene exhibit considerable variability, as indicated by the confidence intervals. Concentrations of naphthalene measured at SEWA range from 9.19 ng/m^3 to 167 ng/m^3. The maximum naphthalene concentration was measured on November 19, 2014, the same day the highest acetaldehyde and formaldehyde concentrations were measured and the second highest benzene and 1,3-butadiene concentrations were measured.

- Arsenic concentrations measured at SEWA during the second quarter of 2014 appear lower than those measured during the other calendar quarters. A review of the data shows that arsenic concentrations measured at SEWA range from 0.008 ng/m^3 to 1.73 ng/m^3. Six of the seven arsenic concentrations less than or equal to 0.1 ng/m^3 measured at SEWA were measured during the second quarter (with one measured during the first quarter and none measured during the third or fourth quarters). Additionally, only one arsenic measurement greater than 1 ng/m^3 was measured during the second quarter of 2014, with the other eight spread out across the other calendar quarters. The maximum arsenic concentrations measured during the first and fourth quarters are roughly twice the maximum concentrations measured during the second and third quarters of 2013. The second highest arsenic concentration was measured at SEWA on November 19, 2014 (1.58 ng/m^3).

- Concentrations of nickel measured at SEWA appear highly variable, with the quarterly average for the third quarter nearly four times greater than the first quarter average (and the other quarterly average concentrations falling in-between). Concentrations of nickel measured at SEWA in 2014 range from 0.17 ng/m^3 to 6.17 ng/m^3. Three of the four nickel concentrations greater than 5 ng/m^3 were measured at SEWA in August, with the fourth measured on November 19, 2014 (5.32 ng/m^3). None of the 17 nickel concentrations greater than 2 ng/m^3 were measured at SEWA before June.

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

- SEWA only appears in Table 4-9 for VOCs once; SEWA has the sixth highest annual average concentration of carbon tetrachloride among sites sampling VOCs. SEWA is the first NMP site outside of Calvert City, Kentucky to appear in Table 4-9 for carbon tetrachloride. However, the annual average concentrations for most NMP sites span less than 0.1 µg/m^3. A similar observation was made in the 2012 and 2013 NMP reports.

- SEWA does not appear in Table 4-10 for carbonyl compounds. As indicated above, SEWA has one of the lowest annual average acetaldehyde concentrations and the lowest annual average concentration of formaldehyde among NMP sites sampling these pollutants.

- SEWA does not appear in Table 4-11 for naphthalene. SEWA has the 15th highest annual average concentration of naphthalene among NMP sites sampling PAHs.

- As shown in Table 4-12, SEWA has the third highest annual average concentration of nickel among all NMP sites sampling metals (PM_{10}), behind only ASKY-M and BOMA. SEWA ranked second highest in the 2012 and 2013 NMP reports while SEWA had the highest annual average nickel concentration in the 2010 and 2011 NMP reports.

- SEWA also has the seventh highest annual average concentration of arsenic among NMP sites sampling PM_{10} metals.

23.4.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 23-4 for SEWA. Figures 23-4 through 23-12 overlay the site's minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations for each pollutant, as described in Section 3.4.3.1, and are discussed below.

Figure 23-4. Program vs. Site-Specific Average Acetaldehyde Concentration

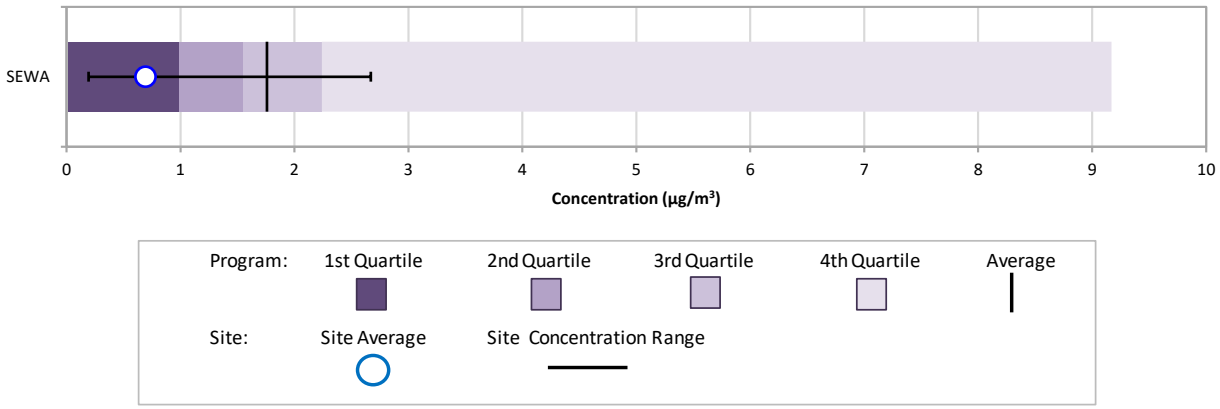


Figure 23-4 presents the box plot for acetaldehyde for SEWA and shows the following:

- All but one of SEWA's acetaldehyde measurements are less than the program-level third quartile (2.24 µg/m^3).

- SEWA's annual average acetaldehyde concentration is more than 1 µg/m^3 less than the program-level average concentration for acetaldehyde (1.76 µg/m^3) and is also less than the program-level first quartile (0.98 µg/m^3).

- This site has one of the lowest annual average concentrations of acetaldehyde among NMP sites sampling carbonyl compounds, with only two sites having lower annual average concentrations of acetaldehyde.

Figure 23-5. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentration

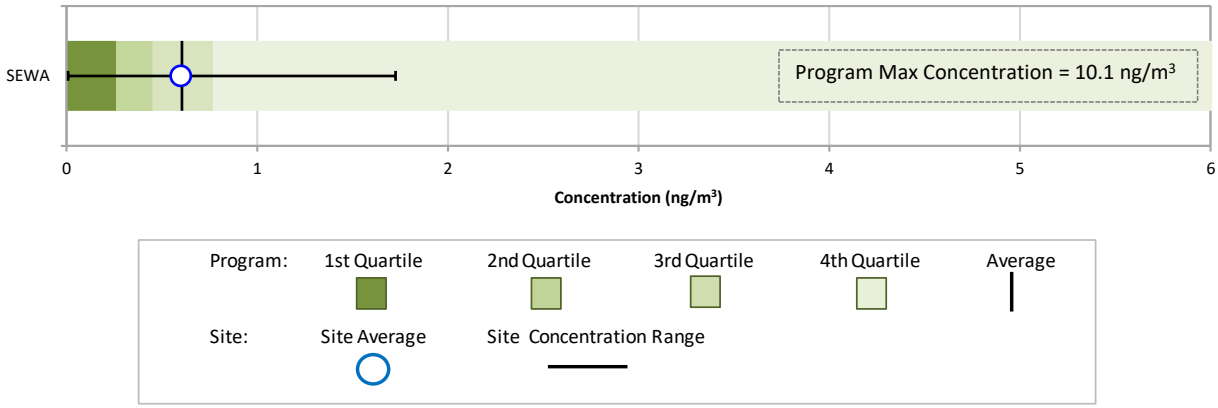


Figure 23-5 presents the box plot for arsenic for SEWA and shows the following:

- The program-level maximum arsenic concentration (10.1 ng/m^3) is not shown directly on the box plot in Figure 23-5 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The maximum arsenic concentration measured at SEWA is considerably less than the maximum concentration measured across the program.

- SEWA's annual average arsenic (PM_{10}) concentration is very similar to the program-level average concentration.

- There were no non-detects of arsenic measured at SEWA, although this is difficult to discern in Figure 23-5.

Figure 23-6. Program vs. Site-Specific Average Benzene Concentration

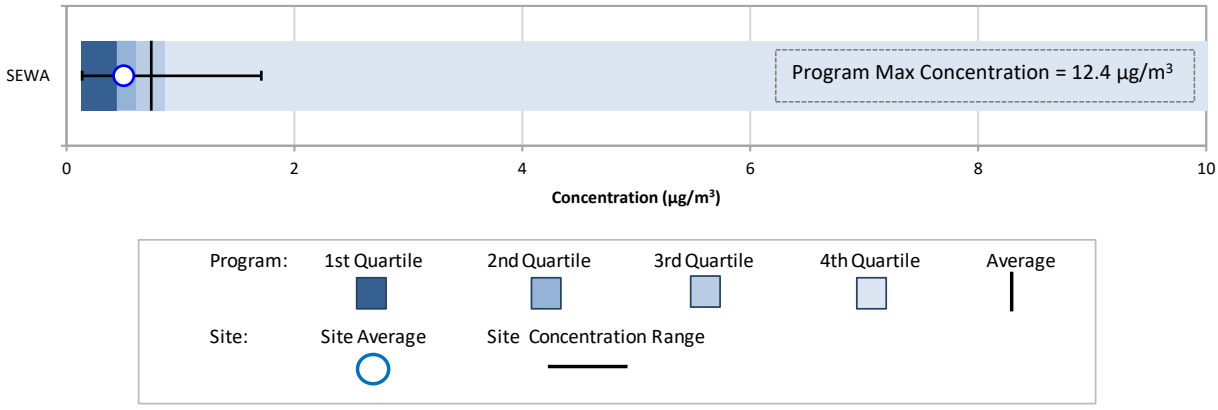


Figure 23-6 presents the box plot for benzene for SEWA and shows the following:

- The program-level maximum benzene concentration (12.4 µg/m^3) is not shown directly on the box plot in Figure 23-6 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- All benzene concentrations measured at SEWA in 2014 are less than 2 µg/m^3.

- The annual average benzene concentration for SEWA falls between the program-level median concentration and program-level first quartile. Among other NMP sites, SEWA has one of the lowest annual average concentrations of benzene (ranking 26th).

Figure 23-7. Program vs. Site-Specific Average 1,3-Butadiene Concentration

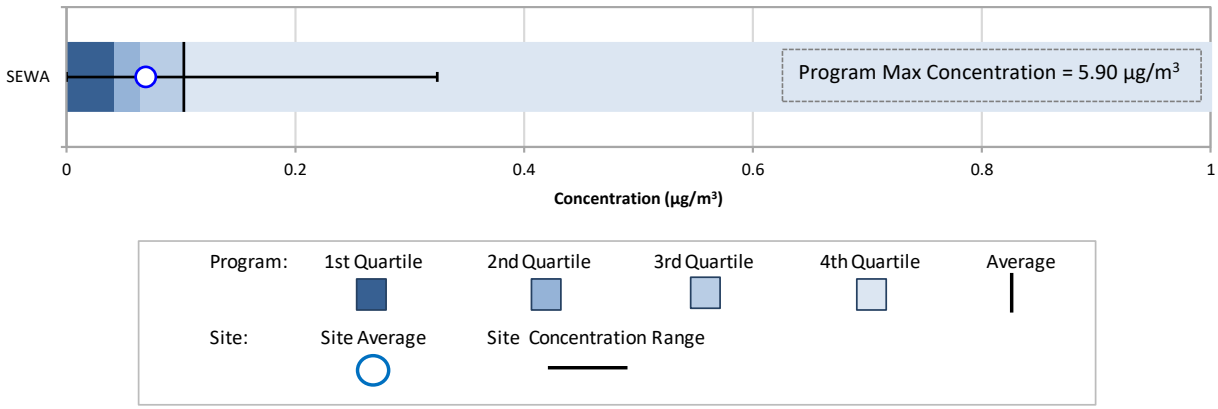


Figure 23-7 presents the box plot for 1,3-butadiene for SEWA and shows the following:

- Similar to benzene, the program-level maximum 1,3-butadiene concentration (5.90 µg/m^3) is not shown directly on the box plot in Figure 23-7 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 1 µg/m^3.

- The annual average 1,3-butadiene concentration for SEWA is just greater than the program-level median concentration and less than both the program-level average and third quartile, which are very similar to each other.

- Seven non-detects of 1,3-butadiene were measured at SEWA.

Figure 23-8. Program vs. Site-Specific Average Carbon Tetrachloride Concentration

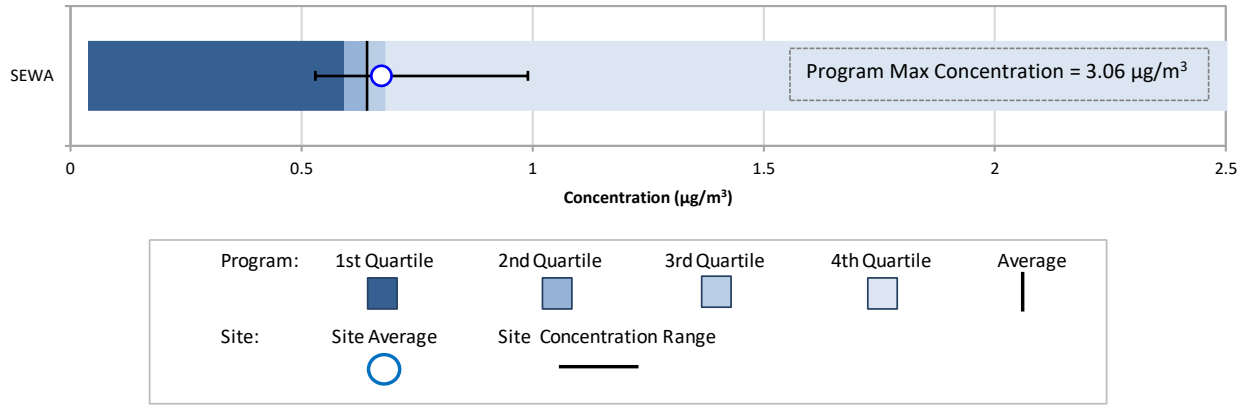


Figure 23-8 presents the box plot for carbon tetrachloride for SEWA and shows the following:

- The scale of the box plot in Figure 23-8 has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level median and average concentrations are similar and plotted nearly on top of each other.

- The range of carbon tetrachloride concentrations measured at SEWA spans approximately 0.5 µg/m^3.

- The annual average concentration of carbon tetrachloride for SEWA is greater than the program-level average concentration and just less than the program-level third quartile, although less than 0.04 µg/m^3 separates these three values.

Figure 23-9. Program vs. Site-Specific Average 1,2-Dichloroethane Concentration

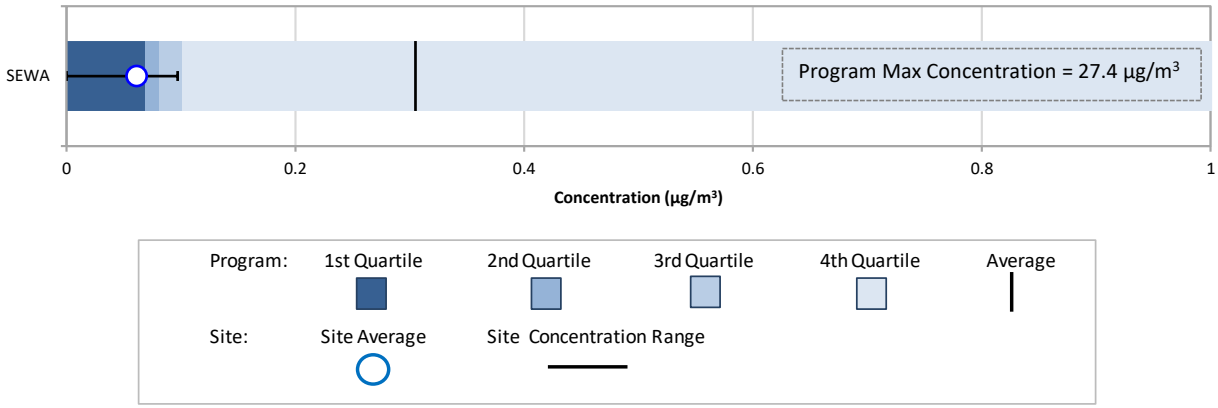


Figure 23-9 presents the box plot for 1,2-dichloroethane for SEWA and shows the following:

- The scale of the box plot in Figure 23-9 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (27.4 µg/m^3) is considerably greater than the majority of measurements.

- All of the measurements of 1,2-dichloroethane measured at SEWA are less than the program-level third quartile (0.101 µg/m^3). Note that the program-level average concentration of 0.31 µg/m^3 is being driven by the measurements at the upper end of the concentration range.

- SEWA's annual average concentration of 1,2-dichloroethane is less than the program-level first quartile.

- Seven non-detects of 1,2-dichloroethane were measured at SEWA.

Figure 23-10. Program vs. Site-Specific Average Formaldehyde Concentration

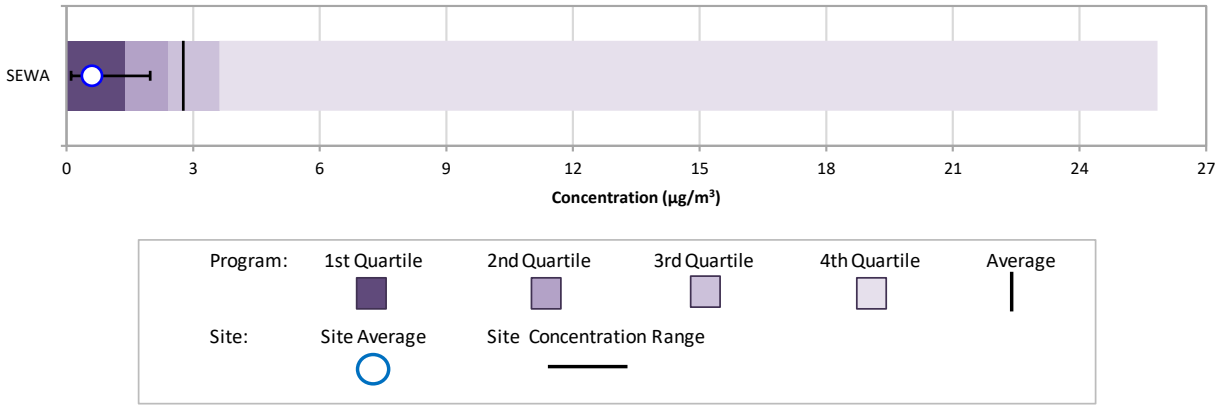


Figure 23-10 presents the box plot for formaldehyde for SEWA and shows the following:

- All formaldehyde concentrations measured at SEWA in 2014 are less than 2 µg/m^3. The maximum formaldehyde concentration measured at SEWA falls between the program-level first quartile and median concentrations.

- The annual average concentration for SEWA is less than the program-level first quartile (1.40 µg/m^3) and is the lowest annual average among NMP sites sampling formaldehyde, both for 2014 and in previous years.

Figure 23-11. Program vs. Site-Specific Average Naphthalene Concentration

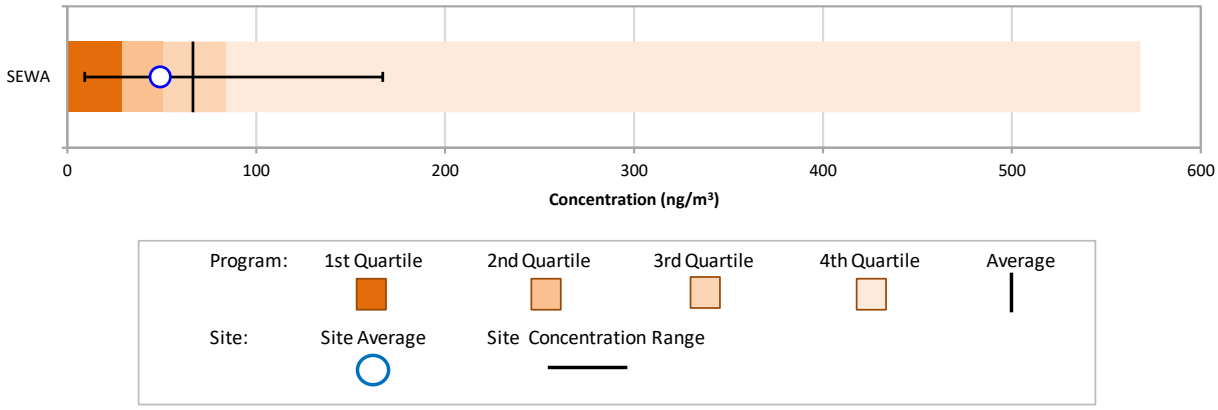


Figure 23-11 presents the box plot for naphthalene for SEWA and shows the following:

- The maximum naphthalene concentration measured at SEWA is considerably less than the maximum concentration measured across the program.

- The annual average concentration of naphthalene for SEWA is less than the program-level average concentration and similar to the program-level median concentration.

Figure 23-12. Program vs. Site-Specific Average Nickel (PM_{10}) Concentration

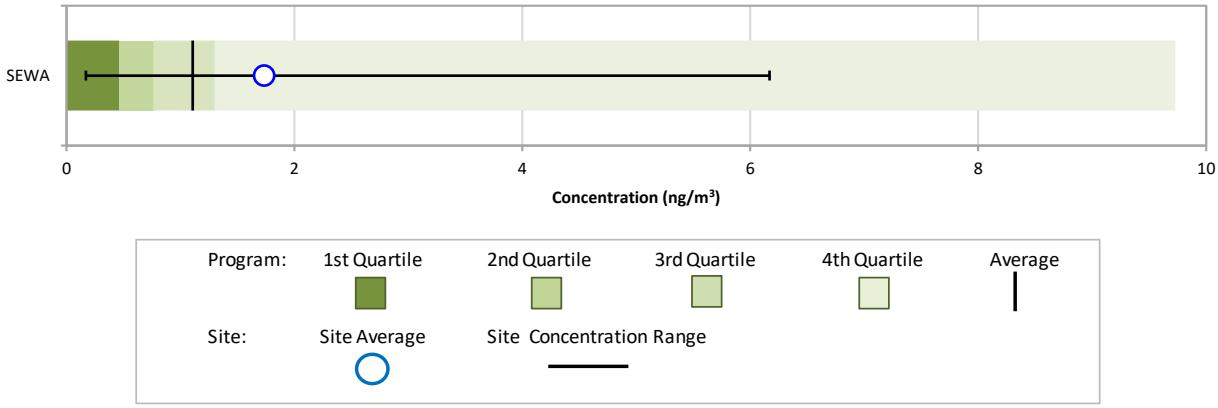


Figure 23-12 presents the box plot for nickel for SEWA and shows the following:

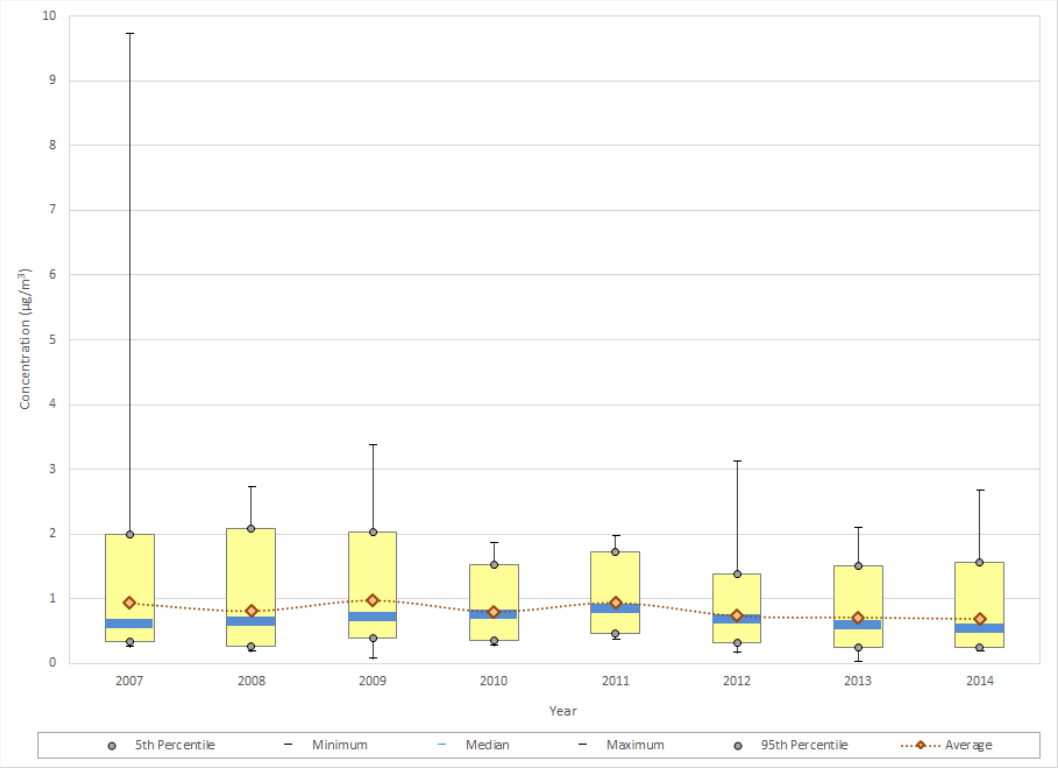
- Although the maximum nickel concentration measured at SEWA is less than the maximum concentration measured across the program, it is among the higher measurements across the program. SEWA is one of only five NMP sites at which nickel concentrations greater than 6 ng/m^3 were measured.

- SEWA's annual average concentration is greater than the program-level average concentration and program-level third quartile. Recall from the previous section that this site has the third highest annual average concentration of nickel among NMP sites sampling PM_{10} metals.

23.4.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.3.2. Sampling for PM_{10} metals, VOCs, and carbonyl compounds under the NMP began in 2007 and sampling for PAHs began in 2008. Thus, Figures 23-13 through 23-21 present the 1-year statistical metrics for each of the pollutants of interest for SEWA. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 23-13. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SEWA



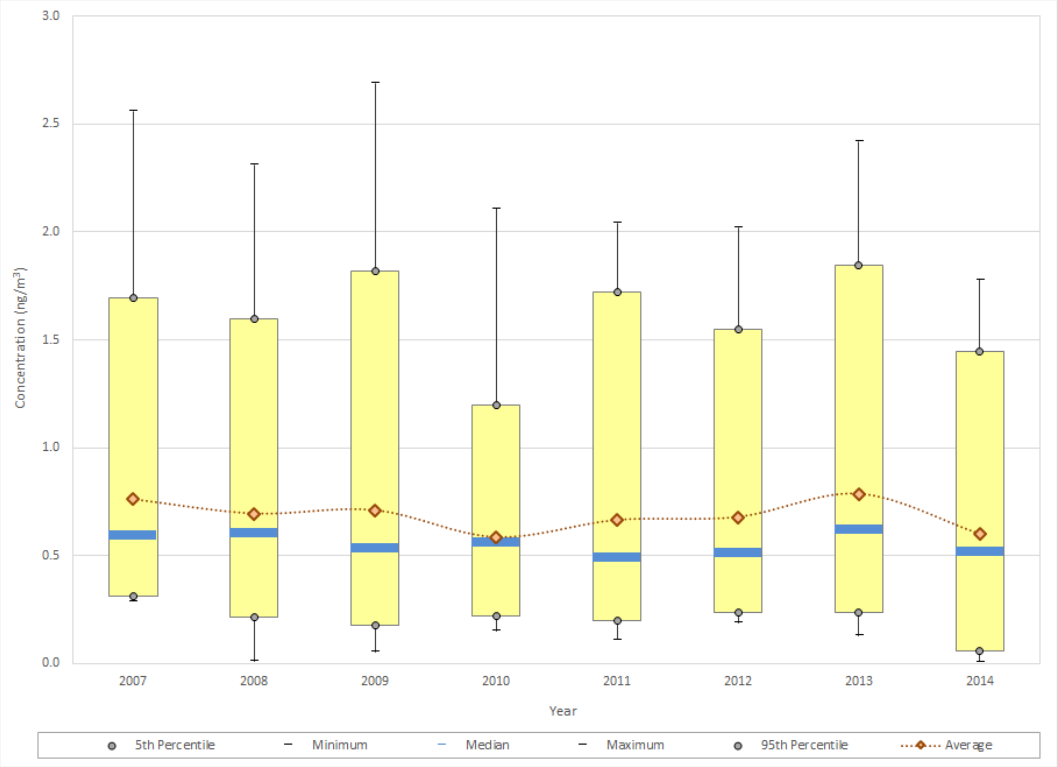
Observations from Figure 23-13 for acetaldehyde concentrations measured at SEWA include the following:

- The maximum acetaldehyde concentration was measured at SEWA on July 17, 2007 (9.73 µg/m^3). The next highest concentration is considerably less (3.38 µg/m^3, measured in September 2009). Only one other acetaldehyde concentration greater than 3 µg/m^3 has been measured at SEWA (September 2012).

- The 1-year average concentrations have a slight undulating pattern through 2012, with years with slightly lower concentrations alternating with years with slightly higher concentrations. Through 2012, the 1-year average concentrations ranged from 0.74 µg/m^3 (2012) to 0.98 µg/m^3 (2009). The 1-year average acetaldehyde concentration changed little between 2012 and 2014 and is at a minimum for 2014 compared to the other years of sampling (0.69 µg/m^3).

- The median concentration exhibits a steady increasing trend for the first 5 years of sampling, ranging from 0.61 µg/m^3 (2007) to 0.85 µg/m^3 (2011). The median then decreased each year between 2011 and 2014, reaching a minimum of 0.54 µg/m^3 for the entire sampling period.

Figure 23-14. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at SEWA



Observations from Figure 23-14 for arsenic (PM_{10}) concentrations measured at SEWA include the following:

- The maximum arsenic concentration was measured at SEWA on January 19, 2009 (2.69 ng/m^3), although a similar concentration was also measured in 2007 (2.56 ng/m^3). In total, 11 arsenic concentrations greater than 2 ng/m^3 have been measured at SEWA, at least one in each year of sampling except 2014.

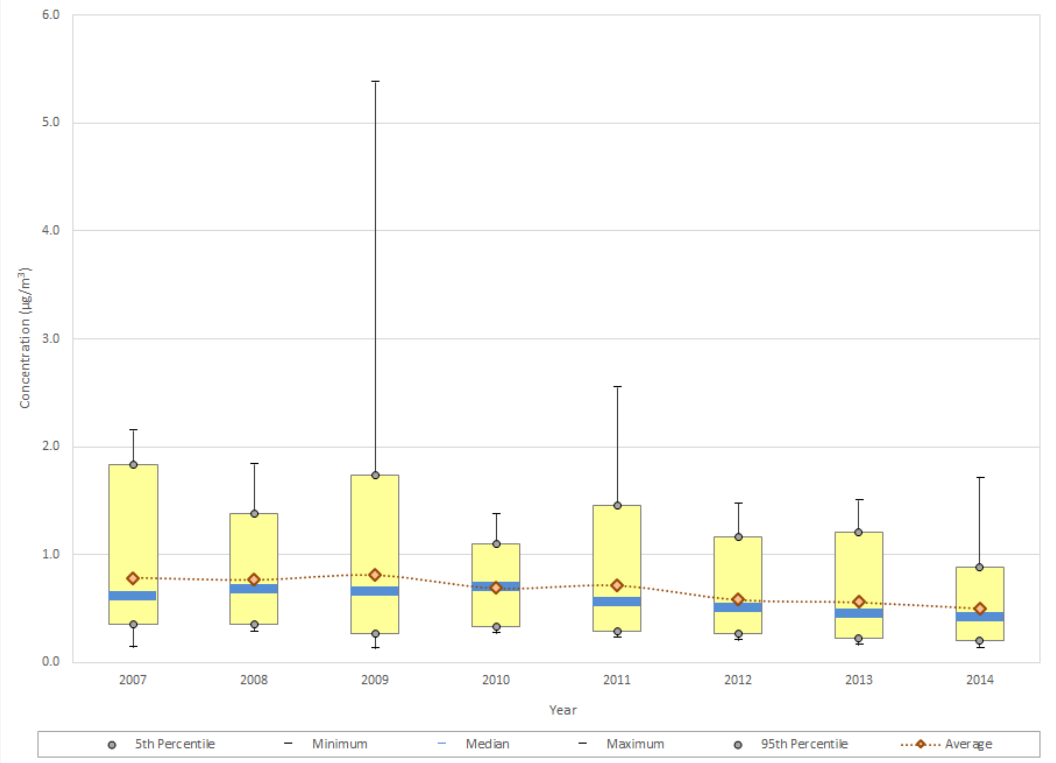
- There have been no non-detects of arsenic measured at SEWA since the onset of sampling, including 2008 and 2014, where it appears the minimum concentration is zero. For each of these years, the minimum concentration of arsenic is around

0.01 ng/m^3. Seven of the nine arsenic concentrations less than or equal to 0.1 ng/m^3 were measured in 2014.

- Despite the fluctuations shown, the 1-year average concentration of arsenic for SEWA has only varied by about 0.2 ng/m^3, ranging from 0.58 ng/m^3 (2010) to 0.79 ng/m^3 (2013). Confidence intervals indicate that the changes are not statistically significant. The median concentration has varied by even less, from 0.50 ng/m^3 (2011) to 0.63 ng/m^3 (2013).

- All of the statistical parameters exhibit decreases between 2013 and 2014, with the minimum, 5th percentile, 95th percentile, and maximum concentrations all at a minimum since the onset of sampling in 2007.

Figure 23-15. Yearly Statistical Metrics for Benzene Concentrations Measured at SEWA



Observations from Figure 23-15 for benzene concentrations measured at SEWA include the following:

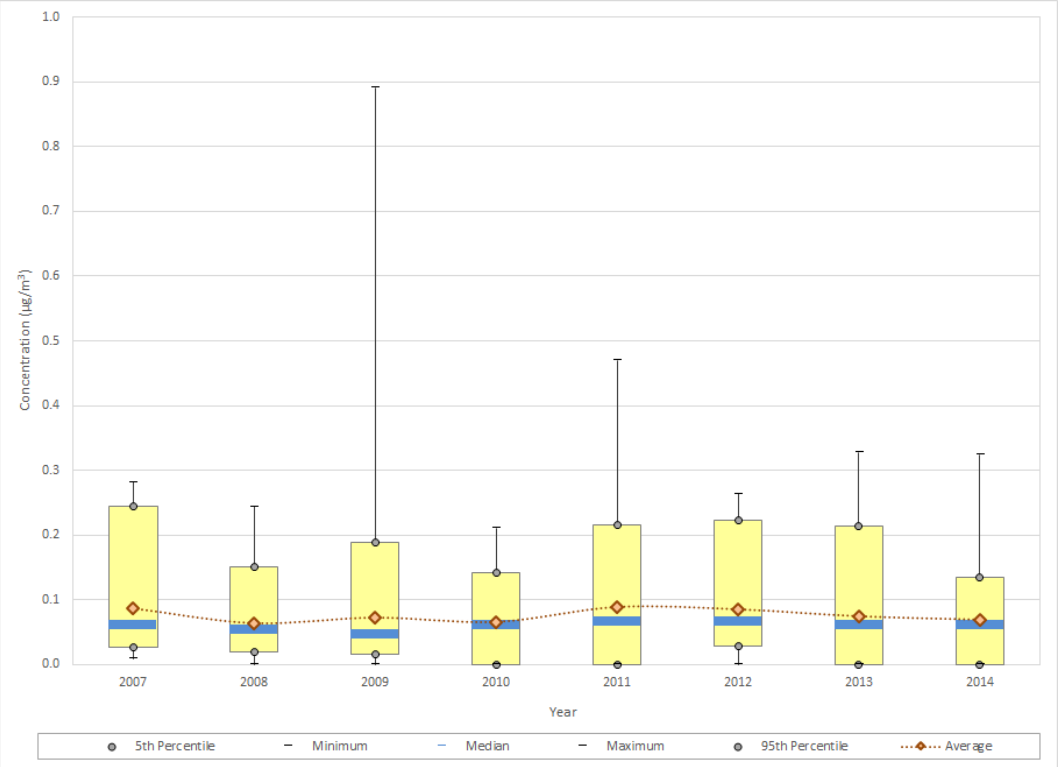
- The maximum benzene concentration was measured at SEWA on January 19, 2009 (5.38 µg/m^3), which is the same day the maximum arsenic concentration was measured. The next highest concentration was roughly half as high (2.55 µg/m^3, measured in January 2011). Only five benzene concentrations greater than 2 µg/m^3 have been measured at SEWA.

- Overall, benzene concentrations have a slight decreasing trend at SEWA, although this decrease is interrupted by the two years that the highest benzene concentrations

were measured. If the maximum concentrations measured in 2009 and 2011 were removed from the calculations, the 1-year average concentration would have a steady decreasing trend for the entire period. The 1-year average concentration of benzene has ranged from 0.50 µg/m^3 (2014) to 0.81 µg/m^3 (2009).

- The concentrations of benzene appear to have a seasonal trend at SEWA. Of the 68 benzene concentrations greater than 1 µg/m^3, 57 have been measured during the colder months of the year, either during the first quarter (24) or fourth quarter (33) of any given year.

Figure 23-16. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at SEWA



Observations from Figure 23-16 for 1,3-butadiene concentrations measured at SEWA include the following:

- The maximum 1,3-butadiene concentration (0.89 µg/m^3) was measured at SEWA on the same day as the maximum arsenic and benzene concentrations were measured, January 19, 2009. The next highest concentration was approximately half as high (0.47 µg/m^3) and was measured on the same day in January 2011 as the second highest benzene concentration.

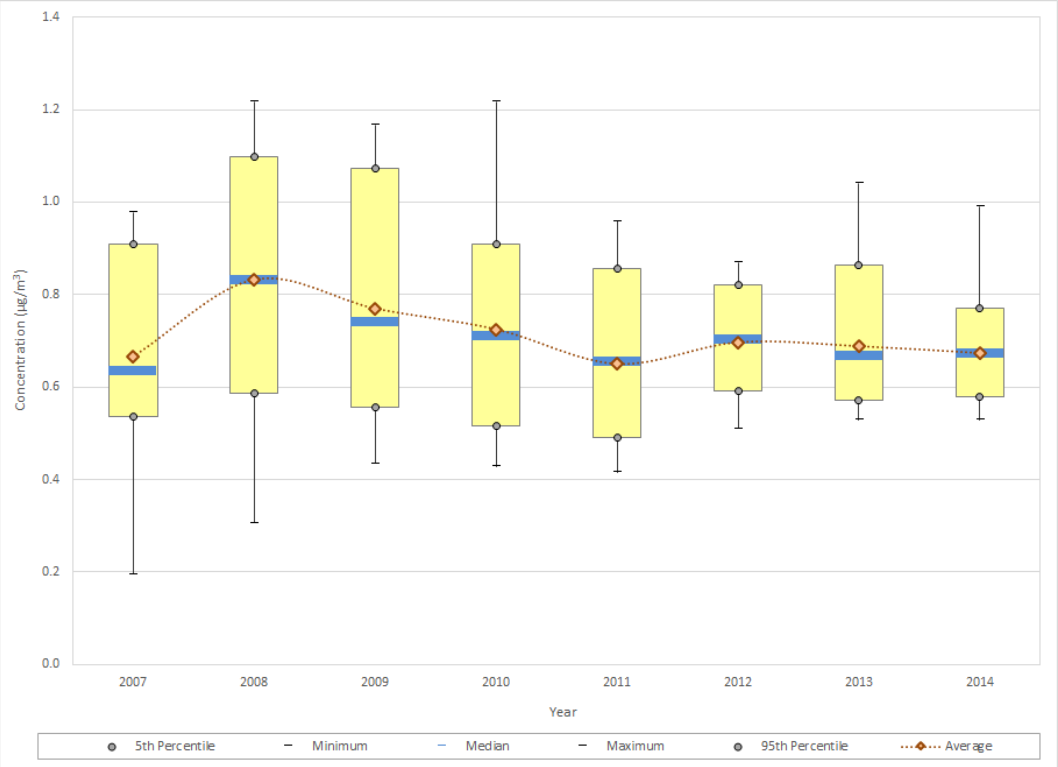
- At least one non-detect of 1,3-butadiene has been measured each year at SEWA since the onset of sampling, with the exception of 2007, as indicated by the minimum concentration. For 2010, 2011, 2013, and 2014, both the minimum and 5th percentile are zero, indicating that at least 5 percent of the measurements were non-detects. Eleven percent of the measurements were non-detects for 2010, 17 percent were non-

detects for 2011, 16 percent were non-detects for 2013, and 13 percent were non-detects for 2014. The percentage of non-detects is 3 percent for each of the remaining years.

- The 1-year average concentration has changed little over the years of sampling, ranging from 0.06 µg/m^3 (2008) to 0.09 µg/m^3 (2011). Interestingly, the year with the greatest number of non-detects (2011) also has the greatest number of measurements greater than 0.2 µg/m^3 (seven).

- After fluctuating during the first few years of sampling, the 95th percentile was fairly static between 2011 and 2013, then decreased by nearly half for 2014. The 95th percentile is at a minimum for 2014, indicating that the majority of measurements are less than 0.13 µg/m^3 in 2014.

Figure 23-17. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at SEWA



Observations from Figure 23-17 for carbon tetrachloride concentrations measured at SEWA include the following:

- Nineteen concentrations of carbon tetrachloride greater than 1.0 µg/m^3 have been measured at SEWA since the onset of sampling in 2007. All but two of these were measured in 2008 and 2009, with one each in 2010 and 2013. The maximum carbon tetrachloride concentration (1.22 µg/m^3) has been measured twice at SEWA, once in 2008 and once in 2010.

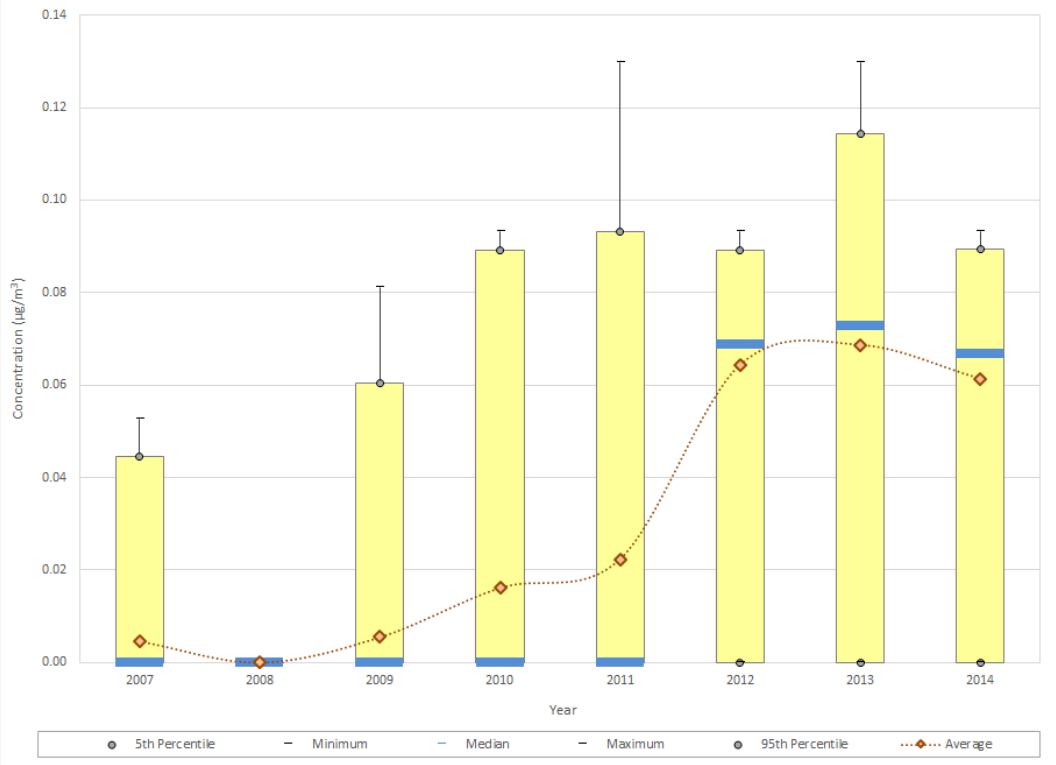
- All of the statistical metrics increased from 2007 to 2008. Eleven concentrations measured in 2008 were greater than the maximum concentration measured in 2007. In addition, the number of carbon tetrachloride concentrations greater than 0.75 µg/m^3 increased from 12 in 2007 to 43 for 2008.

- Between 2008 and 2011, a steady decreasing trend in the concentrations is shown, with the 1-year average concentration for 2011 returning to 2007 levels.

- The range of measurements tightened for 2012 and is the smallest range of measurements since the onset of sampling. Yet, both the 1-year average and median concentrations exhibit significant increases. As the number of concentrations falling into the 0.65 µg/m^3 to 0.85 µg/m^3 range increased, from 29 for 2011 to 43 in 2012, the number of concentrations less than 0.6 µg/m^3 fell from 20 to seven during this time frame.

- Despite the increase in the maximum concentration and the 95th percentile for 2013, both the 1-year average and median concentrations exhibit slight decreases, although the difference is not statistically significant. This is also true for 2014.

Figure 23-18. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at SEWA



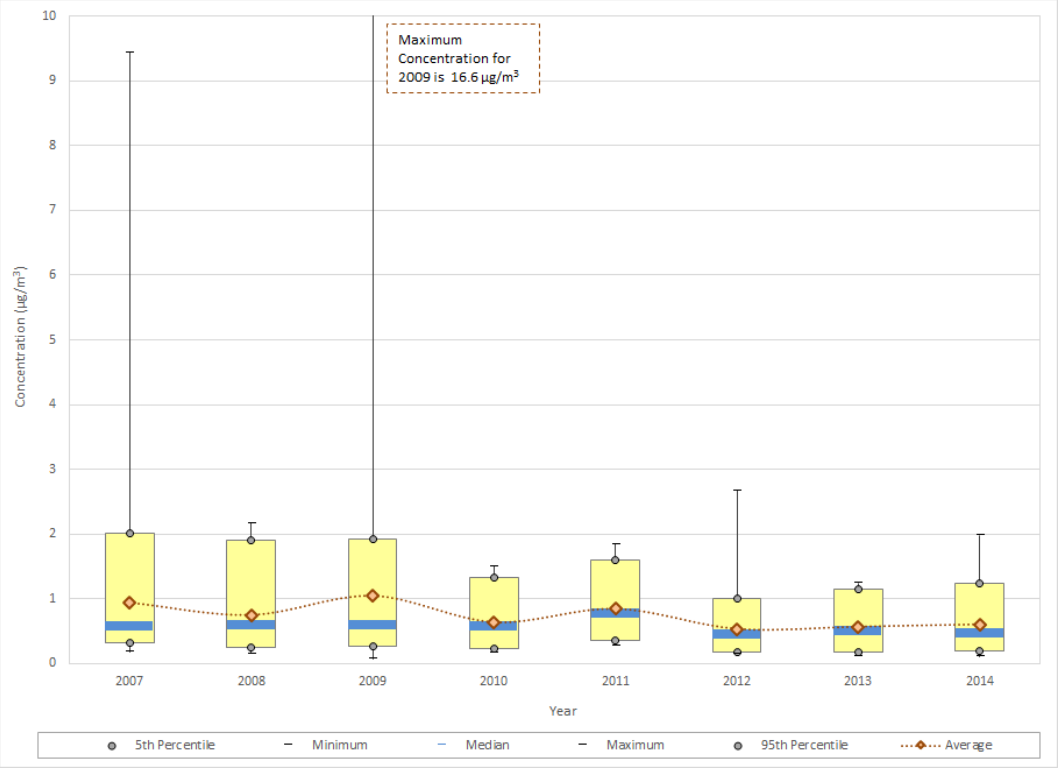
Observations from Figure 23-18 for 1,2-dichloroethane concentrations measured at SEWA include the following:

- The minimum, 5th percentile, and median concentrations are zero for 2007 through 2011. This indicates that at least half of the measurements were non-detects. In 2008, there were no measured detections of 1,2-dichloroethane. The percentage of measured detections in 2007 and 2009 was around 10 percent, after which there is an increasing trend. For 2012, the percentage of measured detections is 93 percent, a considerable increase from 26 percent in 2011. This percentage leveled off a bit for 2013 and 2014 (at 88 percent each).

- As the number of measured detections increased, particularly for 2012 and the years that follow, the median and 1-year average concentrations increased correspondingly.

- The median concentration is greater than the 1-year average concentration for 2012, 2013, and 2014. This is because there were still several non-detects (or zeros) factoring into the 1-year average concentration for these years, which can pull an average down in a similar manner that an outlier can drive an average upward, while the range of measured detections is rather small.

Figure 23-19. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SEWA

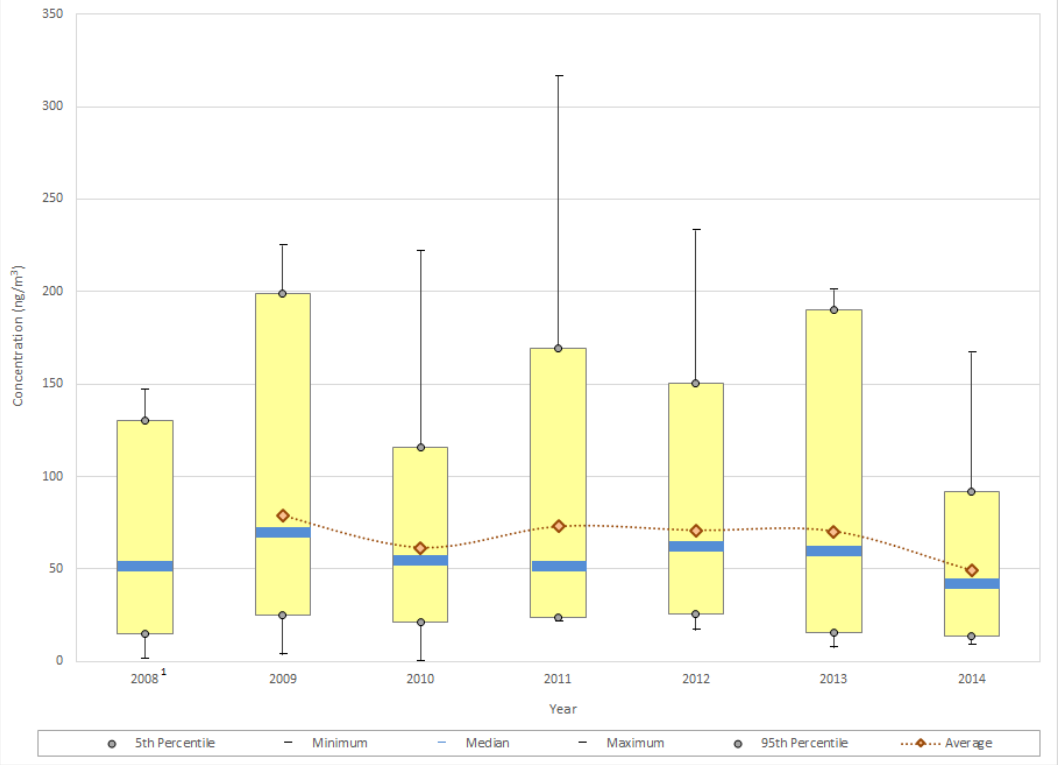


Observations from Figure 23-19 for formaldehyde concentrations measured at SEWA include the following:

- The maximum formaldehyde concentration was measured at SEWA on January 13, 2009 (16.6 µg/m^3). The next highest concentration (9.44 µg/m^3) was measured on the same day in 2007 as the maximum acetaldehyde concentration. Only one other formaldehyde concentration greater than 3 µg/m^3 has been measured at SEWA and was also measured in 2009. Only nine concentrations greater than 2 µg/m^3 have been measured since the onset of carbonyl compound sampling at SEWA, and all but one of these were measured prior to 2010.

- The 1-year average concentrations have an undulating pattern through 2012, with a "down" year followed by an "up" year. Between 2007 and 2012, the 1-year average formaldehyde concentrations have ranged from 0.53 µg/m^3 (2012) to 1.04 µg/m^3 (2009). The 1-year average formaldehyde concentration exhibits a very subtle increase between 2012 to 2014, although the changes are not statistically significant. The 1-year average concentrations calculated for 2012, 2013, and 2014 are the lowest averages shown in Figure 23-19.

Figure 23-20. Yearly Statistical Metrics for Naphthalene Concentrations Measured at SEWA



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2008.

Observations from Figure 23-20 for naphthalene concentrations measured at SEWA include the following:

- SEWA began sampling PAHs under the NMP in March 2008. Because a full year's worth of data is not available, a 1-year average concentration is not presented for 2008, although the range of measurements is provided.

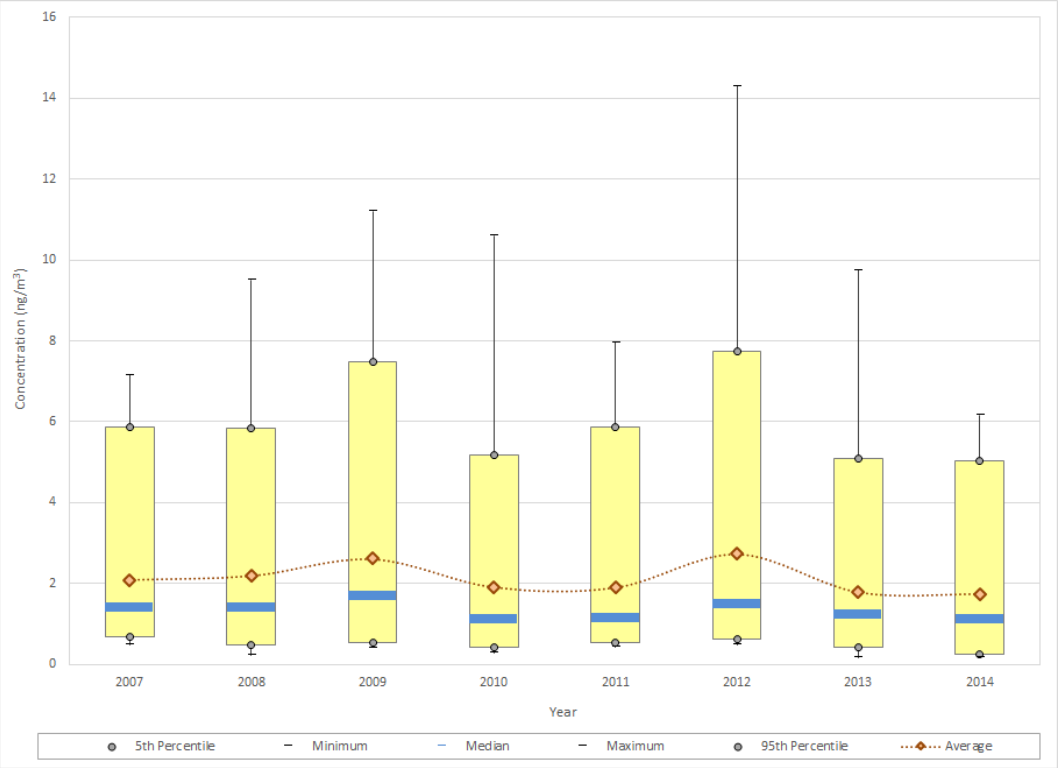
- The maximum naphthalene concentration measured at SEWA was measured in 2011 (317 ng/m^3). This is the only naphthalene measurement greater than 250 ng/m^3 measured at this site. Eight additional measurements greater than 200 ng/m^3 have been measured at SEWA and are spread across the years of sampling, except 2008.

- Each of the statistical parameters shown exhibits an increase from 2008 to 2009. Although the range of concentrations measured in 2009 is similar to those measured in 2010, the 95th percentile decreased by almost half from one year to the next. The number of naphthalene concentrations greater than 100 ng/m^3 decreased by nearly two-thirds, from 19 in 2009 to seven for 2010.

- With the exception of the median concentration, each of the statistical parameters exhibits an increase for 2011, with the 1-year average concentration nearly returning to 2009 levels. This is partially driven by the maximum concentration measured this year.

- Little change in the 1-year average concentration is shown between 2011 and 2013, after which a significant decrease is shown for 2014. The fewest naphthalene concentrations greater than 100 ng/m^3 were measured in 2014 (one), with most years having 10 or more (2010 is the exception at seven). In addition, the median concentration for 2014 is less than 50 ng/m^3 for the first time, indicating that more than half of the measurements were less than 50 ng/m^3.

Figure 23-21. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at SEWA



Observations from Figure 23-21 for nickel concentrations measured at SEWA include the following:

- The two highest concentrations of nickel (14.3 ng/m^3 and 11.8 ng/m^3) were both measured at SEWA in 2012, although concentrations greater than 10 ng/m^3 were also measured in 2009 (two) and 2010 (one).

- The 1-year average concentration exhibits an increase between 2007 and 2009, after which a decrease in shown for 2010, with little change for 2011. An increase in the 1-year average concentration is shown for 2012, which is followed by a decrease for 2013 and little change for 2014. Confidence intervals calculated on the dataset indicate that the changes shown are not statistically significant as the concentrations measured are fairly variable. The median concentrations exhibit a similar pattern.

- The difference between the 1-year average and median concentrations is greater than 0.50 ng/m^3 for all years (and greater than 1.0 ng/m^3 for 2012). This also indicates that there is considerable variability in the measurements of nickel.

- Despite this variability, all the 1-year average concentrations of nickel fall on either side of 2 ng/m^3. Exactly 1 ng/m^3 separates the minimum 1-year average concentration calculated (1.74 ng/m^3, 2014) from the maximum 1-year average concentration (2.74 ng/m^3, 2012). If 2009 and 2012 are excluded, the difference among the 1-year averages is less than 0.5 ng/m^3.

23.5 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to air toxics at the Washington monitoring site. Refer to Sections 3.2, 3.4.3.3, and 3.4.3.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

23.5.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Washington site and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers may want to shift their air monitoring priorities. Refer to Section 3.4.3.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 23-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 23-5. Risk Approximations for the Washington Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Cancer Risk Approximation (in-a-million)	Noncancer Hazard Approximation (HQ)
Seattle, Washington - SEWA						
Acetaldehyde	0.0000022	0.009	61/61	0.69 ± 0.13	1.53	0.08
Benzene	0.0000078	0.03	60/60	0.50 ± 0.07	3.92	0.02
1,3-Butadiene	0.00003	0.002	53/60	0.07 ± 0.01	2.08	0.03
Carbon Tetrachloride	0.000006	0.1	60/60	0.67 ± 0.02	4.04	0.01
1,2-Dichloroethane	0.000026	2.4	53/60	0.06 ± 0.01	1.60	<0.01
Formaldehyde	0.000013	0.0098	61/61	0.60 ± 0.10	7.85	0.06
Arsenic (PM_{10})[a]	0.0043	0.000015	60/60	0.60 ± 0.11	2.58	0.04
Naphthalene[a]	0.000034	0.003	61/61	49.25 ± 7.46	1.67	0.02
Nickel (PM_{10})[a]	0.00048	0.00009	60/60	1.74 ± 0.40	0.83	0.02

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

Observations from Table 23-5 for SEWA include the following:

- The pollutants with the highest annual average concentrations for SEWA are acetaldehyde, carbon tetrachloride, formaldehyde, and benzene.

- The pollutants with the highest cancer risk approximations are formaldehyde, carbon tetrachloride, benzene, and arsenic. The cancer risk approximation for formaldehyde for SEWA is the lowest among this pollutant's site-specific cancer risk approximations and is one of only three less than 10 in-a-million.

- The noncancer hazard approximations for SEWA are all considerably less than 1.0, with the highest calculated for acetaldehyde (0.08), indicating that no adverse noncancer health effects are expected from these individual pollutants.

23.5.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 23-6 presents the 10 pollutants with the highest emissions from the 2011 NEI (version 2) that have cancer toxicity factors. Table 23-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 23-6 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for SEWA, as presented in Table 23-5. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 23-6. Table 23-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard 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 3.4.3.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 23.5.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 23-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Washington Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (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)**
Seattle, Washington (King County) - SEWA					
Benzene	930.96	Formaldehyde	1.01E-02	Formaldehyde	7.85
Formaldehyde	776.28	Benzene	7.26E-03	Carbon Tetrachloride	4.04
Ethylbenzene	460.42	1,3-Butadiene	4.24E-03	Benzene	3.92
Acetaldehyde	442.08	Naphthalene	2.98E-03	Arsenic (PM_{10})	2.58
1,3-Butadiene	141.43	POM, Group 2b	1.76E-03	1,3-Butadiene	2.08
Tetrachloroethylene	95.67	POM, Group 2d	1.16E-03	Naphthalene	1.67
Naphthalene	87.72	Ethylbenzene	1.15E-03	1,2-Dichloroethane	1.60
POM, Group 2b	19.97	POM, Group 5a	1.11E-03	Acetaldehyde	1.53
POM, Group 2d	13.20	Acetaldehyde	9.73E-04	Nickel (PM_{10})	0.83
Trichloroethylene	11.73	Nickel, PM	5.36E-04		

Table 23-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Washington Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Seattle, Washington (King County) - SEWA					
Toluene	4,999.08	Acrolein	2,910,205.08	Acetaldehyde	0.08
Xylenes	1,895.75	Formaldehyde	79,212.57	Formaldehyde	0.06
Hexane	1,472.55	1,3-Butadiene	70,716.54	Arsenic (PM_{10})	0.04
Methanol	1,144.61	Cyanide Compounds, gas	63,595.60	1,3-Butadiene	0.03
Benzene	930.96	Acetaldehyde	49,120.41	Nickel (PM_{10})	0.02
Formaldehyde	776.28	Benzene	31,032.01	Benzene	0.02
Ethylbenzene	460.42	Naphthalene	29,239.94	Naphthalene	0.02
Ethylene glycol	455.61	Xylenes	18,957.50	Carbon Tetrachloride	0.01
Acetaldehyde	442.08	Lead, PM	16,900.94	1,2-Dichloroethane	<0.01
Methyl isobutyl ketone	205.29	Nickel, PM	12,405.52		

Observations from Table 23-6 for SEWA include the following:

- Benzene, formaldehyde, and ethylbenzene are 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 are formaldehyde, benzene, and 1,3-butadiene.

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for King County.

- Formaldehyde has the highest cancer risk approximation for SEWA. This pollutant has the highest toxicity-weighted emissions and ranks second for quantity emitted. Benzene, naphthalene, 1,3-butadiene, and acetaldehyde also appear on all three lists.

- Carbon tetrachloride and arsenic, which rank second and fourth, respectively, for cancer risk approximations for SEWA, do not appear on either emissions-based list. This is also true for 1,2-dichloroethane. Nickel, which ranks ninth among the pollutants of interest for SEWA, has the 10th highest toxicity-weighted emissions for King County, but is not among the highest emitted (of the pollutants with cancer UREs).

- POM, Group 2b is the eighth highest emitted "pollutant" in King County and ranks fifth for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at SEWA including acenaphthene, fluorene, and perylene. A single concentration of acenaphthene failed a screen, but this pollutant was not identified as a pollutant of interest for SEWA.

- POM, Group 2d ranks ninth for total emissions and sixth for its toxicity-weighted emissions. POM, Group 2d does not includes any PAHs sampled for at SEWA. POM, Group 5a also has the eighth highest toxicity-weighted emissions for King County. Benzo(a)pyrene is part of POM, Group 5a. A single concentration of benzo(a)pyrene failed a screen, but this pollutant was not identified as a pollutant of interest for SEWA.

Observations from Table 23-7 for SEWA include the following:

- Toluene, xylenes, and hexane are the highest emitted pollutants with noncancer RfCs in King County. The quantity of the emissions of these pollutants are considerably higher than the emissions for the pollutants topping the emissions-based list in Table 23-6.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for King County, followed by formaldehyde and 1,3-butadiene. Although acrolein was sampled for at SEWA, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based 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 have the highest toxicity-weighted emissions for King County.

- Acetaldehyde, formaldehyde, and benzene appear on all three lists in Table 23-7.

- Naphthalene, 1,3-butadiene, and nickel are among SEWA's pollutants of interest that also appear among those with the highest toxicity-weighted emissions, although none of these appear among the highest emitted (of those with a noncancer RfC).

- Arsenic, carbon tetrachloride, and 1,2-dichloroethane are pollutants of interest for SEWA that appear on neither emissions-based list.

23.6 Summary of the 2014 Monitoring Data for SEWA

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

❖ *Thirteen pollutants failed at least one screen for SEWA.*

❖ *Acetaldehyde has the highest annual average concentration for SEWA, although all of the pollutants of interest for SEWA have annual average concentrations less than 1 µg/m^3.*

❖ *The annual average concentration of nickel for SEWA is the third highest among NMP sites sampling PM_{10} metals. Conversely, the annual average concentration of formaldehyde for SEWA is the lowest among NMP sites sampling carbonyl compounds.*

❖ *Concentrations of benzene exhibit an overall decreasing trend over the period sampling period at SEWA. Concentrations of naphthalene decreased significantly for 2014. The number of non-detects of 1,2-dichloroethane has decreased considerably at SEWA in recent years.*

24.0 Data Quality

This section discusses the data quality of the ambient air measurements that constitute the 2014 NMP dataset. Each monitoring program under the NMP has its own specific Data Quality Objectives (DQOs) which have been established and approved by EPA, consistent with the specific data use needs of the individual monitoring program. Because the DQOs are program-specific and the ERG laboratory is contracted to perform services for a subset of the overall program participants, attainment of the individual program DQO(s) is not assessed in this report. This section establishes data quality through the assessment of Data Quality Indicators (DQI) in the form of MQOs specific to the program elements conducted by the ERG laboratory. MQOs are designed to control and evaluate the various phases of the measurement process (sampling, preparation, analysis, etc.) to ensure that the total measurement quality meets the overall program data quality needs. In accordance with ERG's EPA-approved QAPP (ERG, 2013), the following MQOs were assessed: completeness, precision, and accuracy (also called bias).

The quality assessments presented in this section show that the 2014 monitoring data are of a known and high quality, consistent with the intended data use. The overall method-specific completeness was greater than 85 percent for each method. The method precision for collocated and duplicate analyses met the precision MQO of 15 percent Coefficient of Variation (CV) for most methods, with the exceptions of TO-13A for PAHs and ASTM D7614 for hexavalent chromium measurement (which are both just outside the 15 percent MQO). The analytical precision for replicate analyses for all methods met the precision MQO of 15 percent CV, with all methods less than 10 percent. Audit samples show that ERG is meeting the accuracy requirements of the NATTS TAD (EPA, 2009b). These data quality indicators are discussed in further detail in the following sections.

24.1 Completeness

Completeness refers to the number of valid samples successfully collected and analyzed compared to the number of total samples scheduled to be collected and analyzed. The MQO 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, 2013). The MQO of 85 percent completeness was met by all but seven of 108 site-method combinations. Completeness statistics are presented and discussed more thoroughly in Section 2.4.

24.2 Method Precision

Precision defines the level of agreement 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 through a common inlet probe such that the same air parcel is being sampled. This simultaneous collection is typically achieved by teeing the line from the sampler to two canisters (or other sampling media) and doubling the flow rate applied to achieve integration over the 24-hour collection period. *Collocated* samples are samples collected simultaneously through separate inlet probes, regardless of sampler set-up (i.e., either two separate sampling systems or a single sampling system with multiple inlets). Because the samples are not collected using a common inlet, the system is sampling potentially different air parcels. The overarching difference between the two sample types is whether or not the potential for non-homogeneity of the air parcel is being considered as part of the precision calculation. Duplicate samples provide an indication of "intra-system" variability while collocated samples provide an indication of "inter-system" variability, of which the non-homogeneity of the air parcels sampled factors into the level of precision measured.

During the 2014 sampling year, where possible, duplicate or collocated samples were collected on at least 10 percent of the scheduled sample days, as outlined in the EPA-approved QAPP. This provides a minimum of six pairs of either duplicate or collocated samples per site and method. For the VOC, SNMOC, and carbonyl compound methods, samples may be duplicate or collocated. For PAHs, metals, and hexavalent chromium, only collocated samples may be collected due to limitations of the sampling media/instrumentation. For each method, these duplicate or collocated samples were then analyzed in replicate at the laboratory. *Replicate measurements* are repeated analyses performed on a duplicate or collocated pair of samples and are discussed in greater detail in Section 24.3. Where duplicate or collocated events were not possible at a given monitoring site, additional replicate samples were run on individual samples to provide an indication of analytical precision, and are discussed further in Section 24.3.

Method precision is calculated by comparing the concentrations of the duplicates/collocates for each pollutant. The CV for duplicate or collocated samples was calculated for each pollutant and each site. The following approach was employed to estimate how closely the collected and analyzed samples agree with one another:

> ***Coefficient of Variation (CV)*** provides a relative measure of data dispersion compared to the mean. CV can be calculated two ways. The first, which expresses the CV as a ratio of the standard deviation and the mean, is used for a single variable. The second, which is provided below, is ideal when comparing paired values, such as a primary concentration and a duplicate concentration. A coefficient of variation of 1 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.

$$CV = 100 \times \sqrt{\frac{\sum_{i=1}^{n} \left[\frac{(p-r)}{0.5 \times (p+r)}\right]^2}{2n}}$$

Where:

p = the primary result from a duplicate or collocated pair;
r = the secondary result from a duplicate or collocated pair;
n = the number of valid data pairs (the 2 adjusts for the fact that there are two values with error).

CVs were based on every pair of duplicate or collocated samples collected during the program year. However, only measurements at or above the MDL were used in these calculations. Thus, the number of pairs included in the calculations varies significantly from pollutant to pollutant. To make an overall estimate of method precision, program-level average CVs were calculated as follows:

- A site-specific CV was calculated for each pollutant, per the equation above.
- A pollutant-specific average CV was calculated for each method.
- A method-specific average CV was calculated and compared to the precision MQO.

Table 24-1 presents the 2014 NMP method precision for VOCs, SNMOCs, carbonyl compounds, PAHs, metals, and hexavalent chromium, presented as the average CV (expressed as a percentage). CVs exceeding the 15 percent MQO are bolded in the table. Four of the six analytical methods met the program MQO of 15 percent CV for precision. TO-13A/PAHs and hexavalent chromium results did not meet the MQO of 15 percent, although they are just outside

the criteria (and are discussed further in the individual method sections). This table also includes the number of pairs that were included in the calculation of the method precision. The total number of pairs including those with concentrations less than the MDL (and with two numerical results) is also included in Table 24-1 for each method to provide an indication of the effect that excluding those with concentrations less than the MDL has on the population of pairs in the dataset. For some methods, such as TO-11A for carbonyl compounds, the difference is small; for others, such as TO-15 for VOCs, the difference is relatively large.

Table 24-1. Method Precision by Analytical Method

Method/Pollutant Group	Average Coefficient of Variation (%)	Number of Pairs Included in the Calculation	Total Number of Pairs Without the >= MDL exclusion
VOC (TO-15)	9.63	2,782	3,366
SNMOC	7.50	340	428
Carbonyl Compounds (TO-11A)	5.41	1,578	1,579
PAHs (TO-13A)	**18.73**	291	314
Metals Analysis (Method IO-3.5/FEM)	12.98	1,760	2,168
Hexavalent Chromium (ASTM D7614)	**17.96**	4	4
MQO	15.00 percent CV		

Bold = CV greater than or equal to 15 percent

Tables 24-2 through 24-7 present method precision for VOCs, SNMOCs, carbonyl compounds, PAHs, metals, and hexavalent chromium, respectively, as the CV per pollutant per site and the average CV per site, per pollutant, and per method. Also included in these tables is the number of duplicate and/or collocated pairs included in the CV calculations. For methods where duplicate or collocated samples are both possible, the type of sample collected at each site is identified and the average CV based on sample type is also provided. CVs exceeding the 15 percent MQO are bolded in each table. The CVs that exceed the program MQO for precision are often driven by relatively low concentrations, even though they are greater than the MDL, as these may result in relatively large CVs.

24.2.1 VOC Method Precision

Table 24-2 presents the method precision for all duplicate and collocated VOC samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the VOCs listed. The duplicate and collocated sample precision results exhibit low- to high-level variability, where the CV ranges from 0 percent (a few pollutants for several sites) to 94.84 percent (dichloromethane for GLKY). The CV for dichloromethane for GLKY is based on four pairs of samples greater than the MDL. In three of the four pairs, the duplicate sample was considerably greater than the primary sample. The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies, from none (17 pollutants) to 15 (methyl isobutyl ketone). Dichloromethane is the only other pollutant besides methyl isobutyl ketone with a CV greater than or equal to 15 percent for at least 10 sites.

The pollutant-specific average CV, as shown in orange in Table 24-2, ranges from 0 percent (1,1-dichloroethene) to 23.51 percent (dichloromethane). For 1,1-dichloroethene, the precision is based on a single pair of measurements greater than the MDL. The site-specific average CV, as shown in green in Table 24-2, ranges from 5.53 percent (DEMI) to 14.79 percent (SEWA). None of the sites have a site-specific average CV greater than or equal to15 percent. Note that TVKY collected collocated samples more frequently than the 10 percent requirement. The overall average method precision for VOCs is 9.63 percent. Note that the results for acrolein, acetonitrile, acrylonitrile, and carbon disulfide were excluded from the precision calculations due to the issues described in Section 3.2.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-2 while sites at which collocated samples were collected are highlighted in purple. Collocated VOC samples were collected at only two of the sites shown in Table 24-2 (PXSS and TVKY); the remainder collected duplicate VOC samples. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-2 in blue while the average CV for sites collecting collocated samples is shown in purple. The average CV for both precision types meets the MQO of 15 percent, with the variability associated with collocated samples (9.48 percent) slightly less than the variability associated with duplicate samples (10.06 percent).

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant

Pollutant	***BTUT***	**CHNJ**	**CSNJ**	***DEMI***	**ELNJ**	***GLKY***
Acetylene	2.57	0.79	1.75	2.37	3.62	3.18
tert-Amyl Methyl Ether	--	--	--	--	--	--
Benzene	4.04	7.90	2.17	10.31	12.57	6.39
Bromochloromethane	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--
Bromomethane	5.58	9.34	3.45	--	8.76	5.45
1,3-Butadiene	8.92	6.92	4.54	2.75	5.26	**15.80**
Carbon Tetrachloride	4.16	9.07	1.92	2.42	9.72	**22.30**
Chlorobenzene	--	--	--	2.86	**61.16**	--
Chloroethane	**24.34**	**53.64**	**33.10**	5.11	0.00	--
Chloroform	6.72	4.75	3.65	**27.63**	2.37	3.02
Chloromethane	2.91	7.36	5.57	2.85	3.57	1.41
Chloroprene	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--
p-Dichlorobenzene	8.66	--	--	--	13.71	--
Dichlorodifluoromethane	3.85	1.05	1.23	2.22	2.65	0.36
1,1-Dichloroethane	--	--	--	--	--	--
1,2-Dichloroethane	4.99	7.17	4.23	5.87	4.99	4.13
1,1-Dichloroethene	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--	--
Dichloromethane	**59.22**	6.94	7.82	9.86	7.64	**94.84**
1,2-Dichloropropane	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--
Dichlorotetrafluoroethane	5.03	4.15	2.29	1.65	4.31	2.52
Ethyl Acrylate	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	10.67	--	--	--	5.04	--
Ethylbenzene	8.22	**31.76**	5.44	3.47	3.23	**37.10**
Hexachloro-1,3-butadiene	--	--	--	--	--	--
Methyl Isobutyl Ketone	**26.22**	**20.91**	4.19	10.64	**17.97**	0.00
Methyl Methacrylate	--	--	--	--	5.44	--
Methyl *tert*-Butyl Ether	14.14	**18.43**	**27.30**	--	3.33	--
n-Octane	6.48	14.04	3.91	6.38	5.96	**35.76**

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	***BTUT***	**CHNJ**	**CSNJ**	***DEMI***	**ELNJ**	***GLKY***
Propylene	14.70	**21.86**	3.76	4.29	3.69	10.92
Styrene	9.46	6.72	**38.25**	6.02	11.73	**20.20**
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Tetrachloroethylene	4.77	3.30	2.65	8.12	3.83	
Toluene	**21.77**	**15.49**	**16.28**	3.90	2.78	8.58
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,1,1-Trichloroethane	11.47	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--
Trichloroethylene	11.59	--	--	--	0.00	--
Trichlorofluoromethane	3.47	1.54	1.85	2.07	2.65	0.42
Trichlorotrifluoroethane	3.46	1.10	2.88	1.88	2.79	1.05
1,2,4-Trimethylbenzene	9.86	12.88	12.17	3.98	13.68	--
1,3,5-Trimethylbenzene	10.03	6.73	12.22	4.30	2.09	--
Vinyl chloride	--	--	10.88	--	--	--
m,p-Xylene	**27.07**	**41.57**	3.22	4.01	4.22	**16.98**
o-Xylene	**21.22**	**34.65**	5.64	3.26	2.64	**19.84**
Average CV by Site	11.85	13.46	8.24	5.53	7.46	14.77
# of Pairs Collected by Site	6	6	5	6	5	4

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*GPCO*	*NBIL*	NBNJ	OCOK	*PXSS*	ROIL
Acetylene	4.98	4.34	4.17	2.91	1.18	5.82
tert-Amyl Methyl Ether	--	--	--	--	--	--
Benzene	4.91	8.35	4.27	10.95	2.16	3.13
Bromochloromethane	--	--	--	--	--	--
Bromodichloromethane	--	**20.61**	--	--	2.89	--
Bromoform	--	0.00	4.88	--	--	--
Bromomethane	**22.26**	10.73	4.79	10.88	5.24	0.00
1,3-Butadiene	6.44	3.32	9.01	11.76	5.13	1.88
Carbon Tetrachloride	**24.95**	6.26	4.24	7.35	4.13	**19.50**
Chlorobenzene	--	--	0.00	--	--	--
Chloroethane	--	--	11.54	**30.15**	--	7.86
Chloroform	7.77	9.79	2.07	6.48	4.00	2.95
Chloromethane	3.61	5.12	4.67	4.37	2.08	4.08
Chloroprene	--	--	--	--	--	--
Dibromochloromethane	--	9.73	--	--	0.00	--
1,2-Dibromoethane	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--
p-Dichlorobenzene	--	--	--	--	8.65	--
Dichlorodifluoromethane	2.91	5.26	2.95	2.14	3.03	2.60
1,1-Dichloroethane	--	--	--	--	--	--
1,2-Dichloroethane	7.14	10.14	4.66	4.80	6.39	3.07
1,1-Dichloroethene	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--	--
Dichloromethane	**19.89**	7.10	5.39	10.38	**42.99**	10.66
1,2-Dichloropropane	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--
Dichlorotetrafluoroethane	4.00	5.56	3.01	2.25	5.57	3.48
Ethyl Acrylate	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	10.92	3.36	3.63	--	--	--
Ethylbenzene	5.78	7.08	9.09	7.95	1.53	4.53
Hexachloro-1,3-butadiene	--	--	--	--	--	--
Methyl Isobutyl Ketone	**27.19**	**16.68**	**24.84**	**34.75**	**24.57**	**18.73**
Methyl Methacrylate	**18.20**	--	--	--	8.32	--
Methyl *tert*-Butyl Ether	--	--	--	--	--	--
n-Octane	11.52	3.13	**21.42**	14.94	5.43	8.32

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*GPCO*	*NBIL*	NBNJ	OCOK	*PXSS*	ROIL
Propylene	8.71	7.51	7.61	**21.60**	9.95	3.16
Styrene	**31.68**	3.01	3.25	**24.69**	7.72	**33.55**
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Tetrachloroethylene	1.76	8.47	6.26	5.06	3.07	8.12
Toluene	**16.86**	5.05	5.12	9.21	1.14	3.87
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--
Trichloroethylene	--	--	--	--	--	0.00
Trichlorofluoromethane	4.09	6.62	2.91	2.38	2.22	1.94
Trichlorotrifluoroethane	3.07	3.94	3.38	2.87	1.79	3.06
1,2,4-Trimethylbenzene	8.00	8.84	14.24	6.19	2.62	12.94
1,3,5-Trimethylbenzene	9.71	6.90	7.44	**16.28**	5.29	14.73
Vinyl chloride	--	--	--	--	--	--
m,p-Xylene	5.03	6.28	7.27	6.19	1.60	3.57
o-Xylene	6.06	7.51	8.03	6.67	2.07	3.75
Average CV by Site	10.67	7.17	6.79	10.53	6.10	7.13
# of Pairs Collected by Site	5	3	6	6	4	6

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*S4MO*	*SEWA*	SPIL	TMOK	TOOK	TROK
Acetylene	2.87	2.52	**30.47**	4.30	9.02	4.26
tert-Amyl Methyl Ether	--	--	--	--	--	--
Benzene	**23.32**	4.71	**24.63**	5.69	5.57	4.98
Bromochloromethane	--	--	--	--	--	--
Bromodichloromethane	6.43	--	--	--	--	--
Bromoform	--	--	--	--	--	--
Bromomethane	4.56	--	12.76	3.58	7.33	3.70
1,3-Butadiene	10.86	6.82	3.60	9.56	9.07	8.77
Carbon Tetrachloride	**15.30**	2.72	**21.30**	7.97	7.72	6.83
Chlorobenzene	--	--	--	--	--	--
Chloroethane	**18.69**	--	**22.61**	4.88	--	--
Chloroform	4.73	**22.48**	6.47	6.31	7.24	6.55
Chloromethane	3.63	3.16	4.36	7.91	8.98	3.94
Chloroprene	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--
p-Dichlorobenzene	5.71	--	--	**18.58**	**21.43**	**29.74**
Dichlorodifluoromethane	0.79	2.95	2.41	3.99	8.83	2.76
1,1-Dichloroethane	--	--	--	--	--	--
1,2-Dichloroethane	8.53	5.45	9.70	7.05	1.92	5.07
1,1-Dichloroethene	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	5.66	--	6.15
Dichloromethane	**18.19**	**61.92**	4.43	**19.83**	**15.57**	**28.79**
1,2-Dichloropropane	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--
Dichlorotetrafluoroethane	7.06	8.96	5.94	4.37	8.25	2.70
Ethyl Acrylate	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	6.07	--	--	--	--	--
Ethylbenzene	9.54	**39.31**	3.85	7.05	11.87	10.57
Hexachloro-1,3-butadiene	--	--	--	--	--	--
Methyl Isobutyl Ketone	**19.62**	**42.09**	9.10	**24.95**	12.08	**15.83**
Methyl Methacrylate	--	--	--	**17.37**	--	--
Methyl *tert*-Butyl Ether	--	--	--	--	--	--
n-Octane	**18.23**	8.67	4.15	7.55	3.81	4.98

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*S4MO*	*SEWA*	SPIL	TMOK	TOOK	TROK
Propylene	4.42	8.74	**34.64**	9.84	6.93	4.06
Styrene	12.62	6.17	3.21	**21.99**	**24.44**	10.87
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Tetrachloroethylene	7.68	3.17	**37.36**	6.41	7.51	2.59
Toluene	8.05	**30.19**	**30.91**	6.56	3.08	7.80
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--
Trichloroethylene	--	--	7.06	--	--	--
Trichlorofluoromethane	0.85	2.85	2.83	3.85	9.01	2.70
Trichlorotrifluoroethane	2.14	4.26	3.60	4.05	6.66	1.62
1,2,4-Trimethylbenzene	7.11	3.10	4.80	9.97	7.09	11.95
1,3,5-Trimethylbenzene	**19.36**	4.16	5.05	**15.29**	6.26	11.67
Vinyl chloride	--	--	--	--	--	--
m,p-Xylene	7.95	**35.47**	2.28	6.07	**15.04**	11.20
o-Xylene	9.43	**30.41**	5.32	6.33	**15.18**	11.38
Average CV by Site	9.42	14.79	11.65	9.18	9.60	8.52
# of Pairs Collected by Site	6	7	5	5	5	6

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	TVKY	YUOK	# of Pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Acetylene	6.14	3.42	127	5.03	5.19	3.66
tert-Amyl Methyl Ether	--	--	0	--	--	--
Benzene	12.04	3.23	127	8.07	8.17	7.10
Bromochloromethane	--	--	0	--	--	--
Bromodichloromethane	--	--	5	9.98	13.52	2.89
Bromoform	--	--	2	2.44	2.44	--
Bromomethane	11.14	**20.20**	54	8.32	8.34	8.19
1,3-Butadiene	9.25	3.85	110	7.18	7.17	7.19
Carbon Tetrachloride	6.51	3.74	127	9.41	9.86	5.32
Chlorobenzene	--	--	4	**21.34**	**21.34**	--
Chloroethane	11.61	--	31	**18.63**	**19.26**	11.61
Chloroform	14.66	5.04	117	7.73	7.56	9.33
Chloromethane	5.05	7.60	127	4.61	4.73	3.57
Chloroprene	--	--	0	--	--	--
Dibromochloromethane	--	--	3	4.87	9.73	0.00
1,2-Dibromoethane	--	--	0	--	--	--
m-Dichlorobenzene	--	--	0	--	--	--
o-Dichlorobenzene	--	--	0	--	--	--
p-Dichlorobenzene	--	--	15	**15.21**	**16.30**	8.65
Dichlorodifluoromethane	2.89	3.40	127	2.91	2.91	2.96
1,1-Dichloroethane	9.20	--	5	9.20	--	9.20
1,2-Dichloroethane	8.67	6.78	113	6.04	5.87	7.53
1,1-Dichloroethene	0.00	--	1	0.00	--	0.00
cis-1,2-Dichloroethylene	14.14	--	1	14.14	--	14.14
trans-1,2-Dichloroethylene	7.31	1.86	5	5.25	4.56	7.31
Dichloromethane	**30.98**	7.81	124	**23.51**	**22.02**	**36.99**
1,2-Dichloropropane	--	--	0	--	--	--
cis-1,3-Dichloropropene	--	--	0	--	--	--
trans-1,3-Dichloropropene	--	--	0	--	--	--
Dichlorotetrafluoroethane	6.53	3.97	127	4.58	4.42	6.05
Ethyl Acrylate	--	--	0	--	--	--
Ethyl *tert*-Butyl Ether	--	--	19	6.61	6.61	--
Ethylbenzene	12.84	8.10	118	11.41	11.88	7.19
Hexachloro-1,3-butadiene	--	--	0	--	--	--
Methyl Isobutyl Ketone	**39.20**	**36.60**	84	**21.31**	**20.13**	**31.88**
Methyl Methacrylate	--	--	4	12.33	13.67	8.32
Methyl t*ert*-Butyl Ether	--	--	12	**15.80**	**15.80**	--
n-Octane	**21.74**	4.63	117	10.55	10.22	13.59

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	TVKY	YUOK	# of Pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Propylene	9.31	**22.80**	127	10.92	11.07	9.63
Styrene	**46.18**	11.59	74	**16.67**	**15.53**	**26.95**
1,1,2,2-Tetrachloroethane	--	--	0	--	--	--
Tetrachloroethylene	7.64	7.38	74	7.11	7.32	5.36
Toluene	**36.25**	11.42	127	12.22	11.49	**18.70**
1,2,4-Trichlorobenzene	--	--	0	--	--	--
1,1,1-Trichloroethane	--	--	1	11.47	11.47	--
1,1,2-Trichloroethane	7.79	--	3	7.79	--	7.79
Trichloroethylene	6.73	--	8	5.08	4.66	6.73
Trichlorofluoromethane	**21.56**	3.34	127	3.96	3.08	11.89
Trichlorotrifluoroethane	3.79	3.46	126	3.04	3.07	2.79
1,2,4-Trimethylbenzene	14.50	10.99	95	9.21	9.28	8.56
1,3,5-Trimethylbenzene	10.85	13.75	59	9.59	9.76	8.07
Vinyl chloride	7.07	--	17	8.97	10.88	7.07
m,p-Xylene	12.59	5.30	120	11.15	11.60	7.09
o-Xylene	14.26	8.22	118	11.09	11.42	8.17
Average CV by Site	13.39	8.74	2,782	9.63	10.06	9.48
# of Pairs Collected by Site	25	6				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.2.2 SNMOC Method Precision

The SNMOC method precision for duplicate samples is presented in Table 24-3 as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the SNMOCs listed. The duplicate sample precision results from duplicate samples exhibit low- to mid-level variability among the pollutants and sites, ranging from a CV of 0.62 percent (isobutane for NBIL) to 32.07 percent (methylcyclohexane for NBIL). The CVs for 34 pollutants are less than 15 percent for both sites; conversely, there is only one pollutant listed where the CV is greater than or equal to 15 percent for both sites: 2-methylhexane.

The pollutant-specific average CV, as shown in orange in Table 24-3, ranges from 0.92 percent (*n*-dodecane) to 22.58 percent (2-methylhexane). The site-specific average CV, as shown in green in Table 24-3, ranges from 7.21 percent (NBIL) to 7.78 percent (BTUT); these are the only sites at which duplicate SNMOC samples were collected. No collocated SNMOC samples were collected during the 2014 program year. The overall average method precision for SNMOCs is 7.50 percent. Note that the results for TNMOC were not included in the precision calculations.

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Duplicate Samples by Site and Pollutant

Pollutant	***BTUT***	***NBIL***	# of pairs	Average by Pollutant
Acetylene	4.72	2.85	9	3.79
Benzene	10.70	6.77	9	8.74
1,3-Butadiene	2.72	--	1	2.72
n-Butane	7.10	1.73	9	4.42
1-Butene	--	--	0	--
cis-2-Butene	4.72	--	3	4.72
trans-2-Butene	**20.00**	--	3	**20.00**
Cyclohexane	8.32	4.98	8	6.65
Cyclopentane	4.48	**23.67**	5	14.07
Cyclopentene	--	--	0	--
n-Decane	6.68	6.73	5	6.71

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Duplicate Samples by Site and Pollutant (Continued)

Pollutant	*BTUT*	*NBIL*	# of pairs	Average by Pollutant
1-Decene	--	--	0	--
m-Diethylbenzene	--	--	0	--
p-Diethylbenzene	--	--	0	--
2,2-Dimethylbutane	7.66	2.13	4	4.89
2,3-Dimethylbutane	3.44	5.63	8	4.54
2,3-Dimethylpentane	3.38	4.64	9	4.01
2,4-Dimethylpentane	3.52	8.41	7	5.96
n-Dodecane	0.92	--	1	0.92
1-Dodecene	--	--	0	--
Ethane	1.87	2.63	9	2.25
2-Ethyl-1-butene	--	--	0	--
Ethylbenzene	4.25	2.70	6	3.47
Ethylene	7.11	3.68	9	5.39
m-Ethyltoluene	2.11	4.72	4	3.41
o-Ethyltoluene	1.00	--	1	1.00
p-Ethyltoluene	14.51	12.31	3	13.41
n-Heptane	1.91	6.70	8	4.30
1-Heptene	--	--	0	--
n-Hexane	6.51	2.70	9	4.60
1-Hexene	--	--	0	--
cis-2-Hexene	--	--	0	--
trans-2-Hexene	--	--	0	--
Isobutane	10.05	0.62	9	5.34
Isobutylene	--	--	0	--
Isopentane	4.82	2.27	2	3.55
Isoprene	**22.58**	2.24	7	12.41
Isopropylbenzene	--	--	0	--
2-Methyl-1-butene	8.26	--	4	8.26
3-Methyl-1-butene	--	--	0	--
2-Methyl-1-pentene	--	--	0	--
4-Methyl-1-pentene	--	--	0	--
2-Methyl-2-butene	4.41	1.38	3	2.89
Methylcyclohexane	5.58	**32.07**	8	**18.83**
Methylcyclopentane	8.64	7.45	9	8.05
2-Methylheptane	3.22	--	3	3.22
3-Methylheptane	4.09	--	3	4.09
2-Methylhexane	**18.97**	**26.19**	9	**22.58**

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Duplicate Samples by Site and Pollutant (Continued)

Pollutant	***BTUT***	***NBIL***	# of pairs	Average by Pollutant
3-Methylhexane	**15.71**	--	3	**15.71**
2-Methylpentane	13.31	13.72	9	13.51
3-Methylpentane	3.70	4.79	9	4.25
n-Nonane	5.78	7.13	5	6.45
1-Nonene	--	--	0	--
n-Octane	4.03	0.92	6	2.47
1-Octene	--	--	0	--
n-Pentane	2.98	1.02	9	2.00
1-Pentene	**29.72**	5.93	4	**17.82**
cis-2-Pentene	7.25	--	3	7.25
trans-2-Pentene	3.60	--	4	3.60
a-Pinene	**15.40**	11.69	7	13.55
b-Pinene	--	--	0	--
Propane	1.65	1.30	9	1.47
n-Propylbenzene	3.55	2.93	2	3.24
Propylene	11.67	8.49	9	10.08
Propyne	--	--	0	--
Styrene	--	--	0	--
Toluene	**21.86**	2.81	9	12.33
n-Tridecane	--	--	0	--
1-Tridecene	--	--	0	--
1,2,3-Trimethylbenzene	4.61	3.21	2	3.91
1,2,4-Trimethylbenzene	8.57	2.12	8	5.35
1,3,5-Trimethylbenzene	**16.30**	--	2	**16.30**
2,2,3-Trimethylpentane	2.61	--	1	2.61
2,2,4-Trimethylpentane	4.66	9.70	9	7.18
2,3,4-Trimethylpentane	14.26	**24.55**	8	**19.40**
n-Undecane	10.68	--	1	10.68
1-Undecene	--	--	0	--
m-Xylene/*p*-Xylene	6.88	6.16	8	6.52
o-Xylene	5.59	3.34	8	4.46
SNMOC (Sum of Knowns)	3.34	1.62	9	2.48
Sum of Unknowns	7.39	**23.38**	9	**15.39**
Average CV by Site	7.78	7.21	340	7.50
# of Pairs Collected by Site	6	3		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

24.2.3 Carbonyl Compound Method Precision

Table 24-4 presents the method precision for duplicate and collocated carbonyl compound samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the carbonyl compounds listed. The duplicate and collocated sample results exhibit low- to mid-level variability, ranging from a CV of 0.00 percent (hexaldehyde for GLKY and propionaldehyde for NBIL) to 32.86 percent (2-butanone for SYFL). The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies from none (six pollutants) to two (acetone and tolualdehydes).

The pollutant-specific average CV, as shown in orange in Table 24-4, ranges from 2.85 percent (acetaldehyde) to 9.57 percent (tolualdehydes). The site-specific average CV, as shown in green in Table 24-4, ranges from 2.13 percent (NBNJ) to 11.56 percent (SYFL). None of the sites collecting duplicate or collocated carbonyl compound samples have a site-specific average CV greater than or equal to 15 percent. The overall average method precision is 5.41 percent for carbonyl compounds.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-4 while sites at which collocated samples were collected are highlighted in purple. Collocated carbonyl compound samples were collected at only three of the sites shown in Table 24-4 (DEMI, INDEM, and PXSS); the remainder collected duplicate samples. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-4 in blue while the average CV for sites collecting collocated samples is shown in purple. The average CV for both precision types meets the MQO of 15 percent, with the variability associated with collocated samples (8.77 percent) greater than the variability associated with duplicate samples (4.95 percent).

Table 24-4. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant

Pollutant	AZFL	*BTUT*	CHNJ	CSNJ	*DEMI*	ELNJ	*GLKY*
Acetaldehyde	2.15	1.98	1.05	1.10	11.99	1.04	1.09
Acetone	6.40	3.62	4.72	14.47	1.83	**16.13**	1.49
Benzaldehyde	4.64	3.65	5.59	8.37	**22.45**	4.04	7.96
2-Butanone	13.81	2.30	6.39	7.98	5.24	11.17	2.17
Butyraldehyde	7.72	2.35	2.02	3.90	**18.87**	2.66	0.51
Crotonaldehyde	4.18	3.60	3.09	4.36	3.42	5.44	2.09
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	10.34	2.00	2.14	1.71	8.37	1.22	0.61
Hexaldehyde	12.74	7.09	6.86	4.56	11.00	5.04	0.00
Isovaleraldehyde	--	--	--	--	--	--	--
Propionaldehyde	4.14	2.64	1.68	2.34	6.29	1.11	1.43
Tolualdehydes	9.57	8.03	6.15	8.81	**29.03**	6.59	11.16
Valeraldehyde	11.12	4.98	6.25	4.33	6.71	3.66	5.33
Average CV by Site	7.89	3.84	4.18	5.63	11.38	5.28	3.08
# of Pairs Collected by Site	5	6	6	6	7	6	5

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-4. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*GPCO*	INDEM	*NBIL*	NBNJ	OCOK	ORFL	*PXSS*
Acetaldehyde	1.44	8.63	1.84	1.50	5.95	1.08	4.41
Acetone	2.16	9.94	1.95	1.09	4.55	9.87	5.64
Benzaldehyde	4.17	12.83	7.00	4.62	6.66	3.40	4.78
2-Butanone	1.90	6.94	0.86	1.28	7.63	9.99	3.21
Butyraldehyde	1.99	10.26	2.09	1.45	4.48	4.26	7.92
Crotonaldehyde	3.21	8.94	3.96	2.33	5.84	4.06	6.64
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	1.60	6.27	1.13	1.26	4.01	1.78	4.34
Hexaldehyde	2.83	10.97	4.33	2.02	6.44	5.32	4.31
Isovaleraldehyde	--	--			--	--	--
Propionaldehyde	2.70	8.76	0.00	0.50	6.56	1.58	4.51
Tolualdehydes	9.34	6.74	11.79	6.25	8.36	5.91	8.23
Valeraldehyde	6.51	13.94	6.04	1.12	6.03	9.66	6.02
Average CV by Site	3.44	9.47	3.73	2.13	6.05	5.17	5.46
# of Pairs Collected by Site	6	11	3	2	6	6	6

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-4. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	ROIL	*S4MO*	*SEWA*	*SKFL*	SPIL	*SYFL*	TMOK
Acetaldehyde	1.75	1.15	5.18	3.07	3.59	1.56	1.45
Acetone	7.58	4.13	1.95	2.94	7.72	**22.30**	5.81
Benzaldehyde	6.23	2.25	9.50	5.16	3.38	10.31	4.66
2-Butanone	8.71	3.91	2.06	6.56	4.99	**32.86**	4.42
Butyraldehyde	6.74	4.01	7.81	3.94	3.60	8.47	3.21
Crotonaldehyde	7.12	2.45	3.78	4.18	4.33	7.75	3.70
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	3.55	1.61	3.71	3.38	3.75	2.60	1.08
Hexaldehyde	5.83	7.28	6.63	2.49	6.01	6.44	3.35
Isovaleraldehyde	--	--	--	--	--	--	--
Propionaldehyde	2.73	2.73	5.08	3.02	2.10	3.79	1.85
Tolualdehydes	7.75	9.15	8.77	10.25	7.94	**21.88**	7.70
Valeraldehyde	6.92	6.12	4.84	7.23	5.07	9.22	6.45
Average CV by Site	5.90	4.07	5.39	4.75	4.77	11.56	3.97
# of Pairs Collected by Site	6	6	6	4	5	6	6

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-4. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	TOOK	TROK	WPIN	YUOK	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Acetaldehyde	1.09	0.70	3.81	2.71	148	2.85	2.10	8.34
Acetone	1.41	1.26	3.26	11.12	148	6.13	6.18	5.80
Benzaldehyde	4.17	3.95	8.84	4.93	142	6.54	5.61	13.35
2-Butanone	6.53	1.18	3.09	9.56	139	6.59	6.79	5.13
Butyraldehyde	2.71	1.83	4.59	5.29	145	4.91	3.89	12.35
Crotonaldehyde	2.44	1.50	5.23	11.22	147	4.59	4.36	6.33
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	2.41	0.90	4.18	1.56	148	3.02	2.57	6.33
Hexaldehyde	2.74	3.99	6.57	5.77	148	5.62	5.20	8.76
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	1.22	2.13	5.40	3.28	148	3.10	2.64	6.52
Tolualdehydes	9.42	6.07	6.52	7.81	122	9.57	8.87	14.67
Valeraldehyde	6.18	7.35	7.08	5.33	143	6.54	6.22	8.89
Average CV by Site	3.67	2.80	5.33	6.24	1,578	5.41	4.95	8.77
# of Pairs Collected by Site	6	6	10	6				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.2.4 PAH Method Precision

The method precision results for collocated PAH samples are shown in Table 24-5 as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the PAHs listed. All samples evaluated in this section are collocated samples. Collocated systems were the responsibility of the participating agency for sites sampling PAHs. Thus, collocated samples were not collected at most PAH sites because few sites had collocated samplers. Therefore, the method precision for PAHs for 2014 is based on data from three sites (DEMI, RUCA, and SEWA) and a total of only 18 sample pairs. The results from collocated samples exhibit low- to high-level variability, ranging from a CV of 2.30 percent (perylene for DEMI) to 67.91 percent (indeno(1,2,3-cd)pyrene for RUCA). The overall average method precision was 18.73 percent, which is greater than the MQO of 15 percent CV.

The pollutant-specific average CV, as shown in orange in Table 24-5, ranges from 2.30 percent (perylene) to 36.18 percent (benzo(a)anthracene). The site-specific average CVs, as shown in green in Table 24-5, vary across the sites, from 9.35 percent for DEMI, to 19.32 percent for SEWA, and 34.68 percent for RUCA. None of the CVs for DEMI are greater than or equal to 15 percent while many PAHs are greater than or equal to 15 percent for RUCA and SEWA, with the CVs for RUCA most often the highest of the three sites. A review of the individual sample pairs for RUCA shows that higher CVs for this site is being driven by two sample pairs. One pair in particular (the July 22, 2014 sample pair) has rather poor precision, with 11 of the 22 pollutants with an individual pollutant-specific CV greater than or equal to 15 percent, and six of these approaching or greater than 100 percent. If this sample is removed from the CV calculation for the program, the MQO of 15 percent would be met.

Table 24-5. PAH Method Precision: Coefficient of Variation Based on Collocated Samples by Site and Pollutant

Pollutant	*DEMI*	*RUCA*	*SEWA*	# of Pairs	Average by Pollutant
Acenaphthene	9.71	9.39	11.05	18	10.05
Acenaphthylene	10.05	**41.91**	**21.35**	7	**24.44**
Anthracene	7.58	**28.87**	11.85	14	**16.10**
Benzo(a)anthracene	13.62	**60.94**	**33.99**	15	**36.18**
Benzo(a)pyrene	7.61	--	**46.52**	8	**27.07**
Benzo(b)fluoranthene	11.52	**60.43**	**21.64**	16	**31.20**
Benzo(e)pyrene	10.76	**57.25**	**27.25**	15	**31.75**
Benzo(g,h,i)perylene	8.64	**49.23**	**25.84**	16	**27.90**
Benzo(k)fluoranthene	10.25	--	--	6	10.25
Chrysene	7.84	**44.20**	**22.29**	18	**24.78**
Coronene	8.61	**31.69**	**19.45**	14	**19.92**
Cyclopenta[cd]pyrene	14.31	--	--	1	14.31
Dibenz(a,h)anthracene	6.19	--	--	4	6.19
Fluoranthene	8.57	13.77	12.69	18	11.68
Fluorene	10.74	13.15	8.89	15	10.93
9-Fluorenone	10.19	14.18	10.41	18	11.60
Indeno(1,2,3-cd)pyrene	9.43	**67.91**	**25.54**	14	**34.29**
Naphthalene	11.15	12.83	8.43	18	10.80
Perylene	2.30	--	--	2	2.30
Phenanthrene	7.96	12.07	11.07	18	10.37
Pyrene	8.65	**18.39**	**20.15**	18	**15.73**
Retene	10.10	**53.28**	9.44	18	**24.27**
Average CV by Site	9.35	**34.68**	**19.32**	291	**18.73**
# of Pairs Collected by Site	6	6	6		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

24.2.5 Metals Method Precision

The method precision for all collocated metals samples are presented in Table 24-6 as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the metals listed. All samples evaluated in this section are collocated samples. The results from collocated samples exhibit low- to mid-level variability, ranging from a CV of 0 percent (beryllium and mercury for GLKY and cobalt for UNVT) to 45.43 percent (chromium for BOMA). The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies from none (manganese) to five (cadmium), with several metals exceeding 15 percent CV for only one or two sites. Note that BOMA, GLKY, S4MO, and TOOK collected collocated samples more frequently than the 10 percent requirement.

The pollutant-specific average CV, as shown in orange in Table 24-6, ranges from 6.22 percent (manganese) to 20.70 percent (nickel), with four of the 11 metals with an average CV greater than 15 percent. The site-specific average CV, as shown in green in Table 24-6, ranges from 6.72 percent (UNVT) to 20.94 percent (BOMA). Three sites (BOMA, GLKY and S4MO) have site-specific average CVs greater than or equal to 15 percent. The overall average method precision for metals is 12.98 percent.

Table 24-6. Metals Method Precision: Coefficient of Variation Based on Collocated Samples by Site and Pollutant

Pollutant	ASKY-M	*BOMA*	*BTUT*	*GLKY*	*GPCO*
Antimony	2.43	11.34	4.59	**21.00**	1.98
Arsenic	6.28	**26.97**	**15.37**	**17.32**	8.48
Beryllium	**15.67**	**18.52**	**19.30**	0.00	11.66
Cadmium	3.44	**27.31**	**16.06**	**27.35**	6.02
Chromium	10.74	**45.43**	--	0.51	--
Cobalt	7.39	**18.14**	5.78	**19.73**	6.58
Lead	3.78	5.86	1.06	**23.53**	2.94
Manganese	3.37	4.74	3.33	12.62	3.73
Mercury	**25.49**	**27.21**	**28.28**	0.00	--
Nickel	**33.57**	**32.74**	5.35	**37.78**	12.35
Selenium	5.07	12.04	**17.26**	12.54	12.34
Average CV by Site	10.66	**20.94**	11.64	**15.67**	7.34
# of Pairs Collected by Site	5	35	7	25	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-6. Metals Method Precision: Coefficient of Variation Based on Collocated Samples by Site and Pollutant (Continued)

Pollutant	*S4MO*	TOOK	*UNVT*	# of pairs	Average by Pollutant
Antimony	12.99	**16.57**	1.78	204	9.08
Arsenic	**20.04**	4.74	5.80	167	13.12
Beryllium	**23.52**	10.55	--	99	14.17
Cadmium	13.24	**21.00**	**23.05**	206	**17.18**
Chromium	--	7.10	--	54	**15.94**
Cobalt	14.47	7.14	0.00	199	9.91
Lead	12.16	8.59	4.32	206	7.78
Manganese	11.80	5.71	4.46	206	6.22
Mercury	12.96	**16.46**	--	86	**18.40**
Nickel	**28.18**	6.87	8.73	191	**20.70**
Selenium	13.49	3.56	5.66	142	10.24
Average CV by Site	**16.28**	9.84	6.72	1,760	12.98
# of Pairs Collected by Site	60	56	6		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

24.2.6 Hexavalent Chromium Method Precision

Table 24-7 presents the method precision results from collocated hexavalent chromium samples as the CV per site and the overall average CV for the method. All samples evaluated in this section are collocated samples. Only two NATTS sites sampled hexavalent chromium in 2014, RIVA and S4MO, although sampling was discontinued in July 2014 at S4MO. The site-specific CV ranges from 6.13 percent for RIVA to 29.80 percent for S4MO; note that these CVs are based on two collocated pairs for each site. The overall average method precision for hexavalent chromium is 17.96 percent, as shown in orange in Table 24-7, which is greater than the MQO of 15 percent CV for method precision. Note, however, that the precision calculations are based on only four collocated pairs.

Table 24-7. Hexavalent Chromium Method Precision: Coefficient of Variation Based on Collocated Samples by Site

Pollutant	*RIVA*	*S4MO*	# of pairs	Average by Pollutant
Hexavalent Chromium	6.13	**29.80**	4	**17.96**
# of Pairs Collected by Site	2	2	4	

Bold = CV greater than or equal to 15 percent
Orange shading indicates the average CV for this method.
BOLD ITALICS = EPA-designated NATTS Site

24.3 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, including random "noise" inherent to analytical instruments. Laboratories can evaluate the analytical precision of ambient air samples by comparing concentrations measured during multiple analyses of a single sample (i.e., replicate samples). Replicate analyses were run on duplicate or collocated samples collected during the program year. CVs were calculated for every replicate analysis run on duplicate or collocated samples collected during the program year. In addition, replicate analyses were also run on select individual samples to provide an indication of analytical precision for monitoring sites unable to collect duplicate or collocated samples (i.e., samplers "unequipped" to collect duplicate or collocated samples). Individual samples with replicate analyses were also factored into the CV calculations for analytical precision. However, only results at or above the MDL were used in these calculations, similar to the calculation of method precision discussed in Section 24.2.

Table 24-8 presents the 2014 NMP analytical precision for VOCs, SNMOCs, carbonyl compounds, PAHs, metals, and hexavalent chromium, presented as average CV (expressed as a percentage). The average CV for each method met the program MQO of 15 percent for precision. The analytical precision for all methods is less than 9 percent. This table also includes the number of pairs that were included in the calculation of the analytical precision. The total number of pairs including those with concentrations less than the MDL (and two numerical results) is also included in Table 24-8 to provide an indication of the effect that excluding those with concentrations less than the MDL has on the population of pairs in the dataset.

Table 24-8. Analytical Precision by Analytical Method

Method/Pollutant Group	Average Coefficient of Variation (%)	Number of Pairs Included in the Calculation	Total Number of Pairs Without the >= MDL exclusion
VOCs (TO-15)	6.09	6,923	8,284
SNMOCs	3.78	2,047	2,601
Carbonyl Compounds (TO-11A)	2.59	3,550	3,552
PAHs (TO-13A)	4.87	2,607	2,887
Metals Analysis (Method IO-3.5/FEM)	6.51	4,276	5,226
Hexavalent Chromium (ASTM D7641)	8.75	8	8
MQO	15.00 percent CV		

Bold = CV greater than or equal to 15 percent

Tables 24-9 through 24-14 present analytical precision for VOCs, SNMOCs, carbonyl compounds, PAHs, metals, and hexavalent chromium, respectively, as the CV per pollutant per site and the average CV per pollutant, per site, and per method. Pollutants exceeding the 15 percent MQO for CV are bolded in each table. In Tables 24-9 through 24-14, the number of pairs in comparison to the respective tables listed for duplicate or collocated analyses in Tables 24-2 through 24-7 is higher, the reason for which is two-fold. One reason is because each primary and duplicate (or collocated) sample produces a replicate analysis. The second reason is due to replicates run on individual samples. This is also the reason the number of sites provided in Tables 24-9 through 24-14 is higher than Tables 24-2 through 24-7. The replicate analyses of duplicate, collocated, and individual samples indicate that the analytical precision level is within the program MQOs.

24.3.1 VOC Analytical Precision

Table 24-9 presents analytical precision results from replicate analyses of duplicate, collocated, and select individual VOC samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the VOCs listed. The analytical precision results from replicate analyses show that, for most of the pollutants, the VOC analytical precision is within 15 percent. The CV ranged from 0 percent (several pollutants and several sites) to 34.69 percent (methyl *tert*-butyl ether for SPIL). The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies from none (32 pollutants) to four (styrene).

The pollutant-specific average CV, as shown in orange in Table 24-9, ranges from 1.98 percent (1,1,1-trichloroethane) to 16.02 percent (*cis*-1,2-dichloroethylene). The CV for *cis*-1,2-dichloroethylene is the only pollutant-specific CV greater than or equal to 15 percent and is based on the replicate analysis of two samples collected at TVKY, the only site for which at least one pair of measurements greater than the MDL were collected. The site-specific average CV, as shown in green in Table 24-9, ranges from 3.12 percent (SPAZ) to 7.35 percent (CHNJ). The overall average analytical precision is 6.09 percent. Note that the results for acrolein, acetonitrile, acrylonitrile, and carbon disulfide were excluded from the precision calculations due to the issues described in Section 3.2.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-9, sites at which collocated samples were collected are highlighted in purple, and sites for which replicates were run on individual samples are highlighted in brown. Collocated VOC samples were collected at only two of the sites shown in Table 24-9 (PXSS, and TVKY); replicates were run on individual VOC samples for seven sites, and the remainder of sites collected duplicate VOC samples. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-9 in blue, the average CV for sites collecting collocated samples is shown in purple, and the average CV for sites for which replicates were run on individual samples is shown in brown. The average CV for all three precision types meets the MQO of 15 percent, with the CV ranging from 5.01 percent (replicates run on individual samples) to 6.53 percent (replicates run on collocated samples).

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	ASKY	ATKY	BLKY	*BTUT*	CCKY	CHNJ
Acetylene	4.03	2.56	2.54	4.25	3.30	2.49
tert-Amyl Methyl Ether	--	--	--	--	--	--
Benzene	4.88	4.05	4.05	6.14	6.77	6.11
Bromochloromethane	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--
Bromomethane	8.88	7.97	8.64	4.28	3.63	6.87
1,3-Butadiene	11.47	6.92	5.79	6.08	8.71	9.04
Carbon Tetrachloride	2.98	2.02	2.31	5.05	3.31	4.27
Chlorobenzene	--	--	--	--	--	--
Chloroethane	12.12	9.38	7.10	6.33	--	5.88
Chloroform	3.85	7.32	6.76	7.97	8.63	6.32
Chloromethane	1.91	1.78	1.57	4.40	2.72	2.07
Chloroprene	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--
p-Dichlorobenzene	--	--	--	13.04	--	--
Dichlorodifluoromethane	1.94	1.42	1.34	4.79	2.85	2.25
1,1-Dichloroethane	--	2.77	--	--	--	--
1,2-Dichloroethane	5.36	8.05	8.45	6.53	8.32	8.83
1,1-Dichloroethene	--	0.00	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--	--
Dichloromethane	3.07	2.24	2.01	9.54	4.94	7.21
1,2-Dichloropropane	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--
Dichlorotetrafluoroethane	5.03	6.45	4.50	5.22	2.99	4.49
Ethyl Acrylate	--	--	--	--	--	--
Ethyl *ter*t-Butyl Ether	--	--	--	4.18	--	--
Ethylbenzene	8.51	**16.32**	9.58	4.30	8.69	9.88
Hexachloro-1,3-butadiene	--	--	--	--	--	--
Methyl Isobutyl Ketone	7.29	5.58	7.95	7.01	11.57	5.67
Methyl Methacrylate	--	6.73	--	--	--	--
Methyl *tert*-Butyl Ether	3.01	--	--	1.90	--	6.90

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ASKY	ATKY	BLKY	*BTUT*	CCKY	CHNJ
n-Octane	9.89	14.66	11.63	5.33	9.21	9.36
Propylene	2.42	1.02	3.23	4.88	2.93	2.76
Styrene	10.68	13.30	**17.72**	6.53	10.47	**23.55**
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Tetrachloroethylene	9.43	5.98	--	6.41	--	3.55
Toluene	4.21	4.70	5.48	4.22	9.94	6.00
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,1,1-Trichloroethane	--	0.00	--	3.97	--	--
1,1,2-Trichloroethane	--	8.00	--	--	--	--
Trichloroethylene	--	0.00	--	3.78	--	--
Trichlorofluoromethane	1.35	1.32	1.51	4.54	2.58	2.29
Trichlorotrifluoroethane	1.77	2.73	2.45	4.78	2.52	2.26
1,2,4-Trimethylbenzene	9.40	12.58	12.86	4.40	8.11	**19.75**
1,3,5-Trimethylbenzene	10.46	12.15	**15.71**	3.17	9.87	**15.48**
Vinyl chloride	--	0.95	1.35	--	0.00	--
m,p-Xylene	7.07	14.66	10.99	3.91	7.71	7.92
o-Xylene	6.77	**15.96**	9.90	3.68	9.27	9.98
Average CV by Site	6.07	6.24	6.62	5.35	6.21	7.35
# of Pairs Collected by Site	8	7	7	12	4	14

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	CSNJ	*DEMI*	ELNJ	*GLKY*	*GPCO*	LAKY
Acetylene	1.48	1.95	3.31	5.53	1.85	1.28
tert-Amyl Methyl Ether	--	--	--	--	--	--
Benzene	3.41	3.32	4.21	4.90	3.35	2.37
Bromochloromethane	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--
Bromomethane	7.58	0.00	1.33	4.08	3.19	6.67
1,3-Butadiene	9.15	4.14	9.41	14.33	5.20	5.10
Carbon Tetrachloride	2.13	3.24	3.72	1.63	2.65	1.77
Chlorobenzene	--	10.22	3.02	--	--	--
Chloroethane	9.26	4.70	9.90	6.92	4.37	0.00
Chloroform	5.31	3.28	6.43	4.44	6.08	3.38
Chloromethane	1.31	1.52	3.05	1.39	1.49	1.47
Chloroprene	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--
p-Dichlorobenzene	--	--	7.73	--	--	--
Dichlorodifluoromethane	1.49	1.65	3.18	1.24	1.73	1.37
1,1-Dichloroethane	--	--	--	--	--	--
1,2-Dichloroethane	6.84	3.75	5.21	4.15	4.74	5.19
1,1-Dichloroethene	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--	--
Dichloromethane	4.53	2.10	3.94	3.14	2.32	1.84
1,2-Dichloropropane	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--
Dichlorotetrafluoroethane	2.85	2.45	6.78	3.01	3.68	3.05
Ethyl Acrylate	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	--	--	5.60	--	5.30	--
Ethylbenzene	6.97	3.65	6.54	12.45	5.71	6.02
Hexachloro-1,3-butadiene	--	--	--	--	--	--
Methyl Isobutyl Ketone	6.05	6.73	8.87	6.28	6.66	6.73
Methyl Methacrylate	--	--	10.88	--	9.68	--
Methyl *tert*-Butyl Ether	3.12	--	7.79	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	CSNJ	*DEMI*	ELNJ	*GLKY*	*GPCO*	LAKY
n-Octane	5.35	4.69	7.87	**16.57**	7.08	8.23
Propylene	1.96	1.51	3.24	2.63	2.05	1.48
Styrene	5.78	4.43	**15.53**	10.59	3.99	8.02
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Tetrachloroethylene	5.01	4.45	4.42	--	2.68	7.44
Toluene	3.87	3.64	3.51	4.99	3.04	2.71
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--
Trichloroethylene	--	--	6.25	--	--	3.45
Trichlorofluoromethane	1.71	1.50	3.37	1.56	1.50	1.26
Trichlorotrifluoroethane	3.21	1.34	3.50	2.03	1.86	2.16
1,2,4-Trimethylbenzene	6.70	4.54	6.56	**16.77**	6.37	7.38
1,3,5-Trimethylbenzene	12.31	4.31	12.04	14.89	11.89	7.00
Vinyl chloride	3.70	--	--	--	--	1.10
m,p-Xylene	6.63	3.90	5.26	10.12	4.55	4.97
o-Xylene	7.05	4.24	5.56	12.66	5.55	6.26
Average CV by Site	4.99	3.51	6.06	6.93	4.39	3.99
# of Pairs Collected by Site	10	12	10	8	10	7

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	LEKY	*NBIL*	NBNJ	OCOK	*PXSS*	ROIL
Acetylene	5.65	2.81	3.95	2.82	2.45	2.74
tert-Amyl Methyl Ether	--	--	--	--	--	--
Benzene	3.60	3.38	6.03	4.64	2.74	2.22
Bromochloromethane	--	--	--	--	--	--
Bromodichloromethane	--	5.06	--	--	8.16	--
Bromoform	--	7.51	7.14	--	--	--
Bromomethane	4.92	7.15	3.45	5.53	3.70	3.72
1,3-Butadiene	12.35	11.10	11.65	10.92	7.59	6.88
Carbon Tetrachloride	2.90	2.90	4.59	3.52	2.31	3.54
Chlorobenzene	--	--	4.56	--	--	--
Chloroethane	10.28	0.00	5.27	7.63	--	12.51
Chloroform	5.65	2.71	4.24	5.88	3.29	6.13
Chloromethane	1.35	3.01	3.34	2.24	1.48	2.30
Chloroprene	--	--	--	--	--	--
Dibromochloromethane	--	5.32	--	--	8.84	--
1,2-Dibromoethane	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--
p-Dichlorobenzene	--	--	--	--	8.24	3.63
Dichlorodifluoromethane	1.25	3.04	3.40	2.08	1.67	2.28
1,1-Dichloroethane	--	--	--	--	--	--
1,2-Dichloroethane	4.29	7.90	7.74	5.76	5.34	6.66
1,1-Dichloroethene	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--	--
Dichloromethane	1.76	3.34	3.21	2.99	1.85	3.41
1,2-Dichloropropane	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--
Dichlorotetrafluoroethane	5.98	6.31	3.70	3.59	4.30	5.06
Ethyl Acrylate	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	--	5.05	8.73	--	--	--
Ethylbenzene	12.07	3.72	14.01	6.45	4.51	5.60
Hexachloro-1,3-butadiene	--	--	--	--	--	--
Methyl Isobutyl Ketone	4.22	3.48	5.13	5.63	7.45	14.44
Methyl Methacrylate	7.71	--	--	--	7.92	--
Methyl *tert*-Butyl Ether	3.07	--	--	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	LEKY	*NBIL*	NBNJ	OCOK	*PXSS*	ROIL
n-Octane	**15.62**	7.43	12.67	10.47	6.01	3.55
Propylene	2.26	4.17	3.54	2.59	1.76	2.45
Styrene	5.54	4.64	11.71	12.15	11.30	12.71
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--
Tetrachloroethylene	5.75	4.78	8.59	4.33	4.37	5.85
Toluene	2.20	3.82	5.46	3.44	2.91	2.57
1,2,4-Trichlorobenzene	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--
Trichloroethylene	--	--	--	--	--	2.89
Trichlorofluoromethane	1.37	3.03	3.16	1.98	1.26	2.04
Trichlorotrifluoroethane	2.58	3.11	3.03	3.53	1.77	3.16
1,2,4-Trimethylbenzene	11.76	4.49	**15.36**	7.04	6.58	5.20
1,3,5-Trimethylbenzene	6.75	3.93	14.31	9.67	8.78	8.14
Vinyl chloride	--	--	--	--	--	--
m,p-Xylene	10.15	3.43	11.56	5.48	4.40	3.17
o-Xylene	11.58	4.10	13.13	5.88	5.41	3.58
Average CV by Site	6.02	4.51	7.24	5.45	4.87	5.05
# of Pairs Collected by Site	8	7	12	12	8	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*S4MO*	*SEWA*	SPAZ	SPIL	TMOK	TOOK	TROK
Acetylene	1.53	3.29	1.67	5.35	3.70	7.96	3.84
tert-Amyl Methyl Ether	--	--	--	--	--	--	--
Benzene	2.63	4.96	3.09	4.64	4.67	5.94	3.82
Bromochloromethane	--	--	--	--	--	--	--
Bromodichloromethane	2.13	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--
Bromomethane	10.32	--	0.00	12.81	6.97	6.67	3.80
1,3-Butadiene	10.61	4.60	2.43	4.94	8.19	9.94	6.67
Carbon Tetrachloride	8.95	3.55	2.08	3.95	4.71	7.69	4.44
Chlorobenzene	--	--	--	--	--	--	--
Chloroethane	7.37	8.32	3.75	4.93	4.56	--	2.48
Chloroform	3.42	4.23	3.31	7.13	6.21	6.80	6.69
Chloromethane	1.69	2.56	1.13	3.10	3.11	8.10	3.94
Chloroprene	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--
p-Dichlorobenzene	6.21	--	6.22	--	13.93	6.55	6.03
Dichlorodifluoromethane	1.29	2.55	1.12	2.62	3.05	7.93	3.70
1,1-Dichloroethane	--	--	--	--	--	--	--
1,2-Dichloroethane	9.54	5.11	3.38	11.04	11.05	9.01	3.47
1,1-Dichloroethene	--	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	2.57	--	**18.66**	--	2.22
Dichloromethane	2.81	2.45	2.48	3.09	3.39	4.66	4.09
1,2-Dichloropropane	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	7.72	2.61	2.89	7.84	7.01	6.14	3.53
Ethyl Acrylate	--	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	12.71	--	--	3.14	--	--	4.29
Ethylbenzene	9.57	4.22	3.88	7.85	6.51	3.64	4.17
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	6.75	6.96	5.58	5.97	5.29	6.41	7.07
Methyl Methacrylate	--	--	--	--	12.86	--	--
Methyl *tert*-Butyl Ether	--	--	--	**34.69**	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*S4MO*	*SEWA*	SPAZ	SPIL	TMOK	TOOK	TROK
n-Octane	10.87	6.22	3.84	7.69	6.20	6.59	6.68
Propylene	3.48	2.85	1.59	2.87	2.58	5.74	2.82
Styrene	5.95	9.00	4.66	8.68	**17.26**	6.33	5.89
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--
Tetrachloroethylene	11.33	4.97	4.57	5.13	6.48	5.97	6.35
Toluene	4.44	4.05	2.91	4.38	4.59	3.00	3.55
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--
Trichloroethylene	--	--	--	7.85	--	--	--
Trichlorofluoromethane	1.12	2.51	1.08	2.80	2.92	8.36	3.81
Trichlorotrifluoroethane	2.57	2.28	0.89	2.49	3.44	7.13	2.43
1,2,4-Trimethylbenzene	8.59	5.31	5.17	8.35	7.79	4.04	6.59
1,3,5-Trimethylbenzene	6.63	8.84	5.41	**15.48**	13.91	3.99	6.00
Vinyl chloride	--	--	--	--	--	--	--
m,p-Xylene	7.58	4.78	4.37	6.67	6.08	3.53	4.18
o-Xylene	9.52	4.71	4.18	7.57	6.03	3.21	4.35
Average CV by Site	6.33	4.62	3.12	7.25	7.18	6.21	4.53
# of Pairs Collected by Site	13	14	10	12	10	10	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	TVKY	YUOK	# of Pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs	Average for Unequipped
Acetylene	3.15	5.80	311	3.38	3.59	2.80	3.01
tert-Amyl Methyl Ether	--	--	0	--	--	--	--
Benzene	4.65	5.57	311	4.30	4.44	3.69	4.12
Bromochloromethane	--	--	0	--	--	--	--
Bromodichloromethane	--	--	11	5.12	3.60	8.16	--
Bromoform	10.10	--	5	8.25	7.32	10.10	--
Bromomethane	5.94	0.00	149	5.31	5.16	4.82	5.81
1,3-Butadiene	6.36	11.79	275	8.20	8.59	6.97	7.54
Carbon Tetrachloride	3.30	5.17	311	3.65	4.20	2.80	2.48
Chlorobenzene	--	--	8	5.93	5.93	--	--
Chloroethane	5.90	3.02	99	6.33	6.09	5.90	7.11
Chloroform	5.95	9.26	289	5.58	5.70	4.62	5.56
Chloromethane	2.68	4.49	311	2.56	2.95	2.08	1.70
Chloroprene	--	--	0	--	--	--	--
Dibromochloromethane	--	--	7	7.08	5.32	8.84	--
1,2-Dibromoethane	--	--	0	--	--	--	--
m-Dichlorobenzene	--	--	0	--	--	--	--
o-Dichlorobenzene	--	--	0	--	--	--	--
p-Dichlorobenzene	--	0.00	46	7.16	7.14	8.24	6.22
Dichlorodifluoromethane	2.89	4.22	311	2.53	2.92	2.28	1.61
1,1-Dichloroethane	6.30	--	11	4.54	--	6.30	2.77
1,2-Dichloroethane	6.37	8.63	282	6.69	7.00	5.86	6.15
1,1-Dichloroethene	11.40	--	3	5.70	--	11.40	0.00
cis-1,2-Dichloroethylene	**16.02**	--	2	**16.02**	--	**16.02**	--
trans-1,2-Dichloroethylene	6.63	9.70	13	7.96	10.20	6.63	2.57
Dichloromethane	5.15	6.59	305	3.63	4.04	3.50	2.62
1,2-Dichloropropane	--	--	0	--	--	--	--
cis-1,3-Dichloropropene	--	--	0	--	--	--	--
trans-1,3-Dichloropropene	--	--	0	--	--	--	--
Dichlorotetrafluoroethane	7.51	7.61	310	4.90	4.98	5.91	4.41
Ethyl Acrylate	--	--	0	--	--	--	--
Ethyl *tert*-Butyl Ether	--	--	45	6.12	6.12	--	--
Ethylbenzene	11.07	11.09	291	7.67	7.02	7.79	9.29
Hexachloro-1,3-butadiene	--	--	0	--	--	--	--
Methyl Isobutyl Ketone	8.09	4.28	223	6.78	6.59	7.77	6.99
Methyl Methacrylate	--	--	9	9.30	11.14	7.92	7.22
Methyl *tert*-Butyl Ether	--	7.19	31	8.46	10.26	--	3.04

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-9. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	TVKY	YUOK	# of Pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs	Average for Unequipped
n-Octane	12.66	7.99	285	8.68	7.92	9.33	10.44
Propylene	3.58	5.42	311	2.88	3.20	2.67	2.13
Styrene	10.10	9.79	204	9.86	9.69	10.70	10.06
1,1,2,2-Tetrachloroethane	--	--	0	--	--	--	--
Tetrachloroethylene	5.51	5.69	167	5.79	5.65	4.94	6.64
Toluene	4.69	4.80	311	4.19	4.08	3.80	4.59
1,2,4-Trichlorobenzene	--	--	0	--	--	--	--
1,1,1-Trichloroethane	--	--	3	1.98	3.97	--	0.00
1,1,2-Trichloroethane	9.75	--	8	8.88	--	9.75	8.00
Trichloroethylene	5.19	--	20	4.20	5.19	5.19	1.72
Trichlorofluoromethane	2.83	4.37	311	2.49	2.92	2.04	1.50
Trichlorotrifluoroethane	3.27	5.78	310	2.89	3.22	2.52	2.16
1,2,4-Trimethylbenzene	10.18	9.87	242	8.58	8.21	8.38	9.61
1,3,5-Trimethylbenzene	11.82	6.02	146	9.59	9.50	10.30	9.62
Vinyl chloride	5.59	--	46	2.12	3.70	5.59	0.85
m,p-Xylene	10.54	9.53	296	6.78	6.02	7.47	8.56
o-Xylene	11.55	9.89	294	7.47	6.71	8.48	9.13
Average CV by Site	7.17	6.55	6,923	6.09	5.95	6.53	5.01
# of Pairs Collected by Site	50	12					

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.2 SNMOC Analytical Precision

Table 24-10 presents analytical precision results from replicate analyses of duplicate and select individual samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the SNMOCs listed. The CV ranges from 0 percent (*p*-ethyltoluene for BMCO and 2,3,4-trimethylpentane for RFCO) to 15.44 percent (*a*-pinene for PACO). *a*-Pinene is the only pollutant with a CV greater than or equal to 15 percent.

The pollutant-specific average CV, as shown in orange in Table 24-10, ranges from 0.71 percent (ethane) to 9.67 percent (*p*-diethylbenzene). None of the SNMOCs shown in Table 24-10 have an average CV greater than or equal to 15 percent. The site-specific average CV, as shown in green in Table 24-10, ranges from 3.14 percent (BRCO) to 3.90 percent (RICO); analytical precision for all seven sites sampling SNMOCs falls between 3 percent and 4 percent. The overall average analytical precision is 3.78 percent. Note that the results for TNMOC were not included in the precision calculations.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-10 while sites for which replicates were run on individual samples are highlighted in brown. Collocated SNMOC samples were not collected at the NMP sites sampling SNMOC. Duplicate SNMOC samples were collected at only BTUT and NBIL; replicates were run on individual SNMOC samples collected at the five Garfield County, Colorado sites. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-10 in blue while the average CV for sites for which replicates were run on individual samples is shown in brown. The variability ranges from 3.63 percent (replicates run on individual samples) to 4.08 percent (replicates run on duplicate samples).

Table 24-10. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	BMCO	BRCO	*BTUT*	*NBIL*	PACO
Acetylene	3.87	3.26	1.89	1.46	4.55
Benzene	3.60	3.97	2.43	4.43	2.86
1,3-Butadiene	--	--	5.25	--	--
n-Butane	0.69	0.38	0.96	1.74	0.71
1-Butene	--	--	--	--	--
cis-2-Butene	--	--	5.50	--	9.24
trans-2-Butene	--	--	4.46	--	8.08
Cyclohexane	1.20	2.19	4.31	6.70	1.32
Cyclopentane	3.08	2.83	2.47	13.23	1.54
Cyclopentene	--	--	--	--	--
n-Decane	6.19	8.85	7.40	5.18	5.85
1-Decene	--	--	--	--	--
m-Diethylbenzene	--	--	--	--	--
p-Diethylbenzene	--	6.33	13.01	--	--
2,2-Dimethylbutane	4.05	1.76	3.93	6.36	2.82
2,3-Dimethylbutane	2.00	2.50	1.15	5.30	1.71
2,3-Dimethylpentane	5.45	3.81	2.84	4.86	3.08
2,4-Dimethylpentane	8.64	6.51	3.89	4.85	5.66
n-Dodecane	--	--	7.76	--	--
1-Dodecene	--	--	--	--	--
Ethane	0.65	0.50	0.71	0.59	0.70
2-Ethyl-1-butene	--	--	--	--	--
Ethylbenzene	3.34	--	7.48	5.22	10.72
Ethylene	1.68	0.69	1.42	2.34	1.11
m-Ethyltoluene	6.09	5.72	3.08	7.26	2.96
o-Ethyltoluene	--	--	4.39	--	--
p-Ethyltoluene	0.00	4.03	6.57	3.39	5.87
n-Heptane	2.52	3.37	2.65	7.59	2.11
1-Heptene	--	--	--	--	--
n-Hexane	1.68	2.01	2.66	2.33	2.00
1-Hexene	--	--	--	--	--
cis-2-Hexene	--	--	--	--	--
trans-2-Hexene	--	--	--	--	--
Isobutane	0.71	0.38	0.92	2.90	0.50
Isobutylene	--	--	--	--	--
Isopentane	0.65	0.66	0.39	0.97	--
Isoprene	1.28	2.38	3.13	1.27	3.31

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	BMCO	BRCO	*BTUT*	*NBIL*	PACO
Isopropylbenzene	--	--	1.77	--	--
2-Methyl-1-butene	12.43	0.32	5.58	--	7.28
3-Methyl-1-butene	--	--	--	--	--
2-Methyl-1-pentene	--	--	--	--	--
4-Methyl-1-pentene	--	--	--	--	--
2-Methyl-2-butene	--	--	5.33	4.82	0.28
Methylcyclohexane	1.14	2.80	2.35	5.24	0.73
Methylcyclopentane	1.46	1.96	3.21	2.66	1.95
2-Methylheptane	2.96	8.11	5.79	--	5.60
3-Methylheptane	2.34	1.33	4.85	--	3.28
2-Methylhexane	1.69	2.74	1.65	3.69	2.06
3-Methylhexane	2.58	5.09	2.29	--	1.28
2-Methylpentane	0.90	1.63	2.34	1.73	0.70
3-Methylpentane	2.30	2.12	2.96	2.63	1.24
n-Nonane	1.84	3.55	2.02	4.02	2.64
1-Nonene	--	2.54	5.84	--	3.08
n-Octane	2.18	2.24	3.17	5.54	1.56
1-Octene	5.35	9.44	4.49	--	3.55
n-Pentane	1.02	0.54	1.41	1.09	1.30
1-Pentene	2.86	1.86	3.08	1.36	3.12
cis-2-Pentene	--	--	5.80	--	--
trans-2-Pentene	--	--	3.63	--	2.44
a-Pinene	4.06	5.91	6.10	6.04	**15.44**
b-Pinene	--	--	--	--	--
Propane	0.58	0.47	0.97	0.89	0.45
n-Propylbenzene	--	3.38	4.48	3.65	6.94
Propylene	7.47	4.26	2.66	2.51	3.93
Propyne	--	--	--	--	--
Styrene	6.67	2.70	--	--	5.45
Toluene	3.11	2.98	2.29	1.68	2.75
n-Tridecane	--	--	--	--	--
1-Tridecene	--	--	--	--	--
1,2,3-Trimethylbenzene	0.54	--	3.94	--	7.36
1,2,4-Trimethylbenzene	6.51	7.34	6.09	3.18	4.96
1,3,5-Trimethylbenzene	7.44	--	9.35	--	5.43
2,2,3-Trimethylpentane	--	--	4.38	--	2.48

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	BMCO	BRCO	*BTUT*	*NBIL*	PACO
2,2,4-Trimethylpentane	--	--	3.48	5.69	--
2,3,4-Trimethylpentane	--	0.69	5.03	5.72	0.90
n-Undecane	--	--	4.38	1.57	5.24
1-Undecene	--	--	--	--	--
m-Xylene/*p*-Xylene	3.78	4.30	2.66	4.06	2.50
o-Xylene	4.25	5.08	4.13	6.37	3.14
SNMOC (Sum of Knowns)	0.56	0.46	2.36	0.69	1.17
Sum of Unknowns	2.51	1.77	2.77	3.25	0.78
Average CV by Site	3.17	3.14	3.82	3.86	3.48
# of Pairs Collected by Site	8	7	12	6	7

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	RFCO	RICO	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Unequipped
Acetylene	2.52	2.35	54	2.84	1.67	3.31
Benzene	2.85	1.81	54	3.14	3.43	3.02
1,3-Butadiene	--	11.31	3	8.28	5.25	11.31
n-Butane	1.14	1.72	54	1.05	1.35	0.93
1-Butene	--	--	0	--	--	--
cis-2-Butene	4.07	6.51	20	6.33	5.50	6.61
trans-2-Butene	1.61	2.98	20	4.29	4.46	4.23
Cyclohexane	5.11	1.04	48	3.12	5.51	2.17
Cyclopentane	4.66	4.19	39	4.57	7.85	3.26
Cyclopentene	--	--	--	--	--	--
n-Decane	3.31	4.36	31	5.88	6.29	5.71
1-Decene	--	--	0	--	--	--
m-Diethylbenzene	--	--	0	--	--	--
p-Diethylbenzene	--	--	2	9.67	13.01	6.33
2,2-Dimethylbutane	2.20	4.99	34	3.73	5.14	3.17
2,3-Dimethylbutane	4.79	2.03	48	2.78	3.23	2.61
2,3-Dimethylpentane	1.67	2.61	49	3.47	3.85	3.32
2,4-Dimethylpentane	--	6.06	40	5.94	4.37	6.72
n-Dodecane	2.07	--	3	4.92	7.76	2.07
1-Dodecene	--	--	0	--	--	--
Ethane	0.49	1.35	54	0.71	0.65	0.74
2-Ethyl-1-butene	--	--	0	--	--	--
Ethylbenzene	5.67	8.49	31	6.82	6.35	7.05
Ethylene	1.22	2.63	54	1.58	1.88	1.47
m-Ethyltoluene	2.97	4.39	39	4.64	5.17	4.43
o-Ethyltoluene	3.86	8.34	4	5.53	4.39	6.10
p-Ethyltoluene	3.25	4.58	28	3.96	4.98	3.55
n-Heptane	2.89	2.31	50	3.35	5.12	2.64
1-Heptene	--	--	0	--	--	--
n-Hexane	2.60	1.79	54	2.15	2.49	2.01
1-Hexene	--	--	0	--	--	--
c*is*-2-Hexene	--	--	0	--	--	--
trans-2-Hexene	--	--	0	--	--	--
Isobutane	0.84	1.77	54	1.15	1.91	0.84
Isobutylene	--	--	0	--	--	--
Isopentane	--	2.55	9	1.05	0.68	1.29
Isoprene	2.46	1.82	32	2.24	2.20	2.25

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	RFCO	RICO	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Unequipped
Isopropylbenzene	--	--	1	1.77	1.77	--
2-Methyl-1-butene	7.42	4.17	23	6.20	5.58	6.33
3-Methyl-1-butene	--	--	0	--	--	--
2-Methyl-1-pentene	--	--	0	--	--	--
4-Methyl-1-pentene	--	--	0	--	--	--
2-Methyl-2-butene	4.08	5.50	19	4.00	5.07	3.28
Methylcyclohexane	2.93	2.00	50	2.46	3.80	1.92
Methylcyclopentane	5.31	1.52	54	2.58	2.93	2.44
2-Methylheptane	--	9.06	32	6.30	5.79	6.43
3-Methylheptane	--	2.76	30	2.91	4.85	2.43
2-Methylhexane	2.34	1.67	54	2.26	2.67	2.10
3-Methylhexane	3.58	4.74	24	3.26	2.29	3.46
2-Methylpentane	2.70	1.16	54	1.59	2.04	1.42
3-Methylpentane	5.23	2.68	54	2.74	2.80	2.71
n-Nonane	4.27	5.28	37	3.38	3.02	3.52
1-Nonene	--	3.78	4	3.81	5.84	3.14
n-Octane	2.57	2.07	45	2.76	4.36	2.12
1-Octene	--	2.26	15	5.02	4.49	5.15
n-Pentane	0.74	1.18	54	1.04	1.25	0.96
1-Pentene	4.65	3.76	20	2.96	2.22	3.25
cis-2-Pentene	--	--	5	5.80	5.80	--
trans-2-Pentene	6.06	4.16	19	4.07	3.63	4.22
a-Pinene	2.06	--	28	6.60	6.07	6.87
b-Pinene	--	--	0	--	--	--
Propane	1.02	1.86	54	0.89	0.93	0.88
n-Propylbenzene	3.43	6.01	15	4.65	4.06	4.94
Propylene	3.76	2.43	54	3.86	2.58	4.37
Propyne	--	--	0	--	--	--
Styrene	1.40	6.83	14	4.61		4.61
Toluene	1.09	2.09	54	2.28	1.98	2.40
n-Tridecane	--	--	0	--	--	--
1-Tridecene	--	--	0	--	--	--
1,2,3-Trimethylbenzene	3.61	2.92	12	3.67	3.94	3.61
1,2,4-Trimethylbenzene	4.87	4.49	42	5.35	4.64	5.63
1,3,5-Trimethylbenzene	5.17	8.93	15	7.26	9.35	6.74
2,2,3-Trimethylpentane	--	--	4	3.43	4.38	2.48

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	RFCO	RICO	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Unequipped
2,2,4-Trimethylpentane	3.64	4.57	21	4.35	4.59	4.11
2,3,4-Trimethylpentane	0.00	--	20	2.47	5.37	0.53
n-Undecane	--	--	4	3.73	2.98	5.24
1-Undecene	--	--	0	--	--	--
m-Xylene/*p*-Xylene	5.20	2.51	50	3.57	3.36	3.66
o-Xylene	7.52	2.83	50	4.76	5.25	4.56
SNMOC (Sum of Knowns)	0.99	8.96	54	2.17	1.52	2.43
Sum of Unknowns	2.33	6.52	54	2.85	3.01	2.78
Average CV by Site	3.20	3.90	2,047	3.78	4.08	3.63
# of Pairs Collected by Site	7	7				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.3 Carbonyl Compound Analytical Precision

Table 24-11 presents the analytical precision results from replicate analyses of duplicate, collocated, and select individual carbonyl compound samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV for the carbonyl compounds listed. The overall average CV was 2.59 percent, which is well within the program MQO of 15 percent CV. The analytical precision results from replicate analyses range from 0 percent (several pollutants at different sites) to 14.37 percent (tolualdehydes for PACO), indicating that every pollutant-site combination has a CV less than or equal to 15 percent.

The pollutant-specific average CV, as shown in orange in Table 24-11, ranges from 0.57 percent (acetone) to 4.60 percent (tolualdehydes), indicating that all of the pollutant-specific average CVs are less than 5 percent. The site-specific average CV, as shown in green in Table 24-11, ranges from 1.68 percent (NBNJ) to 4.08 percent (PACO), indicating that all of the site-specific average CVs are also less than 5 percent.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-11, sites at which collocated samples were collected are highlighted in purple, and sites for which replicates were run on individual samples are highlighted in brown. Collocated carbonyl compound samples were collected at three of the sites shown in Table 24-11 (DEMI, INDEM, and PXSS); replicates were run on individual samples for seven sites, and the remainder of sites collected duplicate samples. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-11 in blue, the average CV for sites collecting collocated samples is shown in purple, and the average CV for sites for which replicates were run on individual samples is shown in brown. The average CV for all three precision types are less than 3 percent, meeting the MQO of 15 percent, with the variability ranging from 2.49 percent (replicates run on duplicate samples) to 2.94 percent (replicates run on individual samples).

Table 24-11. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	ASKY	AZFL	BMCO	BRCO	*BTUT*	CHNJ	CSNJ	*DEMI*
Acetaldehyde	0.62	1.44	0.44	0.38	0.38	0.62	0.93	0.46
Acetone	0.40	0.72	0.33	0.30	0.30	0.70	0.59	0.53
Benzaldehyde	4.69	2.97	2.44	9.94	3.37	5.22	3.33	3.70
2-Butanone	0.79	3.28	0.66	2.17	0.73	2.07	2.63	1.49
Butyraldehyde	2.37	2.60	1.45	5.54	1.12	2.62	1.59	1.79
Crotonaldehyde	1.82	3.34	2.38	1.15	2.90	2.40	1.90	2.55
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	0.42	2.17	0.68	3.29	0.63	1.48	0.74	0.87
Hexaldehyde	7.70	4.75	2.70	0.00	4.01	5.42	2.43	4.11
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	1.61	2.03	0.00	2.08	1.29	1.95	1.87	1.39
Tolualdehydes	5.53	5.28	5.12	7.71	4.10	4.78	3.97	4.07
Valeraldehyde	4.33	4.34	3.70	3.55	3.01	4.59	3.10	3.34
Average CV by Site	2.75	2.99	1.81	3.28	1.99	2.90	2.10	2.21
# of Pairs Collected by Site	6	10	2	3	12	12	12	17

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ELNJ	*GLKY*	*GPCO*	INDEM	LEKY	*NBIL*	NBNJ	OCOK
Acetaldehyde	0.51	0.97	0.62	2.02	0.38	0.25	0.57	1.11
Acetone	0.57	0.40	0.38	0.90	0.53	0.50	0.00	1.58
Benzaldehyde	3.80	2.88	2.91	4.10	5.06	2.37	5.10	5.15
2-Butanone	2.94	2.78	1.72	2.54	1.96	1.89	0.71	1.22
Butyraldehyde	2.56	2.10	2.20	3.08	1.56	2.48	0.55	1.97
Crotonaldehyde	1.70	1.45	3.00	3.10	3.07	4.89	1.65	0.91
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	0.41	0.85	0.69	1.45	0.48	0.49	0.43	1.36
Hexaldehyde	3.38	8.61	3.17	4.88	2.18	5.82	2.40	3.62
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	0.96	1.05	1.79	2.56	1.90	2.55	0.44	2.10
Tolualdehydes	5.07	3.47	4.67	5.32	2.91	3.27	5.70	4.84
Valeraldehyde	2.42	6.96	4.36	4.70	4.63	4.72	0.94	4.65
Average CV by Site	2.21	2.87	2.32	3.15	2.24	2.66	1.68	2.59
# of Pairs Collected by Site	12	10	12	22	6	7	4	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ORFL	PACO	*PXSS*	RFCO	RICO	ROIL	*S4MO*	*SEWA*
Acetaldehyde	0.82	3.03	0.61	1.69	0.85	0.62	0.54	1.88
Acetone	0.95	0.22	0.35	0.36	0.73	0.52	0.40	0.60
Benzaldehyde	2.87	7.09	3.77	2.72	7.47	3.50	5.53	3.70
2-Butanone	2.48	1.99	2.01	1.74	1.22	2.39	0.89	2.27
Butyraldehyde	2.97	4.98	1.99	9.98	4.59	3.00	2.86	3.92
Crotonaldehyde	1.46	2.67	1.86	2.60	1.40	2.80	2.97	4.79
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	0.96	2.05	0.53	1.07	3.63	0.76	0.97	1.87
Hexaldehyde	3.36	1.90	3.70	5.80	4.20	3.11	2.95	4.58
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	1.68	1.48	1.93	3.97	2.58	1.74	1.61	2.86
Tolualdehydes	4.61	14.37	4.60	4.75	0.00	4.55	4.64	2.66
Valeraldehyde	3.78	5.04	2.78	3.23	5.70	4.47	4.22	3.79
Average CV by Site	2.36	4.08	2.19	3.45	2.94	2.50	2.51	2.99
# of Pairs Collected by Site	12	3	12	3	3	12	12	15

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	***SKFL***	**SPIL**	***SYFL***	**TMOK**	**TOOK**	**TROK**	**WPIN**
Acetaldehyde	1.46	0.73	0.81	0.41	1.04	0.56	1.47
Acetone	0.83	0.79	0.61	0.84	0.41	0.29	0.78
Benzaldehyde	4.15	2.96	5.29	3.65	5.30	2.18	4.14
2-Butanone	2.22	2.30	2.62	1.01	0.63	1.78	2.97
Butyraldehyde	1.88	2.12	3.23	1.59	3.10	3.77	4.19
Crotonaldehyde	1.86	2.24	1.42	2.30	2.01	1.28	3.79
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	1.90	1.20	1.05	1.12	1.85	1.04	1.56
Hexaldehyde	4.43	4.49	4.40	3.51	4.33	2.54	3.91
Isovaleraldehyde	--	--	--	--	--	--	--
Propionaldehyde	2.99	1.80	2.82	1.55	1.57	2.04	3.01
Tolualdehydes	3.87	2.57	4.67	3.79	4.33	4.19	3.81
Valeraldehyde	3.75	3.36	3.97	3.82	4.09	4.47	4.41
Average CV by Site	2.67	2.23	2.81	2.15	2.61	2.20	3.09
# of Pairs Collected by Site	11	10	12	12	12	12	21

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	YUOK	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs	Average for Unequipped
Acetaldehyde	0.50	333	0.90	0.83	1.03	1.06
Acetone	0.82	333	0.57	0.62	0.60	0.41
Benzaldehyde	4.85	321	4.26	3.87	3.85	5.63
2-Butanone	2.43	313	1.89	2.00	2.01	1.50
Butyraldehyde	1.58	326	2.85	2.45	2.29	4.35
Crotonaldehyde	2.57	332	2.38	2.44	2.51	2.16
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--
Formaldehyde	0.71	333	1.21	1.10	0.95	1.66
Hexaldehyde	4.33	331	3.96	4.07	4.23	3.50
Isovaleraldehyde	--	--	--	--	--	--
Propionaldehyde	1.53	331	1.90	1.87	1.96	1.95
Tolualdehydes	4.07	277	4.60	4.22	4.66	5.77
Valeraldehyde	3.89	320	4.00	3.96	3.61	4.31
Average CV by Site	2.48	3,550	2.59	2.49	2.52	2.94
# of Pairs Collected by Site	12					

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.4 PAH Analytical Precision

Table 24-12 presents analytical precision results from replicate analyses of collocated and select individual samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the PAHs listed. The CV ranges from 0.37 percent (coronene for BTUT) to 22.41 percent (perylene for BXNY). CVs for only four pollutant-site combinations are greater than or equal to 15 percent.

The pollutant-specific average CV, as shown in orange in Table 24-12, ranges from 2.19 percent (phenanthrene) to 8.66 percent (perylene). The site-specific average CV, as shown in green in Table 24-12, ranges from 3.25 percent (BTUT) to 8.61 percent (RIVA). The overall average analytical precision CV is 4.87 percent.

Sites at which collocated PAH samples were collected are highlighted in blue in Table 24-12 while sites for which replicates were run on individual samples are highlighted in brown. Collocated PAH samples were collected at DEMI, RUCA, and SEWA; replicates were run on individual PAH samples for the remaining sites. The average CV for sites that collected collocated PAH samples was calculated and is shown at the end of Table 24-12 in blue while the average CV for sites for which replicates were run on individual samples is shown in brown. The variability ranges from 4.18 percent (replicates run on collocated samples) to 5.02 percent (replicates run on individual samples).

Table 24-12. PAH Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	*BOMA*	*BTUT*	*BXNY*	*CELA*	*DEMI*	*GLKY*	*GPCO*	*NBIL*
Acenaphthene	3.13	4.38	2.57	4.39	2.45	1.78	1.61	4.72
Acenaphthylene	7.69	2.96	3.35	0.86	8.05	6.31	2.23	5.62
Anthracene	5.41	5.67	1.91	6.14	4.92	9.23	2.02	6.49
Benzo(a)anthracene	4.16	0.66	3.38	3.67	3.21	4.95	4.60	5.69
Benzo(a)pyrene	4.20	1.90	4.01	4.13	4.08	6.88	1.08	5.97
Benzo(b)fluoranthene	4.94	4.30	2.16	2.45	2.28	3.40	1.55	5.34
Benzo(e)pyrene	4.43	1.07	2.43	3.20	2.29	4.83	3.70	7.07
Benzo(g,h,i)perylene	4.22	8.03	1.82	3.73	2.68	5.86	1.26	5.45
Benzo(k)fluoranthene	4.30	4.52	12.70	10.48	5.92	5.15	6.66	9.35
Chrysene	2.57	3.25	1.51	2.54	2.86	3.47	2.53	5.32
Coronene	3.22	0.37	3.70	4.79	5.04	10.39	6.87	8.37
Cyclopenta[cd]pyrene	--	--	4.84	3.54	9.79	--	9.56	--
Dibenz(a,h)anthracene	--	--	--	--	7.61	--	9.23	10.50
Fluoranthene	1.97	2.72	2.90	4.76	2.70	2.26	2.92	5.65
Fluorene	2.20	1.29	2.70	5.16	2.13	3.18	2.86	4.50
9-Fluorenone	2.64	3.94	3.38	5.36	2.00	3.12	4.19	5.83
Indeno(1,2,3-cd)pyrene	10.18	1.26	8.56	4.06	5.41	8.39	4.10	9.13
Naphthalene	4.06	4.04	1.50	3.69	3.59	2.56	3.97	5.97
Perylene	--	--	**22.41**	--	6.79	--	7.78	9.41
Phenanthrene	1.39	0.99	1.43	1.14	1.36	2.29	1.13	4.94
Pyrene	2.15	3.50	2.97	5.10	2.37	2.10	2.78	5.69
Retene	5.47	6.94	14.63	3.69	5.15	5.94	2.80	6.95
Average CV by Site	4.12	3.25	4.99	4.14	4.21	4.85	3.88	6.57
# of Pairs Collected by Site	7	7	7	6	12	11	7	6

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-12. PAH Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	***PRRI***	***PXSS***	***RIVA***	***ROCH***	***RUCA***	***S4MO***	***SEWA***	***SJJCA***
Acenaphthene	2.71	4.97	12.66	2.56	3.35	3.68	3.01	4.48
Acenaphthylene	3.05	3.97	5.05	3.35	2.63	3.20	2.92	5.03
Anthracene	4.59	3.65	**17.09**	10.59	4.73	9.38	3.25	3.68
Benzo(a)anthracene	5.20	2.31	2.21	2.00	2.97	2.84	2.80	2.43
Benzo(a)pyrene	4.69	6.70	2.41	3.50	0.46	7.50	6.41	3.54
Benzo(b)fluoranthene	1.86	5.95	10.51	3.21	5.78	3.85	2.51	8.29
Benzo(e)pyrene	3.06	6.61	1.53	3.58	3.56	2.75	5.29	3.45
Benzo(g,h,i)perylene	3.44	4.43	2.62	5.33	6.14	3.67	3.36	4.25
Benzo(k)fluoranthene	8.17	4.30	6.43	8.47	8.29	7.10	5.82	6.78
Chrysene	1.36	3.12	12.52	1.40	3.88	1.80	3.81	2.44
Coronene	2.38	3.87	4.34	3.37	6.03	3.90	3.76	4.29
Cyclopenta[cd]pyrene	10.40	--	--	--	--	8.14	--	2.48
Dibenz(a,h)anthracene	1.61	--	5.41	--	0.70	6.31	--	10.02
Fluoranthene	2.23	2.39	11.17	2.80	2.10	4.27	3.34	6.08
Fluorene	2.07	1.65	13.36	2.97	2.66	3.36	2.44	3.61
9-Fluorenone	2.30	2.70	12.02	2.86	3.23	3.25	3.66	2.50
Indeno(1,2,3-cd)pyrene	3.76	4.68	6.36	8.33	8.81	5.46	5.63	2.85
Naphthalene	3.93	3.49	14.69	4.88	4.13	6.74	2.17	5.16
Perylene	4.23	13.06	3.00	--	6.94	5.59	--	7.44
Phenanthrene	0.89	2.19	12.59	0.69	1.55	2.21	1.09	1.49
Pyrene	2.09	3.04	11.63	3.49	2.66	3.90	3.45	6.95
Retene	5.09	6.83	13.13	6.10	3.41	7.18	3.84	6.42
Average CV by Site	3.60	4.50	8.61	4.18	4.00	4.82	3.61	4.71
# of Pairs Collected by Site	9	8	7	9	14	9	14	8

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-12. PAH Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*SKFL*	*UNVT*	*WADC*	# of Pairs	Average by Pollutant	Average for Collocated Pairs	Average for Unequipped
Acenaphthene	1.79	9.87	1.71	155	3.99	2.93	4.19
Acenaphthylene	7.92	7.26	2.60	83	4.42	4.54	4.40
Anthracene	4.84	5.06	4.07	124	5.93	4.30	6.24
Benzo(a)anthracene	6.55	1.20	6.41	122	3.54	2.99	3.64
Benzo(a)pyrene	4.38	9.06	5.84	98	4.57	3.65	4.74
Benzo(b)fluoranthene	5.09	1.33	3.65	146	4.13	3.52	4.24
Benzo(e)pyrene	1.51	13.50	2.65	126	4.03	3.71	4.09
Benzo(g,h,i)perylene	4.95	14.19	2.75	139	4.64	4.06	4.75
Benzo(k)fluoranthene	5.33	**19.29**	7.92	80	7.74	6.68	7.94
Chrysene	3.70	4.27	3.57	155	3.47	3.52	3.46
Coronene	7.19	4.68	4.70	106	4.80	4.94	4.78
Cyclopenta[cd]pyrene	--	--	--	16	6.97	9.79	6.49
Dibenz(a,h)anthracene	--	--	--	20	6.42	4.16	7.18
Fluoranthene	1.44	5.46	2.11	164	3.65	2.71	3.82
Fluorene	2.16	1.59	1.60	121	3.24	2.41	3.39
9-Fluorenone	2.40	3.91	1.80	164	3.74	2.96	3.89
Indeno(1,2,3-cd)pyrene	4.64	2.64	5.33	125	5.77	6.62	5.61
Naphthalene	5.18	2.41	1.28	164	4.39	3.30	4.60
Perylene	--	--	--	14	8.66	6.86	9.12
Phenanthrene	1.12	1.28	1.78	164	2.19	1.33	2.35
Pyrene	1.53	2.93	2.33	164	3.72	2.83	3.89
Retene	3.69	**22.24**	5.22	157	7.09	4.13	7.65
Average CV by Site	3.97	6.96	3.54	2,607	4.87	4.18	5.02
# of Pairs Collected by Site	8	7	8				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.5 Metals Analytical Precision

Table 24-13 presents analytical precision results from replicate analyses of collocated and select individual samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the metals listed. The CVs exhibit low- to mid-level variability, ranging from 0 percent (for several sites and pollutants) to 33.33 percent (beryllium for PAFL).

The pollutant-specific average CV, as shown in orange in Table 24-13, ranges from 1.67 percent (manganese) to 15.95 percent (beryllium). Beryllium is the only pollutant with a pollutant-specific average CV greater than or equal to 15 percent. The site-specific average CV, as shown in green in Table 24-13, ranges from 3.03 percent (LEKY) to 10.48 percent (BAKY); all 21 sites sampling metals have site-specific average CVs less than 15 percent. The overall average analytical precision CV is 6.51 percent.

Sites at which collocated metals samples were collected are highlighted in blue in Table 24-13 while sites for which replicates were run on individual samples are highlighted in brown. Collocated metals samples were collected at eight sites; replicates were run on individual PAH samples at the remaining 13 sites. The average CV for sites that collected collocated metals samples was calculated and is shown at the end of Table 24-13 in blue while the average CV for sites for which replicates were run on individual samples is shown in brown. The variability ranges from 5.95 percent (replicates run on individual samples) to 7.35 percent (replicates run on collocated samples).

Table 24-13. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	ASKY-M	BAKY	BLKY	*BOMA*	*BTUT*	CCKY
Antimony	1.31	1.62	0.79	1.38	2.14	2.12
Arsenic	7.69	**15.06**	8.05	**19.44**	13.62	14.67
Beryllium	**17.59**	**24.43**	--	**27.75**	**20.54**	0.00
Cadmium	4.06	9.05	2.32	7.90	13.85	10.79
Chromium	1.56	--	--	0.80	--	--
Cobalt	1.36	6.51	0.00	5.22	4.45	0.00
Lead	0.85	1.64	1.30	1.37	1.66	0.85
Manganese	0.94	1.98	1.05	1.22	1.55	0.64
Mercury	13.42	**26.24**	--	**21.04**	11.03	0.00
Nickel	4.65	8.28	13.86	4.96	4.04	**17.23**
Selenium	3.45	9.98	1.30	8.91	8.88	8.06
Average CV by Site	5.17	10.48	3.58	9.09	8.17	5.44
# of Pairs Collected by Site	15	6	1	70	14	5

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*GLKY*	*GPCO*	LEKY	*NBIL*	OCOK	PAFL
Antimony	1.89	1.44	1.71	4.17	1.87	1.64
Arsenic	**15.14**	11.35	5.68	4.80	5.45	3.80
Beryllium	**24.59**	**15.79**	--	**15.18**	10.34	**33.33**
Cadmium	13.40	7.88	5.25	**18.15**	4.28	**17.93**
Chromium	0.00	--	--	2.54	2.39	--
Cobalt	13.08	5.48	3.40	4.00	6.18	10.95
Lead	1.39	0.60	0.79	3.83	6.52	4.03
Manganese	1.00	0.97	0.81	4.82	5.16	3.63
Mercury	7.86	--	--	12.24	7.23	9.36
Nickel	**16.03**	5.24	4.18	0.92	4.68	0.65
Selenium	9.93	7.30	2.41	4.48	3.96	1.77
Average CV by Site	9.48	6.23	3.03	6.83	5.28	8.71
# of Pairs Collected by Site	55	24	6	7	8	4

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*PXSS*	*S4MO*	*SEWA*	*SJJCA*	TMOK	TOOK
Antimony	1.22	3.89	1.50	0.89	1.19	1.37
Arsenic	14.66	13.17	12.51	**21.86**	1.42	1.95
Beryllium	**17.41**	**19.93**	--	--	6.80	7.30
Cadmium	1.70	6.04	8.96	**16.41**	**23.26**	2.69
Chromium	--	--	--	--	1.90	1.58
Cobalt	0.65	5.04	1.13	3.26	1.09	2.67
Lead	0.52	0.83	0.96	0.85	1.12	1.62
Manganese	0.78	0.86	0.78	1.10	2.37	1.88
Mercury	**21.35**	**21.15**	**21.69**	12.50	4.98	8.18
Nickel	3.27	5.52	1.48	8.95	2.67	1.94
Selenium	1.68	7.07	--	5.36	1.24	2.35
Average CV by Site	6.32	8.35	6.13	7.91	4.37	3.05
# of Pairs Collected by Site	6	121	6	6	3	113

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	TROK	*UNVT*	YUOK	# of pairs	Average by Pollutant	Average for Collocated Pairs	Average for Unequipped
Antimony	1.93	3.57	1.55	494	1.87	2.12	1.71
Arsenic	2.81	8.74	3.44	406	9.78	11.39	8.78
Beryllium	9.99	--	4.27	249	**15.95**	**19.07**	13.53
Cadmium	7.66	**27.36**	4.11	496	10.14	10.40	9.99
Chromium	3.01	--	2.33	128	1.79	0.98	2.43
Cobalt	1.75	11.59	2.03	479	4.28	6.11	3.15
Lead	3.64	1.60	1.90	496	1.80	1.24	2.15
Manganese	1.39	1.17	0.93	496	1.67	1.20	1.96
Mercury	10.87	--	12.95	226	13.06	13.78	12.67
Nickel	2.64	**17.74**	1.66	455	6.22	7.51	5.42
Selenium	2.43	8.86	1.07	351	5.02	7.09	3.64
Average CV by Site	4.37	10.08	3.29	4,276	6.51	7.35	5.95
# of Pairs Collected by Site	6	13	7				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicates were run on individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.6 Hexavalent Chromium Analytical Precision

Table 24-14 presents analytical precision results from replicate analyses of collocated samples as the CV per site and the overall average CV for hexavalent chromium. Recall from Section 24.2.6 that two NATTS sites sampled hexavalent chromium in 2014, RIVA and S4MO, although sampling was discontinued in July 2014 at S4MO. The site-specific CV for RIVA (14.81 percent) is considerably higher than the CV for S4MO (2.69 percent), although both CVs are less than 15 percent. The CVs for both sites are based on two sets of collocated samples and their replicates, resulting in four pairs each. The overall average analytical precision of hexavalent chromium is 8.75 percent, as shown in orange in Table 24-14.

Table 24-14. Hexavalent Chromium Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site

Pollutant	*RIVA*	*S4MO*	# of pairs	Average by Pollutant
Hexavalent Chromium	14.81	2.69	8	8.75
# of Pairs Collected by Site	4	4		

Bold = CV greater than or equal to 15 percent
Orange shading indicates the overall average CV for this method.
Blue shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.4 Accuracy

Laboratories typically evaluate their accuracy (or bias) by analyzing audit samples that are prepared by an external source. The pollutants and the respective concentrations of the audit samples are unknown to the laboratory. The laboratory analyzes the samples and the external source compares the measured concentrations to the reference concentrations of those audit samples and calculates a percent difference. 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 VOCs, carbonyl compounds, PAHs, metals, and hexavalent chromium, which are used to quantitatively measure analytical accuracy. Tables 24-15 through 24-19 present ERG's results for PT audit samples analyzed in 2014. Note that the way in which the results of the PT audit are reported changed mid-2014. Results for PT audit samples prepared prior to May 2014 are presented as percent recovery while the results from the second half of the year are presented as percent difference. Percent recovery-based audit results are calculated as follows:

$$\text{Percent of True (\% Recovery)} = \frac{X_{lab}}{X_{true}} \times 100$$

Where:

X_{lab} is the analytical result from the laboratory;
X_{true} is the true concentration of the audit sample.

This calculation results in percent recovery values near 100 percent. The program MQO is ± 25 percent recovery; thus, percent recovery values between 75 percent and 125 percent are

acceptable. Beginning with May 2014 PT audit samples, the results are presented as percent difference, which is calculated as follows:

$$\text{Percent Difference} = \frac{X_{lab} - X_{true}}{X_{true}} \times 100$$

Where:

X_{lab} is the analytical result from the laboratory;
X_{true} is the true concentration of the audit sample.

This calculation results in values that appear much lower than percent recovery. The program MQO of ± 25 percent still applies but percent difference values between 0 percent and ± 25 percent are acceptable. Note that the "true" value used in the calculations above can be based on the mean value of the confirmation laboratory's results or the mean result of all participating NATTS laboratories and is also indicated in the tables that follow.

The results of the 2014 PT audit samples show that few of the pollutants for which PT audit samples were analyzed exceed the MQO for accuracy. Of the 67 results provided in Tables 24-15 through Table 24-19, only four exceed the MQO for accuracy (three for VOCs and one for metals). However, none failed multiple audits in 2014.

Table 24-15. TO-15 NATTS PT Audit Samples

Pollutant	February 2014[1] % Recovery	August 2014[2] % Difference
Acrolein	**127.1**	5.2
Benzene	111.1	14.5
1,3-Butadiene	104.2	-1.8
Carbon Tetrachloride	**130.9**	21.6
Chloroform	**129.7**	7.2
1,2-Dibromoethane	106.3	-6.9
1,2-Dichloroethane	123.0	-3.8
Dichloromethane	113.5	13.8
1,2-Dichloropropane	112.9	2.3
cis-1,3-Dichloropropene	107.9	-1.6
trans-1,3-Dichloropropene	119.5	-17.7
1,1,2,2-Tetrachloroethane	119.1	13.0
Tetrachloroethylene	112.3	0.1
Trichloroethylene	112.9	-4.9
Vinyl chloride	116.8	12.5

[1] The true value is based on the confirmation laboratory's mean.
[2] The true value is based on the mean of participating NATTS laboratories.
Bold = Greater than ± 25 percent MQO

Table 24-16. TO-11A NATTS PT Audit Samples

Pollutant	February 2014[1] % Recovery	August 2014[2] % Difference
Acetaldehyde	NS	-1.0
Benzaldehyde	98.5	4.2
Formaldehyde	99.0	-1.5
Propionaldehyde	86.5	-4.7

NS = Not spiked onto PT audit sample provided to the laboratory
[1] The true value is based on the confirmation laboratory's mean.
[2] The true value is based on the mean of participating NATTS laboratories.
Bold = Greater than ± 25 percent MQO

Table 24-17. TO-13A NATTS PT Audit Samples[1]

Pollutant	May 2014	December 2014
Acenaphthene	6.2	6.2
Anthracene	4.6	12.5
Benzo(a)pyrene	NS	15.4
Fluoranthene	8.2	NS
Fluorene	-5.1	12.4
Naphthalene	6.6	13.3
Phenanthrene	-5.2	4.3
Pyrene	1.9	9.6

NS = Not spiked onto PT audit sample provided to the laboratory.
Bold = Greater than ± 25 percent MQO
[1] Audit result based on percent difference from mean of participating NATTS laboratories.

Table 24-18. Metals NATTS PT Audit Samples[1]

Pollutant	May 2014	December 2014
Antimony	-8.8	**-29.1**
Arsenic	4.6	17.0
Beryllium	NS	8.4
Cadmium	NS	0.1
Cobalt	3.5	3.1
Lead	-2.0	-0.5
Manganese	4.4	NS
Nickel	-19.5	0.1
Selenium	17.6	0.6

NS = Not spiked onto PT audit sample provided to the laboratory.
Bold = Greater than ± 25 percent MQO
[1] Audit result based on percent difference from mean of participating NATTS laboratories.

Table 24-19. Hexavalent Chromium NATTS PT Audit Sample[1]

Pollutant	May 2014
Hexavalent Chromium	8.0

[1] Audit result based on percent difference from mean of participating NATTS laboratories.
Bold = Greater than ± 25 percent MQO

ERG's use of the ICP/MS was approved in 2012 as a FEM for the sampling and analysis of lead for adherence to the National Ambient Air Quality Standards (NAAQS) (EPA 2012a). This approval requires additional quality assurance steps, including the analysis of quarterly audit strips. Table 24-20 provides the results of the quarterly NAAQS audit results for lead for ERG for 2014. All results are within the percent recovery target of ± 15 percent.

Table 24-20. Lead NAAQS Quarterly Audit Samples[1,2]

Pollutant	Filter #	Analysis #	March 2014	September 2014	December 2014
Lead	1	1	95.8	102.0	99.4
		2	91.2	102.6	97.6
		3	97.0	101.3	95.2
	2	1	97.8	98.2	100.0
		2	98.9	97.3	100.0
		3	96.6	97.2	96.9

[1] Audit result represents percent of nominal spike value.
[2] A second quarter 2014 audit sample was not prepared by the confirmation laboratory.
Bold = Greater than ± 15 percent recovery target

The accuracy of the 2014 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 during the 2014 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, 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 2014 monitoring data accurately represent ambient air quality.

25.0 Results, Conclusions, and Recommendations

The following discussion summarizes the results of the data analyses contained in this report, renders conclusions based on those results, and presents recommendations applicable to future air toxics monitoring efforts. As demonstrated by the results of the data analyses discussed throughout this report, NMP data offer a wealth of information for assessing air quality by evaluating trends, patterns, correlations, and the potential for health risk. NMP data should ultimately assist a wide range of audiences in understanding the complex nature of ambient air pollution.

25.1 Summary of Results

Analyses of the 2014 monitoring data identified the following notable results, observations, trends, and patterns in the program-level and state- and site-specific air monitoring data.

25.1.1 Program-level Results Summary

- *Number of participating sites.* Twenty of the 51 monitoring sites are EPA-designated NATTS sites. An additional 30 UATMP sites participated in the NMP in 2014. Data from one special study site (ROIL) are also included in the report. The number of NATTS sites whose data are included in the 2014 NMP report is less than in previous years due to the removal of hexavalent chromium from the list of target pollutants for which to monitoring is required.

- *Total number of samples collected and analyzed.* Over 7,800 valid samples were collected at participating program sites and analyzed at the ERG laboratory, yielding nearly 225,000 valid measurements of air toxics, including primary, duplicate, collocated, and replicate results.

- *Detects.* Of the 198 pollutants for which statistical summaries are provided in Tables 4-1 through 4-6, all but five were detected at least once over the course of the 2014 monitoring effort. The detection of a given pollutant is subject to the sensitivity limitation associated with the analytical methods used and the limitations of the instruments. Simply stated, an MDL is the lowest concentration of a target pollutant that can be measured and reported with 99 percent confidence that the pollutant concentration is greater than zero. Approximately 55 percent of the reported measurements were greater than the associated MDLs. At the method level, this percentage varies considerably, from 42 percent for SNMOCs to 83 percent for carbonyl compounds. Quantification below the MDL is possible and an acceptable analytical result; therefore, these results are incorporated into the data analyses. These measurements account for 9 percent of concentrations. Non-detects account for the remaining 36 percent of results.

- *Program-level Pollutants of Interest.* The pollutants of interest at the program-level are based on the total number of concentrations greater than the associated risk screening value, or those "failing the screen". Thirty-four pollutants failed at least one risk screening value; of those pollutants,12 were identified as program-level pollutants of interest.

- *Seasonal Trends.* Fewer pollutants exhibited identifiable seasonal trends in the concentrations measured during the 2014 program year (at least from a program-level perspective). Formaldehyde concentrations tended to be highest during the warmer months of the year, similar to past years. Acetaldehyde concentrations exhibit a similar pattern, but to a lesser degree. Conversely, benzene and naphthalene concentrations tended to be higher during the colder months of the year, particularly during the first quarter, although higher benzene concentrations were also measured during the third quarter of 2014.

25.1.2 State-level Results Summary

***Arizona*.**

- The Arizona monitoring sites are located in Phoenix. PXSS is a NATTS site; SPAZ is a UATMP site.

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at PXSS. VOCs were sampled for at SPAZ.

- Fifteen pollutants failed screens for PXSS, 11 of which contributed to 95 percent of failed screens. PXSS failed the highest number of screens among all NMP sites. Six pollutants failed screens for SPAZ, all of which contributed to 95 percent of failed screens.

- Of the pollutants of interest for PXSS, formaldehyde has the highest annual average concentration, followed by acetaldehyde and benzene. These are the only pollutants of interest with annual average concentrations greater than 1 $\mu g/m^3$.

- Benzene has the highest annual average concentration for SPAZ, and is the only pollutant with an annual average concentration greater than 1 $\mu g/m^3$.

- SPAZ and PXSS have the highest annual average concentrations of *p*-dichlorobenzene and ethylbenzene among NMP sites sampling this pollutant. These two sites also have the second and third highest annual average concentrations of 1,3-butadiene.

- Sampling for the site-specific pollutants of interest has occurred at PXSS and SPAZ for at least 5 consecutive years; thus, a trends analysis was conducted for each site for the site-specific pollutants of interest. Benzene and ethylbenzene concentrations measured at both sites have decreased over recent years. The detection rate of 1,2-dichloroethane at both sites has been steadily increasing over the years.

- Formaldehyde has the highest cancer risk approximation for PXSS and is the only pollutant of interest with a cancer risk approximation greater than 10 in-a-million for either site. Benzene has the highest cancer risk approximation for SPAZ. None of the pollutants of interest for either site have a noncancer hazard approximation greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Maricopa County, while toluene is the highest emitted pollutant with a noncancer toxicity factor. Formaldehyde has the highest cancer toxicity-weighted emissions, while acrolein has 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.

- PAHs were sampled for at each of the three sites. In addition, PM_{10} metals were also sampled for at SJJCA.

- Naphthalene failed screens for all three sites. A single concentration of benzo(a)pyrene also failed a screen for CELA. Four other pollutants, in addition to naphthalene and benzo(a)pyrene, failed screens for SJJCA.

- Naphthalene has the highest annual average concentration among the pollutants of interest for CELA, RUCA, and SJJCA.

- Sampling for the site-specific pollutants of interest has occurred at CELA, RUCA, and SJJCA for at least 5 consecutive years; thus, a trends analysis was conducted for each site for the site-specific pollutants of interest. Concentrations of naphthalene exhibit a decreasing trend at CELA in recent years while progressively higher concentrations of nickel have been measured at SJJCA over the last several years.

- Of the pollutants of interest for each site, naphthalene has the highest cancer risk approximation for all three California sites. The noncancer hazard approximations for each pollutant of interest are considerably less than an HQ of 1.0 for all three sites.

- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Los Angeles and Riverside Counties, while benzene is the highest emitted pollutant with a cancer toxicity factor in Santa Clara County. Formaldehyde has the highest cancer toxicity-weighted emissions for all three counties.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Los Angeles, Riverside, and Santa Clara Counties, while acrolein has 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 UATMP sites located northeast of Grand Junction in Garfield County. The sites are located in the towns of Battlement Mesa (BMCO), Silt (BRCO), Parachute (PACO), Carbondale (RFCO), and Rifle (RICO).

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at GPCO. SNMOCs and carbonyl compounds were sampled for at the Garfield County sites.

- Sixteen pollutants failed at least one screen for GPCO, 11 of which contributed to 95 percent of failed screens. Five pollutants failed screens for PACO and RICO, while four pollutants failed screens for BRCO and three pollutants failed screens for BMCO. Benzene, formaldehyde, and acetaldehyde were identified as pollutants of interest for all five Garfield County sites as well as GPCO.

- Of the pollutants of interest for GPCO, formaldehyde has the highest annual average concentration, followed by acetaldehyde and benzene.

- RICO is the only Garfield County site for which annual average concentrations could be calculated for all of the site-specific pollutants of interest. Benzene has the highest annual average concentration for RICO. This is also true for RFCO and PACO, although annual average concentrations could not be calculated for the carbonyl compounds for these sites. Formaldehyde has the highest annual average concentration for BMCO, although annual average concentrations could not be calculated for the SNMOCs for this site. Annual average concentrations could not be calculated for any of the pollutants of interest for BRCO due to a series of invalid samples during sampling.

- PACO has the highest annual average concentration of benzene among NMP sites sampling this pollutant for the second year in a row. RICO has the third highest annual average concentration of benzene. GPCO has the second highest annual average concentration of acetaldehyde and the third highest annual average concentration of ethylbenzene among NMP sites sampling these pollutants.

- Sampling for the site-specific pollutants of interest has occurred at GPCO, BRCO, PACO, and RICO for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Notable trends include: Benzene concentrations at GPCO have an overall decreasing trend across the years of sampling while concentrations of naphthalene have decreased in recent years. Concentrations of acetaldehyde and formaldehyde have a decreasing trend at RICO.

- Formaldehyde has the highest cancer risk approximation for GPCO (by an order of magnitude) and is the fifth highest cancer risk approximation calculated across the program for 2014. Formaldehyde has the highest cancer risk approximation for RICO as well, which is the only other Colorado site for which cancer risk approximations for all of the site-specific pollutants of interest could be calculated. All noncancer hazard approximations are less than an HQ of 1.0 for all of the Colorado sites, where noncancer hazard approximations could be calculated.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in both Mesa and Garfield Counties, while formaldehyde has the highest cancer toxicity-weighted emissions for both counties.

- While toluene is the highest emitted pollutant with a noncancer toxicity factor for both Mesa and Garfield Counties, acrolein has the highest noncancer toxicity-emissions for both counties.

District of Columbia.

- The Washington, D.C. monitoring site (WADC) is a NATTS site.

- PAHs were sampled for at WADC.

- Naphthalene accounted for more than 96 percent of failed screens for this site and was the only pollutant identified as a pollutant of interest. Benzo(a)pyrene and fluorene each failed a single screen.

- Naphthalene was detected in every valid PAH sample collected at WADC. The annual average concentration of naphthalene for WADC is the ninth highest annual average concentration among NMP sites sampling this pollutant.

- Sampling for the site-specific pollutants of interest has occurred at WADC for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of naphthalene have a decreasing trend at WADC.

- The cancer risk approximation for naphthalene is 2.29 in-a-million. The noncancer hazard approximation for naphthalene is considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in the District of Columbia, while toluene is the highest emitted pollutant with a noncancer toxicity factor. Formaldehyde has the highest cancer toxicity-weighted emissions, while acrolein has the highest noncancer toxicity-weighted emissions in the District.

Florida.

- Three of the Florida monitoring sites are located in the Tampa-St. Petersburg-Clearwater CBSA (SYFL, AZFL, and SKFL) and two are located in the Orlando-Kissimmee-Sanford CBSA (ORFL and PAFL). SKFL and SYFL are NATTS sites while the other three are UATMP sites.

- Carbonyl compounds were sampled for at AZFL, ORFL, and SYFL. PAHs were sampled for at SKFL in addition to carbonyl compounds. Metals (PM_{10}) were sampled for at PAFL.

- Acetaldehyde and formaldehyde failed screens for all four Florida sites sampling carbonyl compounds. Naphthalene also failed screens for SKFL. Arsenic was the only speciated metal to fail screens for PAFL.

- Formaldehyde has the highest annual average concentration for AZFL, SYFL, and ORFL; annual average concentrations of acetaldehyde were just slightly less for each site. Annual average concentrations could not be calculated for the carbonyl compounds for SKFL. PAFL's annual average arsenic concentration ranks fourth highest among NMP sites sampling metals (PM_{10}).

- Sampling for the site-specific pollutants of interest has occurred at all of the Florida sites for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. The following notable observations regarding trends include: Acetaldehyde concentrations have a decreasing trend over the last few years at SKFL, while concentrations of acetaldehyde exhibit an increasing trend at ORFL.

- Formaldehyde has the highest cancer risk approximation for AZFL, SYFL, and ORFL, ranging from roughly 25 in-a-million to 30 in-a-million. The cancer risk approximation for arsenic for PAFL is 3.50 in-a-million. Naphthalene's cancer risk approximation for SKFL is 1.85 in-a-million. All noncancer hazard approximations for the pollutants of interest for the Florida sites are less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Pinellas, Hillsborough, and Orange Counties. Benzene has the highest cancer toxicity-weighted emissions for Pinellas County; formaldehyde has the highest cancer toxicity-weighted emissions for Hillsborough County; and hexavalent chromium has the highest cancer toxicity-weighted emissions for Orange County.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in all three Florida counties with NMP sites while acrolein has the highest noncancer toxicity-weighted emissions for all three counties.

***Illinois*.**

- Two 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. A third site, ROIL, is located in Roxana, on the Illinois border near St. Louis.

- VOCs and carbonyl compounds were sampled for at all three Illinois sites. SNMOCs, PAHs, and metals (PM_{10}) were also sampled for at NBIL. NBIL is one of only two NMP sites sampling both VOCs and SNMOCs.

- Eighteen pollutants failed screens for NBIL; 13 pollutants failed screens for SPIL; and 12 pollutants failed screens for ROIL. Among the site-specific pollutants of interest, the three Illinois sites have seven pollutants in common: two carbonyl compounds (acetaldehyde and formaldehyde) and five VOCs (benzene,

1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane, and hexachloro-1,3-butadiene).

- Acetaldehyde has the highest annual average concentration for NBIL, while formaldehyde has the highest annual average concentration for SPIL and ROIL.

- NBIL has the second highest annual average concentration of naphthalene among NMP sites sampling PAHs. ROIL has the second highest annual average concentration of benzene among NMP sites sampling VOCs. SPIL has the fourth highest annual average concentration of acetaldehyde among sites sampling carbonyl compounds.

- Sampling for the site-specific pollutants of interest has occurred at NBIL and SPIL for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Most notably, concentrations of acetaldehyde have been increasing significantly at NBIL in recent years, while concentrations of formaldehyde have been decreasing. In addition, the detection rate of 1,2-dichloroethane at both NBIL and SPIL has been increasing steadily over the last few years of sampling.

- Formaldehyde has the highest cancer risk approximation for all three Illinois sites. All noncancer hazard approximations for the pollutants of interest for the Illinois sites are less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Cook County, while formaldehyde has the highest cancer toxicity-weighted emissions. Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Madison County, while coke oven emissions (PM) have the highest cancer toxicity emissions.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor for both counties, while acrolein has the highest noncancer toxicity-weighted emissions for both counties.

Indiana.

- There are two Indiana monitoring sites sampling under the NMP, one located in Indianapolis (WPIN) and a second located in Gary, near Chicago (INDEM). Both are UATMP sites.

- Carbonyl compounds were sampled for at WPIN and INDEM.

- Formaldehyde and acetaldehyde failed screens for both INDEM and WPIN; all of the measured detections of formaldehyde failed screens for both sites.

- Formaldehyde has the highest annual average concentration for both sites.

- Sampling for the site-specific pollutants of interest has occurred at WPIN and INDEM for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of acetaldehyde and formaldehyde have decreased at WPIN over the last few years.

- The cancer risk approximations for formaldehyde are an order of magnitude greater than the cancer risk approximations for acetaldehyde for both sites. The noncancer hazard approximations for the pollutants of interest for the Indiana sites are considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in both Marion and Lake Counties. Coke oven emissions (PM) have the highest cancer toxicity-weighted emissions for Lake County while formaldehyde has the highest cancer toxicity-weighted emissions for Marion County.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in both Lake and Marion Counties while acrolein has the highest noncancer toxicity-weighted emissions for both counties.

Kentucky.

- Three Kentucky monitoring sites are located in northeast Kentucky, two in Ashland (ASKY and ASKY-M) and one near Grayson Lake (GLKY). The Grayson Lake monitoring site is a NATTS site. One monitoring site is located south of Evansville, Indiana (BAKY). Five monitoring sites are located in or near the Calvert City area (ATKY, BLKY, CCKY, LAKY, and TVKY). The final monitoring site is located in Lexington, in north-central Kentucky (LEKY).

- All of the Kentucky monitoring sites sampled for VOCs except ASKY-M and BAKY. PAHs, carbonyl compounds, and PM_{10} metals were also sampled for at GLKY. Carbonyl compounds were also sampled for at ASKY and LEKY and PM_{10} metals were also sampled for at ASKY-M, BAKY, CCKY, and LEKY. The CCKY site was discontinued in October 2014 and the metals instrumentation moved to the BLKY site.

- The number of pollutants failing screens for the Kentucky sites varies from two (BAKY) to 11 (LEKY and TVKY). Most of the Kentucky sites had nine or more pollutants fail screens.

- Of the pollutants of interest for each site, formaldehyde has the highest annual average concentration for all three sites sampling carbonyl compounds (GLKY, ASKY, and LEKY). Manganese has the highest annual average concentration for ASKY-M, while arsenic has the highest annual average concentration for BAKY (although arsenic was also the only pollutant of interest for this site). Carbon tetrachloride has the highest annual average concentration for CCKY, while 1,2-dichloroethane has the highest annual average concentration for BLKY, LAKY, and TVKY and vinyl chloride has the highest annual average concentration for ATKY.

- ASKY-M has the highest annual average concentrations of arsenic and nickel among NMP sites sampling PM_{10} metals.

- The Calvert City sites account for the five highest annual average concentrations of both carbon tetrachloride and 1,2-dichloroethane, and account for three of the highest annual average concentrations of 1,3-butadiene.

- Sampling for the site-specific pollutants of interest has occurred at GLKY for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Benzene concentrations measured at GLKY have a slight decreasing trend over the years of sampling.

- Formaldehyde has the highest cancer risk approximations among the pollutants of interest for the three Kentucky sites sampling carbonyl compounds while arsenic has the highest cancer risk approximation among the two Kentucky sites sampling only PM_{10} metals. Among the Calvert City sites, 1,2-dichloroethane has the highest cancer risk approximations. The cancer risk approximation for TVKY for 1,2-dichloroethane is the highest cancer risk approximation calculated among the site-specific pollutants of interest across the program. None of the pollutants of interest for which noncancer hazard approximations could be calculated were greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in all Kentucky counties with NMP sites, except Henderson County, where benzene ranks second to formaldehyde. Coke oven emissions have the highest cancer toxicity-weighted emissions for Boyd County; formaldehyde has the highest cancer toxicity-weighted emissions for Carter, Henderson, Livingston, and Fayette Counties; and benzene has the highest cancer toxicity-weighted emissions for Marshall County.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Boyd, Carter, Livingston, and Fayette Counties; carbonyl sulfide is the highest emitted pollutant with a noncancer toxicity factor in Henderson County; and methanol is the highest emitted pollutant with a noncancer toxicity factor in Marshall County. Acrolein has the highest noncancer toxicity-weighted emissions in five of the Kentucky counties, but ranks second to chlorine in Marshall County.

***Massachusetts*.**

- The Massachusetts monitoring site (BOMA) is a NATTS site located in Boston.

- Metals (PM_{10}) and PAHs were sampled for at BOMA.

- Four pollutants failed screens for BOMA. Arsenic and naphthalene each accounted for at least 40 percent of the site's failed screens.

- Of the pollutants of interest, naphthalene has the highest annual average concentration.

- BOMA has the second highest annual average concentration of nickel among NMP sites sampling PM_{10} metals.

- Sampling for the site-specific pollutants of interest has occurred at BOMA for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Naphthalene concentrations have a decreasing trend at BOMA.

- Naphthalene and arsenic are the only pollutants of interest to have cancer risk approximations greater than 1.0 in-a-million for BOMA. None of the pollutants of interest for BOMA have noncancer hazard approximations greater than an HQ of 1.0.

- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Suffolk County and has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in Suffolk County, while acrolein has the highest noncancer toxicity-weighted emissions.

***Michigan*.**

- The Michigan monitoring site (DEMI) is a NATTS site located in Dearborn, southwest of Detroit.

- VOCs, carbonyl compounds, and PAHs were sampled for at DEMI.

- Thirteen pollutants failed screens for DEMI, of which nine were identified as pollutants of interest.

- Formaldehyde and acetaldehyde have the highest annual average concentrations for DEMI. DEMI has the highest annual average concentration of naphthalene among NMP sites sampling PAHs.

- Sampling for the site-specific pollutants of interest has occurred at DEMI for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Benzene concentrations exhibit a steady decreasing trend although concentrations have leveled out in recent years. Concentrations of acetaldehyde have a slow, steady increasing trend over the last several years of sampling. In addition, the detection rate of 1,2-dichloroethane at DEMI has been increasing steadily over the last few years of sampling.

- Formaldehyde has the highest cancer risk approximation for DEMI. None of the pollutants of interest for DEMI have noncancer hazard approximations greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Wayne County, while coke oven emissions (PM) have the highest cancer toxicity-weighted emissions. Hydrochloric acid is the highest emitted pollutant with a noncancer toxicity factor in Wayne County, while acrolein has the highest noncancer toxicity-weighted emissions.

Missouri.

- The NATTS site in Missouri (S4MO) is located in St. Louis.

- VOCs, carbonyl compounds, PAHs, metals (PM_{10}), and hexavalent chromium were sampled for at S4MO, although hexavalent chromium sampling was discontinued after July 4, 2014.
- Twenty-three pollutants failed at least one screen for S4MO, 14 of which contributed to 95 percent of failed screens. S4MO has the second highest number of pollutants failing screens.

- Of the pollutants of interest for S4MO, formaldehyde and acetaldehyde have the highest annual average concentrations and are the only pollutants with annual average concentrations greater than 1 $\mu g/m^3$.

- S4MO has the second highest annual average concentration of arsenic (PM_{10}) and the third highest annual average concentration of *p*-dichlorobenzene among NMP sites sampling these pollutants.

- Sampling for the site-specific pollutants of interest has occurred at S4MO for at least 5 consecutive years; thus, a trends analysis was conducted for each of the site-specific pollutants of interest. Concentrations of benzene have an overall decreasing trend at S4MO, and concentrations of ethylbenzene and cadmium have decreased as well.

- Formaldehyde has the highest cancer risk approximation for S4MO. None of the pollutants of interest for S4MO have a noncancer hazard approximation greater than an HQ of 1.0.

- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in St. Louis (city) and has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor, while acrolein has the highest noncancer toxicity-weighted emissions in St. Louis (city).

New Jersey.

- Three of the UATMP sites in New Jersey are located in the New York-Newark-Jersey City CBSA and are located in the towns of Chester (CHNJ), Elizabeth (ELNJ), and North Brunswick (NBNJ). A fourth UATMP site (CSNJ) is located in the Philadelphia-Camden-Wilmington CBSA.

- VOCs and carbonyl compounds were sampled for at all four New Jersey sites.

- Fourteen pollutants failed at least one screen for CSNJ; nine pollutants failed at least one screen for CHNJ; and 12 pollutants failed at least one screen for both ELNJ and NBNJ. The New Jersey sites have six pollutants of interest in common: acetaldehyde, formaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and 1,2-dichloroethane.

- Of the site-specific pollutants of interest, formaldehyde and acetaldehyde have the highest annual average concentrations for CSNJ, CHNJ, and ELNJ. Carbon tetrachloride had the highest annual average concentration for NBNJ, although annual average concentrations for the carbonyl compounds could not be calculated. A defective sampler resulted in the invalidation of samples collected between May 5, 2014 and December 31, 2014.

- CSNJ and ELNJ rank second and third, respectively, for their annual average concentrations of formaldehyde; ELNJ also has the third highest annual average concentration of acetaldehyde among NMP sites sampling carbonyl compounds.

- Sampling for the site-specific pollutants of interest has occurred at three of the four New Jersey sites for at least 5 consecutive years; specifically, ELNJ is the longest running NMP site still participating in the NMP. As such, a trends analysis was conducted for the site-specific pollutants of interest for ELNJ, CHNJ, and NBNJ. Benzene and ethylbenzene concentrations have decreased significantly at ELNJ since sampling began. At CHNJ, concentrations of 1,3-butadiene have been increasing in recent years. In addition, the detection rates of 1,2-dichloroethane and hexachloro-1,3-butadience have been increasing steadily over the last few years of sampling at CHNJ, ELNJ, and NBNJ.

- Formaldehyde has the highest cancer risk approximation for CSNJ, CHNJ, and ELNJ. Benzene has the highest cancer risk approximation for NBNJ (where cancer risk approximations could not be calculated for the carbonyl compounds). None of the pollutants of interest for the New Jersey sites have noncancer hazard approximations greater than an HQ of 1.0.

- Benzene and formaldehyde are the highest emitted pollutants with cancer toxicity factors in Camden, Union, Middlesex, and Morris Counties. These two pollutants also have the highest toxicity-weighted emissions for each county, although the order varied.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Camden, Union, Middlesex, and Morris Counties. Acrolein has the highest noncancer toxicity-weighted emissions for each New Jersey county.

New York.

- The New York monitoring sites are located in New York City (BXNY) and Rochester (ROCH). Both are NATTS sites.

- PAHs were sampled for at both BXNY and ROCH.

- Six pollutants failed screens for BXNY and four pollutants failed screens for ROCH. Naphthalene failed the majority of screens for both sites.

- Naphthalene has the highest annual average concentration for BXNY and ROCH, although the annual average concentration for BXNY is nearly twice the annual average calculated for ROCH.

- BXNY has the third highest annual average concentration of naphthalene among NMP sites sampling PAHs and is one of only four sites with an annual average concentration greater than 100 ng/m^3.

- Sampling for the site-specific pollutants of interest has occurred at ROCH for greater than 5 consecutive years; thus, a trends analysis was conducted for each of the site-specific pollutants of interest. The maximum concentrations for each of ROCH's three pollutants of interest were measured in 2014.

- Naphthalene has the highest cancer risk approximation among the pollutants of interest for both ROCH and BXNY. Naphthalene is the only pollutant of interest for either site with a noncancer toxicity factor. The noncancer hazard approximations for naphthalene for these two sites are considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor for Bronx and Monroe Counties while formaldehyde has the highest cancer toxicity-weighted emissions for both counties.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor for both Bronx and Monroe Counties while acrolein has the highest noncancer toxicity-weighted emissions for both counties.

Oklahoma.

- There are five UATMP sites in Oklahoma: three are located in Tulsa (TOOK, TMOK, and TROK) and two are located in or near Oklahoma City (OCOK and YUOK).

- VOCs, carbonyls compounds, and metals (TSP) were sampled for at each of the Oklahoma sites. The Oklahoma sites are the only NMP sites sampling TSP metals.

- Sixteen pollutants failed screens for TOOK; 15 failed screens for TMOK; 14 failed screens for TROK and OCOK; and 13 failed screens for YUOK.

- Formaldehyde and acetaldehyde have the highest annual average concentrations for each of the five Oklahoma sites.

- The three Tulsa sites have the fourth through sixth highest annual average concentrations of *p*-dichlorobenzene among NMP sites sampling this pollutant. TOOK and TROK also have the fourth and fifth highest annual average concentrations of ethylbenzene, respectively, with the annual average concentration for TMOK ranking eighth. These sites also have some of the highest annual average concentrations of hexachloro-1,3-butadiene among NMP sites sampling VOCs.

- Sampling for the site-specific pollutants of interest has occurred at TOOK, TMOK, and OCOK for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Acetaldehyde, ethylbenzene, benzene, and manganese concentrations have decreased at TOOK in recent years. Acetaldehyde, benzene and ethylbenzene concentrations at TMOK have also decreased in recent years. Acetaldehyde and formaldehyde concentrations at OCOK have also decreased. Detection rates of 1,2-dichloroethane have increased at TOOK, TMOK, and OCOK in recent years.

- Formaldehyde has the highest cancer risk approximations for each of the Oklahoma monitoring sites. None of the pollutants of interest for the Oklahoma sites have a noncancer hazard approximation greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Oklahoma and Tulsa Counties and has the highest cancer toxicity-weighted emissions for both counties. Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Canadian County and has the highest cancer toxicity-weighted emissions for that county.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Oklahoma and Tulsa Counties, while xylenes are the highest emitted pollutant with a noncancer toxicity factor in Canadian County. Acrolein has the highest noncancer toxicity-weighted emissions for all three counties.

***Rhode Island*.**

- The Rhode Island monitoring site (PRRI) is located in Providence and is a NATTS site.

- PAHs were sampled for at PRRI.

- Two pollutants failed screens for PRRI, although all but one of PRRI's failed screens were attributable to naphthalene. As a result, naphthalene is PRRI's only pollutant of interest.

- Naphthalene concentrations measured at PRRI span an order of magnitude, ranging from 14.7 ng/m^3 to 163 ng/m^3.

- Sampling for the site-specific pollutants of interest has occurred at PRRI for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of naphthalene have a decreasing trend at PRRI in recent years.

- The cancer risk approximation for naphthalene for PRRI is 1.77 in-a-million. The noncancer hazard approximation for this pollutant is considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Providence County, while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor, while acrolein has the highest noncancer toxicity-weighted emissions for Providence County.

Utah.

- The NATTS site in Utah (BTUT) is located in Bountiful, north of Salt Lake City.

- VOCs, carbonyl compounds, SNMOCs, PAHs, and metals (PM_{10}) were sampled for at BTUT. This site is one of only two NMP sites sampling both VOCs and SNMOCs.

- Nineteen pollutants failed screens for BTUT, 12 of which contributed to 95 percent of this site's failed screens.

- Of the site-specific pollutants of interest, dichloromethane has the highest annual average concentration for BTUT, which is consistent with previous years of sampling. BTUT has the highest annual average concentrations of hexachloro-1,3-butadiene, formaldehyde, and acetaldehyde among NMP sites sampling these pollutants.

- Sampling for the site-specific pollutants of interest has occurred at BTUT for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. The most notable trend is for benzene. Concentrations of benzene have a decreasing trend at BTUT. Concentrations of 1,3-butadiene also have also decreased in recent years. Concentrations of acetaldehyde and formaldehyde exhibit decreases for 2014 following a significant increase in concentrations for 2013.

- The pollutant with the highest cancer risk approximation for BTUT is formaldehyde; this is the second highest cancer risk approximation calculated across the program. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Davis County and has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor, while acrolein has the highest noncancer toxicity-weighted emissions for Davis County.

Vermont.

- The NATTS site in Vermont (UNVT) is located in Underhill, near the city of Burlington.

- PAHs and metals (PM_{10}) were sampled for at UNVT. However, the Vermont Department of Environmental Conservation invalidated all of its nickel and total chromium concentrations for the second half of 2014. This is due to a contamination issue related to a new weighing and equilibration chamber at their laboratory

- Arsenic (PM_{10}) was the only pollutant to fail screens for UNVT.

- Arsenic concentrations measured at UNVT were less than 1.0 ng/m^3, ranging from 0.003 ng/m^3 to 0.83 ng/m^3.

- UNVT has the lowest annual average concentration of arsenic (PM_{10}) among NMP sites sampling the pollutant.

- Sampling for site-specific pollutants of interest has occurred at UNVT for at least 5 consecutive years; thus, a trends analysis was conducted, where applicable. Changes in annual average concentrations of arsenic for UNVT are not statistically significant.

- The cancer risk approximation for arsenic (PM_{10}) for UNVT is 0.92 in-a-million. The noncancer hazard approximation for this pollutant is considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Chittenden County, while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in Chittenden County, while acrolein has the highest noncancer toxicity-weighted emissions.

Virginia.

- The NATTS site in Virginia is located near Richmond (RIVA).

- PAHs and hexavalent chromium were sampled for at RIVA. RIVA is the only site at which hexavalent chromium was sampled for year-round.

- Three pollutants failed screens for RIVA, with concentrations of naphthalene accounting for 96 percent of failed screens, and thus, is the only pollutant of interest for this site.

- Naphthalene concentrations measured at RIVA range from 21.3 ng/m^3 to 178 ng/m^3.

- Sampling for PAHs has occurred at RIVA for at least 5 consecutive years; thus, a trends analysis was conducted for naphthalene. Concentrations of naphthalene exhibit a decreasing trend at RIVA.

- The cancer risk approximation for naphthalene at RIVA is 2.13 in-a-million, while the noncancer hazard approximation is significantly less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Henrico County, while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in Henrico County, while acrolein has the highest noncancer toxicity-weighted emissions.

Washington.

- The NATTS site in Washington is located in Seattle (SEWA).

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at SEWA.

- Thirteen pollutants failed screens for SEWA, of which nine were identified as pollutants of interest for this site.

- None of the site-specific pollutants of interest for SEWA have annual average concentrations greater than 1 $\mu g/m^3$. Acetaldehyde and carbon tetrachloride have the highest annual average concentrations for this site. The annual average concentration of formaldehyde for SEWA is the lowest among NMP sites sampling this pollutant.

- SEWA has the third highest annual average concentration of nickel among NMP sites sampling metals (PM_{10}). This site had the second highest annual average nickel concentration for 2012 and 2013.

- Sampling for the site-specific pollutants of interest has occurred at SEWA for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of benzene have a decreasing trend at SEWA. Concentrations of naphthalene exhibit a significant decrease for 2014. In addition, the detection rate of 1,2-dichloroethane at SEWA has been increasing steadily over the last few years of sampling.

- Formaldehyde has the highest cancer risk approximation for SEWA, although it is the lowest cancer risk approximation for formaldehyde among NMP sites. All of the noncancer hazard approximations for the pollutants of interest for SEWA are less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in King County while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in King County, while acrolein has the highest noncancer toxicity-weighted emissions.

25.1.3 Composite Site-level Results Summary

- Twenty-two pollutants were identified as site-specific pollutants of interest, based on the risk-based screening process. Acetaldehyde, formaldehyde, and benzene were the most common pollutants of interest among the monitoring sites. Benzene was identified as a pollutant of interest for all 32 sites that sampled this pollutant (with Method TO-15 or SNMOC). Acetaldehyde and formaldehyde were identified as pollutants of interest for all 32 sites that sampled carbonyl compounds. Naphthalene was identified as a pollutant of interest for 17 of the 19 sites that sampled PAHs (with GLKY and UNVT as the exceptions). Arsenic was identified as a pollutant of interest for 20 of the 21 sites that sampled metals (with BLKY, at which metals sampling did not begin until late October, as the exception).

- Several pollutants were identified as site-specific pollutants of interest for only one or two sites. For instance, dichloromethane is a pollutant of interest for only BTUT; trichloroethylene is a pollutant of interest for only SPIL; and 1,1,2-trichloroethane is a pollutant of interest for only TVKY.

- Table 25-1 summarizes which pollutants of interest were identified for each site, how many pollutants of interest were identified for each site, and how many sites for which each pollutant was identified as a pollutant of interest.

- EPA dropped the requirement to sample hexavalent chromium under the NATTS program beginning in July 2013; as such, all but two of the participating NATTS sites (S4MO and RIVA) stopped sampling this pollutant prior to 2014. Concentrations of hexavalent chromium measured at S4MO and RIVA failed few screens in 2014 and hexavalent chromium was not identified as a pollutant of interest for either site.

- Formaldehyde frequently had the highest site-specific annual average concentration among the site-specific pollutants of interest; formaldehyde had the highest annual average concentration for 23 sites. Naphthalene had the next highest at 10 followed by benzene with four.

- Five sites have cancer risk approximations greater than 50 in-a-million, four for formaldehyde (BTUT, GPCO, CSNJ, ELNJ) and one for 1,2-dichloroethane (TVKY). Formaldehyde tended to have the highest cancer risk approximation on a site-specific basis. This is true for 27 NMP sites. The highest cancer risk approximation for formaldehyde was calculated for BTUT (76.95 in-a-million). Yet, this is the second highest the annual average-based cancer risk approximation. The cancer risk approximation for 1,2-dichloroethane based on TVKY's annual average concentration is 91.92 in-a-million. Benzene and 1,3-butadiene are the only other pollutants for which a cancer risk approximation greater than 10 in-a-million was calculated (one each).

Table 25-1. Summary of Site-Specific Pollutants of Interest

State	Site	# of Pollutants of Interest	Acenaphthene	Acetaldehyde	Arsenic	Benzene	Benzo(a)pyrene	1,3-Butadiene	Cadmium	Carbon Tetrachloride	*p*-Dichlorobenzene	1,2-Dichloroethane	Dichloromethane	Ethylbenzene	Fluoranthene	Fluorene	Formaldehyde	Hexachloro-1,3-butadiene	Manganese	Naphthalene	Nickel	1,1,2-Trichloroethane	Trichloroethylene	Vinyl chloride
AZ	***PXSS***	11		X	X	X		X		X	X	X		X			X	X		X				
AZ	SPAZ	6				X		X		X	X	X		X										
CA	***CELA***	1																		X				
CA	***RUCA***	1																		X				
CA	***SJJCA***	4			X		X													X	X			
CO	BMCO	3		X		X											X							
CO	BRCO	3		X		X											X							
CO	***GPCO***	11	X	X	X	X		X		X		X		X			X	X		X				
CO	PACO	4		X		X		X									X							
CO	RFCO	4		X		X		X									X							
CO	RICO	5		X		X		X						X			X							
DC	***WADC***	1																		X				
FL	AZFL	2		X													X							
FL	ORFL	2		X													X							
FL	PAFL	1			X																			
FL	***SKFL***	3		X													X			X				
FL	***SYFL***	2		X													X							
IL	***NBIL***	12	X	X	X	X		X		X		X			X	X	X	X		X				
IL	ROIL	8		X		X		X		X		X		X			X	X						
IL	SPIL	8		X		X		X		X		X					X	X					X	
IN	INDEM	2		X													X							
IN	WPIN	2		X													X							

BOLD ITALICS = EPA-designated NATTS Site

Table 25-1. Summary of Site-Specific Pollutants of Interest (Continued)

State	Site	# of Pollutants of Interest	Acenaphthene	Acetaldehyde	Arsenic	Benzene	Benzo(a)pyrene	1,3-Butadiene	Cadmium	Carbon Tetrachloride	*p*-Dichlorobenzene	1,2-Dichloroethane	Dichloromethane	Ethylbenzene	Fluoranthene	Fluorene	Formaldehyde	Hexachloro-1,3-butadiene	Manganese	Naphthalene	Nickel	1,1,2-Trichloroethane	Trichloroethylene	Vinyl chloride
KY	ASKY	6		X		X		X		X		X					X							
KY	ASKY-M	4			X				X										X		X			
KY	ATKY	6				X		X		X		X						X						X
KY	BAKY	1			X																			
KY	BLKY	6				X		X		X		X						X						X
KY	CCKY	7			X	X		X		X		X						X						X
KY	***GLKY***	7		X	X	X		X		X		X					X							
KY	LAKY	6				X		X		X		X						X						X
KY	LEKY	7		X	X	X		X		X		X					X							
KY	TVKY	6				X		X		X		X						X				X		X
MA	***BOMA***	3			X															X	X			
MI	***DEMI***	9		X		X		X		X		X		X		X	X			X				
MO	***S4MO***	14	X	X	X	X		X	X	X	X	X		X		X	X	X		X				
NJ	CHNJ	6		X		X		X		X		X					X							
NJ	CSNJ	8		X		X		X		X		X		X			X	X						
NJ	ELNJ	8		X		X		X		X		X		X			X	X						
NJ	NBNJ	8		X		X		X		X		X		X			X	X						
NY	***BXNY***	5	X				X								X	X				X				
NY	***ROCH***	3	X													X				X				
OK	OCOK	7		X	X	X		X		X		X					X							
OK	TMOK	10		X	X	X		X		X	X	X		X			X	X						
OK	TOOK	12		X	X	X		X		X	X	X		X			X	X	X		X			
OK	TROK	10		X	X	X		X		X	X	X		X			X	X						

BOLD ITALICS = EPA-designated NATTS Site

Table 25-1. Summary of Site-Specific Pollutants of Interest (Continued)

State	Site	# of Pollutants of Interest	Acenaphthene	Acetaldehyde	Arsenic	Benzene	Benzo(a)pyrene	1,3-Butadiene	Cadmium	Carbon Tetrachloride	*p*-Dichlorobenzene	1,2-Dichloroethane	Dichloromethane	Ethylbenzene	Fluoranthene	Fluorene	Formaldehyde	Hexachloro-1,3-butadiene	Manganese	Naphthalene	Nickel	1,1,2-Trichloroethane	Trichloroethylene	Vinyl chloride
OK	YUOK	8		X	X	X		X		X		X					X	X						
RI	***PRRI***	1																		X				
UT	***BTUT***	12		X	X	X		X		X		X	X	X			X	X		X	X			
VA	***RIVA***	1																		X				
VT	***UNVT***	1			X																			
WA	***SEWA***	9		X	X	X		X		X		X					X			X	X			
Total		287	5	32	20	32	2	30	2	27	6	27	1	14	2	5	32	19	2	17	6	1	1	5

BOLD ITALICS = EPA-designated NATTS Sites

- Carbon tetrachloride often had relatively high cancer risk approximations (based on annual average concentrations) compared to other pollutants of interest among the monitoring sites, ranging between 3 in-a-million and 6 in-a-million, but tended to have relatively low emissions and toxicity-weighted emissions, according to the NEI. This pollutant appears only once in the emissions-based tables for counties with NMP sites (Marshall County, Kentucky, where the four of the five Calvert City sites are located).

- None of the noncancer hazard approximations based on annual average concentrations of the site-specific pollutants of interest were greater than an HQ of 1.0. The noncancer hazard approximation calculated for BTUT's annual average concentration of formaldehyde (with an HQ of 0.60) is the highest of all annual average-based noncancer hazard approximations. Formaldehyde tended to have the highest noncancer hazard approximations on a site-specific basis, followed by naphthalene, 1,3-butadiene, and arsenic.

- Of those pollutants with cancer UREs, formaldehyde, benzene, acetaldehyde, and ethylbenzene often had the highest county-level emissions for participating counties. Benzene, formaldehyde, and 1,3-butadiene typically had the highest toxicity-weighted emissions (of those with a cancer URE).

- Of those pollutants with a noncancer RfC, toluene, xylenes, hexane, and benzene were often the highest emitted pollutants, although they rarely had the highest toxicity-weighted emissions. Acrolein tended to have the highest toxicity-weighted emissions of pollutants with noncancer RfCs, although acrolein emissions were generally low when compared to other pollutants. Acrolein appears only twice among the 10 highest emitted pollutants for counties with NMP sites (Garfield County, Colorado and Canadian County, Oklahoma). 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. Besides acrolein, formaldehyde and 1,3-butadiene tended to have the highest toxicity-weighted emissions among the pollutants with noncancer RfCs.

- Although production of carbon tetrachloride has declined sharply over the last 30 years due to its role as an ozone depleting substance, it has a relatively long atmospheric lifetime and thus, is present at similar levels at nearly any given location. NMP sites are located in a variety of locations across the country with different purposes behind the monitoring at each site. In most cases, the concentrations of carbon tetrachloride measured across the program confirm the ubiquitous nature of this pollutant. However, carbon tetrachloride concentrations measured at the Calvert City, Kentucky sites were often higher than levels of this pollutant collected elsewhere. Vinyl chloride is an industrial-marker and is rarely measured at detectable levels (this pollutant has a 16 percent detection rate across the program). The five Calvert City, Kentucky sites together account for more than 72 percent of the measured detections of vinyl chloride for 2014 (which is a similar percentage as 2013). Individually, these sites have the highest number of measured detections of vinyl chloride among NMP sites sampling VOCs. The Calvert City sites also account

for the 124 highest concentrations of 1,2-dichloroethane measured across the program. These ambient air measurements agree with corresponding emissions data in the NEI. These three pollutants appear among the highest emitted pollutants in Marshall County, Kentucky (among those with a cancer URE) but are not among the highest emitted pollutants for any other county with an NMP site. From a quantitative standpoint, the emissions of carbon tetrachloride, 1,2-dichloroethane, and vinyl chloride in Marshall County are higher than their emissions in any other county with an NMP site.

- For every NMP site for which 1,2-dichloroethane is a pollutant of interest and where a trends analysis could be conducted for this pollutant (16 sites), a dramatic increase in the number of measured detections is shown over the most recent years of sampling, particularly for 2012, which was mostly sustained for 2013 and 2014. This pollutant was detected in less than 10 percent of samples at most sites participating in the NMP prior to 2010 (and still participating now); the rate increased significantly since 2010, slowly at first then significantly in 2012. The detection rate of this pollutant is between 75 percent and 100 percent for most NMP sites for 2014.

25.1.4 Data Quality Results Summary

Completeness, precision, and accuracy were assessed for the 2014 monitoring effort. The quality assessments presented in this report show that the 2014 monitoring data are of a known and high quality, based on the attainment of the established MQOs.

To the largest extent, ambient air concentration datasets met the MQO for completeness. Only seven out of 108 site- and method-specific datasets failed to comply with the MQO of 85 percent completeness while 30 datasets achieved 100 percent completeness.

Method (i.e., sampling and analytical) precision and analytical precision were determined for the 2014 NMP monitoring efforts using CV calculations based on duplicate, collocated, and replicate samples. Method precision for most analytical methods utilized during the 2014 NMP was within the MQO of 15 percent CV (with the exceptions of TO-13A (PAHs) and hexavalent chromium). Analytical precision for each method was determined to be less than 15 percent CV. The precision calculations presented in this report are based on analytical results greater than or equal to the sample- and pollutant-specific MDL.

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. Most of the pollutants for which audit samples were analyzed met

the MQO for accuracy. Of the 37 pollutants analyzed for via audit samples, only four exceeded the MQO of ± 25 percent recovery (and none failed multiple audits).

25.2 Conclusions

Conclusions extrapolated from the data analyses of the data generated from the 2014 NMP monitoring efforts are presented below.

- A large number of concentrations are greater than their respective risk screening values, particularly for many of the NATTS MQO Core Analytes. For several of the pollutants, all or nearly all of the measurements fail screens. Examples of frequently detected pollutants that typically fail all or nearly all of their screens include benzene, carbon tetrachloride, formaldehyde, acetaldehyde, 1,2-dichloroethane, and 1,3-butadiene. Some of the lesser detected pollutants still fail relatively large numbers of screens. For example, even though hexachloro-1,3-butadiene was detected relatively infrequently, most of the measured detections failed screens. The MDL for this pollutant is relatively high (0.29 $\mu g/m^3$) while the toxicity factor is relatively low (0.045 $\mu g/m^3$). Thus, all or nearly all of the measured detections fail screens.
- Although the number of concentrations failing screens varies from year to year, the percentage of failed screens compared to the number of measured detections has hovered around 36 percent for the last four years. Risk screening values are often updated from year-to-year, although the only changes for the 2014 report have to do with how the PAHs are grouped into POM Groups and not the screening values themselves.

- For those pollutants for which annual average concentrations could be calculated and that have available cancer UREs, none of the cancer risk approximations were greater than 100 in-a-million. In total, 31 site- and pollutant-specific cancer risk approximations were greater than 10 in-a-million (24 for formaldehyde, five for 1,2-dichloroethane, and one each for benzene and 1,3-butadiene); and nearly 80 percent were greater than 1.0 in-a-million.

- For those pollutants for which annual average concentrations could be calculated and have available noncancer RfCs, none of the noncancer hazard approximations were greater than an HQ of 1.0.

- When comparing the highest emitted pollutants for a specific county to the pollutants with the highest toxicity-weighted emissions, the pollutants tended to be 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 (and did not rank less than third for any county with an NMP site), but was not one of the pollutants with highest toxicity-weighted emissions for any of these counties. Conversely, while acrolein had the highest noncancer toxicity-weighted emissions for all but one county with an NMP site (where it ranked second

rather than first), it was among the highest emitted pollutants for only two counties with NMP sites (and ranked no higher than eighth).

- The number of states and sites participating in the NMP changes from year-to-year. The number of sites participating in the 2014 NMP decreased considerably, from 66 for 2013 to 51 for 2014. This is predominantly due to the removal of hexavalent chromium from the NATTS list of required pollutants for which to sample.

- Many of the data analyses utilized in this report require data from year-round (or nearly year-round) sampling. Of the 108 site-method combinations, only three site-method combinations did not cover the entire year: Sampling at the CCKY site was discontinued in October 2014 and the metals instrumentation was moved to BLKY, where sampling resumed. Hexavalent chromium sampling was discontinued at S4MO in July 2014. Thus, the percentage of time-period averages and subsequent risk-based analyses that could not be calculated decreased for 2014 compared to 2013. Fewer data gaps allow for more complete results and inter-site comparisons.

- Of the 51 monitoring sites participating in the 2014 NMP, none sampled for all six available pollutant groups under the NMP through the national contract laboratory. Three sites (S4MO, BTUT, and NBIL) sampled for five pollutant groups and another four sites (GLKY, PXSS, GPCO, and SEWA) sampled four pollutant groups. The wide range of pollutant groups sampled for among the sites, which is often the result of different purposes behind the monitoring at the sites, makes it difficult to draw definitive conclusions regarding air toxics in ambient air in a global manner.

- The data analyses contained in the 2014 NMP report reflect the inclusion of data from a number of source-oriented monitoring sites. Newer source-oriented sites include several of the Kentucky sites and the Camden, New Jersey site. Many of these sites are the drivers for certain pollutant(s) in the 2014 report. This can easily be seen in the graphical comparisons of the site-specific averages to the program-level average concentrations contained in Sections 5 through 23. For many of these pollutants, particularly the VOCs, the highest concentrations were considerably greater than the majority of measurements, such that the scale in the figures needed to be greatly reduced.

- This report strives to represent data derived from the best laboratory practices and utilize the best data analysis techniques available. Examples of this for 2014 include the improvement of MDLs and the incorporation of updated values for various toxicity factors. This can lead 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. Relatively few major changes were instituted between the 2013 and 2014 NMP reports. The major difference between the 2014 report and other reports in recent years is the use of meteorological measurements collected at the sites themselves (as opposed to NWS data).

25.3 Recommendations

Based on the conclusions from the 2014 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 long-term participation in the NMP.

- *Participate in the National Monitoring Programs year-round.* Many of the analyses presented in the 2014 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 for 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.* In 2012, two analytical methods were accepted by governing bodies as approved methods with which to analyze specific pollutants. ERG's hexavalent chromium method was approved as an ASTM method and ERG's inorganic method for both TSP and PM_{10} was accepted as a FEM for lead (NAAQS). These approvals were obtained after various method enhancements that improve the detection and recovery of these pollutants. 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). An update to the Compendium methods is underway at EPA and is an example of potential method optimization.

- *Revise the pollutants targeted for sampling based on lessons learned in the field, in the laboratory, and/or from the annual report.* In conjunction with method improvements, the analytes targeted for monitoring should/needs to be reviewed and revised periodically based on experience with the collection and analysis methods and

based on the findings in the annual report. Pollutants initially targeted for ambient monitoring may no longer be considered problematic based on monitoring results and could be discontinued. The removal of hexavalent chromium from the target analyte list for the NATTS program is an example of this. Other pollutants may prove problematic from a sampling and/or analytical stand point and can be removed from the target analyte list due to uncertainties associated with its analytical results. In addition, studies may indicate that one analytical method is better than another at providing accurate results for a given pollutant. All of these factors should be considered when determining the pollutants for which to monitor.

- *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, consistent with the guidelines presented in the NATTS TAD, is integral to the identification of trends and measuring the effectiveness of regulation. Revisions to the NATTS TAD were approved by EPA in 2016 and implementation is required by participating agencies by October 31, 2017. It is expected that the revised document will enhance method consistency.

- *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, dichloromethane concentrations have been highest at BTUT and GPCO for multiple years and trichloroethylene concentrations have been highest at SPIL for multiple years. Further examination of the data in conjunction with meteorological phenomena and potential emissions events or incidents, or further site characterization may help state and local agencies pinpoint issues affecting air quality in their area.

- *Consider more rigorous study of the effect 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 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.* Concentrations of many pollutants sampled during the 2014 program year were greater than risk screening values 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).

26.0 References

ACE, 2016. U.S. Army Corps of Engineers. Huntington District, Grayson Lake website. http://www.lrh.usace.army.mil/Missions/CivilWorks/Recreation/Kentucky/GraysonLake.aspx Date Last Accessed: 7/18/2016.

ASTM, 2012. ASTM, International. ASTM D7614-12 Standard Test Method for Determination of Total Suspended Particulate (TSP) Hexavalent Chromium in Ambient Air Analyzed by Ion Chromatography (IC) and Spectrophotometric Measurements. http://www.astm.org/Standards/D7614.htm Date Last Accessed: 1/29/2016.

ASTM, 2013. ASTM, International. ASTM D6209-13 Standard Test Method for Determination of Gaseous and Particulate Polycyclic Aromatic Hydrocarbons in Ambient Air (Collection on Sorbent-Backed Filters with Gas Chromatographic/Mass Spectrometric Analysis). http://www.astm.org/Standards/D6209.htm Date Last Accessed: 1/29/2016.

AZ DOT, 2016. Arizona Department of Transportation. Transportation Data Management System website. 2010 and 2011 AADTs. http://adot.ms2soft.com/tcds/tsearch.asp?loc=Adot&mod= Date Last Accessed: 1/7/2016.

CA DOT, 2014. State of California Department of Transportation, Division of Traffic Operations. 2014 Traffic Volumes on the California State Highway System. Sacramento, CA. http://traffic-counts.dot.ca.gov/ Date Last Accessed: 1/7/2016.

Calvert City, 2016. Calvert City - Industry website. http://www.calvertcity.com/industry.htm Date Last Accessed: 7/18/2016.

Carbondale, 2016. Carbondale, Colorado. The Town website. http://www.carbondale.com/town Date Last Accessed: 6/10/2016.

CCRPC, 2016. Chittenden County Regional Planning Commission. Chittenden County Traffic Counts website. 2011 Data. http://www.ccmpo.us/data/index.php?count=ATR Date Last Accessed: 1/11/2016.

Census Bureau, 2013a. U.S. Census Bureau. February 2013. List 1. Core Based Statistical Areas (CBSAs) and Combined Statistical Areas (CSAs). http://www.census.gov/population/metro/data/def.html Date Last Accessed: 1/11/2016.

Census Bureau, 2013b. U.S. Census Bureau. Metropolitan and Micropolitan Statistical Areas website. http://www.census.gov/population/metro/ Date Last Accessed: 1/11/2016.

CO DOT, 2014. Colorado Department of Transportation. Online Transportation Information System (OTIS), Traffic Data Explorer. 2014 data. http://dtdapps.coloradodot.info/otis/ Date Last Accessed: 1/7/2016.

DC DOT, 2014. District Department of Transportation. October 2014. 2013 Traffic Volumes Map. Washington, D.C. http://ddot.dc.gov/page/traffic-volume-maps Date Last Accessed: 1/8/2016.

DC WSA, 2016. District of Columbia Water and Sewer Authority. Tunnel Overview website. https://www.dcwater.com/workzones/projects/first_street_tunnel/summary.cfm Date Last Accessed: 10/27/2016.

EPA, 1986. U.S. EPA. 1986. 40 CFR Part 136, Appendix B. Definition and Procedure for the Determination of the Method Detection Limit, Revision 1.11. http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr136_main_02.tpl Date Last Accessed: 1/11/2016.

EPA, 1998. U.S. EPA. September 1998. Technical Assistance Document for Sampling and Analysis of Ozone Precursors. EPA/600-R-98/161. Research Triangle Park, NC. http://www.epa.gov/ttnamti1/pamsguidance.html Date Last Accessed: 1/26/2016.

EPA, 1999a. U.S. EPA. January 1999. Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). EPA/625/R-96/010b. Cincinnati, OH. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 1/26/2016.

EPA, 1999b. U.S. EPA. January 1999. Compendium Method TO-11A: Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC). EPA/625/R-96/010b. Cincinnati, OH. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 1/26/2016.

EPA, 1999c. U.S. EPA. January 1999. Compendium Method TO-13A: Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/Mass Spectrometry (GC/MS). EPA/625/R-96/010b. Cincinnati, OH. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 1/26/2016.

EPA, 1999d. U.S. EPA. June 1999. Compendium Method IO-3.5: Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). EPA/625/R-96/010a. Cincinnati, OH. http://www.epa.gov/ttn/amtic/files/ambient/inorganic/mthd-3-5.pdf Date Last Accessed: 1/26/2016.

EPA, 2007. U.S. EPA. May 2007. 1990-2002 NEI HAP Trends: Success of CAA Air Toxic Programs in Reducing HAP Emissions and Risk. Paper presented by Anne Pope at the 16th Annual International Emission Inventory Conference. Raleigh, NC. http://www.epa.gov/ttn/chief/conference/ei16/session6/a.pope.pdf Date Last Accessed: 5/6/2016.

EPA, 2009a. U.S. EPA. April 2009. UATMP, NATTS, CSATAM, PAMS, and NMOC Support, Contract No. EP-D-09-048. pp. 1-2 through 1-3.

EPA, 2009b. U.S. EPA. April 1, 2009. Technical Assistance Document for the National Air Toxics Trends Stations Program, Revision 2. Research Triangle Park, NC. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 1/11/2016.

EPA, 2009c. U.S. EPA. September 10, 2009. Schools Air Toxics Monitoring Activity (2009) Uses of Health Effects Information in Evaluating Sample Results. https://www3.epa.gov/air/sat/techinfo.html Date Last Accessed: 5/6/2016.

EPA, 2010a. U.S. EPA. October 2010. A Preliminary Risk-based Screening Approach for Air Toxics Monitoring Data Sets, version 2. EPA-904-B-06-001. Atlanta, GA. nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1009A7C.TXT Date Last Accessed: 3/7/2016.

EPA, 2010b. U.S. EPA. December 2010. Data Quality Evaluation Guidelines for Ambient Air Acrolein Measurements. http://www.epa.gov/ttn/amtic/files/ambient/airtox/20101217acroleindataqualityeval.pdf Date Last Accessed: 3/7/2016.

EPA, 2011a. U.S. EPA. June 2011. Technical Report for School: Assessing Outdoor Air Near Schools: Riggins School, North Birmingham Elementary School, and Lewis Elementary School (Birmingham, Alabama). http://www3.epa.gov/air/sat/NorthBirmi.html Date Last Accessed: 1/19/2016.

EPA, 2012a. U.S. EPA. June 2012. Ambient Air Monitoring Reference and Equivalent Methods: Designation of Three New Equivalent Methods. Federal Register Volume 77, Number 106, p. 32632. http://www.gpo.gov/fdsys/pkg/FR-2012-06-01/html/2012-13350.htm Date Last Accessed: 1/29/2016.

EPA, 2012b. U.S. EPA. September 2012. National Air Toxics Trends Stations (NATTS) Network Assessment, Revised Draft. Prepared by Eastern Research Group, Inc.

EPA, 2014. U.S. EPA. September 2014. UATMP, PAMS, and NMOC Support, Contract No. EP-D-14-030.

EPA, 2015a. U.S. EPA. March 4, 2015. 2011 National Emissions Inventory, Version 2. http://www.epa.gov/ttnchie1/net/2011inventory.html Date Last Accessed: 3/7/2016.

EPA, 2015b. U.S EPA. December 17, 2015. NATA: Glossary of Terms website. https://www.epa.gov/national-air-toxics-assessment/nata-glossary-terms Date Last Accessed: 3/7/2016.

EPA, 2015c. U.S. EPA. December 2015. Technical Support Document EPA's 2011 National-scale Air Toxics Assessment. Pg 20-22. https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document Date Last Accessed: 5/13/2016.

EPA, 2015d. U.S. EPA. December 2015. Technical Support Document EPA's 2011 National-scale Air Toxics Assessment. Appendix H. https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document Date Last Accessed: 1/6/2017.

EPA, 2016a. U.S. EPA. Air Toxics - National Air Toxics Trends Stations website. http://www3.epa.gov/ttnamti1/natts.html Date Last Accessed: 1/11/2016.

EPA, 2016b. U.S. EPA. Technology Transfer Network (TTN), Air Quality System (AQS) website. http://www.epa.gov/aqs Date Last Accessed: 1/11/2016.

EPA, 2016c. U.S. EPA. What are Hazardous Air Pollutants? website. https://www.epa.gov/haps/what-are-hazardous-air-pollutants Date Last Accessed: 3/7/2016.

EPA, 2016d U.S. EPA. Phaseout of Class I Ozone-Depleting Substances website. https://www.epa.gov/ods-phaseout/phaseout-class-i-ozone-depleting-substances Date Last Accessed: 5/10/2016.

EPA, 2017. U.S. EPA. National Emissions Inventory (NEI) website. https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei Date Last Accessed: 2/9/17.

ERG, 2013. Eastern Research Group, Inc. 2013. Support for the EPA National Monitoring Programs (UATMP, NATTS, CSATAM, PAMS, and NMOC Support), Quality Assurance Project Plan, Category 1. Contract No. EP-D-09-048. Morrisville, NC.

FAC, 2007. Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses In Clean Water Act Programs, Appendix D: DQ FAC Single Laboratory Procedure v2.4. December 2007. Submitted to the U.S. EPA. https://www.epa.gov/cwa-methods/procedures-detection-and-quantitation Date Last Accessed: 1/6/2017.

FL DOT, 2014. Florida Department of Transportation. Florida Traffic Online Mapping Application (2014). http://www2.dot.state.fl.us/FloridaTrafficOnline/viewer.html Date Last Accessed: 1/8/2016.

FHWA, 2015. Federal Highway Administration. 2015. Highway Statistics 2015. Glossary website. https://www.fhwa.dot.gov/policyinformation/statistics/2015/16_glossary.cfm Date Last Accessed: 2/9/17.

GCPH, 2015. Garfield County Public Health Department. June 2015. Garfield County 2014 Air Quality Monitoring Report. Page 4-4. Rifle, CO. Prepared by Air Resource Specialists, Inc., Ft. Collins, CO. p. 4-4. http://www.garfield-county.com/air-quality/ Date Last Accessed: 6/10/2016.

GCRBD, 2014. Garfield County Road and Bridge Department. Garfield County Road Traffic Counts. 2014 Data. http://www.garfield-county.com/road-bridge/county-roads.aspx Date Last Accessed: 1/6/2016.

Girardi, 2015. Girardi, Steven. 2015. Company buys Raytheon property, plans mixed-use development. Tampa Bay Times. July 27, 2015. http://www.tbo.com/pinellas-county/company-buys-raytheon-property-plans-mixed-use-development-20150727/ Date Last Accessed: 1/6/2017.

IL DOT, 2013/2014. Illinois Department of Transportation. Getting Around Illinois website. Average Annual Daily Traffic map viewer. 2013 and 2014 data. http://www.gettingaroundillinois.com/ Date Last Accessed: 1/8/2016.

IN DOT, 2011. Indiana Department of Transportation. Average Daily Traffic and Commercial Vehicles Interactive map. 2011 Data. http://www.in.gov/indot/2469.htm Date Last Accessed: 1/8/2016.

KY, 2016. Kentucky State Parks. Grayson Lake History website. http://parks.ky.gov/parks/recreationparks/grayson-lake/history.aspx Date Last Accessed: 7/18/2016.

KYTC, 2014. Kentucky Transportation Cabinet. Interactive Statewide Traffic Counts mapping application. 2012-2014 Data. http://transportation.ky.gov/Planning/Pages/count-maps.aspx Date Last Accessed: 1/8/2016.

LADCO, 2003. Lake Michigan Air Directors Consortium. December 2003. Phase II: Air Toxics Monitoring Data: Analyses and Network Design Recommendations. Final technical report prepared by Battelle Memorial Institute and Sonoma Technology, Inc. http://www.ladco.org/reports/toxics/battelle_2/ Date Last Accessed: 1/11/2016.

Lakes, 2011. Lakes Environmental. June 2011. WRPLOT View 7.0.0. http://www.weblakes.com/products/wrplot/index.html Date Last Accessed: 11/10/2015.

MA DOT, 2010. Massachusetts Department of Transportation, Highway Division. Transportation Data Management System. 2010 Traffic Count. http://www.massdot.state.ma.us/highway/TrafficVolumeCounts.aspx Date Last Accessed: 1/8/2016.

MI DOT, 2014. Michigan Department of Transportation. Traffic Monitoring Information System (TMIS) website. Annual Average Daily Traffic Report (2014). http://mdotnetpublic.state.mi.us/tmispublic/Search.aspx Date Last Accessed: 1/8/2016.

MO DOT, 2013. Missouri Department of Transportation, Transportation Planning. 2013 St. Louis District Traffic Volume and Commercial Vehicle Count Map. Jefferson City, MO. http://www.modot.org/safety/trafficvolumemaps.htm Date Last Accessed: 1/8/2016.

NCDC, 2014. National Climatic Data Center. Quality Controlled Local Climatological Data (QCLCD). 2014 Data. https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/quality-controlled-local-climatological-data-qclcd Date Last Accessed: 1/6/2017.

NHMU, 2017. Natural History Museum of Utah. Stefan Brems. Salt Lake Valley Weather Patterns. https://nhmu.utah.edu/sites/default/files/attachments/SaltLakeValleyWeatherPatterns.pdf Date Last Accessed: 1/3/2017.

NJ DOT, 2014. New Jersey Department of Transportation. Roadway Information and Traffic Monitoring System Program interactive Traffic Count Reports. 2010, 2012 Data. http://www.state.nj.us/transportation/refdata/roadway/traffic_counts/ Date Last Accessed: 1/8/2016.

NJ DOTr, 2008. New Jersey Department of Treasury. January 2008. New Jersey Traffic and Revenue Study, New Jersey Turnpike & Route 440 Asset Appraisal. Final Report prepared by Steer Davies Gleave in association with CRA International and EDR Group. London, England. http://www.njslom.org/njtrstudypart2.pdf Date Last Accessed: 1/8/2016.

NOAA, 1999. NOAA. March 1998. Automatic Surface Observing System (ASOS) User's Guide. http://www.nws.noaa.gov/asos/ Date Last Accessed: 10/31/2016.

NYS DOT, 2013. New York State Department of Transportation. Traffic Data Viewer mapping application. 2013 Data. https://www.dot.ny.gov/divisions/engineering/applications/traffic-data-viewer Date Last Accessed: 1/8/2016.

OK DOT, 2014. Oklahoma Department of Transportation, Planning and Research Division. 2014 Annual Average Daily Traffic Oklahoma Highway System maps. Oklahoma City, OK. http://www.okladot.state.ok.us/maps/aadt/index.htm Date Last Accessed: 1/11/2016.

Peltier, 2016. Peltier Technical Services, Inc. Peltier Tech Charts for Excel 3.0. Downloaded March 8, 2016. http://peltiertech.com/Utility30/ Date Last Accessed: 3/22/2016.

Podmolik, 2015. Podmolik, Mary Ellen. 2015. Canadian Pacific seeks new use for Schiller Park intermodal site. Chicago Tribune. January 20, 2015. http://www.chicagotribune.com/business/breaking/ct-railway-terminal-development-0121-biz-20150120-story.html Date Last Accessed: 2/9/2017.

RI DOT, 2009. Rhode Island Department of Transportation. December 2009. State Highway Map of Rhode Island, Traffic Flow Map 2009. http://www.dot.ri.gov/about/maproom/index.php Date Last Accessed: 1/8/2016.

Seattle, 2016. Seattle Parks and Recreation. Jefferson Park website. http://www.seattle.gov/parks/find/parks/jefferson-park Date Last Accessed: 12/16/2016.

UT DOT, 2013. Utah Department of Transportation. AADT Traffic Map Updated Using 2013 Data (via Google Earth kmz file). http://www.udot.utah.gov/main/f?p=100:pg:0::::V,T:,528 Date Last Accessed: 1/8/2016.

UVM, 2015. The University of Vermont. Proctor Maple Research Center Mission website. http://www.uvm.edu/~pmrc/?Page=mission.htm Date Last Accessed: 11/28/2016.

VA DOT, 2013. Virginia Department of Transportation, Traffic Engineering Division. Average Daily Traffic Volumes with Vehicle Classification Data on Interstate, Arterial, and Primary Routes 2013. http://www.virginiadot.org/info/2014_traffic_data.asp Date Last Accessed: 1/11/2016.

WS DOT, 2014. Washington State Department of Transportation. Traffic Volume Map Application. 2014 Data. http://www.wsdot.wa.gov/mapsdata/tools/trafficplanningtrends.htm Date Last Accessed: 1/11/2016.

WUSTL, 2013. Email from Jay Turner, Washington University in St. Louis. August 29, 2013.

WUSTL, 2016. Washington University in St. Louis, Air Quality Laboratory. Roxana Air Quality Study website. http://raqs.seas.wustl.edu/ Date Last Accessed: 9/1/2016.