

## **Fourth Operational Phase Ambient Air Monitoring Program, Winter 2013-2014 and 2014-2015**

**Montgomery County, Maryland Solid Waste Resource Recovery Facility  
Dickerson, Maryland**

**Final Report  
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*Prepared for:*  
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D - Metal Lab Reports – Alpha Labs

E – Mercury Lab Data/Reports – Brooks Rand Labs

F – PCDDs/PCDFs – Cape Fear Analytical Labs

G – TRC Data Validation Memorandums

H – Independent Peer Review

## **GLOSSARY OF ACRONYMS**

**RRF** – Resource Recovery Facility

**MCRRF** – Montgomery County Resource Recovery Facility, located in Dickerson, Maryland.

**XRF** – X-ray Fluorescence; an analytical technique that measures emissions of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombarding with high-energy X-rays or gamma rays. For this report, XRF refers to the analytical process of determining the presence and level of metals on particulate filters.

**TSP** – Total Suspended Particulate

**EPA** – Environmental Protection Agency

**PCDDs/PCDFs** – Polychlorinated Dibenzo-p-Dioxins/Polychlorinated Dibenzofurans; Dioxins and furans consist of a class of 210 chlorinated organic compounds (i.e., PCDDs and PCDFs). Of these, 17 specific PCDD/PCDF compounds, called congeners, are considered to be toxic and have been assigned relative toxicity factors known as Toxic Equivalency Factors (TEFs). A TEF reflects the relative toxicity of an individual PCDD or PCDF compound compared to 2,3,7,8-TCDD, the most toxic and well-studied congener among the PCDDs/PCDFs. The overall concentration of a sample is calculated by multiplying the concentration values for each of the 17 PCDDs/PCDFs by its TEF. The sum of the products of the TEFs and associated congener concentrations then becomes the 2,3,7,8-TCDD toxic equivalent (TEQ), a value which can be used to evaluate a sample containing a mixture of PCDDs/PCDFs.

**NAAQS** – National Ambient Air Quality Standards

**AERMOD** – American Meteorological Society/Environmental Protection Agency Regulatory Model

**DAFIG** – Dickerson Area Facilities Implementation Group

**CFR** – Code of Federal Regulations

**CVAFS** – Cold Vapor Atomic Fluorescence Spectroscopy; an analysis technique for determining the mercury content on an iodated carbon trap.

**CTDEEP** – Connecticut Department of Energy and Environmental Protection

**POPs** – Persistent Organic Pollutants; chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment.

**BRL** – Brooks Rand Labs; responsible for analysis of iodated carbon traps for mercury.

**SOP** – Standard Operating Procedure

**MDL** – Method Detection Limit

**MRL** – Method Reporting Limit

**PUF** – Polyurethane Foam; sampling media used to collect vapor phase PCDDs/PCDFs.

**HRGC-HRMS** – High Resolution Gas Chromatograph-High Resolution Mass Spectrometer

**SIM** – Selected Ion Monitoring

**QA/QC** – Quality Assurance Quality Control

**RPD** – Relative Percent Difference

**Profile** - a set of data often in graphic form portraying the significant features of something: a graph representing the extent to which an individual sample exhibits traits or components as determined by analysis

**Fingerprint**- analytical evidence that characterizes an object or substance

**Aggregate** - formed by the collection of units into a body, mass, or amount: collective

### **DATA QUALIFIERS**

**U** – Reported concentration below the Method Detection Limit

**ND** – Nondetect result

**J** – Reported concentration is an estimate as a result of QA/QC review and/or the data validation process

### **UNITS**

**lpm** – liters per minute

**m** – meters

**ng** – nanogram

**ug** – microgram

**pg** - picogram

**ml** – milliliters

**kV** – kilovolts

### **WIND DIRECTIONS (blowing from)**

**N** – North; winds blowing from the north correspond to  $348.46^{\circ}$  to  $360^{\circ}$  to  $11.25^{\circ}$

**NNE** – North Northeast;  $11.26^{\circ}$  to  $33.45^{\circ}$

**NE** – Northeast;  $33.46^{\circ}$  to  $55.95^{\circ}$

**ENE** – East Northeast;  $55.96^{\circ}$  to  $78.45^{\circ}$

**E** – East;  $78.46^{\circ}$  to  $100.95^{\circ}$

**ESE** – East Southeast;  $100.96^{\circ}$  to  $123.45^{\circ}$

**SE** – Southeast;  $123.46^{\circ}$  to  $145.95^{\circ}$

*SSE – South Southeast; 145.96° to 168.45°*  
*S – South; 168.46° to 190.95°*  
*SSW – South Southwest; 190.96° to 213.45°*  
*SW – Southwest; 213.46° to 235.95°*  
*SSW – South Southwest; 235.96° to 258.45°*  
*W – West; 258.46° to 280.95°*  
*WNW – West Northwest; 280.96° to 303.45°*  
*NW – Northwest; 303.46° to 325.95°*  
*NNW – North Northwest; 325.96° to 348.45°*

## **EXECUTIVE SUMMARY**

### **Background**

The Division of Solid Waste Services, in the Montgomery County Department of Environmental Protection, is responsible for the County's solid waste facilities which include a municipal waste Resource Recovery Facility (RRF) located in Dickerson, Maryland. During the planning process for this facility, which became operational in the spring of 1995, the County made commitments to conduct human health risk assessments relative to RRF emissions and conduct ambient environmental monitoring during both pre-operational and post-operational phases of the RRF in response to concerns from the local community.

The County initiated a multi-media monitoring program in the vicinity of the facility to monitor a variety of constituents in abiotic and biotic environmental media. The sampling programs which began in 1994-95 (pre-operational phase) included ambient air monitoring and non-air media monitoring components.

This reports represents the results from the winter 2013-2014 and 2014-2015 sampling programs or fourth operational phase of ambient air monitoring in the vicinity of the Montgomery County Resource Recovery Facility (MCRRF).

### **Purpose and Objectives**

The primary objective of this ambient air monitoring program was to determine whether or not there were measurable changes in the concentrations of certain constituents (those the public requested to be monitored) in the actual environment. Fingerprinting techniques were employed in order to distinguish, to the extent possible, the role of the RRF emissions in any observed trends. A secondary objective was to assess, to the extent possible, the consistency of field observations with the results of the air dispersion modeling and other technical protocols performed in preparation of TRC's "2014 Health Risk Assessment Update for the Montgomery County Resource Recovery Facility (RRF)." The contents of this report confirm that these objectives have been met.

### **Sampling Program**

Two sampling locations used previously for all ambient air monitoring campaigns were used for the current program. The Lucketts site is identified as the background location predominantly upwind of the MCRRF and the Beallsville site is identified as the "impact" location situated predominantly downwind of MCRRF. Historical particulate concentration isopleths representing air dispersion modeling of MCRRF particulate emissions served as the basis for the original designation of the two sampling sites.

Ambient air samples were collected at the two sites in the vicinity of the MCRRF during the winters of 2014 and 2015. Sample collection information is provided in Table ES-1. During the summer of 2014 source emission samples were collected at the three unit stacks of the MCRRF over the period of August 11<sup>th</sup> through 14<sup>th</sup>.

**Table ES-1: Montgomery County RRF Ambient Sampling Event Summary**

Chemical Class	Sampling Sites	Sampling Event	Sampling Period		Notes
			Start Time	End Time	
Metals (including Mercury)	Lucketts	1	1/28/2014 10:27	1/29/2014 10:27	24-hour sample
	Beallsville*	1	1/28/2014 13:30	1/1/2914 13:31	24-hour sample
	Lucketts	2	2/6/2014 16:43	2/7/2014 15:43	23-hour sample
	Beallsville*	2	2/6/2014 17:46	2/7/2014 16:46	23-hour sample
	Lucketts	3	2/26/2014 11:20	2/27/2014 11:20	24-hour sample
	Beallsville*	3	2/26/2014 14:34	2/27/2014 14:34	24-hour sample
Dioxins/ Furans	Lucketts	1	2/3/2015 10:20	3/4/2015 20:00	31-day sample
	Beallsville*	1	2/3/2015 12:10	3/4/2015 21:40	31-day sample

\*All samples at the Beallsville site were collected as a collocated pair.

Three 1-hour isokinetic sample runs were collected at each unit stack. A total of nine samples plus one blank were shipped to Chester LabNet for analysis for metals by X-Ray Fluorescence (XRF).

### Laboratory Analyses

Ambient air particulate filter samples were analyzed for metals using two different methods. Each filter was initially analyzed for Total Suspended Particulate (TSP) and a series of metals as follows: arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg) and nickel (Ni). These analyses were performed by Alpha Laboratory (Mansfield, MA). Once this analysis was completed, the filters were submitted to Chester LabNet for analyses by X-Ray fluorescence (XRF, EPA Method TO-3.3) for a broader suite of 35 metals. The XRF data were used to compile metals/elements profiles in the ambient air samples. The metals analyses were conducted on four samples from each of three sampling events. Each sampling event consisted of the following sample types: Beallsville (collocated pair), Lucketts (single sample) and field blank.

Sampling was also conducted using iodated carbon traps for total mercury (particulate and vapor) in accordance with EPA Method 1631. Sample analyses were performed by Brooks Rand Laboratories (Seattle, WA).

A single 31 day sampling event for Polychlorinated Dibenzo-p Dioxins and Polychlorinated Dibenzofurans (PCDDs/PCDFs), also known as dioxins and furans, took place during the calendar period February 3 to March 4, 2015. All PCDDs/PCDFs samples at each site were collected in duplicate; four total at Beallsville and two total at Lucketts. A collocated pair of samples collected at the Beallsville site and a single sample collected at the Lucketts site were analyzed for PCDDs/PCDFs. These analyses were performed by Cape Fear Analytical (Wilmington, NC).

A total of nine filter samples (plus a blank) representing particulate emissions from the MCRRF were submitted to Chester LabNet for metals analyses by X-Ray fluorescence (EPA Method TO-3.3). These included samples from each of nine separate source emissions sampling events. Three 1-hour sampling events took place at each of the three (3) stacks or emission points located at the MCRRF. These samples were collected over a four (4) day calendar period in August 2014. Each of the ten samples was analyzed for 35 metals. The XRF data were used to compile a metals/elements profile for MCRRF emissions.

## **SUMMARY AND CONCLUSIONS**

### **Metals**

- Concentrations for the majority of the seven metals measured during the three sampling events were comparable at the Lucketts and Beallsville sampling stations. These data collectively do not indicate any influences on ambient air concentrations attributable to emissions of these same metals from the MCRRF. Rather these data represent background concentrations for metals at both sites attributable to an aggregate of regional source contributions impacting both sites in a similar manner.
- The highest mean concentrations (averaged across the three sampling events) were observed for lead. The values of 2.02 ng/m<sup>3</sup> and 2.01 ng/m<sup>3</sup> reported for the Lucketts and Beallsville sites, respectively, are essentially identical and significantly below the 150 ng/m<sup>3</sup> National Ambient Air Quality Standard (NAAQS) for lead expressed as a 24 hour time weighted average. Again, these data are considered to represent background lead concentrations in ambient air in the study region.
- Beryllium was not detected in any samples collected during both the 2014 campaign and the 2008 sampling campaign. Chromium was not detected during the 2014 campaign. Mercury was not detected in any samples collected in 2014, but was detected at very low levels in two out of three sampling events in 2008. Lead, arsenic and nickel mean concentrations for the 2008 sampling campaign were slightly higher than the 2014 mean concentrations for these same metals. The highest mean concentrations for all three of these metals were observed in 2008 at the Lucketts school background site.
- The metals data indicate that concentrations for the majority of the metals were comparable at both sites independent of the site orientation relative to the MCRRF. The Beallsville site, even though situated predominantly downwind of the MCRRF, had metals concentrations comparable to background. These data do not indicate any influences from MCRRF source emissions.
- The XRF metals/elements composition in MCRRF emissions is substantially different from the XRF composition in the ambient air samples. This indicates that MCRRF particulate emissions are not measurably impacting particulate matter collected at the Lucketts or Beallsville sampling sites.

## Modeling RRF Emissions

- Ambient air concentrations associated with MCRRF emissions were also calculated using the USEPA-approved AERMOD dispersion model. AERMOD modeling results shown in Table ES-2 indicate that the contributions attributable to MCRRF emissions are a very small fraction of the concentrations measured during the 2014 (metals) and 2015 (PCDDs/PCDFs) sampling events. This observation indicates that neither of the monitoring sites are being measurably impacted by MCRRF emissions.
- In the absence of the air dispersion modeling analyses the principal report conclusion that there are no indications of any influences from MCRRF source emissions remains valid. The additional data that support this principal conclusion are as follows: regulated metals concentrations, comparison of regulated metals concentrations upwind of the RRF to those measured downwind, elemental profiles, PCDDs/PCDFs profiles and trend analysis.
- Comparison of the concentrations shown in Table ES-2 representing Washington, DC to the measured concentrations at the Lucketts and Beallsville sites indicates no substantial difference in concentrations and suggests that regional background sources are the predominant contributors to concentrations measured at all three sites.

**Table ES-2: Modeled Concentrations from RRF Emissions Compared to Background Ambient Air Measurements**

Period	Analyte	Modeled Incremental Air Conc. Due to RRF Emissions (ug/m3)		Measured Air Conc. (ug/m3)		Avg Daily Air Conc. at DC* (ug/m3)	Ratio of Modeled Incremental Air Concentrations from RRF to Measured Air Concentrations	
		Lucketts	Beallsville	Lucketts	Beallsville		Lucketts	Beallsville
Feb 3, 2015 - Mar 4, 2015	Dioxins / Furans TEQ	0.1E-11	0.3E-11	3,900E-11	1,200E-11	No data	0.00003	0.00024
Jan 28, 2014 - Jan 29, 2014	Arsenic	0.1E-06	1.8E-06	5,47E-06	5,35E-06	7,16E-06	0.00018	0.00337
	Beryllium	0.3E-08	5.0E-08	ND	ND	305.5E-08		
	Cadmium	0.1E-06	1.5E-06	1,67E-06	191E-06	130E-06	0.00048	0.00762
	Chromium	0.1E-06	2.1E-06	ND	ND	2,201E-06		
	Lead	0.1E-05	2.3E-05	164E-05	152E-05	305E-05	0.00076	0.01491
	Mercury	0.3E-06	5.5E-06	ND	ND	577E-06		
	Nickel	0.3E-06	5.1E-06	617E-06	753E-06	1,040E-06	0.00045	0.00672
Feb 6, 2014 to Feb 7, 2014	Arsenic	0.1E-06	0.9E-06	416E-06	665E-06	716E-06	0.00016	0.00135
	Beryllium	0.3E-08	3.7E-08	ND	ND	305.5E-08		
	Cadmium	0.1E-06	1.0E-06	ND	ND	130E-06		
	Chromium	0.1E-06	1.7E-06	ND	ND	2,201E-06		
	Lead	0.1E-05	1.3E-05	219E-05	220E-05	305E-05	0.00045	0.00605
	Mercury	0.3E-06	4.6E-06	ND	ND	577E-06		
	Nickel	0.3E-06	4.1E-06	867E-06	726E-06	1,040E-06	0.00035	0.00571
Feb 26, 2014 to Feb 27, 2014	Arsenic	0.1E-06	1.2E-06	375E-06	356E-06	716E-06	0.00013	0.00340
	Beryllium	0.1E-08	3.3E-08	ND	ND	305.5E-08		
	Cadmium	0.04E-06	0.9E-06	132E-06	ND	130E-06		
	Chromium	0.1E-06	1.2E-06	ND	ND	2,201E-06		
	Lead	0.1E-05	1.5E-05	223E-05	188E-05	305E-05	0.00027	0.00772
	Mercury	0.2E-06	4.5E-06	ND	ND	577E-06		
	Nickel	0.1E-06	3.5E-06	967E-06	1,116E-06	1,040E-06	0.00015	0.00311

\* District of Columbia (DC) concentrations from the National Air Toxics Database  
<http://www.epa.gov/ttnamti1/toxdat.html#data>

Mercury values from 3-year period of 2006 to 2008. All other pollutants 2011 to 2013. PM<sub>10</sub> values used when provided (rather than PM<sub>2.5</sub>).  
 ND = None detected

## PCDDs/PCDFs

- Profiles presented as a percent of total PCDDs/PCDFs (Cl<sub>4</sub> – Cl<sub>8</sub>) measured at each site are comparable. The profiles at both sites are consistent with those typically reported for ambient air on a global basis where a blend of combustion sources represent the principal contributions to atmospheric concentrations of PCDDs/PCDFs (see Figure ES-1).
- PCDDs/PCDFs profiles are remarkably similar to those observed by AECOM during the third operational phase air monitoring event in 2008 (see Figure ES-1). At that time these profiles were also found to be typical of numerous types of combustion sources.
- Measured concentrations of total PCDDs/PCDFs at the Lucketts site (3.7 pg/m<sup>3</sup>) were roughly three and one-half times higher than concentrations measured at the Beallsville site (1.05 pg/m<sup>3</sup>) during the 31 day sampling event. Based upon these data it has been concluded that MCRRF emissions are not contributing to the ambient concentrations of PCDDs/PCDFs measured at either the Lucketts or Beallsville site. Concentrations of PCDDs/PCDFs measured at both sampling sites more likely represent ambient background conditions attributable to an aggregate of combustion sources operating in winter time in the study region. These sources included but are not limited to the following: residential, municipal and commercial/ industrial heating, wood combustion, forest and brush fires, backyard barrel burning, yard waste burning, agricultural burning and vehicle emissions (e.g. diesel powered).
- The higher concentrations measured at the Lucketts site suggest influences from localized combustion sources in the site vicinity and not simply regional background as suggested by the Beallsville data. The differences in measured concentrations at the two (2) sites are not attributable to measurement precision. (Concentrations of 1.09 pg/m<sup>3</sup> and 1.02 pg/m<sup>3</sup> measured in collocated samples at the Beallsville site are in good agreement.). These localized combustion sources may include but not be limited to the following: residential and commercial heating, wood stove emissions, brush fires, backyard barrel burning, and vehicle emissions (e.g. diesel powered).
- The composite profile for MCRRF emissions differs significantly from the profile characteristic of the ambient air samples. For example, the PCDDs profile characteristic of the ambient air samples (Cl<sub>4</sub>< Cl<sub>5</sub>< Cl<sub>6</sub><Cl<sub>7</sub><Cl<sub>8</sub>) is not consistent with the MCRRF emissions profile. OCDD, which predominates in the ambient air profile (35-40% of Cl<sub>4</sub> - Cl<sub>8</sub> total) represents <10% of the emissions source profile for the same homologue sum (Cl<sub>4</sub> – Cl<sub>8</sub>). These data do not support the finding that MCRRF emissions are contributing to PCDDs/PCDFs measured at either of the two sites during both the 2008 and 2015 sampling events (see Figure ES-1).
- The 2,3,7,8- substituted HxCDFs profiles observed in each of the three ambient air samples are nearly identical and indicative of aggregate regional combustion source influences.
- Trend analysis based upon all ambient monitoring data \* collected at the Lucketts and Beallsville sites when compared to stack emissions monitoring data for the same time

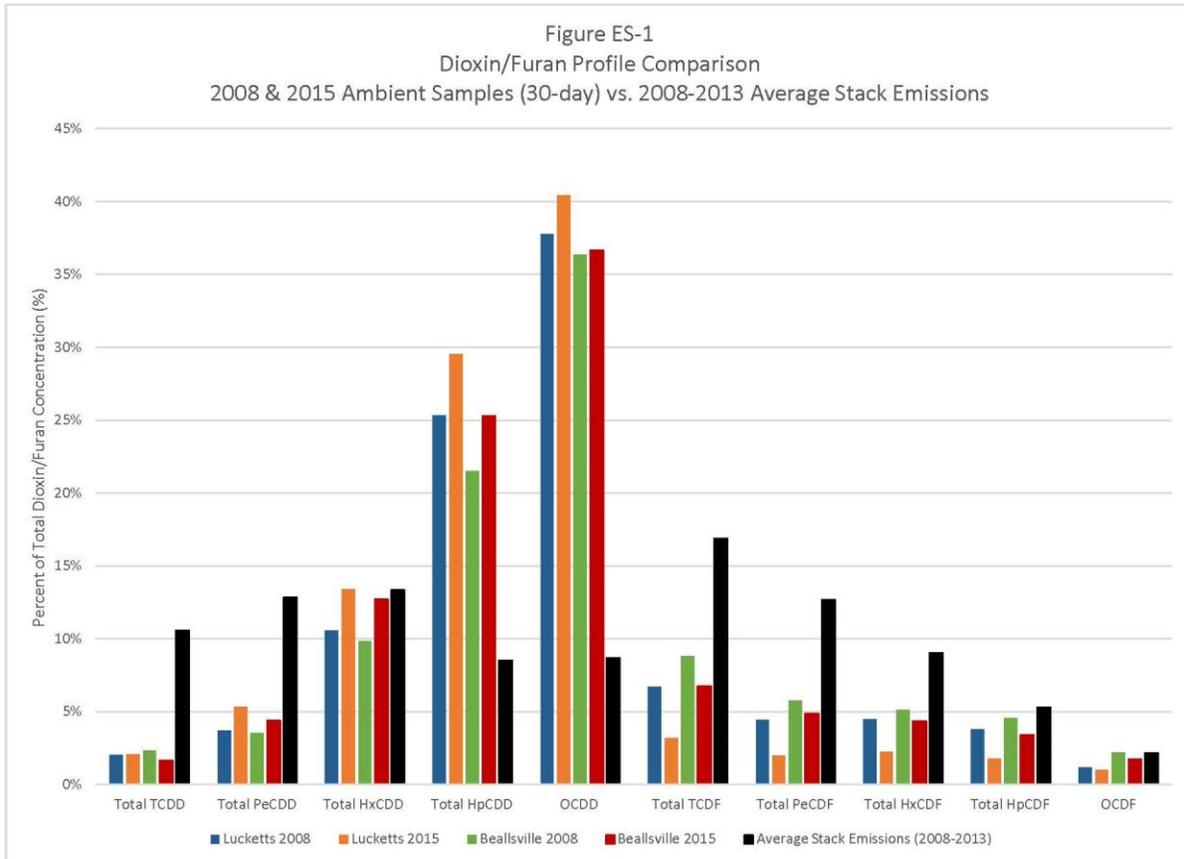
period indicate no measurable influences on ambient air concentrations attributable to MCRRF source emissions.

**Table ES-3: Total PCDDs/PCDFs Comparison of Ambient Air Concentrations in this Study with Concentrations Measured in Other Locations**

	Location	pg/m <sup>3</sup>
Urban US Cities	Hartford, CT	2.6
	Los Angeles, CA	7.4
	Phoenix, AZ	27
	Fresno, CA	51
	Bridgeport, CT	1.9
	Bloomington, IN	1.8
Rural Locations	TeWera, NZ	0.88
	Culverden, NZ	0.48
	Mohawk Mountain, CT (winter)	0.58
	Mohawk Mountain, CT (fall)	0.53
	Burlington, CT (winter)	0.68
	Burlington, CT (fall)	0.41
Remote Locations	Baring Head, NZ	0.14
	Nelson Lakes, NZ	0.04
	Bermuda (1993-1994)	0.11
	Bermuda (1996-1997)	0.04
	Barbados	0.02
Local 2015	Lucketts 2015	3.70
	Beallsville 2015 (mean)	1.05
Local 2008	Lucketts 2008	1.86
	Beallsville 2008 (mean)	1.40
PCDDs/PCDFs = Sum of Total PCDDs/PCDFs Tetra – Octa (Cl <sub>4</sub> - Cl <sub>8</sub> ) mass concentrations		

\* This data set consists of all data collected in ambient air prior to operation of the MCRRF, as well as, all data collected during the four (4) operational phase monitoring programs.

**Figure ES-1: Dioxin/Furan Profile Comparison 2008 & 2015 Ambient Samples (30-day) vs. 2008-2013 Average Stack Emissions**



## **1.0 PROJECT BACKGROUND AND DESCRIPTION**

### **1.1 Background**

The Division of Solid Waste Services, in the Montgomery County Department of Environmental Protection, is responsible for the County's solid waste facilities which include a municipal waste Resource Recovery Facility (RRF) located in Dickerson, Maryland. During the planning process for this facility, which became operational in the spring of 1995, the County made commitments to conduct human health risk assessments relative to RRF emissions and conduct ambient environmental monitoring during both pre-operational and post-operational phases of the RRF in response to concerns from the local community.

The County initiated a multi-media monitoring program in the vicinity of the facility to monitor a variety of constituents in abiotic and biotic environmental media. The sampling programs which began in 1994-95 (pre-operational phase) included ambient air monitoring and non-air media monitoring components.

This report represents the results from the winter 2013-2014 and 2014-2015 sampling programs or fourth operational phase of ambient air monitoring in the vicinity of the MCRRF.

A draft version of this report has undergone independent 3<sup>rd</sup> party review by CPF Associates, Inc. Comments and responses to those comments can be found in Appendix H. All applicable changes have been carried through this final document

### **1.2 Purpose and Objectives**

The primary objective of this ambient air monitoring program was to determine whether or not there were measurable changes in the concentrations of certain constituents (those the public requested to be monitored) in the actual environment. Fingerprinting techniques were employed in order to distinguish, to the extent possible, the role of the RRF emissions in any observed trends. A secondary objective was to assess, to the extent possible, the consistency of field observations with the results of the air dispersion modeling and other technical protocols performed in preparation of TRC's "2014 Health Risk Assessment Update for the Montgomery County Resource Recovery Facility (RRF)." The contents of this report confirm that these objectives have been met.

### **1.3 Historical Review**

The pre-operational phase of air monitoring was conducted between February 1994 and February 1995. The pre-operational program was designed to produce baseline data for target chemicals in ambient air. Subsequent to the facility becoming operational, air media monitoring was conducted beginning in February 1996 and concluding in August 1997. Following review of the pre-operational and first operational phase air sampling programs, the County's Dickerson Area Facilities Implementation Group (DAFIG) Air Quality Sub-committee recommended that the air program be conducted periodically (once every five years) and be limited to selected toxic metals and PCDDs/PCDFs. The second operational phase monitoring effort in this program was

conducted in two phases; a period of 29 days during December 10, 2002 – January 8, 2003 and the second phase, a 33-day period from May 21 through June 23, 2003. The third operational phase air monitoring program took place during the calendar period January 16, 2008 through February 16, 2008 approximately twelve (12) years after the MCRRF became operational. [2]

## **2.0 SAMPLING LOCATIONS**

### **2.1 Introduction**

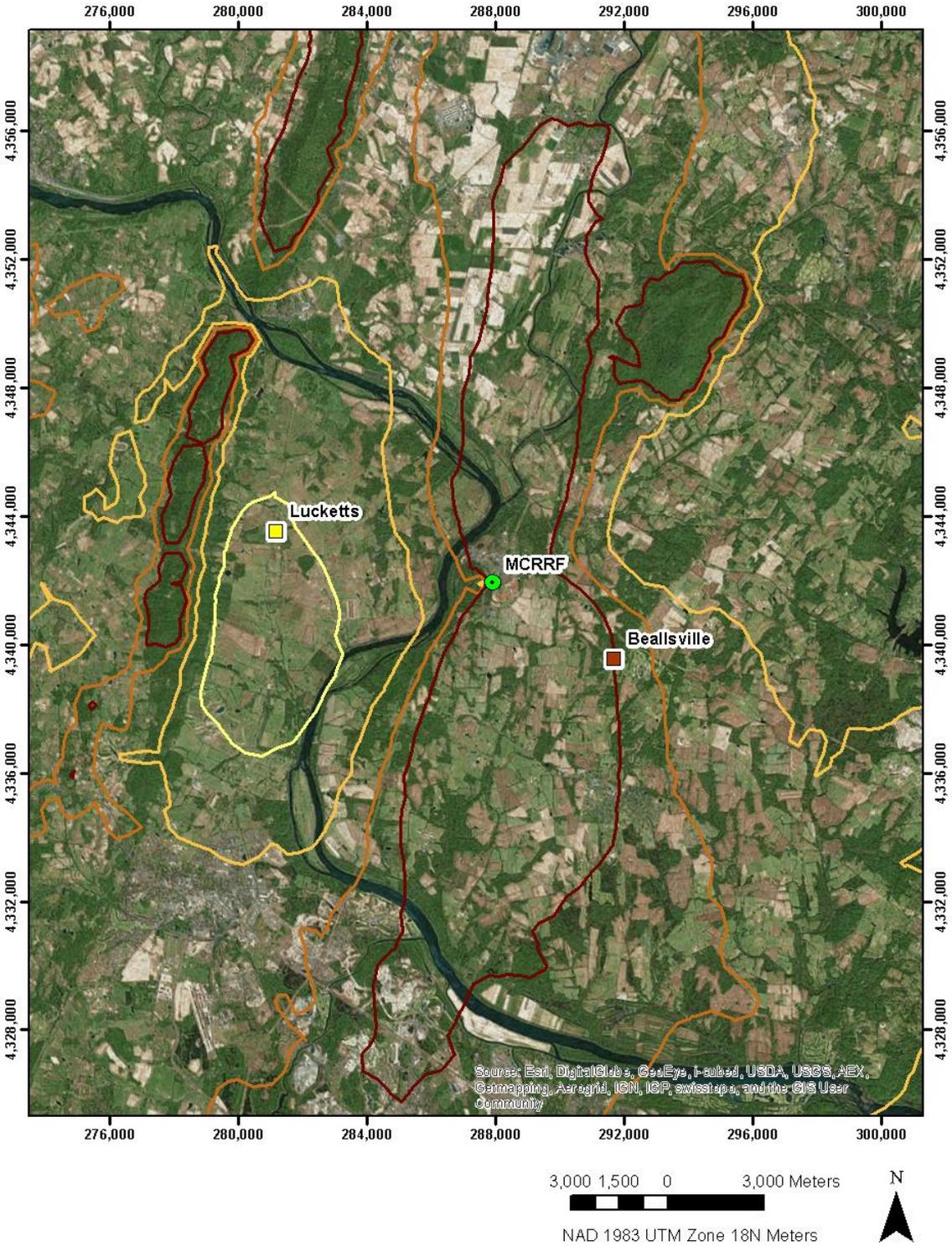
Two sampling locations used previously for all ambient air monitoring campaigns were used for the current program. It was important that the sampling locations be identical to those used during all prior sampling campaigns. In this manner data collected during the current program could be compared directly to data collected historically at these same locations (AECOM 2008 for example). The two locations are shown relative to the MCRRF in Figure 2-1. The Lucketts site is identified as the background location because it is predominantly upwind of the MCRRF and the Beallsville site is identified as the “impact” location situated predominantly downwind of the MCRRF. Historical particulate concentration isopleths developed based upon air dispersion modeling of MCRRF particulate emissions are shown on Figure 2-1. These isopleths have served as the basis for the original placement of the two sampling sites.

### **2.2 Lucketts Site**

#### ***2.2.1 Description of Location***

The background location established for this sampling program was at the Lucketts Elementary School. Lucketts Elementary School is located at 14550 James Monroe Highway, in Leesburg, Virginia. The Lucketts site is located approximately three miles west of the MCRRF as shown in Figure 2-1.

Figure 2-1: Sampling Locations Relative to MCRRF Facility



Note: Concentration isopleths represent 5-year average particulate air concentrations at ground level. Colors of isopleth lines show regions of low (yellow), medium (orange shades), and higher (brown) impacts.

### 2.2.2 Location of Samplers

The ambient samplers were installed on the roof of Lucketts Elementary School, in the north east corner. At this sampling location the roof, above the gymnasium, is approximately 20 feet above ground level. Figure 2-2 depicts the actual location of the Total Suspended Particulate (TSP)/metals high volume air samplers during the three January/February 2014 sampling events. Figure 2-3 depicts the actual location of the PCDDs/PCDFs samplers during the February 2015 sampling event (30 days).

**Figure 2-2: Lucketts Sampling Location (Winter 2014 Sampling Events)  
TSP/Metals Samplers – February 2014**



**Figure 2-3: Lucketts Sampling Location (Winter 2015 30 Day Sampling Event)  
Dioxin/Furan Samplers - February 2015**



## **2.3 Beallsville Site**

### ***2.3.1 Description of Location***

The “impact” location was at the Beallsville Fire Station. The fire station is located at 19801 Beallsville Rd. in Beallsville, Maryland. The Beallsville site is located approximately four miles East Southeast of the MCRRF as shown in Figure 2-1.

### ***2.3.2 Location of Samplers***

The Beallsville sampling location was behind the firehouse, to the southeast, in a recreation area. Ambient samplers (including co-located pairs) were installed on the roof of a pavilion on the south side of a baseball field. At this sampling location, the samplers were approximately 14 feet above ground level. Figure 2-4 depicts actual locations of samplers during the three January/February 2014 sampling events. Figure 2-5 depicts the actual locations of the PCDDs/PCDFs samplers during the February 2015 sampling event (31 days).

**Figure 2-4: Beallsville Sampling Location (Winter 2014 Sampling Events)  
TSP/Metals Samplers – February 2014**



**Figure 2-5: Beallsville Sampling Location (Winter 2015 31 Day Sampling Event)  
Dioxin/Furan Samplers - February 2015**



### **3.0 SAMPLE COLLECTION PROCEDURES**

The following sections provide a brief description of the sampling procedures that were employed for each parameter and a summary of the equipment used.

#### **3.1 Metals**

Three 24-hour sampling events for metals took place at each of the two sampling locations. A single sampler was set up at the Lucketts School Site and a co-located sampler pair was set up at the Beallsville Site.

Quartz fiber filters (8"x10") were used in high volume air samplers to collect TSP samples. These samples were collected utilizing high volume air sampling techniques in accordance with US EPA Standard Reference Method 40 CFR Part 50 Appendix B, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method). Samples were collected over a 24-hour period. During each sampling event ambient air was collected at a flow rate of approximately 1000 liters per minute (lpm), resulting in a final sample volume of approximately 1,200 – 1,500 m<sup>3</sup>. Numbered, pre-weighed quartz fiber filters provided by Alpha Analytical were placed in each sampling system prior to the start of each sampling event and removed at the end of each sampling period.

The TSP filters were analyzed for metals using two different methods. First, each filter was analyzed by Alpha Analytical in Mansfield, MA for a target list of seven metals: beryllium, cadmium, chromium, lead, nickel, arsenic and mercury (particulate associated only). These are the same metals evaluated in previous air sampling programs. Once this metals analysis was completed, the filters were shipped to a second lab (Chester LabNet in Tigard, OR) where they were analyzed for a broader suite of metals to provide metals profiles in the ambient air samples. These ambient air profiles were compared to similarly determined profiles of MCRRF emissions to evaluate potential impacts of MCRRF emissions on ambient air quality.

#### **3.2 Mercury**

Three 24-hour sampling events for mercury took place at each of the two sampling locations. As with the TSP metals, a single sampler was set up at the Lucketts School Site and a co-located sampler pair was set up at the Beallsville Site.

An iodated carbon trap was used to collect total mercury (particulate associated plus vapor). The samples were then analyzed using cold vapor atomic fluorescence (CVAFS). The carbon trap is a proven and sensitive method for detecting trace ambient levels of atmospheric mercury. To collect the mercury sample, a personal sampling pump was attached to the carbon trap and set at a flow rate of approximately 0.4 lpm for 24 hours, resulting in a total air volume of approximately 0.6 m<sup>3</sup>. An arrow on the tube indicated the direction of the air flow. Prior to collection, the end plugs of the carbon traps were removed while wearing clean gloves and placed into the bag in which the tube was received. Upon completion of the sampling event, these plugs were placed back on the carbon traps while wearing clean gloves.

### **3.3 PCDDs/PCDFs**

A single 31-day sampling event took place at each of the two sampling locations. A single sampler, plus one back-up was set up at the Lucketts School Site and a co-located sampler pair plus two back-ups were set up at the Beallsville Site.

PCDDs/PCDFs samples were collected utilizing a TSP type filter, which was necessary to address the higher particulate collection that takes place over a 31 day sampling event. To collect a dioxins/furans sample, the filter and polyurethane foam cartridge were installed within a PS-1 sampler, and set at a flow rate of approximately 200 lpm. The total volume over the 31 day sampling period was approximately 8,500 m<sup>3</sup>. The sampling method followed the Connecticut Department of Energy and Environmental Protection (CTDEEP) method which represents a highly sensitive and reliable technique for sampling of PCDDs/PCDFs congeners and other persistent organic pollutants (POPs) at ultra-trace levels in ambient air. [3] Field methodology incorporated flow audits, weekly flow checks, and motor/brush replacements prior to each sampling event.

### **3.4 Stack Samples – Particulate EPA M5/M29**

Three one-hour test runs were collected over a four day period at the three stacks of the MCRRF. Isokinetic stack sampling was performed by Testar Inc. Total particulate samples from these runs were collected utilizing EPA Methods 5/202 and 29. The resulting nine filter samples (three from each stack) plus one blank were analyzed for metals by XRF.

## 4.0 LABORATORY ANALYSIS

### 4.1 Ambient Metals Samples

Filters with unique ID numbers were conditioned in an environmentally controlled and monitored chamber to a constant humidity and temperature then gravimetrically tared. The starting (tare) weight was recorded for use upon return of the filters as samples. After the filters had been collected, they were returned to Alpha Analytical and conditioned as before and weighed. The final filter weight minus the tare weight was calculated and the TSP value was reported. [4]

#### 4.1.1 TSP Metals (Method 6020)

Subsequently, Alpha Analytical performed analysis of the filters for metals and particulate mercury. Two strips from the center of the filter were cut and one was used for metals digestion and one for mercury digestion. The metals preparation was performed following EPA Method 3050 with subsequent analysis by EPA Method SW-846 Methods 6020A/7471B [5, 6]. The mercury preparation and analysis was performed following EPA Method 7471 [7].

#### 4.1.2 Metals (XRF) – Ambient Air Filter Samples

After the Method 6020 analysis of TSP filters was conducted, the filters were shipped to Chester LabNet for more detailed testing. The test consisted of taking 46 millimeter (mm) diameter punches from each sample and analysis by Energy Dispersive X-Ray Fluorescence (EDXRF) using EPA method IO-3.3. The following excitation conditions were used to analyze the samples:

Condition 0: used a Fe secondary target for excitation of Al, Si, P, S, Cl, K, Ca, Ti, V, and Cr K $\alpha$  X-rays. The Fe secondary target is located 45° relative to the sample. The X-ray tube excitation energy was 25 kV, and the counting live time was 200 seconds.

Condition 1: used a Ge secondary target for excitation of K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, and Zn K $\alpha$  X-rays. The Ge secondary target is located 45° relative to the sample. The X-ray tube excitation energy was 30 kV, and the counting live time was 240 seconds.

Condition 2: used direct excitation from the Rh X-ray tube which is filtered with a Rh foil prefilter for the excitation of Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Y, Zr, Mo K $\alpha$  X-rays, as well as Hg and Pb L $\alpha$  and L $\beta$  X-rays. The direct excitation source is located 23° relative to the sample. The X-ray tube excitation energy was 35 kV, and the counting live time was 400 seconds.

Condition 3: used direct excitation from the Rh X-ray tube which is filtered with a W foil prefilter for the excitation of Pd, Ag, Cd, In, Sn, Sb, Ba, and La K $\alpha$  X-rays. The direct excitation source is located 23° relative to the sample. The X-ray tube excitation energy was 55 kV, and the counting live time was 560 seconds.

The detector was located 45° relative to the sample in each excitation condition.

A quality assurance standard was analyzed simultaneously, and provided a comparison to values established during calibration for Ti, Fe, Se, Cd, and Pb. One sample was chosen out of each analysis batch for reanalysis. The values for Al through Ge (atomic numbers 13 through 32) were corrected for theoretical absorption due to the deposit, as well as the quartz filter matrix. The data was then corrected for spectral overlaps, and reported “as is”. No blank corrections were made for quartz filter analyses due to the broad variability of “contaminants” found in the substrate.

## 4.2 Mercury

All carbon trap samples were prepared in accordance with EPA Method 324 and analyzed in accordance with EPA Method 1631, Revision E, by Brooks Rand Labs (BRL). Samples were digested with nitric acid and sulfuric acid (a 70:30 ratio) at 90 °C for 4 hours. The digests were then brought up to volume with 35% bromine monochloride (BrCl), which oxidized all of the mercury to Hg(II). The digests were then analyzed with stannous chloride (SnCl<sub>2</sub>) reduction, single gold amalgamation, and CVAFS detection using a Brooks Rand Instruments MERX-T CVAFS Mercury Automated-Analyzer.

The results were method blank-corrected as described in the calculations section of the relevant BRL standard operating procedures (SOPs) and were evaluated using reporting limits that had been adjusted to account for sample aliquot size, if necessary. The *Sample Results* page of the respective lab reports provide additional information about sample-specific method detection limits (MDLs), method reporting limits (MRLs), and other details (see Appendix E). Samples were reported on a ng/trap basis. Sample results that were less than the MDL were qualified U and reported at the MDL.

## 4.3 PCDDs/PCDFs

Prior to field deployment, sample media was prepared at the laboratory (i.e., glassware was prepared and the polyurethane foam (PUF) and filter were purchased pre-cleaned). Surrogate compounds (i.e., sampling standards) were added to the center bed of the PUF using a pipette; quality control aliquots were also prepared at this time and stored refrigerated in 4 ounce jars to be analyzed along with the sample batch. Laboratory quality control samples included a method blank, laboratory control samples, and a laboratory control sample duplicate.

Samples were analyzed by Cape Fear Analytical in Wilmington, NC in accordance with US EPA Method TO-9A (Determination of Polychlorinated, Polybrominated and Brominated/Dibenzo-p-Dioxins and Dibenzofurans in Ambient Air). The samples were extracted according to Method TO-9A. At the end of the extraction period, the solvent was concentrated to about 30 mL, cooled and transferred to a 60 mL vial, half of the extract was then archived into a second 60 mL vial. Prior to analysis sample extracts underwent a cleanup procedure. The TO-9A air samples were subjected to two types of cleanup columns, one being a silica gel column and the other a florisil column. The sample extract was then added to the cleanup column and eluted into

collection vials. The dioxin fraction was collected in dichloromethane, concentrated to approximately 0.5 mL and quantitatively transferred to a labeled vial.

Following cleanup sample extracts were reduced to dryness and reconstituted with 20 uL of nonane which contained the injection standard. The batch of sample extracts was then subjected to High Resolution Gas Chromatography-High Resolution Mass Spectrometry (HRGC-HRMS) selected ion monitoring (SIM) analysis using a DB-5 fused silica capillary column. Qualified peaks were quantified using defined calibration procedures. Predetermined Quality Assurance/Quality Control (QA/QC) criteria were used to verify acceptable analysis parameters that were maintained from sampling through analysis for each sample, method blank, and control spike. Concentration results for dioxins and furans were calculated in units of  $\text{pg}/\text{m}^3$  based on sample volumes provided by TRC.

#### **4.4 Metals (XRF) – MCRRF Source Particulate Samples**

The nine quartz filter samples collected from the three units at the MCRRF plus one blank were analyzed by X-Ray Fluorescence (XRF) at Chester LabNet in Tigard, Oregon. Sample preparation and analyses procedures employed by the lab were identical to those used for XRF analyses of the ambient air samples. These procedures were described previously in Section 4.1.2.

## **5.0 SAMPLING SCHEDULE**

Ambient air samples were collected at two sites in the vicinity of the MCRRF during the winters of 2014 and 2015. The Beallsville site and Lucketts site were described previously in Section 2.0 of this report. Three 24-hour TSP metals and mercury samples were collected over the period of January 28<sup>th</sup> through February 27<sup>th</sup> of 2014. One 31-day sampling period for dioxins and furans took place over the period of February 3<sup>rd</sup> through March 4<sup>th</sup> of 2015. Sample collection information is provided in Table 5-1. During the summer of 2014 source emission samples were collected at the three unit stacks of the MCRRF over the period of August 11<sup>th</sup> through 14<sup>th</sup>. Sample collection information for stack samples is provided in Table 5-2.

### **5.1 Metals**

Metals samples were collected following the method summarized in Section 3.1. For each sampling event a co-located pair of high-volume samplers was set up at the Beallsville site, while a single high-volume sampler was set up at the Lucketts site. Metals samples were collected over a 24-hour period, with the exception of the second sampling event which took place over a 23-hour period. Metals samples were shipped to Alpha Analytical in Mansfield, MA for analysis in accordance with EPA Method SW-846 Methods 6020A/7471B. Subsequent to metals analysis at Alpha Analytical, a portion of the filter was sent to Chester LabNet in Tigard, Oregon for analysis by XRF.

### **5.2 Mercury (Total Vapor/Particulate)**

Mercury samples were collected following the method summarized in Section 3.2. For each sampling event a co-located pair of low-volume samplers was set up at the Beallsville site, while a single low-volume sampler was set up at the Lucketts site. All samples were collected over a 24-hour period, with the exception of the second sampling event which took place over a 23-hour period. Mercury samples were shipped to Brooks Rand Laboratories located in Seattle, WA for analysis in accordance with EPA Method 1631, Revision E.

### **5.3 PCDDs/PCDFs**

Dioxins/furans samples were collected following the method summarized in Section 3.3. For the 31-day sampling event a co-located pair of PS-1 samplers was set up at the Beallsville site, while a single PS-1 sampler was set up at the Lucketts site. An identical set of samplers were also in operation at both sites in the event there were any issues with the primary samplers during the 31-day sampling period. Dioxins/furans samples were shipped to Cape Fear Analytical in Wilmington, NC for analysis in accordance with US EPA Method TO-9A.

**Table 5-1: Montgomery County RRF Ambient Sampling Event Summary**

Chemical Class	Sampling Sites	Sampling Event	Sampling Period		Notes
			Start Time	End Time	
Metals (including Mercury)	Lucketts (Background)	1	1/28/2014 10:27	1/29/2014 10:27	24-hour sample
	Beallsville* (Impact)	1	1/28/2014 13:30	1/1/2914 13:31	24-hour sample
	Lucketts (Background)	2	2/6/2014 16:43	2/7/2014 15:43	23-hour sample
	Beallsville* (Impact)	2	2/6/2014 17:46	2/7/2014 16:46	23-hour sample
	Lucketts (Background)	3	2/26/2014 11:20	2/27/2014 11:20	24-hour sample
	Beallsville* (Impact)	3	2/26/2014 14:34	2/27/2014 14:34	24-hour sample
Dioxins/Furans	Lucketts (Background)	1	2/3/2015 10:20	3/4/2015 20:00	31-day sample
	Beallsville* (Impact)	1	2/3/2015 12:10	3/4/2015 21:40	31-day sample

\*All samples at the Beallsville site were collected as a collocated pair.

**5.4 Stack Samples – Particulates EPA M5/M29**

During the calendar period August 11<sup>th</sup> through 14<sup>th</sup> 2014 Testar collected stack samples following the methods described in Section 3.4. Three 1-hour isokinetic sample runs were collected at each unit stack. A total of nine samples and one reagent blank were shipped to Chester LabNet for XRF analysis.

**Table 5-2: Stack Sampling Summary**

Unit Stack	Run #	Start Time	End Time
1	1	8/11/2014 14:04	8/11/2014 15:08
	2	8/12/2014 16:46	8/12/2014 17:51
	3	8/13/2014 12:50	8/13/2014 13:58
2	1	8/12/2014 17:20	8/12/2014 18:27
	2	8/13/2014 16:02	8/13/2014 17:07
	3	8/14/2014 7:06	8/17/2015 8:15
3	1	8/13/2014 12:51	8/13/2014 13:59
	2	8/14/2014 7:43	8/14/2014 8:48
	3	8/14/2014 9:09	8/14/2014 10:14

## 6.0 RESULTS

### 6.1 Metals

Three separate sampling events took place, each representing a 24 hour sampling period in the winter of 2014. Collocated TSP filter samples were collected at the Beallsville site while a single sample was collected at the Lucketts site. Samples were collected during three calendar periods as follows: January 28 to 29, February 6 to 7, and February 26 to 27.

All metals filter samples were analyzed for TSP and a series of metals as follows: arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg) and nickel (Ni). Results are summarized in Table 6-1. All parameters are reported in units of  $\text{ng}/\text{m}^3$ . Note that results for mercury represent particulate associated concentrations only. High volume filter sampling techniques such as those used here are not appropriate for the collection of vapor phase or gaseous mercury present in the atmosphere. Average concentrations for each parameter are also provided in Table 6-1 as follows: site specific basis (averaged across all sampling events).

**Table 6-1: Montgomery County RRF Ambient Air Sampling Program High Volume Total Suspended Particulates and Metals Results**

Sampling Event	Sample Location	Sample ID	Start Date	Start Time	End Date	Start Temp	End Temp	Volume m3 (STP)	Results																			
									Arsenic		Beryllium		Cadmium		Chromium		Lead		Mercury		Nickel		Particulate(TSP)					
									ug	ng/m3	ug	ng/m3	ug	ng/m3	ug	ng/m3	ug	ng/m3	ug	ng/m3	ug	ng/m3	ug	ng/m3	g	ug/m3		
1	Beallsville	B'ville-Metals-1-Pri	1/28/2014	13:30	1/29/2014	12	19	1,833.6	<b>0.981</b>	<b>0.595</b>	< 0.27	0.135	ND	<b>0.351 J</b>	<b>0.351</b>	<b>0.191</b>	< 45	22.5	ND	<b>2.79 J</b>	<b>1.52</b>	< 0.045	0.0225	ND	<b>1.38</b>	<b>0.753</b>	<b>0.029</b>	<b>15.8</b>
	Beallsville	B'ville-Metals-1-Col	1/28/2014	13:30	1/29/2014	12	19	1,813.9	<b>1.11</b>	<b>0.612</b>	< 0.27	0.135	ND	<b>3.04 J</b>	<b>3.04</b>	<b>1.68</b>	< 45	22.5	ND	<b>4.10 J</b>	<b>2.26</b>	< 0.045	0.0225	ND	<b>1.71</b>	<b>0.943</b>	<b>0.0296</b>	<b>16.3</b>
	Lucketts	Luck-Metals-1-Pri	1/28/2014	10:27	1/29/2014	10	12	1,864.1	<b>1.02</b>	<b>0.547</b>	< 0.27	0.135	ND	<b>0.312</b>	<b>0.312</b>	<b>0.167</b>	< 45	22.5	ND	<b>3.05</b>	<b>1.64</b>	< 0.045	0.0225	ND	<b>1.15</b>	<b>0.617</b>	<b>0.04</b>	<b>21.5</b>
	Field Blank	FBB-Metals-1						N/A	< 0.45	N/A	< 0.27	0.135	N/A	< 0.18	0.09	N/A	< 45	22.5	N/A	< 0.54	N/A	< 0.045	0.0225	N/A	< 0.9	N/A	-0.0019	N/A
2	Beallsville	B'ville-Metals-2-Pri	2/6/2014	17:46	2/7/2014	31	40	1,803.2	<b>1.2</b>	<b>0.665</b>	< 0.27	0.135	ND	< 0.18	0.09	ND	< 45	22.5	ND	<b>3.96</b>	<b>2.20</b>	< 0.045	0.0225	ND	<b>1.31</b>	<b>0.726</b>	<b>0.0249</b>	<b>13.8</b>
	Beallsville	B'ville-Metals-2-Col	2/6/2014	17:46	2/7/2014	31	40	1,737.2	<b>1.1</b>	<b>0.633</b>	< 0.27	0.135	ND	< 0.18	0.09	ND	< 45	22.5	ND	<b>3.88</b>	<b>2.23</b>	< 0.045	0.0225	ND	<b>1.34</b>	<b>0.771</b>	<b>0.03</b>	<b>17.3</b>
	Lucketts	Luck-Metals-2-Pri	2/6/2014	16:43	2/7/2014	35	40	1,660.0	<b>0.69</b>	<b>0.416</b>	< 0.27	0.135	ND	< 0.18	0.09	ND	< 45	22.5	ND	<b>3.63</b>	<b>2.19</b>	< 0.045	0.0225	ND	<b>1.44</b>	<b>0.867</b>	<b>0.0485</b>	<b>29.2</b>
	Field Blank	FBB-Metals-2						N/A	< 0.45	ND	< 0.27	0.135	N/A	< 0.18	0.09	N/A	< 45	22.5	N/A	< 0.54	N/A	< 0.045	0.0225	N/A	< 0.9	N/A	<b>0.0017</b>	N/A
3	Beallsville	B'ville-Metals-3-Pri	2/26/2014	14:34	2/27/2014	31	32	1,711.7	<b>0.609</b>	<b>0.356</b>	< 0.27	0.135	ND	< 0.18	0.09	ND	< 45	22.5	ND	<b>3.22</b>	<b>1.88</b>	< 0.045	0.0225	ND	<b>1.91</b>	<b>1.116</b>	<b>0.0299</b>	<b>17.5</b>
	Beallsville	B'ville-Metals-3-Col	2/26/2014	14:34	2/27/2014	31	32	1,717.1	<b>0.719</b>	<b>0.419</b>	< 0.27	0.135	ND	<b>0.233</b>	<b>0.233</b>	<b>0.136</b>	< 45	22.5	ND	<b>3.39</b>	<b>1.97</b>	< 0.045	0.0225	ND	<b>1.67</b>	<b>0.973</b>	<b>0.03</b>	<b>20.0</b>
	Lucketts	Luck-Metals-3-Pri	2/26/2014	11:20	2/27/2014	33	33	1,737.0	<b>0.652</b>	<b>0.375</b>	< 0.27	0.135	ND	<b>0.229</b>	<b>0.229</b>	<b>0.132</b>	< 45	22.5	ND	<b>3.88</b>	<b>2.23</b>	< 0.045	0.0225	ND	<b>1.68</b>	<b>0.967</b>	<b>0.0382</b>	<b>22.0</b>
	Field Blank	FBB-Metals-3						N/A	< 0.45	ND	< 0.27	0.135	N/A	< 0.18	0.09	ND	< 45	22.5	N/A	< 0.54	N/A	< 0.045	0.0225	N/A	< 0.9	N/A	<b>0.0003</b>	N/A
Mean Sample Results from all Sampling Events at Lucketts									0.787	0.446	0.135	0.077	0.210		0.120	22.5	12.8	3.52	2.02	0.023	0.013	1.42	0.817	0.042	24.2			
Mean Sample Results from all Sampling Events at Beallsville									0.953	0.537	0.135	0.076	0.649		0.367	22.5	12.7	3.56	2.01	0.023	0.013	1.55	0.880	0.030	16.8			

Notes:  
 Volumes are provided in cubic meters at standard temperature and pressure  
 Volumes are not available for field blank samples, since no air was collected through those filters  
 Values in **bold** indicate detected concentrations  
 Mean Sample Results were calculated with NDs=1/2 Reporting Limit  
 J - Data Qualifier refer to Appendix G  
 N/A - Not Applicable  
 ND - Not Detected

## **6.2 Mercury (Total/Vapor Particulate)**

Three (3) separate sampling events took place, each representing a 24 hour composite sampling period in the winter of 2014. Collocated samples were collected at the Beallsville site while a single sample was collected at the Lucketts site. Samples were collected during three (3) calendar periods as follows: January 28 to 29, February 6 to 7 and February 26 to 27. All samples were analyzed for total mercury (vapor and particulate). Results are summarized in Table 6-2 and reported in units of  $\text{ng}/\text{m}^3$ . Average concentrations on a site specific basis (averaged across all sampling events) are also provided.

Table 6-2  
Montgomery County RRF Ambient Air Sampling Program  
Low Volume Mercury Results (Total Vapor + Particulate)

Sampling Event	Sample Location	Sample ID	Start Date	End Date	Volume (m3)	Total Hg (ng)	Total Hg (ng/m3)	Comments
1	Beallsville	B'ville-Hg-1-Pri	1/28/2014	1/29/2014	0.5944	<b>22.1</b> <b>22.1</b> J	<b>37.2</b>	spike set up at B'ville location
	Beallsville	B'ville-Hg-1-Col	1/28/2014	1/29/2014	0.5886	< 1.1 0.55 J	ND	
	Beallsville	B'vill-Spike-Hg-1	1/28/2014	1/29/2014	0.5685	<b>47</b> <b>47</b>	<b>82.7</b>	
	Lucketts	Luck-Hg-1-Pri	1/28/2014	1/29/2014	0.5436	< 1.1 0.55	ND	
2	Beallsville	B'ville-Hg-2-Pri	2/6/2014	2/7/2014	0.6086	< 1.1 0.55	ND	no air drawn through FBB
	Beallsville	B'ville-Hg-2-Col	2/6/2014	2/7/2014	0.6029	< 1.1 0.55	ND	
	Beallsville	FBB-Hg-1	2/6/2014	2/7/2014	0.0000	<b>37.6</b> <b>37.6</b>	N/A	
	Lucketts	Luck-Hg-2-Pri	2/6/2014	2/7/2014	0.5690	< 1.1 0.55	ND	
3	Beallsville	B'ville-Hg-3-Pri	2/26/2014	2/27/2014	0.6348	<b>1.3</b> <b>1.3</b> J	<b>2.048</b>	no air drawn through FBB sample lost during transport
	Beallsville	B'ville-Hg-3-Col	2/26/2014	2/27/2014	0.6281	<b>3.1</b> <b>3.1</b> J	<b>4.935</b>	
	Beallsville	FBB-Hg-2	2/26/2014	2/27/2014	0.0000	< 1.1 0.55	N/A	
	Lucketts	Luck-Hg-3-Pri	2/26/2014	2/27/2014		INVALID SAMPLE		
Mean Sample Results from all Sampling Events at Lucketts						<b>0.55</b>	<b>0.001</b>	
Mean Sample Results from all Sampling Events at Beallsville						<b>4.69</b>	<b>0.008</b>	

Notes:

Volumes are provided in cubic meters at standard temperature and pressure

Volumes are not available for field blank samples, since no air was collected through these media

Values in **bold** indicate detected concentrations

Mean Sample Results were calculated with NDs=1/2 Reporting Limit

Sample B'ville-Spike-Hg-1 was spiked at the lab, prior to analysis, with 50 ng Hg. Resulting %R = 94%. Refer to Appendix E.

A field blank sample was not collected during the first sampling event.

J - Data Qualifier Refer to Appendix G

N/A - Not Applicable

ND - Not Detected

### 6.3 PCDDs/PCDFs

A single 31 day sampling event took place during the calendar period February 3 to March 4, 2015. All samples at each site were collected in duplicate; four (4) total at Beallsville and two (2) total at Lucketts. A collocated pair of samples collected at the Beallsville site and a single sample collected at the Lucketts site were analyzed for polychlorinated dioxins and polychlorinated furans (PCDDs/PCDFs). Results for each of the 17 2,3,7,8-substituted PCDDs/PCDFs congeners and eight homologue groups (total tetra, Cl<sub>4</sub>, – hepta, Cl<sub>7</sub>, and octa, Cl<sub>8</sub>, PCDDs and PCDFs) are summarized in Table 6-3.

A summary of the homologue group data only (Cl<sub>4</sub> – Cl<sub>8</sub>) for the three sample set is provided in Table 6-4. These results were used in plotting the PCDDs/PCDFs profiles presented in Section 8.3 to follow. All results presented in Tables 6-3 and 6-4 are provided in units of pg/m<sup>3</sup> and represent values not corrected with the corresponding field or laboratory method blanks.

**Table 6-3**  
**Montgomery County RRF Ambient Air Sampling Program**  
**Dioxins/Furans Sampling Results - 31 day Samples Collected February 3, 2015 - March 4, 2015**

Sample ID	Bville-Dioxins-PS-4-Primary				Bville-Dioxins-PS-1-Collocate			Bville Blank-Dioxins		Lucketts-Dioxins-PS-5-Primary			Lucketts Blank-Dioxins	
Sampling Location	Beallesville				Beallesville			Beallesville		Lucketts School			Lucketts School	
Sample Volume (m3)	8,844.6				8,628.6			N/A		8,707.3			N/A	
Parameter	TEF	Conc.	Flag	TEQ Subtotal	Conc.	Flag	TEQ Subtotal	Conc.	Flag	Conc.	Flag	TEQ Subtotal	Conc.	Flag
2,3,7,8-TCDD	1.0000	< 0.001	U	1.14E-03	<b>0.001</b>	J	1.14E-03	< 0.001	U	<b>0.003</b>		3.00E-03	< 0.0004	U
1,2,3,7,8-PeCDD	1.0000	<b>0.004</b>	J	3.91E-03	<b>0.003</b>	J	3.32E-03	< 0.0005	U	<b>0.017</b>		1.73E-02	< 0.001	U
1,2,3,4,7,8-HxCDD	0.1000	<b>0.006</b>	J	6.36E-04	<b>0.005</b>	J	5.11E-04	< 0.001	U	<b>0.020</b>		1.99E-03	< 0.001	U
1,2,3,6,7,8-HxCDD	0.1000	<b>0.010</b>	J	9.50E-04	<b>0.009</b>	J	9.15E-04	< 0.001	U	<b>0.034</b>		3.38E-03	< 0.001	U
1,2,3,7,8,9-HxCDD	0.1000	<b>0.011</b>	J	1.09E-03	<b>0.012</b>	J	1.23E-03	< 0.001	U	<b>0.039</b>		3.93E-03	< 0.001	U
1,2,3,4,6,7,8-HpCDD	0.0100	<b>0.122</b>	J	1.22E-03	<b>0.112</b>	J	1.12E-03	< 0.001	U	<b>0.455</b>	J	4.55E-03	< 0.001	U
OCDD	0.0003	<b>0.416</b>		1.25E-04	<b>0.344</b>		1.03E-04	<b>0.004</b>	J	<b>1.480</b>		4.44E-04	<b>0.002</b>	J
2,3,7,8-TCDF	0.1000	<b>0.002</b>	J	1.68E-04	< 0.002	U	1.73E-04	< 0.001	U	<b>0.003</b>		2.59E-04	< 0.001	U
1,2,3,7,8-PeCDF	0.0300	<b>0.002</b>	J	5.16E-05	<b>0.002</b>	J	6.12E-05	< 0.0003	U	<b>0.003</b>	J	9.36E-05	< 0.001	U
2,3,4,7,8-PeCDF	0.3000	<b>0.003</b>	J	8.97E-04	<b>0.004</b>	J	1.12E-03	< 0.0003	U	<b>0.005</b>	J	1.53E-03	< 0.001	U
1,2,3,4,7,8-HxCDF	0.1000	<b>0.004</b>	J	4.03E-04	<b>0.004</b>	J	4.03E-04	< 0.0003	U	<b>0.007</b>	J	6.75E-04	< 0.001	U
1,2,3,6,7,8-HxCDF	0.1000	<b>0.004</b>	J	3.73E-04	<b>0.004</b>	J	3.80E-04	< 0.0003	U	<b>0.006</b>	J	5.72E-04	< 0.0004	U
2,3,4,6,7,8-HxCDF	0.1000	<b>0.005</b>	J	4.67E-04	<b>0.004</b>	J	3.99E-04	< 0.0003	U	<b>0.007</b>	J	7.45E-04	< 0.0005	U
1,2,3,7,8,9-HxCDF	0.1000	<b>0.003</b>	J	2.65E-04	<b>0.002</b>	J	2.04E-04	< 0.0004	U	<b>0.005</b>	J	4.75E-04	< 0.001	U
1,2,3,4,6,7,8-HpCDF	0.0100	<b>0.018</b>	J	1.80E-04	<b>0.018</b>	J	1.80E-04	< 0.0004	U	<b>0.028</b>	J	2.78E-04	<b>0.001</b>	J
1,2,3,4,7,8,9-HpCDF	0.0100	<b>0.003</b>	J	3.10E-05	<b>0.003</b>	J	3.06E-05	< 0.001	U	<b>0.005</b>	J	4.74E-05	< 0.001	U
OCDF	0.0003	<b>0.020</b>	J	5.91E-06	<b>0.016</b>	J	4.77E-06	< 0.003	U	<b>0.036</b>		1.09E-05	< 0.001	U
Total TCDD	N/A	<b>0.014</b>		N/A	<b>0.019</b>	J	N/A	< 0.001	U	<b>0.076</b>		N/A	< 0.0004	U
Total PeCDD	N/A	<b>0.044</b>		N/A	<b>0.046</b>		N/A	< 0.0005	U	<b>0.196</b>	J	N/A	< 0.001	U
Total HxCDD	N/A	<b>0.127</b>		N/A	<b>0.135</b>		N/A	< 0.001	U	<b>0.491</b>		N/A	< 0.001	U
Total HpCDD	N/A	<b>0.269</b>	J	N/A	<b>0.254</b>	J	N/A	< 0.001	U	<b>1.080</b>	J	N/A	< 0.001	U
Total TCDF	N/A	<b>0.067</b>	J	N/A	<b>0.072</b>	J	N/A	< 0.001	U	<b>0.117</b>	J	N/A	< 0.001	U
Total PeCDF	N/A	<b>0.048</b>	J	N/A	<b>0.052</b>		N/A	< 0.0002	U	<b>0.073</b>		N/A	< 0.0002	U
Total HxCDF	N/A	<b>0.049</b>		N/A	<b>0.042</b>		N/A	< 0.0003	U	<b>0.082</b>	J	N/A	< 0.0004	U
Total HpCDF	N/A	<b>0.035</b>	J	N/A	<b>0.035</b>	J	N/A	< 0.0004	U	<b>0.065</b>	J	N/A	<b>0.001</b>	J
Sum of Total PCDDs/PCDFs Tetra – Octa (Cl4 - Cl8)		<b>1.09</b>			<b>1.02</b>			<b>0.012</b>		<b>3.70</b>			<b>0.008</b>	
<b>Total TEQ</b>		<b>0.012</b>			<b>0.011</b>			<b>N/A</b>		<b>0.039</b>			<b>N/A</b>	

Notes:

Volumes are provided in cubic meters at standard temperature and pressure

Volumes are not available for field blank samples, since no air was collected through those samples

Values in **bold** represent detected concentrations

J - Data Qualifier Refer to Appendix G

U - Analyte was analyzed for, but not detected above the specified estimated detection limit.

TEF - Toxic Equivalency Factor; van den Berg, et.al, 2006, "The 2005 World Health Organization Re-evaluation of Human and Mamallian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds"

TEQ - Toxicity Equivalence; sum of individual 2,3,7,8-PCDDs/PCDFs TEQ Subtotals, values presented in scientific notation (e.g. 1.0E-04 = 0.0001)

N/A - Not Applicable

**Table 6-4: Montgomery County RRF Ambient Air Sampling Program Dioxins/Furans Sampling Results (Homologue Sums) – 31 Day Samples Collected February 3, 2015 – March 4, 2015**

Sample ID	B'ville-Dioxins-PS-4-Primary	B'ville-Dioxins-PS-1-Collocate	Lucketts-Dioxins-PS-5-Primary
Sampling Location	Beallsville	Beallsville	Lucketts School
Sample Volume (m <sup>3</sup> )	8,844.6	8,628.6	8707.3
<b>Homologue Sums</b>	Conc.	Conc.	Conc.
<b>TO-9A Dioxins/Furans (pg/m<sup>3</sup>)</b>			
Total TCDD	<b>0.014</b>	<b>0.019</b>	<b>0.076</b>
Total PeCDD	<b>0.044</b>	<b>0.046</b>	<b>0.196</b>
Total HxCDD	<b>0.127</b>	<b>0.135</b>	<b>0.491</b>
Total HpCDD	<b>0.269</b>	<b>0.254</b>	<b>1.080</b>
OCDD	<b>0.416</b>	<b>0.344</b>	<b>1.480</b>
Total TCDF	<b>0.067</b>	<b>0.072</b>	<b>0.117</b>
Total PeCDF	<b>0.048</b>	<b>0.052</b>	<b>0.073</b>
Total HxCDF	<b>0.049</b>	<b>0.042</b>	<b>0.082</b>
Total HpCDF	<b>0.035</b>	<b>0.035</b>	<b>0.065</b>
OCDF	<b>0.020</b>	<b>0.016</b>	<b>0.036</b>
Sum of Total PCDDs/PCDFs (Tetra – Octa) (Cl <sub>4</sub> - Cl <sub>8</sub> )	<b>1.09</b>	<b>1.02</b>	<b>3.70</b>

Notes:

Volumes are provided in cubic meters at standard temperature and pressure

Values in **bold** represent detected concentrations

#### 6.4 Metals – XRF – TSP Filter Samples

A total of twelve (12) filter samples (8”x10” quartz) were submitted to Chester LabNet for metals analyses by X-Ray fluorescence (EPA Method TO-3.3). Small aliquots of filter media were removed from each filter sample to undergo XRF analyses. These included four (4) samples from each of three (3) sampling events. Each sampling event consisted of the following sample types: Beallsville (collocated pair), Lucketts (single sample) and field blank. Each sample was analyzed for the 35 metals listed in Table 6-5. A complete set of results on a sample specific basis are reported in Appendix B. All results are provided in units of ug/filter and do not represent blank corrected values. These data were used to develop the metallic profiles shown in Section 8 to follow.

**Table 6-5: Metals Listing X-Ray Fluorescence Analyses (MDL ug/Filter)  
Chester LabNet**

<b>Metal</b>	<b>Symbol</b>	<b>MDL</b>
Aluminum	Al	609
Phosphorus	P	415
Sulfur	S	64.3
Chlorine (as Chloride)	Cl	20.6
Potassium	K	7.60
Calcium	Ca	5.45
Titanium	Ti	3.98
Vanadium	V	3.93
Chromium	Cr	4.09
Manganese	Mn	5.13
Iron	Fe	4.02
Cobalt	Co	3.38
Nickel	Ni	3.67
Copper	Cu	3.52
Zinc	Zn	3.49
Gallium	Ga	4.37
Germanium	Ge	3.73
Arsenic	As	3.12
Selenium	Se	2.88
Bromine (as Bromide)	Br	2.68
Rubidium	Rb	3.42
Strontium	Sr	4.10
Yttrium	Y	5.14
Zirconium	Zr	6.30
Molybdenum	Mo	9.27
Palladium	Pd	7.58
Silver	Ag	8.06
Cadmium	Cd	8.44
Indium	In	8.91
Tin	Sn	10.4
Antimony	Sb	12.2
Barium	Ba	37.7
Lanthanum	La	48.5
Mercury	Hg	6.70
Lead	Pb	8.17

MDL = Method Detection Limit for analyte (ug/filter). Represents three (3) sigma interferences free value (see Appendix B and C).

## **6.5 Metals – XRF – EPA Method 5/29 MCRRF Stack Samples**

A total of nine filter samples, plus a blank, representing particulate emissions from the MCRRF were submitted to Chester LabNet for metals analyses by X-Ray fluorescence (EPA Method TO-3.3). Small aliquots of filter media were removed from each filter to undergo XRF analyses. These included samples from each of nine separate source emissions sampling events. Three sampling events each representing a sampling period of one hour took place at each of the three stacks or emission points located at MCRRF. These samples were collected over a four day calendar period in August 2014. Each of the ten samples was analyzed for the 35 metals listed in

Table 6-5. A complete set of results on a sample specific basis are reported in Appendix C. All results are provided in units of ug/filter and do not represent blank corrected values. These data were used to develop the metallic profiles shown in Section 8 to follow.

## **7.0 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**

### **7.1 Data Review and Validation**

Data validation was conducted by TRC on the dioxin/furan sampling results using the USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (USEPA, 2011). The inorganic metals data were also validated by TRC using the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2010). In general, although several minor issues were noted by TRC, the data was determined to be valid as reported. The data validation memorandums prepared by TRC are presented in Appendix G.

### **7.2 Laboratory Data**

#### **7.2.1 Chester LabNet – Metals by XRF**

QA/QC data for metals analyses performed using X-Ray fluorescence by Chester LabNet are provided in the individual lab reports contained in Appendices B and C. Key features of the Chester LabNet QA/QC program are as follows:

- Precision Data – replicate analyses of Quality Control Standard QS285.
- Accuracy Data – Analyses of NIST SRM samples (SRM 1832 and 1833).
- Replicate analyses of actual field samples.

#### **7.2.2 Alpha Labs – Metals and TSP**

Quality Assurance/Quality Control data for metals and TSP analyses performed by Alpha Labs are provided in the individual lab reports contained in Appendix D. Key features of the Alpha Labs QA/QC program are as follows:

- Method blank analysis – batch QC.
- Lab control sample (LCS) – spike recovery (%) – data for all analytes within acceptable range.
- Matrix spikes (% recovery) – data for all analytes within acceptable range.
- Lab duplicates (% RPD).

### **7.2.3 Cape Fear Analytical LLC - PCDDs/PCDFs**

Quality Assurance/Quality Control data for PCDDs/PCDFs analyses performed by Cape Fear Analytical LLC are provided in the lab report contained in Appendix F. Key features of the QA/QC program are as follows:

- Method blanks – met acceptance limits.
- Field surrogates (isotopically labeled) – all surrogate compound/recovery data were within acceptance limits with the exception of one standard (>120%).
- Laboratory control sample (LCS) – spike recoveries met acceptance limits.
- Laboratory control sample duplicate (LCSD) - spike recoveries met acceptance limits.
- LCS/LCSD RPD (%) – relative % differences between LCS and LCSD met acceptance limits.

### **7.2.4 Brooks Rand Labs – Mercury (Total Vapor and Particulate)**

Quality Assurance/Quality Control data for mercury analyses (total vapor and particulate) performed by Brooks Rand Labs are provided in the lab reports contained in Appendix E.

## **7.3 Collocated Sampler Precision Data (% RPD)**

All samples collected at the Beallsville site were collected in duplicate using a pair of collocated sampling systems. These data were used to define the precision of the combined sample collection and laboratory analyses methods. Precision is defined as the relative percent difference (RPD) between measured concentrations of target compounds present in each of the collocated samples. Precision criteria were not met for mercury, cadmium and lead in one or more collocated pairs. Results that did not meet requirements were qualified as estimates during the data validation process. These data are discussed further in the TRC data validation reports found in Appendix G.

## 8.0 DISCUSSION OF RESULTS

### 8.1 Metals

#### 8.1.1 Site /Event Specific

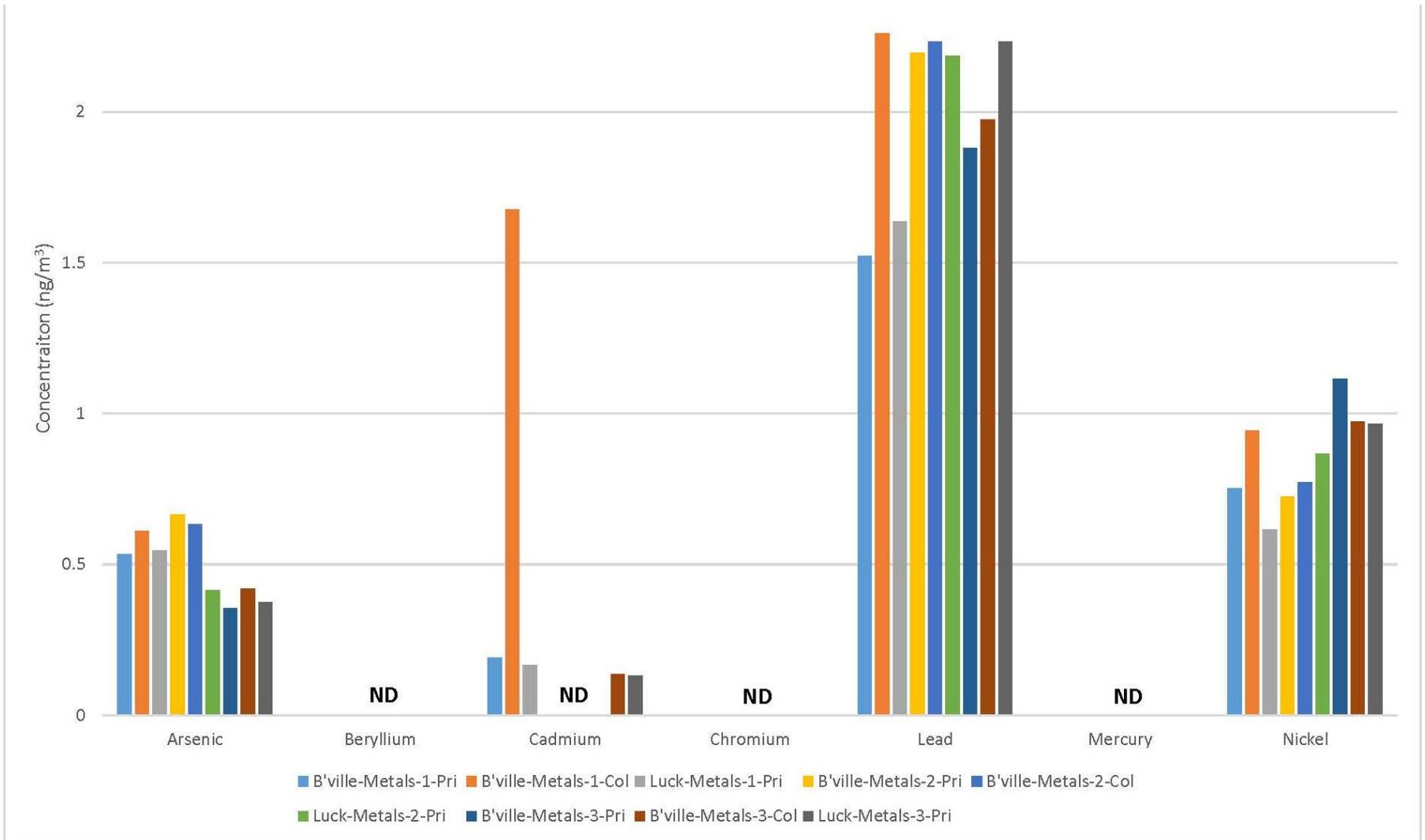
Metals data were summarized previously in Table 6-1. These data are plotted on a site and event specific basis in Figure 8-1. Measured concentrations are shown for the following four metals: arsenic, cadmium, lead and nickel. The three remaining metals (beryllium, chromium and particulate mercury) were not detected in any of the nine samples analyzed and are plotted with a value of “0” (ND=0). As shown concentrations for six of the seven metals are comparable at the two sampling stations. (The only exception is cadmium where the mean concentration for all six samples collected at Beallsville is influenced by an outlier). These data collectively do not indicate any influences on ambient air concentrations attributable to emissions of these same metals from the MCRRF. Rather these data suggest that the concentrations for metals at both the Beallsville and Lucketts sites are likely to be attributable to an aggregate of background regional source contributions impacting both sites in a similar manner (see Section 8.1.3.2).

The highest mean concentrations (averaged across the three sampling events) were observed for lead. The values of 2.02 ng/m<sup>3</sup> and 2.01 ng/m<sup>3</sup> reported for the Lucketts and Beallsville sites, respectively, are essentially identical and significantly below the 150 ng/m<sup>3</sup> NAAQS for lead expressed as a 24 hour time weighted average. Again, these data are considered to be representative of background concentrations for lead in ambient air in the study region (see Section 8.1.3.2).

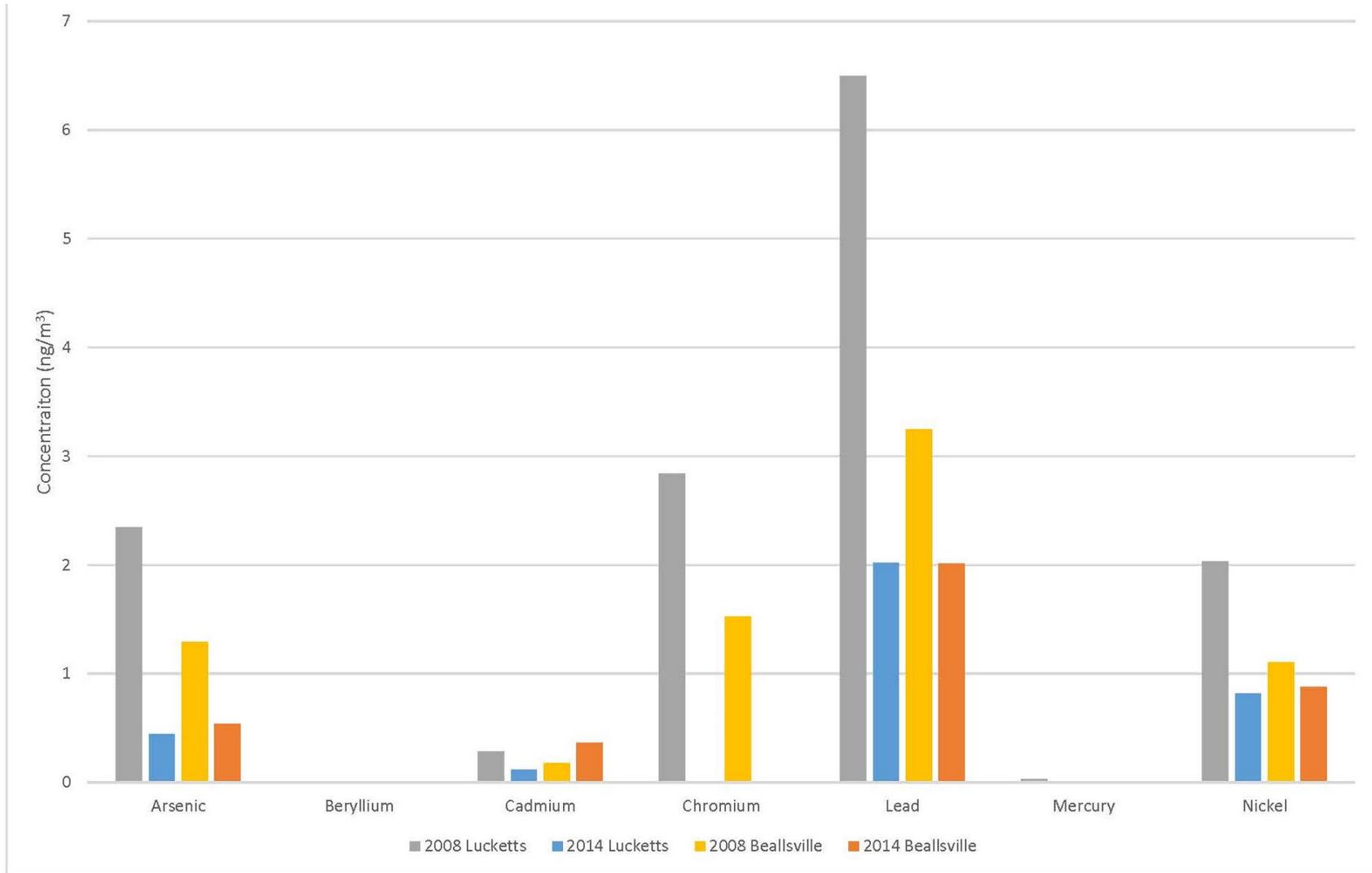
#### 8.1.2 Comparison to 2008 Data (AECOM)

The 2014 data set was further compared to the ambient metals data set representing the third operational phase conducted during the winter of 2008. [2] Beryllium was not detected in any samples collected during both the 2014 campaign and the 2008 sampling campaign. Chromium was not detected during the 2014 campaign, however 2008 concentrations for chromium were influenced by blank contamination. Mercury was not detected in any samples collected in 2014, but was detected at very low levels in two out of three sampling events in 2008. Lead, arsenic and nickel mean concentrations for the 2008 sampling campaign were slightly elevated above the 2014 mean concentration for these same metals. These data are plotted graphically in Figure 8-2. The highest mean concentrations for all three metals were observed in 2008 at the Lucketts school background site. These data again do not indicate any influences on ambient air concentrations attributable to emissions from the MCRRF.

**Figure 8-1: Montgomery County RRF Metals Sampling Results – Winter 2014**



**Figure 8-2: Montgomery County RRF Comparison of Metals Results (mean values) 2008 vs 2014**



Note: Chromium results from 2008 were influenced by blank contamination.

### **8.1.3 Upwind/Downwind Data Comparison – Event Specific**

#### **8.1.3.1 Meteorology**

Meteorological data provided to TRC by MCRRF staff were used to create profiles of wind speed and direction for each of the three 24 hour metals sampling events that took place in the winter of 2014. These plots or wind roses are shown in Figures 8-3, 8-4 and 8-5 respectively for the following three calendar periods: January 28-29, February 6-7, and February 26-27, 2014.

These three sampling events were characterized by winds originating from the west to north quadrant and more specifically West (W), Northwest (NW), North Northwest (NNW) and West Northwest (WNW). These wind trajectory data place the Lucketts site predominantly upwind of MCRRF and Beallsville predominantly downwind of MCRRF. Data from the three sampling events were examined more closely as described in Section 8.1.3.2 to follow.

#### **January 28-29, 2014**

Winds originated predominantly from the NW, NNW and WNW (>80% combined). This wind trajectory places the Lucketts site predominantly upwind of MCRRF and the Beallsville site predominantly downwind of MCRRF (see Figure 2-1).

#### **February 6-7, 2014**

Winds originated predominantly from the WNW (>30%). This wind trajectory places the Lucketts site predominantly upwind of MCRRF and the Beallsville site predominantly downwind of MCRRF (see Figure 2-1).

#### **February 26-27, 2014**

Winds during this sampling event were more variable than during the two prior events. The majority of the winds originated from the NNW, NW, and WNW (approximately 40% total). These wind trajectories place the Lucketts site predominantly upwind of MCRRF and the Beallsville site predominantly downwind of MCRRF (see Figure 2-1). Winds originating from the SSE, SE, and ESE were also present during this sampling event. These wind trajectories which place the Lucketts site predominantly downwind of MCRRF took place approximately 16% of the time.

#### **8.1.3.2 Data Analyses**

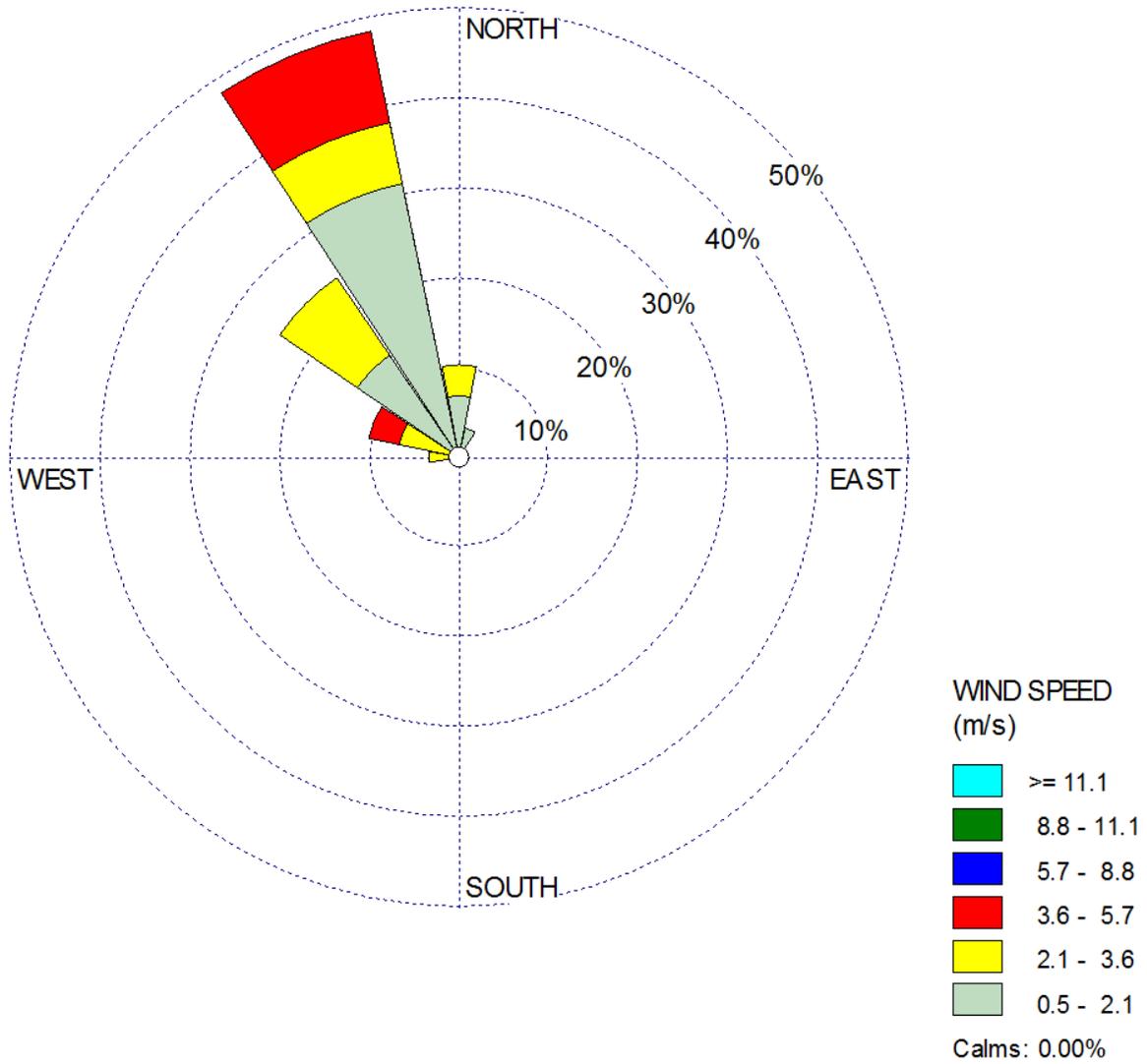
##### **January 28-29, 2014**

Examination of the metals concentrations at both sites during this sampling event indicated that the following metals were not detected: beryllium, chromium and mercury. Arsenic concentrations at both sites were very similar (0.55 ng/m<sup>3</sup> at Lucketts and 0.57 ng/m<sup>3</sup> at Beallsville; average of collocated sampling results) while lead (1.64 ng/m<sup>3</sup> at Lucketts and 1.89 ng/m<sup>3</sup> at Beallsville; average of collocated sampling results) and nickel (0.62 ng/m<sup>3</sup> at Lucketts

and 0.85 ng/m<sup>3</sup> at Beallsville; average of collocated sampling results) were slightly greater at Beallsville than were measured at Lucketts.

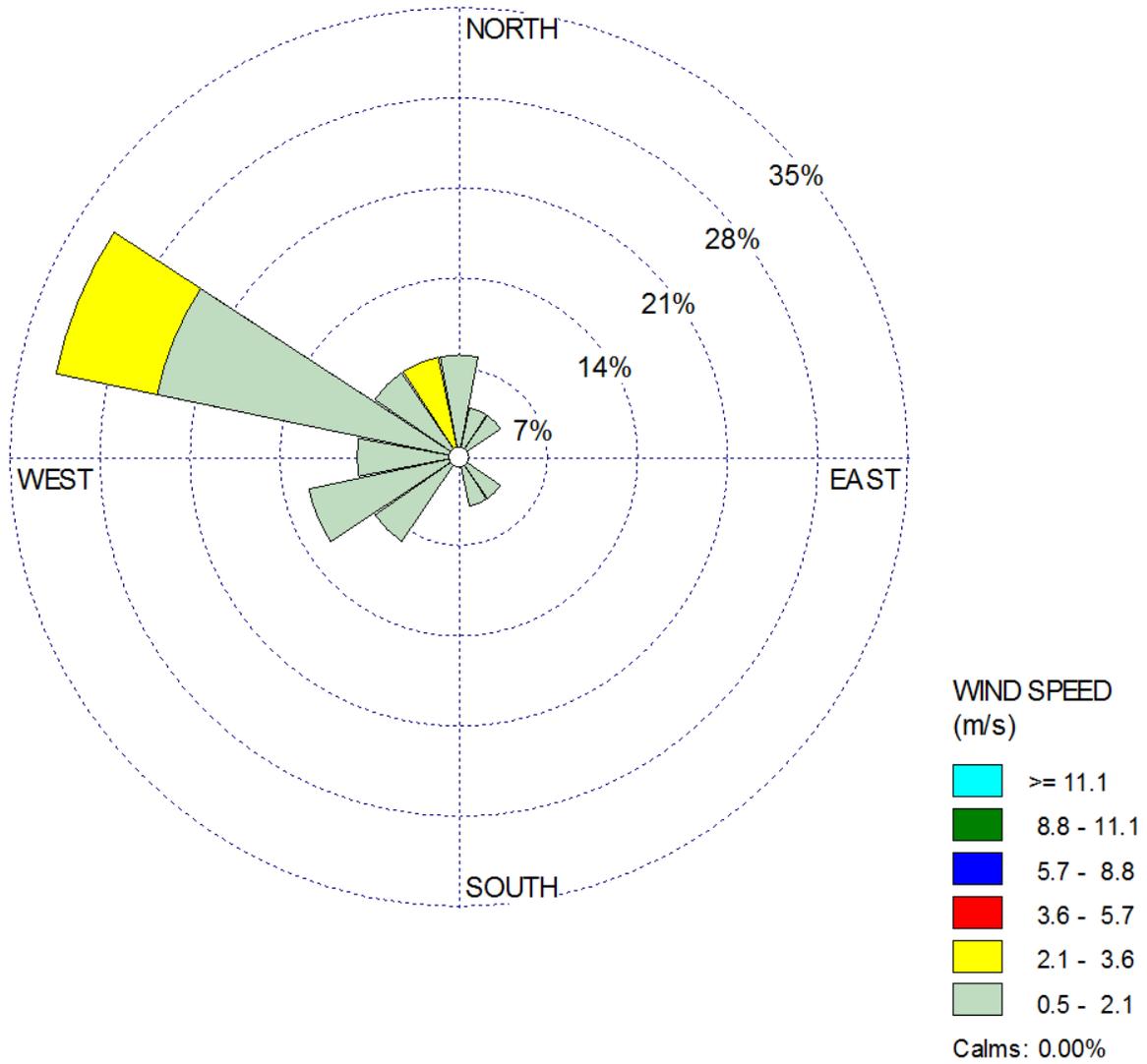
**Figure 8-3: Wind Rose (24 Hour Composite)**

**January 28-29, 2014 Sampling Event**



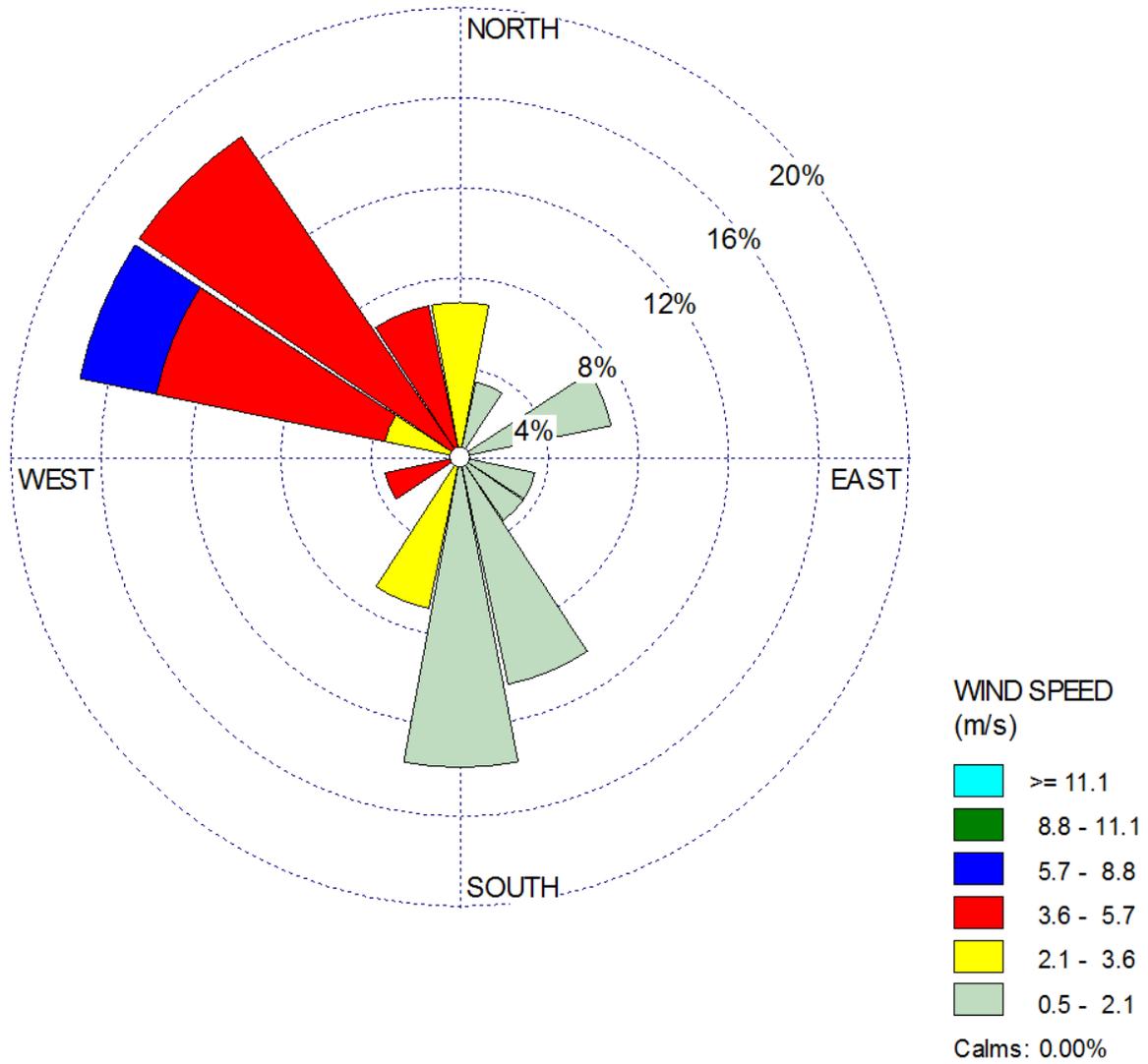
**Figure 8-4: Wind Rose (24 Hour Composite)**

**February 6-7, 2014 Sampling Event**



**Figure 8-5: Wind Rose (24 Hour Composite)**

**February 26-27, 2014 Sampling Event**



## **February 6-7, 2014**

Examination of the metals concentrations at both sites during this sampling event indicated that the following metals were not detected: beryllium, cadmium, chromium and mercury. Lead concentrations at both sites were the same (2.2 ng/m<sup>3</sup> at Lucketts and an average of 2.2 ng/m<sup>3</sup> at Beallsville) and nickel concentrations were comparable (0.87 ng/m<sup>3</sup> at Lucketts and an average of 0.75 ng/m<sup>3</sup> at Beallsville). Only arsenic was slightly different at the two (2) sites (0.42 ng/m<sup>3</sup> at Lucketts and an average of 0.65 ng/m<sup>3</sup> at Beallsville). These data indicate that concentrations for the majority of the metals were comparable at both sites independent of the site orientation relative to MCRRF emissions. The Beallsville site even when situated predominantly downwind of MCRRF had metals concentrations comparable to background. These data do not support any influences from MCRRF source emissions.

## **February 26-27, 2014**

Examination of the metals concentrations at both sites during this event indicated that the following metals were not detected: beryllium, chromium and mercury. Concentrations of lead (2.2 ng/m<sup>3</sup> at Lucketts and an average of 1.9 ng/m<sup>3</sup> at Beallsville), nickel (0.97 ng/m<sup>3</sup> at Lucketts and an average of 1.04 ng/m<sup>3</sup> at Beallsville), arsenic (0.38 ng/m<sup>3</sup> at Lucketts and an average of 0.39 ng/m<sup>3</sup> at Beallsville) and cadmium (0.13 ng/m<sup>3</sup> at Lucketts and an average of 0.14 ng/m<sup>3</sup> at Beallsville) at both sites were all quite comparable. These data indicate that concentrations for all of the metals at both sites were independent of the site orientation relative to MCRRF emissions. The Beallsville site even when situated predominantly downwind of MCRRF had metals concentrations comparable to background. These data do not indicate any influences from MCRRF source emissions.

## **8.2 XRF Profile Analyses**

As discussed previously in Sections 6.4 and 6.5, filters from both ambient air and source emissions samples were analyzed for the 35 elements listed in Table 6-5. This more detailed elements data set was used to compare the profiles of elements in the ambient air samples to profiles in MCRRF emissions. The XRF results reported on a ug/filter basis for each sample (not as concentrations) are found in Appendix B. Laboratory reported values (ug/filter) for each element were compared to the corresponding field blank and corrected for concentrations found in the blank (ug/filter).

These blank corrected values were used for the following types of data comparisons:

- Site specific (Lucketts vs Beallsville)
- Event specific (three (3) sampling events)
- Ambient air vs. MCRRF emissions profiles

### 8.2.1 *Site/Event Specific Comparisons*

Elemental profiles are presented on a site and sampling event specific basis in Figure 8-6. Results are plotted on a ug/filter basis for all elements present in each sample substantially above levels found for the same elements in the corresponding filter blank. Those elements found at the highest concentrations in all nine of the ambient air filter samples (listed in decreasing order of concentration) are as follows: chlorine (as chloride) > calcium > sulfur > iron > aluminum > potassium.

Some observations based upon review of these data are as follows:

- The highest concentrations (ug/filter) of chlorine (as chloride), iron, aluminum, and potassium were measured in the three sampling events that took place at the Lucketts site in 2014.
- Maximum or highly elevated concentrations (ug/filter) of a number of elements were found in the February 26-27, 2014 sampling event (#2) which took place at the Lucketts site. These included aluminum, sulfur, chlorine (as chloride), potassium, calcium, titanium, and iron.

Some of these same data are presented as profiles in Figure 8-7. A number of the elements which appeared in Figure 8-6 at the highest concentrations have been removed and the scale (ug/filter) of the y axis adjusted to allow for closer examination of the remaining elements present in lower concentrations.

An observation based upon review of these data is as follows:

- A number of elements are present in all nine ambient filter samples and also at the highest concentrations (listed in decreasing order) as follows: potassium > copper > zinc > manganese > bromine (as bromide).

Figure 8-6  
 Metals XRF Results (Blank Corrected)  
 Ambient Samples Winter 2014

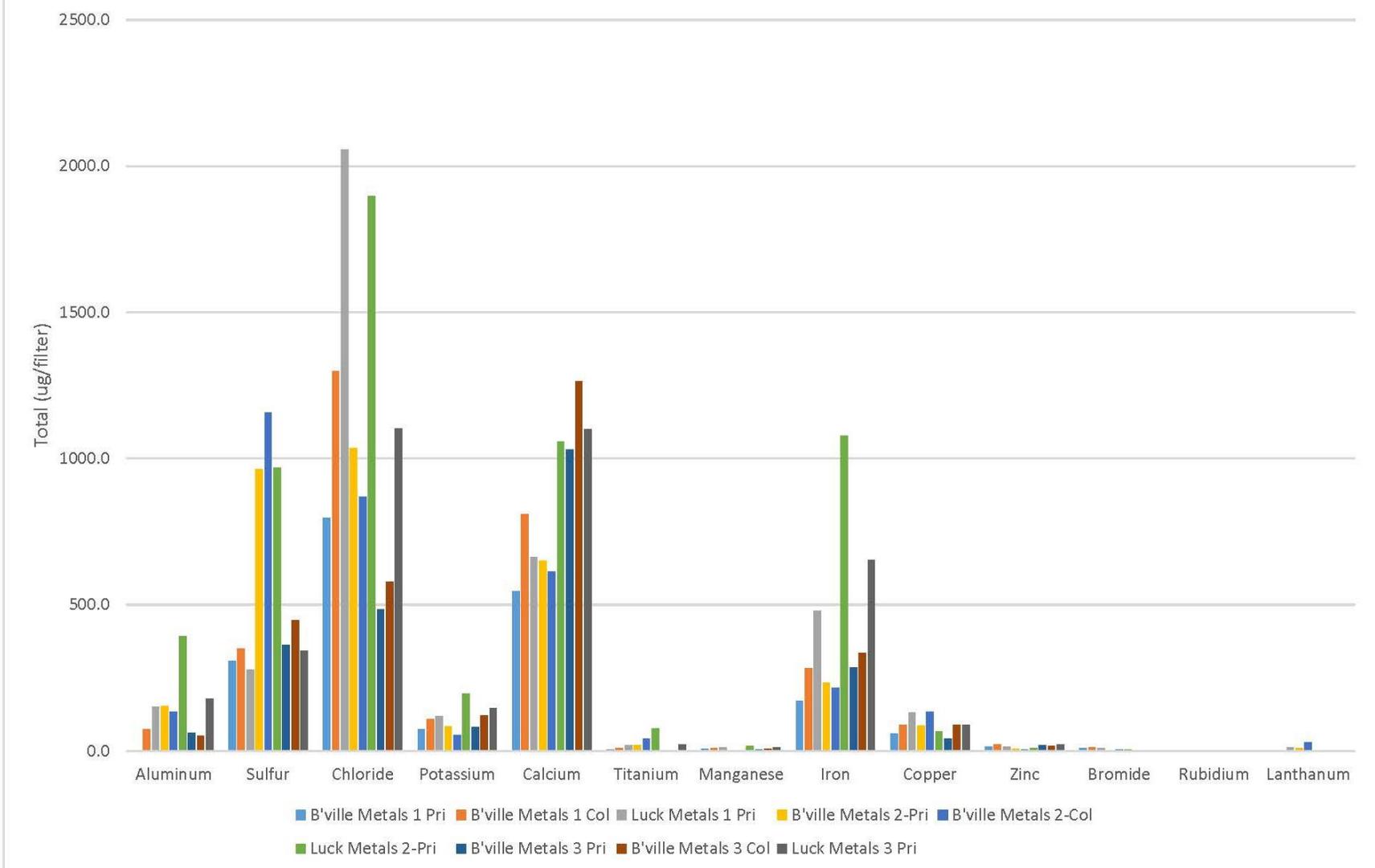
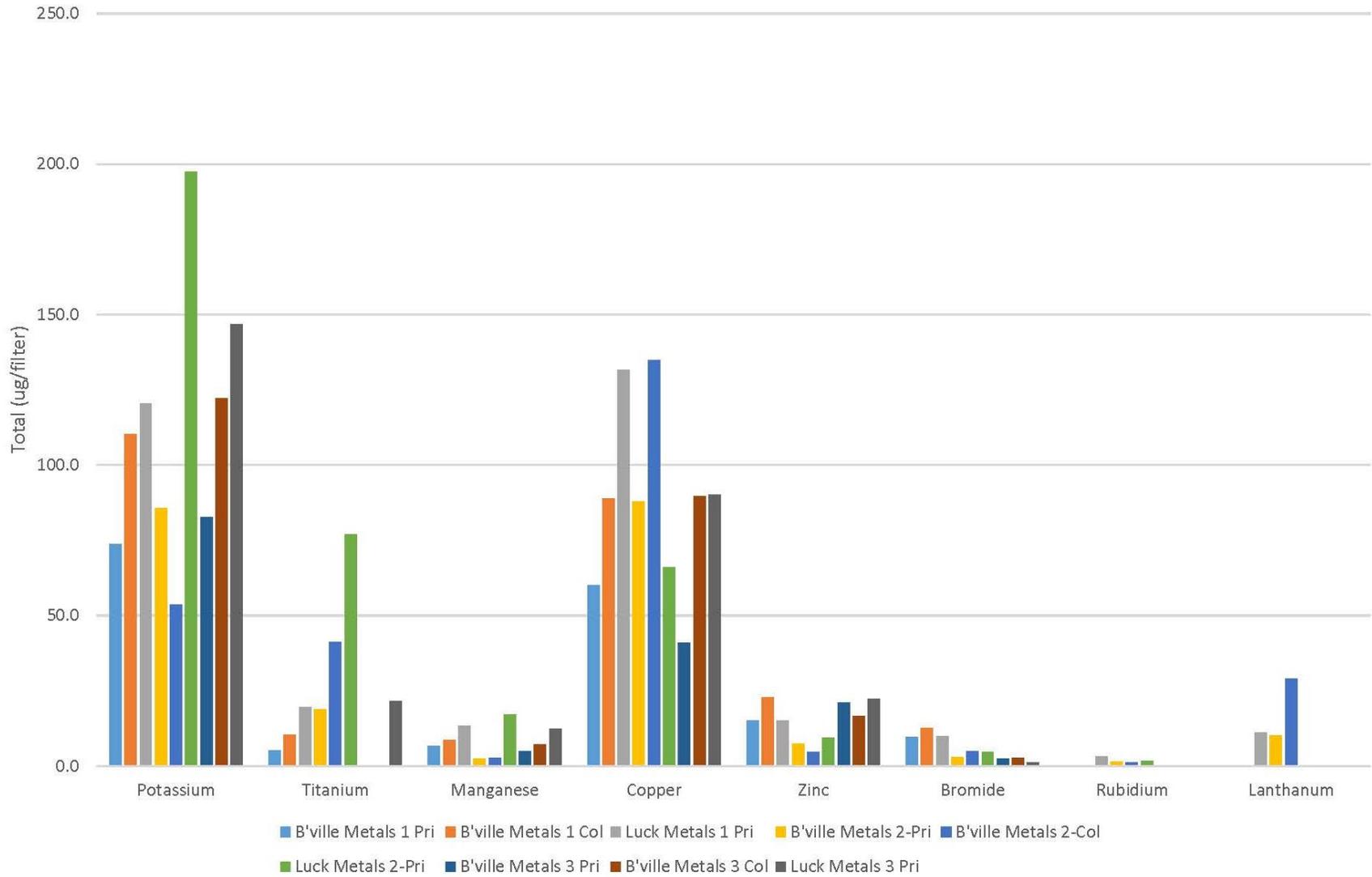


Figure 8-7  
 Metals XRF Results (Blank Corrected)  
 Ambient Samples Winter 2014



## 8.2.2 Ambient/Source Data Comparison

Ambient air filter sample data are plotted again in Figures 8-8 and 8-9. Results are displayed on a site specific basis representing an average or mean value (ug/filter) for all three sampling events (nine filters, three filters per sample location). These data are compared to average values (ug/filter) from the nine source emissions sampling events. These data resulted from analyses of nine filter samples collected from the three MCRRF combustors in August 2014. Actual filter results (in ug/filter) for each metal are also shown above each of the respective bars.

Based upon review of these data the following observations have been made:

- The concentrations for the majority of the thirteen elements shown are higher at both the Lucketts and Beallsville sites than were measured in the MCRRF source emissions samples. These are (listed in order of decreasing concentration) as follows: chlorine (as chloride) > calcium > sulfur > iron > aluminum > potassium > copper.
- A number of the thirteen elements present in both ambient and source samples were found to be equivalent in concentration (these elements present in much lower concentrations in both sample types include the following: manganese, zinc, bromine (as bromide) and lanthanum).

Direct comparison of ambient air filter mass measurements to those present in the MCRRF source filters is not the most appropriate approach for profile analyses since the filter sizes and air volumes collected are not the same. It is more appropriate to compare ratios of levels of elements found in MCRRF stack emissions to the same ratios of elements found in ambient air samples. Some criteria used for the selection of elements for comparison were as follows:

- Elements predominant in ambient filter samples at Beallsville (predominantly downwind of MCRRF) and not detected in stack filter samples (< 1 ug/filter).
- Elements predominant in ambient filter samples at both Lucketts and Beallsville and not detected in source filter samples (< 1 ug/filter).
- Elements present in comparable concentrations in all three (3) filter sample types.
- Elements present in similar ratios in ambient filters from the two sites.

Based upon these criteria a number of elements and ratios of elements were selected for examination as follows: copper, potassium, zinc, aluminum, sulfur, calcium, and iron. Relevant observations are as follows:

- **Aluminum** – non-detected in MCRRF source samples and present in Lucketts (mean – 241 ug/filter) and Beallsville (mean – 167 ug/filter) filter samples.
- **Calcium** – measured at 111 ug/filter (mean) in MCRRF source samples and 1435 ug/filter (mean) in Beallsville filter sample set.

- **Copper** - < 1 ug/filter (mean) in MCRRF source samples and 95 ug/filter (mean) in Beallsville (downwind) filter sample set. Also present in Lucketts filter sample set at 96 ug/filter (mean).
- **Potassium** – 16 ug/filter (mean) in MCRRF source filter samples and 194 ug/filter (mean) in Beallsville (downwind) filter sample set.
- **Zinc** – found in comparable concentrations in all three filter sample types (Lucketts 15.6 ug/filter, Beallsville 19.1 ug/filter and MCRRF source 19.5 ug/filter).
- **Sulfur** – Lucketts (619 ug/filter), Beallsville (530 ug/filter) and MCRRF source (40 ug/filter).
- **Iron** – Lucketts (737 ug/filter), Beallsville (295 ug/filter) and MCRRF source (78 ug/filter).
- **Iron/Sulfur** (ratio) – Beallsville (295/619 = 0.48) and MCRRF source (78/40 = 1.95).
- **Potassium/Zinc** (ratio) – Beallsville (194/19 = 10.2), Lucketts (155/15.6 = 9.9), MCRRF source (16/19.5 = 0.82).
- **Calcium/Iron** (ratio) – Beallsville (1435/295 = 4.9), Lucketts (941/737 = 1.3), MCRRF source (111/78 = 1.4).
- **Calcium/Copper** (ratio) – Beallsville (1435/95 = 15), Lucketts (941/96 = 9.8), MCRRF source (111/0.8 = 139).

These data indicate substantial differences in the elemental profiles and the ratios of selected elements in MCRRF source filter samples as compared to ambient filter samples. Elements present in air emissions from MCRRF would be expected to be in similar ratios to particulate found in ambient air if the source of the particulate originated from the MCRRF. In several cases the differences in ratios are greater than a factor of 10. These data collectively provide further evidence that MCRRF particulate emissions are not measurably impacting particulate matter collected at either the Lucketts or Beallsville sampling sites (see Section 8.1.3.1).

Figure 8-8  
 Mean Metals XRF Results (Blank Corrected)  
 Ambient Samples (winter 2014) and Stack Samples (summer 2014)

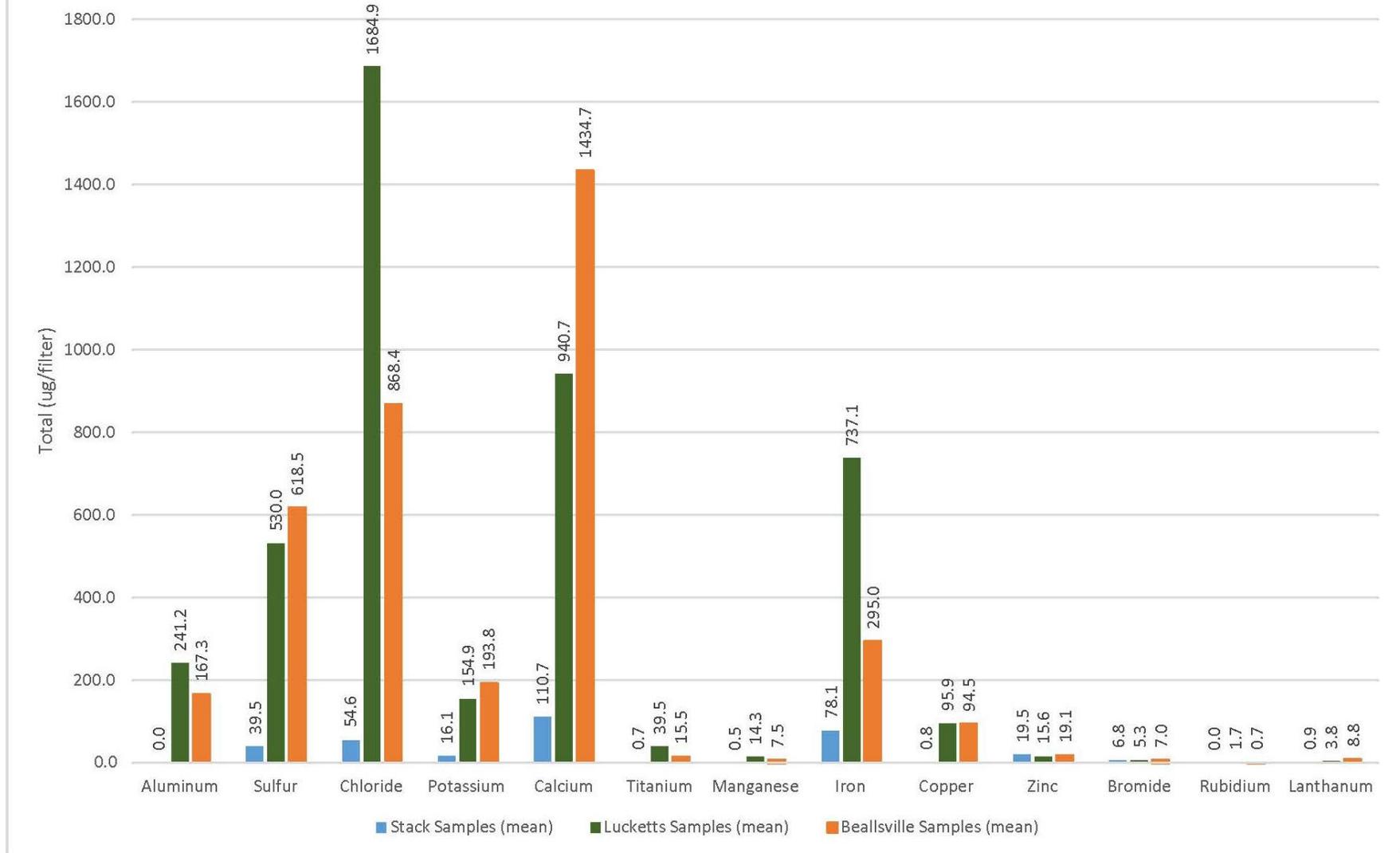
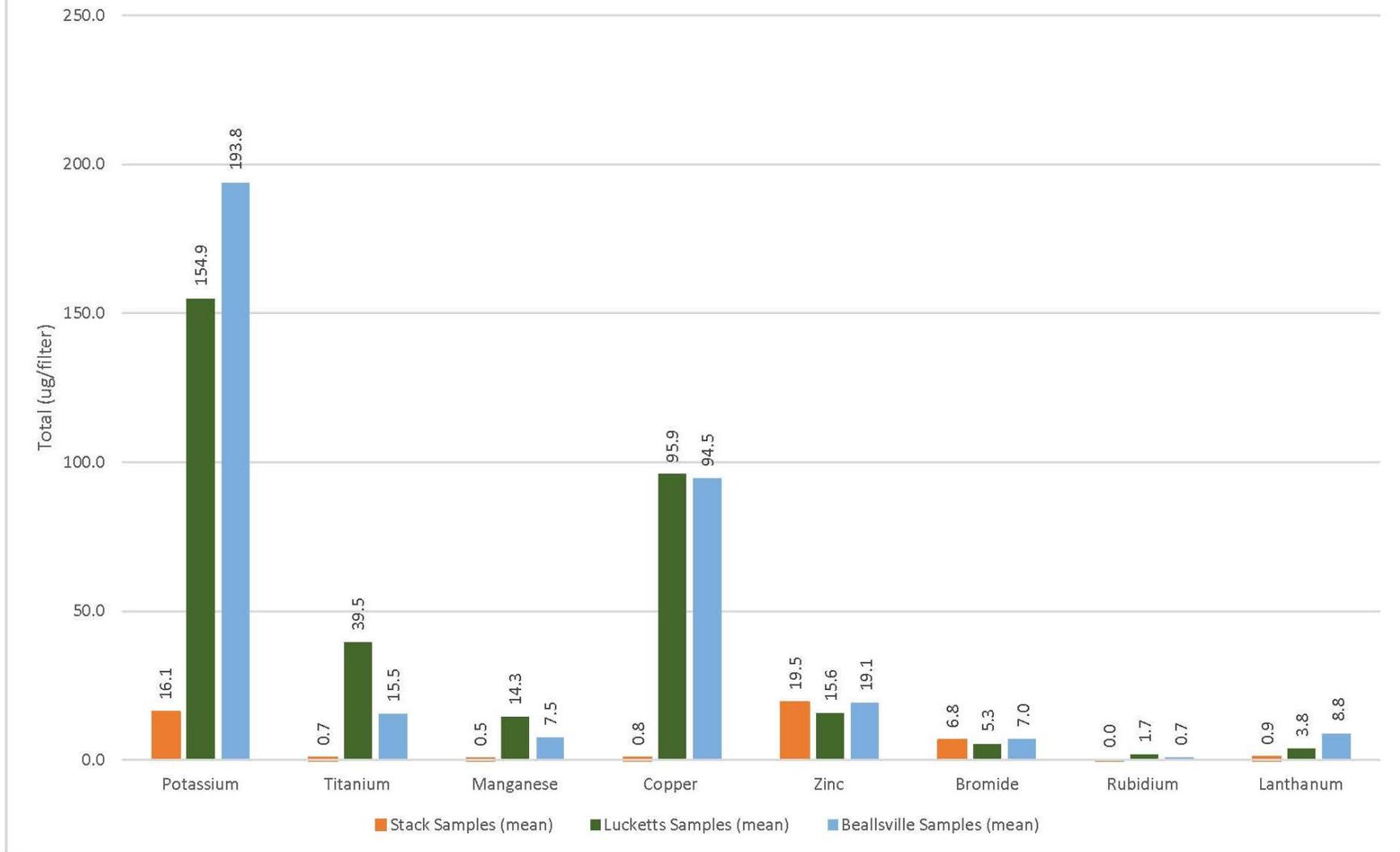


Figure 8-9  
 Mean Metals XRF Results (Blank Corrected)  
 Ambient Samples (winter 2014) and Stack Samples (summer 2014)



### 8.3 PCDDs/PCDFs

PCDDs/PCDFs data presented previously in Section 6.3 and Tables 6-3 and 6-4 were used to plot homologue profiles for Cl<sub>4</sub> – Cl<sub>8</sub> PCDDs/PCDFs. These profiles were compared to those representing the 2008 third operational sampling campaign [2] as well as homologue profiles representing MCRRF emissions for the 2008-2013 calendar period. Mass concentrations for these same homologue groups (total Cl<sub>4</sub> – Cl<sub>8</sub> PCDDs/PCDFs) present in ambient air during the 2015 sampling event (31 day) were also compared to total PCDDs/PCDFs measured at other remote, rural and urban locations globally.

#### 8.3.1 Site Specific Comparison

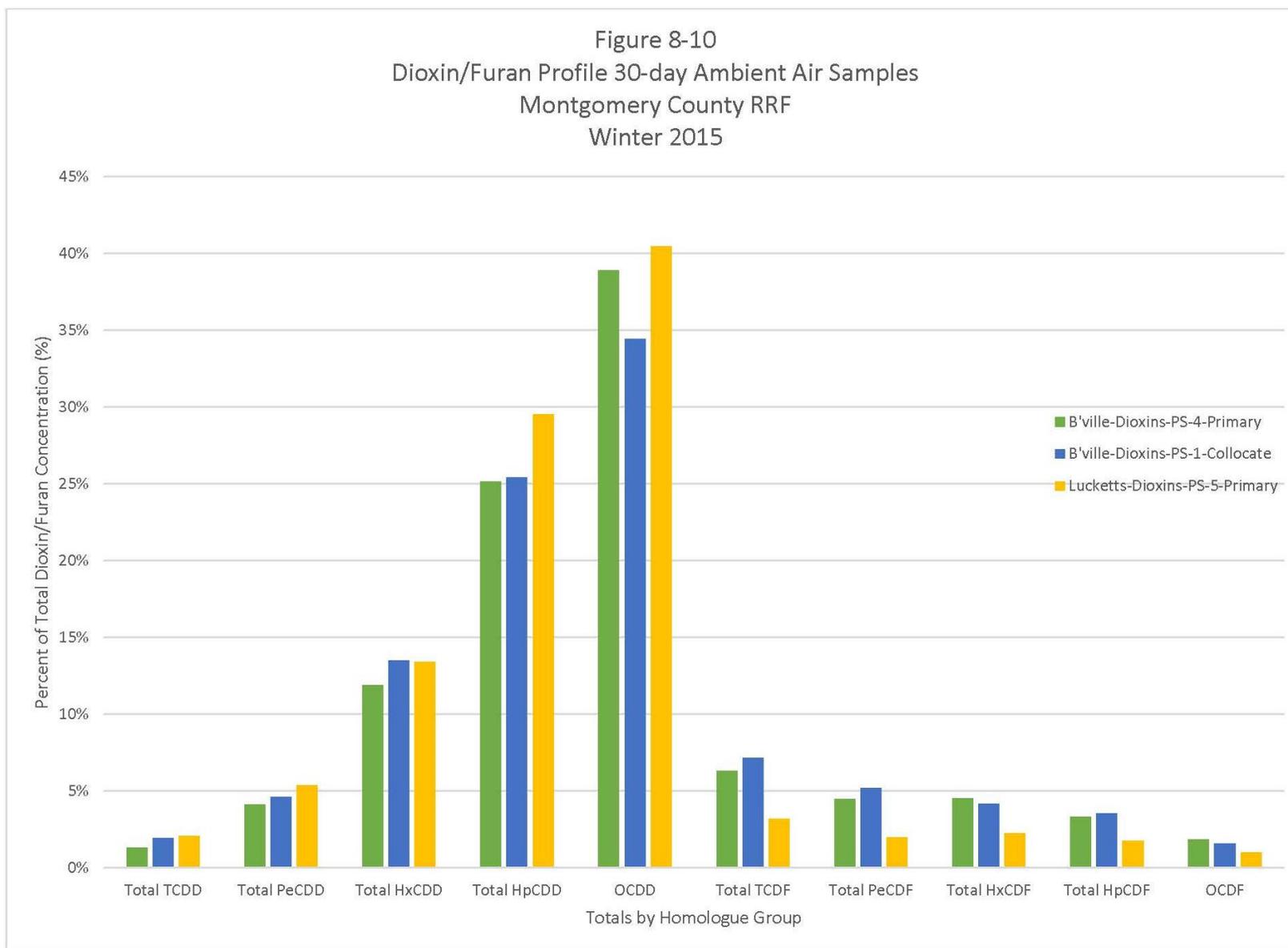
Total PCDDs/PCDFs concentrations (Cl<sub>4</sub> – Cl<sub>8</sub>) were presented previously in Table 6-4. These data indicate that measured concentrations at the Lucketts site (3.7 pg/m<sup>3</sup>) were higher than corresponding concentrations measured at the Beallsville site (mean = 1.05 pg/m<sup>3</sup>).

Homologue profiles for these same data are shown in Figure 8-10. In this figure, the vertical (or “y” axis) dimension represents the percentage of total PCDDs/PCDFs (Cl<sub>4</sub> – Cl<sub>8</sub>) measured at each site on a homologue specific basis, so that these profiles can be readily compared. As can be seen, the homologue profiles for ambient air at Beallsville and Lucketts are remarkably similar. What this indicates is that air quality at those locations is influenced by a common source or set of sources.

The profiles at both sites are consistent with those typically reported for ambient air on a global basis where a blend of combustion sources represent the principal contributions to atmospheric concentrations of PCDDs/PCDFs. These combustion sources include but are not limited to the following: automotive exhaust (e.g. diesel), wood combustion (e.g. residential), oil and coal combustion, landfill fires, forest and brush fires, back yard barrel burning, yard waste burning, and agricultural burning, [17,18,19]. Within the PCDDs homologue groups (Cl<sub>4</sub> – Cl<sub>8</sub>) we find increasing concentrations with corresponding increases in chlorine substitution (Cl<sub>4</sub>, <Cl<sub>5</sub>, <Cl<sub>6</sub>, <Cl<sub>7</sub>, <Cl<sub>8</sub>). Conversely, the PCDFs profile within the Cl<sub>4</sub> – Cl<sub>8</sub> homologue groups indicates diminishing concentrations with corresponding increases in chlorine substitution (Cl<sub>4</sub>, >Cl<sub>5</sub>, >Cl<sub>6</sub>, >Cl<sub>7</sub>, >Cl<sub>8</sub>). [10, 11, 12, 13, 14]

Finally, as will be seen in Figure 8-12, in Section 8.3.4, these profiles for air at Beallsville and Lucketts are also remarkably similar to those observed by AECOM during the third operational phase air monitoring event in 2008 [2]. This can be seen by observing just the colored bars in Figure 8-12.

**Figure 8-10: Dioxin/Furan Profile 30-day Ambient Air Samples Montgomery County RRF Winter 2015**



## 8.3.2 *Upwind/Downwind Data Comparison*

### 8.3.2.1 **Meteorology**

Wind speed and directional data were provided to TRC by staff of the MCRRF. These data representing the calendar period of the 31 day PCDDs/PCDFs sampling event (February 3 – March 4, 2015) were used to prepare the wind rose plot shown in Figure 8-11.

As shown (see Figure 2-1) winds originating from the northwest and blowing to the southeast place the Beallsville site predominantly downwind of the MCRRF. This corresponds to a wind direction of 302 degrees (WNW). Conversely, when winds originate from the Southeast and blow towards the Northwest the Lucketts site is predominately downwind of the MCRRF. This corresponds to a wind direction of 103 degrees (East Southeast).

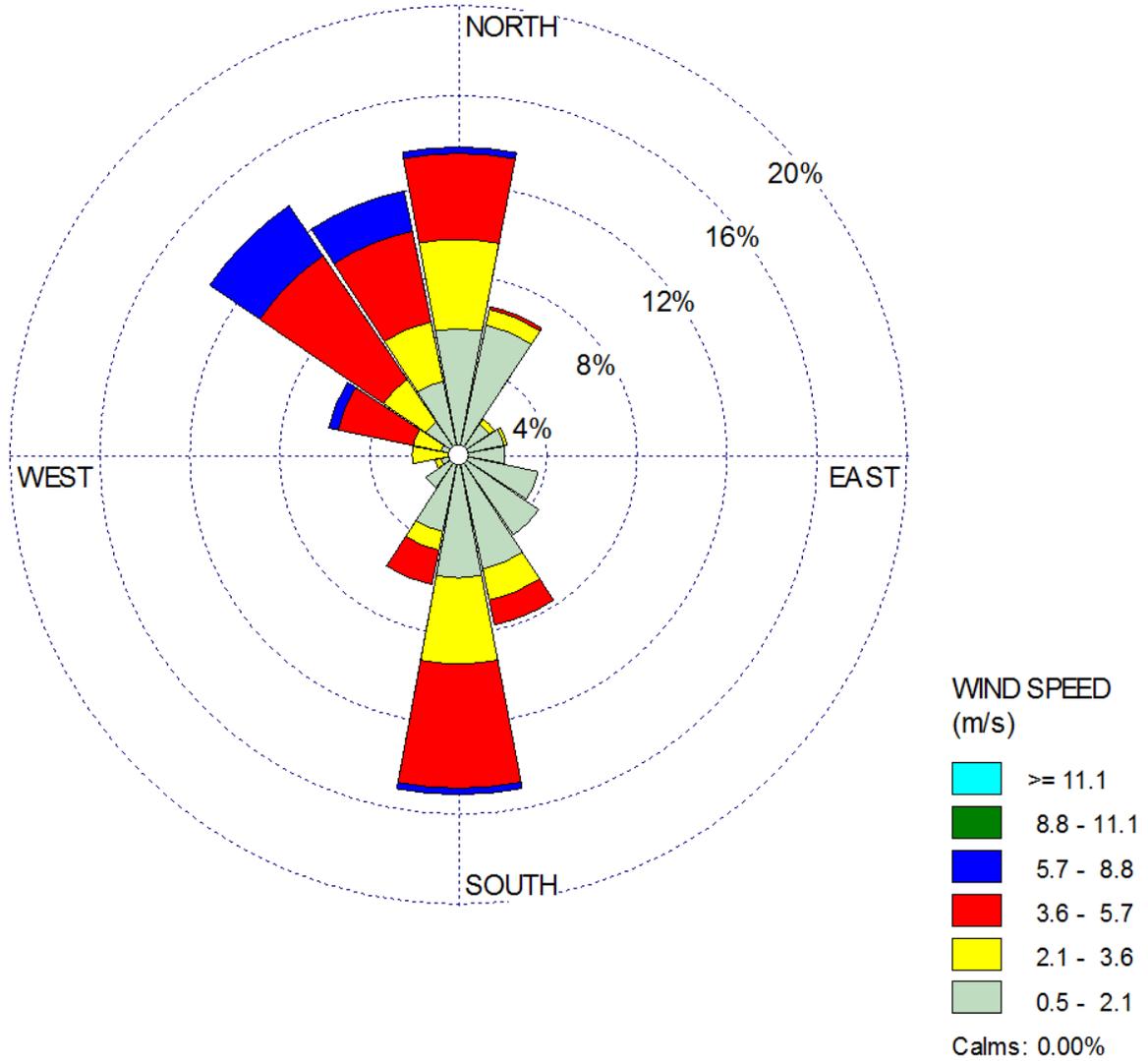
If the range of winds are expanded to include an additional sector (+/-1) beyond the 302 degrees for Beallsville and the 103 degrees for Lucketts the following ranges defining the predominantly downwind direction from MCRRF result for each site:

- Beallsville – 258.7 – 326.25 degrees (W – NW)
- Lucketts – 78.75 – 146.25 degrees (E – SE)

Based upon these ranges the wind directional data shown in Figure 8-11 place the Beallsville site downwind of the MCRRF 21.4% of the time during the 31 day sampling event. Conversely, these same wind directional data shown in Figure 8-11 place the Lucketts site downwind of the MCRRF 10.2% of the time during the 31 day sampling event.

**Figure 8-11: Wind Rose (31 Days)**

**February 3 – March 4, 2015**



### 8.3.2.2 Data Analyses

As shown in Table 6-4 and Table 8-1, measured concentrations of total PCDDs/PCDFs at the Lucketts site ( $3.7 \text{ pg/m}^3$ ) were roughly three and one-half times higher than average concentrations measured at the Beallsville site ( $1.05 \text{ pg/m}^3$ ) during the 31 day sampling event. The Lucketts site was shown (Section 8.3.2.1) to be downwind of the MCRRF approximately 10% of the time during the 31 day sampling event. The Beallsville site, conversely, was shown to be downwind of the MCRRF approximately 21% of the time during the 31 day sampling event. Based upon these data it can be concluded that MCRRF emissions are not measurably contributing to the ambient concentrations of PCDDs/PCDFs measured at either the Lucketts or Beallsville sites.<sup>1</sup>

Concentrations of PCDDs/PCDFs measured at both sampling sites more likely represent ambient background conditions attributable to an aggregate of combustion sources influencing ambient air concentrations at locations both upwind and downwind of the RRF during the 31 day monitoring period.

### 8.3.3 *Comparison of Ambient PCDDs/PCDFs Concentrations (2015) to Historical Data (2008) and Other Remote, Rural and Urban Locations*

Total PCDDs/PCDFs concentrations ( $\text{Cl}_4 - \text{Cl}_8$ ) for the Lucketts and Beallsville sites from 2015 and 2008 are presented in Table 8-1. The Lucketts site PCDDs/PCDFs concentration for the 2015 sampling event of  $3.70 \text{ pg/m}^3$  is higher than the  $1.86 \text{ pg/m}^3$  measured during the 2008 sampling event. Conversely, the mean PCDDs/PCDFs concentration of  $1.05 \text{ pg/m}^3$  measured at the Beallsville site during the 2015 sampling event is less than the mean value of  $1.40 \text{ pg/m}^3$  measured during the 2008 event.

The 2015 data set is also compared to PCDDs/PCDFs data ( $\text{Cl}_4 - \text{Cl}_8$ ) representative of a number of urban, rural and remote locations worldwide. [10, 11, 12, 13, 14, 15, 16] The Beallsville mean concentration of  $1.05 \text{ pg/m}^3$  is consistent with the lower end of the concentration range for various US urban locations and slightly higher than concentrations representative of rural locations (in Connecticut and New Zealand). The 2015 Lucketts site concentration is comparable to concentrations measured in some US cities such as Hartford, Connecticut.

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<sup>1</sup> This is supported by the fact that detection limits provided through use of the state-of-the art measurement technology on this program (HRGC/HRMS) are significantly higher than incremental ambient concentrations resulting from dispersion modeling (AERMOD) of RRF emissions.

**Table 8-1: Total PCDDs/PCDFs Comparison of Ambient Air Concentrations in this Study with Concentrations Measured in Other Locations.**

	<b>Location</b>	<b>pg/m<sup>3</sup></b>	<b>Reference</b>
Urban US Cities	Hartford, CT	2.6	12
	Los Angeles, CA	7.4	11
	Phoenix, AZ	27	13
	Fresno, CA	51	10
	Bridgeport, CT	1.9	12
	Bloomington, IN	1.8	14
Rural Locations	TeWera, NZ	0.88	15
	Culverden, NZ	0.48	15
	Mohawk Mountain, CT (winter)	0.58	12
	Mohawk Mountain, CT (fall)	0.53	12
	Burlington, CT (winter)	0.68	12
	Burlington, CT (fall)	0.41	12
Remote Locations	Baring Head, NZ	0.14	15
	Nelson Lakes, NZ	0.04	15
	Bermuda (1993-1994)	0.11	16
	Bermuda (1996-1997)	0.04	16
	Barbados	0.02	16
Local 2015	Lucketts 2015	3.70	Table 6-4
	Beallsville 2015 (mean)	1.05	Table 6-4
Local 2008	Lucketts 2008	1.86	2
	Beallsville 2008 (mean)	1.40	2
PCDDs/PCDFs = Sum of Total PCDDs/PCDFs Tetra – Octa (Cl <sub>4</sub> - Cl <sub>8</sub> ) mass concentrations			

#### **8.3.4 Comparison to MCRRF Emissions Data**

PCDDs/PCDFs homologue profiles (Cl<sub>4</sub> - Cl<sub>8</sub>) for the 2015 sampling event presented previously in Figure 8-10 are compared further to profiles from the 2008 sampling event in Figure 8-12. Profiles are presented on a site specific basis for both Lucketts and Beallsville. All of the profiles shown for the 2008 and 2015 ambient air sampling events are consistent with those found in a variety of combustion source emissions. It is likely that the PCDDs/PCDFs measured at both the Lucketts and Beallsville sites represent background concentrations attributable to influences from an aggregate of combustion source emissions in the study region (see Section 8.3.1 and 8.3.6 for a representative listing of these combustion sources).

The PCDDs/PCDFs homologue profile (Cl<sub>4</sub> - Cl<sub>8</sub>) representing source emissions from the three units at the MCRRF are also shown in Figure 8-12. These profiles were created from emissions data provided by staff of the MCRRF and represent a composite profile of compliance test data (EPA Method 23) collected during the calendar period 2008-2013. As shown, the composite profile for MCRRF emissions differs substantially from the profile characteristic of the ambient air samples. For example, the PCDDs profile characteristic of the ambient air samples (Cl<sub>4</sub>< Cl<sub>5</sub>< Cl<sub>6</sub><Cl<sub>7</sub><Cl<sub>8</sub>) is not maintained in the MCRRF emissions profile. OCDD, which predominates the ambient air profile (35-40 percent of Cl<sub>4</sub> - Cl<sub>8</sub> total) represents <10 percent of the emissions source profile for the same homologue group sum (Cl<sub>4</sub> - Cl<sub>8</sub>).

The TCDF homologue group which represents approximately 17 percent of the emissions source profile represents only an approximate 3-8 percent of the ambient air profile. In fact the TCDF homologue group contribution of 17 percent is greater than the contribution of any of the PCDDs homologue groups (Cl<sub>4</sub> - Cl<sub>8</sub>). These data do not support the supposition that MCRRF emissions are measurably contributing to PCDDs/PCDFs measured at either of the two sites during both the 2008 and 2015 sampling events.

#### **8.3.5 Congener Specific Analyses – Ambient Air**

2,3,7,8– HxCDF congener profiles for the Lucketts and Beallsville sites are shown graphically in Figure 8-13. The profile displays contributions for each of the four 2,3,7,8 substituted HxCDF congeners as a percent of the total concentration represented by the HxCDF homologue group. The total percent contribution of the four congeners as a sum is also shown. The profiles observed in each of the three ambient air samples are nearly identical which indicates that MCRRF emissions are not measurably impacting ambient air at the predominantly downwind Beallsville site and that the measured concentrations are similarly influenced by aggregate regional combustion sources. [12]

#### **8.3.6 Other Potential PCDD/PCDF Sources**

Figure 8-14 presents profiles for tetra- through octa-chlorinated PCDD/PCDF homologues that are emitted from a variety of other potential combustion sources including unleaded gasoline (vehicles with catalytic converter), household waste via barrel burning, coal from utility boilers and wood (industrial sources). These profiles were derived from emission data presented in USEPA (2001b) and are based on detected values only (i.e., ND = 0).

The homologue profiles for all of these sources other than barrel burning of household waste are dominated by OCDDs. Barrel burning of household waste results in tetra-CDFs being the most dominant homologues followed by penta-CDFs. Unleaded gasoline combustion is comprised primarily of OCDDs and tetra-CDFs while coal combustion is dominated by OCDDs and then tetra-CDDs, penta-CDFs and OCDFs. Wood combustion is also comprised primarily of OCDDs followed by nearly equal amounts of tetra-CDFs and penta-CDFs.

As there may be many contributing PCDD/PCDF sources, the comingling of these emission sources presents difficulties in identifying a single primary source of PCDDs/PCDFs. Background concentrations of PCDDs/PCDFs in ambient air are most often attributed to emissions from a variety of combustion sources. These include the following: automotive, wood combustion (residential and industrial), oil and coal combustion, landfill fires, forest and brush fires, back yard barrel burning, yard waste burning and agricultural burning [17, 18, 19]. A study published by Columbia University in 2012 showed that an estimated 78 percent of the total dioxin emissions in the United States were attributable to the following major sources: back yard burning, land fill fires, brush and forest fires. [19]

In order to illustrate the contributions to ambient air associated with PCDDs/PCDFs emissions from a variety of combustion sources likely located in the study region the following published emission factors [17, 18] are provided on a source specific basis:

Indoor Residential Wood Stoves-

0.5 ng I-TEQ or WHO<sub>98</sub> TEQ/kg of wood

(Based upon an Environment Canada study in North America using native woods)

Accidental Structural Fires

32 ug I – TEQ per Fire

Forest and Brush Fires

3 ng WHO<sub>98</sub> TEQ/kg wood/brush

Backyard and Barrel Burning

77 ng WHO<sub>98</sub> TEQ/kg fuel

Residential Yard Waste Burning

10 ng WHO<sub>98</sub> TEQ /kg

Vehicles (Diesel)

540 pg WHO<sub>98</sub> TEQ/Liter (Fuel)

Vehicles (Unleaded Gasoline)

16 pg WHO<sub>98</sub> TEQ/Liter (Fuel)

These combustion sources and associated PCDDs/PCDFs emissions factors are not intended to represent all sources in the study region but rather to illustrate that these sources do represent contributions to PCDDs/PCDFs found in ambient air. The source types and numbers of each present in the study region during the 31 day PCDDs/PCDFs monitoring event is unknown at this time. The actual potential contributions of these and other sources in the aggregate cannot be determined without an extensive inventory in the study region. This emissions inventory and associated impacts on PCDDs/PCDFs found in ambient air was beyond the scope of the air monitoring program.

Figure 8-12  
 Dioxin/Furan Profile Comparison  
 2008 & 2015 Ambient Samples (30-day) vs. 2008-2013 Average Stack Emissions

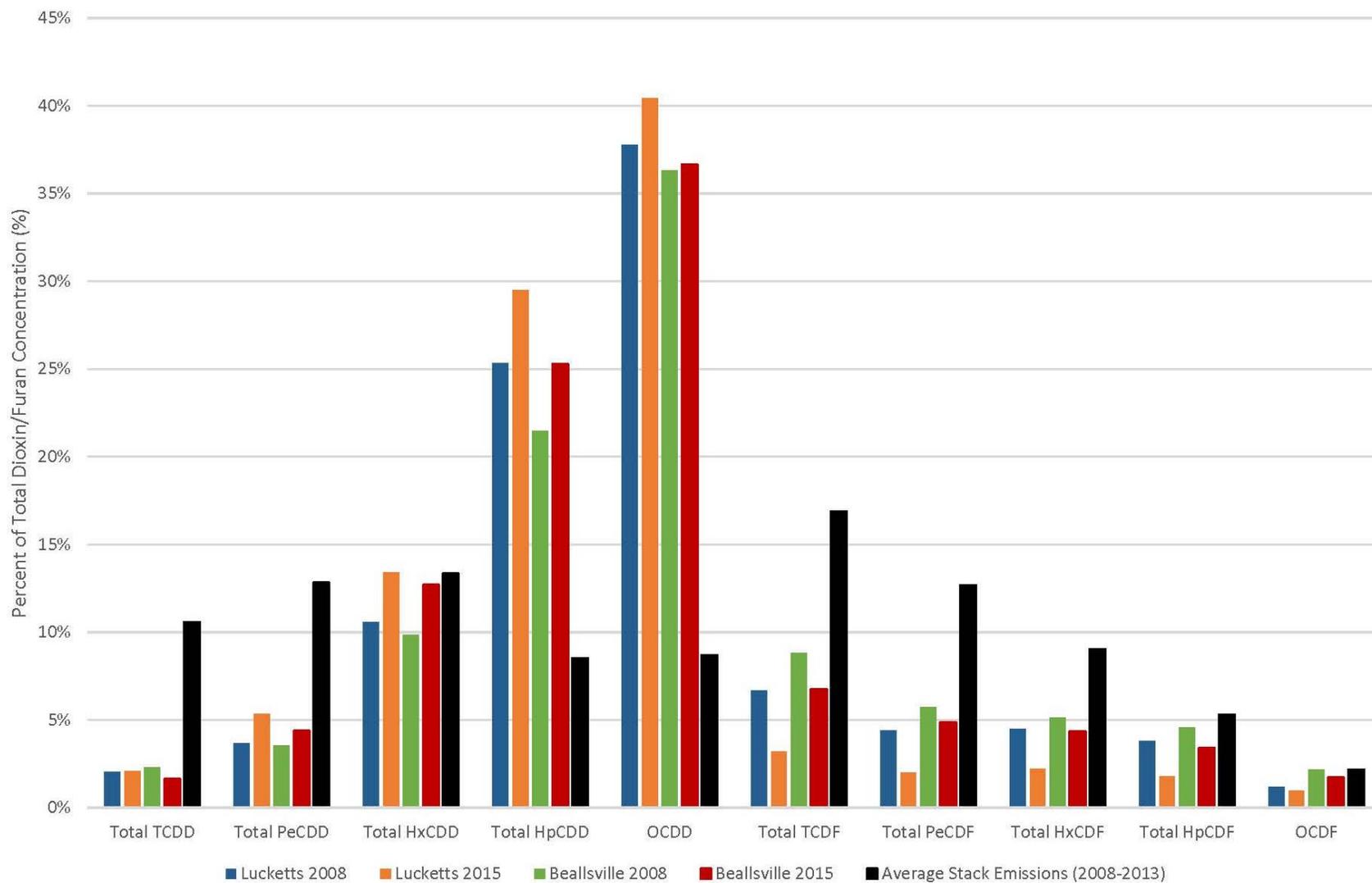
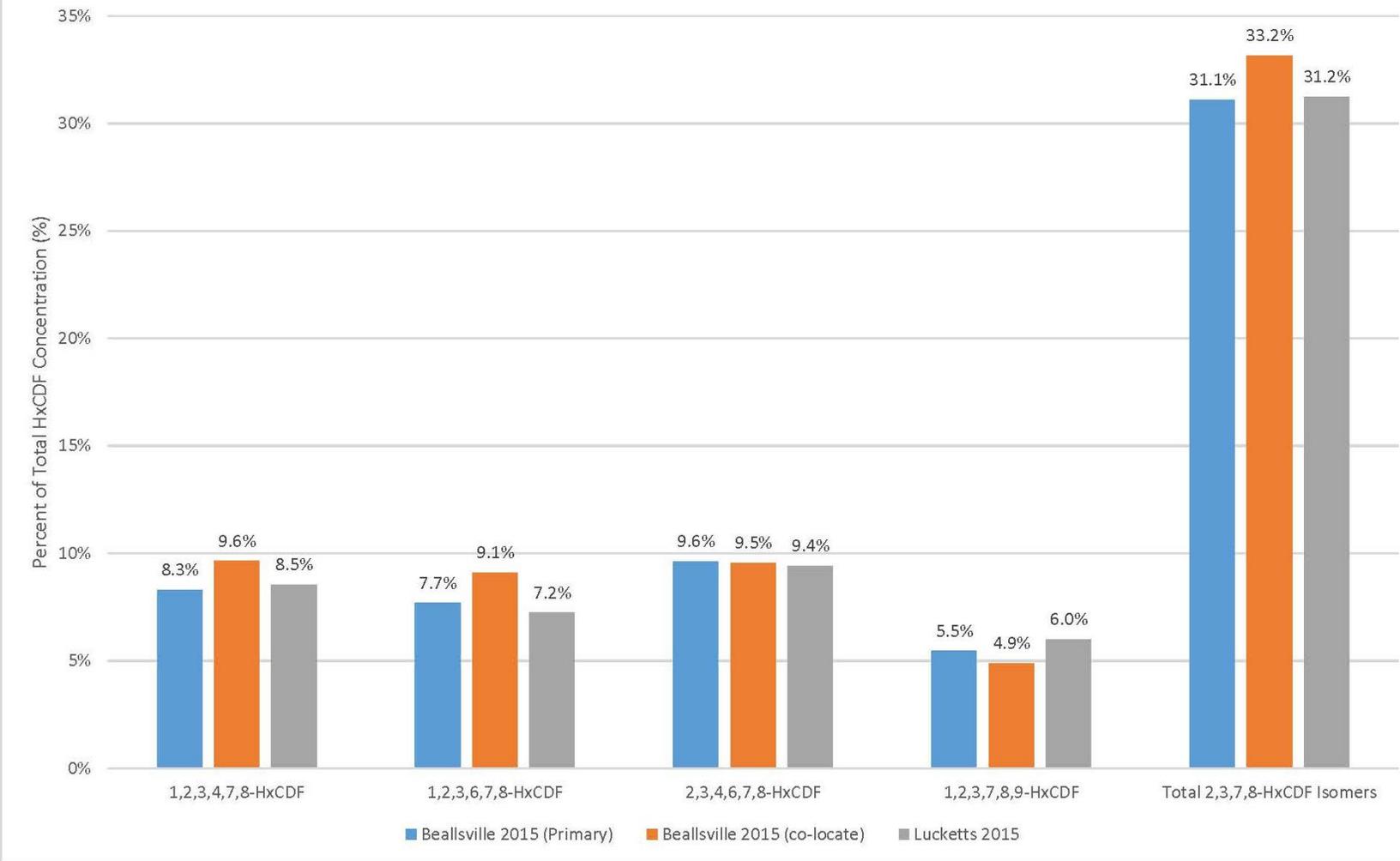
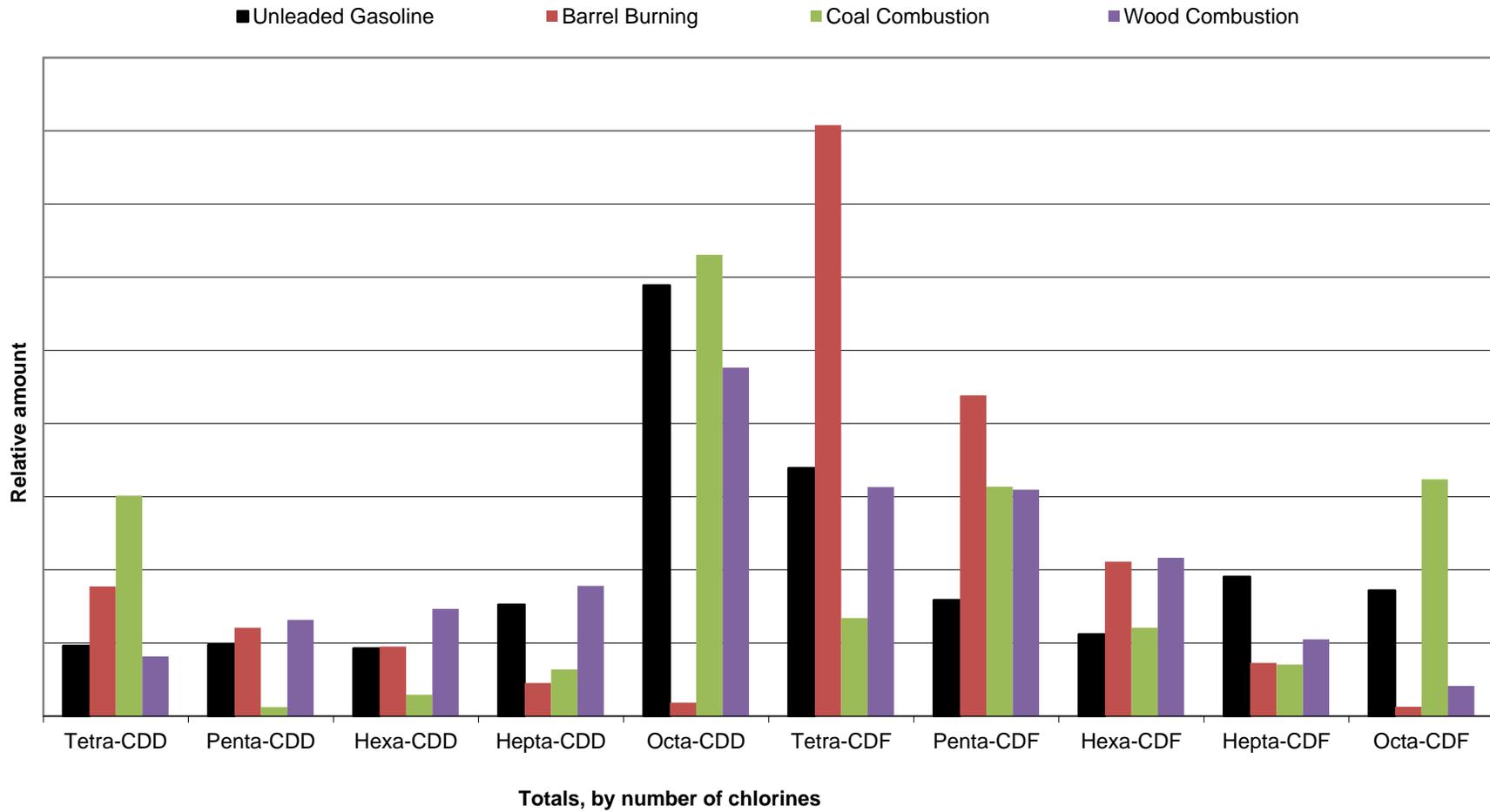


Figure 8-13  
HxCDF Profile 30-day Ambient Air Samples  
Montgomery County RRF  
Winter 2015



**Figure 8-14: Typical Pattern of PCDD/PCDF Emission's from Other Potential Sources**



## 8.4 Trend Analysis

The DAFIG requested consideration of any trends evident in the ambient air monitored over the years from pre-operational monitoring to the latest monitoring year. The Mann-Kendall<sup>2</sup> trend test is a statistical analysis that can be used to identify if a series of data has an increasing or decreasing trend. The analysis computes each of early measurements versus each of later ones and sums them up as Mann-Kendall statistic “S” values. Then a confidence factor was statistically estimated for each series of data. A confidence factor of 95% or above was used to define if an upward (positive S) or a downward (negative S) trend existed for a series of data. To avoid the uncertainties brought by non-detects, only the data of detected congeners and metals over the whole ambient air study programs were analyzed. As shown in Table 8-2, OCDD, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,6,7,8-HxCDF, 2,3,4,6,7,8-HxCDF, and OCDF each demonstrated a downward trend over the study period, and all other pollutants demonstrated no trend.

**Table 8-2: Mann-Kendall Analysis for Impacted Site (Beallsville)**

Mann-Kendall Analysis for Impacted Site (Beallsville)												
Program	CDD/CDF, pg/m3										Metal, ng/m3	
	1,2,3,6,7,8-HxCDD	1,2,3,7,8,9-HxCDD	1,2,3,4,6,7,8-HpCDD	OCDD	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDF	2,3,4,6,7,8-HxCDF	OCDF	Lead	Nickel
<b>Pre-Op</b>	0.0885	0.1096	2.2807	22.6926	0.0414	0.0409	0.0310	0.0272	0.0412	0.8747	2.8500	1.9700
<b>1996-97</b>	0.0232	0.0352	0.2617	0.8560	0.0298	0.0228	0.0226	0.0185	0.0261	0.0625	5.3200	0.8630
<b>2002-03</b>	0.0025	0.0031	0.1044	0.3922	0.0026	0.0042	0.0533	0.0243	0.0280	0.0197	4.5019	1.2368
<b>2008</b>	0.0114	0.0182	0.1375	0.5077	0.0031	0.0050	0.0071	0.0061	0.0078	0.0307	3.2506	1.1066
<b>2015</b>	0.0095	0.0115	0.1170	0.3800	0.0020	0.0035	0.0040	0.0040	0.0045	0.0180	1.8667	0.8650
<b>Mann-Kendall S</b>	-6	-6	-6	-8	-8	-8	-6	-8	-8	-8	-4	-4
<b>Confidence Factor</b>	88.3%	88.3%	88.3%	95.8%	95.8%	95.8%	88.3%	95.8%	95.8%	95.8%	75.8%	75.8%
<b>Trend</b>	No Trend	No Trend	No Trend	Downward	Downward	Downward	No Trend	Downward	Downward	Downward	No Trend	No Trend

For comparison, the same congeners and metals in RRF stack emissions were also analyzed using the same Mann-Kendall test. As shown in Table 8-3, there is no increasing or decreasing trend indicated for any of the RRF emitted constituents. These data do not indicate any influences from the MCRRF source emissions.

<sup>2</sup> Gilbert RO (1987). Statistical Methods for environmental Pollution Monitoring. New York: Van Norland Reinhold.

**Table 8-3: Mann-Kendall Analysis for Stack Emissions**

Mann-Kendall Analysis for Stack Emissions												
Year	CDD/CDF, ng/dscm										Metal, ug/dscm	
	1,2,3,6,7,8-HxCDD	1,2,3,7,8,9-HxCDD	1,2,3,4,6,7,8-HpCDD	OCDD	1,2,3,7,8-PeCDF	2,3,4,7,8-PeCDF	1,2,3,4,7,8-HxCDF	1,2,3,6,7,8-HxCDF	2,3,4,6,7,8-HxCDF	OCDF	Lead	Nickel
1995	0.0161	0.0287	0.1769	0.5487	0.0121	0.0184	0.0679	0.1251	0.0193	0.200	19.3700	0.3740
1996	0.0055	0.0099	0.0311	0.0881	0.0079	0.0190	0.0204	0.0068	0.0130	0.015	NA	NA
1997	0.0149	0.0104	0.1819	0.7688	0.0141	0.0128	0.0613	0.0294	0.0333	0.654	NA	NA
1998	0.0043	0.0045	0.0300	0.0417	0.0036	0.0051	0.0148	0.0056	0.0077	0.019	NA	NA
1999	0.0055	0.0029	0.0296	0.0360	0.0026	0.0042	0.0023	0.0026	0.0027	0.003	NA	NA
2002	0.0052	0.0028	0.0322	0.0393	0.0045	0.0057	0.0044	0.0047	0.0054	0.005	6.8967	1.6033
2003	0.0130	0.0162	0.1035	0.1933	0.0196	0.0254	0.0245	0.0358	0.0422	0.085	1.8200	1.6100
2004	0.0039	0.0022	0.0250	0.0418	0.0034	0.0049	0.0042	0.0044	0.0045	0.006	4.2733	1.8333
2005	0.0071	0.0046	0.0539	0.0768	0.0054	0.0064	0.0072	0.0066	0.0070	0.014	4.9500	1.4367
2006	0.0114	0.0088	0.0991	0.1875	0.0132	0.0187	0.0197	0.0221	0.0217	0.076	12.0800	2.0567
2007	0.0085	0.0048	0.0637	0.1028	0.0048	0.0080	0.0067	0.0069	0.0096	0.016	11.0200	1.2980
2008	0.0115	0.0085	0.0991	0.2719	0.0109	0.0134	0.0147	0.0171	0.0215	0.105	29.9233	0.8000
2009	0.0095	0.0037	0.0560	0.1291	0.0129	0.0145	0.0133	0.0133	0.0171	0.021	7.9500	1.3940
2010	0.0091	0.0061	0.0274	0.0335	0.0045	0.0059	0.0048	0.0035	0.0049	0.004	8.4833	0.6490
2011	0.0107	0.0107	0.0737	0.1538	0.0421	0.0320	0.0389	0.0425	0.0325	0.061	2.8067	1.2870
2012	0.0044	0.0028	0.0258	0.0415	0.0058	0.0067	0.0071	0.0079	0.0067	0.011	6.4033	1.8167
2013	0.0123	0.0059	0.0494	0.0713	0.0107	0.0133	0.0138	0.0146	0.0125	0.015	3.1200	1.5433
2014	0.0034	0.0021	0.0199	0.0309	0.0019	0.0031	0.0027	0.0027	0.0034	0.005	10.2567	2.3100
<b>Mann-Kandell S</b>	<b>-13</b>	<b>-39</b>	<b>-37</b>	<b>-33</b>	<b>-3</b>	<b>-5</b>	<b>-39</b>	<b>-11</b>	<b>-19</b>	<b>-25</b>	<b>-5</b>	<b>9</b>
<b>Cofidence Factor</b>	<b>67.5%</b>	<b>92.5%</b>	<b>91.4%</b>	<b>88.7%</b>	<b>53.0%</b>	<b>56.0%</b>	<b>92.5%</b>	<b>64.8%</b>	<b>75.2%</b>	<b>81.8%</b>	<b>58.7%</b>	<b>66.9%</b>
<b>Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>	<b>No Trend</b>

## **8.5 Model Predicted Ambient Concentrations (From RRF Emissions) Compared to Ambient Air Measurements**

As noted in Section 1, a secondary objective of this report was to assess, to the extent possible, the consistency of field measurements with the air dispersion modeling results presented in TRC's "2014 Health Risk Assessment Update for the Montgomery County Resource Recovery Facility (RRF)." [1]

None of the preceding results has relied in any way on air dispersion modeling, but have been based solely on actual measurements, and none of these results have indicated measurable influences from the RRF emission on the ambient air quality. So far, five independent approaches have been taken to make use of ambient air observations in order to discern an indication of impacts on the ambient air from RRF emissions. These are as follows: regulated metals concentrations, comparison of regulated metals concentrations upwind of MCRRF to those measured downwind, elemental profiles, PCDDS/PCDFS profiles, and trend analysis. In all cases no impacts from MCRRF emissions were found.

In this section, comparisons are made between the ambient air monitored and the predictions made by the EPA's air dispersion model, AERMOD. Specifically, to investigate the potential influence of MCRRF emissions on ambient air quality, the ambient air monitoring data were compared with the model's predicted incremental concentrations on ambient air concentrations at the two air sampling sites. Each sampling period was modeled using the AERMOD dispersion model and average exit velocity and exhaust temperature data from MCRRF stacks as recorded in operational records concurrent with the ambient sampling. These records were provided to TRC by MCRRF staff. As a practical matter, stack sampling for pollutant emissions was not conducted concurrently with the ambient sampling. Instead, modeled emission rates were based on the most recent stack sampling data available, conducted in August 2014, which measured stack gas concentrations at Units 1, 2, and 3 individually. The relative consistency of stack emissions over time can be seen in the same reference cited above. [1] Meteorology data was processed following the same data processing procedure as the prior 2013 modeling analyses, including the use of the same version (12345) of the AERMET meteorological data pre-processor. Seasonal land characteristics were updated to reflect the 2014 and 2015 sampling periods, respectively.

Model runs were setup and executed using AERMOD version 12345 (same version used for the prior 2013 analyses) for each period of interest (start and stop times rounded to the nearest inclusive hour). Dioxins/Furans TEQ were modeled as 2, 3, 7, 8-TCDD (which is modeled as 66.4% vapor phase, with the balance as particle bound phase). The metals were modeled as particles, except mercury which was modeled as vapor. Air concentrations were calculated at each respective monitoring location (see Figure 2-1) so that results could be compared to each of the three (3) sampling events.

Table 8-4 presents the AERMOD model's predicted ambient concentrations attributable to the RRF emissions for dioxin/furans and metals and compares these with the measured concentrations of the same analytes at Lucketts and Beallsville. According to the USEPA seven rigorous AERMOD evaluation studies where issues of background sources are eliminated (e.g.

by means of adding to the stack emissions a tracer gas that does not exist in the environment), have demonstrated that AERMOD reliably predicts downwind ground-level air concentrations to match observed concentrations well within a factor of two. [1] The AERMOD predictions listed in Table 8.4 indicate that the contributions attributable to the RRF are an extremely small fraction of the monitored concentrations. (See actual data last two columns of Table 8-4 which presents a ratio of modeled concentrations to actual concentrations measured at both the Lucketts and Beallsville sites)<sup>3</sup>.

For additional context, also shown in the Table 8-4, are the 3-year averages for compounds as measured by EPA's air toxics monitoring site in the District of Columbia (DC). As shown results for all three (3) locations (Beallsville, Lucketts and DC) are reasonably consistent (generally within a factor of 2), indicating that none of the monitoring sites are being impacted by a dominant local emission source. Comparison of the DC monitored concentrations to the Lucketts and Beallsville monitored concentrations indicates that regional background sources are the predominant contributors to concentrations in the region.

The ambient air observations data from the two monitoring sites is more consistent with the hypothesis that the air at both sites is impacted by background sources than with a theory that AERMOD is materially inaccurate.

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<sup>3</sup> It should be noted that detection limits for all target compounds reported herein are significantly higher than the corresponding incremental ambient air concentrations resulting from dispersion modeling (AERMOD) of RRF emissions. Hence the latter concentration in all cases cannot be actually measured. For example the method detection limit for lead in all ambient samples was  $0.30 \text{ E-}03 \text{ ug/m}^3$ . The corresponding modeled incremental air concentration in all three (3) Lucketts ambient air sampling events was  $0.1 \text{ E-}05 \text{ ug/m}^3$ . Lead concentrations actually measured at the Lucketts site in all three (3) sampling events ranged from  $164\text{-}223 \text{ E-}05 \text{ g/m}^3$ . This latter range represents a factor greater than 1640 to 2230 times the modeled incremental ambient air concentration and only a factor of 547 to 743 times the method detection limit achievable.

**Table 8-4: Modeled Concentrations from RRF Emissions Compared to Background Ambient Air Measurements**

Period	Analyte	Modeled Incremental Air Conc Due to RRF Emissions (ug/m3)		Measured Air Conc (ug/m3)		Avg Daily Air Conc at DC* (ug/m3)	Ratio of Modeled Incremental Air Concentrations from RRF to Measured Air Concentrations	
		Lucketts	Beallsville	Lucketts	Beallsville		Lucketts	Beallsville
Feb 3, 2015 to Mar 4, 2015	Dioxins / Furans TEQ	0.1E-11	0.3E-11	3,900E-11	1,200E-11	No data	0.00003	0.00024
Jan 28, 2014 to Jan 29, 2014	Arsenic	0.1E-06	1.8E-06	547E-06	535E-06	716E-06	0.00018	0.00337
	Beryllium	0.3E-08	5.0E-08	ND	ND	305.5E-08		
	Cadmium	0.1E-06	1.5E-06	167E-06	191E-06	130E-06	0.00048	0.00762
	Chromium	0.1E-06	2.1E-06	ND	ND	2,201E-06		
	Lead	0.1E-05	2.3E-05	164E-05	152E-05	305E-05	0.00076	0.01491
	Mercury	0.3E-06	5.5E-06	ND	ND	577E-06		
	Nickel	0.3E-06	5.1E-06	617E-06	753E-06	1,040E-06	0.00045	0.00672
Feb 6, 2014 to Feb 7, 2014	Arsenic	0.1E-06	0.9E-06	416E-06	665E-06	716E-06	0.00016	0.00135
	Beryllium	0.3E-08	3.7E-08	ND	ND	305.5E-08		
	Cadmium	0.1E-06	1.0E-06	ND	ND	130E-06		
	Chromium	0.1E-06	1.7E-06	ND	ND	2,201E-06		
	Lead	0.1E-05	1.3E-05	219E-05	220E-05	305E-05	0.00045	0.00605
	Mercury	0.3E-06	4.6E-06	ND	ND	577E-06		
	Nickel	0.3E-06	4.1E-06	867E-06	726E-06	1,040E-06	0.00035	0.00571
Feb 26, 2014 to Feb 27, 2014	Arsenic	0.1E-06	1.2E-06	375E-06	356E-06	716E-06	0.00013	0.00340
	Beryllium	0.1E-08	3.3E-08	ND	ND	305.5E-08		
	Cadmium	0.04E-06	0.9E-06	132E-06	ND	130E-06		
	Chromium	0.1E-06	1.2E-06	ND	ND	2,201E-06		
	Lead	0.1E-05	1.5E-05	223E-05	188E-05	305E-05	0.00027	0.00772
	Mercury	0.2E-06	4.5E-06	ND	ND	577E-06		
	Nickel	0.1E-06	3.5E-06	967E-06	1,116E-06	1,040E-06	0.00015	0.00311

\* District of Columbia (DC) concentrations from the National Air Toxics Database

<http://www.epa.gov/tnamt1/toxdet.html#data>

Mercury values from 3-year period of 2006 to 2008. All other pollutants 2011 to 2013. PM<sub>10</sub> values used when provided (rather than PM<sub>2.5</sub>).

ND = None detected

## 9.0 SUMMARY AND CONCLUSIONS

### 9.1 Metals (Concentrations)

- Concentrations for the majority of the seven metals measured during the three sampling events are comparable at the two sampling stations. These data collectively do not indicate any influences on ambient air concentrations attributable to emissions of these same metals from the MCRRF. Rather these data represent background concentrations for metals at both the Beallsville and Lucketts sites attributable to an aggregate of source contributions impacting both sites in a near identical manner.
- The highest mean concentrations (representing the three events) were observed for lead. The values of 2.02 ng/m<sup>3</sup> and 2.01 ng/m<sup>3</sup> reported for the Lucketts and Beallsville sites, respectively, are identical and significantly below the 150 ng/m<sup>3</sup> NAAQS for lead expressed as a 24 hour time weighted average. Again, these data represent background concentrations for lead in ambient air in the study region.
- Beryllium was not detected in any samples collected during both the 2014 campaign and the 2008 sampling campaign. Chromium was not detected during the 2014 campaign. Mercury was not detected in any samples collected in 2014, but was detected at very low levels in two out of three sampling events in 2008. Lead, arsenic and nickel mean concentrations for the 2008 sampling campaign were slightly elevated above the 2014 mean concentration for these same metals. The highest mean concentrations for all three of these metals were observed in 2008 at the Lucketts school background site.
- The 2014 metals data indicate that concentrations for the majority of the metals were comparable at both sites independent of the site orientation relative to the MCRRF. The Beallsville site even when situated predominantly downwind of MCRRF had metals concentrations comparable to background. These data do not indicate any influences from MCRRF source emissions.

### 9.2 Elemental Profiles

- Elemental profiles (XRF) data indicate significant difference in both measured concentrations and more importantly ratios of selected elements concentrations in comparison of MCRRF source filter samples to ambient filter samples.
- These data collectively provide further evidence that MCRRF particulate emissions are not measurably impacting particulate matter collected at the Lucketts site, as well as, the Beallsville sampling site even when situated predominantly downwind of the MCRRF.

### 9.3 Modeling RRF Emissions

- AERMOD modeling results indicate that the contributions attributable to the RRF are a very small fraction of the concentrations measured during the 2014 (metals) and 2015 (PCDDs/PCDFs) sampling events. This observation is consistent with the monitored concentrations at the three locations, (Lucketts, Beallsville and Washington, DC) indicating that none of the monitoring sites are being impacted by a dominant local emission source.

- Comparison of the concentrations representing Washington, DC to the measured concentrations at the Lucketts and Beallsville sites indicates that regional, background sources are the largest contributors to concentrations measured at all three sites.

#### 9.4 PCDDs/PCDFs

- Profiles presented as a percent of total PCDDs/PCDFs (Cl<sub>4</sub> – Cl<sub>8</sub>) measured at each site are comparable. The profiles at both sites are consistent with those typically reported for ambient air on a global basis where a blend of combustion sources represent the principal contributions to atmospheric concentrations of PCDDs/PCDFs.
- PCDDs/PCDFs profiles are remarkably similar to those observed by AECOM during the third operational phase air monitoring event in 2008. At the time these profiles were found to be typical of numerous types of combustion sources.
- Measured concentrations of PCDDs/PCDFs at the Lucketts site (3.7 pg/m<sup>3</sup>) were roughly three and one-half times higher than concentrations measured at the Beallsville site (1.05 pg/m<sup>3</sup> as an average) during the 31 day sampling event. Based upon these data it has been determined that MCRRF emissions are not contributing to the concentrations of PCDDs/PCDFs measured at the Lucketts site in comparison to concentrations measured at the Beallsville (impact) site. Concentrations of PCDDs/PCDFs measured at both sampling sites more likely represent ambient background conditions attributable to an aggregate of combustion sources operating in winter time in the study region.
- The Lucketts site PCDDs/PCDFs concentration for the 2015 sampling event of 3.70 pg/m<sup>3</sup> is significantly higher than the value of 1.86 pg/m<sup>3</sup> measured during the 2008 sampling event. Conversely, the mean PCDDs/PCDFs concentration of 1.05 pg/m<sup>3</sup> measured at the Beallsville site during the 2015 sampling event is less than the mean value of 1.40 pg/m<sup>3</sup> measured during the 2008 event.
- The Beallsville mean PCDDs/PCDFs (Cl<sub>4</sub> – Cl<sub>8</sub>) concentration of 1.05 pg/m<sup>3</sup> is consistent with the lower end of the urban data range and slightly higher than concentrations representative of rural locations. The Lucketts site concentration suggests influences from combustion sources in the site vicinity and/or study region.
- All of the profiles shown for the 2008 and 2015 sampling events are consistent with those found in a variety of combustion source emissions. It is likely that the PCDDs/PCDFs measured at both the Lucketts and Beallsville sites represent background concentrations attributable to an aggregate of combustion source emissions in the study region.
- The composite profile for MCRRF emissions differs significantly from the profile characteristic of the ambient air samples. For example, the PCDDs profile characteristic of the ambient air samples (Cl<sub>4</sub>< Cl<sub>5</sub>< Cl<sub>6</sub><Cl<sub>7</sub><Cl<sub>8</sub>) is not maintained in the MCRRF profile. OCDD, which predominates the ambient air profile (35-40 percent of Cl<sub>4</sub> - Cl<sub>8</sub> total) represents <10 percent of the source profile for the same homologue sum (Cl<sub>4</sub> – Cl<sub>8</sub>). These data do not support the finding that MCRRF emissions are contributing to

PCDDs/PCDFs measured at either of the two sites during both the 2008 and 2015 sampling events.

- The 2,3,7,8– substituted HxCDFs profiles observed in each of the three ambient air samples are nearly identical and indicative of primarily combustion source influences.

## **9.5 Data Trend Analysis**

- Trend analysis of all ambient monitoring data<sup>4</sup> collected at the Beallsville site and stack emissions monitoring data for the same time period indicate no measurable influences on ambient air concentrations attributable to MCRRF source emissions.

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<sup>4</sup> This data set consists of all data collected in ambient air prior to operation of the MCRRF, as well as, all data collected during the four (4) operational phase monitoring programs.

## 10.0 REFERENCES

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## APPENDICES

A – Field Notes, Chain of Custody (COC) Records (Compact Disk)

B - Chester LabNet – XRF Metals Data Report – TSP Filter Samples (March 10, 2014) Report #14-089.

C – Chester LabNet – XRF Metals – EPA Method 5/M29 Stack Particulate Data (September 3, 2014) Report #14-371

D - Metal Lab Reports – Alpha Labs

E – Mercury Lab Data/Reports – Brooks Rand Labs

F – PCDDs/PCDFs – Cape Fear Analytical Labs

G – TRC Data Validation Memorandums

H- Independent Peer Review