

**Baseline Quality of Ambient and Personal Air
Within the New Jersey Meadowlands District**

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Submitted by:

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Executive Summary:

The field measurements of the ambient air quality and the personal exposure monitoring study commenced during the first year of the Baseline Study being conducted in the Meadowlands. The long term ambient air quality measurement began in March 2005. The measurement protocols include both particulate matter and gaseous species. At the present time there are insufficient measurement results available for interpreting the annual air quality at the four sites selected for the long term study.

The first field intensive study was completed during the Fall of 2004 and it was focused on personal air measurements of volatile organics. The locations included in the personal monitoring study are 1) Mills Creek Marsh/Secaucus High School, 2) Losen Creek Park at Little Ferry, 3) Eric Landfill/Harris Meadow and 4) the Richard W. De Corte Park trailer.

The results for the first intensive personal monitoring study conducted in the late Fall found that all the aromatic compounds yielded exposures that were measured in the New Jersey Relationship of Indoor Outdoor and Personal Air Study (RIOPA). Further, mobile source emissions appeared to dominate the aromatic compound exposures. Finally, other types of sources were associated with the measured levels of chlorinated compounds. The second phase of the personal monitoring study was commenced during the Summer of 2005, and the long term monitoring results will begin to yield a larger database for analysis.

Background:

The NJ Meadowlands Commission has provided a vision for the preservation and re-development of the almost 20,000 acres of land that comprise the Meadowland District. The different redevelopment plans will increase the number of people and the amount of time these individuals spend within the District. The current air pollution and personal air monitoring study is being conducted to evaluate the potential exposures to air toxic pollutants emitted from sources in and near the Meadowlands District. It is also intended to measure the background levels for residential areas within and immediately adjacent to the district, for workers on site, and for visitors to the district who utilize the proposed recreational facilities and areas. Both measurement and modeling activities are being conducted to examine these potential exposures. This report provides a description of the long term sampling program and initial results from that program, and the results from a fall 2004 intensive personal sampling program that was conducted during the first year of this three year project.

Purpose and Specific Aims:

1. An air pollution measurement study will be conducted to examine the current air quality in the Meadowlands district for air toxics and pollutants and provide baseline measurements of exposure for specific activities conducted in the Meadowlands.

Activities during first year

Long Term Sampling

Four sampling sites (Figure 1) were selected in collaboration with MERI, two for collection of particulate matter samples and all four for the collection of volatile organic compounds (VOCs). Sampling is conducted for 48 hours using passive samplers (3M-OVM badges) for the VOC samples, and two pump samplers (MSP-Model 400 MEM™- Micro-Environmental Monitor) for collecting PM-10 (particles less than 10 µm in diameter) for subsequent mass, trace elemental and organic/elemental carbon analyses (EC/OC). The equipment for the routine sample collection, and training for collection of these samples were provided to MERI staff by EOHSI personnel. Routine collection of all samples commenced in March 2005 on an every sixth day cycle. The volatile organic compounds were analyzed by Dr. Shin, MERI, using the GC/MS system at EOHSI. This was done pending purchase and receipt of a similar instrument at MERI. In addition, to the use of the GC/MS instrument, EOHSI Exposure Measurement and Assessment Division provided direct training and supervision of Dr. Shin efforts while he was at EOHSI. Thus, the planned QC samples analyses by EOHSI has not commenced yet, but will once all designated routine analyses are to shifted to the MERI facilities.

The initial results for the PM_{2.5} mass, trace metals and organic/element carbon OC/EC) are presented in Tables 1, 2, and 3 respectively. While the methods used differ from standard EPA reference methods and sample duration is for 48 hours rather than 24 hours as is proposed in EPA methods, the standards and the data collected by others using EPA methods can still be compared in first level evaluations. Included are measurements made in other locals completed by NJ DEP (<http://www.state.nj.us/dep/airmon/appb02.pdf>) and other studies that collected 48 hour samples, such as the RIOPA study conducted in Elizabeth, NJ, Houston, TX and Los Angeles, CA (Meng et al, 2005, Weisel et al 2005) and the TEACH study conducted in New York City, NY and Los Angeles, CA (Kinney et al 2002, Sax et al 2004). The species analyzed in the long term sampling study were selected because they may have sources in the Meadowland region because of motor vehicle emissions, emissions from landfills, and other contaminated wastes or emissions from construction activities during the redevelopment. Other contaminants include those listed as a Hazardous Air Toxic (<http://www.epa.gov/ttn/atw/orig189.html>) or Criteria Pollutants (particulate matter (PM_{2.5}) and lead). Some comparison data are provided following each Table. However, it is important to emphasize that at this time there are too few values available for evaluation of trends, etc. This will be provided in our subsequent reports.

Intensive Sampling

An intensive sampling program was conducted during the fall of 2004. At that time, EOHSI personnel collected personal air samples while walking along different hiking trails within the Meadowlands development area. These trails were selected in collaboration with MERI staff to be from different regions of the Meadowlands District (figure 2a). This was done to

examine the impact that different types of emission sources (i.e. emissions from landfills, development, truck traffic, automobile traffic, construction) that could have air quality and personal exposure that can result from the emitted air pollutants. The locations selected were: Mills Creek Marsh/ the Secaucus High School, Losen Creek Park at Little Ferry, Erie Landfill/Harrier Meadow, and Richard W. DeKorte Park Trails (figures 2b-e). The personal monitoring will provide information on personal VOC concentrations and exposures that occur within locations that include recreational facilities or the residential areas. The overall study designed used during the first intensive was:

1. Technician walk for 2-3 hours along the four designated sampling paths while collecting personal air samples
2. Morning and afternoon samples collection
3. Collection during late fall (November 4 through December 3, 2004).

The samples were collected on adsorbents (figure 3) using sampling pumps (BGI Model 400, Waltham, MA) operated at a nominal flow rate of 200ml/min. Two to three hour samples were collected that resulted in approximately four liters of air being passed through the sampler. Two types of adsorbents traps were used during sampling, one trap type being a proprietary material purchased as prepared traps,-Supelco Air Toxics (Supelco Inc, PA), and the second trap type containing a layered Tenax TA[®] placed over a layer of Carbopac X[®] (Supelco Inc, PA) prepared in the EOHSI laboratories. The traps were analyzed by thermal desorption (ATD400, Perken Elmer[®], MA) coupled with Gas Chromatography/Mass Spectrometry (GC5980 Series II/MSD 5971b, Hewlett Packard[®]). The target compounds

being analyzed were those appearing on the EPA air toxics list and those included in EPA Method TO-14 (Table 4).

Results:

Summary results obtained during the Intensive Sampling period are provided in Table 5. Only compounds that were measurable in at least one sample are included in the table. The compounds which were detected in all of the samples included aromatic compounds, which are emitted from mobile sources, and carbon tetrachloride, which was present at its global background levels. Several compounds were detected in the majority of the samples collected and these included: methylene chloride, a common industrial solvent and chemical used as an intermediate in chemical manufacturing; 2-chlorotoluene, an agricultural pesticide and an industrial solvent; and bromochloromethane (also called halon 1011) a major component used in fire extinguishers and a compound used as a flame retardant in a number of commercial applications.

Box plots, displaying the median, mean, quartiles and extreme values for ambient air concentrations measured along each of the hiking paths are given in figures 4a and b. Also provided in the figure are the mean, ambient air concentrations measured by the New Jersey Department of Environmental Protection at a site in Camden, NJ which has been operated for the last two decades and concentrations measured by the this project's investigators using identical sampling techniques in Elizabeth, NJ, during 1999-2001. The latter were collected to evaluate ambient source emissions contributions within exposure to an urban population. For the compounds measured at the comparison sites, the levels measured in the

Meadowlands are slightly higher than the concentrations measured in Camden, NJ and similar to the values measured in Elizabeth, NJ. The Elizabeth measurements were biased because the site was designed specifically to collect samples near sources of ambient emissions of volatile organics.

To evaluate whether the emissions were likely to be from within or nearby the Meadowlands District the concentrations were plotted versus average wind speed over the sampling period (figures 5a – i) These were compared to toluene concentrations (figures 6a – b), a compound with strong mobile source emissions and some industrial emissions.

Windspeed and Concentrations

The concentrations of the aromatic compounds (benzene, toluene, ethyl benzene, 1,2,4 trimethylbenzene, xylenes and isopropylbenzene) all declined with increasing wind speed (except for a single day's sample collected when the wind was stagnant for the entire sampling time). This is consistent with mobile sources or other emissions close to or within the Meadowlands being dominant for these compounds, rather than long range transport into the region.

The concentration of several halogenated compounds, (bromobenzene, bromochloromethane, methylene chloride, 2 chlorotoluene and Freon) declined with increasing wind speed. This trend is indicative of a continuous source or sources for these compounds within or near the Meadowland.

Carbon tetrachloride showed no consistent trend with wind speed and its levels were similar to background global values. This indicates that carbon tetrachloride is not being emitted from sites within or near the Meadowlands district.

Tetrachloroethene's ambient air concentrations did not decline with wind speed and was only present in a limited number of samples. This suggests that the emissions are not uniform over time.

Comparison to Toluene Concentration

Toluene is a compound with strong mobile source contributions associated with measured concentrations. By examining the ratios of a compound's concentration to toluene in a series of samples collected in a region over several days, it is possible to determine the probability that toluene and that compound have similar sources. This was done visually by plotting the concentration of each compound against the concentration of toluene in each sample. If the plot shows a linear trend with few points deviating from that association, the same source is likely. If major deviations are observed, then a variety of sources are contributing to the compound measured concentrations of toluene.

The concentrations of the other aromatic compounds (benzene, ethyl benzene, 1,2,4 trimethylbenzene, xylenes and isopropylbenzene) were linear as related to the toluene concentration. This result implies that common, local sources in or near the Meadowlands District exist for each of these compounds. This result is consistent with each of these compounds being emitted primarily from automobiles and trucks. Two sections of the New

Jersey Turnpike, a main North-South thoroughfare in New Jersey, and a major East-West roadway (NJ Route 3 leading to the Lincoln Tunnel) bisect or border the Meadowlands District.

The concentrations of halogenated compounds, (bromobenzene, bromochloromethane, methylene chloride, 2 chlorotoluene, Freon, carbon tetrachloride and tetrachloroethylene) did not show a linear relationship with the toluene concentration, consistent with each having distinct sources and presumably not mobile sources.

Figure 5a thru i were visually examined to see whether differences in concentrations exist among the samples collected at the different sites. No distinct differences in air concentrations are evident across the sites for each of the detected compounds except tetrachloroethene. The latter was only above the limit of detection in samples collected near the MERI buildings. This suggests that there were no emissions near any of the sites that greatly increased the concentration (order of magnitude effect) of the measured compounds, with the possible exception of tetrachloroethene. However, since all samples were not collected at the same time, smaller differences in concentration among the sites would not be detectable.

Summary for Winter Intensive

- Concentrations were generally higher than background ambient levels measured at the NJDEP Camden site
- Aromatic compound concentrations were similar to concentrations found in the NJ RIOPA study, which collected samples primarily in close proximity to ambient sources, such as major roadways
- Most compound concentrations vary inversely with wind speed, indicative of local sources within or near the Meadowlands District
- Mobile source emissions appear to dominate the aromatic compounds concentrations measured in the personal monitoring study
- Presence of other sources for chlorinated compounds are likely

The summer intensive personal monitoring study will be conducted during July 2005. Our next report will compare and contrast the results with those reported for the Fall/winter season.

Meng, Q.Y., Turpin, B.J., Korn, L., Weisel, C.P., Morandi, M., Colome, S., Zhang, J.J., Stock, T., Spektor, D., Winer, A., Zhang, L., Lee, J.H., Giovanetti, R., Cui W., Kwon, J., Alimokhtari, S., Shendell, D., Jones, J., Farrar, C., and Maberti, S., "Influence of ambient (outdoor) sources on residential indoor and personal PM2.5 concentrations: Analyses of RIOPA data", *Journal of Exposure Analysis and Environmental Epidemiology*, 15, 17-28, 2005.

Kinney, PL, Chillrud, SN, Ramstrom, S, Ross, J, Spengler, JD, Exposure to multiple air toxics in New York City, *Environmental Health Perspectives*, 110 Supp. 4:539-546, 2002

Sax, SN, Bennett, DH, Chullrun, SN, Kinney, PL, Spengler, JD Differences in source emission rates of volatile organic compounds in inner-city residences of New York City and Los Angeles, *Journal of Exposure Analysis and Environmental Epidemiology* 14 Suppl 1:S95-109, 2004

Weisel, C.P., Zhang, J.J., Turpin, B.J., Morandi, M.T., Colome, S., Stock, T.H., Spektor, D.M., Korn, L., Winer, A., Alimokhtari, S., Kwon, J., Mohan, K., Harrington, R., Giovanetti, R., Cui, W., Afshar, M., Maberti, S., and Shendell, D., "Relationship of Indoor, Outdoor and Personal Air (RIOPA) study: study design, methods and quality assurance/control results", *Journal of Exposure Analysis and Environmental Epidemiology*, 15, 123-137, 2005

Table 1
Preliminary PM_{2.5} Mass (µg/m³) for
Samples Collected in Meadowlands District

Date Started	Date Ended	Site 1	Site 1 Duplicate	Site 2	Site 2 Duplicate	Comments
03/17/05	03/19/05	20.30	24.01	20.83		
03/23/05	03/25/05	11.43		10.27	8.67	
04/04/05	04/06/05	13.83		6.64		
04/10/05	04/12/05	NA		NA		Filters lost after sampling Filters lost after sampling Need to confirm Site 1 Flow
04/16/05	04/18/05	NA	NA	NA		
04/22/05	04/24/05	26.11		6.86		
04/28/05	04/30/05	14.51		8.44		
05/04/05	05/06/05	12.56		10.38		
05/10/05	05/12/05	17.03		15.94		
05/16/05	05/18/05	11.29		8.22	9.82	
05/22/05	05/24/05	6.97		4.83		

RIOPA Study Elizabeth, NJ 20.4±10.7 (median 18.2) µg/m³

Houston, TX 14.7±13.2 (median 5.7) µg/m³

Los Angeles, CA 19.2±16.1 (median 13.3) µg/m³

Camden NJ NJ DEP Web Site 2002 Annual Average 16, Highest 24-hour 95, 2nd Highest 24-hour 61µg/m³

EPA National Ambient Air Quality Standard annual average 15, 24-hour 65µg/m³

Table 2 Preliminary Organic Carbon (OC), Elemental Carbon (EC) & Total Carbon (TC) ($\mu\text{g}/\text{m}^3$) for Samples Collected in Meadowlands District												
		Site 1			Site 2			Duplicates				
Date Started	Date Ended	OC	EC	TC	OC	EC	TC	OC	EC	TC	NOTES	
03/17/05	03/19/05	5.38	0.99	6.37	5.81	0.29	6.10				Low flow on Dup and Q1	
03/23/05	03/25/05	NA	NA	NA	2.90	0.58	3.48				Q1 pump malfunction	
04/04/05	04/06/05	5.61	0.87	6.48	3.82	1.19	5.01	4.36	0.82	5.19	site 1 duplicate	
04/10/05	04/12/05	NA	NA	NA	NA	NA	NA				Filters lost after sampling	
04/16/05	04/18/05	NA	NA	NA	NA	NA	NA				Filters lost after sampling	
04/22/05	04/24/05	1.93	0.36	2.29	1.81	0.42	2.23					
04/28/05	04/30/05	3.64	0.42	4.06	3.30	0.53	3.83	3.34	0.46	3.80	site 2 duplicate	
05/04/05	05/06/05	3.52	0.54	4.06	3.49	0.64	4.13					
05/10/05	05/12/05	5.09	1.12	6.21	6.33	1.42	7.75					
05/16/05	05/18/05	5.09	0.59	5.69	4.63	0.46	5.09					
05/22/05	05/24/05	3.67	0.45	4.12	2.92	0.35	3.27					

Organic Carbon

RIOPA Study Elizabeth, NJ 4.8 (median) $\mu\text{g}/\text{m}^3$

Houston, TX 4.2 \pm (median) $\mu\text{g}/\text{m}^3$

Los Angeles, CA 6.5 \pm (median) $\mu\text{g}/\text{m}^3$

Camden NJ NJ DEP Web Site 2002 Annual Average 5.1, Highest 24-hour 49, 2nd Highest 24-hour 15 $\mu\text{g}/\text{m}^3$

Elemental Carbon

RIOPA Study Elizabeth, NJ 1.3 \pm (median) $\mu\text{g}/\text{m}^3$

Houston, TX 0.65 \pm (median) $\mu\text{g}/\text{m}^3$

Los Angeles, CA 1.62 \pm (median) $\mu\text{g}/\text{m}^3$

Camden NJ NJ DEP Web Site 2002 Annual Average 0.73, Highest 24-hour 2.7, 2nd Highest 24-hour 2.5 $\mu\text{g}/\text{m}^3$

**Table 3
Preliminary Elemental Analyses (ng/m³)
for Samples Collected in Meadowlands District (Uncensored Data)**

ID Number	Site	Date	Chromium	Manganese	Copper	Zinc	Arsenic	Selenium	Cadmium
T005	Site 2	3/17/2005	0.35	4.35	7.64	6.76	ND	0.44	0.14
T006	Site 1 Duplicate	3/17/2005	1.79	4.79	10.41	11.62	ND	ND	0.42
T008	Site 2	3/23/2005	ND	1.26	2.28	4.04	ND	ND	0.05
T010	Site 2 Duplicate	3/23/2005	ND	1.03	3.01	3.67	ND	ND	0.02
T009	Site 1	3/23/2005	0.24	1.64	2.13	6.69	ND	ND	0.07
T012	Site 1	4/4/2005	2.03	4.85	5.46	9.97	0.76	ND	0.08
T013	Site 2	4/4/2005	ND	ND	ND	ND	ND	13.28	ND

ID Number	Site	Date	Mercury	Lead	Lithium	Magnesium	Vanadium	Cobalt	Nickel
T005	Site 2	3/17/2005	ND	4.52	0.13	55.60	5.75	0.12	3.54
T006	Site 1 Duplicate	3/17/2005	0.28	4.72	0.17	61.14	6.42	0.37	27.45
T008	Site 2	3/23/2005	0.47	1.12	0.02	23.75	1.28	0.12	2.19
T010	Site 2 Duplicate	3/23/2005	0.09	0.65	0.01	7.28	0.98	0.08	2.07
T009	Site 1	3/23/2005	ND	1.48	0.03	13.77	1.68	0.29	3.94
T012	Site 1	4/4/2005	ND	5.03	0.14	58.27	3.38	0.08	2.34
T013	Site 2	4/4/2005	ND	ND	0.01	ND	0.12	ND	ND

ND – not detected

Mercury values are questionable since it might volatilize from the particulate phase during collection.

Comparison Metal Data from Two DEP sites on Fine Particles – 2002
(<http://www.state.nj.us/dep/airmon/appb02.pdf>)

DEP Site 2002	Chromium	Manganese	Copper	Zinc	Arsenic	Selenium	Cadmium
Candem Annual Average	2.6	2.3	4.5	12	0.9	1.4	2.5
Daily Maximum	54	7.2	29	89	5.4	5.7	15
2nd Highest Daily	13	7.1	23	43	4.8	5.5	14
Elizabeth Annual Average	3.3	3.1	7.1	18	1.1	1.7	2.8
Daily Maximum	40	10	27	60	5.1	9.7	26
2nd Highest Daily	32	9.7	18	51	3.3	6.0	21

DEP Site 2002	Mercury	Lead	Lithium	Magnesium	Vanadium	Cobalt	Nickel
Candem Annual Average	1.3	4.7	Not	5.5	6.2	0.2	3.6
Daily Maximum	8.4	38	Available	185	43	1.7	15
2nd Highest Daily	8.3	22		59	42	1.5	14
Elizabeth Annual Average	1.2	4.7		9.5	7.6	0.3	4.8
Daily Maximum	7.2	15		189	53	2.8	30
2nd Highest Daily	5.9	12		165	44	2.6	26

Table 4		
Target VOC Compounds During Intensive Sampling Program		
Benzene	Freon 11	p-Xylene
Benzyl chloride	Freon 113	Styrene
Carbon tetrachloride	Freon 114	Tetrachloroethylene
Chlorobenzene	Freon 12	Toluene
Chloroform	Hexachlorobutadiene	trans-1,3-Dichloropropene
1,2-Dichloropropane	m-Dichlorobenzene	Trichloroethylene
1,2-Dichloroethane	Methyl bromide	1,1,2,2-Tetrachloroethane
1,2-Dibromoethane	Methyl chloride	1,2,4-Trimethylbenzene
1,1-Dichloroethane	Methyl chloroform	1,2,4-Trichlorobenzene
cis-1,2-Dichloroethylene	m-Xylene	1,1,2-Trichloroethane
cis-1,3-Dichloropropene	o-Dichlorobenzene	1,3,5-Trimethylbenzene
Dichloromethane	o-Xylene	Vinyl chloride
Ethyl chloride	p-Dichlorobenzene	Vinylidene chloride
Ethylbenzene		

Table 5
Summary Statistics for VOC ($\mu\text{g}/\text{m}^3$) for Samples Collected in
Meadowlands District During Intensive Sampling

Compounds	Number above detection	Mean	Std. Deviation	Minimum	Maximum
toluene	14	6.08	6.93	0.76	26.46
benzene	14	2.77	1.94	0.78	7.40
m,p-xylene	14	1.54	2.14	0.25	8.18
o-xylene	14	1.22	1.55	0.23	5.96
1,2,4-trimethylbenzene	14	1.11	1.56	0.25	6.29
ethylbenzene	14	0.84	0.91	0.26	3.63
carbon tetrachloride	14	0.70	0.14	0.51	0.98
trichlorofluoromethane (Freon 11)	13	1.88	0.83	1.22	3.66
methylene chloride	12	1.30	1.74	0.00	6.65
2-chlorotoluene	12	0.69	0.58	0.23	2.18
bromochloromethane	9	0.50	0.40	0.11	1.33
tert-butylbenzene	8	0.29	0.17	0.14	0.65
isopropylbenzene	7	0.26	0.13	0.13	0.52
4-isopropyltoluene	6	0.41	0.44	0.17	1.30
tetrachloroethene	4	0.30	0.19	0.06	0.49
styrene	3	0.65	0.23	0.43	0.90
bromobenzene	3	0.63	0.25	0.43	0.91
sec-butylbenzene	3	0.18	0.06	0.14	0.25
n-propylbenzene	3	0.16	0.12	0.03	0.25
n-butylbenzene	2	0.34	0.06	0.30	0.38
trichloroethene	1	1.28	.	1.28	1.28
chlorobenzene	1	0.51	.	0.51	0.51
1,1,1-trichloroethane	1	0.40	.	0.40	0.40
1,2-dichlorobenzene	1	0.31	.	0.31	0.31

Listing of Figures

Figures	Title
1	Locations of Long Term Samples
2	Locations of Trails Followed for Intensive Sampling 2004 <ol style="list-style-type: none">Map of siteMills Creek Marsh/Secaucus High SchoolLosen Creek Park at Little FerryErie Landfill/Harrier MeadowRichard W. DeKorte Park Trails
3	Personal Air Sampler
4	Box Plots <ol style="list-style-type: none">Aromatic CompoundsHalogenated Compounds
5	Comparison of Concentration at Each Site with Wind Speed <ol style="list-style-type: none">BenzeneEthyl BenzeneToluene1,2,4 Trimethyl BenzeneBromobenzeneBromochlorobenzeneCarbon TetrachloroideMethylene ChlorideFreon2-ChlorotolueneTetrachloroethyleneIsopropyl Benzene
6	Compound Concentration Comparison to Toluene Concentration <ol style="list-style-type: none">Mobile Source CompoundsHalogenated Compounds (benzene included for reference)

Appendix A

Quality Control/Quality Assurance Procedures

A number of quality assurance/quality control steps (QA/QC) were taken during the field sampling and analysis. These included: measuring the flow rate before and after sampling, collection of field blanks, comparison of two adsorbents traps for evaluation of losses of compounds during sampling, use of multipoint calibration curve and external standard check of calibration curve.

The results of the blank analyses are given in Table A-1. Only benzene and toluene showed consistent blank levels, which were likely due to thermal degradation of adsorbent material in the trap. The average blank value for these two compounds was subtracted from the samples to correct for the blank contribution.

Calibration curves were prepared by first creating a stock gas standard by injecting 100 μ L of commercially available certified mixed standard containing 60 target compounds (Ultra Scientific DWM-580) at a concentration of 200ng/ μ L each in methanol, into a heated 2000mL round glass bulb with a Mininert Valve. The Mininert Valve facilitates the removal of the standard without losses. The gas standard was well mixed by shaking the glass bulb, which contained approximately ten small glass beads, for a minimum of 30seconds. After mixing, a known volume of the gas standard was withdrawn for transference to an adsorbent trap. The volumes of the standards withdrawn from the bulb using a gas tight syringe were: 50, 100, 200, 500, 1000 or 2500 μ L. The gas standard gas was injected into a heated transfer line through which high purity nitrogen was continuously flowed and to which an adsorbent trap was

attached. The nitrogen flow rate was ~200mL/min and continually flowed through the heated 125 mL glass apparatus for 5 minutes, thereby flushing the system with approximately eight times its volume to completely transfer the standard onto the adsorbent trap. The selected volumes used resulted in placing 0.5, 1.0, 2.0, 5.0, 10, or 25 ng of each compound on individual adsorbent traps which were analyzed in a manner identical to samples. Peak areas for each compound's ion chromatogram were tabulated to create the calibration table, which was used for quantitation of the samples. Calibration curves had R^2 values exceeding at least 0.95, with the majority of curves having an $R^2 > 0.98$. Examples of the calibration curves are given in figures A-1.

The calibration curve was checked by injecting an external standard containing 10ng of the compounds onto an adsorbent trap and calculating the concentration using the calibration curves. While there were individual compounds that had values outside the $\pm 30\%$ criteria for agreement, the majority of the compounds had both standard checks within this range. The concentrations of compounds with responses between $\pm 30\%$ and $\pm 40\%$ should be considered qualitative, i.e. present but with high uncertainty for their exact concentration (Table A-2). External standard checks for compounds that had a deviation greater than 40% should not be quantified based on the current curves and included dibromochloromethane, bromodichloromethane, 1,1-dichloroethane, and 1,4-dichlorobenzene. These compounds were not detected in any of the samples, so recalibration was not done.

The comparison of the two trap materials showed inconsistent results. For some sample pairs, good agreement was evident, while for other sample pairs the Air Toxic trap collected considerably less amounts for most compounds (figures A-2). It is still unclear why this occurred as controlled laboratory studies do not show this difference. The results provided in this report therefore only use the results obtained from the two adsorbent traps prepared at EOHSI.

Table A-1
Results of Blank Trap Analyses (ng per trap)

Compound	1	2	3	4	5	6	7	8	9	10	11	12	13	Average
toluene	N.D.	N.D.	N.D.	0.78	0.63	0.97	3.13	0.92	N.D.	2.51	1.39	1.42	N.D.	1.47
benzene	N.D.	0.24	N.D.	0.54	0.5	0.72	1.23	1	1.1	3.06	1.41	1.88	0.88	1.17
ethylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.89	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
m,p-xylene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.48	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
styrene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
o-xylene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.56	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
isopropylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
n-propylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
tetrachloroethene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
dibromochloromethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,3-dichloropropane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,1,2-trichloroethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
2-chlorotoluene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2,4-trimethylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2.97	13.97	N.D.	N.D.	N.D.	-
tert-butylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
4-isopropyltoluene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
n-butylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
sec-butylbenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,4-dichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
trichlorofluoromethane	N.D.	N.D.	N.D.	N.D.	1.37	10.51	1.23	N.D.	N.D.	0.13	N.D.	N.D.	N.D.	-
1,1-dichloroethene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
methylene chloride	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2.78	N.D.	N.D.	N.D.	N.D.	-
1,1-dichloroethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
cis-1,2-dichloroethene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
2,2-dichloropropane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
bromochloromethane	N.D.	0.61	N.D.	0.41	N.D.	-0.47	2.6	N.D.	N.D.	0.08	N.D.	N.D.	N.D.	-
1,1,1-trichloroethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
carbon tetrachloride	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2-dichloroethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,1-dichloropropene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
trichloroethene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
dibromomethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
cis-1,3-dichloropropene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
trans-1,3-dichloropropene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2-dibromoethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
Chlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,1,2,2-tetrachloroethane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
Bromobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,3-dichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,4-dichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2-dichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2,4-trichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2,3-trichlorobenzene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
Naphthalene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
1,2-dichloropropane	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-
trans-1,2-dichloroethene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	-

Table A-2
External Standard Check of Calibration Curve

Compound	Std 1		Std 2		Compound	Std 1		Std 2	
chloroform	9.5	ng	6.6	ng	tetrachloroethene	9.4	ng	7.7	ng
bromodichloromethane	11.8	ng	8.9	ng	dibromochloromethane	4.3	ng	3.5	ng
dibromochloromethane	6.1	ng	2.5	ng	1,3-dichloropropane	12.7	ng	9.9	ng
bromoform	8.7	ng	7.5	ng	1,1,2-trichloroethane	10.8	ng	8.7	ng
toluene	11.0	ng	9.0	ng	2-chlorotoluene	9.7	ng	9.0	ng
benzene	11.5	ng	9.2	ng	1,2,4-trimethylbenzene	8.2	ng	7.4	ng
ethylbenzene	10.2	ng	8.7	ng	tert-butylbenzene	7.4	ng	6.6	ng
m,p-xylene	9.1	ng	7.5	ng	4-isopropyltoluene	6.2	ng	6.2	ng
styrene	9.2	ng	12.6	ng	n-butylbenzene	6.4	ng	6.0	ng
o-xylene	8.5	ng	7.2	ng	sec-butylbenzene	7.3	ng	6.6	ng
isopropylbenzene	8.7	ng	7.3	ng	1,4-dichlorobenzene	7.1	ng	10.9	ng
n-propylbenzene	5.5	ng	5.4	ng	trichlorofluoromethane	7.4	ng	18.	ng
1,1-dichloroethene	9.3	ng	-	ng	t-1,3-dichloropropene	16.8	ng	14.2	ng
methylene chloride	8.2	ng	4.4	ng	1,2-dibromoethane	10.6	ng	10.2	ng
1,1-dichloroethane	2.4	ng	1.9	ng	chlorobenzene	9.2	ng	8.0	ng
cis-1,2-dichloroethene	11.9	ng	9.2	ng	1,1,2,2-tetrachloroethane	7.9	ng	6.9	ng
2,2-dichloropropane	11.3	ng	3.9	ng	bromobenzene	6.5	ng	6.2	ng
bromochloromethane	9.3	ng	6.5	ng	1,3-dichlorobenzene	5.8	ng	7.7	ng
1,1,1-trichloroethane	10.7	ng	5.2	ng	1,4-dichlorobenzene	3.4	ng	5.3	ng
carbon tetrachloride	10.6	ng	5.6	ng	1,2-dichlorobenzene	7.6	ng	7.1	ng
1,2-dichloroethane	12.2	ng	9.6	ng	1,2,4-trichlorobenzene	8.0	ng	8.6	ng
1,1-dichloropropene	10.5	ng	8.4	ng	1,2,3-trichlorobenzene	7.6	ng	6.6	ng
trichloroethene	13.1	ng	9.8	ng	naphthalene	8.6	ng	7.5	ng
dibromomethane	19.0	ng	13.9	ng	1,2-dichloropropane	10.7	ng	8.0	ng
c-1,3-dichloropropene	11.5	ng	9.5	ng	t-1,2-dichloroethene	14.1	ng	9.2	ng

List of Figures for Appendix:

A-1 Examples of Calibration Curves

A-2 Comparison of Adsorbents