



DEP Sampling Study at USA TODAY Report Sites

Midland Elementary/Middle School, Midland, Pennsylvania – Final Report

Background

In response to a USA TODAY special report titled “The Smokestack Effect – Toxic Air and America’s Schools”, the Pennsylvania Department of Environmental Protection (DEP), Bureau of Air Quality (BAQ) conducted air sampling for toxic pollutants at a select group of schools in Pennsylvania. The schools were chosen based on their modeled relative ranking above the reference school (Meredith Hitchens Elementary School in Ohio) cited in the report. Additional schools were chosen where USA TODAY conducted their own sampling and risk analysis, and proposed the school required further investigation.

Of the 95 schools where “snapshot” air samples were taken by the USA TODAY, the Midland Elementary/Middle School was listed as one of the top seven schools where the highest readings occurred. The USA TODAY listed chromium and manganese as the pollutants of concern at this site. See USA TODAY’s information on their website at <http://smokestack.usatoday.com/>.

An initial three air samples were taken at the Midland Elementary/Middle School in December, 2008. The samples were analyzed for toxic metals and the results published in a report dated February 23, 2009. The DEP agreed to an additional 6 months of air sampling to alleviate concerns that the initial sampling was not representative. Sampling was also conducted specifically for hexavalent chromium, the most toxic form of chromium. Air monitoring was concluded with the sample started on August 26, 2009.

Findings

The total excess lifetime cancer risk based on DEP sampling is 1.2 in 100,000. The risk calculation assumes an adult weighing 70 kilograms (154 pounds) will breathe 20 m^3 (706 ft^3) of air each day for 365 days a year, over a 70-year lifetime of exposure. This level of cancer risk falls within the US Environmental Protection Agency’s (EPA) generally acceptable risk range of 1-in-10,000 to 1-in-a-million. This differs from the USA TODAY’s determination through sampling that toxic pollution levels may be unacceptable.

Because the DEP sampling found the concentrations of the pollutants measured at this site to be below non-cancer health benchmarks, non-cancer health effects are not expected from breathing the air at this school.

DEP Sampling

Air sampling at the school looked for concentrations of toxic metals in particles including arsenic, beryllium, cadmium, total chromium, manganese, lead, nickel and zinc.

The toxic metals samples were collected over a 96-hour period using a high-volume particulate sampler with a quartz-fiber filter, and were analyzed by the DEP Laboratory. The procedure is based on the EPA Compendium Methods IO-2 and IO-3. The DEP laboratory can detect very low levels of pollutants in the range well below 1 microgram (μg) (one millionth of a gram) per cubic meter (m^3) of air.

The hexavalent chromium samples were collected over a 24-hour period using method developed for EPA’s National Air Toxics Trends Stations. Analysis of these samples was performed by the Eastern Research Group (ERG) laboratory.

Summarizing the Data

In summarizing the toxic metals sampling data, DEP calculated average concentrations from nineteen samples for each toxic metal compound. If a compound was not detected, or found at a concentration below the Reporting Limit (RL) in all three samples, an average was not calculated. If a compound was detected in at least one sample, the average was calculated using ½ the lab RL for any non-detects.

In summarizing the hexavalent chromium data, DEP calculated the average concentration from three samples. Likewise, if hexavalent chromium was not detected, ½ the lab detection limit was substituted to calculate the average.

Note that there are neither state nor national air quality standards for most of these pollutants (except for lead). Therefore, the DEP evaluated the health risks associated with breathing the measured concentrations of these pollutants using risk assessment methods approved by the EPA.

Overview of Risk Factors and Reference Doses

The excess lifetime cancer risk for each compound was calculated using unit risk factors (URFs), and the risk for non-cancer health effects was calculated using reference air concentrations (RfCs). The URF is a measure of the probability of developing cancer from exposure over a lifetime to a specified concentration of a given chemical. The RfC is the concentration below which no (non-cancer) adverse health effects are expected to occur over a lifetime of continuous exposure. The EPA Integrated Risk Information System (IRIS) database was the primary source for the risk factors. In some cases, there were no inhalation risk data for a chemical in the IRIS database, so other sources were referenced.

The URF and RfC are derived by assuming an adult weighing 70 kilograms (154 pounds) will breathe 20 m³ (706 ft³) of air each day for 365 days a year, over a 70-year lifetime of exposure.

The excess lifetime cancer risk is calculated for each compound by multiplying its URF by the average concentration. The individual risks for each chemical are added to get the total excess lifetime cancer risk at that site.

The excess lifetime cancer risk numbers are written in an exponential format (e.g. 1.0E-04). Refer to Table 1 when interpreting these numbers. For example, an excess lifetime cancer risk of 1.2E-05 means that 1.2 more people in a population of 100,000 (or 12 more in a million) are likely to develop cancer. This is above and beyond the national lifetime cancer risk of slightly less than 1 in 2 in men, and slightly more than 1 in 3 in women.

Table 1. Interpreting the risk numbers.

Risk	Exponential	Decimal	Read as...
1.0E-08	1x10 ⁻⁸	0.00000001	1 in 100 million
1.0E-07	1x10 ⁻⁷	0.0000001	1 in 10 million
1.0E-06	1x10 ⁻⁶	0.000001	1 in 1 million
1.0E-05	1x10 ⁻⁵	0.00001	1 in 100,000
1.0E-04	1x10 ⁻⁴	0.0001	1 in 10,000

Any risk estimate is based on a number of assumptions and some of the assumptions DEP made for this study include:

- The average concentration of the samples collected is the concentration that the student will be exposed to over a lifetime;
- The concentrations measured at the sampling site are representative of exposures to the student population in the school;
- Hexavalent chromium concentrations are assumed to be 1/7th the total chromium concentration when calculating the cancer risk based on the toxic metal results;
- The effects of exposure to multiple chemicals are additive;
- The only excess risk considered in this report is due to inhalation.

The hazard quotient (non-cancer health risk) associated with each of the relevant compounds is calculated by simply dividing the compound average concentration by the respective RfC. The individual hazard quotients for each compound are summed to get the hazard index. If this value is less than one, and inhalation is the only source of exposure, then those chemicals concentrations are not likely to cause adverse non-cancer health affects.

Excess Lifetime Cancer Risk

The goal of Federal and State Air Pollution Agencies, when dealing with the emission of a toxic pollutant from an industrial source is to limit the risk from that pollutant to the surrounding community to less than one in a million excess lifetime cancer risk (from inhalation). The risk to communities is generally higher due to the fact there are multiple sources and multiple pollutants. In conducting risk assessments at hazardous waste cleanup projects and superfund sites, EPA generally considers a lifetime cancer risk to an individual of between 1-in-10,000 and 1-in-a-million as an acceptable range.

The results of toxic metal sampling can be found in Table 2. The total excess lifetime cancer risks for inhalation, based on the average concentration of toxic metals from the sampling, is 1.2 in 100,000 (1.2E-05) and is shown in Table 3. This value falls between the 1-in-10,000 and 1-in-a-million range. With the conservative assumptions used by the DEP in conducting this risk assessment, the actual risk may be lower. For the purpose of comparison, Table 3 also shows the excess lifetime cancer risk for inhalation based on the 2007 average annual monitoring data from DEP air toxic monitors across the Commonwealth. The total risk of 1.2 in 100,000 (or 12 in a million) calculated for the Midland Elementary/Middle School is just above the statewide cancer risk for toxic metals (at 9.9 in a million).

To quantify the actual amount of hexavalent chromium (chromium VI), rather than use an estimate based on total chromium concentrations, the Department contracted with the ERG laboratory to analyze samples specifically for hexavalent chromium. The total excess lifetime cancer risks for inhalation, based on the average concentration of hexavalent chromium from the sampling, is 6.0 in 10 million (6.0E-07) and is shown in Table 4 along with the actual hexavalent chromium concentrations that were measured. These results indicate a small risk of cancer due to hexavalent chromium and that DEP's assumption of "1/7 the total chromium result is hexavalent chromium" is very conservative (the worst-case scenario).

Non-Cancer Health Effects

There were no toxic metals with average concentrations above their respective RfC (a hazard quotient less than 1). Furthermore, the hazard index (the individual hazard quotients summed) was below 1 as well. Consequently, non-cancer health effects are not expected from breathing the air at the school.

Table 3 also shows the hazard index and hazard quotients based on the 2007 average annual monitoring data from DEP air toxic monitors across the Commonwealth. When compared to statewide results, manganese concentrations are found at higher levels in Midland, but again, are within the acceptable range.

The EPA has set National Ambient Air Quality Standards (NAAQS) for six principal pollutants, including lead, to protect public health and welfare. The NAAQS for lead is a 0.15 ug/m³ average in any 3-month period (also known as a 3-month rolling average). None of the lead concentrations from the DEP sampling approached this level and therefore are not a concern.

Differences Between the DEP and USA TODAY Studies

The USA TODAY used a “snapshot” sample (one sample) to quantify the levels of toxic pollutants near the school. A better approach is to collect multiple samples to account for factors such as weather conditions, emission schedules, etc. The DEP took multiple samples and averaged the results for each compound that was analyzed.

A major difference in the data analysis occurred between the DEP and USA TODAY in the treatment of the total chromium results. Chromium can take multiple forms in the air including chromium III, a relatively harmless form and essential nutrient in diet, and chromium VI, the form linked to cancer. The USA TODAY assumed that the total chromium result was composed entirely of the more harmful variety. The DEP does not make this extreme assumption, but still conservatively estimates the ratio of chrome VI to chrome III as 1 to 6 (or 1/7th).

Another reason for differences in sampling results may be due to the way the samples were collected and analyzed. Responses to requests for more information on the USA TODAY's sampling and analysis methods, protocols, and quality assurance documents have not been provided.

Conclusion

Although the USA TODAY ranked Midland Elementary/Middle School as one of the top seven schools based on the sampling they conducted, sampling of the air by the DEP for the stated pollutants of concern does not indicate an unacceptable risk to the students attending the school.

For additional information on modeled toxic concentrations in the United States down to the census tract level, see the EPA National Air toxics Assessment (NATA) web site at:
<http://www.epa.gov/ttn/atw/natamain/>.

Table 2. DEP Toxic Metal Sampling Results at the Midland Elementary/Middle School.

Date	DEP Samples (ug/m ³)							
	Arsenic	Beryllium	Cadmium	Total Chromium	Lead	Manganese	Nickel	Zinc
12/9/08	0.00068	<RL	0.00027	0.00146	0.00332	0.01204	0.00077	0.01580
12/16/08	0.00124	<RL	0.00247	0.00197	0.02927	0.02413	0.00095	0.22357
12/23/08	0.00113	<RL	0.00051	0.00202	0.01050	0.01918	0.00090	0.12432
12/30/08	0.00147	<RL	0.00032	0.00217	0.00736	0.02124	0.00056	0.05272
2/3/09	0.00114	<RL	0.00118	0.00420	0.01196	0.07666	0.00150	0.15390
2/24/09	0.00116	<RL	0.00111	0.00245	0.01417	0.02788	0.00232	0.17795
3/3/09	0.00144	<RL	0.00241	0.00353	0.04320	0.04437	0.00222	0.59869
3/10/09	0.00196	<RL	0.00112	0.00141	0.02126	0.02572	0.00131	0.23683
3/17/09	0.00156	<RL	0.00082	0.00233	0.00969	0.02423	0.00266	0.17943
3/24/09	0.00180	<RL	0.00068	0.00114	0.01002	0.02410	0.00079	0.12398
3/31/09	0.00134	<RL	0.00084	0.00184	0.01431	0.05457	0.00242	0.28375
4/7/09	0.00128	<RL	0.00229	0.00127	0.03109	0.02543	0.00066	0.26147
4/14/09	0.00166	<RL	0.00329	0.00137	0.03919	0.01893	0.00093	0.24767
4/21/09	0.00066	<RL	0.00041	0.00191	0.01084	0.02271	0.00120	0.11280
4/28/09	0.00093	<RL	0.00122	0.00049	0.01496	0.01653	0.00070	0.10471
5/5/09	0.00139	<RL	0.00023	0.00213	0.00767	0.02352	0.00172	0.05417
5/12/09	0.00170	<RL	0.00149	0.00443	0.02844	0.05166	0.00483	0.32602
5/19/09	0.00208	<RL	0.00117	0.00725	0.02866	0.09502	0.00791	0.21349
5/26/09	0.00025	<RL	0.00009	0.00177	0.00304	0.02041	0.00176	0.00497
Average	0.00131		0.00115	0.00238	0.01784	0.03307	0.00190	0.18401

<RL	- Compound not detected, or less than the Lab Reporting Limit (RL), in all DEP samples.
#	- Compound not detected. DEP substituted 1/2 the Lab Reporting Limit to calculate the average.

Table 3. Summary of DEP Toxic Metal Sampling Results at the Midland Elementary/Middle School.

CAS #	Metal	USA TODAY Sample ^a ug/m ³	DEP Average ^b ug/m ³	Unit Risk Factor (URF) m ³ /μg	Source URF	Excess Lifetime Cancer Risk ^c	2007 PA Excess Lifetime Cancer Risk ^d	Reference Air Conc. (RfC) μg/m ³	Source RfC	Hazard Quotient ^e	2007 PA Hazard Quotient ^d
7440-38-2	Arsenic	0.00047	0.00131	4.3E-03	IRIS	5.6E-06	3.6E-06	1.5E-02	CalEPA	0.09	0.06
7440-41-7	Beryllium	<LOD	<RL	2.4E-03	IRIS			2.0E-02	IRIS		
7440-43-9	Cadmium	0.00020	0.00115	1.8E-03	IRIS	2.1E-06	4.6E-07				
7440-47-3	Chromium (Total)	0.04336	0.00238								
18540-29-9	Chromium VI (Assumed) ^f		0.00034	1.2E-02	IRIS	4.1E-06	5.0E-06	1.0E-01	IRIS	0.00	0.00
7439-92-1	Lead ^g	0.00220	0.01784	1.2E-05	CalEPA	2.1E-07	8.9E-08				
7439-96-5	Manganese	0.05190	0.03307					5.0E-02	IRIS	0.66	0.20
	Nickel ^h	0.00659	0.00190	2.4E-04	IRIS	4.6E-07	6.3E-07				
7440-66-6	Zinc	0.01300	0.18401								
Total						1.2E-05	9.9E-06	Hazard Index		0.8	0.3

^a Samples were collected over a 96-hour period on 37mm filters.

^b Samples were collected over a 96-hour period using EPA Method IO-2 and IO-3.

^c Risk due to inhalation is based on the average of the samples (ELCR = Avg x URF). Risk is not calculated for compounds that were not detected in any sample.

^d Calculated by averaging data collected in 2007 at the Chester, Erie, Lancaster, Lewisburg, Marcus Hook, Reading and Swarthmore toxic monitoring sites.

^e A Hazard Quotient < 1 indicates no expected non-cancer health effects (HQ = Avg / RfC). The HQ is not calculated for compounds not detected in any sample.

^f Chromium VI concentration assumed to be 1/7th the Total Chromium concentration by DEP for study purposes.

^g The NAAQS standard for lead is 0.15 ug/m³ (rolling 3-month average).

^h The URF for Nickel is the IRIS value for Nickel (Refinery Dust).

<LOD	- Compound concentration less than the Lab Limit of Detection.
<RL	- Compound not detected, or less than the Lab Reporting Limit (RL), in all DEP samples.
#	- Compound not detected. DEP substituted 1/2 the Lab Reporting Limit to calculate the average.

IRIS - EPA's Integrated Risk Information System

CalEPA - California EPA

Table 4. DEP Hexavalent Chromium (Chromium-6) Sampling Results at the Midland Elementary/Middle School.

CAS #	Metal	USA TODAY Sample ^a ug/m ³	DEP Samples ^b				Unit Risk Factor (URF) m ³ /μg	Source URF	Excess Lifetime Cancer Risk ^c	2007 PA Excess Lifetime Cancer Risk ^{d,e}	Reference Air Conc. (RfC) μg/m ³	Source RfC	Hazard Quotient ^f	2007 PA Hazard Quotient ^d
			3/16/09 ug/m ³	3/19/09 ug/m ³	3/25/09 ug/m ³	Average ug/m ³								
18540-29-9	Chromium VI	0.04336	0.00010	0.000002	0.00005	0.00005	1.2E-02	IRIS	6.0E-07	5.0E-06	1.0E-01	IRIS	0.00	0.00

^a The sample is a Total Chromium result, assumed by the USA TODAY to be 100% Chrome VI, collected over a 96-hour period on 37mm filters.

^b Samples were collected over a 24-hour period beginning on the date shown using the method developed for EPA's National Air Toxics Trends Stations.

^c Risk due to inhalation is based on the average of three samples (ELCR = Avg x URF).

^d Calculated by averaging Total Chromium data collected in 2007 at the Chester, Erie, Lancaster, Lewisburg, Marcus Hook, Reading and Swarthmore toxic monitoring sites.

^e For study purposes, the calculated cancer risk is based on the assumption that Chromium VI concentration was 1/7th the Total Chromium concentration.

^f A Hazard Quotient < 1 indicates no expected non-cancer health effects (HQ = Avg / RfC).

- Compound not detected. DEP substituted 1/2 the lab detection limit to calculate the average.

IRIS - EPA's Integrated Risk Information System