Evaluation of Volatile Organic Compounds in Outdoor Air at Woodson Middle School (2014–2016)

Woodson Middle School

HOPEWELL, VIRGINIA

Letter Health Consultation

March 27, 2023

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Dear Charles Turner,

Thank you for the opportunity to review the air monitoring results collected 2014–2016 at Woodson Middle School in Hopewell, VA. As requested, the Virginia Department of Health (VDH) has finished reviewing the volatile organic compounds (VOCs) monitoring results for public health implications. Sampling methodology used and site descriptions have been described in previous risk assessments prepared for you and will not be discussed here.

DISCUSSION

Results

The following section contains results and comparison values (CVs) for VOCs monitored in 2014–2016 at Woodson. CVs are discussed in more detail in the public health implications section. For a complete list of all VOCs monitored each year, their frequency of detection, maximum and average concentrations, refer to tables at the end of this letter.

VDH compared the yearly maximum concentration of each VOC with their CV. Out of approximately 60 VOCs analyzed, five VOCS yearly average concentration exceeded their chronic CVs. The maximum and yearly average concentrations of the five VOCs and their CVs are shown in Table 1.

Table 1. Volatile organic compounds with yearly average concentrations that exceeded chronic comparison value (2014–2016).

Analyte	2014		2015		2016		CV	Source
	Max	Avg	Max	Avg	Max	Avg		
Acrolein-unverified	**1.20E+00**	**2.13E-01**	**2.98E+00**	**3.76E-01**	**3.21E+00**	**5.66E-01**	8.70E-03	RMEG (chronic)
Acrylonitrile	**3.90E-01**	**1.70E-02**	**3.00E-02**	5.00E-04	<MDL	<MDL	6.80E-03	CREG
Benzene	**5.40E-01**	**1.75E-01**	**7.30E-01**	**1.63E-01**	**6.40E-01**	**1.37E-01**	4.00E-02	CREG
Carbon tetrachloride	**3.10E-01**	**8.72E-02**	**1.00E-01**	**7.05E-02**	**1.00E-01**	**6.49E-02**	2.60E-02	CREG
Chloroform	**2.50E-01**	**2.54E-02**	**5.00E-02**	**2.25E-02**	**4.00E-02**	**1.97E-02**	8.90E-03	CREG

(*Source:* DEQ) All units parts per billion (ppb). **Max** – maximum; **Avg** – average; **CV** – comparison value; **CREG** – cancer risk evaluation guide; **RMEG** – reference media evaluation guide; **bold** – values that exceed the CV; **MDL** – less than minimum detectable level.

Of the five reported here, only acrolein and acrylonitrile yearly average concentration exceeded their CV during the 2009–2013 monitoring period. During 2009–2013 benzene, carbon tetrachloride, and chloroform were detected in >90% of samples but their yearly average did not exceed their CV. In addition, while ethylene dichloride and 1,3-hexachlorobutadiene were detected in multiple samples in the 2009–2013 sampling period, in the 2014–2016 sampling period ethylene dichloride was detected in only four samples, and 1,3-hexachlorobutadiene was not detected in any.

Public Health Implications

Contaminants in the environment can only impact human health if individuals are (1) exposed to contaminants and (2) if contaminants are present at sufficient concentrations. Residents can potentially be exposed to contaminants in ambient air whenever they spend time outdoors. Evaluation of the VOCs with air concentrations above their respective CV are discussed below.

Contaminant evaluation

VDH uses CVs to evaluate air contaminant concentrations. CVs are media-specific concentrations used to identify contaminants that often require additional evaluation. They are derived using standard default exposure assumptions and are not site-specific. For contaminants detected below their respective CVs, exposure is not anticipated to result in adverse health effects. Concentrations above CVs do not mean that adverse health effects occurred or will occur, but that further investigation is needed. Therefore, the CVs should not be used to predict the occurrence of adverse health effects.

CVs used to evaluate contaminants at the sampling sites:

- Reference media evaluation guides (RMEGs) are Agency for Toxic Substances and Disease Registry (ATSDR)-derived CVs based on non-cancer health effects for chronic exposure duration only. RMEGs represent the concentration in a specific medium (e.g., water or soil) at which daily human exposure is unlikely to result in adverse non-carcinogenic effects. For air, RMEGs are the same as corresponding U.S Environmental Protection Agency's (EPA's) inhalation reference concentrations (RfCs).
- Cancer risk evaluation guides (CREGs) are ATSDR-specific CVs that are used to identify concentrations of cancer-causing substances that are unlikely to result in a significant increase

of cancer rates in an exposed population. ATSDR develops CREGs using EPA's cancer slope factor or inhalation unit risk, a target risk level (10^{-6}), and default exposure assumptions. The target risk level of 10^{-6} represents an estimated risk of 1 excess cancer case in an exposed population of 1 million.

The five VOCs with average concentrations that exceeded their CVs were evaluated further. The most recent (2016) ambient air concentrations of each VOC are similar to what has been reported elsewhere (Table 2). The potential for these VOCs to cause adverse health effects depends on the length of exposure, the concentration of the VOC, and sensitivity of the individual. Table 2 summarizes ambient air concentrations reported in the literature, sources of each VOC, and their potential health effects.

Table 2. Air concentrations, potential sources, and health effects for five selected VOCs

Volatile Organic Compound	Reported Air Concentrations	Source	Health Effect (s)
Acrolein	0.2 ppb in urban air; 0.12 ppb in rural air Typical indoor air 0.02 to 12 ppb	automobile tobacco coal or oil power plants industrial	humans: watery eyes, nose and throat irritation not classifiable as to carcinogenicity in humans
Acrylonitrile	concentrations average less than 1 ppb near industrial source not been detected in typical ambient air	manufacturing facilities that use acrylonitrile	humans: headaches and nausea, temporary damage to blood cells and liver
Benzene	between 0.1 to 1.5 ppb in urban locations	industrial	humans: affects multiple organs including nervous system, kidneys, liver, and lungs may reasonably be expected to cause cancer
Carbon tetrachloride	0.01 to 0.05 ppb	industrial landfills	humans: can affect the nervous system, and may affect the liver, kidney, digestion tract and the body's ability to fight infection. shown to cause cancer in laboratory animals
Chloroform	rural and urban air average 0.002-0.003 ppb	industrial	humans: no information on human health effects animals: irritation of the nose, kidney and liver damage not classifiable as to its carcinogenicity in humans

(Source: Agency for Toxic Substances and Disease Registry.) *Accessed online September 2015* http://www.atsdr.cdc.gov/

Cancer risk

The yearly average concentrations of the carcinogens, acrylonitrile, benzene, carbon tetrachloride, and chloroform exceeded their CVs multiple times. Three carcinogens, 1,3-butadiene, trichloroethylene,

and vinyl chloride had only one maximum concentration that exceeded their chronic CV. However, they did not exceed their acute CV and, therefore, are not discussed further. VDH used the highest reported yearly average concentration for each of these compounds to calculate the cancer risk (see Box 1). This approach may overestimate the cancer risk because it assumes that a community member is exposed to the highest concentration of each carcinogen over their entire lifespan. The additional calculated cancer risk for each VOC is within EPA's generally acceptable risk range (1 in 10,000 to 1 in 1,000,000) and is therefore considered low. VDH also calculated the total excess cancer risk by adding the estimated cancer risk for each individual contaminant. The total excess cancer risk (less than 3 in 1,000,000) is still considered to be very low, especially considering that the background cancer rate in the United States is about one in three.

Box 1. Cancer risk calculation for carcinogens discussed

To estimate cancer risk from inhaling carcinogens discussed, the inhalation unit risk (IUR) factor in $(\mu g/m^3)^{-1}$ for each carcinogen is multiplied by the air concentration of the contaminant in $\mu g/m^3$.* See Equation 1 below.

Equation 1

Cancer Risk = IUR × Concentration

Acrylonitrile (2014–2015 average concentration 0.009 µg/m^3)

$6.1\times10^{-7} = 6.8\times10^{-5}\ (\mu g/m^3)^{-1} \times 0.009\ \mu g/m^3$ = less than 7 additional cancers in 10 million

Benzene (2014–2016 average concentration 0.16 µg/m^3)

$1.2\times10^{-6} = 7.8\times10^{-6}\ (\mu g/m^3)^{-1} \times 0.16\ \mu g/m^3$ = less than 2 additional cancers in 1 million

Carbon tetrachloride (2014–2016 average concentration 0.07 µg/m^3)

$4.2\times10^{-7} = 6\times10^{-6}\ (\mu g/m^3)^{-1} \times 0.07\ \mu g/m^3$ = less than 5 additional cancers in 10 million

Chloroform (2014–2016 average concentration 0.02 µg/m^3)

$4.6\times10^{-7} = 2.3\times10^{-5}\ (\mu g/m^3)^{-1} \times 0.02\ \mu g/m^3$ = less than 5 additional cancers in 10 million

*Concentration ($\mu g/m^3$) = (Concentration (ppb) × molecular weight)/24.45

Non-cancer risk discussion

The non-carcinogen, 1,2,4-trichlorobenzene, had one maximum concentration that exceeded its chronic CV. It did not exceed its acute CV and, therefore, will not be discussed further.

Acrolein maximum and yearly average concentrations exceeded its chronic non-cancer CV. Acrolein yearly maximum and average air concentrations also exceeded its non-cancer CV during

2009-2013. Concentrations for acrolein are noted as unverified, so the actual concentration of acrolein may differ. The method used may not accurately measure concentrations of acrolein, so to verify this a new method will be used in 2023.[1]

Acrolein is a liquid with a burnt, sweet, pungent odor that can be detected by most individuals in air at 0.25 parts per million (ppm). It is primarily used to make other compounds and as a pesticide. It can enter the environment if not stored properly and as the result of burning wood, tobacco, vehicle fuels.

Acrolein's effects on your health depends on the amount and length of time of exposure. Acrolein is very irritating to the eyes, nose, throat, lungs, stomach, and skin. As you are exposed to more acrolein, and for a longer period of time, the effects that you experience are likely to become worse. If you breathed in low levels of acrolein for a short time, your eyes might water, and your nose and throat might become sore. These effects disappear within minutes after the exposure stops. However, if you were exposed to higher levels, your lungs might be affected more severely and for a longer time.

In general, children are not likely to be affected by acrolein more than adults. However, children who are sensitive to irritants in the air (such as children with asthma) may be more sensitive to lung irritation from acrolein. In animal studies, ingestion of very large amounts of acrolein during pregnancy caused reduced birth weights and skeletal deformities in newborns. However, the levels causing these effects were often fatal to the mother. These effects were not seen at levels that were also not toxic to the mother.

The health risk from eating food or drinking water containing acrolein is not known. The Department of Health and Human Services (DHHS) has not classified acrolein as to its carcinogenicity. The International Agency for Research on Cancer (IARC) has determined that acrolein is not classifiable as to carcinogenicity in humans. The EPA has stated that the potential carcinogenicity of acrolein cannot be determined based on an inadequate database.

The reported average concentrations of acrolein were evaluated using the ATSDR Public Health Assessment Site Tool for chronic, intermediate, and acute duration exposure in a school scenario. Risks to middle-school students, schoolteachers, and school workers were evaluated using both central tendency exposure (CTE) and reasonable maximum exposure (RME). The CTE is for average or typical exposure, whereas the RME refers to individuals who are at the high end of the exposure distribution (approximately the 95th percentile). The model generated a hazard quotient (HQ) greater than one for all receptors using the CTE or the RME in the chronic and intermediate duration exposure scenarios (see Tables 6 and 7). The concentrations reported are stated to be provisional values, so the actual acrolein concentration may differ.

[1] Personal Communication, Virginia Department of Environmental Quality, February 2023.

CONCLUSIONS

Acrylonitrile, benzene, carbon tetrachloride, and chloroform air concentrations are not a health hazard because there calculated cancer risk is low.

If measured concentrations of "acrolein-unverified" are the actual concentration of acrolein at Woodson Middle School then this is a health hazard to students, teachers, and workers, because the calculated hazard quotient is greater than one.

RECOMMENDATION

Monitor acrolein in air at Woodson Middle School using validated methods when they become available.

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Attachments

Table 3. Volatile organic compounds air monitoring results and comparison values - 2014

Analyte	Samples Run	Detections	Max	Avg	CV	CV Type
Acetone	44	44	1.15E+01	3.85E+00	8.00E+03	RMEG (chronic)
Acetonitrile	59	48	2.58E+00	5.20E-01	3.60E+01	RMEG (chronic)
Acrolein—unverified	59	43	1.20E+00	2.13E-01	8.70E-03	RMEG (chronic)
Acrylonitrile	59	3	3.90E-01	1.70E-02	6.80E-03	CREG
Benzene	59	59	5.40E-01	1.75E-01	4.00E-02	CREG
Benzyl chloride	44	2	1.00E-01	1.11E-02	1.10E-02	RSL (cancer)
Bromodichloromethane	15	0	0.00E+00	0.00E+00	1.13E-02	RSL (cancer)
Bromoform	15	0	0.00E+00	0.00E+00	8.80E-02	CREG
Bromomethane	59	4	4.00E-02	5.90E-03	1.00E+00	EMEG (chronic)
1,3-Butadiene	59	7	1.70E-01	1.49E-02	1.50E-02	CREG
Carbon disulfide	44	36	2.60E-01	4.71E-02	2.20E+02	RMEG (chronic)
Carbon tetrachloride	59	57	3.10E-01	8.72E-02	2.60E-02	CREG
Chlorobenzene	59	1	4.00E-02	2.95E-03	1.13E+02	RSL (noncancer)
Chloroethane	15	1	8.00E-02	5.00E-03	3.80E+03	RMEG (chronic)
Chloroform	59	3	2.50E-01	2.54E-02	8.90E-03	CREG
Chloromethane	59	59	8.20E-01	5.94E-01	3.00E+01	EMEG (chronic)
Cyclohexane	59	15	1.30E-01	2.36E-02	1.70E+03	RMEG (chronic)
1,2-Dibromoethane	59	1	3.00E-02	1.48E-03	2.20E-04	CREG
1,2-Dichlorobenzene	15	0	1.00E-02	6.25E-04	3.50E+01	RSL (noncancer)
1,3-Dichlorobenzene	15	0	2.00E-02	1.25E-03	N/A	N/A
1,4-Dichlorobenzene	59	1	1.10E-01	9.18E-03	1.00E+01	EMEG (chronic)
1,1-Dichloroethane	15	0	0.00E+00	0.00E+00	3.21E-01	RSL (cancer)
cis-1,2-Dichloroethene	15	0	0.00E+00	0.00E+00	2.00E+05	PEL
trans-1,2-Dichloroethene	15	1	9.00E-02	5.63E-03	2.00E+02	EMEG (inter-mediate)
1,1-Dichloroethylene	15	0	0.00E+00	0.00E+00	1.00E+00	EMEG (chronic)
1,2-Dichloropropane	59	5	8.00E-02	7.05E-03	8.70E-01	RMEG (chronic)
cis-1,3-Dichloropropene	59	0	1.00E-02	1.64E-04	5.50E-02	CREG
trans-1,3-Dichloropropene	59	0	2.00E-02	9.84E-04	5.50E-02	CREG
Dibromochloromethane	15	0	0.00E+00	0.00E+00	N/A	N/A
Dichlorodifluoro-methane	59	59	6.70E-01	5.13E-01	2.02E+01	RSL (noncancer)

Analyte	Samples Run	Detections	Max	Avg	CV	CV Type
Dichloromethane	59	59	2.47E+00	1.89E-01	1.80E+01	CREG
Ethyl Acetate	15	1	1.00E-01	6.25E-03	2.00E+01	RSL (noncancer)
Ethylbenzene	59	17	1.20E-01	2.87E-02	6.00E+01	EMEG (chronic)
Ethylene dichloride	59	4	1.80E-01	1.30E-02	1.00E+00	EMEG (chronic)
p-Ethyltoluene	59	3	9.00E-02	1.38E-02	N/A	N/A
Freon 113	59	58	1.50E-01	7.98E-02	1.00E+06	PEL
Freon 114	59	0	3.00E-02	1.54E-02	1.00E+06	PEL
n-Heptane	59	39	1.70E-01	5.21E-02	1.03E+02	RSL (noncancer)
n-Hexane	59	39	4.70E-01	7.61E-02	2.00E+02	RMEG (chronic)
Hexachloro-1,3-Butadiene	59	0	0.00E+00	0.00E+00	4.30E-03	CREG
Methyl chloroform	59	6	6.00E-02	8.03E-03	3.80E+03	RMEG (chronic)
Methyl methacrylate	15	0	0.00E+00	0.00E+00	1.70E+02	RMEG (chronic)
MTBE	59	0	1.00E-02	4.92E-04	8.30E+02	RMEG (chronic)
Propylene	15	0	0.00E+00	0.00E+00	1.80E+03	RSL (noncancer)
Styrene	59	21	1.40E-01	2.48E-02	2.00E+02	EMEG (chronic)
1,1,2,2-Tetrachloroethane	59	0	0.00E+00	0.00E+00	5.86E-02	RSL (cancer)
Tetrachloroethylene	59	4	7.00E-02	1.28E-02	5.70E-01	CREG
Toluene	59	57	1.45E+00	2.04E-01	1.00E+03	EMEG (chronic)
1,2,4-Trichlorobenzene	3	0	0.00E+00	0.00E+00	2.83E-01	RSL (noncancer)
1,1,2-Trichloroethane	59	0	1.00E-02	4.92E-04	1.00E-02	CREG
Trichloroethylene	59	0	2.00E-02	8.20E-04	4.00E-02	CREG
Trichlorofluoromethane	59	59	3.40E-01	2.46E-01	9.97E+05	PEL
1,2,4-Trimethylbenzene	59	6	1.30E-01	2.33E-02	1.20E+01	RMEG (chronic)
1,3,5-Trimethylbenzene	59	3	8.00E-02	7.21E-03	1.20E+01	RMEG (chronic)
Vinyl chloride	59	1	8.00E-02	2.95E-03	4.40E-02	CREG
m,p-Xylenes	59	47	4.60E-01	7.30E-02	2.30E+01	RMEG (chronic)
o-Xylene	59	11	1.70E-01	3.10E-02	2.30E+01	RMEG (chronic)

(*Source:* DEQ) All units are in parts per billion (ppb). **REL**-Recommended Exposure Limit, **RSL**-Regional Screening Level, **N/A**-Not Available, **PEL**-Permissible Exposure Limit, **EMEG**-Environmental Media Exposure Guideline, **CREG**-Cancer Risk Exposure Guideline, **Int.**-Intermediate, **RfC**-Reference Concentration, **Num**-number of samples collected, **Max**- maximum concentration, **Avg-** average concentration, **CV**-comparison value

Table 4. Volatile organic compounds air monitoring results and comparison values - 2015

Analyte	Samples Run	Detections	Max	Avg	CV	CV Type
Acetonitrile	57	27	4.42E+00	1.03E+00	3.60E+01	RMEG (chronic)
Acrolein—unverified	57	26	2.98E+00	3.76E-01	8.70E-03	RMEG (chronic)
Acrylonitrile	57	0	3.00E-02	5.00E-04	6.80E-03	CREG
Benzene	57	56	7.30E-01	1.63E-01	4.00E-02	CREG
Bromodichloromethane	57	0	0.00E+00	0.00E+00	1.13E-02	RSL (cancer)
Bromoform	57	0	0.00E+00	0.00E+00	8.80E-02	CREG
Bromomethane	57	0	0.00E+00	0.00E+00	1.00E+00	EMEG (chronic)
1,3-Butadiene	57	0	0.00E+00	0.00E+00	1.50E-02	CREG
Carbon tetrachloride	57	55	1.00E-01	7.05E-02	2.60E-02	CREG
Chlorobenzene	57	1	4.00E-02	8.33E-04	1.13E+02	RSL (noncancer)
Chloroethane	57	0	0.00E+00	0.00E+00	3.80E+03	RMEG (chronic)
Chloroform	57	2	5.00E-02	2.25E-02	8.90E-03	CREG
Chloromethane	57	56	7.70E-01	5.78E-01	3.00E+01	EMEG (chronic)
Cyclohexane	57	1	8.00E-02	6.33E-03	1.70E+03	RMEG (chronic)
Dibromochloromethane	57	0	0.00E+00	0.00E+00	N/A	N/A
1,2-Dibromoethane	57	0	0.00E+00	0.00E+00	2.20E-04	CREG
1,2-Dichlorobenzene	57	4	1.20E-01	5.00E-03	3.50E+01	RSL (noncancer)
1,3-Dichlorobenzene	57	1	1.40E-01	5.83E-03	N/A	N/A
1,4-Dichlorobenzene	57	3	1.90E-01	1.22E-02	1.00E+01	EMEG (chronic)
1,1-Dichloroethane	57	0	0.00E+00	0.00E+00	3.21E-01	RSL (cancer)
cis-1,2-Dichloroethene	57	0	0.00E+00	0.00E+00	2.00E+05	PEL
trans-1,2-Dichloroethene	57	0	0.00E+00	0.00E+00	2.00E+02	EMEG (inter-mediate)
1,1-Dichloroethylene	58	0	0.00E+00	0.00E+00	1.00E+00	EMEG (chronic)
Dichlorodifluoro-methane	57	56	6.40E-01	5.11E-01	2.02E+01	RSL (noncancer)
Dichloromethane	57	56	1.60E-01	8.03E-02	1.80E+01	CREG
1,2-Dichloropropane	57	0	4.00E-02	2.00E-03	8.70E-01	RMEG (chronic)
cis-1,3-Dichloropropene	57	1	4.00E-02	1.00E-03	5.50E-02	CREG
trans-1,3-Dichloropropene	57	0	3.00E-02	6.67E-04	5.50E-02	CREG
Ethyl Acetate	57	7	2.80E-01	1.20E-02	2.00E+01	RSL (noncancer)
Ethylbenzene	57	27	1.30E-01	2.88E-02	6.00E+01	EMEG (chronic)

Analyte	Samples Run	Detections	Max	Avg	CV	CV Type
Ethylene dichloride	57	0	2.00E-02	9.17E-03	1.00E+00	EMEG (chronic)
p-Ethyltoluene	57	2	2.00E-01	1.37E-02	N/A	N/A
Freon 113	58	57	1.70E-01	8.30E-02	1.00E+06	PEL
Freon 114	57	0	0.00E+00	0.00E+00	1.00E+06	PEL
n-Heptane	57	29	6.30E-01	6.50E-02	1.03E+02	RSL (noncancer)
Hexachloro-1,3-Butadiene	57	0	2.00E-02	3.33E-04	4.30E-03	CREG
n-Hexane	57	40	5.70E-01	9.12E-02	2.00E+02	RMEG (chronic)
Methyl chloroform	57	0	1.00E-02	1.67E-04	3.80E+03	RMEG (chronic)
Methyl methacrylate	57	0	0.00E+00	0.00E+00	1.70E+02	RMEG (chronic)
MTBE	57	0	0.00E+00	0.00E+00	8.30E+02	RMEG (chronic)
Propylene	57	3	3.37E+00	8.25E-02	1.80E+03	RSL (noncancer)
Styrene	57	9	6.80E-01	3.50E-02	2.00E+02	EMEG (chronic)
1,1,2,2-Tetrachloroethane	57	0	1.00E-02	1.67E-04	5.86E-02	RSL (cancer)
Tetrachloroethylene	57	4	6.00E-02	1.23E-02	5.70E-01	CREG
Tetrahydrofuran	57	1	6.00E-02	1.00E-03	6.80E+02	RMEG (chronic)
Toluene	57	56	1.23E+00	2.03E-01	1.00E+03	EMEG (chronic)
1,2,4-Trichlorobenzene	58	1	3.40E-01	1.13E-02	2.83E-01	RSL (noncancer)
1,1,2-Trichloroethane	57	0	0.00E+00	0.00E+00	1.00E-02	CREG
Trichloroethylene	57	1	1.20E-01	2.00E-03	4.00E-02	CREG
Trichlorofluoromethane	57	55	3.00E-01	2.38E-01	9.97E+05	PEL
1,2,4-Trimethylbenzene	57	8	2.30E-01	1.82E-02	1.20E+01	RMEG (chronic)
1,3,5-Trimethylbenzene	57	2	5.00E-02	5.00E-03	1.20E+01	RMEG (chronic)
Vinyl chloride	57	0	0.00E+00	0.00E+00	4.40E-02	CREG
m,p-Xylenes	57	35	4.40E-01	8.85E-02	2.30E+01	RMEG (chronic)
o-Xylene	57	18	1.70E-01	3.73E-02	2.30E+01	RMEG (chronic)

(*Source:* DEQ) All units are in parts per billion (ppb). **REL**-Recommended Exposure Limit, **RSL**-Regional Screening Level, **N/A**-Not Available, **PEL**-Permissible Exposure Limit, **EMEG**-Environmental Media Exposure Guideline, **CREG**-Cancer Risk Exposure Guideline, **Int.**-Intermediate, **RfC**-Reference Concentration, **Num**-number of samples collected, **Max**- maximum concentration, **Avg-** average concentration, **CV**-comparison value

Table 5. Volatile organic compounds air monitoring results and comparison values - 2016

Analyte	Samples Run	Detections	Max	Avg	CV	CV Type
Acetonitrile	58	57	7.01E+00	2.42E+00	3.60E+01	RMEG (chronic)
Acrolein-unverified	58	47	3.21E+00	5.66E-01	8.70E-03	RMEG (chronic)
Acrylonitrile	58	0	0.00E+00	0.00E+00	6.80E-03	CREG
Benzene	58	58	6.40E-01	1.37E-01	4.00E-02	CREG
Bromodichloro-methane	58	0	0.00E+00	0.00E+00	1.13E-02	RSL (cancer)
Bromoform	58	0	0.00E+00	0.00E+00	8.80E-02	CREG
Bromomethane	58	0	0.00E+00	0.00E+00	1.00E+00	EMEG (chronic)
1,3-Butadiene	58	0	0.00E+00	0.00E+00	1.50E-02	CREG
Carbon tetrachloride	58	57	1.00E-01	6.49E-02	2.60E-02	CREG
Chlorobenzene	58	0	0.00E+00	0.00E+00	1.13E+02	RSL (noncancer)
Chloroethane	58	4	5.30E-01	1.87E-02	3.80E+03	RMEG (chronic)
Chloroform	58	19	4.00E-02	1.97E-02	8.90E-03	CREG
Chloromethane	58	58	7.50E-01	5.43E-01	3.00E+01	EMEG (chronic)
Cyclohexane	58	2	8.00E-02	4.92E-03	1.70E+03	RMEG (chronic)
Dibromochloromethane	58	0	0.00E+00	0.00E+00	N/A	N/A
1,2-Dibromoethane	58	0	1.00E-02	3.28E-04	2.20E-04	CREG
1,2-Dichlorobenzene	58	2	6.00E-02	2.95E-03	3.50E+01	RSL (noncancer)
1,3-Dichlorobenzene	58	2	7.00E-02	3.44E-03	N/A	N/A
1,4-Dichlorobenzene	58	3	1.20E-01	8.85E-03	1.00E+01	EMEG (chronic)
Dichlorodifluoromethane	58	58	6.20E-01	4.70E-01	2.02E+01	RSL (noncancer)
1,1-Dichloroethane	58	0	0.00E+00	0.00E+00	3.21E-01	RSL (cancer)
1,1-Dichloroethylene	58	0	0.00E+00	0.00E+00	1.00E+00	EMEG (chronic)
cis-1,2-Dichloroethene	58	0	0.00E+00	0.00E+00	2.00E+05	PEL
trans-1,2-Dichloroethene	58	0	0.00E+00	0.00E+00	2.00E+02	EMEG (inter-mediate)
Dichloromethane	58	54	3.40E-01	8.34E-02	1.80E+01	CREG
1,2-Dichloropropane	58	0	0.00E+00	0.00E+00	8.70E-01	RMEG (chronic)
cis-1,3-Dichloropropene	58	0	0.00E+00	0.00E+00	5.50E-02	CREG
trans-1,3-Dichloropropene	58	0	0.00E+00	0.00E+00	5.50E-02	CREG
Ethyl acetate	58	8	1.90E-01	1.10E-02	2.00E+01	RSL (noncancer)
Ethylbenzene	58	21	1.30E-01	2.36E-02	6.00E+01	EMEG (chronic)
Ethylene dichloride	58	0	0.00E+00	0.00E+00	1.00E+00	EMEG (chronic)

Analyte	Samples Run	Detections	Max	Avg	CV	CV Type
p-Ethyltoluene	58	6	1.80E-01	7.87E-03	N/A	N/A
Freon 113	58	58	2.10E-01	8.03E-02	1.00E+06	PEL
Freon 114	58	0	0.00E+00	0.00E+00	1.00E+06	PEL
n-Heptane	58	30	3.60E-01	5.26E-02	1.03E+02	RSL (noncancer)
Hexachloro-1,3-Butadiene	58	0	1.00E-02	1.64E-04	4.30E-03	CREG
n-Hexane	58	44	5.70E-01	8.93E-02	2.00E+02	RMEG (chronic)
Methyl chloroform	58	0	0.00E+00	0.00E+00	3.80E+03	RMEG (chronic)
Methyl methacrylate	58	0	0.00E+00	0.00E+00	1.70E+02	RMEG (chronic)
MTBE	58	0	0.00E+00	0.00E+00	8.30E+02	RMEG (chronic)
Propylene	58	6	7.90E-01	4.92E-02	1.80E+03	RSL (noncancer)
Styrene	58	48	5.60E-01	2.38E-02	2.00E+02	EMEG (chronic)
1,1,2,2-Tetrachloroethane	58	0	1.00E-02	1.64E-04	5.86E-02	RSL (cancer)
Tetrachloroethylene	58	2	5.00E-02	8.20E-03	5.70E-01	CREG
Tetrahydrofuran	58	5	1.50E-01	8.20E-03	6.80E+02	RMEG (chronic)
Toluene	58	58	8.00E-01	1.66E-01	1.00E+03	EMEG (chronic)
1,2,4-Trichlorobenzene	58	2	1.70E-01	7.05E-03	2.83E-01	RSL (noncancer)
1,1,2-Trichloroethane	58	0	0.00E+00	0.00E+00	1.00E-02	CREG
Trichloroethylene	58	0	2.00E-02	4.92E-04	4.00E-02	CREG
Trichlorofluoromethane	58	58	3.30E-01	2.39E-01	9.97E+05	PEL
1,2,4-Trimethylbenzene	58	18	1.80E-01	3.07E-02	1.20E+01	RMEG (chronic)
1,3,5-Trimethylbenzene	58	6	6.00E-02	5.08E-03	1.20E+01	RMEG (chronic)
Vinyl chloride	58	0	0.00E+00	0.00E+00	4.40E-02	CREG
m,p-Xylenes	58	25	4.20E-01	6.39E-02	2.30E+01	RMEG (chronic)
o-Xylene	58	20	1.80E-01	2.84E-02	2.30E+01	RMEG (chronic)

(*Source:* DEQ) All units are in parts per billion (ppb). **REL**-Recommended Exposure Limit, **RSL**-Regional Screening Level, **N/A**-Not Available, **PEL**-Permissible Exposure Limit, **EMEG**-Environmental Media Exposure Guideline, **CREG**-Cancer Risk Exposure Guideline, **Int.**-Intermediate, **RfC**-Reference Concentration, **Num**-number of samples collected, **Max**- maximum concentration, **Avg-** average concentration, **CV**-comparison value

Table 6. School: Site-specific exposure point concentrations for chronic exposure to acrolein in air at average detection values (0.88 µg/m³ (0.39 ppb)) along with non-cancer hazard quotients*

Exposure Group	CTE Adjusted EPC (µg/m³)	CTE Adjusted EPC (ppb)	CTE Non-cancer Hazard Quotient	CTE Cancer Risk	CTE Exposure Duration (yrs)	RME Adjusted EPC (µg/m³)	RME Adjusted EPC (ppb)	RME Non-cancer Hazard Quotient	RME Cancer Risk	RME Exposure Duration (yrs)
Middle School 6th – 8th grades	0.13	0.057	6.6 †	-	3	0.22	0.096	11 †	-	3
Full time educator	0.17	0.073	8.4 †	-	5	0.22	0.096	11 †	-	20
Full time worker	0.21	0.093	11 †	-	5	0.21	0.093	11 †	-	20

Source: DEQ

Abbreviations: adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m³ = micrograms per meter cubed; ppb = parts per billion; mg/kg/day = milligram chemical per kilogram body weight per day; yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.2.1.0. The non-cancer hazard quotients were calculated using the chronic (greater than 1 year) reference concentration of 0.02 µg/m³.

† A shaded cell indicates the hazard quotient is greater than 1, which ATSDR evaluates further.

Table 7. School: Site-specific exposure point concentrations for intermediate exposure to acrolein in air at average detection values (0.88 µg/m³ (0.39 ppb)) along with non-cancer hazard quotients*

Exposure Group	CTE Adjusted EPC (µg/m³)	CTE Adjusted EPC (ppb)	CTE Non-cancer Hazard Quotient	RME Adjusted EPC (µg/m³)	RME Adjusted EPC (ppb)	RME Non-cancer Hazard Quotient
Middle School 6th – 8th grades	0.18	0.077	1.9 †	0.24	0.11	2.7 †
Full time educator	0.22	0.097	2.4 †	0.24	0.11	2.7 †
Full time worker	0.22	0.097	2.4 †	0.22	0.097	2.4 †

Source: DEQ

Abbreviations: adjusted EPC = the exposure point concentration (EPC) times the appropriate exposure factors; µg/m³ = micrograms per meter cubed; ppb = parts per billion; mg/kg/day = milligram chemical per kilogram body weight per day

* The calculations in this table were generated using ATSDR's PHAST v2.2.1.0. The non-cancer hazard quotients were calculated using the intermediate (two weeks to less than 1 year) minimal risk level of 0.092 µg/m³.

† A shaded cell indicates the hazard quotient is greater than 1, which ATSDR evaluates further.