# Evaluation of Volatile Organic Compounds in Outdoor Air at Woodson Middle School (2017–2019)

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 2017–2019 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 2017–2019 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 (2017–2019).**

| Analyte | 2017 | | 2018 | | 2019 | | CV | CV Type |
|---|---|---|---|---|---|---|---|---|
| | Max | Avg | Max | Avg | Max | Avg | | |
| Acrolein-unverified | **2.12E+00** | **5.45E-01** | **1.55E+00** | **3.62E-01** | **7.12E+00** | **5.31E-01** | 8.70E-03 | RMEG (chronic) |
| Benzene | **6.40E-01** | **1.58E-01** | **2.90E-01** | **1.09E-01** | **6.30E-01** | **1.46E-01** | 4.00E-02 | CREG |
| Carbon tetrachloride | **1.20E-01** | **7.00E-02** | **1.30E-01** | **6.90E-02** | **1.40E-01** | **6.28E-02** | 2.60E-02 | CREG |
| Chloroform | **6.00E-02** | **2.36E-02** | **5.00E-02** | **2.21E-02** | **1.10E-01** | **2.41E-02** | 8.90E-03 | CREG |
| 1,2-Dibromo-ethane | **5.00E-02** | **2.46E-03** | **5.00E-02** | **3.93E-03** | **8.00E-02** | **6.07E-03** | 2.20E-04 | 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, benzene, carbon tetrachloride, and chloroform have yearly average air concentrations that have exceeded their CVs multiple times during 2009–2016 monitoring period.

### *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 (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<br><br>Typical indoor air 0.02 to 12 ppb | automobile<br>tobacco<br>coal or oil power plants<br><br>industrial | humans: watery eyes, nose and throat irritation<br><br>not classifiable as to carcinogenicity in humans |
| 1,2 Dibromethane | 2.6 parts per trillion in urban and suburban areas<br><br>1.9 ppt near source-dominated areas | Emissions into air from industrial processing facilities | humans: long-term exposure have been reported to have reproductive effects in workers. Vomiting and diarrhea has also been reported by exposed workers<br><br>shown to cause weight loss, and damage to stomach, liver, kidneys, and sperm in laboratory animals |
| Benzene | between 0.1 to 1.5 ppb in urban locations | industrial | humans: affects multiple organs including nervous system, kidneys, liver, and lungs<br><br>may reasonably be expected to cause cancer |
| Carbon tetrachloride | 0.01 to 0.05 ppb | industrial<br><br>landfills | humans: can affect the nervous system, and may affect the liver, kidney, digestion tract and the body's ability to fight infection.<br><br>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<br><br>animals: irritation of the nose, kidney and liver damage<br><br>not classifiable as to its carcinogenicity in humans |

*(Source:* Agency for Toxic Substances and Disease Registry. *Accessed online January 2023* http://www.atsdr.cdc.gov/)

*Cancer risk*

The yearly average concentrations of the carcinogens, benzene, carbon tetrachloride, chloroform, and 1,2 dibromoethane exceeded their CVs multiple times during the 2016-2019 monitoring period. VDH used the 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 2 in 100,000) is still considered to be 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**

**Benzene (2017–2019 average concentration 0.44 µg/m$^3$)**

$3.4\times10^{-6} = 7.8\times10^{-6}$ $(\mu g/m^3)^{-1} \times 0.44$ $\mu g/m^3$ = less than 4 additional cancers in 1 million

**Carbon tetrachloride (2017–2019 average concentration 0.42 µg/m$^3$)**

$2.5\times10^{-6} = 6\times10^{-6}$ $(\mu g/m^3)^{-1} \times 0.42$ $\mu g/m^3$ = less than 3 additional cancers in 1 million

**Chloroform (2017–2019 average concentration 0.11 µg/m$^3$)**

$2.5\times10^{-6} = 2.3\times10^{-5}$ $(\mu g/m^3)^{-1} \times 0.11$ $\mu g/m^3$ = less than 3 additional cancers in 1 million

**1,2 Dibromoethane (2017–2019 average concentration 0.03 µg/m$^3$)**

$9\times10^{-6} = 3\times10^{-4}$ $(\mu g/m^3)^{-1} \times 0.03$ $\mu g/m^3$ = less than 10 additional cancers in 1 million

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

*Non-cancer risk discussion*

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 2009–2016. 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 $95^{th}$ 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, and will be determined in future sampling.

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

## CONCLUSIONS

Benzene, carbon tetrachloride, chloroform, and 1,2-dibromoethane air concentrations are not a health hazard because their 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 – 2017**

| Analyte | Samples Run | Detections | Max | Avg | CV | CV Type |
|---|---|---|---|---|---|---|
| Acetonitrile | 61 | 58 | 1.03E+01 | 2.18E+00 | 3.60E+01 | RMEG (chronic) |
| Acrolein | 61 | 51 | 2.12E+00 | 5.45E-01 | 8.70E-03 | RMEG (chronic) |
| Acrylonitrile | 61 | 0 | 0.00E+00 | 0.00E+00 | 6.80E-03 | CREG |
| Benzene | 61 | 60 | 6.40E-01 | 1.58E-01 | 4.00E-02 | CREG |
| Bromodichloromethane | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.13E-02 | RSL (cancer) |
| Bromoform | 61 | 0 | 2.00E-02 | 3.28E-04 | 8.80E-02 | CREG |
| Bromomethane | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+00 | EMEG (chronic) |
| 1,3-Butadiene | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.50E-02 | CREG |
| Carbon tetrachloride | 61 | 60 | 1.20E-01 | 7.00E-02 | 2.60E-02 | CREG |
| Chlorobenzene | 61 | 4 | 1.00E-01 | 4.10E-03 | 1.13E+02 | RSL (noncancer) |
| Chloroethane | 61 | 1 | 3.40E-01 | 5.57E-03 | 3.80E+03 | RMEG (chronic) |
| Chloroform | 61 | 33 | 6.00E-02 | 2.36E-02 | 8.90E-03 | CREG |
| Chloromethane | 61 | 61 | 9.80E-01 | 6.24E-01 | 3.00E+01 | EMEG (chronic) |
| Cyclohexane | 61 | 1 | 6.00E-02 | 9.84E-04 | 1.70E+03 | RMEG (chronic) |
| Dibromochloromethane | 61 | 0 | 0.00E+00 | 0.00E+00 | N/A | N/A |
| 1,2-Dibromoethane | 61 | 1 | 5.00E-02 | 2.46E-03 | 2.20E-04 | CREG |
| 1,2-Dichlorobenzene | 61 | 9 | 1.40E-01 | 1.51E-02 | 3.50E+01 | RSL (noncancer) |
| 1,3-Dichlorobenzene | 61 | 8 | 1.90E-01 | 1.56E-02 | N/A | N/A |
| 1,4-Dichlorobenzene | 61 | 8 | 2.40E-01 | 2.13E-02 | 1.00E+01 | EMEG (chronic) |
| Dichlorodifluoromethane | 61 | 61 | 6.50E-01 | 5.30E-01 | 2.02E+01 | RSL (noncancer) |
| 1,1-Dichloroethane | 61 | 0 | 0.00E+00 | 0.00E+00 | 3.21E-01 | RSL (cancer) |
| cis-1,2-Dichloroethene | 61 | 0 | 0.00E+00 | 0.00E+00 | 2.00E+05 | PEL |
| trans-1,2-Dichloroethene | 61 | 0 | 0.00E+00 | 0.00E+00 | 2.00E+02 | EMEG (intermediate) |
| 1,1-Dichloroethylene | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+00 | EMEG (chronic) |
| Dichloromethane | 61 | 60 | 2.30E-01 | 9.36E-02 | 1.80E+01 | CREG |
| 1,2-Dichloropropane | 61 | 0 | 0.00E+00 | 0.00E+00 | 8.70E-01 | RMEG (chronic) |
| cis-1,3-Dichloropropene | 61 | 0 | 0.00E+00 | 0.00E+00 | 5.50E-02 | CREG |
| trans-1,3-Dichloropropene | 61 | 0 | 0.00E+00 | 0.00E+00 | 5.50E-02 | CREG |
| Ethyl Acetate | 61 | 4 | 9.00E-02 | 4.59E-03 | 2.00E+01 | RSL (noncancer) |
| Ethylbenzene | 61 | 28 | 1.30E-01 | 2.93E-02 | 6.00E+01 | EMEG (chronic) |

| Analyte | Samples Run | Detections | Max | Avg | CV | CV Type |
|---|---|---|---|---|---|---|
| Ethylene dichloride | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+00 | EMEG (chronic) |
| p-Ethyltoluene | 61 | 14 | 2.10E-01 | 1.43E-02 | N/A | N/A |
| Freon 113 | 61 | 61 | 2.50E-01 | 8.52E-02 | 1.00E+06 | PEL |
| Freon 114 | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+06 | PEL |
| n-Heptane | 61 | 26 | 2.80E-01 | 4.46E-02 | 1.03E+02 | RSL (noncancer) |
| Hexachloro-1,3-butadiene | 61 | 0 | 1.00E-02 | 1.64E-04 | 4.30E-03 | CREG |
| n-Hexane | 61 | 42 | 4.30E-01 | 9.64E-02 | 2.00E+02 | RMEG (chronic) |
| Methyl chloroform | 61 | 0 | 0.00E+00 | 0.00E+00 | 3.80E+03 | RMEG (chronic) |
| Methyl methacrylate | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.70E+02 | RMEG (chronic) |
| MTBE | 61 | 0 | 0.00E+00 | 0.00E+00 | 8.30E+02 | RMEG (chronic) |
| Propylene | 61 | 1 | 4.60E-01 | 7.54E-03 | 1.80E+03 | RSL (noncancer) |
| Styrene | 61 | 61 | 2.80E-01 | 4.64E-02 | 2.00E+02 | EMEG (chronic) |
| 1,1,2,2-Tetrachloroethane | 61 | 0 | 1.00E-02 | 8.20E-04 | 5.86E-02 | RSL (cancer) |
| Tetrachloroethylene | 61 | 10 | 2.80E-01 | 1.39E-02 | 5.70E-01 | CREG |
| Tetrahydrofuran | 61 | 3 | 6.00E-02 | 2.79E-03 | 6.80E+02 | RMEG (chronic) |
| Toluene | 61 | 61 | 9.90E-01 | 2.30E-01 | 1.00E+03 | EMEG (chronic) |
| 1,2,4-Trichlorobenzene | 61 | 5 | 3.30E-01 | 2.18E-02 | 2.83E-01 | RSL (noncancer) |
| 1,1,2-Trichloroethane | 61 | 0 | 2.00E-02 | 9.84E-04 | 1.00E-02 | CREG |
| Trichloroethylene | 61 | 0 | 3.00E-02 | 1.48E-03 | 4.00E-02 | CREG |
| Trichlorofluoromethane | 61 | 61 | 3.20E-01 | 2.53E-01 | 9.97E+05 | PEL |
| 1,2,4-Trimethylbenzene | 61 | 39 | 2.80E-01 | 5.79E-02 | 1.20E+01 | RMEG (chronic) |
| 1,3,5-Trimethylbenzene | 61 | 19 | 1.90E-01 | 1.34E-02 | 1.20E+01 | RMEG (chronic) |
| Vinyl chloride | 61 | 0 | 0.00E+00 | 0.00E+00 | 4.40E-02 | CREG |
| m,p-Xylenes | 61 | 37 | 4.50E-01 | 9.00E-02 | 2.30E+01 | RMEG (chronic) |
| o-Xylene | 61 | 31 | 1.50E-01 | 3.49E-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 – 2018**

| Analyte | Samples Run | Detections | Max | Avg | CV | CV Type |
|---|---|---|---|---|---|---|
| Acetonitrile | 61 | 36 | 3.81E+00 | 3.31E-01 | 3.60E+01 | RMEG (chronic) |
| Acrolein | 61 | 40 | 1.55E+00 | 3.62E-01 | 8.70E-03 | RMEG (chronic) |
| Acrylonitrile | 61 | 0 | 0.00E+00 | 0.00E+00 | 6.80E-03 | CREG |
| Benzene | 61 | 57 | 2.90E-01 | 1.09E-01 | 4.00E-02 | CREG |
| Bromodichloromethane | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.13E-02 | RSL (cancer) |
| Bromoform | 61 | 0 | 2.00E-02 | 4.92E-04 | 8.80E-02 | CREG |
| Bromomethane | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+00 | EMEG (chronic) |
| 1,3-Butadiene | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.50E-02 | CREG |
| Carbon tetrachloride | 61 | 57 | 1.30E-01 | 6.90E-02 | 2.60E-02 | CREG |
| Chlorobenzene | 61 | 4 | 8.00E-02 | 7.70E-03 | 1.13E+02 | RSL (noncancer) |
| Chloroethane | 61 | 0 | 0.00E+00 | 0.00E+00 | 3.80E+03 | RMEG (chronic) |
| Chloroform | 61 | 32 | 5.00E-02 | 2.21E-02 | 8.90E-03 | CREG |
| Chloromethane | 61 | 57 | 7.40E-01 | 5.57E-01 | 3.00E+01 | EMEG (chronic) |
| Cyclohexane | 61 | 2 | 3.00E-02 | 1.48E-03 | 1.70E+03 | RMEG (chronic) |
| Dibromochloromethane | 61 | 0 | 2.00E-02 | 3.28E-04 | N/A | N/A |
| 1,2-Dibromoethane | 61 | 0 | 5.00E-02 | 3.93E-03 | 2.20E-04 | CREG |
| 1,2-Dichlorobenzene | 61 | 3 | 1.20E-01 | 1.71E-02 | 3.50E+01 | RSL (noncancer) |
| 1,3-Dichlorobenzene | 61 | 20 | 1.90E-01 | 2.39E-02 | N/A | N/A |
| 1,4-Dichlorobenzene | 61 | 3 | 3.20E-01 | 3.26E-02 | 1.00E+01 | EMEG (chronic) |
| Dichlorodifluoromethane | 61 | 57 | 6.50E-01 | 5.09E-01 | 2.02E+01 | RSL (noncancer) |
| 1,1-Dichloroethane | 61 | 1 | 2.00E-02 | 3.28E-04 | 3.21E-01 | RSL (cancer) |
| cis-1,2-Dichloroethene | 61 | 0 | 0.00E+00 | 0.00E+00 | 2.00E+05 | PEL |
| trans-1,2-Dichloroethene | 61 | 42 | 0.00E+00 | 0.00E+00 | 2.00E+02 | EMEG (intermediate) |
| 1,1-Dichloroethylene | 61 | 1 | 2.00E-02 | 3.28E-04 | 1.00E+00 | EMEG (chronic) |
| Dichloromethane | 61 | 22 | 4.30E-01 | 1.07E-01 | 1.80E+01 | CREG |
| 1,2-Dichloropropane | 61 | 0 | 0.00E+00 | 0.00E+00 | 8.70E-01 | RMEG (chronic) |
| cis-1,3-Dichloropropene | 61 | 0 | 0.00E+00 | 0.00E+00 | 5.50E-02 | CREG |
| trans-1,3-Dichloropropene | 61 | 0 | 0.00E+00 | 0.00E+00 | 5.50E-02 | CREG |
| Ethyl acetate | 61 | 7 | 9.00E-02 | 6.72E-03 | 2.00E+01 | RSL (noncancer) |
| Ethylbenzene | 61 | 8 | 6.00E-02 | 1.61E-02 | 6.00E+01 | EMEG (chronic) |
| Ethylene dichloride | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+00 | EMEG (chronic) |

| Analyte | Samples Run | Detections | Max | Avg | CV | CV Type |
|---|---|---|---|---|---|---|
| p-Ethyltoluene | 61 | 1 | 2.00E-01 | 7.21E-03 | N/A | N/A |
| Freon 113 | 61 | 57 | 1.90E-01 | 8.23E-02 | 1.00E+06 | PEL |
| Freon 114 | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.00E+06 | PEL |
| n-Heptane | 61 | 22 | 8.70E-01 | 5.21E-02 | 1.03E+02 | RSL (noncancer) |
| Hexachloro-1,3-butadiene | 61 | 0 | 3.00E-02 | 9.84E-04 | 4.30E-03 | CREG |
| n-Hexane | 61 | 44 | 4.10E-01 | 8.15E-02 | 2.00E+02 | RMEG (chronic) |
| Methyl chloroform | 61 | 0 | 0.00E+00 | 0.00E+00 | 3.80E+03 | RMEG (chronic) |
| Methyl methacrylate | 61 | 0 | 0.00E+00 | 0.00E+00 | 1.70E+02 | RMEG (chronic) |
| MTBE | 61 | 0 | 0.00E+00 | 0.00E+00 | 8.30E+02 | RMEG (chronic) |
| Propylene | 61 | 6 | 4.80E-01 | 3.41E-02 | 1.80E+03 | RSL (noncancer) |
| Styrene | 61 | 17 | 2.50E-01 | 2.87E-02 | 2.00E+02 | EMEG (chronic) |
| 1,1,2,2-Tetrachloroethane | 61 | 0 | 2.00E-02 | 1.80E-03 | 5.86E-02 | RSL (cancer) |
| Tetrachloroethylene | 61 | 12 | 5.00E-02 | 1.31E-02 | 5.70E-01 | CREG |
| Tetrahydrofuran | 61 | 2 | 5.00E-02 | 1.64E-03 | 6.80E+02 | RMEG (chronic) |
| Toluene | 61 | 57 | 1.36E+00 | 1.54E-01 | 1.00E+03 | EMEG (chronic) |
| 1,2,4-Trichlorobenzene | 61 | 2 | 4.70E-01 | 3.57E-02 | 2.83E-01 | RSL (noncancer) |
| 1,1,2-Trichloroethane | 61 | 0 | 3.00E-02 | 9.84E-04 | 1.00E-02 | CREG |
| Trichloroethylene | 61 | 0 | 3.00E-02 | 1.48E-03 | 4.00E-02 | CREG |
| Trichlorofluoromethane | 61 | 56 | 2.90E-01 | 2.32E-01 | 9.97E+05 | PEL |
| 1,2,4-Trimethylbenzene | 61 | 12 | 2.20E-01 | 3.51E-02 | 1.20E+01 | RMEG (chronic) |
| 1,3,5-Trimethylbenzene | 61 | 1 | 5.00E-02 | 4.43E-03 | 1.20E+01 | RMEG (chronic) |
| Vinyl chloride | 61 | 0 | 0.00E+00 | 0.00E+00 | 4.40E-02 | CREG |
| m,p-Xylenes | 61 | 19 | 1.50E-01 | 4.67E-02 | 2.30E+01 | RMEG (chronic) |
| o-Xylene | 61 | 12 | 6.00E-02 | 1.95E-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 – 2019**

| Analyte | Samples Run | Detections | Max | Avg | CV | CV Type |
|---|---|---|---|---|---|---|
| 1,1,2,2-Tetrachloroethane | 61 | 1 | 8.00E-02 | 3.28E-03 | 5.86E-02 | RSL (cancer) |
| 1,1,2-Trichloroethane | 61 | 1 | 9.00E-02 | 3.61E-03 | 1.00E-02 | CREG |
| 1,1-Dichloroethane | 61 | 1 | 9.00E-02 | 1.48E-03 | 3.21E-01 | RSL (cancer) |
| 1,1-Dichloroethylene | 61 | 1 | 1.00E-01 | 1.64E-03 | 1.00E+00 | EMEG (chronic) |
| 1,2,4-Trichlorobenzene | 61 | 11 | 1.03E+00 | 1.02E-01 | 2.83E-01 | RSL (noncancer) |
| 1,2,4-Trimethylbenzene | 61 | 37 | 2.40E-01 | 8.21E-02 | 1.20E+01 | RMEG (chronic) |
| 1,2-Dibromoethane | 61 | 2 | 8.00E-02 | 6.07E-03 | 2.20E-04 | CREG |
| 1,2-Dichlorobenzene | 61 | 10 | 3.00E-01 | 3.43E-02 | 3.50E+01 | RSL (noncancer) |
| 1,2-Dichloropropane | 61 | 1 | 1.30E-01 | 2.13E-03 | 8.70E-01 | RMEG (chronic) |
| 1,3,5-Trimethylbenzene | 61 | 8 | 5.00E-02 | 9.51E-03 | 1.20E+01 | RMEG (chronic) |
| 1,3-Butadiene | 61 | 1 | 1.20E-01 | 1.97E-03 | 1.50E-02 | CREG |
| 1,3-Dichlorobenzene | 61 | 20 | 4.10E-01 | 5.07E-02 | N/A | N/A |
| 1,4-Dichlorobenzene | 61 | 9 | 5.10E-01 | 5.30E-02 | 1.00E+01 | EMEG (chronic) |
| Acetonitrile | 61 | 20 | 2.95E+02 | 5.49E+00 | 3.60E+01 | RMEG (chronic) |
| Acrolein | 61 | 40 | 7.12E+00 | 5.31E-01 | 8.70E-03 | RMEG (chronic) |
| Acrylonitrile | 61 | 1 | 9.00E-02 | 1.48E-03 | 6.80E-03 | CREG |
| Benzene | 61 | 59 | 6.30E-01 | 1.46E-01 | 4.00E-02 | CREG |
| Bromodichloromethane | 61 | 1 | 1.00E-01 | 1.64E-03 | 1.13E-02 | RSL (cancer) |
| Bromoform | 61 | 0 | 5.00E-02 | 1.64E-03 | 8.80E-02 | CREG |
| Bromomethane | 61 | 1 | 1.20E-01 | 1.97E-03 | 1.00E+00 | EMEG (chronic) |
| Carbon tetrachloride | 61 | 56 | 1.40E-01 | 6.28E-02 | 2.60E-02 | CREG |
| Chlorobenzene | 61 | 8 | 1.30E-01 | 1.18E-02 | 1.13E+02 | RSL (noncancer) |
| Chloroethane | 61 | 1 | 1.30E-01 | 2.13E-03 | 3.80E+03 | RMEG (chronic) |
| Chloroform | 61 | 24 | 1.10E-01 | 2.41E-02 | 8.90E-03 | CREG |
| Chloromethane | 61 | 59 | 7.60E-01 | 5.55E-01 | 3.00E+01 | EMEG (chronic) |
| cis-1,2-Dichloroethene | 61 | 1 | 8.00E-02 | 1.31E-03 | 2.00E+05 | PEL |
| cis-1,3-Dichloropropene | 61 | 1 | 8.00E-02 | 1.31E-03 | 5.50E-02 | CREG |
| Cyclohexane | 61 | 2 | 1.00E-01 | 2.13E-03 | 1.70E+03 | RMEG (chronic) |
| Dibromochloromethane | 61 | 1 | 7.00E-02 | 2.30E-03 | N/A | N/A |
| Dichlorodifluoromethane | 61 | 59 | 5.70E-01 | 4.65E-01 | 2.02E+01 | RSL (noncancer) |
| trans-1,2-Dichloroethene | 61 | 31 | 9.00E-02 | 1.48E-03 | 2.00E+02 | EMEG (intermediate) |

| Analyte | Samples Run | Detections | Max | Avg | CV | CV Type |
|---|---|---|---|---|---|---|
| Dichloromethane | 61 | 37 | 3.50E-01 | 1.02E-01 | 1.80E+01 | CREG |
| trans-1,3-Dichloropropene | 61 | 1 | 7.00E-02 | 1.15E-03 | 5.50E-02 | CREG |
| Ethyl Acetate | 61 | 8 | 2.80E-01 | 1.54E-02 | 2.00E+01 | RSL (noncancer) |
| Ethylbenzene | 61 | 20 | 1.10E-01 | 2.69E-02 | 6.00E+01 | EMEG (chronic) |
| Ethylene dichloride | 61 | 1 | 1.00E-01 | 1.64E-03 | 1.00E+00 | EMEG (chronic) |
| Freon 113 | 61 | 59 | 1.60E-01 | 7.93E-02 | 1.00E+06 | PEL |
| Freon 114 | 61 | 1 | 1.20E-01 | 1.97E-03 | 1.00E+06 | PEL |
| Hexachloro-1,3-Butadiene | 61 | 2 | 8.00E-02 | 2.46E-03 | 4.30E-03 | CREG |
| | | | | | | |
| Methyl chloroform | 61 | 1 | 9.00E-02 | 1.48E-03 | 3.80E+03 | RMEG (chronic) |
| Methyl methacrylate | 61 | 1 | 8.00E-02 | 1.31E-03 | 1.70E+02 | RMEG (chronic) |
| MTBE | 61 | 1 | 9.00E-02 | 1.48E-03 | 8.30E+02 | RMEG (chronic) |
| n-Heptane | 61 | 34 | 5.60E-01 | 6.23E-02 | 1.03E+02 | RSL (noncancer) |
| n-Hexane | 61 | 43 | 4.60E-01 | 9.18E-02 | 2.00E+02 | RMEG (chronic) |
| | | | | | | |
| p-Ethyltoluene | 61 | 13 | 2.20E-01 | 2.30E-02 | N/A | N/A |
| Propylene | 61 | 4 | 5.20E-01 | 2.39E-02 | 1.80E+03 | RSL (noncancer) |
| Styrene | 61 | 36 | 5.40E-01 | 6.10E-02 | 2.00E+02 | EMEG (chronic) |
| Tetrachloroethylene | 61 | 7 | 1.10E-01 | 8.85E-03 | 5.70E-01 | CREG |
| Tetrahydrofuran | 61 | 6 | 2.20E-01 | 8.36E-03 | 6.80E+02 | RMEG (chronic) |
| Toluene | 61 | 59 | 9.70E-01 | 1.78E-01 | 1.00E+03 | EMEG (chronic) |
| | | | | | | |
| | | | | | | |
| Trichloroethylene | 61 | 1 | 1.10E-01 | 3.44E-03 | 4.00E-02 | CREG |
| Trichlorofluoromethane | 61 | 58 | 3.20E-01 | 2.32E-01 | 9.97E+05 | PEL |
| Vinyl chloride | 61 | 1 | 1.00E-01 | 1.64E-03 | 4.40E-02 | CREG |
| m,p-Xylenes | 61 | 33 | 3.60E-01 | 7.48E-02 | 2.30E+01 | RMEG (chronic) |
| o-Xylene | 61 | 26 | 1.50E-01 | 3.23E-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 (0.48 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 | 0.16 | 0.071 | 8.2 † | - | 3 | 0.27 | 0.12 | 14 † | - | 3 |
| Full time educator | 0.21 | 0.091 | 10 † | - | 5 | 0.27 | 0.12 | 14 † | - | 20 |
| Full time worker | 0.27 | 0.12 | 13 † | - | 5 | 0.27 | 0.12 | 13 † | - | 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 (0.48 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 | 0.22 | 0.096 | 2.4 † | 0.30 | 0.13 | 3.3 † |
| Full time educator | 0.28 | 0.12 | 3.0 † | 0.30 | 0.13 | 3.3 † |
| Full time worker | 0.28 | 0.12 | 3.0 † | 0.28 | 0.12 | 3.0 † |

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.