

CHLOROFORM (CHCl₃)

Chemical Abstracts Service (CAS) Number: 67-66-3

General Information

Chloroform is a colorless liquid that is not very soluble in water and is very volatile. The major effect from acute (short-term) inhalation exposure to chloroform is central nervous system depression. Chronic (long-term) exposure to chloroform by inhalation in humans has resulted in effects on the liver, including hepatitis and jaundice, and central nervous system effects, such as depression and irritability. Chloroform has been shown to be carcinogenic in animals after oral exposure, resulting in an increase in kidney and liver tumors. U.S. EPA has classified chloroform as a Group B2, probable human carcinogen.

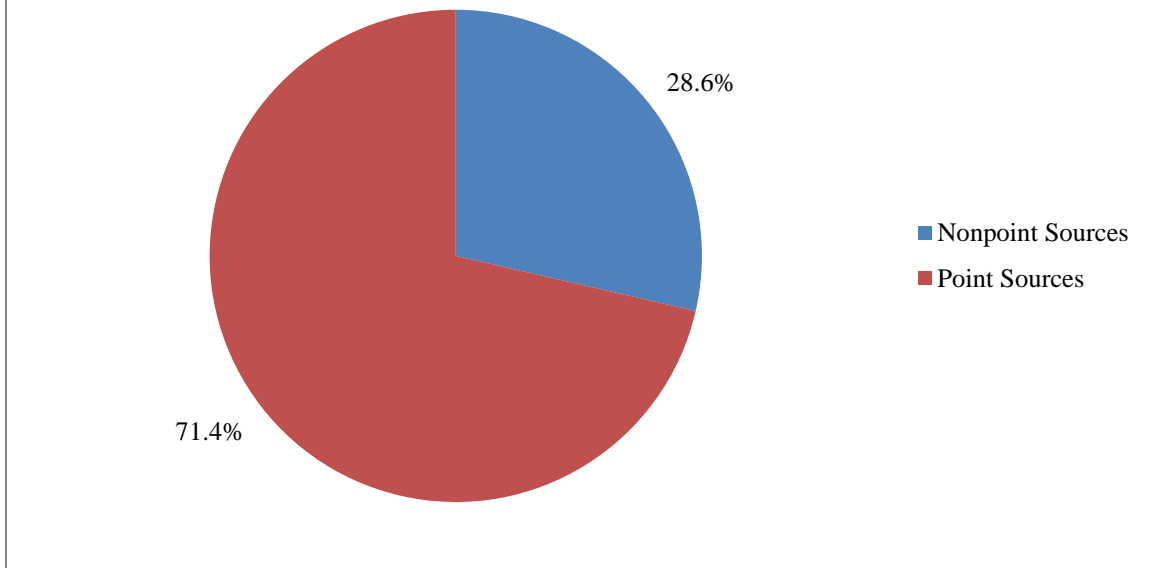
Sources

- Chloroform may be released to the air from a large number of sources related to its manufacture and use, as well as its formation in the chlorination of drinking water, wastewater, and swimming pools. Pulp and paper mills, hazardous waste sites, and sanitary landfills are also sources of air emissions.
- Human exposure to chloroform may occur through drinking water, where chloroform is formed as a result of the chlorination of naturally occurring organic materials found in raw water supplies.
- Chloroform may also be found in some foods and beverages, largely from the use of tap water during production processes.

Indiana Emissions

IDEM collects HAP emissions information for the categories of point sources (large stationary sources like power plants and factories), nonpoint sources (aka area sources - smaller stationary sources like gas stations and dry cleaners), and mobile sources (vehicles, airplanes, marine vessels, etc.).* Estimated statewide emissions of chloroform totaled 2.25 tons in the 2014 calendar year. Of this total, 71.4% was attributed to point sources and 28.6% was attributed to nonpoint sources.

2014 Indiana Chloroform Emission Sources



* For additional examples of types of emission sources, please visit IDEM's Hazardous Air Pollutants page at: <http://www.in.gov/idem/toxic/pages/hap/index.html>. For specific details on industrial sources of air toxics, please visit U.S. EPA's Toxics Release Inventory (TRI) page at: <https://www.epa.gov/toxics-release-inventory-tri-program>.

Measured Concentration Trends

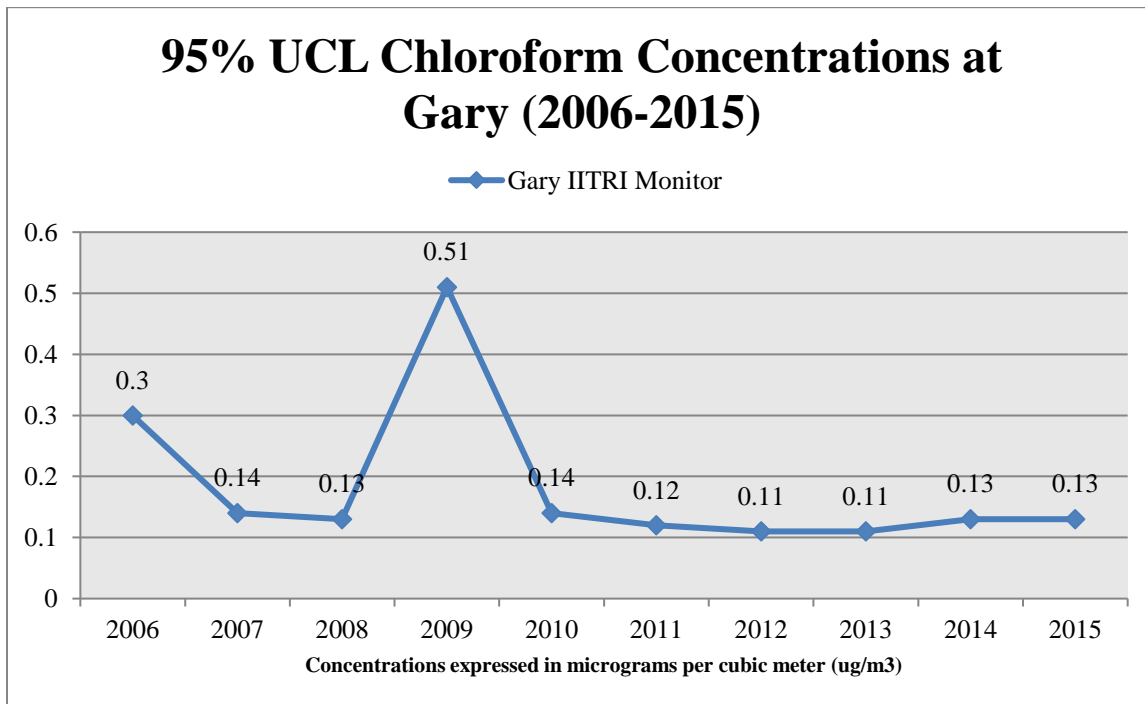
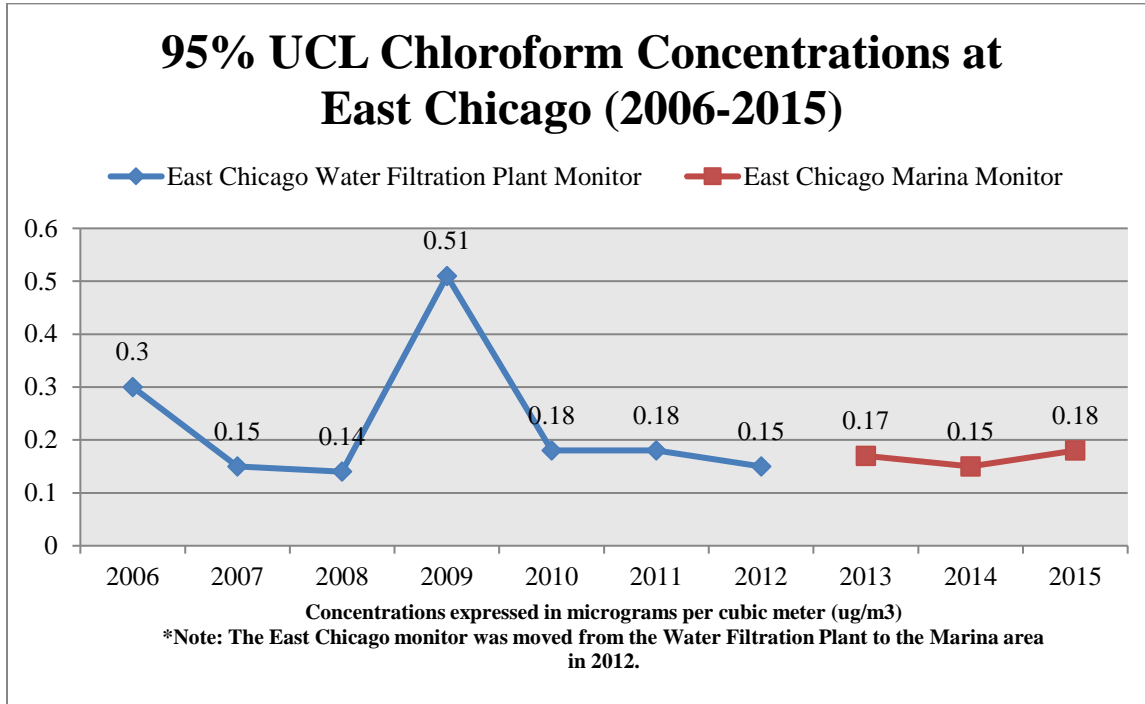
Ambient air monitoring data most accurately represents a limited area near the monitor location. All monitors for air toxics sample every sixth day. The monitoring locations by themselves are not sufficient to accurately characterize air toxic concentrations throughout the entire state, however, results from the monitors will provide exposure concentrations with a great deal of confidence at the monitoring locations.

The ambient air monitoring results were analyzed using U.S. EPA recommended statistical methods. IDEM evaluated the data so that a 95% upper confidence limit of the mean (UCL) could be determined. A 95% UCL represents a value which one can be 95% confident that the true mean of the population is below that value.

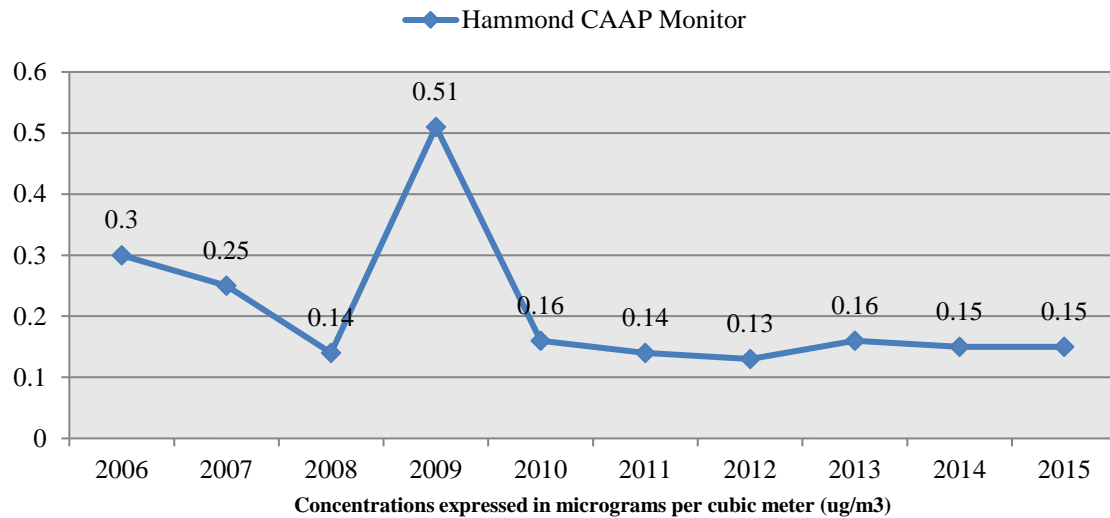
To learn more about the current monitoring locations, please visit IDEM's Air Toxics Monitor Siting webpage at: <http://www.in.gov/idem/toxic/2337.htm>

Data analysis was performed for each monitor that operated for a significant portion of the analysis period. This analysis determined the detection rate, which is defined as the percentage of valid samples taken statewide that had a quantifiable concentration of the pollutant. The statewide detection rate of chloroform for the monitors analyzed from 2006-2015 was 52.0%.

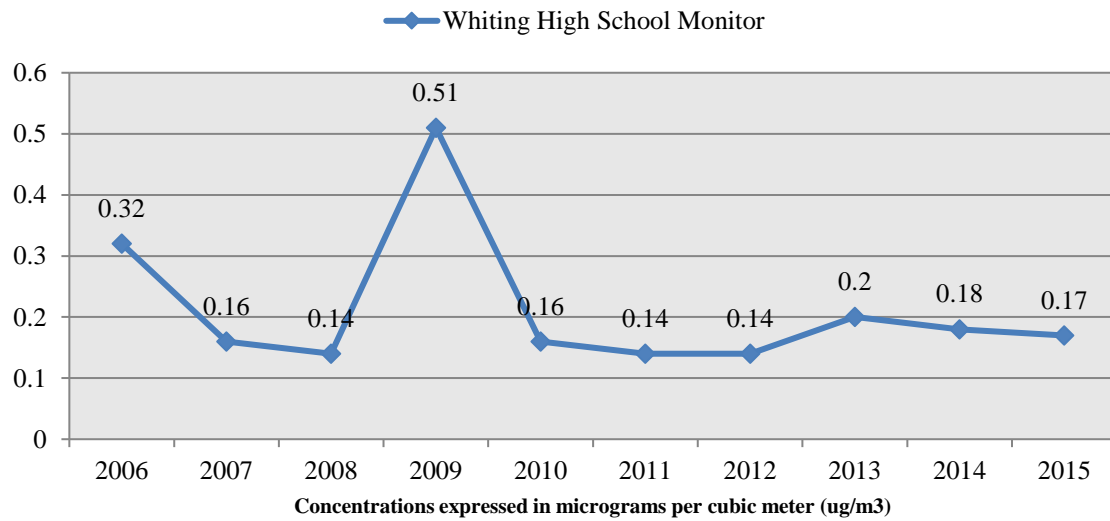
This detection rate was sufficient to perform a trend analysis, but too low to support a high level of confidence in the results. Trend graphs for each of these monitors are provided below.



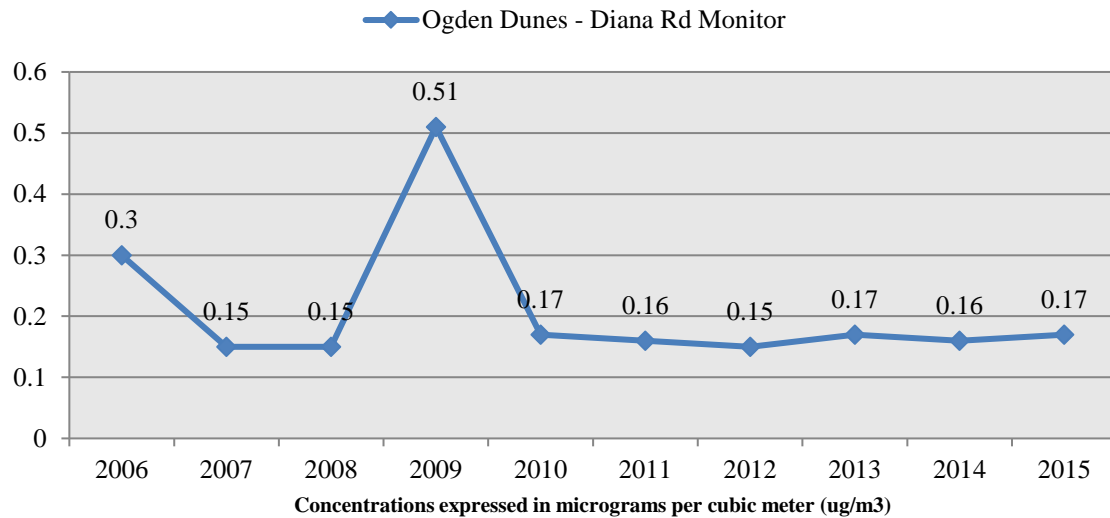
95% UCL Chloroform Concentrations at Hammond (2006-2015)



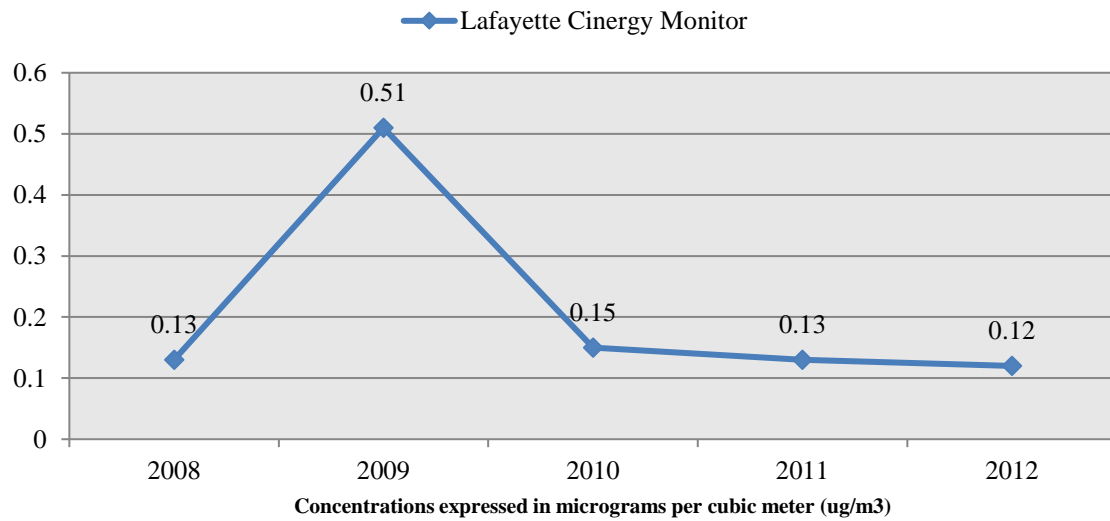
95% UCL Chloroform Concentrations at Whiting (2006-2015)



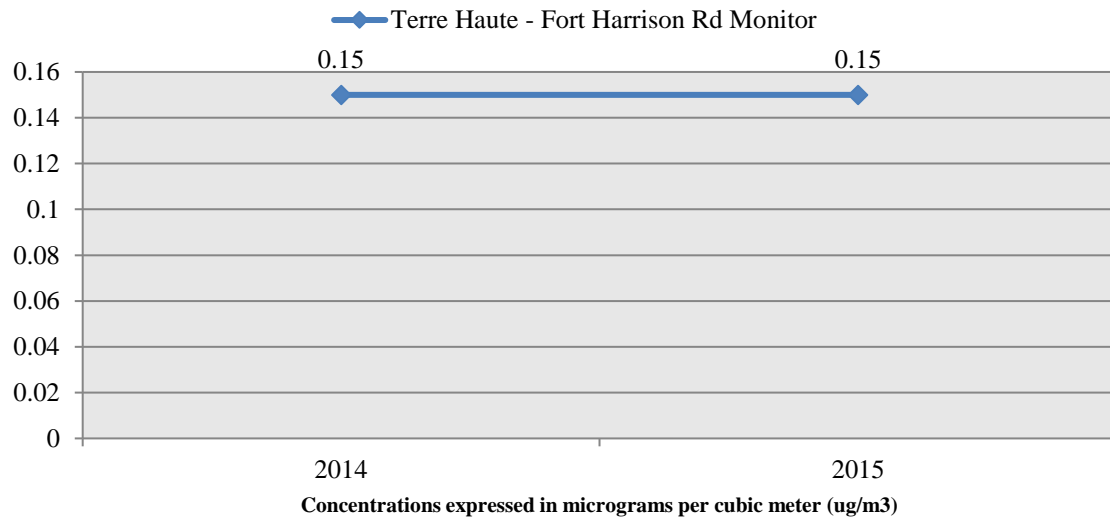
95% UCL Chloroform Concentrations at Ogden Dunes (2006-2015)



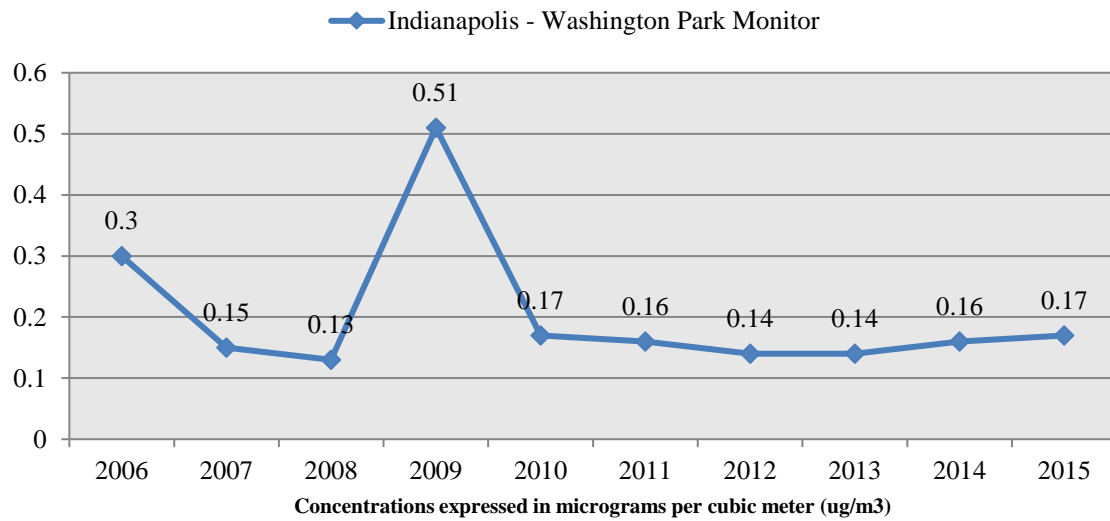
95% UCL Chloroform Concentrations at Lafayette (2008-2012)



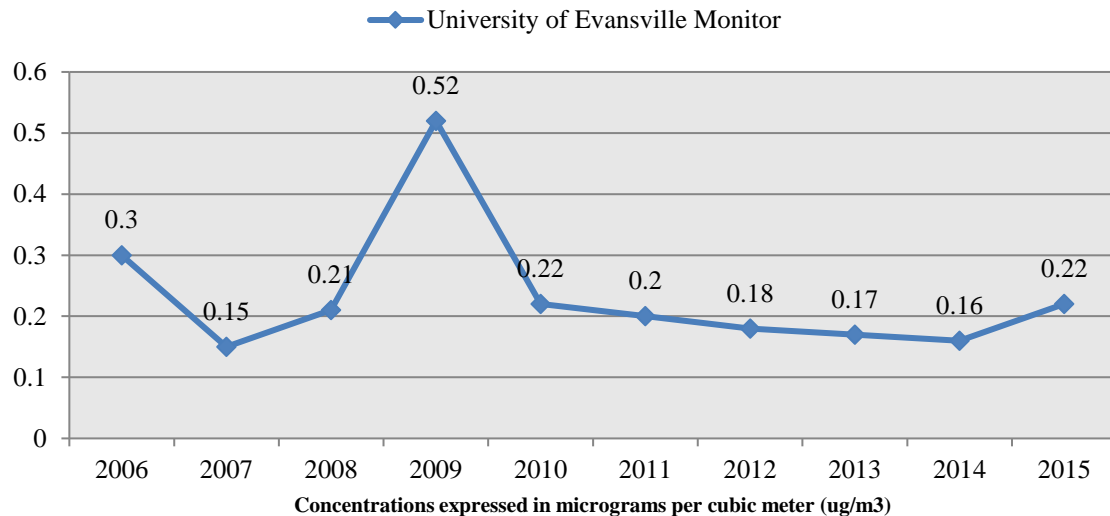
95% UCL Chloroform Concentrations at Terre Haute (2014-2015)



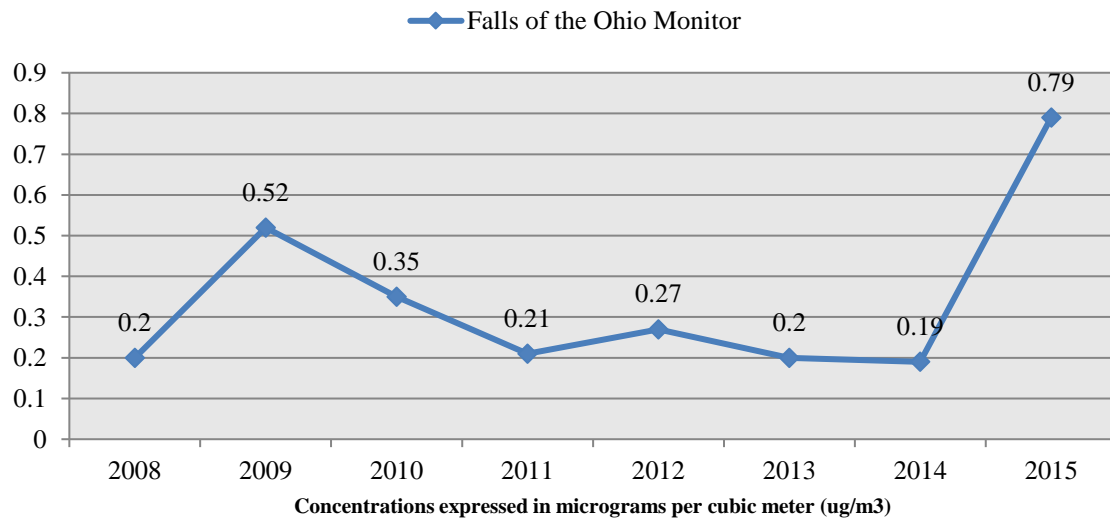
95% UCL Chloroform Concentrations at Indianapolis (2006-2015)



95% UCL Chloroform Concentrations at Evansville (2006-2015)



95% UCL Chloroform Concentrations at Clarksville (2008-2015)



The analysis of monitoring data from 2006 to 2015 indicates that concentrations of chloroform remained relatively stable throughout the state. The one apparent exception is a spike at all locations in 2009. This apparent spike is actually due to a higher calculated method detection limit (MDL) for 2009, and does not indicate an actual increase in concentrations of chloroform. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence. The calculated MDL varies from year to year, and is the value

used when non-detections are identified. Years with a high rate of non-detections can be heavily influenced by variability in the MDL.

The one exception that cannot be explained by variability in the MDL is a spike in 2015 at Clarksville. The calculated concentration in this case was heavily skewed by an unusually high reading of 9.08 recorded on 11/13/2015. This reading appears to be an outlier in the data, and no pattern of consistently high readings could be found in the full 2015 data set. The high reading of 9.08 is also well below the Reference Concentration of 98.00. More information about the reference concentration can be found in the hazard quotient section below.

Hazard Quotient

IDEM evaluates chronic (lifetime) non-cancer hazard assuming a threshold for each pollutant at which a health effect can be observed. That is, it assumes safe exposure to the pollutant up to a certain level before it is possible to experience a health effect from breathing the pollutant. IDEM uses health protective assumptions by taking into account people who might be more sensitive to the pollutants. The hazard quotient is a ratio that divides the measured concentration of a pollutant by the reference concentration (RfC). A hazard quotient under 1.0 is commonly recognized to be below the health-protective level. Hazard quotients over 1.0 indicate that further investigation may be necessary and does not necessarily mean that health effects are expected. Given the many health-protective assumptions used in the evaluation, most non-cancer hazards over 1.0 are still unlikely to be associated with observable adverse health effects.

The average concentration of chloroform was evaluated for each air pollutant monitor over the span of this study. The results for each monitor are displayed in the table below. The calculated hazard quotient is well below 1.0 at all monitors, which indicates that the measured concentrations of chloroform do not present a risk for non-cancer health effects.

Table 1. Chloroform Hazard Quotients (concentrations expressed in micrograms per cubic meter)

Monitor	Years	Average Concentration	Reference Concentration (RfC)*	Hazard Quotient
East Chicago Water Filtration Plant	2006-2012	0.23	98.00	0.002
East Chicago Marina	2013-2015	0.16	98.00	0.002
Gary ITRI	2006-2015	0.19	98.00	0.002
Hammond CAAP	2006-2015	0.20	98.00	0.002
Whiting High School	2006-2015	0.21	98.00	0.002
Ogden Dunes – Diana Rd	2006-2015	0.21	98.00	0.002
Lafayette Cinergy	2008-2012	0.23	98.00	0.002
Terre Haute – Fort Harrison Rd	2014-2015	0.15	98.00	0.002
Indianapolis –	2006-2015	0.20	98.00	0.002

Washington Park				
University of Evansville	2006-2015	0.22	98.00	0.002
Clarksville – Falls of the Ohio	2008-2015	0.32	98.00	0.003

* Reference Concentration Source: Integrated Risk Information Service (IRIS)

Cancer Risk

IDEM uses U.S. EPA methods and toxicological information from reliable sources when calculating potential cancer risk estimates. Potential lifetime cancer risk estimates are obtained by multiplying ambient air concentrations by cancer slope factors. The resulting calculations give a number that is expressed using the term “lifetime cancer cases per number of people.” U.S. EPA uses a range between one in a million and one hundred in a million (1 to 100) when evaluating whether the estimated risk is at a level where action should be taken. Generally, U.S. EPA considers lifetime cancer risk estimates over one hundred in a million to be at levels where action or more investigation is required. Lifetime cancer risks that fall between the one in a million and 100 in a million range generate decisions and actions taking into account the assumptions used to determine the estimate. Lifetime cancer risk estimates below one in a million are usually considered not to require further action.

Chloroform has been classified as a probable human carcinogen. The estimated risk of contracting cancer from chloroform runs within a range of 3.45-7.36 in a million at monitors across the state. Based on the calculated risk levels, chloroform is not a priority for immediate action but trends in concentrations should be closely monitored in the future.

Table 2. Chloroform Additional Lifetime Cancer Risk (concentrations expressed in micrograms per cubic meter)

Monitor	Years	Average Concentration	Cancer Risk (in one million)*
East Chicago Water Filtration Plant	2006-2012	0.23	5.29
East Chicago Marina	2013-2015	0.16	3.68
Gary ITRI	2006-2015	0.19	4.37
Hammond CAAP	2006-2015	0.20	4.60
Whiting High School	2006-2015	0.21	4.83
Ogden Dunes – Diana Rd	2006-2015	0.21	4.83
Lafayette Cinergy	2008-2012	0.23	5.29
Terre Haute – Fort Harrison Rd	2014-2015	0.15	3.45
Indianapolis – Washington Park	2006-2015	0.20	4.60
University of Evansville	2006-2015	0.22	5.06
Clarksville – Falls of the Ohio	2008-2015	0.32	7.36

* Additional Cancer Risk Factor Source: Integrated Risk Information Service (IRIS).