

BENZENE (C⁶H⁶)

Chemical Abstracts Service (CAS) Number: 71-43-2

General Information

Benzene occurs as a volatile, colorless, highly flammable liquid with a sweet odor. Benzene is used as a constituent in motor fuels; as a solvent for fats, waxes, resins, oils, inks, paints, plastics, and rubber; in the extraction of oils from seeds and nuts; and in photogravure printing. It is also used as a chemical intermediate. Benzene is also used in the manufacture of detergents, explosives, pharmaceuticals, and dyestuffs.

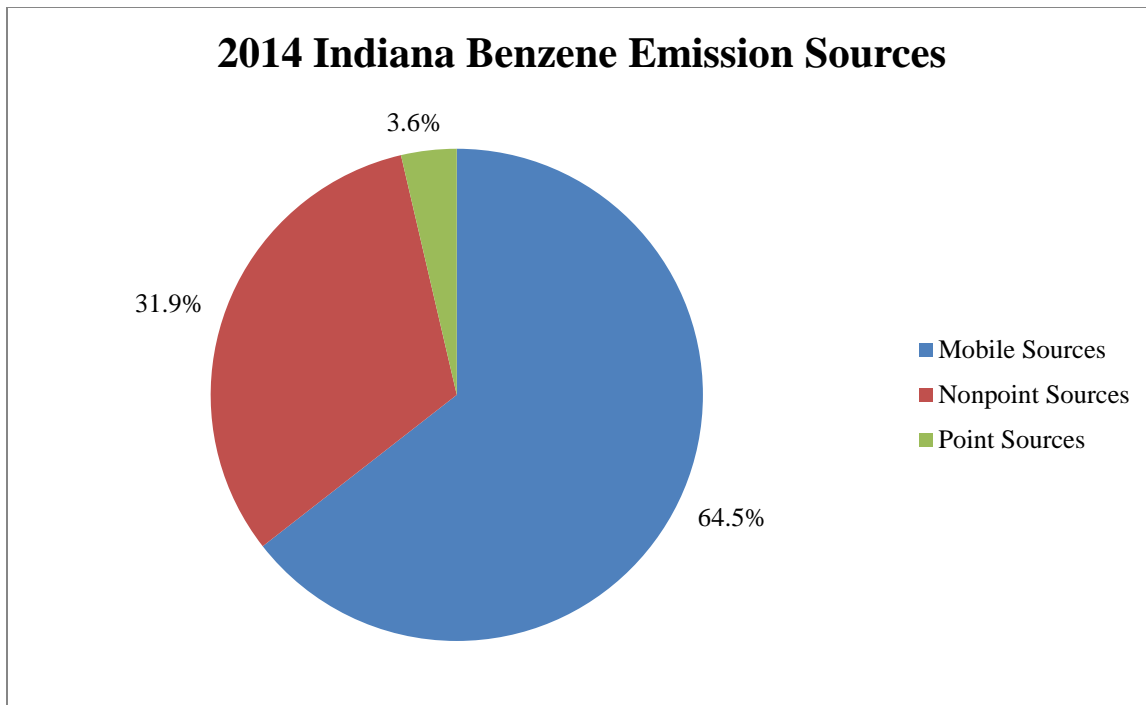
Short-term inhalation exposure to benzene may cause drowsiness, dizziness, headaches, as well as eye, skin, and respiratory tract irritation, and, at high levels, unconsciousness. Long-term inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia, in occupational settings. Reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests. Increased incidences of leukemia (cancer of the tissues that form white blood cells) have been observed in humans occupationally exposed to benzene. U.S. EPA has classified benzene as known human carcinogen for all routes of exposure.

Sources

- Benzene is found in emissions from burning wood, coal and oil, byproduct recovery coke ovens, motor vehicle exhaust, evaporation from gasoline storage and transport, tobacco smoke and in industrial solvents. These sources contribute to elevated levels of benzene in the ambient air, which may subsequently be breathed by the public.
- Tobacco smoke may account for nearly half the national exposure to benzene.
- Individuals employed in industries that manufacture or use benzene may be exposed to the highest levels of benzene.
- Individuals may also be exposed to benzene by consuming contaminated water.

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 benzene totaled 3754.54 tons in the 2014 calendar year. Of this total, 64.5% was attributed to mobile sources, 31.9% to nonpoint sources, and the remaining 3.6% to point 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

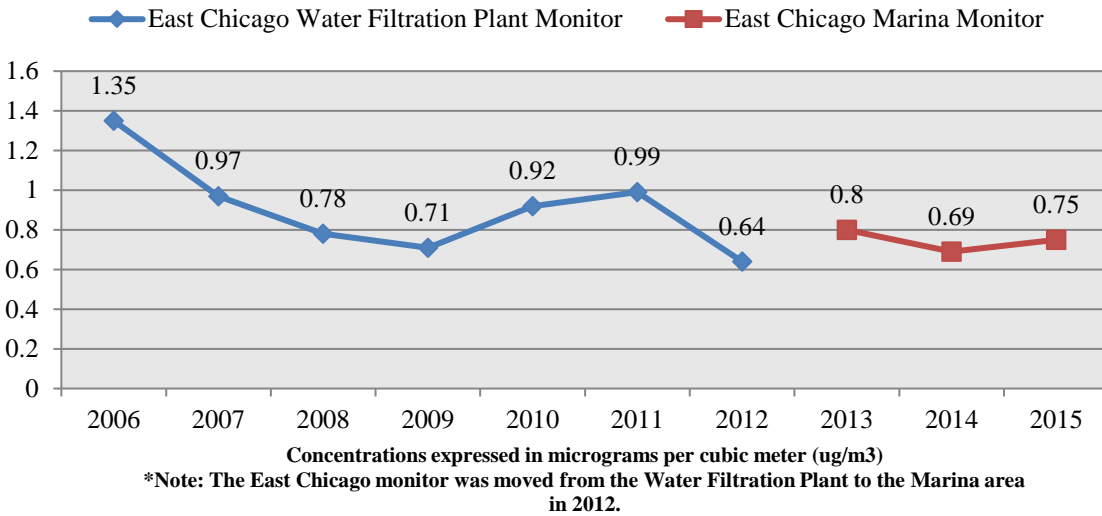
Ambient air monitoring data most accurately represents a limited area near the monitor location. All monitors for air toxics sample every sixth day. The monitoring locations by themselves are not sufficient to accurately characterize air toxic concentrations throughout the entire state, however, results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

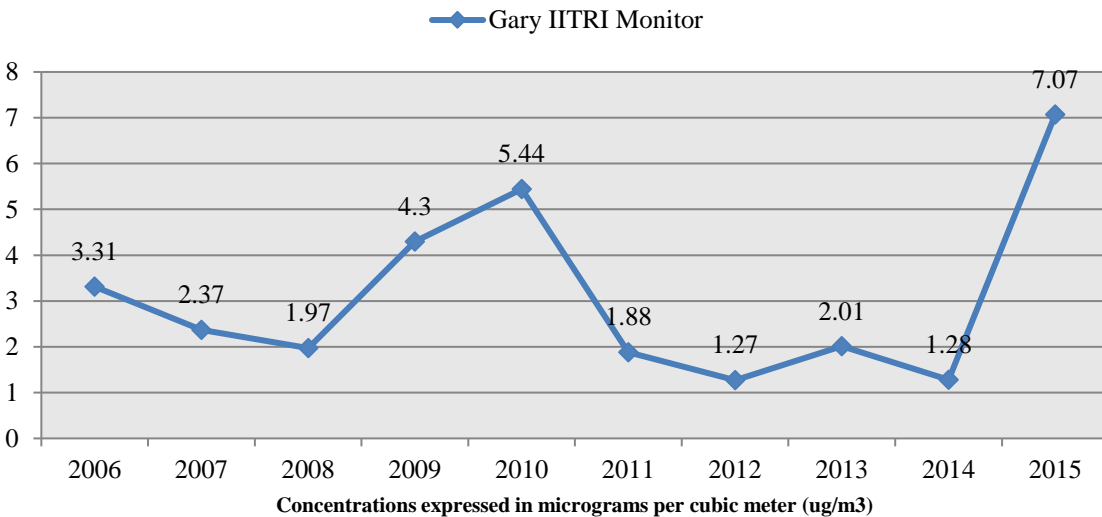
To learn more about the current monitoring locations, please visit IDEM’s Air Toxics Monitor Siting webpage at: <http://www.in.gov/idem/toxic/2337.htm>

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 benzene for the monitors analyzed from 2006-2015 was 98.7%. Trend graphs for each of these monitors are provided below.

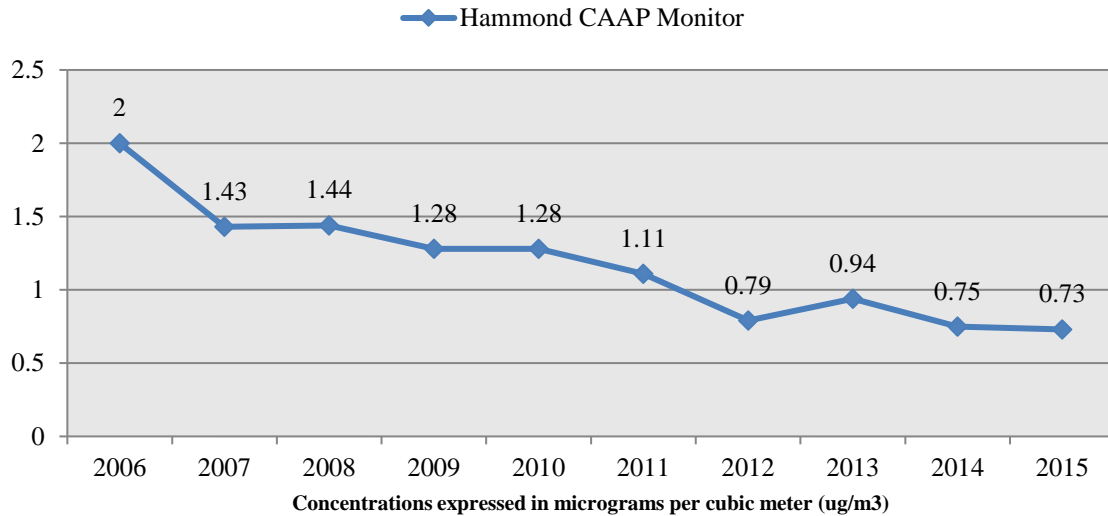
95% UCL Benzene Concentrations at East Chicago (2006-2015)



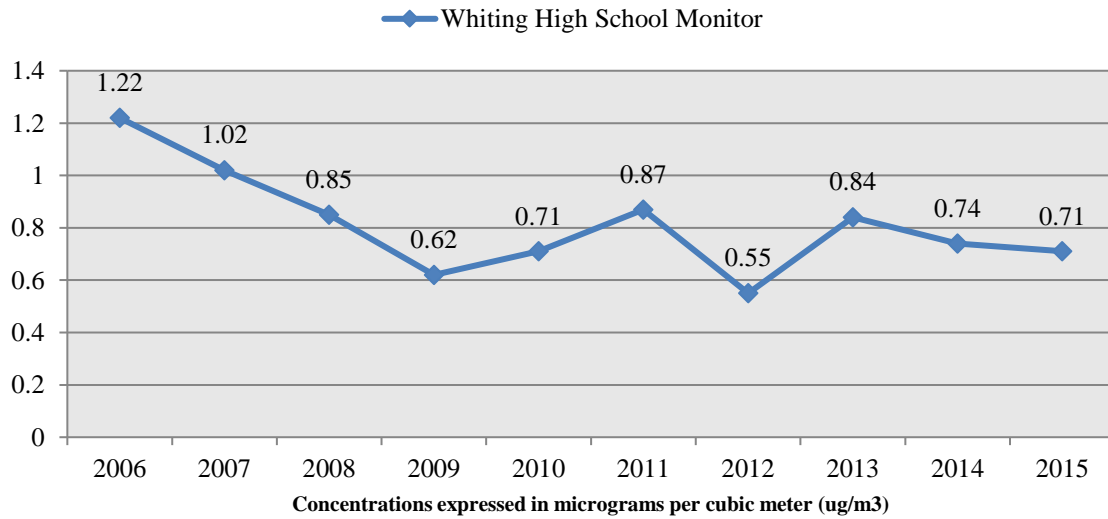
95% UCL Benzene Concentrations at Gary (2006-2015)



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

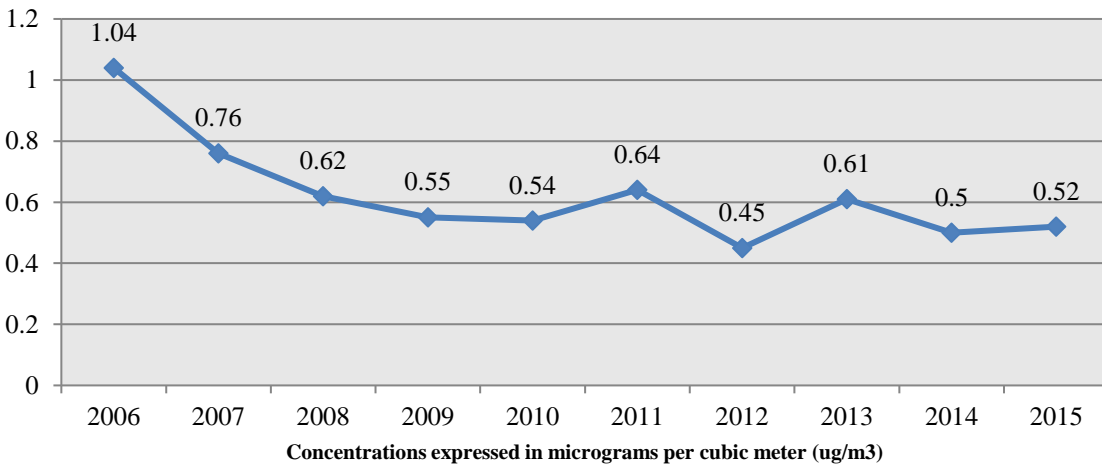


95% UCL Benzene Concentrations at Whiting (2006-2015)



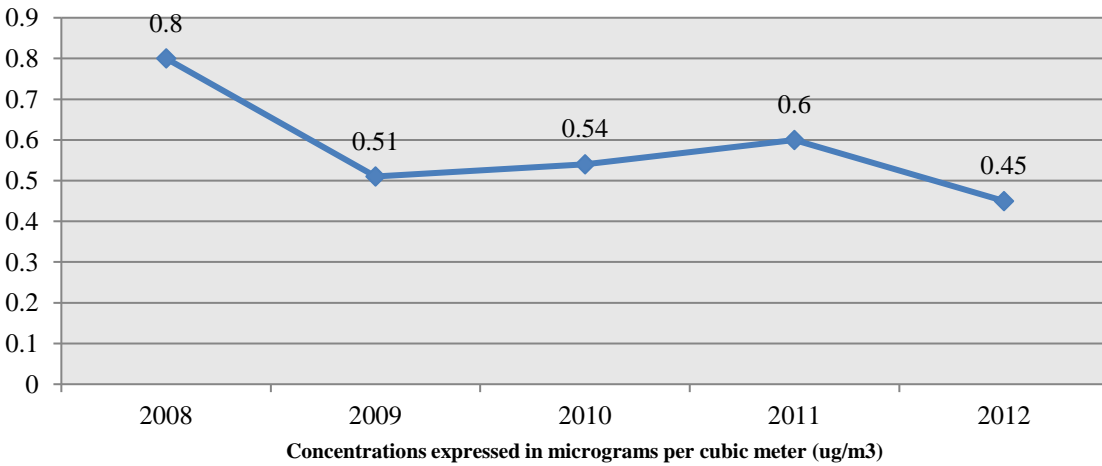
95% UCL Benzene Concentrations at Ogden Dunes (2006-2015)

—◆— Ogden Dunes - Diana Rd Monitor



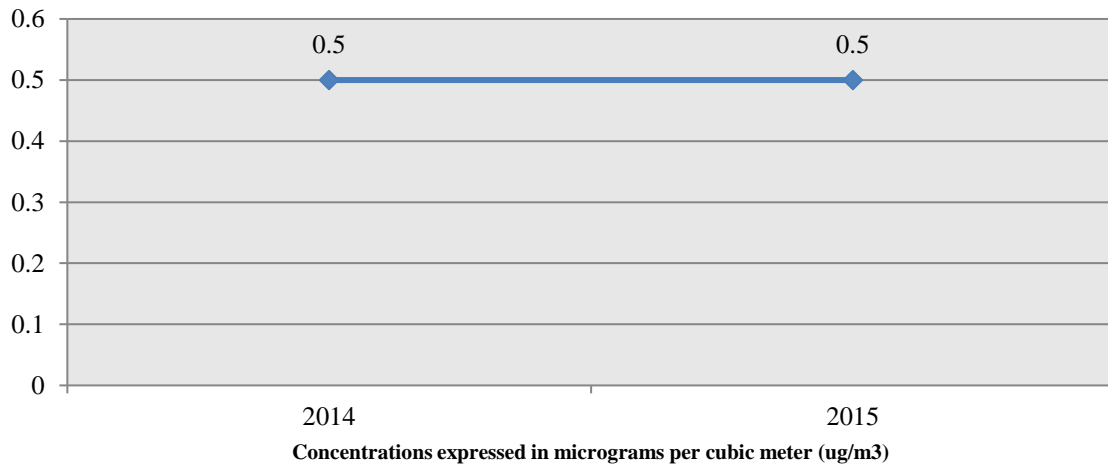
95% UCL Benzene Concentrations at Lafayette (2008-2012)

—◆— Lafayette Cinergy Monitor



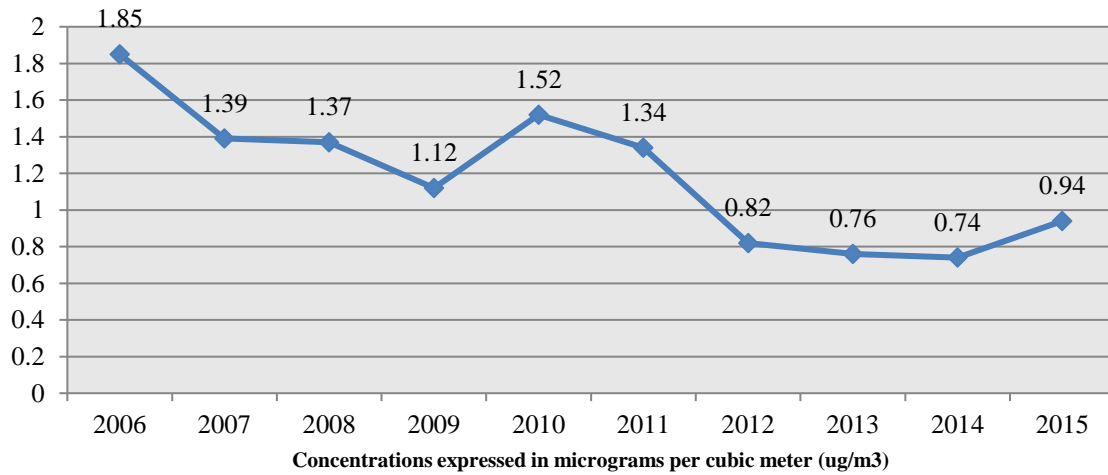
95% UCL Benzene Concentrations at Terre Haute (2014-2015)

—◆— Terre Haute - Fort Harrison Rd Monitor

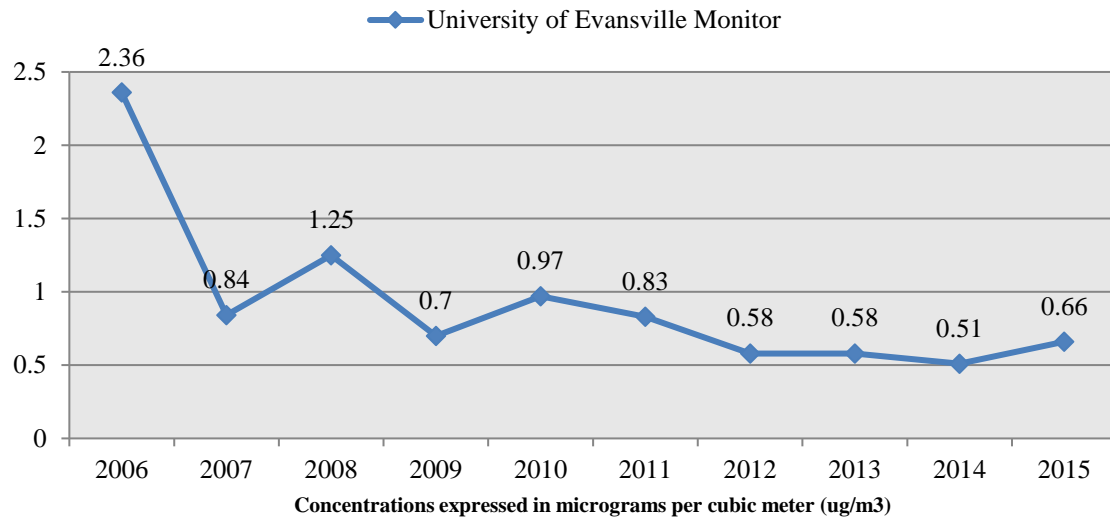


95% UCL Benzene Concentrations at Indianapolis (2006-2015)

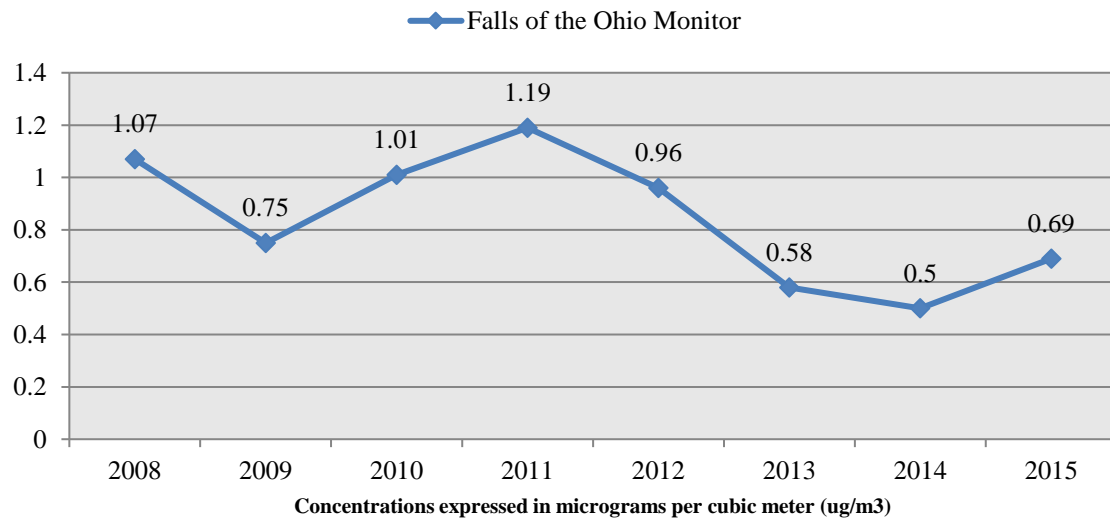
—◆— Indianapolis - Washington Park Monitor



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



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



The analysis of monitoring data from 2006 to 2015 indicates that concentrations of benzene have generally declined over that time. The exception to this trend can be observed at the Gary IITRI monitor, where average concentrations of benzene were lower from 2011-2014 before experiencing a spike in 2015. This spike was heavily influenced by an abnormally high reading of 126.71 micrograms per cubic meter recorded on 1/12/2015. This reading was more than 20 times higher than any other reading at this monitor during the 2015 calendar year, which

suggests the possibility of an erroneous sample. Removing this sample from the 2015 dataset would drop the 95% UCL value from 7.07 to 1.37 micrograms per cubic meter.

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 benzene 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 benzene do not present a risk for non-cancer health effects.

Table 1. Benzene 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 | 0.85 | 30.00 | 0.028 |
| East Chicago Marina | 2013-2015 | 0.71 | 30.00 | 0.024 |
| Gary IITRI | 2006-2015 | 2.50 | 30.00 | 0.083 |
| Hammond CAAP | 2006-2015 | 1.08 | 30.00 | 0.036 |
| Whiting High School | 2006-2015 | 0.75 | 30.00 | 0.025 |
| Ogden Dunes – Diana Rd | 2006-2015 | 0.57 | 30.00 | 0.019 |
| Lafayette Cinergy | 2008-2012 | 0.55 | 30.00 | 0.018 |
| Terre Haute – Fort Harrison Rd | 2014-2015 | 0.49 | 30.00 | 0.016 |
| Indianapolis – Washington Park | 2006-2015 | 1.07 | 30.00 | 0.036 |
| University of Evansville | 2006-2015 | 0.81 | 30.00 | 0.027 |
| Clarksville – Falls of the Ohio | 2008-2015 | 0.79 | 30.00 | 0.026 |

* 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.

Benzene has been classified as a known human carcinogen. The estimated risk of contracting cancer from benzene consistently runs greater than one in a million at monitors across the state. Based on the calculated risk levels, benzene has been flagged as one of the most significant cancer risk drivers related to Indiana air quality.

Table 2. Benzene 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 | 0.85 | 6.63 |
| East Chicago Marina | 2013-2015 | 0.71 | 5.54 |
| Gary ITRI | 2006-2015 | 2.50 | 19.50 |
| Hammond CAAP | 2006-2015 | 1.08 | 8.42 |
| Whiting High School | 2006-2015 | 0.75 | 5.85 |
| Ogden Dunes – Diana Rd | 2006-2015 | 0.57 | 4.45 |
| Lafayette Cinergy | 2008-2012 | 0.55 | 4.29 |
| Terre Haute – Fort Harrison Rd | 2014-2015 | 0.49 | 3.82 |
| Indianapolis – Washington Park | 2006-2015 | 1.07 | 8.35 |
| University of Evansville | 2006-2015 | 0.81 | 6.32 |
| Clarksville – Falls of the Ohio | 2008-2015 | 0.79 | 6.16 |

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