Iowa Toxics Sampling 2019

Results for Acetaldehyde and Formaldehyde

Iowa DNR Ambient Air Monitoring Group

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Summary

Scope

Section 112 of the Clean Air Act contains the federal strategy for protecting the public from air toxics emissions, also known as "hazardous air pollutants" (HAPs) [Reference 1]. HAPs are pollutants that are known or suspected to cause cancer, other serious health effects, or adverse environmental effects. The Clean Air Act provides a list of 187 HAPs for regulatory action [Reference 2]. Emitters of large amounts of these HAPs are subject to regulations, by the Environmental Protection Agency (EPA) and its regulatory partners at the State and local level. Such regulations can require adoption of work practices or installation of control technologies in order to reduce HAP emissions [Reference 3].

To assist with the regulation of HAPs, the Clean Air Act requires a periodic national air toxics assessment (NATA) of the estimated public health risk posed by outdoor HAPs [Reference 4]. The EPA developed the National Air Toxics Trends Station (NATTS) network to obtain long term monitoring data in outdoor HAP concentrations across the nation as a component of its residual risk assessment [Reference 5]. EPA's current NATTS network consists of 27 sites across the United States, and a listing of these sites are provided as [Reference 6]. These sites contain a standard suite of samplers and analytical protocols [Reference 7] and can monitor over 100 pollutants.

There are no NATTS sites in Iowa. Iowa does have its own five air toxic monitoring sites. Unlike NATTS sites, Iowa's air toxics sites do not have instrumentation to measure toxic metals, polycyclic aromatic hydrocarbons, or black carbon (particulate matter emitted from sources that burn fossil fuels). Iowa air toxic sites monitor for acetaldehyde and formaldehyde. The 2011 NATA results portrayed formaldehyde contributing to the national cancer risk by 53 percent and acetaldehyde contributing 11 percent. From the 2011 NATA, formaldehyde was considered a national cancer driver and acetaldehyde a national cancer contributor [Reference 8].

Sampling Schedules

For the Iowa Air Toxic Monitoring Network, the sampling schedule for formaldehyde and acetaldehyde is based on Iowa's ozone season. Iowa's ozone season, as defined by EPA, is March through October. Air toxic samples were collected at a frequency of one sample every sixth day inside ozone season and one sample every twelfth day outside ozone season. For calculations of average pollutant levels and cancer risks, 12-day block averages were created. The days in a given block are the days between two days on EPA's one in twelve day sampling schedule, including the later of the two days that bracket this interval. Averaging over these 12-day blocks, instead of averaging over the raw data, is performed in order to avoid biasing the average due to accelerated sampling during ozone season.

Data Capture

For the purpose of this report, a valid twelve-day average is determined from the sum of one or more samples collected during the scheduled twelve-day sampling period (12-day block). The annual data capture rate is defined as the ratio of the number of valid twelve-day averages divided by the number of scheduled twelve-day periods in the year, which is 30 twelve day periods for 2019. EPA data analysis guidelines typically require 75% data completeness across each sampling quarter. Quarterly completeness is the ratio of the number of valid twelve day averages within a quarter divided by the number of scheduled twelve day periods in that quarter. With the exception of the Des Moines site in the first quarter of 2019, all Iowa sites met this quarterly data capture goal for formaldehyde and acetaldehyde.

Data Handling

This report characterizes only the cancer risk associated with exposure to the toxic contaminants measured, and does not quantify other "non-cancer" public health risks such as neurological or reproductive damage associated with the measured exposure levels. The cancer risk associated with a given exposure level was quantified only when an inhalation unit cancer risk was available in EPA's Integrated Risk Information System (IRIS) database. For the purpose of this report, a unit cancer risk of 1-in-1 million implies that, if 1 million people are exposed to the same concentration of a pollutant continuously (every day, 24 hours per day) over 70 years (an assumed lifetime), no more than one person is expected or would likely contract cancer from this exposure [Reference 9]. Note, this risk would be in addition to any cancer risk borne by a person not exposed to these air toxics.

The EPA's IRIS program uses weight of evidence and hazard descriptors to categorize chemicals for carcinogenicity [Reference 10]. Chemicals are organized into groups based on their descriptor, from Group A "Carcinogenic to Humans" to Group E "Not Likely to Be Carcinogenic to Humans" [Reference 11]. Group B contains probable human carcinogens, "Likely to Be Carcinogenic to Humans". Formaldehyde is a Group B1 carcinogen. B1 pollutants are associated with limited evidence of carcinogenicity in humans but sufficient evidence of carcinogenicity in animals. Acetaldehyde is classified as a Group B2 carcinogen. B2 classification for pollutants indicates only sufficient evidence of carcinogenicity in animals.

Precision Data

Precision statistics are calculated from the results of the analysis of duplicate cartridges. Precision statistics shown in this report have been calculated using the methodology applicable to collocated fine particulate data pairs as specified in the Code of Federal Regulations (CFR), Title 40, Chapter 1, Subchapter C, Part 58, Appendix A (typically referenced as 40 CFR Part 58, Appendix A). The formulas are reproduced in this document as Appendix A.

Results of the Analysis

EPA's current process of estimating cancer risk is based on the unit risk estimate for inhalation as discussed in the Data Handling section above. To restate, the unit cancer risk represents the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent over a lifetime at a concentration of 1 micrograms per meter cubed (µg/m3) in air [Reference 11]. Formaldehyde and acetaldehyde concentrations were measured at levels above the EPA benchmark of one in a million excess lifetime cancer risk at all Iowa sites. Comparing the 2019 averages among the five Iowa sites, formaldehyde is associated with a much higher excess lifetime cancer risk than acetaldehyde. When the calculated 2019 formaldehyde excess cancer risk is compared to acetaldehyde excess cancer risk for each of the Iowa sites, formaldehyde ranges from approximately 1.5 times greater than acetaldehyde at Chancy Park in Clinton to approximately 12 times greater than acetaldehyde at Musser Park in Muscatine.

Reviewing the results of the network sites, formaldehyde levels at Musser Park in Muscatine were the highest in the Iowa network, with 75 excess cancer risks per million, calculated using the site's annual average. Acetaldehyde levels at Chancy Park in Clinton were the highest in the network, with 13 excess cancer risks per million, calculated using the site's annual average. Musser Park in Muscatine and Chancy Park in Clinton also had the highest calculated formaldehyde and acetaldehyde excess cancer risks, respectively, for the calendar year 2018.

For formaldehyde, the 2019 calculated excess lifetime cancer risks are similar for the Cedar Rapids, Clinton and Davenport sites, ranging from 20 to 26 excess cancer risks per million. The Des Moines site was calculated at 33 excess cancer risks per million for formaldehyde. Regarding acetaldehyde, the calculated excess lifetime cancer risks were similar for Cedar Rapids, Davenport, and Des Moines sites, ranging from 2.7 to 2.9 per million. The Muscatine site was calculated at 6 excess cancer risks per million for acetaldehyde.

Formaldehyde and acetaldehyde are both primary and secondary contaminants, though about 83 percent of ambient formaldehyde and 90 percent of ambient acetaldehyde are formed by secondary reactions [Reference 12]. A primary contaminant is directly emitted into the ambient air from its source. A secondary contaminant is formed from a chemical reaction with other contaminants already present in the atmosphere from natural or anthropogenic sources. Motor vehicle emissions contribute to primary emissions by incomplete combustion of fuel; secondary formation of these contaminants results from photochemical oxidation of exhaust pipe pollutants. Secondary formation of these contaminants is enhanced in the summertime due to suitable weather conditions such as higher temperature and greater hours of sunlight. Formaldehyde is also produced in large quantities by events such as forest or brush fires [Reference 13].

In interpreting the results of the risk assessment contained in this type of report, EPA has encouraged States to compare the risks associated with toxic outdoor air pollution to other risks experienced in everyday life. The highest excess lifetime cancer risk calculated in this report is approximately 75 excess cancers per million, associated with the 2019 annual average

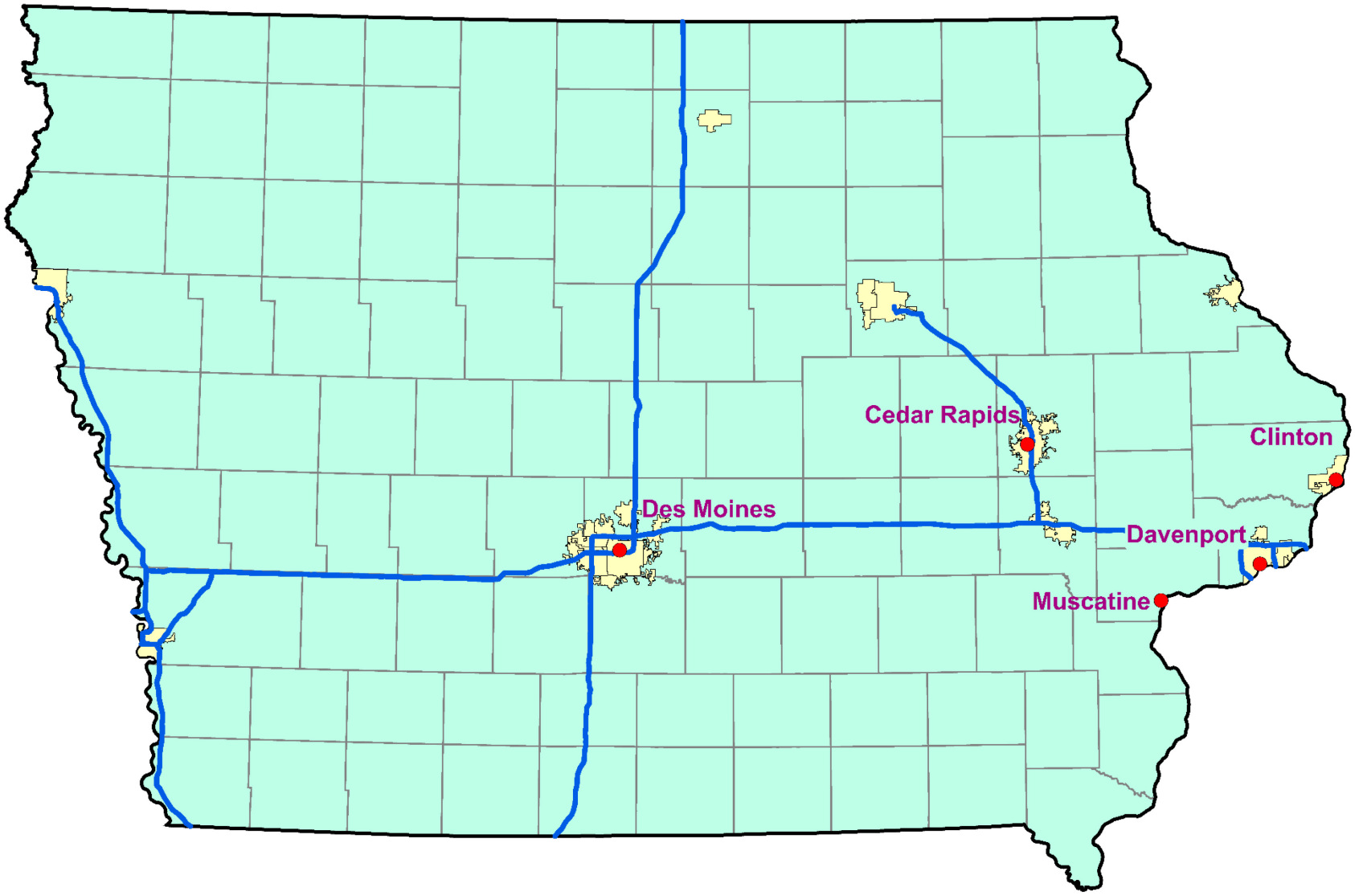
formaldehyde level in Muscatine. For comparison, according to the 2017 edition of Injury Facts published by the National Safety Council, the lifetime risk of dying in a motor vehicle accident is 8.8×10^{-3}, or approximately 116 times higher. The lifetime risk of being killed by lightning is 6.2×10^{-6}, or approximately 12 times lower than the risk of developing cancer using the Muscatine site 2019 average level of formaldehyde exposure for comparison [Reference 14].

References

1. Hyperlink is for EPA web site which provides information on federal rules regulating air toxics.
2. Hyperlink is for EPA website that lists current hazardous air pollutants.
3. Hyperlink is for EPA website discussing regulations limiting HAP emissions.
4. Hyperlink is for the EPA National Air Toxics Assessment website (2014 is the latest national assessment of health risks due to HAPs).
5. Hyperlink is for EPA website regarding National Air Toxics Trends Stations.
6. Hyperlink is for EPA website listing current NATTS sites.
7. Hyperlink is for the EPA PDF Document titled Technical Assistance Document for the NATTS Program, dated October 2016.
8. Hyperlink is for EPA 2016 power point presentation summarizing review of 2011 national air toxics assessment.
9. Hyperlink is for EPA website titled "Frequently Asked Questions for NATA".
10. Hyperlink is for EPA Integrated Risk Information System website.
11. Hyperlink is for EPA Risk Assessment for Carcinogenic Effects website.
12. Hyperlink is for documented cited as: Weinhold, Bob. "Pollution Portrait: The Fourth National-Scale Air Toxics Assessment." Environmental Health Perspective, June 2011; 119(6): A254-A257.
13. Hyperlink is for document cited as: Reinhardt TE, Ottmar RD. “Baseline Measurements of Smoke Exposure Among Wildland Firefighters.” Journal of Occupational and Environmental Hygiene, 2004 Sep; 1 (9):593-606.
14. Hyperlink is for the National Safety Council website listing the Lifetime Mortality Odds.

Iowa 2019 Air Toxics Monitoring Network

Site Location Map

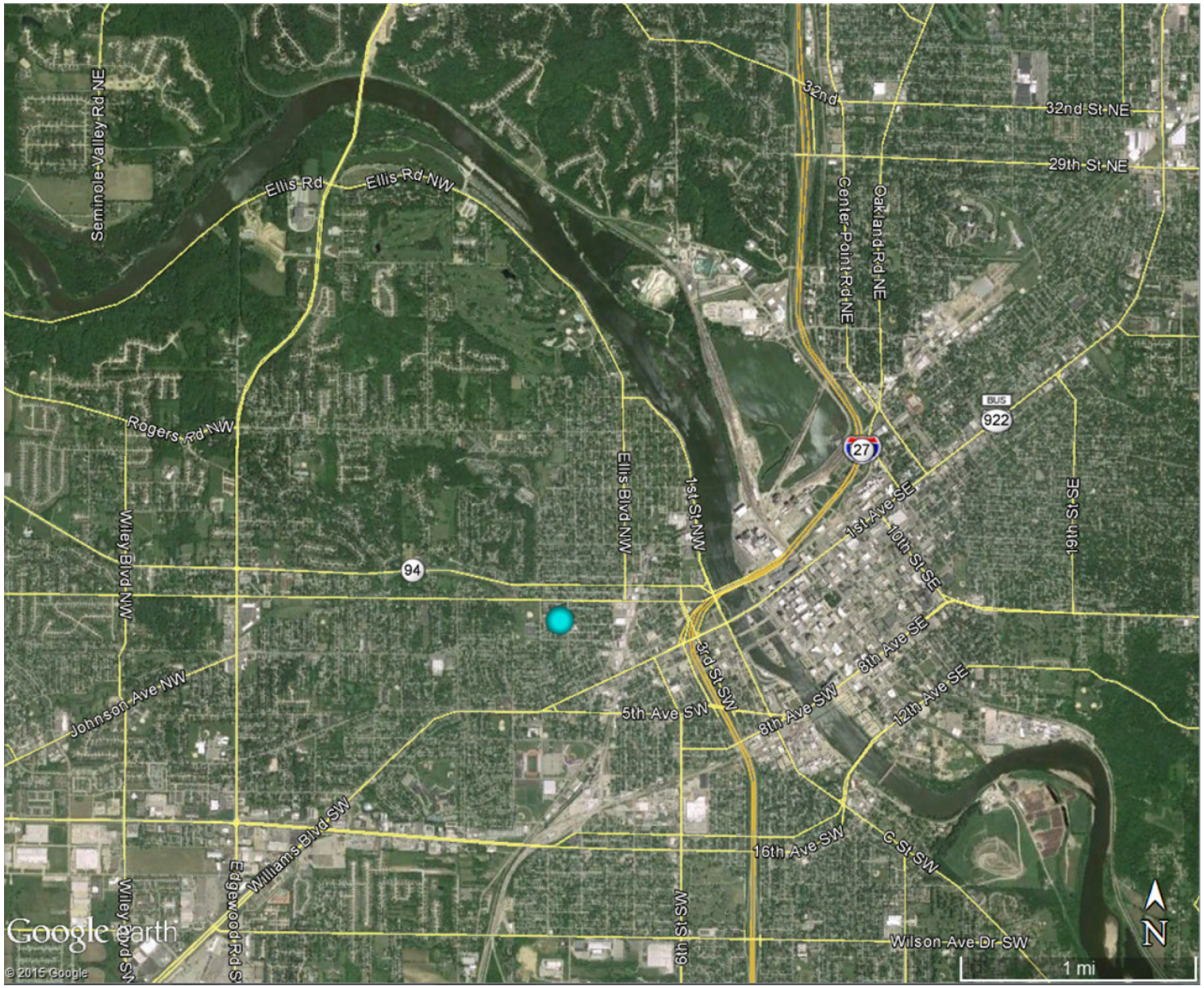


Air Toxics Monitoring Network 2019 Site Details

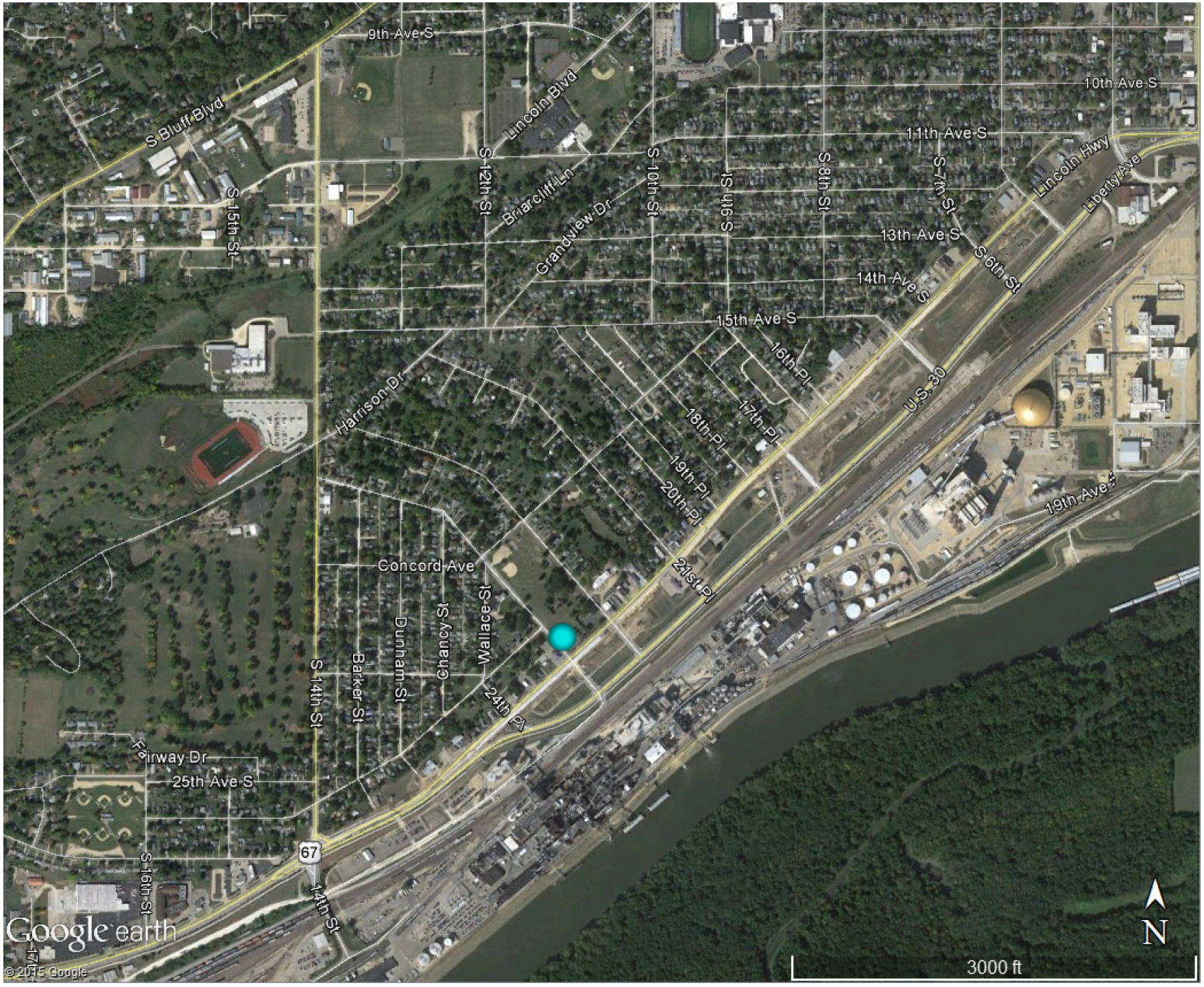
Site ID	Site Label	City	Address	County
190450019	Clinton, Chancy Park	Clinton	23rd & Camanche	Clinton
191130040	Cedar Rapids, Public Health	Cedar Rapids	500 11th St. NW	Linn
191390020	Muscatine, Musser Park	Muscatine	Oregon St. & Earl Ave.	Muscatine
191530030	Des Moines, Health Dept.	Des Moines	1907 Carpenter Ave.	Polk
191630015	Davenport, Jefferson School	Davenport	10th St. & Vine St.	Scott

Site Photos

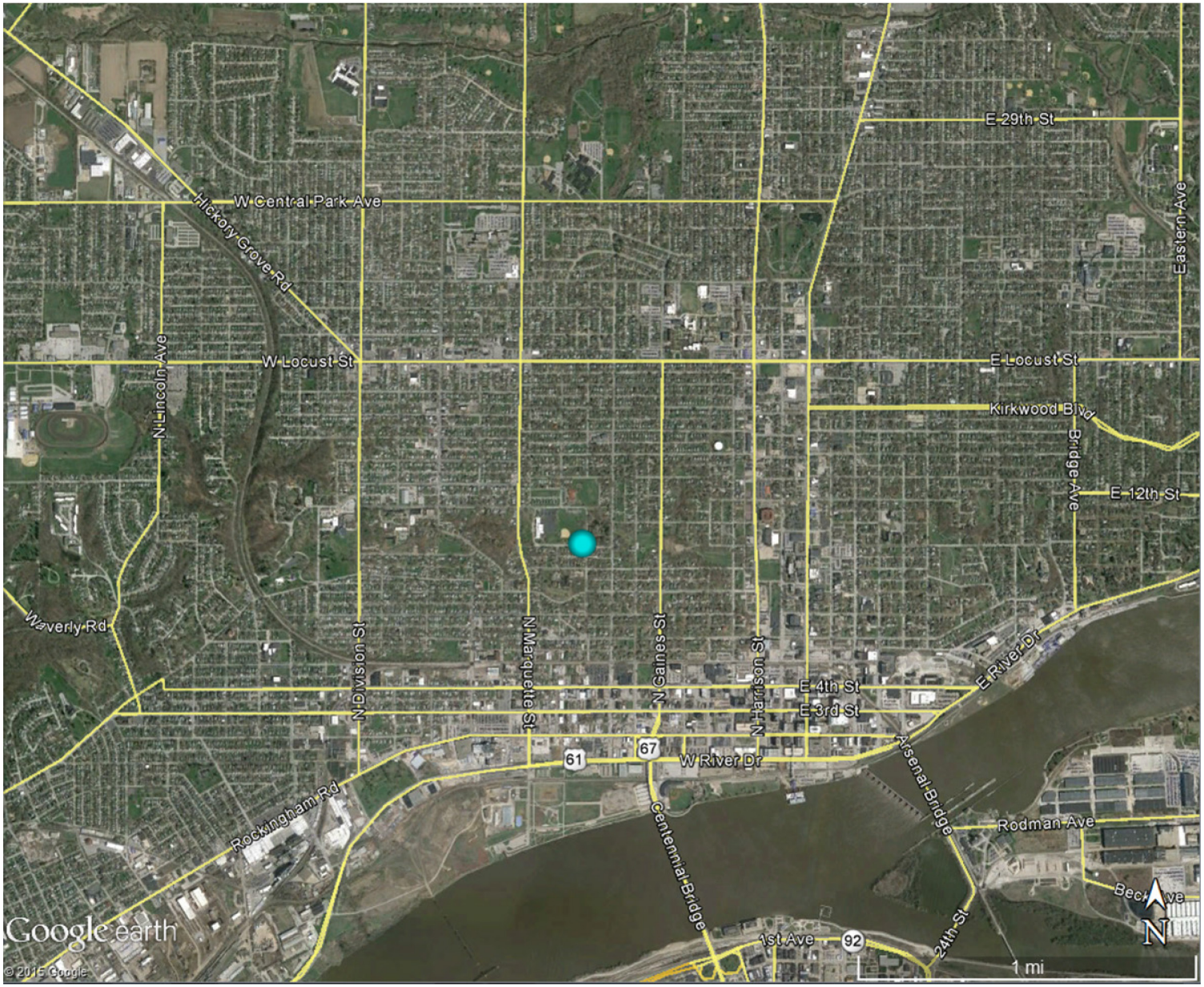
[Cedar Rapids, Public Health]



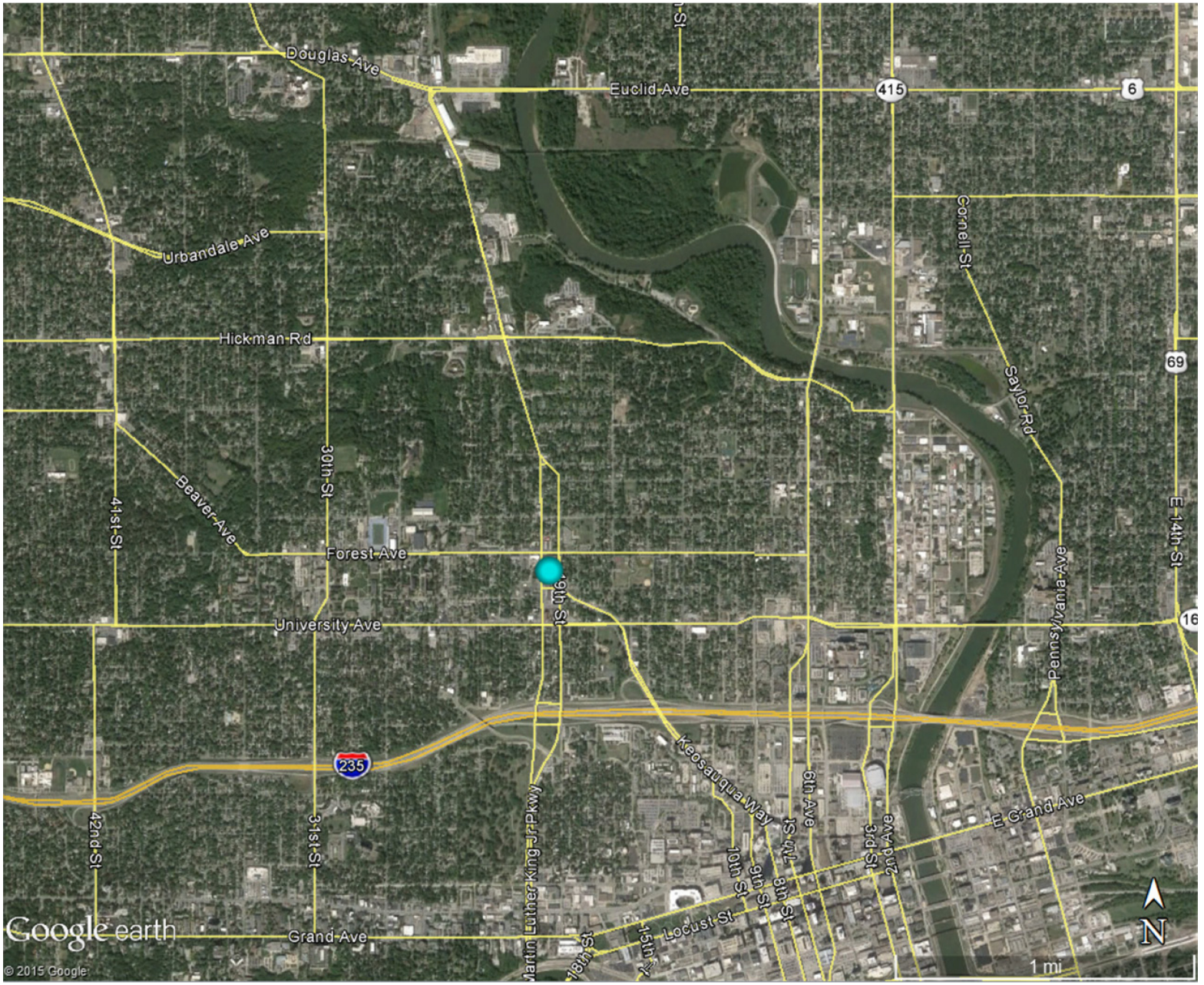
Clinton, Chancy Park



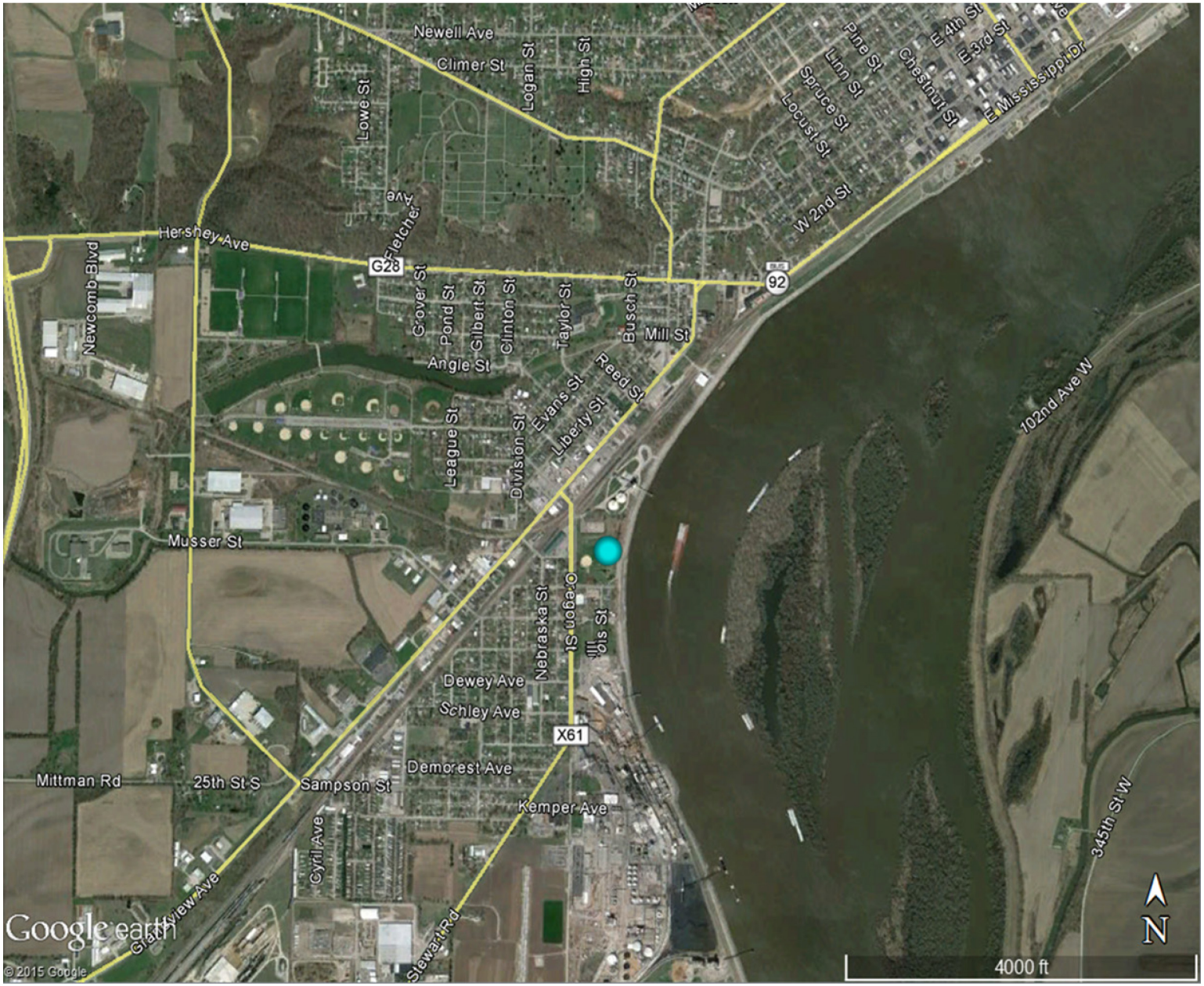
Davenport, Jefferson School



[Des Moines, Health Department]

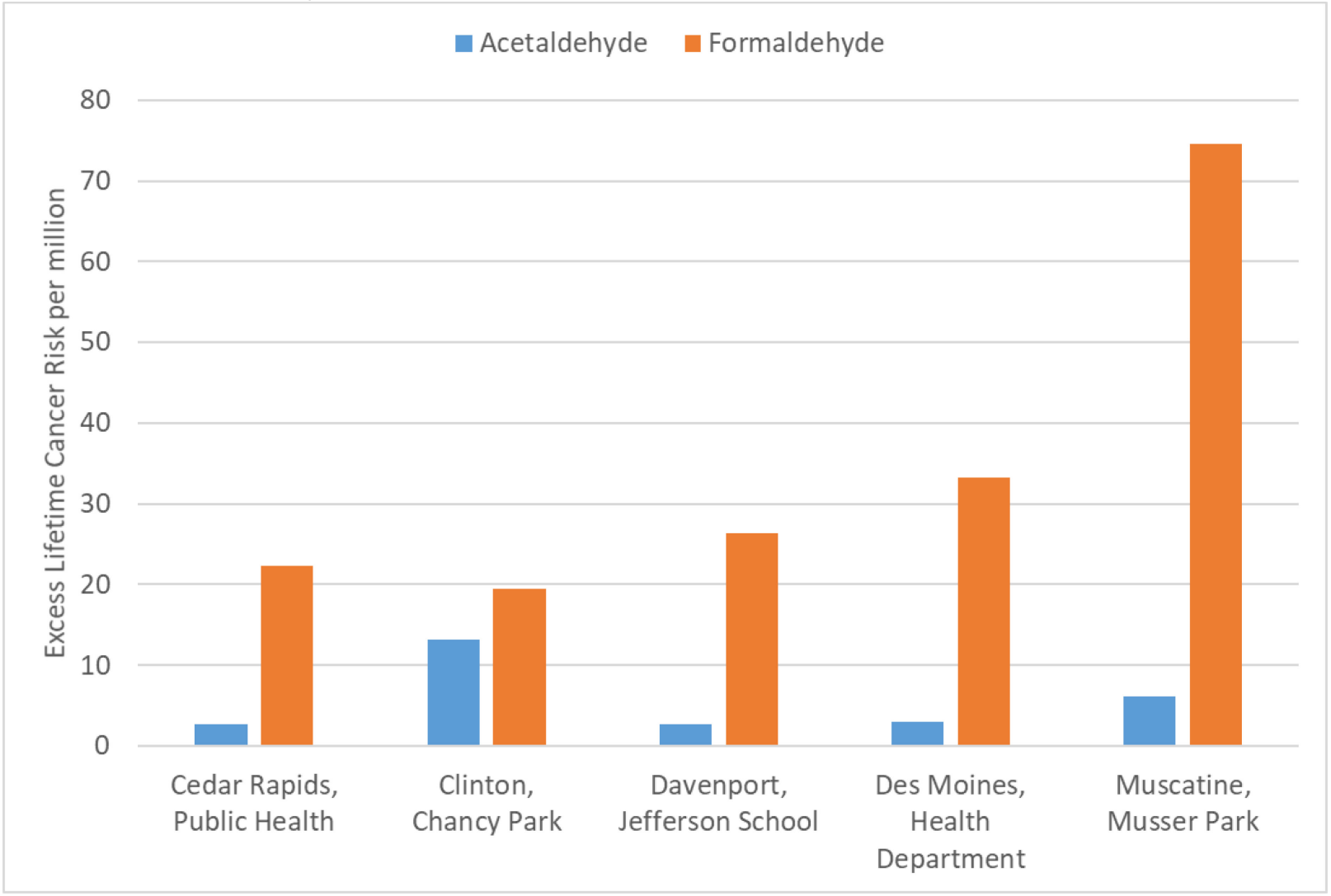


[Muscatine, Musser Park]



Annual Summary

2019 Graph of Excess Cancer Risk per Million for Iowa Sites



2019 Annual Concentration[1] (ppb)

Site / Pollutant	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson School	Des Moines, Health Dept.	Muscatine, Musser Park
Formaldehyde	1.4 (±0.3)	1.2 (±0.4)	1.6 (±0.3)	2.1 (±0.3)	4.7 (±0.7)
Acetaldehyde	0.7 (±0.1)	3.3 (±1.7)	0.7 (±0.1)	0.7 (±0.1)	1.5 (±0.4)

2019 Annual Excess Cancer Risk per Million

Site / Pollutant	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson School	Des Moines, Health Dept.	Muscatine, Musser Park
Formaldehyde	22 (±5)	20 (±6)	26 (±5)	33 (±5)	75 (±11)
Acetaldehyde	2.7 (±0.3)	13 (±7)	2.8 (±0.3)	2.9 (±0.3)	6 (±2)

2019 Annual Percent Data Capture[2]

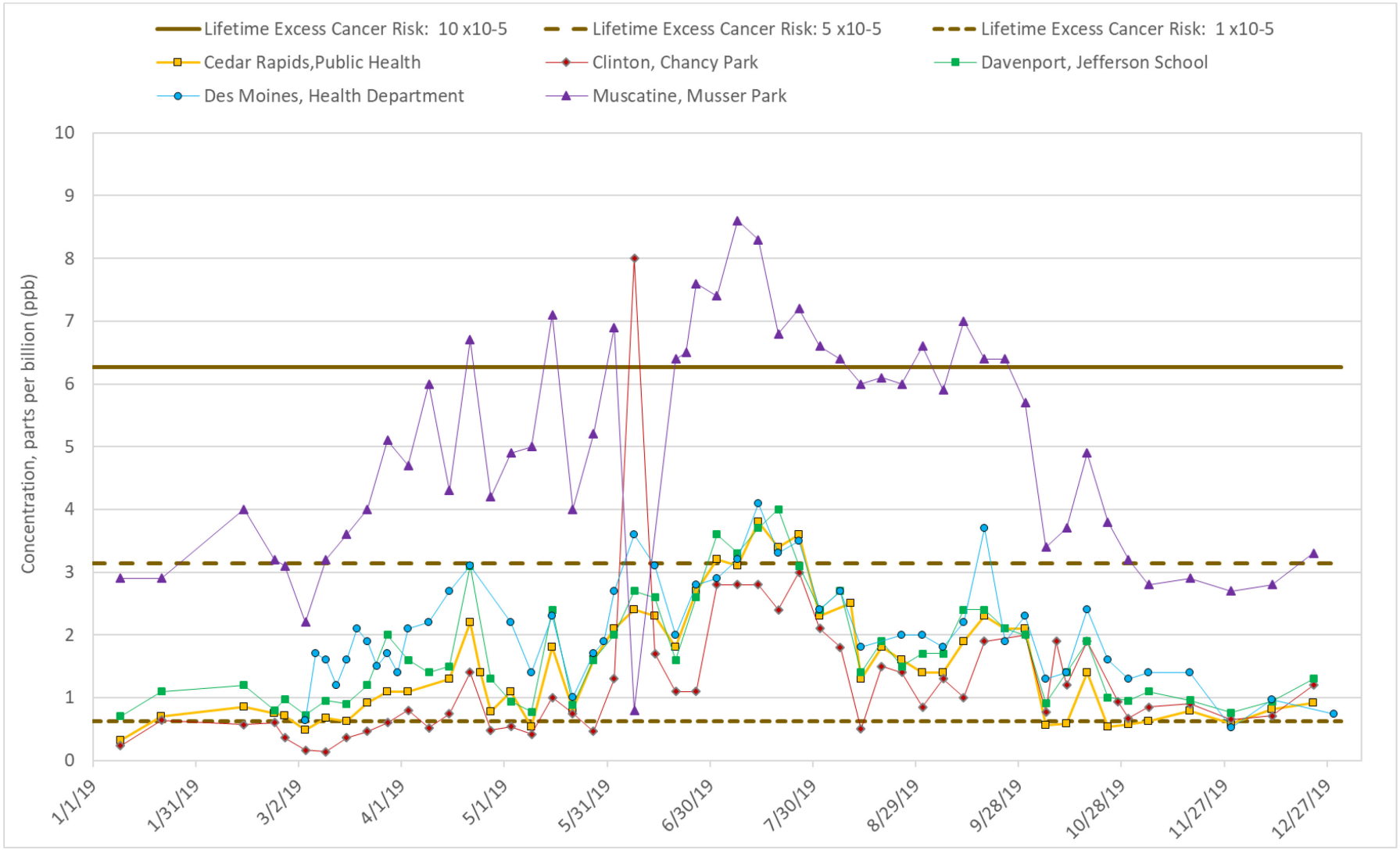
Site / Pollutant	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson School	Des Moines, Health Dept.	Muscatine, Musser Park
Formaldehyde	97%	97%	97%	80%	97%
Acetaldehyde	97%	97%	97%	80%	97%

[1]Data in the Concentration and Cancer Risk tables were averaged over 12 day blocks to prevent seasonal bias. Values listed in parentheses represent the 95% Confidence Interval for the mean.

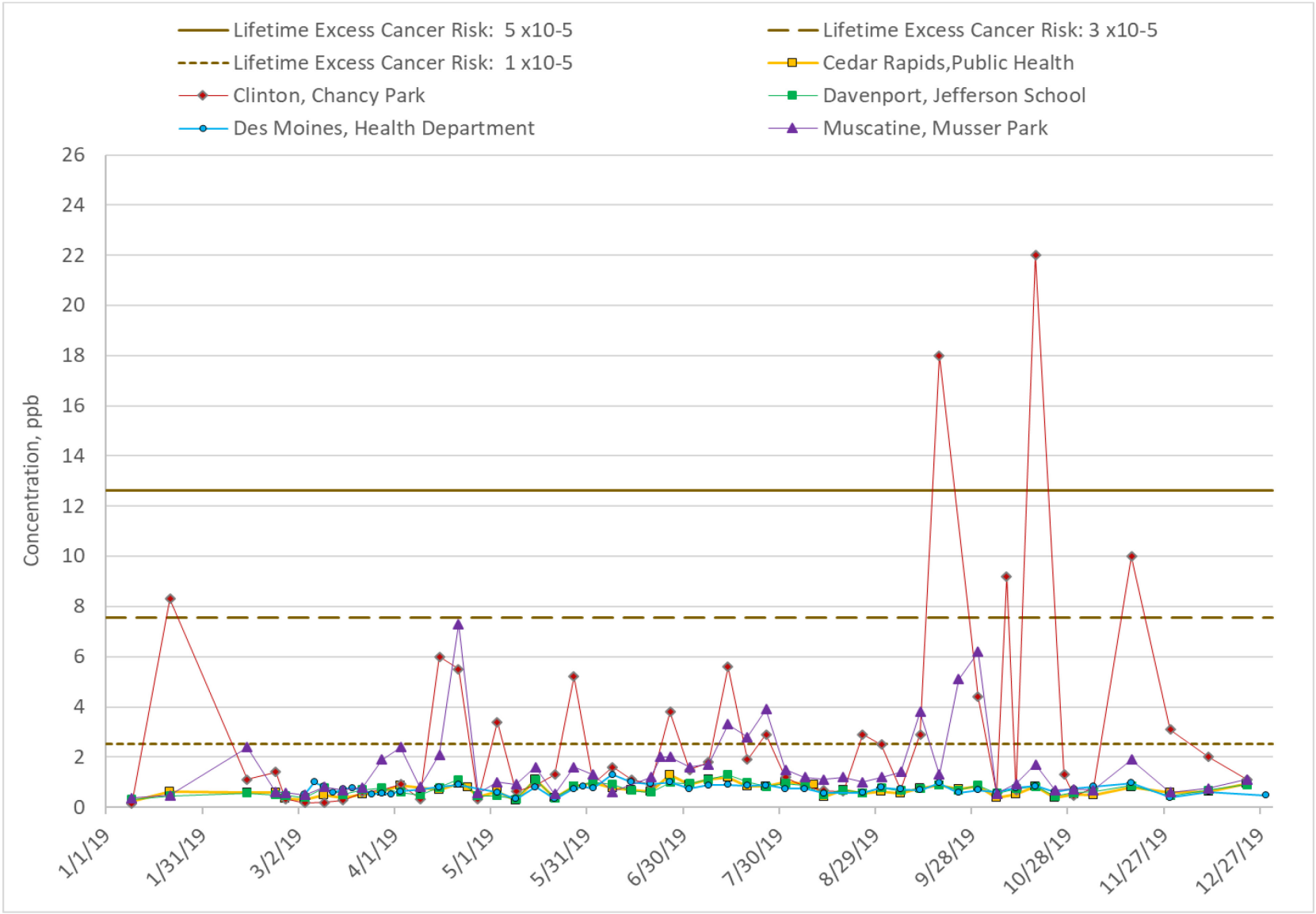
[2] Data capture indicated is the number of 12 day blocks with at least one valid sample, divided by the total number of twelve day blocks in 2019, which was 30 in 2019.

Raw Data

Graph of 2019 Formaldehyde Concentrations



Graph of 2019 Acetaldehyde Concentrations



Raw Data– 2019 Formaldehyde Concentrations (ppb)

Date	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson Sch.,	Des Moines, Health Dept.	Muscatine, Musser Park
1/9/2019	0.32	0.23	0.7		2.9
1/21/2019	0.7	0.64	1.1		2.9
2/2/2019					
2/14/2019	0.85	0.57	1.2		4
2/23/2019	0.75	0.6	0.8		3.2
2/26/2019	0.71	0.36	0.97		3.1
3/4/2019	0.48	0.16	0.72	0.64	2.2
3/7/2019				1.7	
3/10/2019	0.67	0.14	0.95	1.6	3.2
3/13/2019				1.2	
3/16/2019	0.62	0.36	0.9	1.6	3.6
3/19/2019				2.1	
3/22/2019	0.92	0.46	1.2	1.9	4
3/25/2019				1.5	
3/28/2019	1.1	0.6	2	1.7	5.1
3/31/2019				1.4	
4/3/2019	1.1	0.8	1.6	2.1	4.7
4/9/2019		0.52	1.4	2.2	6
4/15/2019	1.3	0.74	1.5	2.7	4.3
4/21/2019	2.2	1.4	3.1	3.1	6.7
4/24/2019	1.4				
4/27/2019	0.78	0.48	1.3		4.2
5/3/2019	1.1	0.54	0.94	2.2	4.9
5/9/2019	0.53	0.42	0.77	1.4	5
5/15/2019	1.8	1	2.4	2.3	7.1
5/21/2019	0.82	0.75	0.88	1	4
5/27/2019	1.6	0.46	1.6	1.7	5.2
5/30/2019				1.9	
6/2/2019	2.1	1.3	2	2.7	6.9
6/8/2019	2.4	8	2.7	3.6	0.8
6/14/2019	2.3	1.7	2.6	3.1	
6/20/2019	1.8	1.1	1.6	2	6.4
6/23/2019					6.5
6/26/2019	2.7	1.1	2.6	2.8	7.6
7/2/2019	3.2	2.8	3.6	2.9	7.4
7/8/2019	3.1	2.8	3.3	3.2	8.6
7/14/2019	3.8	2.8	3.7	4.1	8.3
7/20/2019	3.4	2.4	4	3.3	6.8
7/26/2019	3.6	3	3.1	3.5	7.2
8/1/2019	2.3	2.1	2.4	2.4	6.6

Date	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson Sch.,	Des Moines, Health Dept.	Muscatine, Musser Park
8/7/2019		1.8	2.7	2.7	6.4
8/10/2019	2.5				
8/13/2019	1.3	0.5	1.4	1.8	6
8/19/2019	1.8	1.5	1.9		6.1
8/25/2019	1.6	1.4	1.5	2	6
8/31/2019	1.4	0.85	1.7	2	6.6
9/6/2019	1.4	1.3	1.7	1.8	5.9
9/12/2019	1.9	1	2.4	2.2	7
9/18/2019	2.3	1.9	2.4	3.7	6.4
9/24/2019	2.1		2.1	1.9	6.4
9/30/2019	2.1	2	2	2.3	5.7
10/6/2019	0.56	0.77	0.91	1.3	3.4
10/9/2019		1.9			
10/12/2019	0.59	1.2	1.4	1.4	3.7
10/18/2019	1.4	1.9	1.9	2.4	4.9
10/24/2019	0.54		1	1.6	3.8
10/27/2019		0.93			
10/30/2019	0.57	0.67	0.95	1.3	3.2
11/5/2019	0.63	0.85	1.1	1.4	2.8
11/17/2019	0.79	0.9	0.96	1.4	2.9
11/29/2019	0.58	0.65	0.76	0.52	2.7
12/11/2019	0.82	0.71	0.94	0.97	2.8
12/23/2019	0.92	1.2	1.3		3.3
12/29/2019				0.74	

Raw Data– 2019 Acetaldehyde Concentrations (ppb)

Date	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson Sch.	Des Moines, Health Dept.	Muscatine, Musser Park
1/9/2019	0.23	0.16	0.31		0.37
1/21/2019	0.63	8.3	0.46		0.47
2/2/2019					
2/14/2019	0.58	1.1	0.56		2.4
2/23/2019	0.6	1.4	0.49		0.6
2/26/2019	0.34	0.33	0.48		0.57
3/4/2019	0.29	0.18	0.39	0.53	0.49
3/7/2019				1	
3/10/2019	0.49	0.2	0.77	0.82	0.81
3/13/2019				0.58	
3/16/2019	0.38	0.28	0.5	0.73	0.69
3/19/2019				0.76	
3/22/2019	0.53	0.59	0.7	0.7	0.79
3/25/2019				0.53	
3/28/2019	0.64	0.68	0.77	0.55	1.9
3/31/2019				0.53	
4/3/2019	0.87	0.92	0.59	0.64	2.4
4/9/2019		0.34	0.49	0.71	0.81
4/15/2019	0.69	6	0.79	0.81	2.1
4/21/2019	0.95	5.5	1.1	0.89	7.3
4/24/2019	0.79				
4/27/2019	0.41	0.31	0.46		0.56
5/3/2019	0.62	3.4	0.45	0.59	1
5/9/2019	0.27	0.64	0.34	0.34	0.92
5/15/2019	1.1	0.88	1.1	0.8	1.6
5/21/2019	0.39	1.3	0.36	0.34	0.52
5/27/2019	0.85	5.2	0.85	0.73	1.6
5/30/2019				0.82	
6/2/2019	0.96	0.93	1	0.75	1.3
6/8/2019	0.77	1.6	0.92	1.3	0.61
6/14/2019	0.7	1.1	0.66	1	
6/20/2019	0.64	0.9	0.6	0.93	1.2
6/23/2019					2
6/26/2019	1.3	3.8	0.98	1	2
7/2/2019	0.89	1.5	0.94	0.74	1.6
7/8/2019	1.1	1.8	1.1	0.87	1.7
7/14/2019	1.2	5.6	1.3	0.9	3.3
7/20/2019	0.84	1.9	1	0.86	2.8
7/26/2019	0.82	2.9	0.82	0.88	3.9
8/1/2019	1	1.2	0.94	0.74	1.5

Date	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson Sch.	Des Moines, Health Dept.	Muscatine, Musser Park
8/7/2019		0.82	0.86	0.74	1.2
8/10/2019	0.9				
8/13/2019	0.4	0.67	0.5	0.56	1.1
8/19/2019	0.7	0.64	0.69		1.2
8/25/2019	0.55	2.9	0.58	0.58	1
8/31/2019	0.62	2.5	0.78	0.79	1.2
9/6/2019	0.56	0.68	0.66	0.72	1.4
9/12/2019	0.76	2.9	0.73	0.69	3.8
9/18/2019	0.88	18	0.89	0.97	1.3
9/24/2019	0.73		0.68	0.58	5.1
9/30/2019	0.84	4.4	0.87	0.68	6.2
10/6/2019	0.39	0.56	0.56	0.59	0.54
10/9/2019		9.2			
10/12/2019	0.53	0.67	0.73	0.78	0.93
10/18/2019	0.82	22	0.83	0.85	1.7
10/24/2019	0.38		0.44	0.61	0.68
10/27/2019		1.3			
10/30/2019	0.51	0.45	0.58	0.73	0.72
11/5/2019	0.47	0.76	0.64	0.82	0.69
11/17/2019	0.81	10	0.86	0.97	1.9
11/29/2019	0.57	3.1	0.46	0.39	0.59
12/11/2019	0.63	2	0.68	0.62	0.76
12/23/2019	0.93	1.1	0.89		1.1
12/29/2019				0.48	

Precision Statistics

Statistic / Pollutant	Number of Pairs	Coefficient of Variation	Lower 90% Confidence Limit	Upper 90% Confidence Limit
Formaldehyde	75	1.9%	1.7%	2.2%
Acetaldehyde	75	1.5%	1.3%	1.7%

Note: These Precision Statistics are generated from duplicate sample pairs collected in 2019. Coefficient of variation and confidence limits are calculated as indicated in Appendix A.

Appendix A. Precision Calculations

Let c_i^1 and c_i^2 represent two concentrations from a particular monitoring location taken on the same day. If both are greater than the MDL, then they may be used to estimate the precision of the data at the sampling location as follows:

First compute the average:

$$\bar{c_i} = \frac{c_i^1 + c_i^2}{2}$$

And the mean difference:

$$d_i = \frac{c_i^1 - c_i^2}{\bar{c_i}} * 100$$

Define the coefficient of variation for the pair of samples as:

$$CV_i = \frac{d_i}{\sqrt{2}}$$

Compute the root mean square of the individual coefficients of variation to determine the coefficient of variation of the data at the site for the entire year:

$$CV = \sqrt{\frac{\sum_{i=1}^{n} CV_i^2}{n}}$$

Finally, compute confidence limits in the usual way:

$$\text{Lower Confidence Limit} = CV\sqrt{\frac{n}{X^{-1}(0.05,n)}}$$

$$\text{Upper Confidence Limit} = CV\sqrt{\frac{n}{X^{-1}(0.95,n)}}$$

Where X^{-1} represents the inverse of the chi-squared distribution.