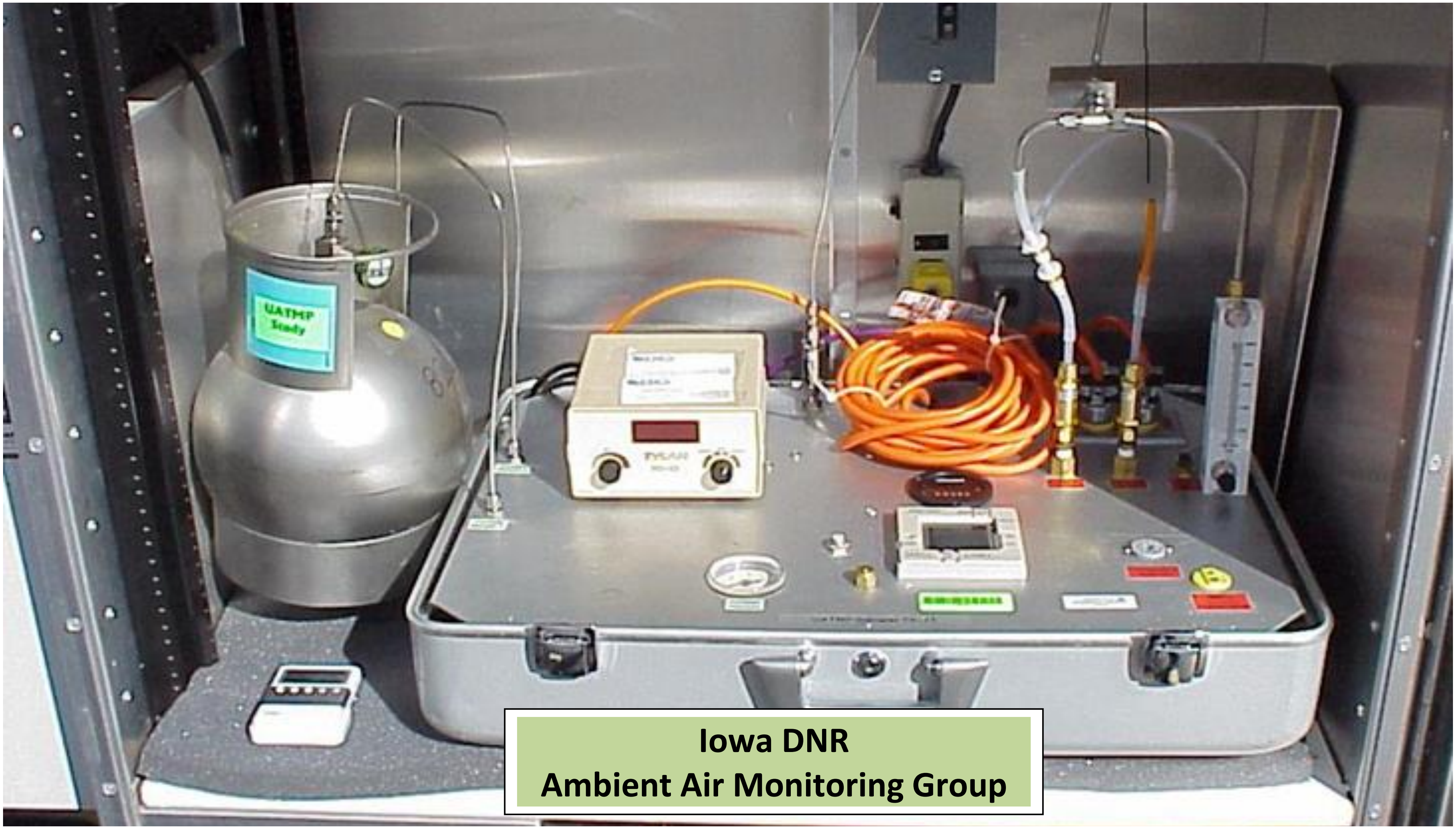
Iowa Toxics Sampling 2016

Results for Acetaldehyde and Formaldehyde



Iowa DNR
Ambient Air Monitoring Group

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Summary

Scope

Section 112 of the Clean Air Act [1] contains the federal strategy for protecting the public from air toxics emissions. The Act specifies a particular list of air toxics called "hazardous air pollutants" (HAPs) for regulatory action [2]. Emitters of large amounts of these HAPs are subject to regulations that require adoption of work practices or installation of control technologies in order to reduce HAP emissions [3]. The Act requires a periodic assessment of the residual health risk posed by the HAPs [4] and adoption of additional control standards where necessary [5].

In order to establish long term trends in HAP concentrations across the nation as a component of its residual risk assessment, the Environmental Protection Agency (EPA) has funded national air toxics trends stations (NATTS) [6]. These sites contain a standard suite of samplers and analytical protocols [7]. Unlike NATTS sites, Iowa's air toxics sites do not have instrumentation to measure toxic metals, polycyclic aromatic hydrocarbons, or black carbon.

A review of the historical air toxics monitoring dataset [8] argues that benzene, formaldehyde, 1,3-butadiene, acrolein, arsenic, hexavalent chromium, and diesel particulate pose the greatest risk to the public health on a national level. Only one of the seven national risk drivers is discussed in this report.

Sampling Schedules

Samples were gathered on a nominal schedule of one sample every twelfth day. The monitoring schedule for formaldehyde and acetaldehyde was accelerated to one in six days during ozone season (April through October). In calculations of average pollutant levels and cancer risks, samples collected on a more frequent schedule were averaged over the twelve day period between scheduled samples to estimate a one in twelve sampling schedule and avoid introduction of bias to the data.

Data Capture

For the purpose of this report, we define a valid twelve-day average as an average constructed from one or more samples collected during the scheduled twelve-day sampling period. The 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 (31). EPA data analysis guidelines usually require 75% data completeness across each sampling quarter. All Iowa sites met the 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" 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 Air Unit Cancer Risk was available in EPA's Integrated Risk Information System (IRIS) database.

Precision Data

Precision data are reported for the total number of duplicate pairs of cartridges collected. Precision statistics shown in this report have been calculated according to 40 CFR Part 58, Appendix A (2006) using the methodology applicable to collocated fine particulate data pairs. The formulas are reproduced in Appendix A.

Results of the Analysis

Formaldehyde and acetaldehyde concentrations were measured at levels above the EPA benchmark at all Iowa sites. Formaldehyde levels measured during the study period are associated with a much higher cancer risk than acetaldehyde at the Iowa sites in 2016.

IRIS specifies different levels of certainty associated with its cancer risk factors. Formaldehyde is a Class B1 carcinogen, and acetaldehyde is classified as a Class B2 carcinogen. Class B contains probable human carcinogens; Class B1 pollutants are associated with limited evidence of carcinogenicity in humans but sufficient evidence of carcinogenicity in animals, whereas a B2 classification indicates only sufficient evidence of carcinogenicity in animals [9].

A primary contaminant is directly emitted into the ambient air from its source. A secondary contaminant is formed from a chemical reaction of other contaminants already present in the atmosphere from natural or anthropogenic sources.

Formaldehyde and acetaldehyde are both primary and secondary contaminants. Motor vehicle emissions contribute to primary emissions by incomplete combustion of fuel; secondary formation results from photochemical oxidation of exhaust pipe pollutants. Secondary formation of these pollutants 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 natural events such as forest or brush fires [10]. In interpreting the results of the risk assessment contained in this type of report, EPA has encouraged States to compare the risks caused by toxic outdoor air pollution to other risks experienced in everyday life. The highest excess lifetime cancer risk identified in this report is approximately three excess cancers per 100,000 people (3×10^{-5}), associated with average formaldehyde levels at the source-oriented sites in Muscatine and Clinton. 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 as 8.8×10^{-3}, or approximately 300 times higher. The lifetime risk of being killed by lightning is 6.2×10^{-6}, or approximately 4.7 times lower than developing cancer at this level of formaldehyde exposure [11].

References

1. Federal rules regulating air toxics: http://www.epa.gov/ttn/atw/eparules.html

2. Current list of HAPs and their health effects: http://www.epa.gov/ttn/atw/hlthef/hapindex.html

3. EPA regulations limiting HAPs emissions: https://www.epa.gov/haps/reducing-emissions-hazardous-air-pollutants

4. EAP's latest national assessment of health risks due to HAPs: https://www.epa.gov/national-air-toxics-assessment

5. Residual risk assessments: http://www.epa.gov/ttn/atw/rrisk/rtrpg.html

6. Current list of NATTS sites: http://www.epa.gov/ttnamti1/files/ambient/airtox/nattsite.pdf

7. Sampling protocol used to operate NATTS sites: http://www.epa.gov/ttn/amtic/files/ambient/airtox/NATTS_Model_QAPP.pdf

8. Historical review of air toxics monitoring data: http://www.ladco.org/reports/toxics/sti/

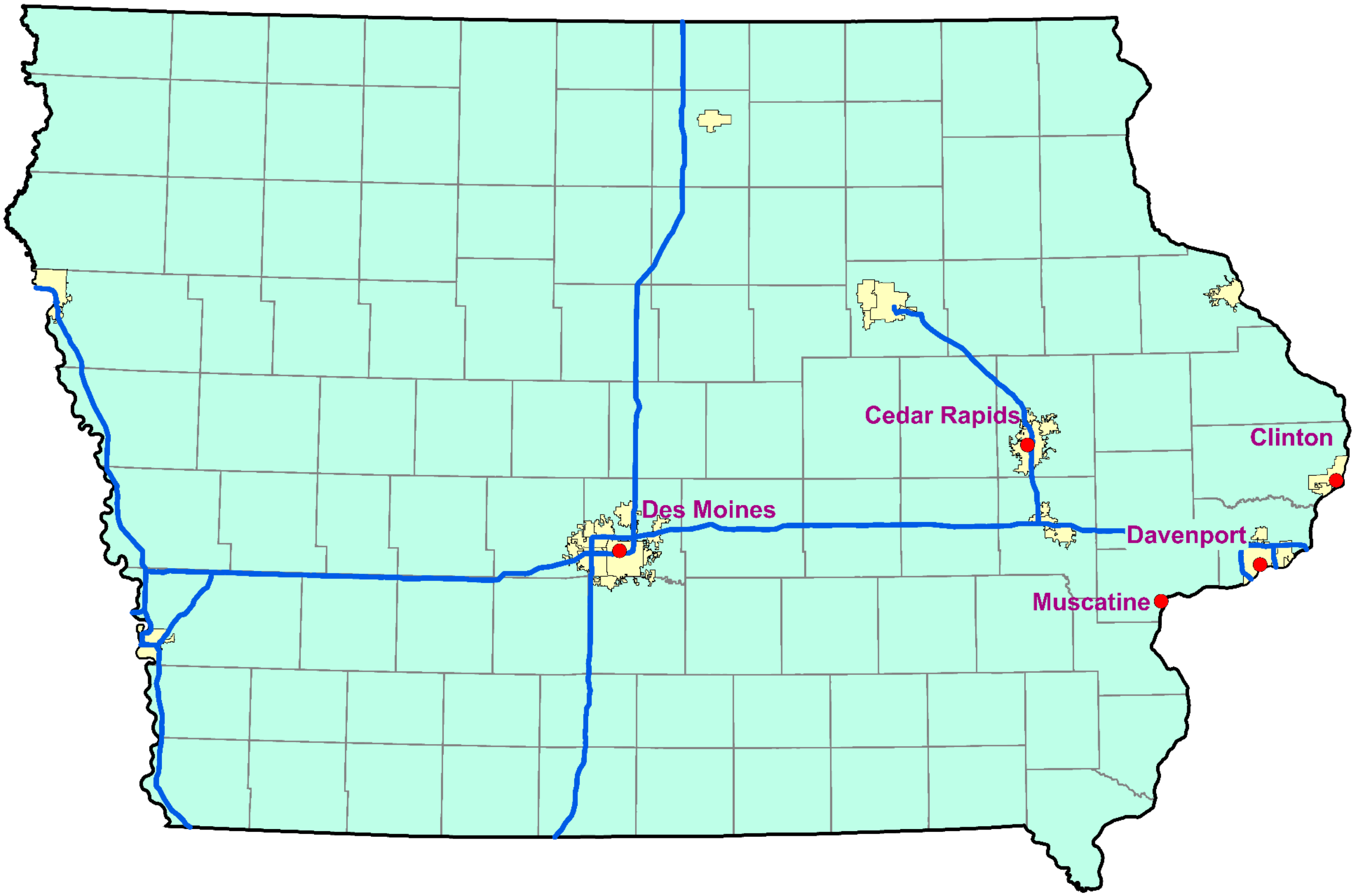
9. Integrated Risk Information System: http://www.epa.gov/iris

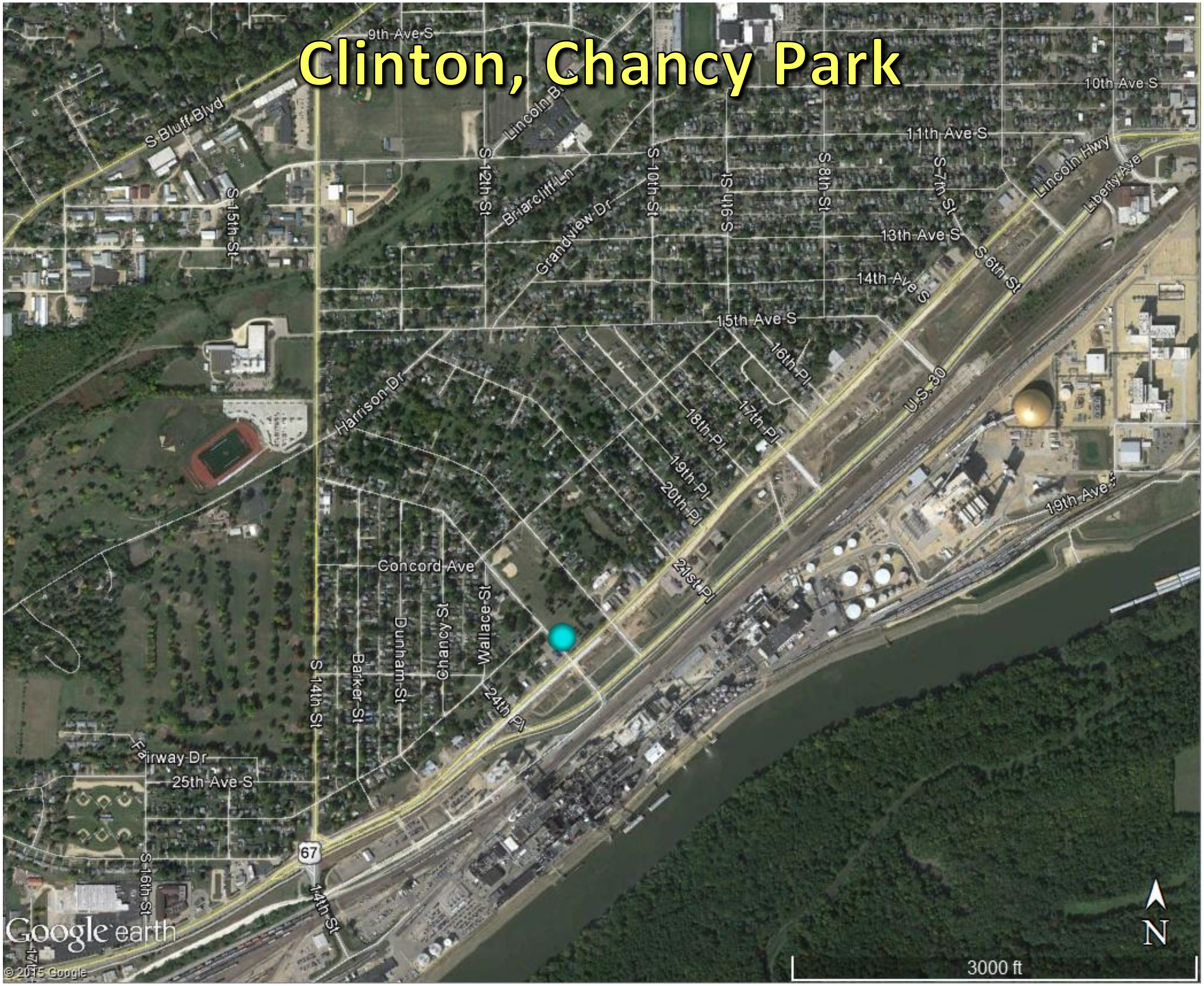
10. Reinhardt TE, Ottmar RD. "Baseline Measurements of Smoke Exposure Among Wildland Firefighters." Journal of Occupational and Environmental Hygiene 2004 Sep; 1 (9):593-606. http://www.ncbi.nlm.nih.gov/pubmed?term=Baseline%20Measurements%20of%20Smoke%20Exposure%20Among%20Wildland

11. Mortality Odds: http://www.nsc.org/learn/safety-knowledge/Pages/injury-facts-chart.aspx

Air Toxics Monitoring Network 2016				
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

Iowa 2016 Air Toxics Monitoring Network

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10th Ave S
11th Ave S
S Bluff Blvd
Lincoln Blvd
S 12th St
Briarcliff Ln
Grandview Dr
S 10th St
S 9th St
S 8th St
S 7th St
Lincoln Hwy
Liberty Ave
13th Ave S
S 6th St
14th Ave S
S 15th St
15th Ave S
16th Pl
17th Pl
18th Pl
19th Pl
20th Pl
21st Pl
U.S. 30
19th Ave S
Harrison Dr
Concord Ave
Wallace St
Chancy St
Dunham St
Barker St
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24th Pl
Fairway Dr
25th Ave S
S 16th St
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14th St
Google earth
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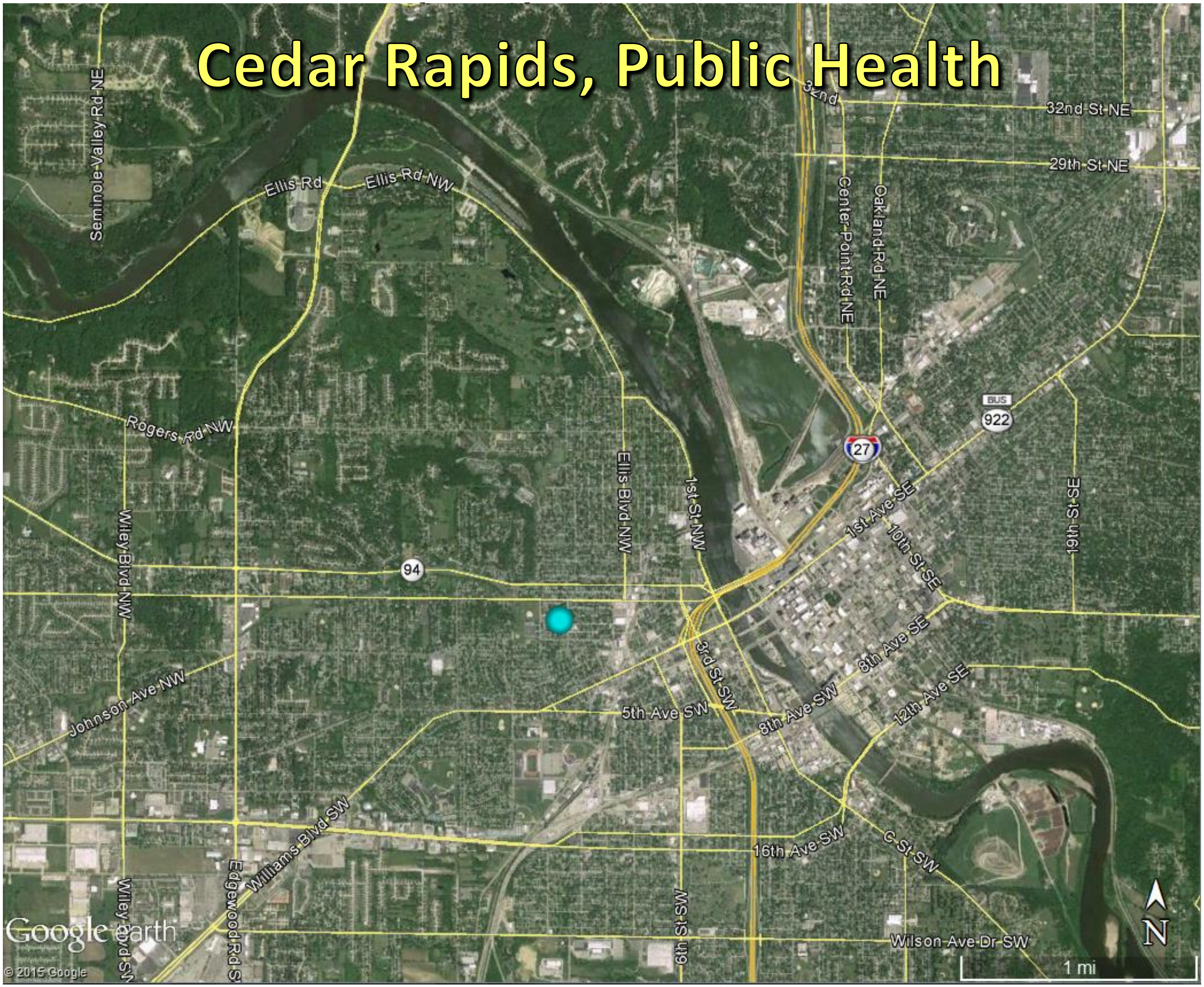
3000 ft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Seminole-Valley-Rd-NE
Ellis-Rd
Ellis-Rd-NW
32nd-St-NE
29th-St-NE
Center-Point-Rd-NE
Oakland-Rd-NE
Rogers-Rd-NW
BUS
922
27
Ellis-Blvd-NW
1st-St-NW
1st-Ave-SE
10th-St-SE
19th-St-SE
Wiley-Blvd-NW
94
3rd-St-SW
8th-Ave-SE
Johnson-Ave-NW
5th-Ave-SW
8th-Ave-SW
12th-Ave-SE
Williams-Blvd-SW
16th-Ave-SW
C-St-SW
Edgewood-Rd-S
Wiley-Blvd-SW
6th-St-SW
Wilson-Ave-Dr-SW
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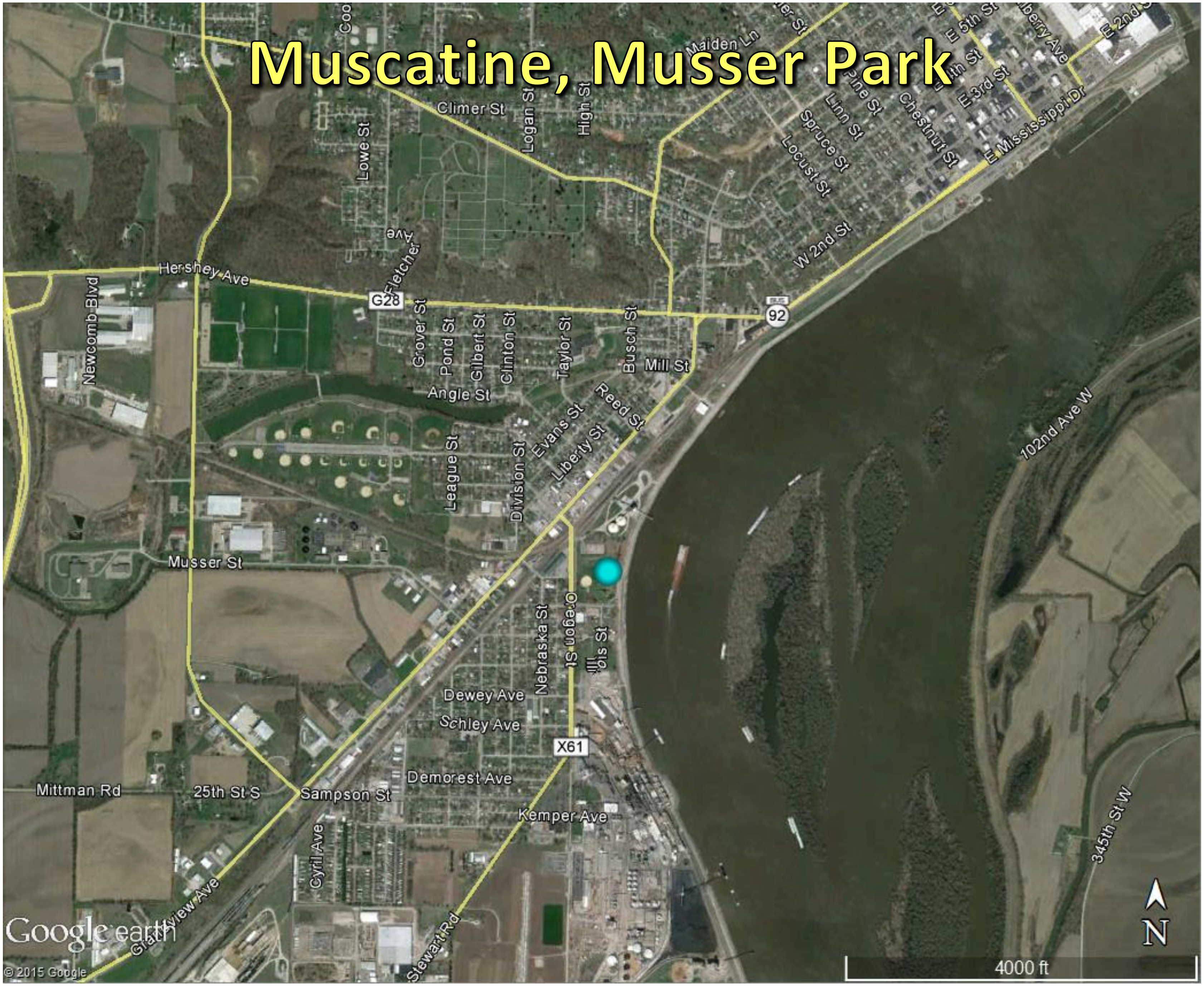
Muscatine, Musser Park
Climer St
Logan St
High St
Maiden Ln
Lowe St
Hershey Ave
G28
Fletcher Ave
Grover St
Pond St
Gilbert St
Clinton St
Taylor St
Busch St
Mill St
Angle St
Reed St
Evans St
Liberty St
League St
Division St
Newcomb Blvd
Musser St
Spruce St
Locust St
Linn St
Pine St
Chestnut St
E 3rd St
E 5th St
E Mississippi Dr
E 2nd St
W 2nd St
92
102nd Ave W
Oregon St
Nebraska St
Dewey Ave
Schley Ave
X61
Demorest Ave
Kemper Ave
Mittman Rd
25th St S
Sampson St
Cyril Ave
Stewart Rd
345th St W
Google earth
© 2015 Google
4000 ft
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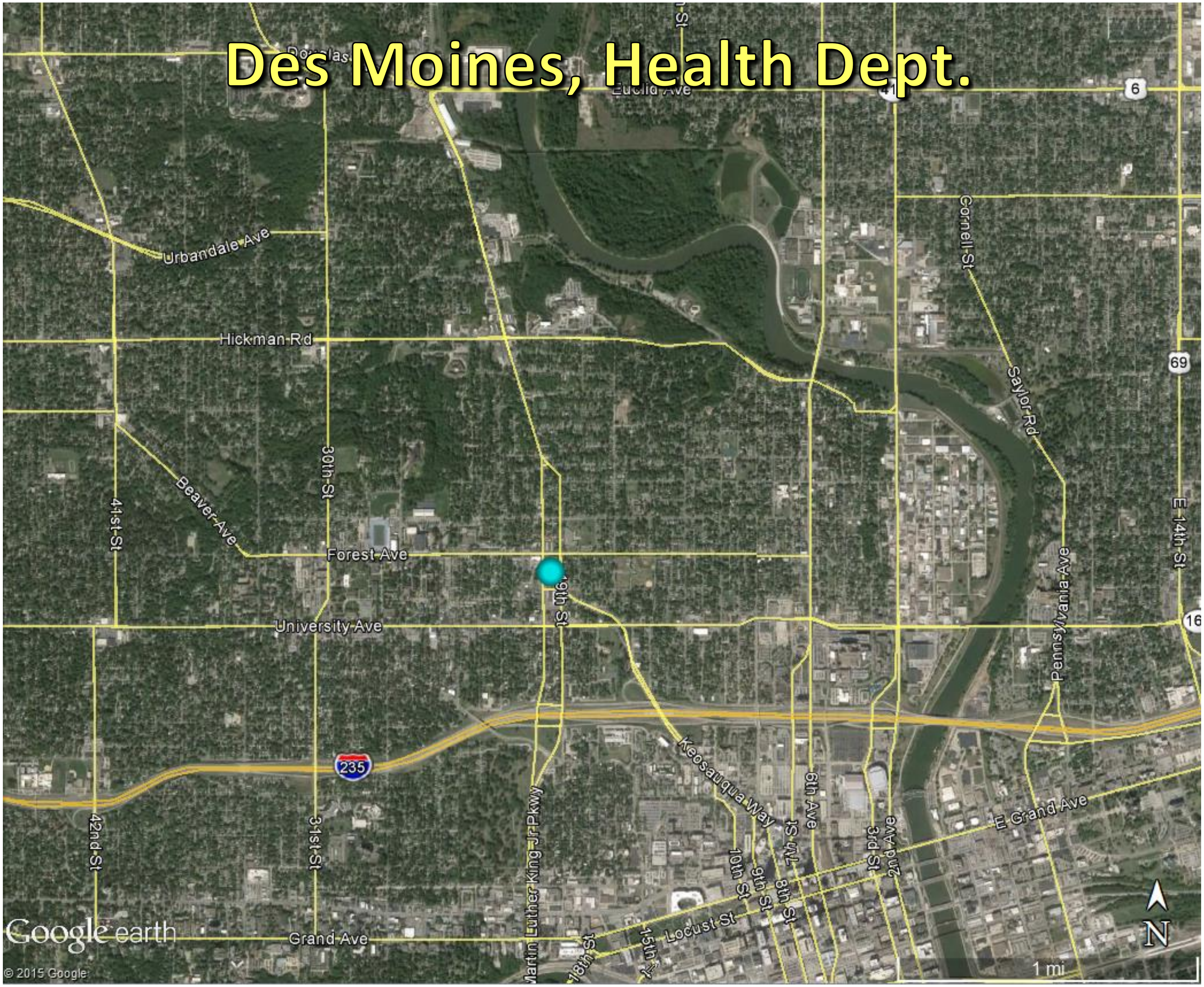
Des Moines, Health Dept.
Euclid Ave
Urbandale Ave
Hickman Rd
Cornell St
Saylor Rd
30th St
41st St
Beaver Ave
Forest Ave
19th St
University Ave
Pennsylvania Ave
E 14th St
Keosauqua Way
6th Ave
3rd St
2nd Ave
E Grand Ave
42nd St
31st St
Martin Luther King Jr Pkwy
10th St
9th St
8th St
7th St
Locust St
15th St
18th St
Grand Ave
235
6
69
16
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Davenport, Jefferson School
E 29th St
W Central Park Ave
Hickory Grove Rd
Eastern Ave
W Locust St
E Locust St
N Lincoln Ave
Kirkwood Blvd
Bridge Ave
E 12th St
Waverly Rd
N Division St
N Marquette St
N Gaines St
N Harrison St
E River Dr
E 4th St
E 3rd St
67
61
W River Dr
Arsenal Bridge
Rockingham Rd
Centennial Bridge
Rodman Ave
Beck Ave
1st Ave
92
24th St
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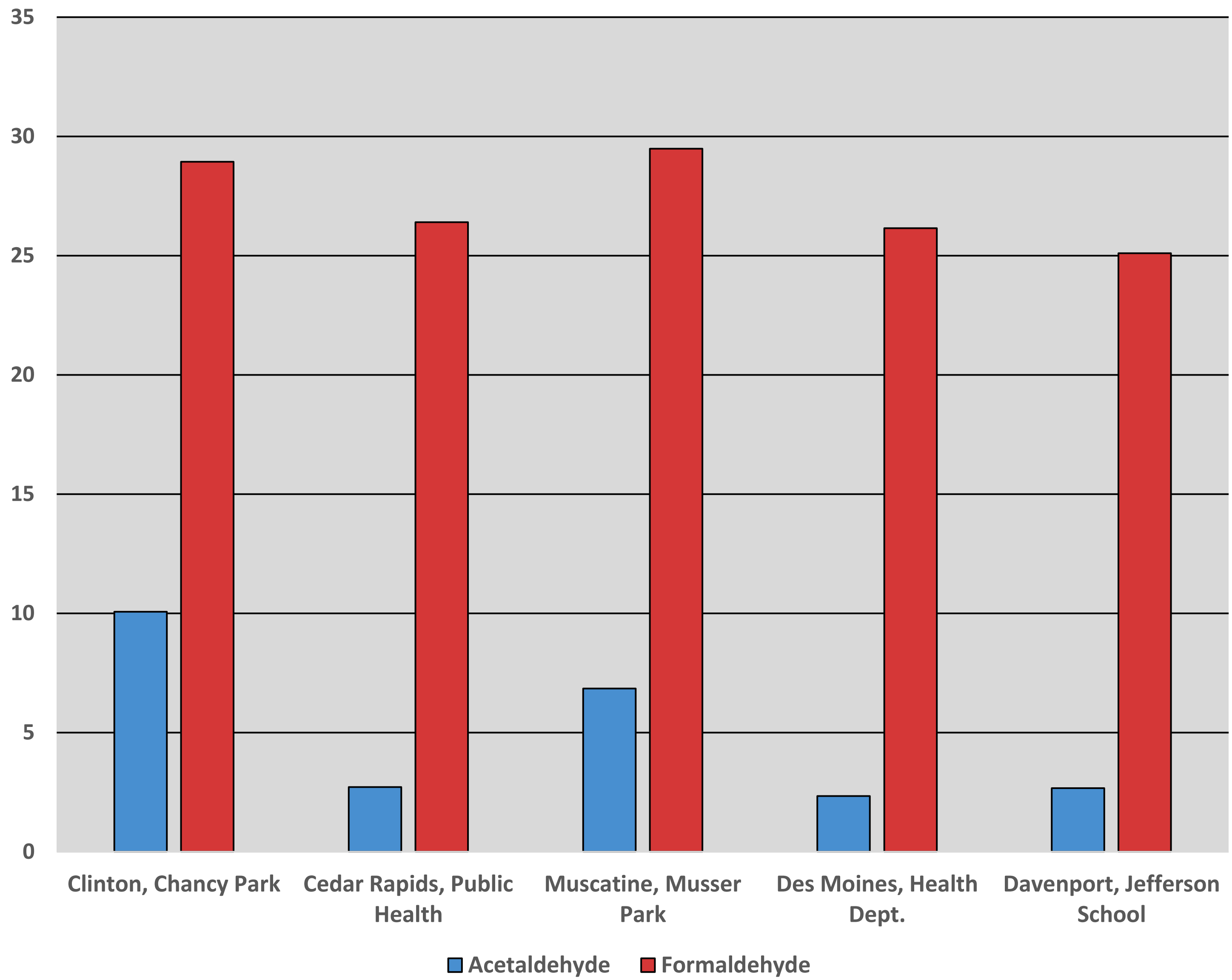
Excess Cancer Risk per Million People, Aldehydes – 2016

Site / Pollutant	Clinton, Chancy Park	Cedar Rapids, Public Health	Muscatine, Musser Park	Des Moines, Public Health	Davenport, Jefferson School
Formaldehyde	29 (±5)	26 (±5)	29 (±5)	26 (±5)	25 (±4)
Acetaldehyde	10.1 (±4.3)	2.7 (±0.4)	6.8 (±2.5)	2.3 (±0.2)	2.7 (±0.3)

Values listed in parentheses represent the 95% Confidence Interval.

Excess Cancer Risk per Million People, Aldehydes – 2016



Concentration Summary – Aldehydes (ppb)

Site / Pollutant	Clinton, Chancy Park	Cedar Rapids, Public Health	Muscatine, Musser Park	Des Moines, Public Health	Davenport, Jefferson School
Formaldehyde	**1.8 (±0.3)**	**1.7 (±0.3)**	**1.8 (±0.3)**	**1.6 (±0.3)**	**1.6 (±0.3)**
Acetaldehyde	**2.5 (±1.8)**	**0.7 (±0.1)**	**1.7 (±0.6)**	**0.6 (±0.1)**	**0.7 (±0.1)**

Notes: Values indicated are the average concentrations in parts per billion measured at each site in 2016.
Data from enhanced summer monitoring at the site were averaged to prevent seasonal bias.
Values listed in parentheses represent the 95% Confidence Interval for the mean.

Percent Data Capture

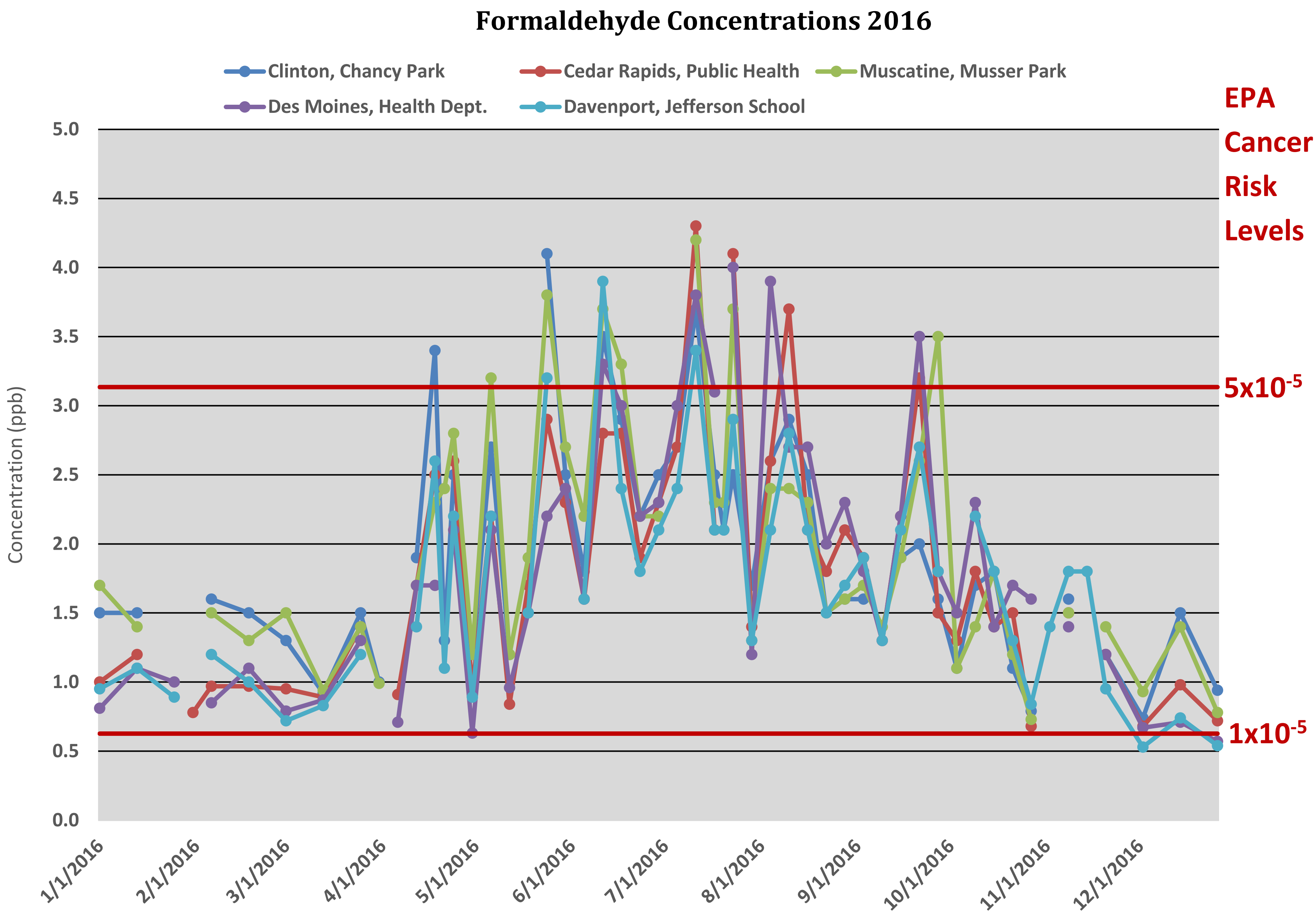
Site / Pollutant	Clinton, Chancy Park	Cedar Rapids, Public Health	Muscatine, Musser Park	Des Moines, Public Health	Davenport, Jefferson School
Formaldehyde	97%	97%	97%	100%	97%
Acetaldehyde	97%	97%	97%	100%	97%

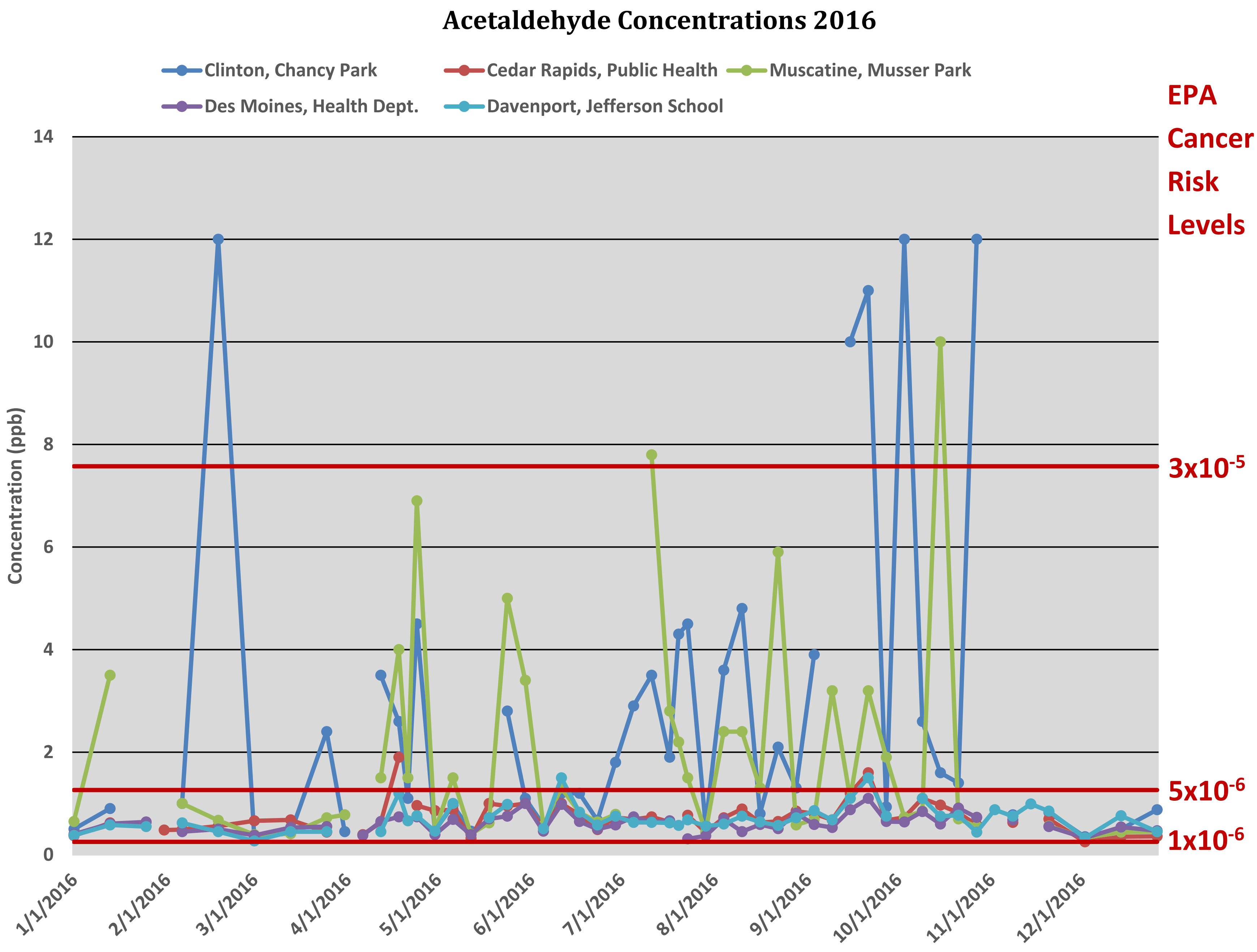
Note: Values indicated represent the number of valid samples taken relative to the scheduled number of samples at each site in 2016.

Annual Toxics Precision Statistics

Statistic / Pollutant	Number of Pairs	Coefficient of Variation	Lower 90% Confidence Limit	Upper 90% Confidence Limit
Formaldehyde	73	5.24%	4.62%	6.08%
Acetaldehyde	73	6.69%	5.90%	7.76%

Notes: Statistic generated from collocated sample pairs collected in 2016. Coefficient of variation and confidence limits were calculated according to 2006 methods in Appendix A.


Formaldehyde Concentrations 2016
Clinton, Chancy Park
Cedar Rapids, Public Health
Muscatine, Musser Park
Des Moines, Health Dept.
Davenport, Jefferson School
EPA Cancer Risk Levels
$5x10^{-5}$
$1x10^{-5}$
Concentration (ppb)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016


Acetaldehyde Concentrations 2016
Clinton, Chancy Park
Cedar Rapids, Public Health
Muscatine, Musser Park
Des Moines, Health Dept.
Davenport, Jefferson School
EPA Cancer Risk Levels
3x10-5
5x10-6
1x10-6
Concentration (ppb)
14
12
10
8
6
4
2
0
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016

Raw Data – Formaldehyde Concentration (ppb)

Date	Clinton, Chancy Park	Cedar Rapids, Public Health	Muscatine, Musser Park	Des Moines, Health Dept.	Davenport, Jefferson School
1/1/2016	1.5	1	1.7	0.81	0.95
1/13/2016	1.5	1.2	1.4	1.1	1.1
1/25/2016				1	0.89
1/31/2016		0.78			
2/6/2016	1.6	0.97	1.5	0.85	1.2
2/18/2016	1.5	0.97	1.3	1.1	1
3/1/2016	1.3	0.95	1.5	0.79	0.72
3/13/2016	0.92	0.89	0.94	0.87	0.83
3/25/2016	1.5	1.4	1.4	1.3	1.2
3/31/2016	1		0.99		
4/6/2016		0.91		0.71	
4/12/2016	1.9	1.7	1.7	1.7	1.4
4/18/2016	3.4	2.5	2.3	1.7	2.6
4/21/2016	1.3		2.4		1.1
4/24/2016	2.5	2.6	2.8	2.1	2.2
4/30/2016	1.2	0.95	1.2	0.63	0.89
5/6/2016	2.7	2.2	3.2	2.1	2.2
5/12/2016	1.2	0.84	1.2	0.96	
5/18/2016		1.7	1.9	1.5	1.5
5/24/2016	4.1	2.9	3.8	2.2	3.2
5/30/2016	2.5	2.3	2.7	2.4	
6/5/2016	1.8	1.6	2.2	1.6	1.6
6/11/2016	3.5	2.8	3.7	3.3	3.9
6/17/2016	2.9	2.8	3.3	3	2.4
6/23/2016	2.2	1.9	2.2	2.2	1.8
6/29/2016	2.5	2.3	2.2	2.3	2.1
7/5/2016	2.7	2.7		3	2.4
7/11/2016	3.7	4.3	4.2	3.8	3.4
7/17/2016	2.5	2.1	2.3	3.1	2.1
7/20/2016	2.1		2.3		2.1
7/23/2016	2.5	4.1	3.7	4	2.9
7/29/2016	1.7	1.4	1.3	1.2	1.3
8/4/2016	2.6	2.6	2.4	3.9	2.1
8/10/2016	2.9	3.7	2.4	2.7	2.8
8/16/2016	2.5	2.1	2.3	2.7	2.1
8/22/2016	1.5	1.8	1.5	2	1.5
8/28/2016	1.6	2.1	1.6	2.3	1.7
9/3/2016	1.6	1.9	1.7	1.8	1.9
9/9/2016		1.3	1.4	1.3	1.3
9/15/2016	1.9	2.2	1.9	2.2	2.1
9/21/2016	2	3.2	2.6	3.5	2.7
9/27/2016	1.6	1.5	3.5	1.8	1.8
10/3/2016	1.1	1.3	1.1	1.5	
10/9/2016	1.7	1.8	1.4	2.3	2.2
10/15/2016	1.8	1.4	1.8	1.4	1.8
10/21/2016	1.1	1.5	1.2	1.7	1.3
10/27/2016	0.79	0.68	0.73	1.6	0.84
11/2/2016					1.4
11/8/2016	1.6	1.5	1.5	1.4	1.8
11/14/2016					1.8
11/20/2016	1.2	1.2	1.4	1.2	0.95
12/2/2016	0.74	0.68	0.93	0.67	0.53
12/14/2016	1.5	0.98	1.4	0.71	0.74
12/26/2016	0.94	0.72	0.78	0.57	0.54

Raw Data – Acetaldehyde Concentration (ppb)

Date	Clinton, Chancy Park	Cedar Rapids, Public Health	Muscatine, Musser Park	Des Moines, Health Dept.	Davenport, Jefferson School
1/1/2016	0.5	0.37	0.65	0.4	0.38
1/13/2016	0.9	0.62	3.5	0.61	0.58
1/25/2016				0.64	0.55
1/31/2016		0.48			
2/6/2016	1	0.49	1	0.45	0.62
2/18/2016	12	0.56	0.67	0.5	0.45
3/1/2016	0.35	0.66	0.39	0.38	0.27
3/13/2016	0.42	0.68	0.41	0.53	0.45
3/25/2016	2.4	0.44	0.72	0.55	0.45
3/31/2016	0.45		0.78		
4/6/2016		0.39		0.38	
4/12/2016	3.5	0.63	1.5	0.65	0.45
4/18/2016	2.6	1.9	4	0.74	1.2
4/21/2016	1.1		1.5		0.66
4/24/2016	4.5	0.96	6.9	0.74	0.76
4/30/2016	0.47	0.86	0.47	0.39	0.46
5/6/2016	0.97	0.88	1.5	0.69	1
5/12/2016	0.46	0.32	0.4	0.39	
5/18/2016		1	0.62	0.7	0.72
5/24/2016	2.8	0.95	5	0.75	0.98
5/30/2016	1.1	1	3.4	1	
6/5/2016	0.58	0.53	0.57	0.46	0.51
6/11/2016	1.2	1	1.3	0.98	1.5
6/17/2016	1.2	0.78	0.83	0.65	0.83
6/23/2016	0.67	0.49	0.64	0.5	0.58
6/29/2016	1.8	0.73	0.79	0.58	0.75
7/5/2016	2.9	0.69		0.74	0.63
7/11/2016	3.5	0.74	7.8	0.64	0.63
7/17/2016	1.9	0.64	2.8	0.66	0.62
7/20/2016	4.3		2.2		0.57
7/23/2016	4.5	0.77	1.5	0.31	0.68
7/29/2016	0.57	0.44	0.45	0.37	0.56
8/4/2016	3.6	0.72	2.4	0.7	0.6
8/10/2016	4.8	0.89	2.4	0.45	0.75
8/16/2016	0.8	0.63	1.3	0.59	0.64
8/22/2016	2.1	0.65	5.9	0.51	0.57
8/28/2016	1.3	0.85	0.58	0.81	0.72
9/3/2016	3.9	0.8	0.69	0.59	0.86
9/9/2016		0.68	3.2	0.53	0.68
9/15/2016	10	1.2	1.1	0.88	1.1
9/21/2016	11	1.6	3.2	1.1	1.5
9/27/2016	0.93	0.67	1.9	0.65	0.75
10/3/2016	12	0.73	0.73	0.64	
10/9/2016	2.6	1.1	0.85	0.84	1.1
10/15/2016	1.6	0.97	10	0.6	0.75
10/21/2016	1.4	0.82	0.7	0.91	0.77
10/27/2016	12	0.58	0.55	0.73	0.44
11/2/2016					0.88
11/8/2016	0.78	0.63	0.75	0.68	0.75
11/14/2016					0.99
11/20/2016	0.83	0.7	0.56	0.55	0.85
12/2/2016	0.35	0.25	0.33	0.33	0.33
12/14/2016	0.5	0.35	0.44	0.54	0.76
12/26/2016	0.88	0.36	0.45	0.47	0.45

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:

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

And the mean difference:

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

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.