Iowa Ambient Air Monitoring
Annual Report
2008

Air Quality Bureau
Iowa Department of Natural Resources

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Iowa Ambient Air Monitoring Annual Network Report: 2008

Iowa Department of Natural Resources - Air Quality Bureau - Air Monitoring Group

Introduction

The purpose of this review is to compare ambient air monitoring data gathered in the state of Iowa during 2008 with the National Ambient Air Quality Standards (NAAQS) established by the Environmental Protection Agency (EPA). The EPA has established NAAQS for seven "criteria" pollutants: particulate matter with a diameter less than 10 microns (PM_{10}), particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$), sulfur dioxide, ozone, nitrogen dioxide, carbon monoxide, and lead. Continuous monitoring methods have been approved by EPA for all criteria pollutants except lead. Filter samplers and laboratory filter weighing procedures have been approved by EPA for both $PM_{2.5}$ and PM_{10}. All data (with the exception of carbon monoxide) summarized in this review was obtained using methods approved by EPA for comparison with the NAAQS. Carbon monoxide is monitored in Iowa with trace-level instruments that have not been approved by the EPA as a Federal Reference or Federal Equivalent Method, but have been recommended for use in quantifying low levels of carbon monoxide typical of most urban areas.

This report is divided into two parts. The first part is an executive summary, indicating where exceedances of the NAAQS were measured in Iowa during 2008. A more comprehensive review, which includes the location and summary data for each monitor in the network, is included in the second part.

Gaseous pollutant monitors (ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide) provide hourly values and operate 24 hours a day, seven days a week. Ozone monitors are operated only when ozone levels are highest, from April through October. Particulate filter samplers run for 24 hours at a time and collect one filter per day. Most PM_{10} and $PM_{2.5}$ filter based monitors are operated at a sampling frequency of one sample every third day. Some particulate monitoring sites are run at frequencies greater than this nominal frequency if they are located in highly populated areas, near pollution sources, or if pollutant levels are close to health standards. Lead was not monitored in Iowa in 2008.

Incomplete data may skew the summary statistics for a monitor. In order to alert the reader to data completeness problems, monitors that were added or removed part way through the year have been indicated by an asterisk, and data completeness statistics have been provided for each monitor. If a monitor collected all of the scheduled samples, then it has an associated data completeness of 100%. If the data capture from a monitor is insufficient to compute a valid annual average according to EPA completeness criteria, then the bar representing the comparison of the annual average to the NAAQS for that specific monitor is shaded to be lighter than the rest of the bars on the corresponding chart. In 2008 there were 25 NAAQS exceedances in the state of Iowa. All of the exceedances were associated with the $PM_{2.5}$ standard and are detailed in this report.

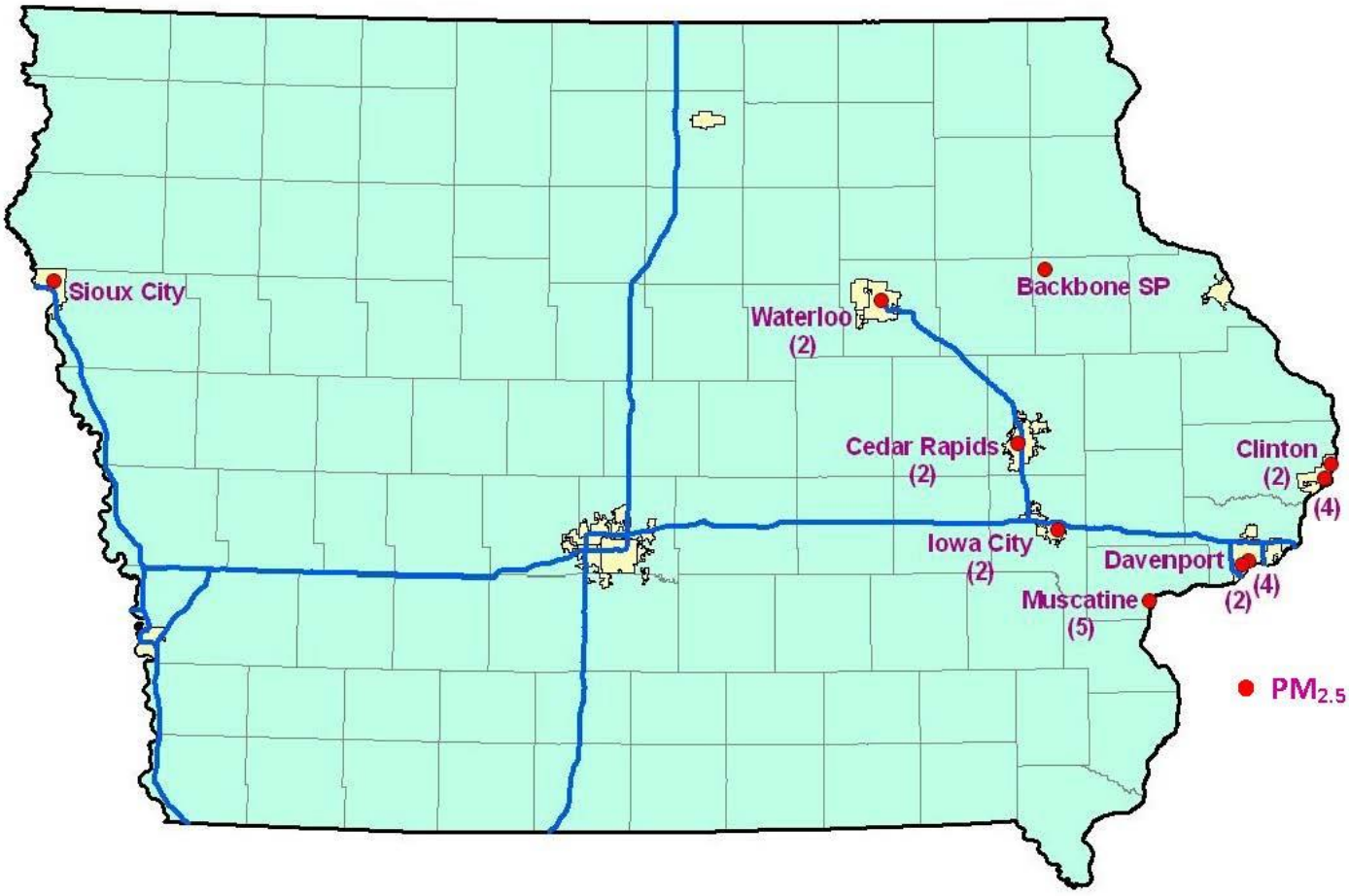
Data used to create this report were gathered by three organizations under contract with the Iowa Department of Natural Resources: the University of Iowa Hygienic Laboratory, the Linn County Public Health Department, and the Polk County Public Works Air Quality Division. Contract funds were provided by US EPA, the state of Iowa legislature, and regulated industry. Air pollution data for Iowa and all other states are available online at: http://www.epa.gov/air/data/. Additional information on the NAAQS is available at: http://www.epa.gov/air/criteria.html.

Exceedances of National Ambient Air Quality Standards (NAAQS) in Iowa

Pollutant	Averaging Period	Exceedance Level	Units	Number of Exceedances
Ozone	8hr	0.076*	ppm	0
PM 2.5	24hr	35.5	micrograms per cubic meter	25
	annual	15.05	micrograms per cubic meter	0
PM10	24hr	155	micrograms per cubic meter	0
Sulfur dioxide	3hr	0.55	ppm	0
	24hr	0.145	ppm	0
	annual	0.0305	ppm	0
Carbon monoxide	1hr	35.5	ppm	0
	8hr	9.5	ppm	0
Nitrogen dioxide	annual	0.0535	ppm	0
Lead	quarterly	1.55**	micrograms per cubic meter	N/A***

*The NAAQS for Ozone was lowered from 0.085 parts per million to 0.076 parts per million in May of 2008
**The NAAQS for Lead was lowered from 1.5 to 0.15 micrograms per cubic meter, effective 10/18/2008
***Lead was not monitored in 2008

NAAQS Exceedance Locations in Iowa Measured



$PM_{2.5}$ NAAQS Exceedances in Iowa Measured

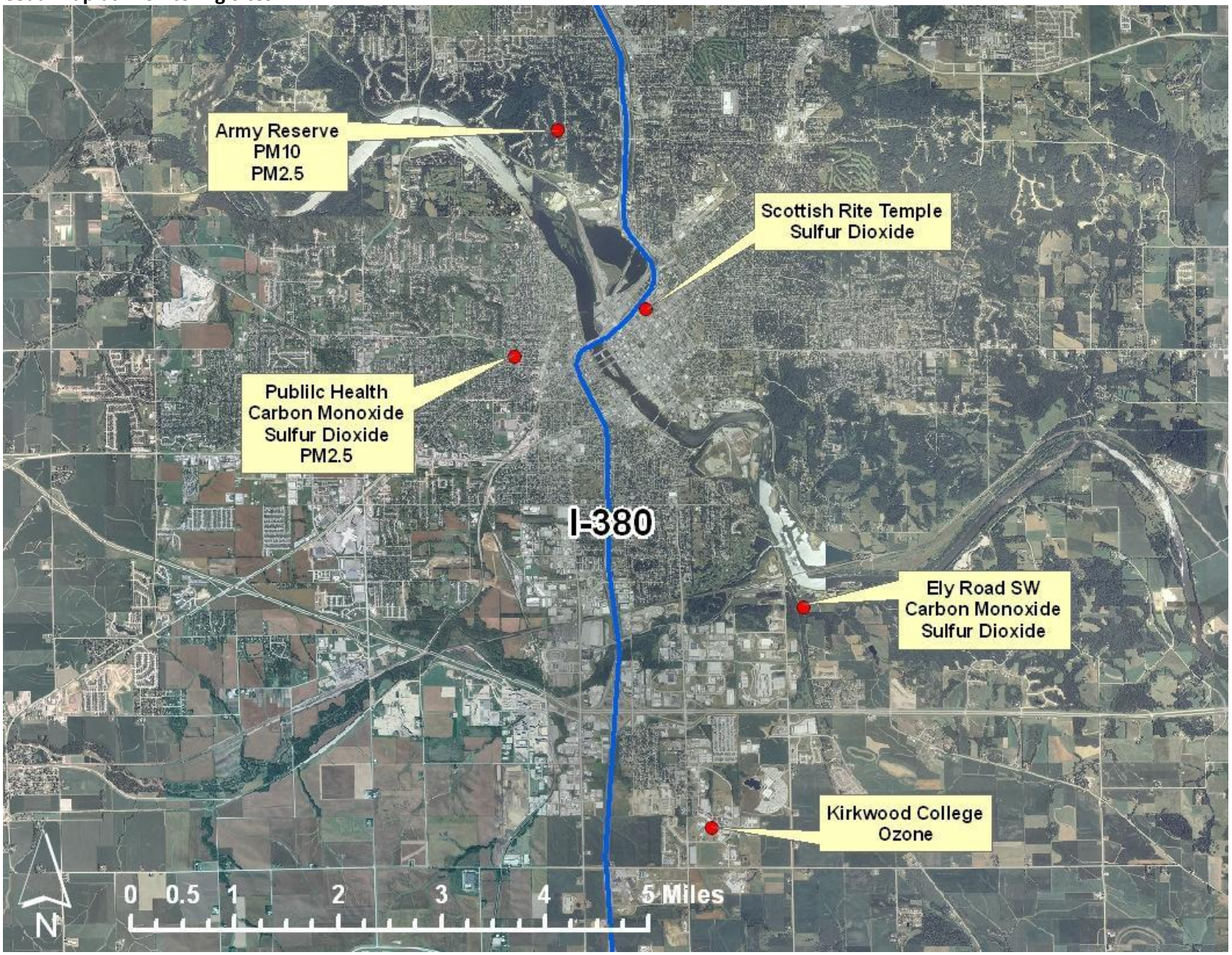
Sampling Frequency	**Daily**	**Daily**	**Daily**	**Daily**	**1 in 3**	**Daily**	**Daily**	**1 in 3**	**1 in 3**	**Daily**	
Monitoring Site	Blackhawk Foundry	Garfield Elementary	Hoover Elementary	Linn Public Health	Grout Museum	Jefferson Elementary	Chancy Park	Lowell Elementary	Backbone State Park	Rainbow Park	
Exceedance Date	Concentration (micrograms per cubic meter)										Count
1/27							36.3				1
2/3					37.5			37.6	36.8		3
2/23	46.2	48.4	43.2	41.7		43.5	50.3			50.5	7
2/24	35.5	38.5	37.8	36.3	41.2		49.3			43	7
3/11	45.8										1
4/23		35.6									1
7/4						62.3					1
9/26	36.8										1
10/22		50.7									1
10/23		45									1
12/18							35.6				1
Count	4	5	2	2	2	2	4	1	1	2	**Total= 25**

Iowa Ambient Monitoring Network
Site Locations

Site ID	Name	City	Address	County	Site Label	Pollutants
190130008	Grout Museum	Waterloo	West Park St. & South St.	Black Hawk	Waterloo, Grout Museum	PM10, PM2.5
190170011	Waverly Airport	Waverly	Waverly Airport	Bremer	Waverly, Airport	Ozone
190330018	Holnam Cement	Mason City	17th St. & Washington St.	Cerro Gordo	Mason City, Holnam Cement	PM10, SO2
190330020	Washington Sch.	Mason City	700 N. Washington Avenue	Cerro Gordo	Mason City, Washington Sch.	PM10
190450019	Chancy Park	Clinton	23rd & Camanche	Clinton	Clinton, Chancy Park	PM2.5, SO2
190450021	Rainbow Park	Clinton	Roosevelt St.	Clinton	Clinton, Rainbow Park	Ozone, PM2.5
190550001	Backbone State Park	not in a city	Fish Hatchery Backbone State Park	Delaware	Backbone State Park	PM2.5
190851101	Highway Maintenance Shed	Pisgah	1575 Hwy 183	Harrison	Pisgah, Highway Maintenance	Ozone
191032001	Hoover Elementary	Iowa City	2200 East Court	Johnson	Iowa City, Hoover Sch.	PM10, PM2.5
191110008	Fire Station	Keokuk	111S. 13th St.	Lee	Keokuk, Fire Station	PM2.5
191130028	Kirkwood College	Cedar Rapids	6301 Kirkwood Blvd SW (Iowa Hall)	Linn	Cedar Rapids, Kirkwood Coll.	Ozone
191130031	Scottish Rite Temple	Cedar Rapids	616 A Ave.	Linn	Cedar Rapids, Scottish Rite Temple	SO2
191130033	Coggon Elementary School	Coggon	408 E Linn St.	Linn	Coggon, Coggon Elementary School	Ozone
191130037	Army Reserve Center	Cedar Rapids	1599 Wenig Rd. NE	Linn	Cedar Rapids, Army Reserve	PM10, PM2.5
191130038	Ely Rd. SW	Cedar Rapids	Ely Rd. SW	Linn	Cedar Rapids, Ely Rd. SW	CO, SO2
191130040	Public Health	Cedar Rapids	500 11th St. NW	Linn	Cedar Rapids, Public Health	CO, PM2.5, SO2
191370002	Viking Lake State Park	not in a city	2780 Viking Lake Road	Montgomery	Viking Lake State Park	Ozone, PM10, PM2.5
191390015	Garfield School	Muscatine	1409 Wisconsin	Muscatine	Muscatine, Garfield Sch.	PM10, PM2.5
191390020	Musser Park	Muscatine	Oregon St. & Earl Ave.	Muscatine	Muscatine, Musser Park	SO2
191471002	Iowa Lakes College	Emmetsburg	Iowa Lakes Community College - S Camp	Palo Alto	Emmetsburg, Iowa Lakes Coll.	Ozone, PM10, PM2.5
191530030	Public Health Bldg.	Des Moines	1907 Carpenter	Polk	Des Moines, Public Health Bldg.	CO, NO2, Ozone, PM10, PM2.5, SO2
191532510	Indian Hills Junior High	Clive	9401 Indian Hills	Polk	Clive, Indian Hills Sch.	PM10, PM2.5
191550009	Franklin Elementary	Council Bluffs	3130 C Ave.	Pottawattamie	Council Bluffs, Franklin Sch.	PM10, PM2.5

Site ID	Name	City	Address	County	Site Label	Pollutants
191630014	Scott County Park	Davenport	Scott County Park	Scott	Scott County Park	Ozone
191630015	Jefferson Elementary	Davenport	10th St. & Vine St.	Scott	Davenport, Jefferson Sch.	CO, NO2, Ozone, PM10, PM2.5, SO2
191630017	Linwood Mining	Buffalo	11100 110th Ave.	Scott	Buffalo, LW Mining	PM10
191630018	Adams Elementary	Davenport	3029 N Division St.	Scott	Davenport, Adams Sch.	PM10, PM2.5
191630019	Black Hawk Foundry	Davenport	300 Wellman St.	Scott	Davenport, BH Foundry	PM10, PM2.5
191690011	Slater Elementary	Slater	505 Linn St.	Story	Slater, Slater Sch.	Ozone
191770006	Lake Sugema	not in a city	24430 Lacey Trl, Keosauqua Lake Sugema	Van Buren	Keosauqua, Lake Sugema	Ozone, PM10, PM2.5, SO2
191810022	Lake Ahquabi State Park	not in a city	1650 118th Ave.	Warren	Lake Ahquabi State Park	Ozone
191930017	Lowell Elementary	Sioux City	27th at Morgan	Woodbury	Sioux City, Lowell Sch.	PM10, PM2.5
191970004	Jannsen Farm	Clarion	Jannsen Farm	Wright	Clarion, Jannsen Farm	PM2.5

Monitoring Site Locations
Cedar Rapids Monitoring Sites



Davenport Monitoring Sites

Des Moines/Clive Monitoring Sites

Site Changes

Sites Removed at the End of 2007

Site	Name	City	County	Site Label	Start Date	End Date	Pollutants
191130029	Science Station	Cedar Rapids	Linn	Cedar Rapids, Science Station	-	12/31/2007	SO_2
191390016	Greenwood Cemetery	Muscatine	Muscatine	Muscatine, Greenwood Cemetery	-	12/31/2007	SO_2
191390017	Muscatine Power & Water	Muscatine	Muscatine	Muscatine, Power and Water	-	12/31/2007	SO_2
191530059	National By-Products	Des Moines	Polk	Des Moines, Nat. By-Products	-	12/23/2007	PM2.5

Monitors Removed During 2008

Site	Name	City	County	Site Label	Start Date	End Date	Pollutants
191130038	Ely Rd. SW	Linn	Cedar Rapids	Cedar Rapids, Ely Rd. SW*	-	3/31/2008	SO_2
191130038	Ely Rd. SW	Linn	Cedar Rapids	Cedar Rapids, Ely Rd. SW*	-	3/31/2008	CO

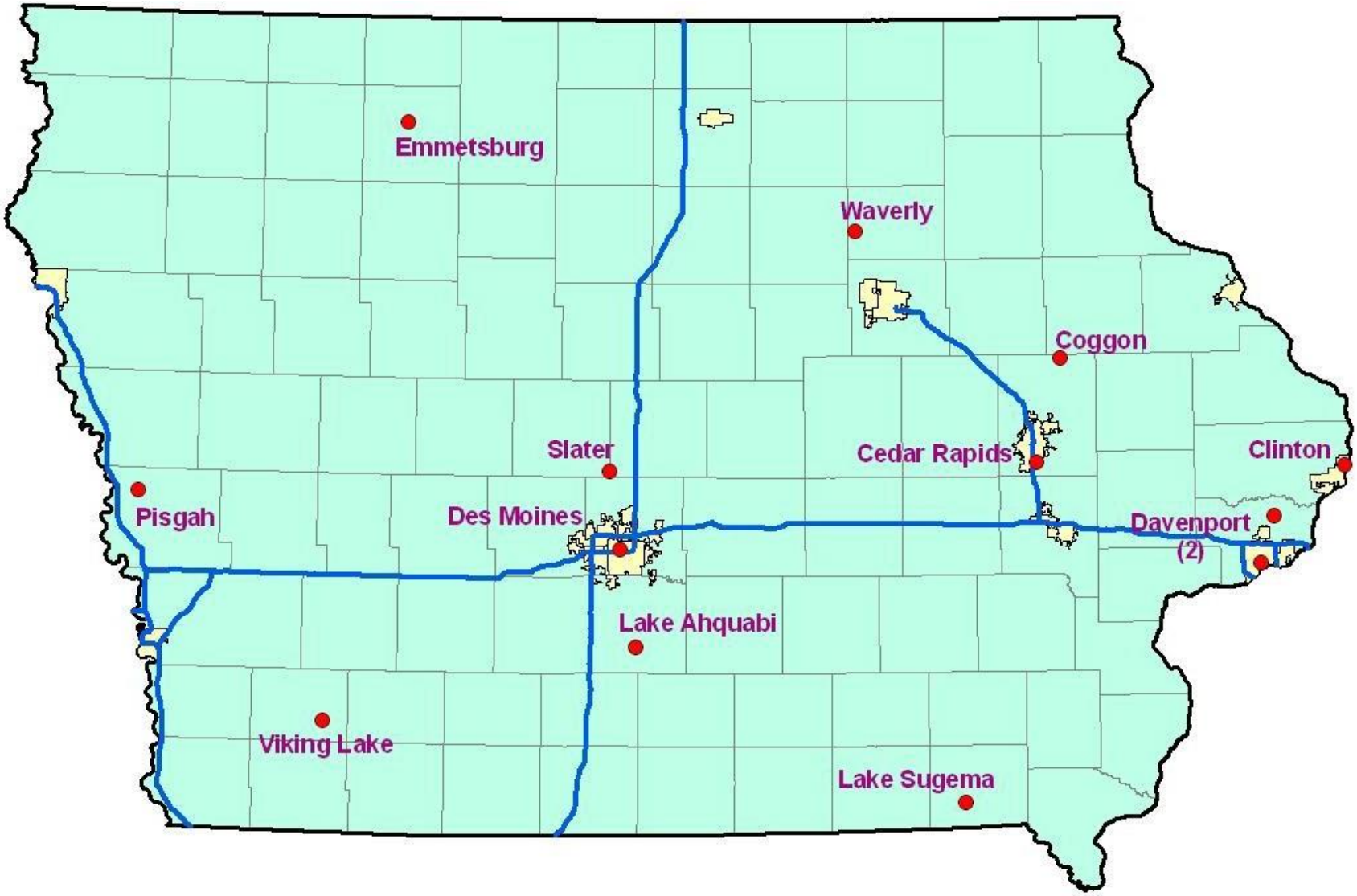
Monitors Added During 2008

Site	Name	City	County	Site Label	Start Date	End Date	Pollutants
191130040	Public Health	Cedar Rapids	Linn	Cedar Rapids, Public Health	1/15/2008	-	PM2.5
191130040	Public Health	Cedar Rapids	Linn	Cedar Rapids, Public Health	4/11/2008	-	SO_2
191130040	Public Health	Cedar Rapids	Linn	Cedar Rapids, Public Health	4/11/2008	-	CO
191032001	Hoover Elementary	Iowa City	Johnson	Iowa City, Hoover Sch.	1/1/2008	-	PM_{10}

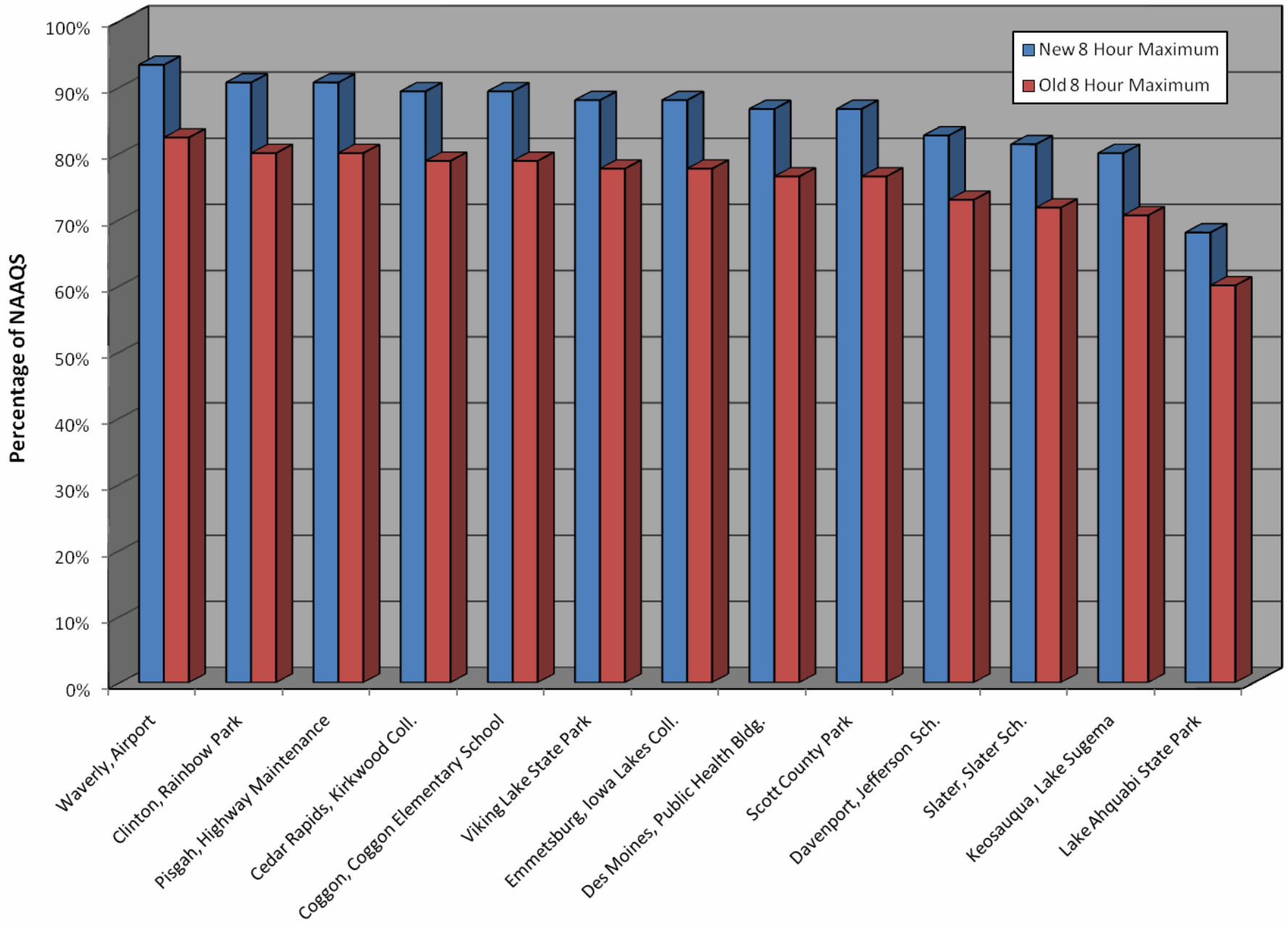
Ozone Monitoring Sites
Site Locations

Site	Name	City	County	Site Label
190170011	Waverly Airport	Waverly	Bremer	Waverly, Airport
190450021	Rainbow Park	Clinton	Clinton	Clinton, Rainbow Park
190851101	Highway Maintenance Shed	Pisgah	Harrison	Pisgah, Highway Maintenance
191130028	Kirkwood College	Cedar Rapids	Linn	Cedar Rapids, Kirkwood Coll.
191130033	Coggon Elementary School	Coggon	Linn	Coggon, Coggon Elementary School
191370002	Viking Lake State Park	not in a city	Montgomery	Viking Lake State Park
191471002	Iowa Lakes College	Emmetsburg	Palo Alto	Emmetsburg, Iowa Lakes Coll.
191530030	Public Health Bldg.	Des Moines	Polk	Des Moines, Public Health Bldg.
191630014	Scott County Park	Davenport	Scott	Scott County Park
191630015	Jefferson Elementary	Davenport	Scott	Davenport, Jefferson Sch.
191690011	Slater Elementary	Slater	Story	Slater, Slater Sch.
191770006	Lake Sugema	not in a city	Van Buren	Keosauqua, Lake Sugema
191810022	Lake Ahquabi State Park	not in a city	Warren	Lake Ahquabi State Park

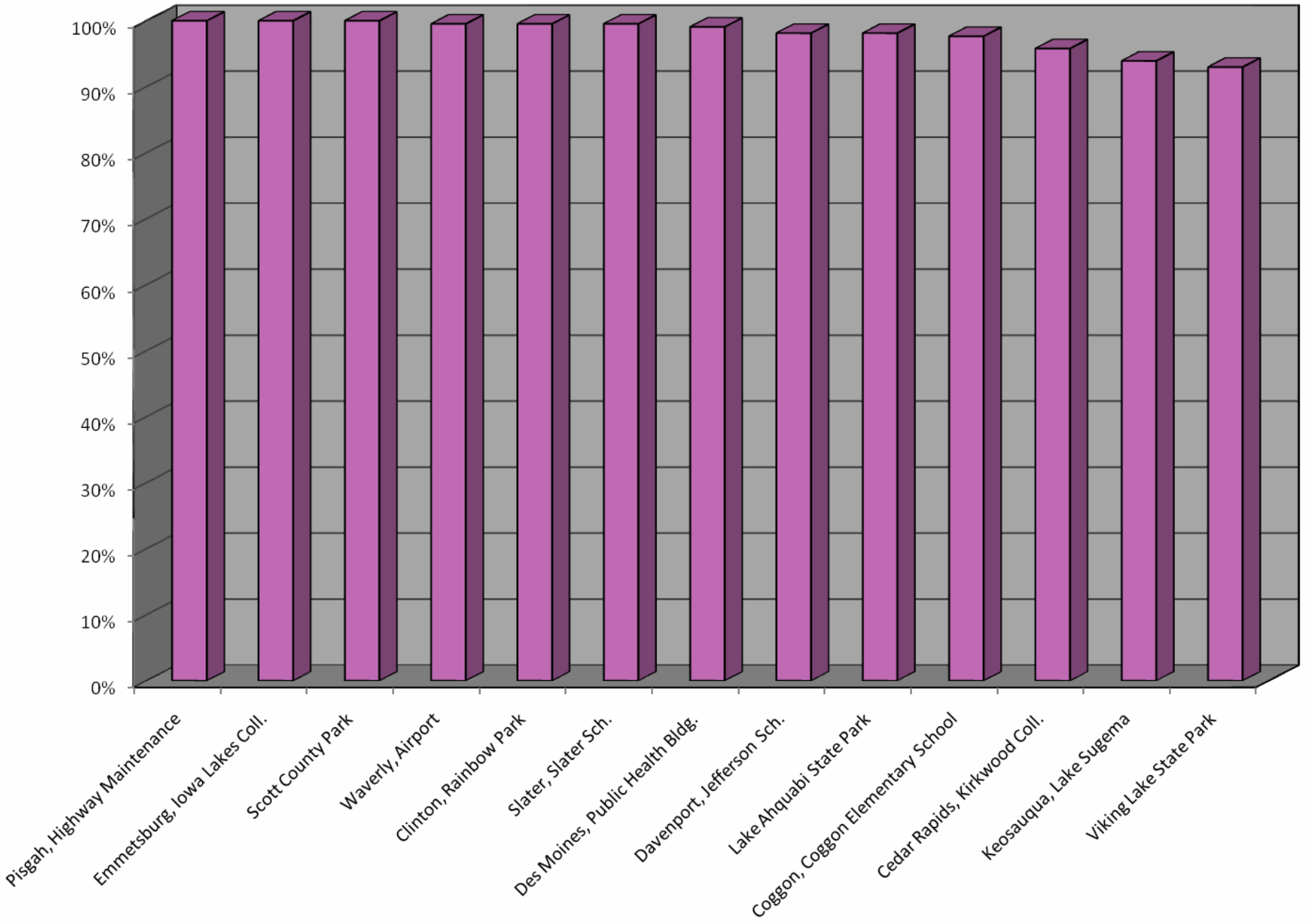
Ozone Monitor Locations



Comparison of 2008 Ozone Data with National Ambient Air Quality Standards



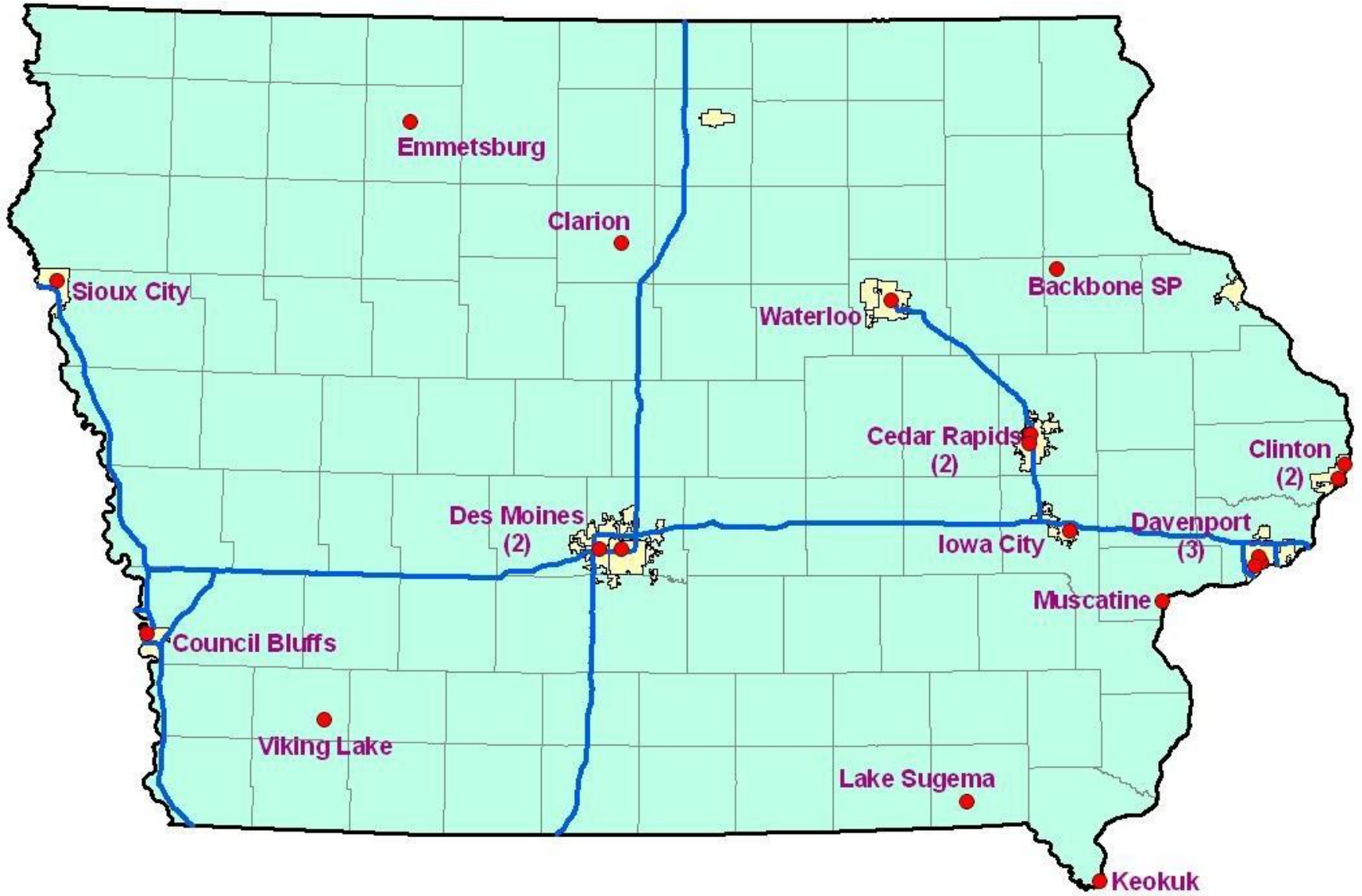
Data Completeness



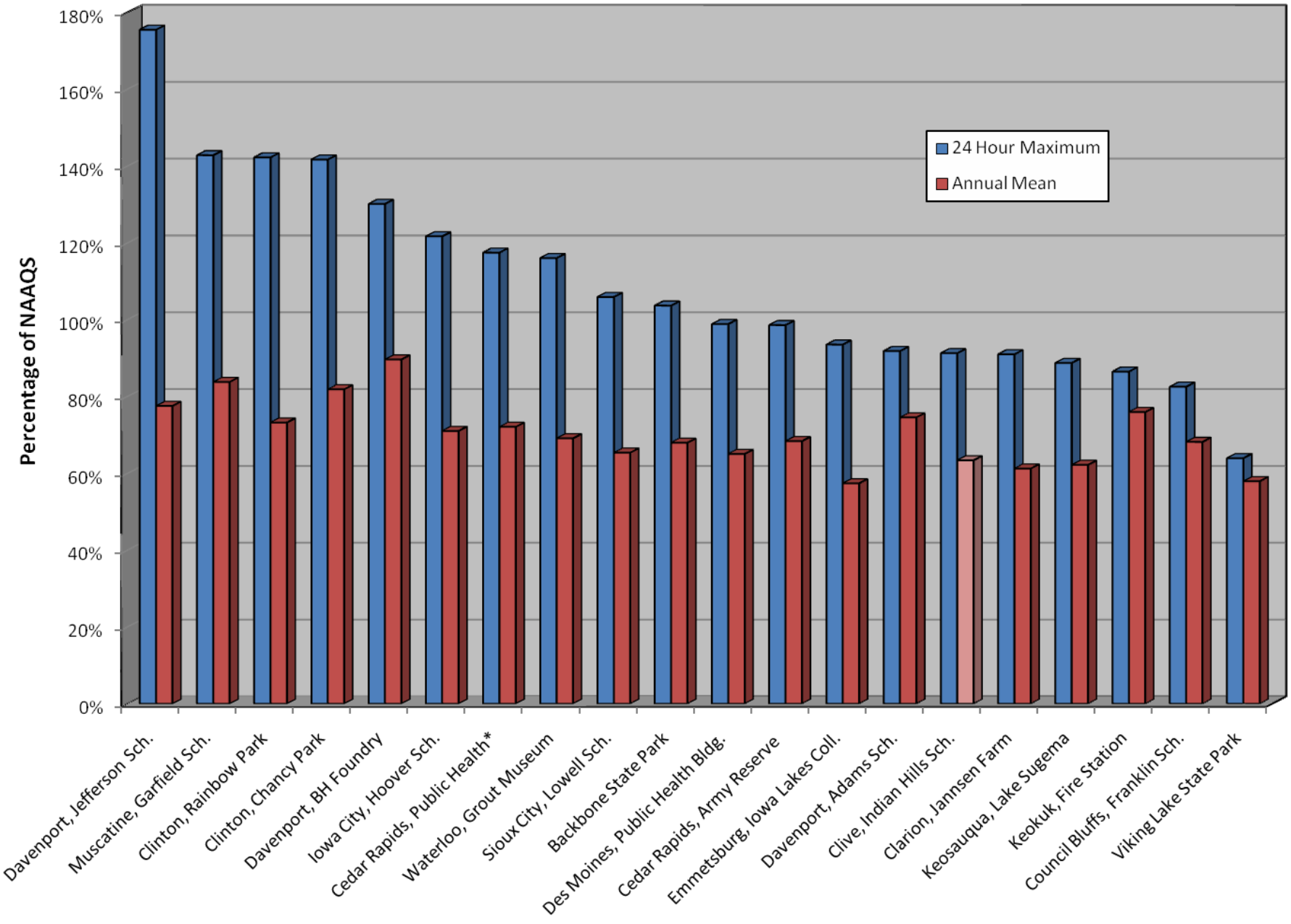
$PM_{2.5}$ Monitoring Sites
Site Locations

Site	Name	City	County	Site Label
190130008	Grout Museum	Waterloo	Black Hawk	Waterloo, Grout Museum
190450019	Chancy Park	Clinton	Clinton	Clinton, Chancy Park
190450021	Rainbow Park	Clinton	Clinton	Clinton, Rainbow Park
190550001	Backbone State Park	not in a city	Delaware	Backbone State Park
191032001	Hoover Elementary	Iowa City	Johnson	Iowa City, Hoover Sch.
191110008	Fire Station	Keokuk	Lee	Keokuk, Fire Station
191130037	Army Reserve Center	Cedar Rapids	Linn	Cedar Rapids, Army Reserve
191130040	Public Health	Cedar Rapids	Linn	Cedar Rapids, Public Health
191370002	Viking Lake State Park	not in a city	Montgomery	Viking Lake State Park
191390015	Garfield School	Muscatine	Muscatine	Muscatine, Garfield Sch.
191471002	Iowa Lakes College	Emmetsburg	Palo Alto	Emmetsburg, Iowa Lakes Coll.
191530030	Public Health Bldg.	Des Moines	Polk	Des Moines, Public Health Bldg.
191532510	Indian Hills Junior High	Clive	Polk	Clive, Indian Hills Sch.
191550009	Franklin Elementary	Council Bluffs	Pottawattamie	Council Bluffs, Franklin Sch.
191630015	Jefferson Elementary	Davenport	Scott	Davenport, Jefferson Sch.
191630018	Adams Elementary	Davenport	Scott	Davenport, Adams Sch.
191630019	Black Hawk Foundry	Davenport	Scott	Davenport, BH Foundry
191770006	Lake Sugema	not in a city	Van Buren	Keosauqua, Lake Sugema
191930017	Lowell Elementary	Sioux City	Woodbury	Sioux City, Lowell Sch.
191970004	Jannsen Farm	Clarion	Wright	Clarion, Jannsen Farm

$PM_{2.5}$ Monitor Locations



Comparison of 2008 $PM_{2.5}$ Data with National Ambient Air Quality Standards



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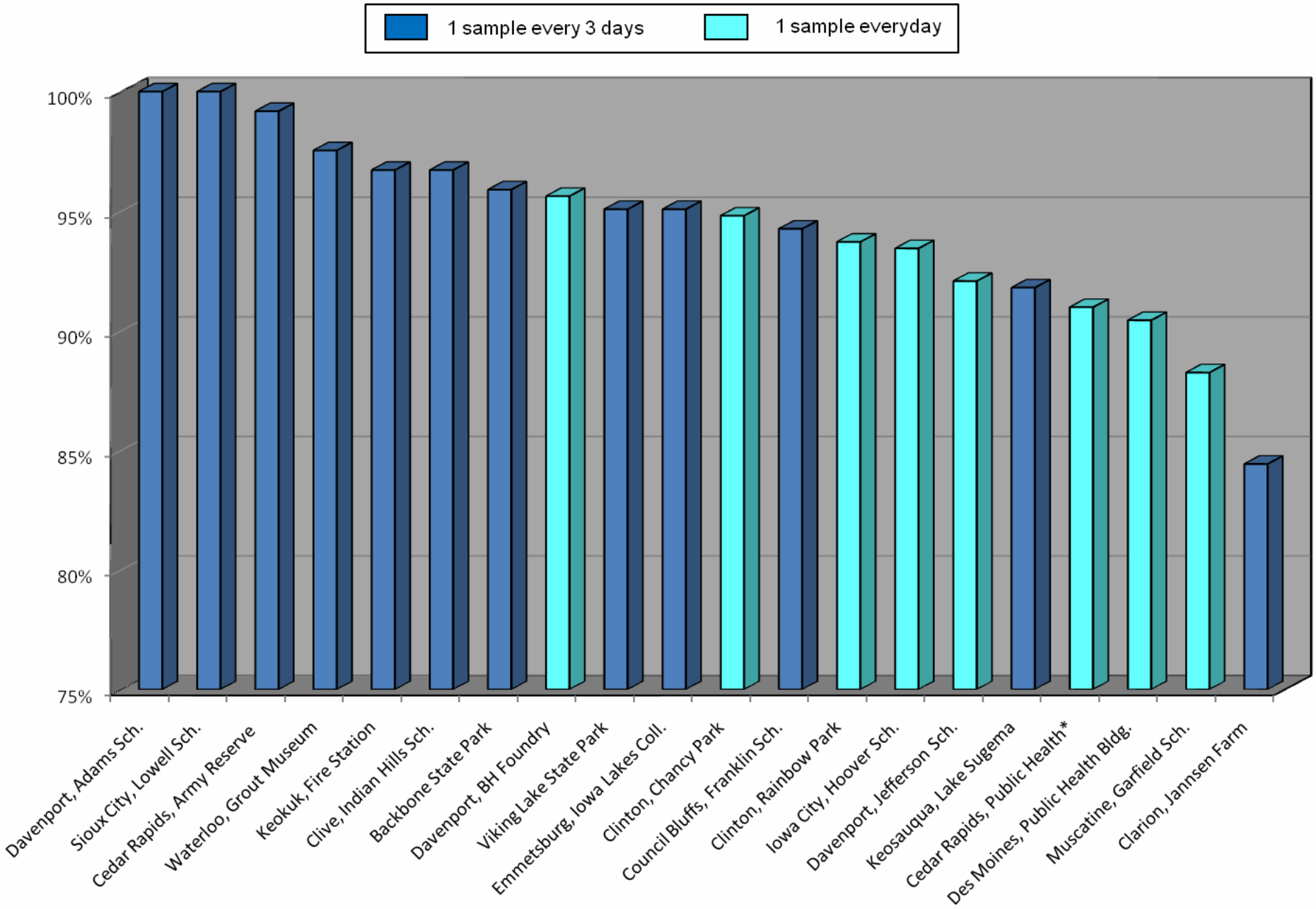
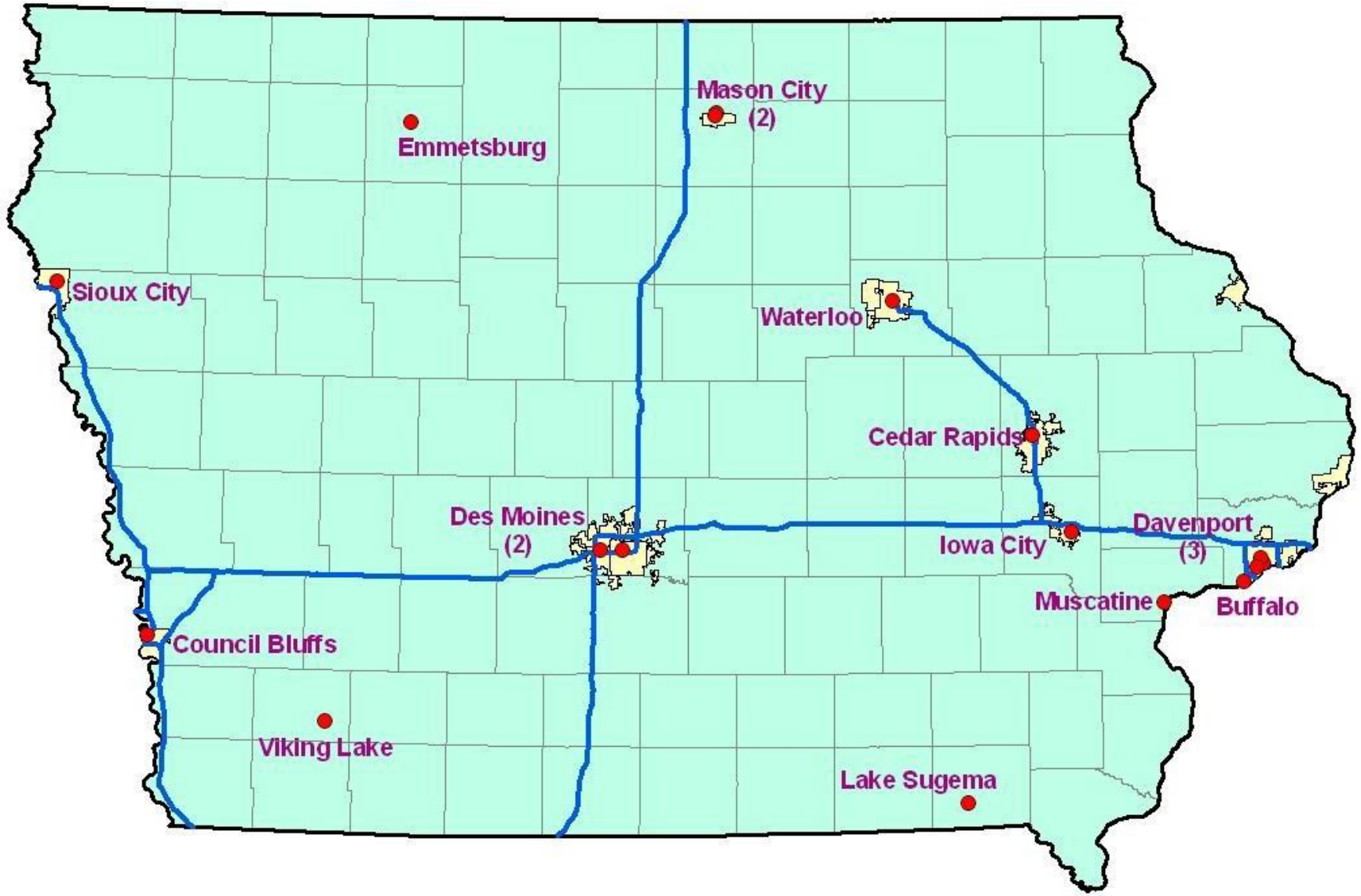


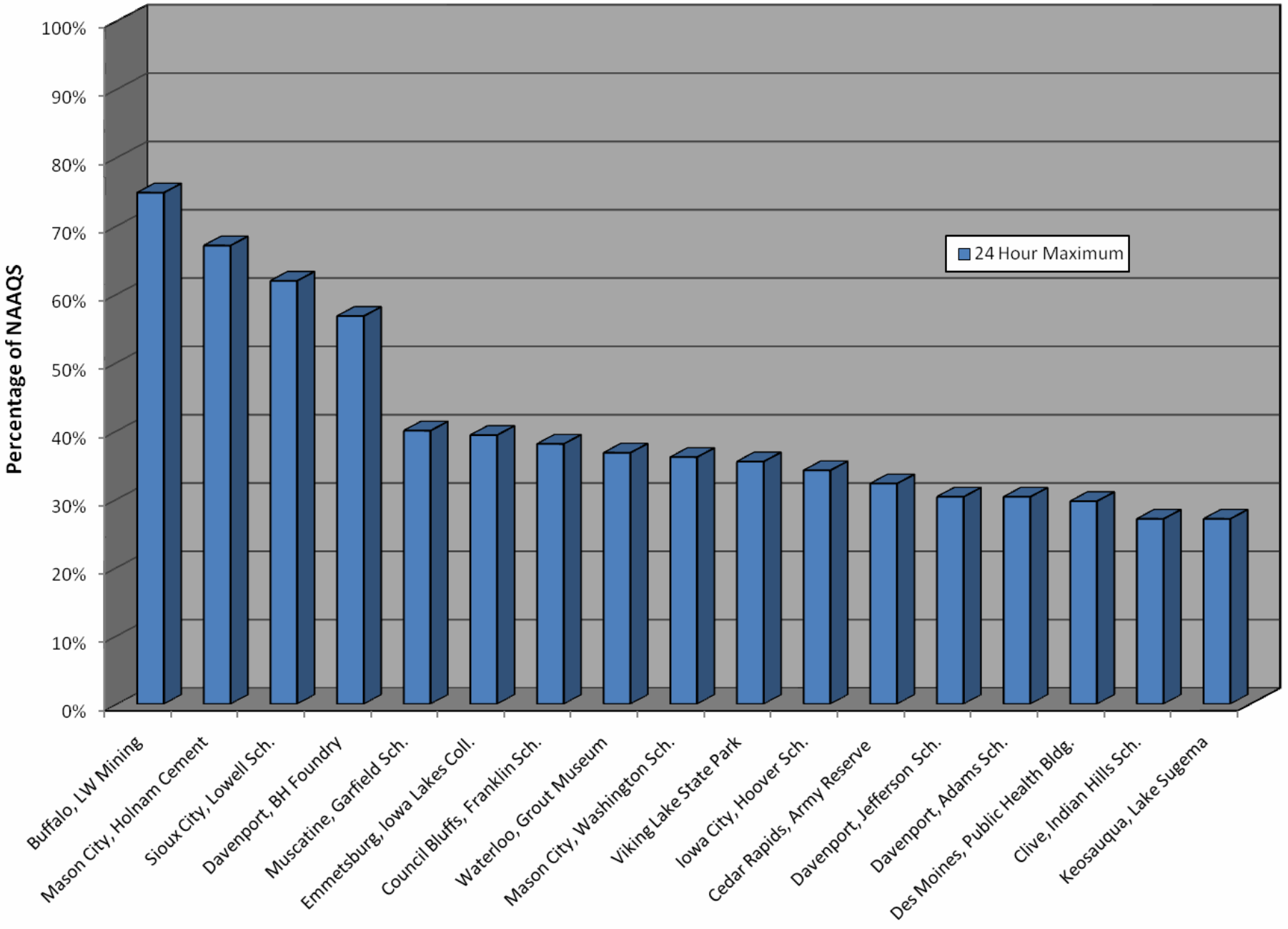
PM_{10} Monitoring Sites
Site Locations

Site	Name	City	County	Site Label
190130008	Grout Museum	Waterloo	Black Hawk	Waterloo, Grout Museum
190330018	Holnam Cement	Mason City	Cerro Gordo	Mason City, Holnam Cement
190330020	Washington Sch.	Mason City	Cerro Gordo	Mason City, Washington Sch.
191032001	Hoover Elementary	Iowa City	Johnson	Iowa City, Hoover Sch.
191130037	Army Reserve Center	Cedar Rapids	Linn	Cedar Rapids, Army Reserve
191370002	Viking Lake State Park	not in a city	Montgomery	Viking Lake State Park
191390015	Garfield School	Muscatine	Muscatine	Muscatine, Garfield Sch.
191471002	Iowa Lakes College	Emmetsburg	Palo Alto	Emmetsburg, Iowa Lakes Coll.
191530030	Public Health Bldg.	Des Moines	Polk	Des Moines, Public Health Bldg.
191532510	Indian Hills Junior High	Clive	Polk	Clive, Indian Hills Sch.
191550009	Franklin Elementary	Council Bluffs	Pottawattamie	Council Bluffs, Franklin Sch.
191630015	Jefferson Elementary	Davenport	Scott	Davenport, Jefferson Sch.
191630017	Linwood Mining	Buffalo	Scott	Buffalo, LW Mining
191630018	Adams Elementary	Davenport	Scott	Davenport, Adams Sch.
191630019	Black Hawk Foundry	Davenport	Scott	Davenport, BH Foundry
191770006	Lake Sugema	not in a city	Van Buren	Keosauqua, Lake Sugema
191930017	Lowell Elementary	Sioux City	Woodbury	Sioux City, Lowell Sch.

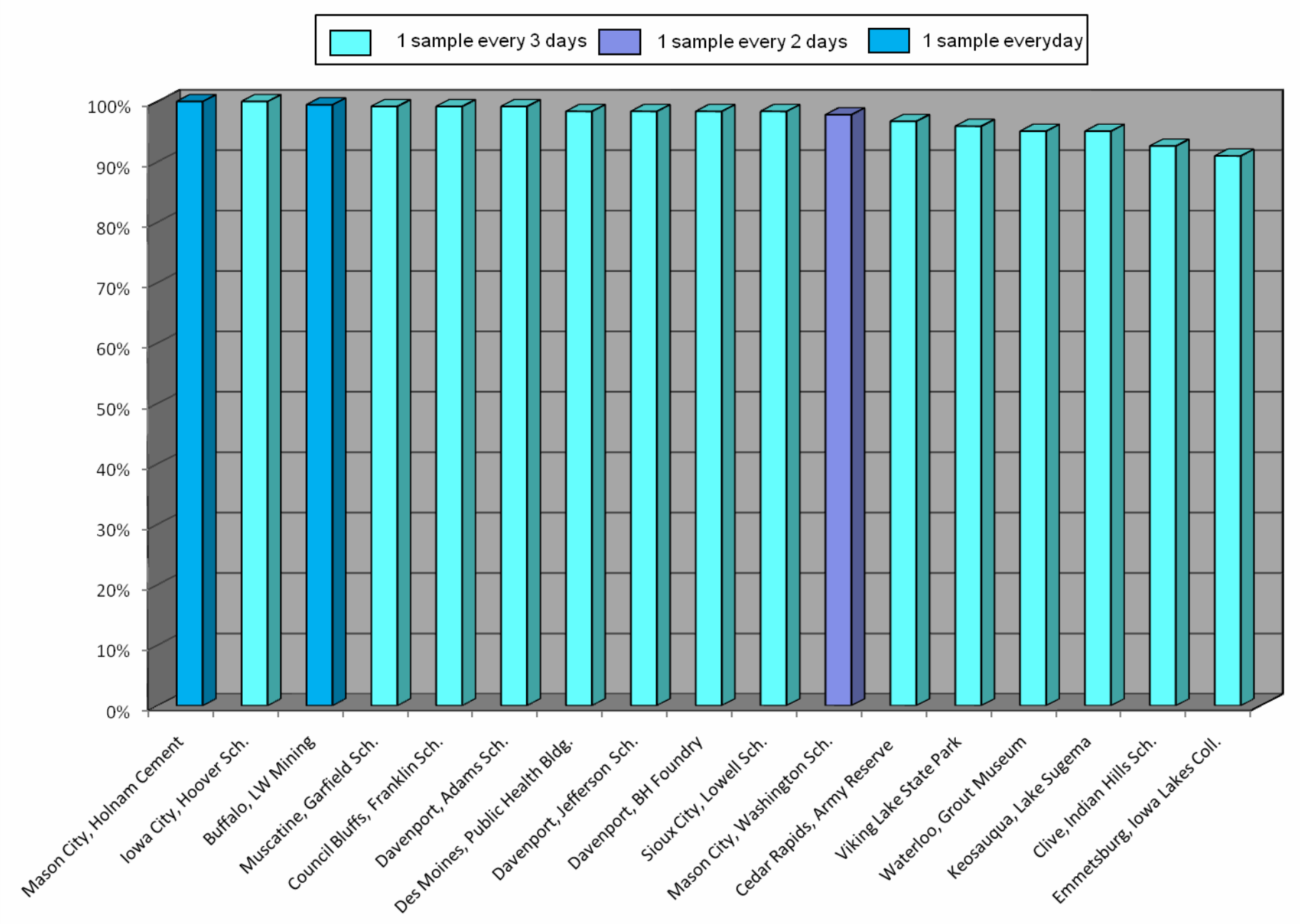
PM_{10} Monitor Locations



Comparison of 2008 PM_{10} Data with the National Ambient Air Quality Standard



Data Completeness

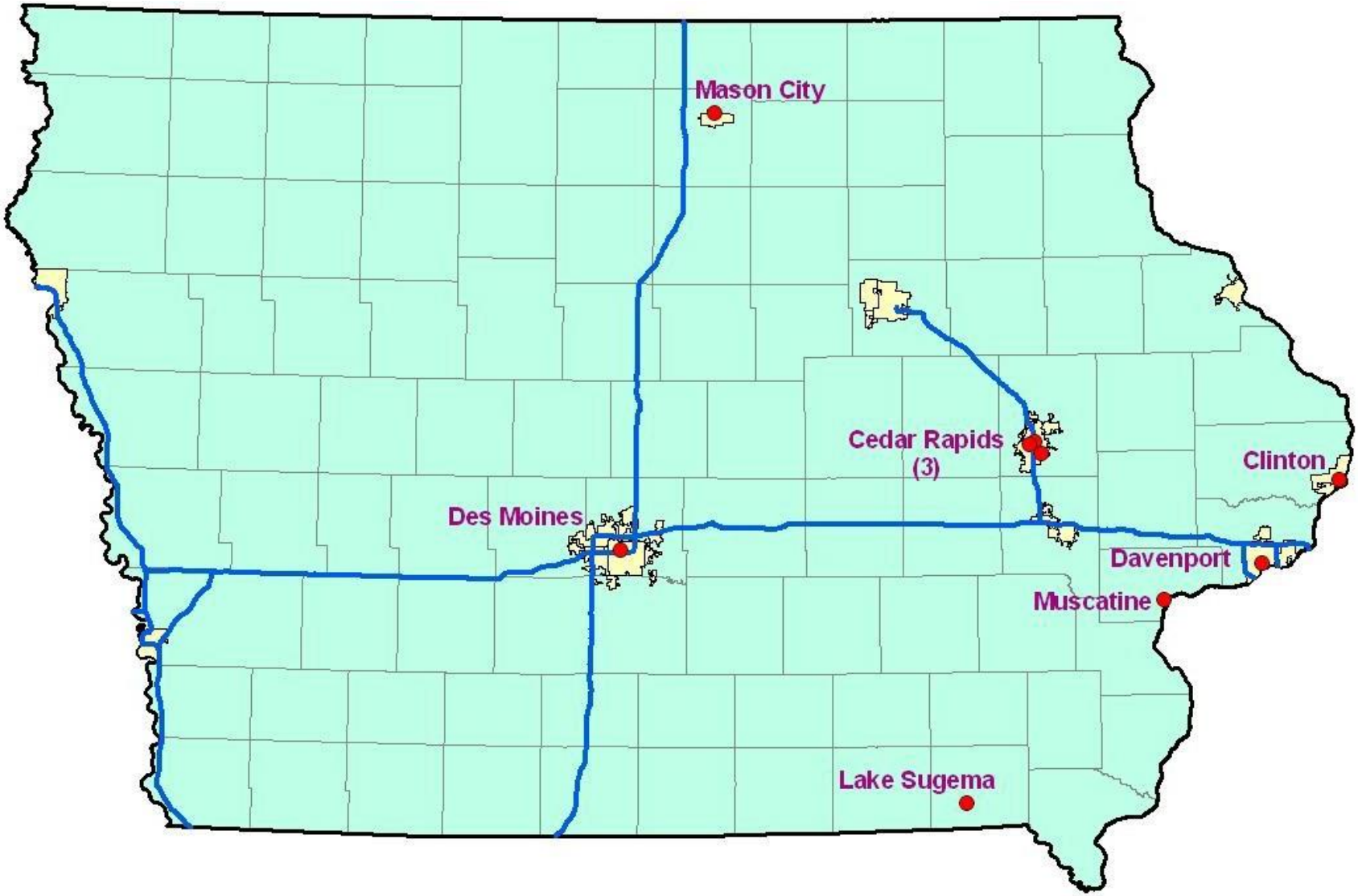


Sulfur Dioxide Monitoring Sites
Site Locations

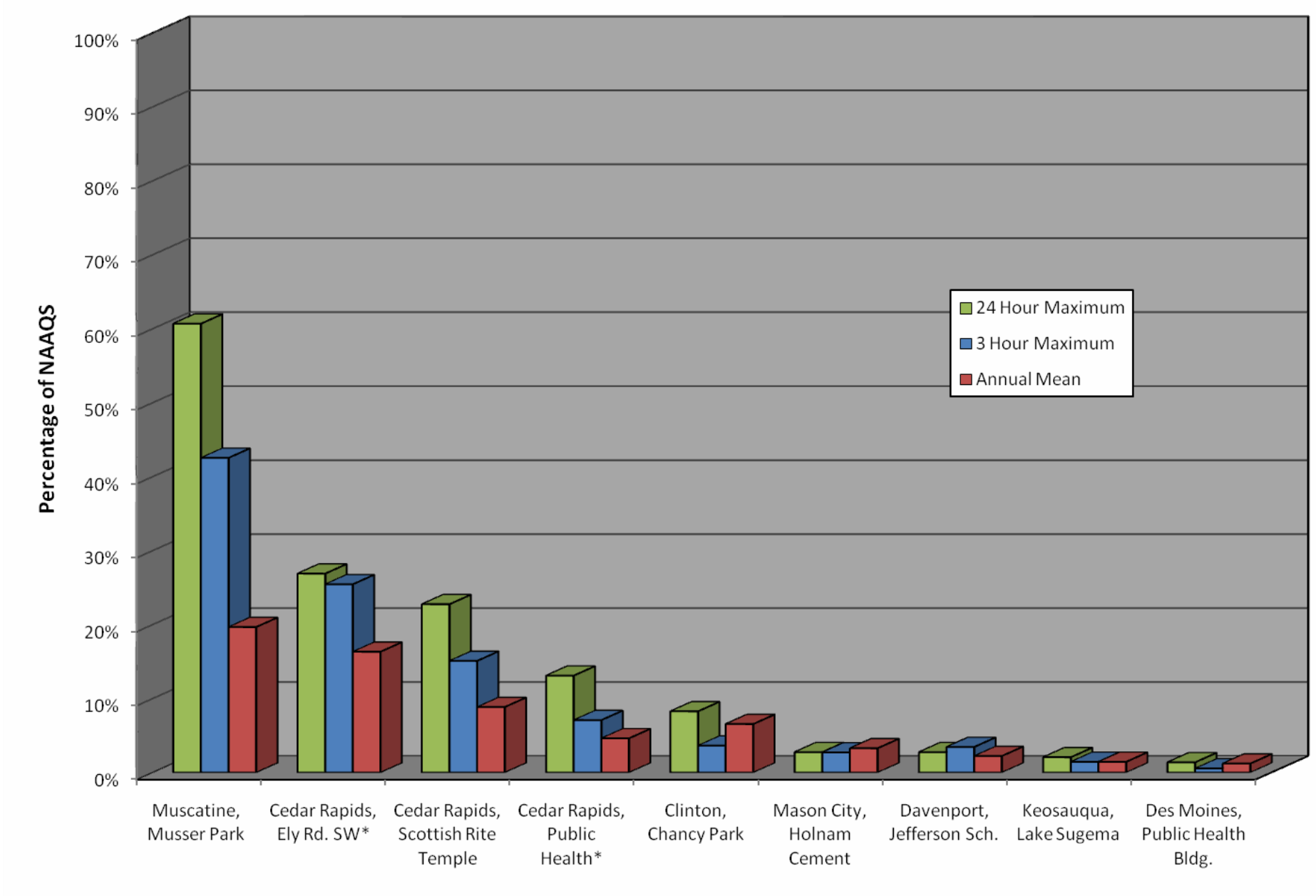
Site	Name	City	County	Site Label
190330018	Holnam Cement	Mason City	Cerro Gordo	Mason City, Holnam Cement
190450019	Chancy Park	Clinton	Clinton	Clinton, Chancy Park
191130031	Scottish Rite Temple	Cedar Rapids	Linn	Cedar Rapids, Scottish Rite Temple
191130038	Ely Rd. SW	Cedar Rapids	Linn	Cedar Rapids, Ely Rd. SW
191130040	Public Health	Cedar Rapids	Linn	Cedar Rapids, Public Health
191390020	Musser Park	Muscatine	Muscatine	Muscatine, Musser Park
191530030	Public Health Bldg.	Des Moines	Polk	Des Moines, Public Health Bldg.
191630015	Jefferson Elementary	Davenport	Scott	Davenport, Jefferson Sch.
191770006	Lake Sugema	not in a city	Van Buren	Keosauqua, Lake Sugema

Note: In August of 2010, EPA conducted an audit of the Muscatine Musser Park SO_2 monitoring site. The audit showed that the monitor recorded levels about 16% higher than EPA's SO_2 standard. The failed audit was traced back to the use of bad calibration standards to calibrate the SO_2 monitor. After dialog with EPA, the department decided to invalidate the data gathered at this site over the period when the bad standards were in use; from 9/30/2008 to 8/20/2010. The charts in this report were updated on 1/5/2011 to reflect the removal of the bad data from 9/30/2008 to the end of the year.

Sulfur Dioxide Monitor Locations



Comparison of 2008 Sulfur Dioxide Data with National Ambient Air Quality Standards



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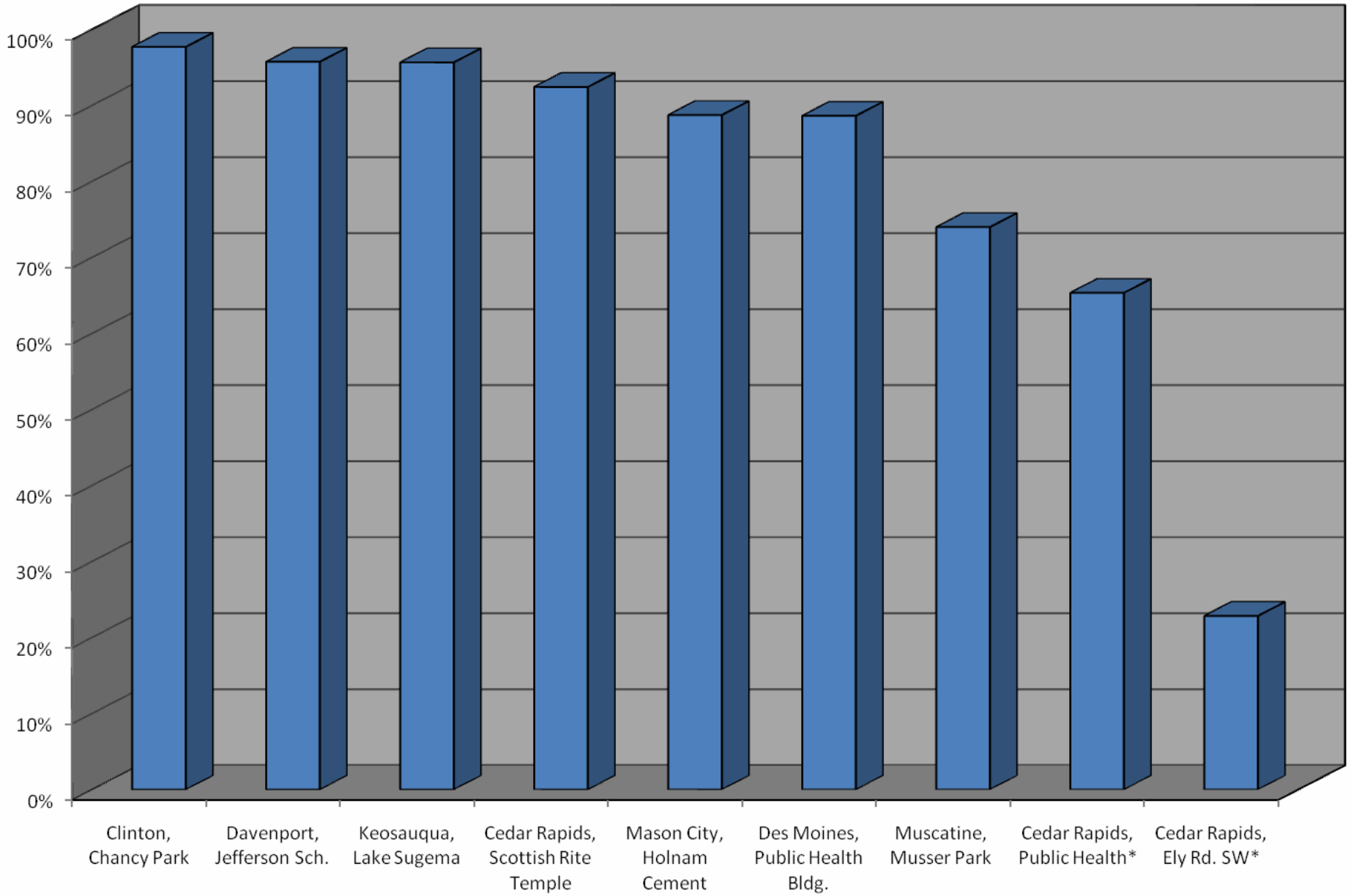
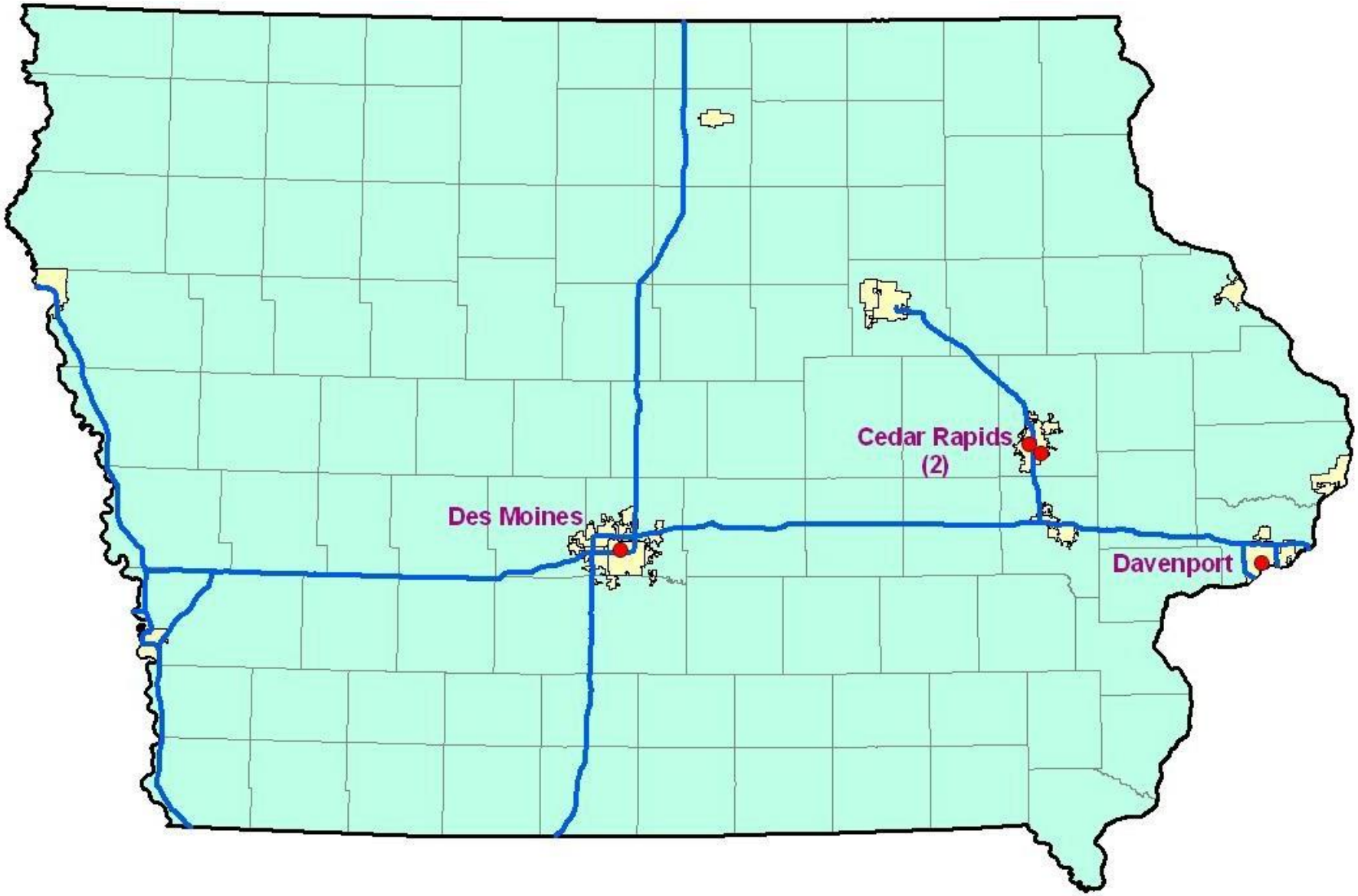


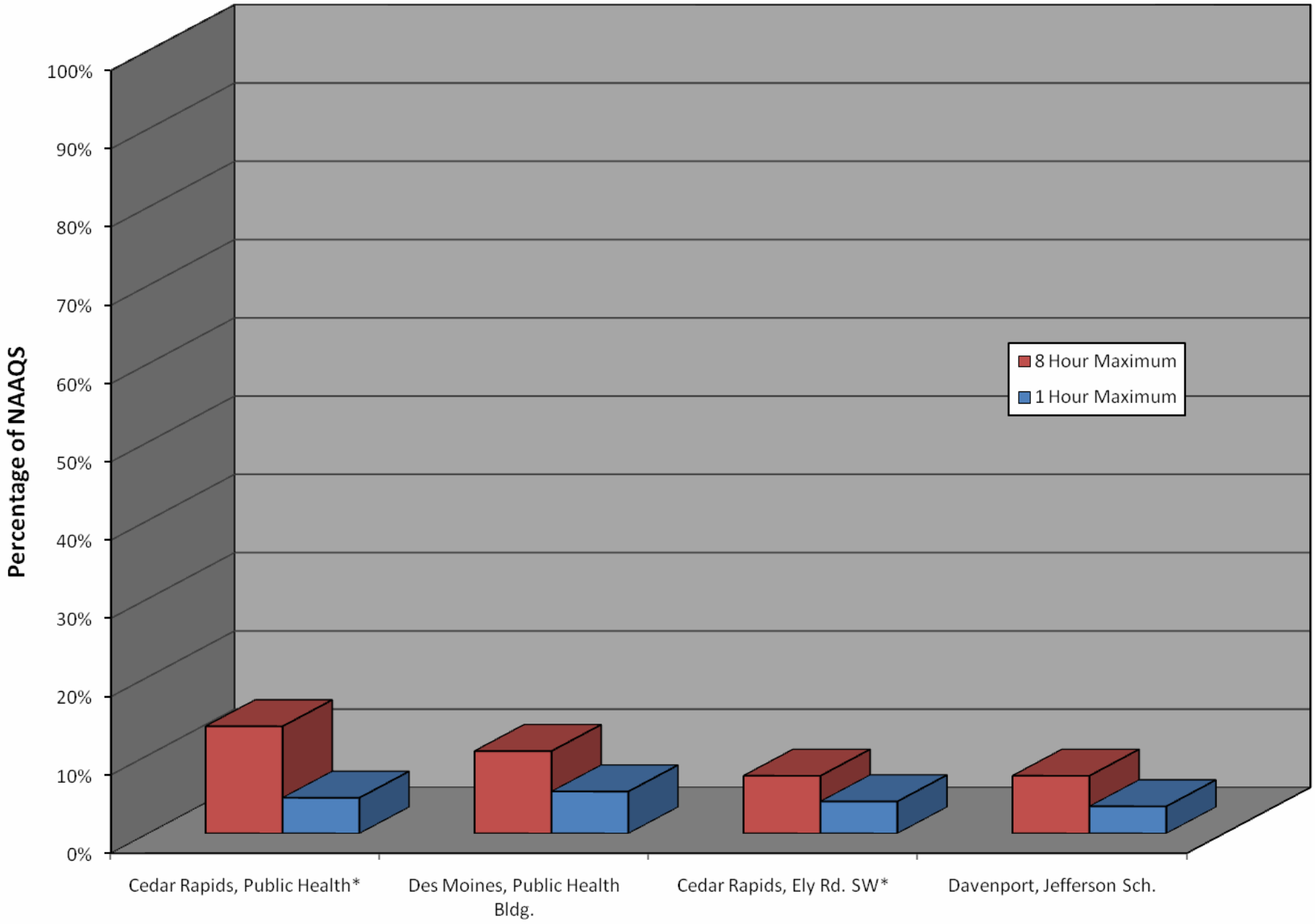
Carbon Monoxide Monitoring Sites
Site Locations

Site	Name	City	County	Site Label
191130038	Ely Rd. SW	Cedar Rapids	Linn	Cedar Rapids, Ely Rd. SW
191130040	Public Health	Cedar Rapids	Linn	Cedar Rapids, Public Health
191530030	Public Health Bldg.	Des Moines	Polk	Des Moines, Public Health Bldg.
191630015	Jefferson Elementary	Davenport	Scott	Davenport, Jefferson Sch.

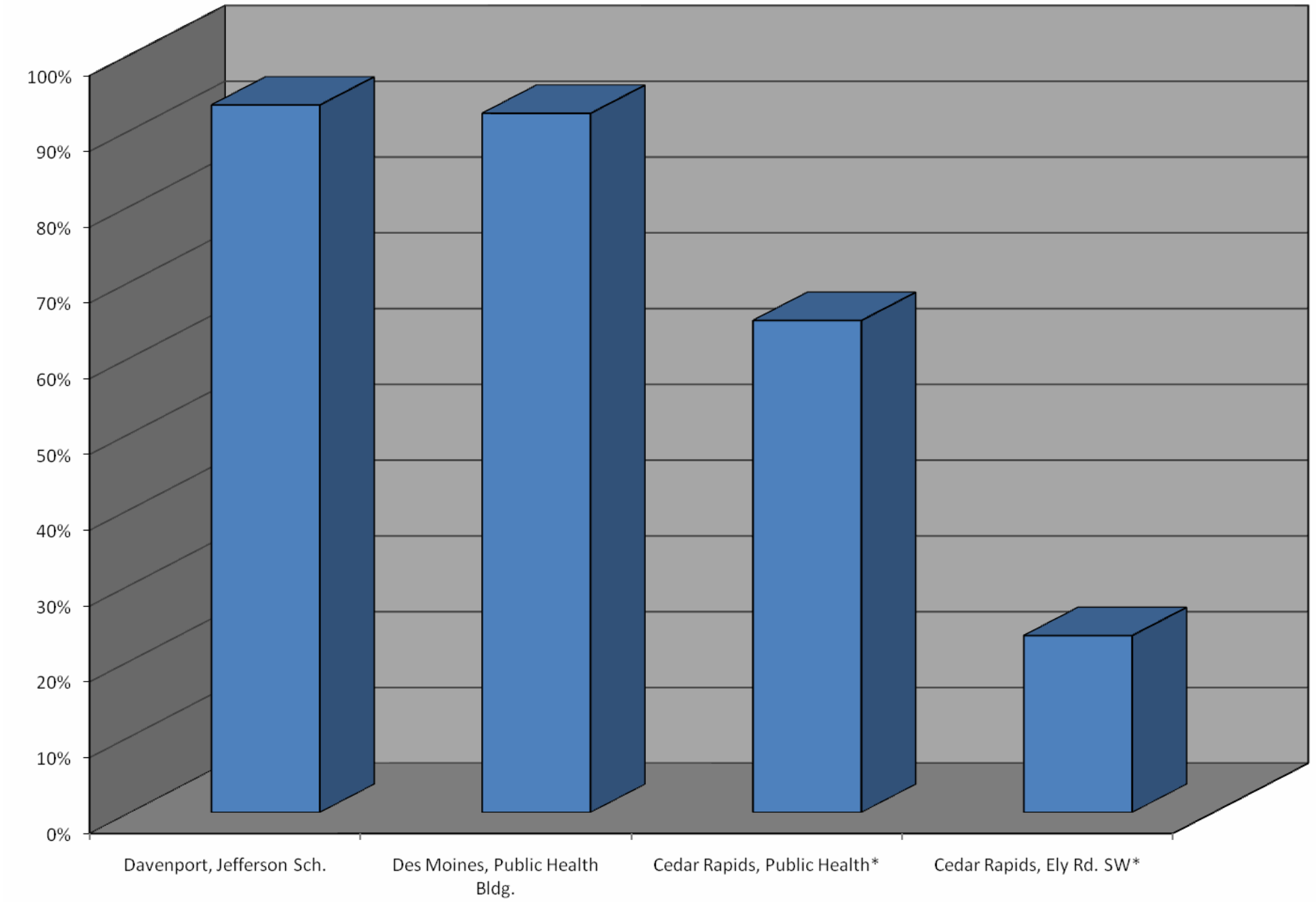
Carbon Monoxide Monitor Locations



Comparison of 2008 Carbon Monoxide Data with National Ambient Air Quality Standards



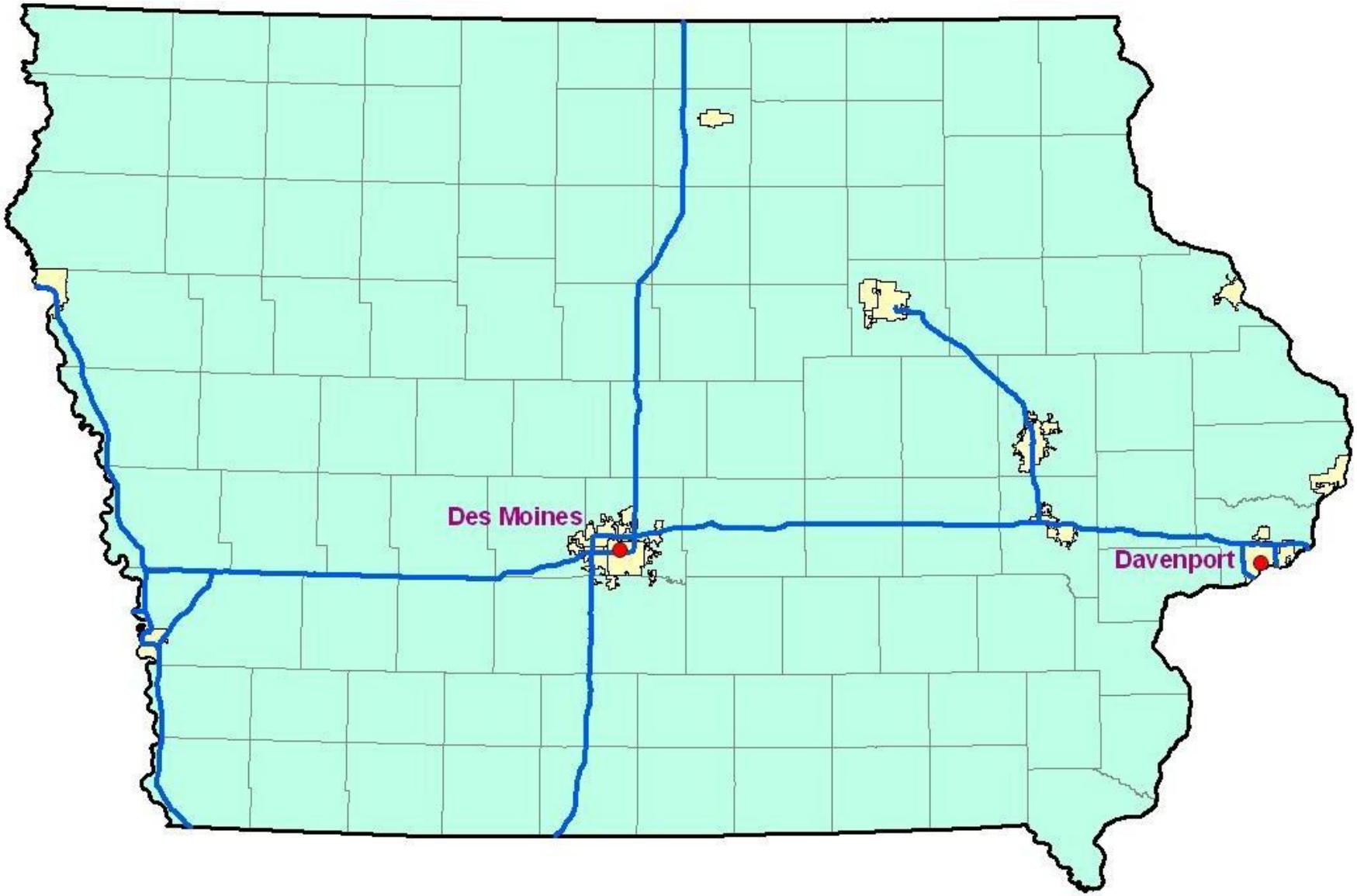
Data Completeness



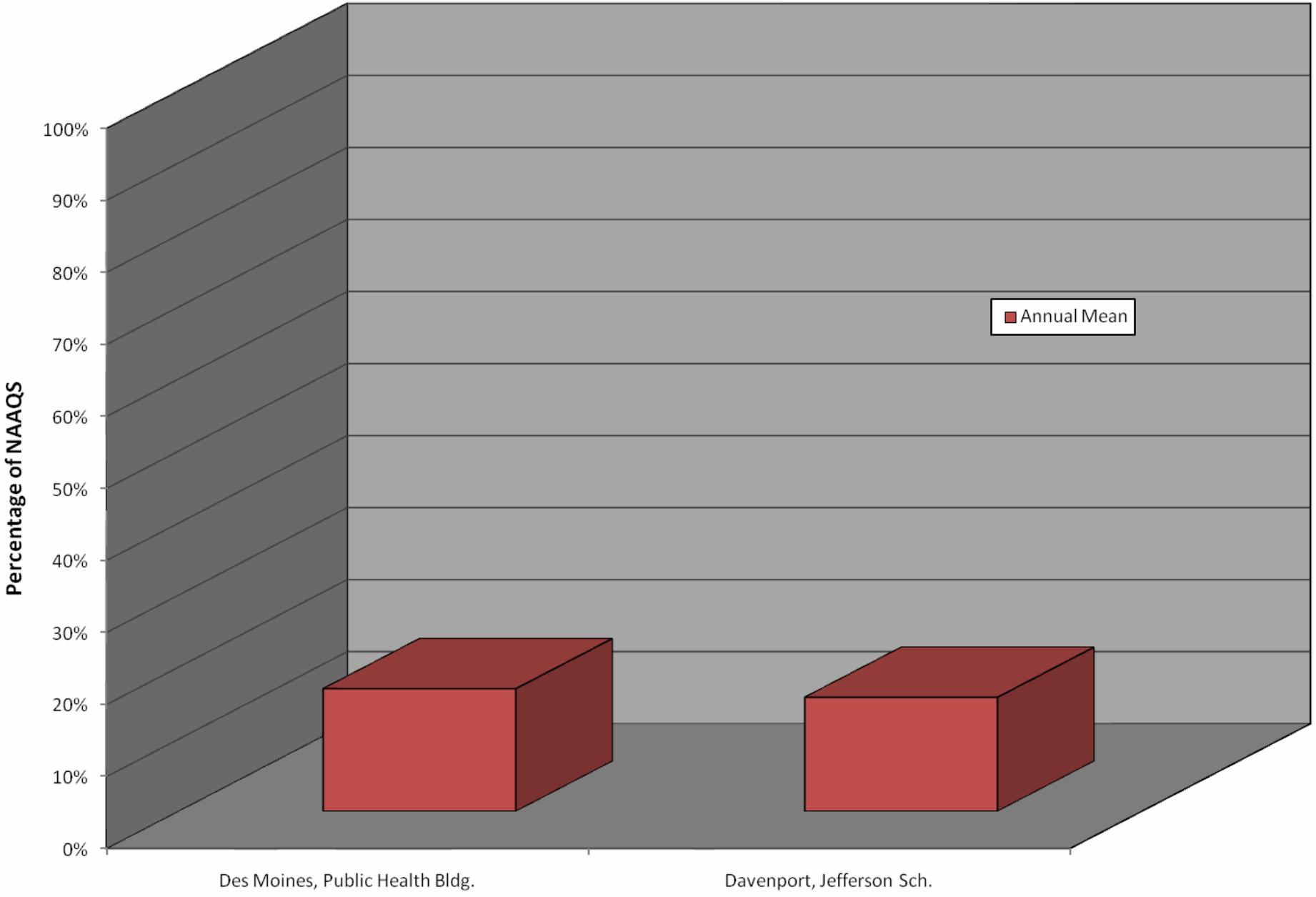
Nitrogen Dioxide Monitoring Sites
Site Locations

Site	Name	City	County	Site Label
191530030	Public Health Bldg.	Des Moines	Polk	Des Moines, Public Health Bldg.
191630015	Jefferson Elementary	Davenport	Scott	Davenport, Jefferson Sch.

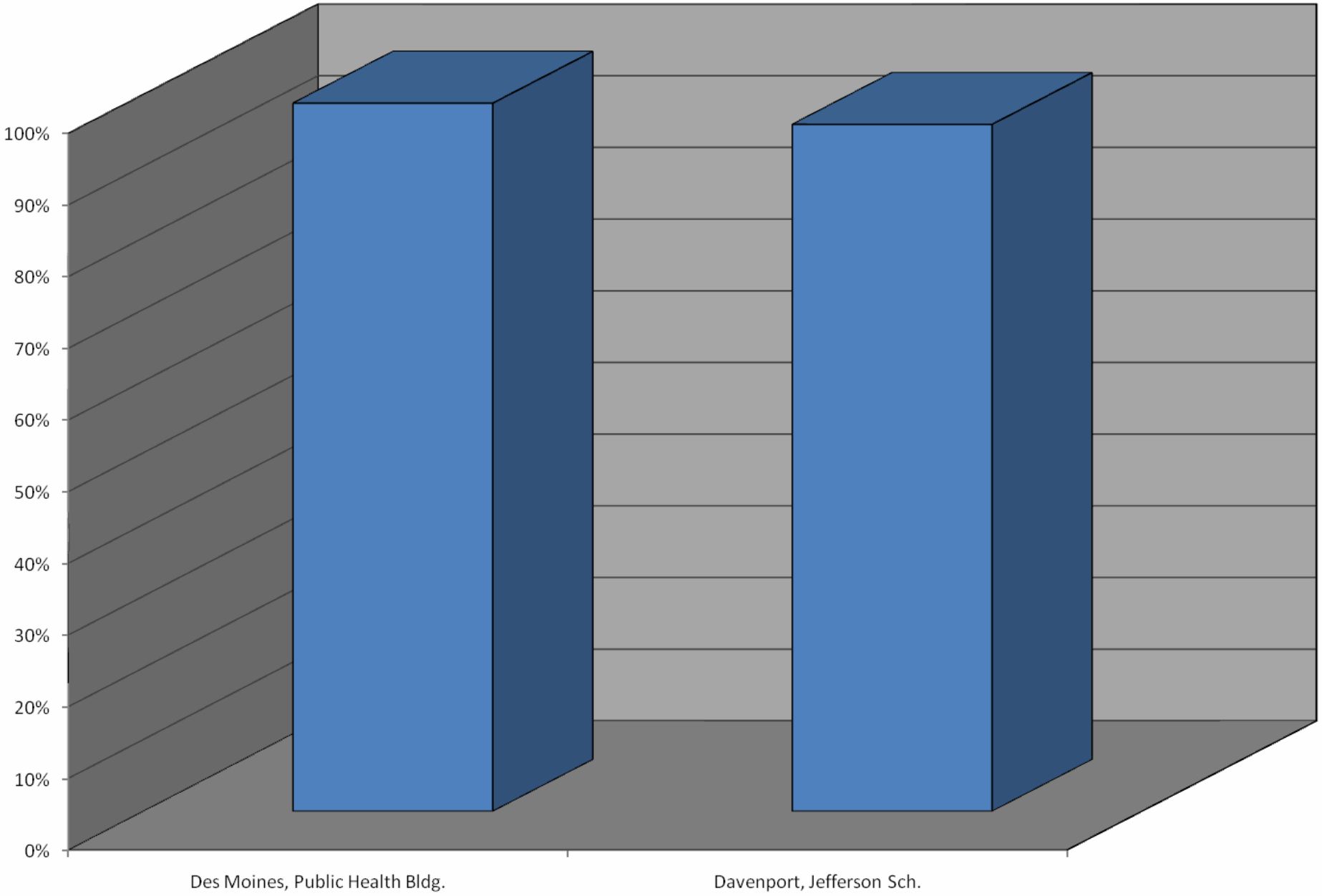
Nitrogen Dioxide Monitor Locations



Comparison of 2008 Nitrogen Dioxide Data with the National Ambient Air Quality Standard



Data Completeness



Additional Chart Information
Listed below is additional information that may be useful in interpreting the charts contained in this review

Ozone
Comparison of 2008 Ozone Data with National Ambient Air Quality Standards
This chart shows the highest eight-hour ozone average (expressed as a percentage of the "new" 0.076 ppm and "old" 0.085 ppm eight-hour NAAQS) for each ozone monitor operated in 2008. The National Ambient Air Quality Standard for ozone was changed from 0.085 ppm to 0.076 ppm in May of 2008.

Data Completeness
This chart shows the total number of valid ozone monitoring days (based on 8-hour average, expressed as a percentage of the total number of days in the ozone season) for each ozone monitor operated in 2008. According to EPA guidelines, an ozone monitoring day is considered valid if at least 75% of the hourly averages for the 8-hour period are available. In the event that less than 75% of the 8-hour averages are available, a day is also counted as valid if the daily maximum 8-hour average for that day is greater than the NAAQS (0.076 ppm). Ozone season runs from April through October; this amounts to 214 possible sampling days. An ozone monitor that recorded data for all 214 days of the season would have a data capture rate of 100%.

PM2.5
Comparison of 2008 $PM_{2.5}$ Data with National Ambient Air Quality Standards
This chart shows the highest 24-hour value (expressed as a percentage of the 35.5 $\mu g/m^3$ 24-hour NAAQS), and the annual average (expressed as a percentage of the 15.05 $\mu g/m^3$ annual NAAQS) for each $PM_{2.5}$ monitor operated in 2008.

Data Completeness
This chart shows the fraction of scheduled sampling days for each $PM_{2.5}$ monitor operated in 2008, where a $PM_{2.5}$ sample was actually collected. During 2008, $PM_{2.5}$ samplers in Iowa were scheduled to operate at a sampling frequency of either one sample every third day (122 scheduled samples) or one sample every day (366 scheduled samples). The sampling frequency of each monitor is indicated by the color of the bar.

PM_{10}
Comparison of 2008 PM_{10} Data with National Ambient Air Quality Standards
This chart shows the highest 24-hour value (expressed as a percentage of the 155 $\mu g/m^3$ 24-hour NAAQS) for each PM_{10} monitor operated in 2008.

Data Completeness
This chart shows the fraction of scheduled sampling days in 2008, for each PM_{10} monitor operated in 2008, where a PM_{10} sample was actually collected. During 2008, PM_{10} samplers in Iowa were scheduled to operate at a frequency of one sample every third day (122 scheduled samples), one sample every other day (183 scheduled samples), or one sample every day (366 scheduled samples). The sampling frequency of each monitor is indicated by the color of the bar in the chart.

Sulfur Dioxide
Comparison of 2008 Sulfur Dioxide Data with National Ambient Air Quality Standards
This chart shows the highest 3-hour value (expressed as a percentage of the 0.55 ppm 3-hour NAAQS), the highest 24-hour value (expressed as a percentage of the 0.145 ppm 24-hour NAAQS), and the annual average (expressed as a percentage of the 0.0305 ppm annual NAAQS) for each sulfur dioxide monitor operated in Iowa in 2008.

Data Completeness
This chart shows the total number of hourly sulfur dioxide values (expressed as a percentage of the total number of hours in 2008) for each sulfur dioxide monitor that operated in 2008. A sulfur dioxide monitor that recorded data for all 8784 hours during 2008 would have a data capture rate of 100%.

Carbon Monoxide

Comparison of 2008 Carbon Monoxide Data with National Ambient Air Quality Standards

This chart shows the highest 1-hour value (expressed as a percentage of the 35.5 ppm 1-hour NAAQS) and the highest 8-hour value (expressed as a percentage of the 9.5 ppm 8-hour NAAQS) for each carbon monoxide monitor operated in 2008.

Data Completeness

This chart shows the total number of hourly carbon monoxide values (expressed as a percentage of the total number of hours in 2008). A carbon monoxide monitor that recorded data for all 8784 hours during 2008 would have a data capture rate of 100%.

Nitrogen Dioxide

Comparison of 2008 Nitrogen Dioxide Data with National Ambient Air Quality Standards

This chart shows the annual average (expressed as a percentage of the 0.0535 ppm annual NAAQS) for each nitrogen dioxide monitoring site that operated in 2008.

Data Completeness

This chart shows the total number of hourly nitrogen dioxide values (expressed as a percentage of the total number of hours in 2008). A nitrogen dioxide monitor that recorded data for all 8784 hours during 2008 would have a data capture rate of 100%.