Flint Hills Air Monitoring Network
Data Analysis

Summary Report
May 10, 2004

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STS Project 98563A

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Table of Contents

Flint Hills
STS Project 98563A
May 10, 2004

1.0 INTRODUCTION

The Minnesota Pollution Control Agency (MPCA), as part of their state-wide air quality assessment network, currently conducts ambient air quality monitoring at four sites near the Flint Hills Rosemount petroleum refinery (facility). Table 1 summarizes which parameters are currently being monitored at each of these locations.

Table 1. Monitoring Site Summary

Parameter	Desig.	Site 420	Site 423	Site 441	Site 442
Carbon Monoxide [1]	CO	X	X		
Nitric Oxides [1]	NO_x	X	X		
Nitrogen Dioxide [1]	NO_2	X	X		
Sulfur Dioxide [1]	SO_2	X	X	X	X
Total Reduced Sulfur [1]	TRS			X	X
Hazardous Air Pollutants [2]	HAPs	X	X	X	X
Wind Speed	WS	X	X		
Wind Direction	WD	X	X		
Temperature	Temp	X	X		

[1] Emitted from refinery in reportable quantities
[2] Only certain HAPs emitted from refinery in reportable quantities (see Table 3)

Each of the parameters listed above are being measured in the field on a continuous basis, except for the hazardous air pollutants (HAPs). HAPs samples are taken as 24-hour composite samples, collected once every six days. HAPs samples are sent to the MPCA laboratory where they are analyzed for a variety of specific volatile compounds. Particulate HAPs are scheduled to be analyzed at MPCA, but to date this analysis has not been completed at any of the sites near the facility. Table 2 lists the specific chemicals currently being analyzed by MPCA in the HAP samples in the state-wide program.

Flint Hills
STS Project 98563A
May 10, 2004

Table 2. MPCA Analyzed HAP Species

Constituent
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
Trichlorofluoromethane (Freon 11)
Dichlorodifluoromethane (Freon 12)
1,3-Butadiene
Formaldehyde
Acetaldehyde
Propionaldehyde
Butyraldehyde
t-Crotonaldehyde
Acetone
Methylene Chloride
Chloroform
Carbon Tetrachloride
1,1-Dichloroethane
1,1,1-Trichloroethane
1,2-Dichloroethane
Tetrachloroethylene
1,1,2,2-Tetrachloroethane
Bromomethane
1,1,2-Trichloroethane
Trichloroethylene
1,1-Dichloroethylene
1,2-Dichloropropane
t-1,3-Dichloropropylene
1,3-Dichloropropylene
c-1,2-Dichloroethylene
1,2-Dibromoethane
Hexachlorobutadiene
Vinyl Chloride
o-Xylene
m/p-Xylene
Benzene
Toluene
Ethylbenzene
1,3,5-Trimethylbenzene
1,2,4-Trimethylbenzene
Styrene
4-Ethyltoluene
Benzaldehyde
Chlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene

The objective of the state-wide monitoring network is not specifically to determine the ambient air impacts of particular facilities on their surrounding neighborhoods. Rather, the system is primarily designed to provide ambient air quality data to the MPCA from each area for comparison to other sites/areas located throughout Minnesota. Thus, it is not surprising that an evaluation of this particular monitoring network vis-à-vis its ability to determine the health impacts of a the Flint Hills facility on its adjacent neighborhoods indicates a less than perfect system.

STS Consultants, Ltd. (STS) was nevertheless requested by the Flint Hills Community Advisory Council (Council) in 2002 to evaluate this monitoring network with respect to facility impacts. Table 3 lists the HAPs that are being monitored by MPCA at each at these four stations and itemizes those that are being released from the facility. As can be seen in Table 4, of the 44 HAPs that are being monitored, eight (8) are reported within the USEPA's Toxic Release Inventory (TRI) program as emitted from the facility. Seven of the eight have been emitted over the last four years of reporting. One additional chemical, 1,2-dibromoethane, was newly identified in 2001 (previously it was listed in 1998).

Based on the facility's existing annual TRI reports at that time (1998-2000) as well as the monitoring data obtained for all of the HAP components evaluated, specific chemicals were identified by the Council in 2002 as being of importance from a continuing review standpoint. The Council identified twelve chemicals that they requested to be reviewed on a quarterly basis.

STS was now recently asked to review the data for these compounds using the most recent monitoring data and to provide their review on a quarterly basis to the Council. This first report under the contract includes the evaluation of six of the 12 targeted chemicals – sulfur dioxide, nitrogen dioxide, formaldehyde, carbon tetrachloride, benzene, and ethylbenzene. The other six targeted chemicals (acrolein, nickel, chromium, zinc, cobalt, and manganese) were unable to be evaluated at this time, as no monitoring data are currently available. This evaluation utilized the fourth quarter, 2003 monitoring data

Flint Hills
STS Project 98563A
May 10, 2004

Table 3: Air Monitoring Analytes vs. Facility Emissions (TRI)

Monitored Chemical	TRI Reported Emissions			
	1998	1999	2000	2001
Acetaldehyde				
Acetone				
Benzaldehyde				
Benzene	x	x	x	x
Bromomethane				
1,3-Butadiene				
Butyraldehyde				
Carbon Tetrachloride				
Chlorobenzene				
Chloroform				
t-Crotonaldehyde				
1,2-Dibromoethane	x			x
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)				
1,2-Dichlorobenzene				
1,3-Dichlorobenzene				
1,4-Dichlorobenzene				
Dichlorodifluoromethane (Freon 12)				
1,1-Dichloroethane				
1,2-Dichloroethane				
1,1-Dichloroethylene				
c-1,2-Dichloroethylene				
1,2-Dichloropropane				
1,3-Dichloropropylene				
Ethylbenzene	x	x	x	x
4-Ethyltoluene				
Formaldehyde				
Hexachlorobutadiene				
Methylene Chloride				
Propionaldehyde				
Styrene	x			
t-1,3-Dichloropropylene				
1,1,2,2-Tetrachloroethane				
Tetrachloroethylene	x	x	x	x
Toluene	x	x	x	x
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)				
1,1,1-Trichloroethane				
1,1,2-Trichloroethane				
Trichloroethylene				
Trichlorofluoromethane (Freon 11)				
1,2,4-Trimethylbenzene	x	x	x	x
1,3,5-Trimethylbenzene				
m/p-Xylene	x	x	x	x
o-Xylene	x	x	x	x
Vinyl Chloride				

2.0 REVIEW SUMMARY

2.1 Data Quality Analysis

Before any statements can be made regarding the health impacts of the monitoring data on the neighboring general public, the analytical data obtained from the monitoring network need to be reviewed with respect to its quality. Only quality data can be utilized to make risk statements of this nature.

STS reviewed the monitoring equipment and procedures used by the MPCA in the March 2002 report. The conclusion was that these data meet the data quality requirements from appropriate equipment and analyzing procedures perspectives. The HAP sampling data, a 24-hour composite sample taken once every six days, are not directly applicable for comparison to either acute or chronic health criteria. In this analysis, the values have been adjusted using a factor of 2.5 (reflective of the typical relationship between one- and twenty-four-hour averages for acute criteria) and 0.53 (to adjust from quarterly to annual averages for chronic criteria).

For the six chemicals where no data are currently available, the MPCA has been assessing their procedures to assure quality data. The procedures used to analyze the metallic chemicals (nickel, chromium, zinc, cobalt, and manganese) and acrolein have not yet satisfied the MPCA's QA/QC requirements, therefore they have released no data for these chemicals.

2.2 Data Review/Findings

2.2.1 Health Standards and Comparison

In order to put these ambient air monitoring data into perspective in regards to public health impacts, a toxicity assessment for each requested, monitored chemical was first completed. This toxicity assessment involved a search of USEPA chemical toxicity databases (IRIS, 2002; HEAST, 1997), the Minnesota Department of Health's Health

Risk Values (HRVs), and California EPA's Air Toxics Standards. Presented in Table 4 are the results of this search.

Listed in Table 4 are air concentrations of each chemical of concern in this study that are believed to be safe for the public to be exposed to. Acute criteria represent acceptable air concentrations of chemicals for exposure up to a one hour time period. Chronic criteria are air concentrations of chemicals that the public can be exposed to continuously throughout their entire lifetime.

Table 4: Health Criteria

Chemical	Federal Standards/Criteria[A]	State Standards/Criteria[B]	
		Acute	Chronic
Carbon Monoxide	34,990 (1) ; 8,750 (8)		
Nitric Oxides			
Nitrogen Dioxide	53	250 (CAL EPA)	
Sulfur Dioxide	500 (3); 140 (24); 31		
Acrolein	0.009		0.03 (s)
Formaldehyde	0.65	77	0.65
Carbon Tetrachloride	0.11	300 (CAL EPA)	
Benzene	0.41	314	0.41–1.4
Ethylbenzene	231	2,308	

[A] NAAQS or RfC (ppb); carcinogens set at 10^{-5} risk level: (1) = 1-hour standard, (8) = 8-hour standard; (3) = 3-hour standard, (24) = 24-hour standard, (qtr) = quarterly (3-month) standard; criteria not identified with an exposure period are chronic standards.

[B] HRV ($\mu g/m^3$): (s) = subchronic health risk value

CAL EPA = California Environmental Protection Agency

2.2.2 Data Interpretation

2.2.2.1 Relative Risk Analysis

In the March 2002 report, STS listed emission chemicals from the facility by their relative health impact at the time. The impact was based on the reported amounts of the chemicals emitted by the facility in 1998 through 2000 and their health criteria.

The relative risk of each emission chemical was again determined for this analysis using the facility's most recent reporting data (year 2001) using the following five steps:

- obtain annual reported emission rate for each listed chemical emission from the facility;

- determine the lowest health criteria for those compounds possessing more than one value (Table 4);
- calculate a relative ranking of each chemical using the following equation:

$$\text{Relative Health Impact} = \frac{\text{Emission Rate of Chemical}}{\text{Chemical's Toxicity Value}}$$

- list the chemical emissions by relative health impact, with the highest first;
- identify those emission chemicals that are currently being monitored by the network.

Table 5 of this report presents this quantitative analysis for the facility emissions that possess acute criteria. This table represents this analysis for the most current available TRI data (2001). As can be seen in the table, benzene is the highest ranking chemical currently being monitored. This compound ranks third (ranking changes depending on the year of evaluation), accounting for about 6% of the total relative risk. Nickel compounds are ranked first, and are designated a targeted compound. Nickel emissions singly account for nearly 60% of the total relative risk. Although emissions are generally lower for year 2001 than previous years (1998-2000), the relative risk order is very similar with nickel accounting for the majority of the risk.

Table 6 presents this relative risk analysis for those facility emissions that possess chronic criteria. The table also represents this analysis for the most current available emissions data (2001). A similar finding can be seen in this table as with the acute relative risk analysis. Benzene again is the highest ranking chemical currently being monitored currently and again represents only a small percentage of the total relative risk calculated for the year. For 2001, the highest ranked emissions from this facility are all inorganic substances – chromium compounds, nickel compounds, zinc compounds, and cobalt compounds. Chromium accounts for approximately 84% of the total risk (this risk table assumes 100% of the chromium is chromium VI, this has not been tested). All four of these metals are listed as targeted compounds for this continuing assessment project. Again, the ranking of these chemicals is very similar to the rankings created from emission data for the years 1998 to 2000 in the analysis in 2002.

Table 7 provides another qualitative comparison. In this table, the facility's list of reportable chemical emissions was compared to what is being currently monitored by the

network as well as what chemicals are reported as being emitted by other facilities in Dakota County. Emissions from the other facilities were also taken from the 2001 TRI. With the exception of xylenes, the facility represents the major source in the area for these compounds.

Table 5: Toxic Release Inventory For The Refinery - 2001 Reporting Year (1/1/2001 - 12/31/2001)
Relative Acute Health Impact Of The Toxic Chemicals Emitted Into The Air

Chemical or Chemical Category	Total Emissions (Fugitive and Stack) (lb/year)	State Acute Health Standards/Criteria[A] ($\mu g/m^3$)	Notes	Relative Health Impact	Monitored Chemicals	Targeted Chemicals
Nickel Compounds	770	6		128.3		x
Mercury Compounds	53	1.8		29.44		
Benzene	14,400	1000		14.4	x	x
Selenium Compounds	42	2.94	B	14.29		
Chlorine	2,340	290		8.07		
Hydrochloric Acid (Aerosols)	16,000	2100		7.62		
Ammonia	17,019	3200		5.32		
Methanol	93,000	25000	B	3.72		
Chromium	539	150	B	3.59		x
Lead Compounds	132	38.1	B	3.46		
Xylene (Mixed Isomers)	45,200	22000		2.05	x	
Copper Compounds	175	100		1.75		
Ethyl Benzene	9,100	10000		0.91	x	x
Toluene	32,000	37000		0.86	x	
Barium Compounds	468	1520	B	0.31		
Perchloroethylene	4,200	20000		0.21	x	
Phenol	388	5800		0.067		
Naphthalene	2,560	78600	B	0.033		
Carbon Disulfide	21	6000		0.0035		

Notes:
[A] - HRV
[B] - USEPA, July 1998. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA530-D-98-001A - Appendix A, Table A-4

Table 6: Toxic Release Inventory For The Refinery - 2001 Reporting Year (1/1/2001 - 12/31/2001)
Relative Chronic Health Impact Of The Toxic Chemicals Emitted Into The Air

Chemical or Chemical Category	Total Emissions (Fugitive and Stack) (lb/year)	Federal Chronic Health Standards/Criteria[A] ($\mu g/m^3$)	Notes	State Chronic Health Standards/Criteria[B] ($\mu g/m^3$)	Notes	Relative Health Impact	Monitored Chemicals	Targeted Chemicals
Chromium Compounds	539	0.0008	Chromium VI	0.0008	Chromium VI	673750		x
Nickel	770	70.20		0.02	Nickel refinery dust	38500		x
Zinc Compounds	34,130	0.9				37922		x
Cobalt Compounds	69	0.003				23000		x
Chlorine	2,340	0.20				11700		
Benzene	14,400	1.30		1.30		11077	x	x
Tetrachloroethylene	4,200	1.69				2485	x	
Manganese Compounds	310	0.2	Manganese	0.20	Manganese	1550		x
Barium Compounds	468	0.50				936		
Naphthalene	2,560	3.00		3.00		853		
Hydrochloric Acid (Aerosol)	16,000	20.00		20.00		800		
1,2-Dibromoethane	14	0.05				280		
Ammonia	17,019	80		80.00		212.7		
Lead Compounds	132	0.83				159	x	
Toluene	32,000	400		400.00		80	x	
Xylene (mixed isomers)	45,200	700				64.6		
1,2,4-Trimethylbenzene	6,100	180	used value for 1,3,5-Trimethylbenzene			33.9	x	
Ethylene Glycol	11,000	400				27.5		
Methanol	93,000	4000				23.25		
n-Hexane	34,000			2000.00		17		
Ethylbenzene	9,100	1000				9.1	x	x
Propylene	16,700	3000				5.57		
Selenium Compounds	42	20.00				2.1		
Phenol	388	200				1.94		
Cumene	600	400		4000		1.5		
Carbonyl Sulfide	550	700		700.00		0.79		
Biphenyl	127	175	calculated from subchronic RfD			0.73		
Phenanthrene	53	110	used value for Pyrene			0.48		
Ethylene	7,300	20000				0.37		
Anthracene	53	1100				0.048		

Notes:
[A] NAAQS or RfC
[B] HRV

Flint Hills
STS Project 98563A
May 10, 2004

Table 7: 2001 Reported Facility Air Emissions (TRI) vs. Air Monitoring Analytes and Neighboring Emissions

Emission Chemical	Facility Emissions TRI (lb/yr)[A]	Monitored (?)	Neighbor Emissions	Neighbor Name
A. Organic Compounds				
Anthracene (PAC)	53			
Acrolein	0			none in Dakota Co.
Benzene	14,400	X	(550 lb/yr)	Koch Sulfur
Benzo(g,h,i)perylene (PAC)	25			
Biphenyl	127			
Cumene	600			
1,2-Dibromoethane	27			
1,2-Dichloroethane	35			
t-Butyl alcohol	79			
Carbon Tetrachloride	0			none in Dakota Co.
Cyclohexane	1,780			
Ethylbenzene	9,100	X	(390 lb/yr)	Koch Sulfur
Ethylene	7,300			
Ethylene Glycol	11,000			
Formaldehyde	0			none in Dakota Co.
n-Hexane	34,000		(1400 lb/yr)	Koch Sulfur
Methanol	93,000		(255 lb/yr)	Chemcentral
Naphthalene	2,560		(290 lb/yr)	Koch Sulfur
Phenanthrene (PAC)	53			
Phenol	388			
Propylene	16,700			
Tetrachloroethylene	4,200	X		
1,2,4-Trimethylbenzene	6,100	X		
Toluene	32,000	X	(3400 lb/yr)	Chemcentral & Koch Sulfur
Xylenes	45,200	X	(50026 lb/yr)	C
B. Inorganics				
Ammonia	17,019			
Barium compounds	468			
Carbon Disulfide/carbonyl Sulfide	571			
Chlorine	2,340		(28 lb/yr)	Spectro Alloys
Chromium compounds	539		(178 lb/yr)	Chart Inds.
Cobalt compounds	69			
Copper compounds	175		(759 lb/yr)	Spectro Alloys
Hydrochloric Acid (Aerosol)	16,000		(1868 lb/yr)	Spectro Alloys
Lead compounds	132		(3965 lb/yr)	B
Manganese compounds	310			
Mercury compounds	53		(36 lb/yr)	Excel Energy
Nickel compounds	770		(198 lb/yr)	Chart Inds.
Selenium compounds	42			
Zinc compounds	34,130			
Vanadium compounds	110			

[A] Total emissions: Fugitive + stack emissions
[B] Lead emissions from Chart Inds., Excel Energy, Gopher Resource Corp., and Spectro Alloys.
[C] Xylene emissions from Chemcentral, Koch Sulfur, and Waterous Co.

2.2.3 Data Comparison to Air Quality Standards

The fourth quarter of the calendar year 2003 was chosen to begin the series of quarterly data to be analyzed with this study as it was the most recent data available for analysis. Each monitored parameter at each of the monitoring sites for this quarter was analyzed to compute standard descriptive statistics: maxima and means for annual, quarterly, and 1-hour averaging times (also 3-hour for SO_2), as well as the 95% confidence limits of the mean values. Also calculated was the probability (chance) that the true average of the data for each quarter would exceed the chronic health criteria for a chemical. Since only one quarter was analyzed, a numerical adjustment was made to estimate the annual average for comparison to the chronic standards. Likewise, the HAPs analyses were based on 24-hour integrated samples, thus a numerical adjustment was made to adjust to the shorter averaging period. [Note: as discussed earlier, this adjustment could not completely account for the "worst" one hour-averaged concentration of each acute toxic chemical as is desirable for the acute risk analysis. Only continuous monitoring could accurately provide that data.]

The results of this descriptive analysis are summarized in Figures 1 through 5 for the criteria pollutants and Figures 6 through 11 for the HAP chemicals. Each figure has been formatted in a similar manner. On the X-axis, the 2003 fourth quarter data are compared to the 2001 value from the previous study. On the Y-axis is an air concentration range chosen to encompass both the chemical's health criterion and the maximum or calculated average of the monitoring data. Data specific to each monitor location is designed by a different symbol. The "criterion line" does not contain any symbols. The smaller graph is an expanded image of the 2003 fourth quarter data. The small graph has the data points affiliated with each monitoring site as well as the monitored concentration ranges (for maximum values) or the standard deviation (for averaged values).

Reading each figure is performed in an identical manner. If the monitoring data for any given year and any given monitor is less than the criterion concentration, then with respect to that chemical at that location, no risk to public health is present. For example, Figure 1 shows the three-hour averaged data for sulfur dioxide. The health criterion is 500 ppb. All of the monitoring data are below 25 ppb. Thus, it can be concluded from

these data that acute exposure to sulfur dioxide in the areas of the monitors does not present a health risk to the public. Statistical analyses of these data were performed, but not shown on this figure because the confidence interval is so small. In a separate analysis, it was determined that there is less than 0.01% chance that the true three hour-averaged sulfur dioxide concentration at these monitoring locations would actually exceed this air quality standard.

The following sections detail the analysis for each of the 11 figures.

Sulfur Dioxide 3-hour Average

Figure 1 displays the maximum three-hour averages for the four monitored sites and compares the concentrations with a 500 ppb criteria. The maximum three-hour average was calculated from the hourly data available. Each monitoring site has a maximum and 95% upper confidence limit well below the criteria. The monitoring data are all less than 25 ppb, considerably below the USEPA standard of 500 ppb. Statistical analysis of the data indicates that there is less than 0.01% chance probability that these data would exceed this standard.

Sulfur Dioxide 24-hour Average

Figure 2 displays the maximum 24-hour averages for the four monitored sites and compares the concentrations with a 140 ppb criteria. The maximum 24-hour average was calculated from the hourly data available. Each monitoring site has a maximum and 95% upper confidence limit of less than 10% of the criteria. The monitoring data are all less than 11 ppb, considerably below the USEPA standard of 140 ppb. Statistical analysis of the data indicates that there is less than 0.01% chance probability that these data would exceed this standard.

Sulfur Dioxide Annual Average

Figure 3 displays the average annual concentration for the four monitored sites and compares the concentrations with a 31 ppb criteria. The quarterly average was calculated from the hourly data available and then adjusted to an annual average using a factor of 0.53. The scaled annual averages for each monitoring site and 95% confidence level are well below the criteria. The expanded view also illustrates that the standard

deviations are less than 10% of the criteria. The monitoring data all have averages less than 1 ppb, considerably below the USEPA standard of 31 ppb. Statistical analysis of the data indicates that there is less than 0.01% chance probability that these data would exceed this standard.

Nitrogen Dioxide 1-hour Average

Figure 4 displays the maximum one-hour averages for the two monitored sites and compares the concentrations with a 250 ppb criteria. The maximum one-hour average was calculated from the hourly data available. Each monitoring site has a maximum and 95% upper confidence limit well below the criteria. The monitoring data are all less than 50 ppb, considerably below the USEPA standard of 250 ppb. Statistical analysis of the data indicates that there is less than 0.01% chance probability that these data would exceed this standard.

Nitrogen Dioxide Annual Average

Figure 5 displays the annual averages for the two monitored sites and compares the concentrations with a 53 ppb criteria. The quarterly average was calculated from the hourly data available and then adjusted to an annual average using a factor of 0.53. The scaled annual averages for each monitoring site and 95% confidence level are well below the criteria. The expanded view also illustrates that the standard deviations are less than 20% of the criteria. The monitoring data have averages less than 4 ppb, considerably below the USEPA standard of 53 ppb. Statistical analysis of the data indicates that there is less than 0.01% chance probability that these data would exceed this standard.

Formaldehyde 1-hour Average

Figure 6 displays the maximum one-hour averages for the four monitored sites and compares the concentrations with a 77 ppb criteria. The maximum one-hour average was scaled from the 24-hour averaged data available with a factor of 2.5. Each monitoring site has a maximum and 95% upper confidence limit well below the criteria. The monitoring data are all less than 10 ppb, considerably below the Minnesota Department of Health standard of 77 ppb. Statistical analysis of the data indicates that there is less than 0.05% chance probability that these data would exceed this standard.

Formaldehyde Annual Average

Figure 7 displays the annual average concentrations for the four monitored sites and compares them to a 0.65 ppb criteria. The quarterly average was calculated from the 24-hour averaged data available and then adjusted to an annual average using a factor of 0.53. As shown in this figure, the calculated annual averaged mean concentration of formaldehyde, as well as its 95% confidence interval, were below the formaldehyde health criterion for three monitors. The exception is for monitor 420, where both the average and the upper 95% confidence limit were higher than the criterion. From the quarterly data for monitor 420, it was shown that for this one year, there was a 75% chance that the true average would have exceeded this standard.

Carbon Tetrachloride Annual Average

Figure 8 displays the annual averages for the four monitored sites and compares the concentrations with a 0.11 ppb criteria. The quarterly average was calculated from the 24-hour averaged data available and then adjusted to an annual average using a factor of 0.53. The scaled annual averages for each monitoring site and 95% confidence level are well below the criteria. The expanded view also illustrates that the standard deviations are less than 50% of the criteria. The monitoring data all have averages less than 0.05 ppb, considerably below the standard of 0.11 ppb. Statistical analysis of the data indicates that there is less than 0.05% chance probability that these data would exceed this standard.

Benzene Annual Average

Figure 9 displays the annual averages for the four monitored sites and compares the concentrations with a 0.41 ppb criteria. The quarterly average was calculated from the 24-hour averaged data available and then adjusted to an annual average using a factor of 0.53. The scaled annual averages for each monitoring site and 95% confidence level are well below the criteria. The expanded view also illustrates that the standard deviations are less than 25% of the criteria. The monitoring data all have averages less than 0.13 ppb, considerably below the Minnesota Department of Health standard of 0.41 ppb. Statistical analysis of the data indicates that there is less than 005% chance probability that these data would exceed this standard.

Ethylbenzene 1-hour Average

Figure 10 displays the maximum one-hour averages for the four monitored sites and compares the concentrations with a 2,300 ppb criteria. The maximum one-hour average was scaled from the 24-hour averaged data available with a factor of 2.5. Each monitoring site has a maximum and 95% upper confidence limit well below the criteria. The monitoring data are all less than 0.5 ppb, considerably below the Minnesota Department of Health standard of 2,300 ppb. Statistical analysis of the data indicates that there is less than 0.05% chance probability that these data would exceed this standard.

Ethylbenzene Annual Average

Figure 11 displays the annual averages for the four monitored sites and compares the concentrations with a 230 ppb criteria. The quarterly average was calculated from the 24-hour averaged data available and then adjusted to an annual average using a factor of 0.53. The scaled annual averages for each monitoring site and 95% confidence level are well below the criteria. The expanded view also illustrates that the standard deviations are less than 1% of the criteria. The monitoring data all have averages less than 0.03 ppb, considerably below the USEPA standard of 230 ppb. Statistical analysis of the data indicates that there is less than 0.05% chance probability that these data would exceed this standard.

Figure 1

Sulfur Dioxide Maximum 3-Hour Average Concentration

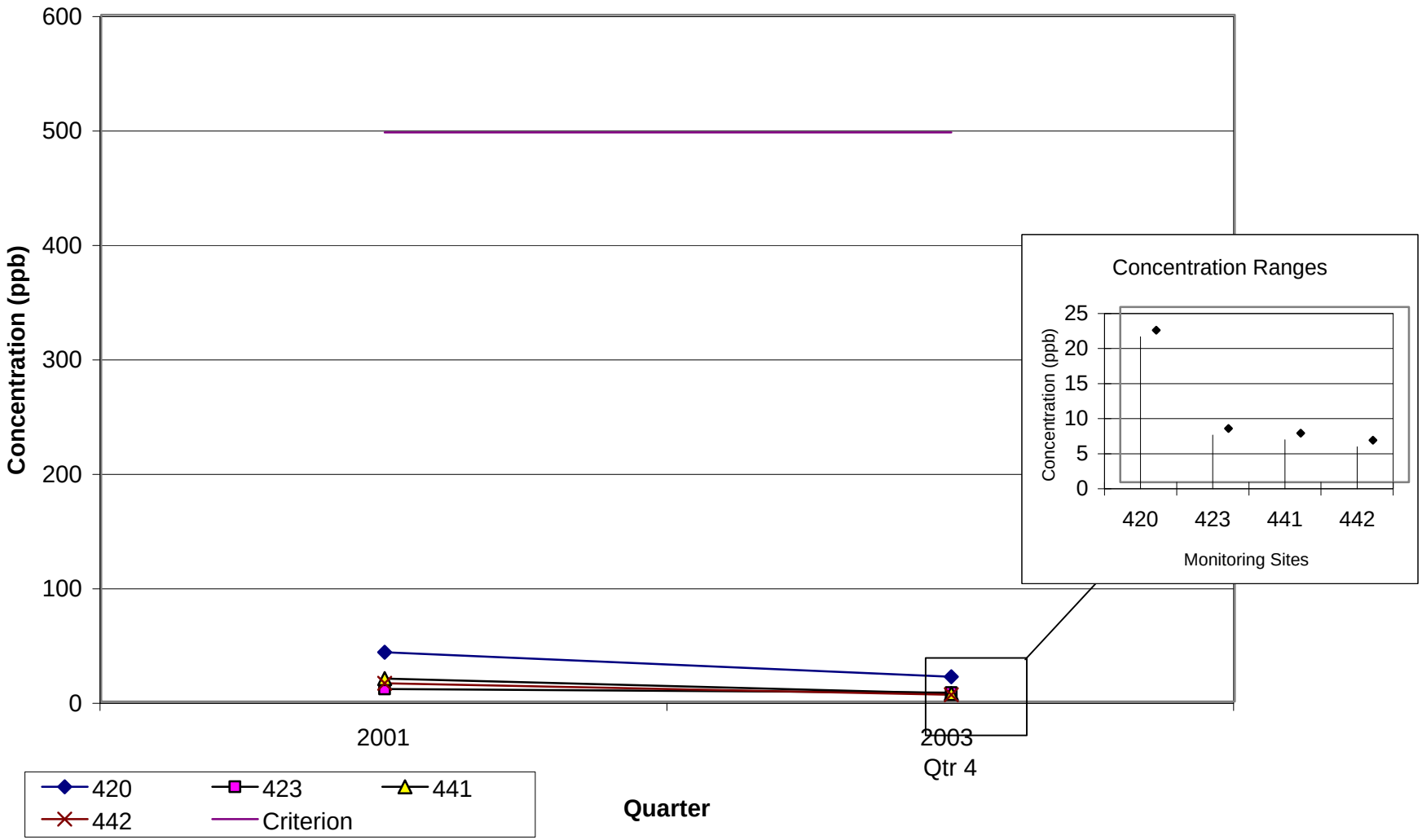


Figure 2

Sulfur Dioxide Maximum 24-Hour Average Concentration

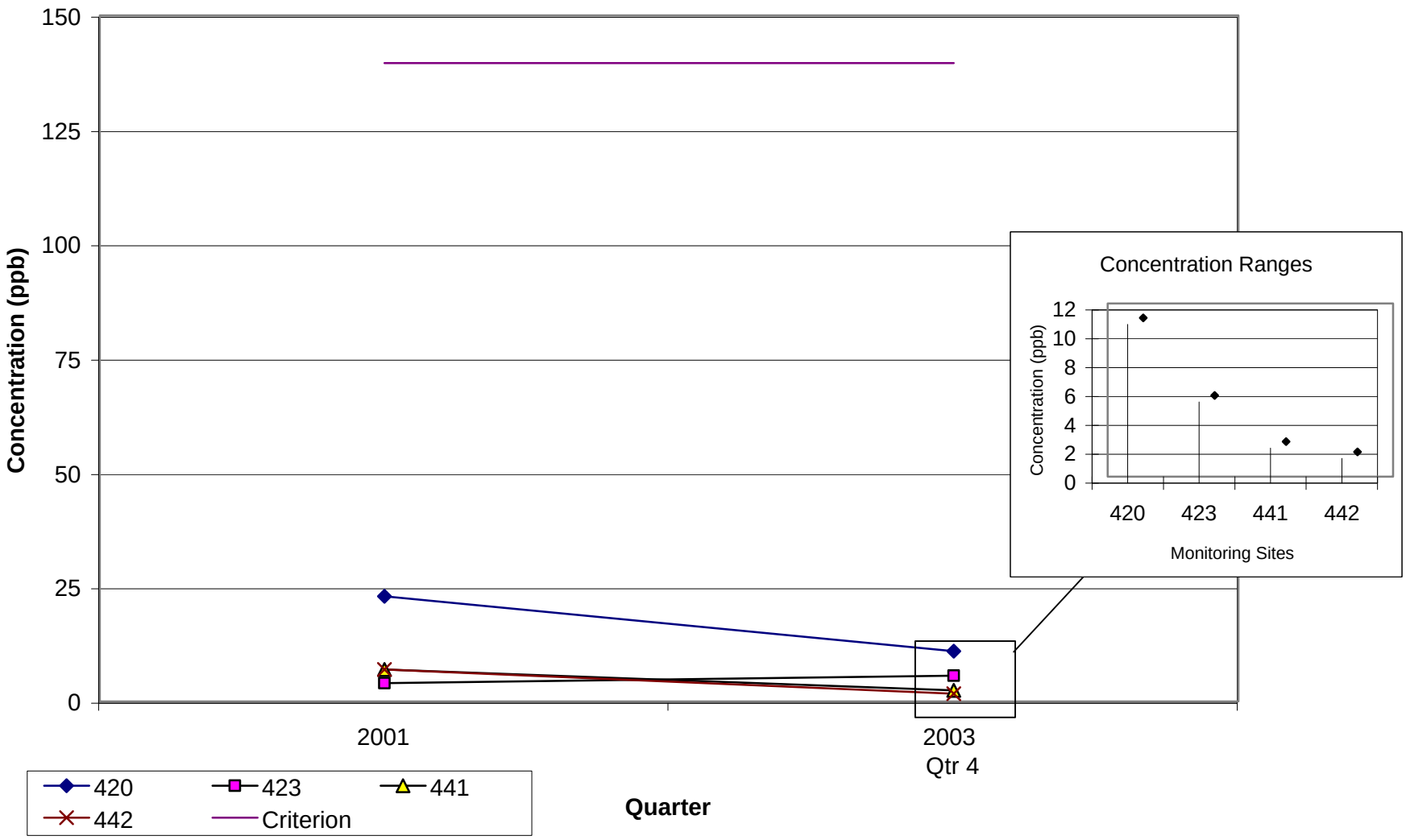


Figure 3

Sulfur Dioxide Annual Average Concentration

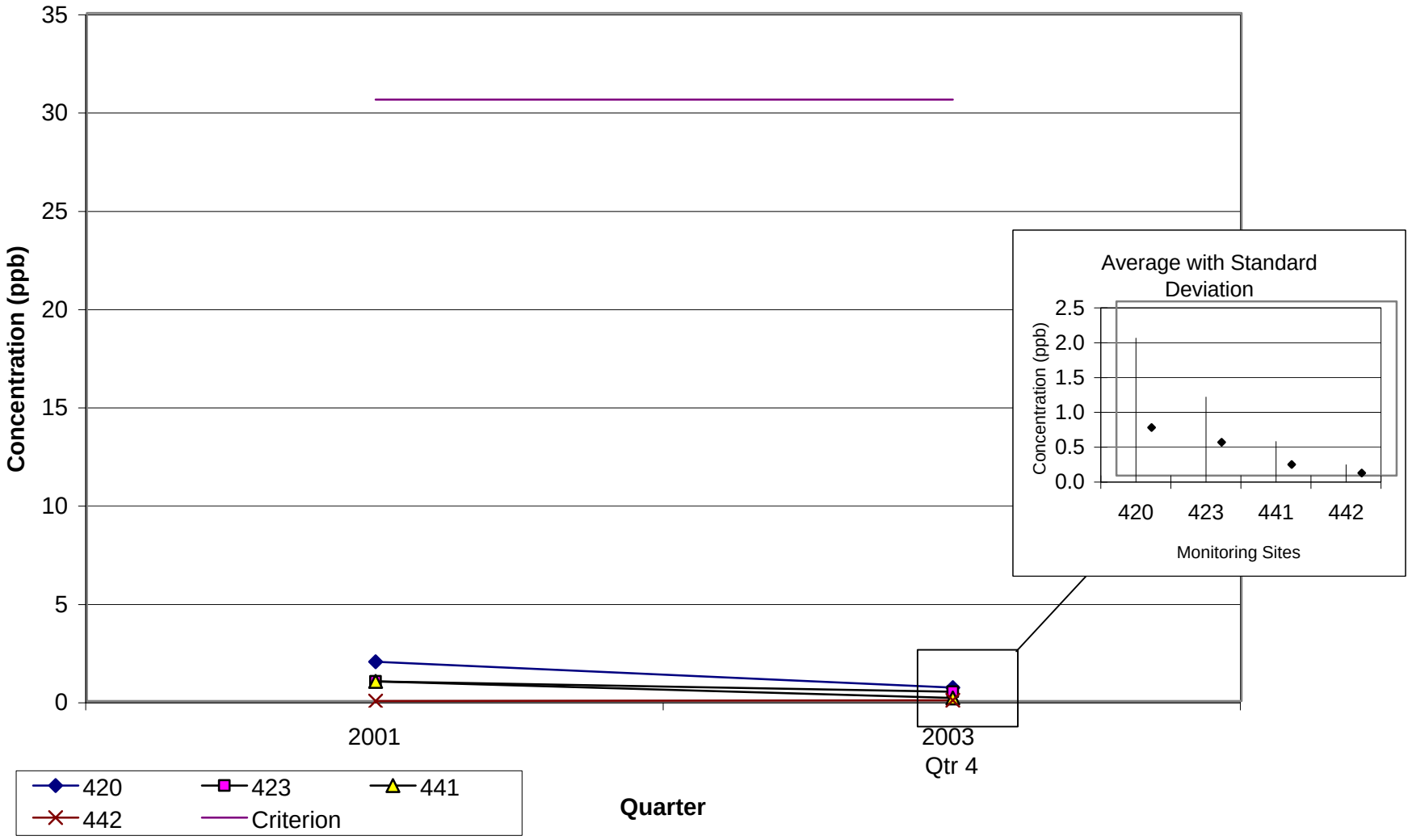


Figure 4

Nitrogen Dioxide Maximum 1-Hour Average Concentration

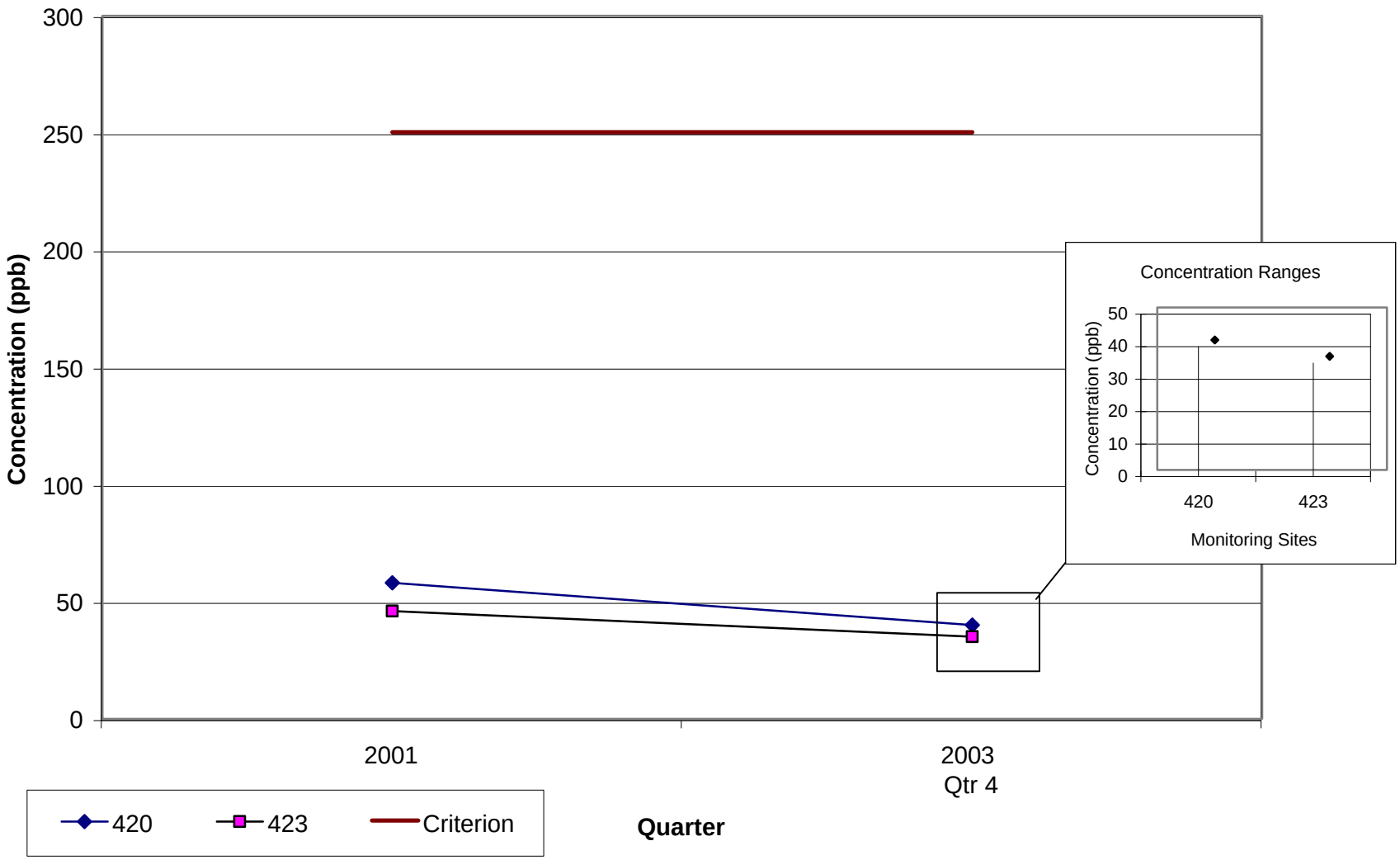


Figure 5

Nitrogen Dioxide Annual Average Concentration

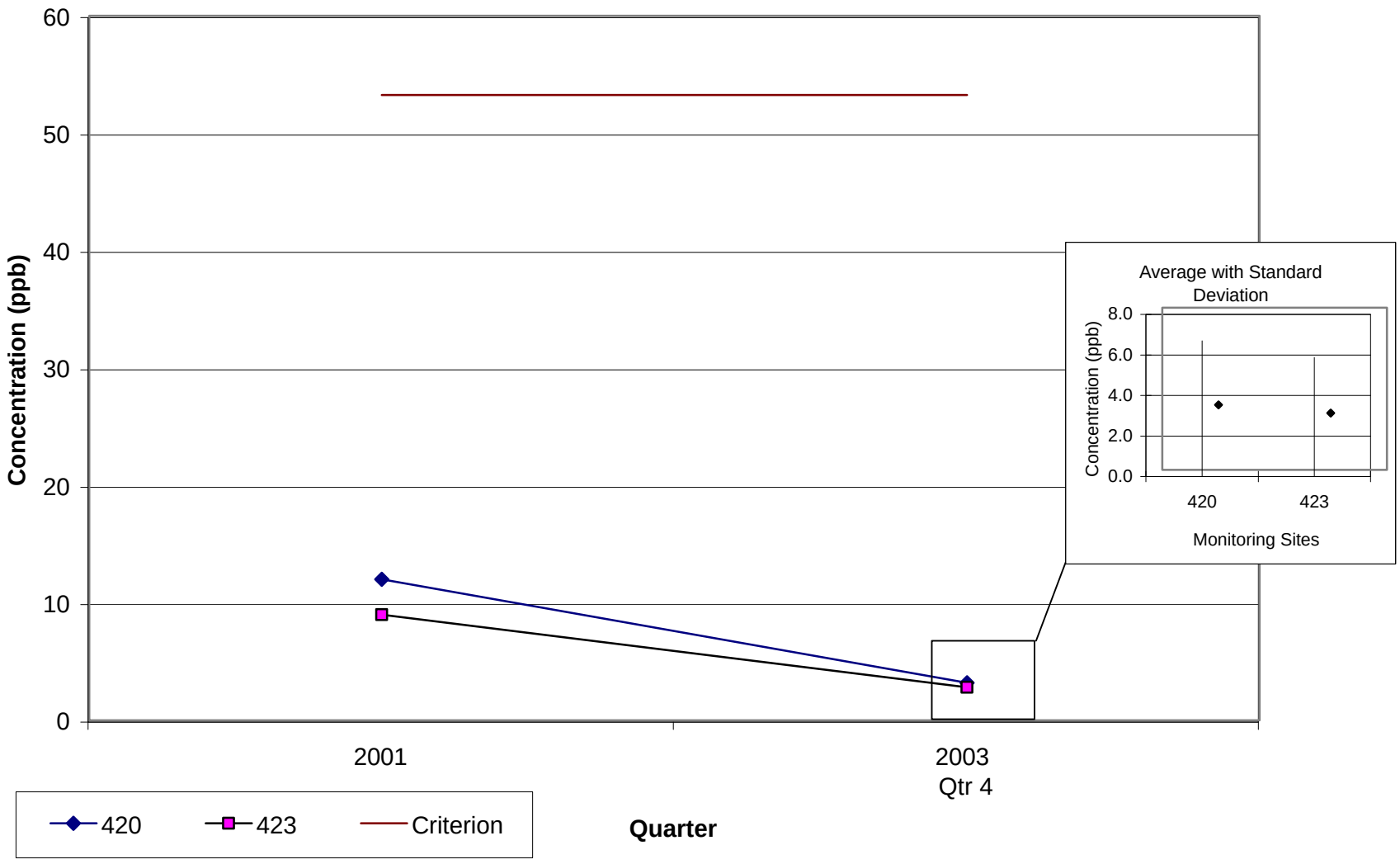


Figure 6

Formaldehyde Maximum 1-Hour Average Concentration

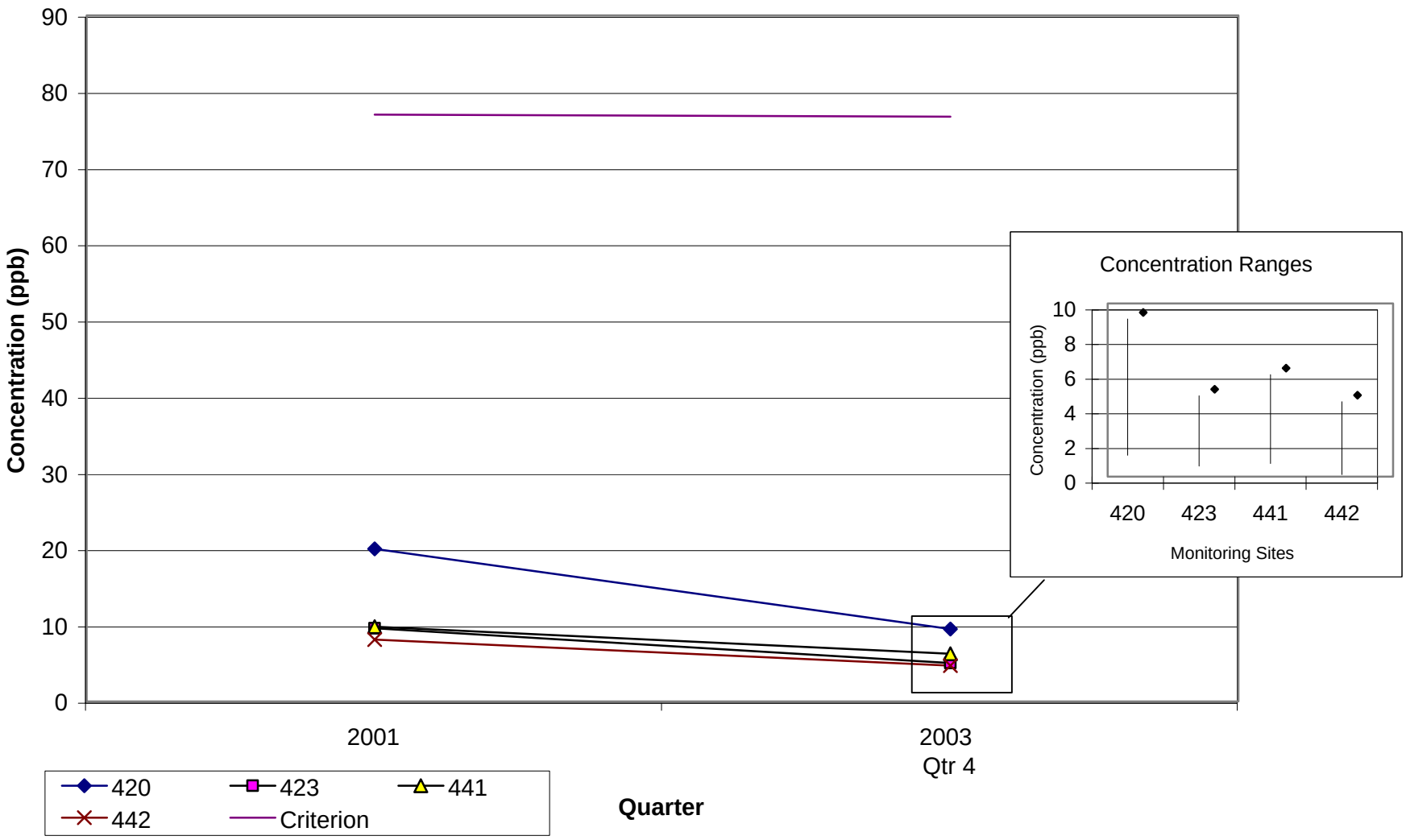


Figure 7

Formaldehyde Annual Average Concentration

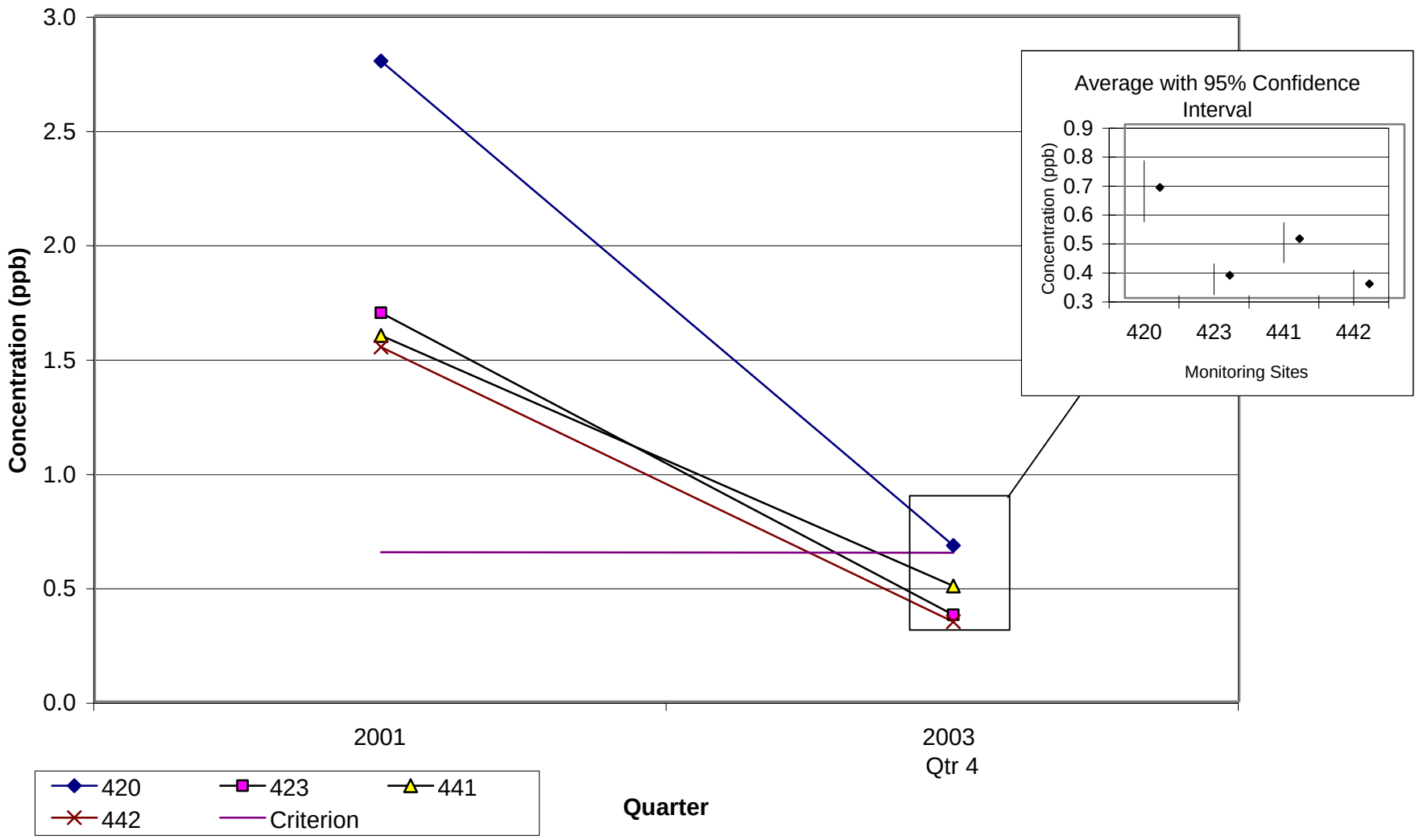


Figure 8

Carbon Tetrachloride Annual Average Concentration

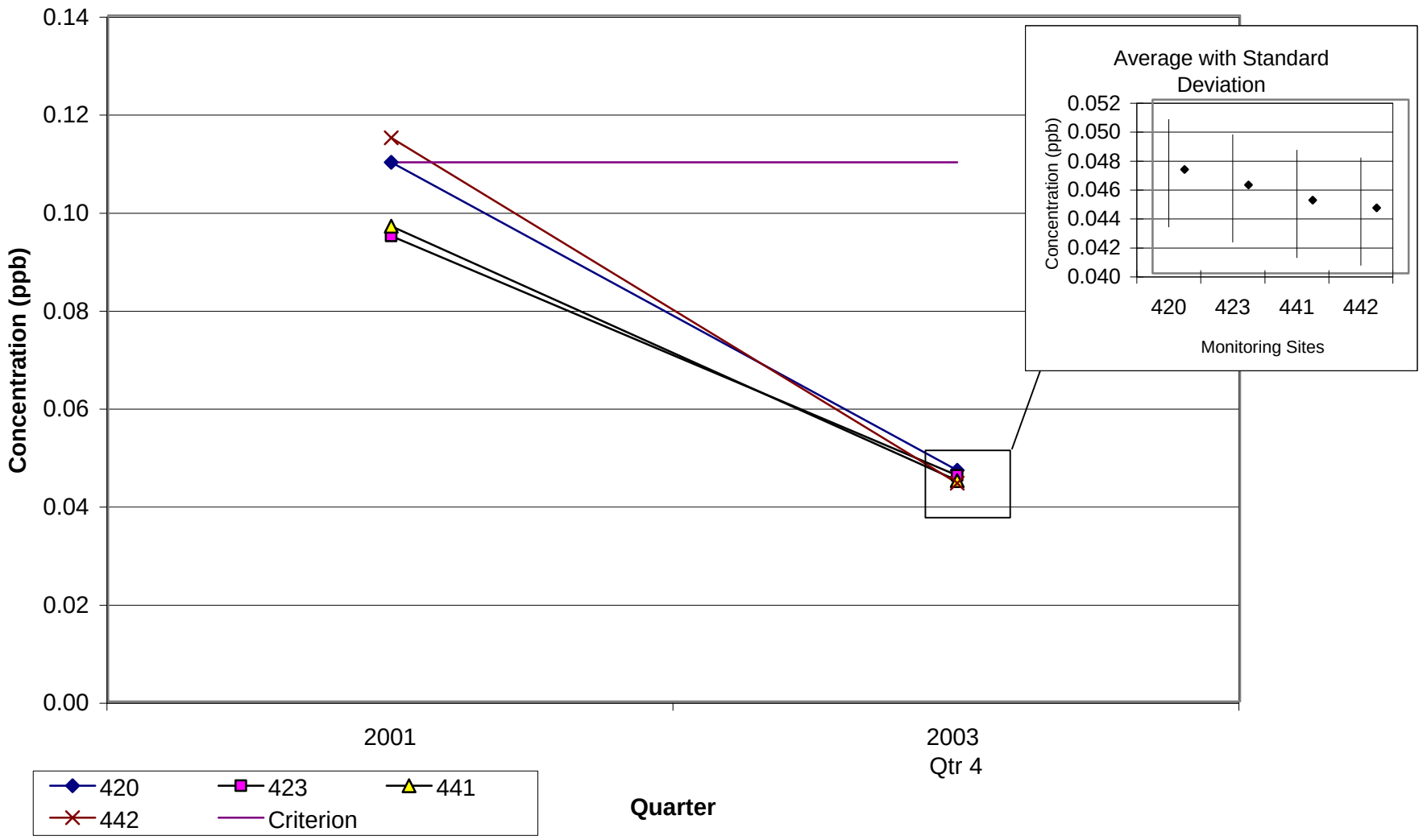


Figure 9

Benzene Annual Average Concentration

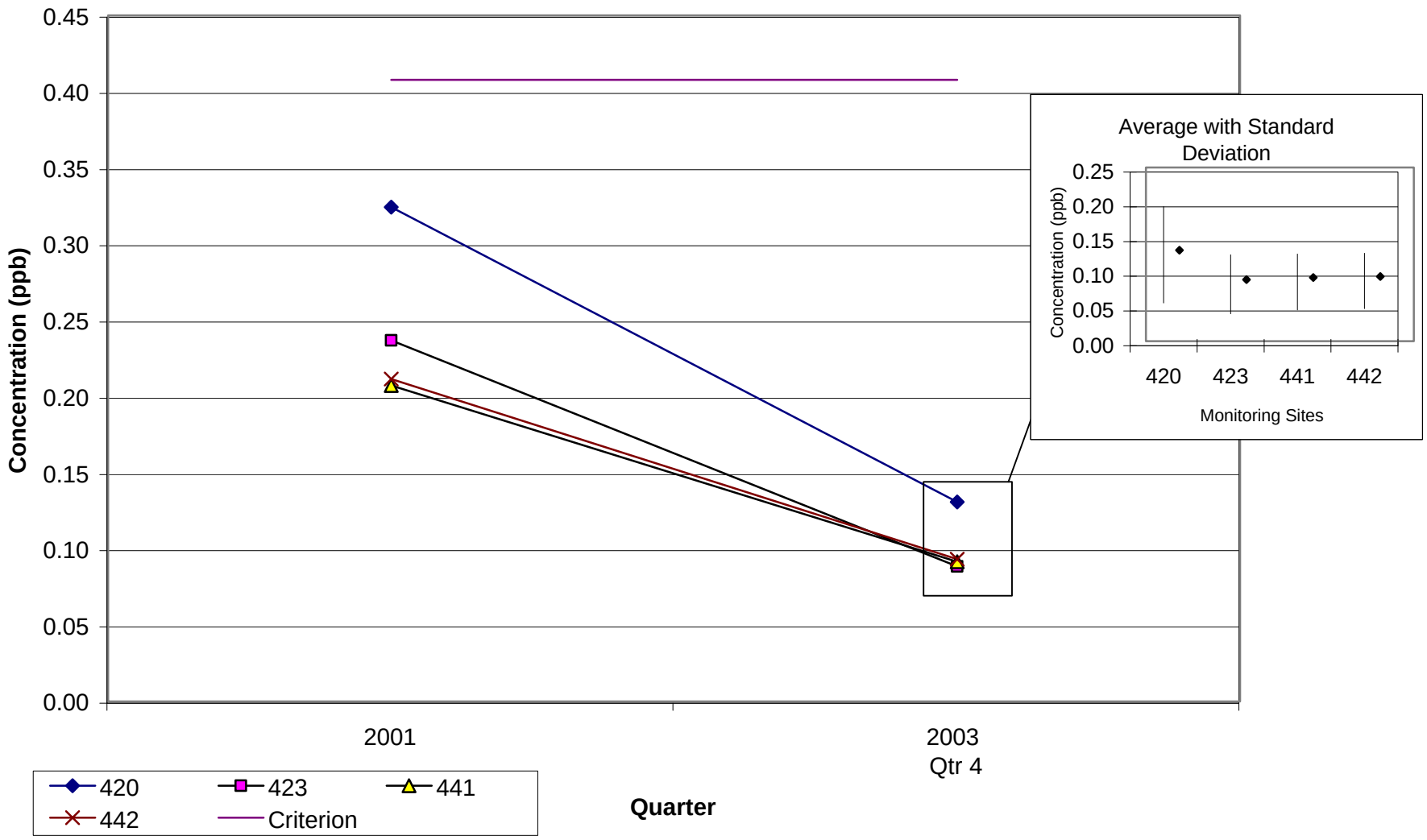


Figure 10

Ethylbenzene Maximum 1-Hour Average Concentration

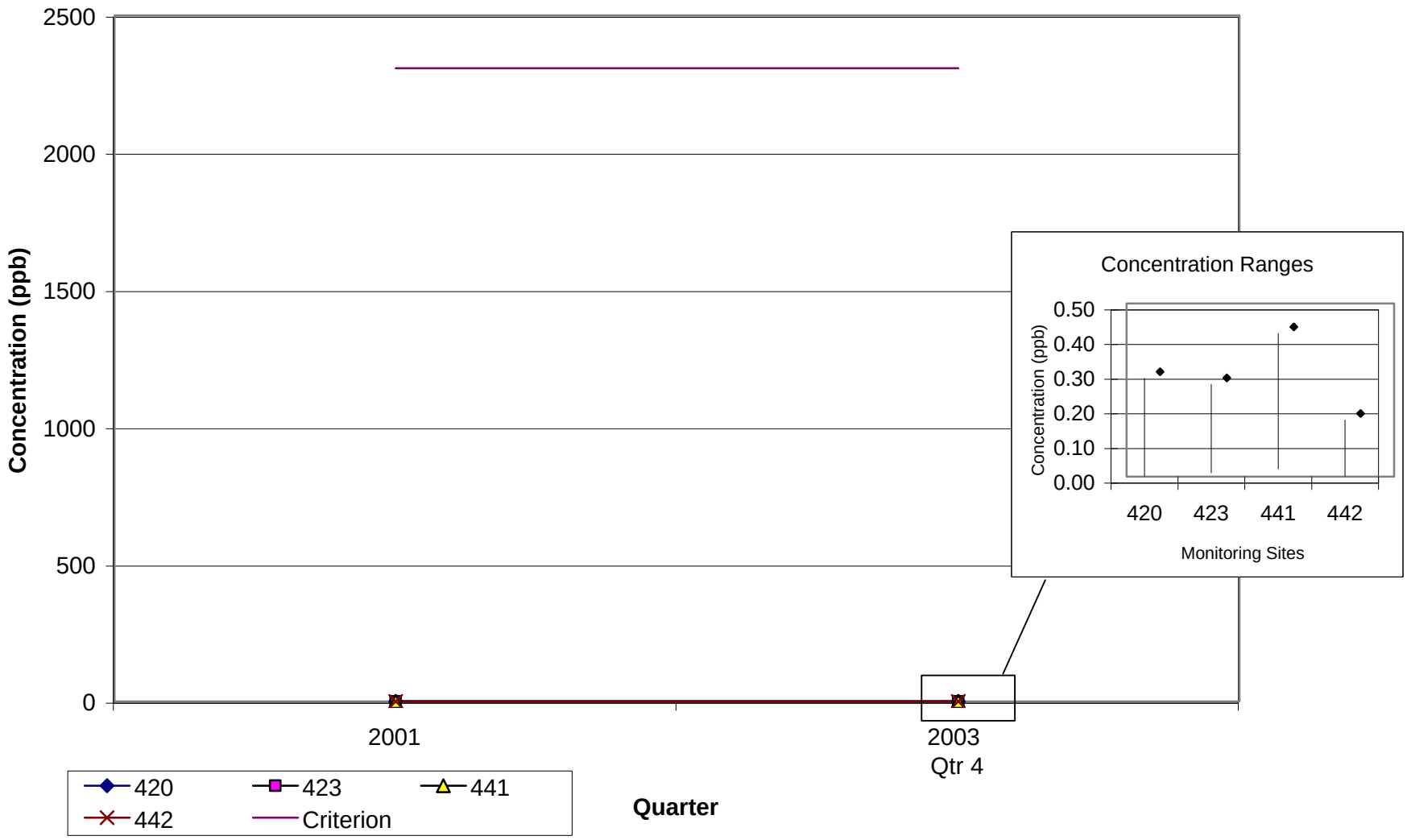
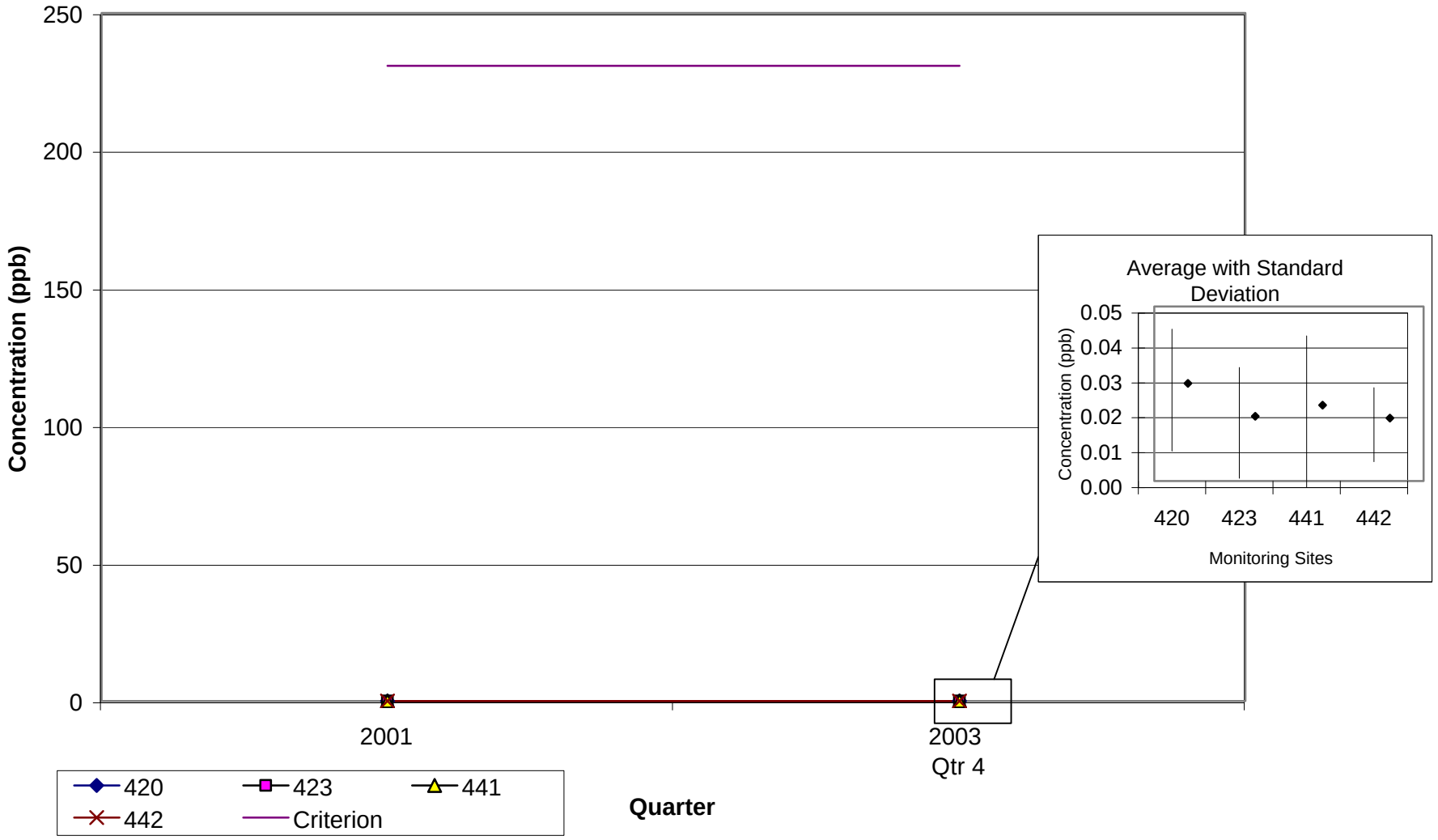


Figure 11

Ethylbenzene Annual Average Concentration



Flint Hills
STS Project 98563A
May 10, 2004

3.0 CONCLUSIONS

The March 2002 report indicated that of the targeted chemicals currently being monitored only formaldehyde might be a chemical of concern in the area of the facility. Flint Hills does not report this chemical on their annual TRI emissions submittal. STS looked at other TRI reporting facilities in Dakota County. Formaldehyde was not reported as being emitted from any of the facilities. It is likely that the majority of the formaldehyde concentrations come from combustion sources, either mobile or stationary.