Richmond, VA NATTS Network Assessment Review

- Established 2008: Carbonyls, Chromium VI, PAHs, PM_{10} Metals, and VOCs
    - Chromium VI ended in in 2016
- For the NATTS Network Assessment (2008-2022):
    - 17 of 17 Method Quality Objective (MQO) Core HAPs were included in the national trends
    - 237 of 238 pollutant datasets were suitable for trends analysis
    - Annual Average and 3-Year Rolling Average Concentrations were decreasing for cadmium (PM_{10}), naphthalene, and nickel (PM_{10}).
    - 100% Reporting of Datasets
- Method Quality Objectives (MQO): 2008-2022
    - Completeness: Met 85% completeness in 238 of 238 pollutant datasets
    - Method Detection Limits: Met MDL Target Ratio of 1.00 in 216 of 255 pollutant datasets
    - Bias: Met ±25% for 206 of 216 pollutant datasets
    - Overall Method Precision: Met ≤15% CV for 59 of 74 pollutant datasets
    - Analytical Method Precision: Met ≤15% CV for 113 of 158 pollutant datasets
- Analytical Laboratories for 2022

VOC	Carbonyl	PM_{10} Metals	PAHs
VADCLS	VADCLS	VADCLS	ERG

- Equipment Year Deployed

Equipment Type	VOC	Carbonyl	PM_{10} Metals	PAHs
Sampler	2021	2022	2009	2008
Analytical	2004	2012	2019	2021
Preconcentrator	2012	NA	NA	NA
Standards Preparation	2021	NA	NA	NA
Canister Cleaning	2018	NA	NA	NA
Extraction	NA	NA	2016	2019

National Summary: NATTS data were collected at 27 locations across the United States, with sites beginning in 2003 or later (Figure 1) for 20 core HAPs. Over 670,000 concentrations (primary, secondary, and replicate) were generated and analyzed for this assessment. Pollutant datasets were scored to assess whether they were suitable for trends analysis. Each pollutant dataset was evaluated against four MQOs: Completeness; Sensitivity; Bias; and Precision. Datasets that were suitable (A- or B-rated) for six consecutive years were used for national trends analysis (Table 1).

National trends were determined by comparing the most recent 3-year blocked averages (e.g., 2017-2019 vs. 2020-2022) to determine if the NATTS Trends DQO was being met:

To be able to detect a 15 percent difference (trend) between the annual mean concentrations of successive 3-year periods within acceptable levels of decision error.

Of the 20 core HAPs. 17 were assessed for the NATTS Trends DQO. Due to sampling and analytical issues, acrolein was not considered for trends analysis (Table 2). Additionally, hexavalent chromium was discontinued as a required pollutant and ethylene oxide became an official MQO pollutant beginning in 2021. The assessment showed that across the network, 11 of those 17 pollutants were decreasing between the 3-year blocks, while four of those pollutants were increasing between the 3-year blocks. Two pollutants did not exhibit a noticeable trend.

Figure 1. NATTS Site and Year Established

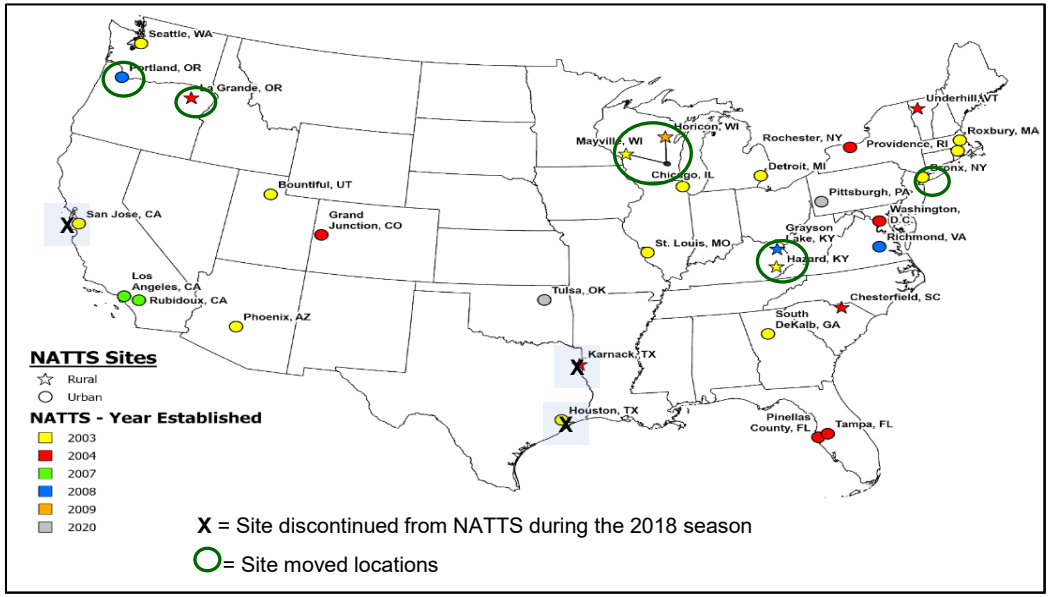


Table 1. NATTS Network Assessment: Count and Percentage of Suitable Datasets by Pollutant Group

Pollutant Group	A-rated		B-rated		Does Not Meet	
	#	%	#	%	#	%
VOCs	1,968	58%	864	25%	572	17%
Carbonyls	668	68%	231	24%	77	8%
PM_{10} Metals	1,906	66%	775	27%	217	7%
PAHs	571	77%	144	19%	29	4%
Total = 8,704	5,113	64%	2,014	25%	895	11%

Table 2. Three-Year Block Averages for National Trends

Pollutant[a,b,c]	Units	# Sites	Block 1	Block 2	% Difference
Acetaldehyde	µg/m^3	16	1.48	1.34	-9.2%
Arsenic (PM_{10})	ng/m^3	18	0.68	0.64	-6.6%
Benzene	µg/m^3	16	0.529	0.525	-0.8%
Benzo(a)pyrene	ng/m^3	18	0.086	0.072	-16.6%
Beryllium (PM_{10})	ng/m^3	18	0.008	0.010	15.0%
Butadiene, 1,3-	µg/m^3	15	0.057	0.054	-5.1%
Cadmium (PM_{10})	ng/m^3	20	0.087	0.090	3.7%
Carbon Tetrachloride	µg/m^3	15	0.53	0.50	-5.3%
Chloroform	µg/m^3	16	0.173	0.165	-4.8%
Formaldehyde	µg/m^3	15	2.809	2.482	-11.7%
Lead (PM_{10})	ng/m^3	20	2.44	2.43	-0.5%
Manganese (PM_{10})	ng/m^3	20	6.69	7.31	9.2%
Naphthalene	ng/m^3	17	42.00	35.10	-16.4%
Nickel (PM_{10})	ng/m^3	19	0.87	0.83	-3.7%
Tetrachloroethylene	µg/m^3	15	0.12	0.12	1.5%
Trichloroethylene	µg/m^3	14	0.019	0.022	16.3%
Vinyl Chloride	µg/m^3	16	0.004	0.001	-69.0%

[a] Acrolein was not assessed due to sampling and analytical issues

[b] Sampling for ethylene oxide formally began in 2021 and is not assessed

[c] Hexavalent chromium (not assessed) was discontinued in 2013

NATTS Monitoring Site Report: Richmond, VA

Site Information

Region	3
NATTS Site Type	Urban
County	Henrico
AQS Site Code	51-087-0014
NATTS Operating Agency	VA Dept. Environmental Quality
Latitude	37.55655
Longitude	-77.400411
AQS Land Use	Residential
AQS Location Setting	Suburban
10-Mile Population	334,760

Figure 2. NATTS Site Location

Pollutant Datasets Evaluation: Suitable for Trends (Y=yes; Y(T)=yes, and used for DQO Trends; N=No; "--"=not rated)

Final Pollutant Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Acetaldehyde	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Arsenic (PM_{10})	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Benzene	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Benzo(a)pyrene	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Beryllium (PM_{10})	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Butadiene, 1,3-	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Cadmium (PM_{10})	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Carbon tetrachloride	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Chloroform	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Formaldehyde	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Lead (PM_{10})	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Manganese (PM_{10})	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Naphthalene	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Nickel (PM_{10})	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Tetrachloroethylene	--(a)	Y	Y	Y	N(b)	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Trichloroethylene	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)
Vinyl chloride	--(a)	Y	Y	Y	Y	Y	Y	Y	Y	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)	Y(T)

[a]: NATTS sampling officially began in Summer 2008

Table 3. NATTS Network Assessment Data (2003-2022) - National Distribution Statistics By Type[a]

Analyte	Units	Site Type	# Data Records	% Detections	Arithmetic Mean[b]	Percentile Value[c]						
						5th	10th	25th	50th	75th	90th	95th
Acetaldehyde	µg/m^3	Urban	22,000	100%	1.73 ± 0.02	0.50	0.65	0.95	1.42	2.15	3.19	3.96
	µg/m^3	Rural	6,392	100%	1.17 ± 0.03	0.36	0.45	0.65	0.92	1.35	1.98	2.67
	µg/m^3	All Sites	28,392	100%	1.61 ± 0.02	0.45	0.58	0.85	1.29	1.97	2.99	3.79
Arsenic (PM_{10})	ng/m^3	Urban	21,944	95%	0.87 ± 0.03	0.03	0.16	0.32	0.56	0.96	1.65	2.37
	ng/m^3	Rural	6,385	96%	0.49 ± 0.02	0.03	0.08	0.16	0.35	0.58	0.93	1.30
	ng/m^3	All Sites	28,329	96%	0.78 ± 0.02	0.03	0.13	0.27	0.51	0.87	1.51	2.16
Benzene	µg/m^3	Urban	22,246	99%	0.85 ± 0.01	0.23	0.29	0.42	0.64	1.02	1.62	2.20
	µg/m^3	Rural	5,932	90%	0.52 ± 0.01	ND	0.06	0.20	0.38	0.67	1.08	1.51
	µg/m^3	All Sites	28,178	97%	0.78 ± 0.01	0.16	0.23	0.36	0.58	0.95	1.52	2.07
Benzo(a)pyrene	ng/m^3	Urban	17,810	73%	0.10 ± 0.01	ND	ND	ND	0.04	0.10	0.23	0.35
	ng/m^3	Rural	4,735	37%	0.07 ± 0.01	ND	ND	ND	ND	0.02	0.19	0.38
	ng/m^3	All Sites	22,545	65%	0.09 ± 0.01	ND	ND	ND	0.03	0.09	0.22	0.35
Beryllium (PM_{10})	ng/m^3	Urban	21,786	77%	0.042 ± 0.004	ND	ND	0.0005	0.005	0.015	0.043	0.098
	ng/m^3	Rural	6,062	49%	0.018 ± 0.002	ND	ND	ND	ND	0.004	0.012	0.041
	ng/m^3	All Sites	27,848	71%	0.037 ± 0.003	ND	ND	ND	0.003	0.011	0.038	0.083
Butadiene, 1,3-	µg/m^3	Urban	22,220	78%	0.092 ± 0.002	ND	ND	0.018	0.051	0.110	0.215	0.317
	µg/m^3	Rural	5,940	29%	0.017 ± 0.001	ND	ND	ND	ND	0.011	0.054	0.104
	µg/m^3	All Sites	28,160	68%	0.076 ± 0.002	ND	ND	ND	0.039	0.092	0.190	0.283
Cadmium (PM_{10})	ng/m^3	Urban	21,954	93%	0.184 ± 0.014	ND	0.019	0.043	0.081	0.160	0.354	0.572
	ng/m^3	Rural	6,067	89%	0.092 ± 0.005	ND	ND	0.026	0.055	0.099	0.179	0.270
	ng/m^3	All Sites	28,021	92%	0.164 ± 0.011	ND	0.012	0.039	0.075	0.143	0.300	0.518
Carbon Tetrachloride	µg/m^3	Urban	22,202	98%	0.556 ± 0.002	0.336	0.423	0.486	0.550	0.638	0.725	0.784
	µg/m^3	Rural	5,909	84%	0.494 ± 0.010	ND	ND	0.342	0.533	0.629	0.728	0.807
	µg/m^3	All Sites	28,111	95%	0.543 ± 0.003	ND	0.363	0.475	0.547	0.636	0.726	0.788
Chloroform	µg/m^3	Urban	22,218	88%	0.243 ± 0.016	ND	ND	0.094	0.129	0.205	0.398	0.630
	µg/m^3	Rural	5,942	56%	0.062 ± 0.002	ND	ND	ND	0.049	0.098	0.134	0.228
	µg/m^3	All Sites	28,160	82%	0.205 ± 0.013	ND	ND	0.076	0.110	0.187	0.342	0.543

Table 3. NATTS Network Assessment Data (2003-2022) - National Distribution Statistics By Type[a]

Analyte	Units	Site Type	# Data Records	% Detections	Arithmetic Mean[b]	Percentile Value[c]						
						5th	10th	25th	50th	75th	90th	95th
Formaldehyde	µg/m^3	Urban	22,024	100%	3.03 ± 0.04	0.69	1.00	1.57	2.42	3.72	5.47	6.95
	µg/m^3	Rural	6,432	100%	2.16 ± 0.04	0.49	0.64	1.03	1.67	2.69	4.12	5.34
	µg/m^3	All Sites	28,456	100%	2.83 ± 0.03	0.61	0.86	1.42	2.25	3.50	5.22	6.65
Lead (PM_{10})	ng/m^3	Urban	21,955	100%	3.97 ± 0.10	0.70	0.95	1.46	2.49	4.34	7.87	11.16
	ng/m^3	Rural	6,066	99%	1.93 ± 0.14	0.34	0.45	0.75	1.27	2.14	3.59	4.96
	ng/m^3	All Sites	28,021	100%	3.53 ± 0.09	0.53	0.75	1.22	2.17	3.88	6.99	10.10
Manganese (PM_{10})	ng/m^3	Urban	21,906	100%	9.76 ± 0.25	1.06	1.49	2.53	4.96	10.43	20.40	30.79
	ng/m^3	Rural	6,067	99%	3.79 ± 0.12	0.48	0.74	1.34	2.48	4.49	8.08	11.64
	ng/m^3	All Sites	27,973	100%	8.47 ± 0.20	0.84	1.22	2.16	4.19	8.99	18.13	27.27
Naphthalene	ng/m^3	Urban	17,811	100%	67.25 ± 0.97	13.42	18.03	28.73	49.00	84.13	136.42	180.00
	ng/m^3	Rural	4,732	98%	21.76 ± 1.02	2.79	4.04	6.84	12.47	23.51	45.68	69.01
	ng/m^3	All Sites	22,543	100%	57.70 ± 0.83	5.92	9.77	20.41	40.15	74.11	124.40	167.26
Nickel (PM_{10})	ng/m^3	Urban	21,958	98%	1.76 ± 0.05	0.29	0.40	0.62	1.02	1.86	3.32	5.05
	ng/m^3	Rural	5,989	85%	0.56 ± 0.07	ND	ND	0.10	0.26	0.53	0.96	1.63
	ng/m^3	All Sites	27,947	95%	1.50 ± 0.04	0.00	0.17	0.45	0.84	1.59	2.92	4.47
Tetrachloroethylene	µg/m^3	Urban	22,209	84%	0.24 ± 0.05	ND	ND	0.05	0.12	0.22	0.43	0.68
	µg/m^3	Rural	5,936	38%	0.07 ± 0.02	ND	ND	ND	ND	0.04	0.12	0.31
	µg/m^3	All Sites	28,145	75%	0.21 ± 0.04	ND	ND	ND	0.08	0.20	0.38	0.61
Trichloroethylene	µg/m^3	Urban	22,204	43%	0.040 ± 0.008	ND	ND	ND	ND	0.043	0.096	0.152
	µg/m^3	Rural	5,922	19%	0.019 ± 0.003	ND	ND	ND	ND	ND	0.029	0.124
	µg/m^3	All Sites	28,126	38%	0.036 ± 0.006	ND	ND	ND	ND	0.033	0.085	0.148
Vinyl Chloride	µg/m^3	Urban	22,021	18%	0.0046 ± 0.0003	ND	ND	ND	ND	ND	0.0126	0.0251
	µg/m^3	Rural	5,940	13%	0.0070 ± 0.0008	ND	ND	ND	ND	ND	0.0125	0.0304
	µg/m^3	All Sites	27,961	17%	0.0051 ± 0.0003	ND	ND	ND	ND	ND	0.0126	0.0253

[a] Statistics presented are from pollutant datasets which were suitable for trends.

[b] The arithmetic mean is the average of all samples results which include actual measured values. If no chemical was registered, then a value of zero is used when calculating the mean.

[c] ND: No results of this chemical were registered by the laboratory analytical equipment.

Table 4. Summary Statistics for Richmond, VA

Analyte	Units	# Data Records	% Detection	Arithmetic Mean[a]	Percentile Value[b]						
					5th	10th	25th	50th	75th	90th	95th
Acetaldehyde	µg/m^3	866	100%	1.40 ± 0.04	0.68	0.81	1.03	1.31	1.66	2.05	2.42
Arsenic (PM_{10})	ng/m^3	860	100%	0.77 ± 0.04	0.22	0.29	0.43	0.63	0.94	1.33	1.66
Benzene	µg/m^3	852	94%	0.54 ± 0.02	ND	0.22	0.32	0.47	0.70	0.92	1.24
Benzo(a)pyrene	ng/m^3	834	72%	0.06 ± 0.01	ND	ND	ND	0.03	0.07	0.15	0.22
Beryllium (PM_{10})	ng/m^3	857	33%	0.0028 ± 0.0005	ND	ND	ND	ND	0.002	0.010	0.017
Butadiene, 1,3-	µg/m^3	852	2%	0.004 ± 0.002	ND	ND	ND	ND	ND	ND	ND
Cadmium (PM_{10})	ng/m^3	860	99%	0.12 ± 0.01	0.02	0.03	0.05	0.09	0.14	0.23	0.30
Carbon Tetrachloride	µg/m^3	852	96%	0.51 ± 0.01	0.23	0.38	0.45	0.51	0.57	0.64	0.70
Chloroform	µg/m^3	852	62%	0.08 ± 0.01	ND	ND	ND	0.10	0.11	0.15	0.16
Formaldehyde	µg/m^3	866	100%	2.94 ± 0.12	1.04	1.30	1.73	2.40	3.74	5.30	6.40
Lead (PM_{10})	ng/m^3	860	100%	2.21 ± 0.20	0.77	0.93	1.33	1.84	2.52	3.38	4.11
Manganese (PM_{10})	ng/m^3	860	100%	2.55 ± 0.10	0.78	1.00	1.53	2.31	3.16	4.21	5.06
Naphthalene	ng/m^3	834	100%	73.03 ± 3.78	21.31	26.67	38.38	58.46	90.66	129.62	166.92
Nickel (PM_{10})	ng/m^3	860	100%	0.67 ± 0.02	0.35	0.37	0.46	0.58	0.77	1.05	1.26
Tetrachloroethylene	µg/m^3	852	51%	0.09 ± 0.01	ND	ND	ND	0.07	0.14	0.22	0.34
Trichloroethylene	µg/m^3	850	5%	0.01 ± 0.01	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	µg/m^3	852	0%	0.0010 ± 0.0012	ND	ND	ND	ND	ND	ND	ND

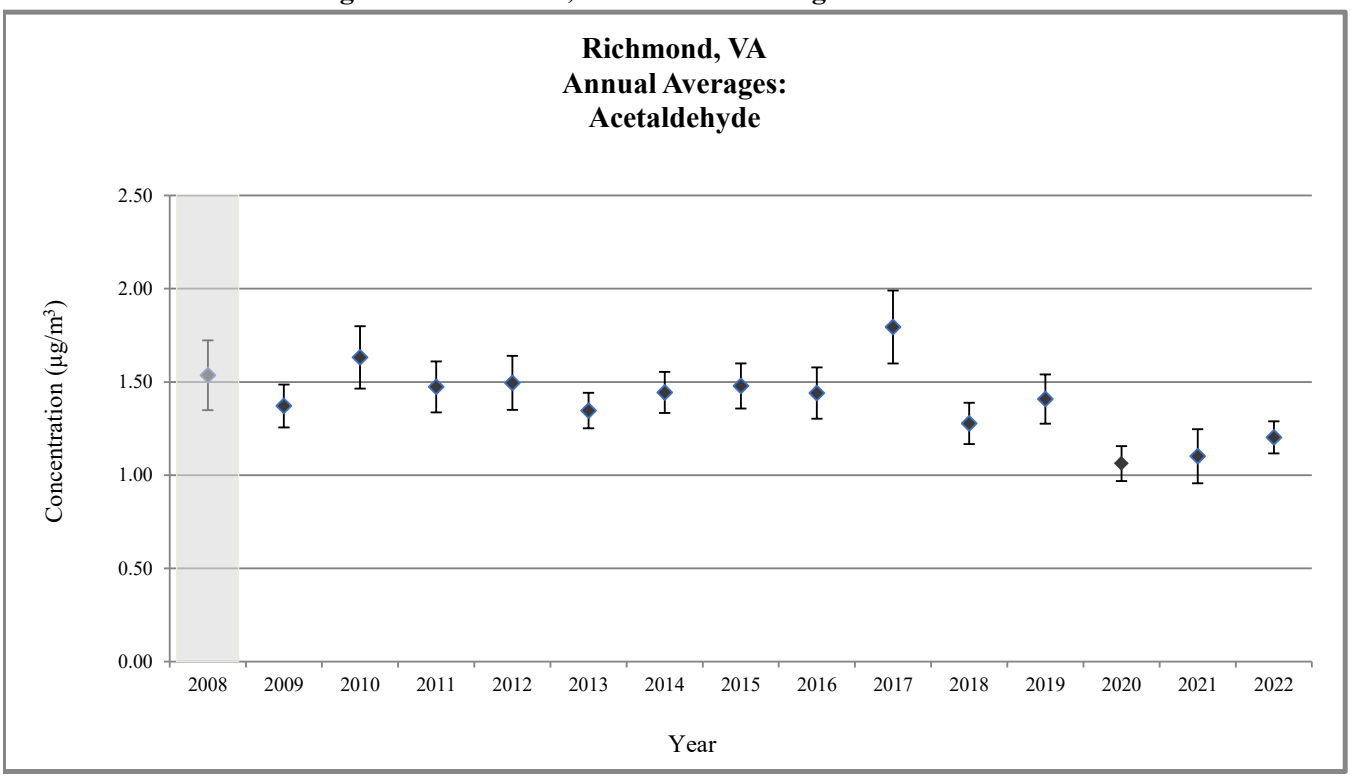
[a] :The arithmetic mean is the average of all samples results which included actual measured values. If no chemical was registered, then a value of zero is used.

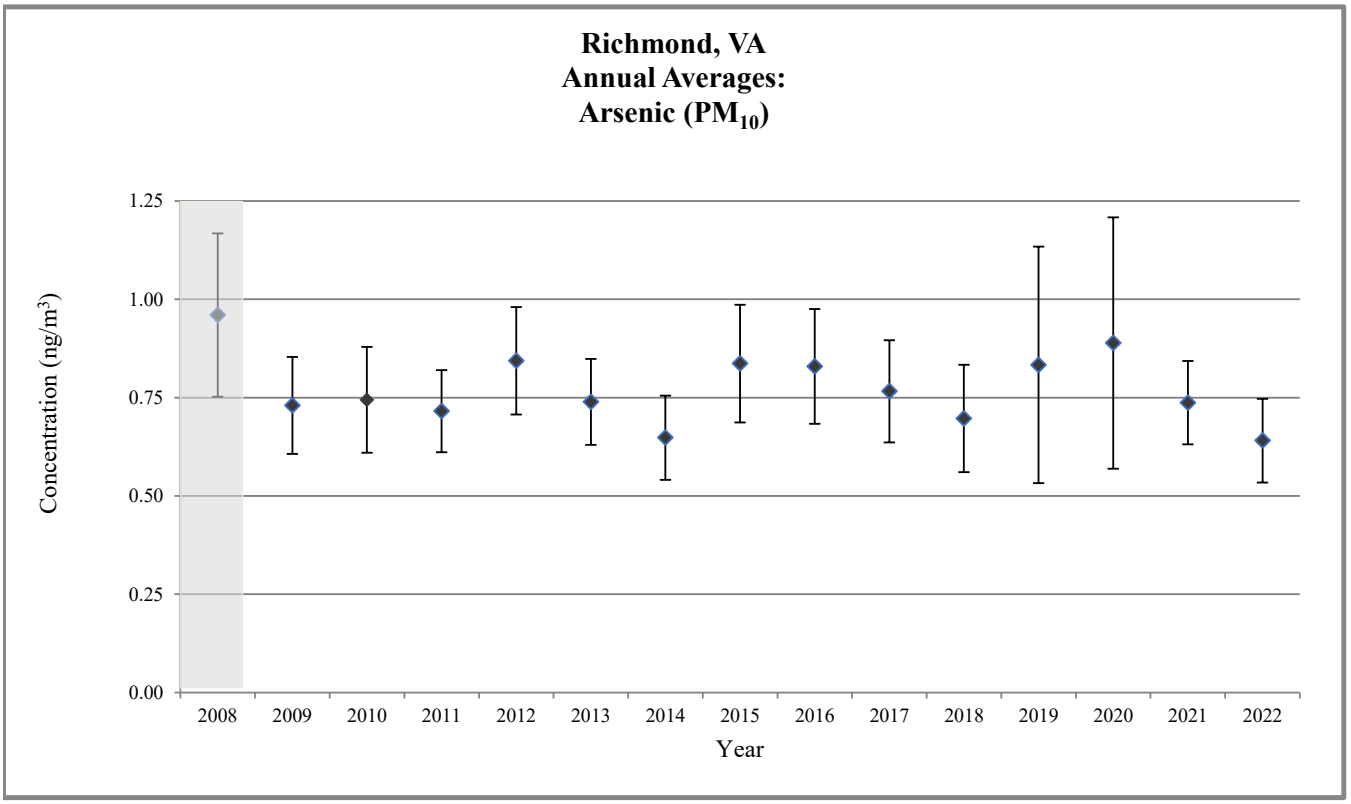
[b] ND: No results of this chemical were registered by the laboratory analytical equipment.

Table 5. Analytical Labs Supporting this Site

Pollutant Group	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
VOCs	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS
Carbonyls	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS
PM_{10} Metals	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS	VADCLS
PAHs	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG	ERG

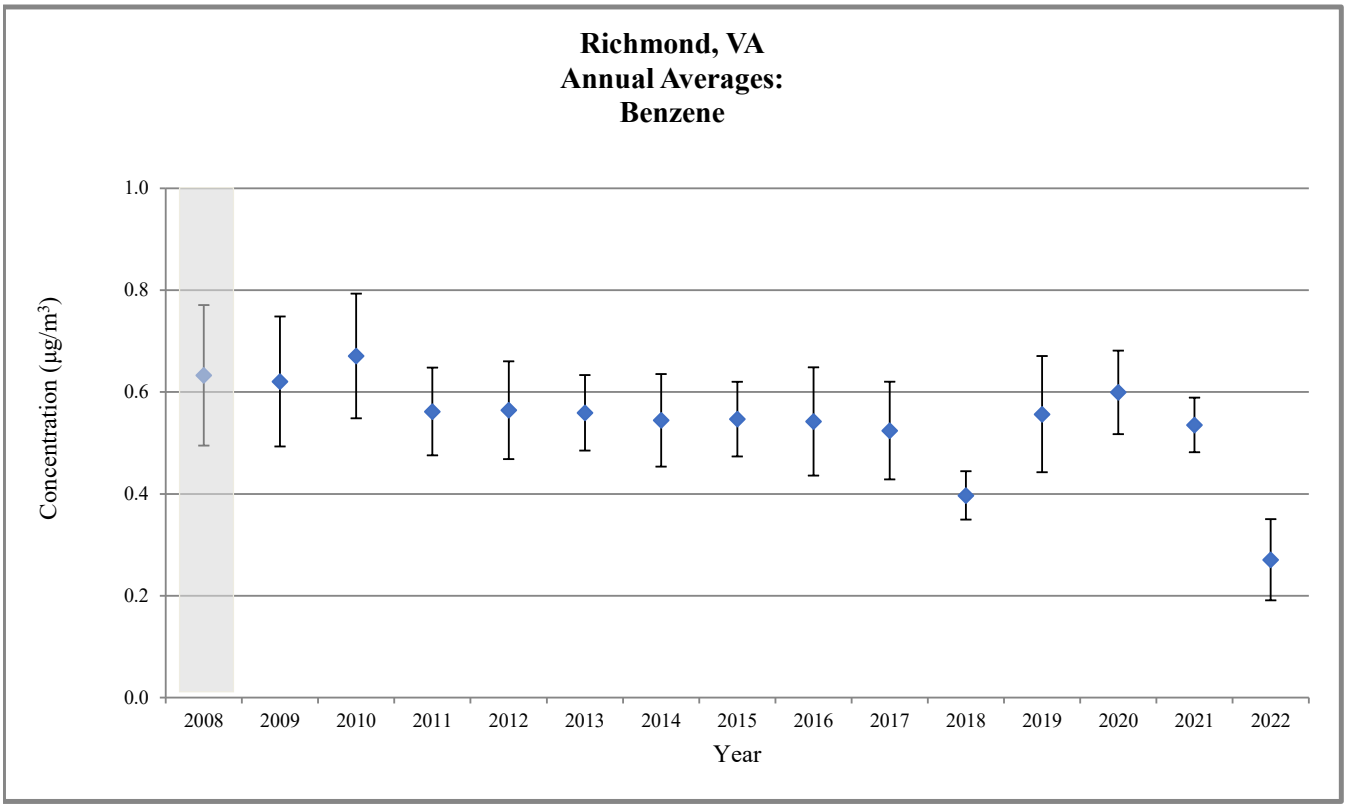
Figure 3. Richmond, VA Annual Average Concentrations

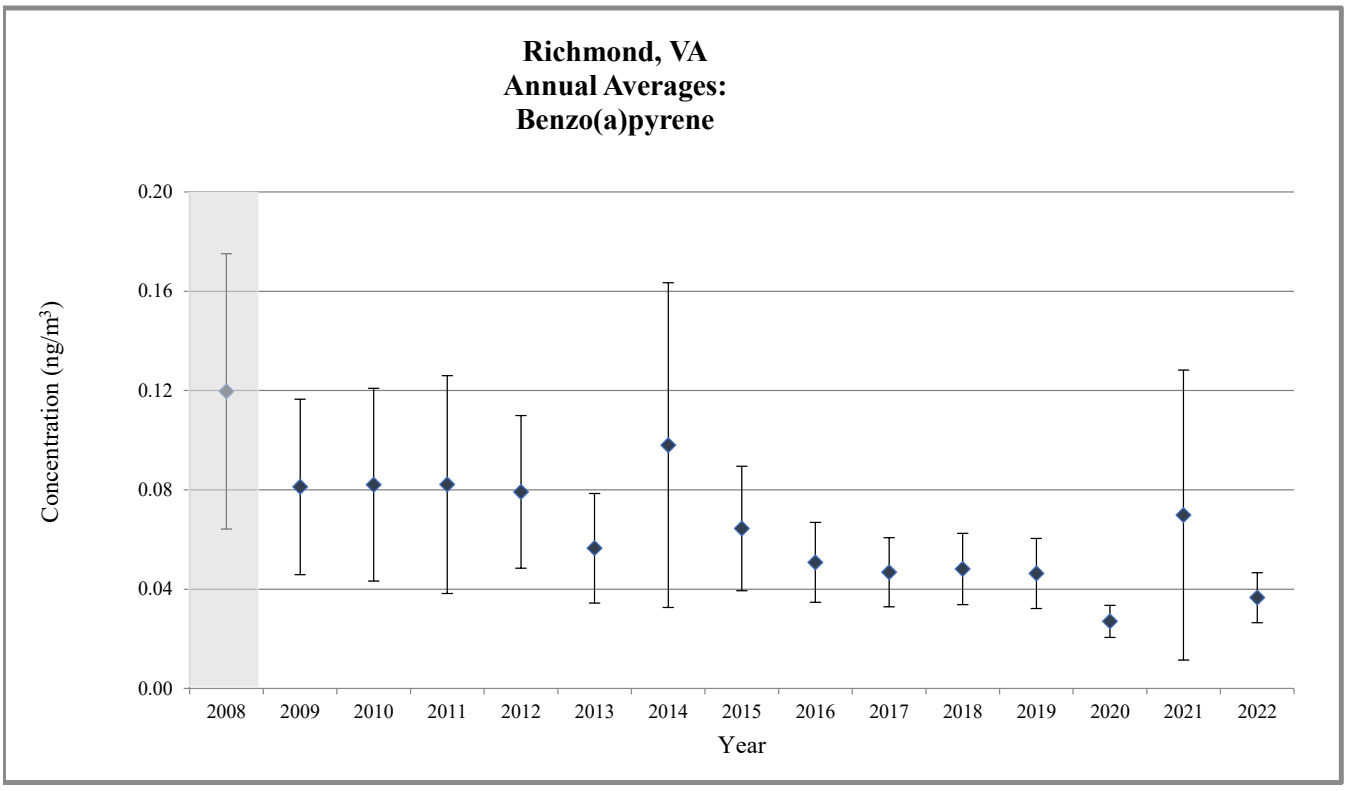




Sampling began midway through the year.
Does not meet MQO

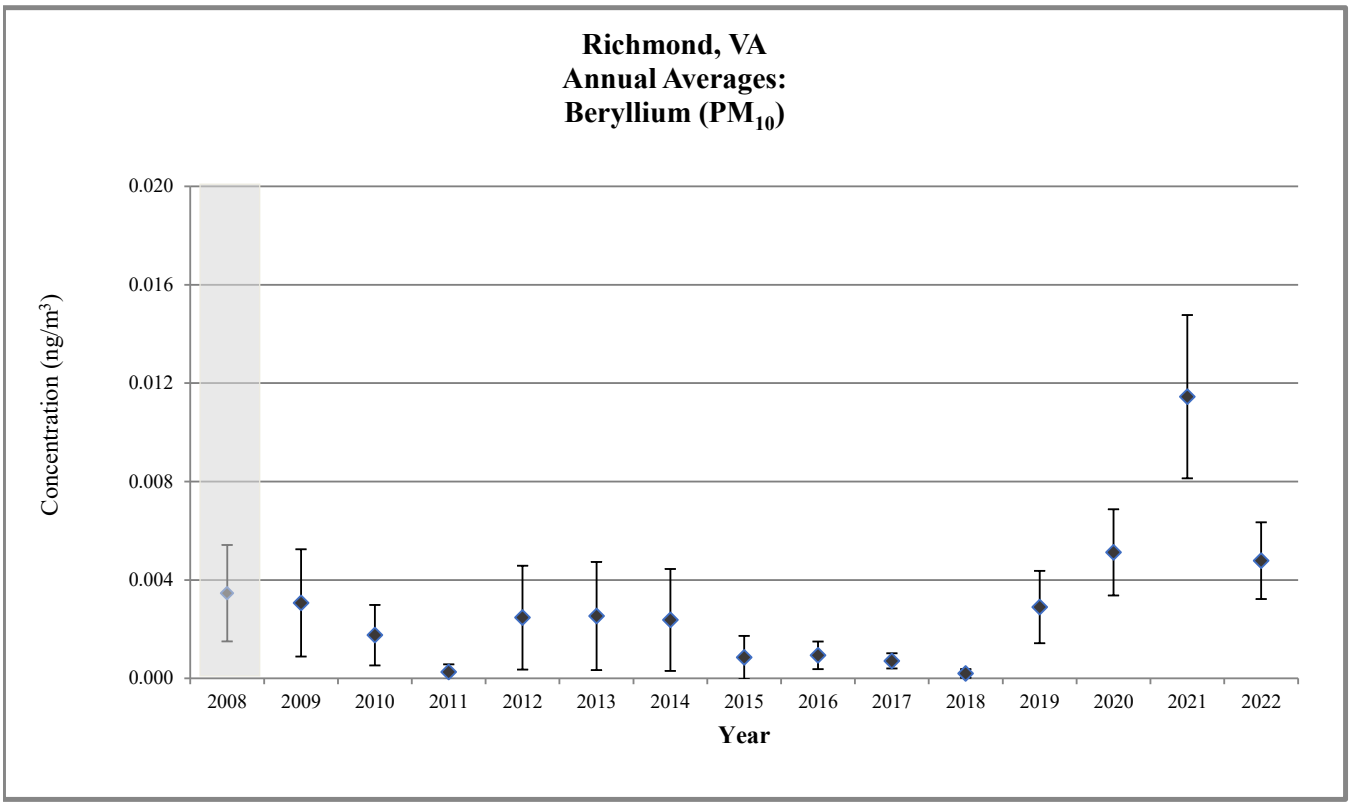
Figure 3. Richmond, VA Annual Average Concentrations

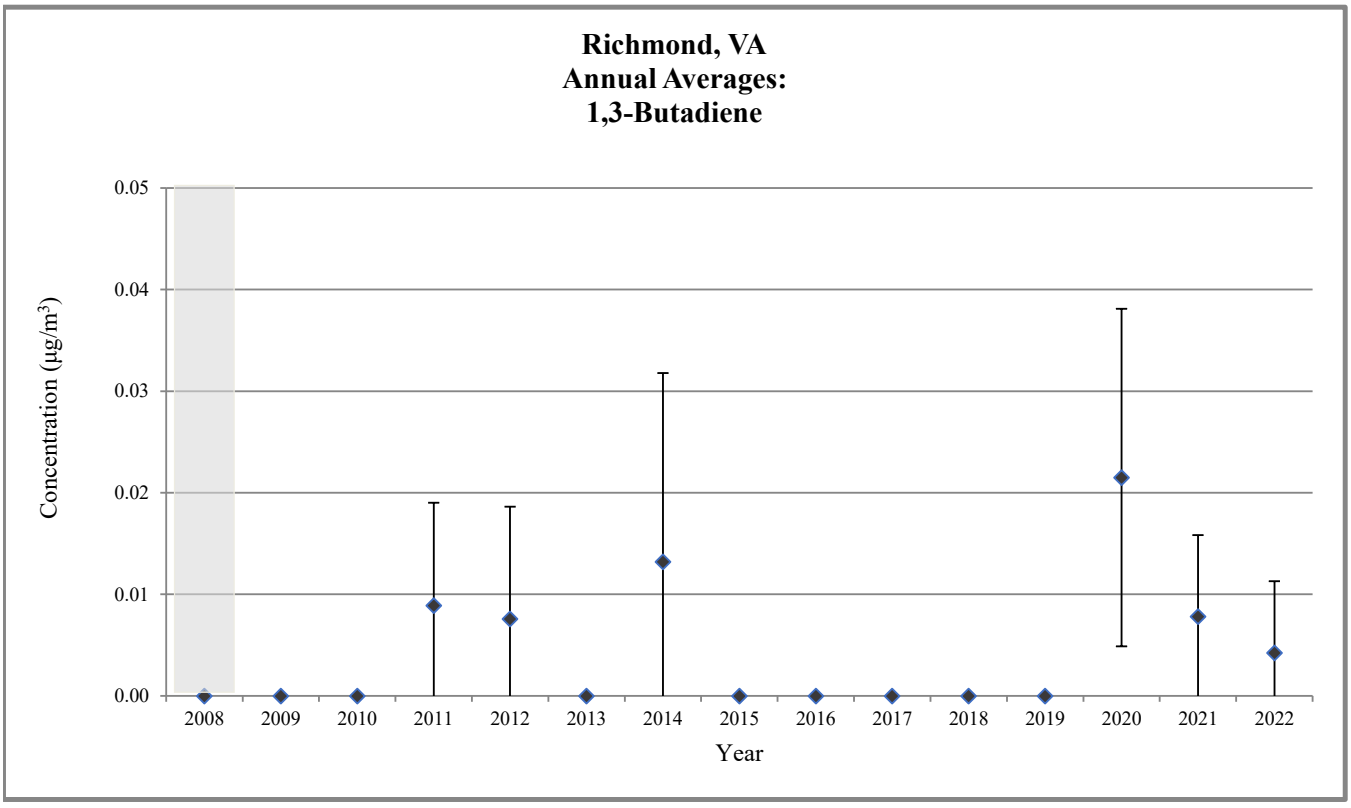




Sampling began midway through the year.
Does not meet MQO

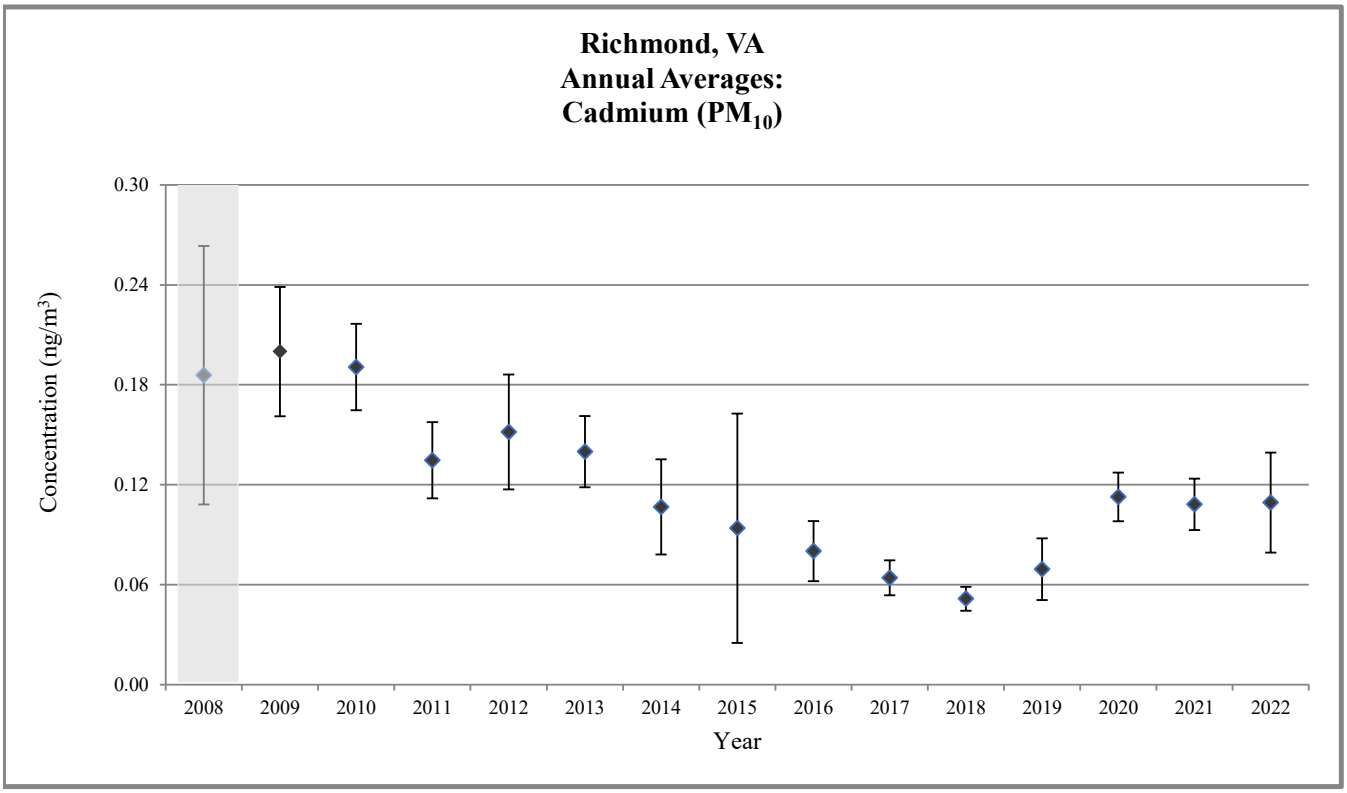
Figure 3. Richmond, VA Annual Average Concentrations

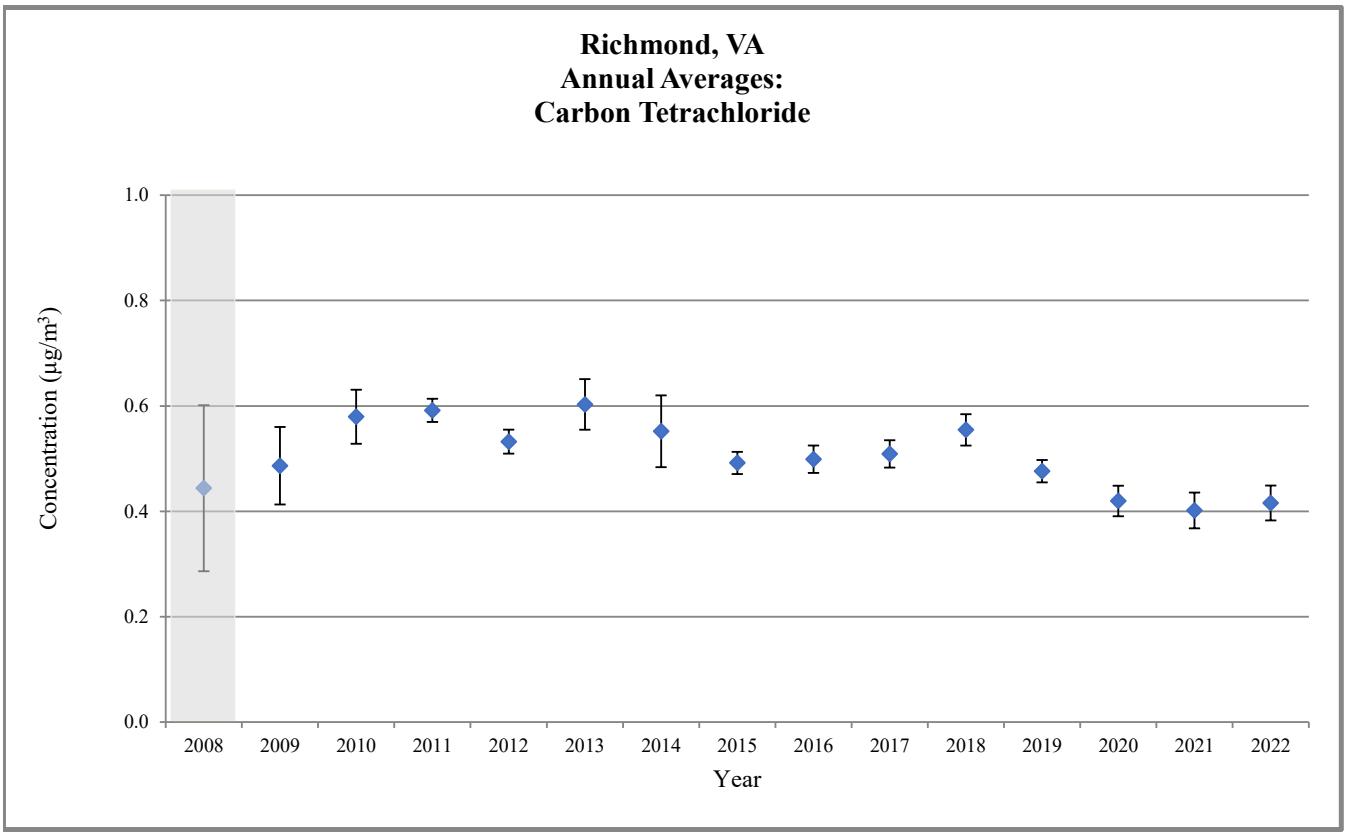




Sampling began midway through the year.
Does not meet MQO

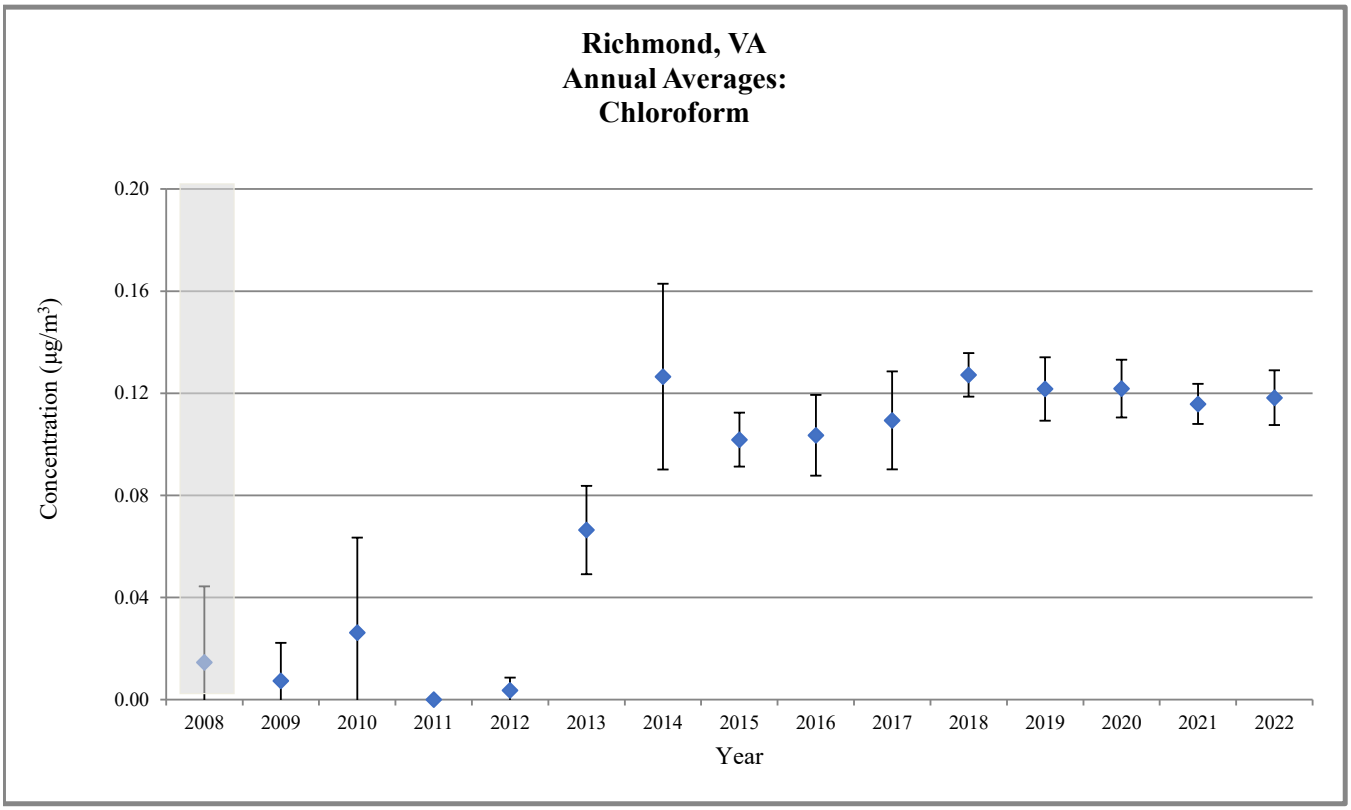
Figure 3. Richmond, VA Annual Average Concentrations

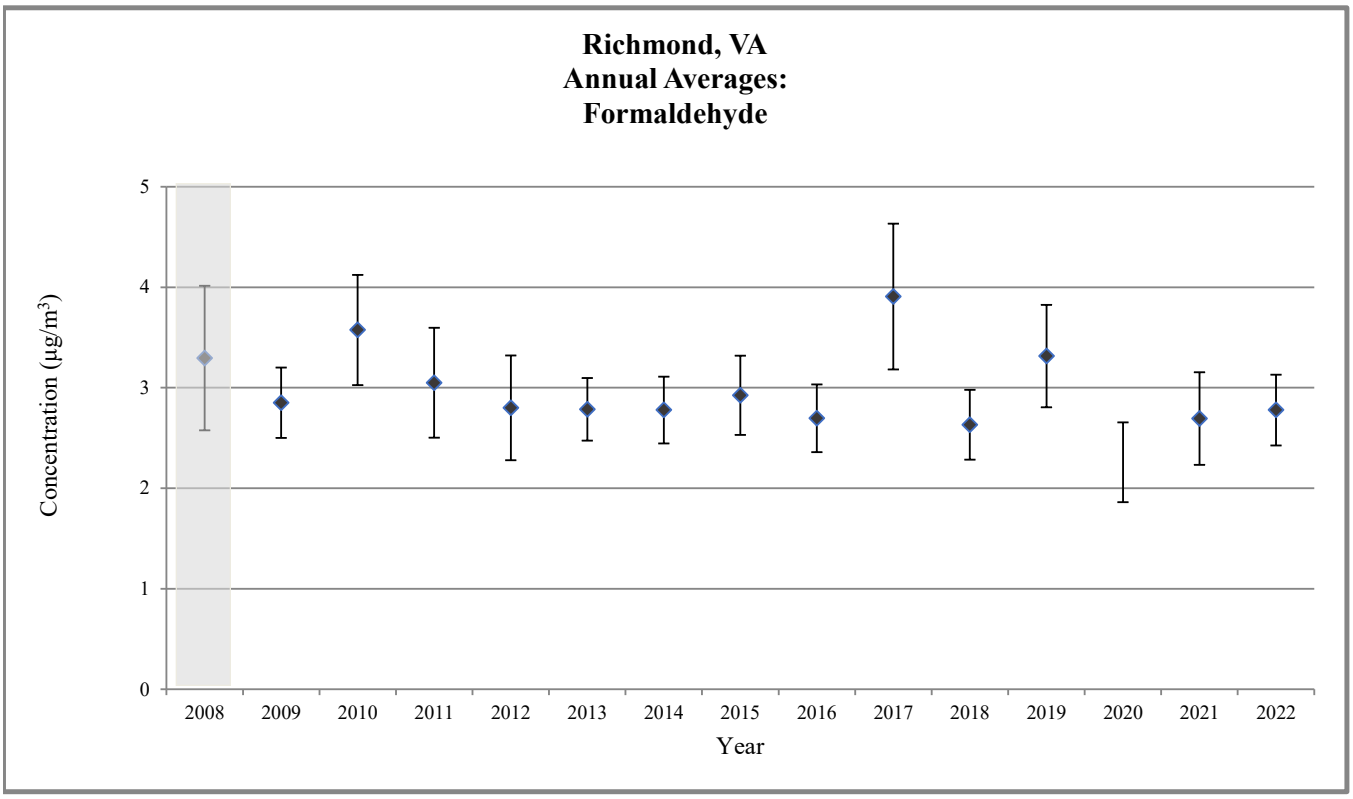




Sampling began midway through the year.
Does not meet MQO

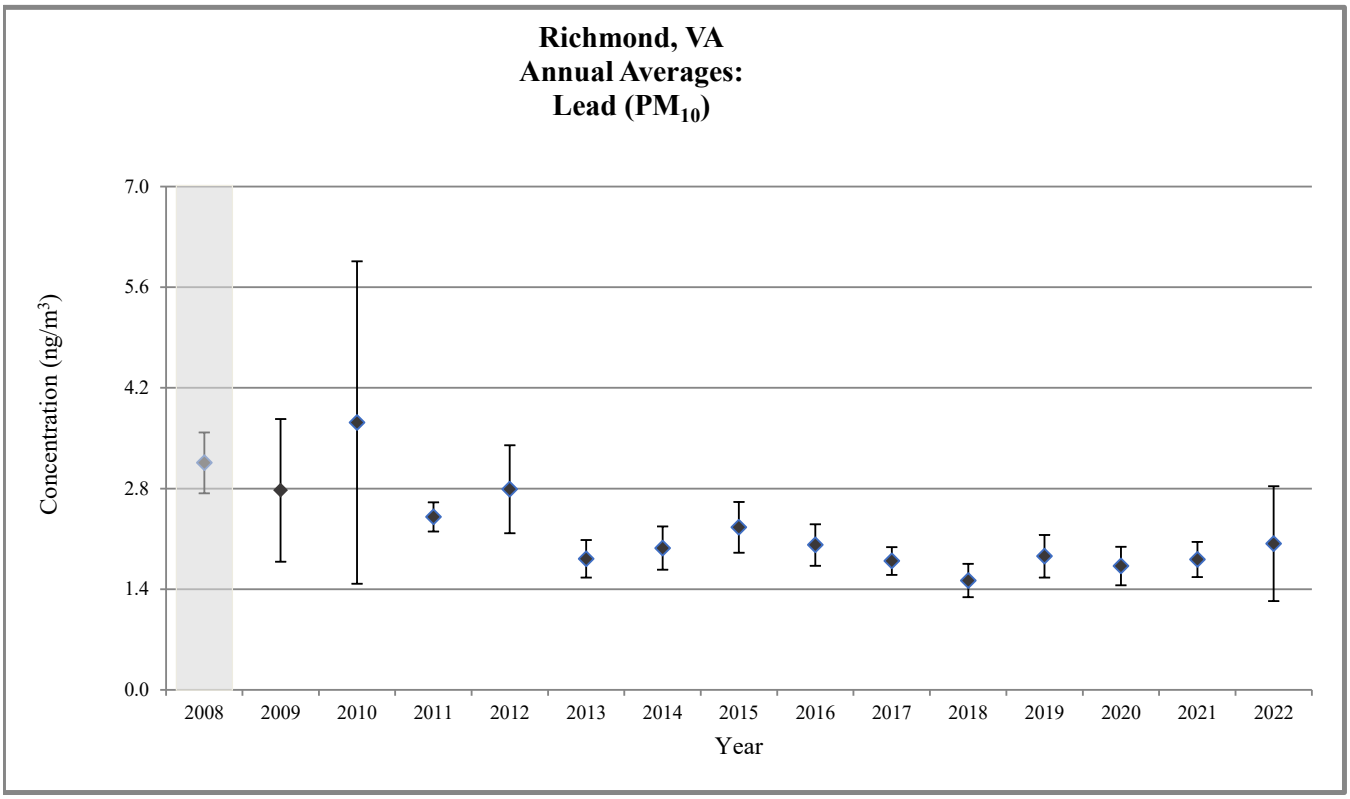
Figure 3. Richmond, VA Annual Average Concentrations

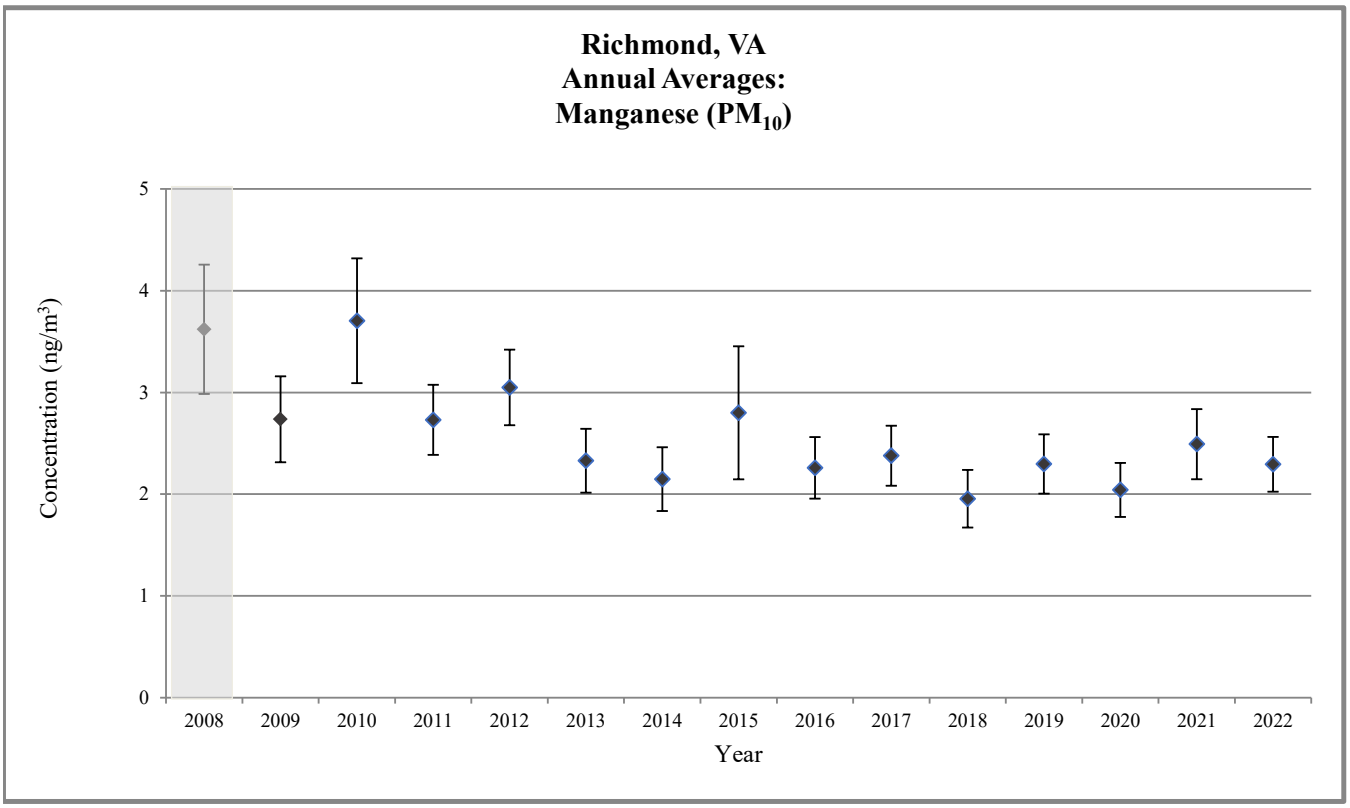




Sampling began midway through the year.
Does not meet MQO

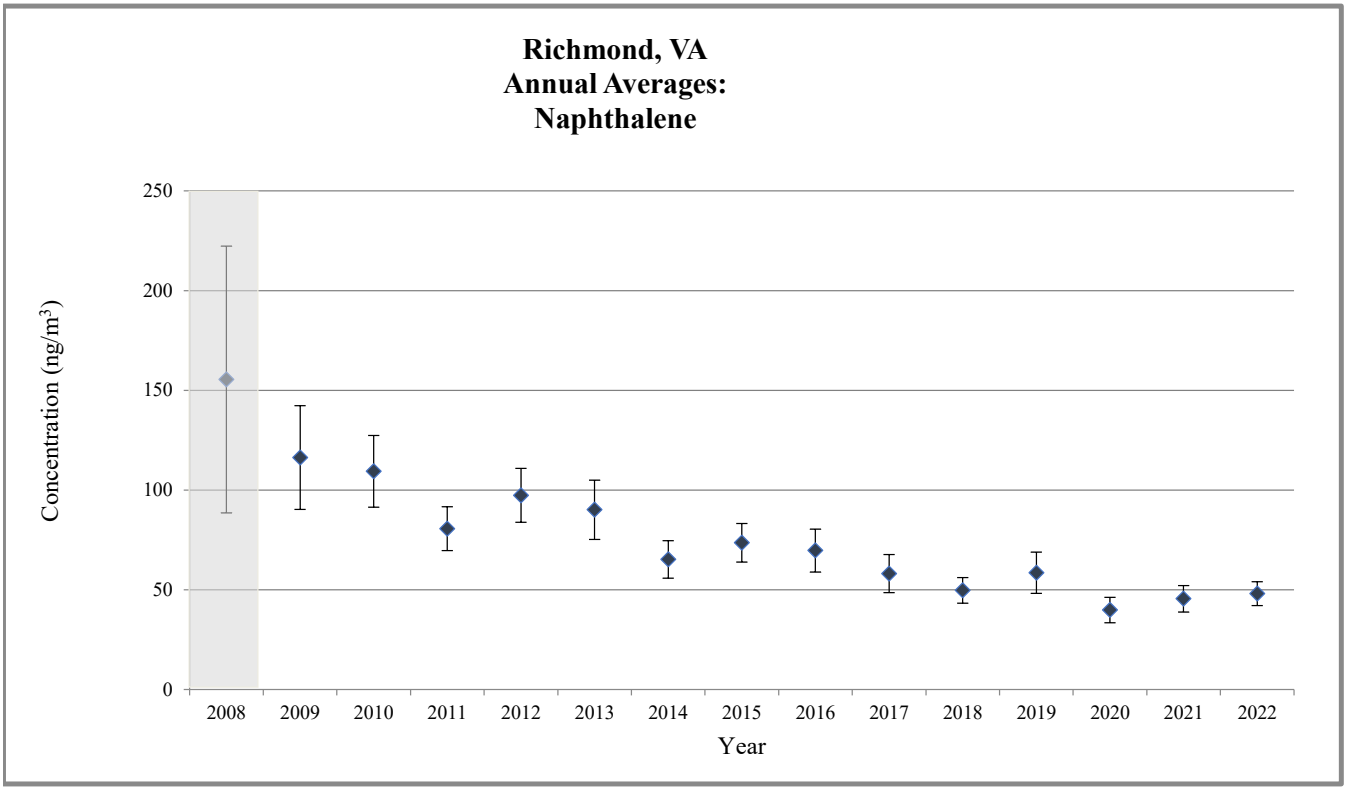
Figure 3. Richmond, VA Annual Average Concentrations

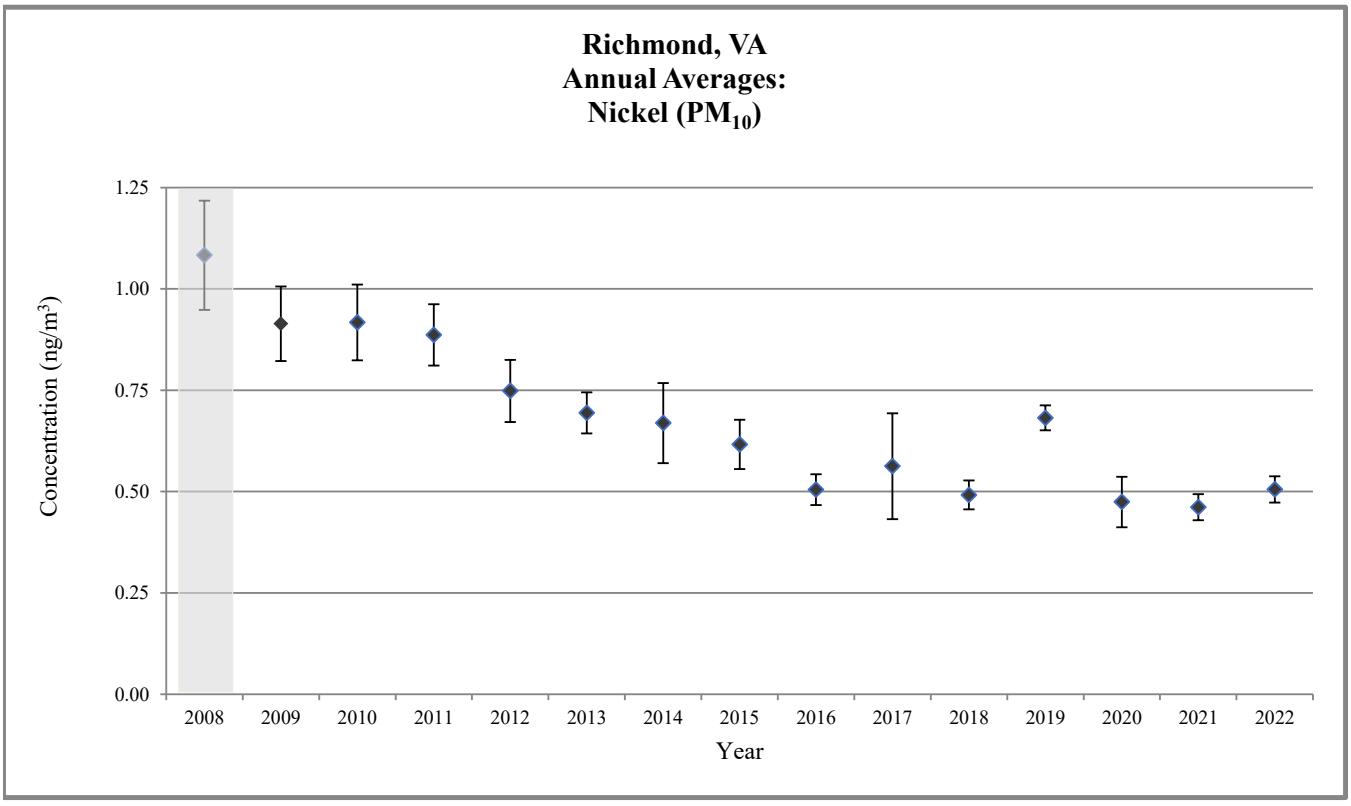




Sampling began midway through the year.
Does not meet MQO

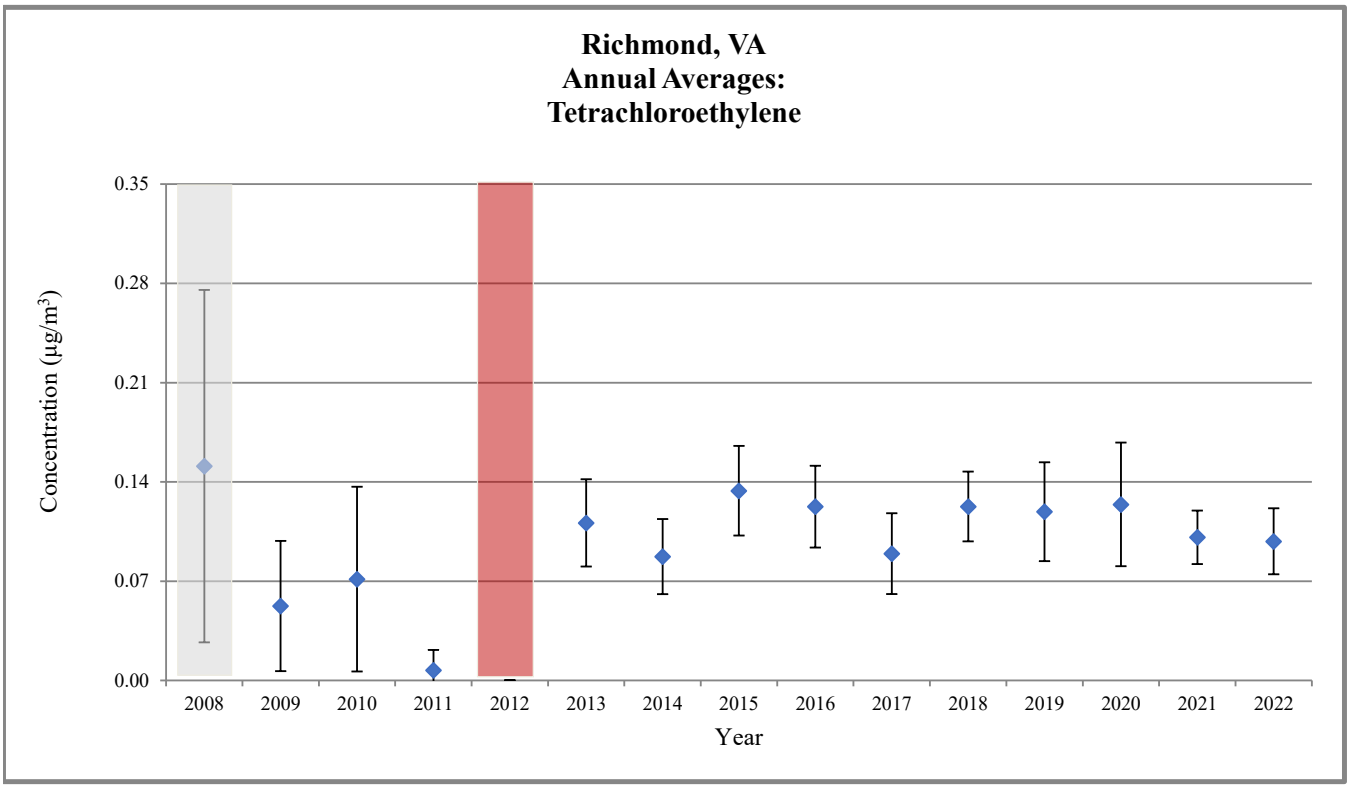
Figure 3. Richmond, VA Annual Average Concentrations

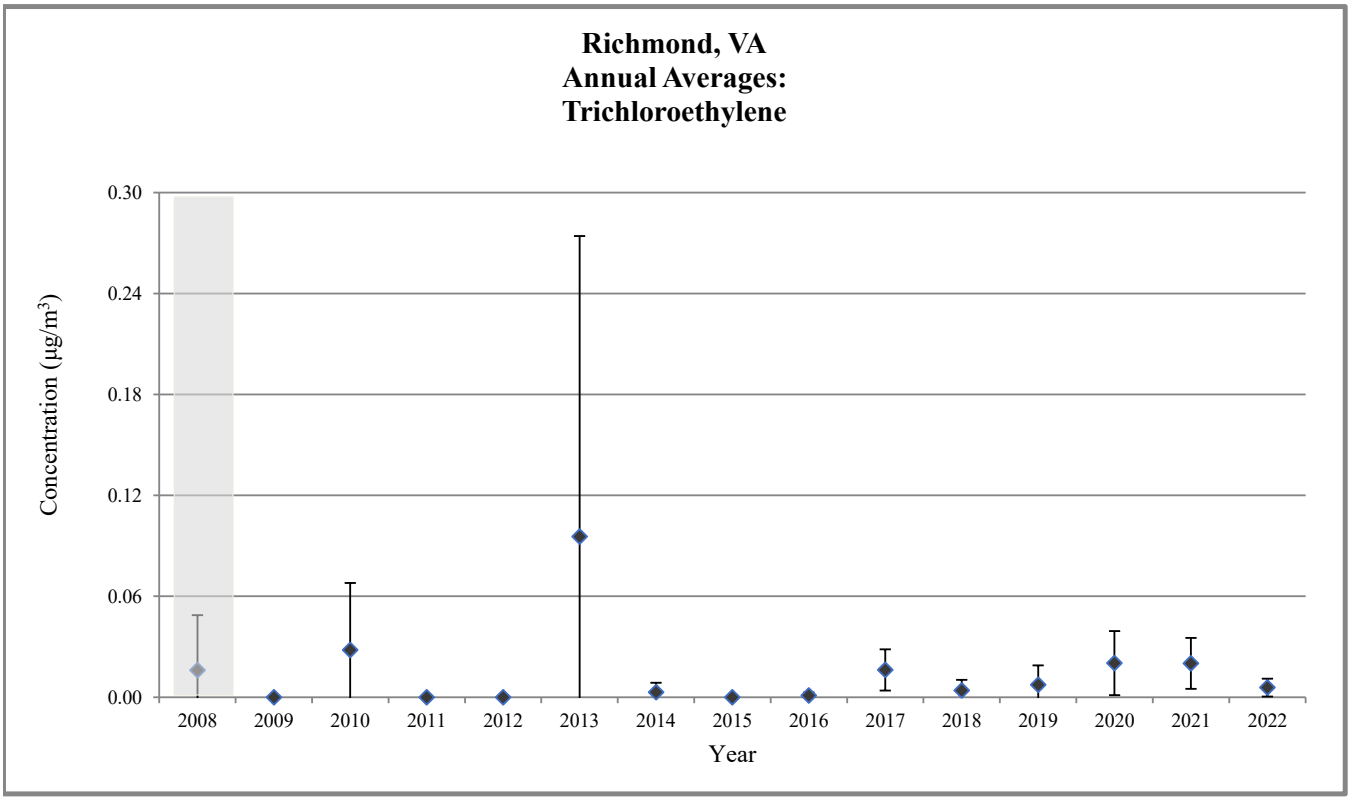




Sampling began midway through the year.
Does not meet MQO

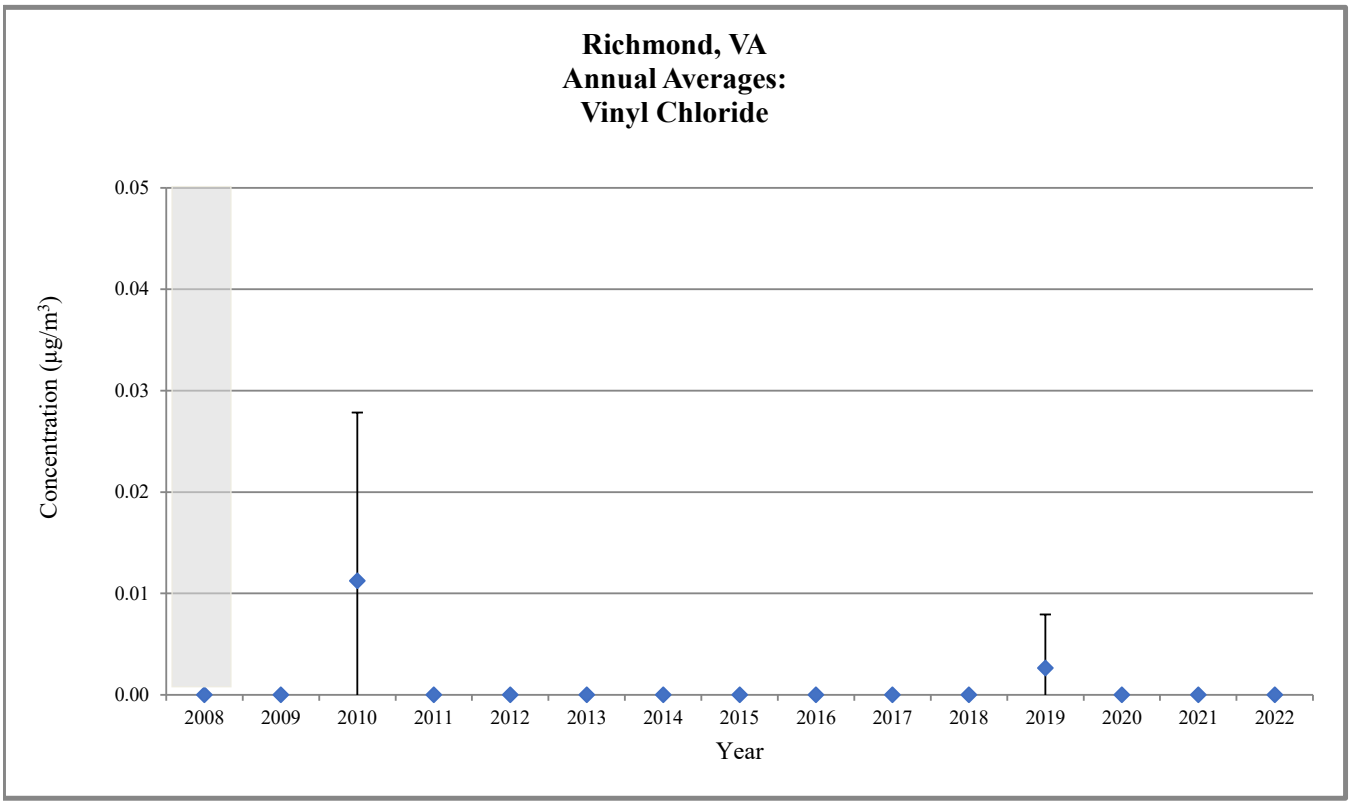
Figure 3. Richmond, VA Annual Average Concentrations





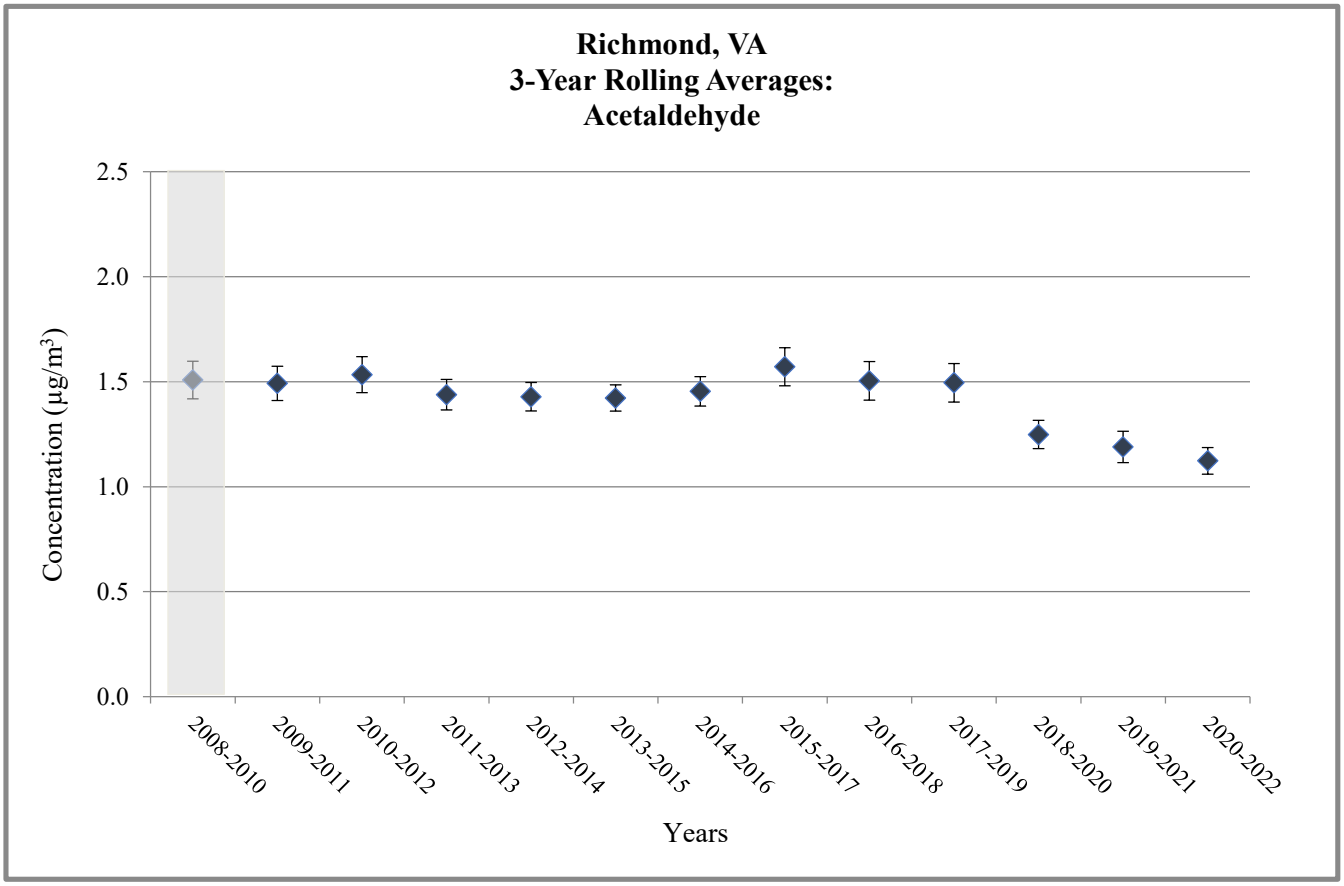
Sampling began midway through the year.
Does not meet MQO

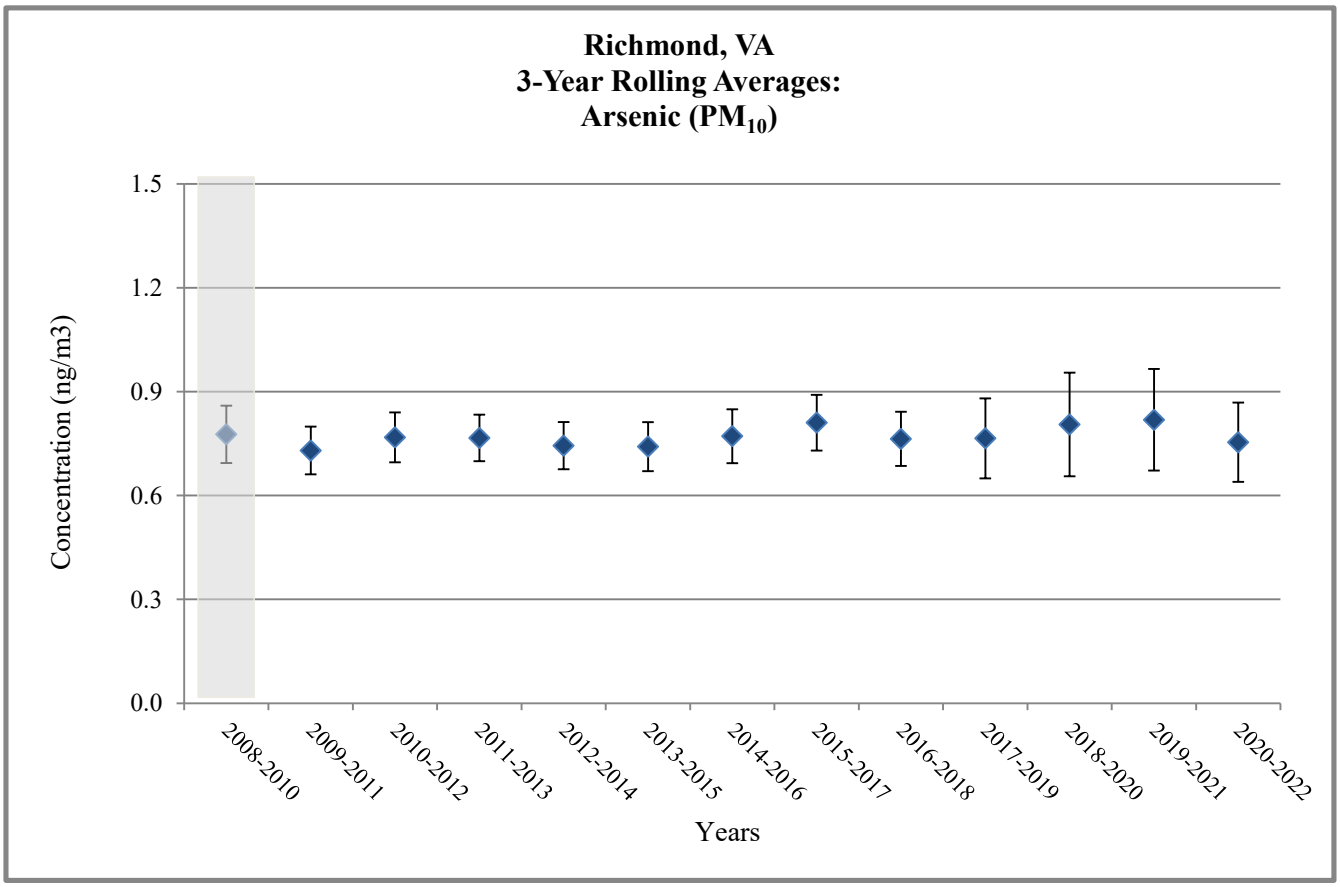
Figure 3. Richmond, VA Annual Average Concentrations



Sampling began midway through the year.
Does not meet MQO

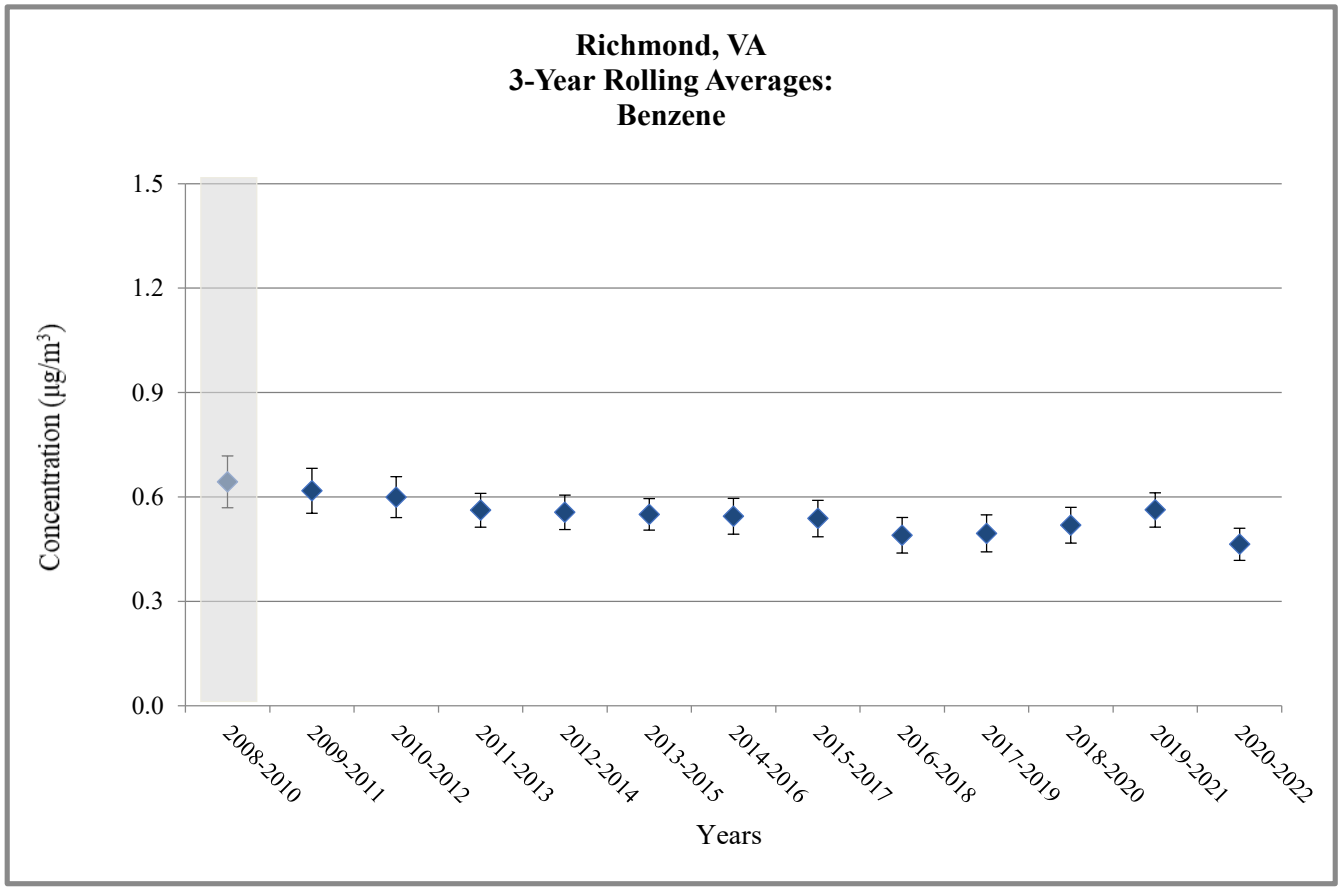
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

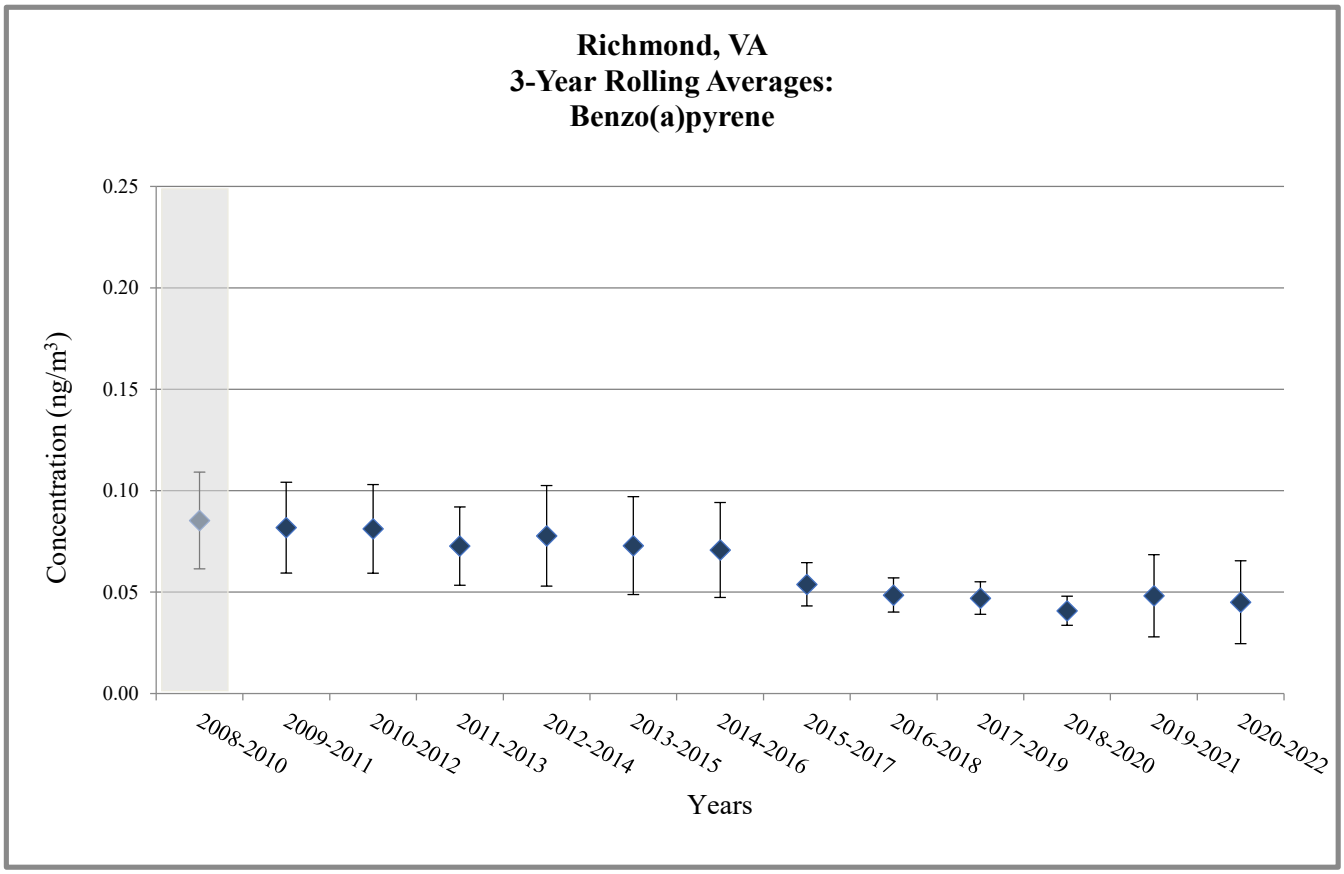




Does not meet MQO or wasn't able to collect enough samples

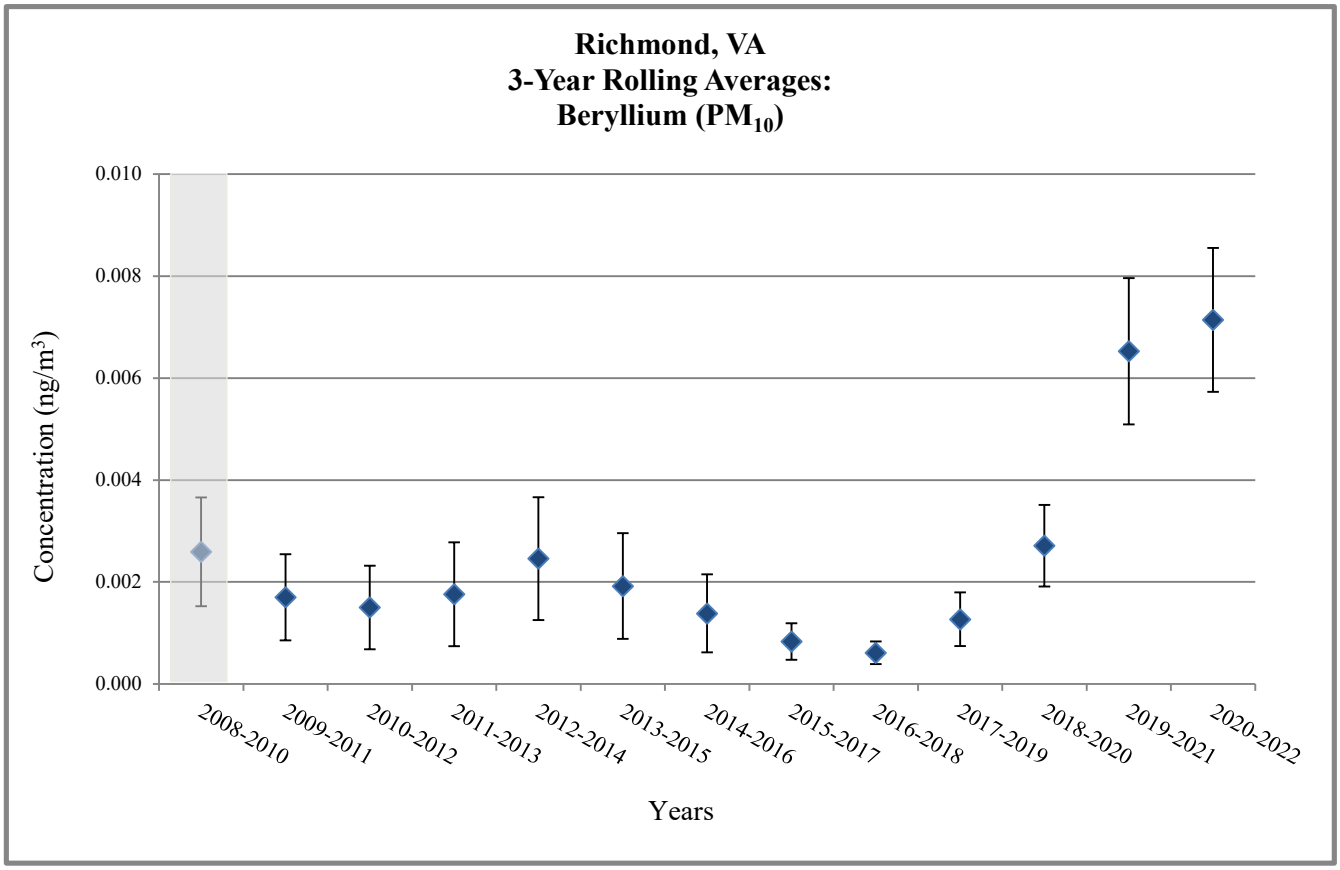
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

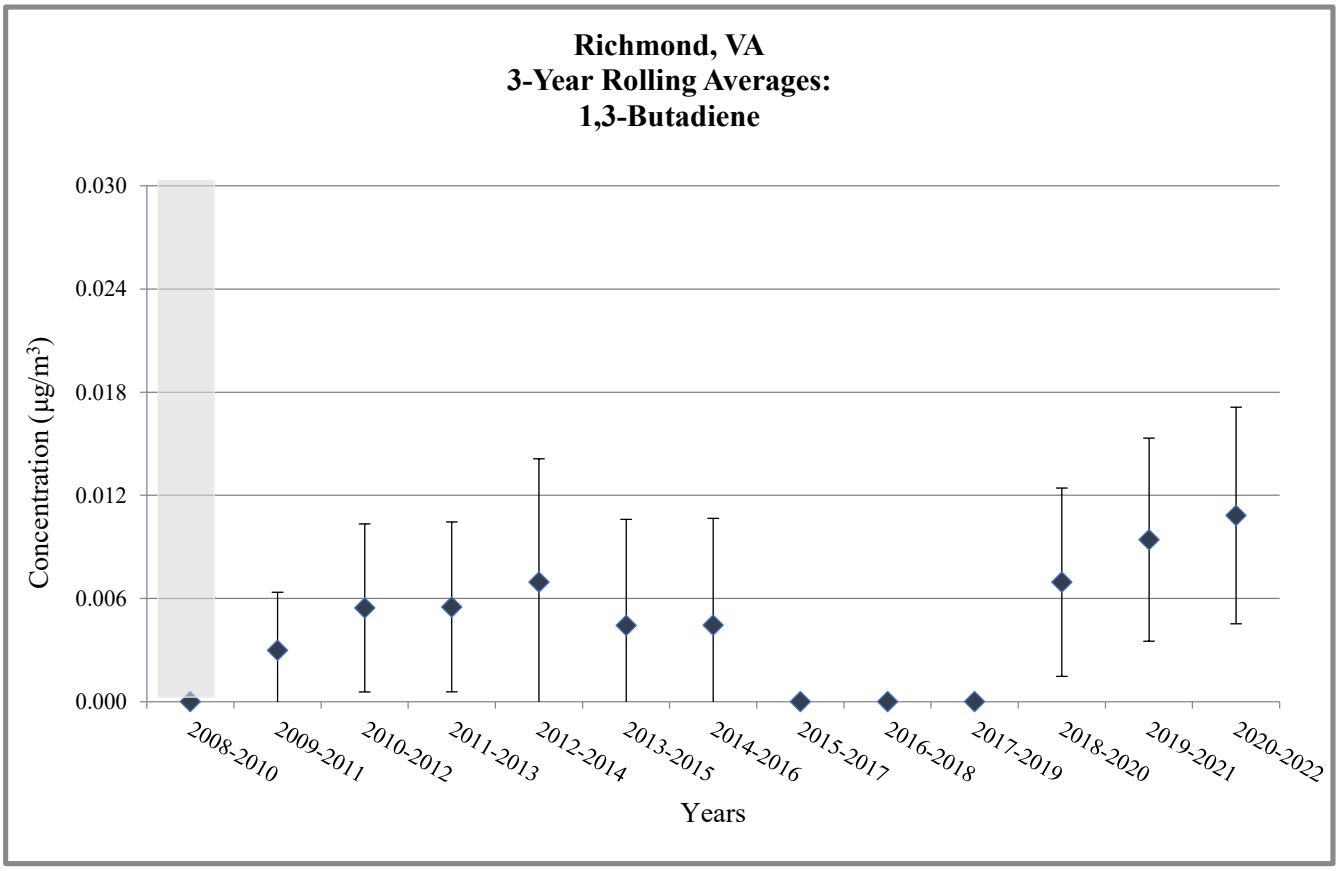




Does not meet MQO or wasn't able to collect enough samples

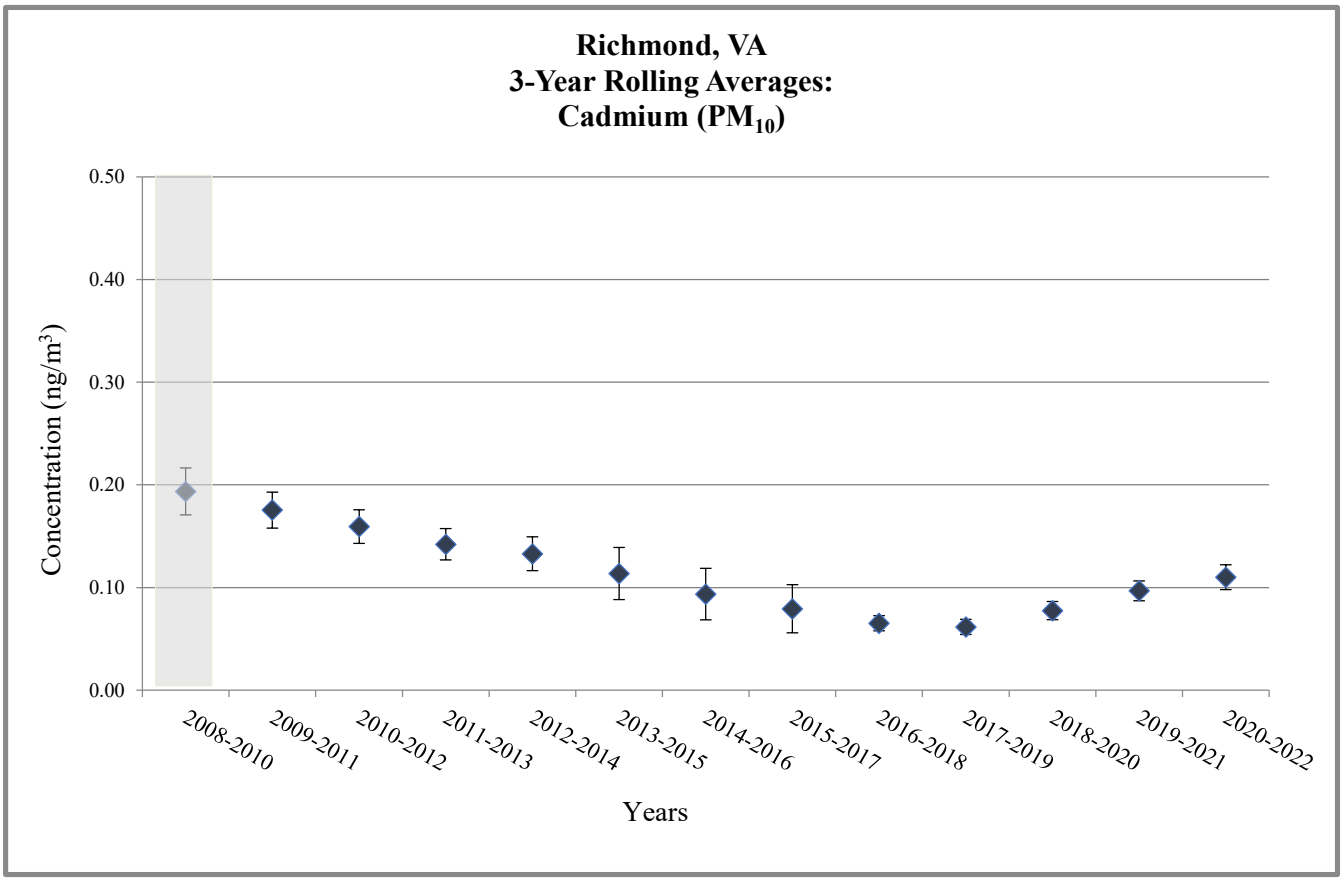
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

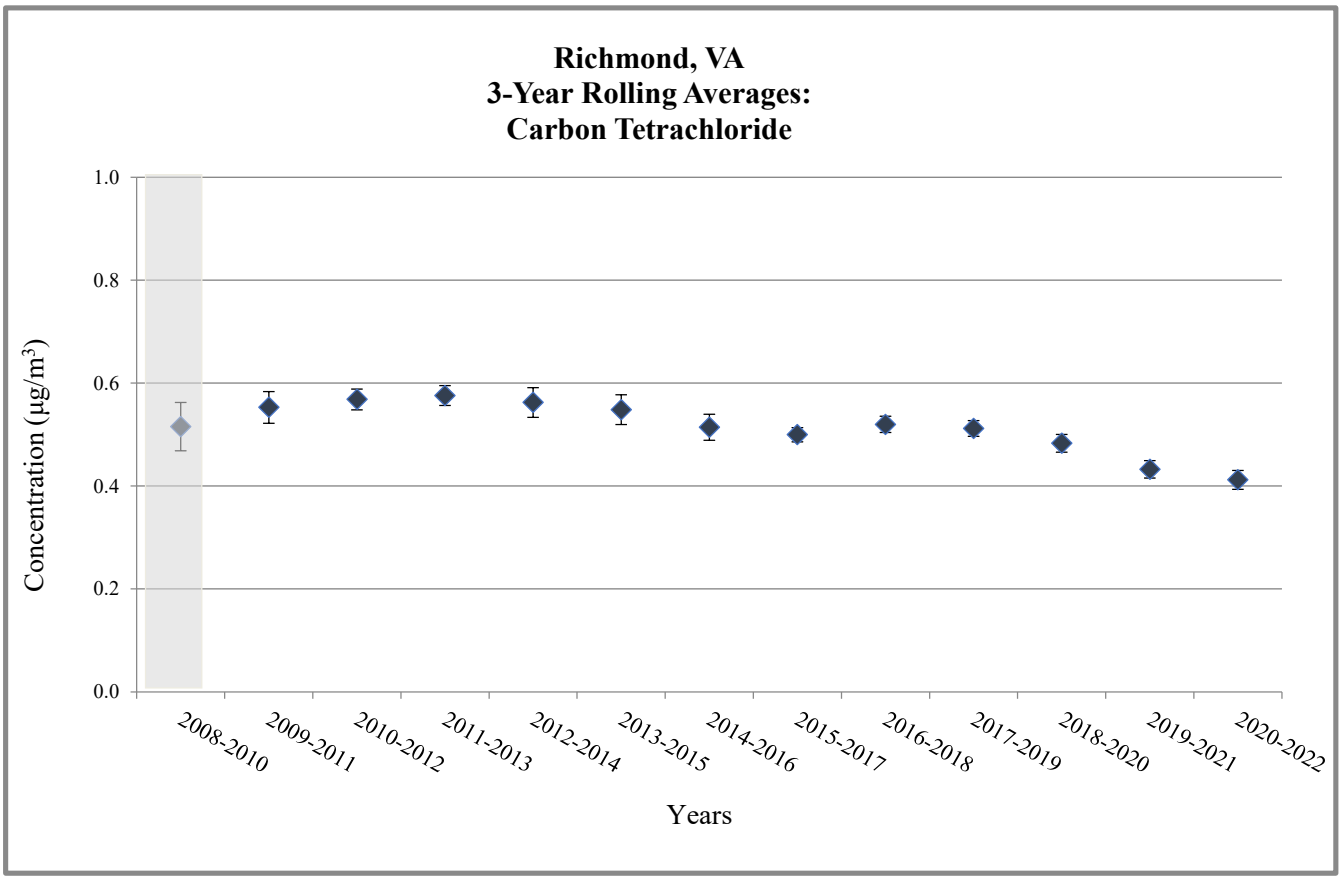




Does not meet MQO or wasn't able to collect enough samples

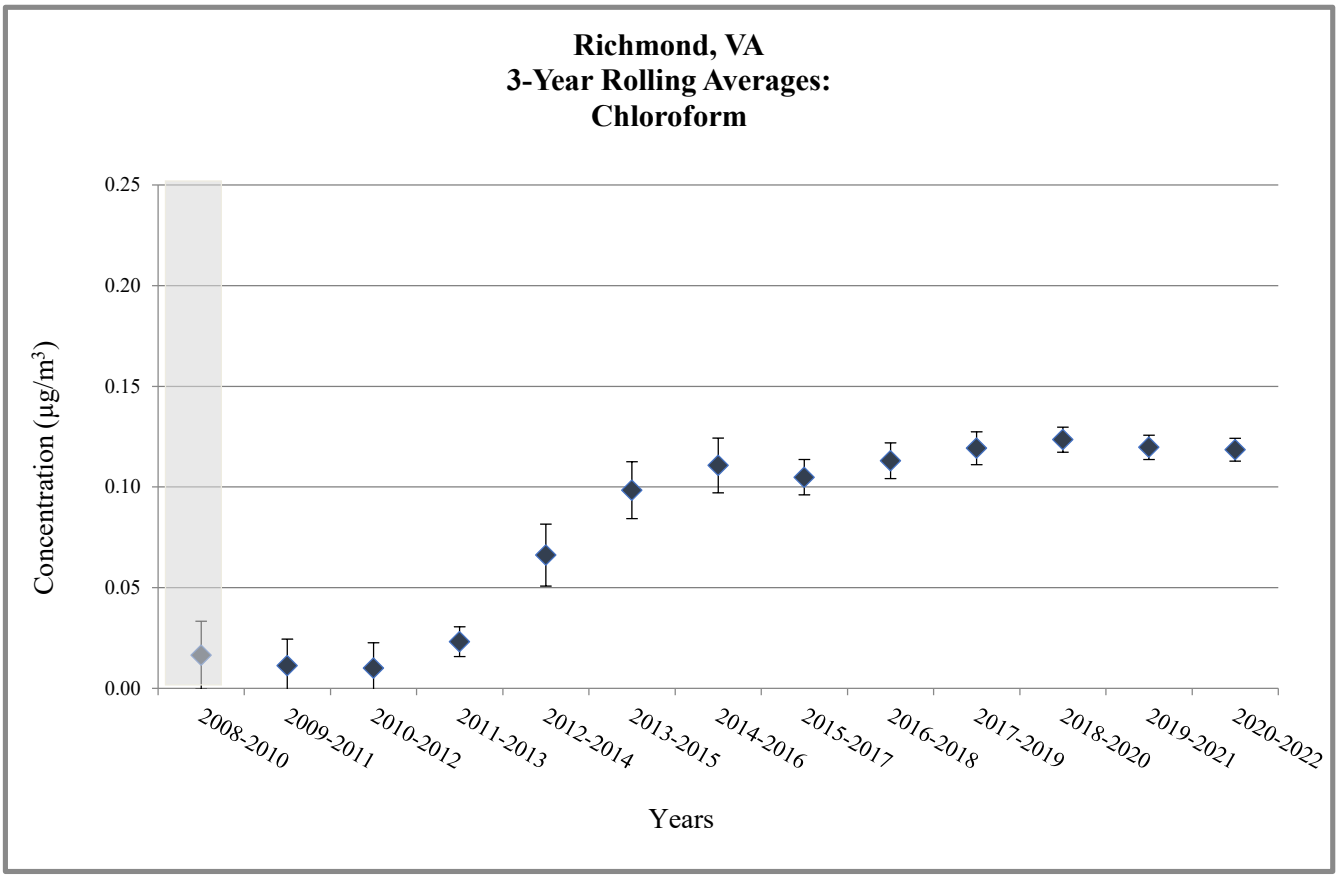
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

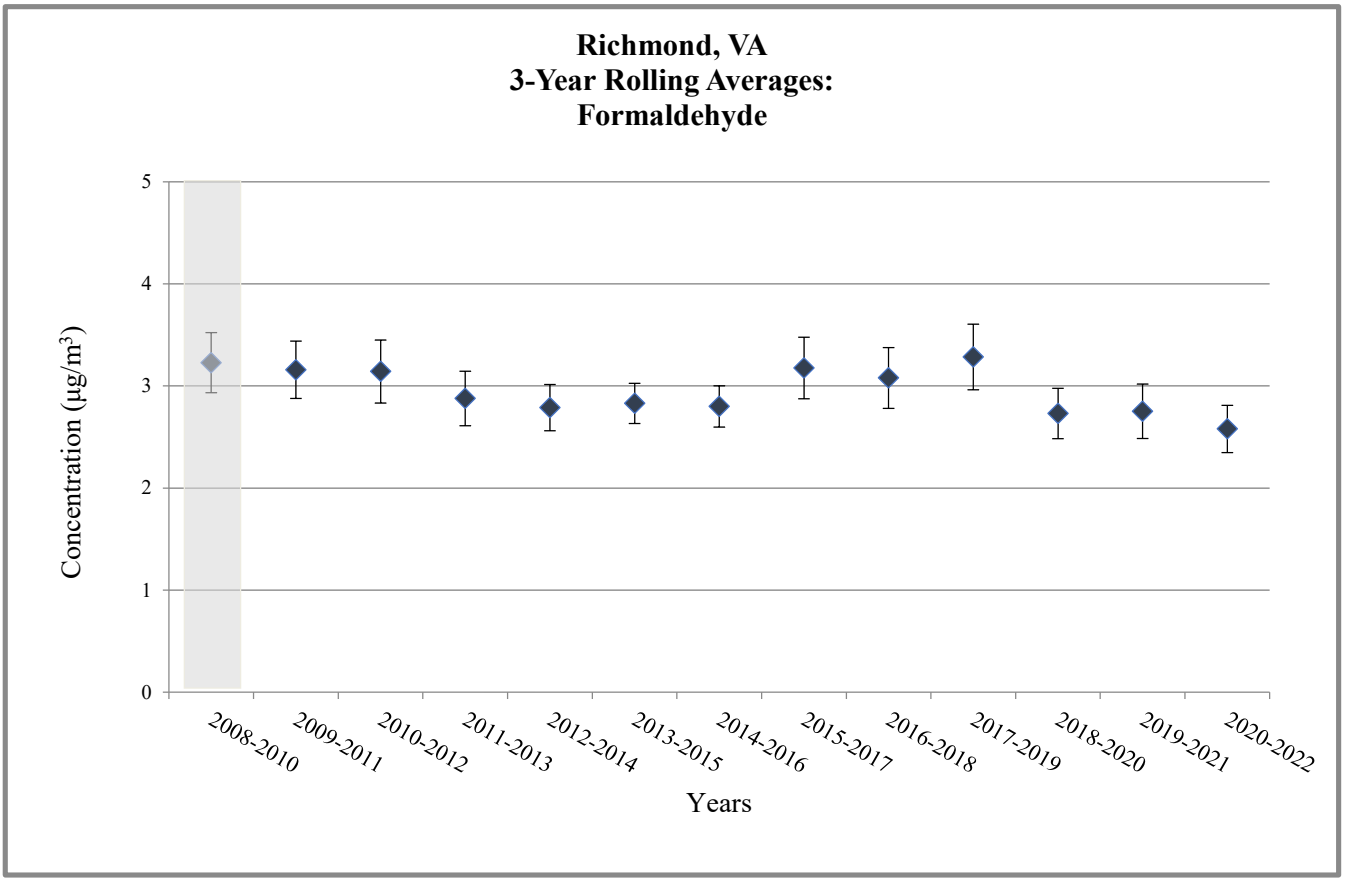




Does not meet MQO or wasn't able to collect enough samples

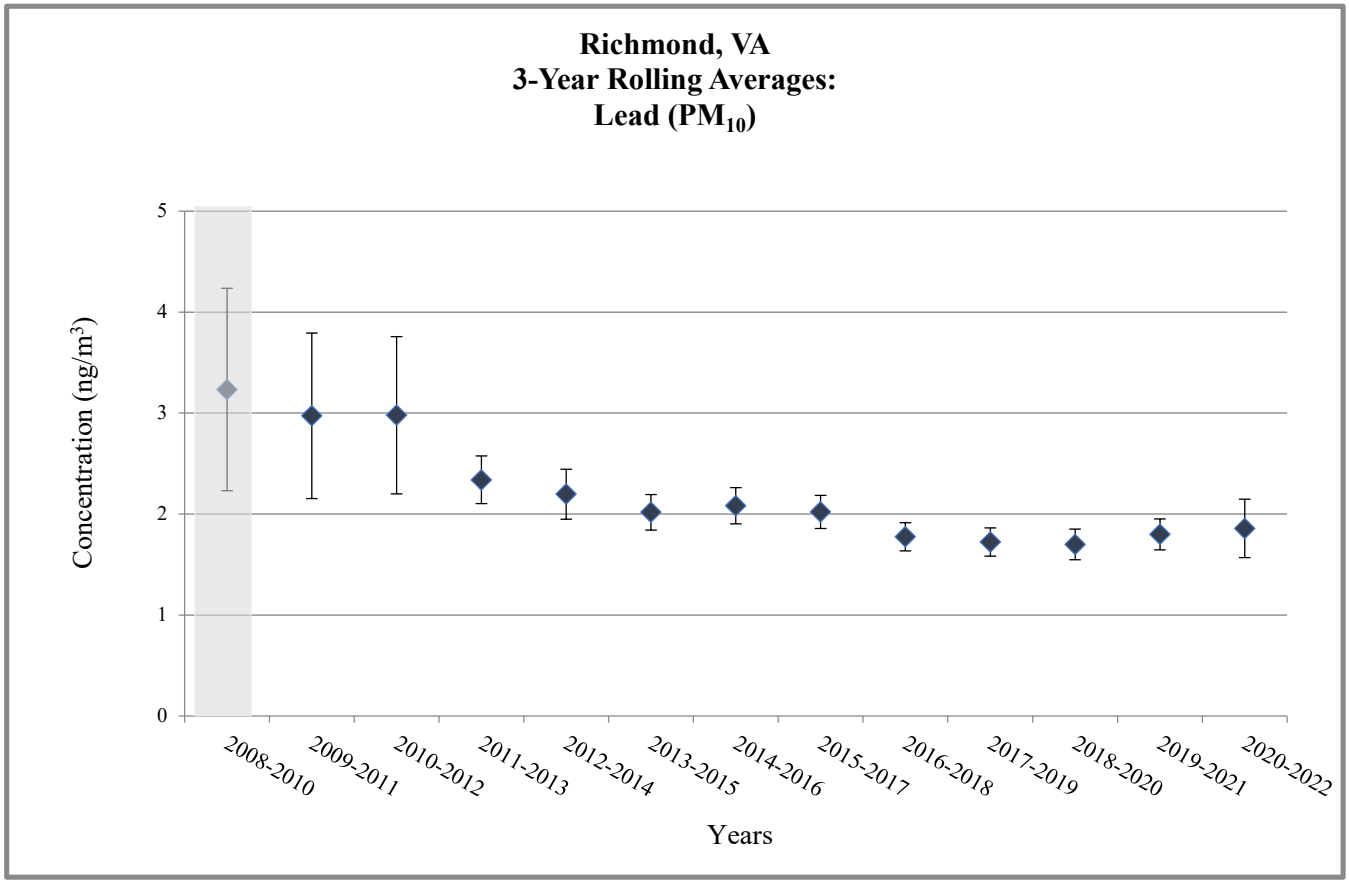
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

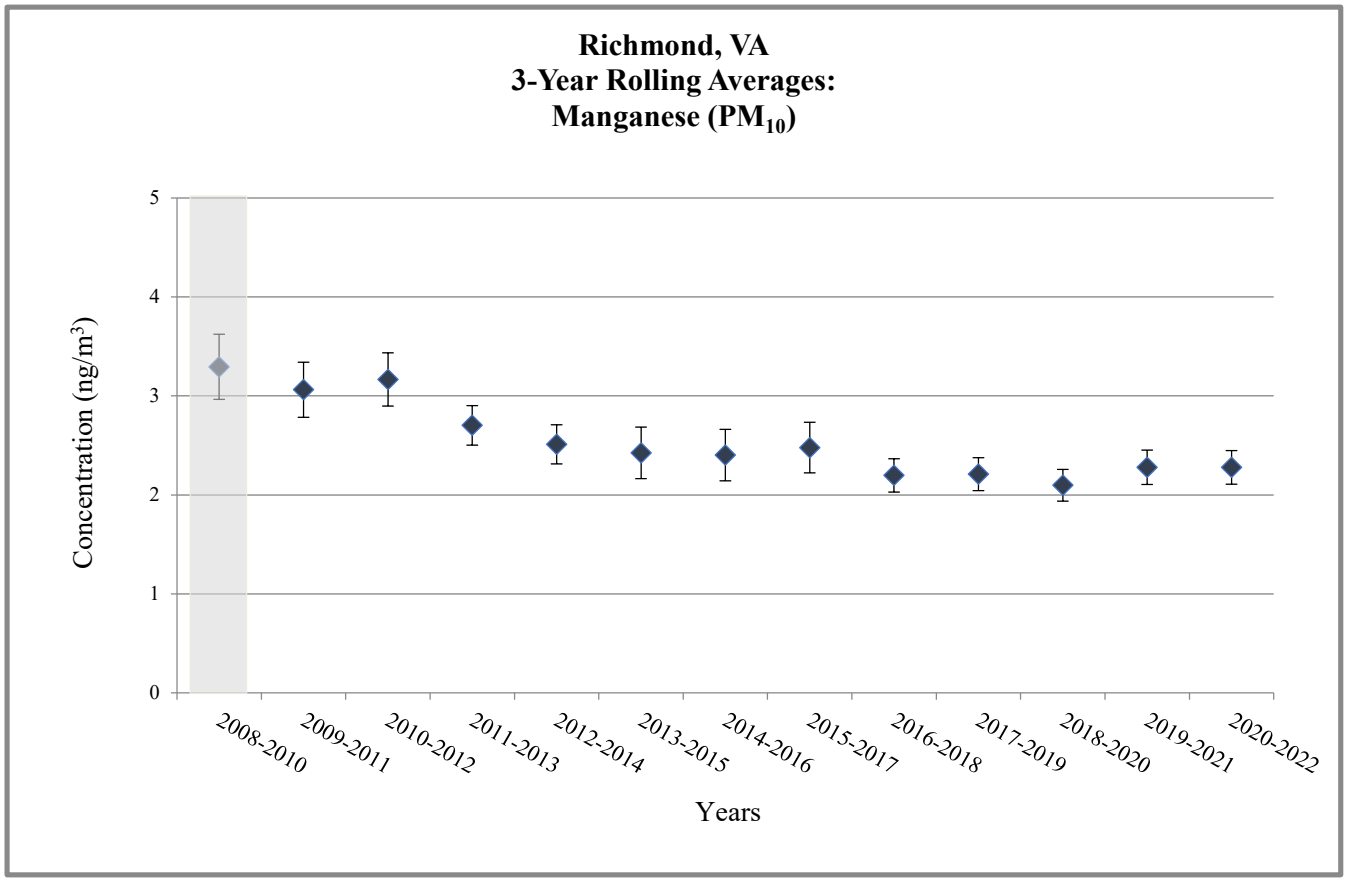




Does not meet MQO or wasn't able to collect enough samples

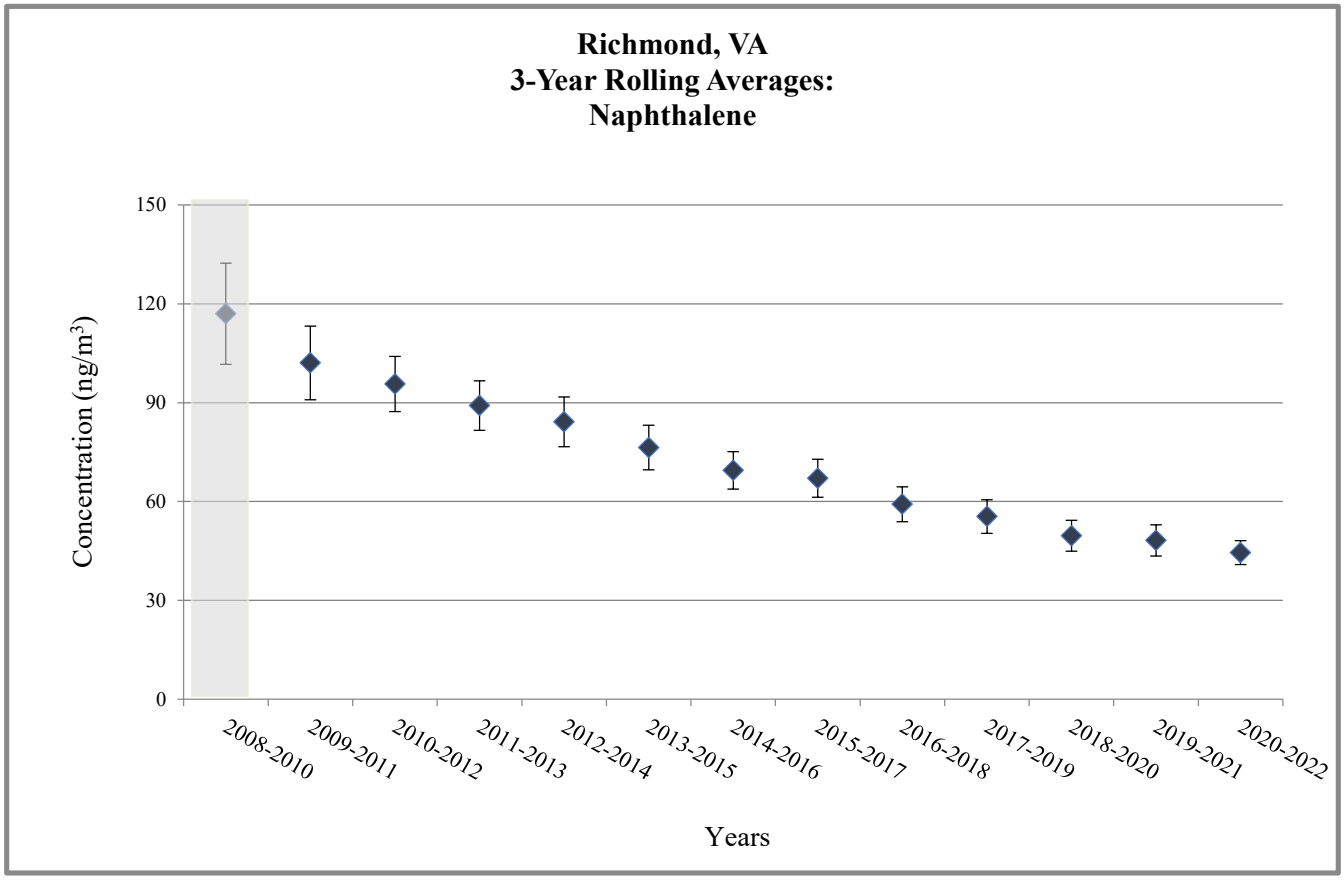
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

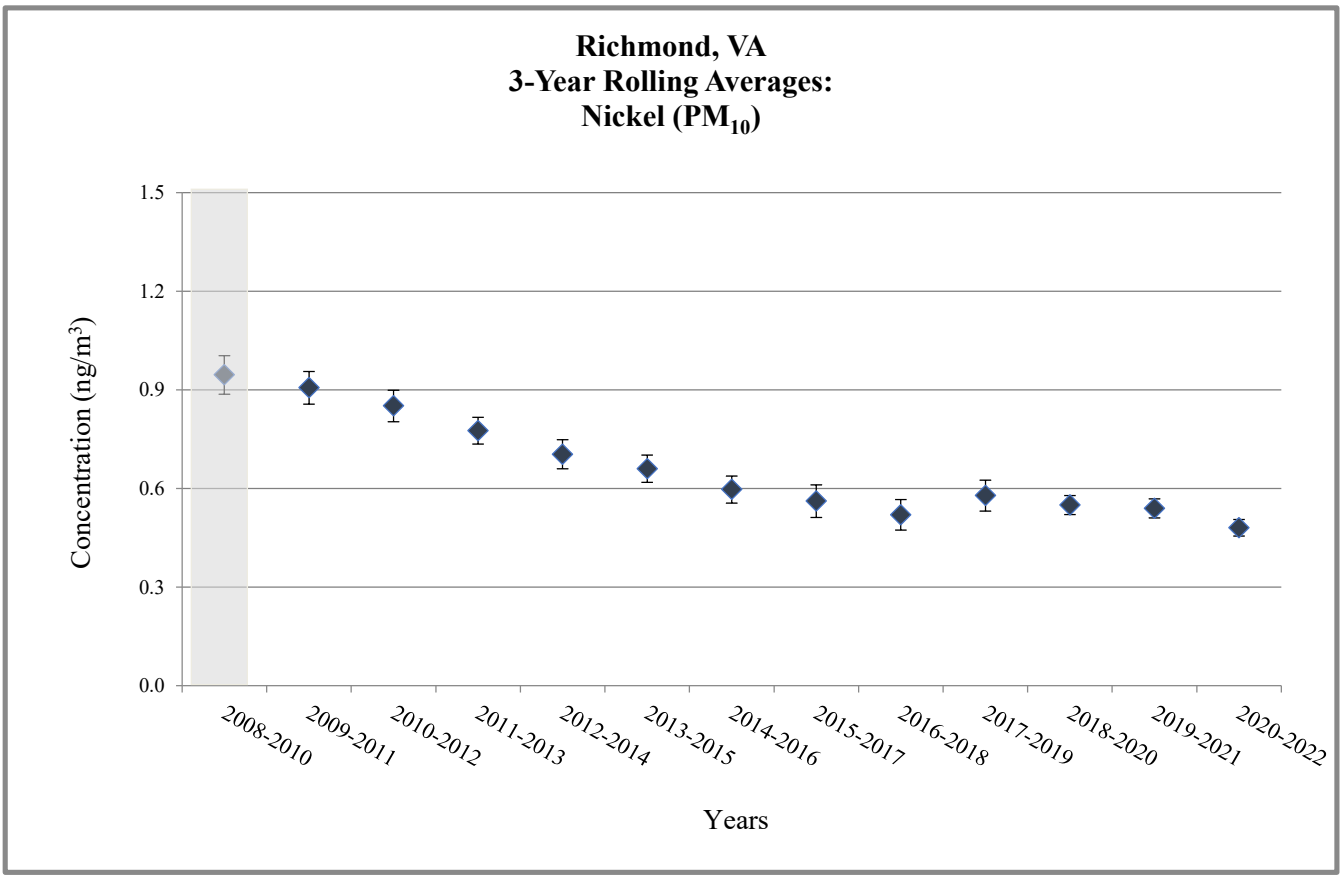




Does not meet MQO or wasn't able to collect enough samples

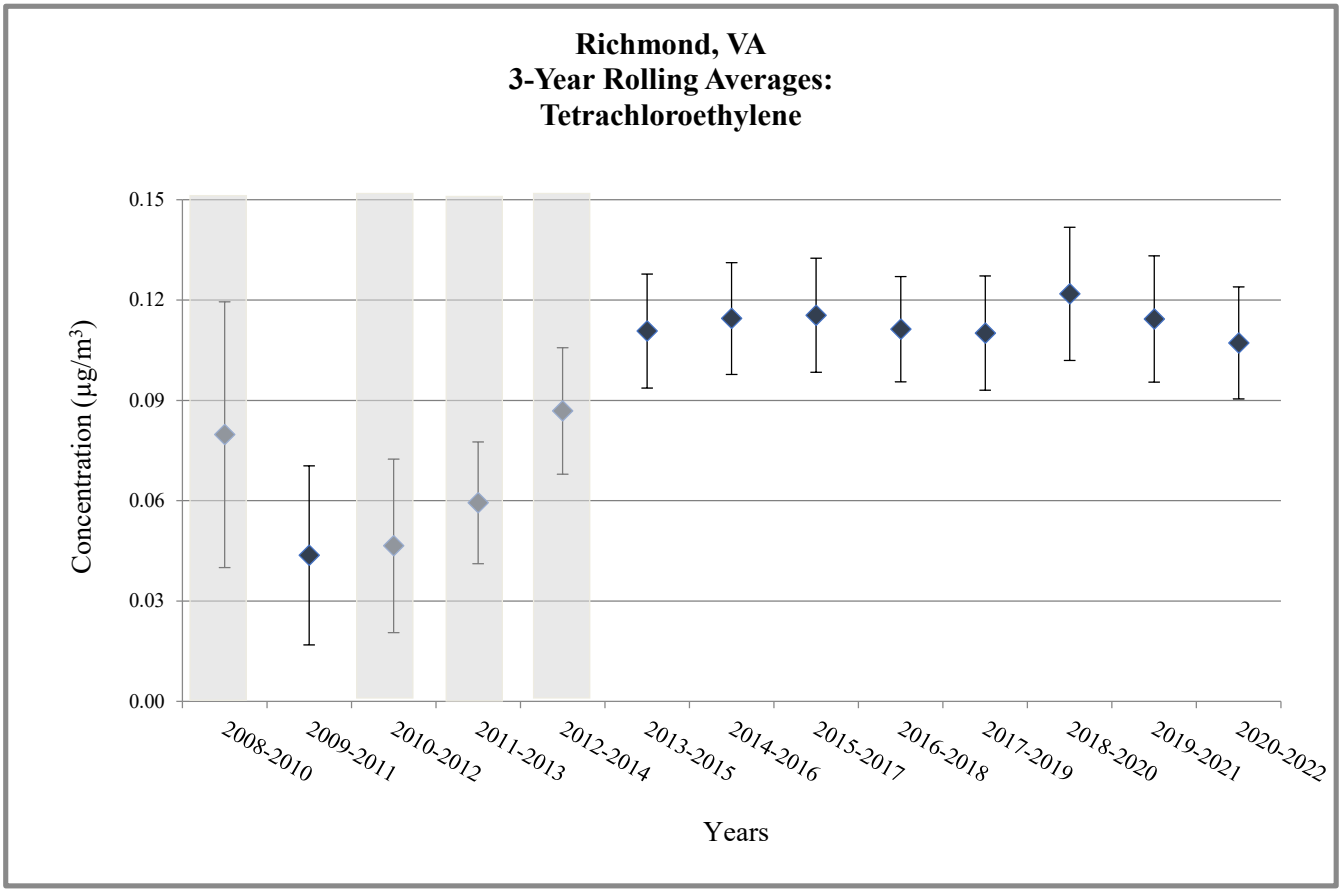
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations

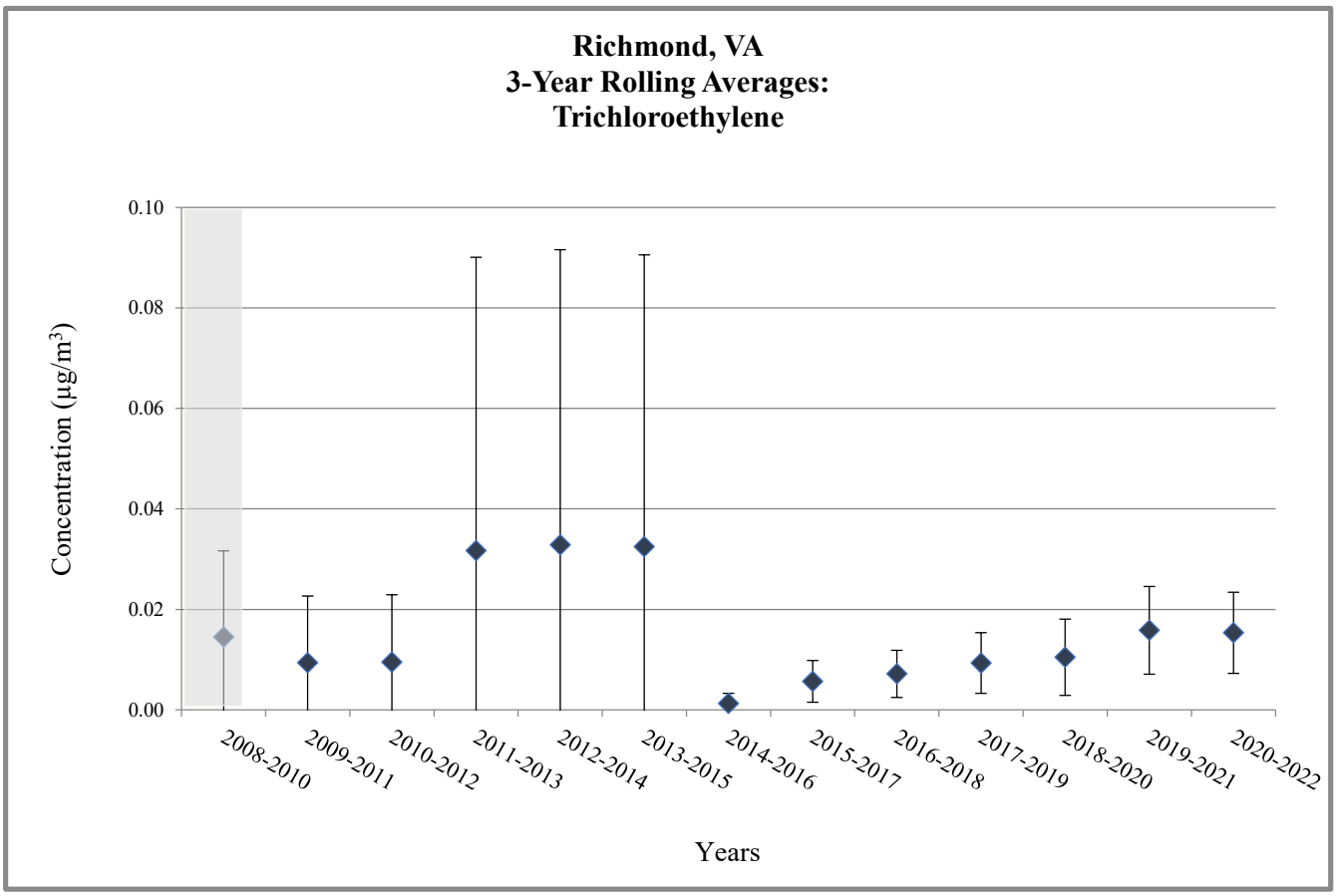




Does not meet MQO or wasn't able to collect enough samples

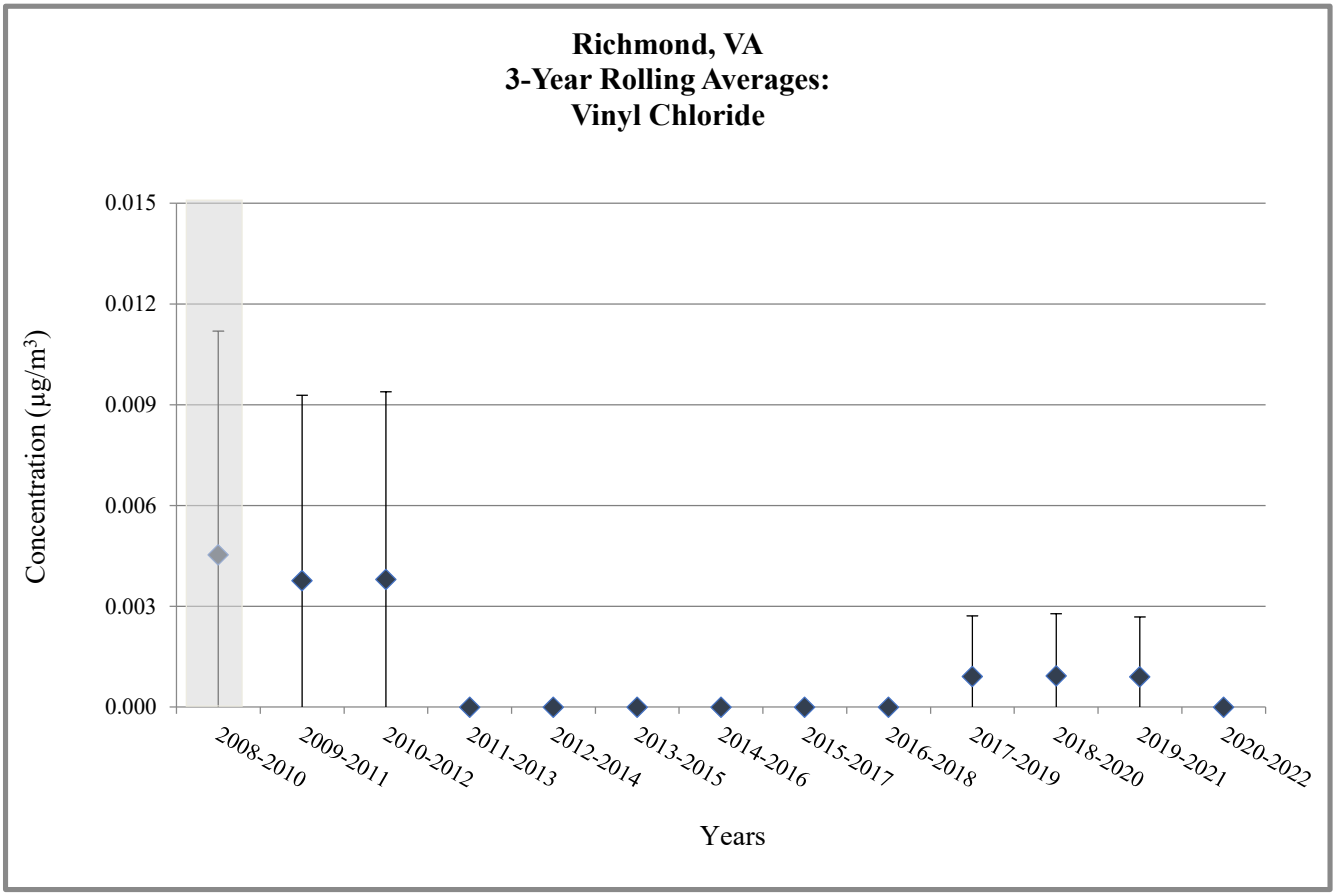
Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations





Does not meet MQO or wasn't able to collect enough samples

Figure 4. Richmond, VA - 3-Year Rolling Average Concentrations



Does not meet MQO or wasn't able to collect enough samples

Table 6. NATTS Network Assessment: MQO#1 - Completeness Percentage at Richmond, VA

Year	Benzene	Butadiene, 1,3-	Carbon tetrachloride	Chloroform	Tetrachloroethylene	Trichloroethylene	Vinyl chloride	Acetaldehyde	Formaldehyde	Arsenic (PM10)	Beryllium (PM10)	Cadmium (PM10)	Lead (PM10)	Manganese (PM10)	Nickel (PM10)	Benzo(a)pyrene	Naphthalene
	VOCs							Carbonyls		PM10 Metals						PAHs	
Richmond, VA (AQS Site Code: 51-087-0014)																	
2008	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a	--a
2009	98	98	98	98	98	98	98	100	100	98	98	98	98	98	98	100	100
2010	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	98	98
2011	100	100	100	100	100	100	100	98	98	97	97	97	97	97	97	100	100
2012	95	95	95	95	95	95	95	100	100	98	98	98	98	98	98	92	92
2013	97	97	97	97	97	97	97	100	100	98	98	98	98	98	98	95	95
2014	98	98	98	98	98	98	98	98	98	97	97	97	97	97	97	93	93
2015	100	100	100	100	100	100	100	100	100	98	98	98	98	98	98	93	93
2016	95	95	95	95	95	95	95	98	98	97	97	97	97	97	97	98	98
2017	95	95	95	95	95	95	95	98	98	98	93	98	98	98	98	95	95
2018	89	89	89	89	89	89	89	98	98	98	98	98	98	98	98	98	98
2019	97	97	97	97	97	97	97	93	93	97	97	97	97	97	97	100	100
2020	89	89	89	89	89	89	89	95	95	95	95	95	95	95	95	92	92
2021	98	98	98	98	98	98	98	95	95	98	98	98	98	98	98	98	98
2022	98	98	98	98	98	95	98	98	98	98	98	98	98	98	98	93	93

A-rated: ≥85%
B-rated: Between 75% to 85%
Does not meet: ≤75%
-- No data available

[a]: Scheduled sampling began midway through the year, thus, the site did not have the opportunity to collect enough samples to meet the 85% MQO.

Table 7. NATTS Network Assessment: MQO#2 - Reported Method Detection Limits (MDLs) at Richmond, VA

Year	Benzene	Butadiene, 1,3-	Carbon tetrachloride	Chloroform	Tetrachloroethylene	Trichloroethylene	Vinyl chloride	Acetaldehyde	Formaldehyde	Arsenic (PM10)	Beryllium (PM10)	Cadmium (PM10)	Lead (PM10)	Manganese (PM10)	Nickel (PM10)	Benzo(a)pyrene	Naphthalene
	VOCs							Carbonyls		PM10 Metals						PAHs	
Richmond, VA (AQS Site Code: 51-087-0014)																	
2008	0.76	1.06	0.81	0.23	1.92	0.41	0.95	0.23	0.06	0.40	0.02	0.16	0.01	0.02	0.09	0.11	0.02
2009	1.33	0.69	1.15	0.35	1.36	0.28	0.79	0.08	0.06	0.10	0.01	0.01	0.00	0.01	0.09	0.08	0.01
2010	0.69	1.95	1.63	0.49	1.24	0.66	1.25	0.14	0.08	0.119	0.022	0.016	0.00	0.01	0.10	0.06	0.01
2011	0.61	1.08	1.11	0.37	1.12	0.18	1.23	0.14	0.08	0.08	0.02	0.02	0.003	0.00	0.04	0.06	0.006
2012	1.03	1.48	1.11	0.29	2.51	0.72	1.56	0.17	0.04	0.08	0.02	0.03	0.00	0.00	0.04	0.08	0.007
2013	0.39	1.13	1.15	0.36	1.20	1.42	1.09	0.08	0.28	0.08	0.02	0.03	0.00	0.00	0.04	0.08	0.01
2014	0.39	0.77	1.15	0.34	1.60	0.94	0.81	0.04	0.28	0.08	0.04	0.03	0.002	0.00	0.10	0.05	0.02
2015	0.76	0.77	1.59	0.34	1.60	0.94	0.81	0.04	0.60	0.08	0.02	0.03	0.001	0.00	0.04	0.22	0.01
2016	0.61	0.40	1.04	0.21	0.88	0.94	0.28	0.06	0.28	0.08	0.02	0.02	0.001	0.00	0.04	0.10	0.04
2017	0.61	0.40	1.04	0.21	0.88	1.02	0.28	0.06	0.28	0.31	0.02	0.02	0.003	0.02	0.13	0.04	0.11
2018	0.42	0.40	1.04	0.21	0.88	0.97	0.28	0.19	0.70	0.19	0.02	0.05	0.005	0.03	0.17	0.02	0.09
2019	0.42	0.84	1.26	0.23	0.96	0.97	1.32	0.19	0.70	0.27	0.021	0.047	0.005	0.04	0.21	0.02	0.06
2020	0.42	0.84	1.26	0.23	0.96	0.97	1.32	0.32	1.01	0.66	0.085	0.144	0.007	0.04	0.37	0.01	0.03
2021	0.42	0.84	1.26	0.23	0.96	0.97	1.32	0.07	0.38	0.35	0.086	0.145	0.007	0.04	0.38	0.01	0.05
2022	0.42	0.44	1.11	0.20	0.80	0.54	0.46	0.07	0.38	0.34	0.107	0.145	0.008	0.04	0.38	0.01	0.05

A-rated: MDL to Target MDL ratio ≤ 1

B-rated" MDL to Target MDL ratio between 1 and 2

Does Not Meet MDL to Target MDL ratio>2

-- No data available

Table 8. NATTS Network Assessment: MQO#3 - Bias Percent Difference at Richmond, VA

Year	Benzene	Butadiene, 1,3-	Carbon tetrachloride	Chloroform	Tetrachloroethylene	Trichloroethylene	Vinyl chloride	Acetaldehyde	Formaldehyde	Arsenic (PM10)	Beryllium (PM10)	Cadmium (PM10)	Lead (PM10)	Manganese (PM10)	Nickel (PM10)	Benzo(a)pyrene	Naphthalene
	VOCs							Carbonyls		PM10 Metals						PAHs	
Richmond, VA (AQS Site Code: 51-087-0014)																	
2008	--a	--a	--a	--a	--a	--a	--a	--a	--a	15.6	-1.7	6.7	5.1	-20.1	5.0	--b	--b
2009	-21.2	-16.6	-17.6	-29.0	-6.5	-9.4	-20.6	-11.0	-6.5	22.3	29.1	17.1	77.5	-7.8	11.1	-1.7	-7.7
2010	-13.2	6.1	9.2	-9.3	-6.5	-1.8	-5.9	1.6	2.4	-8.0	-9.4	-15.1	-21.6	-17.8	-6.1	-2.3	-17.1
2011	23.8	17.9	3.1	-5.5	14.7	6.7	18.0	-3.7	-0.8	-6.8	-8.2	-11.5	-7.5	-6.5	-8.9	-2.1	-13.9
2012	--b	--b	--b	--b	--b	--b	--b	--b	--b	12.9	14.3	8.3	10.2	8.9	-0.3	25.2	21.4
2013	-3.4	18.9	4.5	-0.6	30.1	26.1	8.8	-5.5	3.2	-3.1	2.1	-4.8	-3.4	-9.5	4.7	-5.7	25.5
2014	11.1	3.8	4.4	-2.2	15.7	13.4	18.0	-3.9	0.1	0.0	--c	--c	11.9	7.4	--d	-16.3	0.7
2015	-3.5	-8.5	8.8	-0.7	-10.7	-9.2	-16.4	--b	--b	--b	--b	--b	--b	--b	--b	-14.2	-11.4
2016	-11.6	4.4	16.3	-7.0	1.4	6.3	-1.4	-4.3	-17.5	-1.2	-3.0	-0.4	-1.5	-0.3	29.4	-10.5	-9.5
2017	0.9	1.1	11.2	3.6	-5.7	-7.6	3.6	2.7	1.8	-2.0	-3.7	-4.7	-5.8	-3.1	15.8	-22.4	-11.6
2018	-4.3	11.5	-7.6	3.6	-0.7	-1.5	4.0	-10.6	-9.3	-5.3	-3.5	-1.3	-0.7	0.6	12.6	-14.8	-20.7
2019	-4.8	18.9	-4.8	-2.0	5.3	-1.6	6.3	-1.3	-7.1	2.6	4.4	-0.4	2.9	2.5	-0.7	29.3	18.5
2020	-13.9	38.8	-4.5	5.2	4.4	8.2	16.1	1.3	-1.5	1.3	-1.0	2.1	-1.0	-2.4	-3.6	13.1	15.8
2021	-10.4	9.9	3.7	-1.9	1.6	-1.3	3.3	-0.3	4.3	4.5	0.0	0.0	-4.4	0.8	3.6	0.1	-2.0
2022	-2.9	-11.1	-8.0	-12.0	0.0	0.0	-21.4	-7.2	-4.5	--b	--b	--b	--b	--b	--b	--b	--b

A-rated:±25%

B-rated: Between 25% to 35% or between -25% to -35%

Does not meet:>35% or <35%

-- No data available

[a]: Although this pollutant was sampled for at this site and year, the lone Proficiency Test sample for 2008 was sent before the initiation of this NATTS site.

[b]: No Proficiency Test samples were sent for this pollutant and year.

[c]: The Proficiency Test sample for this pollutant was 0; the site reported a concentration as "< MDL", rather than 0. EPA accepted this result.

[d]: Although a Proficiency Test sample was sent to the lab supporting this site and year, the results were nullified by EPA due to QA issues.

Table 9. NATTS Network Assessment: MQO#4 - Overall Method Precision %CV at Richmond, VA

Year	Benzene	Butadiene, 1,3-	Carbon tetrachloride	Chloroform	Tetrachloroethylene	Trichloroethylene	Vinyl chloride	Acetaldehyde	Formaldehyde	Arsenic (PM10)	Beryllium (PM10)	Cadmium (PM10)	Lead (PM10)	Manganese (PM10)	Nickel (PM10)	Benzo(a)pyrene	Naphthalene
	VOCs							Carbonyls		PM10 Metals						PAHs	
Richmond, VA (AQS Site Code: 51-087-0014)																	
2008	7.2	--a	9.2	--a	9.9	--a	--a	32.8	56.5	--	--	--	--	--	--	--	--
2009	9.3	--a	10.1	--a	9.4	--a	--a	2.9	1.9	--	--	--	--	--	--	--	--
2010	17.4	--a	15.8	--a	--a	--a	--a	--	--	--	--	--	--	--	--	--	--
2011	8.1	--a	5.8	--a	10.9	--a	--a	2.6	2.5	--	--	--	--	--	--	--	--
2012	7.1	10.9	5.6	--a	0.0	--a	--a	2.4	3.9	--	--	--	--	--	--	--	--
2013	13.6	--a	6.5	--a	--a	--a	--a	3.0	2.9	--	--	--	--	--	--	--	--
2014	7.0	12.9	15.0	--a	0.0	--a	--a	1.9	2.4	--	--	--	--	--	--	--	--
2015	5.1	--a	6.5	--a	37.2	--a	--a	6.7	7.9	--	--	--	--	--	--	--	--
2016	32.8	--a	6.6	11.7	8.7	--a	--a	2.4	3.4	--	--	--	--	--	--	--	--
2017	--	--	--	--	--	--	--	1.7	2.7	--	--	--	--	--	--	--	--
2018	--	--	--	--	--	--	--	2.2	2.8	--	--	--	--	--	--	--	--
2019	--	--	--	--	--	--	--	2.3	3.1	4.3	--a	15.4	7.1	1.8	10.3	--	--
2020	--	--	--	--	--	--	--	3.4	3.7	24.2	--a	18.6	15.7	27.9	--a	--	--
2021	--	--	--	--	--	--	--	27.4	28.1	6.4	--a	30.1	8.5	3.5	--a	--	--
2022	--	--	--	--	--	--	--	1.1	0.9	3.5	--a	17.8	7.9	11.5	12.1	--	--

Green = precision ≤ 15%

Yellow = precision > 15% to ≤ 25%

Red = precision > 25%

-- Gray = dataset was not rated

[a]: The primary and/or replicate value were less than the MDL, so no calculation could be made.

Table 10. NATTS Network Assessment: MQO#4 - Analytical Method Precision %CV at Richmond, VA

Year	Benzene	Butadiene, 1,3-	Carbon tetrachloride	Chloroform	Tetrachloroethylene	Trichloroethylene	Vinyl chloride	Acetaldehyde	Formaldehyde	Arsenic (PM10)	Beryllium (PM10)	Cadmium (PM10)	Lead (PM10)	Manganese (PM10)	Nickel (PM10)	Benzo(a)pyrene	Naphthalene
	VOCs							Carbonyls		PM10 Metals						PAHs	
Richmond, VA (AQS Site Code: 51-087-0014)																	
2008	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2009	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2011	--	--	--	--	--	--	--	2.1	2.1	--	--	--	--	--	--	--	--
2012	--a	--a	--a	--a	--a	--a	--a	2.4	0.8	--a	--a	--a	--a	--a	--a	10.1	0.5
2013	7.6	--b	6.7	--b	--b	--b	--b	1.3	1.3	2.6	--b	36.9	9.0	3.3	12.6	--b	1.3
2014	4.6	--b	31.4	--b	--b	0.0	--b	0.6	0.4	7.0	--b	40.9	10.9	3.0	18.0	2.4	14.7
2015	3.7	--b	7.1	0.0	1.2	6.4	--b	0.6	0.4	3.0	--b	10.3	7.7	2.8	3.4	--b	0.7
2016	4.7	--b	7.6	10.1	0.0	0.0	--b	0.6	0.4	5.8	--b	38.0	10.7	2.4	9.8	--b	3.3
2017	8.0	--a	4.2	0.0	--b	--a	--a	0.7	0.8	4.9	--b	17.3	3.3	2.1	12.1	0.5	3.2
2018	3.0	--a	6.4	0.0	0.0	--b	--a	1.0	0.5	2.4	--b	22.3	5.5	1.9	2.9	1.2	1.1
2019	2.3	--a	8.1	0.0	16.7	--a	--a	1.4	1.2	4.2	--b	15.3	7.0	1.7	9.6	2.6	1.1
2020	4.5	18.7	8.3	0.0	3.0	0.0	--a	0.4	0.3	2.1	--b	52.1	6.1	4.0	1.1	1.0	0.8
2021	3.6	--a	6.4	--b	0.0	--b	--a	0.6	0.8	6.4	--b	30.2	8.4	3.4	--b	1.8	0.9
2022	0.0	--a	5.9	16.3	0.0	--b	--a	0.3	0.3	--a	--a	--a	--a	--a	--a	1.3	0.2

A-rated:≤ 15% CV

B-rated: Between 15%CV to25% CV

Does Not Meet: >25% CV or did not report Precision (required in the NATTS Workplan Template since 2012)

-- No data available

[a]: Per the NATTS Workplan template, analytical replicates were required to be reported to AQS for this sampling year.

[b]: The primary and/or replicate value were less than the MDL, so no calculation could be made.

Appendix A. Equipment Inventory

Pollutant Type	Year(s)	Manufacturer/Model, Extraction Type, and Year
Sampling Equipment		
Carbonyls	2008-2014	ATEC 8000 Cartridge Sampler (Year Deployed: 1999)
	2015-2018	ATEC 8000 Cartridge Sampler (Year Deployed: 2014)
	2019	ATEC 8000 Cartridge Sampler (Year Deployed: 2019)
	2020	ATEC 8000 Cartridge Sampler (Year Deployed: 2020)
	2021	ATEC 8000 Cartridge Sampler (Year Deployed: 2021)
	2022	ATEC 8000 Cartridge Sampler (Year Deployed: 2022)
PAHs	2008-2022	Tisch Environmental PUF+ Sampler (Year Deployed: 2008)
PM_{10} Metals	2008	Wedding RFPS-1087-066 Hi-Vol Sampler (Year Deployed: <1988)
	2009-2022	Wedding RFPS-1087-066 Hi-Vol Sampler (Year Deployed: 2009)
VOCs	2008-2014	Xontech 910PC Canister Sampler (Year Deployed: <1988)
	2015-2017	Xontech 910PC Canister Sampler (Year Deployed: 2015)
	2018-2019	Xontech 901 (Year Deployed: 2018)
	2020	ATEC 2200-1P-NBT Canister Sampler (Year Deployed: 2020)
	2021	ATEC 2200-1P-NBT Canister Sampler (Year Deployed: 2021)
	2022	ATEC 2200-1P-NBT Canister Sampler (Year Deployed: 2021)(Late due to Lab Issues)
Analytical Equipment		
Carbonyls	2008-2011	Dionex ASI-100 HPLC, UVD-170U multiple wavelength detector (Year Deployed: <2000)
	2012-2014	Agilent 1260 Infinity HPLC with DAD (Year Deployed: 2012)
	2015-2022	Agilent 1260 Infinity/variable wavelength absorbance detector (Year Deployed: 2012)
PAHs	2008-2013	HP/Agilent 5890/5971 GC/MS (Year Deployed: 2008)
	2014-2018	HP/Agilent 7890B/5975C GC/MS (Year Deployed: 2014)
	2021	HP/Agilent 7890B/5975C GC/MS (Year Deployed: 2015); HP/Agilent 6890/5973 GC/MS (Year Deployed: 2021)
	2022	HP/Agilent 6890/5973 GC/MS (Year Deployed: 2021)
PM_{10} Metals	2008-2018	HP/Agilent 7500ce ICP-MS (Year Deployed: 2006)
	2019-2022	Agilent 7900 ICP-MS (Year Deployed: 2019)
VOCs	2008-2014	HP/Agilent 6890N/5973 GC/MS (Year Deployed: <2002)
	2015-2022	HP/Agilent 6890N/5973 GC/MS (Year Deployed: 2004)
Preconcentrator Equipment		
VOCs	2008-2011	Entech 7100A (Year Deployed: <2002)
	2012-2022	Entech 7200 (Year Deployed: 2012)
Standards Preparation Equipment		
VOCs	2008-2021	Entech 4600A (dynamic dilution) (Year Deployed: 2004)
	2022	Entech 4700 (Precision Satic Diluter) (Year Deployed: 2021)
Canister Cleaning Equipment		
VOCs	2008-2011	Entech 3100A (Hot) (Year Deployed: 2006)
	2012-2017	Entech 3100 (Hot) (Year Deployed: 2012)
	2018-2022	Entech 3100-D (Hot) (Year Deployed: 2018)
PM_{10} Extraction Equipment		
PM_{10} Metals	2008	Thermolyne 2200 (hotblock) (Year Deployed: unknown)
	2009	Environmental Express SC182 (Hotblock) (Year Deployed: 2009)
	2010-2015	Environmental Express SC182 (Hotblock) (Year Deployed: 2010)
	2016-2022	Environmental Express SC182 (Hotblock) (Year Deployed: 2016)
PAHs Extraction Equipment		
PAHs	2008-2018	Dionex -300 (ASE) (Year Deployed: 2004)
	2019-2022	Dionex -350 (ASE) (Year Deployed: 2019)