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Stormwater Phosphorus Characteristics and WinSLAMM Modifications

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Summary
It has long been desired to incorporate an ability to modify the phosphorus concentrations for each season in the WinSLAMM parameter files. The following is a summary of constituent seasonal variations are reported in the National Stormwater Quality Database (ver 4.02) (Maestre and Pitt 2006). Appendix A contains details of this seasonal analyses, stressing the upper Midwest and Northeast region of the US (from the NY report noted below). Appendix B contains data used in this memo to calculate the ratios of the median seasonal concentrations to the annual concentrations by location and land use for all constituents that had significant seasonal variations.

Single land use concentration data were examined using full factorial analyses to identify significant main factors (seasons, land use, and location) and significant interactions. Two-way and three-way interactions were included in the analyses. Table 1 shows the results from the factorial analyses. A p-value smaller than 0.05 indicates that the factor, or interaction of factors, was found to be significant at least at the 5% significance level.

The results indicated that the factors for land use, and the EPA Rain Zone (location), plus the interaction land use–rain zone were the most important factors. Therefore, local data should be used for the specific land uses under consideration. Season alone was not significant for any constituent except for TKN. Note that bacteria were not evaluated due to missing data in some of the important categories. Historically, bacteria have been found to vary by season (generally much lower in colder seasons for northern areas). For all the constituents except TSS, concentrations in the open space land use were lower than for the other land uses, while, samples collected at freeways and industrial sites had the highest concentrations. Total phosphorus and TKN appear to be high during the summer and low during the winter. No clear variations in concentration were observed between spring and fall. Samples collected in EPA Rain Zone 3 (the southeast) had the lowest concentrations for all the constituents. The largest concentrations were observed in EPA Rain Zone 6 (the southwest) followed by rain zones 1 (Great Lakes and northeast) and 4 (Mississippi valley).

Table 1. p-values for main factors and interactions

Constituent	Land Use (LU)	Season (SN)	EPA Rain Zone (EPA)	LU*SN	LU*EPA	SN*EPA	LU*EPA*SN
TSS mg/L	<0.0001	0.74	<0.0001	0.02	<0.0001	0.18	<0.0001
BOD mg/L	<0.0001	0.16	<0.0001	0.0008	<0.0001	0.001	0.22
COD mg/L	<0.0001	0.13	<0.0001	0.03	<0.0001	0.014	0.009
TP mg/L	<0.0001	0.69	<0.0001	0.055	<0.0001	0.0004	<0.0001
NO2+NO3 mg/L	<0.0001	0.11	<0.0001	0.052	<0.0001	0.034	0.057
TKN mg/L	0.0026	0.02	<0.0001	0.99	<0.0001	<0.0001	0.17
Cu µg/L	<0.0001	0.11	<0.0001	0.62	<0.0001	0.038	0.14
Pb µg/L	<0.0001	0.76	<0.0001	0.42	<0.0001	0.29	0.012
Zn µg/L	<0.0001	0.91	<0.0001	0.94	<0.0001	0.014	<0.0001

Yellow high-lighted cells indicate significant differences (p<0.05)

All of the constituents listed above have significant seasonal effects when examining the seasonal effects interaction with location, or with both location and land use. Therefore, it may be worthwhile to expand seasonal options for all constituents, not just for phosphorus. The ratios of seasonal concentrations to annual concentrations for each land use and location are shown in this memo, reflecting these factorial analyses.

It is suggested that a similar approach previously presented for particle size modifications be used for seasonal constituent differences. This would use ratio factors showing the adjustments for each season compared to the current overall constituent values. These factors need to be applied to both the particulate strength values and the filtered concentration values. Not all constituents have data reflecting seasonal changes, and not all seasons will be modified. For situations of no change, the ratio factors would be 1.0. Limited data are available for seasons, but it may be most useful to allow changes for each month, as seasonal ranges vary. If using just seasonal changes, then the beginning months of each season would have to be specified (such as using the current season definitions for the tree interception equations). Also, these analyses are for the land use concentrations, while WinSLAMM parameter files use land use source area concentration values. Source area seasonal data are limited and not available for these analyses. In the absence of these seasonal source area data, these land use factors could be applied to the source areas.

The following is a summary from a series of reports I prepared for the New York State Attorney General's office of phosphorus characteristics and treatment that has some more detailed information concerning phosphorus variations and trends.

New York State Phosphorus Report Summary

Several years ago, I prepared a report for the New York State Attorney General's office: *Review of Stormwater Phosphorus Characteristics and Treatment for New Development in the New York City Watershed* (September 5, 2017). The following is the executive summary of that report:

> 'This report addresses the following question: "Can treated stormwater from a development project proposed at an undeveloped site (e.g. forest, meadow) be expected to achieve no net increase in total phosphorus (TP) loading?" The short answer is "highly unlikely." This report also evaluates the effectiveness of certain stormwater controls for new development projects in the New York City Watershed and provides recommendations for improvements that can be implemented through the 2017 Filtration Avoidance Determination (FAD).
>
> Stormwater regulations of the New York City Department of Environmental Protection (DEP) do not require applicants to perform phosphorous loading analyses which would ensure that effluents from proposed development projects do not increase phosphorus discharges, compared to pre-development levels. (This is also true for New York State Department of Environmental Conservation (DEC) permits, but the subject of this study is stormwater policies within the New York City Watershed within the context of potential improvements by DEP pursuant to the 2017 FAD.) This presents a particular difficulty for the City's Croton system reservoirs that do not currently meet water quality standards due to eutrophic conditions from excessive phosphorus discharges within their watersheds. Moreover, phosphorous discharges within the Delaware system reservoirs can also contribute to this problem in Croton system reservoirs. Water from the Delaware System's Rondout reservoir is fed by the other Delaware system reservoirs (the Cannonsville, Neversink, and Pepacton) and can travel through the Delaware Aqueduct into the West Branch Reservoir and then into the Croton system's eutrophic Croton Falls, Muscoot, and New Croton reservoirs.
>
> As discussed below, even when stormwater controls are properly designed and implemented, we can generally expect a net increase in phosphorus discharges from new development. To address this problem, I recommend that sponsors of development projects be required to establish that their planned stormwater controls would achieve no net increase in phosphorus discharges. TP and total suspended solids (TSS) are usually closely correlated, along with some metals. Therefore, removal of TP in sedimentation ponds or wetlands will also result in the removal of about half the TSS. Metals would be removed somewhat less than the TSS (lead the most, copper and zinc less). Infiltration controls (with

no underdrains) would reduce all pollutants at the same rate, as the infiltrating water removes all pollutants from the surface runoff.

Recent research has shown that some of the stormwater controls allowed by DEP regulations -- grassed filter strips, grass swales, and bioretention systems – can actually increase phosphorus concentrations in stormwater. These controls can therefore lead to increased phosphorus discharge loading (concentrations times runoff volumes). Therefore, the use of these controls needs to be carefully evaluated to ensure that increases in phosphorus concentrations are offset by runoff volume reductions, in addition to meeting other control objectives."

As part of this report, I prepared several extensive appendices (Appendix A is included as part of this memo):

"• Appendix A: provides an analysis of TP data in the National Stormwater Quality Database. According to this analysis, location, land use, and season can all affect the expected total TP concentrations in stormwater. Data from the upper Midwest and Northeast U.S. were examined and three statistically significant land use groups were identified: 1) residential land uses (low density suburban to high density residential areas), 2) open space (such as parks, golf courses, and cemeteries) plus industrial land uses, and 3) institutional land uses (such as schools and government facilities) plus commercial land uses (central business districts, shopping centers and strip commercial). (There were too few observations from freeway locations in these regions for comparison).

Limited data indicates that snowmelt from developed urban areas can contribute relatively large TP loads to a receiving water. These discharges, and their control, also need to be considered when evaluating changes in TP loads associated with development.

• Appendix B: The International Stormwater BMP Database evaluates the performance of stormwater controls. This appendix summarizes the effectiveness of stormwater treatment on TP and includes: biological filtration, bioretention, dry detention basins, grass filter strips, grass swales, inlet inserts, media filters, oil/grit separators, physical separators, physical separators with volume control, porous pavement, sand filtration, treatment trains, wetland basins, wetland channels, and wet retention ponds.

• Appendix C: presents state regulations restricting the use of TP in fertilizers and laundry detergents. These regulations are an important part of TP control in developed areas but need to be used in conjunction with other stormwater controls.

• Appendix D: presents information for a number of models that can evaluate TP sources, discharges, and controls in urban areas. Many of the most common models were developed to assist with drainage design, where large single storms were evaluated. Some users have adapted these methods to evaluate smaller precipitation events and their impacts on water quality. If only outfall flow conditions are desired, and data are available to verify the model, these models can be reasonably accurate. However, these modified models are often in error when quantifying pollutant sources and can lead to large errors when applied to smaller precipitation events and to water quality analyses. Models used without verification may be suitable for preliminary analyses, with the understanding that greater uncertainty will accompany the results.

• Appendix E: Hidden Meadow Development Stormwater Analysis Summary. As noted earlier, the Hidden Meadow development is on a forested site. It is about 35 acres in size, with about 10 acres developed in multi-family residences, parks, and roadways, and 5 acres of undeveloped area that drains onto the developed area. The stormwater quality model, WinSLAMM (version 10.3), was used to calculate the expected post-development stormwater quality (focusing on total phosphorus) for this typical residential development.

The total phosphorus load after development is expected to increase by about 0.22 pounds per year, even with the extensive stormwater controls at the site and offsite stormwater treatment. Detailed information for this analysis is included in this appendix.

• Appendix F: Costco Stormwater Analysis Summary. The Costco site is a redeveloped area that was originally occupied by a plant nursery/lawn mower service center, two residential properties, a former motel, and a fence company. The re-developed area is comprised of large parking areas and a large Costco building, along with several outbuildings. The total area is about 24 acres. The pre- and post- redeveloped site areas were evaluated using the stormwater quality model, WinSLAMM (version 10.3), to calculate stormwater total phosphorus discharges for this typical redevelopment commercial project.

The total phosphorus load after re-development is expected to increase by about 1.37 pounds per year, even with the extensive stormwater controls at the site and offsite stormwater treatment. Detailed information for this analysis is included in this appendix."

Recommendations to Incorporate Changing Seasonal Phosphorus Concentrations in WinSLAMM

The NSQD (ver 4) was sorted by major land use categories, then by location, and finally by season. The particulate strengths were calculated based on the total minus filtered concentrations divided by the TSS concentrations and multiplied by a factor to result in mg/kg units. These particulate concentrations and the filtered concentrations were then summarized by land use, location, and season. Appendix B contains these data. Ratios of the seasonal median values to the annual median values, by location and land use for the filtered concentrations and particulate strength values are shown in the following tables. The following are the constituents summarized on these tables (if data are available):

TSS (mg/L)
Fecal Coliform (#/100 mL)
Ammonia (mg/L)
N02+NO3 (mg/L as N)
Phosphorous Filtered as P (mg/L)
Phosphorus particulate strength (mg/kg)
Phosphate Ortho as P (mg/L)
Cadmium Filtered (ug/L)
Cadmium part strength (ug/kg)
Chromium Filtered (ug/L)

Chromium part strength (ug/kg)
Copper Filtered (ug/L)
Copper part strength (ug/kg)
Iron, Filtered as Fe (ug/L)
Iron part strength (ug/kg)
Lead Filtered After 1984 (ug/L)
Lead part strength (ug/kg)
Nickel Filtered (ug/L)
Nickel part strength (ug/kg)
Zinc Filtered (ug/L)

Few seasons, locations, or land uses have complete sets of data, while most have data for TSS, bacteria, and nutrients. Blanks on the tables reflect an absence of information and should be replaced with ratios of 1.0 (no seasonal variations). A few ratios are yellow-highlighted reflecting ratios of <0.1 or >10. Most of these extreme ratios are for fecal coliform bacteria, although some of the metals also indicate extreme ratios. Some of the regions also have few data (especially region 8 which only had one NSQD city and only residential data.

Seasonal Ratios for EPA Rain Zone 1 (Upper Midwest and Northeast)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA1 Winter	0.93	0.12	0.64	1.33	1.23	0.68	0.34
resid EPA1 Spring	1.11	0.22	1.51	0.93	0.94	1.01	0.80
resid EPA1 Summer	1.29	13.35	1.25	1.00	0.92	0.99	1.03
resid EPA1 Fall	0.60	6.32	0.82	0.92	1.72	1.18	1.16
commercial EPA1 Winter	1.46	0.18	0.81	1.10	1.00	0.70	
commercial EPA1 Spring	1.96	2.51	1.09	1.05	0.93	0.55	
commercial EPA1 Summer	1.06	21.46	1.12	0.99	0.80	1.30	
commercial EPA1 Fall	0.69	1.07	1.19	0.89	1.17	1.56	
institutional EPA1 Winter							
institutional EPA1 Spring	0.65			0.93			
institutional EPA1 Summer	1.02	1.13		0.94	1.00	1.00	
institutional EPA1 Fall	0.18	0.47	1.00	1.38	1.00	2.58	
industrial EPA1 Winter	2.30	0.05	0.96	1.12	5.75	0.86	
industrial EPA1 Spring	1.12	0.22	1.15	1.08	0.75	0.97	
industrial EPA1 Summer	0.90	13.85	1.26	1.04	0.65	1.05	
industrial EPA1 Fall	0.83	1.00	0.66	0.75	1.15	1.17	
open space EPA1 Winter							
open space EPA1 Spring	1.21	3.83	0.97	1.30			
open space EPA1 Summer							
open space EPA1 Fall	1.00	1.00	1.03	0.74			1.00

Seasonal Ratios for EPA Rain Zone 2 (Mid-Atlantic)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA2 Winter	0.86	0.60	0.76	0.86	0.81	1.01	
resid EPA2 Spring	1.22	0.63	1.21	1.08	0.81	1.01	
resid EPA2 Summer	1.14	3.75	1.62	1.18	1.09	0.93	
resid EPA2 Fall	0.85	1.92	0.93	0.93	1.13	1.04	
commercial EPA2 Winter	1.17	0.35	0.82	0.88	0.82	0.73	
commercial EPA2 Spring	1.13	1.09	1.13	1.13	1.00	1.08	
commercial EPA2 Summer	0.78	0.93	0.99	1.19	1.00	1.13	
commercial EPA2 Fall	0.91	1.71	1.03	0.90	1.27	1.00	
institutional EPA2 Winter	1.11		0.74	0.80	0.96	7.07	
institutional EPA1 Spring	1.18		1.03	0.55	1.20	1.17	
institutional EPA2 Summer	0.93		1.55	0.94	1.28	1.00	
institutional EPA2 Fall	1.11		0.74	0.80	0.96	7.07	
industrial EPA2 Winter	1.15	0.31	0.74	0.84	0.80	0.78	
industrial EPA2 Spring	1.05	0.50	1.07	1.23	1.10	0.93	
industrial EPA2 Summer	0.78	4.56	1.54	1.15	1.05	0.98	
industrial EPA2 Fall	0.96	2.43	0.93	0.76	1.15	1.11	
freeway EPA2 Winter	2.28	0.91	1.41	1.16	1.06	1.04	
freeway EPA2 Spring	0.82	3.48	1.08	1.05	0.81	0.29	
freeway EPA2 Summer	1.24	0.99		0.88			
freeway EPA2 Fall	0.78	1.27	0.68	1.14	1.00	10.90	
open space EPA2 Winter	0.50	1.02	0.41	0.63	6.00	0.65	
open space EPA2 Spring	0.55	2.49	1.51	1.10	0.33	1.81	
open space EPA2 Summer	1.52	1.46	1.47	1.11	3.00	0.37	
open space EPA2 Fall	2.00	0.66		0.71	0.83	0.66	

ratio of medians (seasonal to annual value)	Cadmium Filtered (ug/L)	Cadmium part strength (ug/kg)	Chromium Filtered (ug/L)	Chromium part strength (ug/kg)	Copper Filtered (ug/L)	Copper part strength (ug/kg)	Lead Filtered After 1984 (ug/L)	Lead part strength (ug/kg)	Zinc Filtered (ug/L)	Zinc part strength (ug/kg)
resid EPA2 Winter	0.80		0.75	0.07	0.84	1.03	0.80	0.98	0.95	0.96
resid EPA2 Spring	1.59	1.00	1.13	1.16	1.42	1.22	0.60		1.14	1.52
resid EPA2 Summer	0.67				0.98	0.94	0.90	1.15	0.93	1.44
resid EPA2 Fall					1.32	0.65	3.20	0.57	1.18	0.54
commercial EPA2 Winter					1.19	0.68	1.25	0.75	1.13	1.03
commercial EPA2 Spring			0.74	1.95	1.81	0.88	0.63	0.80	1.55	0.83
commercial EPA2 Summer	1.00	1.00			0.59	1.27	0.75	3.58	0.49	1.43
commercial EPA2 Fall			1.26	0.05	0.93	1.48	1.25	1.00	1.04	0.18

Seasonal Ratios for EPA Rain Zone 3 (Southeast)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)
resid EPA3 Winter	1.83	0.66	3.17	0.89	0.69	0.73
resid EPA3 Spring	0.96	0.46	1.00	1.76	1.39	1.07
resid EPA3 Summer	0.83	5.01	0.83	2.02	1.09	1.01
resid EPA3 Fall	0.87	6.09		0.72	1.09	1.28
commercial EPA3 Winter	0.99	1.00	2.62	0.34	1.10	1.41
commercial EPA3 Spring	2.22	0.30	0.76	5.25	0.45	0.60
commercial EPA3 Summer	0.64	3.23	0.90	1.00	0.92	0.80
commercial EPA3 Fall	1.19				1.85	2.10
institutional EPA3 Winter				0.71		
institutional EPA3 Spring				0.90		
institutional EPA3 Summer				1.23		
institutional EPA3 Fall				0.61		
industrial EPA3 Winter	0.77	0.10	1.13	1.36	1.11	0.88
industrial EPA3 Spring	1.67	0.62	0.80	2.17	0.82	1.79
industrial EPA3 Summer	0.80	3.90	0.90	1.49	0.71	1.47
industrial EPA3 Fall	1.29	0.54	1.67	0.96	1.14	1.26
freeway EPA3 Winter	0.73				0.99	1.45
freeway EPA3 Spring	1.01				5.20	1.33
freeway EPA3 Summer	1.70				0.87	0.79
freeway EPA3 Fall	0.94				1.07	1.00

ratio of medians (seasonal to annual value)	Cadmium Filtered (ug/L)	Cadmium part strength (ug/kg)	Copper Filtered (ug/L)	Copper part strength (ug/kg)	Lead Filtered After 1984 (ug/L)	Lead part strength (ug/kg)	Zinc Filtered (ug/L)	Zinc part strength (ug/kg)
commercial EPA3 Winter			1.00	1.27	1.00	1.00	0.67	1.00
commercial EPA3 Spring			0.48				0.78	0.47
commercial EPA3 Summer	0.37	0.28	0.69	0.89			1.39	1.16
commercial EPA3 Fall	1.63	1.72	4.48				5.28	2.86

Seasonal Ratios for EPA Rain Zone 4 (Lower Mississippi)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA4 Winter	0.67	0.27	1.13	0.82	0.66	0.65	
resid EPA4 Spring	1.36	0.27	1.55	1.00	1.05	1.03	
resid EPA4 Summer	0.88	1.49	0.54	1.12	1.04	1.00	3.20
resid EPA4 Fall	1.17	1.78	1.46	0.96	1.04	5.56	0.90
commercial EPA4 Winter	1.00	0.15	1.00	0.86	1.00	0.83	
commercial EPA4 Spring	1.08	0.40		0.63	0.59	1.43	0.67
commercial EPA4 Summer	0.95	1.71	1.50	1.17	0.91	2.00	1.24
commercial EPA4 Fall	0.64	1.80		1.00	1.27	0.69	1.33
institutional EPA4 Winter							
institutional EPA4 Spring	1.67						
institutional EPA4 Summer	0.93						
institutional EPA4 Fall	0.87						1.00
industrial EPA4 Winter	1.22	0.68	2.00	1.16	1.38	0.47	
industrial EPA4 Spring	1.66	0.61	0.54	1.01	0.58	0.78	4.28
industrial EPA4 Summer	0.97	1.24	1.19	1.31	1.31	1.70	1.00
industrial EPA4 Fall	0.91	6.29	0.00	0.78	0.77	1.06	0.22
open space EPA4 Winter	1.21	0.28	0.91	0.58	2.34	1.50	
open space EPA4 Spring	2.75	0.27		0.55	1.19	0.27	
open space EPA4 Summer	1.65	1.51	1.09	1.54	0.44	0.92	
open space EPA4 Fall	0.28	2.60		2.10	1.00	1.06	

Seasonal Ratios for EPA Rain Zone 5 (most of Texas and some surrounding areas)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)
resid EPA5 Winter	0.78	0.34		0.89	0.78	0.87
resid EPA5 Spring	1.03	0.97		1.11	1.04	0.98
resid EPA5 Summer	1.09	5.86		1.07	0.90	0.35
resid EPA5 Fall	0.97	1.64		0.83	1.15	1.17
commercial EPA5 Winter	0.99	0.24		1.00	0.60	0.98
commercial EPA5 Spring	0.81	1.01		1.06	1.20	1.03
commercial EPA5 Summer						
commercial EPA5 Fall	1.80	1.86		0.77	1.36	0.96
industrial EPA5 Winter	0.97	0.68		1.01	1.20	1.33
industrial EPA5 Spring	0.96	0.39		1.06	1.00	0.88
industrial EPA5 Summer	0.62	2.53		1.03	0.96	0.56
industrial EPA5 Fall	1.12	1.75		0.91	1.17	0.86
open space EPA5 Winter	1.77	0.32		1.03	1.00	1.00
open space EPA5 Spring	0.98	1.84		0.63	1.00	1.94
open space EPA5 Summer	0.84	32.43		1.05	1.00	0.28
open space EPA5 Fall	2.33	5.05		1.62	5.05	1.41

Seasonal Ratios for EPA Rain Zone 6 (Southwest)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA6 Winter	0.98	2.11	0.85	0.85	0.91	0.66	0.71
resid EPA6 Spring	0.84	0.24	0.91	0.89	0.83	1.21	0.98
resid EPA6 Summer	1.16	0.18	2.99	1.14	1.83	3.33	1.33
resid EPA6 Fall	1.63	0.20	1.89	1.00	2.17	1.10	1.10
commercial EPA6 Winter	1.43	1.48	0.84	0.65	0.63	0.82	0.52
commercial EPA6 Spring	1.16	1.52	0.20	0.91	0.75	1.12	0.83
commercial EPA6 Summer	1.44	0.52	1.63	1.27	1.63	0.80	1.34
commercial EPA6 Fall	0.35	1.33	0.81	0.95	1.28	2.73	0.79
institutional EPA6 Winter	1.12		0.83		0.90	0.64	
institutional EPA6 Spring	0.59		1.07		0.75	1.73	
institutional EPA6 Summer							
institutional EPA6 Fall	1.23		1.52		2.44	1.00	
industrial EPA6 Winter	0.77	1.61	0.59	0.71	0.70	1.01	0.79
industrial EPA6 Spring	1.05	0.89	0.77	0.88	0.75	0.73	1.04
industrial EPA6 Summer	1.79	0.92	2.09	1.24	1.28	1.53	0.95
industrial EPA6 Fall	1.05	1.02	1.70	0.94	1.65	1.15	1.63
freeway EPA6 Winter	1.03	0.76	0.75		1.00	0.83	0.89
freeway EPA6 Spring	0.87	1.18	0.83		0.78	0.71	1.11
freeway EPA6 Summer							
freeway EPA6 Fall	0.72	7.65	1.30		1.87	3.09	3.67
open space EPA6 Winter	2.18	3.90	1.12		1.14	0.52	
open space EPA6 Spring	0.45	1.00	0.79		0.87	2.74	
open space EPA6 Summer	2.05	0.47	3.36				
open space EPA6 Fall	0.50	0.44	1.56		0.86	4.04	

ratio of medians (seasonal to annual value)	Cadmium Filtered (ug/L)	Cadmium part strength (ug/kg)	Chromium Filtered (ug/L)	Chromium part strength (ug/kg)	Copper Filtered (ug/L)	Copper part strength (ug/kg)	Iron, Filtered as Fe (ug/L)	Iron part strength (ug/kg)	Lead Filtered After 1984 (ug/L)	Lead part strength (ug/kg)	Nickel Filtered (ug/L)	Nickel part strength (ug/kg)	Zinc Filtered (ug/L)
resid EPA6 Winter			0.73		0.89	0.82	1.02	1.90	0.71	1.00	0.83	16.62	1.00
resid EPA6 Spring	0.93	1.00	1.05		0.74	1.21	0.79	0.43			0.75	1.07	0.84
resid EPA6 Summer					2.18	1.47			2.69				3.80
resid EPA6 Fall	2.40	0.00	1.47		1.60	1.41	1.49	1.77	1.08		1.14	0.93	1.99
commercial EPA6 Winter	1.00				1.18	16.60	1.84	1.00	0.35				0.66
commercial EPA6 Spring					0.91	0.74	0.67	1.16	1.00		1.00	1.00	1.15
commercial EPA6 Summer					0.91		1.81	0.71	1.42				1.42
commercial EPA6 Fall					1.09	2.67	1.00	10.68	0.78	1.00			2.84
institutional EPA6 Winter	0.85	4.56			0.94	0.81	1.22	1.26			0.99	1.50	0.77
institutional EPA6 Spring					1.17	2.57	0.70	0.34			1.11	1.41	1.00
institutional EPA6 Summer													
institutional EPA6 Fall	1.42	0.18	1.00		1.60	1.44	1.99	5.66	1.00	1.00	1.17	0.34	1.40
industrial EPA6 Winter	1.63	1.34	1.00	1.45	0.90	1.28	1.00	1.00	1.00	0.98	1.50	1.00	1.47
industrial EPA6 Spring	0.41	0.60	1.50	0.68	1.00	0.86			0.08	1.02	1.00	1.12	0.92
industrial EPA6 Summer					2.00	0.51			3.94				0.12
industrial EPA6 Fall					1.00				2.21				0.63
freeway EPA6 Winter	0.30	1.17	0.97	1.00	0.88	0.85	1.60	1.35	0.75	1.00	0.71	0.89	0.83
freeway EPA6 Spring	2.41	1.25	0.77	1.15	1.21	1.16			0.86	1.14	0.96	0.95	0.94
freeway EPA6 Summer													
freeway EPA6 Fall	1.07	0.77	1.35	0.69	2.33	0.78	1.00	0.59	2.31	0.71	2.67	1.18	2.08
open space EPA6 Winter					0.67	0.73	0.90	0.38					
open space EPA6 Spring					1.00	1.36	1.14	4.54					
open space EPA6 Summer													
open space EPA6 Fall					2.78		0.82	2.51					

Seasonal Ratios for EPA Rain Zone 7 (Coastal Northwest)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA7 Winter	0.98	0.54	0.65	1.29	0.53	1.00	0.70
resid EPA7 Spring	0.90	0.78	0.57	0.97	0.55	1.70	0.60
resid EPA7 Summer	1.71	1.22		0.47			0.40
resid EPA7 Fall	0.92	1.66	1.67	0.57	8.55	0.76	1.70
commercial EPA7 Winter	1.39	0.72	0.40	1.40	1.38	0.80	1.00
commercial EPA7 Spring	0.68	1.37	1.20	0.96	0.57	1.48	1.70
commercial EPA7 Summer	4.40	1.82		0.60			0.40
commercial EPA7 Fall	0.75	1.58	1.07	1.28	2.95	0.69	0.85
industrial EPA7 Winter	0.90	0.40	0.90	0.88	1.59	0.64	1.42
industrial EPA7 Spring	0.95	4.75	1.00	0.52	0.41	1.36	0.15
industrial EPA7 Summer	1.14	1.00	3.20	1.90			1.85
industrial EPA7 Fall	1.18	1.65	0.70	1.03			0.46
freeway EPA7 Winter	1.04	0.23	1.00	1.43			1.10
freeway EPA7 Spring	2.30	1.73	1.21	0.61			0.40
freeway EPA7 Summer	2.41	2.14	1.33	5.36			0.40
freeway EPA7 Fall	0.55	1.32	1.17	0.82			1.20

ratio of medians (seasonal to annual value)	Cadmium Filtered (ug/L)	Cadmium part strength (ug/kg)	Chromium Filtered (ug/L)	Chromium part strength (ug/kg)	Copper Filtered (ug/L)	Copper part strength (ug/kg)	Lead Filtered After 1984 (ug/L)	Lead part strength (ug/kg)	Nickel Filtered (ug/L)	Nickel part strength (ug/kg)	Zinc Filtered (ug/L)	Zinc part strength (ug/kg)
resid EPA7 Winter	1.00	1.00	1.00	1.00	0.70	0.83	3.00	0.86	1.00	0.79	1.00	1.00
resid EPA7 Spring			1.00	1.17	1.00	0.86	1.00	0.91	1.00	2.04	0.68	1.24
resid EPA7 Summer			0.90	0.83	0.80	1.07	0.50	1.71			0.28	0.92
resid EPA7 Fall			2.50	2.37	1.60	1.59	1.00	2.28	1.50	1.31	1.25	0.98
commercial EPA7 Winter	0.83	1.00	1.00	0.99	0.75	0.65	1.50	1.15	1.20	1.03	0.98	0.58
commercial EPA7 Spring	1.20		0.50	1.00	1.67	1.96	0.50	0.48	0.80	1.06	0.96	1.16
commercial EPA7 Summer			0.50	1.16	1.00	2.12	0.75	2.08			0.48	1.78
commercial EPA7 Fall	3.00		1.50	0.86	2.00	1.00	0.85	1.08	1.20	0.89	1.67	1.03
industrial EPA7 Winter	2.25	0.73	0.88	0.76	1.14	1.04	2.00	1.13	1.00	0.63	0.80	0.96
industrial EPA7 Spring	0.63	1.07	1.75	1.64	0.64	0.69	1.00	0.80	3.64	1.22	0.80	0.87
industrial EPA7 Summer			1.50	0.73	1.86	1.26	0.50	0.69	3.86	0.66	1.38	1.07
industrial EPA7 Fall	1.00	1.04	1.88	6.99	0.79	1.22	0.60	1.21	1.64	1.29	0.92	1.00
freeway EPA7 Winter	1.33	0.94	1.00	1.00	0.75	0.78	1.09	1.07	0.57	0.71	0.90	0.93
freeway EPA7 Spring	1.00	0.89	0.67	1.22	0.83	0.75	1.74	0.74	0.86	0.86	1.10	1.02
freeway EPA7 Summer	0.83	1.14	1.67	0.90	4.67	1.65	1.74	1.06	5.43	1.50	5.67	1.08
freeway EPA7 Fall	1.00	3.98	1.17	0.75	1.17	1.12	0.87	0.97	1.14	1.14	1.00	1.33

Seasonal Ratios for EPA Rain Zone 8 (Interior Northwest)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA8 Winter							
resid EPA8 Spring	0.96	0.18	0.90	1.00			0.96
resid EPA8 Summer	0.87	6.67	1.19				2.88
resid EPA8 Fall	1.66	1.21	1.22				1.00

ratio of medians (seasonal to annual value)	Copper Filtered (ug/L)	Copper part stremgth (ug/kg)	Nickel Filtered (ug/L)	Nickel part strength (ug/kg)	Zinc Filtered (ug/L)	Zinc part strength (ug/kg)
resid EPA8 Winter						
resid EPA8 Spring	0.39	1.00	1.00	1.00	0.91	0.90
resid EPA8 Summer	1.61				2.62	1.00
resid EPA8 Fall					0.82	

Seasonal Ratios for EPA Rain Zone 9 (Northern Plains)

ratio of medians (seasonal to annual value)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Ammonia (mg/L)	N02+NO3 (mg/L as N)	Phosphorous Filtered as P (mg/L)	Phos part strength (mg/kg)	Phosphate Ortho as P (mg/L)
resid EPA9 Winter	0.35						
resid EPA9 Spring	0.92	0.46	0.90	0.85	1.06	0.97	0.78
resid EPA9 Summer	1.22	1.13	1.03	0.98	1.00	1.17	1.15
resid EPA9 Fall	0.77			1.91	1.34	1.03	0.43
commercial EPA9 Winter	0.46						
commercial EPA9 Spring	0.74	0.04	1.00	0.79	0.85	1.00	1.36
commercial EPA9 Summer	1.32	1.77	0.81	1.06	0.78	0.85	0.89
commercial EPA9 Fall	0.34		0.00		2.33	2.17	1.02
institutional EPA9 Winter							
institutional EPA9 Spring	1.45			0.99	0.83	0.92	1.27
institutional EPA9 Summer	1.18			0.99	1.00	0.95	0.90
institutional EPA9 Fall	0.20			1.28	2.17	2.16	0.93
industrial EPA9 Winter	0.72						
industrial EPA9 Spring	2.29	0.52	1.13	0.72	2.88	1.03	
industrial EPA9 Summer	1.00	5.19	1.00	1.00	0.92	1.00	
industrial EPA9 Fall	2.00						
open space EPA9 Winter							
open space EPA9 Spring	0.96		0.82		0.80	1.00	
open space EPA9 Summer	3.37		1.05		1.40	0.67	
open space EPA9 Fall							

Conclusions

EPA Rain Zone, the interaction between EPA Rain Zone and land use, and land use alone, were all statistically significant when examining variations in stormwater pollutant concentrations. However, based on the analyses, season alone is not a significant factor. Yet, the interaction between season and EPA Rain Zone is significant for all the standard pollutants, except for TSS and total lead. For land use categories, the variability between sampling locations is greater than between land uses, which justifies the need to examine many sampling sites at one geographical area. Therefore, seasonal variations should be considered when examining a land use at a specific location, if the data are available (the 3-way interaction was significant for many of the pollutants).

Detailed analyses examined total phosphorus concentrations contained in the NSQD, version 4.02. These analyses indicate that total phosphorus concentrations varied by geographical location (as reflected by the EPA Rain Zone), land use, and season. An example analysis was therefore conducted focusing only on the total phosphorus concentrations observed in the EPA Rain Zone 1 (the northeast and upper Midwest areas of the U.S.). About 1,020 observations for total phosphorus were available for this area from 69 locations in eight states (IL, IN, MA, MI, MN, NH, NY, and WI), with data collected from June 1970 through December 2003. Trend analyses of the residential area total phosphorus data did show a significant, but very small, decrease in total phosphorus concentrations with time during this sampling period. Less than a 10% decrease was found during this 34 year period. There were no significant trends in total phosphorus residential concentrations according to rain depth. Analyses of the filterable fraction of the total residential area phosphorus concentrations indicated that about 50 to 60% of the total phosphorus was in filterable forms.

As part of the preparation of this memo, sorted NSQD data by location, land use, and season allowed ratios of median seasonal values to median annual values for many of the constituents. These ratio factors can be used to adjust the WinSLAMM pollutant concentration values (for filtered pollutants and particulate strengths) by season. These seasonal ratio factors may be applied for source area pollutant values in the absence of seasonal values for source areas.

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Appendix A: Analysis of Total Phosphorus Stormwater Monitoring Information as Contained in the National Stormwater Quality Database (NSQD), Version 4.02

Introduction

The University of Alabama and the Center for Watershed Protection were awarded a U.S. Environmental Protection Agency, Office of Water 104(b)3 grant in 2001 to collect and evaluate stormwater data from a portion of NPDES (National Pollutant Discharge Elimination System) MS4 (municipal separate storm sewer system) stormwater permits. Version 3 of this database was completed under continued 104(b)3 support from the EPA, while Version 4 was completed in 2015 with support from University of Alabama, Wright Water Engineers, and Geosyntec Consultants. The general approach in data collection was to contact EPA regional offices to obtain state contacts for the MS4 data, then the individual municipalities with Phase I permits were targeted for data collection. Version 4.02 of the NSQD represents major urban area land uses, such as: residential, commercial, and open space. This monitoring data, collected over nearly a fifteen-year period from more than 250 municipalities throughout the country, was used to create the National Stormwater Quality Database (NSQD). The NSQD has several applications. For example, it can characterize national stormwater quality, provide guidance for future sampling needs, enhance local stormwater management activities in areas having limited data, and be compared to historical benchmarks. The NSQD also provides recommendations for improving the quality and management of future NPDES monitoring efforts.

Only stormwater quality outfall data are included in the NSQD, representing untreated stormwater leaving the sites. Receiving water data, source area sheetflow data, and data from locations affected by stormwater control practices are not included in the database (see the International BMP Database for stormwater performance data). Other data incorporated into the NSQD comes from various sources including; Nationwide Urban Runoff Program (NURP) (US EPA, 1983), the International Best Management Practice (BMP) Database (ASCE 2002), and specialized research projects conducted by states and by the U.S. Geological Survey Urban-Stormwater Database (Smullen and Case 2002; Driver, et al. 1985). All of the data sources were carefully reviewed (in fact, most of the effort in compiling the NSQD was spent in Quality Assurance/Quality Control (QA/QC) reviews of the data). QA/QC reviews were very important to verify the correctness of data that was added to the database. The NSQD contains extensive data for most land uses and locations for a broad range of conventional pollutants, nutrients, bacteria, heavy metals, along with some organic compounds. As an example, early lead data are included separately as a special constituent for trend analyses). The early NURP data were very helpful in filling data gaps from the upper Midwest and northeastern areas of the country, and to extend the time period of the observations.

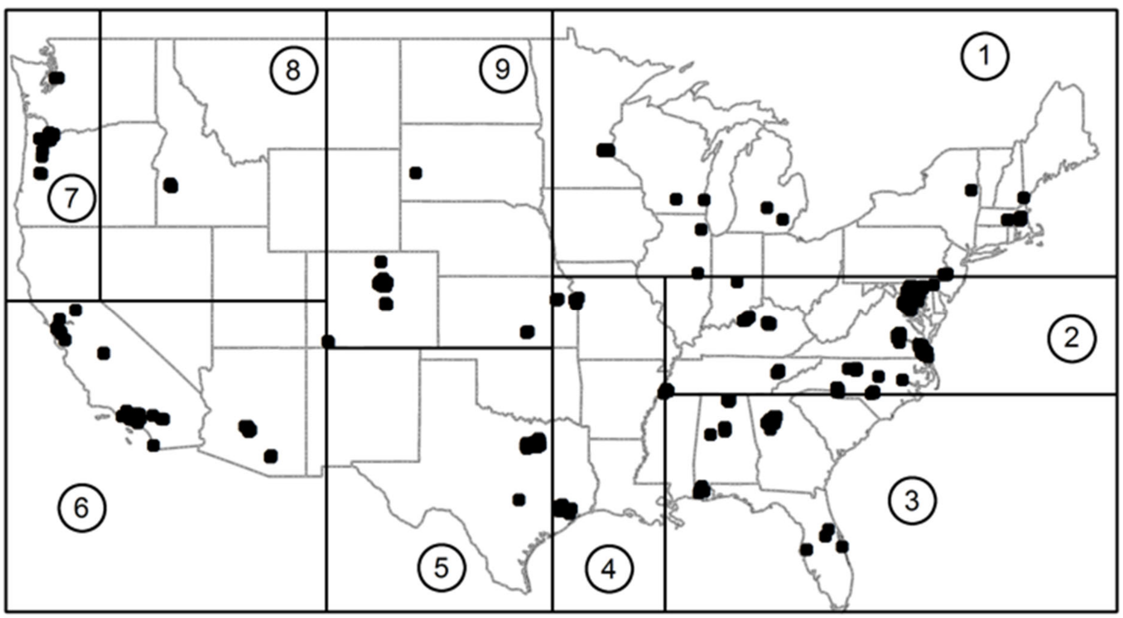
More than 9,000 stormwater monitoring events are recorded in version 4.02 of the NSQD, representing more than 600 sampling locations (median of 10 samples per site, with a maximum of 115 per site). Table 1 shows the 6 land uses, 9 EPA Rain Zones and four seasons used as data identifiers in the NSQD database. When more than one land use was present, it was considered a mixed site with the major land use noted. About 48% of the storm events stored in the database were collected in residential land use areas, followed by commercial areas with 20%, industrial areas with 13%, open space and freeways with 6% each, and institutional at 5%.

Figure 1 presents a map showing the EPA Rain Zones in the U.S., along with the locations of the communities represented in the database.

Table 1. Main Land Uses, EPA Rain Zones and Seasons Identified in the NSQD

Major Land Uses	EPA Rain Zones	Season
Commercial	Zone 1 – Great Lakes and Northeast	Spring: February – April
Freeway	Zone 2 – Mid-Atlantic	Summer: May – July
Industrial	Zone 3 – Southeast	Fall: August – October
Institutional	Zone 4 – Lower Mississippi Valley	Winter: November – January
Open Space	Zone 5 – Texas	
Residential	Zone 6 – Southwest	
	Zone 7 – Coastal Northwest	
	Zone 8 – Interior Northwest	
	Zone 9 – Northern Plains	

Figure 1. Sampling Locations for Data Contained in the National Stormwater Quality Database, version 4.02, by EPA Rain Zones.



The complete NSQD, version 4.02, is available as a large (7.5Mb) Excel spreadsheet at: http://www.bmpdatabase.org/nsqd.html. This website (which also contains the International BMP database) includes a new NSQD data extraction tool to explore and assess data prior to in-depth analyses. Detailed statistical analyses, site descriptions, and early versions of the database are available in a 2005 EPA final report entitled "The National Stormwater Quality Database, Version 1.1: A Compilation and Analysis of NPDES Stormwater Monitoring Information" located at: http://unix.eng.ua.edu/~rpitt/Publications/Stormwater%20Characteristics/NSQD%20EPA.pdf

Observations

There are many factors that may affect stormwater quality. These factors include, but are not limited to the following; land use, geographical region (EPA Rain Zone), and season. The NSQD includes sampling location information such as city, state, land use, drainage area, and EPA Rain Zone. The database also includes sampling information such as date, season, and rain depth, along with the concentrations for many constituents. Supplemental information available at each sampling location includes the exact sampling locations (street intersections or longitude/latitude), breakdown of land use by percentage, aerial photographs, topographic maps, information on sampling procedures, and quality control. It is important to note that the supplemental information available can vary for different sites.

Land use has an important impact on the quality of stormwater. For example, the concentrations of heavy metals are generally higher for industrial land use areas due to manufacturing processes and other activities that generate these materials. Seasons could also be a factor in the variation of nutrient concentrations in stormwater due to seasonal uses of fertilizers and seasonal leaf drop. Most studies also report lower bacteria concentrations in the winter than in the summer. Lead concentrations in stormwater also have significantly decreased since the elimination of lead in gasoline (as noted, the earlier NURP lead data were therefore not included in the main body of the NSQD).

Multivariate statistical analyses can be used to compare different constituent concentrations with land use and geographical location, along with different sampling methods. Some of the analyses used earlier versions of the NSQD when project resources enabled more extensive data analyses. For the most recent project efforts, most of our time was used to acquire additional data and to conduct needed quality control. More detailed discussions of the earlier NSQD results are found in various references, including Maestre, *et al.* (2004; 2005; 2006; 2007) and Pitt, *et al.* (2003 and 2004a/b). As noted above, metal concentrations are generally higher for industrial and commercial land uses, however EPA Rain Zone effects on pollutant concentrations appear to be important also. Lower concentrations for total dissolved solids (TDS), 5-day biochemical oxygen demand (BOD_5), and bacteria as fecal coliforms were also observed in industrial land use areas. Fecal coliform concentrations are relatively high for residential and mixed residential land uses, and nitrate concentrations are higher for the freeway land use. Open space land use areas show consistently low concentrations for the constituents examined.

Land use and geographical region analyses

Maestre and Pitt (2007) prepared a general linear model (GLM) that included the interaction effects between land use, geographical region, and season. The following discussion summarizes findings from this report which are relevant today. This analysis examined only a few of the constituents that were well represented in each category and included total suspended solids (TSS), BOD_5, chemical oxygen demand (COD), total phosphorus (TP), nitrite (NO_2)+nitrate (NO_3), total Kjeldahl nitrogen (TKN), copper (Cu), lead (Pb), and zinc (Zn).

EPA Rain Zone 8 was eliminated from these analyses due to lack of data, while all four seasons were examined as they were well represented in all of the selected land uses and EPA Rain Zones. Two-way and three-way interactions were included in the model, with the results shown in Table 2. A p-value smaller than 0.05 indicates that the factor, or interaction of factors, was found to be significant at least at the 5% significance level.

The results indicated that the factors for land use, and the EPA Rain Zone, plus the interaction land use–rain zone were the most important factors used in the model. There were significant differences by EPA Rain Zone, and land use for all the constituents. None of the seasonal factors alone were significant for any constituent, except for TKN, but seasonal effects interacting with the other factors were significant for many constituents. The interaction between land uses and EPA Rain Zone is very important and must be considered when determining likely stormwater concentrations for a site.

For all the constituents except TSS, concentrations in the open space land use were lower than for the other land uses, while, samples collected at freeways and industrial sites had the highest concentrations. Total phosphorus and TKN appear to be high during the summer and low during the winter. No clear variations in concentration were observed between spring and fall. Samples collected in EPA Rain Zone 3 (the southeast) had the lowest concentrations for all the constituents. The largest concentrations were observed in EPA Rain Zone 6 (the southwest) followed by EPA Rain Zones 1 (Great Lakes and northeast) and 4 (Mississippi valley).

Table 2. P-Values for Main Factors and Interactions (Values Less Than 0.05 Are Traditionally Considered Significant)

Constituent	Land Use (LU)	Season (SN)	EPA Rain Zone (EPA)	LU*SN	LU*EPA	SN*EPA	LU*EPA*SN
TSS mg/L	<0.0001	0.74	<0.0001	0.017	<0.0001	0.18	<0.0001
BOD mg/L	<0.0001	0.16	<0.0001	0.0008	<0.0001	0.0011	0.22
COD mg/L	<0.0001	0.13	<0.0001	0.034	<0.0001	0.014	0.0085
TP mg/L	<0.0001	0.69	<0.0001	0.055	<0.0001	0.0004	<0.0001
NO2+NO3 mg/L	<0.0001	0.11	<0.0001	0.052	<0.0001	0.034	0.057
TKN mg/L	0.0026	0.024	<0.0001	0.99	<0.0001	<0.0001	0.17
Cu µg/L	<0.0001	0.11	<0.0001	0.62	<0.0001	0.038	0.14
Pb µg/L	<0.0001	0.76	<0.0001	0.42	<0.0001	0.28	0.012
Zn µg/L	<0.0001	0.91	<0.0001	0.94	<0.0001	0.014	<0.0001

Evaluation of Total Phosphorus Stormwater Concentrations

This data analysis focuses on total phosphorus concentrations contained in the newest version of the NSQD (version 4.02). Figure 2 is a grouped box and whisker plot (prepared using SigmaPlot 13) comparing the concentration distributions from six major land uses. The central box indicates the 25th, 50th, and 75th percentile concentrations, while the ends of the whiskers indicate the 5th and 95th percentile values. The separate dots outside of the whiskers indicate values less than the 5th and greater than the 95th percentile values. This plot indicates that the data distributions are reasonably symmetrical and similar for each land use, with the institutional land use area generally having the lowest total phosphorus concentrations and the residential areas generally having the highest total phosphorus concentrations.

Figure 2. Box and Whisker Plots Comparing Total Phosphorus Concentrations for all Land Uses Using Data Contained in the NSQD, version 4.02.

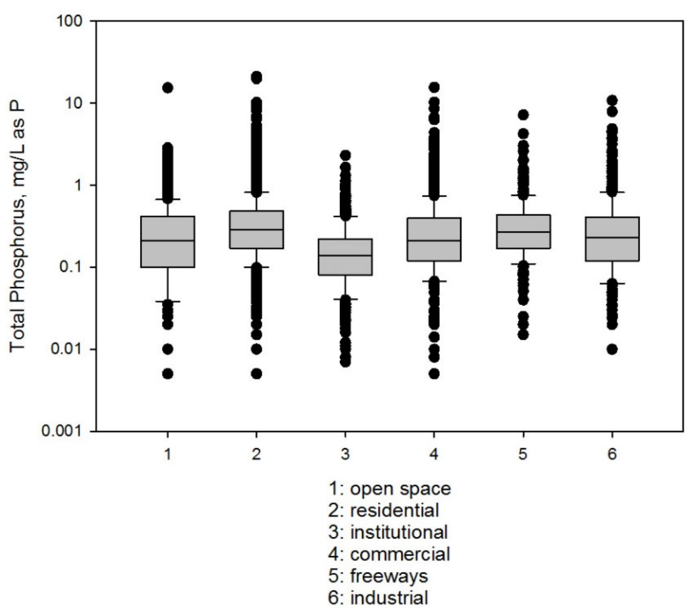


Table 3 summarizes the Kruskal-Wallis analysis (SigmaPlot 13) results comparing the total phosphorus concentrations for each land use, as shown on the above box and whisker plot. These results indicate that at least one land use is significantly different from the others ($p < 0.001$).

Table 3. All Total Phosphorus Data by Land Use using Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
All open space TP	446	0	0.21	0.1	0.42
All resid TP	3855	0	0.29	0.17	0.482
All instit TP	414	0	0.14	0.08	0.223
All commer TP	1599	1	0.21	0.12	0.4
All freeways TP	378	0	0.27	0.17	0.436
All indus TP	1000	0	0.23	0.12	0.41
H = 336.254 with 5 degrees of freedom. (P = <0.001)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)					

Table 4 shows the individual comparisons indicating significant differences. Most land uses are significantly different from each other, based on pairwise multiple comparison tests (Dunn's test in SigmaPlot 13). The exceptions, as shown in Table 4, are open space vs. industrial; residential vs. freeways; and freeway vs. industrial land use areas. The grouped box and whisker plots also indicate potential overlapping data for these pairs, while the others are more distinctly different.

Table 4. Probability of Significant Differences Between Land Use Pairs (Dunn's Test)

	open space	residential	institutional	commercial	freeway	industrial
open space	X	<0.001	<0.001	<0.001	<0.001	1.0
residential	<0.001	X	<0.001	<0.001	1.0	<0.001
institutional	<0.001	<0.001	X	<0.001	<0.001	<0.001
commercial	<0.001	<0.001	<0.001	X	<0.001	<0.001
Freeway	<0.001	1.0	<0.001	<0.001	X	0.017
industrial	1.0	<0.001	<0.001	1.0	0.017	X

Tables 5 through 10 summarize the observed total phosphorus concentration statistical characteristics for each land use category. The overall data distribution is shown (as plotted in the box and whisker graph), along with data distributions for each EPA Rain Zone, and for each season. Not all land uses had sufficient data in all rain zones for these summaries. The coefficients of variation (COV, the ratio of the standard deviation to the average values) are relatively large, indicating wide data spreads. However, with large numbers of data in many categories, valid statistical analyses are still possible, as shown in the following discussions, especially considering the similar distribution patterns shown on the box and whisker plots.

Table 5. NSQD, version 4.02, Open Space (OS) Total Phosphorus Concentrations (mg/L as P)

	Overall	EPA Rain Zone							Season			
	All Open Space TP as P (mg/L)	Zone 1 OS TP as P (mg/L)	Zone 2 OS TP as P (mg/L)	Zone 3 OS TP as P (mg/L)	Zone 4 OS TP as P (mg/L)	Zone 5 OS TP as P (mg/L)	Zone 6 OS TP as P (mg/L)	Zone 9 OS TP as P (mg/L)	Fall OS TP as P (mg/L)	Winter OS TP as P (mg/L)	Spring OS TP as P (mg/L)	Summer OS TP as P (mg/L)
number	446	78	103	91	18	67	75	14	106	128	93	119
average	0.363	0.290	0.319	0.471	1.135	0.373	0.149	0.506	0.378	0.371	0.263	0.421
median	0.210	0.187	0.200	0.355	0.315	0.250	0.069	0.470	0.235	0.160	0.190	0.330
minimum	0.005	0.035	0.005	0.005	0.005	0.010	0.025	0.210	0.025	0.010	0.010	0.005
maximum	15.400	2.500	2.500	2.855	15.400	2.290	2.510	1.000	2.855	15.400	1.500	2.500
standard deviation	0.813	0.361	0.361	0.460	3.566	0.413	0.313	0.260	0.469	1.385	0.264	0.404
COV	2.24	1.25	1.13	0.98	3.14	1.11	2.10	0.51	1.24	3.73	1.00	0.96

Table 6. NSQD, version 4.02, Residential Total Phosphorus Concentrations (mg/L as P)

	Overall	EPA Rain Zone									Season			
	All resid TP as P (mg/L)	Zone 1 resid TP as P (mg/L)	Zone 2 resid TP as P (mg/L)	Zone 3 resid TP as P (mg/L)	Zone 4 resid TP as P (mg/L)	Zone 5 resid TP as P (mg/L)	Zone 6 resid TP as P (mg/L)	Zone 7 resid TP as P (mg/L)	Zone 8 resid TP as P (mg/L)	Zone 9 resid TP as P (mg/L)	Fall resid TP as P (mg/L)	Winter resid TP as P (mg/L)	Spring resid TP as P (mg/L)	Summer resid TP as P (mg/L)
number	3855	551	1865	304	122	206	228	290	15	274	943	785	1091	1036
average	0.427	0.402	0.427	0.308	0.611	0.467	0.410	0.305	0.851	0.625	0.408	0.287	0.454	0.524
median	0.290	0.295	0.280	0.150	0.357	0.360	0.310	0.200	0.696	0.470	0.290	0.210	0.300	0.333
minimum	0.005	0.005	0.010	0.010	0.025	0.080	0.025	0.010	0.219	0.071	0.005	0.005	0.015	0.010
maximum	21.200	6.690	19.900	21.200	5.330	4.190	4.960	3.610	2.950	6.420	5.330	4.250	19.900	21.200
standard deviation	0.710	0.432	0.750	1.246	0.774	0.417	0.429	0.374	0.712	0.599	0.431	0.293	0.797	0.975
COV	1.66	1.08	1.76	4.04	1.27	0.89	1.05	1.22	0.84	0.96	1.06	1.02	1.75	1.86

Table 7. NSQD, version 4.02, Institutional Total Phosphorus Concentrations (mg/L as P)

	Overall	EPA Rain Zone						Season			
	All instit TP as P (mg/L)	Zone 1 instit TP as P (mg/L)	Zone 2 instit TP as P (mg/L)	Zone 3 instit TP as P (mg/L)	Zone 4 instit TP as P (mg/L)	Zone 6 instit TP as P (mg/L)	Zone 9 instit TP as P (mg/L)	Fall instit TP as P (mg/L)	Winter instit TP as P (mg/L)	Spring instit TP as P (mg/L)	Summer instit TP as P (mg/L)
number	414	13	45	175	37	49	95	65	77	75	197
average	0.197	0.167	0.237	0.116	0.112	0.303	0.308	0.198	0.175	0.237	0.190
median	0.140	0.150	0.190	0.103	0.100	0.230	0.178	0.140	0.144	0.176	0.121
minimum	0.007	0.026	0.025	0.007	0.025	0.115	0.011	0.010	0.018	0.011	0.007
maximum	2.310	0.370	0.980	0.449	0.270	1.020	2.310	1.020	0.550	0.780	2.310
standard deviation	0.219	0.093	0.194	0.077	0.064	0.191	0.355	0.185	0.118	0.194	0.263
COV	1.11	0.56	0.82	0.66	0.57	0.63	1.15	0.93	0.67	0.82	1.39

Table 8. NSQD, version 4.02 Commercial Total Phosphorus Concentrations (mg/L as P)

	Overall	EPA Rain Zone									Season			
	All commercial TP as P (mg/L)	Zone 1 commer TP as P (mg/L)	Zone 2 commer TP as P (mg/L)	Zone 3 commer TP as P (mg/L)	Zone 4 commer TP as P (mg/L)	Zone 5 commer TP as P (mg/L)	Zone 6 commer TP as P (mg/L)	Zone 7 commer TP as P (mg/L)	Zone 8 commer TP as P (mg/L)	Zone 9 comer TP as P (mg/L)	Fall commer TP as P (mg/L)	Winter commer TP as P (mg/L)	Spring commer TP as P (mg/L)	Summer commer TP as P (mg/L)
number	1598	293	613	698	139	111	84	61	7	178	376	294	419	452
average	0.376	0.240	0.364	0.441	0.288	0.600	0.460	0.398	0.568	0.373	0.391	0.328	0.365	0.388
median	0.210	0.140	0.230	0.220	0.160	0.160	0.375	0.280	0.497	0.230	0.217	0.193	0.210	0.200
minimum	0.005	0.022	0.005	0.005	0.025	0.010	0.025	0.005	0.163	0.008	0.010	0.005	0.008	0.010
maximum	15.600	8.600	6.720	15.600	3.550	15.600	2.000	3.300	1.080	6.300	15.600	3.670	8.600	10.300
standard deviation	0.701	0.534	0.479	0.891	0.464	1.874	0.353	0.493	0.350	0.601	0.900	0.443	0.654	0.715
COV	1.86587	2.22	1.32	2.02	1.61	3.12	0.77	1.24	0.62	1.61	2.30	1.35	1.79	1.84

Table 9. NSQD, version 4.02, Freeways Total Phosphorus Concentrations (mg/L as P)

	Overall	EPA Rain Zone							Season			
	All freeways TP as P (mg/L)	Zone 1 free TP as P (mg/L)	Zone 2 free TP as P (mg/L)	Zone 3 free TP as P (mg/L)	Zone 5 free TP as P (mg/L)	Zone 6 free TP as P (mg/L)	Zone 7 free TP as P (mg/L)	Zone 9 free TP as P (mg/L)	Fall free TP as P (mg/L)	Winter free TP as P (mg/L)	Spring free TP as P (mg/L)	Summer free TP as P (mg/L)
number	378	3	90	14	14	211	24	22	74	151	108	45
average	0.406	0.433	0.317	0.165	0.198	0.477	0.347	0.425	0.468	0.366	0.466	0.292
median	0.270	0.410	0.240	0.125	0.125	0.298	0.280	0.315	0.365	0.250	0.250	0.260
minimum	0.015	0.353	0.020	0.071	0.020	0.015	0.110	0.100	0.015	0.025	0.020	0.070
maximum	7.191	0.537	3.030	0.459	0.750	7.191	0.900	2.600	2.600	2.600	7.191	0.910
standard deviation	0.558	0.094	0.345	0.122	0.204	0.676	0.198	0.527	0.425	0.353	0.877	0.194
COV	1.38	0.22	1.09	0.74	1.03	1.42	0.57	1.24	0.91	0.97	1.88	0.66

Table 10. NSQD, version 4.02, Industrial Total Phosphorus Concentrations (mg/L as P)

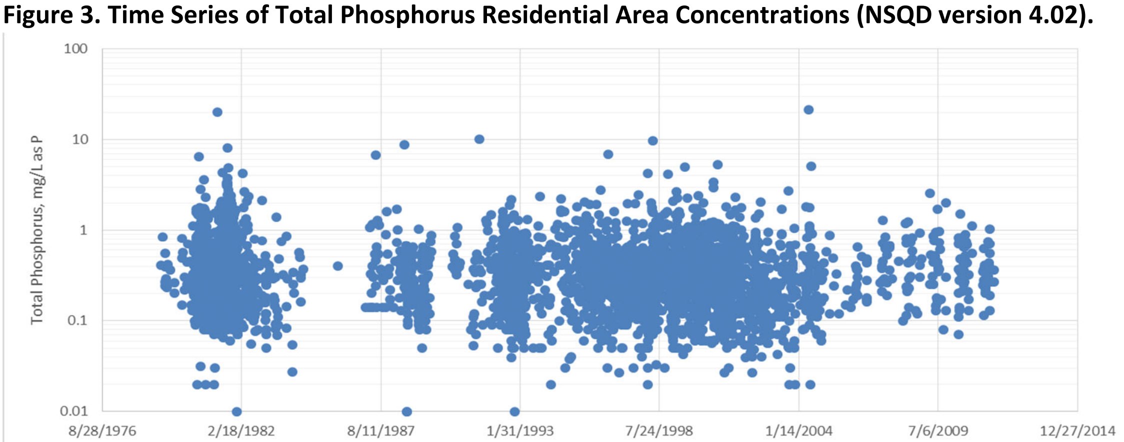
	Overall	EPA Rain Zone									Season			
	All indus TP as P (mg/L)	Zone 1 indus TP as P (mg/L)	Zone 2 indus TP as P (mg/L)	Zone 3 indus TP as P (mg/L)	Zone 4 indus TP as P (mg/L)	Zone 5 indus TP as P (mg/L)	Zone 6 indus TP as P (mg/L)	Zone 7 indus TP as P (mg/L)	Zone 8 indus TP as P (mg/L)	Zone 9 indus TP as P (mg/L)	Fall indus TP as P (mg/L)	Winter indus TP as P (mg/L)	Spring indus TP as P (mg/L)	Summer indus TP as P (mg/L)
number	1000	106	362	136	78	108	150	30	1	29	245	254	256	245
average	0.398	0.291	0.318	0.233	0.578	0.257	0.797	0.527	0.313	0.426	0.344	0.380	0.411	0.460
median	0.230	0.210	0.220	0.175	0.255	0.185	0.450	0.460		0.330	0.249	0.228	0.220	0.230
minimum	0.010	0.040	0.020	0.024	0.010	0.010	0.025	0.064		0.090	0.020	0.010	0.010	0.020
maximum	10.800	1.500	4.880	1.500	10.800	2.640	7.900	1.400		1.300	2.500	4.600	10.800	7.900
standard deviation	0.654	0.266	0.467	0.217	1.345	0.304	0.981	0.335		0.294	0.367	0.571	0.825	0.748
COV	1.640676	0.91	1.47	0.93	2.33	1.18	1.23	0.64		0.69	1.07	1.50	2.01	1.63

Trend Analyses of NSQD Residential Land Use Phosphorus Data

A time series analyses was conducted for residential total phosphorus data in the NSQD to observe any concentration trends associated with both time and rain depth. More than 3,800 total phosphorus observations are available in the NSQD, version 4.02, for residential land uses.

The Figure 3 time series plot illustrates the total phosphorus residential area concentrations by sampling data (all EPA Rain Zones and seasons combined) as contained in the NSQD (version 4.02). Stormwater nutrient concentrations, especially in residential areas, are likely affected by homeowner fertilizer use, vegetation debris, and other landscaping practices (including erosion of nutrient-rich soils). Residential area fertilizer use has likely changed over time, especially in areas having phosphate restrictions. The analysis of variance (ANOVA) on the regression coefficients (using Excel) for the very large number of observations indicated a statistically significant but very small trend ($p = 0.01$). Over a 31-year monitoring period, from 1979 to 2011, the total phosphorus concentrations decreased by about 10% (by 0.087 mg/L). Several hundred monitoring locations are included in this dataset, with most only active for short periods. It is expected that phosphorus trends may be more obvious if data were available for an individual location over many years, compared to this combined analysis of multiple locations. Similar analyses for the other land uses resulted in similar findings.

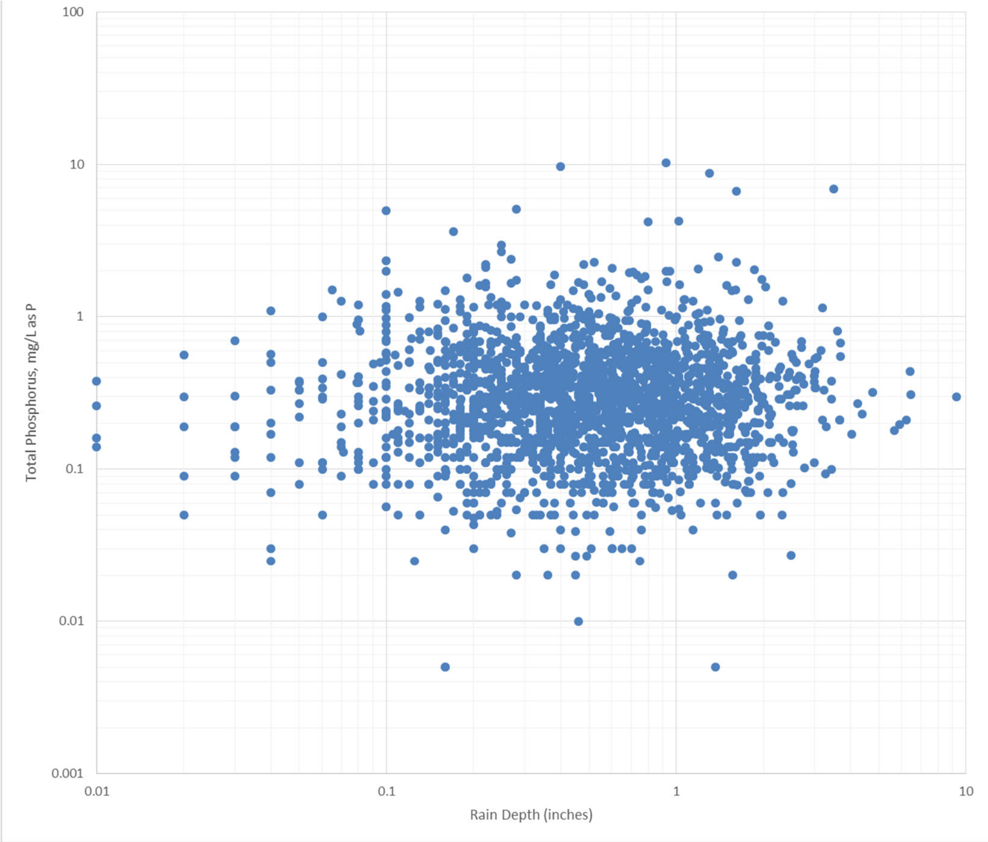
Figure 3. Time Series of Total Phosphorus Residential Area Concentrations (NSQD version 4.02).



The Figure 4 scatterplot compares the residential area total phosphorus concentrations plotted against the rain depths associated with these same monitored events. Typical assumptions about stormwater concentrations and rains include: larger rains produce greater erosion and delivery of contaminants, but that the larger discharge volumes tend to dilute the runoff, resulting in lower overall concentration values. It is also sometimes assumed that smaller rains are associated with "first-flush" higher concentrations. These assumptions imply that larger concentrations are associated with smaller rains rather than larger rains.

During this 31 year period of time, the rains ranged from 0.01 to 9.28 inches, with an average rain depth of 0.72 inches (and a median depth of 0.52 inches). The rains represented in this analysis therefore include a broad range, with most events of intermediate rain depths. The ANOVA on the regression analysis (using Excel) for these data pairs indicated no significant relationship or trend of total phosphorus with changes in rain depth, even with more than 2,100 data pairs ($p = 0.53$).

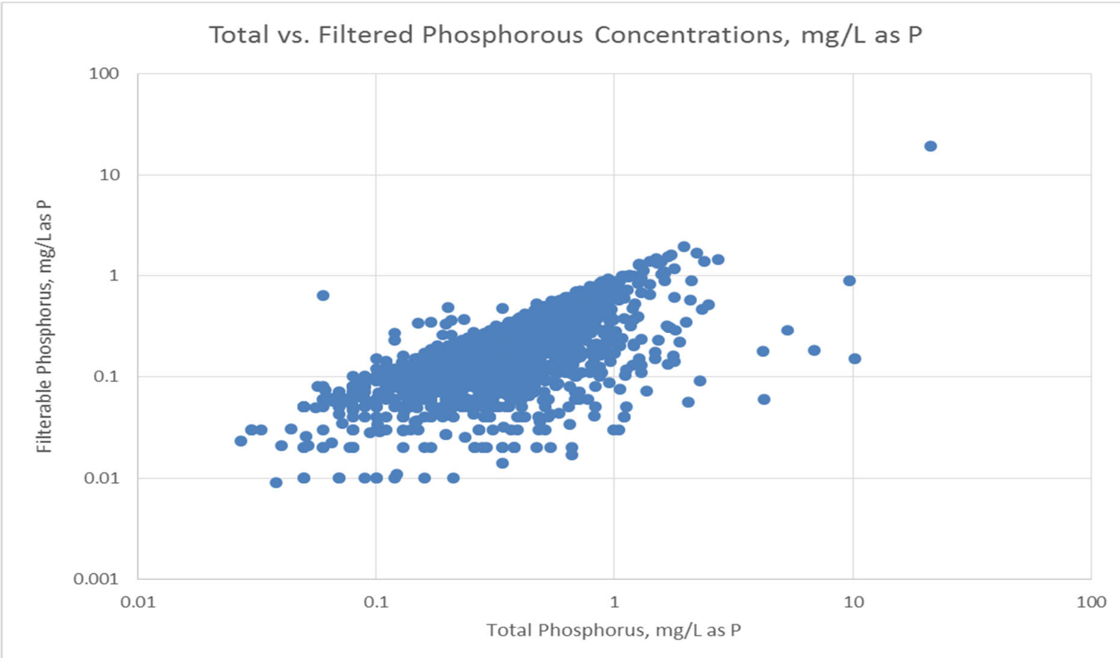
Figure 4. Total Phosphorus Concentrations vs. Rain Depth for All Residential Land Uses from the NSQD, version 4.02.



Figures 5 and 6 and Table 11 compare the total phosphorus concentrations with concurrent filterable phosphorus concentrations (material passing through a nominal 0.45 µm membrane filter, which can include a variety of pollutant forms, including colloids and organic complexes; not all of the filterable material are in "dissolved" or ionic forms) for the residential land use area data for all locations and seasons in the NSQD, version 4.02. The filterable phosphorus portion of the total phosphorus concentration is usually much more difficult to remove using conventional stormwater management practices (which usually rely on sedimentation or filtering). It is also readily available for aquatic plant growth and more likely to cause eutrophication problems. The smaller the filterable fraction (and larger the particulate-bound fraction), the greater removal usually occurs with conventional stormwater control practices. The filterable fraction usually needs to be treated using chemical (coagulation/precipitation, ion exchange, or sorption) or biological (nutrient uptake) processes. Infiltration can also reduce phosphorus surface water discharges by capturing the phosphorus in surface soils during infiltration, as long as groundwater contamination potential is low.

The Figure 5 scatterplot of total vs. filterable phosphorus concentrations indicate that the largest ratio approaches 1 (the apparent upper line of observations along the 1:1 slope), but most are below this upper limit (a few data observations indicate filterable concentrations larger than the total concentrations reflecting minor, but common, processing and analysis errors).

Figure 5. Scatterplot of Total vs. Filterable Phosphorus From Residential Land Uses in NSQD, version 4.02.



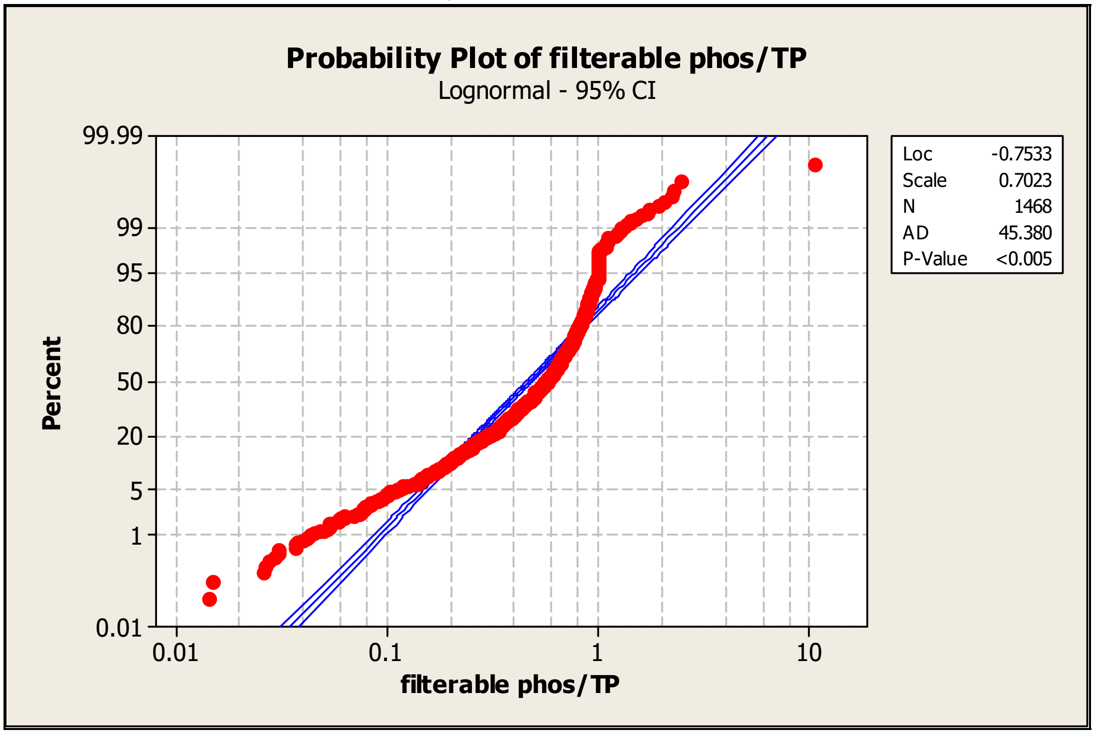
The above scatterplot of total vs. filterable phosphorus concentrations resulted in a very significant regression relationship between these variables ($p < 0.001$) with a slope term (the overall average ratio of filterable to total phosphorus) of 0.53. This is in good agreement with the usually assumed filterable fraction of about 50%. Table 11 summarizes the total and filterable concentrations, and their ratio for the NSQD, version 4.02, residential area observations. The median and the average ratios are both 0.57 when examining the available 1,468 data pairs.

Table 11. Total and Filterable Phosphorus Concentrations at NSQD, version 4.02, Residential Land Use Areas

	Total Phosphorous (mg/L as P)	Filterable Phosphorus (mg/L as P)	Ratio of Filterable to Total Phosphorus
Number	1,468	1,468	1,468
Average	0.46	0.23	0.57
Median	0.33	0.16	0.57
Minimum	0.03	0.01	0.01
Maximum	21.2	19.3	10.7
Standard deviation	0.77	0.54	0.39
COV	1.68	2.34	0.69

Figure 6 is a log-normal probability plot (using Minitab 16) of the calculated filterable to total phosphorus ratios for these data, visually showing the spread of these data ratios. About 2% of the filterable concentrations were greater than the total concentrations (these are the data points in the scatterplot that are above the 1:1 slope), reflecting typical data variations associated with sample processing and analyses.

Figure 6. Log-Normal Probability Plot of Filterable to Total Phosphorus Concentrations from Residential Areas in the NSQD, version 4.02.



Total Phosphorus Concentration Relationships by Geographical Area and by Season for All Land Uses in the NSQD, version 4.02

More detailed geographical area and seasonal analyses were conducted focusing on residential area total phosphorus concentrations only, due to their large number of observations compared to the other land uses. The Figure 7 box and whisker plot for the different EPA rain zones shows reasonably symmetrical and similar distributions for all geographical area groups, but with larger differences between the areas. The Kruskal-Wallis analyses on Table 12 indicated at least one of the areas was significantly different from the others ($p < 0.001$).

Figure 7. Box and Whisker Plots for NSQD, version 4.02, Residential Total Phosphorus Concentrations by Geographical Location.

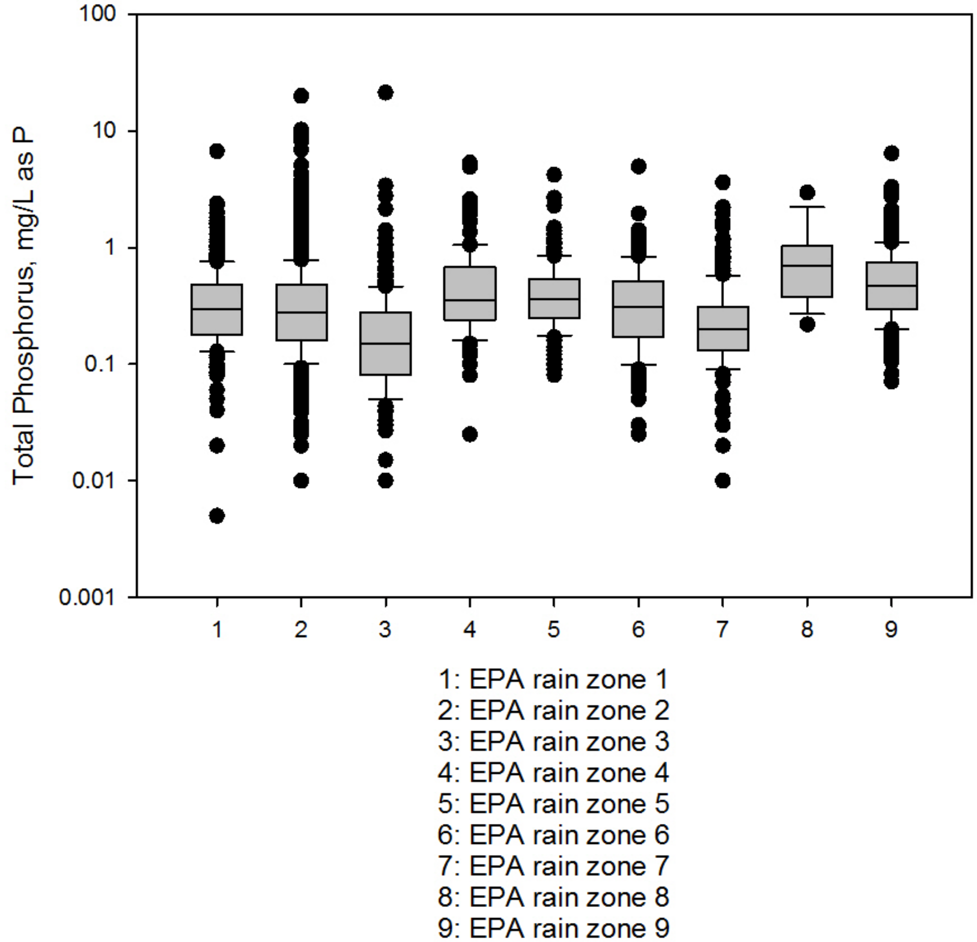


Table 12. Residential Area TP Data by EPA Rain Zone using Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
Z1 res TP	551	0	0.30	0.18	0.48
Z2 res TP	1865	0	0.28	0.16	0.48
Z3 res TP	304	0	0.15	0.08	0.28
Z4 res TP	122	0	0.36	0.24	0.68
Z5 res TP	206	0	0.36	0.25	0.54
Z6 res TP	228	0	0.31	0.17	0.52
Z7 res TP	290	0	0.2	0.13	0.31
Z8 res TP	15	0	0.70	0.38	1.03
Z9 res TP	274	0	0.47	0.30	0.75
H = 356.756 with 8 degrees of freedom. (P = <0.001)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)					

These analyses also indicated significant differences between most of the EPA rain zone areas, as indicated on the Dunn's multi-pairwise Table 13.

Table 13. Dunn's Multi-Pairwise Comparisons between all EPA Rain Zones for Residential Total Phosphorus Concentrations

	1	2	3	4	5	6	7	8	9
1	X	1.0	<0.001	0.035	0.004	1.0	<0.001	0.013	<0.001
2	1.0	X	<0.001	0.001	<0.001	1.0	<0.001	0.005	<0.001
3	<0.001	<0.001	X	<0.001	<0.001	<0.001	0.063	<0.001	<0.001
4	0.035	0.001	<0.001	X	1.0	0.20	<0.001	0.99	0.61
5	0.004	<0.001	<0.001	1.0	X	0.068	<0.001	0.77	0.11
6	1.0	1.0	<0.001	0.20	0.068	X	<0.001	0.022	<0.001
7	<0.001	<0.001	0.063	<0.001	<0.001	<0.007	X	<0.001	<0.001
8	0.013	0.005	<0.001	0.99	0.77	0.022	<0.001	X	1.0
9	<0.001	<0.001	<0.001	0.61	0.11	<0.001	<0.001	1.0	X

Potential significant data overlaps may occur for EPA Rain Zones 1, 2, and 6; 3 and 7; and 4, 5, 8, and 9, resulting in three geographical groups for residential areas.

The Figure 8 box and whisker plot and Tables 14 and 15 show the same residential land use data separated by season (all geographical areas combined). The Kruskal-Wallis analyses indicated that at least one season is significantly different from the others ($p < 0.001$).

Figure 8. Box and Whisker Plot of NSQD, version 4.02, Total Phosphorus Residential Area Concentrations Grouped by Season.

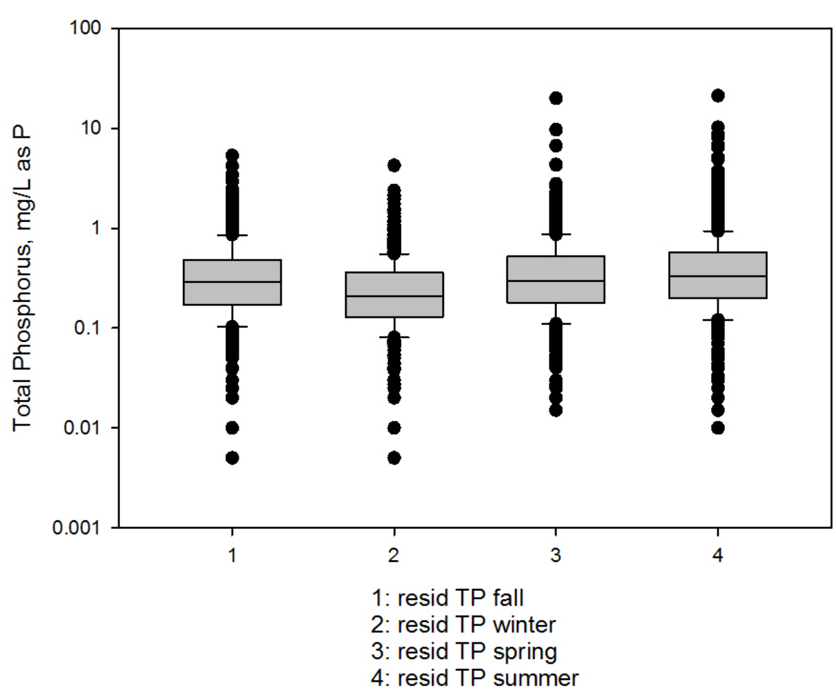


Table 14. Residential Area TP Data by Season using Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
resid TP fall	943	0	0.29	0.17	0.48
resid TP winter	785	0	0.21	0.13	0.36
resid TP spring	1091	0	0.30	0.18	0.52
resid TP summer	1036	0	0.33	0.20	0.57
H = 149.709 with 3 degrees of freedom. (P = <0.001)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)					

The Dunn's pair-wise comparisons of all of the NSQD residential land use total phosphorus data indicate that the winter season had the lowest total phosphorus concentrations, summer had the highest concentrations, and fall and spring had intermediate concentrations.

Table 15. Dunn's Pair-Wise Comparisons of Residential Total Phosphorus Concentrations by Season

	fall	winter	spring	summer
fall	X	<0.001	1.0	<0.001
winter	<0.001	X	<0.001	<0.001
spring	1.0	<0.001	X	0.017
summer	<0.001	<0.001	0.017	X

<u>EPA Rain Zone 1 Total Phosphorus Analyses</u>

The following analyses examine EPA Rain Zone 1 total phosphorus concentrations for all land uses by season. The prior analyses indicated that geographical area, land use, and season all affect the likely total phosphorus concentrations for an area. These data are from 69 locations in 8 states, and total 1,019 observations. Samples were collected between 1979 and 2003, covering a period of about 24 years. Tables 16 through 23 list the station names by state and the amount of total phosphorus data available from each in EPA Rain Zone 1.

Table 16. Illinois Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

Illinois Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
Lake_Ellyn_1_Inflow_Lake_Ellyn	4/3/1980	6/8/1981	18	1	18	4/3/1980	6/8/1981

Table 17. Indiana Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

Indiana Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
Basin_C1_control	7/17/1999	12/5/2003	12				
Basin_C2_test	7/17/1999	12/5/2003	12				
Basin_I1_control	7/17/1999	12/5/2003	11				
Basin_I2_test	7/17/1999	12/5/2003	11				
Basin_C3	10/8/1999	12/5/2003	10				
Basin_R1_control	10/8/1999	10/14/2003	9				
Basin_R2_test	10/8/1999	10/14/2003	9	7	74	7/17/1999	12/5/2003

Table 18. Massachusetts Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

Massachusetts Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
P4_Anna_St_Fitzgerald_Brook	6/16/1980	9/26/1980	6				
P5_Convent_Tributary to Coal Mine Brook	6/20/1980	8/11/1980	8				
P1_Jordan_Pond_Inlet	6/29/1980	9/18/1980	8				
P2_Rt_9_Belmont_St	7/17/1980	9/18/1980	5				
P3_Locust_St_Tributary to Belmont St	7/17/1980	9/26/1980	6				
Addison Wesley	4/4/1981	8/5/1981	5				
Hemlock Road	4/14/1981	8/5/1981	5				
Brighton_25E037	4/11/1992	6/24/1992	3				
Charlestown_29J212	4/11/1992	8/14/1992	3				
Dorchester_8J102	4/11/1992	6/24/1992	3				
Hyde_Park_2F120	4/17/1992	6/24/1992	3				
West_Roxebury_13D077_078	4/17/1992	3/18/1998	15				
Beaver Brook	3/28/2000	9/28/2003	11				
Brookdale Street	3/28/2000	9/28/2003	12				
Camp Street	3/28/2000	9/28/2003	11				
Middle Brook	3/28/2000	9/28/2003	11				
New Bond Street	3/28/2000	9/28/2003	11				
Olean Street	3/28/2000	9/28/2003	12				
Park Ave and Maywood St	3/28/2000	9/28/2003	12				
Mount_Vernon_26K099	6/2/2001	7/17/2001	3				
Wesley_G_Ross_6G108	9/25/2001	9/25/2001	1				
27K397_Mount_Vernon_St_Charlestown	3/3/2002	4/28/2002	3				
5F208_HydeParkAve_Hyde_Park	4/11/2003	10/26/2002	11	23	168	6/16/1980	9/28/2003

Table 19. Michigan Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

Michigan Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
PITAARETBNNINLT Pitt AA RB N PNI	6/29/1979	5/10/1981	13				
Pittsfield_Retention_Basin_1_in_Pittsfield_Retent	6/30/1979	10/24/1980	7				
GCO_MI006_Waverly_Hills	4/3/1980	10/17/1981	35				
MI1001_Grand_River	4/3/1980	11/19/1981	22				
Upsized_Pipe_1_Inlet_MI008_Grace_St_N_Inlet	4/3/1980	11/19/1981	40				
MI1002_Industrial_Drain	5/30/1980	10/19/1981	18				
Traver_Creek_Detention_Basin_1_in_Traver_Crk_Retention	4/11/1981	6/13/1981	5	7	140	6/29/1979	11/19/1981

Table 20. Minnesota Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

Minnesota Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
Carver_Ravine_Wetland_Detention_Facility_01_in_Carver_Ravine	4/26/1988	4/4/1989	19				
Carver_Ravine_Wetland_Detention_Facility_03_out_Carver_Ravine	5/8/1988	4/4/1989	9				
Site1_Harriet_Pkwy_44th_St	1/30/2001	10/4/2002	14				
Site5a_Snelling_ave_S_and_E_24th_St	3/9/2001	10/8/2002	24				
Site2_Luella_St_at_Orange_ave	3/15/2001	10/7/2002	13				
Site3_Vandalia_St_350_ft_S_of_Capp_Rd	3/15/2001	10/7/2002	13				
Site4_Charles_ave_Mackubin_to_Arundel_St	3/15/2001	10/7/2002	11				
Charles Ave	5/6/2001	11/12/2001	9				
E_Harriet_Pkwy_W44_St	5/6/2001	10/13/2001	10				
Luella St Orange Ave	5/6/2001	10/13/2001	9				
E_29_St_31_Ave_S	5/20/2001	11/12/2001	10				
Vandalia St	5/20/2001	11/12/2001	10	12	151	4/26/1988	10/8/2002

Table 21. New Hampshire Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

New Hampshire Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
1_PKG_Shop_n_Save_Parking_Lot	7/29/1980	10/6/1981	27	1	27	7/29/1980	10/6/1981

Table 22. New York Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

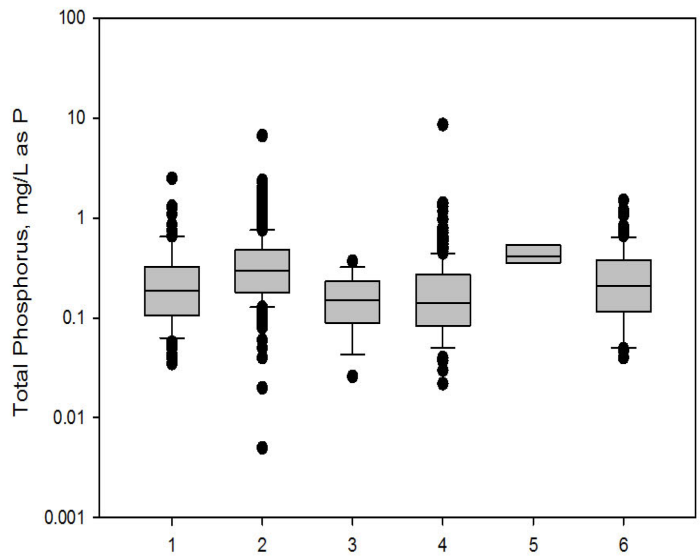
New York Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
Cedar Lane Storm Sewer	9/2/1980	11/20/1981	32				
Sherriff's Dock SS	9/2/1980	11/20/1981	33				
NY_1021_Unqua_Influent	9/18/1980	7/20/1981	8				
NY1031_Carlls_River_Street_Sweeping	11/17/1980	10/25/1982	24	4	97	9/2/1980	10/25/1982

Table 23. Wisconsin Monitoring Locations in EPA Rain Zone 1, NSQD, version 4.02

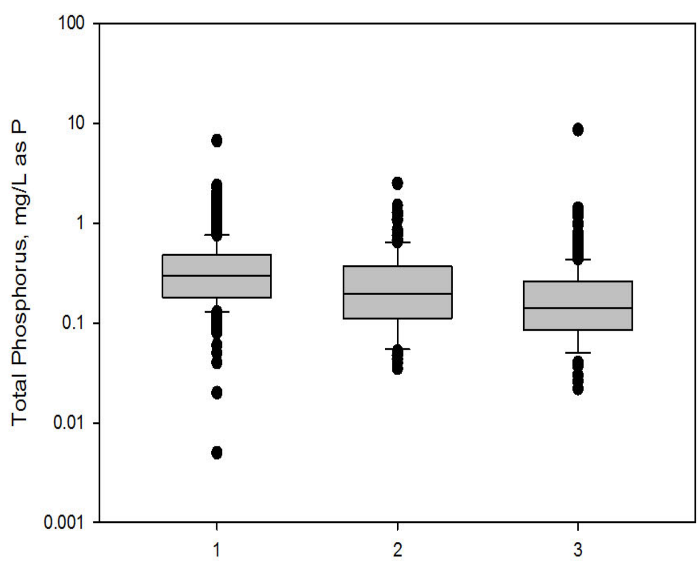
Wisconsin Station Name	First event	Last event	# of events	# stations in state	# events in state	first event in state	last event in state
Wood Center	3/14/1980	10/17/1981	47				
Post Office Capital Court South	4/3/1980	10/17/1981	60				
Rustler Capital Court North	4/4/1980	10/17/1981	37				
State Fair	5/28/1980	10/17/1981	28				
N Hastings	6/2/1980	7/25/1981	24				
N_Burbank_633	6/6/1980	10/17/1981	45				
Lincoln Creek	4/4/1981	10/6/1981	23				
Wet_Pond_Monroe_St_I1	2/28/1987	4/5/1988	30				
Harper Road	6/17/1993	11/12/1993	7				
Lakeland Ave	6/17/1993	4/12/1994	6				
Observatory Dr	6/17/1993	8/12/1994	8				
Syene Road	6/17/1993	9/22/1994	15				
West Towne	6/17/1993	5/14/1994	7				
Annamark Road	10/8/1993	5/14/1994	7	14	344	3/14/1980	9/22/1994

The first analyses compared the different land uses in EPA Rain Zone 1, as shown on Figure 9 box and whisker plots and Tables 24 and 25 multivariate analyses.

Figure 9. Box and Whisker Plots of NSQD, version 4.02, Total Phosphorus EPA Rain Zone 1 Concentrations Grouped by Land Use (Significant Land Use Groupings).



1: Open Space
2: Residential
3: Institutional
4: Commercial
5: Freeways
6: Industrial



1: residential; 2: open space plus inudstrial; 3: institutional plus commercial

Table 24. Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
Z1 TP OS	78	0	0.19	0.11	0.33
Z1 TP Res	551	0	0.30	0.18	0.48
Z1 TP instit	13	0	0.15	0.090	0.24
Z1 TP commer	293	0	0.14	0.083	0.27
Z1 TP free	3	0	0.41	0.35	0.54
Z1 TP indus	106	0	0.21	0.12	0.38
H = 146.660 with 5 degrees of freedom. (P = <0.001)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)					

The Kruskal-Wallis tests indicated that at least one land use were different from the others. Therefore, multiple pairwise comparisons (Dunn's test) were used, as summarized in Table 25 of p values for all pairs.

Table 25. Pairwise p Values for EPA Rain Zone 1 Total Phosphorus Concentrations by Land Use Groups

	open space	residential	institutional	commercial	freeways	industrial
open space	X	<0.001	1.0	0.76	0.59	1.0
residential	<0.001	X	0.015	<0.001	1.0	<0.001
institutional	1.0	0.015	X	1.0	0.23	1.0
commercial	0.76	<0.001	1.0	X	0.18	0.015
freeways	0.59	1.0	0.23	0.18	X	0.95
industrial	1.0	<0.001	1.0	0.015	0.95	X

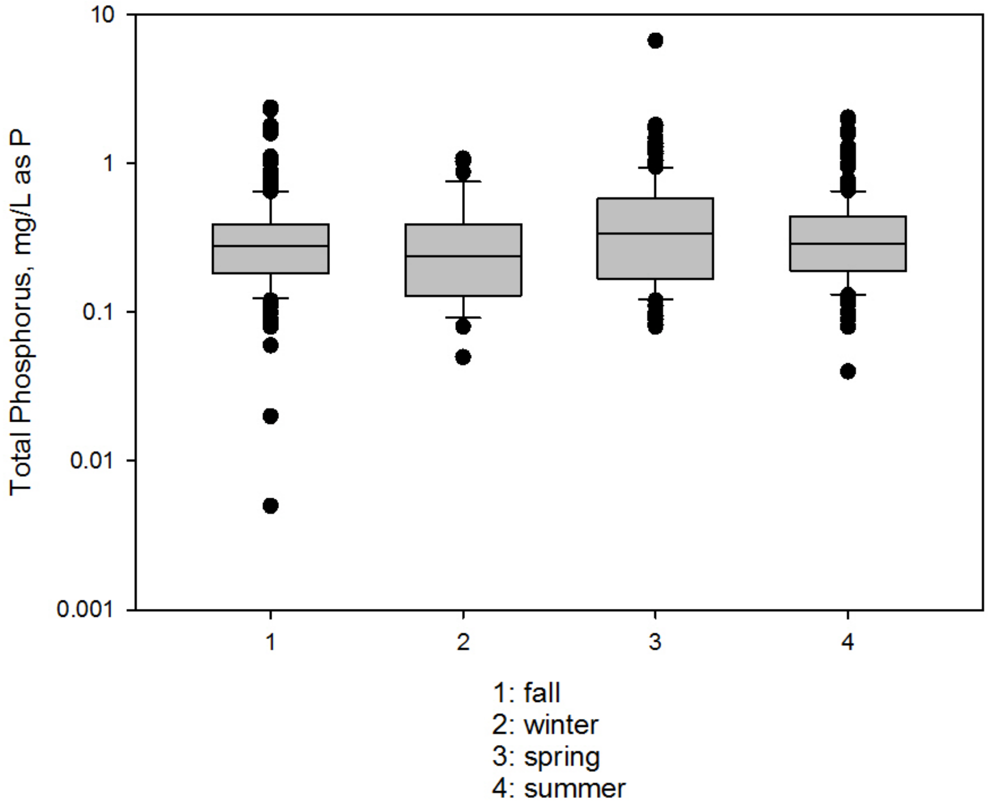
Very few data were available for freeways, so they were not included in the final groupings. The significant land use groupings of EPA Rain Zone 1 total phosphorus data were therefore further evaluated for seasonal effects:

- Residential land uses
- Open space plus industrial land uses
- Institutional plus commercial land uses

It is possible that the last two groups could be further combined, leaving residential areas as the only separate land use for this area. The box and whisker plot for these three combined categories are also shown above with the plots for the individual groups.

The following analyses examine these three groups by season. The first is for the residential group of total phosphorus observations shown on Figure 10 and Tables 26 and 27.

Figure 10. Box and Whisker Plots of NSQD, version 4.02, EPA Rain Zone 1 Residential Land Use Total Phosphorus Concentrations Grouped by Season.



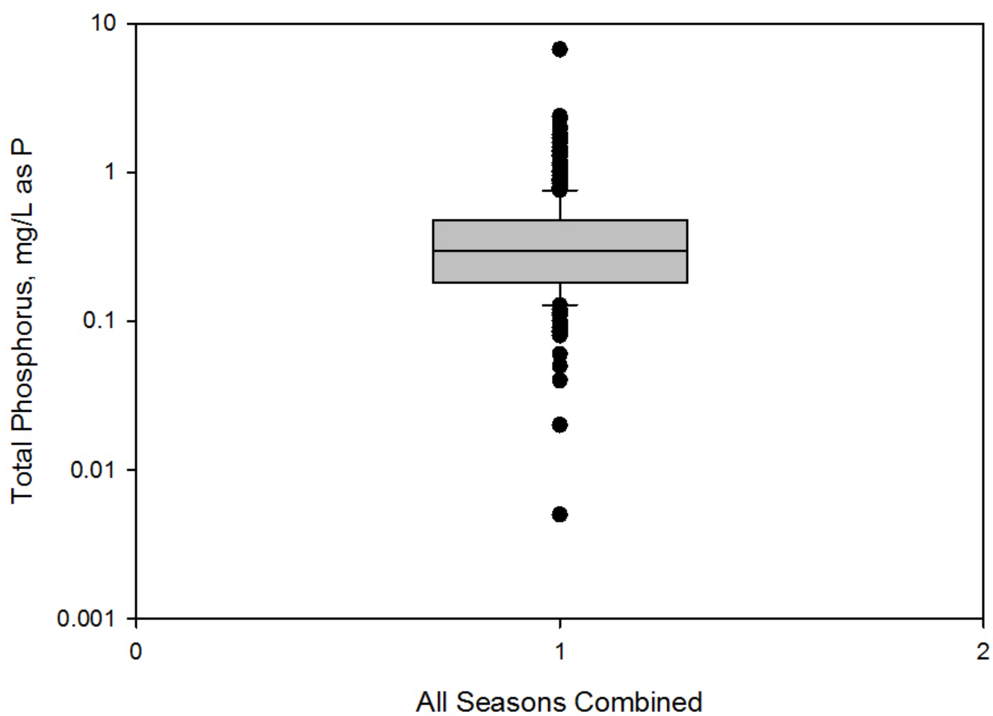


Table 26. EPA Rain Zone 1 Residential Area Total Phosphorus Comparisons using the Kruskal-Wallis One Way Analysis of Variance on Ranks Test

Group	N	Missing	Median	25%	75%
Z1 res fall TP	164	0	0.89	0.14	0.99
Z1 res winter TP	38	0	0.24	0.13	0.32
Z1 res spring TP	142	0	0.49	0.78	0.95
Z1 res summer TP	207	0	0.29	0.19	0.44
H = 7.920 with 3 degrees of freedom. (P = 0.048)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.048)					

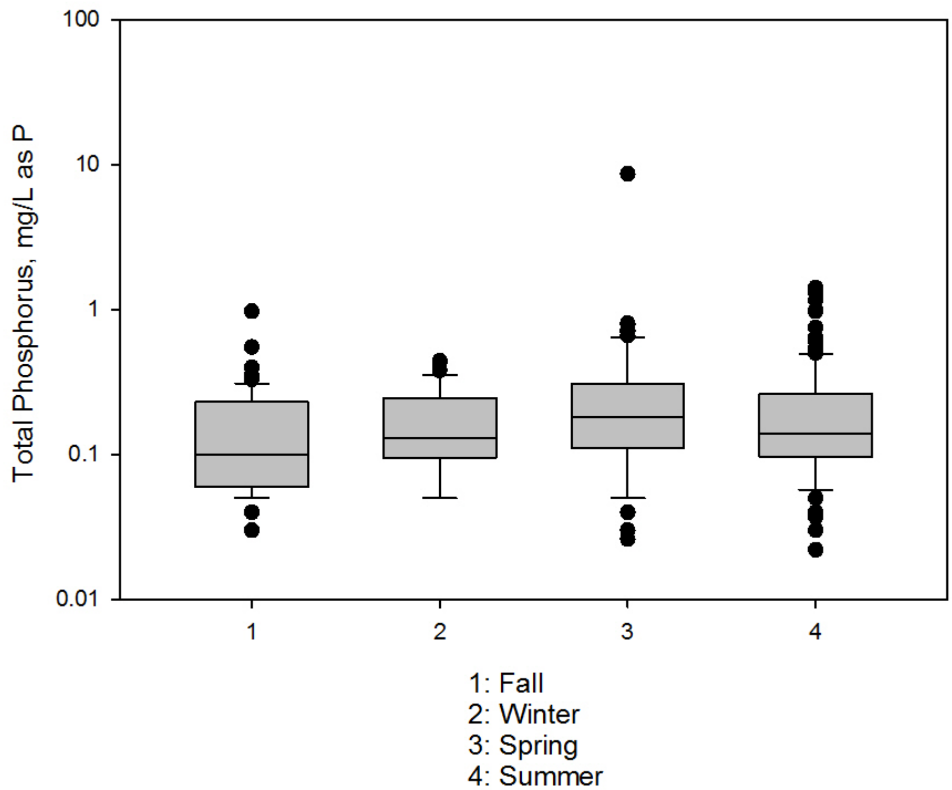
Table 27. Pairwise p Values for EPA Rain Zone 1 Total Phosphorus Concentrations by Season Groups for Residential Land Use Areas

	Fall	Winter	Spring	Summer
Fall	X	1.0	0.19	1.0
Winter	1.0	X	0.10	1.0
Spring	0.19	0.10	X	0.41
Summer	1.0	1.0	0.41	X

Although the Kruskal-Wallis test indicates that at least one season was significantly different from the others (p = 0.048), the pairwise tests were not able to identify any significant differences. Therefore, the residential land use total phosphorus values in this region were not separated by seasonal difference.

The following analyses shown on Figure 11 and Tables 28 through 30 examine the combined group of institutional plus commercial land use total phosphorus data.

Figure 11. Box and Whisker Plots of NSQD, version 4.02, EPA Rain Zone 1 Institutional Plus Commercial Land Use Total Phosphorus Concentrations Grouped by Season.



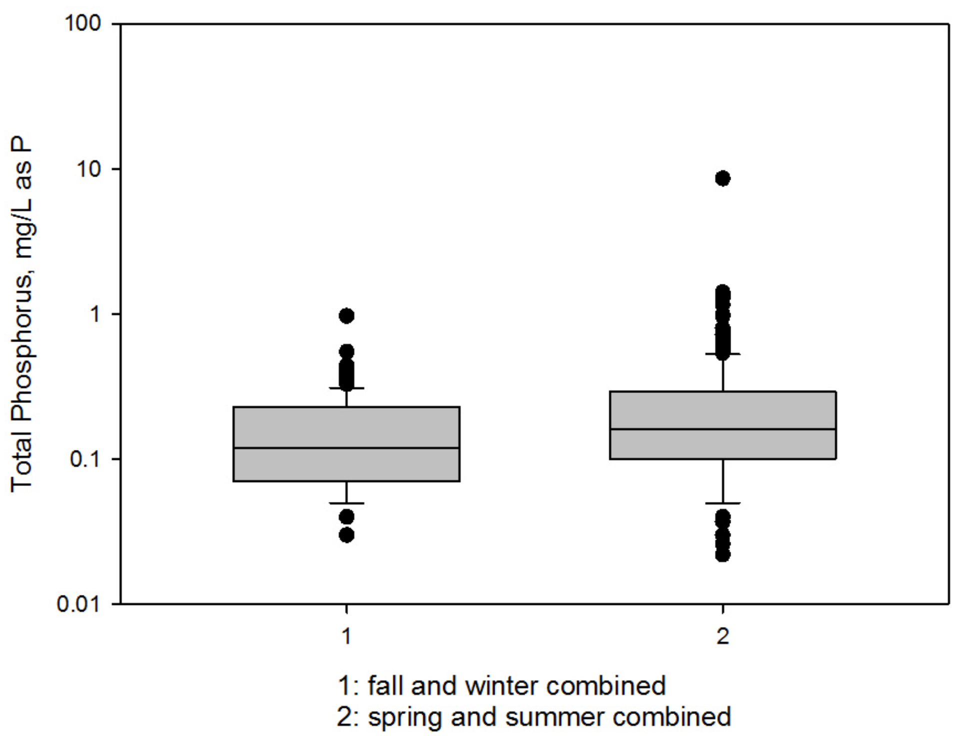


Table 28. EPA Rain Zone 1 Institutional plus Commercial Area Total Phosphorus Comparisons using the Kruskal-Wallis One Way Analysis of Variance on Ranks Test by Seasons

Group	N	Missing	Median	25%	75%
Z1 fall inst commer TP	79	0	0.1	0.06	0.23
Z1 winter inst commer TP	33	0	0.13	0.095	0.45
Z1 spring inst commer TP	68	0	0.18	0.11	0.31
Z1 summer inst commer TP	126	0	0.14	0.078	0.23
H = 12.164 with 3 degrees of freedom. (P = 0.007)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.007)					

Table 29. Pairwise p Values for EPA Rain Zone 1 Total Phosphorus Concentrations by Season Groups for Institutional plus Commercial Land Use Areas

	Fall	Winter	Spring	Summer
Fall	X	1.0	0.005	0.082
Winter	1.0	X	0.68	1.0
Spring	0.005	0.68	X	1.0
Summer	0.082	1.0	1.0	X

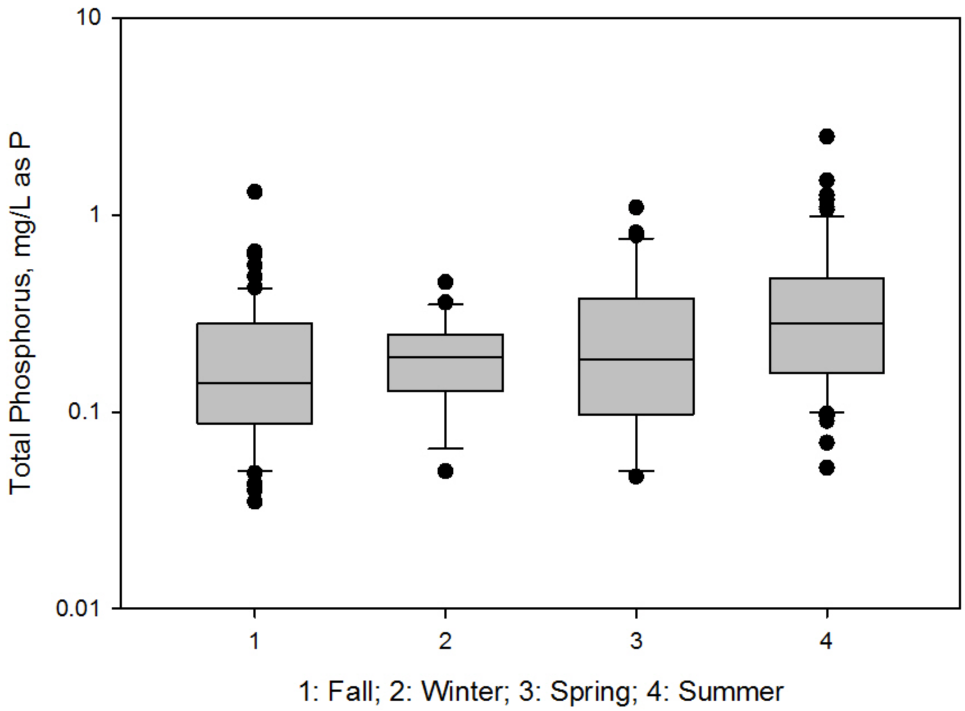
The Kruskal-Wallis test indicated that at least one season was different from the others. The obvious differences shown are between spring and fall and possibly fall and summer. Further analyses investigated the seasons by grouping fall with winter and spring with summer, as also shown on the preceding box and whisker plot. As shown by the Mann-Whitney test (SigmaPlot 13), these two groups were significantly different, with the summer-spring group having larger total phosphorus concentrations compared to the winter-fall group.

Table 30. Mann-Whitney Rank Sum Test Comparing Institutional plus Commercial Total Phosphorus Values for Fall and Winter vs. Summer and Spring Seasonal Groups

Group	N	Missing	Median	25%	75%
Z1 fall win inst commer TP	112	0	0.12	0.07	0.23
Z1 spring summ inst commer TP	194	0	0.16	0.1	0.22
Mann-Whitney U Statistic= 8602.500					
T = 14930.500 n(small)= 112 n(big)= 194 (P = 0.002)					
The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = 0.002)					

The total phosphorus concentrations in the combined open space plus industrial land use group was also evaluated as shown on Figure 12 and Tables 31 through 33.

Figure 12. Box and Whisker Plots of NSQD, version 4.02, EPA Rain Zone 1 Open Space Plus Industrial Land Use Total Phosphorus Concentrations Grouped by Season.



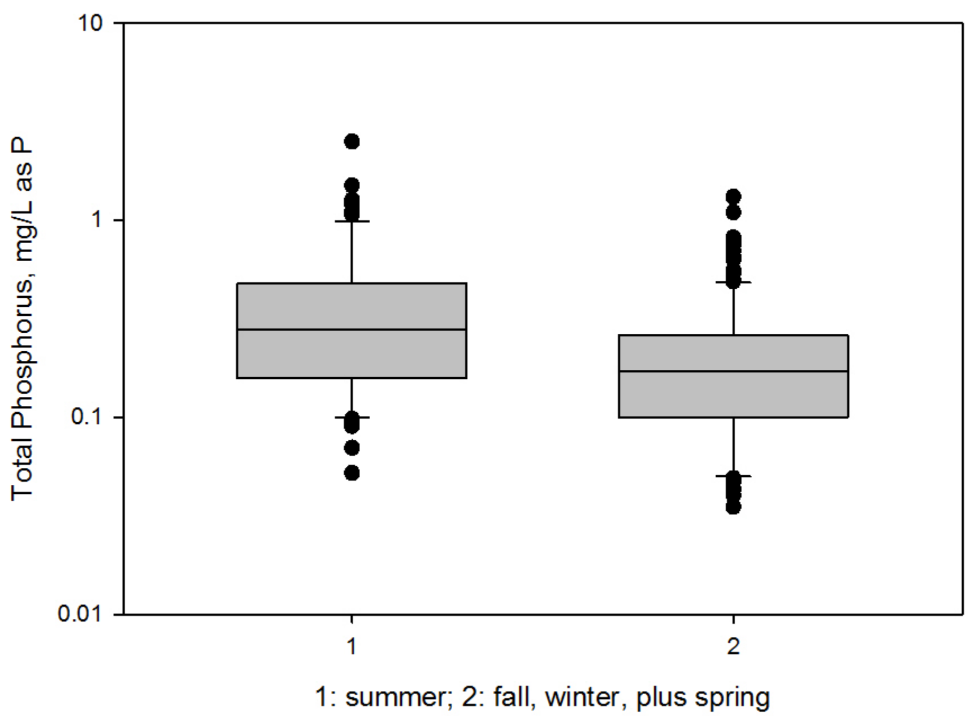


Table 31. Open Space and Industrial Land Use Seasonal Analyses using the Kruskal-Wallis One Way Analysis of Variance on Ranks Test

Group	N	Missing	Median	25%	75%
ZI fall opnspc indus TP	63	0	0.14	0.087	0.28
ZI winter opnspc indus TP	22	0	0.89	0.38	0.58
ZI spring opnspc indus TP	36	0	0.95	0.097	0.89
Z1 summer opnspc indus TP	63	0	0.28	0.67	0.48
H = 19.639 with 3 degrees of freedom. (P = <0.001)					
The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)					
To isolate the group or groups that differ from the others use a multiple comparison procedure.					

The Kruskal Wallis test indicated that at least one seasonal data set was significantly different from the others. Table 32 shows all pairwise comparisons for these data.

Table 32. Pairwise p Values for EPA Rain Zone 1 Total Phosphorus Concentrations by Season Groups for Open Space plus Industrial Land Use Areas

	Fall	Winter	Spring	Summer
Fall	X	1.0	1.0	<0.001
Winter	1.0	X	1.0	0.19
Spring	1.0	1.0	X	0.01
Summer	<0.001	0.19	0.01	X

The major differences were between the fall and summer seasons, while the summer and spring seasons also indicated significant differences in total phosphorus concentrations, with the summer concentrations appearing to be larger than the other groups on the grouped box and whisker plot and the fall period being the lowest. Therefore, these data were grouped with fall, winter, and spring all combined, with summer left separate, as shown on the above plot. The Mann-Whitney analysis on Table 33 shows that these two data groups are significantly different (p<0.001), with the summer having the highest total phosphorus concentrations compared to the other group of remaining seasons.

Table 33. Mann-Whitney Rank Sum Test Comparing Open Space plus Industrial Total Phosphorus Values for Summer vs. Fall, Winter and Spring Seasonal Groups

Group	N	Missing	Median	25%	75%
Z1 op spc indus summer TP	63	0	0.28	0.67	0.48
Z1 opspc indus fall wint sprin	121	0	0.17	0.1	0.26
Mann-Whitney U Statistic= 2330.500					
T = 7308.500 n(small)= 63 n(big)= 121 (P = <0.001)					
The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P = <0.001)					

Appendix B: Seasonal, Land Use, and Location Values from NSQD ver 4.

Residential								
		TSS (mg/L)	**Fecal Coliform (colonies/100 mL)**	**Ammonia (mg/L)**	**N02+NO3 (mg/L as N)**	**Phosphorous Filtered as P (mg/L)**	**Phos part strength (mg/kg)**	**Phosphate Ortho as P (mg/L)**
Residential overall:	count	2352	520	774	1639	1076	964	137
	median	57	7401.5	0.38	0.65	0.1795	2.700575	0.19
	stdev	239.9165	385166.3	0.849786	1.708351	0.622860905	34.18694	0.266277177
	avg	125.7131	82052	0.643535	0.987822	0.258188259	6.280238	0.263743796
	COV	1.91	4.69	1.32	1.73	2.41	5.44	1.01
Residential EPA 1:	count	268	74	90	192	69	64	13
	median	84	4100	0.486	0.609	0.132	2.66051	0.16
	stdev	162.8292	740417.6	0.682915	0.551375	0.239827422	7.744697	0.114959692
	avg	139.0049	176588.1	0.686111	0.753397	0.209115942	5.286272	0.155692308
	COV	1.17	4.19	1.00	0.73	1.15	1.47	0.74
Residential EPA 2:	count	1156	189	477	946	470	434	0
	median	43	2400	0.29	0.59	0.16	3.529412	
	stdev	136.0027	17245.37	0.42072	2.132229	0.185684955	47.33579	
	avg	87.05341	9347.945	0.410983	1.028579	0.213061702	7.89366	
	COV	1.56	1.84	1.02	2.07	0.87	6.00	
Residential EPA 3:	count	121	28	3	53	78	58	0
	median	23	2622.5	0.06	0.5	0.101	3.61724	
	stdev	172.0979	225415.8	0.078102	1.255479	2.176840914	46.6312	
	avg	83.82612	52270.39	0.1	0.929962	0.414505128	15.4764	
	COV	2.05	4.31	0.78	1.35	5.25	3.01	
Residential EPA 4:	count	117	62	8	62	51	49	5
	median	99	33500	0.92	0.812	0.28	1.8	0.05
	stdev	726.8345	44364.97	0.5378	0.580641	0.182855134	7.540141	0.058906706
	avg	405.0205	44291.58	1.08	0.894452	0.28	4.957651	0.082
	COV	1.79	1.00	0.50	0.65	0.65	1.52	0.72
Residential EPA 5:	count	107	70	0	106	69	61	0
	median	76	29000		0.7	0.27	2.5	
	stdev	106.3083	180308.7		0.785001	0.153769126	3.20452	
	avg	109.6449	106601.4		0.885915	0.290289855	3.083464	
	COV	0.97	1.69		0.89	0.53	1.04	
Residential EPA 6:	count	145	39	120	31	137	113	20
	median	61	90000	0.4605	1.1	0.23	1.028986	0.21
	stdev	138.925	848892.8	0.915519	0.46028	0.269685049	6.473326	0.215306391
	avg	106.1172	387869.2	0.831567	1.107742	0.321313869	2.956459	0.281
	COV	1.31	2.19	1.10	0.42	0.84	2.19	0.77
Residential EPA 7:	count	158	47	25	53	18	17	24

	median	82	1600	0.3	0.7	0.055	6.733333	0.1
	stdev	90.35955	44838.94	1.132167	0.9235	0.572663348	20.8546	0.10357382
	avg	98.27215	16965.7	0.62152	0.865472	0.346611111	13.65719	0.126666667
	COV	0.92	2.64	1.82	1.07	1.65	1.53	0.82
Residential EPA 8:	count	7	5	7	1	0	0	5
	median	53	4500	0.68	0.48			0.2079
	stdev	113.036	12268.54	0.149423				0.18532472
	avg	96.85714	8496	0.714429	0.48			0.27298
	COV	1.17	1.44	0.21				0.68
Residential EPA 9:	count	273	6	44	195	184	168	70
	median	111.91	41000	2.14	0.93	0.18	1.550209	0.235
	stdev	294.0135	25838.91	1.610879	0.985009	0.22821524	2.441872	0.319491914
	avg	208.5562	32373.33	2.523636	1.138518	0.251859602	2.351663	0.3382
	COV	1.41	0.80	0.64	0.87	0.91	1.04	0.94

Residential															
		Cadmium Filtered (ug/L)	**Cadmium part strength (ug/kg)**	**Chromium Filtered (ug/L)**	**Chromium part strength (ug/kg)**	**Copper Filtered (ug/L)**	**Copper part strength (ug/kg)**	**Iron, Filtered as Fe (ug/L)**	**Iron part strength (ug/kg)**	**Lead Filtered After 1984 (ug/L)**	**Lead part strength (ug/kg)**	**Nickel Filtered (ug/L)**	**Nickel part strength (ug/kg)**	**Zinc Filtered (ug/L)**	**Zinc part strength (ug/kg)**
Residential overall:	count	8	4	13	9	152	114	40	30	42	25	23	14	150	113
	median	1.095	9.166667	1.71	41.2371134	9.11	104.9572	235	6473.94	4.5	196.4286	4	26.95625	50	774.1935
	stdev	1.043421	5.116644	4.2908092	46.0856344	20.7043	1608.292	1259.97	28765.99	27.66523	387.9438	4.992312	348.9624	119.4862	2536.878
	avg	1.24875	9.848901	3.96538462	53.1609482	15.11072	497.7989	569.575	17617.83	14.38333	282.533	5.908261	127.5374	85.41467	1433.364
	COV	0.84	0.52	1.08	0.87	1.37	3.23	2.21	1.63	1.92	1.37	0.84	2.74	1.40	1.77
Residential EPA 1:	count	0	0	0	0	11	7	0	0	1	1	0	0	11	6
	median					1.4	152.6316			0.6	28.78788			6.5	144.6429
	stdev					60.93195	3047.554							77.84323	1057.015
	avg					35.20909	1670.952			0.6	28.78788			49.27273	763.1956
	COV					1.73	1.82							1.58	1.38
Residential EPA 2:	count	4	1	4	4	33	26	0	0	15	10	0	0	43	33
	median	0.75	10	1.47	39.4573643	7.12	193.75			2.5	183.8346			28	1166.667
	stdev	0.4539		0.2957899	31.0875924	11.60161	1207.495			5.062702	280.6215			15.38174	2479.102
	avg	0.7225	10	1.4375	39.8046052	10.89303	570.0175			5.166667	236.8436			30.2093	1827.367
	COV	0.63		0.21	0.78	1.07	2.12			0.98	1.18			0.51	1.36
Residential EPA 3:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Residential EPA 4:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	median														
	stdev														
	avg														
	COV														
Residential EPA 5:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Residential EPA 6:	count	3	2	4	0	87	61	40	30	14	3	12	6	67	47
	median	1.5	6.364469	9.5		12.4	87.09677	235	6473.94	23.8	46.42857	9.1	40.51632	100	642.8571
	stdev	1.274101	2.784395	3.73753484		13.697	1764.66	1259.97	28765.99	40.5738	43.41053	5.034648	526.7024	155.3589	3252.521
	avg	2.133333	6.364469	9.475		16.36966	464.885	569.575	17617.83	35.64286	61.42447	9.090833	263.6459	145.6224	1528.927
	COV	0.60	0.44	0.39		0.84	3.80	2.21	1.63	1.14	0.71	0.55	2.00	1.07	2.13
Residential EPA 7:	count	1	1	5	5	19	19	0	0	12	11	10	7	25	24
	median	0.7	16.66667	1	41.2371134	5	62.5			1	216.4948	2	17.54386	40	626.3889
	stdev			0.91214034	56.5847786	3.481992	96.04082			2.369311	499.5957	1.173788	15.66656	24.30535	852.9615
	avg	0.7	16.66667	1.58	63.8460226	5.973684	94.60486			2.25	407.4389	2.6	25.73115	39.1	962.4502
	COV			0.58	0.89	0.58	1.02			1.05	1.23	0.45	0.61	0.62	0.89
Residential EPA 8:	count	0	0	0	0	2	1	0	0	0	0	1	1	4	3
	median					6.2	76.47059					0.8	23.52941	45	760.8696
	stdev					5.374012								40.41761	149.9678
	avg					6.2	76.47059					0.8	23.52941	59.25	709.8131
	COV					0.87								0.68	0.21
Residential EPA 9:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														

	avg															
	COV															

Commercial								
		TSS (mg/L)	**Fecal Coliform (colonies/100 mL)**	**Ammonia (mg/L)**	**N02+NO3 (mg/L as N)**	**Phosphorous Filtered as P (mg/L)**	**Phos part strength (mg/kg)**	**Phosphate Ortho as P (mg/L)**
Commercial overall:	count	1132	284	349	788	505	450	135
	median	52	3250	0.48	0.67505	0.11	2.358289	0.12
	stdev	212.0554	72449.34	1.016547	0.830286	0.282986179	7.90126	0.225377814
	avg	119.827	24050.36	0.759639	0.864537	0.221625941	4.574666	0.196281481
	COV	1.769681	3.012401	1.338198	0.960382	1.276863975	1.727177	1.148237787
Commercial EPA 1:	count	197	23	62	152	24	19	0
	median	96.3	2050	0.37	0.6505	0.15	2.272727	
	stdev	166.5768	13125.46	0.256494	0.517555	0.062413709	24.53695	
	avg	142.9497	6774.435	0.434516	0.760941	0.142083333	10.47566	
	COV	1.17	1.94	0.59	0.68	0.44	2.34	
Commercial EPA 2:	count	445	124	224	402	183	169	0
	median	43	2574	0.485	0.68	0.11	3.333333	
	stdev	160.032	31778.35	0.686276	0.957528	0.210478673	5.761721	
	avg	87.37396	14929.29	0.647902	0.926199	0.192459016	4.661389	
	COV	1.83	2.13	1.06	1.03	1.09	1.24	
Commercial EPA 3:	count	100	5	6	18	84	80	0
	median	49.5	2000	0.105	0.2955	0.31	3.112903	
	stdev	124.1597	3066.268	0.115412	0.445728	0.416094581	6.352353	
	avg	91.3762	3220	0.15	0.443222	0.410775	6.089381	
	COV	1.36	0.95	0.77	1.01	1.01	1.04	
Commercial EPA 4:	count	121	38	3	25	25	21	22
	median	39	17500	0.4	0.75	0.11	2.5	0.105
	stdev	329.136	107891.6	0.321455	0.615887	0.317131413	4.53291	0.184116587
	avg	144.7793	53267.89	0.533333	0.9338	0.2484	4.85937	0.176818182
	COV	2.27	2.03	0.60	0.66	1.28	0.93	1.04
Commercial EPA 5:	count	38	40	0	39	34	29	0
	median	34.5	8050		0.52	0.05	1.945652	
	stdev	111.7848	111108		0.237948	0.03494596	3.228699	
	avg	70.71053	39723.83		0.550692	0.055147059	2.900022	
	COV	1.58	2.80		0.43	0.63	1.11	
Commercial EPA 6:	count	34	14	30	33	37	19	22
	median	70.5	5400	1.6	1.1	0.32	3.561644	0.29
	stdev	202.1576	10764.66	2.288982	0.865809	0.308696037	16.65763	0.230106318
	avg	141.7941	9264.286	2.185133	1.256061	0.383918919	10.00942	0.331818182
	COV	1.43	1.16	1.05	0.69	0.80	1.66	0.69
Commercial EPA 7:	count	35	31	15	32	6	5	22

	median	50	1900	0.5	0.25	0.0645	2.592593	0.1
	stdev	94.42856	111415.2	0.998754	0.484821	0.616836445	1.407792	0.10597823
	avg	87.8	28608.81	0.783333	0.4275	0.327	2.673141	0.128636364
	COV	1.08	3.89	1.28	1.13	1.89	0.53	0.82
Commercial EPA 9:	count	162	9	9	87	112	108	69
	median	80.75	15000	1.4	0.77	0.0645	1.378989	0.1
	stdev	311.8032	27035.16	0.94408	0.87511	0.18483009	1.900298	0.249036061
	avg	193.6091	19717	1.471111	0.980805	0.129767857	1.805045	0.18084058
	COV	1.61	1.37	0.64	0.89	1.42	1.05	1.38

Commercial															
		Cadmium Filtered (ug/L)	**Cadmium part strength (ug/kg)**	**Chromium Filtered (ug/L)**	**Chromium part strength (ug/kg)**	**Copper Filtered (ug/L)**	**Copper part strength (ug/kg)**	**Iron, Filtered as Fe (ug/L)**	**Iron part strength (ug/kg)**	**Lead Filtered After 1984 (ug/L)**	**Lead part strength (ug/kg)**	**Nickel Filtered (ug/L)**	**Nickel part strength (ug/kg)**	**Zinc Filtered (ug/L)**	**Zinc part strength (ug/kg)**
Commercial overall:	count	13	6	11	11	52	44	5	5	35	24	11	8	78	69
	median	0.36	13	2	64.516129	9.5	204.8387	320	3880.597	5	454.2857	3	25.32051	57	830.5085
	stdev	17.13222	274.448	1.28262869	32.4265402	13.23395	2386.22	189.2881	16963.32	21.97588	572.8297	3.34664	20.81302	155.4889	8597.717
	avg	6.381538	139.7745	2.16181818	58.3477464	12.43654	692.9323	384	11409.78	14.28857	586.1515	4	31.30596	105.6154	2779.344
	COV	2.684654	1.963505	0.59331016	0.55574623	1.064118	3.443656	0.492938	1.486735	1.538004	0.977272	0.83666	0.664826	1.472218	3.093434
Commercial EPA 1:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Commercial EPA 2:	count	1	1	2	2	14	13	0	0	6	5	0	0	17	16
	median	0.2	20	2.89	33.074391	7.565	200			8	266.6667			129	3577.508
	stdev			1.07480231	44.4653323	3.62763	293.7953			5.879342	414.6802			76.96203	3823.188
	avg	0.2	20	2.89	33.074391	7.757143	291.1581			9.166667	518.4127			125.1765	4096.978
	COV			0.37	1.34	0.47	1.01			0.64	0.80			0.61	0.93
Commercial EPA 3:	count	2	2	0	0	8	4	0	0	1	1	0	0	19	19
	median	38	402.3297			14.5	227.2133			6	127.5917			9	293.6508
	stdev	33.94113	411.8453			26.26649	252.9389							170.4913	1591.306
	avg	38	402.3297			25.25	244.9042			6	127.5917			58.05263	750.6786
	COV	0.89	1.02			1.04	1.03							2.94	2.12
Commercial EPA 4:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Commercial EPA 5:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														

	avg														
	COV														
Commercial EPA 6:	count	1	0	0	0	9	6	5	5	11	1	1	1	16	10
	median	3				11	482.1429	320	3880.597	30	142.8571	10	75.14451	98.5	1010.007
	stdev					5.101743	6356.368	189.2881	16963.32	30.1092				132.682	21841.64
	avg	3				13.44444	3058.89	384	11409.78	34.81818	142.8571	10	75.14451	153.125	7890.639
	COV					0.38	2.08	0.49	1.49	0.86				0.87	2.77
Commercial EPA 7:	count	9	3	9	9	21	21	0	0	17	17	10	7	26	24
	median	0.3	5.882353	2	66.6666667	6	171.4286			2	500	2.5	25	54	1004.95
	stdev	0.346186	2.215447	1.3228756	29.530215	9.982413	364.4195			4.08136	629.4334	2.836273	11.80331	188.9537	1530.223
	avg	0.417778	4.662539	2	63.9640476	10.24286	351.0005			3.3	659.1249	3.4	25.04331	98.34615	1377.242
	COV	0.83	0.48	0.66	0.46	0.97	1.04			1.24	0.95	0.83	0.47	1.92	1.11
Commercial EPA 9:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														

Institutional								
		TSS (mg/L)	**Fecal Coliform (colonies/100 mL)**	**Ammonia (mg/L)**	**N02+NO3 (mg/L as N)**	**Phosphorous Filtered as P (mg/L)**	**Phos part strength (mg/kg)**	**Phosphate Ortho as P (mg/L)**
Institutional overall:	count	237	3	51	291	113	101	46
	median	66.95	3400	0.292	0.18	0.12	1.057692	0.057999998
	stdev	351.4658	1374.773	1.523763	0.496729	0.180140102	12.08872	0.248659639
	avg	144.6702	3100	0.620647	0.401285	0.171185841	3.766353	0.112369565
	COV	2.43	0.44	2.46	1.24	1.05	3.21	2.21
institutional EPA1:	count	13	3	1	12	5	4	0
	median	76	3400	0.6	1.145	0.06	1.435786	
	stdev	56.64793	1374.773		0.456117	0.034351128	2.393685	
	avg	73.67846	3100	0.6	1.143333	0.054	2.567006	
	COV	0.77	0.44		0.40	0.64	0.93	
institutional EPA2:	count	45	0	16	45	14	11	0
	median	64.26		0.31	0.56	0.125	3.333333	
	stdev	83.24506		0.198759	0.465718	0.062092628	18.36242	
	avg	86.16711		0.37375	0.628667	0.126428571	11.45242	
	COV	0.97		0.53	0.74	0.49	1.60	
institutional EPA3:	count	0	0	0	161	0	0	0
	median				0.077			
	stdev				0.121092			
	avg				0.110584			
	COV				1.10			
institutional EPA4:	count	36	0	0	0	0	0	1
	median	50.5						0.08
	stdev	37.44892						
	avg	62.51351						
	COV	0.60						
institutional EPA6:	count	51	0	34	0	48	42	0
	median	69		0.2885		0.1885	0.517394	
	stdev	90.06338		1.859134		0.217936938	1.373381	
	avg	94.21569		0.737441		0.264458333	1.074738	
	COV	0.96		2.52		0.82	1.28	
institutional EPA9:	count	92	0	0	73	46	44	45
	median	76			0.67	0.059999999	1.099271	0.057999998
	stdev	543.5667			0.581564	0.115594871	15.37315	0.251421037
	avg	242.7554			0.780274	0.100217392	4.523137	0.113088888
	COV	2.24			0.75	1.15	3.40	2.22

Institutional															
		Cadmium Filtered (ug/L)	**Cadmium part strength (ug/kg)**	**Chromium Filtered (ug/L)**	**Chromium part strength (ug/kg)**	**Copper Filtered (ug/L)**	**Copper part strength (ug/kg)**	**Iron, Filtered as Fe (ug/L)**	**Iron part strength (ug/kg)**	**Lead Filtered After 1984 (ug/L)**	**Lead part strength (ug/kg)**	**Nickel Filtered (ug/L)**	**Nickel part strength (ug/kg)**	**Zinc Filtered (ug/L)**	**Zinc part strength (ug/kg)**
Institutional overall:	count	6	4	1	0	45	38	37	35	2	1	6	5	34	27
	median	1.31	1.060049	11.2		10.4	58.17188	279	5591.837	15.85	25	6.44	20.625	93.45	362.3188
	stdev	0.802363	5.547481			11.37885	969.4374	1086.359	20281.31	12.37437		2.749703	32.75424	54.10545	892.2192
	avg	1.313333	3.554653	11.2		14.19133	293.9798	561.3014	12912.94	15.85	25	6.096667	34.17269	99.10588	726.3241
	COV	0.61	1.56			0.80	3.30	1.94	1.57	0.78		0.45	0.96	0.55	1.23
institutional EPA1:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
institutional EPA2:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
institutional EPA3:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
institutional EPA4:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
institutional EPA6:	count	5	3	1	0	44	37	36	35	2	1	5	4	33	26
	median	1.42	1.458333	11.2		10.6	60.60606	279.5	5591.837	15.85	25	6.48	35.04934	93.9	373.4671
	stdev	0.602561	6.370448			11.43209	981.7136	1097.565	20281.31	12.37437		1.596459	32.60718	52.72728	901.6987

	avg	1.556	4.51895			14.38886	301.4046	576.8889	12912.94	15.85		7.056	41.59454	101.7152	749.3106
	COV	0.39	1.41			0.79	3.26	1.90	1.57	0.78		0.23	0.78	0.52	1.20
institutional EPA9:	count	1	1	0	0	1	1	1	0	0	0	1	1	1	1
	median	0.1	0.661765			5.5	19.26471	0.15				1.3	4.485294	13	128.6765
	stdev														
	avg														
	COV														

Industrial								
		TSS (mg/L)	**Fecal Coliform (colonies/100 mL)**	**Ammonia (mg/L)**	**N02+NO3 (mg/L as N)**	**Phosphorous Filtered as P (mg/L)**	**Phos part strength (mg/kg)**	**Phosphate Ortho as P (mg/L)**
Industrial overall:	count	695	348	298	560	370	336	70
	median	75	2250	0.45	0.6555	0.095	1.939926	0.23
	stdev	261.1604	279290.4	0.819019	0.803846	0.195829752	11.21182	0.218431307
	avg	160.9249	46489.53	0.664812	0.873754	0.150882162	3.8457	0.273285714
	COV	1.62	6.01	1.23	0.92	1.30	2.92	0.80
Industrial EPA1:	count	105	40	58	103	27	24	1
	median	81	1350	0.52	0.564	0.04	2.438601	0.33
	stdev	247.3206	568231	1.380276	0.401852	0.080105717	33.7589	
	avg	169.2276	97380.7	0.817121	0.661184	0.085185185	9.888561	0.33
	COV	1.46	5.84	1.69	0.61	0.94	3.41	
Industrial EPA2:	count	267	119	153	235	134	128	0
	median	47	1600	0.35	0.63	0.1	2.440442	
	stdev	78.27748	35772.33	0.448945	0.679094	0.232216716	6.913522	
	avg	72.27341	14399.39	0.504392	0.808766	0.160402985	3.976191	
	COV	1.08	2.48	0.89	0.84	1.45	1.74	
Industrial EPA3:	count	79	46	11	58	66	59	0
	median	42	2050	0.15	0.415	0.07	1.428571	
	stdev	123.2876	10685.72	0.086865	1.275227	0.10511294	10.87578	
	avg	99.22658	6624.261	0.176364	0.840052	0.089506061	4.54471	
	COV	1.24	1.61	0.49	1.52	1.17	2.39	
Industrial EPA4:	count	83	40	6	31	30	28	11
	median	82	1700	0.745	0.727	0.13	0.899919	0.09
	stdev	228.1171	355826.1	0.593487	0.49164	0.110776258	1.369947	0.172104619
	avg	161.7952	83426.78	0.846667	0.820903	0.151	1.422713	0.18
	COV	1.41	4.27	0.70	0.60	0.73	0.96	0.96
Industrial EPA5:	count	50	53	0	53	53	46	0
	median	157	9700		0.651	0.06	0.97619	
	stdev	362.5224	350412		0.288527	0.081902434	1.279433	
	avg	226.96	87560.19		0.679981	0.089622642	1.28565	
	COV	1.60	4.00		0.42	0.91	1.00	
Industrial EPA6:	count	68	20	56	62	55	46	39
	median	311	5600	0.765	1.7	0.2	2.124324	0.28
	stdev	471.8263	357841.1	0.850493	0.996633	0.256583353	5.648586	0.21644097
	avg	474.3088	103595	1.012839	1.844032	0.287272727	3.712379	0.341794872
	COV	0.99	3.45	0.84	0.54	0.89	1.52	0.63
Industrial EPA7:	count	24	27	11	15	2	2	19
	median	114.5	600	0.5	0.29	0.0875	2.926142	0.13

	stdev	222.3713	15742.3	0.496533	0.169397	0.072831998	1.480443	0.208332281
	avg	182.7083	6103.852	0.636364	0.293333	0.0875	2.926142	0.183684211
	COV	1.22	2.58	0.78	0.58	0.83	0.51	1.13
Industrial EPA9:	count	19	3	3	3	3	3	0
	median	130	8100	0.86	0.9	0.13	0.698276	
	stdev	313.013	22162.13	0.628517	0.378594	0.285832119	0.62758	
	avg	290.6842	16806.67	0.936667	0.733333	0.29	0.713941	
	COV	1.08	1.32	0.67	0.52	0.99	0.88	

Industrial															
		Cadmium Filtered (ug/L)	**Cadmium part strength (ug/kg)**	**Chromium Filtered (ug/L)**	**Chromium part strength (ug/kg)**	**Copper Filtered (ug/L)**	**Copper part strength (ug/kg)**	**Iron, Filtered as Fe (ug/L)**	**Iron part strength (ug/kg)**	**Lead Filtered After 1984 (ug/L)**	**Lead part strength (ug/kg)**	**Nickel Filtered (ug/L)**	**Nickel part strength (ug/kg)**	**Zinc Filtered (ug/L)**	**Zinc part strength (ug/kg)**
Industrial overall:	count	23	17	20	17	43	37	1	1	28	18	22	18	47	41
	median	0.6	6.428571	3	97.3451327	8	187.5	120	2142.857	5	208.5131	6.5	54.37666	115	1078.571
	stdev	1.376696	6.984716	2.82229022	330.373769	7.948686	193.673			34.74557	184.088	19.05818	34.11522	1051.013	885.8111
	avg	1.247391	8.21695	3.868	252.435766	10.90698	250.4806	120	2142.857	22.44286	250.236	13.5	57.21058	302.4043	1214.315
	COV	1.10	0.85	0.73	1.31	0.73	0.77			1.55	0.74	1.41	0.60	3.48	0.73
Industrial EPA1:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Industrial EPA2:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Industrial EPA3:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Industrial EPA4:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														

	stdev														
	avg														
	COV														
Industrial EPA5:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Industrial EPA6:	count	8	6	9	7	23	18	1	1	15	6	9	7	27	22
	median	0.245	4.559524	2	72.2222222	10	171.4286	120	2142.857	24	130.9524	2	67.85714	59	1010.119
	stdev	0.64127	2.326042	0.99608121	361.644875	8.461959	252.7441	#DIV/0!	#DIV/0!	41.0252	301.178	3.370625	40.26684	117.2582	978.4108
	avg	0.47375	4.449735	2.59555556	223.980726	12.82609	267.8127	120	2142.857	39.06667	255.167	3.888889	76.68007	95.59259	1214.847
	COV	1.35	0.52	0.38	1.61	0.66	0.94	#DIV/0!	#DIV/0!	1.05	1.18	0.87	0.53	1.23	0.81
Industrial EPA7:	count	15	11	11	10	20	19	0	0	13	12	13	11	20	19
	median	0.8	10.60606	4	125.008444	7	216.2162			2	239.0056	11	42.01681	228	1125
	stdev	1.499428	7.886254	3.41919714	325.233564	6.867927	118.755			2.953399	105.4614	22.60106	23.90595	1585.155	791.7419
	avg	1.66	10.27179	4.90909091	272.354295	8.7	234.0607			3.261538	247.7705	20.15385	44.8209	581.6	1213.7
	COV	0.90	0.77	0.70	1.19	0.79	0.51			0.91	0.43	1.12	0.53	2.73	0.65
Industrial EPA9:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														

Freeways								
		TSS (mg/L)	**Fecal Coliform (colonies/100 mL)**	**Ammonia (mg/L)**	**N02+NO3 (mg/L as N)**	**Phosphorous Filtered as P (mg/L)**	**Phos part strength (mg/kg)**	**Phosphate Ortho as P (mg/L)**
Freeways overall:	count	266	67	76	114	40	38	103
	median	74.5	2000	1.045	1.18	0.1355	2.06235	0.09
	stdev	335.9506	22719.15	2.152921	1.45647	1.243959734	9.927388	0.12495179
	avg	140.3939	8553.403	1.652974	1.528947	0.4482725	5.268375	0.128592233
	COV	2.39	2.66	1.30	0.95	2.78	1.88	0.97
Freeways EPA 2:	count	123	18	7	81	5	4	0
	median	62.7	2000	0.85	1.37	0.094	0.719828	
	stdev	155.2013	37209.19	0.468468	1.488158	0.142856571	7.228919	
	avg	113.4598	11338.22	0.885714	1.770864	0.146	4.162656	
	COV	1.37	3.28	0.53	0.84	0.98	1.74	
Freeways EPA 3:	count	13	0	0	0	14	13	0
	median	24.6				0.0346	3.684211	
	stdev	51.52832				0.073381705	15.31415	
	avg	36.20385				0.055707143	9.065032	
	COV	1.42				1.32	1.69	
Freeways EPA 6:	count	104	26	56	0	21	21	81
	median	97	1700	1.39		0.197	1.644266	0.09
	stdev	503.3709	16364.95	2.428435		1.662014214	4.398798	0.13321036
	avg	182.64	7945.385	1.962071		0.781952381	3.128677	0.148333333
	COV	2.76	2.06	1.24		2.13	1.41	0.90
Freeways EPA 7:	count	26	23	13	24	0	0	22
	median	108.5	2200	0.6	0.28			0.05
	stdev	129.7533	12852.19	0.356712	0.632223			0.034594122
	avg	150.9231	7061.304	0.734615	0.5125			0.055909091
	COV	0.86	1.82	0.49	1.23			0.62

Freeways															
		Cadmium Filtered (ug/L)	**Cadmium part strength (ug/kg)**	**Chromium Filtered (ug/L)**	**Chromium part strength (ug/kg)**	**Copper Filtered (ug/L)**	**Copper part strength (ug/kg)**	**Iron, Filtered as Fe (ug/L)**	**Iron part strength (ug/kg)**	**Lead Filtered After 1984 (ug/L)**	**Lead part strength (ug/kg)**	**Nickel Filtered (ug/L)**	**Nickel part strength (ug/kg)**	**Zinc Filtered (ug/L)**	**Zinc part strength (ug/kg)**
Freeways overall:	count	30	21	79	46	129	90	4	4	63	59	64	61	104	86
	median	0.6825	4.265302	2.3	73.7142857	10.9	191.5175	335	25428.57	1.8	295.2381	4	48.49922	51	1127.232
	stdev	0.938684	4.260111	1.98884538	61.4111403	30.73732	177.8078	355.1995	13787.37	6.525037	517.2064	12.02657	114.9702	236.5392	792.8158
	avg	0.912233	5.81226	2.8245443	84.7311084	20.47519	245.4424	435	24678.3	3.961111	458.7864	8.711203	73.97693	127.4691	1311.708
	COV	1.03	0.73	0.70	0.72	1.50	0.72	0.82	0.56	1.65	1.13	1.38	1.55	1.86	0.60
Freeways EPA 2:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Freeways EPA 3:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
Freeways EPA 6:	count	23	14	72	39	104	66	4	4	45	41	56	53	79	62
	median	0.76	5.127373	2.3	79.026131	11.6	238.0122	335	25428.57	1.86	270	4.15	50.8	50	1189.441
	stdev	1.055152	4.293667	2.00805778	65.6585847	33.43132	196.5305	355.1995	13787.37	4.736534	585.9229	12.63656	122.1757	264.9733	823.7368
	avg	1.002913	5.977834	2.80748611	88.7995863	23.22404	269.7022	435	24678.3	3.776667	487.6525	9.134232	79.84386	143.4403	1415.825
	COV	1.05	0.72	0.72	0.74	1.44	0.73	0.82	0.56	1.25	1.20	1.38	1.53	1.85	0.58
Freeways EPA 7:	count	7	7	7	7	25	24	0	0	18	18	8	8	25	24
	median	0.6	3.030303	3	66.6666667	6	169.9234			1.15	315.7336	3.5	31.37066	51	914.4921
	stdev	0.20354	4.512151	1.91485422	16.5715834	8.560958	82.76483			9.843574	313.5131	5.970164	20.63226	91.89079	646.9959
	avg	0.614286	5.481113	3	62.0638743	9.04	178.7278			4.422222	393.0358	5.75	35.1085	77	1042.739
	COV	0.33	0.82	0.64	0.27	0.95	0.46			2.23	0.80	1.04	0.59	1.19	0.62

Open Space								
		TSS (mg/L)	**Fecal Coliform (colonies/100 mL)**	**Ammonia (mg/L)**	**N02+NO3 (mg/L as N)**	**Phosphorous Filtered as P (mg/L)**	**Phos part strength (mg/kg)**	**Phosphate Ortho as P (mg/L)**
open space overall:	count	152	81	39	77	88	73	11
	median	44.5	2000	0.179	0.59	0.08	0.754717	0.14
	stdev	836.777	334714.3	1.227771	0.769529	0.273686874	6.634844	0.052414432
	avg	261.9481	64756.12	0.791872	0.849792	0.175977273	2.902958	0.145454545
	COV	3.19	5.17	1.55	0.91	1.56	2.29	0.36
open space EPA 1:	count	5	6	4	5	0	0	4
	median	24	2150	0.165	0.23			0.16
	stdev	14.89295	24384.23	0.061644	0.137477			0.039475731
	avg	26.6	14277.33	0.17	0.26			0.1725
	COV	0.56	1.71	0.36	0.53			0.23
open space EPA 2:	count	32	8	4	26	18	14	0
	median	22	4700	0.245	1.27	0.06	1.867978	
	stdev	41.85876	9184.459	0.236132	1.01837	0.179677452	10.04815	
	avg	39.28438	9202.75	0.2975	1.172692	0.163888889	5.500018	
	COV	1.07	1.00	0.79	0.87	1.10	1.83	
open space EPA 4:	count	18	14	2	17	17	15	0
	median	300	14600	1.65	0.49	0.16	0.714286	
	stdev	310.0112	18324.83	0.212132	0.744813	0.142103421	8.770024	
	avg	369.6111	17927.86	1.65	0.782941	0.199411765	3.180136	
	COV	0.84	1.02	0.13	0.95	0.71	2.76	
open space EPA 5:	count	17	20	0	20	14	11	0
	median	118	1850		0.63	0.08	0.728346	
	stdev	506.7405	86684.88		0.436523	0.291757916	6.323719	
	avg	285.2353	26352.5		0.7367	0.199285714	3.203558	
	COV	1.78	3.29		0.59	1.46	1.97	
open space EPA 6:	count	73	33	22	2	32	26	0
	median	20	500	0.143	0.995	0.07	0.459496	
	stdev	1160.734	517475.8	0.419843	0.572756	0.380467285	2.962338	
	avg	330.7808	130543	0.251045	0.995	0.16925	1.795811	
	COV	3.51	3.96	1.67	0.58	2.25	1.65	
open space EPA 9:	count	7	0	7	7	7	7	7
	median	257.13		3.1	0.56	0.15	0.775929	0.12
	stdev	248.8972		1.430453	0.309023	0.054116277	0.16367	0.055075705
	avg	396.7157		2.884286	0.515714	0.134285714	0.754771	0.13
	COV	0.63		0.50	0.60	0.40	0.22	0.42

Open Space															
		Cadmium Filtered (ug/L)	**Cadmium part strength (ug/kg)**	**Chromium Filtered (ug/L)**	**Chromium part strength (ug/kg)**	**Copper Filtered (ug/L)**	**Copper part strength (ug/kg)**	**Iron, Filtered as Fe (ug/L)**	**Iron part strength (ug/kg)**	**Lead Filtered After 1984 (ug/L)**	**Lead part strength (ug/kg)**	**Nickel Filtered (ug/L)**	**Nickel part strength (ug/kg)**	**Zinc Filtered (ug/L)**	**Zinc part strength (ug/kg)**
open space overall:	count	0	0	1	1	7	5	18	16	0	0	0	0	3	1
	median			3.4	61.5384615	1.7	645	255	2130.573					103	101.8201
	stdev					5.221117	274.0273	995.6863	7900.497					39.15354	
	avg			3.4	61.5384615	3.684286	497.8135	503.2778	5523.364					116	101.8201
	COV					1.42	0.55	1.98	1.43					0.34	
open space EPA 1:	count	0	0	0	0	2	1	0	0	0	0	0	0	1	0
	median					0.895	645								
	stdev					1.138442									
	avg					0.895									
	COV					1.27									
open space EPA 2:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
open space EPA 4:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
open space EPA 5:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														
open space EPA 6:	count	0	0	1	1	5	4	18	16	0	0	0	0	2	1
	median			3.4	61.5384615	1.8	528.4014	255	2130.573					94	101.8201
	stdev					5.926213	301.8189	995.6863	7900.497					12.72792	
	avg					4.8	461.0168	503.2778	5523.364					94	
	COV					1.23	0.65	1.98	1.43					0.14	
open space EPA 9:	count	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	median														
	stdev														
	avg														
	COV														