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The National Stormwater Quality Database (NSQD), Version 4.02

Background

The National Stormwater Quality Database (NSQD) is an urban stormwater runoff characterization database developed under the direction of Dr. Robert Pitt, P.E., of the University of Alabama and the Center for Watershed Protection under support from the U.S. Environmental Protection Agency. Originally released in 2001, followed by several updates by Dr. Pitt and Dr. Alexander Maestre (also while at the University of Alabama), it has recently moved to a new long-term home as a companion project to the International Stormwater BMP Database. The NSQD is being maintained as a separate stand-alone database, serving as an important resource for municipal stormwater managers and researchers who are seeking urban runoff characterization data. The NSQD can be searched for water quality data based on land use, state, and EPA Rain Zone, along with several other criteria. The NSQD can be downloaded from the website, and a new web application has been developed to accommodate custom data extraction queries. The NSQD Version 4.02 (last updated January 2015) can be downloaded in two formats containing the same information (http://www.bmpdatabase.org/nsqd.html):

NSQD Version 4.02 Excel Spreadsheet (original format)
NSQD Version 4.02 Access Database (new format) (incorporated with International BMP Database web site data extraction and statistical analyses tools)

In 2001, 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 to collect and evaluate stormwater data from a portion of the NPDES (National Pollutant Discharge Elimination System) MS4 (municipal separate storm sewer system) stormwater permit holders. In 2008, the NSQD was updated with additional data under continued 104(b)3 support from the EPA. These stormwater quality data and site descriptions were collected and reviewed to describe the characteristics of national stormwater quality, to provide guidance for future sampling needs, and to enhance local stormwater management activities in areas having limited data. The monitoring data collected over nearly a ten-year period from more than 200 municipalities throughout the country have a great potential in characterizing the quality of stormwater runoff and comparing it against historical benchmarks. Prior use of the NSQD data include statistical analyses of the data and providing recommendations for improving the quality and management value of future NPDES monitoring efforts. The current version 4.02 contains the results of about 9,100 urban runoff events and more than 100 different constituents (but many of the obscure constituents have few data). The data are distributed between six main urban land uses: 49% residential, 20% commercial, 13% industrial, 6% freeways, 6% institutional, and 6% open space.

Description of the NSQD, Version 4.02

Table 1 lists the constituents included in version 4.02 of the NSQD, and the number of observations (in some cases, most of the observations are below the reported detection limits).

Table 1. Constituents and Numbers of Observations Included in NSQD, version 4.02 (having at least 50 observations)

Total events: 9,130	Total nitrogen: 1,213	Total chromium: 2,328
Precipitation depth: 5,172	Total Kjeldahl N: 7,044	Filtered chromium: 821
Runoff depth: 2,591	Total organic N: 66	Total copper: 5,915
Hardness: 1,670	Ammonia: 3,020	Filtered copper: 1,002
Alkalinity: 525	Nitrate N: 1,028	Cyanide: 1,338
pH: 3,253	Nitrite N: 714	Total iron: 608
Temperature: 1,251	Nitrite + nitrate: 5,748	Filtered iron: 556
TDS, 4,158	Total phosphorus: 8,019	Total lead: 363 (before 1984)
Conductivity: 1,517	Filtered P: 4,051	Total lead: 5,032 (since 1984)
Chloride: 869	Ortho phosphate: 746	Filtered lead: 1,016 (since 84)
Total solids: 100	Filtered ortho P: 244	Total mercury: 1,702
Total suspended solids: 7,713	Total antimony: 1,584	Filtered mercury: 706
Turbidity: 936	Filtered antimony: 641	Total nickel: 2,164
BOD5: 5,227	Total arsenic: 2,441	Filtered nickel: 807
COD: 5,290	Filtered arsenic: 770	Total selenium: 1,737
DO: 192	Total barium: 582	Filtered selenium: 682
Fecal coliforms: 2,223	Total beryllium: 1,509	Total silver: 1,880
Fecal streptococcus: 1,317	Filtered beryllium: 578	Filtered silver: 766
Total coliforms: 282	Total cadmium: 4,105	Total thallium: 1,423
	Filtered cadmium: 961	Filtered thallium: 653
		Total zinc: 6,638
		Filtered zinc: 984

Table 1. Constituents and Numbers of Observations Included in NSQD, version 4.02 (having at least 50 observations) (continued)

Oil and grease: 2,330	1,2-Dichloropropane: 212*
Total petroleum hydrocarbons: 295	Trans-1,3-Dichloropropene: 150*
Acrolein: 464*	1,3-Dichloropropylene: 42*
Acrylonitrile: 205*	Ethyl benzene: 575
Benzene: 213	Methyl bromide: 207*
Bromoform: 189*	Methyl chloride: 321
Carbon tetrachloride: 189*	Methylene chloride: 457
Chlorobenzene: 213*	1,1,2,2-Tetachloroethane: 222*
Chlorodibrimo methane: 189*	Tetrachloroethylene: 99
Chloroethane: 213*	Trichloroflourormethane: 156*
Chloroethylvinylether: 624	Toluene: 573
Chloroform: 499	1,2-Transdichloroethylene: 82*
Dichlorobro methane: 116	1,1,1-Trichloroethane: 226
1,1-Dichloroethane: 258*	1,1,2-Trichloroethane: 222*
1,2-Dichloroethane: 247	Trichloroethylene: 83*
1,1-Dichloroethylene: 71*	Vinyl chloride: 222*

* All, or almost all, non-detected (about 13 organic compounds had the highest detection frequency)

The NSQD contains data from about 600 outfall sampling locations, with a median of 10 samples per site (maximum 115). Most of the data in version 4 was obtained from Phase I NPDES municipal monitoring programs, along with several other sources (USGS, BMP database outfall data before controls, special state and academic research programs, NURP, etc.). More than 700 new storms were added to this most recent version of the database since version 3. The International Stormwater BMP Database, hosts to the NSQD, now provides data extraction and analysis tools to assist the user. Most of the effort associated with the NSQD during its development included QA/QC processes to verify the data, especially for unusual conditions. Figure 1 illustrates the sources of the data within EPA rainfall zones (not the same as EPA administrative regions).

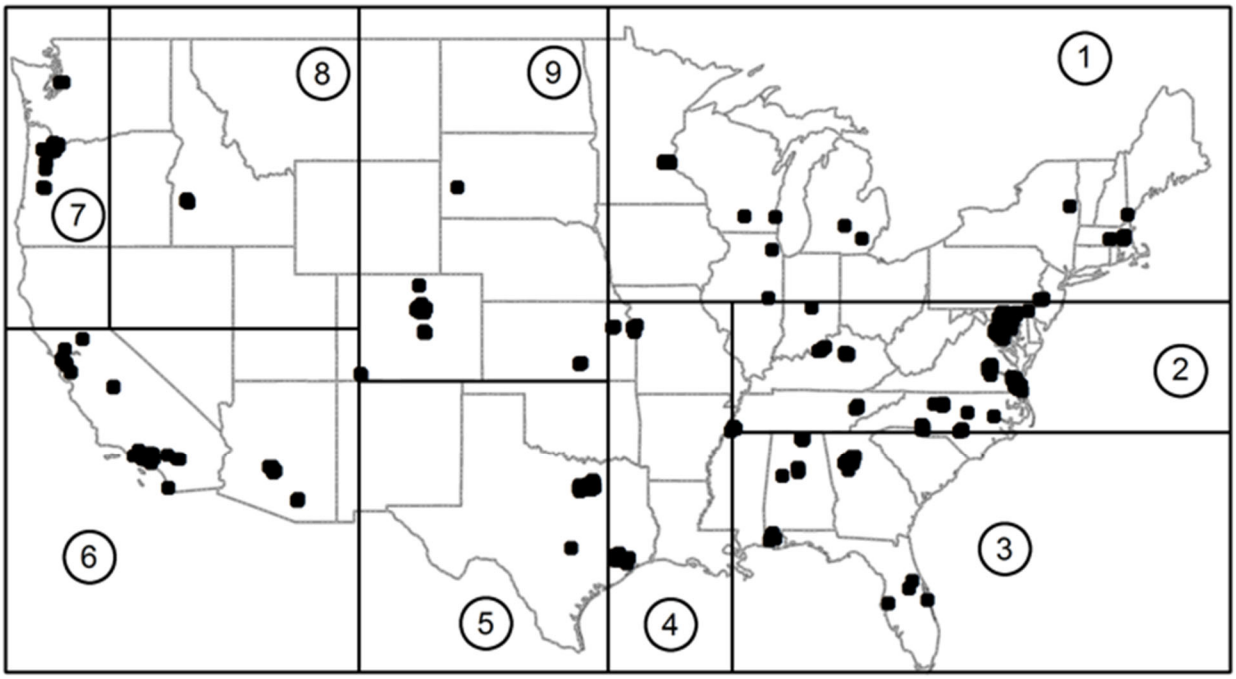


Figure 1. Distributions of NSQD data sources per EPA rainfall zones.

Maestre (many publications) was one of the primary researchers who helped develop and evaluate the NSQD. He investigated first-flush factors, examined distributions of the values and explored various data substitution options for handling non-detectable values, amongst many other interesting stormwater and data analysis issues. Figure 2 is an example of an Xbar-S chart he prepared for each constituent to identify sites within a land use group that did not appear to fall within expected data distributions. He the reviewed those sites, including aerial photographs.

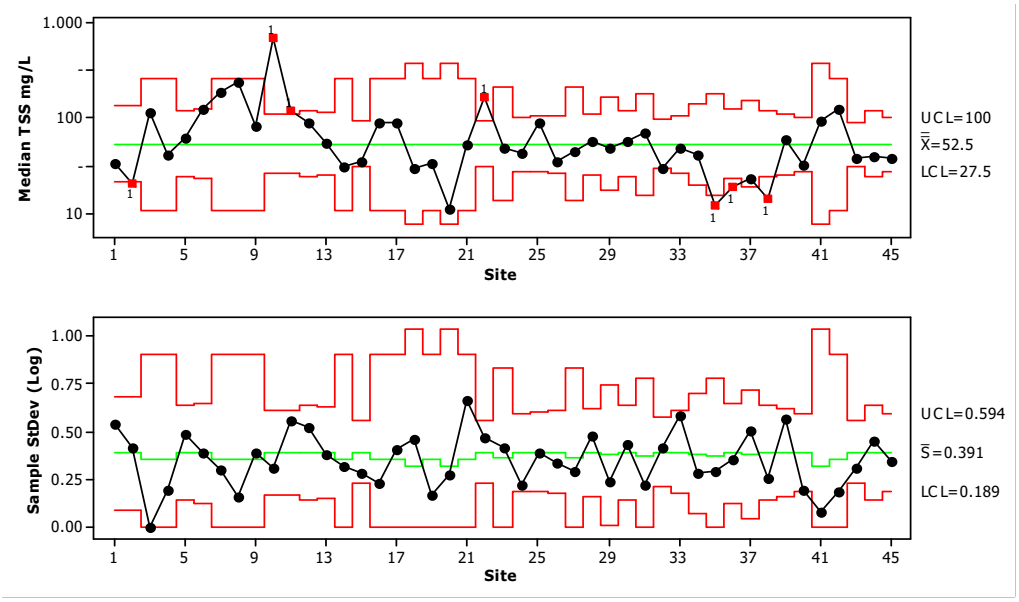


Figure 2. Xbar-S chart of Total Suspended Solids in commercial land use sites indicating unusually high values at some locations (Maestre).

Figure 3 is an example from one of the questionable sites that had high suspended solids concentrations. This photograph shows evidence of sediment tracking from an adjacent sand and gravel operation affecting an adjacent monitored commercial site.

Figure 3. Aerial photograph of a monitored commercial area having unusually high TSS concentrations showing proximity to quarry operation.

It is well know that stormwater characteristics vary considerably. Geographical area and land use have been identified as important factors affecting base flow and stormwater runoff quality, for example. Many graduate students and other stormwater researchers have used earlier versions of the NSQD to explore potential relationships of factors that may affect stormwater quality. A selection of these efforts are listed in the references. As an example, Bochis (2010) during her PhD research using an earlier version of the NSQD calculated the main factors and interactions affecting stormwater quality, as shown on Table 2. Yellow and green cells note statistically significant relationships ($p<0.05$); yellow should be used for predictive purposes as they contain the highest order interaction terms.

Table 2. Main Factors and Interactions Affecting Stormwater Quality (Bochis 2010)

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_5 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
$NO_2 + NO_3$ 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 mg/L	<0.0001	0.11	<0.0001	0.62	<0.0001	0.038	0.14
Pb mg/L	<0.0001	0.76	<0.0001	0.42	<0.0001	0.29	0.011
Zn mg/L	<0.0001	0.91	<0.0001	0.94	<0.0001	0.014	<0.0001

Land use is a consistent factor affecting the observed variation in stormwater quality, while location (EPA rain zones) are also very important, and season alone had little effect. An example use of these data to calibrate WinSLAMM for different regions in the US is shown below (Pitt 2011). Figure 4 is a map showing the NSQD version 3 data locations separated into six major geographical locations. Table 3 shows the land use and location distribution of 114 locations that had detailed development characteristics available to supplement the NSQD water quality data.

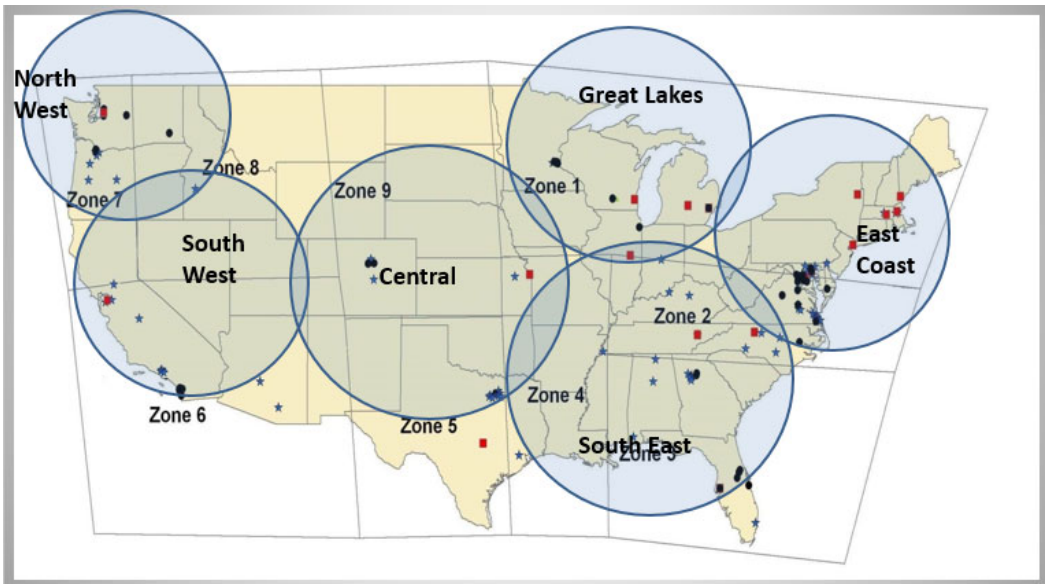


Figure 4. NSQD data locations organized into six geographical areas used to calibrate WinSLAMM.

Table 3. Number of Locations by Geographical Area and Land Use for WinSLAMM Calibration

	Commercial	Industrial	Institutional	Open Space	Resid.	Freeways/ Highways	Total by Region
Central	4	2	4	1	5	3	19
East Coast	3	1	1	1	2	3	11
Great Lakes (the USGS/DNR files)	6	4	4	2	11	4	31
Northwest	2	1	1	1	3	3	11
Southeast	7	2	3	5	8	4	29
Southwest	5	1	1	1	2	3	13
Total by Land Use	27	11	14	11	31	20	114

These areas were described in the WinSLAMM model using the best available site data. The long-term average modeled concentrations were compared to the observed concentrations for each location. Example comparison scatterplots are shown in Figure 5. Obviously, some constituents had better matches that others, but the lines of equal values were all significant. It should be noted that all models require calibration and verification. The NSQD is a good place to start for preliminary analyses, but additional locally collected information is necessary for the greatest reliability.

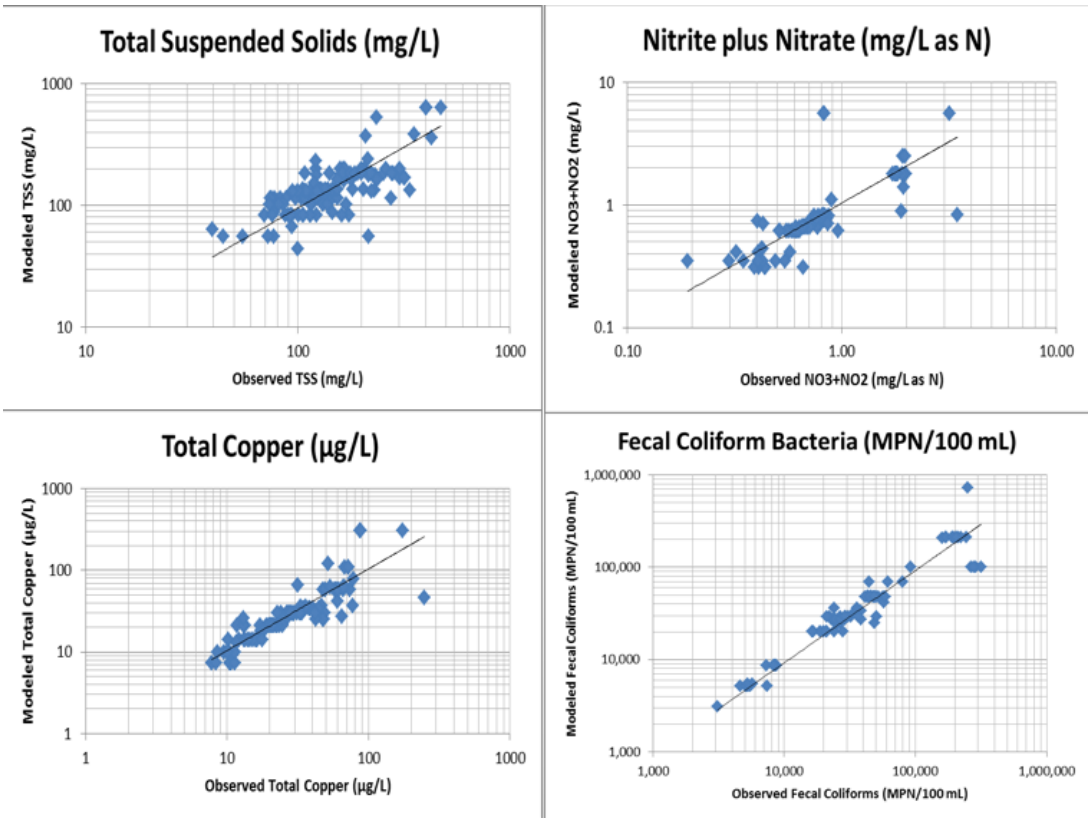


Figure 5. WinSLAMM modeled and observed concentrations for selected NSQD locations.

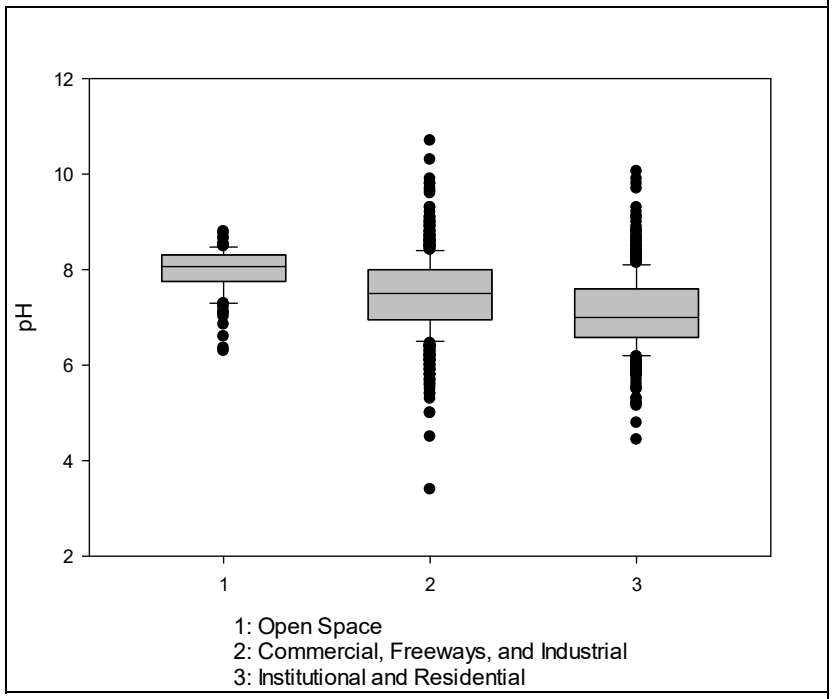
Data Summary

The following is a brief analysis using data from NSQD ver. 4.02 to determine large-scale land use significant differences and associations. Only data from single land use locations were used in these analyses, limiting these analyses to about 5,200 runoff events overall. The remaining data are from mixed land use areas and were therefore not used in this example analysis. Generally, the minimum number of observations per land use per constituent selected for these analyses was about 50 (if fewer, they were not examined). Some of the constituents also had relatively large amounts of non-detected values. The non-detected values were substituted with constant values for these graphical and robust statistical analyses. A selection of eighteen major stormwater constituents were examined having suitable amounts of data, including: pH, SS, COD, fecal coliforms, TKN, NH_3, NO_2+NO_3, P, filtered P, Cd, Cr, Cu, filtered Cu, Pb, Ni, Zn, filtered Zn, and oil and grease.

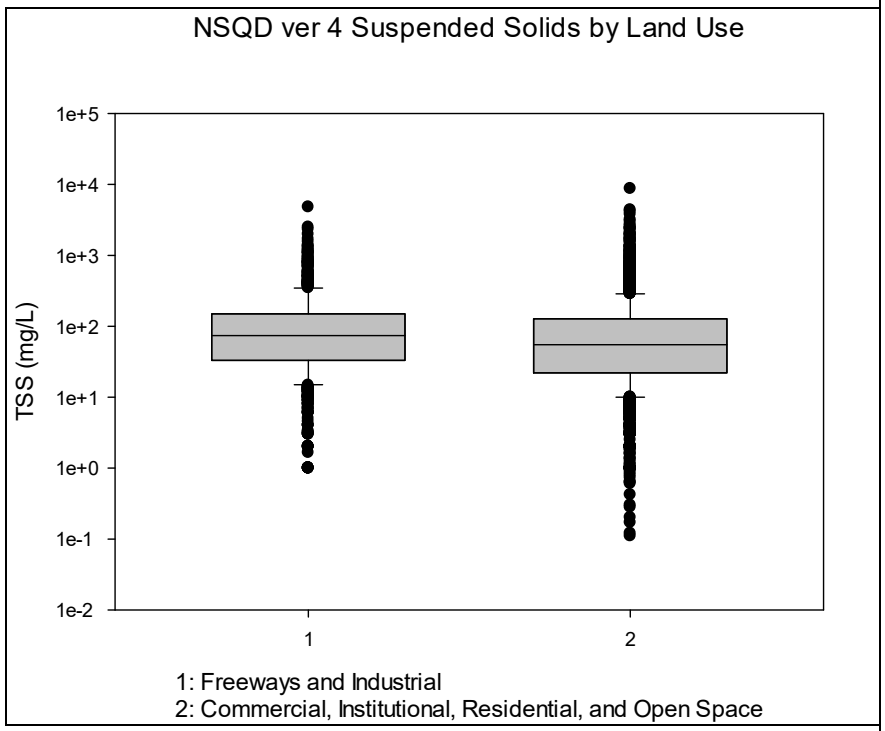
The data for all NSQD constituents were downloaded, and data from the mixed land use locations were removed. The remaining data were then sorted into the six major land use categories (commercial, freeways, industrial, institutional, residential, and open space) and the numbers of observations (and non-detectable values) determined. Non-detectable values were substituted with appropriate constant values to not distort the data distributions and plots. Statistical summaries of the data for these six land uses (and for the total data set with all land uses combined) were then examined. Minitab (version 16) was then used to create multiple probability distributions (all in log-normal space, except for pH). SigmaPlot (version 13) was then used to prepare grouped box and whisker plots of the land uses and overall data sets, along with nonparametric Kruskal-Wallis One Way Analysis of Variance on Ranks (most

of the data were not normally distributed, even after log transformations due to the large amounts of information). The results of these plots and statistical tests were then used to identify candidate groupings of the land uses. The plots and analyses were then repeated for the candidate groups. Some further data groupings were needed for a few of the constituents until the Kruskal-Wallis tests indicated that all of the remaining data groups were significantly different ($p < 0.05$). These data are summarized on the following pages (grouped box-and-whisker plots along with numbers of observations, the coefficient of variation (standard deviation divided by the mean), the median concentration, and the percentage of all observations that had not-detected concentrations. Values of non-detected occurrences larger than about 15% are high-lighted in yellow. These indicate potential distortions of analytical results (such as the COV values). The box plots clearly illustrate the calculated significance of the different data groupings. The Appendix presents these results for the individual land uses and for the final combined land use groups.

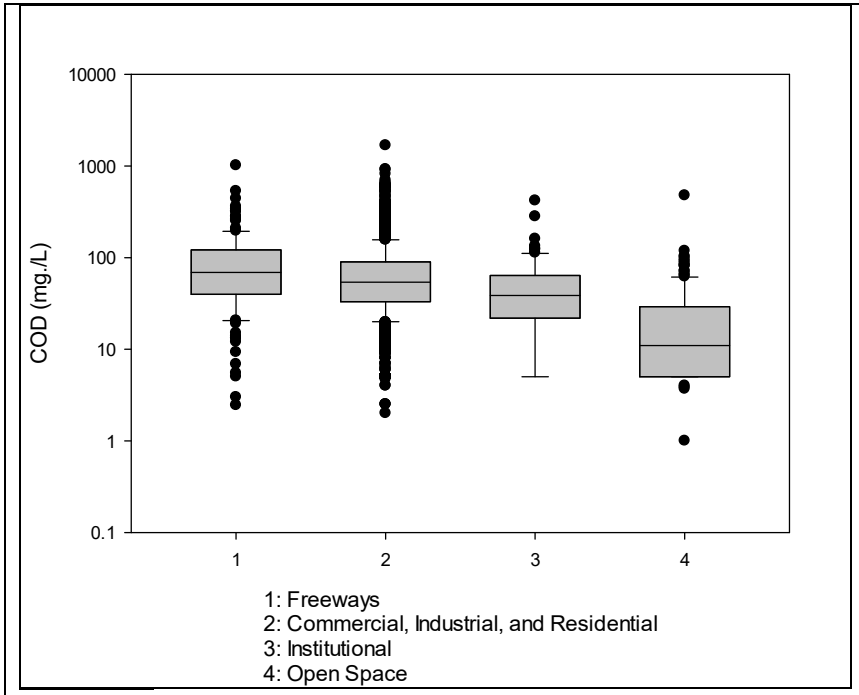
In most cases, freeways had the highest concentrations and open space areas had the lowest concentrations, as expected. Industrial data were often combined with the high concentration data groups and institutional and residential data were often combined with the lower concentration data groups. In many cases, the land use data sets associated with the lower concentrations had many non-detected observations, as expected, and the open space and institutional areas sometimes had few sampled events. The COV values (and the plots) indicate typically expected large variations in the stormwater concentrations in these groups. However, the very large number of data available for most data groupings increases the confidence of the calculated medians (and data ranges), and the confidence calculations of the comparison tests. Most of the confidence results (p values) are much smaller than the typically accepted value of 0.05 (most are <0.001), also indicating significant power in the comparison results.



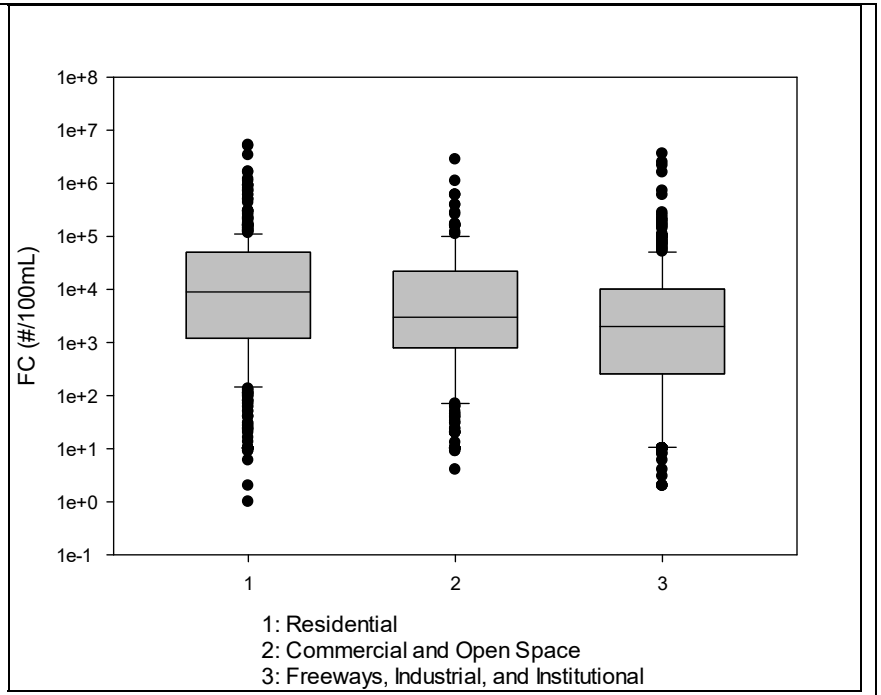
	pH - open space	pH - commercial, freeway, and industrial	pH - institutional and residential
count	116	902	836
COV	0.06	0.10	0.10
median	8.1	7.5	7.0
% ND	0.0	0.1	0.2



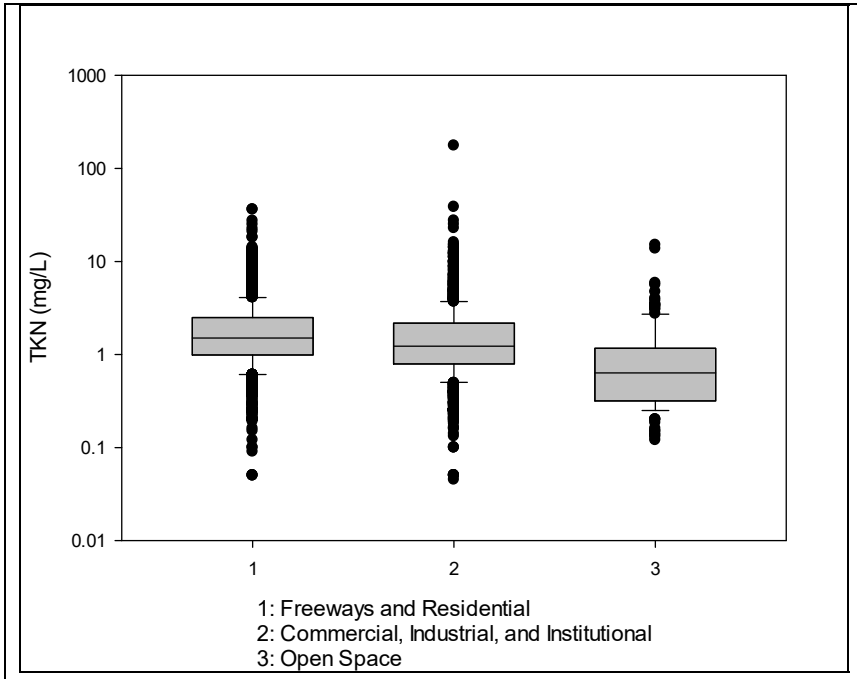
	SS - freeway and industrial	SS - commercial, institutional, residential, and open space
count	967	3,905
COV	1.00	2.23
median (mg/L)	74	55
% ND	0.6	0.8



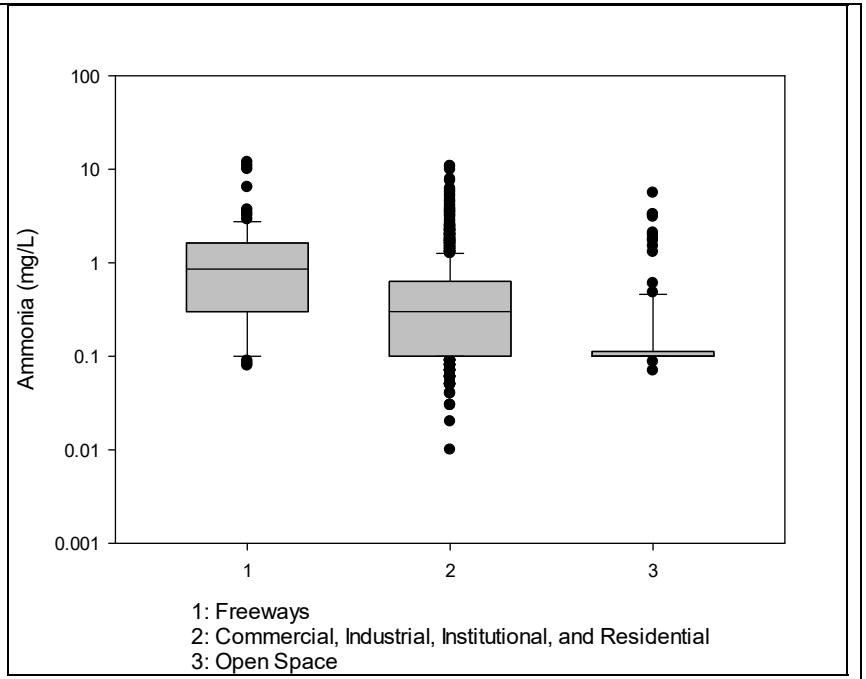
	COD - freeways	COD - commercial, industrial, and residential	COD - institutional	COD - open space
count	130	2,849	78	154
COV	1.17	1.14	1.14	1.75
median (mg/L)	69	54	39	11
% ND	0.8	2.8	16.7	38.3



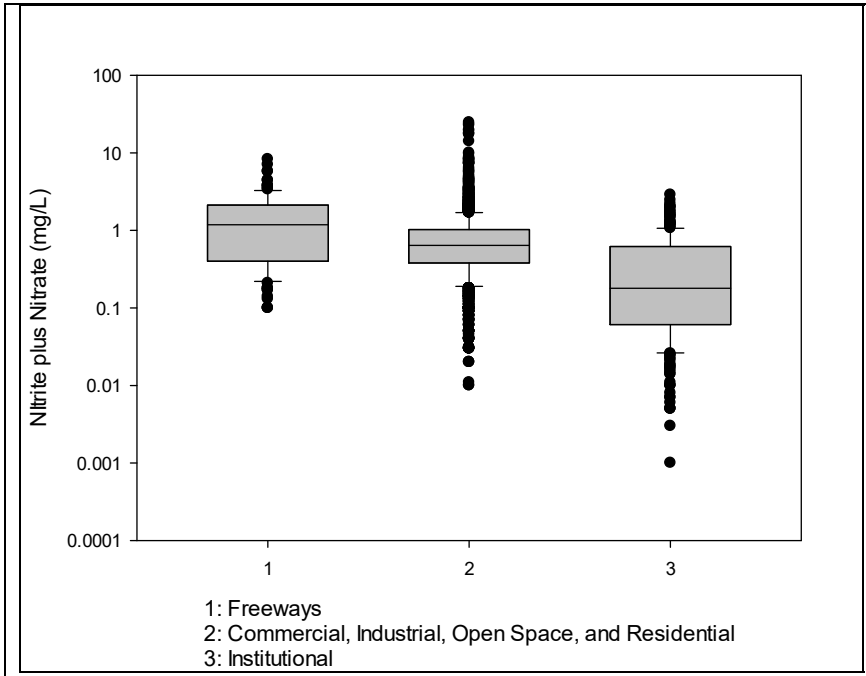
	FC - residential	FC - commercial and open space	FC - freeway, industrial, and institutional
count	579	403	465
COV	4.49	4.54	6.18
median (#/100mL)	9,000	3,000	2,000
% ND	10.4	9.4	10.1



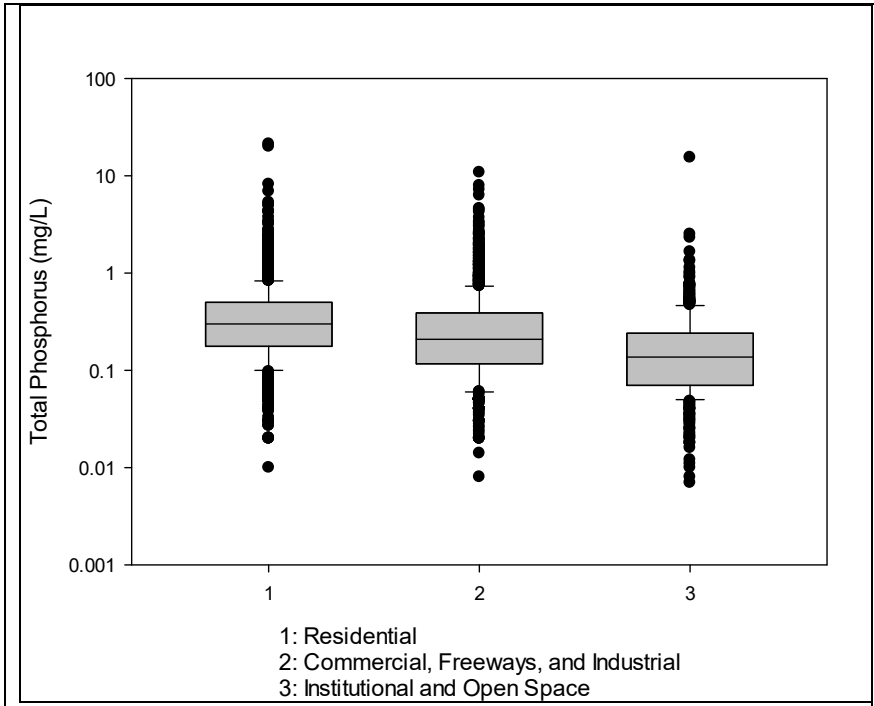
	TKN - freeway and residential	TKN - commercial, industrial, and institutional	TKN - open space
count	2,290	2,028	158
COV	1.12	2.28	1.56
median (mg/L)	1.5	1.2	0.6
% ND	1.9	2.4	12.0



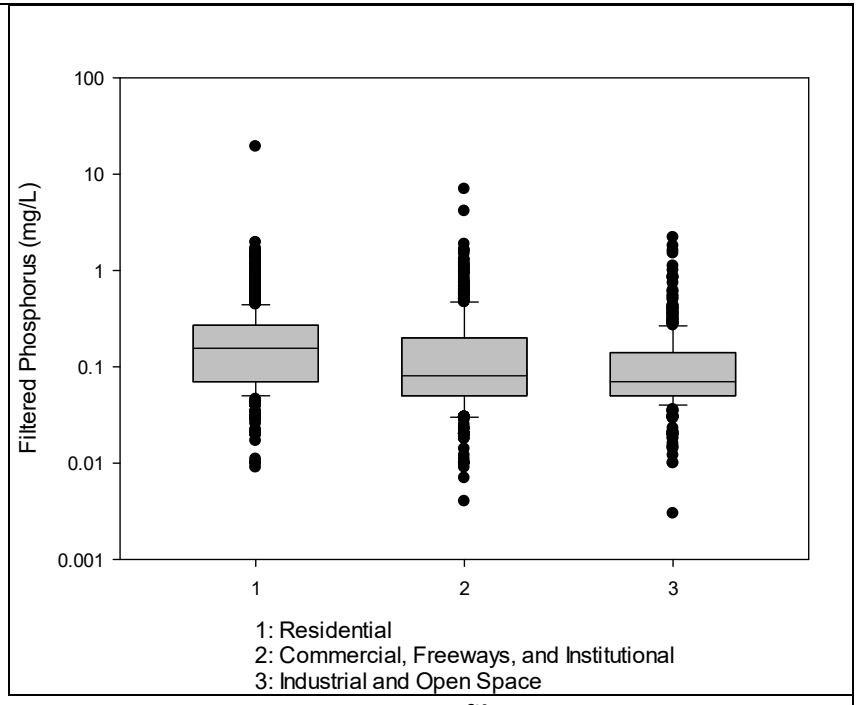
	NH3 - freeways	NH3 - commercial, industrial, institutional, and residential	NH3 - open space
count	88	1,821	121
COV	1.44	1.51	2.36
median (mg/L)	0.9	0.3	nd (0.1)
% ND	13.6	19.2	67.8



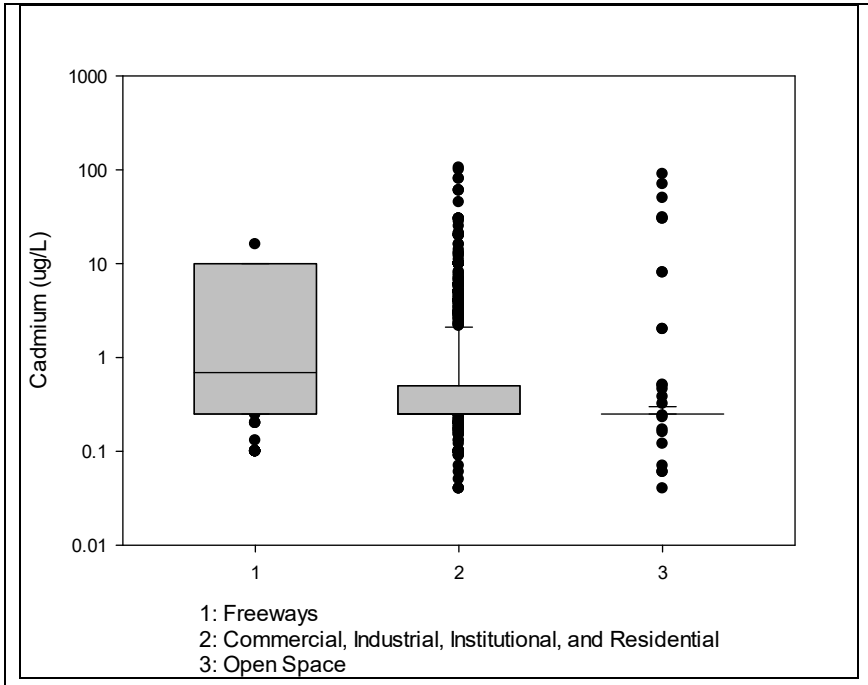
	NO2NO3 - freeways	NO2NO3 - commercial, industrial, open space, and residential	NO2NO3 - institutional
count	115	3,125	292
COV	0.96	1.49	1.24
median (mg/L)	1.2	0.6	0.2
% ND	0.9	2.0	0.3



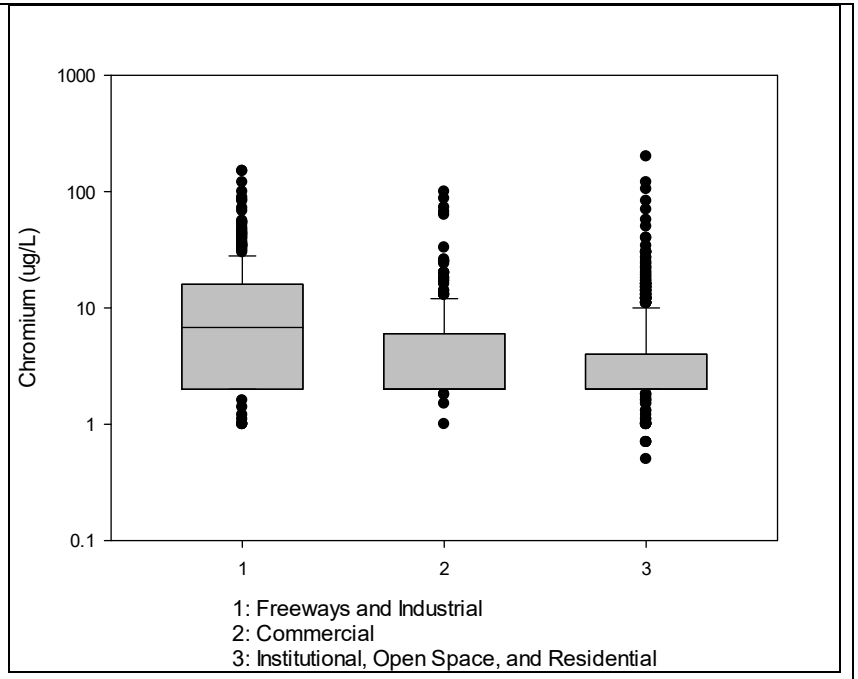
	TP - residential	TP - commercial, freeway, and industrial	TP – institutional and open space
count	2,277	2,097	555
COV	1.76	1.57	2.98
median (mg/L)	0.300	0.209	0.137
% ND	2.0	4.1	7.9



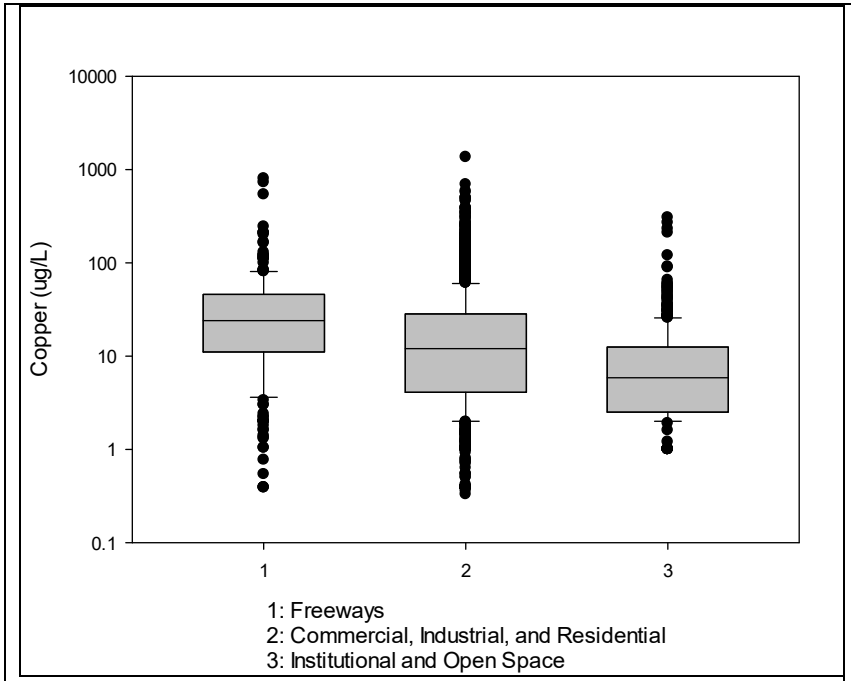
	filt P - residential	filt P - commercial, freeway, and institutional	filt P - industrial and open space
count	1,244	800	613
COV	2.54	1.90	1.47
median (mg/L)	0.156	0.081	0.070
% ND	13.5	17.8	25.3



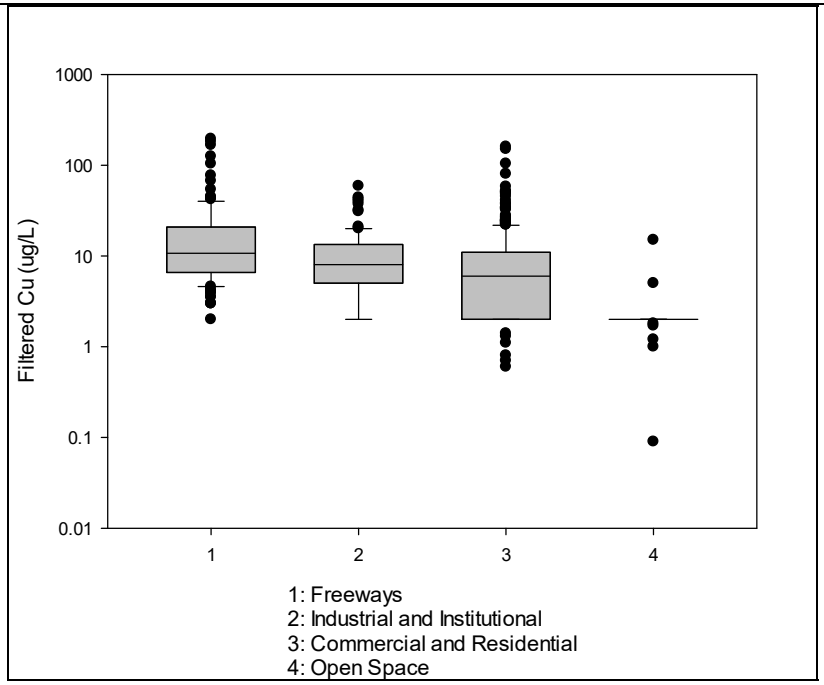
	Cd - freeways	Cd - commercial, industrial, institutional, and residential	Cd - open space
count	190	2,561	152
COV	1.30	3.98	4.60
median (µg/L)	0.69	nd (0.25)	nd (0.25)
% ND	18.4	58.8	84.2



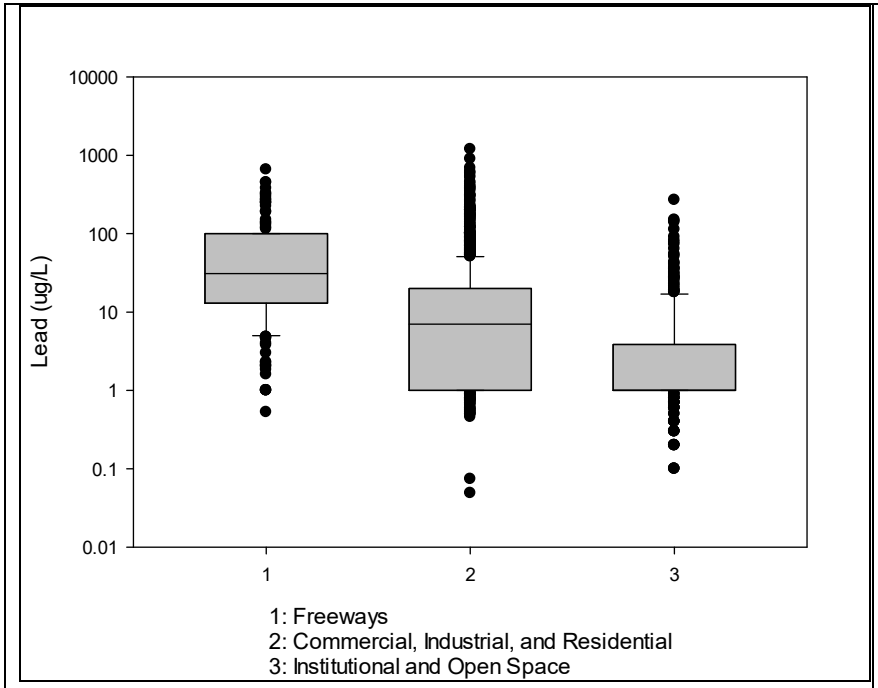
	Cr - freeway and industrial	Cr - commercial	Cr - institutional, open space, and residential
count	379	330	791
COV	1.45	1.75	2.2
median (µg/L)	6.8	2.0	nd (2)
% ND	24.5	47.6	61.8



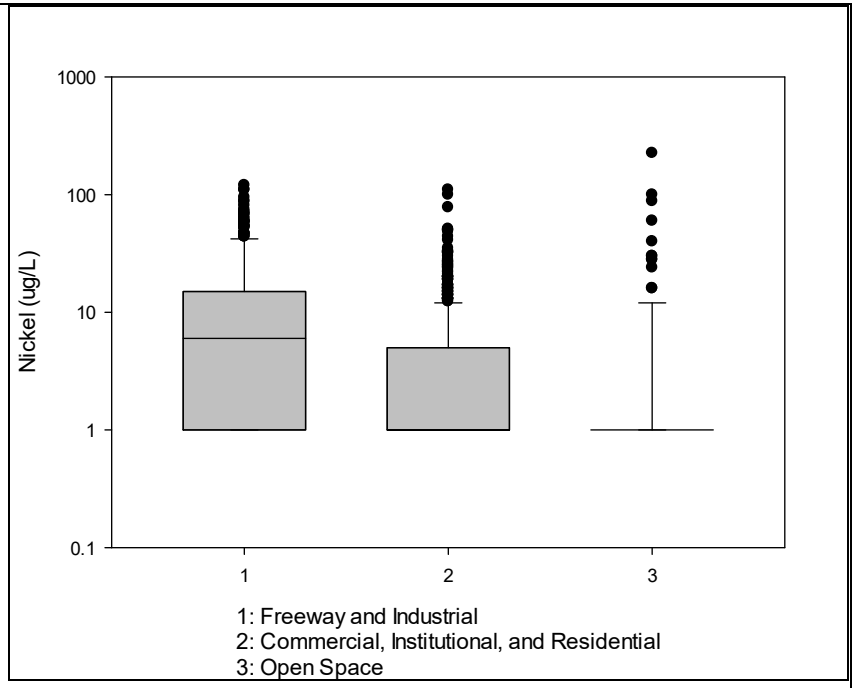
	Cu - freeways	Cu - commercial, industrial, and residential	Cu - institutional and open space
count	243	3090	461
COV	1.90	2.00	2.15
median (µg/L)	24.0	12.0	5.9
% ND	1.6	14.5	13.4



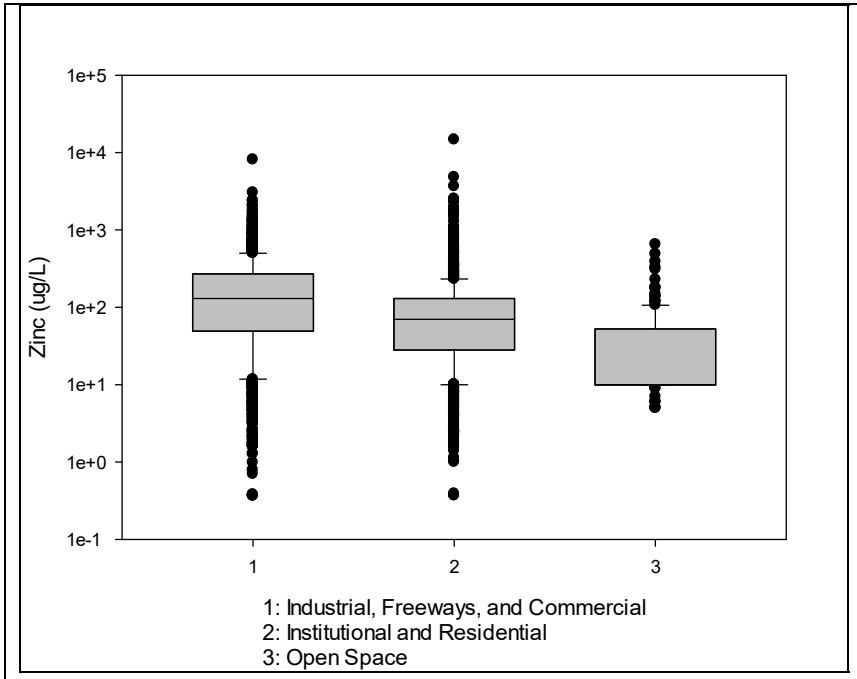
	filt Cu - freeways	filt Cu - industrial and institutional	filt Cu - commercial and residential	filt Cu - open space
count	130	104	311	88
COV	1.51	0.90	1.63	0.68
median (µg/L)	10.7	8	6	nd (2)
% ND	0.8	15.4	34.4	92.0



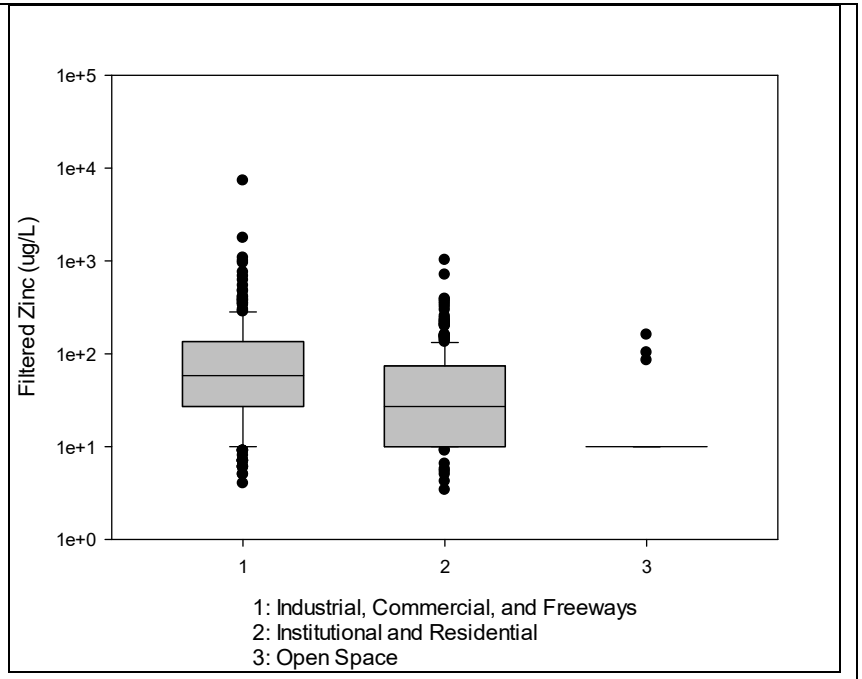
	Pb - freeways	Pb - commercial, industrial, and residential	Pb - institutional and open space
count	232	2,497	409
COV	1.34	2.57	3.00
median (µg/L)	31.0	7.0	1.0
% ND	1.7	29.5	39.4



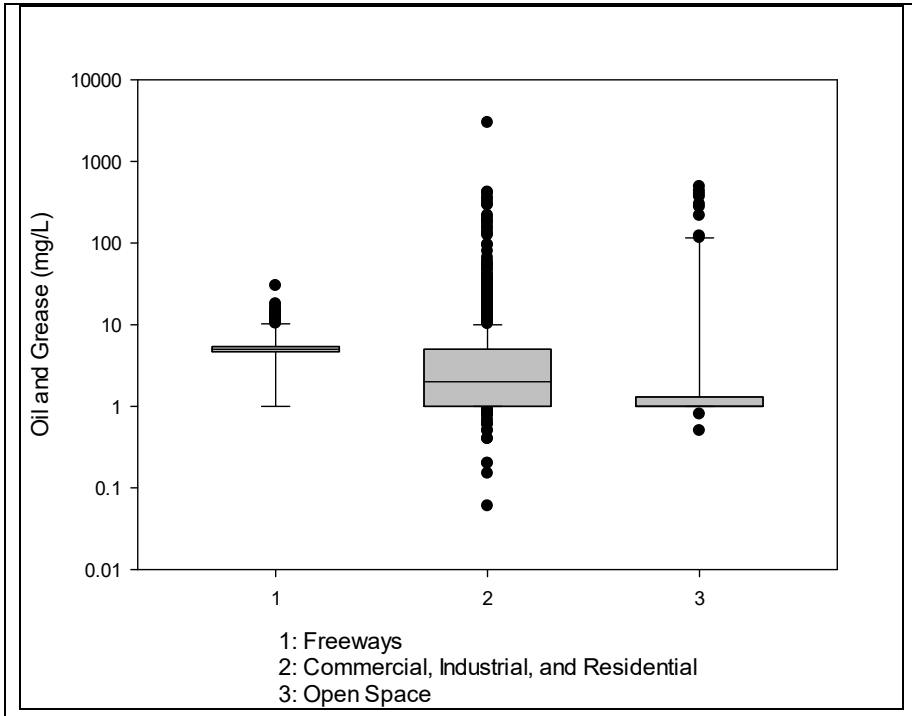
	Ni - freeway and industrial	Ni - commercial, institutional, and residential	Ni - open space
count	396	960	129
COV	1.46	1.84	3.46
median (µg/L)	6.0	nd (1.0)	nd (1.0)
% ND	35.1	60.6	81.4



	Zn - commercial, freeway, and industrial	Zn - institutional and residential	Zn - open space
count	1,804	2,088	170
COV	1.51	3.15	1.79
median (µg/L)	130	70	10
% ND	1.00	4.69	47.1



	filt Zn - industrial, commercial, and freeway	filt Zn - institutional and residential	filt Zn - open space
count	235	295	89
COV	3.32	1.62	1.48
median (µg/L)	58	27	nd (10)
% ND	2.6	37.6	96.6



	O&G - freeways	O&G - commercial, industrial, and residential	O&G - open space
count	150	1,462	91
COV	0.66	8.87	2.98
median (mg/L)	5.00	2.00	nd (1)
% ND	12.7	37.5	67.0

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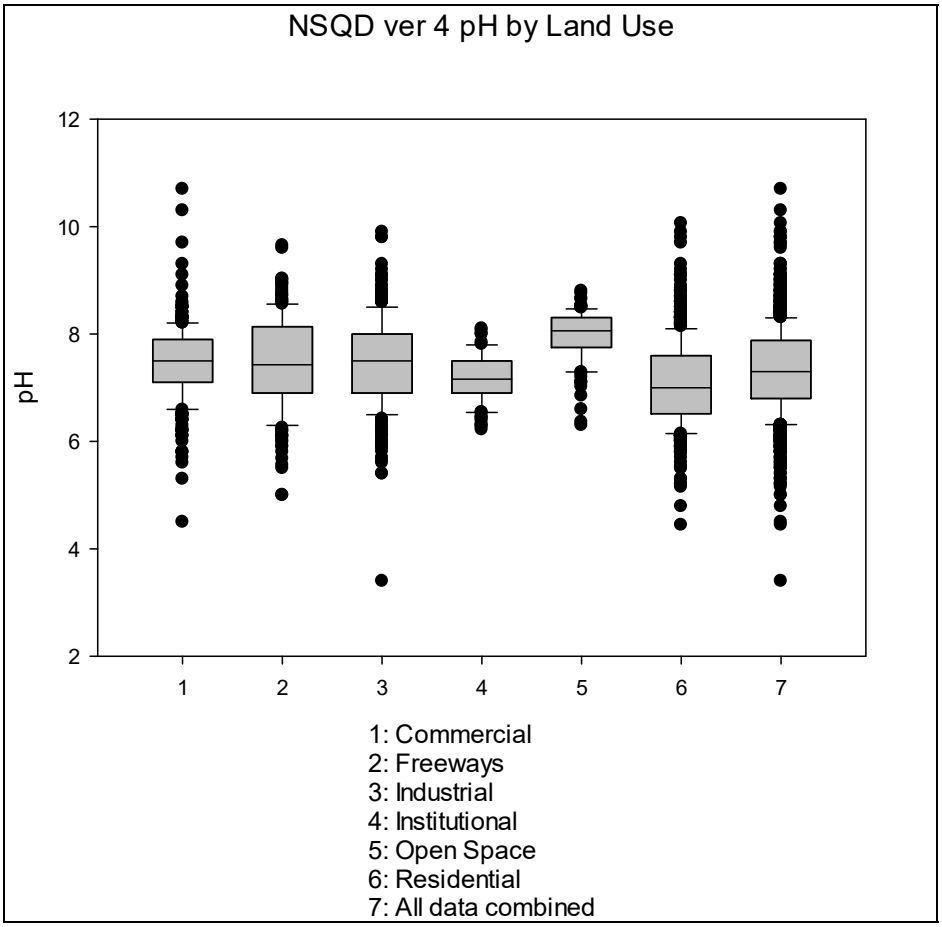
Appendix: Land Use Differences for NSQD ver. 4.02 Data

pH

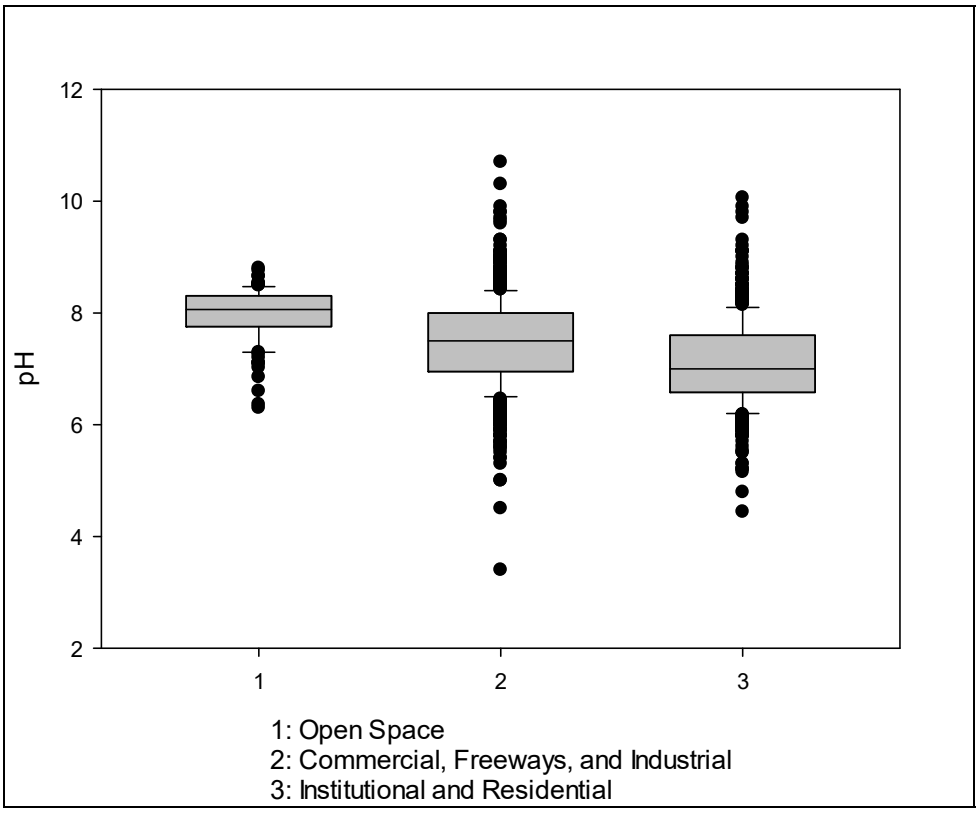
summary stats:	pH - commercial	pH - freeways	pH - industrial	pH - institutional	pH - open space	pH - residential	all pH
count	333	200	369	90	116	746	1854
mean	7.5	7.5	7.5	7.2	8.0	7.1	7.3
stdev	0.7	0.9	0.8	0.5	0.5	0.8	0.8
COV	0.09	0.12	0.11	0.06	0.06	0.11	0.11
median	7.5	7.4	7.5	7.2	8.1	7.0	7.3
min	4.5	5.0	3.4	6.2	6.3	4.4	3.4
max	10.7	9.7	9.9	8.1	8.8	10.1	10.7
# ND	0	0	0	0	0	0	0
% ND	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Kruskal-Wallis One Way Analysis of Variance on Ranks P Values (yellow comparisons are significant)

P values	**pH - commercial**	**pH - freeways**	**pH - industrial**	**pH - institutional**	**pH - open space**	**pH - residential**
pH - commercial	X	1	1	0.004	<0.001	<0.001
pH - freeways	1	X	1	0.034	<0.001	<0.001
pH - industrial	1	1	X	0.019	<0.001	<0.001
pH - institutional	0.004	0.034	0.019	X	<0.001	1
pH - open space	<0.001	<0.001	<0.001	<0.001	X	<0.001
pH - residential	<0.001	<0.001	<0.001	1	<0.001	X

summary stats:	pH - open space	pH - com free indus	pH - institut res
count	116	902	836
mean	8.0	7.5	7.1
stdev	0.5	0.8	0.7
COV	0.06	0.10	0.10
median	8.1	7.5	7.0
min	6.4	3.4	4.4
max	8.8	10.7	10.1
# ND	0	1	2
% ND	0.0	0.1	0.2



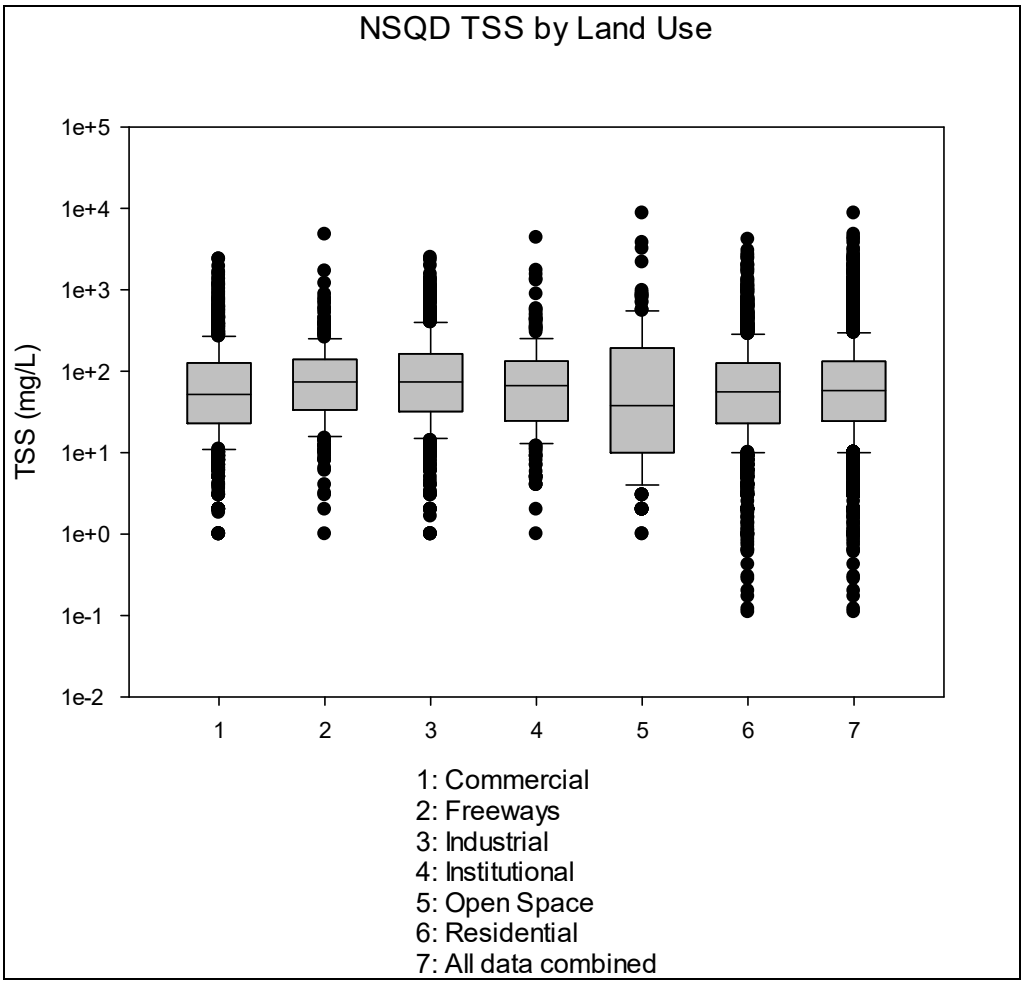
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
pHOpenspace vs pHInstututRes	666.254	12.561	<0.001
pHOpenspace vs pHComFreIndus	396.657	7.512	<0.001
pHComFreIndus vs pHInstututRes	269.596	10.49	<0.001

Industrial combined with commercial and freeway areas
Institutional combined with residential areas

Suspended Solids

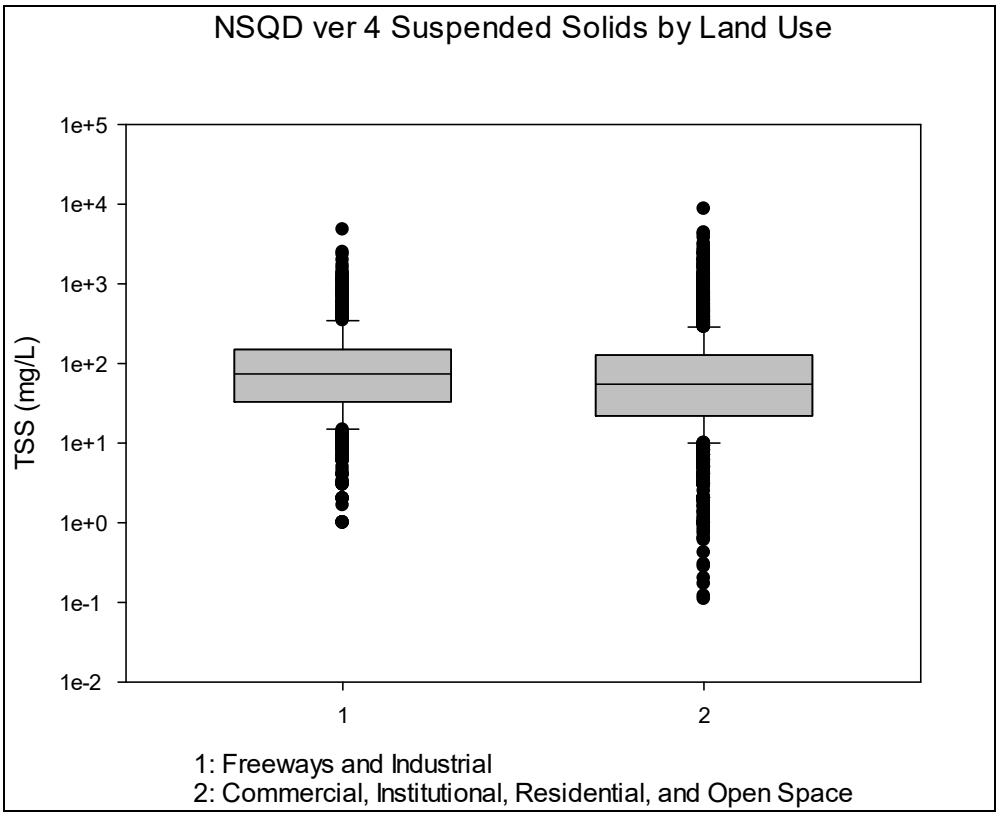
summary stats:	**SS - commercial**	**SS - freeways**	**SS - industrial**	**SS - institutional**	**SS - open space**	**SS - residential**	**all TSS (mg/L)**
count	1,143	267	700	238	160	2,364	4,871
mean	119	140	160	144	249	125	133
stdev	211	335	261	351	817	239	260
COV	1.78	2.40	1.63	2.44	3.28	1.91	1.96
median	52	74	74	67	38	56	58
min	1	1	1	1	1	0.11	0.11
max	2,385	4,800	2,490	4,380	8,728	4,168	4,800
# ND	11	1	5	1	8	12	38
% ND	1.0	0.4	0.7	0.4	5.0	0.5	0.8



All Pairwise Multiple Comparison Procedures (Dunn's Method) :

P values	**SS - commercial**	**SS - freeways**	**SS - industrial**	**SS - institutional**	**SS - open space**	**SS - residential**
SS - commercial	X	0.015	<0.001	1	1	1
SS - freeways	0.015	X	1	1	0.005	0.044
SS - industrial	<0.001	1	X	0.8	<0.001	<0.001
SS - institutional	1	1	0.8	X	0.33	1
SS - open space	1	0.005	<0.001	0.33	X	0.63
SS - residential	1	0.044	<0.001	1	0.63	X

summary stats:	**SS - free indus**	**SS - com instit res open**
count	967	3,905
mean	283	129
stdev	283	288
COV	1.00	2.23
median	74	55
min	1	0.11
max	4,800	8,728
# ND	6	32
% ND	0.6	0.8



All Pairwise Multiple Comparison Procedures (Dunn's Method)

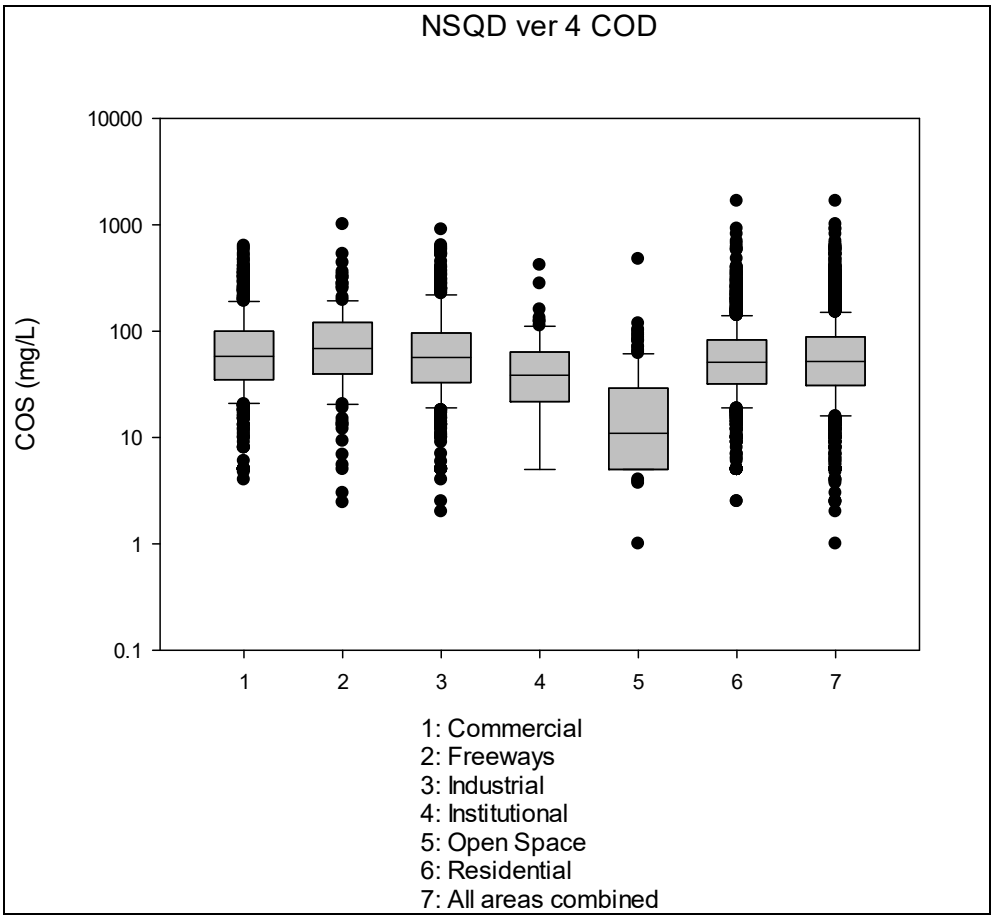
Comparison	Diff of Ranks	Q	P	P<0.050
SSFreeIndus vs SSComInsResOp	307.556	6.087	<0.001	Yes

Freeway and industrial combined
Commercial, institutional, residential, and open space combined

COD

summary stats:	COD - commercial	COD - freeways	COD - industrial	COD - institutional	COD - open space	COD - residential	all COD
count	734	130	518	78	154	1597	3211
mean	87	102	91	54	25	72	77
stdev	89	119	108	61	44	85	91
COV	1.02	1.17	1.19	1.14	1.75	1.17	1.17
median	58	69	57	39	11	51	52
min	4	2	2	5	1	3	1
max	635	1,013	906	418	476	1,674	1,674
# ND	19	1	11	13	59	49	152
% ND	2.6	0.8	2.1	16.7	38.3	3.1	4.7

institutional and open space non-detects >15%

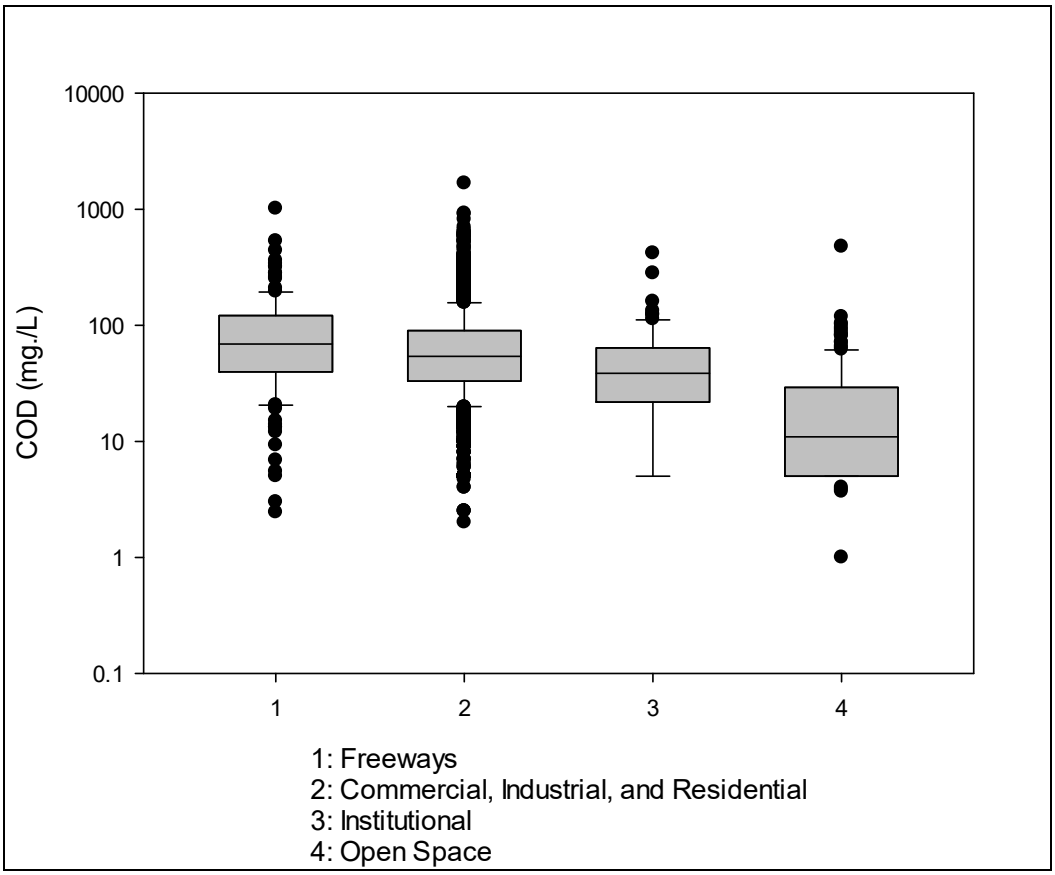


Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	**COD - commercial**	**COD - freeways**	**COD - industrial**	**COD - institutional (many NDs)**	**COD - open space (many NDs)**	**COD - residential**
COD - commercial	X	1	1	<0.001	<0.001	0.002
COD - freeways	1	X	0.37	<0.001	<0.001	0.003
COD - industrial	1	0.37	X	<0.001	<0.001	0.31
COD - institutional (many NDs)	<0.001	<0.001	<0.001	X	<0.001	0.015
COD - open space (many NDs)	<0.001	<0.001	<0.001	<0.001	X	<0.001
COD - residential	0.002	<0.001	0.31	0.015	<0.001	X

summary stats:	COD - freeways	COD - com indus res	COD - institutional	COD - open space
count	130	2,849	78	154
mean	102	80	54	25
stdev	119	91	61	44
COV	1.17	1.14	1.14	1.75
median	69	54	39	11
min	2	2	5	1
max	1,013	1,674	418	476
# ND	1	79	13	59
% ND	0.8	2.8	16.7	38.3

institutional and open space areas have many nondetected values



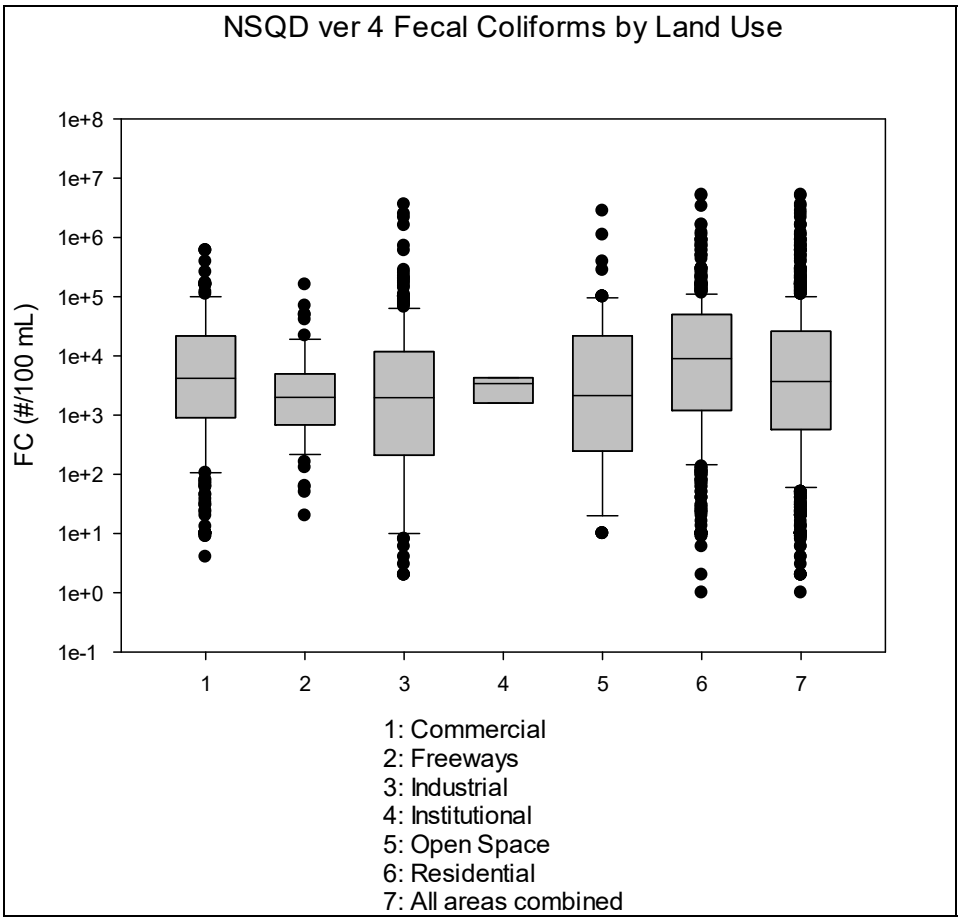
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
CODFree vs CODOpenspace	1310.426	11.868	<0.001
CODFree vs CODIstit	666.159	5.017	<0.001
CODFree vs CODComIndusRes	252.246	3.034	0.014
CODComIndusRes vs CODOpenspace	1058.18	13.797	<0.001
CODComIndusRes vs CODIstit	413.913	3.89	<0.001
CODIstit vs CODOpenspace	644.267	5	<0.001

Industrial combined with commercial and residential areas

Fecal Coliforms

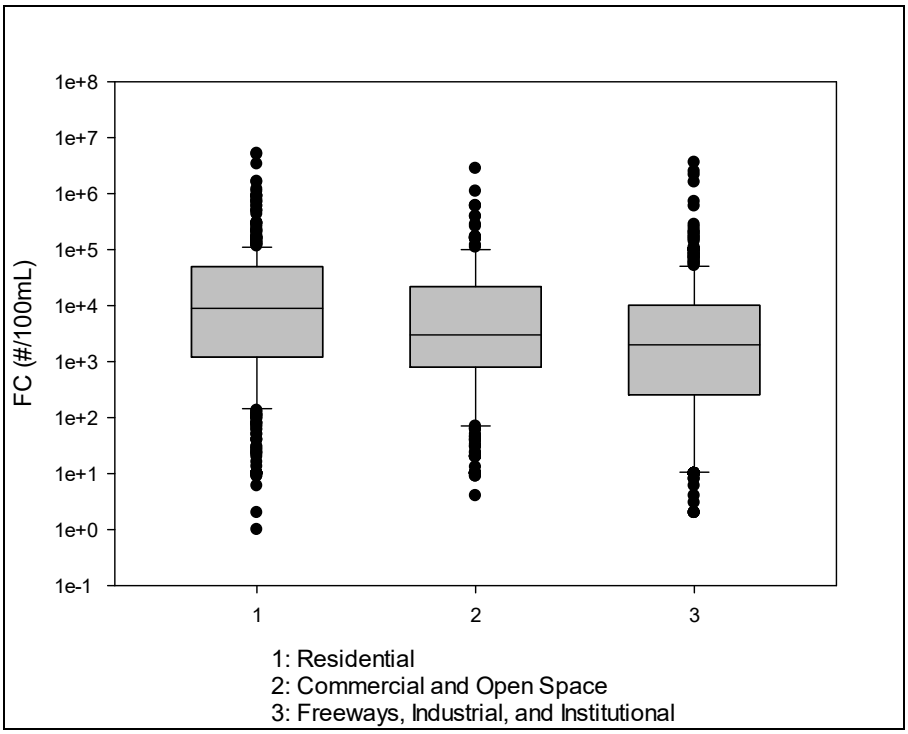
summary stats:	**FC - commercial**	**FC - freeways**	**FC - industrial**	**FC - institutional**	**FC - open space**	**FC - residential**	**FC - all**
count	313	67	395	3	90	579	1,447
mean	27,893	8,553	44,756		63,837	81,290	55,151
stdev	71,526	22,719	262,640		317,745	365,251	282,910
COV	2.56	2.66	5.87		4.98	4.49	5.13
median	4,200	2,000	1,980		2,150	9,000	3,700
min	4	20	2	1,600	10	1	1
max	610,000	160,000	3,600,000	4,300	2,800,000	5,230,000	5,230,000
# ND (both < and >)	29	0	47	0	9	60	145
% ND	9.3	0.0	11.9		10.0	10.4	10.0



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	FC - commercial	FC - freeways	FC - industrial	FC - institutional (too few data)	FC - open space	FC - residential
FC - commercial	X	0.27	0.003	1	1	0.047
FC - freeways	0.27	X	1	1	1	<0.001
FC - industrial	0.003	1	X	1	1	<0.001
FC - institutional (too few data)	1	1	1	X	1	1
FC - open space	1	1	1	1	X	0.004
FC - residential	0.047	<0.001	<0.001	1	0.007	X

summary stats:	FC - residential	FC - com open	FC - free indus instit
count	579	403	465
mean	81,290	35,920	39,271
stdev	365,251	162,934	242,522
COV	4.49	4.54	6.18
median	9,000	3,000	2,000
min	1	4	2
max	5,230,000	2,800,000	3,600,000
# ND (both < and >)	60	38	47
% ND	10.4	9.4	10.1



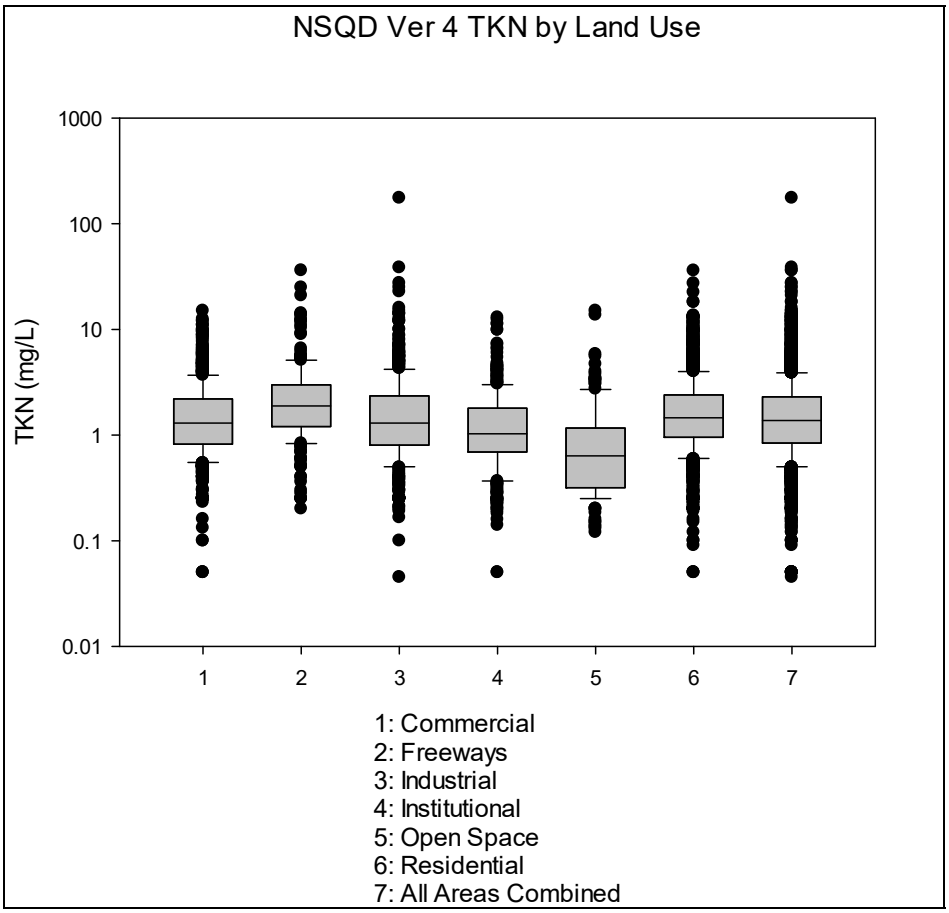
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
FCRes vs FCFreeINdusInstit	205.127	7.883	<0.001
FCRes vs FCComOpen	104.268	3.846	<0.001

Industrial combined with freeways and institutional (few data)
Commercial and open space combined

Total Kjeldahl Nitrogen

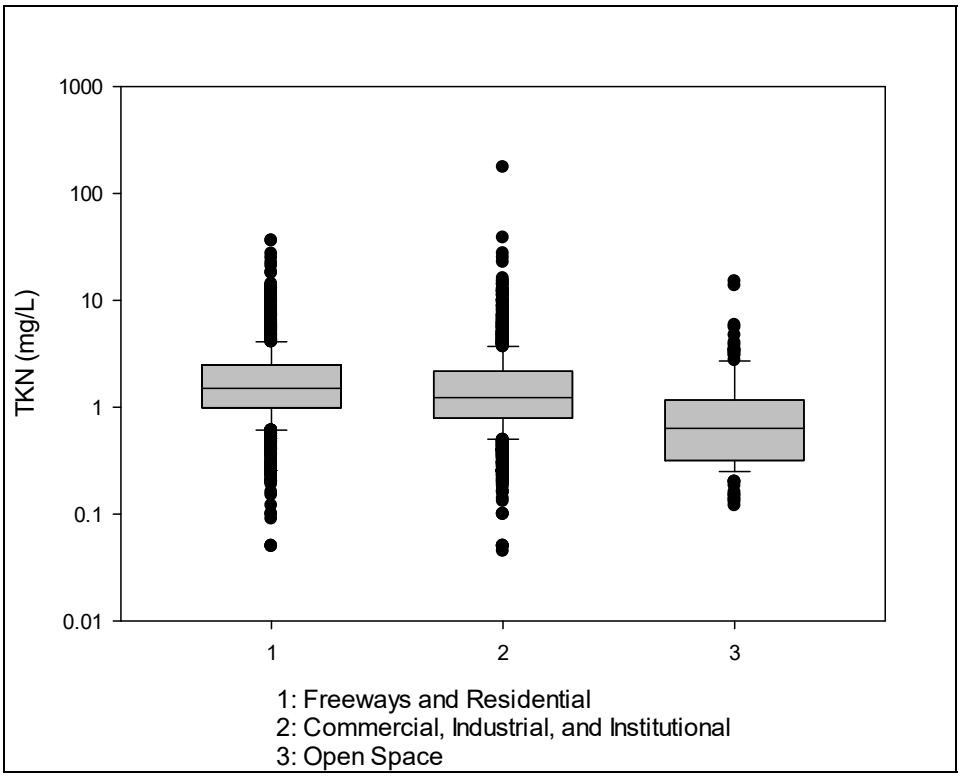
summary stats:	**TKN - commercial**	**TKN - freeways**	**TKN - industrial**	**TKN - institutional**	**TKN - open space**	**TKN - residential**	**TKN - all**
count	958	261	672	398	158	2029	4457
mean	1.8	2.8	2.3	1.5	1.2	2.1	2.0
stdev	1.8	3.6	7.3	1.7	1.8	2.2	3.5
COV	0.95	1.29	3.12	1.09	1.56	1.07	1.71
median	1.3	1.9	1.3	1.0	0.6	1.5	1.4
min	15.0	36.2	175.0	13.0	15.0	36.0	175.0
max	15.0	36.2	175.0	13.0	15.0	36.0	175.0
# ND	21	4	25	3	19	40	112
% ND	2.2	1.5	3.7	0.8	12.0	2.0	2.5



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	TKN - commercial	TKN - freeways	TKN - industrial	TKN - institutional	TKN - open space	TKN - residential
TKN - commercial	X	<0.001	<0.001	<0.001	<0.001	0.01
TKN - freeways	<0.001	X	<0.001	<0.001	<0.001	<0.001
TKN - industrial	1	<0.001		<0.001	<0.001	0.014
TKN - institutional	<0.001	<0.001	X	X	<0.001	<0.001
TKN - open space	<0.001	<0.001	<0.001	<0.001	X	<0.001
TKN - residential	0.01	<0.001	<0.001	<0.001	<0.001	X

summary stats:	**TKN - free res**	**TKN - com indus instit**	**TKN - open space**
count	2,290	2,028	158
mean	2.2	1.9	1.2
stdev	2.4	4.4	1.8
COV	1.12	2.28	1.56
median	1.5	1.2	0.6
min	0.1	0.0	15.0
max	36.2	175.0	15.0
# ND	44	49	19
% ND	1.9	2.4	12.0



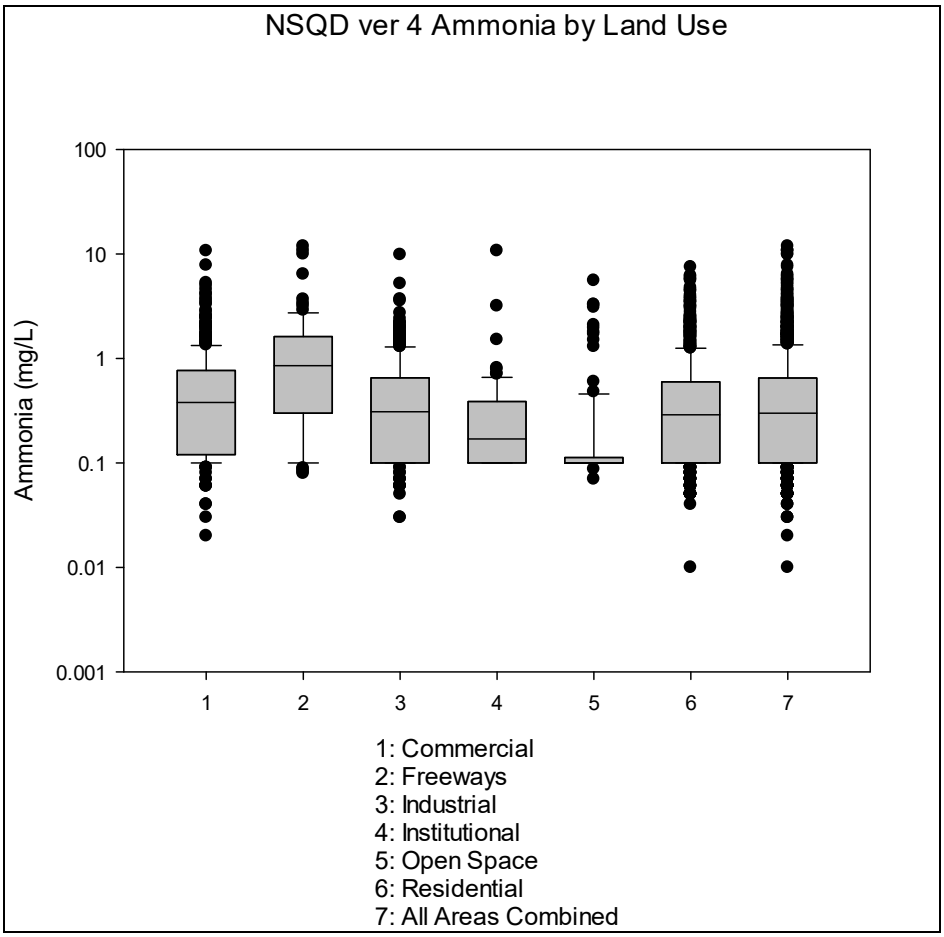
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
TKNFreRes vs TKNOpenspace	1173.975	11.045	<0.001
TKNFreRes vs TKNCoIndusInstit	298.161	7.567	<0.001
TKNCoIndusIns vs TKNOpenspace	875.815	8.205	<0.001

Ammonia

summary stats:	**NH3 - commercial**	**NH3 - freeways**	**NH3 - industrial**	**NH3 - institutional**	**NH3 - open space**	**NH3 - residential**	**NH3 - all**
count	423	88	380	77	121	941	2030
mean	0.6	1.4	0.5	0.4	0.3	0.5	0.6
stdev	1.0	2.1	0.8	1.3	0.8	0.8	1.0
COV	1.48	1.44	1.40	2.83	2.36	1.46	1.62
median	0.4	0.9	0.3	0.2	0.1	0.3	0.3
min	0.0	0.1	0.0	0.1	0.1	0.0	0.0
max	10.7	11.9	9.8	10.8	5.6	7.5	11.9
# ND	74	12	82	26	82	168	444
% ND	17.5	13.6	21.6	33.8	67.8	17.9	21.9

Many non-detects

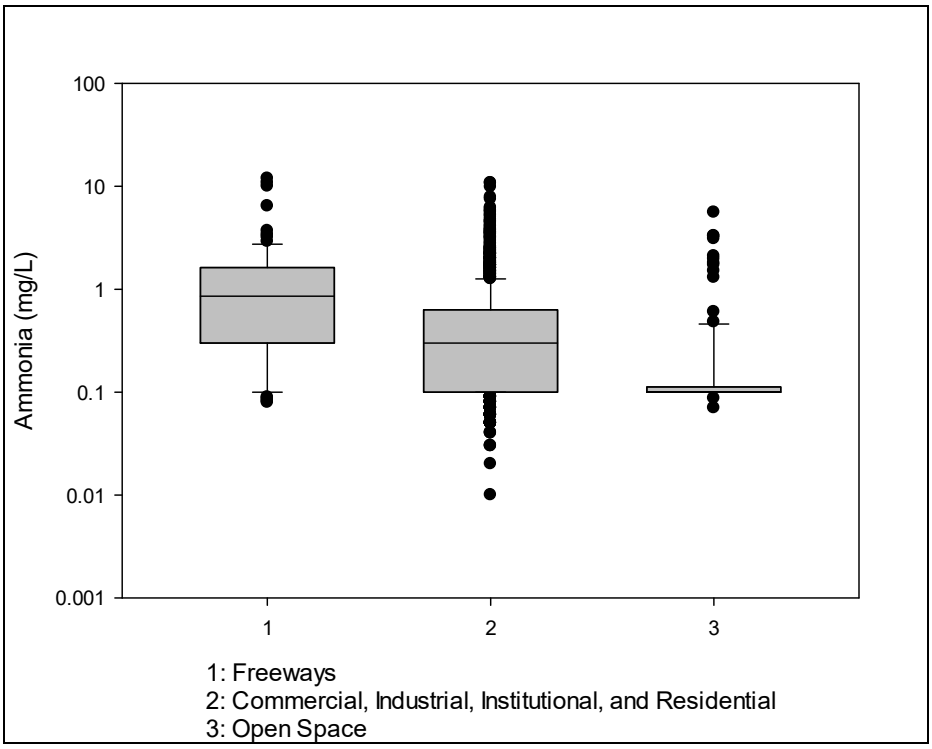


Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	NH3 - commercial	NH3 - freeways	NH3 - industrial	NH3 - institutional	NH3 - open space	NH3 - residential
NH3 - commercial	X	<0.001	1	0.003	<0.001	0.043
NH3 - freeways	<0.001	X	<0.001	<0.001	<0.001	<0.001
NH3 - industrial	1	<0.001	X	0.062	<0.001	1
NH3 - institutional	0.003	<0.001	0.062	X	0.016	0.25
NH3 - open space	<0.001	<0.001	<0.001	0.016	X	<0.001
NH3 - residential	0.043	<0.001	1	0.25	<0.001	X

P values	NH3 - commercial	NH3 - freeways	NH3 - industrial	NH3 - institutional	NH3 - open space	NH3 - residential
NH3 - commercial	X	<0.001	1	0.003	<0.001	0.043
NH3 - freeways	<0.001	X	<0.001	<0.001	<0.001	<0.001
NH3 - industrial	1	<0.001	X	0.062	<0.001	1
NH3 - institutional	0.003	<0.001	0.062	X	0.016	0.25
NH3 - open space	<0.001	<0.001	<0.001	0.016	X	<0.001
NH3 - residential	0.043	<0.001	1	0.25	<0.001	X

summary stats:	NH3 - freeways	NH3 - com ind inst res	NH3 - open space
count	88	1,821	121
mean	1.4	0.6	0.3
stdev	2.1	0.9	0.8
COV	1.44	1.51	2.36
median	0.9	0.3	0.1
min	0.1	0.0	0.1
max	11.9	10.8	5.6
# ND	12	350	82
% ND	13.6	19.2	67.8



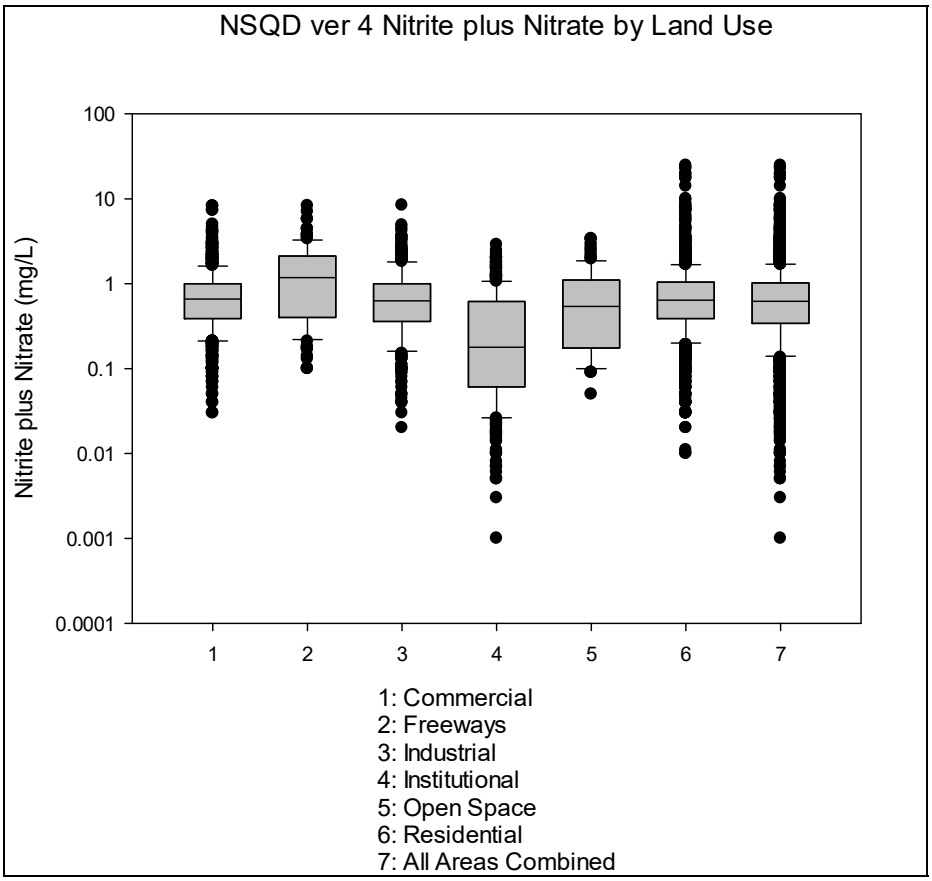
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
NH3Free vs NH3Openspace	863.188	10.511	<0.001
NH3Free vs NH3CoIndInsRes	390.636	6.106	<0.001
NH3CoIndInsRes vs NH3Openspace	472.551	8.587	<0.001

Industrial combined with commercial, institutional, and residential

Nitrites plus Nitrates

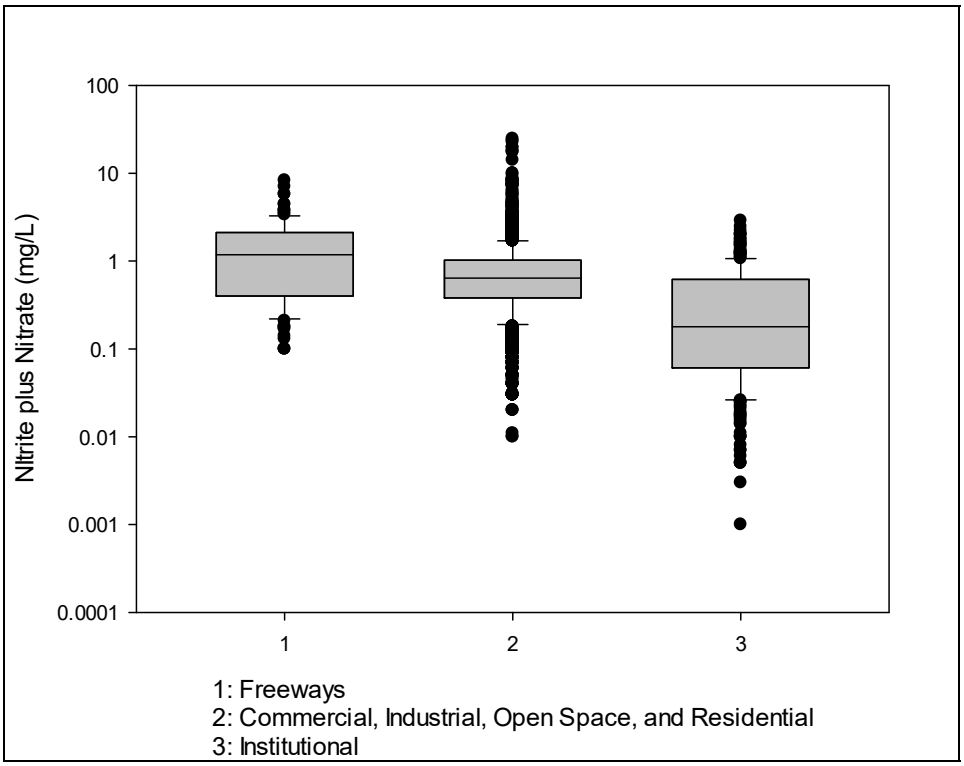
summary stats:	**NO2NO3 - commercial**	**NO2NO3 - freeways**	**NO2NO3 - industrial**	**NO2NO3 - institutional**	**NO2NO3 - open space**	**NO2NO3 - residential**	**N02+NO3 - all**
count	798	115	579	292	85	1663	3532
mean	0.9	1.5	0.8	0.4	0.8	1.0	0.9
stdev	0.8	1.5	0.8	0.5	0.8	1.7	1.3
COV	0.97	0.96	0.95	1.24	0.98	1.74	1.49
median	0.7	1.2	0.6	0.2	0.5	0.6	0.6
min	0.0	0.1	0.0	0.0	0.1	0.0	0.0
max	8.2	8.3	8.4	2.9	3.4	24.7	24.7
# ND	10	1	19	1	8	24	63
% ND	1.3	0.9	3.3	0.3	9.4	1.4	1.8



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	NO2NO3 - commercial	NO2NO3 - freeways	NO2NO3 - industrial	NO2NO3 - institutional	NO2NO3 - open space	NO2NO3 - residential
NO2NO3 - commercial	X	<0.001	1	<0.001	0.82	1
NO2NO3 - freeways	<0.001	X	<0.001	<0.001	<0.001	<0.001
NO2NO3 - industrial	1	<0.001	X	<0.001	1	1
NO2NO3 - institutional	<0.001	<0.001	<0.001	X	<0.001	<0.001
NO2NO3 - open space	0.82	<0.001	1	<0.001	X	0.91
NO2NO3 - residential	1	<0.001	1	<0.001	0.91	X

summary stats:	**NO2NO3 - freeways**	**NO2NO3 - com ind open res**	**NO2NO3 - institutional**
count	115	3,125	292
mean	1.5	0.9	0.4
stdev	1.5	1.4	0.5
COV	0.96	1.49	1.24
median	1.2	0.6	0.2
min	0.1	0.0	0.0
max	8.3	24.7	2.9
# ND	1	61	1
% ND	0.9	2.0	0.3



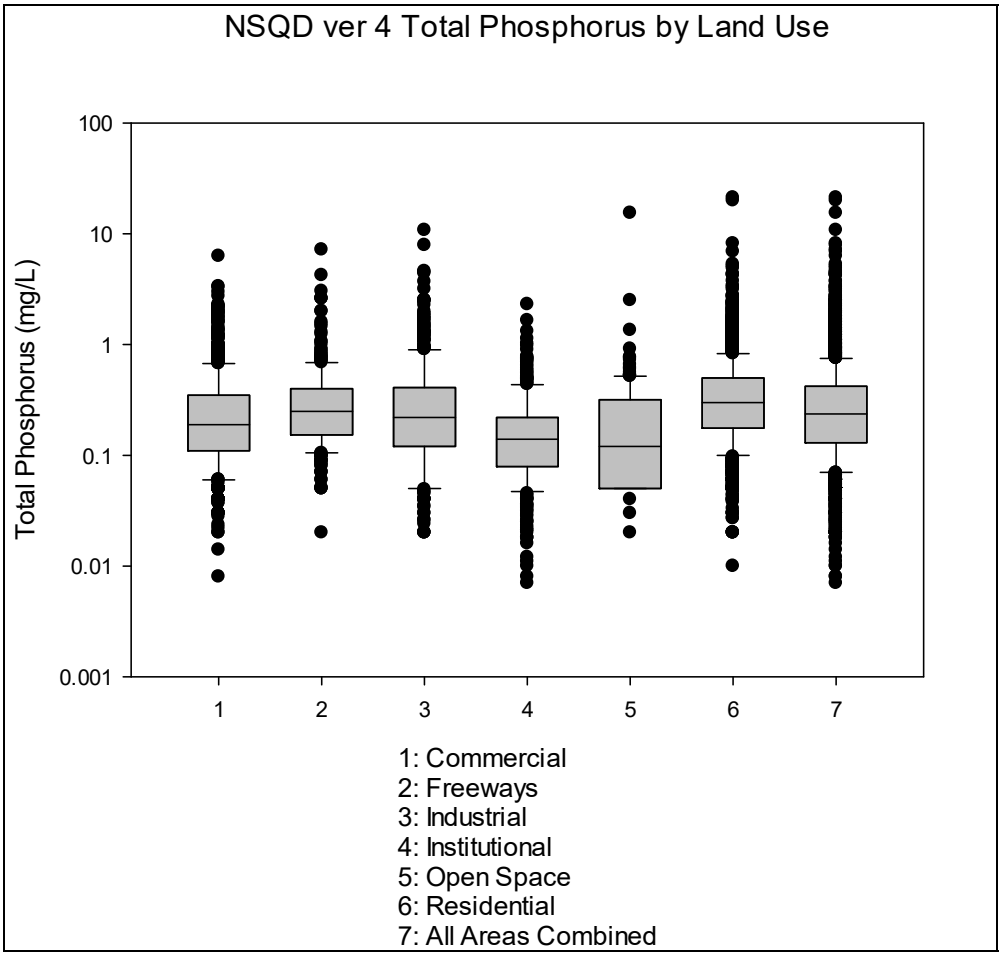
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
NO2NO3Free vs NO2NO3Instit	1360.255	12.116	<0.001
NO2NO3Free vs NO2NO3CoIdOpRe	482.608	4.984	<0.001
NO2NO3CoIdOpRe vs NO2NO3Instit	877.647	14.064	<0.001

Industrial combined with commercial, open space, and residential

Total Phosphorus

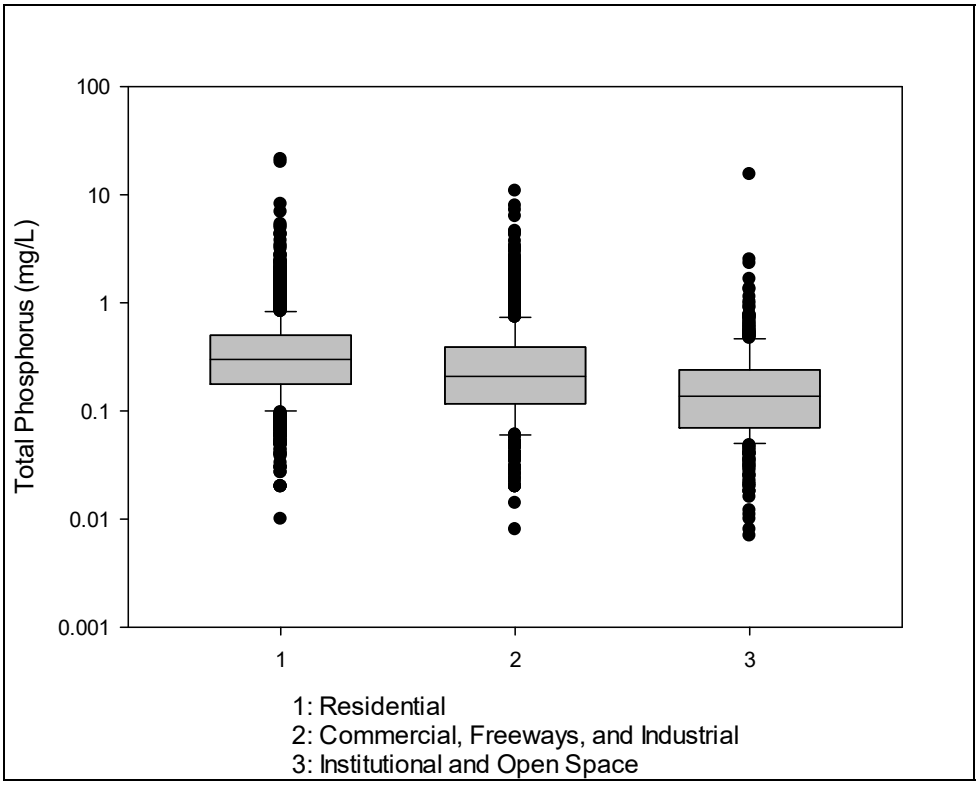
summary stats:	**TP - commercial**	**TP - freeways**	**TP - industrial**	**TP - institutional**	**TP - open space**	**TP - residential**	**TP - all**
count	1,124	291	682	395	160	2,277	4,929
mean	0.314	0.394	0.403	0.198	0.313	0.441	0.380
stdev	0.416	0.605	0.711	0.223	1.231	0.775	0.683
COV	1.33	1.54	1.77	1.12	3.94	1.76	1.80
median	0.190	0.250	0.220	0.140	0.120	0.300	0.236
min	0.008	0.020	0.020	0.007	0.020	0.010	0.007
max	6.300	7.191	10.800	2.310	15.400	21.200	21.200
# ND	48	3	34	7	37	45	174
% ND	4.3	1.0	5.0	1.8	23.1	2.0	3.5



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	TP - commercial	TP - freeways	TP - industrial	TP - institutional	TP - open space	TP - residential
TP - commercial	X	<0.001	0.088	<0.001	<0.001	<0.001
TP - freeways	<0.001	X	0.14	<0.001	<0.001	0.32
TP - industrial	0.088	0.14	X	<0.001	<0.001	<0.001
TP - institutional	<0.001	<0.001	<0.001	X	1	<0.001
TP - open space	<0.001	<0.001	<0.001	1	X	<0.001
TP - residential	<0.001	0.32	<0.001	<0.001	<0.001	X

summary stats:	TP - residential	TP - com free indus	TP - instit open
count	2,277	2,097	555
mean	0.441	0.354	0.231
stdev	0.775	0.556	0.688
COV	1.76	1.57	2.98
median	0.300	0.209	0.137
min	0.010	0.008	0.007
max	21.200	10.800	15.400
# ND	45	85	44
% ND	2.0	4.1	7.9



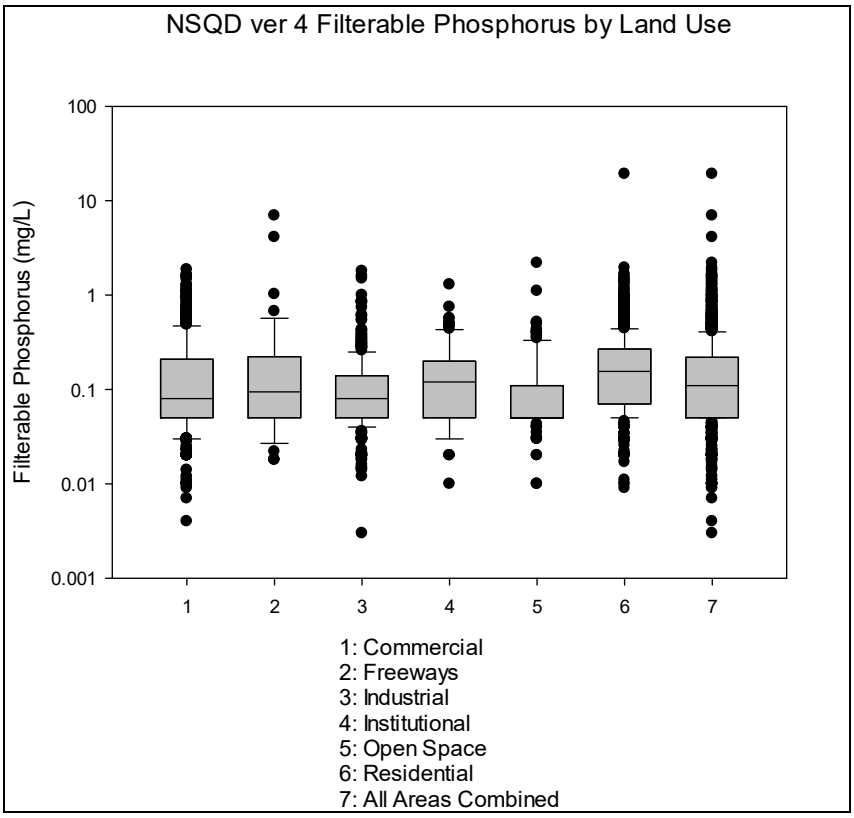
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
TPRes vs TPInstitOpen	1189.755	17.661	<0.001
TPRes vs TPComFreInd	530.515	12.318	<0.001
TPComFreInd vs TPInstitOpen	659.241	9.705	<0.001

Commercial, freeways and industrial areas combined
Institutional and open space areas combined

Filtered Phosphorus

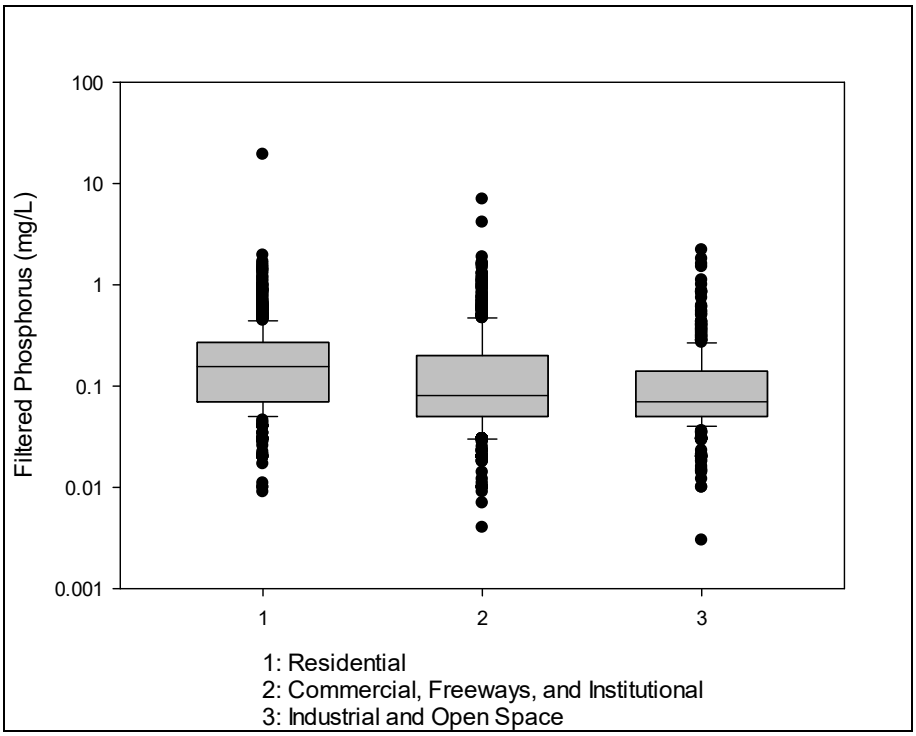
summary stats:	**filt P - commercial**	**filt P - freeways**	**filt P - industrial**	**filt P - institutional**	**filt P - open space**	**filt P - residential**	**filt P - all**
count	638	45	469	117	144	1,244	2,657
mean	0.186	0.404	0.130	0.167	0.127	0.230	0.196
stdev	0.261	1.178	0.179	0.178	0.222	0.584	0.459
COV	1.41	2.92	1.38	1.07	1.75	2.54	2.34
median	0.080	0.094	0.080	0.120	0.050	0.156	0.110
min	0.004	0.018	0.003	0.010	0.010	0.009	0.003
max	1.870	6.973	1.800	1.300	2.200	19.300	19.300
# ND	133	5	99	4	56	168	465
% ND	20.8	11.1	21.1	3.4	38.9	13.5	17.5



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	**filt P - commercial**	**filt P - freeways**	**filt P - industrial**	**filt P - institutional**	**filt P - open space**	**filt P - residential**
filt P - commercial	X	1	0.28	1	0.029	<0.001
filt P - freeways	1	X	1	1	0.47	0.19
filt P - industrial	0.28	1	X	0.049	1	<0.001
filt P - institutional	1	1	0.049	X	0.005	0.03
filt P - open space	0.029	0.47	1	0.005	X	<0.001
filt P - residential	<0.001	0.19	<0.001	0.03	<0.001	X

summary stats:	**filt P - residential**	**filt P - com free instit**	**filt P - indus open**
count	1,244	800	613
mean	0.230	0.195	0.129
stdev	0.584	0.372	0.190
COV	2.54	1.90	1.47
median	0.156	0.081	0.070
min	0.009	0.004	0.003
max	19.300	6.973	2.200
# ND	168	142	155
% ND	13.5	17.8	25.3



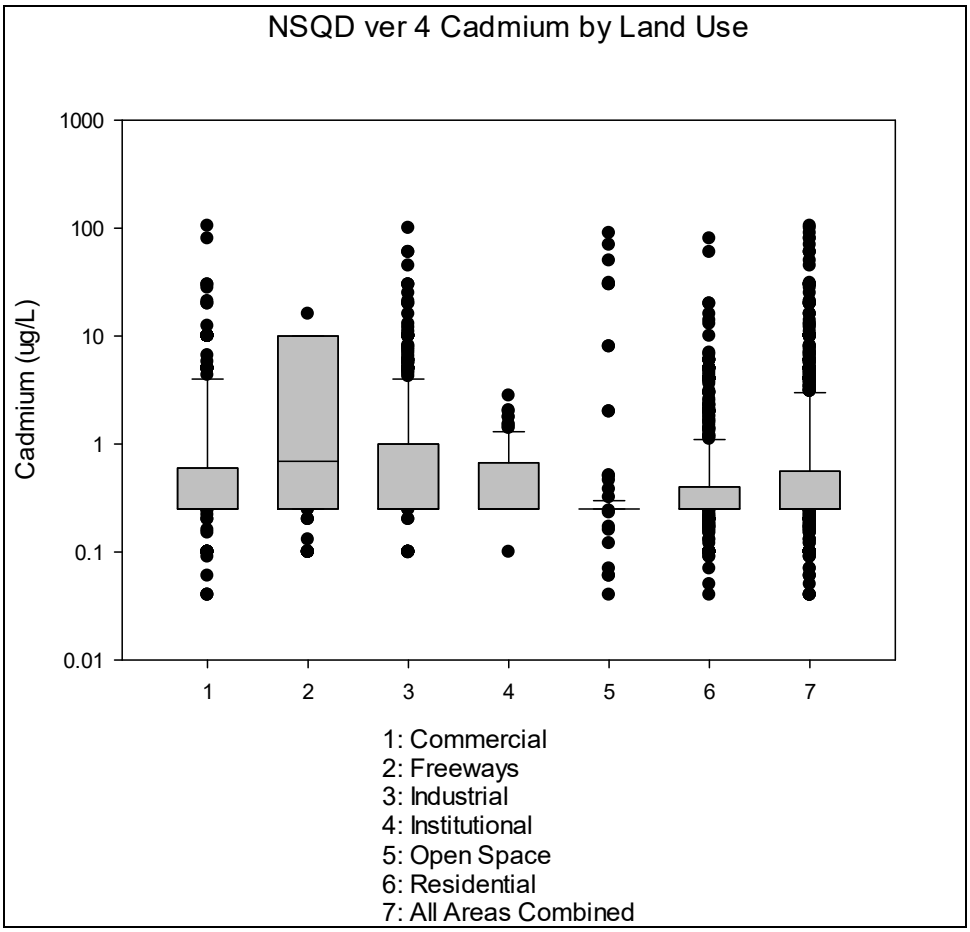
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
filtPRes vs filtPIndusOpen	488.088	12.893	<0.001
filtPRes vs filtPComFreInst	330.962	9.519	<0.001
filtPComFreIn vs filtPIndusOpe	157.127	3.816	<0.001

Industrial combined with open space
commercial, freeways, and institutional combined

Cadmium

summary stats:	**Cd - commercial**	**Cd - freeways**	**Cd - industrial**	**Cd - institutional**	**Cd - open space**	**Cd - residential**	**Cd - all**
count	563	190	663	107	152	1228	2796
mean	1.67	3.19	1.77	0.54	2.34	0.79	1.45
stdev	6.43	4.16	6.15	0.50	10.79	3.19	5.45
COV	3.86	1.30	3.47	0.92	4.60	4.01	3.76
median	0.25	0.69	0.25	0.25	0.25	0.25	0.25
min	0.04	0.1	0.099	0.1	0.04	0.04	0.04
max	105	16.05	100	2.8	90	80	105
# ND	345	35	312	58	128	792	1670
% ND	61.3	18.4	47.1	54.2	84.2	64.5	59.7

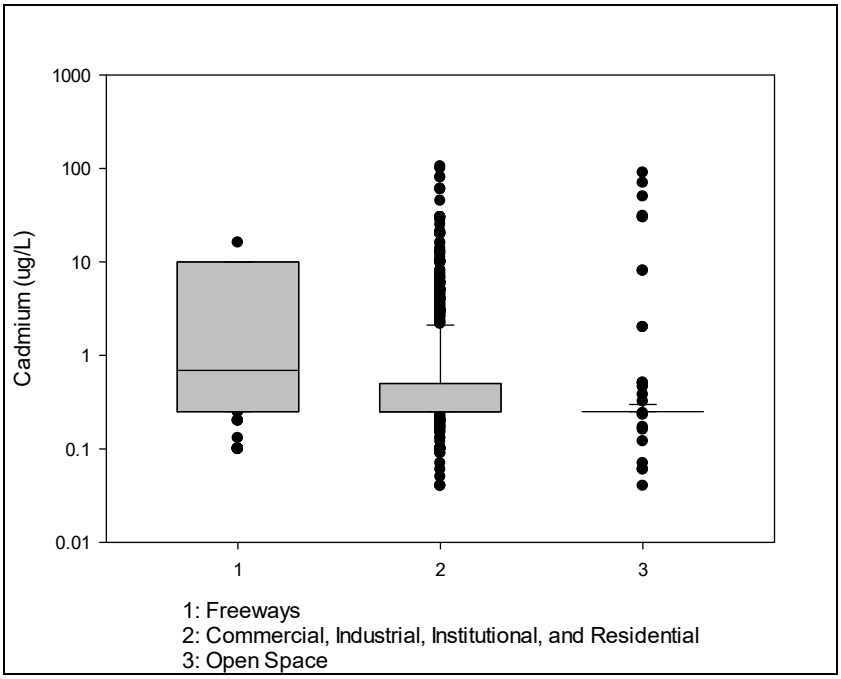


Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	**Cd - commercial**	**Cd - industrial**	**Cd - institutional**	**Cd - open space**	**Cd - residential**
Cd - commercial	X	0.022	1	<0.001	0.065
Cd - industrial	0.022	X	1	<0.001	<0.001
Cd - institutional	1	1	X	<0.001	0.16
Cd - open space	<0.001	<0.001	<0.001	X	0.028
Cd - residential	0.065	<0.001	0.16	0.028	X

summary stats:	**Cd - freeways**	**Cd - com indus inst res**	**Cd - open space**
count	190	2,561	152
mean	3.19	1.23	2.34
stdev	4.16	4.90	10.79
COV	1.30	3.98	4.60
median	0.69	0.25	0.25
min	0.10	0.04	0.04
max	16.05	105	90
# ND	35	1,507	128
% ND	18.4	58.8	84.2

Many non-detectable values



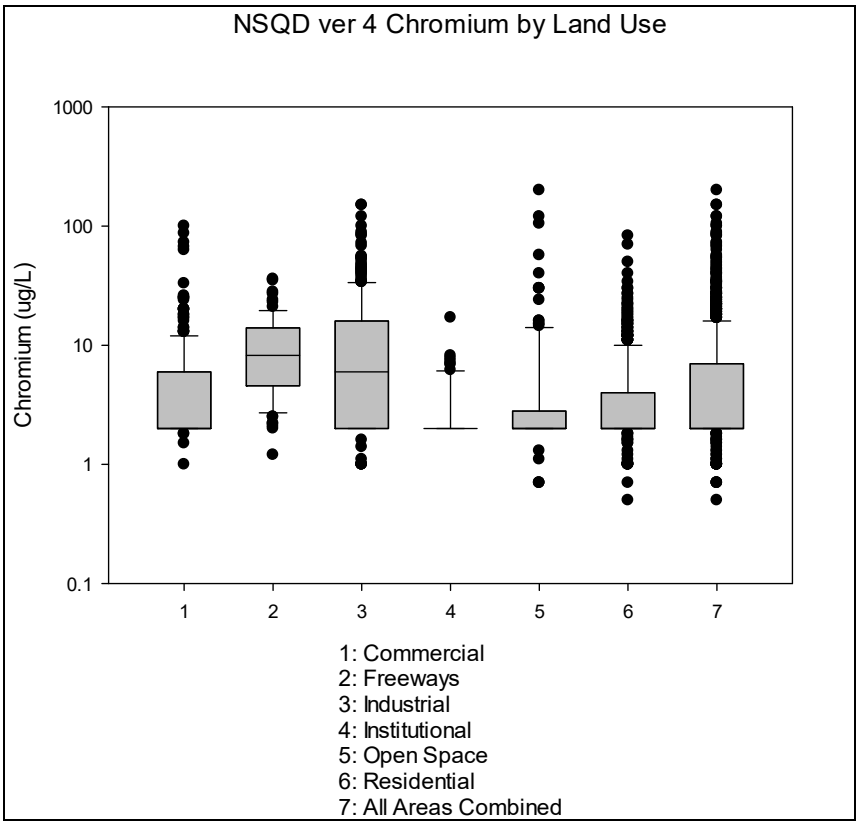
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
CdFree vs CdOpen	875.721	9.601	<0.001
CdFree vs CdCoIndsInstRes	563.952	8.948	<0.001
CdCoIndsInstRes vs CdOpen	311.769	4.456	<0.001

Commercial, industrial, institutional, and residential areas combined

Chromium

summary stats:	**Cr - commercial**	**Cr - freeways**	**Cr - industrial**	**Cr - institutional**	**Cr - open space**	**Cr - residential**	**Cr - all**
count	330	76	303	74	147	570	1500
mean	5.9	10.3	13.3	2.9	7.5	4.5	7.1
stdev	10.3	7.4	20.2	2.4	21.7	6.8	13.5
COV	1.75	0.72	1.52	0.80	2.88	1.51	1.91
median	2.0	8.3	6.0	2.0	2.0	2.0	2.0
min	1.0	1.2	1.0	2.0	0.7	0.5	0.5
max	100.0	36.0	150.0	17.1	200.0	83.0	200.0
# ND	157	1	92	60	101	328	739
% ND	47.6	1.3	30.4	81.1	68.7	57.5	49.3

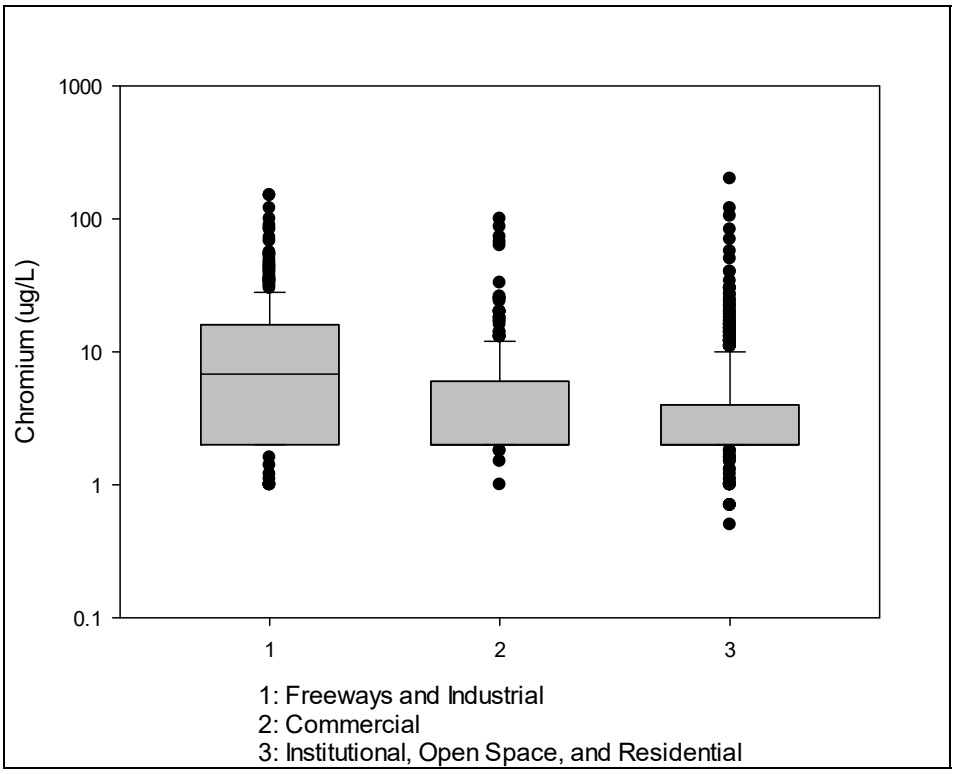


Kruskal-Wallis One Way Analysis of Variance on Ranks P Values

P values	**Cr - commercial**	**Cr - freeways**	**Cr - industrial**	**Cr - institutional**	**Cr - open space**	**Cr - residential**
Cr - commercial	X	<0.001	<0.001	0.009	0.058	0.026
Cr - freeways	<0.001	X	0.004	<0.001	<0.001	<0.001
Cr - industrial	<0.001	0.004	X	<0.001	<0.001	<0.001
Cr - institutional	0.009	<0.001	<0.001	X	1	1
Cr - open space	0.058	<0.001	<0.001	1	X	1
Cr - residential	0.026	<0.001	<0.001	1	1	X

summary stats:	**Cr - free indus**	**Cr - commercial**	**Cr - instit open res**
count	379	330	791
mean	12.7	5.9	4.9
stdev	18.4	10.3	11.1
COV	1.45	1.75	2.2
median	6.8	2.0	2
min	1.0	1.0	0.5
max	150.0	100.0	200
# ND	93	157	489
% ND	24.5	47.6	61.8

Many non-detectable values

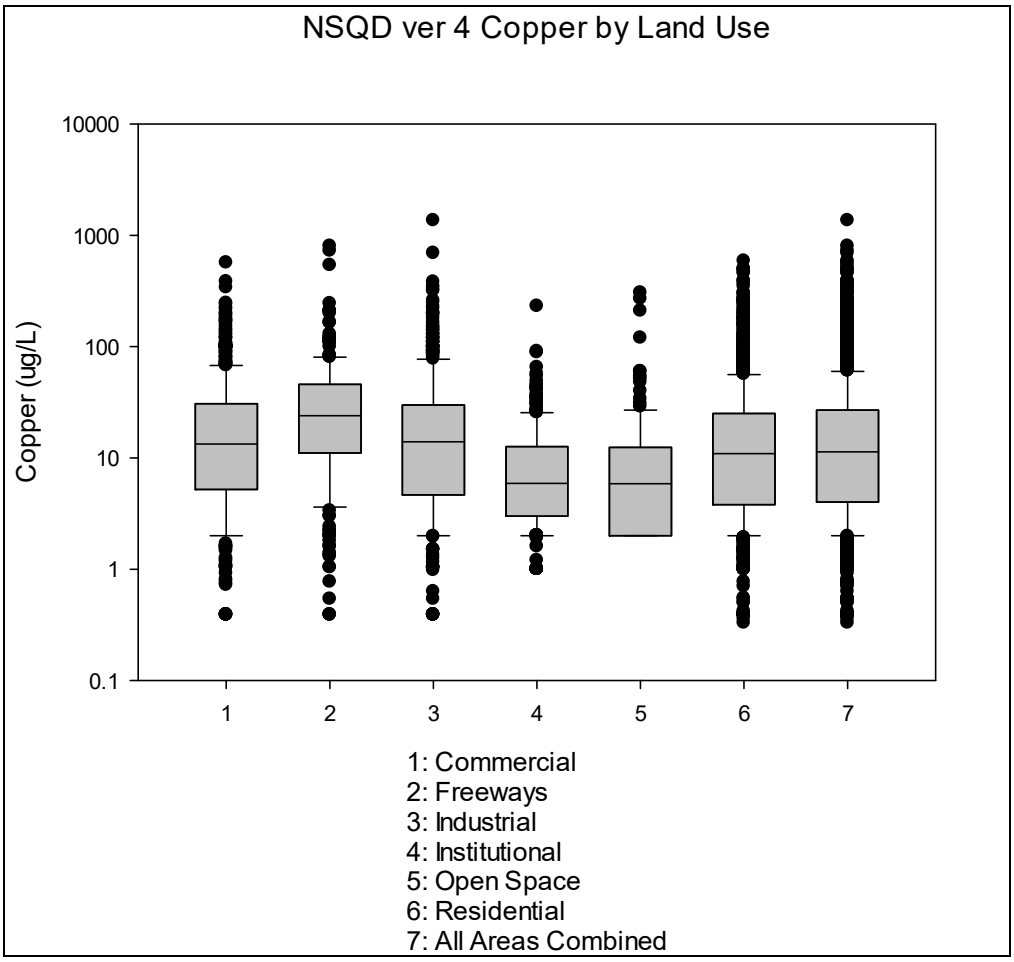


All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
CrFreeIndus vs CrInstitOpenRes	342.417	12.654	<0.001
CrFreeIndus vs CrCom	233.789	7.169	<0.001
CrCom vs CrInstitOpenRes	108.627	3.827	<0.001

Copper

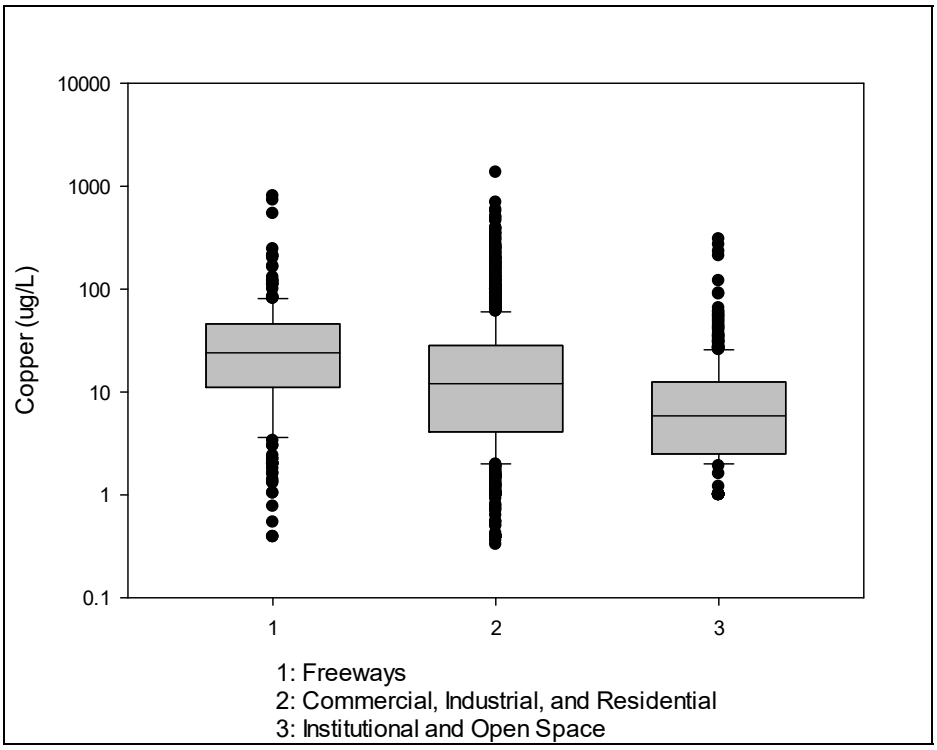
summary stats:	**Cu - commercial**	**Cu - freeways**	**Cu - industrial**	**Cu - institutional**	**Cu - open space**	**Cu - residential**	**Cu - all**
count	802	243	634	296	165	1,654	3,794
mean	27.8	43.7	31.7	10.9	14.8	25.2	26.5
stdev	43.2	83.0	75.4	17.9	37.0	49.4	54.6
COV	1.56	1.90	2.38	1.64	2.51	1.96	2.06
median	13.3	24.0	14.0	5.9	5.9	10.9	11.3
min	0.4	0.4	0.4	1.0	2.0	0.3	0.3
max	569	800	1,360	232	305	590	1,360
# ND	112	4	90	10	52	247	515
% ND	14.0	1.6	14.2	3.4	31.5	14.9	13.6



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	**Cu - commercial**	**Cu - freeways**	**Cu - industrial**	**Cu - institutional**	**Cu - open space**	**Cu - residential**
Cu - commercial	X	<0.001	1	<0.001	<0.001	0.006
Cu - freeways	<0.001	X	<0.001	<0.001	<0.001	<0.001
Cu - industrial	1	<0.001	X	<0.001	<0.001	0.07
Cu - institutional	<0.001	<0.001	<0.001	X	1	<0.001
Cu - open space	<0.001	<0.001	<0.001	1	X	<0.001
Cu - residential	0.006	<0.001	0.07	<0.001	<0.001	X

summary stats:	**Cu - freeways**	**Cu - com indus res**	**Cu - instit open**
count	243	3090	461
mean	43.7	27.2	12.3
stdev	83.0	54.4	26.4
COV	1.90	2.00	2.15
median	24.0	12.0	5.9
min	0.4	0.3	1.0
max	800	1360	305
# ND	4	449	62
% ND	1.6	14.5	13.4



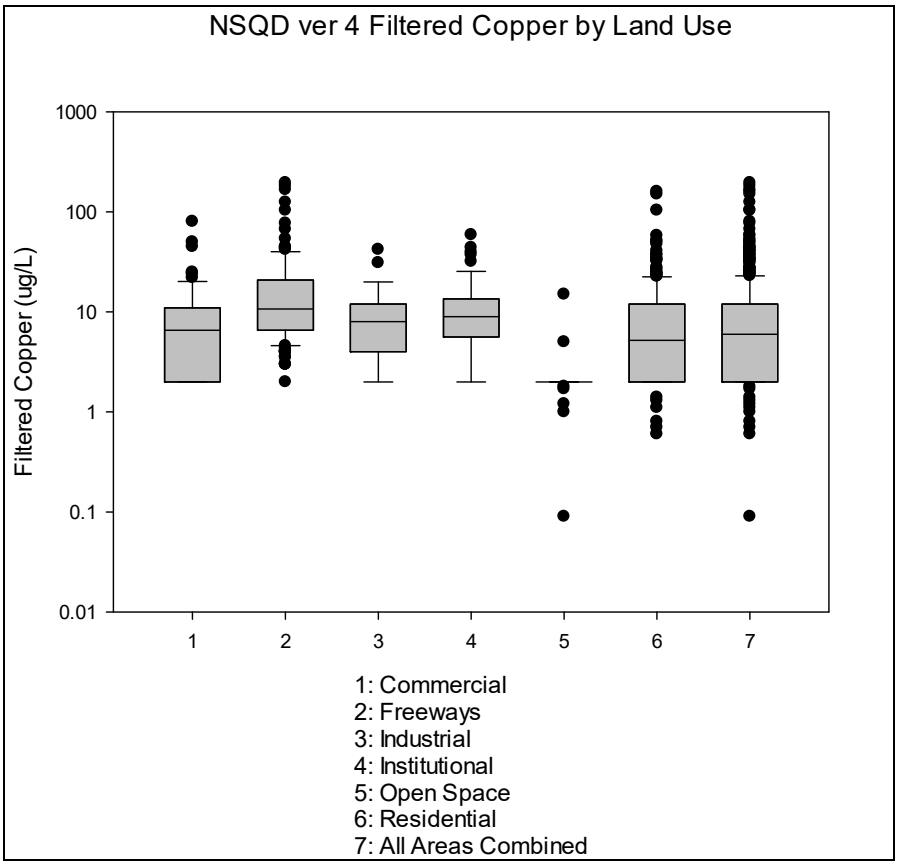
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
CuFree vs CuInstitOpen	1099.615	12.663	<0.001
CuFree vs CuComIndusRes	570.628	7.819	<0.001
CuComIndusRes vs CuInstitOpen	528.987	9.672	<0.001

Industrial combined with commercial and residential
Institutional and open space combined

Filtered Copper

summary stats:	**filt Cu - commercial**	**filt Cu - freeways**	**filt Cu - industrial**	**filt Cu - institutional**	**filt Cu - open space**	**filt Cu - residential**	**Cu - all**
count	68	130	49	55	88	243	633
mean	10.0	20.3	9.8	12.0	2.1	10.2	11.3
stdev	12.4	30.7	8.0	11.3	1.4	17.5	19.3
COV	1.24	1.51	0.81	0.94	0.68	1.72	1.71
median	6.6	10.7	8.0	9.0	2.0	5.2	6.0
min	2.0	2.0	2.0	2.0	0.1	0.6	0.1
max	80	195	42	59	15	160	195
# ND	16	1	6	10	81	91	205
% ND	23.5	0.8	12.2	18.2	92.0	37.4	32.4

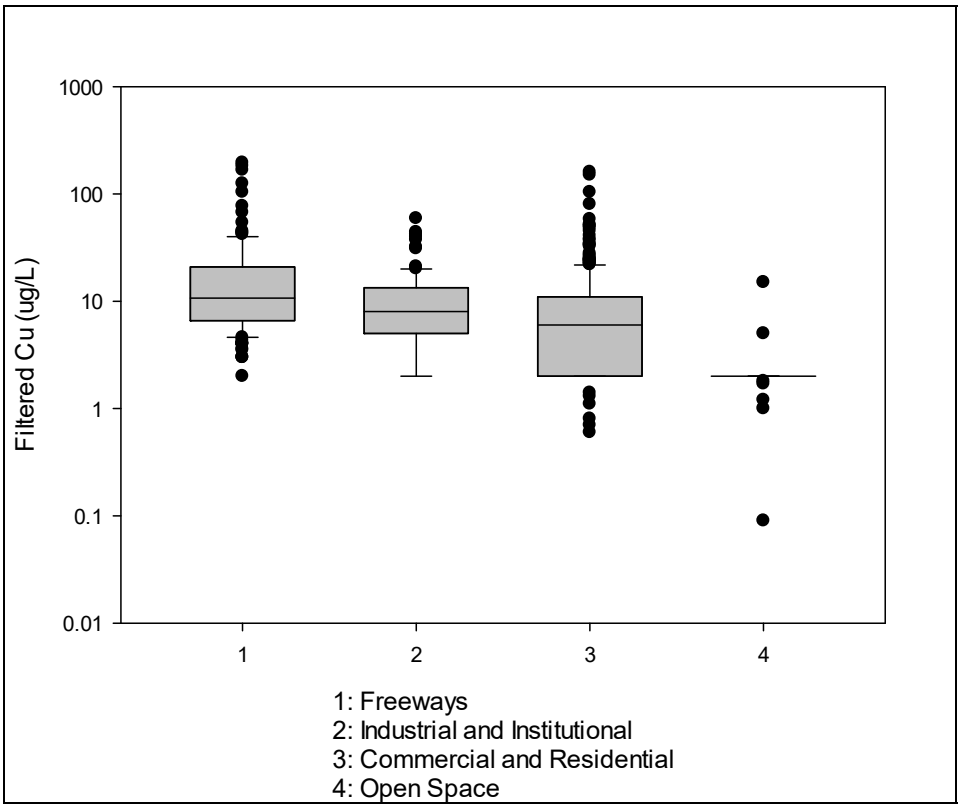


Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	**filt Cu - commercial**	**filt Cu - freeways**	**filt Cu - industrial**	**filt Cu - institutional**	**filt Cu - residential**
filt Cu - commercial	X	<0.001	1	1	1
filt Cu - freeways	<0.001	X	0.076	0.48	<0.001
filt Cu - industrial	1	0.076	X	1	0.34
filt Cu - institutional	1	0.48	1	X	0.021
filt Cu - residential	1	<0.001	0.34	0.021	X

summary stats:	**filt Cu - freeways**	**filt Cu - indus instit**	**filt Cu - com res**	**filt Cu - open space**
count	130	104	311	88
mean	20.3	11.0	10.2	2.1
stdev	30.7	9.9	16.5	1.4
COV	1.51	0.90	1.63	0.68
median	10.7	8	6	2.0
min	2.0	2	0.6	0.1
max	195	59	160	15
# ND	1	16	107	81
% ND	0.8	15.4	34.4	92.0

Many non-detectable values



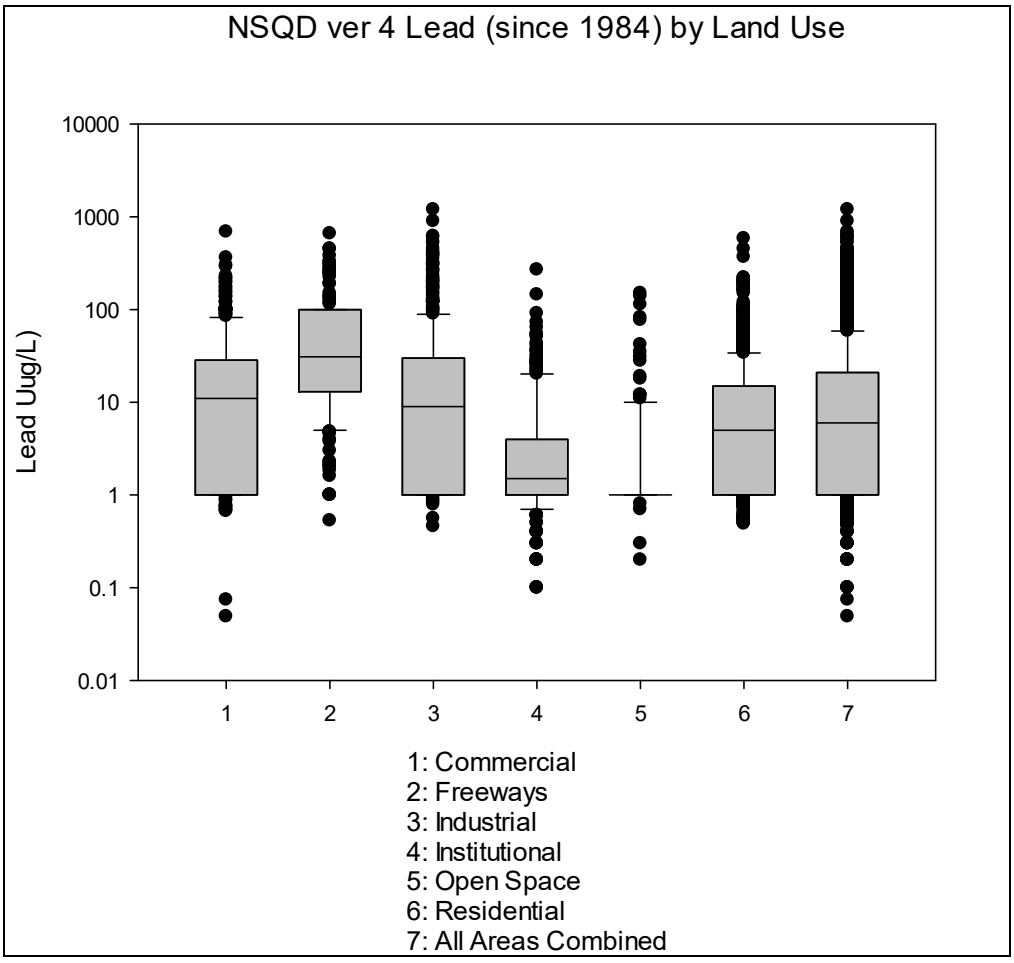
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
filtCuFree vs filtCuOpen	319.352	12.65	<0.001
filtCuFree vs filtCuComRes	132.999	6.963	<0.001
filtCuFree vs filtCuIndusIn	66.215	2.752	0.036
filtCuIndusIn vs filtCuOpen	253.137	9.557	<0.001
filtCuIndusIn vs filtCuComRes	66.783	3.224	0.008
filtCuComRes vs filtCuOpen	186.354	8.44	<0.001

industrial combined with institution
commercial combined with residential

Lead (since 1984)

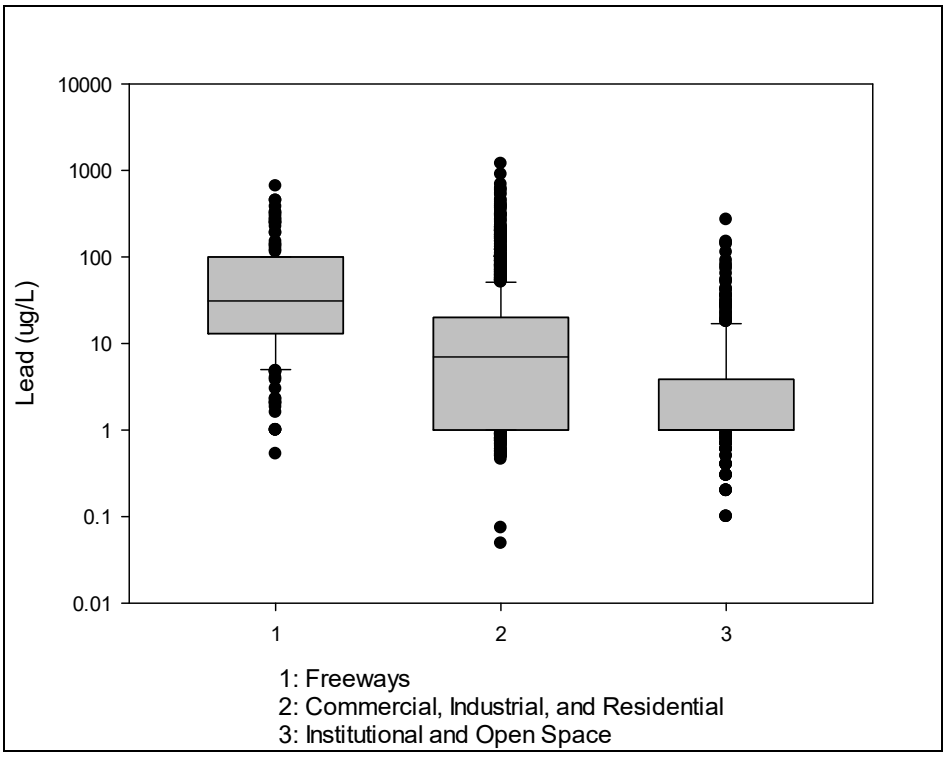
summary stats:	**Pb - commercial**	**Pb - freeways**	**Pb - industrial**	**Pb - institutional**	**Pb - open space**	**Pb - residential**	**Pb - all**
count	569	232	583	250	159	1,345	3,138
mean	27.7	63.6	39.0	7.7	6.6	15.2	24.4
stdev	51.3	84.9	99.9	22.4	20.7	35.0	60.6
COV	1.85	1.34	2.56	2.93	3.15	2.31	2.48
median	11.0	31.0	9.0	1.5	1.0	5.0	6.0
min	0.0	0.5	0.5	0.1	0.2	0.5	0.0
max	689	660	1,200	269	150	585	1,200
# ND	138	4	168	45	116	430	901
% ND	24.3	1.7	28.8	18.0	73.0	32.0	28.7



Kruskal-Wallis One Way Analysis of Variance on Ranks P values

P values	**Pb - commercial**	**Pb - freeways**	**Pb - industrial**	**Pb - institutional**	**Pb - residential**
Pb - commercial	X	<0.001	1	<0.001	<0.001
Pb - freeways	<0.001	X	<0.001	<0.001	<0.001
Pb - industrial	1	<0.001	X	<0.001	<0.001
Pb - institutional	<0.001	<0.001	<0.001	X	<0.001
Pb - residential	<0.001	<0.001	<0.001	<0.001	X

summary stats:	**Pb - freeways**	**Pb - com ind res**	**Pb - instit open**
count	232	2,497	409
mean	63.6	23.6	7.2
stdev	84.9	60.7	21.7
COV	1.34	2.57	3.00
median	31.0	7.0	1.0
min	0.5	0.0	0.1
max	660	1,200	269
# ND	4	736	161
% ND	1.7	29.5	39.4



All Pairwise Multiple Comparison Procedures (Dunn's Method)

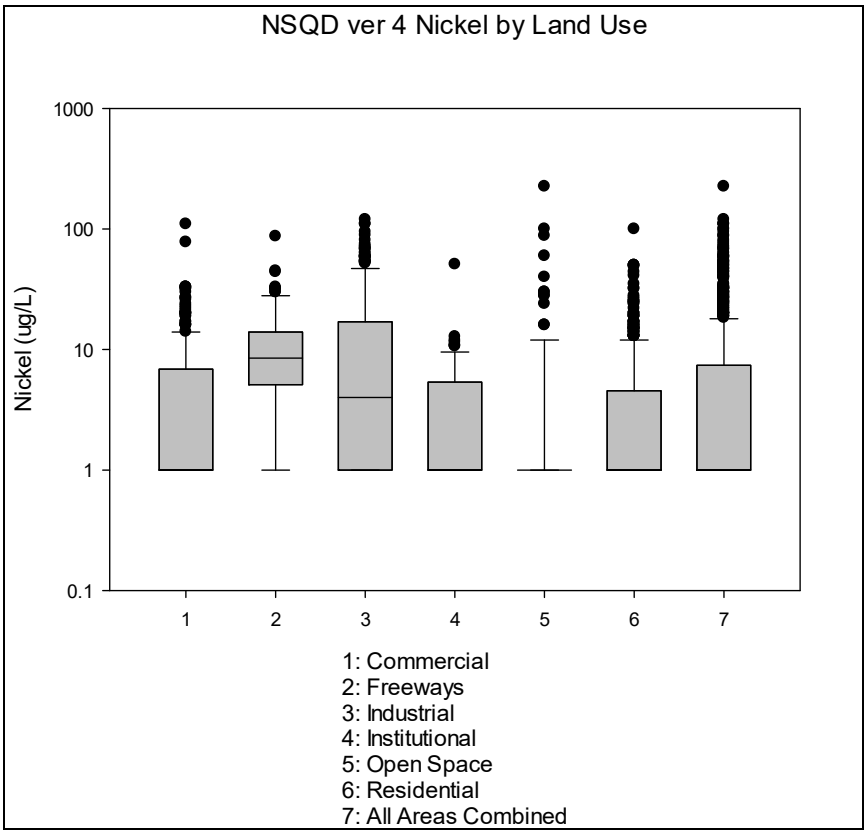
Comparison	Diff of Ranks	Q	P
PbFree vs PbINstitOpen	1372.097	18.426	<0.001
PbFree vs PbComIndusRes	818.366	13.16	<0.001
PbComIndusRes vs PbINstitOpen	553.731	11.458	<0.001

Industrial combined with commercial and residential areas
Institutional and open space areas combined

Nickel

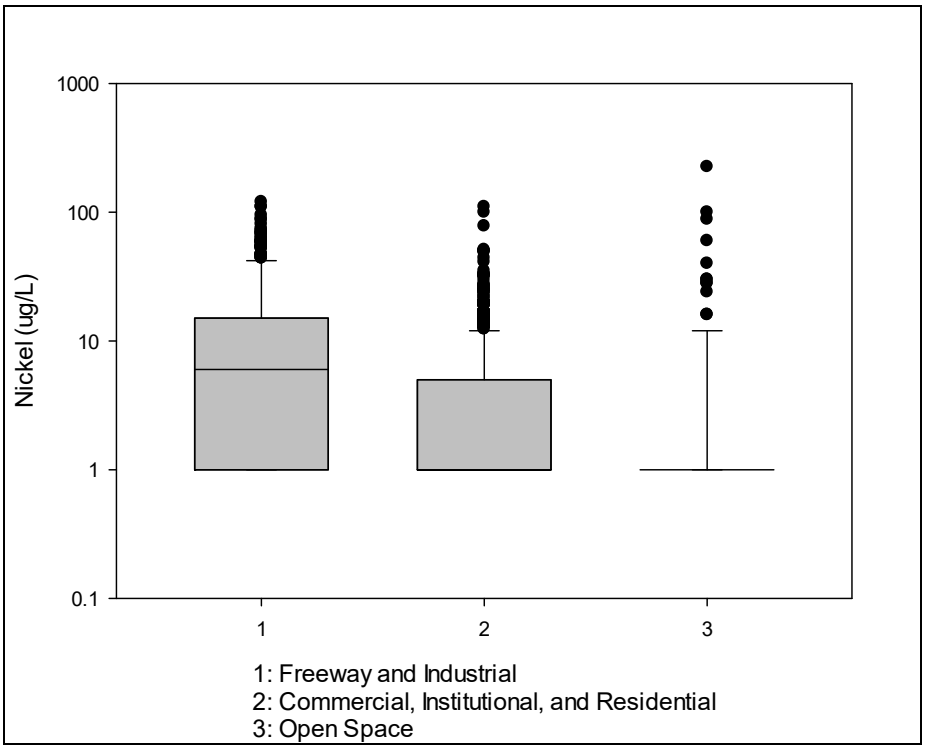
summary stats:	**Ni - commercial**	**Ni - freeways**	**Ni - industrial**	**Ni - institutional**	**Ni - open space**	**Ni - residential**	**NI - all**
count	316	99	297	74	129	570	1,485
mean	5.4	12.0	14.0	3.5	6.9	4.4	7.2
stdev	9.8	12.0	21.7	6.5	23.9	8.0	14.7
COV	1.80	1.00	1.55	1.87	3.46	1.85	2.04
median	1.0	8.5	4.0	1.0	1.0	1.0	1.0
min	1.0	1.0	1.0	1.0	1.0	1.0	1.0
max	110	87	120	51	226	100	226
# ND	170	10	129	54	105	358	826
% ND	53.8	10.1	43.4	73.0	81.4	62.8	55.6

Many non-detectable values



Not enough data for reliable Kruskal-Wallis analyses.

summary stats:	**Ni - free indus**	**Ni - com instit res**	**Ni - open space**
count	396	960	129
mean	13.5	4.6	6.9
stdev	19.7	8.6	23.9
COV	1.46	1.84	3.46
median	6	1	1.0
min	1	1	1.0
max	120	110	226
# ND	139	582	105
% ND	35.1	60.6	81.4



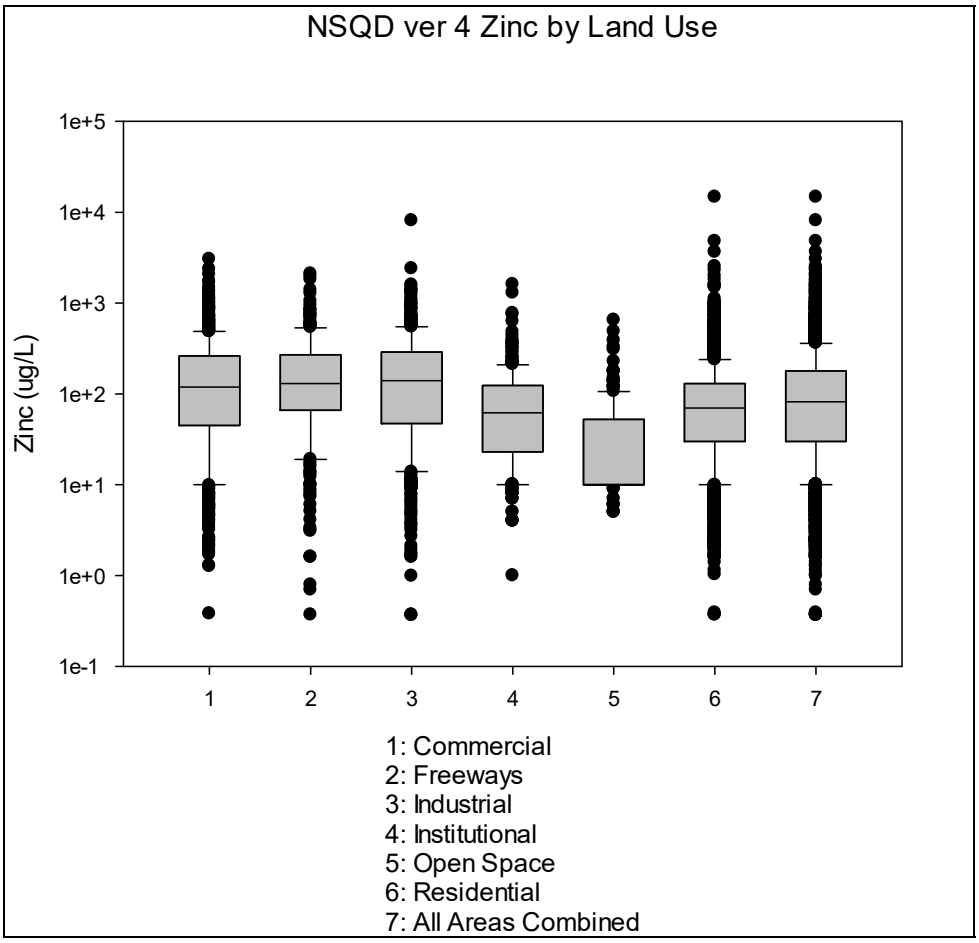
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
NiFreIndus vs NiOpen	360.052	8.282	<0.001
NiFreIndus vs NiComInstitRes	247.936	9.681	<0.001
NiComInstitRes vs NiOpen	112.115	2.788	0.016

Freeways and industrial combined
Commercial, institutional, and residential combined

Zinc

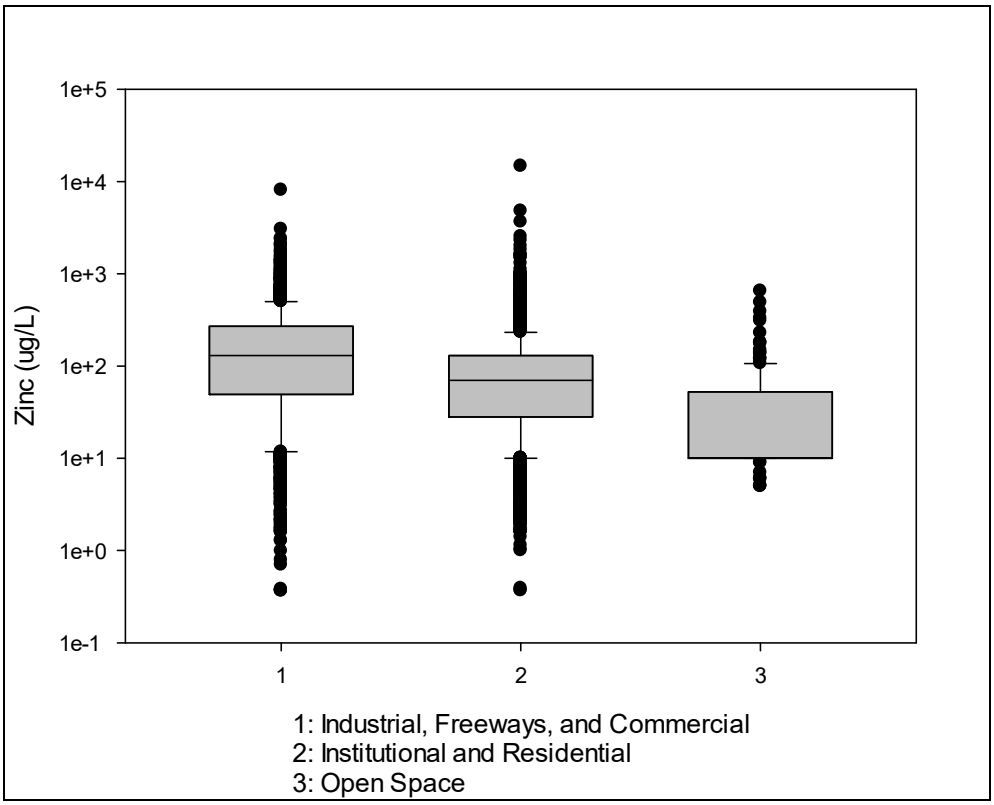
summary stats:	**Zn - commercial**	**Zn - freeways**	**Zn - industrial**	**Zn - institutional**	**Zn - open space**	**Zn - residential**	**ZN - all**
count	877	272	655	299	170	1,789	4,062
mean	202	220	229	102	46	126	160
stdev	269	284	400	154	82	413	356
COV	1.33	1.29	1.75	1.51	1.79	3.27	2.22
median	119	130	140	62	10	70	82
min	0.4	0.4	0.4	1.0	5.0	0.4	0.4
max	3,050	2,100	8,100	1,610	651	14,700	14,700
# ND	8	3	7	5	80	93	196
% ND	0.9	1.1	1.1	1.7	47.1	5.2	4.8



Kruskal-Wallis One Way Analysis of Variance on Ranks P Values

P values	**Zn - commercial**	**Zn - freeways**	**Zn - industrial**	**Zn - institutional**	**Zn - residential**
Zn - commercial	X	0.48	0.45	<0.001	<0.001
Zn - freeways	0.48	X	1	<0.001	<0.001
Zn - industrial	0.45	1	X	<0.001	<0.001
Zn - institutional	<0.001	<0.001	<0.001	X	1
Zn - residential	<0.001	<0.001	<0.001	1	X

summary stats:	**Zn - com free indus**	**Zn - instit res**	**Zn - open space**
count	1,804	2,088	170
mean	214	123	46
stdev	325	387	82
COV	1.51	3.15	1.79
median	130	70	10
min	0.37	0.37	5.0
max	8,100	14,700	651
# ND	18	98	80
% ND	1.00	4.69	47.1



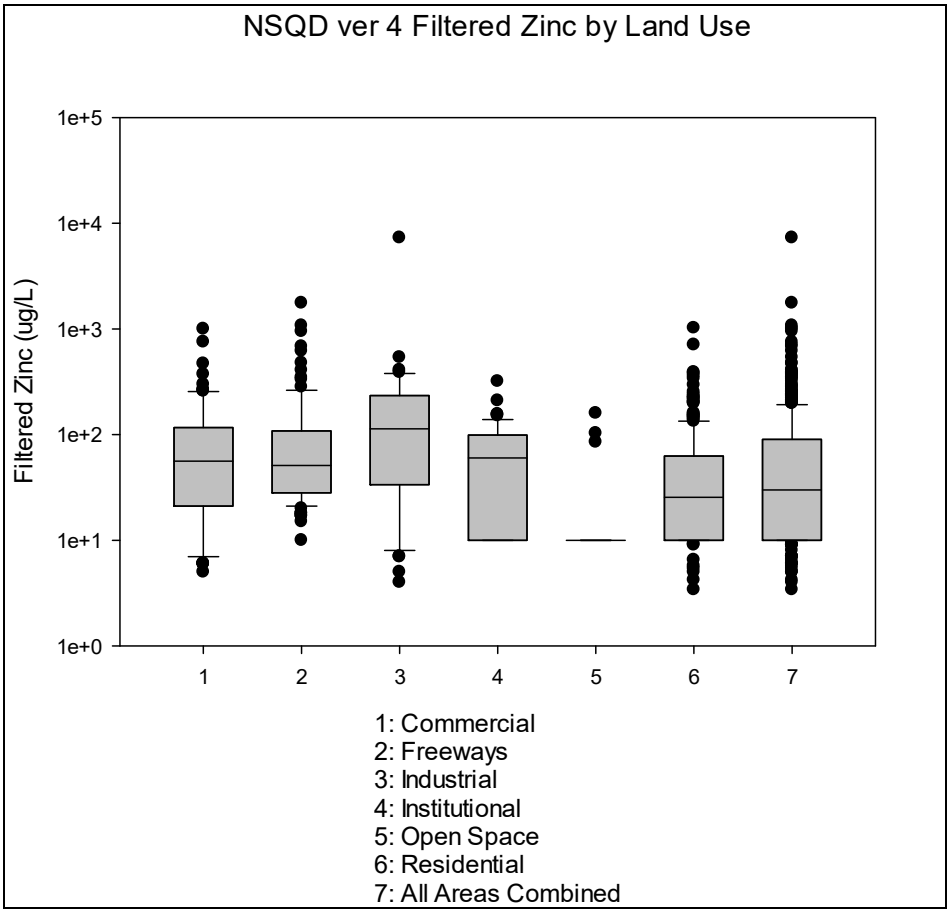
All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
ZnIndusFreCom vs ZnOpen	1364.119	14.498	<0.001
ZnIndusFreCom vs ZnInstitRes	579.786	15.38	<0.001
ZnInstitRes vs ZnOpen	784.333	8.385	<0.001

Industrial combined with freeways and commercial areas
Institutional and residential areas combined

Filtered Zinc

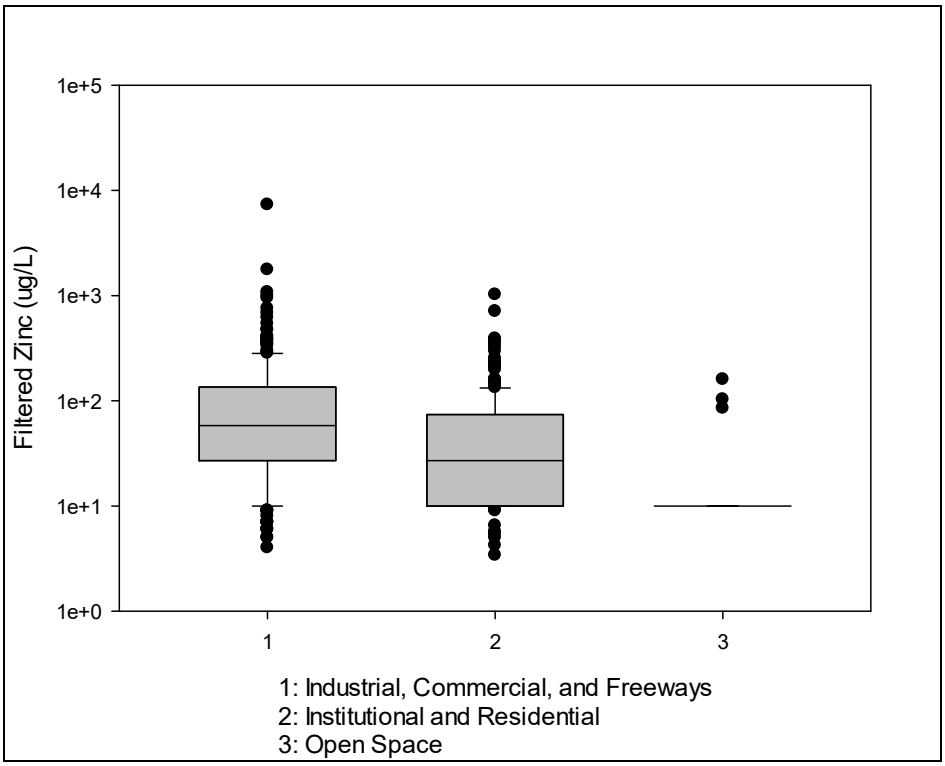
summary stats:	**filt Zn - commercial**	**filt Zn - freeways**	**filt Zn - industrial**	**filt Zn - institutional**	**filt Zn - open space**	**filt Zn - residential**	**filt Zn - all**
count	81	105	49	55	89	240	619
mean	102	126	290	65	14	57	88
stdev	154	236	1031	61	20	101	322
COV	1.51	1.87	3.55	0.93	1.48	1.77	3.68
median	56	51	113	60	10	26	30
min	5.0	10.0	4.0	10.0	10.0	3.4	3.4
max	1,000	1,766	7,300	320	160	1,020	7,300
# ND	3	1	2	21	86	90	203
% ND	3.7	1.0	4.1	38.2	96.6	37.5	32.8



Kruskal-Wallis One Way Analysis of Variance on Ranks P Values

P values	filt Zn - commercial	filt Zn - freeways	filt Zn - industrial	filt Zn - institutional	filt Zn - residential
filt Zn - commercial	X	1	0.42	1	0.002
filt Zn - freeways	1	X	1	0.56	<0.001
filt Zn - industrial	0.42	1	X	0.093	<0.001
filt Zn - institutional	1	0.56	0.093	X	0.28
filt Zn - residential	0.002	<0.001	<0.001	0.28	X

summary stats:	filt Zn - indus com fre	filt Zn - instit res	filt Zn - open space
count	235	295	89
mean	152	59	14
stdev	506	95	20
COV	3.32	1.62	1.48
median	58	27	10
min	4.0	3.4	10.0
max	7,300	1,020	160
# ND	6	111	86
% ND	2.6	37.6	96.6



All Pairwise Multiple Comparison Procedures (Dunn's Method)

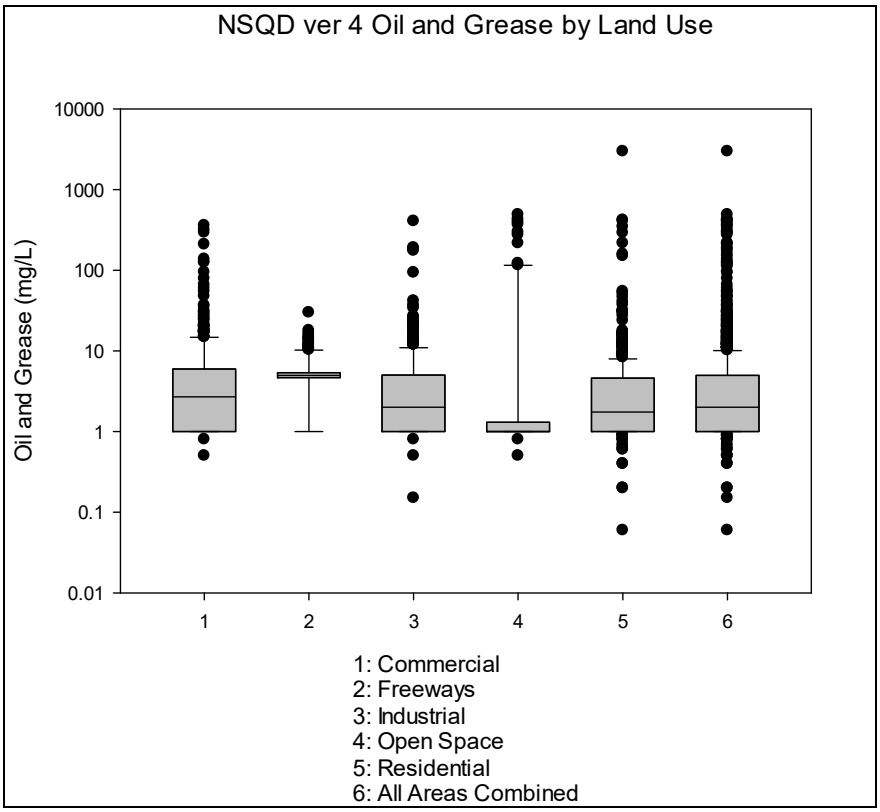
Comparison	Diff of Ranks	Q	P
filtZnComFreI vs filtZnOpen	250.495	11.254	<0.001
filtZnComFreI vs filtZnResInst	97.738	6.251	<0.001
filtZnResInstit vs filtZnOpen	152.757	7.063	<0.001

Industrial combined commercial and freeways
Residential and Institutional areas combined

Oil and Grease

summary stats:	**O&G - commercial**	**O&G - freeways**	**O&G - industrial**	**O&G - institutional**	**O&G - open space**	**O&G - residential**	**O&G - all**
count	411	150	385	0	91	666	1,703
mean	9.265	5.572	6.866		33.203	10.985	10.349
stdev	32.310	3.670	26.825		98.839	119.356	80.813
COV	3.49	0.66	3.91		2.98	10.87	7.81
median	2.700	5.000	2.000		1.000	1.750	2.000
min	0.500	1.000	0.150		0.500	0.060	0.060
max	359.000	30.000	408.000		491.000	2,980.000	2,980.000
# ND	132	19	146		61	270	628
% ND	32.1	12.7	37.9		67.0	40.5	36.9

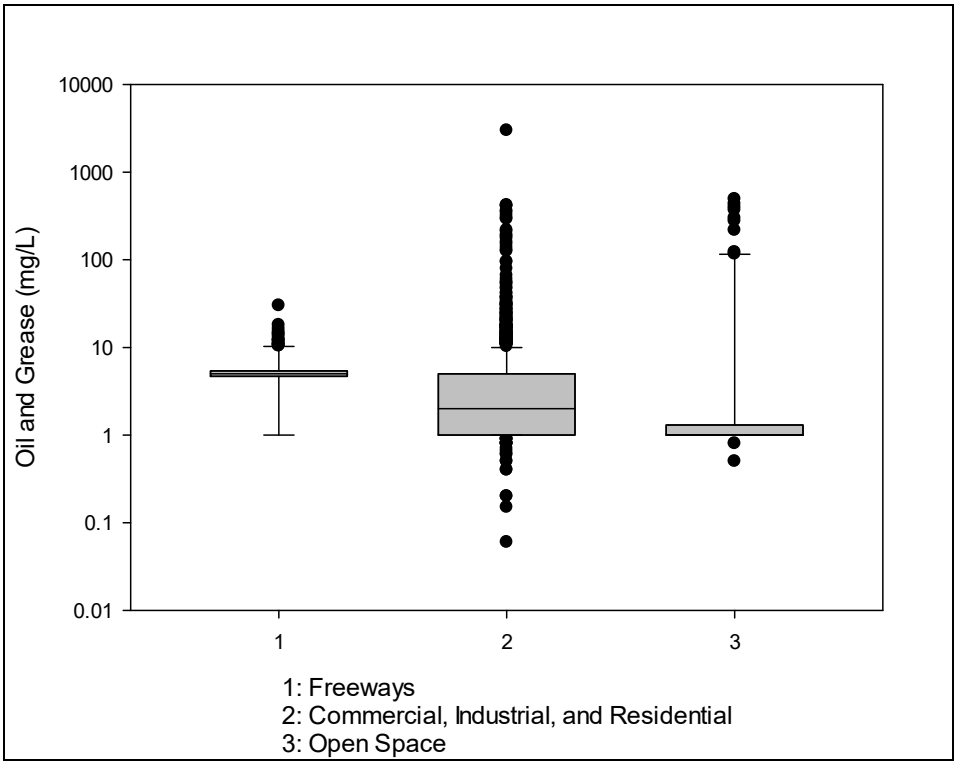
Many non-detectable values and no data from institutional areas



Kruskal-Wallis One Way Analysis of Variance on Ranks P Values

P values	**O&G - commercial**	**O&G - freeways**	**O&G - industrial**	**O&G - open space**	**O&G - residential**
O&G - commercial	X	<0.001	0.73	<0.001	<0.001
O&G - freeways	<0.001	X	<0.001	<0.001	<0.001
O&G - industrial	0.73	<0.001	X	0.004	0.33
O&G - open space	<0.001	<0.001	0.004	X	0.14
O&G - residential	<0.001	<0.001	0.33	0.14	X

summary stats:	**O&G - freeways**	**O&G - com indus res**	**O&G - open space**
count	150	1,462	91
mean	5.57	9.42	33.20
stdev	3.67	83.48	98.84
COV	0.66	8.87	2.98
median	5.00	2.00	1.00
min	1.00	0.06	0.50
max	30	2,980	491
# ND	19	548	61
% ND	12.7	37.5	67.0



All Pairwise Multiple Comparison Procedures (Dunn's Method)

Comparison	Diff of Ranks	Q	P
O&GFree vs O&GOpen	532.035	8.142	<0.001
O&GFree vs O&GComIndusRes	342.158	8.115	<0.001
O&GComIndusRes vs O&GOpen	189.877	3.574	0.001

Industrial combined with commercial and residential
(no oil and grease data for institutional areas)