The Updated National Stormwater Quality Database (NSQD), Version 3

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Stormwater NPDES Data Collection and Evaluation Project

- The University of Alabama and the Center for Watershed Protection were awarded an EPA 104(b)3 grant in 2001 to collect, review, and analyze selected Phase 1 NPDES stormwater permit data.
- We received an extension of the project in 2005 to expand the database to include under-represented areas. We recently completed 3.1 of the database (version 2 was not posted as it was an interim version that had not undergone complete QA/QC reviews).
- The National Stormwater Quality Database (NSQD) is available on the Internet.

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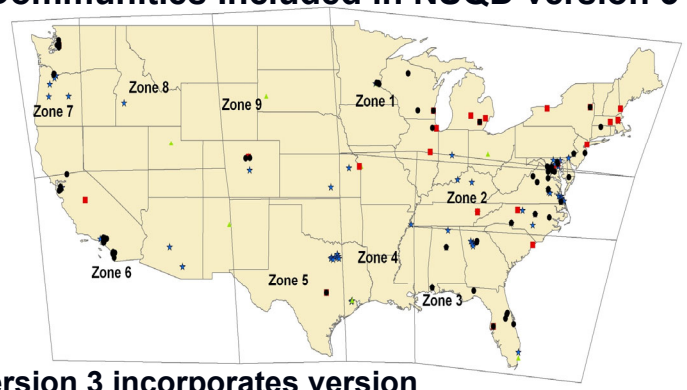
Communities Included in NSQD version 3



Version 3 incorporates version 1.1 data, plus additional MS4 data, along with selected data from the International BMP Database, the USGS, and NURP.

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Number of Events and Geographical Coverage in NSQD ver. 3

RAIN ZONE	TOTAL EVENTS	PERCENTAGE
Zone 1- Great Lakes and Northeast	1,271	15
Zone 2- Mid Atlantic	3,984	46
Zone 3- Southeast	744	9
Zone 4- Lower Mississippi Valley	301	4
Zone 5- Texas	799	9
Zone 6- Southwest	417	5
Zone 7- Northwest	865	10
Zone 8- Rocky Mountains	24	0.3
Zone 9- Midwest	197	2
TOTAL	8,602	100

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Number of Events and Land Use Coverage in NSQD ver. 3

LAND USE	TOTAL EVENTS	PERCENTAGE
Residential	2,933	34
Commercial	1,080	13
Institutional	55	1
Industrial	893	10
Freeway	734	9
Open Space	125	2
Mixed Land Uses	2,782	31
TOTAL	8,602	100

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Total Suspended Solids by Land Use and Geographical Area (mg/L)

		1	2	3	5	7	All
Commercial	Mean	135	86	60	67	81	118
	Count	237	454	50	40	42	916
	COV	1.2	1.8	2.0	1.6	1.1	1.7
Industrial	Mean	177	78	96	244	182	171
	Count	100	304	82	43	24	719
	COV	1.4	1.0	1.3	1.6	1.2	1.7
Residential	Mean	140	85	107	109	100	123
	Count	332	1,388	122	107	170	2,386
	COV	1.2	1.7	1.6	1.0	0.9	2.0
ALL	Mean	155	97	95	138	126	137
	Count	1,132	3,466	420	488	443	6,780
	COV	1.6	1.7	1.5	1.5	1.7	2.2

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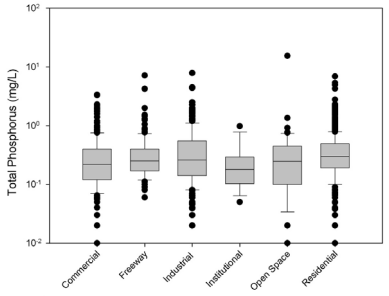
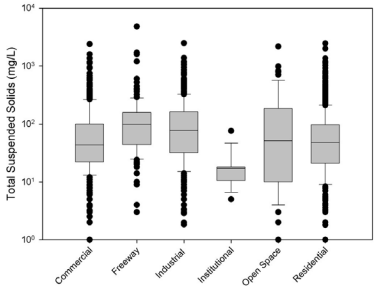
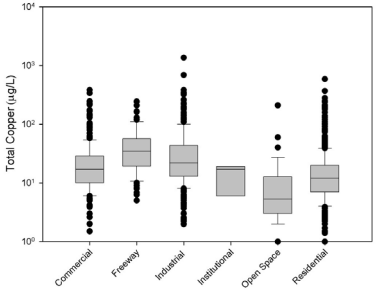
These grouped box-whisker plots sort all of the data by land use. Kruskal-Wallis analyses indicate that all constituents have at least one significantly different category from the others. Heavy metal differences are most obvious.







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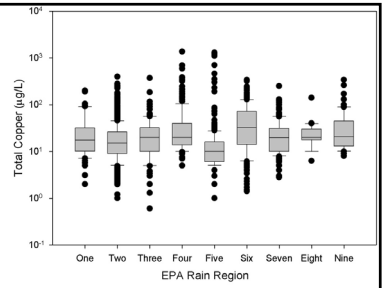
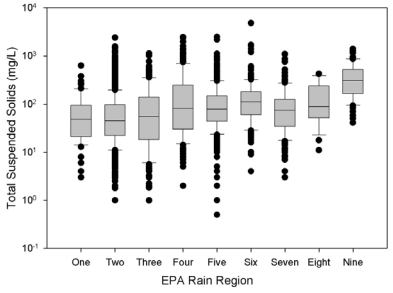
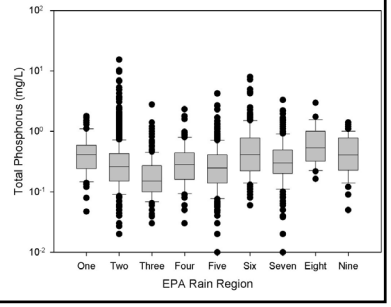
Residential area concentrations grouped by EPA rain zones. Zones 1-4 are east half of country, zones 5-9 are western half of country. Zones 3 and 7 are the wettest zones.







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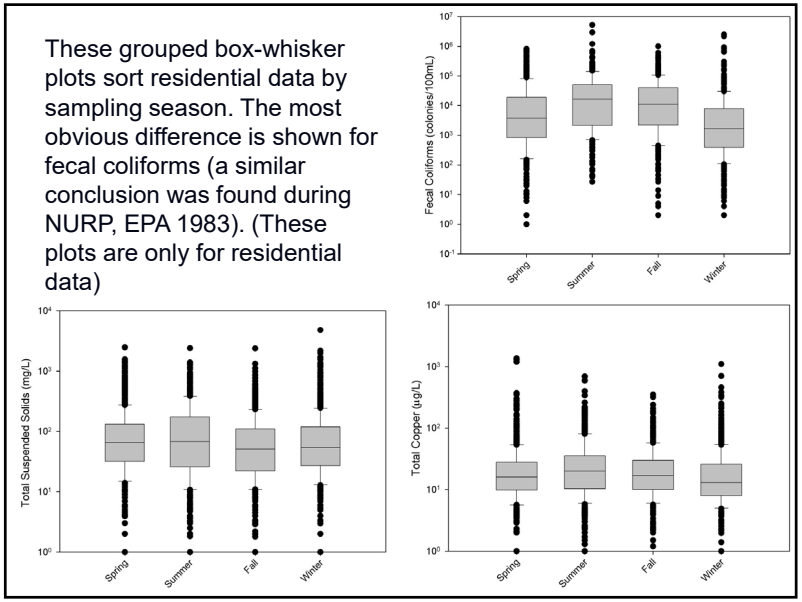
These grouped box-whisker plots sort residential data by sampling season. The most obvious difference is shown for fecal coliforms (a similar conclusion was found during NURP, EPA 1983). (These plots are only for residential data)



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Main Factors and Interactions Affecting Outfall Concentrations

	Land Use (LU)	Season (SN)	Rain Zone (RN)	LU*SN	LU*RN	SN*RN	LU*RN* SN
TSS	<0.001	0.737	<0.001	0.017	<0.001	0.184	<0.001
BOD	<0.001	0.155	<0.001	0.001	<0.001	0.001	0.221
COD	<0.001	0.134	<0.001	0.034	<0.001	0.014	0.009
TP	<0.001	0.687	<0.001	0.055	<0.001	<0.001	<0.001
NO2+NO3	<0.001	0.108	<0.001	0.052	<0.001	0.034	0.057
Cu	<0.001	0.112	<0.001	0.623	<0.001	0.038	0.141
Pb	<0.001	0.765	<0.001	0.420	<0.001	0.285	0.012
Zn	<0.001	0.910	<0.001	0.936	<0.001	0.014	<0.001

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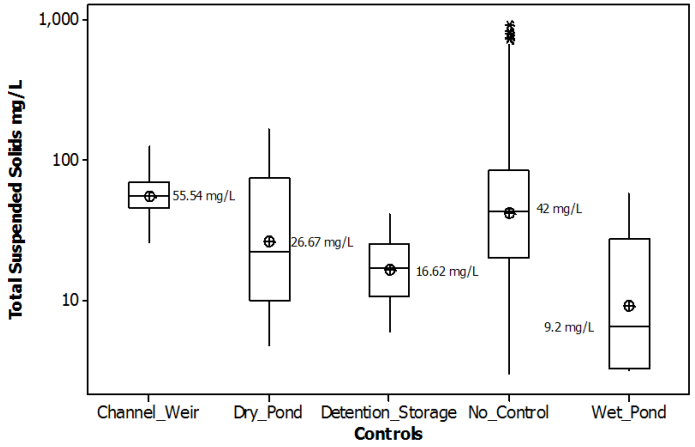
Comparison of Stormwater Control Practices (Residential Land Uses EPA Rain Zone 2)



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Why Monitor as Part of MS4 Permits?

- "Characterization" monitoring may not be necessary unless in under-represented areas or land uses.
- Monitoring at small scales (having homogeneous characteristics) more useful than for large multi-land use locations.
- More efficient to require monitoring to learn about processes (sources, transport, control, and effects) and for program assessment/validation.
- A coordinated monitoring program for an area would be much more efficient than a standardized "one-size-fits-all" approach.

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Recommendations for Improved Future Regulatory Monitoring Activities

- Better site descriptions (drainage area delineation, effective percentage impervious area, transient and adjacent activities that may affect water quality) are always needed.
- Adequate on-site rain gauges and flow monitoring critical.
- Monitor for the complete event duration (not just "first flush," or only for 3 hours)
- Statistical analyses indicated differences between automatic and manual sampling. Automatic flow-weighted composite sampling may be preferred in most cases, supplemented with bed load and floatables sampling.

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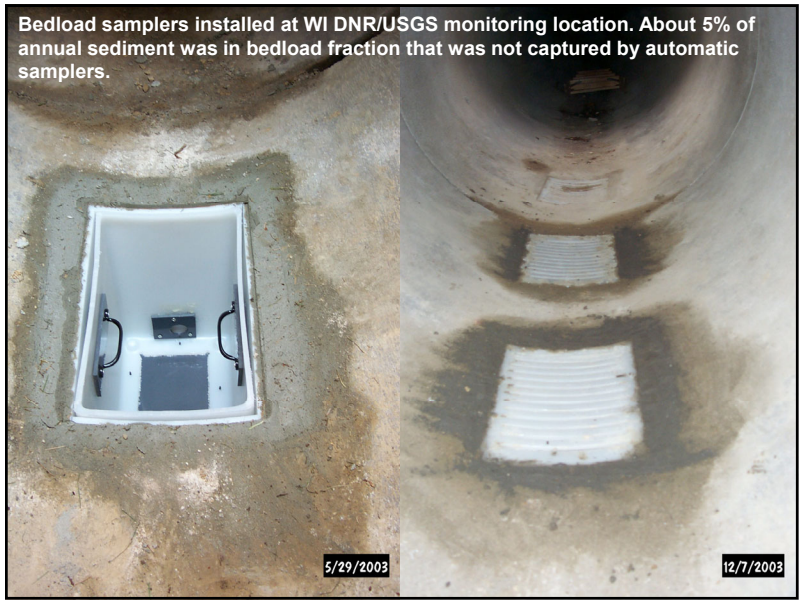

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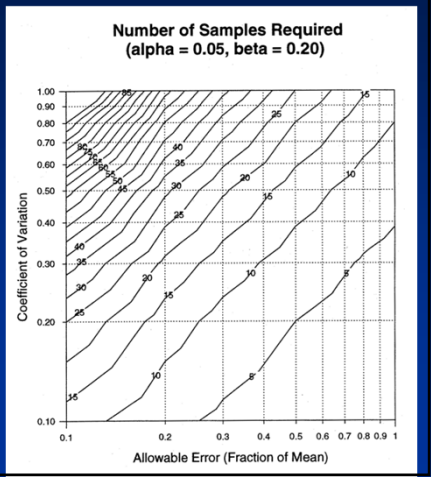
Experimental Design - Number of Samples Needed

The number of samples needed to characterize stormwater conditions for a specific site is dependent on the COV and allowable error. For most constituents and conditions, about 20 to 30 samples may be sufficient for most objectives. Most Phase 1 sites only have about 10 events, but each stratification category usually has much more.



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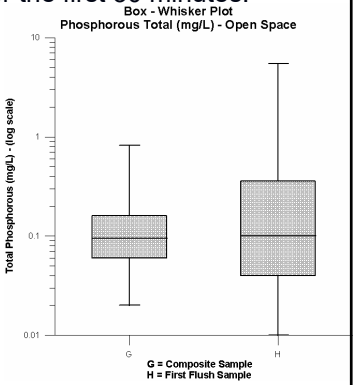
Comparison of First-Flush and Composite Samples

More than 400 paired samples were available for comparison. The first-flush samples are for the first 30 minutes.

The Fligner-Policello (symmetrical about the medians) and the Mann-Whitney (symmetrical and same variance) non-parametric comparison tests were used to compare the paired first-flush concentrations with the whole storm composite concentrations. The Anderson-Darling test was used to test for normality.



Common for concentrations to be similar, but first-flush variance larger

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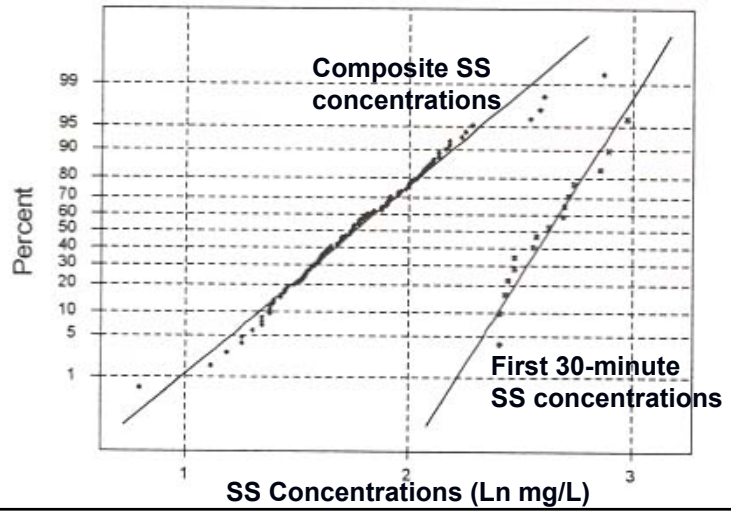
Example for commercial area suspended solids showing a significant first-flush effect:



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First-Flush Observations

- COD, BOD_5, TDS, TKN, and Zn all had significant first-flushes for all land uses (except for open space).
- The ratio of the first-flush to composite concentrations ranged from 1.3 to 1.7 for these constituents.
- Turbidity, pH, fecal coliforms, fecal strep., total N, dissolved P, and orthophosphate did not have significant first-flushes for most of the separate land uses.
- No open space, and only a few institutional data sets had significant first-flushes.

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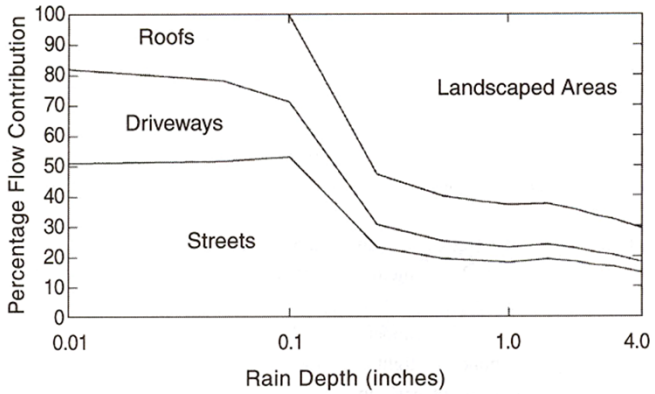
Flow Sources for Different Rain Depths



Runoff originates from different areas as the rain depth changes; "first flush" doesn't represent all flows. Routing of source hydrographs during complex rains results in mixing of first flushes from individual source areas and first flushes not commonly seen at outfalls, unless they drain areas have large impervious area fractions.

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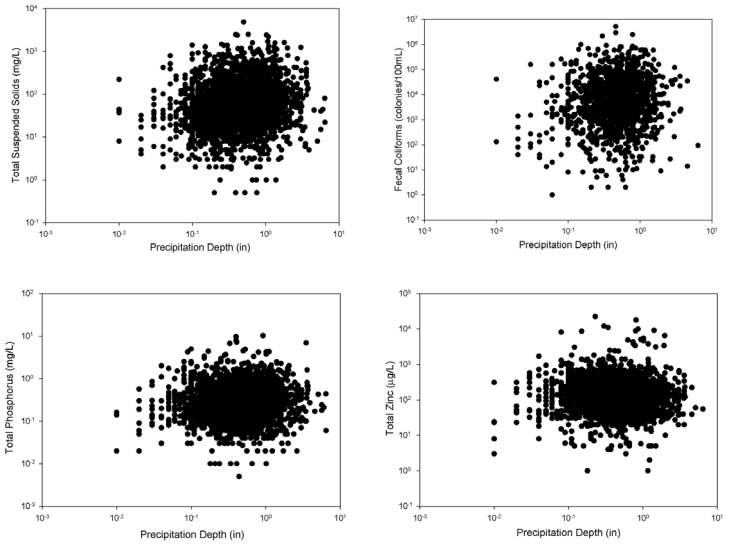
Plots of concentrations vs. rain depth typically show random patterns.



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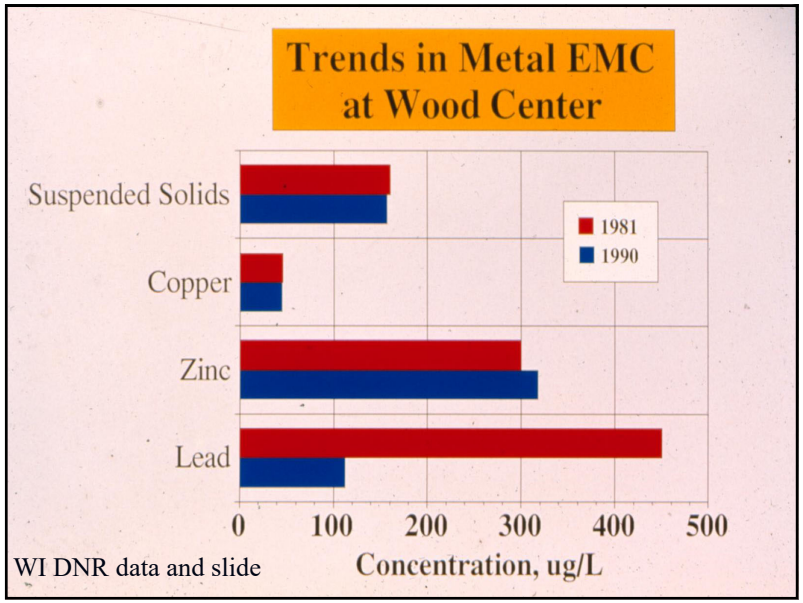

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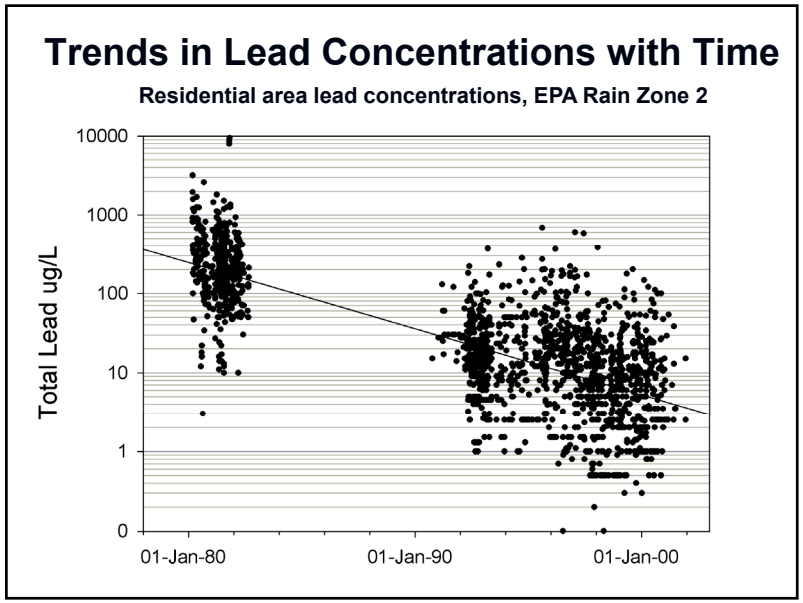

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Conclusions

- Much concern expressed about use of Phase 1 MS4 data due to various experimental designs, different sampling and analytical procedures, etc.
- However, the large amount of data, the documentation available (although some hard to locate), and the wide range of conditions included in the monitoring programs, allow a great deal of information to be extracted and summarized.

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Conclusions

- The database can be used to evaluate the performance of stormwater controls, type of conveyance, sampling procedures, etc.
- Phase 1 MS4 data shows significant patterns for different land uses and geographical locations for most constituents.
- More data needed in under-represented areas for more complete evaluations.

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Acknowledgements

- Bryan Rittenhouse, the US EPA project officer for the Office of Water, is gratefully acknowledged.
- The many municipalities and firms who worked with us to submit data and information were obviously crucial and the project could not have been conducted without their help.
- A number of graduate students at the University of Alabama and staff at the Center for Watershed Protection were active project participants and supplied critical project assistance.

Download the NSQD and supporting information at: http://unix.eng.ua.edu/~rpitt/Research/ms4/mainms4.shtml