Stormwater Management Research at the University of Alabama

Robert Pitt
Department of Civil, Construction, and Environmental Engineering
The University of Alabama

1

Current Major Stormwater Projects in the Department of Civil, Construction, and Environmental Engineering

- *Environmental Contamination Sensor Development and Evaluations Associated with Natural Disasters, Center for Optical Sensors and Spectroscopies, (COSS).* (NSF and the University of Alabama at Birmingham)
- *Biofiltration Media Evaluation* (GeoSyntec Consultants and Boeing Co.)
- *National Demonstration of Advanced Drainage Concepts using Green Solutions for CSO Control* (US EPA and TetraTech)

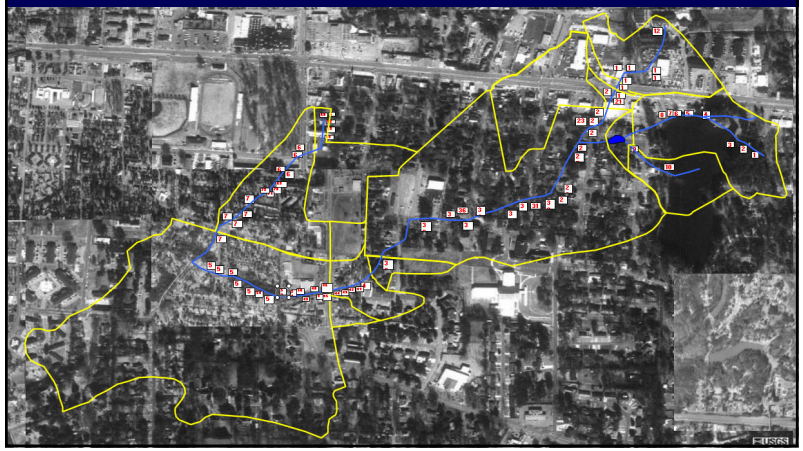
2

Current Major Stormwater Projects in the Department of Civil, Construction, and Environmental Engineering (cont.)

- *Identification and Treatment of Emerging Contaminants in Wet Weather Flows* (US Environmental Protection Agency)
- *Verifying the Performance of the Full-Scale Upflow Filter in Tuscaloosa, AL* (Hydro-International)
- *Developing Local Stormwater Indicator Monitoring Programs to Demonstrate Environmental Results,* with the Center for Watershed Protection (EPA Office of Wastewater Management 104(b)3 grant)

3

A storm drainage system in Tuscaloosa used to evaluate inappropriate discharge protocols developed for EPA



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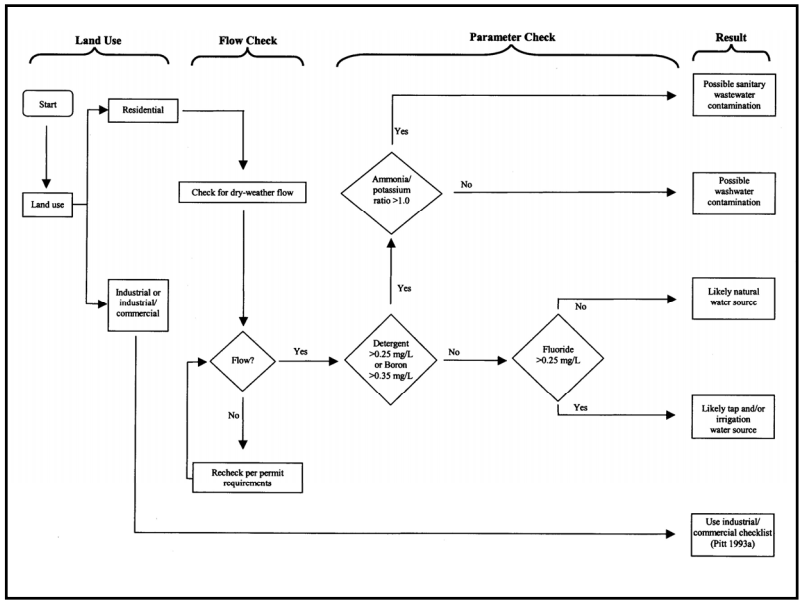

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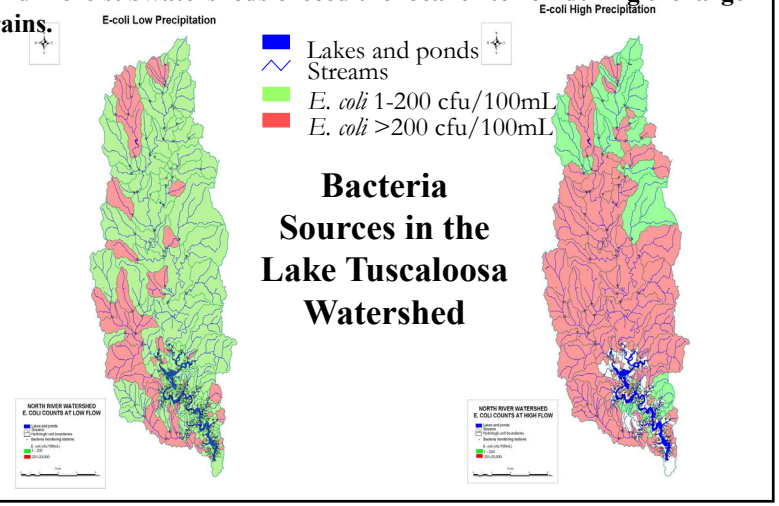
Higher *E. coli* levels were found in subwatersheds of Lake Tuscaloosa during large rains (>25 mm), compared to smaller rains, and more subwatersheds exceed the local criterion during the larger rains.



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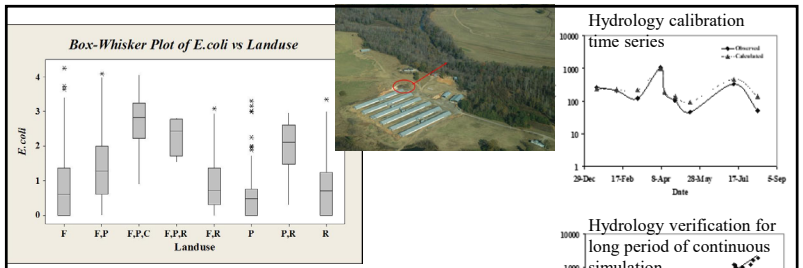
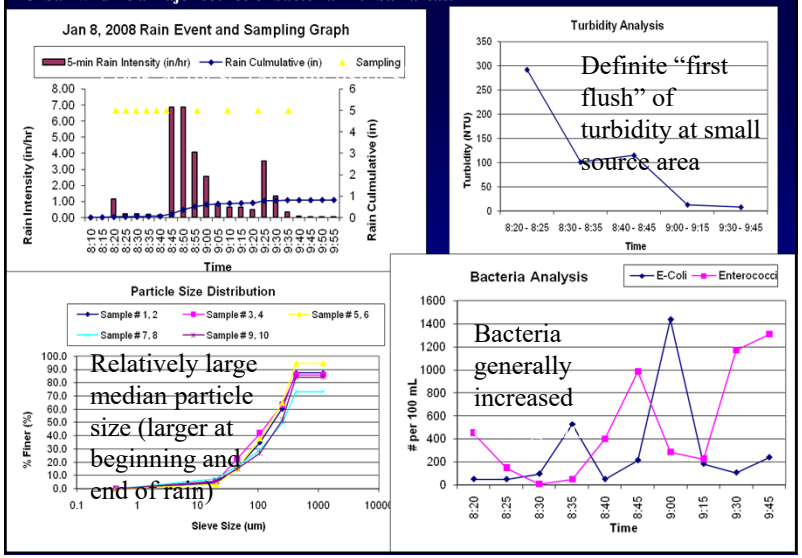


Watershed monitoring indicated that subwatersheds having chicken facilities had much greater levels of *E. coli* than subwatersheds having other land uses:
-forested land had the lowest, then residential areas, then pastures/cattle feedlots, then chicken facilities with the highest

7

Recent Monitoring of 0.4 ha Parking Lot and Surrounding Landscaped Area, Tuscaloosa, AL – Urban wildlife a major source of bacteria in urban areas.



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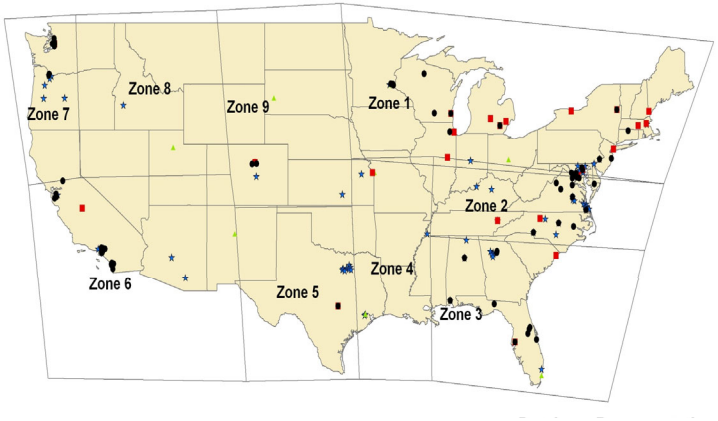
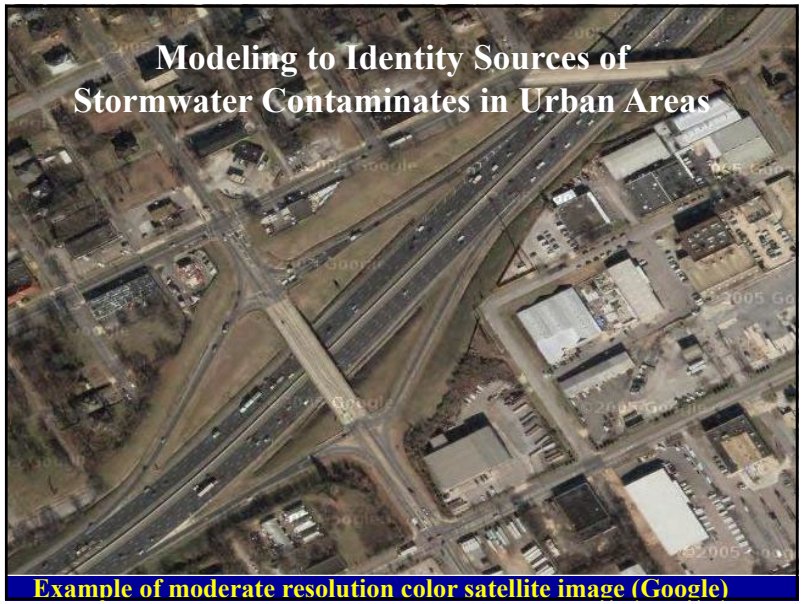
National Stormwater Quality Database, Developed for the EPA to compile existing stormwater discharge permit data



9

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

10



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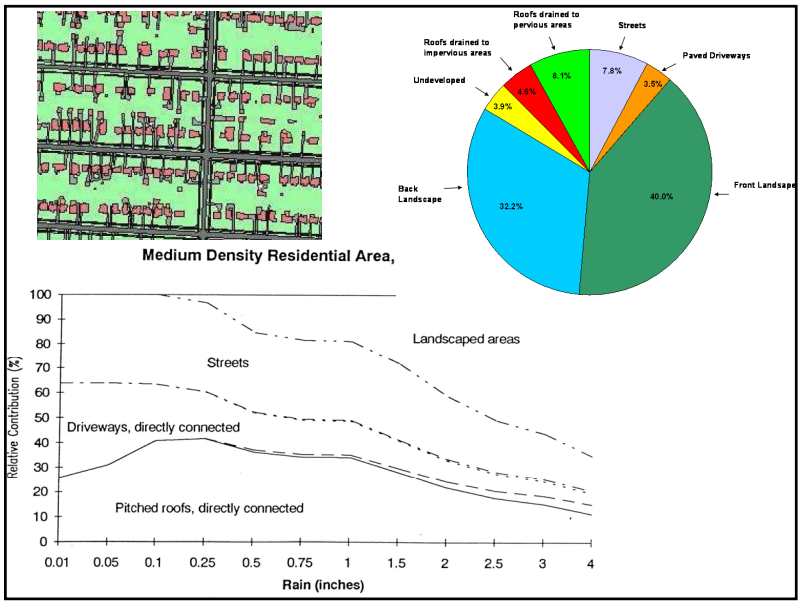
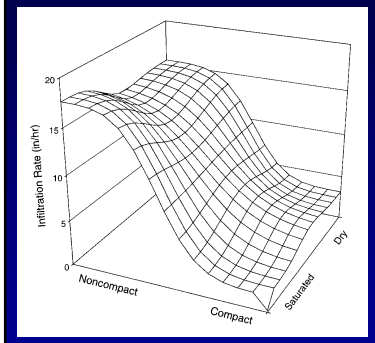
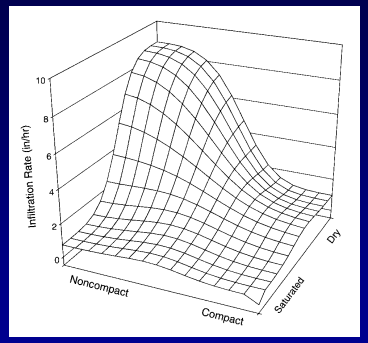


12

Infiltration Rates in Disturbed Urban Soils





Sandy Soils

Clayey Soils

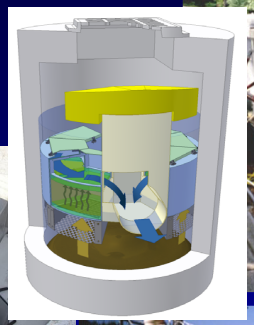
Field research has shown that the infiltration rates of urban soils are strongly influenced by compaction, probably more than by moisture saturation.

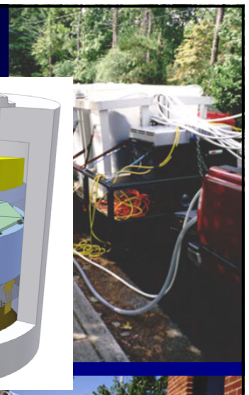
13

Soil modifications can result in greatly enhanced infiltration in marginal soils.

14

Development and Testing of Treatment Methods





15

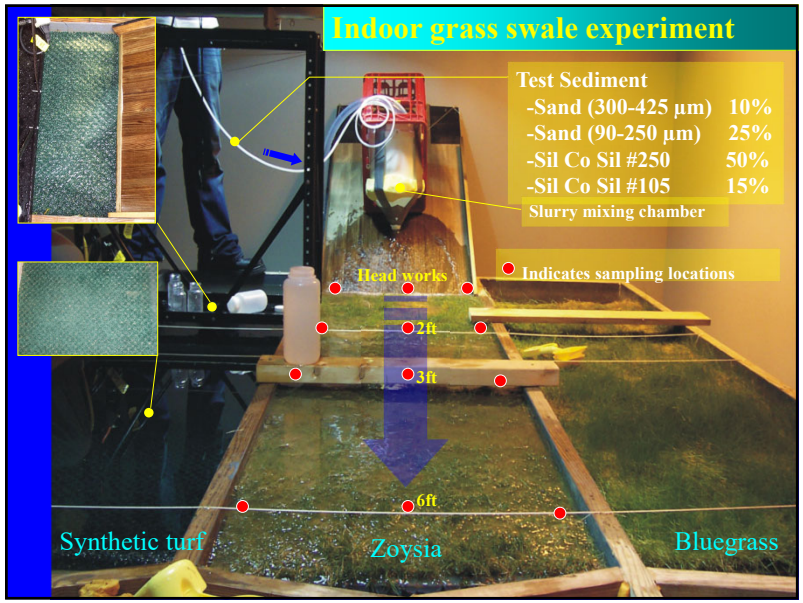
Some laboratory and field pilot-scale test setups (EPA and WERF-supported research at Univ. of Alabama). Critical that tests use actual stormwater, not artificial mixtures.

16

Sediment transport in grass swales

Used factorial experimental design to identify the variables (and interactions) which significantly affect the performance of grass swales
- grass type,
- flow length,
- slope,
- flow rate,
- flow depth,
- sediment concentration,
- particle size

17



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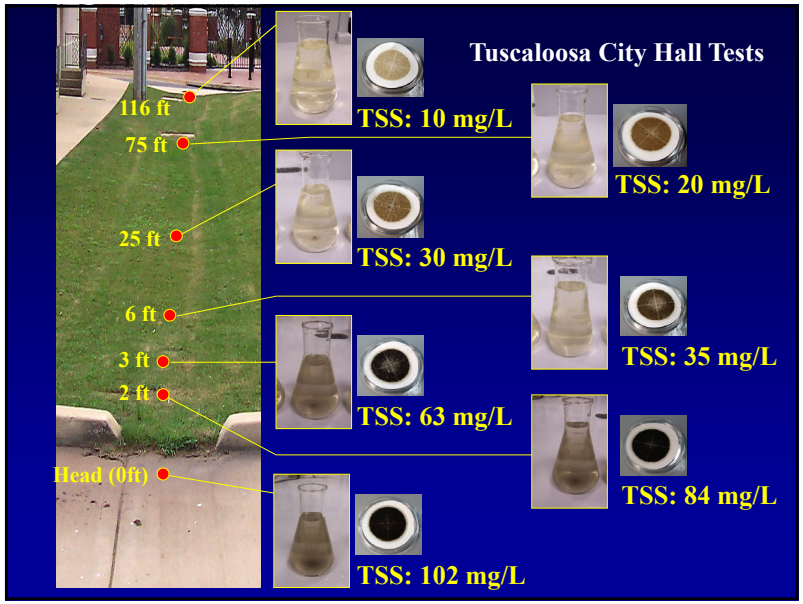


19

Laboratory Media Studies

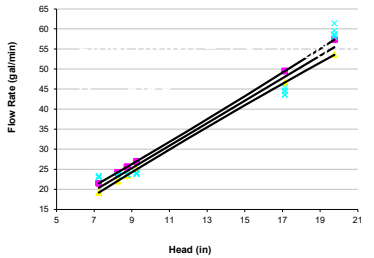
- Rate and Extent of Metals Capture
  - Capacities (partitioning)
  - Kinetics (rate of uptake)
- Effect of pH & pH changes due to media, particle size, interfering ions, etc
- Packed bed filter studies
- Physical properties and surface area determinations

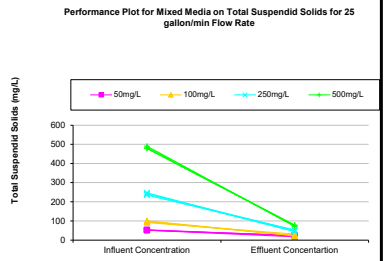
20

Installation of full-sized UpFlow Filter at Tuscaloosa for long-term monitoring

21

Preliminary Results of Full-Scale Field Installation (controlled tests)





25 gallon/min Flow Rate and 100 mg/L Conc.

Particle Size (µm)	Influent Conc. (mg/L)	Effluent Conc. (mg/L)	Reduction (%)
< 0.45	220	160	27
0.45 to 3	5.2	1.1	78
3 to 12	19	11	38
12 to 30	26	8.3	68
30 to 120	16	1.3	92
120 to 1180	28	0.18	99
> 1180	5.7	0	100
sum >0.45 µm	99	21.9	78

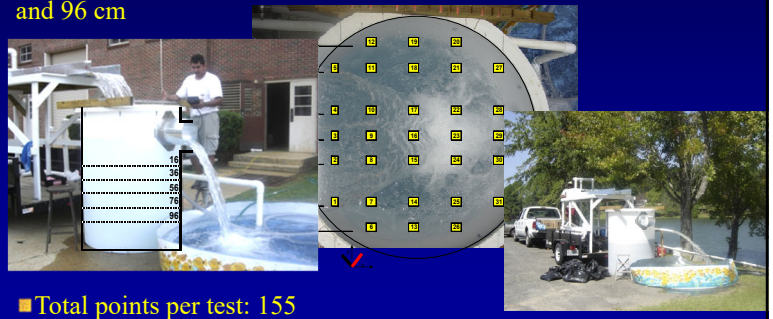
25 gallon/min Flow Rate and 500 mg/L Conc.

Particle Size (µm)	Influent Conc. (mg/L)	Effluent Conc. (mg/L)	Reduction (%)
< 0.45	240	120	49
0.45 to 3	26	3.2	88
3 to 12	92	32	65
12 to 30	130	28	79
30 to 120	81	3.9	95
120 to 1180	142	0.55	100
> 1180	30	0	100
sum >0.45 µm	500	67.7	86

22

Scour of Captured Sediment in Storm Drain Catchbasin Inlets

- Three flow rates: 10, 5, and 2.5 LPS (160, 80, and 40 GPM)
- Velocity measurements (Vx, Vy, and Vz)
- Five overlying water depths above the sediment: 16, 36, 56, 76, and 96 cm



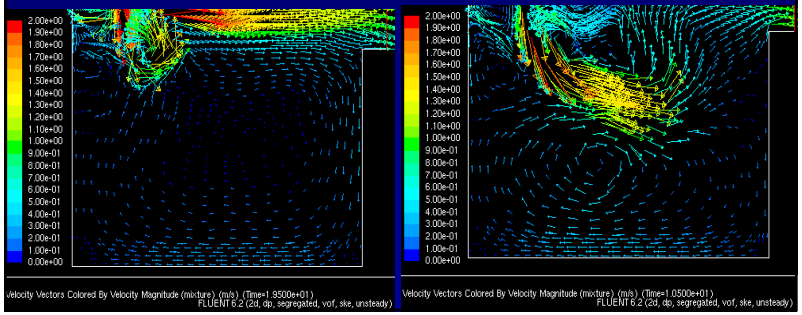
- Total points per test: 155
- 30 instantaneous velocity measurements at each point

23

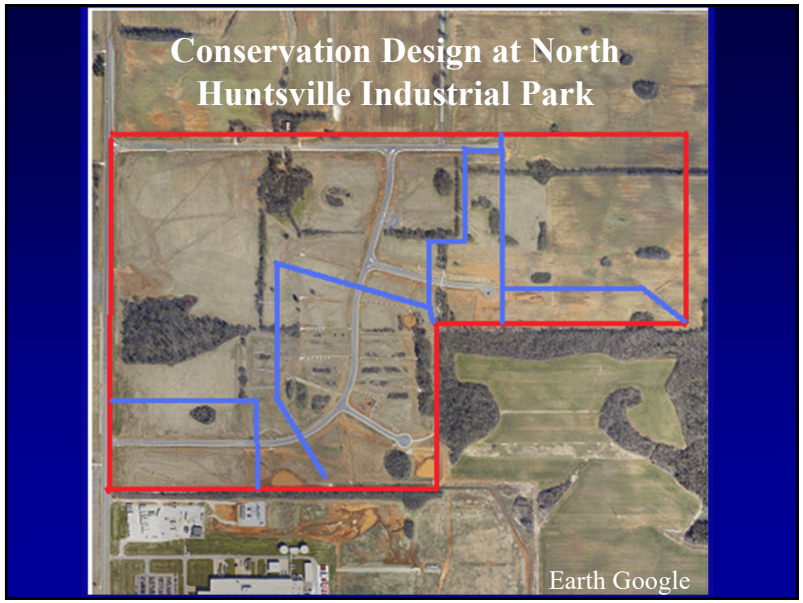
CFD Modeling to Calculate Scour/Design Variations

- Used CFD (Fluent 6.2 and Flow 3D) to determine scour from stormwater controls; results being used to expand WinSLAMM analyses after verification with full-scale physical model

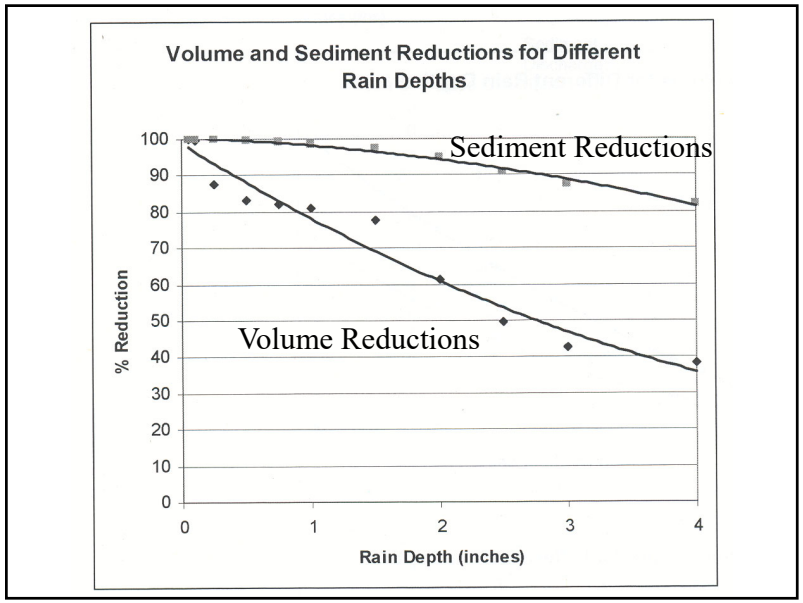
- This is an example of the effects of the way that water enters a sump on the depth of the water jet and resulting scour



24


Conservation Design at North Huntsville Industrial Park
Earth Google

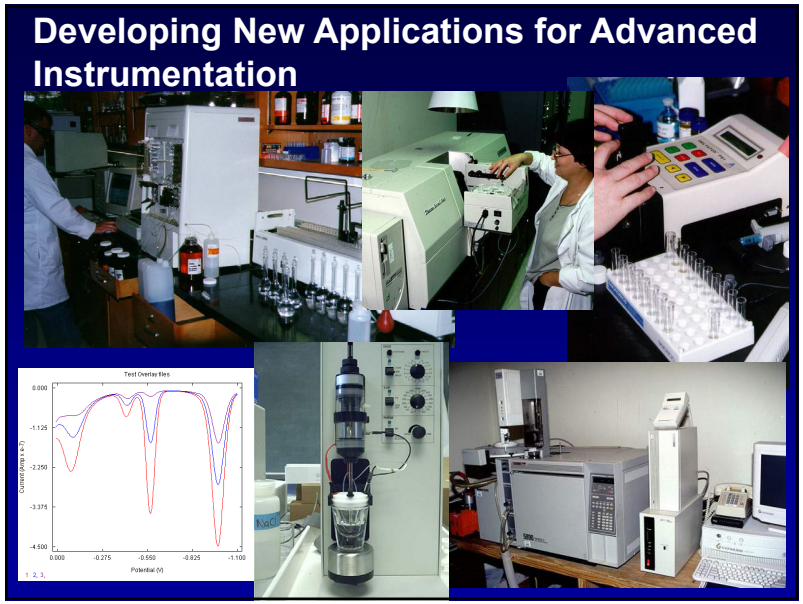
25


Volume and Sediment Reductions for Different Rain Depths
Sediment Reductions
Volume Reductions
% Reduction
Rain Depth (inches)
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4

26

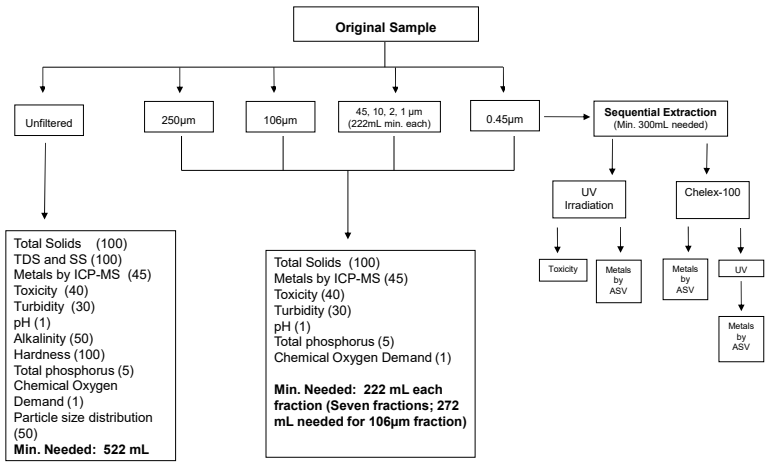

Evaluating New Analytical Methods to Solve Problems

27


Developing New Applications for Advanced Instrumentation

28

Developed Sample Processing Flow Schemes



29

Sampling Sites

- Sediment samples were collected from three urban creeks in the Tuscaloosa and Northport, Alabama, city areas

Site 1: Cribbs Mill Creek

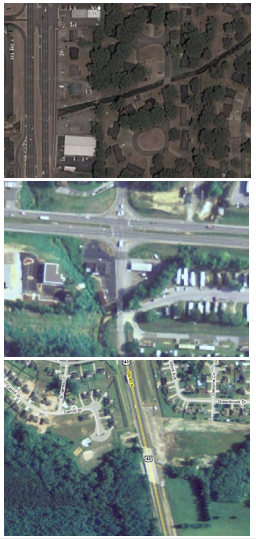
- Source areas: medium density two story family home residential area
- No history of sanitary sewage contamination (Pitt, *et al* 2005)

Site 2: Hunter Creek

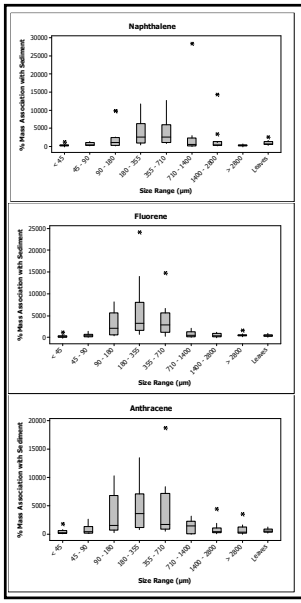
- Source areas: automobile service commercial areas, heavy traffic along McFarland Blvd., and runoff from trailer park residential areas

Site 3: Carroll Creek

- Source areas: A residential area on one side and forested lands on the other side of the creek
- Has a recent history (in 2006) of sanitary sewer overflows (SSOs) into the creek (ADEM Consent Order No. 07-139-CWP to City of Northport)

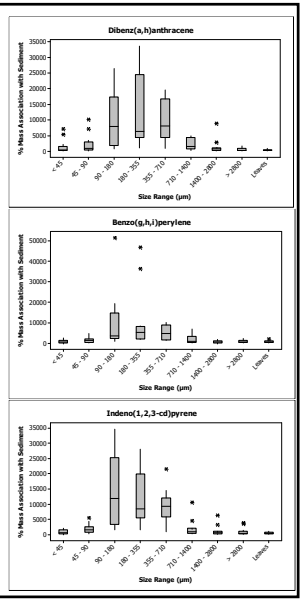


30



Mass of PAHs by Particle Sizes

Almost all of the sediment PAHs are associated, by mass, in the intermediate particle size fraction (90 to 710 µm), even though this size range had the lowest concentrations



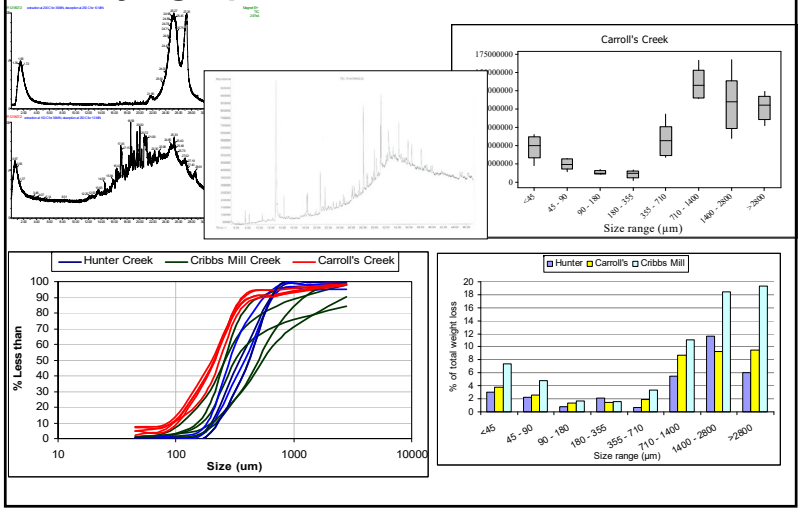
31

What are Emerging Water Contaminants?

- Initial investigations during the mid 1990s in Europe and in some US cities found pharmaceuticals and personal care products in receiving waters, sanitary sewage discharges, and even in some treated drinking waters.
- The EPA currently has expanded the list of emerging water contaminants to include many classes of compounds that are not traditionally covered in water quality regulations, but are suspected of being harmful.

32

Characterizing Emerging Contaminants and Identifying Options for Treatment



33

Stormwater Treatment Technologies that are Good Candidates for EC Removal

- Biofiltration and bioinfiltration. We are conducting groundwater fate modeling to investigate potential groundwater contamination of ECs during infiltration through different soils
- Sedimentation. Our fugacity modeling indicates that many ECs are associated with particulates and can be trapped in wet detention ponds
- Other commonly used stormwater controls likely have less potential treatability of most emerging contaminants due to high flow rates and short contact periods
- Activated sludge and strong oxidation have been shown to be good treatment unit operations for emerging contaminants at wastewater treatment plants, but these processes are not common for stormwater control, but are used at treatment facilities receiving combined sewage.

34

Stormwater Research in the Department of Civil, Construction, and Environmental Engineering

- We have been involved in stormwater research for many years and have investigated receiving water effects, sources of pollutants, and have developed effective control practices.
- We have also been involved in the development of stormwater regulations and design manuals throughout the country
- We have made over 100 presentations at technical conferences during the last 2 years.

35

Acknowledgements

- Over the years we have had support from many organizations, including the cities of Tuscaloosa, Northport, Huntsville, and Birmingham, The University of Alabama, SWMA, ALDOT, and ADEM.
- Much of our stormwater research has been funded by the Wet Weather Flow Program of the US Environmental Protection Agency. Other supporting agencies have included NSF, DOT, the Small Business Administration, Water Environment Research Foundation, plus various state agencies in California, Washington, Missouri, New York, Wisconsin, amongst others.
- Recent industrial clients have included TVA, Boeing, HydroInternational, GeoSyntec, and TetraTech.
- None of our research would have been possible without the hard work of numerous graduate and undergraduate students.

36