Illicit Discharge Detection and Elimination

Indicator Monitoring

Wissahickon IDDE Workshop
Fort Washington, PA
May 31, 2011

Indicator Monitoring

- More detailed sampling to:
  - ID problem outfalls not apparent from physical indicators alone
  - Test suspect or problem outfalls to confirm if illicit discharge
  - Determine flow type
  - Analyze intermittent discharges

Discharge Flow Types

- Pathogenic & toxic discharges
  - Sanitary wastewater
  - Commercial & Industrial discharges
- Nuisance & aquatic life threatening discharges
  - Landscaped irrigation runoff
  - Construction site dewatering
  - Automobile washing
  - Laundry wastes
- Unpolluted discharges
  - Infiltrating groundwater
  - Natural springs
  - Domestic water line leaks

Indicators to Identify Sources of Contamination

Ideal indicator to identify major flow sources has the following characteristics:

- Significant difference in concentrations between possible pollutant sources;
- Small variations in concentrations within each likely pollutant source category;
- Conservative behavior (i.e., no significant concentration change due to physical, chemical or biological processes);
- Ease of measurement with adequate detection limits, good sensitivity and repeatability.

Key Lab Considerations

- Equipment cost
- Staff training
- Number of samples
- Safety
- Disposal

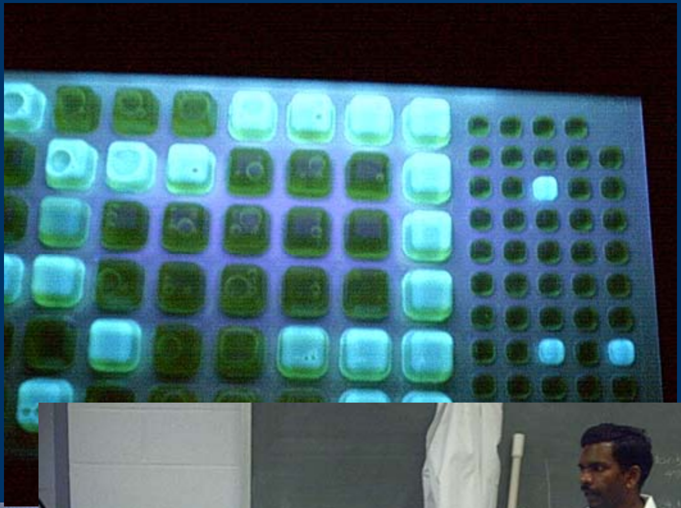


Photo Source: Robert Pitt

Simple and Inexpensive Analytical Methods (can be used in the field, but usually much easier, safer, and more efficient in lab)

- Comparative colorimetric methods (apparent color, detergents after extraction)
- Simple probes (pH, conductivity, ion selective potassium)
- Spectrophotometric (fluoride, ammonia, boron)


HACH


ATTENTION


Catalog No.
C-9400


HORIBA
7
x100
x10
x1
ppm
K
off
on
std
slope
CARDY
K+
COMPACT ION METER C-131


Portable Datalogging Spectrophotometer
0.00 mg/L NH3-N Salic
655nm
HACH DR/2010
%T 7
ABS 8
CONC 9
ZERO
READ
RECALL STORE
ERASE CE
PRINT 4
TIMER 5
BATT 6
EXIT
SELECT PRGM
SHIFT
0
+/- 1
SETUP 2
USER PRGM 3
ENTER


FLUORIDE
POCKET COLORIMETER
FLUORIDE
mg/L F⁻
ZERO
READ
HACH


FLUORIDE
mg/L F⁻
ZERO
READ
HACH
Pocket Colorimeter™

Field vs. lab analysis

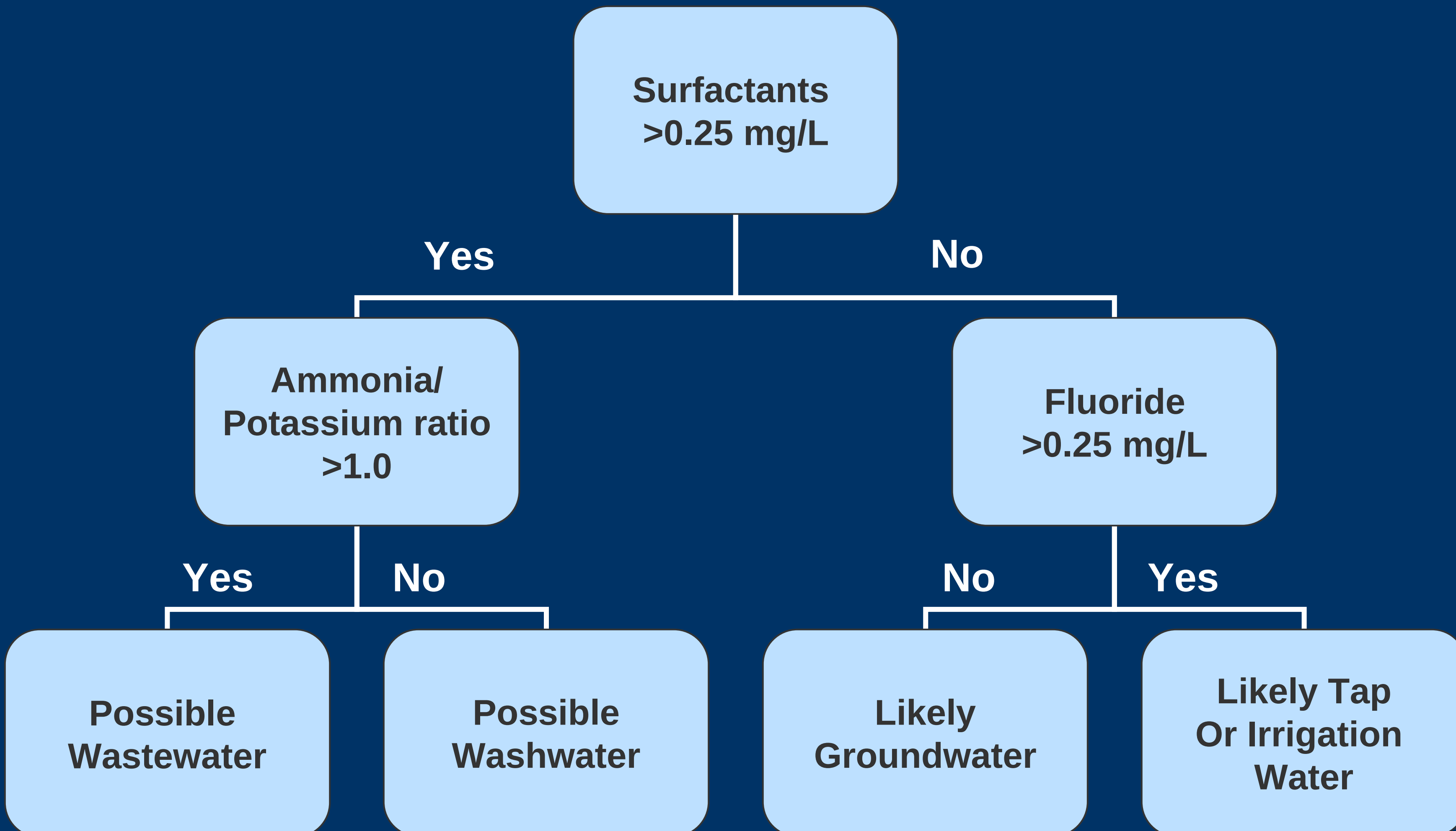
Techniques to Interpret Indicator Data

- Single Parameter Screening
- Flow Chart Method
- Industrial Flow Benchmarks
- Chemical Mass Balance Model

Single Parameter Screening (not necessarily recommended)

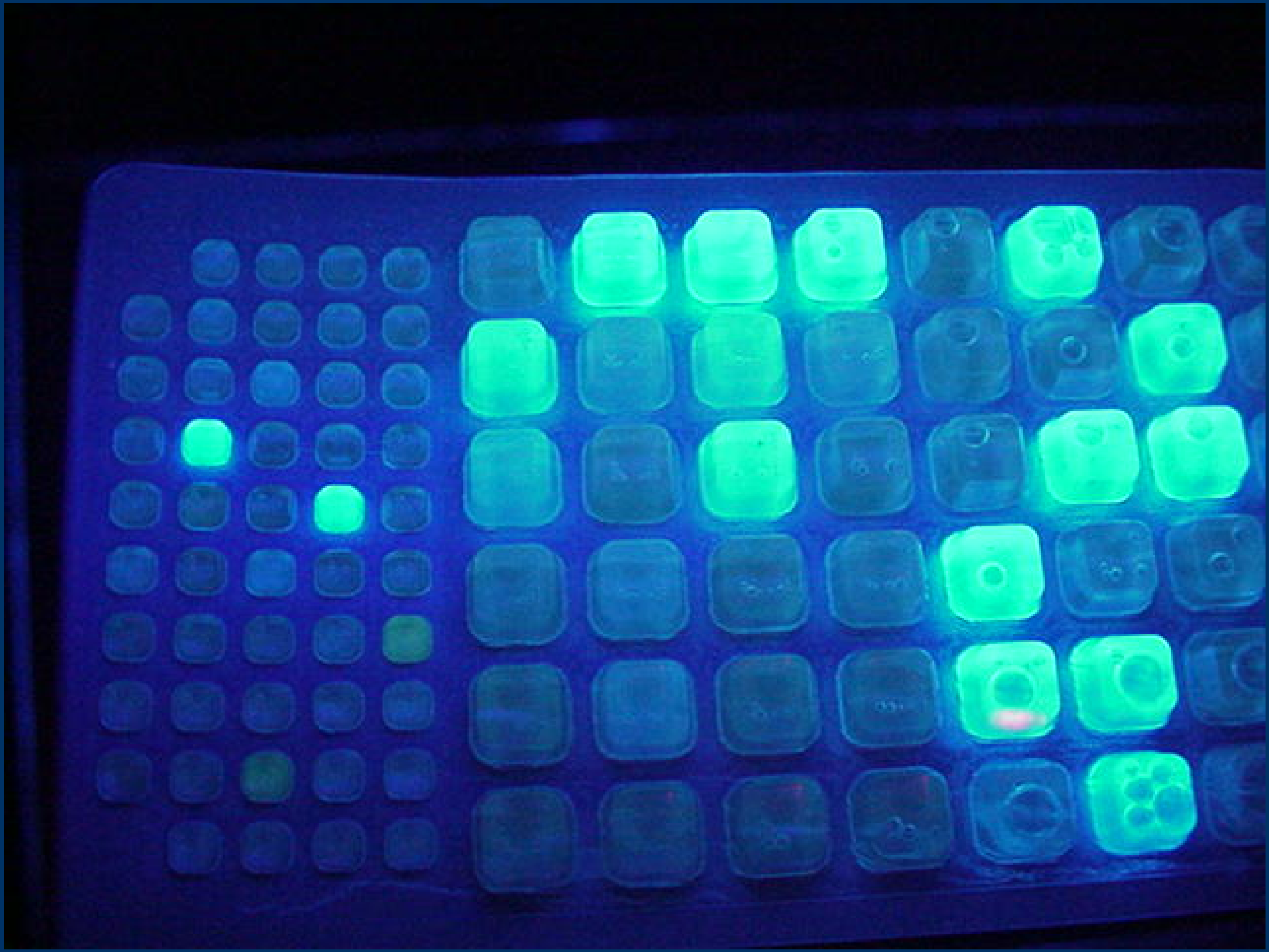
- Detergents
  - Best single parameter to detect illicit discharges
  - Analysis conducted in controlled lab setting
- Ammonia
  - Concentrations >1mg/L is positive indicator of sewage
  - Analysis in field using portable spectrophotometer

IDDE Flow Chart (Brown et al, 2004)

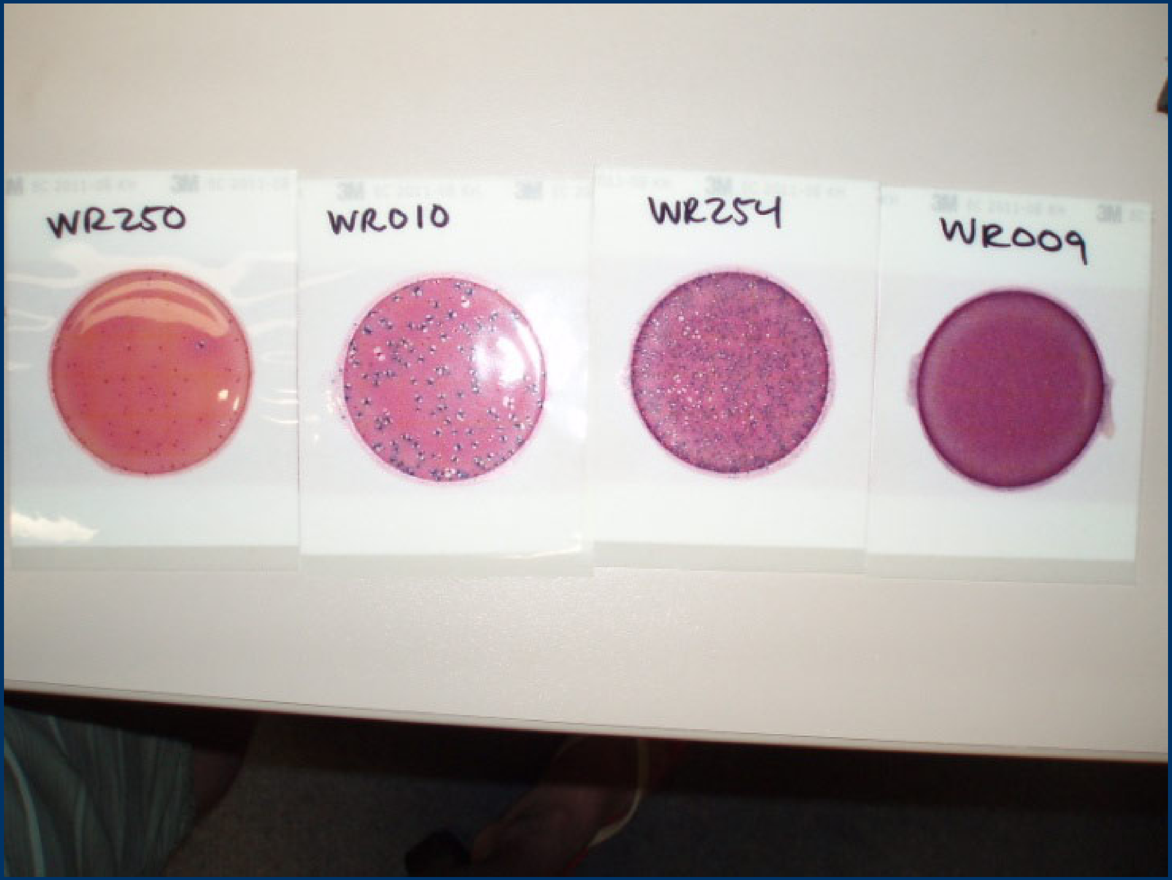


Bacteria Monitoring

Quantitray Under UV Light



3M Petrifilm Plates



Benchmark Concentrations to Identify Industrial Discharges

Benchmark	Concentration	Notes
Ammonia (mg/L)	**≥50**	▸ Existing "Flow Chart" Parameter ▸ Concentrations higher than the benchmark can identify a few industrial discharges
Potassium (mg/L)	**≥ 20**	▸ Existing "Flow Chart" Parameter ▸ Excellent indicator of a broad range of industrial discharges
Color (Units)	**≥ 500**	▸ Supplemental parameter that identifies a few specific industrial discharges
Conductivity (μS/cm)	**≥ 2,000**	▸ Identifies a few industrial discharges ▸ May be useful to distinguish between industrial sources
Hardness (mg/L as $CaCO_3$)	**≤10 ≥ 2,000**	▸ Identifies a few industrial discharges ▸ May be useful to distinguish between industrial sources
pH (Units)	**≤ 5**	▸ Only captures a few industrial discharges ▸ High pH values may also indicate an industrial discharge but residential wash waters can have a high pH as well
Turbidity (NTU)	**≥ 1,000**	▸ Supplemental parameter that identifies a few specific industrial discharges

Chemical Fingerprint Library

- Shallow Groundwater
- Spring Water
- Tap water
- Irrigation
- Sewage
- Septic Tank Discharge
- Common Industrial Discharges
- Commercial Car Wash
- Commercial Laundry

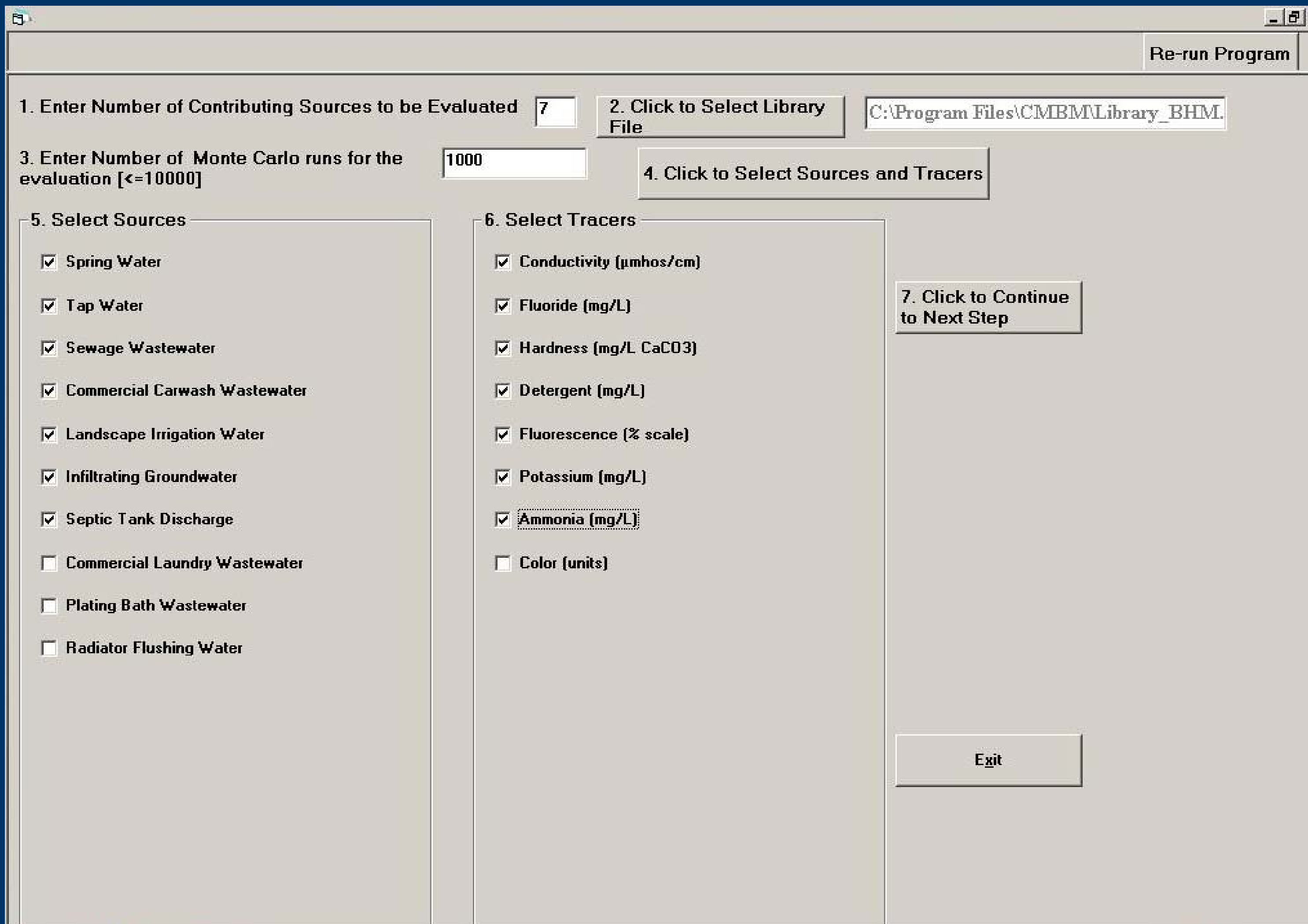
Preliminary Tuscaloosa, AL, "Library" File Data

Mean/(COV)	Fluoride (mg/L)	Detergents (mg/L MBAS)	Ammonia (mg/L, as N)	Potassium (mg/L)
Tap water	0.95 (0.03)	0 (0)	0 (0)	1 (0)
Spring water	0.024 (1.3)	0 (0)	0.034 (0.82)	3.4 (0.79)
Car wash water	0.02 (1.4)	80 (1.2)	0.55 (0.27)	6 (0.94)
House laundry water	1.1 (0.18)	960 (0.06)	1.0 (0.15)	2 (0)
Sewage	0.68 (0.07)	11 (0.12)	22 (0.71)	12 (0.19)
Industrial wastewater	0.21 (1.7)	6.0 (0.68)	5.3 (0.73)	49 (0.52)

Preliminary Tuscaloosa, AL, “Library” File Data

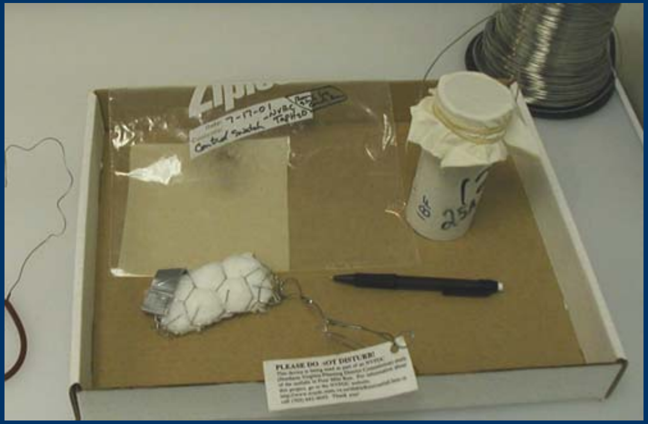
Mean/(COV)	Hardness (mg/L)	Fluorescence (mg/L as Tide)	*E. Coli* (mpn/100 mL)	Enterococci (mpn/100 mL)
Tap water	66 (0.07)	0 (0)	0 (0)	0 (0)
Spring water	34 (0.22)	2.7 (1.6)	2.4 (0.8)	1.0 (1.6)
Car wash water	36 (0.82)	131 (0.01)	1480 (0.07)	1213 (1.4)
House laundry water	16 (0.23)	1117 (0.15)	n/a	n/a
Sewage	50 (0.28)	187 (0.28)	1413 (not (0.65) discrete)	1220 (not (1.1) discrete)
Industrial wastewater	32 (0.15)	278 (0.78)	409 (2.7)	477 (2.3)

Chemical Mass Balance Model



Special Indicators for Intermittent Discharges

- Optical brightener monitoring
- Outfall damming
- Caulk Dams
- Take a sample from the pool
- Toxicity testing



Results of Field Verification Tests

Drainage areas for 10 outfalls were studied in detail in order to verify actual sources of contamination.

Data analysis method	**Information obtained**	**Percentage of false negatives**	**Percentage of false positives**
Physical indicators	Some contaminated outfalls missed and some uncontaminated outfalls falsely accused.	20%	10%
Detergents	All contaminated outfalls correctly identified!	0	0
Flow chart	All major contaminating sources identified correctly!	0	0
Chemical mass balance	All contaminated outfalls correctly identified, and most sources correctly identified and reasonably well quantified!	0	0

Take Home Points

- For single parameter screening, use detergents or ammonia
- Detergents, fluoride, ammonia, and potassium recommended as most useful for identifying contamination of storm drainage systems, as well as tests for *E. coli* or Enterococci
- Begin to document and understand the chemical signatures in Richmond, VA

Q/A