Stormwater Monitoring: A Primer on Basic Data and Methods

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Why are we here?

- Pending federal regulations
- Some existing state and local regulations
- Focus on construction site runoff
- Growing need for data in MS4 communities

Water Quality Priorities for Stormwater Management:

Active Construction

- B & C horizon soils
- Event-based runoff
- 20 Acres or fewer in size
- Finite time frame

Post-Construction/MS4

- All Soil Types
- Wet and dry season concerns
- City/Watershed scale
- Ongoing troubleshooting

Active Construction Site Monitoring: A Focus on Sediment

- Long been considered primary sources for water quality concerns
- Just one of many parameters that can have severe impacts on water quality in our urbanized landscapes.
- Optimal surrogate for other pollutants.

What *else* can we get out of this?

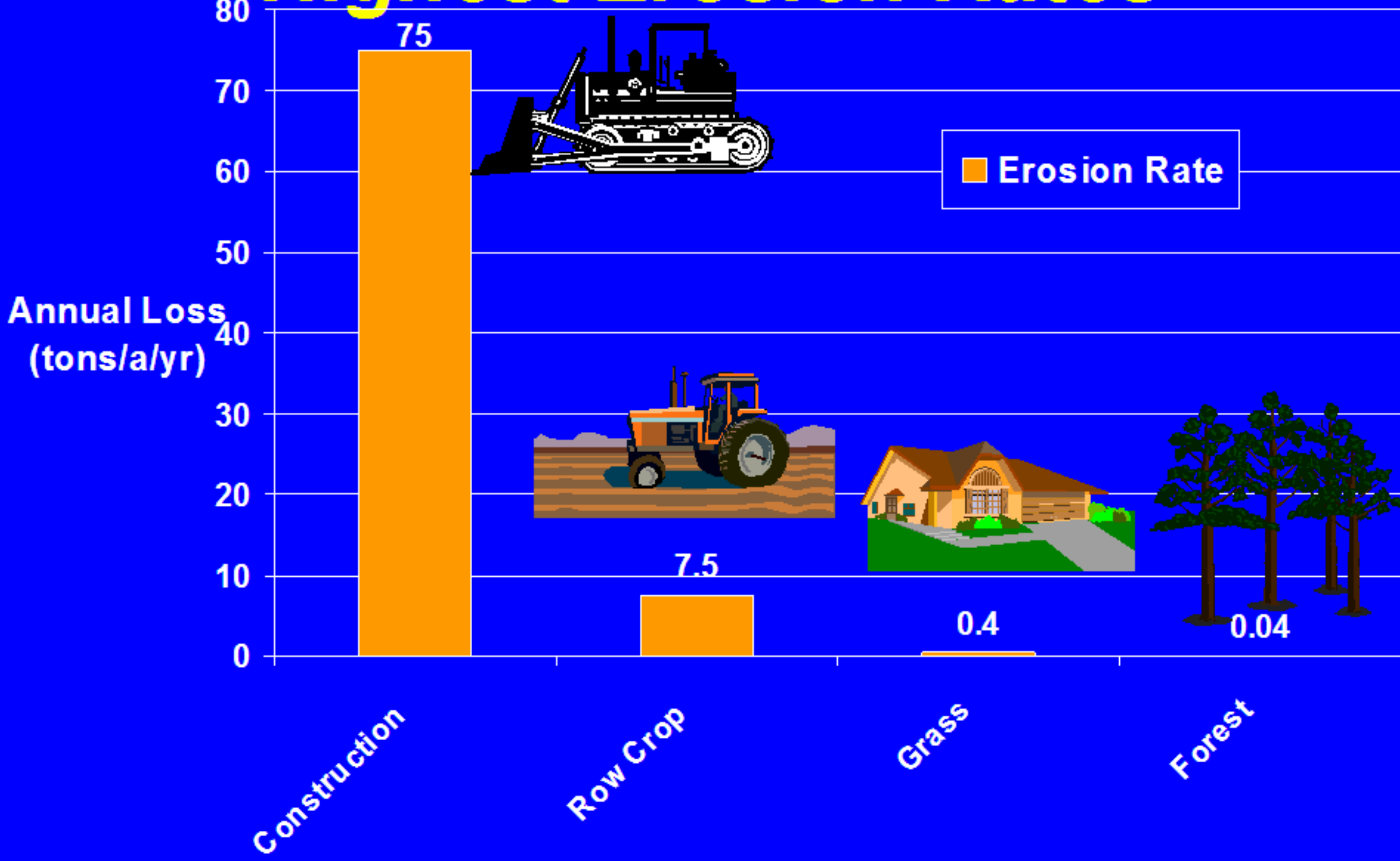
- Preparation for what is to come.
- Establishing workable plans for gathering data.
  - Weekly sampling with erosion control inspections.
  - Event-based sampling.
  - Begin to predict/plan and implement based on data you collect.

Effluent

- **Effluent:** Discharge water or gas from a natural body of water, or from a human-made structure.

- **Effluent Limitation Guidelines (ELGs):** The maximum amount of a pollutant that an entity is permitted to release into a water body over a given period of time – usually 24 hours.

Construction Sites Have Highest Erosion Rates



Source: US EPA

Turbidity Concentration Over Time = Degradation

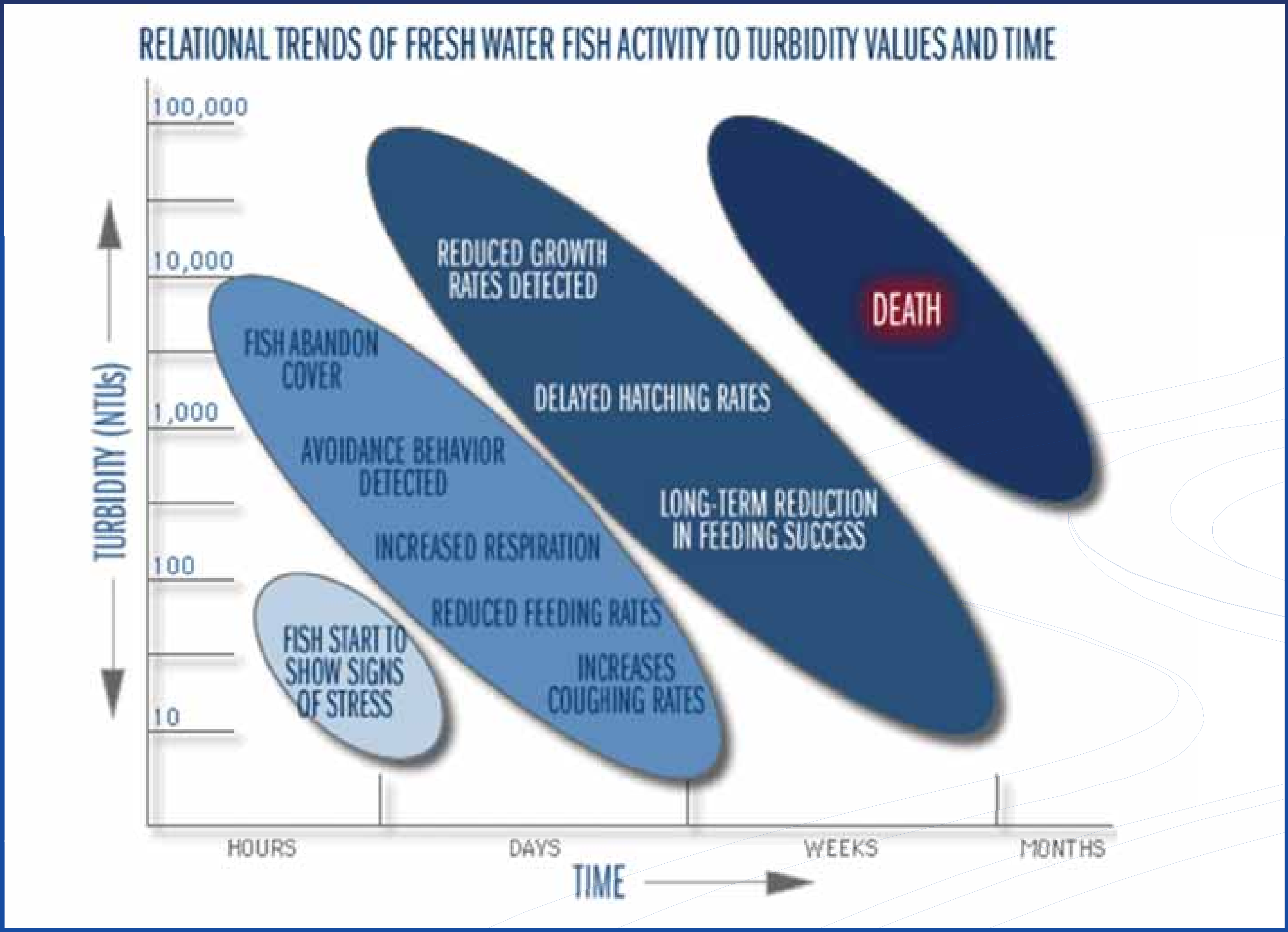


Image source: oftimeandtheriver.com

So what are we to do?

- Advanced monitoring techniques & programs
  - Mostly research-based
  - Very costly
  - Highly credible data
- Stormwater triage
  - Event-based monitoring
  - ELGs will be driven by this

The NTU/SSC/Turbidity Debate

- NTU
  - Index of light scattering by suspended particles.
  - Relative measurement
  - Indexes water "cloudiness"
- SSC - Suspended Sediment Concentration
  - Produced by measuring the dry weight of **all** the sediment
  - from a known volume of a water-sediment mixture.
- TSS – Total Suspended Solids
  - Measuring the dry weight of sediment from a known volume of a **subsample** of the original.
  - Originally designed for analyses of wastewater.
  - Unreliable for the analysis of natural-water samples.
- Turbidity
  - Must be calibrated to a "proper" scientific quantity.

Why NTU?

- Likely the most practical unit of measuring sediment content in standing or moving waters.
- Initially, EPA proposed a 280 NTU limit for effluent discharge from specified construction sites.
- No numeric guideline exists today.

Turbidity (water cloudiness)

- Usually measured in the laboratory.
- True NTUs are derived from taking a measurement of defracted light at a right angle to a known quantity of light.
- Often uncritically taken to be equivalent to visual clarity.

Formazin Standards

- Turbidity Standard for all turbidimeters
- Colloidal polymer suspension with set NTU measurements
- USEPA accepted for calibration purposes

Turbidimeters & NTU Measurements:

- Do generate NTU measurements for compliance monitoring.

- However…
  - Turbidimeters require calibration.
  - Different instruments may produce different numbers.
  - An arbitrary measurement, usually measured relative to a formazin standard.
  - Turbidity is not uniquely related to visual clarity or SSC.

(Smith and Davies-Colley, 2001 & 2002)

General Comments on Turbidimeters

- Potential causes of false low readings:
  - Coarse floating debris that settles out rapidly
  - Presence of color in sample water due to dissolved substances that absorb light will cause turbidity measurements to be low.
- Potential causes of false high readings:
  - Air bubbles in the water.

Care for Turbidimeters

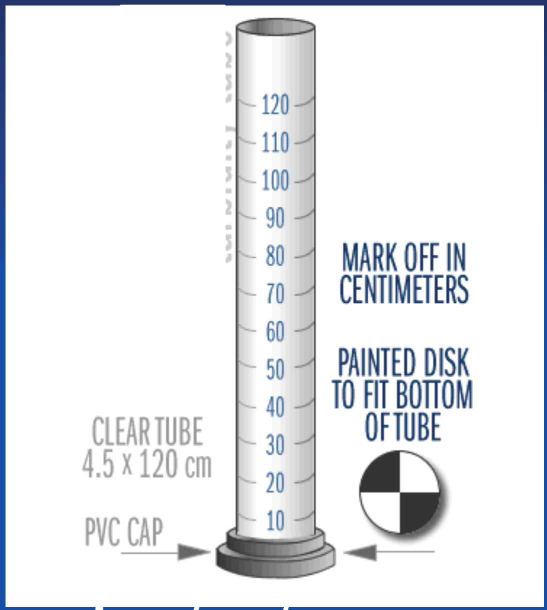
- Turbidimeters are not weatherproof. Avoid exposure to moisture, extreme temperatures and soils.
- Avoid:
  - Fingerprints or handling the cell below the line where light passes through placed in the meter.
  - Scratching cells as this will distort the meter reading.
  - Placing cells directly in clothing pockets, as this may scratch the cell.

Visual Clarity as a Measurement

- Considered a "true" scientific measurement
- Has immediate environmental relevance
- Is readily understood
- Is not particularly subjective
- Can be measured with better precision than SSC and turbidity
- Is more relevant than SSC and turbidity

Applying Monitoring to Active Construction

- Focus on sediment
- Manual transparency measurements
  - Quick
  - Affordable
  - Generates a baseline understanding



Should a higher level of accuracy be required, then consider a meter or lab analysis to reinforce the initial data collected in the field.

IOWATER Transparency Tube

- Subjective, reflected light reading
- Enabled by sunlight
- Works within the ability/ limitations of the human eye ~ 100 cm.

Transparency Conversion Chart*

Centimeters	Inches	NTU (approx.)
<6.4	<2.5	>240
6.4 to 7.0	2.5 to 2.75	240
7.1 to 8.2	2.76 to 3.25	185
8.3 to 9.5	3.26 to 3.75	150
9.6 to 10.8	3.76 to 4.25	120
10.9 to 12.0	4.26 to 4.75	100

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Depth in Centimeters = 244.13 *(Turbidity in NTU)$^{-0.662}$

Let's Find the Magic Number

Depth in Centimeters = 244.13 *(Turbidity in NTU)$^{-0.662}$

$280^{-0.662}$ = .0239873

.0239873 x 244.13 = 5.8560…

So, 280 NTU ~ 6 cm on the Transparency Tube

Would this be a compliant sample?

Straight from the Vendor:

"My take on their situation is the meter does not belong in the pickup truck. Who is checking the date on the standards or if the dishwasher did his job?"

- Why?
  - The standards vials expire and need to be replaced about once a year.
  - Vials for grab samples have to be kept sterile and unmarred or the readings are not valid.

My Take on Things

- Transparency tube measurements are better than nothing at all and are a cost-effective bridge until new technologies advance.
- Sites needing a higher level of accuracy may choose to purchase turbidimeters.
  - Determine who is responsible for the meter.
  - Maintain calibration records.

What to do for now?

- Instruments exist.
  - Turbidimeters: $600-$1500
  - Transparency Tube: $35-$100
- Invest what you are able to, but invest wisely.

Other parameters?

- pH
  - Concrete washout systems
  - Lime/limestone products in use
- Dissolved Oxygen
  - Flocculent/Polymer use (along with pH?)
- Temperature
  - Sediment Basins
- Hydrocarbons
  - Areas prone to spills

Federal Guidelines?

- Numerical standards back to the drawing board.
- Something will eventually take effect.
- In the meantime…
  - Focus on proactive solutions.
  - Consider impacts to habitat.

What would I have in my toolbox today?

- Transparency Tube
- DO Kit
- pH strips

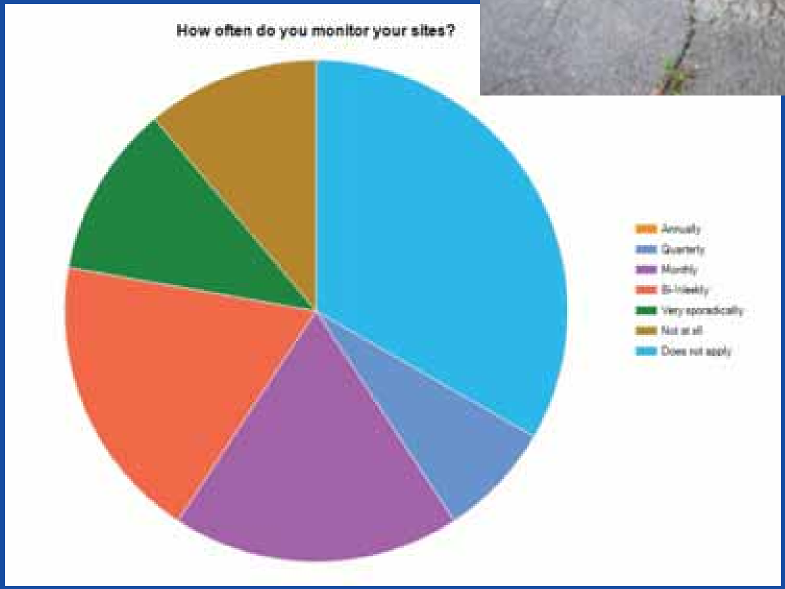
How do they all interconnect?

- Biological
- Chemical
- Physical
- Socio-Economic

Image source: NRCS, MN DNR


KEEP
CALM
AND
CARRY
ON

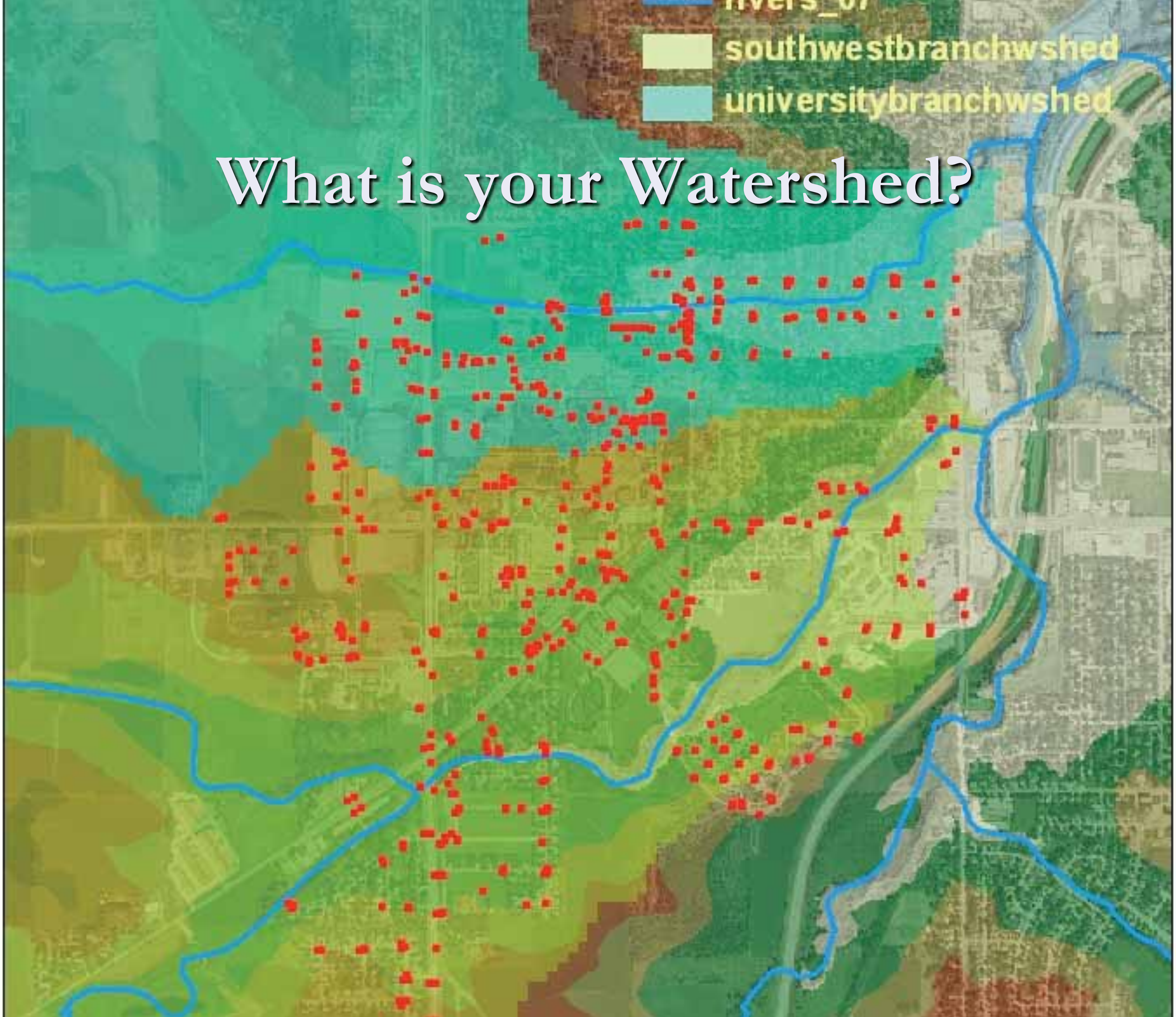
So you want to start monitoring…



Questions to be asked:

- *What do you already know?*
  - Gather as much existing data and reference material for the project site. If this is a construction site, include your geotechnical information, any existing site or design plans, etc.
- *What do you <u>want to</u> know?*
  - This question will depend on the purpose for gathering data. In Sections 6 and 7 we will go into more detail on these topics.
- *What's the area you want to assess?*
  - The size of the project site or location of your monitoring will affect the overall scope of your plan.
- *How will the data be used?*
  - Will you be submitting data to others, or is the data for your own records only?

What is your Watershed?

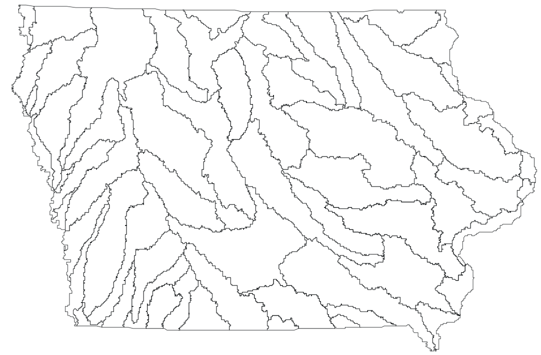


At what scale do you wish to operate?

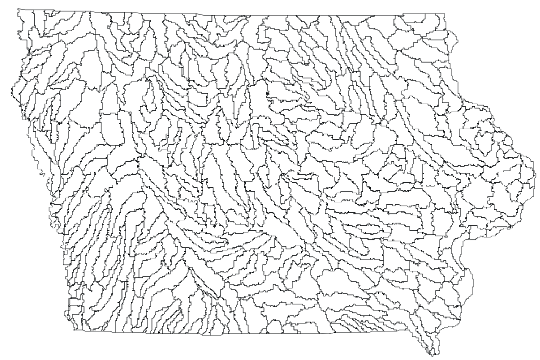
The larger the HUC, the smaller the watershed.

Each digit represents a characteristic describing the scale of the watershed.

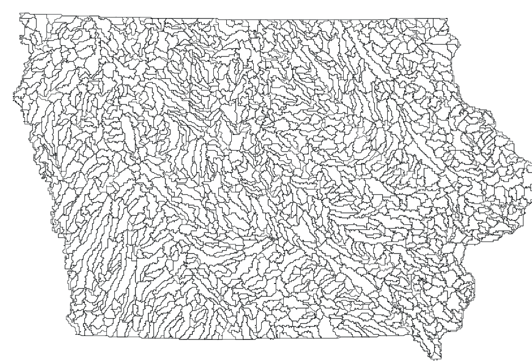
Smaller watersheds are more detailed descriptions, making their HUC have more digits than a larger watershed.



8-digit HUCs
56 basins
390.6 - 1,953 mi^2



10-digit HUCs
Approximately 400 basins
62.5 - 390.6 mi^2



12-digit HUCs
Approximately 1,600 basins
15.6 - 62.5 mi^2

Basic Monitoring Concepts

- **Baseline Assessment**
  - Initial investigation.
  - No other data exists, or conducted prior to a change in the landscape.
  - Can serve as a “control” when comparing data after land disturbance, changes in management, or other impacts on a water body occur.

Basic Monitoring Concepts

- **Compliance Monitoring**
  - Recorded in order to remain in compliance with local, state or federal regulations.
  - ***Always follow the guidelines provided by the regulatory agency first.***
  - Any additional monitoring may be considered “above and beyond” the basic monitoring required by the regulatory agency.

Basic Monitoring Concepts

- **Snapshot Sampling**
  - Gather initial, discrete data on a number of locations at a given time.
  - Community Involvement: engage and energize citizens in other watershed protection activities.
    - Citizens
    - Local organizations
    - Youth
    - Other stakeholders

Basic Monitoring Concepts

- **Performance Monitoring**
  - Determine water quality impacts of specific structural or non-structural practices.
  - May require pre and post data, as well as interval samples over time.
  - May be used to validate models.
  - Both short and long-term impacts may be assessed..

Basic Monitoring Concepts

- **Receiving Water Assessments**
  - May link to watershed improvement plan or Total Maximum Daily Load (TMDL)
  - May be done in cooperation with state or federal agencies
    - More broadly understand local water quality problems
    - Identify sources of impairment
    - Work to establish watershed-wide management plans.

Basic Monitoring Concepts

- **Source Area Monitoring**
  - May help identify or detect critical sources of stormwater pollutants.
    - Illicit discharge detection
    - Identification of "hot spots"
  - Solutions oriented – not problem seeking!

Basic Sampling Methods

Discrete Sampling

Composite Sampling

Sampling Alternatives

- Bucket/pole method may be used.
  - Pour samples into cells as quickly as possible.
  - Stir or swirl the sample bucket as needed to keep the solids suspended before pouring.
- Take cell only to sampling site, leave meter behind.

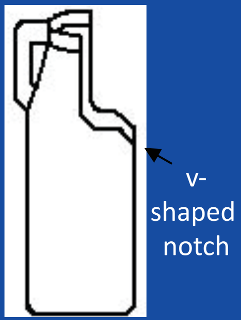


Image source: IOWATER Manual, thestamfordtimes.com

Monitoring Methodology

- Micro-Site Approach to Data Collection
  - <40 acres preferred
- Land Use Types
  - Residential/Commercial/Industrial
- Land Forms
  - Rooftops/Roads/Parking Lots/Turf/Crops/Native
- Fixed Sites/Structures
  - Location based on access
  - Ability/Ease of use for sample collectors
- Stream Sampling
  - Wet & Dry weather sampling
  - Above& Below sampling
  - Flow

Evaluation & Reporting Results

- Increase Data Set Over Time
  - Local Data Collection
  - Other Areas
- Statistical Analysis
  - Predictive Modeling tools
  - Aid in "prescribing" practices
- Are we generating measurable results?

Data Collection Considerations

- Time of year
- Location
- Frequency
- Time of day
- Weather conditions
- Who should do it

Monitoring for Construction
A few questions:

- What existing information should you gather about the project?
- What existing information should you gather about the site?
- What might be key parameters to monitor?
- What equipment would be needed?
- What kind of budget should be estimated?

What do I plan to do?

- Baseline assessment?
- Sediment is the key parameter.

- Does the site includes basins?
  - pH?
  - Temperature?
  - DO?

During Weekly Inspections…

- Equipment
  - Transparency tube
  - Thermometer
  - pH meter

- Budget
  - Equipment: $\leq$ \$200
  - Lab fees: \$500 set aside for measurements in need of greater accuracy

Phase II Minimum Measures

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

Water quality monitoring can bring it all together.

Ways to Incorporate Monitoring

	Public Outreach & Education	Public Participation & Involvement	IDDE	Construction Runoff	Post-Con	Good Housekeeping
Snapshots	✓	✓				✓
IOWATER	✓	✓	✓	✓	✓	✓
Modeling & Assessment	✓		✓		✓	✓
Targeted Composite Sampling			✓		✓	✓
BMP Monitoring	✓				✓	✓

"In many cases, the resources being spent for outfall monitoring could be more effectively spent to better understand many other aspects of an effective stormwater management program."

Robert Pitt, et.al. (2004)

Uses of an IOWATER Kit

- Construction Site Inspections
  - Turbidity Tube
  - DO Kit
  - pH strips
- Public Events
  - Snapshots
  - Partnering Activities
- Random/Scheduled Monitoring
  - Connecting/Engaging with Local Volunteers

Public Education and Outreach

- IOWATER Volunteer Water Monitoring Network
  - Snapshot monitoring events
  - Forming IOWATER "teams"

- Gathering & Sharing Data from Existing Sources
  - Watershed Atlas
  - IOWATER Database
  - Storet Database

IOWATER Equipment	Price per Item
Aquatic Dip Net	$24.81
Dissolved Oxygen Test Kit	$30.63
Phosphate Test Kit	$35.79
Thermometer	$5.10
Tape Measure	$32.00
pH Test Strips	$8.38
N/Ni Test Strips	$11.90
Transparency Tube	$26.50
Plastic Tub	$0.77
Tennis Ball on 1-Meter String	$1.63
3-Ring Binder	$1.45
IOWATER bag	$6.20
Magnifying Cube	$0.89
Meter Stick	$0.90
Waste container	$0.30
Chloride Titrators	$23.65
Secchi Disc	$32.00
Total for Level 1	$242.90

IOWATER
Volunteer Water Quality Monitoring

Other State Volunteer Programs

MISSOURI
STREAM
TEAM

Nebraska
Wildlife
Federation

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

The Kansas Department of
Health and Environment
Mark Parkinson, Governor - John W. Mitchell, Acting Secretary
Curtis State Office Building 1000 SW Jackson Topeka, KS. 66612
(785) 296-1500 FAX:(785)368-6368 Email:info@kdheks.gov


Partners in S
KCCI
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Public Participation/Involvement

- Monitoring & Awareness Events
  - Snapshot Sampling
  - Stream/Lake/Pond Cleanup Days
- Partnering with Local Groups
  - SWCD
  - Local Nonprofit Groups
  - County Naturalist Programs & Events


Hurley
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IOWA


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IDDE

- Create opportunities for partnering versus "targeting."
  - Engage with local volunteers/stakeholders
  - School groups

- Regular activities in the watershed increase awareness of ongoing impacts to water quality.

Source area monitoring **to identify stormwater pollutants**

- **Create baseline data**
- **"Source" = "hot spots"**
- **Can include IDDE**

- **Targeting specific land use for BMP implementation**
  - **Identifying a problem**
  - **Determining its impact**
  - **Reacting accordingly**
  - **Measuring success**

Construction Site Runoff Control

- Primary concern is sediment.
  - EGS regulations pending.

- Other parameters of concern:
  - pH
  - Dissolved Oxygen
  - Temperature
  - Hydrocarbons & Organic Compounds

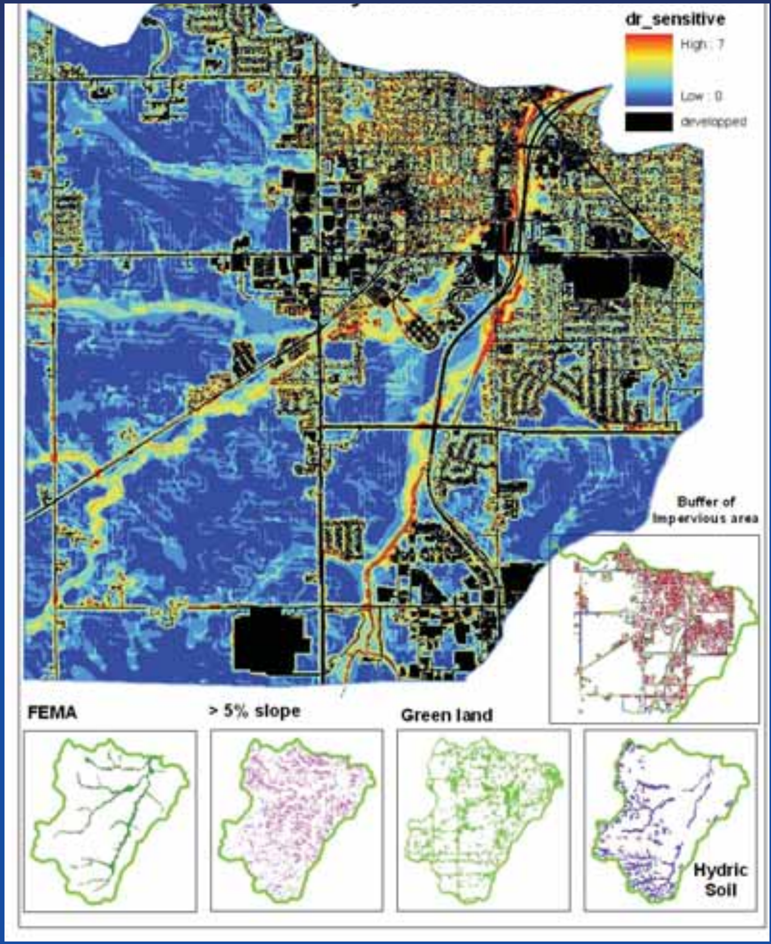
Post Construction Runoff Control

- Planned developments and retrofits
- Often least noticeable, yet most potential for impact.
- Two major factors:
  - A: Inability to infiltrate
  - B: Introduction of potential contaminants

Post Construction Runoff Control

- Planning for pollutant load reduction: WinSLAMM & other models
- Both retrofits and new construction
- Takes volume and pollutant load into account
  - Sediment
  - Nutrients
  - Metals
  - Bacteria (somewhat)

Post Construction Runoff Control



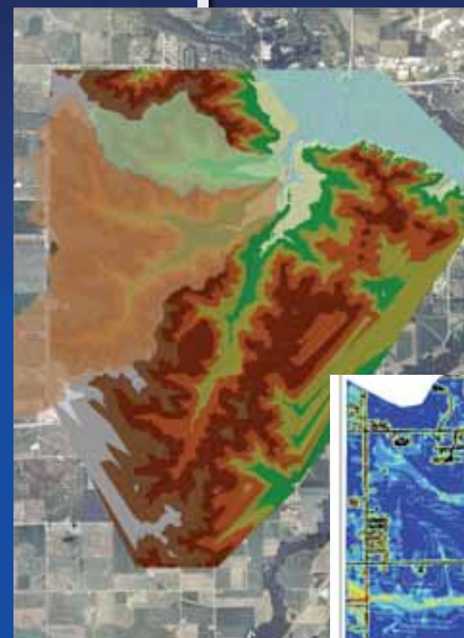
- Assess – Model – Monitor
  - Identify parameters and source data (inputs).
  - Run your model.
  - Monitor to determine actual results.

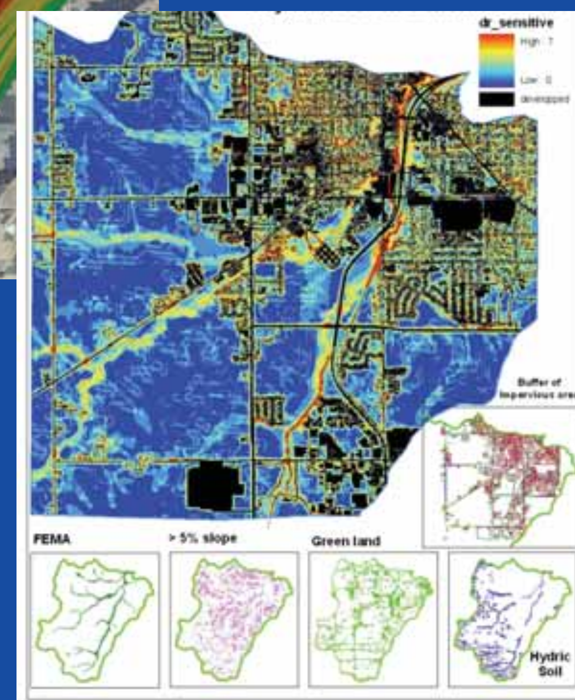
"New" MS4 Program Design

- Specific monitoring beyond basic characterization:
  - **Receiving water assessments** to understand local problem (impairment)
  - **Source area monitoring** to identify critical sources of stormwater pollutants (may include IDDE)
  - **Treatability tests** to verify performance of stormwater controls for local conditions (BMPs)
  - **Assessment monitoring to verify success** of the local stormwater management approach (including model calibration and verification).

Receiving water assessments **to understand local problems**

- Watershed approach
- Align with USEPA Section 319 Nonpoint Source Program
- Targeting impaired water bodies identified by 303(d) lists.





Verify/Validate BMP Performance

- Short and long-term impacts
- Target specific pollutants/treatments
- Generate a quantifiable benchmark
- *Can prove costly!*

Assessment monitoring to measure success

- Listed last, although most important
- Can/should include model calibration and verification to determine actual impact on local water quality
- Must align with initial assessment work in order to measure accurately (Garbage in, garbage out: don't just bring it in at the end of the project and expect good data!)

We are part of a very big puzzle.

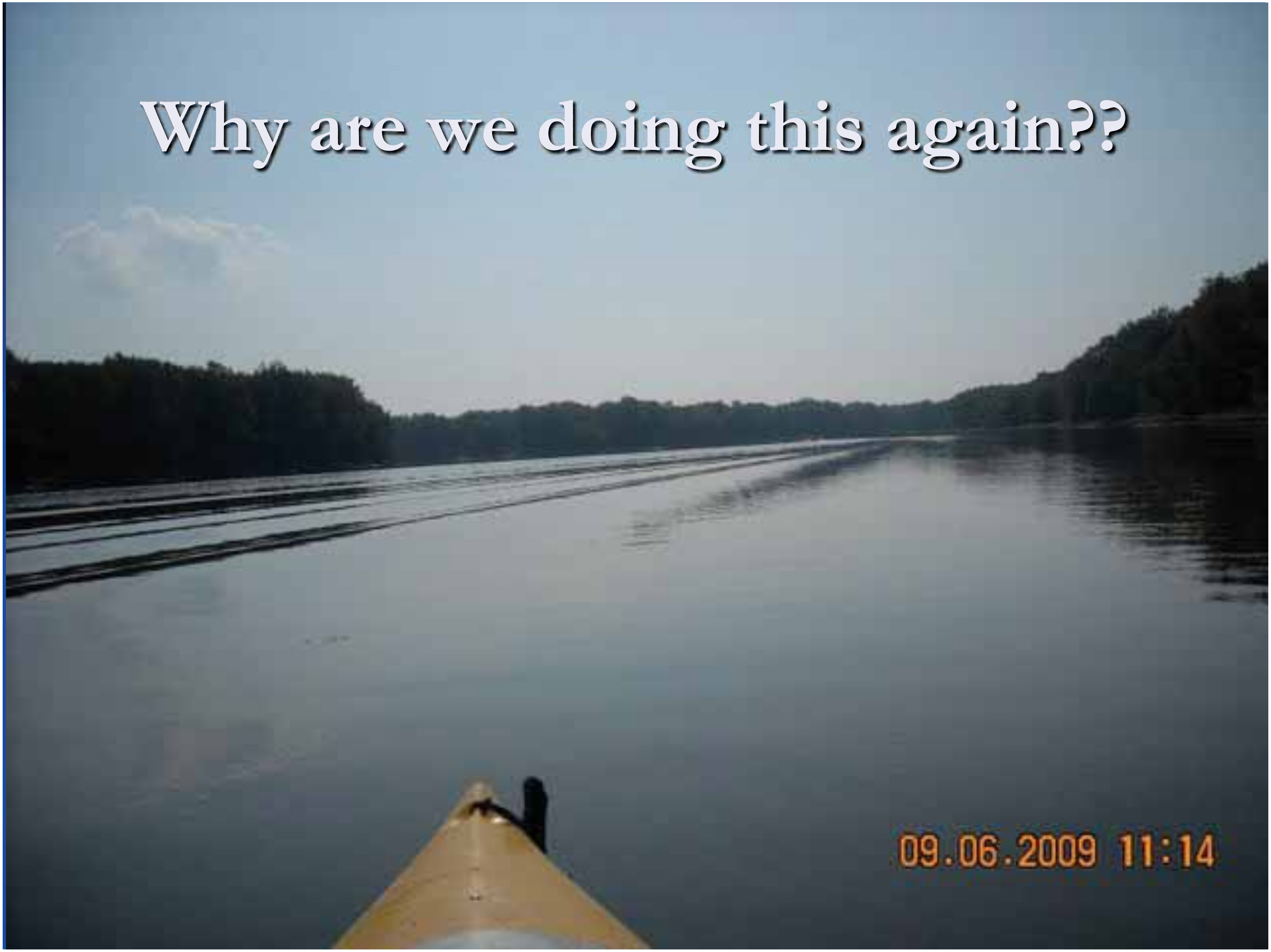
Meaningful data is valuable data.

- Monitor with a goal – answer a question.
- Partnerships can help make data collection easier.
- Existing resources can increase efficiency.
- Data can be a great communications/ educational tool.
- Many MS4 requirements can be met through monitoring.

We're all in this together.

- Compliance isn't easy.
- All entities are facing challenges.
- "Ducking" could result in consequences!

Why are we doing this again??



Additional Materials & Resources

- IOWATER Volunteer Water Monitoring Program (www.iowater.net)
- Center for Watershed Protection (www.cwp.org)
  - Urban Subwatershed Restoration Manual Series
- University of Minnesota Erosion & Stormwater Management Program (www.erosion.umn.edu)
- Stormwater Manager's Resource Center (www.stormwatercenter.net)
- Iowa Stormwater Management Manual (www.intrans.iastate.edu/pubs/stormwater/index.cfm)

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Any questions?
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