Remedial Options and Watershed Management

South River Expert Panel10-06-09

ROP Work Group (Grosso)

Innovative Task Team (Harris)

Watershed Restoration Efforts (Brent)

Bank Stabilization Pilot (Morrison)

Purpose of the SRST ROP Work Group:

Review, evaluate and test promising remediation strategies for the South River

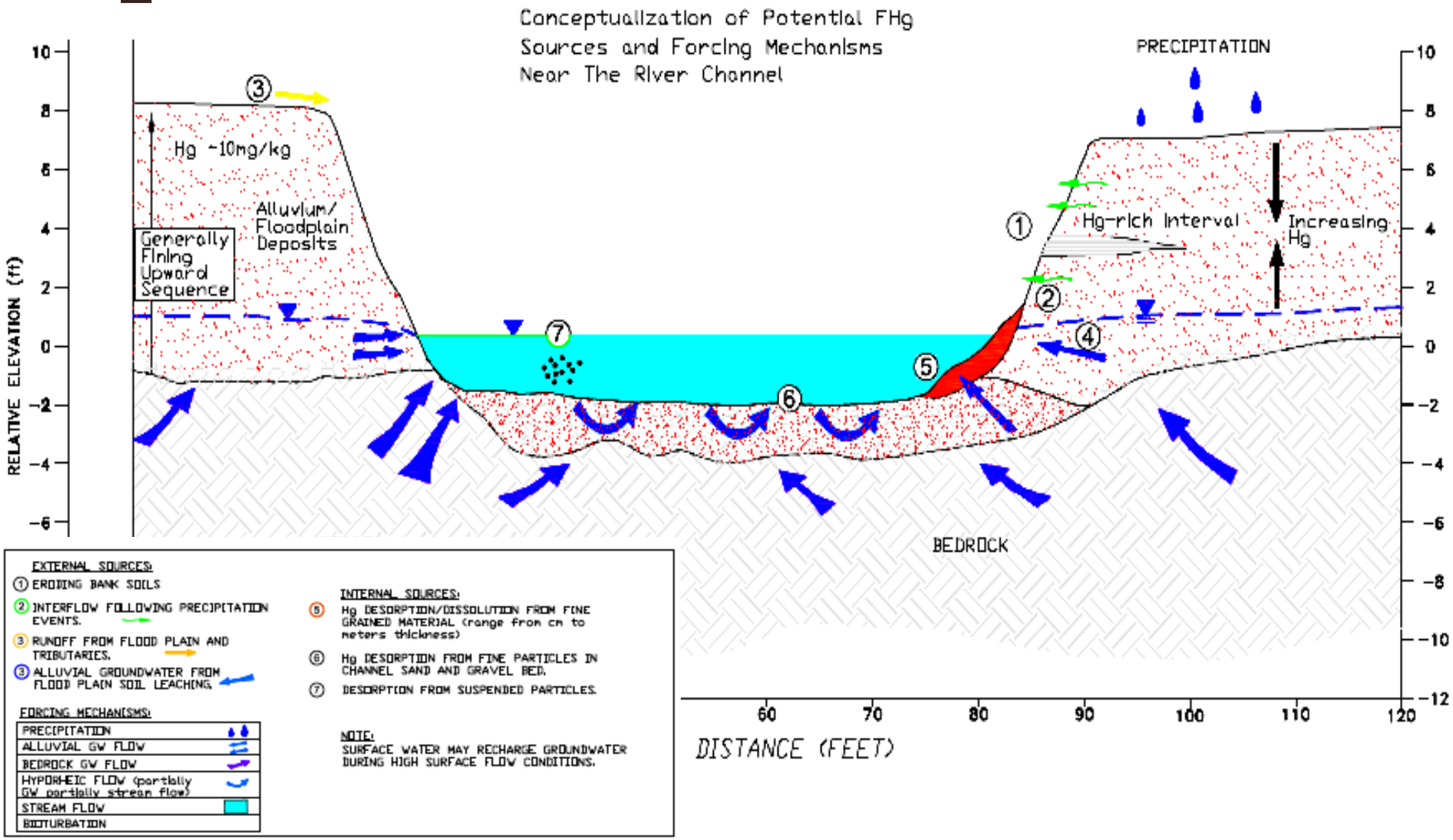
South River
Remedial Action Objectives

- Reduce fish tissue Hg levels to concentrations that would allow consumption by humans
- Ensure protection of aquatic and terrestrial ecology with respect to Hg exposure

Assumptions and Challenges

- Assumptions
  - Soil banks erosion is the main external source of inorganic mercury to the river
  - Methylation occurs in both the fine-grained (storage) and coarse-grained (transport) sediments in the river
- Challenges
  - South River is a relatively high energy, bedrock gravel river
  - Mercury cycling is complex

Schematic of Possible Contributions to FHg in Water Column (for Mass Balance)



2009 ROP Activities

- Constructed technology matrix to capture possible remediation approaches / technologies
- Plant Site Corrective Measures Study
- Bench scale testing of promising mercury sorbents
- Formed an Innovative Task Team to add to possible alternatives
- Bank Stabilization Pilot
- TMDL development for Hg, bacteria, nutrients and sediment

Technology Matrix (unscreened)

- Monitored Natural Recovery (baseline)
- Physical Actions…e.g.
  - Bank stabilization
  - Capping
  - Removal
  - Sediment traps
- Treatment Options…e.g.
  - Aeration
  - Sorptive materials
  - Water treatment (polymers, ultrafiltration, thermal desorption)
- Administrative Controls
  - Fish Exchange
  - BMPS to reduce erosion and runoff

Bench Scale Testing of Sorbents
(Gilmour, Ghosh and Henry)

- Conducted mesocosm studies – activated carbon, Thiol SAMMs, modified organoclay (MRM)
- Fourteen day trials with SR sediment appear promising
- All amendments reduced accumulation of MeHg in worms
  - Thiol SAMMS reduced MeHg in worms by roughly 95%
  - PAC reduced MeHg in worms by roughly 90%
  - MRM reduced MeHg in worms by roughly 70%
- Thiol SAMMS and PAC reduced total Hg and MeHg in porewater
- MRM and PAC – higher MeHg concentrations in sediment compared to control
  - Needs further evaluation

Innovative Technologies Task Team

- **Workgroup members:**
  - **Reed Harris (Reed Harris, Ltd)**
  - **Mike Newman (VIMS)**
  - **Carol Ptacek (University of Waterloo)**
  - **Danny Reible (University of TX Austin)**

Innovative Task Team Objective

Identify innovative technologies to reduce the bioavailability of mercury in the South River, without harming the biota.

Innovative Task Team Approach

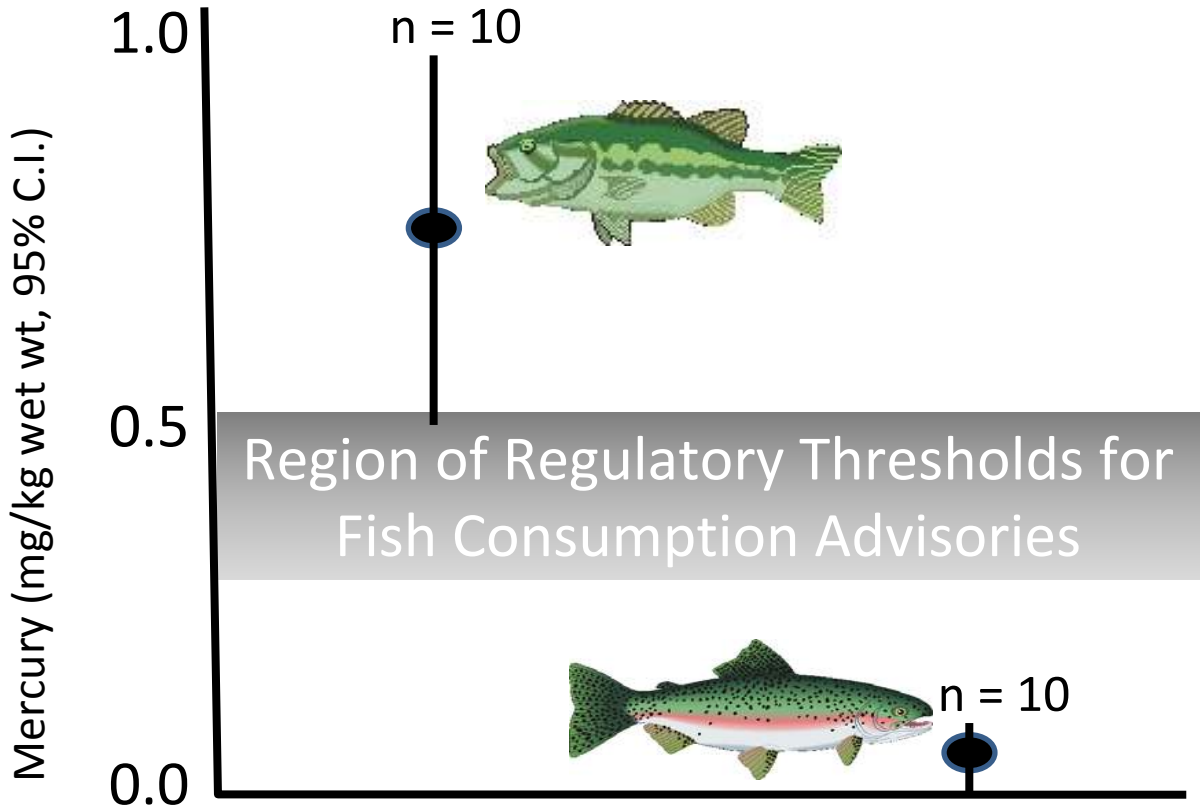
- Options do not have to be fully developed yet.
- Start with all ideas “on the table”
- Identify short list of options, if any, to consider further
- Identify pros, cons and uncertainties in each case
- Identify next steps to evaluate options, and necessary resources
- Document findings in Technical Memo

Innovative Task Team Recommendations

- Two track approach:
  - Trophic food web modifications in short term
  - Longer term effort to reduce MeHg levels in overall aquatic system

Preliminary Results Remedial option	Enhances Trout Habitat	Reduces MeHg Levels in Ecosystem
Group 1: Bank Stabilization (to complement engineered approach)		
- Vegetative cap	X	X
- Limit livestock access to banks	X	X
Group 2: Sediment Caps		
- Sand/gravel cap		X
- Caps amended with sorbent		X
Group 3 : Alter activity of microbes		
- Reduce load of limiting nutrient	X	X
- Add nitrogen to P limited systems.		X
- Enhance microbial demethylation		X
Group 4: Trophic Modification		
- Stock trout, reduce bass. Set up fish exchange, reward, or similar mechanism	X	
- Enhance habitat for trout		
- Modify habitat to favor insects	X	
- Reduce forage fish trophic level	X	
- Stock larger fish	X	
- Promote faster growth rates (triploids, feed fish , modified habitat)	X	
- Supply low-MeHg food	X	
Group 5: Point source control		
- Reduction of Hg(II) by magnetite		X

Bass and Trout – Body burden



(North of DuPont Footbridge, April 10, 2007)

Innovative Task Team Results Summary

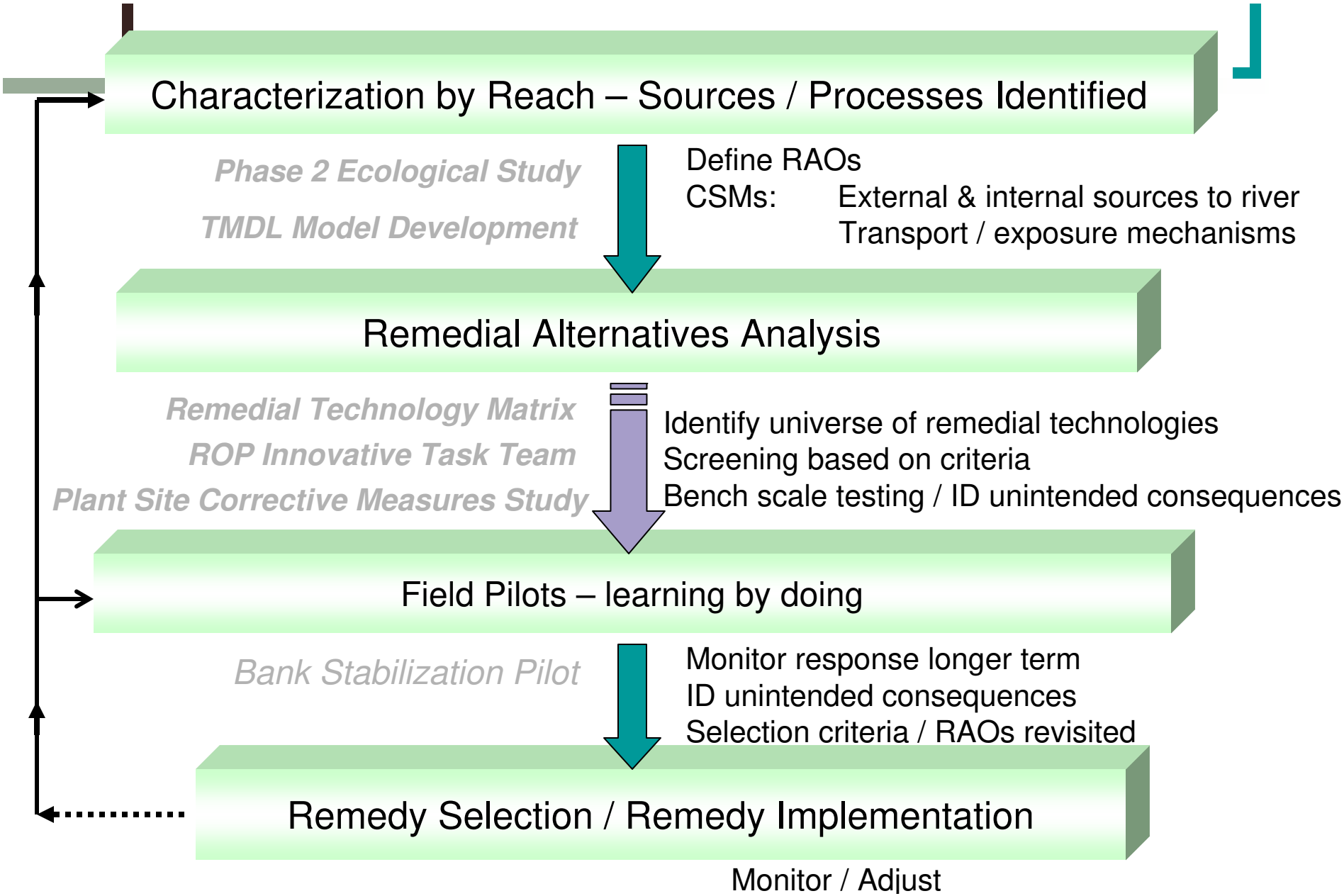
- Restoration of trout habitat and fishery has potential to reduce sportfish Hg in short term
  - Note: Focus group to further develop will be formed
- A series of other measures could help reduce MeHg in overall ecosystem in longer term
- Technical Memo drafted

Variables and Uncertainty

- Will reduced nutrients required for TMDL result in higher or lower fish Hg in the South River?
- Will increased coarse-grained substrate increase methyl mercury production?
- Others?

Remedial Options Program

Remedial Action Selection / Testing Process for SR



Additional Watershed Restoration Efforts in the South River

Robert Brent

October 6, 2009

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Other Impairments in the South River

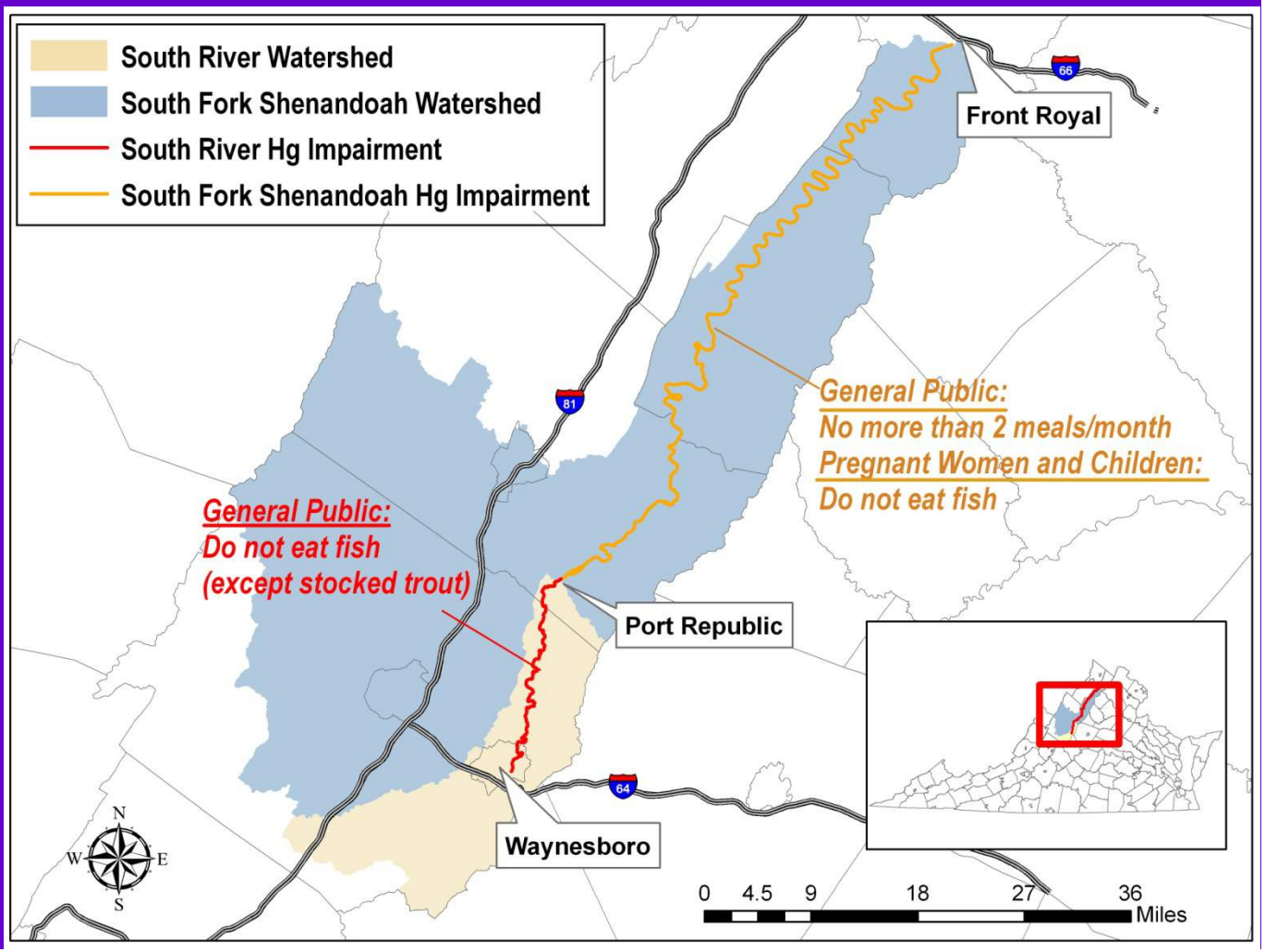
- SRST has focused on Hg impairment in the South River, but Hg is just 1 of 3 impairments listed for the South River
- CWA Section 303(d) Listed Impairments:
    1. Fish consumption impairment – due to mercury in fish tissue
    2. Bacterial impairment – due to excess fecal bacteria
    3. Aquatic life impairment – failure to support a healthy and diverse aquatic life

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Fish Consumption Impairment

- Health Department advisory against eating fish from the South River



Bacterial Impairment

What does it mean?

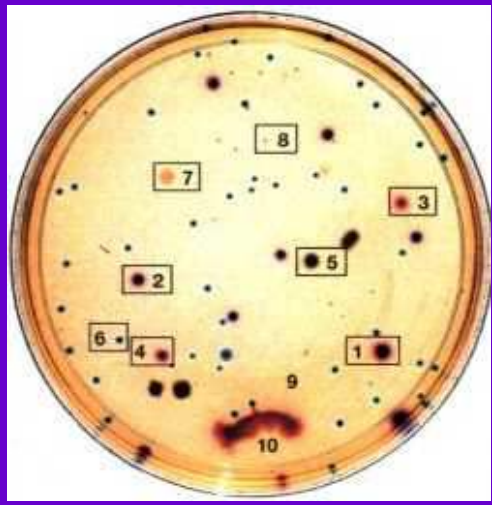
- Bacteria from human and/or animal waste exceeds the state's standard for safe swimming

What is the standard?

- No more than 235 E. coli/100ml water

How is it assessed?

- Stream is listed as impaired if more than 10% of samples collected exceed the standard

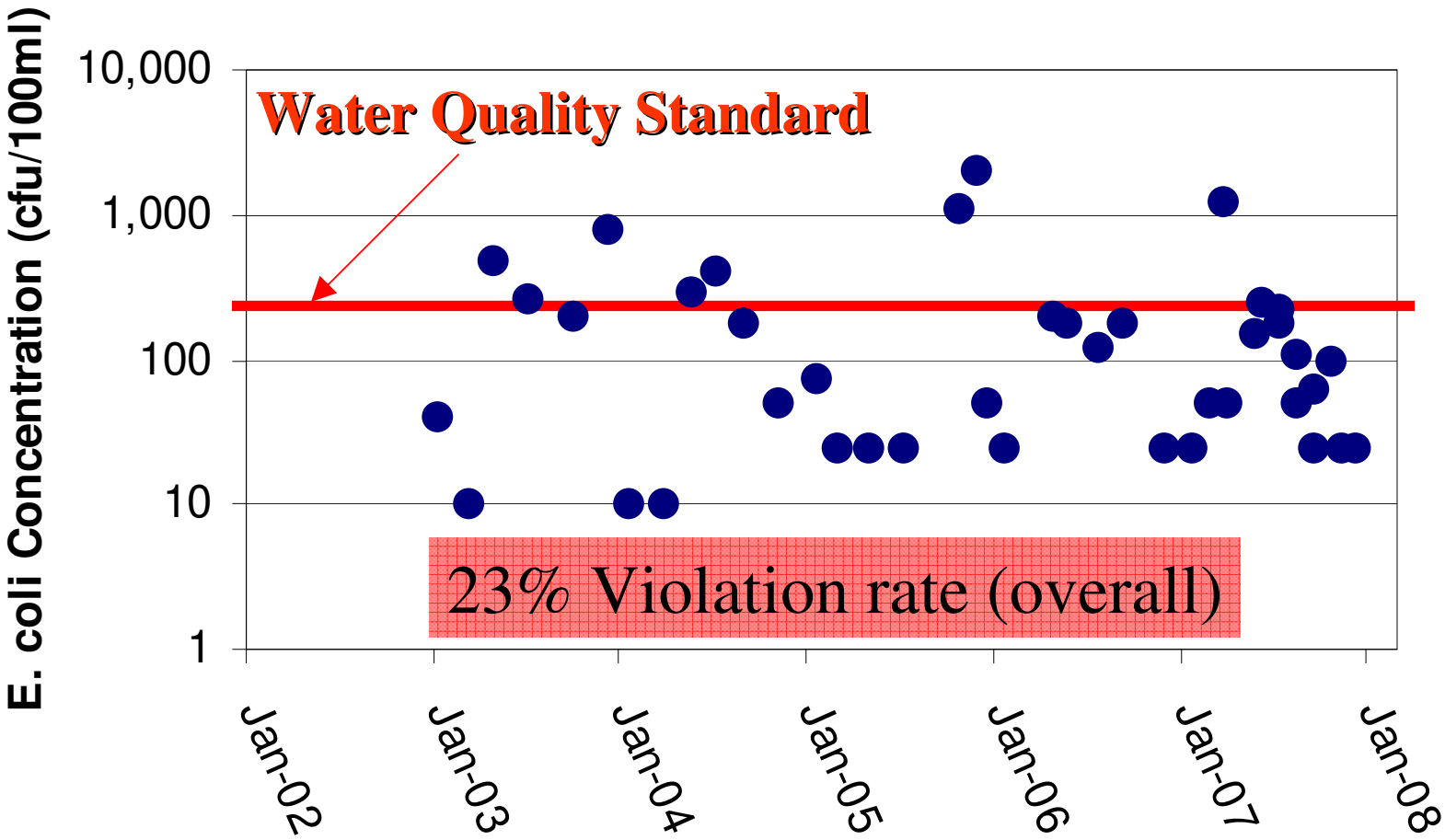


JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

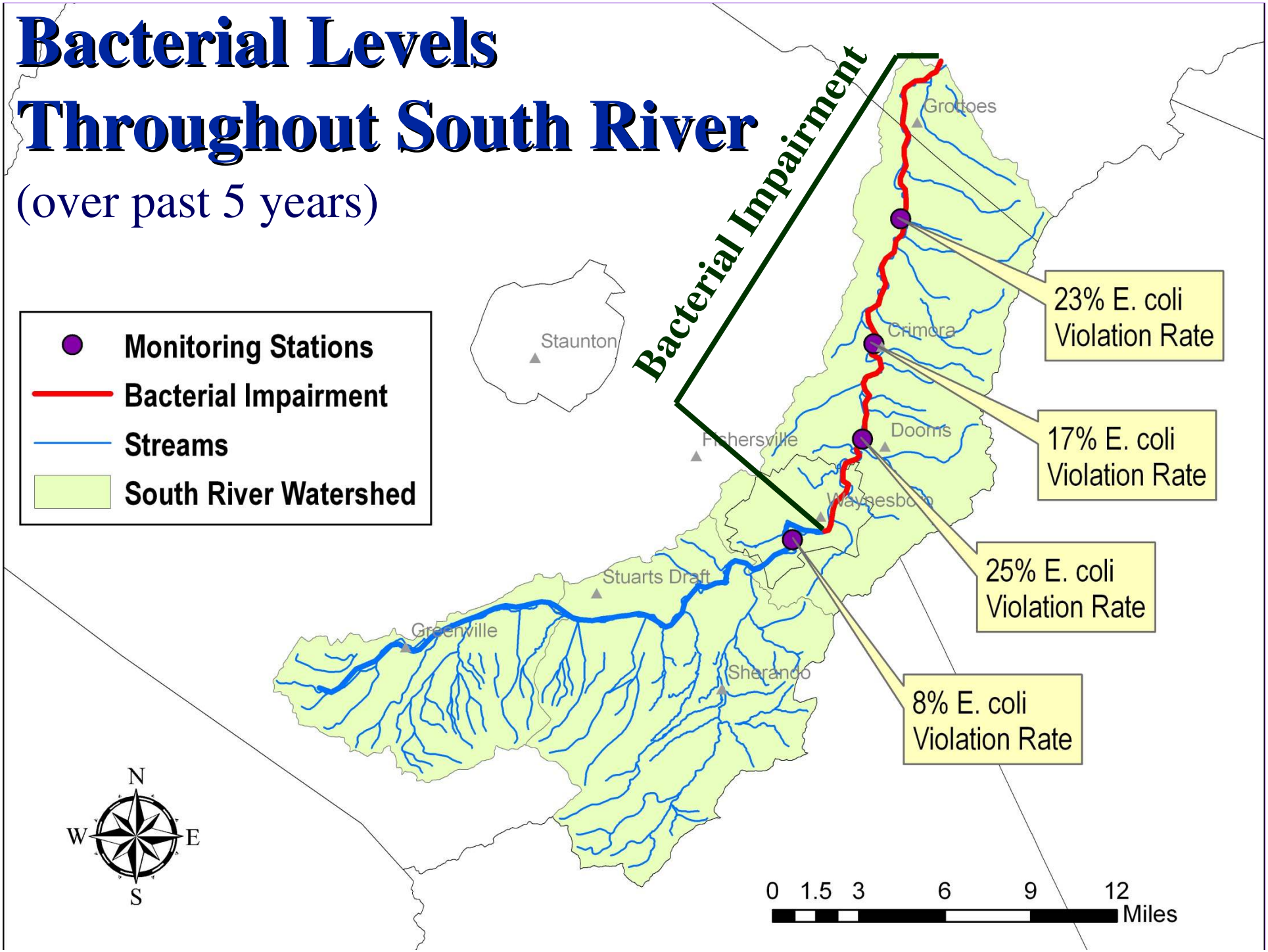
What Are Bacteria Levels in the South River?

(Rt 778, Harriston)



Bacterial Levels Throughout South River

(over past 5 years)



Aquatic Life (Benthic) Impairment

What does it mean?

- Stream does not fully support a healthy and diverse aquatic life

What is the standard?

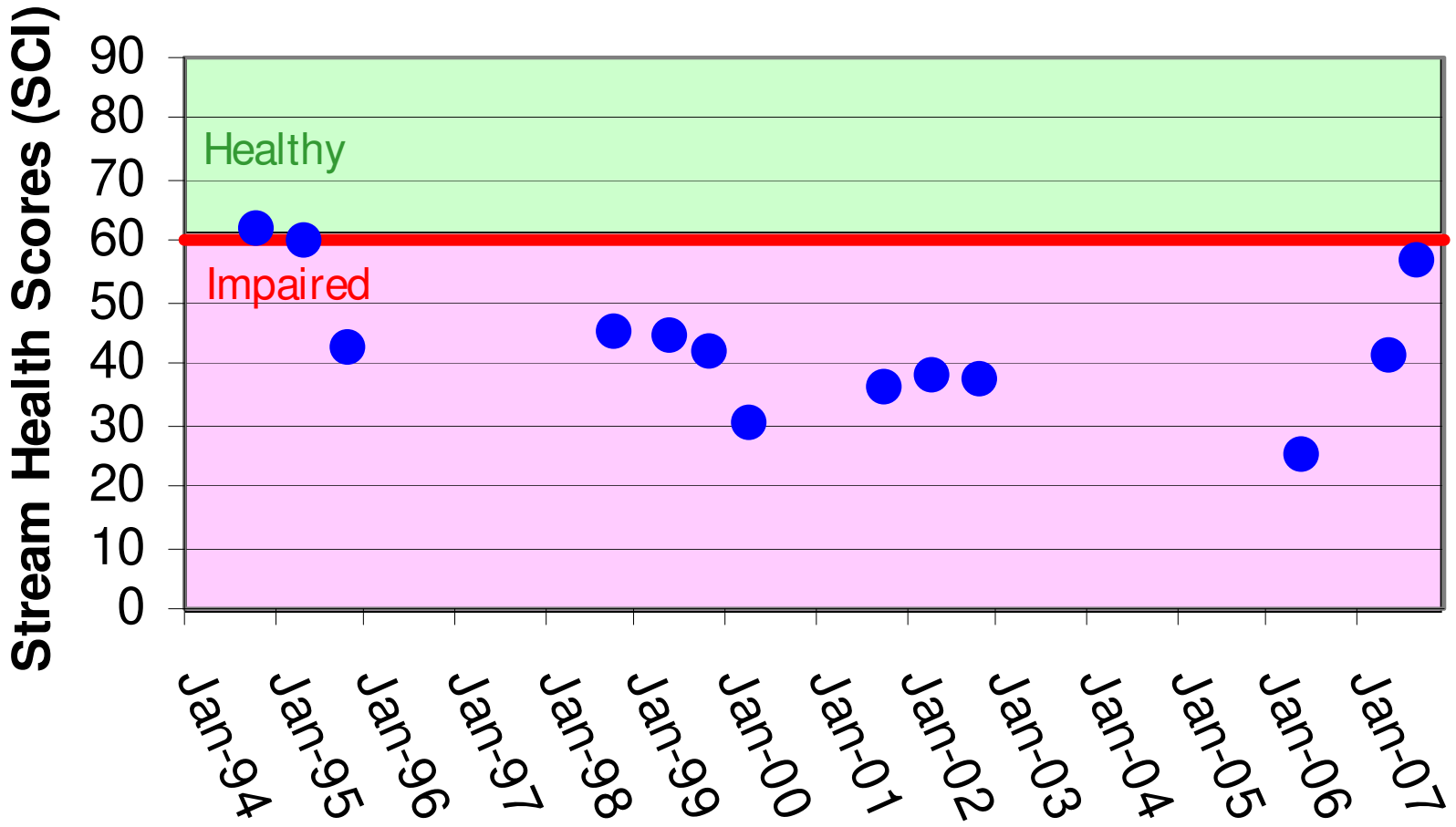
- State waters shall be free from pollutants which are harmful to aquatic life

How is it assessed?

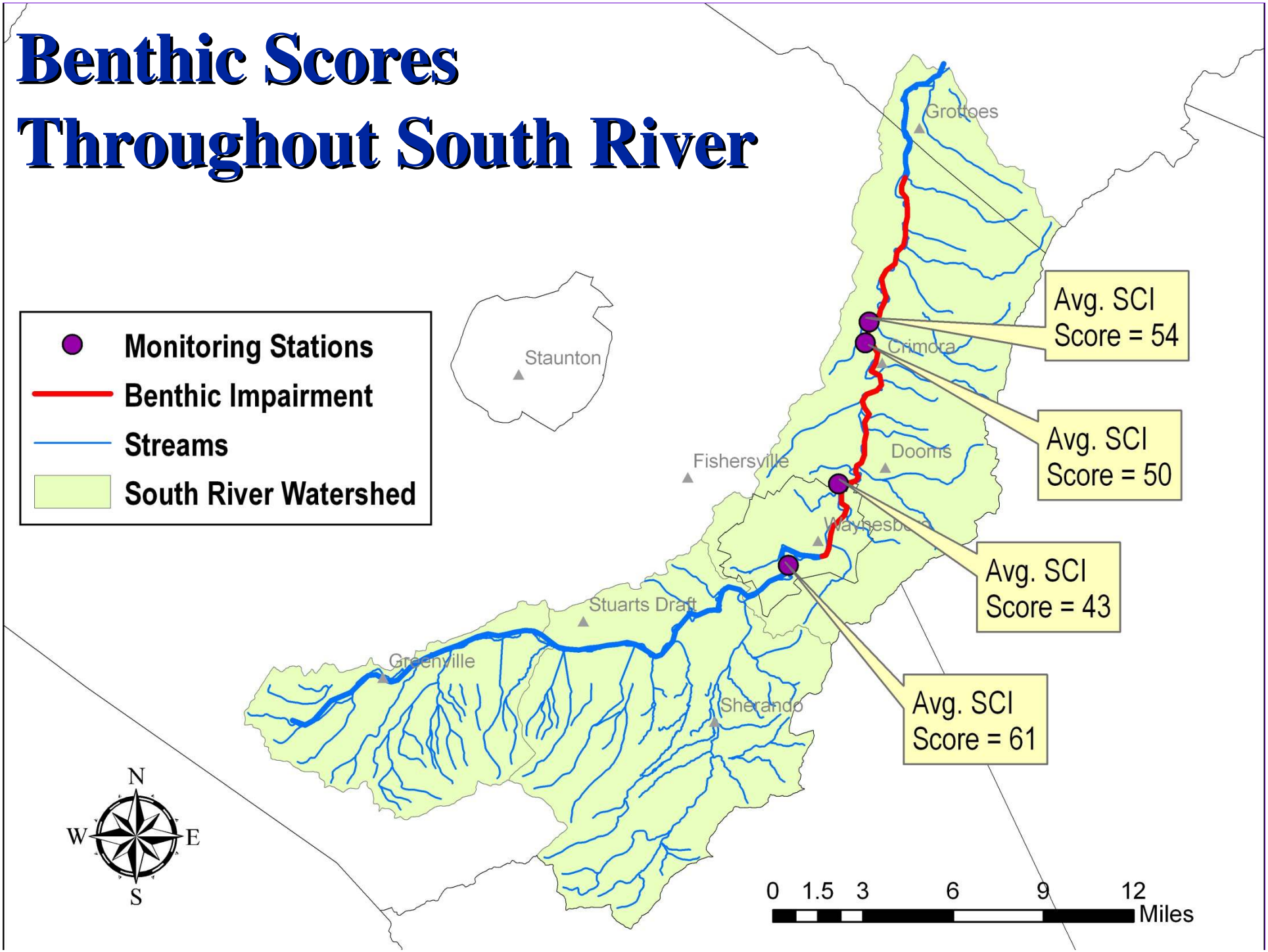
- Biologist collects and identifies benthic macroinvertebrates
- The numbers and kinds of benthic macroinvertebrates collected are compared to a healthy reference condition
- The stream is given a Stream Condition Index (SCI) score (<60 = impaired)

What are Benthic Scores in the South River?

(Hopeman Parkway)



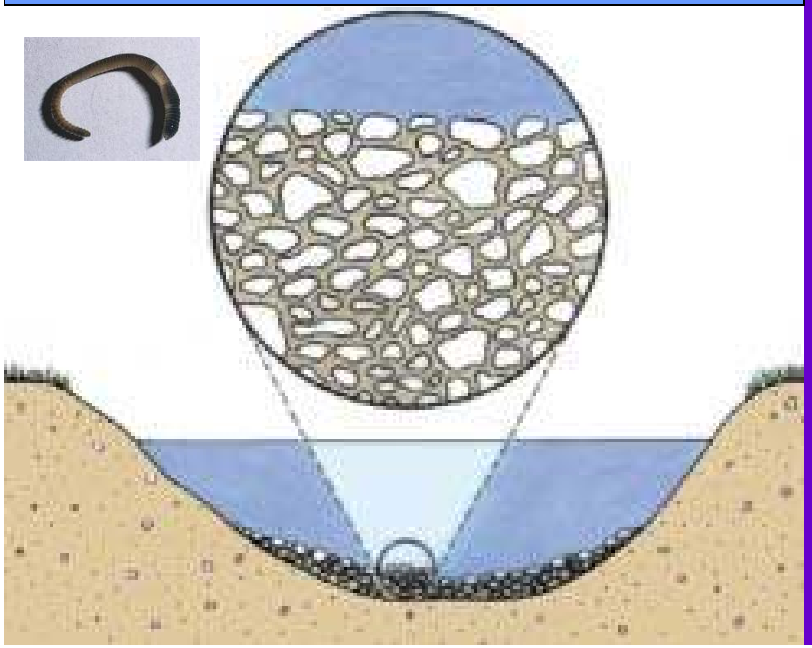
Benthic Scores Throughout South River



Aquatic Life Impairment

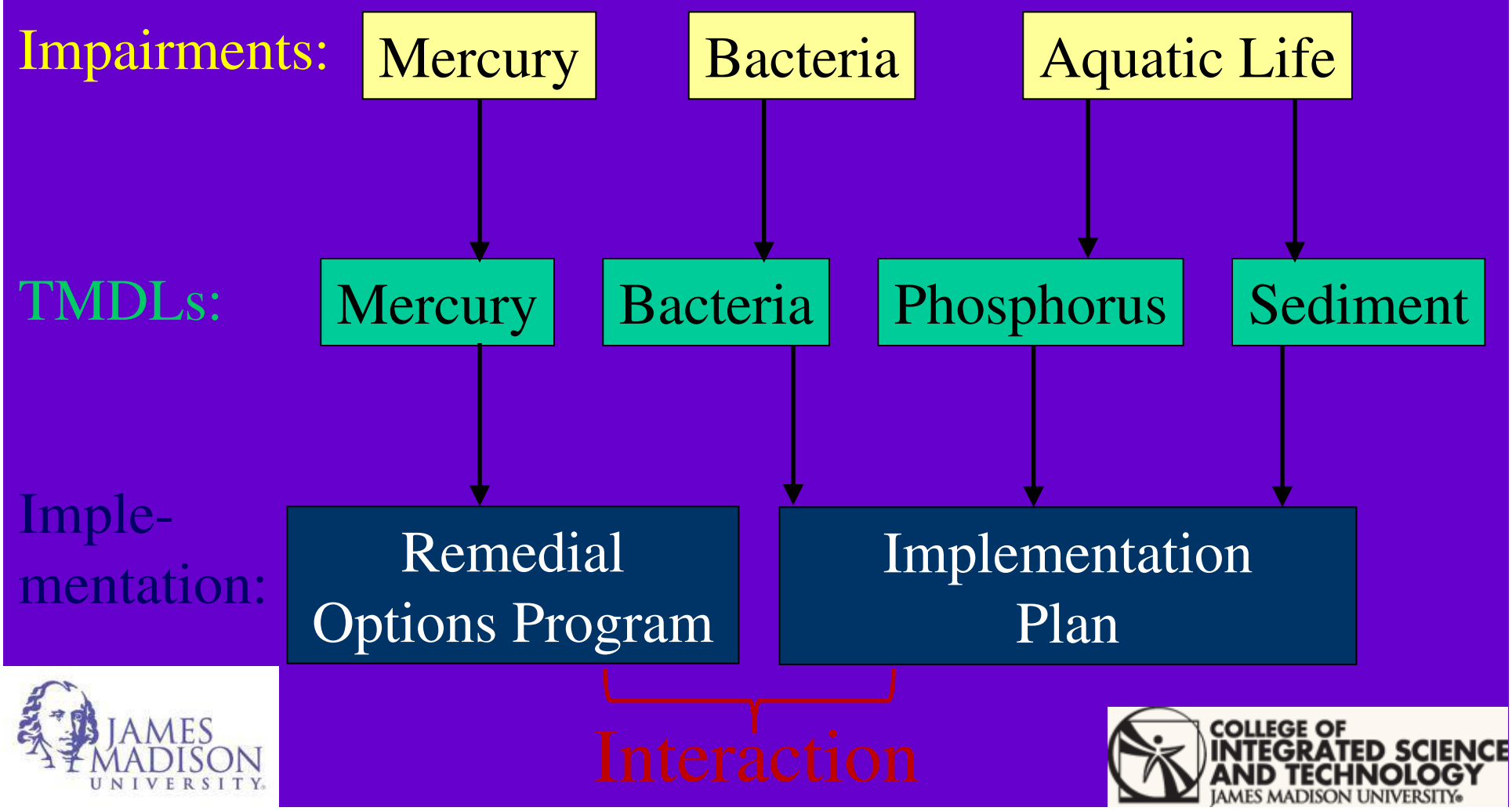
- Stressor analysis was conducted
- Identified excess sediment and phosphorus as most probable stressors

Excess Sediment



Excess Phosphorus

Regulatory Approach to These Impairments



JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Anticipated Elements of IP

- Reduced nutrient levels in major discharges
  - Chesapeake Bay nutrient regulations are driving major upgrades at some dischargers
- Decreased livestock access
- Decreased runoff and erosion from agricultural areas
- Decreased runoff and washoff from impervious urban areas

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Nutrient Reductions

	TN Allocation (lbs/yr)	2008 TN Load (lbs/yr)	Necessary Reduction
Invista	78,941	18,828	-
*Stuarts Draft	48,729	11,150	-
Vesper View	5,695	2,809	-
Harriston	5,695	854	-
Waynesboro	48,729	130,199	81,470 (63%)

	TP Allocation (lbs/yr)	2008 TP Load (lbs/yr)	Necessary Reduction
Invista	1,009	456	-
*Stuarts Draft	3,655	2,418	-
Vesper View	761	580	-
Harriston	761	458	-
Waynesboro	3,655	33,179	29,524 (89%)

* Upgrades planned, to allow trading among Augusta Co. owned facilities

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Nutrient Reductions

- Impact on mercury methylation and uptake?

Beneficial Impact

- Reduced nutrient levels will reduce biological activity, and may slow mercury methylation

Detrimental Impact

- In some nutrient rich environments, nutrient reductions have resulted in increased mercury levels in biota

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY JAMES MADISON UNIVERSITY

Decreased Livestock Access

- Restricting livestock access to streams is a centerpiece of IP's for bacteria and sediment

Beneficial Impact

- Reduced streambank erosion in contaminated areas will greatly reduce mercury loading

Detrimental Impact

- Reduced sediment inputs from non-contaminated areas (if large) could increase average mercury concentration on suspended particles

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Reduced Runoff from Ag Land

- Agricultural best management practices (BMPs) that reduce bacteria, nutrient, and sediment runoff will be encouraged
  - Improved pasture management
  - Nutrient management
  - No-till planting
  - Cover crops
  - Riparian buffers

<u>Beneficial Impact</u>

- Reduced runoff in contaminated floodplain may reduce mercury loading

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

Reduced Runoff from Urban Areas

- Urban stormwater BMPs that reduce bacteria, nutrient, and sediment runoff will be encouraged
  - Street sweeping
  - Increased infiltration
  - Detention/retention
  - Riparian buffers

<u>Beneficial Impact</u>

- Reduced runoff in contaminated floodplain may reduce mercury loading

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY JAMES MADISON UNIVERSITY

Conclusions

- SRST needs to remain aware and involved in other restoration activities in the watershed
- May be advantages in leveraging efforts
  - Stream exclusion / riparian buffers / bank restoration
- Overall, those activities are likely to be beneficial for mercury restoration efforts

JAMES MADISON UNIVERSITY

COLLEGE OF INTEGRATED SCIENCE AND TECHNOLOGY
JAMES MADISON UNIVERSITY

south river SCIENCE TEAM

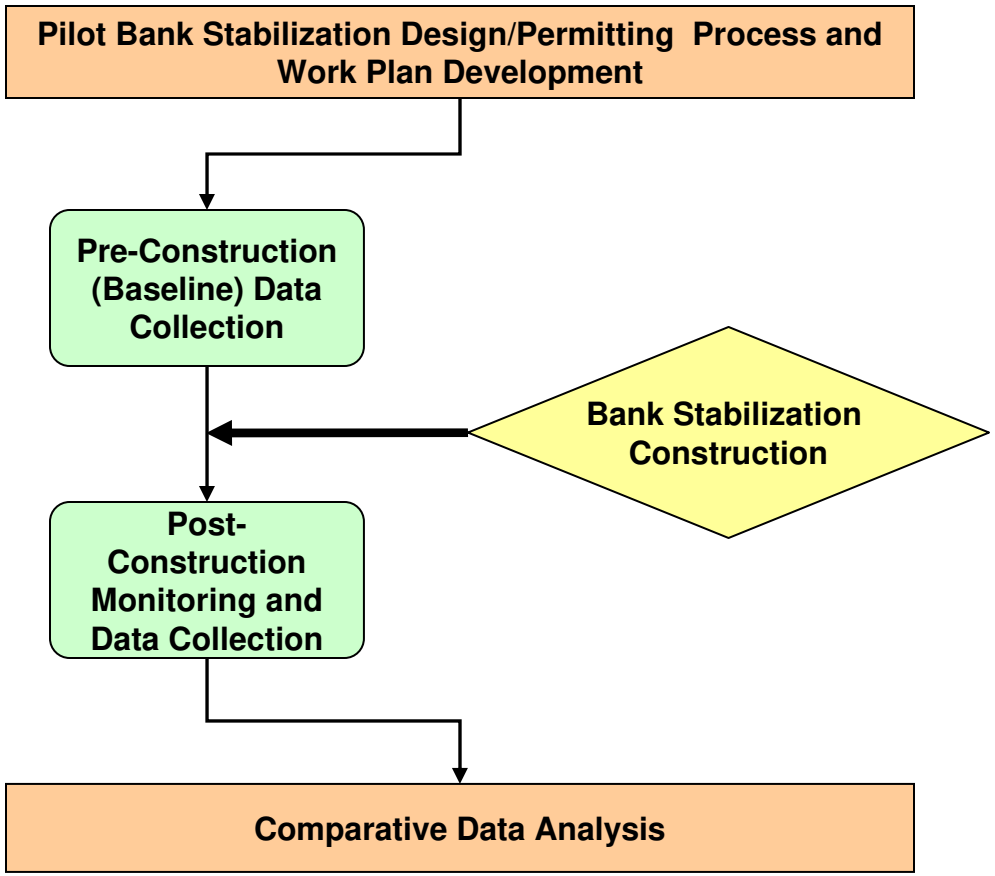
Bank Stabilization Pilot: Monitoring For Success

Expert Panel Meeting; October 6, 2009

URS

Pilot Bank Stabilization Conceptual Process

- Study Objectives Linked with Quantitative Success Criteria
- Data Collections Integrated into SRST Studies
- Bank Stabilization Designed to Improve Riparian Habitat



URS

Project Objectives Are Linked to Success Criteria

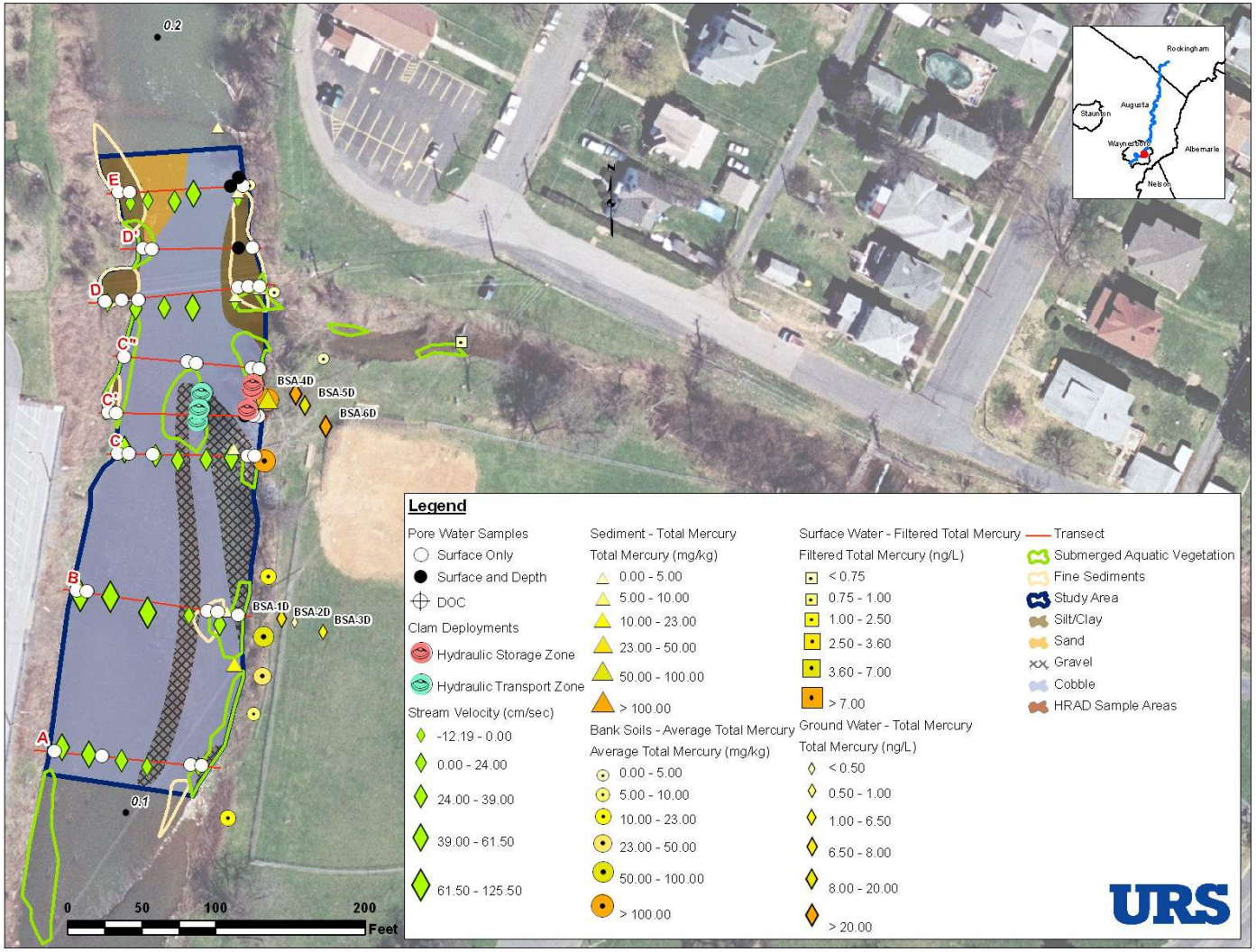
- Primary Objectives
  - Reduce river bank erosion
  - Stabilize the bank
  - Enhance existing aquatic and riparian ecosystems
  - Reduce mercury (Hg) loads
- Secondary Objectives
  - Evaluate groundwater/bank interactions
  - Evaluate potential changes in the mercury methylation
  - Evaluate river bank stability at adjacent locations

Pilot Study Baseline Data Collection in 2009

√	**Cross-Sectional Channel Morphology**
√	**Grain Size Distribution**
√	**Flow Characteristics**
√	**Habitat Evaluation**
√	**Mercury Characterization**
√	**Groundwater/River Interactions**

URS

Pilot Study Baseline Data Collection Locations



URS

Mercury Characterization – Highest THg Concentrations in Sediment Co-located with Soil

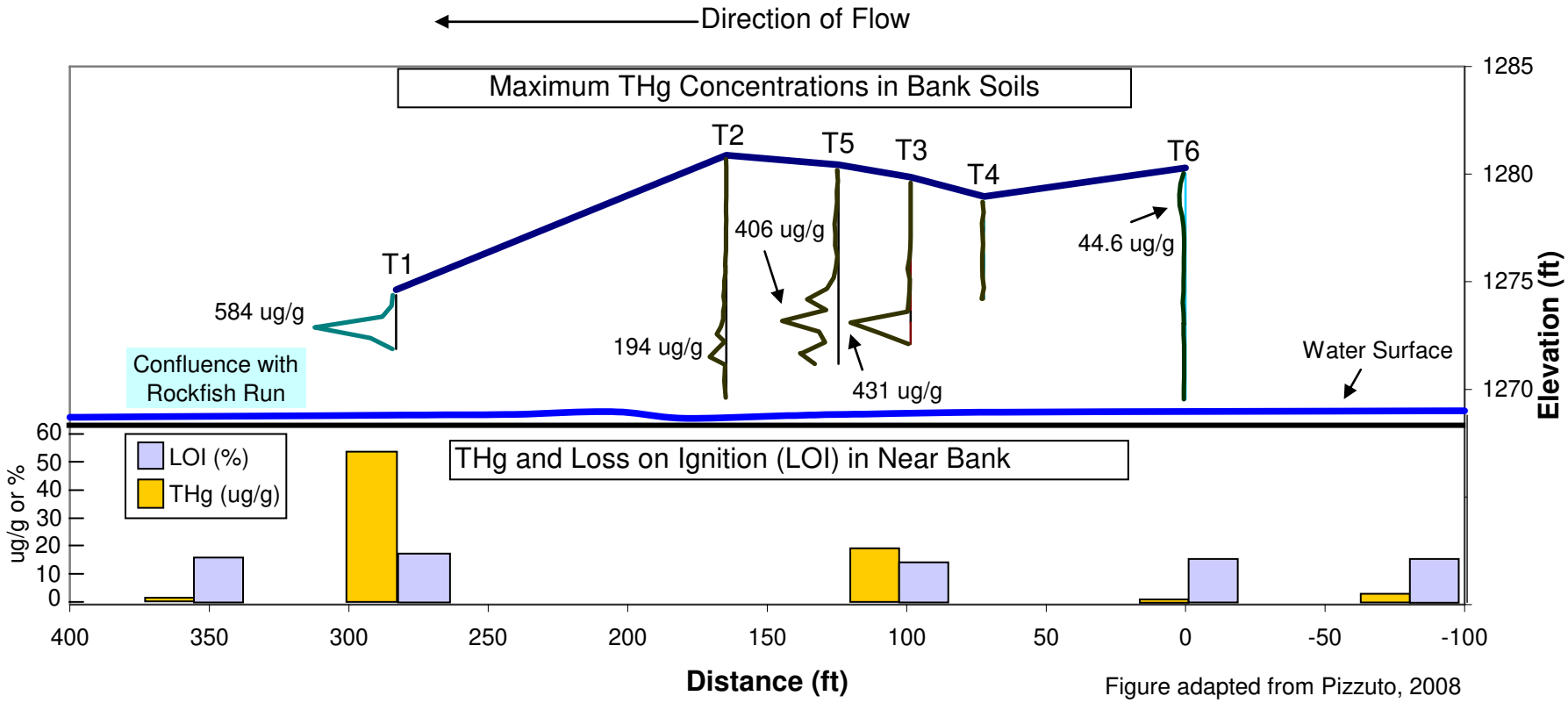
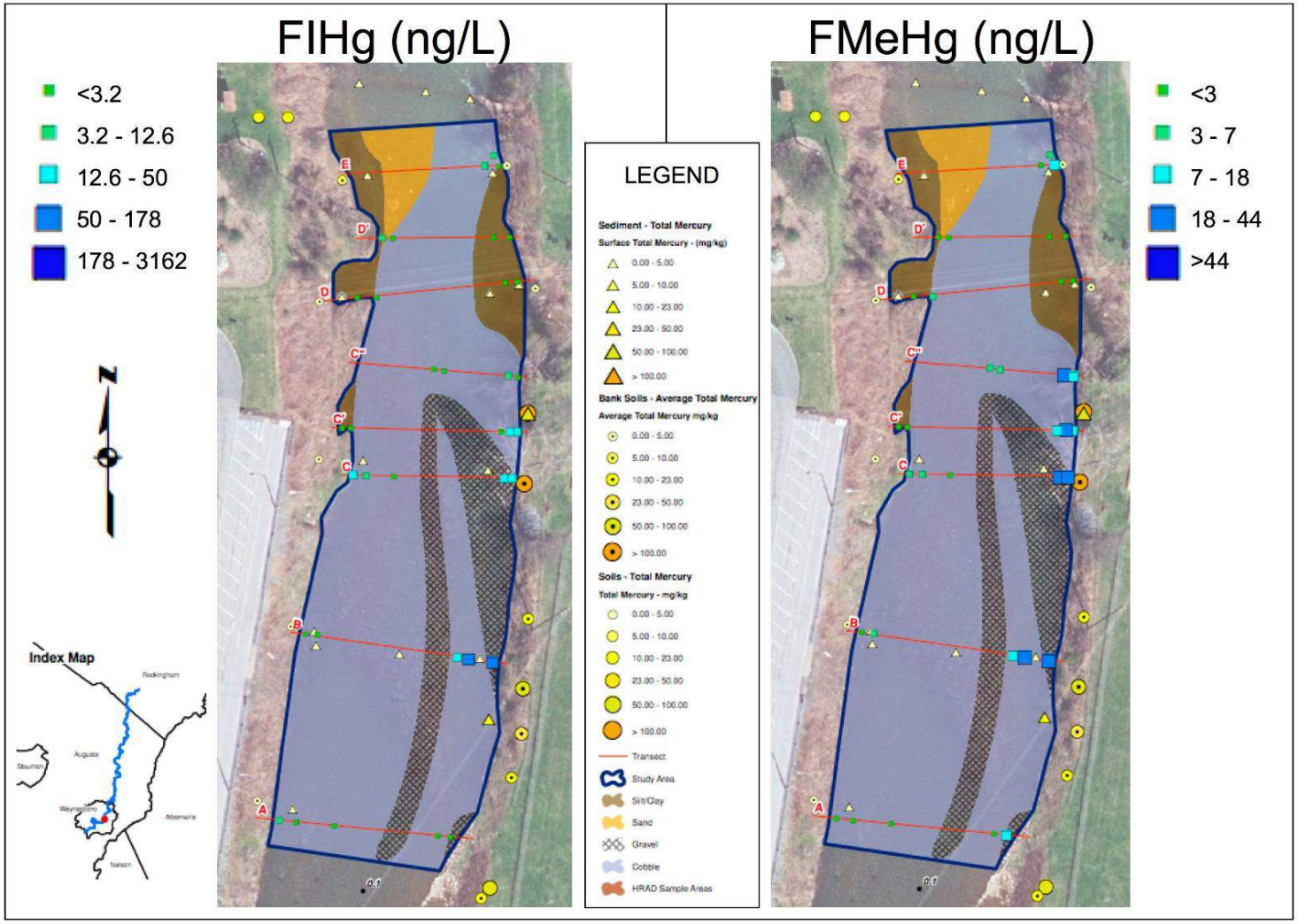


Figure adapted from Pizzuto, 2008

Notes: The total mercury (THg) concentrations in soil were collected in December 2007 from six transects (T1 through T6) from a bank near RRM 0.1. Data are shown as vertical lines with the maximum THg concentration identified with a text box. In August 2008, sediment samples were collected as a baseline data set development for the near-bank region in this area and analyzed for THg and percent loss on ignition (LOI). The THg and LOI data are presented as columns; LOI is a measure of organic matter in sediment and is presented to illustrate that concentration differences in sediment are not due to changes in organic matter.

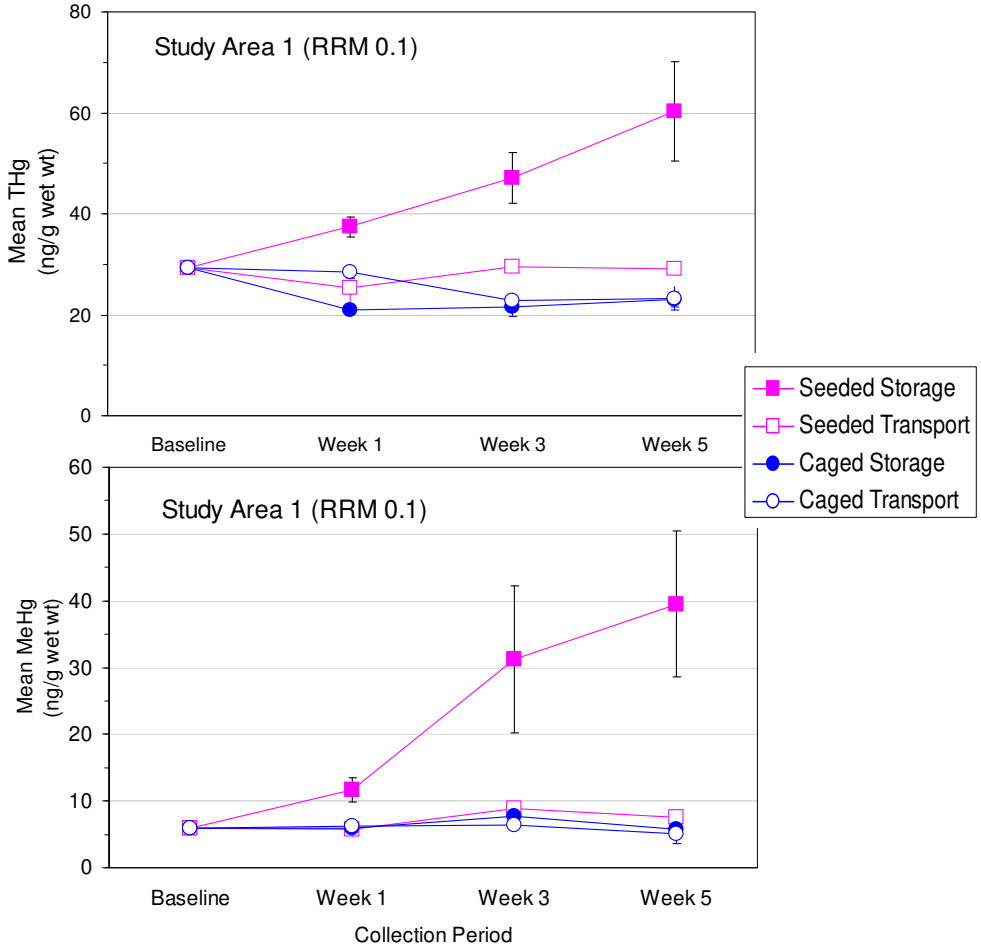
URS

Porewater Hg Concentrations are Highest Near Pilot Bank



URS

Mercury Characterization – Seeded Clams Near the Pilot Bank Have Significantly Higher Hg Concentrations



URS

Bank Stabilization Pilot Study Path Forward

- Baseline data collections are completed and beginning data evaluations
- Construction phase is currently in progress
- Post construction data collections will begin after construction is completed:
  - Initial Post-Storm Inspections
  - Performance Monitoring
    - Mercury Characterization and Groundwater/Bank Interactions – Spring
    - Seasonal evaluations of channel cross-sections, habitat redevelopment, and other physical characteristics (e.g. in-river grain size and velocity measurements along transects)
  - Two-Year Storm Event Monitoring

Thought Starters for Discussion

- What information was unclear & needs further clarification?
- What do you lack that will limit your ability to respond to the feedback questions?
- What strengths & weaknesses can you identify in our program?
- Can you identify any significant holes in our data collection programs, hypotheses, laboratory & field studies, etc. that will limit our decision making ability?
- What areas can be marked as "Complete?"
- What conflicts with "accepted mercury wisdom" can you identify in our results to date?
- Please comment as you are able on efforts by others to address the issues we confront in the South River, including similarities & differences between approaches & programs.