EPA/600/R-08/073
May 2008

Summary Report of the NSF/EPA WATERS Network Workshop

April 30 - May 1, 2008

EPA/NRMRL Facility Resources: Science Briefs and Presentations

EPA
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science BRIEF
BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

National **Risk Management** Research Laboratory

www.epa.gov/nrmrl/

The Test and Evaluation Facility Cincinnati, Ohio

Introduction

The Test and Evaluation Facility (T&E) is located on the grounds of Cincinnati's Mill Creek wastewater treatment plant. There, studies are conducted on new treatment technologies for contaminants in water and wastewater for EPA's National Risk Management Research Laboratory (NRMRL). This unique facility has a high-bay area for bench-, pilot-, and full-scale research. It is supported by analytical laboratories, chemical storage, and office space.

A wide variety of innovative water, wastewater, and soil/sediment treatment technologies and environmental monitoring and control systems are conceived, designed, fabricated, and evaluated at T&E. Innovative environmental management concepts may subsequently be field-validated and nationally applied. T&E researchers verify water security monitoring and treatment technologies as part of EPA's Environmental Technology Verification Program.

Administered by NRMRL, T&E is operated by a working core of experienced EPA engineers and technicians, along with contract engineers and operators. The contracted full-time research engineers and scientists work as principal investigators for T&E studies and may be supported by subcontracted specialists and consultants from academia or industry.

Background

Designed in 1977 and opened in 1979, T&E is a multipurpose research facility. Research conducted there encompasses drinking water treatment, wastewater treatment, and hazardous waste, soil, and ground water remediation. The facility is a two-story building with 33,000 square feet of space subdivided into 16 work areas. T&E was designed with functional versatility for future use.

Under the Resource Conservation and Recovery Act, T&E is a permitted treatment, storage, and disposal facility that holds an Ohio EPA Treatability Exclusion. This exclusion allows the facility to conduct treatability studies using quantities of all categories of hazardous waste. This is unmatched by any similar facility in the nation.

Features

T&E is a ventilated, fully heated and lighted facility. Its features include:

- Wastewater flows to the 16 experimental locations in the 24,000-square-foot high-bay area
- Two 5-ton bridge cranes for ease of relocating large pieces of experimental equipment
- A well-equipped, 700-square-foot machine shop for fabricating specialty items and building or repairing experimental apparatus
- A 275-square-foot greenhouse for agricultural studies of pollutant application to soils
- 10,000 gallons of stainless steel tank storage; drum storage areas for twenty 55-gallon drums
- Hazardous waste tank leak and spill monitoring and alarm capability tied into an automatic facility shutdown system

To allow for installation and removal of experimental equipment and units, several large rollup doors facilitate the movement of trucks and large equipment, including trailer-mounted pilot plants, in and out of the building.

T&E is equipped with:

- Chlorinated, dechlorinated, and deionized water supplies
- Low- and high-pressurized air supplies
- Electrical supply (110, 240, 480 volts)
- Analytical chemistry laboratories (2,000 square feet)
- Chemical storage area
- Hazardous liquid and solid storage facilities
- Liquid pumping systems
- Environmental chambers
- Office space (5,800 square feet)

The on-site chemistry laboratories give scientists the flexibility to study:

- Phytoremediation
- Drinking water contaminants
- Biosensors (devices that determine the concentration of substances and other biological parameters of interest)
- Small systems (public water systems serving fewer than 10,000 people)
- Water distribution systems, using two water distribution system simulators

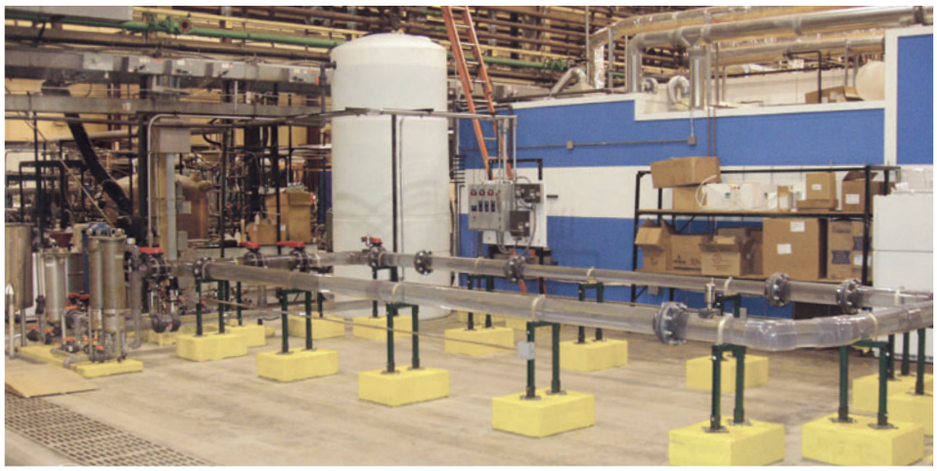
The T&E facility may be used by scientists and engineers from other federal agencies, academic institutions, nonprofit organizations, and private companies. Provisions are in place to ensure that EPA research will not be impacted by any agreements. In most cases, EPA will provide in-kind services and contractor support for studies at the T&E facility.

Results

EPA's objectives are to reduce the risk to public health, ensure clean and safe drinking water, and enhance science and research. EPA accomplishes these by conducting leading-edge, sound scientific research that reduces human exposure to contaminants in drinking water.

Research conducted at T&E has led to technologies and strategies for controlling and monitoring drinking water contaminants, including microbial pathogens and inorganic and organic chemicals. The primary areas of research are:

- Drinking water and the Contaminant Candidate List
- Bio-monitoring
- Package plants (technologies packaged together to provide an affordable solution for small-system operators who may not otherwise be able to efficiently treat water)
- Distribution systems
- Remote monitoring demonstrations



To reduce the risk to public health, researchers at T&E study source water, water treatment technologies, and water distribution systems. Specific contaminants are also investigated to determine treatment and analytical alternatives.

Drinking water and wastewater studies at T&E support EPA regulations and provide regulators and utilities with environmental results. Studies promote the development and commercialization of practical and innovative technologies that enhance drinking water quality. T&E provides diverse opportunities to convert drinking water and wastewater research into solutions for public water systems in the United States.

CONTACT

Bio-monitoring – Joel Allen
(513) 487-2806
allen.joel@epa.gov

Small systems – Craig Patterson
(513) 487-2805
patterson.craig@epa.gov

Water distribution systems – Christopher Impellitteri
(513) 487-2872
impellitteri.christopher@epa.gov

U.S. Environmental Protection Agency
Office of Research and Development, National Risk Management Research Laboratory

EPA/600/F-08/004
April 2008

U.S. EPA Test & Evaluation Facility

Roy Haught

The WATERS Network Project Workshop

- Designed 1977 and Opened 1979
  - Wastewater, Solid, and Water
- Progressively designed to make the facility functionally versatile for future use.
- A resource in which a wide variety of innovative environmental protection technologies are;
  - Conceived, designed, and evaluated
  - Bench- and pilot- and full-scale level

- Located at City of Cincinnati Mill Creek Wastewater Treatment Plant.

- Variety of wastewater and water streams are available to the T&E Facility for research purposes.

- Studies promote the development and commercialization of practical and innovative technologies to enhance water quality.

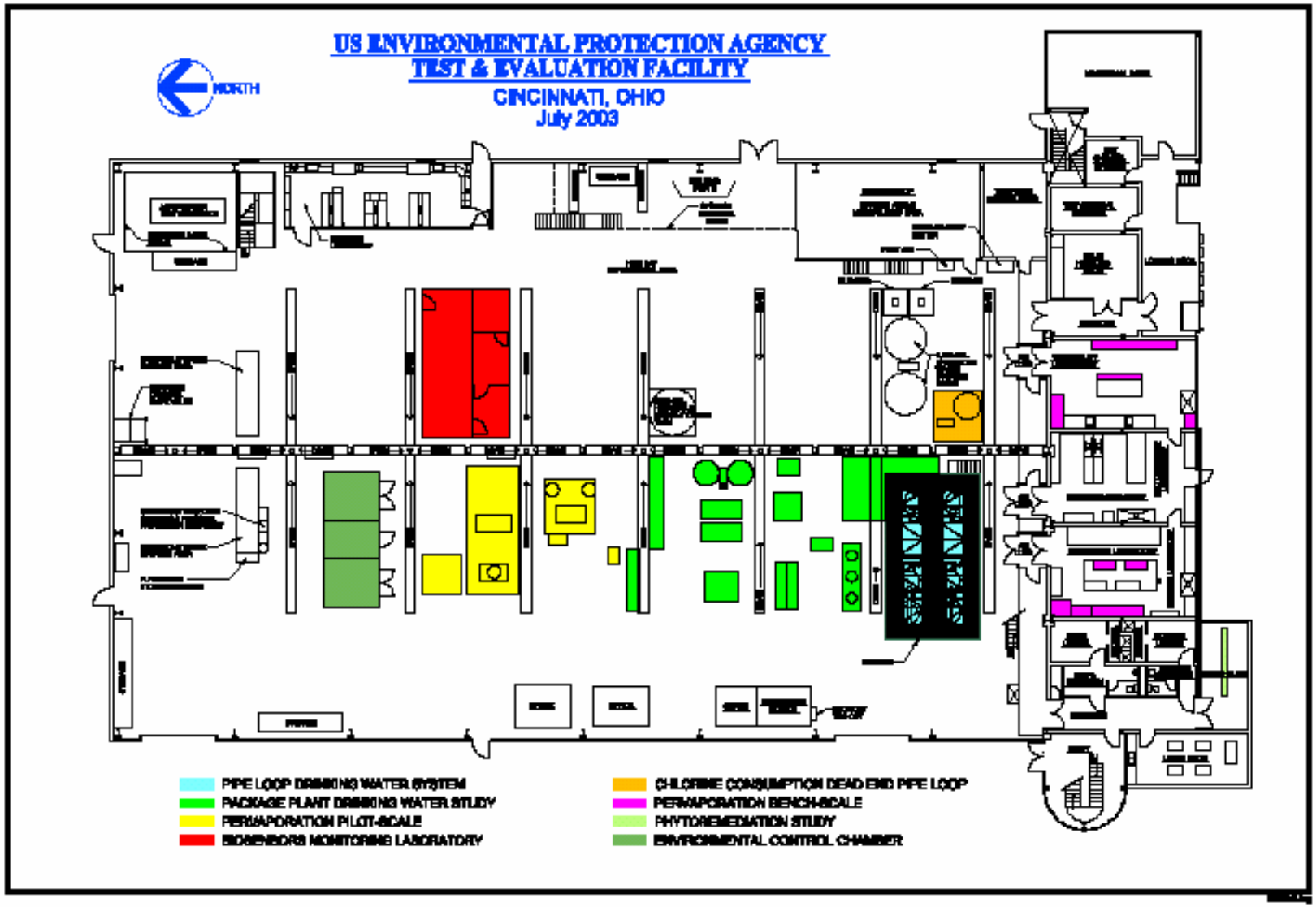
- T&E Facility is a two-story 33,000 ft^2 building
  - 24,000 ft^2, 30-foot tall “High-bay” experimental area.
  - Subdivided into 16 work areas
  - 2,000 ft^2 of analytical laboratories,
  - 700 ft^2 machine shop, and
  - 5,800 ft^2 of office space.
- Utilities; Accessible to all work areas.
- TSDF/RCRA –
- Wastes are discharges into the sanitary sewer.

- Experimental Work Area 30 ft Tall
- Two 5-Ton Bridge Cranes
- Green House and Environmental Chambers
- Fully Heated and Lighted
- Ventilation System
- Machine Shop
- Three- 16 ft overhead doors
- Professional, Engineering, Scientific, Craftsmen, Technical & Analytical Support

- Available to other Government Organizations via an Interagency Agreement (IAG)

- Available to public and private clients from all sectors either through either a;
  - Cooperative Research and Development Agreement (CRADA) with the U.S. EPA
  - Third-party contract agreement with the on-site contractor.

- The principal requirement for research to be conducted at the T&E Facility
  - It must be within the scope and mission of the U.S. EPA's National Risk Management Research Laboratory


US ENVIRONMENTAL PROTECTION AGENCY
TEST & EVALUATION FACILITY
CINCINNATI, OHIO
July 2003
NORTH
PIPE LOOP DRINKING WATER SYSTEM
PACKAGE PLANT DRINKING WATER STUDY
PERVAPORATION PILOT-SCALE
BIOSENSORS MONITORING LABORATORY
CHLORINE CONSUMPTION DEAD END PIPE LOOP
PERVAPORATION BENCH-SCALE
PHYTOREMEDIATION STUDY
ENVIRONMENTAL CONTROL CHAMBER

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The Urban Watershed Research Facility Edison, New Jersey

Introduction

In an undeveloped and undisturbed environment, rainfall is naturally filtered and absorbed by soil and plants, protecting aquatic systems by slowly releasing the water to ground water and streams. In an urban setting with development and lots of impervious surfaces, natural protection is short-circuited. Storm water is rapidly and purposefully transported from rooftops, parking lots, and streets—where it has collected pollutants—to sewers. The sewers route the water to receiving water or a treatment plant. The rapid runoff can degrade receiving water or exceed treatment plant capacity.

Scientists in the National Risk Management Research Laboratory (NRMRL) at the Urban Watershed Management Research Facility in Edison, New Jersey, investigate alternative approaches to managing this wet-weather flow, so that flow is lessened and flow-associated pollutants are decreased.

Background

The facility occupies 205 acres on the former Raritan Arsenal property, a suburban location about 30 miles southwest of New York City. The many buildings and trailers are in an isolated, secure 20-acre open space established to develop and evaluate the performance of common and innovative storm water management practices. The laboratory building is configured to conduct bench-scale analyses of environmental samples.

Features

The facility includes:

- Greenhouses that allow all-season operation
- Analytical laboratories for on-site analysis of common chemical and microbial stressors
- A high-bay engineering development and support area
- Automated electronic monitoring and automatic sampling equipment
- Office space and storage

Researchers routinely monitor and record climatic data. On-site storage tanks, and mixing, transfer, and distribution equipment provide storm water collected from an adjacent, highly impervious drainage area. Other outdoor resources include pilot-scale swales, wet ponds, and wetlands to allow for evaluation of common control practices under varying loading and design conditions. Sewage can be accessed from a local treatment authority for research efforts that require sanitary waste. The Edison facility provides a safe location for collecting engineering data needed for design and evaluation.

The facility also features 2,500 feet of buried pipeline. This pipeline test apparatus is capable of supporting controlled-condition experiments on infrastructure conveyance and storage systems. Its primary use is to evaluate the performance of leak detection and location devices and procedures under static conditions; it will be upgraded and expanded to meet research needs for aging water infrastructure.

Four representative pipelines support research on pipelines that simulate those in use at operational facilities. The test pipelines enable convenient study of:

- Different pipe and backfill materials
- Equipment designed to monitor for leaks and corrosion, and prevent backflow and contamination
- Remote-control instrumentation and inspection technologies

Five buried experimental pipelines include four 500-foot loops and one 100-foot loop. A test pit provides the flexibility to change leak rates and backfill materials, and control backfill moisture content. The area surrounding the test pit enables replacement of 20-foot spool sections without the need to excavate.

The pipeline test apparatus complements the pipe loops at the Test and Evaluation Facility in Cincinnati, Ohio.

In August 2005, EPA renewed its commitment to support green power by entering into a three-year contract to purchase 6 million kilowatt hours (kWh) of green power annually for the Edison facility in the form of renewable energy certificates. This contract supports the generation of renewable energy from wind farms in South Dakota, North Dakota, and Wyoming, and will offset 100 percent of the electricity consumption at the facility.

Three solar water-heating systems are the primary source of hot water. All three systems consist of a preheat tank (between 66 and 120 gallons) and various numbers of roof-mounted, single-glazed, liquid-evacuated tube collectors. Because the building relies on the electrical systems only for auxiliary water heating when necessary, the solar heaters allow the facility to conserve electricity and fossil fuel. So far, Edison's solar technology has registered energy savings results significantly higher than expected.

Results

Wet-weather flow includes storm water, sanitary sewer overflow, and combined sewer overflow. Untreated releases of wet-weather flow can harm receiving water, which can lead to unsafe drinking water. The majority of the U.S. population lives in urban settings, where there are greater risks associated with water quality. But hydrologic-hydraulic improvements can be made. NRMRL scientists study the structural integrity of drainage and treatment systems, the control and treatment of discharge, and the effects of the discharge on receiving water.

One storm water control system under evaluation by NRMRL at the Edison facility is green roofs. The Green Roof Research Project centers on storm water absorbency. Green roofs are vegetative covers applied to building roofs to slow or totally absorb rainfall runoff during storms. While the concept of over-planted roofs is ancient, the goal of modern green roof technology is to replace the absorptive capacity of the land on which the building was erected. The vegetative layer can reduce building energy demand, extend the usable lifetime of the roof, reduce noise levels, provide habitat, and provide aesthetic value.

NRMRL researchers at Edison are investigating permeable pavement systems that allow rainfall to pass through the roadway to the underlying soil, significantly reducing runoff volume. The pavement has the potential to:

- Reduce deicing needs in winter month
- Generate less traffic noise
- Produce a lower surface temperature

Research at Edison supports the activities of various EPA organizations:

- The Office of Solid Waste and Emergency Response's Environmental Response Branch
- The Office of Research and Development's Release Control Branch
- The Regional Environmental Science and Assessment Division
- The Regional Enforcement and Compliance Assistance Division's Pesticides and Toxic Substances Program
- The Regional Emergency and Remedial Response Division's Emergency Preparedness Program

Scientists at the Edison facility continue to develop and demonstrate new technologies and methods to manage the risks to public health, property, and the environment from wet-weather flow.

CONTACT
John Beier
(732) 321-4382
beier.johne@epa.gov

U.S. Environmental Protection Agency
Office of Research and Development, National Risk Management Research Laboratory

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The WATERS Network Project Workshop

Green Infrastructure Research Facility

Edison, New Jersey

Michael Borst

A Research Question (one of many)

What is the performance of green Infrastructure management alternatives?

- Effects of loading variation?
- Effects of antecedent conditions
- Changes with season?
- Effects of design options?

Preliminary observations

- Field data collection for performance evaluation is expensive, difficult, hazardous, time consuming, and generates uncertain data.
  - Hard to do at all
  - Very very hard to do well
  - How to complete statistical replication of a stochastic event?

Solution: Build demonstration site

- Reasonable scale
- Introduce a “significant” level of control
- Improved QA/QC
- Educational outreach / demonstration site
- Collaborative opportunities
- Design site for monitoring and instrumentation

Permeable Surfaces

Green Roof

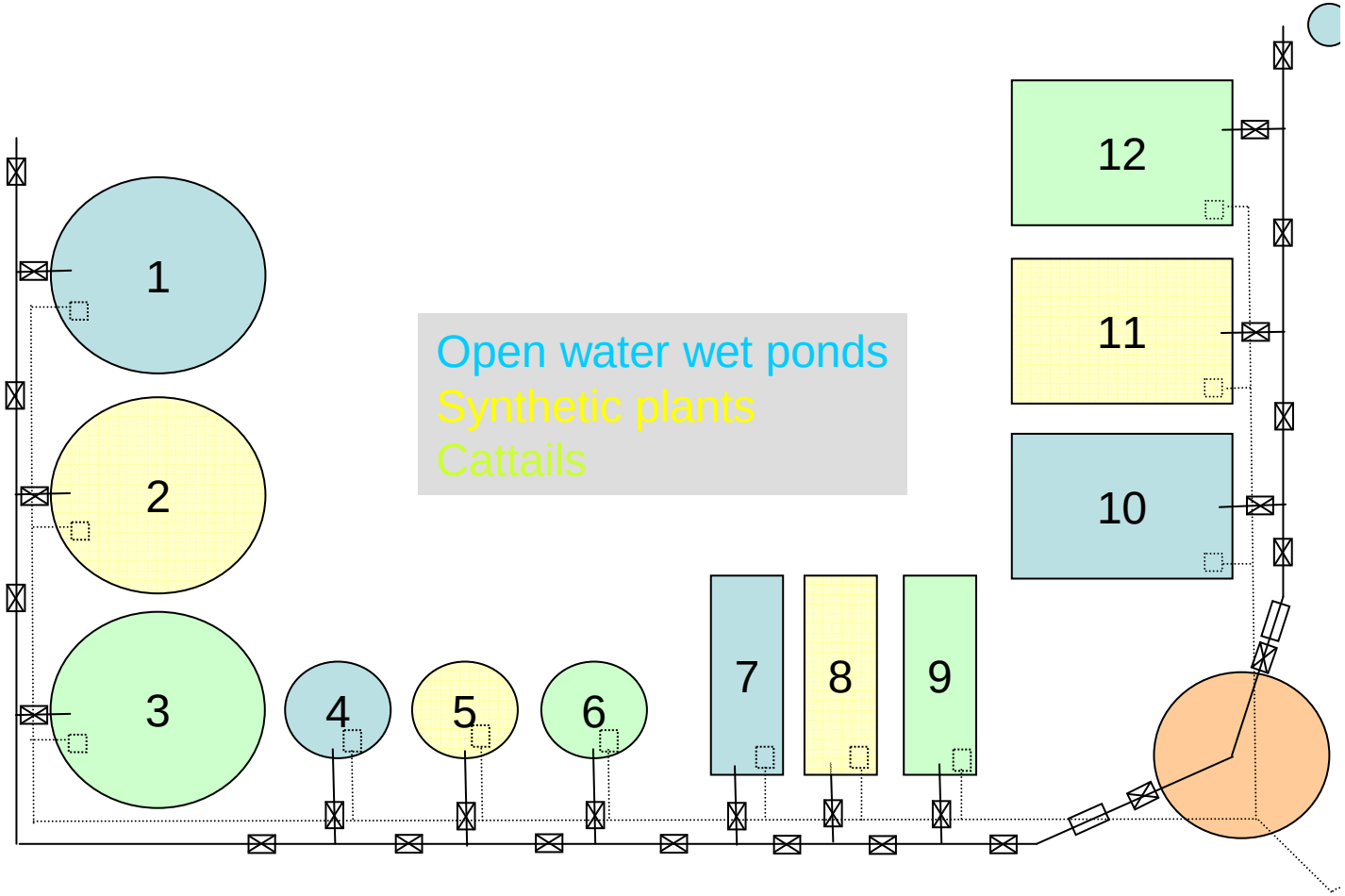
UWRF
constructed wetland
swales
rain gardens
Permeable pavement
pipelines

Google Earth


Swales
Rain Garden
Constructed wetlands
Permeable surface
(being installed)
Laboratory space
(analytical and engineering)

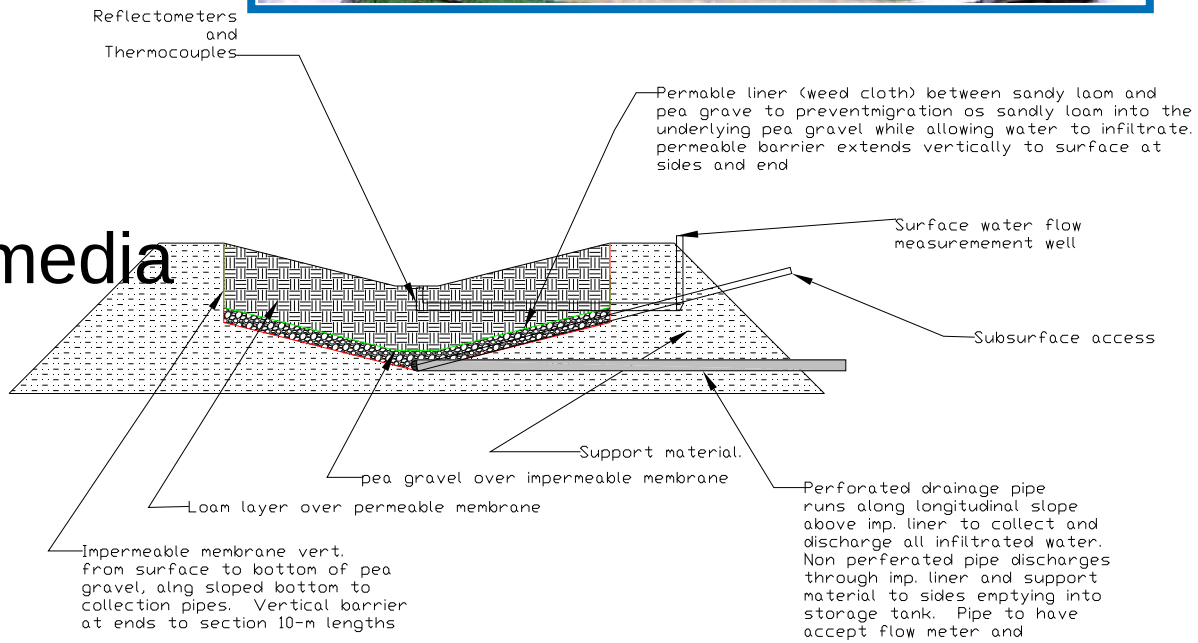
Constructed wetlands

- Variables
  - Shape
  - Loading
  - Vegetation



Swales

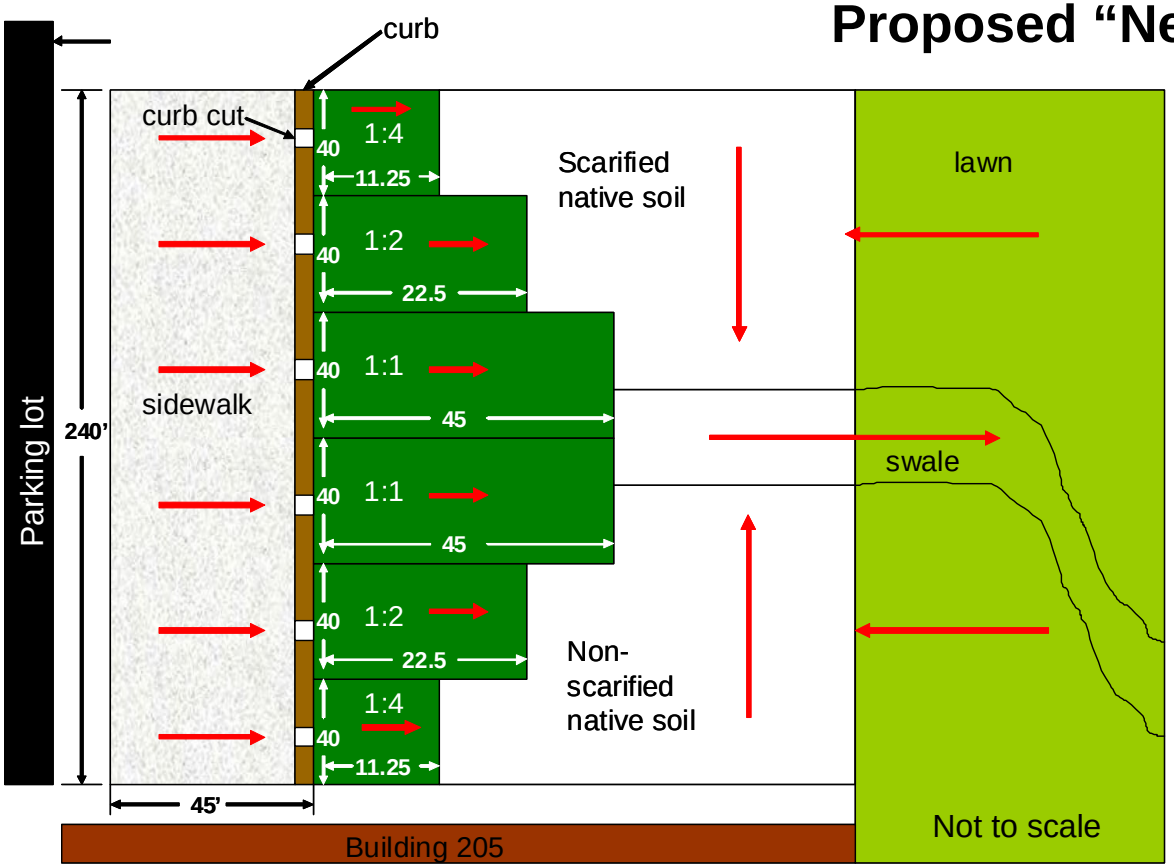
- Three swales
- Imbedded instrumentation
- Trapezoidal cross section with 4:1 side lopes
- 0.5% to 5% slope
- Variable infiltration media
- 40-m long in 10-m segments



Rain Gardens

- Variables
  - Vegetation type (grass v. herbaceous)
  - Organic carbon content of media (newspaper?)
  - Hydraulic loading (Q/A)
  - Induced anoxic zones
- Eight gardens, 8-ft diameter
- Underdrain collection

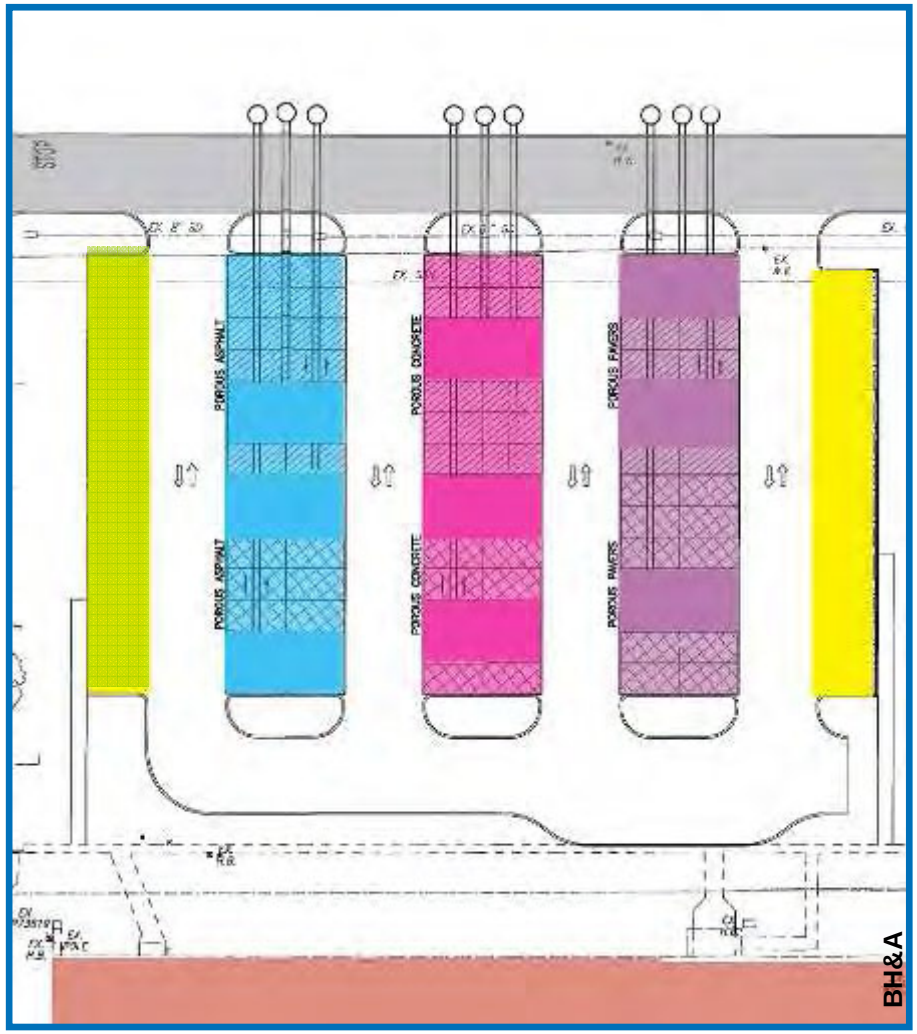
Proposed “New York City” experiments



City of Portland, Dept. of Env. Services

Permeable pavement

- About 1 acre total area
- Three permeable surfaces surrounded by impermeable traffic lanes
- End parking area to be impermeable surface (runoff feeds rain garden)
- Liner with underdrain and tanks for some segments
- Heavily instrumented
- Adjacent climatic monitoring
- Direct infiltration elsewhere
- About 110 spaces total
- Anticipate full use
- Piggyback on EEC project



Phase 3 Conceptual Pilot

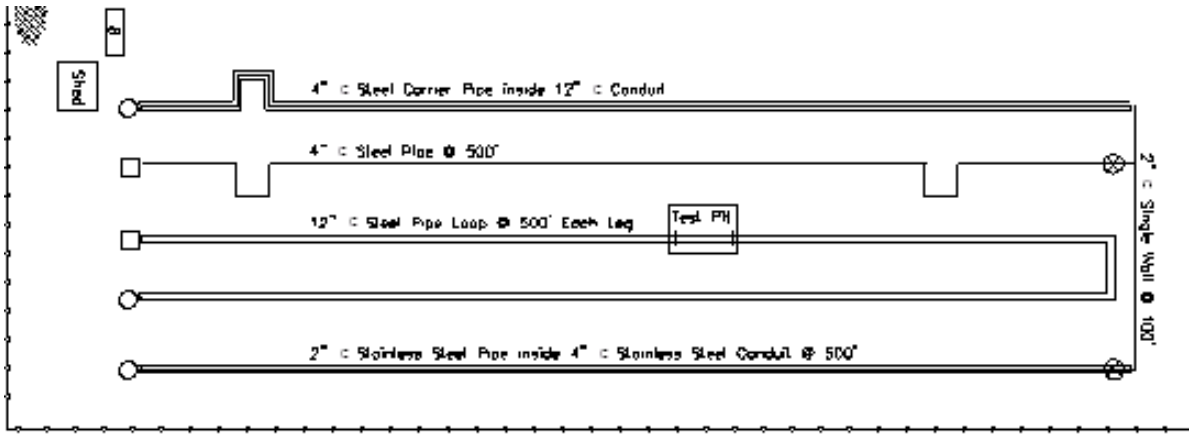
Green roof

- Builds from existing NRMRL work
  - Region 3 & PSU
  - Region 8 EPA building
- Piggyback on EEC project
  - About 15,000 ft² on existing building
  - Instrumented
  - Multiple perceived benefits
- Approached to participate Green Wall demonstration

Google Earth 2008

- Roughly 15,000 ft² flat roof area
- Currently in external engineering review for building structural considerations.
- Paired study with other part of building roof
- Runoff loads (quantity and quality)
- Energy use (?)

Pipeline Test Facility

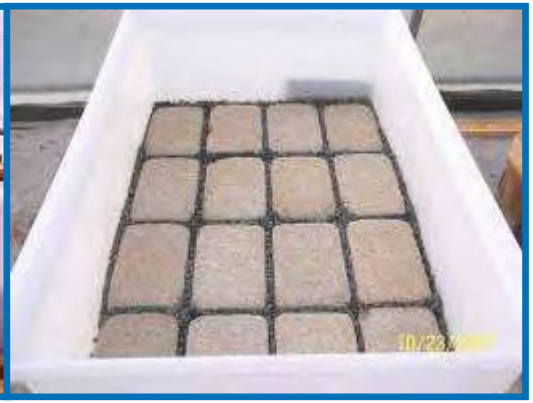


Pipeline Test Apparatus

- Performance data on innovative systems, devices, procedures for:
  - leak detection/location
  - condition assessment
  - Rehabilitation
- Goals
    - reduce energy and water losses
    - reduce unnecessary capital expansion (e.g., excess capacity)
    - reduce premature capital replacement
- Expand and accelerate acceptance of innovative technologies

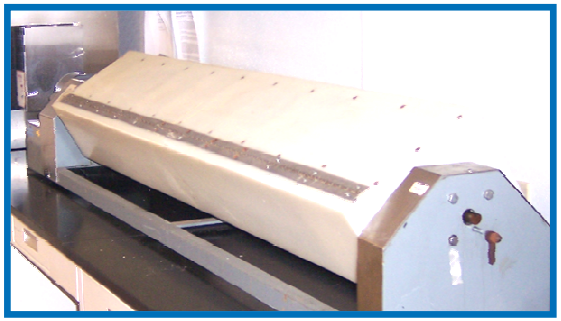
Smaller-scale support

Permeable pavement



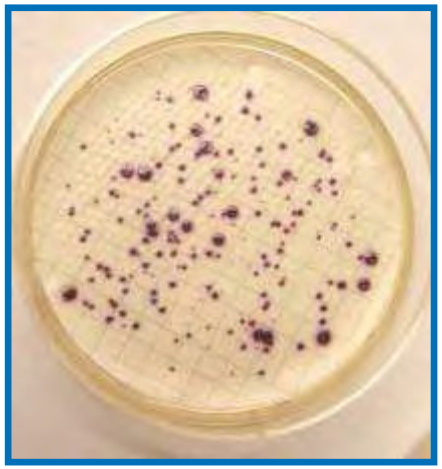
Media comparison

Flume hydraulics



On-site lab support

- Improves reliability
- QA / QC
- Turn around time!



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BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

National **Risk Management** Research Laboratory
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The Experimental Stream Facility Clermont County, Ohio

Introduction

A watershed is the natural land area that drains into a common waterway, such as a stream, lake, estuary, wetland, aquifer, or even the ocean. Watersheds are important—they supply drinking water, provide recreation, and sustain life. So it's also important to reduce the loading of stressors (pollutants) to watershed streams and lakes.

Part of EPA's Sustainable Water Infrastructure Initiative is encouraging the adoption of the "watershed approach," which is incorporating watershed-sensitive alternatives into utility planning and management practices. The watershed approach is supported by the results from the research conducted at the Experimental Stream Facility (ESF).

Background

ESF is a research facility located in Milford, Ohio. EPA leases ESF from Clermont County, and scientists and engineers from EPA's National Risk Management Research Laboratory (NRMRL) share space with the Clermont County Sewer District Water Quality Testing Laboratory.

ESF is in the watershed drained by the Lower East Fork of the Little Miami River. Water is pumped through ESF from the Lower East Fork to provide a balance between the controlled conditions of a laboratory and the variability of the natural environment necessary to sustain native communities. Studies are performed to understand the relationship dynamics between the plant and animal life in the laboratory and those in the river.

Small-stream ecosystems comprise over 72 percent of the river miles in the United States. Yet the role they play in managing watershed-level water quality remains uncertain, and they are commonly overlooked in watershed models. Many small streams remain unregulated, so they are put into culverts or replaced with storm sewers during land development, which eliminates any role they may play in maintaining water quality. NRMRL researchers conduct studies to better understand the relative importance of small-stream ecosystems and the role they play in watershed management.

ESF is the result of collaborative efforts from a number of sources. The facility was originally designed for the needs of a multinational corporation (the Procter and Gamble Company). Today, cross-laboratory collaboration takes advantage of expertise within several divisions of EPA's Office of Research and Development, while biweekly meetings attended by project officers, technicians, and contractor staff guide the research activities.

Features

ESF is unique in design and experimental setup. Because some stream channels receive test chemical doses while others do not, it is possible to distinguish chemical effects from natural environmental influences on stream organisms. Emerging contaminants of concern, such as endocrine-disrupting compounds, can be added precisely and simultaneously with the influent river water at the head of each experimental channel. Suspended solid and nutrient concentrations in the supplied river water can be manipulated as well. Very few operations other than ESF have the level of dosing precision and fail-safe design hardwired into their experimental setup.

Furthermore, incoming and outgoing river water and effluents can be automatically monitored and recorded every few minutes for temperature, pH, dissolved oxygen, conductivity, stream flow conditions (light levels, temperature, and humidity), turbidity, and weather conditions.

The facility features:

- Stream channels – eight 40-foot-long channels with upper and lower sections and a tail tank; many flow configurations are possible
- Water sources – two natural sources (the East Fork of the Little Miami River and the Heiserman Stream) and final effluent from the adjacent wastewater treatment plant

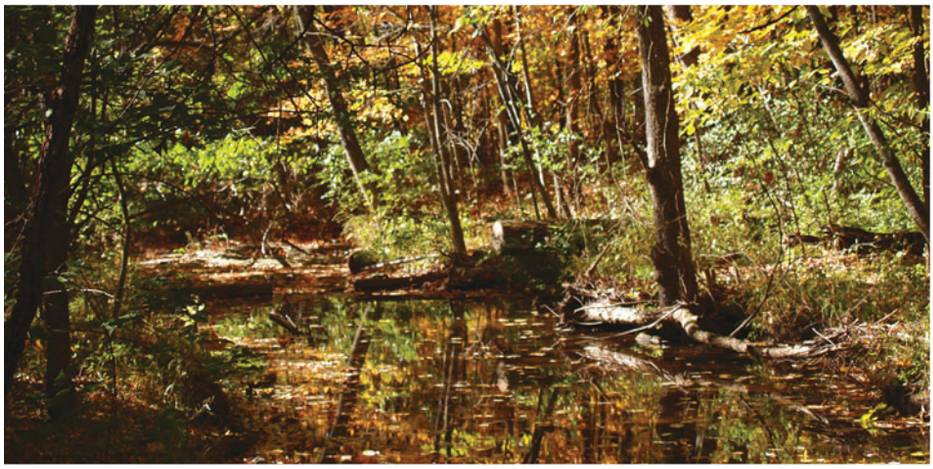
- Solar irradiance – special lights simulate a stream with a forest canopy and a stream in an open field
- Chemical dosing system
- Supervisory Control and Data Acquisition (SCADA) system – sensors, valves, and meters connected to a central computer to monitor and control flows, lights, chemical delivery, and data collection

ESF may be used by scientists and engineers in other federal agencies, states, academic institutions, nonprofit organizations, and private companies. Provisions are in place to ensure that EPA research will not be impacted by any agreements. In most cases, EPA will provide federal employees to operate the facilities.

Results

Reducing the loading of stressors to watersheds is of concern to environmental stakeholders, including local and state governments, utilities, developers, and homeowners. Adopting the watershed approach and best management practices (BMPs) to control both urban and rural sources of waterborne pollutants is helping to reduce contaminants at the watershed level.

The chief beneficiaries are the environmental decision makers who will use ESF data in watershed models to better characterize how streams react to and process emerging contaminants and stressful mixtures, and to quantitatively link known stressors in stream flow with the structure and function of stream ecosystems.



CONTACT
Donald Brown
(513) 569-7630
brown.donald@epa.gov

Christopher Nietch
(513) 569-7460
nietch.christopher@epa.gov

SEE ALSO
Sustaining Our Nation's Water Infrastructure (PDF)
(24 pp, 640 KB)
http://www.epa.gov/waterinfrastructure/pdfs/brochure_si_sustainingournationswaters.pdf

U.S. Environmental Protection Agency
Office of Research and Development, National Risk Management Research Laboratory

EPA/600/F-08/006
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The WATERS Network Project Workshop

Experimental Stream Facility (ESF) and Nested Watershed Monitoring

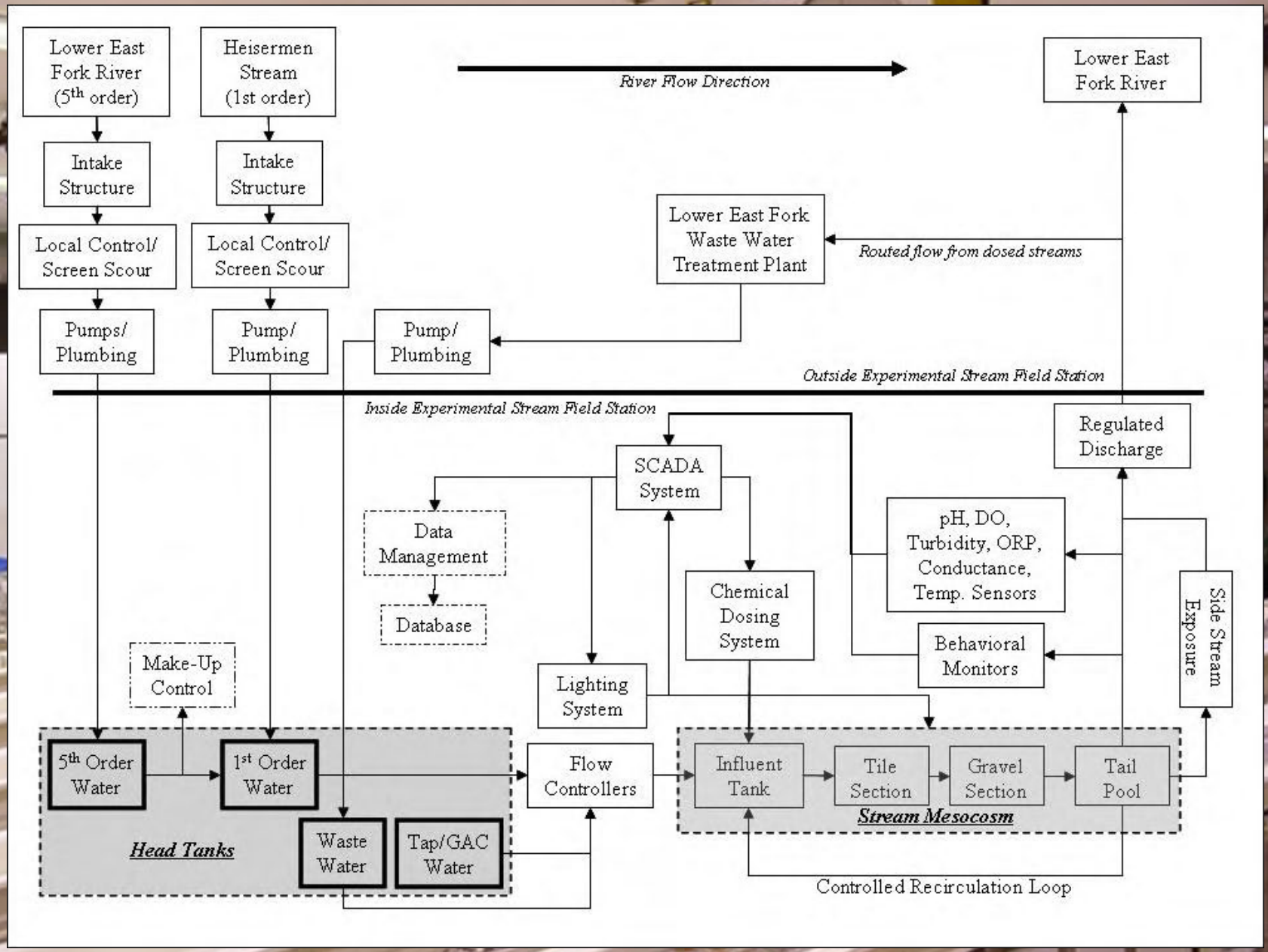
Integrating risk assessment and management objectives for water quality protection

Christopher Nietch

Scope

- Controlled experiments at the meso-scale to support the development of stressor/pollutant loading to in-stream ecology linkages in watershed models.
- Support process-level understanding of ecotoxicology and fate and transport mechanisms for emerging contaminants and stressful mixtures.
- Continuity in base analytics among studies to provide meta-information on ecosystem structure and function useful to the development and testing of new indicators of stress-response, monitoring technologies, and/or management methods and models.

ESF Process Flow Diagram



Stream Mesocosm Design

- Designed for focus on biotic responses.
- Replicated repeated measures within channels for statistical power: Tile and Gravel-filled Trays.
- Controlled residence times for reaction kinetics while maintaining channel velocities and pollution prevention.
- Sampling/exposure methods for drift, emergence, behavioral monitoring, and side-stream enclosures.
- Channel sections are interchangeable and can be linked in series for longitudinal work.

Gravel Section

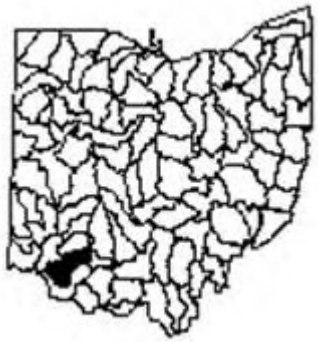
- The gravel section simulates a riffle habitats of real streams.
  - Froude, Reynolds, Boundary Shear fall within real ranges for experimental flows
- Residence time at the whole mesocosm scale can be adjusted to match real reaches.
  - Recirculation
  - Mesocosms in series

Linkage to the Field

The same parameters estimated in gravel trays during ESF experiments are made for trays that have been placed in the field, including the following as base:

Total sediment accumulation
Size-fraction specific mass, organic content (LOI), Carbon, Nitrogen, and Phosphorus
Intergravel Ammonia, Nitrate-Nitrite, SRP, TN, TP, and DOC
Gravel periphyton AFDM and Chl-a
Macroinvertebrate community structure

Nested Watershed Monitoring

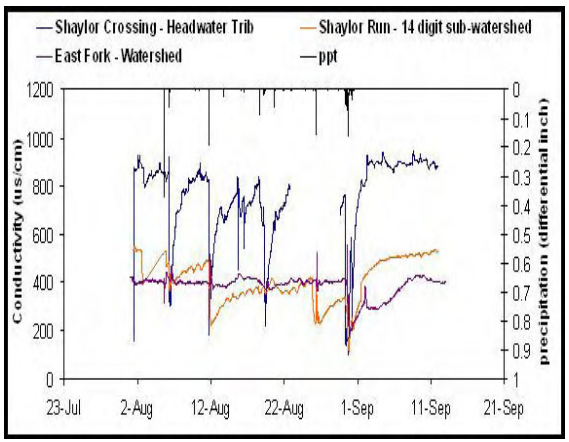


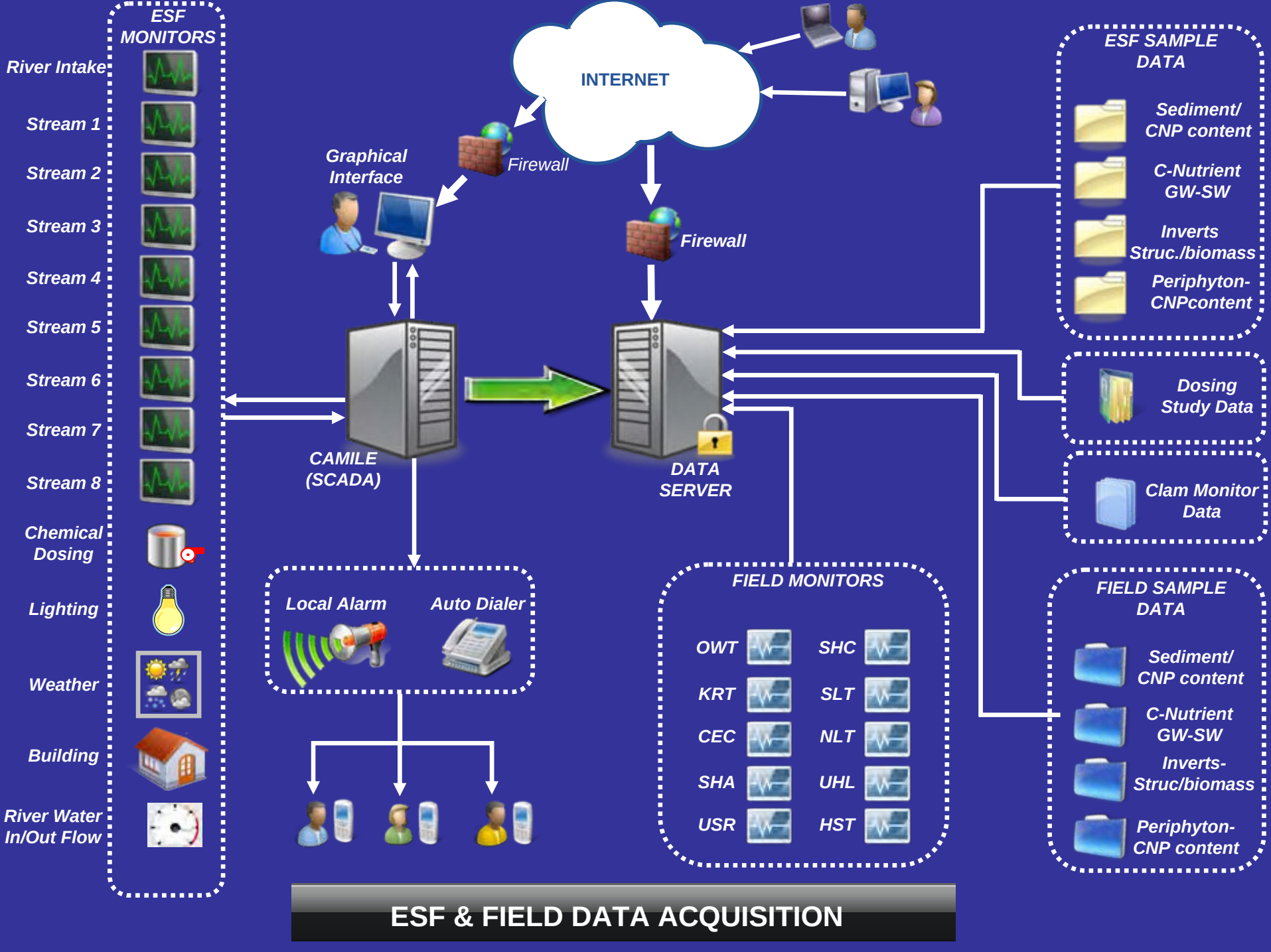
ESF

East Fork "Mixed-Use" Watershed (500 mi^2)

- Lot's of 'Issues' for this watershed
- Headwatersheds (10) vary in size- 100 to 1500 acres.
- 5 headwaters nested within 3rd/4th order confluent channels to mainstem
- Mainstem continuous and historical monitoring points

Scaling




ESF MONITORS
River Intake
Stream 1
Stream 2
Stream 3
Stream 4
Stream 5
Stream 6
Stream 7
Stream 8
Chemical Dosing
Lighting
Weather
Building
River Water In/Out Flow
INTERNET
Graphical Interface
Firewall
Firewall
CAMILE (SCADA)
DATA SERVER
ESF SAMPLE DATA
Sediment/ CNP content
C-Nutrient GW-SW
Inverts Struc./biomass
Periphyton- CNPcontent
Dosing Study Data
Clam Monitor Data
Local Alarm
Auto Dialer
FIELD MONITORS
OWT
SHC
KRT
SLT
CEC
NLT
SHA
UHL
USR
HST
FIELD SAMPLE DATA
Sediment/ CNP content
C-Nutrient GW-SW
Inverts- Struc/biomass
Periphyton- CNP content
ESF & FIELD DATA ACQUISITION

Collaborative Approaches and Processes

- Infeasible not to work collaboratively. ORD's experimental data needs are too dense to afford time for studies that are not in some way supportive of developing applied assessment and management tools.
- Organizational and data sharing protocols to guide study design, O&M during, and synthesis.
  - Biweekly meetings with minutes disseminated to large e-mail group.
    - Technical Support-Contract
    - All Issues "Biotic"
    - "All Scientists"
- "Lead" designated for each study - final say on experimental design and scheduling. Responsible for first draft of major synthesis product (manuscript).
- QAPP addendum and HASP updated if necessary; Experimental configurations implemented and tested. New data threads integrated into data management system.
- Objectives within studies may support basic science (e.g. theoretical ecology of invertebrate drift responses; biological transformity; ecohydrology – ecosedimentology at microhabitat scale).
- Primary stressor of focus for a specific study may support multiple paths of research. (e.g., Development of endpoints for antimicrobial exposure while using effects to inform the relative functional roles of fungi and bacteria in stream periphyton communities.
- Testing the response of new monitoring and measurement instrumentation/methods/endpoints in relation to traditional assessment parameters in meso-scale/controlled setting. (e.g., genomic-based indicators of community structure changes (diatoms, microorganisms, macroinvertebrates). → more tomorrow.

EPA
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science BRIEF
BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

National **Risk Management** Research Laboratory

www.epa.gov/nrmrl/

Robert S. Kerr Environmental Research Center Ada, Oklahoma

Introduction

The Kerr Center, situated on 16 acres three miles south of Ada, Oklahoma, houses the Ground Water and Ecosystems Restoration Division (GWERD) of the National Risk Management Research Laboratory (NRMRL). The division develops strategies and technologies to protect and restore ground water, surface water, and ecosystems affected by human-made and natural events. The center, which includes the Gaar Corner field site, contains state-of-the-science analytical chemistry equipment, specialized instrumentation, and field equipment to study the transport and transformation of contaminants in soil and ground water.

Background

In 1961, amendments to the Federal Water Pollution Control Act of 1956 directed the federal government to establish field laboratories in various parts of the United States as research facilities to combat increasing national water pollution problems. One of these field laboratories was established in Ada, Oklahoma. Completed in 1966, the center was named for Robert S. Kerr, a long-time U.S. senator from Oklahoma.

With its beginnings as a regional U.S. Public Health Service laboratory under the U.S. Department of the Interior, the Kerr Center provided technical assistance and training, and conducted research to solve water pollution problems in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

In 1970, the Kerr Center became one of 15 research laboratories administered by the newly created EPA through its Office of Research and Development (ORD). Between 1970 and 1980, research at the Kerr Center included investigations on water quality, land treatment, and ground water, and the environmental effects of mining, irrigation, petroleum and petroleum-related activities, and animal wastes.

ORD was realigned in 1995 and EPA's 15 research laboratories were consolidated into three national laboratories and two centers. As a result, the Subsurface Protection and Remediation Division of NRMRL was formed. From 1995 until 1997, the division's mission was to conduct research to support EPA efforts to protect and remediate the subsurface environment. In 1997, the mission was expanded to include research on ecosystem restoration. In 2002, the division's name was changed to the Ground Water and Ecosystems Restoration Division to reflect the change in its mission.

To reduce its environmental footprint, the center became EPA's first carbon-neutral laboratory. This means the center reduces energy use whenever possible and implements carbon offsets to mitigate any remaining greenhouse gas emissions caused by using energy. The result is net zero emissions.

Features

The three-story Kerr Center provides 50,000 square feet of laboratory and office space. An addition to the facility in 1993 provides another 20,000 square feet for the library, computer support services, and a conference center. The nearby 10,000-square-foot annex contains a machine shop and storage facilities for field equipment and supplies. Separate facilities have been constructed for storing bulk chemicals, compressed gases, and hazardous waste.

Besides the Kerr Center, GWERD researchers use the 110-acre Gaar Corner field site to conduct research. Garr Corner is located nine miles west of Ada and is the setting for both in-house research and collaborative efforts with academic and commercial partners and private companies.

The field site encompasses a mixture of woodlands, open fields, and ponds. Researchers use the site in their efforts to safeguard underground supplies of drinking water from contamination by pollutants introduced to the subsurface via injection wells. It offers several types of underground injection wells for evaluating mechanical integrity:

- Three logging wells
- A calibration well
- A leak-test well
- Three monitoring wells

Gaar Corner is also used for ecosystem research studies. With its sixteen 40-square-foot enclosures, the site supports research on interactions among primary consumers, plants, microbes, detritivores, and soil chemistry. Research also focuses on the ecosystem's susceptibility to nitrogen deposition and the development of novel management interventions for improving nitrogen-use efficiency in watersheds. In addition to the enclosures, researchers at Gaar Corner use a 2,000-square-foot laboratory with computer facilities, a 1,000-square-foot shop and storage building, and a weather station.

Results

GWERD addresses areas of research that are part of ORD's strategic plan and NRMRL's mission. The division is EPA's center of expertise for the investigation of the soil and subsurface environment, and ecosystem restoration nationwide. Topics of research at the Kerr Center include:

- The potential use of in situ bioremediation as a method of restoring contaminated ground water
- The effects of concentrated animal feeding operations on water quality
- The existence and implications of nonaqueous phase liquids and ways to clean them up
- The use of permeable reactive barriers to remediate contamination from metals and chlorinated solvents
- Site-specific technical support for over 300 Superfund, Resource Conservation and Recovery Act, and brownfield sites
- Evaluation of the effectiveness of ecosystem restoration efforts on streams in several different states across the country

Research is conducted at the Kerr Center to:

- Enhance understanding of the physical, chemical, and biological processes that control the transport of mass and energy in surface and subsurface ecosystems through the movement of water
- Develop and evaluate the means to protect and restore ground and surface water
- Evaluate the benefits of restoring and managing ecosystems

Information transfer materials and activities (e.g., handbooks, journal articles, reports, research briefs, issue papers, workshops, and symposia) assist EPA in protecting and restoring public health and the environment. GWERD's Center for Subsurface Modeling Support (CSMoS) provides public domain ground water and vadose zone modeling software and services along with direct technical support to EPA and state decision makers.

CONTACT
Bob Puls
(580) 436-8543
puls.robert@epa.gov

SEE ALSO
Center for Subsurface Modeling Support (CSMoS)
http://www.epa.gov/ada/csmos.html

U.S. Environmental Protection Agency
Office of Research and Development, National Risk Management Research Laboratory

EPA/600/F-08/003
April 2008

The WATERS Network Project Workshop

Ecosystem Restoration Research at GWERD

Paul M. Mayer, Ph.D.

USEPA/ORD/NRMRL/GWERD

Ground Water & Ecosystems Restoration Division Ada, OK

- Mission: Conduct research and technical assistance to provide the scientific basis to support the development of strategies and technologies to protect and restore ground water, surface water, and ecosystems impacted by man and natural disturbances

Focus Areas

Wetlands/Streams Restoration
Nitrogen

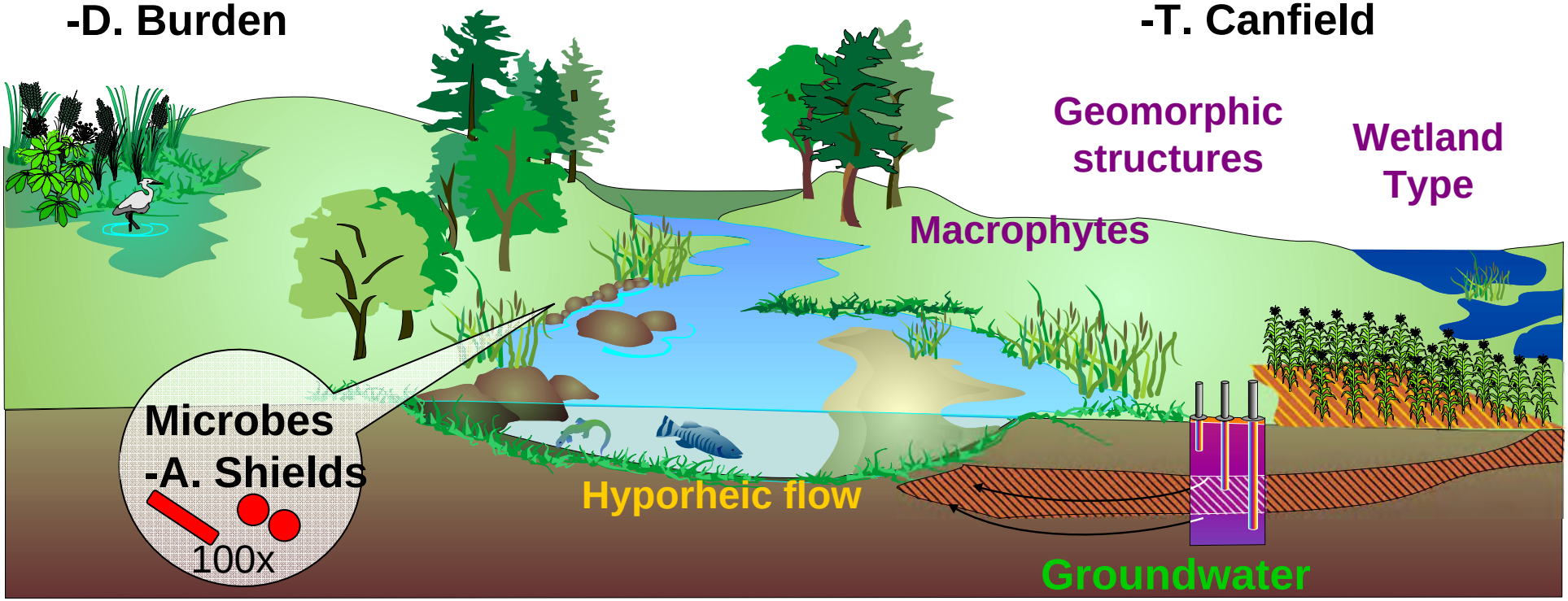
PI's conducting ecosystem restoration research at GWERD lab in Ada, OK

Wetlands
-T. Canfield
-D. Burden

Riparian Buffers
-P. Mayer

Floodplains
-K. Forshay

Decision Support
-D. Burden
-T. Canfield

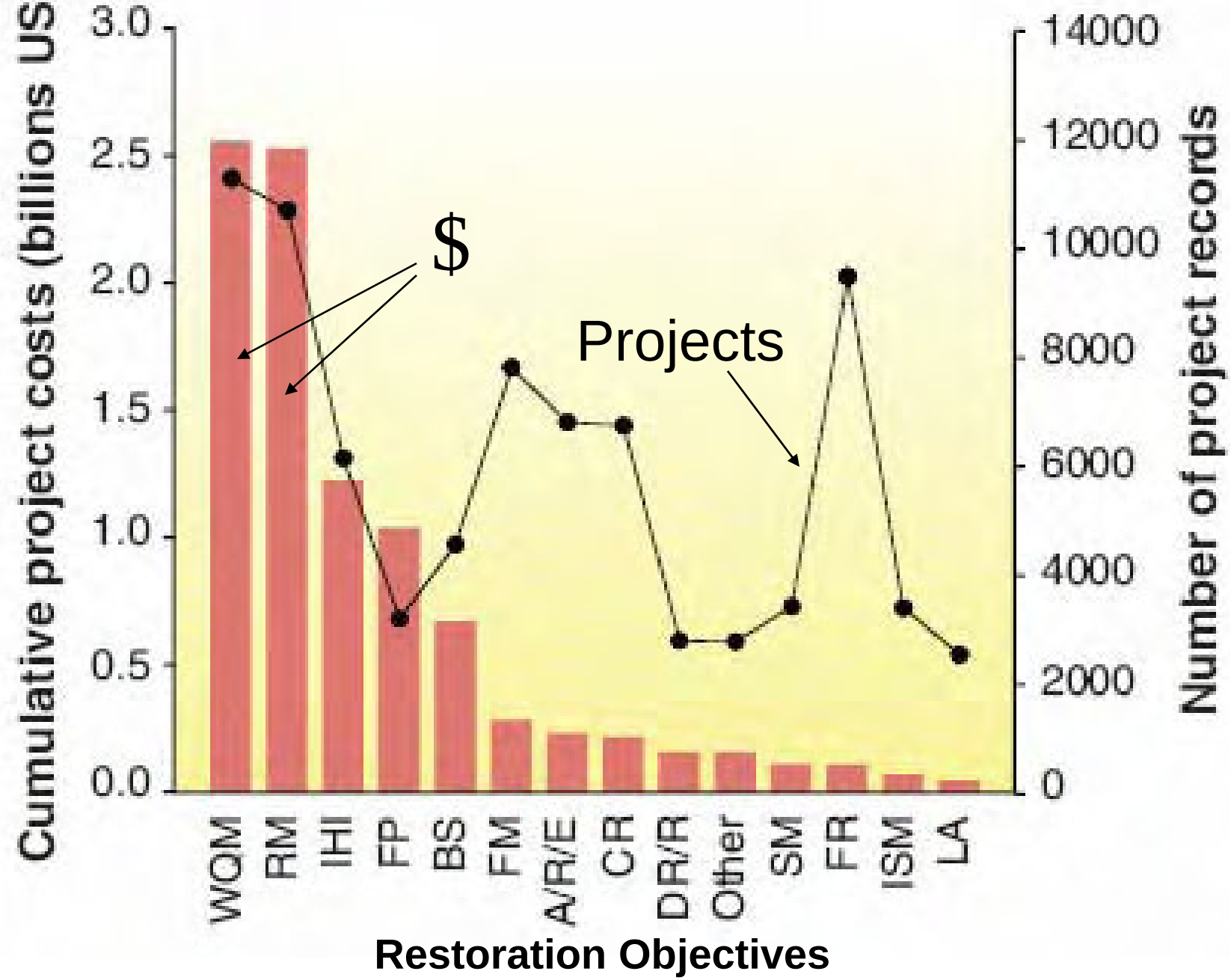


Modeling
B. Faulkner, C Cooper

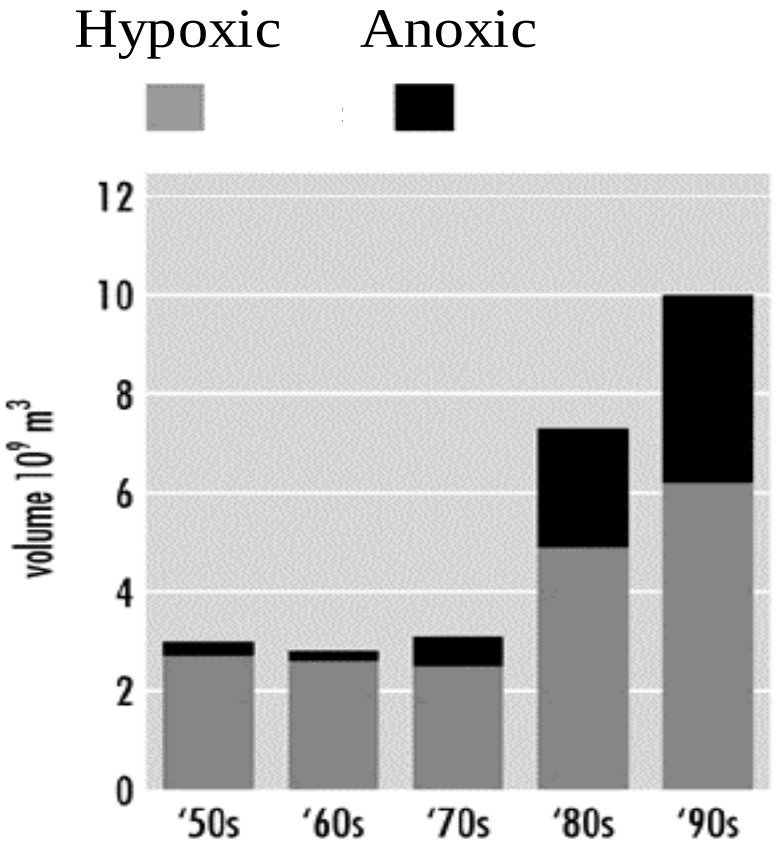
Groundwater
-B. Faulkner, C Cooper
-P. Mayer

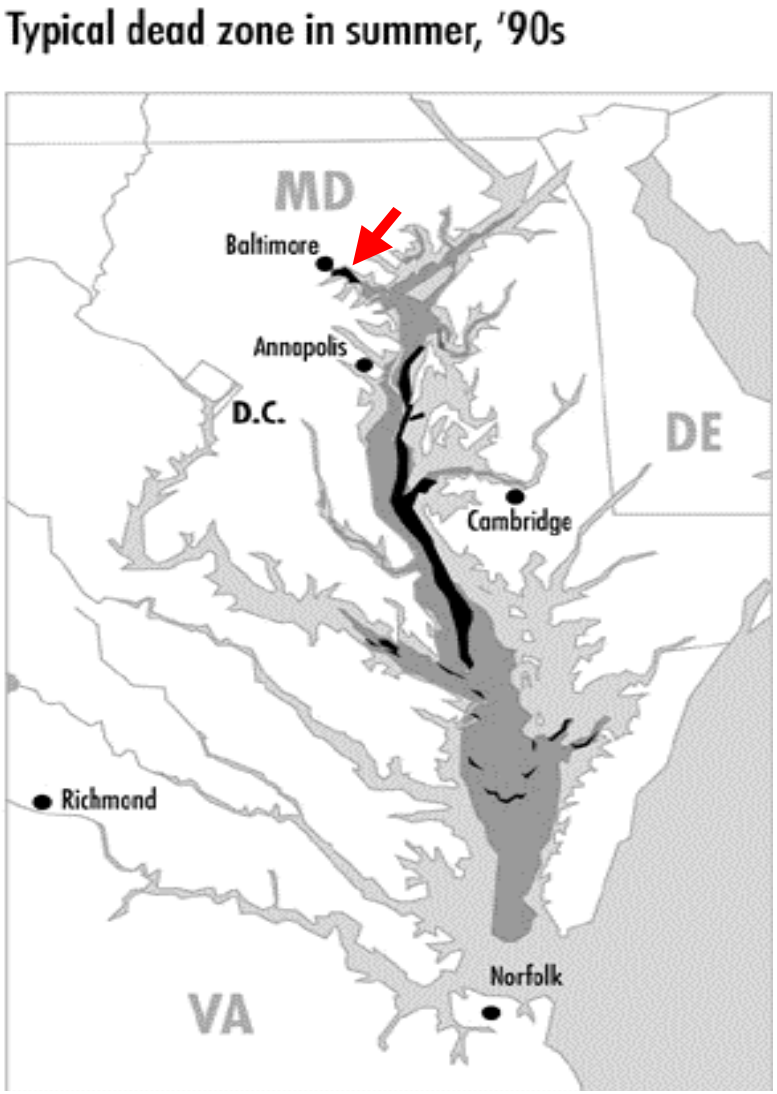
Costs of river restoration in the U.S.

(Bernhardt et al. 2005. *Science* 308:636-637)



Excess nitrogen is a non-point source pollutant that impairs water quality

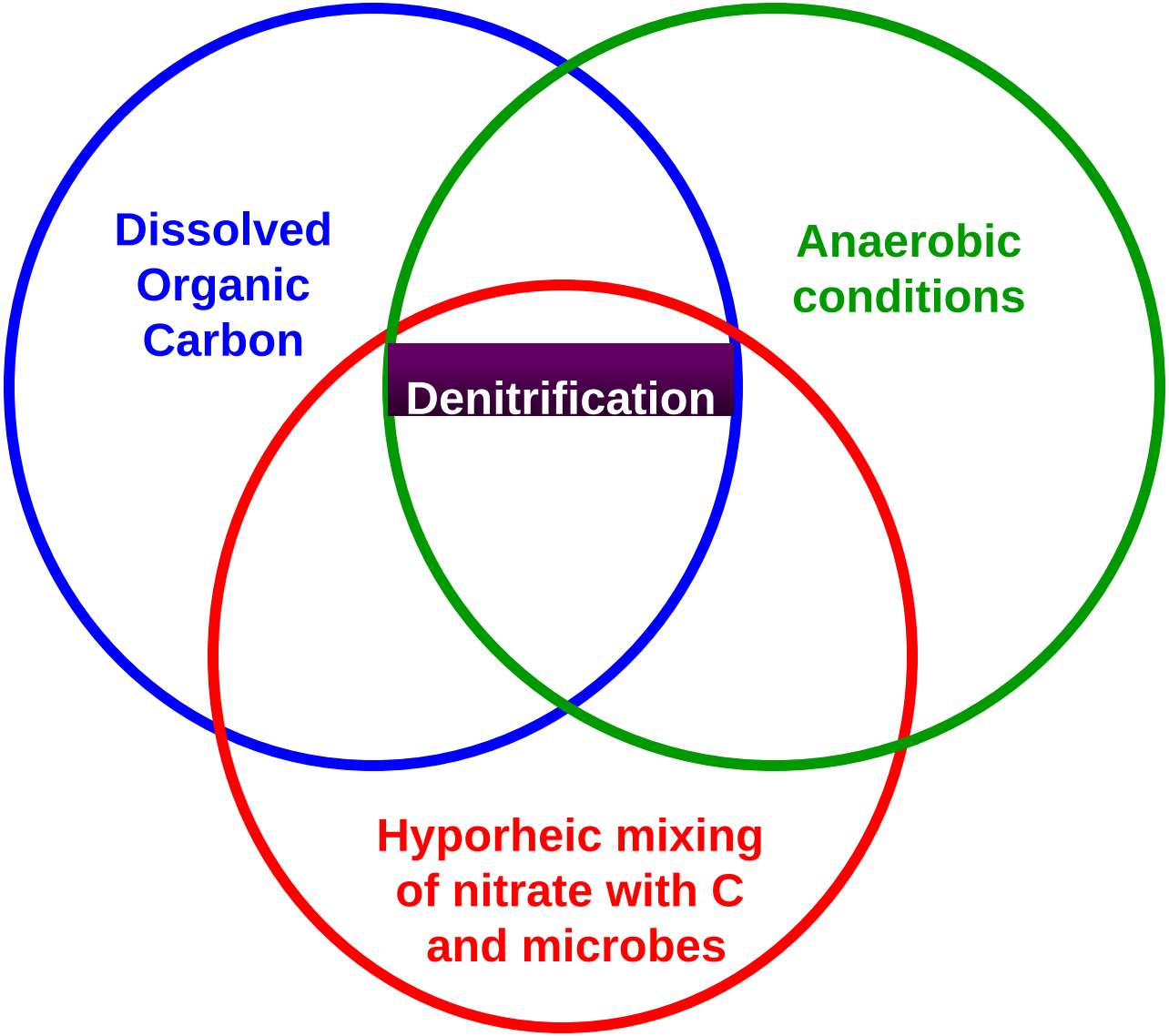




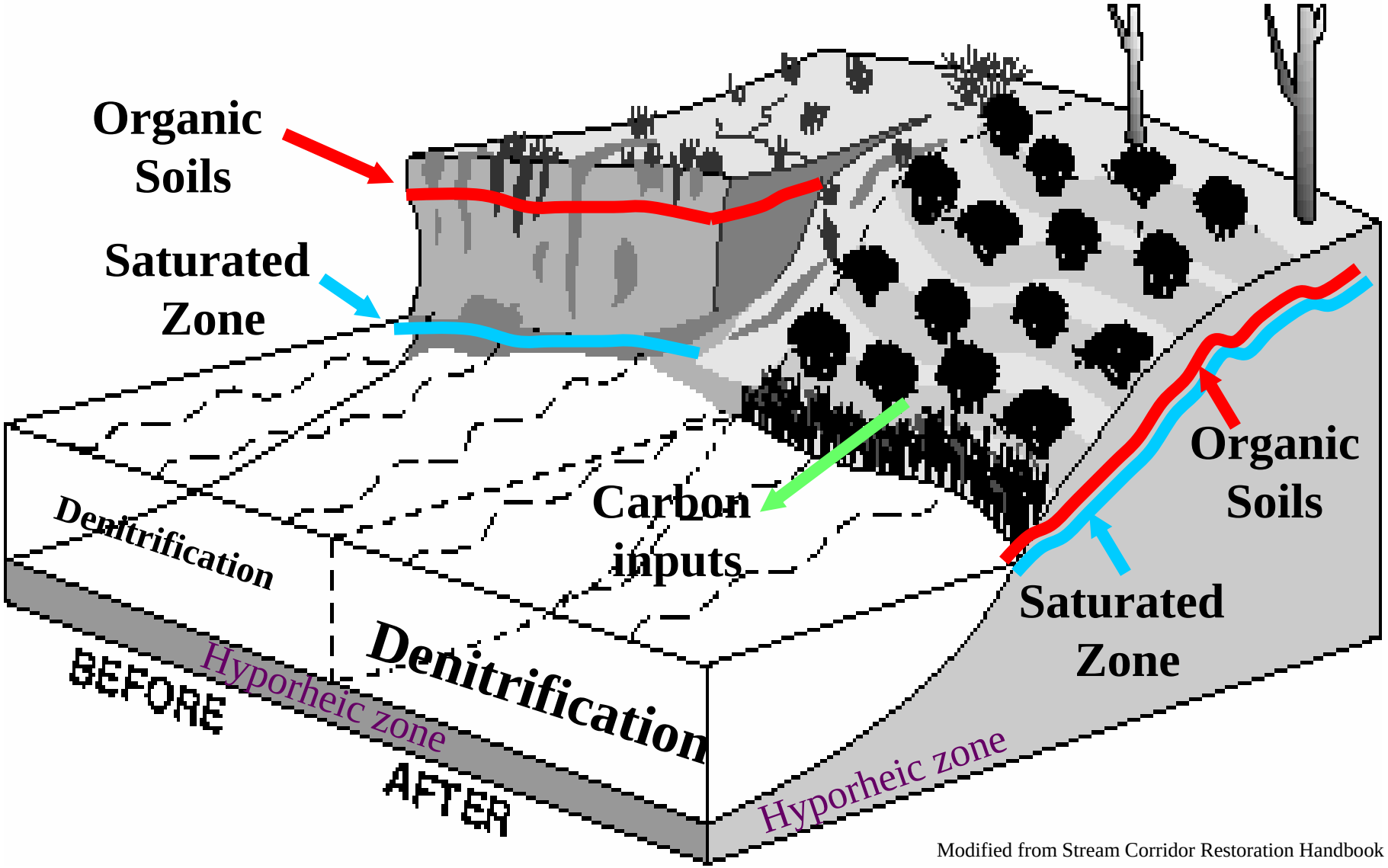

Minebank Run – before restoration
Loss of Ecosystem Services


Minebank Run – after restoration
Restoration of Ecosystem Services?
Nutrient processing
Sediment control
Flood control
Temperature moderation
Biodiversity

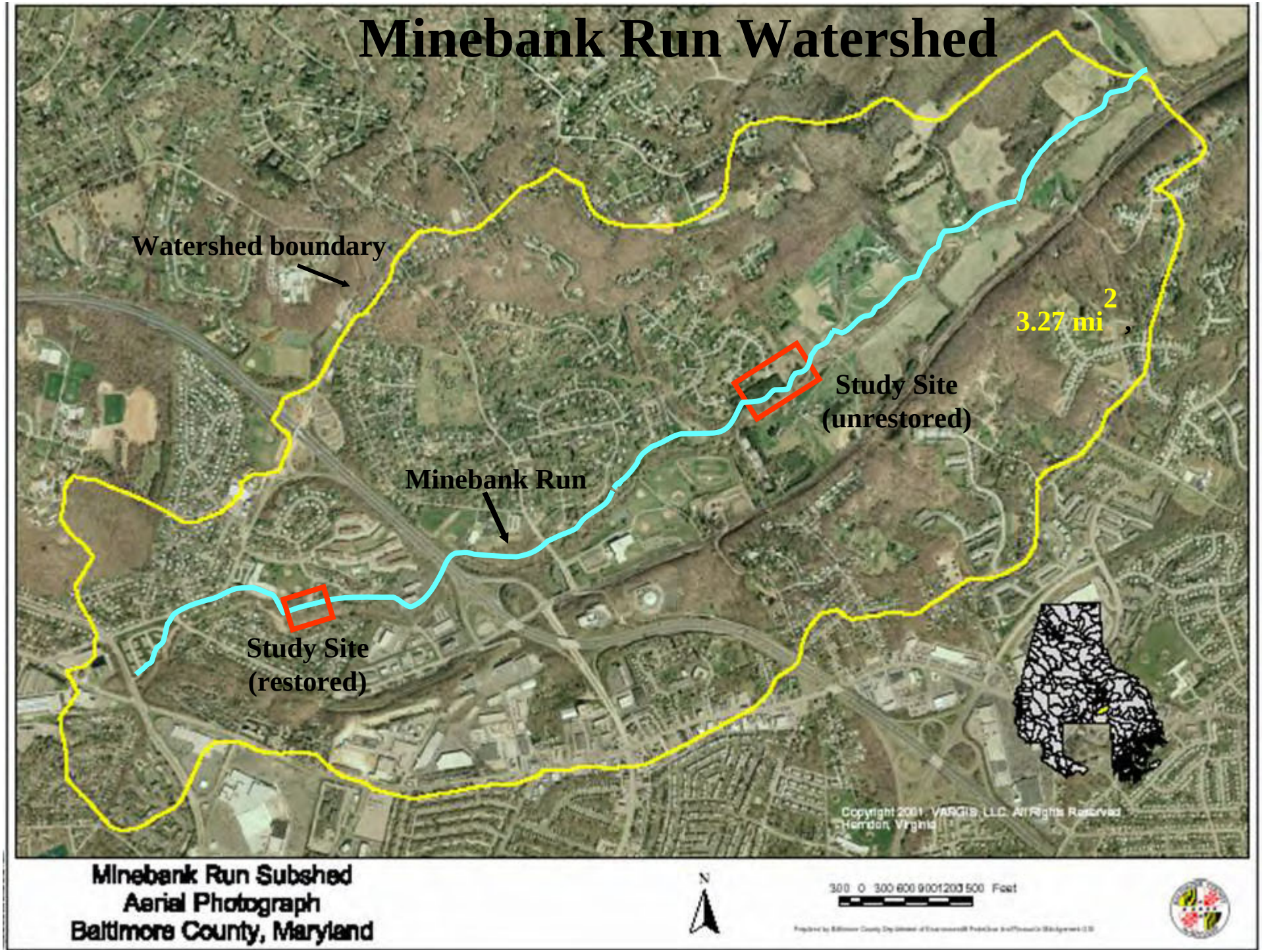
N removal via denitrification



Biochemical effects of geomorphic restoration

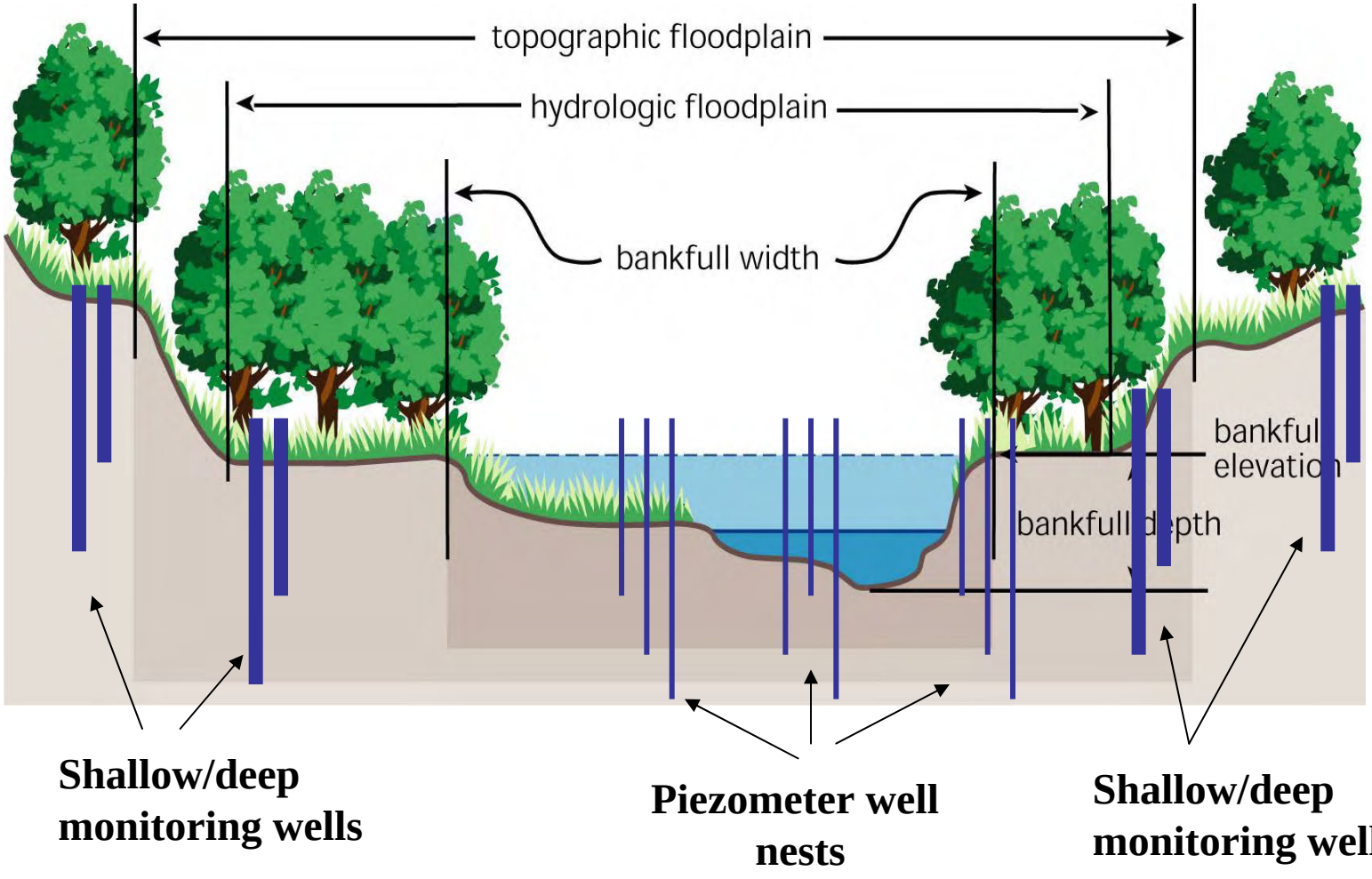


Modified from Stream Corridor Restoration Handbook


Minebank Run Watershed
Watershed boundary
3.27 mi2
Study Site
(unrestored)
Minebank Run
Study Site
(restored)
Copyright 2001 VARGIS, LLC. All Rights Reserved
Herndon, Virginia
Minebank Run Subshed
Aerial Photograph
Baltimore County, Maryland
N
300 0 300 600 900 1200 500 Feet

GWERD specializes in studying subsurface biochemical processes

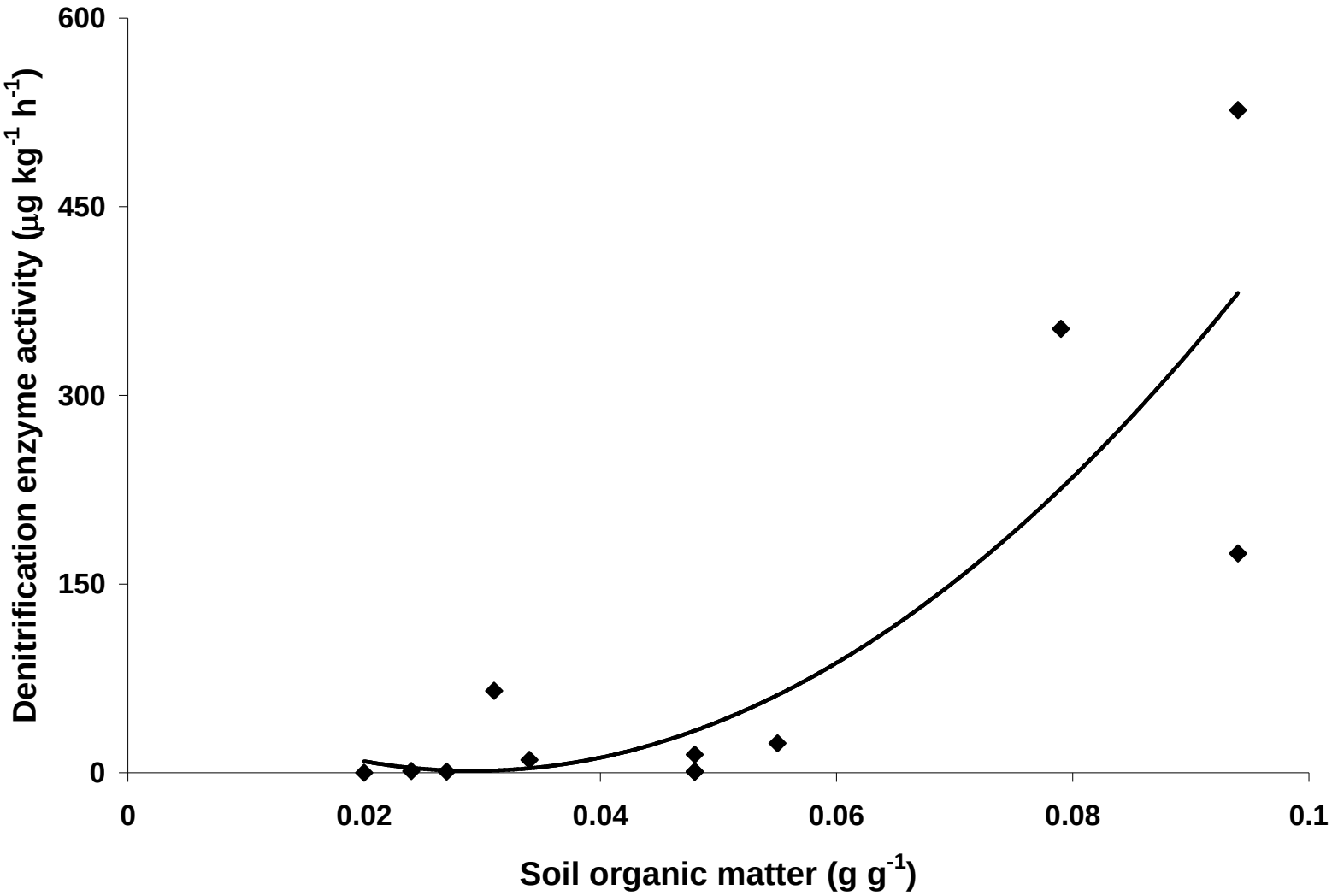
Groundwater Monitoring



Collaborators

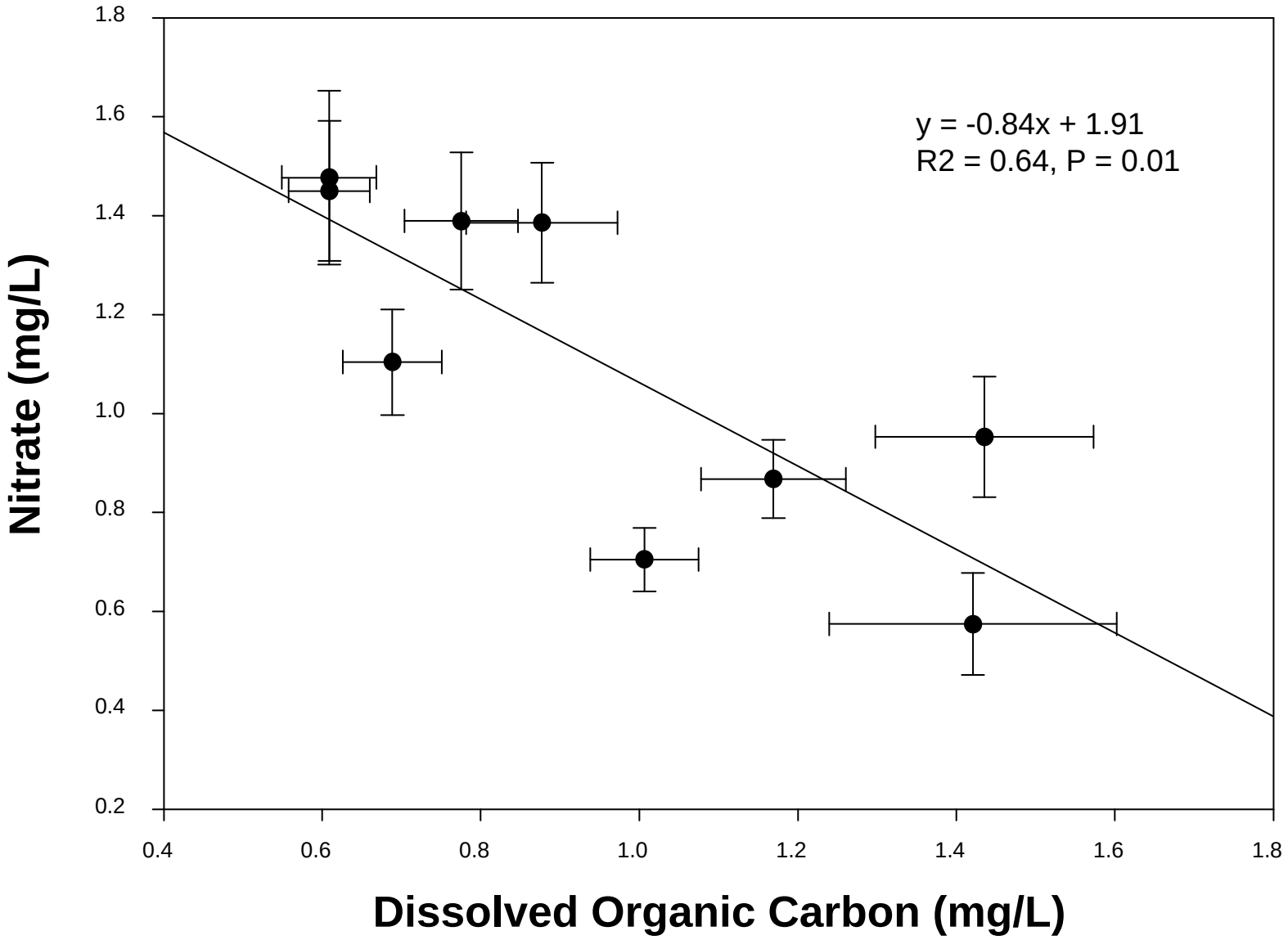
USGS-Water Resources Division-Baltimore
Baltimore Ecosystem Study - LTER
Institute of Ecosystem Studies
U Maryland - Center for Environmental Studies,
Chesapeake Bay Lab, Appalachian Lab
Oklahoma State University
Baltimore County DEPRM
Chesapeake Bay Program
Maryland Sea Grant
US Forest Service
Baltimore County Parks Dept.
Maryland Dept Natural Resources
Franklin and Marshall College
College of Franklin and Marshall
Johns Hopkins University

Denitrification increases with soil organic matter

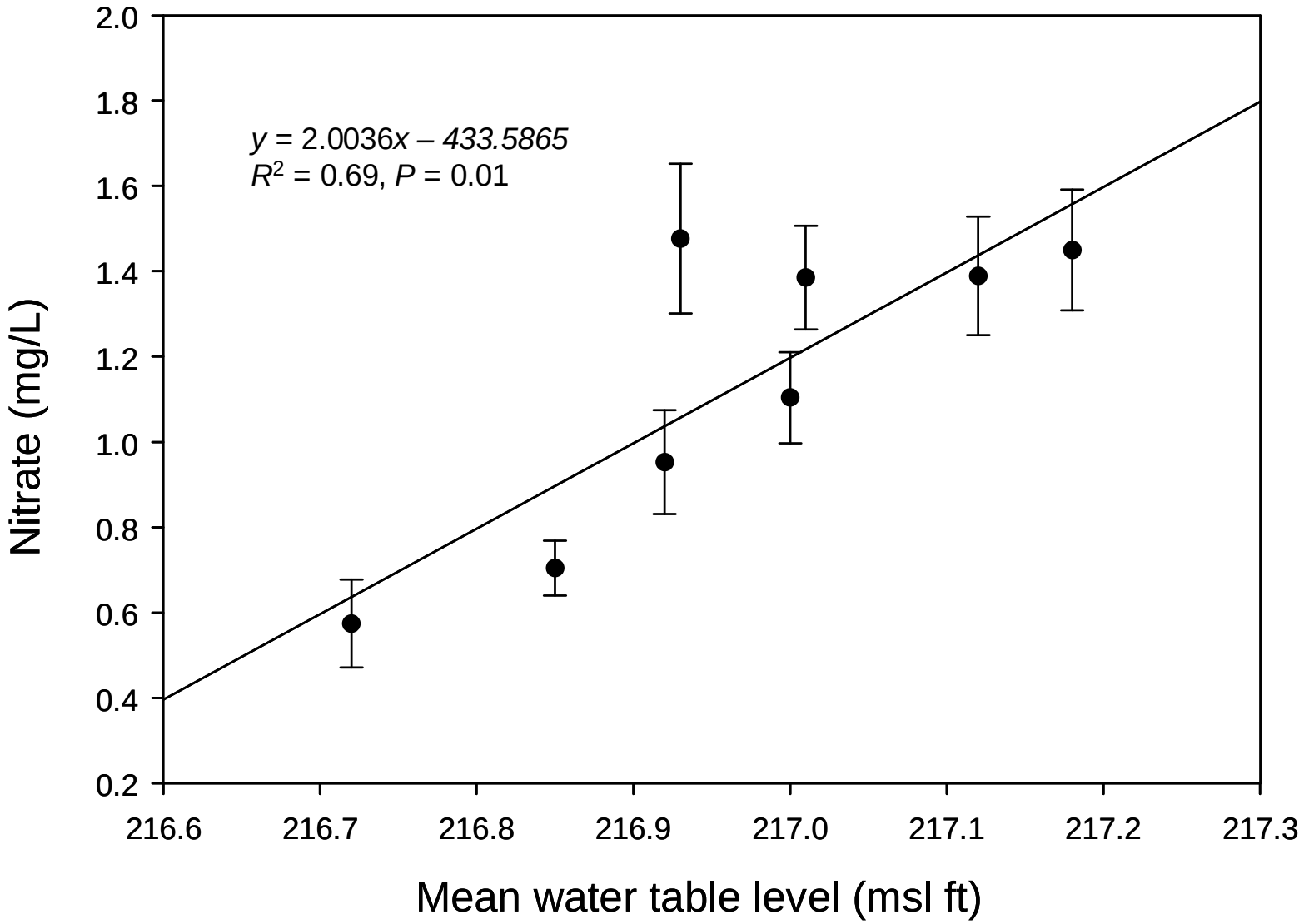


Gift Groffman & Mayer 2008 Restoration Ecology

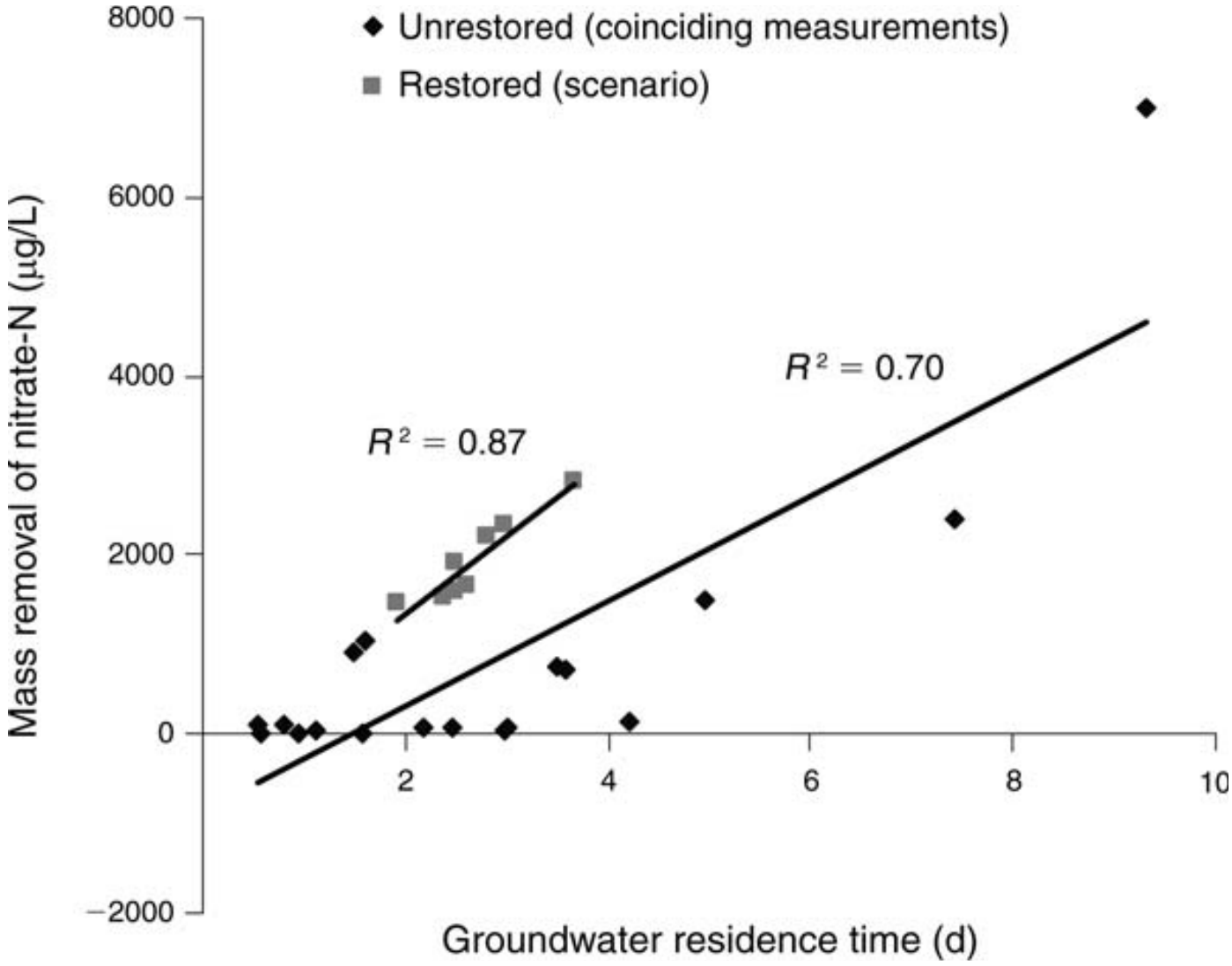
Hyporheic NO_3^- and DOC are linked



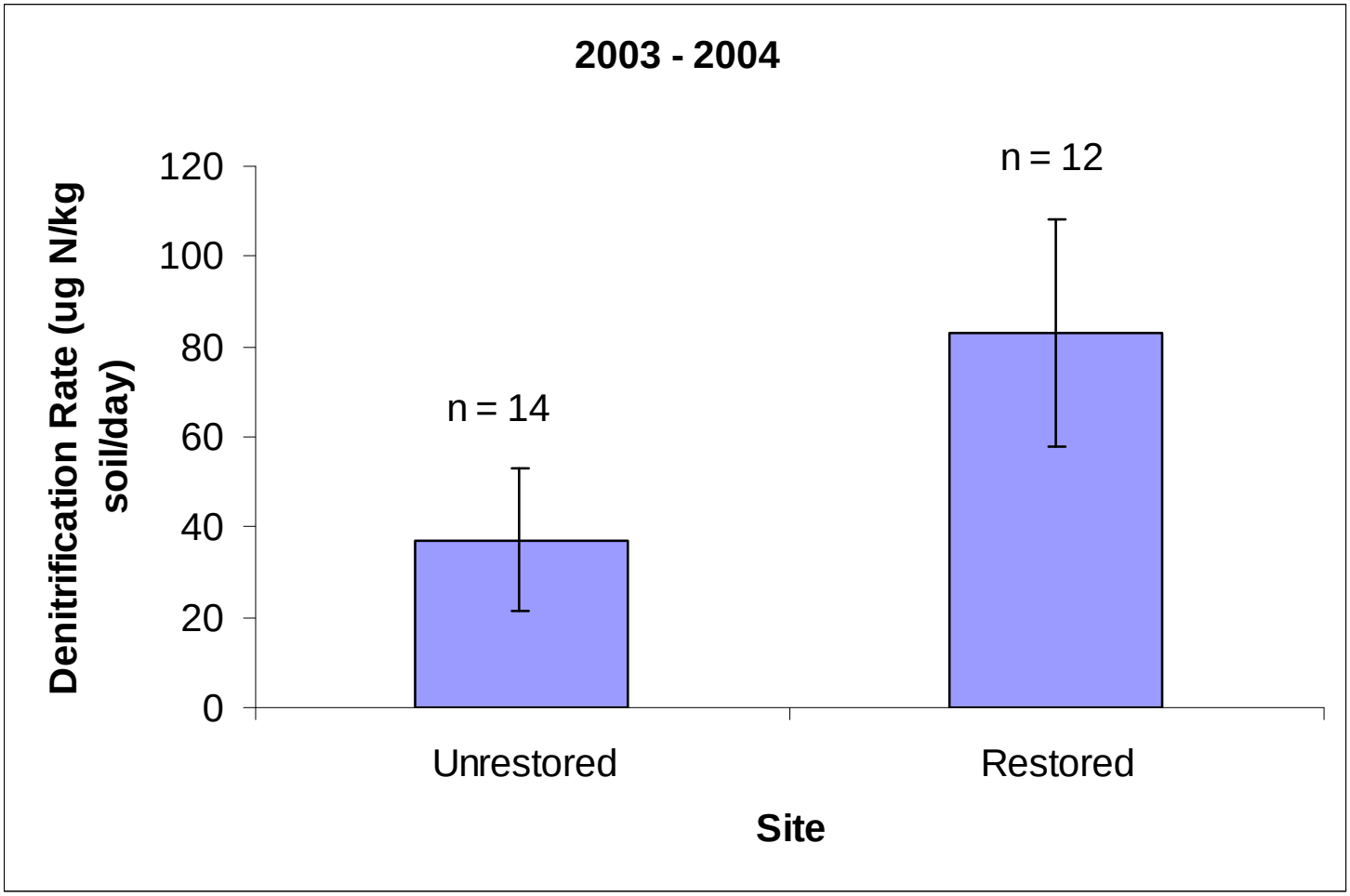
NO_3^- and hydrology are linked



N removal is linked to GW residence

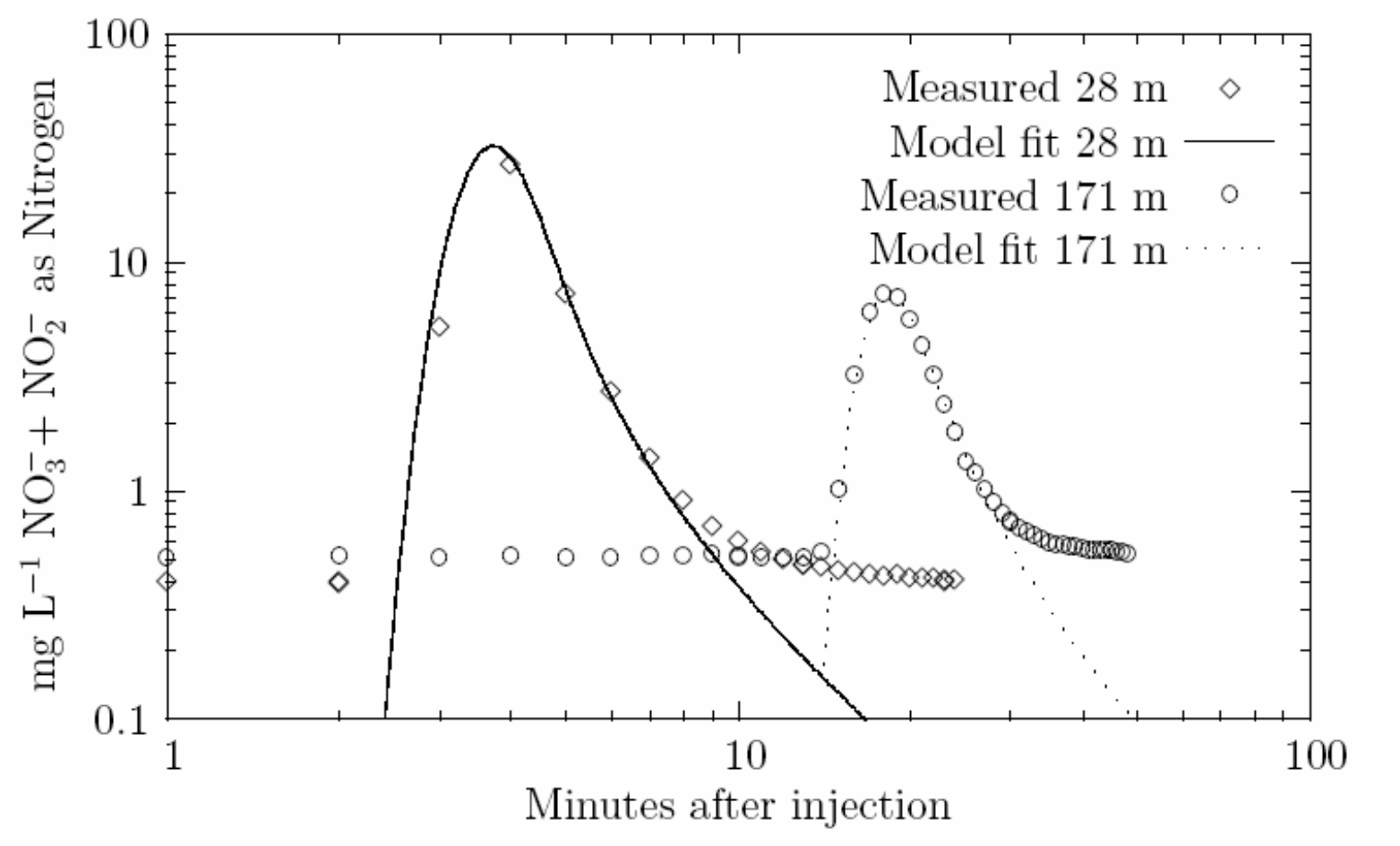


Stream restoration improved N uptake via denitrification



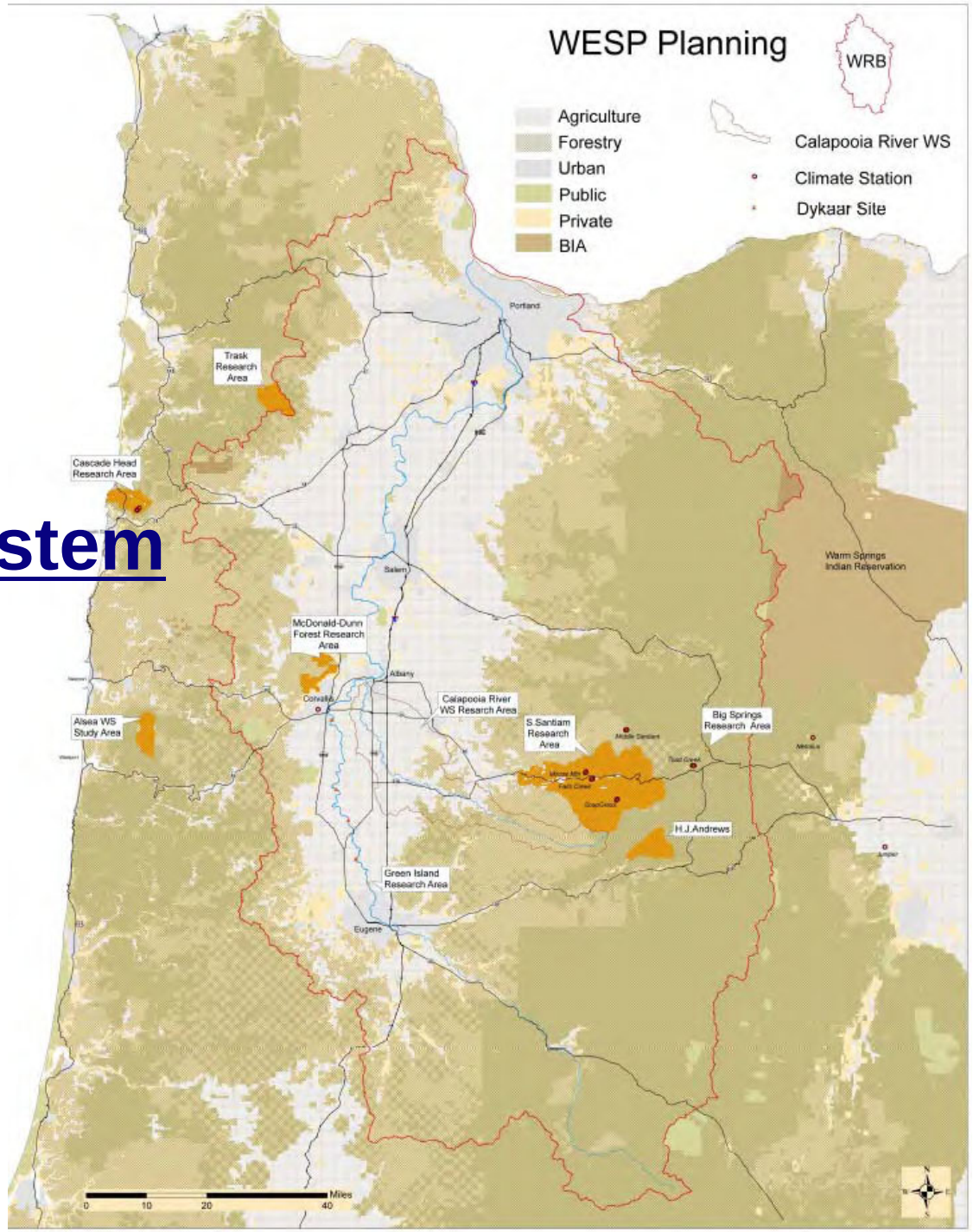
Kaushal, Groffman, Mayer, Striz, Doheny, and Gold. Effects of stream restoration on denitrification at the riparian-stream interface of an urbanizing watershed of the mid-Atlantic U.S. 2008 Ecological Applications

Nutrient metrics meta-analysis

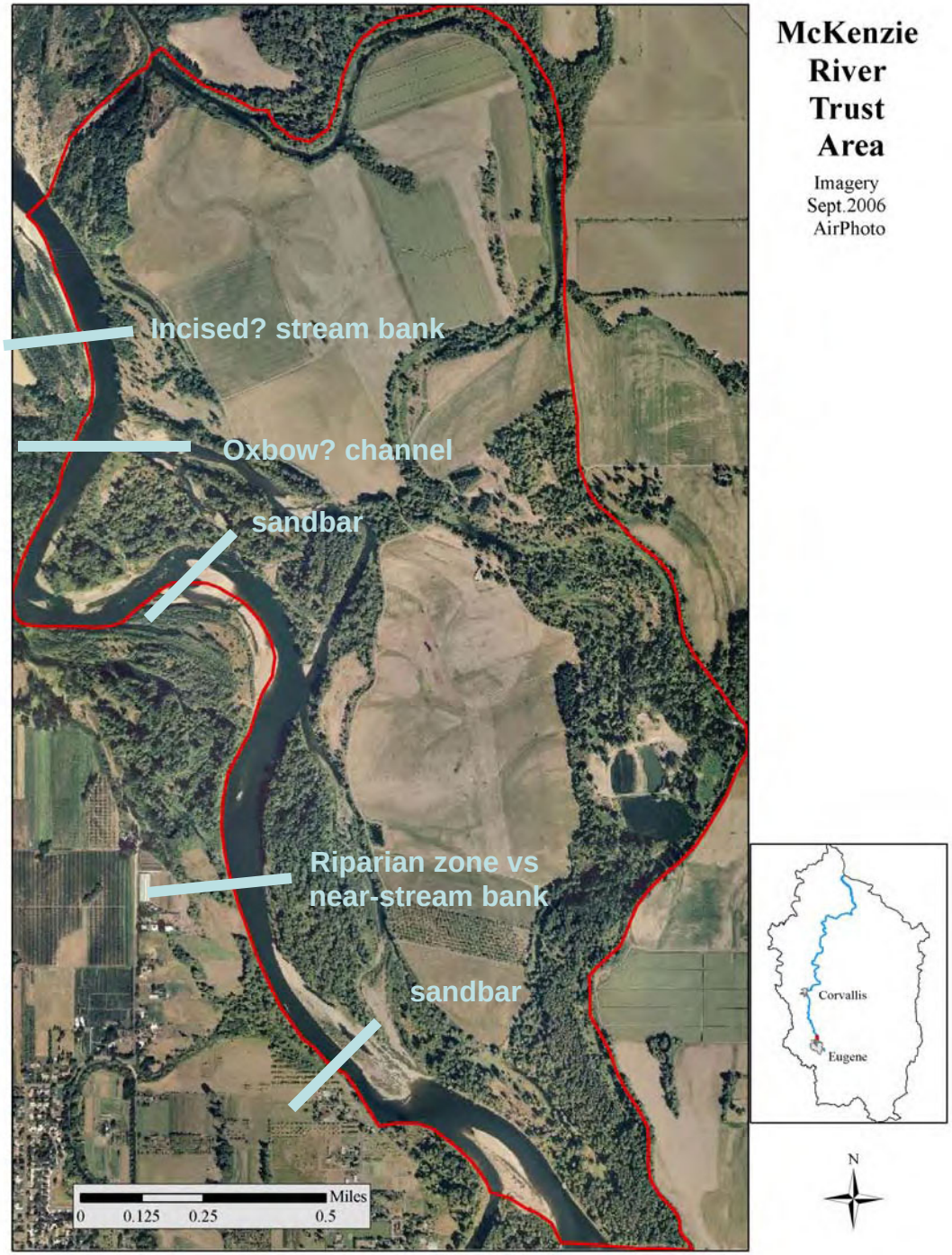


Faulkner BR. (accepted) Bayesian modeling of the assimilative capacity component of nutrient TMDLs. Water Resour. Res.

New research in Willamette River Basin, Oregon – Mapping and managing ecosystem services

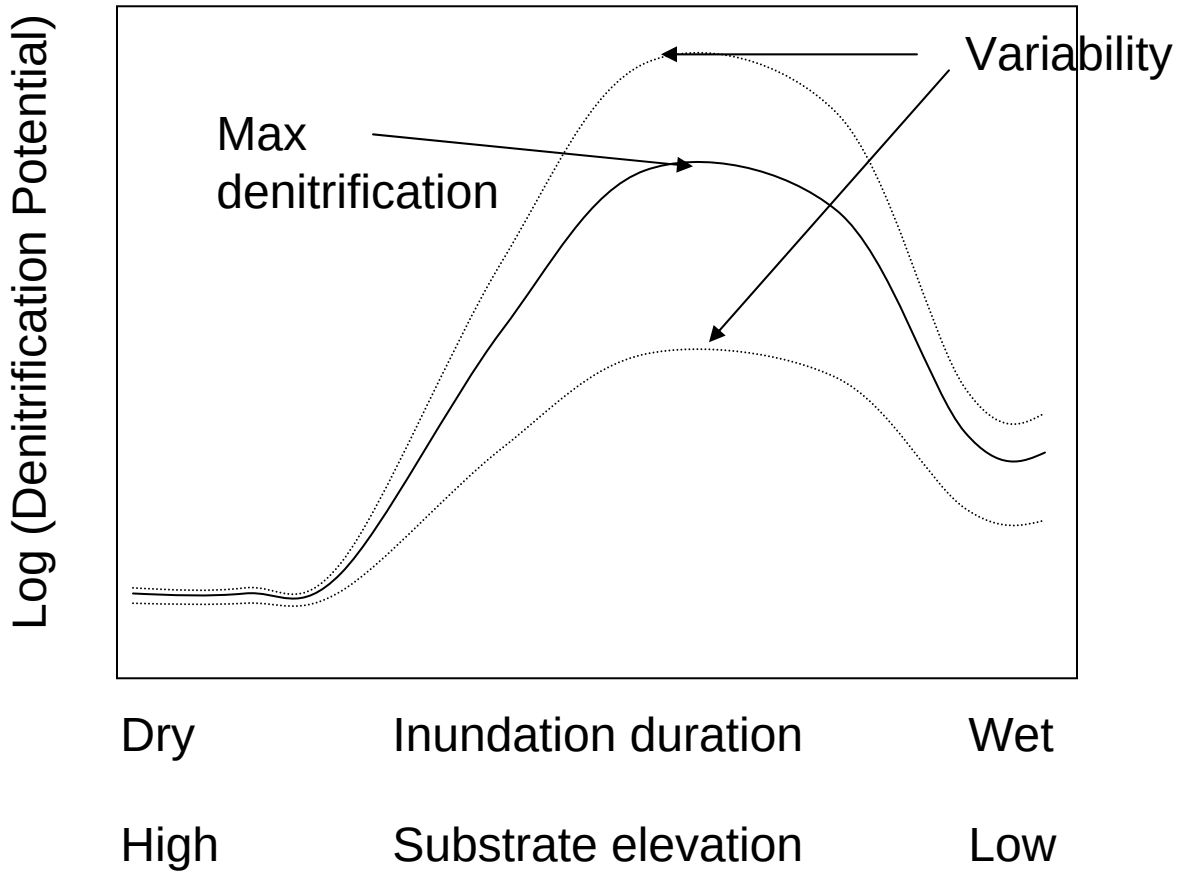


Green Island research site

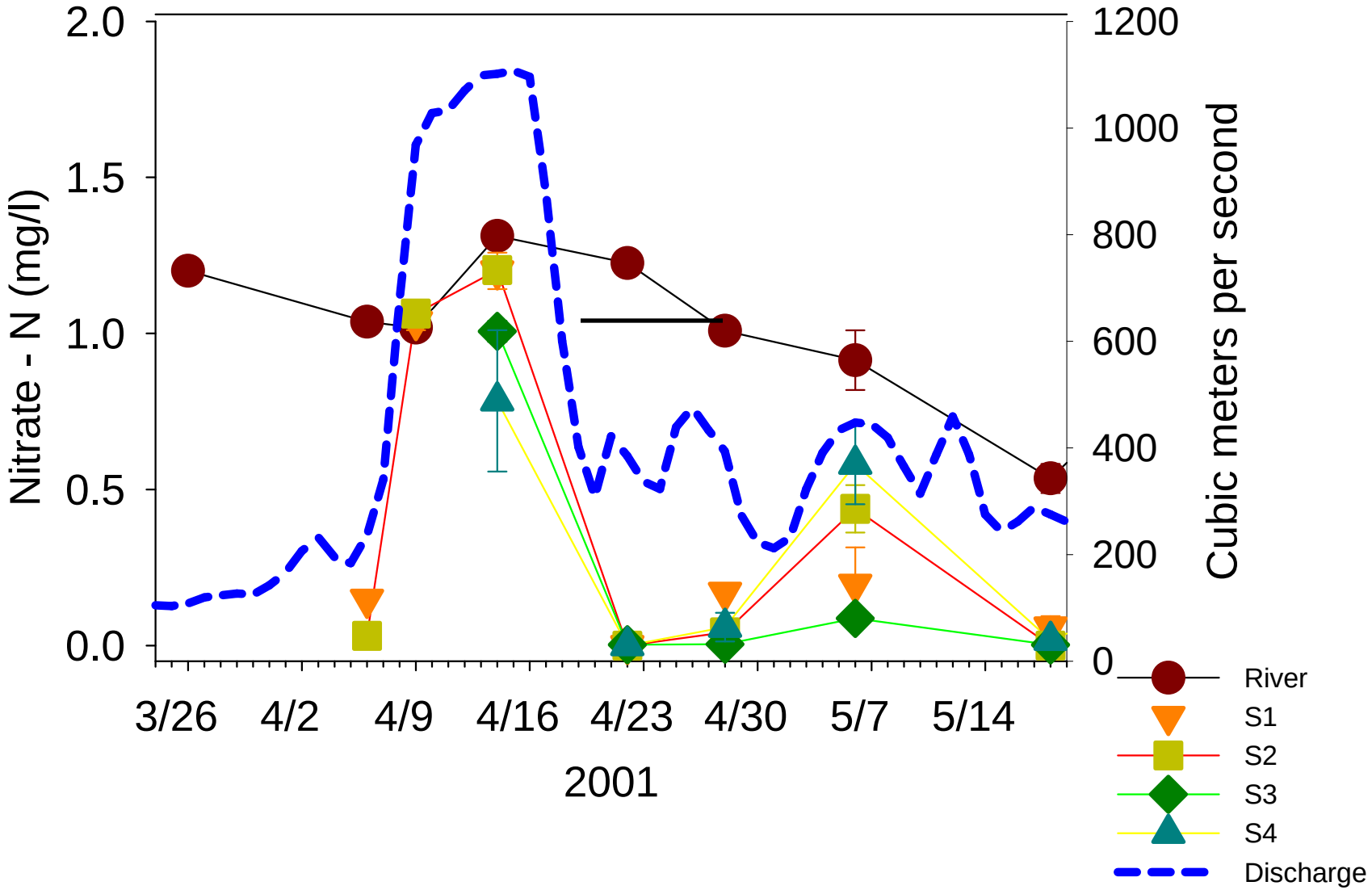


Theoretical basis for restoration – How are C, N, & hydrology linked?

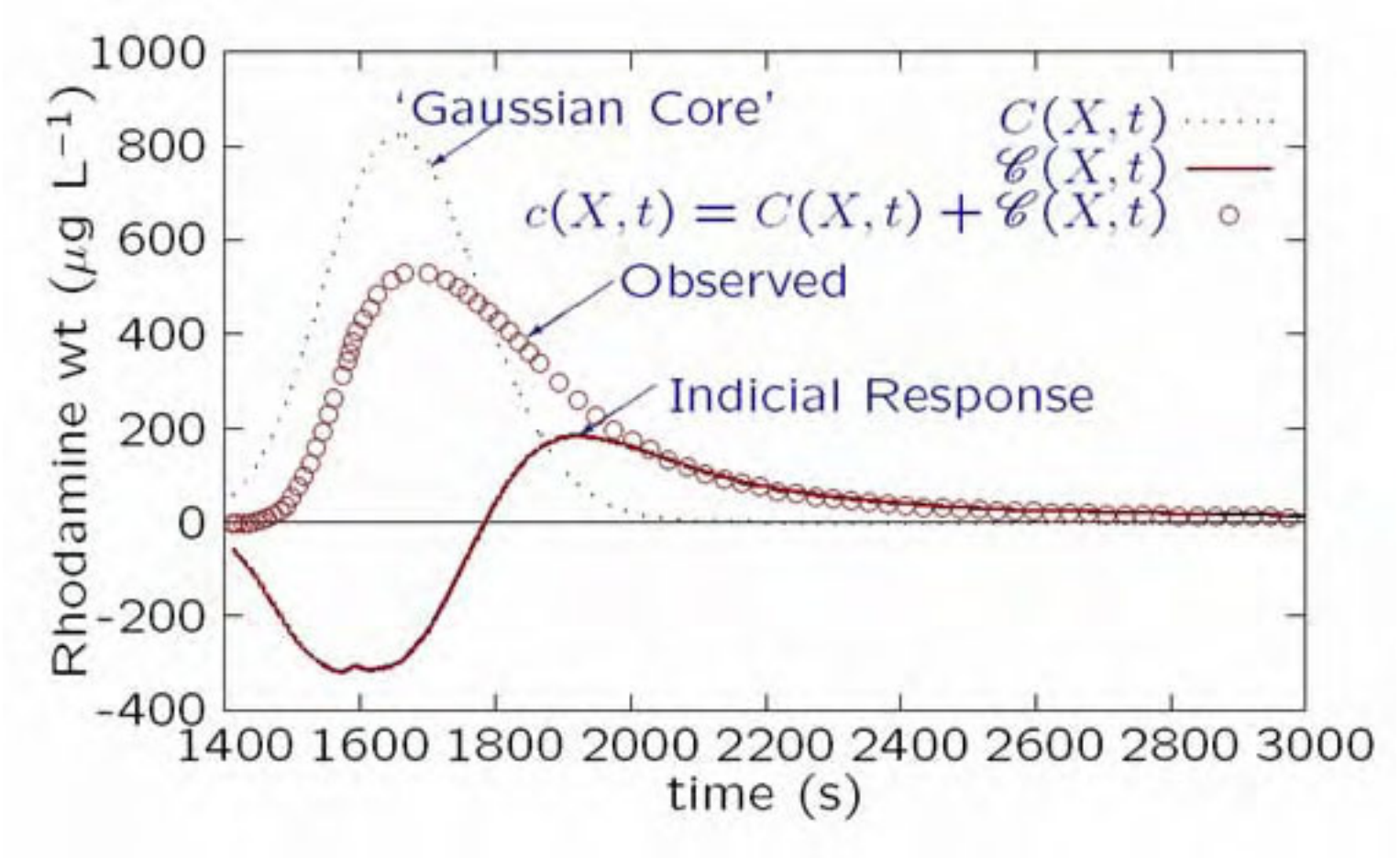
Denitrification response to flooding in the Willamette Basin



Empirical understanding of ecosystem function/services: N arrives during flooding then quickly disappears

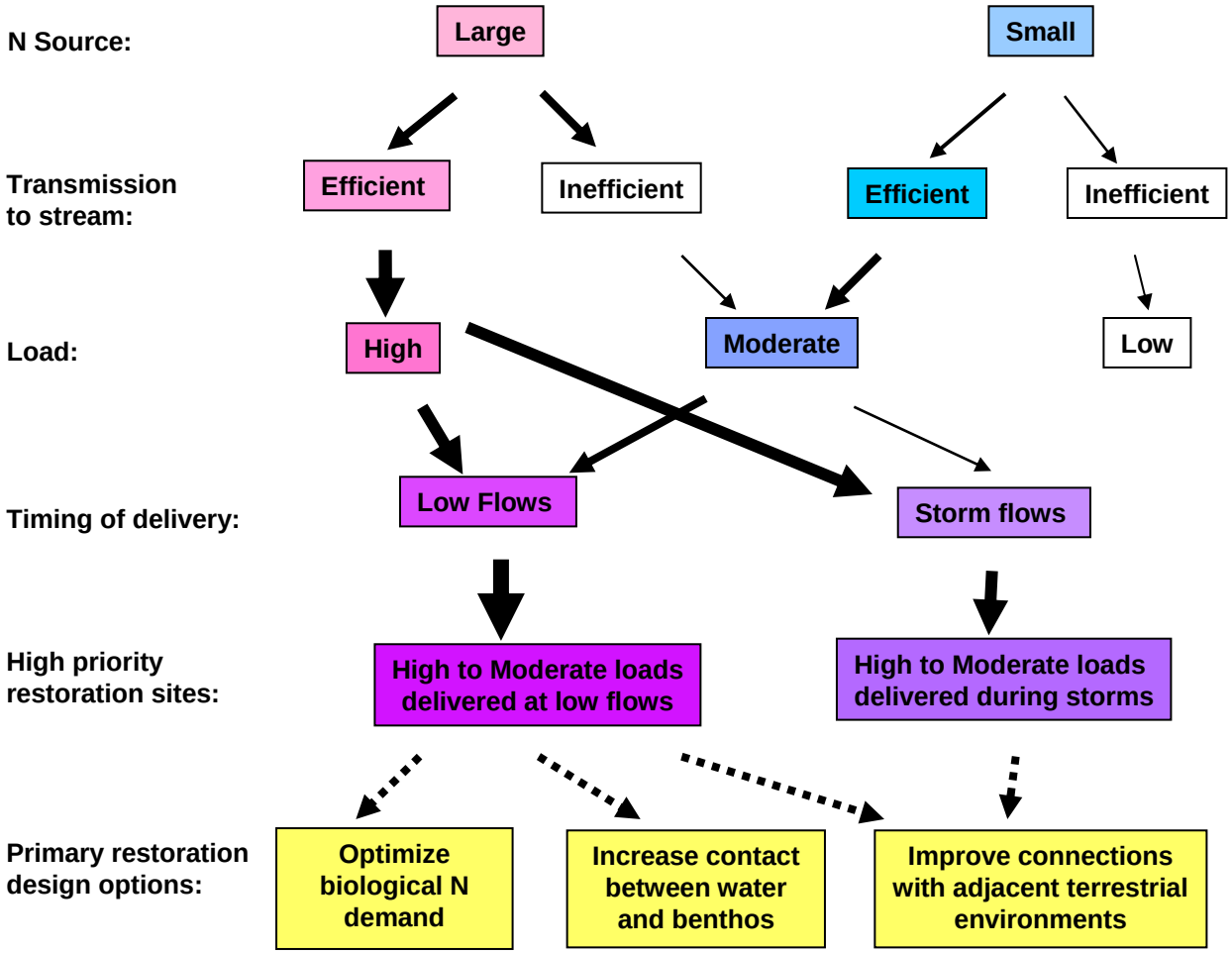


Modeling: Nutrient retention metrics to load attenuation



Faulkner BR, Campana ME. 2007. Compartmental Model of Nitrate Retention in Streams. Water Resour. Res. 43, W02406, doi:10.1029/2006WR004920.

Applications: Identify BMP's for stream restoration



Craig, Palmer, Richardson, Filoso, Bernhardt, Bledsoe, Doyle, Groffman, Hassett, Kaushal, Mayer, Smith, & Wilcock. Stream restoration strategies for reducing river nitrogen loads. In press, *Frontiers in Ecology and the Environment*

Opportunities for NSF grantee collaboration with ORD researchers

- Ecosystem response to restoration
  - lots of data gaps
  - work collaboratively, not like STAR
  - publish papers
  - applied research and tech transfer
- Access to research sites and facilities
- Data sharing
- Gadgets, Gages, Analyses

Questions?