Technical Guidance Training:

Characterization of Contaminated Ground Water Discharge to Surface Water

George Nicholas, Moderator

SRSWP Technical Guidance Development

George.Nicholas@dep.nj.gov

WELCOME

- ***In-Person Attendees***

- ***Webinar Attendees***

Continuing Education Credits

Applied to the *SRP Professional Licensing Board to receive* **2.5 Regulatory CECs**

Attendance Requirements:

- Must sign-in / sign-out: May not miss more than 45 minutes of the training
- Webinar participants must be logged-in and answer 3 out of 4 test questions
  (randomly inserted in the presentation)

Attendance Certificates
(Issued by the LSRPA)

After todays training, DEP will compile a list of "in-person" and "webinar" participants eligible for CECs

- DEP will send an email to those who registered and checked the box to receive a "Training Certificate"
- Email will contain a "Link" to a LSRPA webpage, which will have instructions on how to access certificates *(LSRPA - $25 processing fee)*

Test Your Knowledge !

For webinar participants

EXAMPLE WEBINAR QUIZ SLIDE

Water skiing can be a drag

- ❑ True
- ❑ False

SRWMP

Important reminders

- **Please mute cell phones**
- **Phone calls / conversations**
  - Please take outside of the meeting room
- **Question/Answers**
  - Taken at end of presentations
  - Please wait for the microphone
  - Webinar participants, wait for questions to “open up” and type in question

SRWMP

NJDEP TECHNICAL GUIDANCE UPDATE

George Nicholas, Chairperson
SRSWP Technical Guidance Development
George.Nicholas@dep.nj.gov

Presentation for: Technical Guidance Document Training:
Characterization of Contaminated Ground Water to Surface Water
Tuesday, February 23, 2016

Technical Guidance

- 23 documents completed
- 6 currently in development
- Technical Guidance Available at http://www.nj.gov/dep/srp/guidance

ROUND 1 Technical Guidance Committees

Document Status

	COMMITTEES	Draft Issued		Final Doc. Posted	Revised	Training Conducted
		Comment START	Comment END			
1	**Alternative and Clean Fill**	1/28/2011	3/11/2011	8/26/2011	ver 2.0 12/29/11	11/16/11
2	**Analytical Methods**	3/18/2013	4/29/2013	4/2014		6/24/14
3	**Compliance - Attainment**	4/4/2012	5/16/2012	9/24/2012		11/27/12
4	**Conceptual Site Model**	4/13/2011	5/25/2011	12/16/2011		1/30/12
5	**Ecological Evaluation**	4/19/2011	5/31/2011	8/30/2011	ver 1.2 8/29/2012	12/12/11
6	**Ground Water SI/RI/RA**	7/18/2011	8/29/2011	4/3/2012		4/10/12
7	**Historic Fill**	6/1/2011	7/13/2011	10/24/2011	ver 2.0 4/29/2013	11/16/11
8	**Immediate Environmental Concern (IEC)**	2/16/2011	3/30/2011	8/26/2011	ver 1.1 3/2015	9/8/11
9	**Investigation of Underground Storage Tank Systems**	4/12/2011	5/24/2011	4/12/2012		4/24/12

ROUND 1 Technical Guidance Committees

Document Status

	COMMITTEES	Draft Issued		Final Doc. Posted	Revised	Training Conducted
		Comment START	Comment END			
10	**Landfill Guidance**	4/12/2011	5/24/2011	2/7/2012	ver 1.1 8/1/2012	4/24/12
11	**Light Non-Aqueous Phase Liquid (LNAPL)**	12/21/2010	2/1/2011	6/14/2011	ver 1.2 8/1/2012	6/15/11
12	**Linear Construction**	10/20/2011	12/1/2011	1/27/2012		1/30/12
13	**Monitored Natural Attenuation**	5/25/2011	7/6/2011	3/1/2012		3/6/12
14	**Preliminary Asssessment**	4/4/2011	5/16/2011	1/30/2012	ver 1.1 4/19/2013	2/29/12
15	**Presumptive and Alternate Remedy**	3/22/2011	5/3/2011	7/22/2011	ver 2.0 8/2013	7/26/11
16	**Receptor Evaluation**	10/25/2010	11/9/2010	1/12/2011		6/2011
17	**Soil SI/RI/RA**	4/12/2011	5/24/2011	2/21/2012	ver 1.1 8/1/2012	5/4/12
18	**Technical Impracticability**	3/13/2012	4/24/2012	12/3/2013		2/19/14
19	**Vapor Intrusion**	5/12/2011	6/23/2011	1/13/2012	ver 3.1 3/6/2013	2/13/12

Round II Technical Guidance Committees

(February 2016)

	Committee Start	Draft Issued Comment Period Start	Comment Period End	Final Doc posted	Training Date
Capping	Sept. 2012	3/11/2014	4/22/2014	7/14/2014	11/20/2014
Off-Site Source	Sept. 2012	9/17/2014	10/29/2014	4/28/2015	6/2/2015
Child Care Centers	April 2013	6/17/2015	7/29/2015		
GW Discharge to SW	Sept. 2012	6/9/2015	7/21/2015	1/19/16	**2/23/16**
Pesticides	Sept. 2012	7/16/2014	8/27/2014	12/2015	**3/3/16**
Catastrophic Events	Jan. 2014	12/29/15	2/09/16		
Commingled Plume	Sept. 2012	Est. Mar 2016			
Performance Monitoring	Sept. 2012	Est. Apr 2016			

EPH Protocol	August 2015	Est. Mar-Dec 2016			
ARS Ingestion-Dermal	August 2015	Est. Mar-Dec 2016			

On-Going
Tech Guidance Updates
(To Support Remediation Standards)

- Vapor Intrusion Technical Guidance
- Impact to Ground Water (IGW) Documents:
  - Synthetic Precipitation Leaching Procedure (SPLP) Guidance Document.
  - SESOIL guidance
  - Soil-Water Partition Equation guidance document
  - SESOIL/AT123D guidance

Can be found on the Soil Remediation Standards Webpage:
http://www.nj.gov/dep/srp/guidance/rs/

SRWMP

Other Tech Guidance Updates:

- ECO Guidance: *(Version 1.3, issued 2/2015)*
- Fill Guidance: *(Version 3.0, issued 4/2015)*
- Landfills Guidance: *(Version 1.2, issued 9/2015)*
- Soils SI/RI/RA: *(Version 1.2 issued 3/2015)*
- Preliminary Assessment Guidance *(version 1.2 issued 10/2015)*

SRWMP

Technical Guidance Training
Contaminated Ground Water Discharge to Surface Water

February 23, 2016

NJ LICENSED SITE REMEDIATION LSRPA PROFESSIONALS ASSOCIATION

NJ Licensed Site Remediation Professionals Association

Thank You To Our Sponsors

Diamond Sponsors

AWT ENVIRONMENTAL SERVICES, INC.
Professional Contractors in Site Remediation, Decontamination and Waste Management

(856) 858-8584 • www.enviroprobe.com
ENVIROPROBE SERVICE INCORPORATED
Geophysical Borehole Logging
Rota-Sonic Drilling
Geoprobe

eurofins | Lancaster Laboratories Environmental

EWMI
RAPID RESPONSE INC.

Platinum Sponsors

PeroxyChem

SGS ACCUTEST LABORATORIES

CLEANEARTH®
Faster, smarter, greener solutions.™

ALPHA ANALYTICAL
World Class Chemistry

REGENESIS

Gold Sponsors

SCARINCI HOLLENBECK
ATTORNEYS AT LAW

HC Hampton-Clarke

ECDI
East Coast Drilling, Inc.

IAL
Integrated Analytical Laboratories LLC

ESI EnviroSolutions
"The Answer to Waste"

puresoil
Service. Performance. Results.

hepure™ technologies inc

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

SET
GEOPHYSICS & DRILLING SERVICES

Riker Danzig
RIKER DANZIG SCHERER HYLAND PERRETTI LLP

ALS

DPK CONSULTING
LAND SURVEYORS
Service Without Boundaries

Giordano Halleran & Ciesla
ATTORNEY AT LAW

Pace Analytical®

ERIS
ENVIRONMENTAL RISK INFORMATION SERVICE

Summit
Drilling ▬ Direct Push ▬ Injection
An Exceptional Experience

ddms™
Environmental Chemistry & Data Validation Services
www.ddmsinc.com

PANTHER TECHNOLOGIES INC.

APL
AQUA PRO-TECH LABORATORIES
Certified Environmental Testing

EDR®

Silver Sponsors

FIRSTECH ENVIRONMENTAL, INC.
"Responsive Environmental Solutions"

RSG
RIGSBY SEARCH GROUP, LLC

SURVEYING BORBAS & MAPPING

EST
Associates, Inc.
NJ DEP Certified
Sampling Specialists

ROI Environmental Staffing

ESC
LAB SCIENCES

OBAR
SYSTEMS, INC.

Active
Environmental Technologies, Inc.

NORTHSTAR ENVIRONMENTAL SERVICES

Eco-Rental Solutions

CASCADE DRILLING, L.P. AND SUBSIDIARIES

LSRP Continuing Education Requirements

36 Continuing Education Credits (CECs) over 3 year LSRP license renewal period:

Minimum no. of CECs must be satisfied in these categories:

3 CECs Ethics

10 CECs Regulatory

14 CECs Technical

9 CECs Discretionary

Continuing Ed
Programs vs. Activities

Proposed Rules LSRP Continuing Ed. NJAC 7:26I Subchapter 4

Continuing Education "PROGRAMS":

1 CEC = 1 hour of instruction at universities, colleges, DEP, LSRPA and other organizations

Includes "Alternative Verifiable Learning Formats" (AVLF)

Webinars - Exam required

No more than 18 CECs allowed for AVLFs / 3-year cycle

Continuing Education "ACTIVITIES": Applications for each activity

Teaching a course

Preparing and giving presentations

Presenting a paper

"Activities" limited to 18 CECs / 3 year renewal cycle

WANTED - VOLUNTEERS

GET INVOLVED !

LSRPA Committees

- Bylaws
- Continuing Education
- Finance
- Legal/Legislative
- Nominating
- Regulatory Outreach
- Communications
- Membership
- Risk Management/LP
- Mentoring
- External Stakeholders

UPCOMING LSRPA EVENTS

February 25 - Dinner Meeting – Borehole Geophysics East Windsor
(1Tech. CEC)

March 1 and 2 – Principles QA/QC for Env. Field Programs, Warren NJ
(13 Tech. CECs)

March 8 – LSRP Ethics Class Montclair State U.
(3 Ethics CECs)

March 15 – Member Breakfast, Livingston
(? CECs)

March 31 – Child Care Regulatory Training, Livingston
(4 Reg. CECs)

May 18 – Remedial Action Permit Training, Bordentown
(3.5 Reg. CECs)

Visit LSRPA.org for details and registration

Thank You

Clarification - Investigating Impacts to Surface Water

November 25, 2016 DEP Listserv

Tess Fields, SRWMP, Training Coordinator
Anne Hayton, SRWMP, Technical Coordinator
Bureau of Environmental Evaluation and Risk Assessment

Why we do training…

Provide remediation parties and LSRPs:

- New technical or administrative information
- Perquisite regulatory training for the LSRP exam
- Clarification of existing guidance or regulatory requirements
- When, DEP is seeing “issues” with submitted remedial phase documents and RAOs

What is DEP's Process?

- BCAIN – administratively complete
- Bureau of Inspection and Review
  - Inspect all key document submission and RAOs for potential (more detailed) review
  - Review may be done by BIR reviewers, geologists and technical coordinators
- When submittals are not in compliance with rules or guidance…
  - Given the chance to address noncompliance, or
  - Withdraw one or more of submitted key documents

SRWMP

"Remedial investigation" means a process to determine the nature and extent of a discharge of a contaminant at a site or a discharge of a contaminant that has migrated or is migrating from the site and the problems presented by a discharge, and may include data collected, site characterization, sampling, monitoring, and the gathering of any other sufficient and relevant information necessary to determine the necessity for remedial action.

Technical Requirements for the Remediation of Contaminated Sites – N.J.A.C. 7:26E-1.8

SRWMP

RI Regulatory Timeframes
N.J.A.C. 7:26E-4.10
Sites with requirement to remediate after March 2, 2010

Soil contamination only: 1 years for PA/SI
3 years for RI =
4 years from trigger date

Soil and/or other media: 1 years for PA/SI
5 years for RI =
6 years from trigger date

Statutory Deadline for RI Completion

For all discharges/contaminated areas of concern at the site where the contamination was identified on or before May 7, 1999

SRRA (N.J.S.A. 58:10C-27.1)

Allowed an additional 2 years to complete the RI of a site that was subject to the May 2014 deadline to **May 7, 2016** (if seven criteria were met)

Statutory Deadline for RI Completion

There will be no further extensions on the requirement to complete the RI by May 7, 2016.

Responsibilities of the Person Responsibility for Conducting Remediation

N.J.A.C. 7:26E-1.5(a)

The person responsible for conducting the remediation shall conduct remediation pursuant to this chapter (Tech Rules) and

N.J.A.C 7:26C-1.2

LSRP Code of Conduct

N.J.A.C. 7:26I-6.2

An LSRP's highest priority in the performance of professional services shall be the protection of public health and safety and the environment.

Investigating Impacts from Contaminated Sites to Surface Water Listserv

- Purpose
- Key Concepts
- Decision Points
- Available Resources

Web link: http://www.state.nj.us/dep/srp/guidance/srra/inv_impacts_to_surface_water.pdf

SRWMP

Purpose and Key Concepts

- Department recognized confusion regarding responsibilities for off-site impacts to Surface Water
- Department identified need to clarify that NJDEP Technical Requirements, N.J.A.C. 7:26E, apply to every site even when…

  - industrial/developed environment
  - delineation will overlap with other projects
  - surface water is part of CERCLA study

NJDEP Technical Requirements for Site Remediation (N.J.A.C. 7:26E)

- Subchapter 1.16, Ecological Receptor Evaluation
- Subchapter 3.6, Site Investigation for Surface Water and Sediment
- Subchapter 4.8, Remedial Investigation for Surface Water and Sediments
- Subchapter 5.1e, Remedial Action Requirements for free and residual product

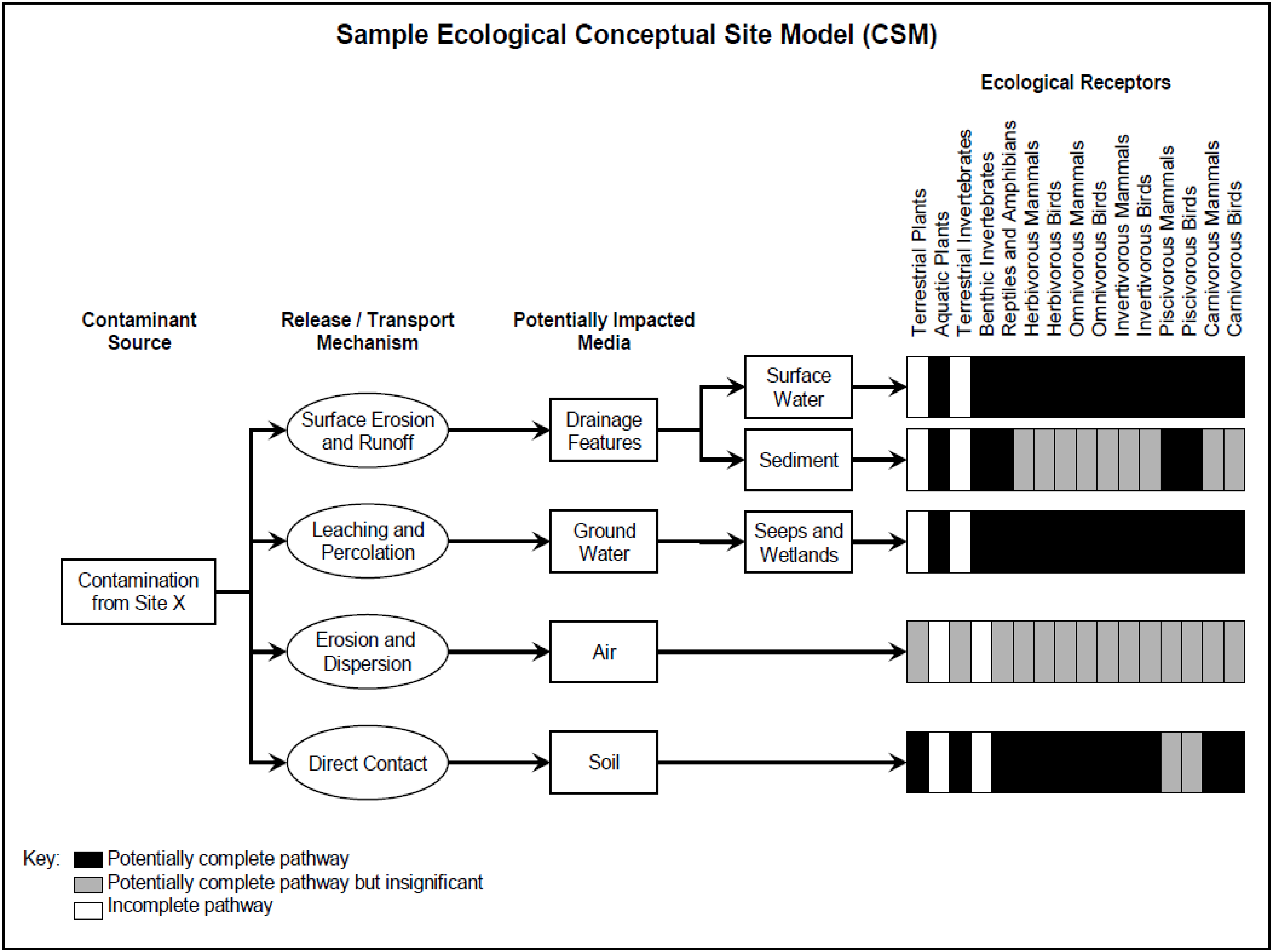
SRWMP

Decision Points

Receptor evaluation - ecological (N.J.A.C. 7:26E-1.16)

- Determine if there is a **environmentally sensitive natural resource** (ESNR)
  - On the site
  - Adjacent to the site
  - Potentially affected by current or historical impacts from the site
- Determine if **contaminant concentrations** on-site are greater than ecological screening criteria (ESC) or aquatic NJ Surface Water Quality Standards (SWQS)

SRWMP


Sample Ecological Conceptual Site Model (CSM)
Ecological Receptors
Terrestrial Plants
Aquatic Plants
Terrestrial Invertebrates
Benthic Invertebrates
Reptiles and Amphibians
Herbivorous Mammals
Herbivorous Birds
Omnivorous Mammals
Omnivorous Birds
Invertivorous Mammals
Invertivorous Birds
Piscivorous Mammals
Piscivorous Birds
Carnivorous Mammals
Carnivorous Birds
Contaminant Source
Release / Transport Mechanism
Potentially Impacted Media
Contamination from Site X
Surface Erosion and Runoff
Leaching and Percolation
Erosion and Dispersion
Direct Contact
Drainage Features
Ground Water
Air
Soil
Surface Water
Sediment
Seeps and Wetlands
Key:
Potentially complete pathway
Potentially complete pathway but insignificant
Incomplete pathway

Decision Points (continued)

- Determine if contamination from the site may have reached a sensitive resource (ESNR)
  - Identify contaminant migration pathways – historic and current
  - Sampling design should consider all possible contaminant migration pathways between the site and surface water/sediment
  - Collect focused samples along these pathways and, if warranted, collect samples in surface water and sediment
- Determine if free or residual product exists and requires abatement

SRWMP

Decision Points (continued)

Compare SI site data to NJDEP Ecological Screening Criteria (ESC) http://www.nj.gov/dep/srp/guidance/ecoscreening/

If **contaminant concentrations** on-site **ARE NOT** greater than ESC or SWQS and/or a pathway does not exist - Document results in Ecological Evaluation (EE) report

If **contaminant concentrations** on-site are **ARE** greater than ESC or SWQS and a pathway exists –
Conduct Remedial Investigation of Ecological Receptors

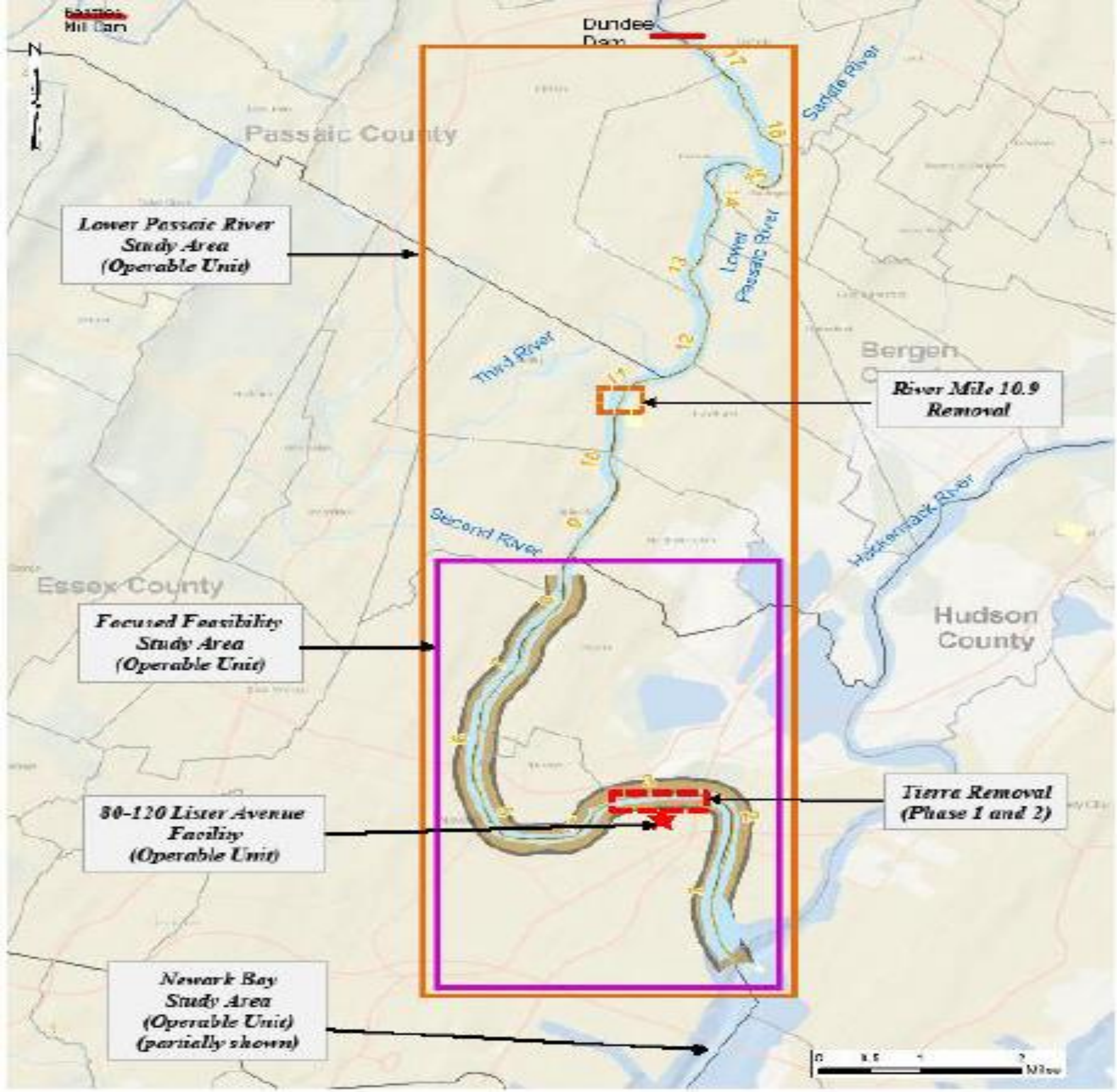
Decision Points (continued)

Remedial investigation of ecological receptors (N.J.A.C. 7:26E-4.8)

- Complete delineation into and within sediment and surface water, and
- Conduct Ecological Risk Assessment (ERA), if needed, to determine remediation goals

Complicating Factors

- Waterbodies in highly developed and industrialized areas
- Existing "Legacy" contamination from multiple sources (historical discharge impacts)
- Tidal conditions
- Existing CERCLA or RCRA jurisdiction



Diamond Alkali Superfund Site Project Areas U.S. EPA – Region 2 April 2014

Available Resources

NJDEP Ecological Evaluation Technical Guidance, Feb 2015

Information from other entities involved with nearby remedial activities (e.g., other LRSPs, NJDEP, USEPA, USACE, USFWS)

Technical Consultation with NJDEP-Site Remediation Program

Lines of evidence approach and professional judgement

Available Resources (continued)

- Enlist services of subcontractor specializing in ecological evaluations and risk assessments
- NJDEP Annual Ecological Risk Assessment 2-day Course at Rutgers (**March 15 and 16, 2016)**
- For CERCLA and RCRA sites, coordinate with USEPA Regional Project Manager and NJDEP case team; document coordination in Remedial Investigation/Remedial Action report

SRWMP

Available Resources (continued)

- How can you find out where the NPL sites are?

  http://www.nj.gov/dep/srp/superfund/

- How can you find out what work was conducted by other RPs in the area?

  http://www.nj.gov/dep/srp/kcsnj/

- NJ GeoWeb:
  http://www.nj.gov/dep/gis/apps.html

SRWMP

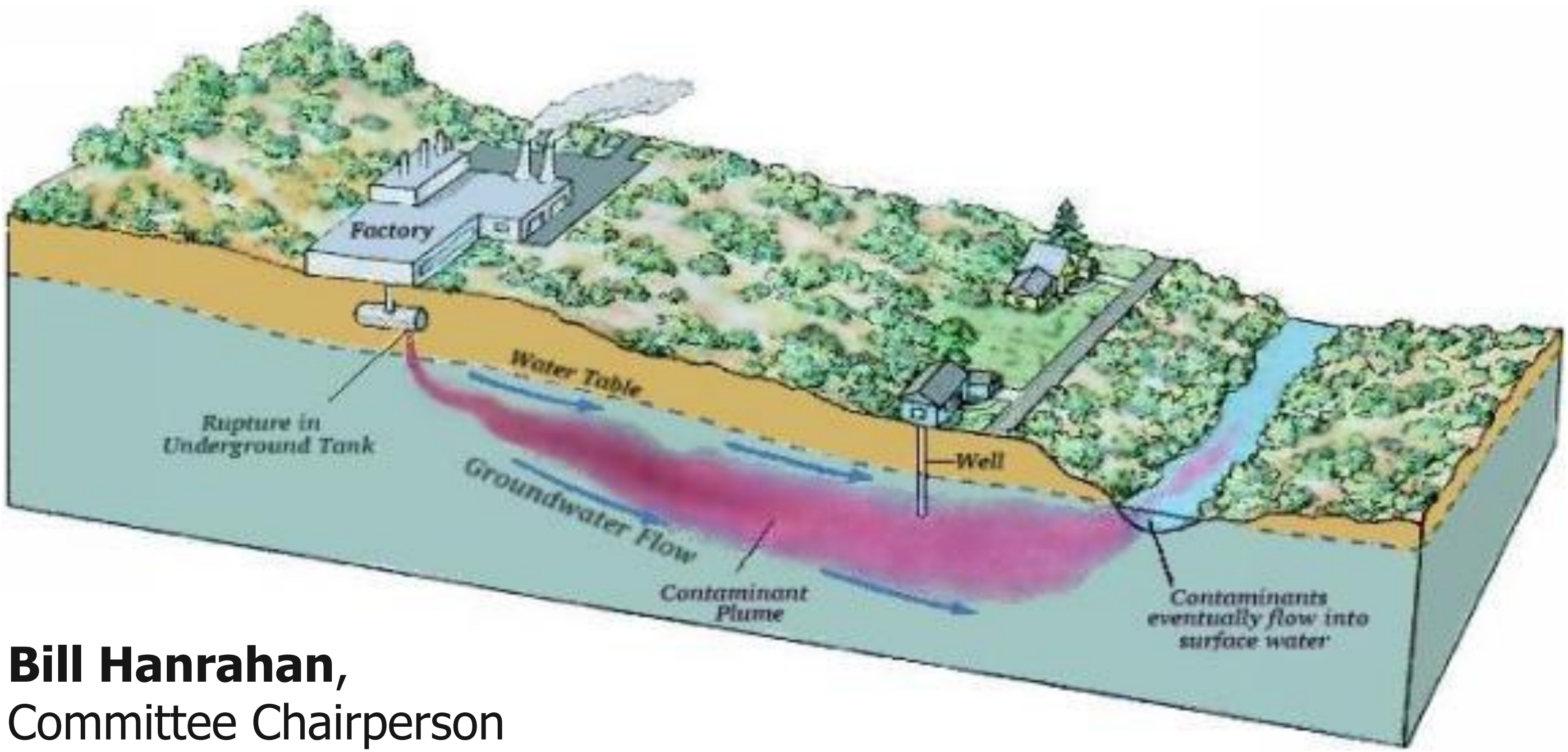
Conclusion

- The delineation of site-related contamination to an sensitive ecological resource is an important part of a completed remedial investigation and <u>subject to the RI extended timeframes</u>

- Requirements still apply when a site overlaps with other sites and/or overlaps with a CERCLA investigation in the same surface water body

Questions?

Characterization of Contaminated Ground Water Discharge to Surface Water Technical Guidance



Bill Hanrahan,
Committee Chairperson
NJDEP, BEMSA

Thank You!

Dan Cooke, Amec Foster Wheeler Env. & Infrastructure, Inc.

Bill Cordasco, TRC Environmental Corporation

Scott Drew, Geosyntec

Nancy Grosso, DuPont Corporate Remediation Group

Ward Ingersoll, NJDEP, Env. Meas. and Site Assessment

Jill Monroe, NJDEP, Ground Water Pollution Abatement

Christina Page, NJDEP, Inspection and Review

John Ruhl, NJDEP, Env. Evaluation and Risk Assessment

Terrance Stanley, Langan Engineering and Env. Serv.

Guidance Overview

- Approach for Evaluating Contaminated GW discharge to SW
- Conceptual Models of GW-SW Interaction
- Site Specific Model Development
- Characterization Methods and Tools
- Remedial Action/Performance Monitoring

Purpose
Address the Technical Requirements

- Is there a potential that SW is contaminated by GW discharge?
  - Conceptual model
- If so, sample in the suspected location of greatest contamination
  - Characterization Methods and Tools
- Remedial Action/Performance Monitoring

Regulations Applicable to the Investigation of Contaminated Ground Water Impacts to Surface Water

Jill Monroe – Supervising Geologist
Bureau of Ground Water Pollution Abatement

SRWMP

Site Remediation Program Rules

Rules Defining RI and RA Workplans

- Remediation Standards (N.J.A.C.-7:26D)
  - Ground Water Quality Standards (N.J.A.C.-7:9C)
  - Surface Water Quality Standards (SWQS) (N.J.A.C. 7:9B)

- Technical Requirements for Site Remediation ("Tech Rule") (N.J.A.C. 7:26E)

Other SRP Rules

- Administrative Requirements for the Remediation of Contaminated Sites (ARRCS) Rules (N.J.A.C. 7:26C)
- Underground Storage of Hazardous Substances (UST) Rules (N.J.A.C. 7:14B)
- Industrial Site Recovery Act (ISRA) Rules (N.J.A.C. 7:26B)
- NJPDES Regulations (N.J.A.C. 7:14A)

SRWMP

Remediation Standards - Ground Water and Surface Water

- Adopted the GWQS and SWQS policies, narrative criteria and numeric standards as MINIMUM REMEDIATION STANDARDS

- Established the requirements to remediate adverse impacts to GW and SW as receptors, and to limit risks to other receptors affected by contaminated GW or SW

GWQS and SWQS policies affect the RI and RA of GW and SW

The **OVERALL GOALS** of the water quality regulations are:

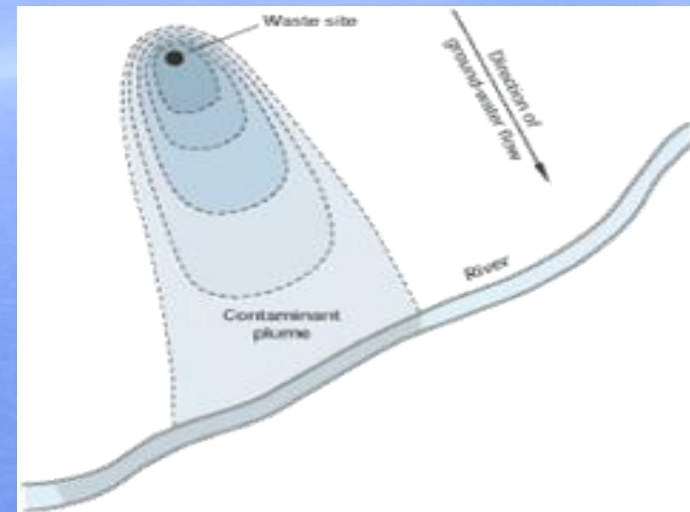
- **MAINTAIN** water quality that is better than standards
- **RESTORE** water quality that is worse than standards
- **PRESERVE** natural water quality of designated waters
- **PROTECT** public health
- **SAFEGUARD** aquatic life
- **ENHANCE** the multiple uses of water

RI Situations

GW impact no SW discharge

SW impact from non-GW related source

What is the trigger to evaluate a GW impact to SW?



Site Investigation

What will the SI need to provide?

•SW and sediment pore water data in the GW discharge zone to confirm the contaminant migration pathway is complete

•Type(s) of contaminants to determine potential impacts to SW/sediment/aquatic life/eco receptors

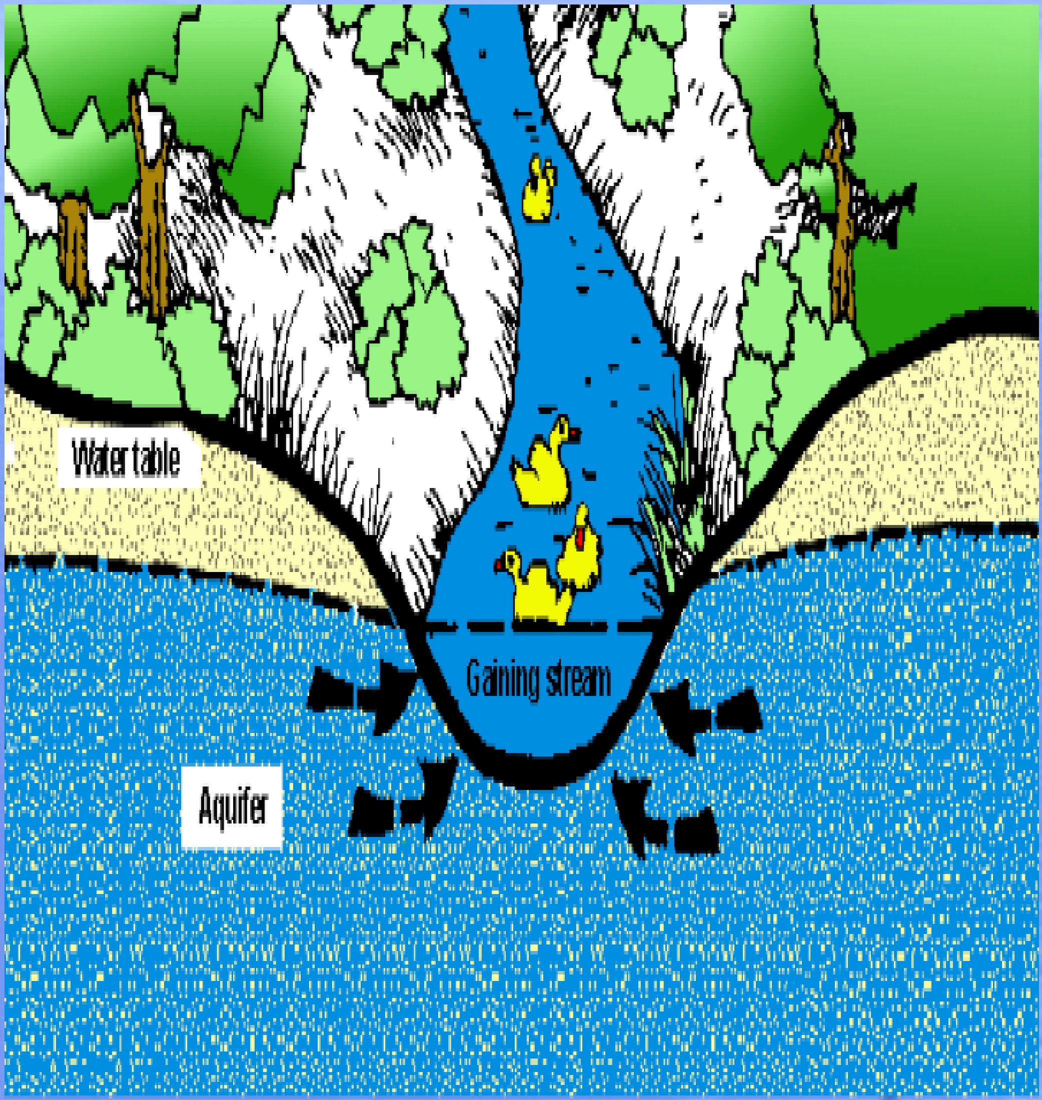
Remedial Investigation

What will the RI need to provide?

- Existing (or background) surface water quality and uses
- Delineation of all impacts to SW and receptors
- SW data, as needed for criteria

Remedial Action Plan Factors

- SW body classification
- Anti-degradation category
- Existing water quality
- Existing uses
- COCs – type, concentrations
- Extent of impacted area
- Receptor impacts



#GOALS !!!!

How Will the Remediation:

- **MAINTAIN** water quality that is better than standards
- **RESTORE** water quality that is worse than standards
- **PRESERVE** natural water quality of designated waters
- **PROTECT** public health
- **SAFEGUARD** aquatic life
- **ENHANCE** the multiple uses of water

SRWMP

Development of the GW-SW Conceptual Model

Terrance Stanley
Langan

Development of the GW-SW Conceptual Model

General Conceptual Models:

1. Ground Water – Stream Interaction
2. The Hyporheic Zone
3. Ground Water – Wetland Interaction
4. Ground Water – Lake Interaction
5. Coastal GW-SW Interaction

SRWMP

Conceptual Site Model

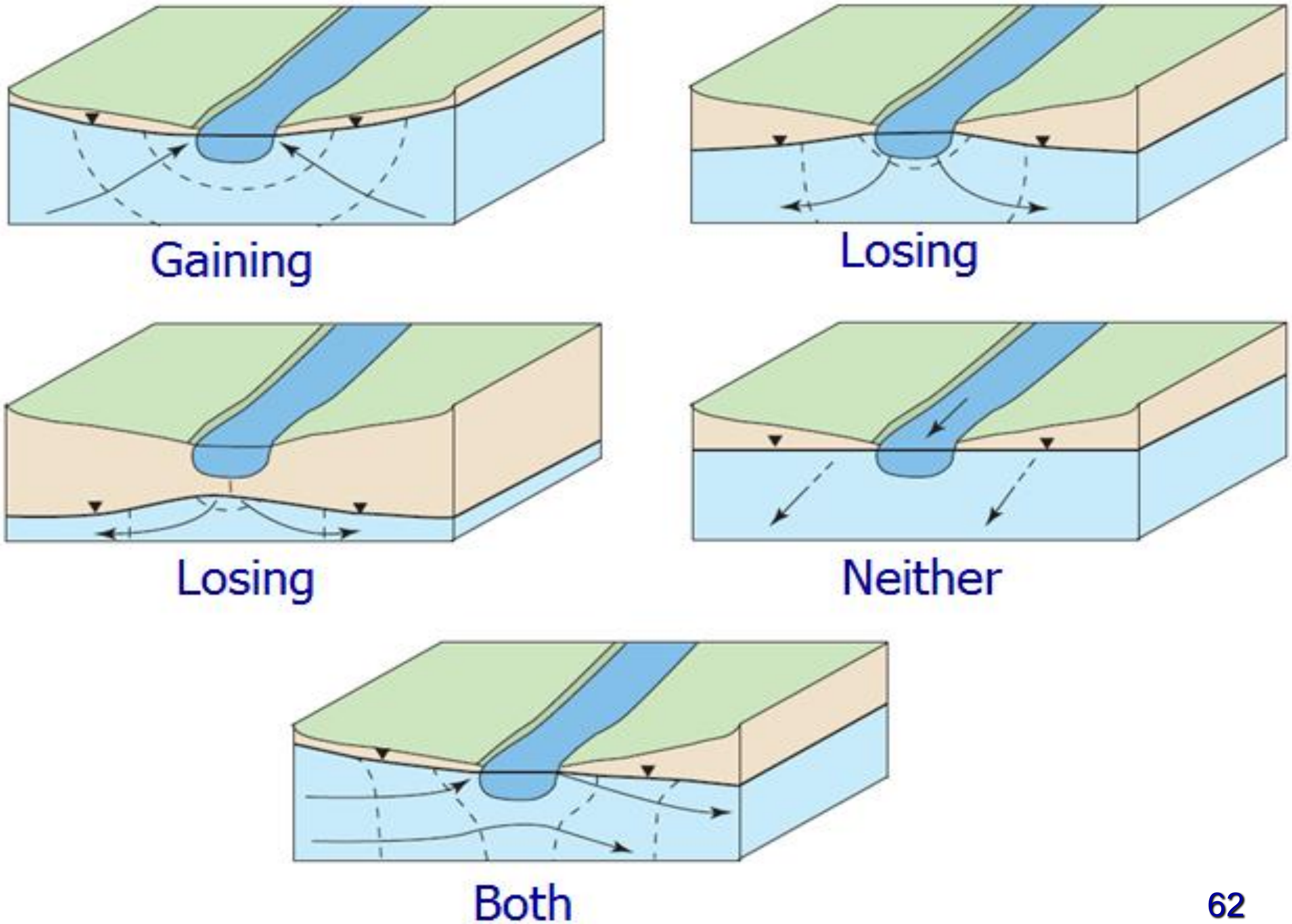
A conceptual site model is a written and/or illustrative representation of the conditions and the physical, chemical and biological processes that control the transport, migration and potential impacts of contamination (in soil, air, ground water, surface water and/or sediments) to human and/or ecological receptors.

Conceptual Site Model

An initial site-specific CSM for ground water to surface water discharge can be created through a desktop review using on-line resources:

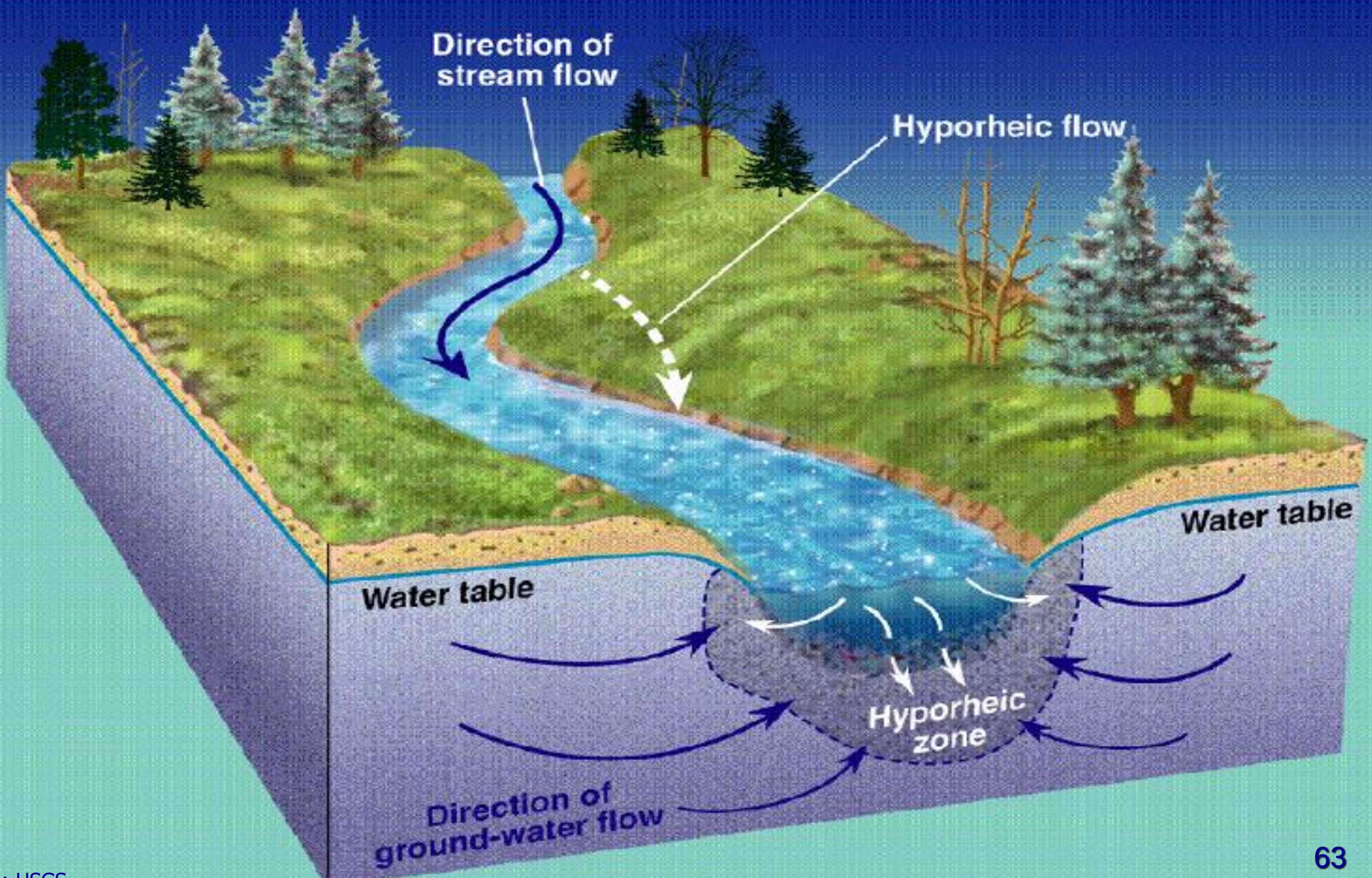
- Topographic maps
- NJDEP GIS files
- Geological maps & cross sections
- NJGS Hydrogeology database for aquifer properties
- USGS surface water and ground water monitoring networks

Ground Water – Stream Interactions: Gaining and Losing



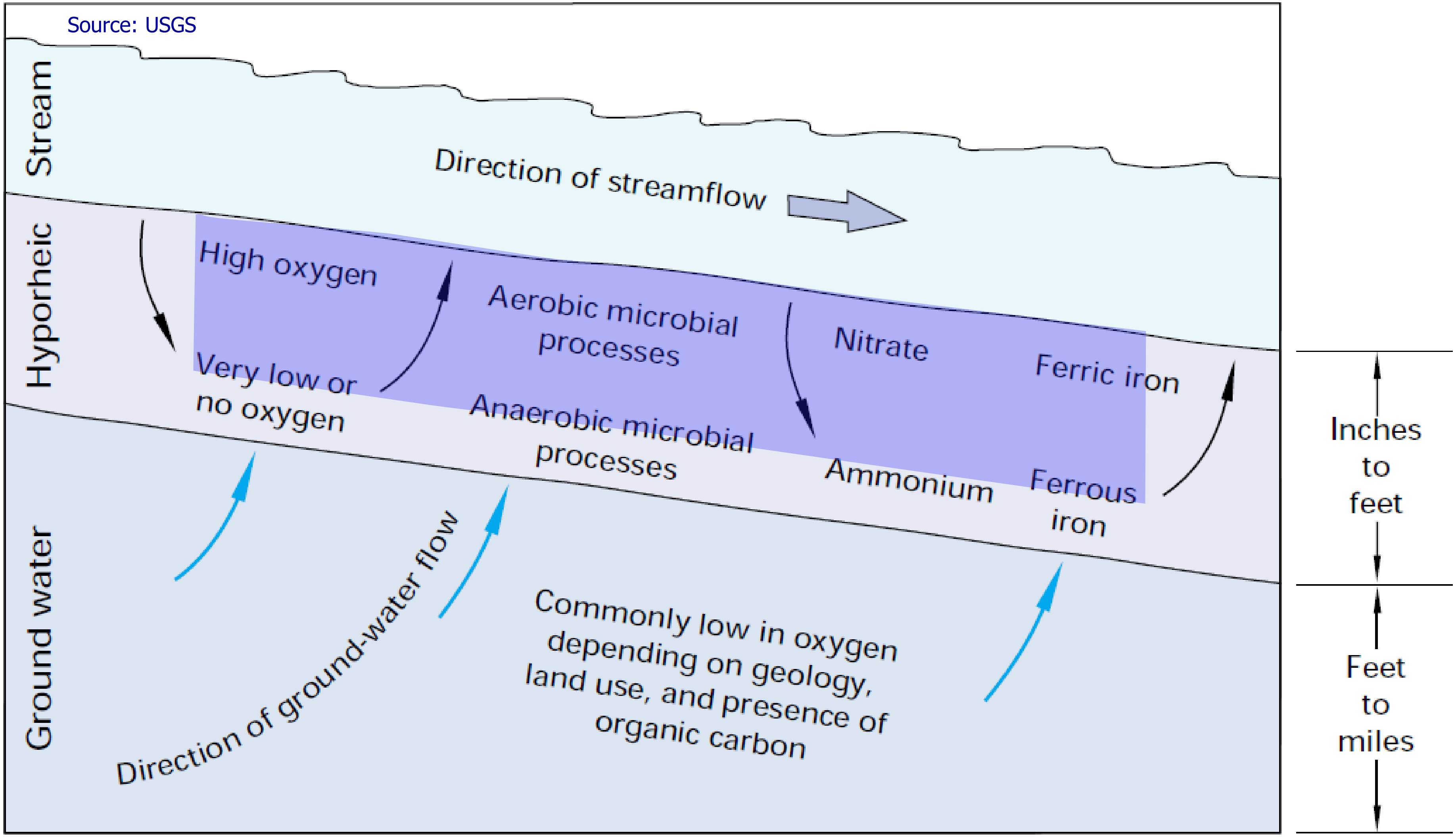
Source: USGS 2008 Field Techniques for Estimating Water Fluxes Between Surface Water and Ground Water

Ground Water – Stream Interactions: Hyporheic Zone

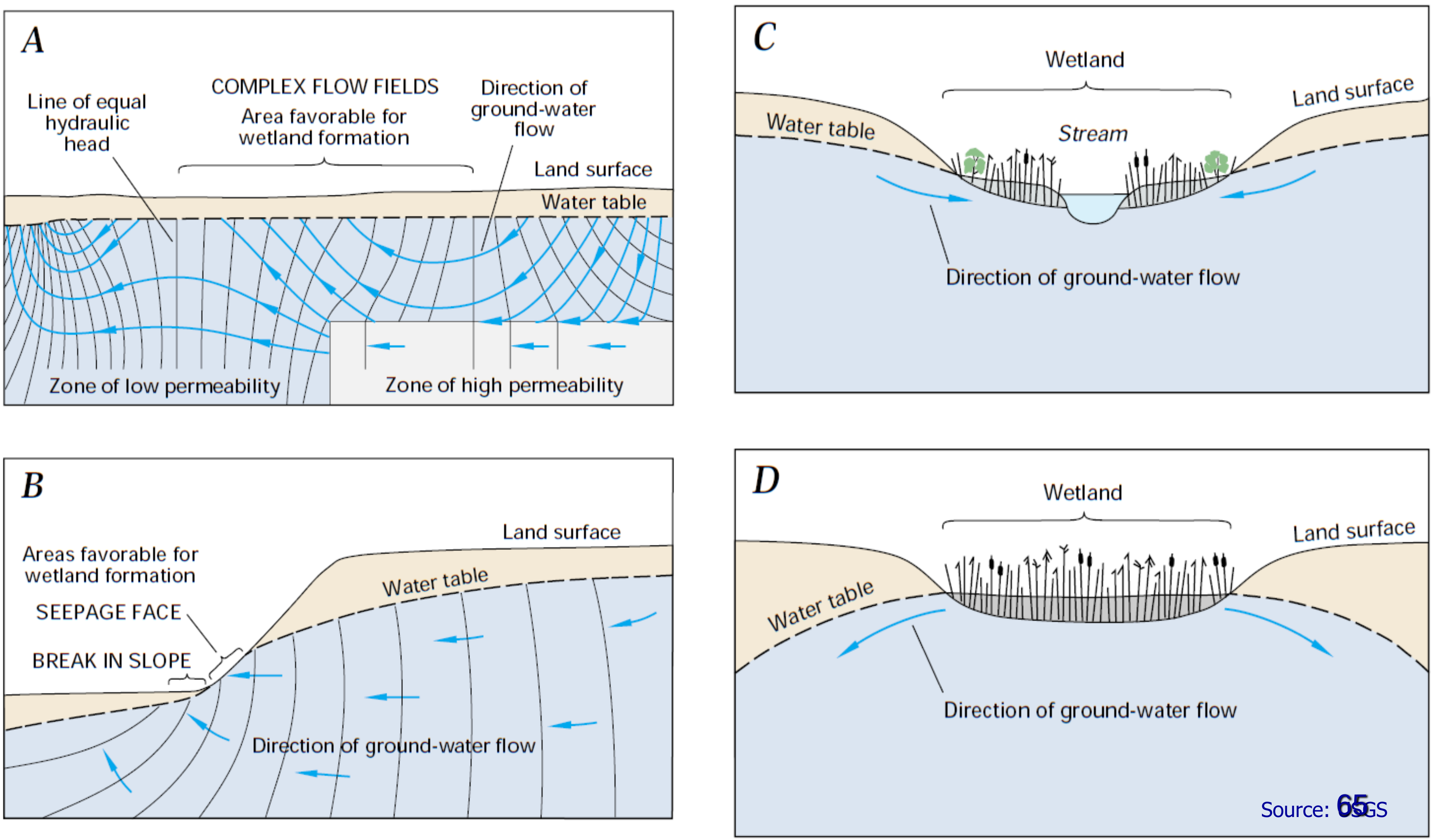


Source: USGS

Ground Water – Stream Interactions: Hyporheic Zone

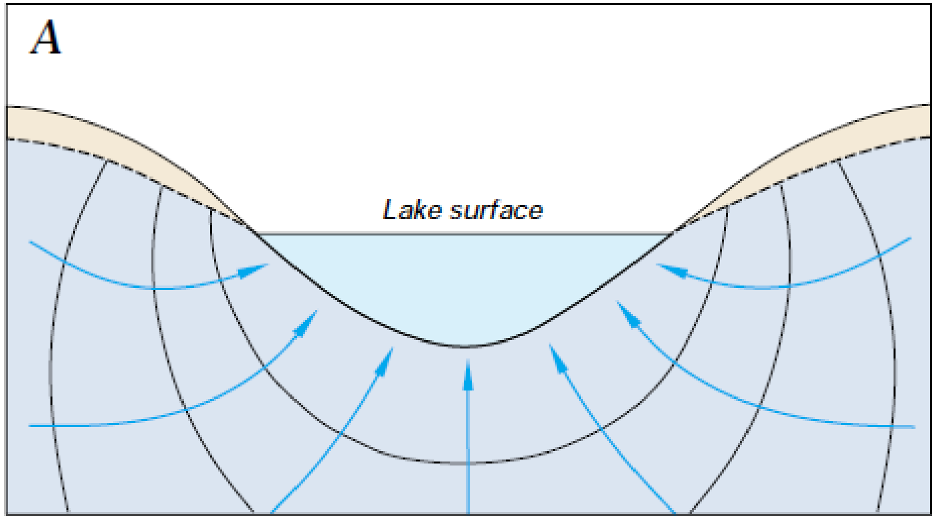


Ground Water - Wetland Interactions

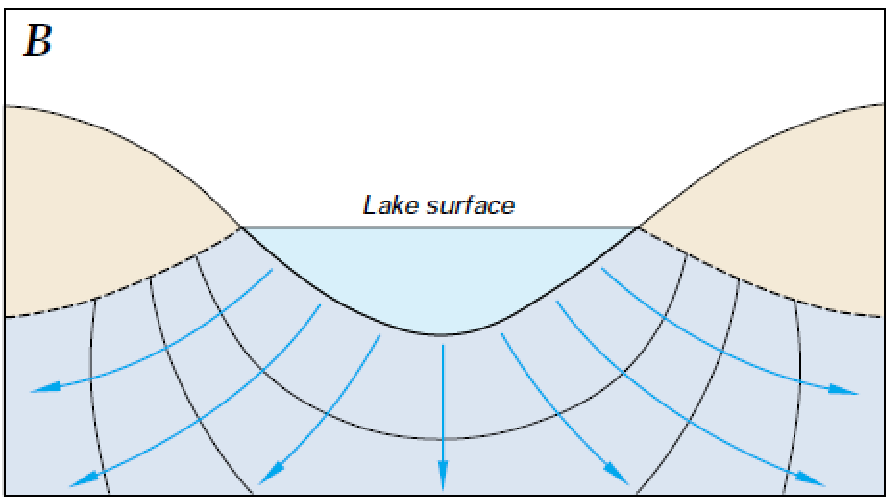


Source: USGS

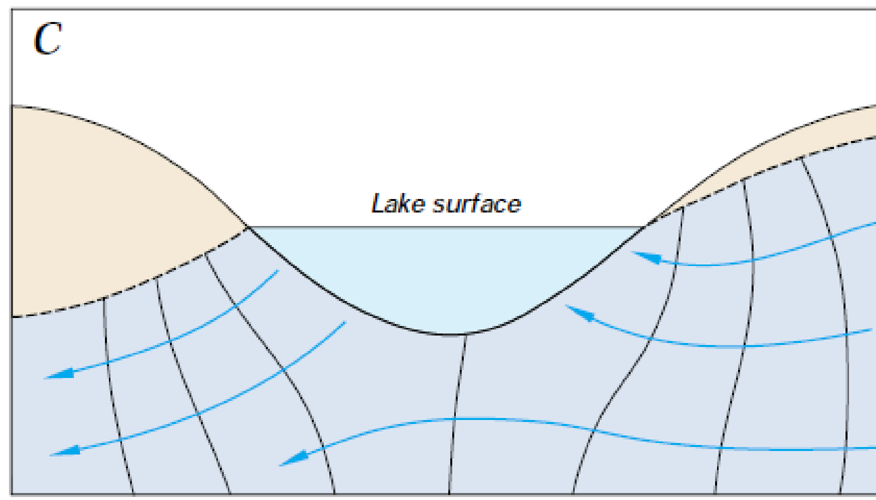
Ground Water – Lake Interaction



Lake Receiving Groundwater



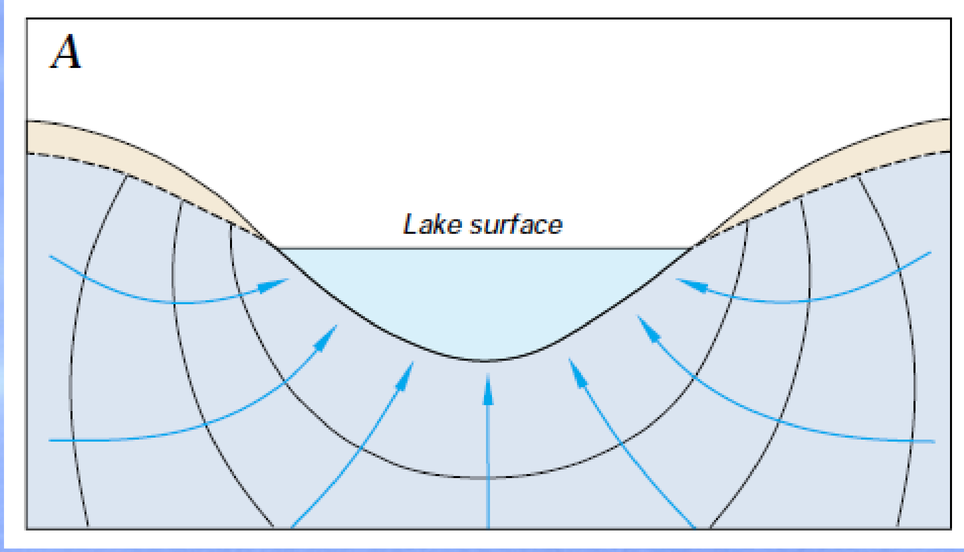
Lake Seepage to Groundwater



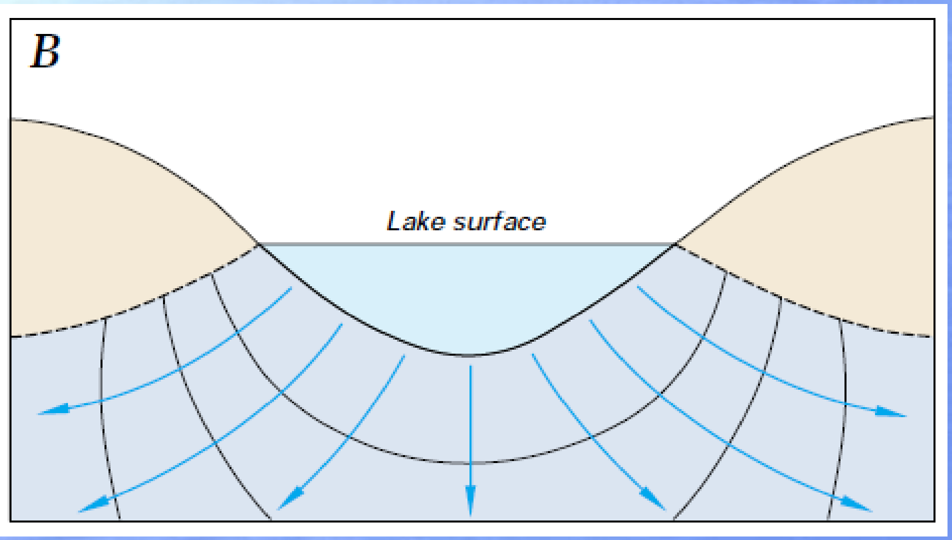
Lake Receiving Groundwater and Seepage to Groundwater

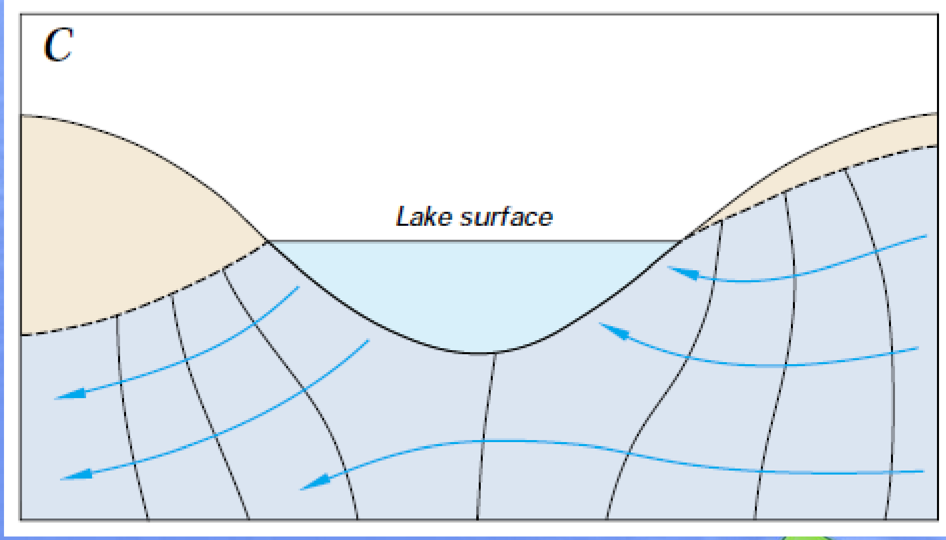
Source: USGS

Ground Water – Lake Interaction



Lake Receiving Groundwater



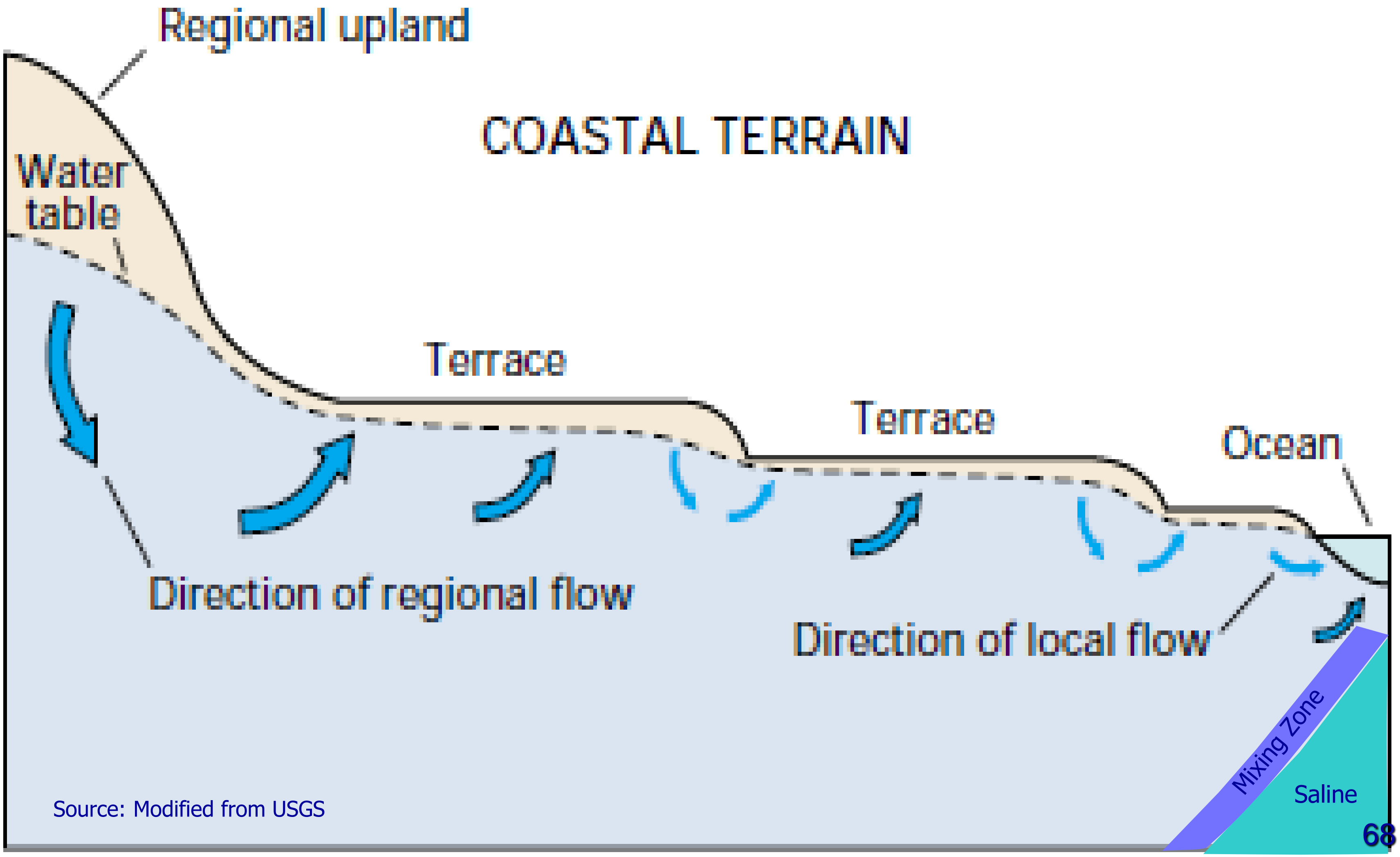


Lake Seepage to Groundwater

Lake Receiving Groundwater and Seepage Groundwater

Source: USGS

Coastal GW – SW Interaction



Source: Modified from USGS

Summary

- Several generalized conceptual models for GW and SW interaction were presented.
- These conceptual models can be used as a starting point for developing a site-specific conceptual site model.
- After desktop review a site investigation typically follows, which should further refine the conceptual site model.

Methods and Tools for Locating and Characterization Contamination

John Ruhl

NJDEP- BEERA

Methods and Tools for Locating and Characterizing Contamination

- Section 6.0 of the guidance document, including Appendices C and D, and Table 2.
- The identified Methods and Tools are not exhaustive.
- Information was compiled by Bill Cordasco of TRC Environmental, Corp. and John Ruhl of NJDEP/BEERA

Tools for Identifying GW Discharge Zones in Surface Water

- GW-SW Investigation Triggers:
  - Inspections – Beginning with PA/Initial Receptor Evaluation for Visual/Olfactory Evidence
  - Information from on-going GW investigation
- Locating GW-SW Discharge Zones/Points:
  - Physical Properties -
    - Temperature
    - Conductivity & Resistivity

Temperature

Ground Level Thermal Imaging:

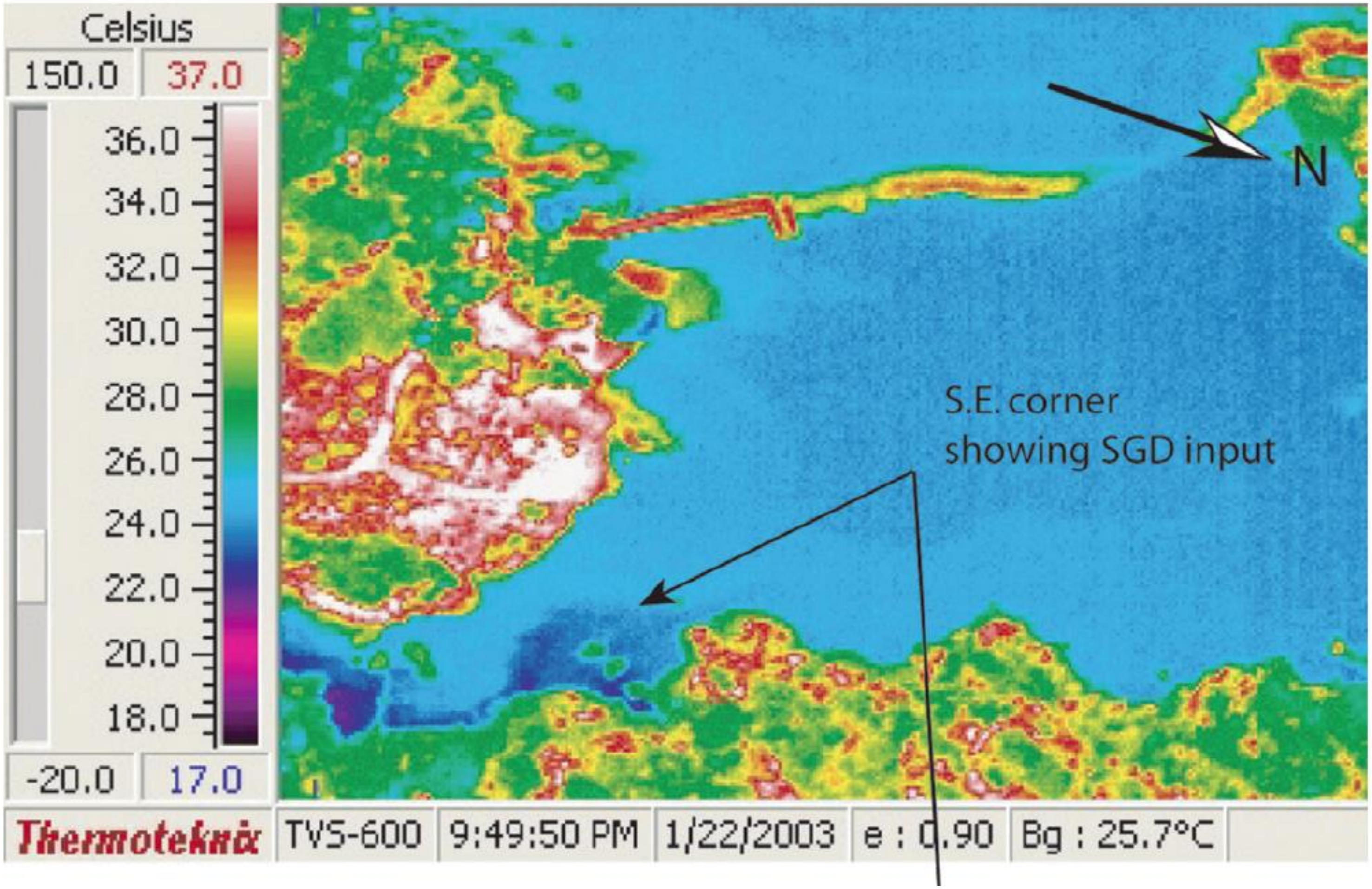
- Forward Looking Infrared Camera (FLIR)

Temperature based on Infrared energy is assigned “false” color in visible spectrum . Cooler bank seepage (blues) entering warmer stream water (orange).

Infrared Imaging Movie

*

Source: Geophysics for USGS Groundwater/Surface-water Interaction Studies
USGS/Martin Briggs



Inferred submarine groundwater discharge (SGD) into a fishpond using a handheld infrared camera aboard an unmodified aircraft at Kaloko, Hawaii .

Aerial FLIR image from Jan 2003 showing cooler groundwater (dark blue) of ~23C entering pond (light blue) with water temp of ~25C (Fig 3.).

Land-bridge is ~1,000 ft long.

Source: Duarte et al., 2006

Ground Level Thermal Measurements:

- Handheld Instruments - Thermometers, Thermocouples, and Thermistors
  - usually employed in more "focused" or "discrete-point" investigations
  - difference between the instruments is the physics of how each operates
  - each type has its advantages and disadvantages

Fiber-Optic Surveys

- Distributed Temperature Sensing
  - uses standard telecommunications optical fibers
  - laser light is pulsed along entire cable length to measure temp every meter

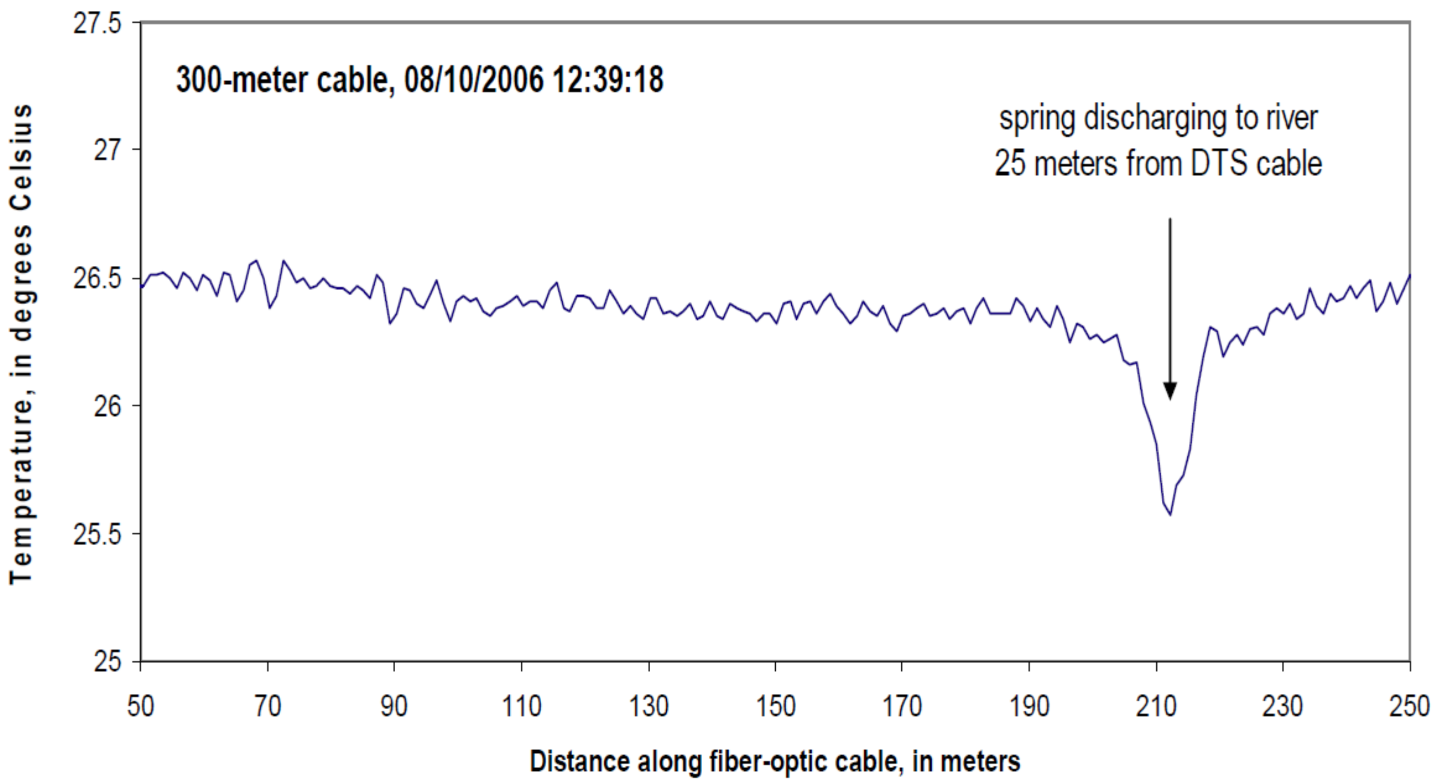


Figure 2: Temperature data showing thermal anomaly, Shenandoah River, Clarke County, Virginia.

Lane and others, 2008

Conductivity & Resistivity

- Handheld Electronic Probe
  - usually employed in more "focused" or "discrete-point" investigations

Depending upon the manufacturer, may be able to obtain longer probe

This example: Measures conductivity, resistivity, temperature, specific conductance, salinity, total dissolved solids (TDS), pH, ORP, pH/ORP combination, ammonium (ammonia), nitrate, chloride and dissolved oxygen.

Source: YSI Professional Plus (Pro Plus) Multiparameter Instrument (TM)

Towed Electronic Probe

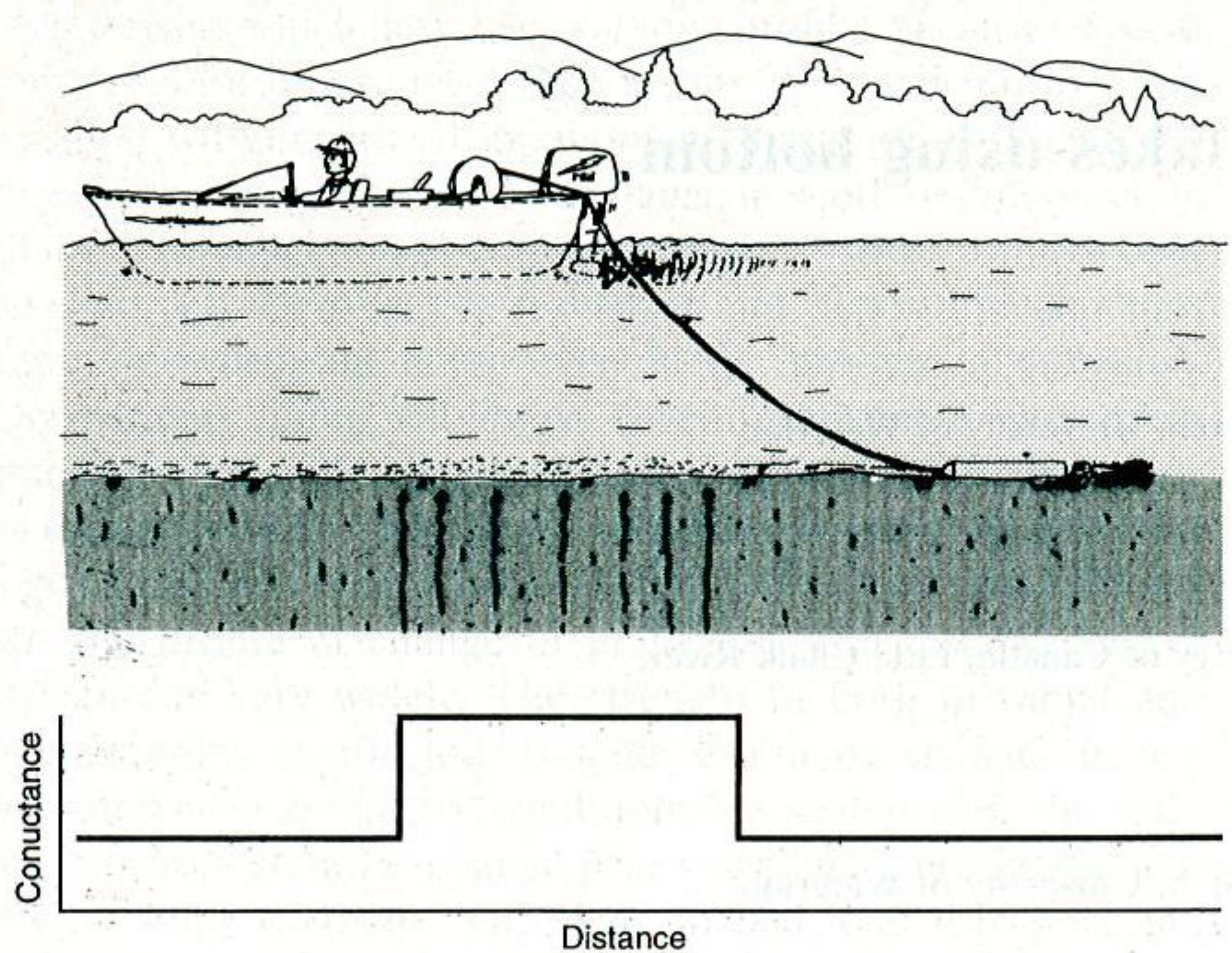


Figure 1. The sediment probe being towed behind a small boat. The probe is used to detect areas of more electrically conductive groundwater inflow.

Source: Harvey et al., 1997

Sediment Pore Water Evaluation

- Diffusion Sampling
- Equilibrium Sampling
- Direct Pore Water Sampling
- Centrifugation

Additional information in Appendix F – Sediment Pore Water Sampling Techniques of the *Ecological Evaluation Technical Guidance*

Diffusion Sampling: allows equilibrium attainment between surrounding water across a diffusion barrier to a capture medium

- Vapor Diffusion Sampler
- Water Dialysis Bags
- Peepers
- Nylon-Screen Diffusion Sampler (NSDS)
- Diffusion Equilibration in Thin Films
- Diffusive Gradient in Thin Films (DGTs)
- Amplified Geochemical Imaging Passive Sampler
- Semi-Permeable Membrane Devices (SPMDs)

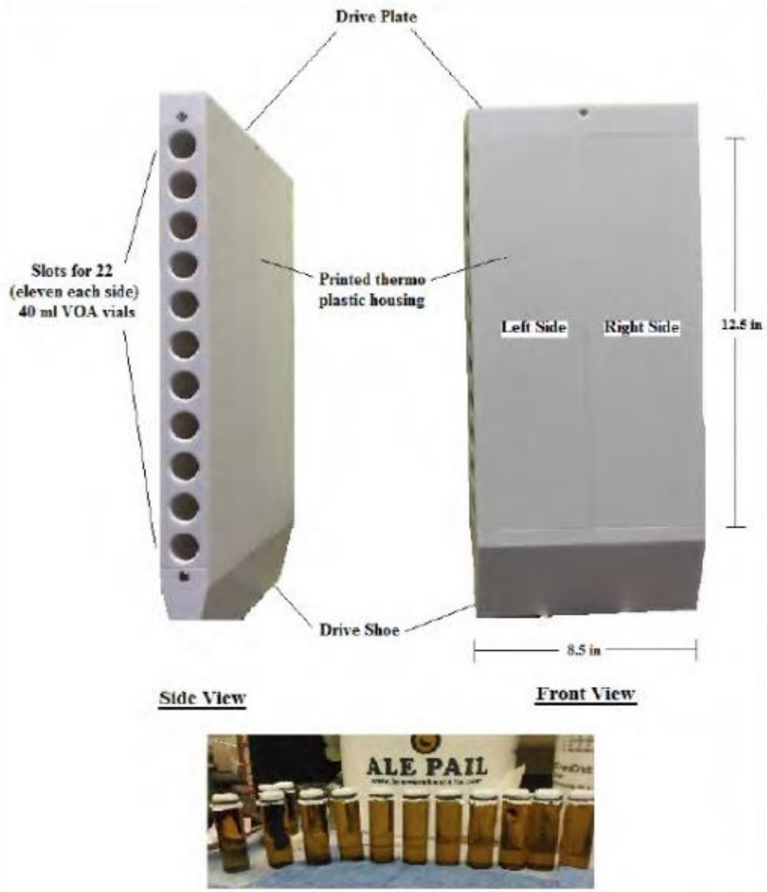
All are passive devices (deployed in-situ and later retrieved)
All are liquid to liquid transfer of solutes, except for Vapor Diffusion Sampler

Water Dialysis/Passive Diffusion Bags

Figure 5.16 PDB for Sediments using bag provided by Columbia. (Photograph by J. Schoenleber)

Source: NJDEP Field Sampling Procedures Manual Section 5.2.1.11.2

Peepers



Prepared vials with permeable membranes ready for insertion into peeper slots

Figure 3
Peeper Example

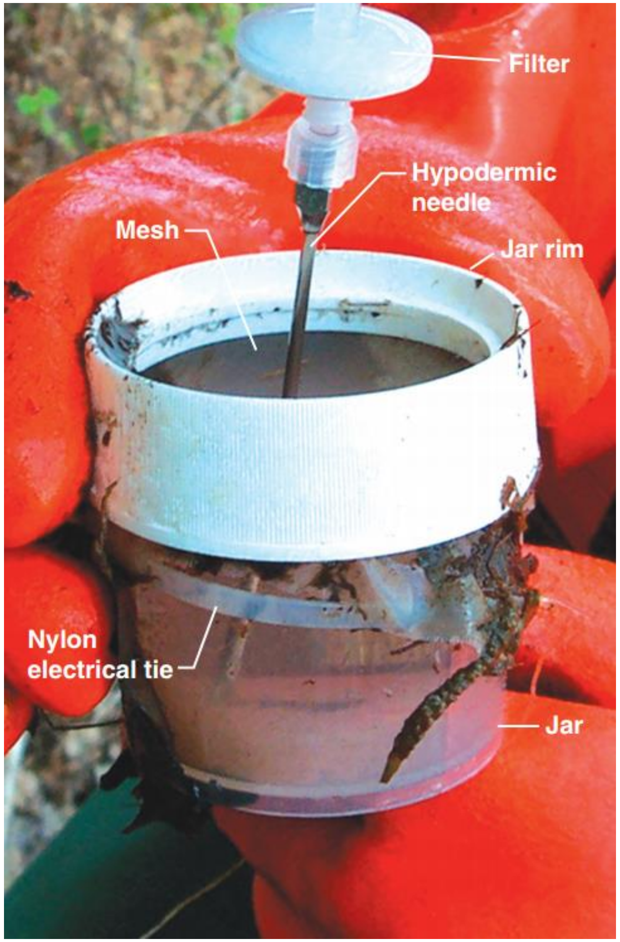
Detailed Vertical Pore Water
Evaluation Using Peepers
Sampling and Analysis Plan

Custom 3-D printer generated housing (Drive Plate) capable of holding 22 prepared vials (11 per side) for vertical sampling of pore waters.

Source: DuPont

Nylon-Screen Diffusion Sampler (NSDS)

- Used for determining pore water metals concentrations
- ~2.5” diameter, 125-mL polypropylene jar (lab sample jar) large enough for lab analytical needs
- cap center bored-out leaving only screw-on rim for securing nylon mesh
- 120-µm nylon-screen mesh (~10 x 10 cm)
- NSDS filled with deionized water, buried in the sediment, and allowed to equilibrate with its environment
- Upon retrieval, pore water extracted with syringe



Source: USGS Scientific Investigations Report 2005-5155 (Zimmerman et al. 2005)

Diffusion Equilibration in Thin Films (DET)

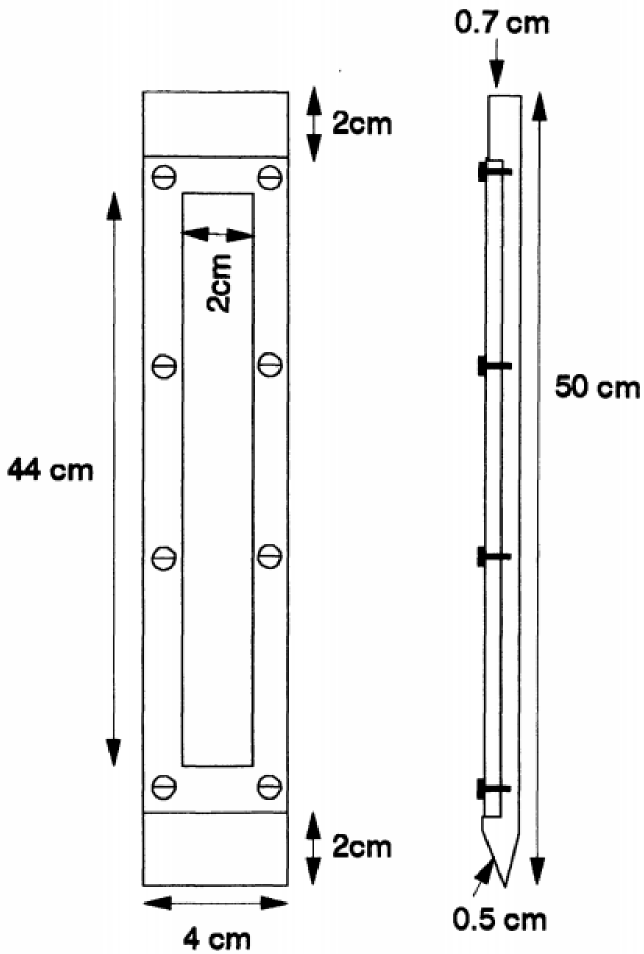


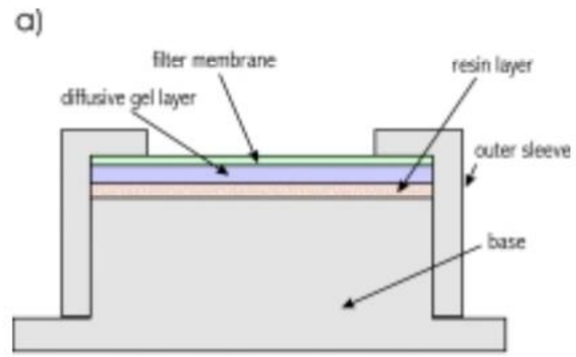
Fig. 1. Diagram and dimensions of the sediment sampling probe. The materials are Perspex with nylon screws.

Accumulating medium consists of a gel polymer (~15%) mixed with distilled deionized water (~85%) and cast to a thickness of ~0.5 to 1 mm. The "window" (area between the screws) is covered with permeable cellulose acetate filter membrane about a half-micron in thickness.

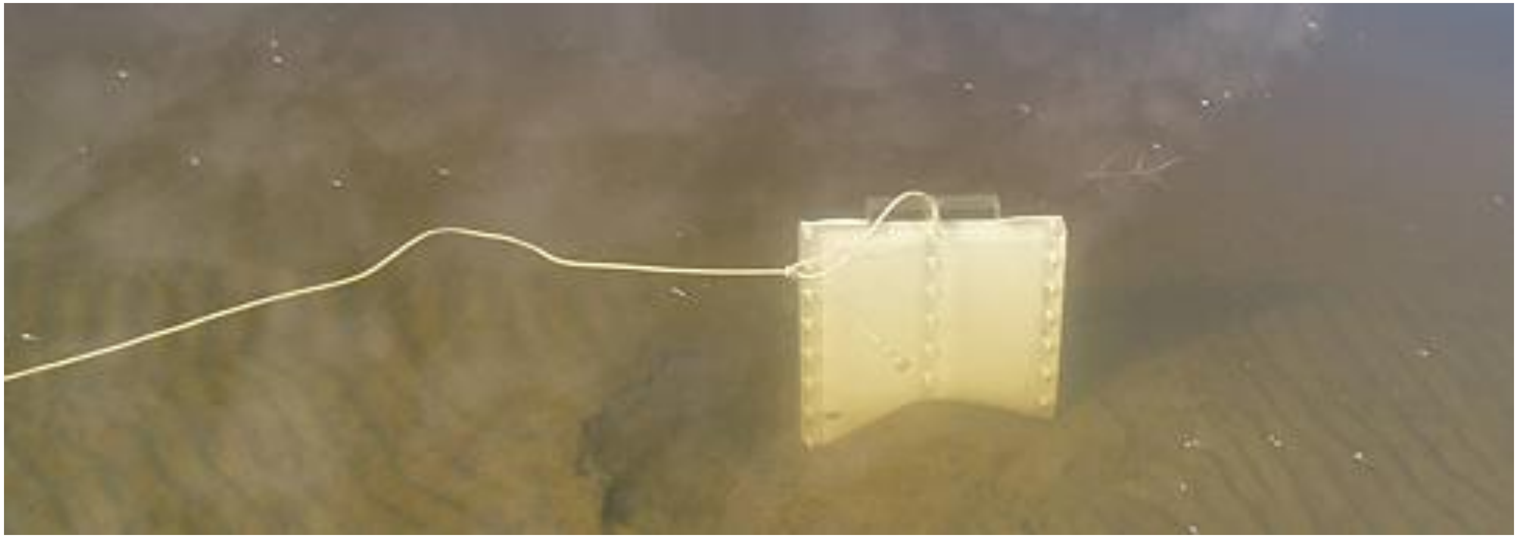
Source: Krom et al., 1994

Diffusive Gradient in Thin Films (DGTs)

Resin layer [brown] serves as a sink for labile metal species which diffuse through the polyacrylamide diffusion-layer [lavender]. The filter membrane [green] (pore size = 0.45 µm) protects the fragile polyacrylamide surface and isolates it from particles.



Schematic Cross-Section of "Piston-type" DGT Sampler (Figure 4-3a)
Source: International Network for Acid Prevention (March 2002)



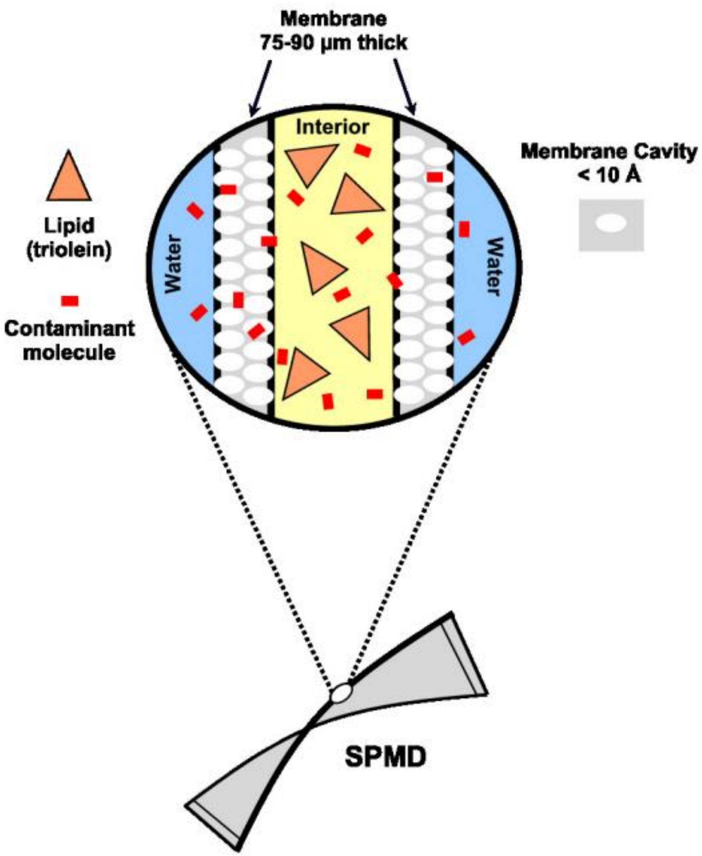
Source: Lorax Environmental Services Ltd

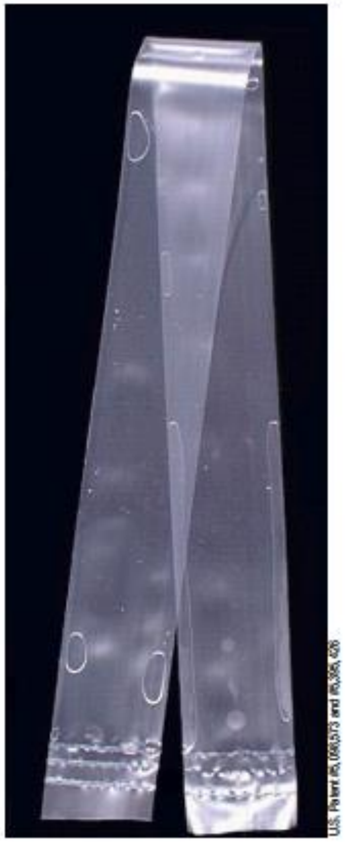
Amplified Geochemical Imaging Passive Sampler (f.k.a. “Gore-Sorber”)

Source: www.agisurveys.net

Using a rod, sampler is pushed or driven into sediment to the desired depth. A premeasured pole with samplers secured at different heights may be used for vertical profiling.

Semipermeable Membrane Devices (SPMD)





Source: USGS - Columbia Environmental Research Center

Duane Chapman

Equilibrium Samplers

- Polyethylene (PE)
- Polyoxymethylene (POM)
- Solid Phase Microextraction Devices (SPME)
  - Polydimethylsiloxane (PDMS) as fiber-optic cable sheathing

Targets hydrophobic contaminants
Deployable in-situ (sediment, water column, or both concurrently)
Can also be used ex-situ (return with pore water to lab)

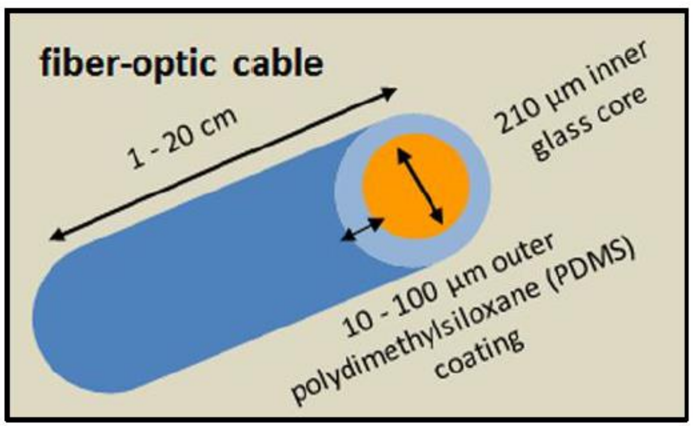


Figure 3. Close-up view of SPME fiber.

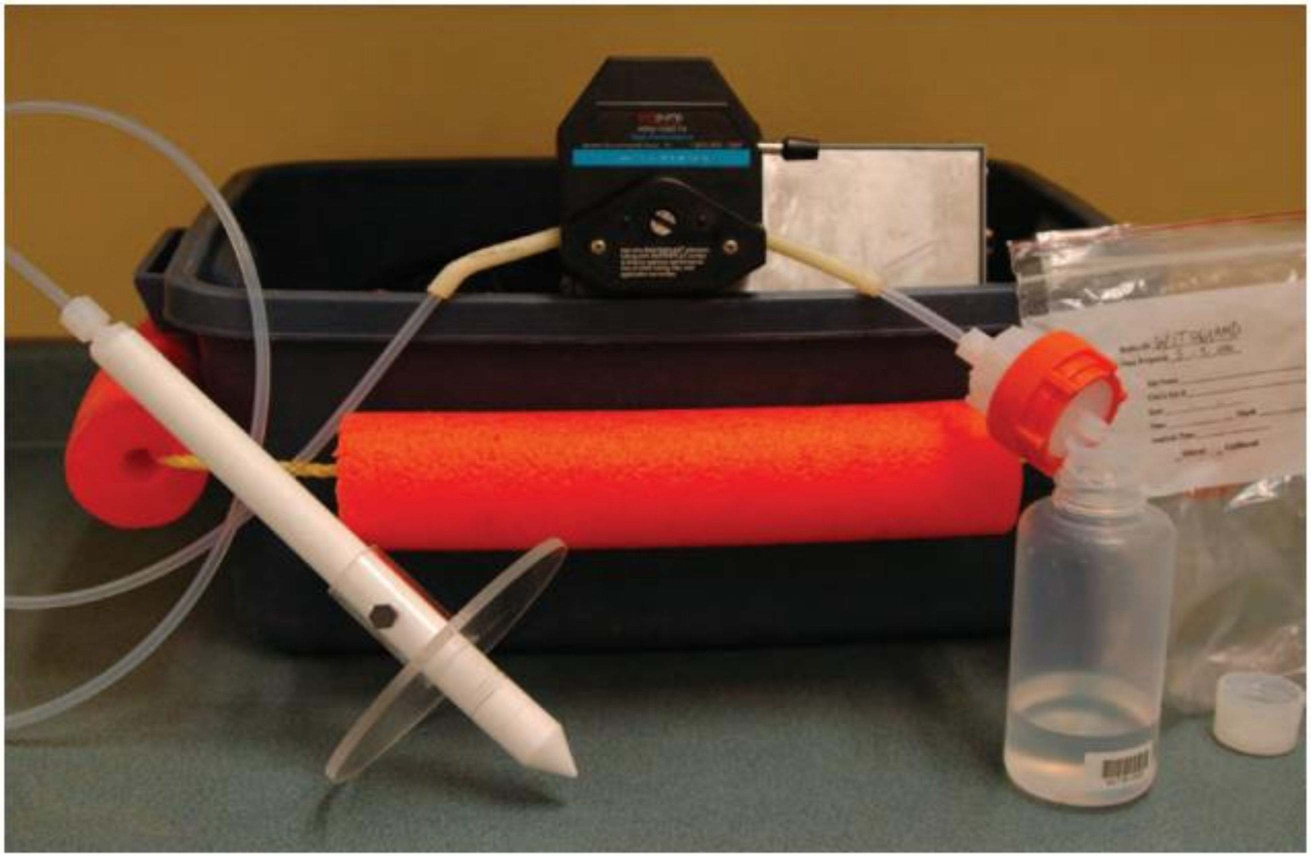
Figure 2. Photographs of selected passive samplers.

EPA OSWER Directive 9200.1-110FS (Dec. 2012)

Direct Pore Water Sampling Evaluation

- Pore Water Piezometers
- Syringe Samplers
- Push Point Samplers
- Trident Probe
- UltraSeep System

Pore Water Piezometers



Pore-water sampling equipment: Pore water piezometer and tubing, peristaltic pump, and sample collection bottle. (Photograph by Michelle Lutz, U.S. Geological Survey, May 2006.)

Push Point Samplers (PPS)

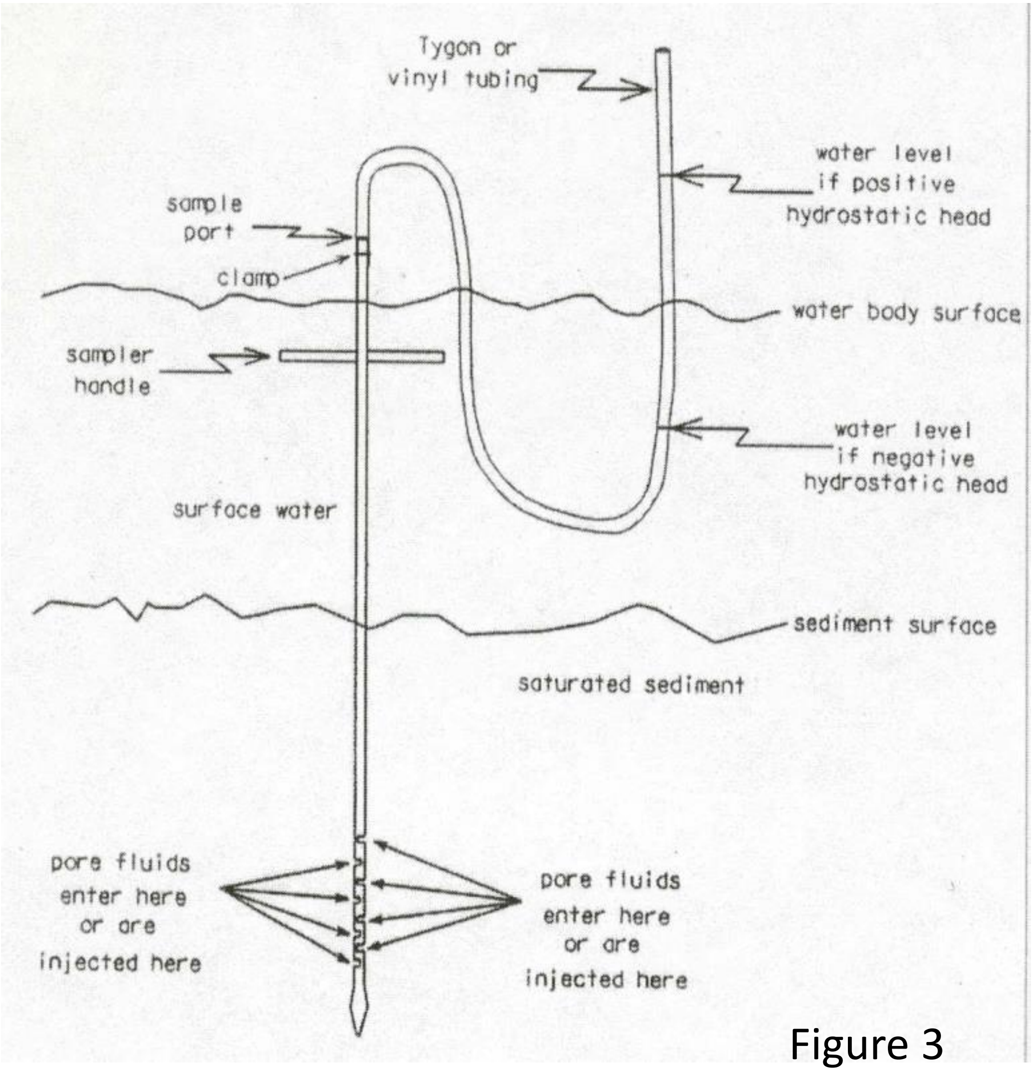


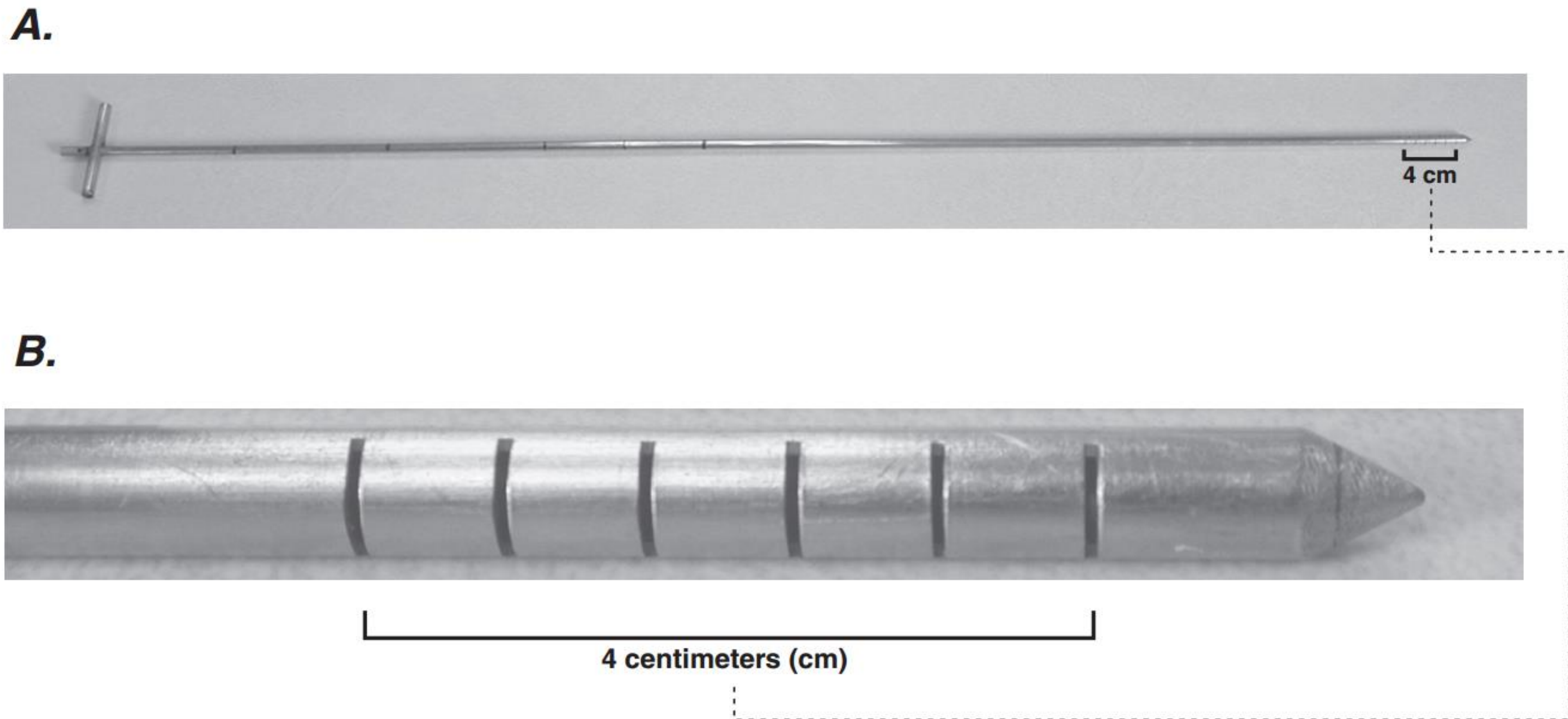
Figure 3

http://www.epa.gov/sites/production/files/documents/r8-src_eh-03.pdf.

Sediment Pore Water Sampling using a *Micro Push Point*

USEPA SOP#EH-03, East Helena Site, Montana (September 2003)

PushPoint Extreme Sampler (TM) (*MHE Products*)



Stainless steel T-handle tube (91 cm long x 6.4 mm diam with 0.635-mm slots)

Source: USGS Scientific Investigations Report 2005-5155 (Fig. 3) [Zimmerman et al. 2005]

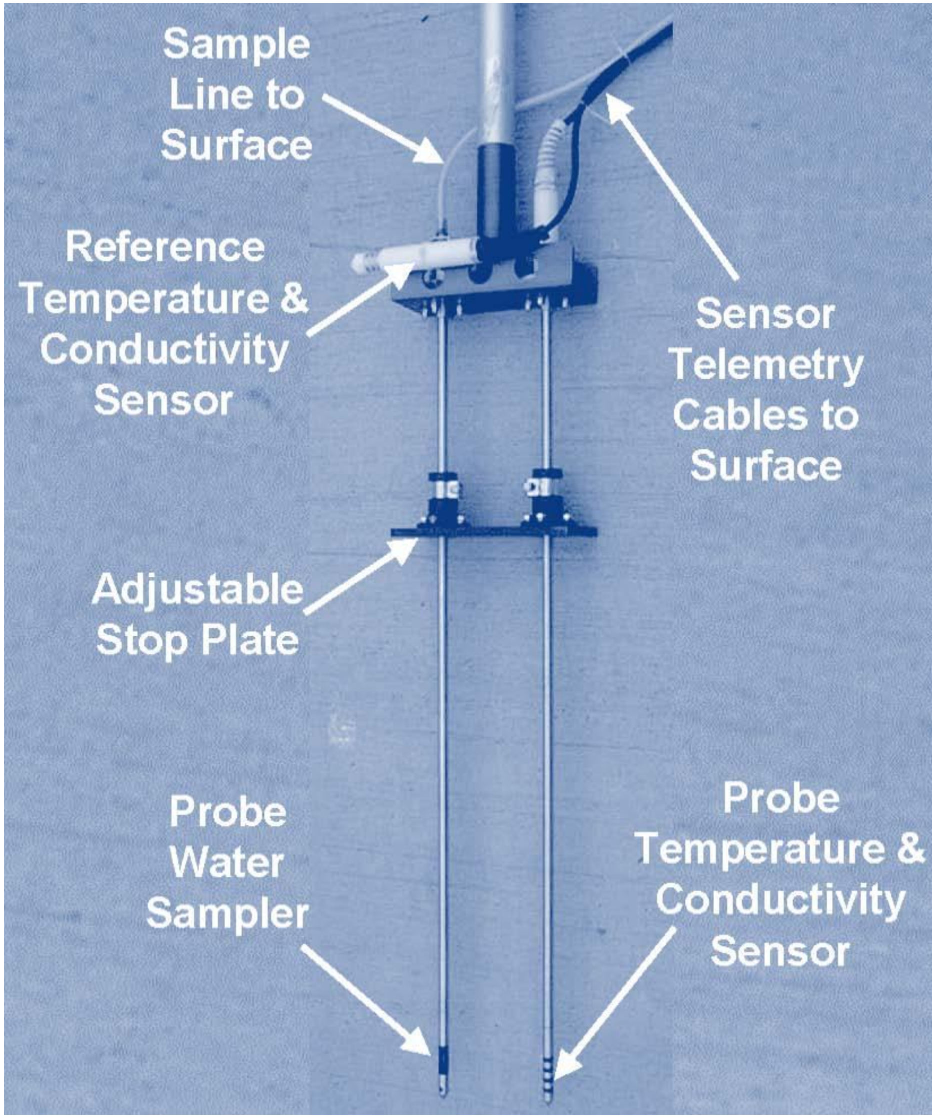
US Navy ***Trident Probe***

- Contaminant Concentration
- Temperature
- Conductivity

Inserted into sediments.

Right prong (digital oceanographic thermometer) measures temperature (-5 to +45 °C) and conductivity (0 to 80 mS/cm).

Left prong is for pore water sample collection (syringe or vacuum pump extraction) to depth of 3 feet below Sed/SW interface.



Source: https://clu-in.org/programs/21m2/navytools/gsw/

US Navy ***UltraSeep***

- Temperature
- Conductivity
- Contaminant Concentration
- Flow (advective flux)

Submersible battery power for 4 days of continuous operation.

Temp & Conductivity data measured and stored in unit.

Flow meter continuously measures specific discharge or recharge from 1 to 1000 cm/day.

Up to 10 seepage water samples can be collected in 1-liter sample bags.

Max deployment depth of 70 m.

Source: https://clu-in.org/programs/21m2/navytools/gsw/

Centrifugation - Large volumes of bulk sediments are collected in the field, returned to the lab, and centrifuged to extract pore water for subsequent analysis.

SURFACE WATER ASSESSMENT: Sampling Methods

FSPM section *5.2.3 Surface Water and Liquid Sampling Equipment*

Two most common methods:

- Dip Grab (sample container immersed)
- Pump & Tubing

Questions?

Assessment of electrical resistivity method to map groundwater seepage zones in heterogeneous sediments

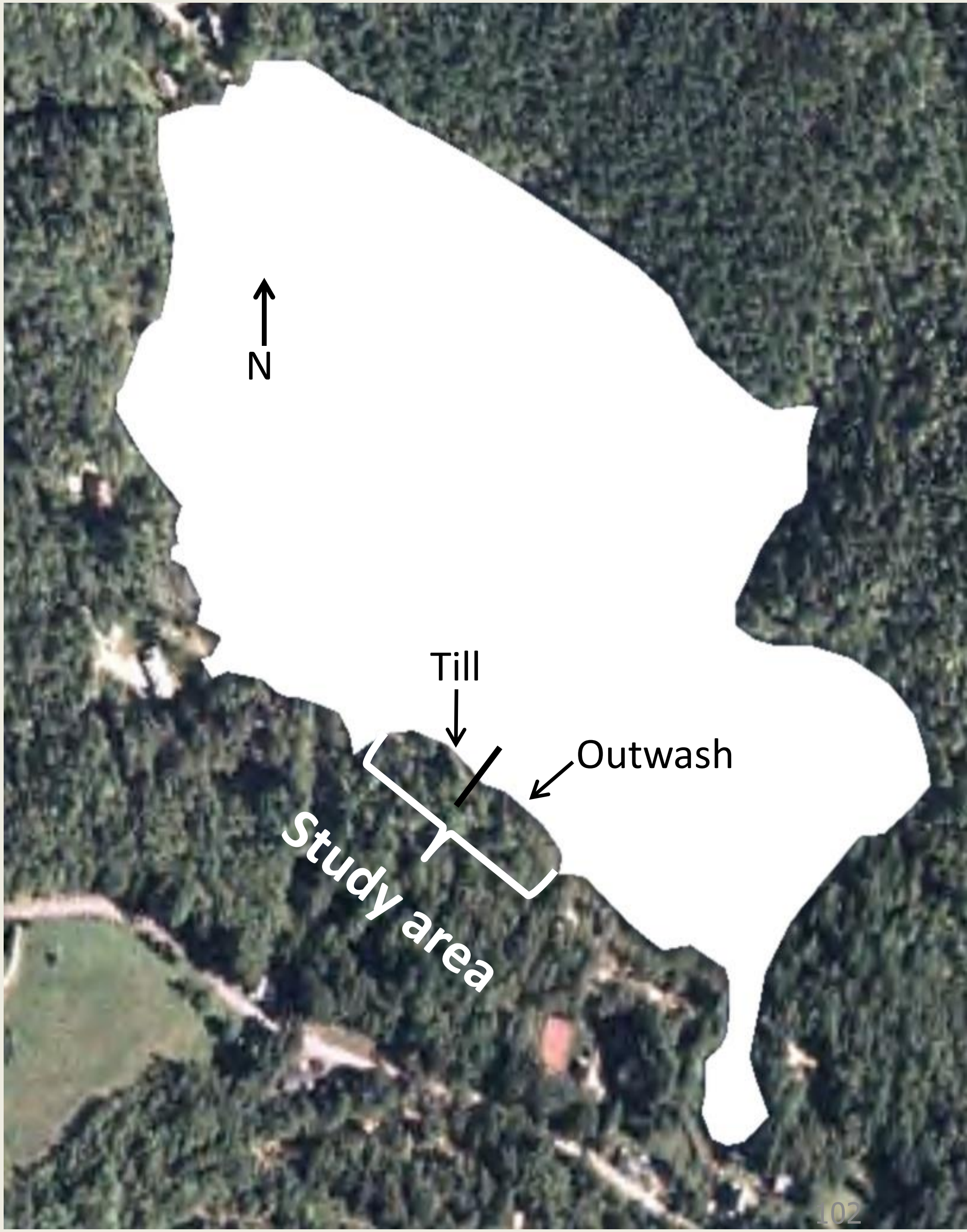
Michael Gagliano
New Jersey Geological & Water Survey

Mirror Lake, NH

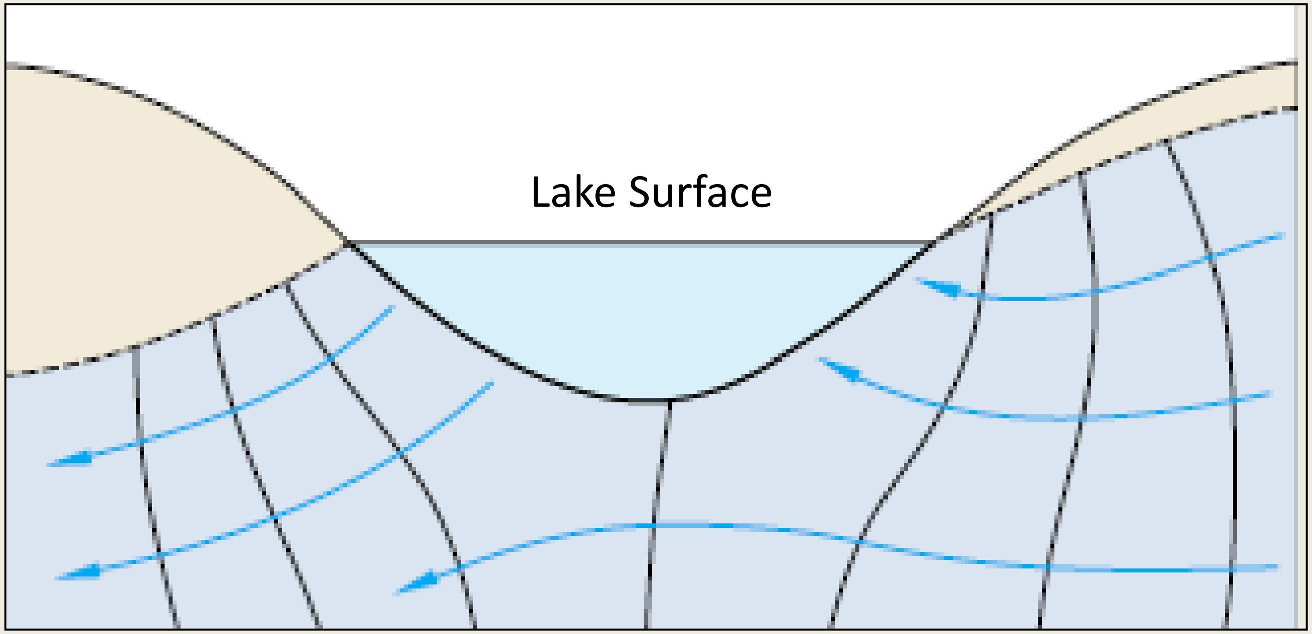
- Small glacial lake (15 ha) underlain by fractured crystalline bedrock
- Bedrock covered by glacial till and sand/gravel outwash
- Till and outwash covered by 0-3m of organic fines
- Part of the Hubbard Brook experimental forest
  - Long term study site of USGS
  - Lots of data

Southwest Shore

- Sand and gravel outwash
- Glacial till
- Organic sediment covers most of the site (<1mm in some cases)
- Area of high lake water discharge (up to 300 cm/day) in the sand and gravel outwash

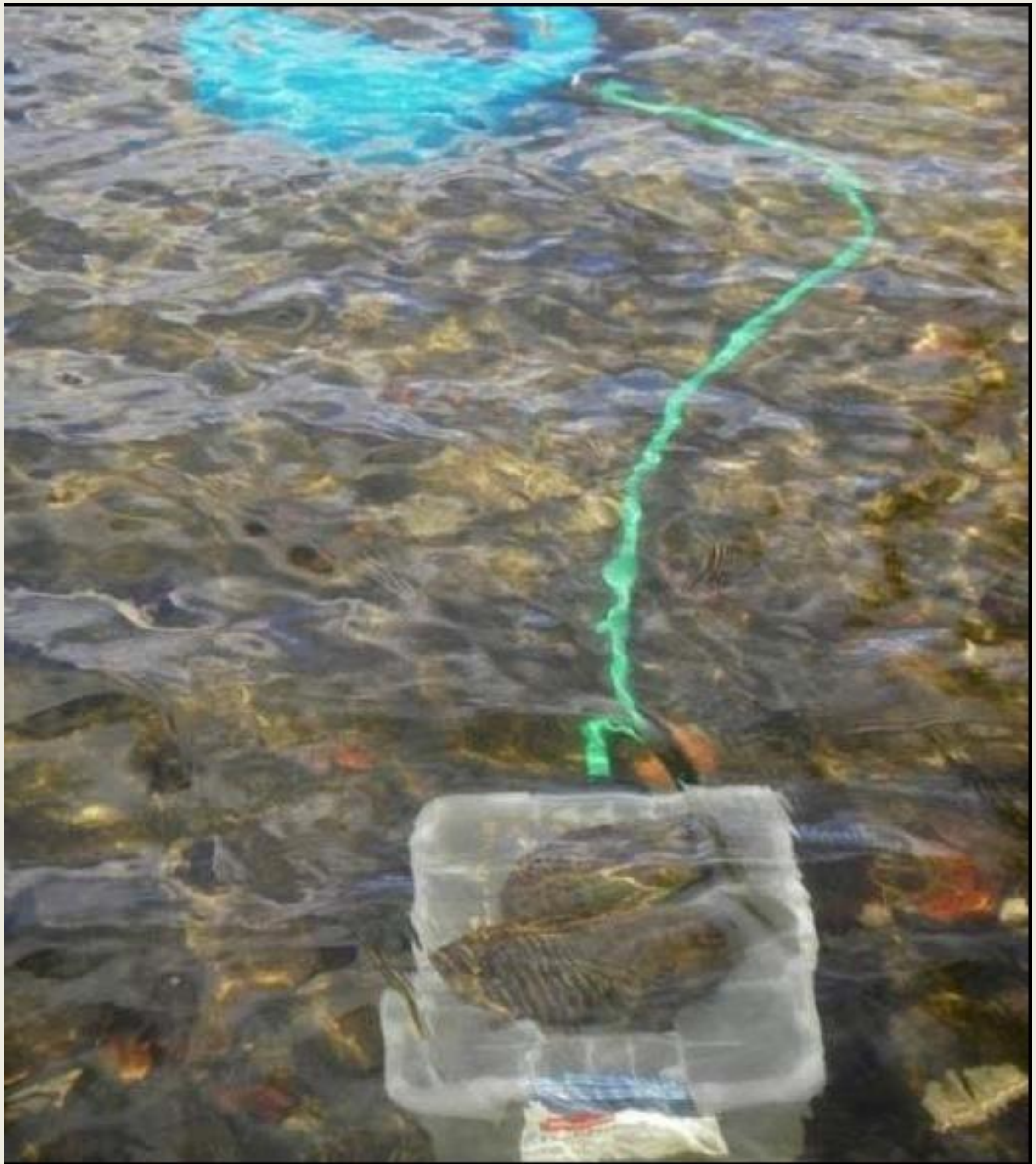


Seepage



From Winter et al., 1999

Seepage Meters

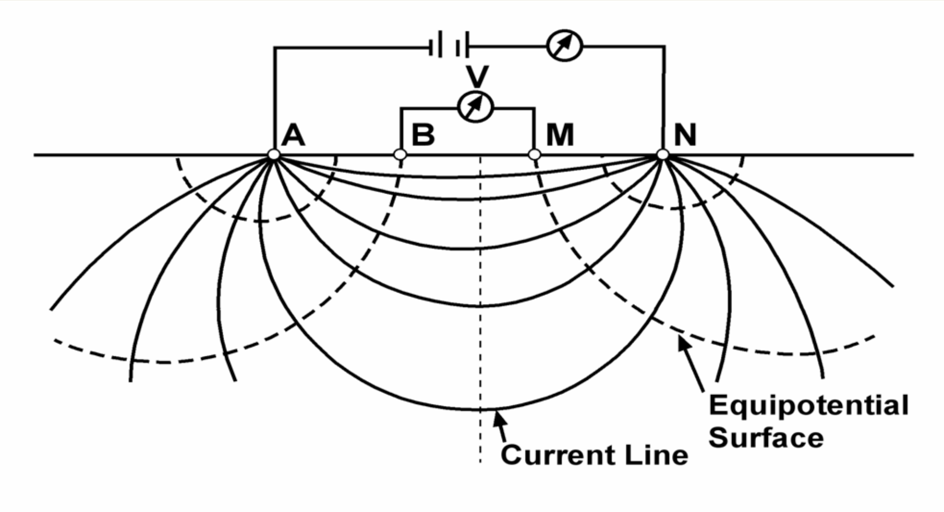


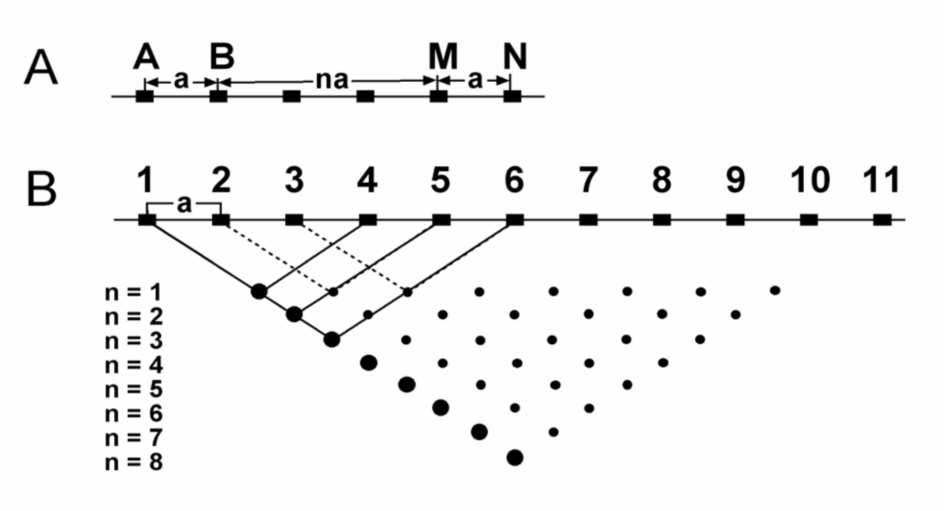
Geophysics

- Electrical resistivity
- Factors linking groundwater and resistivity
  - Porosity (φ)
  - Saturation (s)
  - Resistivity of the pore water (ρ_w)
  - Bulk resistivity (ρ)

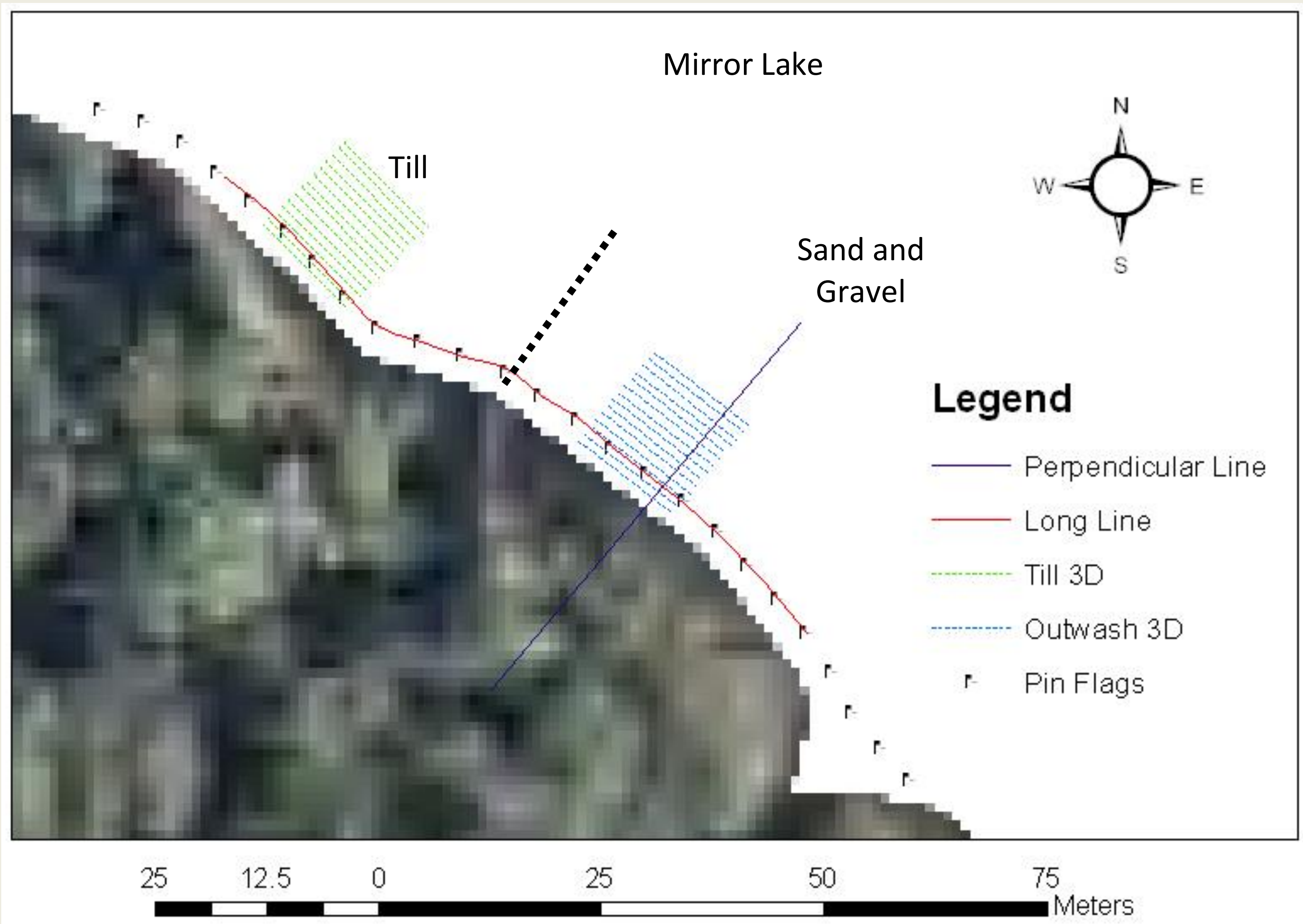
Electrical Resistivity

- Measures resistance of the subsurface to current flow

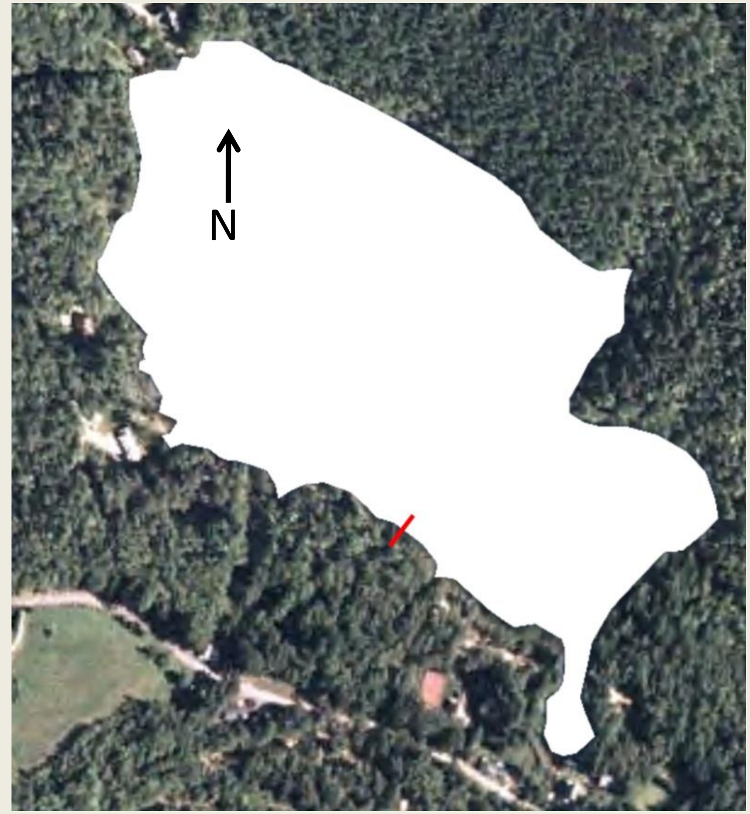


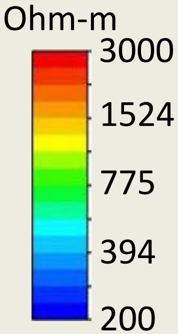


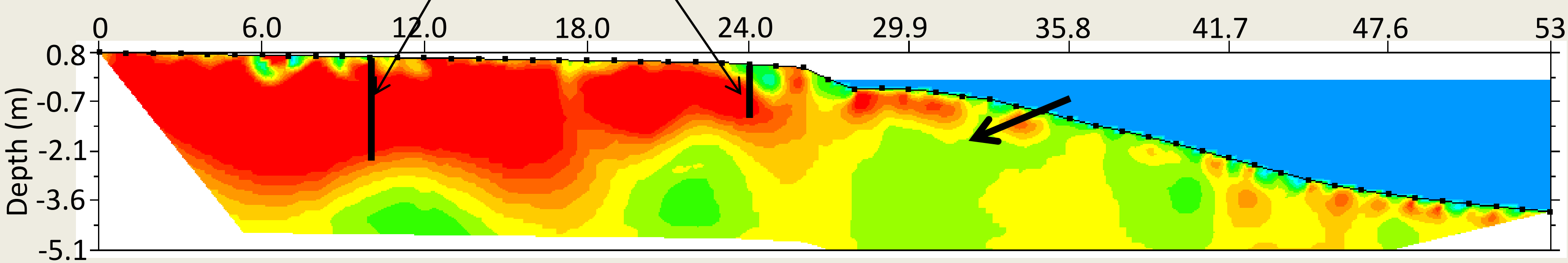
Survey Locations



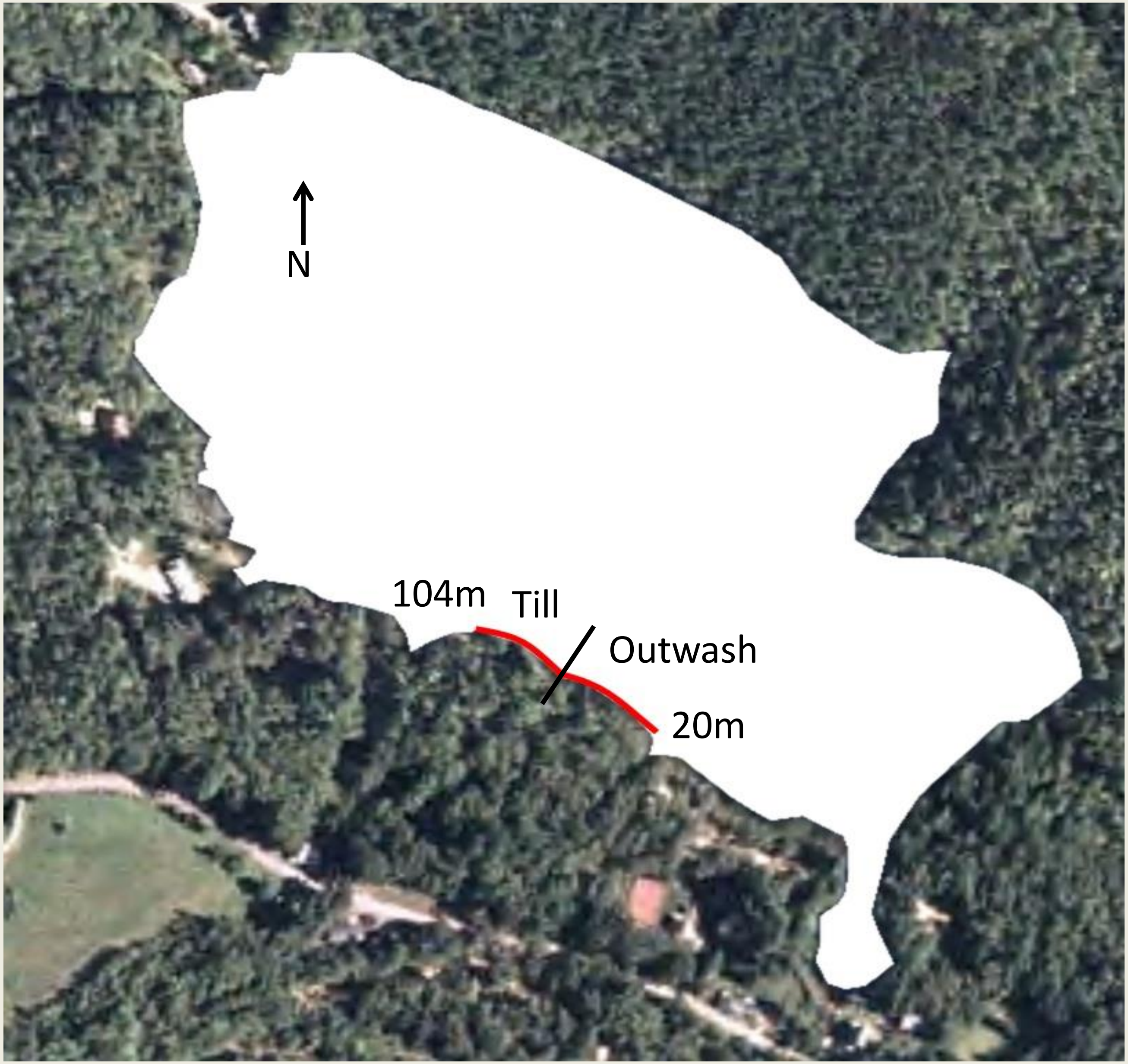
Perpendicular to Shore



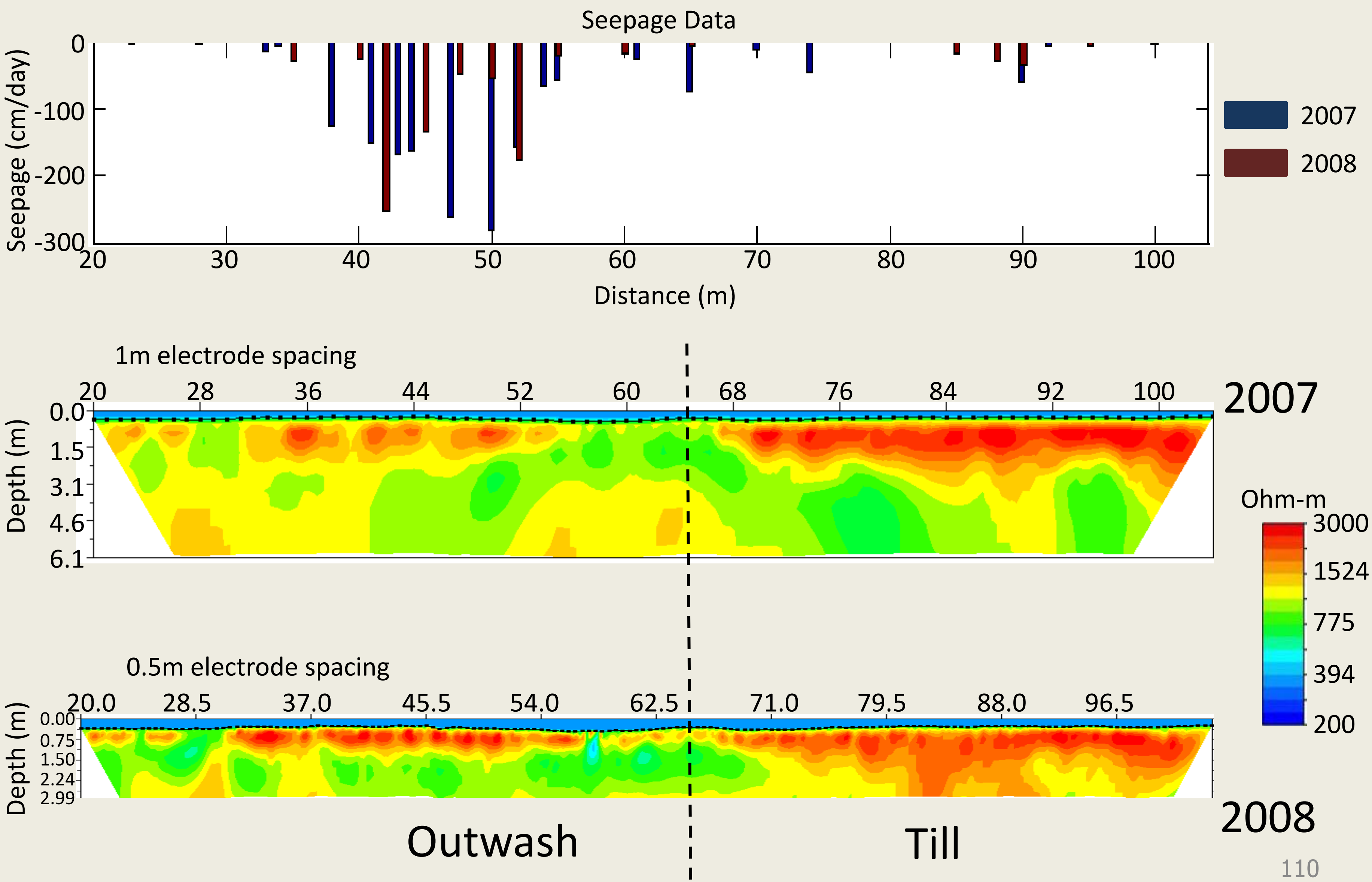




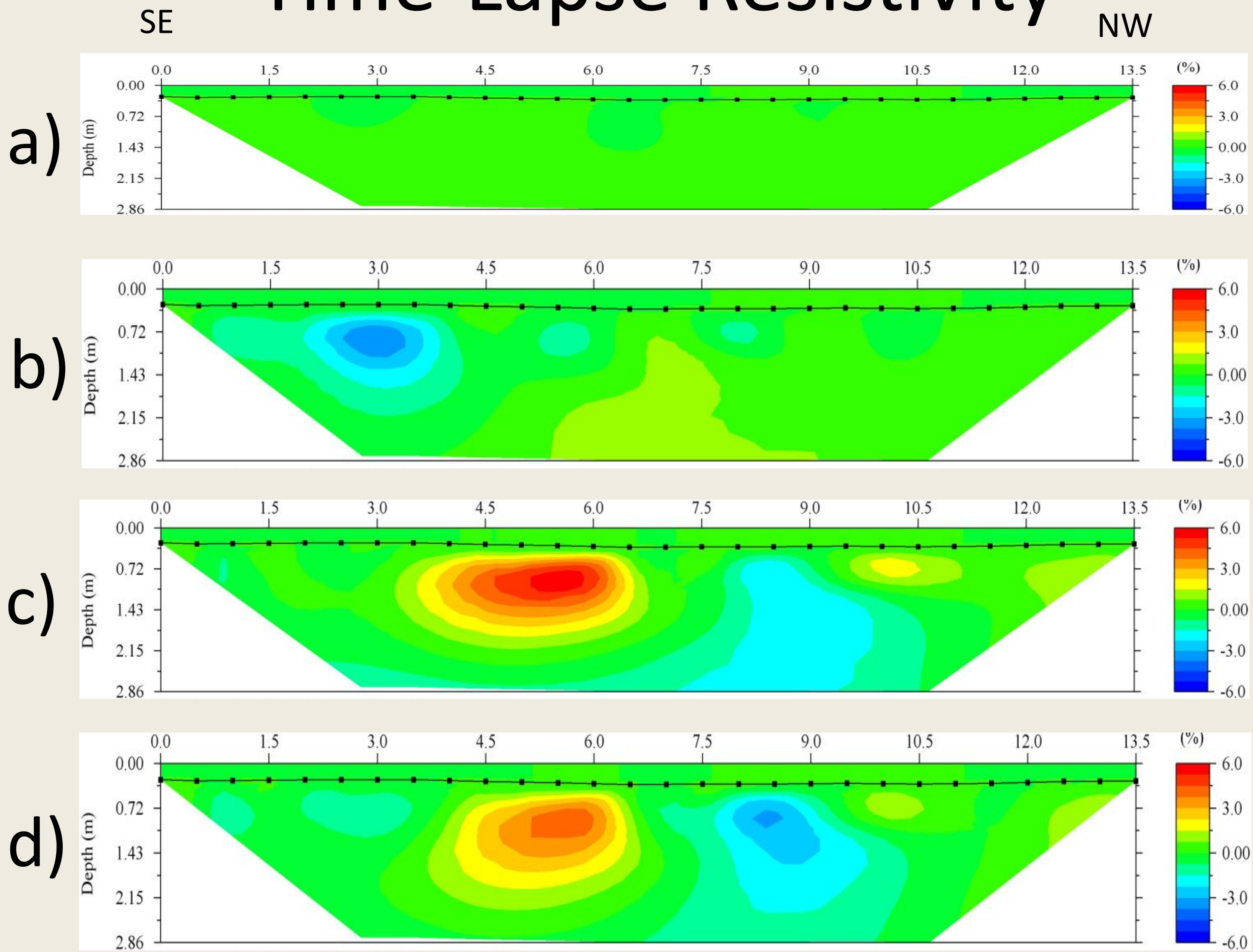
Parallel to Shore



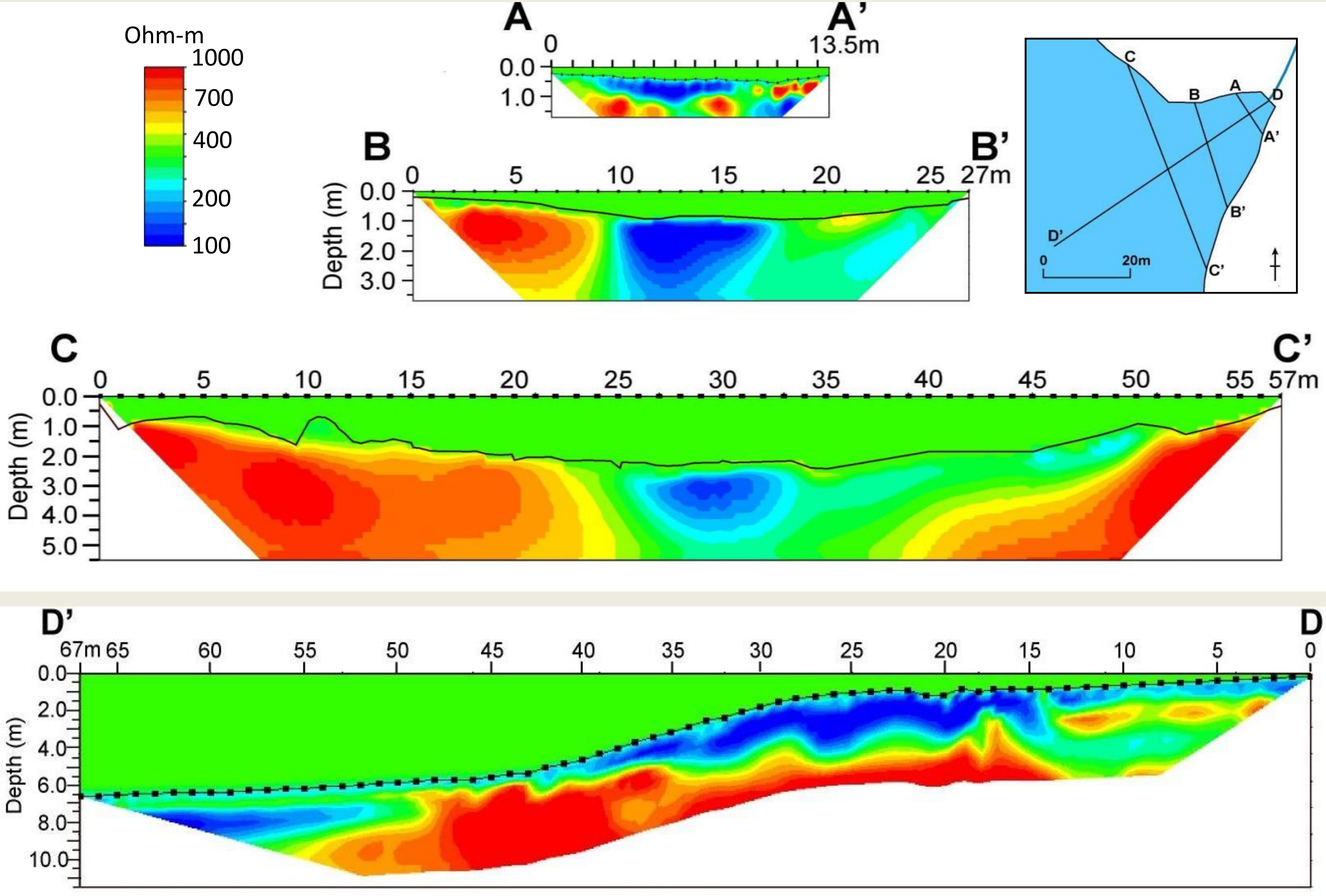
Parallel to Shore



Time-Lapse Resistivity



Northeast Inlet Salt Plume



Summary

- Electrical resistivity lines perpendicular to shore could map the water table and hydraulic gradient
- Electrical resistivity lines parallel to shore was able to identify broad zones of geologic heterogeneity that may predict seepage
- The surface layer of organic sediment, even though < 1cm thick, may play a large role in seepage rates
- Resistivity is able to identify broad zones of contaminant plumes.

Remedial Action and Performance Monitoring Program

A program necessary to evaluate the effectiveness of the selected remedial technology through monitoring

Dan Cooke

Amec Foster Wheeler

Remedial Action Strategies for Ground Water Plume Discharge

- Ground Water Plume Treatment Amendments
- Permeable Reactive Barriers
- Ground Water Containment
- Monitored Natural Attenuation/Recovery

Performance Monitoring

- Site-specific monitoring plan
- Address sources of variability
- Considers use of the surface water body
- Fate and transport modeling can be useful for designing monitoring points

Performance Monitoring General Considerations

- Climate/Weather
- Topography
- Stream/Surface Water Morphology
- Tidal Influence
- Urbanization

Developing a Remediation Monitoring Plan

The Monitoring Plan will be based on specific performance objectives of the remedy

Developing a Remediation Monitoring Plan

A Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) should be prepared to define key elements of the Monitoring Plan

Developing a Remediation Monitoring Plan

A statistical evaluation of pre- and expected post-remedy conditions will ensure that adequate sampling is conducted to make decisions.

SRWMP

Developing a Remediation Monitoring Plan

Generally, more sampling is needed during the initial phases of the monitoring program.

Developing a Remediation Monitoring Plan

If MNA is part of the remedy, long-term monitoring endpoints that depend on the processes dominant in natural recovery have to be included in the plan.

Case Studies: Mitigation

Scott Drew, LSRP
Geosyntech Consultants, Inc.

Remedial Action Strategies

- Ground Water Treatment Amendments
  - Examples: biostimulation, bioaugmentation, chemical oxidation or reduction
- Permeable Reactive Barriers
  - Examples: organoclay/activated carbon, zero valent iron, biological barriers, air sparging
- Ground Water Containment
  - Examples: sheet piling, slurry walls, hydraulic containment.

Case Studies

- Case Study 1

  Mitigation of the discharge of groundwater from a former Manufactured Gas Plant Site

- Case Study 2

  Mitigation of the discharge of chlorinated ethanes to a tidal creek

SRWMP

Case Study 1 - Former MGP Site

- Redeveloped as office and residential condominiums
- Area is comprised of historically filled wetlands
- Seeps (and odors) were noticed during low tides
- Sheen was visible at high tides
- A storm sewer was acting as a conduit for contaminated ground water, through ground water flow in pipe bedding and by leakage of groundwater into the sewer.

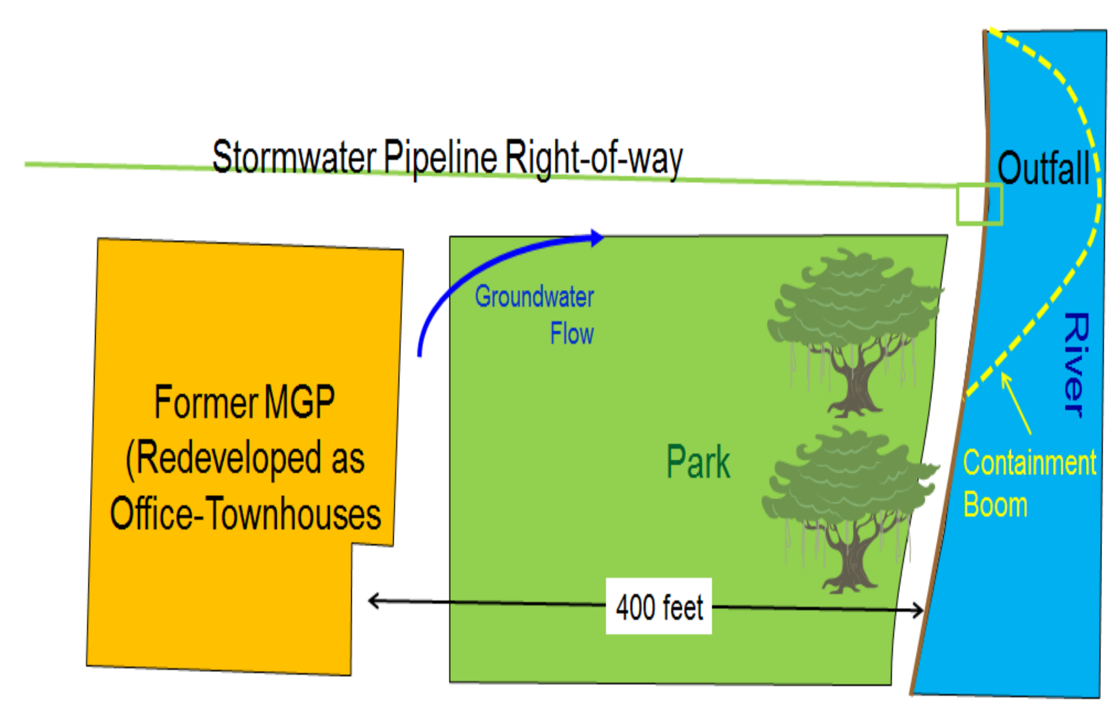
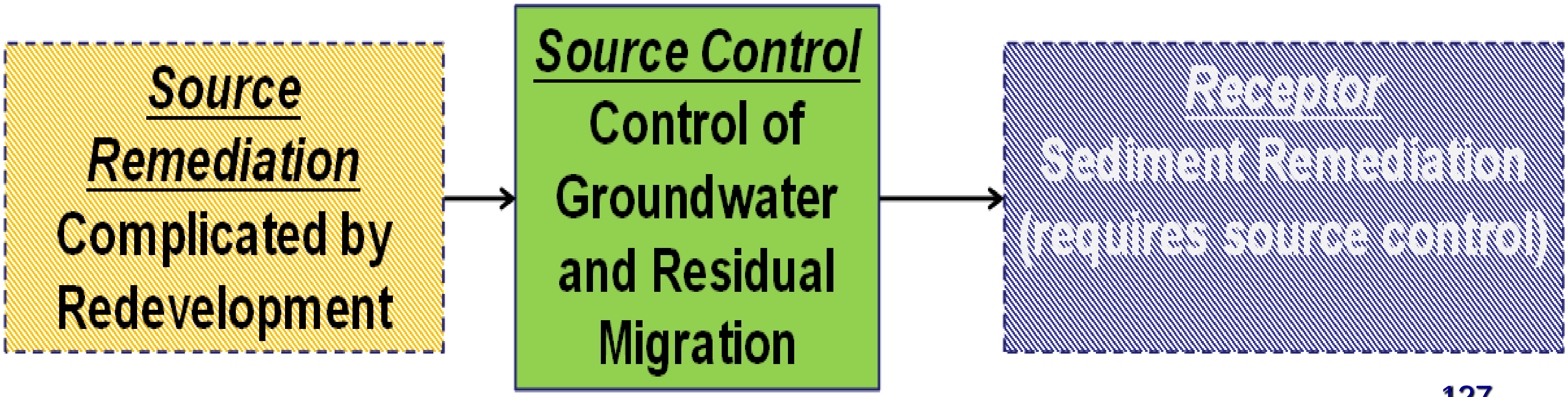


Figure 1: Conceptual Site Plan

Case Study 1 - Former MGP Site

- Compounds of Interest: VOCs, PAHs, intermittent LNAPL
- Remedial goals for sediment require mitigation of discharge
- Limited options for source remediation- focus on mitigation
- The sewer was relined to prevent infiltration



Case Study 1 - Former MGP Site

- Biosparging (aerobic bioremediation) was selected as a component of the treatment system
- A pre-design pilot study was performed to determine effective radius of influence
- Soil gas data indicated that soil vapor extraction for recovery was not required. Intermittent sparging performed (energy efficient; avoid unintentional hydraulic barrier)

SRWMP

Case Study 1 - Former MGP Site

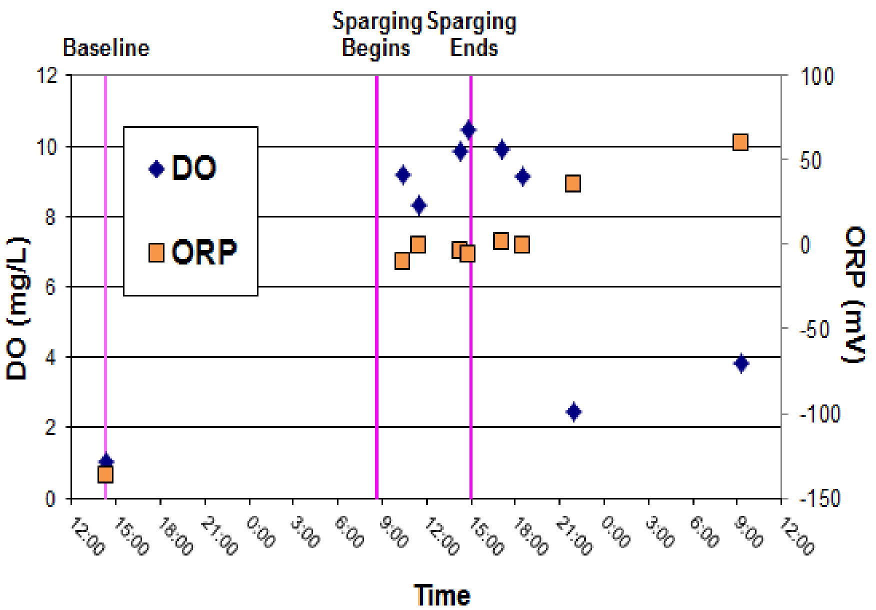


Figure 2a: DO and ORP Monitoring During and After Air Injection

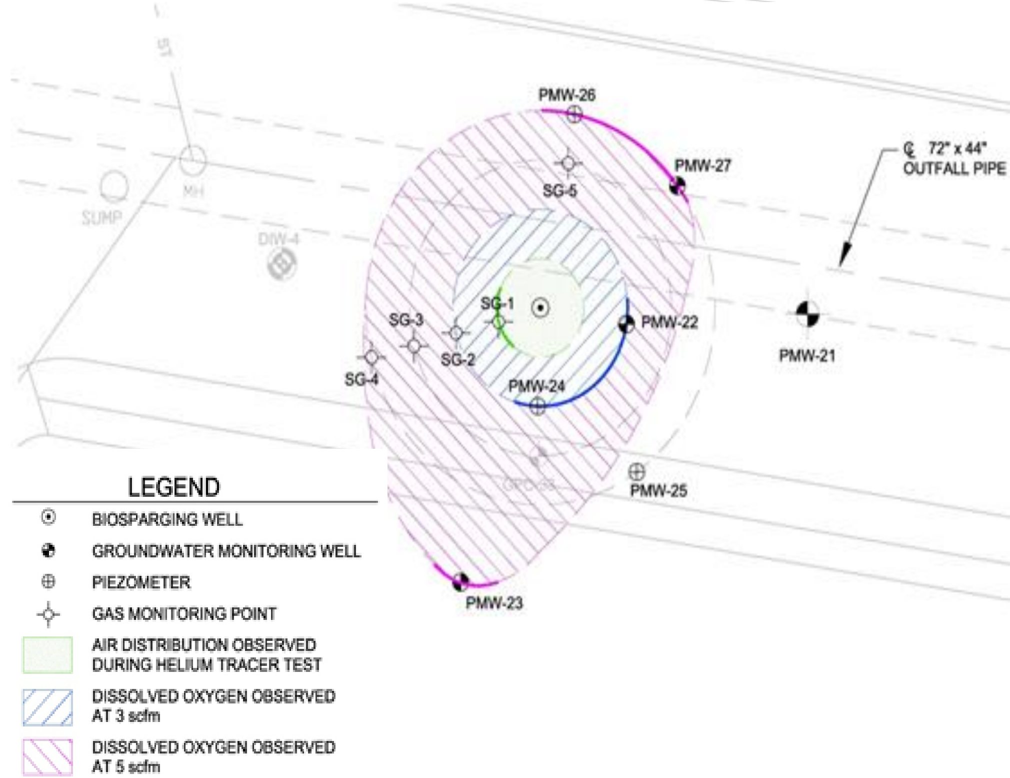


Figure 2b: Extent of Air Injection Influence

SRWMP

Case Study 1 - Former MGP Site

Additional Components:

- Up gradient submerged oil water separator to remove LNAPL

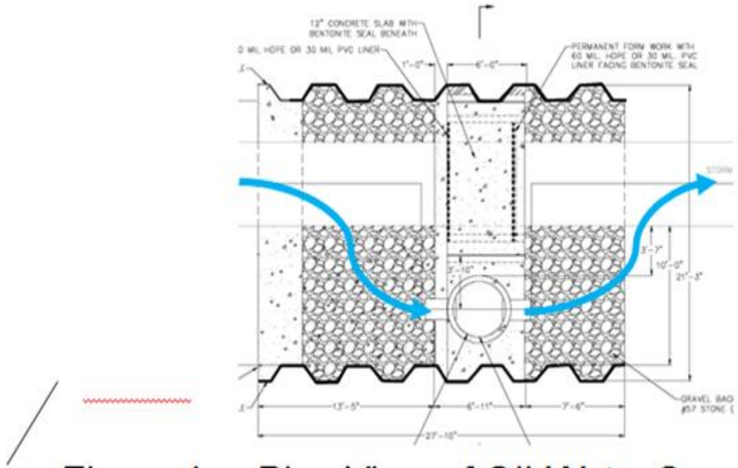


Figure 4a: Plan View of Oil-Water Separator

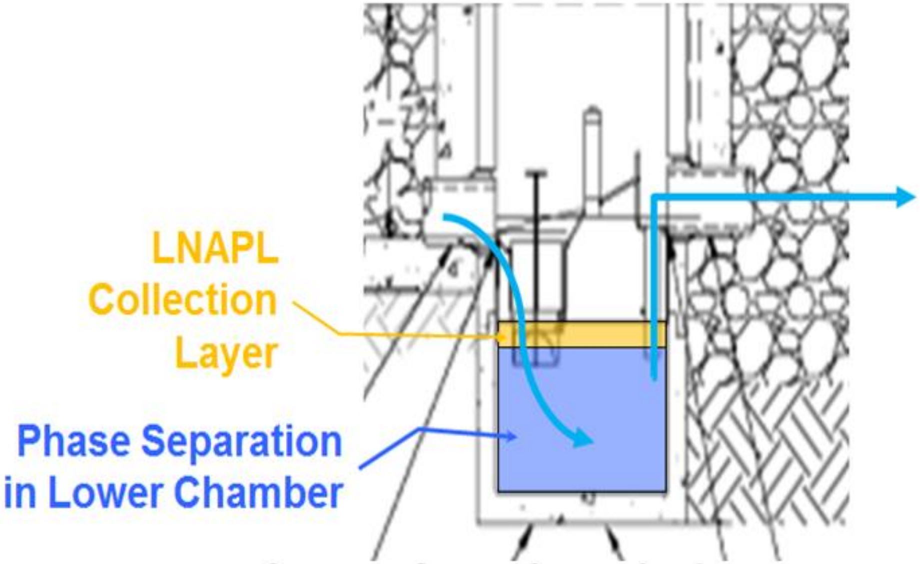


Figure 4b: Sectional View of Oil-Water Separator

Case Study 1 - Former MGP Site

- Additional components:
  - Down gradient permeable reactive barrier- organoclay and activated carbon for polishing
  - Media installed in removable baskets for maintenance
- System installed in 2013 and is operating as designed

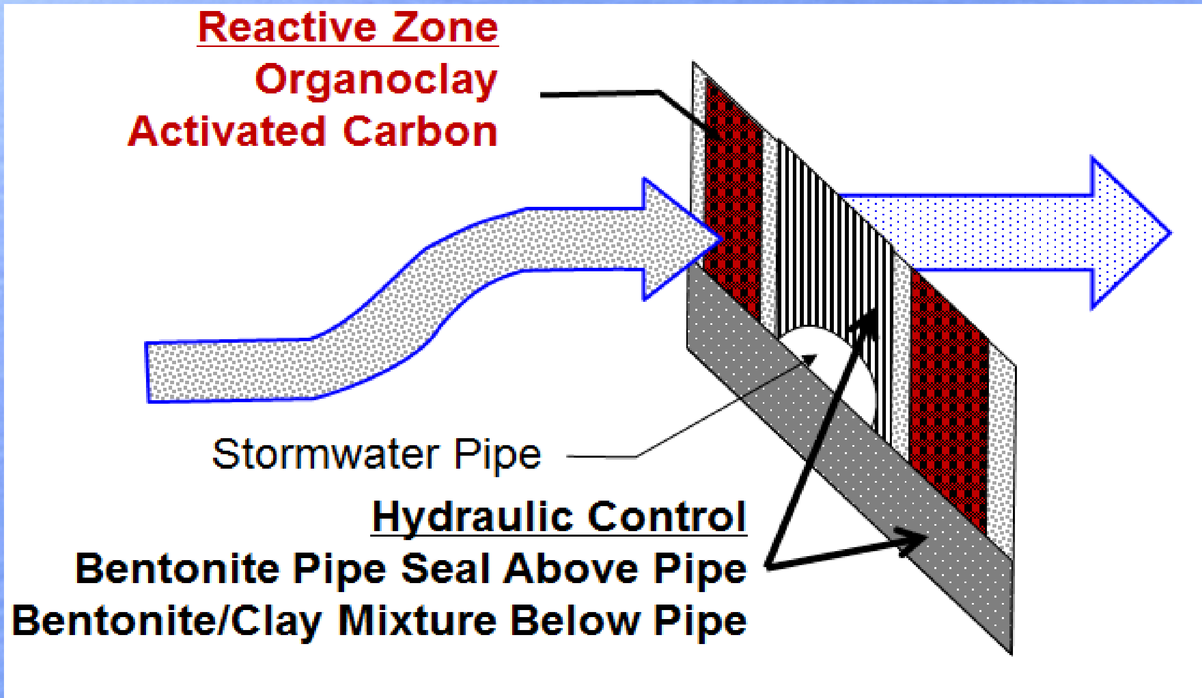
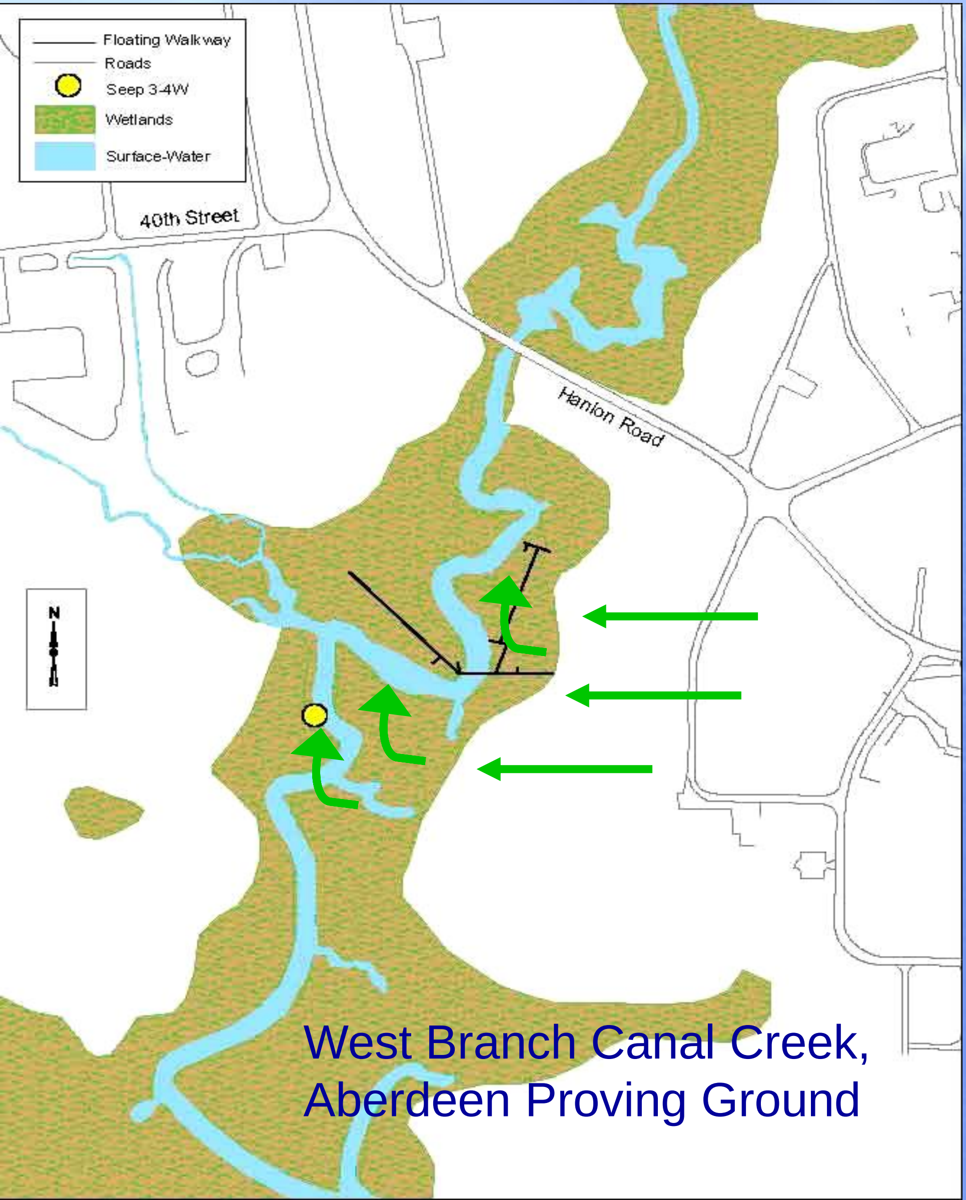


Figure 6: Conceptual View of PRB

Innovative Solution for Chlorinated Solvent Bioremediation at the Groundwater-Surface Water Interface

Groundwater Issues Stimulate Technology Development



West Branch Canal Creek, Aberdeen Proving Ground

DANC, chlorinated solvent mixture
- 96% 1,1,2,2-Tetrachloroethane (TeCA)
- 4% Trichloroethene (TCE)

Groundwater impacted

Groundwater discharges into wetlands

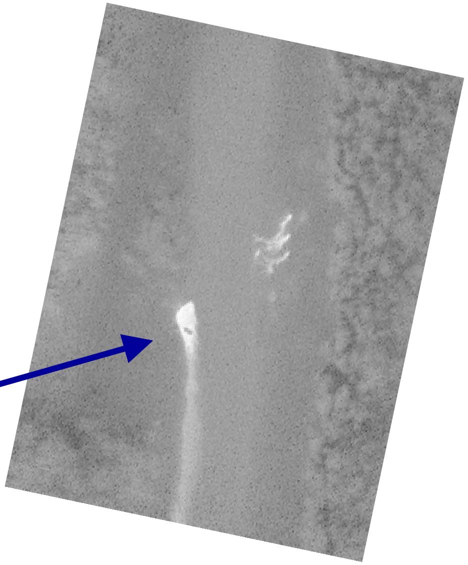
Wetlands discharge to surface water
- Diffuse flow areas exhibit complete natural degradation of solvents (incomplete exposure pathway)
- Seep areas exhibit no degradation (completed exposure pathway)
- TeCA, TCE, CT and CF

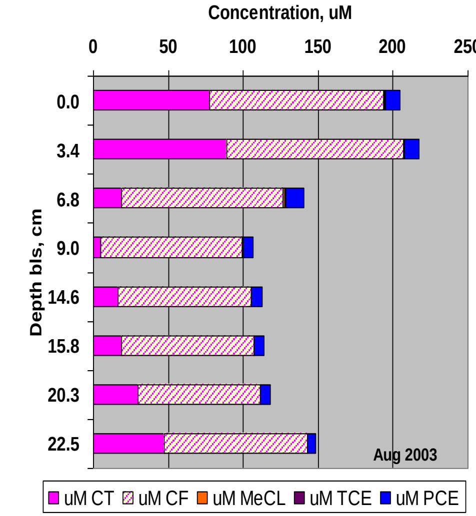
SRWMP

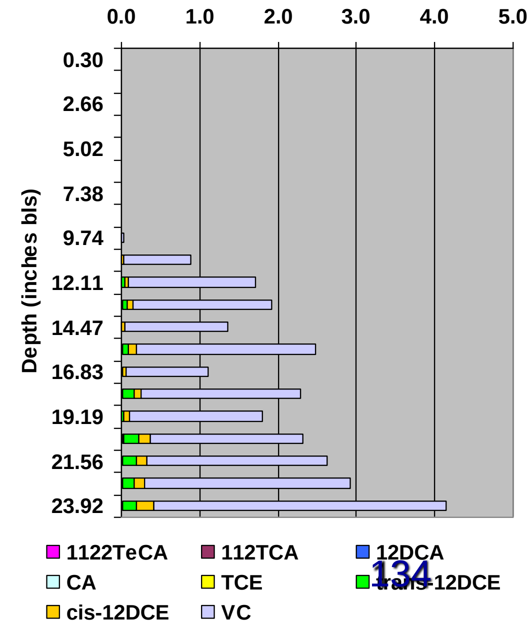
Solvent Release from Seep Area

Figure 1. Microseep sites at Canal Creek, APG, Maryland

Kilometers
0 30 60 120 180 240







Seepage Velocity: 0.7 to 3 ft/yr in wetland, 42 to 86 ft/yr in seep

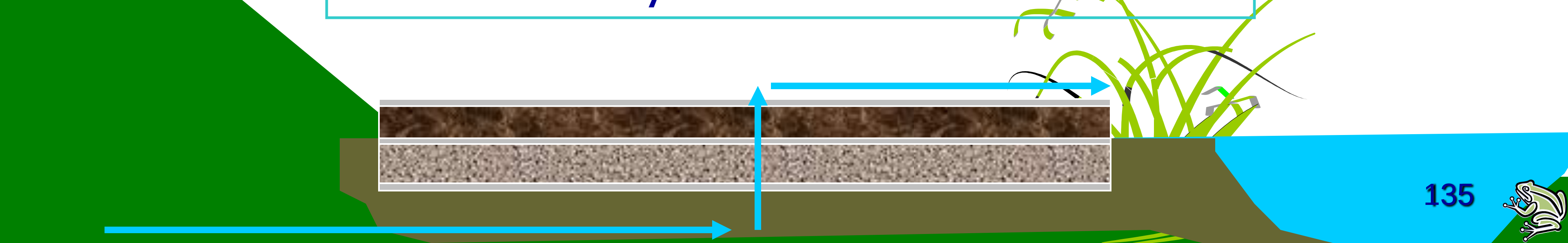
Bioreactive Mat Concept

A passive, permeable reactive barrier comprised of an organic-based matrix, bioaugmented with dechlorinating culture and placed at the seep surface

MAXIMIZE the overall VOC mass reduction in the mat through biotic (and abiotic) mechanisms

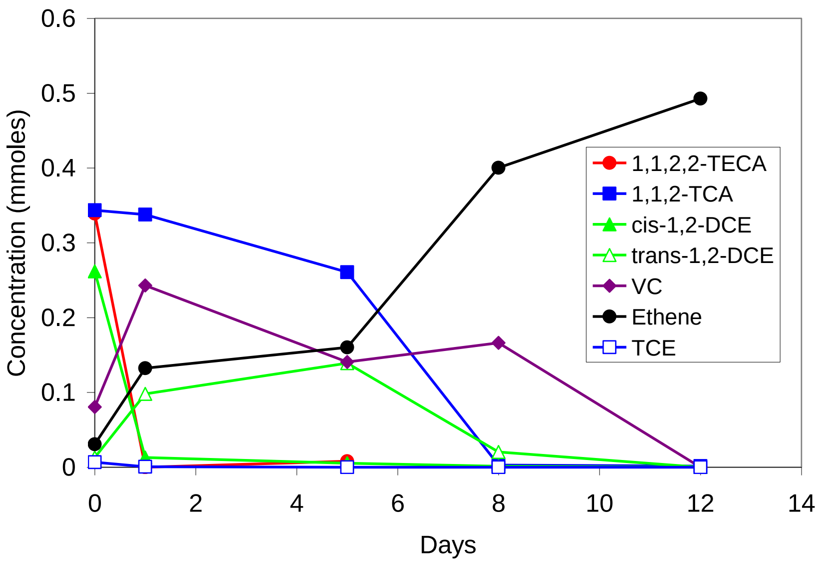
MAXIMIZE the efficiency and life expectancy of bioaug. culture in its delivery to and propagation in the mat

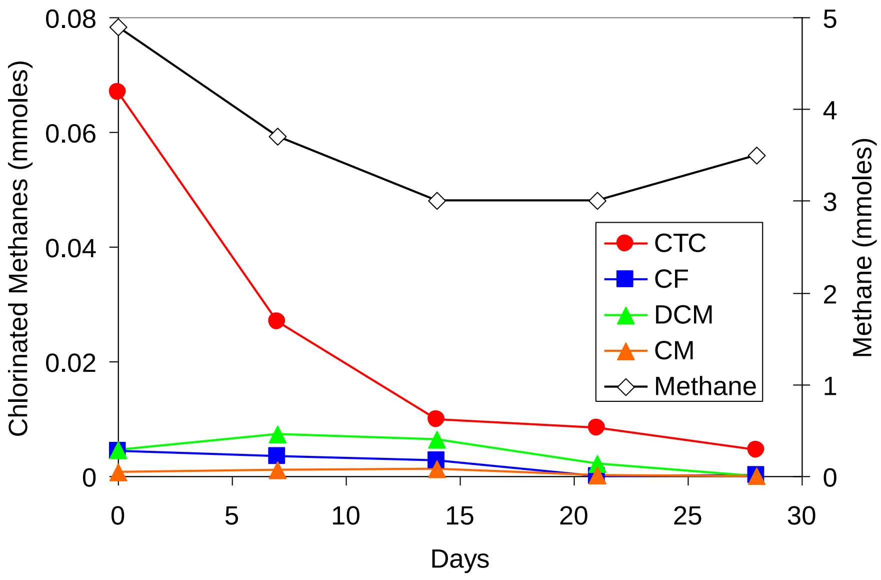
ACHIEVE geotechnical, hydraulic, and geochemical compatibility with the wetland ecosystem



Chlorinated ethenes, ethanes, and methanes Dechlorinated by WBC-2

Chlorinated Solvent Dechlorination by WBC2



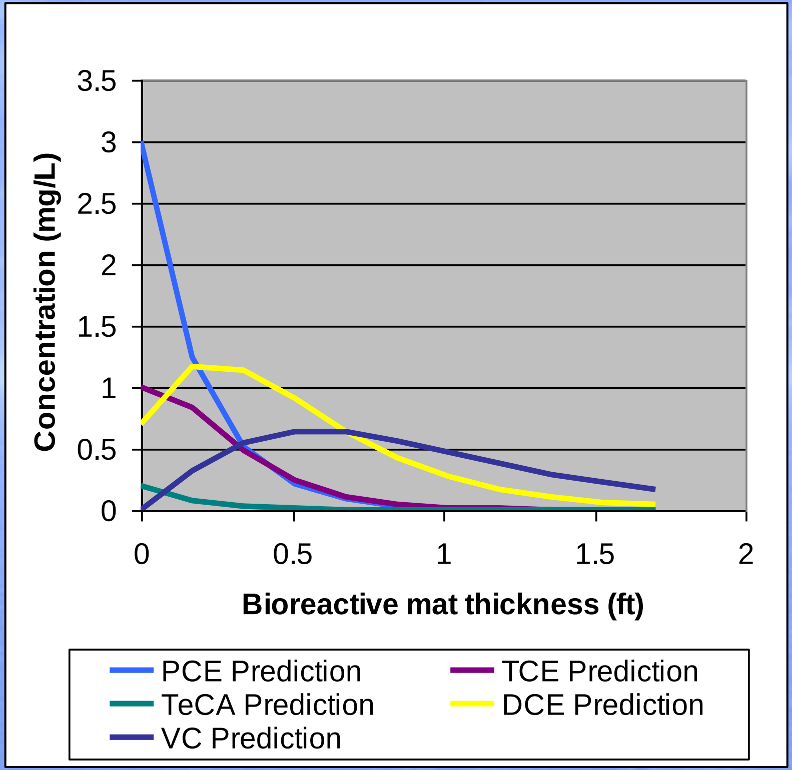


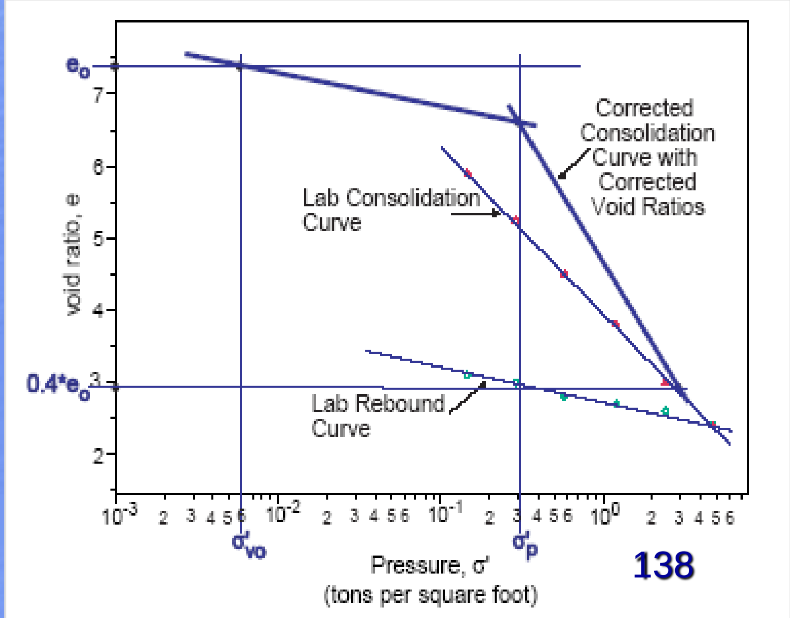
In Situ Treatability Study

- Control - simulates natural conditions
- Biostimulated - provides electron donor
  - Lactate
  - Chitin
- Bioaugmented - provides WBC-2
- Biostimulated and Bioaugmented - electron donor and WBC-2

Bioreactive Mat Design

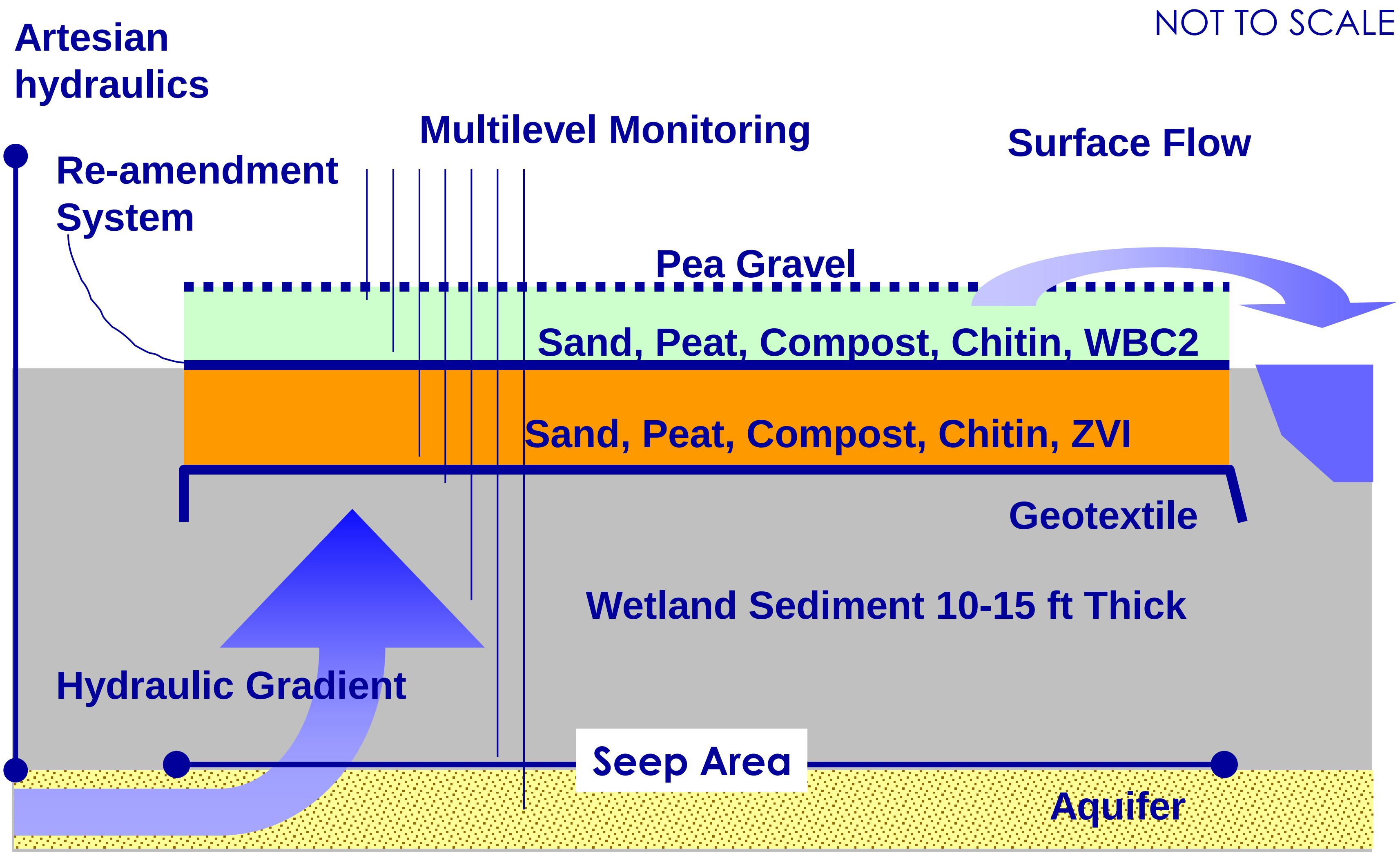
- WBC-2 proves suitably active, effective, and reliable for bioaugmentation
- Engineering issues
  - Mat thickness for >90% VOC removal
  - Shear strength of sediment
  - Compressive strength of sediment and maximum thickness of the mat
  - Mat permeability
  - Installation methods
- Multi-level, multi-parameter monitoring





Reactive Mat Design

1.5 ft thick, keyed 1 ft into sediment



Site Preparation

Sediment Removal

Sediment Removal

Material Placement

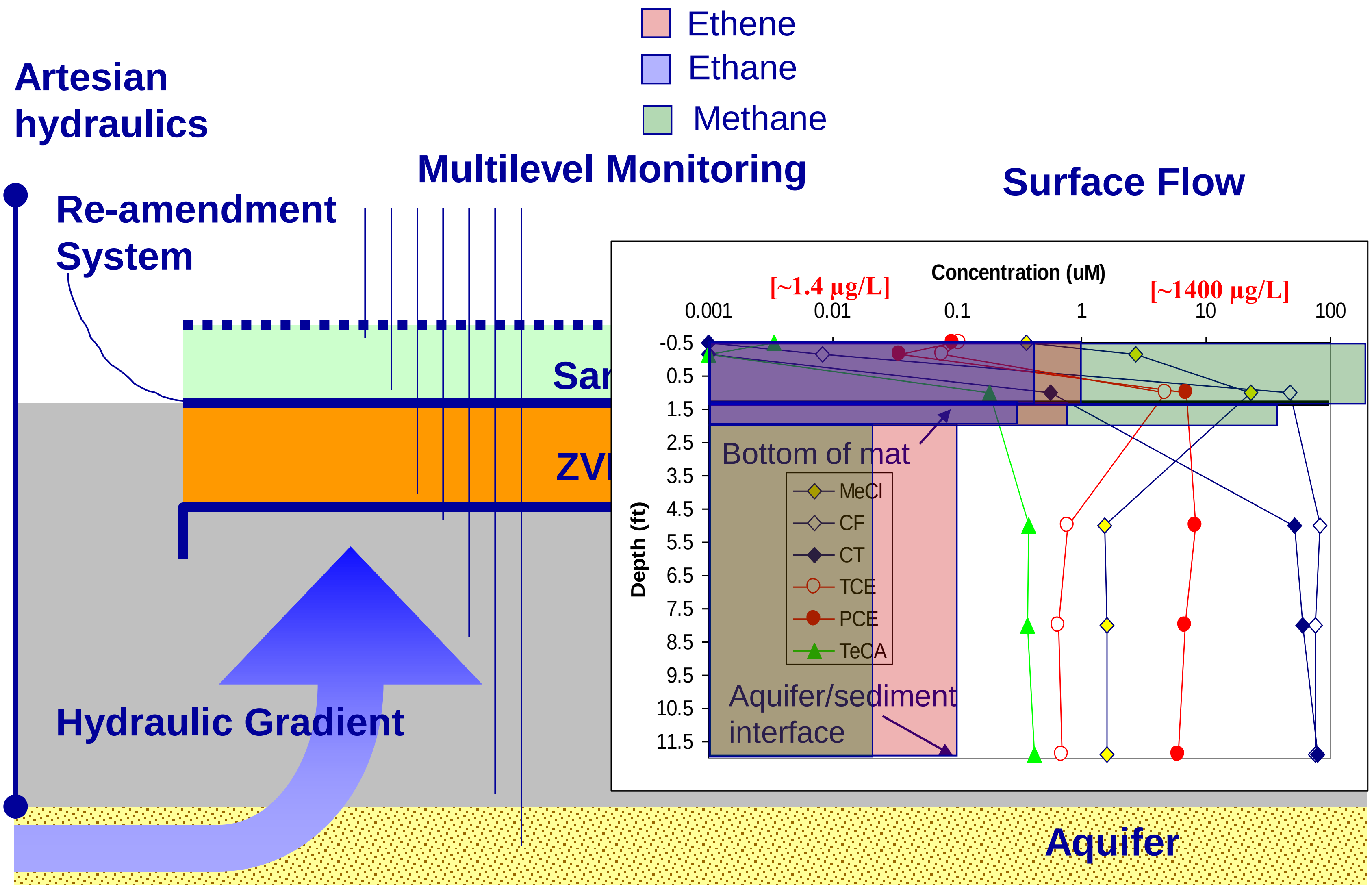
Bioaugmentation

In place – Oct 2004

Shoring removal

May 2005

Reactive Mat Design and Performance



Mass Removal

Date	CE+CA % removal	CM % removal
Nov-2004	99	95
Mar-2005	88	81
Jun-2005	96	99.8
Sep-2005	99	99

Case Study 2: Conclusions

- Successful progression from concept to design to implementation of bioreactive mat in a tidal wetland seep using commercially available materials and WBC-2
- No adverse effects to surface water quality (nutrients, trace metals)
- Minimal initial settlement of materials, stable in environment

Questions?