Superfund Records Center
SITE: Centredale
BREAK: 13.4
OTHER: 273426

**FINAL AGENDA**
**[4/20/07]**

**CENTREDALE DIALOG MEETING #4**
**Radisson Hotel Providence Harbor**
**Bayview Room**
**April 23, 2007**

SDMS DocID 273426

**Meeting goals:**

- Update on site activities since July 2006 meeting
- Update on RI/FS schedule and public outreach and communication activities
- Review new information resulting from the detailed analysis of cleanup alternatives [including screening of the dam removal alternatives]

**10:30 am COFFEE**

**10:45 am Review Agenda**

**11:00 am Update on dam removal alternatives and hydrodynamic model**

- Review results of screening analysis related to dam removal
- Review and discuss questions the planned dam removal hydrodynamic model is designed to answer

**11:30 pm Update on RI/FS schedule and public outreach and communication**

- Review and update EPA's schedule for completing the RI/FS
- Discuss public outreach/communication surrounding completion of the RI/FS

**12:15 LUNCH**

**1:30 pm Update on site activities**

- Review analyses conducted since July 2006 meeting [including groundwater contamination investigation and Oxbow Area studies]
- Questions and discussion

**2:45 pm Review new information from detailed analysis of cleanup alternatives**

- Review detailed analysis of alternatives including monitoring, institutional controls and disposal options

**3:45 pm Review of meeting and next steps**

**4:00 pm ADJOURN**

# Remedial Investigation and Feasibility Study

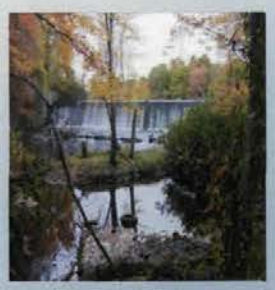
Centredale Manor Restoration Project
North Providence, Rhode Island
April 2007

## Presentation Overview

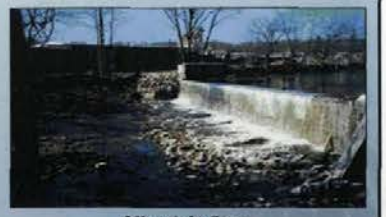
- **Update on Dam Removal Alternatives**
  - Screening analysis of sediment alternatives with dam removal
  - Hydrodynamic model
- **Update on RI/FS Schedule and Public Outreach**
- **Update on Site Activities**
  - Oxbow area studies
  - Groundwater contamination
- **Feasibility Study – New Information**
  - Detailed analysis of alternatives
- **Next Steps**

## Update on Dam Removal Alternatives

- **Screening Analysis of Dam Removal Alternatives**
- **Hydrodynamic Model**



**Lyman Mill Dam**



**Allendale Dam**



## Dam Removal Alternatives Screening Analysis

- **Nine Alternatives were Identified with the Dams in Place and Four were Retained from Screening**
- **Three Additional Alternatives were Identified with the Dams Removed**
  - **Alternative 10** Dam Removal and Isolation Capping
  - **Alternative 11** Dam Removal, Excavation, and Disposal or Treatment
  - **Alternative 12** Dam Removal, Partial Excavation, Isolation Capping, and Disposal or Treatment
- **Alternatives were Evaluated Against Threshold Criteria**
  - **Effectiveness**
    - Short and long term effectiveness in providing protection of human health and the environment
  - **Implementability**
    - Technical and administrative feasibility, including ability to construct, reliably operate, and meet regulations until remedy is complete
  - **Cost**
    - Relative present worth costs accurate to +50% to -30% based on various cost estimating

## Dam Removal Alternatives Screening Analysis

- **ALTERNATIVE 10 – DAM REMOVAL AND ISOLATION CAPPING**
  - **Divert surface water, place multi-layer cap over pond bottom and remove dams**
    - Total cap thickness 4 to 6 ft
    - Three layer cap: sand, gravel, and armor rock
  - **Monitoring**
    - Long-term (cap integrity, sediment and fish monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., prevent excavation, restricted access for utilities, long-term maintenance of cap)



## Dam Removal Alternatives Screening Analysis

- **ALTERNATIVE 11 – DAM REMOVAL, EXCAVATION, AND DISPOSAL OR TREATMENT**
  - **Divert surface water, excavate sediment with chemical concentrations above the RGs throughout entire pond, remove dams, and restore final water body**
    - 150,000 cy removed (less under nearshore CDF option)
    - Water body: river channel and small pond areas, rip-rap placed in areas of high flows
    - Four disposal/treatment options
  - **Monitoring**
    - Long term (periodic sediment and fish monitoring, CDF integrity)
  - **Institutional Controls**
    - Land use controls for CDF (e.g., long-term maintenance of CDF)

## Dam Removal Alternatives Screening Analysis

- **ALTERNATIVE 12 – DAM REMOVAL, PARTIAL EXCAVATION, ISOLATION CAPPING, AND DISPOSAL OR TREATMENT**
  - **Divert surface water, excavate sediment with chemical concentrations above the RGs from targeted areas, place isolation cap over areas not excavated, remove dams, and restore final water body**
    - 60,000 cy removed
    - Water body: small pond areas, engineered river channel
    - Five disposal/treatment options
  - **Monitoring**
    - Long term (sediment monitoring, periodic fish monitoring, cap and/or CDF integrity)
  - **Institutional Controls**
    - Land use controls (e.g., prevent excavation, restricted access for utilities, long-term maintenance of cap/CDF)

## Dam Removal Alternatives Screening Analysis

| | Dam Removal Alternatives | | |
|---|---|---|---|
| | **(10) Isolation Capping** | **(11) Excavation and Disposal or Treatment** | **(12) Partial Excavation, Isolation Capping, and Disposal or Treatment** |
| **Effectiveness** | Low | High | High |
| **Implementability** | Not implementable | Moderate to Difficult | Moderate to Difficult |
| **Cost** | Not applicable | $49M to $145M | $34M to $76M |
| **Monitoring** | Scheduled monitoring and 5-year reviews (perpetuity)<br>Long-term monitoring of cap | Periodic monitoring (support 5-yr reviews)<br>Long-term monitoring of on-site containment facility | Scheduled monitoring and 5-year reviews (perpetuity) |
| **Institutional Controls** | Use restrictions<br>Long-term cap maintenance | Use restrictions and long-term maintenance of on-site containment facility | Use restrictions and long-term maintenance of on-site containment facility, engineered channel and capped floodplain areas |

## Dam Removal Alternatives Hydrodynamic Model

***What Do We Need to do to Further Evaluate the Dam Removal Alternatives?***

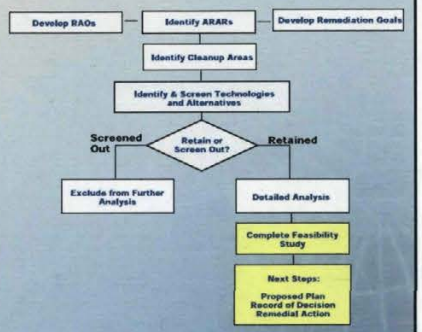
- **Develop Hydrodynamic Model**
  - Better understand system hydrodynamics with dams removed
  - Support design of a stable river channel under a range of flow conditions
  - Evaluate effects of dam removal on hydrodynamics and floodplain inundation under high-flow conditions
  - Estimate potential effect on flood flows downstream of Manton Dam

Not the Woonasquatucket River

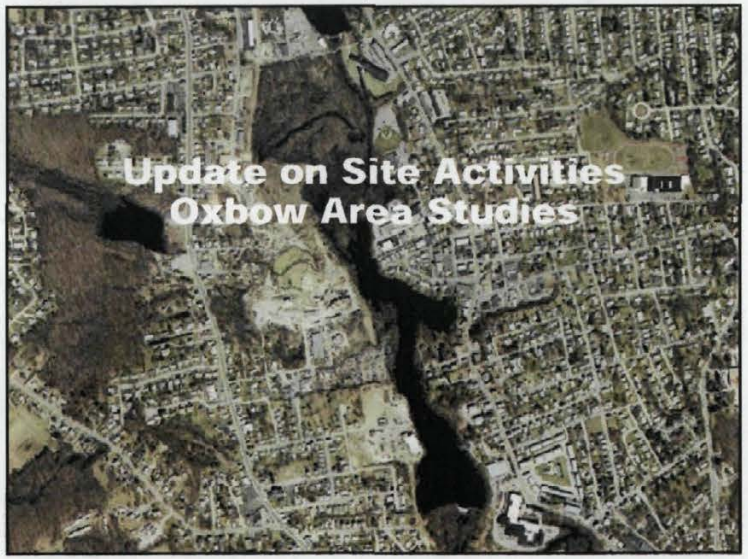


## Update on RI/FS Schedule and Public Outreach

- **Public Meeting, Fall 2007**
  - Detailed Evaluation of Dam Removal Alternatives and Model
- **Feasibility Study Report, Early 2008**
- **Public Meeting, Early 2008**
  - Comparative Analysis of Alternatives and Preview to Proposed Plan
- **Release Proposed Plan to Public, Early 2008**
- **Public Comment/Public Meetings (60-d)**
- **Response to Comment (90-d)**
- **Record of Decision, Summer 2008**






## Feasibility Study Action Areas

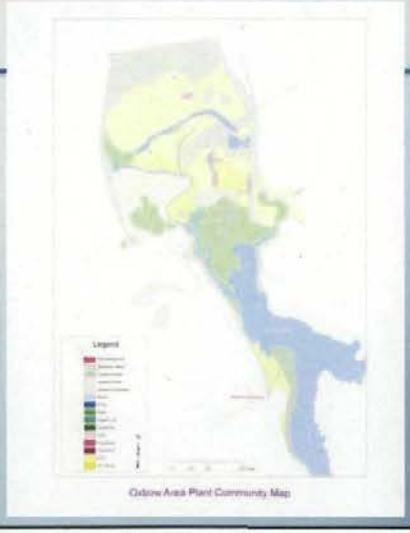
- **The Five Action Areas Being Evaluated in the Feasibility Study Include**
  - Allendale and Lyman Mill Pond Sediment
  - Allendale Floodplain Soil
  - **Lyman Mill Floodplain Soil (including the Oxbow) and Stream Sediment**
  - Source Area Soil
  - Source Area Groundwater

## Oxbow Area Studies

- **Key Questions:**
  - *What are the functions and values of the Oxbow habitat?*
  - *Are the public and wildlife at risk?*
  - *How is EPA going to manage risks at the Oxbow?*
- **Study Components:**
  - Wetland Study
  - Risk Assessment
  - Feasibility Study (FS) update

## ACOE Oxbow Area Wetland Studies

- Review of Site History
- Wetland Delineation
- Plant Community Mapping
- Qualitative Wetlands Functions and Values Assessment (Corps Highway Methodology)



## Functions and Values

- Groundwater Recharge/Discharge
- Floodflow Alteration
- Fish Habitat
- Sediment/Toxicant Retention
- Nutrient Removal
- Production Export
- **Wildlife Habitat**
- Recreation
- Educational/Scientific Value
- Uniqueness/Heritage

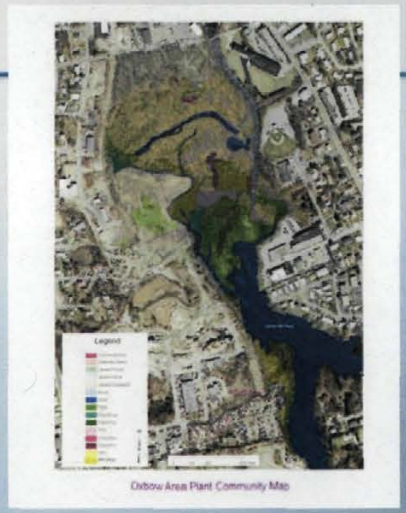


## Wildlife Habitat Considerations

- Significant Size/Uniqueness
- Diverse Plant Communities
- Abundant Food Plants
- Nesting Habitat (waterfowl, songbirds)
- Numerous Snags and Habitat Logs

  (most < 8" diameter)
- Possible Vernal Pools






Oxbow Area Plant Community Map



## Possible Vernal Pools

## Conclusions

Oxbow Area Provides Significant Wildlife Habitat

- Unique Area Along Lower Woonasquatucket
- Significant Size
- Diverse Plant Communities
- Possible Vernal Pools



## Oxbow Risk Assessment

*Are the Public and Wildlife at Risk?*

- **Addendum to Baseline Risk Assessment**
  - Human Health
  - Ecological

## Oxbow Risk Assessment Human Health

*Are Toxic Contaminants Present?*

- Dioxin/furans, PCBs, pesticides, metals

*Who is Exposed? How Often?*

- Local residents and visitors
  - Recreational activities (e.g., hiking)
- Assumed exposure frequencies (maximum 78 d/yr and average 39 d/yr)

*How are People Exposed to Contaminants?*

- Direct contact with wetland soil *during recreational activities*
- Incidental ingestion

## Oxbow Risk Assessment Human Health

*How Toxic are the Chemicals?*

- Used EPA toxicity data to estimate potential non-cancer and cancer health effects at different exposure levels
  - **Non-cancer hazard** is comparison of allowable exposure to amount of exposure estimated at the site (hazard index)
  - **Cancer risk** is the increased probability of getting cancer

*Are there Potential Health Risks?*

- Incremental non-cancer hazards are below EPA's risk range
- Dermal contact with wetland soil at the Oxbow exceeds EPA's cancer risk range (maximum exposure only)
- Primary contributor to risk is **dioxin**

## Oxbow Risk Assessment Ecological

***Are Toxic Contaminants Present Where Animals Live?***

- Dioxin/furans, PCBs, pesticides, metals

***What Animals Are Exposed? How Exposed?***

- Floodplain invertebrates, *amphibians,* birds, and mammals
- Estimated daily exposure to chemicals in soil and food
- Ongoing exposure to chemicals that bioaccumulate in tissue

## Oxbow Risk Assessment Ecological

***How are Wildlife Exposed to Contaminants?***

- Direct contact with wetland soil
- Ingestion of biota (e.g., earthworms)
- Incidental ingestion of wetland soil
- Tissue residues (internal exposure)

***How Toxic are the Chemicals?***

- Site-specific data and EPA toxicity reference values used to assess potential for chemicals to cause harm
  - Comparison of analytical data to soil benchmarks
  - Comparison of estimated earthworm concentrations to tissue benchmarks
  - Comparison of estimated wildlife oral exposures to safe levels



## Oxbow Risk Assessment Ecological

***Are there Potential Ecological Risks?***

- Floodplain soil invertebrates may be at substantial risk of harm based on comparison to conservative benchmarks
  - Exposure to dieldrin, lindane, DDE, DDD and zinc
  - Other measures used in the baseline suggest less potential risk

- Mammal and bird populations that consume worms and insects appear to be at substantial risk of harm
  - Dioxin (2,3,7,8-TCDD) primary contributor to risk
  - Bioaccumulation hazard

- Mammal populations that consume a broad variety of foods do not appear to be at risk

## Oxbow Risk Assessment Conclusions

- **Passive Recreational Visitors and Worm-feeding Mammal and Bird Populations Appear to be At Risk**
  - Primary contributor to risk is dioxin

- **Risk Estimate Uncertainties**
  - Limited data available
  - Potential sampling bias
  - Selected exposures not evaluated (e.g., plants, aquatic receptors)
  - Exposure and habitat assumptions

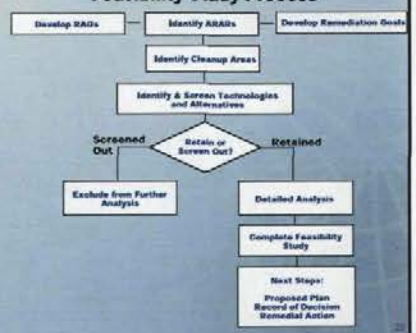
- **Overall Risk Estimates are Conservative**

## Oxbow FS Update

*How is EPA Going to Manage Risks at the Oxbow?*

- **Conduct Feasibility Study (FS)**
  - Develop remedial action objectives
  - Identify potential Applicable or Relevant and Appropriate Requirements (ARARs)
  - Develop remediation goals
  - Identify cleanup areas
  - Identify and evaluate cleanup options

**Feasibility Study Process**






## Oxbow FS Update
## Remedial Action Objectives

**Remedial Action Objectives are designed to:**

- Describe what the remedy is expected to accomplish
- Protect human health and the environment
- Prevent or minimize exposure to and migration of contaminants

***"Eliminate unacceptable risks to human health and the environment***

***Optimize short-term impacts and long-term benefits for animals***

***Minimize potential downstream migration of contaminated sediment or floodplain soil"***



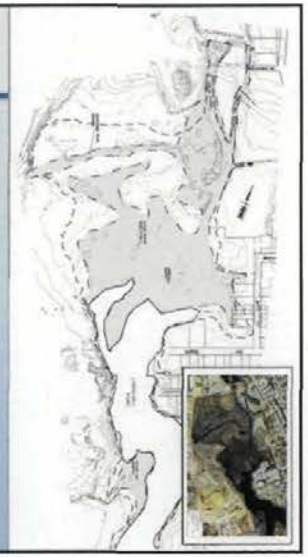
## Oxbow FS Update
## Remediation Goals

- **No Applicable Federal or State Action Levels**
- **Preliminary Remediation Goals (PRGs)**
  - Range of risk values
  - Specific exposure pathways and chemicals of concern
  - Protective of human health and the environment
- **The Remediation Goal (RG) is the Risk-based PRG or Background; Whichever is Higher**
  - Based on background for dioxin, primary contributor to risk



## Oxbow FS Update
## Cleanup Area

- **Compare Site Data to Remediation Goals**
- **Evaluate Area Topography, Vegetation, and Land Use**
- **Balance Ecological Risk-reduction Against Habitat Loss**
- **Identify Areas and Volumes for Cleanup**
  - 17.5 acres
  - 35,000 cubic yards (cy)
  - Excavation depth 1 ft



## Oxbow FS Update
## Screening Analysis

**Six Potential Remedial Alternatives Were Identified:**

- **Alternative 1 No Further Action**
  - No active remediation
- **Alternative 2 Monitored Natural Recovery**
  - Allow natural processes to address contamination and monitor progress
- **Alternative 3 Enhanced Natural Recovery**
  - Apply thin-layer cover to accelerate natural recovery and monitor progress
- **Alternative 4 Excavation with Disposal or Treatment**
  - Remove contaminated material to uniform depth and dispose in containment facility on-site, incinerate on-site, or dispose off-site
- **Alternative 5 Partial Excavation and Enhanced Natural Recovery with Disposal or Treatment**
  - Remove contaminated material to uniform depth at *targeted* areas and dispose, place thin-layer cover over areas not excavated, and monitor progress.
- ***Alternative 6 Limited Excavation and Monitored Natural Recovery with Disposal or Treatment***
  - Remove contaminated material to uniform depth at *targeted* areas and dispose, allow natural processes to address contamination in areas not excavated, and monitor progress



**Key Differences in Action Area:**

- **Mass removal**
- ***Focused excavation* to optimize short-term impacts and long-term benefits to animals**
- **Excavate areas**
  - With highest likelihood of human exposure, and
  - Where contaminant migration is most likely
- **Additional sampling to validate footprint**

## Oxbow FS Update
## Screening Analysis

**Preliminary Remedial Alternatives were Evaluated with Respect to Three Evaluation Criteria**

- **Effectiveness**
  - Short and long term effectiveness in providing protection of human health and the environment
- **Implementability**
  - Technical and administrative feasibility, including ability to construct, reliably operate, and meet regulations until remedy is complete
- **Cost**
  - Relative present worth costs accurate to +50% to -30% based on various cost estimating



## Oxbow FS Update
## Screening Analysis - Results

| | Non-Removal Actions | | |
|---|---|---|---|
| | (1) No Further Action | (2) Monitored Natural Recovery (MNR) | (3) Enhanced Natural Recovery (ENR) |
| Effectiveness | Not effective | Low | Moderate |
| Implementability | Routine | Routine | Routine |
| Cost | $62K | $1.2M | $8M |
| Monitoring | *Periodic monitoring* after severe event | *Scheduled monitoring and* 5-year reviews (perpetuity) | Scheduled monitoring and 5-year reviews (perpetuity)<br>Long-term monitoring of cover |
| Institutional Controls | None | Recreational use restrictions<br>Future use restrictions (e.g., prevent excavation) | Recreational use restrictions<br>Future use restrictions (e.g., prevent excavation)<br>Long-term maintenance of cover |

## Oxbow FS Update
## Screening Analysis - Results

| | Removal Actions *with Disposal or Treatment* | | |
|---|---|---|---|
| | (4) Excavation | (5) Partial Excavation and Enhanced Natural Recovery | (6) Limited Excavation and Monitored Natural Recovery |
| Effectiveness | High | Moderate to High | Moderate |
| Implementability | Moderate | Moderate | Moderate |
| Cost | $14M to $48M | $13M to $34M | $8M to $22M |
| Monitoring | Periodic monitoring (support 5-yr reviews) | Scheduled monitoring and 5-year reviews (perpetuity)<br>Long-term monitoring of cover | Scheduled monitoring and 5-year reviews (perpetuity) |
| Institutional Controls | Future use restrictions (e.g., prevent excavation) | Recreational use restrictions<br>Long-term and future use restrictions to reduce human exposure (e.g., restrict access, prevent excavation)<br>Long-term maintenance of cover | Recreational use restrictions<br>Long-term and future use restrictions to reduce human exposure (e.g., restrict access, prevent excavation) |

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## Oxbow FS Update
## Screening Analysis - Results

| | Disposal or Treatment Options | | |
|---|---|---|---|
| | On-site CDF | On-site Thermal Treatment | Off-site Disposal/Treatment |
| Effectiveness | High | High | High |
| Implementability | Moderate to Difficult | Moderate to Difficult | Moderate to Difficult |
| Cost | Low | Moderate | High |
| Monitoring | Long-term monitoring of CDF | Monitoring during treatment | None |
| Institutional Controls | *Future use restrictions*<br>Long-term maintenance of CDF (e.g., limit size of woody growth on top of CDF) | None | None |

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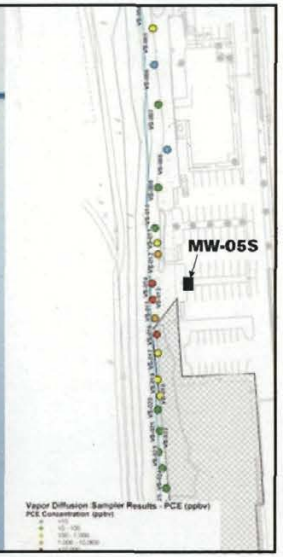
## Groundwater Investigation

- **Key Findings from Remedial Investigation**
  - Localized volatile organic compound (VOC) and dioxin contamination
  - Groundwater from MW-05S has highest concentrations of VOCs and dioxin
  - Plume of VOC-contaminated groundwater discharge to river near MW-05S
  - ***Is contaminated groundwater an ongoing source or migration pathway of dioxin to the river?***
- **Groundwater Investigation**
  - Groundwater flow direction
  - Semi-permeable membrane device (SPMD) study

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## Groundwater Flow Direction

- **Water Level Measurements**
  - 2 surface water locations
  - 23 monitoring wells
  - 14 piezometers
- **Groundwater Flow Direction**
  - Shallow groundwater flow generally to south
  - Elevated water table at MW-05S

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## SPMD Study

- **What is an SPMD?**
  - Semi-permeable membrane device
  - Low density polyethylene tubing containing a thin film of a pure, high-molecular weight lipid
- **How are they Used?**
  - Mimic biological systems
  - Measure bioavailable pollutants that partition across the membrane

http://www.est-lab.com/spmd.php

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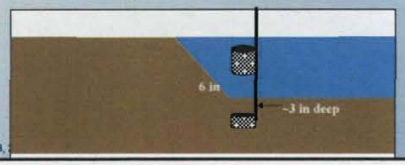
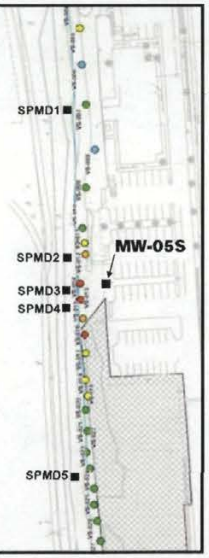
## SPMD Study – Design

- **SPMDs Deployed at 6 Locations**
  - 1 SPMD in groundwater at MW-05S
  - 5 SPMDs in river
  - Zone influenced by groundwater plume
- **Co-located Sediments Sampled**
- **Groundwater Sampled at MW-05S**
- **Chemical Testing**
- **Estimated Concentrations in Surrounding Water Using SPMDs**

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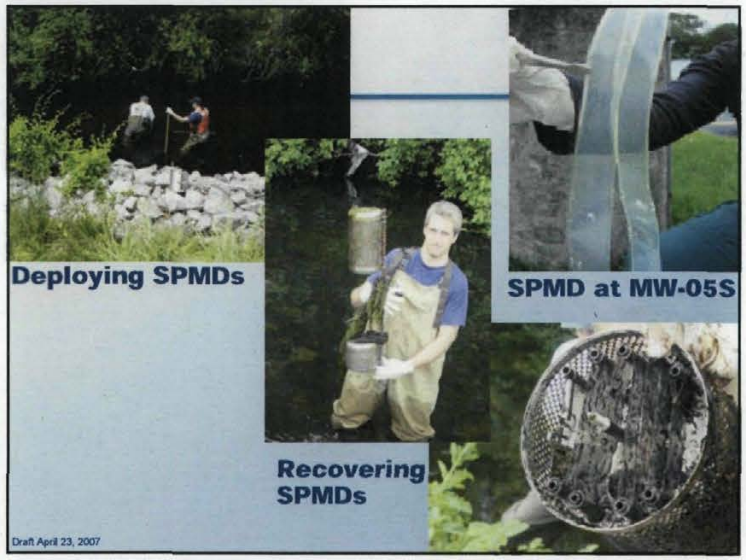


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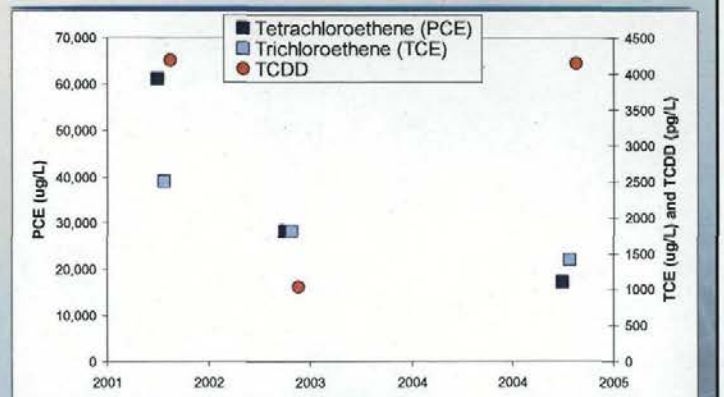
## SPMD Study – Measured Groundwater Results




**RIDEM Groundwater Objectivies**
PCE = 150 ug/L
TCE = 540 ug/L

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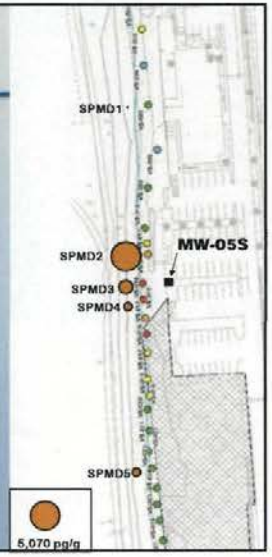
## SPMD Study – Measured Sediment Results

- **Concentrations of 2,3,7,8-TCDD (pg/g) Measured in River Sediments:**
  - Lowest concentration in upstream sediment (SPMD1)
  - Higher concentrations in sediment located in vicinity of groundwater plume (SPMD2 and SPMD3)
  - *Concentrations decrease farther downstream*
  - Sediments were consistently 'coarse sand' along river bank

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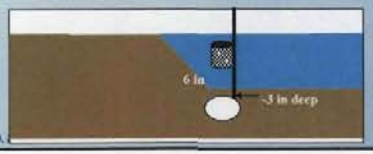
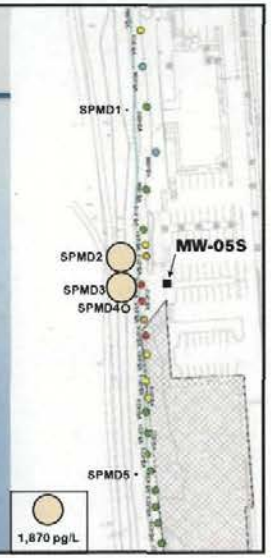
## SPMD Study – Buried Sediment SPMD Results

- **Estimated Concentrations (pg/L) of 2,3,7,8-TCDD in Groundwater/ Pore water Based on SPMDs Buried in River Sediments:**
  - TCDD was sampled by the SPMD
  - Lowest concentration in upstream sediment (SPMD1)
  - Highest concentrations at SPMD2 and SPMD3, two locations expected to be most influenced by groundwater plume
  - Concentrations decrease farther downstream

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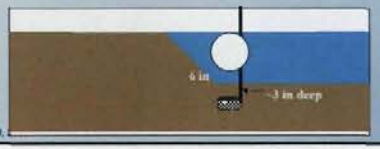
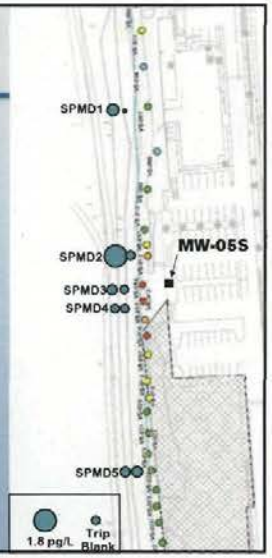
## SPMD Study – River Water SPMD Results

- **Estimated Concentrations (pg/L) of 2,3,7,8-TCDD in Surface Water Based on SPMDs Deployed in the Water Column:**
  - Concentrations in river were generally low, except at SPMD2 (one replicate)
  - Trip blank contained low levels of TCDD, indicating high efficiency of SPMDs for capturing contaminants
  - TCDD signal in river was not evident, consistent with significant dilution and rapid river flow

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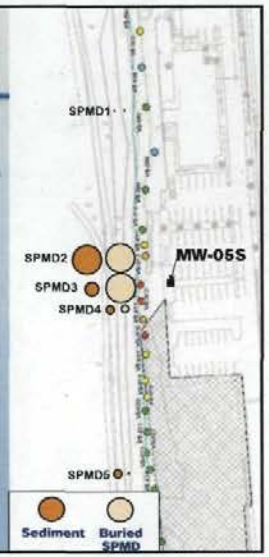
## SPMD Study Conclusions

- **Potential Sources of TCDD to the River**
  - Pore water associated with contaminated sediment
  - Contaminated groundwater flowing through sediment
- **Contaminated Sediments Likely Not Primary Source**
  - Uniformly sandy characteristics of river sediment
  - Similar patterns in sediment and buried SPMD data except at SPMD3
- ***Contaminated Groundwater Is Likely Ongoing Source or Migration Pathway of TCDD to the River***

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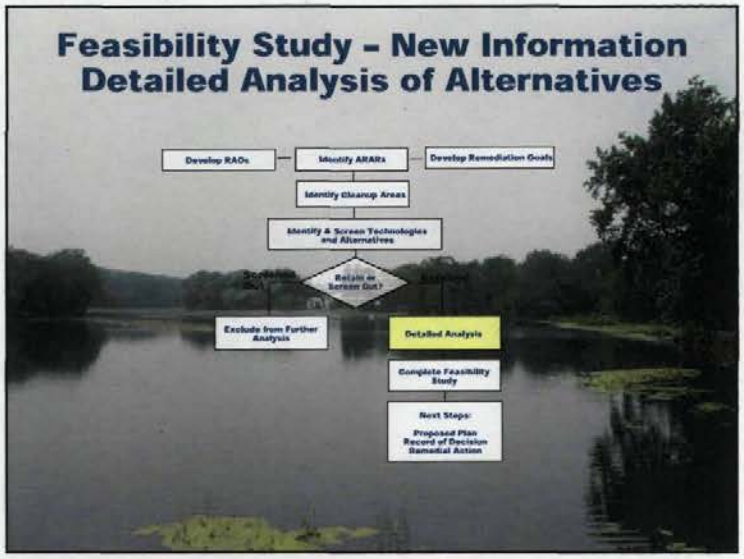
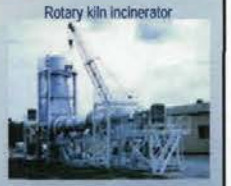
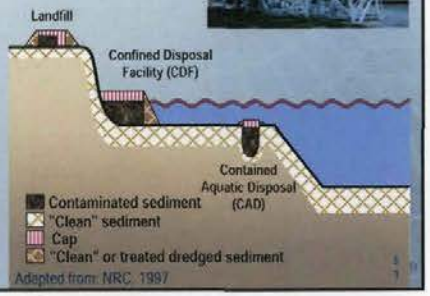
## Feasibility Study - New Information Detailed Analysis of Alternatives




## Response Actions Considered

- **Institutional Controls**
  - Permits, use restrictions
- **Non-removal Actions**
- **Removal Actions**
- **Dewatering**
- **Treatment**
  - Incineration, chemical treatment
- **Disposal**
  - On-site confinement
  - On-site thermal
  - Off-site disposal or treatment




Adapted from: NRC, 1997

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## Retained Alternatives Were Evaluated Against NCP Criteria

- **Overall Protection of Human Health and the Environment**
  - Elimination, reduction, and/or control of site risks
- **Compliance with ARARs**
  - Ability to meet Federal, State, and/or Local ARARs
- **Long-term Effectiveness and Permanence**
  - Residual risk after completion of remedy
- **Reduction of Toxicity, Mobility and Volume Through Treatment**
- **Short-term Effectiveness**
  - Effects to community, site workers, and/or environment during construction/implementation
- **Implementability**
  - Technical and administrative feasibility including potential technical difficulties, reliability, and availability of necessary goods and services
- **Cost**
- ***State Acceptance***
  - Issues and concerns of the regulatory agencies to be addressed in the ROD
- ***Community Acceptance***
  - Public issues and concerns to be addressed in the Record of Decision (ROD)

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## Feasibility Study Action Areas

- **The Five Action Areas Evaluated in the Feasibility Study Include**
  - Allendale and Lyman Mill Pond Sediment
  - Allendale Floodplain Soil
  - Lyman Mill Floodplain Soil (including the Oxbow) and Stream Sediment
  - Source Area Soil
  - Source Area Groundwater



## Allendale and Lyman Mill Pond Sediment Alternatives

**Four of the Remedial Alternatives were Retained for Further Evaluation**

- **Alternative 1** No Further Action
- **Alternative 5** Isolation Capping
- **Alternative 7** Excavation and Disposal or Treatment
- **Alternative 9** Partial Excavation, Isolation Capping and Disposal or Treatment

## Allendale and Lyman Mill Pond Sediment Alternatives

- ALTERNATIVE 1 – NO FURTHER ACTION
  - **No active remediation**
  - **Monitoring**
    - Periodic monitoring to support five-year reviews
  - **Institutional Controls**
    - RIDOH could maintain fishing advisory



## Allendale and Lyman Mill Pond Sediment Alternatives

- ALTERNATIVE 5 – ISOLATION CAPPING
  - **Place 2 ft thick sand cap over entire pond bottom using shallow draft water-based equipment**
    - 1 ft isolation layer overlain by 1 ft erosion control/habitat layer
    - Top layer designed for 100-yr flood (cobble or coarse gravel at upstream inlets)
    - 190,000 tons of cap material
  - **Monitoring**
    - Design (water depth)
    - Construction quality control (water quality monitoring, post-cap confirmation)
    - Long-term (cap integrity, water/sediment/fish monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., prevent excavation, restricted access for utilities, long-term maintenance of cap)

## Allendale and Lyman Mill Pond Sediment Alternatives

- **ALTERNATIVE 7 – EXCAVATION AND DISPOSAL OR TREATMENT**
  - **Lower water levels and excavate sediment with chemical concentrations above the RGs**
    - Maximum depth 4 ft; avg depth 2.1 ft Allendale and 2.6 ft at Lyman Mill
    - 150,000 cy removed
    - Post-excavation cap if RGs not achieved
  - **Dewatering (mechanical)**
    - 2 to 3 acres for equipment and sediment stockpiles
  - **Monitoring**
    - Design (sediment cores)
    - Construction quality control (water quality, post-excavation confirmation sampling)
    - Long term (periodic water/sediment/fish monitoring)
  - **Institutional Controls**
    - Land use controls for CDF (e.g., long-term maintenance of CDF)

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## Allendale and Lyman Mill Pond Sediment Alternatives

- **ALTERNATIVE 9 – PARTIAL EXCAVATION, ISOLATION CAPPING, AND DISPOSAL OR TREATMENT**
  - **Lower water levels, excavate top 2 ft at targeted areas, and place 2 ft thick sand cap over entire pond**
    - 60,000 cy removed
    - 190,000 tons cap material
  - **Dewatering (mechanical)**
    - 2 to 3 acres for equipment and sediment stockpiles
  - **Monitoring**
    - Design (water depth)
    - Construction quality control (water quality monitoring, post-cap confirmation)
    - Long-term (cap integrity, water/sediment/ fish monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., prevent excavation, restricted access for utilities, long-term maintenance of cap)

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## Allendale and Lyman Mill Pond Sediment Alternatives Detailed Analysis Results

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | (1) No Further Action | (5) Isolation Capping | (7) Excavation and Disposal or Treatment | (9) Partial Excavation, Isolation Capping, and Disposal or Treatment |
| Overall Protection of Human Health and the Environment | Not effective | Moderate | High | Moderate |
| Compliance with ARARs | High | Moderate | High | High |
| Long-term Effectiveness and Permanence | Not effective | Moderate | Moderate to High | Moderate |
| Reduction of Toxicity, Mobility, or Volume through Treatment | Not effective | Not effective | Not effective | Not effective |
| Short-term Effectiveness | High | Low | Low | Low |
| Implementability | Routine | Moderate | Moderate to Difficult | Moderate to Difficult |
| Cost | $340K | $23M | $44M to $107M | $37M to $62M |
| Implementation Time | Not applicable | 12 months | 18 months | 16 months |

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## Allendale Floodplain Soil Alternatives

**Two of the Remedial Alternatives were Retained for Further Evaluation**

- **Alternative 1** No Further Action
- **Alternative 5** Excavation and Disposal or Treatment

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## Allendale Floodplain Soil Alternatives

- **ALTERNATIVE 1 – NO FURTHER ACTION**
  - **No active remediation**
  - **Monitoring**
    - Periodic monitoring to support five-year reviews (conducted in conjunction with pond sediment)
  - **Institutional Controls**
    - ICs not component of remedy



## Allendale Floodplain Soil Alternatives

- **ALTERNATIVE 5 – EXCAVATION AND DISPOSAL OR TREATMENT**
  - **Excavate top 1 ft in areas that provide ecological floodplain habitat, backfill with clean material, and restore floodplain habitat**
    - 3,700 cy removed
  - **Monitoring**
    - Design (floodplain survey)
    - Construction quality control (air and noise monitoring, post-excavation confirmation sampling)
  - **Institutional Controls**
    - No use restrictions anticipated

## Allendale Floodplain Soil Alternatives Detailed Analysis Results

| Criteria | Alternative | |
|---|---|---|
| | (1) No Further Action | (5) Excavation and Disposal or Treatment |
| Overall Protection of Human Health and the Environment | Not effective | High |
| Compliance with ARARs | High | High |
| Long-term Effectiveness and Permanence | Not effective | High |
| Reduction of Toxicity, Mobility, or Volume through Treatment | Not effective | Not effective |
| Short-term Effectiveness | High | Low |
| Implementability | Routine | Moderate to Difficult |
| Cost | $0K | $1.4M to $6M |
| Implementation Time | Not applicable | 1 month |



## Lyman Mill Floodplain Soil (Oxbow) and Stream Sediment Alternatives

**Four of the Remedial Alternatives were Retained for Further Evaluation**

- **Alternative 1** No Further Action
- **Alternative 3** Enhanced Natural Recovery
- **Alternative 5** Partial Excavation, Enhanced Natural Recovery, and Disposal or Treatment
- **Alternative 6** Limited Excavation, Monitored Natural Recovery, and Disposal or Treatment

## Lyman Mill Floodplain Soil (Oxbow) and Stream Sediment Alternatives

- ALTERNATIVE 1 – NO FURTHER ACTION
  - **No active remediation**
  - **Monitoring**
    - Periodic monitoring to support five-year reviews
  - **Institutional Controls**
    - ICs not component of remedy



## Lyman Mill Floodplain Soil (Oxbow) and Stream Sediment Alternatives

- ALTERNATIVE 3 – ENHANCED NATURAL RECOVERY
  - **Place thin-layer cover (3 inches thick) over entire area using a broadcast or spraying technique**
    - Apply during dormant season
    - 10,600 tons of cover material
    - Consider water flow control structures
  - **Monitoring**
    - Design (sediment/soil sampling)
    - Construction quality control (air and noise monitoring, confirmation of cover placement)
    - Long-term (cover integrity, sediment/soil/ biota monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., access restrictions, prevent excavation, long-term maintenance of cover)

## Lyman Mill Floodplain Soil (Oxbow) and Stream Sediment Alternatives

- ALTERNATIVE 5 – PARTIAL EXCAVATION, ENHANCED NATURAL RECOVERY, AND DISPOSAL OR TREATMENT
  - **Excavate top 1 ft at targeted areas, backfill, place thin-layer cover over remaining area, and restore habitat**
    - 23,000 cy removed
    - 3,700 tons cover material
  - **Monitoring**
    - Design (sediment/soil sampling)
    - Construction quality control (air and noise monitoring, confirmation of cover placement)
    - Long-term (cover integrity, sediment/soil/ biota monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., access restrictions, prevent excavation, long-term maintenance of cover)

## Lyman Mill Floodplain Soil (Oxbow) and Stream Sediment Alternatives

- ALTERNATIVE 6 – LIMITED EXCAVATION, MONITORED NATURAL RECOVERY, AND DISPOSAL OR TREATMENT
  - **Excavate top 1 ft at targeted areas, backfill, and restore habitat**
    - 14,000 cy removed
  - **Monitoring**
    - Design (sediment/soil sampling)
    - Construction quality control (air and noise monitoring, confirmation of backfill placement)
    - Long-term (sediment/soil/biota monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., access restrictions, prevent excavation)

## Lyman Mill Floodplain Soil (Oxbow) and Stream Sediment Alternatives Detailed Analysis Results

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | (1) No Further Action | (3) Enhanced Natural Recovery | (5) Partial Excavation, ENR, and Disposal or Treatment | (6) Limited Excavation, MNR, and Disposal or Treatment |
| Overall Protection of Human Health and the Environment | Not effective | Low | Moderate | Moderate |
| Compliance with ARARs | High | High | High | High |
| Long-term Effectiveness and Permanence | Not effective | Moderate | High | Moderate to High |
| Reduction of Toxicity, Mobility, or Volume through Treatment | Not effective | Not effective | Not effective | Not effective |
| Short-term Effectiveness | High | Moderate | Low | Moderate |
| Implementability | Routine | Moderate | Moderate to Difficult | Moderate to Difficult |
| Cost | $220K | $4M | $13 to $31M | $8M to $20M |
| Implementation Time | Not applicable | 4 months | 10 months | 6 months |



## Source Area Soil Alternatives

**Three of the Remedial Alternatives were Retained for Further Evaluation**

- **Alternative 1** No Further Action
- **Alternative 2** Upgrade and Maintain Existing Caps and Parking Lots
- **Alternative 3** Convert to RCRA Caps and Maintain

## Source Area Soil Alternatives

- **ALTERNATIVE 1 – NO FURTHER ACTION**
  - **No active remediation**
  - **Monitoring**
    - Periodic monitoring to support five-year reviews
  - **Institutional Controls**
    - ICs not component of remedy

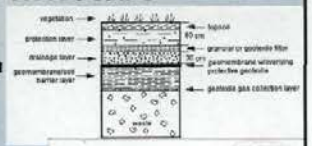


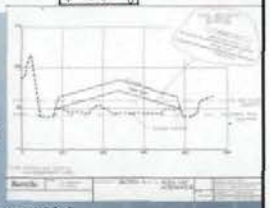
## Source Area Soil Alternatives

- **ALTERNATIVE 2 – UPGRADE AND MAINTAIN EXISTING CAPS AND PARKING LOTS**
  - **Upgrade existing soil covers**
    - Remove existing vegetation
    - Import sand/gravel soil and regrade to 3% slope
    - Cover with topsoil and hydro-seed
  - **Upgrade parking lot areas**
    - Place asphalt sealant over entire parking lot areas
  - **Monitoring**
    - Construction quality control (air and noise monitoring)
    - Long term (cap integrity)
  - **Institutional Controls**
    - Land use controls (e.g., prohibit excavation, restrict access for buried utilities, maintenance of caps and parking lots)

## Source Area Soil Alternatives

- **ALTERNATIVE 3 – CONVERT TO RCRA CAPS AND MAINTAIN**
  - **Convert existing soil covers and parking lots to RCRA cover system**
    - Remove vegetation, asphalt, and regrade to 3% slope
    - Replace topsoil and grass with gravel and asphalt in paved areas
    - Total cover thickness 24-30 inches over geomembrane layer
    - Relocate utilities to 'clean 'corridor'
  - **Monitoring**
    - Construction quality control (air and noise)
    - Long term (cap integrity)
  - **Institutional Controls**
    - Land use controls (e.g., prohibit excavation, restrict access for buried utilities, maintenance of caps and parking lots)





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## Source Area Soil Alternatives Detailed Analysis Results

| Criteria | Alternative | | |
|---|---|---|---|
| | (1) No Further Action | (2) Upgrade and Maintain Existing Caps and Parking Lots | (3) Convert to RCRA Caps and Maintain |
| Overall Protection of Human Health and the Environment | Moderate | High | High |
| Compliance with ARARs | High | High | High |
| Long-term Effectiveness and Permanence | Low | High | High |
| Reduction of Toxicity, Mobility, or Volume through Treatment | Not Effective | Not Effective | Not Effective |
| Short-term Effectiveness | High | Moderate | Moderate |
| Implementability | Routine | Routine | Routine |
| Cost | $150K | $4M | $9M |
| Implementation Time | Not applicable | 4 months | 6 months |

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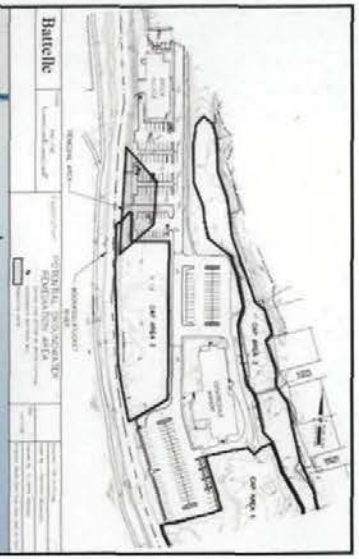
## Groundwater Alternatives

**Five of the Remedial Alternatives were Retained for Further Evaluation**

- **Alternative 1** No Further Action
- **Alternative 2** Excavate/Dewater
- **Alternative 3a** Hydraulic Containment Barrier
- **Alternative 4** Passive Reactive Barrier (Biowall)
- **Alternative 5** In-situ Chemical Oxidation

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## Groundwater Alternatives

- **ALTERNATIVE 1 – NO FURTHER ACTION**
  - **No active remediation**
  - **Monitoring**
    - Periodic monitoring to support five-year reviews (conducted in conjunction with source area soil)
  - **Institutional Controls**
    - ICs not component of remedy

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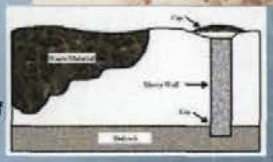
## Groundwater Alternatives

- **ALTERNATIVE 2 – EXCAVATE/DEWATER**
  - **Focused excavation to ~4 ft at VOC/dioxin impacted area**
    - Approximately 3,400 cy removed and disposed off-site
  - **Dewatering**
    - Approximately 40,000 gal extracted groundwater treated and discharged
  - **Monitoring**
    - Design (soil borings and analysis)
    - Construction quality control (air and noise monitoring; water and soil characterization)
  - **Institutional Controls**
    - No future use restrictions anticipated

## Groundwater Alternatives

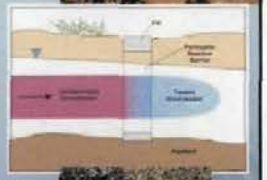
- **ALTERNATIVE 3a – HYDRAULIC CONTAINMENT BARRIER**
  - **Install steel sheet piling completely around impacted area under Brook Village parking lot to prevent groundwater flow to river**
    - Approximately 60 feet deep and 600 ft circumference
    - Place surface cover to prevent water infiltration
    - Install piezometers
  - **Monitoring**
    - Construction quality control (air and noise monitoring)
    - Long term (GW elevations)
  - **Institutional Controls**
    - Land use controls (e.g., maintenance of barrier and surface cover)





## Groundwater Alternatives

- **ALTERNATIVE 4 – PASSIVE REACTIVE BARRIER (BIOWALL)**
  - **Excavate soil and install biowall along impacted area to prevent migration of contaminants in groundwater to river**
    - Biowall comprised of plant material, compost, and coarse sand or river rock
    - 30 ft deep, 3 ft thick, 230 ft long
    - 300 cy soil disposed off-site
    - Install groundwater monitoring wells
  - **Monitoring**
    - Design (feasibility testing)
    - Construction quality control (air and noise; soil characterization)
    - Long term (groundwater monitoring)
  - **Institutional Controls**
    - Land use controls (e.g., maintenance of biowall)



## Groundwater Alternatives

- **ALTERNATIVE 5 – IN-SITU CHEMICAL OXIDATION**
  - **Inject hydrogen peroxide using Cool-Ox™ process into groundwater at impacted area in Brook Village parking lot**
    - Treated area 60 ft by 160 ft and 12 ft deep; injections at 5 ft intervals
    - Chemical destruction of VOCs; effective oxidation of dioxin also demonstrated (Lundy, 2005)
  - **Monitoring**
    - Construction (noise monitoring)
    - Long term (periodic monitoring to support 5-yr reviews)
  - **Institutional Controls**
    - Land use controls (e.g., restrict future site use of groundwater)

## Groundwater Alternatives Detailed Analysis Results

| Criteria | Alternative | | | | |
|---|---|---|---|---|---|
| | (1) No Further Action | (2) Excavate/ Dewater | (3a) Hydraulic Containment Barrier | (4) Passive Reactive Barrier | (5) In-situ Chemical Oxidation |
| Overall Protection of Human Health and the Environment | Low | High | Moderate | Moderate | High |
| Compliance with ARARs | Low | High | High | High | Moderate |
| Long-term Effectiveness and Permanence | Low | High | Moderate | Moderate | Moderate |
| Reduction of Toxicity, Mobility, or Volume through Treatment | Not Effective | Low | Not Effective | Moderate | High |
| Short-term Effectiveness | High | Moderate | Moderate | Moderate | High |
| Implementability | Routine | Moderate | Moderate | Moderate | Routine |
| Cost | $0 | $2.2M | $1.9M | $1.8M | $1.2M |
| Implementation Time | Not applicable | 18 months | 18 months | 18 months | 12 months |

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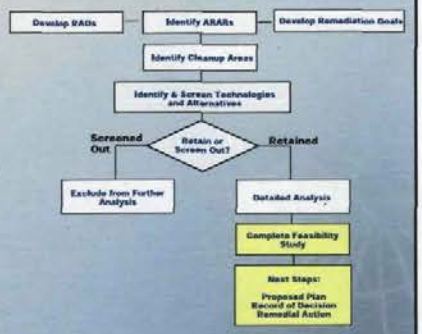
## Next Steps - RI/FS Schedule and Public Outreach

- **Public Meeting, Fall 2007**
  - Detailed Evaluation of Dam Removal Alternatives and Model
- **Feasibility Study Report, Early 2008**
- **Public Meeting, Early 2008**
  - Comparative Analysis of Alternatives and Preview to Proposed Plan
- **Release Proposed Plan to Public, Early 2008**
- **Public Comment/Public Meetings (60-d)**
- **Response to Comment (90-d)**
- **Record of Decision, Summer 2008**

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# ACOE Oxbow Area Wetland Studies

- Review of Site History
- Wetland Delineation
- Plant Community Mapping
- Qualitative Wetlands Functions and Values Assessment (Corps Highway Methodology)

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# Site History

1894 USGS Topo

1939 USGS Topo

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1939 Aerial Photo

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Areas Filled Since 1939

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## Methods - Wetland Delineation

- ACOE 3-parameter approach
  - soils
  - vegetation
  - hydrology
- Distinct Topographical Boundary in Most Areas

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## Methods- Plant Community Mapping and Vegetation Studies

- Aerial Photo Interpretation
  (2003 black and white stereo imagery)
- Field Verification of Community Maps
- Plant Community Composition
  - Meander Surveys
  - Plot Studies
  - Limited data for spring flora

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## Methods Wetland Functions and Values

- ACOE Highway Methodology
- Qualitative Wildlife Habitat Evaluation

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Oxbow Area Plant Community Map

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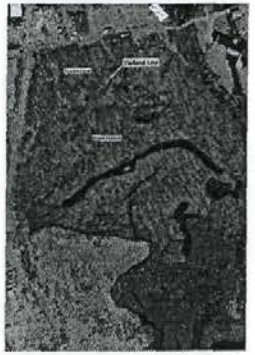
## Problem Areas

- Disturbed or Atypical Soils
  - Northern Boundary & Upland "Islands"
- Wetland Line in Problem Areas is Conservative (vegetation based)



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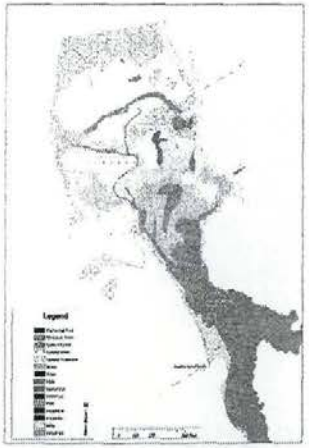

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Oxbow Area Plant Community Map

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## Wetland Plant Communities

- Forested
  - Red Maple
  - White Oak
  - Northern Arrowood
  - Highbush Blueberry
  - Winterberry
  - Glossy Buckthorn

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## Wetland Plant Communities

- Forested/Shrub
  - Red Maple
  - Northern Arrowood
  - Highbush Blueberry
  - Winterberry
  - Red Osier Dogwood
  - Glossy Buckthorn
  - Cinnamon Fern
  - Royal Fern

## Wetland Plant Communities

- Emergent
  - Purple Loosestrife
  - Swamp Loosestrife
  - Swamp Rose
  - Smartweeds
  - Morning Glory
  - Arrowhead

## Invasives

- Oriental Knotweed
- Oriental Bittersweet
- Purple Loosestrife
- Glossy Buckthorn
- Tree of Heaven
- Bush Honeysuckle
- Phragmites
- Japanese Barberry
- Garlic Mustard



## Possible Vernal Pools

## Functions and Values

- Groundwater Recharge/Discharge
- **Floodflow Alteration**
- **Fish Habitat**
- Sediment/Toxicant Retention
- Nutrient Removal
- Production Export
- **Wildlife Habitat**
- **Recreation**
- Educational/Scientific Value
- Uniqueness/Heritage



## Floodflow Alteration

## Fish Habitat

## Wildlife Habitat Considerations

- Significant Size/Uniqueness
- Diverse Plant Communities
- Abundant Food Plants
- Nesting Habitat (waterfowl, songbirds)
- Numerous Snags and Habitat Logs (most < 8" diameter)
- Possible Vernal Pools

## Recreation

- Some Trails Present
- Evidence of Fishing
- Off Road Vehicles Use
- No Hunting Permitted in Johnston
- Access to Emergent & Shrub Wetlands Very Limited by Soft Soils



## Conclusions

Oxbow Area Provides Significant Wildlife Habitat

- Unique Area Along Lower Woonasquatucket
- Significant Size
- Diverse Plant Communities
- Possible Vernal Pools