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Special Acknowledgements

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Technical Requirements for Site Remediation, N.J.A.C. 7:26E

- Readopted December 17, 2002
- Last Amended February 22, 2011
- Reproposed August 15, 2011

Use the *Ecological Evaluation Technical Guidance, August 2011,* NOW!

Document review process for the LSRP Program

- **Ecological Evaluations (as part of SI/RI) and Ecological Risk Assessments (as part of RI)**
  - **Submitted to the Case Assignment**
  - **Inspection and review process**
  - **Component review by technical support staff and direct coordination with LSRP (if needed)**
- **Site-specific risk-based remediation goals and risk management decision goals require Department approval**

Training Session Outline

- 2.0 Purpose
- 3.0 Document Overview
- 5.0 Technical Guidance for the Preparation of Ecological Evaluations
- 6.0 Technical Guidance for the Preparation of Ecological Risk Assessments
- 7.0 Determination of Ecological Risk-Based Remediation Goals
- 8.0 Uncertainty
- 9.0 Risk Management Considerations

2.0 Purpose

To provide guidance on how to conduct evaluations in environmentally sensitive natural resources (ESNRs)

- Ecological Evaluation (EE) –To enable the decision for NFA or ERA
- Ecological Risk Assessment (ERA)- To verify risk and provide data to determine site-specific ecological risk-based remediation goals and risk management decisions (RMDs)

3.0 Document Overview

- **How to Prepare Ecological Evaluations:**

  (1) examine the site for the co-occurrence of ESNRs, COPECs, contaminant migration pathways

  (2) compare data with ecological screening criteria

  (3) comparison with background contaminant levels

  (4) NFA vs ERA

  (5) How to write EE report

- **How to prepare Ecological Risk Assessments:**

  (1) Risk characterization based on multiple lines of evidence

  (2) Data development including rigorous biological tests

  (3) Provide data needed to determine site-specific risk-based remediation goals and RMDs.

  (4) How to write ERA report

3.0 Document Overview (con't)

- Guidance for special circumstances
  - Wetlands, Estuaries, PCB Aroclors vs congeners, Dioxin TEQ approach
- How to develop ecological risk based remediation goals
- How to develop risk management decisions (RMD)
- Technical Appendices


Questions?

ECOLOGICAL EVALUATIONS

Chapter 5

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Technical Requirements for Site Remediation, N.J.A.C. 7:26E

Applicable to *all sites* in SRP

- Receptor Evaluation (N.J.A.C. 7:26E-1.19)
- Site Investigation-Ecological Evaluation (N.J.A.C.7:26E-3.11)
- Remedial Investigation of Ecological Receptors (N.J.A.C.7:26E-4.7)

Ecological Evaluation - 3 Parts

Identify

1) Environmentally sensitive natural resources (ESNRs) (i.e., 7:1E-1.8 and Pinelands)

2) Contaminants of potential ecological concern (COPEC) (site related)

3) Potential contaminant migration pathways to environmentally sensitive natural resources

Ecological Evaluation - 3 Parts

Current Tech Regs

- COPECs – During SI
- ESNRs – During SI
- Migration Pathways – – During SI

Proposed Tech Regs /Guidance Document

- COPECs – During SI
- ESNRs – During SI
- Migration Pathways – During RI

Evaluate Data

Current Tech Regs

- Draw conclusions from data gathered in answering the three questions/ conditions in SI.

Proposed Tech Regs /Guidance Document

- Draw conclusions from data gathered in answering the two questions/conditions within SI. NFA if either is absent.
- Migration Pathways in RI.

Evaluate Data

Current Tech Regs

- If **ALL** three conditions are met, then in accordance with NJAC 7:26E-3.11, further evaluation is required.

Proposed Tech Regs /Guidance Document

- If **ALL** three conditions are met , then in accordance with NJAC 7:26E-1.16, 4.8, further evaluation is required.

Evaluate Data

- **IMPORTANT –** If ALL three conditions are not present, then NFA. Otherwise the investigation will proceed to NJAC 7:26E-4.7 (4.8)
- A written concise summary documenting the findings of the Ecological Evaluation is required in accordance with NJAC 7:26E-3.11 (1.16, 4.8)

5.2.1 Environmentally Sensitive Natural Resources

- **Identify areas on-site, adjacent to the site, or under potential influence of the site in any manner**
  - **Reference: N.J.A.C. 7:1E-1.8: Discharge of Petroleum and Other Hazardous Substances (not intended to be all inclusive) http://www.nj.gov/dep/rpp/brp/dp/downloads/NJAC_7_1E.pdf**
  - **Reference: N.J.S.A. 13:18A-1 et seq. and N.J.A.C. 7:50 (Pinelands) http://www.state.nj.us/pinelands/images/pdf%20files/pinelandsprotectionact1.pdf**

5.2.1 Environmentally Sensitive Natural Resources

- **Perform qualitative survey to identify vegetative community (habitat) and wildlife**
  - **ecologist must be familiar with State and Federal Guidance and literature references for plant community assessment**
  - **visually estimate the dominant plant species for each vegetative stratum (canopy, shrub, herbaceous) as per standard procedure**

5.2.1 Environmentally Sensitive Natural Resources

- **prime growing season (mid-May – beginning September) to assess visible indicators of stressed vegetation (stunting, chlorosis, brown/dying leaf tips, barren soil) absence of stressed vegetation does not mean absence of contamination or impact**

- **wildlife identified based on actual sightings or evidence (tracks, scat, nests, song, call, vernal pools, etc.)**

- **identify all surface water bodies on site map; note morphology, areal extent, discharge points**

5.2.1 Environmentally Sensitive Natural Resources

- **present in the Ecological Evaluation report:**
  - **General description of land use, including man-made features attractive to ecological receptors (e.g., waste lagoons, ditches)**
  - **Vegetative cover type description and map indicating ESNR boundaries, with aerial extent of each community/habitat type; formal wetland delineation, function and value assessment required on a case-by case basis, in accordance with N.J.A.C.7:7A**
  - **Tabular listing of species observed or expected, year round or migratory species. Include taxonomic class, common and Latin names, feeding guild, and location of residence among habitat types**

5.2.1 Environmentally Sensitive Natural Resources

- **present in the Ecological Evaluation report:**
  - **Documentation of consultation with NJ Natural Heritage Program regarding presence of Rare, Threatened, and/or Endangered Species: 609-292-9400 http://www.state.nj.us/dep/parksandforests/natural/heritage/**
  - **i-Map NJ DEP http://njgin.state.nj.us/dep/DEP_iMapNJDEP/viewer.htm**
  - **New Jersey's Landscape Project http://www.state.nj.us/dep/fgw/ensp/landscape/**

5.2.2 Contaminants of Potential Ecological Concern (COPEC)

- **present in the Ecological Evaluation report:**
  - **Data for each site-related and reference sample, in tabular format according to media and chemical fraction; include tentatively identified compounds**
  - **PQLs/MDLs, data mean, maximum, 95% UCL, concentration range, frequency of detection, and data qualifiers for each media/AOC**
  - **SW: metals [dissolved (filtered) + total (unfiltered)], hardness as CaCO3, pH**
  - **sediment: particle size, TOC, pH**

5.2.2 Contaminants of Potential Ecological Concern (COPEC)

- **Comparison with ecological screening value – present data summary and screening values in table, with exceedances highlighted**
  - **data < screen – NFA**
  - **data > screen – further investigation**
  - **ensure MDLs low enough**
  - **No COPEC excluded without adequate justification**
  - **Present sample locations, screening values, and data that exceed screens on vegetative cover type map (“Chem boxes”)**

5.2.3 Migration Pathway

- **perform evaluation of site topography, surface drainage features, contaminant chemical characteristics, and fate and transport mechanisms.**
- **present in the Ecological Evaluation report actual observations or description of potential migration pathways**

5.2.3 Migration Pathway

- **direct observations of contaminant migration**
  - **presence of stressed/dead vegetation**
  - **discolored soil, sediment, surface water**
  - **presence of seeps, outfalls, other discharges**
  - **acute effects on biota**

5.2.3 Migration Pathway

- potential for contaminant migration
  - migration during storm events/tidal reversals
  - direct emplacement of contaminants into ESNRs
  - discharge of contaminated ground water to surface water
  - food chain effects

5.3 Recommended Sample Collection in Support of EE

- 5.3.1 When to Collect Samples
  - Contamination above ESC & ESNR present
  - Migration pathways
  - Historic or on-going discharges
  - Stressed vegetation, seeps, sheens, etc.
  - GW discharges to SW or wetland
- Sediment:
  - TOC, pH, particle grain Size
- Surface Water:
  - TOC, DO, Hardness ($CaCO_3$), filtered & non-filtered

5.3 Recommended Sample Collection in Support of EE

- 5.3.2 Where to Collect Samples
  - 5.3.2.1 Potential Contaminant Migration Pathways
    - Ditches & swales
    - Overland flow
    - Ground water
  - 5.3.2.2 Environmentally Sensitive Natural Resources
    - Aquatic Systems (Standing Water, Flowing Water)
    - Wetlands (Emergent, Shrub-Scrub, Forested)
    - Uplands

5.3 Recommended Sample Collection in Support of EE

- 5.3.3 How to Collect Samples (FSPM)
  - 5.3.3.1 Soils and Sediments
    - Surface discharge/subsurface discharge
    - VOCs/other contaminants
    - Discrete samples
    - Potential for scouring/dredging or sediment
  - 5.3.3.2 Surface Water
    - Seep/Discharges
    - Contaminated Sediment
    - General

5.3 Recommended Sample Collection in Support of EE

- 5.3.4 Background Considerations
  - Refine COPEC List
  - Help Determine if COPEC is Site Related
  - Site Contaminant Levels Relative to Regional Levels
  - Develop RMD Goals for ESNRs

5.4 Comparison of Sample Data with ESC

- ESCs not promulgated
- ESCs do not address bioaccumulation
- Can propose alternate ESC with justification; however, human-health based SRS are not applicable to ecological receptors

◆ 5.4.1 Potential Contaminant Migration Pathways

- Ditches and Swales
- Overland Flow
- Ground water

5.4 Comparison of Sample Data with ESC

- 5.4.2 Surface Water Bodies
  - Freshwater
    - Surface Water and Sediment
  - Saline Waters
    - Surface Water and Sediment

5.4 Comparison of Sample Data with ESC

- 5.4.3 Wetlands
  - Freshwater
    - Surface Water, Sediment and Soil
  - Saline Waters
    - Surface Water, Sediment and Soil

5.4 Comparison of Sample Data with ESC

- 5.4.4 Uplands
  - ESC (PRGs, EcoSSLs, etc.)
  - SRS for uplands that could potentially be developed
  - Engineering and Institutional Controls for uplands that could potentially be developed

5.5 Ecological Evaluation Report

- **Present All Data and Highlight Exceedences of ESC in ESNRS or Migration Pathways**
  - **Figures:**
    - **Chem Boxes**
    - **Map and label ESNR boundaries, size, location, relation to AOC**
    - **Habitat, vegetative cover type**
    - **Sample date, depth, ESC**
    - **Morphology, Aerial Extent, Flow and Tidal Information, Discharge Point**

5.5 Ecological Evaluation Report

- **Present All Data and Highlight Exceedences of ESC in ESNRS or Migration Pathways**
  - **Data:**
    - **Tabular format according to medium, chemical fraction, etc.**
    - **MDLs, mean, maximum, 95% UCL, range, frequency**
    - **Qualified or rejected data clearly noted**
    - **SW: filtered & unfiltered (metals), hardness, pH, salinity, temperature, Eh, DO**
    - **Sediment: TOC, particle grain size, pH, Eh**

5.5 Ecological Evaluation Report

- **Identify the need for more rigorous ecological evaluation/site-specific ecological risk assessment or NFA**
- **Identify data gaps and recommendations on how to fill**
- **Remedial Action Appropriate (i.e. hot spot removal to ESC or background)**


Questions?

Ecological Risk Assessments

Section 6.0

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6.0 Technical Guidance for Preparing Ecological Risk Assessments

- If the findings of the EE indicate that further ecological evaluation pursuant to N.J.A.C. 7:26E-4.7 is warranted, additional ecological evaluation is required in the form of an ERA.

- The ERA must be conducted in accordance with steps 3 through 8 of ERAGS (N.J.S.A. 58:10B-12).

EE Decision Points

- No further ecological evaluation is appropriate.
- Further ecological evaluation is required.
  - ERA appropriate to the complexity of a site
- A remedial action the higher of the ESC or background
  - Appropriate for smaller, simpler sites

6.1 Ecological Risk Assessment Process Pursuant to N.J.A.C. 7:26E-4.7 (- 4.8)

- ERA is conducted in accordance with USEPA guidance
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* or "ERAGs" (EPA 540-R-97-0006; June 1997)
- 8-Step process, of which only the last 6 apply to the NJDEP process
- Outline of the process that the LSRP will be responsible for if an ERA is conducted
- Feeds into the development of ecologically-based remediation goals and risk management decisions

Eight Step Process

- Screening-Level Ecological Risk Assessment
  - Step 1 – Screening Level Problem Formulation/Effects Evaluation
  - Step 2 – Screening Level Exposure Estimate/Risk Characterization*

* - SMDP

Eight Step Process (Continued)

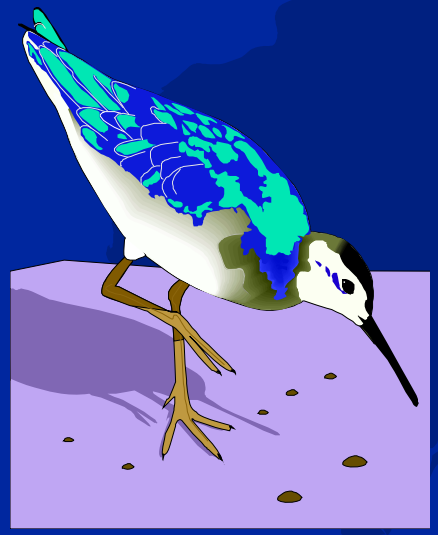
- Baseline Ecological Risk Assessment (BERA)
  - Step 3 – Problem Formulation*
  - Step 4 – Study Design/Data Quality Objectives*
  - Step 5 – Field Verification of Sampling Design*
  - Step 6 – Site Investigation and Analysis of Exposure and Effects (Analysis)*
  - Step 7 – Risk Characterization
  - Step 8 – Risk Management*

* - SMDP

What is an ERA?

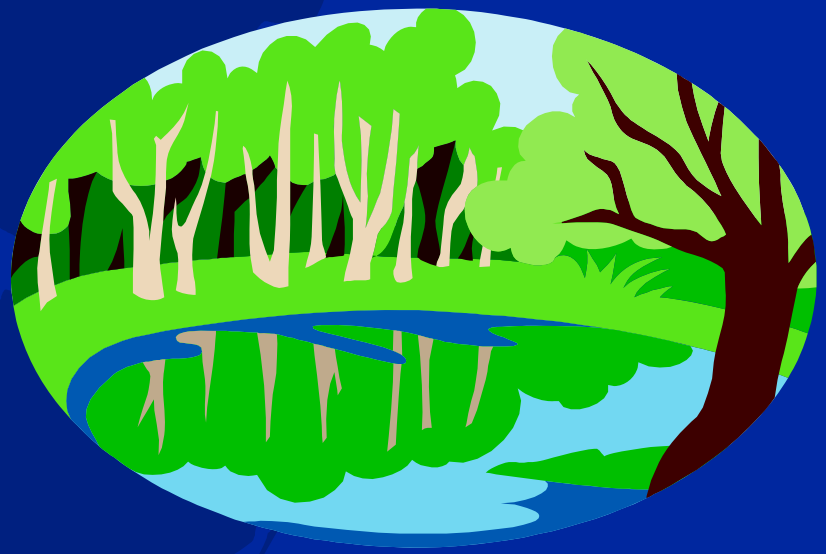
Evaluation of the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors

EPA, 1992



Stressors

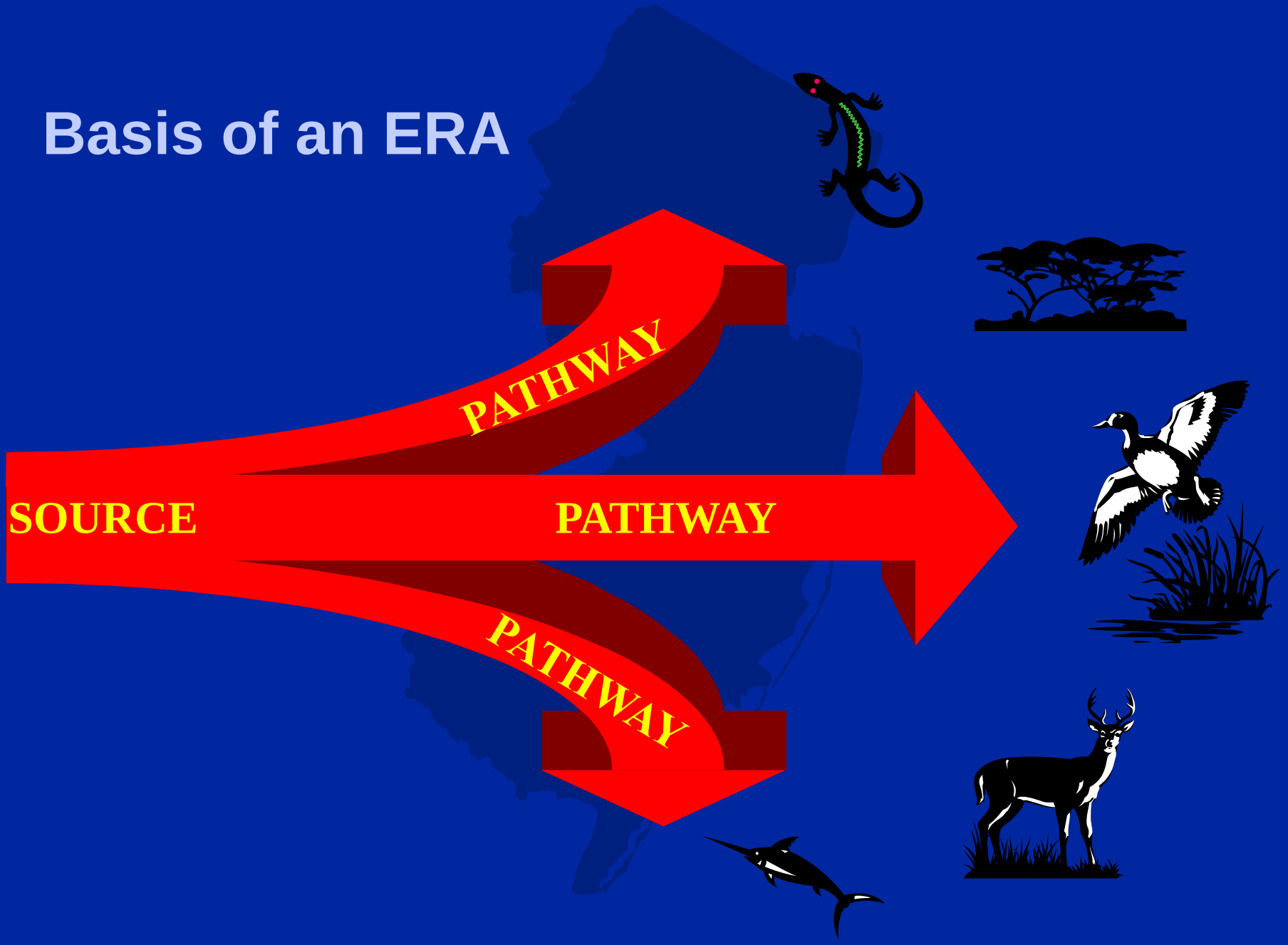
- Chemical
- Physical
- Biological

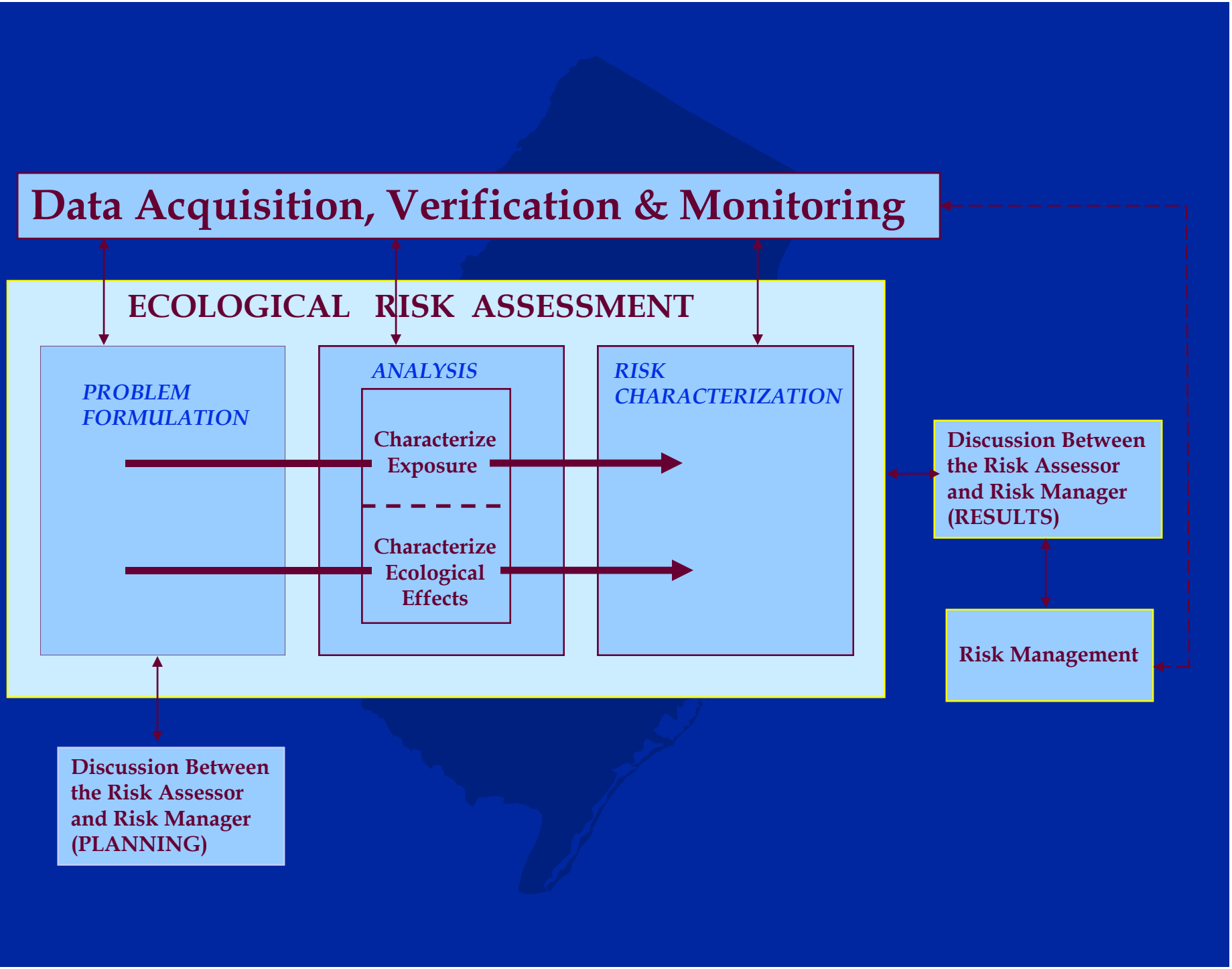


Ecological Risk Assessment

- Multi-disciplinary process for collecting, organizing and analyzing information to estimate the probability of adverse impacts to ecological receptors
- Tiered approach
  - Lower tiers protective, higher tiers predictive
  - Lower tiers use conservative assumptions, higher tiers use site-specific data and mechanistic models
  - Evaluate each tier to decide if the next is needed
  - Objective is to progressively reduce uncertainty

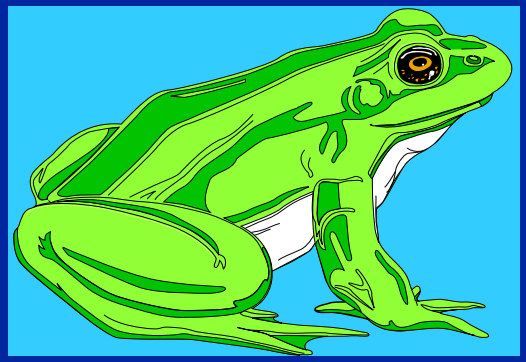
Basis of an ERA




Data Acquisition, Verification & Monitoring
ECOLOGICAL RISK ASSESSMENT
PROBLEM FORMULATION
ANALYSIS
Characterize Exposure
Characterize Ecological Effects
RISK CHARACTERIZATION
Discussion Between the Risk Assessor and Risk Manager (RESULTS)
Risk Management
Discussion Between the Risk Assessor and Risk Manager (PLANNING)

6.1.1 Problem Formulation

- Defines the nature of the problem and the characteristics of the risk assessment needed to solve it
  - Identify ecosystem at risk
  - Identify potential ecological effects
  - Select assessment/measurement endpoints
  - Conceptual Site Model



- Risk assessors' first opportunity to incorporate "perspectives" into the assessment
- First evaluation of comparative risks at a site

6.1.1.1 Assessment and Measurement Endpoints

- Assessment Endpoints are neutral expressions of the actual environmental goals to be protected
- Not management goals
- Defined by:
  - Ecological entity (species, species groups, community, ecosystem)
  - Attributes of the ecological entity (growth, survival, species diversity)

Assessment Endpoints

- Ecosystem
  - Productive capability
- Population
  - Extinction
  - Abundance
  - Yield/production
  - Age/Size class structure
- Community
  - Sport value
  - Recreation quality
  - Biological stability
  - Desirability

Measurement Endpoints (Measures of Effects)

- Ecosystem
  - Biomass
  - Productivity
  - Nutrient dynamics
- Community
  - Number of species
  - Dominance
  - Diversity
- Population
  - Occurrence
  - Abundance
  - Age/class structure
  - Reproductive success
- Individual
  - Death
  - Growth
  - Fecundity
  - Behavior

Example Endpoint

- Assessment Endpoint 1: Evaluate the potential for adverse changes in the survival, reproduction, and growth of fish populations utilizing a river in the vicinity of a site resulting from exposures to COPECs in sediments, surface waters, and/or prey
  - ME 1: Surface water sampling results
  - ME 2: Surface water bioassay
  - ME 3: Fish tissue analysis
  - ME 4: Sediment sampling results
  - ME 5: Sediment bioassay
  - ME 6: Bioaccumulation studies
  - ME 7: Benthic – Fish food chain modeling

Selection of Endpoints

- Assessment Endpoints
  - What component of the environment is at risk?
  - How should efforts be defined
    - Legal
    - Regulatory
    - Public concerns
- Measurement Endpoints
  - Directly related to assessment endpoints
  - Consistent relationship

Characteristics of Good Endpoints

- Social relevance
- Biological relevance
- Unambiguous
- Measurable or predictable
- Susceptible to the hazard
- Logically related to the decision process

6.1.1.2 Ecological Conceptual Site Model

- Describes predicted relationships among stressors, exposure, and assessment endpoint responses
- Identifies potential sources
- Identifies complete and incomplete exposure pathways
- Identifies potential receptors (primary and secondary)

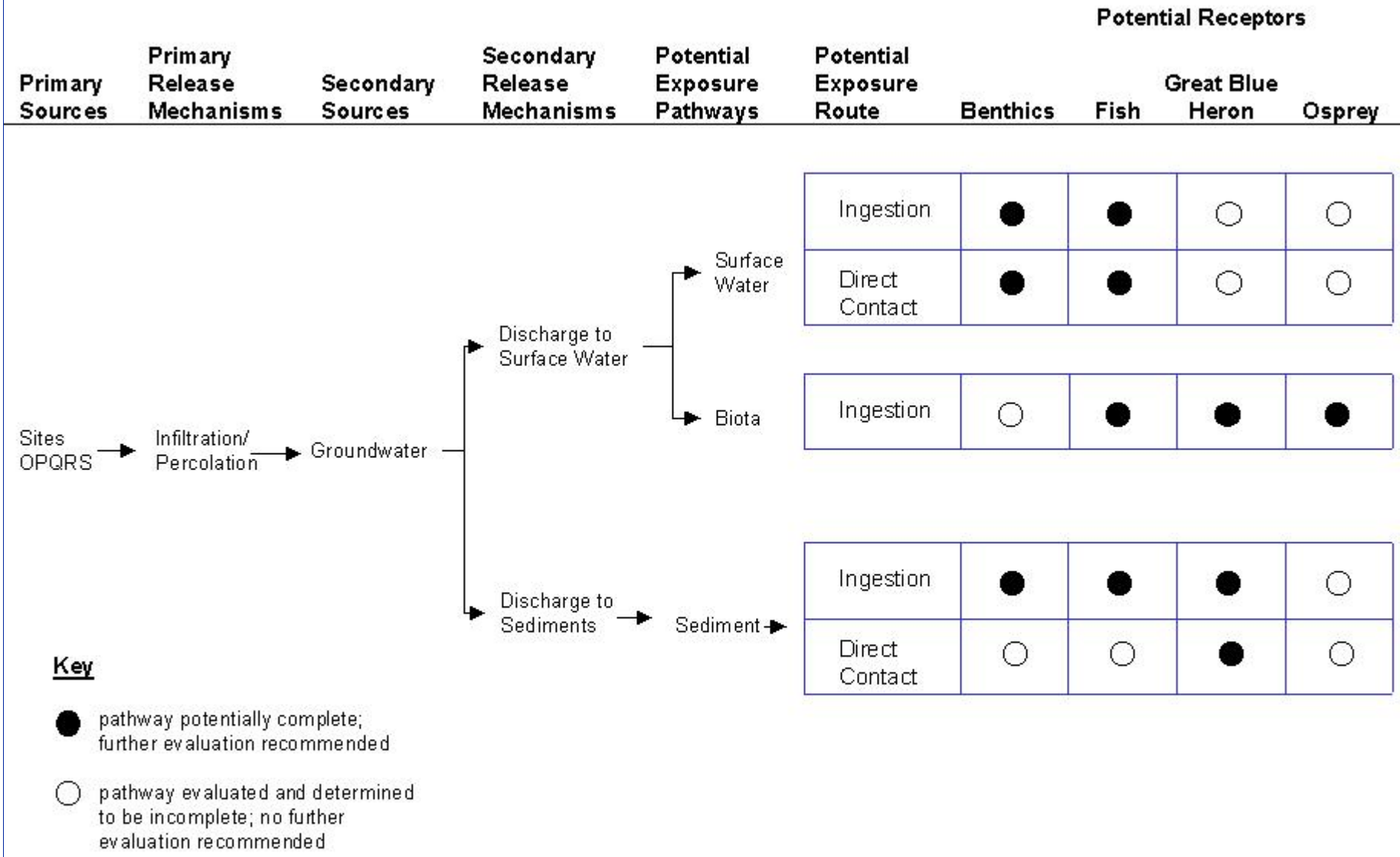


Figure 1A
Aquatic Conceptual Site Model for the Mississippi River Ecological Risk Assessment
Sauget Area 2 RI/FS SSP
Sauget Area 2 Sites Group

6.1.2 Analysis

- Exposure Characterization/Assessment
  - Stressor characterization
- Effects Assessment
  - Use of limited data on ecological effects can result in highly uncertain and overly conservative risk estimates
  - Safety factors for taxonomic extrapolations
  - Agencies prefer use of most conservative values

Exposure Characterization

- Type: Chemical, physical, or biological
- Intensity: Concentration
- Duration: Acute (short-term) or chronic (long-term)
- Frequency: Single event, episodic or continuous
- Timing: Relative to ecological/biological cycles
- Occurrence: Homogenous or heterogeneous
- Scale: Geographic extent

Tools for Conducting Exposure Assessments

- Desk top information/scientific literature
- Chemical data from site-related matrices
- Tissue residue data
- Bioaccumulation/food web modeling
- Biomarkers

Effects Assessment

- Determination of the nature of the effects and their magnitude as a function of exposure
- Assessments made using
  - Literature studies/review
  - Laboratory toxicity tests
  - Ambient media toxicity tests
  - Field studies
  - Biological surveys

6.1.3 Risk Characterization

- Characterize type, nature, extent and the strength of adverse ecological risks associated with chemicals identified at your site based on evaluation of data collected in Analysis phase
- Statistically compare data from area of concern with data from reference area
- Compare toxicological benchmarks with representative estimated doses
- Evaluate stressor-response relationships

Risk Characterization (Continued)

- Hazard Quotient
  - HQ = Exposure Concentration/Benchmark
- HQs less than one indicate the potential for an adverse ecological risk is minimal
- HQ of one or greater is not confirmation of an impact, just indication of the potential for an adverse ecological risk

8.0 Uncertainty Evaluation

- Built into discussions on measures of exposure and effects
- Subject to professional judgment and scrutiny
- Often qualitative
- Provides perspective on soundness of lines of evidence

6.1.3.1 Food Chain Modeling
6.1.3.3 Toxicity Reference Values

- Cannot calculate risk characterization to wildlife based on direct exposures
- Must calculate a dose for each receptor
- HQ = ADD/TRV
  - ADD is the Average Daily Dose
  - TRV is the Toxicity Reference Value or screening benchmark (NOAEL/LOAEL)
  - NOAEL HQ reflective of impact to individual
  - LOAEL HQ reflective of impact to population

ADD Calculation

$$ADD = (Dose_{food} + (Dose_{sediment} \text{ or } Dose_{soil}) + Dose_{water}) \times SUF$$

where:

ADD	=	Average daily dose of COPEC (mg/kg BW/day)
$Dose_{food}$	=	Dose of COPEC in food (mg/kg BW/day)
$Dose_{sediment}$	=	Dose of COPEC in sediment (mg/kg BW/day), aquatic
$Dose_{soil}$	=	Dose of COPEC in soil (mg/kg BW/day), terrestrial
$Dose_{water}$	=	Dose of COPEC in water (L/kg BW/day)
SUF	=	Seasonal Use Factor (unitless)

Modeling Steps

- Select wildlife or aquatic species to be evaluated
  - Herbivore versus carnivore
  - Should be applicable to your site
- Identify chemical data to be used in modeling
- Using Plant Uptake Factors (PUFs) or receptor Bioconcentration Factors (BCFs), calculate estimated chemical concentrations in food sources
- Calculate dose
- Divide by TRV and determine risk numbers

Limitations of Modeling

- Modeling versus site-specific information
- Collection of site-specific input parameters for food chain modeling
- Question of scope
  - Cost
  - Technical practicability

6.1.3.2 Bioaccumulation

- Bioaccumulation: Accumulation of contaminants in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated media
- Assimilation is controlled by matrix, chemical, & species-specific factors
- Magnitude of bioaccumulation highly site-specific

Factors Controlling Bioaccumulation

- Exposure concentrations
- Organic carbon
- K_{OW}
- Grain size
- History of exposure
- Genetic makeup
- Magnitude of exposure
- Feeding behavior/preference
- Size/age
- Metabolism
- Growth
- % lipid
- Metals – Valence state

6.1.3.4 Weight-of-Evidence

- Process by which measurement endpoints are related to an assessment endpoint to evaluate whether significant risk is posed to the environment (examination of lines of evidence)
- Designed and tested during Problem Formulation
- Results integrated during Risk Characterization
- Qualitative or quantitative

Lines of Evidence

- Matrix sampling
- Biological sampling
  - Population surveys/species inventories
  - Tissue sampling
- Benthic invertebrate survey
- Bioassays/toxicity testing
- Bioaccumulation studies

Line of Evidence	Result	Explanation
Media Analyses	+	Concentrations of inorganic constituents in soil collected in developed areas exceeded benchmarks
Biological Surveys	-	Surrounding vegetative communities in the wetland, deciduous forest, and open field habitats were very diverse and were composed of common typical plants found within the habitat classification.
Weight-of-Evidence	-	The conservative screening process resulted in the identification of several COPECs in a localized developed areas. The vegetative surveys indicates that COPEC concentrations are unlikely impacting the plants. The potential risks from these metals are likely substantially reduced due to decreased bioavailability and exposure to the plants.

6.3 Ecological Risk Assessment Report

- Executive Summary
- Objectives of the ERA
- Problem formulation
  - Comprehensive site history and descriptions of the ESNRs located on, adjacent to and potentially under the influence of the site
  - Identification of assessment and measurement endpoints, development of ECSM
  - Identification of TRVs and other screening benchmarks

ERA Report (Continued)

- Description of field activities
- Results of the chemical and biological analyses and risk calculations including tabular results and figures showing ESNRs, sampling locations, date and depths and analytical results in excess of the appropriate ESC and delineation samples by media, chemical fraction and area;
- Uncertainty analysis
- Conclusions; and
- Appendices, containing laboratory analytical data and field logs

Preparation of the ERA

- Examination of all lines of evidence
  - Weight of Evidence approach
- Presentation of all site-specific ecological risks
- Threshold for effects on Assessment Endpoints
- Likelihood of risk
- Location and areal extent of contamination
- Degree to which thresholds are exceeded
- Half-life of contamination and potential for natural recovery


Questions?

ERA Data Development: Characterization Tools and Methods

Section 6.2

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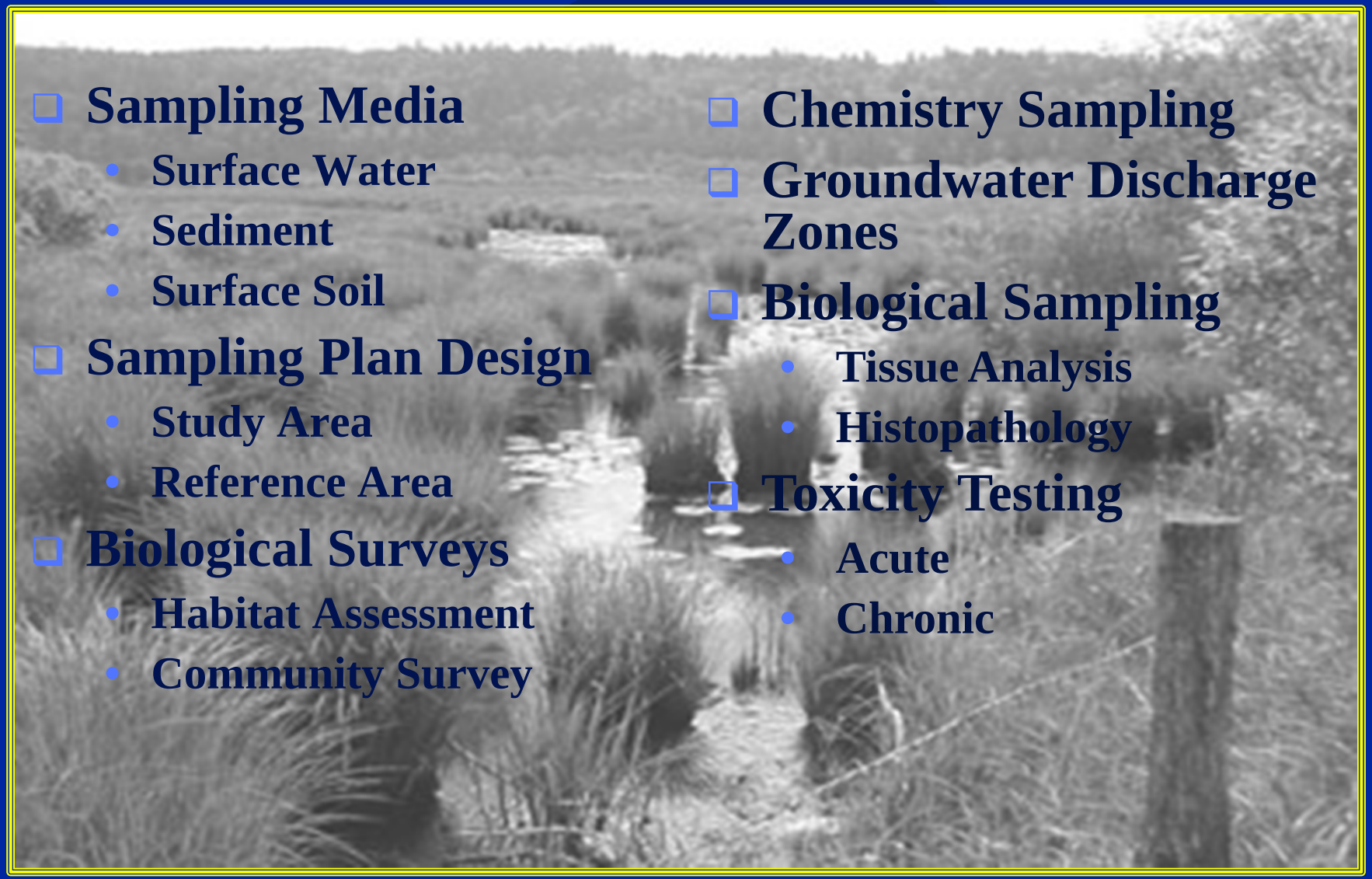
Characterization: Media, Design Methods, and Tools



- **Sampling Media**
  - Surface Water
  - Sediment
  - Surface Soil
- **Sampling Plan Design**
  - Study Area
  - Reference Area
- **Biological Surveys**
  - Habitat Assessment
  - Community Survey
- **Chemistry Sampling**
- **Groundwater Discharge Zones**
- **Biological Sampling**
  - Tissue Analysis
  - Histopathology
- **Toxicity Testing**
  - Acute
  - Chronic

Preliminary Data Needs

- Site history
- Result of previous investigations (e.g., the EE)
- Locations and characteristics of historic and current COPEC sources and contaminant migration pathways
- Extent and nature of surrounding land use

Surface Water: Sampling Plan Design

- Study Area Sampling
  - Smaller water bodies – additional grab samples
  - Larger water bodies – transect approach
  - Tidal water bodies – high and low tide
- Reference Area Sampling – upgradient of the mixing zone

Surface Water: Biological Surveys

- Habitat Assessment
  - Incorporates the potential limitations on a community that may not be attributable to the COPECs under investigation
  - Aquatic and riparian habitats
  - Same area as planned for a community survey
  - Spring and summer timeframes

Surface Water: Biological Surveys

- Community Surveys
  - Measure biological conditions
    - Structure : biological characteristics
    - Function: rate processes
  - Include three types of habitat types
    - Lentic environments: fish and macroinvertebrates
    - Lotic environments: algae and zooplankton
    - Wetlands: plants

Surface Water: Biological Sampling (Fish)

- Target species should represent feeding guilds and habitat(s)
- Grab samples preferred
- End of growing season
- Collection methods
  - Seining
  - Cast netting
  - Minnow traps
  - Electro-shocking
- Fish observation records
- Whole body analysis

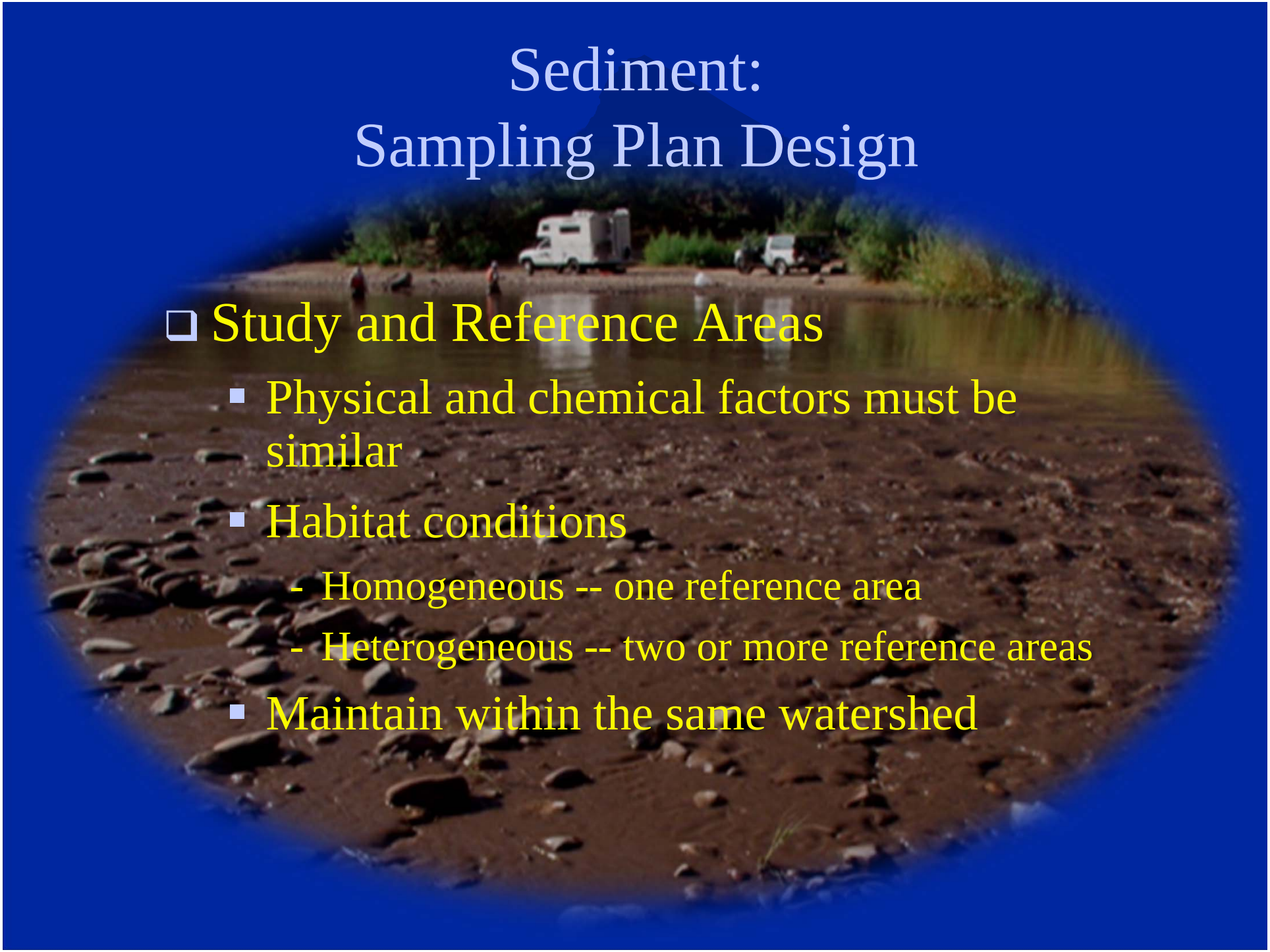
Surface Water: Toxicity Testing

- Indication of potential effects on aquatic biota, including:
  - Growth
  - Survival
  - Reproduction
- Test type dependent on salinity (i.e., > 3,000 ppt = saline)
  - Freshwater
    - Fathead minnow
    - Daphnia
  - Estuarine/Marine
    - Sheepshead minnow
    - Mysid shrimp
- Acute studies (1 to 4 days)
- Chronic studies (≥ 7 days)

Sediment:
Sampling Plan Design

- Sampling Depths
  - 0-0.5 feet (the biologically active zone) suitable for EEs
  - Greater than 0.5 feet if potential for deposition exists
- Sample Volumes
  - Sufficient substrate
  - Preparation of subsamples
    - Bulk chemistry analysis
    - Toxicity testing
- Sample Size

Sediment: Sampling Plan Design



- Study and Reference Areas
  - Physical and chemical factors must be similar
  - Habitat conditions
    - Homogeneous -- one reference area
    - Heterogeneous -- two or more reference areas
  - Maintain within the same watershed

Sediment: Benthic Macroinvertebrate Surveys

- Evaluates ecological integrity of the aquatic system
- Identification and analysis of community, population and functional parameters
- Integrate interactions of multiple contaminants and multiple routes of exposure
- Respond to a broad array of pollutants
- Temporally collocate with sediment bulk chemistry samples

Sediment: Pore Water Sampling

- Accurately predicts toxicity and observed community level effects
- Based on the equilibrium partitioning theory
- More accurate measure of bioavailability (toxicity) than simply screening bulk sediment data
- Assists in addressing the groundwater to surface water discharge pathway in the biotic zone

Sediment:
Pore Water Sampling Tools

Ultrasonic Seepage Meter

Trident Probe

Ultra Seep System

Push-Point Sampler

Piezometers

Peeper

Sediment: Toxicity Testing

- Useful in identifying potential effects on aquatic biota
- Effects measured:
  - Survival/lethality
  - Growth
  - Reproduction/fecundity

- Freshwater and saltwater species (*H. azteca, C. dilutus, N. virens)*
- Acute (10-day) and chronic (≥20 days) studies
- Laboratory and "reference" control samples
- Spatially and temporally collocated with bulk sediment chemistry samples
- Standardized guidance and test methods established

Sediment: Pore Water and Elutriate Toxicity Tests

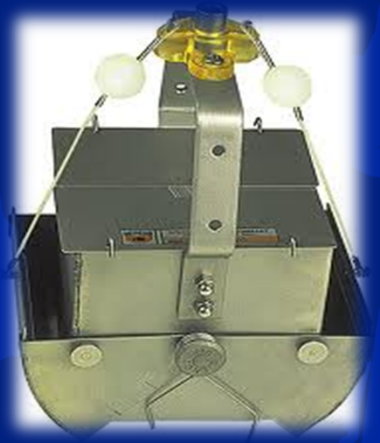
- Pore water - assess impacts on benthic organisms
- Elutriates – assess impacts of sediment resuspension on aquatic organisms
- Standardized methods unavailable – aqueous toxicity test methods recommended

Sediment:
Biological Sampling (Benthos)

- Measures contaminant concentrations in benthic macroinvertebrates
- Helps establish a site-specific bioaccumulation factor
- Composite samples from single or multiple habitats
- Spatially and temporally collocated with sediment samples
- Background samples from comparable conditions for same analytical suite

Sediment:
Biological Sampling Tools

- Techniques
  - Hester-Dendy
  - Surber
  - Grab Samplers
  - Kicknets



Surface Soil: Sampling Plan Design

- Sample depth(s) dependent on terrestrial receptors anticipated within study area
- Sampling should consider qualitative indicators of bioavailability (i.e., TOC, grain size, cation exchange capacity, pH)
- Establish background/reference conditions
  - Upgradient/off-site conditions
  - Regional (ambient) soil quality

Surface Soil: Habitat Assessments & Community Surveys

- Employed at complex sites
- Supports development of problem formulation – focused more on species inventories
- Many community assessment techniques available
  - Plant specific
  - Special management areas
  - Wildlife

Surface Soil: Biological Sampling

- Used to measure whole body contaminant concentrations in prey consumed by predators of concern
- Compared to dietary benchmarks and literature-based criteria to estimate risk
- Helps establish a site-specific bioaccumulation factor
- Spatially and temporally collocated with surface soil samples
- Background samples from comparable conditions

Receptors of Interest

Surface Soil: Toxicity Testing

- Indicator of potential effects on soil invertebrate and plants
- Measured effects:
  - Survival
  - Growth
  - Reproduction (earthworm only)
  - Germination (plants only)
- Acute (14 day) and chronic (≥28 day) studies

Outcomes of a Properly Designed ERA Study

- Identification and quantification of the contamination
- Understanding of the distribution of the COPECs relative to the appropriate ESCs or background
- Understanding of the physical, chemical and biological processes and temporal trends affecting the fate and bioavailability of the COPECs
- Identification of complete exposure pathways
- Identification of current potential ecological risks posed by the contamination
- Identification of potential bioaccumulation risks
- Understanding of the impact of disturbance of impacted media on the species in and around the site that are dependent on the terrestrial or aquatic system in question


Questions?

Risk-Based Remediation Goals and Risk Management Considerations

Chapters 7 and 9

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7.0 Determination of Ecological Risk-Based Remediation Goals

Ecological remediation goals, or cleanup levels, are chemical-specific concentrations or other appropriate goals that are protective of ecological receptors in an environmentally sensitive natural resource (ESNR)

Functions of Remediation Goals

- Serve as target concentrations for remedial action (e.g., excavation, capping)
- Identify aerial extent/volume/cost for media to be addressed by remedial actions
- Starting point for Risk Management Decision (RMD) goals

Three approaches to determining remediation goals:

1. Higher of ecological soil/sediment screening criteria and local background

2. Soil/sediment toxicity test results

3. Numeric values back-calculated from standard food chain model that use site-specific tissue residue concentrations

1. Clean-up goals via higher of ecological soil/sediment screening criteria and background

- Most applicable to small remedial actions or hot-spot removal where risk is presumed
- Does not apply to NPL sites, which require BERA process

2. Clean-up goals via soil / sediment toxicity tests

- Measure effects on cultured invertebrate survival, growth, reproduction in site sediment/soil samples.
- Most appropriate for non-biomagnifying contaminants

a. “Concentration-response” approaches in guidance

b. AET approach - “apparent effects threshold” - highest contaminant concentration associated with LACK of effects

AET- Hypothetical Example

- Assume 5 sample locations, chemical analyses and toxicity testing conducted at each location
- For each contaminant, order the results for the sample locations from highest to lowest concentrations:

Station #	As Conc (mg/kg)	Earthworm toxicity, biomass red.
2	1000	*
1	300	*
4	150	*
5	**30**	NE
3	12	NE

* - significant effect in toxicity test

NE - no significant effect

AET= 30 mg/kg = Remediation Goal

3. Clean-up goals via back-calculation using food chain model and site-specific tissue residue data

- Appropriate to use for persistent biomagnifying contaminants

- For each contaminant where hazard quotient >1 in ERA food chain models, algebraically rearrange standard dose equation to solve for "safe" sediment /soil concentrations

- May end up with multiple ecological risk-based remediation goals for different contaminants and receptor groups/feeding guild – generally choose most conservative or proceed with Risk Management

9.1 Soil Remediation Standards and Deed Notices

- SRS not appropriate for ESNRs because human exposure different
- Engineering and Institutional Controls not appropriate for ESNRs, except uplands that may be developed in the future
- ESNRs can be preserved in perpetuity (e.g. conservation easements, farmland preserved areas, wetland mitigation areas protected pursuant to 7:7A-15.14)

9.2 Risk Management Decisions

- Adjusting Ecological Risk-Based Remediation Goals (habitat preservation for rare or sensitive habitat, technical impracticability)
- Consider present and predicted value of the affected ESNRs
- Consider remedial activity's potential beneficial and/or detrimental effects on the ESNRs' value

9.2 Risk Management Decisions

- Impaired habitats can provide some valuable ecological benefit (i.e., food source, breeding, rearing, shelter, etc.)
- The ecosystem extends beyond the perimeter of the impaired area
- Reduction in ecological benefits in one area of the ecosystem may be offset by a corresponding increase in ecological benefits in another part of the ecosystem

9.2 Risk Management Decisions

- Restoration activities must exceed the future decreased ecological benefits associated with the continued exposure to COPECs and/or any remedial activities

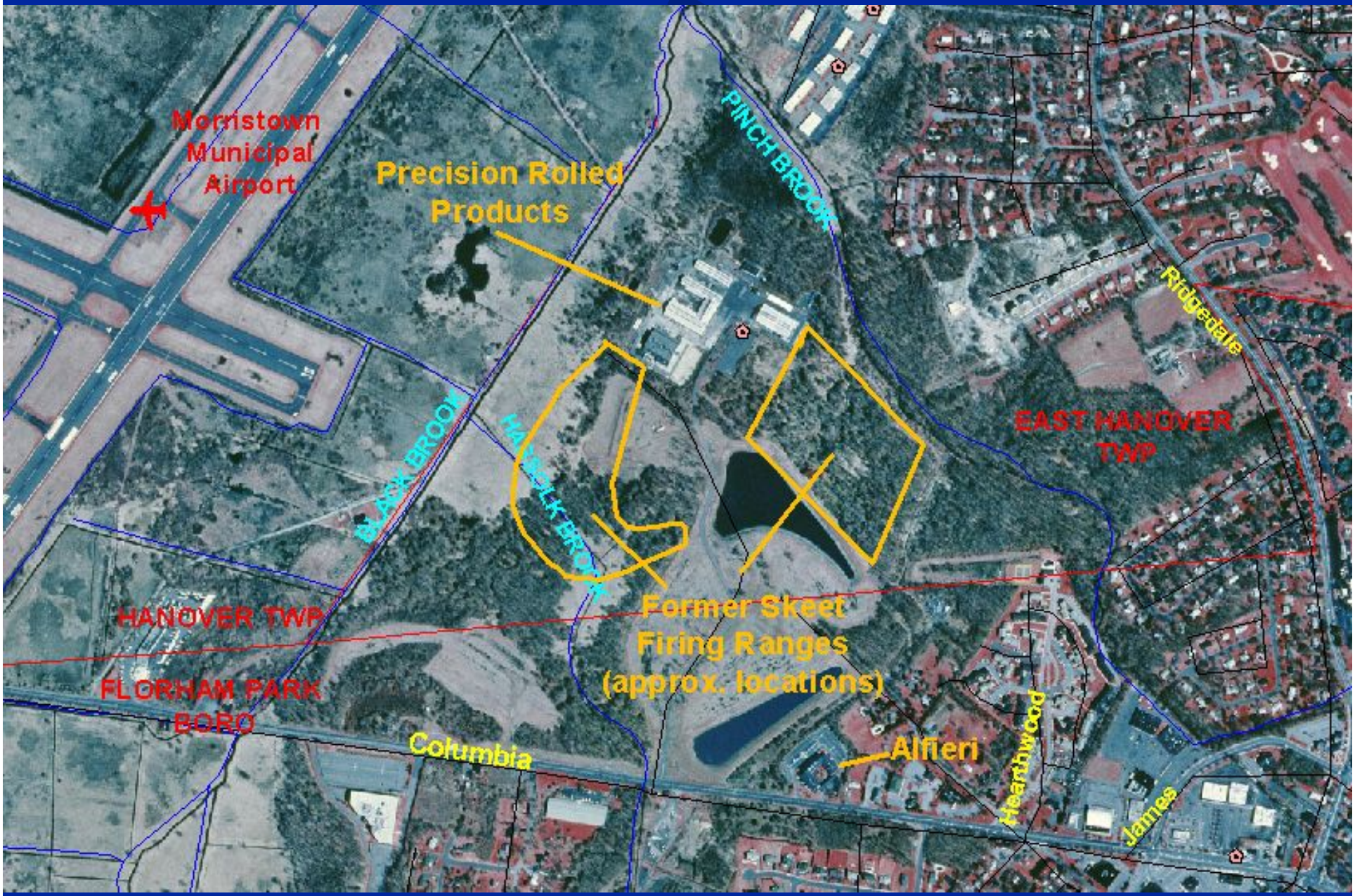
9.2 Risk Management Decisions

- All Risk-Based Remediation Goals and RMDs must be approved by NJDEP

(N.J.S.A. 58:10B-12 & N.J.A.C. 7:26E-4.7(b) - Proposed N.J.A.C. 7:26E-4.8(c)3)

Sample Site

- Two Historic Trap and Skeet Ranges
- Pb Levels in Excess of 100,000 ppm
  - Only One Intact Pellet Found Over Entire Site
- Majority of Contaminated Soil in Top Six Inches
- Groundwater Impact Minimal
- Channelized Streams Impacted
  - Toxicity Testing Showed 25% Mortality


Morristown Municipal Airport
Precision Rolled Products
PINCH BROOK
Ridgedale
EAST HANOVER TWP
BLACK BROOK
HANOVER TWP
Former Skeet Firing Ranges (approx. locations)
FLORHAM PARK BORO
Columbia
Alfieri
Hearthwood
James

Sample Site

- Collected Earthworms from Contaminated Soils
  - 7.71 mg/Kg - 5,898 mg/Kg
- Calculated BAFs Based on Soil Concentration and Earthworm Concentration
- Calculated ‘Safe Soil Level’ of 300 ppm Based on NOAELs for Higher Trophic Levels
- Would have to Clear Cut Majority of Mature Forested Wetland Area

Sample Site

- Risk Management Decision
- Percent Reduction in Total Pb Mass vs. Acre of Mature Forested Wetland Removed
  - What is Overall Reduction in Ecological Risk
  - Value of Mature Forested Wetland
  - Preserve Vernal Pools (None in ‘Hot Zone,’ but Eight of Fifteen exhibited Elevated Pb Levels)
- Human Health Considerations (i.e., Deed Notice and Engineering Controls - Uplands)

Sample Site

- Remove 94% of Total Pb Mass by Removing Hot Spots
- Cap Upland Areas containing Elevated Pb with Clean Fill Material
- Reduce Receptor Uptake of Pb 93%
- Remediate to 8,000 ppm in Eastern Zone and 5,000 ppm in Western Zone

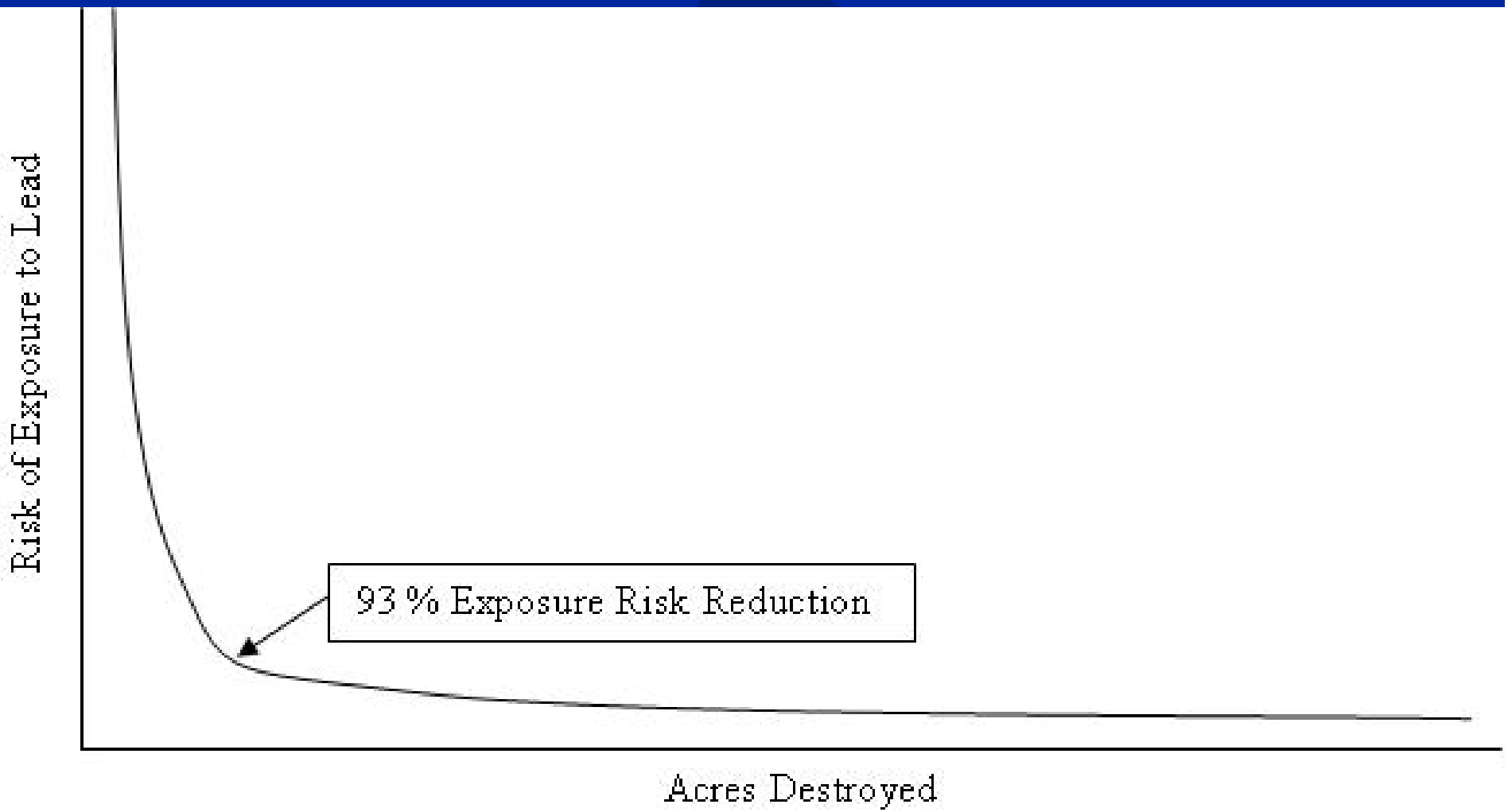
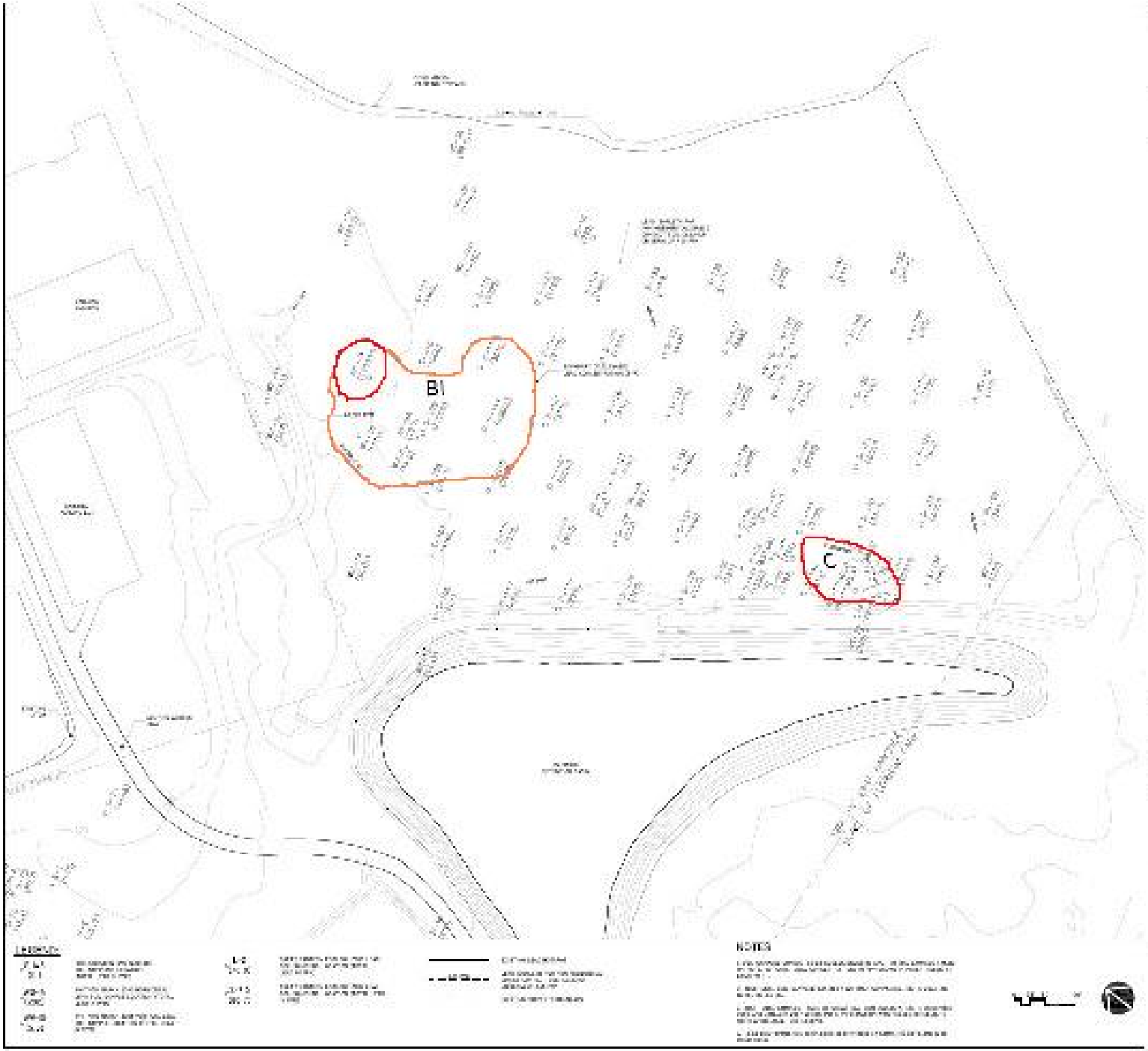


Figure 9-1: Plot of Exposure Risk Reduction vs. Acres of Habitat Destroyed



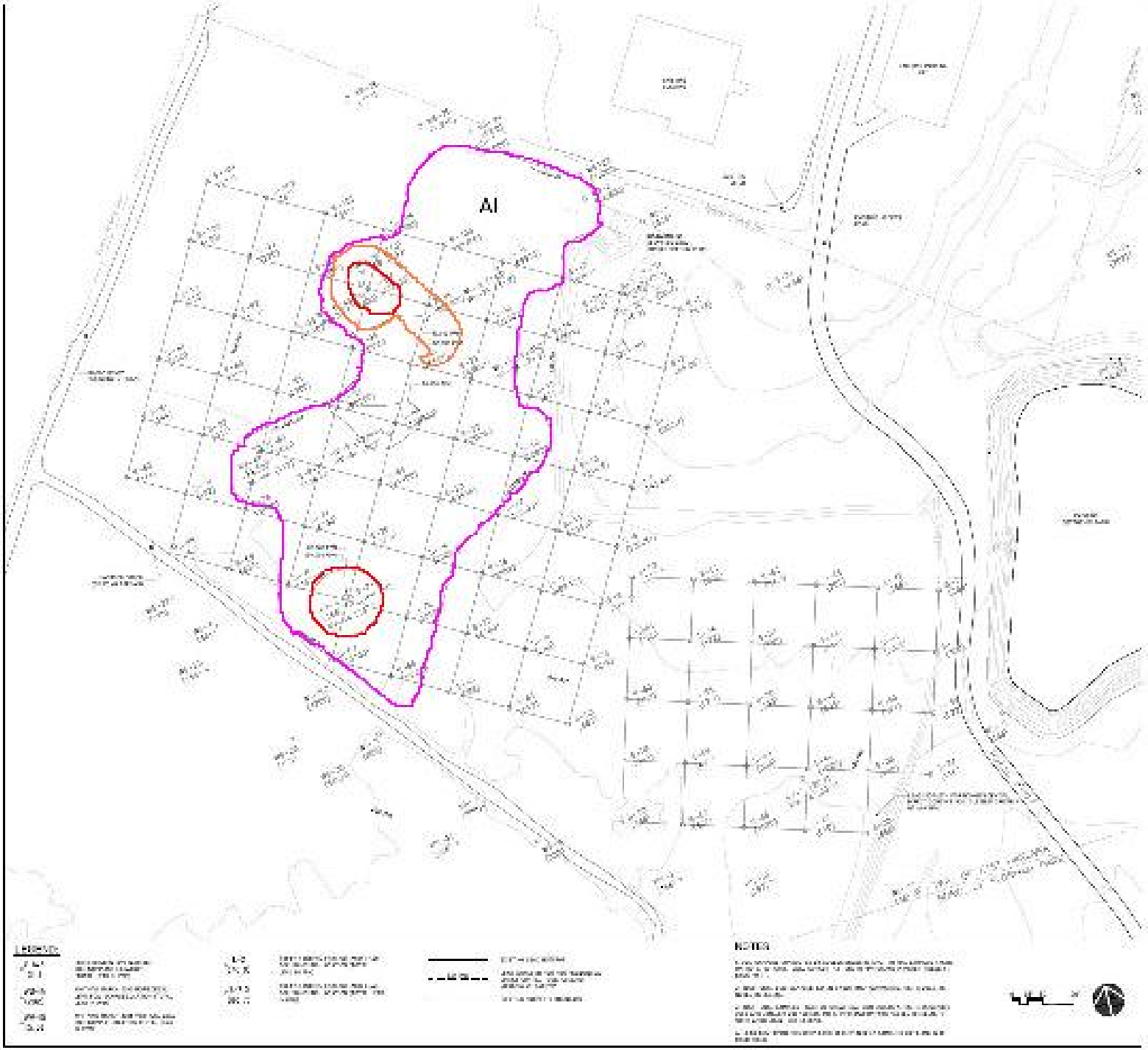
TRIUMPH SQUARE

DRAFT
NOT FOR
CONSTRUCTION

GREAT EASTERN
ECOLOGY

LEAD SAMPLES
EAST

X0003



TRIUMPH SQUARE

EAST HANOVER, NEW JERSEY

DRAFT
NOT FOR
CONSTRUCTION

GREAT EASTERN ECOLOGY

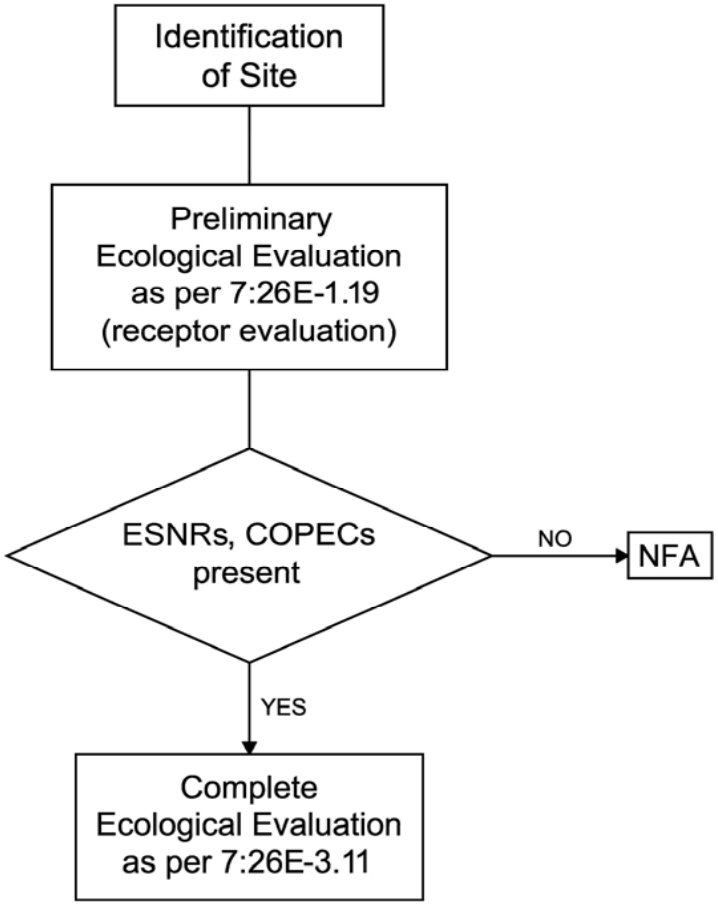
LEAD SAMPLES WEST

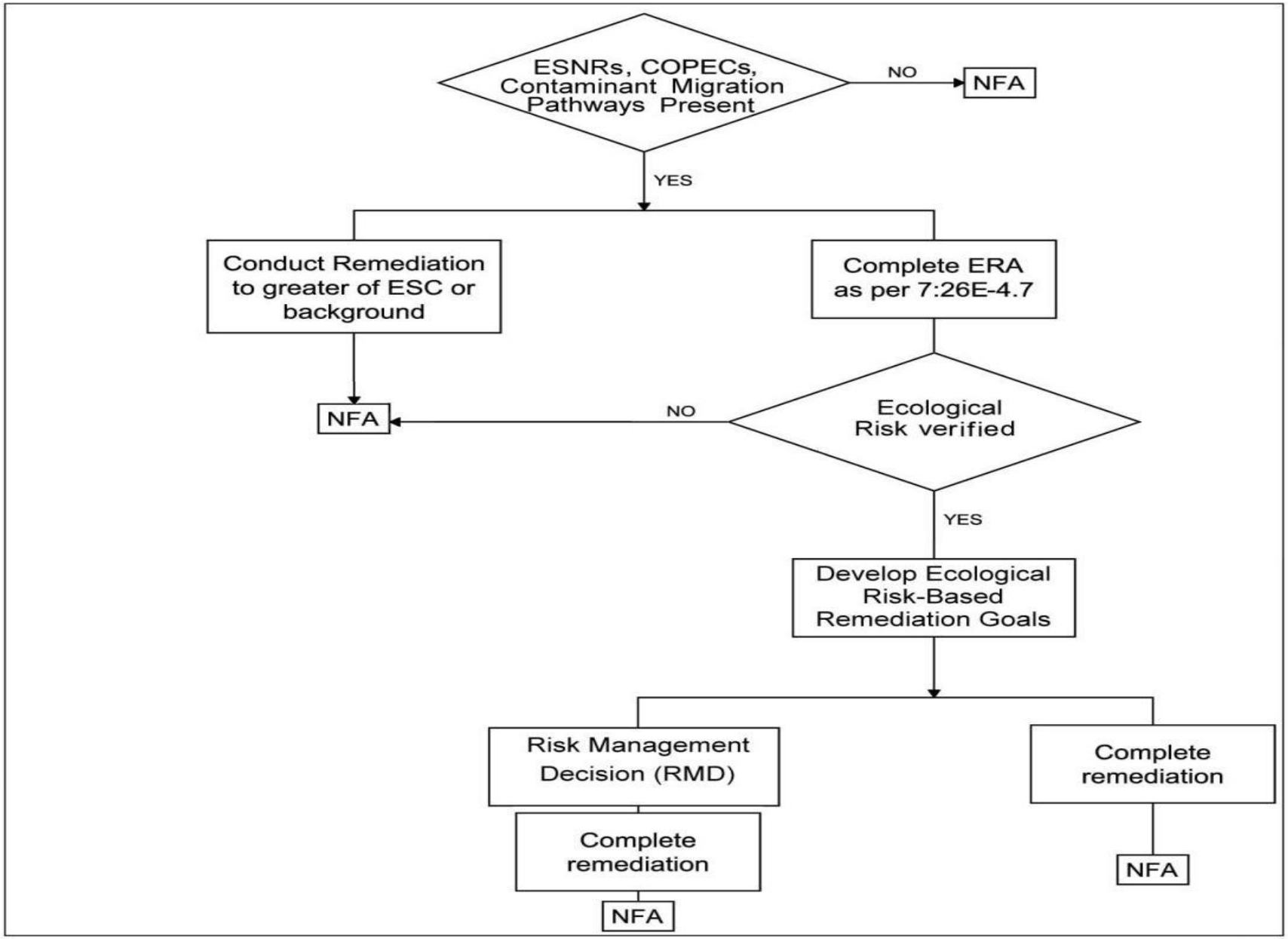
X0004

Sample Site

- Preserve 22+ Acres of Wetland with Elevated Pb Levels
- Destroy 7.5 Acre of Habitat
  - 3.7 Acres of Herbaceous Wetland
  - 2.8 Acres of Forested Wetland
    - As of 2002, only 1% of Approved Forested Wetland Restorations in New Jersey were Successful
    - Will Try to Preserve Specific Large Trees
  - 1.0 Acre of Upland Habitat
- Restore and Enhance Stream Habitat
  - Physical Modification, Sediment Removal, Wetland Management

CONCEPTUAL ECOLOGICAL RISK DECISION TREE




ESNRs, COPECs, Contaminant Migration Pathways Present
NO
NFA
YES
Conduct Remediation to greater of ESC or background
Complete ERA as per 7:26E-4.7
NFA
NO
Ecological Risk verified
YES
Develop Ecological Risk-Based Remediation Goals
Risk Management Decision (RMD)
Complete remediation
NFA
Complete remediation
NFA


Questions?