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A GIS solution to evaluating remedial alternatives in sediment remediation and recovery

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Leon M. Delwiche

and Jon Nuwer, PhD



Sediment Remediation/Recovery Modeling

A GIS solution to evaluating remedial alternatives in sediment remediation and recovery – April 4 2018



Today's Dialogue

Sediment Cleanup – Recovery and Remediation

- Objectives
- Where does GIS help?
- Scenario Modeling – Tools and applied example

Sediment Cleanup Overview

Primary Objectives

- Determine whether existing conditions are compliant with proposed sediment cleanup levels (SCLs) for hazardous substances. **(COCs)**
- Must attain SCL within reasonable timeframe
- Combination of active remediation and natural recovery

How can GIS-based models help?

- What is the spatial extent of the 'site'?
- Will cleanup levels be met through natural recovery?
- What is the optimized remediation to comply with regulations?
- What are the outcomes of different management decisions?



Dredging



Capping

Spatial Data Modeling Scenarios

- Need a way to model multiple scenarios to help in management decisions
- Model parameters are COC dependent
- Becomes a data management problem

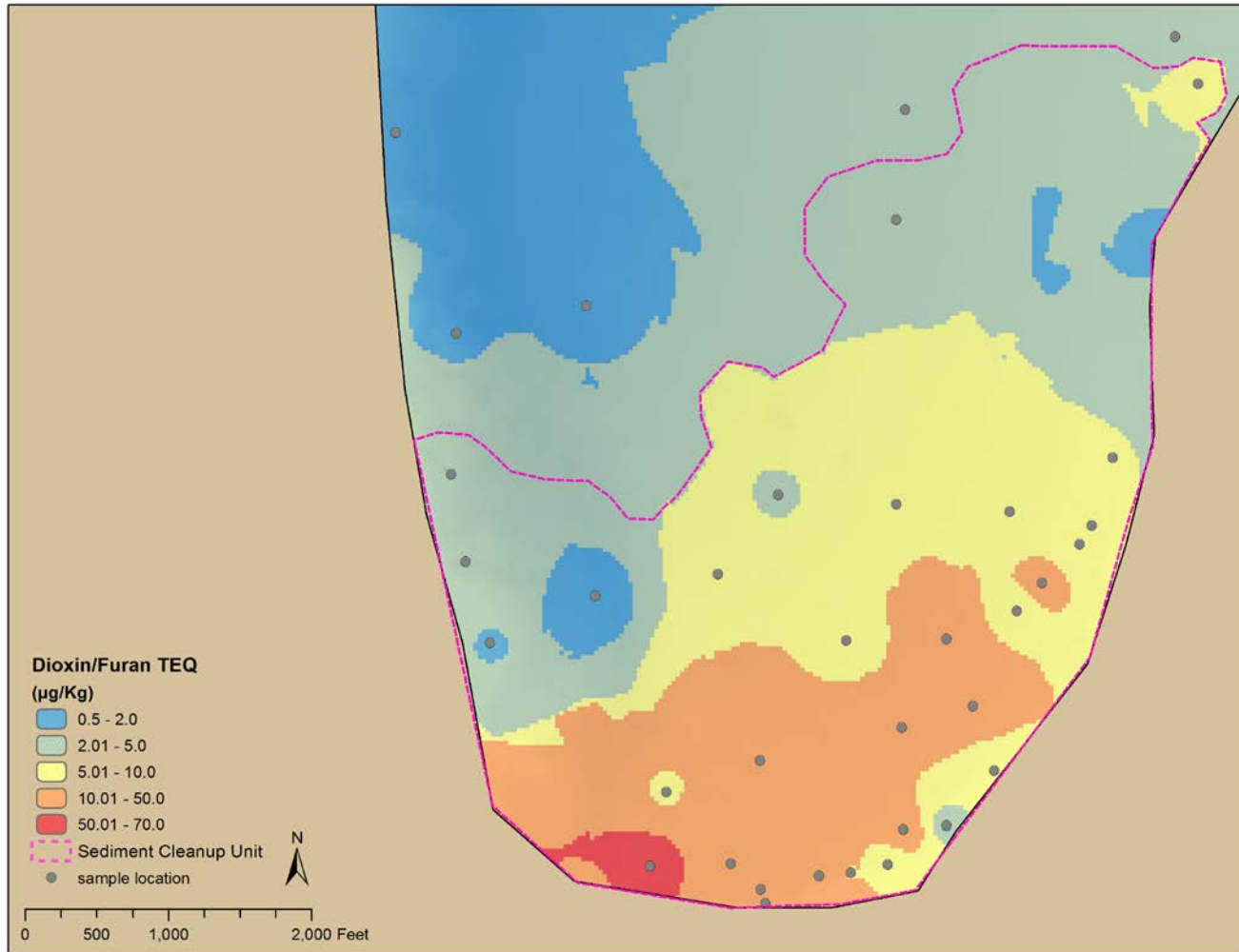


Customized Toolbox

1. Natural Recovery
2. Active Remediation
3. Integrated Remediation With Recovery

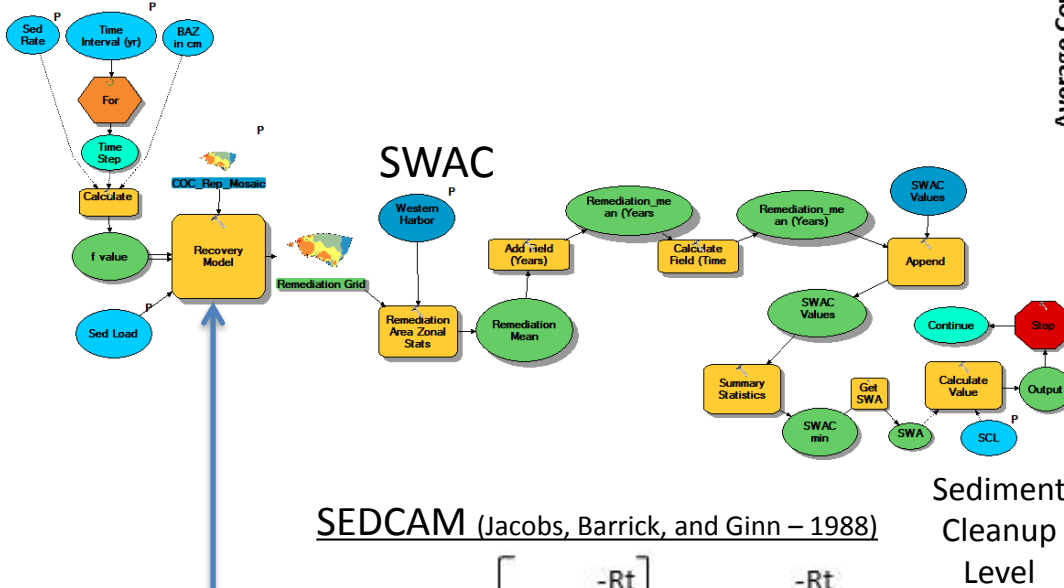
Scenario Modeling – Dioxin/Furan Example

Initial Concentration



Natural Recovery Model

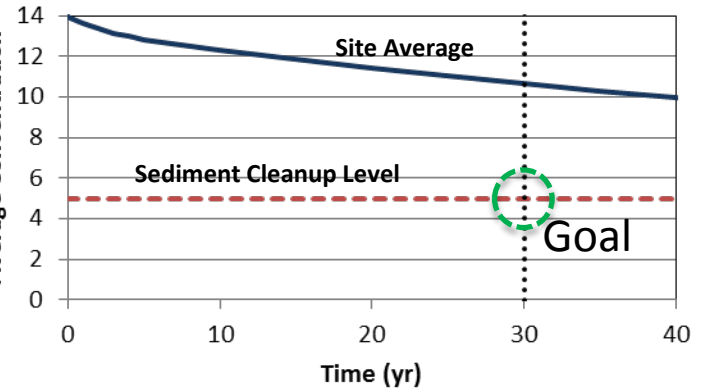
Time



SEDCAM (Jacobs, Barrick, and Ginn – 1988)

$$C_t = C_d \cdot \left[1 - e^{-\frac{Rt}{B}} \right] + C_i \cdot e^{-\frac{Rt}{B}}$$

Sediment
Cleanup
Level



Model Parameters

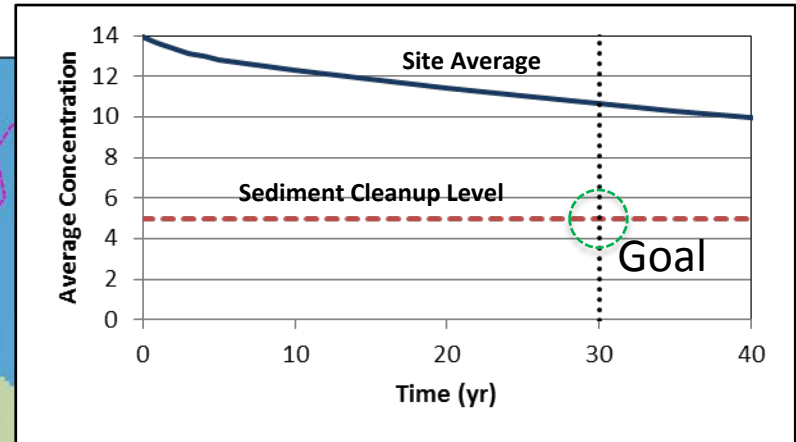
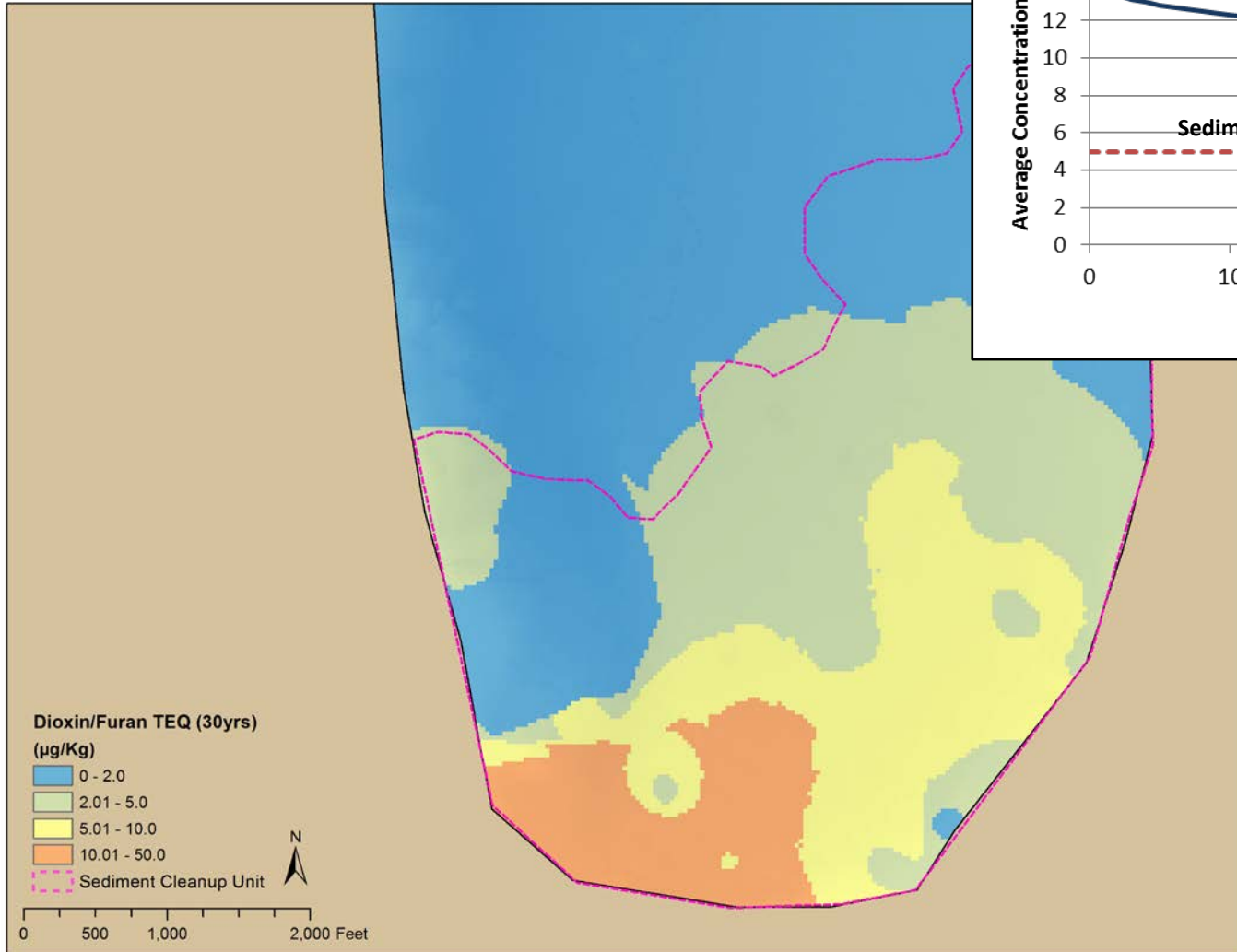
- Chemical Loading (C_d)
- Bioturbation (B)
- Sedimentation Rate (R)

1. Depositing solids and solids in the mixed layer have the same density
2. No diffusion/degradation of COC

How much time will it take for the system to recover on its own?

Scenario Modeling – Natural Recovery

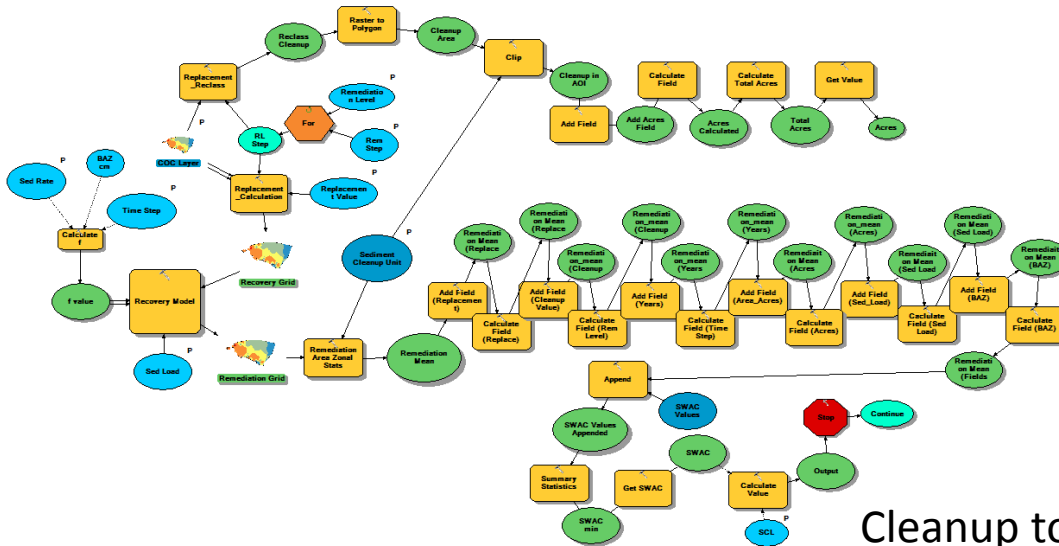
30 Year Recovery Result



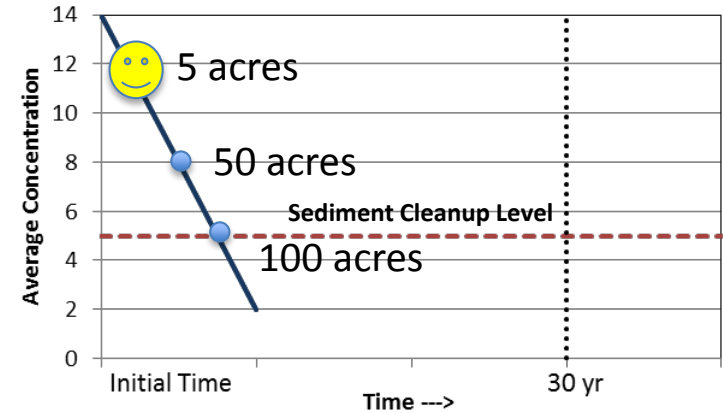
Active Remediation?

Active Remediation Model

Replace hot spots with "clean" sediment

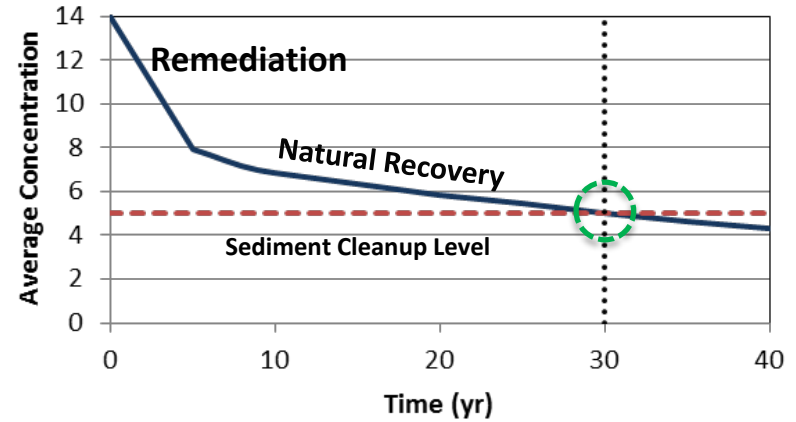
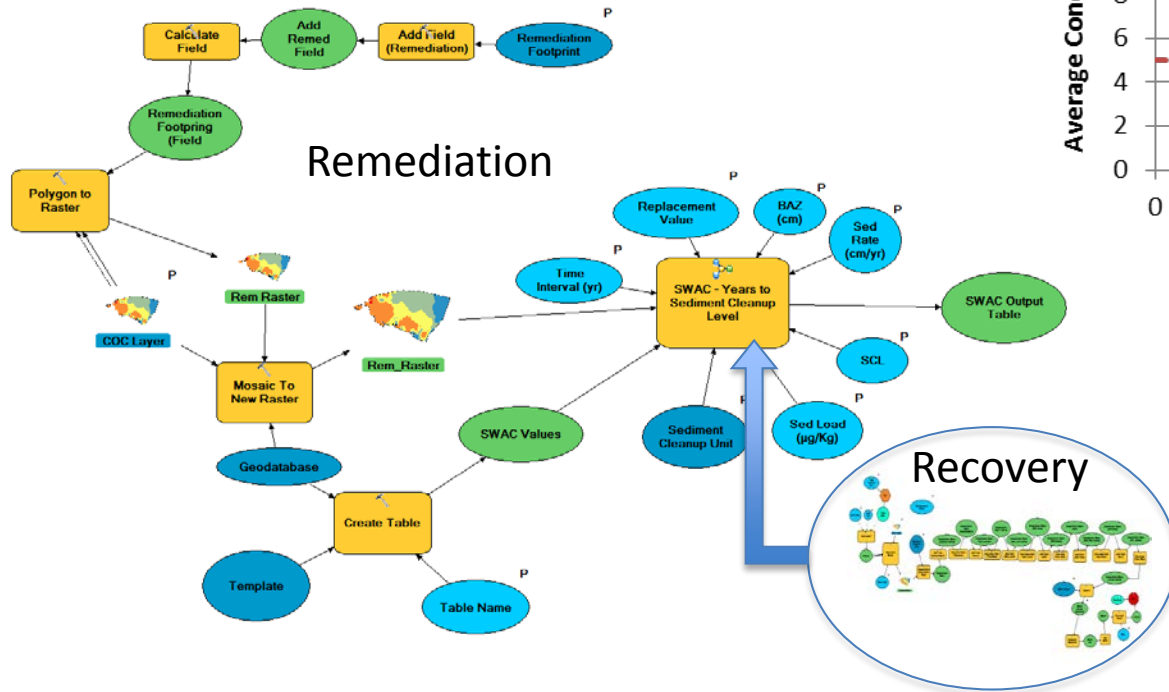


Cleanup to Regional Background



What's the area of remediation required to meet cleanup level?

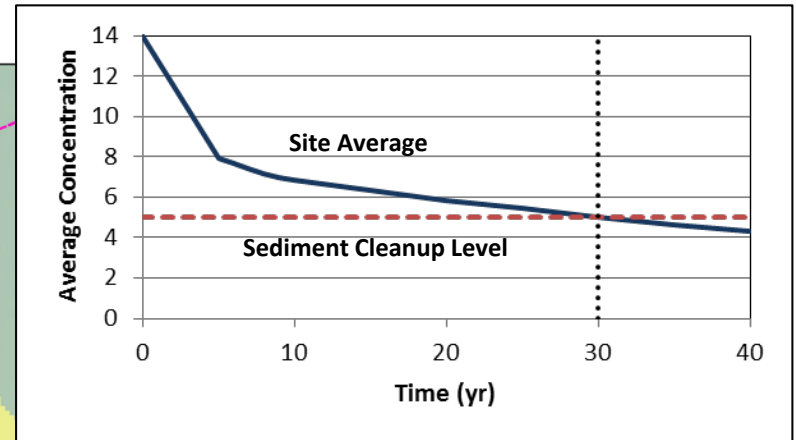
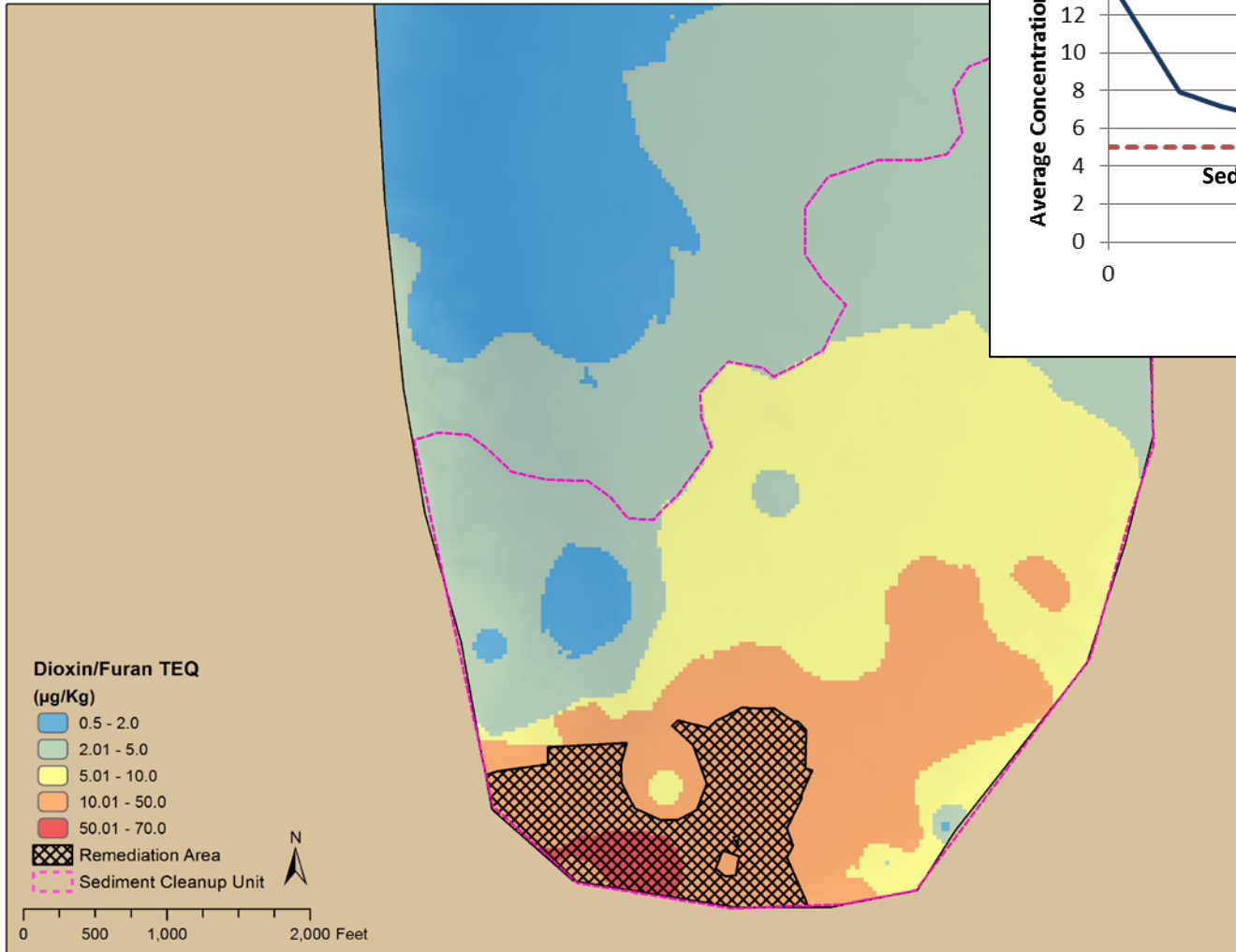
Integrated Remediation and Recovery



- Model variables frequently vary depending on management decisions
- Can reevaluate using toolset

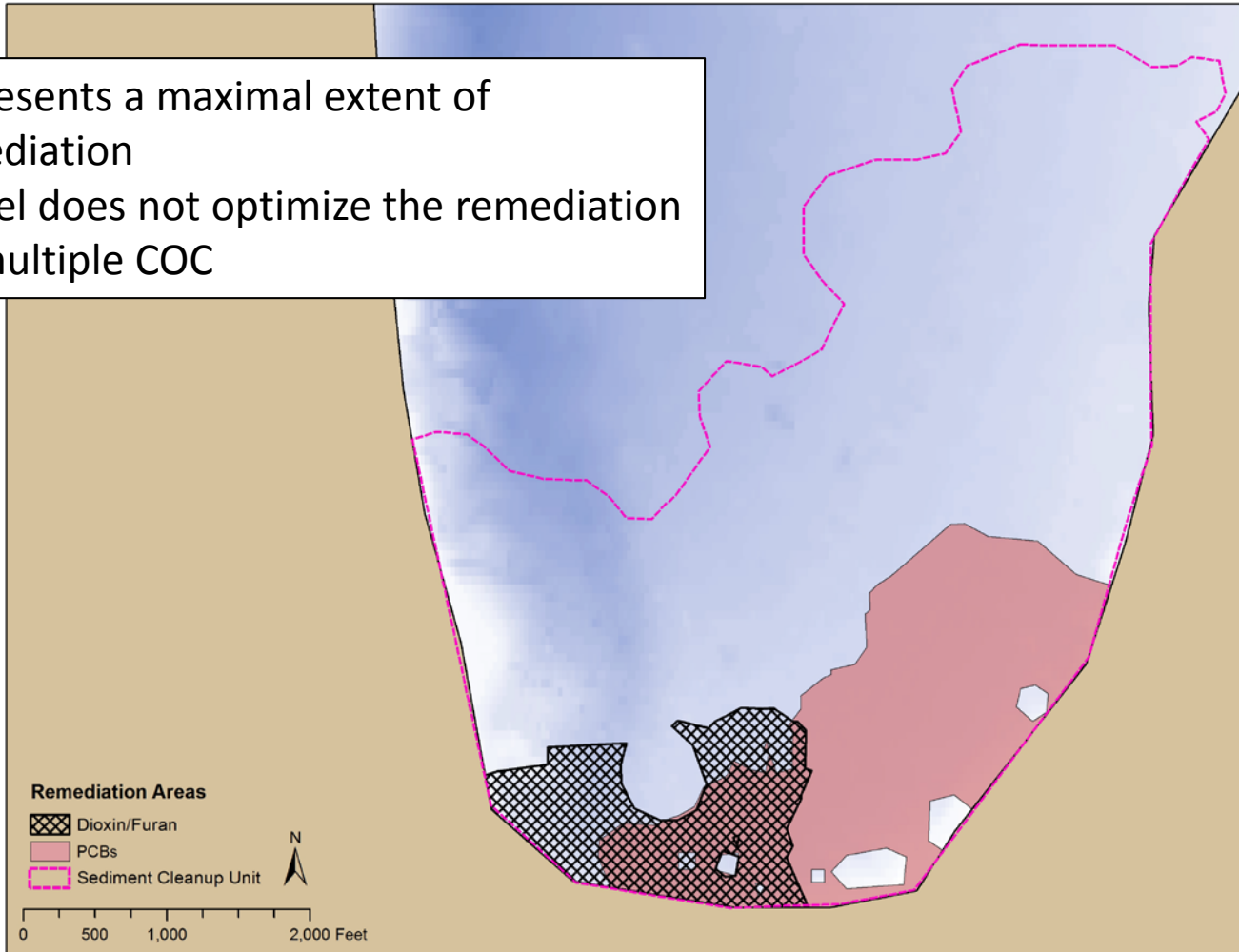
After remediation, how much time to meet the sediment cleanup level?

Scenario Modeling – Optimal Dioxin/Furan Remediation



Scenario Modeling – Optimal Site -Wide Remediation

- Represents a maximal extent of remediation
- Model does not optimize the remediation for multiple COC





Questions?



Reference

Jacobs, L., R. Barrick, and T. Ginn 1988. Application of a Mathematical Model (SEDCAM) to Evaluate the Effects of Source Control on Sediment Contamination in Commencement Bay. pp. 677 to 684. [In:] Proceedings; First Annual Meeting on Puget Sound Research; Volume 2. 18 to 19 March 1988; The Seattle Center; Seattle, Washington. Puget Sound Water Quality Authority; Seattle, Washington.