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Evaluating Source Control Sufficiency with TIGSED, a Small-Scale Sediment Contamination Model

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Agenda

- Source Control Sufficiency Assessment Overview
- SEDCAM
- TIGSED
- Case Studies
  - Source Control Sufficiency Assessment
  - Dredging Contamination
  - Roadway Recontamination Assessment

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Reducing Recontamination Potential

- Source control sufficiency assessments help avoid recontamination of costly sediment remediation
- Sediment remediation in complex waterway Superfund projects is expensive
  - Portland Harbor estimate: $1.13 billion (EPA 2019)
  - LDW estimate: $327 million (EPA 2014)
- It's imperative these costly remediations are not recontaminated in the future
- These assessments are complicated by multiple potential contaminant sources
- In Pacific Northwest, EPA has required these assessments in the design process

Sediment transport

Fires on overwater structures or vessels

Stormwater discharges

Spills from overwater vessels or structures

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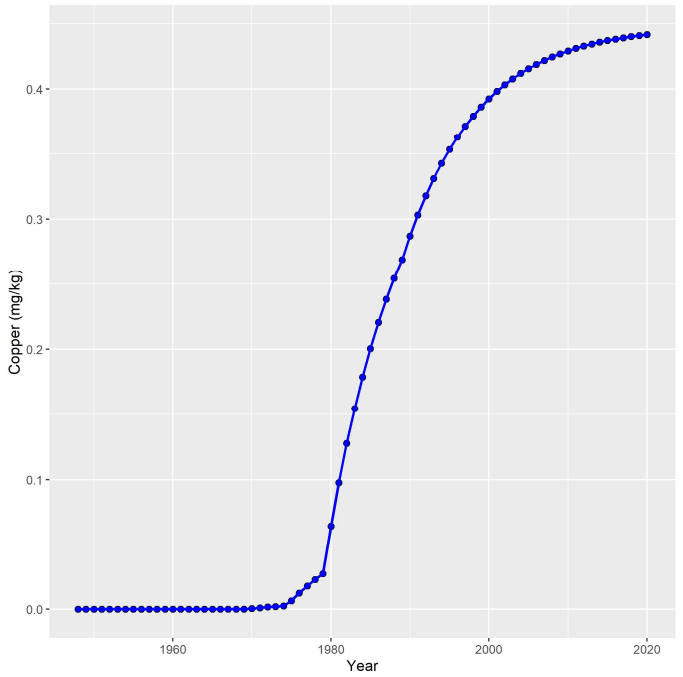
Modeling Sediment Contamination in Simple Systems

Modeling sediment concentrations can account for interaction of multiple sources

Sediment Contamination Assessment Model (SEDCAM) is a mass-balance equation for modeling sediment concentration over time

$$C_t = \frac{M}{(M+kS)} \times C_I \times \left[1 - e^{\frac{-(kS+M)}{S}}\right] + C_O \times e^{\frac{-(kS+M)t}{S}}$$

SEDCAM predicts surface sediment (C_t) change over time (t) based on existing sediment (C_O) and incoming sediment (C_I) concentrations



Lucinda Jacobs, Robert Barrick, and Thomas Ginn, "Application of a Mathematical Model (SEDCAM) to Evaluate the Effects of Source Control on Sediment Contamination in Commencement Bay", 1998

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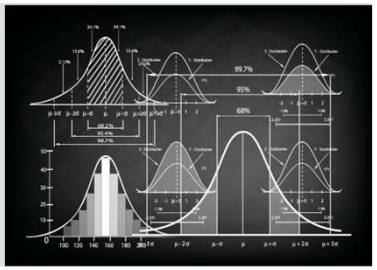
Modeling Sediment Contamination in Complex Multi-Source Systems

- TIGSED© uses the SEDCAM model, often in combination with hydrodynamic modeling, to get SEDCAM results at finer resolutions
- TIGSED accounts for the complexity inherent in large waterways

Conducting millions of SEDCAM calculations in minutes



Considering differing sediment conditions

Accounting for year-by-year environmental variations

Handling non-stormwater discharge pathways

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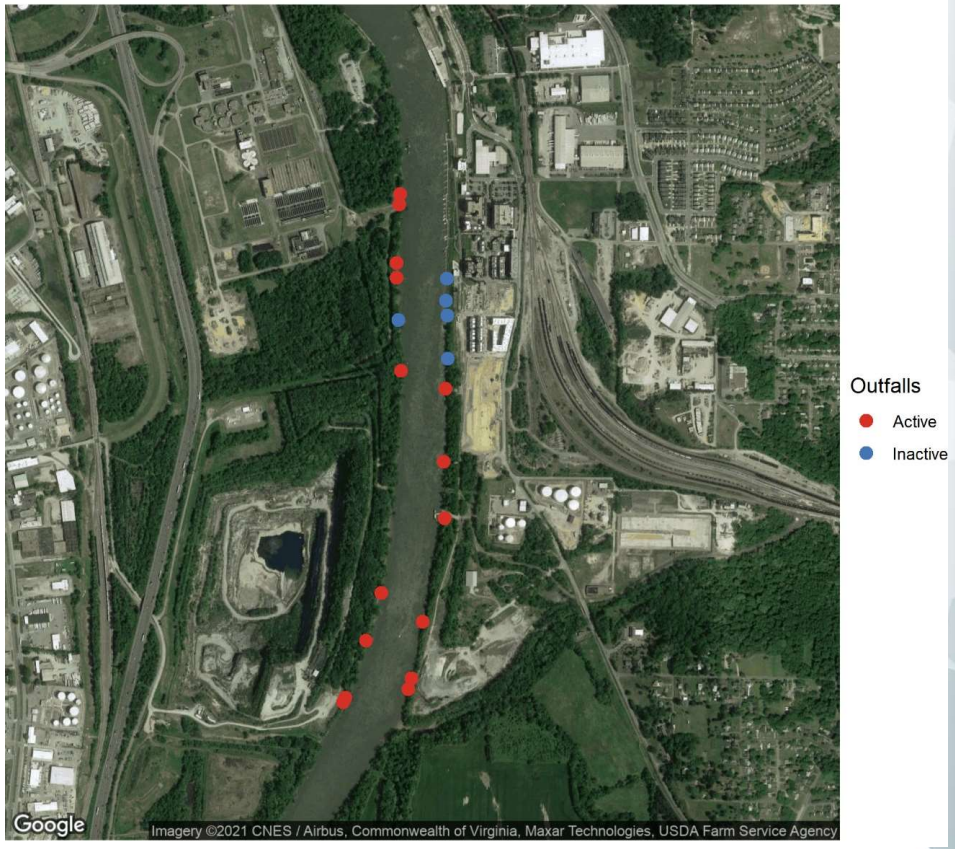
Case Study 1: Source Control Sufficiency Assessment

- **Background**: Manufacturing company's outfalls are primary source of copper contamination in sediment.
- **Problem**: If all discharges are re-routed to the sanitary sewer will the remediated area be re-contaminated?
- **Solution**: Model future sediment concentrations in the river assuming the discharges are re-routed as proposed.



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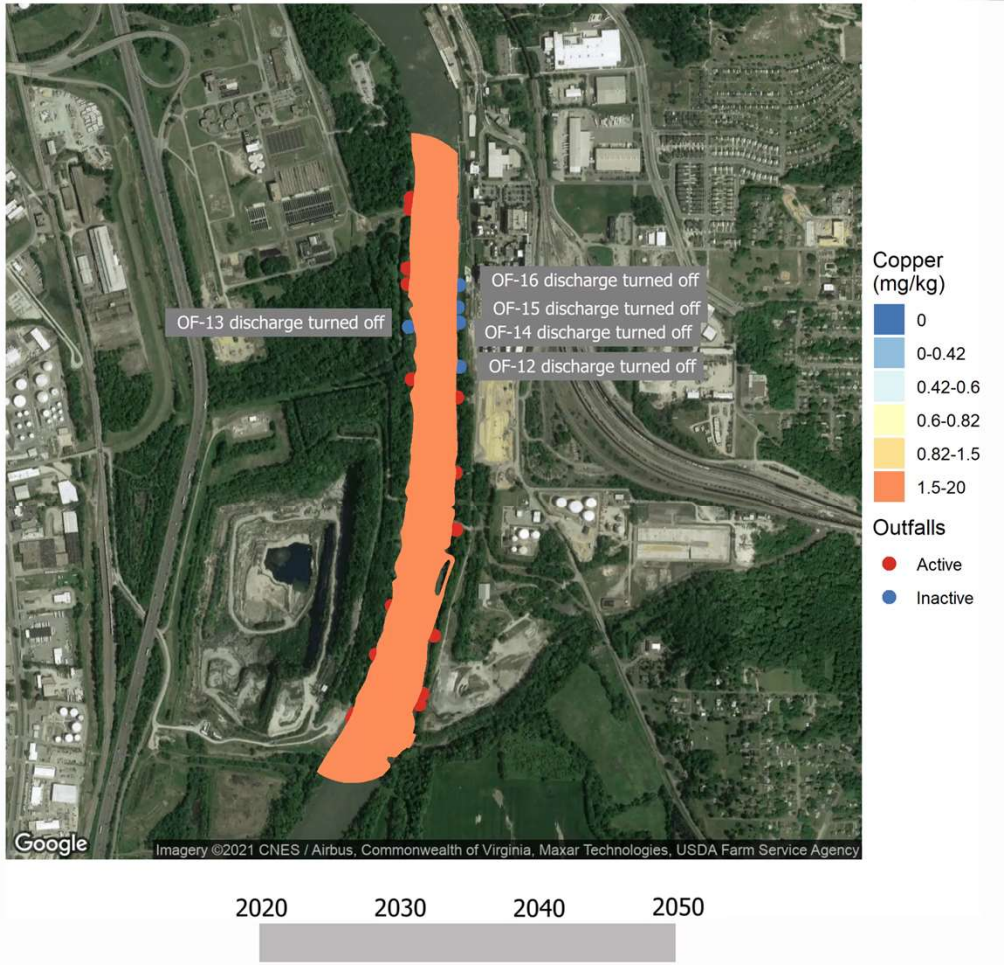
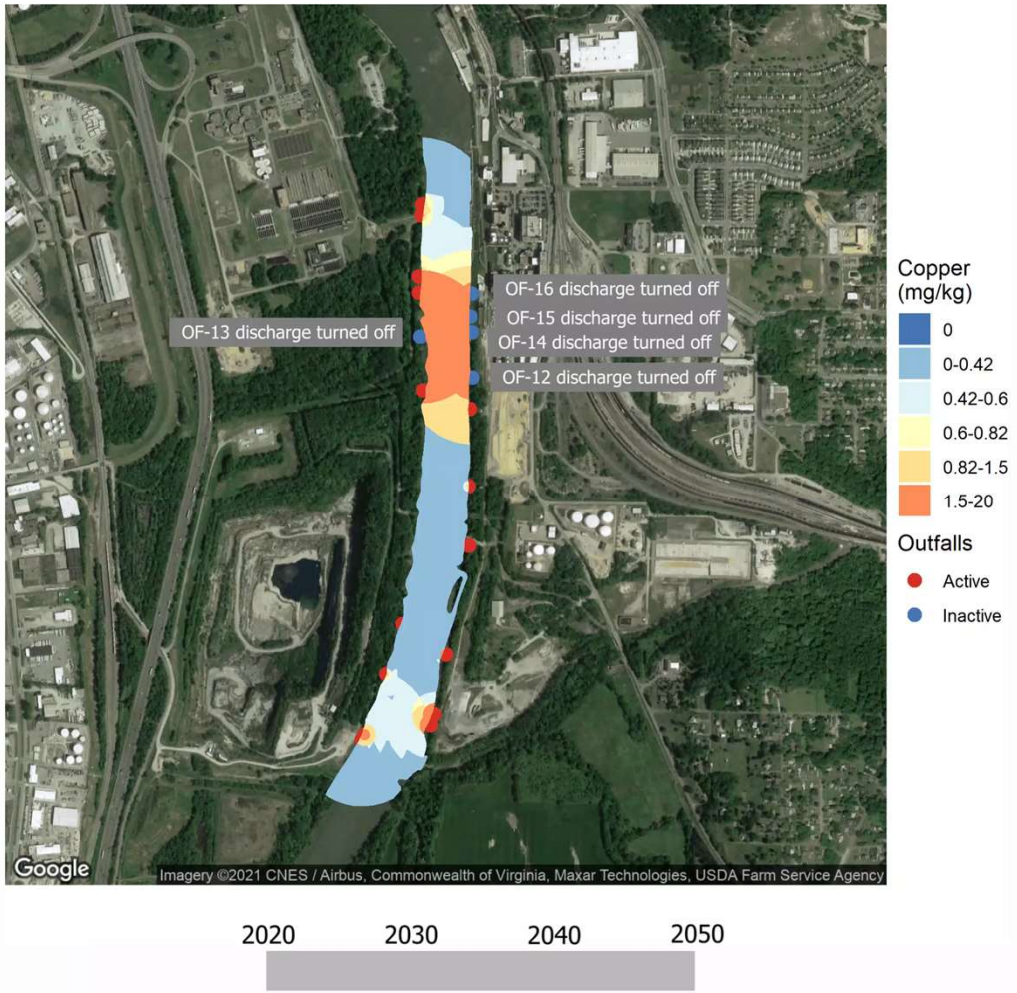
Case Study 1: Modeling Area as Simple System

- SEDCAM modeling of average copper concentration and contributions from 20 outfalls across 1.5 miles assuming the manufacturing company's outfalls no longer discharge to the river
- Model shows study-wide reduction in copper concentration below cleanup levels (0.82 mg/kg) over time
- Given high density of outfalls in certain areas, modeling of average inputs may miss areas of smaller and/or larger changes in concentration



Case Study 1: Modeling Area as Complex System

- TIGSED modeling uses deposition modeling from each outfall to conduct SEDCAM calculation for each overlapping area
- Results in finer resolution of contamination changes
- Model shows:
  - Improvement below cleanup level (0.82 mg/kg) in area where outfall discharge re-routed
  - Downstream area of river will show exceedance of cleanup level within 30 yrs



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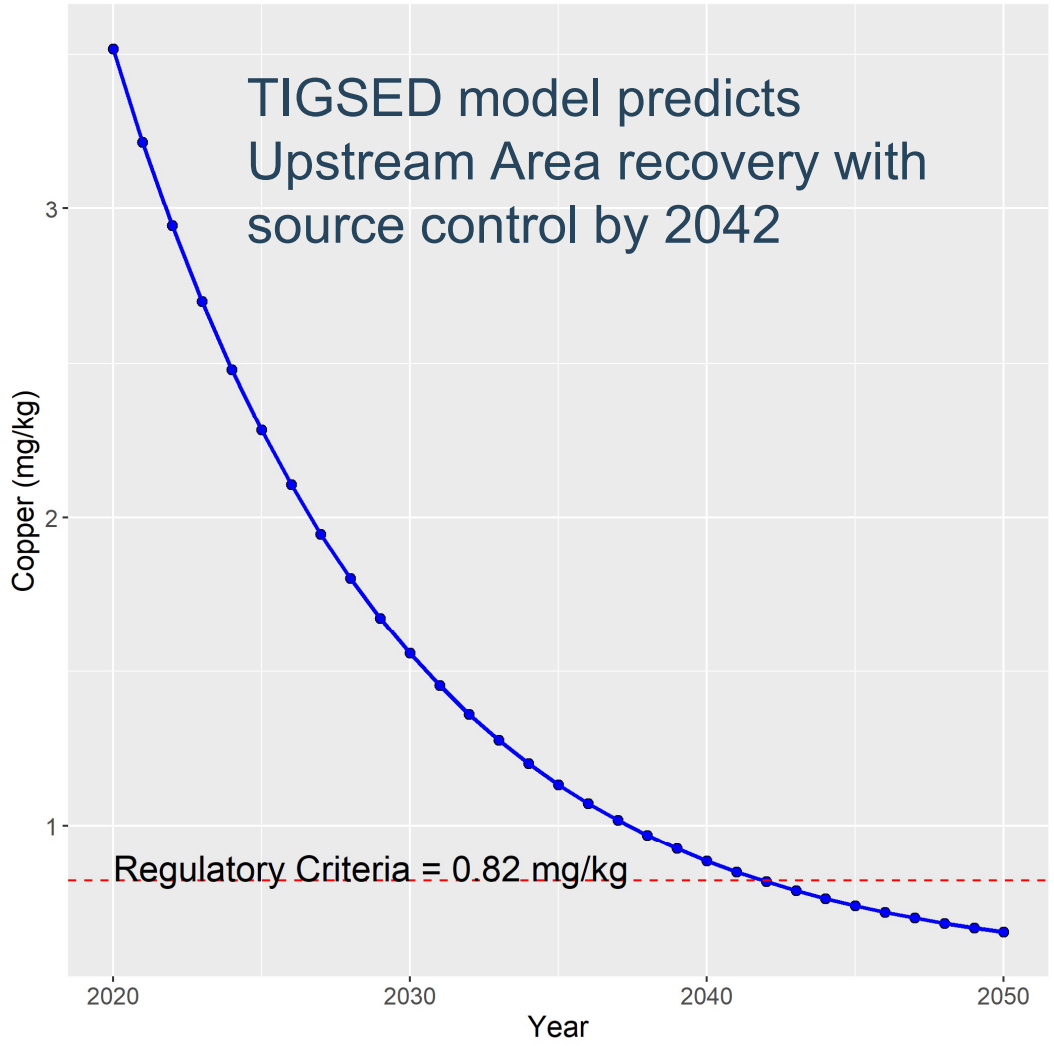

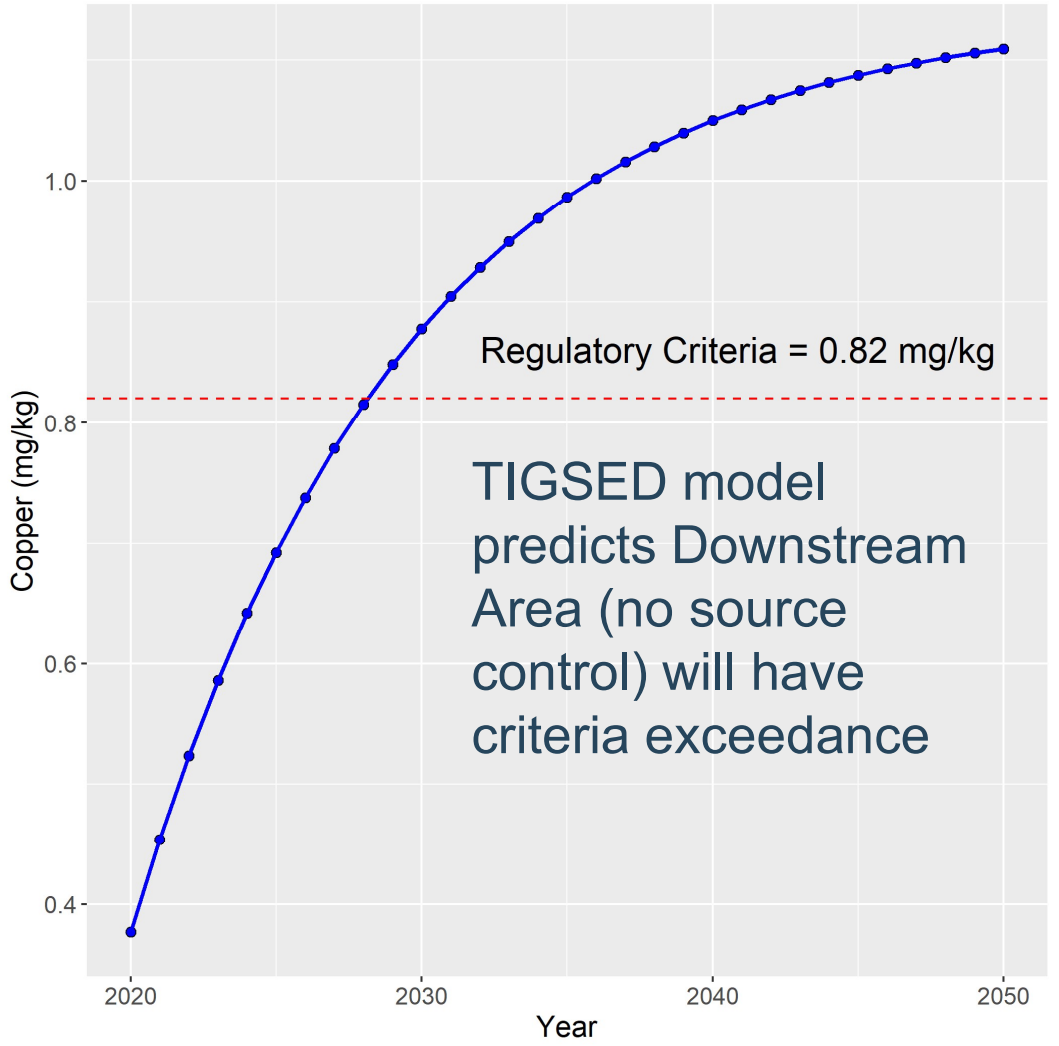

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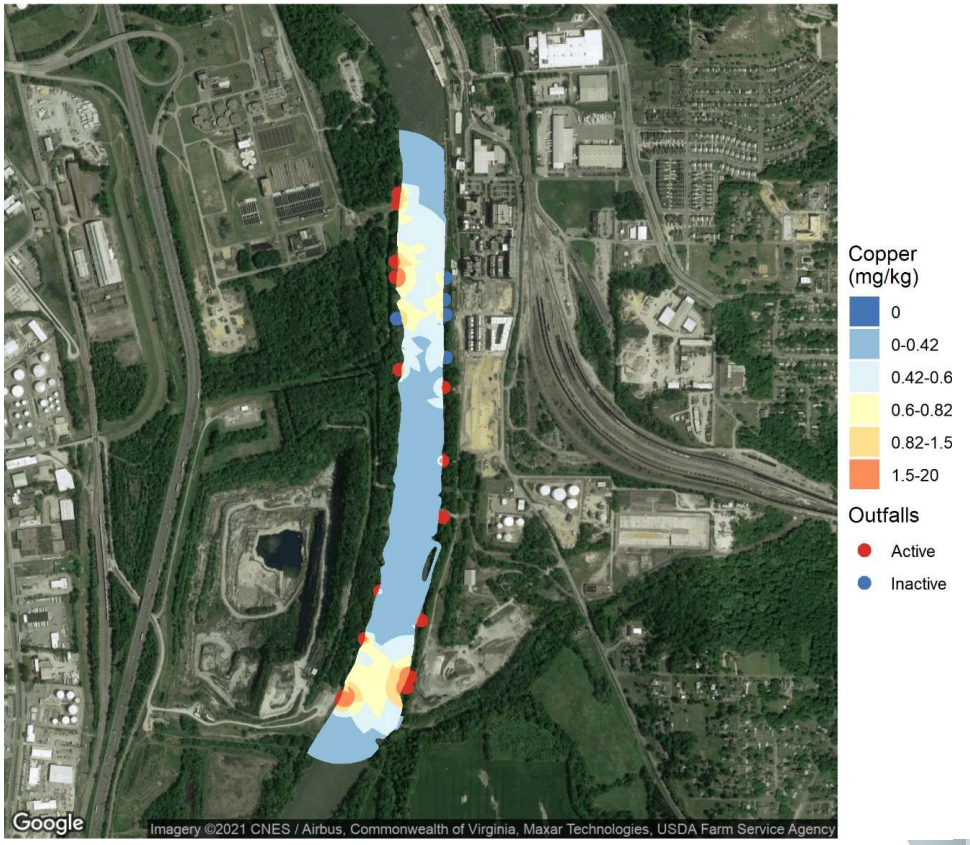
Case Study 1: Conclusions

- TIGSED model indicated that re-routing of outfalls was sufficient for natural recovery of localized area of contaminated sediments
- Results indicated that control of outfalls will not result in long-term recontamination
- Results also indicated unexpected potential for downstream area to become contaminated by other sources



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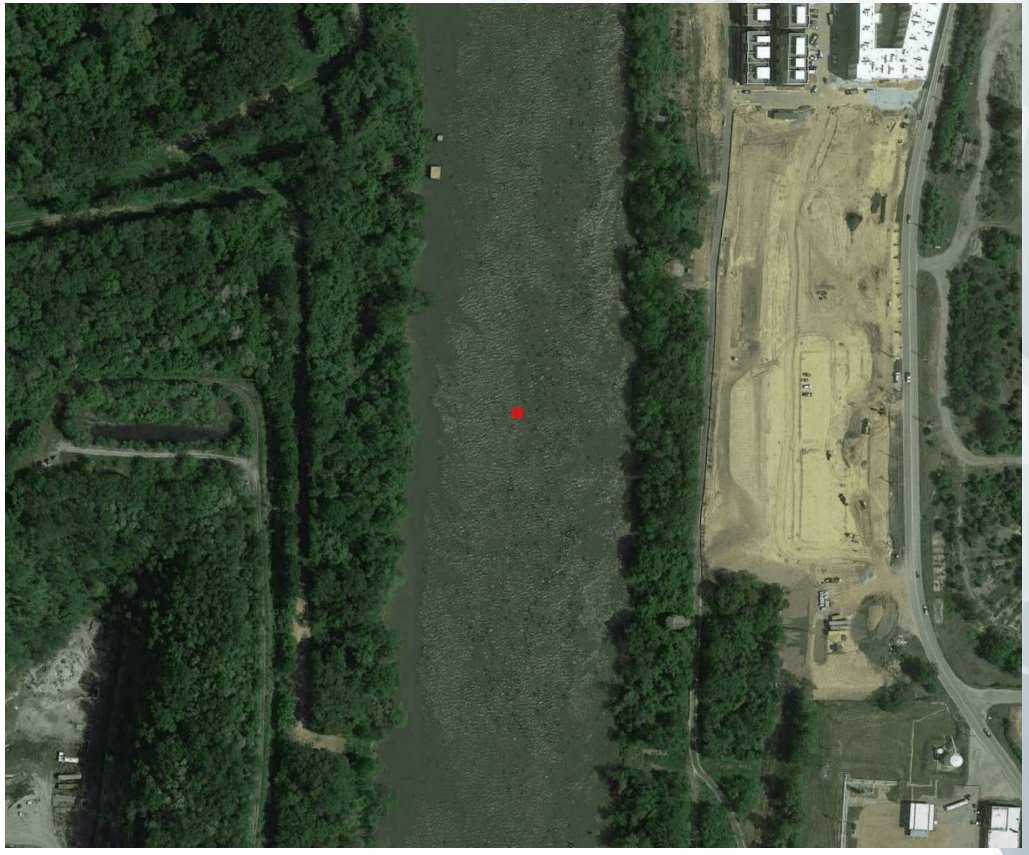
Case Study 2: Dredging Contamination

- **Background:** A regulatory agency is evaluating dredging as an option to remediate sediments
- **Problem:** Will resuspension during dredging spread cadmium contamination outside the dredging area?
- **Solution:** Use TIGSED to model sediment contamination associated with resuspension from dredging



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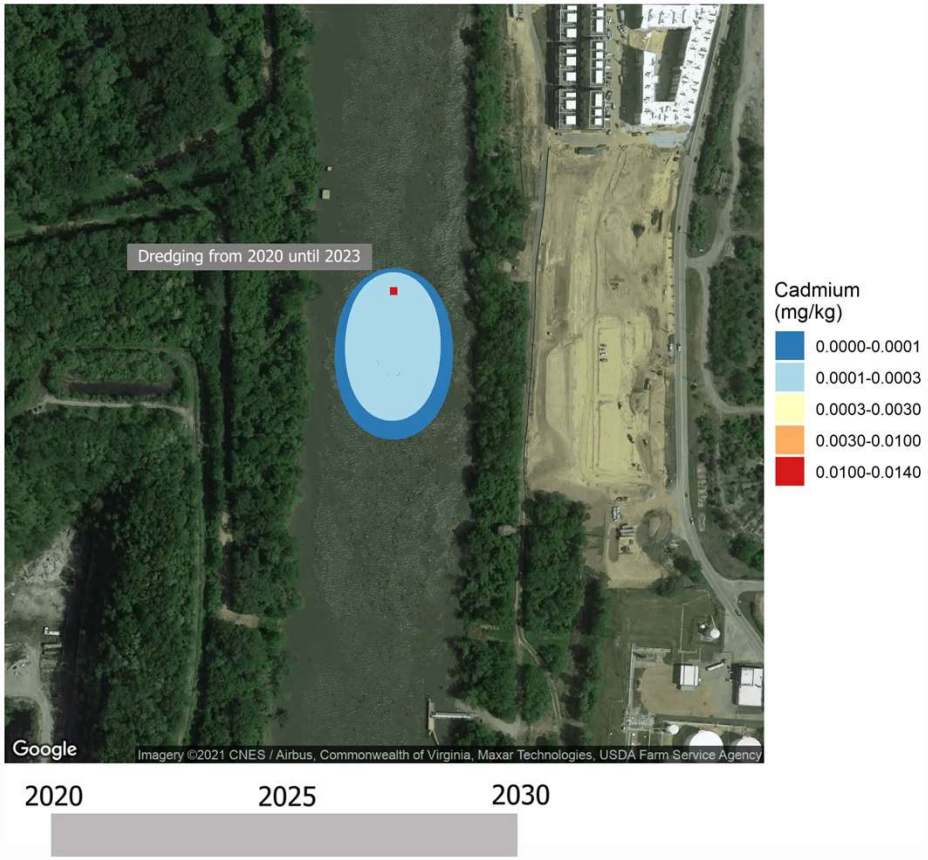
When evaluating three years of dredging with some releases each year, TIGSED model finds:

- At the end of dredging operations, the sediment concentration of cadmium is elevated
- Seven years after dredging sediment has recovered and concentrations are an order of magnitude lower than concentrations measured at the end of dredging



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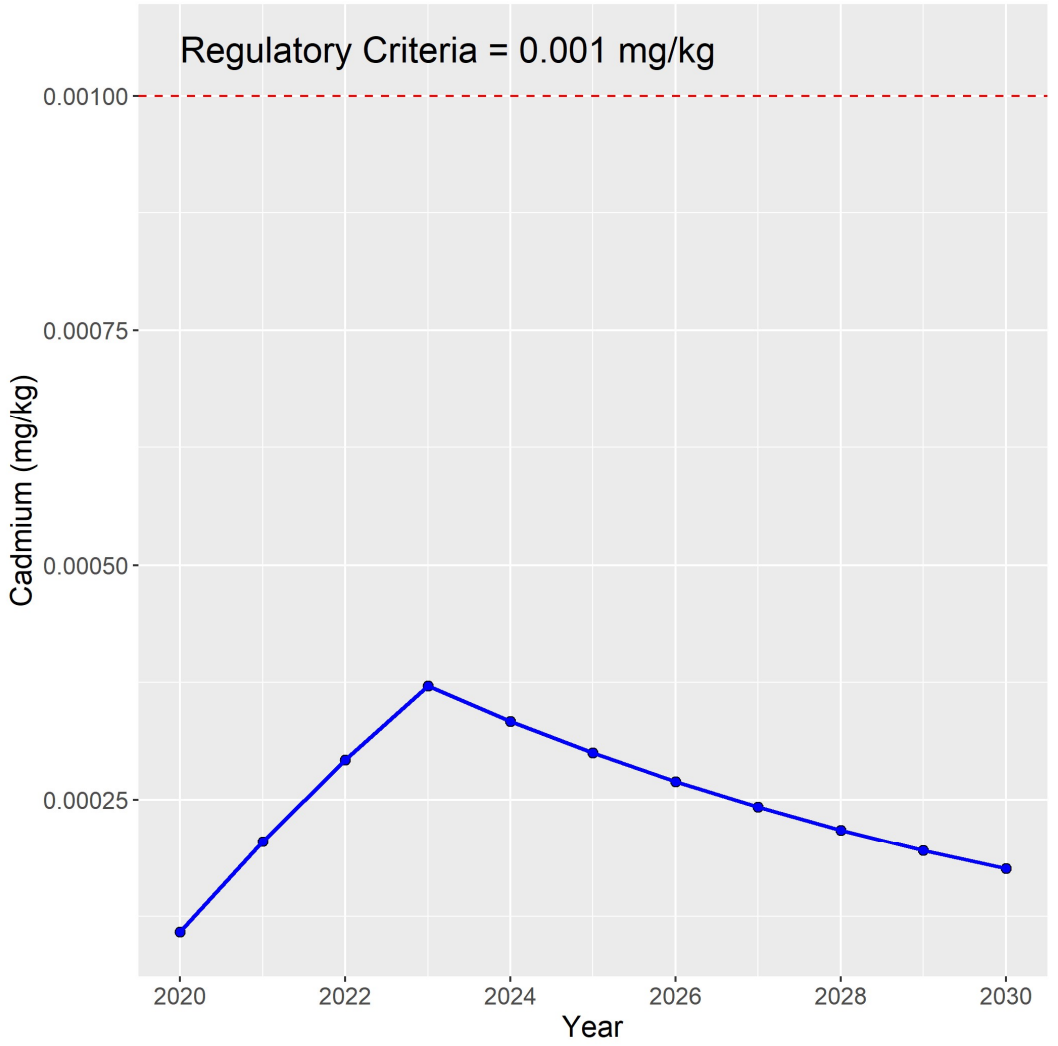
TIGSED model also shows that none of the areas impacted by dredging exceed regulatory criteria.



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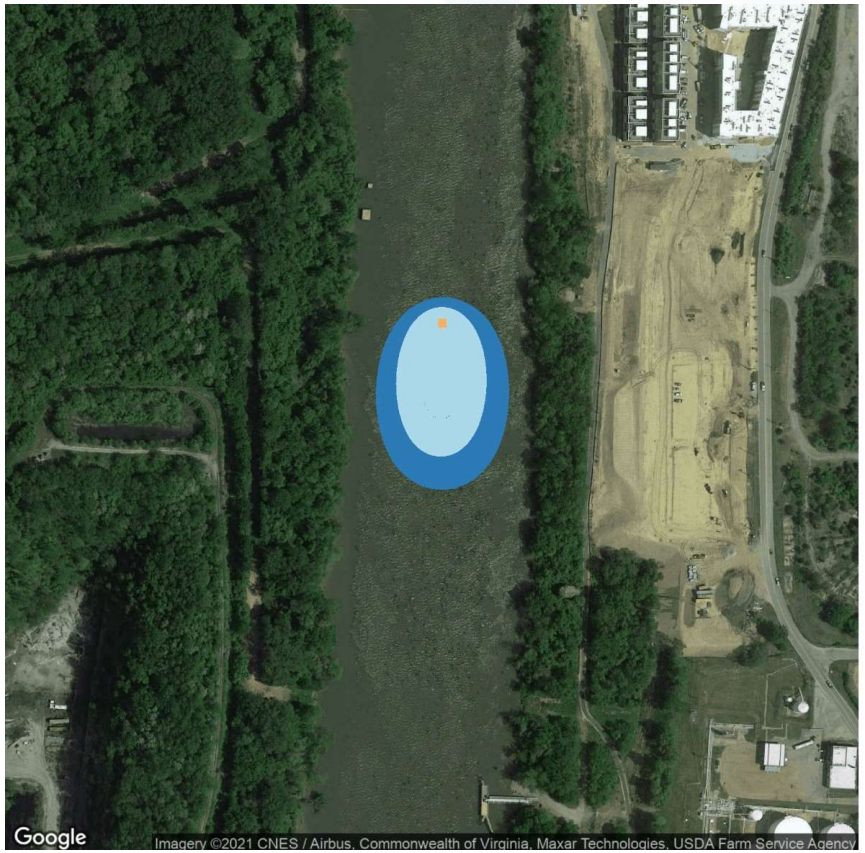
Case Study 2: Conclusions

- Extent of cadmium contamination temporarily increases due to loss of dredge material
- However, system recovers to near pre-dredging concentrations after seven years
- None of the surrounding areas exceed regulatory criteria as part of dredging event
- Areas near point of dredging show higher concentrations, which wouldn't be seen in simple model



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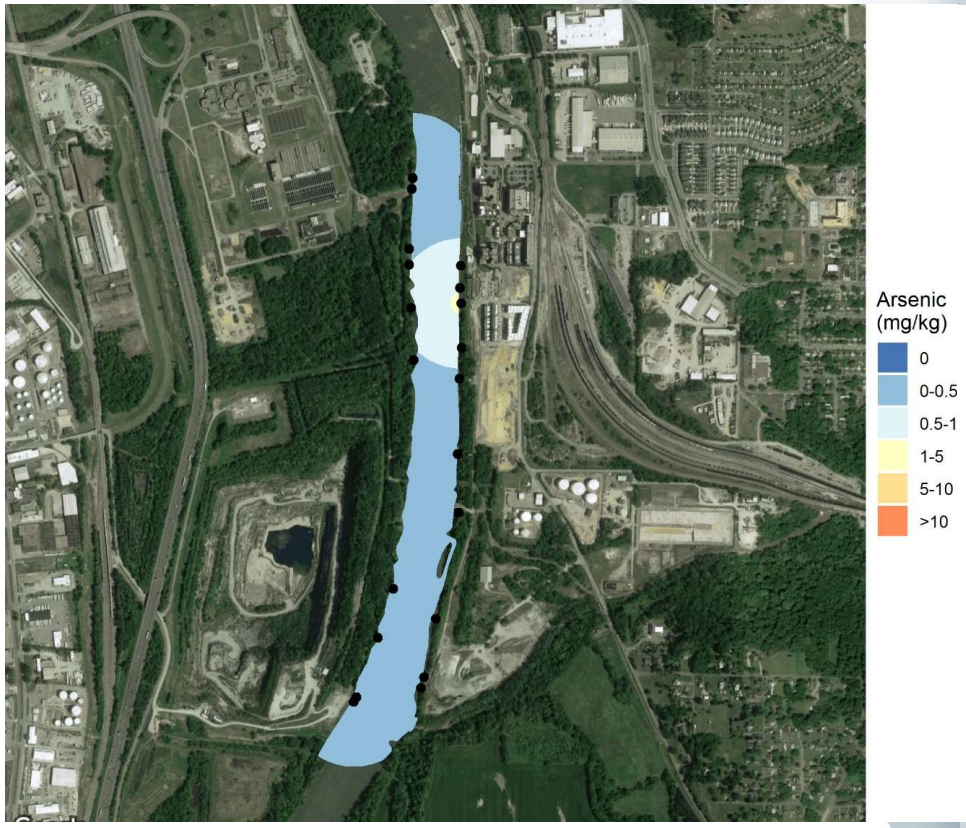
Case Study 3: Roadway Recontamination Assessment

- **Background:** Discharges from roadway outfalls and bridge coatings contain arsenic.
- **Problem:** Arsenic concentrations are being remediated (1 mg/kg cleanup criteria). Are roadway outfalls and bridge coatings a source of recontamination?
- **Solution:** Model sediment concentrations over time using TIGSED, assuming roadway outfalls and bridges are the only arsenic contributions. Determine if arsenic concentrations exceed cleanup levels.



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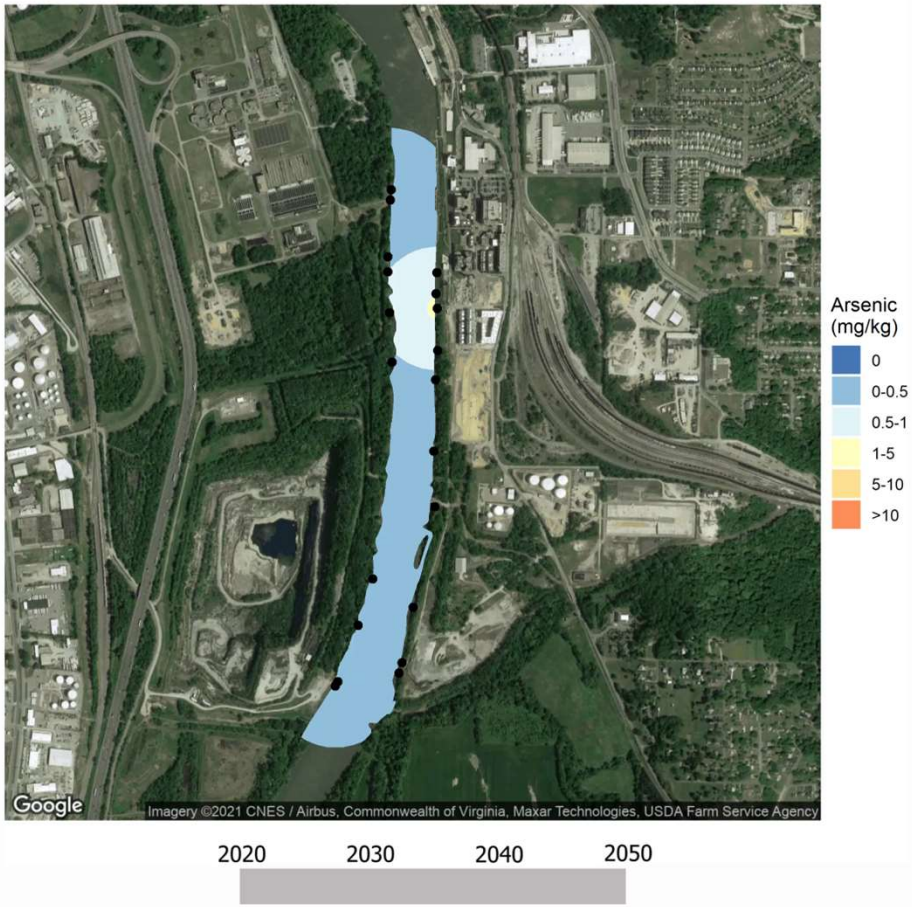
Assuming that roadway outfalls and bridges are the only source of arsenic post-remediation, TIGSED finds:

- Roadways and bridges are potentially responsible for arsenic exceedance of cleanup level (1 mg/kg) by 2030
- Planned 2030 outfall work will address outfalls associated with exceedance
- This limited area would recover naturally by 2050



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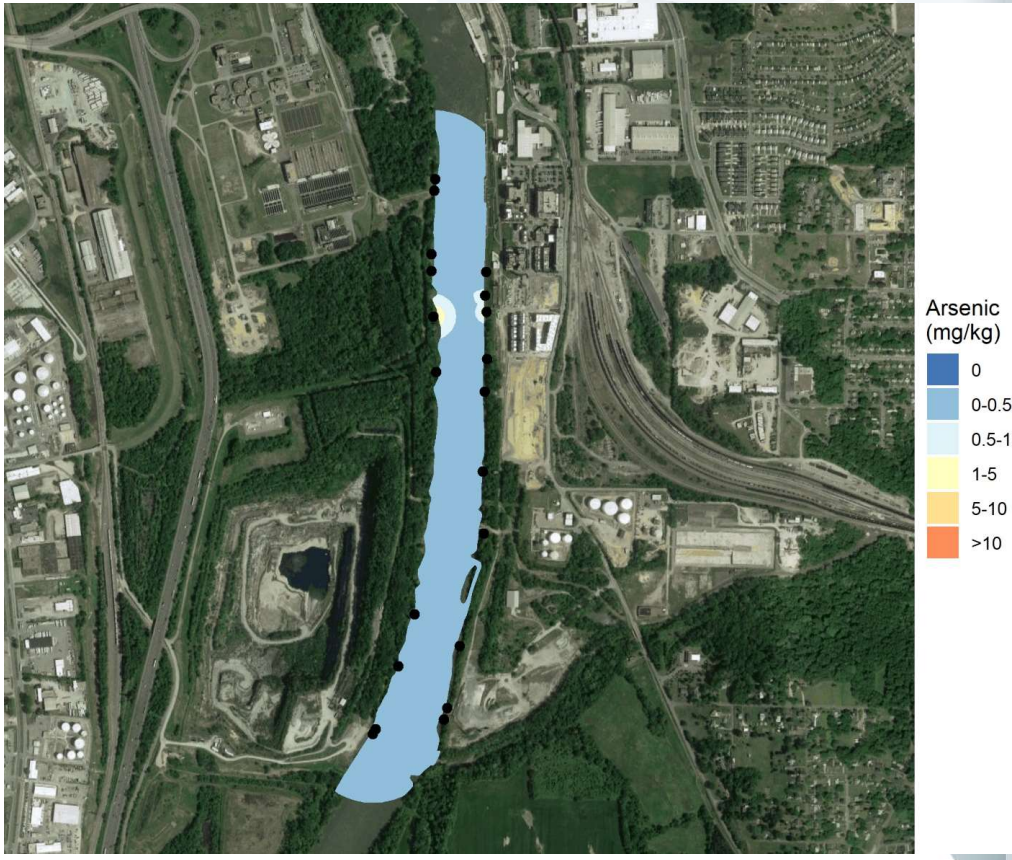
Case Study 3: Conclusions

- Roadways and bridges could contribute to exceedance of sediment cleanup levels for arsenic
- However, planned work in 2030 will address outfalls that result in exceedances
- Planned 2030 work may need to occur prior to remediation



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Summary

- Modeling a water body using a simple SEDCAM equation can provide useful insight into dynamics of sediment contamination and/or recovery
- More complex systems may require a more sophisticated implementation of SEDCAM, such as TIGSED, which can account for finer spatial resolutions and annual variation in various contaminant and sediment conditions
- The increased accuracy and precision of a more complex model can help meet design requirements, reduce potential for recontamination, and provide increased confidence in results
- TIGSED can:
  - Identify unexpected potential contamination sources
  - Provide confirmation of limited contamination
  - Help in addressing timing of remediation and/or source control

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Thank You

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