Black Butte Mine: From Investigation to Remedy-Focused Decisions

EPA Region 10 Black Butte Mine Site

What happens **NEXT** is happening **NOW**.

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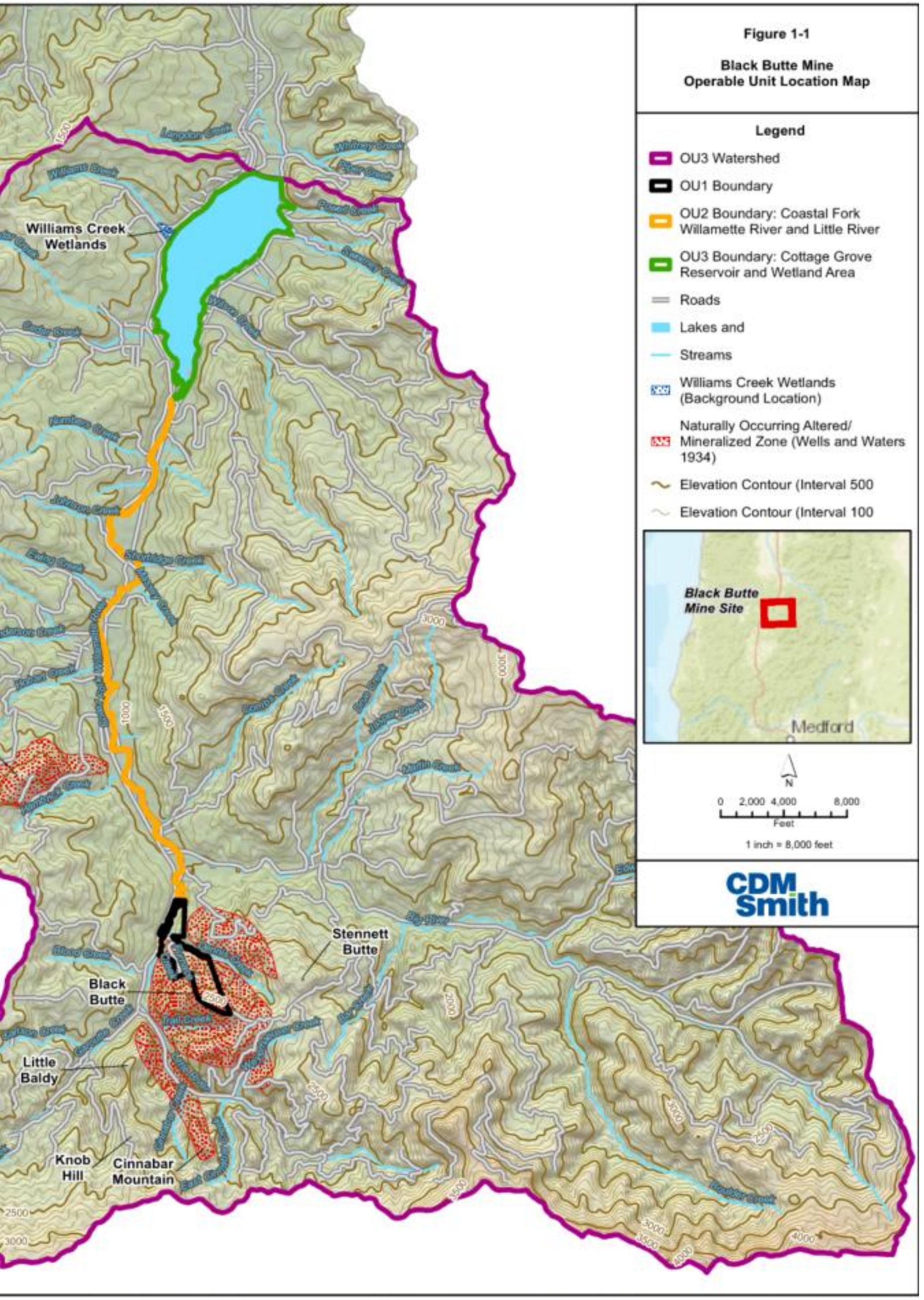


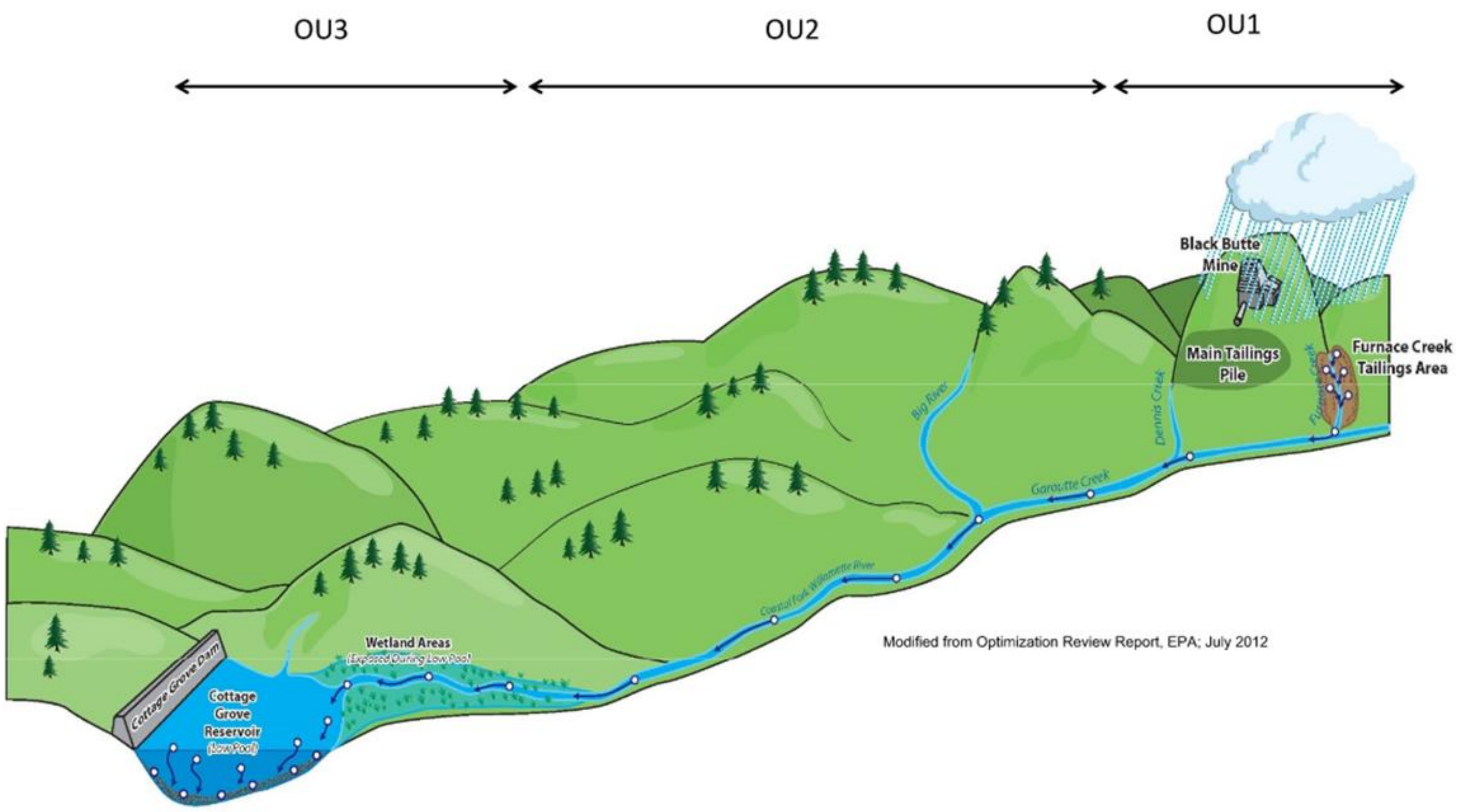
Agenda

1. Site Overview and Framework
2. Remedial Investigation (RI) Findings
3. Key Insights:
   - Isotope Fingerprinting
   - Methylmercury Processes
4. Data Gaps and Targeted Investigations
5. Treatability Study Approach
6. Transistion to Feasibility Study (FS)
7. Lessons Learned

Site Overview and Framework

Site Overview

- Legacy mercury mine in a watershed setting
- Source → Transport → Receptor System



Modified from Optimization Review Report, EPA; July 2012

- OU1: Mine source areas
- OU2: Downstream transport corridor
- OU3: Reservoir environment

Remedial Investigation (RI) Findings

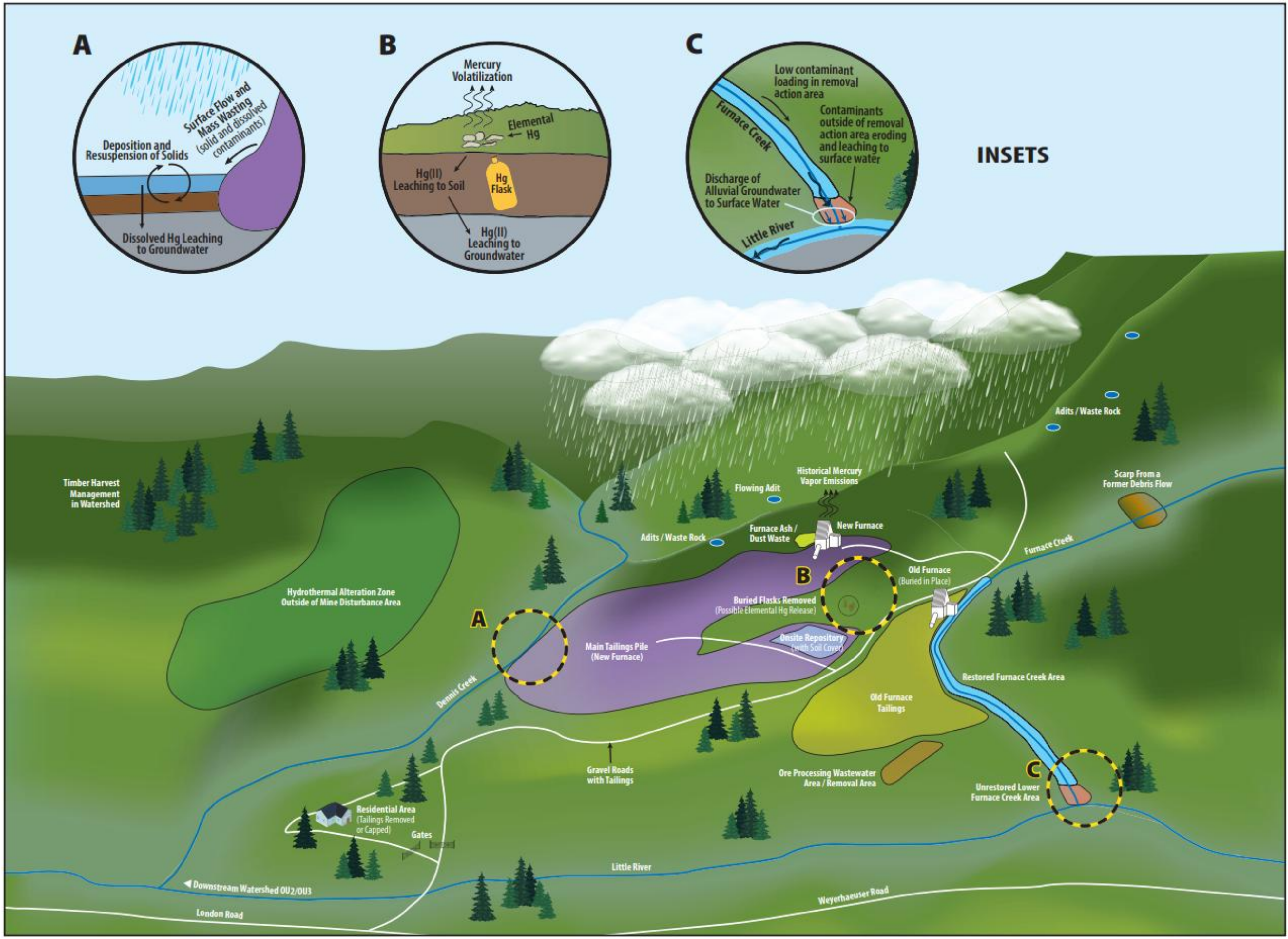
RI Scope

- Multimedia sampling:
  - Surface water, sediment, soil, groundwater, hyporeic porewater, biota (Trophic 1 - 4)
- Hydrologic, geologic, and geochemical charicterization
- Multi-season and spatial coverage

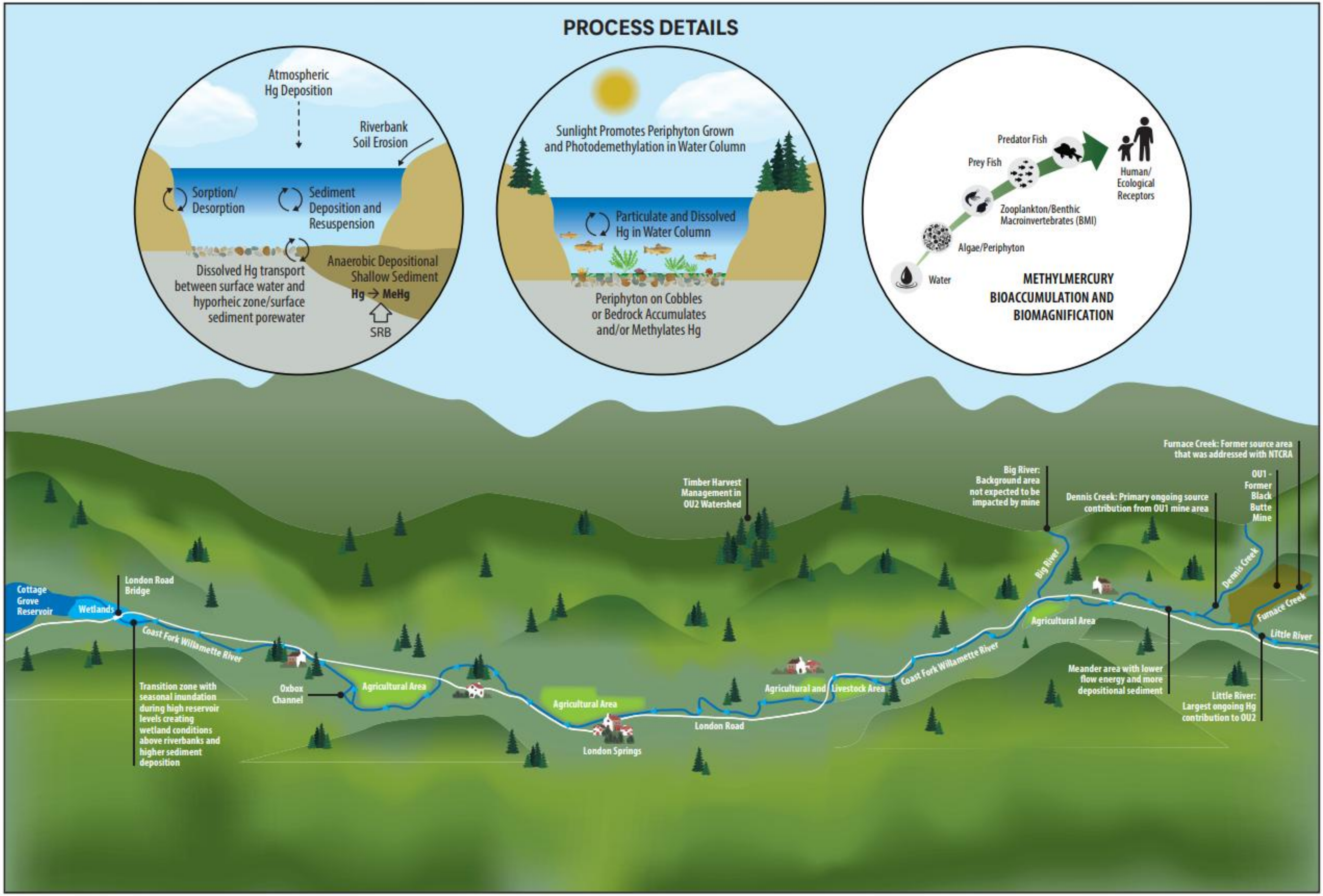
Key RI Findings

- OU1 identified as dominant mercury source to watershed
- Both downstream ***transport***, ***transformation***, and ***bioaccumulatio*** observed in OU2 and OU3
- **Transport** driven by sediment-bound mercury
- **Transformation** to methylmercury driven by periphyton in OU2 and sediment/hypoxia influences
- **Bioaccumulation** largely driven by exposure of methylmercury to base of the food web: examples include but are not limited to periphyton consumption by grazers or algae and zooplankton uptake from the water column

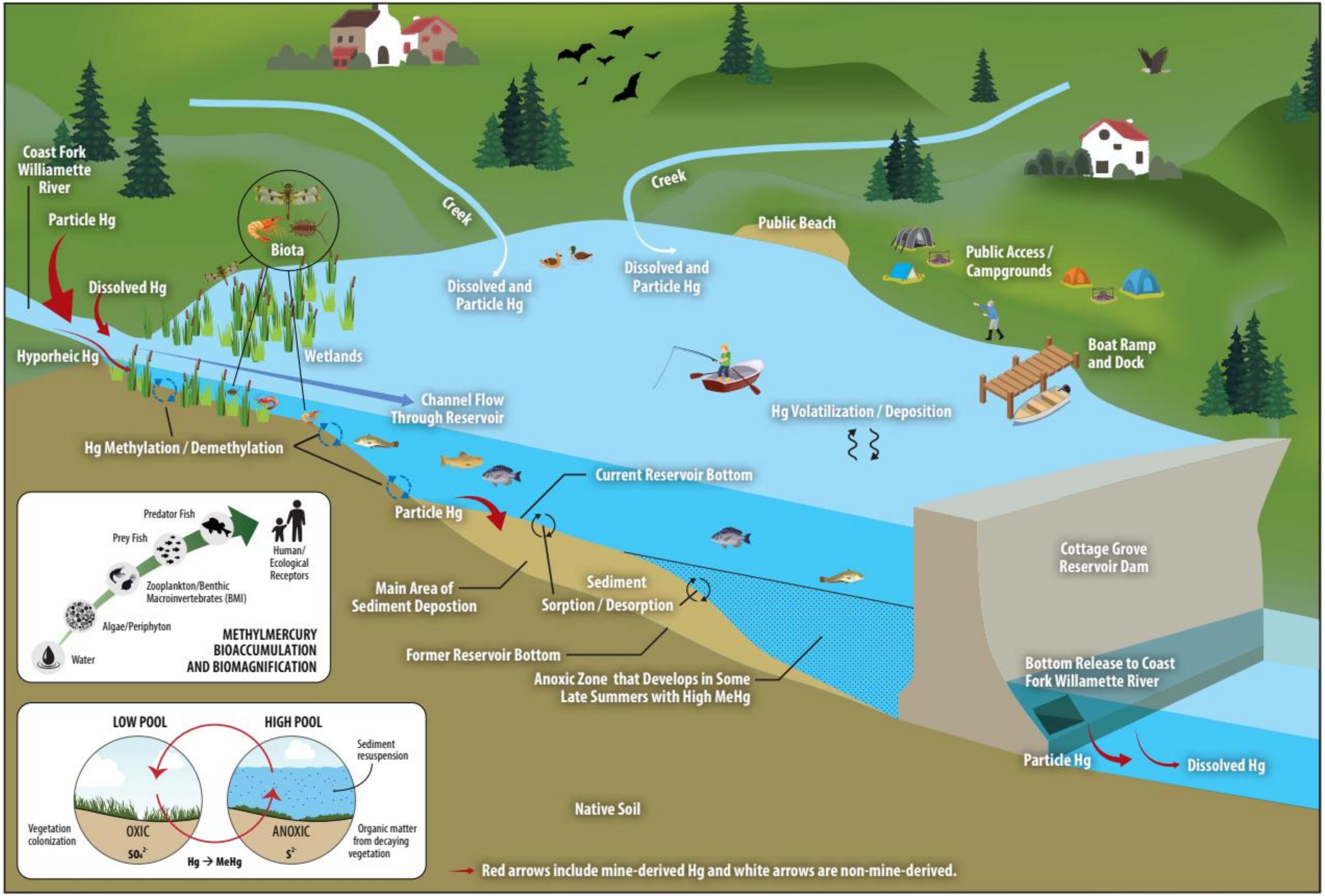
Conceptual Site Model: OU1



Conceptual Site Model: OU2



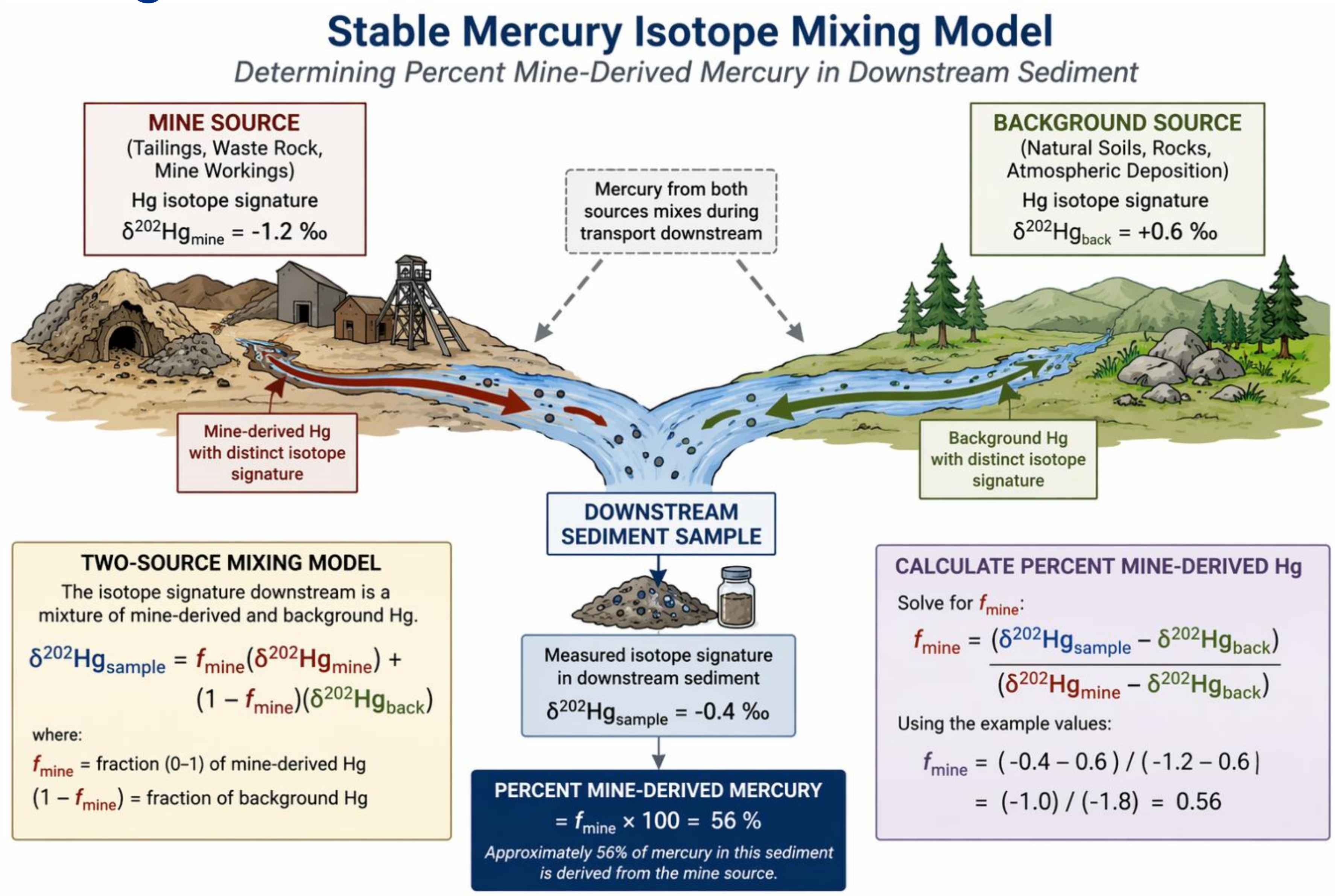
Conceptual Site Model: OU3



Key Insights

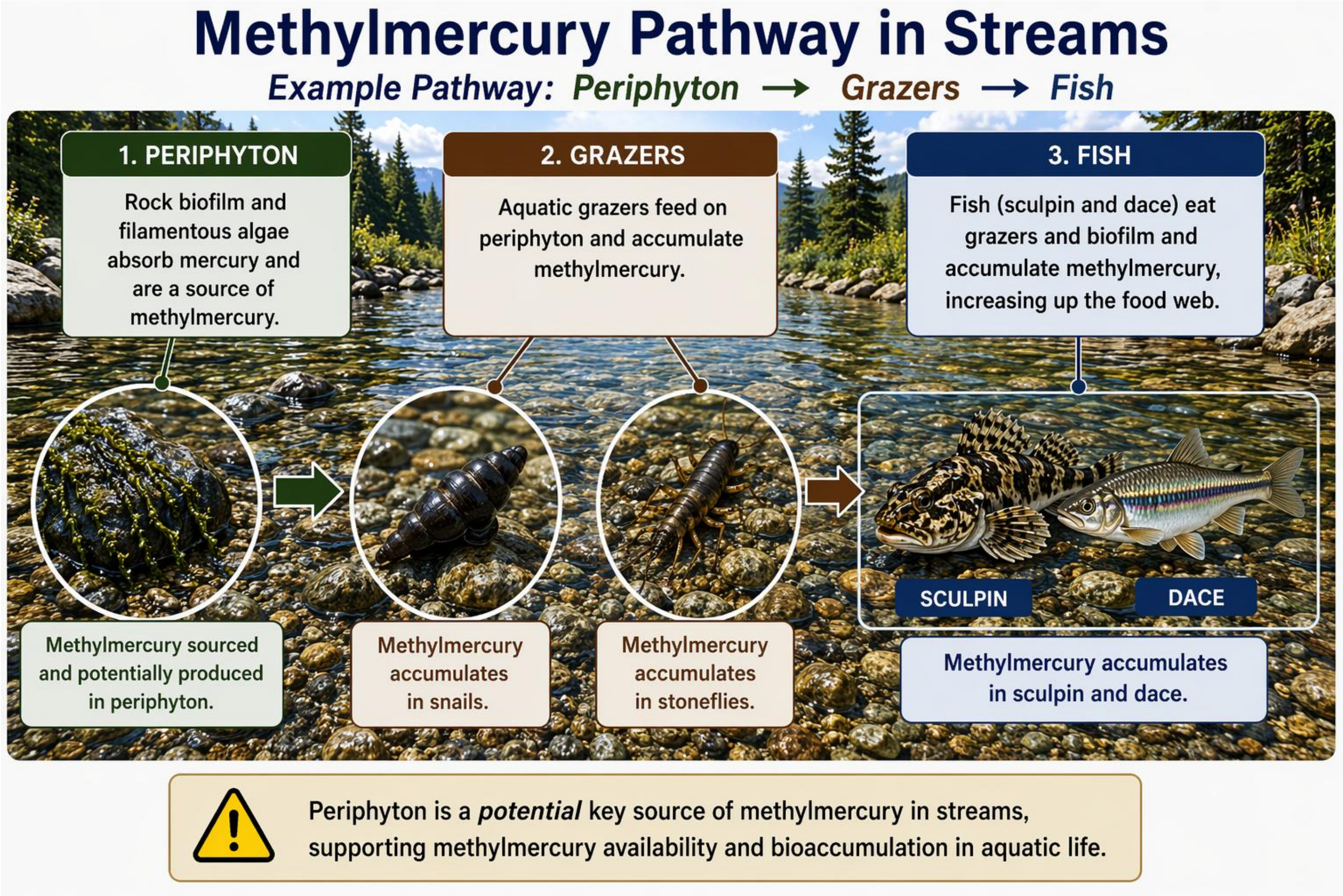
Isotopic Fingerprinting

- Distinguishes between mine derived and background sources
- Aids in transport pathway determination
- Potential pathway toward cleanup goals



Biological Controls on Methylmercury (Game Changer in OU2)

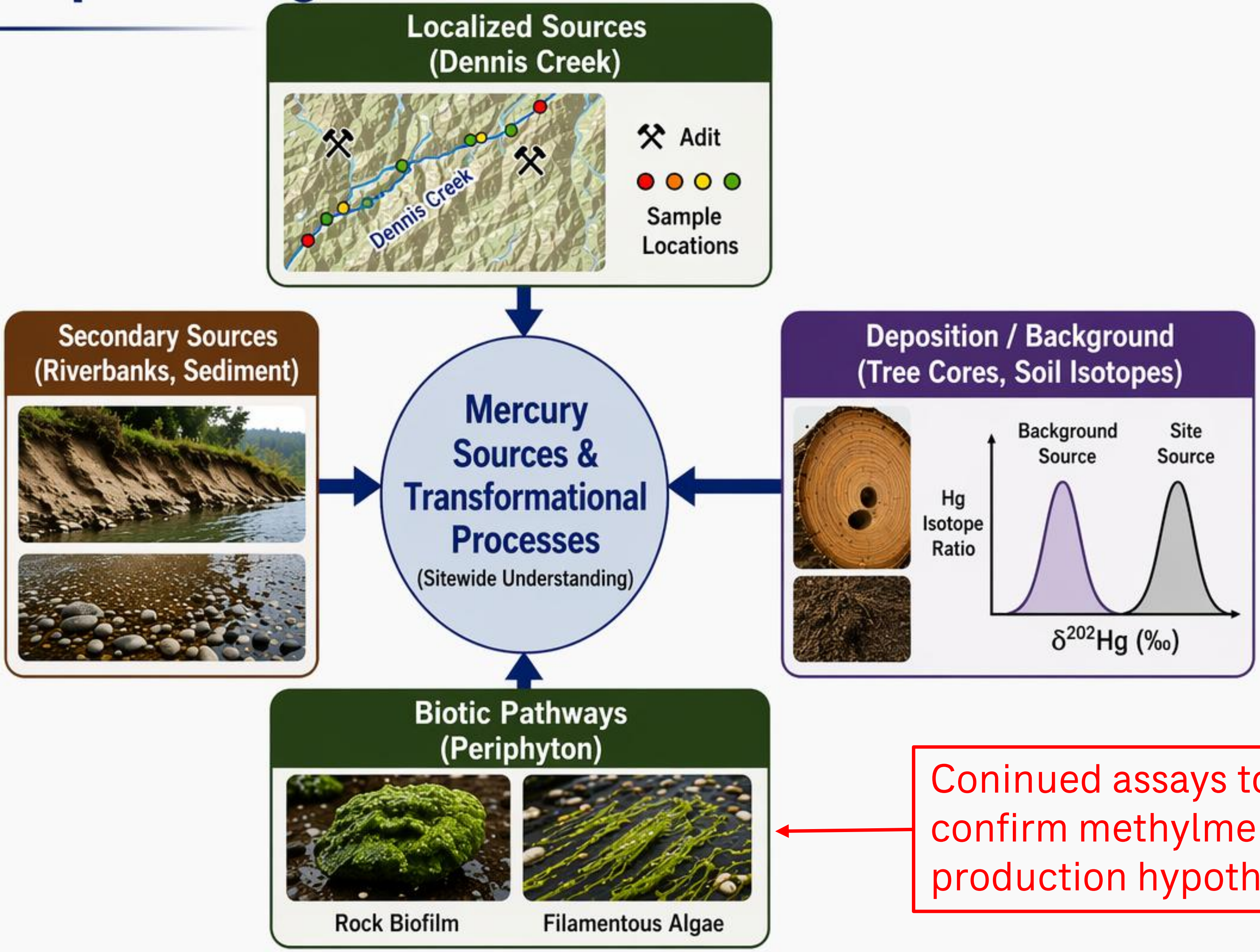
- Transport of inorganic mercury through OU2 not the only mechanism at work
- Periphyton (biofilm and filamentous algae) a major methylmercury source in OU2
  - To both water and base of food web
- Confirmed by modeling and provides rational for elevated fish tissue in OU2
  - WASP8 indicated that sediments are not the sole source



Data Gaps and Targeted Investigations

Targeted Data Gap Investigations

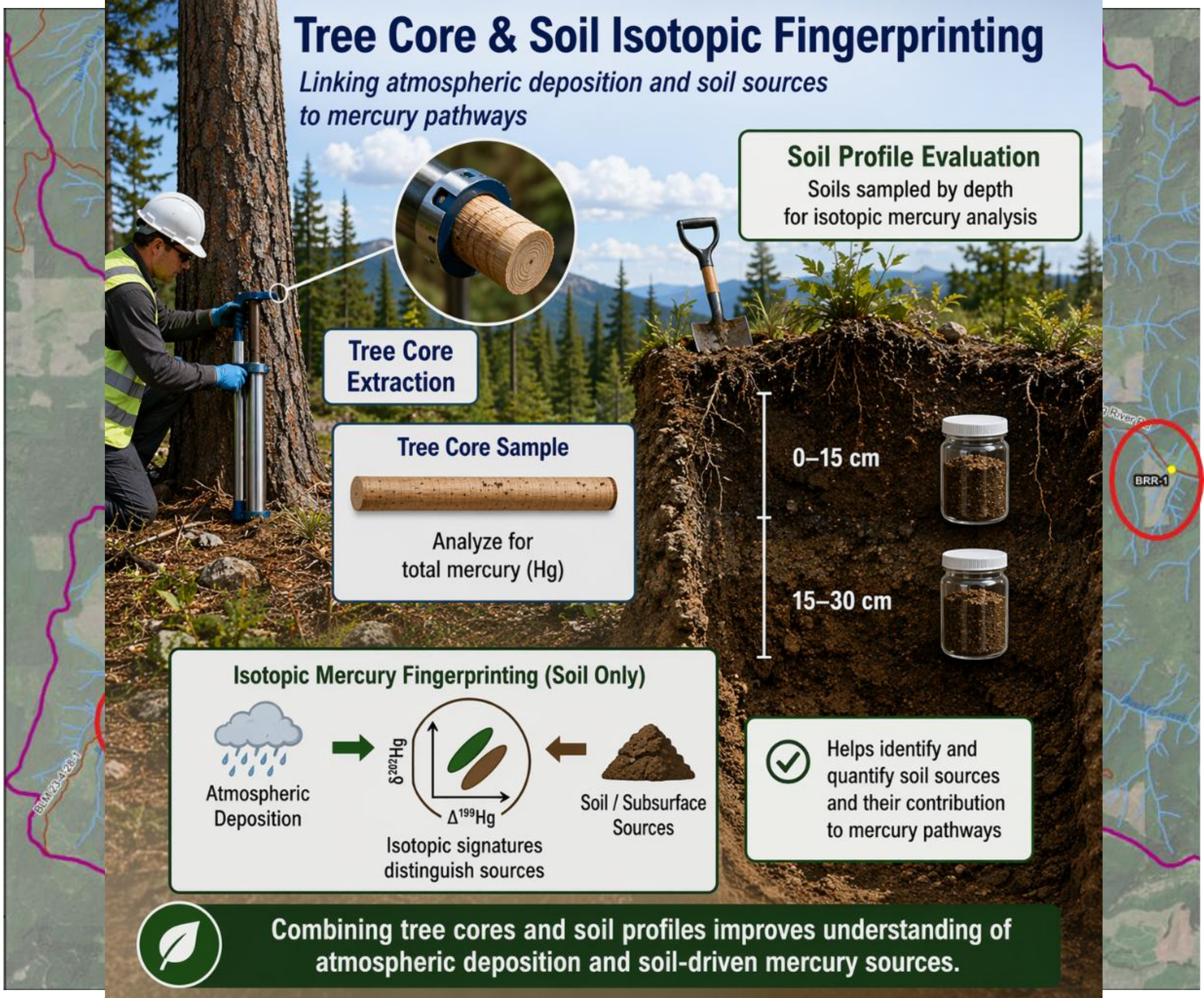
1. Identified localized source areas (Dennis Creek)
2. Evaluated secondary OU2 sources (riverbanks, sediment)
3. Assessed biotic pathways (periphyton)
4. Used tree cores and soil isotopes for deposition and background



Coninued assays to confirm methylmercury production hypothesis

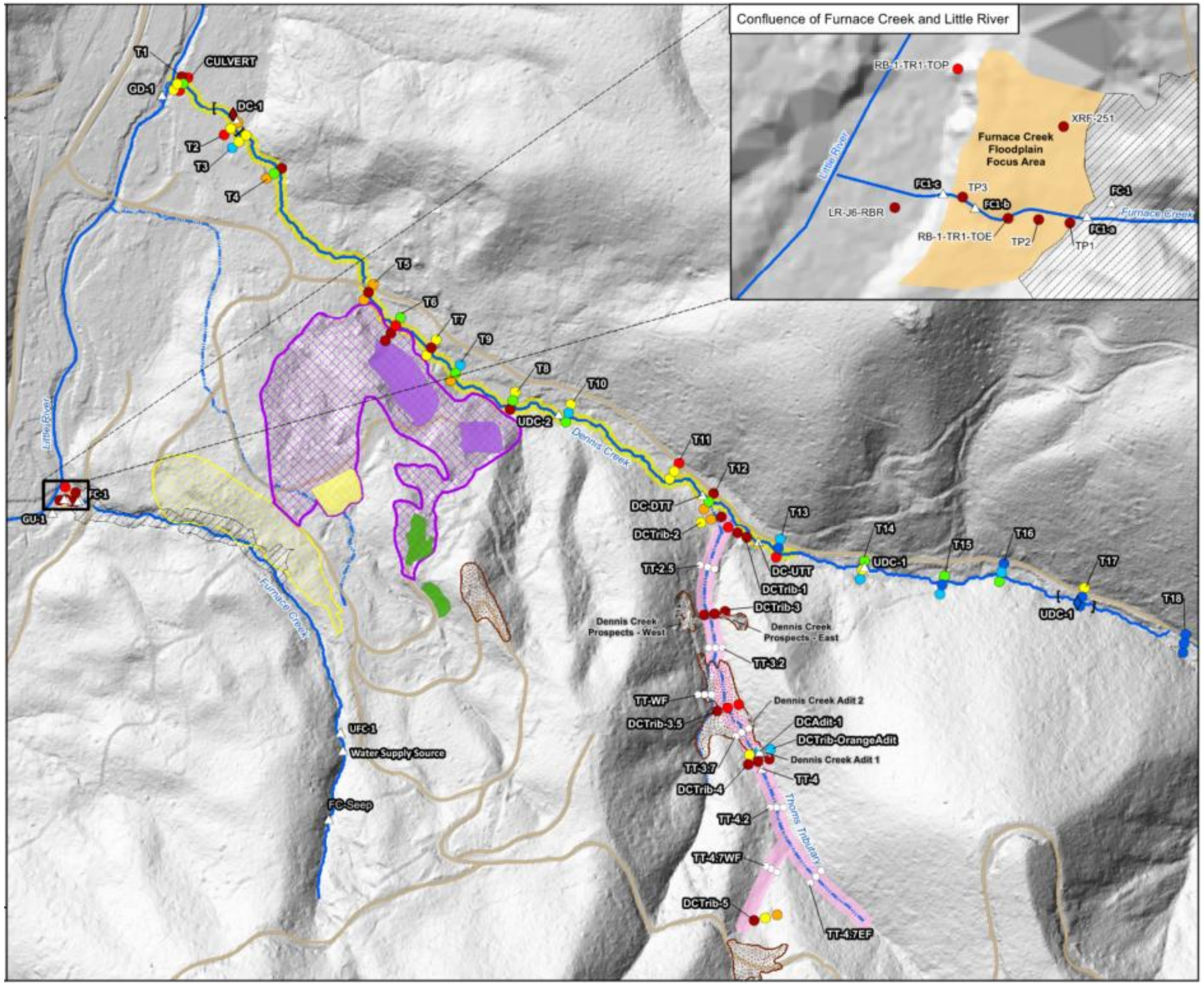
Multiple lines of evidence used to refine understanding of mercury sources and transformational processes areas the site.

Tree Core and Soil Isotopic Mercury at Depth Locations



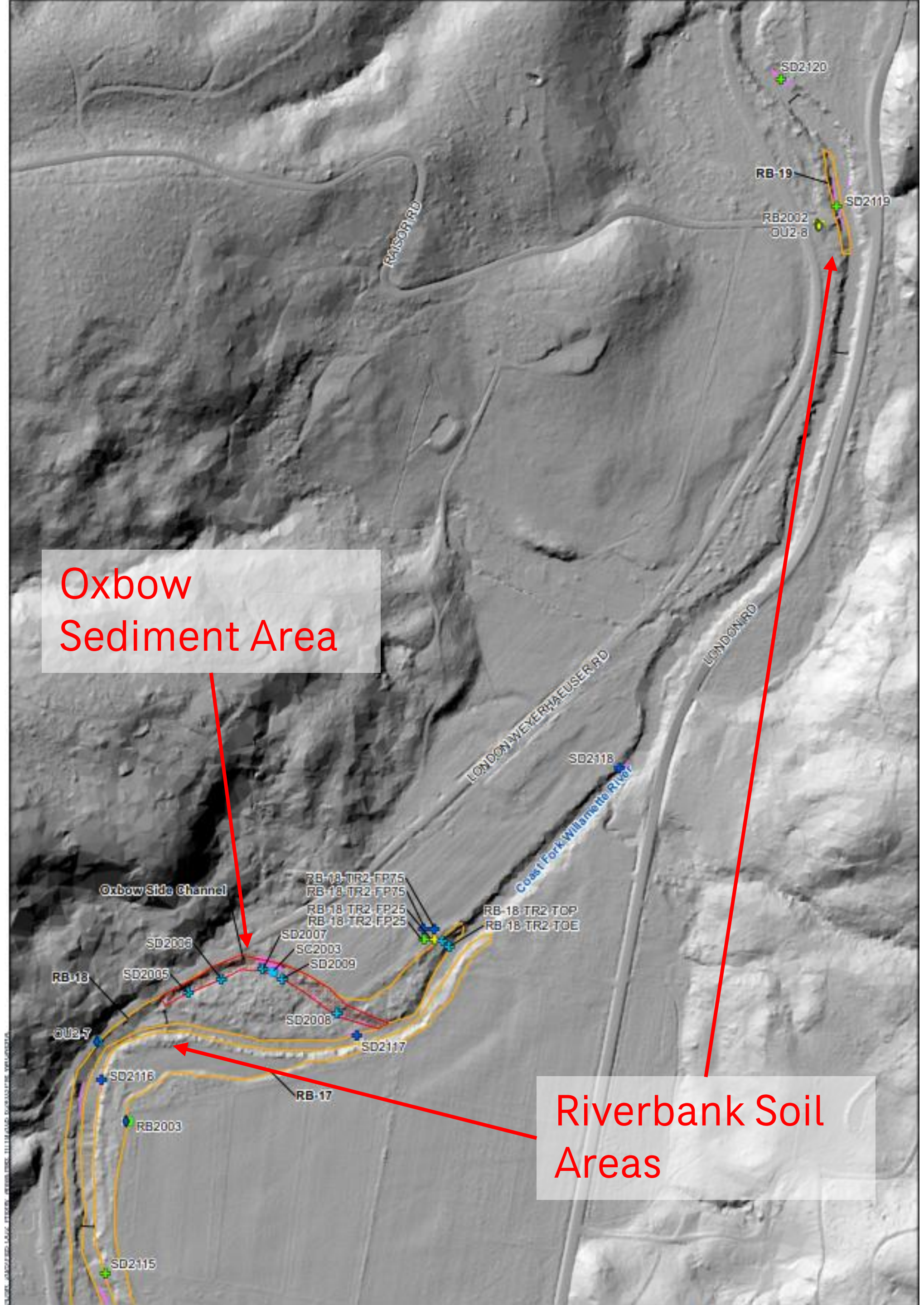
Refining Source Areas (Dennis Creek/OU1)

- Dennis Creek identified as a dominant source area to OU2 with limited resolution
- Targeted sampling refined spatial distribution of mercury contamination
- Results supported prioritized source areas for the FS



Secondary Sources (OU2)

- RI quantifies majority of mercury transport as sediment bound
- Uncertainty remained relative to:
  - Riverbank contribution
  - Depositional sediment contribution
- Tarteged evaluations suggest potential for remobilization under varying flow conditions
- Results inform development of focus areas for FS alternative screening



Treatability Study Approach

Treatability Study Approach

From screening to realistic conditions

1. SCREENING

Identify promising amendments

Mixed with sediment

Microcosm testing

- Multiple amendments
- Range of doses
- Short-term evaluation

Goal: Identify top-performing amendments

2. REFINEMENT

Evaluate across sediment types and optimize dose

Permanently Inundated	Seasonally Inundated	Wetland

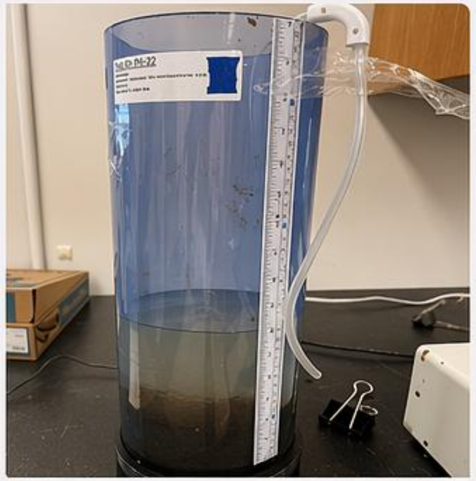
Microcosm testing

- Top amendments tested across sediment types
- Dose optimization
- Performance comparison

Goal: Refine and optimize treatment options

3. ASSESS PERFORMANCE UNDER SITE CONDITIONS

Evaluate performance under realistic site conditions



Mesocosm testing

- Site water and sediment
- Wetting and drying cycles
- Time-series evaluation
- Multiple performance endpoints
- Longer-term assessment

Goal: Confirm performance under site-representative conditions

Sediment Types Tested

- **Permanently Inundated** (Deep/Lacustrine)
- **Seasonally Inundated** (Shallow/Deltaic)
- **Wetland** (Emergent/Tidal)

A tiered approach ensured selection of effective amendments and confirmation of performance under realistic site conditions.

Moving Toward the Feasibility Study

Moving Toward Feasibility Study (FS)

Focused development of remedial alternatives for OU1 and OU2

1. CHARACTERIZATION (Completed RI + Targeted Investigations)

Defined sources, pathways, processes, and uncertainties

Risk evaluation complete across OU1, OU2, and OU3

2. TARGETED DATA (Address Key Focus Areas)

Refined understanding to support FS decisions

Localized sources (Dennis Creek and tributaries)

Secondary OU2 sources (riverbanks and sediments)

OUTCOMES

- Reduced uncertainty
- Refined focus areas
- Data supports remedy decisions

3. DEVELOP ALTERNATIVES (OU1 and OU2 Focus)

Alternatives developed for FS evaluation

FOCUS OF CURRENT FS

- Source areas (OU1)
- Tributary inputs
- Transport pathways (OU2)
- Interim action concept to reduce ongoing upstream sources to OU2

4. INFORM TECHNOLOGY SCREENING & FS ANALYSES

Use results to evaluate and select effective remedies

Treatability Study Results

Identify promising technologies and performance under site-representative conditions

Upcoming Pilot Study

Amendment patches on seasonally inundated sediment in reservoir (in situ)

Validate performance at larger scale and inform technology screening and FS analyses

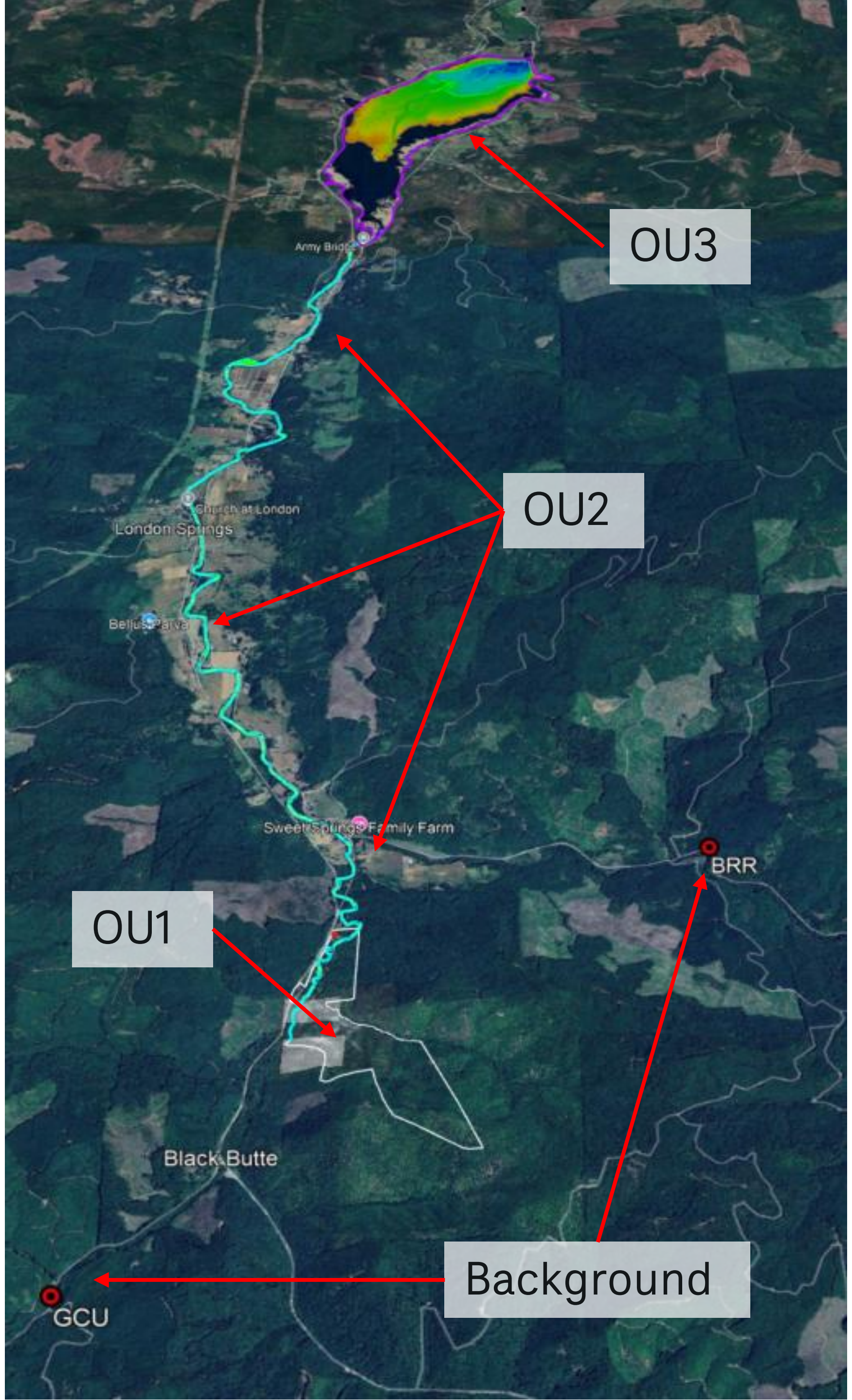
Lessons learned

Lessons Learned

- RI sufficient for overall site characterization and risk assessment but more inputs needed for identifying remedy approach
- Early identification of data gaps improves efficiency
- Targeted investigations reduce uncertainty
- Biological processes are a critical element to fully delineate at mercury-contaminated sites

Lessons Learned cont.

- Iterative process improved remedial focus
- Understanding evolved across investigation phases
- Targeted focus areas support decision ready outcomes



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