

STATE-LED REMEDIATION OF MANISTIQUE RIVER AND HARBOR

Adaptive Management Solutions

February 2019

Improving quality of life.

Presenter



HEATHER VANDEWALKER

Arcadis

Vice President – Syracuse, NY

o 315.671.9382
e heather.vandewalker@arcadis.com

Co-authors

MICHAEL ERICKSON – Arcadis, Novi, MI

SAMUEL NOFFKE – MDEQ, Lansing, MI

JULIE SIMS – NOAA, Ann Arbor, MI

ELIZABETH HOVER – Arcadis, Syracuse, NY

Background

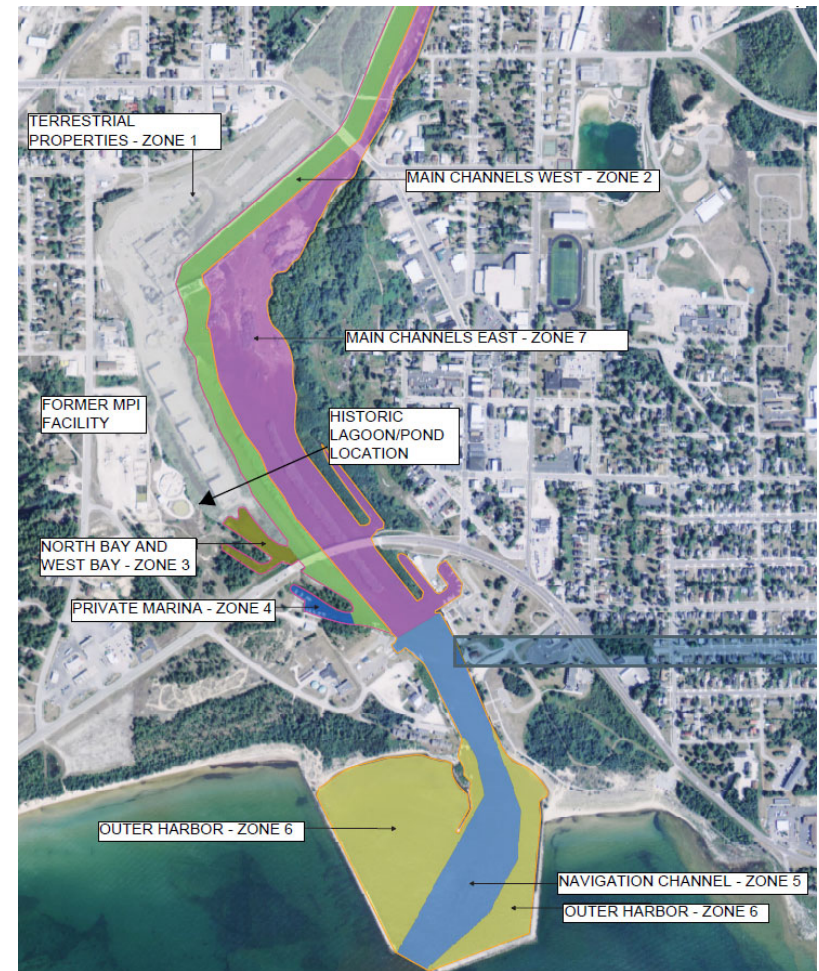
Site Location

- Manistique River and Harbor – Great Lakes AOC
 - Papermaking activities led to wastewater discharge containing PCBs
 - Papermill settled liability with the State and is now bankrupt
- MDEQ leading remediation
 - GLRI funding in partnership with NOAA/GLNPO



Site History

- AOC includes 7 Zones
 - Zone 1 – Terrestrial Properties
 - being addressed separately
 - OU1 - Zones 2, 3, 4
 - OU2 - Zones 5, 6, 7
- Multiple Superfund remedial actions between 1993 and 2000
 - Interim cover (Zone 5; removed in 1996)
 - Sediment dredging (over 70,000 cy; Zones 2, 3, 5, and 6)
 - Gravel habitat cover placement (Zone 3)



Remedial Action Objective

- Remove Beneficial Use Impairments (BUIs)
 - BUI 1 – Restrictions on Fish and Wildlife Consumption
 - Currently there is a fish consumption advisory throughout the AOC
 - BUI 2 – Restrictions on Dredging Activities
 - No disposal restrictions can exist when dredging the navigation channel
- Achieved over time by reducing site-wide (OU1/2) surface sediment PCB concentrations
 - USEPA modeling: 0.2 ppm site-wide SWAC
 - OU1 Zones 3 and 4: 1 ppm
 - OU2 Zone 5: 0.3 ppm
 - OU2 Zone 6: 0.5 ppm

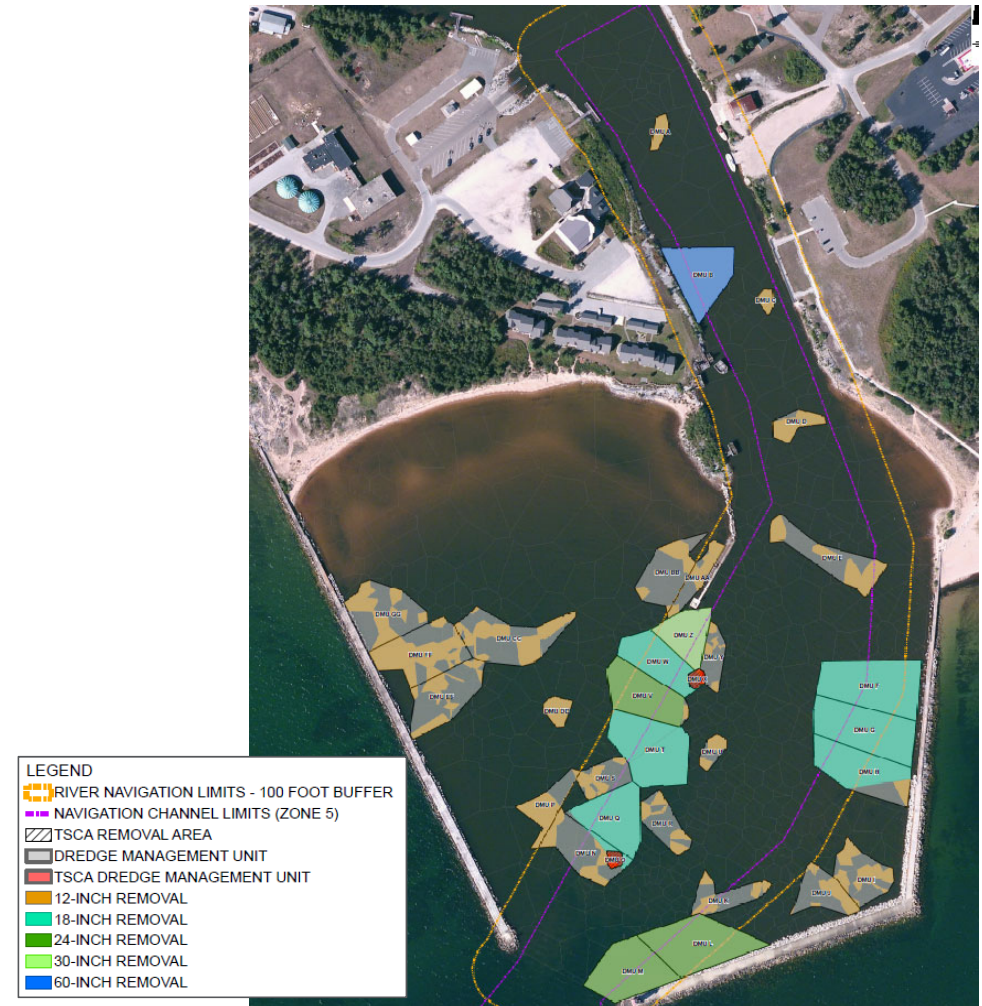
OU1 Remediation

- Performed in 2016 in Zones 3 and 4
- No remediation required in Zone 2
- ~9,400 cy of sediment/debris removed and disposed off-site
 - Targeted sediments with >1 ppm PCBs
- 6-12” sand cover placed over a majority (but not all) of OU1 for residuals management
 - Residual PCBs ranged from 0.05 to 294 mg/kg
- Current overall Site SWAC – 0.36 ppm



OU2 Selected Remedy

- Focused Feasibility Study completed 2016
- Removal with residual sand cover
 - Zone 5 (Nav Channel) – Remove sediment > 0.3 mg/kg to depth
 - Zone 6 (Outer Harbor) – Remove sediment > 0.5 mg/kg in top 12 inches
- Maximum removal – 5 feet
- ~48,000 cy targeted for removal



2017 Sampling/Monitoring Efforts

Post-Remediation – OU1

Pre-Design Investigation – OU2

Sampling/Monitoring Objectives

- Surface sediment sampling to measure OU1/2 PCBs
- Measure PCB bioavailability in:
 - Reference area - relative bioavailability of OU1/2 PCBs
 - OU1 cover surface - need for supplemental amended cover
 - OU2 surface sediment - pre-removal baseline
- Measure PCB flux in:
 - OU1 cover surface - estimate recontamination potential
 - OU2 fractionated sediment - estimate recontamination potential (mobile fines)
- Achieved through use of sediment traps and passive samplers (40 day deployment)



2017 OU1 Sampling and Analysis Findings

- Sediment PCB results (12 locations)
 - Range from ND to 2.0 mg/kg, mean 0.18 mg/kg, median 0.07 mg/kg
- Sediment trap results (2 locations)
 - All ND
- Passive sampler results (8 locations)
 - Total PCB Congeners (Cfree) range from 0.014 to 0.15 µg/L
 - Results from all locations (except one) above reference levels

Results suggest that flux from underlying PCBs, rather than deposition, is the cause of detectable PCBs in cover/surface sediment.

2017 OU2 Sampling and Analysis Findings

- Surface sediment PCB results range from ND to 0.42 mg/kg
- Sediment Traps
 - PCBs detected in 1 out of 4 Non-Separated samples
 - Majority of detections in coarse organic fraction of separated samples
 - No detections in the heavy (mineral) separated fraction
- Passive Samplers
 - Cfree results range from 0.0021 to 0.24 µg/L and do not appear correlated with substrate type
- Hydrodynamics in the Harbor are complex – mobile fines

Results indicate that elevated porewater concentrations do not appear to be associated with substrate type and mobile fines are not an issue.

Incorporation of 2017 Results through Adaptive Management

OU1/OU2 Adaptive Management Approach – Focus on Porewater

OU1

- Use cap breakthrough model to predict porewater PCB at the surface for various cover options to reduce residual bioavailability to fish
 - Use existing porewater data in sediment/cover surface to predict 100-year porewater concentrations

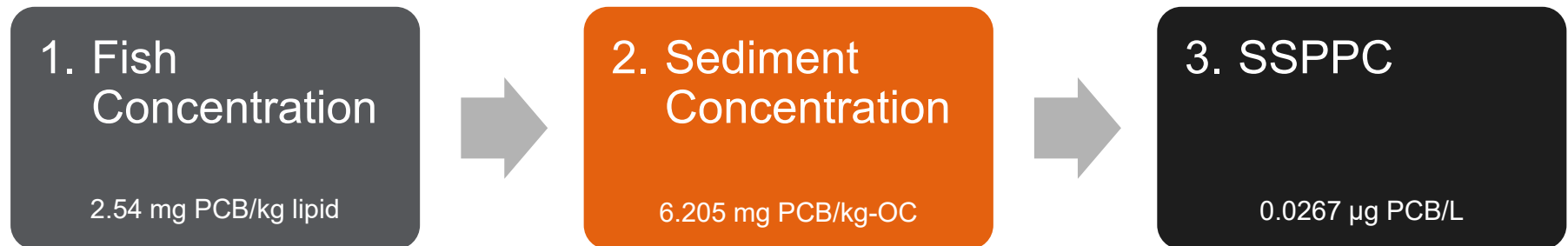
OU2

- Use available PCB and TOC sediment data to estimate post-remediation SWAC needed to achieve reductions in target fish tissue PCBs
 - Incorporate results of OU1 CAPSIM predictions
 - Determine protective OU2 SWAC based on site PRG

Incorporate refined residuals management approach in the remedy to increase influence of remedy on achievement of BUI removal

OU1 – Modeling Analysis Steps

- Step 1 - Develop a Site-Specific Protective Porewater Concentration (SSPPC) to use in evaluation of model results
 - Porewater is a good measure of PCB bioavailability through the food chain



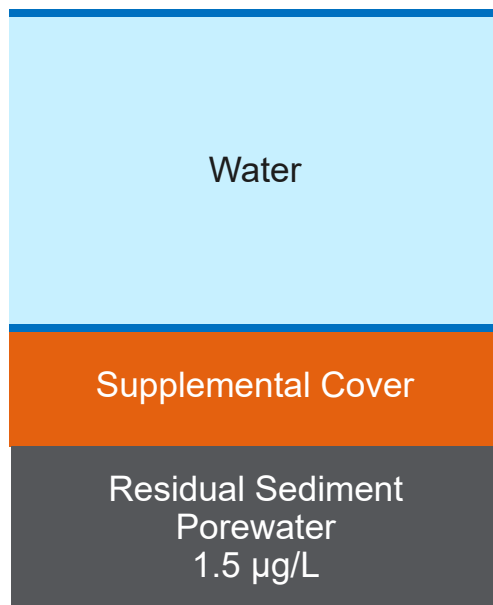
- Step 2 - Model cover options using CAPSIM (100 year simulations)
- Step 3 – Compare results at 3 inches below surface to SSPPC (base of bioturbation zone)

OU1 – Modeled Supplemental Cover Options

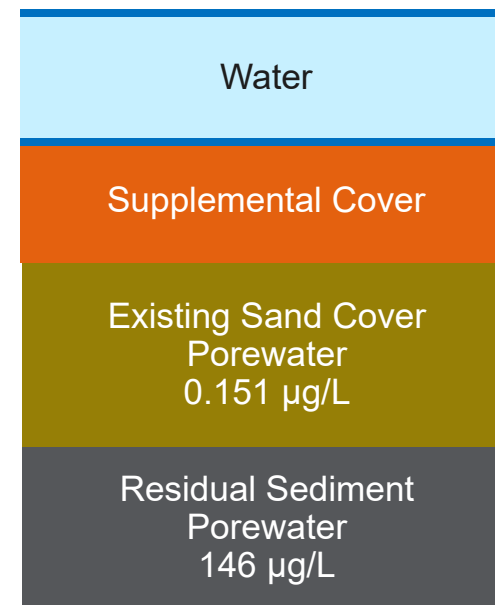
1. 6-inch sand cover
2. 6-inch sand and topsoil cover (1:1 ratio)
3. 10-inch sand/activated carbon cover overlain by 3-inch sand cover
 - 0.5%, 1%, and 4% AC [by weight]
4. 5-inch sand/activated carbon cover overlain by 3-inch sand cover
 - 0.5%, 1%, and 4% AC [by weight]

Generalized Supplemental Cover Options – OU1

- Type 2 (not to scale) – Areas with cover placed in 2016

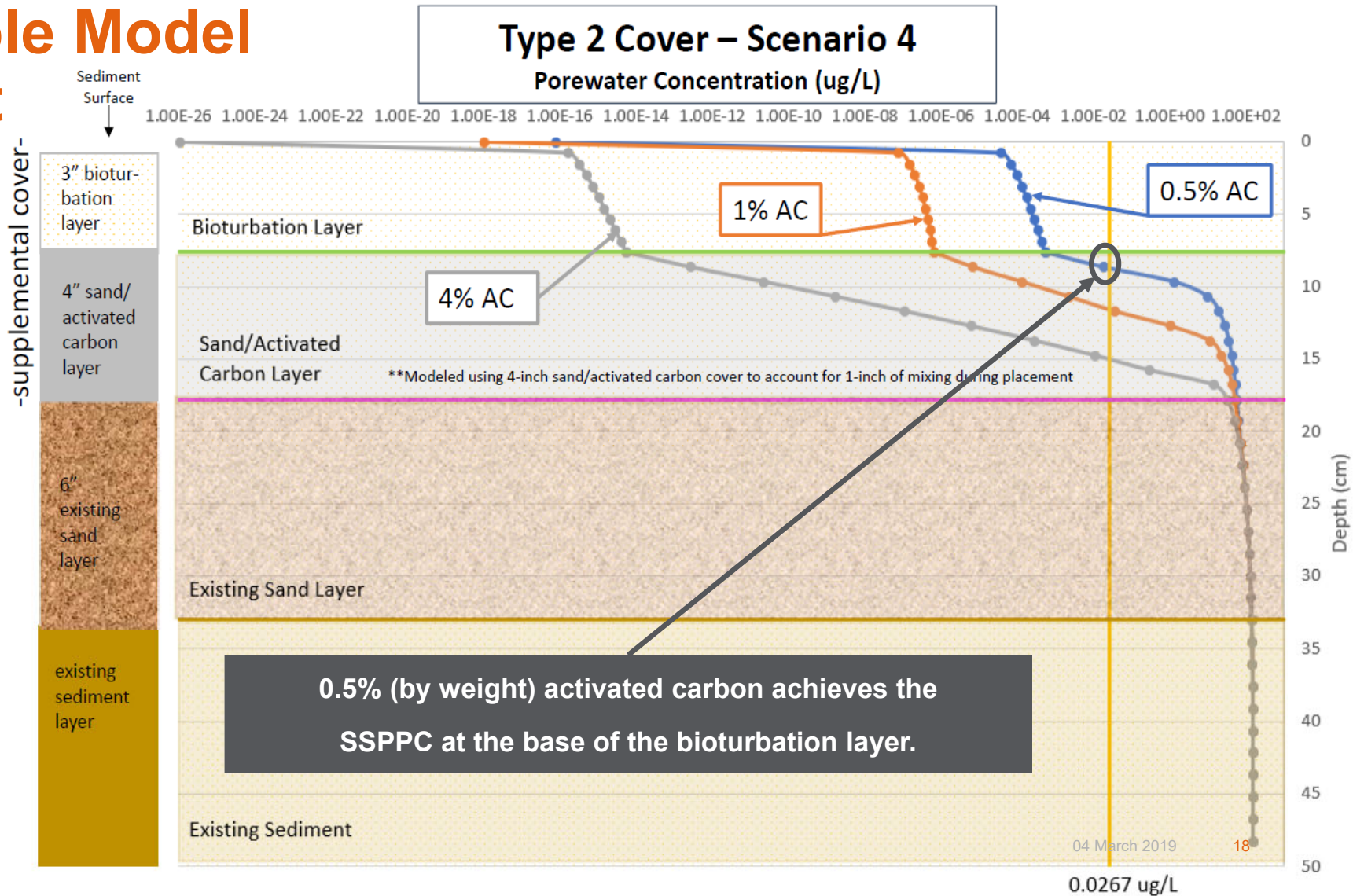


- Type 1 (not to scale) – Areas without cover placed in 2016



Initial porewater concentrations reflect maximum values observed for each layer post-confirmation/PDI sampling.

Example Model Output



Final OU2 Cover Considerations

- Use results of OU1 remediation and modeled cover simulations to inform OU2 cover design
 - Limited pre-design subsurface PCB data
 - Identify post-remediation OU2 target SWAC to meet fish concentrations necessary to remove BUI
 - Difficult to predict post-construction porewater concentrations, therefore TOC-normalized SWAC values used
- No long-term monitoring at site
- Navigational dredging by USACE
- Bioavailability of PCBs to fish in known fish congregation areas

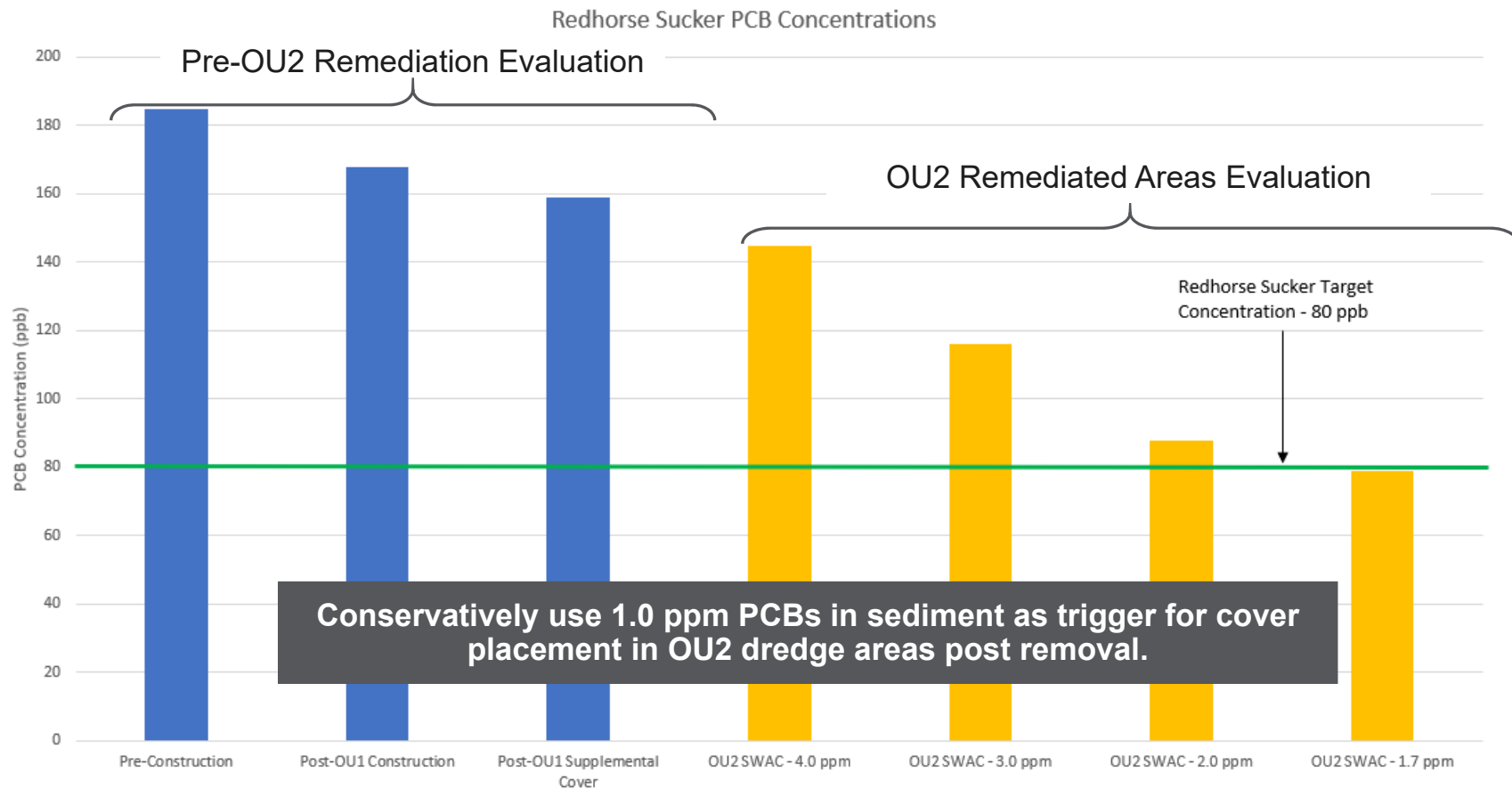
Process for Determining OU2 Target SWAC in Consideration of BUI Removal

1. Step 1 – Determine overall site SWAC prior to OU2 remediation
 - a. Assess the effect of OU1 remediation (2016)
 - b. Assess the effect of adding supplemental cover to OU1 (2019)
2. Step 2 - Use Step 1 results to estimate OU2 remediation impact on site-wide SWAC and determine residuals management need
3. Step 3 – Use results from Step 2 (iteratively) to estimate overall site fish concentrations for comparison to targets for each scenario



Tenth International Conference on Remediation and Management of Contaminated Sediments

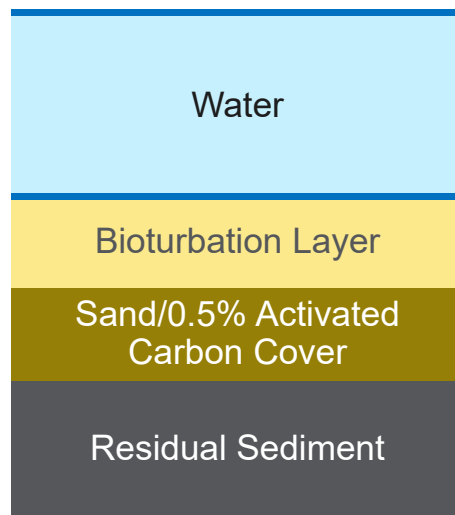
Redhorse Sucker Results



Tenth International Conference on Remediation and Management of Contaminated Sediments

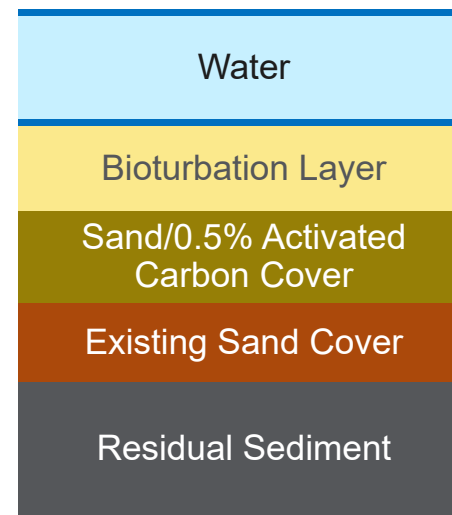
Final Design Cover for OU1 and OU2

- Place minimum 9-inch cover – 0.5% activated carbon and sand
 - Conservative: only 5 inches needed/includes bioturbation layer
- To be placed in both OU1 (all areas) and OU2 (select areas per residual management plan) in 2019



Tenth International Conference on Remediation and Management of Contaminated Sediments

Type 1 Cover



Type 2 Cover

Arcadis.

Improving quality of life.

