Innovative Treatment of Wood-Waste-Impacted Sediments Using Reactive Amendments and DGT Passive Porewater Sulphide Testing Techniques

Presented by

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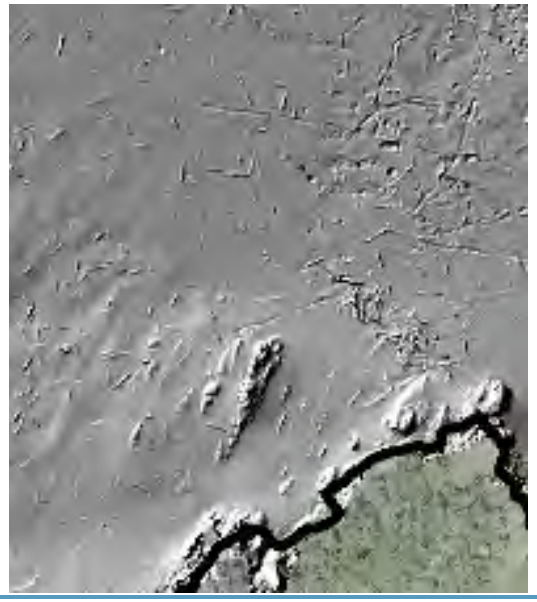
Outline

- Site Setting
- Effects of Wood Waste
- Porewater Sulphides Using DGT
- Bench Scale Treatability Testing
- Plan for Pilot Study


ESQUIMALT HARBOUR
VICTORIA HARBOUR
Nanaimo
Vancouver
Bellingham
Esquimalt Harbour
Victoria
Port Angeles
Seattle
N

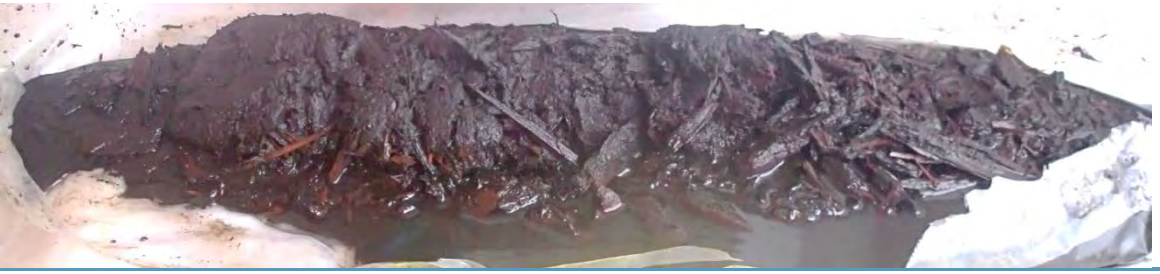
North Esquimalt Harbour

- Log booming
- Log storage
- Wood mill operations



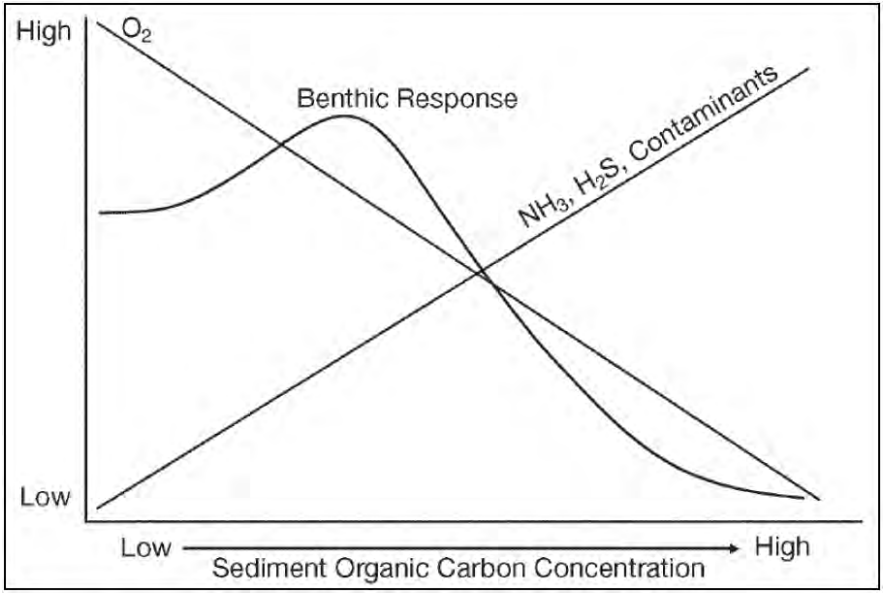
Physical Wood Waste Effects

- Logs, bark, wood chips, processed wood (sawdust), partially decomposed wood fibers
- Slow to decay
- Can isolate benthic organisms from native sediment
- Can be highly flocculent



Chemical Effects

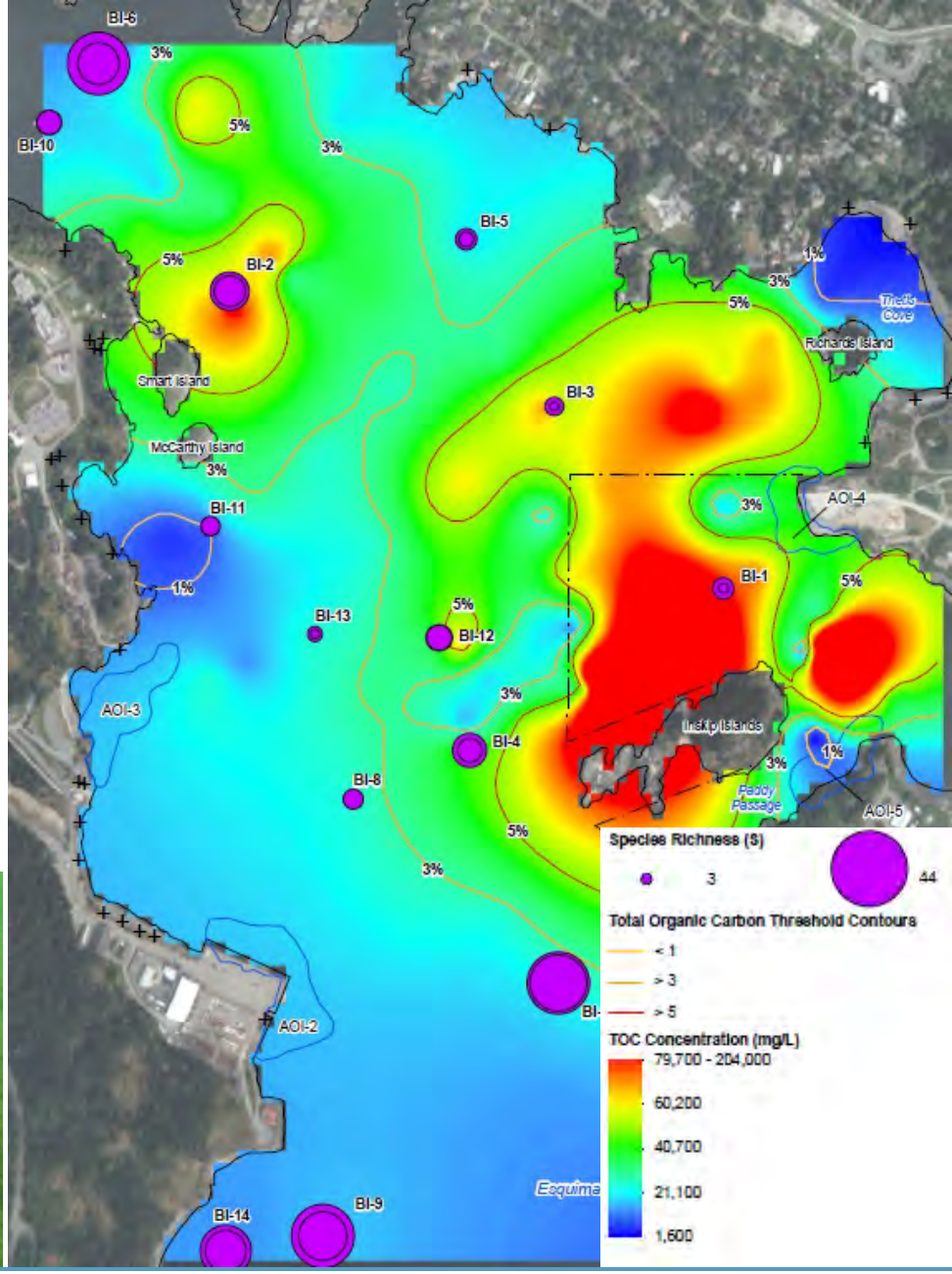
- Wood waste degradation
  - Biochemical oxygen demand
  - Creates anoxic conditions
  - Ammonia production
  - Sulphide production
- Degradation by-products can be toxic to benthic organisms



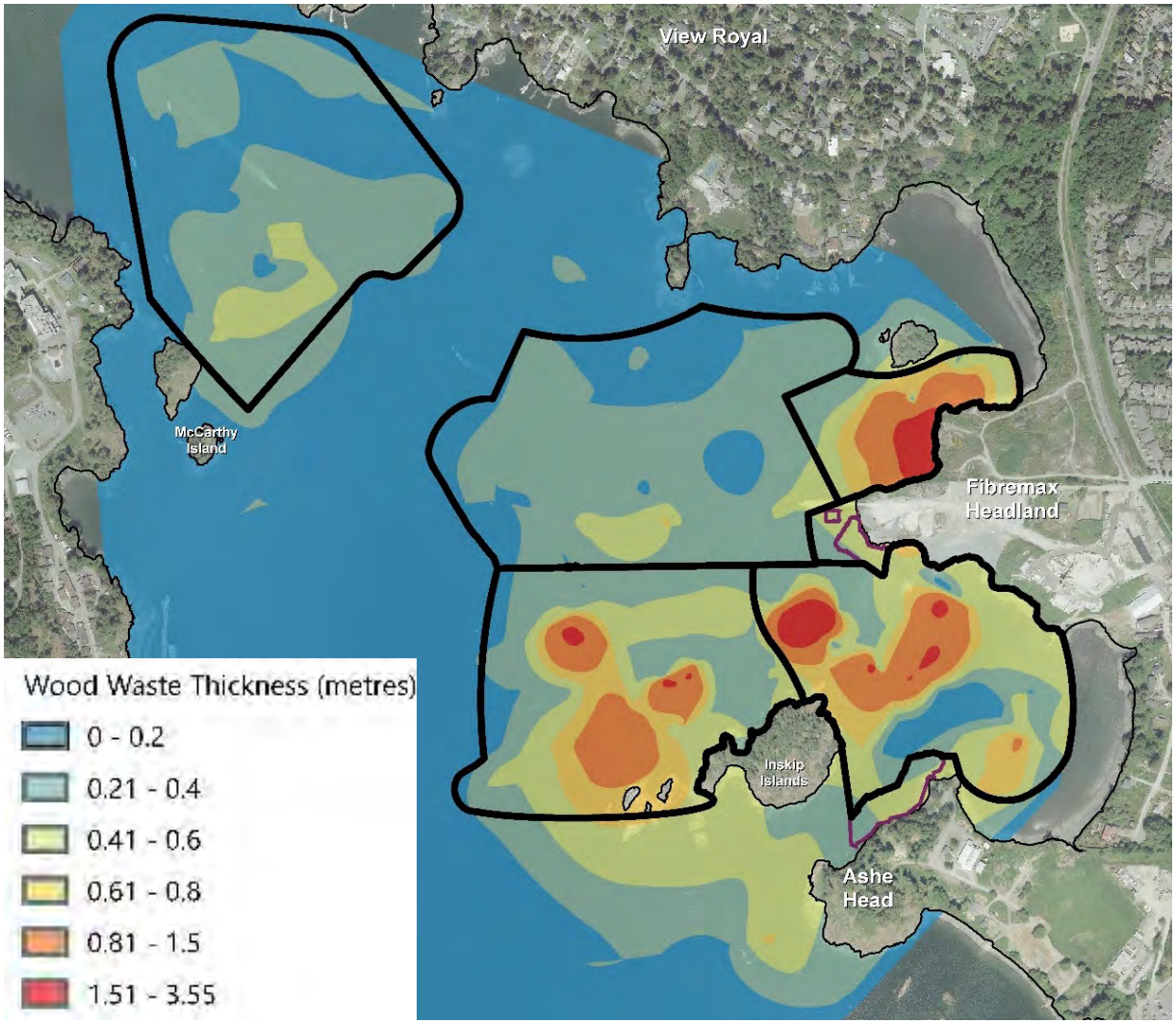
Source: Hyland et al. 2005

Biological Effects

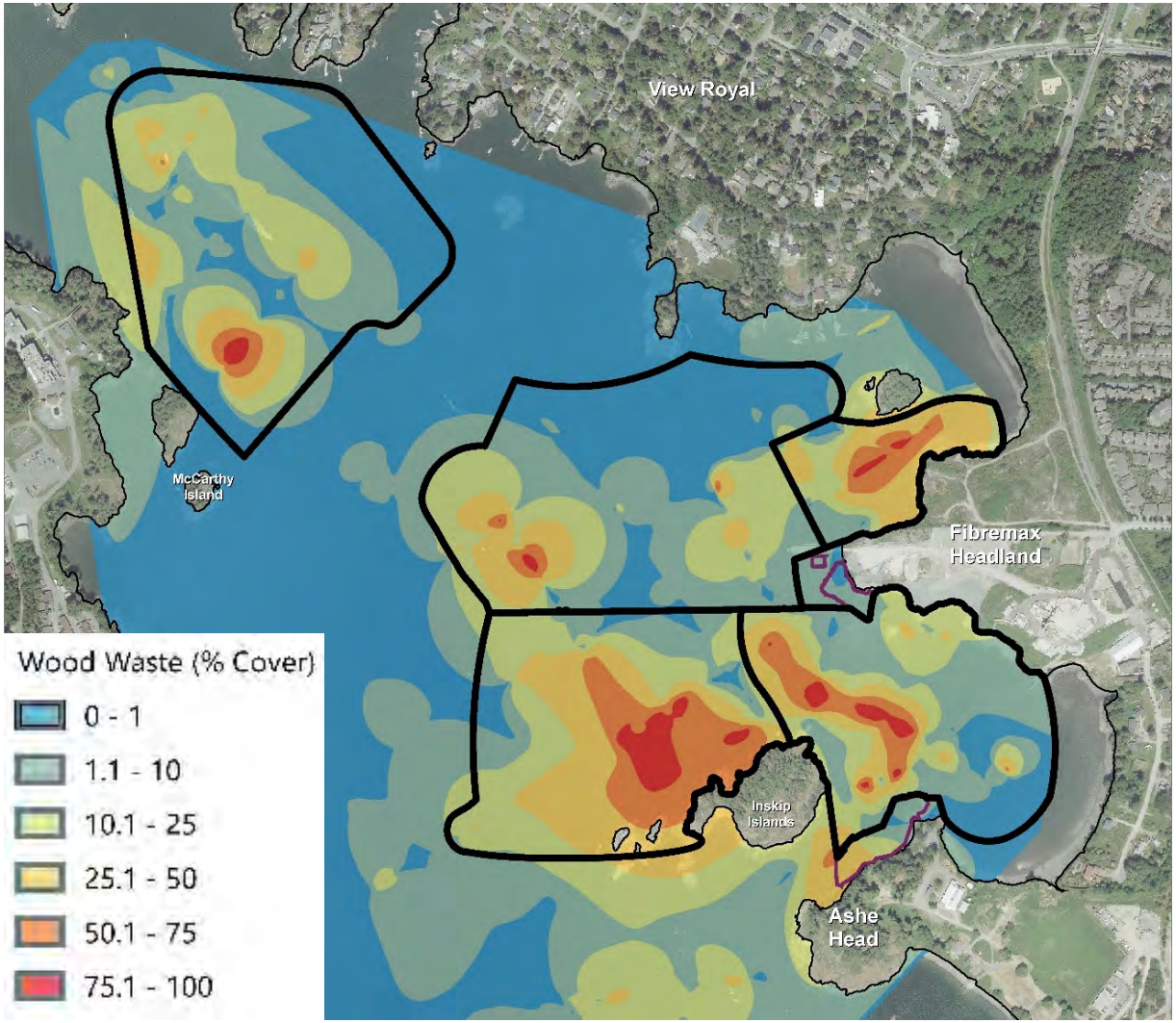
- Reduced benthic community abundance and diversity
- Reduced survival of bivalves
- *Beggiatoa* spp. bacterial mats



Wood Waste Thickness



Wood Waste Cover

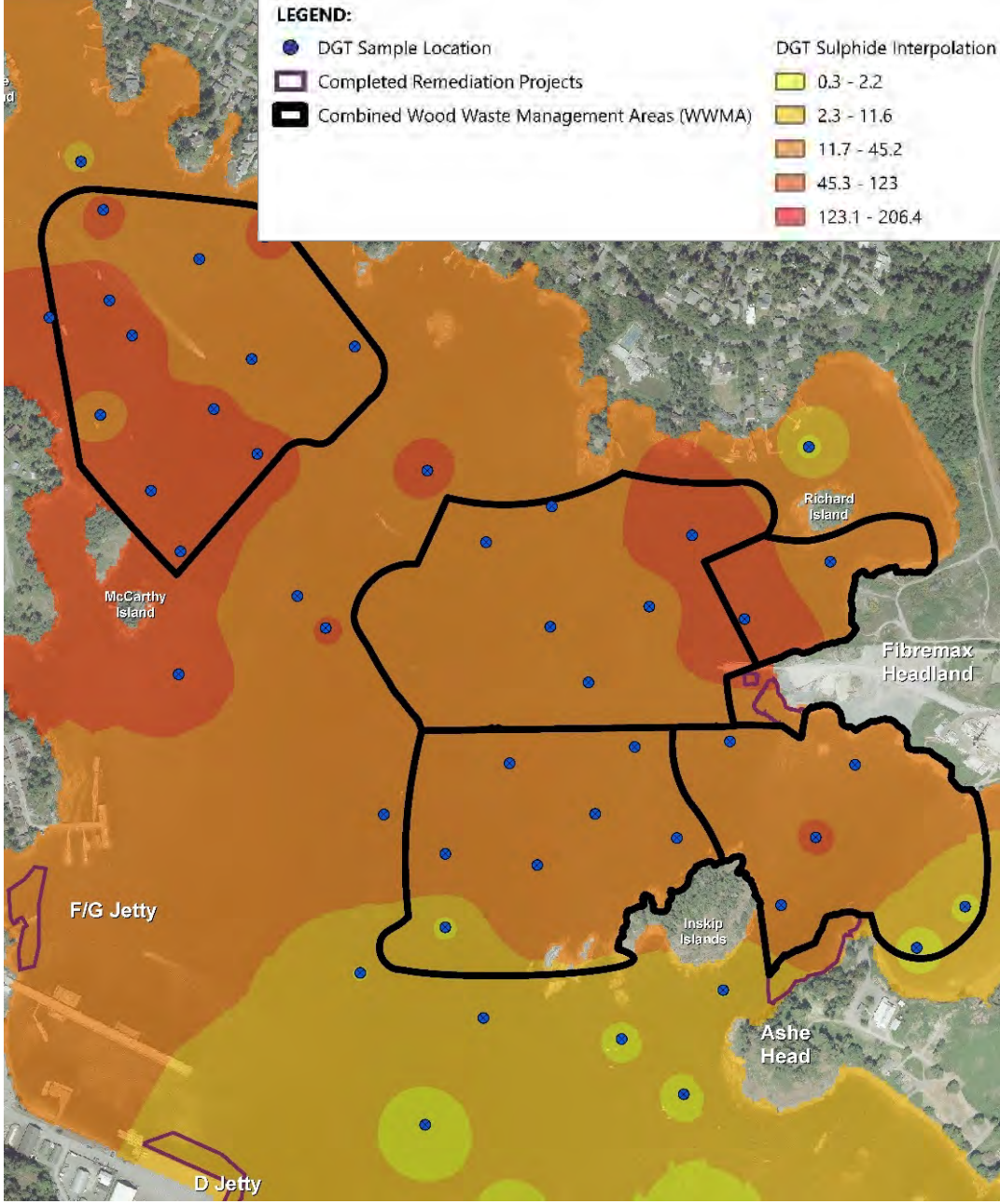


Porewater Sulphides Using DGT

- DGT – Diffusive Gradients in Thin films
  - Increasingly common as reliable in situ measure of porewater sulphide
  - Reaction of sulphide with silver iodide gel (white) to produce silver sulphide (black)
  - Intensity of color is proportional to sulphide on the gel
  - Proportional to exposure duration

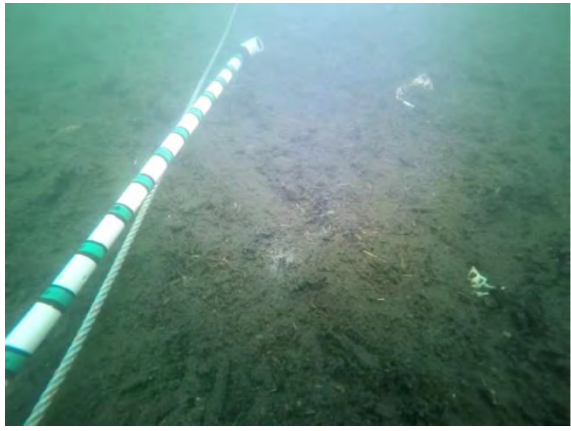
Porewater Sulphide Concentrations

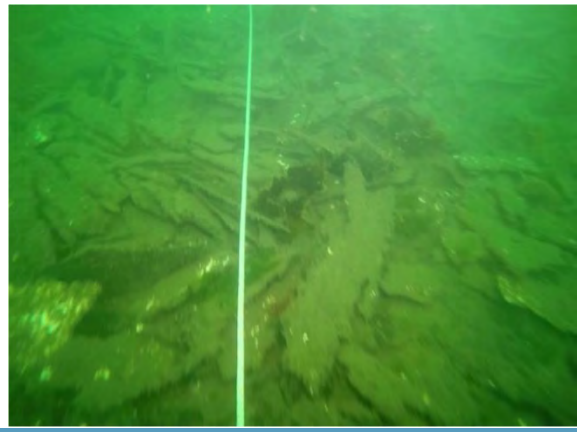
- 65 samples
  - Up to 105 mg/L
  - Median 25 mg/L
- 2 mg/L can cause toxicity to sensitive species
- Usually but not always co-located with wood waste



Wood Waste Remediation Options

- Monitored Natural Recovery
- Enhanced Natural Recovery
- In Situ Treatment
- Engineered Capping
- Dredging





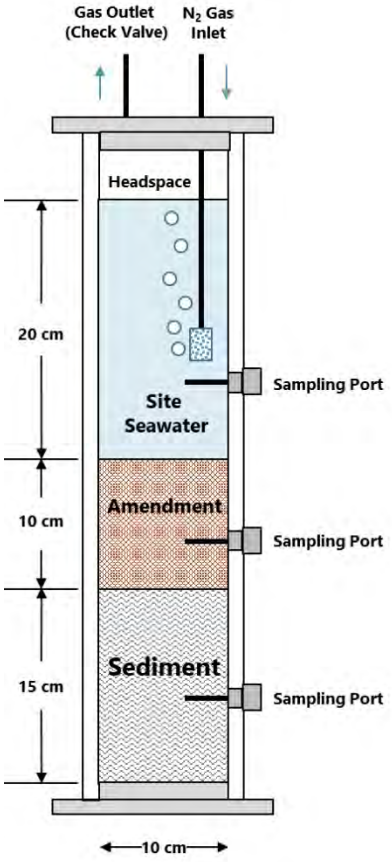
Bench Scale Treatability Testing

- Test effectiveness of sand cover mixed with treatment amendments to reduce bioavailable porewater sulphide
- Siderite dissolves and precipitates iron sulphides (mackinowite)
- Iron and manganese oxide can oxidize sulphide into sulphate

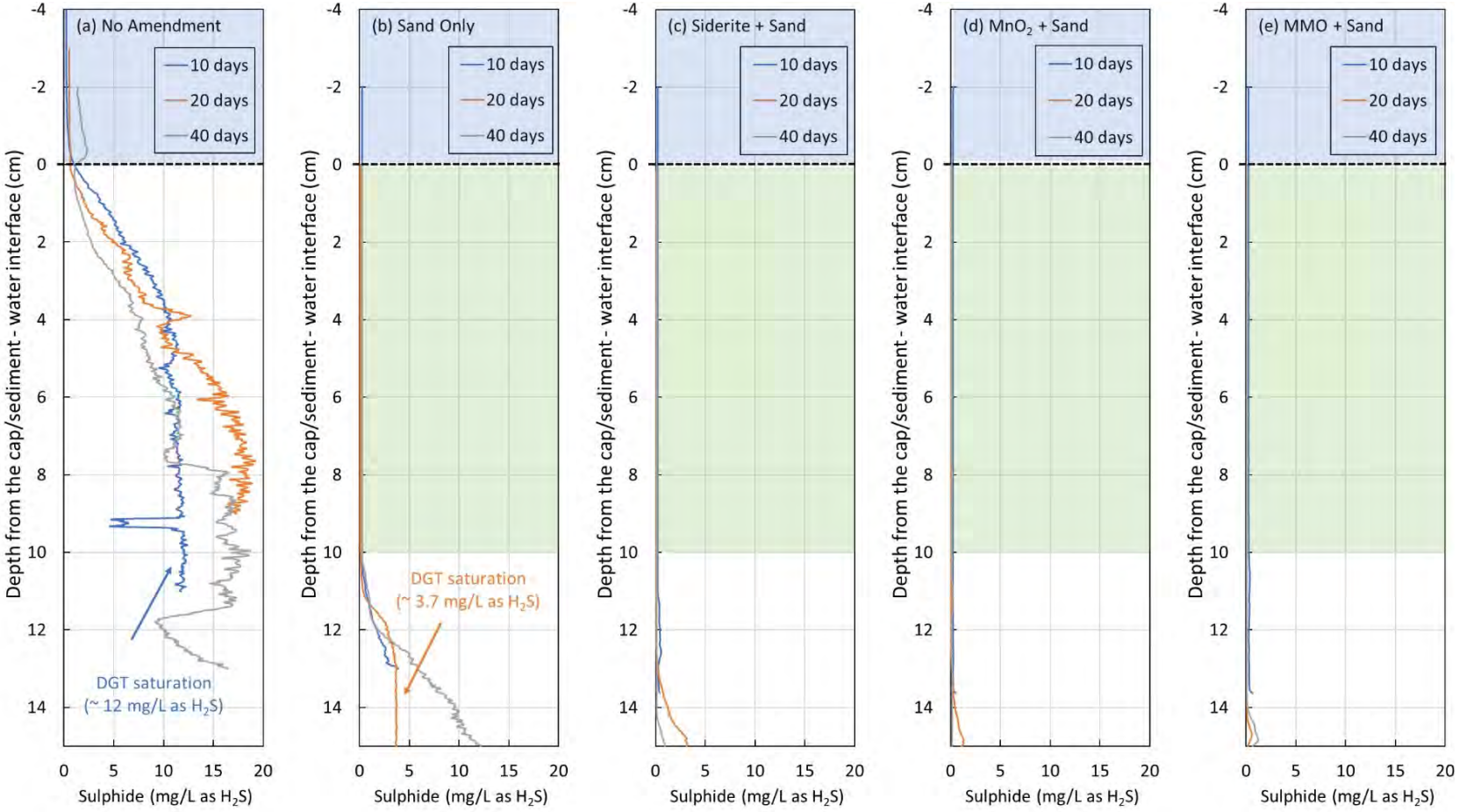
Siderite $FeCO_3$ | Manganese Oxide MnO_2 | Mixed Metal Oxide (MMO)

Treatability Setup

- Sediment Control
- Sand Cover Control
- Siderite Treatment
- MnO_2 Treatment
- MMO Treatment



Treatability Study Results

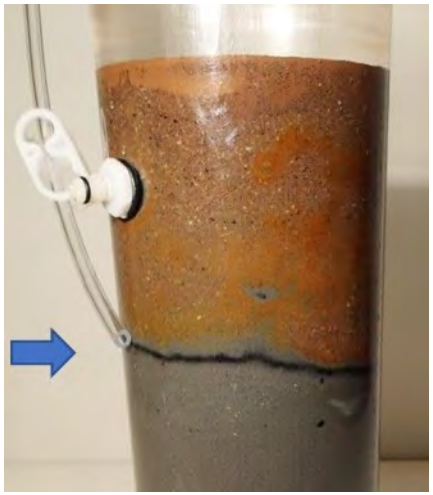


Treatability Results

- Sulphides measured in overlying water after 40 days for sand control but not in treatment amendments
- Iron sulphide precipitate
  - On top of sand-only surface
  - At sand/sediment interface in siderite mesocosm
- Manganese Oxide and MMO oxidize sulphides to sulphate

Treatability Results (cont.)

Sand Control



Siderite

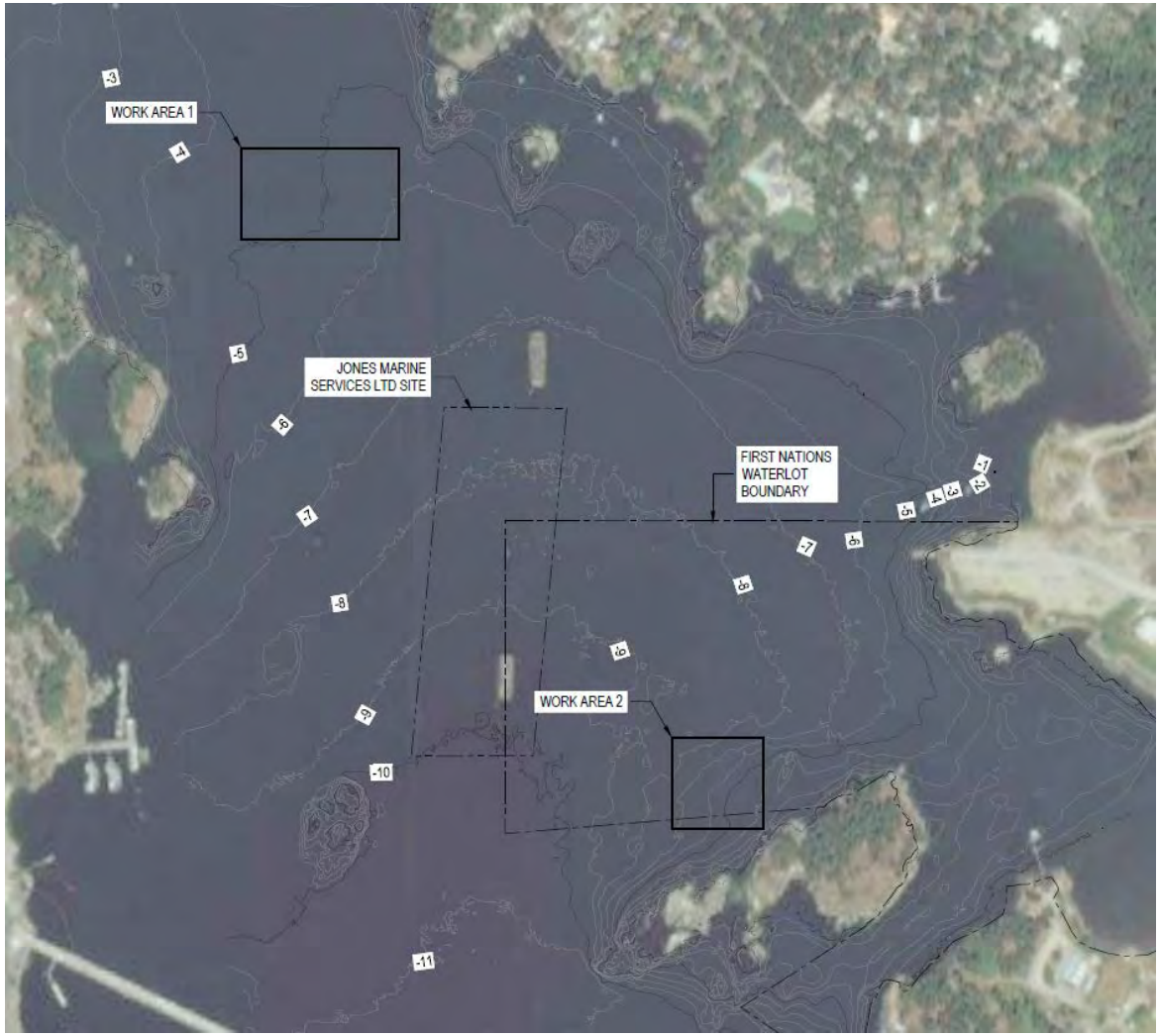
Manganese Oxide

MMO

2019–2020 Pilot Study

- Evaluate Effectiveness
  - Enhanced natural recovery (sand cover)
  - In situ treatment (sand mixed with siderite)
- Evaluate Constructability
  - Blending and placing amended sand layer in two wood waste areas
- 5% granular siderite by weight at 30 cm nominal thickness

2019–2020 Pilot Study (cont.)



Questions/Discussion