



# Waterfront Toronto: Carving a River through a Contaminated Site

SPEAKER

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consultants

WEDA Midwest  
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# Site Location





## The Port Lands: Flood Protection and Redevelopment

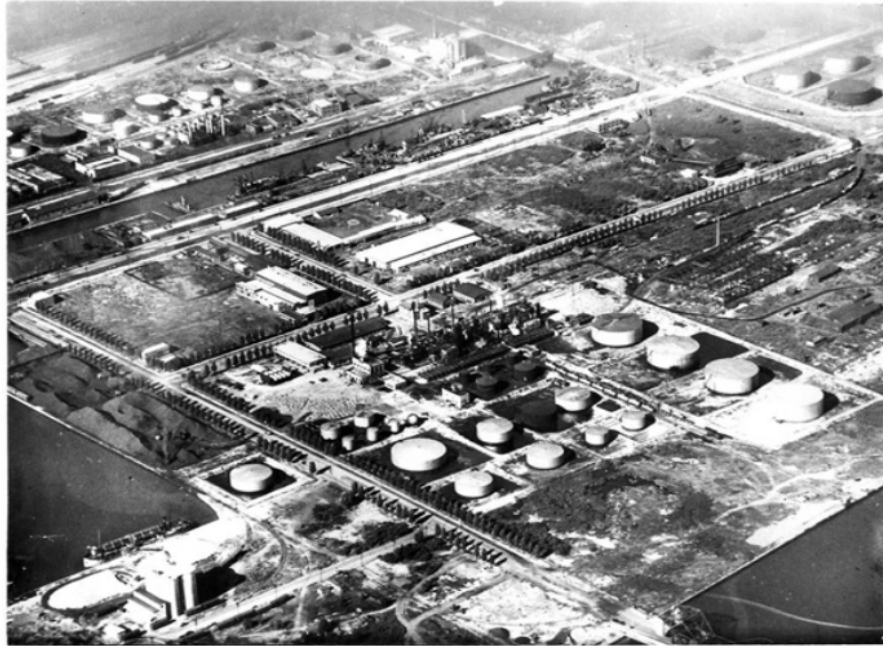
- \$1.25-billion flood-protection project in Toronto's Port Lands district
- Largest urban redevelopment project currently underway in North America
- 100-hectares (~250 acres) of contaminated land
- Redevelopment includes
  - Building a new river valley and naturalizing the mouth of Don River for flood protection
  - Environmental risk management measures (RMMs) to leave contamination in place and prevent recontamination







# The Past...



*Cherry St oil refineries aerial 1930?*

City of Toronto Archives, Fonds 1244, f1244\_it1440

#1440

Port Lands (circa 1930)

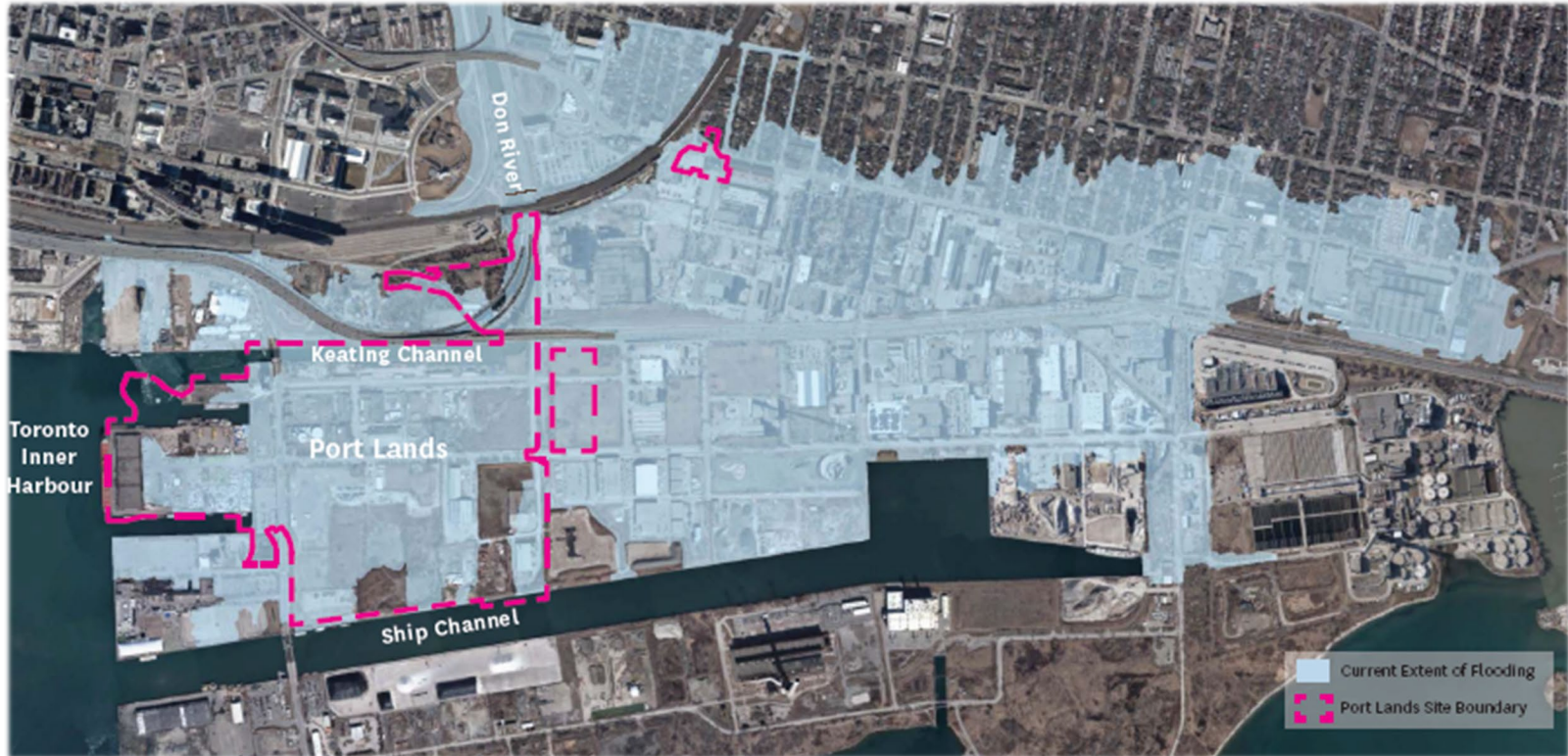


Port Lands, 1970s

Port Lands (1970s)



## The Port Lands: Flood Protection and Redevelopment

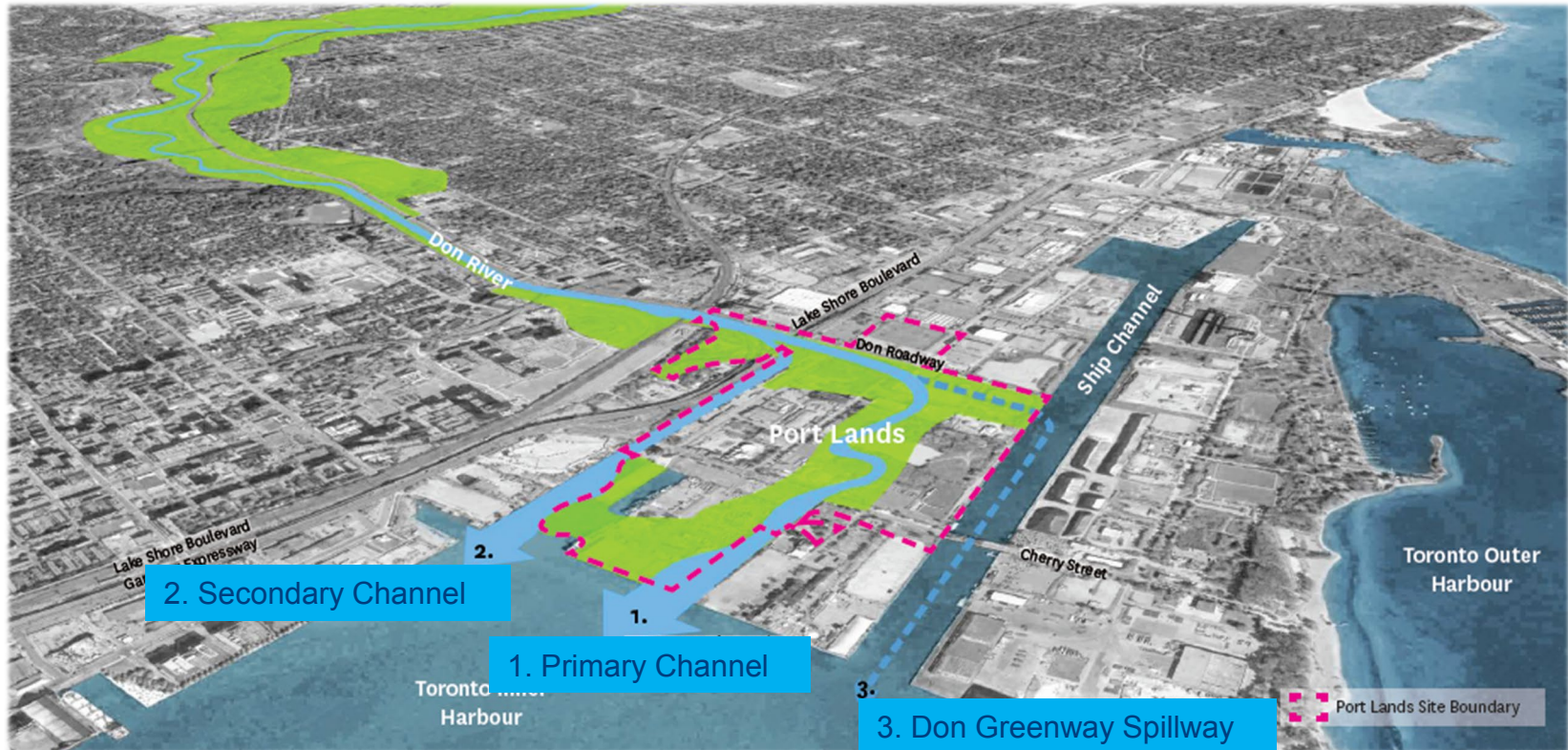


Providing flood protection for 300 hectares (750 acres) of downtown Toronto





## The Port Lands: Flood Protection and Redevelopment



Achieving flood protection through a 3-tier system



# The Future...







# Project Challenges

- Construct new river through a heavily contaminated area
- River finishes to be constructed in the dry
- Significant volume of debris from past construction
- Adjusting regulatory flood event with record increase in lake levels
- Aggressive construction schedule

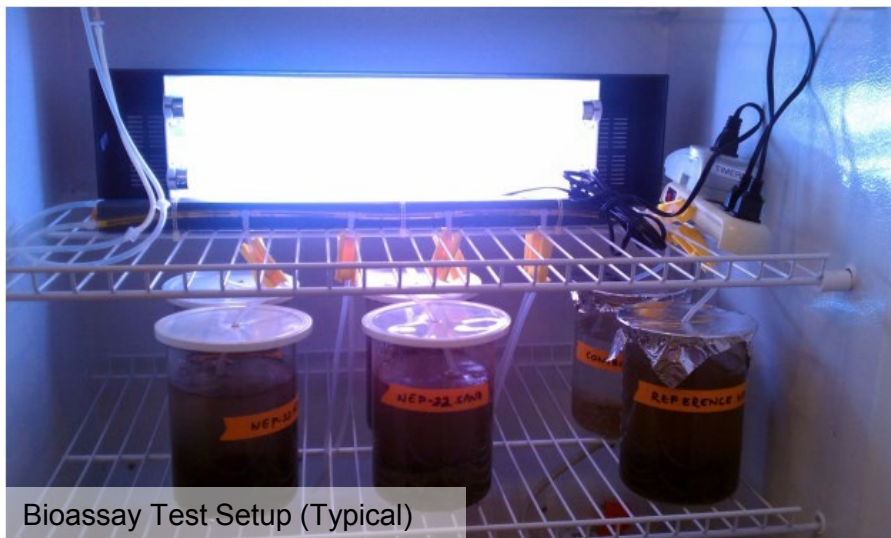






# RMM Design: Performance Criteria

Performance criteria for dissolved phase constituents for the RMM was developed based on ecological benchmarks (EcoBMC) from bioassay toxicity testing and provincial surface water quality criteria



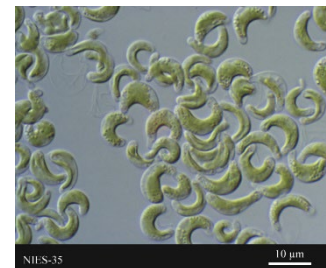
Fathead Minnow



Daphnia Magna  
(Pelagic Invertebrates)



Rainbow Trout

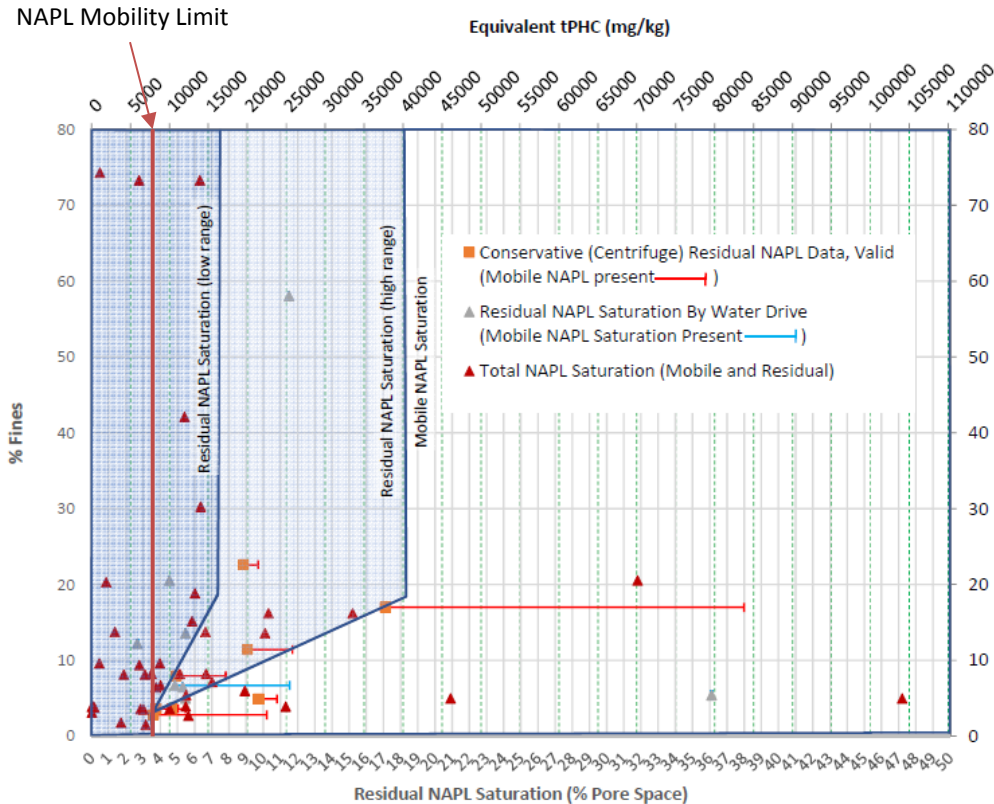


Freshwater Algae  
*Pseudokirchneriella*  
*subcapitata*



# RMM Design: Performance Criteria

Total and Residual NAPL Saturations from Cores (All Data)



Performance criteria for non-aqueous phase liquid (NAPL) impacts for the RMM was developed based on site-specific NAPL mobility study

- Based on the NAPL mobility study following threshold concentrations for sheening potential and NAPL mobility are adopted:
  - Sheening Potential: Total PHC > 1,500 mg/kg
  - NAPL Mobility: Total PHC > 8,000 mg/kg





# Nature and Extent of Contamination

## Contaminant Plume Legend



Petroleum Hydrocarbons (analytical data) > 8,000 mg/kg



Petroleum Hydrocarbons (inferred by LIF data) > 8,000 mg/kg

## Sample Legend



Analytical PHC > 8,000 ppm



LIF PHC > 8,000 ppm



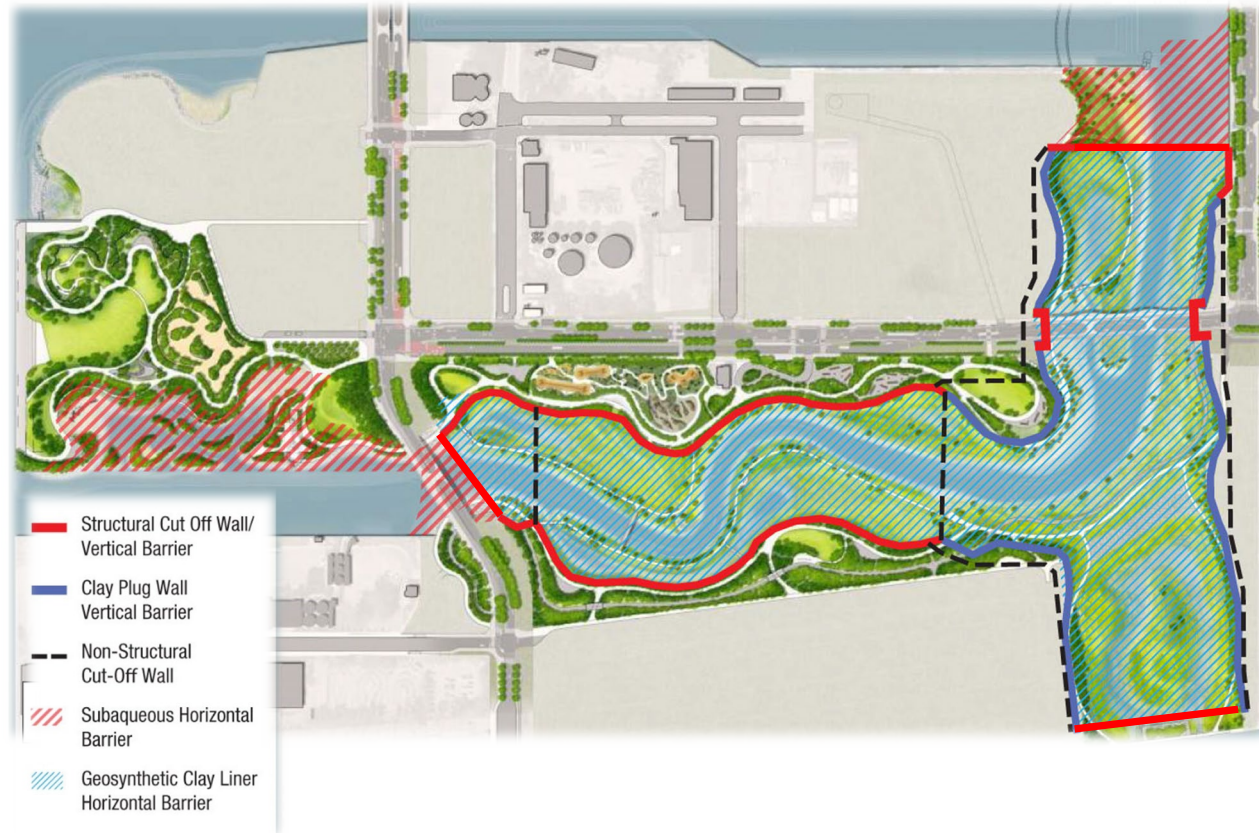
Analytical or LIF PHC < 8,000 ppm





# Design Objectives and Considerations

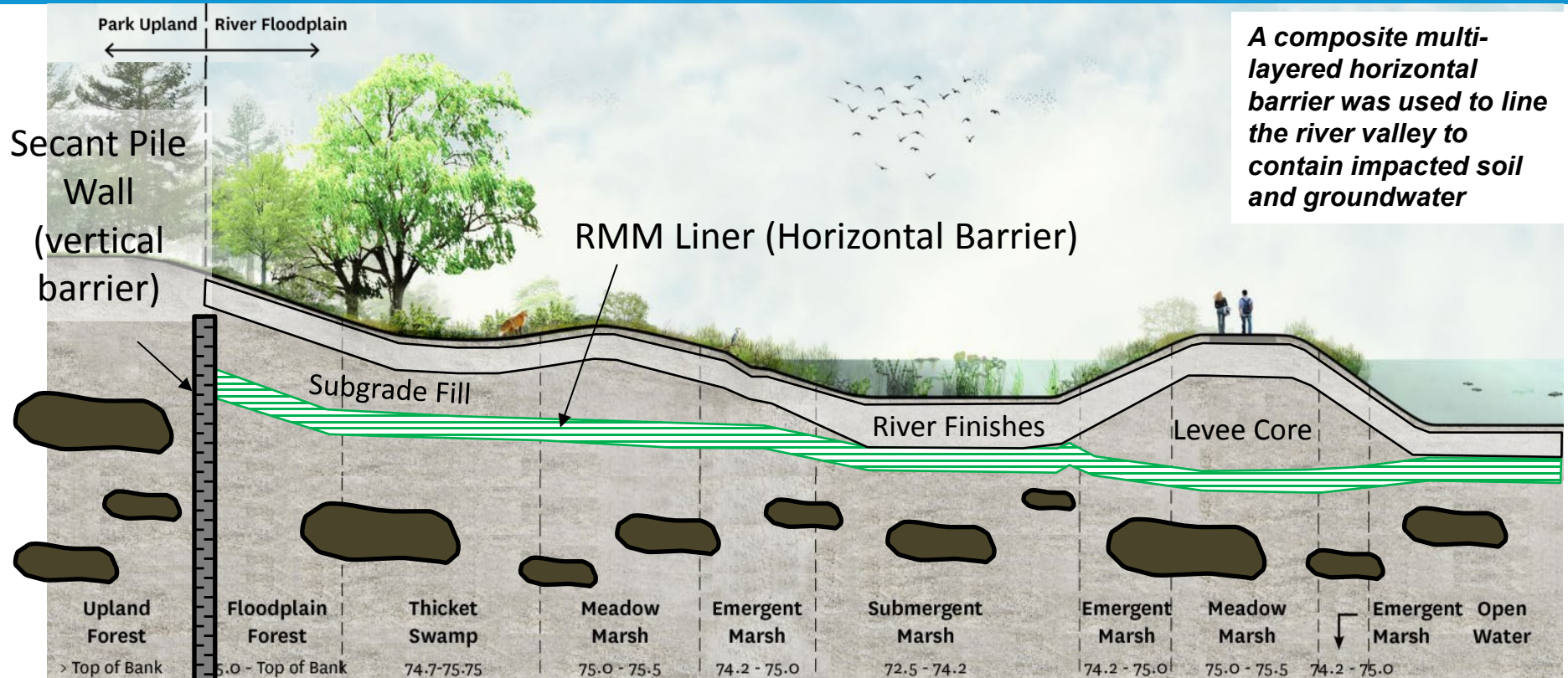
- Design Objectives
  - Hydraulic Control During Construction
  - Long-term protection of residents, recreational users, and ecosystems from legacy contamination
- Design Considerations
  - Construction sequencing and aggressive schedule
  - Poor quality soils
  - Roadway and bridge relocations
  - Work in the wet vs. in the dry
  - Beneficial reuse of soil







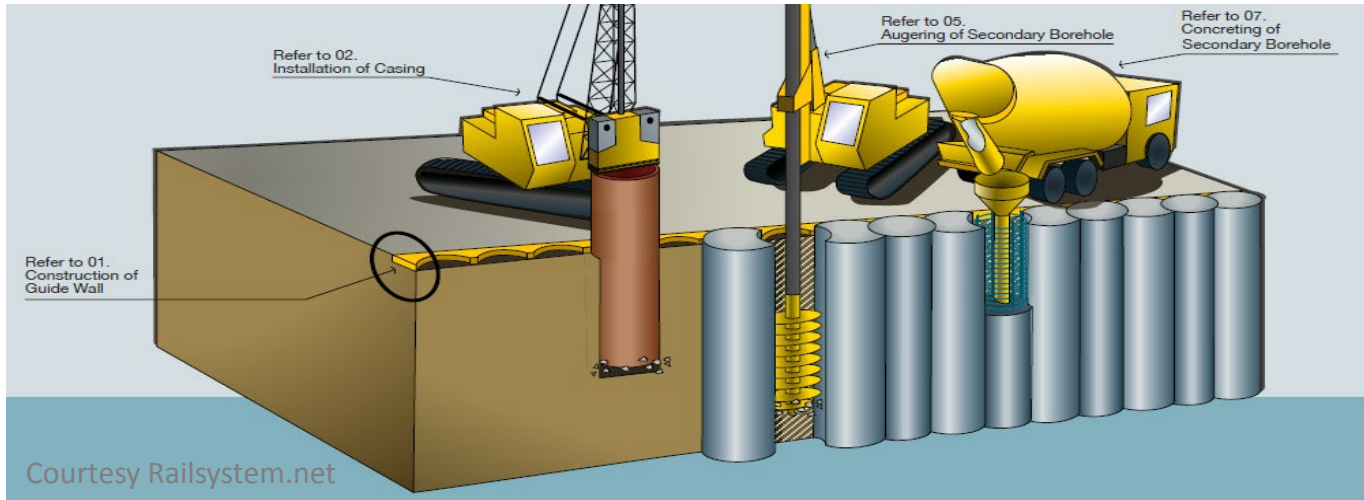
# RMM Overview



**Secant pile walls were constructed along 1,100 m river valley to provide interim hydraulic controls for construction and a long-term vertical barrier for contaminants left in place**



# RMM Design: Secant Piles

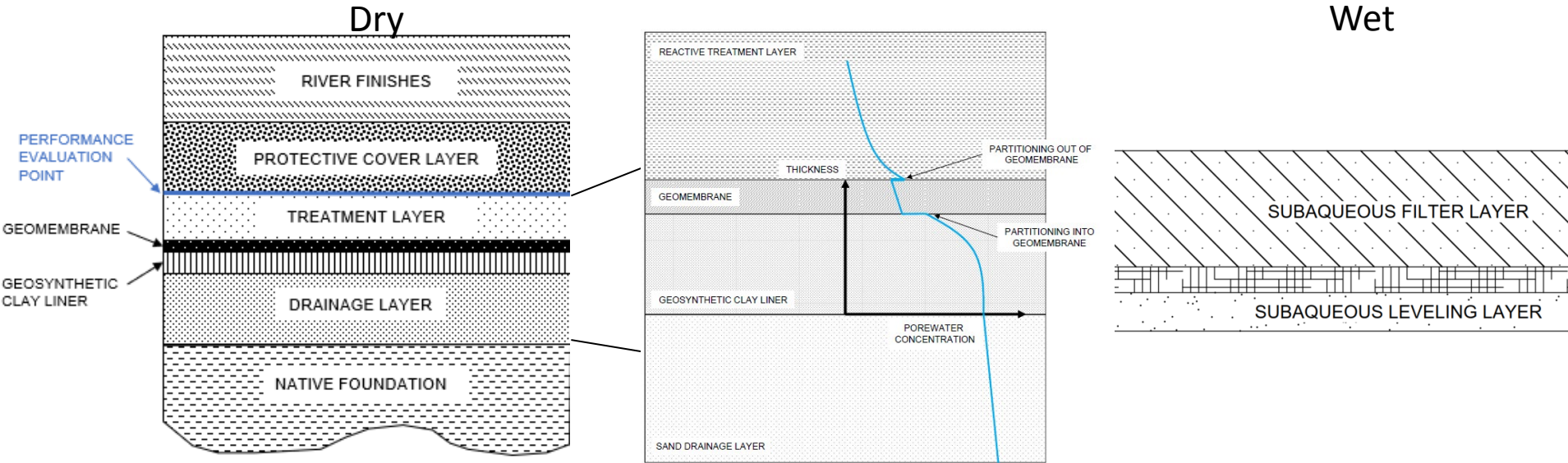


- Interlocked secant pile wall extends 80 to 120' bgs and keys into bedrock
- 2.5 to 3.0' thick low hydraulic conductivity vertical barrier ( $< 1 \times 10^{-8}$  cm/s)
  - Hydraulic cutoff to facilitate construction in the dry and minimize volume of water for treatment
  - Long-term environmental protection by isolating river finishes from contamination outside of the River Valley





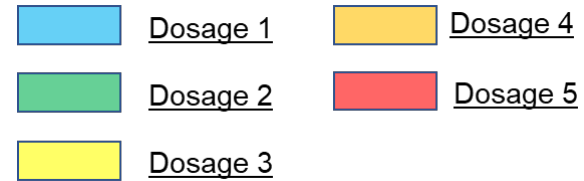
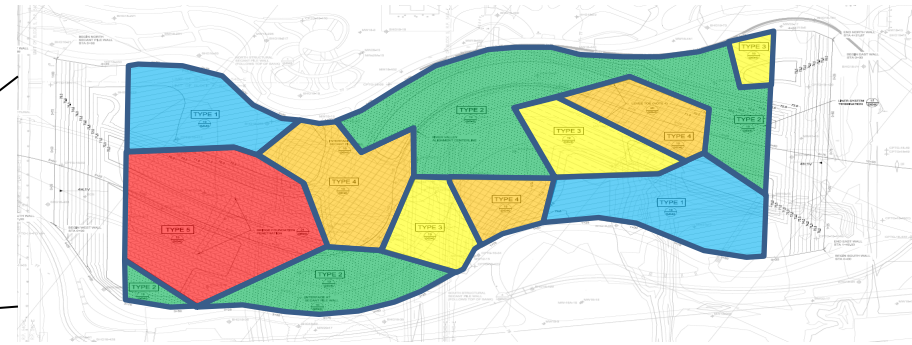
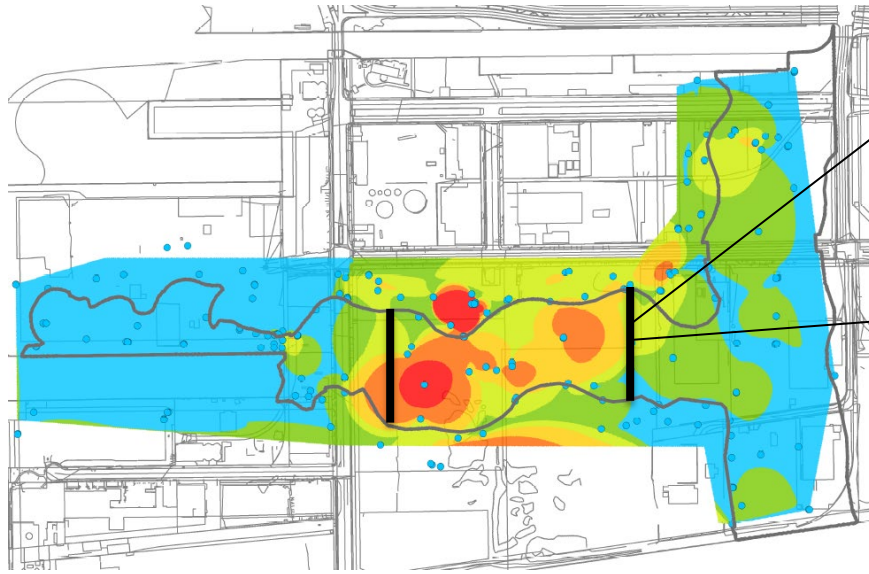
# RMM Design: Horizontal Barrier



- Design Criteria: Prevent dissolved phase concentrations at performance evaluation point exceeding EcoBMCs for 100-year design life
- Selected PHC F2 (EcoBMC: 170 ug/L), naphthalene (EcoBMC: 193.5 ug/L) and anthracene (EcoBMC: 1 ug/L) as representative proxy constituents for design



# Reactive Treatment Layer (RTL) Design





**Characterization of the nature and extent of groundwater contaminants provided a design basis for a horizontal barrier**









**POLLUTE modeling was used to evaluate the reactive treatment layer configuration (i.e., amendment dosage)**

## Legend

-  Waterlot Boundary
-  Groundwater PHC Samples

## Groundwater PHCF2 Concentrations

- |  |   |   |
|--|---|---|
|  Less than 170 ug/L |  1,000 to 1,500 ug/L   |  15,000 to 60,000 ug/L     |
|  170 to 1,000 ug/L |  1,500 to 15,000 ug/L |  Greater than 60,000 ug/L |

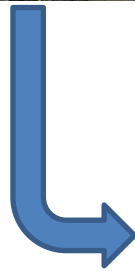




# Vertical Cut-off Wall Construction



Vertical cutoff wall construction



River Valley Excavation



Exposed Cutoff Wall Surface





# Horizontal Barrier Placement



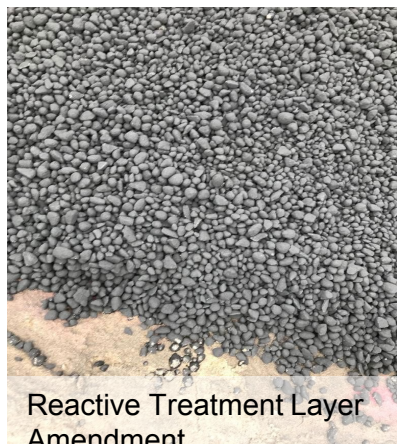
Drainage Layer and GCL Installation



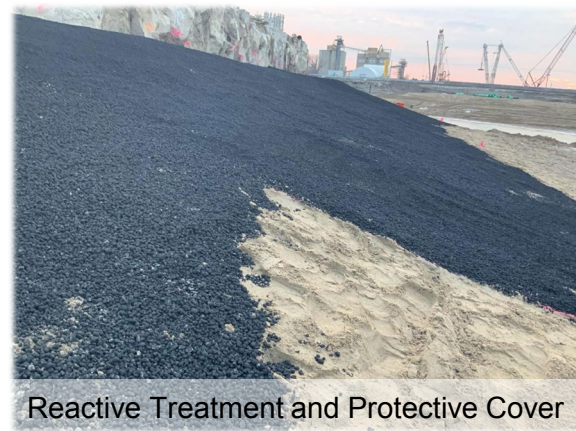
Geomembrane Installation



Geomembrane Seams



Reactive Treatment Layer  
Amendment



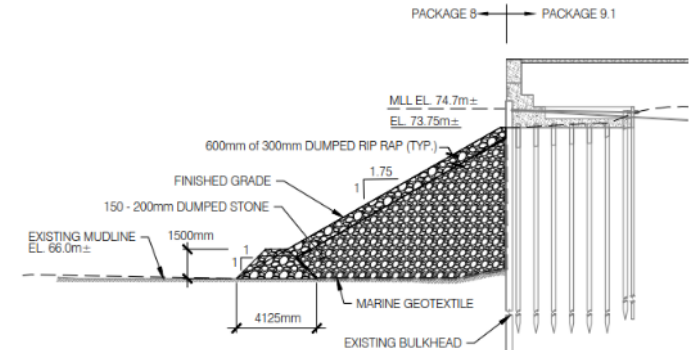
Reactive Treatment and Protective Cover  
Layer Installation



# Polson Slip Sediment Cap Design



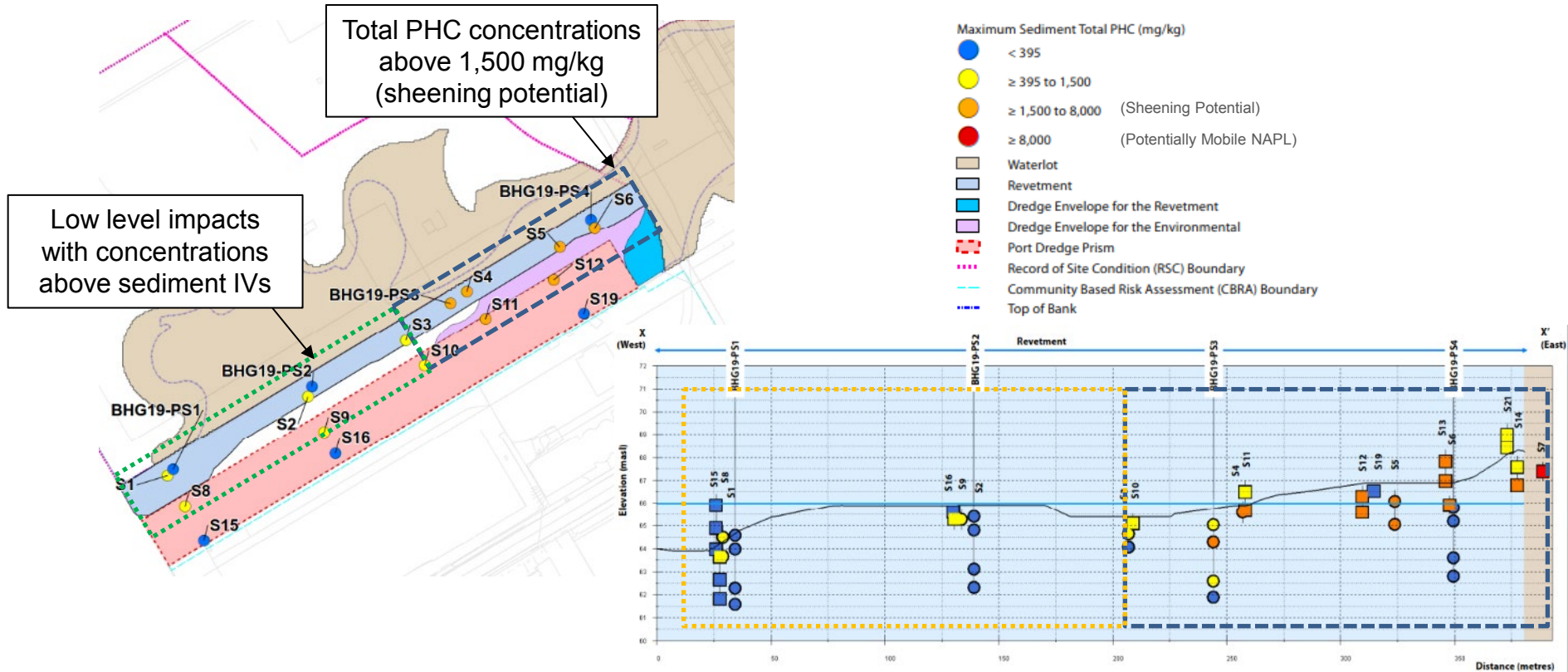
- Construction Elements
  - Demolition of Existing Dockwall
  - Dredging in Polson Slip
  - Permanent revetment design that ties Polson Slip into Canoe Cove
  - Sediment cap at the base of the revetment to manage underlying impacts





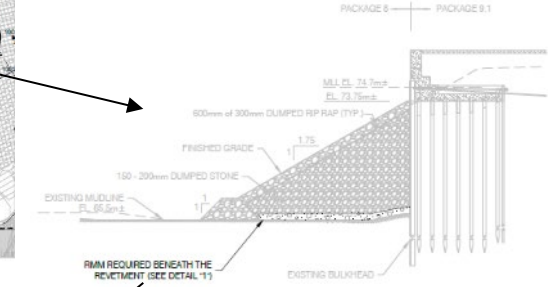
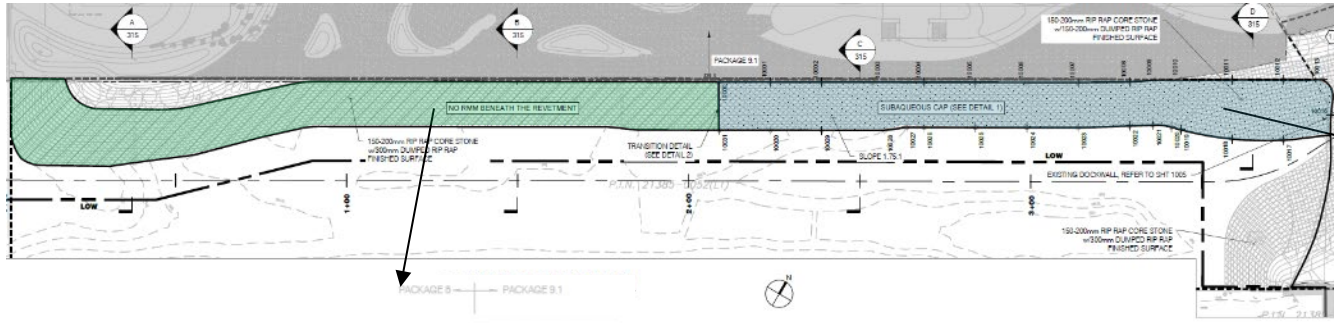


# Polson Slip Sediment Cap Design





# Polson Slip Sediment Cap Design



ISOLATION LAYER - OLEPHILIC CLAY IMPREGNATED GEOCOMPOSITE (SEE NOTE 2)

River Finishes Physically Isolates  
Underlying Sediment and Prevent Scour  
and Migration of Impacted Sediment  
(No additional RMM required)

Sediment Cap Beneath the Revetment with  
1.9 kg/m<sup>2</sup> NAPL Sequestration Capacity  
(max. expected NAPL expression  
throughout design life is 0.7 kg/m<sup>2</sup>)





# Polson Slip Cap Construction



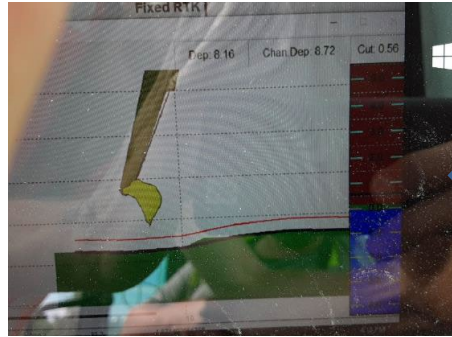
Transport to Site



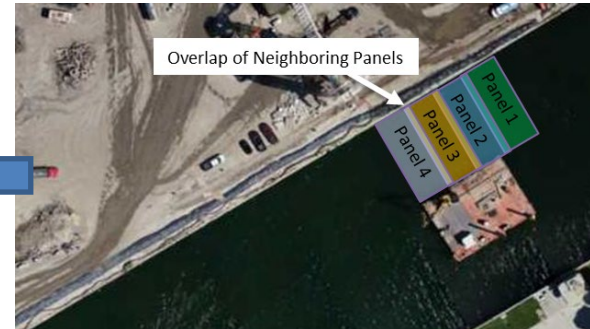
On-shore Setup for Placement



Placement of Geocomposite Cap



Field Construction Oversight with Unmanned Submarine Vessel and Dredge Visualization System



Sequence of Geocomposite Cap Placement



# Acknowledgements and Questions



## Waterfront Toronto (Owner)

- Don Forbes & Joey Herrington



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- Laura Solano



## Geosyntec (River Valley RMM Design and Resident Site Inspector)

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