SUSTAINABLE SEDIMENT SOLUTIONS: STABILIZATION OF CONTAMINATED SEDIMENT

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WHAT IS STABILIZATION OF SEDIMENT?

Transform sediment characteristics by mixing with a pozzolanic material and other additives

- Mitigate hazardous characteristics
- Reduce mobility or leachability of contaminants
- Improve structural characteristics for reuse
- Increase medium stability
- Improve handling characteristics prior to disposal or further treatment

Focus of this presentation is on large scale bulk mixing that can be performed on sediments in place or on dredged materials

WHY STABILIZATION OF SEDIMENT?

- Sustainability and Circular Economy Benefits
  - Minimize need for landfill or off-shore disposal space
  - Minimize sediment transportation requirements
  - Provide opportunities to use dredge material beneficially

    or
  - Reduce need for dredging
- Technology is widely used, accepted, and understood for environmental and geotechnical improvement
- Can stand alone or augment other sediment management technologies
- May reduce cost

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STABILIZATION OR SOLIDIFICATION?

- **Solidification**: Physical transformation from reaction with reagents .
- *Contaminated materials are encapsulated "physically trapped"*
- *Reduction of permeability*
- *Increased compressive strength and media durability*

- **Stabilization**: Chemical reaction between reagents and media
- *Reduction in leachability of targeted contaminants*
- *Transformation of targeted contaminants*
- *Reduction of solubility of contaminants*

DESIRED ENDPOINTS

Performance Requirements are quantifiable metrics that demonstrate you can meet project goal

- Typical Performance Requirements
    - Unconfined Compressive Strength (UCS)
    - Hydraulic Conductivity (HC) lower than surrounding sediment
    - Leachability - Contaminant reduction?
- Define bright line or build in some flexibility
    - Average with floor/ceiling value
    - Different criteria for different areas and future uses

Failure Mode of Sample

STABILIZATION OF POST DREDGED MATERIALS

OR

STABILIZATION OF SEDIMENTS IN PLACE

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POST DREDGE

- Treat Dredge Soils in upland area for beneficial reuse on-site or off-site
- Reduce environmental footprint – less landfill disposal
- Minimizes re-handling
- Requires large upland area
- May reduce sediment dewatering efforts

JÄTKÄSAARI HELSINKI

- Urban renewal project
- Historic port to modern residential area
- Ongoing 2011 to present
- Dredging contaminated sediment, basin stabilization
- Produce usable construction materials

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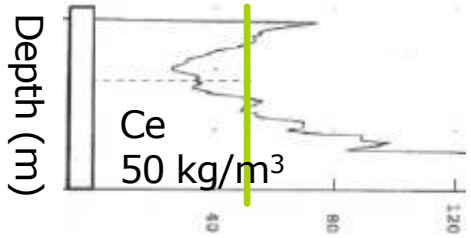
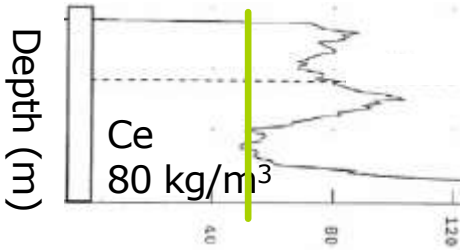
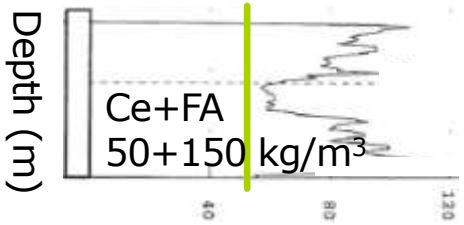
LABORATORY MIX EVALUATION

- Explore promising mixtures
- Exploit industrial by-products?
- Chemical compatibility and leaching
- Strength targets assurance
- Optimum cost-benefit determination

BINDER COSTS, SOME UNIT PRICE CALCULATIONS

	Quality	Relative Binder Cost
	Poor	60%
	Good	100%
	Very good	70%

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LEACHING TEST RESULTS
WEST HARBOUR PHASE III

Element	Limit value [mg/m²]*	Test results** 64 d [mg/m²]
Arsenic, As	58 →	0.4 – 0.6
Barium, Ba	2800 →	4.0 – 9.3
Cadmium, Cd	2,1 →	0.04 – 0.06
Cobalt, Co	280 →	0.21 – 0.25
Copper, Cu	250 →	0.7 – 3.3
Mercury, Hg	1,6 →	0.04 – 0.14
Molybdenum, Mo	70 →	3.6 – 22.9
Nickel, Ni	270 →	0.4 – 2.7

Element	Limit value [mg/m²]*	Test results** 64 d [mg/m²]
Lead, Pb	210 →	0.2 – 0.3
Antimony, Sb	36 →	0.8 – 16.8
Selenium, Se	14 →	0.5 – 1.9
Tin, Sn	280 →	1.5 – 6.5
Vanadinium V	700 →	0.7 – 4.7
Zinc, Zn	330 →	2.4 – 4.0
Fluoride, F	2800 →	105 - 124

Limit values presented in the environmental permit application of Sepänmäki noise barrier.

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Modified test according to standard NEN 7375:2004

Full scale implementation!

- Pilot testing proves laboratory results
- Quality control is key to success
- Designer should be involved
  - On site modifications due to changing conditions
  - Lessons learned for future port work and site

MASS STABILIZATION IN JÄTKÄSAARI

DIFFERENT BINDER RECIPES

Binders:

Cement

Lime cement

Cement and fly ash

Oil shale ash

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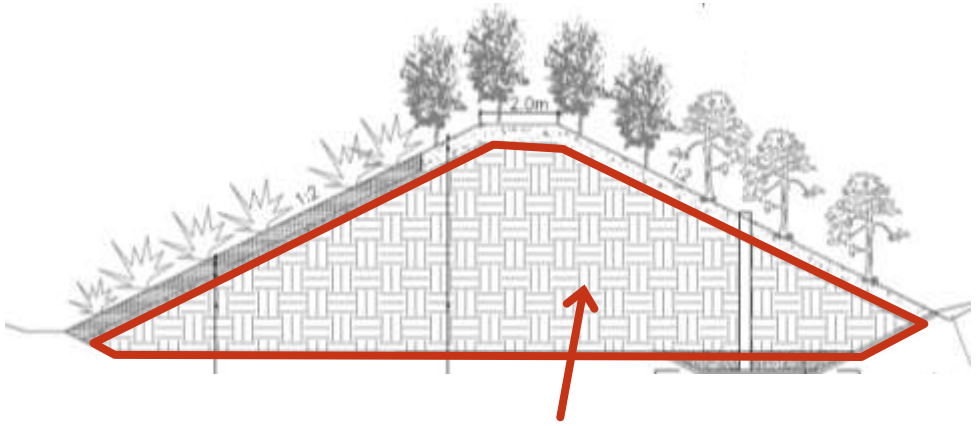
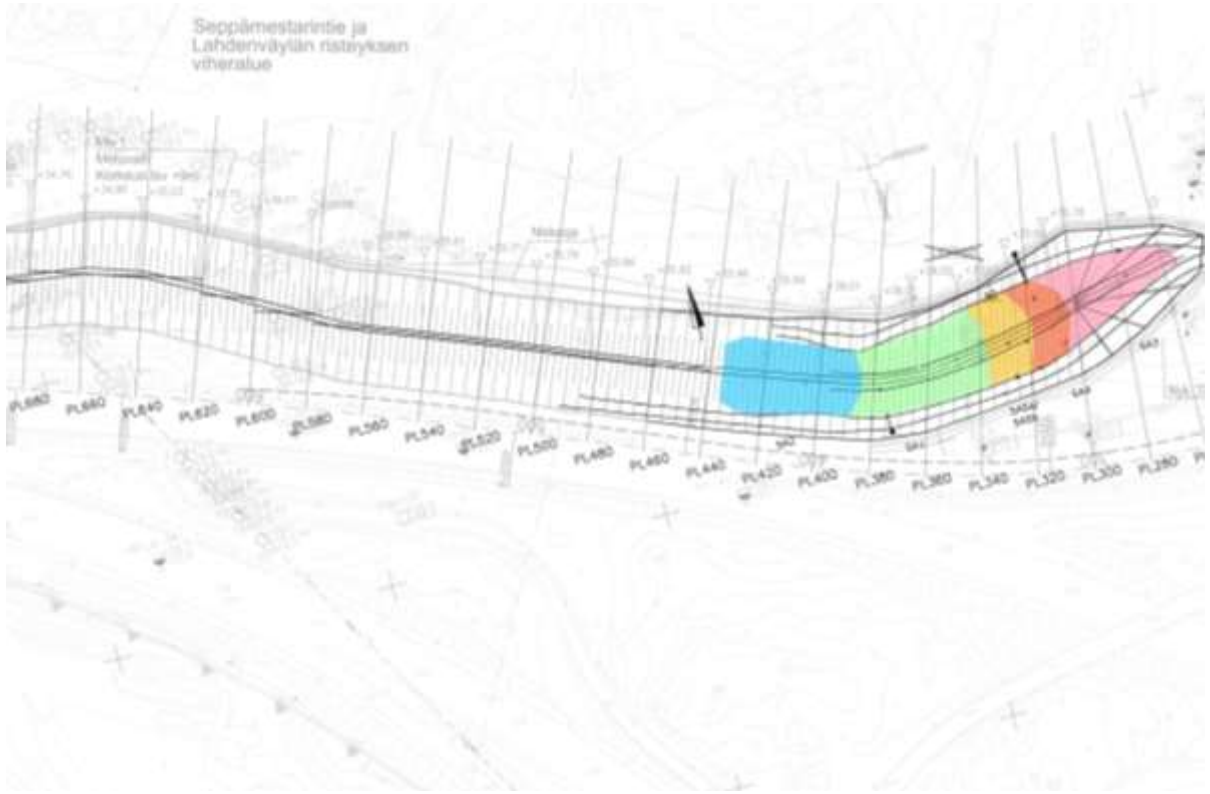
SEPÄNMÄKI NOISE BARRIER



MASS STABILIZED SURPLUS CLAY FROM WEST HARBOUR PHASE III (CONSTRUCTION IN 2016-2017)



SEPÄNMÄKI NOISE BARRIER, DESIGNED H = 5-13 M

SEPÄNMÄKI NOISE BARRIER, HELSINKI

- Construction from April to October 2016
- 2893 truckloads of stabilized sediment (distance from West Harbour 12 km)
- A total of 29540 cubic meters transported and placed

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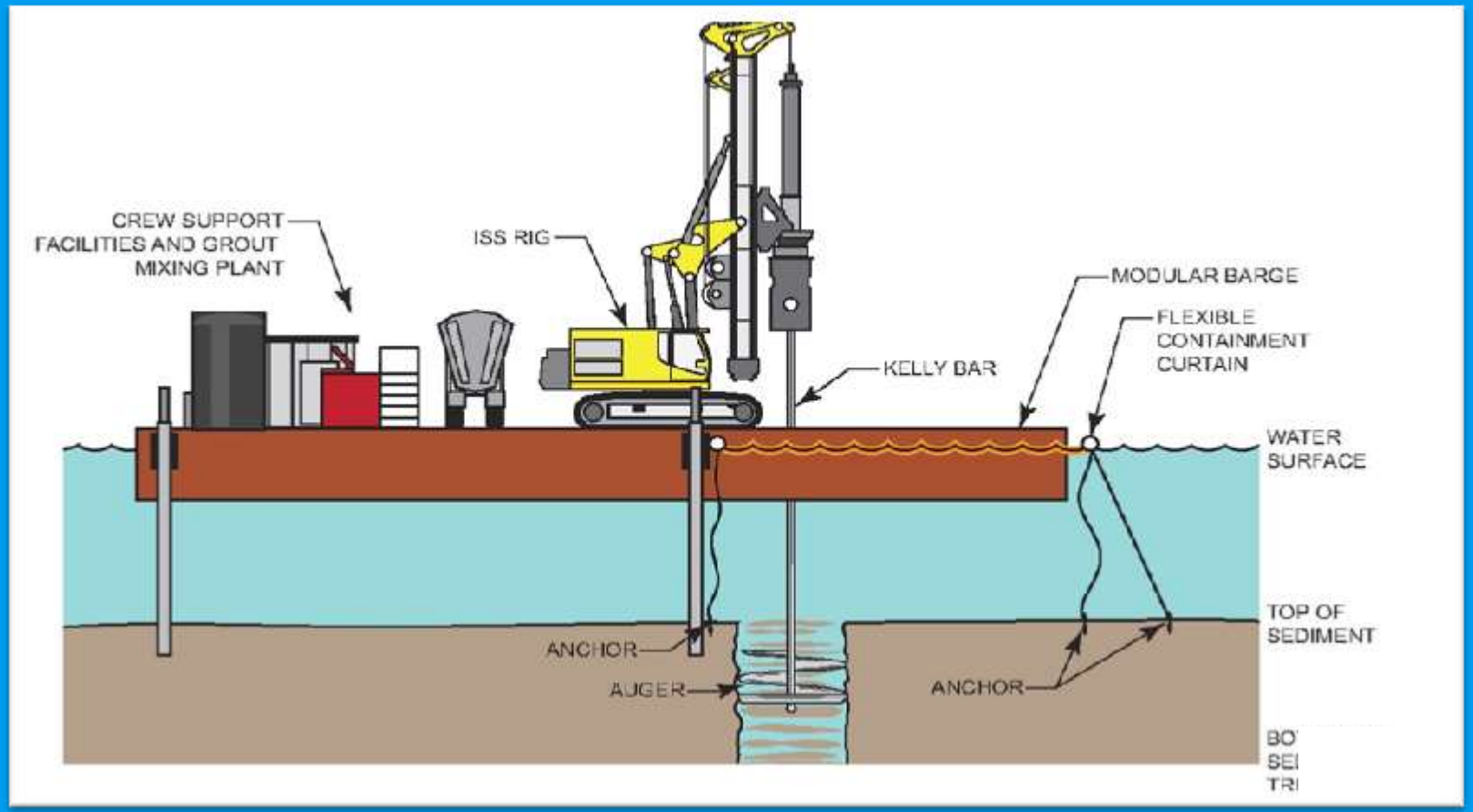
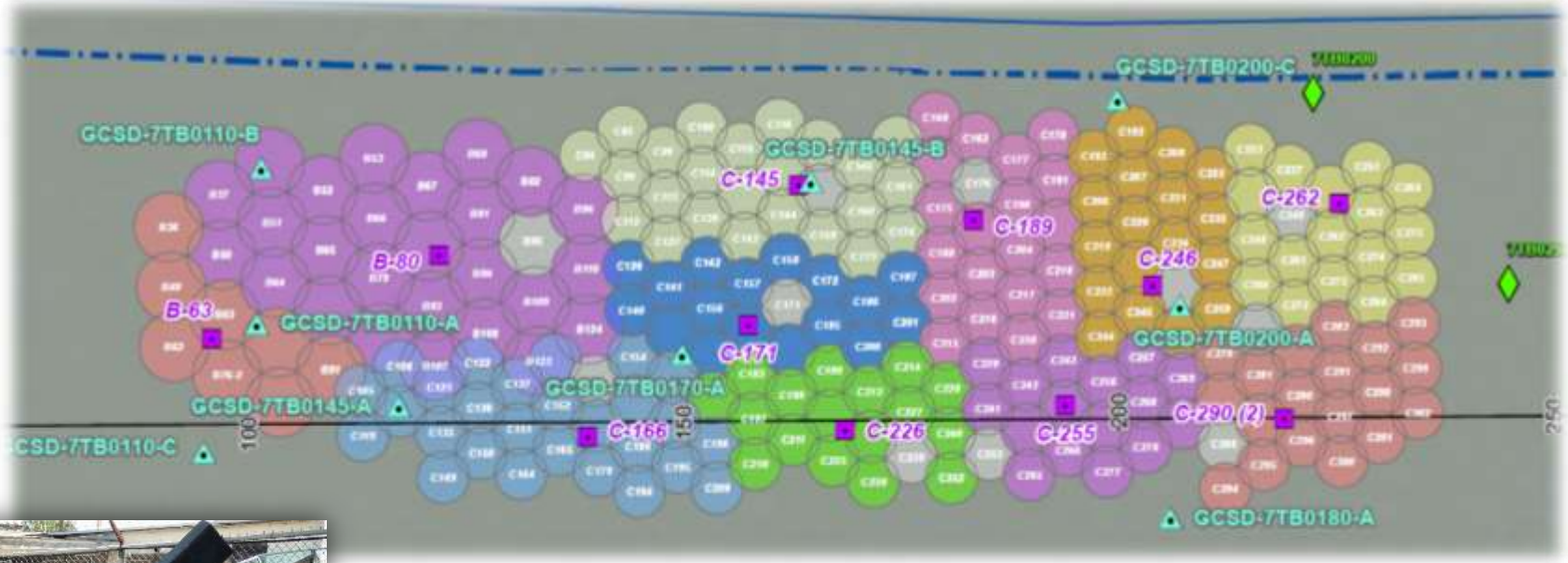
IN PLACE

- Treat sediment in place
- Minimize short term impacts by reducing remediation timeframe
- Minimize infrastructure upgrades and protect existing bulkheads and other structures
- Reduce environmental footprint – less trucks, less landfill disposal
- Resist erosion & scour
- Improve habitat




IN-PLACE

IN PLACE



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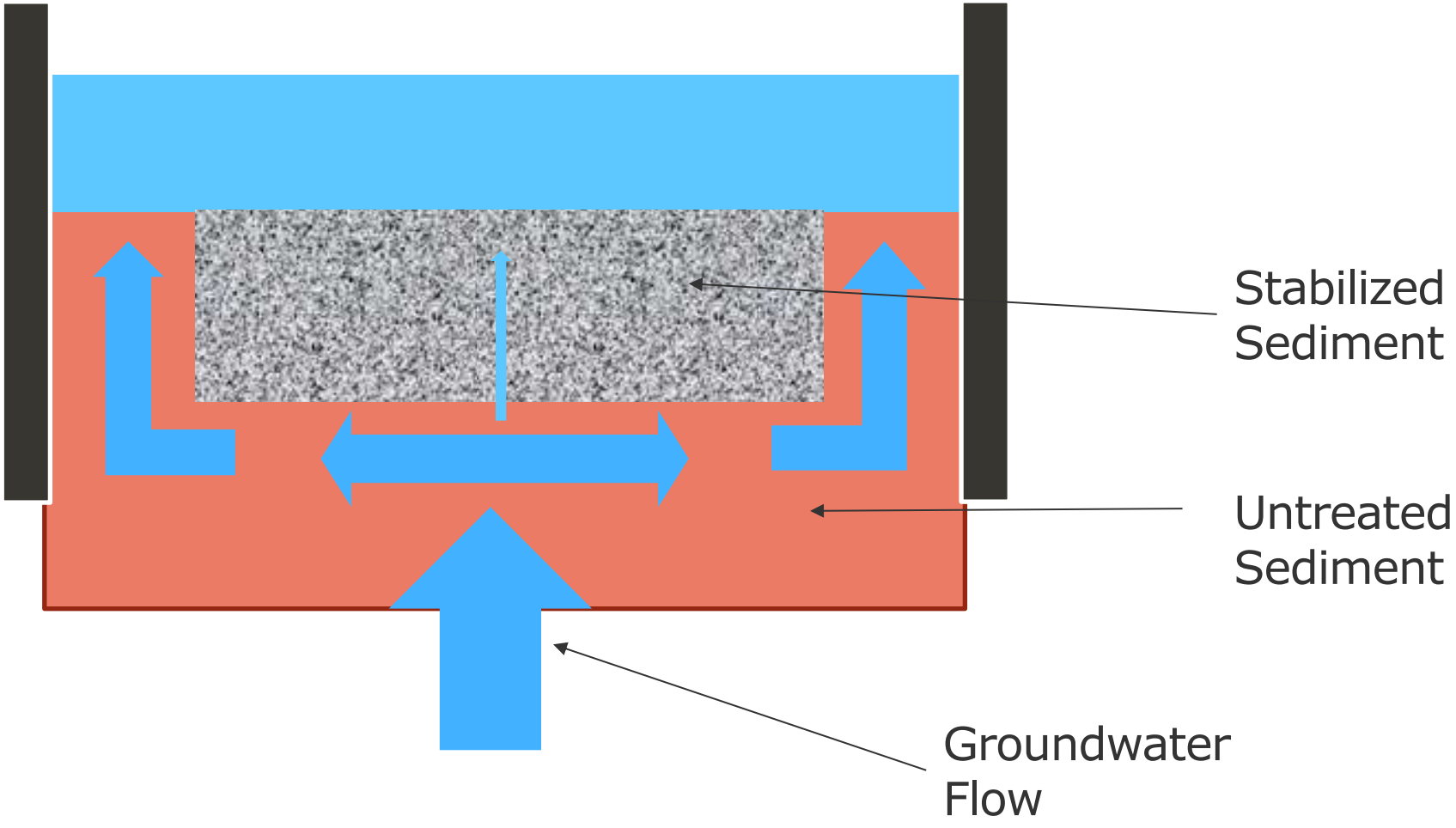
GROUNDWATER FLOW IMPACTS

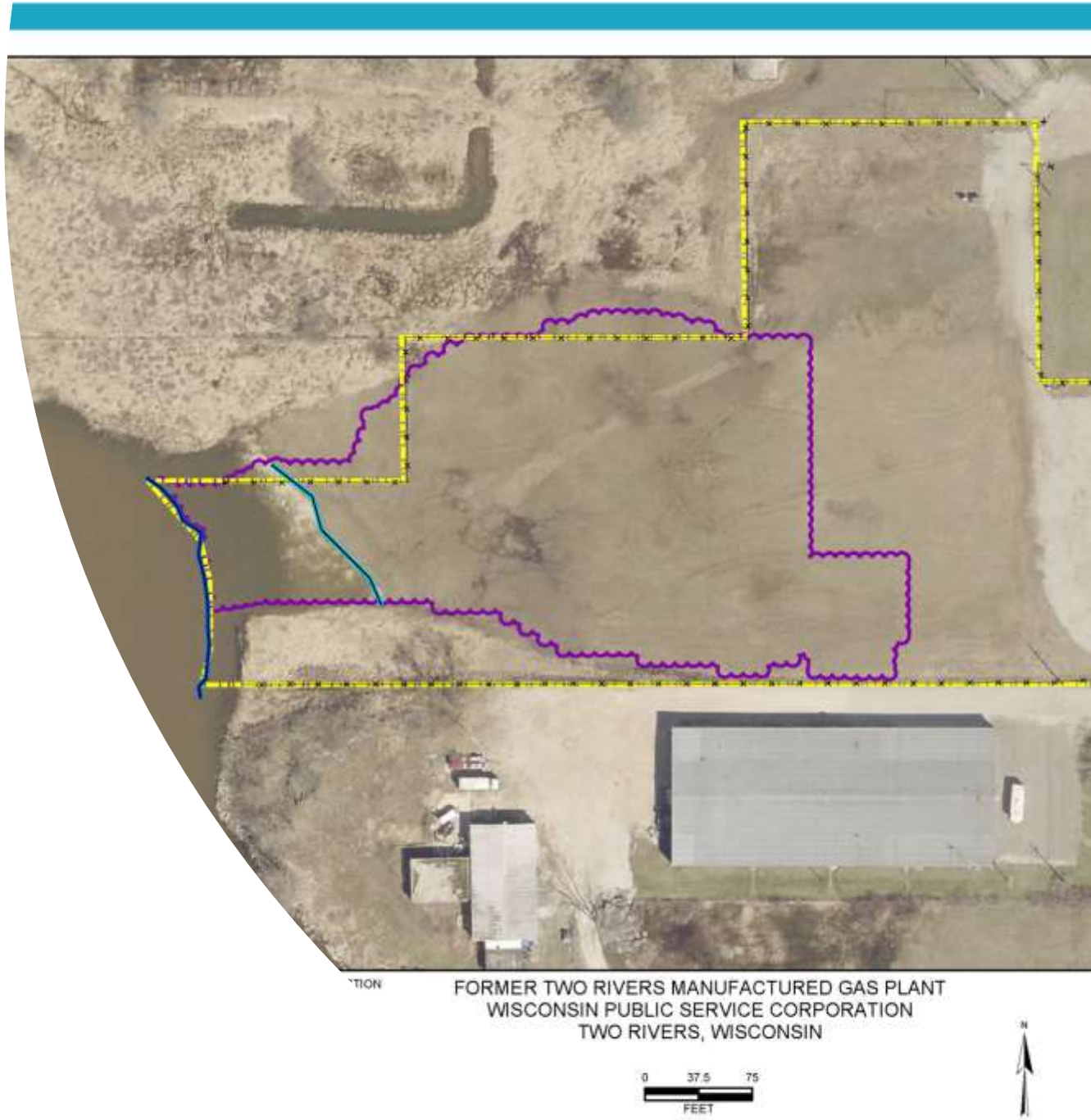


POST IN SITU STABILIZATION CONDITIONS

- Wisconsin, USA
  - MGP Sourcee Material impacted soils
  - 1.6 hectare solidification effort
  - 61,000 m^3 of impacted soils
  - 60 cm of clean fill cover over solidified soil

POST ISS HABITAT EVALUATION

- Solidified area now submerged due to rising Great Lakes water levels
- Clean backfill resembles aquatic environment
- Assessed post ISS Benthic community



POST ISS HABITAT EVALUATION

Two Rivers WI

POST STABILIZATION HABITAT RESULTS

Concentrations of sediment samples collected from ISS area not expected to present risk to benthic invertebrates

Benthic invertebrate community similar between ISS and reference areas

Benthic community at ISS area indicative of earlier succession stage relative to reference area

Benthic community metrics at ISS area supportive of remedial technology in aquatic environments

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THANK YOU!

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