

ASSESSING THE INTEGRITY OF THE SECONDARY CONTAINMENT LINER AT VALDEZ MARINE TERMINAL

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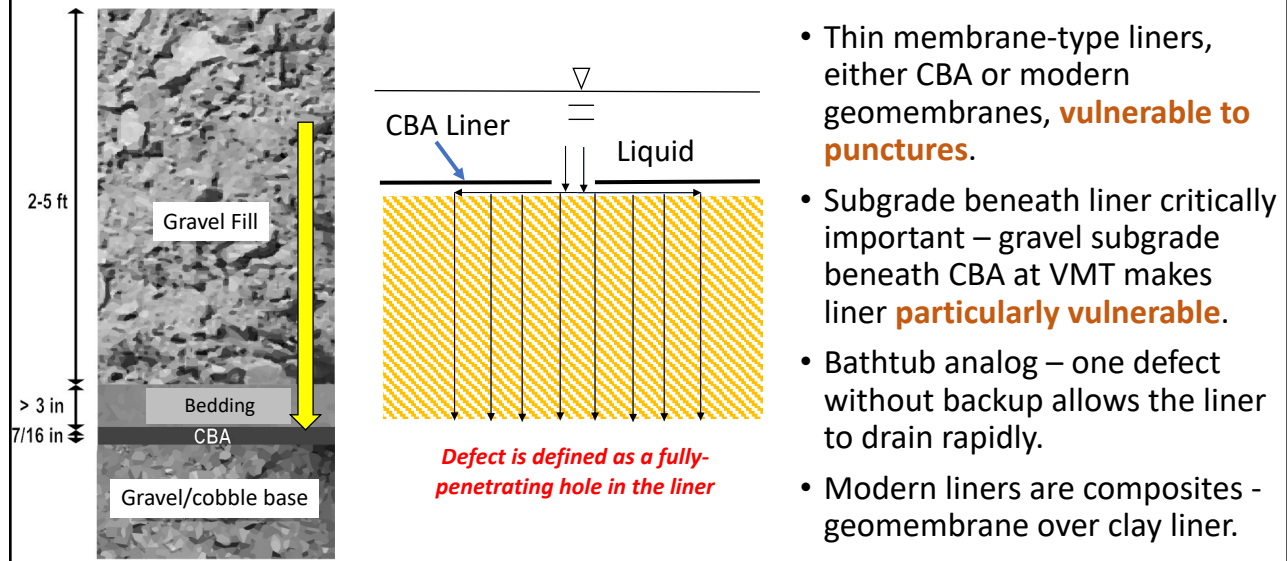
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Engineering Expertise

- **WSP** – Engineering consultant for Alyeska providing assessment and evaluation of secondary containment system (formerly Golder Associates).
- **Joseph Scalia (JS)** – Colorado State University, expert in containment systems.
- **Craig H. Benson (CHB)** – University of Wisconsin-Madison/University of Virginia, expert in containment systems (me).

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Vulnerability of Catalytically Blown Asphalt (CBA) Liner at Valdez Marine Terminal



2.5 ft

Gravel Fill

> 3 in

7/16 in

Bedding

CBA

Gravel/cobble base

CBA Liner

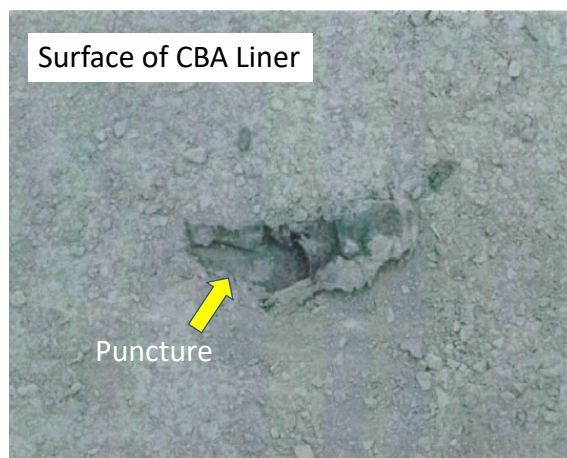
Liquid

Defect is defined as a fully-penetrating hole in the liner

- Thin membrane-type liners, either CBA or modern geomembranes, **vulnerable to punctures**.
- Subgrade beneath liner critically important – gravel subgrade beneath CBA at VMT makes liner **particularly vulnerable**.
- Bathtub analog – one defect without backup allows the liner to drain rapidly.
- Modern liners are composites - geomembrane over clay liner.

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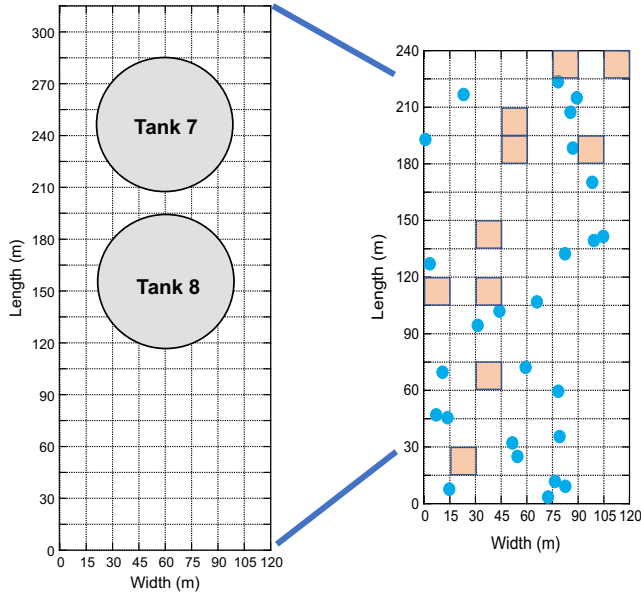
What Causes Defects?



- Installation shortcomings, errors.
- Loading from equipment causing stress concentrations at contact between gravel and CBA liner.
- Oxidation and embrittlement.
- Construction equipment during liner inspections.
- Many others.

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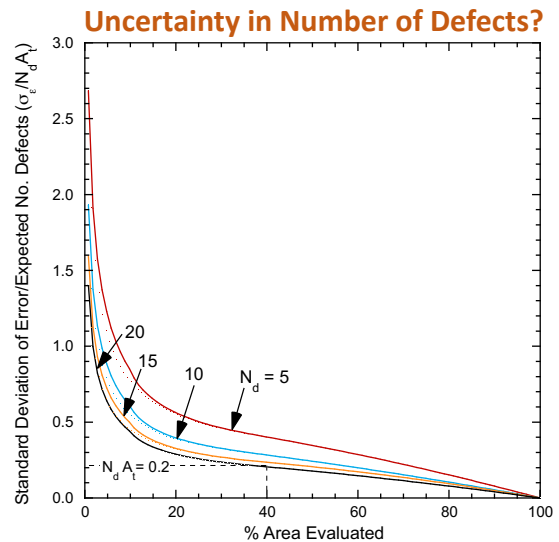
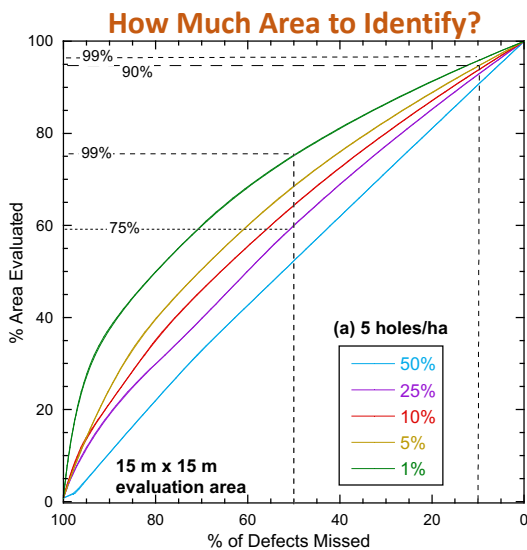
Statistical Assessment of Defects



- Addressed two important questions:
 - How much area must be evaluated to **identify defects** (number, size, location)?
 - How much area must be evaluated to **estimate number of defects** with acceptable uncertainty?
- Used Monte Carlo method to assign defects and evaluation areas.

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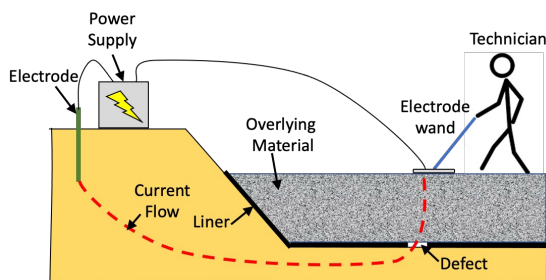
Outcomes of Statistical Analysis



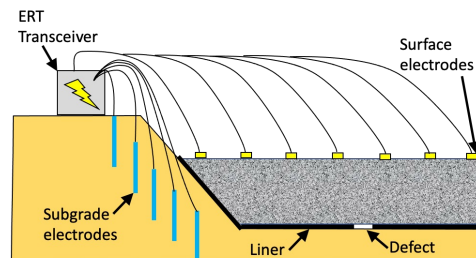
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Field Assessment of Methods

Leak Location Survey



Electrical Resistance Tomography (aka ERT)



Pilot test both methods over at least 20% of CBA liner at West Tank Farm.

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Recommendations

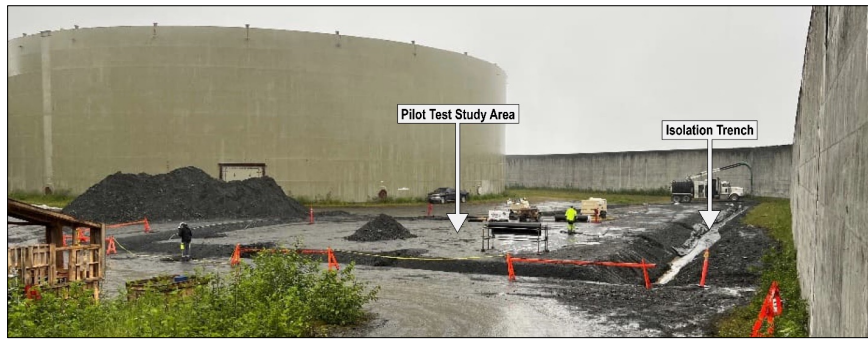
- To estimate **total number of defects**, need to evaluate **at least 20% of area**.
- To **detect and locate defects**, effectively need to evaluate **entire area**.
- **Pilot test leak location** and **ERT** methods in West Tank Farm – at least 20% of area, with direct visual inspection afterwards to ground truth.
- Employ **leak location** and/or **ERT** methods to evaluate CBA liner across **all containment cells** in East Tank Farm.

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Pilot Study of Leak Location Survey & ERT

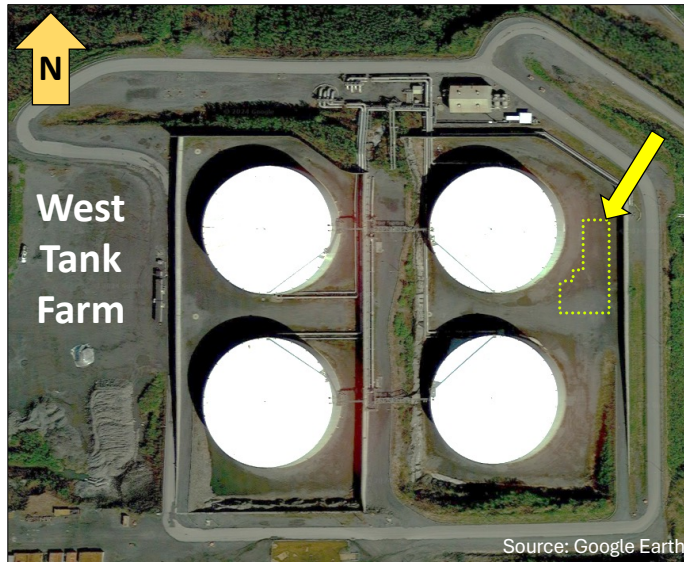
Pilot study conducted by WSP on 22-29 July 2024 included:

- Establishment and verification of electrical isolation
- Electrical leak location (ELL) survey
- Electrical resistance tomography (ERT) survey
- Investigation of existing anomaly detected by ELL
- Investigation of three intentionally induced defects (large gash, small gash, knife slit)



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Pilot Study Location



- 1-m transect spacing
- Transects on N-S & E-W orientation

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Intentional Defects

300-mm cut with gap



150-mm cut, no gap



12 & 25 mm diam. holes



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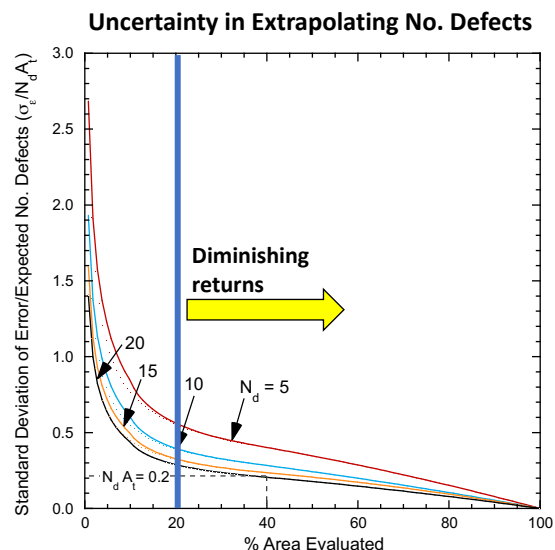
Outcomes of Pilot Tests

- ELL preferred over ERT. ERT method not effective, likely due to thick surface layer over CBA liners.
- ELL surveys on east-west transects did not detect anomalies, existing or intentional. ELL surveys on north-south transects detected existing anomaly. **Lesson – conduct surveys on orthogonal transects with narrower transect spacing.**
- ELL will detect larger anomalies in the CBA, but not smaller anomalies.
- Electrical isolation critical, and can be onerous and challenging.

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WSP's Pilot Study Recommendations – 1

- WSP:** future efforts to **evaluate the integrity of the CBA liner at the VMT should include ELL surveys**, temporarily de-energizing cathodic protection systems, and isolating any known potentially conductive perforations (e.g., metal pipes, storm drain catch basins) where practical.
- JS and CHB:** We **concur**.
- WSP:** ELL survey areas should be sized for each cell to include sufficient area to statistically calculate the estimated permeability of the SCS. WSP recommends a test area of 5% of the SCS
- JS and CHB:** We **disagree** – misunderstands the recommendation for 20% of area.



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WSP's Pilot Study Recommendations – 2

- WSP:** Where future ELL indicates potential defects/leaks, the locations should be marked and excavated for visual inspection. If leaks are discovered, they should be patched, backfilled, and the ELL survey rerun over the location to verify there are no additional leaks.
- JS and CHB:** We **concur**.

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JS and CHB's Recommendations

- Conduct ELL surveys over at least 20% of the CBA-lined area of the East Tank Farm, excluding areas with exposed XR-5 geomembrane. Use narrow (0.5 m) orthogonal transects.
- Establish methodology for computing leakage rate using number of defects and average size of defects as extrapolated from ELL survey outcomes. An effective hydraulic conductivity can also be calculated to compare with 10^{-6} cm/s criterion established in 1992.

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Alyeska's Proposed Testing – 1

(JS and CHB perspective)

- Employ ELL surveys combined with visual inspection.
 - **Require orthogonal transects**
 - **Narrow (0.5 m) transect spacing**
- Isolate from conductive pathways – concrete pipe supports, penetrating pipes, foundations, concrete walls, *conductive liner penetrations such as bentonite repairs*.
 - **Require testing at all previous repair locations.**
 - **Bentonite seals may be identified, which is OK**

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Alyeska's Proposed Testing – 2

(JS and CHB perspective)

- “test at least 5% of the buried SCS within each dike cell”
 - **Misunderstands the rationale for 20% area to reduce uncertainty in number of defects. Require at least 20%.**
 - **Likelihood of detecting defects approaches 0 when testing 5% of area**
- “the overall *pseudo permeability* of each dike cell will be calculated and compared to the theoretical flow which would occur through a newly installed, soil lined SCS with a permeability of 1×10^{-6} cm/s.”
 - **How will this be done? What procedures?**
 - **Defining an appropriate methodology is critical.**