Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Case Study
Tier 2 Data Evaluation

How A Little Upfront Effort Can Save Millions on the Back-End

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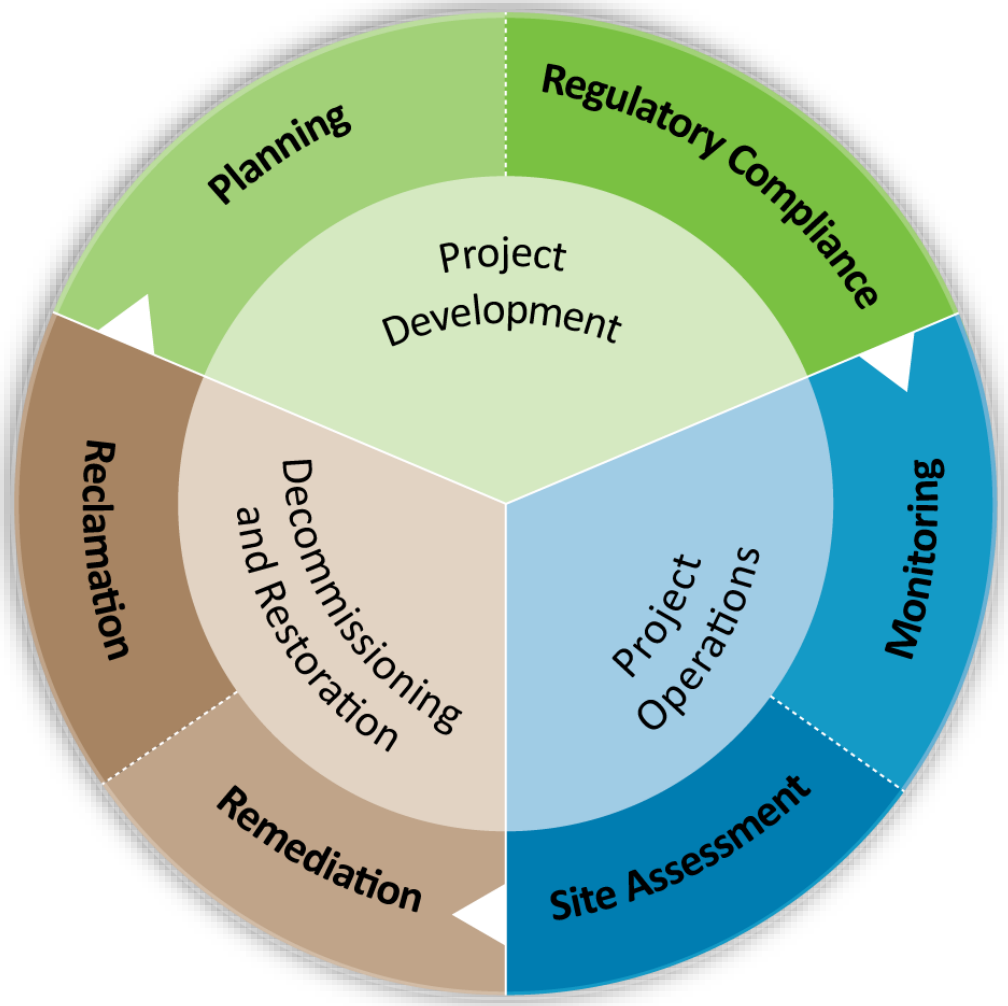
Why ?



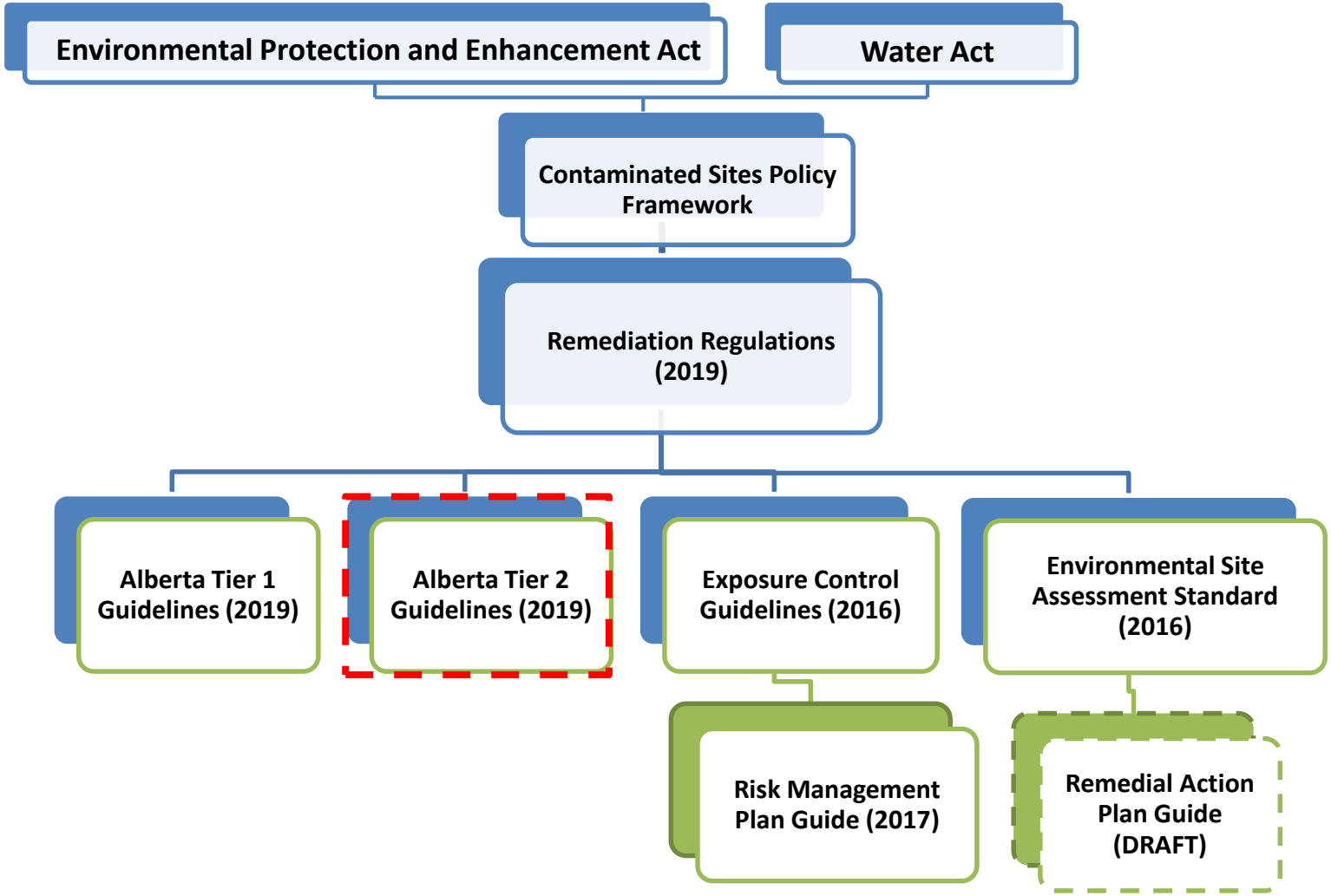
- **<u>Successful project</u>**
- Achieved regulatory closure
- Short time frame < 5 years
- On budget and achieved significant cost saving for client
- Did not compromise safety or the protection of receptors

Try to make the complex simple !

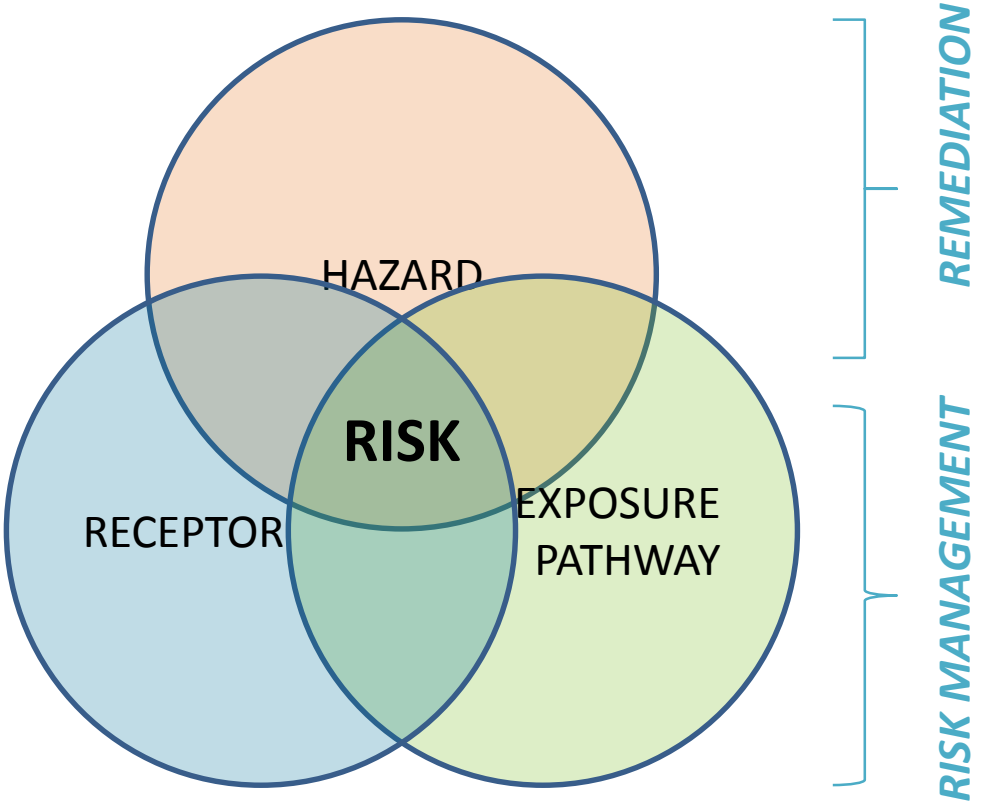
Managing Contaminated Sites

- **Time-sensitive**
- Multidisciplinary involvement requires effective communication and timely completion of deliverables
- New Remediation Regulations – January 2019

The Road Map – Where are you going ?



Remediation vs. Risk Management

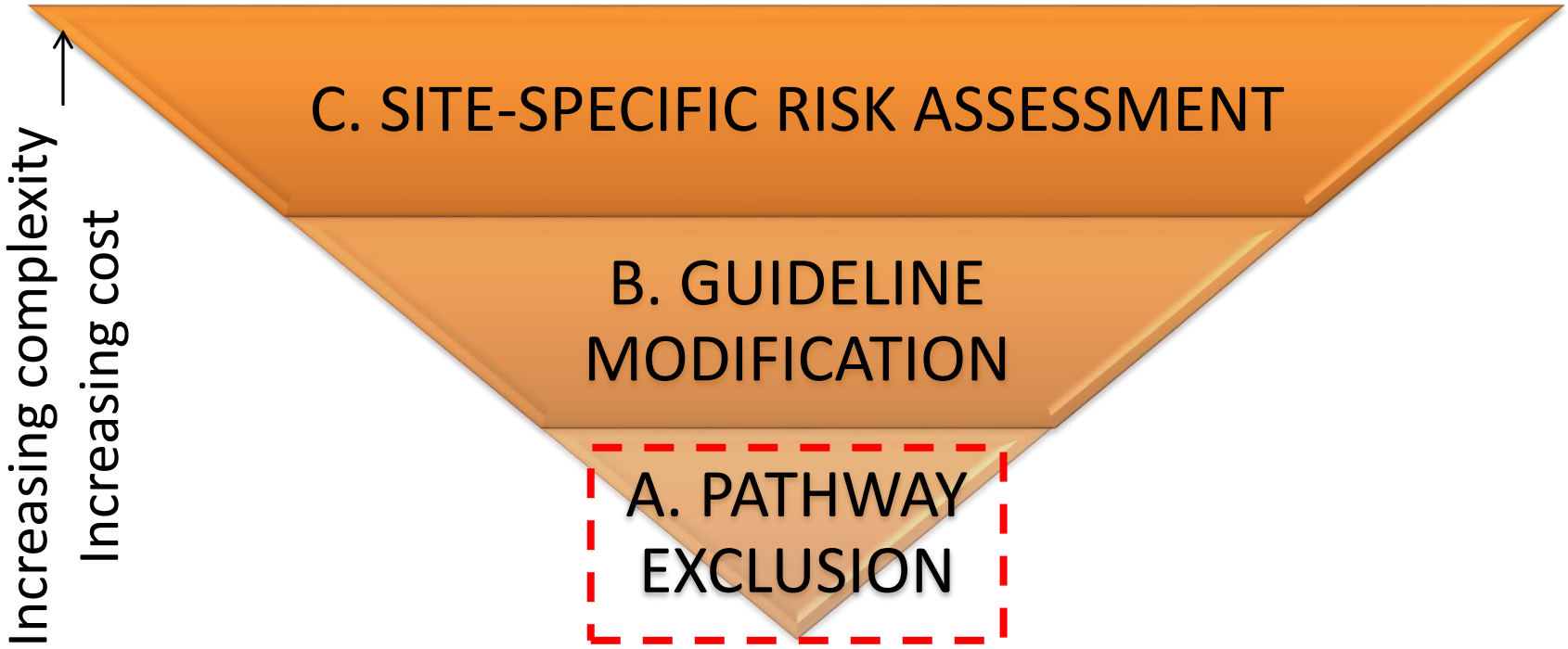


- Remove the hazard (chemical)
- Manage the receptor (human, eco) or exposure pathway

Alberta Tier 1 and Tier 2 Management Approaches

<table>
<tr><th>Tier 1</th><th>Tier 2</th><th>Exposure Control</th></tr>
<tr><td rowspan="4">Meet generic criteria</td><td>Meet site-specific criteria</td><td rowspan="4">Control receptors and/or exposure pathways; monitor; have contingency plan(s)</td></tr>
<tr><td>a) Pathway exclusion</td></tr>
<tr><td>b) Guideline modification</td></tr>
<tr><td>c) Site-specific risk assessment</td></tr>
<tr><td colspan="2">←REGULATORY CLOSURE→
(remediation)</td><td>←NO REGULATORY CLOSURE→
(risk management)</td></tr>
</table>

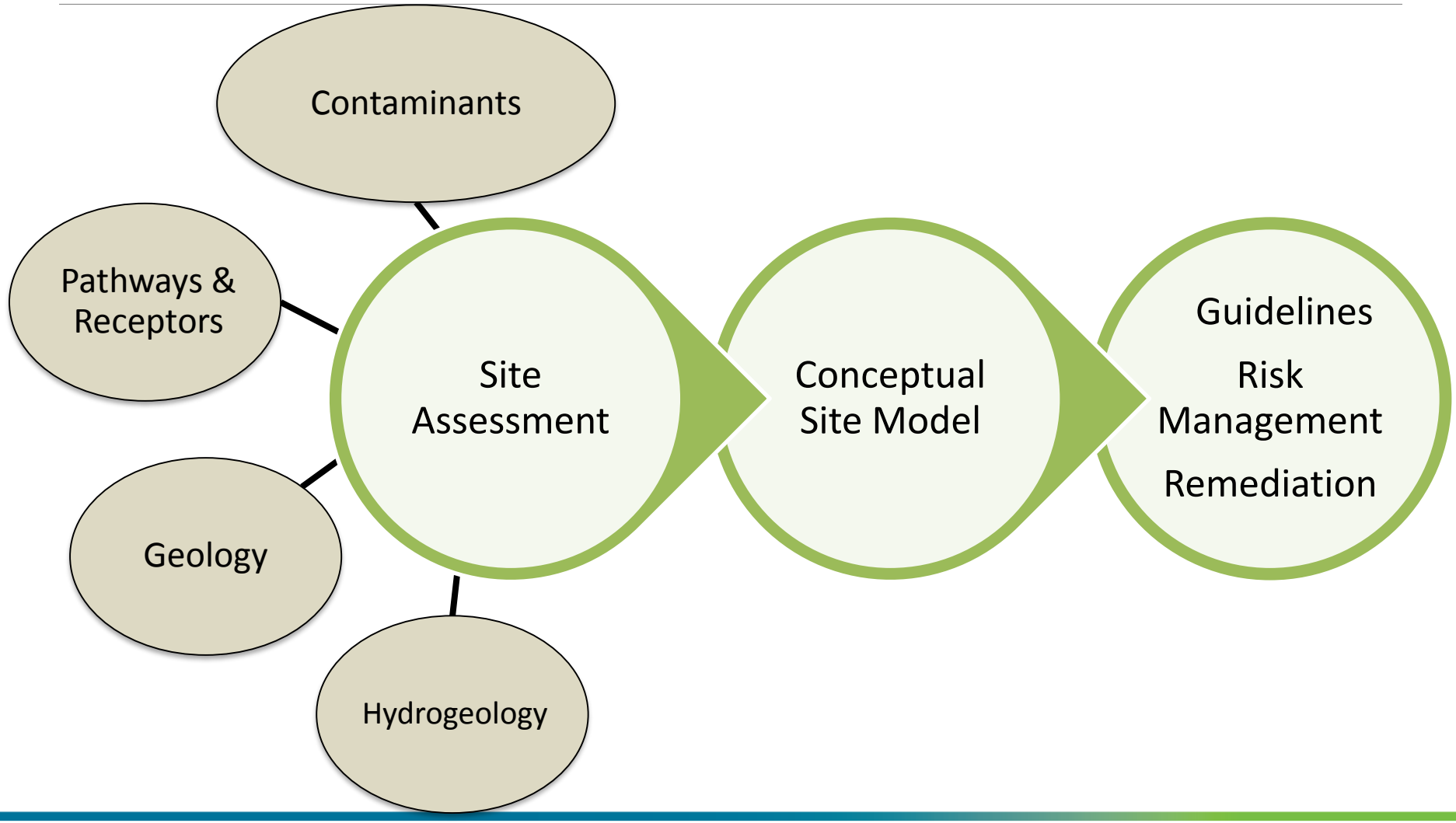
Tier 2 tailors guidelines to a site



Pathway Exclusion

1. Determine applicable land use
2. Determine soil texture
3. Filter by contaminant
   - what are the governing exposure pathways?
   - are they eligible for exclusion?
   - do conditions exist that support exclusion?
4. Exclude pathways as appropriate and modify criteria accordingly
5. Document Methods and Process

Conceptual Site Model (CSM) Work Flow



Case Study

- NW Alberta
- Upland Forested Area
- Lots of Wildlife
- Release within a pipeline right of way
- Emulsion consisted of sour crude and produced water

Control, Containment and Recovery

- ERP – Shut in line and facility
- Relatively small amount of released fluids <6 m^3
- H2S – Major safety challenge
- Pooled fluids recovered by vacuum truck

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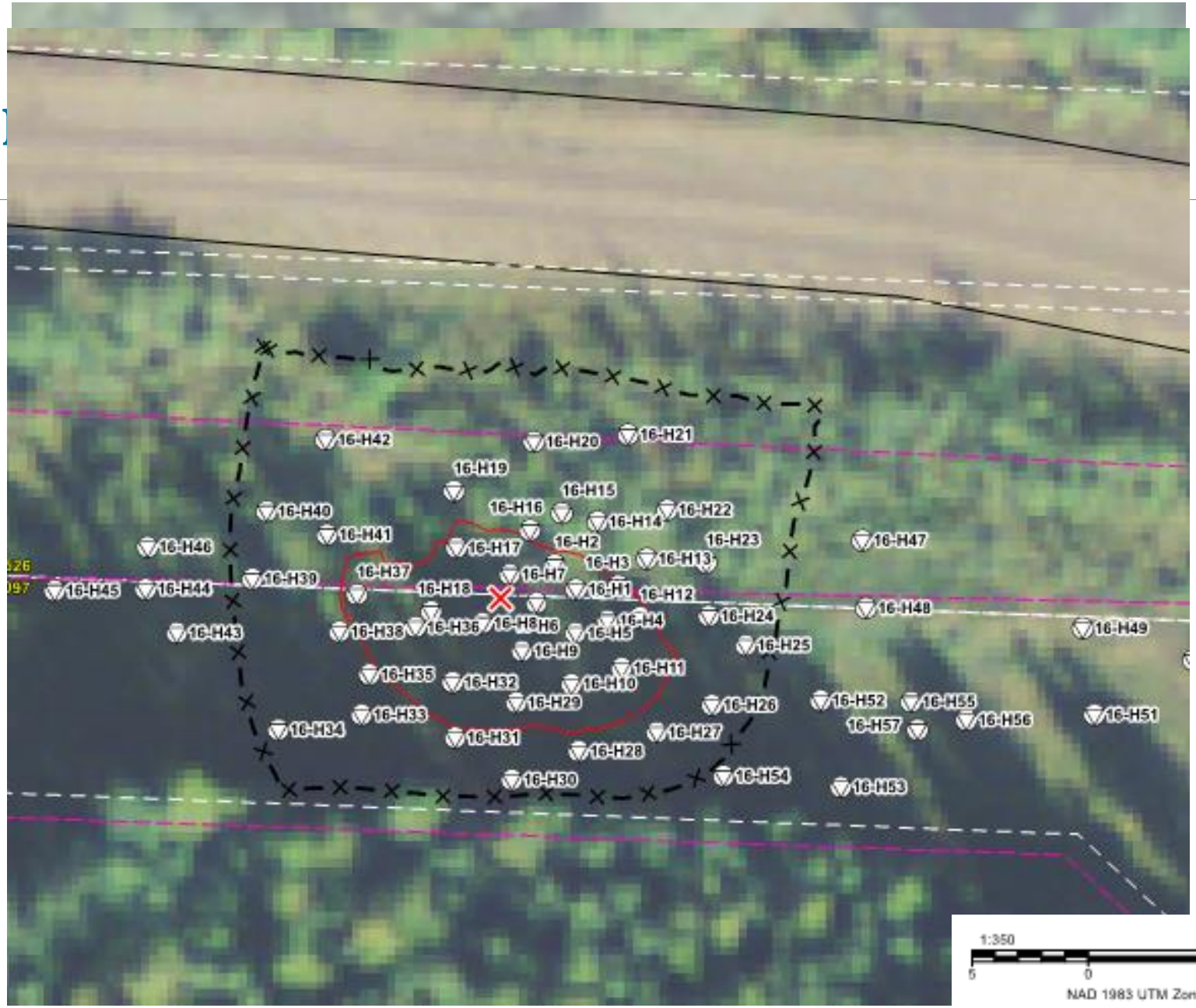
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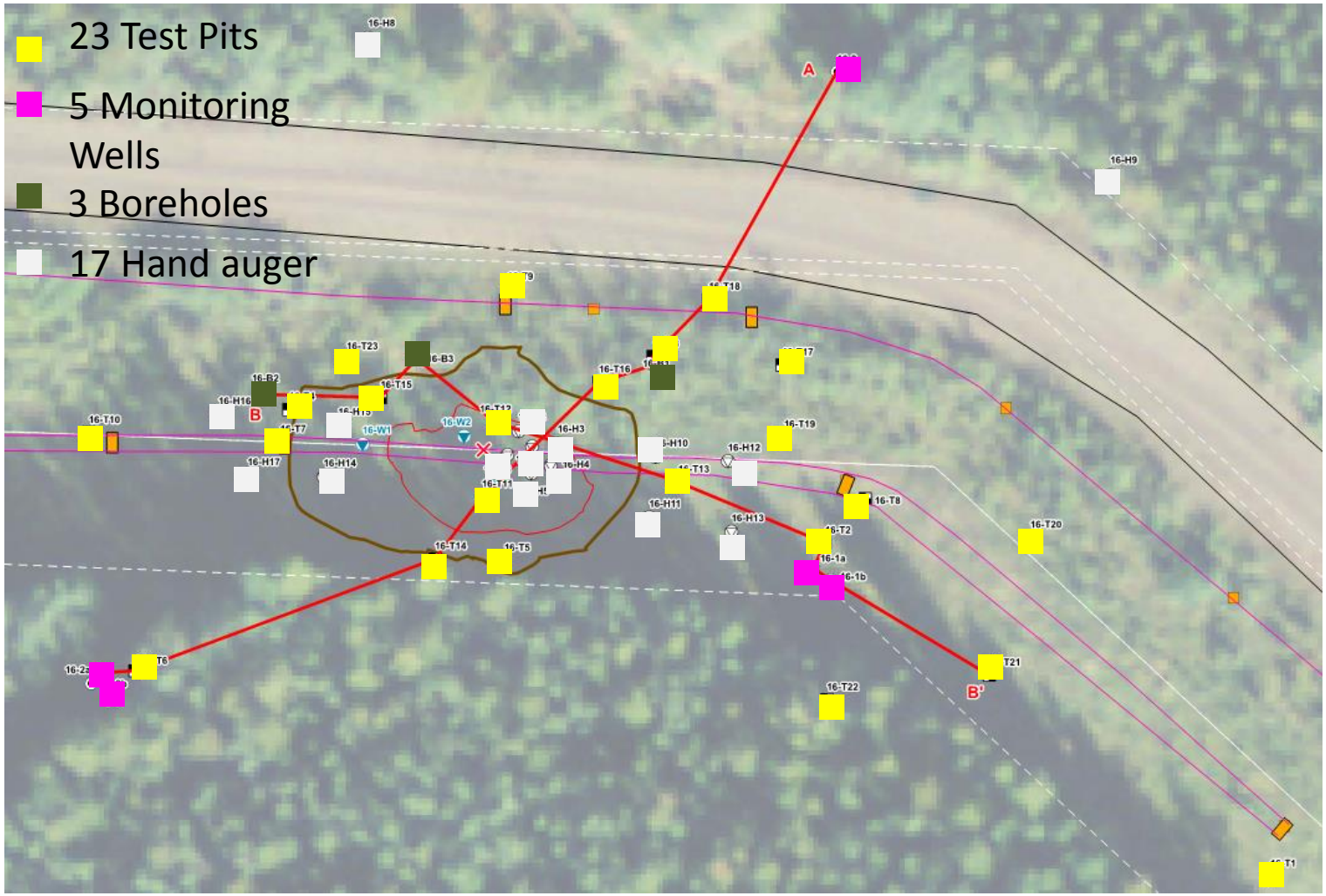
NAD 1983 UTM Zone 11N

Intrusive Site Assessment



CSM

- Geology consisted of organic soils at surface, underlain by clay till to 15 m (bgs).
- Groundwater was measured about 3m (bgs). Likely not static in year 1, due to fine grain soils. Many wells dry after being drilled.
- Geomean soil conductivity 4×10^{-9} m/s based on 4 core samples – using falling head test.
- Natural Area – Fine Grain Soils

CSM – CoPC

- Salinity (chloride), BTEX, F1, F2, and four PAH parameters exceeded Tier 1 guidelines in soil within spill area.
- Fluoranthene and pyrene exceeded Tier 1 guidelines in groundwater at 1 location
- The estimated volume of soil above Tier 1 guideline is 1,850 m^3.

CSM Potential Pathways Evaluated

Potential Exposure Pathway
• Potable groundwater (DUA)
• Eco direct soil contact • Freshwater aquatic life • Wildlife soil/food Ingestion • Wildlife watering • Management limit

Tier 2 Evaluation for DUA Exclusion

- DUA:
  - The hydraulic conductivity is less than the AEP requirement of 1×10^{-6} m/s in all of the bore holes; therefore, the clay till unit is not considered to be a DUA.
- Hydraulic Barrier:
  - There was at least 5 m of massive, unfractured, uncontaminated, fine-grained material with a bulk hydraulic conductivity of 1 × 10-7 m/s or less.
- The low hydraulic conductivity confirmed the clay would not be suitable for use as a DUA and would act as a hydraulic barrier for downward migration of potential contaminants.

Tier 2 Evaluation for FAL Exclusion

- FAL:
  - FAL pathway can be eliminated if the nearest surface water body is greater than 300 m downgradient from the site
- Borrow Area
  - 50 m from the site
  - The next closest surface water is a wetland located 800 m northeast of the break point

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Tier 2 Evaluation for Direct Soil Contact

- DSC:
  - DSC pathway for PHCs F1 to F4 can be eliminated for depths greater than 3 m
  - Application of the “management limits” that represents the maximum concentration that can apply at any depth

- All reported PHCs F1 to F4 concentrations were below Tier 1 guideline.

Tier 2- Exposure Pathways & COC

Exposure Pathway	Soil	Groundwater
• Potable groundwater (DUA) • Eco direct soil contact >3m • Freshwater aquatic life	F1-F4	PAH
• Eco direct soil contact <3m • Wildlife soil/food Ingestion • Wildlife watering • Management limit	TEX B	

Salinity – Tier 1 - Background

- Background Soil Quality
- 95th percentile
  - 28 samples within specific depth interval
  - 0 to 1.5 m (EC = Poor, SAR=Fair)
  - > 1.5 m (EC = Poor, SAR=Fair)

Targeted Remediation Plan

- Soils
  - Excavate PHC-impacted soils to a depth of 2 m bgs to Tier 2
  - Excavate salinity impacts to a depth of 3 m bgs equivalent to background
  - 350 m^3 of impacted soil above Tier 2 guidelines
- GWM
  - Post remedial monitoring (Spring / Fall)
  - Monitor gw quality
- Plan accepted by regulator

Post Remediation

- GW quality met Tier 1 in all subsequent events
- All remediation targets were met for soil and groundwater quality
- Excavation backfilled to match natural grade
- Regulatory closure achieved

Summary

- The estimated volume of soil above Tier 1 guideline is 1,850 m^3
- Using a Tier 2 approach we were able to exclude the DUA, FAL and DSC > 3m pathways
- Total volume of 350 m^3 was required to be removed.
- 80% reduction in soil volume.
- Reduced footprint.

Questions