



# Assessment, Remediation and Risk Management of Petroleum Hydrocarbon Impacts

*A Case Study for Successful Remediation*

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# What this Presentation is About...

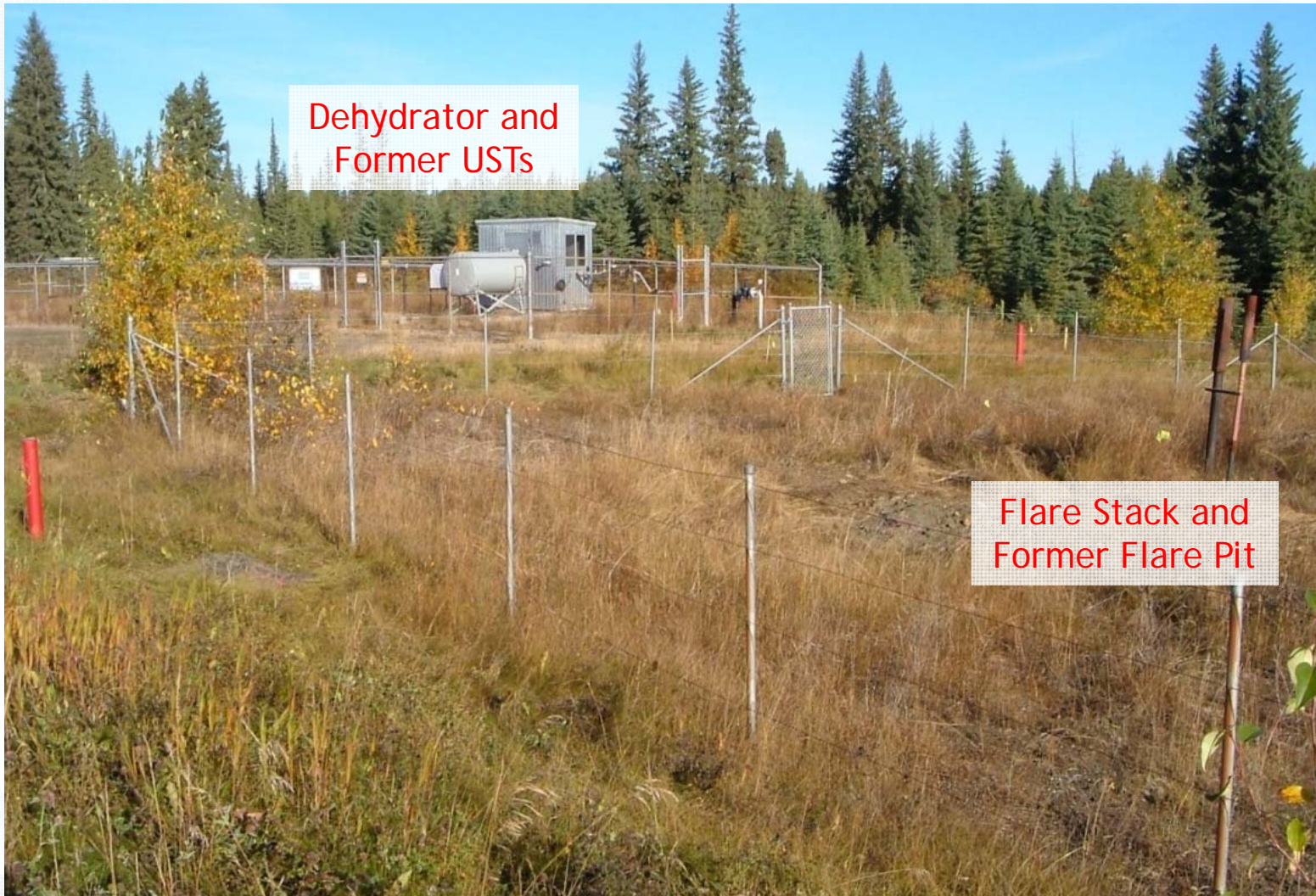
Effecting site remediation success by:

- Listening to your client's concerns/goals
- Understanding the path to regulatory closure
- Developing a robust conceptual site model (CSM)
- Evaluating and selecting appropriate remedial technologies
- Optimizing results through implementing strategic changes



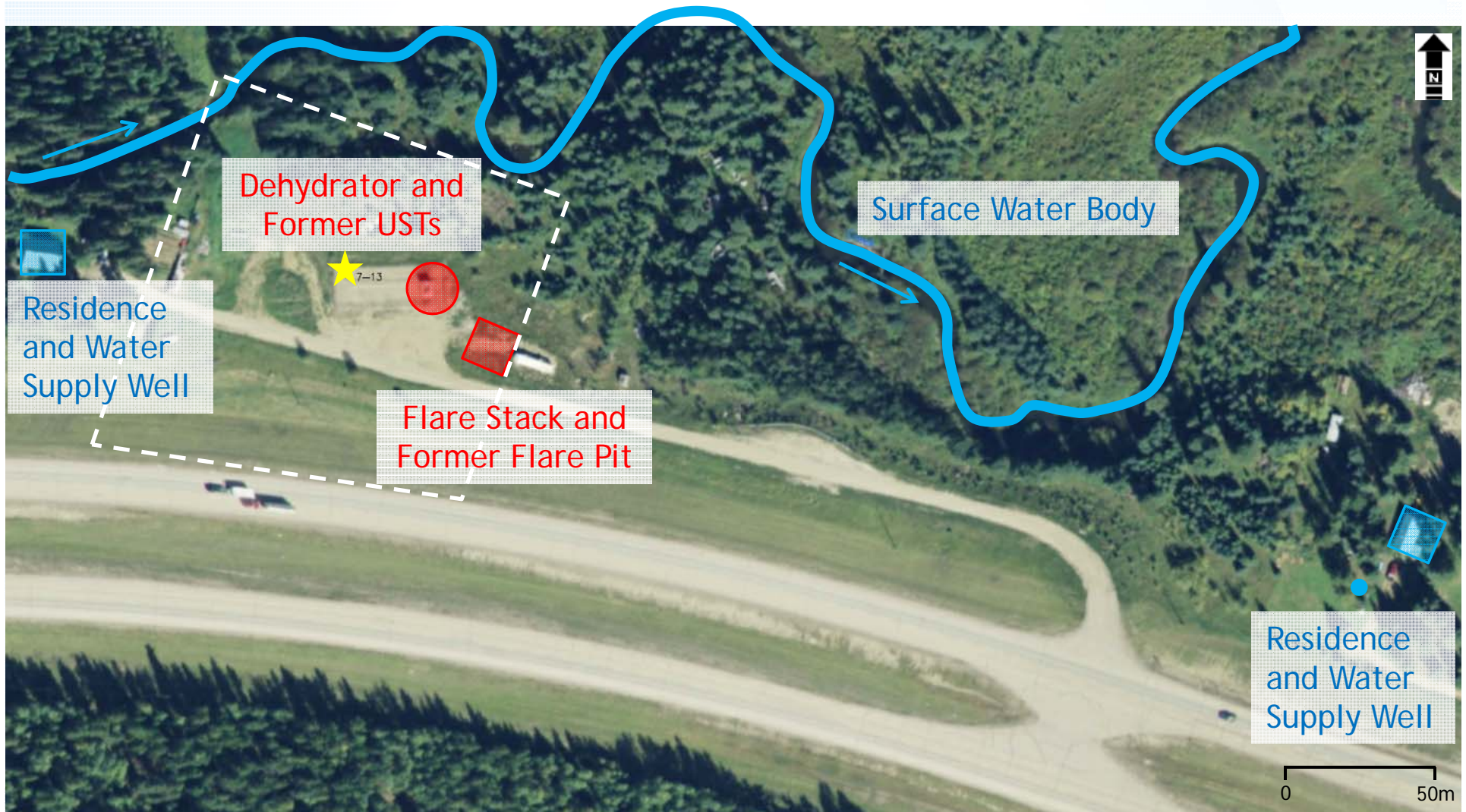


# Case Study



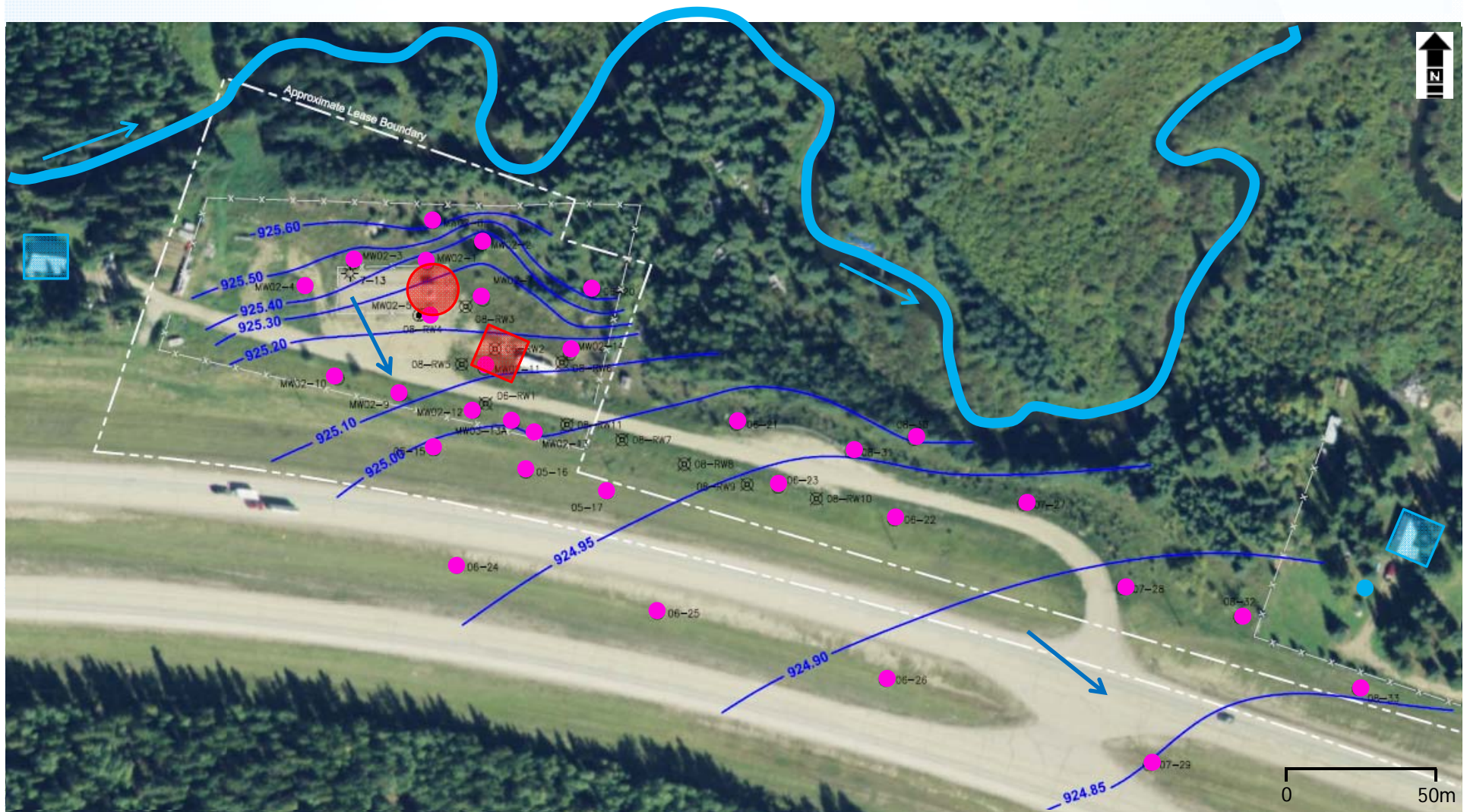


# Sources and Receptors





# Assessment and Groundwater Flow



● Monitoring Well



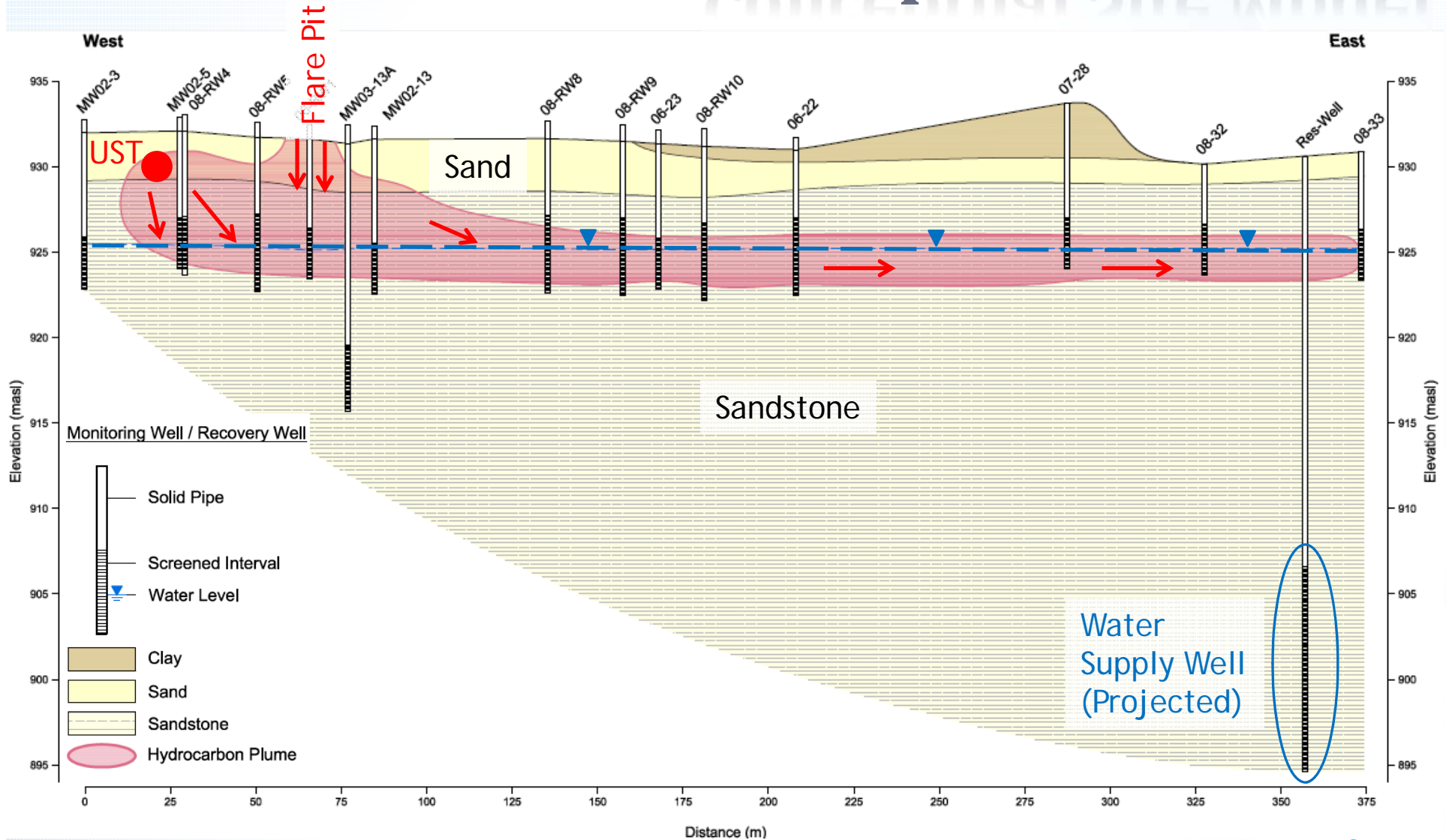


## EXERCISES





# Conceptual Site Model



# Exposure Pathways

Exposure Pathway	Soil	Groundwater
<ul style="list-style-type: none"> <li>Human direct soil contact</li> <li>Vapour inhalation</li> </ul>	B BTEX, F1, F2	B, X, F1, F2
<ul style="list-style-type: none"> <li>Potable groundwater (DUA)</li> </ul>	BTEX, F1, F2	BTEX, F2
<ul style="list-style-type: none"> <li>Management limit</li> </ul>	F1, F2, F3	
<ul style="list-style-type: none"> <li>Eco direct soil contact</li> <li>Freshwater aquatic life</li> <li>Wildlife soil/food</li> <li>Wildlife watering</li> </ul>	BTEX, F1, F2, F3, F4 BTEX, F1, F2 B, T B, T	F2 B, T, X, F2  B





# Client Goals and Regulatory Framework

Remediation		Exposure Control
Tier 1	Tier 2	Some contamination managed in place
Regulatory Closure		No Regulatory Closure



*Reclamation Certificate*

- Requirement to attain a *Reclamation Certificate*
- 10 to 20 years
- DUA cannot be eliminated
- Remediation, rather than risk management



**“You need to hitch your wagon to a star.”**

*—Ralph Waldo Emerson*





# Source Removal – Flare Pit Excavation



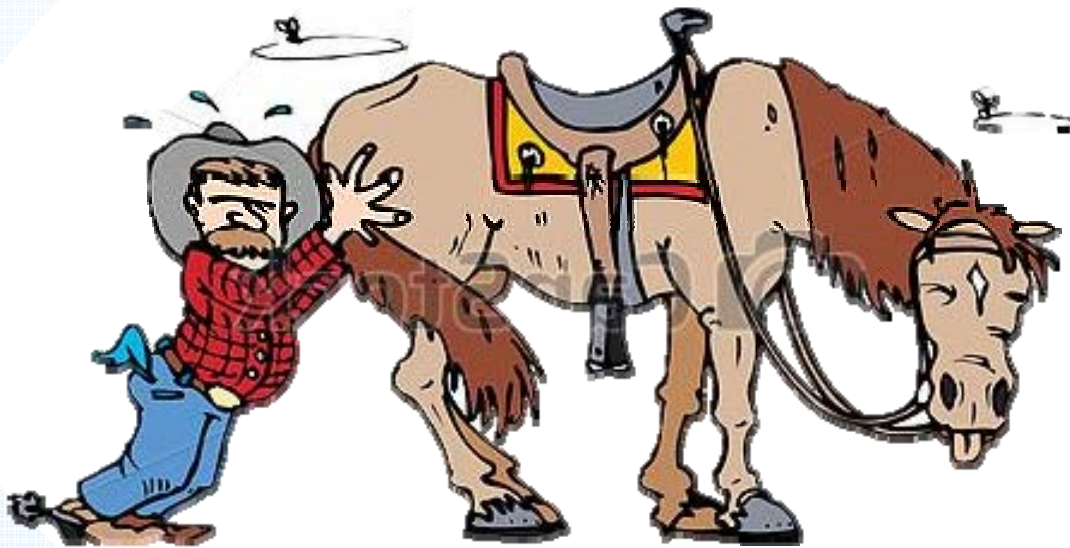
- Targeted source removal was effective
- Addressed the worst-case soil impacts

*Very effective for soil impacts; however, residual groundwater impacts remained.*



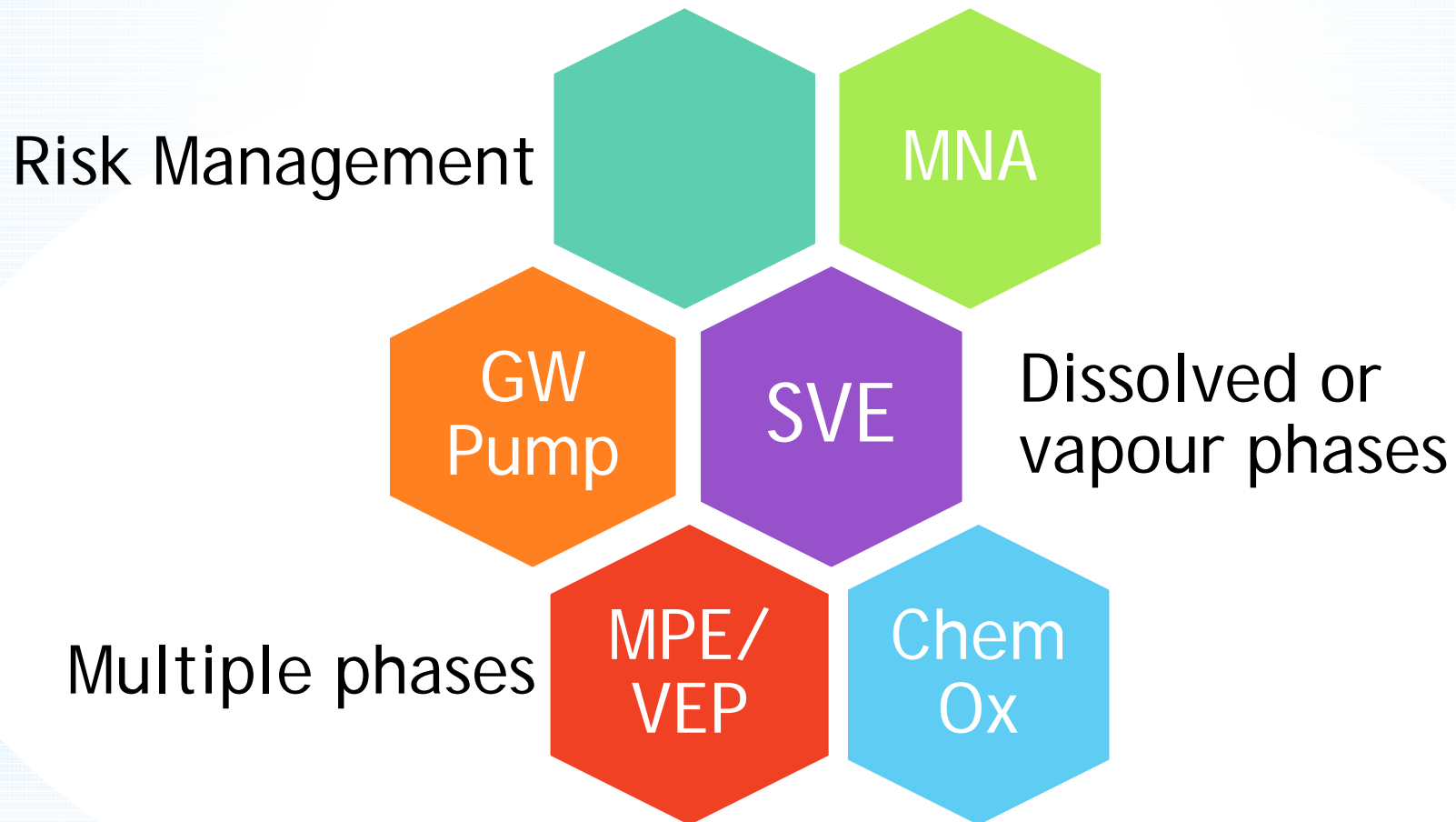
**“Know when it’s time to switch horses.”**

*—Anon.*



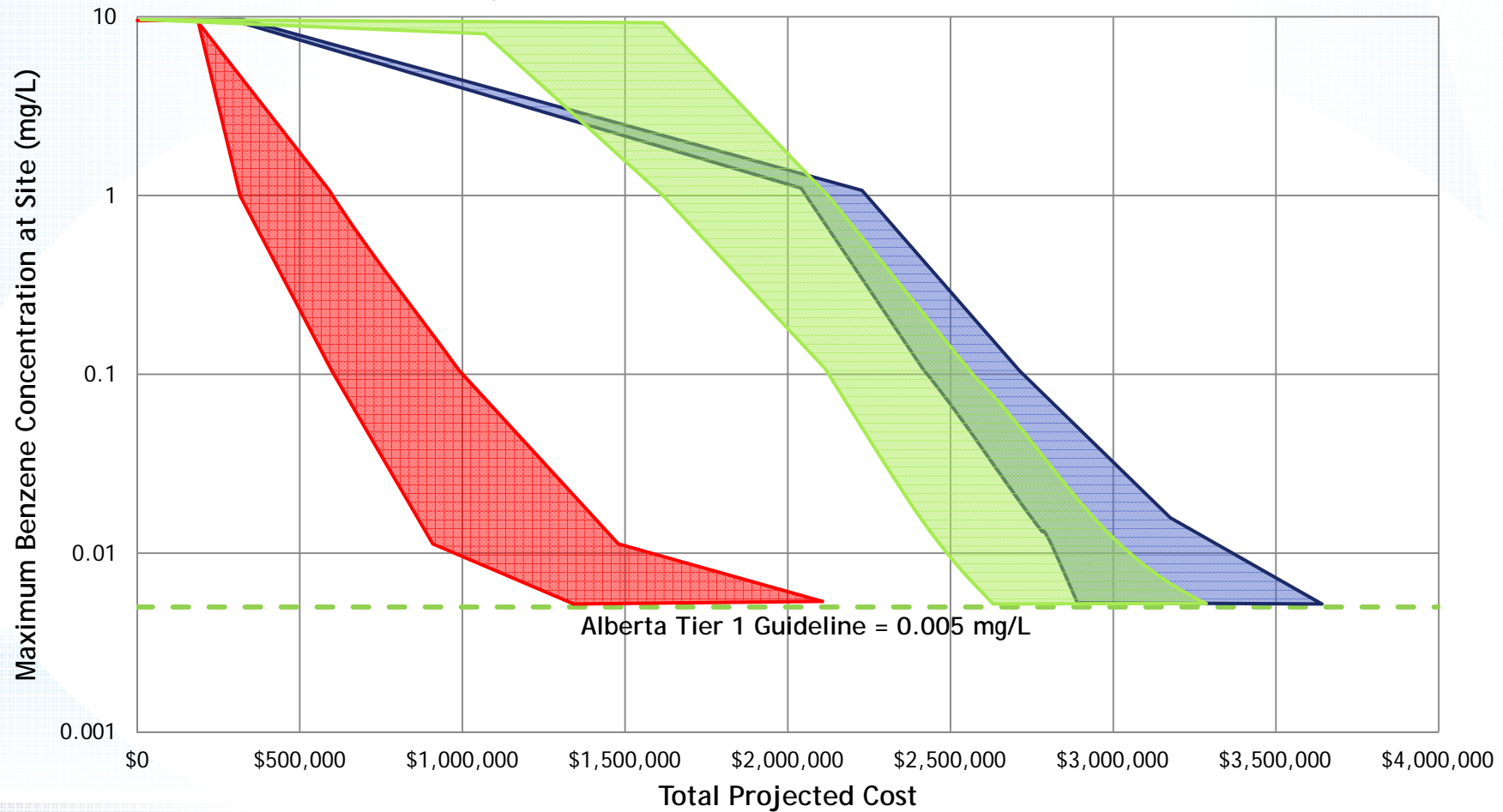


# InSitu Remediation Options



# InSitu Remediation Evaluation

## Projected Costs versus Concentration



MPE/VEP

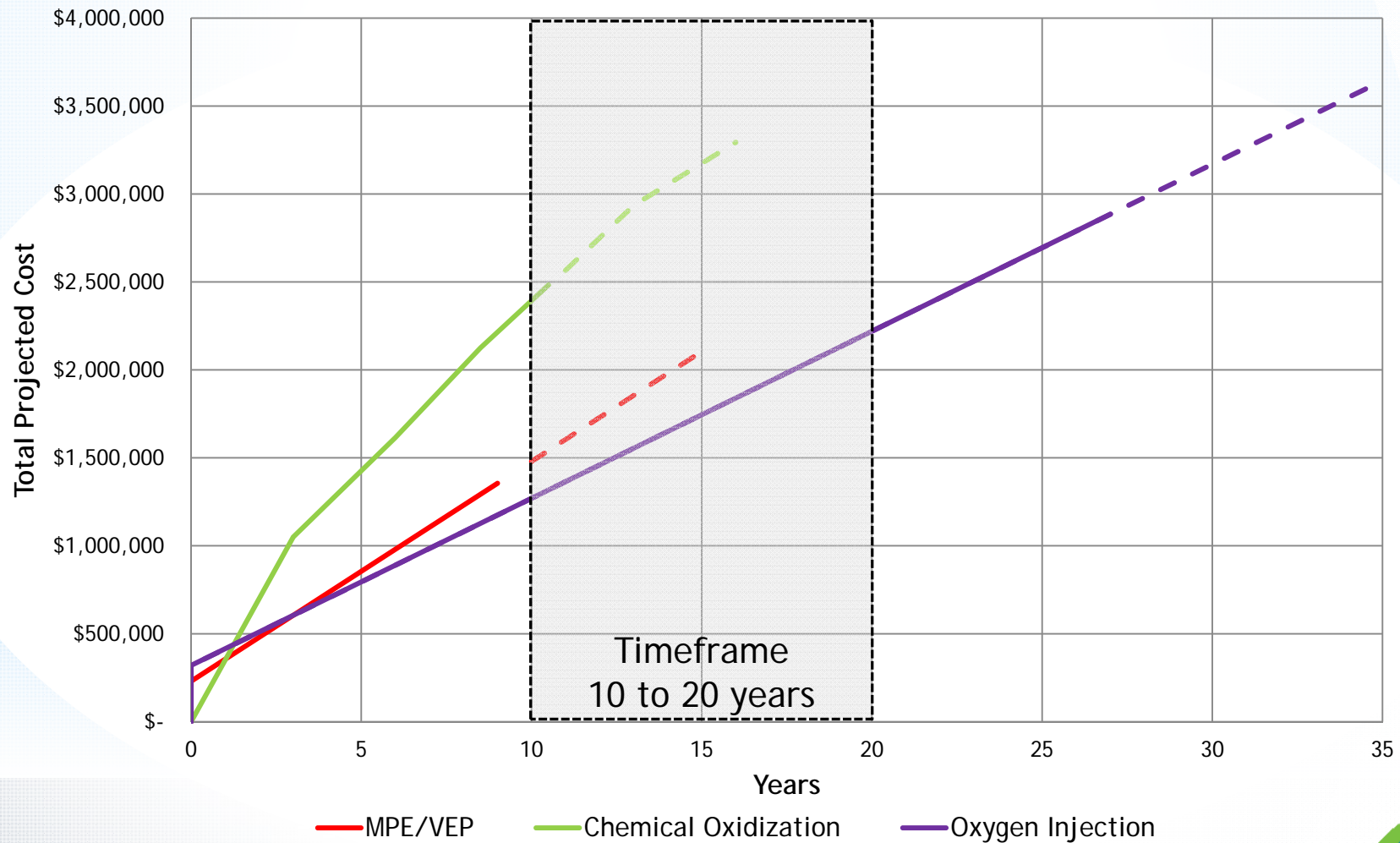
Chemical Oxidization

Oxygen Injection



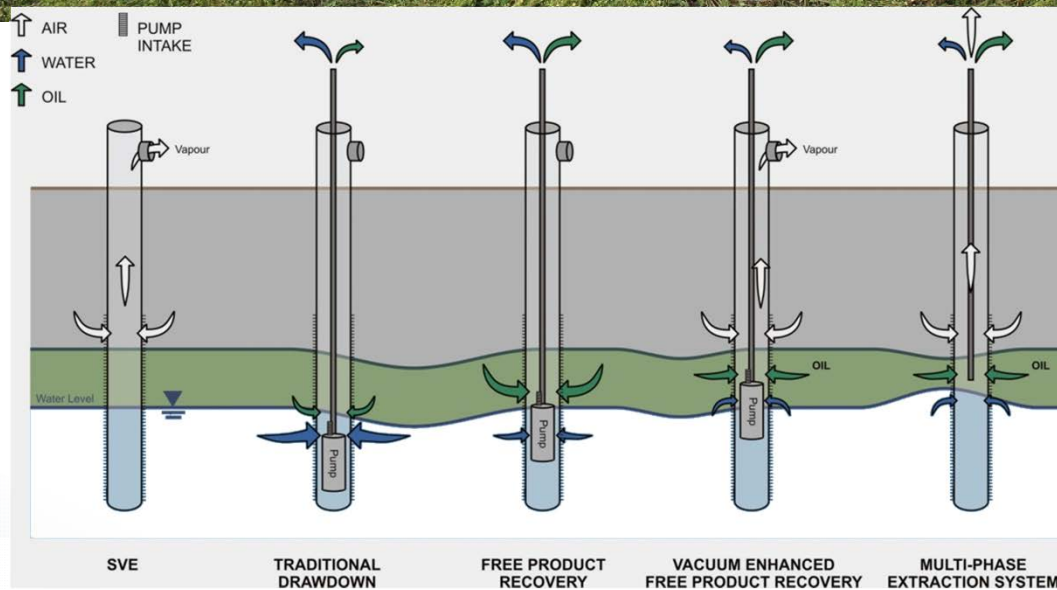
# InSitu Remediation Evaluation

## Projected Costs versus Time



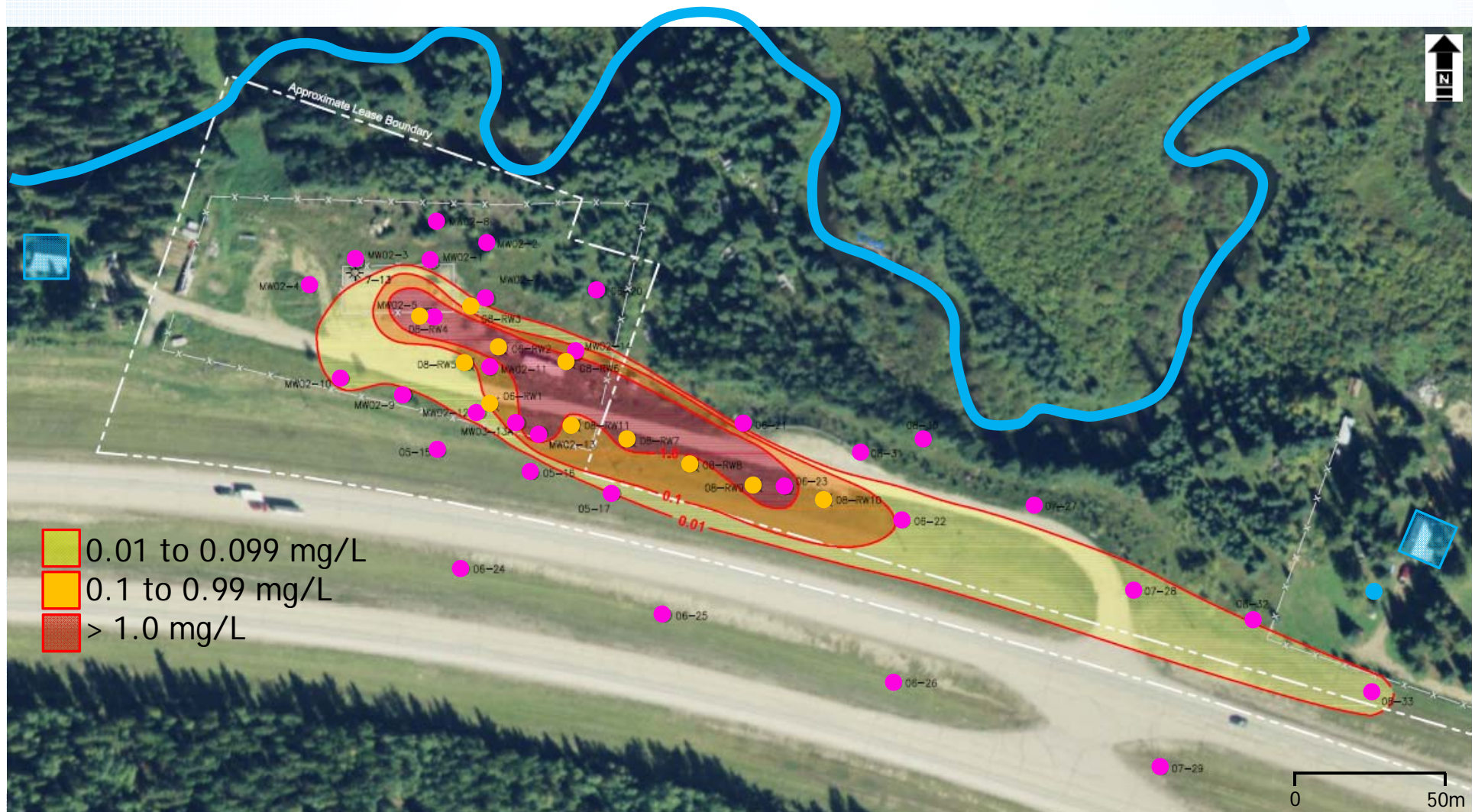


# Pilot Testing



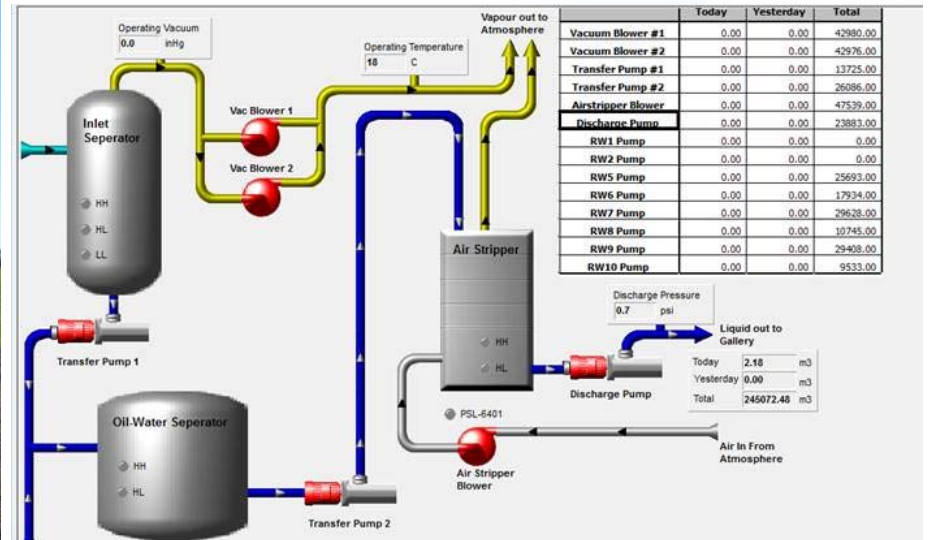


# Recovery Well Installation





# Full-Scale Remediation System





# Results – Hydrocarbon Plume Time Lapse



Maptech Inc. 2011



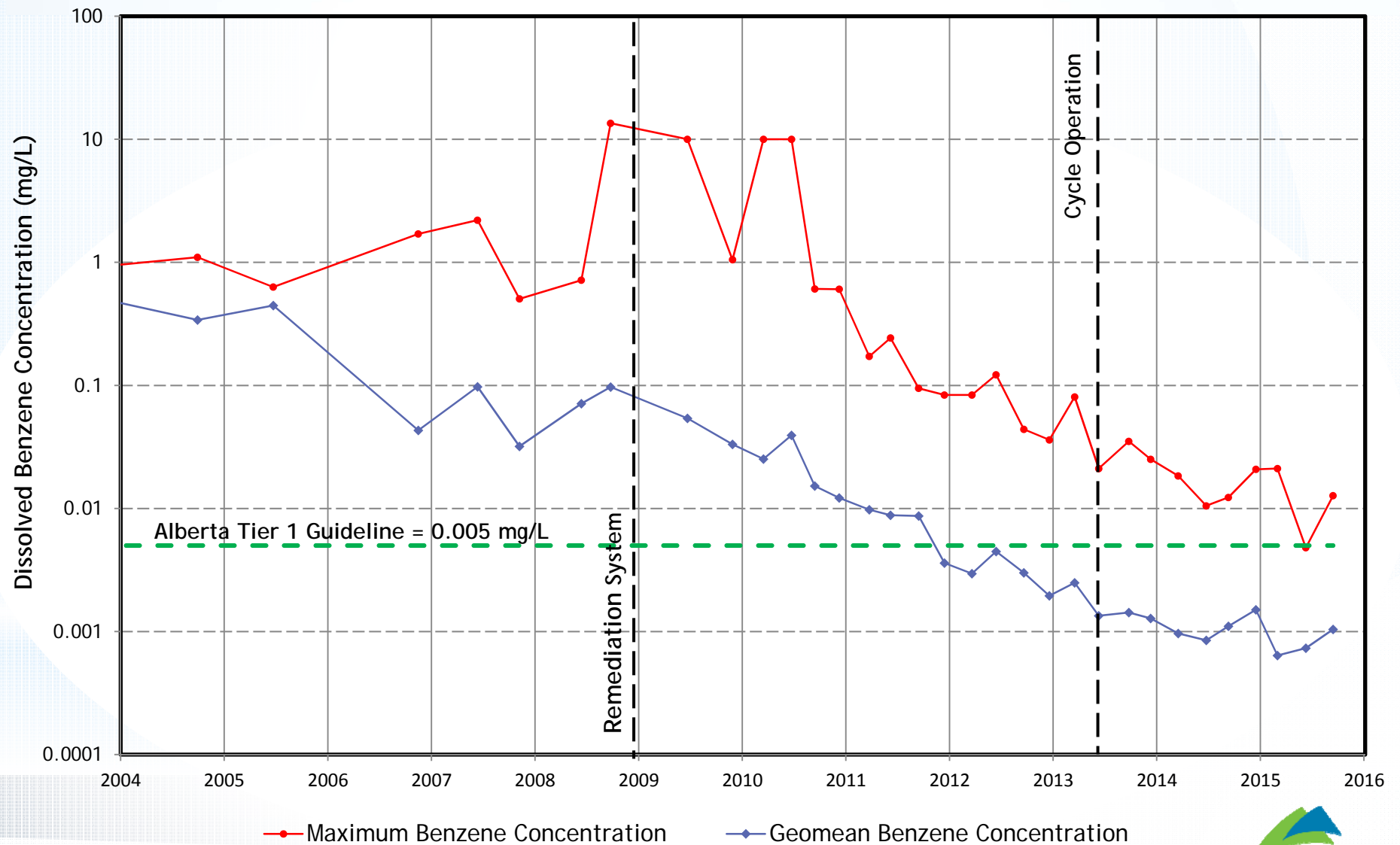
# Residual Contaminants of Concern

Exposure Pathway	Soil	Groundwater
<ul style="list-style-type: none"> <li>Human direct soil contact</li> <li>Vapour inhalation</li> <li>Potable groundwater</li> <li>Management limit</li> </ul>	B BTEX, F1, F2 BTEX, F1, F2 F1, F2, F3	B, X, F1, F2 BTEX, F2
<ul style="list-style-type: none"> <li>Eco direct soil contact</li> <li>Freshwater aquatic life</li> <li>Wildlife soil/food</li> <li>Wildlife watering</li> </ul>	BTEX, F1, F2, F3, F4 BTEX, F1, F2 B, T B, T	F2 B, T, X, F2 B

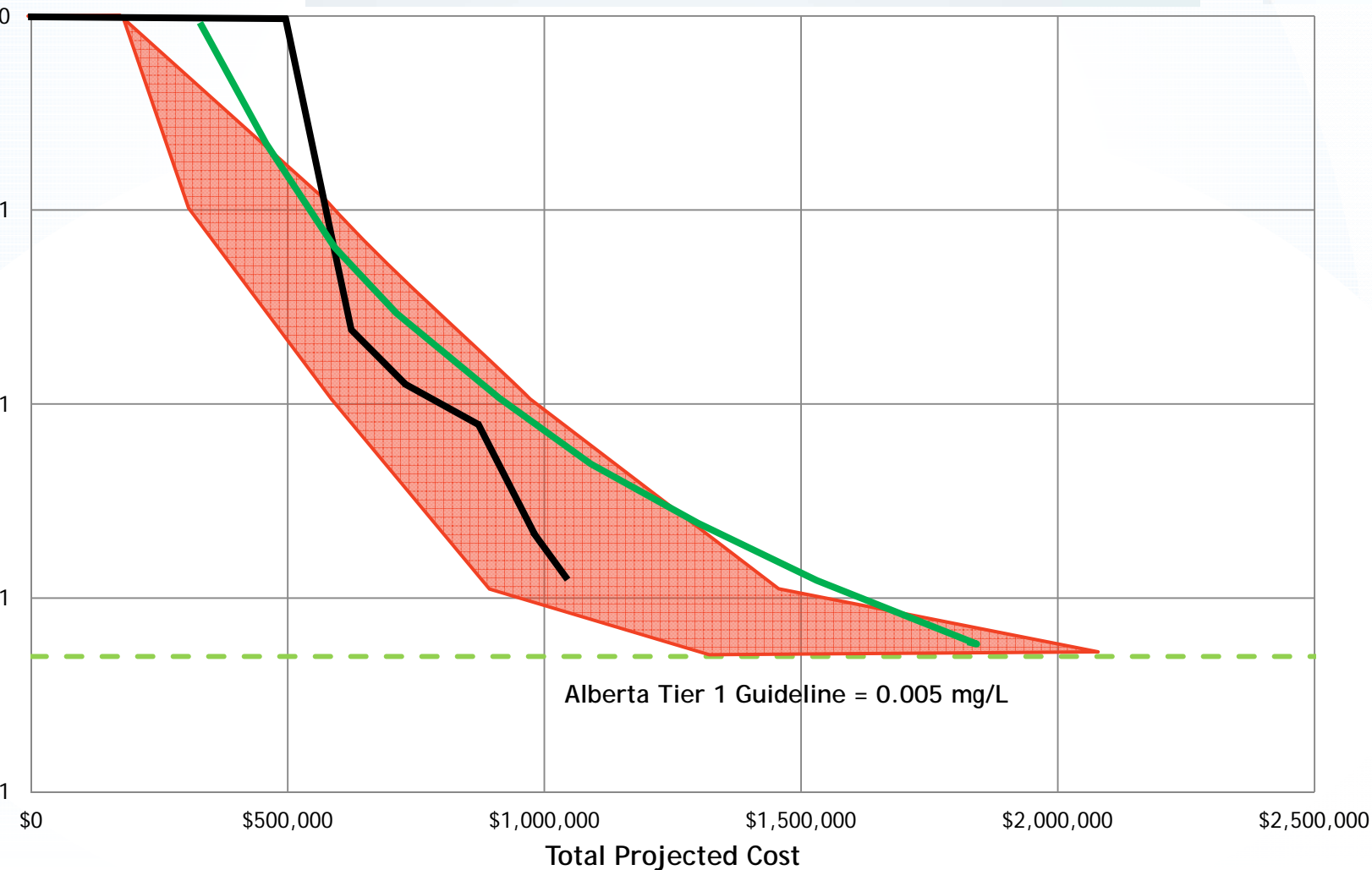




# Remediation Evaluation – Regulatory Goal



# Remediation Evaluation - Costs



MPF/VFP

Actual Costs

Benzene Concentration

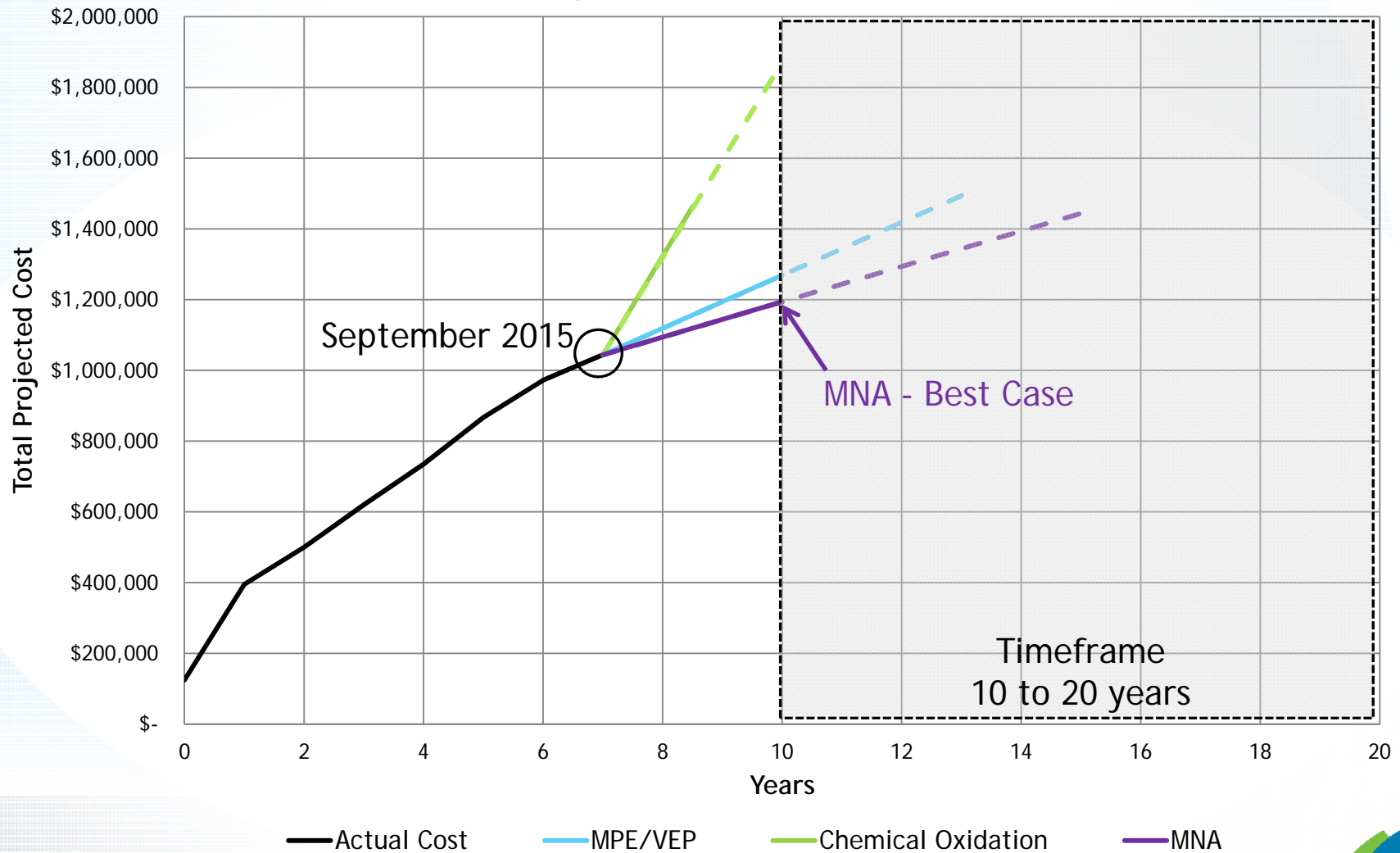


**“Cowboy wisdom...time to circle the wagons”**



# Optimize Remediation Strategy

## Projected Costs versus Time



# Presentation Summary....

Site remediation success is on-track and was achieved by:

- Listening to client's concerns/goals and meeting expectations
- Delineating soil and groundwater impacts and developing a CSM
- Evaluating, selecting and employing multiple strategies to protect receptors, optimize hydrocarbon recovery and reduce costs





# Concluding Comments

“The quickest way to double your money is to fold it over and put it back in your pocket.”



- Successful remediation requires an understanding and balance of client goals and regulatory drivers
- Often, the optimal solution involves “switching horses” because you can’t ride one strategy to the end.
- In tough economic times, cost-effectiveness is especially important.





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ENVIRONMENT & ENGINEERING

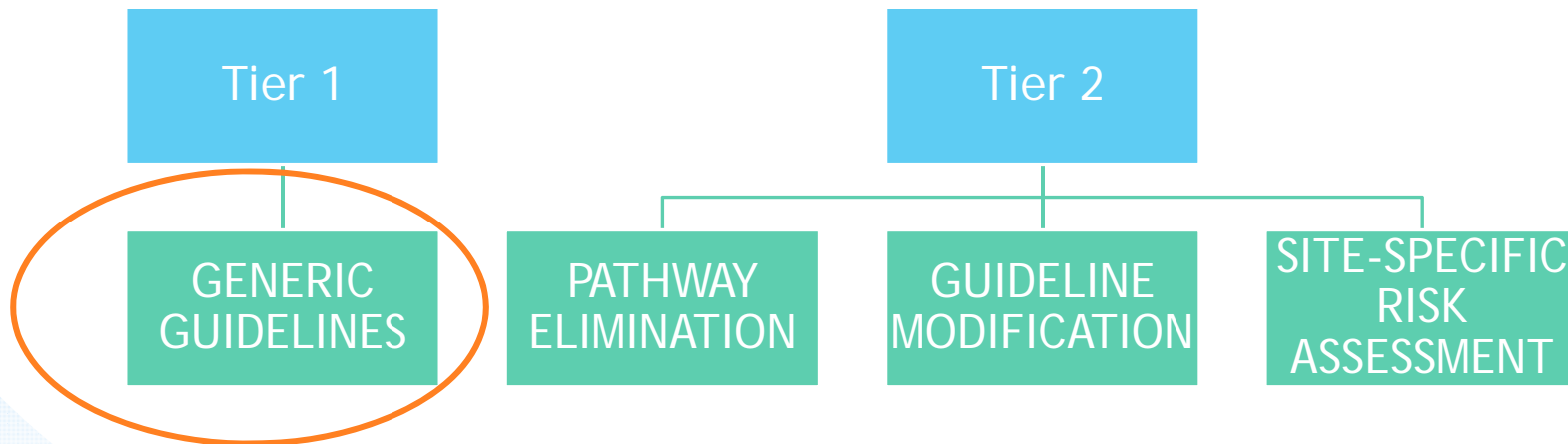
**Questions ?**

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**403.237.0606**

# Site Management Approach

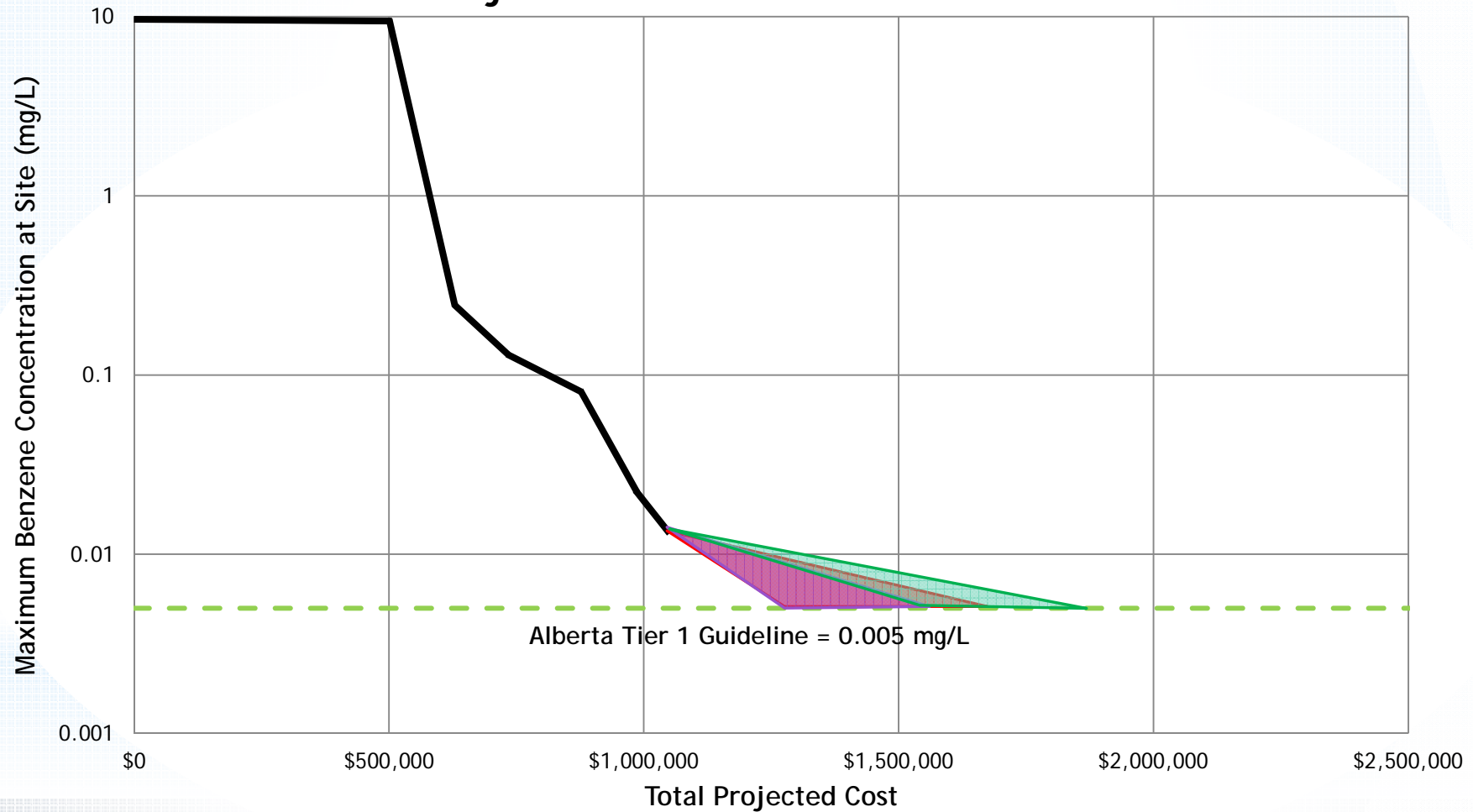
Site requires **remediation** to attain a *Reclamation Certificate*





# Re-Evaluate Remediation Strategy

Projected Costs versus Concentration



— Actual Costs

▨ MPE/VEP

▨ Chemical Oxidation

▨ MNA



# Balancing Game to Select Approach

Cost - Capital and Operating

Time

Receptors - DUA and  
Surface Water

Monitor Remediation  
Progress through GWM

Groundwater Impacts

In Situ Remediation

Soil Impacts

Source Removal - Flare Pit Excavation



Site  
Closure