



MILLENNIUM
EMS Solutions Ltd.

INTEGRATING RISK ASSESSMENT INTO SPILL RESPONSE

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PENGROWTH

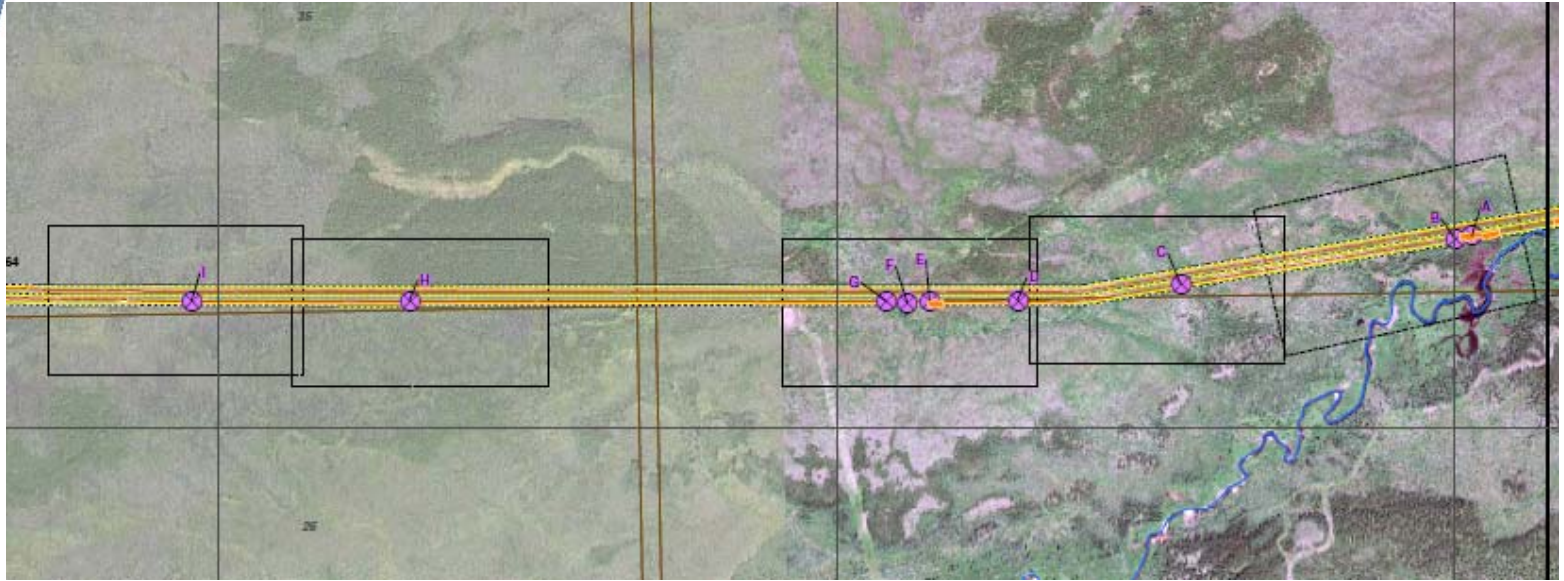
Introduction/Outline

- Background (release event/setting)
- Rationale for incorporating risk assessment into spill response
- Risk assessment approach
- Results
- Challenges
- Key learnings

Setting



Release Description



Why Incorporate Risk Assessment into Response?

- Remote/difficult access and large area affected



Why Incorporate Risk Assessment into Response?

- Protection of the environment (minimize ecosystem damage)



Risk Assessment Approach

- Rapid decision-making
- Immediate engagement of regulators is key

DUA Assessment

- Deep wells
- Hydraulic conductivity testing
- Shallow gravel unit – thickness/yield



Freshwater Aquatic Life

- Creek located near east end of release area
- Other water bodies - are they aquatic habitat?
- Location-specific Tier 2 guidelines



Ecological Direct Contact

- Applicability of Tier 1?
- If vegetation isn't impacted, then remediation is more harmful than release
 - Net environmental benefit
 - Increasingly acceptable to Regulator
- Consideration of short-term vs. long-term effects

Ecological Direct Contact

- Vegetation effects assessment
- Test plots (impacted and controlled)
 - Considered different vegetation communities
- Soil samples at each test plot
- June & August assessments
- Vegetation health; species inventory & community indices
- Tissue samples (plant uptake)

Ecological Direct Contact

- Vegetation effects evident in highly impacted areas



Ecological Direct Contact

- Minimal/no effects in less impacted areas
($F1 < \text{management limit}$)



Management Limits

- Site in green area
 - Green area management limits for F2/F3
 - Exclusion of ecological soil contact at 1.5 m in fine soils
- Areas with shallow gravel (overlain by fine soils)?
 - Plant root evaluation (did not penetrate gravel)
 - 1.5 m fine soil in excavated areas



Source Removal

- Free-phase hydrocarbons in 1 area
 - Potentially mobile based on thickness, density, soil conditions
- Concentrations above management limits
- Concentrations above FAL guidelines near creek
- Areas of evident contamination effects on vegetation



Soil Treatment

- Bio-Reclaim™ (F4 remediation) added to areas of highest remaining contamination
- Precautionary measure

Soil Stockpile Re-use



Results of Risk Assessment

Option	Estimated Remediation Volume (m ³)	Estimated Remediation Cost (\$)
Tier 1	13,450	4,300,000
Tier 2	4,330	1,800,000
SSRA	2,180	1,000,000

- Accompanying reduction in disturbed natural ecosystem

Challenges

- Rapid decisions with limited data and tools to manage risk with client
- Preservation of vegetation plots
- Keeping all stakeholders frequently engaged on the same page
- Balancing data collection time with operations needs & timelines

Learnings/Conclusions

- Risk assessment is viable/cost-effective as part of spill response.
- Very challenging, but rewarding, to conduct risk assessment on spill response timelines.
- Ability to have closure more rapidly



Learnings/Conclusions

- New ways of thinking may be needed for contractors/operations
- Need to understand acceptable level of risk tolerance with all stakeholders
- Ensure commitment from Senior Management
- Resulted in changed release response procedures with client