



A Case Study in Risk Management

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AENV Tiered Remediation Scheme







Why Risk Management ?

1) Tier 1 / Tier 2 objectives often unachievable

- NAPL recovery
- Salts in clays
- Groundwater plumes

2) Too much energy and resources expended chasing diminishing returns





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Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites

US EPA, 2008 OSWER

Green Remediation

Green Remediation Objectives

- Achieve remedial action goals,
- Support use and reuse of remediated parcels,
- Increase operational efficiencies,
- Reduce total pollutant and waste burdens on the environment,
- Minimize degradation or enhance ecology of the site and other affected areas,
- Reduce air emissions and greenhouse gas production,
- Minimize impacts to water quality and water cycles,
- Conserve natural resources,
- Achieve greater long-term financial return from investments, and
- Increase sustainability of site cleanups.



Frameworks for Risk Management

BC – Certificate of Compliance "with Conditions"

- US EPA Technical Impracticability (TI) Waiver
- Australia Clean-Up To the Extent Practicable
- Alberta has....."comfort letter"





Okotoks Gas Plant: Case Study

1959 – commissioned
980,000 m³/day sour gas (34-45% H₂S)
~ 1969 Purchased by Canadian Oxy
1987 Basepad decommissioned
1991 Plant Shutdown



Post Shutdown Activities

2000 D&R Approval Issued 1999 -2001 Active Site Remediation 2001 Surface Reclamation 2002- 2006 Groundwater Remediation 2006 – present Post Remediation Management



Land Blocks



APPROXIMATE EXTENT OF LOWER TERRACE LANDS



Escarpment Feature





Simplified Hydrogeologic Cross-Section





- Goal: to maximize soil treatment and minimize off-site disposal
- Treatment cell constructed on-site
- Hydrocarbon and amine contaminated soils, often with elevated salinity (EC)
- 101,000 tonnes off-site disposal / 40,000 tonnes treated on-site







Plant Layout 1986





Remedial Excavations





Groundwater Remediation

- Solar pump and treat system
- RO removal of chloride from groundwater
- Treated water used for irrigation









- Set stage for eventual transfer of land and water rights to Town of Okotoks
- Land use defined in the East Okotoks Area Structure Plan <u>Upper Terrace</u>: Open Space Parkland <u>Lower Terrace</u>: Commercial park



Risk Management Plan Components



Risks addressed:

1. Residual soil salt impacts on vegetation

- Soil salinity stratification scheme
- Site reclamation with salt tolerant



2. Residual organic impacts in soil and groundwater

Controlled land use – no buildings on Upper Terrace

3. Groundwater impacts to alluvial aquifer

- Source removal and limited remediation
- Monitored natural attenuation



Vegetation Surveys

Health of vegetation assessed on multiple transects (density, diversity, height, roots, chlorosis and necrosis



No adverse effects



Soil Stratification Scheme

Direct push soil coring and conductivity push probe investigation





No indication of salt migration, profiles remained intact



Groundwater Risk Management

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- Geophysical surveys have been a powerful monitoring tool for salt management
- EM31 and electrical resistivity tomography (ERT) surveys:
 - 1. 1996;
 - 2. 1999;
 - 3. 2003; and
 - 4. 2010.





1999 Terrain Conductivity Map

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2003 EM31 Terrain Conductivity Map







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ERT Conductivity Cross-Section

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2010

2003

1999



2009 all chloride < drinking water guideline</p>



- Monitoring wells reduced from >60 to 5
- Frequency reduced to annually
- Proposed further reductions pending 2010 results



Upper Terrace:

Open Space Parkland tie-in with regional pathway system

Lower Terrace:

Commercial park, tie-in with adjacent business park





Upper Terrace Development

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Lower Terrace Development















Conclusions

- Risk management can work
- Redevelopment does not have to wait for a reclamation certificate
- Key is alignment of land use and contamination issues community needs vs exposure controls

But.....





Conclusions

Why Alberta needs a risk management framework:

- 1. promote site re-development
- 2. best practices to reduce contamination and control exposure
- 3. based on achievable outcomes
- 4. adopt principles of green and sustainable remediation