

Risk-Based Closure For Wellsites in NE British Columbia

Remediation Technologies Symposium 2017

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Outline

- Background info on environmental risk assessment
- Regulatory setting in British Columbia
- Case studies (x2)
- Concluding remarks



What is Environmental Risk Assessment?

- ERA is a specialized tool that can be used for management of contaminated sites



- Has been defined as:

“A scientific process for evaluating the likelihood that adverse effects may occur, or are occurring, as a result of exposure to one or more stressors.”



What is Environmental Risk Assessment?

Road to Site Closure



Remediation / Risk Management

ERA

Supplemental Phase II

Phase II

Phase I

General ERA Framework

1. Hazard Identification
2. Receptor Identification
3. Exposure Pathway Identification
4. Exposure Assessment
5. Toxicity Assessment
6. Risk Characterization
7. Uncertainty Assessment



Generic Guidelines vs. Site-Specific

- Both calculated using very similar equations
- Calculation of soil remediation guideline protective of human direct soil contact

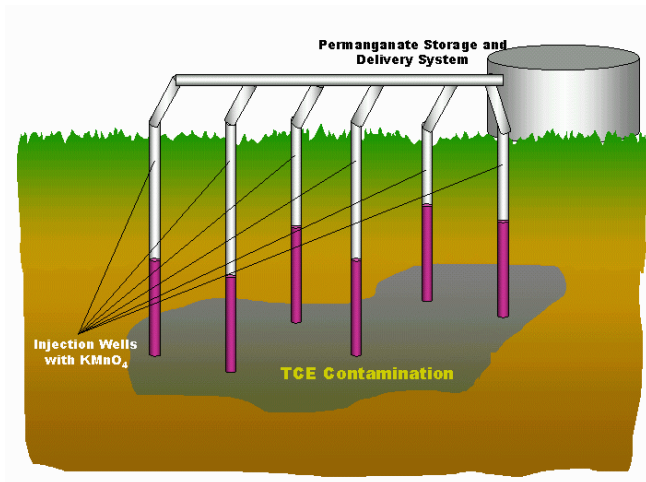
$$SRG_{HDC} = \frac{(TDI - EDI) \times SAF \times BW}{[(AF_G \times SIR) + (AF_L \times IR_S \times ET_2) + (AF_S \times SR)] \times ET_1} + [BSC]$$

Where:

SRG_{HDC}	=	human health-based soil remediation guideline for direct contact (mg/kg);
TDI	=	tolerable daily intake (mg/kg bw per day);
EDI	=	estimated daily intake (mg/kg bw per day);
SAF	=	soil allocation factor (dimensionless);
BW	=	adult or toddler body weight (kg);
AF_G	=	absorption factor for gut (dimensionless);
AF_L	=	absorption factor for lung (dimensionless);
AF_S	=	absorption factor for skin (dimensionless);
SIR	=	adult or toddler soil ingestion rate (kg/day);
IR_S	=	inhalation of particulate matter re-suspended from soil (kg/day);
SR	=	adult or toddler soil dermal contact rate (kg/day);
ET_1	=	exposure term 1 (dimensionless) (days/week ÷ 7 x weeks/year ÷ 52);
ET_2	=	exposure term 2 (dimensionless) (hours/day ÷ 24); and,
BSC	=	background soil concentration (mg/kg).

Outcomes of ERA

- Application of ERA at an affected site generally has three outcomes:
 - No risk and no further work required ✓
 - Some risk with a requirement for monitoring
 - Risk with a requirement for remediation



Why Conduct ERA

- \$\$\$
- Where ERA deemed a feasible approach, cost-savings will be realized
- Remediation following ERA is typically much smaller in scope, and can be completed at a substantially lower cost
- Sustainable option:
 - Allows nature to clean up site (natural attenuation), preserving soil resource
 - No greenhouse gas emissions
 - No safety concerns associated with heavy equipment and trucks
- Great option for complex sites
- Sites where funding is limited - Brownfields



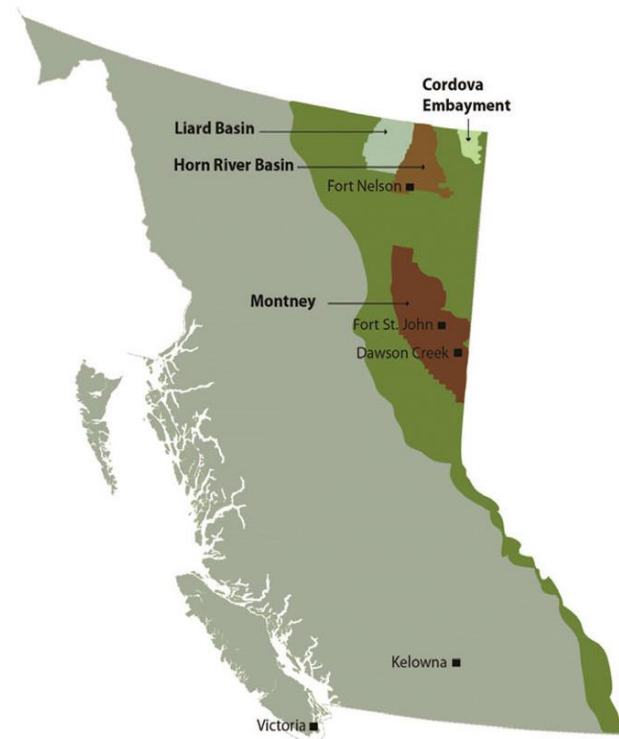
Upstream Oil and Gas Closure

- Asset Retirement Obligation has been met
- Surface infrastructure decommissioned and removed, subsurface remediated, surface reclaimed and land use restored
- Environmental liability associated with the site is considered to be zero
- Certificate of Restoration (BC)
- Reclamation Certificate (AB)



Regulatory Setting – British Columbia

- BC OGC regulates upstream oil & gas (mostly NE BC)
- Clean ups driven by Asset Retirement Obligation and liability management, and to a lesser extent compliance and landowner complaint
- Oil & gas properties belong to Crown or have low financial value
- Issue Certificate of Restoration, Part 1 and Part 2
 - 80 to 220 per year, very few are risk-based
- Semi-prescriptive process ==> allows for “professional judgement”
- 10,000+ suspended/abandoned wellsites in BC



Regulatory Setting – COR Application

- Process outlined in *Certificate of Restoration Application Manual*, June 2016

Risk-Based Standards

Risk-based standards are acceptable risk level from exposure to substances at sites. A Screening Level Risk Assessment (SLRA) will be conducted in accordance with Protocol [13](#) [Screening Level Risk Assessment] to determine whether contamination at a specific site poses acceptable or unacceptable risk to the environment. SLRA cannot be applied without pre-authorization by the MoE director to screen sites where precluding conditions of Protocol 13 are applicable.

Where SLRA failed due to potential for unacceptable risk, a Detailed Ecological Risk Assessment (DERA) is required. A DERA should be conducted in accordance with Protocol [20](#) [Detailed Ecological Risk Assessment Requirements]. A DERA is also expected to follow the procedures and guidance in Technical Guidance [7](#) [Supplemental Guidance for Risk Assessment].

Regulatory Setting - ERA

- Closure of regulatory liability through a risk-based approach provides the same level of human health and ecological protection as closure using generic standards/guidelines developed by regulatory bodies
- Both approaches result in the same regulatory instrument:
 - Certificate of Restoration in BC
 - Reclamation Certificate in AB
- Nuances in BC
 - Require CSAP (Contaminated Sites Approved Professional) approval
- Nuances in AB
 - AER will review ERA approach and provide written approval: RecRemQuestions@aer.ca

Regulatory Setting - Environmental Liability

LIABILITY



Leave in place

- Allows for natural attenuation
- Chemical conc. ↓ over time



Landfill

- Low oxygen environment
- Chemical conc. more stable overtime

Case Study #1

- Wellsite located 130 km NW of Fort St. John, BC
- Oil production from 1962 to 1970, water disposal until 1987
- Site soil, GW, SW and sediment impacted with PHCs and salinity parameters



Case Study #1

- Various investigations, and three different (unsuccessful) remediation trials from 2003 to 2012
- Large volume of site information collected, but not all that required for ERA
- SECURE started work on the site in 2012
- Worked with client and OGC for couple of years to obtain risk-based closure
- Took longer and cost more than anticipated
 - OGC still working through ERA approval process
 - Poor access to site, heli-portable drilling rig required
- Considerable savings over traditional remediation (e.g. excavation)
 - **\$5 million+** to landfill contaminated soil



Case Study #2

- Active wellsite located 140 km NW of Fort St. John, BC
- Various investigations beginning in 1999, SECURE started working on site in 2014
- Contaminant plume identified off-lease in riparian corridor
- Low-end PHCs (BTEX and LEPH) found in gravelly layer roughly 1 mbgs – soil and groundwater exceedances
- Toluene exceedances identified in surface water



Case Study #2

Toluene in Surface Water

- Three exceedances of freshwater aquatic life guideline
- Maximum surface water exceedance was 78x guideline value

Ecological Health Surface Water Screening for the Site

Surface Water COCs	Maximum Conc.	Total no. of samples	BC WQG Approved	No. of samples exceeding standard
			Protection of Freshwater Aquatic Life	
Toluene	39	11	0.5	3

Notes:

NG, no guideline available

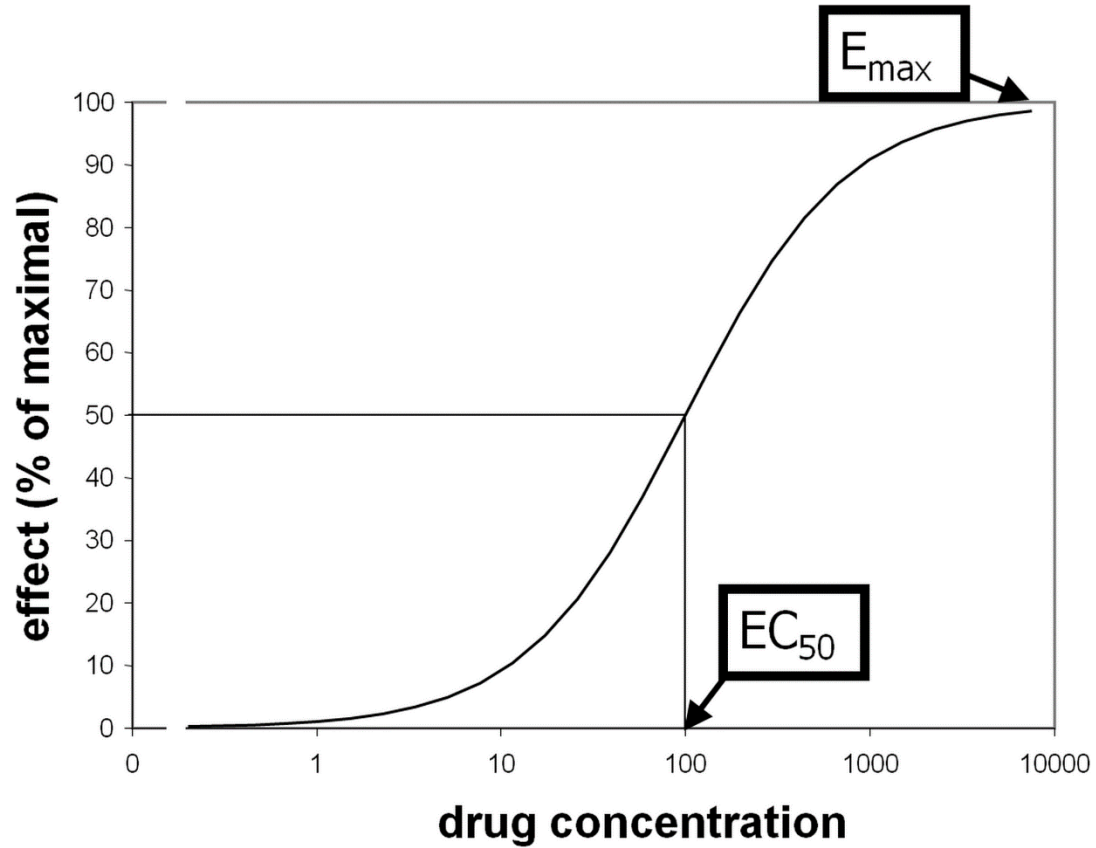
All parameter concentrations are in units of $\mu\text{g/L}$.

Case Study #2

Closer Examination of Toluene SW Guideline

- Guideline based on toxicity tests using rainbow trout (*Oncorhynchus mykiss*) eggs
- Eggs were exposed to toluene at concentrations of 0, 5, 10, 50, 100, 200 and 500 µg/L
- Toxicity endpoints - % survival of eggs, hatching success and survival of fry at several stages of development
- An EC20 (5 µg/L) and EC50 (16 µg/L) were derived from the data based on survival
 - effect concentration at which 20% of the maximum response is observed
 - effect concentration at which 50% of the maximum response is observed
- A safety factor of 10 was applied to the lowest observed effect level (EC20) to derive the WQG of 0.5 µg/L for toluene

Case Study #2



Case Study #2

Great! But.....

- Creek at the site is non-fish bearing
- Therefore, the WQG for toluene is not appropriate
- Nearest fish bearing water body is the Beatton River located roughly 5.5 km downstream of the lease



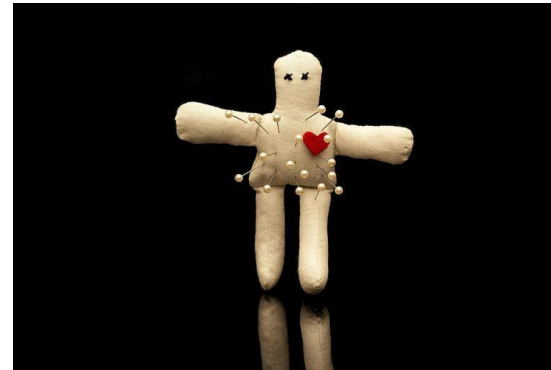
Case Study #2

- Ambient Aquatic Life Guidelines for Toluene, Overview Report lists primary toxicity data obtained from the literature that was assessed in development of the WQG for toluene
- From this list, the most appropriate study for development of a site-specific toluene WQG was one in which water fleas (*Daphnia magna*) were exposed to toluene for 24-hours, after which mobility was examined
- The 24-hr EC50 (concentration at which 50% of the organisms were immobilized) was determined to be 7,000 µg/L
- By applying a SF of 100 (for a paucity of toxicological data and using acute data as opposed to chronic data) a WQG of **70 µg/L** is derived for toluene
- Because the max toluene concentration measured in SW at the site is **39 µg/L**, unlikely that FAL receptors will be adversely impacted as a result of exposure to toluene in SW

Case Study #2

Conclusions

- ERA isn't black magic.....relies on primary literature and defensible scientific approach
- Cannot take generic guidelines/standards at face value
- Need to understand exactly how they were derived to determine whether they are appropriate
 - What is being protected?
 - Is it present at the site now or in the future?



Concluding Remarks

- ERA is one of the best kept secrets in our industry
 - Can lead to site closure in AB and BC
 - Can substantially decrease costs of site clean up
- However, there are a limited number of qualified practitioners and not all regulators and producers fully understand and are comfortable with ERA
 - People naturally fear what they don't understand – evolutionary psychology
- Generic guidelines and ERA result in same regulatory instruments
- How can we solve the suspended/abandoned wellsite issue in BC without ERA?
 - 10,000 wellsites x \$500,000 = **\$5 billion !!!!!!!**
 - Roughly 2% of 2017 Canadian Federal Budget
 - ERA could substantially reduce this cost



Questions/Comments?
