Evaluation of Alternative Approaches for Managing Risks of Salt Releases at Wetland Sites

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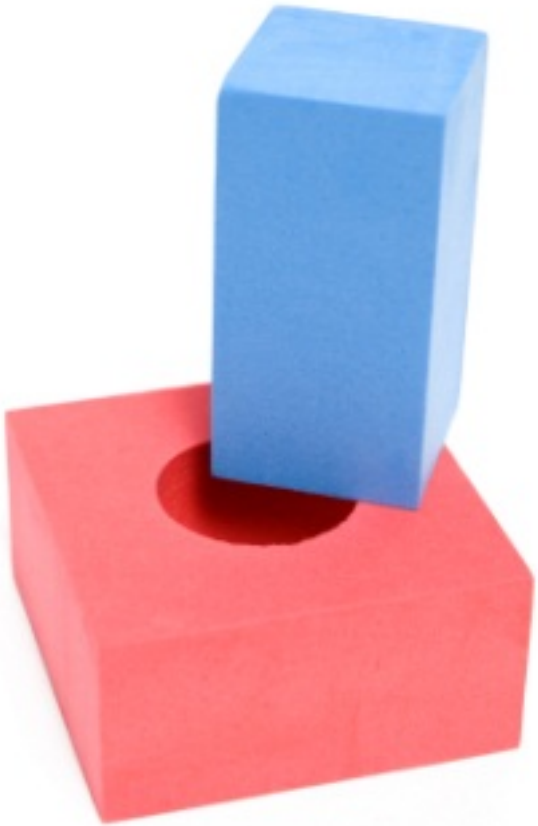
RemTech 2013

HEMMERA

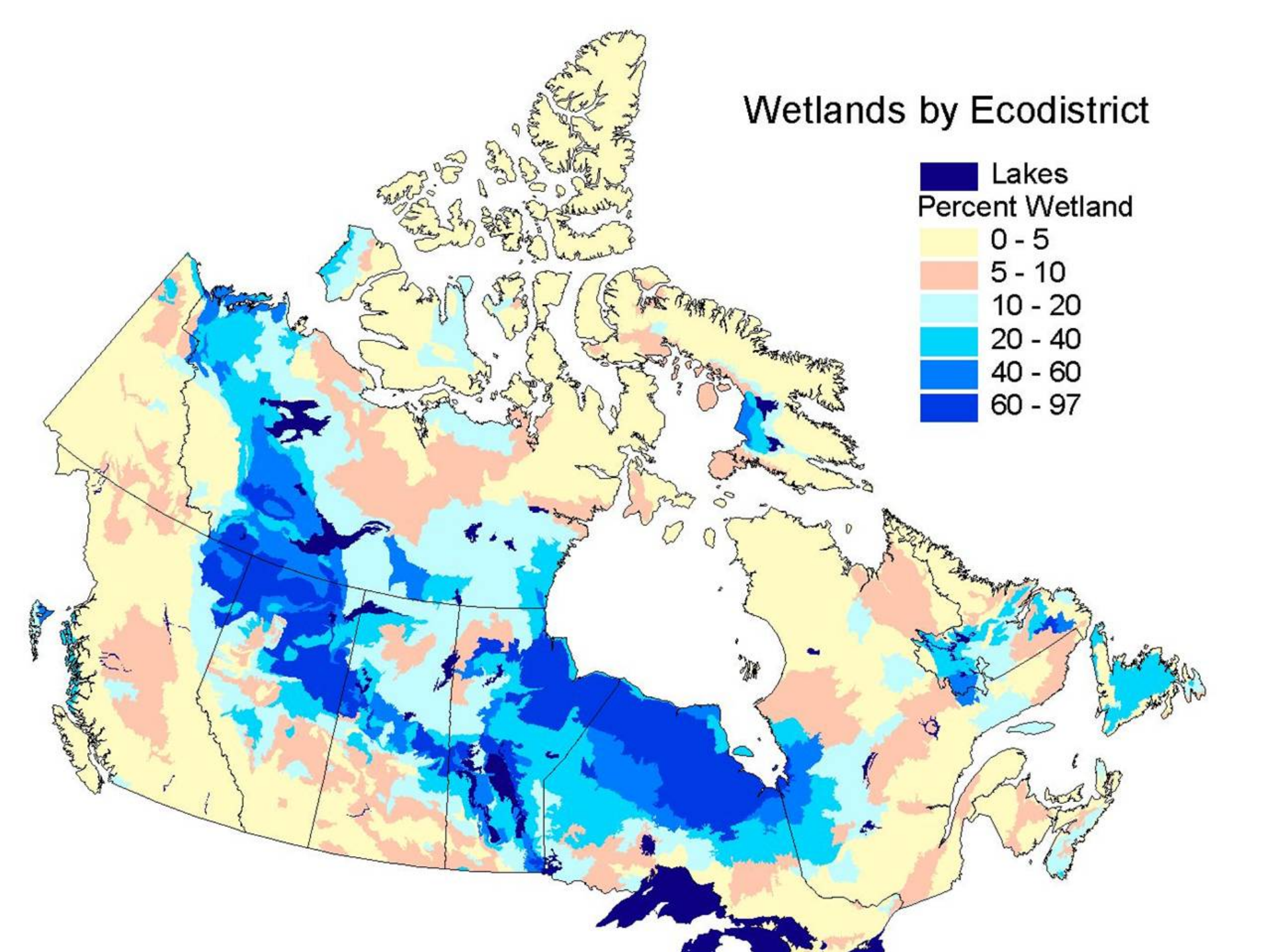
or…



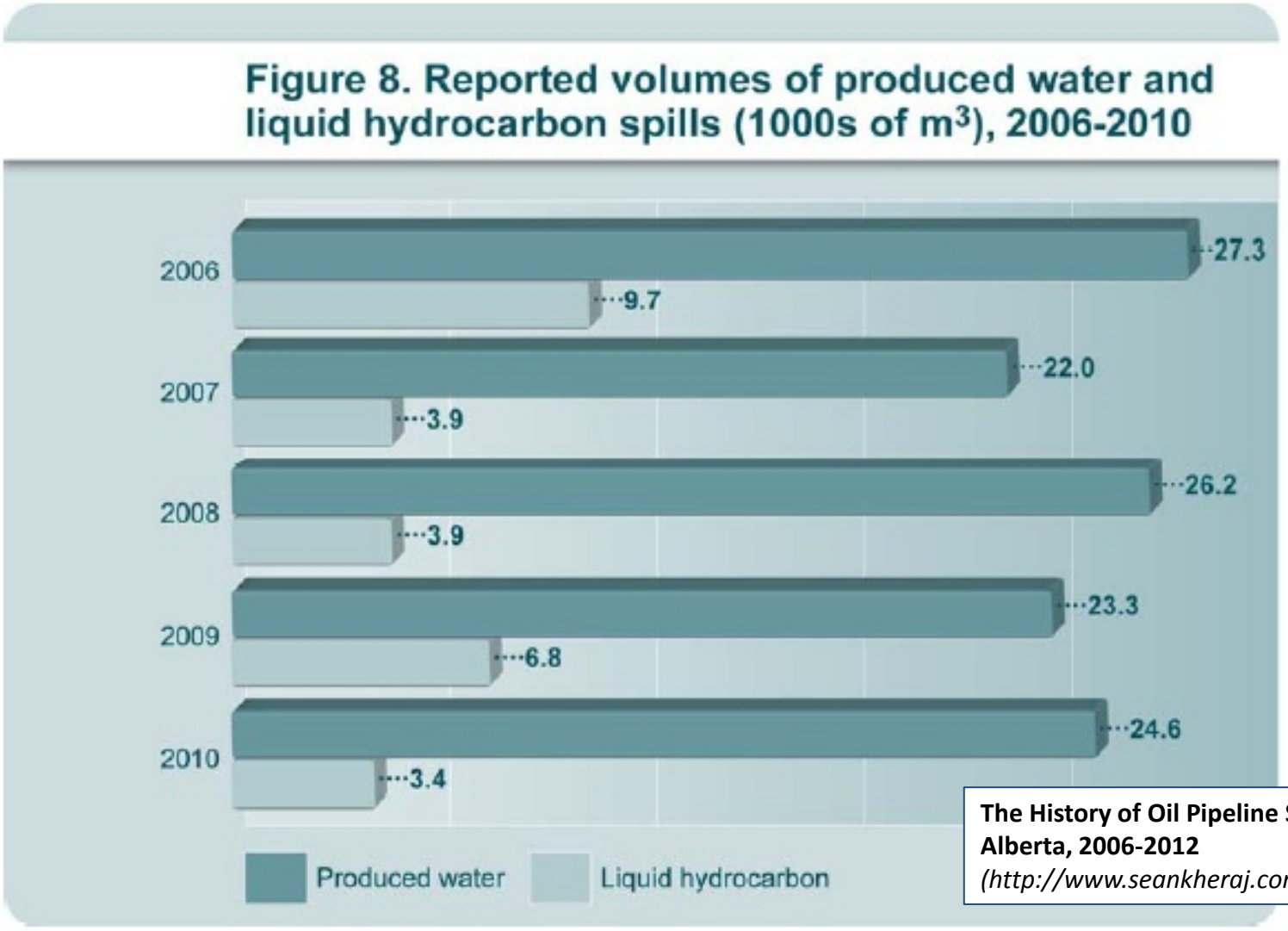
Square pegs and round holes…

Outline

1. Background and Objectives
2. Canadian Tier 1 Risk-Based Thresholds of Effects for Salts and Applicability to Boreal Wetlands
3. Equivalency of Different Salt Contamination Measures
4. Next Steps and Outstanding Issues


Wetlands by Ecodistrict
Lakes
Percent Wetland
0 - 5
5 - 10
10 - 20
20 - 40
40 - 60
60 - 97

1. Background and Objectives



The History of Oil Pipeline Spills in Alberta, 2006-2012
(http://www.seankheraj.com/?p=1257)

Five simple rules for managing salt releases to wetlands

1. **Minimize landscape disturbance!!**
2. Know the hydrological and vegetative characteristics of the spill/release site.
3. Stop and ask - *What am I concerned about?*
4. Understand the relevant contaminant fate processes
5. The wetland vegetation response will guide us home !

Maximize recovery of contaminant mass in immediate release area (source control), while minimizing other disturbances detrimental to wetland restoration goals.

Understand what ecological receptors are at risk. Establish the short-term zone of impact (impacted baseline)

Understand the expected ecosystem trajectory relative to reclamation goals. Evaluate the pros and cons of more active versus more passive approaches.

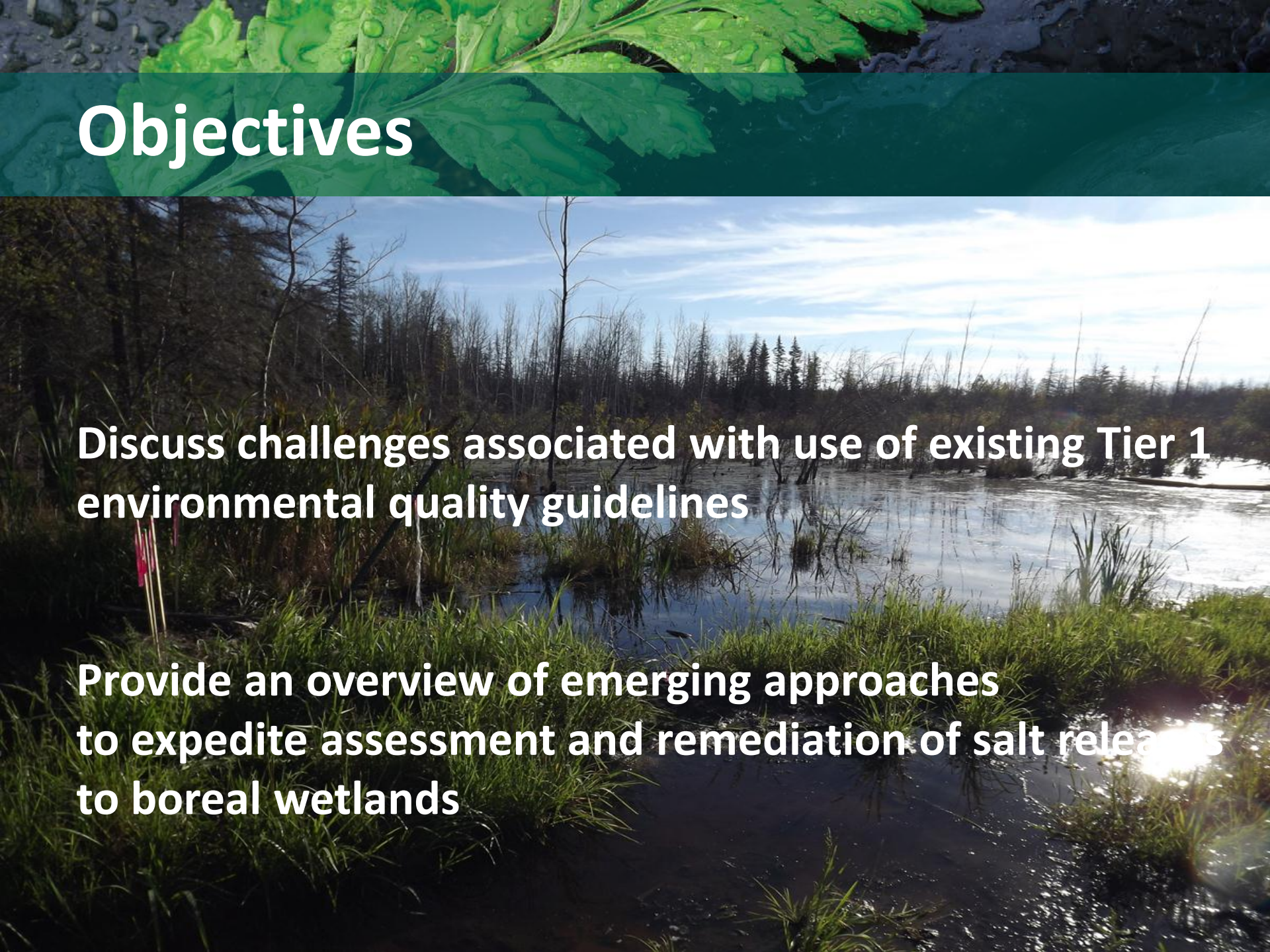
Confirm that contaminant-related barriers to wetland succession and function are no longer present.

TIER 1: AEnv, CCME, BC CSR

TIER 2: Altered Predictions of Exposure Potential from Source Term Based on Fate Modelling – *NOT AVAILABLE*

TIER 3: Detailed Site-specific Ecological Risk Assessment

Objectives



Discuss challenges associated with use of existing Tier 1 environmental quality guidelines

Provide an overview of emerging approaches to expedite assessment and remediation of salt releases to boreal wetlands

2. Canadian Tier 1 Risk-Based Thresholds of Effects for Salts and Applicability to Boreal Wetlands

Alberta Salt Soil Quality Guidelines for Unrestricted Land Use

Table 2.2 Soil Quality Guidelines for Unrestricted Land Use

Parameter		Rating Categories			
		Good	Fair	Poor	Unsuitable
Topsoil[c]	EC dS/m (salinity)	<2[a]	2 to 4	4 to 8	>8
	SAR (sodicity)	<4	4 to 8	8 to 12	>12[b]
Subsoil[c]	EC dS/m (salinity)	<3	3 to 5	5 to 10	>10
	SAR (sodicity)	<4	4 to 8	8 to 12	>12

a Some plants are sensitive to salts at EC < 2 dS/m (e.g., flax, clover, beans, wheat, peas, some garden crops).

b Material characterized by SAR of 12 to 20 may be rated as poor if texture is sandy loam or coarser and saturation % is less than 100.

c Topsoil: surface A horizons on the control area, or the equivalent surface soil on the reclaimed site.
Subsoil: B and C horizons and the upper portion of the parent material.

CCME

Canadian Council of Ministers of the Environment

Le Conseil canadien des ministres de l'environnement

Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life

CHLORIDE ION

Canadian Water Quality Guideline for the chloride ion[a] for the protection of aquatic life

	Long-Term Exposure[b] (mg Cl^-/L)	Short-Term Exposure[c] (mg Cl^-/L)
Freshwater	120[d]	640
Marine	NRG	NRG

[a] Derived from toxicity tests utilizing both $CaCl_2$ and NaCl salts

[b] Derived with mostly no- and some low-effect data and are intended to protect against negative effects to aquatic ecosystem structure and function during indefinite exposures (e.g. abide by the guiding principle as per CCME 2007).

[c] Derived with severe-effects data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events (e.g. inappropriate application or disposal of the substance of concern).

[d] The long-term CWQG may not be protective of certain species of endangered and special concern freshwater mussels (as designated by the Committee on the Status of Endangered Wildlife in Canada, or COSEWIC). This specifically applies to two species; the wavy-rayed lampmussel (*Lampsilis fasciola*) (COSEWIC, 2010a) and the northern riffleshell mussel (*Epioblasma torulosa rangiana*) (COSEWIC, 2010b) (table below). The wavy-rayed lampmussel is indigenous to the lower Great Lakes and associated tributaries, specifically western Lake Erie, the Detroit River, Lake St. Clair and several southwestern Ontario streams. The northern riffleshell mussel is indigenous to the Ausable, Grand, Sydenham and Thames Rivers in Ontario, as well as the Lake St. Clair delta. Discussion with provincial regulators should occur if there is a need to develop more protective site specific values.

NRG = no recommended guideline

Species Sensitivity Distribution (long term exposures) – CCME, 2011

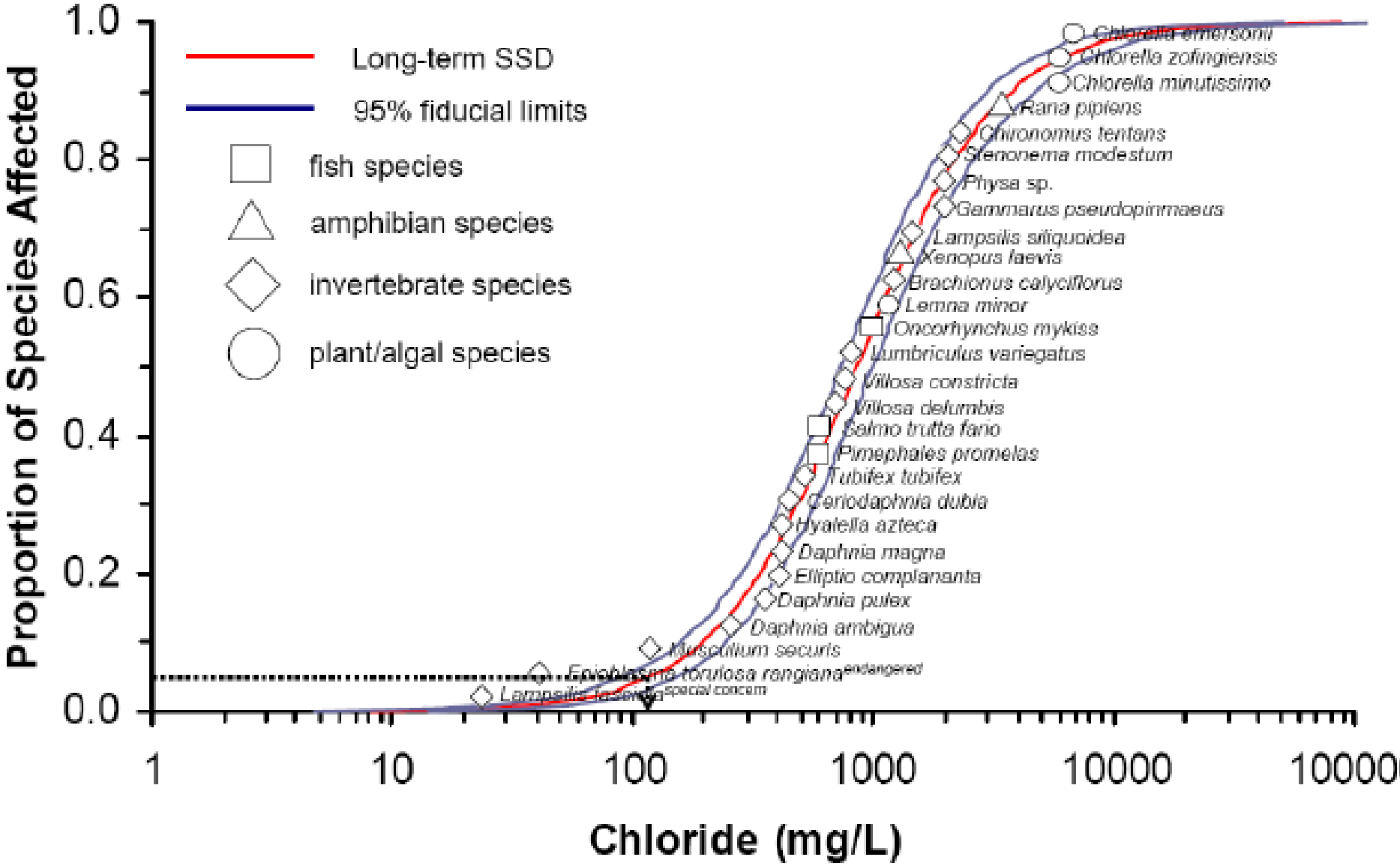
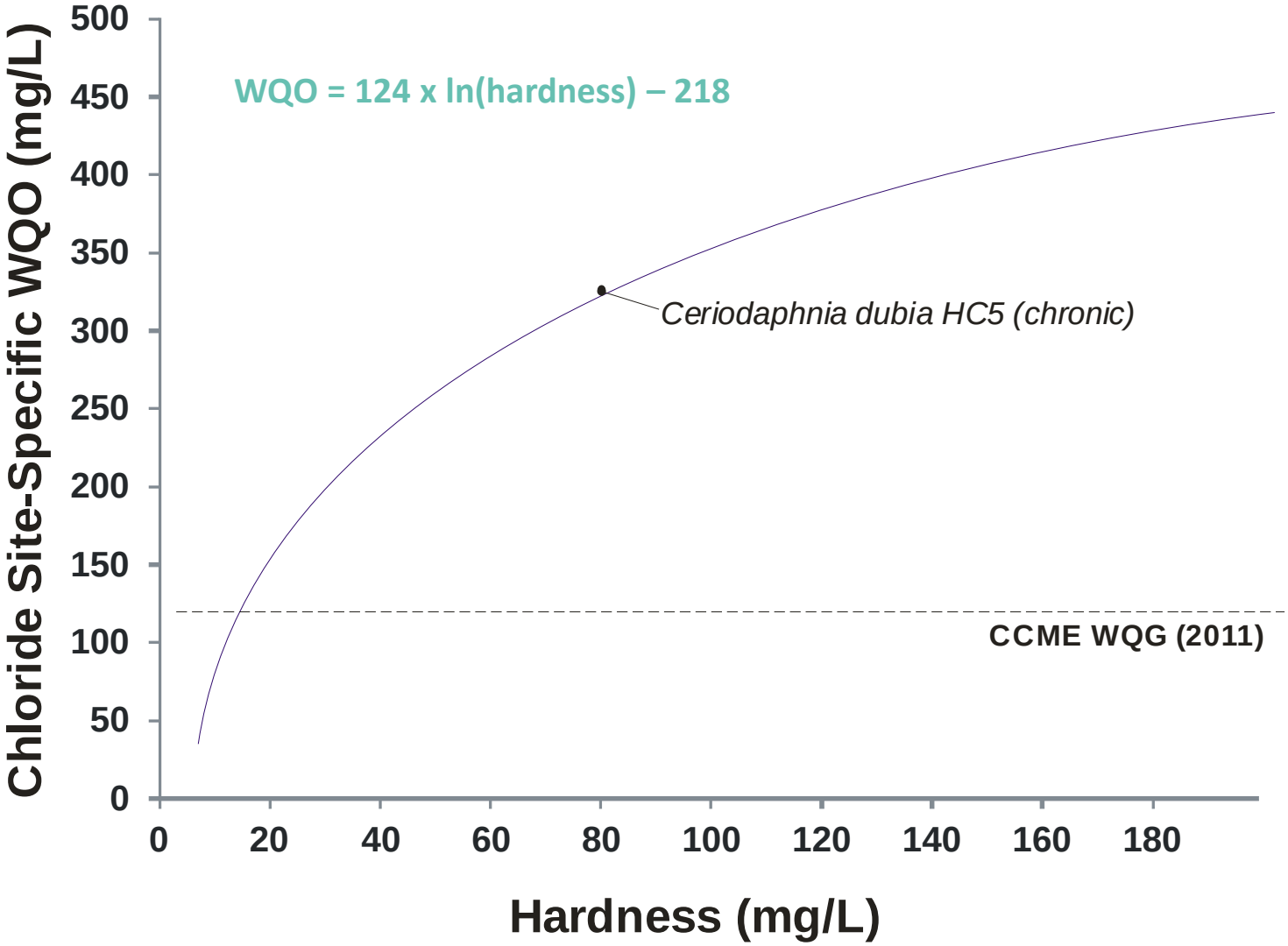


Table 9.11 Long-term no effect and low effect concentrations for species exposed to chloride in freshwater.

Rank	Scientific Name	Common Name	Endpoint	Effective Concentration (mg Cl/L)	Data Quality	Hazen Plotting Position	Reference
1	*Lampsilis fasciola*[a]	Wavy-rayed Lampmussel	24h EC10 (glochidia survival)	24	S	0.02	Bringolf *et al.*, 2007
2	*Epioblasma torulosa rangiana*[b]	Northern Riffle Shell	24h EC10 (glochidia survival)	42	S	0.05	Gillis 2010
3	*Musculium securis*	Fingernail clam	60-80d LOEC (reduced natality)	121	S	0.09	Mackie 1978
4	*Daphnia ambigua*	Water flea	10-d EC10 (mortality and reproduction)	259	S	0.13	Harmon *et al.*, 2003
5	*Daphnia pulex*	Water flea	21-d IC10 (reproduction)	368	S	0.16	Birge *et al.*, 1985 In: Elphick *et al.*, 2010
6	*Elliptio complanata*	Freshwater mussel	24-h EC10 (glochidia survival)	406	S	0.20	Bringolf *et al.*, 2007
7	*Daphnia magna*	Water flea	21-d EC25 (reproduction)	421	P	0.23	Elphick *et al.*, 2011
8	*Hyalella azteca*	Amphipod	28-d EC25 (growth, dry weight)	421	S	0.27	Bartlett 2009 (unpublished)
9	*Ceriodaphnia dubia*	Water flea	7-d IC25 (reproduction)	454	P	0.30	Elphick *et al.*, 2011
10	*Tubifex tubifex*	Oligochaete	28-d IC10	519	P	0.34	Elphick *et al.*,

Choride toxicity threshold is hardness dependent

(Ekati Minesite Site-specific WQO based on data by Elphick 2010 (in CCME 2011)



British Columbia Contaminated Sites Regulation – Soil Matrix Standards for Chloride Ion (mg/kg as sat. paste)

	Agricultural	Urban Parkland	Residential	Commercial	Industrial
HUMAN HEALTH PROTECTION					
Intake of contaminated soil	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g
Groundwater used for drinking water	90	90	90	90	90
ENVIRONMENTAL PROTECTION					
Toxicity to soil invertebrates and plants	**350**	**350**	**350**	**2,500**	**2,500**
Livestock ingesting soil and fodder	NS				
Major microbial functional impairment	NS				
Groundwater flow to surface water used by aquatic life	**550**	**550**	**550**	**550**	**550**
Groundwater used for livestock watering	200				
Groundwater used for irrigation	35	35	35		

Derivation of Matrix Soil Standards for Salt under the British Columbia Contaminated Sites Regulation

June 2002

Report to the British Columbia
Ministry of Water, Land and Air Protection,
Ministry of Transportation and Highways,
British Columbia Buildings Corporation, and the
Canadian Association of Petroleum Producers

Doug A. Bright, Ph.D. and Jan Addison, Ph.D.

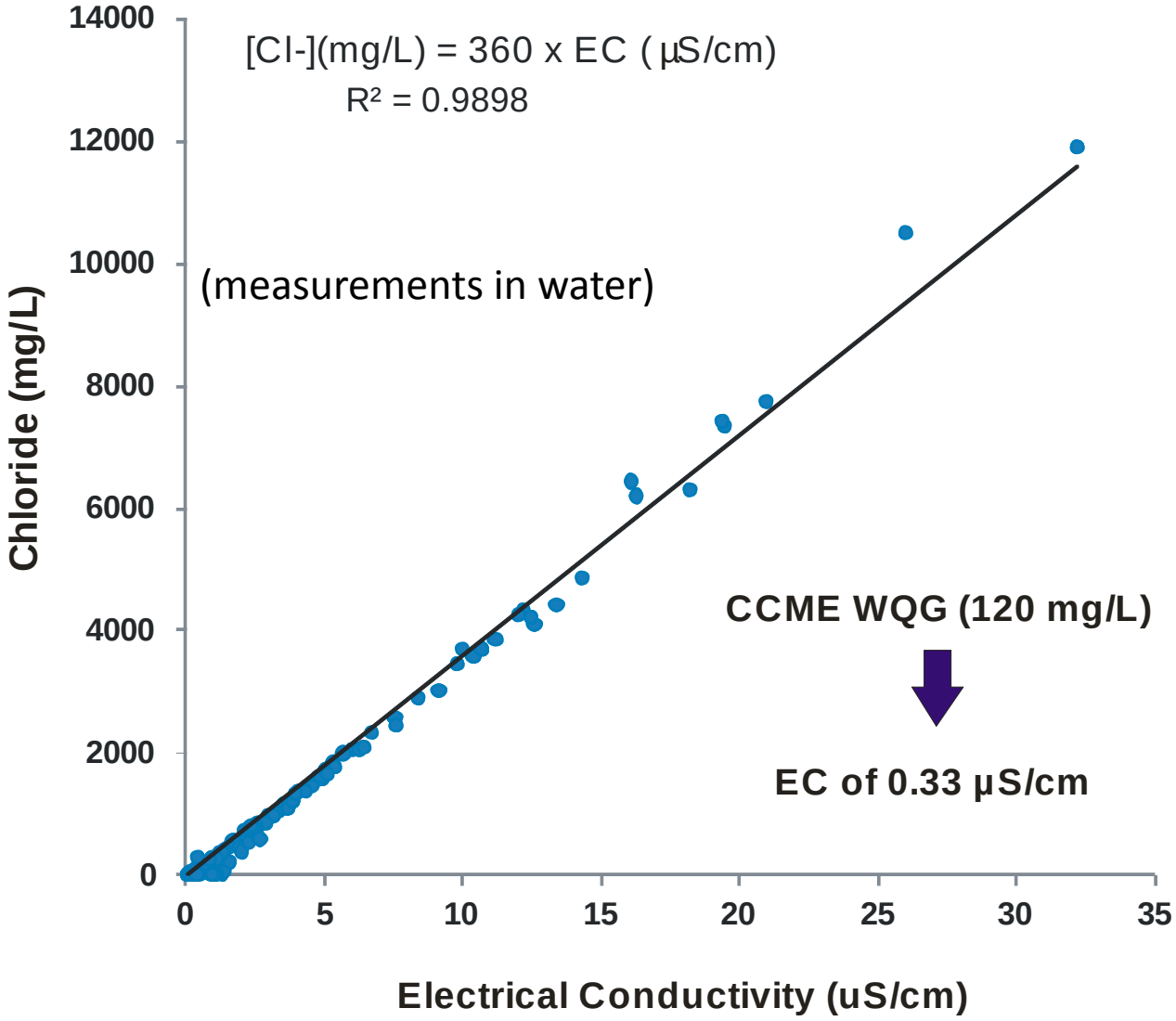
ROYAL ROADS UNIVERSITY

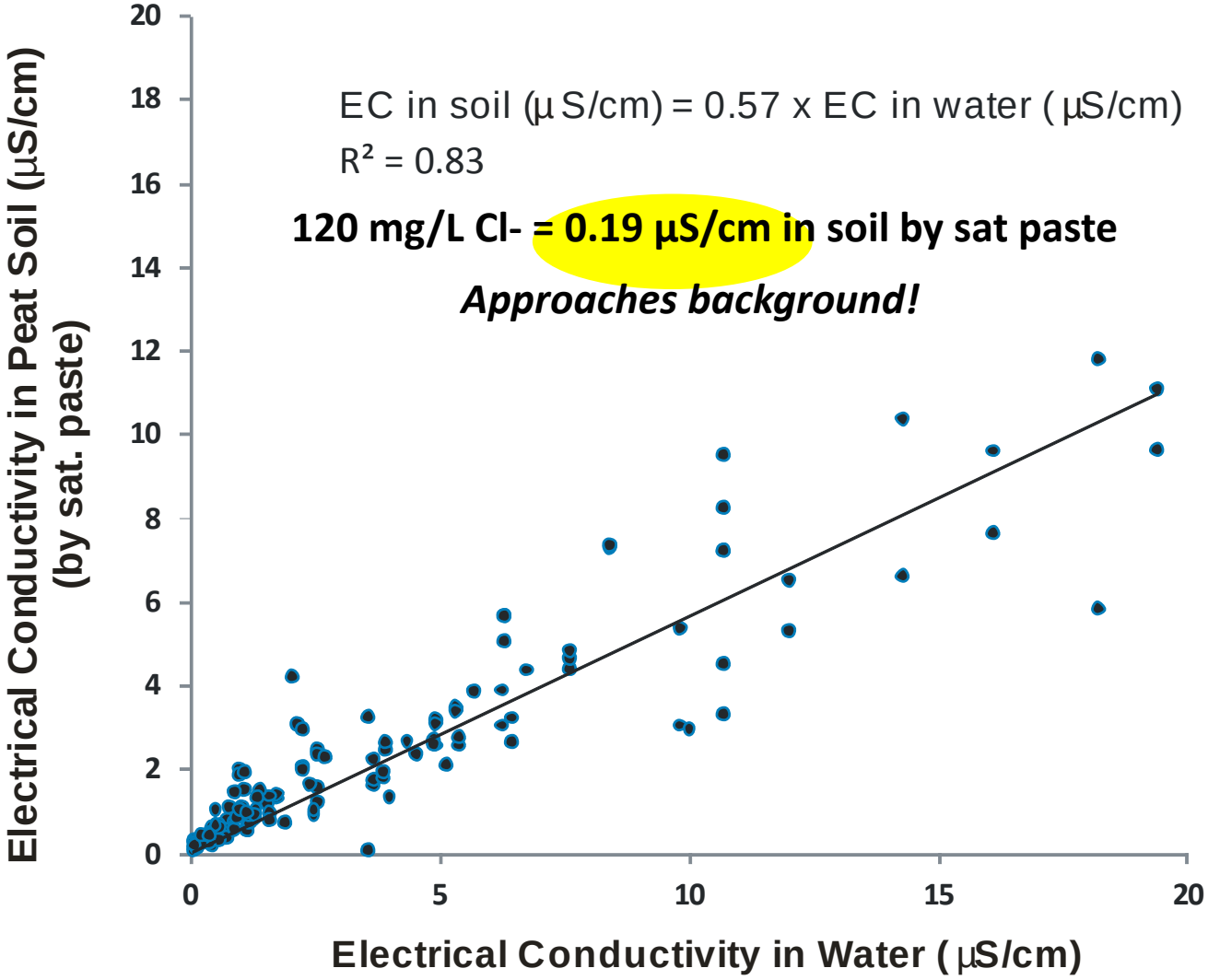
The Issues (with thanks to Mark Hugdahl ALS)

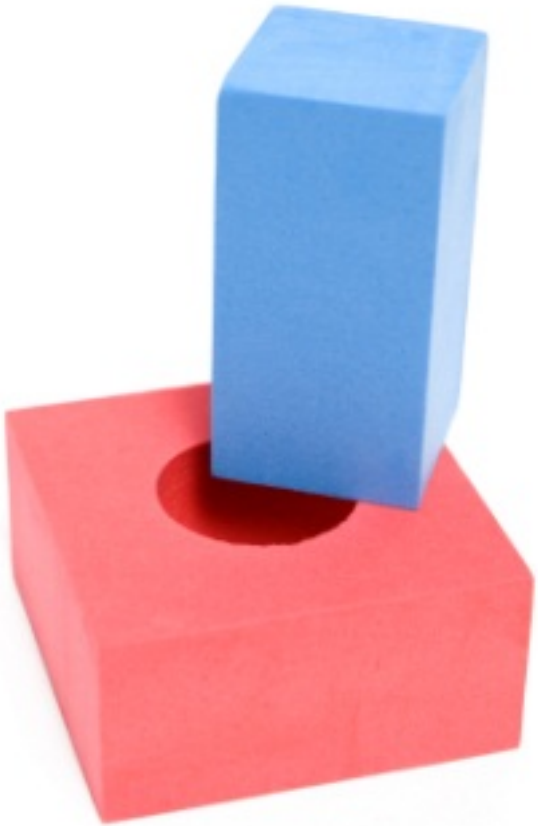
- **Salt Stds were derived for Mineral Soils, not peaty and hydric soils.**
  - Physical properties of minerals soils are very different from peats.
- **Sat. Paste Methodology: Conversion from mg/L pore water concentrations to mg/kg differs radically between Mineral Soils and Organic Soils.**
  - Difference in conversion factors is about 20x!
- **Toxic effects of Na & Cl correlate better with mg/L concentrations than mg/kg.**
  - Na & Cl salts are highly soluble, tend to reside in soil pore waters in the dissolved state.
  - This differs from most metals & organics, which tend to sorb to soils.

- **Soil Invertebrate Tox Tests used for derivations used only Mineral Soils (Addison and Bright, 2002)**
  - Used for *"Toxicity to Soil Invertebrates and Plants"* Standards.
    - Sodium 200 mg/kg, & Chloride 350 mg/kg
  - Soils used for tox tests had only 10-30% moisture.
- **BC CSST Standard Derivations assume Fraser River Sand for Groundwater Transport Model**
  - Used for all groundwater pathway standards, e.g. *"GW Flow to Surface Water used by Aquatic Life"* Standard (Chloride, 550mg/kg).
  - Fraser River Sand is vastly different from peat...

3. Equivalency of Different Salt Contamination Measures



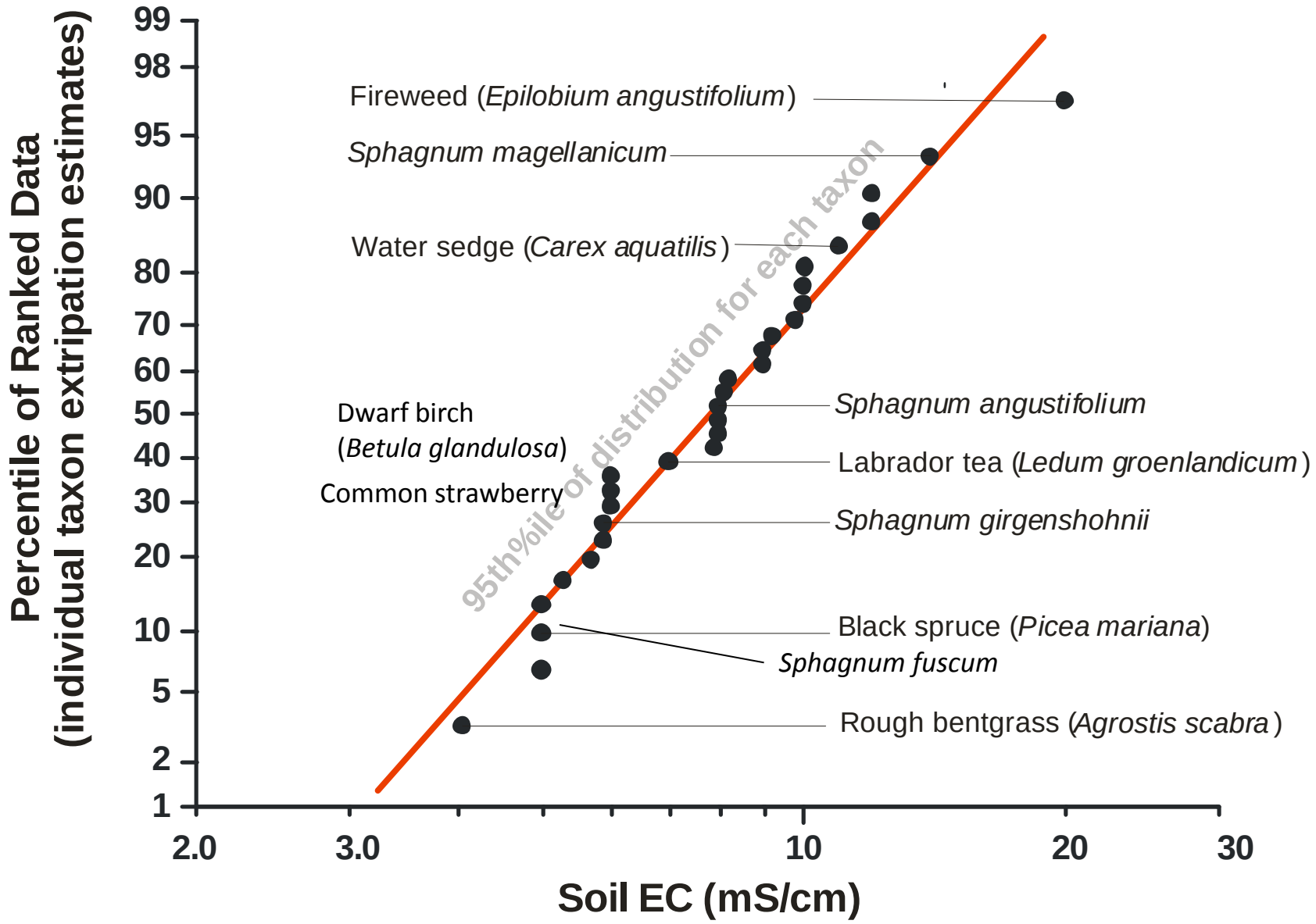

EC in soil (µS/cm) = 0.57 x EC in water (µS/cm)
R² = 0.83
120 mg/L Cl- = 0.19 µS/cm in soil by sat paste
Approaches background!
Electrical Conductivity in Peat Soil (µS/cm) (by sat. paste)
Electrical Conductivity in Water (µS/cm)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20



Square pegs and round holes…

4. Next Steps and Outstanding Issues

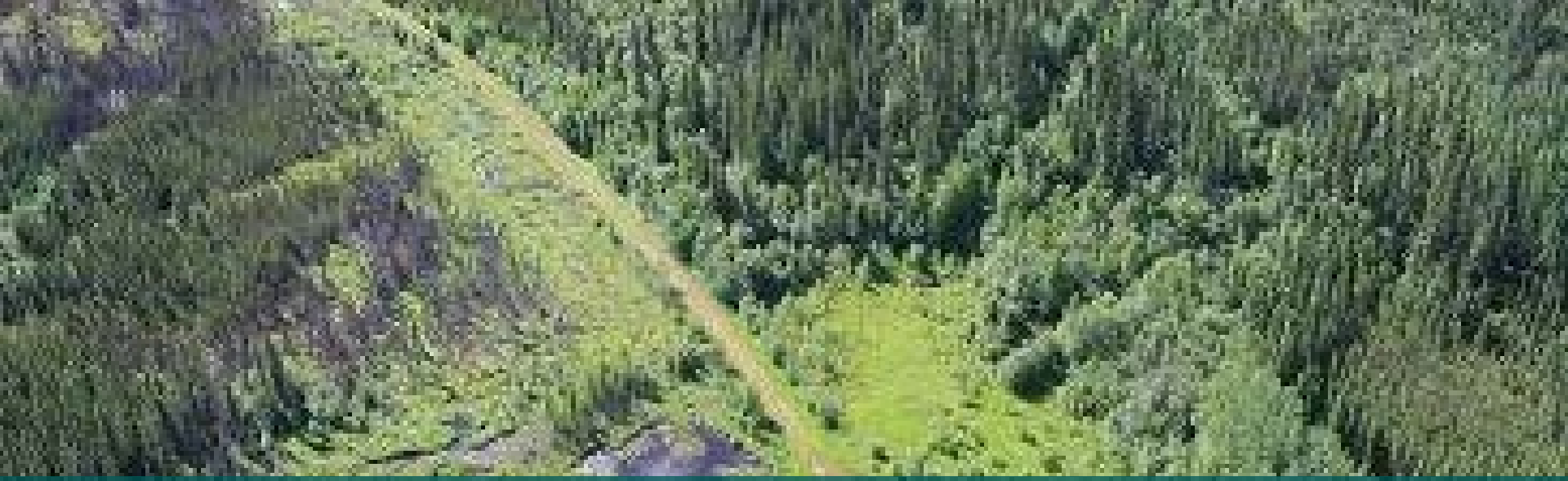
- **Development of wetland specific risk-based thresholds of effects levels (chloride and EC)**
- **CAPP initiative to develop freshwater life chloride water quality guidelines that are hardness adjusted**
- **Development of BC Contaminated Sites “Soil Matrix Standards” based on direct measurement of salinity in soil solution**



New information on relative sensitivity of different taxa is directly relevant for assessing degree of site impairment and recovery

CAPP Initiative to Develop Hardness-specific Cl^- WQG


British Columbia - *Development of Alternative Approaches Under the BC Contaminated Site Regulation for the Assessment and Remediation of Produced Water (Sodium and Chloride) Releases at Boreal Wetland Sites*



Thank you. Questions?

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