Road Deicing Salt Contamination at a Former Highway Works Yard in Penticton, BC-Delineation, Offsite Migration to Adjacent Properties and the Regulatory Approval Process in BC (2019-2024)- A Case Study- Jay Rao, M.A.Sc., P.Eng., CSAP-REMTECH | OCT 18, 2024

Speaker Qualifications



Director - Environmental Services, Western Canada

Jay Rao, M.A.Sc., P.Eng, CSAP

- EXP (2017-Present)
- 23 years of experience in BC in Environmental Investigations.
- Practicing in Alberta since 2014.
- 45 + BC Ministry of Environment & Climate Change Strategy Instruments as project director
- Contaminated Sites Approved Professional Numerical standards Since 2011
- EXP Services Inc. (www.exp.com)



Acknowledgements





Presentation Outline







Presentation Overview

- Site History, Goals and Objectives
- Road deicing salts Overview
- Areas of Potential Environmental Concern and Potential Contaminants of Concern
- Site Layout and Surrounding Land Use
- Archaeological Issues
- BC Contaminated Sites Regulation Process
- Phased Investigations and Findings
- BC Ministry of Environment & Climate Change Strategy -Pre-Approval to Not Delineate
- Plume Monitoring, Stability, Risk Assessment
- Onsite and offsite Instruments- Certificate of Compliance
- Summary



Site History, Client Goals and Objectives



Site History

- The Site operated as a Highway Maintenance Yard beginning in the late 1970s.
- The operations (salt storage, vehicle and equipment maintenance, repair, sandblasting activities ceased in 2019.
- The Site also had a fueling facility with underground storage tanks for diesel and gasoline, pumps. This area was remediated circa early 2000s. Aboveground tanks for fuel were later used.

• <u>Client Goals and Objectives</u>

 As Highway works yard operations ceased, client wanted a Certificate of Compliance from the BC Ministry of Environment and Climate Change Strategy for the Site and any affected offsite areas.



Road Deicing Salts Overview- Water Use Standards

Road salt, or sodium chloride, works by lowering the freezing point of water, causing ice to melt even when the temperature is below water's normal freezing point of 32 degrees F (0 deg C). When salt is applied, it dissolves into separate sodium and chloride ions that disrupt the bonds between water molecules.

Solubility of sodium chloride (NaCl) in water at 25 deg C is 36 g/100 ml of water or 360 g/L.

Water Use Standards

Applicable Water Use Standards at the Site:

CSR Drinking Water Use CSR Aquatic Life Water Use (Freshwater)

Irrigation and livestock water water uses do not apply.



Sodium ion (CAS# 17341-75-2)- DW – 200 mg/L, AWf- NS Chloride ion (CAS# 16887-00-6) -DW- 250 mg/L, AWf -1500 mg/L



Road Deicing Salts – Overview-Contd.- Soil Standards



E7 - Road Salt Storage Facilities

Road Salts, mostly sodium chloride, are used in Canada as de-icing and anti-icing chemicals for winter road maintenance. Calcium chloride is the leading chemical used for dust suppression in Canada. To prevent the clumping of chloride salts during storage and de-icing operations, sodium ferrocyanide and ferric ferrocyanide can be added.

PCOC Substance Class	Activity/Source	Comments			
lons	Salt	Specifically, chloride and sodium			
Cyanide⁴	Anticaking compounds	Secondary to sodium or chloride contamination (i.e. unlikely to be present if salt ion concentrations are not elevated)			

Ref: Contaminated Sites Approved Professional Society- Technical Document- Schedule 2 Activities and Potential Contaminants of Concern, 2018

Soil Standards

Applied BC Contaminated Sites Regulation Standards-Commercial Land Use – Onsite and Offsite

<u>Soil</u>

Sodium- Lowest standard – **1000 microgram/g** (toxicity to soil invertebrates and plants)

Chloride – Lowest standard – 100 microgram/g (groundwater used for drinking water)

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	Note
Site-specific Factor	Wildlands Natural (WL _N)	Wildlands Reverted (WL _R)	Agricultural (AL)	Urban Park (PL)	Residential Low Density (RLها)	Residential High Density (RL _{HD})	Commercial (CL)	Industrial (IL)	
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	> 1 000 mg/g	>1 000 mg/g	> 1 000 mg/g	
Groundwater used for drinking water	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	
ENVIRONMENTAL PROTECTION Toxicity to soil invertebrates and plants	150	200	200	200	200	1 000	1 000	1 000	
Livestock ingesting soil and fodder			NS						
Major microbial functional impairment			NS						
Groundwater flow to surface water used by aquatic life	NS	NS	NS	NS	NS	NS	NS	NS	
Groundwater used for livestock watering			NS						
Groundwater used for irrigation			NS	NS	NS	NS			

MATRIX 32 - NUMERICAL SOIL STANDARDS

SODIUM ION (CHEMICAL ABSTRACT SERVICE NUMBER 17341-25-2)

MATRIX 8 – NUMERICAL SOIL STANDARDS CHLORIDE ION (CHEMICAL ABSTRACT SERVICE NUMBER 16887-00-6)

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	Note
Site-specific Factor	Wildlands Natural (WL _N)	Wildlands Reverted (WL _R)	Agricultural (AL)	Urban Park (PL)	Residential Low Density (RLها)	Residential High Density (RL _{HD})	Commercial (CL)	Industrial (IL)	
IUMAN HEALTH PROTECTION ntake of contaminated soil	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g	> 1 000 mg/g	>1 000 mg/g	> 1 000 mg/g	
froundwater used for drinking water	100	100	100	100	100	100	100	100	1
ENVIRONMENTAL PROTECTION Toxicity to soil invertebrates and lants	200	350	350	350	350	2 500	2 500	2 500	
ivestock ingesting soil and fodder			NS						
fajor microbial functional impairment			NS						
roundwater flow to surface water sed by aquatic life, freshwater	600	600	600	600	600	600	600	600	1
iroundwater used for livestock vatering			250						1
froundwater used for irrigation			40	40	40	40			1

Notes

Standard varies with Kd (partition coefficient) for chloride ion in the soil of a site. Standard is appropriate to a chloride soil Kd range of 0 to 0.1 mL/g. If the Kd for chloride is outside of this specified range, modify the standard in accordance with a director's protocol.

Areas of Potential Environmental Concern and Potential Contaminants of Concern



APECs, PCOCs, AECs and COCs

APEC/AEC #	Media and PCOCs	Media, COCs, and Maximum Concentration
APEC/AEC-1 Former Fuel Dispensing Area	Soil: LEPHs, HEPHs, PAHs, VOCs including BTEX/VPHs, and metals Groundwater: LEPHw, PAHs, VOCs including BTEX/VPHw, and dissolved metals Soil Vapour: VPHv, VOCs, naphthalene	Residual COCs in groundwater (APEC/AEC 18): Dissolved Uranium, Dissolved Sodium, Chloride Remediated COCs in soil (APEC/AEC-18): LEPHs, VPHs Remediated COCs in groundwater: EPHw(C10-C19)
APEC/AEC-2 Former Zinc Contamination in Soil	Soil: Metals Groundwater: Dissolved metals	Remediated COCs in soil: Zinc Residual COCs in groundwater: Dissolved Sodium, Chloride
APEC 3 Surficial Hydrocarbon Staining	Soil: LEPHs, HEPHs, PAHs, VOCs including BTEX/VPHs, and metals	N/A
APEC/AEC-4 Former Salt Shed Areas	Soil: Sodium, chloride, and cyanide Groundwater: Sodium, chloride, and cyanide	Residual COCs in soil: Sodium, Chloride Residual COCs in groundwater: Dissolved Sodium, Chloride
APEC/AEC-5 Former Sandblasting Area	Soil: Metals Groundwater: Dissolved metals	Remediated COCs in soil: Arsenic, Barlum, Cobalt, Copper, Lead, Manganese, Sodium Chloride Remediated (Risk Based) COC in
APEC-6 Former Battery Storage Area	Soil: Lead	Groundwater: Dissolved Sodium N/A
APEC/AEC-7 Former Salt Brine Mixing Area	Soil: Sodium and chloride Groundwater: Sodium and chloride	Residual COCs in soil: Sodium, Chloride
APEC/AEC-8 Vehicle Wash Sump, Oil/Water Separator, and Rock Pit	Soil: LEPHs, HEPHs, PAHs, VOCs including BTEX/VPHs, and metals Groundwater: LEPHw, PAHs, VOCs including BTEX/VPHw, and dissolved metals Soil Vapour: VPHy, VOCs, panchthalene	Residual COCs in groundwater: Dissolved Sodium, Chloride
APEC/AEC-9 Waste Oil AST / Former Waste Oil UST	Soil: LEPHS, HEPHS, PAHS, VOCs including BTEX/VPHS, and metals Groundwater: LEPHw, PAHS, VOCs including BTEX/VPHw, and dissolved metals Soil Vapour: VPHv, VOCs, naphthalene	Remediated COCs in soil: HEPHs Residual COCs in soil: Arsenic
APEC 10 Rock Pit (Northern area at Parcel 290)	Soil: LEPHs, HEPHs, PAHs, VOCs including BTEX/VPHs, and metals Groundwater: LEPHw, PAHs, VOCs including BTEX/VPHw, and dissolved metals Soil Vapour: VPHv, VOCs, naphthalene	N/A
APEC 11 Vehicle Garage	Soil: LEPHs, HEPHs, PAHs, VOCs including BTEX/VPHs, metals, and glycols Groundwater: LEPHw, PAHs, VOCs including BTEX/VPHw, dissolved metals and glycols Soil Vapour: VPHv, VOCs, naphthalene	N/A
APEC/AEC-12 Petroleum Hydrocarbon Impact Area at NE Corner of 360 Waterloo Ave	Soil: LEPHs, HEPHs, PAHs, VOCs including BTEX/VPHs, and metals Groundwater: LEPHw, PAHs, VOCs including BTEX/VPHw, and dissolved metals Soil Vapour: VPHv, VOCs, naphthalene	Residual COCs in soil: Chloride, LEPHs, HEPHs, Benzene Residual COCs in groundwater: LEPHw, Pyrene
APEC/AEC-13	Soil: LEPHs, HEPHs, PAHs	Remediated COCs in soil:

Note 1: LEPH/HEPH: Light/Heavy Extractable Petroleum Hydrocarbons VPH: Volatile Petroleum Hydrocarbons BTEX: Benzene, toluene, ethylbenzene, xylenes PAHs: Polycyclic Aromatic Hydrocarbons VOCs: Volatile Organic Compounds N/A: Not Applicable

Note 2: As per the BC CSR Schedule 3.1, LEPH/HEPH and VPH where indicated as PCOCs in soil are LEPHs/HEPHs and VPHs; As per the BC CSR Schedule 3.2, LEPH and VPH where indicated as a PCOCs in groundwater are LEPHw and VPHw.



Site layout and Surrounding Land Use







FortisBC Substation



Highway 97 and Okanagan Channel



Home Hardware warehouse & storage yard



Okanagan Channel Close up



Former Salt shed area

Archaeological Issues

Trove of native artifacts unearthed in Penticton JOE FRIES Jul 2, 2015



Golder Associates senior archeologist Todd Paquin and archeologist Phoebe Murphy, and Penticton Indian Band members Nelson Phillip and Elliott Tonasket were among those who worked on a recent dig underneath an electrical substation on Huth Avenue.

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The ground below an electric substation in Penticton has now yielded nearly 30,000 First Nations artifacts, a treasure trove one expert believes is among the richest in the Okanagan.

During a six-week dig this spring, a team led by senior archeologist Todd Paguin unearthed 12,000 pieces of bone and 6,000 stone tools, projectile points and remnants from the site at the east end of Huth Avenue, approximately 30 metres from the Okanagan River channel.

"Penticton has a very rich archeological culture and this site is definitely one of the main archeological sites that's been discovered to date in the region," said Paquin, who works for consulting firm Golder Associates

The company was hired by FortisBC to make sure all artifacts unearthed during upgrade work on the



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Articles

Okanagan

- News article from 2015
- 30,000 Penticton First Nation Artifacts recovered
- 12,000 bone pieces, 6,000 • stone tools, projectile points and remnants
- Archaeological materials 3,000-5,000 years old
- The ground under and • around the FortisBC substation was designated a provincial archaeological site following discovery of human remains in 2011.



Site Investigation Process For Regulatory Compliance



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Phased Investigations and Findings -Soil Results



Extent of Soil Impacts (onsite-hatched portion)- Na+, Cl-

Summary of Soil Contamination

- Range of Sodium Concentrations Most Affected area –1,000 -6,320 μg/g (CL std. 1000 μg/g)
- Highest Chloride Concentrations –6,000-8,990 μg/g (CL std. 100 μg/g)
- Deepest Depth of Identified Soil Impacts 14 m – Chloride (259 μg/g), vertically delineated at 20-BH10 (18 m <CL for chloride and sodium.
- Impacts across site, however highest around salt shed and former brine tanks- Surface to approx. 3.5 m below grade
- Impacts within the Home Hardware Property
- Impacts on Huth Avenue

BILE OFFICE

APEC-4: ORMER SALT SHED

9-MW

-MW



Phased Investigations and Findings -Groundwater Results



<u>Onsite</u>

- Highest Sodium Concentration near salt shed- 9,210 mg/L (>250 mg/L – DW)
- Highest Chloride Concentration -15,900 mg/L near salt shed (>200 mg/L-DW, >1500 mg/L- AWf)
- <u>Offsite</u>
- Highest Sodium Concentration 4,210 mg/L
- Highest Chloride Concentration 2,560 mg/L
- BC MOECCS Protocol 11 Upper Cap for Chloride –AW – 15,000 mg/L
- Impacts within Home Hardware Property, Huth Ave
- Depth of Wells
- 6 m to maximum depth of 12 m below grade



Extent of Groundwater Impacts- Sodium and Chloride

Findings - Cross-Sections - Stratigraphy, Hydrogeology



Cross-Section A-A'

Findings - Cross-Sections- Contd.





Pre-Approval to Not Delineate



Plume Monitoring, Stability, Risk Assessment



Okanagan Channel Water Sampling



Spawning Kokanee- 300 m downstream of the site.



Huth Ave- Groundwater Sampling-Bladder Pump



Okanagan River Channel (mostly rocks and cobbles) bottom habitat



Siberian Elm on the eastern bank-Okanagan Channel



Redeveloped Site with a Public Storage Facility

- Is salty groundwater discharging into the Okanagan Channel?
- Does salty groundwater originating at the Site have the potential to discharge into the Okanagan Channel at concentrations exceeding BC Approved Surface Water Quality Guidelines?
- USEPA Bioscreen Modelling using highest Sodium and Chloride concentrations at source. Predict steady state concentrations at receptor- Okanagan Channel.



Plume Monitoring, Stability, Risk Assessment

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Sampling Surface Water with Peristaltic Pump



Public Storage Facility- Site Plan

- Is salty groundwater discharging into the Okanagan Channel? **No**
- Does salty groundwater originating at the Site have the potential to discharge into the Okanagan Channel at concentrations exceeding BC Approved Surface Water Quality Guidelines? Yes
- USEPA Bioscreen Modelling using highest Sodium and Chloride concentrations at source. Predict steady state concentrations at receptor- Okanagan Channel.-Chloride at steady state exceeds BC Approved Water Quality Guidelines



BC Approved Water Quality Guidelines

Chloride:

Short Term Acute- 600 mg/L

Long Term Chronic – 150 mg/L

Sodium: No guideline for Freshwater Aquatic Life

No surface water exceedances above the BC Approved Water Quality Guidelines for chloride over three sampling events in 2020, 2021, 2023.

Public Storage Facility Built 2022.

- Salt Shed Removed
- Salt impacted areas under building cover or pavement cover cutting off direct infiltration of stormwater.
- Offsite concentrations of Sodium and Chloride in groundwater are decreasing after 2022.

Well	Year	Na (mg/L)	Cl (mg/L)	
19-MW16	2020	1620	2560	
	2021	705	1330	
	2023	1140 (30% lower from 2020)	1970 (23% lower from 2020)	
19-MW15	2020	4210	6650	
	2021	696	1330	
	2023	525 (87.5% lower from 2020)	683 (89.7% lower from 2020)	e)

Risk Assessment

Key Considerations

- Paved and Unpaved Areas
- Any soil impacts within the top 1 m of soil within unpaved areas? **No**
- Groundwater plume stable and decreasing? Yes
- Is contaminated groundwater discharging into a surface water receptor at concentrations exceeding applicable BC Approved Water Quality Guidelines? No
- Groundwater beneath the Site and at offsite affected areas must not be used for drinking.

No future requirements for offsite plume monitoring as offsite concentrations of sodium and chloride

concentrations of sodium and chloride in groundwater shown reducing and the Site has been redeveloped with ā Public Storage Building (Grounds covered by buildings and paved surfaces within and around the most affected lot- former brine tanks and salt shed area.

CURRENT/FUTURE SITE CONDITION - PAVED







eccessional visibitit, skidna accompanied by teens, children and loddens. 2. Grouodeaster Xain below grade. Na soil COPCs for humans 3. Municipal water. No Soil COPCs for humans. 4. No soil vapour COPCs





















Certificate of Compliance – Applications (1 of 2)

Site & Management Areas (MA-1- Home Hardware, MA-2- Part of Huth Ave)





Schedule B

Requirements and Conditions

 Any changes in land, vapour or water uses must be promptly identified by the responsible person(s) in a written submission to the Director. An application for an amendment or new Certificate of Compliance may be necessary. The use(s) to which this condition applies are described in Schedule C and in the site investigation documents listed in Schedule D.

The documents listed in Schedule D indicate that vapour attenuation factors were applied to meet Contaminated Sites Regulation numerical standards at the site. These vapour attenuation factors were selected based on assumptions about the structures, locations and depths of buildings existing or expected at and adjacent to the site. These assumptions include the following:

(a) Current and future buildings on the Site and MA-1 will be Slab-on-grade.

Any inconsistencies that arise between the structures, locations and depths of proposed or constructed buildings at or adjacent to the site and the range of structures, locations and depths of buildings assumed in the selection of vapour attenuation factors in the documents listed in Schedule D must be promptly identified by the responsible persons in a written submission to the Director. An application for an amendment or new Certificate of Compliance may be necessary.

- The principal risk controls which must be present or implemented and must be maintained at the site include the following:
 - (a) Paved areas on the Site must remain paved.
 (b) Groundwater beneath the Site and beneath MA-1 and MA-2 must not be used for drinking.
- 3. If requested by the Director, the responsible persons must provide a signed statement indicating whether the principal risk controls listed in clause 2 of this Schedule have been and continue to be met. This may include providing a signed statement by an Approved Professional.
- If requested by the Director, a report signed by an Approved Professional must be submitted for review to the Director and must include the following:
- (a) An evaluation of the performance of the institutional and engineering controls.(b) Supporting documentation.

Na+ and Cl- remediated to risk-based standards – Commercial land use (soil)

CSR Drinking Water Use and Aquatic Life (freshwater) Use standards in groundwater

Groundwater beneath the Site and in Management Areas 1, 2 must not be used for Drinking.

Certificate of Compliance – Applications (2 of 2)

Separate COC -FortisBC owned Sub-Station Parcel



Schedule B

Requirements and Conditions

- Any changes in land, yappur or water uses must be promptly identified by the <u>responsible</u> person(s) in a written submission to the Director. An application for an amendment or new Certificate of Compliance may be necessary. The use(s) to which this condition applies are described in Schedule C and in the site investigation documents listed in Schedule D.
- The principal risk controls which must be present or implemented and must be maintained at the site include the following:

(a) Groundwater beneath the Site must not be used for drinking.

- 3. If requested by the Director, the responsible persons must provide a signed statement indicating whether the principal risk controls listed in clause 2 of this Schedule have been and continue to be met. This may include providing a signed statement by an Approved Professional.
- 4. If requested by the Director, a report signed by an Approved Professional must be submitted for review to the Director and must include the following:
 (a) An evaluation of the performance of the institutional control.
 (b) Supporting documentation.

Na+ and Cl- remediated to risk-based standards – Commercial land use (soil)

CSR Drinking Water Use and Aquatic Life (freshwater) Use standards in groundwater

Groundwater beneath the Site (i.e., FortisBC parcel) must not be used for Drinking.



Summary





Timeline and Milestones

- Investigation Timeframe 2019-2024 (five years)
- Pre-Approval (Not to Delineate Entire Extent of Contamination) Application submitted to BC MOECCS June 2021
- Pre-Approval Received August 2022
- Site Redeveloped with Public Storage Building -2022
- Offsite Plume Monitoring 2020-2023
- COC application submitted May 2024
- COC sign- off anticipated end Oct 2024

Compliance

- Na+ and Cl- remediated to risk-based standards Commercial land use (soil) Only qualitative risk assessment, no quantitative calculations required.
- Soil Salt Impacts -Deepest Depth of Identified Soil Impacts 14 m Chloride (259 $\mu g/g$), vertically delineated at 20-BH10 (18 m <CL for chloride and sodium.
- Groundwater Salt Impacts: 3.5 metres below grade (mbg) 12 mbg (<DW, AWf)vertically delineated.
- Site classified as "Non-High Risk"
- Aquatic receptor not impacted by Chloride in groundwater originating at the Site
- Groundwater both onsite and offsite remediated to CSR Drinking Water Use and Aquatic Life (freshwater) Use standards
- Groundwater beneath the Site and offsite must not be used for Drinking
- No digging of salty soil required for risk-based compliance



Thank You!

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