Scholarships

- Each year, up to three scholarships are awarded to applied science and engineering graduate students whose studies are relevant to the assessment and remediation of contaminated sites.

- Applications are reviewed and successful applicants chosen by an independent selection panel comprised of Technical Review Committee members

Scholarship Recipients

Sorour Nasimi (Mike Macfarlane Award) – Ph.D. program; Natural Resources and Environmental Studies; UNBC

- Research Topic: Enhancing water security in small, rural, remote, and Indigenous communities in Canada by developing innovative water protection planning strategies and advanced contaminant removal technologies.

Cole Merrill – M.Sc. Program; Earth, Ocean, and Atmospheric Sciences; UBC

- Research Topic: Building a groundwater model for a hypothetical decommissioned limestone mine in central British Columbia.

Amanda Reside – Ph.D. program, Environmental Sciences, University of Guelph

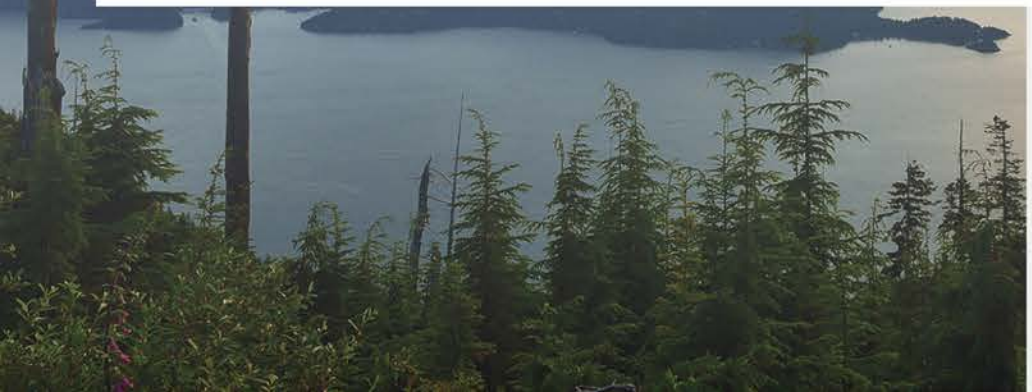
- Sulfolane's environmental fate and risks to wildlife based on a representative sulfolane-impacted site in Alberta.

CSAP

SOCIETY OF CONTAMINATED SITES
APPROVED PROFESSIONALS
OF BRITISH COLUMBIA

Performance Assessment Committee Lessons Learned

Chair: Jason Christensen, P.Eng.



Note: Correct answers are highlighted in yellow.

What documents are required to be listed within Schedule D of the Certification Document?

a) Communications with affected parcel
b) Relevant technical reports
c) Summary of Site Condition
d) Resume of submitting AP

When does an indoor use for vapour evaluation need to be considered?

a) When a building crawlspace is confined space
b) When the property is vacant with potential redevelopment
c) Reverted Wildlands
d) At an urban park with an enclosed concession stand

What are possible PCOCs associated a drycleaning facility?

a) Vinyl chloride
b) VPH
c) LEPH
d) Methylene chloride

A fill unit extends across multiple contiguous properties. When can the fill be statistically evaluated as a single unit? 1 month

a) The fill was applied at the same time
b) The fill unit has the same soil type
c) The data represents a single population
d) The properties are defined as Wide Area

When do off-site industrial activities **not** need to be considered as an APEC?

a) A NOM has not been filed at the Industrial site
b) The Industrial site has a reputable consultant working for them
c) The likelihood of contamination reaching the Site is very low
d) The Industrial Site is located cross gradient

Which of the following are examples Type 1 Sites?

a) Deep soil contamination
b) Contaminated soil located under municipal sidewalk
c) Building with vapour barrier
d) Signage restricting use

Who can prepare a metes and bounds drawing for certification documents?

a) An approved professional
b) A civil engineer
c) A land surveyor
d) CAD technician

What documents are to be included with a site risk classification with upper cap concentrations?VPH results are less than standard in groundwater

a) Cross section drawings
b) Contour maps
c) Exposure pathway questionnaire
d) Borehole Logs

When re-using waste soil on the site as part of an AiP remediation plan, what must be included in the submission?

a) A map showing where deep rooting vegetation is present
b) A cross section showing that waste soil is not placed at surface
c) Sealed record drawing with precise location of contamination
d) Details on extent and nature of soil contamination

What confidence level should be used in a Mann Kendall test to demonstrate stability for a SLRA?

a) 95% confidence (alpha = 0.05)
b) 90% confidence (alpha =0.10)
c) 85% confidence (alpha =0.15)
d) 80% confidence (alpha =0.20)

The groundwater protection model can be used for sites with confined aquifers?

a) True
b) False

Which of the following are required for a SLRA submission?

a) Signed professional statement by QP for habitat assessment
b) Signed professional statement by QP for contaminant persistence
c) Signed professional statement by QP for stability assessment
d) Signed professional statement by QP for overall SLRA

Which of the following standards should soil analytical data be compared against in a DSI?

a) Numerical matrix standards
b) Site specific standards
c) Toxicity reference values
d) P4 background concentrations

If an APEC is investigated and found to not be contaminated, it does need to be reported in the SoSC?

a) True
b) False

Can a sample result be discarded?

a) Yes, if it is unexpected at the sampling location
b) Yes, if it is a statistical outlier and replaced with new samples
c) Yes, if there is a sampling error
d) No, all samples must be retained

What are PCOCs for a wood waste landfill?

a) Non-chlorinated phenols
b) Metals
c) Sulphides
d) PCBs

When may a site be exempt from seasonal groundwater sampling?

a) Never
b) In rare circumstances
c) Tidal influenced sites
d) Bedrock aquifers

Analytical data obtained for an old AiP was compared to pre-omnibus standards. This data isn't required to be compared to current standards.Precautionary Risk Control should be included and no PVP required

a) True
b) False

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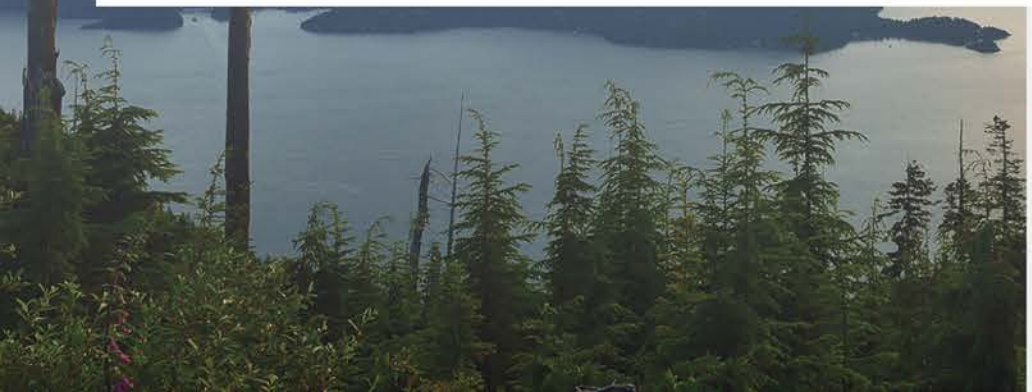
Review of Regional Soil Background Concentrations in BC

Meredith Guest, P.Eng., PMP, CSAP
Thomas Boerman, M.Sc.
Active Earth Engineering



Review of Regional Soil Background Concentrations in BC

2025-06-19

ACTIVE EARTH

ENGINEERING LTD

Introduction

- Determine if sufficient information is available to support making changes / additions to current BC ENV Protocol 4

Objectives

Key Objectives:

- Identify metals in each region that are posing challenges
- Review practices in other jurisdictions
- Identify areas where potential changes could be considered
- Identify data needed to scientifically support potential changes for the list of background concentrations
- Review current regulatory methods for determining regional soil background

Objectives

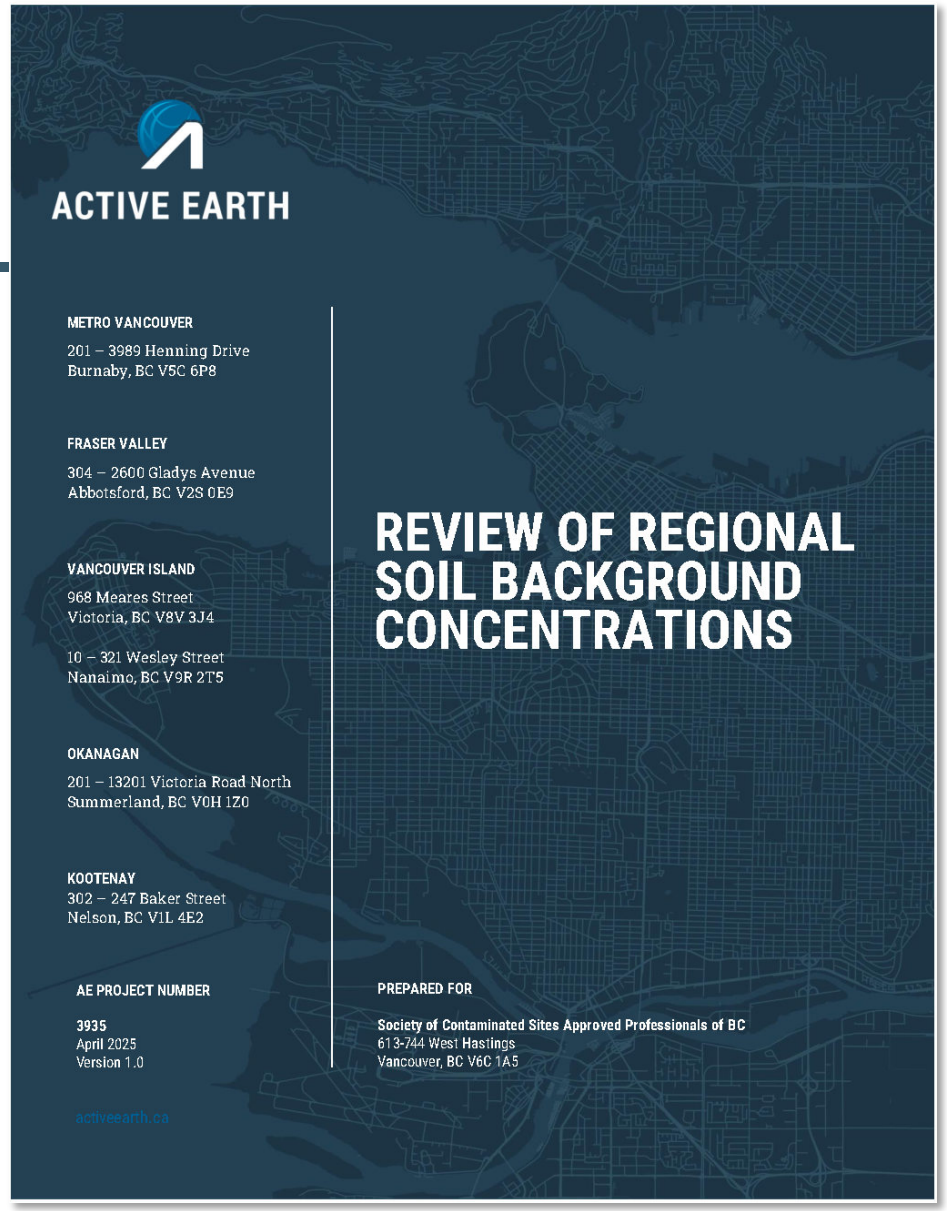
Why Revisit Protocol 4?

- Updated and accurate information improves reliability of the dataset & prevents unnecessary remediation costs
- May allow for incorporation of recent data and improved sample data evaluation/statistical approaches
- Ensures relocation of soils with naturally occurring concentrations > CSR stds are managed properly
- Essential to ensure that management practices in BC remain effective, scientifically sound and aligned with current conditions and regulations

Presentation Outline

Overview

- Jurisdictional Review on background soil concentration studies
- Recap on Protocol 4/28 Process
- Review of ENV submissions to date
- Case Study - Disposal at Sea database in Lower Mainland



Jurisdictional / Agency Review

Various sources of background information from other jurisdictions was reviewed.

- Evaluate different approaches
  - Data Collection
  - Statistical Analyses
- Augment or supplement current data set

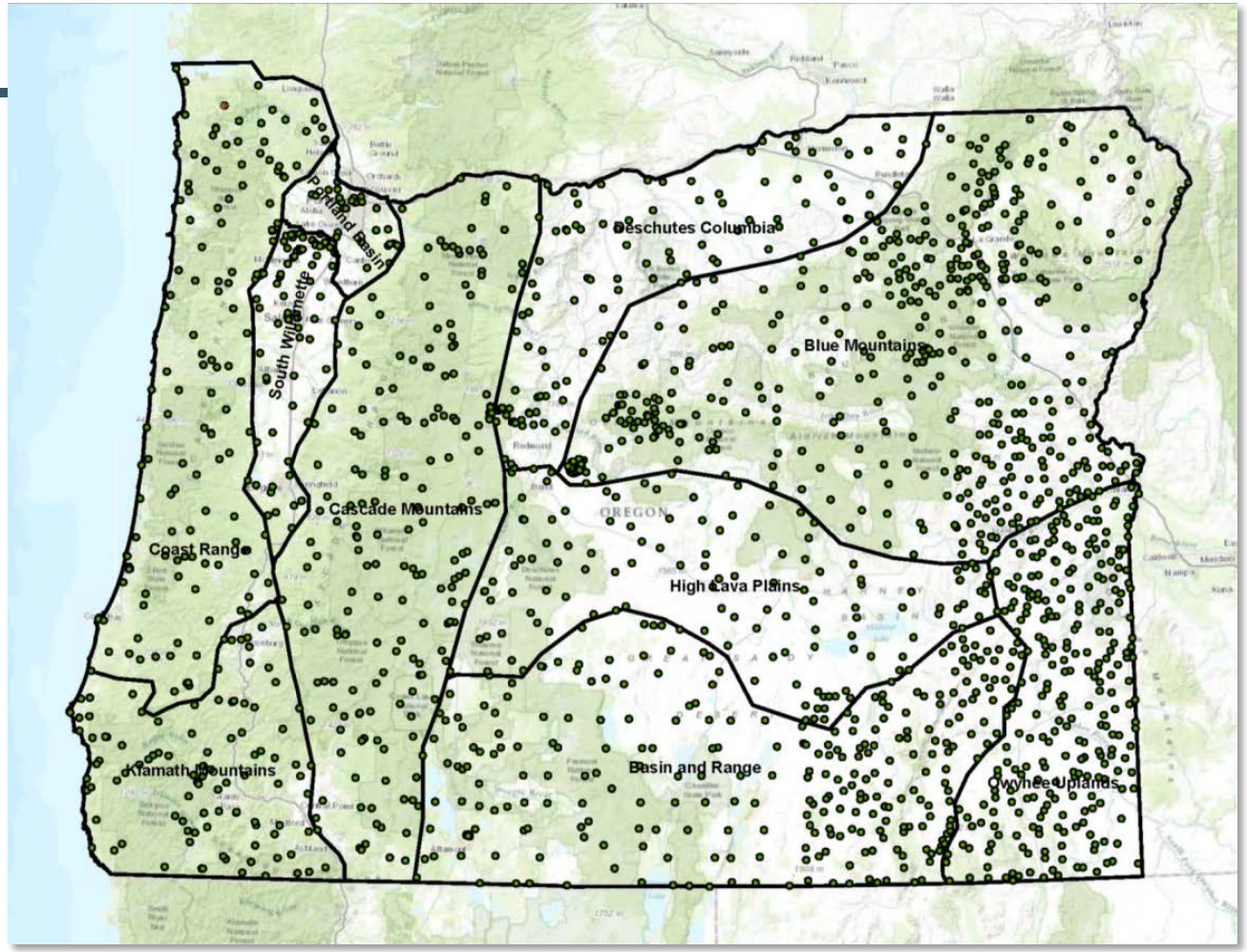
Jurisdictional / Agency Review

Sources of information included:

- Background Evaluation in Alberta
- US studies that developed background reference values (Oregon and Washington)
- Background Arsenic focused studies (Southwest Oregon & Southern California)
- Soil sample collection & guidance for background estimates used in RAs (Canada)
- Study in the Netherlands that included a ‘soil type correction” when evaluating background

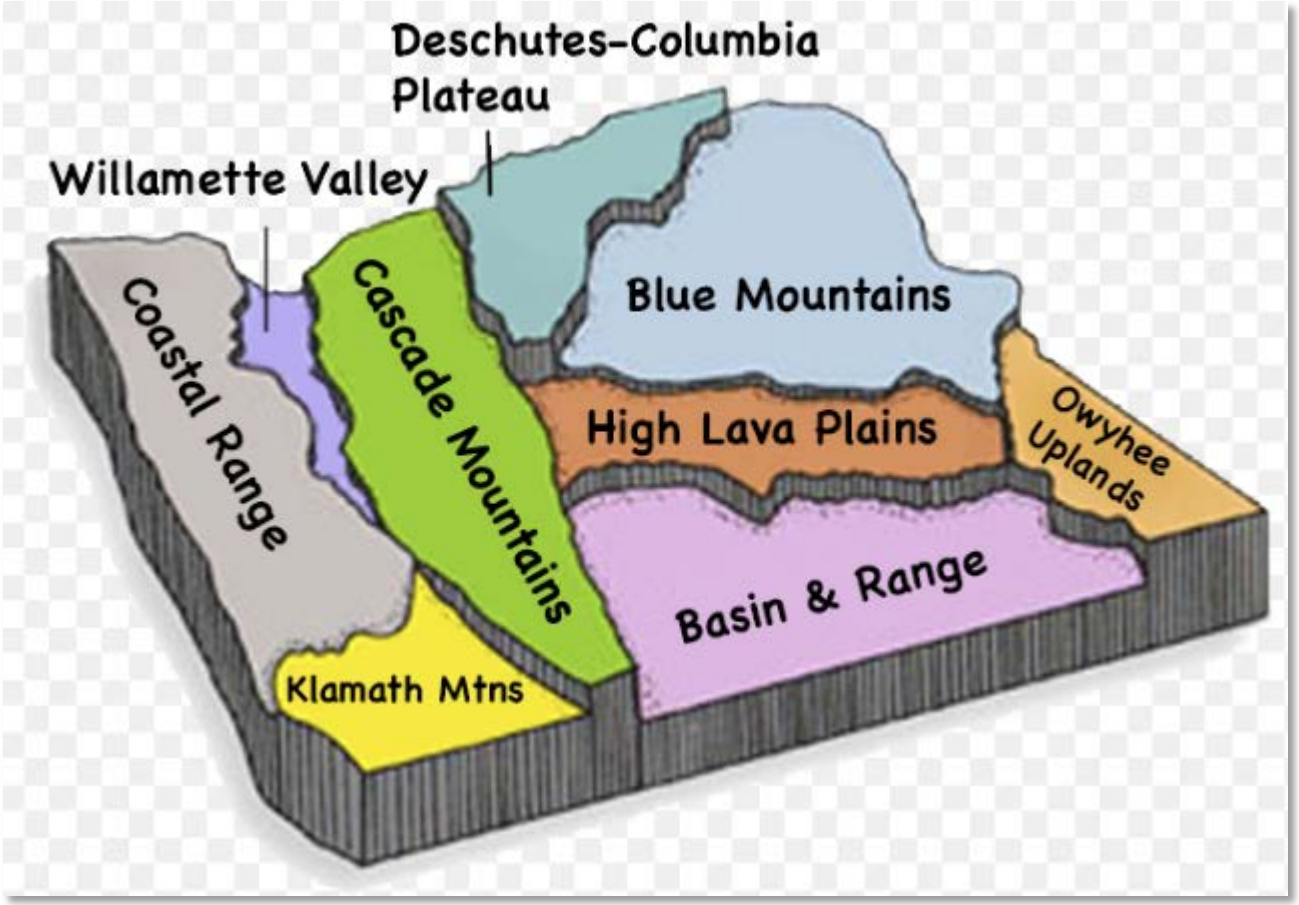
Jurisdictional Review Key Take Aways

- Data sets used in these evaluations were quite comprehensive
- Different statistical values were recommended as background reference values
  - (95th percentile, 95th UPL, 95th UCL of 95th percentile)
- Recommended sampling procedures



Jurisdictional Review – Key Take Aways

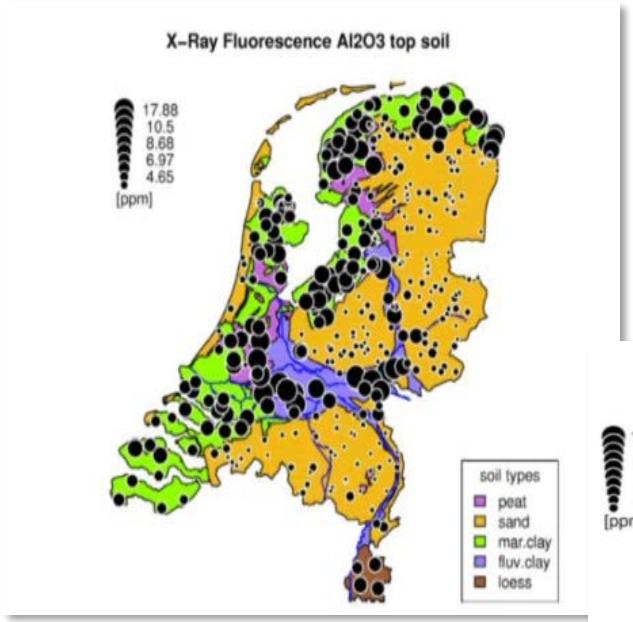
- Defining region by geophysical properties
  - Considering subregions
- Recognizing influence of environmental factors (soil order, elevation, rock type, soil type)
- Data Collection (depth, soil type, surficial geology, grain size)

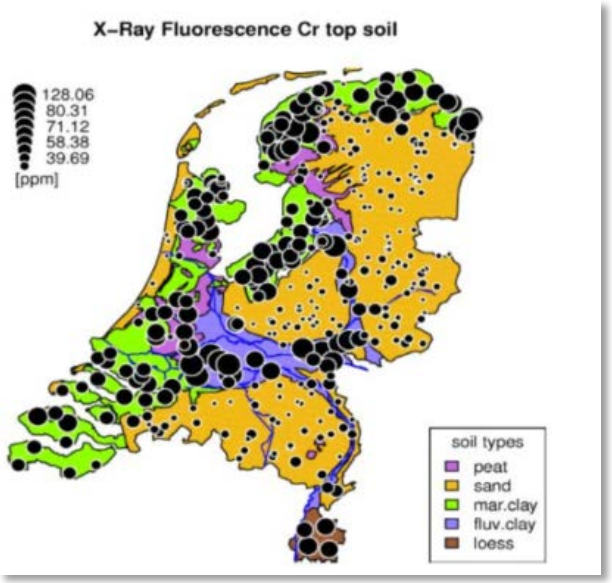


Jurisdictional Review – Dutch Method

Netherlands Alternative Approach (2012)

- The study proposed a method - “soil type correction” to determine background
- Correction methods include 4 parts:
  - A linear regression model based on clay content and organic matter
  - Soil Type Correction (STC) model using the input parameters from part 1. The STC model normalizes the soil concentration to a ‘standard soil’ of 25% clay content
  - Natural background concentrations (from field data)
  - Added risk approach



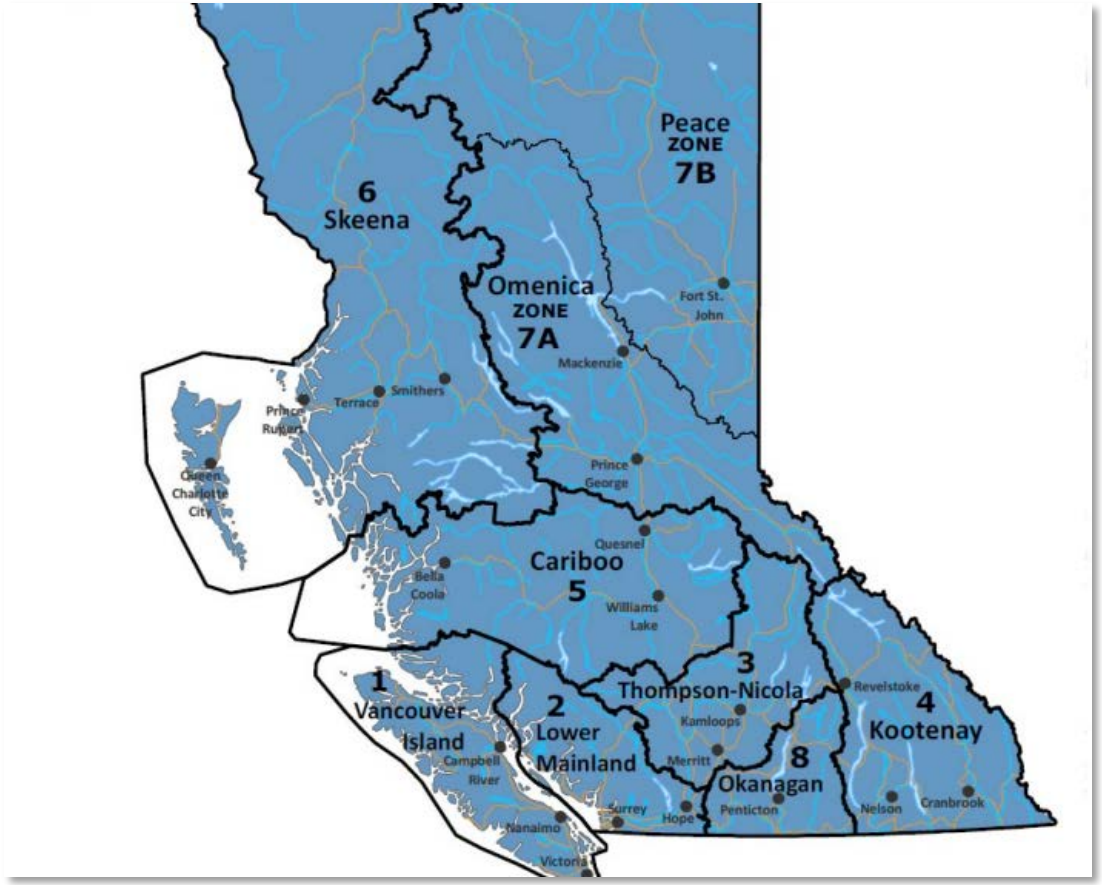


In summary, the background concentrations are normalized for a soil of a 25% weight percentage of clay (and 10% organic content). Concentrations in soils are corrected/normalized for this to check whether background concentrations are exceeded

Soil Background Data Review in BC

The current ENV P4 process was reviewed:

- Identify areas that could be updated/enhanced
- Identify “problematic” metals
- Identify ranges for these parameters
- Review distribution of elevated background parameters (regions, geology, stratigraphy)
- Identify limitations of collected data



Protocol 4 Process

Protocol 4 - (Use Regional Values or Site-Specific approach)

- Option 1 – Regional values in Table 1 of Protocol 4
- Based on 487 samples in 63 locales/sample sites (8 samples per sample site)
- Regional background concentrations in Table 1 where the 95th percentile from this data set

TABLE B - SUMMARY OF REGIONAL BACKGROUND SAMPLE LOCATIONS

Region	Number of samples	Sample Sites (8 samples collected per Sample Site)
1 – Vancouver Island	72	Cassidy, Saanich, Saltspring Island, Cumberland, Campbell River, Victoria, Malahat, Port Alberni, Port Hardy
2 – Lower Mainland	160	Squamish (2x), Port Moody (2x), Maple Ridge, Delta, Burns Bog, Surrey, Abbotsford, Chilliwack, UBC, Stanley Park, Queen Elizabeth Park, Richmond West, Richmond Central, Burnaby Lake, Burnaby North, North Vancouver, New Westminster, Coquitlam
Metro Vancouver	80	UBC, Stanley Park, Queen Elizabeth Park, Richmond West, Richmond Central, Burnaby Lake, Burnaby North, North Vancouver, New Westminster, Coquitlam
3/8 – Thompson/Nicola/ Okanagan	72	Kamloops (2x), Kelowna, Oliver, Merrit, Vernon, Princeton, Salmon Arm, Ashcroft
4 – Kootenay	56	Kimberly, Nelson, Revelstoke, Creston, Castlegar4, Trail2, Invermere, Sparwood, Golden
5 – Cariboo	24	Williams Lake, 100 Mile House, Quesnel/Barkerville
6 – Skeena	48	Kitimat, Smithers, Terrace, Burns Lake, Prince Rupert, Houston
7 – Omenica/Peace	56	Prince George (2x), Dawson Creek, Mackenzie, Fort St. James, Tumbler, Fort St. John

Substance	Region 1 Vancouver Island	Region 2 Lower Mainland	Metro Vancouver[7]	Region 3/8 Thompson/Nicola/ Okanagan	Region 4 Kootenay[8]	Region 5 Cariboo	Region 6 Skeena	Region 7 Omineca/ Peace
aluminium	55 000	35 000	35 000	30 000	25 000	25 000	40 000	40 000
antimony	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
arsenic	(4)	8.5	8.5	15	(4)	10	10	10
barium	250	150	90	200	350	250	300	500
beryllium	0.7	0.7	0.7	0.5	0.8	0.3	0.6	1
boron	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
cadmium	0.95	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)
chromium[5]	65	55	50	70	35	100	40	50
cobalt	30	15	15	20	15	20	15	25
copper	100	75	150	75	35	60	50	70
iron	70 000	30 000	30 000	30 000	30 000	30 000	30 000	40 000
lead	40	200	300	15	120	15	20	25
manganese	5 000	900	1 000	1 000	2 000	850	1 500	1 500
mercury[6]	0.15	0.3	0.35	0.075	0.085	0.09	0.15	0.09
molybdenum	(1)	4	6	2	(1)	(1)	3	3
nickel	50	75	40	85	50	200	40	60
selenium	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
silver	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
strontium	100	60	55	250	150	250	100	70
sulfur	1 000	2 000	3 000	550	950	800	2 500	450
tin	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
vanadium	200	80	75	85	40	75	85	95
zinc	150	100	90	100	200	85	150	150

Table 1 Protocol 4 - Option 1

Substance	Region 1 Vancouver Island	Region 2 Lower Mainland	Metro Vancouver[7]	Region 3/8 Thompson/Nicola/ Okanagan	Region 4 Kootenay[8]	Region 5 Cariboo	Region 6 Skeena	Region 7 Omineca/ Peace
aluminium	55 000	35 000	35 000	30 000	25 000	25 000	40 000	40 000
antimony	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
arsenic	(4)	8.5	8.5	15	(4)	10	10	10
barium	250	150	90	200	350	250	300	500
beryllium	0.7	0.7	0.7	0.5	0.8	0.3	0.6	1
boron	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
cadmium	0.95	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)
chromium[5]	65	55	50	70	35	100	40	50
cobalt	30	15	15	20	15	20	15	25
copper	100	75	150	75	35	60	50	70
iron	70 000	30 000	30 000	30 000	30 000	30 000	30 000	40 000
lead	40	200	300	15	120	15	20	25
manganese	5 000	900	1 000	1 000	2 000	850	1 500	1 500
mercury[6]	0.15	0.3	0.35	0.075	0.085	0.09	0.15	0.09
molybdenum	(1)	4	6	2	(1)	(1)	3	3
nickel	50	75	40	85	50	200	40	60
selenium silver	(4) (1)	(4) (1)	(4) (1)	(4) (1)	(4) (1)	(4) (1)	(4) (1)	(4) (1)
strontium	100	60	55	250	150	250	100	70
sulfur	1 000	2 000	3 000	550	950	800	2 500	450
tin	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
vanadium	200	80	75	85	40	75	85	95
zinc	150	100	90	100	200	85	150	150

Background Soil Concentration Database

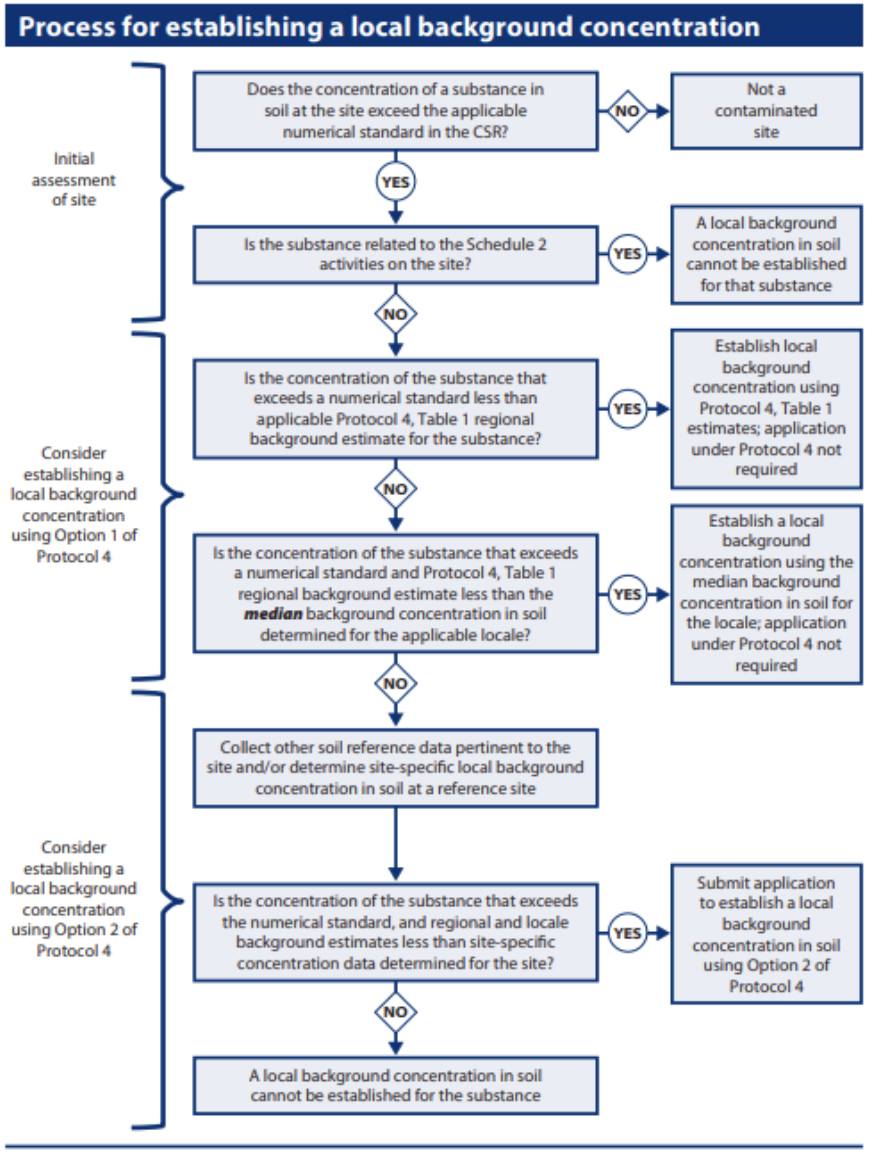
- Large percentage of samples <MDL
- Percentage of samples >50% that were < MDL – shown in red

TABLE C - PERCENTAGE OF SAMPLES WITHIN THE REGIONAL BACKGROUND DATABASE WITH CONCENTRATIONS BELOW THE DETECTION LIMIT

Parameter	Van Island	Lower Mainland	Metro Van	Thompson Nicola	Kootenay	Cariboo	Skeena	Omineca Peace
Aluminum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Antimony	100.0	93.8	87.5	100.0	98.2	100.0	89.6	100.0
Arsenic	100.0	88.1	81.3	91.7	85.7	83.3	77.1	60.7
Barium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Beryllium	10.1	26.3	23.8	16.7	25.0	62.5	45.8	28.6
Boron	100.0	92.5	87.5	100.0	94.6	100.0	85.4	100.0
Cadmium	92.8	93.1	88.8	98.6	76.8	100.0	87.5	100.0
Calcium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium	0.0	0.6	0.0	0.0	0.0	0.0	8.3	0.0
Cobalt	0.0	5.6	2.5	0.0	0.0	0.0	16.7	1.8
Copper	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Iron	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lead	47.8	35.0	21.3	66.7	17.9	25.0	22.9	17.9
Magnesium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manganese	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mercury	0.0	0.0	0.0	13.9	0.0	0.0	0.0	3.6
Molybdenum	98.6	71.3	67.5	81.9	85.7	95.8	68.8	64.3
Nickel	2.9	5.0	3.8	0.0	0.0	0.0	16.7	0.0
Selenium	100.0	95.0	90.0	100.0	98.2	100.0	89.6	100.0
Silver	100.0	95.0	90.0	100.0	98.2	100.0	89.6	100.0
Sodium	4.4	0.0	0.0	1.4	3.6	0.0	0.0	26.8
Strontium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sulfur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thallium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tin	100.0	94.4	88.8	100.0	96.4	100.0	89.6	98.2
Vanadium	0.0	1.9	1.3	0.0	0.0	0.0	10.4	0.0
Zinc	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zirconium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Protocol 4 – Option 2

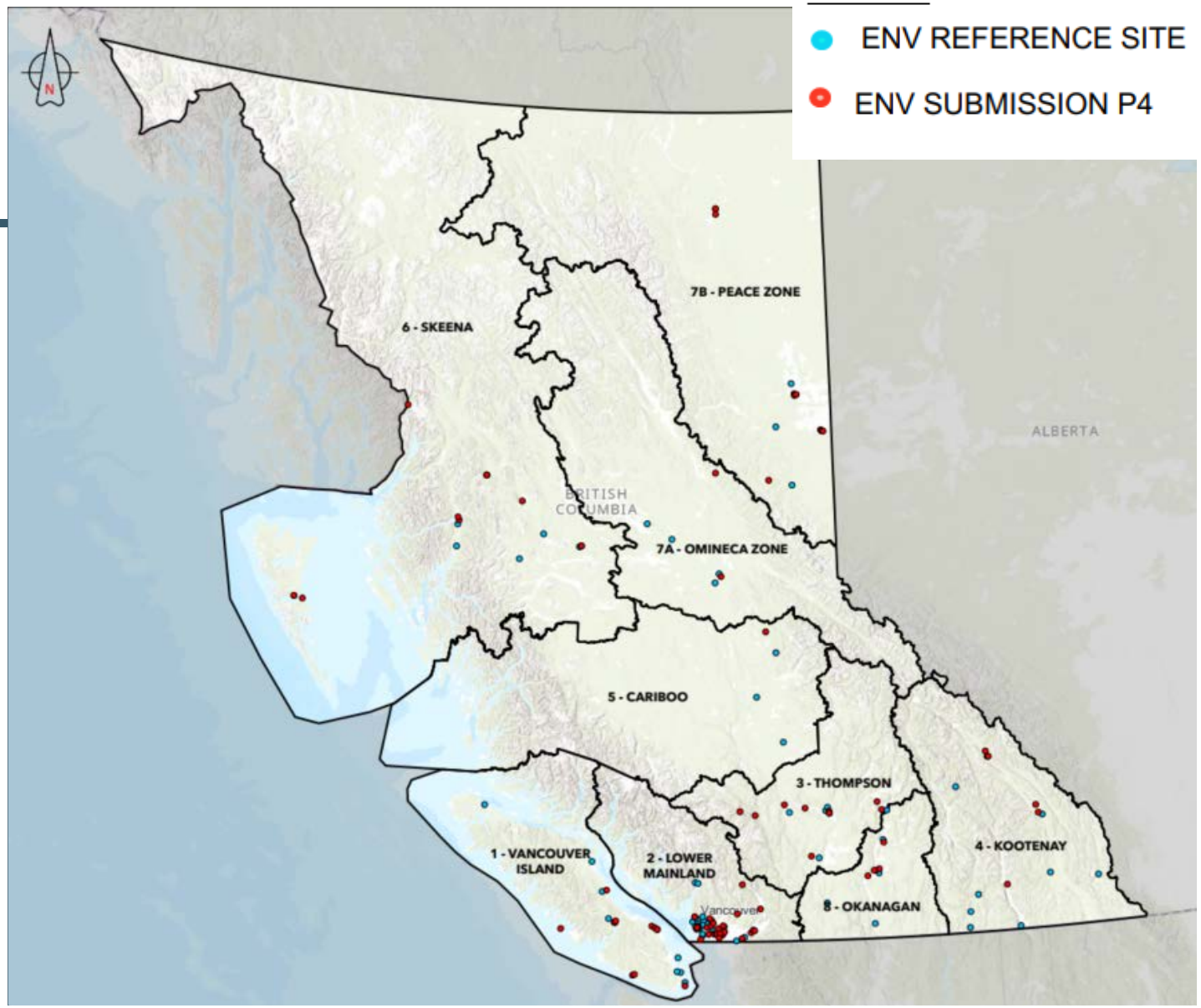
- Option 2
  - In-situ background sampling at appropriate reference site
  - Must be comparable to subject site
  - Can be augmented with ENV data base data (Option 2a)
- This option requires submission to ENV with detailed rationale



ENV Applications Background Metals

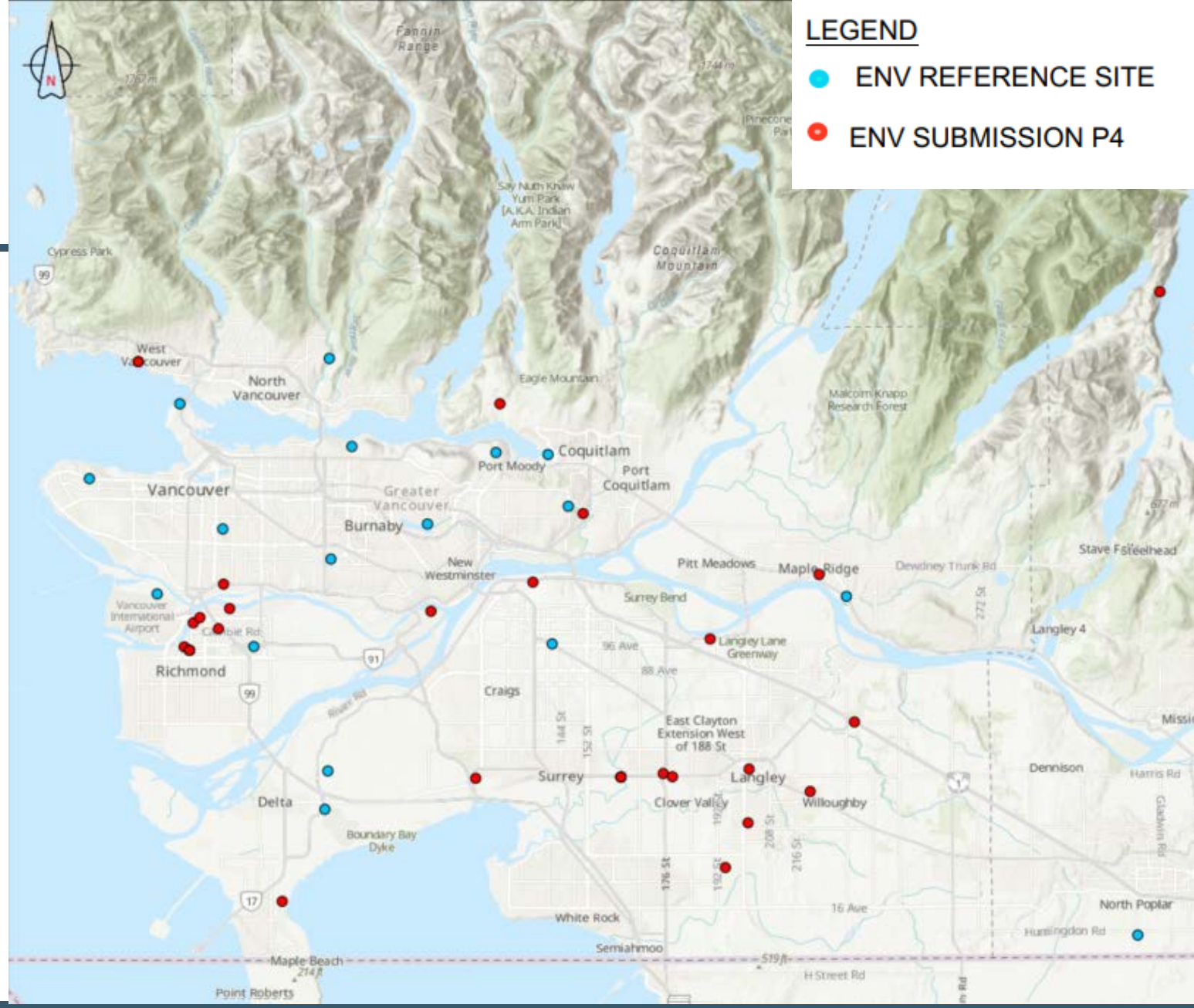
ENV Submissions - Option 2

- Records from both CSAP and ENV were reviewed
  - Broken out by Region and by metals parameter
  - 142 Submissions to date
- Limitations
  - Review did not capture soil stratigraphy or surficial geology present

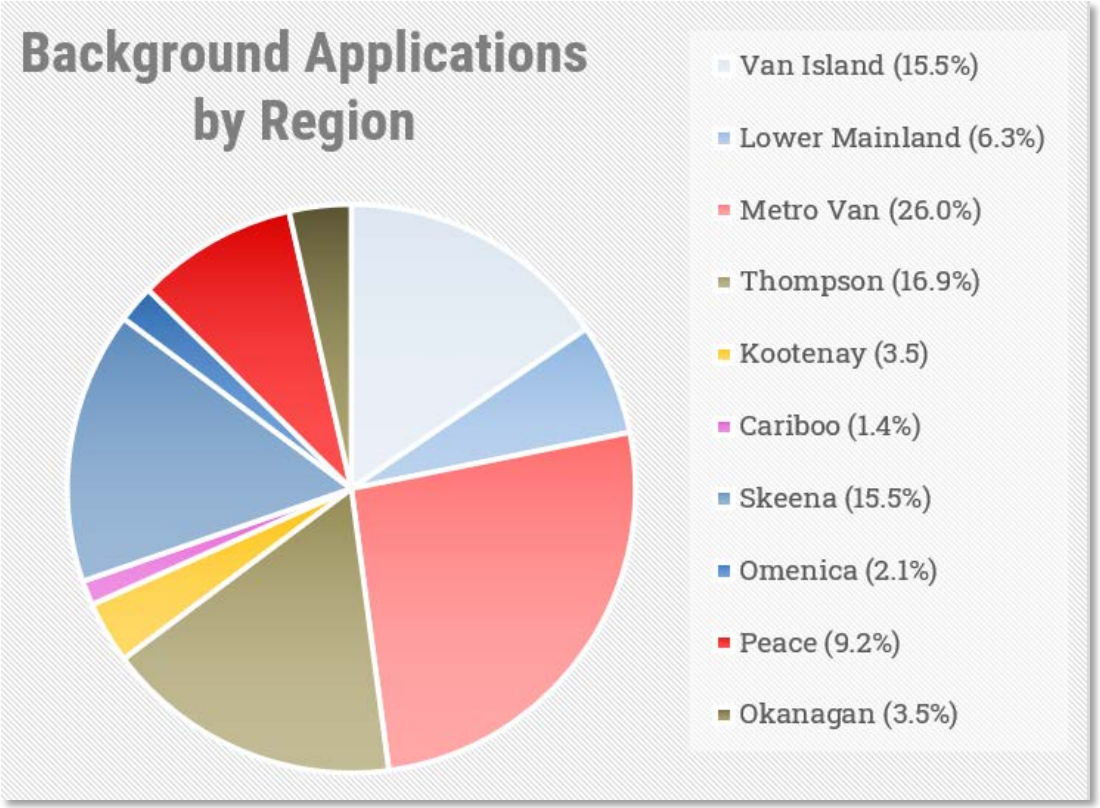


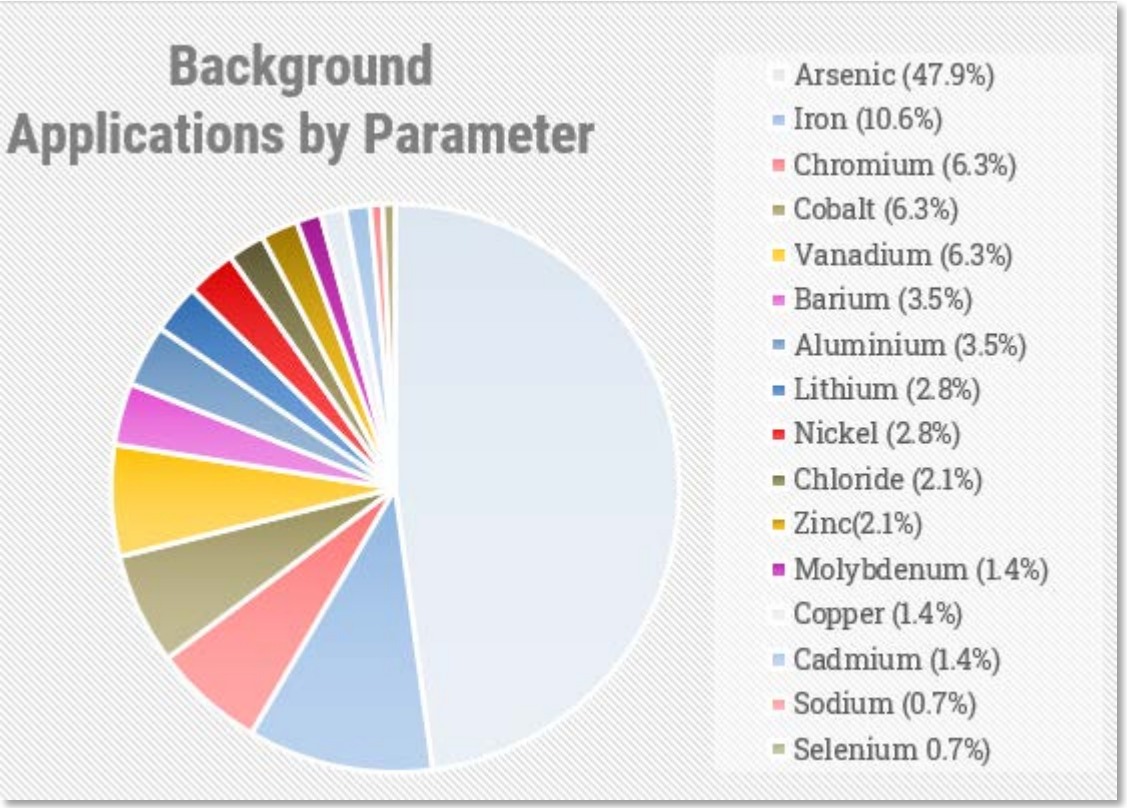
ENV Applications Lower Mainland

- Closer look at the Metro Van

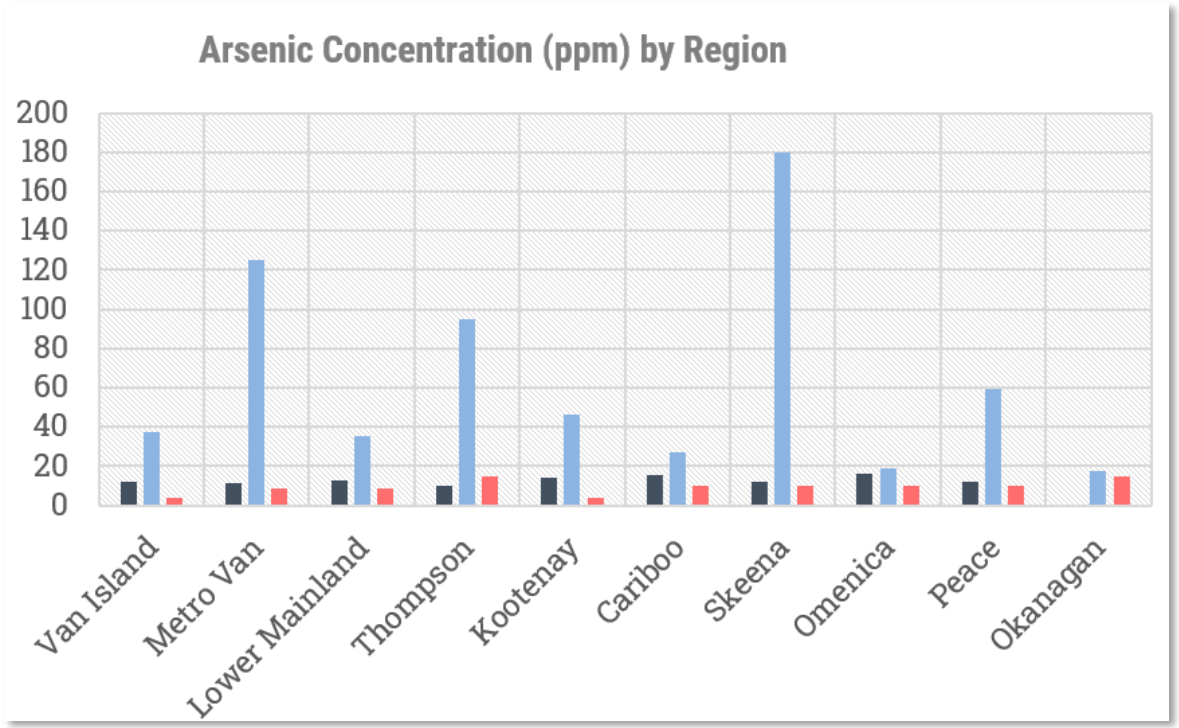


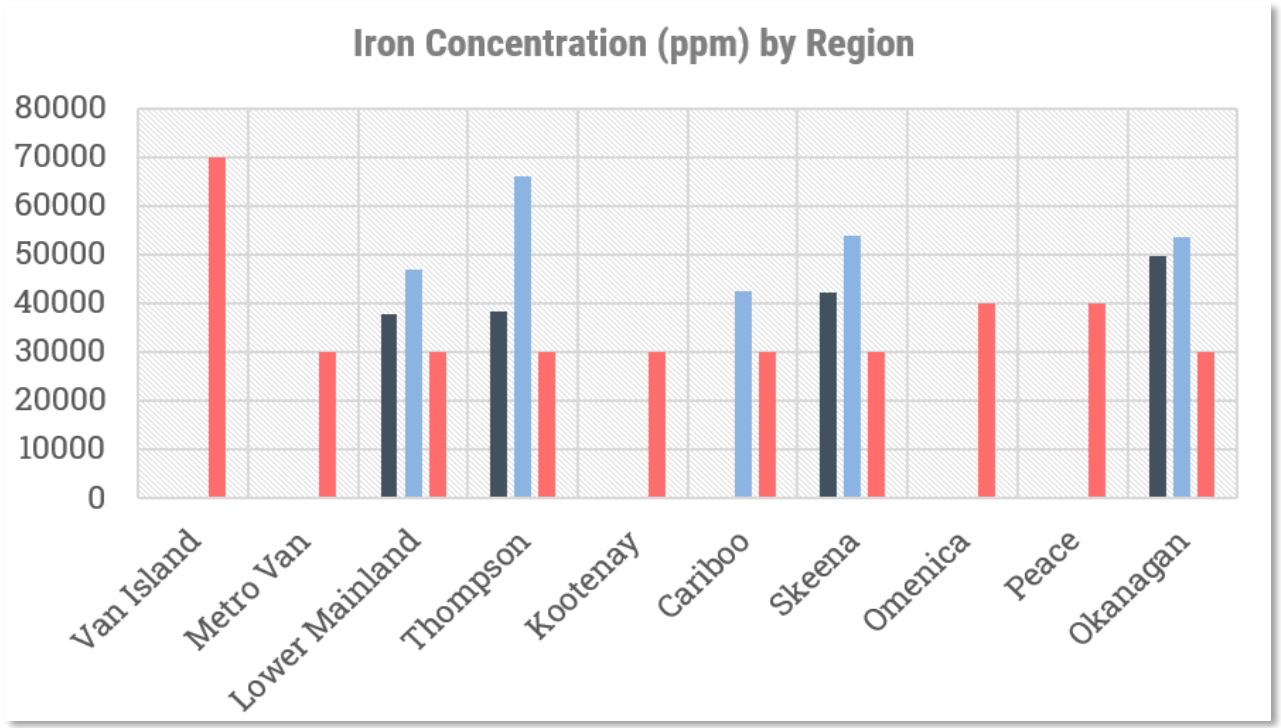
Summary of P4 Submissions to ENV





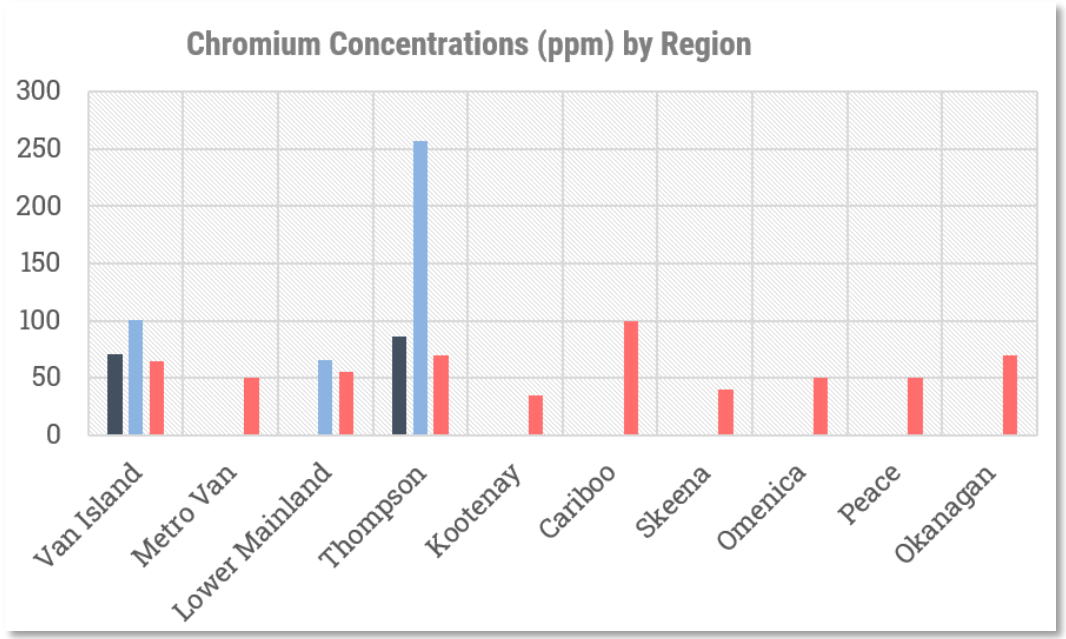
Problematic Metals and Ranges

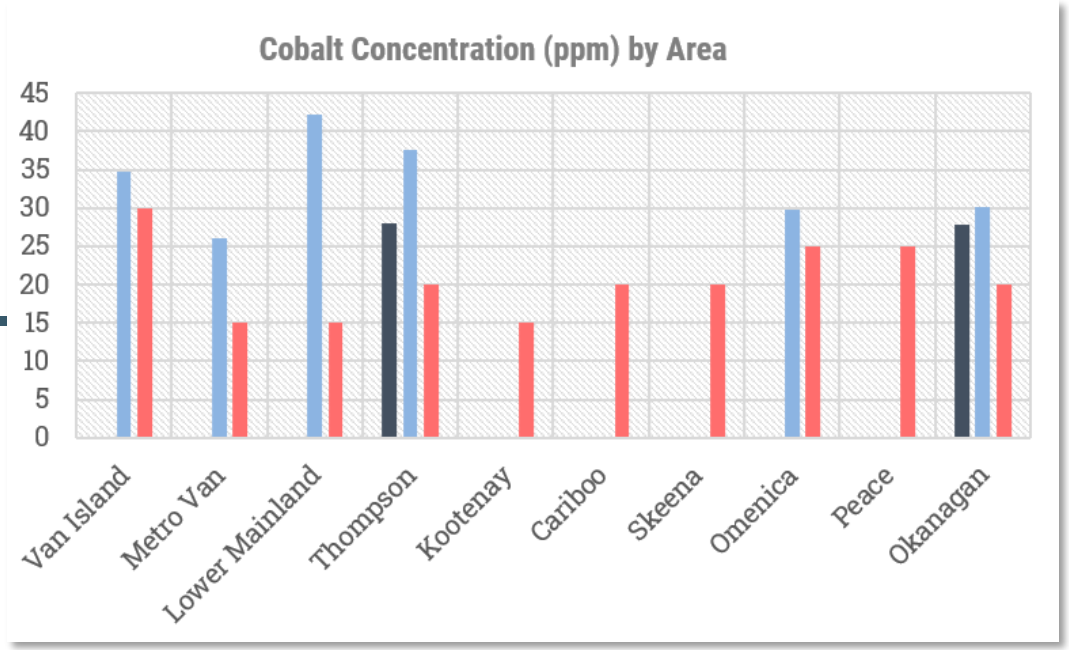


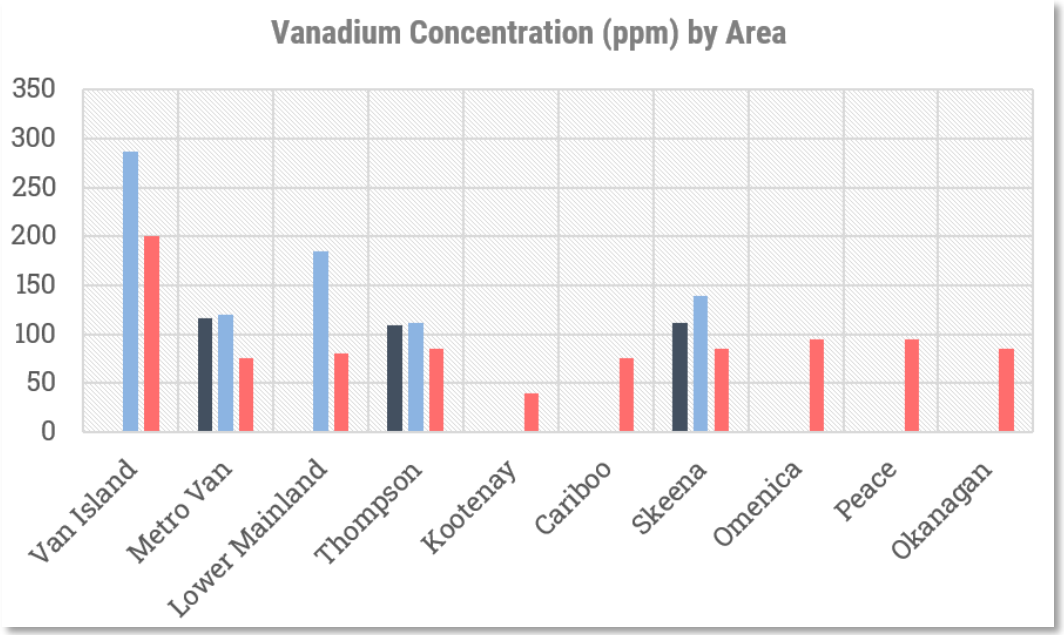


Min. Value Max. Value Table 1 Value

Problematic Metals and Ranges







Protocol 4 Summary

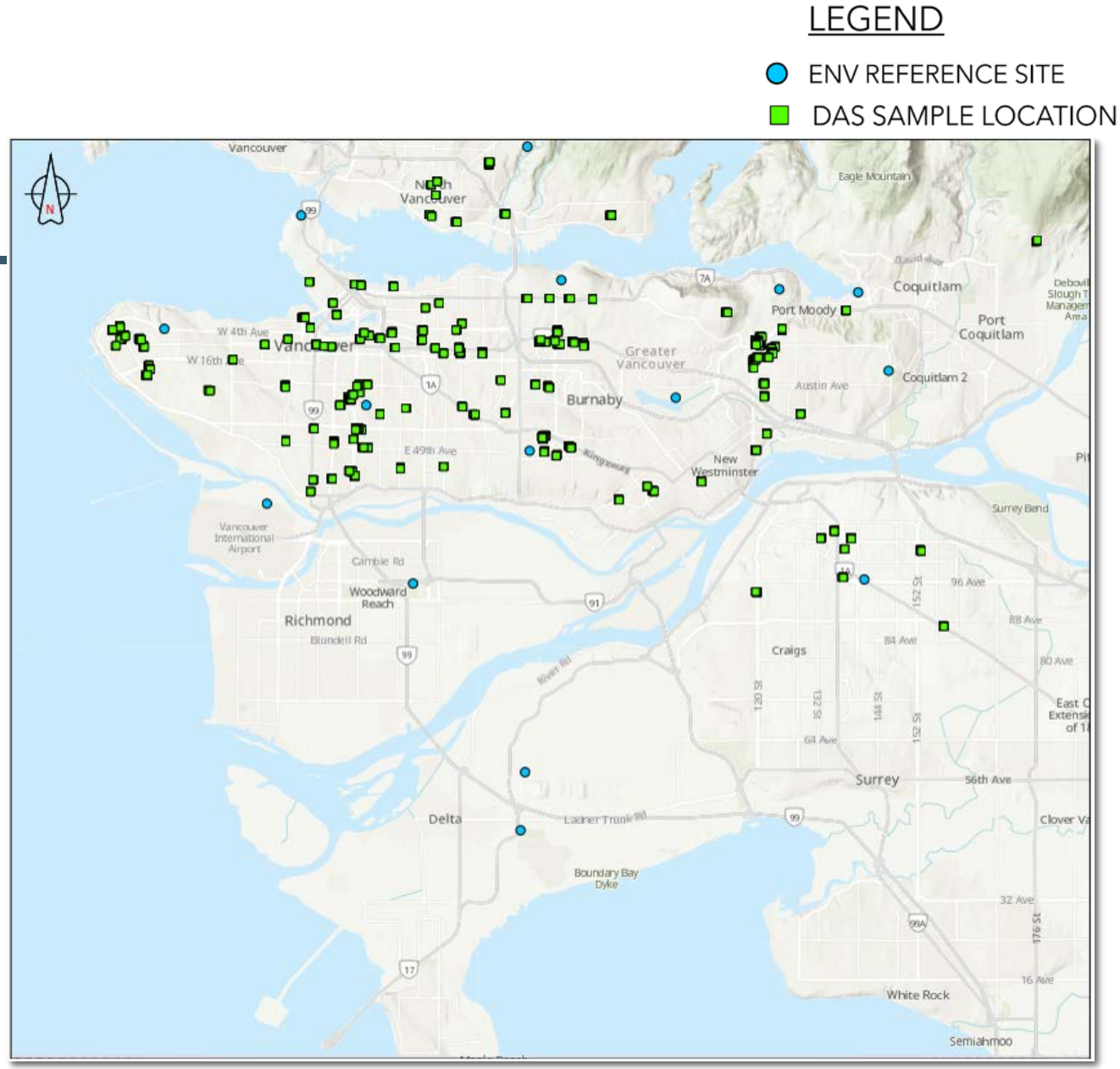
- Minimal data collection used for basis of current Table 1 values
- More detailed studies and more evaluation in other jurisdictions
- Increased number of submissions
- Yes! Arsenic is a problem

TABLE D - ENV APPROVED BACKGROUND CONCENTRATIONS BY AREA AND PARAMETER

Parameter	Van Island	Lower Mainland	Metro Van	Thompson	Kootenay	Cariboo	Skeena	Omenica	Peace	Okanagan	Total
Arsenic	10	5	21	3	4	1	10	2	11	1	68
Aluminum	-	1	2	1	-	-	1	-	-	-	5
Barium	1	-	-	2	-	-	-	-	2	-	5
Cadmium	-	-	-	-	-	-	2	-	-	-	2
Chromium	4	-	1	4	-	-	-	-	-	-	9
Chloride	1	-	2	-	-	-	-	-	-	-	3
Cobalt	1	1	1	3	-	-	-	1	-	2	9
Copper	1	1	-	-	-	-	-	-	-	-	2
Iron	-	-	5	2	-	1	5	-	-	2	15
Lithium	2	-	-	1	1	-	-	-	-	-	4
Molybdenum	-	-	1	1	-	-	-	-	-	-	2
Nickel	1	-	-	3	-	-	-	-	-	-	4
Selenium	-	-	-	1	-	-	-	-	-	-	1
Sodium	-	-	1	-	-	-	-	-	-	-	1
Vanadium	1	1	2	3	-	-	2	-	-	-	9
Zinc	-	-	1	-	-	-	2	-	-	-	3
Total	**22**	**9**	**37**	**24**	**5**	**2**	**22**	**3**	**13**	**5**	**142**

Disposal at Sea (DAS) Database

- Disposal at Sea is a federally regulated permit system for disposal of non-hazardous substances into allocated off-shore locations
- DAS soil permits require material to be chemically inert, inorganic and undisturbed
- Soil suitability is determined through a sequential process
- DAS database contains approximately 1,400 samples within Region 2 and Metro Vancouver



DAS Database – Advantages and limitation

- Good approximation to naturally occurring 'undisturbed' soil
- The database has a significant size and contains useful supplemental data (9x size of the currently used P4 data for Region 2)
- Covers a range of 8 different surficial geology (sub-)classes
- Limited to Region 2 and Metro Vancouver
- Some parameters (Iron) are not regulated for DAS

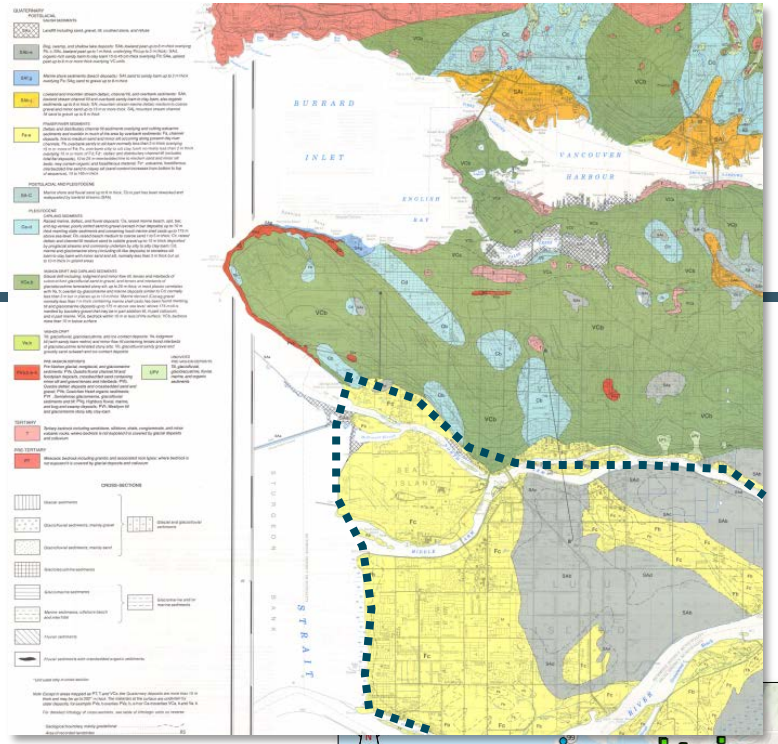
Parameter	Disposal at Sea Screening Criteria (mg/kg)			CSR Standards (mg/kg)	
	CCME Marine ISQG Guidelines	CEPA			
		Disposal at Sea Screening Concentrations	Point Grey Background	Residential Low-Density	Residential High-Density
Arsenic (As)	7.24	-	-	10	10
Cadmium (Cd)[1)]	-	0.6	-	1 3 20 30	1 3 20 40
Chromium (Cr)	52.3	-	-	60	60
Copper (Cu)[1]	-	-	31.7	75 100 150	75 100 300
Lead (Pb)	30.2	-	-	120	120
Mercury (Hg)	-	0.75	-	10	25
Zinc (Zn)[1]	124	-	-	150 200	150 200

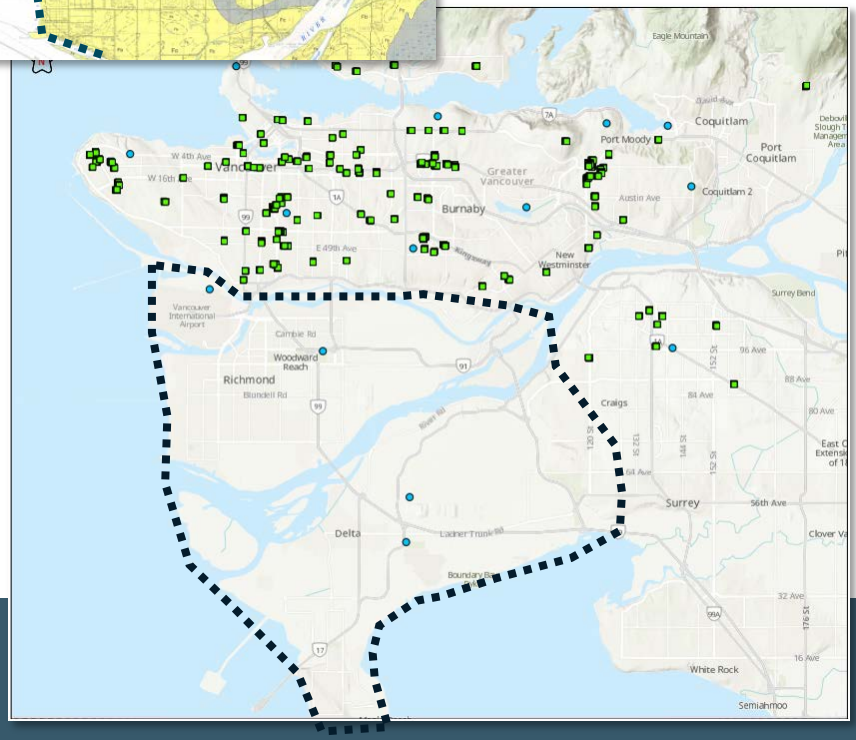
DAS Database

- DAS data includes more than just the metal concentrations – grain size!
- Surficial geology class was matched based on Lat/Lon

Following compilation of the database, we explored two pathways:

1. *Background concentrations based on DAS data compared to current Region 2/Metro Van background concentrations*
2. *Background concentrations based on DAS data for each major surficial geology class*





Results – Background concentrations based on DAS

- 95th Percentile of the DAS data are generally lower than the current standards for Region 2 and/or Metro Vancouver
- 95th Percentile for **Barium, Beryllium, Cadmium, Mercury, Nickel** and **Strontium** are higher than Region 2 and/or Metro Van background concentrations

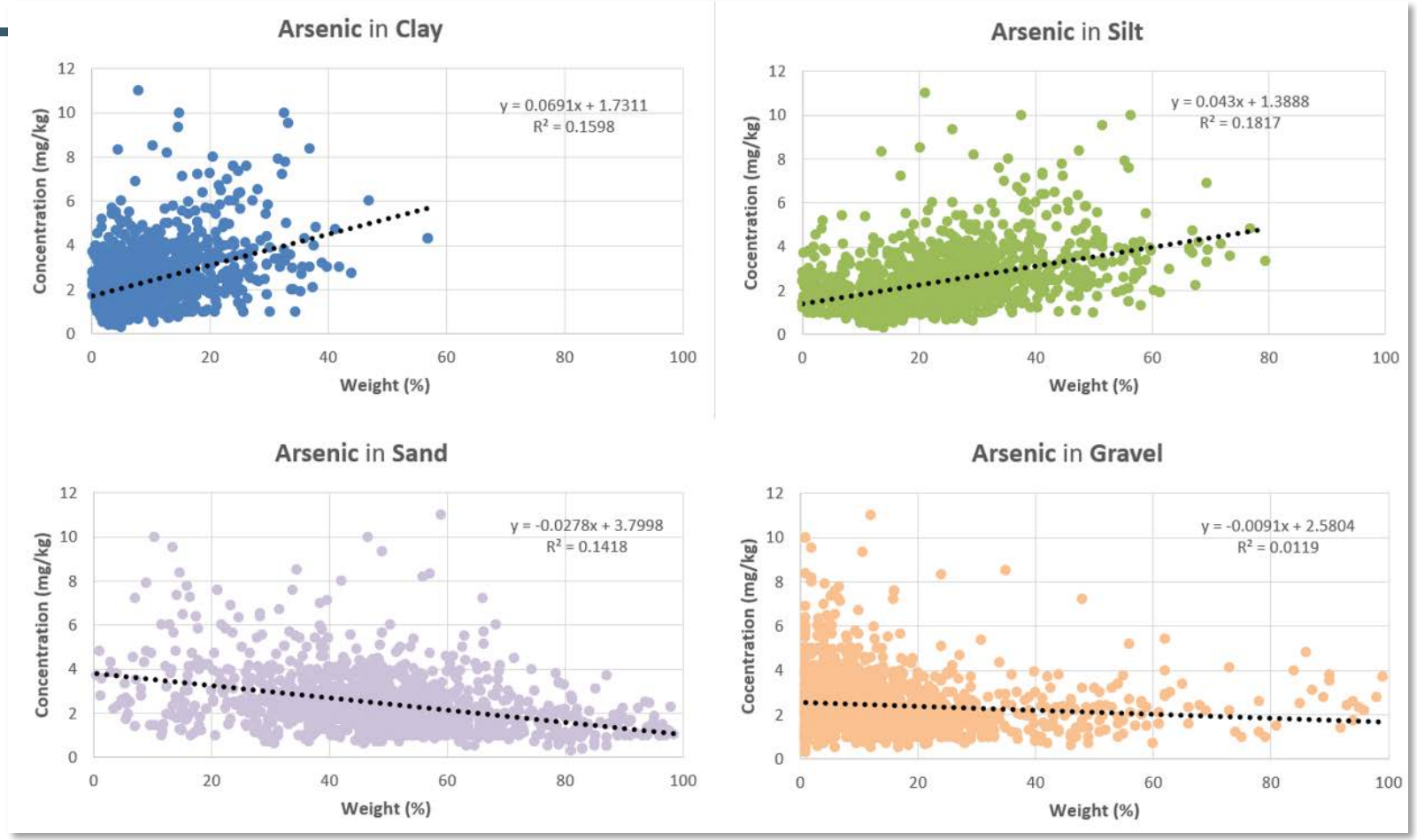
Parameter	Region 2 – Lower Mainland Background concentration (mg/kg)	Metro Vancouver Background concentration (mg/kg)	Number of samples in DAS Database	DAS Derived Background Concentration (95th percentile, in mg/kg)*
Aluminum (Al)	35,000	35,000	18	**15,400**
Antimony (Sb)	4	4	1347	**1**
Arsenic (As)	8.5	8.5	1388	**5**
Barium (Ba)	150	90	1347	**133**
Beryllium (Be)	0.7	0.7	1338	**1**
Boron (B)	1	1	38	**0.6**
Cadmium (Cd)	0.4	0.4	1365	**0.5**
Chromium (Cr)	55	50	1376	**30**
Cobalt (Co)	15	15	1347	**12**
Copper (Cu)	75	150	1415	**35**
Iron (Fe)	30,000	30,000	0	-
Lead (Pb)	200	300	1375	**6.1**
Manganese (Mn)	900	1,000	24	**419**
Mercury (Hg)	0.3	0.35	1348	**0.5**
Molybdenum (Mo)	4	6	1347	**0.6**
Nickel (Ni)	75	40	1347	**54**
Selenium (Se)	4	4	1347	**0.5**
Silver (Ag)	1	1	1347	**0.5**
Strontium (Sr)	60	55	544	**67**
Thallium (Tl)	-	-	1346	**0.5**
Tin (Sn)	4	4	1335	**0.5**
Vanadium (V)	80	75	1349	**71**
Zinc (Zn)	100	90	1373	**63**

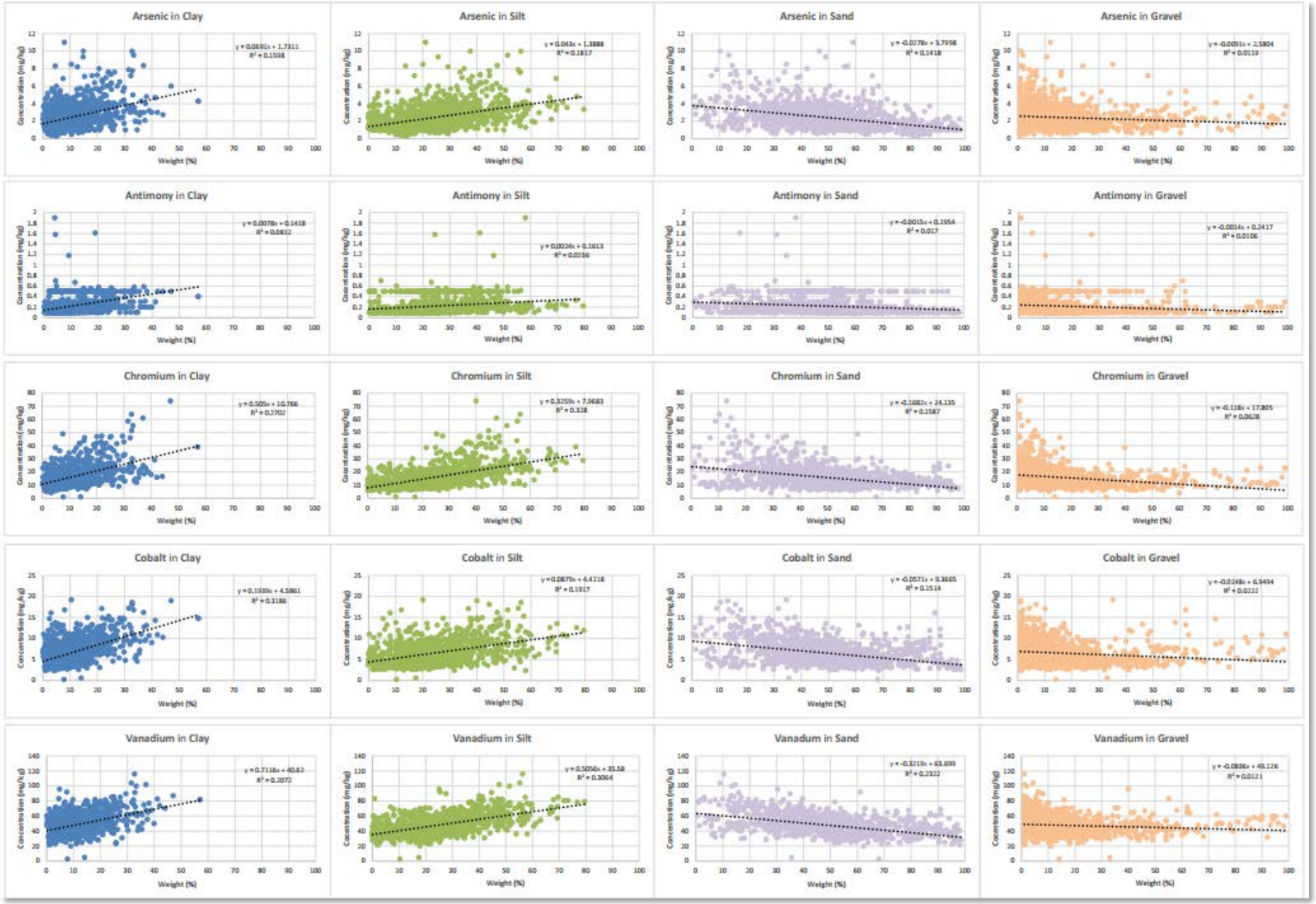
* Values in red indicate the metals where the derived DAS Background Concentration is higher than the Background concentration for Region 2 and/or Metro Vancouver.

Results – Grain Size Considerations

Concentrations for metals:

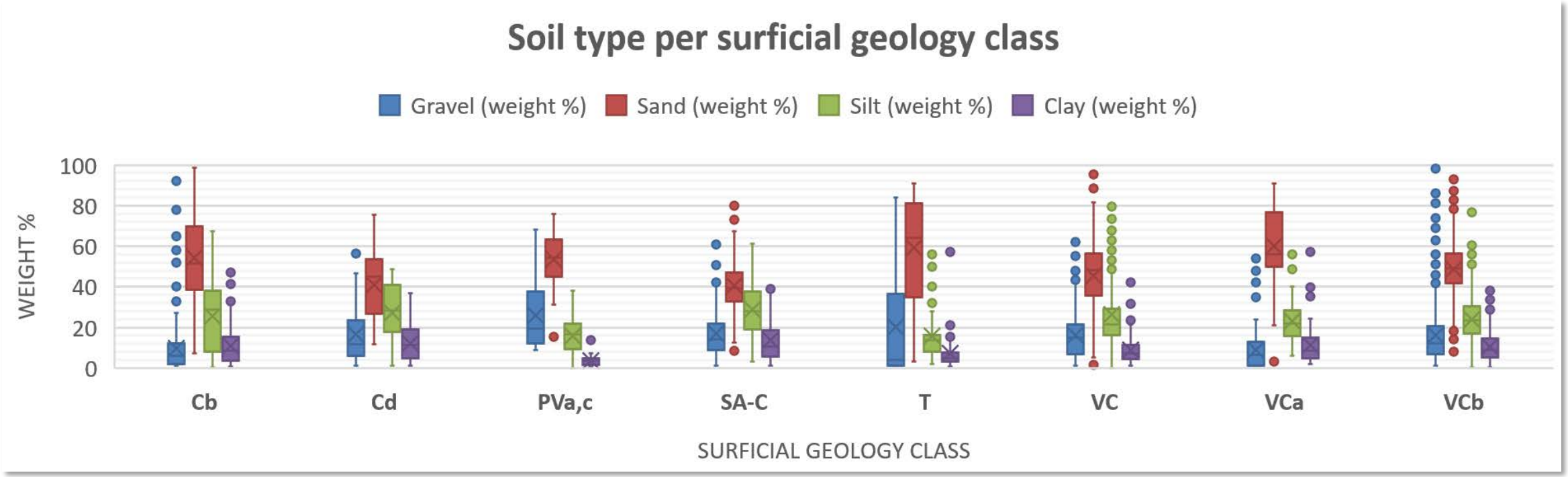
- Higher in samples with higher weight percentages of clay and silt
- Lower in samples with higher weight percentages of sand and gravel.




Arsenic in Clay
Arsenic in Silt
Arsenic in Sand
Arsenic in Gravel
Antimony in Clay
Antimony in Silt
Antimony in Sand
Antimony in Gravel
Chromium in Clay
Chromium in Silt
Chromium in Sand
Chromium in Gravel
Cobalt in Clay
Cobalt in Silt
Cobalt in Sand
Cobalt in Gravel
Vanadium in Clay
Vanadium in Silt
Vanadium in Sand
Vanadium in Gravel
Concentration (mg/kg)
Weight (%)

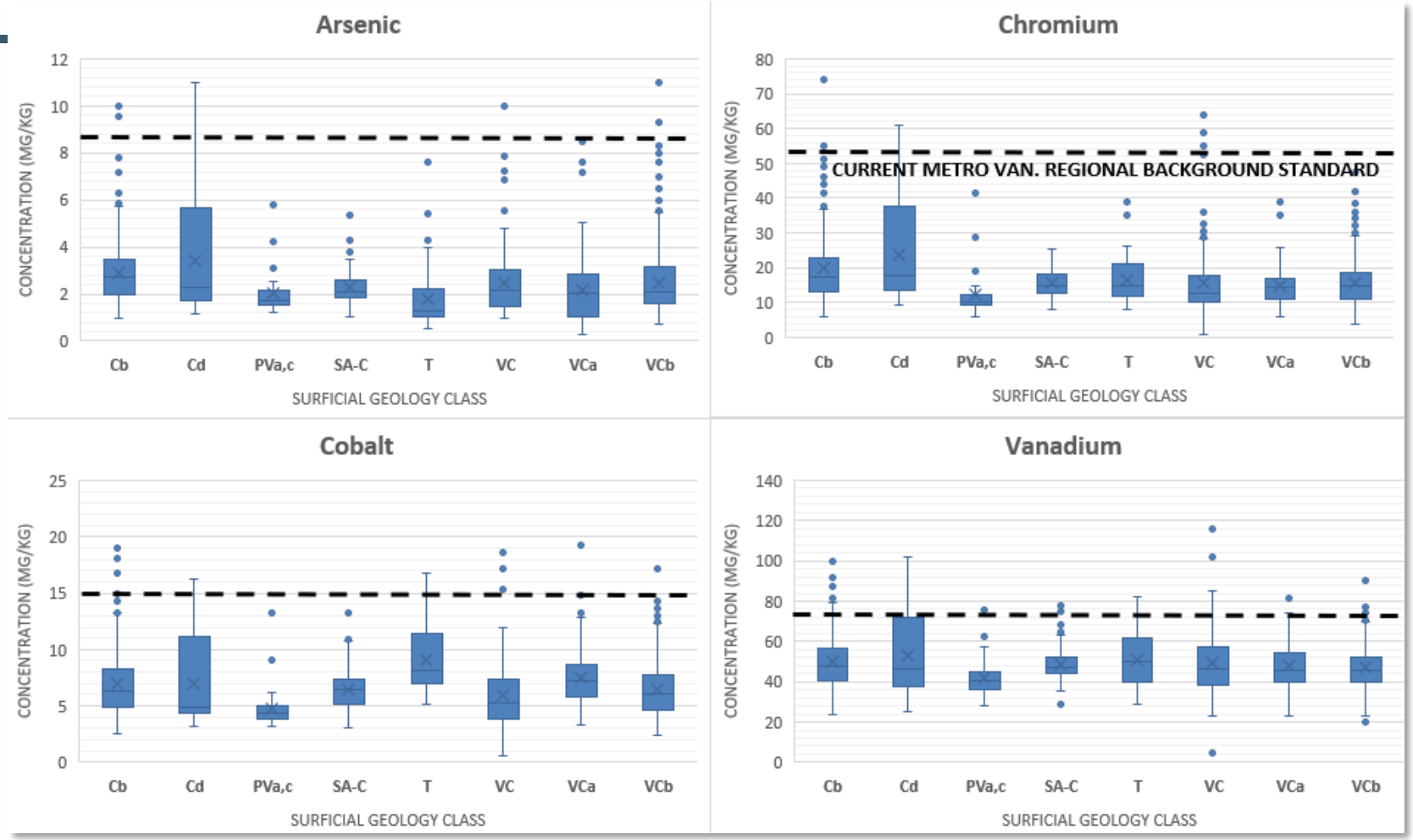
Results – Surficial geology class

The DAS database covered a total of 8 surficial classes, including Capilano Sediments **(C)**, Pre-Vashon Deposits **(PV)**, Salish Sediments **(SA)**, (Pre-)Tertiary bedrock **(T)** and Vashon Drift and Capilano Sediments **(VC)**



Results – Surficial geology class

- We also compared the metal concentration distributions for problematic metals to their current background concentrations



Background Concentrations per Surficial Geology Class

Surficial Geology Background Concentrations:

- **Barium, Cadmium, Mercury, Strontium** and **Vanadium** are higher than the current Region 2 and/or Metro Vancouver background concentrations
- The results show significant discrepancies in metal concentrations between surficial geology classes – i.e., Arsenic in Capilano sediments is 68% higher than in Salish sediments

Parameter	Region 2 – Lower Mainland Background concentration (mg/kg)	Metro Vancouver Background concentration (mg/kg)	Vashon Drift and Capilano Sediments – VC (VC, VCa and VCb)	Capilano Sediments – C (Ca, Cb and Cd)	Salish sediments – SA (SAa, SA-C, SAh, SAi)	Tertiary Bedrock - T
			942 samples	225 samples	152 samples	62 samples
Antimony (Sb)	4	4	0.5	0.5	0.5	0.5
Arsenic (As)	8.5	8.5	4.7	6.4	3.8	4.3
Barium (Ba)	150	90	137.2	128.7	114.2	115.8
Beryllium (Be)	0.7	0.7	0.5	0.5	0.5	0.5
Cadmium (Cd)	0.4	0.4	0.5	0.2	0.5	0.2
Chromium (Cr)	55	50	28.2	46.1	23	26.1
Cobalt (Co)	15	15	11.1	13.1	10.7	14.7
Copper (Cu)	75	150	34.1	37.4	28.4	34.9
Lead (Pb)	200	300	6.1	5.3	6.1	8.8
Mercury (Hg)	0.3	0.35	0.5	0.04	0.5	0.03
Molybdenum (Mo)	4	6	0.5	0.6	1.1	2
Nickel (Ni)	75	40	20.7	32.3	16.9	20.8
Selenium (Se)	4	4	0.5	0.5	0.5	0.5
Silver (Ag)	1	1	0.5	0.5	0.5	0.5
Strontium (Sr)	60	55	69.7	68.5	55.6	44.1
Thallium (Tl)	-	-	0.5	0.5	0.5	0.5
Tin (Sn)	4	4	0.5	0.04	0.5	0.03
Vanadium (V)	80	75	70	79.7	66.6	71.2
Zinc (Zn)	100	90	60	60	71	79.2

DAS results – overall results

- The background concentrations for metals derived using the DAS data, show overall higher background concentrations for **Barium, Cadmium, Mercury, Strontium** and **Vanadium** and lower background concentrations for other metals, including metals frequently requiring approvals from ENV (i.e., **arsenic, chromium, cobalt**)
- The soil grain size results show higher metal concentrations for all metals in finer soils (silts and clays) and lower metal concentrations in coarser soils (sands and gravels). The different surficial geology classes show significantly different grainsize distributions
- Some regions (Richmond, Delta etc.) and surficial geology classes (Fraser River Sediments) remain underrepresented (or not represented at all) in the database, hence outliers in those regions would not be captured in the current data

Recommendations & Conclusions

- Current Protocol 4 Table 1 values are based on a relatively small data set with large percentage of data points being <MDL and collected over 30 years ago
- As more data is acquired updating of database should be considered
  - Augment current dataset with ENV submissions and potential other data sources
  - Evaluate regional boundaries with geology and surficial geology classes
  - Add grain size, soil type and regional geology to submission database
  - Consider subregions within existing boundaries to recognize enriched areas (Arsenic in Richmond)
- Alternative statistical value for background threshold
- Finer materials (clays, weather materials, sediment contribute to elevated background values (particularly arsenic)

Recommendations & Conclusions

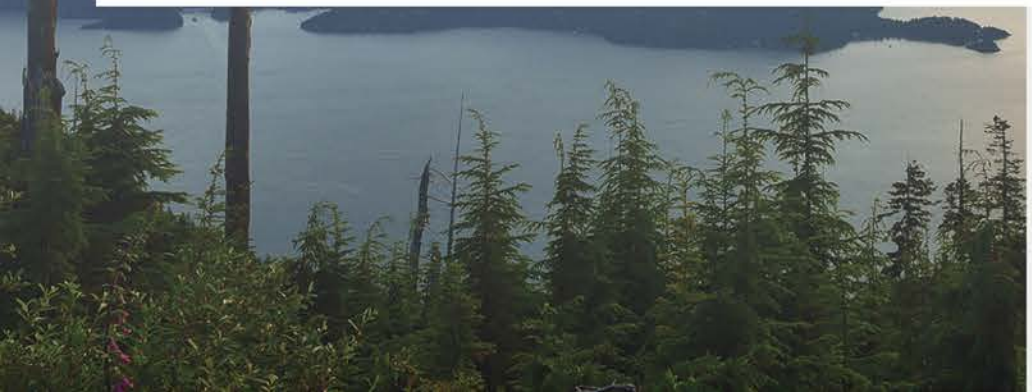
- We understand that CSAP and the TRC are expanding on this study with an additional initiative this year
- Focus to be on the Lower Mainland for further review using additional data from ENV and other sources

CSAP

SOCIETY OF CONTAMINATED SITES
APPROVED PROFESSIONALS
OF BRITISH COLUMBIA

Background Groundwater Concentrations in BC

Aio Haberli, M.Sc., P.Chem., CSAP
PGL Environmental Consultants



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solve & simplify™

Background Groundwater Concentrations in BC

CSAP TRC Project

Land Acknowledgement

We are gathering on the unceded and ancestral territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh) Nations.

PGL Project Team

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External

Insights into 2018 Project…

Stephen Munzar (Core6 Environmental)

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Content

2018 background study – recap

2024 background study

- Scope and goals
- Methodology
- Results
- Recommendations

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2018 Background Study

ENV identified 5 regions of interest to attempt establishing background in groundwater...

- ✓ urban centers with plenty of Site IDs and *potential* suitable sites
- ✓ surficial geology thoroughly characterized
- ✓ abundance of P9s

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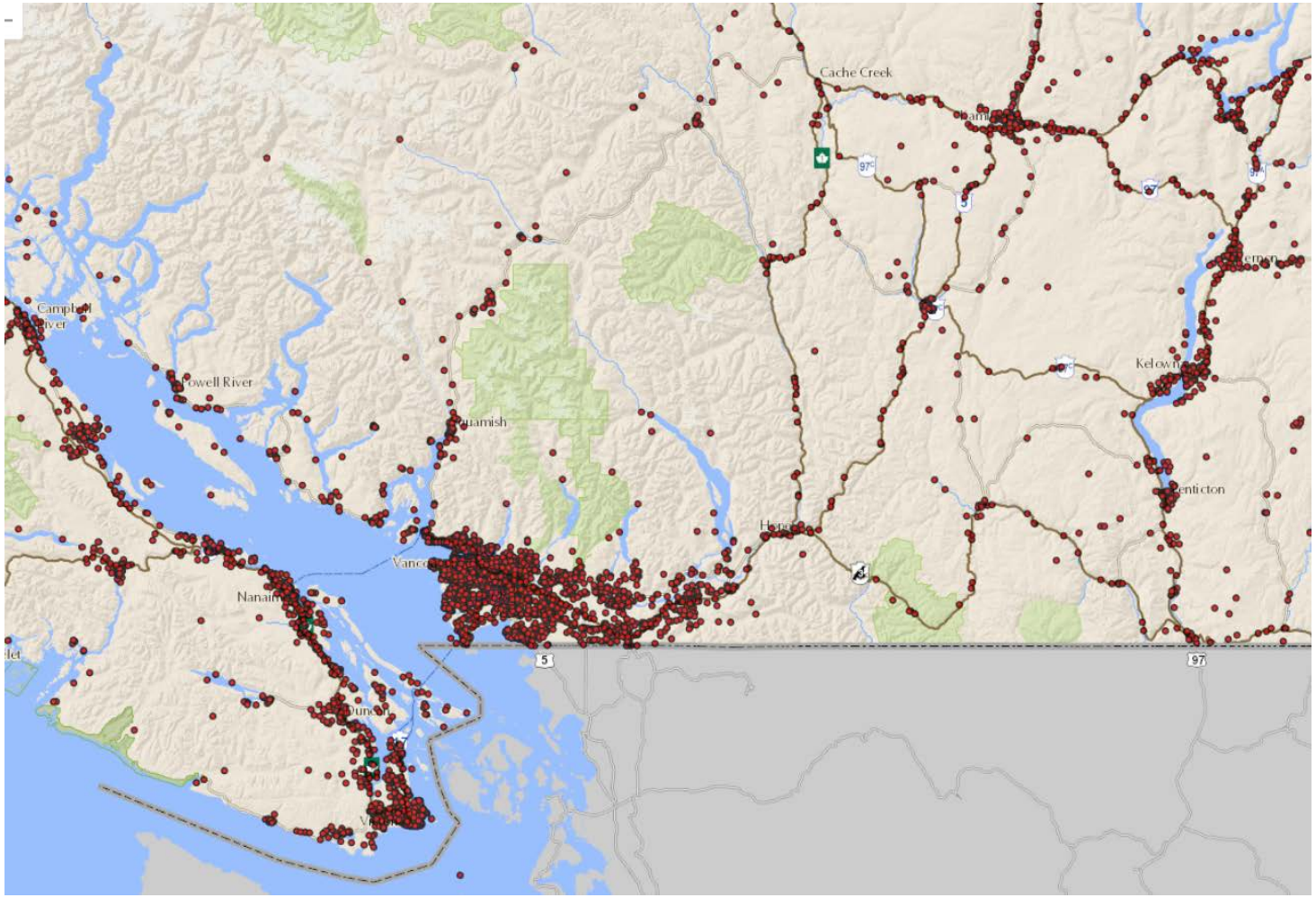
2018 Background Study



✓ Site IDs

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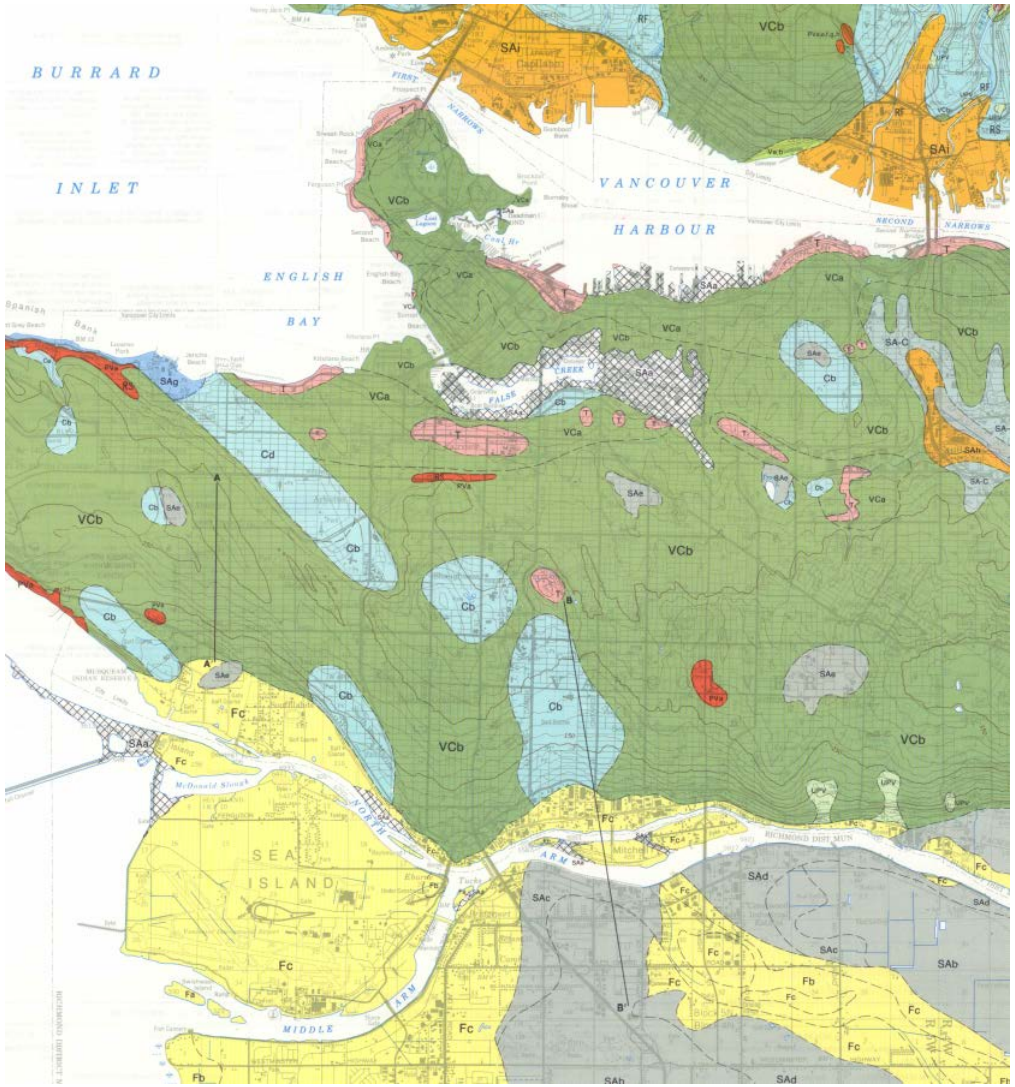
2018 Background Study



✓ surficial geology

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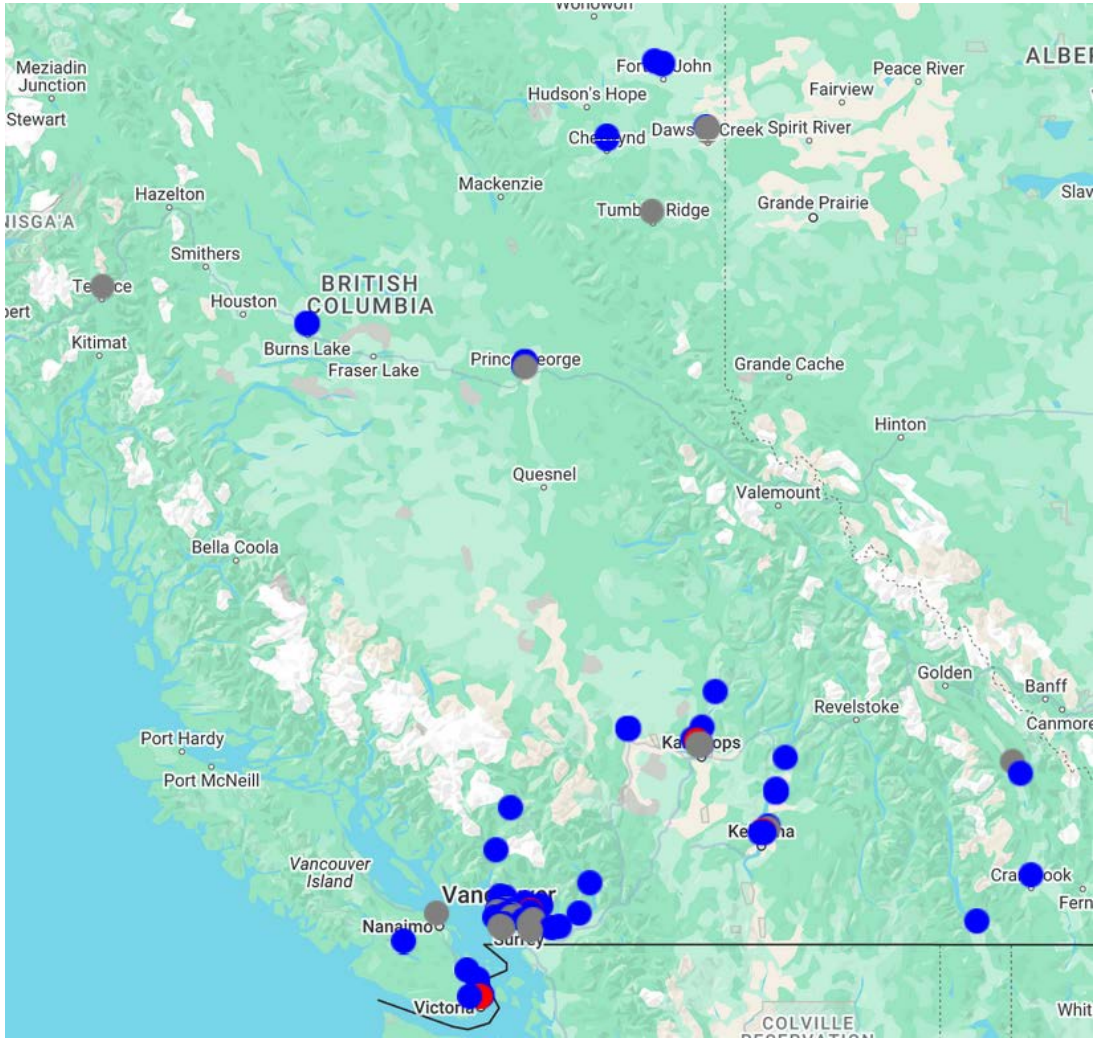
2018 Background Study



✓ P9s (CSAP webmap)

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2018 Background Study

Robust dataset in 3 existing regions

Region	Sub-region	Protocol 9 Sites		Determinations		Contaminated Sites		Total Sites	
		With reports	Used	With reports	Used	With reports	Used	With reports	Used
Lower Mainland	Sub-region 1	41	24	49	22	n/a	20	180	**80**
	Sub-region 2					90	19		
Thompson - Okanagan	(Kamloops)	10	3	6	5	30	2	46	**23**
	(Kelowna)	5	2	4	4	31	7	40	
South Vancouver Island	-	6	3	3	1	70	26	79	**30**
Northeast BC (Fort St. John / Dawson Creek)	-	4	4	1	0	5	4	10	**8**
Prince George	-	2	2	1	1	3	1	6	**4**
Total		**68**	**38**	**64**	**33**	**229**	**84**	**361**	**155**

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2018 Background Study

Insufficient background sites (n<10) in two regions

Region	Sub-region	Protocol 9 Sites		Determinations		Contaminated Sites		Total Sites	
		With reports	Used	With reports	Used	With reports	Used	With reports	Used
Lower Mainland	Sub-region 1	41	24	49	22	n/a	20	180	**80**
	Sub-region 2					90	19		
Thompson - Okanagan	(Kamloops)	10	3	6	5	30	2	46	**23**
	(Kelowna)	5	2	4	4	31	7	40	
South Vancouver Island	-	6	3	3	1	70	26	79	**30**
Northeast BC (Fort St. John / Dawson Creek)	-	4	4	1	0	5	4	10	**8**
Prince George	-	2	2	1	1	3	1	6	**4**
Total		**68**	**38**	**64**	**33**	**229**	**84**	**361**	**155**

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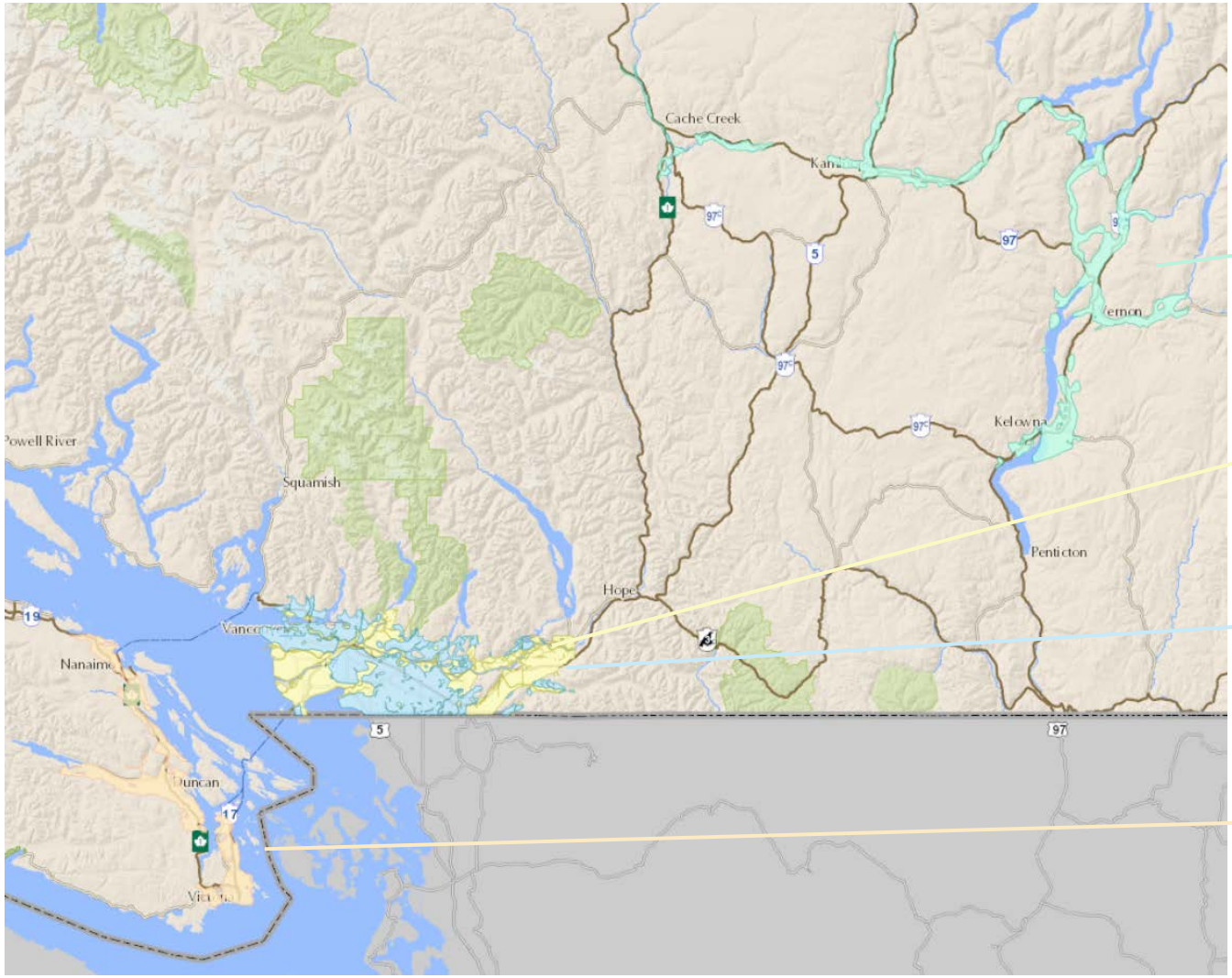
2018 Background Study



Established 3 background regions

Thompson - Okanagan

Lower Mainland
SR 1 (fluvial lowlands)

Lower Mainland
SR 2 (glacial uplands)

South Vancouver Island

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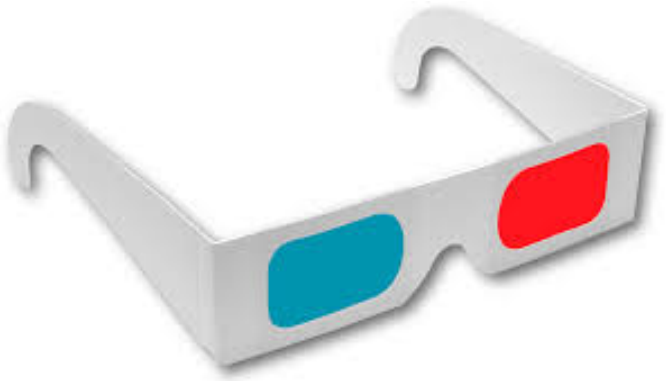
2018 Background Study



Lower Mainland
SR 1 (fluvial lowlands)

Lower Mainland
SR 2 (glacial uplands)

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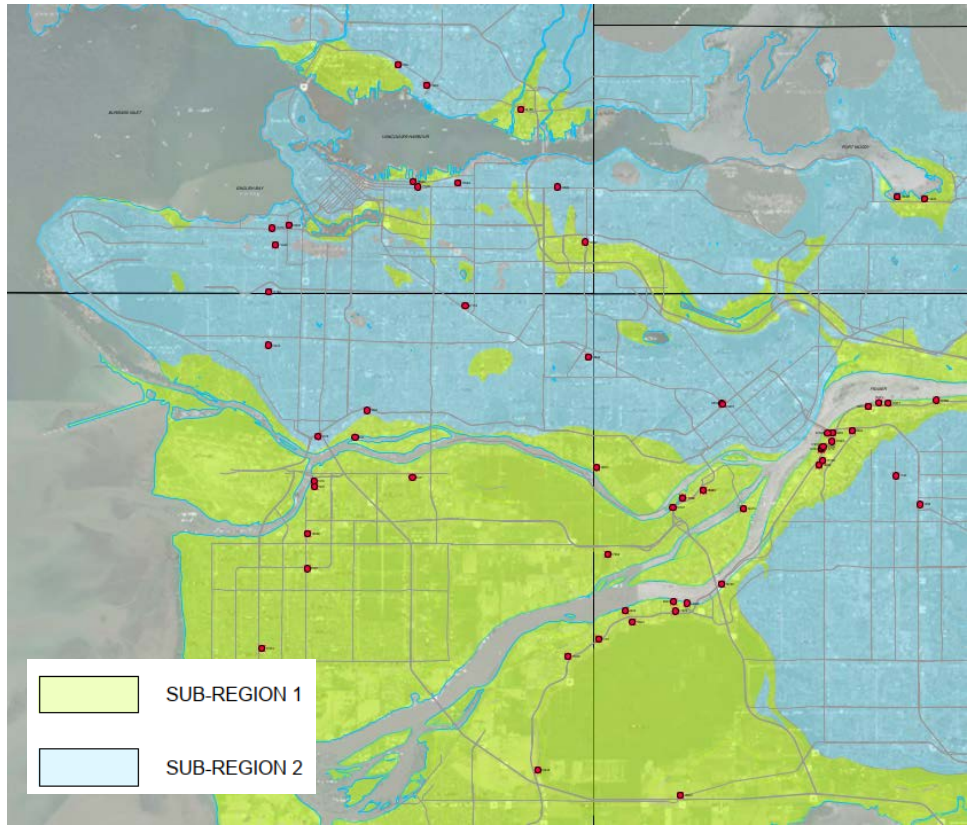
2018 Background Study



It is important to consider that in many areas of the Lower Mainland, the Sub-Region 2 deposits underlie those of Sub-Region 1, and as such, consideration of site geology at depth should also be made when determining which regional background concentration should apply to a given site during an environmental investigation. Similarly, the shallow glacial deposits that make up Sub-Region 2 are commonly underlain by Pre-Vashon glacial sediments, which have been mapped as regional aquifers (e.g. Quadra Sands). These deposits are also in many cases the material targeted by domestic water wells as assessed in the Wilson et al. (2008) study. And due to their distinctly different chemistry as discussed in Section 3.6.2, data from these surficial geologic units have been removed from inclusion into the Sub-Region 2 dataset. Given that the regional background concentrations are distinctly different in the underlying aquifers compared to that of the overlying finer grained glacial deposits (often regarded to as aquitards), it is not recommended that

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Page 20

"in many areas of the Lower Mainland, Sub-region 2 deposits underlie those of Sub-region 1…"

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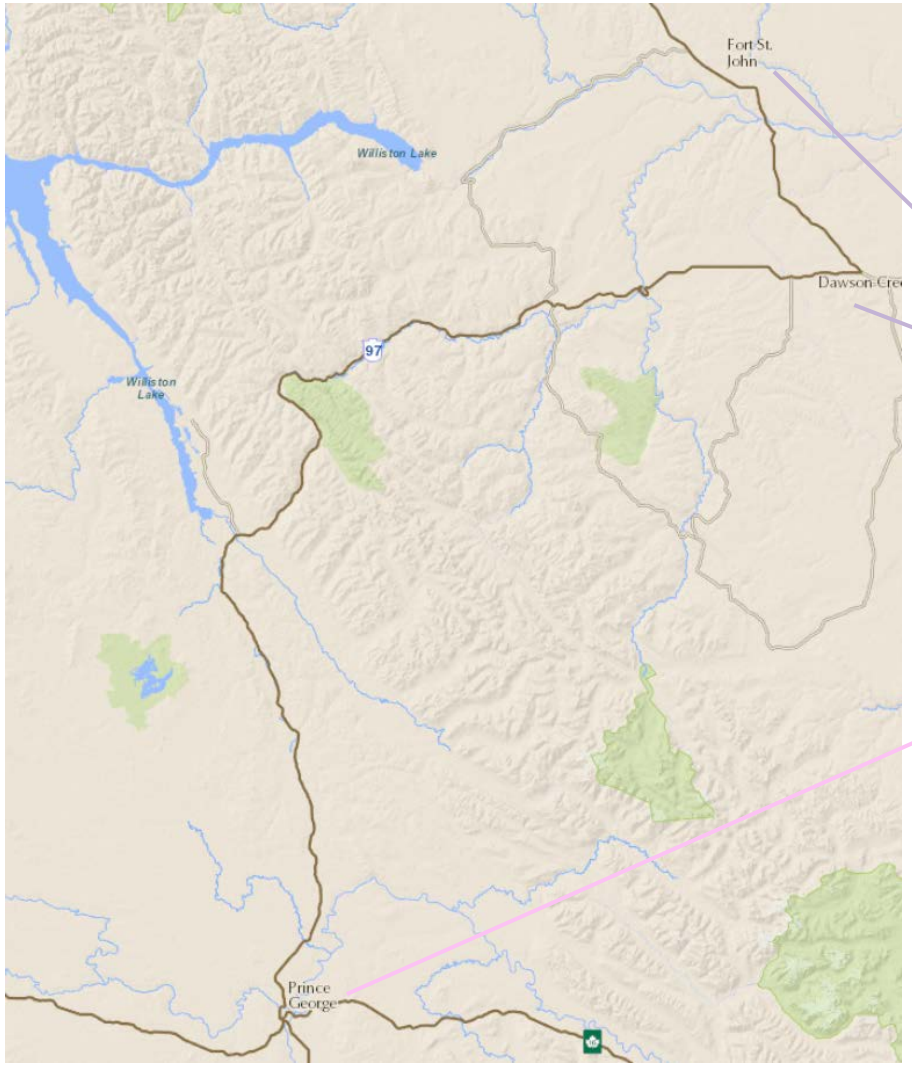
2018 Background Study



Additional sites needed for 2 regions

Northeast BC
(Fort St. John / Dawson Creek)

Prince George

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2018 Background Study

P9 - background concentrations greater than DW and/or AW

Table 1. Regional estimates for local background concentrations in groundwater for inorganic substances

Region	Lower Mainland Sub-Region 1	Lower Mainland Sub-Region 2	Thompson Okanagan Region	Southern Vancouver Island Region
Substance	Background concentration	Background concentration	Background concentration	Background concentration
Aluminum	330	180	230	110
Antimony	1.6	2.9	2.7	2.0
Arsenic	***38***	***13***	***13***	9.0
Barium	490	170	240	250
Beryllium	0.56	**3.3**	1.3	**2.0**
Boron	820	670	880	640
Cadmium	0.97	0.56	0.33	1.0
Chromium	**12**	3.9	**19**	3.0
Cobalt[2]	***62***	***18***	***16***	***14***
Copper	14	13	**32**	8.0

2024 TRC GW Background Project

CSAP RFP - Purpose

"natural background levels of metals in groundwater are still an issue at sites in other parts of the province including the Northeast BC Region and the Prince George Region"

"the purpose of this project would be to expand the dataset such that background concentrations for groundwater could potentially be developed for other regions of the province"

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2024 TRC GW Background Project

sulphate

lithium, sodium

cadmium, chloride, lithium, selenium, strontium, sodium, uranium, sulphate

manganese, selenium

lithium, uranium

2024 TRC GW Background Project

CSAP RFP – Tasks

1. Review the 2018 Background Study methodology used to identify suitable background sites
2. Identify additional sources of information for potential background sites (BCER, etc.)
3. Conduct additional searches of the Site Registry Database for potentially suitable background sites added since 2018
4. Conduct statistical evaluation of database
5. Prepare a summary report
6. Prepare presentation for CSAP event

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2024 TRC GW Background Project

Challenges

- File retrieval of hard copy reports resource intensive (ENV)

- Database scrubbing laborious (PGL)
  - validating Site ID locations
  - remove duplicate sites (affected parcels, cross reference 2018 study)
  - due diligence (spelling municipalities)
  - coding new regions (assign municipalities to areas of interest)
  - merging of 2 databases

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2024 TRC GW Background Project

Challenges

- Report reviews (& data extraction) time consuming (PGL)
- Adding data to established regions could change background values

➢ Adjustments due to budget and timeline constraints

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2024 TRC GW Background Project

Adjusted Scope & Goals

- ✗ No expansion of dataset for 3 established regions
- ✗ No data extraction from reports, no statistics

- ✓ Review methodology
- ✓ Communication with BCER
- ✓ Identify new sites for Prince George and NE BC, obtain and review reports to assess if sufficient suitable sites available to establish background
- ✓ Identify new areas of interest (AOIs) outside the footprint of the established 3 background regions

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Results

- Review Methodology

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Methodology

Methodology adopted from 2018 background study…

core6 ENVIRONMENTAL

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Issued: October 26, 2018
Revised: October 16, 2020

British Columbia Ministry of Environment and Climate Change Strategy
Land Remediation Section
Environment and Climate Change Strategy
2nd Floor, 10470 – 152 Street
Surrey, BC, V3R 0Y3

Re: Establishing Regional Background Groundwater Concentrations in British Columbia

1 INTRODUCTION

Recent (November 1st, 2017) release of the Stage 11 amendments to the Contaminated Sites Regulation have in many instances lowered the groundwater standard for several dissolved metals and metalloids,

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Methodology - Dataset

Identification of potential background sites for evaluation

- 'Filter' was developed by ENV to prepare dataset from Site Registry with Site IDs for further evaluation

- Site IDs were only retained in dataset if application or submission …
  - o P9s
  - o Determinations (not contaminated)
  - o AiPs & CofCs
  - o investigation reports (S2, DSI, etc.)

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Methodology - Dataset

Two ENV datasets ‘filtered’ for Site IDs…

- pre-2018
- 2018-2024

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Methodology - Dataset

Pre-2018 dataset

- Site IDs from years 2018 and prior
- separate spreadsheets for new AOIs
- “raw format” with multiple listings per Site ID
- needed coding for ‘highest tier’ application type

Site	Common Name	Notation Type and Act	Service	Initiated Date	Ministry Conta	Notation Notes	Require	Comple
2382	Shell Bulk Plant- Penticton(Wade Avenue)	CERTIFICATE OF COMPLIANCE ISSUED USI	.	12-Feb-2009	LOCKHART, DAVE	Issued On The Recommendati	No Action	12-Feb-20
2382	Shell Bulk Plant- Penticton(Wade Avenue)	CERTIFICATE OF COMPLIANCE ISSUED USI	.	12-Feb-2009	LOCKHART, DAVE	Issued On The Recommendati	No Action	12-Feb-20
2382	Shell Bulk Plant- Penticton(Wade Avenue)	CERTIFICATE OF COMPLIANCE ISSUED USI	CofC	12-Feb-2009	LOCKHART, DAVE	Issued On The Recommendati	No Action	12-Feb-20
2382	Shell Bulk Plant- Penticton(Wade Avenue)	SITE INVESTIGATION REPORT SUBMITTED.	.	13-Jul-1993	BOYES, DARRYL K	Title: Penticton Bulk Plant, 79	No Action	13-Jul-199
2382	Shell Bulk Plant- Penticton(Wade Avenue)	SITE INVESTIGATION REPORT SUBMITTED.	.	25-Oct-1993	BOYES, DARRYL K	Title: Shell Canada Products L	No Action	25-Oct-19
2382	Shell Bulk Plant- Penticton(Wade Avenue)	SITE INVESTIGATION REPORT SUBMITTED.	.	18-Jun-1996	BOYES, DARRYL K	Title: Phase Iv Subsurface Inv	No Action	18-Jun-19
2382	Shell Bulk Plant- Penticton(Wade Avenue)	SITE INVESTIGATION REPORT SUBMITTED.	.	18-Jun-1996	BOYES, DARRYL K	Title: Penticton Shell Bulk Pla	No Action	18-Jun-19
2382	Shell Bulk Plant- Penticton(Wade Avenue)	SITE INVESTIGATION REPORT SUBMITTED.	.	22-Oct-1992	BOYES, DARRYL K	Title: Penticton Bulk Plant, 79	No Action	22-Oct-19

PGL ENVIRONMENTAL CONSULTANTS

Methodology - Dataset

2018-2024 dataset

- all Site IDs for all of BC for years 2018-2024
- single entry per Site ID
- coded for ‘highest tier’ application type

SiteID	ApplicationID	Priority	ReceivedDate	CommonName	SiteCity	RiskDesignation	CSAPRef	Service
38	13170		2022-06-03	SHELL SERVICE ST/	NORTH VANCOUVER	Non-High Risk	22-023	Certificate of Compliance - nun
48	13058		2022-05-09	SHELL CANADA - 7	PRINCE GEORGE	UnClassified	22-003A	Certificate of Compliance - det
86	11973		2021-08-03	8188 & 8232 MAN	VANCOUVER	Non-High Risk		Approval in principle
91	15082		2024-04-25	45696 YALE ROAD	CHILLIWACK	Non-High Risk	24-002 A	Certificate of Compliance - det
108	12427		2021-11-29	FRASER LANDS	VANCOUVER	Non-High Risk		Approval in principle
139	15266		2024-06-21	WESTMINSTER PIE	NEW WESTMINSTER	High Risk		Certificate of Compliance - det

PGL ENVIRONMENTAL CONSULTANTS

Methodology - Dataset

2018-2024	pre-2018
Prince George	
NE BC	

Methodology - Dataset

2018-2024	pre-2018
Prince George	
NE BC	
Rest of BC (new AOIs)	Rest of BC (new AOIs)

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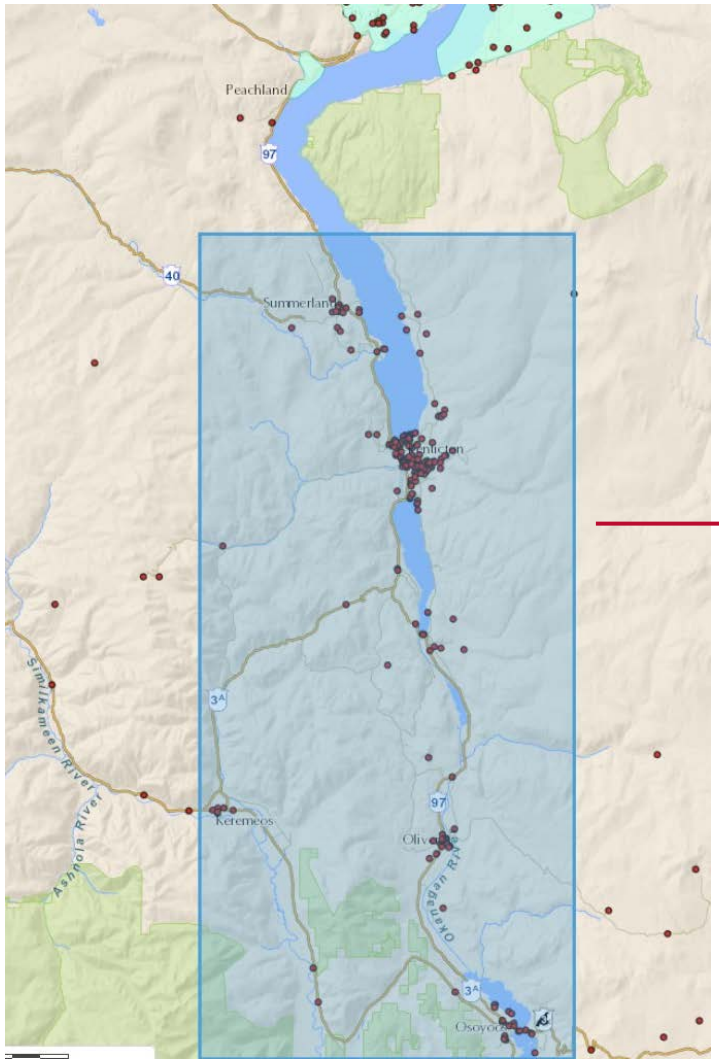
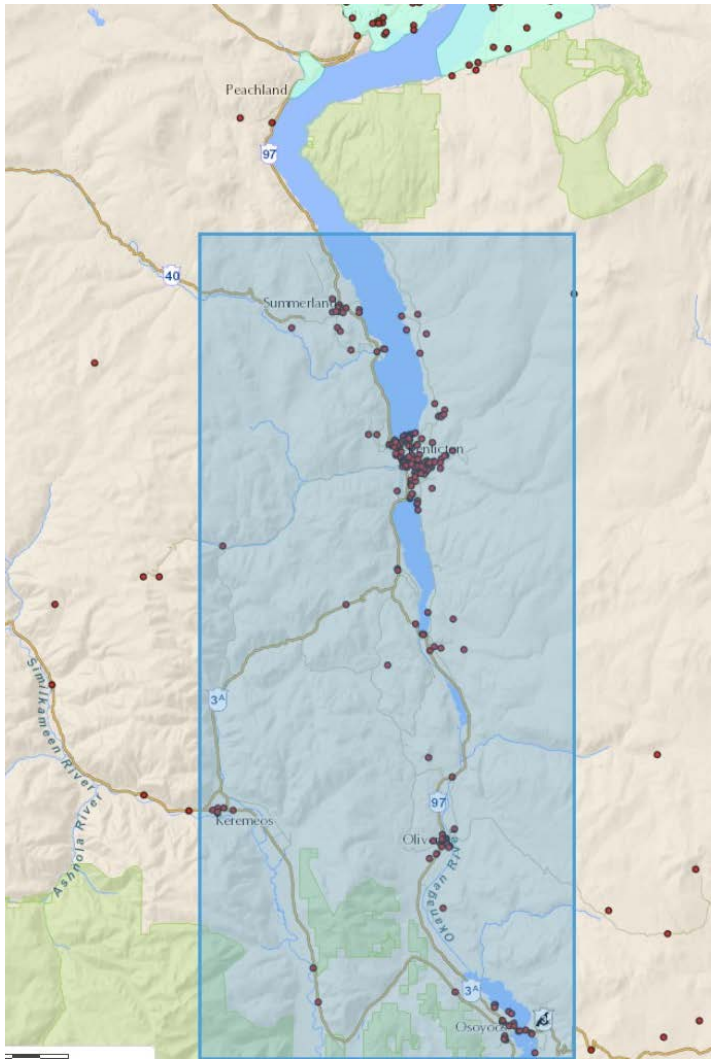
Methodology - Dataset



	number of Site IDs
Municipalities	**total (iMap)**
Cawston	2
Kaleden	3
Keremeos	7
Naramata	5
Okanagan Falls	12
Oliver	26
Osoyoos	23
Penticton	177
Summerland	17
Total	**272**

Methodology - Dataset



database filter...

	number of Site IDs		
Municipalities	**total (iMap)**	**ENV pre-2018**	**ENV 2018-2024**
Cawston	2		
Kaleden	3		
Keremeos	7	5	
Naramata	5	1	
Okanagan Falls	12	3	
Oliver	26	5	1
Osoyoos	23	10	
Penticton	177	76	7
Summerland	17	6	
Total	**272**	**106**	**8**

... removes ~60% of Site IDs

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Methodology - Suitable Sites

Site ID ≠ suitable background site

- duplication (off-site migration)
- reports not available
- cannot verify sampling procedures
- background well selection criteria
- …

Methodology - Well Screening

Background Well Selection Criteria

- ✓ dissolved metals and/or metalloid data
- ✓ screened in shallow aquifers
- ✓ borehole logs
- ✓ known location

- ✗ bedrock
- ✗ screened within fill or backfill
- ✗ influenced by secondary contaminant release processes
- ✗ DL > standard

PGL ENVIRONMENTAL CONSULTANTS

Methodology - Well Screening

screening in 2018 study…

Region	Sub-region	Protocol 9 Sites		Determinations		Contaminated Sites		Total Sites	
		With reports	Used	With reports	Used	With reports	Used	With reports	Used
Lower Mainland	Sub-region 1	41	24	49	22	n/a	20	180	**48**
	Sub-region 2					90	19		**32**
Thompson - Okanagan	Kamloops	10	3	6	5	30	2	46	**10**
	Kelowna	5	2	4	4	31	7	40	**13**
South Vancouver Island	-	6	3	3	1	70	26	79	**30**
Northeast BC (Fort St. John / Dawson Creek)	-	4	4	1	0	5	4	10	**8**
Prince George	-	2	2	1	1	3	1	6	**4**
Total		**68**	**38**	**64**	**33**	**229**	**84**	**361**	**155**

56% 52% 37%

…removed ~50% of sites

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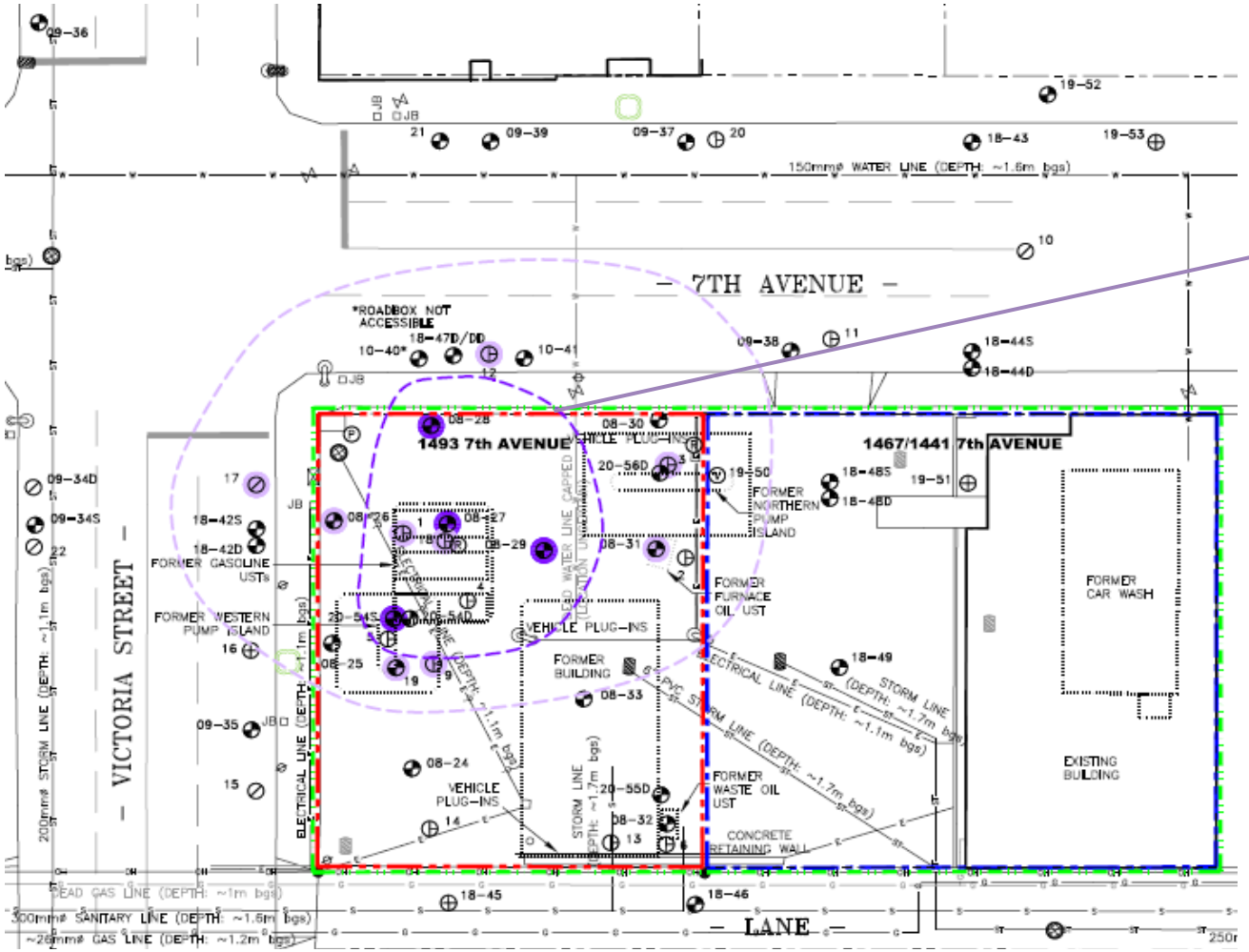
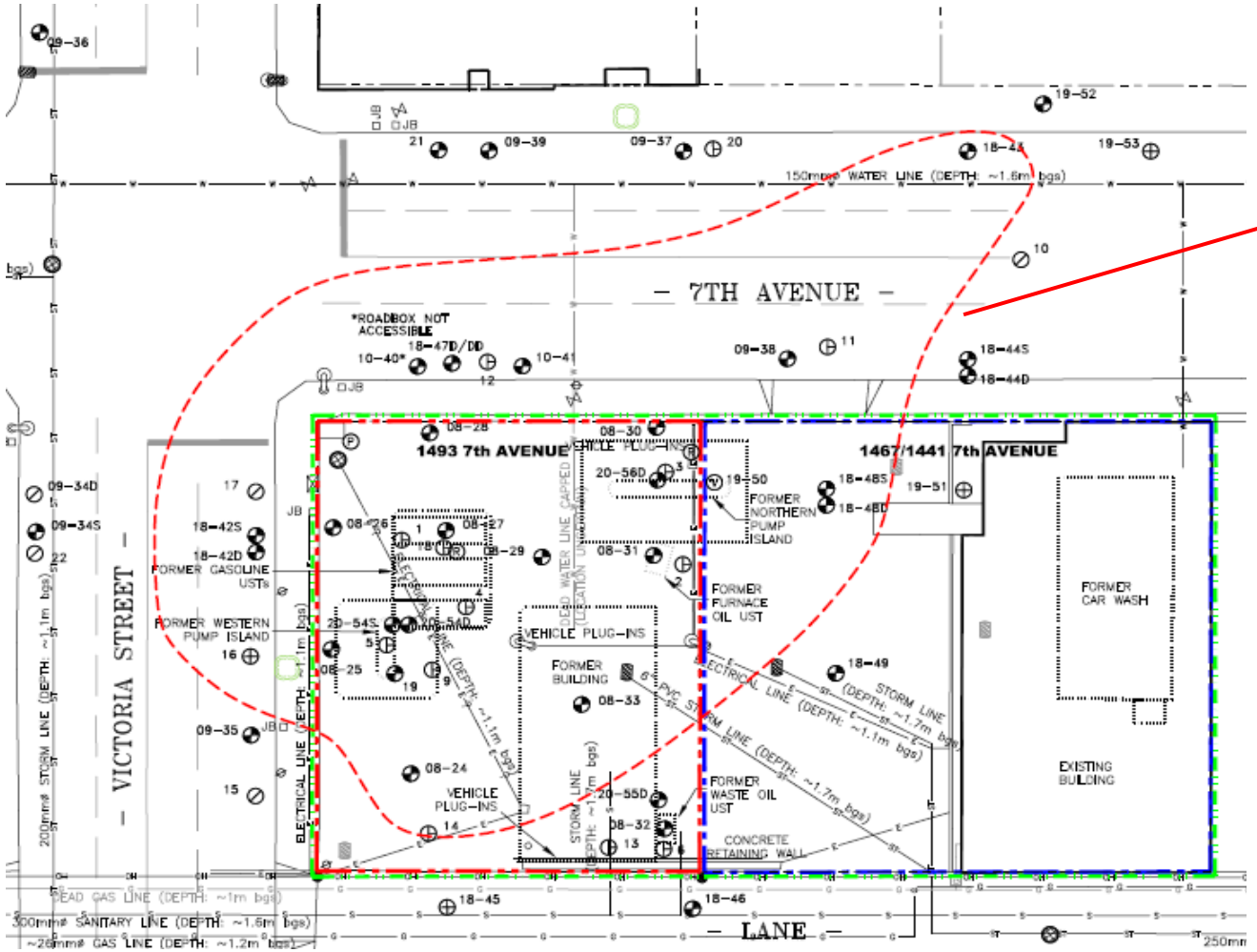
Methodology – Report Review



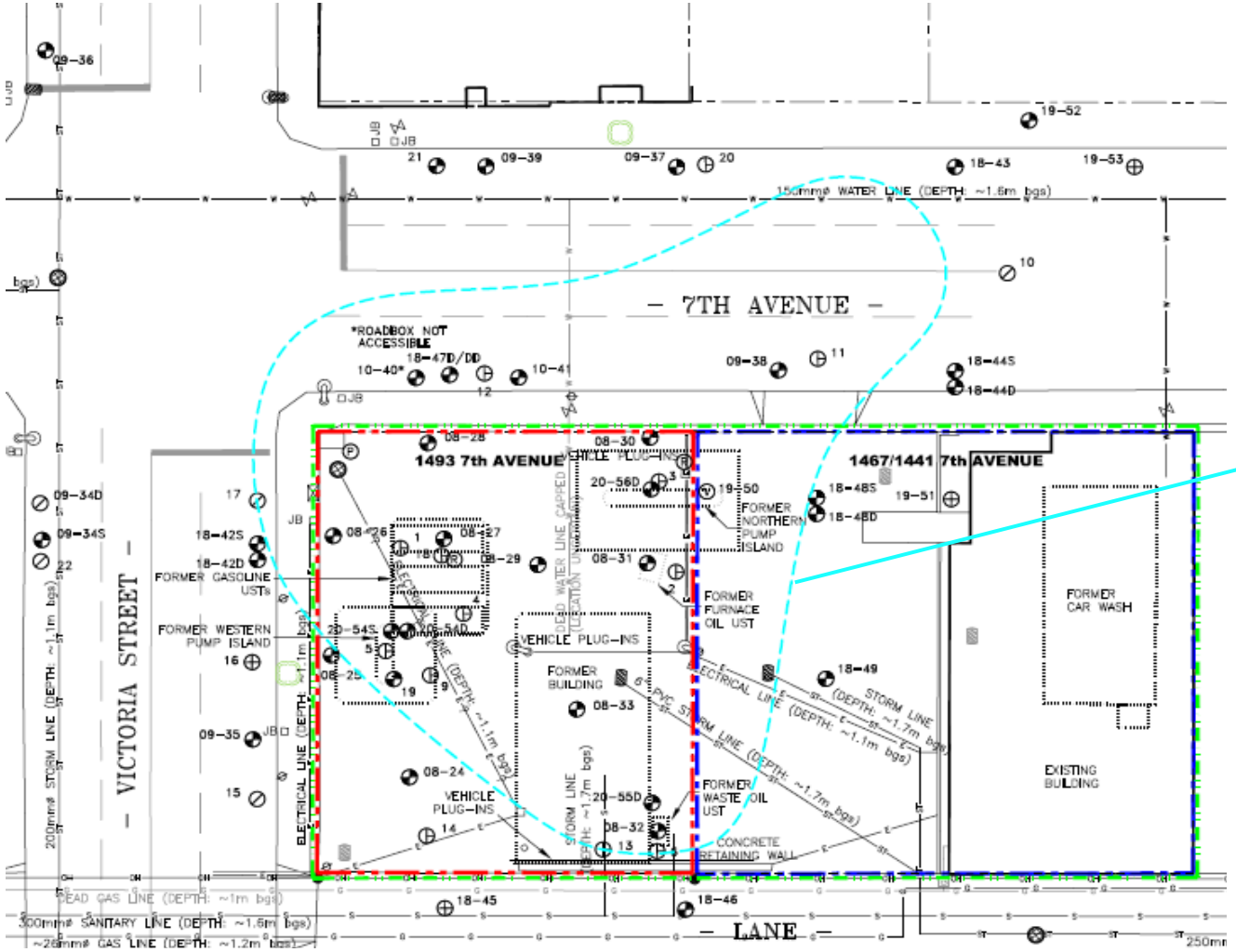
Methodology – Report Review



Soil contamination

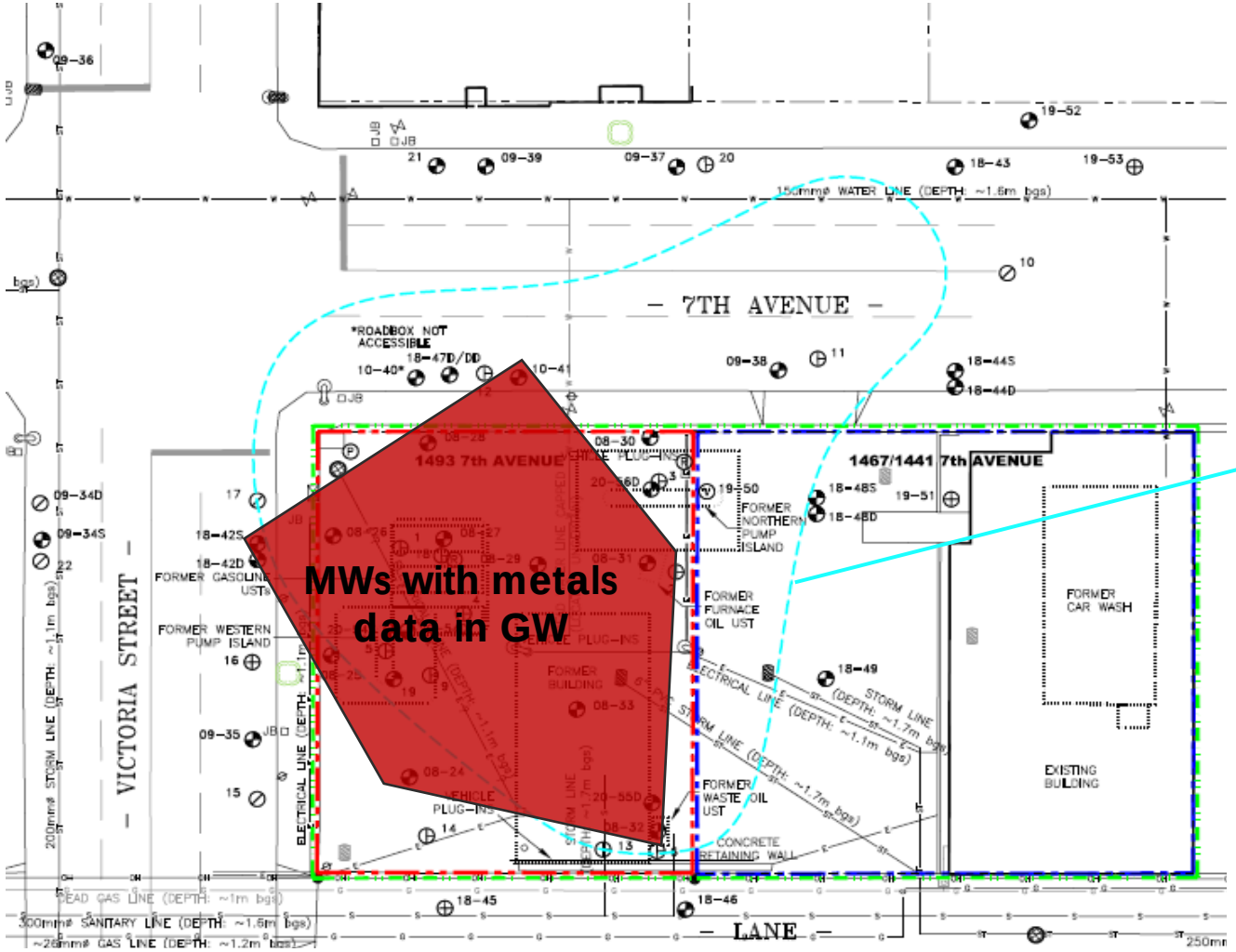
PGL ENVIRONMENTAL CONSULTANTS

Methodology – Report Review



Groundwater plume

Methodology – Report Review



Groundwater plume

not a suitable background site

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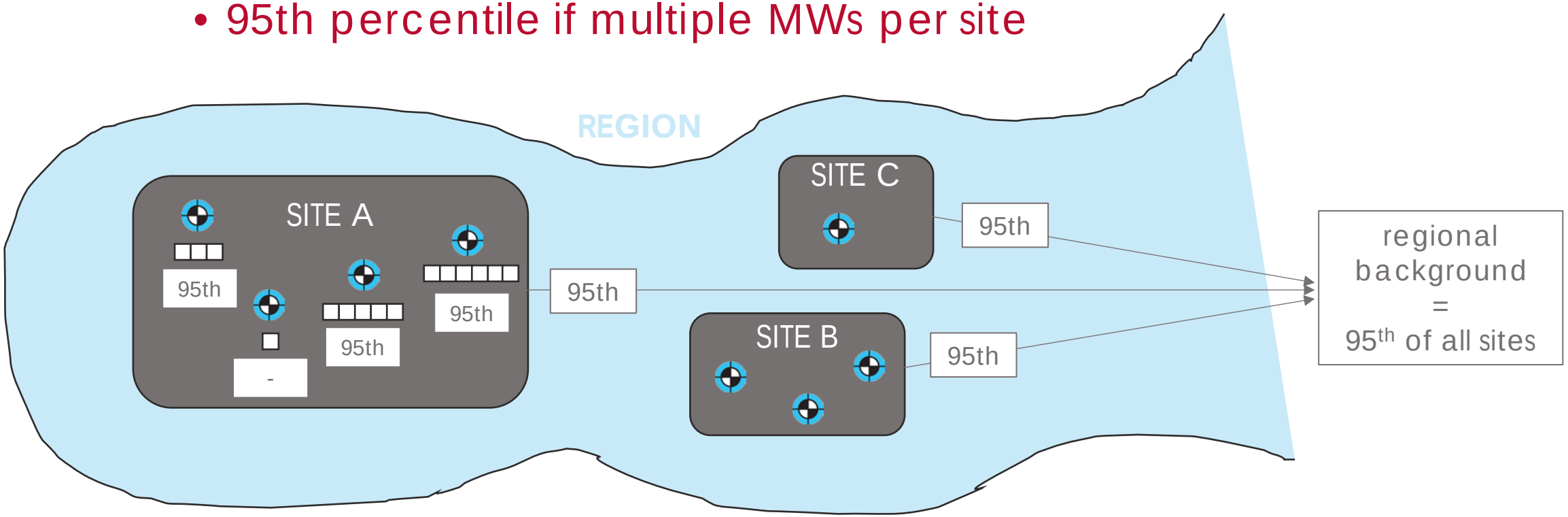
Methodology - Statistics

Background Calculation - Sites

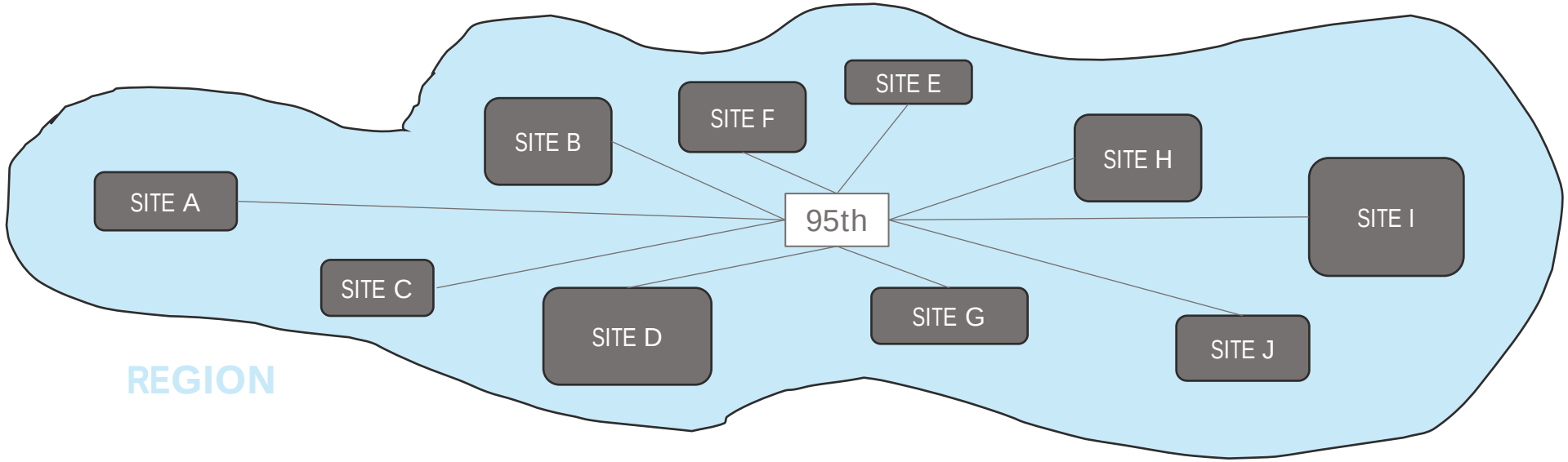
- *generally* according to P9
- 95th percentile of multiple sampling events per MW
- 95th percentile if multiple MWs per site



Methodology - Statistics

Background Calculation – Region

- **minimum 10 suitable sites** for establishing background region
- outlier tests, data distribution analysis (QQ plot, etc.), ANOVA
- Background calculated as 95th percentile of all sites



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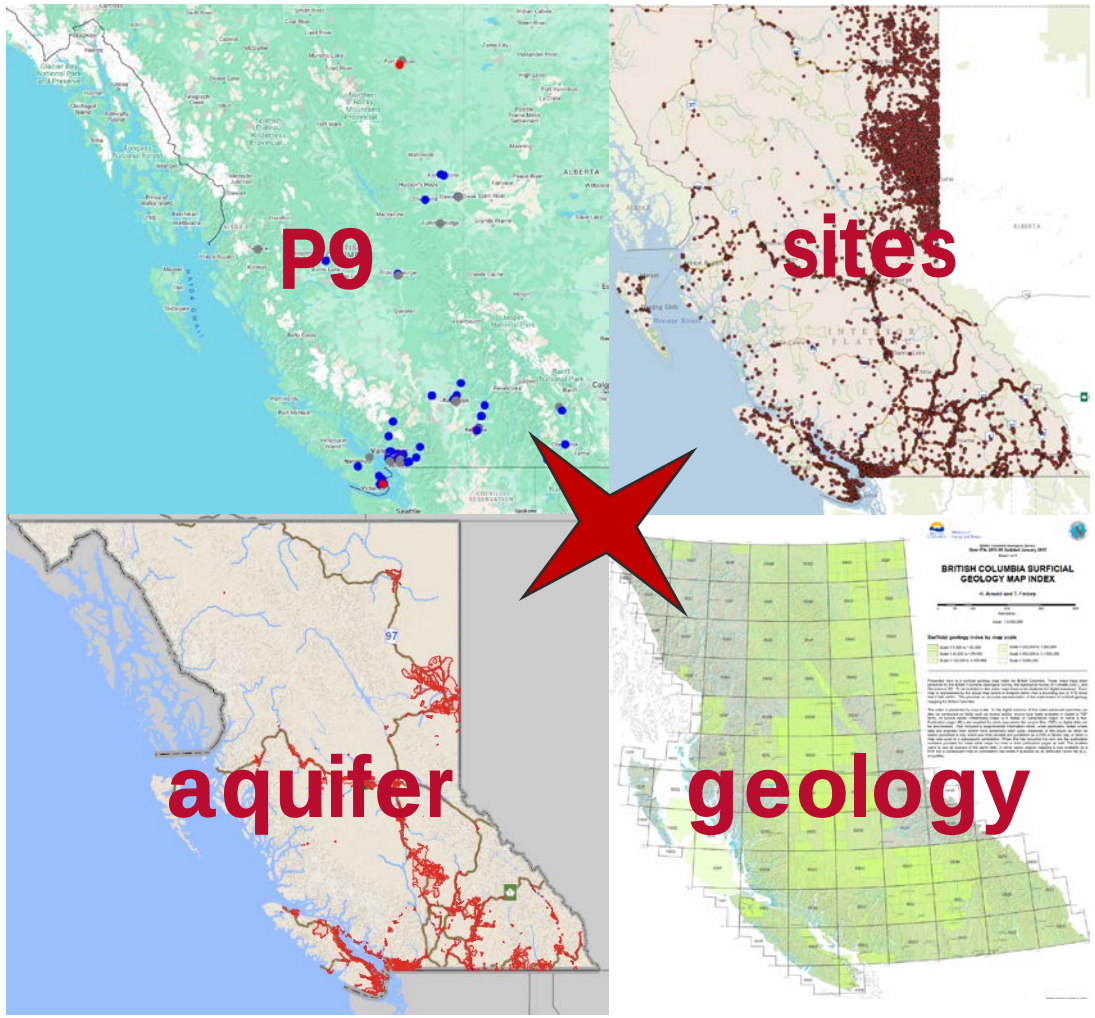
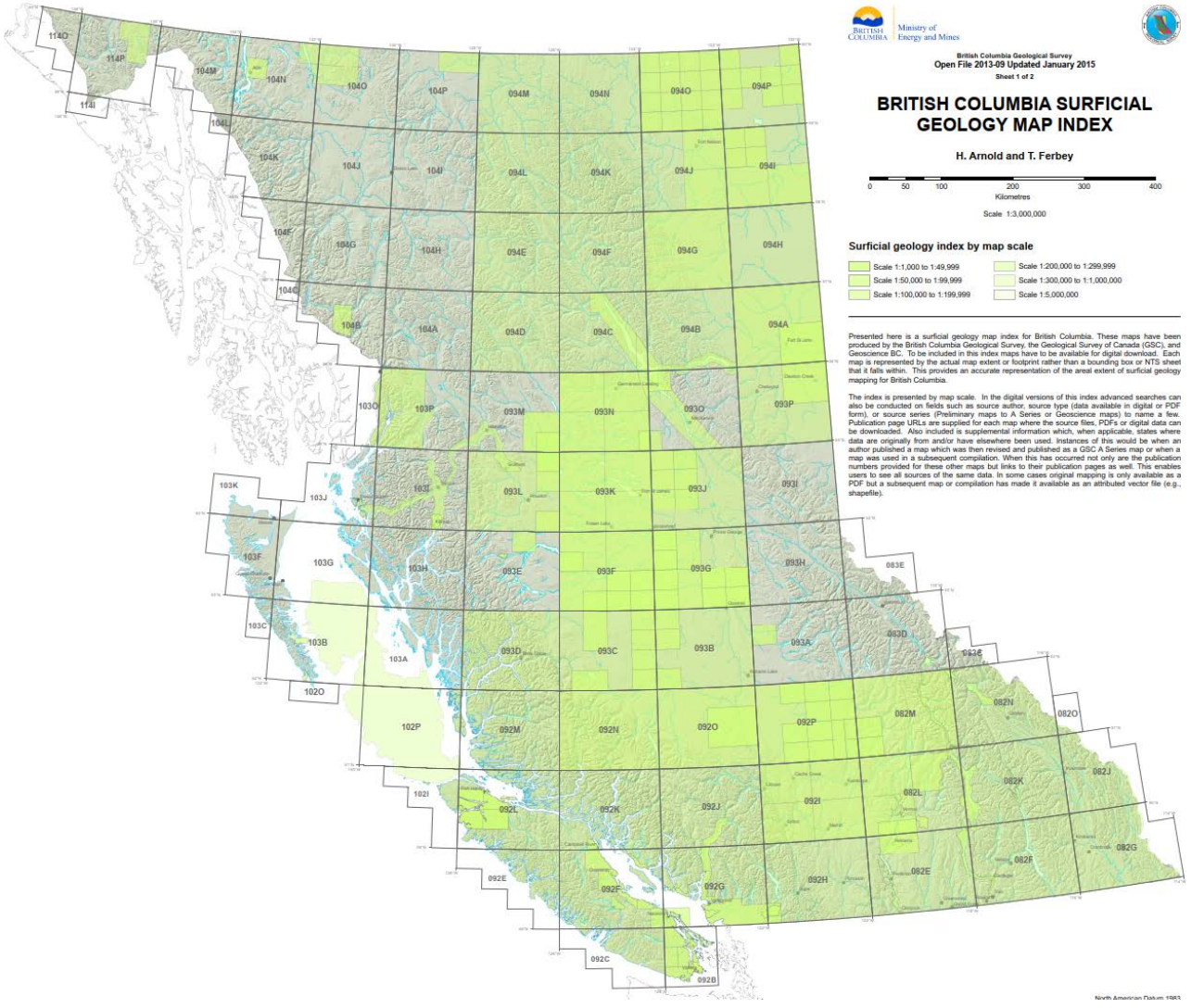
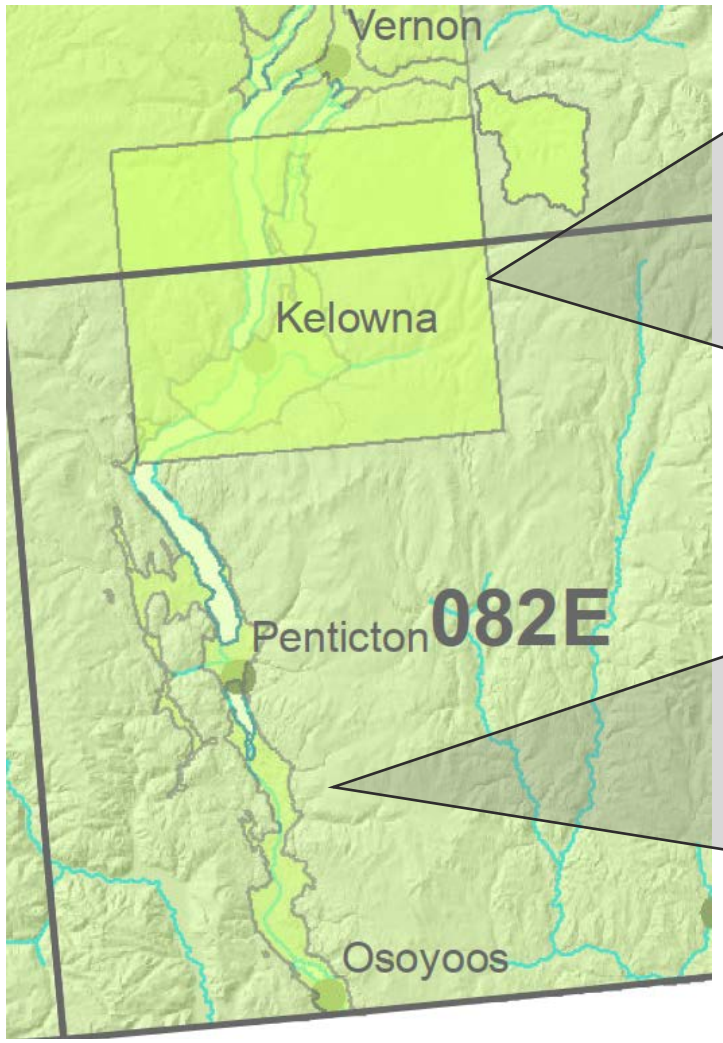
Methodology - Potential New Regions

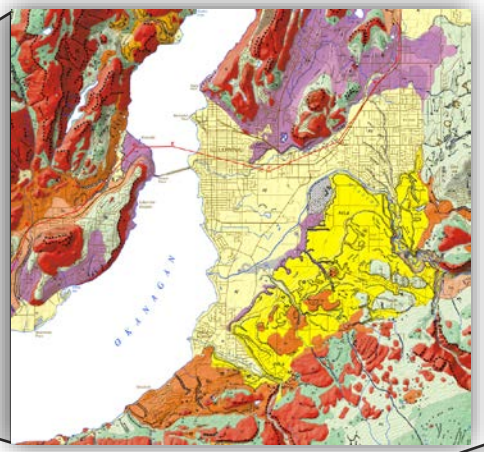


Methodology - Surficial Geology



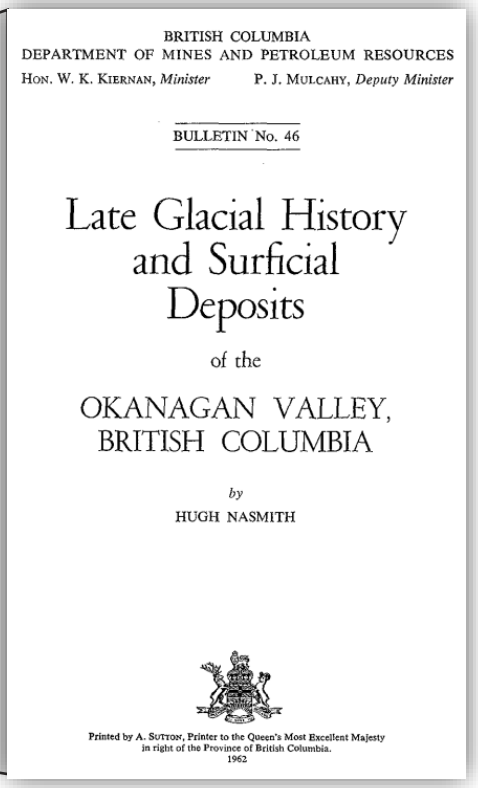
Methodology - Surficial Geology





"hi-fi"

"lo-fi"



BRITISH COLUMBIA
DEPARTMENT OF MINES AND PETROLEUM RESOURCES
HON. W. K. KIERNAN, *Minister* P. J. MULCAHY, *Deputy Minister*

BULLETIN No. 46

Late Glacial History and Surficial Deposits

of the

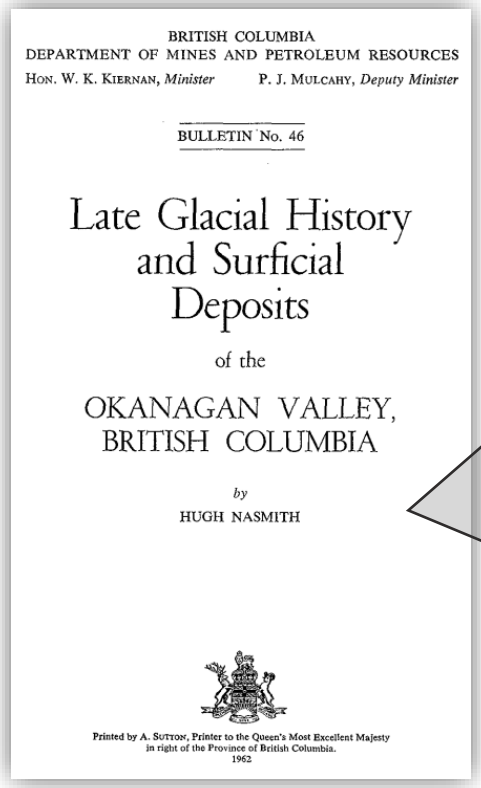
OKANAGAN VALLEY, BRITISH COLUMBIA

by

HUGH NASMITH

Printed by A. SUTTON, Printer to the Queen's Most Excellent Majesty in right of the Province of British Columbia.
1962

Methodology - Surficial Geology



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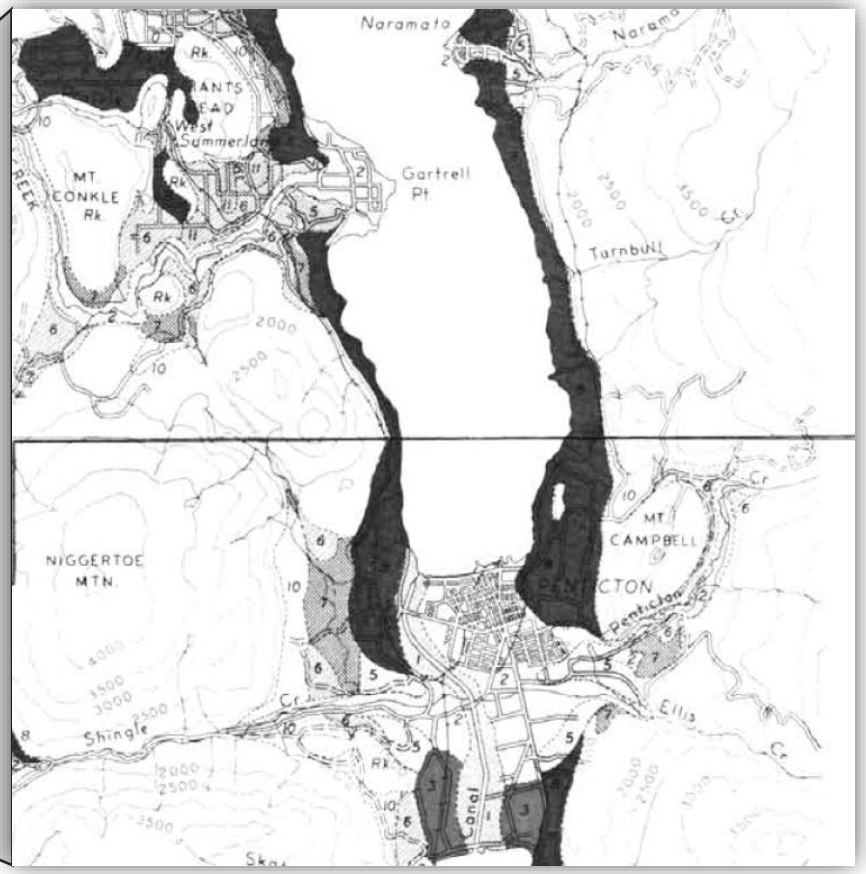

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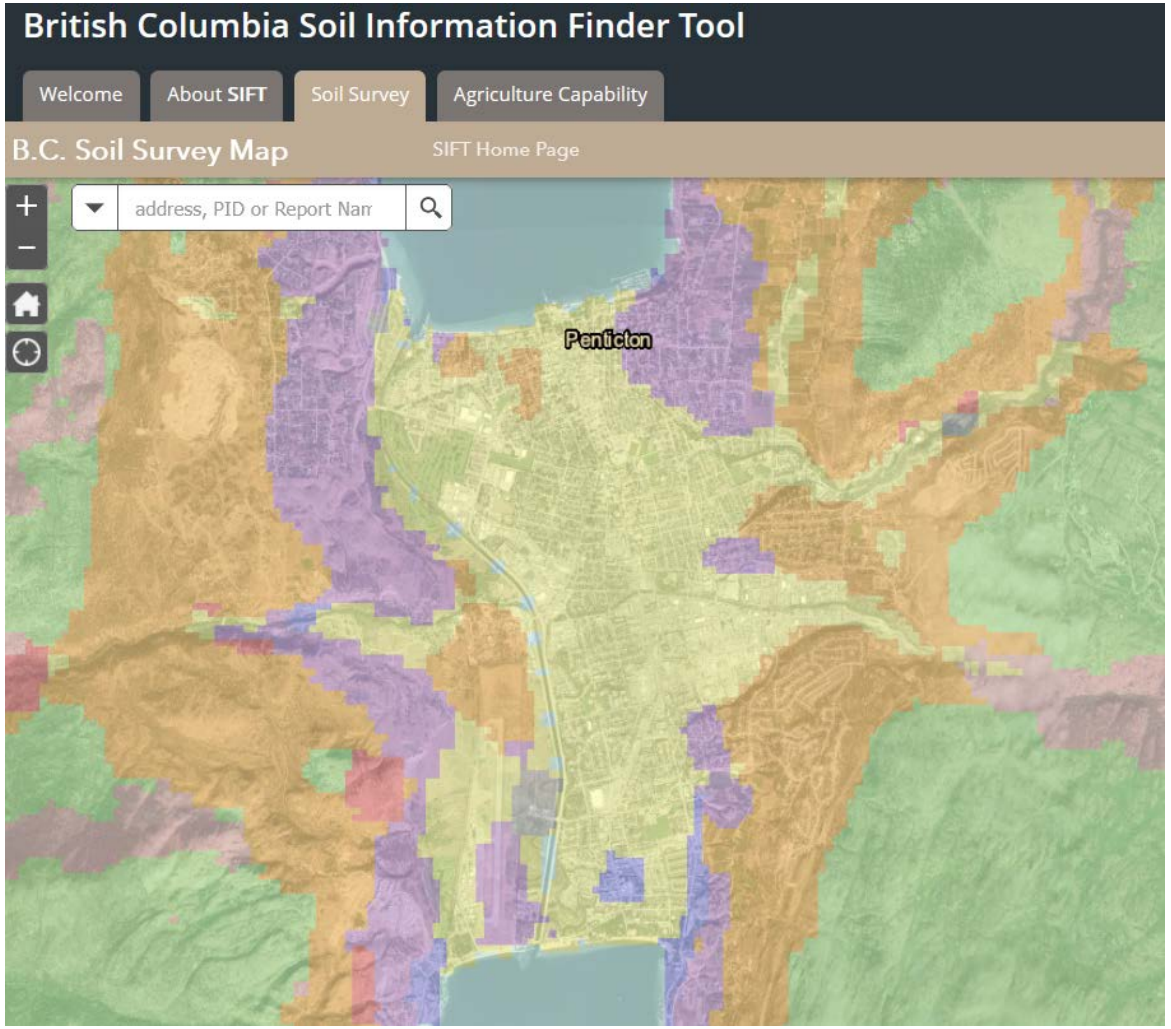
Methodology - Surficial Geology



BC Soil Survey

supplementary information

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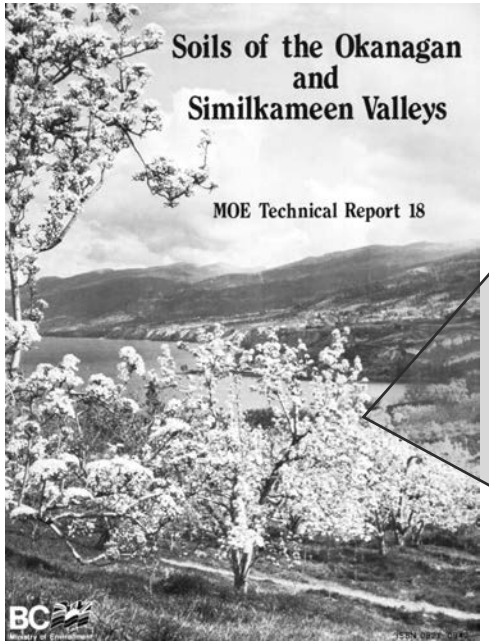
Methodology - Surficial Geology



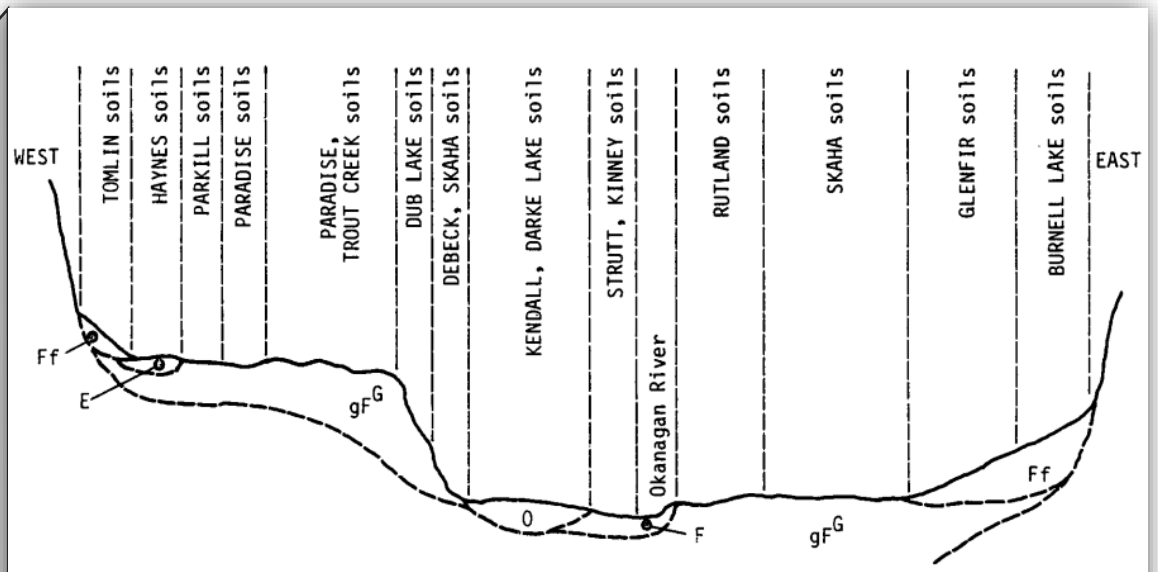


Fig. 7. A schematic cross-section of the Okanagan Valley near McIntire Bluff showing the general relationship between elevation, surficial deposits and the more common soils.

LEGEND

E- Eolian deposits
F- Recent fluvial deposits
gF^G- Gravelly fluvioglacial deposits
sF^G- Sandy fluvioglacial deposits
Ff- Fluvial fan deposits
M- Morainal deposits
O- Organic deposits

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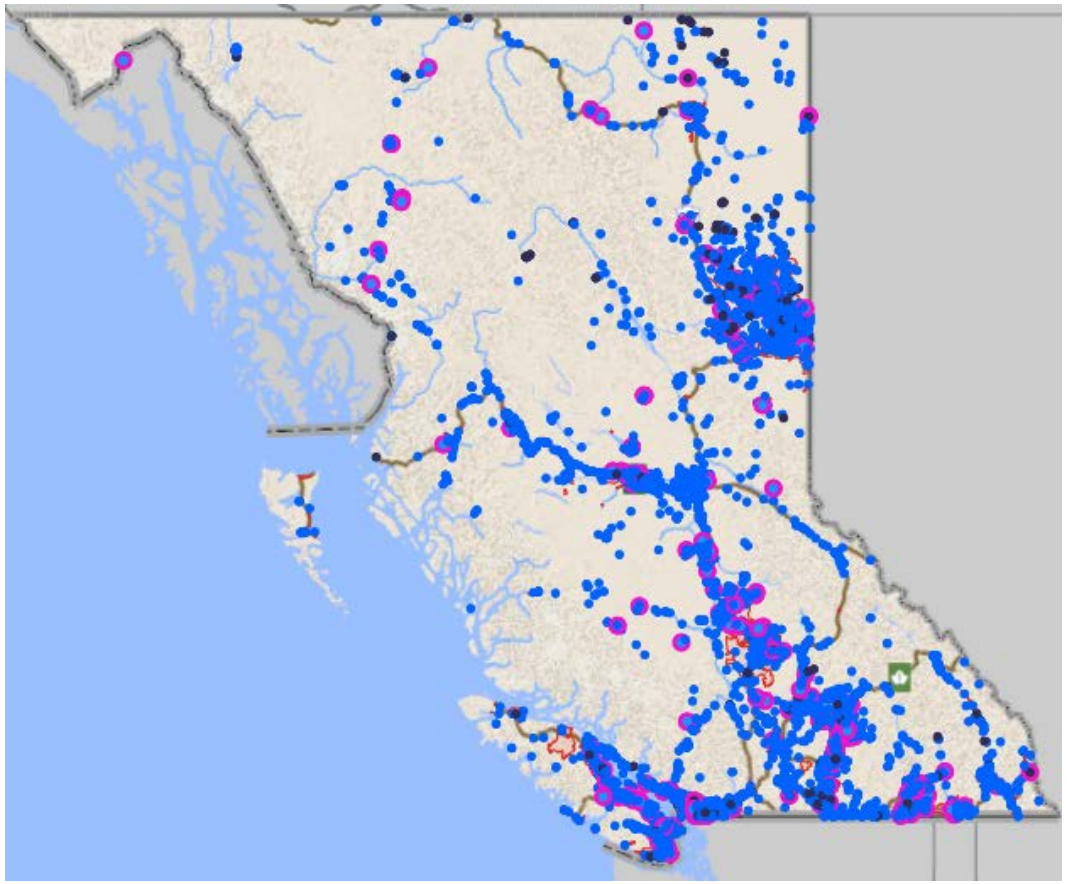
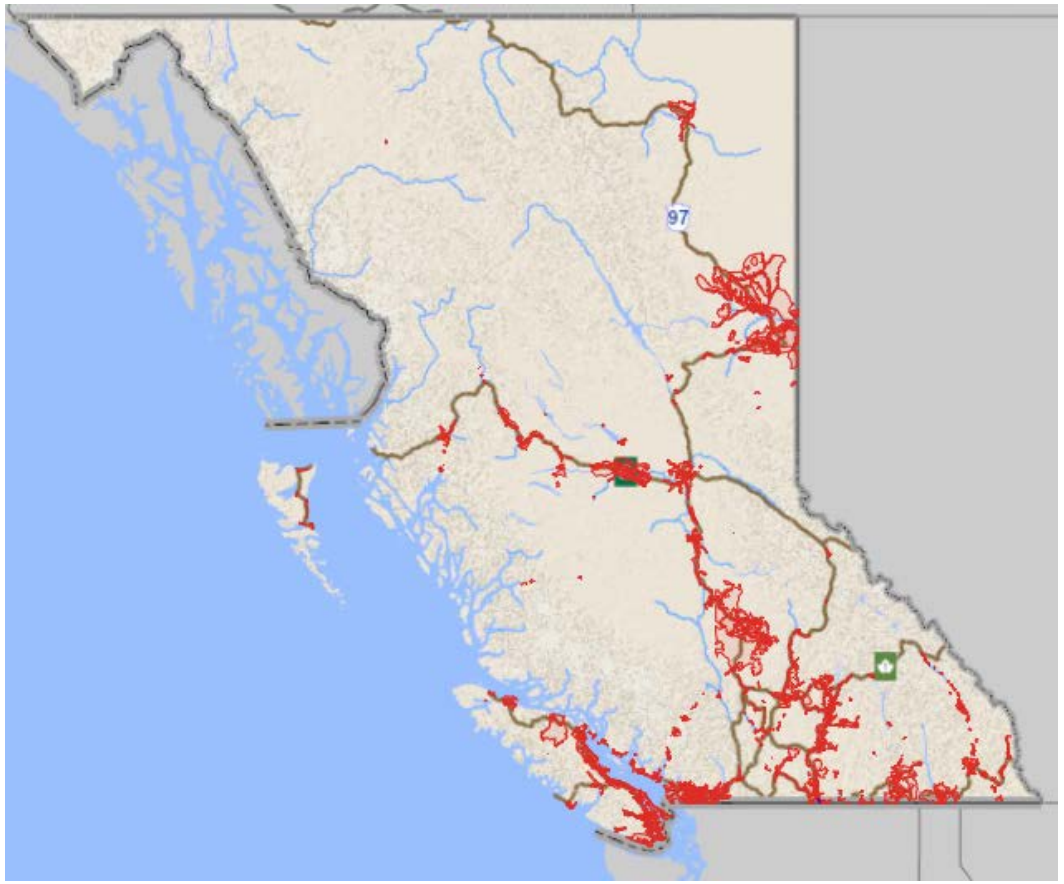
Methodology – Aquifer Mapping

BC Water Resources Atlas





Results

- Communicate with **BCER**

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BCER

- *BCER does have reports, reclamation, clean up, etc. but the information and reports are not in any database*
- *BCER in discussion how to organize groundwater data*
- *difficult to get information from sites prior to 2005 if the sites were deemed clean or remediated*

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Results

- Identify new sites for **NE BC** and **Prince George**, obtain and review reports to assess if sufficient potential background sites available (n ≥ 10)

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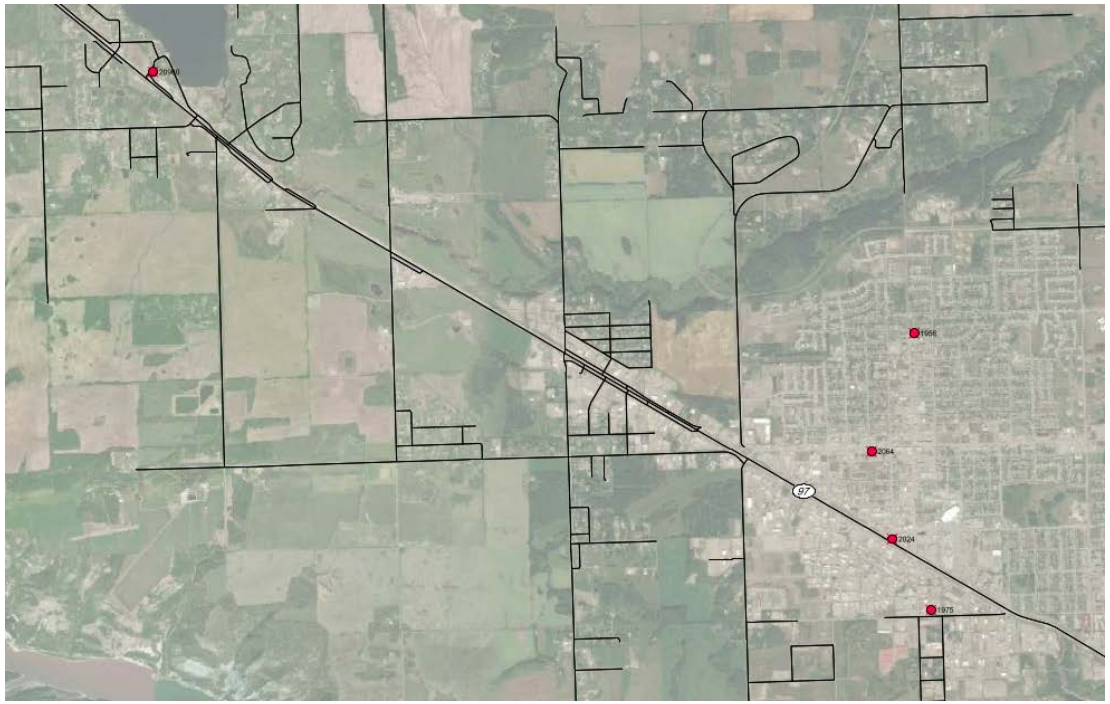
NE BC

2018 study identified 7 suitable sites, not sufficient to established if areas can be combined into single region

Dawson Creek
glaciomarine deposits



Fort St. John
till deposits

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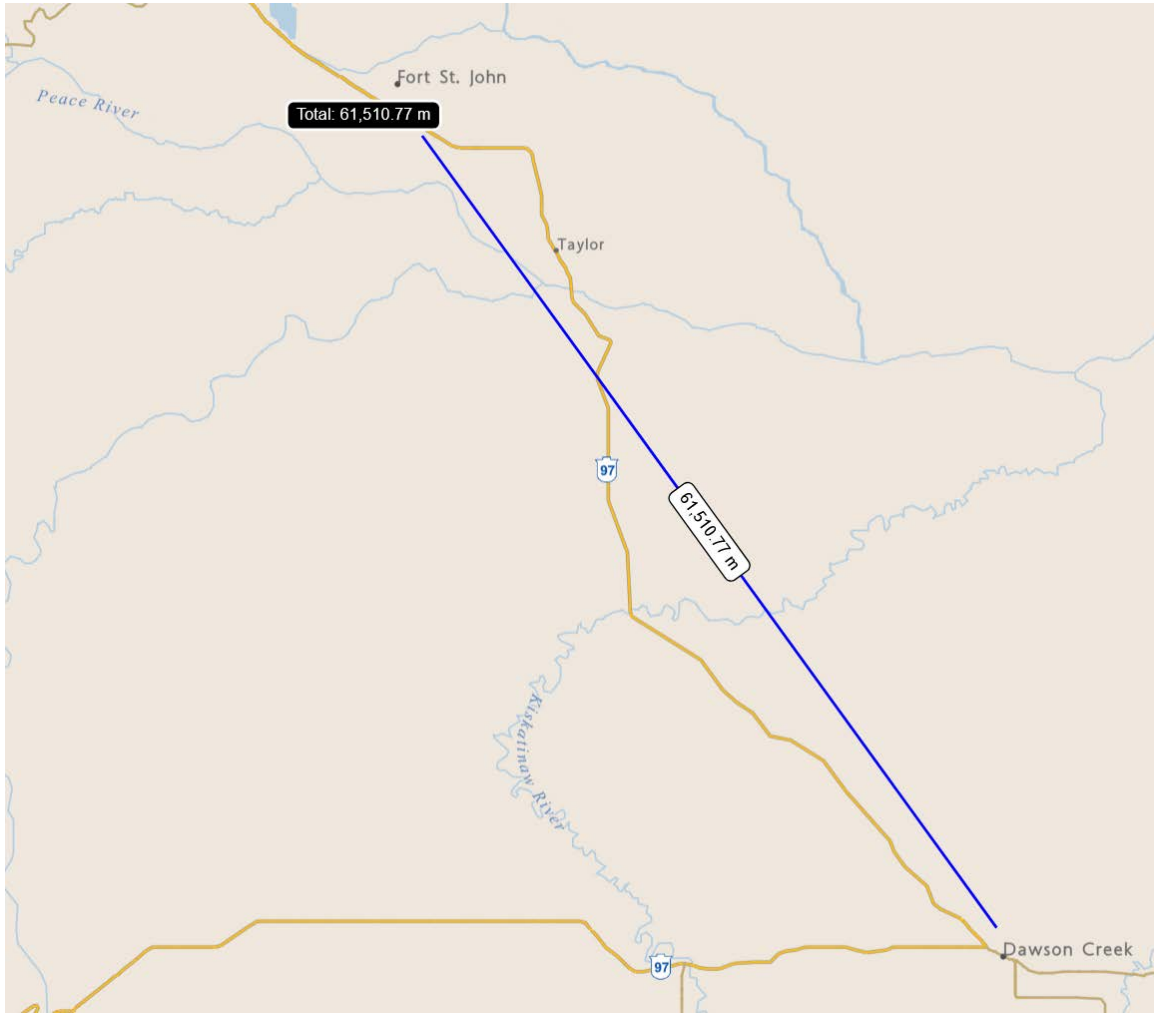
NE BC



municipalities
>60 km apart

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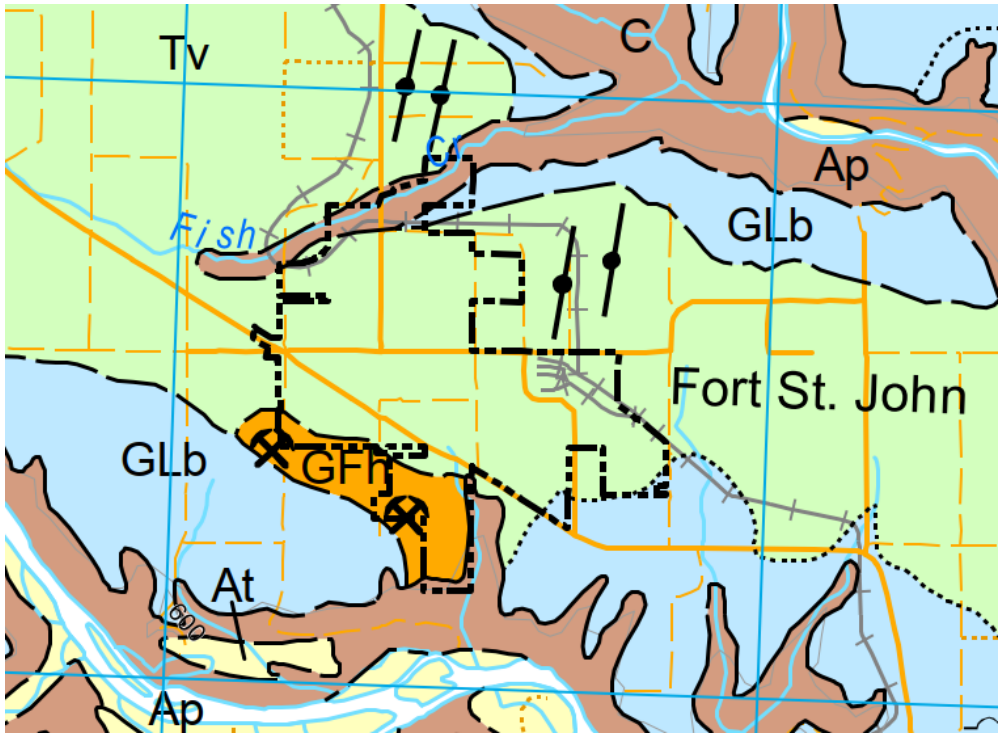
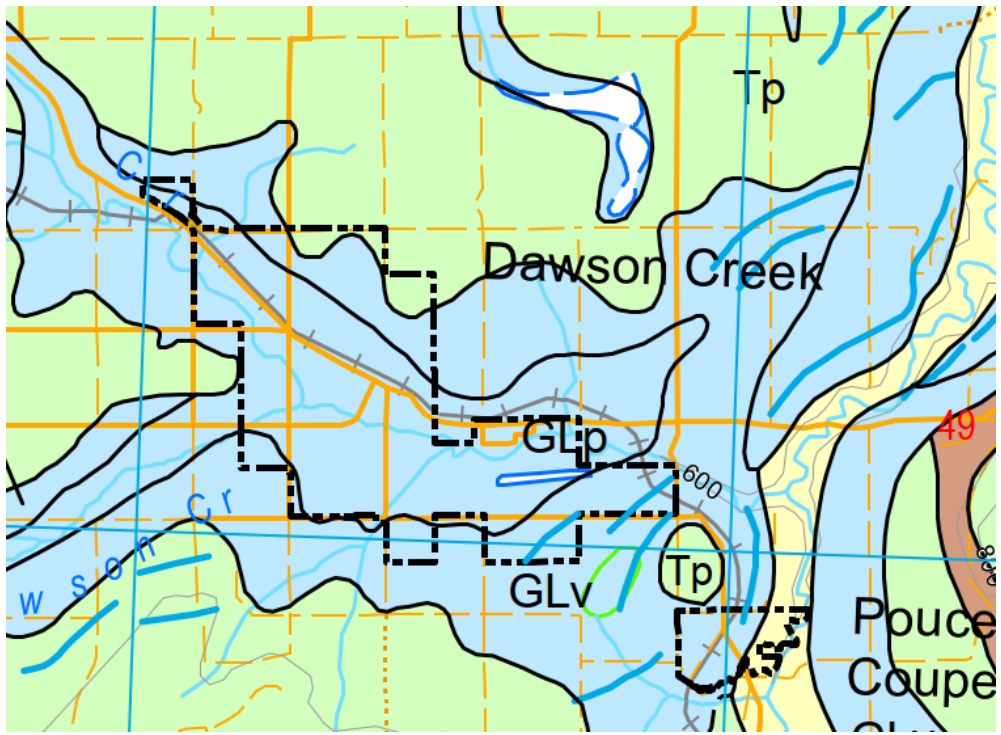
NE BC





distinct geology

T — Till or Glacial Diamict Deposits

GL — Glaciolacustrine Deposits

NE BC

Peace-Beatton Aquifer Mapping and Hydrostratigraphic Characterization

Tibor Lengyel, Andrew Hinnell, and John J. Clague

Kiskatinaw-Peace Aquifer Mapping and Hydrostratigraphic Characterization

Tibor Lengyel, Judit Deri-Takacs, Andrew Hinnell, and John J. Clague

2022 / 2023 aquifer mapping reports for Ft. St. John and Dawson Creek areas

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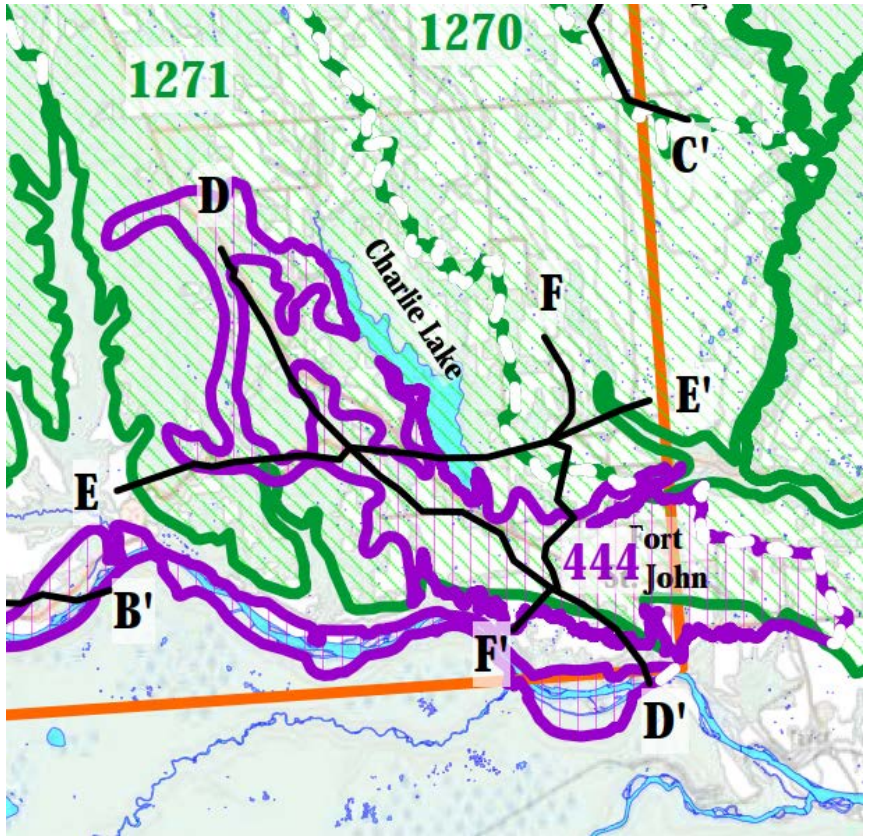
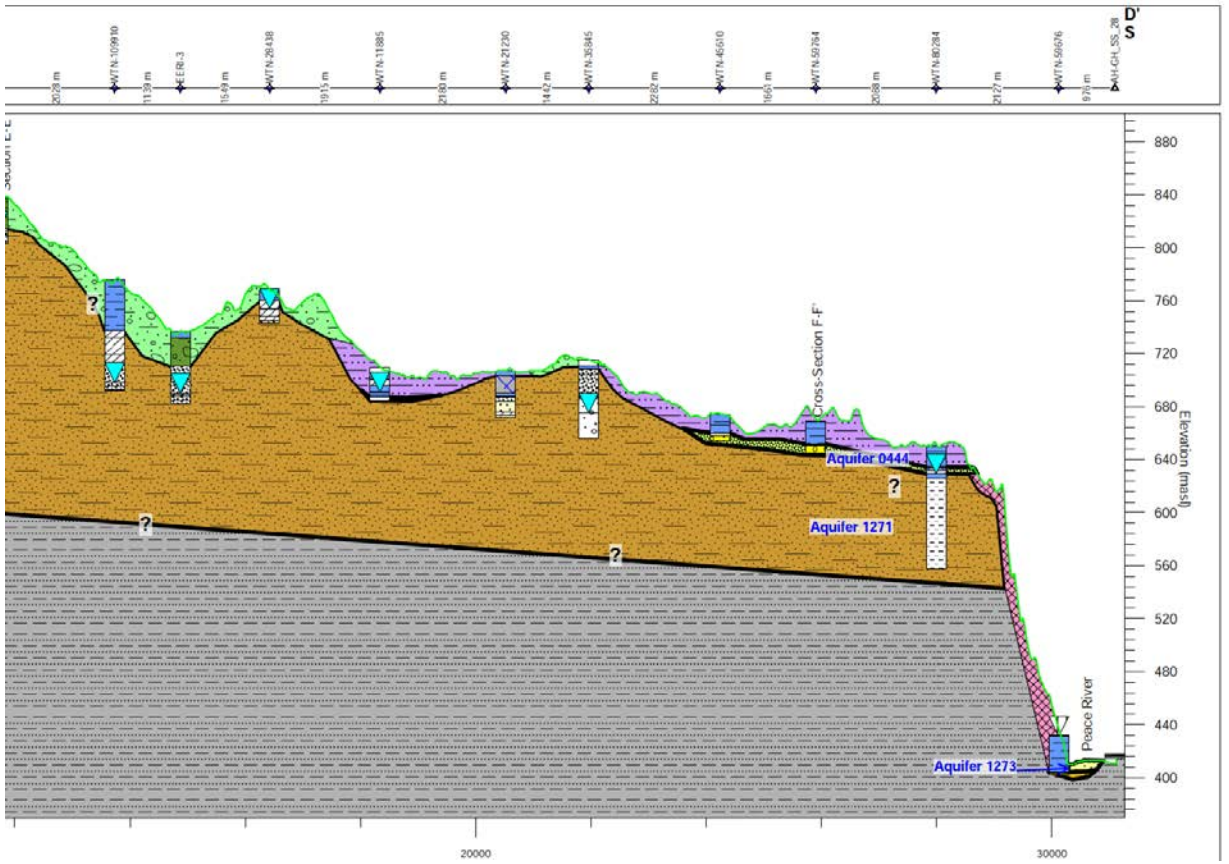
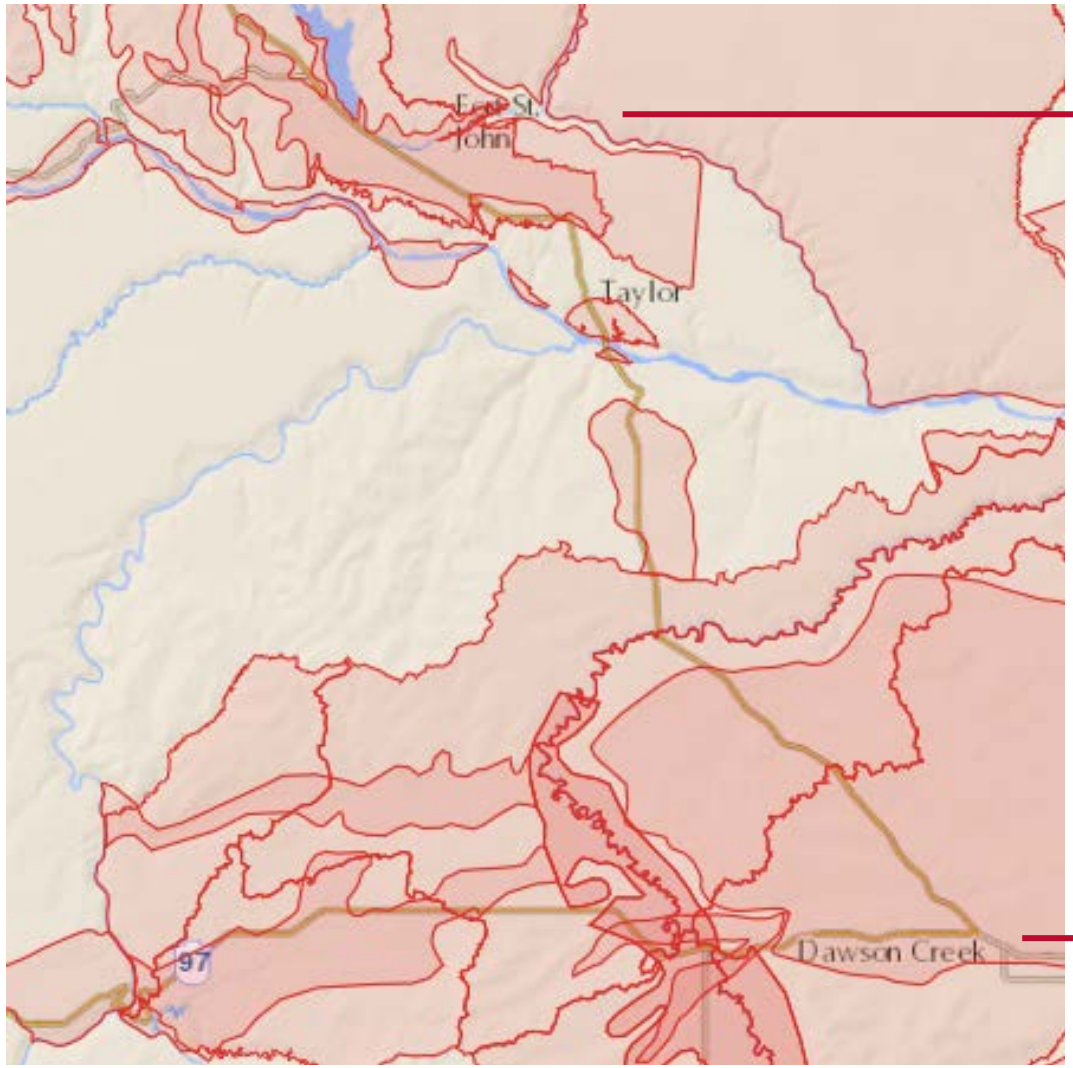
NE BC

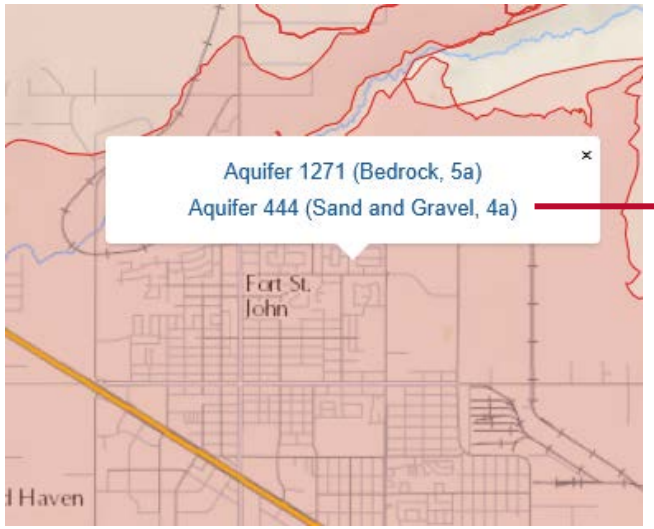
aquifer mapping reports with cross sections and geology information



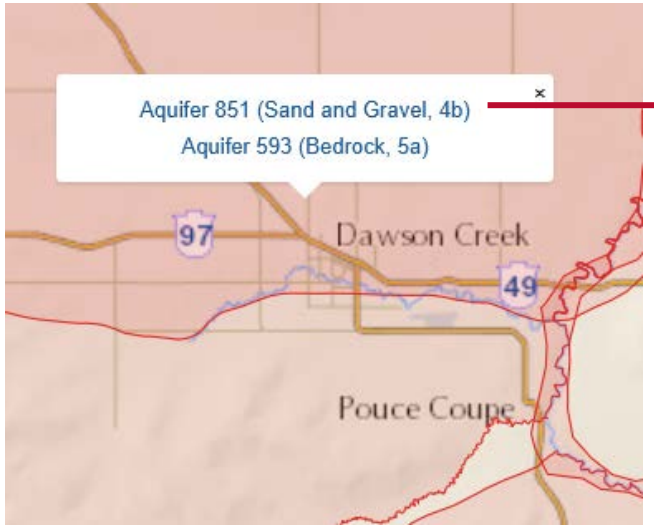


NE BC





confined glacio-fluvial sand and gravel aquifer underneath or in between till



unconfined glacio-fluvial sand and gravel aquifer

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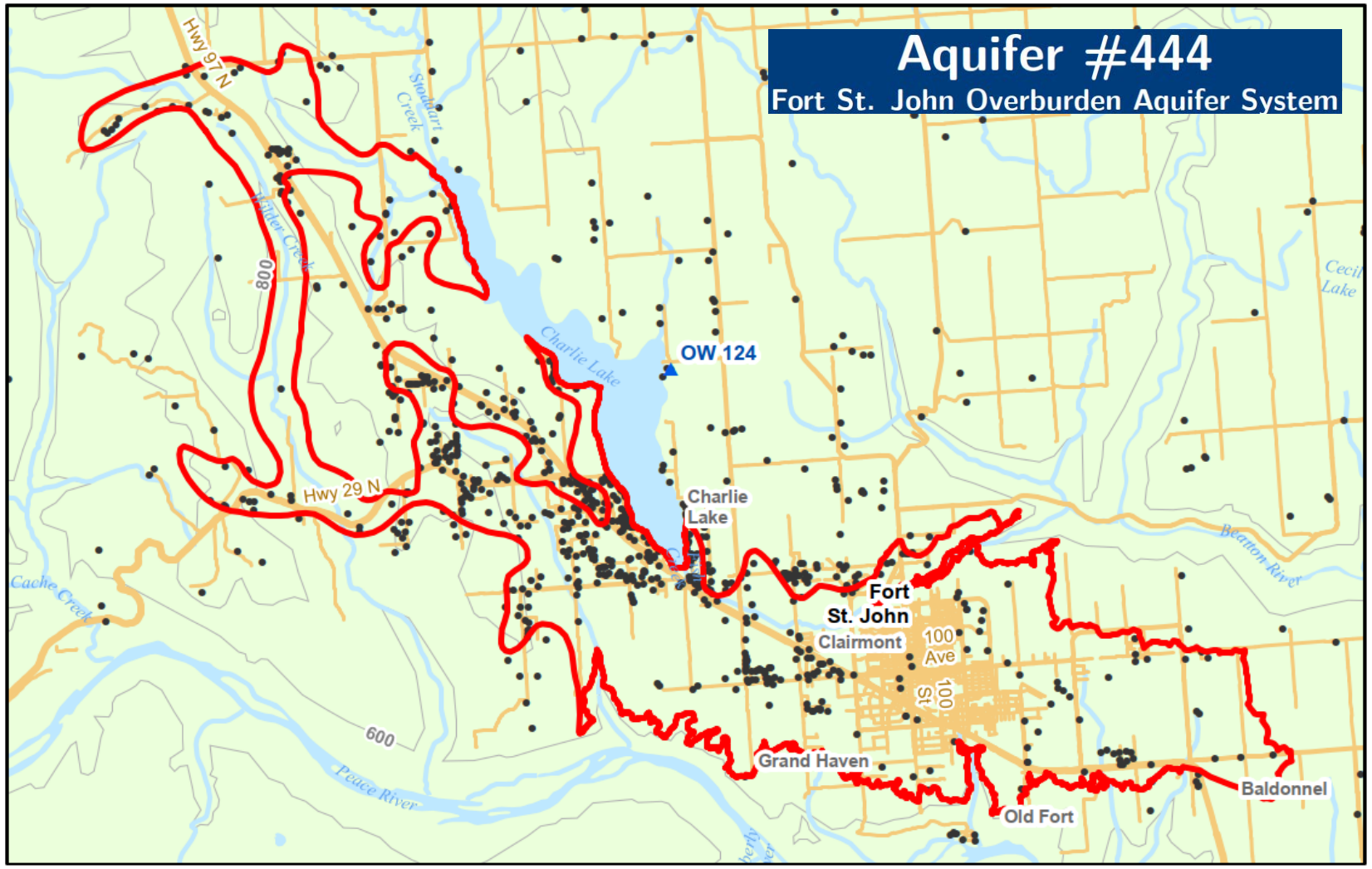
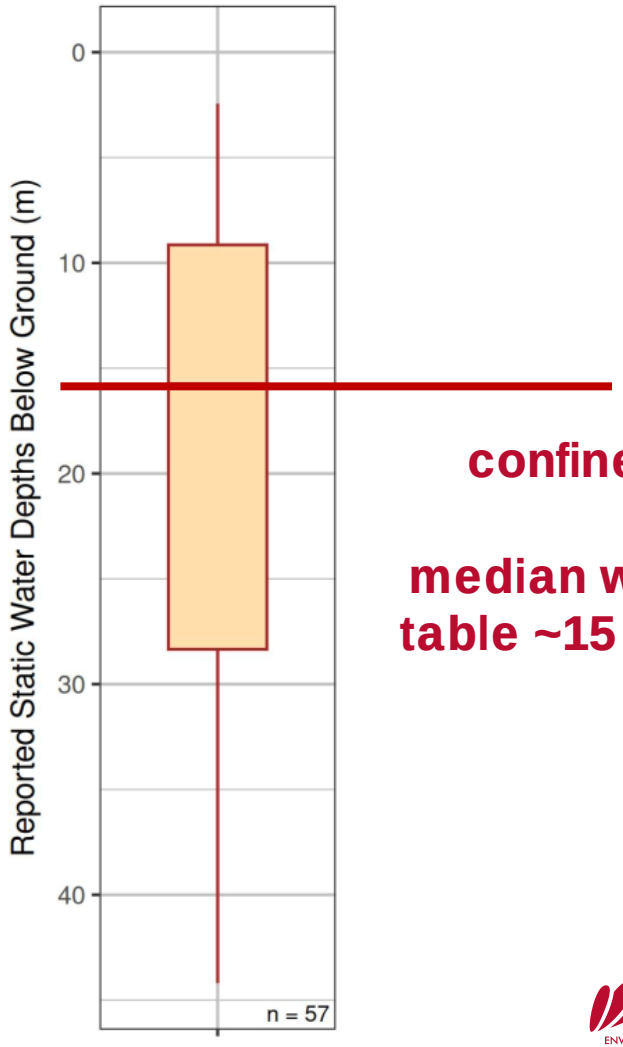
NE BC





confined

median water table ~15 mbg

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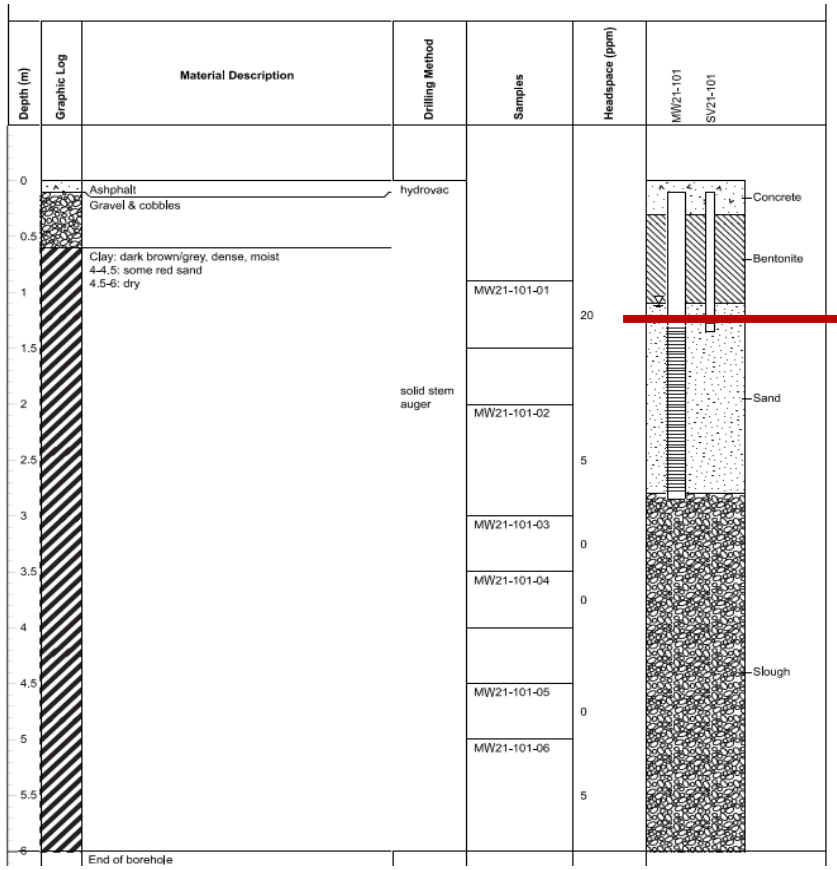
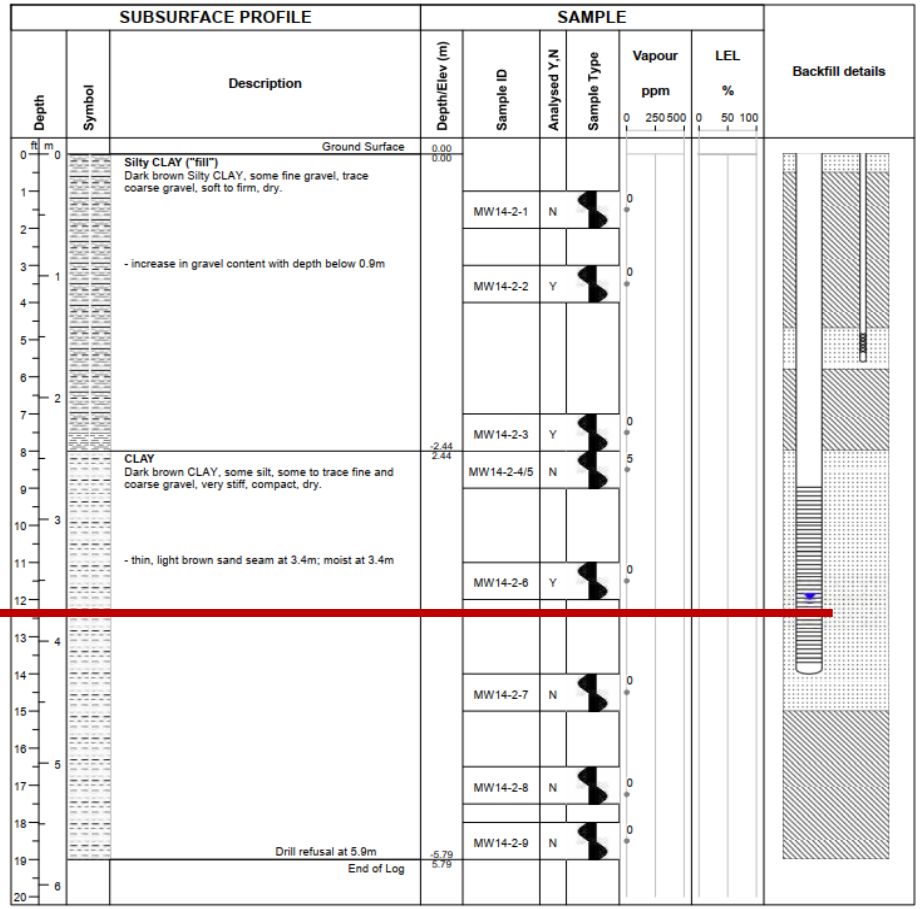
NE BC

BUT, sites with shallow GW in Ft. St. John, unconfined and not within mapped aquifer

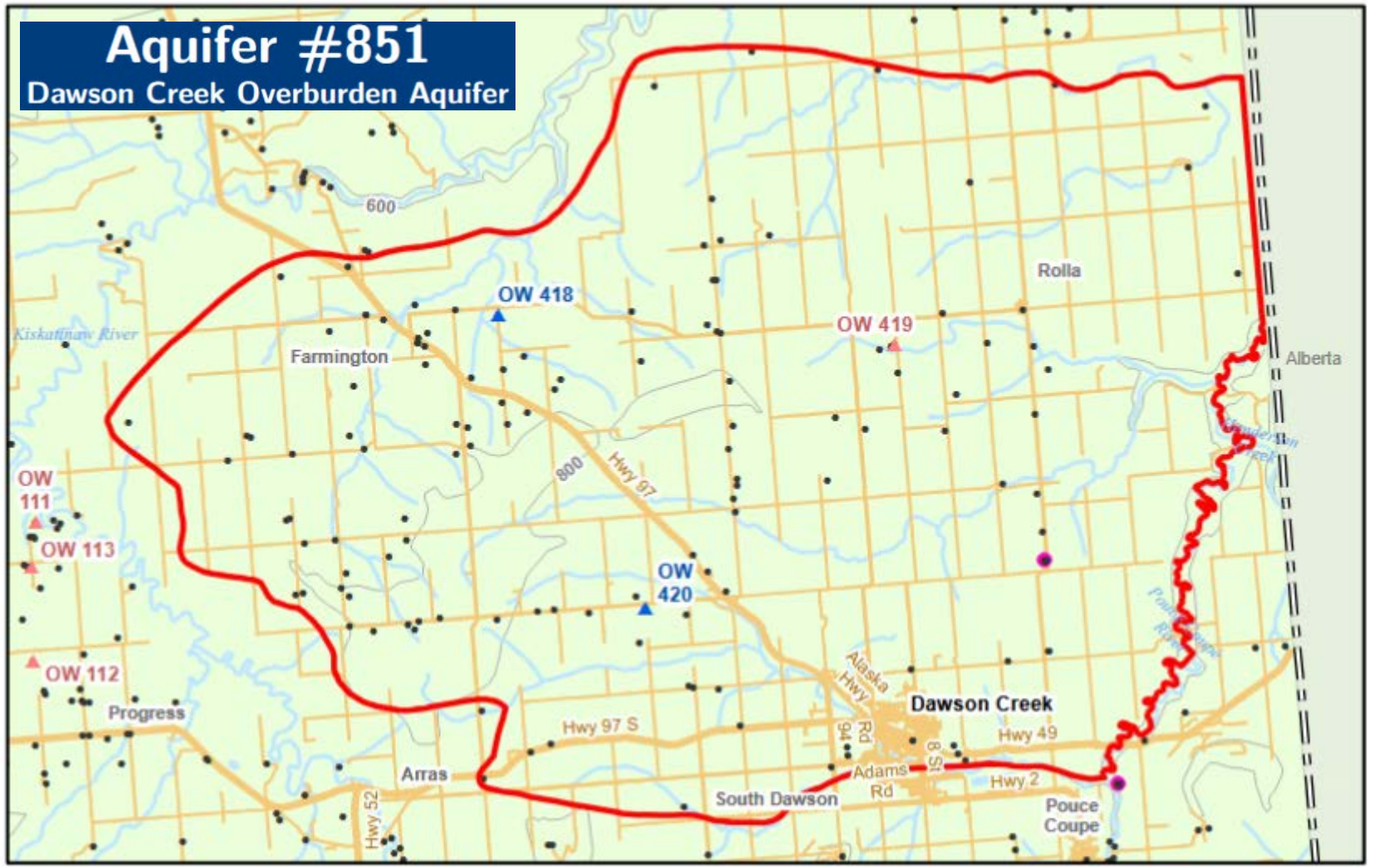


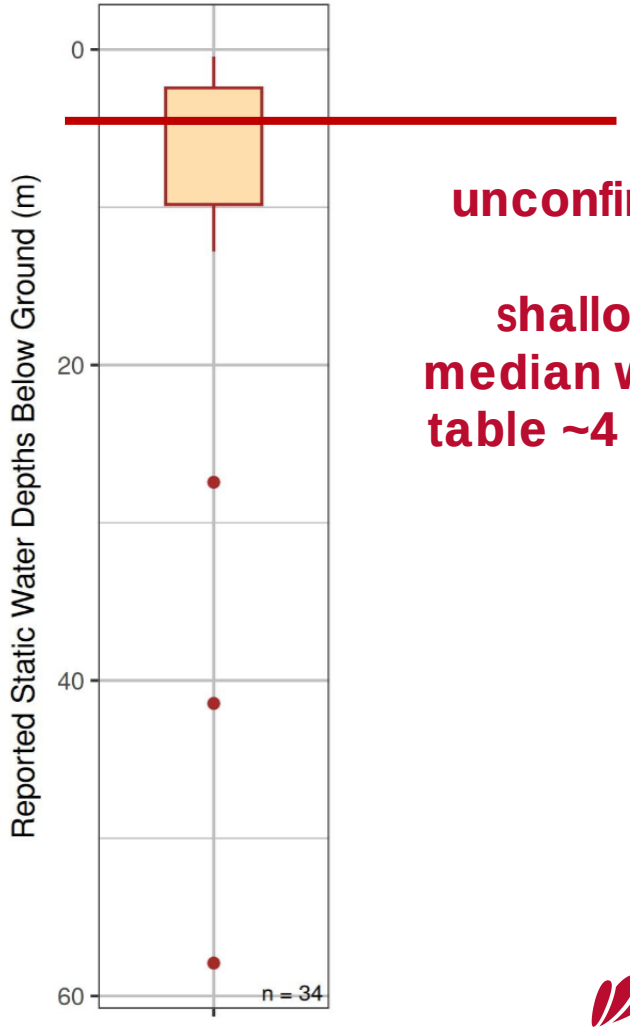
~1.5 mbg

~4 mbg



NE BC



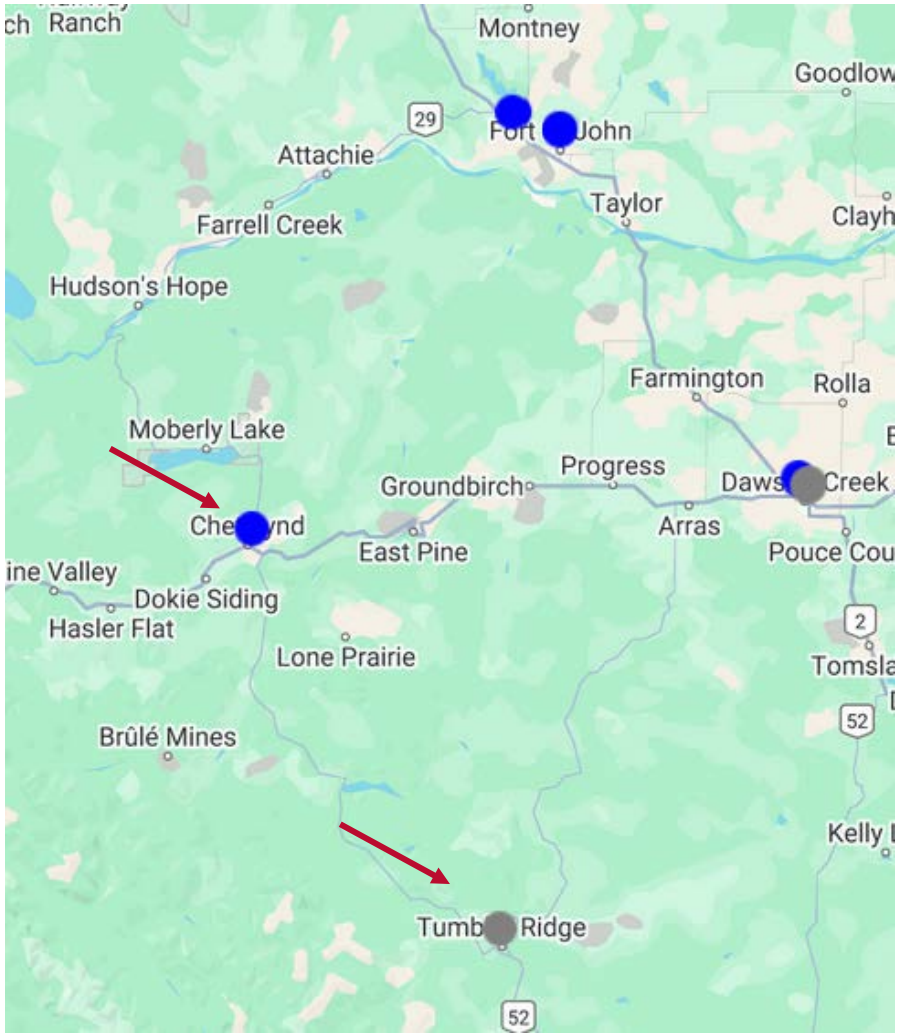


unconfined

shallow median water table ~4 mbg

PGL ENVIRONMENTAL CONSULTANTS

NE BC



additional P9s in Chetwynd & Tumbler Ridge

PGL ENVIRONMENTAL CONSULTANTS

NE BC

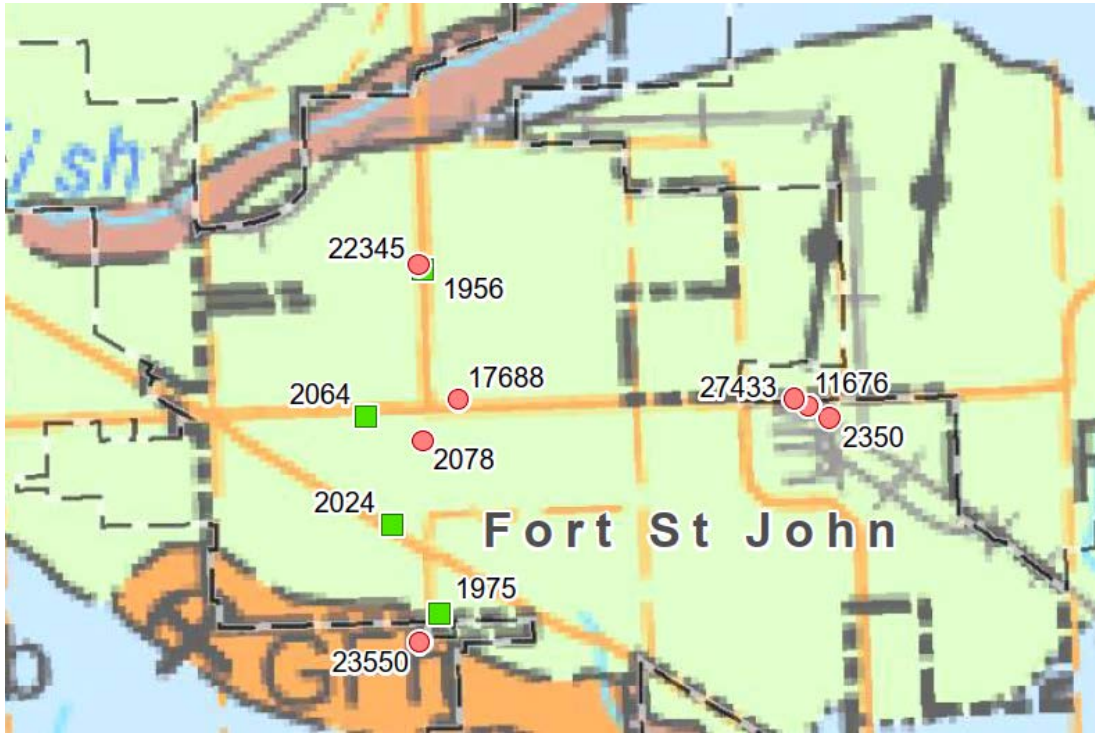
9 new sites since 2018 from ENV dataset...

Region	CofC	P9	Total
Northeast BC	**5**	**4**	**9**
DAWSON CREEK		2	2
FORT ST. JOHN	5	2	7
Total	**5**	**4**	**9**

...5 retained as candidates for background sites after removal of duplicates and report review

PGL ENVIRONMENTAL CONSULTANTS

NE BC



Potential Background Sites (PGL)

Suitable Background Sites (Core6)

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NE BC

SUMMARY

- Reached 10 background sites for region when both municipalities are combined

NEXT STEPS

- data extraction from reports
- statistics if municipalities can be combined or divided into subregions to establish background
- assess if region can be expanded (Chetwynd, Tumbler Ride)

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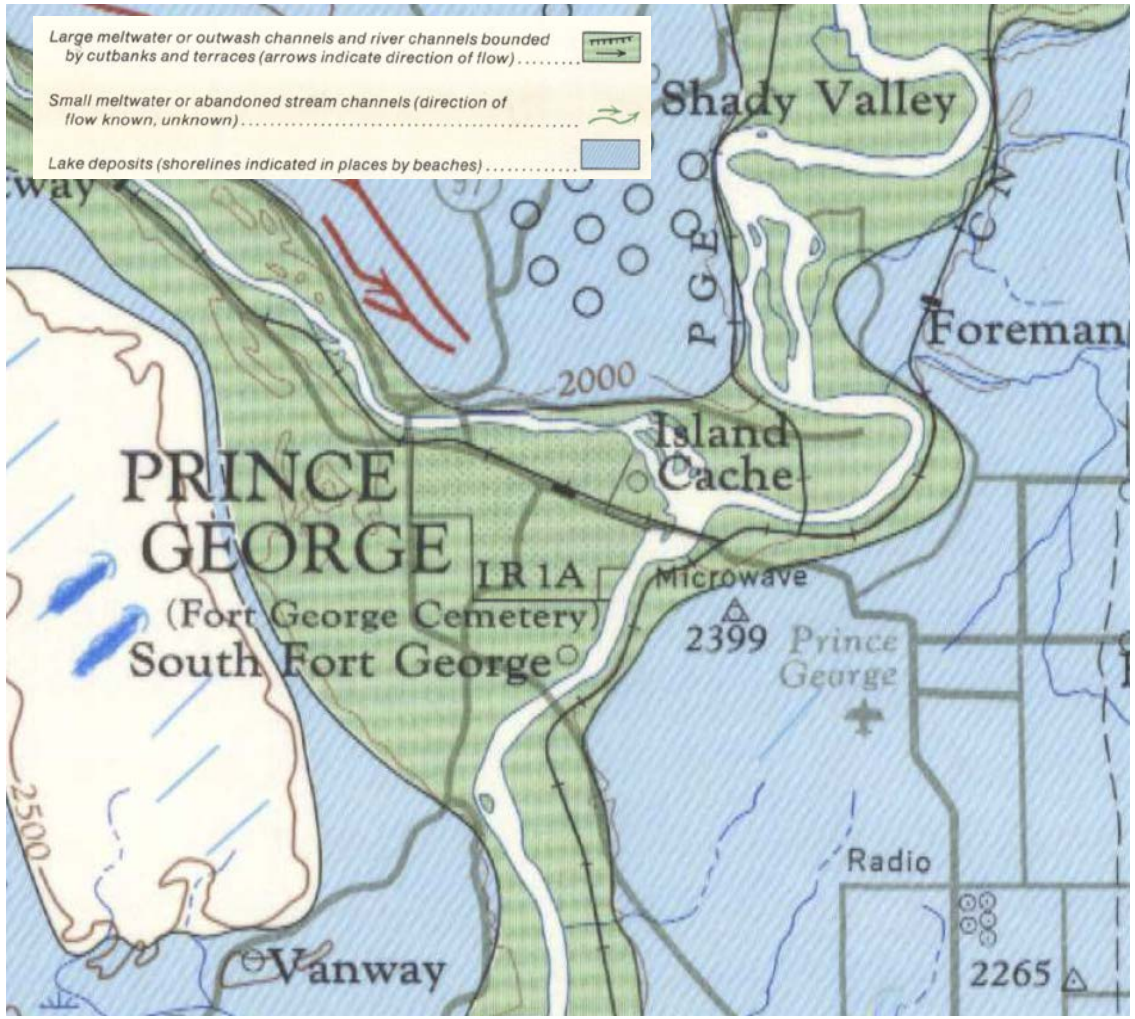
Prince George

2018 study identified 4 suitable sites

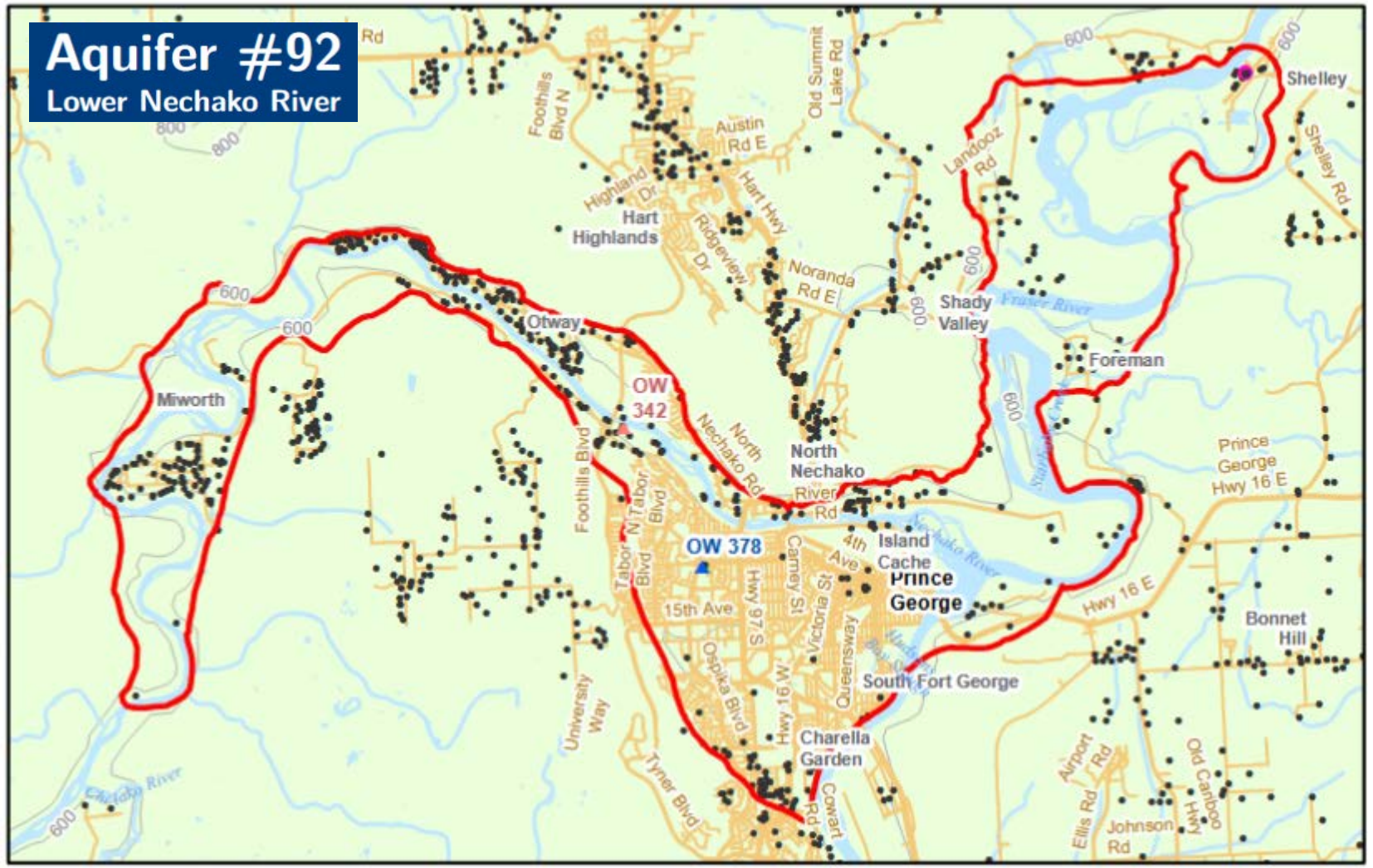
Prince George

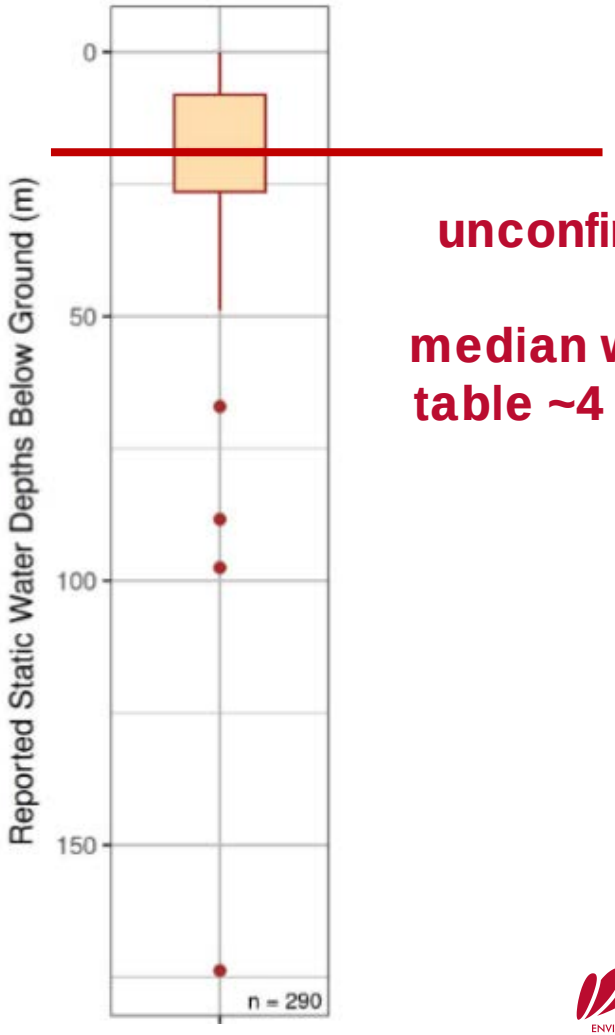


glaciolacustrine and glaciofluvial deposits

PGL ENVIRONMENTAL CONSULTANTS

Prince George





unconfined

median water table ~4 mbg

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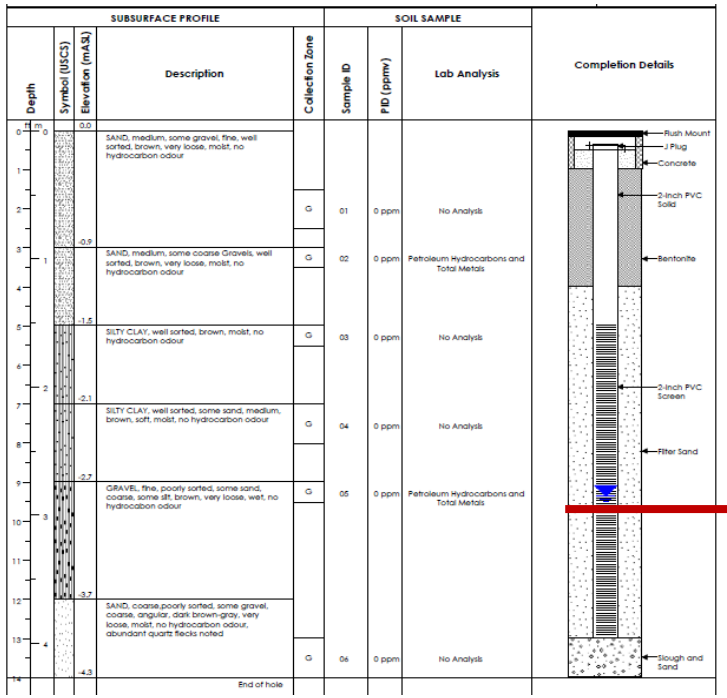
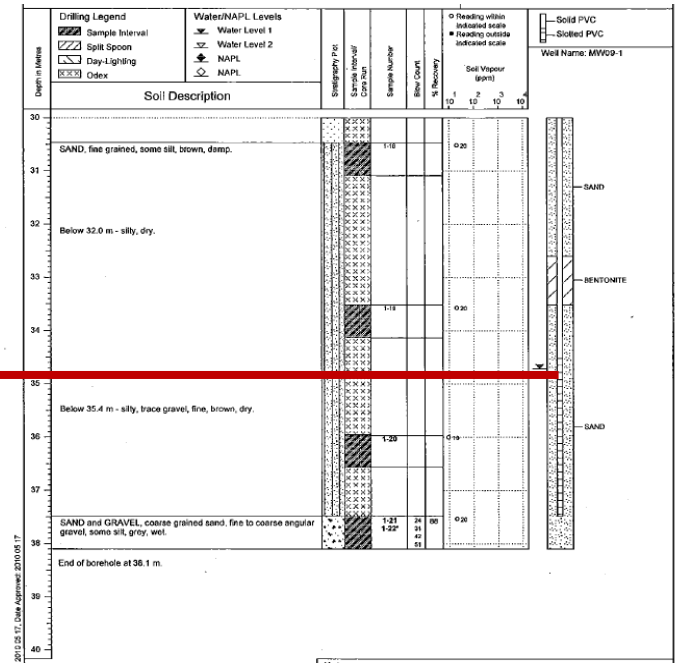
Prince George

BUT, very shallow and very deep water tables…

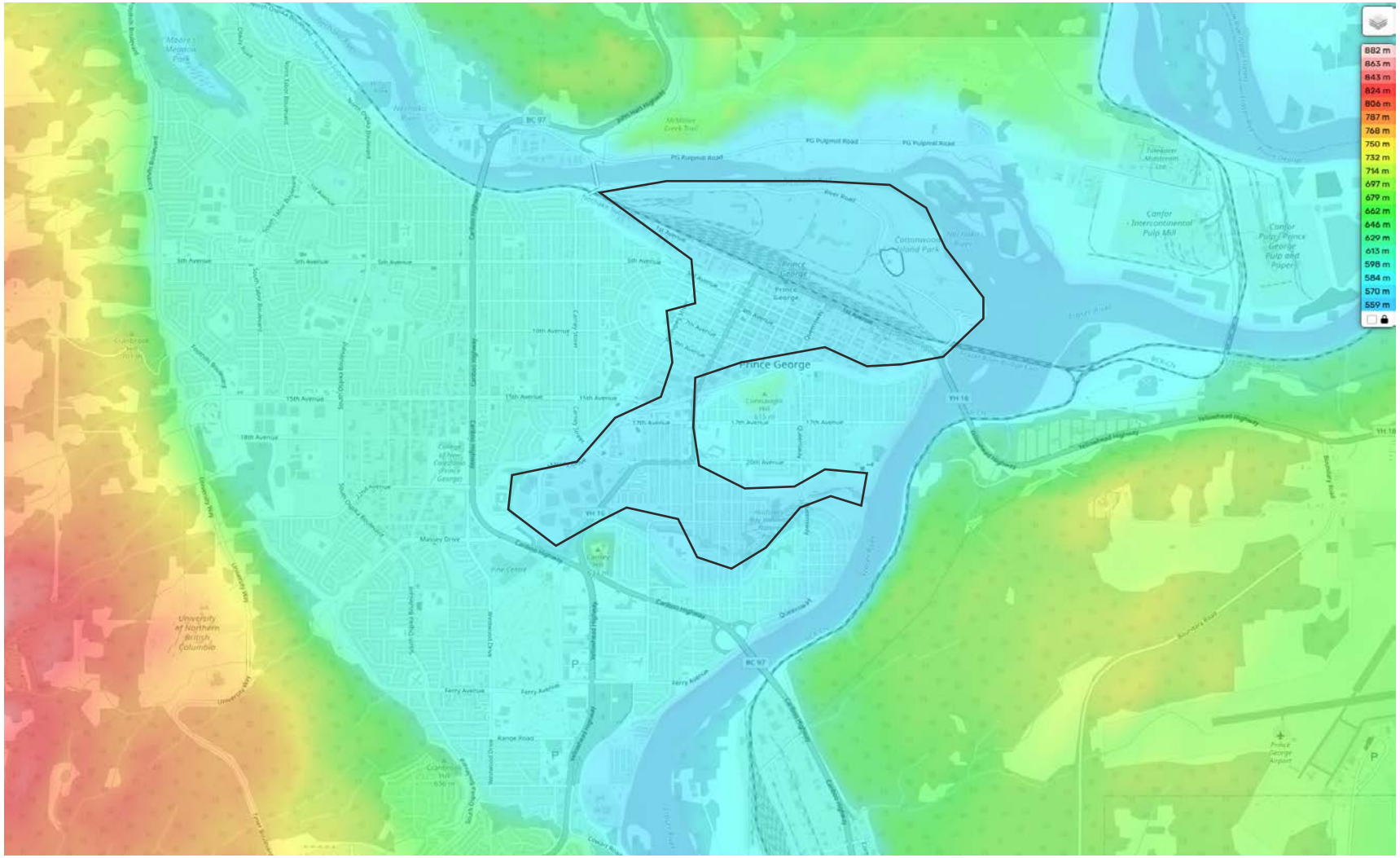


~3 mbg

~35 mbg



Prince George

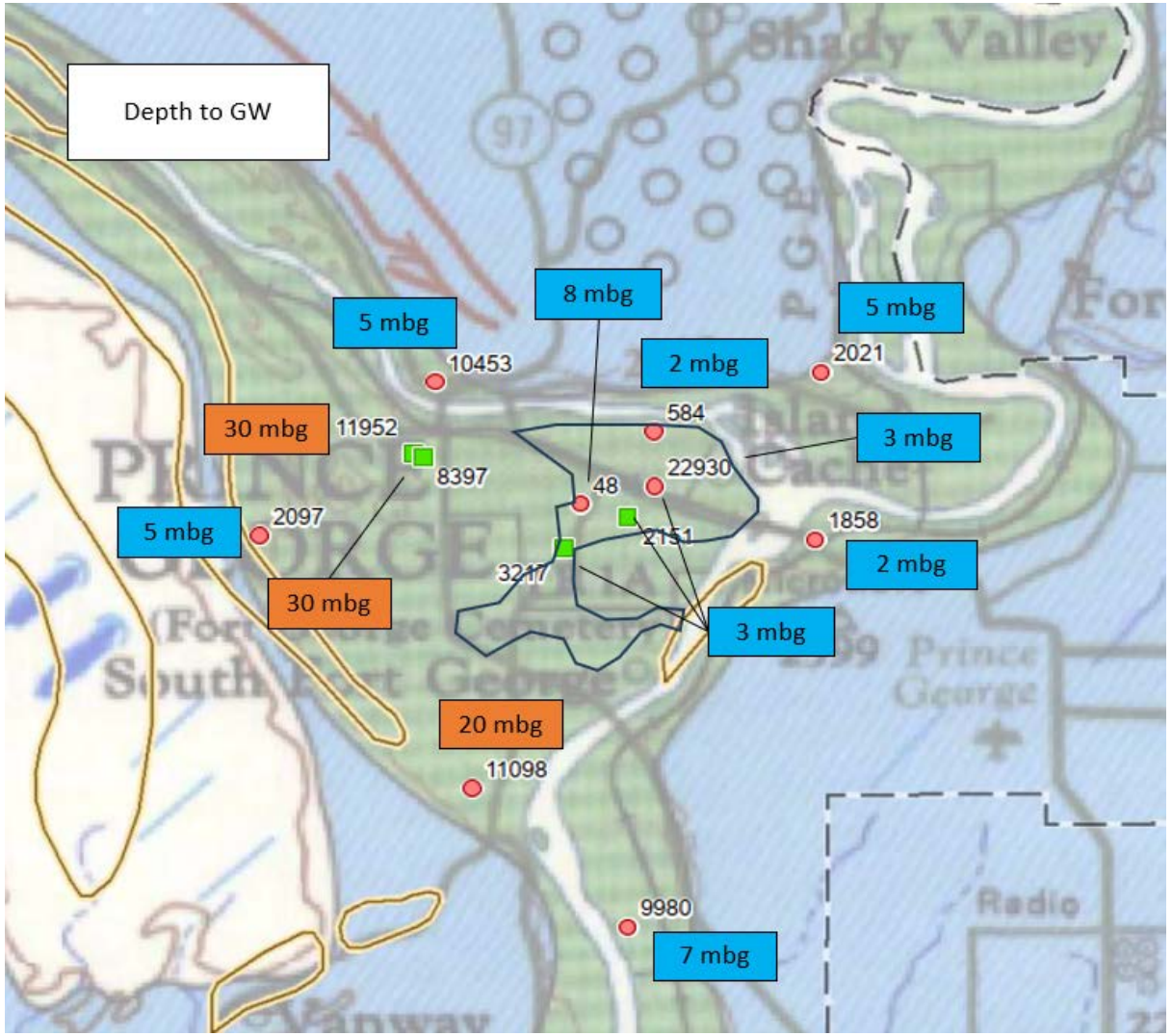


elevation heat map

low lying area

PGL ENVIRONMENTAL CONSULTANTS

Prince George



low lying areas with shallow GW

likely that all MWs with shallow and deep GW tables screened in same mapped unconfined aquifer

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Prince George

14 new sites since 2018 from ENV dataset...

Region	AiP	CofC	Determination (Final)	P9	Total
PRINCE GEORGE	1	9	2	2	14
Total	**1**	**9**	**2**	**2**	**14**

...retained 6 as candidates for background sites after removal of duplicates and report review

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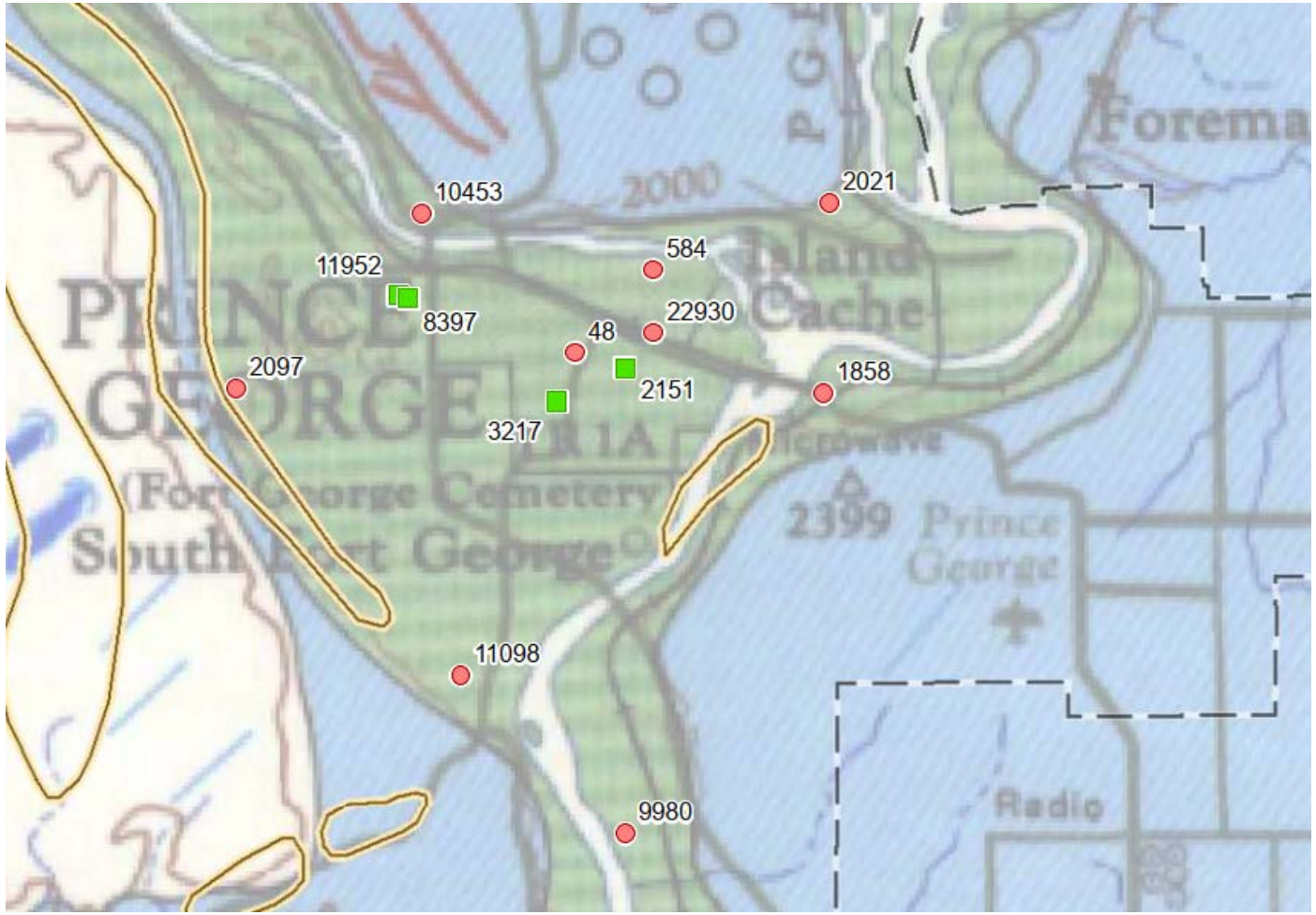
Prince George



- Potential Background Sites (PGL)
- Suitable Background Sites (Core6)

Prince George

SUMMARY

- Reached 10 background sites when considering shallow and deep groundwater screened in same geological unit and unconfined aquifer

NEXT STEPS

- data extraction from reports
- statistics to assess if data of the same population and establish background, if possible

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Potential New Regions

- Identify **new areas of interest (AOIs)** outside the footprint of the established three background regions

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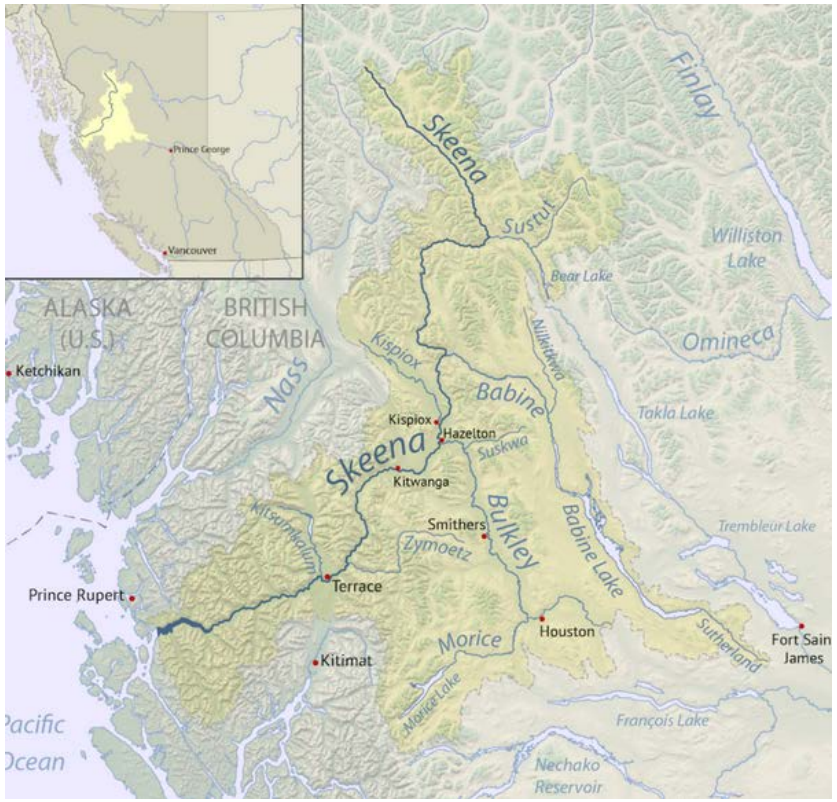
Potential New Regions

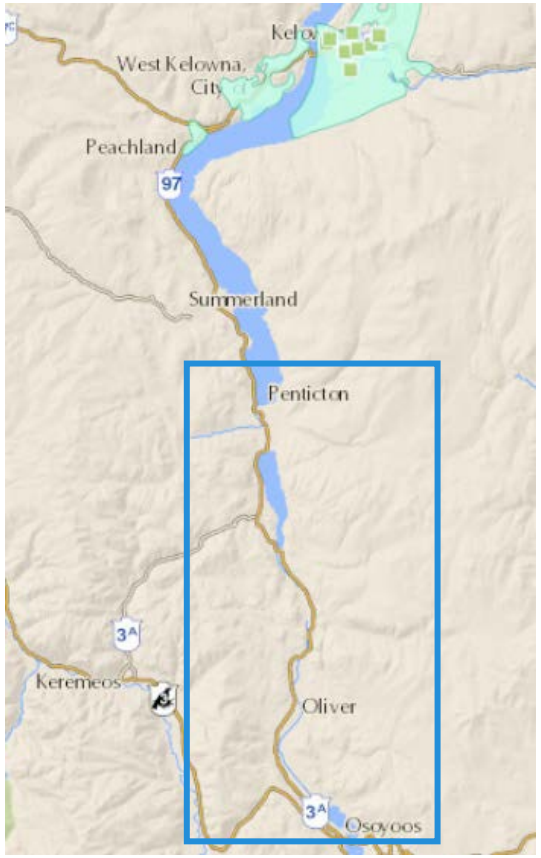
Columbia River catchment



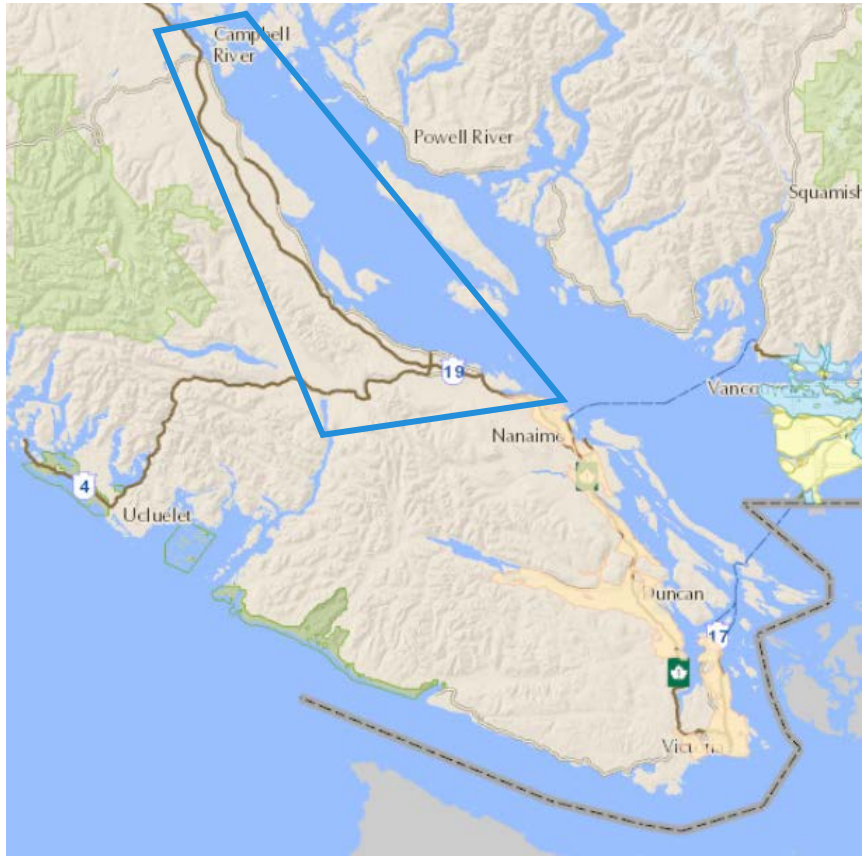
Skeena-Bulkley catchment

PGL ENVIRONMENTAL CONSULTANTS

Potential New Regions



Penticton (Okanagan Basin)



Mid-Island

Potential New Regions

2018-2024 dataset

...used to evaluate number of Site IDs available in regions

Row Labels	AiP	CofC	Determination (Final)	Determination (Preliminary)	P9	Grand Total
Lower Mainland	129	340	78	8	10	565
South Vancouver Island	22	56	9		2	89
Thompson-Okanagan	4	40	3		4	51
Northeast BC		5			4	9
Prince George	1	9	2		2	14
Rest of BC	13	100	17	3	10	143
Grand Total	**169**	**550**	**109**	**11**	**32**	**871**

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Instruments and decisions since 2018

where are site IDs outside the established regions?

Row Labels	AiP	CofC	Determination (Final)	Determination (Preliminary)	P9	Grand Total
Rest of BC	13	100	17	3	10	143

Potential New Regions

Row Labels	AiP	CofC	Determination (Final)	Determination (Preliminary)	P9	Grand Total
Lower Mainland	129	340	78	8	10	565
South Vancouver Island	22	56	9		2	89
Thompson-Okanagan	4	40	3		4	51
Northeast BC		5			4	9
Prince George	1	9	2		2	14
Rest of BC	13	100	17	3	10	143

Potential Regions	AiP	CofC	Determination (Final)	Determination (Preliminary)	P9	Total
Penticton	1	4	1	1	1	**8**
Mid-Island	1	14	3	1	2	**21**
Skeena-Bulkley	3	23	2		1	**29**
Columbia River		25	1		4	**30**
Total	**5**	**66**	**7**	**2**	**8**	**88**

60%
of total

80% P9s

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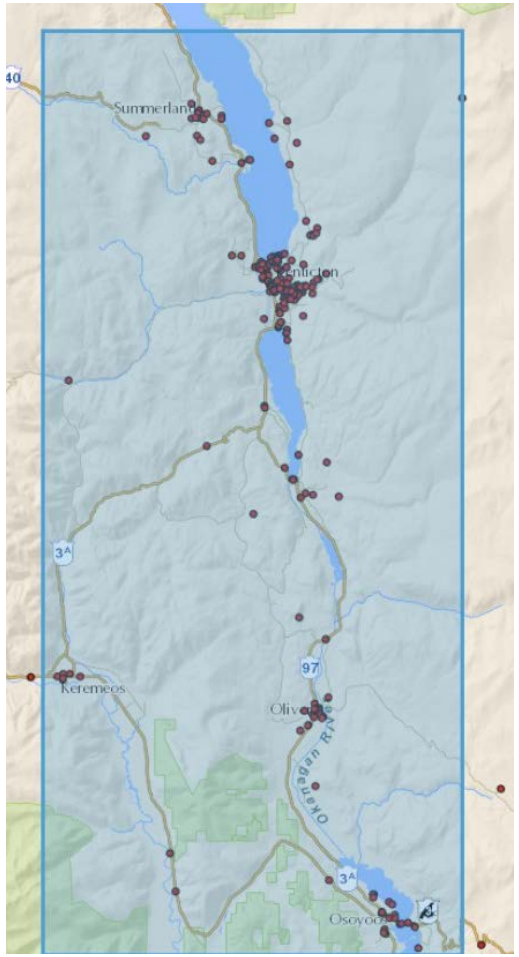
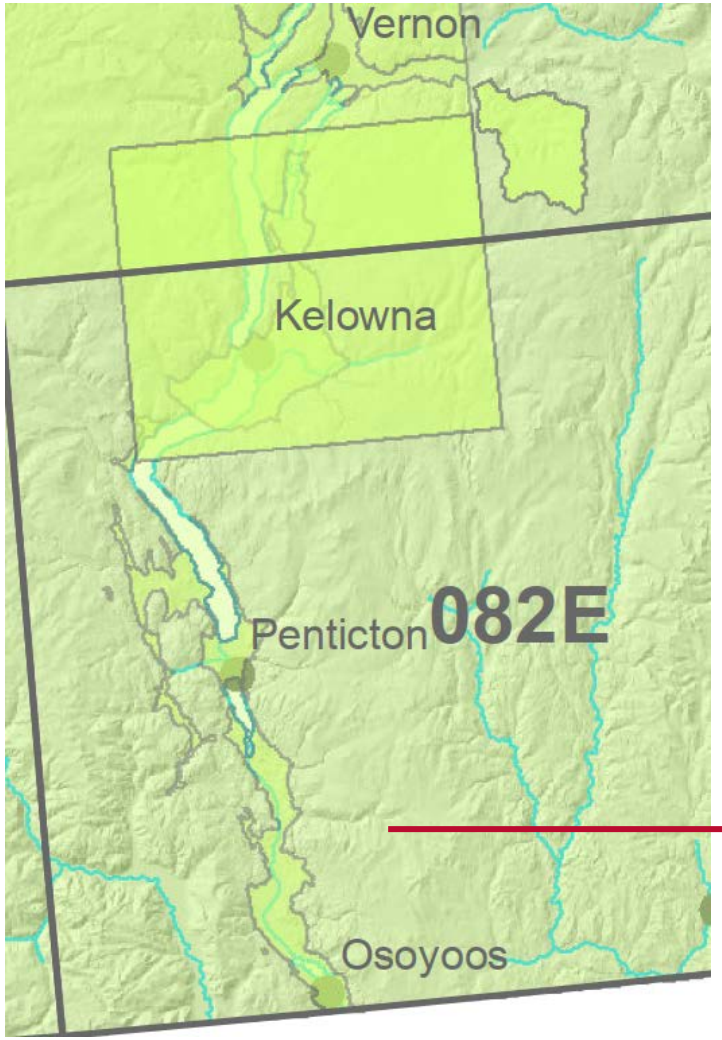
ENVIRONMENTAL CONSULTANTS

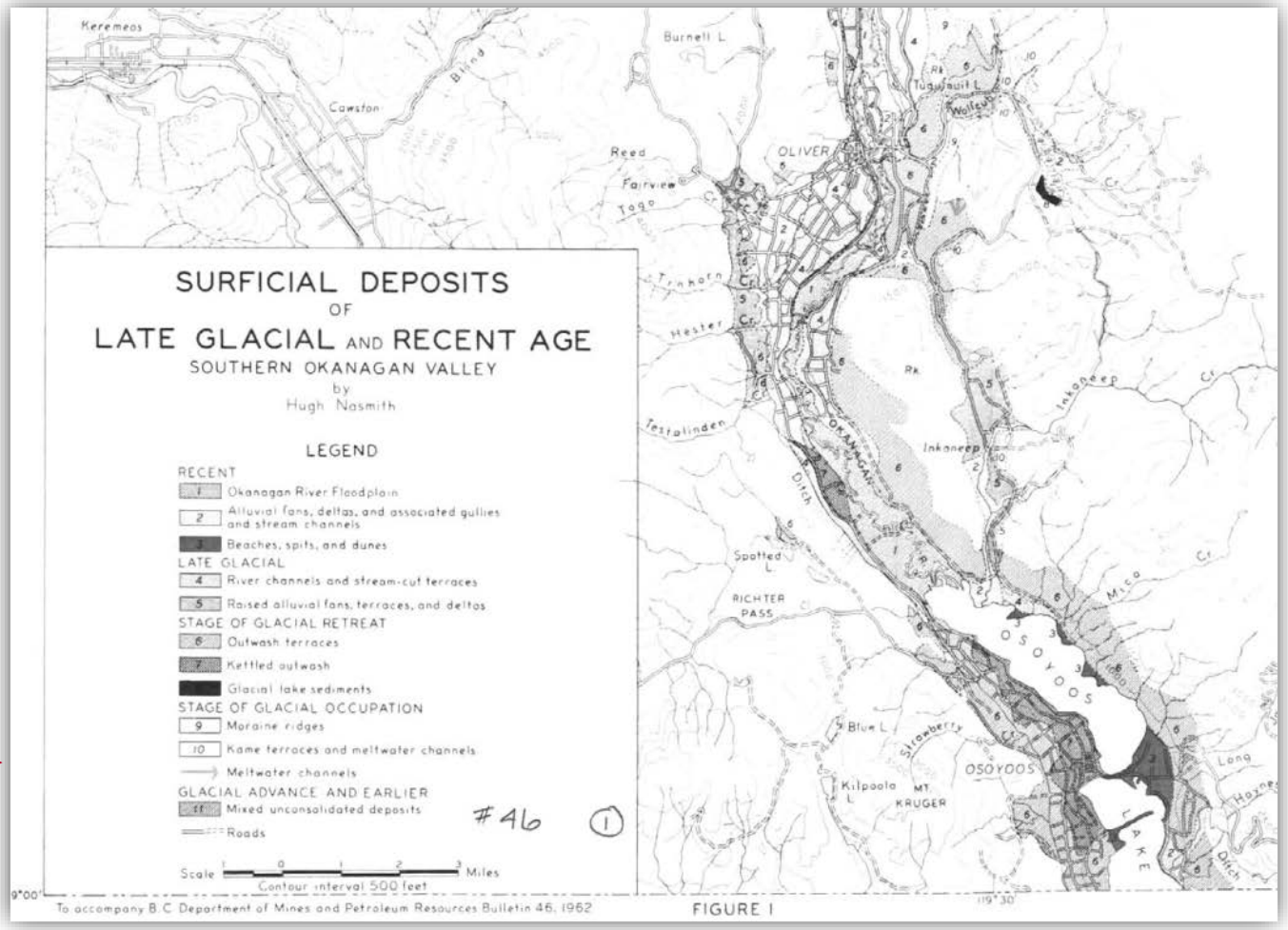
Penticton


Okanagan Lake
Kelowna
Penticton

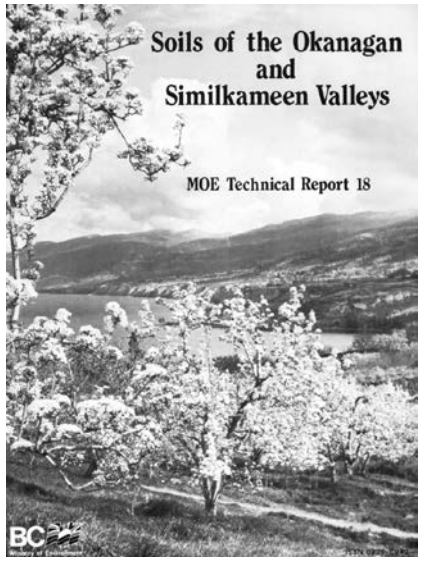

Summerland
Penticton
Keremeos
Oliver
Osoyoos
97
3A

Penticton

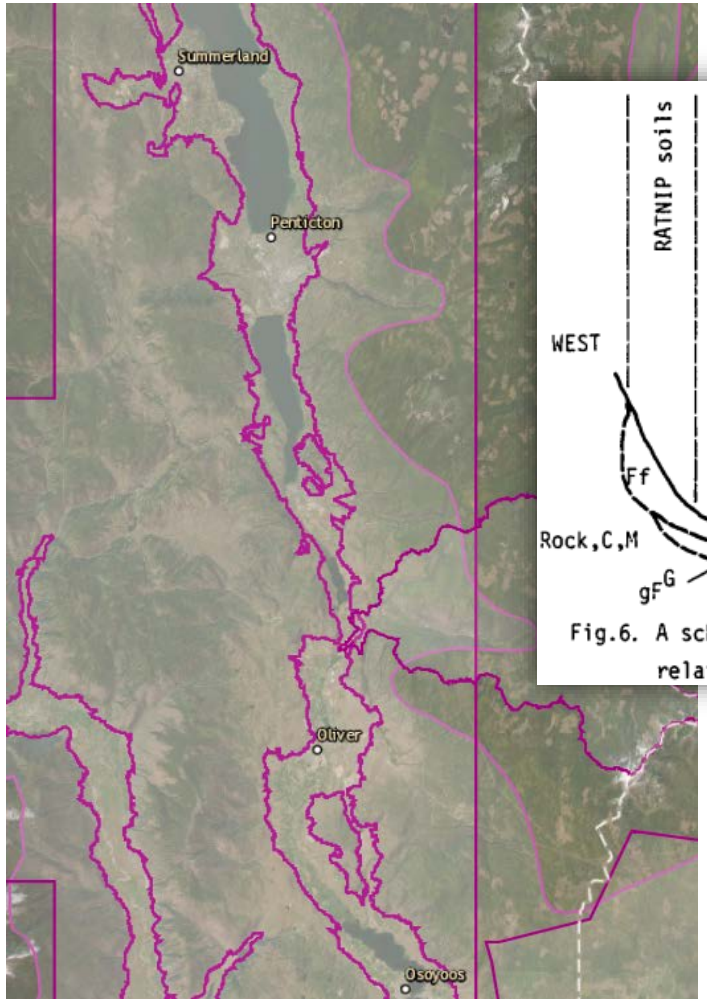

Vernon
Kelowna
Penticton
082E
Osoyoos


SURFICIAL DEPOSITS
OF
LATE GLACIAL AND RECENT AGE
SOUTHERN OKANAGAN VALLEY
by
Hugh Nasmith
LEGEND
RECENT
1 Okanagan River Floodplain
2 Alluvial fans, deltas, and associated gullies and stream channels
3 Beaches, spits, and dunes
LATE GLACIAL
4 River channels and stream-cut terraces
5 Raised alluvial fans, terraces, and deltas
STAGE OF GLACIAL RETREAT
6 Outwash terraces
7 Kettled outwash
Glacial lake sediments
STAGE OF GLACIAL OCCUPATION
9 Moraine ridges
10 Kame terraces and meltwater channels
Meltwater channels
GLACIAL ADVANCE AND EARLIER
11 Mixed unconsolidated deposits
Roads
#46
Scale
Miles
Contour interval 500 feet
To accompany B.C. Department of Mines and Petroleum Resources Bulletin 46, 1962
FIGURE 1
Keremeos
Cawston
Burnell L.
Reed
Fairview
OLIVER
Testalinden
Inkaneep
Spotted L.
RICHTER PASS
OSOYOOS
Blue L.
Kilpoola L.
MT. KRUGER
LAKE

Penticton



soil survey mapping



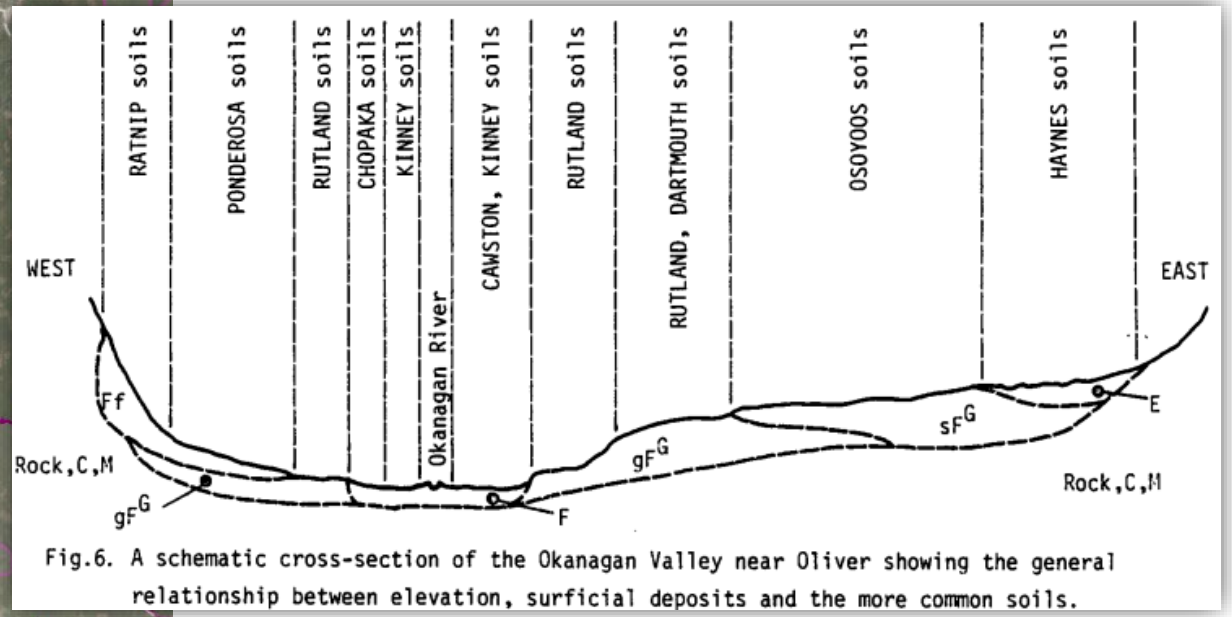


Fig.6. A schematic cross-section of the Okanagan Valley near Oliver showing the general relationship between elevation, surficial deposits and the more common soils.

surficial deposits

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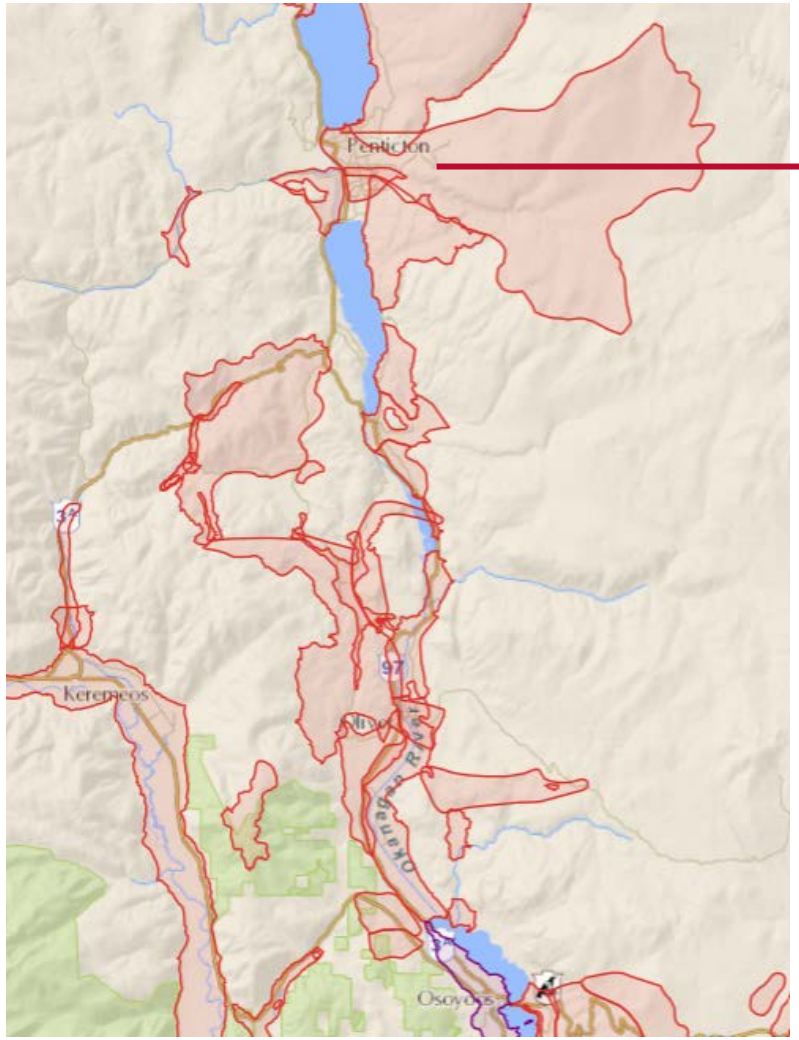
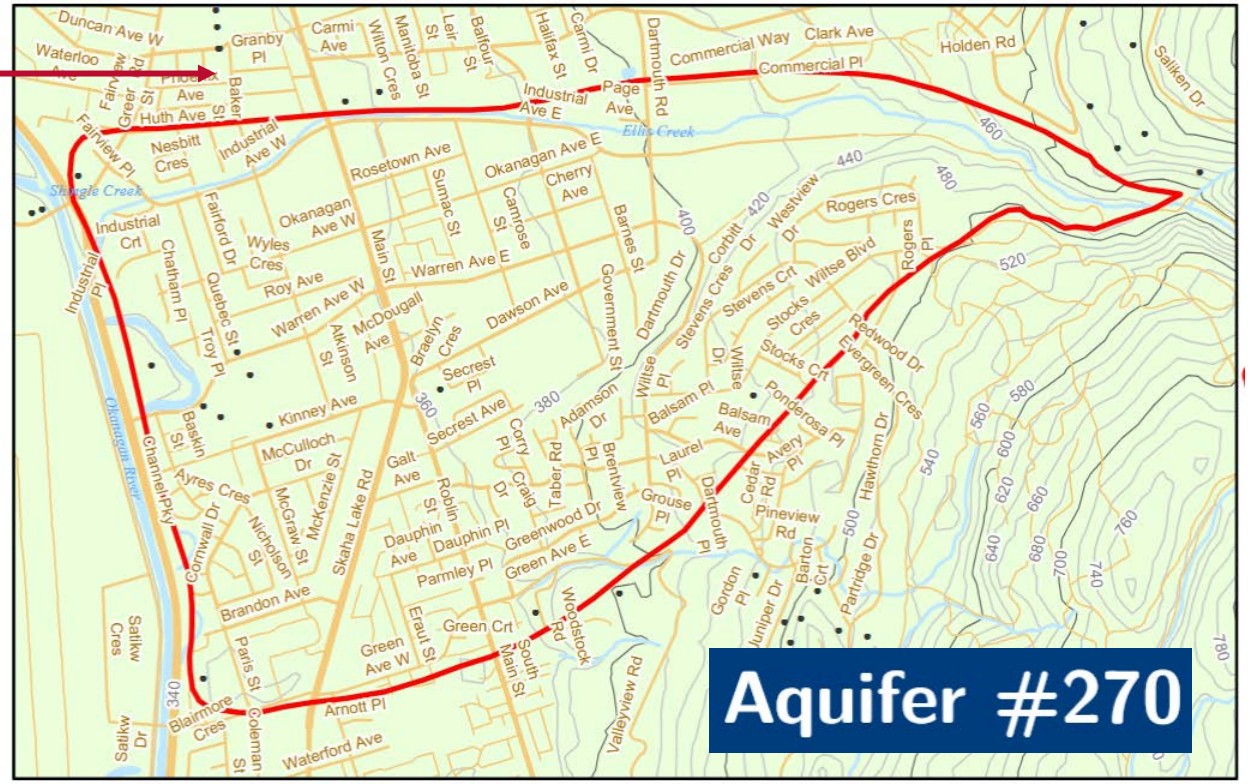
Penticton

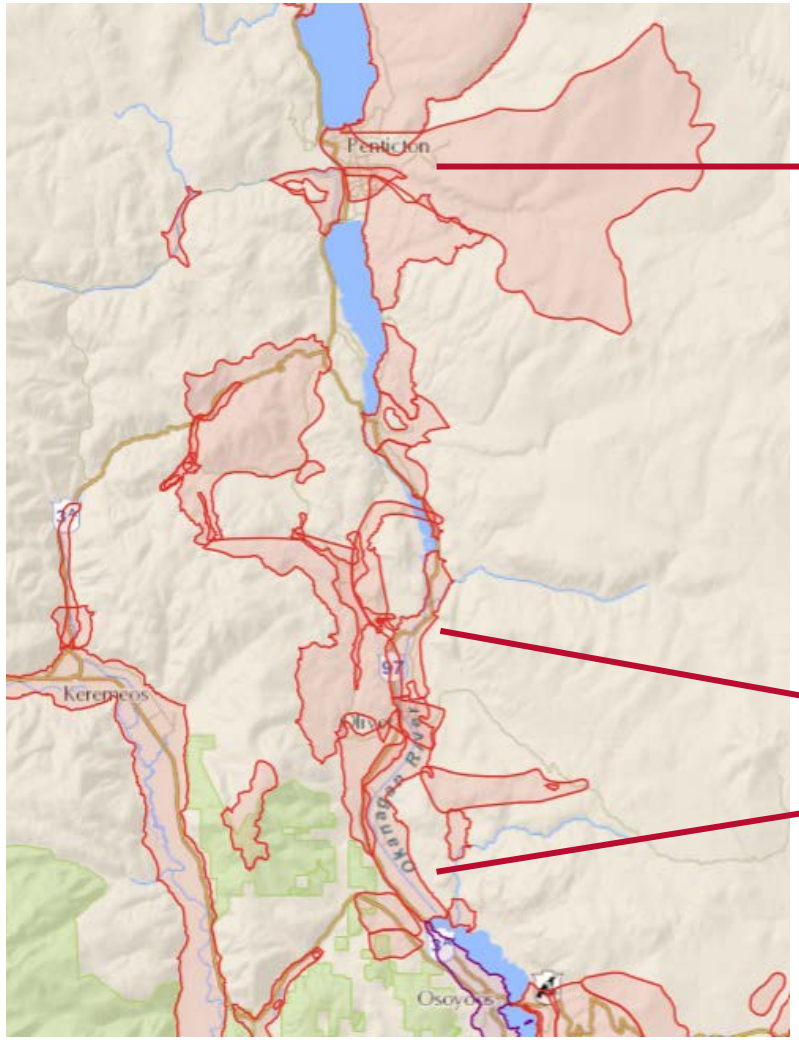




unconfined and bedrock aquifers

PGL ENVIRONMENTAL CONSULTANTS

Penticton



Aquifer #270

?

Aquifer #255

Discharges to Aquifer 254, which we consider the southern extension of the same aquifer;

Aquifer #254

Penticton

~90 potential sites for further evaluation after removing duplicates

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**2**	**2**	**4**			**8**
Oliver		1				1
Penticton	2	1	4			7
Pre-2018 Dataset	**2**	**6**	**30**	**4**	**38**	**80**
Keremeos			2		3	5
Naramata					1	1
Okanagan Falls			1		2	3
Oliver		1	1	1	2	5
Osoyoos	1		3		5	9
Penticton	1	5	22	4	20	51
Summerland			1		5	6
Total	**4**	**8**	**34**	**5**	**38**	**89**

PGL ENVIRONMENTAL CONSULTANTS

Penticton

example of summary table with Site IDs for further evaluation

Table 4
List of Site IDs for Penticton
Background Groundwater Concentrations at Sites in British Columbia
CSAP Society, PGL File 4136-230.01

Site ID	City/Town/Hamlet	Service	Received Date	Completed Date	Database
348	Penticton	Investigation Report	.	09-Jul-1990	pre-2018
415	Penticton	Investigation Report	.	15-Jul-1992	pre-2018
766	Penticton	CofC	.	14-Jan-2009	pre-2018
1101	Penticton	CofC	.	12-Aug-2004	pre-2018
2224	Osoyoos	Investigation Report	.	05-Oct-1993	pre-2018
2225	Osoyoos	Investigation Report	.	05-Oct-1993	pre-2018
2235	Osoyoos	Investigation Report	.	30-Aug-1993	pre-2018
2237	Osoyoos	P9	.	16-May-2014	pre-2018
2241	Osoyoos	Investigation Report	.	08-Jul-1993	pre-2018
2271	Oliver	AiP	.	06-Dec-1996	pre-2018
2272	Keremeos	Investigation Report	.	29-Jul-1992	pre-2018
2281	Okanagan Falls	Investigation Report	.	24-Mar-1994	pre-2018
2348	Penticton	Investigation Report	.	07-Mar-1996	pre-2018
2356	Keremeos	CofC	.	25-Jul-1996	pre-2018
2358	Penticton	Investigation Report	.	16-Dec-1993	pre-2018
2361	Penticton	CofC	.	29-Apr-2013	pre-2018
2380	Summerland	Investigation Report	.	03-Nov-1994	pre-2018
2382	Penticton	CofC	.	12-Feb-2009	pre-2018
2395	Penticton	CofC	2021-11-24	.	2018-2024

PGL ENVIRONMENTAL CONSULTANTS

Penticton

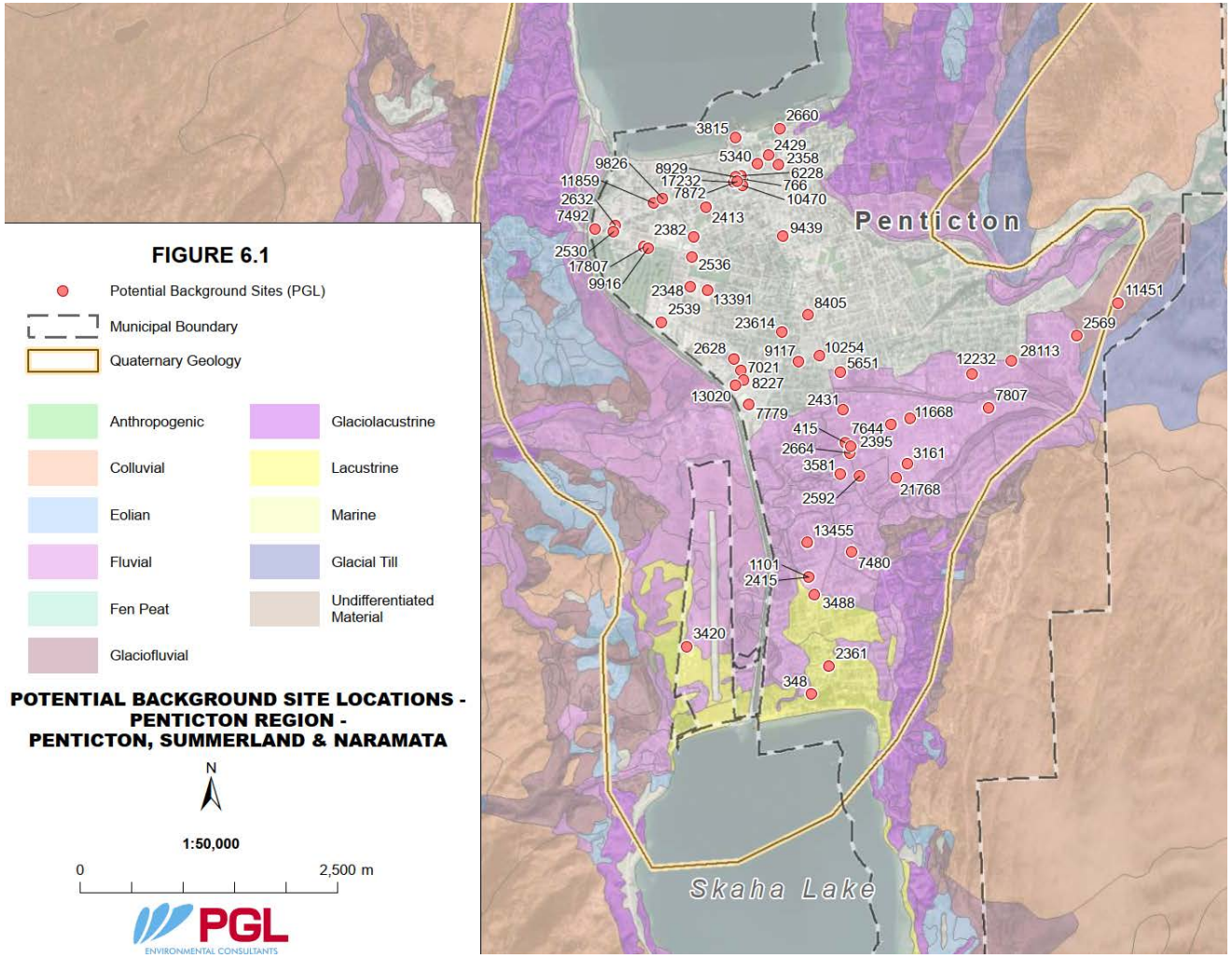
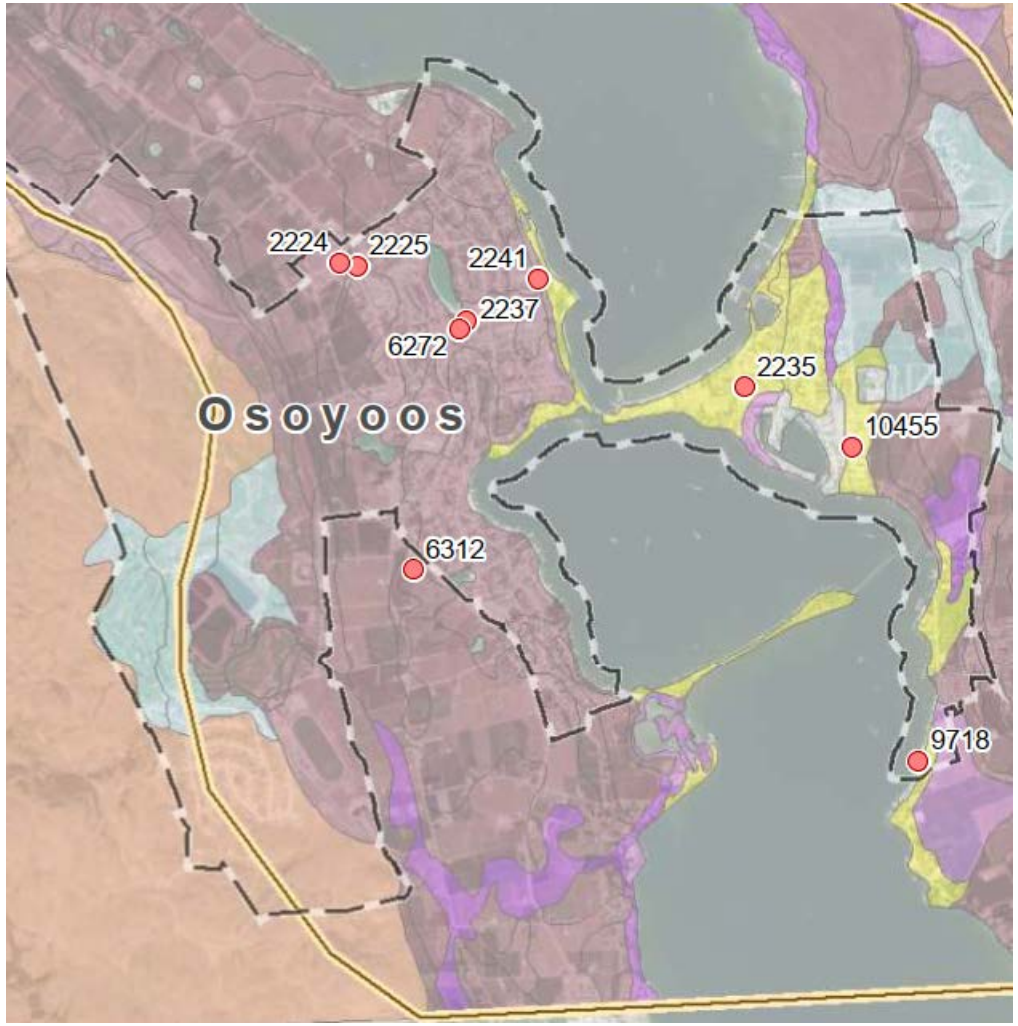


FIGURE 6.1
Potential Background Sites (PGL)
Municipal Boundary
Quaternary Geology
Anthropogenic
Colluvial
Eolian
Fluvial
Fen Peat
Glaciofluvial
Glaciolacustrine
Lacustrine
Marine
Glacial Till
Undifferentiated Material
POTENTIAL BACKGROUND SITE LOCATIONS - PENTICTON REGION - PENTICTON, SUMMERLAND & NARAMATA
N
1:50,000
0
2,500 m
PGL
ENVIRONMENTAL CONSULTANTS
Penticton
Skaha Lake
3815
2660
2429
5340
2358
9826
8929
6228
11859
17232
766
7872
10470
2632
2413
7492
2382
9439
2530
2536
17807
9916
2348
13391
8405
11451
2539
23614
2569
2628
9117
10254
28113
7021
5651
12232
8227
13020
2431
7807
7779
11668
415
7644
2664
2395
3161
3581
21768
2592
13455
7480
1101
2415
3488
3420
2361
348


Osoyoos
2224
2225
2241
2237
6272
2235
10455
6312
9718

Penticton

SUMMARY

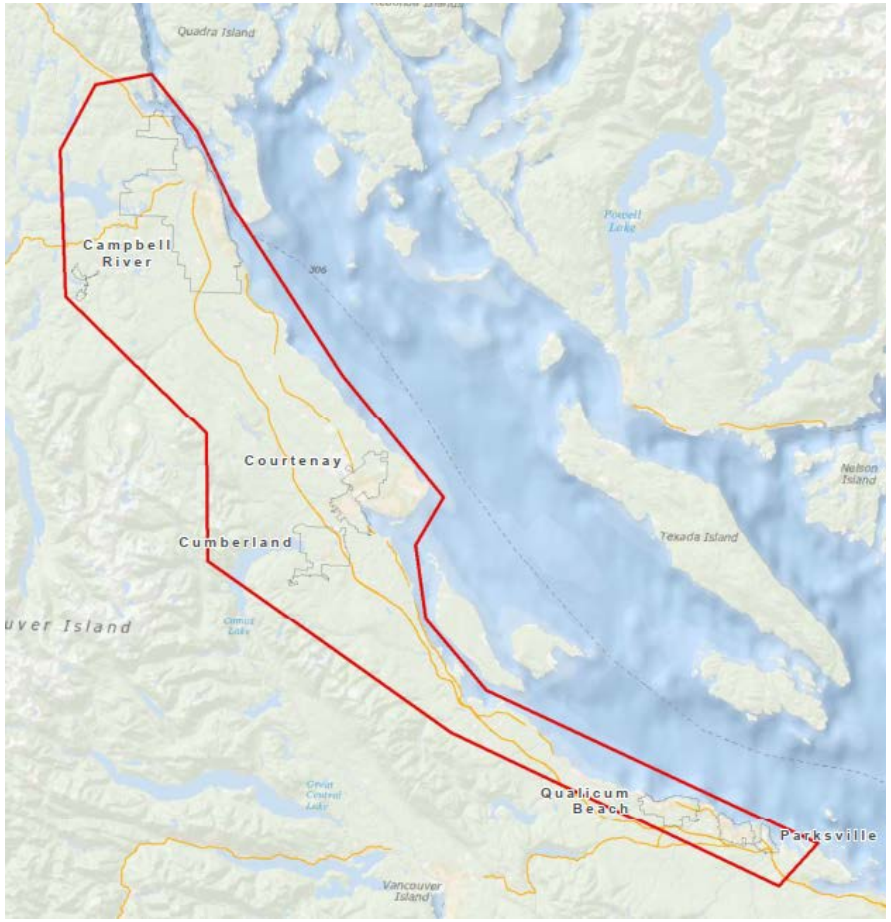
- Penticton with ~60 sites, 2 of which P9s
- Surrounding municipalities with an additional ~30 sites
- Surficial geology (fluvial, glaciofluvial, glaciolacustrine, and colluvium) similar to established region to the north

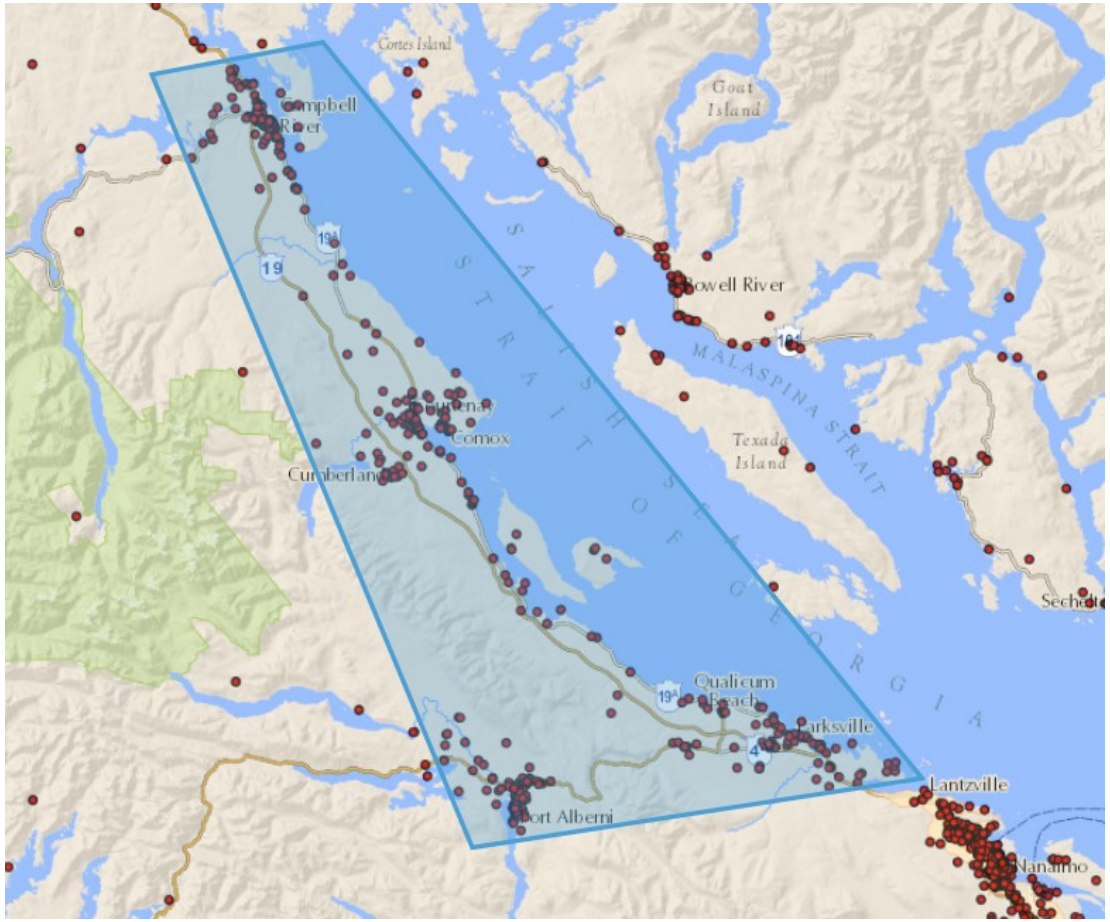
CONCLUSION

- likely feasible to establish background

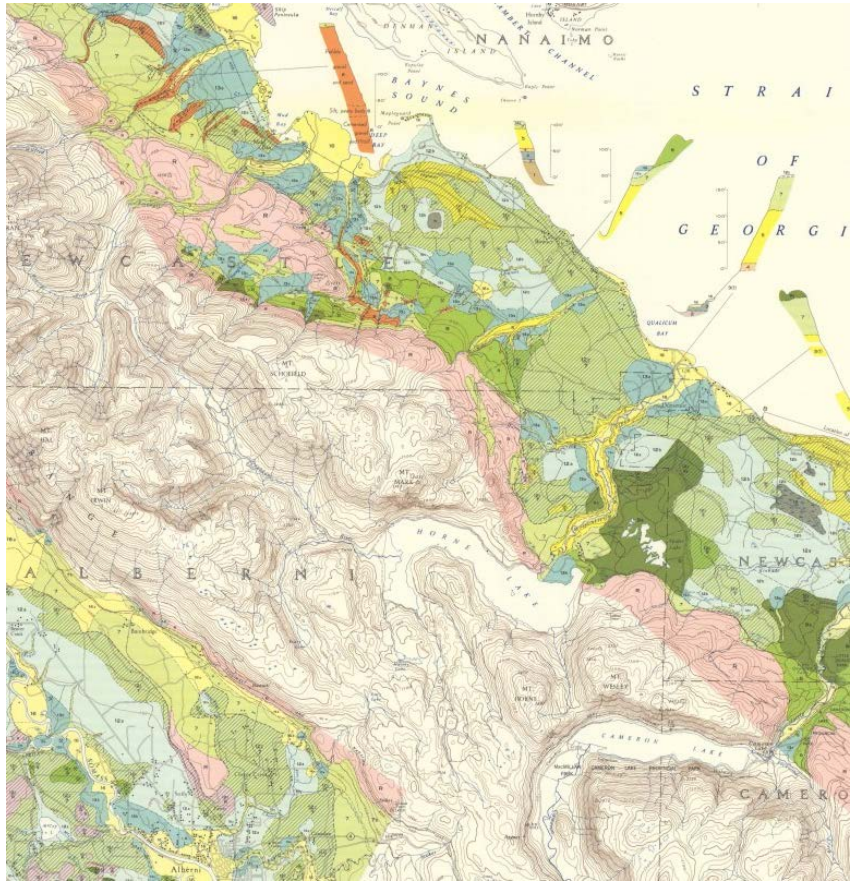
PGL
ENVIRONMENTAL CONSULTANTS

Mid-Island

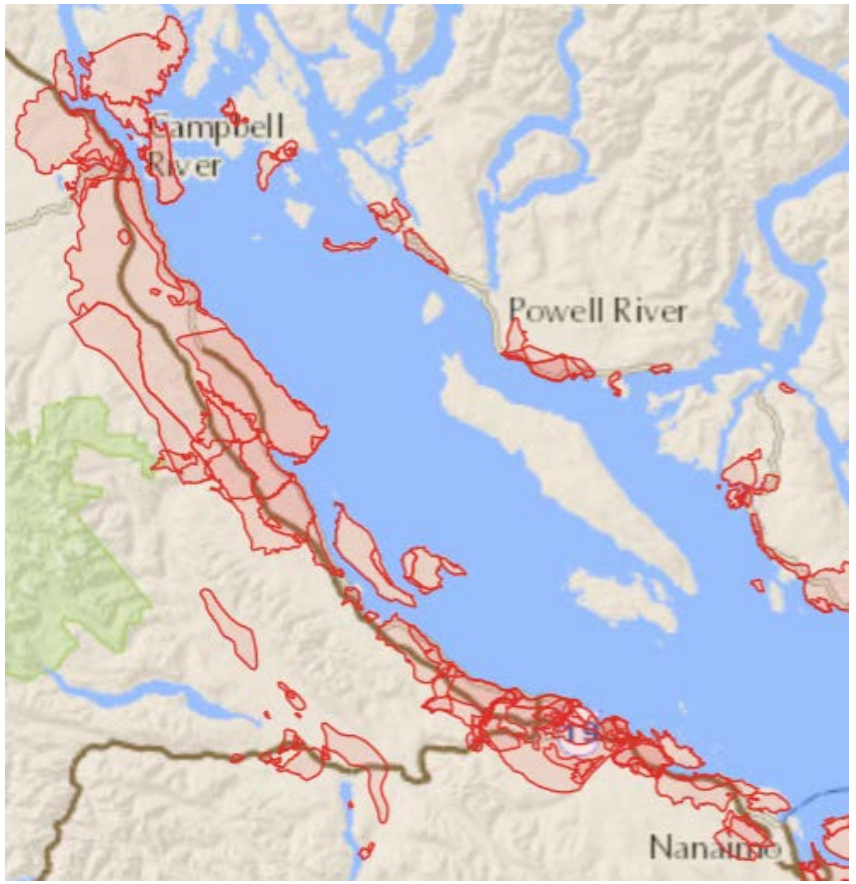

Quadra Island
Campbell River
Courtenay
Cumberland
Qualicum Beach
Parksville
Nelson Island
Texada Island
Vancouver Island


Cortes Island
Campbell River
Goat Island
Powell River
Comox
Cumberland
Texada Island
Qualicum Beach
Parksville
Port Alberni
Lantzville
Nanaimo
STRAIT OF GEORGIA
MALASPINA STRAIT

Mid-Island



surficial geology
&
aquifer mapping



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Mid-Island

~100 potential sites for further evaluation after removing duplicates

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**1**	**4**	**10**	**1**		**16**
Campbell River	1	2	6			9
Comox		1	2			3
Errington			1			1
Parksville		1				1
Qualicum Beach			1			1
Union Bay				1		1
Pre-2018 Dataset		**5**	**29**	**3**	**51**	**88**
Bowser					1	1
Campbell River		2	13	1	16	32
Comox			1		2	3
Courtenay		1	12	2	15	30
Cumberland					3	3
Errington		1			1	2
Fanny Bay					1	1
Nanoose Bay			1		1	2
Parksville		1	1		7	9
Qualicum Beach			1		4	5
Total	**1**	**9**	**39**	**4**	**51**	**104**

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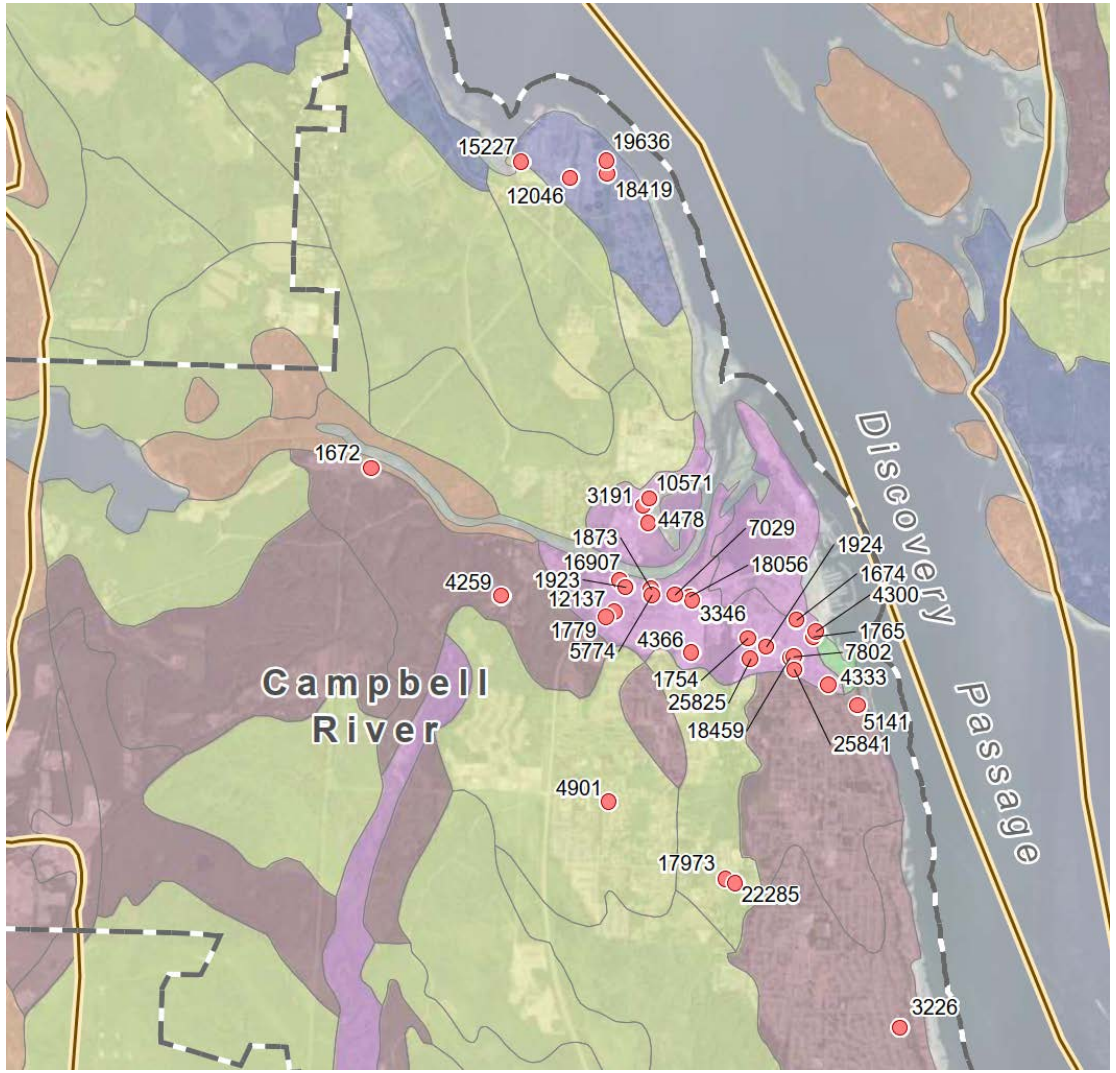
Mid-Island


15227
19636
12046
18419
1672
10571
3191
4478
7029
1873
1924
16907
18056
1674
4259
1923
4300
12137
3346
1765
1779
4366
7802
5774
1754
4333
25825
5141
18459
25841
4901
17973
22285
3226
Campbell River
Discovery Passage

Mid-Island

SUMMARY

- Just a single P9 (Campbell River)
- Campbell River ~40 sites
- Surficial Geology similar to established region to the south (quaternary alluvium and cover materials)
- Mapped aquifers within the quaternary deposits that blanket the area
- Most sites from pre-2018 (hardcopy file retrieval)
- Lots of gas/service stations
- Saltwater intrusion

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Mid-Island

CONCLUSION

- potentially feasible to establish background

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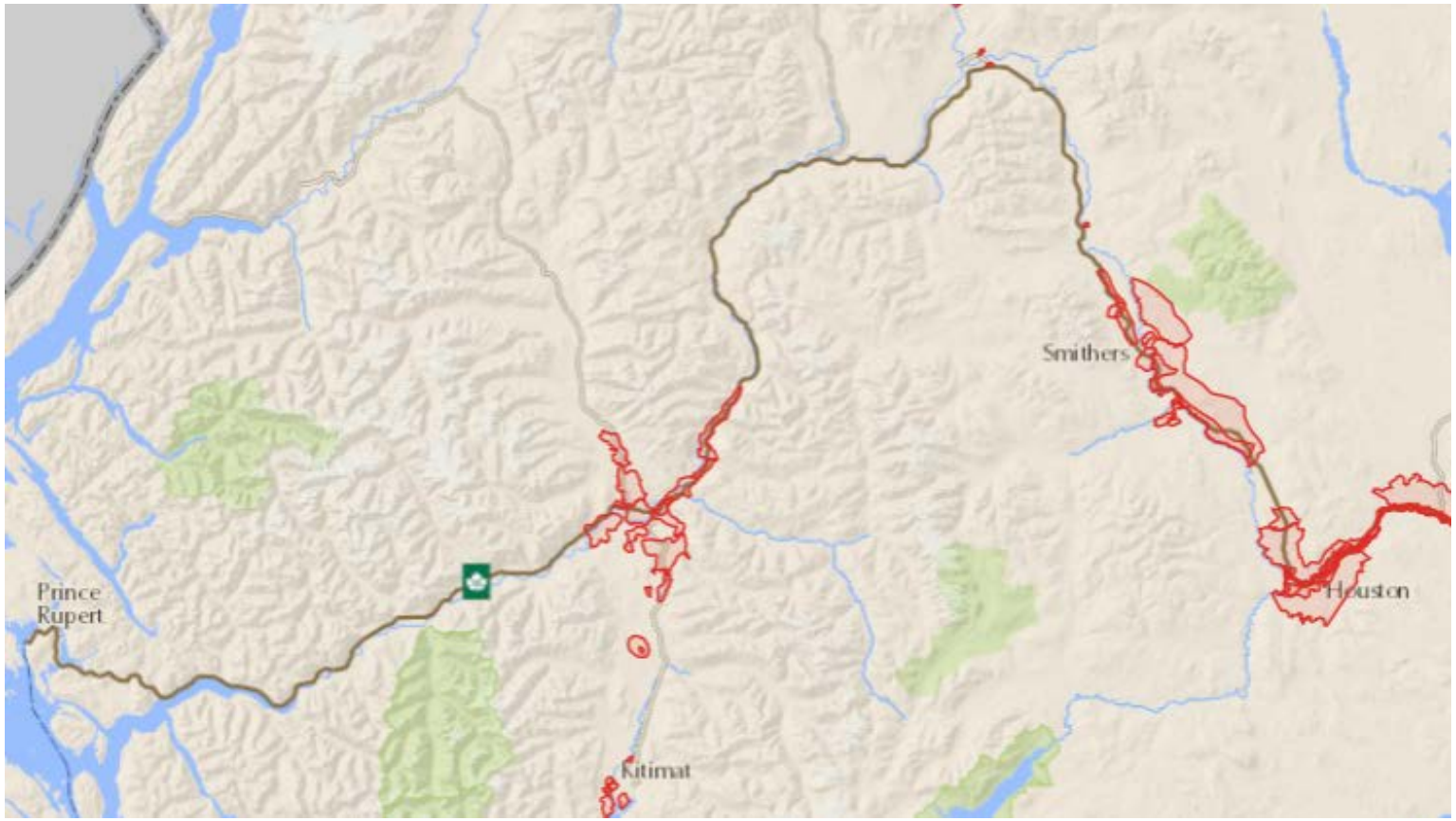
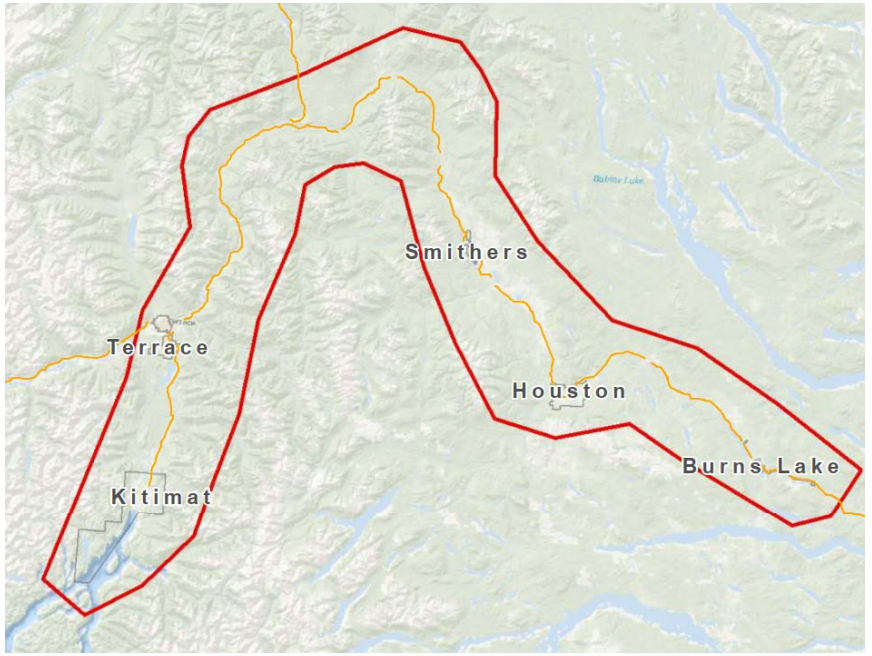
Skeena-Bulkley

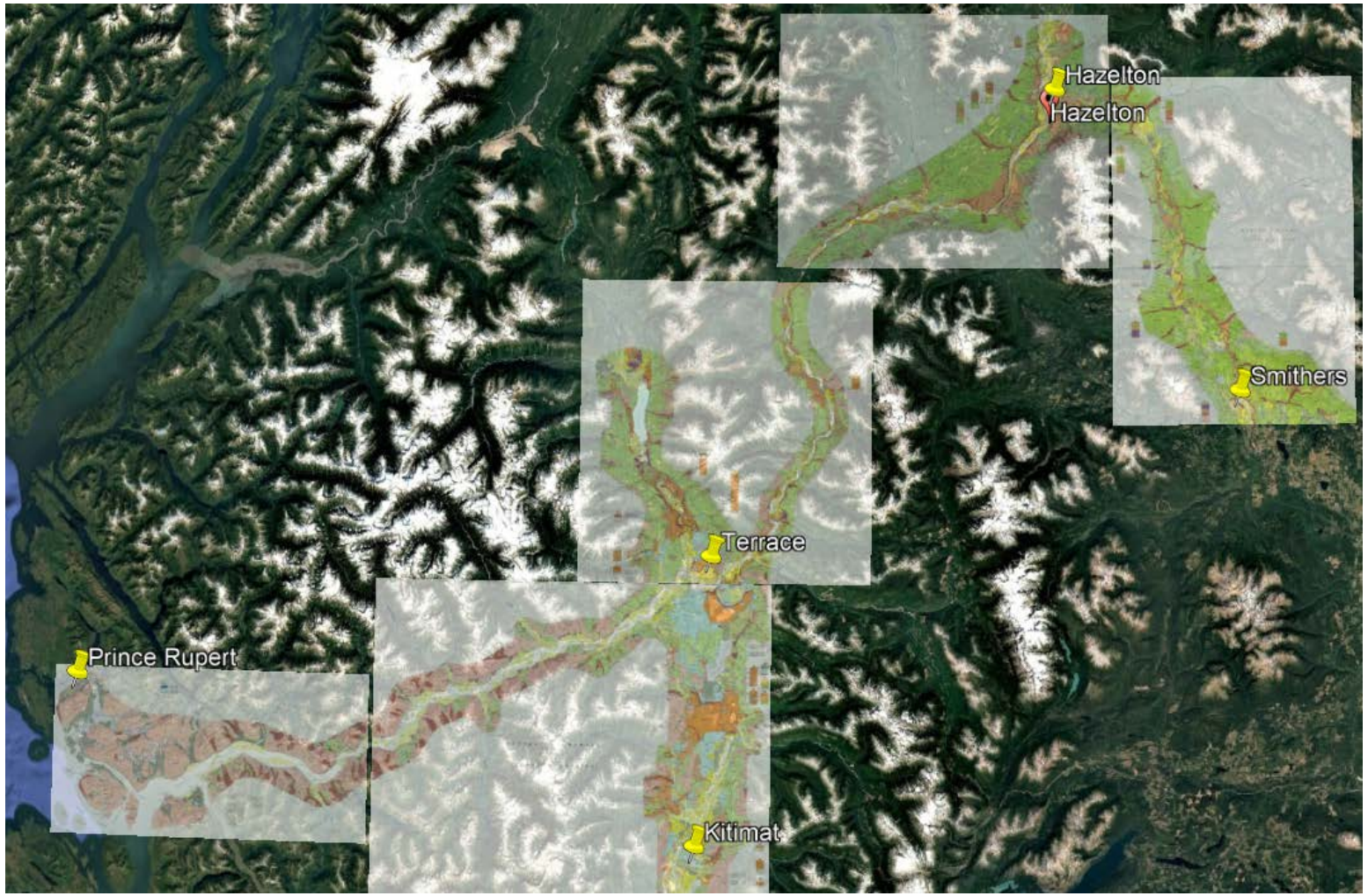




aquifer mapping

PGL ENVIRONMENTAL CONSULTANTS

Skeena-Bulkley



surficial geology

PGL
ENVIRONMENTAL CONSULTANTS

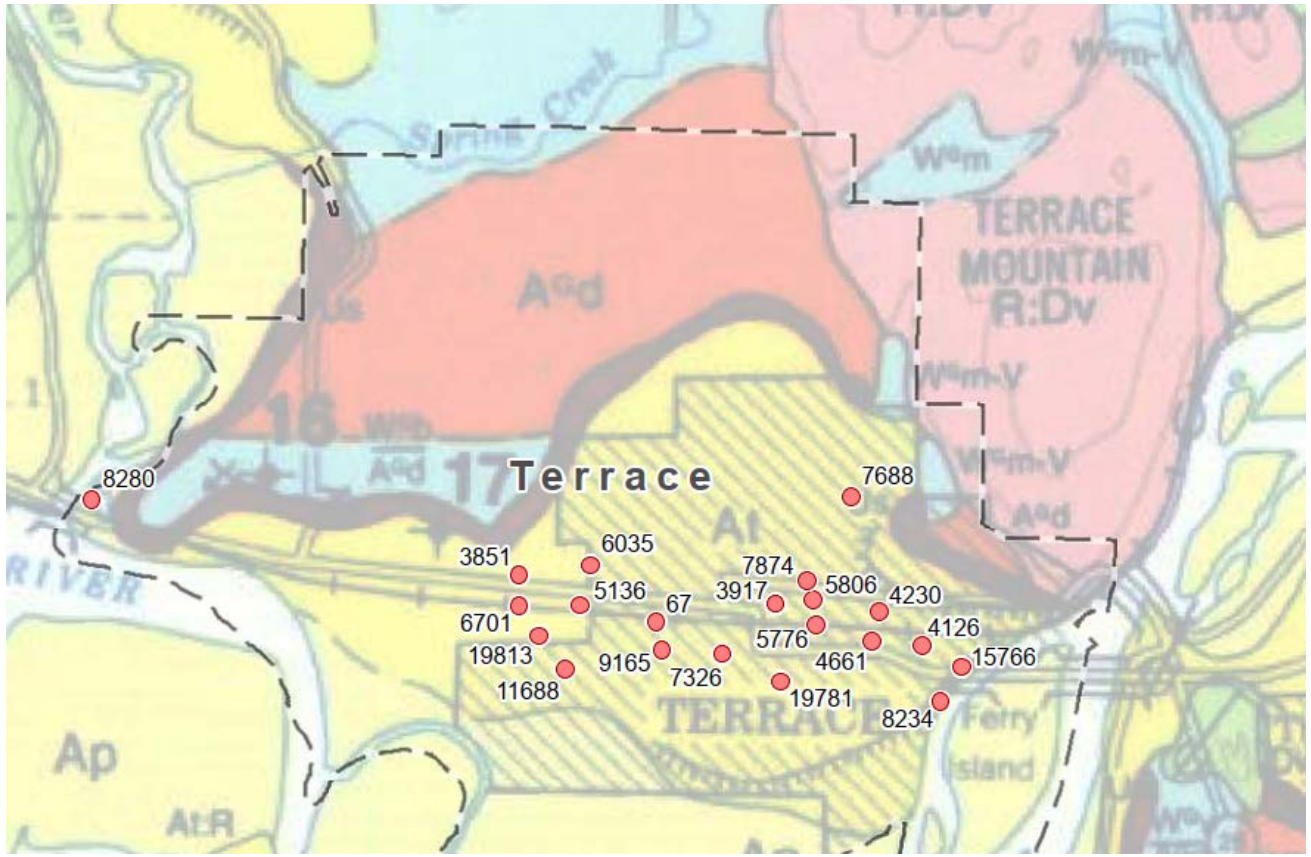
Skeena-Bulkley

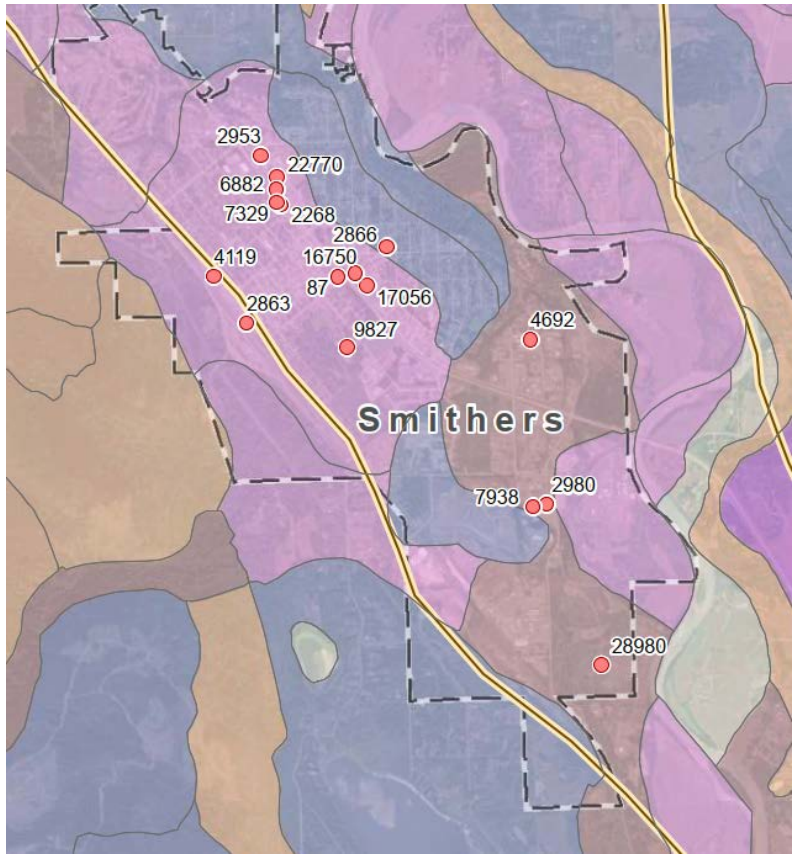
~70 potential sites for further evaluation after removing duplicates

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**1**	**2**	**10**	**3**		**16**
Burns Lake			2	1		3
Kitimat			3	1		4
Smithers	1		1			2
Terrace		2	4	1		7
Pre-2018 Dataset		**5**	**21**	**6**	**25**	**57**
Burns Lake			1		1	2
Cedarvale					1	1
Decker Lake				1	1	2
Houston			5	1	2	8
Kitimat		1	1	1		3
Smithers		1	4	1	9	15
Telkwa					1	1
Terrace		3	8	2	10	23
Topley			2			2
Total	**1**	**7**	**31**	**9**	**25**	**73**

PGL ENVIRONMENTAL CONSULTANTS

Skeena-Bulkley





Skeena-Bulkley

SUMMARY

- Just a single P9 (Smithers)
- Terrace with ~30 Site IDs
- Most sites from pre-2018 (hardcopy file retrieval)
- Surficial geology variable in the Skeena-Bulkley corridor
- Aquifer mapping sparse

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Skeena-Bulkley

CONCLUSION

- region would potentially have to be divided into separate subregions based on local surficial geology:
  - Prince Rupert to Terrace – Bedrock
  - Terrace to Kitimat – Glaciofluvial/Alluvial
  - Terrace to the Hazeltons – Bedrock/Glacial Till
  - Hazeltons to Smithers – Glacial Till
- non-zero possibility to establish background in subregions

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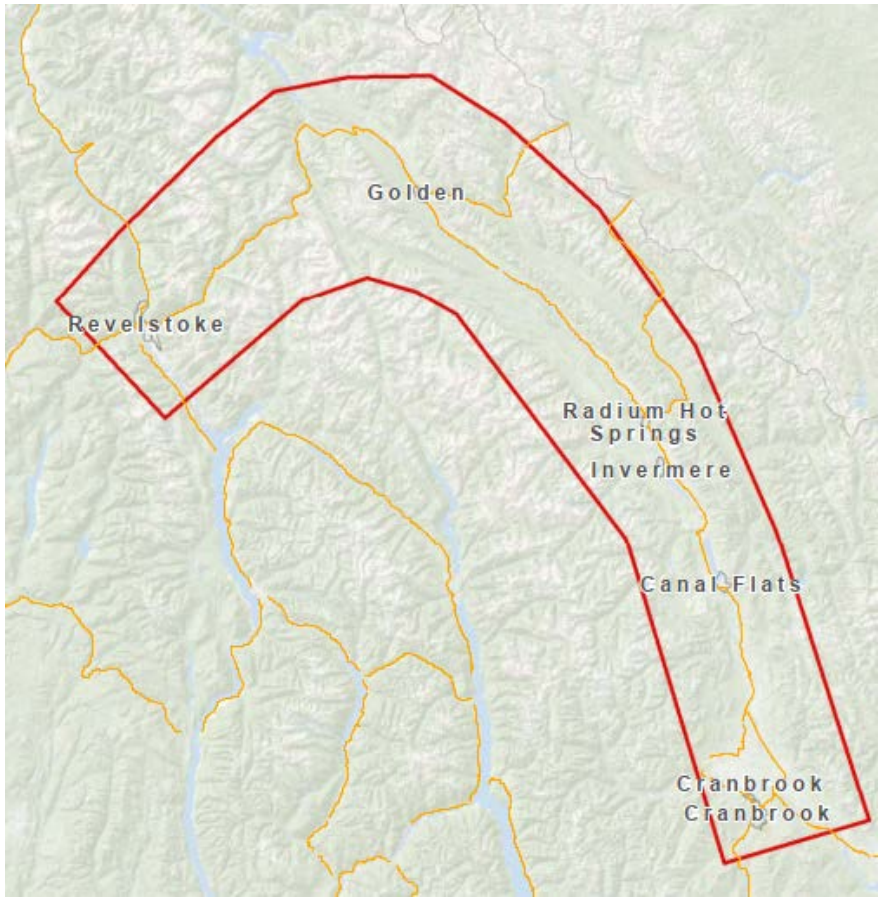
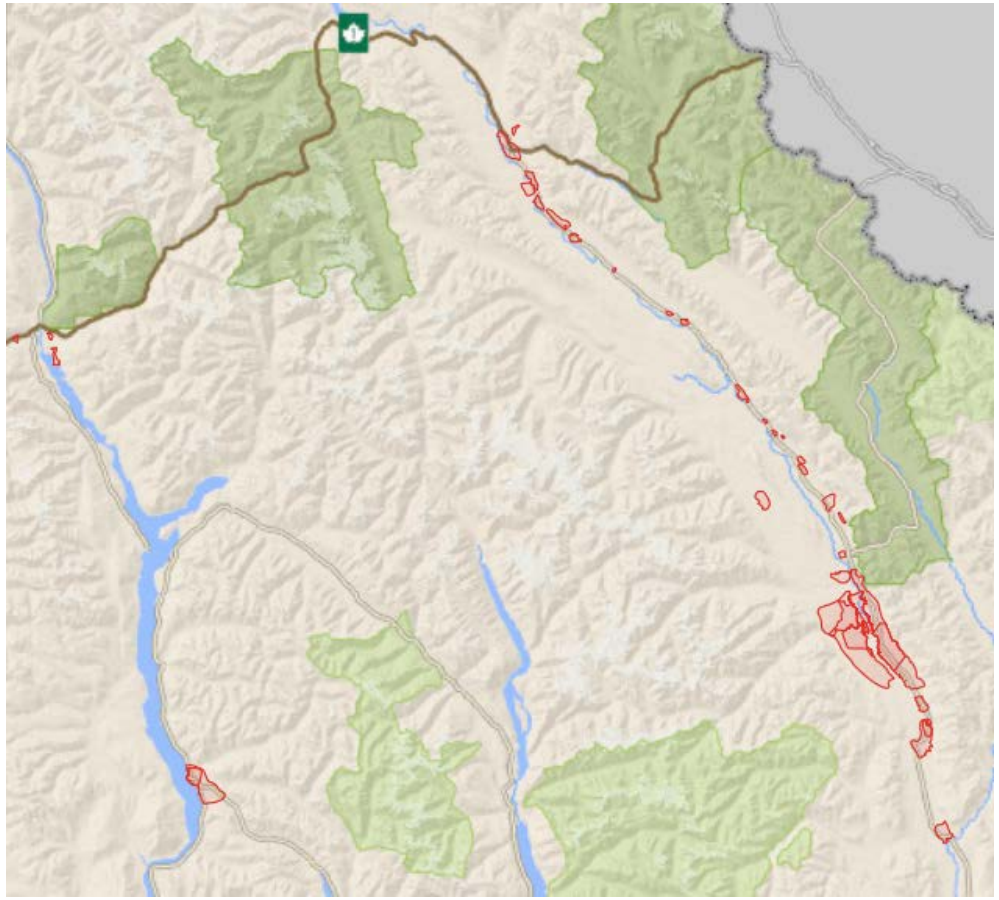
Columbia River





aquifer mapping

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Columbia River

SURFICIAL GEOLOGY

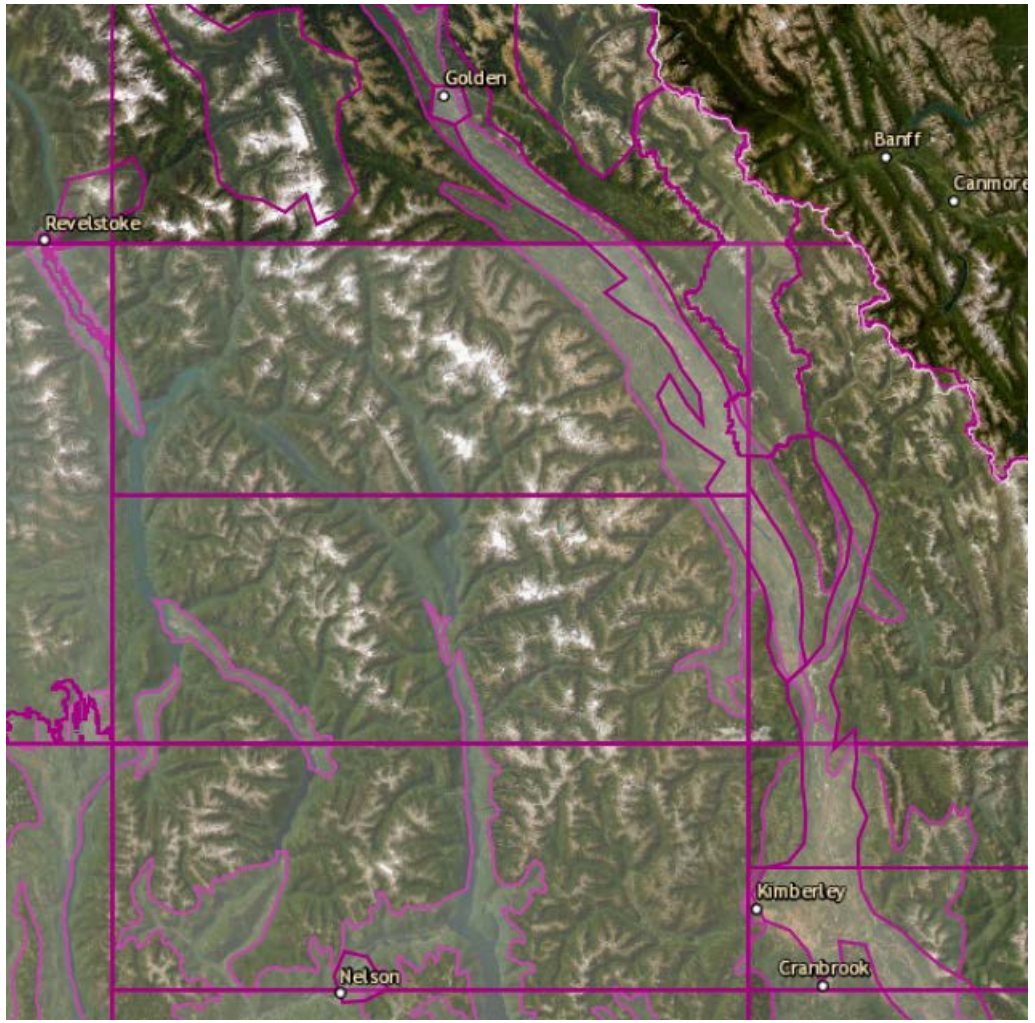
COLUMBIA RIVER VALLEY - DONALD TO REVELSTOKE

R.A. Achard - 1969-70

LEGEND

Fluvial and alluvial deposits (postglacial to present)

A	Alluvium: floodplain deposits, deltas; mainly sand with minor gravel, silt and organic materials.
At	Stream terrace: dominantly gravel but in many places terrace surface is overlain by < 2 m of sand and silty sand.
Af	Fan (active): generally coarse bouldery and blocky gravel near fan apex and finer poorly sorted gravel near fan toe.
Afi	Fan (inactive): as above but no longer subject to sediment deposition.
Avf	Debris-avalanche fan: cone of angular debris at bottom of an avalanche-chute, with levee banks and avalanche-chute locally included.



surficial geology

Columbia River

~60 potential sites for further evaluation after removing duplicates

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**4**	**1**	**17**			**22**
Canal Flats	1	1				2
Golden			1			1
Invermere	1					1
Jaffray			4			4
Nakusp			6			6
Radium Hot Springs			1			1
Revelstoke			2			2
Windermere	2		3			5
Pre-2018 Dataset		**3**	**21**	**3**	**14**	**41**
Canal Flats			1			1
Golden			9		6	15
Invermere			3		2	5
Nakusp					2	2
Radium Hot Springs					2	2
Revelstoke		3	8	3	2	16
Total	**4**	**4**	**38**	**3**	**14**	**63**

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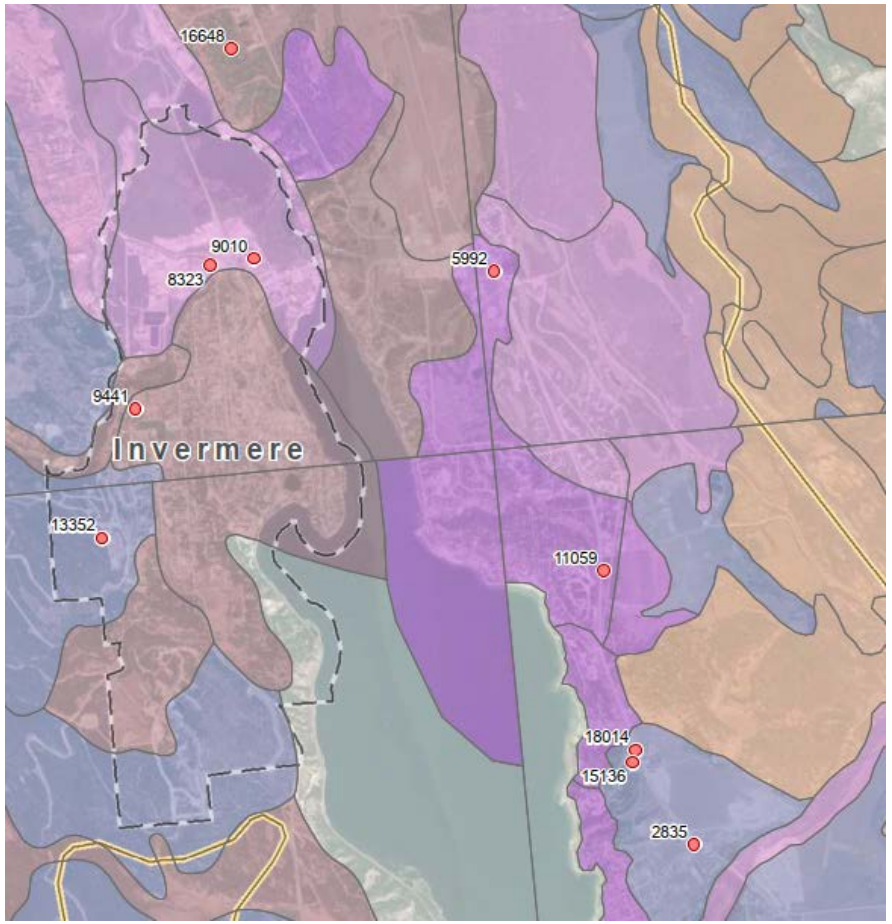
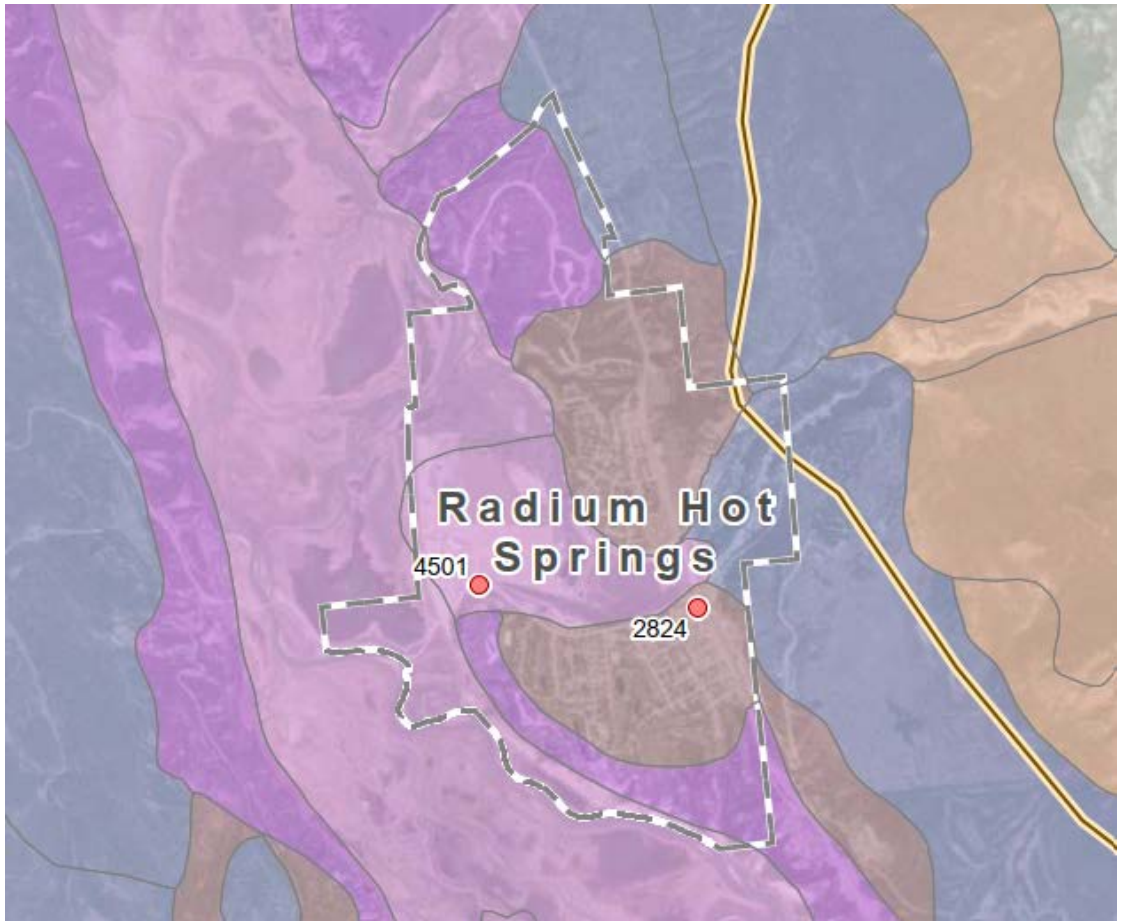
Columbia River





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Columbia River

SUMMARY

- several P9s
- most sites from pre-2018 (hardcopy file retrieval)
- aquifer mapping sparse in some areas
- surficial geology along the valley generally fluvial and glaciofluvial in origin in the low-lying areas

CONCLUSION

- non-zero possibility to establish background

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CONSIDERATIONS

- Review alternative statistical methods for municipalities/regions where less than 10 suitable background sites are available but local Protocol 9 Determinations were granted
- Provincial monitoring well network typically deep wells in DW aquifers, but check shallow observation wells in new AOIs (piper plots, etc.)
- Significant ENV resources needed for evaluation of new AOIs (file retrieval, review, meetings)

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CONCLUSION & OUTLOOK

❖ No new backgrounds established

✓ Project laid foundation for further work

➢ ENV digitizing hardcopy repository (file retrieval)

➢ AI powered data extraction from reports

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RECOMMENDATION

"Small" TRC project

- Data extraction and stats
- Prince George
- NE BC

"Small" TRC project

- Report review, data extraction and stats
- Penticton
- Possibly surrounding area

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RECOMMENDATION

"Major" project

Further evaluate other AOIs in order of decreasing likelihood for success

- Mid-Island
- Columbia River
- Skeena-Bulkley

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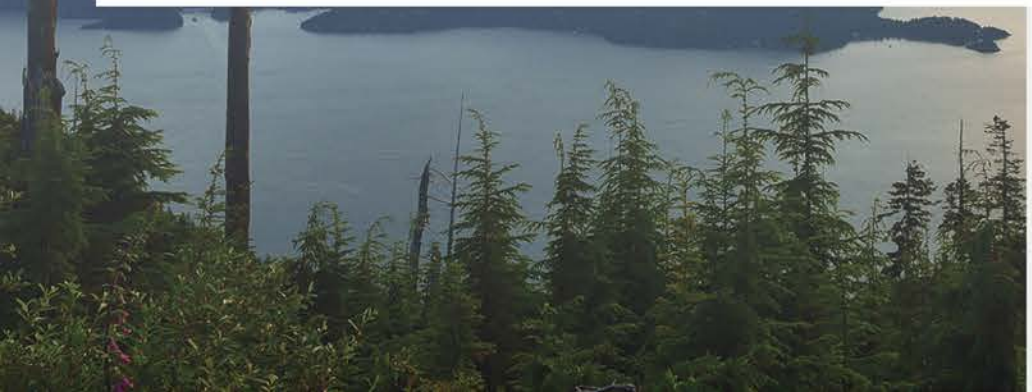
CSAP

SOCIETY OF CONTAMINATED SITES
APPROVED PROFESSIONALS
OF BRITISH COLUMBIA

Poll: Schedule 2 or Not?

David Mitchell, P.Eng.



Question 1

Fire station with storage of PFAS containing Aqueous Film-Forming Foam (AFFF) that does not conduct onsite training exercises represent a Schedule 2 activity?

a. Yes (27)
b. No (27)

Possible Schedule 2: Fire retardant manufacturing, bulk storage or shipping

Question 2

Warehouse facility with a single mobile welding cart used to repair equipment as needed.

a. Yes (14)
b. No (48)

Possible Schedule 2: C6 – welding or machine shops (repair or fabrication)

Question 3

Food industrial facility with workshop and tool area used to repair conveyors, presses and other on-site equipment where needed.

a. Yes (35)
b. No (15)

Possible Schedule 2s:

- C6 – welding or machine shops (repair or fabrication)
  Answer: Possible if welding is taking place
- E1 - appliance, equipment or engine repair, reconditioning, cleaning or salvage

Question 4

Large ink storage tanks at an industrial size printing operation.

a. Yes (61)
b. No (0)

Possible Schedule 2: A6 – ink or dye manufacturing or bulk storage

Question 5

A pile of road salt storage on a non-industrial property, where the road salt is for local use.

a. Yes (39)
b. No (20)

Possible Schedule 2: E7 – road salt or brine storage

Question 6

A small innocent looking marina, where no fueling is provided, boats are relatively small, and no repairs are possible.

a. Yes (27)
b. No (32)

Possible Schedule 2: G3 – dry docks, marinas, shipbuilding or boat repair and maintenance, including paint removal from hulls

Question 7

A shipping facility with two trucks that does basic vehicle maintenance work (change tires or oil).

a. Yes (38)
b. No (19)

Possible Schedule 2: G2 – automotive, truck, bus, subway or other motor vehicle maintenance, repair, salvage or wrecking

Question 8

A recycling depot accepts electronic waste including computer accessories, small household appliances (like toaster ovens) and dry cell type batteries (AAA, AA, C, D, etc). The waste is stored in series of bulk containers until a sufficient quantity is gathered and then the containers are picked up and taken to a location for processing. (Select all that apply)

a. No - Is this activity E1 – appliance, equipment, or engine maintenance, repair, reconditioning cleaning or salvage (5)

b. Maybe - depending on quantity - Is this activity B1 – battery manufacturing, recycling or bulk storage (5)

c. Maybe - depends on sufficient quantity - Is this activity B3 – Electrical equipment manufacturing, refurbishing or bulk storage (7)

d. Is this activity H8: electrical equipment recycling? – are they actually recycling something? (5)

e. Yes - Is this activity H13: municipal waste storage, recycling, composting or landfilling? (6)

Question 9

Is a compounding pharmacy which prepares medications on site from base ingredients.

a. Yes (20)
b. No (32)

Possible Schedule 2: A9 – Pharmaceutical products, or controlled substances as defined in the Controlled Drugs and Substances Act (Canada), manufacturing or operations.

Question 10

A dry cleaner that uses only biodegradable products.

a. Yes (44)
b. No (8)

Possible Schedule 2: E9

Question 11

Are the following marinas Schedule 2 activities.
(Select all that apply)

a. Marina consisting of a dock with room for 10 boats. No fueling, repair or power facilities. (43)
b. Marina consisting of a dock with room for 50 boats. No fueling, repair or power facilities. (42)
c. Marina consisting of a dock with room for 10 boats. One fuel dispenser, with AST on shore. No repair or power facilities. (49)

Question 12

Using pulverized concrete as fill.

a. Yes (40)
b. No (9)

Possible Schedule 2: H5 – landfilling of construction demolition material, including without limitation asphalt and concrete?

Please join us for happy hour at Hyatt's Mosaic Grille on this level

THANK YOU!