Field Sampling Protocols

Earth Sciences Sector

Rick J. McNeil

Natural Resources Canada - Geological Survey of Canada

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North American Soil Geochemical Landscapes Project

Earth Sciences Sector

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 6282

North American Soil Geochemical Landscapes Project
Canadian Field Protocols For Collecting Mineral Soils And Measuring Soil Gas Radon And Natural Radioactivity

P.W.B. Friske, K.L. Ford, I.M. Kettles, M.W. McCurdy, R.J. McNeil, and B.A. Harvey

2010

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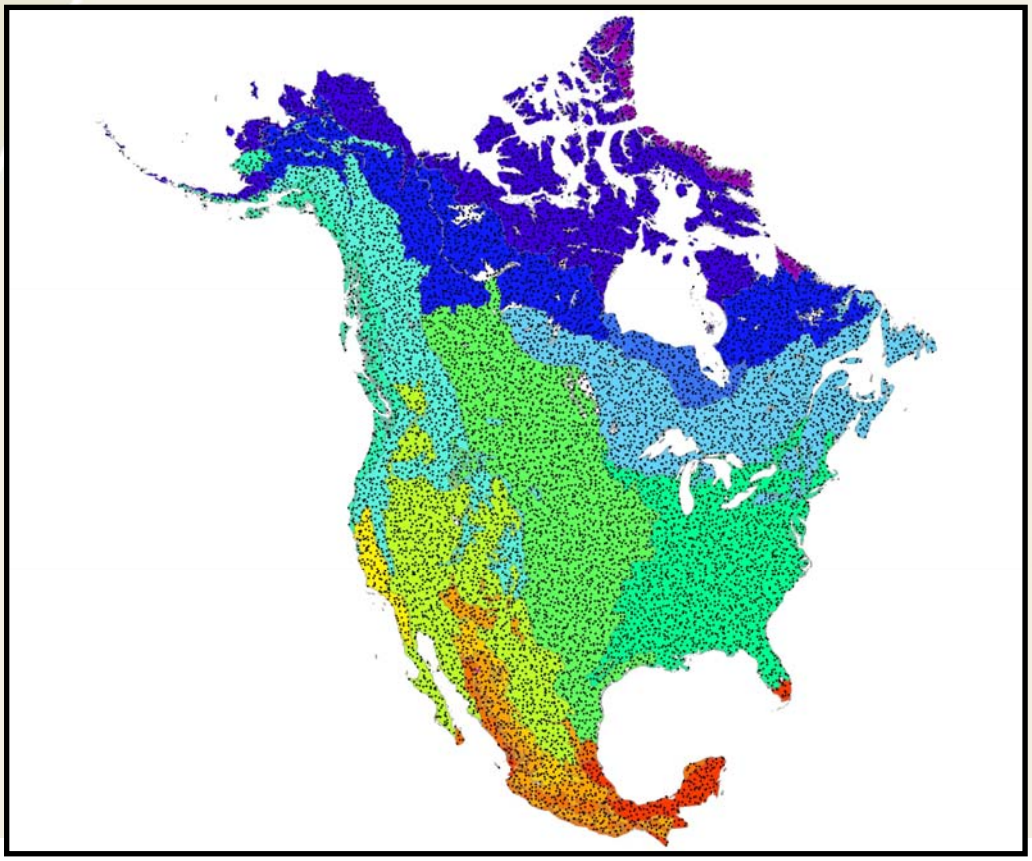
- Field protocols presented here for collecting soil samples and measuring soil gas radon and natural radioactivity were developed and documented as part of the NASGLP
- GSC Open File 6282 (Friske et al., 2010)

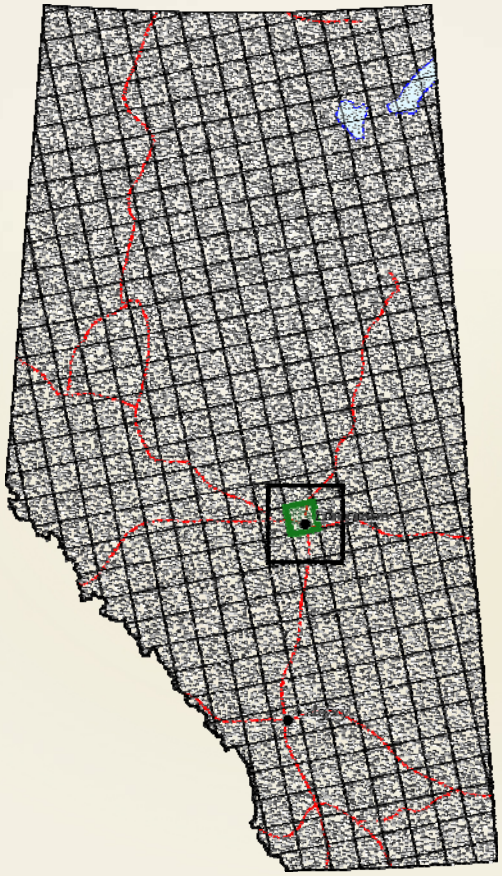
Why have field protocols?

- Sampling can occur over a long period of time
- Many different groups in different geographic regions with different purposes will do sampling
- The use of consistent field protocols ensures that the resultant data sets can be stitched with other similar datasets to produce a final seamless database

Site Selection

- Based on the GRTS : Generalized Random Tessellated Stratified
  - A balanced nested stratified sample design
    (Garrett, 1983)



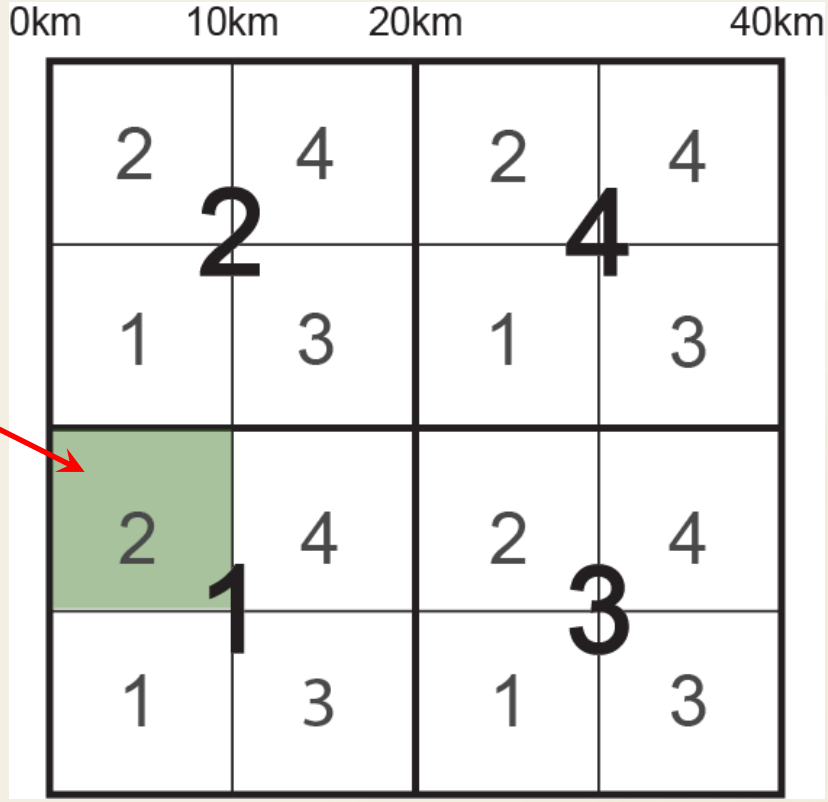


Site Selection

Site is selected within a randomly selected cell quadrant

20 km x 20 km	10 km x 10 km
1	2
1	4
3	1
2	3

The first number defines a 20 km x20 km quadrant and the second a 10 km x10 km quadrant



40 km x 40 km ~64 potential sites

20 km x 20 km ~16 potential sites

10 km x 10 km ~4 potential sites

Site Selection

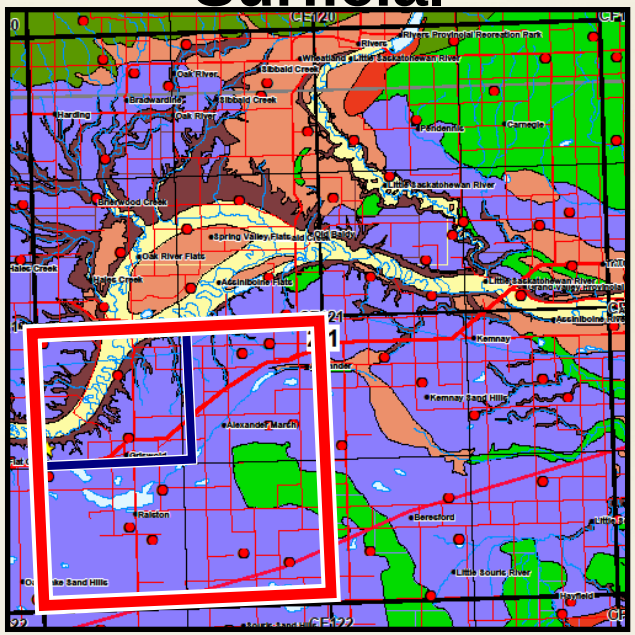
Background information on selected site

- DEM, soil classification, surficial sediments, geology…to know what to expect on site

DEM

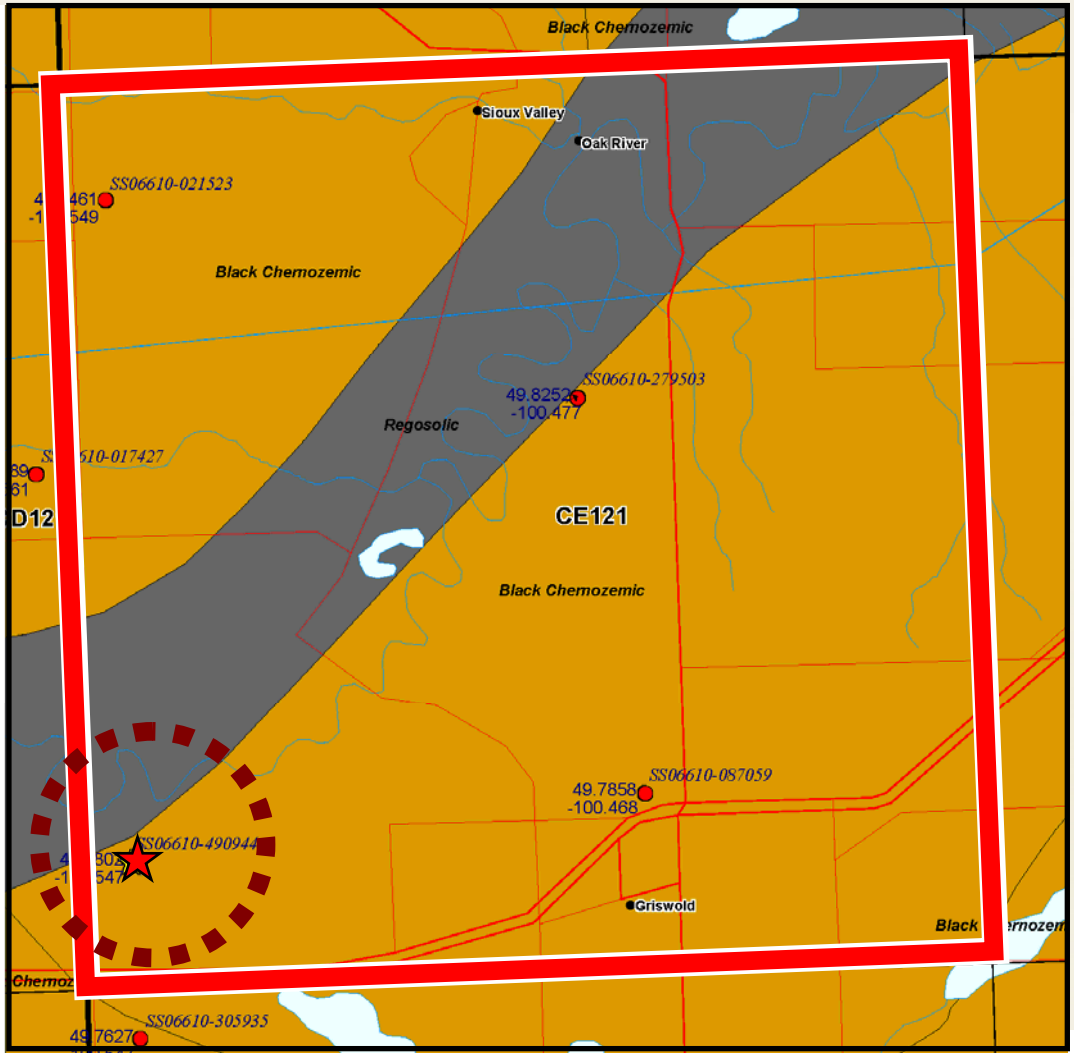
SLC

Surficial



Site Selection

- Site selected in the 10 km x 10 km quadrant
- Use consistent criteria to select site
- Tri-National Project selected site with highest site ID number



Site Selection

- One site is selected and sampled per cell as a minimum

- Other potential sites allow for the selection of alternate sites if the first site selected falls within an area that cannot be sampled (e.g. lake, dump…) or to increase the sample density

- Final site selection is decided by the field crew

- Sample within 500 m of the pre-selected site and should have similar soil landscape characteristics

- Sampling site selection criteria:
  - More than 200 m from major highways
  - More than 100 m from rural roads
  - More than 50 m from end rows in agricultural fields

Equipment

- Suggested list of field equipment *(detailed list in GSC OF 6282)*
  - Kraft bags
  - Plastic bags
  - Steel or plastic sampling tools
  - Soil dutch auger
  - Lexan coring tube
  - Measuring tape
  - 10% HCl
  - GPS
  - Field cards
  - Digital camera

Sample Collection

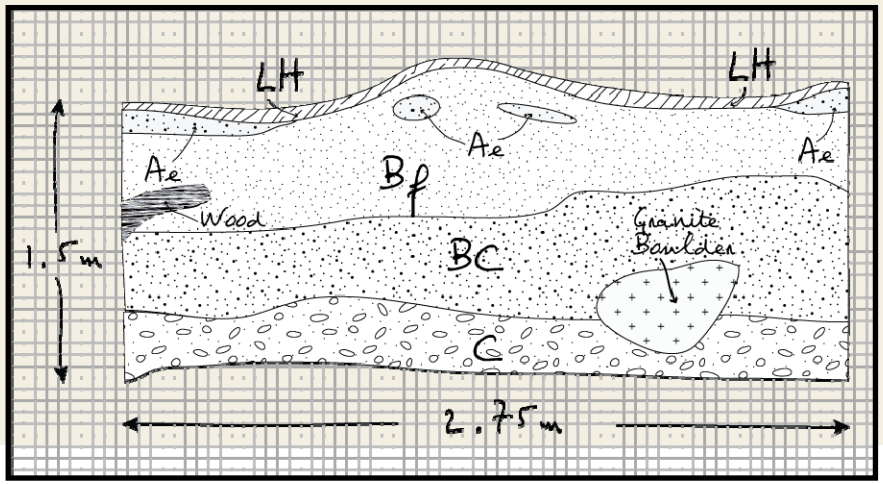
- All equipment should be clean before sampling
- Augering allows you to see the soil profile before digging the pit
- Typical soil pit size 60 cm x 70 cm

Auger sample

Soil Pit

Sample Collection

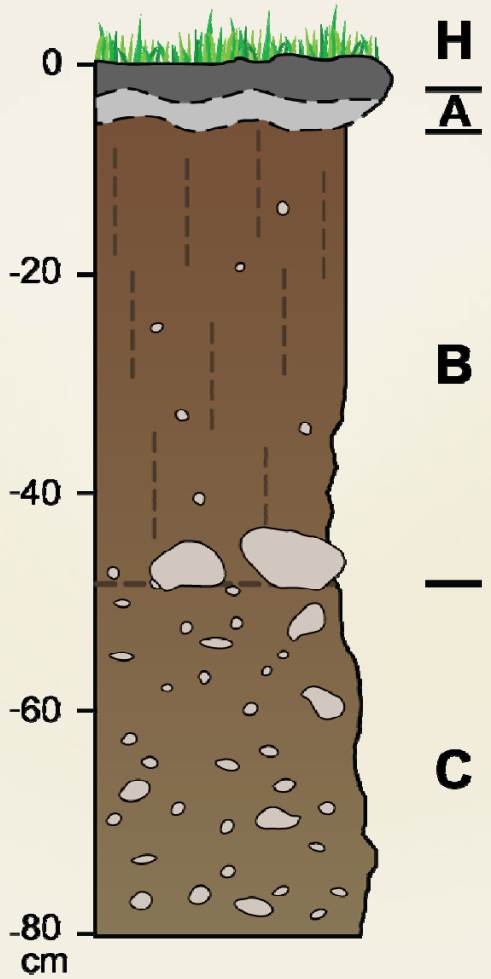
- Depth of the pit will be dependant on the depth of the C-horizon, usually around 40-60 cm
- Align the face of the pit used for sampling so that it will be exposed to maximum direct sunlight
- Avoid disturbance or compaction of the sampling pit face *(especially if bulk density samples are collected)*
- With a clean sample pit face, document the soil profile on the field card and take photographs of the pit and the site



Sample Collection

Samples collected at each Tri-National site include:

- **Public Health layer (0-5 cm)**
  - Bulk density
  - Bulk sample for inorganic chemistry (~5 kg)
- **A-horizon**
  - Bulk density
  - Bullk sample for inorganic chemistry (~5 kg)
- **B-horizon**
  - Bulk density
  - Bulk sample for inorganic chemistry (~5 kg)
- **C-horizon**
  - Bulk density
  - Bulk sample for inorganic chemistry (~5 kg)
- **Soil gas radon**
- **Gamma-ray spectrometry**



Sample Collection

1- C-horizon first *(avoids having to clean the pit…again!)*

- Bulk density samples can sometimes be difficult to collect because of the stoniness and or the compaction of the material

- It is often easier if the bulk sample is collected with a dutch auger. It makes it easier to reach a “true” unmodified parent material.

Sample Collection

2- PH layer *(take a seat…settle-in!)*

- This layer is regarded as the 0-5 cm interval with 0cm referring to the upper soil surface which is considered to be the top boundary of the first soil layer that can support plant/root growth.

- These samples may be in part duplicative of other samples such as the O or A horizons, but are valuable for providing information on that portion of the soil to which humans are most often exposed.

- Collect a bulk density and a bulk inorganic chemistry sample

Bulk Density (PH Layer)

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Sample Collection

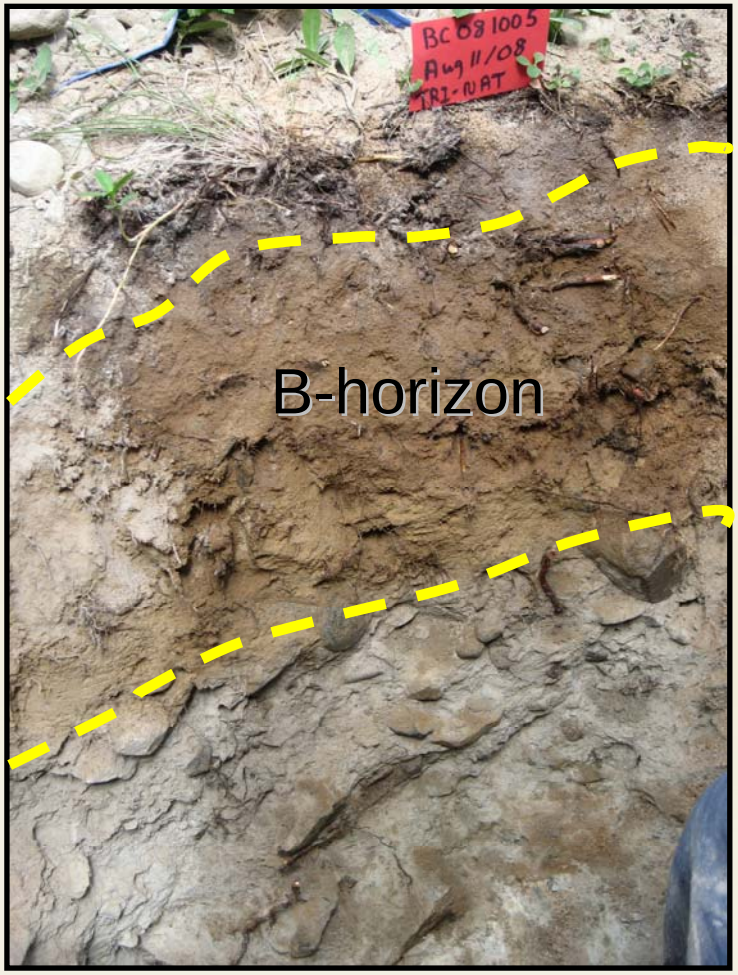
3- A-horizon

- Often is quite difficult to identify because it is thin; it is even more difficult to properly sample.
- Do not include the Ae-horizon, if present.
- When present and thick enough, collect a bulk density and a bulk inorganic sample. Collect material evenly through the horizon to have a representative sample.

Sample Collection

4- B-horizon

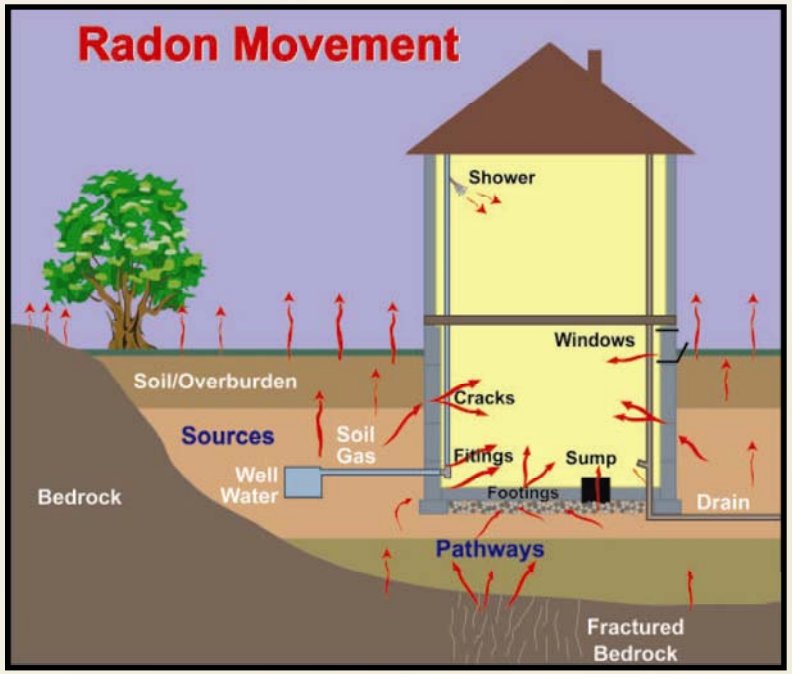
- This sample is generally easier to collect.
- Its colour and texture make it easy to identify
- It typically has a thickness of 10-40 cm
- Collect a bulk density and a bulk inorganic chemistry sample
- Collect material through the entire horizon to have a representative sample



Sample Collection

Soil gas radon

- Radon is naturally occuring and is the second leading cause of lung cancer (WHO, 2005)
- Prior to 2007, Health Canada's guideline for concentration in homes was 800 Bq/m3. In 2007, a new radon strategy lowered the threshold limit of radon exposure to 200 Bq/m3
- Identification of radon-prone areas was part of the new radon strategy
- Systematic soil radon sampling was included as part of the Tri-national soil sampling program



Sample Collection

Soil gas radon sampling

Sample Collection

Radiation measurements at each site include:

- A measurement of total radioactivity at the site is achieved by scanning a 10 m^2 area around the soil pit using a field portable spectrometer (GR320)
- Measurements taken at the four corners of the 10 m^2 area around the pit
- A measurement in the pit after the soil sampling crew is finished.

Sample Collection

In-situ gamma ray spectrometry

Field Data For Soil Sampling

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Tri-National Mineral Soil Sampling Field Data

Site Sample
GRTS Site ☐
NFI Site ☐

Cell ID | **Site ID** | **RepStat**

Resampled Site — No X Yes X → Previous Site ID

NFI Network Label

Samples Collected

PH interval
for inorg. analysis ☐
for org. analysis ☐

A - horizon ☐
B - horizon ☐
C - horizon ☐

Anthrax ☐
NFI (0-15cm) ☐
Other: _____

	Moisture Only	Bulk Density	Sample depth interval Top	Bottom
PH	☐	☐ →	____cm	____cm
A-horizon	☐	☐ →	____cm	____cm
(% of A and H material collected when A material is insufficient) → A ____% H ____%				
B-horizon	☐	☐ →	____cm	____cm
C-horizon	☐	☐ →	____cm	____cm

NTS

Latitude NAD83 . Decimal Degrees

Longitude NAD83 . Decimal Degrees

Elevation m

Weather
Sunny/Clear ☐
Partly cloudy ☐
Overcast ☐
Rain ☐
Sleet ☐
Snow ☐

Date D D M M Y Y

Time START : FINISH :

Air Temp. °C

Name of Samplers

Type of Surface Material
Mineral Soil ☐
Organic Soil ☐
Non-Soil ☐
Urban ☐

Mode of Deposition
Anthropogenic ☐
Colluvial ☐
Eolian ☐
Fluvial ☐
Glaciofluvial ☐
Glaciolacustrine ☐
Glaciomarine ☐
Lacustrine ☐
Marine ☐
Residual ☐
Saprolite ☐
Till (Morainal) ☐
Undifferentiated Mineral ☐
Volcanic ☐

Local Surface Expression
Mineral Surface Form
Blanket ☐
Dissected ☐
Fan ☐
Hummocky ☐
Inclined ☐
Pitted ☐
Level ☐
Rolling ☐
Ridged ☐
Steep ☐
Terrace ☐
Undulating ☐
Veneer ☐

Vegetation Cover
Agricultural Crops ☐
Coniferous Forest ☐
Deciduous Forest ☐
Grassland ☐
Arctic Desert ☐
Lichen ☐
Mixed Forest ☐
Parkland ☐
Shrubland ☐
Tundra ☐
Alpine ☐
High Shrub ☐
Medium Shrub ☐
Low Shrub ☐
Broken Herb - Low Shrub ☐
Unvegetated Surface ☐
Meadow, Wet ☐

Rockiness
Nonrocky (<2%) ☐
Slightly rocky (2-10%) ☐
Moderately rocky (10-25%) ☐
Very rocky (25-50%) ☐
Exceedingly rocky (50-90%) ☐
Excessively rocky (>90%) ☐

Stoniness
Nonstony (<0.01%) ☐
Slightly stony (0.01 - 0.1%) ☐
Moderately stony (0.1 - 3%) ☐
Very stony (3 -15%) ☐
Exceedingly stony (15 - 50%) ☐
Excessively stony (>50%) ☐

Bedrock Type
Igneous, (Intrusive) ☐ _____
Igneous, (Extrusive) ☐ _____
Igneous, (Pyroclastic) ☐ _____
Metamorphic ☐ _____
Sedimentary ☐ _____
Evaporites, Organics, Precipitates... ☐ _____
Other ☐ _____

Slope
Slope Type
Simple ☐
Complex ☐

Slope Gradient

% Slope	Class	
0 to 3	1	☐
4 to 9	2	☐
10 to 15	3	☐
16 to 30	4	☐
31 to 60	5	☐
>60	6	☐

Sample Site Position on Slope
Crest ☐
Upper Slope ☐
Middle ☐
Lower Slope ☐
Toe ☐
Depression ☐

Slope Aspect °

Drainage
Very rapidly drained ☐
Rapidly drained ☐
Well drained ☐
Moderately well drained ☐
Imperfectly drained ☐
Poorly drained ☐
Very poorly drained ☐

Contamination
None ☐
Possible ☐
Probable ☐
Definite ☐
- Farming ☐
- Housing ☐
- Industry ☐
- Logging ☐
- Mining ☐
- Road ☐
- Garbage ☐
- Other _____ ☐

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Field Data for Soil Sampling

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Soil Horizon Description

Site ID

#	1 Horizons				2 Depth		3 HB		4 Colour	5 Mottles				6 Roots			7 CF	8 Structure			9 MC	10 Texture	11 Eff
	D	Ma	Suffix	M	Up	Low	D	F		A	S	C	Colour	S	Q	L	%	G	T	C			
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							

Soil Profile Diagram

Depth of thaw cm Not Applicable ☐ Unknown ☐	Estimated max thaw depth cm Not applicable ☐ Unknown ☐	Depth to bedrock cm Not applicable ☐ Unknown ☐
Depth to watertable cm Unknown ☐	Depth to impermeable layer cm Unknown ☐	

Soil Classification (Section 3)

Order	Great Group	Sub-Group

Comments:

SITE PHOTOS!

Field Data for Soil Sampling

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Codes for Horizon Description

#	1 Horizons				2 Depth		3 HB		4 Colour	5 Mottles				6 Roots			7 CF	8 Structure			9 MC	10 Texture	11 Eff
	D	Ma	Suffix	M	Up	Low	D	F		A	S	C	Colour	S	Q	L	%	G	T	C			
1	-	B	f	-	22	34	G	S	Reddish Brown	C	F	D	Red Brown	F	P	T	30	M	B	F	VF	Sandy Loam	S

1 Horizons
D: Lithological discontinuity
Ma: Master horizons (O, A, B, C)
Suffix: Suffixes
M: Modifier (B1, B2, B3)

3 Horizon Boundary

Distinctness (Vertical Change)	Form
A: Abrupt (<2cm)	**S:** Smooth
C: Clear (2-5 cm)	**W:** Wavy
G: Gradual (5-15cm)	**I:** Irregular
D: Diffuse (>15cm)	**B:** Broken

Table 1. Correlation of Munsell colours with descriptive colours (AG Boden, 1994)

4

Colour hue and value 5	Chroma /1	/2	/3	/4	/6	/8
7.5R 5/	Reddish Gray		Red Gray	Gray Red	Red	
10R 5/					Gray Red	
2.5YR 5/					Red Brown	
5YR 5/	Brownish Gray		Brown Gray		Reddish Brown	
7.5YR 5/		Brown Gray	Gray Brown		Brown	
10YR 5/	Gray				Yellowish Brown	
2.5Y 5/		Yellowish Gray	Yellow Gray		Yellow Brown	
5Y 5/	Greenish Gray		Green Gray	Gray Green	Olive Green	
5G 5/						
5B 5/	Blue Gray					
5BG 5/						

5

Mottles		
Abundance	Size (mm)	Contrast
F: Few (<2mm)	**F:** Fine (<5)	**F:** Faint
C: Common (2-20)	**M:** Medium (5-15)	**D:** Distinct
M: Many (>20)	**C:** Coarse (>15)	**P:** Prominent

6

Roots			
Size / Quantity	**F:** Fine (<2mm)	**M:** Medium (2-5mm)	**C:** Coarse (>5mm)
F: Few	10	1	1
P: Plentiful	10-100	1-10	1-5
A: Abundant	>100	>10	>5

Location
T: Throughout
M: Matted on top of horizons
C: in cracks

7 Coarse Fragments (CF)
Estimated value in % (>0.2 cm)

8 Structure
Grade
W: Weak
M: Moderate
S: Strong
Type
S: Structureless
B: Blocklike
P: Platelike
R: Prismlike
Class
VF: Very fine
F: Fine
M: Medium
C: Coarse

9 Moist consistency
L: Loose
VF: Very friable
F: Friable
M: Firm
VM: Very firm

10 Field Texture
Clay, Sandy Clay, Sandy Clay Loam
Silt, Silty Sand, Silt Loam, Silty Clay Loam
Loam, Sandy Loam, Loamy Sand
Sand, Very Fine Sand, Fine Sand, Medium Sand, Coarse Sand, Very Coarse Sand

11 Effervescence
N: Noncalcareous
W: Weakly
S: Strongly
E: Extremely

Mineral Soil Field Card
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Radon and Spectrometry Field Data

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NASGLP Soil Sampling Field Data – Natural Radioactivity and Radon

Date:	Cell I.D.		Site I.D.
RepStat :	Resampled Site : (Y)	(N)	NFI Plot:
NTS Sheet #:	Lat. (NAD83)		Long. (NAD83)
Weather:			Air Temp (C):
Time (In):	Time (Out):		
Name of Sampler:			

Radioactivity: Spectrometer Serial # - ; GPX 21 Serial # (if applicable) - ;

System Gain (if applicable)	Peak	FWHM	Gain				

Spec #	Total (ppm)	K (pct)	eU (ppm)	eTh (ppm)	Total (cpm)	K (cpm)	eU (cpm)	eTh (cpm)	Scint. Value

Radon

Radon Station #	Depth (m)	1st Pull to / back to (ml)	Sample Vol. (ml)	Ion. Chamber #	Time IC Filled	Time of Meas.	Radon Bkd (kBq/m³)	Radon Conc. (kBq/m³)	Comment

Permeability

Permeability Station #	Depth (m)	1 or 2 Weights	Time Started	Measured Time (s)	Permeability (k/m²)	Comment

Additional Comments:

Recommendations

- Horizon based sampling, otherwise varying amounts of organic matter, Fe- and Mn- sesquioxides, and clays will influence trace element concentrations.

- At minimum the C-horizon (parent material) should be sampled and it might be desirable to collect a sample from the 0-5 cm depth interval (PH interval) which is the layer that most strongly affects human exposure.

- Standard set of sampling equipment such as Kraft paper bags and plastic or steel tools *(no stainless steel and no painted metal tools).*

References

- Friske, P W B; Ford, K L; Kettles, I M; McCurdy, M W; McNeil, R J; Harvey, B A., 2010. North American soil geochemical landscapes project: Canadian field protocols for collecting mineral soils and measuring soil gas radon and natural radioactivity; Geological Survey of Canada, Open File 6282; 177 p.

- Garrett, R.G. 1983, Sampling methodology. In: Howarth, R.J. (ed) Chapter 4 of Handbook of Exploration Geochemistry, Vol. 2, Statistics and Data Analysis in Geochemical Prospecting. Elsevier, p. 83-110.

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