RioTinto

KMP SO_2 EEM Program – Technical Memo S04

Long-term Soil Monitoring Plots
Plot Establishment

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Table of Contents

List of Figures

List of Tables

1 Overview

Under the Environmental Effects Monitoring (EEM) Program, long-term soil monitoring plots will address the observation-based KPI: 'observed change in base cation pool over time' through repeat sampling and analysis of soils for exchangeable base cations every five years (ESSA et al., 2014).

During October–December 2015, long-term soil monitoring plots were established at Coho Flats and at Lakelse Lake, Kitimat Valley. This memo describes the establishment of the plots (i.e., plot locations and layout of plot design) and the initial collection and processing of soil samples (i.e., drying and sieving) during 2015. The monitoring plots will be re-visited for soil bulk density sampling, and mapping of tree locations during 2016. In addition, a background (control or reference) plot will be established at Kamano, far from the smelter emissions plume. Chemical analysis (exchangeable base cations and exchangeable acidity) will be carried out during 2016.

2 Objective and Rationale

The objective of the long-term soil plots is to monitor changes in soil base cation pools over time through repeated sampling and analysis (every five years). The monitoring plots provide a framework for replicate random sampling of soils, allowing for the statistical assessment of changes between sampling campaigns.

Under the EEM Program, long-term soil monitoring plots will be established in near-field and far-field locations with respect to smelter emissions. In addition a background or reference plot will be established (remote from emissions sources outside the Kitimat Valley) to assess whether a change soil base cation pools (if observed) is causally related to the Kitimat Modernisation Project (KMP). Changes in soil exchangeable base cations will initially evaluated in the upper mineral soil (0–5 cm) between sampling periods. If a statistical change is detected, analysis will be carried out down the soil profile.

3 Plot Location and Design

Near-field and far-field plots were established at Coho Flats (latitude: 54.07660, longitude: –128.65117) and Lakelse Lake (latitude: 54.37827, longitude: –128.57990), respectively (Figure 1), to reflect the gradient in atmospheric deposition (ESSA et al. 2013). Plots are located in close proximity to, or co-located with, the NADP atmospheric deposition monitoring stations at Haul Road and Lakelse Lake. At each location, primary and secondary (backup) plots were established within forest stands dominated by western Hemlock; secondary plots (located within 500 m of the primary plot) provide a backup or replacement to the primary plot if disturbed or destroyed within the lifetime of the monitoring program.

Each long-term soil plot is 32 m by 30 m in size and composed of twenty 8 m by 6 m sub-plots lettered A to T; the A sub-plot is oriented to the north-west corner of each plot (Figure 2). Each sub-plot is further divided into twelve 2 m by 2 m sampling grids (numbered 1 to 12); one numbered grid is randomly sampled from each lettered sub-plot at five depths: litter-fibric (LF), humic (H), and 0–5 cm, 5–15 cm, and 15–30 cm depths in the mineral soil (yielding a total of 100 soil samples for each plot, i.e., 5 soil samples by depth within each of the 20 lettered sub-plots). Every five years one numbered grid within each lettered sub-plot will be randomly sampled (note:

individual numbered grids are sampled only once), allowing for a total of twelve sampling campaigns. During the twelve sampling campaigns, each numbered grids is sampled only once.

Figure 1. Location of long-term soil monitoring plots at Coho Flats (near-field) and Lakelse Lake (far-field), Kitimat Valley

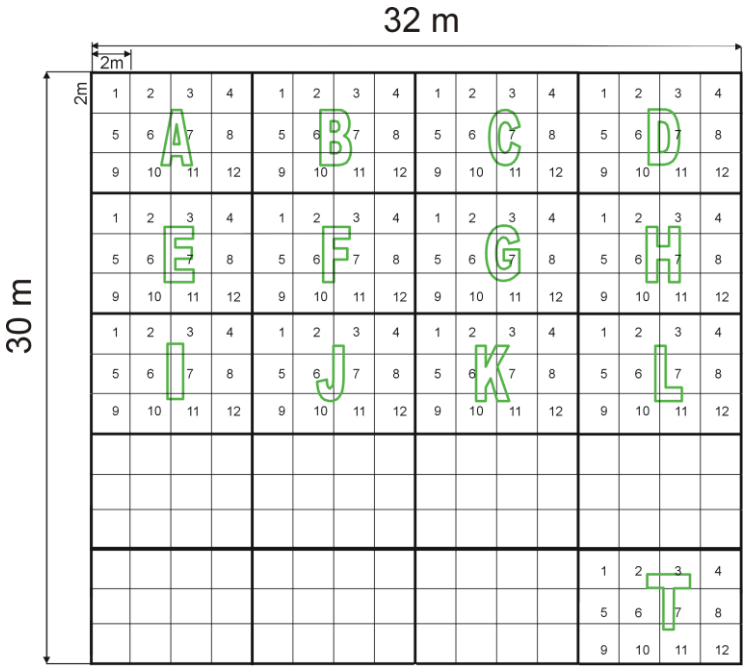

Figure 2. Long-term soil monitoring plot; the plot is divided into twenty 8 m by 6 m sub-plots, lettered A to T; each sub-plot is further divided into twelve 2 m by 2 m sampling grids, numbered 1 to 12.

4 Plot Sampling

During October–December 2015, long-term soil monitoring plots (primary and secondary) were established in forest stands dominated by Western Hemlock at Coho Flats and Lakelse Lake, Kitimat Valley (Figure 3). Within each plot, one numbered grid was randomly sampled from each lettered sub-plot (see Appendix A for a list of sample grids). In total 400 soil samples were collected during 2015 (4 plots × 20 sub-plots × 5 soil depths).

Soil samples from the first (2015) sampling campaign have been dried, sieved to < 2 mm and analysed for pH and organic matter content (Figure 4). There is a noticeable difference in organic matter content between depths in the mineral soil (i.e., there is a statistically significant decrease in organic matter between the 0–5 cm and the lower depths at Lakelse Lake, Figure 4) but not between primary and secondary plots (i.e., there is no statistical difference between the 0–5 cm at Lakelse Lake primary compared with the same depth in Lakelse Lake secondary). During 2016, the mineral soil samples in the 0–5 cm depth at the primary plots will be analyzed for exchangeable base cations, exchangeable acidity, and all remaining soil (from the primary and secondary plots) will be archived.

Figure 3. The long-term soil monitoring plots at Lakelse Lake are located beside the NADP monitoring station (A), in a western Hemlock stand (primary plot is shown in B), and east of the Coho Flats Trail, Kitimat (primary plots is shown in C).

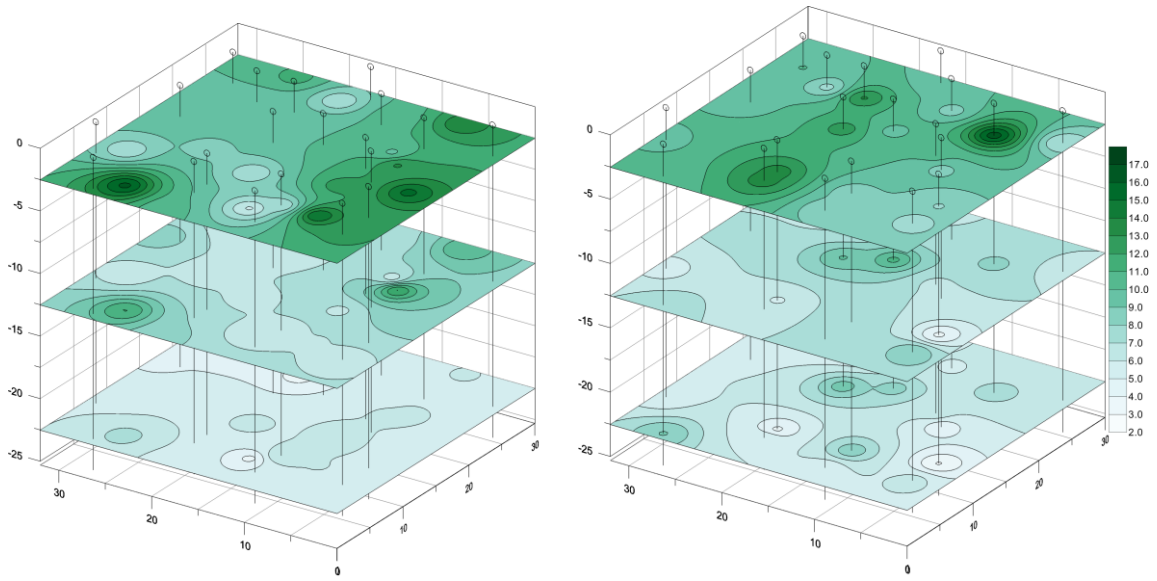

Figure 4. Three-dimensional representation of soil organic matter content (%) in the 0–5 cm, 5–15 cm, and 15–30 cm (mineral) soil depths at the primary (left) and secondary (right) long-term soil monitoring plots at Lakelse Lake. The vertical lines indicate the location of the soil sampling pits (n = 20 per plot, with soil sampling at three depths).

5 Literature Cited

ESSA Technologies, J. Laurence, Limnotek, Risk Sciences International, Rio Tinto Alcan, Trent University, Trinity Consultants and University of Illinois. 2013. Sulphur Dioxide Technical Assessment Report in Support of the 2013 Application to Amend the P2-00001 Multimedia Permit for the Kitimat Modernization Project. Vol.2: Final Technical Report. Prepared for RTA, Kitimat, BC. 450 pp.

ESSA Technologies, J. Laurence, Risk Sciences International, Trent University, and Trinity Consultants. 2014. Kitimat Airshed Emissions Effects Assessment. Report prepared for BC Ministry of Environment, Smithers, BC. 205 pp. + appendices.

6 Appendix A

Table 1. Soil plot grids sampled (at five depths) during 2015 within the primary and secondary plots located at Coho Flats and Lakelse Lake (see Figure 1). Grids are identified by the sub-plot letter and grid number (see Figure 2). Grid locations for the primary plots are also shown in Figure 5.

#	Coho Flats		Lakelse Lake	
	Primary	Secondary	Primary	Secondary
1	A12	A10	A10	A10
2	B08	B06	B11	B06
3	C05	C03	C02	C10
4	D04	D07	D05	D02
5	E11	E07	E04	E06
6	F03	F01	F02	F02
7	G06	G05	G09	G02
8	H06	H01	H07	H04
9	I11	I04	I06	I08
10	J05	J12	J01	J09
11	K12	K05	K04	K10
12	L02	L06	L12	L11
13	M03	M01	M04	M12
14	N12	N02	N05	N04
15	O07	O03	O06	O11
16	P11	P06	P09	P09
17	Q03	Q06	Q12	Q01
18	R02	R02	R07	R03
19	S03	S07	S06	S09
20	T02	T05	T09	T03

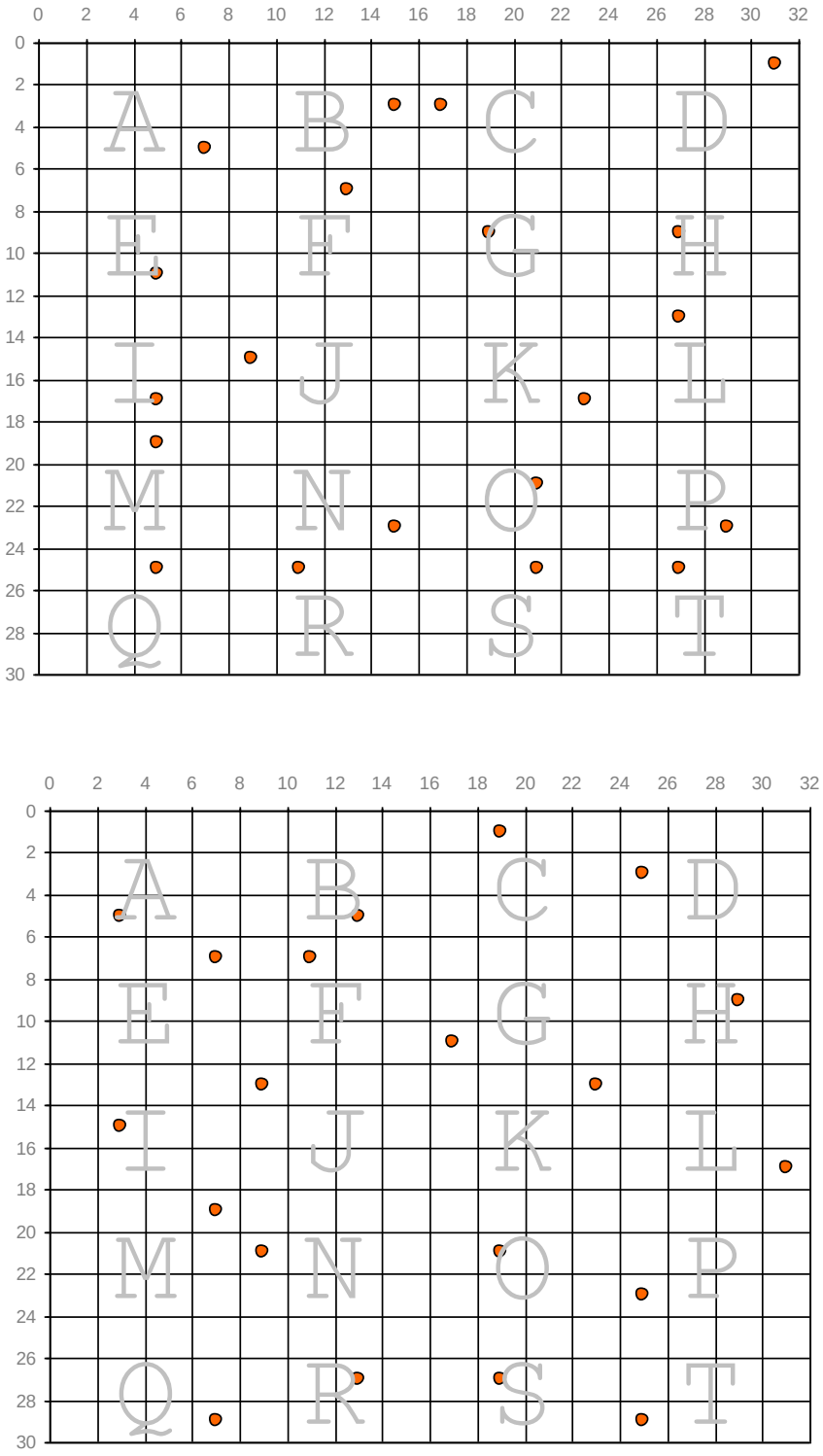

Figure 5. Location of soil sampling grids within letter sub-plots at the primary plots at Coho Flats (upper) and Lakelse Lake (lower).