BRITISH COLUMBIA
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Ministry of Environment

PROTOCOL 4
FOR CONTAMINATED SITES

Determining Background Soil Quality

Prepared pursuant to Section 64 of the
Environmental Management Act

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Date

1.0 Definitions

The following words, acronyms and expressions used in this protocol are defined in the ministry procedure "Definitions and Acronyms for Contaminated Sites":

Act
background concentration
local background concentration in soil
numerical standards
regional background soil quality estimate
Regulation
wide area site

2.0 Introduction

The Contaminated Sites Regulation (the Regulation) provides a "release" as a contaminated site when the concentrations of substances at a site do not exceed local background levels. When assessing, remediating, or relocating contaminated soil, onsite substance concentrations may be evaluated against background.

This protocol summarizes available regional background soil quality estimates for specified inorganic substances in British Columbia and provides procedures to establish background soil quality on a site-specific basis for use under the Regulation. This information may be used to determine contaminated site status, evaluate satisfactory remediation and authorize contaminated soil relocation. The ministry does not recommend the direct quantification of local background concentrations at wide area sites (see section 5.2.3.1 below).

3.0 Regulatory aspects

The regulatory framework considering background concentrations can be found in Part 5, section 11 (3) of the Regulation:

> 11 (3) Subsection (1) does not apply to a site in relation to a substance in the soil, surface water, groundwater, sediment or vapour if the concentration of the substance in the soil, surface water, groundwater, sediment or vapour is not greater than the local background concentration of that substance in the soil, surface water, groundwater, sediment or vapour respectively.

Section 11 (3) denotes substance background concentrations determined on a local background (i.e., site-specific) basis. In addition, regional background soil quality estimates may also be considered equivalent to local background concentrations in soil for the purposes of section 11 (3) of the Regulation.

Section 17 (2) (b) of the Regulation states that a contaminated site is considered to have been satisfactorily remediated if:

> 17 (2) (b) the soil, surface water, groundwater, vapour or sediment at the site does not contain any substance with a concentration greater than the local background concentration of that substance in the soil, surface water, groundwater, vapour or sediment respectively.

Finally, section 45 (3) (b) considers the deposit of contaminated soil at a deposit location to be acceptable if the contaminated soil does not contain any substance with a concentration exceeding:

> 45 (3) (b) the local background concentration of that substance in the soil at the deposit site.

Regional background soil quality concentration estimates may also be considered equivalent to local background concentrations in soil for the purposes of section 17 (2) (b) and 45 (3) (b) of the Regulation.

4.0 Overview

The ministry has considered background soil quality under the Regulation within a three stage approach.

In the first stage the site's substance concentrations are compared to the toxicological-based soil quality standards which, in the development of the Regulation, were adjusted on the basis of provincial or Lower Mainland background soil quality estimates.

The second stage allows the use of regional background soil quality estimates as indicators of local background soil quality at sites located within any particular region.

The third stage allows the assessment of local background soil quality specific to a site using either:

a) ministry reference data (or alternate reference data sources approved by the ministry) for the area, or
b) local background data quantified directly for a reference site substantively similar to the subject site.

This protocol provides procedures to ascertain, using either the stage 2 or 3 approach, the local background soil quality for a substance at a particular site. The details of how a

particular background assessment will be conducted for any specific site may also be discussed with ministry staff.

A report detailing the findings of the background assessment must be submitted to, and approved by, a Director to obtain a background release.

4.1 Process summary

4.1.1 Initial assessment of site status

Note the region in which the suspect contaminated site is located (Figure 1). Compare the soil quality (substance concentrations) measured at the site to the numerical soil standards of the Regulation. Exceedance of standards indicates the site is a contaminated site.

4.1.2 Consideration of background release

4.1.2.1 Stage 2: Regional background approach – Comparison to Table 1

A site may be released as a contaminated site based on regional background.

For the exceedances noted, compare the site's soil quality to the relevant 95th percentile regional background concentrations provided in Table 1. If the relevant Table 1 regional background concentrations are not exceeded, the site may be released as a contaminated site based on regional background.

4.1.2.2 Stage 3: Local background approach – Quantification of local background

A site may also be released as a contaminated site based on consideration of locally assessed background concentrations for the site. Local background concentrations are established by either:

a) comparing site exceedances to ministry data for local background within an area or locale, or other data pertaining to local background concentrations within an area or locale which has been approved for such use by a Director; or
b) comparing site exceedances to local background concentrations quantified directly at a local background reference site approved by a Director.

If the relevant local background concentrations are not exceeded, the site may be released as a contaminated site.

5.0 Procedures

5.1 Stage 2 Approach – Regional background estimates – General procedure

The ministry has determined for specific regions of the province and for the Vancouver area, regional background soil quality estimates for 17 inorganic substances (Table 1). These regional background estimates represent, the 95th percentile value for a substance as described in reference [1].

Where site-specific local background soil quality has not been directly quantified for the site, the regional background soil quality estimates of Table 1 may be used as determinants of background soil quality for the site.

Table 1 regional background soil quality estimates are based on surfical or near surface soil samples obtained at ministry background sites [1, 2]. Consequently, these regional background estimates may only be used as determinants of background soil quality to a maximum depth of 3m from the soil surface at a site. For sites with contamination at depths greater than 3m, background soil quality should be directly quantified using the stage 3 local background approach.

For sites located within the Greater Vancouver area, as described in Figure 2 of this protocol, the Vancouver area background soil quality estimates presented in Table 1 should be used as applicable regional background quality estimates. Sites located within Region 2, which lie outside the Vancouver area, should use the Region 2 background soil quality estimates of Table 1.

5.1.1 Deciding if a site is a contaminated site or has been satisfactorily remediated

Any site at which the soil quality for a specified substance exceeds an applicable Schedule 4 or 5 numerical soil standard in the Regulation, but does not exceed the corresponding appropriate regional background soil quality estimate listed in Table 1, can be provided a release under section 11 (3) or 17 (2) (b) of the Regulation. Otherwise, the site is deemed to be either a contaminated site or an unsatisfactorily remediated contaminated site.

5.1.2 Deciding if contaminated soil is suitable for relocation

Soil to be relocated from a site which exceeds, for a Table 1 specified substance, an applicable Schedule 4, 5 or 7 numerical standard for soil, but does not exceed the corresponding appropriate regional background soil quality estimate for the soil deposit location, can be considered acceptable for deposit at that location in accordance with section 45 (3) (b) of the Regulation. Otherwise, the soil quality standards of sections 45 (2) or 45 (3) (a) apply.

5.1.3 Other substances

Table 1 provides regional background soil quality estimates for 17 inorganic substances only. The ministry does not plan to expand Table 1 beyond those substances. For substances not listed in Table 1, local background soil quality may be established directly using the procedures described in section 5.2 below.

5.1.4 Reporting requirements

Responsible persons wishing to apply for release of their site or to relocate soil from their site on the basis of consideration of regional background soil quality estimates must submit to a Director, for review and approval, the following information:

a) a site investigation report (i.e., a PSI or DSI) which fully characterizes the concentrations of contaminants present in the soil of the site *per se*, or in soil proposed to be relocated from the site,

b) identification of the region in which the site is located, or in the case of proposed soil relocation, the region of the proposed deposit site,

c) a listing of applicable regional background soil quality estimates abstracted from Table 1 of this protocol, and

d) a formal written request for release of the site under section 11 (3) or 17 (2) (b) or approval to relocate soil under 45 (3) (b) of the Regulation.

5.2 Stage 3 Approach - Direct quantification of local background soil quality

Responsible persons wishing to apply for release of their site under section 11 (3) or 17 (2) (b) of the Regulation or to relocate soil under section 45 (3) (b) of the Regulation may elect to directly quantify site-specific local background soil quality for their site in accordance with the procedures detailed below.

5.2.1 General procedures

Local background soil quality for a site may be established in either of two ways:

a) by use of ministry or other reference data pertaining to local background within an area or locale, which has been approved for such use by a Director, or

b) by direct quantification of local background at a local background reference site approved by a Director.

5.2.2 Establishing background based on ministry or other reference data

The data upon which the regional background soil quality estimates of Table 1 are based is available from the ministry [1]. The ministry database is limited in regard to specific locales within certain regions. However, in some circumstances this data may

be sufficient to establish local background for some sites.[1] In addition, for some locales other non-ministry local background reference data may be available.

A responsible person for a site may therefore wish to investigate the possibility of establishing local background concentration for their site based on such reference data, rather than directly assessing local background concentration for their site through the reference site procedure. If this is the case, a responsible person must provide a report for the approval of a Director detailing the source of the reference data used and presenting arguments to show that this data is relevant for the purposes of establishing local background for their site. The arguments presented in the report should provide information similar to that required under the reference site procedures below.

5.2.3 Establishing background based on data obtained at a reference site

Site-specific local background soil quality may be quantified directly through comparison to a carefully chosen reference background site. The emphasis in the reference site procedure is on accurate estimation of substance concentrations in soil which can be shown to be attributable solely to natural (i.e., non-anthropogenic) and generalized non-point anthropogenic sources. This is achieved by careful selection, analysis and comparison of reference site background soil substance concentrations to those observed at the contaminated site in question.

For example, urban areas have been subject to variable levels of anthropogenic non-point source contamination with lead as a result of generalized automobile emissions. Thus, the soil of potential contaminated sites located within most urban areas would be expected to contain some amount of lead. In addition, at sites where lead was used in industrial or commercial activities, the soil may also contain additional lead as a result of point source contamination.

Note
It is not the intent of the Regulation to dismiss, through the background release the need to remediate contaminated sites which have been contaminated through point source releases.

The procedure below quantifies local background soil quality directly through site-specific comparison to a local reference site. If the concentrations of substances in soil at the suspect or remediated contaminated site or in contaminated soil to be relocated do not exceed substance concentrations established for the local reference site (i.e., the local background soil quality), then the site/soil is considered:

a) not to be a contaminated site under section 11 (3), or
b) satisfactorily remediated under section 17 (2) (b), or
c) acceptable for deposit under section 45 (3) (b)

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[1] Due to the small size of the data set, when ministry data is used, reference local background concentrations for a locale should be based on median as opposed to 95th percentile estimates.

5.2.3.1 *Wide area sites*

Under the reference site procedure described below, it is necessary to closely match the contaminated site in question with a local reference site of suitable geographic area and scope. This is problematic in the case of contaminated sites which have been designated wide area sites under the Regulation. Wide area sites tend to be larger complex sites which typically encompass considerable geographic area. While it may be possible to select a reference site of sufficient size and scope to use in the direct assessment of local background soil quality for a wide area site, the sampling time, effort and analysis required to adequately characterize both the wide area contaminated site and its corresponding local wide area reference site would likely be prohibitively expensive.

For this reason, the ministry does not recommend the direct determination of background soil quality for use at wide area sites. Rather, it recommends that background soil quality at such sites be addressed through the use of the ministry's stage 2 regional background soil quality estimates approach.

5.2.3.2 *Reference site procedure – Local reference site characterization*

The reference site should closely match (i.e., be substantively similar to) the contaminated site in question in respect to:

a) geographical characteristics (e.g., location, topography, size/area, etc.),
b) soil physical/chemical characteristics (see soil maps, Geological Survey of Canada information, etc.),
c) hydrology, and
d) soil sampling depth.

Additionally:

a) within cities preference should be given to vacant land (land which has not received imported fill), naturally wooded areas, parks or large residential lots,
b) reference sites must not be located next to or within the general vicinity of contaminant point sources,
c) reference sites with any obvious vegetation damage should be avoided, and
d) the history of the reference site and adjacent land, including current and previous activities must be considered and documented.

5.2.3.3 *Reference site information and data requirements – Site soil sampling and chemical analysis*

Once a suitable local reference site has been located and if needed, permission to sample has been obtained, the following minimum information should be collected:

a) name and address of the property owner
b) current land use
c) surrounding land uses
d) any previous land uses (site history)
e) potential contaminant sources (both natural and anthropogenic)
f) latitude and longitude, and
g) a diagram of sampling plot locations within the overall property boundary.

Additional detailed information related to soil sampling methodology and the nature of the soil samples obtained at the reference site should also be documented. For example, additional information should be recorded concerning soil sample:

a) collection,
b) storage,
c) preparation,
d) archiving,
e) physical characterization, and
f) chemical analysis.

Sampling procedures and chemical analytical requirements differ for inorganic and organic substances. Soil sampling should be performed in accordance with ministry requirements [2, 3].

Ideally, soil samples taken from the reference site and the contaminated site in question should be subjected to identical analyses, using whenever possible, the same chemical analytical laboratory. Samples must be analyzed using ministry approved analytical methods, or alternate methods acceptable to the Director [4].

5.2.3.4 Reporting requirements

Responsible persons wishing to apply for release of their site or to relocate soil from their site[2], on the basis of consideration of local background soil quality must submit to a Director for review and approval the following information:

a) a "Direct Determination of Local Background Soil Quality" report containing, at a minimum, details relevant to:
    i) the selection of the reference site,

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[2] In the case of an application to approve soil relocation under section 45 (3) (b) of the Regulation, a "Direct Determination of Local Background Soil Quality" report containing information equivalent to that described above, must be prepared and submitted for ministry approval. The local reference site described in this report must be shown to be relevant to, and specific for, the proposed deposit site in question.

ii) the geographical location of the reference site (i.e., latitude and longitude, PIDs, etc.),
iii) a complete history of land use(s) at the reference site,
iv) physical characterization of the reference site,
v) soil sampling procedures used,
vi) soil sampling locations used (i.e. a map showing sampling locations),
vii) soil depths sampled,
viii) documentation of the soil contaminants of concern considered,
ix) analytical results obtained,
x) the statistical significance of the results obtained, and
xi) conclusions forthcoming from the assessment of reference site background soil quality and the comparison of reference site background soil quality to the soil quality of the contaminated site in question.

b) identification of the region in which the site is located, or in the case of proposed soil relocation, the region for the proposed deposit site, and
c) formal written request for release of the site under section 11 (3) or 17 (2) (b) of the Regulation or approval to relocate soil under 45 (3) (b) of the Regulation.

6.0 Background release – notification on Site Registry

On the basis of the submitted information a Director may make a Determination of Contaminated Site under section 44 of the Act or section 11 (3) of the Regulation that a site is not contaminated. A Director may also use this information under section 17 (2) (b) of the Regulation to certify that the site has been satisfactorily remediated.

Information submitted in support of an application for release as a contaminated site under section 11 (3) or 17 (2) (b) or to relocate soil under 45 (3) (b) of the Regulation is subject to ministry report review fees normally levied under the Regulation. A Director will not make any decision relating to site status, or suitability of soil to be relocated, based on background soil quality considerations until all requisite fees have been paid.

After making a decision under section 11 (3), 17 (2) (b) or 45 (3) (b) of the Regulation, the Director will provide to the Site Registrar the supporting information relating to local background soil quality for the site in compliance with section 43 of the Act.

Information relating to local background soil quality at a deposit site proposed for the relocation of contaminated soil under section 45 (3) (b) of the Regulation must be included in any Contaminated Soil Relocation Agreement prepared under section 55 of the Act.

7.0 References

1. B.C. Ministry of Environment. (2005). Technical Guidance 17: Soil Quality Database. Victoria, B.C. October 2005. Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/technical-guidance/tg17.pdf

2. British Columbia Ministry of Water, Land and Air Protection. (2005). Technical Guidance 16: Soil Sampling Guide for Local Background Reference Sites. Victoria, B.C. June 2005. Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/technical-guidance/tg16.pdf

3. B.C. Ministry of Environment. (2009). Technical Guidance 1: Site Characterization and Confirmation Testing. Victoria, B.C. January 2009. Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/technical-guidance/tg01.pdf

4. Horvath, S. (editor). (2009). British Columbia Environmental Laboratory Manual. Water & Air Monitoring and Reporting Section. Environmental Quality Branch. Ministry of Environment. Victoria, B.C. July 2009. Available at: http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/guidance-resources/policies-standards

5. B.C. Environment. (1996). "Overview of CSST Procedures for the Derivation of Soil Quality Matrix Standards for Contaminated Sites". Risk Assessment Unit. Environmental Protection. B.C. Ministry of Environment. Victoria, B.C. January 1996. Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/policies-and-standards/overview_of_csst_procedures-derivation_of_soil_quality_matrix_standards_cs.pdf

For more information, contact the Environmental Management Branch at site@gov.bc.ca

Table 1. Regional background soil quality estimates for inorganic substances.[1,2,3,4]

Column I	Column II	Column III	Column IV	Column V	Column VI	Column VII	Column VIII	Column IX
Substance	Region 1 Vancouver Island	Region 2 Lower Mainland	Greater Vancouver Area[5]	Region 3 / 8 Thompson Nicola Okanagan	Region 4 Kootenay	Region 5 Cariboo	Region 6 Skeena	Region 7 Omineca Peace
antimony	(4.0)	15	(4.0)	(4.0)	(4.0)	(4.0)	(4.0)	(4.0)
arsenic	10	20	15	25	10	10	15	15
barium	300	300	150	350	400	300	400	600
beryllium	1.5	1.5	1.0	2.0	2.0	2.0	1.5	2.0
cadmium	0.35	0.40	0.55	0.55	1.5	0.45	0.60	0.90
chromium (total)	90	80	100	150	50	150	65	85
cobalt	50	30	15	30	25	30	15	35
copper	150	45	100	75	45	65	50	75
lead	30	60	300	15	75	9.5	15	35
mercury[6]	(0.025)	0.15	0.4	(0.025)	(0.025)	(0.025)	0.15	(0.025)
molybdenum	(1.0)	(1.0)	6.0	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
nickel	55	80	75	75	50	150	50	60
selenium	(4.0)	(4.0)	2.0	(4.0)	(4.0)	(4.0)	(0.25)	(4.0)
silver	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)
tin	(4.0)	(4.0)	(4.0)	(4.0)	(4.0)	(4.0)	(4.0)	(4.0)
vanadium	250	150	100	150	80	100	100	200
zinc	100	100	90	100	200	85	150	150

Footnotes:

1 All values are in ug/g unless otherwise stated. All values have been rounded in accordance with Contaminated Sites Taskgroup rounding rule [5]. Values in brackets indicate that greater than 50% of values were less that the mean detection concentration (MDC) for the substance, consequently tabled regional estimate is one-half the MDC.

2. Each estimate represents the 95th percentile value obtained for a substance in the region or area.

3. Estimates for background soil determinations are provided for the following regions (see Figure 1):
   - Region 1: Vancouver Island
   - Region 2: Lower Mainland
   - Region 3 / 8: includes Thompson-Nicola and Okanagan
   - Region 4: Kootenay
   - Region 5: Cariboo
   - Region 6: Skeena
   - Region 7: includes Omenica Zone 7A and Peace Zone 7B

4. All soil samples, except those analyzed for mercury, were subject to the aqua regia digestion method summarized in Appendix 1.

5. Listed background soil quality estimates may be used as regional quality estimates within the Greater Vancouver area only. The Greater Vancouver area (see Figure 2) includes:

Burnaby,
Coquitlam,
New Westminster,
North Vancouver,
Port Coquitlam,
Port Moody,
Richmond,
West Vancouver, and
Vancouver.

6. Soil samples for mercury analyses were assayed using US EPA SW846 Method 7471 procedure summarized in Appendix 2.

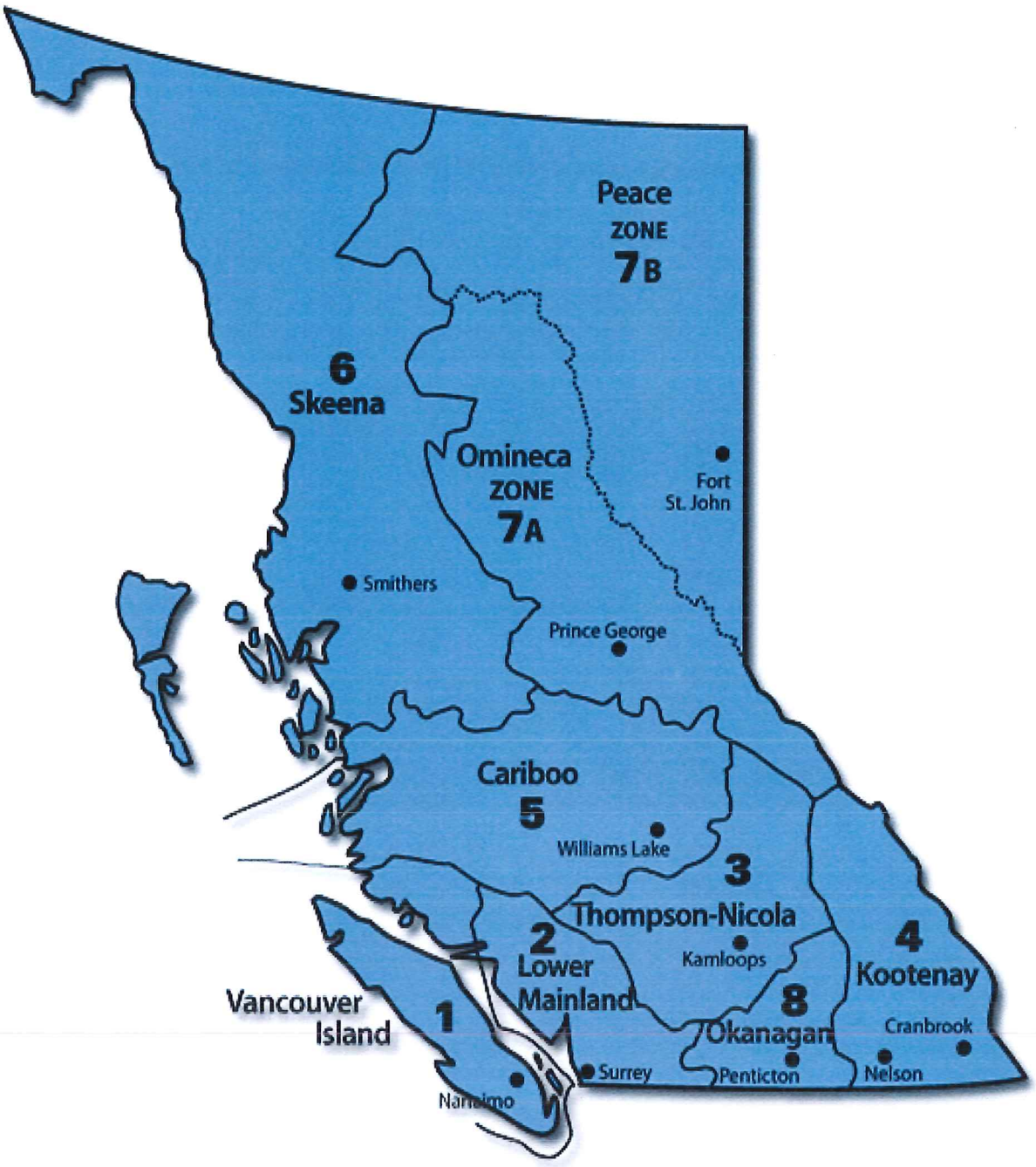

Figure 1. Regional boundaries for background soil determinations.

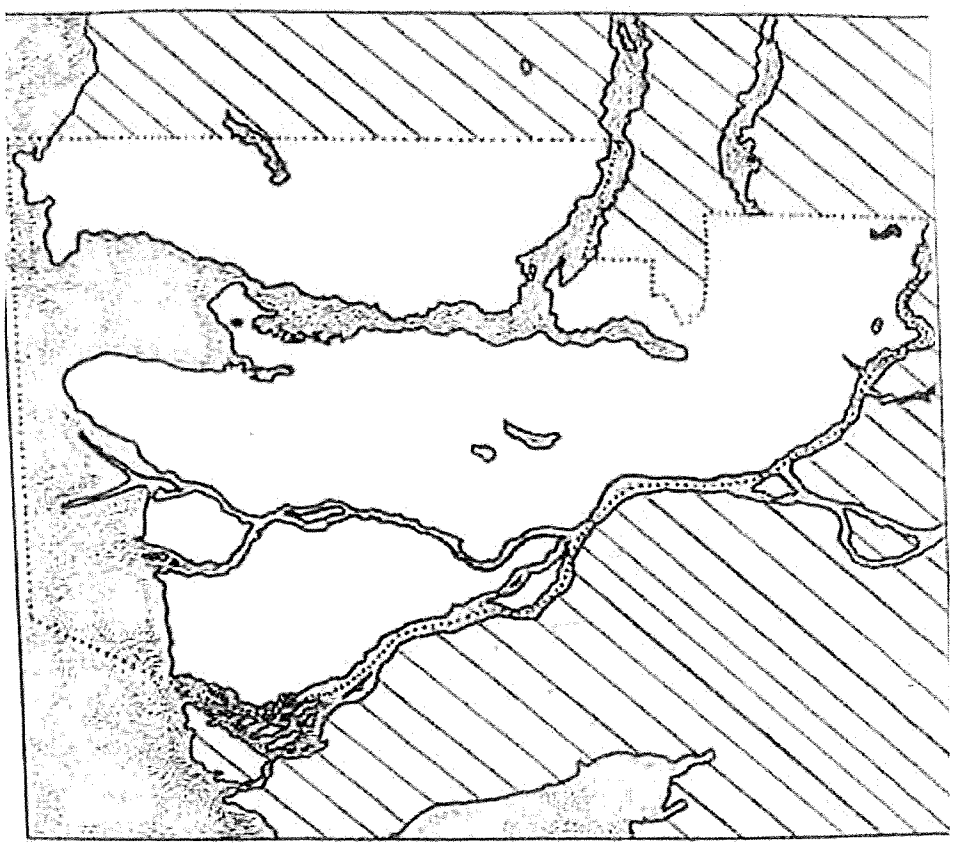

Figure 2. Geographic limits for Greater Vancouver area.

Appendix 1

Summary of Aqua Regia Digestion Method

Reference soil samples used to develop regional background soil quality estimates were subjected to the following digestion procedure:

1. Dry soil samples at 60 ^{o}C, then sieve through a 100 mesh (150 um) screen,
2. Weigh 0.3 g of the dried, meshed sample into a Teflon microwave digestion vessel,
3. Add 4.5 mls Nitric Acid, 1.5 mls Hydrochloric Acid and 4 mls of DI water into the vessel,
4. Digest in a microwave for 25 minutes under high pressure and 175 ^{o}C,
5. Following digestion, bulk samples with DI water up to 50mls,
6. Assay sample, final Nitric Acid concentration is 9%, and final Hydrochloric Acid concentration is 3 %.

For further details of the Aqua Regia soil sample digestion procedure, contact Pacific Environmental Sciences Centre, North Vancouver, British Columbia.

Appendix 2

Summary of US EPA SW846 Method 7471 for Mercury

Reference soil samples used to develop regional background soil quality estimates for mercury were subjected to the following procedure:

1. Convert all forms of mercury in the soil sample to inorganic mercury using an acid-permanganate digestion of the air dried sample.
2. Reduce inorganic mercury to its elemental state using $SnCl_2$.
3. Measure mercury using cold vapour atomic absorption spectrophotometry at a wavelength of 253.7 nm.
4. Analyses were completely automated using a Technicon autosampler coupled to a custom fabricated phase separator and detection using a Milton Roy Mercury monitor fitted with a 30 cm absorbance cell.
5. As a measure of the digestion and analysis efficiency, two SRM's were treated with every batch.

For further details of the mercury digestion/analysis procedure, contact Pacific Environmental Sciences Centre, North Vancouver, British Columbia.