Starting a Community Garden

A Site Assessment Guide for Communities

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DEDICATION

To the urban farmers, community organizers, and backyard gardeners who know the joy of placing their hands in the soil, and the satisfaction of observing a seed mature into a delicious fruit.

To future community gardeners, who aspire to create positive change in their communities. I hope this guide serves to help you achieve your goals, and realize the pleasure and potential that gardening can bring.

Though unassuming, the act of gardening is nothing less than an act of revolution.

INTRODUCTION – HOW TO USE THIS GUIDE

Have you ever walked by that vacant lot near your home, work, or school, and thought "I would love to make this place a garden!" If so, then this guide is for you!

The purpose of this guide is to help you answer some of the big questions about the environmental quality of your site. Questions like:

- How can I find out if the soil is contaminated?
- Is the soil deep enough for my plants to have healthy root systems?
- Are there enough nutrients in the soil?
- Is the site too shady for a garden?

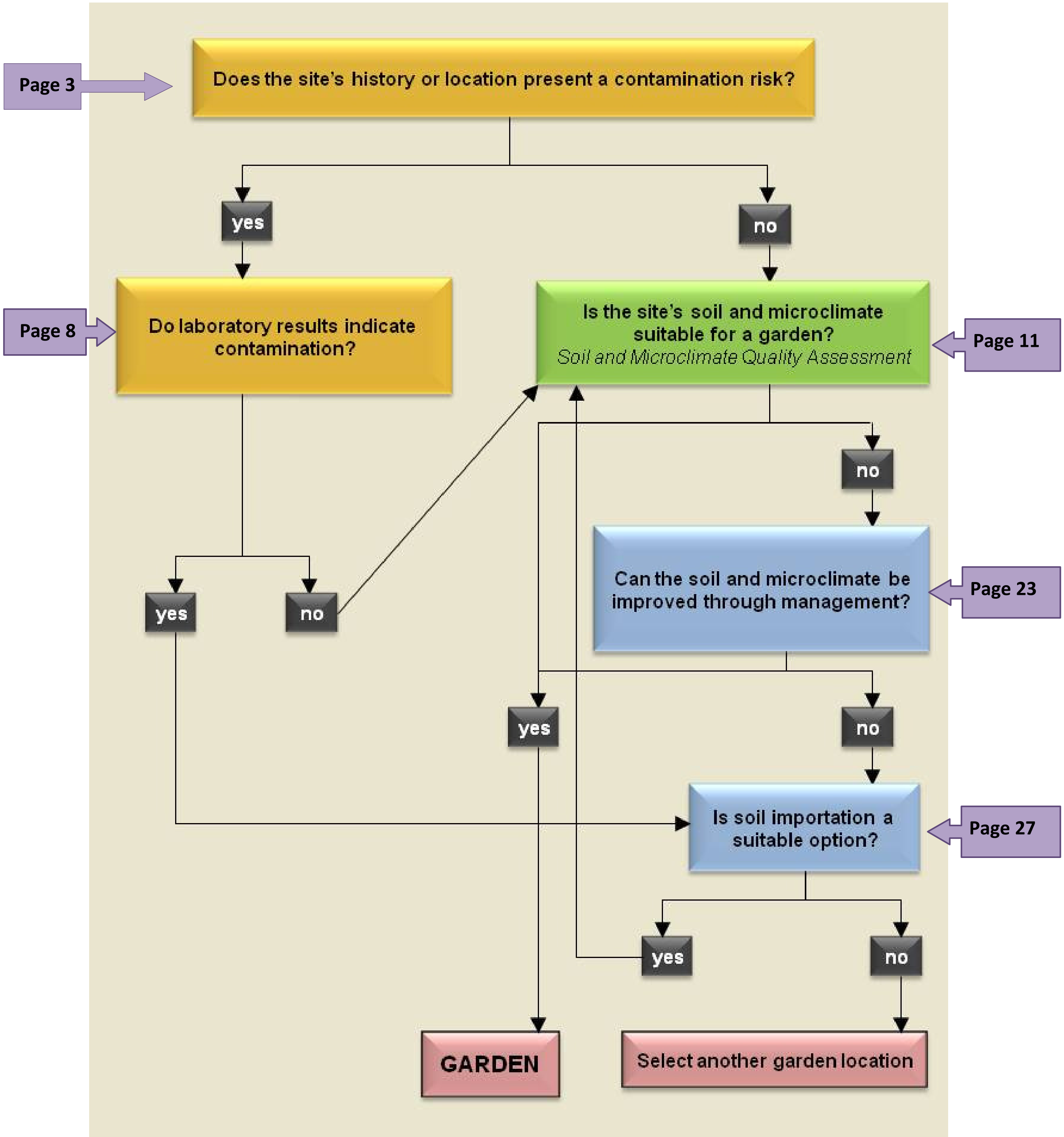
These are important questions to answer after issues regarding site tenure, community support, and liability insurance have been addressed.

To use this site, go to the decision tree diagram on the next page. Starting at the top of the "tree", with the box entitled: "Does the site's history or location present a contamination risk?" Go to the corresponding chapter heading and carry out the suggested activities. These activities should provide information to help determine a "yes" or "no" answer. Proceed down the decision tree, concluding with the boxes "Garden" or "Select another garden location."

All italicized terms are defined in the Glossary on page 28.

References for all books and resource materials are provided on page 34.

SITE ASSESSMENT DECISION TREE



DOES YOUR SITE HISTORY OR LOCATION PRESENT A CONTAMINATION RISK?

Determining if a site contains contaminated soil is the first action that should be taken when assessing a site for garden development. To ensure a site's soil is not contaminated, laboratory testing for contamination is required. These tests are expensive and not always financially accessible to community groups. Regardless of laboratory analysis, a site history should be conducted. Knowledge of a site's history provides an indication of the risk level associated with the site's soil, as well as probable contaminants that may be found on the site.

SITE HISTORY

There are four main ways to gather information on the current and past land uses of a particular brownfield: 1) contacting city officials, 2) accessing historical documentation, 3) talking with neighbours and locals, and 4) taking note of artifacts found onsite

1. CONTACTING CITY OFFICIALS

In the City of Vancouver, the Social Planning and Engineering Departments are able to provide the most information about the previous land uses of brownfield sites. The Director of Social Planning can provide information directly, or put you in contact with an appropriate person from the Department of Engineering.

2. HISTORICAL DOCUMENTATION

The Vancouver City Archives are another important source of historical information. The Vancouver Archives are open to visitors, and are located near the South side of the Burrard Street Bridge at 1150 Chestnut Street. Archivists and reference staff are available to help sort through past maps, architectural plans, City directories and other records of interest.

3. INTERVIEWS

Interviews with neighbours and people who have had contact with the site can provide the most relevant and useful information when conducting a site history. They can give indication of past, as well as present land uses. In one instance, a ***brownfield*** seemed to have low-risk land use history based on the information I received from the Social Planning Department and the City Archives. Upon speaking with a neighbour to the site I learned that another neighbour had been using the brownfield to dispose of the refuse oil from the oil changes he had been performing on his car. This key piece of information would not have been made available to me

FIGURE 1 LA COSECHA GARDEN - CLARK AVENUE AND BROADWAY
PHOTO CREDIT: MELISSA IVERSON

if I had not spoken with this neighbour. People who live, work, or frequently pass by brownfields have information about the kinds of activities that occur on the site that no government official or historical record can provide. In some cases, neighbours who have lived or worked in the area for a long time may be able to recount the history of the site, filling in some of the gaps in archival information.

4. Site Artifacts

Site artifacts consist of materials in or on top of the soil that have been abandoned or discarded onsite. These may include garbage, such as food containers or cigarette butts, or materials remaining from the site's prior use, such as rubble from demolished structures. These artifacts can be important clues to the activities that occurred on the site, including those activities that occurred after the site was left unoccupied.

In addition to compiling a site history, the site's surroundings may also provide clues regarding possible contaminants. For instance, close proximity to roadways or industrial facilities may suggest the presence of related contaminants.

Land uses that pose a risk

Once past land uses have been determined, compare results to Table 1: Past Land Uses and Associated Potential Contaminants and Table 2: Common Contaminants and their Sources. These tables are meant to serve as guidelines only. For a complete list and discussion of toxic effects see *Trace Elements in Soils and Plants* by Alina Kabata-Pendias and Henryk Pendias (2001).

TABLE 1 PAST LAND USES AND ASSOCIATED POTENTIAL CONTAMINANTS

Past Land Use	Potential Contaminants
Housing	Copper Lead Tin Zinc
Construction sites	Cadmium Copper Lead Nickel Tin Zinc Petroleum hydrocarbons
Park	Variable
Commercial (shops, restaurants, etc.)	Copper Lead Tin Zinc
Parking lots, gas stations, and site adjacent to busy roads	Cadmium Lead Petroleum hydrocarbons
Laundromat	Variable
Railway (adjacent to site)	Copper Zinc Petroleum hydrocarbons

TABLE 2 COMMON CONTAMINANTS AND THEIR SOURCES

Contaminant	Anthropogenic Sources
Cadmium	Coal ash Fossil fuel combustion Batteries Pigments, Metal coatings Plastics Manufacture and application of phosphate fertilizers Waste incineration and disposal *Can be atmospherically deposited onsite*
Copper	Anti-fouling paint Wires and electrical conductors Plumbing fixtures and pipes Coins and cooking utensils Wood, leather and fabric preservatives Pesticides and fungicides Sheet metal
Lead	Batteries and battery oxides Coal residues Municipal refuse incineration and wastewaters Older paints, ceramic products, caulking, and pipe solder Lead can persist in the soil from car emissions emitted before the practice of leading gas had ceased. *Can be atmospherically deposited onsite*
Mercury	Municipal waste incineration; Sewage and hospital waste incineration; Coal and other fossil fuel combustion; Cement manufacturing Thermometers and barometers Dental fillings Antiseptic creams, ointments, and skin lighteners Electrical products (e.g., dry-cell batteries, fluorescent lamps, and electrical switches) Production of chlorine gas and caustic soda
Nickel	Used in the chemical and food-processing industries and in the medical profession Shipbuilding Plating and catalysis Valves and heat exchangers Electrodes Smelting and alloy-producing processes Employed in electrolyte solution Plating Batteries *Can be atmospherically deposited onsite*

Tin	Glass coatings Base for the formulation of colors Food additives dyes Perfumes Soaps Polyvinyl chloride (PVC) heat stabilizers Paints and anti-fouling paints Pesticides and pest repellants Can linings for food, beverages, and aerosols. Toothpaste Plastics (e.g., food packages, plastic pipes) *Can be atmospherically deposited onsite*
Zinc	White paints and ceramics Rubber Wood preservatives Manufacturing and dyeing fabrics Major ingredient in smoke from smoke bombs Used by the drug industry (e.g., vitamin supplements, sun blocks, diaper rash ointments, deodorants, athlete's foot preparations, acne and poison ivy preparations, and anti-dandruff shampoos) Coatings to prevent rust Dry cell batteries
Petroleum hydrocarbons	Gasoline Oil Lubricants

DO LABORATORY RESULTS INDICATE CONTAMINATION?

SENDING SOIL SAMPLES TO THE LABORATORY FOR CONTAMINATION ANALYSIS

If the site's history, location, or onsite artifacts reveal a possibility of contamination risk, laboratory analysis should be conducted. Determine what to test for based on the tables above. Commonly, people choose to test for metals, such as lead, copper and cadmium (referred to as ***strong acid soluble metals*** by testing laboratories) and petroleum products such as oils, gasoline, and lubricants (referred to as ***extractable petroleum hydrocarbons***). Contact information for the local laboratory used to conduct contamination analysis for this research is provided below. There are other testing laboratories in the Vancouver-area and mention of this particular laboratory does not indicate preference or endorsement. Before sampling, contact the laboratory of your preference to find out price listings, their particular sampling requirements, and methods of analysis. Some laboratories provide glass jars and coolers with ice packs for sampling.

Maxxam Analytics (formerly Cantest Laboratory) 4606 Canada Way Burnaby, BC Canada V5G 1K5 Tel: (604) 734-7276 Toll-free: 1-800-665-8566

TABLE 3 CONTAMINATION ANALYSIS LABORATORY CONTACT INFORMATION

SAMPLING PROTOCOLS FOR CONTAMINATION ANALYSIS

When soil sampling, you will need: a shovel, a metal and/or plastic trowels, a metal and/or plastic bucket, glass jars, and a cooler with ice packs.

To take a sample:

1) Dig a soil pit approximately 30 cm deep
2) Place trowel 2-3 cm from the edge of the pit and remove a portion on the soil pit wall Figure 2)
3) Cut a rectangle of soil from the centre of the trowel to keep as the sample. Discard soil on either side of the trowel (Figure 3). This will ensure an equal representation of soil from all depths.

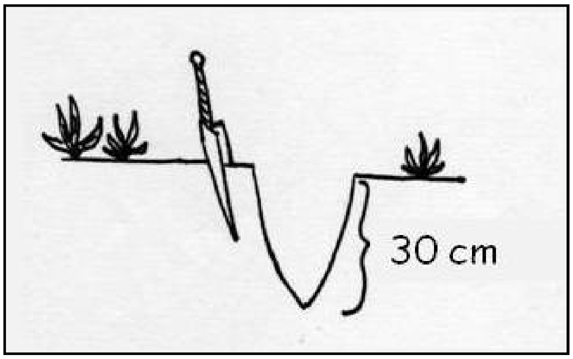


FIGURE 2 TAKING A SOIL SAMPLE (A)

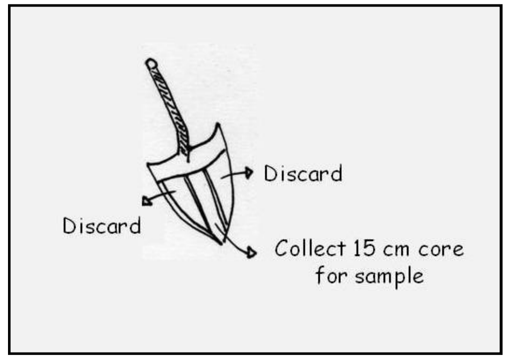


FIGURE 3 TAKING A SOIL SAMPLE (B)

If contaminants of concern are metals or metalloids, do not use a metal trowel or metal bucket. If contaminants of concern are organic compounds, such as petroleum-based contaminants (i.e. gasoline, oil, etc.), do not use plastic trowels, buckets, bags or containers. Store samples in glass containers and keep cool (under 10° C) until analyzed. Clean sampling devices between each sample.

FIGURE 4 LABELING EACH SOIL SAMPLE FOR IDENTIFICATION

PHOTO CREDIT: MELISSA IVERSON

One cost-effective sampling technique is composite sampling. This is when you mix together soil samples taken from similar areas of the site to get an average among those similar areas. Soil samples taken from areas with differing vegetation, soil textures, compaction levels, or elevations (down-slope or up-slope) should **not** be mixed into the same composite sample.

Always record in your notes the areas you have sampled, and give your soil samples names that clearly reflect where they were taken from.

The British Columbia Ministry of Agriculture and Lands published a detailed factsheet on soil sampling (Hughes-Games and Schmidt 2005). A copy of this 4-page factsheet is provided in the appendix (pg 27).

Interpreting Your Results

When results return from the lab, compare them to the table below. Values at or under the government-set limits (provided in the right-hand column) indicate soils that are a safe for growing plants.

TABLE 4 GOVERNMENT LIMITS FOR METALS

Substance	Unit	Government Limit
Antimony	ug/g	20
Arsenic	ug/g	20
Barium	ug/g	500
Beryllium	ug/g	4
Boron	ug/g	2
Cadmium	ug/g	3
Chromium	ug/g	250
Cobalt	ug/g	40
Copper	ug/g	100
Fluoride	ug/g	200
Lead	ug/g	375
Mercury	ug/g	0.8
Molybdenum	ug/g	5
Nickel	ug/g	100
Selenium	ug/g	2
Silver	ug/g	20
Sulphur (elemental)	ug/g	500
Thallium	ug/g	1
Tin	ug/g	5
Vanadium	ug/g	200
Zinc	ug/g	500

It is important to note that government contamination limits are provided in ***total values***, and not ***plant- or bio-available values***. This means that the metal concentrations provided by the laboratory are in the soil, but plants are not necessarily able to take them up. Because of this, it is important to determine the naturally occurring background metal levels for the location. In Vancouver, British Columbia, elevated levels of iron and aluminum are to be expected due to the ***iron- and aluminum-oxides*** characteristic of the region's ***Podzolic soils***. This iron and aluminum is not toxic to plants or humans.

Is your site's soil and microclimate suitable for a garden?

Vancouver's Native Soils

This section contains descriptions of Vancouver's ***native soils***. These soils may be entirely present, partially present, or absent at the predicted locations. If entirely or partially present, this section will help identify characteristics and management practices for each soil. If absent, this section will help characterize the type, and extent of alterations that have occurred on a site.

The City of Vancouver possesses three main soil management groups, though others are present to a lesser extent. These predominant soil management groups are: Bose-Heron, Whatcom-Scat, and Langley-Cloverdale. Each group is located in a particular elevation range, making identification possible. Elevations greater than 65 meters above sea level (MASL) indicate Bose-Heron soils; elevations between 35 and 65 MASL indicate Whatcom-Scat soils, and; elevations below 35 MASL indicate Langley-Cloverdale soils (see Figure 5). Within each of these management groups, soils differ in terms of ***internal soil drainage***, based on ***topography***. Descriptions for the soil series constituting each management group were taken from (Luttmerding 1984), following the model used in the Soil Management Handbook for the Lower Fraser Valley (Bertrand et al. 1991), which can be found at:

www.agf.gov.bc.ca/resmgmt/publist/600Series/6100001_Soil_Mgmt_Handbook_FraserValley.pdf

Minor inclusions of other soil series (Boosey in Bose-Heron, and Berry in Whatcom-Scat and Langley-Cloverdale) were omitted from management group descriptions due to limited presence. Descriptions for Boosey and Berry soils can be found in (Luttmerding 1984).

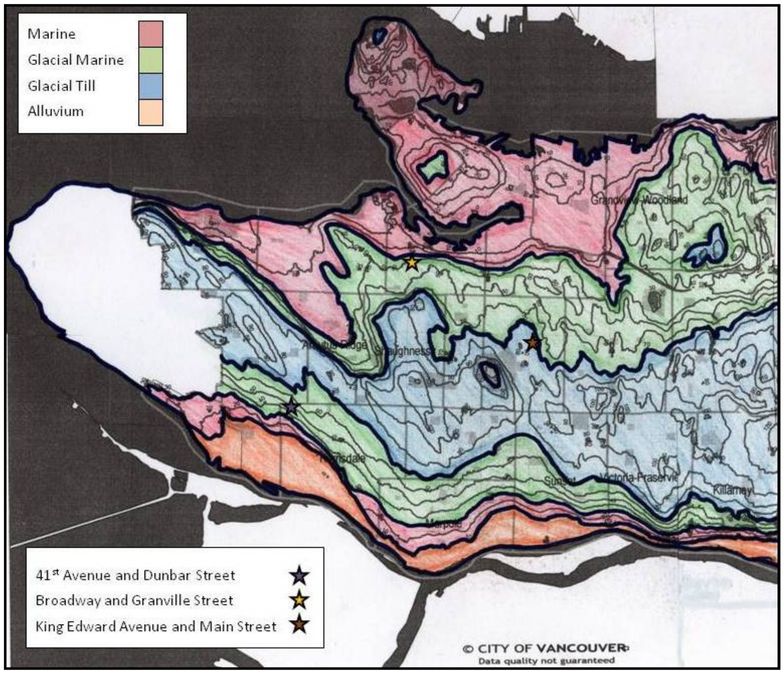


FIGURE 5 THE DIFFERENT SOIL MANAGEMENT GROUPS OF VANCOUVER, BRITISH COLUMBIA

BOSE-HERON MANAGEMENT GROUP

Bose-Heron Soils, found above 65 MASL, range from moderately-well to well-drained in higher landscape positions, to poorly drained in depressions. They consist of a gravelly sandy loam or loamy sand texture near the surface and are approximately a meter thick. They lie on top of impervious ***glacial till parent material***. Soils in this management group will have a low water-holding capacity and ***cation exchange capacity***. For gardening, these properties can be improved with the addition of organic matter. These soils also possess a high ***coarse fraction*** content that can be remedied through rock-picking. Low-lying areas (Heron Series) may have high ***water tables*** that can impact soil rooting depth. In the absence of surface drains or ditches, additional soil (in raised beds, etc.) should be supplemented in such cases.

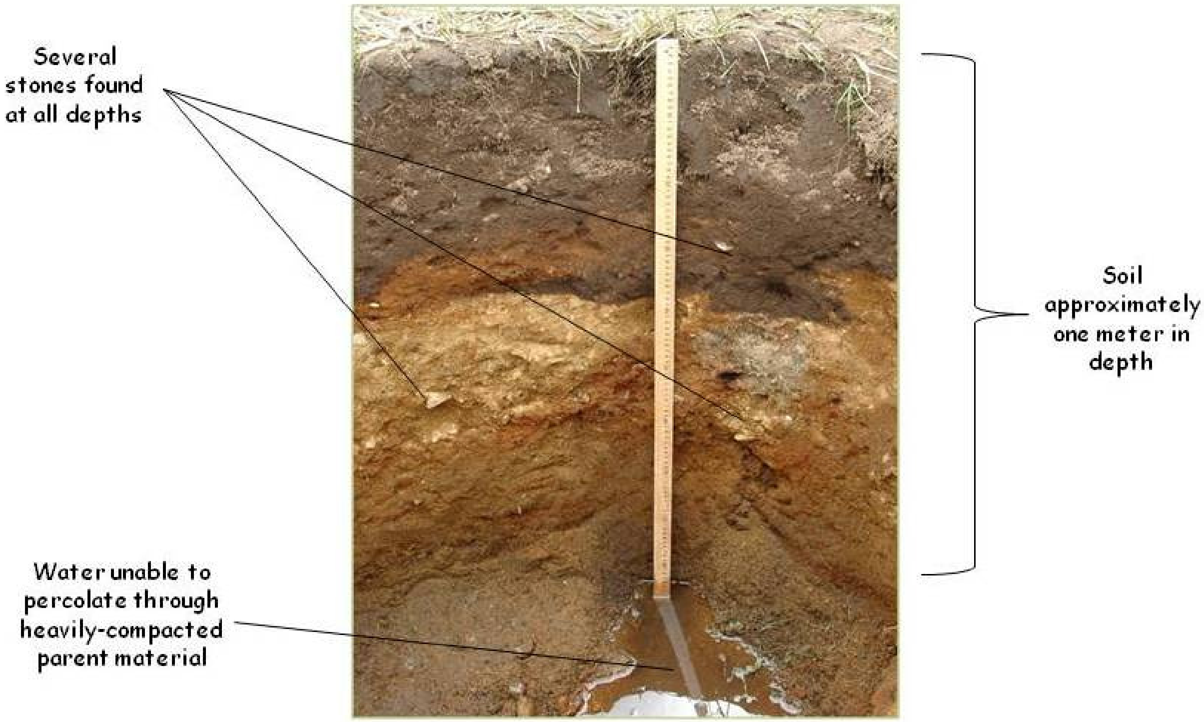


FIGURE 6 BOSE-HERON SOIL MANAGEMENT GROUP
PHOTO CREDIT: RACHEL STRIVELLI

WHATCOM-SCAT MANAGEMENT GROUP

Whatcom-Scat soils are found from 35 MASL to 65 MASL. They are moderately-well to well-drained in higher landscape positions and poorly drained in depressions. Possessing a finer texture than their Bose-Heron counterparts, Whatcom-Scat soils consist mainly of silt loam and silty clay loam. They overlie ***glacial marine material***. This parent material is not impervious, like the glacial till underlying Bose-Heron soils, but does not rapidly drain. Limited rooting depth caused by a high water table in the wintertime, and poor drainage are the limiting factors for gardening in these soils. Installing subsurface drainage or importing additional soil (to increase the soil depth) can correct for these shortcomings in order for ***perennial crops*** to be grown. The finer texture of this soil management group leads to increased water-holding capacity and cation exchange capacity. Fewer rocks are present in these soils than in the Bose-Heron management group. Existing rocks can be removed through rock-picking. Overall, these soils possess a high urban-agricultural capability and should be retained in place and improved. These soils are often mistakenly removed from landscaped sites and replaced with inferior human-made growing media.

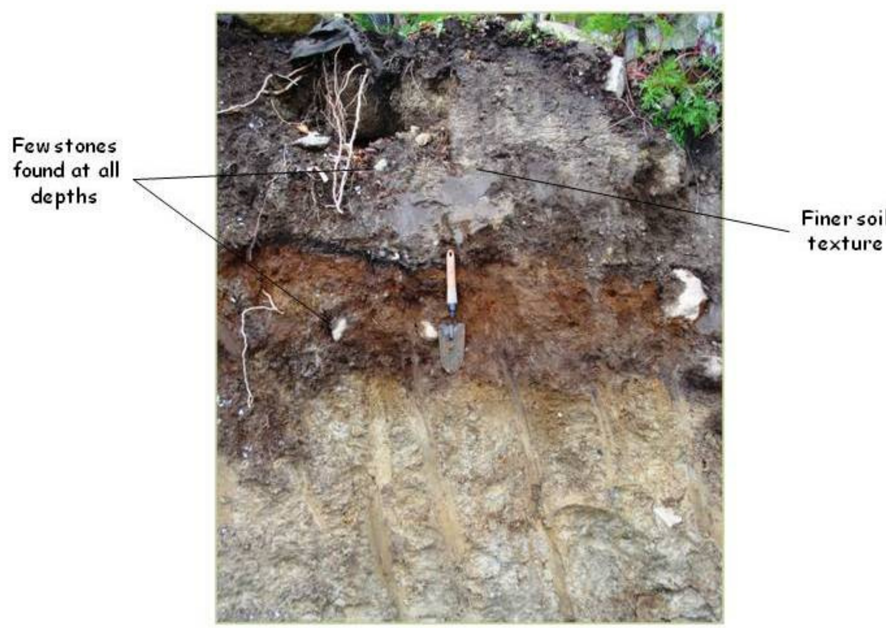


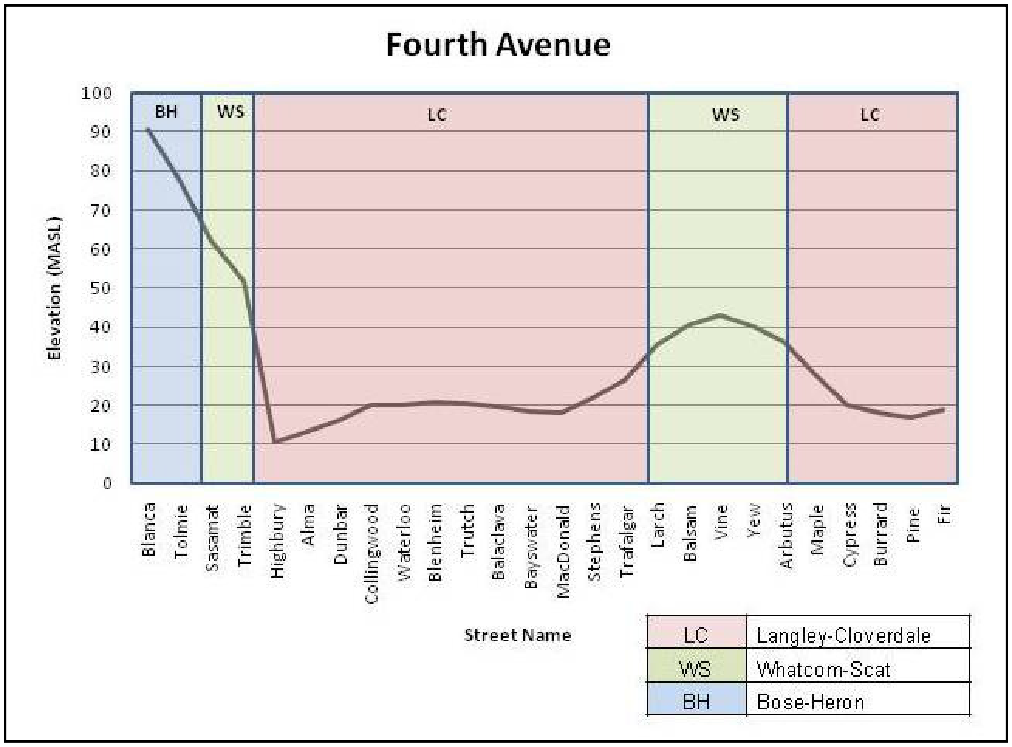
FIGURE 7 WHATCOM-SCAT SOIL MANAGEMENT GROUP
PHOTO CREDIT: MELISSA IVERSON

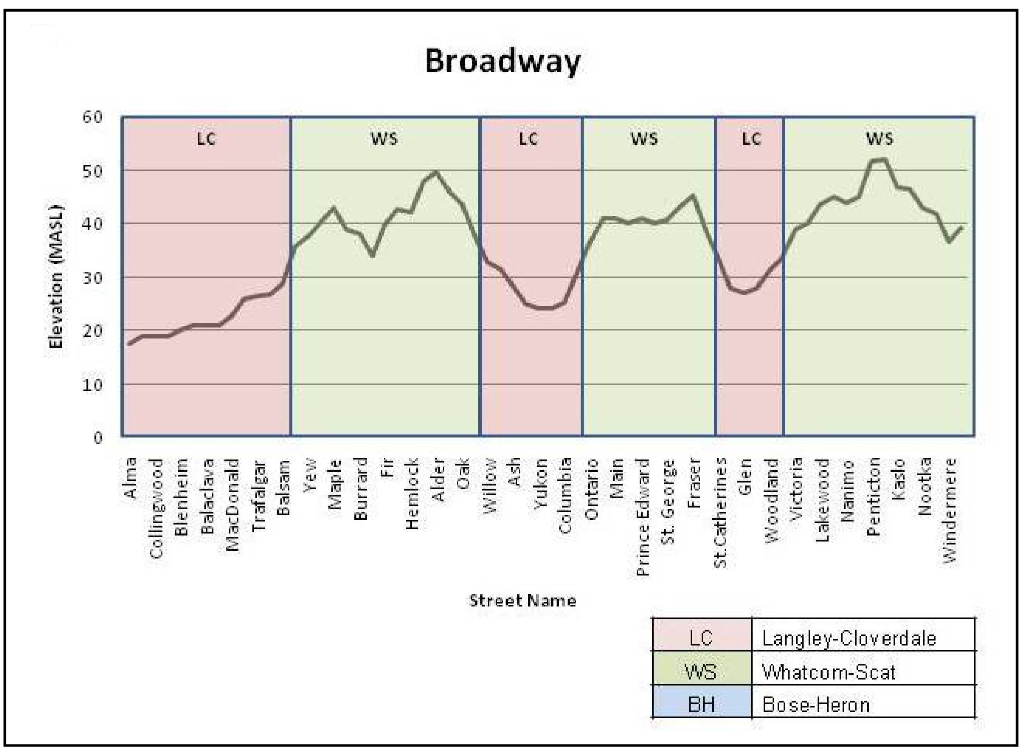
Langley-Cloverdale Management Group

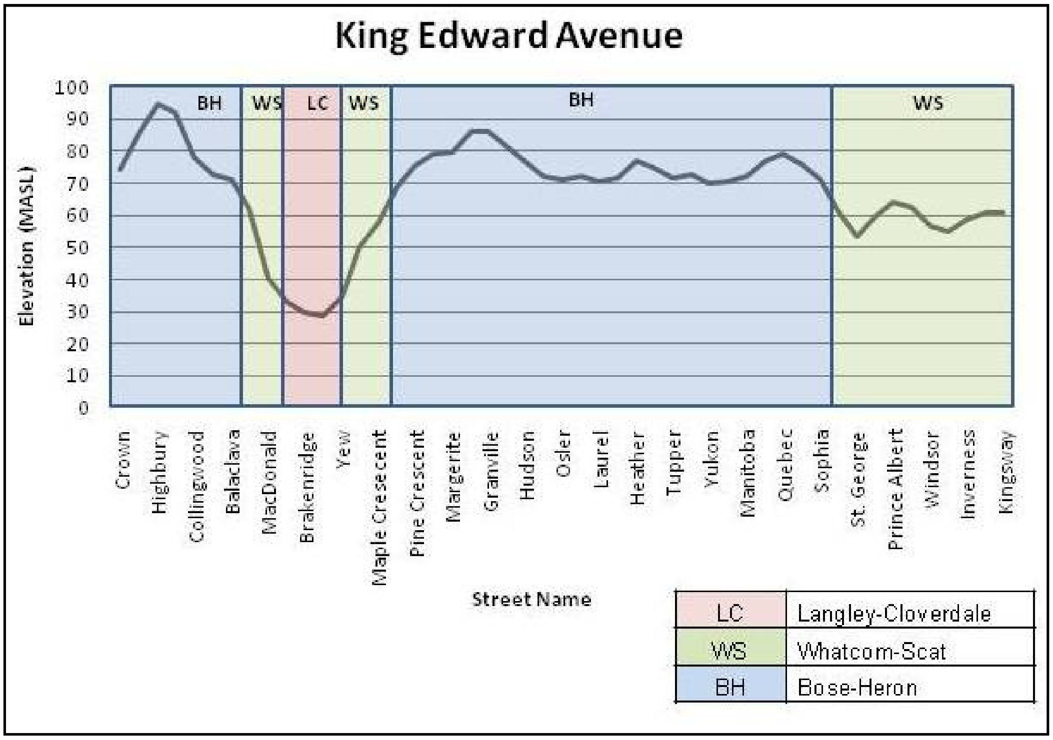
Langley-Cloverdale soils are found below 35 MASL. They are moderately-poor to poorly-drained, have a fine texture, silty clay loam, or clay loam, and tend to be stone-free. They have developed on top of ***marine parent material***. These soils may benefit from the addition of organic matter in order to increase soil aeration. Similar to the Whatcom-Scat management group, these soils can suffer from poor drainage and high ***perched water tables*** in the wintertime. For perennial crops, additional soil or subsurface drainage is needed. Limit traffic on these soils in the wetter months, as they are easily compacted when wet. Raised beds may be a useful management option.

FIGURE 8 LANGLEY-CLOVERDALE SOIL MANAGEMENT GROUP
PHOTO CREDIT: MELISSA IVERSON

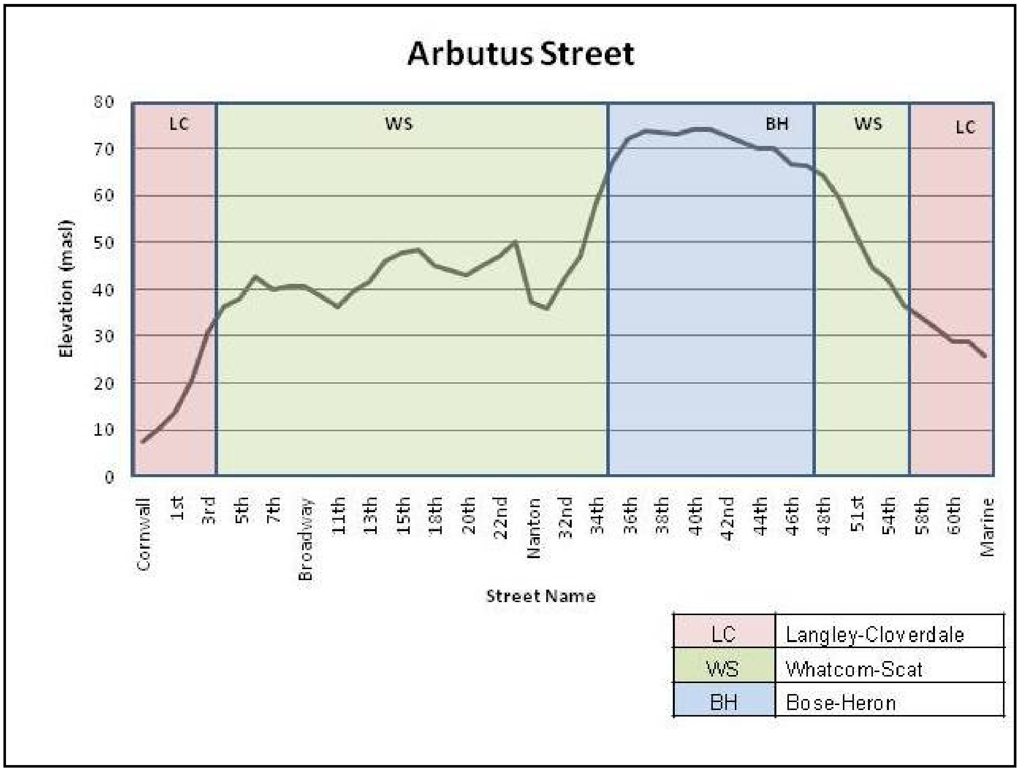
Identification of soil management groups along six of Vancouver's major thoroughfares, Fourth Avenue, Broadway, King Edward Avenue, 41st Avenue, Arbutus/West Boulevard, and Main Street, are provided on the following pages.

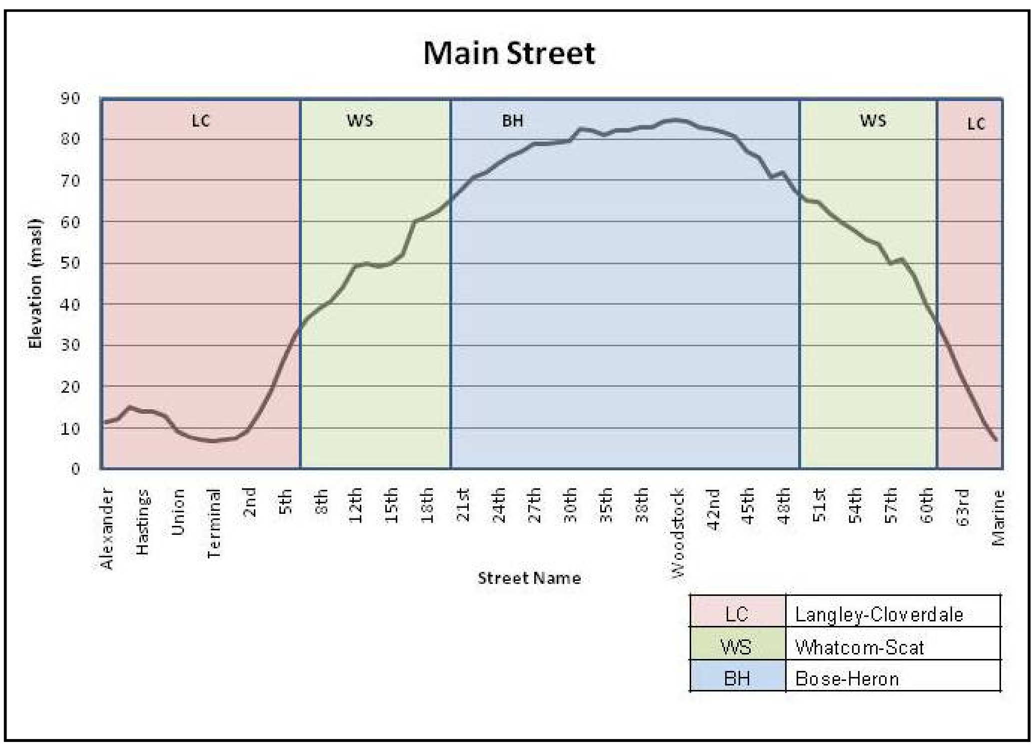





King Edward Avenue
Elevation (MASL)
100
90
80
70
60
50
40
30
20
10
0
BH
WS
LC
WS
BH
WS
Crown
Highbury
Collingwood
Balaclava
MacDonald
Brakenridge
Yew
Maple Cresecent
Pine Crescent
Margerite
Granville
Hudson
Osler
Laurel
Heather
Tupper
Yukon
Manitoba
Quebec
Sophia
St. George
Prince Albert
Windsor
Inverness
Kingsway
Street Name
LC Langley-Cloverdale
WS Whatcom-Scat
BH Bose-Heron


41st Avenue
Elevation (MASL)
120
110
100
90
80
70
60
50
40
30
20
10
0
LC
WS
BH
Camosun
Wallace
Alma
Blenheim
MacKenzie
Larch
Yew
Cypress
Churchill
Hudson
Oak
Heather
Cambie
Columbia
Quebec
Prince Edward
Prince Albert
Ross
Culloden
Dumfries
Bruce
Victoria
Clarendon
Earles
Rupert
McKinnon
Street Name
LC Langley-Cloverdale
WS Whatcom-Scat
BH Bose-Heron


Arbutus Street
LC
WS
BH
WS
LC
Elevation (masl)
80
70
60
50
40
30
20
10
0
Cornwall
1st
3rd
5th
7th
Broadway
11th
13th
15th
18th
20th
22nd
Nanton
32nd
34th
36th
38th
40th
42nd
44th
46th
48th
51st
54th
58th
60th
Marine
Street Name
LC Langley-Cloverdale
WS Whatcom-Scat
BH Bose-Heron


Main Street
LC
WS
BH
WS
LC
Elevation (masl)
90
80
70
60
50
40
30
20
10
0
Alexander
Hastings
Union
Terminal
2nd
5th
8th
12th
15th
18th
21st
24th
27th
30th
35th
38th
Woodstock
42nd
45th
48th
51st
54th
57th
60th
63rd
Marine
Street Name
LC Langley-Cloverdale
WS Whatcom-Scat
BH Bose-Heron

Soil and Microclimate Assessment

To determine the quality of the site's soil and microclimate, please complete the 11-step Soil and Microclimate Assessment on the following pages.

To complete the Assessment, you will need:

- A shovel,
- A trowel,
- A compass,
- The soil texture guide found in the Appendix
- Plastic bags,
- Masking tape and pen (to label the samples),
- A pick ax if the soil is compacted, and
- A pen/pencil to write down your observations.

FIGURE 9 SOIL AND MICROCLIMATE ASSESSMENT IN ACTION

PHOTO CREDIT: CHRIS THOREAU

The Assessment should be completed in multiple areas around your site since conditions can differ within small areas.

Soil and Microclimate Assessment in 11 Steps

1 **Looking over the entire garden site, do you observe features (large stones, concrete slabs, pooling water, etc.) that would detract from a garden site?**

A site free of extraneous material, that allows water to infiltrate and not puddle, is ideal.

2 **Is the site covered in vegetation? If so, does it appear healthy?**

Presence of healthy, abundant vegetation is a good indication that soil conditions are conducive to plant growth.

3 **Dig a pit 50 cm deep**

While digging, take note of the level of difficulty required to excavate the soil at different depths. Determine whether difficulties are due to dense plant cover, compaction, or the presence of rocks or human artifacts.

A productive soil will have ample rooting volume that is not restricted by several stones or human artifacts, a rooting depth of 20 cm, and uncompacted soil to a depth of 50 cm to allow for adequate drainage is recommended.

4 **Does the soil near the surface appear to be dark brown or black?**

Organic matter is important as a source of nutrients, water-holding capacity, aeration, and nutrient holding capability can usually be recognized for its rich dark colour.

5 **Are earthworms abundant in your soil (are they easily spotted when digging)?**

There should be an abundance of earthworms near the surface under moist conditions.

6 **Observe the pile of soil you excavated from the pit. What percentage of the soil is made up of stones larger than 2 cm in diameter?**

If several stones are present, they may restrict the rooting volume of your plants and hinder their growth.

7 **Take a handful of the soil you excavated from the pit. From this soil determine the texture of your soil, following the hand-texturing guide provided.**

A texture that demonstrates characteristics of all three textural classes (loamy) is preferred. Sandy or clayey soils can be augmented with organic matter to improve soil physical properties.

8 **Take a handful of the soil you excavated from the pit. Do the soil particles clump together to form *aggregates*?**

Good structure is characterized by the presence of aggregates, or clumps of soil particles.

9 **Is the site located on a slope? If so, which direction is the slope facing (*aspect*)?**

A slightly sloping site with a south-facing aspect provides the most access to sunlight.

10 **Are there any objects on or adjacent to the site that block access to sunlight?**

The fewer restrictions on sunlight the better, though most plants require a minimum of 6-8 hours of sunlight a day.

11 **Are important nutrients such as nitrogen, phosphorus and potassium found in adequate levels in your soil?**

Laboratory analysis is required to determine these levels. Collect samples for analysis. Information on sampling and result interpretation is provided below.

Nutrient Analysis

Compile a composite sample, representing the entire area of your site, for laboratory nutrient analysis. If one area of the site seems different than the rest, do not include it in this sample. For useful information and instructions, please refer to the soil sampling factsheet found in the appendix (pg 35) and instructions and figures provided in the section titled Sampling Protocols for Contamination Analysis (pg. 8).

Nutrient analysis is important because it provides information on possible nutrient deficiencies, ***pH*** and possible ***lime*** requirements, as well as total organic matter and nitrogen. Early diagnosis of nutrient deficiencies and lime requirements allows time for management remedies, helping ensure the success of the garden. Knowledge of organic matter amounts is also important as a long term indicator of soil quality.

Contact information for a laboratory in the Vancouver area that runs soil nutrient assessments is provided below. We are not aware of other local laboratories that analyze soil samples for available nutrients. The laboratory listed below was used while conducting this research.

Pacific Soil Analysis Inc. #5 - 11720 Voyageur Way Richmond, BC V6X 3G9 Tel: 604-273-8226

TABLE 5 SOIL FERTILITY LABORATORY CONTACT INFORMATION

Different soil laboratories use different testing methods. These methods may be comparable in terms of reliability, but values resulting from different methods should not be compared. Therefore, once you decide on a testing laboratory, it is beneficial to return to the same laboratory for testing in subsequent years. This ensures an accurate comparison of nutrient values over the years.

CAN SOIL AND MICROCLIMATIC QUALITY ISSUES BE RESOLVED THROUGH MANAGEMENT?

After identifying possible soil and microclimate quality issues, use the management solutions table and the nutrient analysis interpretation information in this section to select an appropriate course of action.

MANAGEMENT SOLUTIONS

The table below provides a list of barriers to soil and microclimate quality and corresponding management solutions.

TABLE 6 GARDEN SITE QUALITY ISSUES AND CORRESPONDING MANAGEMENT SOLUTIONS

Soil Attribute	Barrier to Garden Development	Management Options
1. Compaction	Compacted soil	Rototill or aerate the soil with hand tools In severe cases, uses a backhoe to break up the soil Install raised beds with subsurface drainage Add organic matter
2. Soil depth	Depth under one meter	Import soil, install raised beds
3. Stoniness	% coarse fragments	Remove stones
4. Texture	Coarse or fine texture (high % sand or %clay)	Add organic matter
5. Soil organic matter	Low organic matter percentage	Add compost Plant green manure crops such as crimson clover or hairy vetch
6. Soil reaction	pH under 5.5 or over 7	Low pH – add lime High pH – If plants seem healthy, no remediation is needed. If not, add iron- or aluminum-sulfate, or organic matter with pine needles or oak leaves
7. Nutrients	Lower than recommend amounts	Fertilize the soil using organic-approved materials Institute a garden composting system
8. Topography/aspect	Steep slope north-facing aspect	Site design (terracing, leveling) Plant selection (plants with low light requirements*)
9. Sun exposure	Sunlight blocked by on- or off-site structures	Site design (shade avoidance) Plant selection (plants with low light requirements*)

***IN GENERAL, LEAFY VEGETABLES (I.E. SPINACH, LETTUCE, CHARD, ARUGULA, ETC.) ARE THE MOST SHADE-TOLERANT VEGETABLES. ROOTING VEGETABLES (I.E. POTATOES, BEETS, CARROTS, AND TURNIPS) AND VEGETABLES IN THE BRASSICA FAMILY (I.E. BROCCOLI, KALE, KOHLRABI, CABBAGE, ETC.) REQUIRE AN INTERMEDIATE AMOUNT OF SUN EXPOSURE (AT LEAST A HALF DAY OF FULL SUN). FRUITING VEGETABLES, SUCH AS TOMATOES, PEPPERS, SQUASH, EGGPLANTS, REQUIRE THE MOST SUN EXPOSURE.**

Recommended Nutrient Amounts

After receiving laboratory results for nutrient analysis, compare the concentrations with recommended amounts provided in the Table below. Laboratory methods and units of measurements used by the laboratory need to be the same as those used in the interpretation guide in order to effectively compare results.

TABLE 7 RECOMMENDED NUTRIENT AMOUNTS*

Soil Property	Recommended Amount	Excessive Amount	Method‡
pH	6-7.5	-	Potentiometrically determined using 1:1 soil to distilled water slurry and radiometer conductivity cell (Thomas 1996)
Organic matter	>10%	-	Walkley-Black wet oxidation method (Nelson and Sommers 1996)
Total Nitrogen	>0.2%	-	Colourimetrically determined using a Technicon Autoanalyzer – semi micro Kjeldahl digest (Bremner 1996)
Phosphorus	40-100 ppm	>100 ppm	Colourimetrically determined using ascorbic acid colour development method on a 1:10 soil: Bray 0.03 M NH_4F in 0.025 M HCl extract (Bray P1) (Kuo 1996)
Potassium	250-800 ppm	>800 ppm	Determined by Perkin-Elmer Atomic Absorption Spectrophotometer on a 1:5 soil to ammonium acetate extract (Helmke and Sparks 1996; Suarez 1996)
Calcium	1000-2000 ppm	-	
Magnesium	180 ppm	-	
Boron	1-2 ppm	-	Colourimetrically determined on a hot water soluble extract using the azomethine-H method (Keren 1996)
Sulfate-sulfur	>10 ppm	-	Hi-Bismuth reducible method on a 1:2 soil to calcium chloride extract (Tabatabai 1996)

***RECOMMENDED RANGE FOR VANCOUVER'S SOILS**

†PPM, OR PARTS PER MILLION, IS EQUAL TO UG/G, OR MICROGRAMS PER GRAM

‡METHODS LISTED FOR THESE INTERPRETATIONS ARE THE SAME AS THOSE USED BY COMMERCIAL LABORATORY PSAI

In addition to the table provided above, there are two helpful soil test interpretation guides for Northwest soils. The first (Marx, Hart, and Stevens 1999), published in affiliation with Oregon State University can be found at:

http://www.koin.com/Sites/KOIN/pdfs/2008_watershed/soil_test_interpretation.pdf

Another useful soil interpretation guide is titled *Soil Testing Methods and Interpretations* (Neufeld 1980). Unfortunately, it is not available online at this time.

When using either of these interpretation guides, ensure the laboratory methods used are the same as those specified by the interpretation guide. Each guide provides different ranges for each nutrient (high, medium low or excessive, high, deficient). Concentrations falling under the “high” designation are recommended for Vancouver’s soils

IS SOIL IMPORTATION A SUITABLE OPTION?

The use of native soil is preferred if they are suitable for garden use. If shallow soil depth or contamination is identified through the assessment process, soil importation may be a good option.

Sources for imported soil include opportunistic obtainment, donation, or purchase. Soil excavations that occur in conjunction with construction are one opportunist source of soil, and can be learned about through the City's Engineering Department. Check source site history to ensure that it is non-contaminated. A Yard-Trimmings Compost and sand mixture can be donated by the City of Vancouver Transfer and Landfill Operations, Delta, following a brief application process. Garden and landscaping stores sell soils that vary in terms of ingredients, source location, and quality. Do not assume that the imported soil will immediately support plant growth without fertilization or liming. Despite having a dark colour and appearing fertile, most imported soils supply inadequate available nitrogen and should be sampled and tested to determine of other nutrients or lime are needed. This may be true even if the imported soil has a high percentage of organic matter.

FIGURE 10 ADDING AN IMPORTED SOIL MIX TO RAISED GARDEN BEDS AT THE CEDAR COTTAGE GARDEN

PHOTO CREDIT: MELISSA IVERSON

When importing soil, consider the following:

- How much soil is needed?
- How will the soil be delivered to the site?
- If it is delivered by a large truck, how will the vehicle access the site?
- Where should the soil be dumped on the site?

Make sure you are not importing contaminated or nutrient deficient soil to your site. Depending on where you source your material from, you may be able to request the results of nutrient and/or contamination analyses. If contamination analysis has not been conducted, return to the Site Assessment Decision Tree on page 2 of this guide, and carry out the suggested activities to the imported soil.

GLOSSARY

Aggregates – Many soil particles held together in a single mass or cluster. Soil aggregates form different shapes, such as crumb, block-like, or prismatic.

Annual crops – A plant that experiences its complete lifecycle in one year, ending in death. Lettuce, peas, and corn are examples of annual vegetable crops.

Aspect – The direction a slope is facing – north, east, south, west, or a combination thereof.

Bio-available values – The amount of an element – nutrient or non-essential metal – in a form that is available for plant uptake.

Brownfield – A neglected, abandoned, derelict site, commonly found in urban centres.

Cation exchange capacity – Plant nutrients exist in the soil as cations, or positively charged ions. Cation exchange capacity (CEC) is the sum total of exchangeable cations that a soil can adsorb. Therefore CEC represents the amount of nutrients a soil is able to hold.

Coarse fraction content – The percentage of soil particles larger than 2 mm in diameter. These large soil particles include gravel and stones that take up rooting volume and don't effectively hold nutrients.

Compaction – The amount of soil porosity (pores are the places where air and water is stored in a soil). A compact soil will have little room for water and air pores, and will also be difficult to dig.

Composite (samples, sampling) – A sampling method where soil samples from similar areas of a site are combined in order to reduce laboratory costs or time spent conducting analysis.

Extractable petroleum hydrocarbons – A group of common contaminants in urban soils made up of petroleum products such as oils, gasoline, and lubricants.

Glacial marine (parent material) – A parent material created in a marine environment influenced by glacial activity.

Glacial till (parent material) – A parent material consisting of a mixture of clay, silt, sand, and boulders, deposited and compacted by a glacier.

Internal soil drainage – the downward movement of water through a soil.

Lime – A soil amendment used to raise soil pH. Chemically, lime is composed of calcium carbonate.

Marine (parent material) – Parent materials formed in a marine environment, predominantly influenced by the ocean.

Metalloid – A non-metallic element that has some properties of a metal, such as arsenic.

Microclimate – Those climates in close proximity to the soil, in the realm of plant and animal life.

Native soil – Soil formed and developed in situ, and not imported from offsite.

Parent material – mineral or organic material, on top of bedrock, from which soil is developed.

Perched water table – A zone of saturated soil held above the main body of groundwater by an impermeable layer and a dry zone. Impermeable layers, or "hardpans" can be caused by glacial till parent material, or human-introduced materials (such as buried slabs of asphalt) under the soils surface.

Perennial crops – Plants that live for longer than two years. Asparagus, leeks, and eggplant are examples of perennial vegetable crops.

pH – The concentration of hydrogen ions in the soil. The lower the pH, the more acidic the soil - the higher the pH, the more alkaline the soil (on a scale of 1-14). A pH between 6-7.5 is suitable for most plants, though some plants prefer soils that are more acidic or more alkaline.

Plant-available values - See "bio-available values"

Podzolic soil – one of the ten soil orders of Canada (a classification system for soil identification). Podzolic soils are prominent in the Vancouver region, and are acidic and coarse-textured. They are commonly identified by a reddish B-Horizon (the second soil layer from the surface).

Rooting depth – The depth of soil that is available for plant roots without physical restriction. Also referred to as the rooting zone.

Soil structure – The combination or arrangement of soil particles to form aggregates (see "aggregates").

Soil texture – the relative proportion of particle sizes ranging from fine- to –coarse textured. These particle sizes include: clay (less than 0.002 mm), silt (0.002-0.005 mm), and sand (0.005-0.02 mm). An example of a fine-textured soil is silty clay. An example of a coarse-textured soil is loamy sand.

Strong acid soluble metals – Metals such as lead, copper, and cadmium, which are made soluble when extracted with a mixture of nitric and hydrochloric acids by testing laboratories.

Structure – See “soil structure”.

Texture - See “soil texture”.

Topography – The physical features of the earth’s surface, such as elevation and slope.

Total values – The amount of an element – nutrient or non-essential metal – in a form that may or may not be accessible to uptake by plants

Water table – The upper level of groundwater, or the level below which the soil is saturated with water

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About the Author

Born in Chicago, Illinois and raised in Portland, Oregon, Melissa Iverson has spent her entire adult life in one of Canada's most beautiful cities; Vancouver, British Columbia.

Melissa began her love affair with urban agriculture at the tail-end of her undergraduate degree from UBC's faculty of Land and Food Systems, as she became increasingly aware of the costs the current food system imposes on human and ecological health. A curiosity and fascination with soil, one of our most precious (and all-too-often neglected) resources, brought Melissa back to UBC in 2006, where she began a Master's degree in soil science. Since that time, Melissa has been working with communities in Vancouver to find accessible and accurate ways of assessing urban brownfields, neglected and derelict lots, for community gardens. Through these adventures in Vancouver's urban agriculture scene, Melissa has participated in the creation of seven community gardens, witnessing the struggles and triumphs of folks that wish to create spaces to grow their own food, connect with their neighbours, or simply just get their hands in the dirt. This Site Assessment Guide is the product of these experiences and research.

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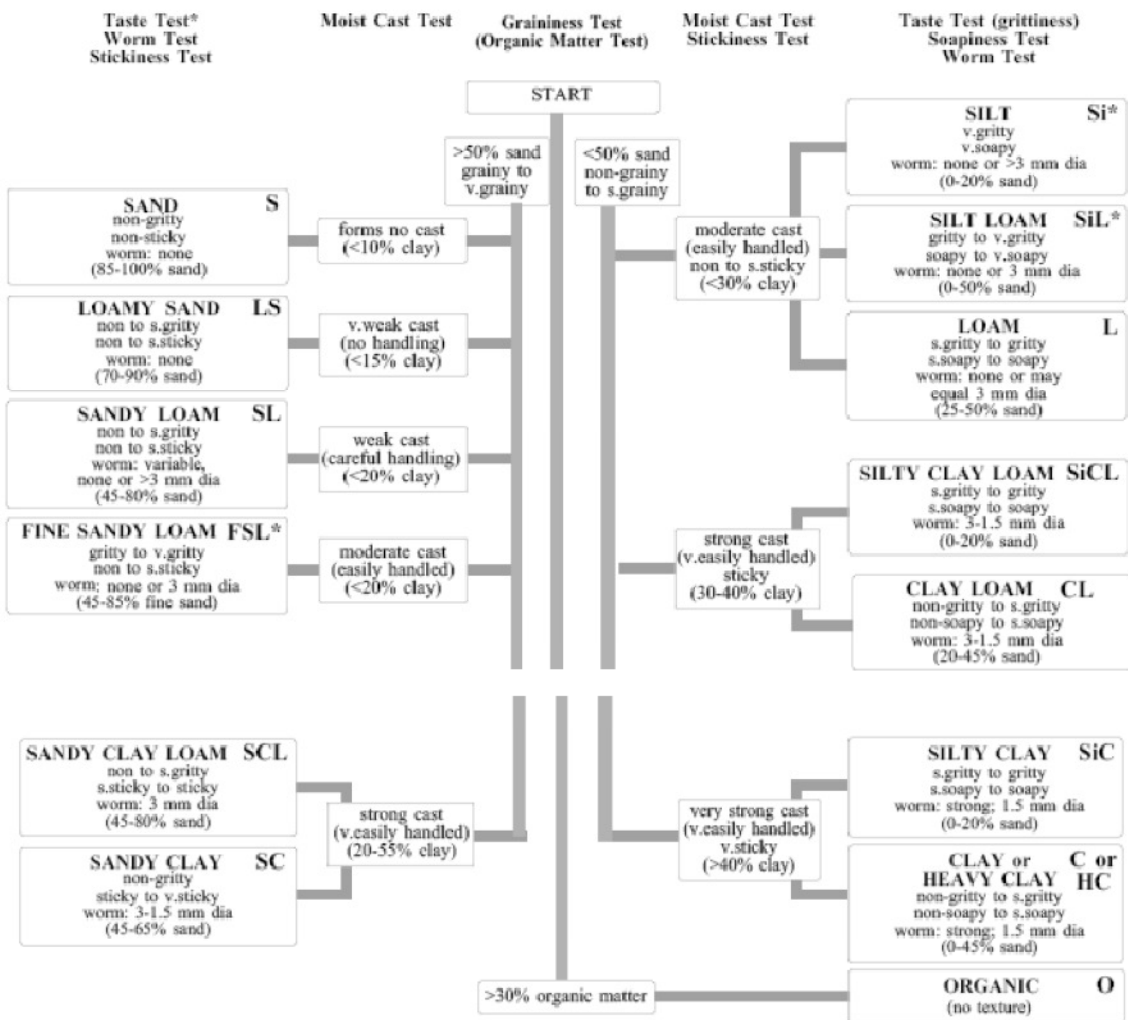
APPENDIX

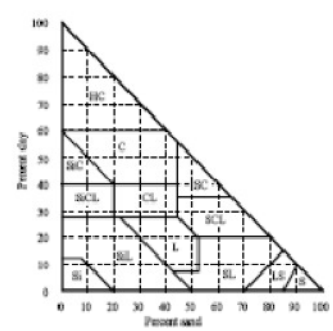
HAND TEXTURING GUIDE



* Silt feels slippery or soapy when wet; fine sand feels stiffer, like grinding compound or fine sandpaper.

Key to Abbreviations	Measurement Conversions
s = slightly	3.0 mm = 1/8"
v = very	1.5 mm = 1/16"
dia = diameter	

Fine Fraction	(particle diameter)
SAND ------------- (S)	2 - .05 mm
SILT --------------- (Si)	.05 - .002 mm
CLAY ------------- (C)	<.002 mm



Nutrient Management
FACTSHEET

BRITISH COLUMBIA
Ministry of Agriculture and Lands

Nutrient Management Factsheet - No. 1 in Series

Order No. 631.500-1
October 2005

SOIL SAMPLING FOR NUTRIENT MANAGEMENT

In Nutrient Management Planning, soil sampling is done to collect a soil sample for lab analysis that represents the variability in the soil of the field being sampled. To do this many small samples will be collected and mixed together to make one composite sample for each field. The results are used to determine what level of additional nutrients, if any, are required for the crop(s) being grown.

There are a number of steps to follow as outlined below to ensure that a representative sample is collected. There are qualified professional agrologists throughout the province who will do soil sampling; contact the closest BCMAL office or the BC Institute of Agrologists (1-604-855-9291) for a list in your area. Factsheet 631.500-7 ***B.C. Agricultural Testing Laboratories*** contains a list of BC labs that do agricultural soil analyses.

When to Collect Soil Samples

Check with the chosen lab as to their turnaround time for soil analysis. Samples may need to be collected 2-3 weeks before the intended time of manure application to give the lab enough time to complete the required analyses. Annual sampling should occur at approximately the same time each year.

South Coastal BC: Soil samples should be collected in late spring, as close as possible to the start of field work provided there is enough time for the lab analyses.

Interior BC: Fall or spring sampling is acceptable in Interior areas. There is minimal loss of soil nitrate-N over winter so a fall soil sample will be as accurate for estimating the soil nitrate-N level as a spring sample. Sample after crop growth has stopped in late September or October, depending on the farm location. If manure has been applied in fall, particularly dairy manure on corn land, a spring soil test which includes ammonia-nitrogen should be done.

Sampling Frequency

Annually cropped fields should be sampled once per year, in late spring just prior to manure application. Fields in perennial forage should be sampled before they are reseeded and thereafter once every 3 years until they are reseeded.

Sampling Strategy

Before beginning soil sampling, consider the variability within each field on the farm. Fields up to 10 ha (25 acres) in size that are fairly level, have a similar soil type throughout and have been farmed for several years as a single unit can be sampled as one unit.

Fields that have significant variability in them should be subdivided into similar units. Variability may be due to topography, eroded areas, sandy vs. clay-rich areas, or sections of a field that have previously been farmed separately and may have received different amounts of manure or fertilizer over the years. Divide such fields into similar units, and sketch the boundaries on a permanent map that is kept with the soil analysis records. Assign a number or name to each field unit. Fields that are otherwise similar but that are greater than 10 ha in size should be subdivided into sampling units of 10 ha in size. Once fields have been subdivided, always sample them in this configuration.

Sampling Pattern

For most agricultural fields that are relatively uniform, samples should be collected from throughout the field using a zig-zag or Z pattern. Avoid areas that are not cropped such as wet spots, or areas that might skew the analysis such as old manure stockpile sites or fertilizer spills. **Figure 1** shows an example of a random soil-sampling pattern (shown in yellow) and areas to avoid (shown in red).

Non-uniform fields should be subdivided into similar units and samples collected from each sampling unit using the same zig-zag or Z pattern as described above. If fields are greater than 10 ha in size, subdivide and sample from each 10 ha piece. Once a pattern has been chosen, always sample using the same pattern.

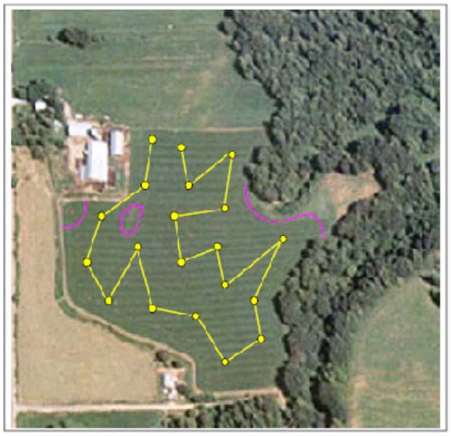


Figure 1 Random Soil Sampling Pattern

Sampling Equipment

Samples can be collected using a soil sampling tube, an auger or a trowel. A soil sampling tube or soil probe (**Figure 2**) works best in well cultivated soils without rocks but is difficult to use in rocky, very dry or very wet soil. An auger or trowel is better for less well cultivated or rocky soils.

Figure 2 Soil Sampling Equipment

When sampling with a tube or auger, follow manufacturers' directions. When sampling with a trowel, make a V-shaped hole where the sample is to be taken. Take a 2-3 cm (1 inch) thick slice down one side of the hole to 15-20 cm (6-8 inches), and trim the slice to form a 2-3 cm (1 inch) wide core (**Figure 3**). Lift out the soil slice and place it into the sample bucket. If sampling for micro-nutrients or metals, ensure that the sampling equipment is clean, and has no rust on it as metals from the equipment itself can contaminate the sample. Wear rubber gloves for micronutrient and metal sampling

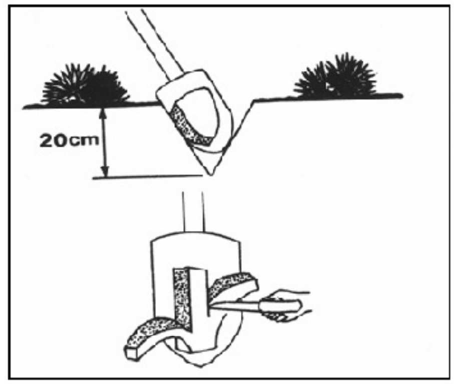


Figure 3 Shovel Method of Soil Sampling

Sampling Depth

For routine nutrient analysis, and metal or micronutrient determination, collect samples to 15 cm deep (6 inches). Most manure and fertilizer nutrients will remain in the top 15 cm (6 inches) of soil. If sampling soil in the fall to monitor soil nitrate-N level, sample at two deeper increments, 15-30 cm (6-8 inches) and 30-60 cm (1-2 feet) if soil conditions permit as excess soil nitrate will move below the top 15 cm (6 inches) with fall rain. When sampling below 15 cm (6 inches), collect separate samples from each additional depth, and composite these separately.

For a further discussion of "report card" or post-harvest soil nitrate testing, see reference below.

> ***Post-harvest Soil Nitrate Testing for Manured Cropping Systems in Western Oregon and Washington***: available on the **Integrated Soil Nutrient and Pest Education** website at http://cropandsoil.oregonstate.edu/nm/

Tips for Sample Collection: Soil samples collected in perennial forage crops will have a layer of sod on top of the soil. Discard the top layer of dead leaves and roots above the mineral soil but not the roots that extend into the soil. When sampling in newly worked bare land, gently press down the soil with your boot before sampling to more accurately mimic the settled soil depth.

Making a Composite Sample

Collect 5 soil samples per ha for small fields or 15 to 20 samples per 10 ha (25 acres) field to make up the composite sample for each field. Each soil sample should be approximately the same size or weight. Place all samples in a clean plastic pail and mix well.

From the mixed samples, take out a small amount of soil (1/2 kg or 1 lb) and place into a heavy plastic bag or clean plastic container. This is the composite sample that will be used for lab analysis. It is very important that it be well mixed as the lab will use only a few grams of soil, and that small amount must represent equally all the cores that were initially placed in the pail.

If the soil is very wet at the time of sampling, it may mix more easily if it is air dried for a day. Use a trowel to break up lumps.

Sample Handling and Containers

Composite samples should be placed in plastic freezer bags or ½ to 1 litre clean plastic containers with screw top lids. Close samples tightly in bag or container. If samples are not to be taken to the lab immediately, place them on ice or freeze until transported to the lab. If shipping samples, ensure they reach the lab as quickly as possible.

Labeling

Clearly label samples with date, field or site identification, sampling depth (0-15 cm or other) and your name or the farm name. Bagged samples should be double bagged and a paper label placed between the two bags. Do not put paper labels in with soil as moisture may destroy label. Do not rely solely on information written on the outside of a plastic bag as it can easily rub off.

What Analyses are Required ?

To complete the nutrient management planning process, the following soil test information is required:

- available phosphorus (P) [Bray P1 or Kelowna]
- available potassium (K) [ammonium acetate or Kelowna]
- nitrate-nitrogen (NO_3-N)
- for spring soil tests in the Interior, ammonia-nitrogen (NH_4-N)

Other information may be included with the soil test report, such as soil concentrations of secondary and micro-nutrients, and metals, bulk density, pH and % organic matter. This is important information, and should be kept on record.

Laboratory Analysis Methods

The following section discusses various analytical methods used in BC to analyze soils for available phosphorus, potassium, and nitrate nitrogen.

Available Phosphorus

This lab method extracts a portion of the total phosphorus in a soil sample. The extracted portion or 'available phosphorus' mimics the amount of phosphorus that is plant-available at the time of sampling (the majority of soil phosphorus is bound up the soil and not immediately plant-available). There are several different extractants used to determine available phosphorus, but the standard analyses used in BC are the Bray P1 and the Kelowna extract.

The Bray P1 is a good predictor of plant-available phosphorus in acidic soils, and is used most frequently on soils from South Coastal BC. It is not considered suitable for high pH soils. The Kelowna extract was developed at the former Provincial Soil Test Lab in Kelowna from the Bray P1, and is the standard extractant used on high pH soils throughout BC and in the western Prairie provinces. It is also considered suitable for acidic soils. It is generally considered that the Kelowna method extracts slightly more phosphorus from soils than the Bray P1 method.

Available Potassium

This lab method extracts a portion of the total potassium in a soil sample. The extracted portion, or 'available potassium' mimics the amount of soil potassium that is plant-available at the time of sampling. In BC, two different extractants are used to determine available potassium, the Kelowna extractant (acetic acid and ammonium fluoride) and ammonium acetate, and each soil lab has its preferred method. It is generally agreed that the Kelowna method extracts about 20% less potassium than the ammonium acetate method.

Nitrate-Nitrogen

This lab method measures the amount of crop-available nitrate in the soil at the time of sampling. The nitrate present at the time of sampling is available for crop uptake over the growing season, but is only a portion of nitrogen that will be crop-available over the season. Nitrogen is released through the summer months by decomposition of organic matter, and adds to the pool of available nitrate in the soil. Unlike the available phosphorus and potassium, a spring soil nitrate test is not an indication of the amount of nitrogen available for that growing season.

Interpreting Lab Results for Nutrient Management Planning

To develop a Nutrient Management Plan, the following information is required from the soil test reports for each field:

- available phosphorus in ppm, ug/mL or mg/L (all are equivalent)
- available potassium in ppm, ug/mL, or mg/L
- nitrate-nitrogen in kg/ha (multiply value in ppm by 1.5)

On the soil lab report, the section where this information is found may be called soil test results, available nutrients, nutrient analysis or another similar term. The fertilizer recommendations are not required other than as a comparison with the recommendation generated by the nutrient management plan.

Converting from "parts per million" (ppm) to "kilograms/hectare" (kg/ha)

To do this conversion correctly requires knowledge of the soil bulk density (in kg/m^3) and the depth of the soil layer being sampled (in metres). If unknown, the suggested defaults are 1000 kg/m3 and 0.15 m (15 cm).

The sample calculation is:

Value in kg/ha = Value in ppm * 10,000 m^2/ha * 0.15 m / 1000 kg/m^3

OR Value in kg/ha = Value in ppm *1.5

Many labs rate the level of each nutrient in the soil as low, medium, high or very high, or deficient, marginal, optimum or excess to indicate how well the soil in each field is supplied with each nutrient. The soil nutrient rating scales for phosphorus and potassium used in the nutrient management planning process are close to those used by most commercial labs.

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