# Potentially Harmful contaminants in urban, community gardens in New Westminster

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April, 2011

A report prepared at the request of the New Westminster Community Garden Society in partial fulfillment of UBC Geography 419: Research in Environmental Geography, for Professor David Brownstein.

*Introduction*

In the past decade, as the problems of increasing urbanization, population and density in cities throughout the world grow rapidly, more and more people have turned to the solution of community urban gardens. While community gardens have been shown to have economic, social and environmental benefits, there are some concerns. “These environmental and human health concerns caused by increasingly close soil-human interactions, along with the “non-negligible” portion of the food supply provided through urban agriculture in both developing and developed countries, have led to an increased importance of urban and suburban soil assessment and management.” (Iveson, 2006)

The New Westminster Community Gardening Society is a group that plans to start various community gardens throughout New Westminster. While the organization is very eager, to develop these gardens they are concerned about the potential environmental and health risks associated with urban farming. In my research paper I worked with this community organization to explore this potential threat. The main question of my research was in essence**, how ‘safe’, nutritious and healthy is the produce that the gardens are currently producing**? The gardeners want to know if there are any harmful effects to their great initiative , caused by pollutants in the area in New Westminster; located on the Burrard Peninsula, on the north bank of the Fraser River, 19 kilometres southeast of the City of Vancouver proper.

*Community Partner*

Throughout the research process I worked with Brennan Ashley; a member from The New Westminster Community Gardening Society. The New Westminster community gardening society's mission statement is "*To develop community gardens throughout the City of New Westminster and by doing so increase the profile of urban agriculture; promote environmentally sustainable gardening practices; increase access to, and the consumption of, locally grown produce; build a sense of community around food; and decrease the City's ecological footprint.*" (Community Gardening Society website) The main aim of the gardens are, therefore, food production and making New Westminster a food secure area. While they acknowledge the social and mental benefits the garden brings, this is not a contributing reason for their existence. As Brennan stated, every plant in the garden should produce food, aesthetics have no importance. And the overall goal of the society, with their New Westminster environmental partner, is to have complete food security in the neighbourhood, through these gardens.

*Literature Review*

There is ample literature which indicates the methods for conducting an analysis of the state and risk of contamination of the community gardens. Below is a summary of some of the literature.

Agrawal et al, 2003, look at the effects of air pollution on urban and peri-urban food production in Varanasi, India. They define "A major threat to crop production is gaseous air pollutants, particularly sulphur dioxide, nitrogen dioxide and the secondary photochemical oxidant, ozone." A study was conducted where different sites were monitored for levels of air pollution. Once these zones were defined their results were analysed; "Site 4 showed the maximum pollution load, which [was] ascribed to its close proximity to the national highway." They also found that parking of vehicles along the road and slow traffic movement lead to increased emissions. The study was conducted not because of the health effects on the food and crops grown in the urban soils, but because it has been shown that in North America "significant yield losses in a range of major crops, have been caused by ambient air pollution." Their work concluded that air pollutants were disturbing and negatively affecting the gardens, and that their results were spatially and seasonally divided. They recommend therefore that certain areas, especially those near major traffic zones should be avoided for proper crop production.

While Aagrawal et al looked at air pollutants and their effects on the growth and production of urban agriculture, Tiller looks at contaminated soils and its consequent health effects. He states that various anthropogenic activities and waste "... associated with buildings, transport and recreation has caused general disturbance of urban soils," and this makes it more difficult to categorize and measure contamination. These specific activities include: "...atmospheric transport of smelter stack emissions, transport of raw materials, dispersal from stored materials such as ore stockpiles, and redistribution of polluted waste products in, e.g., the surrounding areas for roads, land levelling... escape of contaminants especially from land-fill sites for solid and liquid toxic materials is a cause of great concern," but the most concerning factor is automotive lead.

In Canada, the use of leaded gasoline in cars was banned in 1990, but the traces of this lead can remain in the soil for years. Table 1 below shows the different sources of metal contamination, many of which are characteristics of the Sapperton Community Garden.

Figure 1

**Table 1. Industries and land uses associated with urban contamination**[A]

* Main sources of heavy metal contamination

| | |
|---|---|
| Acid/alkali plant and formulation | *Metal treatment |
| Airports | *Mining and extractive industries |
| Asbestos production and disposal | Oil production and storage |
| Chemicals manufacture and formulation | Paint formulation and manufacture |
| *Defence works | Pesticide manufacture and formulation |
| Drum re-conditioning works | Pharmaceutical manufacture and formulation |
| Dry cleaning establishments | Power stations |
| Electrical manufacturing (transformers) | Railway yards |
| *Electroplating and heat treatment premises | *Scrap yards |
| Engine works | *Service stations |
| Explosives industry | *Tanning and associated trades |
| Gas works | Waste storage and treatment |
| Iron and steel works | Wood preservation |
| Land fill sites | |

[A] After ANZECC/NHMRC (1992).

After attempting to look at soils throughout Australia and classify them based on the amount of contaminants and metals present, Tiller compares the data to other rural farms in the area to check if there are any, specifically, urban causes to the soil degradation or rather a regional cause. Tiller concludes that “Site-specific assessment has the potential for greater flexibility in decision making in relation to land use, social costs, economic costs, and benefits of cleaning up or not,” that there is no general rule that can be stated for community gardens in urban areas, but that every site interested in producing food should conduct their own soil analysis in order to make sure that the food they are producing or soil they are coming in contact with are safe.

Zhang researched metal contamination in Ireland. He collects data from two locations, urban and rural and used random sampling and multivariate statistics to measure the different in the concentrations of different pollutants in the soil, and then GIS to analyse the spatial pattern on these pollutants in order to better understand their causes. He, like Tiller, also finds the large adverse effects of automobiles. When testing for contamination around the city “Relatively high concentrations of Cu, Pb and Zn were found in the city centre, old residential areas, and along major traffic routes, showing significant effects of traffic pollution.” And this leads to elevated concentration of heavy metals in urban garden soils. Mining activity definitely leads to metal contamination but even in areas where there was no previous mining traffic still leads to large pollution levels. But besides automobile emissions, "...recent studies have revealed that heavy metals in urban soils also come from wear-and-tear of tires and brakes" so, like Tiller, in areas where there is slow traffic movement the contamination of soils increase. Zhang goes on to classify all the different contaminates and categorizes them in groups based on their sources and effects. Group 5 was identified as a special group. It included Copper, Lead, Zinc and Arsenic and were identified as well-known pollutants in urban soils, due to their low concentration in limestone and granite, their presence is attributed to human activities, mainly from different automobile functions. "Cu [comes] from brake discs and engine wear, Pb from leaded petrol and batteries, and Zn from metal corrosion and tyre wear." Again even while lead emissions from gasoline have declined significantly since the early $21^{st}$ century; the old lead particles "...will still stay because it is quite strongly bound to these soils." These metal contaminations from automobile exhausts, gasoline and brakes can lead to dangerous effects on the soil and Zhang goes on to mention how this contamination could be dangerous for humans growing food in these soils.

Chaney et al, look at lead (Pb) levels in the soil, and note the importance of testing different levels in different areas of the city. Levels are "...much higher in the inner city or if Pb paint could have been used." But they also look at the differences in the uptake of lead by different vegetables. They "...found decaying grass leaves adsorbed more soluble Pb than young growing leaf blades," but that uptake depends on the natural pH level of the soil. "Gardens very high in Pb (say over 3000 ppm) could be used to safely grow fruits and grain crops, but not leafy or root vegetables" (Chaney et al, 1984). The levels in the soil are important as "...plants grown in urban gardens which are highly contaminated with heavy metals may contain elevated metal levels in their edible portions.” So an overly large amount of lead in the soil can lead to elevate lead levels in the food grown in that portion of soil. There are various causes for this lead contamination. Car emissions are a large cause, as lead based gasoline emits throughout the city. Another large cause could be old paints, “...building surfaces scrub particulates from the air (or slow air movement and allow particles to settle out). Rainfall or humans then wash particulates from the walls, and metals accumulate in the houseside soil and/or dust.” When different soils were examined soils next to the exterior of a Pb-painted building are more enriched with lead than soil next to an unpainted building. The authors find, through research, that there is a correlation between high concentration of lead in soils and children with higher-than-usual lead in the blood.

Hough et al, look at various levels of metal contaminants throughout the city, which is caused by past industrial activity and the use of fossil fuels. “Generalized linear cross-validation showed that final predictions of Cd, Cu, Ni, and Zn content of food crops were satisfactory, whereas the Pb uptake models were less robust,” and harder to predict. The authors look into the soil contaminants because “prolonged exposure to heavy metals such as cadmium, copper, lead, nickel, and zinc can cause deleterious health effects in humans.” These effects are easy to calculate when looking at human’s exposure to contaminants in a garden, but “...predicting exposure to potentially toxic metals from consumption of food crops is more complicated because uptake of metals by plants depends on soil properties and plant physiologic factors,” again in order to know the specifics of metal concentration and uptake by plants, basic soil information is required. However, the authors attempt this feat. They began this study by firstly taking the general levels of Cn, Cd, Zn and Ni of vegetables grown in rural allotments and then converged the data into a cross-validation estimation to see what general amount of metals were. They then tested food from urban gardens and looked at how similar the levels were. They tested and accounted for other variables and then looked at the effects of these metal levels for three levels; average exposure, highly exposed, highly exposed infant. Hough et al. conclude that 92% of food harvested from these gardens were found to be safe for the general population, but slightly more dangerous for infants and other vulnerable populations.

The final piece of important literature is a thesis written by Melisa Iveson. In her assessment of community gardens in urban brownfields she notes that “anthropogenic sources are far more prevalent than natural sources and are closely tied to vehicle use, “an increase in various metals in the soils can “decrease rooting volume, impede root growth and the mixing and channelling of soil organisms, and reduce the water-holding capacity of the soil.” These contaminants also affect the chemical composition of soils and could affect the plants and vegetables grown in the soil. The table below summarizes this, as it shows the changes in natural soil properties and their causes.

Figure 2

| **Soil Property** | **Cause(s)** |
|---|---|
| Modified soil reaction (pH), usually elevated | Various causes. May include influence of construction rubble, ash |
| Restricted aeration and water drainage | Compaction; lack of vegetation |
| Interrupted nutrient cycling and a modified soil organism population and activity | Inhospitable environment for plant growth due to factors such as compaction, high pH and contamination |
| Highly modified soil temperature regimes | Small lot size and therefore greater influence of the surrounding area's characteristics |
| Presence of anthropogenic and other contaminants | Remnants of past land use; neglect |

Because of the potential dangers in the food that are produced in urban gardens, Iverson suggests a process of assessing whether a site could be converted into a community garden. This assessment process includes acquiring a site history, soil quality and microclimate quality. This process is important because "... it is possible for plants grown in soils containing high metal levels to remain uncontaminated depending on the bioavailability of the metal in question." After an in depth analysis of these contaminants and their affects on food Melissa drew one conclusion; while there are many barriers to community gardens in these areas and many potential risks if a good framework is set up from the beginning of the gardening process many of these risks can be monitored and/or averted. These site tests that a community can perform before starting the garden can assure safety of the produce grown.

*Methodology- Garden Sites*

I visited and asked about the gardens in order to get an understanding of what the potential threats of their produce was. There was no actual primary, scientific research conducted. Currently the society has set up two gardens as test sites to see how the program will work. Both gardens are located in urban areas of New Westminster. Each site has different challenges regarding the health risks for the food produced.

The first garden (site) is located in a couple blocks from the New Westminster Sky train station Stop. When walking to this garden the surrounding area seems rather calm, and almost suburban, but upon arrival at the garden it is clear to see that the garden has been built on a previous landfill, a common site for community gardens. Brennan mentioned during a meeting that when the group was beginning to build the garden they evidence of potentially dangerous/pollutant materials found hin the rubble, including various objects made of glass and plastic and even old building materials that contained asbestos.

The second garden is located on 121 East Columbia Street. As residents of New Westminster point out this is located close to the Sapperton sky station, in the industrial heart of the city. As I walked closer to the location, using Brennan's directions I thought I had taken the wrong turn, because of the urban setting but then I found it. This garden is located on land from the St Mary the Virgin Anglican Church. This church sits on the extremely busy East Columbia road, a four laned main road (shown in figure 1), and is neighbours to various auto body shops (figure 2) and just a couple meters away from large construction sites, the sky train, other commercial train tracks, large storage yards of rubble, and other factories used for various, unknown industrial processes (figure 3). Other important surrounding urban features include; not only the proximity of the main road, but also the large intersection around 5 meters away (figure 4), as well as the older building, both the church and the house that stands behind the garden which used to be the rector's house (figure 5).

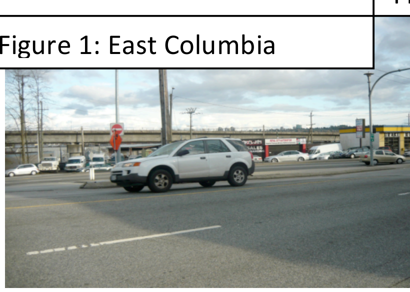
Figure 1: East Columbia


Figure 2: Auto body


Figure 3: Industrial zone


Figure 4: Intersection


Figure 5: Old rector's house

Both building were constructed in the early 1900s, and were never properly refurbished. As Brennan told me, a couple months before the garden was established the community repainted the old rector's house. They began by scraping off old paint and found pieces of old asbestos, the paint was most likely lead based; chips of paint fell all around the garden space and not all of it could have been collected and disposed of. The community plot, thus far, is only at the top of the church yard (around three meters from the main road,) around fourteen 1 x1m plots have been started by bringing in around 20cm of mulch on top a small cardboard base. There are currently plans for extension and Brennan is hoping to expand until the sidewalk of the main road.

*Analysis*

Each of the main pieces of literature reviewed is helpful in understanding the concerns and potential threats to the two community gardens. These literature studies are conclusive about potential metals contamination, their causes and the consequent impacts on food gardens The table below is a summary of some of the activities and contaminants that cause these potential dangers.

Figure 3 PAST LAND USES AND ASSOCIATED POTENTIAL CONTAMINANTS

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

Putting this information together with the physical attributes seen around the two community gardens; the old landfill with unknown anthropogenic artefacts and potentially non-exhaustive site preparation, the surrounding old housing, the old lead based paints, the proximity of construction sites, auto body shops that are adjacent to the St Mary the Virgin church, East Columbia Main road through which commuter traffic in and out of New Westminster flows, the large trucks carrying various building materials which load is often blown into the site space by wind, a large intersection which slows down traffic and leads to exhaust and brake fluid being realised into the air and various industrial activities that occur in large factories with rubble and large vessels. Due to these activities the potential contaminants that the New Westminster Community Society gardens are Copper, Lead, Zinc, Nickel and Tin.

*Potential Effects*

All of the sources conclude that due to urban, anthropogenic activities there are increases in various metal contaminants in urban soils. Whether these metals are absorbed by the soil, how long they remain there and whether they are absorbed by plants are all determined by the soil structure and type of plant species in a specific site. Without specific site research, one can extrapolate that these metals can be ingested by humans who eat the plants grown in such sites. Below is a table which explains the possible effect of consumption of these contaminants. As mentioned previously the main contaminants of concern are Copper, Lead, Nickel and Zinc. In high concentration these metals can lead to liver, brain, lung, bone, intestine and kidney damage, anemia and immuntoxicity.

Figure 4 Contaminants and their health effects following consumption adapted from the Agency for Toxic Substances and Disease Registry (2004, 2008)

| Contaminant | Human Health Effects |
|---|---|
| Cadmium | Lungs, sinuses, kidneys, venous and arterial blood systems |
| Cobalt | Lungs and thyroid. When ingested, can affect the blood, liver, kidneys, and heart |
| Copper | Liver and kidney damage, anemia, immunotoxicity, and developmental toxicity |
| Lead | Brain, intestines, and bones |
| Mercury | Brain and kidneys |
| Nickel | Lungs, sinuses, and skin |
| Tin | Inorganic: Lower respiratory system, gastrointestinal system<br>Organotin: neurotoxic, immunotoxic, hepatic and hematological effects |
| Zinc | Bone, lungs, stomach |
| Titanium | Skin, mucous membranes, eyes, and lungs |
| EPHS | Variable |

*Recommended further action*

Due to the uncertainty of the general metal contaminant levels in soils and the fact that the society currently does not have basic information on the natural soil structure, including basic limestone and Ph I would recommend conducting a simple soil analysis, such as the assessment that Iverson proposes. Based on the brief site location and history conducted in this paper, including completing the 11 step soil and microclimate assessment, there is need for laboratory testing. The first test that should be conducted is a simple Nutrient Analysis which "provides information on possible nutrient deficiencies, *pH* and possible *lime* requirements, as well as total organic matter and nitrogen." (Iverson, 2006) This test can be conducted at the Pacific Soil Analysis Inc. in Richmond.

The second test will examine the actual metal concentrations in the soil. In order to take a soil sample a 30cm deep pit should be dug. Then, using a trowel, collect a couple centimetres of sample soil from the middle of the pit. Cut a rectangle in the trowel and put this sample in a container and on ice until it is taken to the laboratory (Iverson, 2006). In order to minimize costs it is useful to take a mixed sample, this is where samples from various areas of the garden are sampled (as listed above,) then mixed together and sent to the lab to have one test run on the entire batch. This is cheaper than sending various samples and conducting numerous tests. A laboratory that conducts these tests is the Maxxam Analytics (formerly Cantest Laboratory) in Burnaby. When the sample is sent, it should be tested 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*). (Iverson, 2006) Once the lab tests are returned the organization should conduct a cross-check with the British Columbia government which sets limits for metal concentration, to ensure that no concentration is too high. If there is a particular metal of concern or the general structure of the soil (maybe too acidic) is worrying, there are certain management plans that the community can adopt.

*Conclusion*

"In the age of climate change, we must not only overcome the challenge of feeding cities, but do so in a way that decreases the distance our food travels from field to fork" (Iverson, 2006). The New Westminster Gardening Society is a group of citizens for whom this message rings clear. The Society plans to make New Westminster food secure, but setting up numerous urban community gardens in old brownfield sites. This paper looks at the current two gardens. One of these gardens is located on an old landfill site and the other in a church yard in the industrial heart of New Westminster. While the New Westminster Society believes in the benefits that the gardens have to offer the community they fear that due to their very urban locations there could be large contamination to their produce. The literature consulted, some of which was discussed above, emphasizes the potential soil contamination. While air pollution is mentioned, it is often harder to measure and does not seem as threatening as the high metallic concentrations that have been found in soils around the world. There are also certain trees that can be planted as they absorb larger quantities of CO2. The New West Group, currently, has very little knowledge of the soil. While mulch was brought in to start each garden with time and the growing of larger vegetables the ground soil will soon be providing nutrients for their produce. The literature review points to indicates that these locations would be at risk for high contamination..It is highly recommended therefore that both gardens' soils need to be analysed for basic nutrients and also tested for the most likely metal contaminants, Copper, Zinc, Lead, Nickel and Tin. Once these test results have been released, the Society can take proactive management strategies, growing certain vegetables, using specific fertilizers...etc, in order to enjoy that they harvest large and safe produce, thereby completing their mission.

Works Cited

Agrawal, M., B. Singh, M. Rajput, F. Marshall, and J. N. Bell. "Effect of Air Pollution on Peri-urban Agriculture: a Case Study." *Environmental Pollution* 126.3 (2003): 323-29. *Science Direct*. Elsevier Science Ltd, 15 May 2003. Web. 14 Jan. 2011.

Brown, Sally, Judith Hallfrisch, Rufus Chaney, and Qi Xue. "Effect of Biosolids Processing on Lead Bioavailability in an Urban Soil." *Journal of Environmental Quality* 32.1 (2001): 100-08.

Chaney, Rufus, Susan Sterrett, and Howard Mielke. *THE POTENTIAL FOR HEAVY METAL EXPOSURE FROM URBAN GARDENS AND SOIL*. Publication. Washington, DC: Biological Waste Management and Organic Resources Laborator, 1984.

Gromaire-Mertz, M. C., S. Garnaud, A. Gonzalez, and G. Chebbo. "Ingentaconnect Characterisation of Urban Runoff Pollution in Paris." *Ingentaconnect Home*. 1999. Web. 14 Jan. 2011. <http://www.ingentaconnect.com/content/els/02731223/1999/00000039/00000002/art00002>.

Hough, R. L., N. Breward, S. D. Young, N. M. J. Crout, A. M. Tye, A. M. Moir, and I. Thornton. "Assessing Potential Risk of Heavy Metal Exposure from Consumption of Home Produced Vegetables by Urban Populations." *Environmental Health Perspectives* 112.2 (2003): 214-24

Iverson, Melissa A. "Assessing Urban Brownfields for Community Gardens in Vancouver, British Columbia." Thesis. University of British Columbia, 2010. Print.

Lerner, D. N., and J. H. Tellam. "The Protection of Urban Groundwater from Pollution." *Water and Environment Journal* 6.3 (1992): 28-36. *Wiley Online Library*. 2007. Web. 15 Jan. 2011.

Matterson, Kevin C., John C. Ascher, and Gail A. Langellotto. "Bee Richness and Abundance in New York City Urban Gardens." *Annals of the Entomological Society of America,*. Entomological Society of America, 2008. Web. 14 Jan. 2011. <http://www.ingentaconnect.com/content/esa/aesa/2008/00000101/00000001/art00016;jsessionid=urp32pk9fw1n.alexandra>.

Mielke, Howard W. "Lead in New Orleans Soils: New Images of an Urban Environment."*Environmental Geochemistry and Health* 16-16.3-4 (1994): 123-28.

Mougeot, Luc A. "CFP Report 31 - Urban Agriculture: Definition, Presence, Potential and Risks, Main Policy Challenges: International Development Research Centre." *INTERNATIONAL DEVELOPMENT RESEARCH CENTRE | CENTRE DE RECHERCHES POUR LE DÉVELOPPEMENT INTERNATIONAL*. Web. 15 Jan. 2011. <http://www.idrc.ca/en/ev-2571-201-1-DO_TOPIC.html>.

Tiller Kg. "Urban Soil Contamination in Australia." *Australian Journal of Soil Research* 30.6 (1992): 937. CSIRO Publishing, 1992. Web. 15 Jan. 2011.

Zhang, Chaosheng. "Using Multivariate Analyses and GIS to Identify Pollutants and Their Spatial Patterns in Urban Soils in Galway, Ireland." *Environmental Pollution* 142.3 (2006): 501-11. *Science Direct*. Elsevier Science Ltd, 2005. Web. 15 Jan. 2011

Villenueve, Paul, Richard Burnett, Yuanli Shi, Daniel Krewski, and Mark Goldberg. "Journal of Exposure Analysis and Environmental Epidemiology - Abstract of Article: A Time-series Study of Air Pollution, Socioeconomic Status, and Mortality in Vancouver, Canada." *Nature Publishing Group : Science Journals, Jobs, and Information*. Journal of Exposure Analysis and Environmental Epidemiology, 2003. Web. 01 Feb. 2011. http://www.nature.com/jea/journal/v13/n6/abs/7500292a.html

Wakefield, S., F. Yeudall, C. Taron, J. Reynolds, and A. Skinner. "Growing Urban Health: Community Gardening in South-East Toronto." *Health Promotion International* 22.2 (2007): 92-101

Whelan, R., D. Roberts, P. England, and D. Ayre. "The Potential for Genetic Contamination vs. Augmentation by Native Plants in Urban Gardens." *Biological Conservation* 128.4 (2006): 493-500. *Science Direct*. Elsevier Science Ltd, 2005. Web. 14 Jan. 2011.

## Figures Used

Figure 1- Tiller Kg. "Urban Soil Contamination in Australia." *Australian Journal of Soil Research* 30.6 (1992): 937. CSIRO Publishing, 1992. Web. 15 Jan. 2011.

Figure 2- Iverson, Melissa A. "Assessing Urban Brownfields for Community Gardens in Vancouver, British Columbia." Thesis. University of British Columbia, 2010. Print.

Figure 3- Iverson, Melissa A. "Assessing Urban Brownfields for Community Gardens in Vancouver, British Columbia." Thesis. University of British Columbia, 2010. Print.

Figure 4- Iverson, Melissa A. "Assessing Urban Brownfields for Community Gardens in Vancouver, British Columbia." Thesis. University of British Columbia, 2010. Print.

## Abbreviations Used

Cd- Cadmium

CO2- Carbon Dioxide

Cu- Copper

Ni- Nickel

Pb- Lead

pH- refers to the measure of acidity or basicity of a solution

Sn- Tin