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PHYTOTOXICOLOGY TECHNICAL MEMORANDUM

Phytotoxicology 2001 Investigation: Re-sampling of Soil at St. Therese Catholic School - Port Colborne

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Background

On April 18, 2001, the Ecological Standards and Toxicology Section (formerly Phytotoxicology Section) received a request from the MOE Niagara District Office to conduct an investigation of soil contamination on the playing field of St. Therese Catholic School in Port Colborne. The playing field at this school, and all schools in Port Colborne, had been sampled in April 2000 and the results were reported in the MOE Phytotoxicology report SDB-031-3511-2000.

The request for this investigation arose from concern that areas of the St. Therese playing field near a woodlot might contain high metal concentrations, which might have been missed in previous sampling of the school field. The issue surrounding higher metal concentrations in soils near woodlots came out of an earlier Phytotoxicology investigation that examined the role of woodlots in intercepting atmospheric particulates containing nickel and other metals that had been emitted by the International Nickel Company (INCO) refinery during the 66 years that it operated in Port Colborne. The woodlot investigation concluded that woodlots act in the same way as large snow-fences, which slow the wind resulting in higher deposition of particles, in this case containing metals, in and around the woodlot. Over time, this enhanced deposition will result in higher soil metal concentrations in the vicinity of woodlots. Soil metal concentrations were found to be highest in the woodlots, but also high in the areas of fields at the edge of the woodlot facing the INCO refinery. Details of this investigation are contained in the MOE Phytotoxicology report SDB-012-3511-2001. The current investigation was initiated to determine if the soil metal concentrations along the eastern side of the St. Therese playing field near the edge of the woodlot are higher than originally reported in the MOE 2000 Port Colborne school report (SDB-031-3511-2000).

Investigation Procedures

The investigation was conducted on April 18, 2001 by Phytotoxicology scientists Laura Morra (author) and Bill Gizyn. Upon arriving at the school, the principal was informed of the purpose of the visit and consulted about the property lines defining the playing field. The field was measured and a sampling scheme that would systematically assess the whole field, including the eastern edge nearest the woodlot, was developed.

The main part of the field was rectangular, approximately 300 metres in length and 200 metres in width. The length of the field was staked at 50 metre intervals. Samples were taken 1, 20, 90 and 145 metres from the fence line on the east side of the playing field within each 50 metre interval. Samples were also taken 1 metre from the fence line on the west side of the playing field in an attempt to determine if an east-west contamination gradient from the woodlot exists on the St. Therese property. This produced a grid that contained 24 sampling sites. Figure 1 shows the sampling site locations in relation to the school building and the woodlot.

At each sampling location a soil sampler was used to remove cylindrical cores of soil 2 cm in diameter to a depth of 5 cm. Ten cores were collected at each site and mixed thoroughly to form a single composite sample.

The soil samples were processed (air-dried, homogenized, and sieved, first through a 2mm sieve and then ground and passed through a 355µm sieve) at the MOE sample processing laboratory. The processed samples were forwarded to the MOE Laboratory Services Branch where they were analysed for aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, magnesium, molybdenum, nickel, strontium, vanadium, and zinc using the MOE Laboratory Services Branch accredited analytical method E3073L1. Antimony, arsenic, and selenium were analysed using the MOE Laboratory Services Branch accredited analytical method E3245L1.

Results

The results of the soil analyses for all samples are listed in Table 1. This table also reports the maximum and minimum concentrations of each chemical quantified by the analysis. The data are compared to the MOE effects-based Table A and background-based Table F guidelines as published in the *Guideline for Use at Contaminated Sites in Ontario* (see Appendix A). The OTR_{98} guidelines for rural parkland soil are substituted where there are no Table F guidelines (see Appendix C). Soil concentrations in Table 1 exceeding background (Table F guidelines) are in bold font, whereas concentrations exceeding the effects-based Table A guidelines are bolded and underlined. Table 2 summarizes soil metal concentrations in a east-west transect at increasing distance away from the woodlot. For example, the results from Sites 1 to 6 in Figure 1 were averaged to obtain the data in Table 2 identified as “1 m from East fence”. Similarly the results from Sites 21 to 24 in Figure 1 were averaged to obtain the data in Table 2 identified as “1 m from West fence”. This was done to determine if the presence of the woodlot had resulted in higher soil metal concentrations in the playing field adjacent to the edge of the woodlot.

Discussion

The chemical analysis included a total of 20 chemical elements. The concentrations of 12 of these were exclusively below background concentrations. These were aluminum, antimony, arsenic, barium, calcium, chromium, iron, lead, magnesium, manganese, molybdenum, and vanadium. This suggests either there are no anthropogenic sources that contributed to these elements to the soil, or the deposition was insufficient to bring the soil concentrations above background.

Five elements, cadmium, cobalt, copper, selenium, and zinc, are elevated above background concentrations at some of the 24 sample sites but are less than the effects-based Table A guidelines (see Apppendix A) at all of the sites. Since the Table A guidelines are generic (ie. meant to be protective for all conditions anywhere in the province), soil concentrations below Table A should be fully protective of both human health and the natural environment. Strontium concentrations were also above background concentrations, however there is no Table A effects-based guideline for strontium. Strontium concentrations have been observed to exceed background concentrations in the absence of a pollution source. No adverse effects are anticipated as strontium concentrations are only marginally above background.

The remaining two elements, beryllium and nickel, are present in concentrations that exceeded MOE effects-based Table A guidelines at several sample sites. Nickel exceeded the Table A criterion of 200 µg/g at every sample site in the St. Therese field.

Emissions from the INCO refinery contained copper, cobalt, nickel and selenium. The St. Therese school is downwind of INCO in a known high deposition zone. Consequently, the enrichment of soil concentrations of these metals over the playing field at the St. Therese school is attributed to INCO emissions. Beryllium concentrations in soil slightly above the Table A guideline are not unusual in areas near shale deposits, such as the Port Colborne area. Also, there is no consistent pattern of soil beryllium concentrations in Port Colborne relative to the INCO refinery.

The soil metal concentrations determined in this investigation are entirely consistent with the April 2000 soil investigation. In the April 2001 sampling, soil nickel concentrations in the St. Therese playing field ranged from 1,000 µg/g to 1,900 µg/g (Table 1) with a mean concentration of 1251 µg/g nickel. In the April 2000 sampling (excluding a fenced-off playground with 270 µg/g nickel), soil nickel concentrations ranged from 1,045 µg/g to 1,450 µg/g, with a mean of 1273 µg/g. Using a two-sample “t” test, there was no significant difference in nickel concentrations between these two years (P = 0.83).

A review of the data in Table 2 shows a homogeneous contaminant distribution over all the playing field at the St. Therese school, with no pattern of higher soil metal concentrations next to the woodlot. However, the pattern of deposition around a woodlot will depend on the size, height and density of trees in the woodlot. At the St. Therese school, the treed area referred to as a woodlot was so sparse that an enhanced deposition of particulates in the vicinity of the woodlot was not expected.

The Table A effects-based criterion of 200 µg/g nickel relates to potential toxicity to plants growing in nickel-contaminated soil, because plant health is affected at lower soil nickel concentrations than human health. The 1997 MOE/Health Department human health risk assessment of soil nickel contamination in Port Colborne concluded that a lifetime of exposure to concentrations below 9,750 µg/g should not pose a health risk (SDB-EA054.94-3540-1997). The highest soil nickel concentration of the St. Therese field is approximately 20% of the concentration considered safe based on the 1997 risk assessment. In addition, there is an additional safety factor for students at the St. Therese school because the risk associated with exposure to nickel in soil is based on continuous lifetime exposure, not the periodic and short-duration exposure that would normally be experienced by students attending school or playing in the school field.

All samples collected from the St. Therese school in April 2001 were analysed for arsenic, and the highest soil arsenic concentration detected was 11.0 µg/g, which is well below the Table F background-based guideline of 17 µg/g. This concentration is comparable with the arsenic concentration of 9.6 µg/g found in the St. Therese playing fields in the April 2000 sampling.

Conclusions

This investigation reaffirmed that INCO emissions have impacted the playing field at St. Therese Catholic School resulting in soil concentrations of nickel, copper, cobalt, and selenium that are consistently higher than background. It also demonstrated that the woodlot/scrub area east of the playing fields has not contributed to higher deposition along the east side of the playing field. In fact, due to long term atmospheric deposition, a relatively even distribution of contaminants has been verified throughout the St. Therese playing field.

Based on this re-assessment, the soil metal concentrations at the St. Therese school should not be a health risk to the students. Therefore, there is no restriction to the normal use of the playing fields at the St. Therese Catholic School. This position is supported by the local Medical Officer of Health.

Table 1: Chemical Concentrations (µg/g) in Surface Soil (0-5 cm) at the St. Therese Catholic School, April 18, 2001.

	Site												Sites 1 to 24		Guidelines	
Element	1	2	3	4	5	6	7	8	9	10	11	12	Minimum	Maximum	Table F	Table A
Aluminum	23000	28000	26000	29000	26000	24000	21000	21000	28000	27000	24000	20000	14000	29000	(30000)	NG
Antimony	0.7<T	0.5<T	0.4<T	0.5<T	0.4<T	0.4<T	0.4<T	0.4<T	0.4<T	0.4<T	0.4<T	0.3<T	0.2	0.7	1	13
Arsenic	7.6	9	8.1	8.4	7.8	8.1	7.3	7.2	8.1	8.3	7.6	6.4	5.8	11	17	25
Barium	140	160	160	160	160	150	120	130	170	160	140	110	70	170	210	1000
Beryllium	0.9<T	1.2	1.2	**1.3**	**1.3**	1.1<T	0.8<T	0.9<T	**1.4**	**1.3**	1.1<T	0.8<T	0.6	1.4	1.2	1.2
Cadmium	0.2<W	1	0.9<T	**1.6**	**1.1**	0.3<T	0.5<T	0.5<T	**1.3**	**1.1**	0.5<T	0.3<T	0.2	1.6	1	12
Calcium	9600	8700	16000	9000	8800	10000	7000	6300	9000	8100	7300	4300	2300	16000	(55000)	NG
Chromium	28	34	32	33	31	30	27	29	33	32	28	23	17	34	71	1000
Cobalt	**30**	**32**	**26**	**29**	**30**	**30**	**31**	**31**	**34**	**31**	**36**	**27**	24	40	21	50
Copper	**170**	**190**	**140**	**170**	**150**	**130**	**160**	**150**	**190**	**170**	**160**	**120**	79	210	85	300
Iron	18000	22000	24000	23000	22000	22000	18000	19000	20000	19000	16000	16000	15000	27000	(35000)	NG
Lead	49	46	42	46	44	45	50	45	50	48	48	41	38	55	120	200
Magnesium	5900	6300	8000	6200	6200	6600	4800	5100	5600	5600	5100	4300	2800	8000	(20000)	NG
Manganese	230	270	330	260	290	300	200	230	240	210	260	200	200	550	(2200)	NG
Molybdenum	0.5<W	0.5<W	0.6<T	0.5<W	0.5<W	0.5<W	0.6<T	0.5<W	0.5<W	0.5<W	0.5<W	0.5<W	0.5	0.7	2.5	40
Nickel	**1400**	**1500**	**1000**	**1300**	**1200**	**1000**	**1300**	**1200**	**1400**	**1300**	**1300**	**1000**	1000	1900	43	200
Selenium	2.3	2.1	1.8	**2.4**	**2.8**	**2.4**	**2.1**	1.9	**2.8**	**2.3**	**2**	1.7	1.4	2.8	1.9	10
Strontium	68	50	68	**84**	**84**	**84**	59	48	58	**90**	68	66	10	90	(78)	NG
Vanadium	35	45	45	47	43	41	36	38	45	45	38	33	30	47	91	250
Zinc	130	140	120	150	140	120	110	110	130	120	110	89	89	200	160	800

All values are in µg/g air dry weight of single samples. Values in bold and underlined exceed MOE Table A effects based guidelines (see Appendix A). Values in bold exceed MOE Table F background based guidelines(see Appendices A and B). Values in brackets in the Table F guidelines column are MOE OTR_{98} values (see Appendix C).

NG - guideline not available, <W = below analytical detection, <T = a measurable trace amount

Site locations are given in Figure 1.

Table 1 (continued): Chemical Concentrations (µg/g) in Surface Soil (0-5 cm) at the St. Therese Catholic School, April 18, 2001.

Element	Site												Sites 1 to 24		Guidelines	
	13	14	15	16	17	18	19	20	21	22	23	24	Minimum	Maximum	Table F	Table A
Aluminum	23500	20000	20000	16000	18000	21000	24000	14000	19250	18000	16000	17000	14000	29000	(30000)	NG
Antimony	0.2<W	0.5<T	0.5<T	0.4<T	0.4<T	0.3<T	0.5<T	0.3<T	0.7<T	0.5<T	0.4<T	0.6<T	0.2	0.7	1	13
Arsenic	6.8	6.7	8.7	8.1	6.5	5.8	9	7.2	11	8.9	7.3	8.8	5.8	11	17	25
Barium	150	140	120	99	120	120	150	70	110	91	110	96	70	170	210	1000
Beryllium	0.9<T	0.9<T	1<T	0.7<T	0.8<T	0.9<T	1.1<T	0.5<T	0.8<T	0.7<T	0.7<T	0.6<T	0.6	1.4	1.2	1.2
Cadmium	0.5<T	0.5<T	0.4<T	0.5<T	0.2<W	0.4<T	0.4<T	0.2<W	0.2<W	0.2<W	0.3<W	0.2<W	0.2	1.6	1	12
Calcium	8500	10000	7000	3500	8000	5400	8400	2300	9000	8400	5600	5400	2300	16000	(55000)	NG
Chromium	25	25	29	22	24	27	29	17	25	20	22	20	17	34	71	1000
Cobalt	**34**	**35**	**30**	**25**	**29**	**24**	**30**	**27**	**40**	**31**	**27**	**35**	24	40	21	50
Copper	**160**	**160**	**140**	**120**	**140**	79	**160**	**120**	**210**	**170**	**140**	**160**	79	210	85	300
Iron	15000	18000	23000	22000	18000	22000	27000	16000	24000	20000	20000	18000	15000	27000	(35000)	NG
Lead	47	50	42	38	47	41	49	44	47	46	41	55	38	55	120	200
Magnesium	4500	4700	5000	4100	4800	5200	5700	2800	5900	5200	4200	3700	2800	8000	(20000)	NG
Manganese	200	280	360	470	270	400	550	410	370	370	320	420	200	550	(2200)	NG
Molybdenum	0.6<T	0.5<W	0.5<W	0.7<T	0.6<T	0.5<W	0.5<W	0.5<W	0.5<W	0.5<W	0.5<W	0.5<W	0.5	0.7	2.5	40
Nickel	**1300**	**1300**	**1200**	**1100**	**1100**	**580**	**1300**	**1100**	**1900**	**1500**	**1300**	**1600**	1000	1900	43	200
Selenium	**2.6**	**2.2**	**2.6**	1.8	1.9	1.4	**2.4**	1.7	**2.6**	**2.1**	**2**	**2.2**	1.4	2.8	1.9	10
Strontium	36	28	20	15	31	27	21	10	30	19	18	16	10	90	(78)	NG
Vanadium	35	36	39	36	35	39	45	30	39	33	36	34	30	47	91	250
Zinc	120	110	110	93	110	110	130	100	**200**	140	130	140	89	200	160	800

All values are in µg/g air dry weight of single samples. Values in bold and underlined exceed MOE Table A effects based guidelines (see Appendix A). Values in bold exceed MOE Table F background based guidelines(see Appendices A and B). Values in brackets in the Table F guidelines column are MOE OTR_{98} values (see Appendix C).

NG - guideline not available, <W = below analytical detection, <T = a measurable trace amount

Site locations are given in Figure 1.

Table 2: Concentrations of chemical elements in soil transects collected from the St. Therese School, April 18, 2001.

Element	Transect Location					Soil Guideline	
	1 m from West fence	145 m from East fence	90 m from East fence	20 m from East fence	1 m from East fence	Table F	Table A
Aluminum	16,750	19,250	19,000	23,500	26,000	(30,000)	NG
Antimony	0.6<T	0.4<T	0.4<T	0.4<T	0.5<T	1.0	13
Arsenic	9.0	7.1	7.6	7.5	8.2	17	25
Barium	102	115	127	138	155	210	1000
Beryllium	0.7<T	0.8<T	0.9<T	1.1<T	1.2	1.2	1.2
Cadmium	0.2<W	0.3<T	0.5<T	0.7<T	0.9<T	1	12
Calcium	7,100	6,025	7,250	7,000	10,350	(55,000)	NG
Chromium	22	24	25	29	31	71	1000
Cobalt	**33**	**28**	**31**	**32**	**30**	21	50
Copper	**170**	**125**	**145**	**158**	**158**	85	300
Iron	20,500	20,750	19,500	18,000	21,830	(35,000)	NG
Lead	47	45	44	47	45	120	200
Magnesium	4,750	4,625	4,575	5,083	6,533	(20,000)	NG
Manganese	370	408	328	223	280	(2,200)	NG
Molybdenum	0.5<W	0.5<W	0.6<W	0.5<W	0.5<W	2.5	40
Nickel	**1,575**	**1,020**	**1,225**	**1,250**	**1,233**	43	200
Selenium	**2.2**	1.9	**2.3**	**2.1**	**2.3**	1.9	10
Strontium	21	22	25	65	73	(78)	NG
Vanadium	36	37	37	39	43	91	250
Zinc	153	112	108	111	133	160	800

All values reported as µg/g air dry weight, mean of transect samples.

Values in bold exceed Table F guidelines. Values in bold and underlined exceed Table A guidelines.

NG - guideline not available, <W = below analytical detection, <T = a measurable trace amount

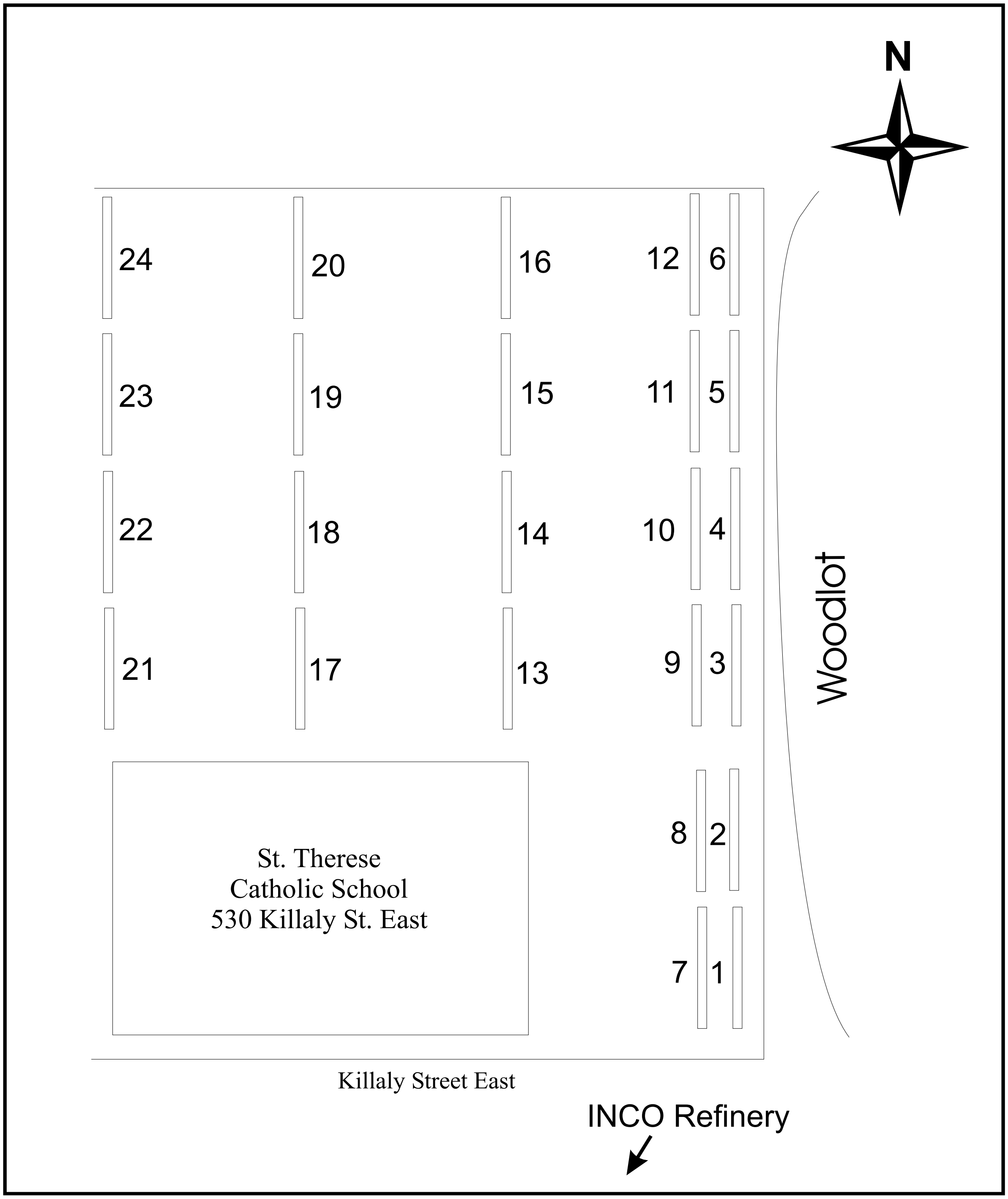

Figure 1: Soil Sampling Sites at the St. Therese Catholic School, April 2001.

Appendix A

Derivation and Significance of the MOE Soil Remediation Criteria (Clean-up Guidelines)

The MOE soil clean-up *Guidelines* have been developed to provide guidance for cleaning up contaminated soil. The *Guidelines* are not legislated Regulations. Also, the *Guidelines* are not action levels, in that an exceedence does not automatically mean that a clean-up must be conducted. The *Guidelines* were prepared to help industrial property owners decide how to clean-up contaminated soil when property is sold and/or the land-use changes. Most municipalities insist that contaminated soil is cleaned up according to the MOE *Guidelines* before they will approve a zoning change for redevelopment, therefore, even though the *Guideline* is voluntary most industrial property owners and developers are obliged to use it. For example, the owner of an industrial property who plans to sell the land to a developer who intends to build residential housing can use the *Guideline* to clean up the soil to meet the residential land-use criteria. In this way previously-contaminated industrial land can be re-used for residential housing without concern for adverse environmental effects.

The *Guideline* contains a series of Tables (A through F), each having criteria for soil texture, soil depth, and ground water use for various land-use categories (eg, agricultural, residential, industrial). Table F *criteria* reflect the upper range of background concentrations for soil in Ontario. An exceedence of Table F indicates the likely presence of a contaminant source. Tables A through E *criteria* are effects-based and are set to protect against the potential for adverse effects to human health, ecological health, and the natural environment, whichever is the most sensitive. By protecting the most sensitive parameter the rest of the environment is protected by default. The *Guideline criteria* take into consideration the potential for adverse effects through direct contact, and through contaminant transfer from soil to indoor air, from ground water or surface water through release of volatile gases, from leaching of contaminants in soil to ground water, or from ground water discharge to surface water. However, the *Guideline criteria* ***may not*** ensure that corrosive, explosive, or unstable soil conditions will be eliminated.

If the decision is made that remedial action is needed, the *criteria* in Tables A to F of the *Guideline* can be used as clean-up targets. In some cases, because of economic or practical reasons, it may not be possible to clean up a site using the generic *criteria* in Tables A to F. The *Guideline* provides a process, called a *site specific risk assessment*, which is used to evaluate the soil contamination with respect to conditions that are unique to the contaminated site. In a *site specific risk assessment* the proponent examines all the potential pathways through which the contamination may impact the environment and must demonstrate that because of conditions unique to that site the environment and human health will not be adversely effected if contamination above the generic *criteria* in Table A to E is left in place.

When contamination is present and a change in land-use is not planned, for example residential properties and Public green spaces near a pollution source, the *Guideline* may be used in making decisions about the need for remediation. This is different from the previously described situation where a company that caused contamination on their own property decides to clean up the soil, usually at the insistence of the municipality who will not approve a zoning change unless remediation is conducted. Decisions on the need to undertake remedial action when the *Guideline criteria* are exceeded ***and*** where the land-use is not changing are made on a site by site basis using *site specific risk assessment* principals and are usually contingent on the contaminants having caused an adverse environmental effect or there is a demonstrated likelihood that the contamination may cause an adverse effect. Because of the long history of industrial operation and our practice of living close to our work place the soil in many communities in Ontario is contaminated above the effects-based *criteria* in the MOE *Guidelines*. In practice, remediation of contaminated soil on privately-owned residential property and Public green spaces has only been conducted in communities when the potential for adverse health effects has been demonstrated.

The soil clean-up *Guidelines* were developed from published U.S. EPA and Ontario environmental data bases. Currently there are criteria for approximately 25 inorganic elements and approximately 90 organic compounds. Criteria were developed only if there were sufficient, defendable, effects-based data on the potential to cause an adverse effect. All of the criteria address human health and aquatic toxicity, but terrestrial ecological toxicity information was not available for all elements or compounds. The development of these clean-up *Guidelines* is a continuous program, and criteria for more elements and compounds will be developed as additional environmental data become available. Similarly, new information could result in future modifications to the existing *Guidelines*.

For more information on the MOE's soil clean-up *Guidelines* please refer to the *Guideline for Use at Contaminated Sites in Ontario. Revised February 1997*, Ontario Ministry of Environment and Energy, PIBs 3161E01, ISBN 0-7778-6114-3. This document is also available on the MOE web site at www.ene.gov.on.ca, refer to *Contaminated Sites: Clean-up Guideline*.

Appendix B

Derivation and Significance of the MOE Soil Background Concentrations

(Soil Clean-up Guideline - Table F)

The Table F criteria in the MOE *Guideline for Use at Contaminated Sites in Ontario* represent the expected background range of various chemicals in soil in Ontario. Ontario Typical Ranges (OTR) were derived from a province-wide soil sampling program conducted to determine the distribution of chemical concentrations resulting from natural geological processes and normal human activity in surface soil in Ontario remote from the influence of known point sources of pollution. OTRs are developed for several land use categories.

OTRs are based on the analytical data from pre-defined sampling, processing and analytical protocols. Complete details on the OTR development process can be found in the MOE report "*Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Moss Bags and Snow*" MOEE 1993. This report describes the development of the OTR_{98}, which represents 98% of the data in the OTR distribution. From a statistical aspect, this is equivalent to the mean plus two standard deviations of a normally distributed population.

A review of the OTR database indicated that a high degree of sampling variability can occur at any given site when concentrations are at background levels, especially when sampling for organic contaminants. Therefore, replicate sampling would be necessary to address variability due to sampling, as well as analytical variability. In order to minimize costly replicate sampling and analysis to proponents in situations where there is little or no danger of effects, the Table F soil background criteria were set at a value equal to the OTR_{98} plus two coefficients of variation (OTR_{98} + 2CVws). The coefficient of variation, in this context, is the average "within site" sampling variability around the OTR_{98}, expressed as a percent coefficient of variability (CVws). This was calculated by taking the average of the "within site" coefficients of variation of all points between the OTR_{98} upper and lower confidence limits (MOEE, 1993). The percent value of 2CVws is converted to an absolute value and added to the OTR_{98}, which becomes the Table F criterion. If the chemical concentration in a single sample is above Table F (OTR_{98} + 2CVws), one can be certain (with 97.5% confidence) that the OTR98 has been exceeded for that chemical.

Rural parkland OTR_{98} values were the basis for the Table F soil background concentrations for the agricultural land use category while urban parkland OTR98 values were the basis for the other land use categories. The term "urban" is defined here as any property that lies within an area that is fully serviced by both municipal water and sewage systems.

Reference

Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Moss Bags, and Snow. MOEE Report Number HCB-151-3512-93, PIBs Number 2792, ISBN 0-778-1979-1.

Appendix C

Derivation and Significance of the MOE "Ontario Typical Range" Soil Guidelines

The MOE "Ontario Typical Range" (OTR) guidelines are being developed to assist in interpreting analytical data and evaluating source-related impacts on the terrestrial environment. The OTRs are used to determine if the level of a chemical parameter in soil, plants, moss bags, or snow is significantly greater than the normal background range. An exceedence of the OTR_{98} (the OTR_{98} is the actual guideline number) may indicate the presence of a potential point source of contamination.

The OTR_{98} represents the expected range of concentrations of chemical parameters in surface soil, plants, moss bags, and snow from areas in Ontario not subjected to the influence of known point sources of pollution. The OTR_{98} represents 97.5 percent of the data in the OTR distribution. This is equivalent to the mean plus two standard deviations, which is similar to the previous MOE "Upper Limit of Normal" (ULN) guidelines. In other words, 98 out of every 100 background samples should be lower than the OTR_{98}.

The OTR_{98} may vary between land use categories even in the absence of a point source of pollution because of natural variation and the amount and type of human activity, both past and present. Therefore, OTRs are being developed for several land use categories. The three main land use categories are Rural, New Urban, and Old Urban. Urban is defined as an area that has municipal water and sewage services. Old Urban is any area that has been developed as an urban area for more than 40 years. Rural is all other areas. These major land use categories are further broken into three subcategories; Parkland (which includes greenbelts and woodlands), Residential, and Industrial (which includes heavy industry, commercial properties such as malls, and transportation rights-of-way). Rural also includes an Agricultural category.

The OTR guidelines apply only to samples collected using standard MOE sampling, sample preparation, and analytical protocols. Because the background data were collected in Ontario, the OTRs represent Ontario environmental conditions.

The OTRs are not the only means by which results are interpreted. Data interpretation should involve reviewing results from control samples, examining all the survey data for evidence of a pattern of contamination relative to the suspected source, and where available, comparison with effects-based guidelines. The OTRs are particularly useful where there is uncertainty regarding local background concentrations and/or insufficient samples were collected to determine a contamination gradient. OTRs are also used to determine where in the anticipated range a result falls. This can identify a potential concern even when a result falls within the guideline. For example, if all of the results from a survey are close to the OTR_{98} this could indicate that the local environment has been contaminated above the anticipated average, and therefore the pollution source should be more closely monitored.

The OTRs identify a range of chemical parameters resulting from natural variation and normal human activity. As a result, it must be stressed that values falling within a specific OTR_{98} should not be considered as acceptable or desirable levels; nor does the OTR_{98} imply toxicity to plants, animals or humans. Rather, the OTR_{98} is a level which, if exceeded, prompts further investigation on a case by case basis to determine the significance, if any, of the above normal concentration. Incidental, isolated or spurious exceedences of an OTR_{98} do not necessarily indicate a need for regulatory or abatement activity. However, repeated and/or extensive exceedences of an OTR_{98} that appears to be related to a potential pollution source does indicate the need for a thorough evaluation of the regulatory or abatement program.

The OTR_{98} supersedes the Phytotoxicology ULN guideline. The OTR program is on-going. The number of OTRs will be continuously updated as sampling is completed for the various land use categories and sample types. For more information on these guidelines please refer to Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Moss Bags, and Snow, MOEE Report Number HCB-151-3512-93, PIBs Number 2792, ISBN 0-778-1979-1.