Windsor Air Quality Study
L'étude sur la qualité de l'air de Windsor

Windsor Air Quality Committee | Comité sur la qualité de l'air de Windsor

Soil and Garden Produce Survey

REPORTS OF THE WINDSOR AIR QUALITY STUDY

1: Windsor Air Quality Study : Executive Summary
2: Windsor Air Quality Study : Emission Inventory for Windsor/Detroit Airshed
3: Windsor Air Quality Study : Air Monitoring Activities
4: Windsor Air Quality Study : TAGA 6000 Survey Results
5: Windsor Air Quality Study : Personal Exposure Survey Results
6: Windsor Air Quality Study : Soil and Garden Produce Survey Results
7: Windsor Air Quality Study : Mathematical Modelling/Source Apportionment
8: Windsor Air Quality Study : Health Effects Assessment
9: Windsor Air Quality Study : Plain Language Summary

ISBN 0-7778-3018-3

WINDSOR AIR QUALITY STUDY:

SOIL AND GARDEN PRODUCE

SURVEY RESULTS

FALL 1994

Cette publication technique
n'est disponible qu'en anglais.

PIBS 3259E

WINDSOR AIR QUALITY STUDY:

SOIL AND GARDEN PRODUCE

SURVEY RESULTS

Report prepared by:

William I. Gizyn
Phytotoxicology Section
Standards Development Branch
Ontario Ministry of Environment and Energy

Report prepared for:

Windsor Air Quality Committee

For further information, please contact:

MOEE Windsor District Office
6th Floor, 250 Windsor Avenue
Windsor, Ontario
N9A 6V9

Phone (519) 254-2546
Facsimile(519) 254-5894

Executive Summary:

In 1989 and 1990 the Phytotoxicology Section collected soil and garden produce samples as part of the MOEE pre-operational study of the new Detroit municipal waste incinerator. These data were subsequently used in conjunction with other MOEE data collected for the Windsor Air Quality Study. This is a data report; interpretation is intentionally limited, as the data were intended for use in the health effects assessment.

Surface soil samples (0-5 cm) were collected from parks and residential properties at 12 urban locations in the Windsor area and 18 rural locations in Essex County. The soil was analyzed for 30 inorganic elements, 16 polycyclic aromatic hydrocarbon (PAH) compounds, 14 chlorinated aromatics (CA), five polychlorinated dibenzo-p-dioxin (PCDD) congeners, five polychlorinated dibenzofuran (PCDF) congeners, and total polychlorinated biphenyls (PCBs). Produce from home gardens (carrot roots, chard leaves, beet roots and beet leaves) were analyzed for PAHs, CAs, PCDD/DFs, and PCBs.

Inorganic elemental soil concentrations were all within normal ranges for their respective soil types. CAs were not detected in soil (<1 or <2 ng/g). PAHs were ubiquitous at the ng/g level, and even though the concentrations were highly variable, they were within normal background ranges. PCBs were not detected (<20 ng/g). PCDD/DFs were detected in over half of the soil samples at the pg/g level, although the concentrations were within the background range documented in Ontario soil.

The labotatory could not provide reliable PAH results for the vegetable produce samples. Neither CAs (<1 or <2 ng/g fresh weight) nor PCBs (<20 ng/g fresh weight) were detected in produce. PCDD/DFs were infrequently encountered. With a single exception, concentrations were less than 30 pg/g fresh weight.

Table of Contents

1 INTRODUCTION

1.1 Soil and Vegetation Monitoring

Chemical substances emitted into the air will deposit onto soil and vegetation surfaces. These chemicals may accumulate in soil over time and reflect the long-term influence of emission sources. Vegetation surfaces will adsorb or absorb chemicals from the air and reflect the short-term influence of emission sources. Alternatively, vegetation may take up the chemical from the soil.

The Phytotoxicology Section of the Standards Development Branch uses soil and vegetation sampling as tools for assessing emissions into the air or spills to the soil. Samples are collected and chemically analyzed to determine the concentrations and spatial distribution of the chemical under investigation.

Soil and vegetation surveys are particularly suited for investigating local chemical contaminant sources. The impacts of such sources are usually of sufficient magnitude to distinguish them above ubiquitous backgrounds in soil and vegetation matrices.

Soil and vegetation based monitoring can also be used to track the presence of chemicals over time. In cases where the influence of a source is only expected to be distinguishable over an extended period, baseline and follow-up sampling of specific receptors can be used to assess such influences.

1.2 Windsor and Essex County Survey

A soil and vegetation based survey to evaluate the influence of the new Detroit municipal waste incinerator was initiated in Windsor and Essex County in 1989 and continued through 1990. This survey will serve to establish a baseline against which data from future surveys could be compared. The data were subsequently adopted for the Windsor Air Quality Study.

The primary receptors in this survey were soil from urban parks and rural residential properties, and silver maple tree foliage from the same locations. Also collected were corn foliage and agricultural field soil, and home grown produce and soil from both urban and rural garden plots. Chemicals analyzed included various major and minor elements as well as a variety of organic compounds.

In this report, the results of the inorganic and organic analyses of soil from the urban parks and rural residences, and the organic analyses of home grown produce will be presented. These data can be utilized in models that quantify health risks associated with the presence of contaminants in the Windsor environment.

2 SURVEY METHODOLOGY

2.1 Survey Design

As was mentioned above, this survey was initiated in 1989. It was refined, by adding more urban locations and expanding the analytical list, and repeated in 1990. This report will consider the 1990 design and data generated by 1990 samples. The data base will be enhanced by including the results of the organic analyses of 1989 samples.

Figure 1 represents the distribution of the sampling locations of 1990. Locations are identified with alphanumeric designations. 'A' and 'B' locations are located in Windsor or neighbouring urban municipalities. 'C', 'D' and 'E' locations are located in rural Essex County.

The 'A' and 'B' locations are located primarily in municipal parks. Soil at twelve such locations was sampled in 1990. The 'C', 'D' and 'E' locations are lawns of rural, residential properties in Essex County. Eighteen such locations had soil sampled in 1990. Appendix A provides some details regarding the locations.

The primary criterion for selecting these locations was based on their spatial distribution. The urban locations were distributed throughout the urban Windsor area. The rural locations were located at fixed distances and along selected azimuthal directions from the Detroit incinerator. Other criteria included uniformity of location characteristics (i.e. maintained sod grass cover) and presence of silver maple trees.

2.2 Soil Sampling Methods

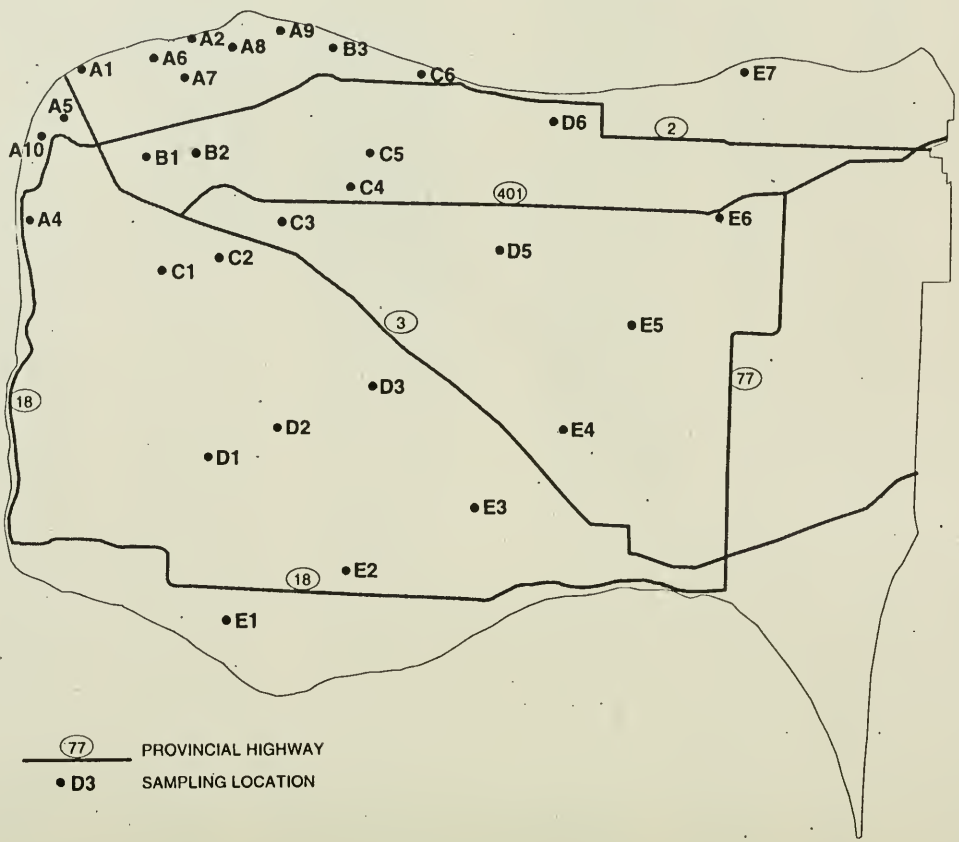
A soil sample designated for inorganic analyses consisted of approximately 12 cores to a depth of five centimetres. The cores were obtained by inserting a core cutting device into the soil to the appropriate depth and extracting the core. These cores were placed into a polyethylene bag. At each location, three samples were collected from areas adjacent to the silver maple sample trees. Details about the sampling location were recorded to permit subsequent sampling at the same location.

At all of the urban and some of the rural locations, an additional sample of soil was taken for analysis of organic chemicals. This sample was taken by extracting six cores using the coring device that had been washed with a soap solution and rinsed with distilled water; and then successively rinsed with acetone and hexane. The soil cores were placed into specially prepared glass jars with aluminum-lined lids. .

The samples designated for inorganic analyses were air dried and disaggregated to pass a two millimetre sieve. Larger material was discarded. An aliquot was then ground in an agate mortar and pestle to completely pass through a 355 micrometre sieve. The processed soil samples were forwarded to the Laboratory Services Branch for analysis of inorganic chemicals.

The samples designated for organic chemical analyses were maintained frozen until forwarded in an as-collected state to the Laboratory Services Branch.

Figure 1: Location of Soil Sampling Locations - 1990



2.3 Garden Produce Sampling Methods

Home gardens located near some of the urban parks or on the rural residential properties were identified for sampling in 1989 and 1990. Because of the wide variety of produce grown in home gardens, it was necessary to restrict the sampling to pre-defined produce. The following produce types were selected; carrot roots, chard leaves, beet roots and beet leaves. These choices included produce cultivated for their edible foliage and roots.

Sampling consisted of removing root crops from the soil or cutting a suitable quantity of leaves from a plant, and placing this material into one of the special jars. All samples were kept frozen until delivered to the Laboratory Services Branch.

2.4 Soil Inorganic Analyses

Soil samples were analyzed for a wide range of major and minor elements. Table 1 lists these elements. Also listed are the detection limit qualifiers, 'W' and 'T', for these data, where such qualifiers were included in the data.

The qualifier 'W' represents the smallest measurable amount of the analyte. The qualifier 'T' indicates that the analyte was detected but should be considered an estimate.

Table 1:	Table 1: Elements Determined in Soil -.1990

Symbol	Name	T	W
As	Arsenic		
Co	Cobalt		
Cd	Cadmium	0.25	0.05
Cr	Chromium		
Cu	Copper		
Hg	Mercury	0.05	0.01
Mn	Manganese		
Mo	Molybdenum	1.0	
Ni	Nickel		
Pb	Lead		
Sb	Antimony	1	0.2
Se	Selenium	1	
Ti	Titanium		
U	Uranium		
V	Vanadium		

Symbol	Name	T	W
Zn	Zinc		
Al	Aluminum		
Fe	Iron		
Be	Beryllium	1	0.5
Mg	Magnesium		
Ca	Calcium		
Sr	Strontium		
Ba	Barium		
Na	Sodium		
K	Potassium		
P	Phosphorus		
N	Nitrogen		
B	Boron	2.5	
F	Fluorine		
S	Sulphur		

2.5 Soil Organic Analyses

Soil samples from some locations were analyzed for various organic compounds These compounds included:

- polycyclic aromatic hydrocarbons
- chlorinated aromatics
- polychlorinated biphenyls
- polychlorinated dibenzo-p-dioxins
- polychlorinated dibenzofurans

Table 2 identifies the specific organic compounds determined in soil.

Table 2: Organic Compounds Determined in Soil - 1989 & 1990

Polycyclic Aromatic Hydrocarbons	Chlorinated Aromatics
Dibenzo(a,h)anthracene	Hexachloroethane
Benzo(g,h,i)perylene	1,3,5-trichlorobenzene
Naphthalene	1,2,4-trichlorobenzene
Acenaphthylene	Hexachlorobutadiene
Acenaphthene	1,2,3-trichlorobenzene
Fluorene	2,4,5-trichlorotoluene
Phenanthrene	2,3,6-trichlorotoluene
Anthracene	alpha 2,6-trichlorotoluene
Fluoranthene	1,2,3,5-tetrachlorobenzene
Pyrene	1,2,4,5-tetrachlorobenzene
Benzo(a)anthracene	1,2,3,4-tetrachlorobenzene
Chrysene	Pentachlorobenzene
Benzo(k)fluoranthene	Hexachlorobenzene
Benzo(b)fluoranthene	Octachlorostyrene
Benzo(a)pyrene	
Indeno(1,2,3-cd)pyrene	Polychlorinated biphenyls(total)

Polychlorinated Dibenzo-p-Dioxins	Polychlorinated Dibenzofurans
Tetrachlorodibenzo-p-dioxins	Tetrachlorodibenzofurans
Pentachlorodibenzo-p-dioxins	Pentachlorodibenzofurans
Hexachlorodibenzo-p-dioxins	Hexachlorodibenzofurans
Heptachlorodibenzo-p-dioxins	Heptachlorodibenzofurans
Octachlorodibenzo-p-dioxin	Octachlorodibenzofuran

2.6 Garden Produce Organic Analyses

Samples from home gardens were submitted for analysis of the same organic compounds as were soil samples. These compounds were listed in Table 2. Technical problems prevented the determination of polycyclic aromatic hydrocarbon concentrations in these produce samples.

Garden produce was not analyzed for inorganic chemicals.

3 RESULTS

3.1 Major and Minor Elements in Soil

Table 3 lists the arithmetic mean and maximum and minimum concentrations of various elements in soil collected in urban and rural locations. This table also reports the frequency with which the concentration data were qualified as being below the 'T' and 'W' reporting criteria. This frequency is based on the 90 samples (12 urban and 18 rural locations times three replicates per location) comprising this survey. The 'T' and 'W' criteria were listed in Table 1 if they were encountered in the data base.

In calculating the mean concentrations, the concentrations qualified with 'T' were used as reported. For example, if the cadmium concentration in a sample was reported as 0.14 <T ug/g, it was considered to be 0.14 ug/g for the purpose of calculating the mean. However, a concentration qualified with 'W' was divided by two in calculating a mean for the location. For example, a mercury concentration of 0.01 <W ug/g was considered to be 0.005 ug/g.

3.2 Polycyclic Aromatic Hydrocarbons in Soil

Polycyclic aromatic hydrocarbons were determined in soil samples collected at 12 urban and five rural locations in 1990. Table 4 reports the PAH concentrations in these samples.

3.3 Chlorinated Aromatics and PCB in Soil

In 1989, soil samples from six urban and eight rural locations were analyzed for chlorinated aromatics and polychlorinated biphenyls. In 1990, soil samples from 12 urban and seven rural locations were subjected to the same analyses. The sampling locations are summarized below.

1989 Urban Locations:	A1, A2, A3, B1, B2, B3
1989 Rural Locations:	C2, C3, C4, D1, D3, D5, E6, E7
1990 Urban Locations:	A1, A2, A4, A5, A6, A7, A8, A9, A10, B1, B2, B3
1990 Rural Locations:	C3, C4, C5, D2, D3, D6, E7

None of the chlorinated aromatic compounds listed in Table 2 were detected above the 'W' detection criteria which was either 1 or 2 nanograms per gram. Total polychlorinated biphenyl concentrations were below the 'W' detection criteria of 20 nanograms per gram.

3.4 Dioxins and Furans in Soil

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in soil were determined by congener group. All data are listed in Table 5. A total of 13 urban and seven rural locations were sampled in 1989 and 1990. Five of the urban locations were sampled in both years, resulting in a total of 25 samples.

Table 3:	Major and Minor Elements in Soil - 1990 (micrograms per gram - dry weight)

	Urban Locations			Rural Locations			Frequency *	
	Mean	Max.	Min.	Mean	Max.	Min.	<T	<W
As	7.2	16.7	4.1	5.8	7.2	4.8		
Co	6.7	8.3	4.0	7.0	8.8	4.8		
Cd	0.79	1.70	0.41	0.49	1.06	0.06	6	7
Cr	25	33	20	23	29	19		
Cu	33	42	22	31	42	24		
Hg	0.08	0.20	0.02	0.04	0.07	0.01	52	11
Mn	244	413	160	223	317	167		
Mo	1.5	1.8	1.1	2.0	3.0	0.8	10	
Ni	21	24	14	23	27	19		
Pb	59	128	23	44	130	17		
Sb	0.53	0.87	0.24	0.52	0.71	0.32	99	1
Se	1.59	2.03	1.04	0.89	1.30	0.52	47	
Ti	0.35	0.44	0.26	0.37	0.44	0.31		
U	0.9	1.3	0.4	1.2	2.2	0.8		
V	35	43	28	39	48	34		
Zn	130	283	73	123	226	66		
Al	14100	17300	8900	15200	19300	11300		
Fe	18800	26700	13300	18200	22000	14300		
Be	0.7	0.8	0.3	0.8	1.0	0.6	96	4
Mg	5900	12300	3800	5800	9800	4000		
Ca	12000	32000	6200	12600	28300	5700		
Sr	42	63	25	61	261	26		
Ba	75	93	37	77	117	52		
Na	81	104	63	82	114	62		
K	2430	3370	1070	3480	4470	2670		
P	800	1000	610	1060	2050	660		
N	4000	4900	3300	4100	5200	3100		
B	7.1	12.7	2.9	9.5	14.3	4.9	6	
F	71	253	35	47	72	31		
S	510	630	420	490	630	360		

* Frequency (%) of concentrations reported with qualifiers <T and <W

Table 4:	Polycyclic Aromatic Hydrocarbons in Soil - 1990 (nanograms per gram - dry weight)

	Urban Locations												Rural Locations				
	A1	A2	A4	A5	A6	A7	A8	A9	A10	B1	B2	B3	C3	C4	C5	D3	D6
Dibenzo(a,h)anthracene	108 <T	40 <W	50 <T	105 <T	108 <T	40 <W	40 <W	20 <W	94 <T	20 <W	20 <W	58 <T	180	40 <W	44 <T	40 <W	47 <T
Benzo(g,h,i)perylene	506	262 <T	65 <T	441	475	270 <T	43 <T	438	390	68 <T	46 <T	97 <T	880	40 <W	41 <T	40 <W	46 <T
Naphthalene	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W
Acenaphthylene	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W
Acenaphthene	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W
Fluorene	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W
Phenanthrene	236	182 <T	20 <W	302	199 <T	22 <T	20 <W	57 <T	102 <T	20 <W	20 <W	47 <T	645	20 <W	20 <W	20 <W	20 <W
Anthracene	58 <T	20 <W	20 <W	28 <T	32 <T	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	20 <W	116 <T	20 <W	20 <W	20 <W	20 <W
Fluoranthene	754	439	20 <W	619	748	265	32 <T	156 <T	287	48 <T	24 <T	155 <T	2000	20 <W	20 <W	20 <W	20 <W
Pyrene	583	322	35 <T	475	598	202	23 <T	129 <T	231	39 <T	20 <W	118 <T	1490	20 <W	20 <W	20 <W	20 <W
Benzo(a)anthracene	369	199 <T	31	228	322	163 <T	20 <W	72 <T	199 <T	33 <T	20 <W	54 <T	800	20 <W	20 <W	20 <W	20 <W
Chrysene	253	1 <T	45 <T	287	369	148 <T	20 <W	103 <T	107 <T	20 <W	20 <W	67 <T	790	20 <W	20 <W	20 <W	20 <W
Benzo(k)fluoranthene	417	146 <T	24 <T	294	346	188 <T	20 <W	149 <T	181 <T	29 <T	20 <W	52 <T	950	20 <W	20 <W	20 <W	20 <W
Benzo(b)fluoranthene	577	310	47 <T	490	608	295	32 <T	296	380	52 <T	20 <W	101 <T	1210	21 <T	20 <W	20 <W	23 <T
Benzo(a)pyrene	453	75 <T	21 <T	205	291	177 <T	20 <W	54 <T	151 <T	25 <T	20 <W	42 <T	910	20 <W	20 <W	20 <W	20 <W
Indeno(1,2,3-cd)pyrene	789	382 <T	71 <T	707	758	403	44 <T	63	589	74 <T	42 <T	125 <T	1600	40 <W	40 <W	40 <W	40 <W

Table 5:	Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans in Soil - 1989 & 1990 (picograms per gram - dry weight)

Location	A1	A1	A2	A2	A3	A4	A5	A6	A7
Year	1989	1990	1989	1990	1989	1990	1990	1990	1990
T_4CDD	900	6.3	250	14	<9	<1.0	4.5	<6.1	<3.3
P_5CDD	680	<7.2	680	14	<20	<2.8	14	<15	<3.2
H_6CDD	<80	10	100	<4.1	<30	14	21	<13	<5.7
H_7CDD	<70	120	200	85	<20	43	42	40	19
O_8CDD	91	97	350	460	240	143	170	240	68
T_4CDF	<4	5.6	<10	120	<8	7.1	49	<9.2	24
P_5CDF	<20	21	38	47	<9	8.6	46	<20	14
H_6CDF	110	<3.3	34	42	<20	17	39	21	9.8
H_7CDF	<70	76	<60	<69	<20	22	40	<110	<6.2
O_8CDF	<20	<23	<30	<42	19	10	21	<100	<13

Location	A8	A9	A10	B1	B1	B2	B2	B3	B3
Year	1990	1990	1990	1989	1990	1989	1990	1989	1990
T_4CDD	<4.3	<3.0	2.1	<40	<13	<10	7.3	77	<7.1
P_5CDD	<5.7	<4.5	5.0	<20	<5.4	<20	<7.3	330	<12
H_6CDD	<8.9	<6.3	7.5	<30	<11	<30	12	<20	<12
H_7CDD	65	35	39	<30	88	<20	43	19	<36
O_8CDD	520	560	150	170	270	140	180	92	160
T_4CDF	60	<2.2	72	<7	33	<7	46	<7	6.2
P_5CDF	12	<5.8	65	<10	15	<10	11	<8	<7.4
H_6CDF	8.8	<4.2	36	<20	31	<20	15	<20	<12
H_7CDF	9.4	14	88	<40	23	<30	28	<20	<46
O_8CDF	<15	9.0	<23	32	<110	26	<110	<10	<100

Location	C2	C3	C4	D3	D5	D6	E6
Year	1989	1990	1990	1990	1989	1990	1989
T_4CDD	<10	3.5	<1.1	<1.7	<8	3.5	<8
P_5CDD	19	10	7.4	<3.2	<10	<1.4	<20
H_6CDD	<20	32	14	37	<80	18	<60
H_7CDD	89	80	52	130	<40	64	<40
O_8CDD	68	230	280	540	82	800	920
T_4CDF	<10	440	5.9	6.2	<8	33	<6
P_5CDF	<7	480	10	3.8	<30	3.9	<10
H_6CDF	<10	420	6.7	23	<40	7.8	<30
H_7CDF	<10	120	33	73	<50	25	<40
O_8CDF	7	40	26	28	<20	10	30

3.5 Chlorinated Aromatics and PCB in Garden Produce

In 1989 and 1990, produce samples as described in Section 2.3 were collected at five urban (A2 sampled both years) and two rural gardens and analyzed for chlorinated aromatics and polychlorinated biphenyls. The sampling locations are summarized below.

1989 Urban Locations:	A1, A2, A3
1989 Rural Locations:	C4, D3
1990 Urban Locations:	A2, A4, A8
1990 Rural Locations:	nil

None of the chlorinated aromatic compounds listed in Table 2 were detected above the 'W' detection criteria which was either 1 or 2 nanograms per gram, fresh weight. Total polychlorinated biphenyl concentrations were below the 'W' detection criterion of 20 nanograms per gram, fresh weight.

3.6 Dioxins and Furans in Garden Produce

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in garden produce samples were determined to the congener group. A total of 25 samples consisting of carrot roots, beet roots, beet leaves and chard leaves were sampled at five different urban and two different rural gardens in 1989 and 1990. All data are listed in Table 6.

Table 6:	Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans in Garden Produce - 1989 & 1990 (picograms per gram - fresh weight)

	Carrot Root							Beet Root						
Location	A1	A2	A2	A3	A4	C4	D3	A1	A2	A3	A4	A8	C4	D3
Year	1989	1989	1990	1989	1990	1989	1989	1989	1990	1989	1990	1990	1989	1989
T_4CDD	<6	<1	<1	<2	<1	<2	<2	<2	<2	<4	<1	<2	<2	<3
P_5CDD	<1	<1	<1	<2	<1	<1	<3	<2	<1	<3	<1	<1	<2	<3
H_6CDD	<2	<1	<1	<2	<1	<2	<3	<2	<1	<2	<1	<1	<2	<3
H_7CDD	<2	<3	<2	<4	<1	<1	<5	<5	<1	<2	<1	9.2	<1	<2
O_8CDD	<30	<20	<5	<20	<2	<4	25	<9	<2	23	<2	180	<4	17
T_4CDF	<2	<3	<1	<5	<1	<2	<2	<4	<2	<4	<1	<2	<1	<3
P_5CDF	<3	<2	<1	<4	<1	<2	<4	<4	<1	<3	<1	<1	<1	<2
H_6CDF	<1	<1	<1	<2	<1	<2	<2	<2	<1	<2	<1	<1	<2	<2
H_7CDF	<3	<6	<1	<6	<1	<2	<4	<5	<2	<2	<1	<1	<2	<4
O_8CDF	<10	<10	<2	<10	<1	<2	<6	<3	<3	<5	<1	<2	<2	<6

	Beet Leaves							Chard			
Location	A1	A2	A3	A4	A8	C4	D3	A2	A2	A4	C4
Year	1989	1990	1989	1990	1990	1989	1989	1989	1990	1990	1989
T_4CDD	<2.0	<1	<1	<2	<2	<1	<2	<3	<1	<2	<0.4
P_5CDD	<1.2	<1	<2	<1	<1	<0.8	<2	<2	<1	<1	<0.4
H_6CDD	<1.4	<1	<2	<1	<1	<0.8	<2	<1	<1	<1	<1
H_7CDD	<1.2	<2	<4	<1	<1	<1	<4	<2	<1	<1	<1
O_8CDD	<3.8	<1	<10	<3	8.2	<2	<8	<6	<2	<3	3.8
T_4CDF	<2.6	<1	<2	<1	<1	<1	<3	<1	<1	<1	<0.4
P_5CDF	<1.8	<1	<2	<1	<1	<1	<3	<3	<1	<1	<0.6
H_6CDF	<1.2	<2	<3	<1	<1	<0.8	<2	<2	<1	<1	<1
H_7CDF	<1.2	<1	<2	<1	<1	<1	<3	<2	<1	<1	<0.9
O_8CDF	<1.1	<2	<4	<1	<1	<1	<4	<4	<1	<1	<1

4 DISCUSSION

4.1 Inorganic Chemicals in Soil

Table 3 reported the mean, maximum and minimum concentrations of a variety of elements in soil from urban and rural locations. A review of this table reveals similarity in mean, maximum and minimum soil concentration between the two types of locations. Because of the relatively small number of locations, 12 urban and 18 rural, an unusually elevated concentration at a single location could translate into noticeably higher mean and maximum. This occurred with fluoride at one urban location.

A graphical representation of the individual data confirmed a lack of spatial trends in the soil concentrations for most elements. Two possible exceptions were cadmium and mercury, which tended to be at higher concentrations at urban locations.

4.2 Polycyclic Aromatic Hydrocarbons in Soil

Table 4 reflects the ubiquitous presence of PAHs in urban soil. The 'A' series urban locations all contained reportable concentrations of PAH compounds. At the 'B' series suburban locations, the concentrations were all qualified with 'T' or 'W'.

Three of the four rural locations had PAH concentrations that were predominantly below the 'W' detection criteria. One location, C3, had PAH concentrations that exceeded any of the urban locations. Clearly, some isolated activity at this location is responsible for the elevated PAH concentrations.

4.3 Chlorinated Aromatics and PCBs in Soil

As was reported above, chlorinated aromatics and PCBs were all below the 'W' detection criteria. This suggests that unless there is a local source or spill of such compounds, soil concentrations will be below the detection criteria.

4.4 Dioxins and Furans in Soil

Dioxins and furans were detected in soil from both urban and suburban locations, at concentations expressed in picograms per gram. Table 5, which lists these data, also reveals evidence of considerable differences in concentrations in samples collected one year apart. Locations A1 and A2 were sampled in 1989 and 1990. The concentration of the T_4CDD and P_5CDD congener groups vary considerably in these two samples.

4.5 Chlorinated Aromatics and PCB in Garden Produce

Chlorinated aromatics and PCB were not detected in garden produce samples.

4.6 Dioxins and Furans in Garden Produce

With a limited number of exceptions, dioxin and furan congener groups were not detected in garden produce samples at picogram per gram concentrations.

5 CONCLUSIONS

With the possible exception of mercury and cadmium, the major and minor elements in soil from urban locations were very similar to those at rural locations. The concentrations of **all** elements in samples collected at urban locations were at or below the urban Upper Limit of Normal (ULN) guideline concentrations. The element concentrations in soil from **all** rural samples had concentrations at or below the rural ULN guidelines. The Appendix B contains a discussion of ULN guidelines.

Urban soil in Windsor contains detectable concentrations of polycyclic aromatic hydrocarbons, while most rural Essex County locations had concentrations below the detection limits.

Chlorinated aromatics and PCBs were not detected in any soil or garden produce samples.

Dioxins and furans are ubiquitous in soil from urban and rural locations. There is also evidence for considerable variability at any given location. The concentrations encountered in garden produce were generally below detection limits.

APPENDIX A

Sampling Locations for Soil and Garden Produce Samples

Site	Description	Municipality	Location
A1	Atkinson Park	Windsor	Riverside Dr. W. / Bridge Ave.
A2	Glengardon Urseline Academy	Windsor	Riverside Dr. E. / Pillette Rd.
A3	Peche Island	Windsor	Detroit River
A4	Sacred Heart Cemetary	LaSalle	Sacred Heart Dr. / Devine St.
A5	Mic Mak Park	Windsor	Prince Rd. / Carmichael Rd.
A6	Wilkestead Park	Windsor	Niagara St. / Chilver Rd.
A7	Long Park	Windsor	Tecumseh Rd. E. / Meldrum Rd.
A8	Homedale Park	Windsor	Edgar St. / St. Mary's Blvd.
A9	East End Park	Windsor	Clairview Ave.
A10	private urban residence	Windsor	Wright St.
B1	Central Park	Windsor	Woodland Ave. / Richardie Blvd.
B2	Devonwood Conservation Area	Windsor	Division Rd. / Cabana Rd. E.
B3	Tecumseh Memorial Park	Tecumseh	Lacasse Blvd. / St. Thomas St.
C1	private rural residence	Sandwich West Twp.	Essex Road 7 / Essex Road 9
C2	private rural residence	Sandwich South Twp.	Essex Road 11 / Prov. Hwy. 3
C3	private rural residence	Sandwich South Twp.	Essex Road 46 / Essex Road 17
C4	private rural residence	Maidstone Twp.	Essex Road 19 / Prov. Hwy. 401
C5	private rural residence	Maidstone Twp.	Essex Road 42 / Essex Road 19
C6	private rural residence	Maidstone Twp.	Essex Road 21 / Prov. Hwy. 2
D1	private rural residence	Colchester North Twp.	Essex Road 11 / Essex Road 12
D2	private rural residence	Colchester North Twp.	Essex Road 12 / Essex Road 15
D3	private rural residence	Colchester North Twp.	Essex Road 12 / Essex Road 23
D5	private rural residence	Maidstone Twp.	Essex Road 46 / Essex Road 25
D6	private rural residence	Maidstone Twp.	Essex Road 42 / Essex Road 27
E1	private rural residence	Colchester South Twp.	Essex Road 13 / Prov. Hwy. 18
E2	private rural residence	Colchester South Twp.	Essex Road 18 / Prov. Hwy. 18
E3	private rural residence	Gosfield South Twp.	Essex Road 18 / Essex Road 29
E4	private rural residence	Gosfield North Twp.	Essex Road 27 / Essex Road 14
E5	private rural residence	Rochester Twp.	Essex Road 8 / Essex Road 31
E6	private rural residence	Rochester Twp.	Essex Road 31 / Prov. Hwy. 401
E7	private rural residence	Tilbury North Twp.	Essex Road 2 / Essex Road 35

Note 1: Soil sample not collected at Site A3 in 1990
Note 2: Garden produce sites designated 'A' and 'B' were collected from urban residential properties near the respective parks or park-like properties.
Note 3: Garden produce sites designated 'C', 'D' and 'E' were collected from the rural residential properties described above.

APPENDIX B

Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: Ontario Ministry of the Environment, 1989, *Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples*, Phytotoxicology Section, Air Resources Branch; Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto, ISBN 0-7729-5143-8). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.