PHYTOTOXICOLOGY BACKGROUND SAMPLING IN THE CITY OF WINDSOR: 1972 - 1986

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Environment Ontario

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Minister

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RECYCLABLE

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In an effort to ascertain background concentrations of inorganics in soils and vegetation throughout the Windsor urban complex and to examine the data for any directional and spatial trends, a full examination of all Phytotoxicology investigations conducted during the period from 1972 - 1986 has been undertaken. These data will serve as a background for site selection and trend analysis in future assessment studies in Ontario that are planned to commence in 1989, following the start-up of the Detroit Incinerator.

This compilation was accomplished by reviewing all historical Phytotoxicology Section investigation files for external requests (complaints from property owners) and assessment surveys (collections around stationary sources and city-wide sampling surveys) in the Windsor area. In total, 32 separate investigation files were utilized consisting of sampling in all except two (1974, 1982) of the 15-year time interval.

The data totals are as follows:

Sample Medium	No. Different Elements Analyzed	Total Analyses Utilized
Soil	18	2375
Vegetation	18	3197
TOTAL	18	5572

Because of the confidential nature of external request investigations (public complaints), all files were given an identification number and all sampling data pertaining to the various private and/or municipal property sampling sites were assigned a N-S and E-W grid co-ordinate (see attached Fig. 1).

The separated data sets for soil and vegetation are presented in Appendices 1 and 2, respectively. Data for the two sampling media also were examined for the number of individual exceedances of the respective Upper Limits of Normal (ULN) guidelines as established by the Phytotoxicology Section. The totals are shown on the last page of each of the two appendices.

The complete listing of the ULN guidelines for soil and vegetation as well as their rationale are presented separately as Appendix 3.

In an effort to identify directional trends in the analytical results, the data in Appendices 1 and 2 were positioned into N-S and E-W gradients to permit an assessment of overall directional trends. The results of this partitioning are shown in the following summary tables:

Table 1	Soil	N-S Trends
Table 2	Soil	E-W Trends
Table 3	Vegetation	N-S Trends
Table 4	Vegetation	E-W Trends

As a final step, the data in Appendices 1 and 2 were further partitioned into individual elemental grid means (Appendices 5 and 6) to enable a full spatial analysis of the data set.

Discussion

A. No. of Samples Exceeding the Respective ULN

The number of exceedances of the ULN for both soils and vegetation are summarized in attached Table 5.

It is apparent from this comparison that in the case of both soil and vegetation, almost one-half of the elements which have been analyzed have yielded one or more analytical results in excess of the respective Upper Limits of Normal guidelines for an urban area.

In the case of those elements displaying exceedances, the percentage of the total data for each element which was comprised of values in excess of the respective ULN ranged from 0.7% - 19.8% for soil and from 0.6% - 33.9% for vegetation (Table 5).

Although most of the exceedances were related to contamination by known sources, the soil Mo values remain an anomaly. This will be examined in greater detail in future surveys.

B. Directional Trend Analysis

An examination of Tables 1 - 4 for evidence of a clearly defined N-S or E-W gradient in the soils and vegetation data has revealed that this type of pattern does not exist. There were a limited number of cases where a significant difference was detected in one or more of the N-S or E-W averages based on standard deviation values; however, these differences are, in all likelihood, due to differences in species analyzed or proximity to local contamination sources.

In a further attempt to display the data in a spatial context a more rigorous evaluation of the data on a grid by grid basis was performed. In order to eliminate some of the variability in the vegetation data the analyses results included in this evaluation were limited to maple species. A complete summary of the soil and maple grid means (with standard deviation and number of samples) is shown in Appendices 5 and 6, respectively. To assist in visually assessing the grid means, the data for all elements in which a mean for at least 10 grids was available have been shown in the following grid maps:

Soil grid means: Figures 2-13
Maple grid means: Figures 14-27

This type of city-wide data analysis to identify spatial trends also was performed in one of the specific assessment surveys which was included in the 1972-1986 data set.

The findings of that assessment survey (Appendix 4) revealed that three general sources of contamination had influenced concentrations of fluoride, chloride, sulphur and certain heavy metals (iron, lead, cadmium and zinc) in soils and/or vegetation foliage in the west Windsor area.

1. The industrialized areas of south Detroit, particularly surrounding Zug Island, Michigan.

2. The industrialized areas of west and central Windsor.

3. Vehicular activity in the general area.

Contours of contamination for the various elements also were presented and are shown in Appendix 4.

In order to compare the findings of the more encompassing data set for 1972-1986 with the trends identified earlier in the more limited assessment survey of 1975-79 (Appendix 4) a summary table was prepared and is attached (Table 6).

An evaluation of this trend analysis summary for the 1972-1986 grid means can be further summarized as follows:

1. Although not necessarily all statistically significant, evidence of spatial trends similar to those reported in Appendix 4 were apparent for 10 soil and 8 maple elemental grid means.

2. A more limited N-S or E-W trend also was apparent for 1 additional soil and 2 additional maple elemental grid means.

3. In comparing the elemental grid means with corresponding single sample Upper Limits of Normal guidelines for elements with at least 10 available grid means it was found that 2 (As, Mo) of the soil and 3 (Cu, F, Pb) of the maple elemental grid means were in excess of the corresponding U.L.N. guidelines.

C. <u>Comparison of MOE Data with other Published Results</u>

While no directly comparable findings for the Phytotoxicology data base have been located, there is one report which presents the analysis of soils and vegetation in the Windsor area for lead and cadmium (1). In that report, the authors found significantly higher levels of both lead and cadmium in soil and vegetation collected in the Windsor area than in corresponding Essex County (rural) samples. With the exception of root lead concentrations, the elevated urban levels were significantly correlated with traffic volume. Unfortunately, the soils data are not directly comparable with those reported by the Phytotoxicology Section due to differences in analytical technique. A direct comparison of the vegetation data also is not possible as only root tissue results were reported for the Windsor sites.

Summary

A complete Phytotoxicology Section data listing for all samples collected during soils and vegetation complaint and assessment survey investigations in the City of Windsor during the 15-year period 1972 - 1986 is presented. The data have been compared with current 'Upper Limits of Normal' guidelines established by the Phytotoxicology Section and also have been keyed into a grid system for examination of N-S and E-W trends as well as individual grid mean spatial trends.

The results of these comparisons confirm that soils and vegetation in the Windsor area are for the most part, fairly representative of a large urban complex. However, a noticeably large number of individual samples and area grid means were found to have exceeded the established Upper Limits of Normal for an urban area. From a spatial aspect, the large degree of variability in the data base caused by the collection of samples over a 15-year period and without any commonality in species selection precluded any definitive conclusions being made as to N-S or E-W directional trends. However, when the data were further reduced to individual grid means for maple and soil only, spatial trends similar to those reported in the 1975-79 West Windsor assessment survey were apparent for the majority of the elemental grid means. These findings confirm the influence of three general contamination sources on soils and vegetation in the Windsor area:

1. The industrialized areas of South and Central Detroit, particularly those in the vicinity of Zug Island, Michigan.

2. The industrialized areas of West and Central Windsor.

3. Vehicular activity in the general urban complex.

Reference Cited

1. Great Lakes Institute, University of Windsor. 1986. A Case Study of Selected Toxic Contaminants in the Essex Region. Vol. I, Physical Sciences, Part Two. Task Group VIIIb - Terrestrial Biology, pp.41.

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TABLE 1

Windsor Soils North South Trends

Map Coordinate		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
B	Mean	12		1.7		24	45		17651	4600	361	3.6		30	194	1400	1.2	28	211
	Standard Dev.	8		0.9		13	21		9526		144	1.8		8	109	1685	0.4	13	94
	No. Samples	17		61		30	30		57	1	9	27		27	61	48	17	28	61
C	Mean	8		1.7	200	24	32	250	18017		212	2.4		26	114	800	0.9	29	117
	Standard Dev.	2		1.1		7	7		6655		48	1.4		6	55	196	0.3	8	74
	No. Samples	18		59	1	30	30	1	59		12	30		30	59	48	18	30	59
D	Mean	6		1.8		22	24		14221			3.8	182	27	150	754	0.7	26	175
	Standard Dev.	1		0.7		6	8		5973			2	35	10	171	213	0.1	11	174
	No. Samples	27		97		49	36		97			21	15	36	97	66	21	49	97
E	Mean	5	850	1.5	223	19	18	57	10316			2.9	381	20	80	586	0.6	15	122
	Standard Dev.	1	267	0.6	42	7	12	16	4805			2	230	6	71	254	0.3	12	64
	No. Samples	27	13	75	13	27	27	13	75			27	13	27	74	88	25	27	75
F	Mean	5		2.1	200	22	36	337	11183			2.5		25	68	843	0.7	33	87
	Standard Dev.	0.5		0.3		6	9		1061			0		1	19	159	0.1	1.5	6
	No. Samples	6		6	1	6	6	1	6			6		6	6	7	6	6	6
G	Mean				275								1180						
	Standard Dev.				130								79						
	No. Samples				4								4						

TABLE 2

Windsor Soils East West Trends

Map Coordinate		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1	Mean				200			337								1200			
	Standard Dev.																		
	No. Samples																		
2	Mean	6	850	2.4	223	14	30	57	12667			2.5	381	19	105	445	0.6	13	196
	Standard Dev.	0.4	267	0.5	42	0.9	0	16	5599			0	230	1	13	376	0.1	3	36
	No. Samples	3	13	9	13	3	3	13	9			3	13	3	9	22	3	3	9
3	Mean	7		2.4		23	25		16485			2.5		23	96	881	0.9	21	207
	Standard Dev.	3		1.1		9	19		10994			0		8	59	261	0.4	11	99
	No. Samples	9		27		9	9		27			9		9	27	27	9	9	27
4	Mean	6		2.4	200	23	22	250	16079			4		28	95	1482	0.8	14	140
	Standard Dev.	2		0.9		4	22		11588			2.4		9	79	1869	0.3	9	81
	No. Samples	13		38	1	15	15	1	38			15		15	38	39	15	15	38
5	Mean	5		1.2		16	18		10569	4600		2.7		18	96	651	0.5	17	135
	Standard Dev.	1		0.5		5	7		4901			0.6		7	83	165	0.1	16	67
	No. Samples	15		52		18	18		48	1		15		15	51	45	15	16	52
6	Mean	8		1.4		19	29		13457			4.2		27	133	700	0.8	19	155
	Standard Dev.	7		0.6		7	12		3170			2.8		7	96	151	0.3	11	66
	No. Samples	14		42		15	15		42			15		15	42	42	14	15	42
7	Mean	7		1.5	275	25	35		13500			3.2	1180	27	148	744	1	27	165
	Standard Dev.	1		0.6	130	6	7		5048			1.1	79	4	109	169	0.3	4	83
	No. Samples	15		48	4	15	15		48			15	4	15	48	48	15	15	48
8	Mean	7		1.6		22	25		15124			3.7	182	31	97	687	0.9	33	139
	Standard Dev.	1		0.4		5	2		3375			1.8	35	10	57	96	0.1	9	78
	No. Samples	15		34		28	24		34			9	15	24	34	15	7	28	34
9	Mean	12		1.7		26	44		18427		275	2.3		25	238	867	1.1	33	232
	Standard Dev.	9		0.8		11	17		6476		125	1.1		6	210	133	0.4	6	231
	No. Samples	9		48		39	30		48		21	30		30	48	18	9	39	48

TABLE 3

Windsor Vegetation North South Trends

Map Coordinate		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
B	Mean	0.4		0.5	2020	3.1	11	27	522	3466	29	0.9	297	3	13	2216	0.4	2	43
	Standard Dev.	0.2		0.4	1198	1.8	6	15	305	205	11	0.3	4	2	9	486	0.1	2	15
	No. Samples	18		91	39	50	50	39	71	3	20	38	3	38	91	51	18	49	91
C	Mean	0.3		0.4	1680	3	10	43	511		24	0.8	110	2.4	16	2442	0.3	1.1	49
	Standard Dev.	0.1		0.4	991	1.6	6	38	216		6	0.4	47	1.5	9	696	0.1	1.1	16
	No. Samples	18		68	50	36	36	50	81		19	36	15	36	68	50	18	38	68
D	Mean	0.3		0.6	2837	3.3	8	23	378			1	441	3.3	29	2196	0.3	1.8	46
	Standard Dev.	0.1		0.3	5435	0.9	2	14	165			0	1010	0.9	54	421	0.1	1.3	19
	No. Samples	24		91	60	33	33	54	84			21	21	33	91	79	21	34	91
E	Mean	0.3	9643	0.5	4440	3.8	8	20	475		25	1	1462	2.9	19	2197	0.2	1.1	54
	Standard Dev.	0.1	2701	0.3	6350	0.8	1.7	13	262		4	0.2	952	1	11	806	0.1	0.4	32
	No. Samples	28	14	84	71	36	30	71	87		6	36	16	36	87	95	28	36	84
F	Mean	0.3		0.4	929	3.2	8	13	282			1		3.7	12	2300	0.2	1	31
	Standard Dev.	0.1		0.2	550	0.7	2	6	21			0		1.5	3	469	0.03	0	5
	No. Samples	6		6	7	6	6	29	6			6		6	6	7	6	6	6
G	Mean				1360			14					635		16	1933			
	Standard Dev.				960			0.5					15		3	189			
	No. Samples				5			3					2		3	3			
H	Mean		14100		1800			30					450			4950			
	Standard Dev.		100		300			3					50			1050			
	No. Samples		2		2			2					2			2			

TABLE 4

Windsor Vegetation East West Trends

Map Coordinate		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1	Mean		14100		1867			29					450			4367			
	Standard Dev.		100		262			2					50			1190			
	No. Samples		2		3			3					2			3			
2	Mean	0.4	9643	0.7	10987	3.5	7	21	588			1	1796	3.7	24	2608	0.1	1.7	78
	Standard Dev.	0.1	2701	0.3	7771	0.5	1.5	20	223			0	784	0.7	10	1290	0.04	0.7	59
	No. Samples	6	14	12	23	6	6	23	12			6	13	6	12	26	6	6	12
3	Mean	0.4		0.7	1308	3.3	9	63	569			1	142	4.2	17	2032	0.3	2.5	54
	Standard Dev.	0.1		0.5	601	0.9	2	45	239			0	11	0.6	4	633	0.1	1.7	26
	No. Samples	9		30	25	9	9	25	33			9	6	9	30	28	9	12	30
4	Mean	0.4		0.9	1584	3.4	8	31	594			1	133	3.6	16	2544	0.3	2.1	41
	Standard Dev.	0.1		0.4	1014	1	2	14	296			0	28	0.8	7	498	0.1	1.7	15
	No. Samples	15		42	43	14	14	43	50			14	12	14	42	43	15	18	42
5	Mean	0.4		0.5	1477	3.6	11	28	488	3466		1	162	3.7	19	2398	0.3	2.1	48
	Standard Dev.	0.2		0.2	1107	1.7	8	14	247	205		0	134	1.1	12	568	0.1	1.6	20
	No. Samples	15		65	39	27	27	39	54	3		15	6	15	65	43	15	20	65
6	Mean	0.3		0.5	1247	4	10	15	320			1		3.6	19	2204	0.2	1.9	50
	Standard Dev.	0.1		0.2	604	1.3	3	4	117			0		0.9	10	363	0.05	2	19
	No. Samples	13		47	30	15	15	30	45			15		15	49	47	13	17	47
7	Mean	0.3		0.3	1611	4	7	15	472		25	0.9	635	3.1	33	1929	0.3	1	41
	Standard Dev.	0.1		0.2	995	1	2	5	289		4	0.3	15	2	69	306	0.05	0.1	18
	No. Samples	15		51	35	21	15	33	51		6	21	2	21	54	48	15	21	51
8	Mean	0.3		0.7	2067	3.4	6	16	325			1	68	3.4	13	1981	0.4	1.4	41
	Standard Dev.	0.1		0.4	617	1.3	1	3	86			0	20	0.6	4	364	0.2	0.5	15
	No. Samples	12		27	12	21	21	12	27			9	12	21	28	26	9	21	27
9	Mean	0.3		0.3	5412	2.3	11	15	423		26	0.7	1326	1.6	15	2117	0.3	0.6	49
	Standard Dev.	0.1		0.3	7899	1.2	5	6	175		10	0.3	1572	1	13	457	0.1	0.2	14
	No. Samples	9		66	24	48	48	40	57		39	48	6	48	66	18	9	48	66

Table 5:

Summary of ULN Exceedences for Soil and Vegetation Collected in Windsor: 1972-1986

Medium	No. of Elements Analyzed	Elements Exceeding ULN Guideline	No. Exceedances	% of Analyses Exceeding ULN
Soil	18	As	4	4.2
		Cd	4	1.3
		Cr	1	0.7
		Fe	7	2.4
		Mn	1	4.8
		Mo	22	19.8
		Pb	7	2.4
Vegetation	18	Cr	1	0.6
		Cu	6	3.9
		F	47	19.0
		Fe	10	3.0
		Mo	3	2.2
		Na	20	33.9
		Pb	3	0.9
		S	4	1.4
		V	2	1.2

Table 6:
Summary of Spacial Trend Analysis for 1972-86 Grid
Mean Data Set*

Medium	Elements with Grid Means in Excess of Upper Limits of Normal Guidelines**			Elements in 1972-86 Grid Mean Data Set Which Display Spatial Trends Similar to Those Reported in the 1975-79 Report (Appendix 4)	Elements in 1972-86 Grid Mean Data Set Which Display a Limited N-S or E-W Spacial Pattern
	Element	No Exceedances	% of Total Grids with Data		
Soil	As Mo	2 9	7.1 32.1	Cd, Cr, Cu, Fe Ni, Pb, S, Se, V, Zn	Mo
Maple	Cu F Pb	4 4 1	14.3 13.8 3.3	As, Cd, F, Fe, Ni, Pb, V, Zn	Cr, Cu

*includes only those elements where 10 or more grid means were available from the total 1972-86 data set

** See Appendix 3.

Fig. 1 Map of Windsor Showing Grid Co-ordinates

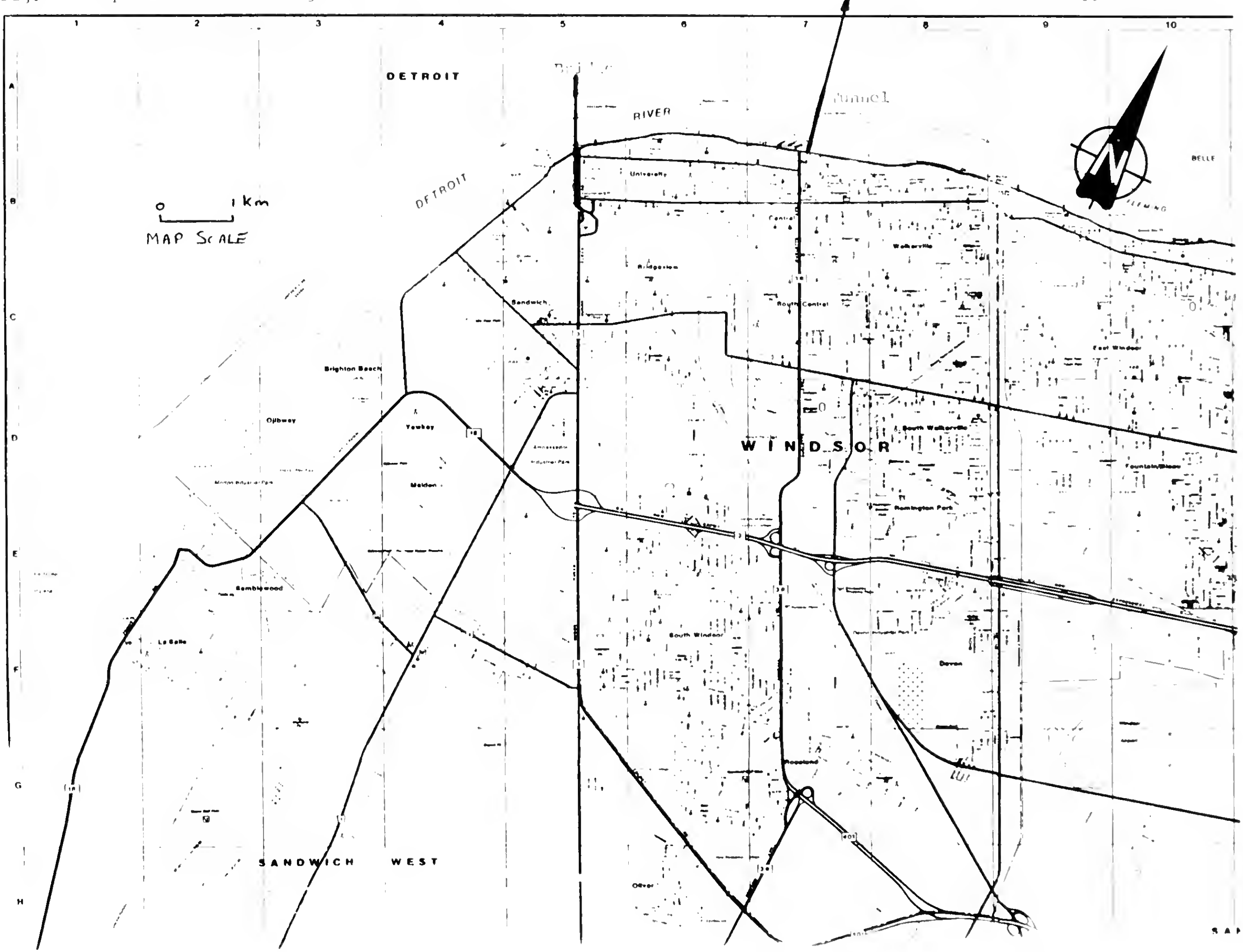


Fig. 2 Arsenic Grid Means for Windsor Soils: 1972-1986

◯ - Circled Means in Excess of ULN

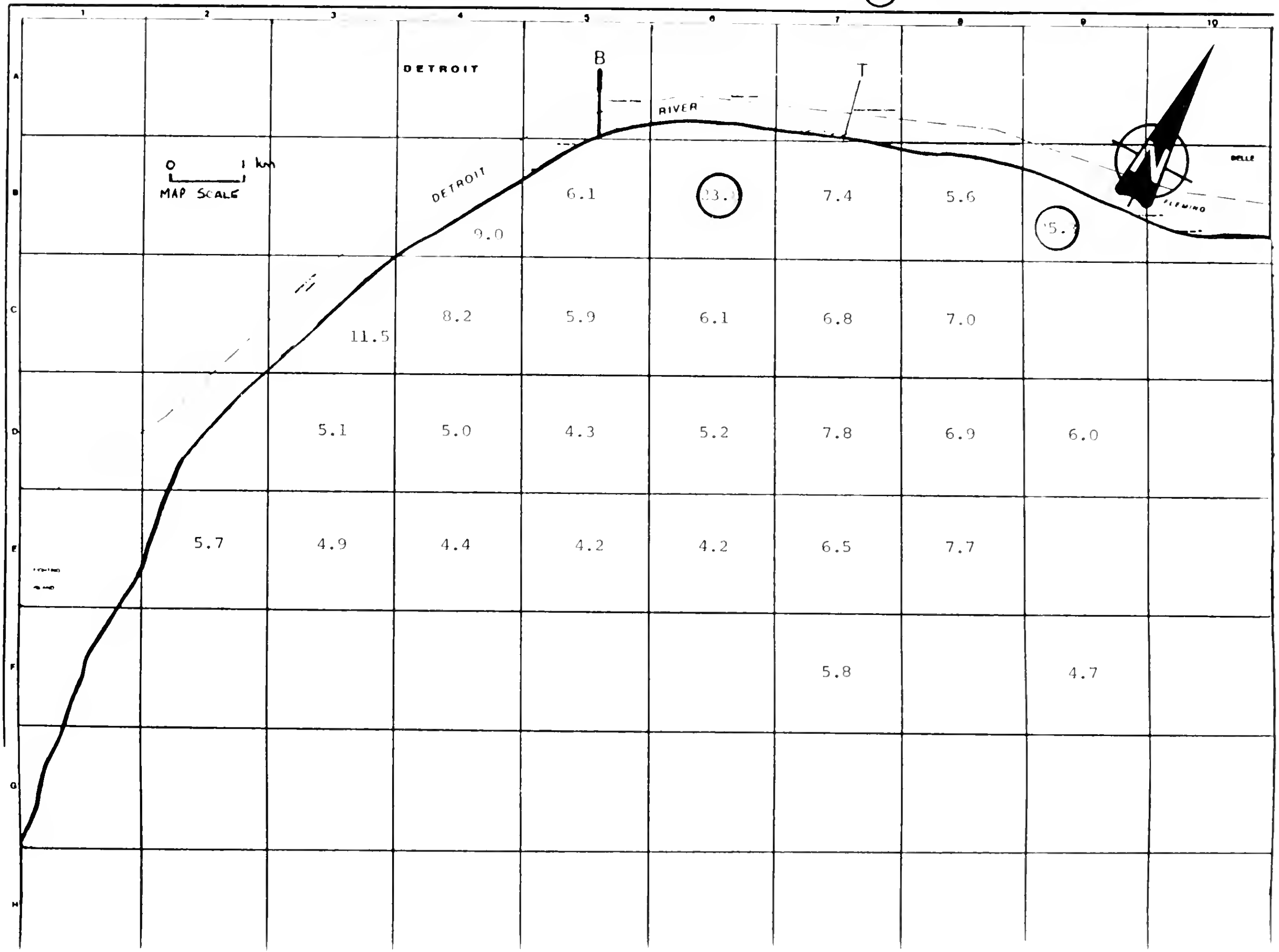


Fig. 3 Cadmium Grid Means for Windsor Soils: 1972-1986

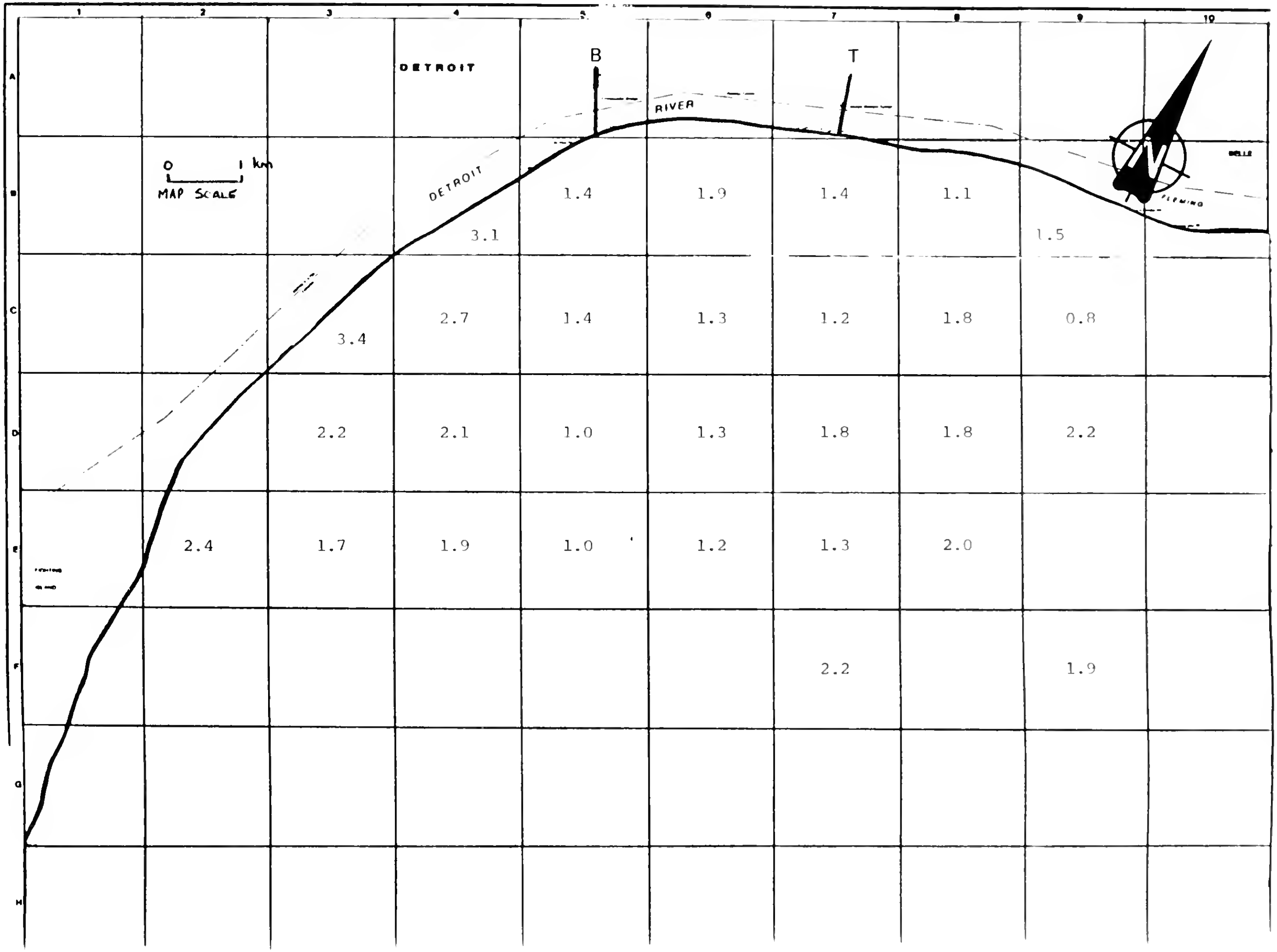


Fig. 4 Chromium Grid Means for Windsor Soils: 1972-1986

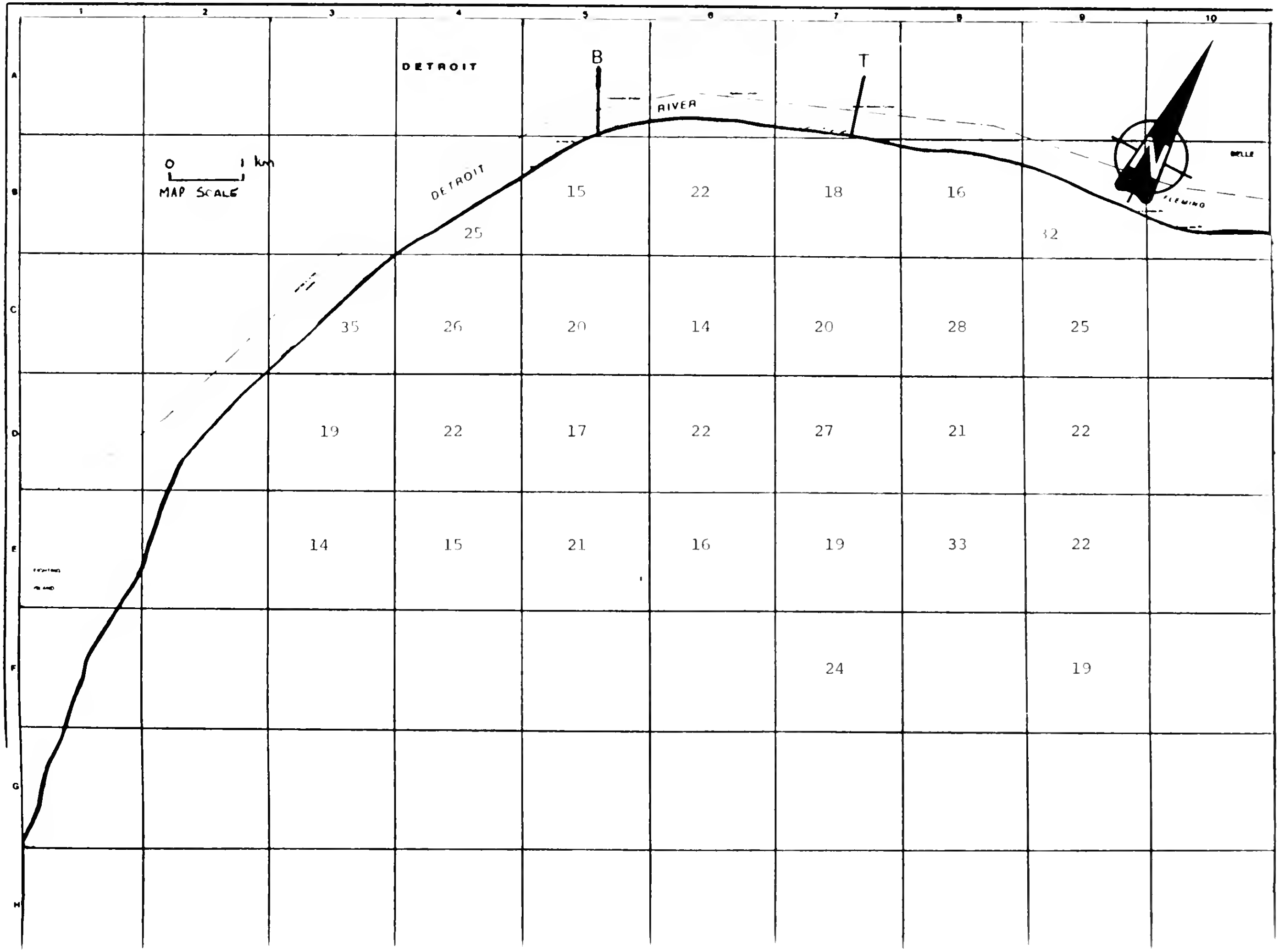


Fig. 5 Copper Grid Means for Windsor Soils: 1972-1986

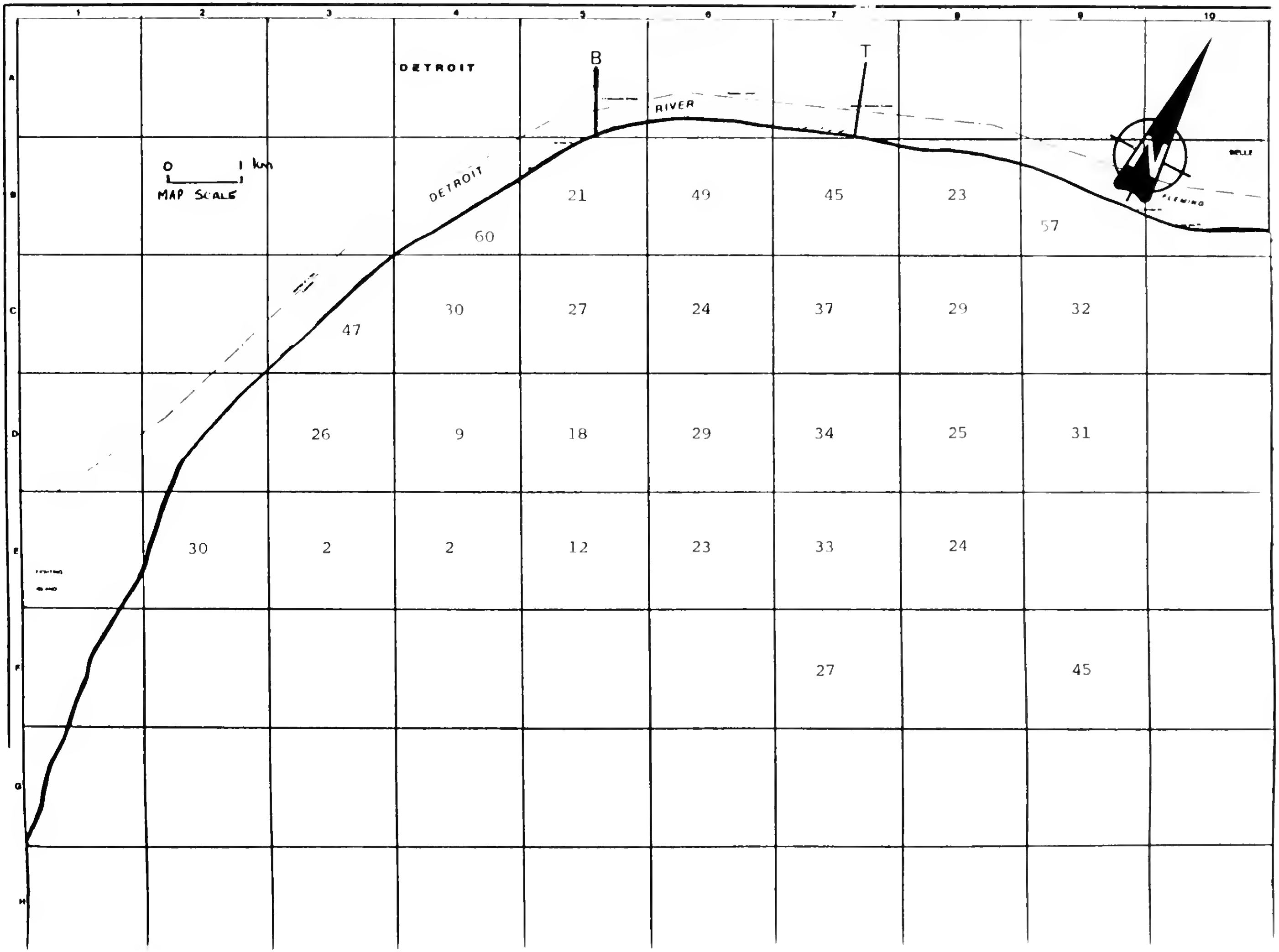


Fig. 6 Iron Grid Means for Windsor Soils: 1972-1986

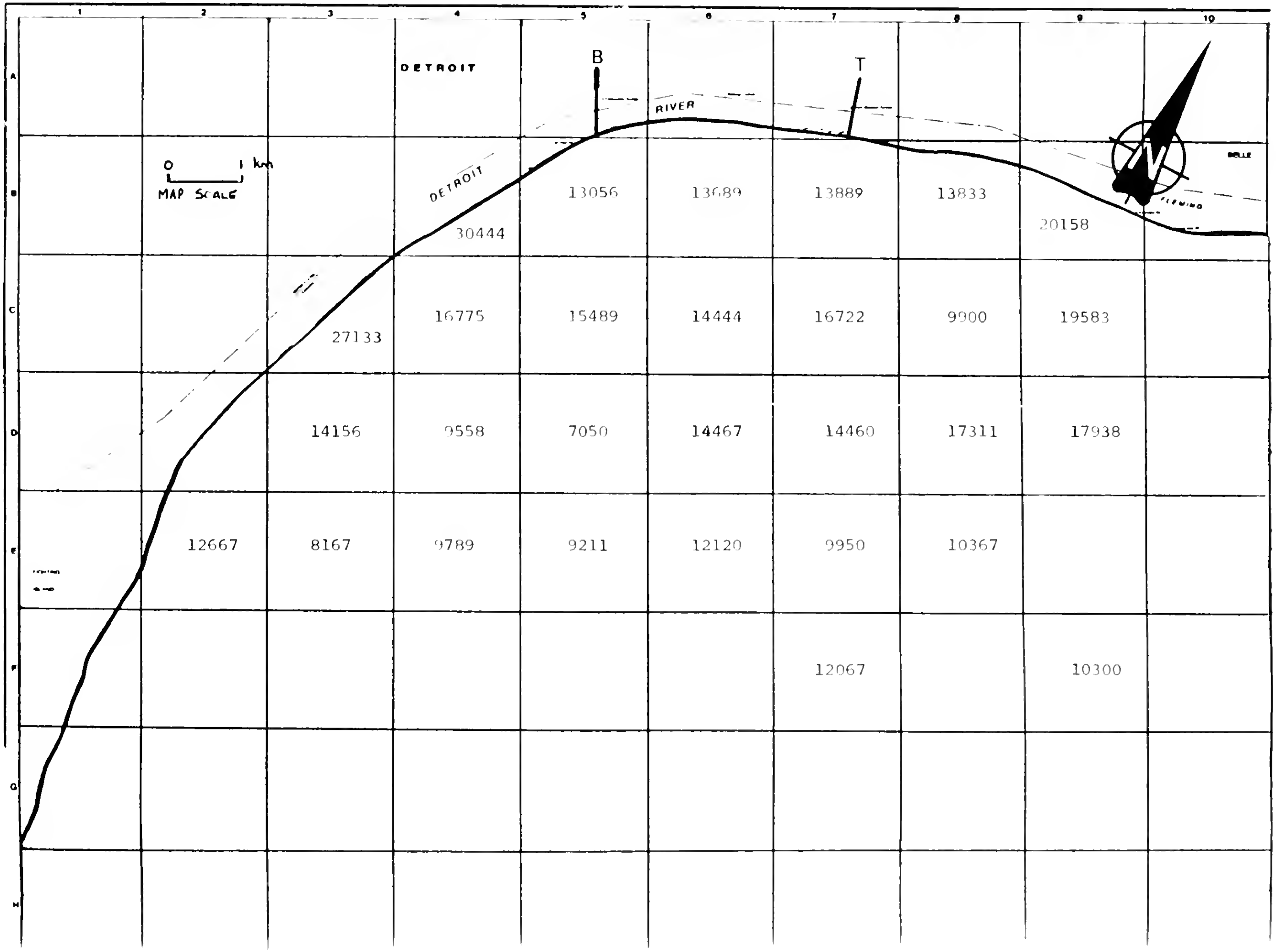


Fig. 7 Molybdenum Grid Means for Windsor Soils: 1972-1986

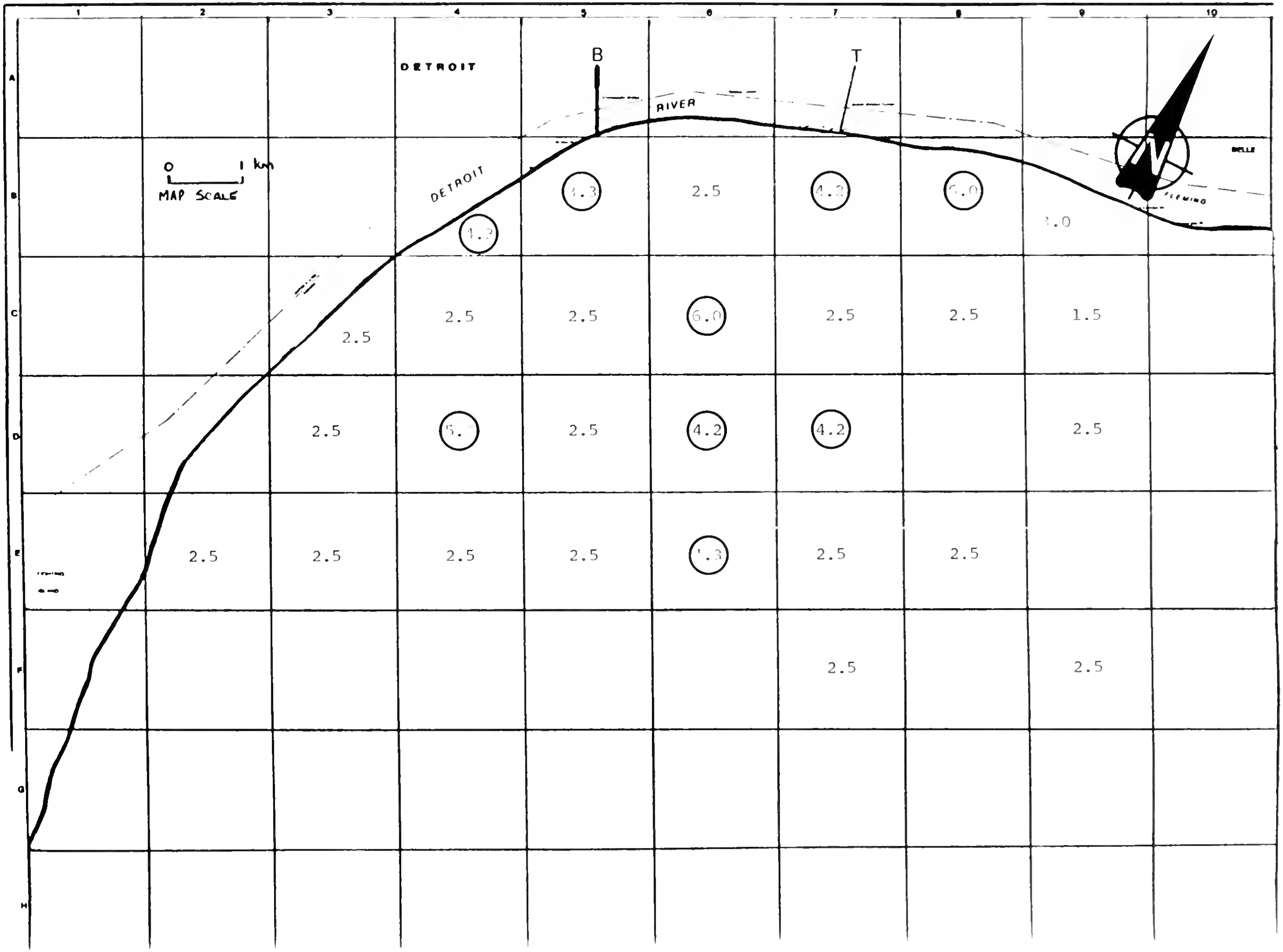


Fig. 8 Nickel Grid Means for Windsor Soils: 1972-1986

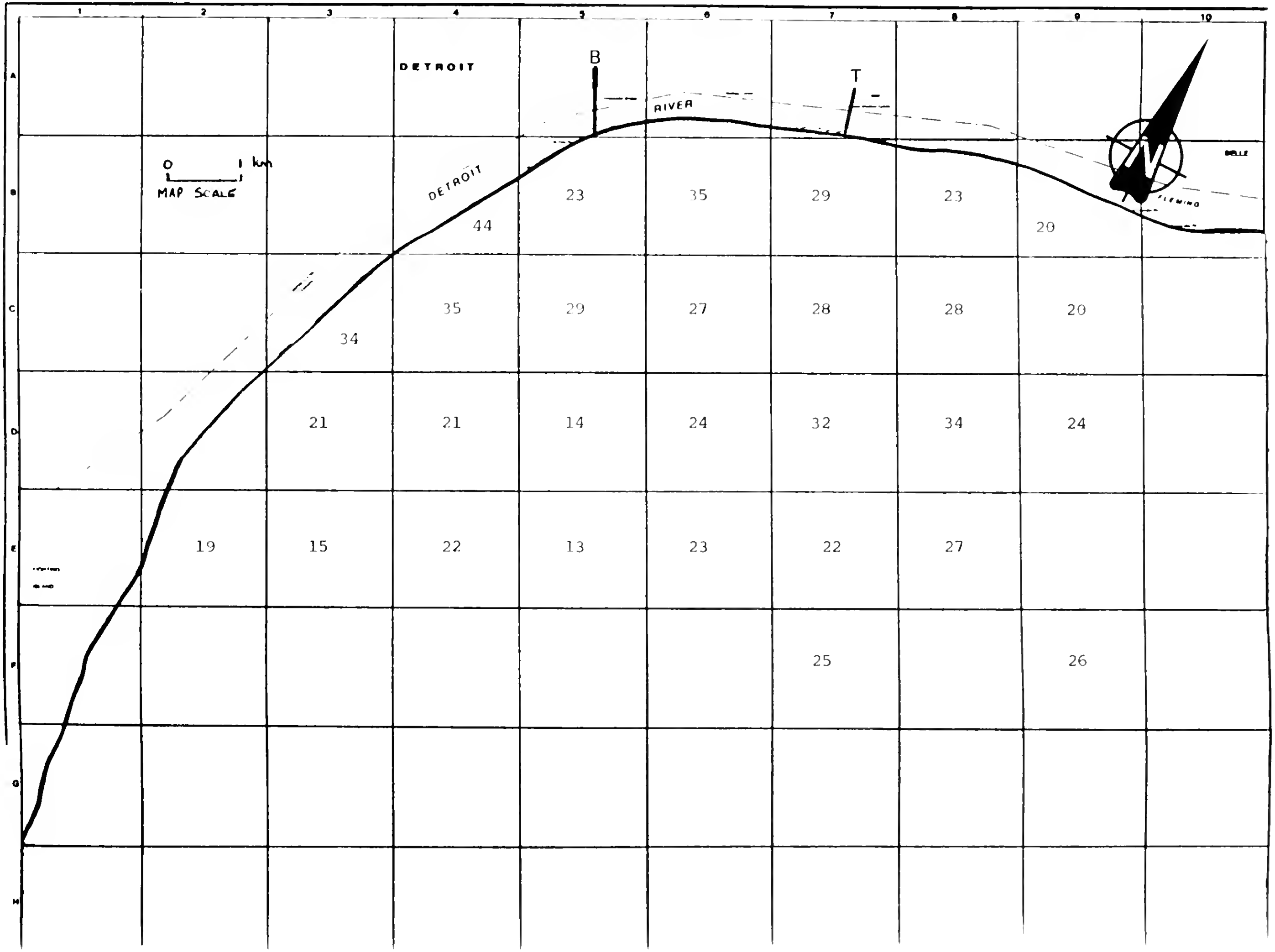


Fig. 9 Lead Grid Means for Windsor Soils: 1972-1986

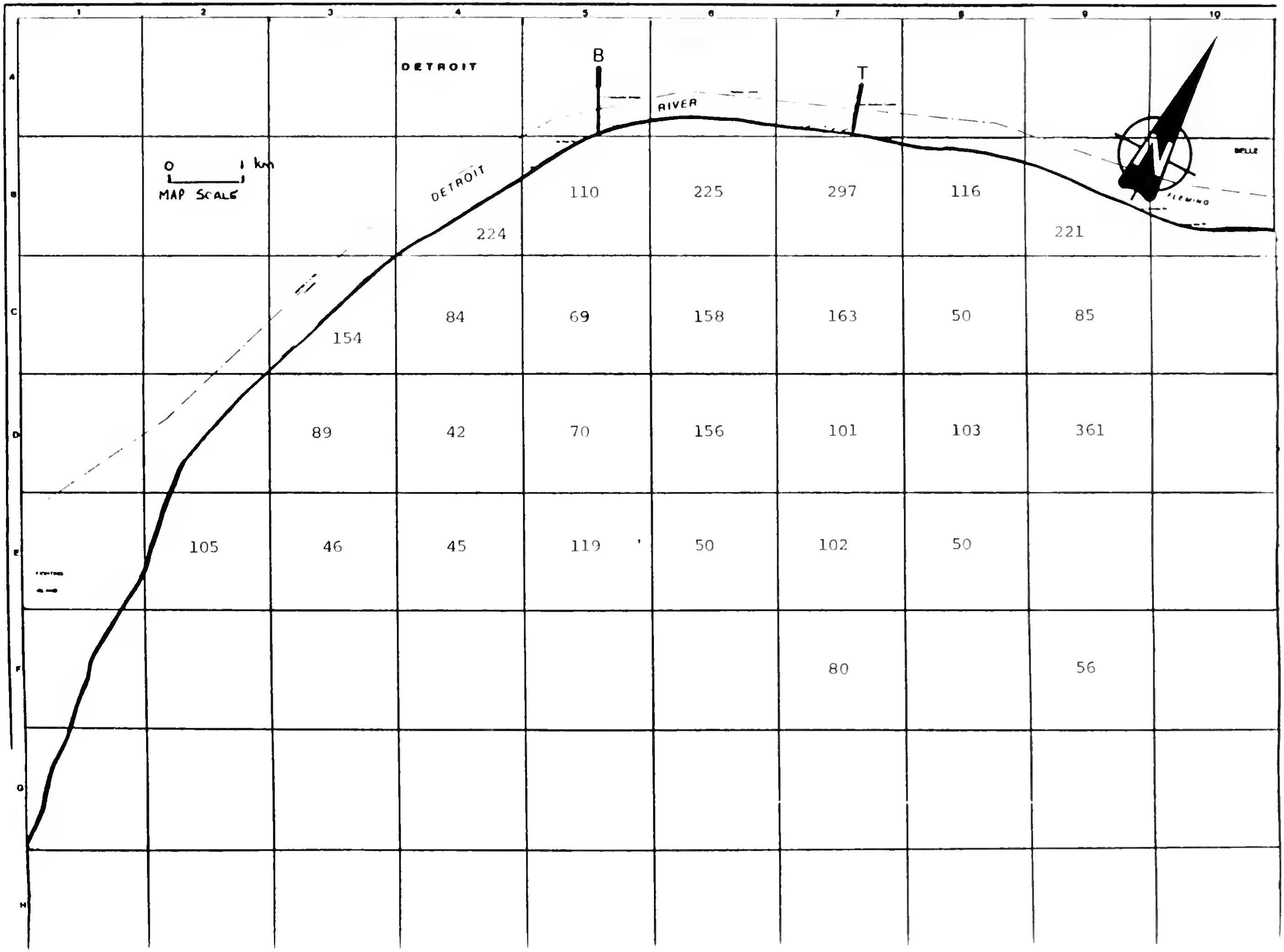


Fig. 10 Sulphur Grid Means for Windsor Soils

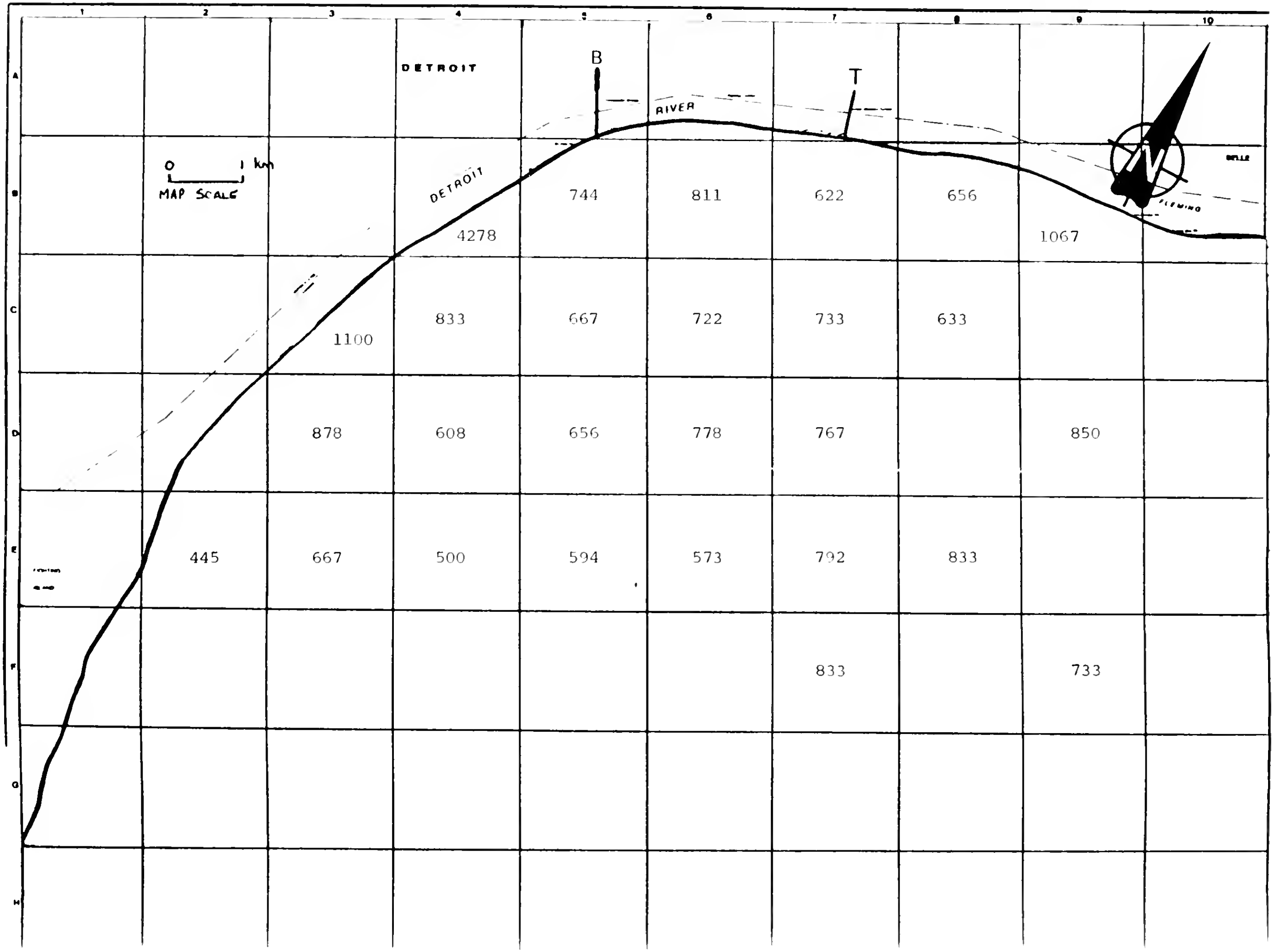


Fig. 11 Selenium Grid Means for Windsor Soils: 1972-1986

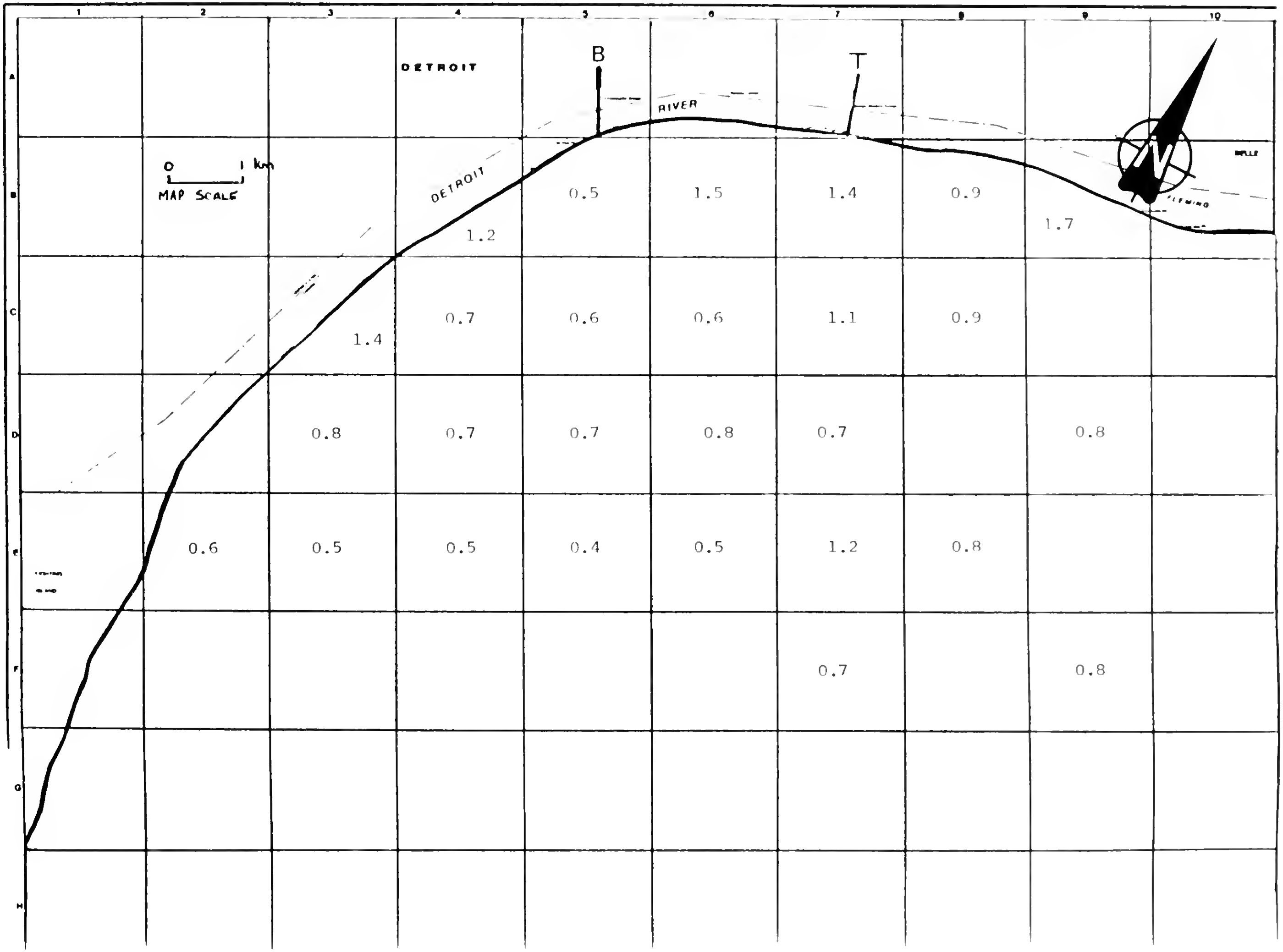


Fig. 12 Vanadium Grid Means for Windsor Soils: 1972-1986

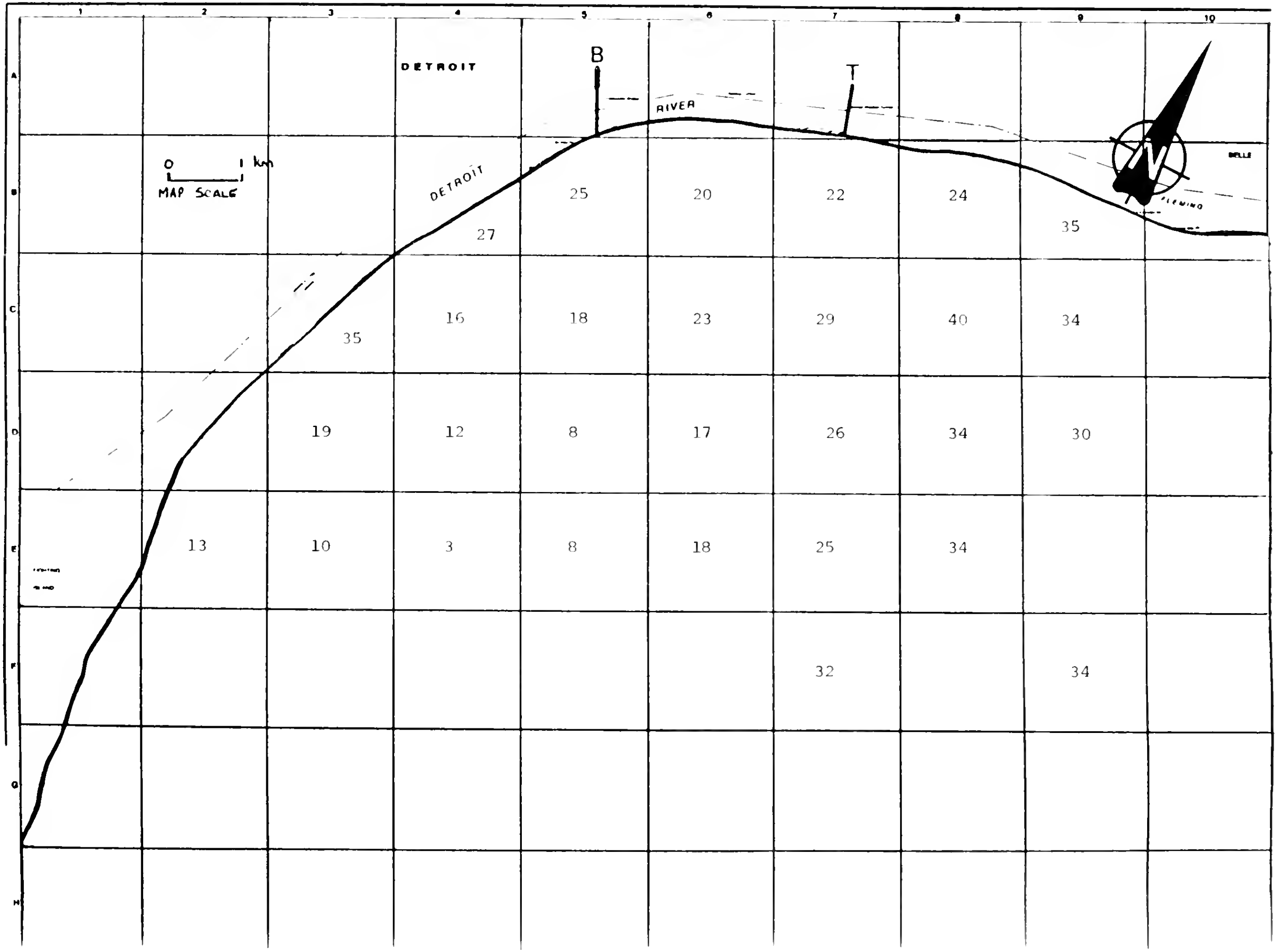


Fig. 13 Zinc Grid Means for Windsor Soils: 1972-1986

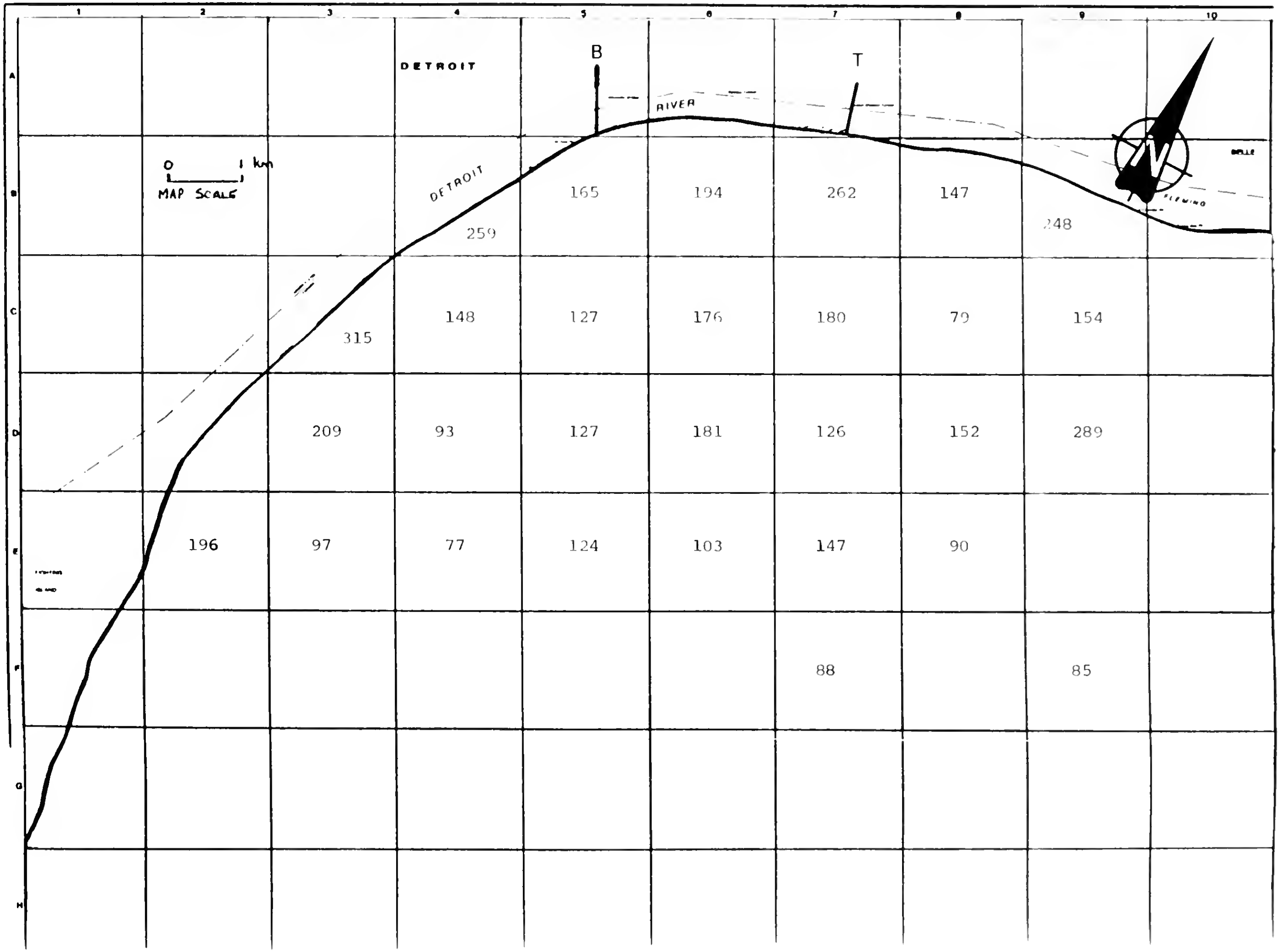


Fig. 14 Arsenic Grid Means for Windsor Maple Foliage: 1972-1986

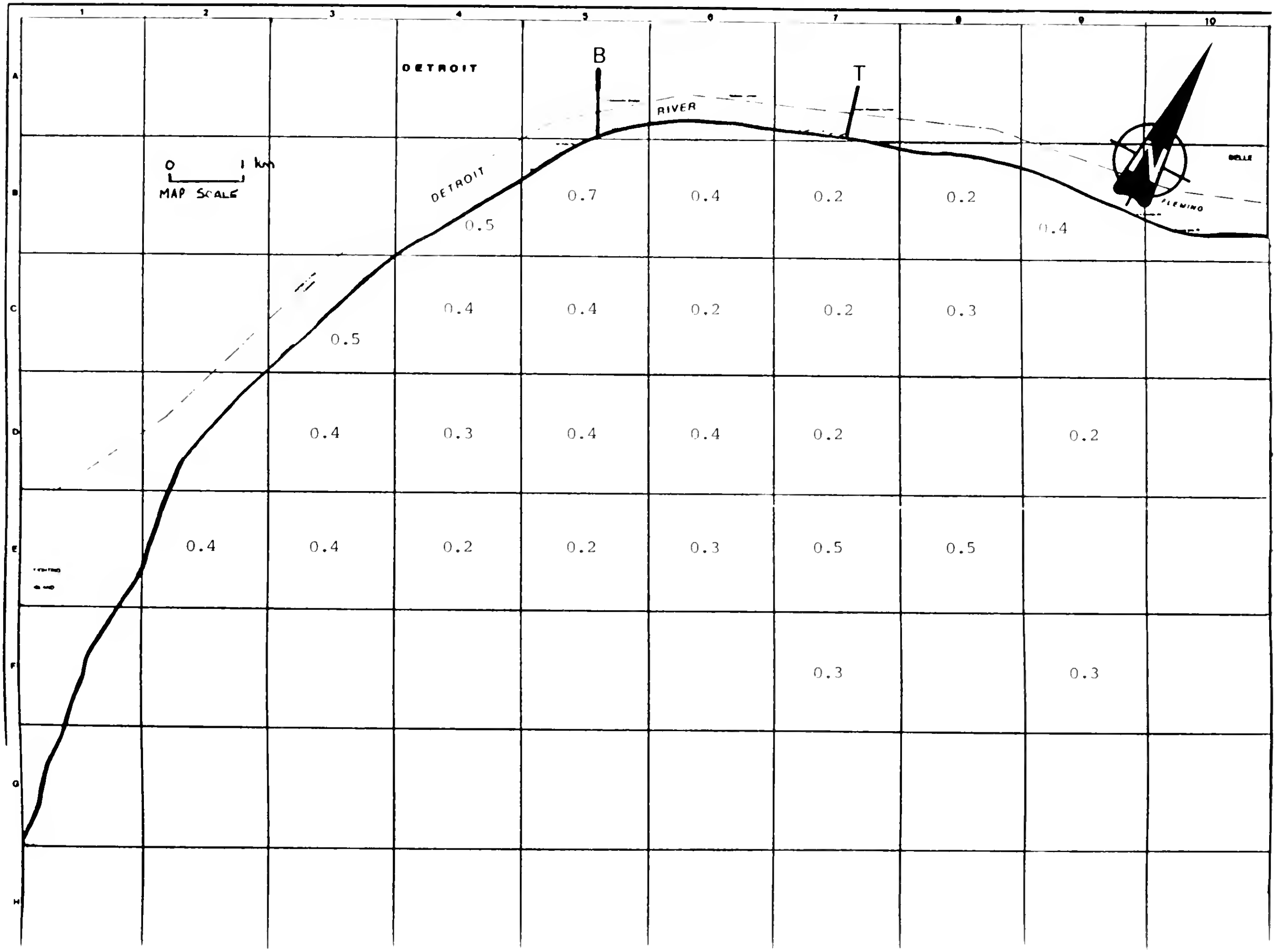


Fig. 15 Cadmium Grid Means for Windsor Maple Foliage: 1972-1986

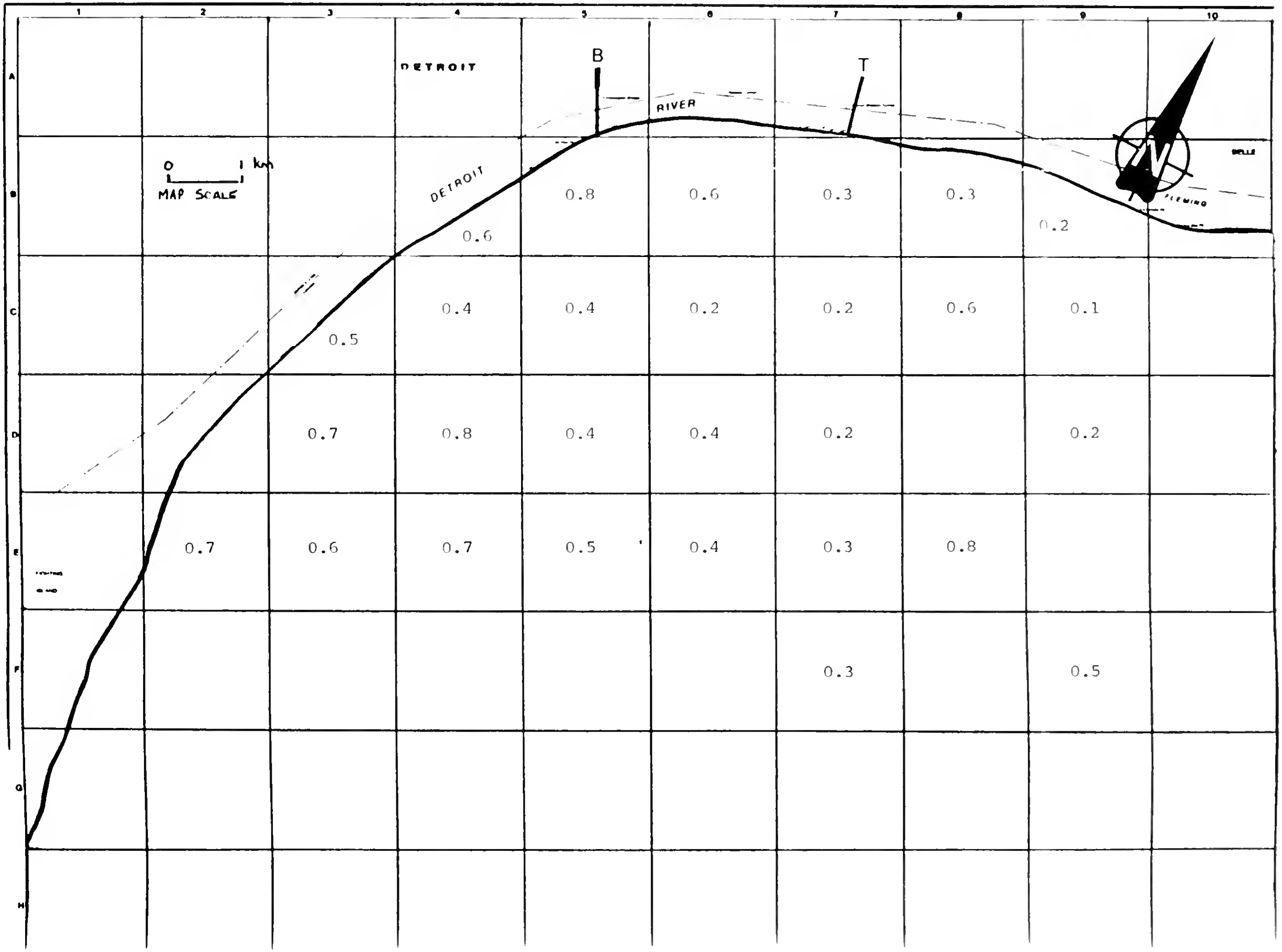


Fig. 16 Chloride Grid Means for Windsor Maple Foliage: 1972-1986

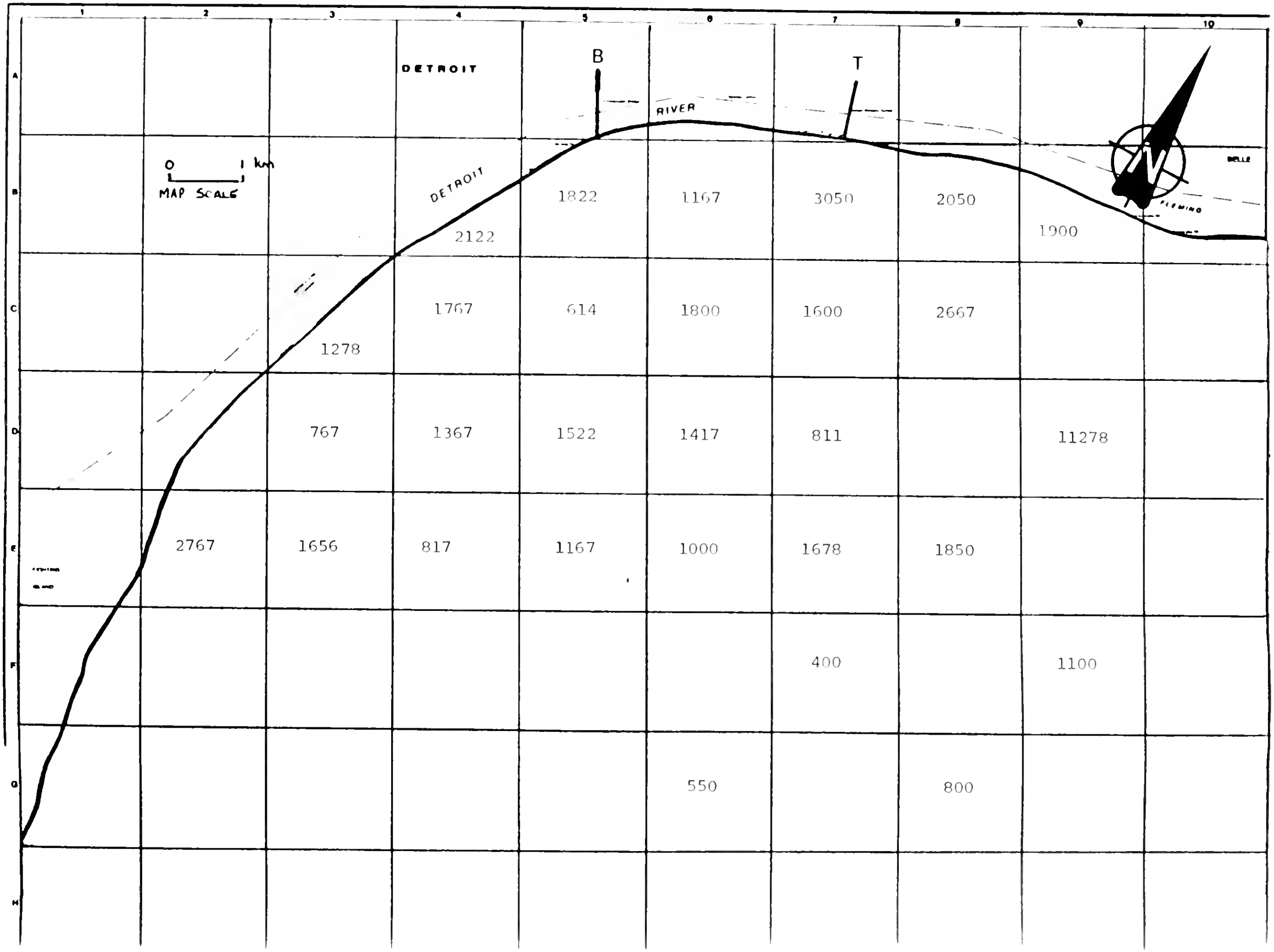


Fig. 17 Chromium Grid Means for Windsor Maple Foliage: 1972-1986

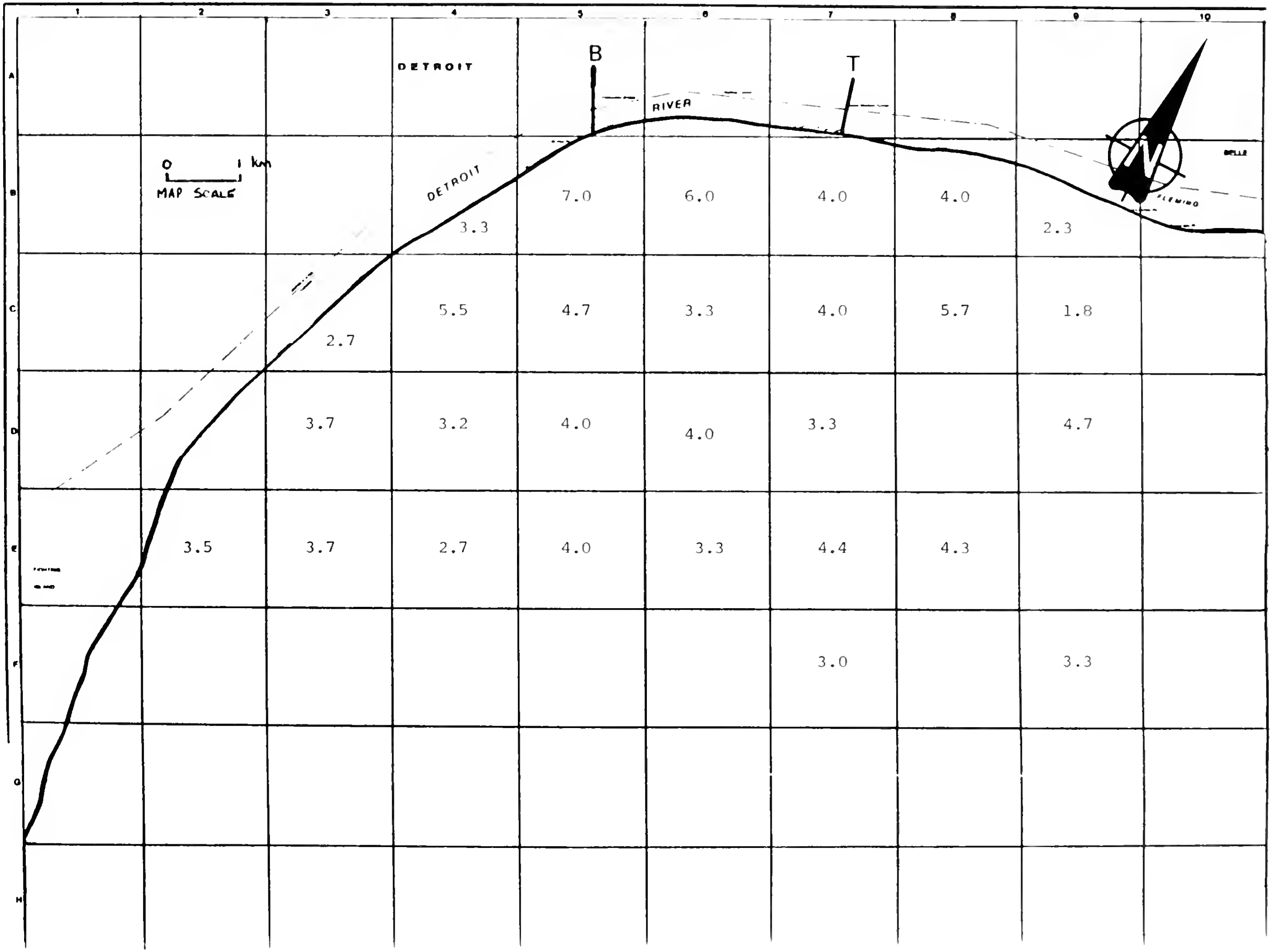


Fig. 18 Copper Grid Means for Windsor Maple Foliage: 1972-1986

◯ - Circled Means in Excess of ULN

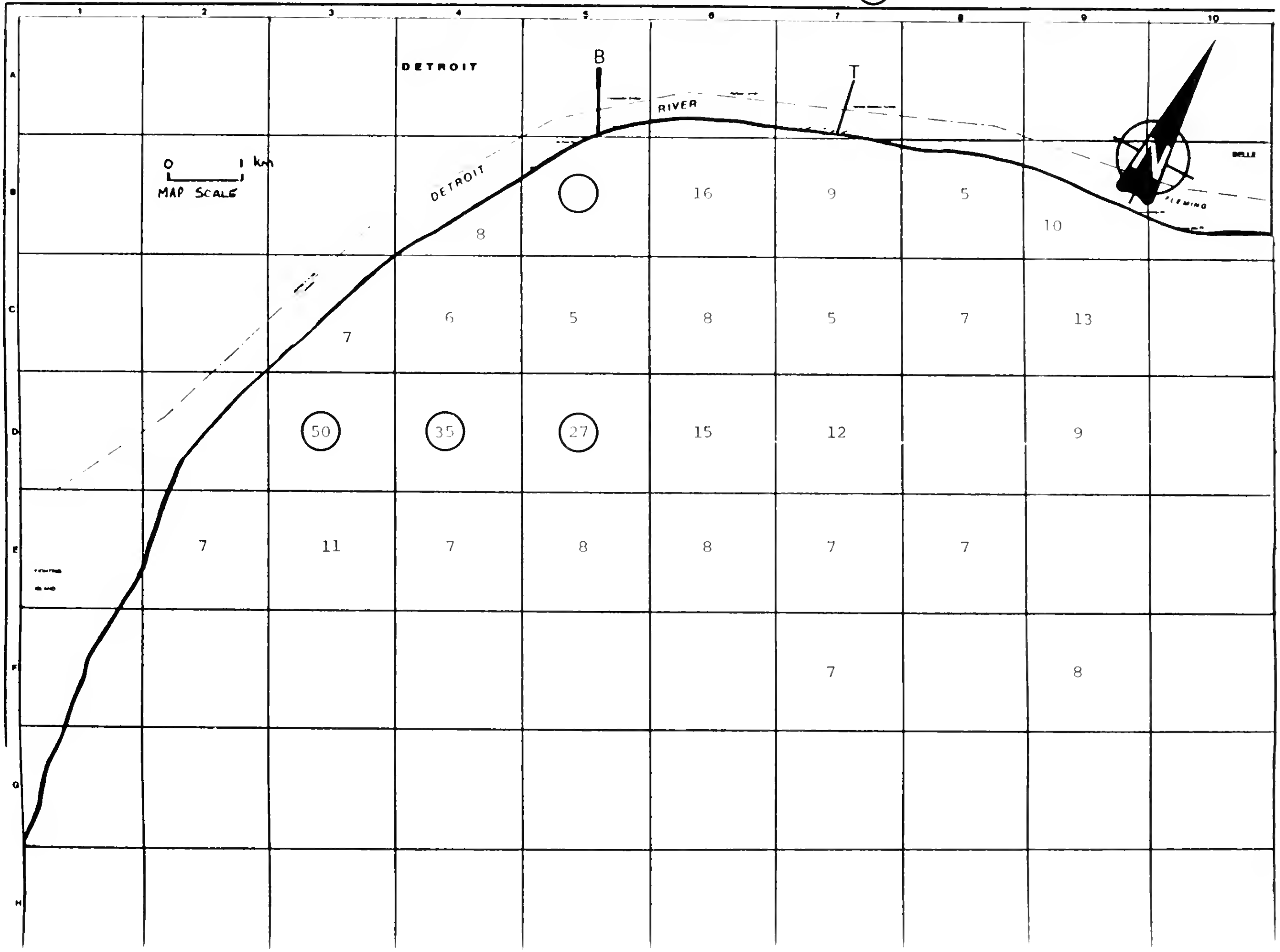


Fig. 19 Fluoride Grid Means for Windsor Maple Foliage: 1972-1986 ◯ - Circled Means in Excess of ULN

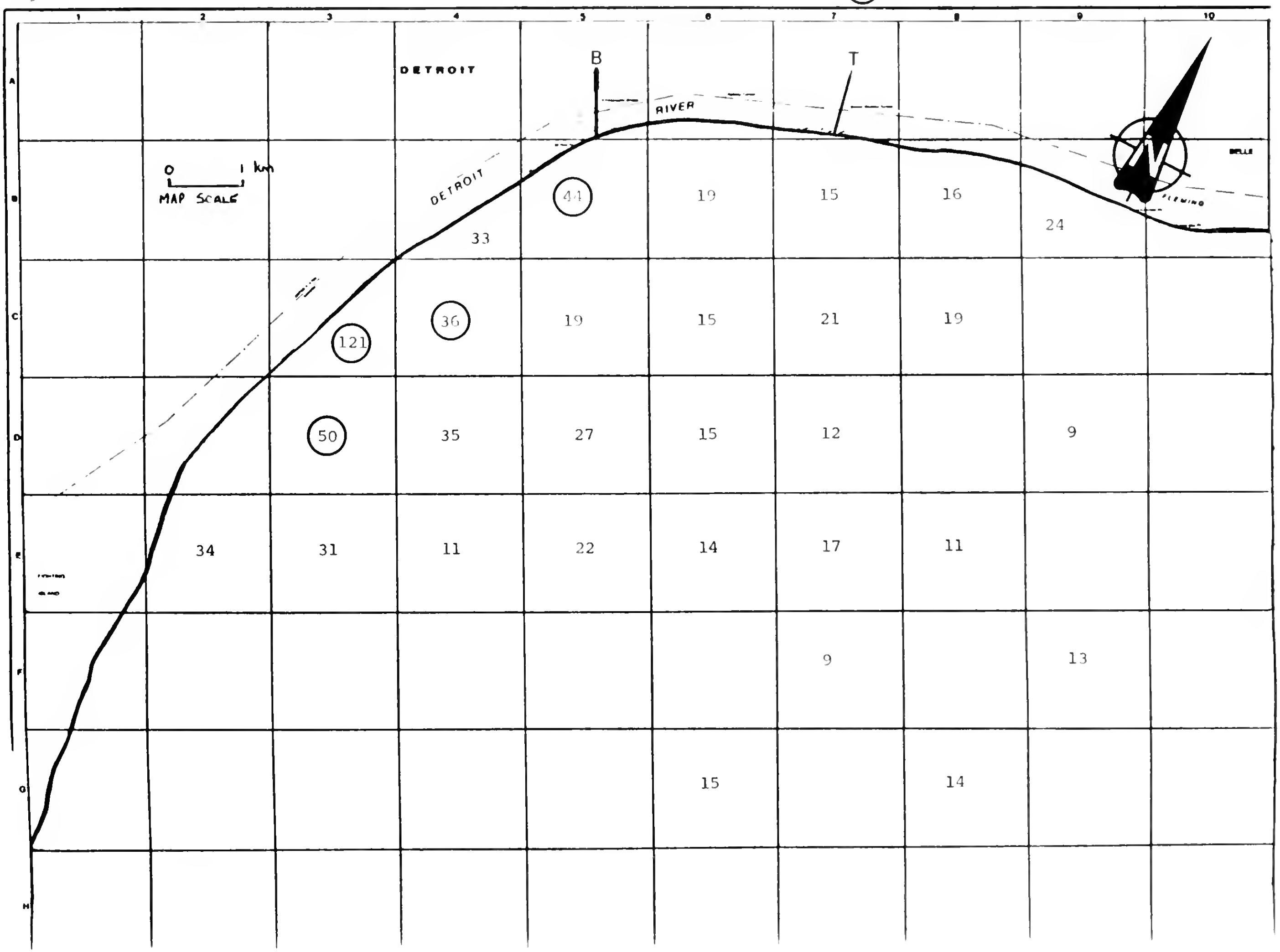


Fig. 20 Iron Grid Means for Windsor Maple Foliage: 1972-1986

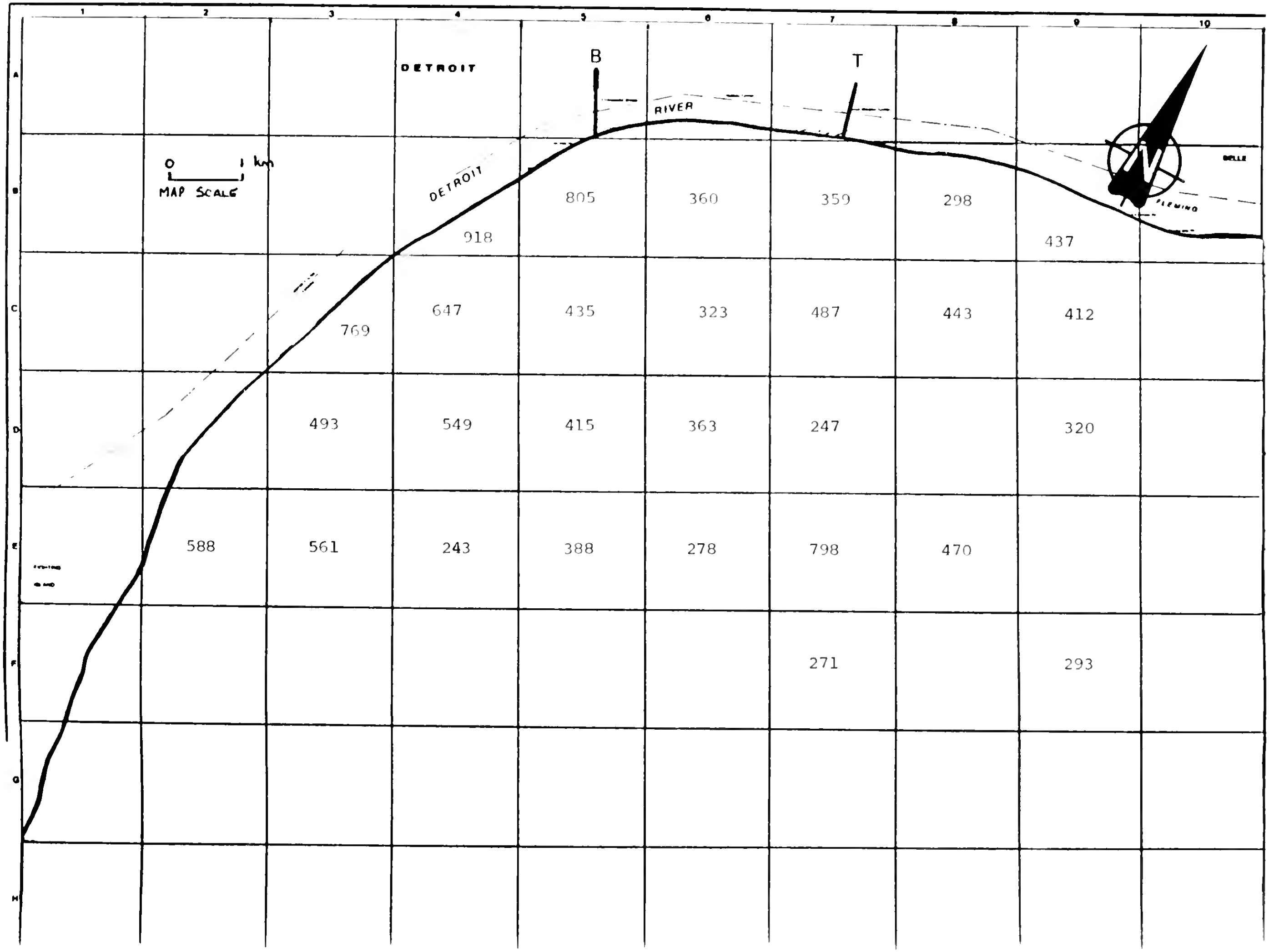


Fig. 21 Molybdenum Grid Means for Windsor Maple Foliage: 1972-1986

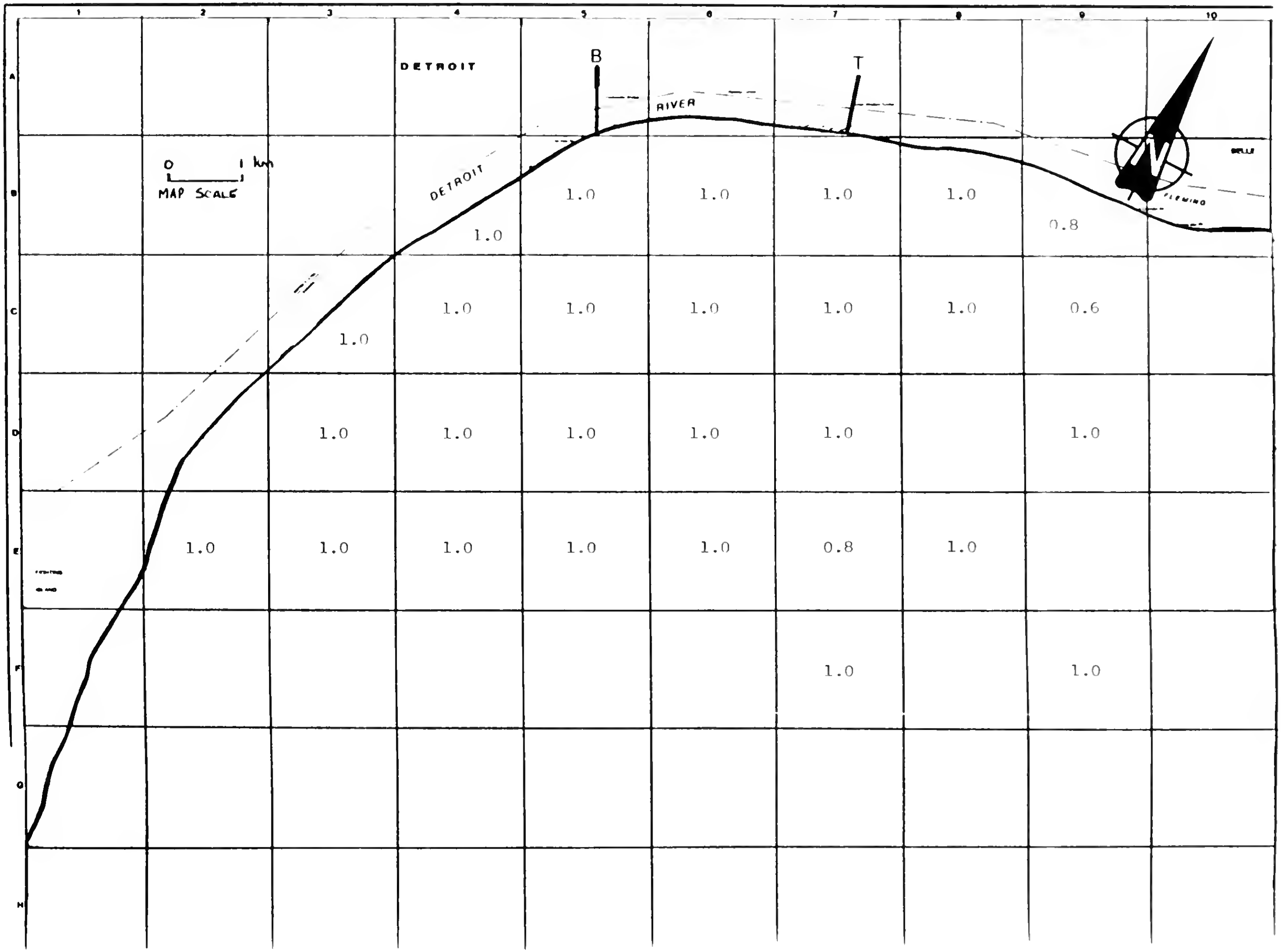


Fig. 22 Nickel Grid Means for Windsor Maple Foliage: 1972-1986

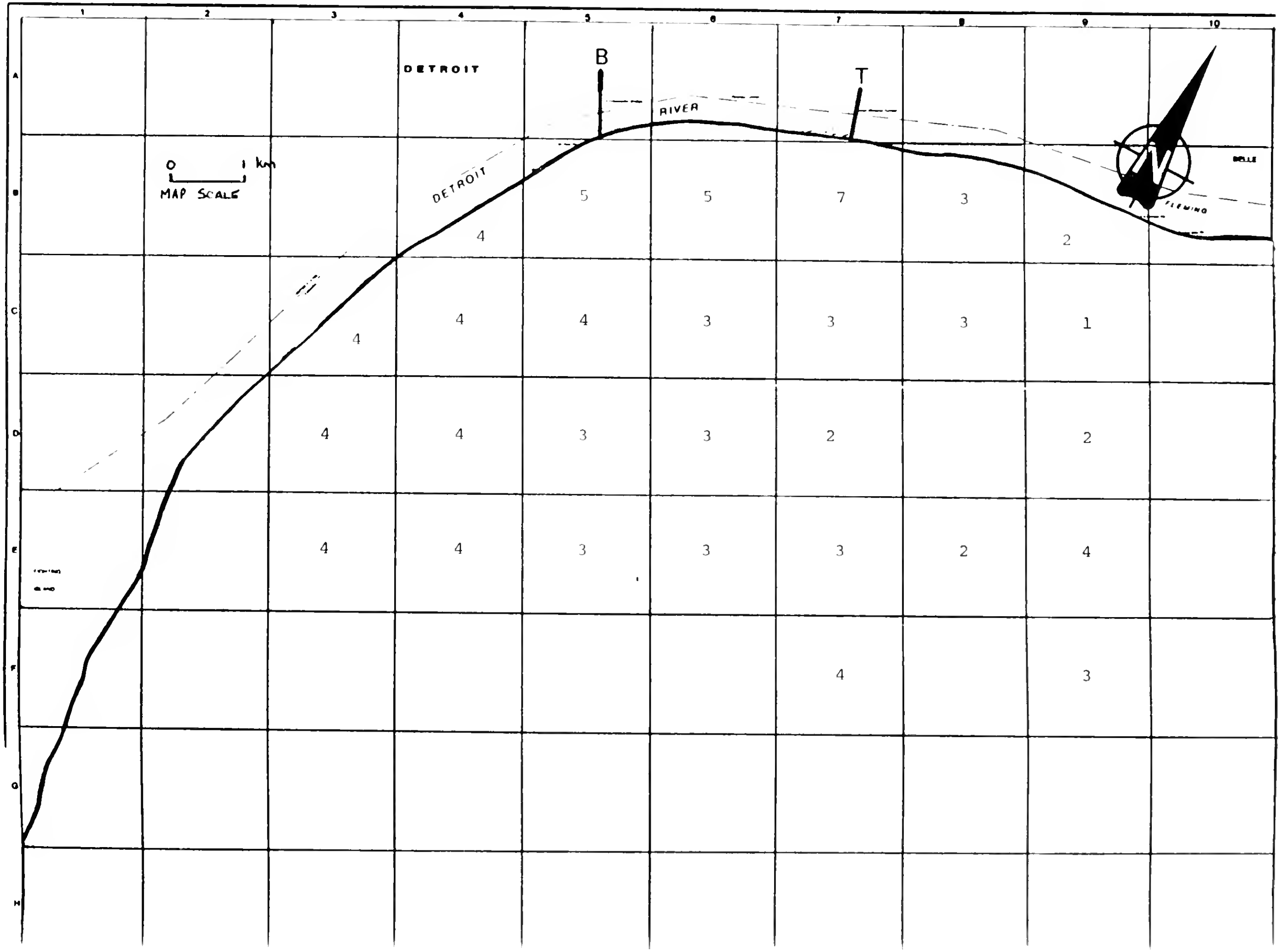


Fig. 23 Lead Grid means for Windsor Maple Foliage: 1972-1986

◯ - Circled Means in Excess of ULN

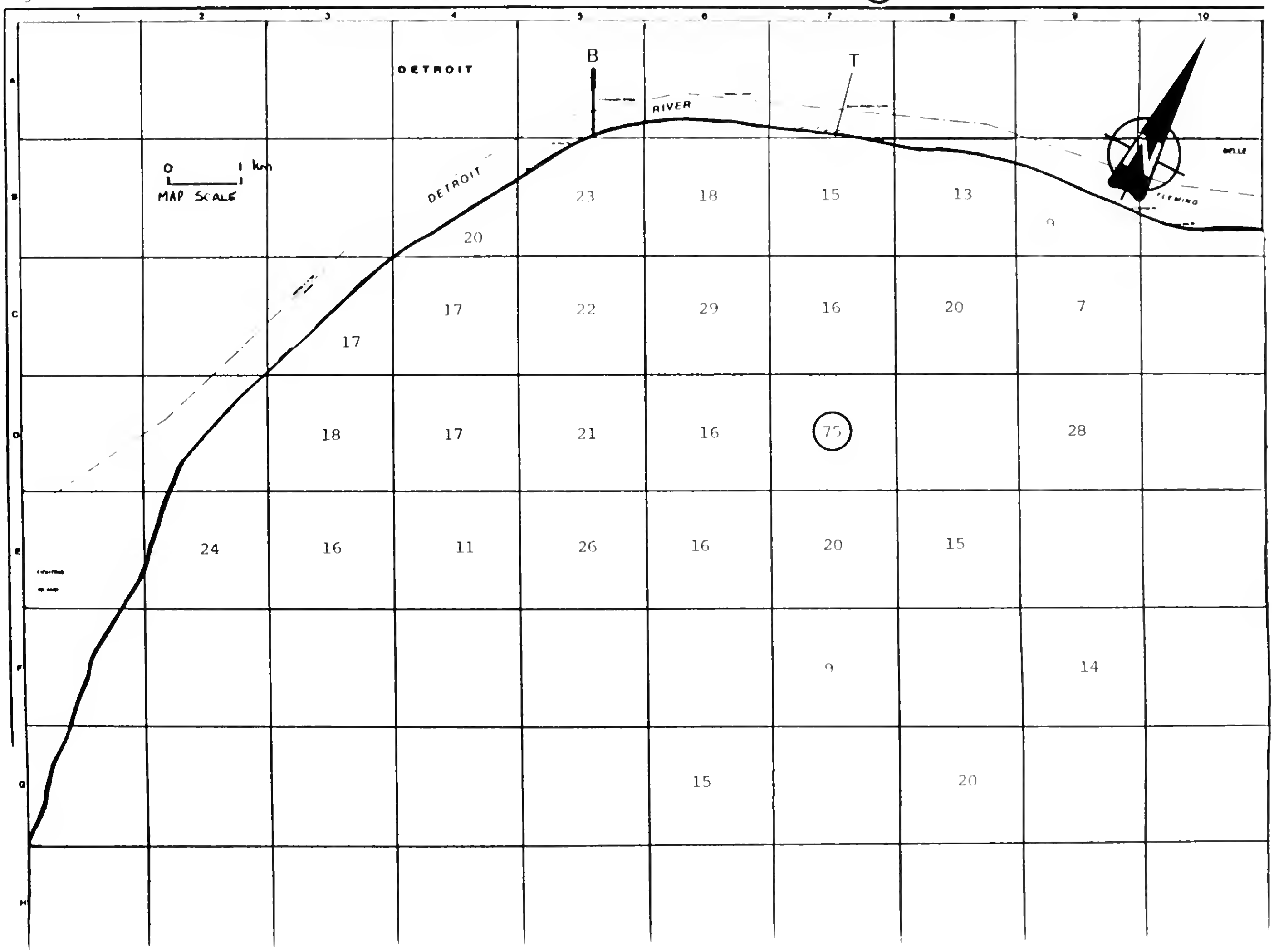


Fig. 24 Sulphur Grid Means for Windsor Maple Foliage: 1972-1986

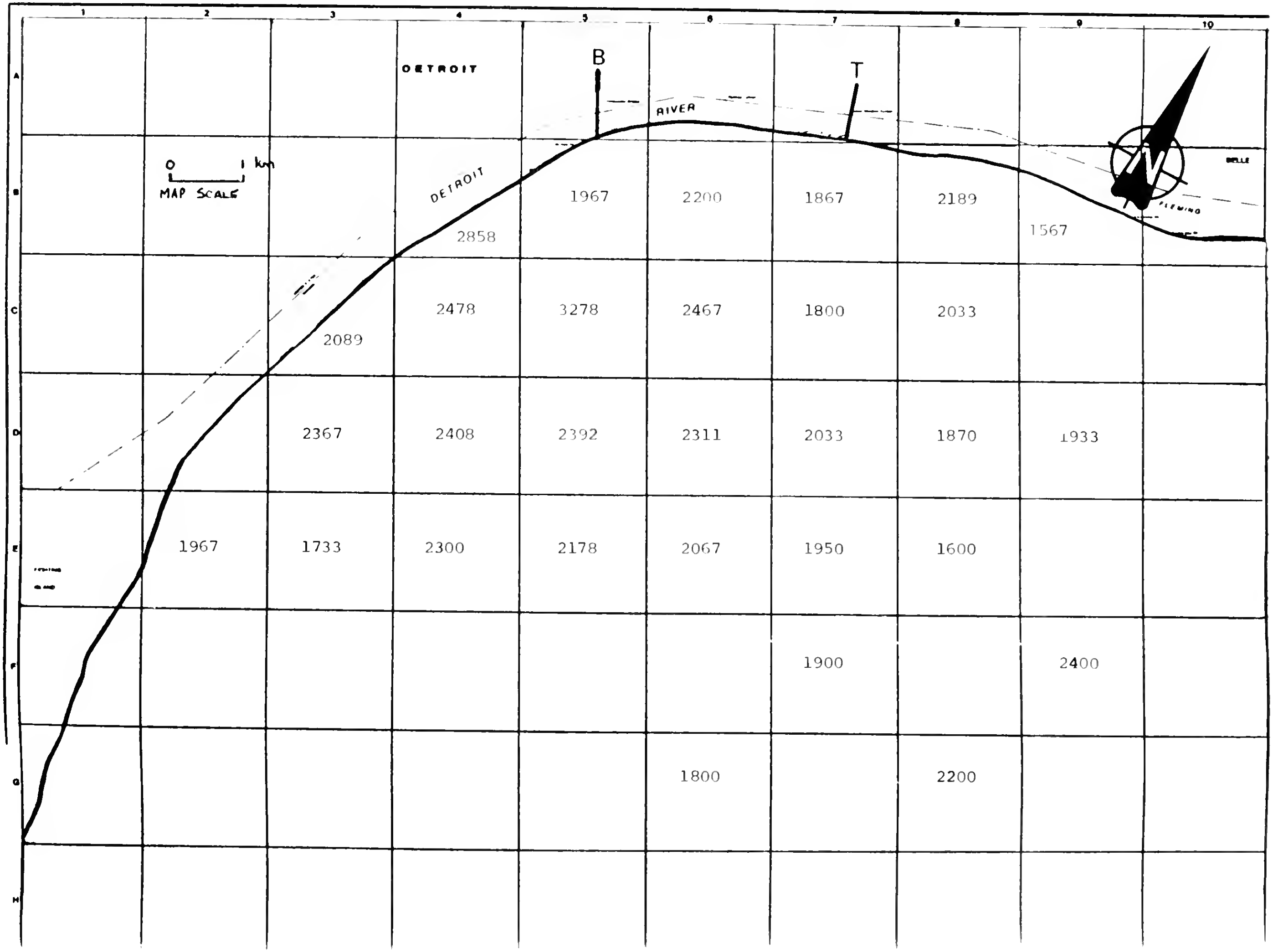


Fig. 25 Selenium Grid Means for Windsor Maple Foliage: 1972-1986

Fig. 26   Vanadium Grid Means for Windsor Maple Foliage: 1972-1986

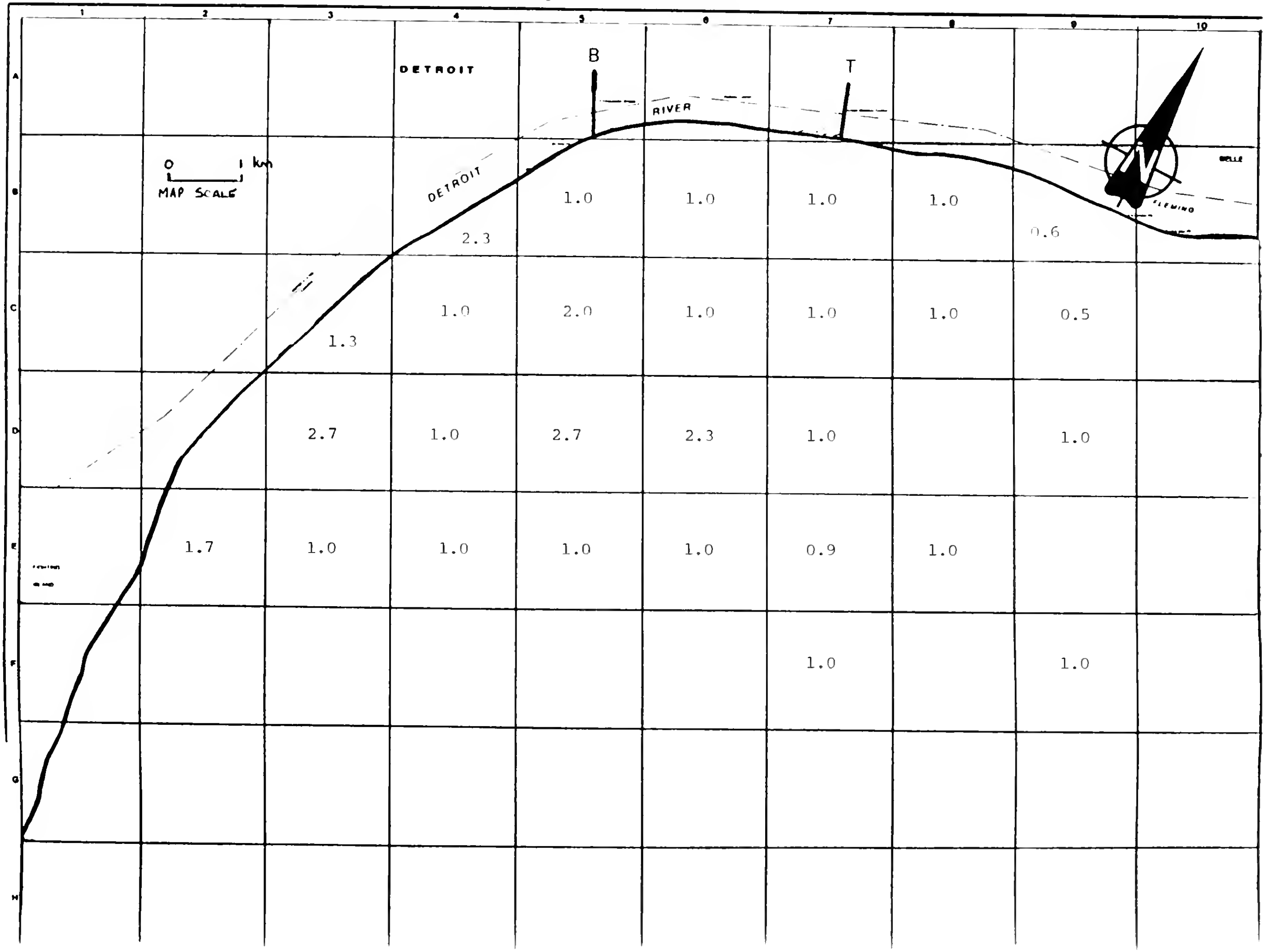
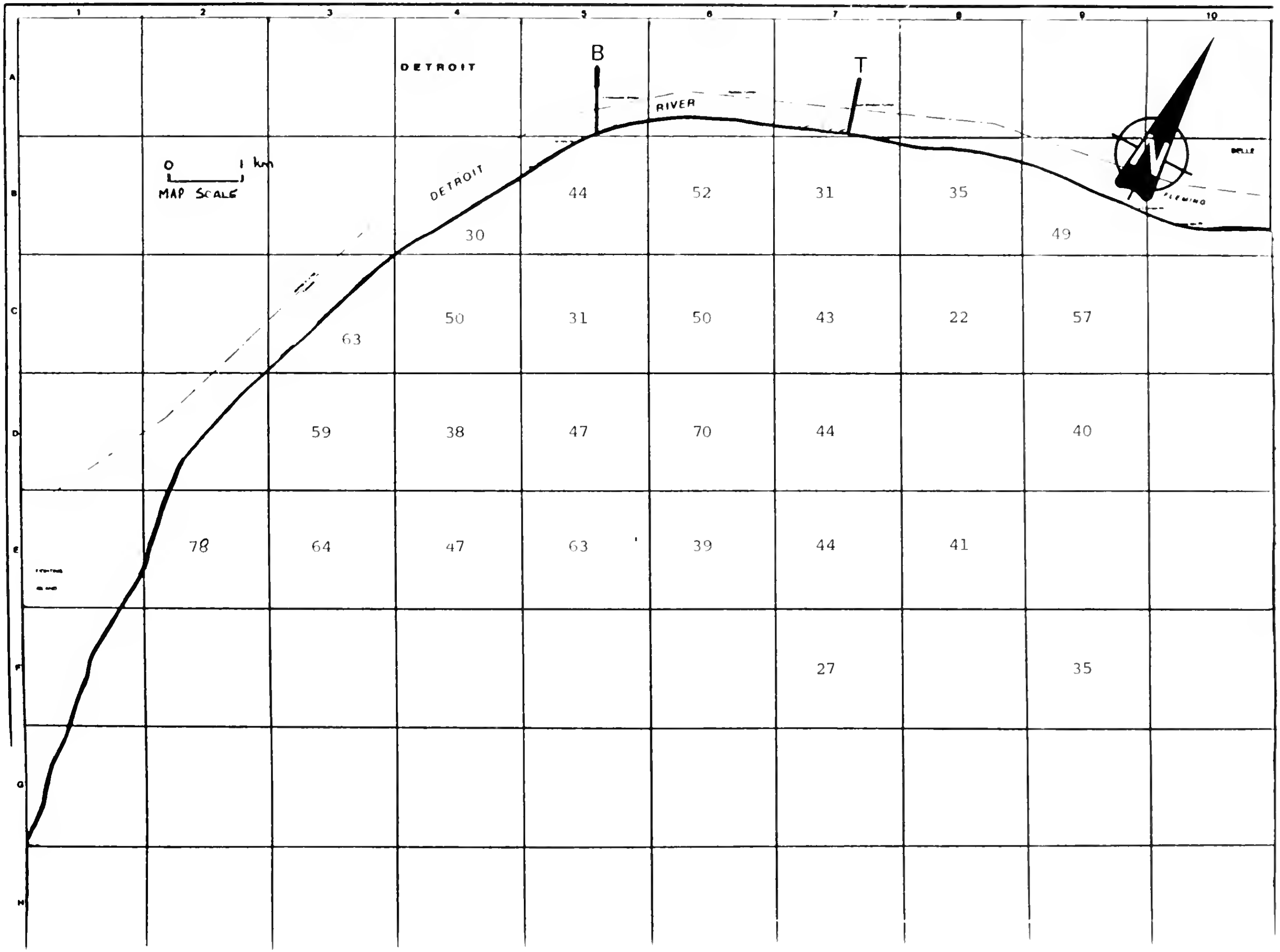


Fig. 27   Zinc Grid Means for Windsor Maple Foliage: 1972-1986



APPENDICIES 1 - 6

APPENDIX 1: Windsor Soil Data for 1972 to 1986

YEAR SAMPLED	REPORT NO.	MAP COORD N-S	MAP COORD E-W	SAMPLE SOIL	TYPE VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1972	1	E	2	0-10			1000		200			50					500			200			
1972	1	E	2	0-10			1000		200			40					800			100			
1972	1	E	2	0-10			1000		200			45					275			200			
1972	1	E	2	0-10			500		200			43					300			100			
1972	1	E	2	0-10			1000		200			38					225			200			
1972	1	E	2	0-10			750		200			38					200			200			
1972	1	E	2	0-10			625		200			58					150			100			
1972	1	E	2	0-10			1050		200			80					200			100			
1972	1	E	2	0-10			750		200			70					150			100			
1972	1	E	2	0-10			750		300			60					625			100			
1972	1	E	2	0-10			625		300			68					300			100			
1972	1	E	2	0-10			500		200			65					375			100			
1972	1	E	2	0-10			1500		300			88					850			200			
1972	3	C	4	0-10					200			250								1000			
1973	3	F	1	0-10					200			337								1200			
1972	4	G	7	0-10					200								1080						
1972	4	G	7	0-10					500								1230						
1972	4	G	7	0-10					200								1280						
1972	4	G	7	0-10					200								1130						
1973	5	D	8	0-5				1.5		12			12500						163			25	129
1973	5	D	8	0-5				2.4		14			13300						285			38	438
1973	5	D	8	0-5				1		19			16400						283			25	413
1973	5	D	8	0-5				1.4		18			14300						125			22	129
1973	5	D	9	0-5				1.5		16			13100						308			22	225
1973	5	D	9	0-5				1.8		17			14900						200			22	350
1973	5	D	9	0-5				2.9		16			8400						488			35	1490
1973	5	D	9	0-5				1.4		15			16300						45			28	106
1973	5	D	9	0-5				2.5		18			13800						708 *			33	263
1973	5	D	9	0-5				0.9		15			15400						125			35	118
1973	5	D	9	0-5				1.4		15			14300						115			22	118
1973	5	D	9	0-5				1.4		16			14000						108			33	130
1973	5	D	9	0-5				3.8		27			15000						950 *			35	950
1975	6	D	9	0-5				2.5					32500						775 *	900			270
1975	6	D	9	0-5				2.5					26300						650 *	800			263
1975	6	D	9	0-5				2.5					28000						600 *	800			225
1975	6	D	9	0-5				2.5					24000						323	900			205

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1975	6	D	9	0-5				2.5					17500						335	900			215
1975	6	D	9	0-5				2.5					20500						300	900			205
1975	6	D	9	0-5				2.3					24000						418	900			213
1975	6	D	9	0-5				2.5					24000						363	700			188
1975	6	D	9	0-5				2.3					26000						383	700			203
1975	6	B	4	0-5				2.5					54500 *						195	7300			220
1975	6	B	4	0-5				3					44800 *						213	6200			268
1975	6	B	4	0-5				3.5					52800 *						203	6800			275
1975	6	C	3	0-5				3.8					37500 *						105	1400			315
1975	6	C	3	0-5				4.3 *					39500 *						100	1400			323
1975	6	C	3	0-5				4					42300 *						100	1300			310
1975	6	D	3	0-5				2.5					21500						105	1300			278
1975	6	D	3	0-5				2.8					28300						125	1200			290
1975	6	D	3	0-5				3.3					23300						150	1200			305
1975	6	E	2	0-5				2					19300						95	990			233
1975	6	E	2	0-5				3.3					21300						100	1000			270
1975	6	E	2	0-5				3					21000						80	1000			225
1975	6	E	3	0-5				2.5					13800						53	700			115
1975	6	E	3	0-5				2.5					14000						53	700			125
1975	6	E	3	0-5				2.3					13300						55	700			118
1975	6	E	4	0-5				2.5					11100						50	300			65
1975	6	E	4	0-5				2.8					11000						50	0			70
1975	6	E	4	0-5				2.8					11400						55	500			68
1975	6	D	7	0-5				3					13500						50	1200			123
1975	6	D	7	0-5				3.8					15800						58	1000			128
1975	6	D	7	0-5				3.5					13300						63	900			118
1975	6	D	4	0-5				2.8					16000						33	600			125
1975	6	D	4	0-5				3					16400						38	400			103
1975	6	D	4	0-5				3.3					15000						40	500			105
1975	6	C	4	0-5				4.3 *					24000						65	700			143
1975	6	C	4	0-5				3.8					24100						70	800			178
1975	6	C	4	0-5				3.8					22500						75	800			165
1975	6	B	5	0-5				1.3					19400						175	900			270
1975	6	B	5	0-5				1.5					20700						183	900			258
1975	6	B	5	0-5				1.5					20700						175	1100			250
1975	6	B	6	0-5				1					14000						213	700			195
1975	6	B	6	0-5				1					14400						193	600			193
1975	6	B	6	0-5				1.3					14900						230	600			215
1975	6	C	5	0-5				1					19600						68	600			130
1975	6	C	5	0-5				1.3					18000						65	700			135

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1975	6	C	5	0-5				1.3					18600						60	700			133
1975	6	D	5	0-5				1					11700						75	700			115
1975	6	D	5	0-5				1					12200						78	800			128
1975	6	D	5	0-5				0.8					10600						73	800			110
1975	6	E	5	0-5				1					15500						50	700			108
1975	6	E	5	0-5				1					15400						53	700			113
1975	6	E	5	0-5				0.8					15100						58	900			130
1975	6	E	5	0-5				1.3					13900						273	900			225
1975	6	E	5	0-5				1.3					15000						305	700			223
1975	6	E	5	0-5				1					13400						263	800			213
1975	6	E	6	0-5				0.8					11600						63	400			133
1975	6	E	6	0-5				0.8					11700						63	500			135
1975	6	E	6	0-5				1					11000						63	600			128
1975	6	E	6	0-5				1.5					17400						50	600			105
1975	6	E	6	0-5				1.5					18100						53	700			123
1975	6	E	6	0-5				1.3					17100						53	600			110
1975	6	D	6	0-5				1.3					17000						58	800			113
1975	6	D	6	0-5				1					17100						55	700			108
1975	6	D	6	0-5				1.3					16500						58	600			113
1975	6	C	6	0-5				0.8					15200						155	700			215
1975	6	C	6	0-5				0.8					15000						168	700			215
1975	6	C	6	0-5				1					14500						135	600			195
1975	6	B	7	0-5				1.3					17600						410	600			360
1975	6	B	7	0-5				1.3					16800						385	700			353
1975	6	B	7	0-5				1.3					17100						343	600			353
1975	6	B	8	0-5				1					15500						145	700			190
1975	6	B	8	0-5				1					16900						163	700			218
1975	6	B	8	0-5				1					15400						160	800			185
1975	6	C	7	0-5				1.5					18200						225	800			293
1975	6	C	7	0-5				1.5					18800						233	800			253
1975	6	C	7	0-5				1.5					18900						218	900			230
1975	6	D	7	0-5				1.3					18200						113	600			138
1975	6	D	7	0-5				1.3					17700						125	700			148
1975	6	D	7	0-5				1.3					18100						120	600			138
1975	6	E	7	0-5				1.5					165						88	700			150
1975	6	E	7	0-5				1.5					169						65	600			163
1975	6	E	7	0-5				1.3					163						95	700			158
1976	8	B	8	0-5				1.3					15800						93	600			140
1976	8	B	8	0-5				1					13900						113	600			135
1976	8	B	8	0-5				1.3					15000						95	600			145

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1976	8	B	7	0-5				1.3					13300						128	500			130
1976	8	B	7	0-5				1					12000						150	400			128
1976	8	B	7	0-5				1.3					11600						145	400			130
1976	8	C	6	0-5				1.3					19000						220	700			200
1976	8	C	6	0-5				1.3					16000						180	700			180
1976	8	C	6	0-5				1.8					16800						195	800			208
1976	8	C	7	0-5				1					17000						108	700			145
1976	8	C	7	0-5				1.3					19300						113	600			155
1976	8	C	7	0-5				1.3					19800						118	600			140
1976	8	D	7	0-5				1					19000						103	400			115
1976	8	D	7	0-5				1					19500						88	600			113
1976	8	D	7	0-5				1					20000						163	700			138
1976	8	E	7	0-5				1.3					20000						160	800			240
1976	8	E	7	0-5				1.5					20300						173	700			295
1976	8	E	7	0-5				1.3					19500						165	800			218
1976	8	E	7	0-5				1.3					8800						38	700			40
1976	8	E	7	0-5				1.3					9500						38	700			45
1976	8	E	7	0-5				0.8					9500						40	700			60
1976	8	E	6	0-5				1.8					14500						45	600			75
1976	8	E	6	0-5				1.5					14000						78	600			160
1976	8	E	6	0-5				1.5					14500						48	600			140
1976	8	D	6	0-5				1.8					14800						350	900			340
1976	8	D	6	0-5				2					15500						380	900			345
1976	8	D	6	0-5				2					14800						295	800			275
1976	8	B	6	0-5				1.3					13000						168	800			190
1976	8	B	6	0-5				1.5					12500						173	700			165
1976	8	B	6	0-5				1.8					13300						183	700			195
1976	8	C	5	0-5				1.5					15300						55	600			125
1976	8	C	5	0-5				1					13800						70	700			75
1976	8	C	5	0-5				1.8					15000						85	600			190
1976	8	D	5	0-5				1.3					7500						70	600			155
1976	8	D	5	0-5				1					6800						68	600			95
1976	8	D	5	0-5				1					6600						68	500			80
1976	8	E	5	0-5				1					8300						28	200			40
1976	8	E	5	0-5				1					7300						25	400			45
1976	8	E	5	0-5				1					7800						28	400			50
1976	8	E	5	0-5				1.3					8000							500			300
1976	8	E	5	0-5				1					6000						333	600			195
1976	8	E	5	0-5				1					7500						373	600			225
1976	8	E	4	0-5				1					9800						43	600			60

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1976	8	E	4	0-5				1					9300						43	500			65
1976	8	E	4	0-5				1.3					8500						45	600			50
1976	8	D	7	0-5				1.3					9500						83	1000			130
1976	8	D	7	0-5				1.5					9800						40	600			70
1976	8	D	7	0-5				1.3					7500						40	700			75
1976	8	D	4	0-5				1					7500						30	300			75
1976	8	D	4	0-5				1					7300						35	300			35
1976	8	D	4	0-5				1					4500						30	300			50
1976	8	C	4	0-5																			
1976	8	C	4	0-5				1.5					9800						88	600			160
1976	8	C	4	0-5				2					9500						120	700			190
1976	8	B	5	0-5				1.5					9300						105	700			170
1976	8	B	5	0-5				1.8					9500						155	800			195
1976	8	B	5	0-5				1.5					7800						120	900			165
1976	8	B	4	0-5				3					21800						220	4800			300
1976	8	B	4	0-5				3.3					20800						230	4400			380
1976	8	B	4	0-5				3					19000						215	4500			320
1976	8	C	3	0-5				2.3					16500						140	900			290
1976	8	C	3	0-5				1.8					13800						98	1000			240
1976	8	C	3	0-5				2.3					15500						133	900			280
1976	8	D	3	0-5				1.5					8000						65	700			185
1976	8	D	3	0-5				1.8					8800						75	800			150
1976	8	D	3	0-5				1.5					8500						75	700			190
1976	8	E	2	0-5				2					8000						110	900			160
1976	8	E	2	0-5				2					8500						103	800			190
1976	8	E	2	0-5				2					8800						95	800			150
1976	8	E	3	0-5				1.5					5800						58	700			95
1976	8	E	3	0-5				1.3					5800						50	700			85
1976	8	E	3	0-5				1					5600						48	700			95
1977	9	B	4	0-5		8.9		2.5		23	53		19300			2.5		43	219	1500	1.17	26	175
1977	9	B	4	0-5		8.7		3		23	48		17000			2.5		45	160	1200	1.31	30	175
1977	9	B	4	0-5		9.3		4		28	78		24000			8 *		43	365	1800	1.17	25	215
1977	9	C	3	0-5		11.1		4.5 *		38	45		29000			2.5		33	243	900	1.38	35	370
1977	9	C	3	0-5		11.4		4.5 *		35	50		24300			2.5		33	260	1100	1.64	35	370
1977	9	C	3	0-5		12		3.5		33	45		25800			2.5		35	203	1000	1.29	35	340
1977	9	D	3	0-5		5.2		2		20	25		8000			2.5		20	63	700	0.96	20	150
1977	9	D	3	0-5		5.4		2		20	25		11500			2.5		20	78	700	0.79	18	173
1977	9	D	3	0-5		4.7		2.5		18	28		9500			2.5		23	63	600	0.75	18	163
1977	9	E	2	0-5		6.2		2		15	30		9300			2.5		20	113	700	0.48	15	180
1977	9	E	2	0-5		5.4		2		13	30		9300			2.5		18	120	900	0.58	8	175

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	9	E	2	0-5		5.6		3		13	30		8500			2.5		20	125	900	0.64	15	185
1977	9	E	3	0-5		4.3		1.4		15	1.5		4900			2.5		15	33	600	0.35	9	75
1977	9	E	3	0-5		5.3		1.5		15	1.5		5000			2.5		15	35	700	0.4	10	85
1977	9	E	3	0-5		5.1		1		15	1.5		5300			2.5		15	33	500	0.6	10	80
1977	9	E	4	0-5		4.4		2		20	2		8000			2.5		23	38	700	0.5	2.5	105
1977	9	E	4	0-5		4.4		1.5		20	2		9500			2.5		20	38	600	0.46	2.5	103
1977	9	E	4	0-5		4.3		2		23	2		9500			2.5		23	40	700	0.61	2.5	105
1977	9	D	4	0-5		5.4		2.3		18	2.3		7800			8 *		20	50	1000	0.87	10	125
1977	9	D	4	0-5		5.4		2		23	2.5		10300			8 *		23	53	1000	0.91	2.5	130
1977	9	D	4	0-5		5.4		1.5		20	2.3		8800			8 *		20	48	1100	0.83	2.5	125
1977	9	D	4	0-5		4.3		2.8		23	15		6600			2.5		21	45	600	0.56	16	80
1977	9	D	4	0-5		4.7		2.5		25	18		7000			2.5		20	53	600	0.62	20	80
1977	9	D	4	0-5		4.5		2		20	15		7500			2.5		20	53	600	0.43	20	80
1977	9	C	4	0-5		7.8		1.5		23	30		16500			2.5		35	75	1000	0.69	13	115
1977	9	C	4	0-5		8.3		2.5		20	30		14500			2.5		35	80	1000	0.71	15	115
1977	9	C	4	0-5		8.6		2.3		35	30		13300			2.5		35	95	900	0.63	20	115
1977	9	B	5	0-5		5.9		1.5		20	28		9800			2.5		25	75	400	0.54	10	135
1977	9	B	5	0-5		6.3		2.5		20	28		11000			5 *		23	75	400	0.57	10	135
1977	9	B	5	0-5		6.2		2.5		25	25		9300			2.5		20	75	600	0.48	10	130
1977	9	B	6	0-5		29.4 *		3		30	48		14800			2.5		38	288	1200	1.59	25	190
1977	9	B	6	0-5		18.2		3		28	48		14300			2.5		35	280	900	1.49	20	200
1977	9	B	6	0-5				3.5		8	50		12000			2.5		33	300	1100		15	205
1977	9	C	5	0-5		5.8		1.5		24	25		13600			2.5		29	65	700	0.71	16	120
1977	9	C	5	0-5		5.8		1.5		15	28		15000			2.5		30	75	700	0.62	13	120
1977	9	C	5	0-5		6.2		1.5		20	28		10500			2.5		28	75	700	0.57	25	115
1977	9	D	5	0-5		4.1		1		18	18		5000			2.5		15	85	700	0.71	2.5	95
1977	9	D	5	0-5		4.4		1		15	18		6300			2.5		13	85	600	0.72	20	95
1977	9	D	5	0-5		4.3		1		18	18		6300			2.5		13	70	600	0.6	2.5	100
1977	9	E	5	0-5		5.9		2.3		18	13		6500			2.5		15	45	500	0.36	2.5	65
1977	9	E	5	0-5		4.9		0.8		15	10		5300			2.5		10	35	500	0.35	2.5	70
1977	9	E	5	0-5		5.1		0.5		13	13		5800			2.5		13	45	600	0.35	10	65
1977	9	E	5	0-5		3.2		1		13	13		4700			2.5		13	35	600	0.5	13	53
1977	9	E	5	0-5		2.8		1		18	13		5500			2.5		13	40	500	0.53	15	55
1977	9	E	5	0-5		3.1		0.5		18	10		4800			2.5		13	35	600	0.5	2.5	55
1977	9	E	6	0-5		3.2		0.5		13	13		5000			2.5		15	30	500	0.42	2.5	65
1977	9	E	6	0-5		3		0.5		13	13		5800			2.5		15	35	600	0.39	2.5	65
1977	9	E	6	0-5		2.9		1		15	10		5500			13 *		13	30	500	0.48	2.5	60
1977	9	E	6	0-5		5.2		1		25	33		10800			2.5		30	55	600	0.72	35	85
1977	9	E	6	0-5		5.3		1.5		23	33		14000			2.5		33	40	600	0.6	40	80
1977	9	E	6	0-5		5.4		1.5		25	33		10800			2.5		33	40	600	0.66	25	85

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	9	D	6	0-5		5		0.9		29	28		13800			2.5		23	66	800	0.75	20	110
1977	9	D	6	0-5		5		0.8		23	30		11400			5 *		25	70	700	0.81	15	115
1977	9	D	6	0-5		5.7		1		15	30		9300			5 *		25	70	800	0.91	15	113
1977	9	C	6	0-5		6		1.5		13	23		11600			8 *		28	110	700	0.68	25	118
1977	9	C	6	0-5		6.1		1.5		15	25		9500			5 *		25	133	800	0.53	23	128
1977	9	C	6	0-5		6.2		1.8		15	25		12400			5 *		28	125	800	0.57	20	128
1977	9	B	7	0-5		6.9		1.5		20	40		11600			2.5		30	243	800	1.62	18	333
1977	9	B	7	0-5		7.7		1.5		20	45		12000			5 *		30	633 *	800	1.3	20	338
1977	9	B	7	0-5		7.6		2		15	50		13000			5 *		28	238	800	1.36	28	233
1977	9	B	8	0-5		5.9		1		15	18		11900			5 *		23	90	600	1.07	25	103
1977	9	B	8	0-5		5.3		1		13	25		9100			8 *		23	90	700	0.78	23	103
1977	9	B	8	0-5		5.5		1		20	25		11000			5 *		23	95	600	0.78	23	100
1977	9	C	7	0-5		6.9		1.3		23	33		12300			2.5		28	145	700	1.17	28	133
1977	9	C	7	0-5		6.8		0.8		20	38		13500			2.5		28	158	700	0.95	28	133
1977	9	C	7	0-5		6.8		0.8		18	40		12700			2.5		28	150	800	1.12	30	138
1977	9	D	7	0-5		8.4		2.5		25	38		12700			2.5		33	158	900	0.72	28	195
1977	9	D	7	0-5		6.9		1.5		23	30		11200			5 *		30	148	700	0.51	25	130
1977	9	D	7	0-5		8		1.3		33	33		11100			5 *		33	158	900	0.72	25	130
1977	9	E	7	0-5		6.8		1.5		35	30		9500			2.5		23	115	1100	1.18	25	130
1977	9	E	7	0-5		6.4		1		35	35		9800			2.5		23	118	1000	1.25	25	133
1977	9	E	7	0-5		6.2		1.3		30	33		12000			2.5		20	123	1000	1.16	25	133
1977	9	F	7	0-5		5.7		1.6		25	29		12900			2.5		24	64	900	0.86	30	84
1977	9	F	7	0-5		5.8		2.5		25	28		12000			2.5		25	68	800	0.78	33	95
1977	9	F	7	0-5		5.8		2.5		23	25		11300			2.5		25	108	800	0.59	33	85
1977	9	F	9	0-5		4.7		2		30	50		9600			2.5		28	55	800	0.75	33	78
1977	9	F	9	0-5		4.6		2		13	45		10500			2.5		25	58	700	0.81	35	85
1977	9	F	9	0-5		4.9		1.8		15	40		10800			2.5		25	55	700	0.69	33	93
1977	9	E	8	0-5		7.7		1.8		15	25		10300			2.5		28	50	800	0.78	35	93
1977	9	E	8	0-5		8.3		2.3		18	23		10500			2.5		28	50	800		35	93
1977	9	E	8	0-5		7.2		1.8		33	23		10300			2.5		25	50	900		33	85
1977	9	D	9	0-5		6.3		2.3		38	30		9100			2.5		25	125	800	0.78	30	103
1977	9	D	9	0-5		6		2.5		35	30		9100			2.5		23	130	1100	0.84	28	108
1977	9	D	9	0-5		5.7		2.5		38	33		10500			2.5		25	128	800	0.81	33	125
1977	9	C	8	0-5		7.2		2		18	30		10900			2.5		30	48	600	0.81	43	78
1977	9	C	8	0-5		6.9		2		33	28		8500			2.5		25	48	600	0.84	38	78
1977	9	C	8	0-5		6.8		1.3		33	28		10300			2.5		28	53	700	0.93	38	80
1977	9	B	9	0-5		24.2 *		2		35	58		10100			5 *		33	213	1100	1.83	35	158
1977	9	B	9	0-5		27.4 *		2.3		18	80		11500			5 *		35	275	1100	1.47	40	160
1977	9	B	9	0-5		24.2 *		2		20	73		10300			5 *		30	255	1000	1.84	38	158
1975	21	B	5	0-2				2.3						4600					225			70	248

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	23	D	5	0-5				1.3					4600						55				170
1977	23	D	5	0-5				1					3400						55				130
1977	23	D	5	0-5				1					3600						55				250
1978	24	D	8	0-5		7		2		20	24		17300				175	28	63			35	108
1978	24	D	8	0-5		7.4		2		21	25		17800				150	23	70			35	118
1978	24	D	8	0-5		6.9		2		23	25		19000				250	24	70			45	120
1978	24	D	8	0-5		6.9		1.8		22	25		17600				160	36	70			33	113
1978	24	D	8	0-5		6.4		1.8		25	25		17300				160	58	70			38	113
1978	24	D	8	0-5		6.5		1.8		24	26		17600				160	40	75			38	113
1979	25	B	5	0-5				0.25		8	14								25				65
1979	25	B	5	0-5				0.25		9	15								20				63
1979	25	B	5	0-5				0.25		5	13								20				55
1985	30	C	9	0-5				0.6		21	26		18000		200	1.2		18	78			29	130
1985	30	C	9	0-5				0.9		22	28		19000		210	1.3		19	91			32	160
1985	30	C	9	0-5				0.6		23	27		19000		250	1.2		20	73			34	130
1985	30	C	9	0-5				0.5		27	30		19000		140	1		20	50			35	170
1985	30	C	9	0-5				0.5		26	31		20000		150	1.1		21	53			38	110
1985	30	C	9	0-5				0.6		23	28		18000		130	1.3		19	49			32	110
1985	30	C	9	0-5				1.4		25	38		20000		220	1.9		21	130			32	190
1985	30	C	9	0-5				1.1		29	41		23000		210	2.3		24	130			39	200
1985	30	C	9	0-5				1		31	41		24000		240	2.1		26	150			39	210
1985	30	B	9	0-5				0.9		22	32		14000		190	2.2		26	100			22	190
1985	30	B	9	0-5				1		26	40		17000		290	2.6		21	140			23	190
1985	30	B	9	0-5				2.9		74 *	100		26000		360	4.2 *		46	510 *			31	640
1985	30	C	9	0-5				0.7		26	40		18000		250	1.8		18	99			31	150
1985	30	C	9	0-5				0.7		23	31		18000		250	1.4		17	66			29	120
1985	30	C	9	0-5				0.6		23	27		19000		290	1.3		18	55			32	170
1985	30	B	9	0-5				1.3		29	51		23000		290	2.1		26	230			34	230
1985	30	B	9	0-5				1.4		29	49		23000		300	2.2		24	230			33	260
1985	30	B	9	0-5				1.2		28	48		23000		290	2.3		24	240			32	230
1985	30	B	9	0-5				0.8		28	43		24000		460	1.3		24	120			37	180
1985	30	B	9	0-5				1.8		44	73		39000 *		720 *	2.5		38	200			60	350
1985	30	B	9	0-5				0.9		26	42		21000		350	1.5		21	140			31	230
1978	32	D	8	0-5				2		23	26		18900				175	29	85			3.5	134
1978	32	D	8	0-5				2		24	28		19800				225	31	88			40	150
1978	32	D	8	0-5				2		24	26		20500				225	30	88			43	133
1978	32	D	8	0-5				2		20	24		17300				175	28	63			35	108
1978	32	D	8	0-5				2		21	25		17800				150	23	70			35	118
1978	32	D	8	0-5				2		23	25		19000				250	24	70			45	120
1978	32	D	8	0-5				1.8		22	25		17600				160	36	70			33	113

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1978	32	D	8	0-5				1.8		25	25		17300				160	58	70			38	113
1978	32	D	8	0-5				1.8		24	26		17600				160	40	75			38	113
No. of samples that exceeded the Upper Limits of Normal						4	0	4	0	1	0	0	7	0	1	22	0	0	7	0	0	0	0

APPENDIX 2: Windsor Vegetation Data (Excluding Grass) for 1972 to 1986

YEAR SAMPLED	REPORT NO.	MAP N-S	COORD E-W	SAMPLE SOIL	TYPE VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1972	1	E	2		GLADIOLUS		10000		21500			3					2800 *			2200			
1972	1	E	2		GLADIOLUS		2600		26500			10					2900 *			4400 *			
1972	1	E	2		GLADIOLUS		12200		20500			3					2000 *			1500			
1972	1	E	2		GLADIOLUS		9800		18000			7					1000 *			2800			
1972	1	E	2		GLADIOLUS		6500		15000			3					1500 *			2400			
1972	1	E	2		GLADIOLUS		12000		16500			10					1500 *			3000			
1972	1	E	2		GLADIOLUS		8400		17000			7					1000 *			2700			
1972	1	E	2		GLADIOLUS		11000		15000			10					1700 *			2500			
1972	1	E	2		GLADIOLUS		12700		14000			7					1300 *			4900 *			
1972	1	E	2		GLADIOLUS		9200		13000			5					1000 *			3100			
1972	1	E	2		GLADIOLUS		7400		14000			5					1100 *			2200			
1972	1	E	2		WILLOW		12200		10000			30					3500 *			7300 *			
1972	1	E	2		WILLOW		12000		22000			55 *								3700			
1972	1	E	2		MAPLE		9000		4800			15					1700 *			1500			
1972	1	H	1		WILLOW		14000		1500			27					400 *			6000 *			
1972	1	H	1		MAPLE		14200		2100			32					500 *			3900			
1973	2	B	4		MAPLE			1											28			5	58
1973	2	B	4		MAPLE			1											18			5	20
1973	2	B	4		LILAC			2											18			5	79
1973	2	B	4		ELM			2											11			5	41
1973	2	B	5		MAPLE			1											22			5	74
1973	2	B	5		MAPLE			1											20			5	51
1973	2	B	6		MAPLE			1											13			5	35
1973	2	C	3		SUMAC			2											21			5	35
1973	2	C	3		SUMAC			1											14			5	45
1973	2	D	3		OAK			2											17			5	45
1973	3	C	4		MAPLE				1200			28								3200			
1973	3	C	3		MAPLE				2900			43 *								2800			
1973	3	F	1		MAPLE				2000			28								3200			
1972	4	G	7		PRIVET				1900								620 *						
1972	4	G	7		PRIVET				3000								650 *						
1975	6	D	9		MAPLE			0.3	2100			13	400						39	1900			35
1975	6	D	9		MAPLE			0.3	2400			15	400						38	1800			34
1975	6	D	9		MAPLE			0.6	2200			15	400						40	1700			36
1975	6	D	9		MAPLE			0.9	1600			22	620						37	2800			60
1975	6	D	9		MAPLE			0.9	1700			25	820						40	2800			60

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1975	6	D	9		MAPLE			0.9	1400			22	820						43	2700			62
1975	6	D	9		ELM			0.3	2600			13	240						22	2300			55
1975	6	D	9		ELM			0.6	2700			21	350						33	2300			55
1975	6	D	9		ELM			0.9	2700			20	350						26	2100			53
1975	6	B	4		M.MAPLE			0.5	2300			50 *	770						19	3500			22
1975	6	B	4		M.MAPLE			0.7	2000			38 *	700						10	3000			18
1975	6	B	4		M.MAPLE			0.4	2400			44 *	620						5	3400			17
1975	6	C	3		S.MAPLE			0.2	1000			122 *	650						11	3400			52
1975	6	C	3		S.MAPLE			0.2	800			151 *	720						12	3600			53
1975	6	C	3		S.MAPLE			0.3	900			122 *	500						10	3400			44
1975	6	D	3		OAK			0.4	500			13	180						16	2100			16
1975	6	D	3		OAK			0.2	300			9	190						15	2200			15
1975	6	D	3		OAK			0.5	300			7	180						28	2100			28
1975	6	E	2		S.MAPLE			0.5	1500			54 *	480						18	1700			41
1975	6	E	2		S.MAPLE			0.5	1600			48 *	490						21	1400			35
1975	6	E	2		S.MAPLE			0.5	1300			53 *	350						13	1500			33
1975	6	E	3		S.MAPLE			0.5	1500			33	450						15	1600			33
1975	6	E	3		S.MAPLE			0.4	1600			31	500						16	1400			34
1975	6	E	3		S.MAPLE			0.4	1400			24	420						14	1600			32
1975	6	E	4		S.MAPLE			1.1	1300			17	240						11	2800			50
1975	6	E	4		S.MAPLE			1.1	900			15	260						12	2700			41
1975	6	E	4		S.MAPLE			1.2	1100			15	230						18	700			39
1975	6	D	7		S.MAPLE			0.5	1100			13	250						11	2000			33
1975	6	D	7		S.MAPLE			0.7	1600			12	230						13	1800			30
1975	6	D	7		S.MAPLE			0.8	1300			11	180						10	2100			30
1975	6	D	4		M.MAPLE			1	1100			28	460						17	2400			28
1975	6	D	4		M.MAPLE			1.1	900			28	460						15	2200			20
1975	6	D	4		M.MAPLE			1	1000			32	350						13	2500			18
1975	6	C	4		S.MAPLE			1.2	1800			31	420						17	2700			46
1975	6	C	4		S.MAPLE			1.2	2200			28	470						15	2800			44
1975	6	C	4		S.MAPLE			1.1	2700			33	420						14	2800			43
1975	6	B	5		S.MAPLE			1.2	800			33	520						15	1800			26
1975	6	B	5		S.MAPLE			1.1	900			37 *	560						17	1800			27
1975	6	B	5		S.MAPLE			1	900			33	530						18	1800			24
1975	6	B	6		S.MAPLE			0.3	300			11	164						10	2300			37
1975	6	B	6		S.MAPLE			0.3	400			11	193						10	2100			38
1975	6	B	6		S.MAPLE			0.3	400			22	172						10	2600			40
1975	6	C	5		S.MAPLE			0.3	900			11	441						21	3300			27
1975	6	C	5		S.MAPLE			0.3	600			44 *	415						20	3600			30
1975	6	C	5		S.MAPLE			0.3	500			26	422						20	2900			25

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1975	6	D	5		S.MAPLE			0.3	1600			48 *	453						18	2100			32
1975	6	D	5		S.MAPLE			0.2	1300			27	521						18	2300			31
1975	6	D	5		S.MAPLE			0.3	1500			40 *	402						17	2100			27
1975	6	E	5		S.MAPLE			0.4	1600			39 *	464						18	2700			43
1975	6	E	5		S.MAPLE			0.5	1400			32	902						18	2600			39
1975	6	E	5		S.MAPLE			0.5	1600			34	443						16	2600			41
1975	6	E	5		S.MAPLE			0.3	800			16	221						14	1900			70
1975	6	E	5		S.MAPLE			0.3	700			18	278						15	2100			84
1975	6	E	5		S.MAPLE			0.4	700			18	227						15	2000			81
1975	6	E	6		S.MAPLE			0.3	600			12	205						10	1500			28
1975	6	E	6		S.MAPLE			0.4	300			16	232						9	2200			34
1975	6	E	6		S.MAPLE			0.3	400			15	244						10	1700			33
1975	6	E	6		S.MAPLE			0.3	1400			18	245						13	1700			41
1975	6	E	6		S.MAPLE			0.3	1300			12	248						12	2200			33
1975	6	E	6		S.MAPLE			0.3	1200			13	273						13	2500			35
1975	6	D	6		S.MAPLE			0.5	1400			16	289						10	2600			58
1975	6	D	6		S.MAPLE			0.4	1500			18	297						10	2600			53
1975	6	D	6		S.MAPLE			0.5	1400			15	263						10	2600			54
1975	6	C	6		S.MAPLE			0.5	2000			18	294						23	2800			45
1975	6	C	6		S.MAPLE			0.5	2400			15	211						21	2700			42
1975	6	C	6		S.MAPLE			0.2	2400			17	212						19	2600			40
1975	6	B	7		S.MAPLE			0.1	3700			14	228						12	1600			21
1975	6	B	7		S.MAPLE			0.1	3000			16	244						10	1700			21
1975	6	B	7		S.MAPLE			0.1	3900			14	217						10	1700			20
1975	6	B	8		S.MAPLE			0.3	1200			17	225						9	2300			33
1975	6	B	8		S.MAPLE			0.2	1500			17	208						9	2500			32
1975	6	B	8		S.MAPLE			0.2	2100			16	212						11	2600			34
1975	6	C	7		S.MAPLE			0.2	1800			22	287						13	1800			35
1975	6	C	7		S.MAPLE			0.2	1800			27	365						13	2200			32
1975	6	C	7		S.MAPLE			0.2	1100			22	302						12	2000			31
1975	6	D	7		S.MAPLE			0.2	300			6	114						11	1900			39
1975	6	D	7		S.MAPLE			0.3	700			18	209						17	2200			41
1975	6	D	7		S.MAPLE			0.3	500			17	187						14	2000			44
1975	6	E	7		S.MAPLE			0.4	2600			17	327						14	1700			28
1975	6	E	7		S.MAPLE			0.4	2000			16	276						11	2000			27
1975	6	E	7		S.MAPLE			0.3	2800			20	334						12	1700			30
1976	7	D	9		S.MAPLE			0.5											38				57
1976	7	D	9		S.MAPLE			0.5											47				63
1976	7	D	9		S.MAPLE			0.4											34				68
1976	7	D	9		ELM			0.3											24				32

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1976	7	D	9		ELM			0.2											20				33
1976	7	D	9		ELM			0.5											22				21
1976	7	D	9		S.MAPLE			0.3											33				32
1976	7	D	9		S.MAPLE			0.3											29				31
1976	7	D	9		S.MAPLE			0.4											27				34
1976	8	B	8		S.MAPLE			0.4					430						17	2300			52
1976	8	B	8		S.MAPLE			0.4					370						12	2000			45
1976	8	B	8		S.MAPLE			0.3					360						11	2000			46
1976	8	B	7		S.MAPLE			0.3					430						17	1900			48
1976	8	B	7		S.MAPLE			0.4					290						7	1900			45
1976	8	B	7		S.MAPLE			0.3					450						11	1800			42
1976	8	C	6		S.MAPLE			0.5					390						46	2600			67
1976	8	C	6		S.MAPLE			0.5					530						48	2800			70
1976	8	C	6		S.MAPLE			0.4					360						33	2400			57
1976	8	C	7		S.MAPLE			0.2					490						18	1500			58
1976	8	C	7		S.MAPLE			0.2					500						12	1400			61
1976	8	C	7		S.MAPLE			0.3					620						17	1500			65
1976	8	D	7		S.MAPLE			0.3					290						350 *	1600			57
1976	8	D	7		S.MAPLE			0.2					290						290 *	1400			51
1976	8	D	7		S.MAPLE			0.3					310						310 *	1400			56
1976	8	E	7		S.MAPLE			0.4					790						41	2200			82
1976	8	E	7		S.MAPLE			0.4					730						39	2300			115
1976	8	E	7		S.MAPLE			0.4					960						54	2100			87
1976	8	E	6		S.MAPLE			0.6					253						19	2700			38
1976	8	E	6		S.MAPLE			0.6					188						15	2200			28
1976	8	E	6		S.MAPLE			0.4					200						15	2500			32
1976	8	E	6		S.MAPLE			0.6					470						31	2500			83
1976	8	E	6		S.MAPLE			0.5					470						37	2200			73
1976	8	E	6		S.MAPLE			0.5					520						28	2800			58
1976	8	D	6		S.MAPLE			0.8					510						26	1900			100
1976	8	D	6		S.MAPLE			0.8					540						29	1900			76
1976	8	D	6		S.MAPLE			0.7					450						19	1900			92
1976	8	B	6		S.MAPLE			0.6					370						15	2200			74
1976	8	B	6		S.MAPLE			0.6					350						23	1900			76
1976	8	B	6		S.MAPLE			0.5					360						13	2200			58
1976	8	C	5		M.MAPLE			0.5					450						23	3000			32
1976	8	C	5		M.MAPLE			0.5					500						26	2900			39
1976	8	C	5		M.MAPLE			0.5					530						27	3000			45
1976	8	D	5		S.MAPLE			0.4					470						20	2100			40
1976	8	D	5		S.MAPLE			0.5					520						32	2200			52

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	P	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1976	8	D	5		S.MAPLE			0.4					560						38	2200			47
1976	8	E	5		S.MAPLE			1					420						38	2000			73
1976	8	E	5		S.MAPLE			0.9					510						39	2000			72
1976	8	E	5		S.MAPLE			0.8					430						40	1800			68
1976	8	E	5		S.MAPLE			0.5					481						51	2900			87
1976	8	E	5		S.MAPLE			0.5					486						44	2600			67
1976	8	E	5		S.MAPLE			0.4					346						43	2300			60
1976	8	E	4		S.MAPLE			0.4					150						13	2800			52
1976	8	E	4		S.MAPLE			0.5					313						13	2500			50
1976	8	E	4		S.MAPLE			0.4					318						13	2900			48
1976	8	D	7		S.MAPLE			0.4					345						16	2700			52
1976	8	D	7		S.MAPLE			0.4					296						16	1900			40
1976	8	D	7		S.MAPLE			0.7					216						15	1900			48
1976	8	D	4		M.MAPLE			0.6					670						31	3000			50
1976	8	D	4		M.MAPLE			0.4					530						26	2400			36
1976	8	D	4		M.MAPLE			0.4					560						24	2300			37
1976	8	C	4		S.MAPLE			0.5					470						13	2500			62
1976	8	C	4		S.MAPLE			0.5					550						16	2700			65
1976	8	C	4		S.MAPLE			0.5					450						20	2500			55
1976	8	B	5		S.MAPLE			0.7					710						29	2100			53
1976	8	B	5		S.MAPLE			0.6					690						22	1800			60
1976	8	B	5		S.MAPLE			0.6					660						27	1900			56
1976	8	B	4		M.MAPLE			0.8					1580 *						27	2800			41
1976	8	B	4		M.MAPLE			0.7					1300 *						27	2700			50
1976	8	B	4		M.MAPLE			0.6					1300 *						21	2700			34
1976	8	C	3		S.MAPLE			0.6					1000						19	1600			85
1976	8	C	3		S.MAPLE			0.5					760						16	1600			87
1976	8	C	3		S.MAPLE			0.6					890						20	1600			85
1976	8	D	3		R.OAK			0.3					284						20	2100			36
1976	8	D	3		R.OAK			0.4					262						17	2200			40
1976	8	D	3		R.OAK			0.3					240						16	1900			47
1976	8	E	2		S.MAPLE			0.7					980						45	2100			184
1976	8	E	2		S.MAPLE			0.6					870						34	2100			180
1976	8	E	2		S.MAPLE			1					1000						43	1800			168
1976	8	E	3		S.MAPLE			0.5					730						22	1800			112
1976	8	E	3		S.MAPLE			0.6					760						22	1600			116
1976	8	E	3		S.MAPLE			0.5					890						22	2000			112
1977	9	B	4		M.MAPLE	0.6		0.8	5700	3	8	40 *	700			1		3	27	3200	0.43	3	28
1977	9	B	4		M.MAPLE	0.5		0.8	3400	3	7	42 *	628			1		5	19	3400	0.34	3	27
1977	9	B	4		M.MAPLE	0.5		0.5	2700	4	8	44 *	660			1		4	22	3100	0.47	1	29

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	9	C	3		S.MAPLE	0.5		1	1300	4	7	117 *	540			1		5	21	1300	0.28	3	56
1977	9	C	3		S.MAPLE	0.4		1.5	1400	1	8	117 *	550			1		4	20	1200	0.36	0.5	52
1977	9	C	3		S.MAPLE	0.5		0.4	1400	3	6	130 *	730			1		4	21	1100	0.27	0.5	55
1977	9	D	3		S.MAPLE	0.4		0.6	800	4	11	56 *	540			1		4	18	2500	0.31	2	53
1977	9	D	3		S.MAPLE	0.4		0.9	800	3	10	48 *	430			1		4	19	2000	0.36	3	61
1977	9	D	3		S.MAPLE	0.4		0.6	700	4	11	45 *	510			1		5	18	2600	0.23	3	64
1977	9	E	2		S.MAPLE	0.5		1.1	3200	3	8	56 *	620			1		5	24	1400	0.2	2	60
1977	9	E	2		S.MAPLE	0.4		1.1	3400	4	8	24	560			1		4	22	1600	0.15	2	70
1977	9	E	2		S.MAPLE	0.4		0.9	2700	3	8	46 *	510			1		4	22	1600	0.16	1	55
1977	9	E	2		M.MAPLE	0.4		0.7	3400	3	4	9	410			1		3	20	2800	0.11	1	33
1977	9	E	2		M.MAPLE	0.3		0.6	3900	4	6	6	390			1		3	14	2900	0.09	1	36
1977	9	E	2		M.MAPLE	0.15		0.3	3900	4	6	8	400			1		3	16	2700	0.08	2	38
1977	9	E	3		S.MAPLE	0.15		0.7	1400	4	9	23	460			1		4	12	1900	0.22	1	49
1977	9	E	3		S.MAPLE	0.4		1	2100	4	10	25	360			1		5	11	1700	0.2	1	39
1977	9	E	3		S.MAPLE	0.5		1	1500	3	13	27	510			1		3	14	2000	0.21	1	47
1977	9	E	4		S.MAPLE	0.3		0.7	700	3	6	9	260			1		3	8	1700	0.18	1	43
1977	9	E	4		S.MAPLE	0.15		0.6	500	3	6	7	210			1		2	4	2200	0.1	1	43
1977	9	E	4		S.MAPLE	0.15		0.2	400	2	8	5	210			1		3	4	2400	0.12	1	53
1977	9	D	4		S.MAPLE	0.4		0.5	900	4	12	27	430			1		4	15	2100	0.21	1	57
1977	9	D	4		S.MAPLE	0.4		1	1200	3	10	30	420			1		3	13	2100	0.21	1	62
1977	9	D	4		S.MAPLE	0.4		0.7	400	3	11	34	460			1		4	11	2200	0.25	1	74
1977	9	D	4		M.MAPLE	0.3		0.6	1700	4	6	14	440			1		3	16	2600	0.21	1	28
1977	9	D	4		M.MAPLE	0.15		1.3	1200	2	5	17	360			1		4	14	2400	0.17	1	25
1977	9	D	4		M.MAPLE	0.15		0.6	1700	3	6	21	450			1		4	7	2700	0.16	1	22
1977	9	C	4		S.MAPLE	0.5		1	1400	5	6	37 *	670			1		5	25	2100	0.32	1	44
1977	9	C	4		S.MAPLE	0.4		1.8	1300	6	6	35	510			1		3	19	2000	0.32	1	38
1977	9	C	4		S.MAPLE	0.4			1400			40 *								2200	0.4		
1977	9	B	5		S.MAPLE	0.8		1	1300	7	23 *	34	710			1		5	26	2100	0.45	1	49
1977	9	B	5		S.MAPLE	0.7		0.6	1200	5	25 *	37 *	800			1		6	28	2300	0.39	1	50
1977	9	B	5		S.MAPLE	0.6		0.5	1300	9 *	39 *	31	670			1		5	25	2100	0.43	1	48
1977	9	B	6		S.MAPLE	0.4		1.3	2400	6	15	23	560			1		5	29	2200	0.29	1	44
1977	9	B	6		S.MAPLE	0.4		1.2	1800	6	20	24	620			1		6	29	2200	0.28	1	57
1977	9	B	6		S.MAPLE	0.4		0.6	1700	6	12	20	450			1		3	26	2100	0.19	1	40
1977	9	C	5		M.MAPLE	0.4		0.6	400	5	5	14	495			1		5	23	3800	0.38	3	28
1977	9	C	5		M.MAPLE	0.4		0.4	500	4	4	12	405			1		4	19	3600	0.38	1	24
1977	9	C	5		M.MAPLE	0.3		0.3	500	5	6	15	445			1		4	22	3400	0.46	2	30
1977	9	D	5		S.MAPLE	0.4		0.7	1600	4	7	26	430			1		4	26	2200	0.23	1	40
1977	9	D	5		S.MAPLE	0.4		0.7	1600	5	6	21	350			1		3	20	2000	0.21	6 *	34
1977	9	D	5		S.MAPLE	0.3		0.4	1700	3	8	22	420			1		3	30	2300	0.23	1	40
1977	9	E	5		S.MAPLE	0.3		0.4	1800	4	9	26	400			1		3	18	1900	0.13	1	77

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	9	E	5		S.MAPLE	0.4		0.5	900	4	8	23	280			1		3	15	1900	0.22	1	57
1977	9	E	5		S.MAPLE	0.15		0.7	1200	5	8	23	350			1		3	18	1900	0.14	1	64
1977	9	E	5		S.MAPLE	0.3		0.2	1100	4	8	14	240			1		3	21	1900	0.16	1	47
1977	9	E	5		S.MAPLE	0.15		0.2	1100	3	8	12	220			1		2	18	2000	0.11	1	55
1977	9	E	5		S.MAPLE	0.15		0.3	1100	4	8	14	280			1		2	18	2100	0.15	1	51
1977	9	E	6		S.MAPLE			0.4		3	8		250			1		3	6	1700		1	27
1977	9	E	6		S.MAPLE			0.5		4	8		210			1		3	10	1900		1	27
1977	9	E	6		S.MAPLE	0.15		0.3	1000	4	7	19	260			1		4	12	1500	0.13	1	32
1977	9	E	6		S.MAPLE	0.3		0.3	1100	3	10	10	220			1		4	14	1700	0.16	1	36
1977	9	E	6		S.MAPLE	0.3		0.8	1300	4	8	13	260			1		3	15	1800	0.17	1	34
1977	9	E	6		S.MAPLE	0.3		0.3	1400	2	9	12	250			1		3	18	1900	0.15	1	36
1977	9	D	6		S.MAPLE	0.4		0.5	1400	4	11	14	300			1		4	17	2300	0.24	1	65
1977	9	D	6		S.MAPLE	0.5		0.8	1400	4	10	12	310			1		3	11	2300	0.19	1	65
1977	9	D	6		S.MAPLE	0.4		0.4	1400	4	12	13	310			1		3	12	2700	0.24	5	71
1977	9	C	6		S.MAPLE	0.15		0.3	1600	5	9	14	298			1		3	29	2100	0.21	1	47
1977	9	C	6		S.MAPLE	0.15		0.3	1400	3	9	12	330			1		3	27	2100	0.15	1	45
1977	9	C	6		S.MAPLE	0.15		0.4	1000	2	6	13	280			1		4	15	2100	0.13	1	34
1977	9	B	7		S.MAPLE	0.15		0.4	2200	5	9	16	430			1		6	21	1900	0.29	1	29
1977	9	B	7		S.MAPLE	0.15		0.4	2700	3	9	13	440			1		7	20	2300	0.24	1	24
1977	9	B	7		S.MAPLE	0.15		0.3	2800	4	9	18	500			1		7	26	2000	0.32	1	26
1977	9	B	8		S.MAPLE	0.15		0.3	2800	4	6	14	280			1		3	20	2000	0.53	1	28
1977	9	B	8		S.MAPLE	0.15		0.3	2400	4	4	14	280			1		4	14	2000	0.69	1	27
1977	9	B	8		S.MAPLE	0.15		0.4	2300	4	4	16	320			1		3	16	2000	0.67	1	20
1977	9	C	7		S.MAPLE	0.15		0.4	1900	4	5	17	560			1		3	18	2000	0.32	1	36
1977	9	C	7		S.MAPLE	0.15		0.2	1400	4	5	21	730			1		3	20	1800	0.36	1	40
1977	9	C	7		S.MAPLE	0.15		0.2	1600	4	6	16	530			1		4	19	2000	0.27	1	32
1977	9	D	7		S.MAPLE	0.15		0.2	900	2	6	8	274			1		3	15	2700	0.3	1	50
1977	9	D	7		S.MAPLE	0.15		0.2	400	5	3	11	300			1		1	17	2200	0.24	1	50
1977	9	D	7		S.MAPLE	0.15		0.2	500	3	4	9	220			1		1	15	2700	0.29	1	41
1977	9	E	7		S.MAPLE	0.6		0.3	1900	5	5	16	800			1		3	21	1600	0.21	1	18
1977	9	E	7		S.MAPLE	0.5		0.2	1600	6	10	17	800			1		3	24	1900	0.19	1	21
1977	9	E	7		S.MAPLE	0.4		0.3	2200	5	7	13	700			1		3	23	1700	0.2	1	38
1977	9	F	7		S.MAPLE	0.4		0.6	400	4	10	7	260			1		3	11	1900	0.22	1	28
1977	9	F	7		S.MAPLE	0.3		0.2	500	3	7	7	284			1		7	9	2100	0.26	1	29
1977	9	F	7		S.MAPLE	0.3		0.2	300	2	5	12	270			1		3	8	1700	0.19	1	24
1977	9	F	9		S.MAPLE	0.4		0.5	1100	4	7	13	310			1		4	10	2600	0.19	1	31
1977	9	F	9		S.MAPLE	0.4		0.5	1000	3	8	13	310			1		2	15	2500	0.19	1	40
1977	9	F	9		S.MAPLE	0.15		0.6	1200	3	8	10	260			1		3	16	2100	0.16	1	33
1977	9	E	8		S.MAPLE	0.5		1		4	8		450			1		4	16	1500	0.24	1	38
1977	9	E	8		S.MAPLE	0.5		0.8	1900	5	7	11	520			1		4	15	1400	0.21	1	45

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	9	E	8		S.MAPLE	0.4		0.7	1800	4	7	11	440			1		3	15	1900	0.27	1	41
1977	9	D	9		S.MAPLE	0.15		0.5	2200	5	9	8	310			1		3	13	2500	0.39	1	24
1977	9	D	9		S.MAPLE	0.15		0.5	1600	5	7	10	350			1		2	14	1400	0.4	1	25
1977	9	D	9		S.MAPLE	0.15		0.6	1700	4	7	10	300			1		2	14	1900	0.44	1	22
1977	9	C	8		S.MAPLE	0.3		0.7	2700	7	8	17	420			1		3	18	2100	0.35	1	26
1977	9	C	8		S.MAPLE	0.3		0.5	2600	6	7	22	460			1		3	20	1900	0.41	1	17
1977	9	C	8		S.MAPLE	0.4		0.5	2700	4	7	19	450			1		4	22	2100	0.43	1	22
1977	9	B	9		S.MAPLE	0.4		0.9	1900	6	11	24	610			1		4	19	1700	0.31	1	61
1977	9	B	9		S.MAPLE	0.3		0.7	1800	5	14	23	550			1		3	26	1300	0.36	1	58
1977	9	B	9		S.MAPLE	0.4		0.9	2000	5	14	25	580			1		3	35	1700	0.33	1	61
1979	13	C	4		S.MAPLE				1400			32	1000				107						
1979	13	C	4		S.MAPLE				1900			39 *	970				100						
1979	13	C	4		S.MAPLE				1800			42 *	970				105						
1979	13	C	3		S.MAPLE				1400			113 *	1030 *				154						
1979	13	C	3		S.MAPLE				1700			113 *	1000				156						
1979	13	C	3		S.MAPLE				1600			100 *	860				144						
1979	13	E	3		S.MAPLE				1300			42 *	560				129						
1979	13	E	3		S.MAPLE				2400			37 *	520				144						
1979	13	E	3		S.MAPLE				1700			37 *	570				126						
1979	13	D	4		S.MAPLE				1800			61 *	800				170						
1979	13	D	4		S.MAPLE				2300			58 *	880				158						
1979	13	D	4		S.MAPLE				2200			66 *	960				158						
1979	13	C	4		S.MAPLE				2500			33	590				156						
1979	13	C	4		S.MAPLE				2900			33	610				135						
1979	13	C	4		S.MAPLE				2600			27	560				177						
1979	13	B	5		S.MAPLE				3500			64 *	1320 *				300						
1979	13	B	5		S.MAPLE				2900			64 *	1030 *				290						
1979	13	B	5		S.MAPLE				3600			67 *	1460 *				300						
1979	13	C	4		S.MAPLE				1000			46 *	810				105						
1979	13	C	4		S.MAPLE				700			38 *	730				100						
1979	13	C	4		S.MAPLE				900			41 *	800				123						
1975	20	E	7		S.MAPLE				600			19							22	2200			
1975	20	E	7		S.MAPLE				300			19							18	1900			
1975	20	E	7		S.MAPLE				1100			20							17	2100			
1975	20	G	6		S.MAPLE				600			14							12	1800			
1975	20	G	6		S.MAPLE				500			15							17	1800			
1975	20	G	8		S.MAPLE				800			14							20	2200			
1975	21	B	5		GRAPE			0.8						3500					16			2	30
1975	21	B	5		GRAPE			0.8						3700					14			3	26
1975	21	B	5		GRAPE			0.9						3200					15			3	32

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1975	21	B	6		LETTUCE			1											15			8 *	82
1977	22	B	4		S.MAPLE				200			10								2000			
1977	22	B	4		S.MAPLE				200			16								2300			
1977	22	B	4		S.MAPLE				200			10								2200			
1977	23	D	5		S.MAPLE			0.3	1400			19	310						13	3100			55
1977	23	D	5		S.MAPLE			0.5	1800			20	320						12	3700			134
1977	23	D	5		S.MAPLE			0.4	1200			19	220						10	2400			32
1978	24	D	8		OAK	0.15		1.4		2.8	7		230				55	3	10			2	50
1978	24	D	8		OAK	0.15		1.3		3	7		315				50	3	10			1	50
1978	24	D	8		OAK	0.15		1.2		2	7		290				60	3	13			2	52
1979	25	B	5		BEET LEAVES			0.3		1.5	9								1				38
1979	25	B	5		BEET LEAVES			0.3		2	9								1				43
1979	25	B	5		BEET LEAVES			0.4		2	10								1				52
1979	25	B	5		BEET ROOT			0.2		3	9								1				29
1979	25	B	5		BEET ROOT			0.2		2.5	30 *								1				34
1979	25	B	5		BEET ROOT			0.2		1.5	8								1				31
1979	25	B	5		LETTUCE			0.6		2.5	6								1				40
1979	25	B	5		LETTUCE			0.6		2.5	7								1				41
1979	25	B	5		LETTUCE			0.6		2.5	7								1				39
1979	25	B	5		SWISS CHARD			0.4		2	13								1				55
1979	25	B	5		SWISS CHARD			0.5		3	13								3				61
1979	25	B	5		SWISS CHARD			0.4		2	13								3				60
1981	26	D	9		N.MAPLE				25000								4400 *						
1981	26	D	9		N.MAPLE				16000								1920 *						
1981	26	D	9		N.MAPLE				33000								1530 *						
1981	26	D	9		N.MAPLE				7000								19						
1981	26	D	9		N.MAPLE				8000								40						
1981	26	D	9		N.MAPLE				7000								51						
1981	26	C	5		LILAC				2600			14	150				22						
1981	26	C	5		LILAC				6600			18	230				24						
1981	26	C	5		S.MAPLE				900			13	250				38						
1977	27	D	8		S.MAPLE															1600			
1977	27	D	8		S.MAPLE															1300			
1977	27	D	8		S.MAPLE															1500			
1977	27	D	8		S.MAPLE															1900			
1977	27	D	8		N.MAPLE															1800			
1977	27	D	8		N.MAPLE															1600			
1977	27	D	8		N.MAPLE															1900			
1977	27	D	8		N.MAPLE															2200			
1977	27	D	8		N.MAPLE															2900			

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1977	27	D	8		N.MAPLE															2000			
1985	28	E	7		S.MAPLE			0.05		3			740		18	0.25		1	8			0.5	34
1985	28	E	7		S.MAPLE			0.1		4			1100 *		26	0.6		2	12			0.5	40
1985	28	E	7		S.MAPLE			0.2		4			1000		25	0.25		1	11			1	40
1985	28	E	7		M.MAPLE			0.2		4			920		22	0.7		1	11			1	32
1985	28	E	7		M.MAPLE			0.3		5			1400 *		31	1.8 *		2	17			1	38
1985	28	E	7		M.MAPLE			0.2		4			1100 *		26	0.7		1	12			1	28
1986	29	F	9		S.MAPLE							8											
1986	29	F	9		S.MAPLE							15											
1986	29	F	9		M.MAPLE							19											
1986	29	F	9		M.MAPLE							20											
1986	29	F	9		M.MAPLE							19											
1986	29	F	9		M.MAPLE							15											
1986	29	F	9		S.MAPLE							14											
1986	29	F	9		S.MAPLE							7											
1986	29	F	9		S.MAPLE							5											
1986	29	F	9		S.MAPLE							4											
1986	29	F	9		S.MAPLE							20											
1986	29	F	9		S.MAPLE							15											
1986	29	F	9		M.MAPLE							20											
1986	29	F	9		M.MAPLE							14											
1986	29	F	9		M.MAPLE							19											
1986	29	F	9		M.MAPLE							12											
1986	29	F	9		M.MAPLE							7											
1986	29	F	9		M.MAPLE							6											
1986	29	F	9		S.MAPLE							6											
1986	29	F	9		S.MAPLE							17											
1986	29	F	9		M.MAPLE							13											
1986	29	F	9		M.MAPLE							17											
1985	30	C	9		S.MAPLE			0.1		1	17		190		14	0.6		0.5	4			0.5	46
1985	30	C	9		S.MAPLE			0.1		0.5	18		140		13	0.5		1	4			0.5	46
1985	30	C	9		S.MAPLE			0.1		1	18		220		15	0.6		0.5	5			0.5	44
1985	30	C	9		S.MAPLE			0.2		2	13		330		29	0.6		1	7			0.5	66
1985	30	C	9		S.MAPLE			0.1		1	18		330		16	0.5		0.5	7			0.5	74
1985	30	C	9		S.MAPLE			0.2		1	13		240		30	0.6		1	6			0.5	63
1985	30	C	9		S.MAPLE			0.05		2	9		470		24	0.6		0.5	5			0.5	41
1985	30	C	9		S.MAPLE			0.2		2	10		370		23	0.7		0.5	6			0.5	45
1985	30	C	9		S.MAPLE			0.1		2	9		380		25	0.7		0.5	5			0.5	44
1985	30	B	9		S.MAPLE			0.1		2	12		460		21	1.7 *		1	6			0.5	53
1985	30	B	9		S.MAPLE			0.2		2	11		470		23	1.4		1	5			0.5	55

SAMPLED	NO.	N-S	E-W	SOIL	VEG.	As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
1985	30	B	9		S.MAPLE			0.2		2	13		480		22	1.8 *		2	7			0.5	56
1985	30	C	9		S.MAPLE			0.2		2	8		460		24	0.7		1	13			0.5	59
1985	30	C	9		S.MAPLE			0.2		2	9		430		23	0.6		1	11			0.5	60
1985	30	C	9		S.MAPLE			0.1		2	10		440		23	0.7		1	12			0.5	58
1985	30	B	9		S.MAPLE			0.1		1	11		200		25	0.5		0.5	5			0.5	48
1985	30	B	9		S.MAPLE			0.1		1	11		240		30	0.5		1	6			0.5	47
1985	30	B	9		S.MAPLE			0.1		1	14		220		17	0.6		1	6			0.5	62
1985	30	B	9		S.MAPLE			0.2		1	6		300		41	0.6		0.5	6			0.5	39
1985	30	B	9		S.MAPLE			0.2		2	6		320		41	0.6		0.5	6			0.5	35
1985	30	B	9		S.MAPLE			0.2		2	6		280		45	0.6		0.5	6			0.5	41
1986	31	C	9		S.MAPLE			0.05		2	25 *		430		22	0.5		2	6			0.5	52
1986	31	C	9		S.MAPLE			0.05		2	29 *		510		23	0.7		2	7			0.5	62
1986	31	C	9		S.MAPLE			0.05		2	11		400		33	0.25		2	8			0.5	79
1986	31	C	9		S.MAPLE			0.05		2	10		460		39	0.25		2	8			0.5	84
1986	31	C	9		S.MAPLE			0.05		3	5		780		25	0.9		3	10			0.5	56
1986	31	B	9		S.MAPLE			0.05		3	5		720		24	0.7		3	8			0.5	52
1986	31	B	9		S.MAPLE			0.05		2	6		660		20	0.9		2	5			0.5	36
1986	31	C	9		S.MAPLE			0.05		3	6		860		25	0.25		1	0.5			0.5	42
1986	31	C	9		S.MAPLE			0.2		2	11		390		21	0.7		2	8			0.5	56
1986	31	B	9		S.MAPLE			0.05		1	11		290		17	0.25		1	5			0.5	49
1986	31	B	9		S.MAPLE			0.05		1	13		240		30	0.25		1	4			0.5	42
1986	31	B	9		S.MAPLE			0.05		2	13		300		31	0.25		2	5			0.5	47
1986	31	B	9		S.MAPLE			0.1		3	9		740		27	1		3	16			0.5	76
1986	31	B	9		S.MAPLE			0.05		3	13		780		24	1.2		3	19			0.5	75
1986	31	B	9		S.MAPLE			0.05		2	11		380		17	0.6		1	6			0.5	36
1986	31	B	9		S.MAPLE			0.05		2	10		370		18	0.25		0.5	6			0.5	34
1986	31	B	9		S.MAPLE			0.1		2	9		390		54	0.6		1	3			0.5	37
1986	31	B	9		S.MAPLE			0.05		2	9		470		52	0.7		1	4			0.5	37
1978	32	D	8		OAK			1		2.5	7		280				95	3.5	10			2	75
1978	32	D	8		OAK			1.1		2.6	7		320				110	4.5	10			1	75
1978	32	D	8		OAK			1.2		2.4	6		265				100	3	10			2	65
1978	32	D	8		OAK			0.7		2.3	5		260				50	4	8			2	27
1978	32	D	8		OAK			0.7		2.4	5		270				65	4	8			2	30
1978	32	D	8		OAK			0.7		2.4	5		285				60	4.5	8			2	30
1978	32	D	8		OAK			1.4		2.8	7		230				55	3	10			2	50
1978	32	D	8		OAK			1.3		3	7		315				50	3	10			1	50
1978	32	D	8		OAK			1.2		2	7		290				60	3	13			2	52
No. of samples that exceed the Upper Limits of Normal						0	0	0	0	1	6	47	10	0	0	3	20	0	3	4	0	2	0

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APPENDIX 3

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DERIVATION AND SIGNIFICANCE OF MOE "UPPER LIMITS OF NORMAL" CONTAMINANT GUIDELINES

The MOE "upper limits of normal" contaminant guidelines shown in the attached table essentially represent the expected maximum concentrations of contaminants in surface soil (non-agricultural), foliage (deciduous and current year coniferous trees and shrubs), grass, moss bags and/or snow from areas of Ontario not subject to the influence of point sources of emissions. "Urban" guidelines are based upon samples collected from centres of minimum 10,000 population. "Rural" guidelines are based upon samples collected from non-built-up areas. Samples were collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch; Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are "normal", 99% of all contaminant concentration results for samples from "background" locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are "non-normal", the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie within the observed upper range of MOE results for Ontario samples. Geometric means were not employed in calculating the guidelines because: 1) tests of two representative non-normal distributions showed that normality was not significantly improved by using log-transformed data, and 2) the guideline concentrations calculated using the geometric mean were considerably higher than the maximum observed concentrations.

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Due to the large variability in element concentrations which may be present across Ontario, even in background data, control samples should always be collected. This is particularly important for soils, which may show large regional variations in element composition due to differences in parent material. Species of vegetation which naturally accumulate high levels of an element also may be encountered.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of above-normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines would not normally be considered toxic. A brief review of world literature has shown that the guideline concentrations are generally within the ranges of results reported by other investigators.

The table of guidelines will be expanded and revised as more data become available.

(August, 1986)

PH74/12

Contaminant Guidelines Representing Upper Limits of Normal Concentrations (ppm, dry weight) of Parameters in Soil, Foliage, Grass, Moss Bags and Snow in Ontario (Urban and Rural). The guidelines are approximately equal to the mean of the data plus three standard deviations.

Parameter	Soil (0-5 cm) Urban	Soil (0-5 cm) Rural	Foliage (unwashed) Urban	Foliage (unwashed) Rural	Grass (unwashed) Rural	Moss Bags++ Urban	Moss Bags++ Rural	Snow+++ Rural
Aluminum	a	a	500***	500	a	a	1700	0.6
Antimony	8	1**	0.5**	0.3**	a	2	a	a
Arsenic	20	10	2	0.5, 2*	c, 8*	2	1	0.04
Boron	15	10**	175	75	20	a	a	a
Cadmium	4	3, 4*	3+	1+	0.5, 2*	4	2	0.003
Calcium	b	b	a	3%	a	a	a	2
Chloride	a	a	b	0.15%	1%	a	0.03%	4
Chromium	50	50	8	8	5	7	a	a
Cobalt	25***	25	2***	2	2, 8*	6	a	c
Copper	100	60	20	20	7, 20*	60	8	0.06
Fluoride	a	a	35	15	12	a	45	a
Iron	3.5%***	3.5%	1000	500	500	3000	1700	0.7
Lead	500	150	60	30	20	200	35	0.07
Magnesium	a	1%	0.7%	0.7%	a	a	a	0.4
Manganese	700	700, 1000*	b	b	50, a*	a	a	a
Mercury	0.5	0.15	0.3	0.1	a	a	0.2	0.0001**
Molybdenum	3	2**	1.5	1.5	6	a	a	a
Nickel	60***	60	7	5, 30*	5, 25*	13	6	0.04
Nitrogen	a	a	b	b	b	a	a	1 (as nitrate)
Phosphorus	a	a	a	a	a	a	a	0.04
Potassium	a	d	a	a	a	a	a	1
Selenium	2	2	0.7	0.5	0.5	a	0.6	a
Silver	c	a	a	a	a	a	a	a
Sodium	a	a	350	50	a	a	b	2
Sulphur	a	0.1%	0.4%	0.4%	0.5%	a	0.1%	3 (as sulphate)
Vanadium	70	70	5***	5	6	a	c	a
Zinc	500	500	250***	250+	40, 100*	800	100	0.3
Alkalinity	n.a	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5.5
Conductivity	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	60
Suspended Solids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	30

Notes:

* Where two values are shown, the first is based mainly on Southern Ontario data while the second is based on NE Region data. Also, there are indications that some of the guidelines, at least for foliage, may be somewhat liberal for the NW Region. THESE GUIDELINES ARE MEANT TO SUPPLEMENT, RATHER THAN REPLACE, SPECIFIC CONTROL DATA.

** Provisional guideline estimated from range of results, pending additional data.

*** Rural results higher than urban results - urban guideline based on rural results.

+ Data for species considered to be accumulators (Populus spp., Betula spp., Salix spp.) excluded.

++ Moss bag guidelines based on 30 day exposure. No data from NE Region.

+++ Snow guidelines are mg/l of meltwater, except conductivity which is µmhos/cm. Based mainly on NW and NE Region data.

a Sample size insufficient (< 30) to establish guideline.

b Concentration highly variable - guideline not established.

c 50% or more of results less than detection limit - guideline not established.

d Discrepancy between Ontario data and literature values - guideline not established.

n.a. not applicable.

rev. Aug. 1986

APPENDIX 4

Ontario

Ministry
of the
Environment

135 St. Clair Avenue West
Suite 100
Toronto Ontario
M4V 1P5

June 16, 1981

MEMORANDUM

TO: Dr. G. Van Volkenburgh
Director
Air Resources Branch

FROM: S.N. Linzon, Supervisor
Phytotoxicology Section
Air Resources Branch

SUBJECT: Phytotoxicology Surveys
West-Windsor 1975-1979

Please find attached a report of phytotoxicology surveys conducted in the west end of Windsor during the years 1975 through 1979. Thirty sampling stations were established in a grid fashion and soil and vegetation were sampled annually for chemical analysis. Excessive levels of fluoride and iron were found at westerly stations influenced by emissions from the Zug Island area industries in Michigan.

S.N. Linzon

S.N. LINZON, Ph.D.

SNL/hm

Attach.

c.c. F.N. Durham
C. Schenk

Ont.

Ministry
of the
Environment

135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

An Examination of Fluoride, Chloride, Metals and Sulphur Contamination of Vegetation and Soils in West Windsor, 1975 to 1979

Phytotoxicology Section
Air Resources Branch

PURPOSE OF THE STUDY

In 1975 Phytotoxicology Section activities in the west half of the City of Windsor were expanded to determine the existence and extent of airborne contamination of vegetation and soils. The new expanded survey was designed not to supplant air quality data but to augment it by assessing the fate of several airborne contaminants and their possible effect on vegetation. Furthermore the survey was not designed to monitor particular industries and may, by virtue of the rather large grid pattern utilized, have missed detecting small, localized point sources of one or more of the contaminants.

SURVEY DESIGN

During the second week of August in 1975, 1976 and 1977 triplicate samples each of vegetation (silver or Manitoba maple) foliage and of soils (0-5 cm depths) were collected at 24 (1975 and 1976) or 30 (1977) locations in west Windsor. In 1979 a similar sampling program was carried out at a smaller number (seven) of locations grouped around the Morton terminal area.

The western sector of Windsor was chosen because it has been the area considered most contaminated by various pollutants emitted from industries both in Canada (the J. Clark Keith power station, the salt mines, and a number of smaller industries) and in the United States (power generating stations, steel manufacturers, automobile manufacturers, etc.). Earlier Phytotoxicology Section surveys (2) had shown abnormally high fluoride levels in maple foliage in the area. Continuing air quality monitoring (1) has revealed fluoridation levels in the area frequently above the Provincial monthly criteria. Air Quality monitoring has also shown levels of chromium, cadmium, copper, iron, lead and sulphur dioxide to be consistently higher in West Windsor than in the surrounding areas.

Sampling sites were chosen with several criteria in mind. First, the sites should not have been disturbed recently (within at least 5 years) by grading or soil addition. The ages of trees growing in the immediate vicinity of the soil sampling sites were used as a normally reliable indicator of lack of such activity. Unused lands (open undeveloped areas common in Windsor by virtue of the fragmented nature of the urban development) were selected often. Secondly, sites were chosen wherever possible, well away (100 m if possible) from major thoroughfares in order to minimize the influence of vehicular activity. Finally, the pattern of sampling sites was generally that of a grid with intersects approximately 1.5 km apart, modified where necessary by the above considerations and by the availability of mature silver or Manitoba maple trees. Maples were chosen for their ubiquity, their size (not as easily shaded or protected by buildings and other trees as would less statuesque vegetation) and because this Section has over several years developed a substantial data base for these species.

All samples were transported to the Phytotoxicology Section processing laboratory in Toronto, dried, ground and submitted to the Vegetation and Soils Unit, Inorganic Trace Contaminants Section, Laboratory Services Branch for chemical analysis. Soil samples were passed through a 40 mesh sieve prior to submission for analysis. Soils were not analysed for either halide due to either the normally large background concentrations (fluorides) which easily mask small airborne additions or the high solubility (chlorides) which result in rapid leaching from soil.

The Phytotoxicology Section established in the early 1970's and has since updated, excessive concentration levels for various elements in vegetation foliage and/or soil, that serve as a guide to when an area or site can be considered significantly contaminated by man's activities. Concentrations which are considered excessive for the elements under study in these surveys are shown circled in each table of results.

RESULTS

(a) Fluoride

Results of the analyses of maple foliage samples collected 1975-1977, unwashed samples, are displayed in figures 1 through 3.

The fluoride contamination observed in West Windsor probably originated from two areas: Michigan, primarily in the vicinity of Zug Island, and the Morton Terminal. Previous Phytotoxicology Section Reports (3) have documented fluoride contamination near this Terminal. A comparison similar to that made in the 1970-1973 Phytotoxicology studies (2) is shown in Table 4. Fluoride levels at Mic Mac Park, after declining each year between 1970 and 1972, remained relatively constant in the following 5 years. At station 2 (Broadway and Sandwich) fluoride levels have remained relatively constant since 1970 with the possible exception of 1972.

Some anomalies exist in the data for the more inland locations, specifically the abnormally high concentrations at stations 13 and 24 in 1975 and the somewhat lower than would be expected fluoride concentrations in foliage samples from site 7 in 1975. The inconsistency of these results suggests that the degree of exposure of the sampled trees (not always the same trees were sampled each year) rather than local fluoride sources was the major influencing factor.

(b) Chloride

Chloride concentrations in maple foliage were low (generally less than 0.35% dry weight) throughout the survey area with the exception of those concentrations found at site 1 in 1976 and 1977, and that found at site 24 in 1976. All elevated results are probably the result of road deicing salt applications. A Phytotoxicology report (4) has documented a salt blow-off problem related to the Canadian Rock Salt Co. Ltd., however, this blow-off would be most likely detected at sites 2,3, or 4. Chlorides were not significantly higher at these sites than in the surrounding area.

(c) Sulphur

The area around sampling site 1 has been used for the disposal of sludge-like material with an apparently higher than normal organic content*. This has resulted in substantially higher than normal sulphur and iron concentrations in the soil. If these site 1 results are ignored however, no coherent pattern of sulphur contamination of soil remains in west Windsor. Vegetation foliage results for sulphur did show a vague trend with stations 1 and 2 in 1975, station 1 in 1977 and station 12 in all years somewhat higher than the apparently normal range of 0.15 to 0.25 percent of dry weight. Sulphur dioxide levels in air (1) do not appear to support a conclusion that these elevated sulphur concentrations are the result of foliar absorption from air. Ambient air quality, with respect to sulphur, improved through the period 1975-1977.

* This observation is based on both field observations and total carbon/organic carbon analyses (not shown) performed on the 1976 collection soils. This material did not however contain appreciably higher than normal concentrations of the other heavy metals.

(d) Iron

When, as above, site 1 soil results have been disregarded and the results of all year's collections for each site are averaged and presented in map form (Figure 4), it is apparent that iron concentrations in soil have been influenced by two general factors. Firstly, as a result of industrial and/or vehicular activity, iron concentrations in soils from mid-Windsor were higher than in soils from more southerly, less densely populated areas surveyed. Secondly, some iron contamination has originated in Michigan as evidenced by higher concentrations in soils from site 2. Vegetation foliage collections/analyses support these observations, in particular the second observation related to Michigan sources. Iron concentrations in vegetation were generally higher in 1976 with 4 results exceeding that level considered excessive by the Phytotoxicology Section.

(e) Lead

The lead concentrations in vegetation and soils are tabulated in tables 2 and 3 and shown graphically in figures 6 and 7. Lead concentrations in foliage were generally low and fell only roughly into 2 patterns: very slightly elevated levels along to the river's edge probably related to transboundary movement and somewhat elevated levels related to Hwy. 3 (Huron Church Road). From table 2 it is apparent that the markedly higher mean value from station 12 is due to the anamolous result from 1976 which probably should be disregarded.

Soil contamination fell into patterns more easily related to industrial and/or automobile activity. Transboundary movement of industry related contamination and automobile activity in downtown Windsor are strongly implicated.

(f) Cadmium

Cadmium concentrations in vegetation and soils are tabulated in Tables 2 and 3 and shown graphically in figures 8 and 9. Both vegetation and soils results show general trends of decreasing concentrations with increasing distance from the south Detroit industrial area. Downtown Windsor appears to have been the least contaminated area surveyed.

(g) Zinc

Zinc concentrations in vegetation and soils are tabulated in Tables 2 and 3 and shown graphically in Figures 10 and 11. Zinc levels in vegetation fall rather poorly into coherent patterns. Neither industrial or downtown Windsor nor industrial south Detroit appear to have contributed significantly. Soil zinc concentrations however did relate to both transboundary contamination and to downtown Windsor.

In 1977 samples of both tree foliage and soils were analysed for an additional seven elements: copper, chromium, molybdenum, nickel, vanadium, arsenic and selenium. These elements are occasionally associated with industrial activity. Vanadium and arsenic concentrations in soil were barely measurable in tree foliage collected at sites near the river but were at or below the analytical detection limit elsewhere. No coherent patterns of the other elements materialized.

DISCUSSION

Three general sources of contamination have influenced concentrations of fluoride, chloride, sulphur and heavy metals in soils and/or vegetation foliage in the West Windsor area: The industrialized areas of south Detroit particularly surrounding Zug Island, Michigan; the industrialized areas of west and central Windsor and vehicular activity in the general area.

The influence of the Zug Island area industries is evidenced by fluoride concentrations in vegetation foliage, iron in vegetation and soils and lead, cadmium and zinc in soils. In each year since 1970, fluoride concentrations in maple foliage from the Broadway and Sandwich area were found to exceed the Phytotoxicology Section excessive levels. Injury due to exposure to airborne fluorides has been observed each year since 1969 on wild grape foliage and occasionally on silver maple foliage growing in the Broadway/Sandwich Streets area. Although measureable, the elevation of metals concentrations was not great enough to visibly impair the health of vegetation.

The impact of Windsor industry is less easily distinguised. As noted above from earlier reports, emissions from the Canadian Rock Salt Company have influenced chloride levels in the vicinity of the company. An earlier Phytotoxicology report (4) described blow-off of sodium chloride from storage piles which caused injury to nearby vegetation. Later reports on the Morton Terminal area have indicated also some very localized salt contamination problems near the Rock Salt Company. In these same reports, the Morton Terminal fluorspar transhipment operation was shown to have had a measureable impact on fluoride concentrations in grass foliage from the vicinity of the Terminal buildings; but, as these reports also indicate, this problem is very localized and was not responsible for the generalized fluoride problem in west Windsor.

The impact of vehicular activity in central Windsor and possibly industrial activity in this area have resulted in elevated lead, iron and zinc levels in soils. Although significantly above background levels such concentrations have not visibly injured vegetation.

For the most part the levels of metals contamination were below those which we have found in Toronto. Table (5) is taken from Table 2.5-1 of the Working Group on Lead report 5 (1974) on Toronto lead levels in vegetation and soil. Virtually all Windsor results (only the anomolous site 12 excepted) for lead in vegetation fell well within that range referred to as "Suburban, remote from traffic and industry". All Windsor lead in soil results fell into "Suburban and/or downtown, remote from traffic and industry".

SUMMARY

Airborne contamination, the result of industrial and vehicular activity in the Windsor/Detroit area has resulted in elevated levels of several elements in soils and/or vegetation foliage in the west Windsor area. These contaminants include iron, lead, cadmium, zinc, fluoride and chloride. Only fluoride levels, detected in the docks area, were high enough to cause visible impairment to the health of sensitive vegetation.

D. S. Harper, Head
Controlled Environment Unit
Phytotoxicology Section

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4. Temple, P. J. (1972), Investigation of salt injury complaints to vegetation in the vicinity of the Ojibway Salt Mine, Canadian Rock Salt Co. Ltd., LaSalle, Ontario, July, 1972. A Phytotoxicology Section Report, Air Resources Branch, Ministry of the Environment.

5. Working Group on Lead (1974), Studies of the Relationship of Environmental Lead Levels and Human Lead Intake. Report to the Ontario Minister of the Environment.

TABLE 1

Fluoride, Chloride and Sulphur Concentrations in Maple Foliage Collected 1975 to 1979 in Windsor

Sampling Site No.	Maple Species Code (MM = Manitoba maple, SiM = silver maple)	Chemical Analyses Results by Element and year of collection (Unwashed Samples)										
		Sulphur (%, dry wt.)			Fluoride (ppm, dry wt.)				Chloride (%, dry wt.)			
		1975	1976	1977	1975	1976	1977	1979	1975	1976	1977	1979
1	MM	0.33	0.27	0.32	44	61	42	-	0.22	0.83	0.39	-
2	SiM	0.35	0.16	0.12	146	106	121	109	0.09	0.11	0.14	0.16
3	SiM (red oak in 1975 and 1976)	0.21	0.21	0.24	9	15	50	39	0.04	0.03	0.08	0.21
4	SiM	0.15	0.20	0.15	51	85	42	62	0.15	0.29	0.31	0.21
5	SiM	0.15	0.18	0.19	29	60	25	39	0.15	0.18	0.17	0.18
6	SiM	0.21	0.27	0.21	16	16	8	-	0.11	0.10	0.05	-
7	SiM	0.22	0.22	0.21	12	21	30	-	0.13	0.12	0.08	-
8	MM	0.15	0.26	0.26	29	34	17	42	0.10	0.19	0.15	0.09
9	SiM	0.28	0.26	0.21	31	33	37	31	0.22	0.24	0.14	0.27
10	SiM	0.18	0.19	0.22	34	49	34	65	0.09	0.14	0.13	0.33
11	SiM	0.23	0.22	0.22	15	26	22	-	0.04	0.29	0.20	-
12	MM	0.33	0.30	0.36	27	23	14	-	0.07	0.07	0.05	-
13	SiM	0.22	0.22	0.22	38	52	23	-	0.15	0.15	0.16	-
14	SiM	0.26	0.19	0.19	35	33	24	-	0.15	0.10	0.13	-
15	SiM	0.20	0.26	0.20	17	38	13	-	0.07	0.11	0.11	-
16	SiM	0.18	0.25	0.18	14	17	19	-	0.04	0.23	0.10	-
17	SiM	0.21	0.25	0.18	14	32	12	-	0.13	0.16	0.13	-
18	SiM	0.26	0.19	0.24	16	28	12	-	0.14	0.11	0.14	-
19	SiM	0.27	0.26	0.21	17	25	13	-	0.23	0.16	0.13	-
20	SiM	0.17	0.04	0.21	15	29	16	-	0.35	0.29	0.26	-
21	SiM	0.25	0.20	0.20	17	23	15	-	0.16	0.22	0.25	-
22	SiM	0.20	0.15	0.19	24	28	18	-	0.16	0.14	0.16	-
23	SiM	0.20	0.19	0.25	14	22	9	-	0.05	0.03	0.06	-
24	SiM	0.18	0.22	0.17	18	60	15	-	0.25	0.45	0.19	-
25	SiM	-	-	0.19	-	-	9	-	-	-	0.04	-
26	SiM	-	-	0.24	-	-	12	-	-	-	0.11	-
27	SiM	-	-	0.16	-	-	11	-	-	-	0.19	-
28	SiM	-	-	0.19	-	-	9	-	-	-	0.18	-
29	SiM	-	-	0.21	-	-	19	-	-	-	0.27	-
30	SiM	-	-	0.16	-	-	24	-	-	-	0.19	-
Phytotoxicology Excessive levels					35	35	35	35				

TABLE 2

Concentrations of Cadmium, Iron, Lead and Zinc in Tree Foliage Samples Collected in Windsor 1975 through 1977

(Unwashed Sample)
Element Concentration by year of collection
(ppm, dry weight)

Station #	Cadmium			Iron			Lead			Zinc		
	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
1	0.5	0.7	0.7	697	1393	663	11	25	23	19	42	28
2	0.2	0.6	0.9	623	847	640	11	18	20	50	86	54
3	0.4	0.3	0.7	183	262	493	20	18	18	38	41	59
4	0.5	0.8	1.0	440	950	563	17	41	23	36	177	63
5	0.4	0.5	0.5	457	793	400	15	22	17	33	113	35
6	1.1	0.4	0.5	243	260	227	14	13	5	43	50	46
7	0.7	0.5	0.7	220	286	437	11	16	13	31	47	64
8	1.0	0.5	0.8	423	587	417	15	27	14	22	41	29
9	1.2	0.5	0.6	437	490	613	15	16	23	44	61	44
10	1.1	0.6	0.7	537	687	727	17	26	27	26	56	49
11	0.3	0.6	1.1	176	360	543	10	17	28	38	69	47
12	0.3	0.5	0.4	426	493	448	20	92	21	27	39	27
13	0.3	0.4	0.6	459	517	400	18	30	25	30	46	38
14	0.5	0.9	0.5	603	453	343	17	39	17	41	71	66
15	0.3	0.5	0.2	242	438	247	15	46	19	78	71	51
16	0.3	0.5	0.4	227	214	240	10	16	9	32	33	29
17	0.3	0.5	0.5	255	487	243	13	32	16	36	71	35
18	0.5	0.8	0.6	283	500	307	10	25	13	55	89	67
19	0.4	0.5	0.3	239	427	303	21	42	24	42	65	42
20	0.2	0.4	0.4	230	390	457	11	12	22	21	45	26
21	0.2	0.4	0.3	215	387	293	10	13	17	33	48	25
22	0.2	0.2	0.2	318	537	607	13	16	19	33	61	36
23	0.3	0.3	0.2	170	297	265	14	19	16	41	55	47
24	0.4	0.4	0.3	312	827	767	12	45	23	28	95	26
25	-	-	0.3	-	-	221	-	-	9	-	-	27
26	-	-	0.5	-	-	307	-	-	14	-	-	35
27	-	-	0.8	-	-	470	-	-	15	-	-	41
28	-	-	0.5	-	-	320	-	-	14	-	-	24
29	-	-	0.6	-	-	433	-	-	20	-	-	22
30	-	-	0.8	-	-	567	-	-	27	-	-	60
Phyto-toxicology levels	5	5	5	800	800	800	100	100	100	250	250	250

TABLE 3

Average Concentrations of Sulphur and Four Metals in Soils Collected in West Windsor 1975 to 1977

Station No.	Concentration of element, dry weight analysis Sulphur (%)	Iron (%)	Lead (ppm)	Cadmium (ppm)	Zinc (ppm)	pH (1976)
1	0.43	3.1	225	3.1	258	7.2
2	0.11	2.7	154	3.4	315	6.7
3	0.09	1.4	89	2.2	209	6.2
4	0.08	1.3	105	2.4	197	7.3
5	0.07	0.82	47	1.7	97	6.7
6	0.05	0.97	45	1.9	77	6.7
7	0.09	1.1	54	2.2	114	6.6
8	0.05	1.0	40	2.1	81	7.5
9	0.08	1.6	69	1.4	127	6.0
10	0.08	1.3	108	1.7	190	7.7
11	0.08	1.4	225	1.9	194	7.0
12	0.07	1.6	69	1.4	127	6.0
13	0.07	0.83	75	1.0	76	6.6
14	0.05	0.96	41	1.0	76	6.6
15	0.07	0.87	223	1.0	171	7.0
16	0.06	0.88	44	0.9	82	5.8
17	0.06	1.5	51	1.4	108	7.3
18	0.08	1.5	156	1.3	181	6.6
19	0.07	1.4	158	1.3	176	6.9
20	0.06	1.4	297	1.2	262	6.7
21	0.06	1.4	116	1.1	147	6.7
22	0.07	1.7	163	1.2	180	6.5
23	0.07	1.7	131	1.4	138	7.6
24	0.08	1.6	126	1.4	180	7.6
25	0.08	1.2	80	2.2	88	-
26	0.07	1.0	56	1.9	85	-
27	0.08	1.0	50	2.0	90	-
28	0.08	1.0	128	2.4	112	-
29	0.06	1.0	50	1.8	79	-
30	0.11	1.1	248	2.1	159	-
Phyto-toxicology Excessive levels	-	-	600	8	400	-

TABLE 4

Fluoride Content of Maple foliage at two Locations in West Windsor, 1970 - 1979

Sampling Location	Sample Preparation*	Fluoride Content of Silver Maple Foliage (ppm, dry weight)							
		Aug.31 1970	Sept.23 1971	Sept.5 1972	Aug.22 1973	Aug.7 1975	Aug.10,11 1976	Aug.9,10 1977	Sept.26 1979
Mic Mac Park (1970-73) (Sta. 9 1975-77)	NW	(134)	(110)	28	35	31	33	(37)	31
	W	(137)	(90)	25	22	-	20	30	-
Broadway & Sandwich Streets (Sta. 2)	NW	(184)	(197)	(43)	(115)	(146)	(106)	(121)	(109)
	W	(57)	(107)	(40)	(62)	-	(65)	(83)	-
Phyto-toxicology Excessive Levels	NW	35	35	35	35	35	35	35	35
	W	-	-	-	-	-	-	-	-

* NW: unwashed preparation

W: washed preparation - one 30 second wash in 0.05% Alconox detergent, 0.05% EDTA followed by three 10 second rinses in distilled water.

TABLE 5

Classification of Toronto According to Expected Lead Levels in the Environment

	TYPE OF AREA	EXPECTED LEAD LEVELS SOIL (ppm)	VEGETATION (ppm) (not washed)
1.	Suburban, remote from traffic and industry.	20 - 200	1-50
2.	Downtown, away from traffic and industry.	100 - 400	50-100
3.	Downtown, 200-500 feet from expressway (remote from industry).	200 - 600	100-150
4.	Downtown, 10-50 feet from major arterial street (remote from industry).	200 - 600	100-150

FIGURE 1

MAP OF WEST WINDSOR SHOWING FLUORIDE CONTOURS FOR UNWASHED MAPLE FOLIAGE, COLLECTED AUGUST, 1975
(circled numbers represent sampling sites)

APPROXIMATE SCALE ON ALL MAPS:
1 inch = 0.5 mile
1 cm = 0.32 km

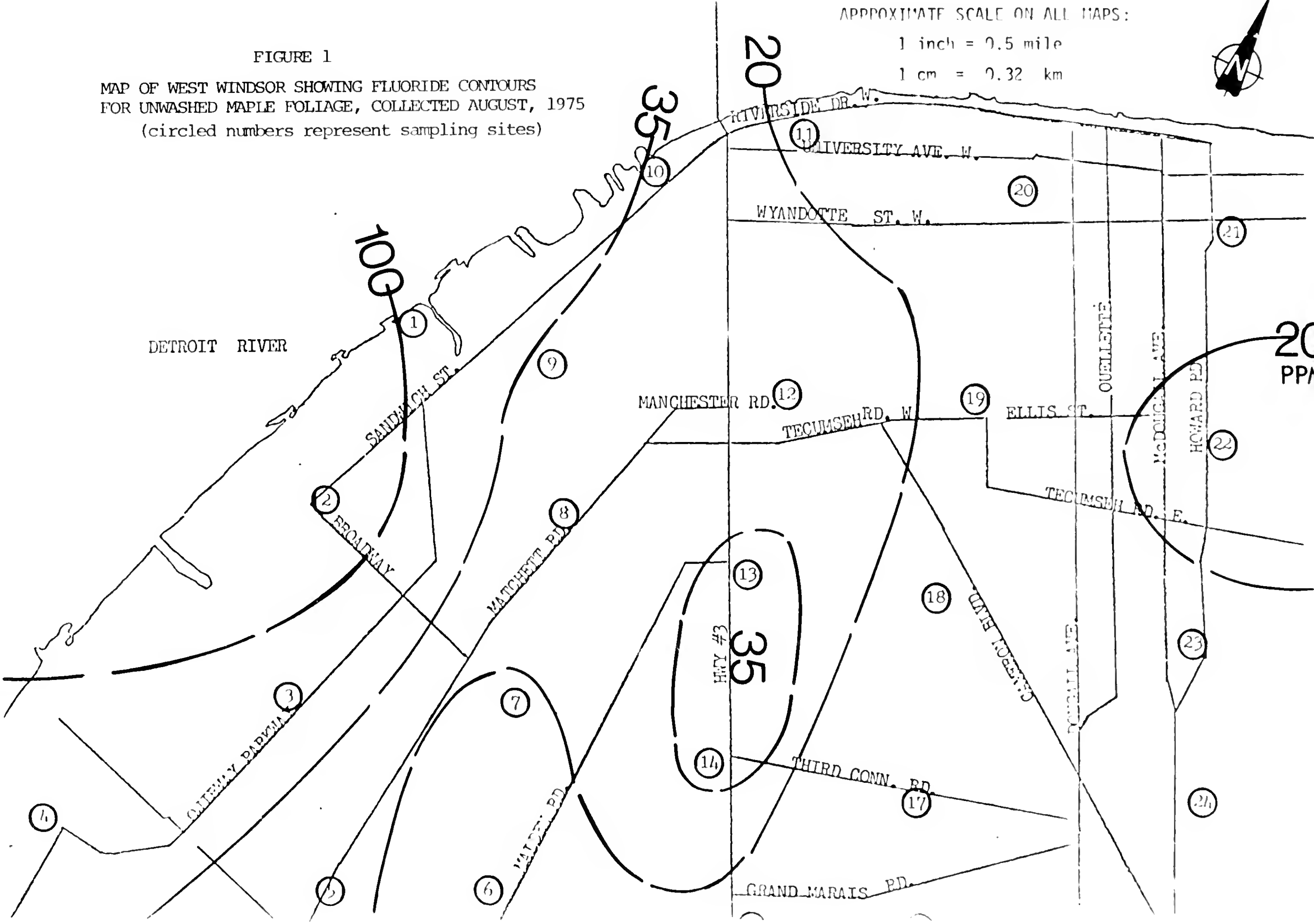


FIGURE 2

MAP OF WEST WINDSOR SHOWING FLUORIDE CONCENTRATION CONTOURS FOR UNWASHED MAPLE FOLIAGE, COLLECTED AUGUST, 1976 (circled numbers represent sampling sites)

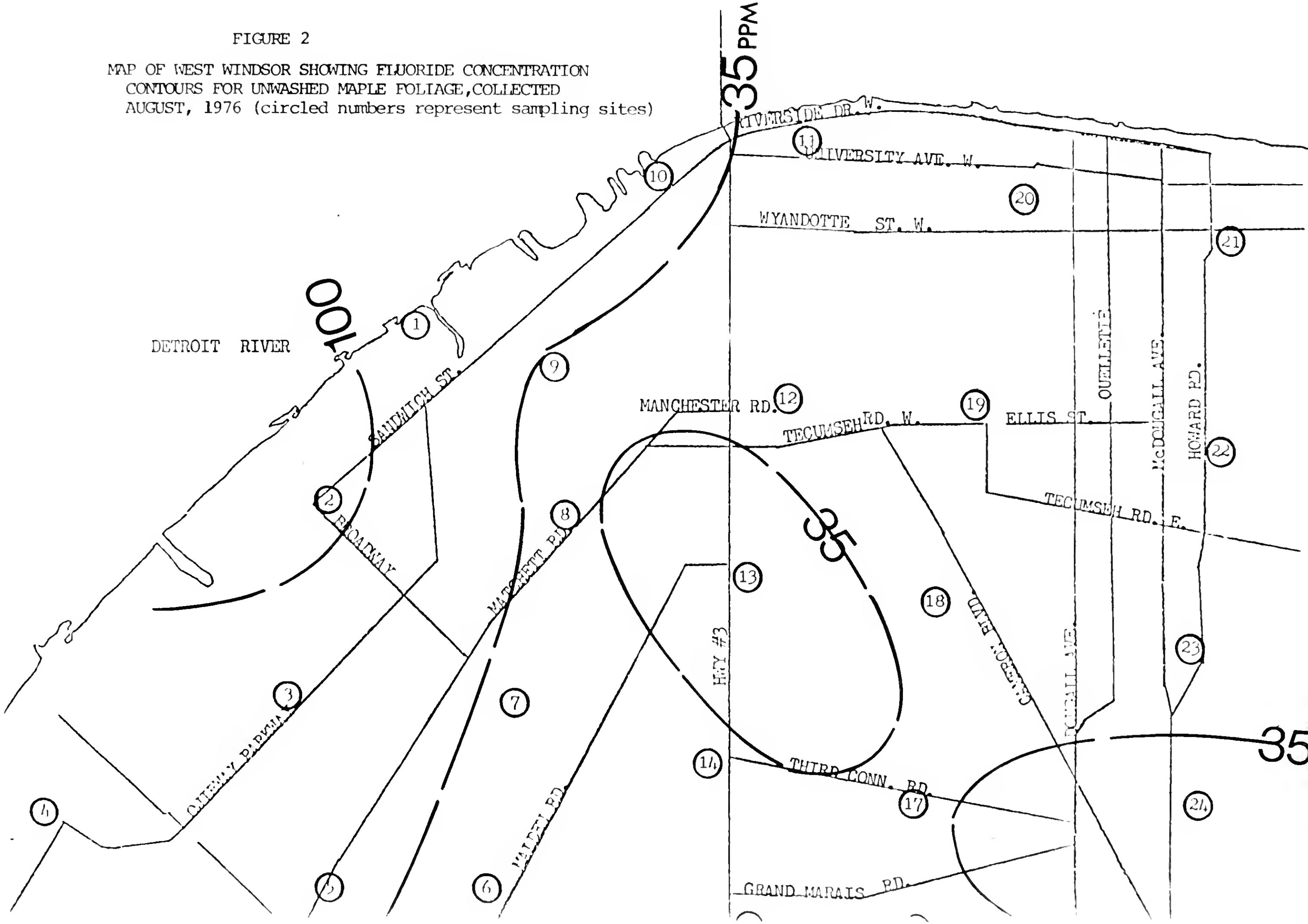


FIGURE 3

MAP OF WEST WINDSOR SHOWING FLUORIDE CONCENTRATION CONTOURS FOR UNWASHED MAPLE FOLIAGE, COLLECTED AUGUST, 1977 (circled numbers represent sampling sites)

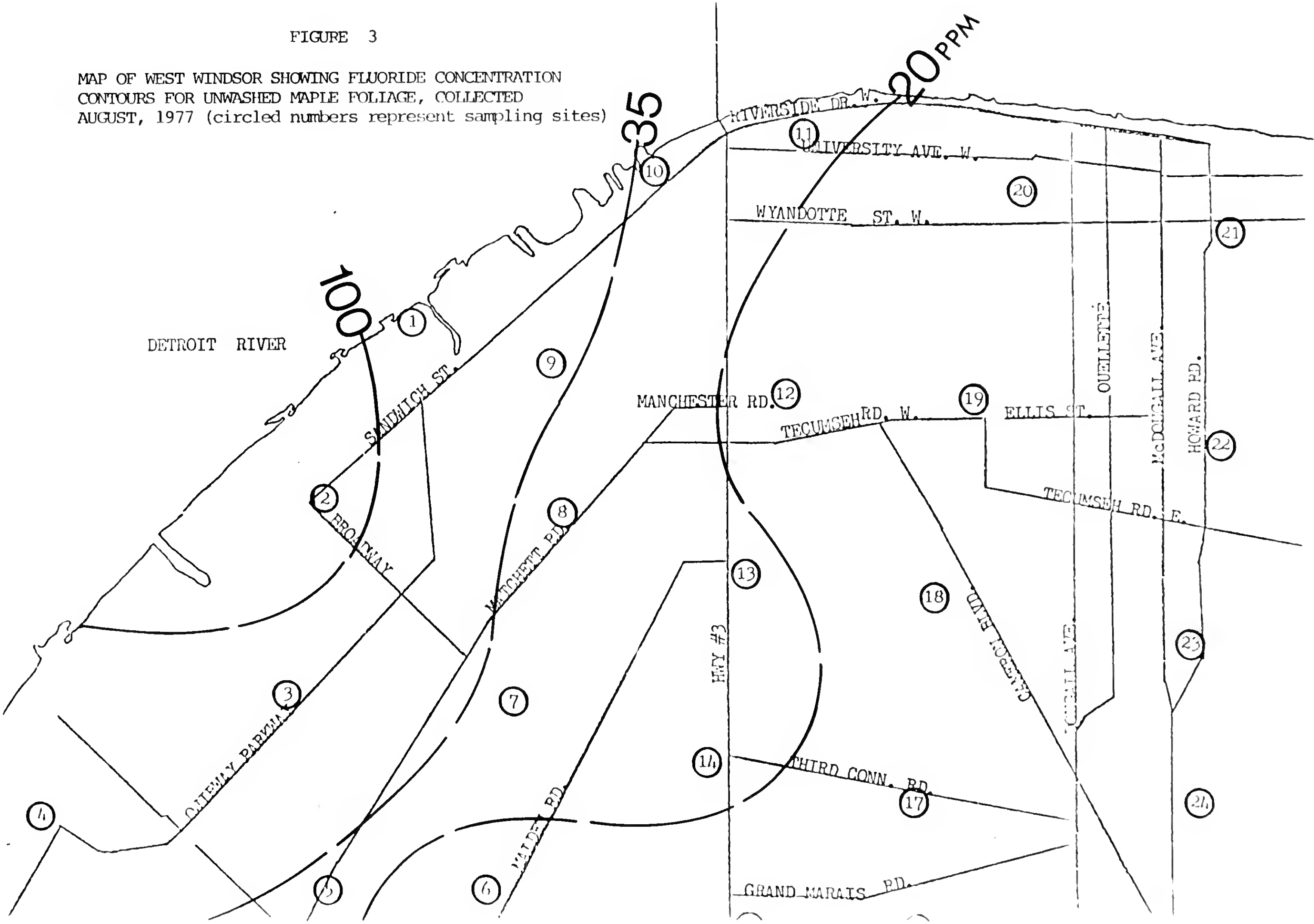


FIGURE 4

MAP OF WEST WINDSOR SHOWING MEAN IRON CONCENTRATION CONTOURS FOR UNWASHED MAPLE FOLIAGE COLLECTED 1975 TO 1977

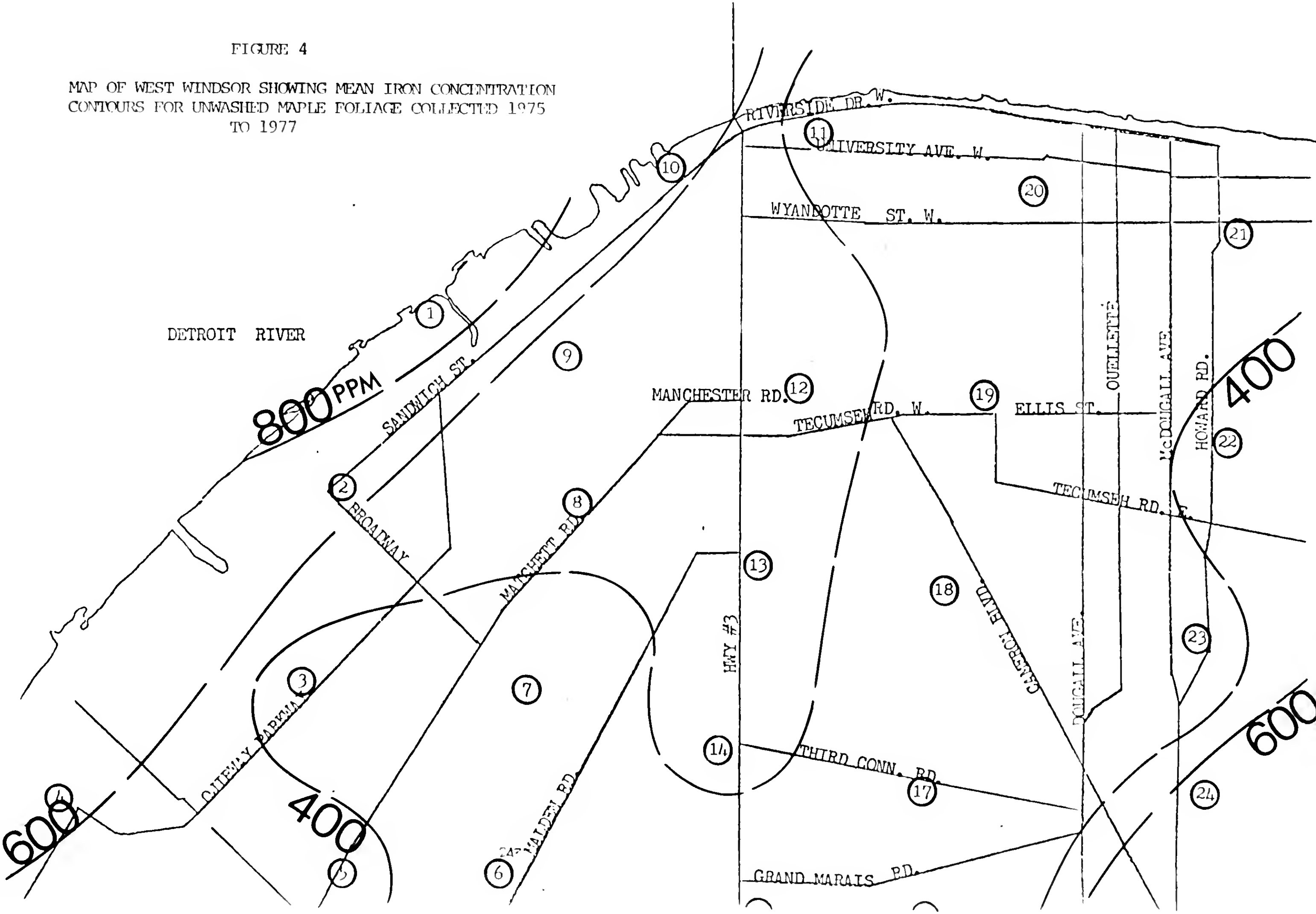


FIGURE 5

MAP OF WEST WINDSOR SHOWING THE MEAN IRON CONCENTRATIONS IN SOILS 1975 - 1977 AS CONCENTRATION CONTOURS

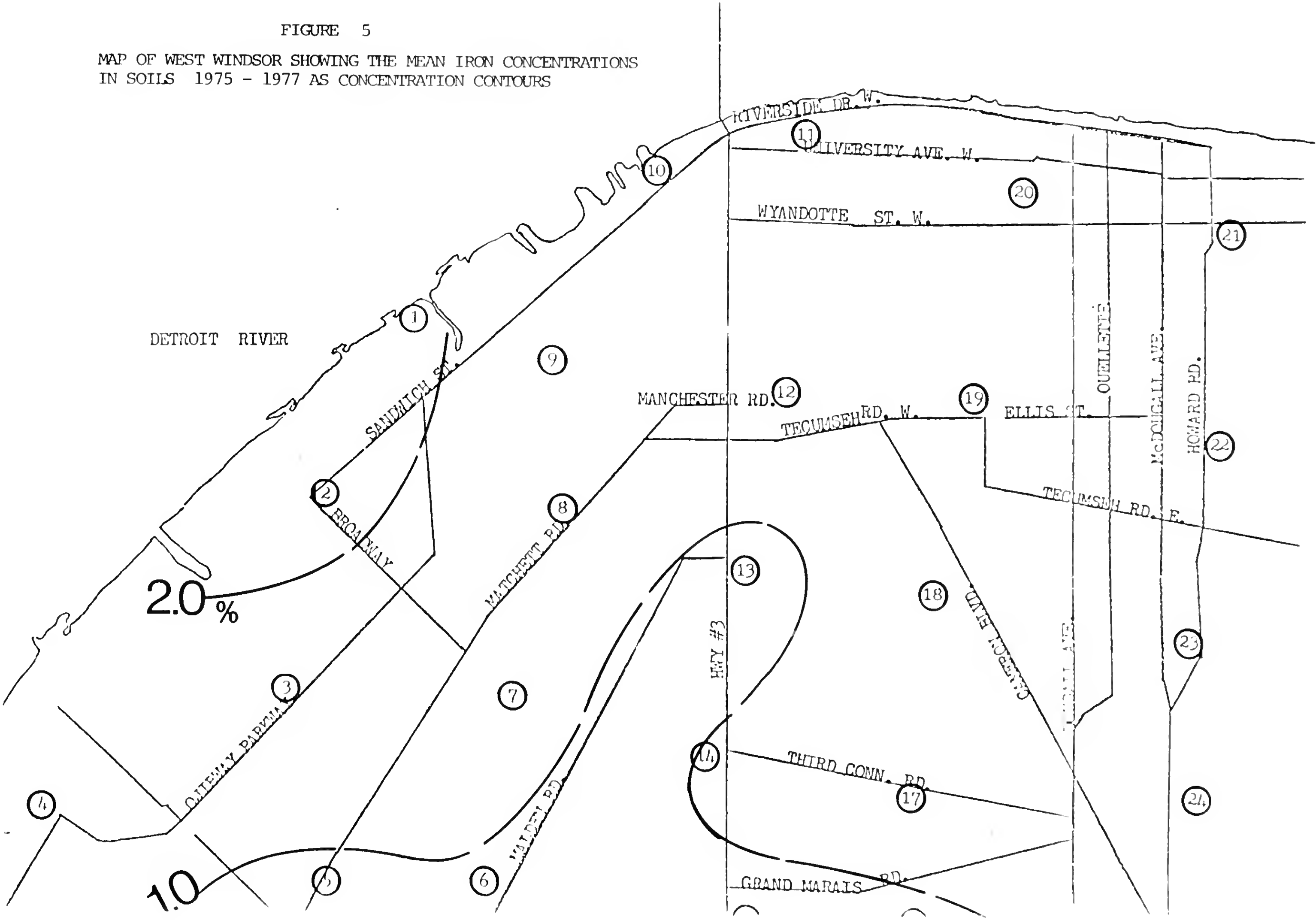


FIGURE 6

MAP OF WEST WINDSOR SHOWING MEAN LEAD CONCENTRATION CONTOURS FOR UNWASHED MAPLE FOLIAGE COLLECTED 1975 to 1977

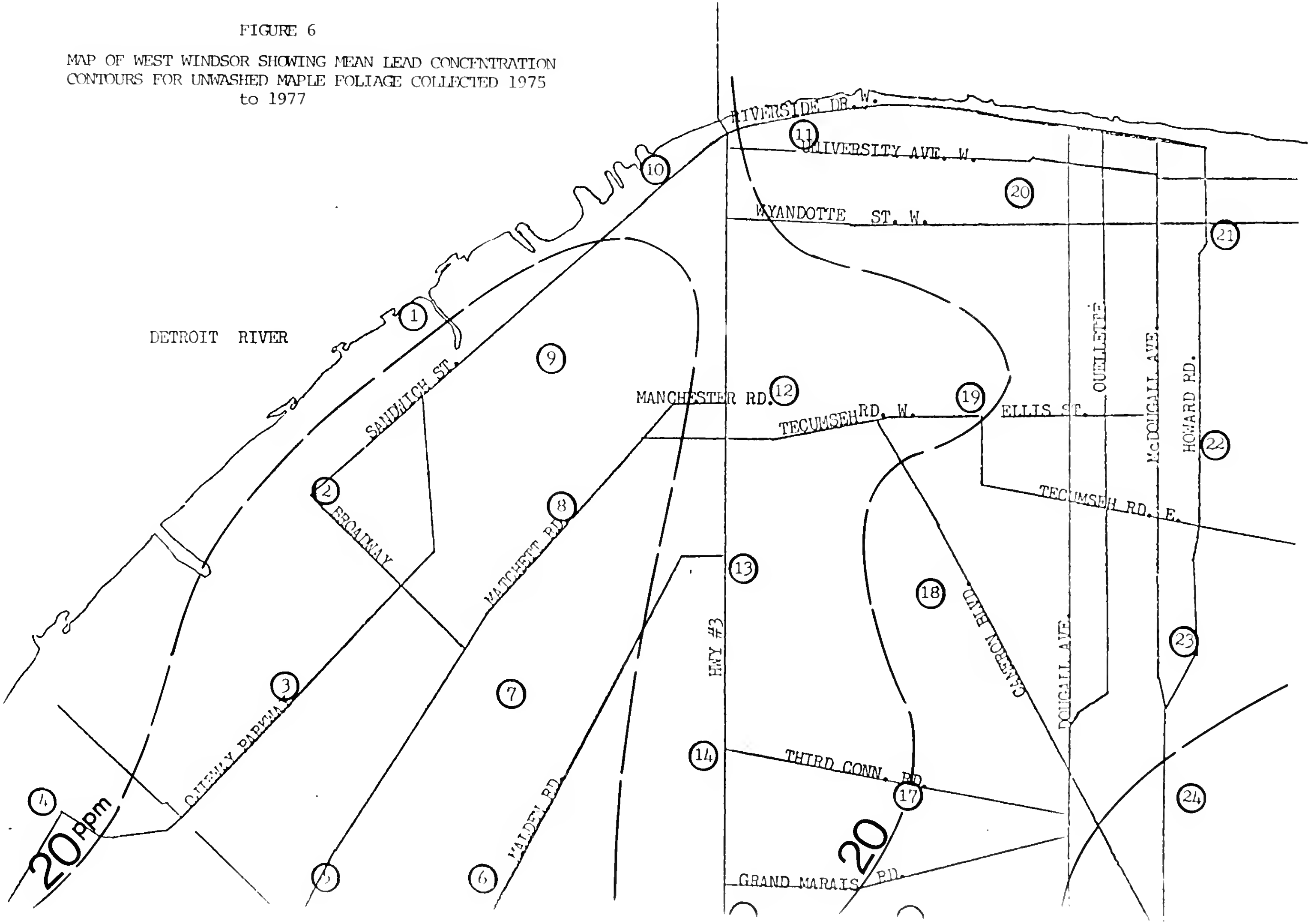


FIGURE 7

MAP OF WEST WINDSOR SHOWING THE MEAN LEAD LEVELS IN SOILS (0-5 cm depths) 1975 - 1977 AS CONCENTRATION CONTOURS

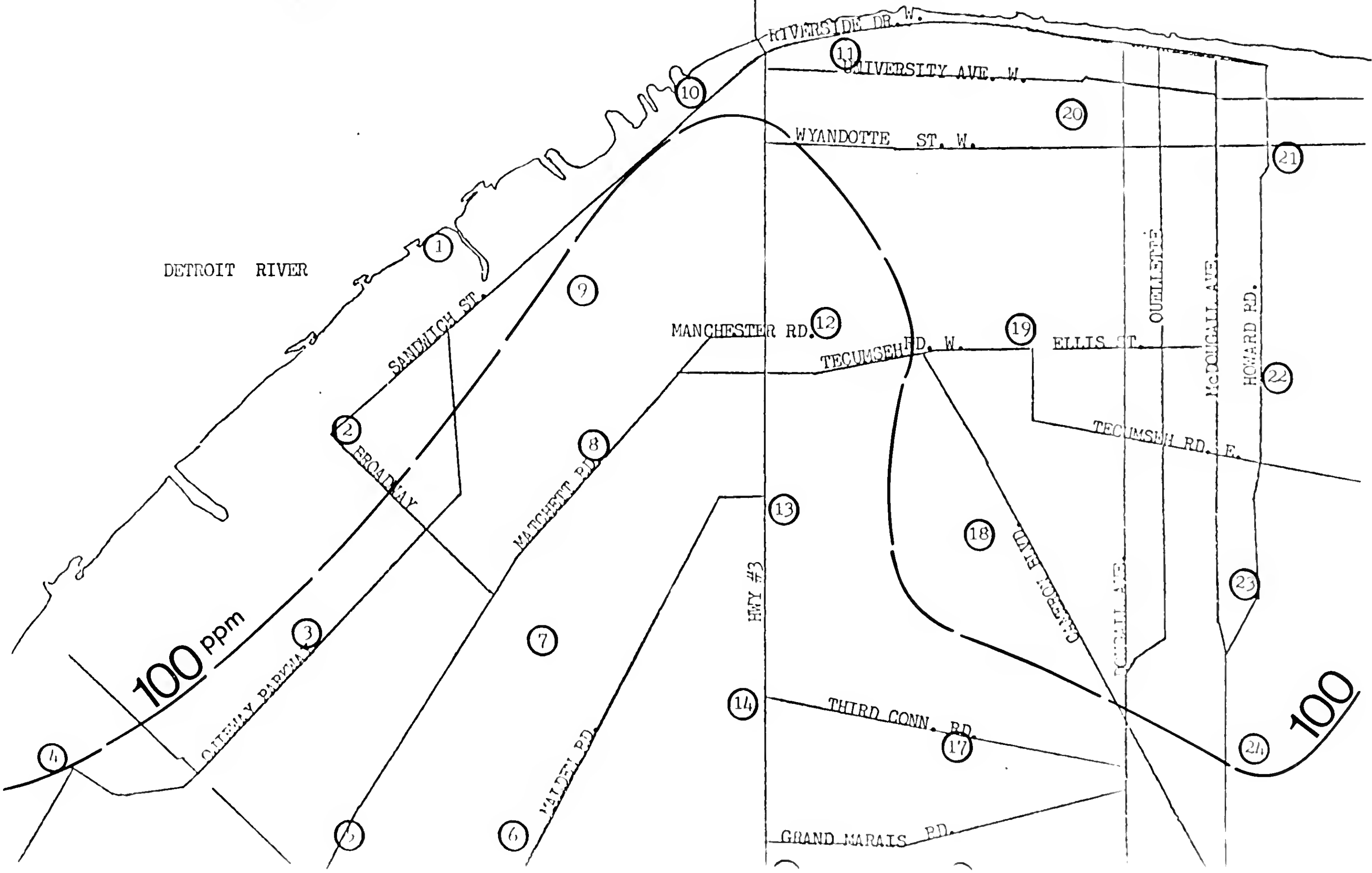


FIGURE 8

MAP OF WEST WINDSOR SHOWING CADMIUM CONTOURS FOR UNWASHED MAPLE FOLIAGE, COLLECTED 1975-1977

(circled numbers represent sampling sites)

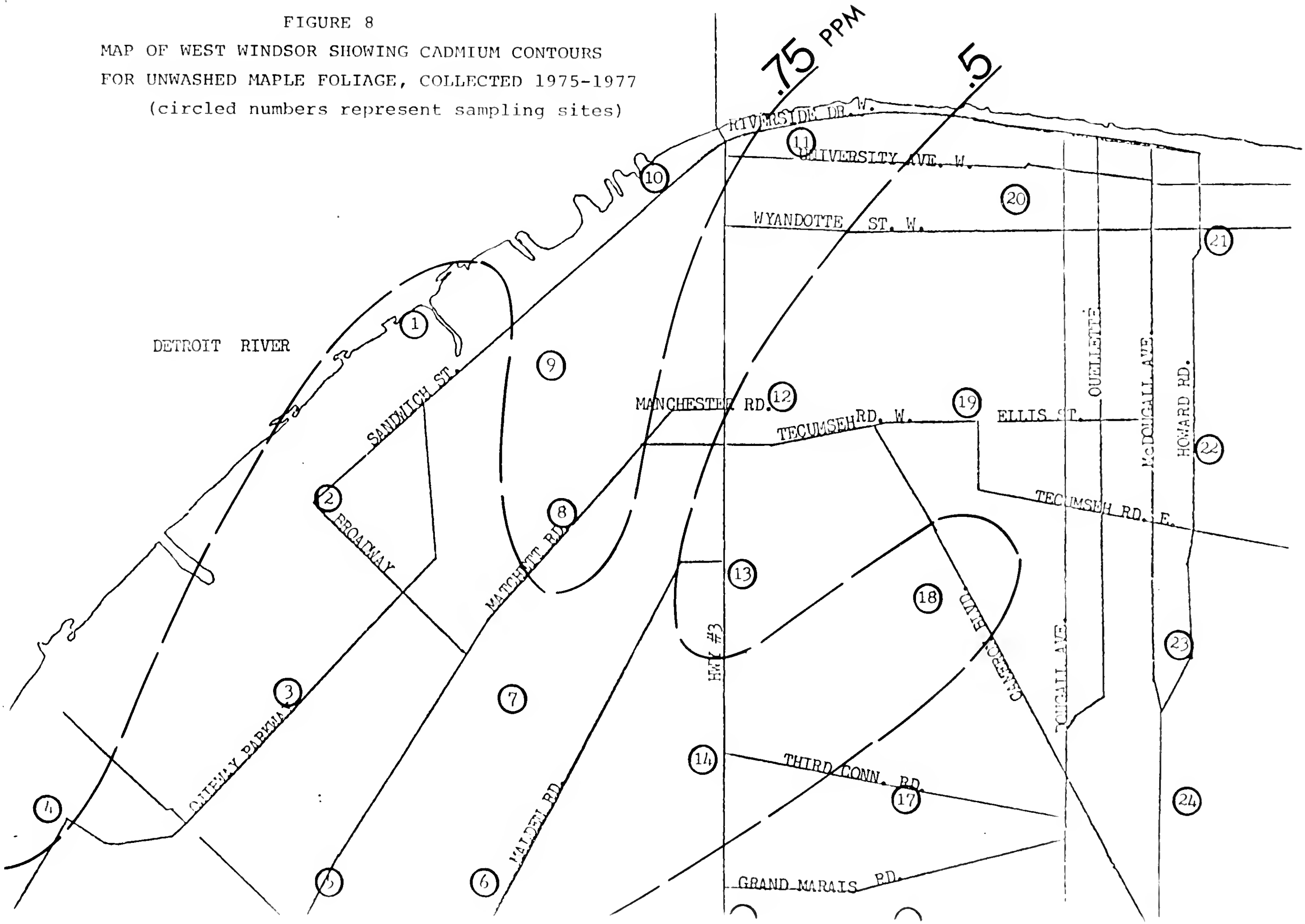


FIGURE 9

MAP OF WEST WINDSOR SHOWING THE MEAN CADMIUM LEVELS IN SOILS (0-5 cm depths) 1975 - 1977 AS CONCENTRATION CONTOURS

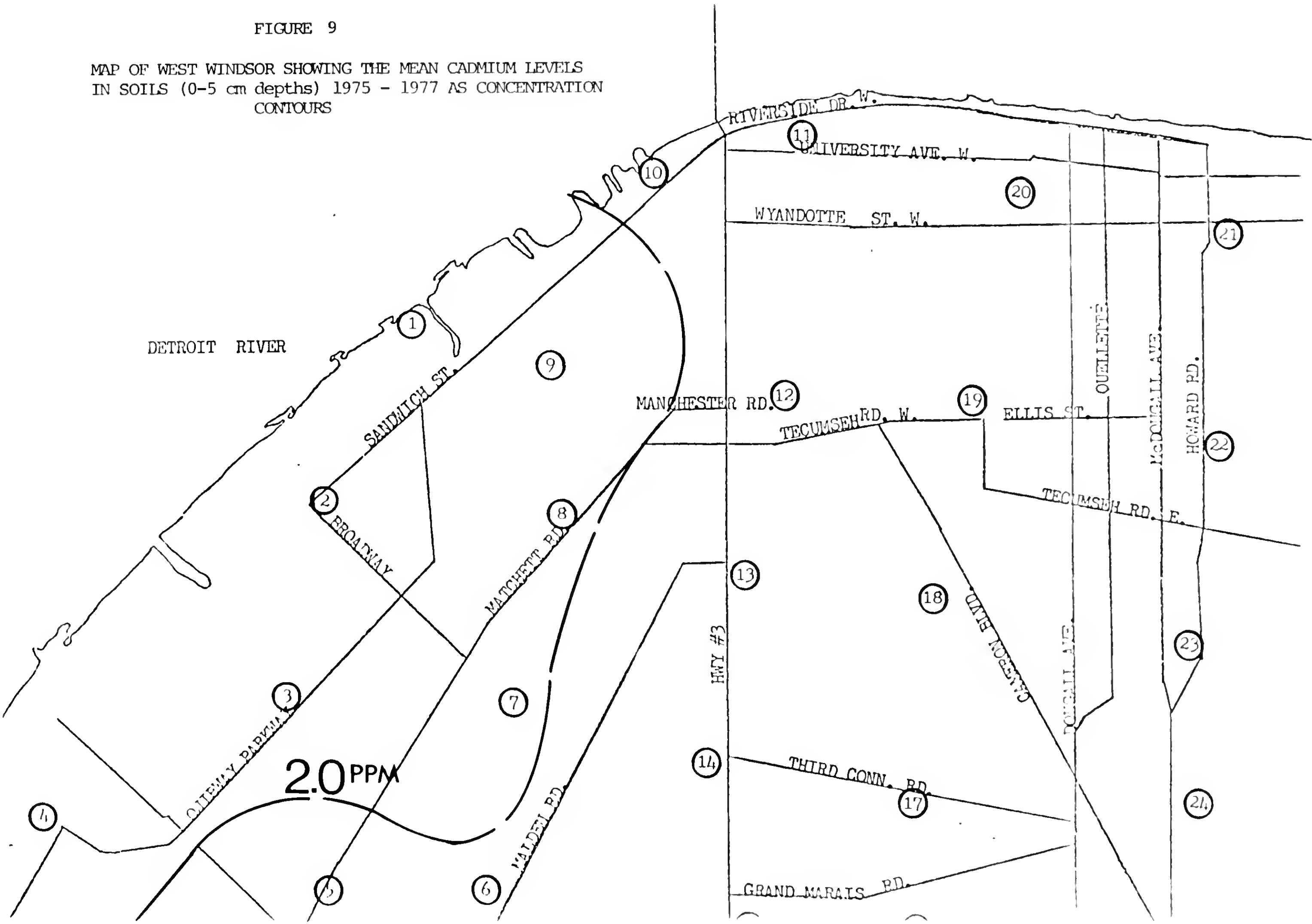


FIGURE 10

MAP OF WEST WINDSOR SHOWING ZINC CONTOURS FOR UNWASHED MAPLE FOLIAGE, COLLECTED 1975 - 1977

(circled numbers represent sampling sites)

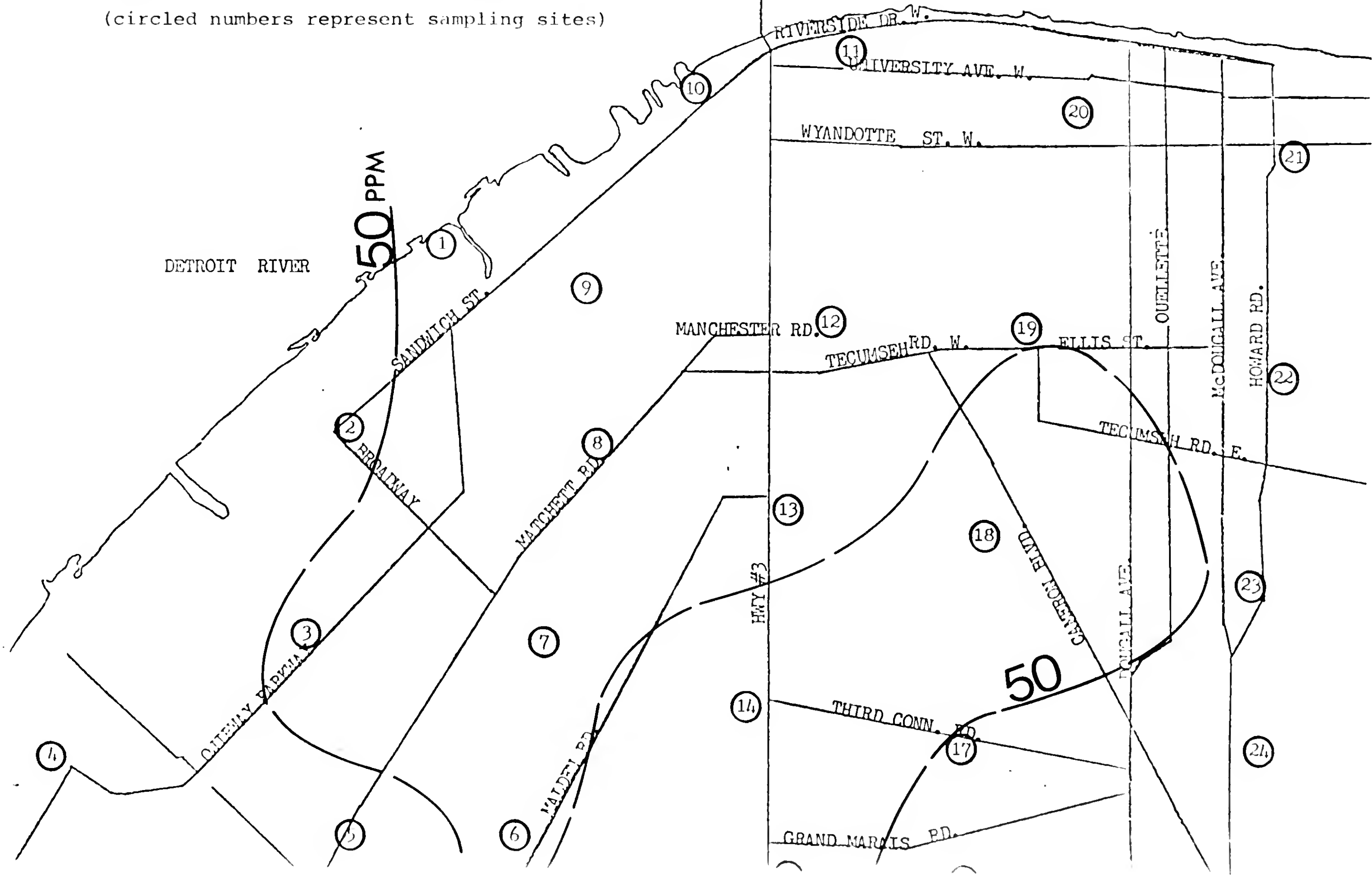
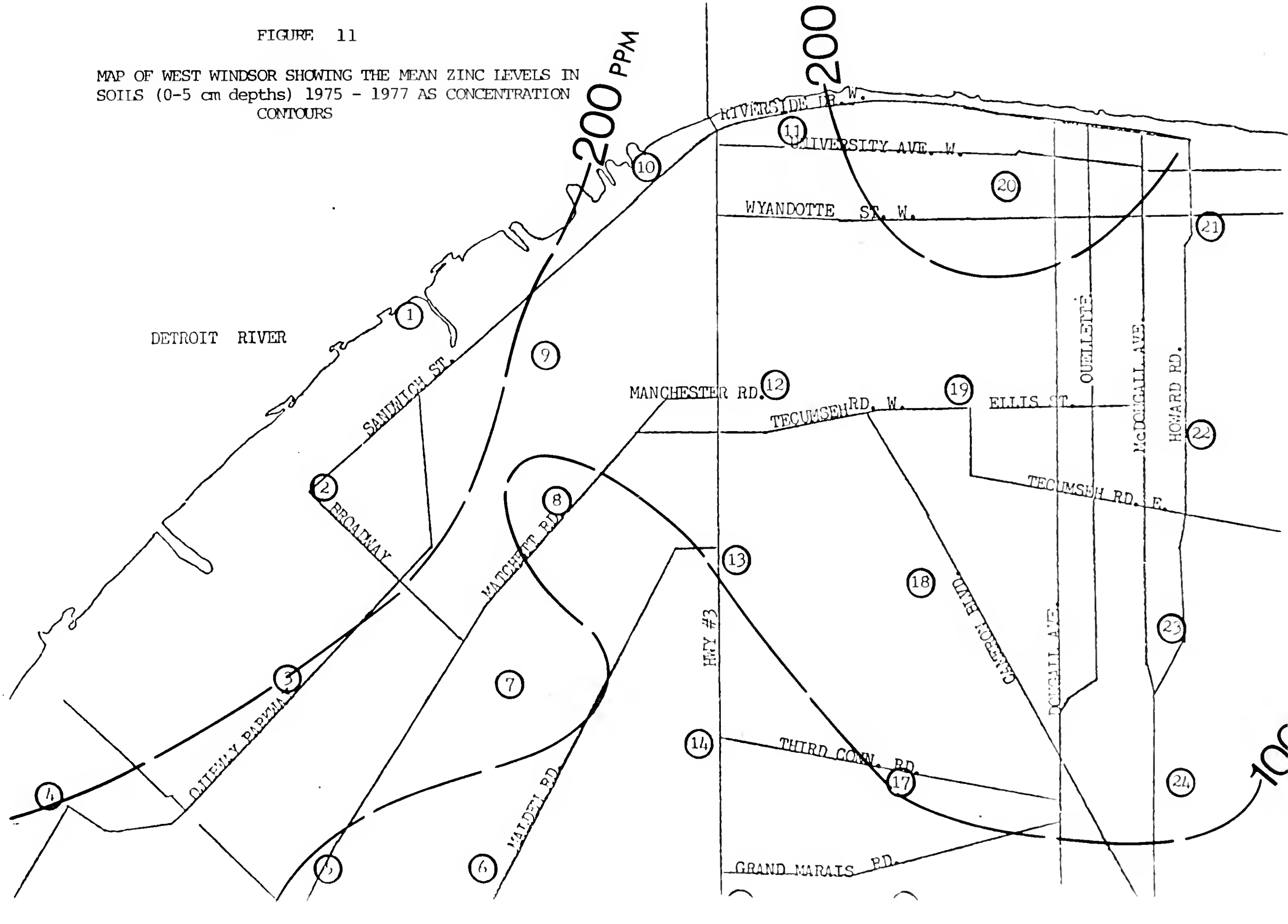


FIGURE 11

MAP OF WEST WINDSOR SHOWING THE MEAN ZINC LEVELS IN SOILS (0-5 cm depths) 1975 - 1977 AS CONCENTRATION CONTOURS



Appendix 5
Elemental Grid Means for Windsor Soils
1972-1986

SOILS

N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
N-S E-W	MEAN	9.0		3.1		25	60		30444			4.3		44	224	4278	1.2	27	259
B 4	STD. DEV.	0.2		0.4		2	13		14643			2.6		1	53	2182	0.1	2	65
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	6.1		1.4		15	21		13056	4600		3.3		23	110	744	0.5	25	165
B 5	STD. DEV.	0.2		0.8		7	7		5169			1.2		2	66	227	0.0	26	74
	NUMBER	3		13		6	6		9			3		3	13	9	3	4	13
N-S E-W	MEAN	23.8		1.9		22	49		13689			2.5		35	225	811	1.5	20	194
B 6	STD. DEV.	5.6		0.9		10	1		976			0.0		2	49	202	0.1	4	13
	NUMBER	2		9		3	3		9			3		3	9	9	2	3	9
N-S E-W	MEAN	7.4		1.4		18	45		13889			4.2		29	297	622	1.4	22	262
B 7	STD. DEV.	0.4		0.3		2	4		2388			1.2		1	155	155	0.1	4	100
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	5.6		1.1		16	23		13833			6.0		23	116	656	0.9	24	147
B 8	STD. DEV.	0.2		0.1		3	3		2450			1.4		0	29	68	0.1	1	40
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	25.3		1.5		32	57		20158		361	3.0		29	221	1067	1.7	35	248
B 9	STD. DEV.	1.5		0.6		14	19		7906		144	1.3		7	103	47	0.2	9	129
	NUMBER	3		12		12	12		12		9	12		12	12	3	3	12	12
N-S E-W	MEAN	11.5		3.4		35	47		27133			2.5		34	154	1100	1.4	35	315
C 3	STD. DEV.	0.4		1.0		2	2		10165			0.0		1	61	200	0.1	0	40
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	8.2		2.7	200	26	30	250	16775			2.5		35	84	833	0.7	16	148
C 4	STD. DEV.	0.3		1.0		6	0		5674			0.0		0	16	141	0.0	3	28
	NUMBER	3		8		3	3		8			3		3	8	9	3	3	8
N-S E-W	MEAN	5.9		1.4		20	27		15489			2.5		29	69	667	0.6	18	127
C 5	STD. DEV.	0.2		0.2		4	1		2681			0.0		1	8	47	0.1	5	28
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	6.1		1.3		14	24		14444			6.0		27	158	722	0.6	23	176
C 6	STD. DEV.	0.1		0.4		1	1		2715			1.4		1	34	63	0.1	2	38
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9

SOILS

N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
N-S E-W	MEAN	6.8		1.2		20	37		16722			2.5		29	163	733	1.1	29	180
C 7	STD. DEV.	0.0		0.3		2	3		2959			0.0		0	47	94	0.1	1	58
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	7.0		1.8		28	29		9900			2.5		28	50	633	0.9	40	79
C 8	STD. DEV.	0.2		0.3		7	1		1020			0.0		2	2	47	0.1	2	1
	NUMBER	3		3		3	3		3			3		3	3	3	3	3	3
N-S E-W	MEAN			0.8		25	32		19583		212	1.5		20	85			34	154
C 9	STD. DEV.			0.3		3	6		1391		43	0.4		3	34			3	33
	NUMBER			12		12	12		12		12	12		12	12			12	12
N-S E-W	MEAN	5.1		2.2		19	26		14156			2.5		21	89	878	0.8	19	209
D 3	STD. DEV.	0.3		0.6		1	1		7474			0.0		1	29	257	0.1	1	59
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	5.0		2.1		22	9		9558			5.3		21	42	608	0.7	12	93
D 4	STD. DEV.	0.5		0.8		2	7		3836			2.8		1	9	272	0.2	7	30
	NUMBER	6		12		6	6		12			6		6	12	12	6	6	12
N-S E-W	MEAN	4.3		1.0		17	18		7050			2.5		14	70	656	0.7	8	127
D 5	STD. DEV.	0.1		0.1		1	0		2854			0.0		1	10	96	0.1	8	45
	NUMBER	3		12		3	3		12			3		3	12	9	3	3	12
N-S E-W	MEAN	5.2		1.3		22	29		14467			4.2		24	156	778	0.8	17	181
D 6	STD. DEV.	0.3		0.4		6	1		2479			1.2		1	133	92	0.1	2	100
	NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
N-S E-W	MEAN	7.8		1.8		27	34		14460			4.2		32	101	767	0.7	26	126
D 7	STD. DEV.	0.6		0.9		4	3		3986			1.2		1	43	202	0.1	1	28
	NUMBER	3		15		3	3		15			3		3	15	15	3	3	15
N-S E-W	MEAN	6.9		1.8		21	25		17311				182	34	103		ERR	34	152
D 8	STD. DEV.	0.3		0.3		3	1		1981				35	11	66		ERR	9	94
	NUMBER	6		19		19	15		19				15	15	19		0	19	19
N-S E-W	MEAN	6.0		2.2		22	31		17938			2.5		24	361	850	0.8	30	289
D 9	STD. DEV.	0.2		0.6		9	1		6775			0.0		1	247	104	0.0	5	320
	NUMBER	3		21		12	3		21			3		3	21	12	3	12	21

SOILS	N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
	N-S E-W E 2	MEAN	5.7	850	2.4	223	14	30	57	12667			2.5	381	19	105	445	0.6	13	196
		STD. DEV.	0.3	267	0.5	42	1	0	16	5599			0.0	230	1	13	376	0.1	3	36
		NUMBER	3	13	9	13	3	3	13	9			3	13	3	9	22	3	3	9
	N-S E-W E 3	MEAN	4.9		1.7		15	2		8167			2.5		15	46	667	0.5	10	97
		STD. DEV.	0.4		0.6		0	0		3927			0.0		0	9	67	0.1	0	17
		NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
	N-S E-W E 4	MEAN	4.4		1.9		21	2		9789			2.5		22	45	500	0.5	3	77
		STD. DEV.	0.0		0.7		1	0		1108			0.0		1	6	211	0.1	0	20
		NUMBER	3		9		3	3		9			3		3	9	9	3	3	9
	N-S E-W E 5	MEAN	4.2		1.0		16	12		9211			2.5		13	119	594	0.4	8	124
		STD. DEV.	1.2		0.4		2	1		4046			0.0		1	125	172	0.1	5	81
		NUMBER	6		18		6	6		18			6		6	17	18	6	6	18
	N-S E-W E 6	MEAN	4.2		1.2		19	23		12120			4.3		23	50	573	0.5	18	103
		STD. DEV.	1.1		0.4		5	11		4054			3.9		9	13	68	0.1	16	31
		NUMBER	6		15		6	6		15			6		6	15	15	6	6	15
	N-S E-W E 7	MEAN	6.5		1.3		33	33		9950			2.5		22	102	792	1.2	25	147
		STD. DEV.	0.2		0.2		2	2		7028			0.0		1	47	150	0.0	0	74
		NUMBER	3		12		3	3		12			3		3	12	12	3	3	12
	N-S E-W E 8	MEAN	7.7		2.0		22	24		10367			2.5		27	50	833	0.8	34	90
		STD. DEV.	0.4		0.2		8	1		94			0.0		1	0	47	0.0	1	4
		NUMBER	3		3		3	3		3			3		3	3	3	1	3	3
	N-S E-W F 1	MEAN				200			337								1200			
		STD. DEV.																		
		NUMBER																		
	N-S E-W F 7	MEAN	5.8		2.2		24	27		12067			2.5		25	80	833	0.7	32	88
		STD. DEV.	0.0		0.4		1	2		655			0.0		0	20	47	0.1	1	5
		NUMBER	3		3		3	3		3			3		3	3	3	3	3	3
	N-S E-W F 9	MEAN	4.7		1.9		19	45		10300			2.5		26	56	733	0.8	34	85
		STD. DEV.	0.1		0.1		8	4		510			0.0		1	1	47	0.0	1	6
		NUMBER	3		3		3	3		3			3		3	3	3	3	3	3

SOILS	N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
	N-S E-W	MEAN				275								1180						
	G 7	STD. DEV.				130								79						
		NUMBER				4								4						

Appendix 6
Elemental Grid Means for Windsor
Maple Foliage 1972-1986

Maple

N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
N-S E-W B 4	MEAN	0.5		0.6	2122	3.3	8	33	918			1.0		4	20	2858	0.41	2.3	30
	STD. DEV.	0.0		0.1	1699	0.5	0	15	347			0.0		1	7	477	0.05	0.9	10
	NUMBER	3		9	9	3	3	9	9			3		3	9	12	3	3	9
N-S E-W B 5	MEAN	0.7		0.8	1822	7.0	29	44	805			1.0	297	5	23	1967	0.42	1.0	44
	STD. DEV.	0.1		0.2	1096	1.6	7	15	293			0.0	5	0	5	176	0.02	0.0	13
	NUMBER	3		9	9	3	3	9	12			3	3	3	9	9	3	3	9
N-S E-W B 6	MEAN	0.4		0.6	1167	6.0	16	19	360			1.0		5	18	2200	0.25	1.0	52
	STD. DEV.	0.0		0.4	830	0.0	3	5	155			0.0		1	8	176	0.04	0.0	14
	NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9
N-S E-W B 7	MEAN	0.2		0.3	3050	4.0	9	15	359			1.0		7	15	1867	0.28	1.0	31
	STD. DEV.	0.0		0.1	585	0.8	0	2	105			0.0		0	6	194	0.03	0.0	11
	NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9
N-S E-W B 8	MEAN	0.2		0.3	2050	4.0	5	16	298			1.0		3	13	2189	0.63	1.0	35
	STD. DEV.	0.0		0.1	544	0.0	1	1	73			0.0		0	4	228	0.07	0.0	10
	NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9
N-S E-W B 9	MEAN	0.4		0.2	1900	2.3	10	24	437		29	0.8		2	9	1567	0.33	0.6	49
	STD. DEV.	0.0		0.3	82	1.3	3	1	174		11	0.4		1	8	189	0.02	0.2	12
	NUMBER	3		23	3	23	23	3	23		20	23		23	23	3	3	23	23
N-S E-W C 3	MEAN	0.5		0.6	1278	2.7	7	121	769			1.0	151	4	17	2089	0.30	1.3	63
	STD. DEV.	0.0		0.4	294	1.2	1	13	180			0.0	5	0	4	990	0.04	1.2	16
	NUMBER	3		9	9	3	3	9	12			3	3	3	9	9	3	3	9
N-S E-W C 4	MEAN	0.4		0.9	1767	5.5	6	36	647			1.0	123	4	17	2478	0.35	1.0	50
	STD. DEV.	0.0		0.3	668	0.5	0	5	193			0.0	26	1	4	290	0.04	0.0	9
	NUMBER	3		8	15	2	2	15	17			2	9	2	8	9	3	2	8
N-S E-W C 5	MEAN	0.4		0.4	614	4.7	5	19	435			1.0	38	4	22	3278	0.41	2.0	31
	STD. DEV.	0.0		0.1	188	0.5	1	11	73			0.0		0	3	322	0.04	0.8	6
	NUMBER	3		9	7	3	3	7	10			3	1	3	9	9	3	3	9
N-S E-W C 6	MEAN	0.2		0.4	1800	3.3	8	15	323			1.0		3	29	2467	0.16	1.0	50
	STD. DEV.	0.0		0.1	516	1.2	1	2	92			0.0		0	11	283	0.03	0.0	12
	NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9

Maple	N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
	N-S E-W	MEAN	0.2		0.2	1600	4.0	5	21	487			1.0		3	16	1800	0.32	1.0	43
	C 7	STD. DEV.	0.0		0.1	277	0.0	0	4	139			0.0		0	3	262	0.04	0.0	13
		NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9
	N-S E-W	MEAN	0.3		0.6	2667	5.7	7	19	443			1.0		3	20	2033	0.40	1.0	22
	C 8	STD. DEV.	0.0		0.1	47	1.2	0	2	17			0.0		0	2	94	0.03	0.0	4
		NUMBER	3		3	3	3	3	3	3			3		3	3	3	3	3	3
	N-S E-W	MEAN			0.1		1.8	13		412		24	0.6		1	7			0.5	57
	C 9	STD. DEV.			0.1		0.6	6		172		6	0.2		1	3			0.0	12
		NUMBER			19		19	19		19		19	19		19	19			19	19
	N-S E-W	MEAN	0.4		0.7	767	3.7	11	50	493			1.0		4	18	2367	0.30	2.7	59
	D 3	STD. DEV.	0.0		0.1	47	0.5	0	5	46			0.0		0	0	262	0.05	0.5	5
		NUMBER	3		3	3	3	3	3	3			3		3	3	3	3	3	3
	N-S E-W	MEAN	0.3		0.8	1367	3.2	8	35	549			1.0	162	4	17	2408	0.20	1.0	38
	D 4	STD. DEV.	0.1		0.3	548	0.7	3	17	184			0.0	6	0	7	253	0.03	0.0	18
		NUMBER	6		12	12	6	6	12	15			6	3	6	12	12	6	6	12
	N-S E-W	MEAN	0.4		0.4	1522	4.0	7	27	415			1.0		3	21	2392	0.22	2.7	47
	D 5	STD. DEV.	0.0		0.1	181	0.8	1	10	96			0.0		0	8	479	0.01	2.4	28
		NUMBER	3		12	9	3	3	9	12			3		3	12	12	3	3	12
	N-S E-W	MEAN	0.4		0.6	1417	4.0	11	15	363			1.0		3	16	2311	0.22	2.3	70
	D 6	STD. DEV.	0.0		0.2	37	0.0	1	2	100			0.0		0	7	318	0.02	1.9	15
		NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9
	N-S E-W	MEAN	0.2		0.4	811	3.3	4	12	247			1.0		2	75	2033	0.28	1.0	44
	D 7	STD. DEV.	0.0		0.2	420	1.2	1	4	59			0.0		1	122	408	0.03	0.0	9
		NUMBER	3		15	9	3	3	9	15			3		3	15	15	3	3	15
	N-S E-W	MEAN															1870			
	D 8	STD. DEV.															424			
		NUMBER															10			
	N-S E-W	MEAN	0.2		0.4	11278	4.7	8	9	320			1.0	1327	2	28	1933	0.41	1.0	40
	D 9	STD. DEV.	0.0		0.1	10528	0.5	1	1	22			0.0	1572	0	11	450	0.02	0.0	17
		NUMBER	3		9	9	3	3	3	3			3	6	3	9	3	3	3	9

Maple

N-S E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
N-S E-W	MEAN	0.4		0.7	2767	3.5	7	34	588			1.0		4	24	1967	0.13	1.7	78
E 2	STD. DEV.	0.1		0.2	982	0.5	1	20	223			0.0		1	10	530	0.04	0.7	59
	NUMBER	6		12	9	6	6	9	12			6		6	12	12	6	6	12
N-S E-W	MEAN	0.4		0.6	1656	3.7	11	31	561			1.0	133	4	16	1733	0.21	1.0	64
E 3	STD. DEV.	0.1		0.2	344	0.5	2	6	149			0.0	8	1	4	194	0.01	0.0	36
	NUMBER	3		9	9	3	3	9	12			3	3	3	9	9	3	3	9
N-S E-W	MEAN	0.2		0.7	817	2.7	7	11	243			1.0		3	11	2300	0.13	1.0	47
E 4	STD. DEV.	0.1		0.3	318	0.5	1	5	50			0.0		0	4	667	0.03	0.0	5
	NUMBER	3		9	6	3	3	6	9			3		3	9	9	3	3	9
N-S E-W	MEAN	0.2		0.5	1167	4.0	8	22	388			1.0		3	26	2178	0.15	1.0	63
E 5	STD. DEV.	0.1		0.2	352	0.6	0	8	158			0.0		0	12	334	0.03	0.0	14
	NUMBER	6		18	12	6	6	12	18			6		6	18	18	6	6	18
N-S E-W	MEAN	0.3		0.4	1000	3.3	8	14	278			1.0		3	16	2067	0.15	1.0	39
E 6	STD. DEV.	0.1		0.1	395	0.7	1	3	97			0.0		0	8	400	0.01	0.0	15
	NUMBER	4		18	10	6	6	10	18			6		6	18	18	4	6	18
N-S E-W	MEAN	0.5		0.3	1678	4.4	7	17	798		25	0.8		2	20	1950	0.20	0.9	44
E 7	STD. DEV.	0.1		0.1	812	0.8	2	2	300		4	0.4		1	12	225	0.01	0.2	27
	NUMBER	3		15	9	9	3	9	15		6	9		9	18	12	3	9	15
N-S E-W	MEAN	0.5		0.8	1850	4.3	7	11	470			1.0		4	15	1600	0.24	1.0	41
E 8	STD. DEV.	0.0		0.1	50	0.5	0	0	36			0.0		0	0	216	0.02	0.0	3
	NUMBER	3		3	2	3	3	2	3			3		3	3	3	3	3	3
N-S E-W	MEAN	0.3		0.3	400	3.0	7	9	271			1.0		4	9	1900	0.22	1.0	27
F 7	STD. DEV.	0.0		0.2	82	0.8	2	2	10			0.0		2	1	163	0.03	0.0	2
	NUMBER	3		3	3	3	3	3	3			3		3	3	3	3	3	3
N-S E-W	MEAN	0.3		0.5	1100	3.3	8	13	293			1.0		3	14	2400	0.18	1.0	35
F 9	STD. DEV.	0.1		0.0	82	0.5	0	5	24			0.0		1	3	216	0.01	0.0	4
	NUMBER	3		3	3	3	3	25	3			3		3	3	3	3	3	3
N-S E-W	MEAN				550			15							15	1800			
G 6	STD. DEV.				50			1							3	0			
	NUMBER				2			2							2	2			

Maple	N-S	E-W		As	Ca	Cd	Cl	Cr	Cu	F	Fe	K	Mn	Mo	Na	Ni	Pb	S	Se	V	Zn
	N-S	E-W	MEAN				800			14							20	2200			
	G	8	STD. DEV.																		
			NUMBER				1			1							1	1			