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PHYTOTOXICOLOGY INVESTIGATION IN THE VICINITY OF THE BROCK WEST LANDFILL SITE, PICKERING - 1986

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Jim Bradley
Minister

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Résumé

Une enquête menée à la fin de l'été 1986 par la Section de phytotoxicologie n'a révélé aucune preuve visible de dégradation de la végétation aux environs de la décharge du quartier ouest de Brock. Des analyses chimiques et dendrochronologiques effectuées dans un échantillon de sites plantés de vieux bouleaux blancs ont généralement étayé ces observations, de légères augmentations d'éléments seulement étant détectées dans quelques-uns des sites contigus. Le seul cas de croissance anormale des arbres a été trouvé dans un site au sud. Cependant, cette constatation semble toucher un cas isolé et ne suffit pas à établir un lien de cause à effet en ce qui concerne l'exploitation de la décharge.

Phytotoxicology Investigation in the Vicinity of the Brock West Landfill Site, Pickering - 1986

Background

The Brock West Landfill site is located approximately 3.2 km north of Highway 401 and just west of Brock Road on Concession 3, in the Municipality of the Town of Pickering. The site consists of approximately 230 acres, of which 159 are approved for the disposal of domestic, commercial, non-hazardous solid industrial and other (sewage sludges) wastes. To date, close to 12 million tonnes of waste have been deposited at the site since it commenced operation in 1975.

In a letter to the Deputy Clerk of the Town of Pickering in April, 1986, following a meeting with the Mayor and Town representatives on February 20, 1986, the Minister of the Environment indicated that in addition to an air monitoring survey following installation and start-up of the full-scale burner system at the end of the summer, a phytotoxicological assessment of the area surrounding the landfill would be conducted.

Following a meeting on-site with Mr. G. Boire, Provincial Officer, Brock West Project, and an initial reconnaissance of the area surrounding the landfill site on June 10, 1986, the Phytotoxicology investigation was conducted on September 4 and 9, 1986 by the writer and Mr. D. McLaughlin.

Visual Observations

With the exception of surface dust deposition and scattered, wind-blown debris (paper, plastic, etc.) on exposed vegetation along the east service road and localized on-site disturbance, soil erosion and surface drainage-associated pockets of vegetation stress/dieback along the perimeter of the landfill site, there were no visually apparent signs of airborne emission effects on local vegetation surrounding the

landfill site; nor was there any evidence of sub-surface gas (methane) or leachate migration effects apparent on any vegetation surrounding the landfill site. Evidence of what appeared to be iron-rich drainage water was observed in a small water-saturated swampy area in the Seaton Hiking Trail to the south; however, this reddish-brown coloured surface fluid did not appear to have had any adverse effect on woody or herbaceous vegetation directly in contact with the drainage area.

Observations for air pollution foliar symptomatology included a host of woody and herbaceous species known to possess a wide range of sensitivity to various air pollutants. The absence of foliar symptoms on vegetation in the vicinity was not unexpected, given the generally non-phytotoxic nature of atmospheric emissions that are associated with the natural escape of gases through soil cover or with flaring sources at landfill sites. These emissions typically include total reduced sulphurs, carbon monoxide, methane, as well as trace amounts of nitrogen oxides, sulphur oxides, and a host of non-methane volatile hydrocarbons which require sophisticated atmospheric monitoring for detection of sub-parts per million and parts per billion levels.

Atmospheric monitoring conducted at the Brock West Landfill site by Mobile Air Monitoring Units of the Air Resources Branch for two weeks in May 1984 (ARB Report No.: ARB-027-85-ARSP/Feb. 1985) and again from March 24 - April 1, 1987 (ARB-115-87-AQM/Sept. 1987), subsequent to the Phytotoxicology survey, also provided corroborating support for the absence of visible vegetation effects, as in no case in either year were any exceedances of applicable MOE Air Quality Standards, Criteria or Guidelines detected for any of the measured contaminants.

Sampling Methodology

In an effort to gain some insight into possible atmospheric/soil contaminant migration from the landfill site, five mature white birch sampling sites were established in the area to the NE, E, SE and S of the landfill (Sites 2 and 3 actually within the boundary of the landfill site), with an additional control site being established

upwind, approximately 3 km NW (see Figure 1). White birch was selected as the test species because of its general abundance throughout the area making it an ideal common denominator specie. At each site, the foliage from the trees was collected from a height of approximately 5 m and the samples were returned to the Phytotoxicology Section for processing on an unwashed, dry weight basis, for submission to the Inorganic Trace Contaminants Section, Laboratory Services Branch. A fresh sample of birch foliage from each site also was collected directly into wide-mouthed glass organic sample containers and submitted directly (without processing) to the Trace Organics Section.

The samples for inorganics were analyzed for the following: iron, manganese, aluminum, arsenic, calcium, cadmium, chloride, cobalt, chromium, copper, fluoride, mercury, molybdenum, sodium, nickel, lead, antimony, selenium, sulphur, vanadium and zinc.

In the case of organics, the samples were analyzed for the following polyaromatic hydrocarbons (PAH's): naphthalene, acenaphthylene, acenaphthene, 9H Fluorene, phenanthrene, anthracene, fluoranthene, pyrene, chrysene, benzo(a)anthracene, benzo(a)pyrene, benzo(k) and benzo(b)fluoranthene, dibenzo(ah)anthracene, benzo(ghi)perylene and indeno(123-cd)pyrene. Because these samples had to be sent to an external laboratory for analysis (Mann Testing Laboratories Ltd.), analyses for other organics (chlorobenzenes, toluenes, PCBs and phenolics) and pesticide compounds which were requested were unable to be performed.

In addition to the foliar samples which were collected at each of the six sites, increment wood cores were extracted in duplicate (E and W sides) from the white birch trees at each location. In each case, the tree was cored at breast height according to standard dendrochronology methodology. The cores were labelled and secured in plastic drinking straws to maintain ring integrity and were returned to the Phytotoxicology Section where they were counted and measured using a Bannister Incremental Measuring Machine interfaced with an Apple IIe microprocessor. The ring width measuring accuracy of this apparatus was 1/100 mm.

Results

The inorganic analysis results for the 22 parameters are shown in Table 1. Shown also are the respective Upper Limits of Normal for rural vegetation. These guidelines represent the upper limit of foliar concentrations expected in rural areas remote from point sources of pollution. They were determined by taking the arithmetic mean of all available analytical data and adding three standard deviations of the mean. It should be emphasized that these guidelines do not represent maximum desirable or allowable levels of contaminants; rather, they serve as an indication of possible environmental contamination. Finally, concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man; however, concentrations which are below the guidelines would not normally be considered toxic.

A review of Table 1 reveals one exceedance of the ULN for chloride at Site 5 to the S of the landfill. Although well below the respective ULN values, there were slight elevations in Fe, Mn, Al, Cd, Na and Zn at Sites 1, 2 and 3 to the immediate NE, E, and SE and, in some cases, at Site 5 to the S. These minor elevations could be due to surface dust re-entrainment, exhaust emissions from truck traffic and service machinery or to natural gas escape or flaring operations at the site. They could also be natural in origin and reflect differences in soil type, root uptake or species variation (age of tree, genetic variation). It should be pointed out, however, that irrespective of the source of the elevated levels, they have not caused any visible impediment to the normal growth and vigour of the surrounding vegetation.

The results of the organic analyses for polynuclear aromatic hydrocarbons (PAH's) (Table 2) revealed a trace amount of phenanthrene as well as 224 ppb of benzo(k) and benzo(b)fluoranthene at Site 2. A value of 942 ppb 9H fluorene also was detected at Site 3. Analysis for all other PAHs in the samples from the vicinity of the landfill failed to find any evidence of contamination above the method detection limits, which ranged from 40 - 60 ppb for the various compounds. In

comparison, the control sample contained 1100 ppb of benzo(k) and benzo(b)fluoranthene.

Obviously, on the basis of these findings, there is no evidence to confirm a relationship between the PAH foliar analysis results and sample proximity to the landfill site.

Growth Analysis

A comparison of the growth of white birch at the five sites surrounding the landfill relative to the control location can be seen in the attached Figures 2 - 6. These graphs are based on corrected incremental ring widths, where the growth at each site over the period from 1951 - 1986 was first normalized against the control tree to negate overall differences which would be associated with climatic variation.

An examination of these graphs reveals fairly similar growth chronologies at the five sites, relative to the control location. The only possible exception was at Site 5 where ring widths since about 1979 have appeared smaller than at the control site.

In an effort to more thoroughly assess tree growth patterns, the corrected ring width data were divided into three major periods, reflecting land use at the landfill site:

1. 1951 - 1962 - prior to any commercial activity at the site.
2. 1963 - 1974 - gravel excavation from the site.
3. 1975 - 1986 - active landfilling operations at the site.

A summary of these comparisons which include mean ring width, standard deviation, % difference from control and statistical significance ('t' test) is shown in Table 3.

From the 't' test comparisons, it is apparent that with the exception of Site 5, tree growth in the vicinity of the landfill site has been statistically no better nor worse than at the control site since the

start of active landfilling in 1975. The statistically significant growth reduction at Site 5 (31.4% less than at the control site) is difficult to evaluate. Although it could be related to the proxomity of this site to the landfill it is also quite possibly related to site disturbance from the utilization of this area as a children's camping area or to water table alterations associated with the excavation at the landfill. Clearly, a wood growth reduction at one site is insufficient to warrant concern with respect to the landfill operations,
particularly in view of the fact that no obvious foliar injury or visibly apparent growth retardation was observed.

Conclusions

On the basis of the Phytotoxicology Section investigation which was conducted in the vicinity of the Brock West Landfill Site in the late summer of 1986 the following conclusions can be drawn:

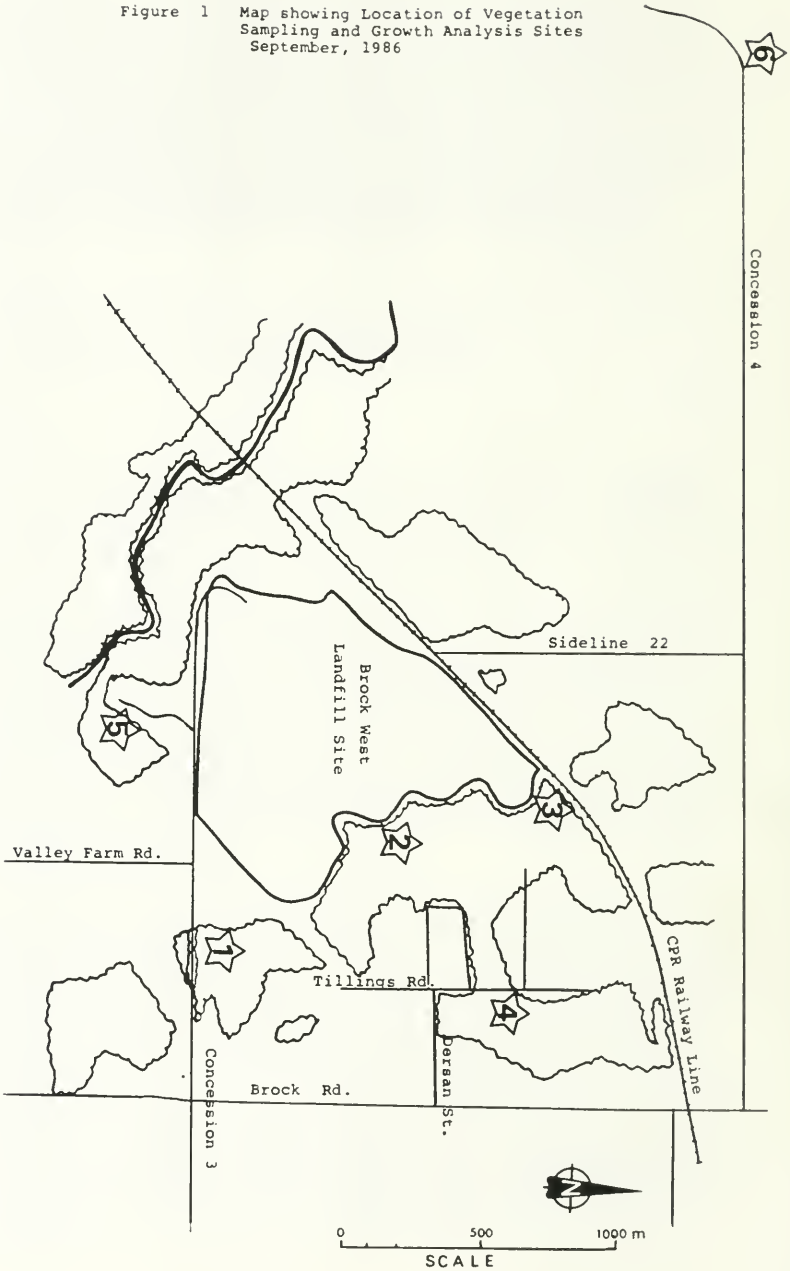
1. With the exception of some surface dust loading and scattered wind-blown debris on nearby vegetation and some general site disturbance, soil erosion, and drainage-associated pockets of vegetation stress/dieback along the E perimeter of the site (within the site boundary), there were no visibly apparent signs of air-borne or soil-borne (gas migration/leachate) effects on neighbouring vegetation.

2. On the basis of inorganic and organic analysis of white birch foliage in the vicinity of the landfill site, there was no clearly defined pattern of contaminant accumulation in tree foliage which could be directly linked with emissions from the landfilling operations. The very minor degree of elevated inorganic element concentrations which were detected at some of the sites bordering the landfill could have resulted from soil re-entrainment (dust). The cause of the one elevated chloride level which was detected to the south (Site 5) could not be determined from this limited sampling.

3. On the basis of the tree growth dendrochronology data, it is apparent that landfilling operations at the site which have been in progress since 1975 have not had any adverse effect on the growth of white birch in the area. The one exception to this general finding was at Site 5; however, given the limited amount of sampling in the area to the S, this one growth reduction cannot be interpreted as an emission effect relative to the landfilling operations.

RE1655

Figure 1 Map showing Location of Vegetation Sampling and Growth Analysis Sites September, 1986



Difference Corrected Ring Widths (mm)

Fig. 2

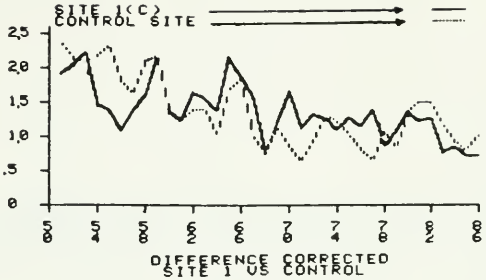


Fig. 3

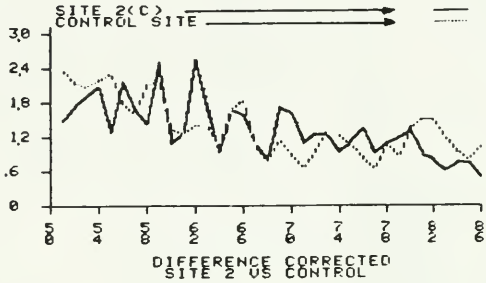


Fig. 4

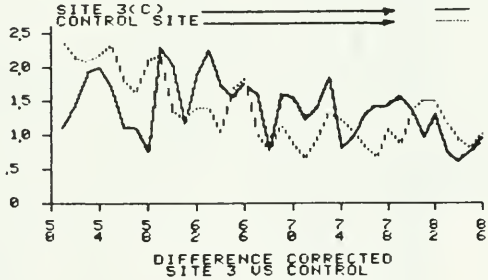


Fig. 5

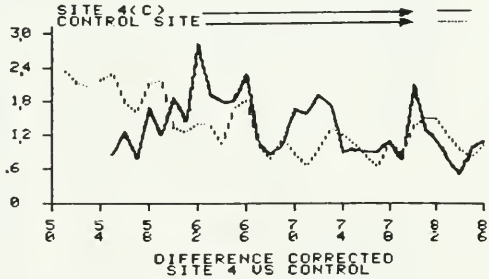


Fig. 6

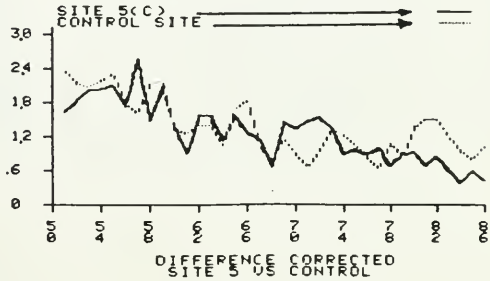


TABLE 1

Summary of Chemical Analyses Results for White Birch Foliage Collected in the Vicinity of the Brock West Landfill Site, Pickering - September 9, 1986

	Chemical Concentration in Unwashed Foilage (ppm dry wt.)																					
Site No.	Fe	Mn	Al	As	Ca	Cd	Cl	Co	Cr	Cu	F	Hg	Mg	Mo	Na	Ni	Pb	Sb	Se	S	V	Zn
1	160	220	110	<0.03	15000	0.5	400	1	2	6	<1	0.05	1500	0.6	29	2	6	0.18	<0.03	1200	<1	120
2	280	100	210	<0.03	13000	0.3	200	1	2	6	<1	0.05	1700	<0.5	37	2	8	0.29	<0.03	1100	<1	130
3	260	96	130	0.07	11000	0.3	400	<1	2	5	<1	0.05	1900	<0.5	22	1	7	0.05	<0.03	1100	<1	86
4	74	110	49	<0.03	12000	0.3	200	<1	1	4	<1	0.02	1200	<0.5	18	1	3	<0.03	<0.03	700	<1	120
5	190	57	160	<0.03	15000	0.3	1700	<1	<1	5	<1	0.04	2200	<0.5	37	<1	4	<0.03	<0.03	900	<1	74
6 (Control)	86	51	50	<0.03	14000	0.2	400	1	<1	5	<2	0.04	1600	<0.5	16	2	4	0.2	<0.03	1600	<1	60
ULN*	500	NE	500	0.5	30000	1	1500	2	8	20	15	0.1	7000	1.5	50	5	30	0.3[a]	0.5	4000	5	250

ULN* Phytotoxicology Upper Limit of Normal for rural vegetation
NE Concentrations highly variable - guideline not established
a provisional guideline estimated from range of results; pending additional data

RE1655-Table.2

Table 2

Summary of Polynuclear Hydrocarbon Analyses Results (ppb)
of White Birch Foliage Collected in the Vicinity of
the Brock West Landfill Site, Pickering - September 9, 1986

PAH COMPOUND	MDL	Site Number					
		6 (control)	1	2	3	5	4
MDL CODE	*	*	*	*	**	*	*
NAPHTHALENE	50	--	--	--	--	--	--
ACENAPTHYLENE	50	--	--	--	--	--	--
ACENAPHTHENE	50	--	--	--	--	--	--
9H FLUORENE	60	--	--	--	942	--	--
PHENANTHRENE	40	--	--	TR	--	--	--
ANTHRACENE	40	--	--	--	--	--	--
FLUORANTHENE	40	--	--	--	--	--	--
PYRENE	40	--	--	--	--	--	--
CHRYSENE	50	--	--	--	--	--	--
BENZO(a)ANTHRACENE	50	--	--	--	--	--	--
BENZO(a)PYRENE	50	--	--	--	--	--	--
BENZO(k) & BENZO(b) FLUORANTHENE	50	1100	--	224	--	--	--
DIBENZO(ah)ANTHRACENE	50	--	--	--	--	--	--
BENZO(ghi)PERYLENE	50	--	--	--	--	--	--
INDENO(123-cd)PYRENE	50	--	--	--	--	--	--
% RECOVERY D10-ANTHRACENE	--	87%	100%	65%	89%	--	--

TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED
MDL = METHOD DETECTION LIMIT
* = MDL AS STATED
** = MDL APPROX. 10 TIMES STATED DUE TO LIMITED SAMPLE AVAILABLE

RE1655-Table.1

Table 3

Summary of White Birch Incremental Growth Patterns
in the Vicinity of the Brock West Landfill Site
Pickering - 1986

Site No	Parameter	Pre Excavation (1951 - 62)	Post Excavation Pre Landfill (1963 - 74)	Post Landfill (1975 - 86)
	Mean Ring Width (mm)	1.6	1.41	1.05
	S.D. (mm)	0.37	0.38	0.26
	% Difference	-14.2	+23.7	0
	't'	-1.811	1.884	0
2	Mean Ring Width (mm)	1.74	1.28	0.92
	S.D. (mm)	0.49	0.34	0.27
	% Difference	-7.4	+12.3	-12.4
	't'	-0.806	1.034	-1.228
3	Mean Ring Width (mm)	1.53	1.49	1.10
	S.D. (mm)	0.49	0.42	0.32
	% Differnce	-18.6	+30.7	+4.8
	't'	-2.015	2.308*	0.431
4	Mean Ring Width (mm)	1.48	1.54	1.02
	S.D. (mm)	0.65	0.47	0.39
	% Difference	-21.3	+35.1	-2.9
	't'	-1.903	2.461*	-0.228
5	Mean Ring Width (mm)	1.76	1.26	0.72
	S.D. (mm)	0.43	0.28	0.21
	% Difference	-1.8	+10.5	-31.4
	't'	-0.745	0.965	-3.479**
6	Mean Ring Width (mm)	1.88	1.14	1.05
	S.D. (mm)	0.39	0.35	0.27

* significant at the 95% level of probability
** significant at the 99% level of probability