H29B

Kaczkur

RESPONSE TO QUESTION ON TSP MEASUREMENTS ASKED BY Dr. Kingham

In order to address the question of similarity on measured suspended particulate matter at Waterdown and Boyne sampling stations two activities were performed. The first looked at individual sampling days and the concomitant winds and precipitation. The second activity examined other available data obtained at Stelco Research Center (the description of the Stelco Research Centre Site and its location are given on pages 109 and 113 respectively of Appendix 1) which is a short distance to the east of site F and just north of the North Service Road.

The Stelco Research Center data is contained in a report entitled "An Assessment of Street Dust and Other Sources of Airborne Particulate Matter in Hamilton, Ontario."

Excerpts from that report are attached in Appendix 1.

> **The general features (page xx) indicate "that the Experimental and Control sites were similar in character and that TSP levels were the result of relatively large scale influences rather than specific predominant sources".**
>
> **"Consistent daily variations were observed in TSP levels, the most probable cause being diurnal variations in wind speed, source emission rate and traffic volume".**
>
> **Highest TSP levels occurred at Stelco Research Centre (page xxi) when winds were out of the southwest, reflecting the impact of both local highways and industry.**
>
> **The measured mean value of TSP (ug/m^3) measured at the Stelco Research Centre from the end of June to the beginning of August was 47 ug/m^3 (geometric mean). This value is given in the last line of Table 4-1 (page 162 of Appendix 1).**

The monthly mean TSP concentrationsat Boyne and Waterdown(revised Table 4.4 in exhibits 29 and 30) during the month of July 1986 were 50 and 48 ug/m^3 respectively.

The similarity between July 1979 readings at Stelco Research Center and July 1986 readings is quite good particularly between the Waterdownand Stelco which are only a few miles apart.

Appendix 1 addressesTSP 1979 measurementsin Section 4.2, page 169 and notes that "variation in TSP levels is very consistent from site to site with high and low TSP values occurring at all sites simultaneously throughout the study." It goes on to describe the effect of meteorology and indicates that windspeed, wind direction and precipitation have an effect on TSP concentrations as shown on Figure4.1, page 170 of Appendix1.

Several sampling days during 1986 were examined in more detail to determine if similar factors to those described in section 4.2, page 169 of Appendix 1 may have influenced the TSP measurements given in exhibits 29 and 30. The following observations were made:

. On May 5 1986, TSP readings were high, 103.9 at Waterdownand 92.7 at Boyne. The winds were fairly strong, 15 km per hour over the 24 hour period, and they were exclusively from the southwest and west southwest direction, the same direction that produced highest levels at the Stelco ResearchCenter.

. On April 26 1986, winds average 8 km/hr and were from the northwest for 12 hours and from the east southeast for 12 hours. The measuredconcentrationswere 66.1 ug/m^3 at Waterdownand 83.0 ug/m^3 at Boyne. There was no rainfall. Half the time (ESE winds) sourceswere upwindof the monitors.

. On March 3 1986, winds were light averaging 4 km/hr. Half the time(12 hours) winds were from the northwest (few sources) and for the remaining 12 hours winds were from the east (urban and industrialsources).

There was no rainfall. The measured concentration at Waterdown was 98.8 ug/m^3 and at Boyne 102.5 ug/m^3.

. On days with rainfall that exceeded 6 mm, TSP levels were low particularly when winds were high or from directions having few sources upwind. The following tables illustrates these effects.

Date	Rainfall (mm)	Wind Direction& Speed	TSP ug/m^3 Waterdown	Boyne
10/09/85	17	NNW16	23.5	17.5
03/11/85	24.6	E26.7	12.6	--
09/11/85	20.4	N12.4	12.3	8.6
18/11/85	9.6	E11.4	50.3	35.3
30/11/85	2.3	E17.6	24.3	22.3
07/02/86	7.0	ENE29.7	11.0	14.4

. Three graphs of measured TSP have been prepared, one for Waterdown,one for Boyne, and one on which the two stations are plotted together. The graphs are included in Appendix 2. The similarity is evident in the third graph, however there are differences particularly in the higher readings. From the middle of September 1985 to mid April 1986 TSP levels are low with the exceptiontwo high readings one in Novemberand one in March.

During the spring and summer of (1986) TSP levels increase and there are a half dozen or more high valuesat both locations.

APPENDIX 1

ISBN 0-7743-7528-0

(25)

AN ASSESSMENT OF STREET DUST AND OTHER SOURCES OF AIRBORNE PARTICULATE MATTER IN HAMILTON, ONTARIO

PREPARED
FOR
ENVIRONMENT CANADA
ONTARIO MINISTRY OF THE ENVIRONMENT
DOFASCO, INC.
STELCO, INC.
CITY OF HAMILTON

ARB-28-82-ARSP

CONDUCTED JOINTLY BY:
ONTARIO RESEARCH FOUNDATION
UNITED TECHNOLOGY & SCIENCE INC.
CONCORD SCIENTIFIC CORPORATION
THE MEP COMPANY

March 5, 1982

influence of area, point and local sources on ambient TSP levels.

- Dispersion Modelling - this technique begins with the source emission rate of a particular pollutant, applies a physical model of the atmosphere based on fluid mechanics to calculate the resultant concentration of the pollutant at any point away from the source. The model used in this study, PAL, allows for assessing the effects of point, area and line sources on ambient TSP air quality.
- Chemical Mass Balance (CMB) - this technique is a form of receptor model in which the detailed relative chemical composition of the particles emitted by each contributing source (source profile) and the same data available for one or more ambient particulate matter samples (receptor profile) are used to calculate the proportionate contribution of each source to the corresponding receptor sample.

RESULTS AND DISCUSSION

General Features

The results of the above analyses and modelling techniques were used to characterize the particulate matter and determine its major sources. The characteristics of the data may be summarized as follows:

- Observed TSP levels were log-normally distributed and consistent from site to site, indicating that the Experimental and Control sites were similar in character, and that the TSP levels were the result of relatively large scale influences rather than specific predominant sources
- Consistent daily variations were observed in TSP levels, the most probable causes being diurnal variations in wind speed, source emission rate, and traffic volume
- At the Cannon St. sites, the highest TSP levels occurred when winds were out of the northeast reflecting the combined impact of emissions from the industrial sector and urban area, whereas

for the School and Stelco Reseach Centre sites, highest levels occurred when winds were out of the southwest, reflecting the impact of both local highways and industry

- Height and distance profiles of TSP levels relative to the roadway show clearly the contribution of reentrained road dust
- Size specific particulate data show that the fraction having an aerodynamic diameter of less the 15 μm comprises approximately 45% of TSP, while the fraction less than 2.5 μm represents approximately 22% of TSP
- The results of chemical and morphological analysis show directional patterns consistent with the observed effect of wind direction on ambient particulate matter levels, and exhibited anticipated source contributions.

Source Apportionment

Three different methods were used to determine the average percent contribution of various source categories to TSP levels in the downtown Hamilton area. The source categories used were as follows:

Area: fugitive dust sources such as unpaved parking lots, construction sites, and small point sources such as residential heating, railway yards and incinerators

Point: major point source emissions in and around the area. This is primarily the steel industry component

Traffic-related: includes both reentrainment road dust and direct vehicular emissions from all streets in the study area

Background: includes the long-range transport component and other unidentified sources beyond the study area

Unexplained: that portion of the TSP levels not apportioned to one of the above source categories by the methods employed. The background term in both the microinventory and dispersion modelling approaches is a residual term and so there is no unexplained portion in these cases.

a photograph of the site.

School Site. A map of the School site is presented in Figure 3-13. Two HiVols, set to operate sequentially, were located on the northwest corner of the roof of the Bell Cairn Memorial School, with the HiVol inlets being located approximately 7 m above the ground. The school is located in the Beach Boulevard area just north of the ramp to the Queen Elizabeth Way (QEW). The site is in a residential area approximately 1.5 km from the south end of Beach Boulevard, 350 m east of the QEW, and approximately 2.0 km northeast of the heavy industrial area. A small gravel parking lot, at the end of Sierra Avenue, is located directly below the HiVol installations and the beach, which is approximately 50 m wide at this point, is situated approximately 20 m to the west of the school. Figure 3-14 shows a photograph of the site.

Farm Site. A map of the Farm site is presented in Figure 3-16. The HiVol was mounted at a height of 4 m on a hydro pole located approximately 100 m west of West Fifth Street. The farm itself is situated on Hamilton Mountain, on the west side of West Fifth Street, approximately 300 m south of the intersection of West Fifth Street and Stonechurch Road. Althought the area is agricultural, the surrounding land is largely fallow because of proposed developments in the area. A tilled area, 150 m by 100 m was located approximately 75 m north of the site. Figure 3-15 shows a photograph of the site.

Stelco Research Centre Site. Figure 3-17 shows a map of the area surrounding the Stelco Research Centre (SRC) site. Three HiVols, set to operate sequentially, were installed at the southwest corner of the roof of the Stelco Research Centre (SRC). The HiVol inlets were situated approximately 8 m above the ground. The building is located on a large (approximately 30 acres) grassed lot, with paved parking lots on the northwest side. A small housing development is situated to the southwest, and approximately 500 m to the south is the intersection of Highway 403 and the QEW, two heavily travelled freeways (combined ADT is approximately 10,000). The heavy industrial area of Hamilton is situated approximately 8 km to the south of this site.

Figure 3-18 is a photograph of the site and shows a view of the HiVols looking southeast from the roof of the Research Centre building.

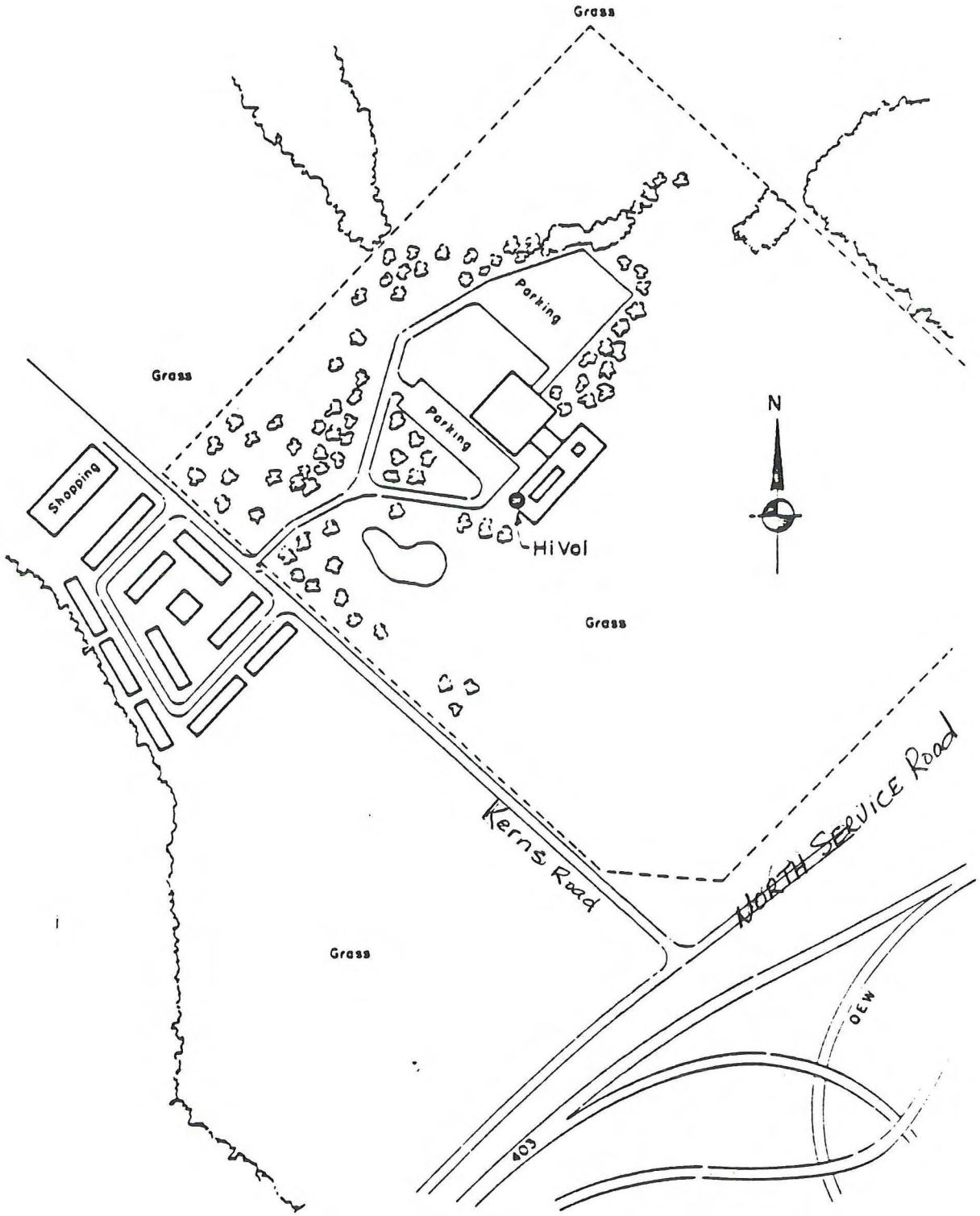


FIGURE 3-17 MAP OF STELCO RESEARCH CENTRE SITE

TABLE 4-1

Summary of Source Contributions for
MicroInventory Regression Equation Determination

Site	Area	Point	Local	Measured Mean ($\mu g/m^3$)	
				Study Period	Annually Adjusted
Experimental 1	4,174	2,422	0.2258	76	65
Experimental 2	5,408	2,422	0.3578	84	71
Experimental 3	8,046	2,422	0.5213	95	81
Experimental 4	8,046	2,422	0.1471	80	68
Experimental 6	8,046	2,422	0.0894	78	66
Control 1	3,059	2,148	0.2808	82	70
Control 2	3,778	2,148	0.4230	88	75
Control 3	5,308	2,148	0.6156	99	84
John Street	6,719	1,998	0.6101	109	93
Oak Avenue	5,455	2,379	0.8576	105	89
School	1,896	4,622	0	77	75
Farm	602	0	0	59	50
Stelco Research Centre	1,166	50	0	47	40

The standard deviations for these latter two calculations are quite similar (~ 5 $\mu g/m^3$) and, as would be anticipated, the correlation coefficients indicate an improvement in the fit of the data compared to the results obtained using the more general terms derived by Pace (51), (Table 4-2). A more substantial contribution by POINT sources and a reduction in the AREA contribution are the major differences compared to the predictions made using the PACE regression equation. The significance of these and other aspects of the microinventory results, including an assessment of the statistical significance of the relationships derived above, will be discussed in Section 5.2.2.

4.2 TSP Measurements

Typical temporal variations of the TSP data are shown in Figure 4-1, using TSP levels during the month of July 1979 at Experimental 3, Control 3 and SRC sites as examples. As can be seen from Figure 4-1, the variation in TSP levels is very consistent from site to site, with high and low TSP values occurring at all sites simultaneously throughout the study. The effects of meteorology are illustrated in the changes in TSP levels indicated as A, B and C in Figure 4-1. In A, over the 24 hour period of June 30 to July 1, the TSP levels dropped dramatically. This decrease coincides with an extended interval of rainfall commencing during the 0600 - 1200 hour period of June 30th. Wind direction is an important parameter in determining TSP loadings in the Hamilton area. The effect of wind is seen in the changes at B and C, where substantial decreases from very high (> 200 $\mu g/m^3$) to much lower (< 100 $\mu g/m^3$) levels occurred due to a wind shift from NE (i.e., from the industrial area) to SW over approximately a 12 hour period. Also observable in Figure 4-1 is the diurnal variation in TSP, with higher levels occurring during the daytime hours. It can be seen that the background levels, represented by the SRC site, follow the general trends in variability, but at much lower levels.

The 6-hour and 12-hour data were averaged for each station and the geometric means, geometric standard deviations and number of values for the complete study period are presented in Table 4-7. The individual data are listed in Appendix D.

The data were subdivided according to meteorological regimes as defined in Section 3.3.2 and the geometric means and standard deviations for each subset

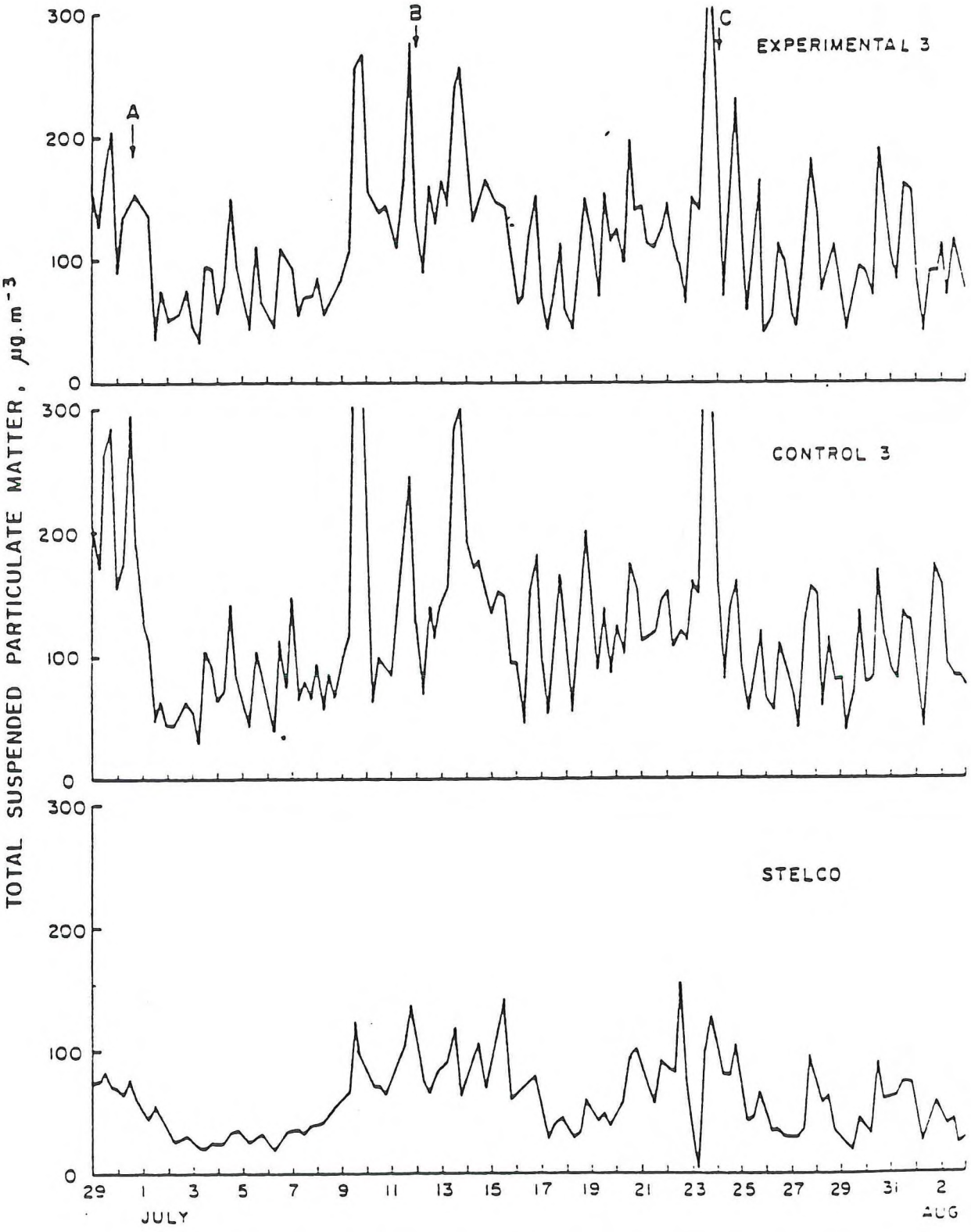
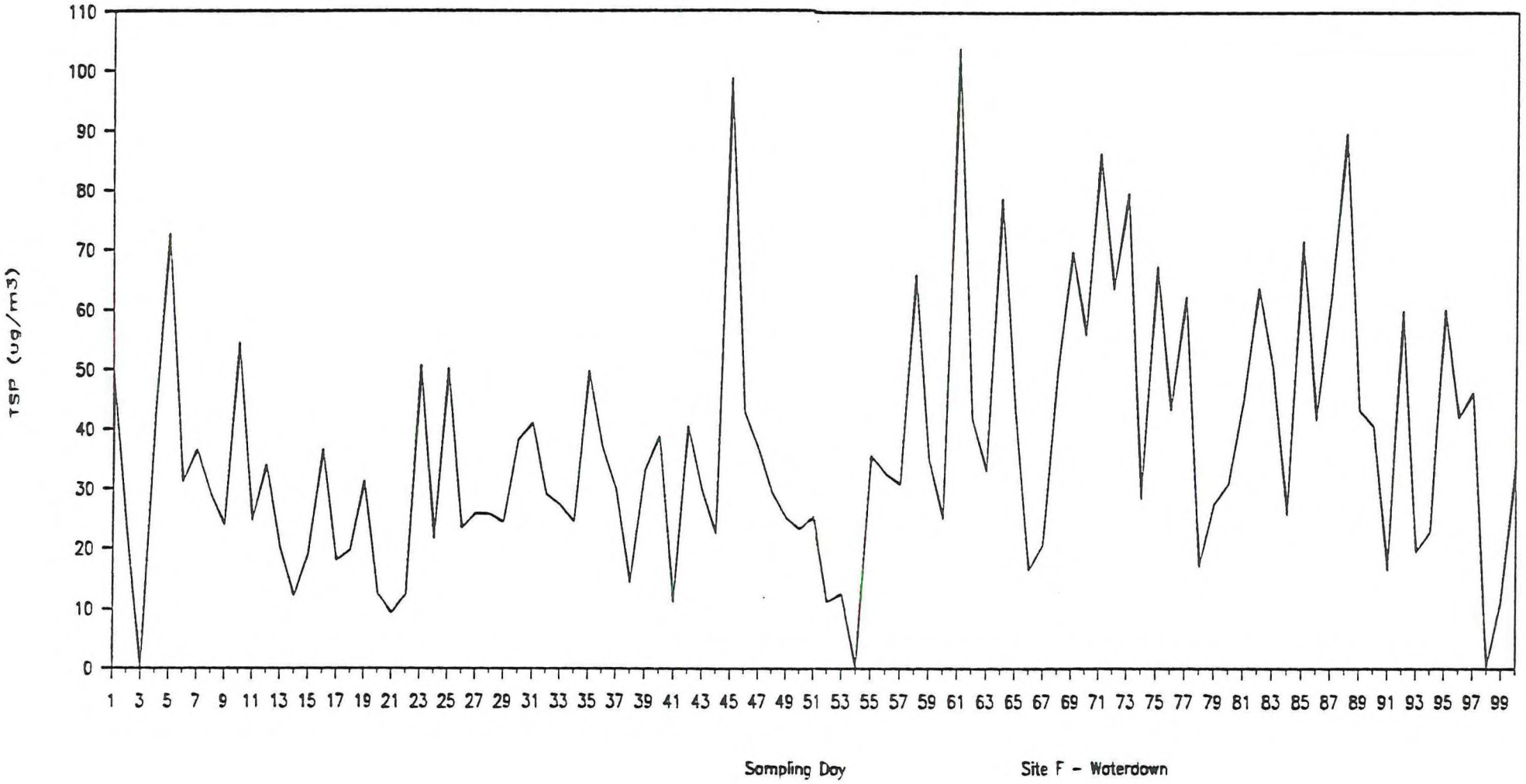


FIGURE 4-1 VARIATION OF TSP LEVELS DURING JULY 1979

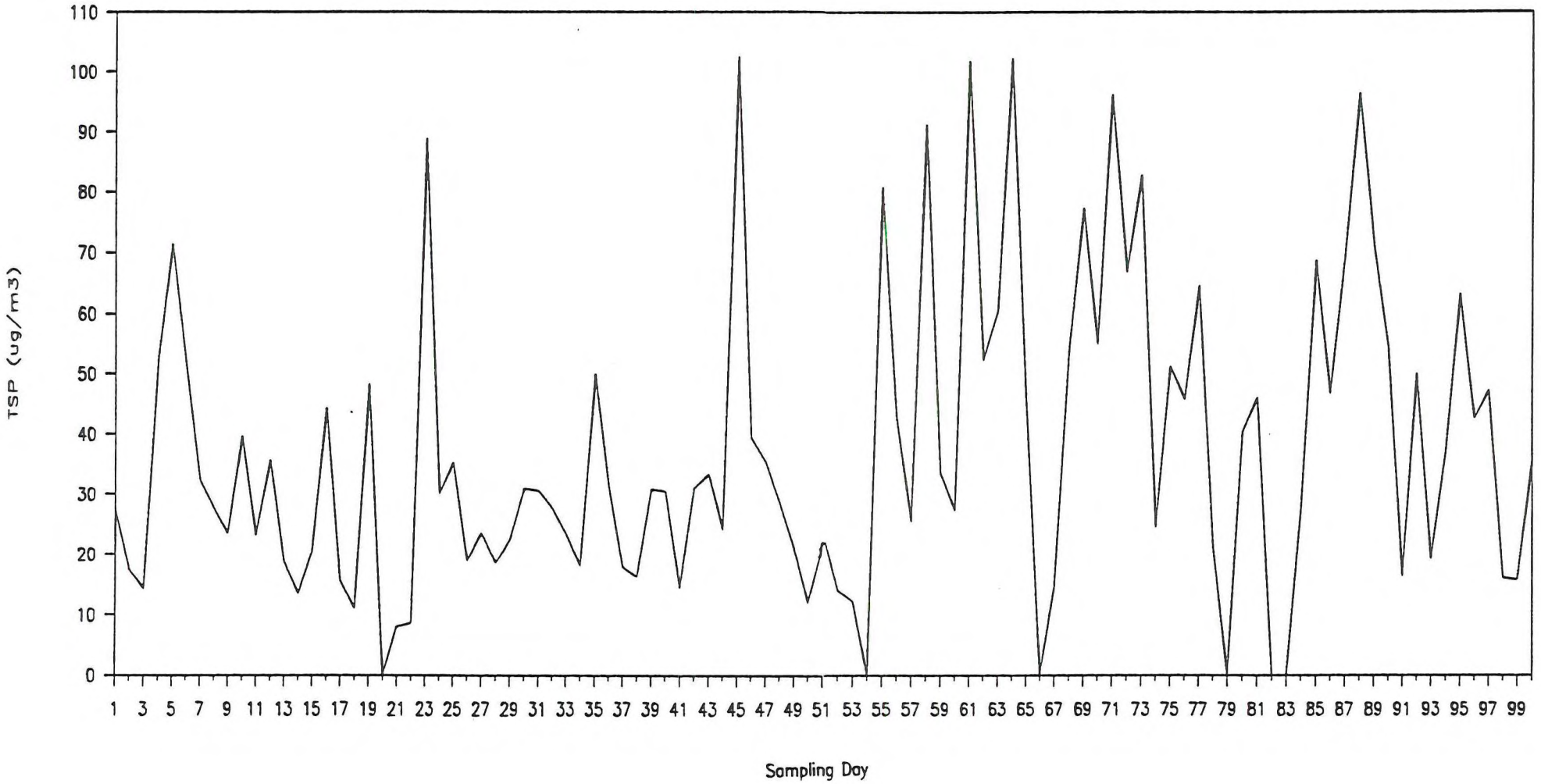
APPENDIX 2

TSP Concentrations



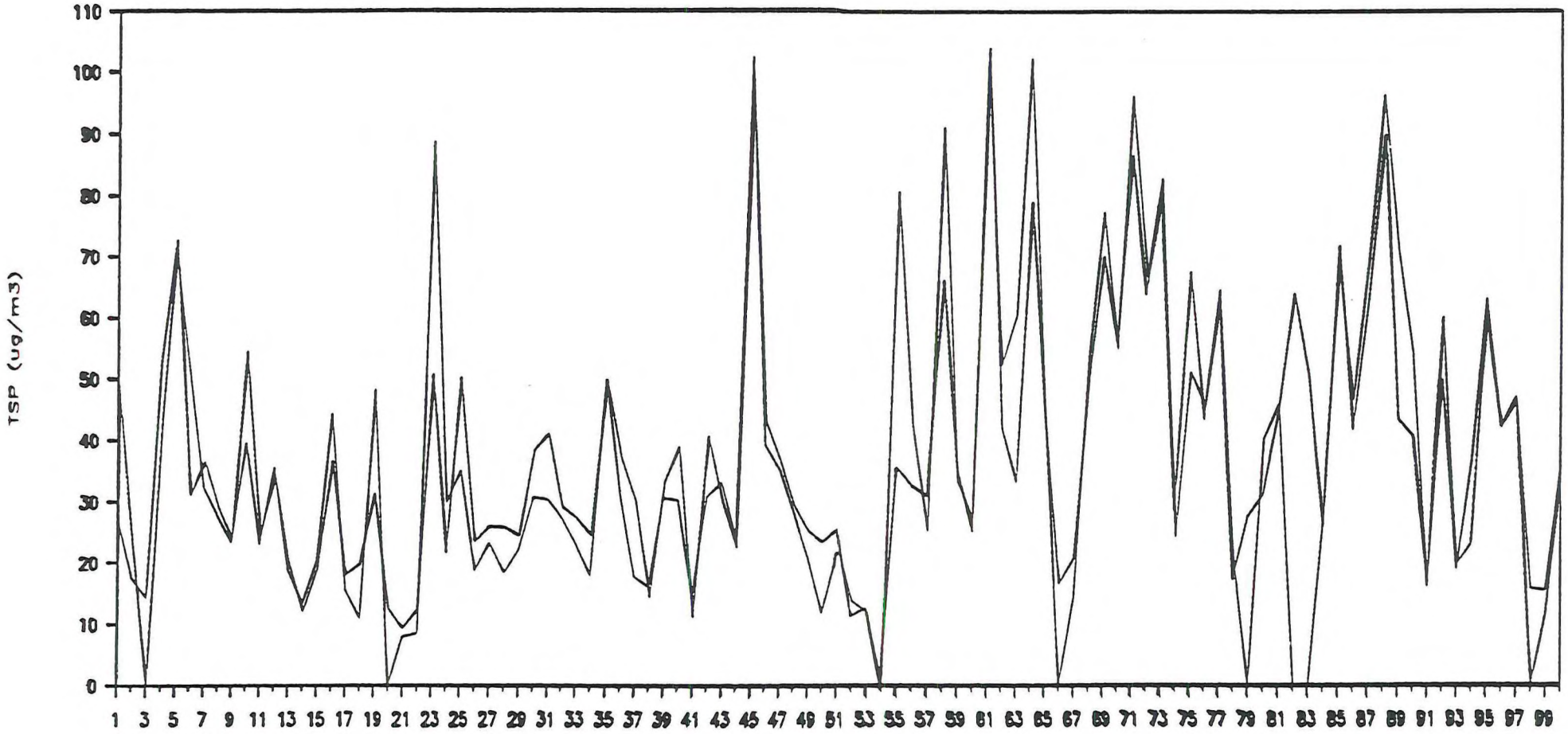
TSP Concentrations

Site D – Boyne



TSP Concentrations

Site D – Boyne



Site F – Waterdown