HALTON REGION LANDFILL TECHNICAL STUDY

AIR QUALITY ANALYSIS

Site D

Schedule I - D

H-29

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EXECUTIVE SUMMARY

Following the Stage 2B, Selection of Candidate Sites, the Stage 2C study evaluated the six candidate sites relative to each other and to applicable criteria. From Stage 2C, two preferred sites, Site D and Site F, were identified. This report describes the further work completed for Site D. Both Stage 2B and Stage 2C are part of the Region of Halton's Landfill Environmental Impact Assessment.

Site D is predicted to have an acceptable impact on the ambient air quality in the area surrounding it. During the construction of the berm, there will be occasional elevated levels of total suspended particulate matter that will occur on about 20 days. Once the berm is finished, total suspended particulate levels, arising from normal landfill operations are not predicted to exceed the ambient air quality criteria promulgated in Regulation 308 of the Environmental Protection Act (Ontario, 1985). Odours from the raw garbage on site are predicted to be undetectable at the site boundaries.

The following mitigation measures were necessary to ensure that the levels of total suspended particulate matter were acceptable. All of the permanent roads within the landfill should be paved and all of the gravel or dirt roads should be wetted on a regular basis during dry weather. The areas where the front end loader works should also be watered regularly during dry weather. All exposed soil should be seeded or grassed at the earliest opportunity. Odour is controlled with the normal practice of properly covering the raw refuse each day.

1.0 REVIEW OF STAGE 2C WORK

The Stage 2C, Technical Report No. 6, Air Quality Assessment (Senes, 1985), was submitted to Halton Region as part of its Environmental Assessment study. That report assessed six Candidate Sites, identified at Stage 2B, Selection of Candidate Sites, for the potential impact in their vicinities, of suspended particulate matter and odour emissions which would arise during the landfill operation. The Stage 2C report was comparative, in that it attempted to distinguish between the sites based on air quality impacts and their compliance with applicable criteria.

For the purpose of the Stage 2C report, operating procedures, site layout and the equipment likely to be in operation were assumed based on current operating practices in the Region of Halton and on information from Hydrology Consultants, regarding site design and operational procedures, and from Giffels Associates Limited, regarding transportation. This information was used to generate emission rates of both dust and odour from the landfill operation. These emission rates were combined with meteorological data to derive expected atmospheric impacts.

From the Stage 2C analysis it was determined that odour would not be readily detectable, except under certain, uncommon meteorological conditions, in the short term. The long term impact of gas generated in the landfill as the garbage decomposes was not addressed.

From the Stage 2C analysis it was determined that elevated levels of total suspended particulate matter (TSP) could be observed at the landfill site boundaries. However, these elevated levels were associated with the unusual conjunction of dry weather, and high levels of activity near any of the site boundaries.

It was concluded that any of the six sites would be acceptable from an air quality point of view. The sites were differentiated only by the proximity of local residences, parks and other areas likely to be affected by the emissions of dust and odour. It was also noted that some mitigative measures could be used to reduce the impacts.

2.0 METHODOLOGY

The assessment of odour and dust impacts from a landfill operation is based on fairly standard estimating procedures described below. The existing conditions at the site were documented using both a field air quality monitoring program and air quality monitoring data published by the Ontario Ministry of the Environment (MOE). An air quality monitoring station was established at the Boyne Community Centre, at the corner of Highway 25 and Britannia Road. Meteorological data were obtained from nearby stations operated by the Atmospheric Environmental Service of Environment Canada.

Using descriptions of the proposed landfill and the proposed operating procedures, emission rates for both dust and odour were calculated. The proposed operating procedures were based on current practices at Halton's landfill and on information from Hydrology Consultants, regarding site design and operational procedures, and from Giffels Associates Limited, regarding transportation. These emission rates and meteorological data were combined in an atmospheric dispersion model to generate estimates of total suspended particulate matter and odour concentrations at neighbouring locations, especially at nearby residences.

The estimated concentrations of total suspended particulate matter were compared to criteria established by the Ontario Ministry of the Environment. Estimated occurrences of detectable odour were judged on their frequency and severity. Mitigative measures were examined and are proposed where necessary.

3.0 CRITERIA USED FOR EVALUATION

Total suspended particulate matter (TSP) and odour impacts, beyond the boundaries of the landfill operation are regulated under the Environmental Protection Act, and Regulation 308 (Ontario, 1985).

TSP is evaluated relative to three criteria.

1. The regulated (Reg. 308) half hour point of impingement of 100 $\mu g/m^3$. A source should not exceed the point of impingement standard, when its impact is calculated using the procedures described in the regulation.

2. The ambient air quality criteria of

   (a) 120 $\mu g/m^3$ for 24 hours and

   (b) 60 $\mu g/m^3$ annual geometric mean are used to evaluate longer term impacts (Ontario, 1985).

Because of the difficulty of measuring odours, odour impact is addressed in the nuisance sections of the Environmental Protection Act. An odour can be considered to be a nuisance if it is detectable, and is judged to be unpleasant (Ontario, 1985). Where odour emission rates are available, they can be used to model atmospheric odours. An odour level greater than 35 odour units per cubic metre (OU/m^3) (1 OU/ft^3) can be considered to be detectable.

4.0 IMPACT ASSESSMENT

4.1 Introduction

This section describes the potential suspended particulate matter and odour emissions from the proposed landfill and their potential impact. The first section describe the existing air quality in the area. The meteorological and climatological parameters that are important in determining odour and suspended particulate matter impact are described next and the remaining three sections describe the potential emissions, predicted impacts and mitigation measures for suspended particulate matter and odour.

4.2 Existing Ambient Air Quality

4.2.1 Introduction

The primary air contaminant of concern from a landfill operation is particulate matter. In Ontario, airborne particulate matter is measured in two ways, as dustfall and as total suspended particulate matter. Dustfall consists of particulate matter which is of sufficient weight to settle from the atmosphere by gravity; this is generally regarded as airborne dust that is greater than 20 micrometers (μm) in actual diameter (Ontario, 1984) . Total suspended particulate matter is the dust in the atmosphere that is sampled with a high volume sampler. It is generally considered to consist of suspended dust particles less than about 44 μm in aerodynamic diameter (Ontario, 1979).

The applicable ambient air quality criteria for dustfall and total suspended particulate matter are presented below (Ontario, 1985).

Dustfall	7 $g/m^2/30$ days - monthly
grams per square metre	4.6 $g/m^2/30$ days - annual mean
per 30 days ($g/m^2/30$ days)	
Total Suspended Particulate Matter	120 $\mu g/m^3$ - 24 hours
micrograms per cubic metre	60 $\mu g/m^3$ - annual geometric mean
($\mu g/m^3$)	

In the sections that follow, ambient air quality measurements have been drawn from the Ontario Ministry of the Environment air quality monitoring stations, and an air quality monitoring station established for this study, near Site D. The location of the landfill site, the SENES air quality monitoring station and a number of the MOE air quality monitoring stations are shown on Figure 4.1.

4.2.2 Total Suspended Particulate Matter

Examination of the data accumulated by MOE since 1969, has shown that the Halton, and Hamilton Wentworth Regions experienced similar trends with respect to the levels of total suspended particulate matter (TSP). Except for those areas in Hamilton which were impacted on by the large industrial sources, there was a steady decrease in the measured TSP levels until the early 1980's. From 1982 onwards the ambient concentrations in the suburban and rural areas have remained steady or shown a slight decrease, with annual geometric means of between 45 and 60 $\mu g/m^3$. Tables 4.1 and 4.2 summarize the last five years data for those locations which are the closest MOE monitors to the proposed landfill site.

Only occasionally does the MOE monitor in areas where there is not a specific need to examine a problem, or where problems are not anticipated. Short term studies may be made for such purposes, to define the limits of areas affected by known sources of emissions, or to ensure that certain areas are free of pollution. Because of this there is very little information about the air

Ta .1

REGIONAL ANNUAL TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATIONS
(Geometric Mean, $\mu g/m^3$)

	HAMILTON WENTWORTH								BURLINGTON	OAKVILLE
Location	Hughson/ Hunter	City Centre	450 Hughson St. North	Upper Wellington/ Inverness	405 Cumberland Ave.	Barton/ Nash	Westdale Library	Bay/ Main	North Shore Blvd.	Woburn Cres.
MOE Monitor Ref. No.	29001	29007	29067	29085	29087	29089	29090	29098	44008	44015
1981	62	57	56	55	65	58	59	na	45	50
1982	67	60	54	57	58	60	53	na	46	45
1983	64	68	57	53	61	57	50	59	49	40
1984	75	na	58	53	59	57	66	55	57	47
1985	61	na	43	44	56	58	55	45	55	45
Average	65.8	61.7	51.6	52.4	59.8	58.0	56.6	53.0	50.4	45.4

Table 4.2

REGIONAL 24 HOUR TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATIONS
($\mu g/m^3$)

	Hughson/ Hunter	City Centre	450 Hughson St. North	Upper Wellington/ Inverness	405 Cumberland Ave.	Barton/ Nash	Westdale Library	Bay/ Main	North Shore Blvd.	Woburn Cres.
Maximum	250	251	320	324	333	185	29	168	286	210
Minimum	19	13	0	18	20	22	7	18	2	8
No. of Times >120	33	20*	14	15	21	9	12	7*	40	11
No. of times >120 in 1985	1	na	1	2	2	0	1	0	9	6

Notes

* Data available for only 3 years

na - not available

quality in the immediate neighbourhood of the site. The only sampling location which can be considered to closely resemble, in terms of local area quality, the potentially affected rural areas was at 24 Lorne Scots Drive in Milton but this station operated only during 1975 and no recent data are available.

Comparison of the data obtained at this station with those from other suburban stations is made in Table 4.3. Results from only a few comparable stations are available for 1975. This table therefore includes the information for the year nearest to 1975 during which those stations operated. It can be seen that the air quality at the Lorne Scots Drive site was as good as or better than that at any of the other sites. Most of the other monitors are located near known sources of suspended particulate matter emissions.

In order to obtain current information on the air quality in the close vicinity of the proposed landfill sites, SENES established an air quality monitoring station, near Site D. The station was operated in accordance with MOE procedures (Ontario, 1979; Ontario, 1984). The monitoring station for Site D is located on the roof of the Boyne Community Centre, on the northwest corner of Highway 25 and Britannia Road approximately 1500 m north of Site D. The location of this station is shown on Figure 4.1.

The results obtained to date are summarized in Tables 4.4 and 4.5. Although the levels are lower than those at any of the MOE sites these results should not be construed as representing the average annual air quality of the sites. Seasonal variations in wind speed, wind direction and precipitation all may affect the levels of TSP encountered. The levels of TSP in the atmosphere range from a low of 8 to a high of 102 $\mu g/m^3$. The geometric mean of the data collected to date is 26 $\mu g/m^3$. These data are typical of suburban and rural areas for the time of year that has been sampled. These data indicate satisfactory ambient air quality with respect to TSP.

4.2.3 Dustfall

Table 4.6 summarizes the dustfall data obtained from the MOE monitoring

FIGURE 4.1

LOCATION OF AIR QUALITY MONITORING STATIONS

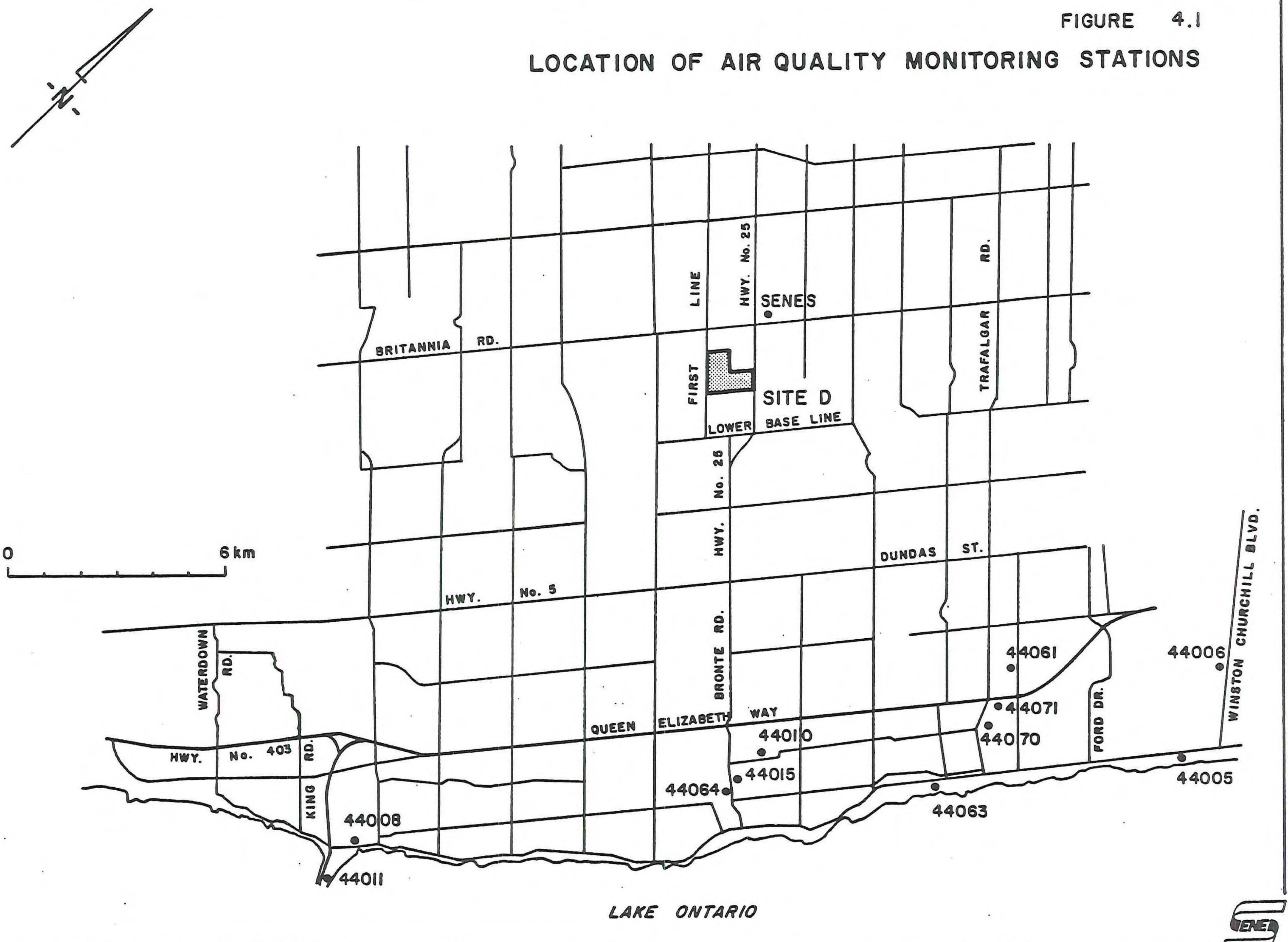


Table 4.3

SUBURBAN AND RURAL TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATIONS
($\mu g/m^3$)

Monitor Number	44032	29001	29007	29067	29085	29087	29089	29090	44005	44008	44010	44011	44012	44015	44030	44031
Geom. Mean	44	75	71	63	61	73	70	67	55	61	39	46	58	62	72	74
Maximum	231	250	208	210	150	184	182	138	431	254	284	220	224	266	237	215
Minimum	14	21	29	20	23	23	22	31	15	7	2	17	20	19	14	17
No. of times >120	4	13	7	4	3	6	3	1	7	5	4	2	6	8	12	17
Year	1975	1975	1975	1975	1979	1979	1980	1980	1975	1979	1976	1982	1982	1980	1975	1975

44032 Lorne Scots Drive - Milton
29001 Hughson/Hunter - Hamilton
29007 City Hall - Hamilton
29067 450 Hughson St. - Hamilton
29085 Wellington/Inverness - Hamilton
29089 Barton/Nash - Hamilton
29090 Westdale Library - Hamilton
44005 Lakeshore E/Brikbank - Oakville
44008 Hwy 2/North Shore Blvd. - Burlington
44010 1298 Rebecca St. - Oakville
44011 110 Omaha Burlington
44012 964 Lakeshore Blvd. - Burlington
44015 Bronte/Woburn Cresc. - Oakville
44030 706 Main St E., Milton
44031 Works Dept. Nipissing Rd. - Milton

Table 4.4

TOTAL SUSPENDED PARTICULATE MATTER CONCENTRATIONS - SITE D (μg/m³)

Date	
07/09/85	27.6
10/09/85	17.5
13/09/85	14.3
16/09/85	52.7
19/09/85	71.4
22/09/85	51.7
25/09/85	32.4
28/09/85	27.6
01/10/85	23.4
04/10/85	39.7
07/10/85	23.1
10/10/85	35.7
13/10/85	18.8
16/10/85	13.4
19/10/85	20.4
22/10/85	44.5
25/10/85	15.6
28/10/85	11.0
31/10/85	48.3
03/11/85	Invalid due to sampler failure.
06/11/85	8.0
09/11/85	8.6
12/11/85	88.9
15/11/85	30.1
18/11/85	35.3
21/11/85	18.8
24/11/85	23.5
27/11/85	18.4
30/11/85	22.3
03/12/85	30.9
09/12/85	30.6
15/12/85	27.6
21/12/85	23.4
27/12/85	18.0
02/01/86	50.0
08/01/86	31.0
14/01/86	17.9
20/01/86	16.1
26/01/86	30.8
01/02/86	30.5
07/02/86	14.4
13/02/86	31.0
20/02/86	33.4
25/02/86	24.1
03/03/86	102.5
Geometric Mean	26.4

Table 4.5

DISTRIBUTION OF TOTAL SUSPENDED PARTICULATE MATTER DATA - SITE D

Range ($\mu g/m^3$)	No. of Samples	Cumulative
100-110	1	1
90-100	0	1
80-90	1	2
70-80	1	3
60-70	0	3
50-60	2	5
40-50	2	8
30-40	11	19
20-30	11	30
10-20	12	42
0-10	2	44

Table 4.6

Halton Region Annual Dustfall Data

Site D 30 day averages ($g/m^2/30$ days)

Station No.	44005	44006	44015	44061	44063	44064	44070	44071
Year								
1979	5.2	3.8	--	2.6	--	3.1	9.3	4.3
1980	3.2	3.2	2.5	2.7	4.5	3.4	8.0	6.3
1981	3.4	2.8	2.5	2.1	4.5	5.0	6.9	4.8
1982	4.5	4.1	2.8	2.8	4.7	4.9	7.8	4.5
1983	2.4	4.4	1.8	2.5	4.2	3.7	5.7	4.2
1984	3.2	3.1	2.4	3.5	4.8	4.5	10.9	4.1
1985	2.9	3.3	2.3	3.5	5.0	3.9	6.7	4.4
Overall Mean	3.5	3.5	2.4	2.8	4.6	4.1	7.9	4.7
No. of Time >7 $g/m^2/30$ days	7	11	1	2	8	9	45	8
No. of Samples	84	82	81	82	70	84	76	82

44005 - Lakeshore East/Birkbank, Oakville
44006 - 494 Winston Churchill Blvd., Oakville
44015 - Bronte Road/Woburn Crescent, Oakville
44061 - 8th Line Road, Oakville
44063 - George/Robinson Streets, Oakville
44064 - 395 Bronte Street, Oakville
44070 - Allan/Pine Streets, Oakville
44071 - South Service Road, Oakville

network at the nearest locations to Site D. The values at these stations range from 0.4 $g/m^2/30$ days (Station No. 44015) to 30.0 $g/m^2/30$ days (Station No. 44006) but at only two (Station No. 44070, 44063) does the annual mean exceed the criterion of 4.6 $g/m^2/30$ days in recent years. It must be noted that in most cases dustfall samplers are located in urban areas or near to potential problem areas for the purpose of determining whether or not high dustfalls occur. Of the monitors listed, numbers 44015 and 44016 most closely approximate rural or suburban locations insofar as they are not situated in the most densely populated downtown areas of Oakville.

In addition to monitoring total suspended particulate matter at the Boyne Community Centre air quality monitoring station, dustfall measurements were also taken. The dustfall data are summarized in Table 4.7.

The dustfall measured to date ranged from 0.2 to 4.8 $g/m^2/30$ days. The mean of the data collected to date is 1.6 $g/m^2/30$ days. These levels are within the ambient air quality criteria and are typical for the area and time of year.

4.2.4 Odour

Odour measurements are not made routinely because of the difficulties of measurement and quantification. The odours experienced in the area surrounding the proposed site are typical of those encountered in agricultural areas across the province. There are at present no known odour sources which impact directly on the vicinity of the site. The surrounding area is primarily agricultural with farmhouses and other residences scattered throughout the area, there are no industrial sources which affect the immediate landfill neighbourhood.

No odours have been detected during visits to and inspection of the area around Site D. However, agricultural activities give rise to occasional emissions of odour, for example when fertilizers are spread, and where livestock are kept they can produce more frequent odour emissions. The

Table 4.7

DUSTFALL DATA - SITE D

September	A	4.8 $g/m^2/30$ days
	B	3.3 $g/m^2/30$ days
October	A	1.7 $g/m^2/30$ days
	B	1.7 $g/m^2/30$ days
November	A	2.3 $g/m^2/30$ days
	B	1.6 $g/m^2/30$ days
December	A	0.9 $g/m^2/30$ days
	B	1.0 $g/m^2/30$ days
January	A	0.7 $g/m^2/30$ days
	B	1.1 $g/m^2/30$ days
February	A	0.2 $g/m^2/30$ days
	B	0.2 $g/m^2/30$ days
Mean		1.6 $g/m^2/30$ days

Ministries of the Environment and of Agriculture and Food issue guidelines with respect to the management of agricultural activities, while the sections of the Environmental Protection Act dealing with odours (Sections 12 and 13) do not apply to "animal wastes disposed of in accordance with normal farming practices". It might therefore, be expected that agricultural odours will be occasionally experienced by residents in the vicinity of the site.

4.2.5 Summary of Air Quality Data

In general the dustfall, total suspended particulate matter and odour related air quality parameters that have been monitored in the area of Site D are within existing MOE air quality criteria. The estimated air quality can be summarized as follows.

Contaminant	Sampling period	Estimated Range	MOE Criteria
Total Suspended Particulate Matter:	Annual Geometric Mean	25 to 40 $\mu g/m^3$	60 $\mu g/m^3$
	24 hour maximum	150 to 200 $\mu g/m^3$	120 $\mu g/m^3$
	24 hour minimum	5 to 15 $\mu g/m^3$	120 $\mu g/m^3$
Dustfall:	Annual Arithmetic Mean	1 to 2 $g/m^2/30$ days	4.6 $g/m^2/30$ days
	Maximum monthly	4 to 5 $g/m^2/30$ days	7 $g/m^2/30$ days
	Minimum monthly	0 to 1 $g/m^2/30$ days	7 $g/m^2/30$ days
Odour:		infrequent agricultural odours	detectable

4.3 Meteorology and Climatology

4.3.1 Introduction

The effects of climatic and meteorological variations on the dispersion of contaminants and the formation of suspended particulate matter are large, variable and complex. Some examples of these effects are briefly described below.

Rainfall not only collects contaminants from the atmosphere and deposits them on the ground, but it reduces the formation of dust by earth moving equipment. Soils, which in a dry state are readily broken down into small particles which can be transported by the wind, form aggregates which are less readily disintegrated when they are wet. Heavy rains produce muds which although not easily converted into wind-transported suspended particulate matter, can become attached to vehicles and vehicle tires, removed from their original locations and deposited on roadways, from which they can later be dispersed as suspended particulate matter when dry conditions occur.

~~In dry weather winds can create suspended particulate matter by erosion of soils and by entrainment of dusts from surfaces upon which they have been deposited. High wind speeds result in the dilution of contaminants which are released at a constant rate, but also increase the erosion and entrainment of particulate material. As a general rule winds of less than 5 m/s do not result in erosion and below that speed the dilution effect of the wind results in lower concentrations of contaminants as the wind speed increases. At very high wind speeds erosion can become a dominant factor if large areas of exposed soil are affected.~~

High temperatures and high winds increase the rate of drying of soils and reduce the final water content of the soil to low levels thereby creating conditions which give rise to increased emissions created by the movement of vehicles on the soil or from mud previously deposited on roadways.

Meteorological conditions affect the extent of dispersion of airborne contaminants. Turbulent conditions increase the rate of dispersion of materials while stable atmospheric conditions limit the rate of dispersion. In this context, atmospheric conditions are categorized into six stability classes shown in the table below. Class A is the most unstable, turbulent condition; Class F is the most stable class. In turn, these are related to wind speeds, the time of day, the incoming solar radiation and the cloud cover

(Turner, 1967).

KEY TO STABILITY CATEGORIES

Surface Wind Speed (at 10 m), m/s	Day: Incoming Solar Radiation			Night	
	Strong	Moderate	Slight	Thinly Overcast or >4/8 Low Cloud	$\leq$3/8 Cloud
< 2	A	A-B	B		
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
6	C	D	D	D	D

The neutral class, D, should be assumed for overcast conditions during day or night.

The interaction of these factors renders the forecasting of contaminant concentrations for any specified short period an impossibility. Only general average concentrations can be predicted with any degree of assurance.

4.3.2 General Climatic Parameters

Site D is located between Highway 25 and First Line and between Britannia Road and Lower Base Line (see Figures 4.1 and 4.4).

Site D lies within the Lake Ontario Climate Region (Brown _et al._, 1980). The major physiographic features affecting the climate of the site are Lake Ontario and the Niagara Escarpment. The general climatic characteristics of the site are presented in Table 4.8.

A number of meteorological stations exist in the general area of site D. Three stations which surround the site are Oakville, Burlington, and Milton-

Table 4.8

GENERAL CLIMATIC CHARACTERISTICS OF THE SITE D AREA

Annual mean daily temperature (°C)	7.7
Annual mean daily maximum temperature (°C)	12.5
Annual mean daily minimum temperature (°C)	2.8
Extreme maximum temperature (°C)	36.8
Extreme mimimum temperature (°C)	-28.2
Mean annual degree days above 0°C	3425.9
Mean annual degree days below 0°C	536.8
Mean date of last frost in spring	May 7
Mean date of first frost in fall	Oct 10
Mean annual frost free period (days)	154
Mean annual rainfall (mm)	686.0
Mean annual snowfall (cm)	123.8
Mean annual total precipitation (mm)	817.0
Mean number of days with measurable rainfall	89
Mean number of days with measurable snowfall	32

Source: Canadian Climate Normals 1951 - 1980
Environment Canada 1982

Kelso. Using data from the Canadian Climate Normals 1951-1980 (Environment Canada, 1982, 1982a), temperature and precipitation conditions on site D were approximated by taking the average of the values from the above three locations. For the remainder of this section any reference to temperature or precipitation conditions on site D is an approximation using the average of the values from the above three meteorological stations.

Wind conditions at Site D were approximated with data from Lester B. Pearson International Airport. (Environment Canada, 1982b).

Temperature

Based on data from the Burlington, Oakville, and Milton-Kelso stations (Environment Canada, 1982) the mean daily temperature for the general area of site D is 7.7°C. The extreme maximum temperature was recorded in August (36.8°C), while the extreme minimum temperature was recorded in January (-28.2°C). Monthly variations in temperature at site D are presented in Table 4.9.

Precipitation

Based on data from the Burlington, Oakville, and Milton-Kelso stations (Environment Canada, 1982a) the mean annual total precipitation for Site D is 817.0 mm. There are an average of 117 days with measurable precipitation per year. Table 4.10 shows monthly variations in total precipitation, rainfall, snowfall, and number of days with measurable values of each. Site D experiences a mean annual rainfall of 686.2 mm and a mean annual snowfall of 123.8 cm. On average there are 89 days/year with measurable rainfall with the greatest number of days with measurable values occurring in April and May. The average number of days/month with measurable values remains essentially constant from June to November. On average there are 32 days/year of measurable snowfall with the greatest number of occurrences in January.

Figure 4.2 shows the monthly variations in mean total precipitation, mean

FIGURE 4.2

TOTAL PRECIPITATION, RAINFALL, AND SNOWFALL SITE D AREA

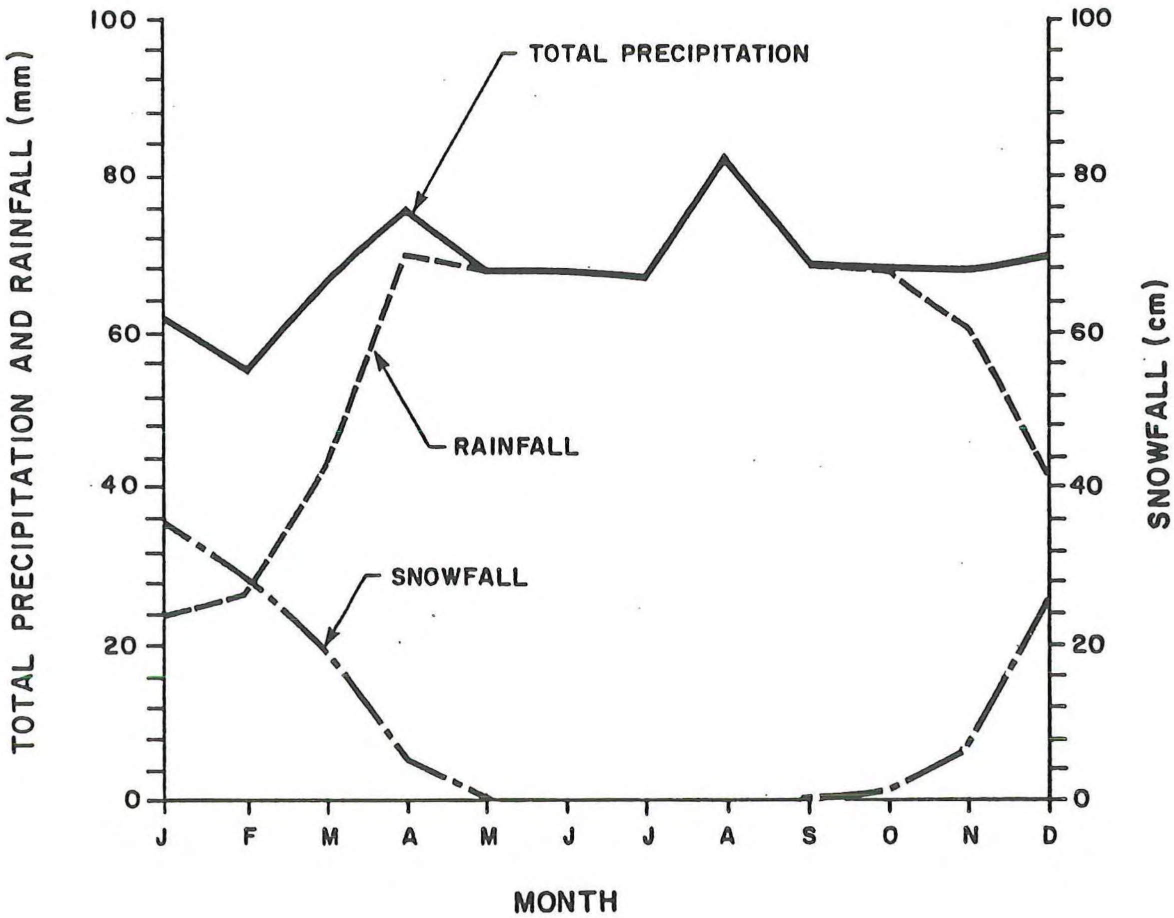


Table 4.9

MONTHLY VARIATIONS IN TEMPERATURE - SITE D AREA*

Mean daily temperature (°C) 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-5.9	-5.2	-0.4	6.4	12.0	17.8	20.6	19.9	15.9	9.8	3.8	-2.6	7.7

Mean daily maximum temperature (°C) 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-1.9	-0.9	-3.6	11.4	17.8	23.6	26.5	25.6	21.4	14.9	7.5	0.9	12.5

Mean daily minimum temperature (°C) 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-9.6	-9.4	-4.5	1.3	6.2	11.9	14.7	14.3	10.4	4.8	0.1	6.1	2.8

Extreme maximum temperature (°C) 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
15.2	13.5	22.3	29.7	33.1	35.0	36.6	36.3	35.2	30.6	23.3	16.8	36.8

Extreme minimum temperature (°C) 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-25.2	-27.0	-23.2	-12.0	-3.7	1.3	4.6	2.2	-1.9	-7.6	-16.8	-26.9	-28.4

All values are averages of values from the Oakville, Burlington, and Milton-Kelso meteorological Stations.

eference: Environment Canada, 1982

Table 4.10

MONTHLY VARIATION IN PRECIPITATION SITE D AREA*

Total precipitation (mm) monthly means 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
61.4	55.4	66.2	75.4	67.7	67.7	66.8	82.3	68.7	68.2	67.6	69.6	817.0

Number of days with measurable precipitation 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
11	10	11	11	10	9	8	9	8	9	10	13	117

Mean rainfall (mm) monthly means 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
24.1	26.6	43.4	69.9	67.8	67.7	66.8	82.3	68.7	67.5	60.2	41.2	686.2

Number of days with measurable rainfall 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
3	3	6	10	10	9	8	9	8	9	8	5	89

Mean snowfall (cm) monthly means 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
35.2	28.1	19.2	5.5	0.0	0.0	0.0	0.0	0.0	1.1	7.5	27.2	123.8

Number of days with measurable snowfall 1951-1980

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
3	3	6	10	10	9	8	9	8	9	8	5	89

* All values are averages of values from the Oakville, Burlington, and Milton-Kelso meteorological Stations.

Reference: Environment Canada, 1982a

rainfall, and mean snowfall.

Severe Weather

The Great Lakes Basin in Ontario lies in the path of storm tracks of low pressure systems. Lows which form in the southwestern United States very often move across the Great Lakes. These storms usually involve tropical or subtropical air streams and are quite often associated with thunderstorms and, on rare occasions, tornados. Lawryniuk (1969) comments, "Tornado occurrences in Ontario are relatively infrequent... The conditions actually analyzed have been recognized as favourable for severe storms by various investigators in recent years but they co-exist only infrequently in Ontario". As well, low pressure systems moving across northern Canada dragging cold fronts southward may produce severe weather during summer months.

4.3.3 Atmospheric Stability and Dispersion

Wind

Wind data from Lester B. Pearson International Airport are presented in Table 4.11. Wind conditions at site D were approximated using Lester B. Pearson International Airport data (Environmental Canada, 1982b). For Site D there are 3 choices of wind recording stations that could be used to represent the winds. The stations are the Hamilton Airport, Hamilton Royal Botanical Gardens (RBG) and Lester B. Pearson International Airport (LBPIA). The Hamilton Airport station is rejected because it is far from Site D and is located on top of the escarpment. The Hamilton RBG station is located on the narrow upslope from Lake Ontario to the Niagara Escarpment to the northwest of Burlington. Both Site D and the LBPIA station are located on the flat grounds between Lake Ontario and the Niagara Escarpment. The RBG station also used a wind run recorder which does not provide data of as high a quality as an hourly wind recorder as installed at LBPIA. For this reason LBPIA data is the data of choice to represent the wind and atmospheric stability conditions at Site D.

Table 4.11

WIND INFORMATION - LESTER B. PEARSON INTERNATIONAL AIRPORT

TORONTO INT'L A ONT.

PERIOD 1955-80 PERIODE

Lat. 43°40′N Long. 079°38′W **Elevation 173 m Altitude**

PERCENTAGE FREQUENCY	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	FRÉQUENCE EN %
N	11.2	12.7	12.2	12.0	11.5	11.3	11.2	11.0	11.3	9.9	7.9	10.0	11.0	N
NNE	3.3	3.4	3.5	3.2	2.5	2.5	2.3	2.6	3.2	2.6	2.4	3.5	2.9	NNE
NE	3.2	3.0	3.7	2.3	2.4	1.6	1.5	1.9	2.3	2.5	2.6	3.9	2.6	NE
ENE	2.4	2.5	3.4	3.2	2.5	1.3	1.2	1.3	2.0	2.2	2.7	3.5	2.3	ENE
E	3.0	4.3	8.1	8.2	6.2	3.5	2.4	2.9	4.2	4.8	4.5	3.6	4.6	E
ESE	2.4	2.2	3.4	3.5	3.6	2.9	2.1	2.5	3.4	3.8	3.8	3.2	3.1	ESE
SE	2.0	1.9	3.2	4.7	5.7	5.8	4.9	4.7	5.2	5.2	4.3	2.9	4.2	SE
SSE	1.7	2.0	2.8	4.3	6.9	7.6	6.4	6.4	5.3	4.8	3.5	2.2	4.5	SSE
S	5.0	5.6	4.1	4.5	6.6	8.0	7.9	6.7	6.9	6.5	6.2	5.7	6.1	S
SSW	6.2	5.2	3.7	3.1	3.5	4.7	4.8	4.4	4.9	5.0	5.3	5.4	4.7	SSW
SW	10.7	6.9	5.1	4.8	5.5	6.9	6.9	7.4	6.9	7.7	8.6	9.7	7.3	SW
WSW	13.1	8.2	5.6	4.6	5.0	6.0	6.4	6.7	5.7	7.5	11.0	10.8	7.5	WSW
W	12.2	12.7	11.3	10.1	8.8	9.4	10.7	10.4	10.3	10.8	13.4	11.4	11.0	W
WNW	6.3	7.4	8.6	8.3	7.3	6.8	7.5	7.1	6.5	6.1	7.0	5.9	7.1	WNW
NW	6.0	8.4	7.7	7.9	7.1	7.3	7.8	8.3	6.4	6.5	5.6	5.8	7.1	NW
NNW	7.9	10.1	9.7	11.1	9.9	8.7	9.1	9.4	9.3	8.1	6.4	8.0	9.0	NNW
Calm	3.4	3.5	3.9	4.2	5.0	5.7	6.9	6.3	6.2	6.0	4.8	4.5	5.0	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMÈTRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	16.7	17.1	15.7	15.8	15.5	14.4	12.8	12.4	12.9	13.3	14.6	16.0	14.8	N
NNE	14.2	15.1	14.0	13.9	12.3	11.7	10.8	11.5	12.4	11.9	12.4	13.5	12.8	NNE
NE	15.2	14.5	14.0	13.6	11.1	9.8	10.3	11.3	9.9	11.2	12.6	14.7	12.4	NE
ENE	18.6	18.1	17.8	17.2	14.8	12.9	12.9	10.9	11.9	14.2	14.7	17.4	15.1	ENE
E	20.1	20.1	21.4	21.2	17.0	14.9	13.1	13.7	14.0	15.6	16.5	19.2	17.2	E
ESE	17.9	16.5	17.5	16.2	14.4	13.1	12.9	12.8	13.3	14.6	15.8	17.8	15.2	ESE
SE	13.9	12.3	11.9	13.3	12.4	12.4	12.5	12.3	11.9	12.3	12.5	13.3	12.6	SE
SSE	12.7	11.8	12.0	13.6	12.8	12.5	12.9	12.6	11.8	11.9	12.2	11.2	12.3	SSE
S	14.0	13.0	11.7	12.3	11.9	11.0	11.5	11.2	12.0	12.1	13.8	13.0	12.3	S
SSW	17.4	16.7	16.9	17.3	15.1	13.8	13.2	12.9	15.3	15.6	17.1	15.6	15.6	SSW
SW	19.9	17.1	20.5	20.0	17.7	15.7	14.6	14.6	16.1	16.7	19.8	19.0	17.6	SW
WSW	23.2	20.6	20.2	20.5	17.8	16.1	14.5	14.4	15.3	16.9	21.5	21.1	18.5	WSW
W	21.2	20.8	20.8	20.3	17.8	15.7	14.5	13.4	15.1	16.9	20.3	20.6	18.1	W
WNW	23.0	21.1	22.2	22.0	20.1	16.8	15.9	15.1	16.3	18.2	20.7	20.8	19.4	WNW
NW	19.1	20.2	20.2	19.3	16.6	14.8	13.6	13.2	14.4	15.7	18.1	18.2	17.0	NW
NNW	19.1	19.6	19.6	20.0	16.8	15.5	13.6	13.1	14.2	15.5	18.0	19.3	17.0	NNW
All Directions														Toutes directions
	18.4	17.6	17.6	17.3	14.9	13.4	12.5	12.3	13.0	14.1	16.6	17.0	15.4	
Maximum Hourly Speed														Vitesse horaire maximale
	77 WSW	77 NNW	97 SW	81 W	71 WSW	63 NW	61 E	71 WNW	69 SW	61 W	80 SVL	70 NNW	97 SW	
Maximum Gust Speed														Vitesse maximale des rafales
	115 E	97 SVL	124 SW	111 W	98 SW	102 NW	89 WSW	93 WSW	92 SW	96 WNW	97 SSW	95 W	124 SW	

Height of anemometer 10.1 m hauteur de l'anémomètre

STATION INFORMATION

Station is located on the slightly rolling to flat terrain. Nearby to the west is a small valley containing the Etobicoke Creek. Most of surrounding countryside is open on which occasional trees are found. The shore of Lake Ontario is about 10 km southeast and main metropolitan area is several km east.

DONNÉES RELATIVES À LA STATION

La station se trouve sur un terrain plat un légrement accidenté. A l'ouest, tout prs, un vallon conduit à Etobickok Creek. La majeure partie de la région environnante est dégagée et ne porte qui quelques arbres. La rive du lac Ontario commence à 10 km au sud-est et le coeur de la ville, à plusieurs km à l'est.

Reproduced from: Environment Canada, 1982b

The predominant wind directions at Lester B. Pearson International Airport are north and west both occurring 11% of the time annually. The next highest frequency is north northwest occurring 9% of the time. The average wind speeds from the north and west directions are 14.8 km/hr and 18.1 km/hr respectively. The highest wind speeds occur with west northwest winds which have a frequency of 7.1% annually. The most infrequent wind directions are east northeast and northeast occurring 2.3% and 2.6% annually. Calm conditions are experienced 5% annually. The highest wind speeds occur in January (18.4 km/hr), and the lowest in August (12.3 km/hr). The maximum hourly wind speed was 97 km/hr from the southwest. The maximum gust speed was 124 km/hr also from the southwest.

Atmospheric Stability

Atmospheric stability affects the ability of the atmosphere to disperse and dilute pollutants, and is a function of the wind speed and temperature lapse rate in the lower layers of the atmosphere. In a standard or neutral atmosphere, the temperature decreases with height while in a stable atmosphere, temperature increases with height and winds are light (an inversion). In an unstable atmosphere, the temperature decrease with height is greater than for the neutral case. The more unstable the atmosphere is, the greater the mechanical and thermal turbulence, and therefore the greater the dispersive capacity of the atmosphere. Stability is commonly reported in a stability array or STAR data set which provides a joint frequency distribution of wind speed, direction, and stability class. Stability is estimated from surface meteorological observations and classified into six atmospheric stability classes, A to F, according to the Pasquill-Gifford categories. Class A is the most unstable, turbulent condition; class F is the most stable class.

The stability array for Lester B. Pearson International Airport (LBPIA) was obtained for the period of record 1953-1984. Conditions at site D were approximated with LBPIA values. The annual stability class distributions for LBPIA are summarized on Table 4.12.

Table 4.12

ANNUAL FREQUENCIES OF OCCURRENCE OF STABILITY CLASSES

Lester B. Pearson International Airport

Stability Class		Annual Frequency of Occurrence(%)
A	Extremely unstable	0.6
B	Moderately unstable	5.0
C	Slightly unstable	9.9
D	Neutral	55.1
E	Moderately stable	11.3
F	Extremely stable	18.1

At LBPIA, neutral conditions (class D stability) occur most frequently, 55.1% of the time, followed by extremely stable conditions (class F stability) 18.1% of the time. Extremely unstable conditions (class A stability) occur only 0.6% of the time. Overall neutral to stable conditions dominate with unstable conditions occurring relatively infrequently.

Monthly variations in frequency of occurrence of atmospheric stability class are presented in Figure 4.3.

4.4 Predicted Emissions

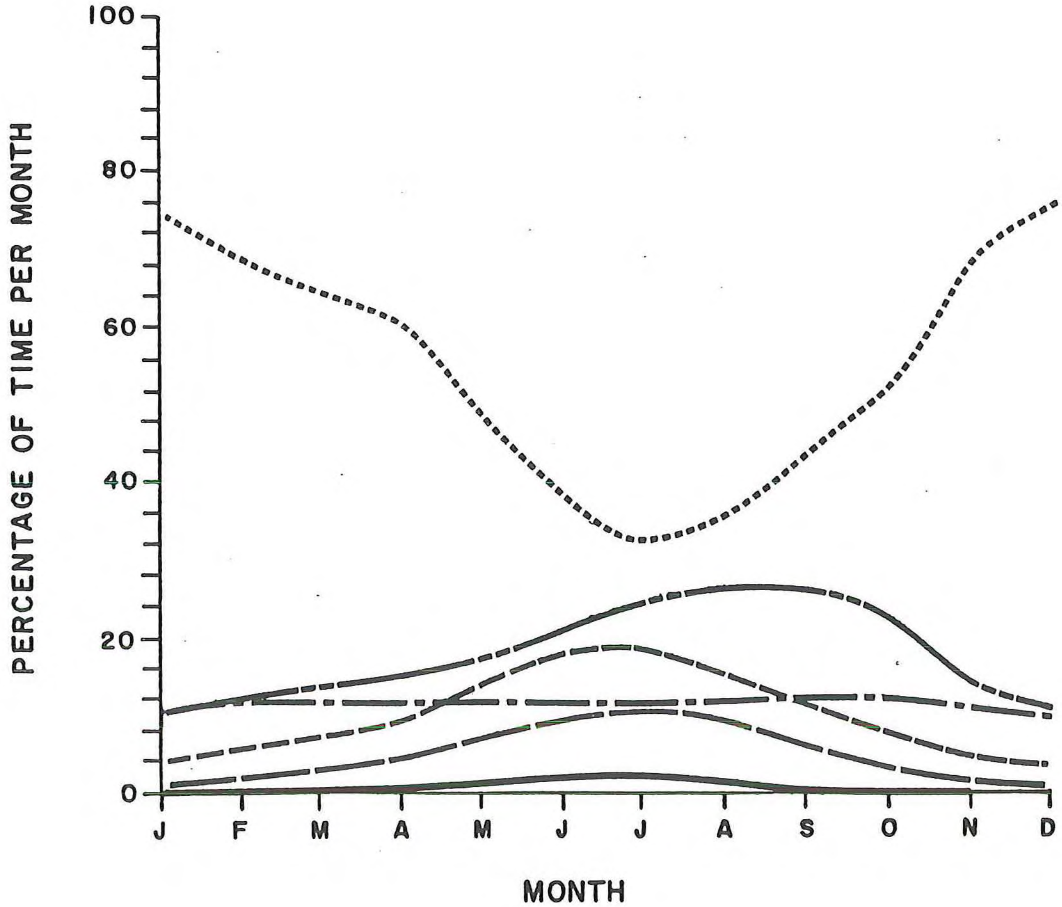
4.4.1 Total Suspended Particulate Matter

Emissions of dusts or suspended particulate matter (TSP) occur mainly as a result of earth moving operations, but also arise from the erosion of exposed soil surfaces by the wind. The mechanical action of earth moving equipment breaks down the soil and releases fine particles which can escape directly into the environment or be disturbed and propelled into the air by the action of the wheels or tracks of vehicles moving across the open soil. The quantities released are dependent not only on the nature of the activities but on the type of soil and climatic conditions. In wet weather and while the soil remains moist the creation of dust is minimized. Dry warm weather and activities which expose large areas of soil to the drying action of the wind result in high emissions. There is no method by which the quantities of dust released at any particular time can be predicted. Evaluations, however, resulting from the observation of a variety of construction equipment has led to the development of a series of empirical equations which may be used to estimate the general level of emissions from the operation of this equipment.

The equations used in this evaluation are shown on Table 4.13. Where these equations take cognizance of precipitation data they have been incorporated into the estimates. Where no such explicit allowance is made it has been assumed that the equations are developed from general information collected in all weather. A review of the available literature indicates that most, if not

FIGURE 4.3

FREQUENCY OF OCCURRENCE OF ATMOSPHERIC STABILITY CLASS LESTER B. PEARSON INTERNATIONAL AIRPORT



LEGEND:

- A STABILITY CLASS
- B STABILITY CLASS
- C STABILITY CLASS
- D STABILITY CLASS
- E STABILITY CLASS
- F STABILITY CLASS

all, these equations are related to weather during which precipitation was not occurring. Thus, the emission estimates used in this report are likely to be worst case estimates.

Using information from the Design and Operations Report for Site D (Hydrology Consultants, 1986) the following site preparation work will be completed.

- building the access road, perimeter roads and ditches
- installing the scale and scale house
- preparing the bulk bin area
- building the maintenance and storage facilities
- excavating the retention ponds
- excavating Cell 1
- installation of the leachate collection system
- construction of the screening berm

Using this information and current general practices probable construction activities were assumed. These assumptions with regard to the site and its operation are detailed below.

The general layout of Site D is shown in Figure 4.4, which also indicates the location of four residences on the western side of the property. The berm, running along the southwest side of the site, is to be constructed from soil removed from the northern most cell (Cell #1) which will be excavated at the start of operations. Construction of the berm can be completed in approximately two months, but details of the methods to be used cannot be defined until the contractor has been selected. Emission estimates must therefore, be based on assumptions as to the actual activities which will be undertaken.

The berm forms a landscape feature of the proposed design, for the benefit of the inhabitants of the nearest residences. It will also serve two other functions. As a sound barrier, the impact of transport noise from the normal site operation will be greatly reduced, it will also increase the dispersion

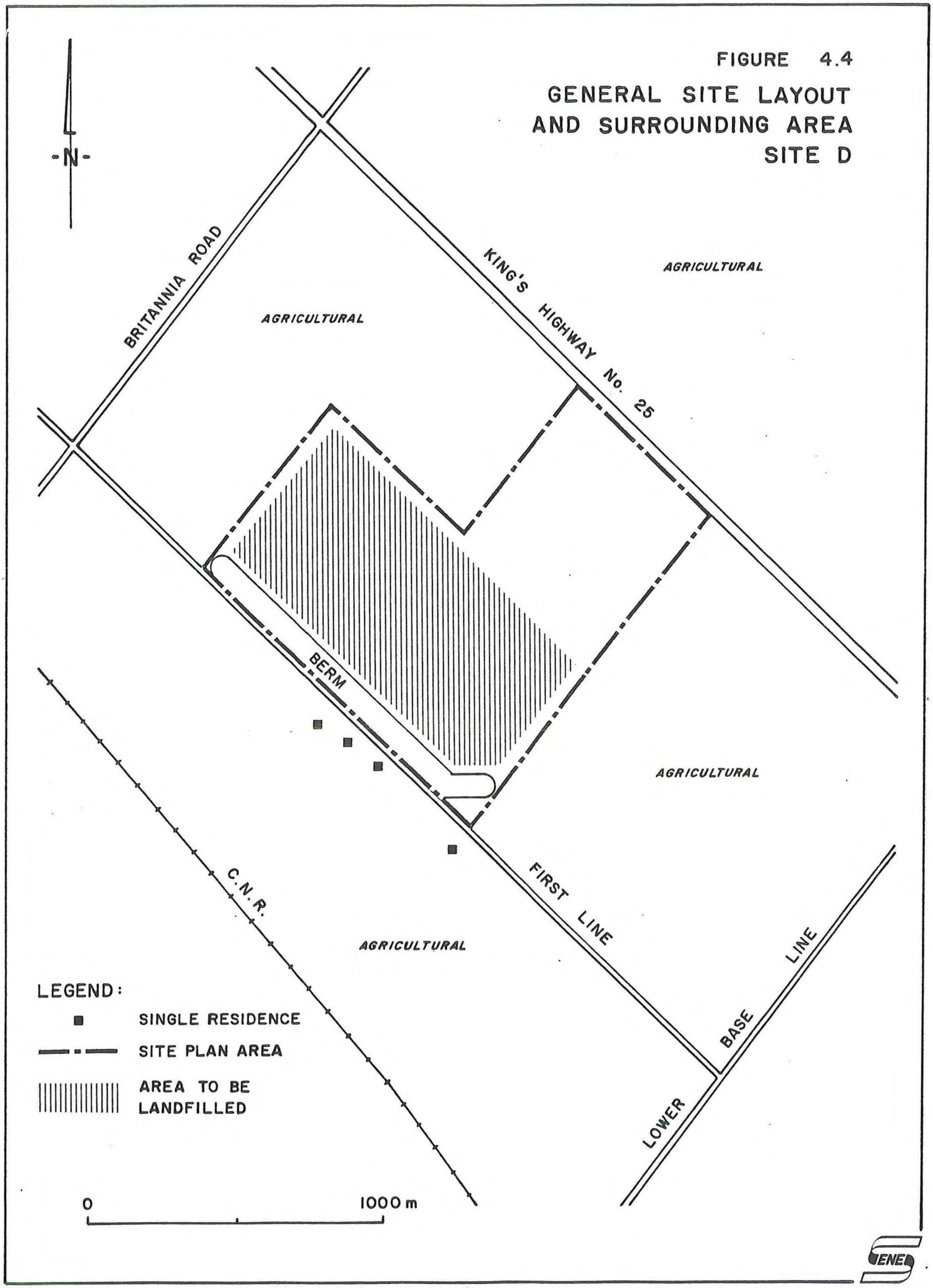


FIGURE 4.4
GENERAL SITE LAYOUT AND SURROUNDING AREA
SITE D

of windborne dusts arising from the site. To afford the earliest protection to the residences, it is recommended that construction of the berm is started by the construction of a segment approximately three hundred metres long, beginning three hundred metres from the northwest corner of the site extending in a southeasterly direction. After this section has been completed the berm should be extended to the northwest before being continued to the southwest corner.

Construction of the recommended first section of the berm can be completed in two weeks and protection, against dust emissions from the earth moving operations within the site, would be afforded the residents within one month. Completion of the berm within a given time frame would then be less critical.

After the berm is completed the scale of earth moving operations will be reduced considerably. As the life of the site is expected to be twenty years, it is assumed that the subsequent cells will be excavated during the next fifteen to eighteen years. Approximately 50% of the soil will be used to cover the exposed landfill wastes on a daily basis, the remainder to be transported to a storage area on the northeastern side of the site. The stored material is then expected to be used as final cover and contouring material when the site is closed.

The largest concentrated emission sources will exist during the excavation of the first cell and construction of the berm. At this time it will be necessary to employ heavy duty machines. Six intermediate capacity scrapers will be required (8.5 m^3) and will need to operate an average of 10 hours per day to do the work in two months. Each scraper will excavate 8.5 m^3 per trip, a total weight of 12 tonnes, and make 15 trips per hour. The scrapers are assumed to weigh 30 tonnes empty and 42 tonnes full. In addition it is assumed that two large bulldozers, one front end loader and one haulage truck will be in use assisting in soil moving, shaping and compacting. One bulldozer is assumed to be in use at the berm, the other working in the cell.

obtained from Hiroshi H35 says only 3 vehicles to be used. scraper.

Estimates of the dust emissions from the use of these machines have been made using emission factors and equations. The scrapers are each assumed to make 15 runs an hour during which they undertake three operations; soil removal and pickup, transport to the berm and return and deposition of soil on the berm. The haulage truck is assumed to move primarily within the cell with only occasional travel to the berm or elsewhere. The bulldozers are assumed to be in constant operation at their respective locations while the front end loader operates at and moves between both the cell and the berm as necessary. Approximately fifty per cent of its time has been allocated to each location. The total emissions from all of the equipment in operation during site construction are shown on Table 4.13.

Access to the site is expected to be from Highway 25 with access to the individual cells by unpaved roads along the northeast side of the site and across partition walls left between adjoining cells. Landfill operations are assumed to begin immediately after completion of the berm construction, at which time excavation of a second cell will commence.

It is proposed that on its completion the berm will be seeded and no wind erosion of soil will occur after that time. Prior to that time an open area of 84,000 m^2 is assumed to be uncovered and susceptible to wind erosion.

The general level of emissions during the normal life of the site have been estimated from the probable scale of activity during the second year of operation. At that time the majority of efforts will be in Cells No. 1 and No. 2, at their southwestern ends (adjacent to First Line). Based on normal operations at other sites, it was assumed that the equipment in use for the site operation will be comprised of:

- 2 compactors
- 1 front end loader
- 2 bulldozers
- 1 scraper
- 1 dump truck
- 1 bulk lift truck

The compactors are assumed to spend 75% of their time compacting garbage with no dust emissions. The bulldozers are also assumed to spend 75% of their time working the trash pile with no dust emissions. The dump truck is assumed to

Table 4.13

EMISSION ESTIMATES CONSTRUCTION PERIOD

	Basis of Estimate	Estimated Value	Uncontrolled Emission Rate	Possible Emission Reduction %	Controlled Emission Rate kg/h
Scraper: Removal (6)	0.026 kg/T	0.026 kg/T	27.3 kg/h	0	27.3
Scraper: Haul to Berm (6)	$9.6 \times 10^{-6} (S)^{1.3}(W)^{2.4}$ kg/VKT	2.6 kg/VKT	85.3 kg/h	0	85.3
Return	$9.6 \times 10^{-6} (S)^{1.3}(W)^{2.4}$ kg/VKT	1.1 kg/VKT	36.1 kg/h	0	36.1
Scraper: Discharge (6)	0.02 kg/T	0.02 kg/T	21.0 kg/h	0	21.0
Bulldozers * (2)	$\frac{2.6 (S)^{1.2}}{(m)^{1.3}}$ kg/h	2.65 kg/h	5.3 kg/h	0	5.3
Wind Erosion***	0.85 T/hectare/yr	0.085 $kg/m^2/yr$	0.8 kg/h	100%**	0.0
Front End Loader	18 g/m^3	1.52 kg/week max.	<0.1 kg/h	25%	<0.1

Notes
* M=12% (in clay) mostly subsoil.
** Ground cover after construction completed.
*** Berm only cells in operation are below ground level.

References: CDOH, 1981; U.S. EPA, 1981' U.S. EPA, 1985.

KEY TO TABLES 4.13 AND 4.14

Symbol	Definition		Assumed Value
S =	Silt content of soil		15%
m =	Moisture content of soil	- topsoil	8%
		- subsoil	12%
K =	Factor for particle size distribution		0.8
V =	Speed of vehicle		30 km/h
w =	No. of wheels	- haul truck	8
		- others	4
W =	Weight of vehicle	- scraper loaded	40 tonnes
		- scraper empty	24 tonnes
H =	Height of soil drop		1 m
Y =	Weight of soil dropped		2 tonnes
u =	Wind speed		2.2 m/s
p =	Number of days with measurable precipitation		117

travel an average of 0.55 km from the cell to an earth storage pile and back. It is assumed to make 5 trips per hour. During Saturday working periods this will be reduced to one compactor and one bulldozer. An average of 390 vehicles per day, of which 80% are light trucks or vans, are assumed to enter this site. Most of the vehicles (80%) will proceed on paved roads to bins where they will dump. The remainder will proceed along gravel roads to the active cell. On Saturdays incoming traffic to the site is assumed to average about 610 vehicles a day, of which the majority (>90%) will be light trucks, vans and cars.

Operating hours are assumed to be 8:00 am to 5:30 pm or weekdays, and from 8:00 am to noon on Saturdays. On Saturdays the bulk bin area will be open to individual haul until 5:30 pm.

It is also anticipated that the movement of soil, from the cells being excavated, to the storage pile beside the site will require the use of a haulage truck which will be loaded by the front end loaders but will tip its contents at the pile unaided. The dust emissions associated with the equipment during the operation of the landfill are shown on Table 4.14.

4.4.2 Odour

Raw Refuse

As described in the Phase 2, Stage 2C Air Quality Assessment (SENES, 1985), quantification of odour emission rates for raw refuse are not readily available. The rate of 2 odour units per square foot per minute (2 $OU/ft^2/min$) used in the Stage 2C report has been accepted and therefore, it is used in this report in predicting the odour source generation rate during landfilling carried out during the day.

It is estimated that the area of raw refuse exposed each day during landfill operations is 500 m^2. Thus, the total odour emission rate is estimated to be

Table 4.14

EMISSION ESTIMATES - OPERATIONS

	Basis of Estimate	Estimated Value	Uncontrolled Emission Rate	Possible Emission Reduction %	Controlled Emission Rate kg/h
Scraper: Removal (small)	0.026 kg/T	0.026 kg/T	1.3 kg/h	0	1.3
Scraper: Haul	$9.6\times10^{-6}\ (S)^{1.3}(W)^{2.4}$ kg/VKT	1.1 kg/VKT	1.3 kg/h	0	1.3
Scraper: Discharge	0.02 kg/T	0.02 kg/T	0.96 kg/h	0	1.0
Bulldozers (2)	$\frac{2.6\ (S)^{1.2}}{(m)^{1.3}}$ kg/h	2.69 kg/h	1.3 kg/h	0	1.3
Front End Loader	18 g/m^3	18 g/m^3	0.62 kg/h	25%	0.5
Compactors (2)	4.6 g/s	4.6 g/s	8.3 kg/h	0	8.3
Truck Traffic	$E=1.7\ K\ \frac{S}{12}\ \frac{V}{48}\ \frac{W}{2.7}^{0.7}\ \frac{w}{4}^{0.5}\ \frac{365-p}{365}$ kg/VKT	0.24 to 1.8 kg/VKT	46.2 kg/h	75%	11.5
Soil Haul to Pile	$E=1.7\ K\ \frac{S}{12}\ \frac{V}{48}\ \frac{W}{2.7}^{0.7}\ \frac{w}{4}^{0.5}\ \frac{365-p}{365}$ kg/VKT	3.4 kg/VKT	10.5 kg/h	75%	2.6
Soil Drop	$\dfrac{0.73 \times 0.0009\ \frac{S}{15}\ \frac{U}{2.5}\ \frac{H}{1.5}}{\frac{M}{2}^{2}\ \frac{Y}{4.6}^{0.33}}$ kg/T	3.8×10^{-5} kg/T	<0.1 kg/h	0	<0.1 kg/h

References: CDOH, 1981; U.S. EPA, 1981; U.S. EPA,1985.

KEY TO TABLES 4.13 AND 4.14

Symbol	Definition		Assumed Value
S =	Silt content of soil		15%
m =	Moisture content of soil	- topsoil	8%
		- subsoil	12%
K =	Factor for particle size distribution		0.8
V =	Speed of vehicle		30 km/h
w =	No. of wheels	- haul truck	8
		- others	4
W =	Weight of vehicle	- scraper loaded	40 tonnes
		- scraper empty	24 tonnes
H =	Height of soil drop		1 m
Y =	Weight of soil dropped		2 tonnes
u =	Wind speed		2.2 m/s
p =	Number of days with measurable precipitation		117

180 odour units per second.

Landfill Gas

Landfill gas is produced as a result of biological decomposition of sanitary landfill wastes. Unlike controlled fermentation or digestion where the variables of the process are controllable, landfill mixing and placement are unpredictable thus gas generation and composition can vary widely and are not easily predicted. Values reported for recovered gas indicate that the major constituents are methane which can range from 40 to 60 percent, and carbon dioxide which can vary from 30 to 50 percent. The amount of nitrogen present changes according to the amount of air entering the landfill. Trace compounds including the organics are quite complex and usually represent in the order of one percent of the landfill gas.

4.5 Atmospheric Impacts

4.5.1 Total Suspended Particulate Matter

Using the assumed operating conditions described in Section 4.4.1, average emission rates were estimated and dispersion modelling was carried out using the Industrial Source Complex Model for Long and Short Time periods (U.S. EPA, 1979, 1979a) ISCLT and ISCST. These models, developed by the U.S. EPA, require the input of meteorological data and a detailed description of point, area and line sources.

For the short term modelling only those conditions having highest potential for creating elevated levels of suspended particulate matter downwind were considered for comparison with the MOE standards. Under the regulation (Ontario, 1985) atmospheric stability classes C and D need to be considered. Of these, the use of the "D" stability class results in the highest concentrations, at ground level.

For the long term annual averages estimates, the meteorological conditions were taken from STAR data files created from the Lester B. Pearson International Airport meteorological station readings.

Short term modelling indicates that, after the berm has been built, under "D" atmospheric stability conditions, with north to northeast winds of constant direction and wind speed, concentrations of the order of 110 $\mu g/m^3$ could occur for short periods on or close to the First Line during normal site operations. Concentrations at the closest residences on First Line are below 50 $\mu g/m^3$.

Examination of the data shows that a great part of this concentration is due to traffic carrying soil from the cells to the holding area and to traffic delivering refuse to the site, and the highest concentrations occur when wind and traffic are flowing in the same direction.

These results represent highest estimated concentration situations for which no mitigative measures have been included, and which are based on very infrequent condition assuming adverse meteorological conditions. Furthermore, the assessment is based on assumptions about working methods and assumes the worst situation when all active operations are close to the highway and on-site traffic is travelling the longest possible route to the corner of the site furthest from the site entrance.

Average annual concentrations estimated by the ISCLT model indicate that concentrations will be well below the MOE Ambient Air Quality Criteria, and will not exceed 10 $\mu g/m^3$ at the nearest residences.

During construction of the berm, there will be considerably higher average concentrations at the nearby residences. The daily average concentrations during this short period will not exceed 130 $\mu g/m^3$ and throughout the period of berm construction, will average under 100 $\mu g/m^3$. Based on the wind direction frequency data, it is estimated that these elevated concentrations could occur on for 20 days during an anticipated 2 month construction period.

The effect of local terrain-variations will not be noticeable in the vicinity of the site. At the distances where the escarpment produces a significant effect on the atmospheric conditions, the particulate matter will be sufficiently dispersed for channelling of air through the valleys to have no appreciable effect on the already low concentrations in the escarpment area.

4.5.2 Odour

Raw Refuse

Short-term calculations of downwind odour concentration from the landfill site based on the assumptions outlined in Section 4.4.2 were made for C, D, E and F atmospheric stability conditions. Only under the more stable conditions were odours estimated to be detectable beyond a hundred metres from the source. The estimated concentrations are presented in Figure 4.5 and show odours would be detected primarily under the most stable conditions, atmospheric stability class "F", at a downwind distance of about 130 meters and a windspeed of 1 m/s. At other less stable atmospheric conditions, better dispersion dilutes the odour to below detectable levels more rapidly. Odour appears to be a localized potential problem and probably would not be detected off-property unless odour emission rates exceeded 2 $OU/ft^2/min$.

The foregoing estimate agrees with measurements carried out at other landfilling operations in southern Ontario (Ontario Research Foundation). Because the meteorological conditions under which odour is estimated to be detectable occur infrequently (12-95 hours per year depending on wind direction) odour is not expected to be a problem at site D.

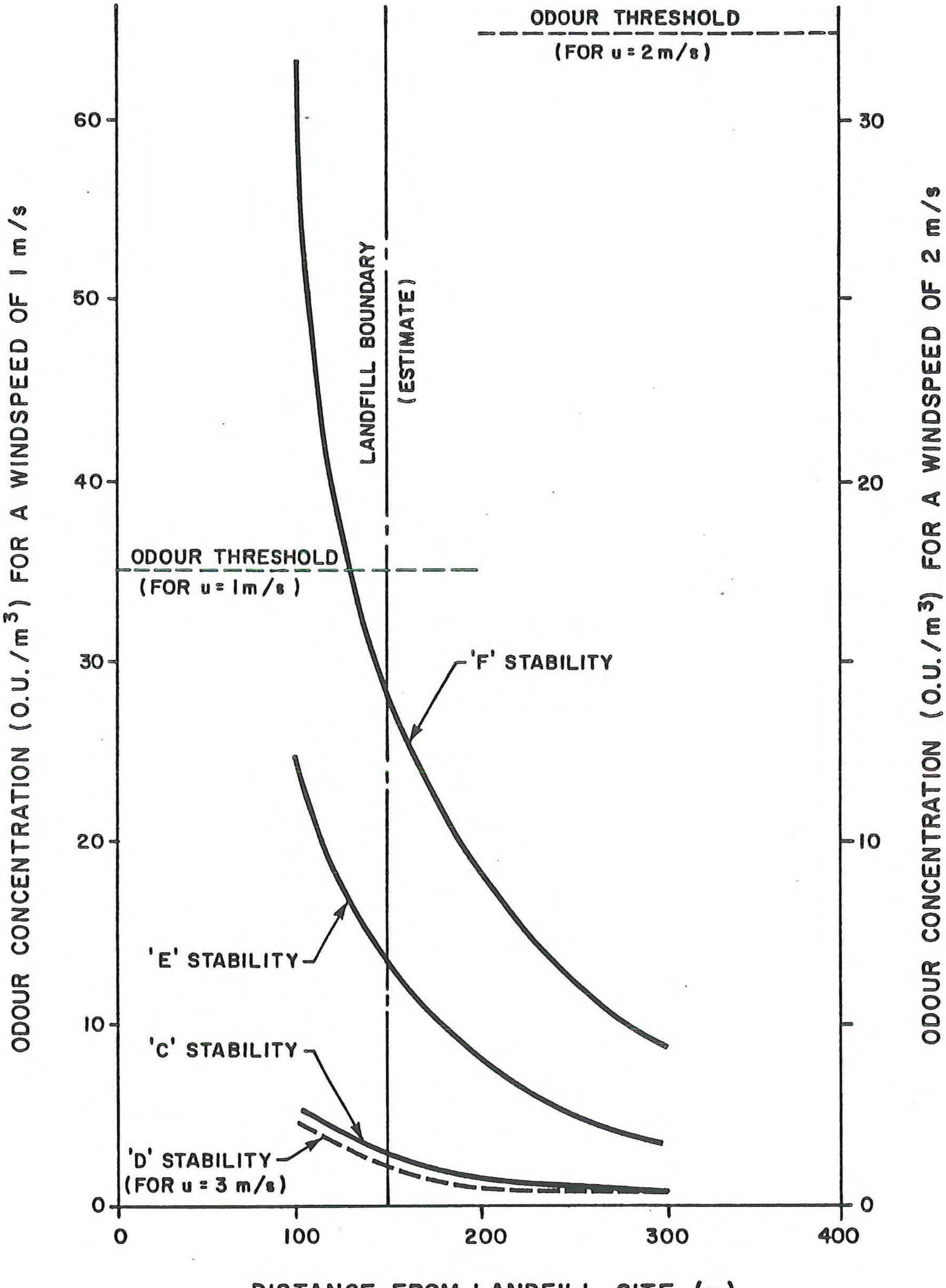
In the long term raw refuse will be covered with 2 or more metres of cover material, consequently there should be no odour from raw refuse.

Landfill Gas

In the short term landfill gas will not likely be generated in appreciable quantities, however, with the passage of time, the generation rate will

FIGURE 4.5

ODOUR CONCENTRATIONS vs. DOWNWIND DISTANCE



NOTE:

SOURCE EMISSION RATE = 2 O.U./FT.^{2}/ MIN.

increase to some maximum level and thereafter it is expected to decrease slowly as feed materials are transformed (used up.).

Malodorous compounds constitute a very small fraction, about 1 per cent or less, of the generated gas. These malodorous compounds are expected to react with the soil cover (Vogel, 1985) thereby being reduced to non-malodorous by-products.

4.6 Recommended Mitigation Measures

4.6.1 Total Suspended Particulate Matter

The main measures which can be used to reduce dust production involve techniques designed to reduce the abrasive effects, on the soil, of traffic movement by the use of paved roads wherever possible, gravel roads where it is not, and surface treatment of both gravel and unpaved traffic routes. The most cost effective method of reducing emission is to spray the travelled surfaces with water. By this means emissions can be reduced by as much as 75%. The use of oil to treat roads is somewhat more effective but, as with watering the surface requires repeated treatment, and unless waste oils, which may contain undesirable impurities, are used the cost becomes prohibitive. Calcium chloride which retains moisture more strongly than does soil also requires repeated applications, and with time reacts with the soil and results in the formation of other calcium salts which contribute to the dusting problem. The most generally accepted method is in fact the use of water, while limiting as far as practicable the use of untreated surfaces for traffic movement.

Since the emission rate of suspended particulate matter is directly dependent on the amount of soil moved and the height from which it is dropped onto stockpiles or the ground, efforts must be made to reduce the amount of movement to a minimum and to keep the height from which material is deposited on to stock piles or the ground as small as possible.

Wherever possible unused open surfaces should be seeded. However, the use of trees to intercept the dusts is unlikely to be effective to any noticeable degree. The dusts consist of fine particles which do not settle readily. The main value of tree planting, with respect to the reduction of dust concentrations, is to create turbulence which assists the dispersion and short term concentrations but has little effect on the long term concentrations. These techniques are summarized on Table 4.15.

4.6.2 Odour

No off-property odour impacts are predicted so no further mitigation measures, other than the normal operating procedures of covering the refuse is considered necessary.

Table 4.15

SUSPENDED PARTICULATE MATTER SUPPRESSION TECHNIQUES

Method	Effectiveness	Comments
1. Road paving	> 95%	Costly for temporary roads. Effectiveness reduced if vehicles deposit mud on the surface.
2. Gravel paving	90%	The gravel gives rise to dust by attrition. Effectiveness reduced by mud and soil deposited by vehicles.
3. Surface oiling	85%	Costly. May result in emissions of contaminants if waste oils are used. Needs repeated treatment.
4. Water sprays	75%	Needs repeated application If excessively sprayed can produce muddy conditions. Most commonly used technique. Cost effective.
5. Calcium chloride	80%	Needs repeated treatment. Washes from surface can eventually create some dust and water quality problems. Costly.
6. Revegetation		Effective in preventing wind erosion but ineffective on constantly travelled areas.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Site D can be developed into an acceptable landfilling operation from an air quality point of view. There will be some adverse dust impacts on the houses along First Line on approximately 20 days during the construction of the berms. During the operation of the landfill on Site D no offsite dust and odour impacts are predicted. All of the predicted impacts are summarized on Tables 5.1 and 5.2.

On Table 5.1 and 5.2 the terms "nil", "low", "medium" and "high" are as defined below:

- nil: no emission and no possible impact
- low: suspended particulate emissions are present but no exceedances of provincial air quality criteria (Section 4.2.1) are predicted
- medium: suspended particulate emissions are present but no exceedances of provincial air quality criteria (Section 4.2.1) are predicted at residences
  some exceedances, 10 percent or less, are possible at the site boundaries depending on the meteorology
- high: predicted suspended particulate concentrations are likely to exceed provincial air quality criteria (Section 4.2.1) more than half the time.

Table 5.1

IMPACTS ON AIR QUALITY FACTORS FOR SITE D

Air Quality Factor	Impact
Total Suspended Particulate Matter	
. Construction	Some adverse dust impacts on 20 days during the construction of the berm.
. Operation	Impacts will be below applicable provincial air quality at residences.
Odour	
. Construction	Not applicable.
. Operation	Not detectable at nearby residences.

Table 5.2

Site D
SUMMARY OF NET ENVIRONMENTAL IMPACTS

Air Quality Impact	Nil	Low	Medium	High
Total Suspended Particulate Matter				
. Construction				Berm construction impacts at residences on First Line for a short period of time.
. Operation			Occasional elevated levels at site boundaries depending on meteorology.	
Odour				
. Construction	no construction related emission.			
. Operation		Predicted to be undetectable at site boundaries.		

(Column heading "Level of Impact" spans Nil, Low, Medium, High.)

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