AM 7891

Time for Breakthrough
15mg/l chloride through UWUT
Site D.

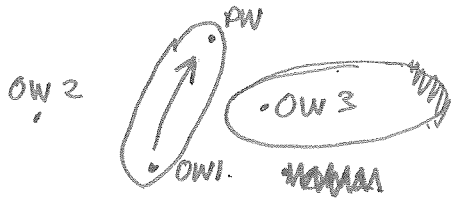
Ex B618
P93
~ 80 years.
93R.
~ 40 years.

initial
conc.
1500

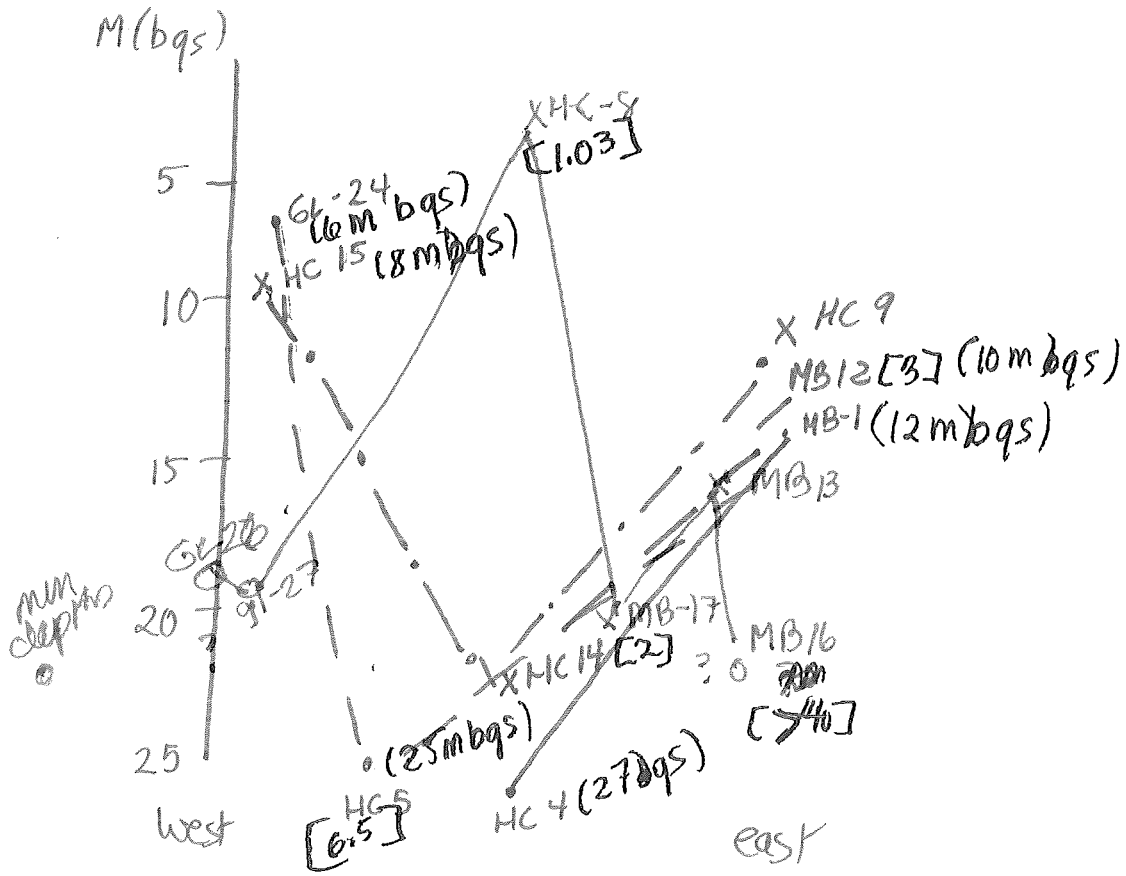
~~Ex B618~~
93R
marginally
less than
~ 40 yrs

- initial
conc. 3000

Ex-Bd-791



Ex -
Bd.-792.



[ ] mhos
chlorides 5000 or less

H-793

I N D E X

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3 PW-1: recovery data

4 OW-1 (HC-4-85-2): drawdown data

5 OW-1: recovery data

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7 OW-2: recovery data

8 drawdown data for:

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MB-13-1: drawdown and recovery data

MB-13: drawdown and recovery data

MB-13-3: drawdown and recovery data

HC-8-85-1: drawdown and recovery data

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63 HC-3-85-4: drawdown adn recovery data

64 HC-3-85-5: drawdown and recovery data

65 HC-4-85, piezometers 1-4: drawdown and recovery data

66 HC-5-85, piezometers 1-4: drawdown and recovery data

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67 Sketch showing location of PW-3 and PW-4

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72 WAT 5, piezometers 3 through 12: drawdown and recovery data (Note: Also Data for PW-4)

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THE CONSOLIDATED HEARINGS BOARD

IN THE MATTER OF Sections 2 and 3 and 6(3) of the Consolidated Hearings Act, 1981, S.O. 1981, c. 20;

-and-

IN THE MATTER OF Sections 12(2) of the Environmental Assessment Act, R.S.O. 1980, c. 140;

-and-

IN THE MATTER OF Sections 30, 35 and 38 of the Environmental Protection Act, R.S.O. 1980, c. 141, as amended;

-and-

IN THE MATTER OF Sections 24 and 61(2) of the Ontario Water Resources Act, R.S.O. 1980, c. 361, as amended;

-and-

IN THE MATTER OF Section 28(3) of, and Regulation 164 under, the Conservation Authorities Act, R.S.O. 1980, c. 85, as amended;

-and-

IN THE MATTER OF Section 40(12) of the Planning Act, S.O. 1983, c. 1, as amended; in connection with site plan control of the sanitary landfill site;

-and-

IN THE MATTER OF Section 22(1) of the Planning Act, 1983 in connection with a referral to this Board by the Honourable Bernard Grandmaitre, Minister of Municipal Affairs, on a request by the Regional Municipality of Halton to amend the Official Plan for the Town of Milton to redesignate a parcel of land comprising Part Lots 3 and 4, Concession 2 N.S. in the Town of Milton from "Agriculture" and "Conservation and Hazard Lands" to permit the construction, operation and maintenance of a landfill site, Minister's File No. 24-OP-0208-A01;

-and-

IN THE MATTER OF Section 34(11) of the Planning Act, 1983 in connection with an appeal to this Board by the Regional Municipality of Halton for an order directing an amendment to By-law 61-85 of the Town of Milton to rezone the lands situated at Lot 3 and part of Lot 4, Concession 2 N.S., in the Town of Milton from "Agriculture" to permit a regional sanitary landfill site and ancillary uses;

-and-

IN THE MATTER OF Section 15(1) of the Planning Act, R.S.O. 1980 ch. 379 in connection with a referral by the Honourable Claude F. Bennett, Minister of Housing on a request by Tremaine Britannia Citizen's Group for consideration of part of the Official Plan for the Halton planning area with respect to Sections 1 to 5 inclusive, 7, 9 and 10 of Part III D3 Solid Waste Management, Minister's File No. OPC-0026;

-and-

IN THE MATTER OF Section 64 of the Ontario Municipal Board Act, R.S.O. 1980, c. 347, as amended in connection with an application by the Regional Municipality of Halton for an order approving:

(a) The acquisition of land for the construction, operation and maintenance of a sanitary landfill site to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton and to do so by one of two alternative methods as follows:

    i) landfilling at the site referred to in Halton's Environmental Assessment as Site F in the City of Burlington;

    ii) landfilling at the site commonly referred to in Halton's Environmental Assessment as Site D in the Town of Milton.

    at an estimated cost of $12,775,000 and the borrowing of money by way of temporary advances not exceeding in the aggregate such estimated cost pending the sale of debentures, and

(b) the issuance of necessary debentures to a maximum of $12,775,000 for a term not to exceed fifteen years;

-and-

IN THE MATTER OF Section 193(5) and paragraph 84 of Section 210 of the Municipal Act, R.S.O. 1980, c. 302, as amended;

-and-

IN THE MATTER OF Sections 6, 7 and 8 of the Expropriations Act, R.S.O. 1980, c. 148;

-and-

IN THE MATTER OF an undertaking of the Regional Municipality of Halton to provide facilities for the purpose of receiving, dumping and disposing of waste as required by section 137 of the REGIONAL MUNICIPALITY OF HALTON ACT, R.S.O. 1980, c. 436, as amended, by acquiring the land for, constructing, operating and maintaining a landfill to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton.

AFFIDAVIT

I, ALFRED ANTHONY SOBANSKI, of the City of Mississauga, in the Regional Municipality of Peel, Senior Hydrogeologist of Trow, Dames & Moore, MAKE OATH AND SAY:

1. Trow, Dames & Moore is a successor company to Trow Hydrology Consultants Limited which is a successor company to Hydrology Consultants. Throughout these changes of name of my employer, I have been responsible for the conduct of hydrogeological studies by my employer for the Regional Municipality of Halton. For convenient reference, I will refer to Trow, Dames & Moore and its predecessor companies as "Trow".

2. I and my staff have diligently searched the files of Trow. The exhibits to this Affidavit constitute all the

available data recorded in connection with the pumping tests conducted by Trow at Sites D and F during 1985 and 1986.

SITE D

Pumping Test #1

3. Pumping test #1 at Site D was conducted in the lower granular unit on the 11th and 12th of December, 1985. The pumping well ("PW-1") was drilled by a cable tool drilling rig at a distance of 3.05 metres to the north-east of HC-4-85 (also referred to in the test as "OW-1"). A new six inch diameter observation well was drilled 9.14 metres south-west of PW-1. Attached and marked as Exhibit "1" to this Affidavit is a sketch which depicts the location of the pumping well and all of the wells which were monitored during the test.

4. PW-1 was pumped for 1,661 minutes at a rate of about one litre per minute from 12:54 p.m. December 11, 1985 to 4:35 p.m. December 12, 1985. Attached and marked as Exhibit "2" to this Affidavit are the original data sheets recording the pumping rate and drawdown at PW-1. Exhibit 2 is in evidence as pages 3 and 4 of Exhibit H-174.

5. Recovery data on PW-1 was collected from 4:35 p.m. on December 12, 1985 to 12:35 a.m. on December 13, 1985, with a single final reading being taken at 8:35 a.m. on December 13th. Attached and marked as Exhibit "3" to this Affidavit is the original recovery data for PW-1. This document is already in evidence as Exhibit H-727, page 1.

6. OW-1 (HC-4-85-2) was monitored for part of the time that PW-1 was pumped. Attached and marked as Exhibit "4" is two pages of drawdown data for OW-1. These pages are already in evidence as pages 5 and 6 of Exhibit H-174. An initial reading was taken in OW-1 at 12:53 and showed a depth to water of 5.795 metres. Readings were taken in OW-1 commencing 10 seconds after the pump was turned on in PW-1. Regular readings were taken from 12:54 p.m. on the 11th of December until 12:53 p.m. on the 12th of December. The final depth to water was 6.750 metres.

7. Recovery data for OW-1 were recorded for eight hours with the reading taken at 480 minutes being a reading taken at 12:35 a.m. on the 13th of December. A single final reading was taken at 8:35 a.m. on the 13th of December. Attached and marked as Exhibit "5" is the recovery data sheet. This document is already in evidence as page 3 of Exhibit H-727. A Theis recovery curve for observation well 1 was prepared and is presented as page 3 of appendix 10 of H-39A. Although this Theis recovery was calculated for the observation well, a typographical error was made and it is misidentified as a recovery curve for "PW-1".

8. Drawdown data were recorded for OW-2 beginning when the pump was turned on at 12:54 p.m. on the 11th of December. The depth to water at that time was 7.410 metres. Attached and marked as Exhibit "6" to this Affidavit are the original data sheets for the drawdown data for OW-2. Photocopies of these data sheets are in evidence as pages 7 and 8 of Exhibit H-174.

It will be seen that the original data sheet is a photocopy with the elapsed time at which readings were expected to be taken recorded thereon. Since the expected elapsed times were not in fact the times when readings were taken, the actual elapsed time is hand written in smaller numbers in the elapsed time Column. I have stroked out the misleading elapsed time numbers on the original data sheet so that the document becomes easier to use. For example, a reading was taken at 2:53 a.m. on the 12th of December, 1985, that is 840 minutes after the pump was turned on. While the data sheet had an elapsed time number of 580, 580 has now been stroked out and the original data sheet carries the elapsed time of 840 minutes. The depth to water at that time was 7.381 metres. The final drawdown reading was taken at 1,620 minutes and the depth to water at that time was 7.356 metres. That reading was taken at 3:53 p.m. on the 12th of December. The pump was turned off at 4:35 p.m.

9. The recovery data for OW-2 were taken for 480 minutes after the pump was turned off. A later, final reading was taken at 8:35 a.m. on the 13th of December. Attached and marked as Exhibit "7" to this Affidavit is a photocopy of the original data sheet. The original data sheet could not be located. Exhibit 7 to this Affidavit is already in evidence as page 2 to Exhibit H-727.

10. During the pumping test of PW-1, the following additional well nests were monitored for possible drawdown:

HC-5-84
HC-2-85
HC-4-84
HC-5-85
MB(1N) OW4
HC-3-85
HC-6-85
HC-8-84

Attached and marked as Exhibit "8" is the original data sheet with the drawdown data recorded for the above-noted well nests. This document is already in evidence as page 4 of Exhibit H-727. 1984 monitoring wells have two piezometers. They are identified on Exhibit 8 as "D" for deep and "S" for shallow. Column three on Exhibit 8 records the time on December 11th when water levels in the various piezometers were measured. Six well nests were measured before pumping commenced but HC-5-84 and HC-2-85 were measured shortly after the pumping was started. Column 6 on Exhibit 8 records the time on December 12th when a second and final reading was taken in each of the wells monitored.

11. Attached and marked as Exhibit "9" to this Affidavit is page 1 of addendum B of Exhibit H-84 which provides data as to the top and bottom of the screen in PW-1 and OW-1.

Pumping Test #2

12. Pumping Test #2 (PW-2) was conducted in a new six inch diameter well which was drilled with a cable-tool drilling rig at a location 3.05 metres north-east of HC-2-85. HC-2-85 was used as an observation well and is also referred to as "OW-1". A second observation well, "OW-2" was also drilled with a cable-

tool drilling rig at a distance of 12.19 metres south-west of the pumping well. Attached and marked as Exhibit "10" to this Affidavit is a sketch denoting the location of the pumping well and all of the wells which were monitored during the pumping test.

13. Pumping commenced at 10:10 a.m. on the 31st of March, 1986 and the pump was operated at a rate of 45.5 litres per minute from that time until 11:05 a.m. on the second of April, 1986. Attached and marked as Exhibit "11" to this Affidavit are the two original data sheets with the drawdown and recovery data for the pumping well. These data sheets are in evidence as pages 10 and 11 of Exhibit H-174. Drawdown data were recorded from the time pumping commenced until the pump was turned off. The depth from measuring point when pumping commenced was 2.37 metres and the depth from measuring point at the end of pumping was 7.60 metres. Recovery data were recorded for 1,230 minutes after pumping stopped. At 580 minutes, the recovery water level was at 4.75 metres below measuring point, and at 1,230 minutes the water had recovered to 4.14 metres below measuring point. A Theis recovery curve for PW-2 was prepared and is in evidence as page 6 of appendix 10 of Exhibit H-39A.

14. Drawdown data, but not recovery data, were recorded at HC-2-85 ("OW-1"). Attached and marked as Exhibit "12" to this Affidavit are the two original data sheets for OW-1. Exhibit 12 is in evidence as pages 12 and 13 of Exhibit H-174. Column 4

records drawdown data in piezometer two, Column 7 records drawdown data in piezometer three, and Column 8 records drawdown data in piezometer one. Drawdown data in piezometer two was taken regularly throughout the 2,945 minutes (49 hours) of the pumping test. Depth to measuring point changed from 2.10 metres at the beginning to 7.19 metres at the end. Drawdown data in piezometers three and one were recorded beginning at 330 minutes and ending at 2,700 minutes. In piezometer three, the depth to water is recorded at 1.83 metres initially and 1.375 metres at 2,700 minutes after pumping began. In piezometer one, the depth to water changed from 1.92 metres at the beginning of pumping to 2.335 metres at the end of pumping.

15. Attached and marked as Exhibit "13" is the drawdown and recovery data recorded in OW-2. These data are in evidence as pages 14 and 15 of Exhibit H-174. Drawdown data in OW-2 were taken from the beginning of pumping until the end of pumping. Although the depth from measuring point is recorded as changing from 3.26 metres to 8.29 metres during the period of the test, it is indicated on Exhibit "13" at the bottom that these levels should read 2.26 metres to 7.29 metres. In my view, it is likely that drawdown data were recorded using a different measuring tape than recovery data and the tape used to record recovery data had been damaged and a metre had been removed from its total length. When a metre is removed from the drawdown data, the initial level at recovery matches the final drawdown

depth of 7.29 metres, as adjusted. Recovery data were recorded from the time the pump was turned off until a final reading was taken on the 7th of April at 9:10 a.m. On the first page of Exhibit 13, recovery data in Columns 9 and 10 constitute intermediate readings taken in between readings recorded in Columns 7 and 8. For example, between the reading in Column 7 at 10 minutes and the reading in Column 8 at 15.5 minutes, readings were taken in Column 9 at 12.5 minutes and at 13.5 minutes.

16. Drawdown data and recovery data are recorded in Comcor well OW-2 which is identified during the pump test as "OW-3". Attached and marked as Exhibit "14" to this Affidavit are the drawdown data for OW-3. Drawdown data were recorded regularly from the beginning of pumping until the end of pumping. The initial depth to water was 1.92 metres and there was no change until after 100 minutes of pumping. The final depth from measuring point is recorded as 3.55 metres. Exhibit 14 is in evidence as page 16 to Exhibit H-174.

17. Recovery data were also taken for OW-3. Attached and marked as Exhibit "15" to this Affidavit is the recovery data for OW-3, these data were not previously entered in evidence. Recovery data were taken from the time the pump was turned off until 9:00 a.m. on the 7th of April, 1986.

18. Drawdown and recovery data were recorded in HC-2-86, piezometer two. This well was identified during the pumping test

as "OW-4". Attached and marked as Exhibit "16" to this Affidavit are the drawdown and recovery data for OW-4, in evidence as p. 10 of Exhibit H-727. Although this document carries an identification "HC-6-86" at the top, this is a misidentification and the recovery data is for HC-2-86-2, also known as OW-4. Since the data on this document are difficult to understand, it has been reorganized below:

DATE	TIME	ELAPSED TIME	DEPTH FROM MP
Mar. 31	12:35		3.635m
Mar. 31	3:00	300	3.635m
Mar. 31		465	3.635m
Mar. 31		690	3.640m
Apr. 1		1060	3.62m
Apr. 2	9:30	2840	3.705m
Apr. 2	9:50	2900	3.710m
Apr. 2	14:20		3.72m
Apr. 2	21:10		3.75m
Apr. 3	8:10		3.765m
Apr. 3	10:20		3.762m
Apr. 3	13:30		3.762m
Apr. 4	9:35		3.782m
Apr. 7	9:35		3.772m
Apr. 10	9:10		3.760m
Apr. 15			3.730m

19. The only drawdown data for HC-3-86-2 are recorded from 17:50 on the 1st of April (1,900 minutes after pumping began) until 8:50 on the 2nd of April (2,800 minutes after pumping began). Attached and marked as Exhibit "17" to this Affidavit are the drawdown data for HC-3-86-2. The initial depth to measuring point was 2.285 metres and the final depth was 2.275 metres. The data for HC-3-86-2 are recorded in Column 8 on Exhibit 17. Exhibit 17 also carries data for OW-1, OW-2 and OW-3. Exhibit 17 is in evidence as page 9 of Exhibit H-727.

20. Drawdown data for MB(1N)OW4 were taken on the 1st and 2nd of April, 1986. Attached and marked as Exhibit "18" to this Affidavit are the drawdown data for this well. These data are in evidence as page 11 of Exhibit H-727.

21. Exhibit 18 also has data for MB(1N)OW3. It would appear that one reading was taken in MB(1N)OW3 at 9:10 and a level recorded at 3.44 metres. The reading on Exhibit 18 taken at 9:10 and recorded as 2.275 metres for HC-10-86 is in fact a reading for HC-3-86-2. The readings of 3.705 and 3.710 metres for "6-86" are in fact readings for OW-4 and these readings were transposed and can be found on Exhibit 16. Attached and marked as Exhibit "19" to this Affidavit is a data sheet which also contains some data for MB(1N)OW3 taken at 11:00 a.m. on the 2nd of April, 1986. There are no base line data for MB(1N)OW3.

22. The first half of Exhibit 19, which is in evidence as page 14 of Exhibit H-727 has drawdown data for HC-3-84. Depth

from measuring point in the deep piezometer changed from 3.16 metres to 3.225 metres. Early and late measurements in the shallow piezometer were both 1.26 metres with changes to 1.28, 1.25 and 1.24 metres recorded during pumping.

23. During pumping test #2, water levels in pumping well #1 (PW-1) and the observation well #2 to PW-1, both in close proximity to HC-4-85, were also monitored. Attached and marked as Exhibit "20" to this Affidavit is a data sheet entitled "HC-4-85". This data sheet, which is in evidence as page 13 of Exhibit H-727 has water level data for a "north" well being observation well #2 to pumping test #1, and "south" being the pumping well for pump test #1. I believe that the handwriting of the word "plugged" on Exhibit 20 is that of Mr. Beechinor.

24. Drawdown and recovery data were recorded for the deep and shallow piezometers at HC-5-84. Attached and marked as Exhibit "21" to this Affidavit is the original data sheet for this well. This data sheet is already in evidence as page 12 of Exhibit H-727.

SITE F

Pumping Test #1

25. Pumping test #1 ("PW-1") was conducted in a new six-inch diameter well drilled by air triconing in a location approximately 19 metres east of MB-13. PW-1 is also identified in the documentation as TW-1. A photocopy of a sketch showing the location of the pumping well and the observation wells is

attached and marked as Exhibit "22" to this Affidavit. All distances recorded on this sketch are distances from the observation wells to the pumping well. For example, the distance from HC-8 to the pumping well is 460 metres and not a greater length as may be suggested by the way in which lines are drawn on Exhibit 22. Exhibit 22 is in evidence as page 1 from addendum I to Exhibit H-34. Attached and marked as Exhibit "23" to this Affidavit are drawdown and recovery data for the pumping well PW-1. Exhibit 23 is in evidence as pages 1 through 4 of Exhibit H-676. PW-1 was pumped from 11:30 a.m. on March 12, 1986 to 1:00 p.m. on March 13, 1986. The pumping rate is recorded on Exhibit 23.

26. During the pumping of PW-1, observations were taken in an observation well drilled for the occasion and variously identified as TW-2 and OW-1. Attached and marked as Exhibit "24" to this Affidavit are the original data sheets for drawdown and recovery data in TW-2, being observation well #1. These data sheets are in evidence as pages 5, 6 and 7 of Exhibit H-676.

27. Attached and marked as Exhibit "25" to this Affidavit are the data sheets for the drawdown and recovery data in WAT 7-1. These data sheets are in evidence as pages 8 and 9 of Exhibit H-676.

28. Attached and marked as Exhibit "26" to this Affidavit are the original data sheets for WAT 7, piezometer 2. These

documents are already in evidence as pages 10 and 11 of Exhibit H-676.

29. Attached and marked as Exhibit "27" to this Affidavit are the original data sheets for drawdown and recovery data recorded at WAT7-3. These documents are in evidence as pages 12 and 13 of Exhibit H-676.

30. Attached and marked as Exhibit "28" to this Affidavit are the data sheets for drawdown and recovery data in WAT 7-4. These documents are in evidence as pages 14 and 15 of Exhibit H-676.

31. Attached and marked as Exhibit "29" to this Affidavit are the data sheets recording drawdown and recovery data in WAT 7-5. These documents are in evidence as pages 16 and 17 of Exhibit H-676.

32. Attached and marked as Exhibit "30" to this Affidavit are the data sheets recording drawdown and recovery data for WAT 7-6. These documents are in evidence as pages 18 and 19 of Exhibit H-676.

33. Attached and marked as Exhibit "31" to this Affidavit are the drawdown and recovery data sheets for WAT 7-7, already in evidence as pages 20 and 21 of Exhibit H-676.

34. Attached and marked as Exhibit "32" to this Affidavit are the drawdown and recovery data sheets for WAT 7-8, in evidence as pages 22 and 23 of Exhibit H-676.

35. Attached and marked as Exhibit "33" to this Affidavit are the drawdown and recovery data sheets for WAT 7-9, in evidence as pages 24 and 25 of Exhibit H-676.

36. Attached and marked as Exhibit "34" to this Affidavit are the drawdown and recovery data sheets for WAT 7-10, in evidence as pages 26 and 27 of Exhibit H-676.

37. Attached and marked as Exhibit "35" to this Affidavit are the drawdown and recovery data sheets for WAT 7-11, in evidence as pages 28 and 29 of Exhibit H-676.

38. Attached and marked as Exhibit "36" to this Affidavit are the drawdown and recovery data sheets for WAT 7-12, in evidence as pages 30 and 31 of Exhibit H-676.

39. Attached and marked as Exhibit "37" to this Affidavit are the drawdown and recovery data sheets for MB-17-1, in evidence as pages 32 and 33 of Exhibit H-676.

40. Attached and marked as Exhibit "38" to this Affidavit are the drawdown and recovery data sheets for MB-17, piezometer #2. These documents are in evidence as pages 34 and 35 of Exhibit H-676.

41. Attached and marked as Exhibit "39" to this Affidavit are the drawdown and recovery data sheets for MB-17-3, in evidence as pages 36 and 37 of Exhibit H-676.

42. Attached and marked as Exhibit "40" to this Affidavit are the drawdown and recovery data sheets for MB-13-1, in evidence as pages 38 and 39 of Exhibit H-676.

43. Attached and marked as Exhibit "41" to this Affidavit are the drawdown and recovery data sheets for MB-13, piezometer #2. These documents are in evidence as pages 40, 41 and 42 of Exhibit H-676.

44. Attached and marked as Exhibit "42" to this Affidavit are the drawdown and recovery data sheets for MB-13-3, in evidence as pages 43, 44 and 45 of Exhibit H-676.

45. Attached and marked as Exhibit "43" to this Affidavit are the drawdown and recovery data sheets for HC-8-85-1, in evidence as pages 46 and 47 of Exhibit H-676.

46. Attached and marked as Exhibit "44" to this Affidavit are the drawdown and recovery data sheets for HC-8-85-2, in evidence as pages 48 and 49 of Exhibit H-676.

47. Attached and marked as Exhibit "45" to this Affidavit are the drawdown and recovery data sheets for HC-8-85-3, in evidence as pages 50 and 51 of Exhibit H-676.

48. Attached and marked as Exhibit "46" to this Affidavit are the drawdown and recovery data sheets for HC-8-85, piezometer #4, in evidence as pages 52 and 53 of Exhibit H-676.

49. Attached and marked as Exhibit "47" to this Affidavit are the drawdown and recovery data sheets for MB-16-1, in evidence as pages 54 and 55 of Exhibit H-676.

50. Attached and marked as Exhibit "48" to this Affidavit are the drawdown and recovery data sheets for MB-16-2, in evidence as pages 56 and 57 of Exhibit H-676.

51. Attached and marked as Exhibit "49" to this Affidavit are the drawdown and recovery data sheets for MB-16-3, in evidence as pages 58 and 59 of Exhibit H-676.

52. Attached and marked as Exhibit "50" to this Affidavit are the drawdown and recovery data sheets for MB-12-1, in evidence as pages 60 and 61 of Exhibit H-676.

53. Attached and marked as Exhibit "51" to this Affidavit are the drawdown and recovery data sheets for MB-12-2, in evidence as pages 62 and 63 of Exhibit H-676.

54. Attached and marked as Exhibit "52" to this Affidavit are the drawdown and recovery data sheets for MB-12-3, in evidence as pages 64 and 65 of Exhibit H-676.

55. Attached and marked as Exhibit "53" to this Affidavit are the drawdown and recovery data sheets for HC-9-85, piezometer #1, in evidence as pages 66 and 67 of Exhibit H-676.

56. Attached and marked as Exhibit "54" to this Affidavit are the drawdown and recovery data sheets for HC-9-85, piezometer #2, in evidence as pages 68 and 69 of Exhibit H-676.

57. Attached and marked as Exhibit "55" to this Affidavit are the drawdown and recovery data sheets for HC-9-85, piezometer #3, in evidence as pages 70 and 71 of Exhibit H-676.

58. Attached and marked as Exhibit "56" to this Affidavit are the drawdown and recovery data sheets for HC-9-85, piezometer #4, in evidence as pages 72 and 73 of Exhibit H-676.

Pumping test #2

59. A new six inch diameter pumping well, variously labelled PW-2 and TW-5, was drilled using an air triconing rig. Attached and marked as Exhibit "**57**" to this Affidavit is a photocopy of page 2 from addendum I to Exhibit H-84 showing the location of PW-2, being approximately 14 metres south of HC-3-85.

60. Attached and marked as Exhibit "**58**" to this Affidavit are the drawdown and recovery data for PW-2. These documents are in evidence as pages 74 through 77 of Exhibit H-676.

61. Attached and marked as Exhibit "**59**" to this Affidavit are the drawdown and recovery data in observation well #1, also known as TW-6. These documents are in evidence as pages 78 through 81 of Exhibit H-676.

62. Attached and marked as Exhibit "**60**" to this Affidavit are the drawdown and recovery data in monitoring well HC-3-85, piezometer 1. These documents are already in evidence as pages 82 and 83 of Exhibit H-676.They are also in evidence as Exhibit H-671.

63. Attached and marked as Exhibit "**61**" to this Affidavit are the drawdown and recovery data for HC-3-B, being piezometer #2. These data are already in evidence as pages 84 through 87 of Exhibit H-676.

64. Attached and marked as Exhibit "**62**" to this Affidavit are the drawdown and recovery data for HC-3-C, being piezometer

#3. These data are in evidence as pages 88 through 91 of Exhibit H-676.

65. Attached and marked as Exhibit "**63**" to this Affidavit are the drawdown and recovery data for HC-3-85-D, being piezometer #4. These data are in evidence as pages 92 and 93 of Exhibit H-676.

66. Attached and marked as Exhibit "**64**" to this Affidavit are the drawdown and recovery data for HC-3-85-E, being piezometer #5. These data are in evidence as pages 94 and 95 of Exhibit H-676.

67. Attached and marked as Exhibit "**65**" to this Affidavit are the drawdown and recovery data for HC-4-85, piezometers 1-4. These data are in evidence as pages 96 and 97 of Exhibit H-676.

68. Attached and marked as Exhibit "**66**" to this Affidavit are the drawdown and recovery data for HC-5-85, piezometers 1-4. These data are already in evidence as pages 98 and 99 of Exhibit H-676.

Pumping Test #3

69. Pumping test #3 (PW-3) occured after pumping test #4 (PW-4). Attached and marked as Exhibit "**67**" to this Affidavit is a photocopy of page 3 of addendum I of Exhibit H-84 showing the location of PW-3 (TW-3/86) and PW-4 (OW-3-86, TW-4/86). TW-3 and TW-4 are six-inch diameter wells drilled with an air triconing drilling rig. TW-4 (PW-4) was pumped on the 24th and again on the 25th of March. Pumping was then discontinued at

TW-4 and TW-3 (PW-3) was pumped on March 26, 1986. PW-3 was pumped at a rate of about 1.8 litres per minute for 420 minutes beginning at 9:05 a.m. on the 26th of March, 1986 and continuing until 4:05 p.m. that day.

70. Attached and marked as Exhibit "**68**" to this Affidavit are the drawdown and recovery data for TW-3 (PW-3). This data is in evidence as pages 100 to 103 of Exhibit H-676.

71. Attached and marked as Exhibit "**69**" to this Affidavit are the drawdown and recovery data recorded in WAT 5, piezometer #1. These documents are in evidence as pages 104 through 107 of Exhibit H-676.

72. Attached and marked as Exhibit "**70**" to this Affidavit are the drawdown and recovery data for WAT 5, piezometer #2. These data are in evidence as pages 108 through 111 of Exhibit H-676.

73. Attached and marked as Exhibit "**71**" to this Affidavit are the drawdown and recovery data recorded in piezometers 3 through 12 of WAT 5. These data are in evidence as page 112 of Exhibit H-676. Exhibit 71 carries drawdown and recovery data for both pumping test #4 at TW-4 and pumping test #3 at PW-3. Pumping test #4 at TW-4 was in fact two tests. The first test was conducted on the 24th of March, 1986 from 12:00 noon until 6:00 p.m. The second test was conducted on the 25th of March, 1986 from 8:20 a.m. until 10:20 p.m. Exhibit 71 being page 112 of Exhibit H-676 has readings at WAT 5 piezemetres 3 through 12

beginning at 7:30 a.m. on the 25th of March. Pumping test #4 began at 8:20 a.m. and the first readings after the test began were taken in WAT 5 at 9:20 a.m. The final reading on the 25th of March was taken at 4:20 p.m. and in piezometer 3 it shows a level of 2.61 metres. On the 26th of March, a reading was taken in piezometers 3 through 12 of WAT 5 at 8:30 a.m. Pumping test #3 at PW-3 was commenced at 9:05 a.m. and the first readings taken in WAT 5 after the test began were at 11:10 a.m. Pumping of PW-3 stopped shortly after 4:00 p.m. on the 26th of March. Readings were taken in piezometers 3 through 12 of WAT 5 at 5:20 and again at 7:00. All of these data are recorded in Exhibit 71 and page 112 of Exhibit H-676. The writing in the horizontal Column marked "effect" on Exhibit 71 and page 112 of Exhibit H-676, is mine.

74. Attached and marked as Exhibit "72" to this Affidavit are drawdown and recovery data recorded at WAT 5, piezometers 3 through 12. These data are in evidence as pages 194 and 195 of Exhibit H-676A. These data relate to readings taken during the pump test at PW-4 as well as the pump tests at PW-3. In Column 2, there are readings taken on the 24th of March between 10:07 and 10:30 a.m. In Column 3, further readings were taken on the 24th of March betweeen 10:45 and 11:05 a.m. In Column 4, there are readings taken on the 26th of March prior to the commencement of pumping test #3 at PW-3, that is readings taken between 7:45 and 8:15 a.m. In Column 5, further readings were taken on the

26th of March, before pumping, between 8:50 and 8:57. Further readings, recorded in Column 6, were taken on the 26th of March between 10:12 and 10:18 a.m. These readings, in piezometers 3, 4 and 5, supplement data that is recorded on Exhibit 71, also being page 112 of Exhibit H-676. For example, in piezometer 3 the reading between 10:12 and 10:18 is 2.58, and the reading at 11:10 is at 2.58. In piezometer 4, the reading between 10:12 and 10:18 is at 3.38, and at 11:10 it is at 3.39. In piezometer 5, the reading taken between 10:12 and 10:18 is 4.12, and the reading was still 4.12 when taken at 11:10 a.m.

75. Attached and marked as Exhibit "73" to this Affidavit are the drawdown and recovery data recorded in WAT 3, piezometers 1 through 12. These data are in evidence as pages 196, 197 and 198 of Exhibit H-676A. Readings recorded on page 197 of Exhibit H-676A were taken on the 24th and 25th of March and are related to pumping of PW-4 rather than PW-3. Data recorded on page 198 of Exhibit H-676A, relates to the two pumping tests that constitute PW-4 and the pumping test that constitutes PW-3. For convenience, I have re-numbered the Columns of this document. Column 1 identifies date, time and the fact that readings were taken in piezometers 1 through 12 of WAT3, piezometers 1 through 3 of MB-11, and piezometers A through M of WAT 6. Column 2 constitutes readings taken on the 24th of March and these readings relate to the first pumping test at PW-4 (TW-4). Columns 3, 4, 5, 6 and 7 constitute readings taken on the 25th

of March, 1986 during the second day of pumping at PW-4 (TW-4). Columns 8, 9 and 10 constitute readings taken on the 26th of March during pump test #3 at PW-3.

76. Attached and marked as Exhibit "74" to this Affidavit are the drawdown and recovery data recorded in WAT 6, piezometers A through M. These documents are in evidence as pages 199 and 200 of Exhibit H-676A. Column 2 constitutes data recorded on the 24th of March during the first day of pumping at PW-4 (TW-4). Data in Column 3 are data taken prior to pumping of PW-3 on the 26th of March, 1983. Data in Column 4 is a single reading in piezometer C taken just before pumping commenced on the 26th of March, 1986. Also attached and marked as Exhibit "75" to this Affidavit is a photocopy of Exhibit N-764 which summarizes some of the drawdown data taken during pumping test #3 at PW-3/86. This document was prepared in our office.

77. Attached and marked as Exhibit "76" to this Affidavit is a cover page for data collected in MB-11, piezometers 1 to 3. Page 198 of Exhibit H-676A, already in evidence in this exhibit as Exhibit 73, records all available data at MB-11.

Pumping Test #4

78. As previously indicated, pumping test #4 was conducted at TW-4 on the 24th of March and again on the 25th of March. Attached and marked as Exhibit "77" to this Affidavit is a copy of Exhibit N-766. This document records some of the drawdown

data taken during the pumping tests at PW-4 (TW-4). This document was prepared in our office.

79. Attached and marked as Exhibit "78" to this Affidavit are the drawdown data in pumping well TW-4 taken on the 24th of March, 1986. These data are in evidence as pages 113 through 115 of Exhibit H-676.

80. Attached and marked as Exhibit "79" to this Affidavit are the drawdown and recovery data at PW-4 taken during pumping on the 25th of March, 1986. These data are in evidence as pages 122 and 123 of Exhibit H-676.

81. Attached and marked as Exhibit "80" to this Affidavit are the drawdown data taken at TW-3 (later PW-3) on the 24th of March, 1986. These data were already in evidence as pages 116 and 117 of Exhibit H-676.

82. Attached and marked as Exhibit "81" to this Affidavit are the drawdown data taken at WAT 5, piezometer #1 on the 24th of March, 1986. These data were already in evidence as pages 118 and 119 of Exhibit H-676.

83. Attached and marked as Exhibit "82" to this Affidavit are the drawdown data recorded at WAT 5, piezometer 2 on the 24th of March, 1986. These data were already in evidence as pages 120 and 121 of Exhibit H-676.

84. Attached and marked as Exhibit "83" to this Affidavit are the drawdown data recorded in TW-3 (PW-3) on the 25th of March and also drawdown data recorded at WAT 5 on the 25th of

March, both sets of data being taken on the 2nd day of pumping at PW-4. These data are in evidence as pages 124 and 125 of Exhibit H-676. Data recorded on page 124 of Exhibit H-676 are for the pumping well, observation well #1, being TW-3 (PW-3), and WAT 5. For convenience, the Columns are labelled A through G on pages 124 and 125, being Exhibit 83 to this Affidavit. Column A records a reading in the pumping well at 2:20 of 5 metres. Column B records three readings in observation well #1 between 2:20 and 2:25 (1425) at 2.337, and 2.323. Column C records readings in WAT 5 taken at 14.28. Between the recordings at Column C and Column D, there are data recorded by the pump operator which evidences changes in the pumping rate and additional measurements on the pumping well. At 15:15, the pumping well level was at 5.05. At 16:56 the water level in the pumping well was at 5.390. Column D records an additional reading at OW-1 at 17:34, of 2.325 metres. Column E records a new set of readings at WAT 5. Piezometers 1 through 5 were read after 17:37, piezometers 6 through 10 were read after 17:45, piezometers 11 and 12 were read after 17:56, and piezometer 13 was read at 17:57. On page 125, Column F records double sets of data at 18:28 and 19:20 for OW-1. I believe that the top numbers, being 2.325, 2.33, 2.32, and 2.335 are the correct readings and that the numbers recorded of 2.235 and 2.23 are someone's interpretation of pencil recordings and are incorrect. Column G records two final sets of reading at WAT 5, one set of

readings commencing at 18:29 and finishing at 18:47, and another set of readings after 19:20.

85. Page 12 of Appendix 10 of H-40A presents a Jacob drawdown curve for PW-4, pumping test #4. Page 12 is mislabelled "Pumping Test No. 3"; it should read Pumping Test #4 and "Pumping Well OW-3-86" should read TW-4-86. Where page 12 reads "OW-3-86: 101.2-121.4 m.a.s.l.", it should read "TW4-86: 128.65-121.38 m.a.s.l."

SWORN before me at the City)
of Toronto in the Municipality)
of Metropolitan Toronto, on)
May 2, 1988.)

ALFRED ANTHONY SOBANSKI

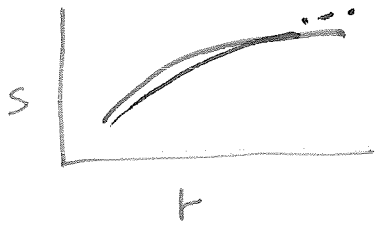
Commissioner for Taking Affidavits

Ex. B 794.

Jacob

$$s = \frac{2.3\,Q}{4\pi T}$$

$$u = \frac{r^2 S}{4Tt}$$



make to M-739

B-795

Differences - B-617

TRow model #1	TRow model #2
45:54	26.88

inflation mm/yr.	
13.7	1.2

Differences B769

TRow model 1	TRow model #2
34.37 (unconnected)	29.94
21.7. (p3 → 769)	1.5

Ministry of the Environment
Ontario

Ministère de l'Environnement

Central Region

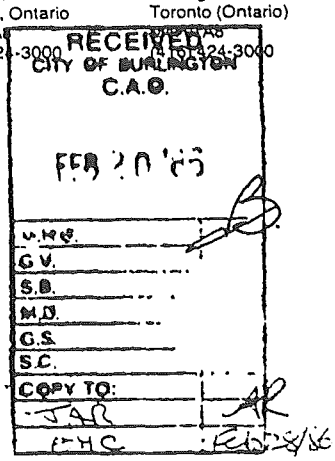
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1986 02 14

The Corporation of the City of Burlington
P.O. Box 5013
Burlington, Ontario
L7R 3Z6

Attention: Mr. Michael H. Boggs
Chief Administrative Officer

Dear Mr. Boggs:

Re: Bayview Park Landfill Site Approvals Schedule

Thank you for your letter of January 31, 1986.

I have considered the matters identified in your letter and am prepared to extend the submission date of your detailed plans and specifications from March 14 to April 14, 1986. I have been informed that by this date the Pollutech Limited studies are expected. Your consultants were advised in October of the length of time required for MOE review of your submissions.

The above change to your schedule will adjust the overall approval schedule in the following way:

	DATE	ACTION REQUIRED	ACTION BY
1.	By March 3/86	Institute the inspection and reporting procedure identified later in this correspondence.	City of Burlington
2.	By April 14/86	Submission of detailed plans and specifications for the following: (a) leachate collection system; (b) transmission sewer; (c) improved site cover and fencing (4 copies required for submission to MOE).	City of Burlington

Ex 3-797

PHASE II

HYDROGEOLOGIC INVESTIGATION

NATIONAL SEWER PIPE LTD

LANDFILL SITE
BURLINGTON

M O R R I S O N B E A T T Y L I M I T E D

290 The West Mall
Etobicoke Ontario
(416) 622-9374

June, 1980
Project No. 130-792

Brian W. Beatty, P.Eng.

Surface Runoff (Q_s)

The runoff component of the hydrologic budget is the last to be considered. While it can be accurately measured in the field, no background streamflow information is available for the two watersheds. Summation of the measured and calculated terms of the budget equation can be done to give an approximation of Q_s.

$$Q_s = P - E - R - \Delta S$$
$$= (76 \text{ cm} - 50 - 5 - 0) = 21 \text{ cm}$$

The magnitude of each component in the calculated hydrologic budget is comparable to budgets determined for similar watersheds by the Ministry of the Environment. It is to be noted that evapotranspiration accounts for about 65% of the annual water loss, while groundwater recharge accounts for only about 6% of the loss.

4.4.2 Bayview Landfill

The hydrologic budget of Bayview landfill will be somewhat different than the watersheds. The major difference will be in the surface runoff (Q_s) and groundwater recharge (R) components. Recharge to the landfill is expected to be high due to gentle surface grades, thin overburden cover, settlement depressions which hold runoff, and relatively permeable cover soils. The annual recharge is estimated to be about 20 cm. Assuming precipitation gains and evapotranspiration losses are similar to the watershed budget, the annual surface runoff (Q_s) component would be as follows:

$$Q_s = P - E - R - \Delta S$$
$$= (76 - 50 - 20 - 0) = 6 \text{ cm}$$

The significant difference in recharge in the landfill and recharge in the shale has resulted in the development of a groundwater mound at the site. At OW 15, the present water table is mounded about 4 m above the original water table.

The increase in water table will result in an increase in the downward hydraulic gradient (refer to Section 4.6) which in turn will allow a slight increase in the calculated recharge rate in the shale beneath the landfill. It is estimated the annual "exfiltration" rate from the base of the landfill could average about 6 cm. The excess recharge (i.e., (20-6) = 14 cm) in the landfill discharges at seepage points around the landfill perimeter. The average annual seepage for the 18 ha landfill, based on an excess recharge rate of 14 cm per year, is about 0.8 L/s. Peak leachate seepage during the spring months is likely 4 to 5 times the average seepage rate.

Ex B-798

HYDROGEOLOGY OF SOLID WASTE DISPOSAL SITES IN NORTHEASTERN ILLINOIS

A Final Report on a Solid Waste Demonstration Grant Project

This report (SW-12d) was prepared
by G.M. HUGHES, R.A. LANDON, and R.N. FARVOLDEN
the Illinois State Geological Survey, Urbana, Illinois
under Demonstration Grant GO6-EC-00006
from the Federal solid waste management program

U.S. ENVIRONMENTAL PROTECTION AGENCY

1971

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The major unconsolidated deposit is glacial till, an unsorted mixture of clay, silt, sand, and boulders deposited directly from the glacial ice. The uppermost bedrock is a fractured dolomite of Silurian Age, a major aquifer in the region. The structure of the area is relatively simple, the rocks dipping eastward at 10-15 feet per mile.

More detailed descriptions of the geology of this area are presented in reports of Suter et at (1959), Willman (1962), Zeizel et al. (1962), and Buschbach (1964).

GROUND WATER. Ground water is an important resource in northeastern Illinois. In 1963, 24 percent of the population obtained water from this source (Sheaffer and Zeizel, 1966, p. 62). There are three major sources of ground water in this area, the deep bedrock aquifer system, the shallow bedrock aquifer system, and the glacial drift aquifer system. The glacial drift aquifer system and the shallow bedrock aquifer system are most susceptible to pollution from solid waste disposal because they are at or near the ground surface. Susceptibility of the shallow bedrock aquifer system is further increased because it is composed of fractured rocks. Recharge to the glacial drift and shallow bedrock aquifer systems is locally derived from precipitation or surface water.

The top of the zone of saturation (or the water table) is generally within 5 to 10 feet of the ground surface except in places where the presence of permeable materials at or near the ground surface has allowed drainage.

INVESTIGATIVE AND ANALYTICAL PROCEDURES

SITE SELECTION. Four sites were studied during the first 2 years of the investigation and one, the Blackwell Forest Preserve site, in late 1968 (figure 2). These were selected from a list of disposal sites in northeastern Illinois compiled by Sheaffer et al. (1963, p. 70-71). Existing sites were chosen because they are in environments typical of those likely to be used for future sites, they represent common hydrogeologic environments in northeastern Illinois, and the altered ground water leaving them provides a tracer to verify hydrogeologic findings. Selection of the sites was based on their hydrogeologic environment, age, access, and extent of the fill.

During the final years more emphasis was placed on the water quality aspect of this investigation. Additional borings were installed at the DuPage County and Winnetka sites, where the hydrogeology was simple and would not obscure water quality relationships, and one boring was installed in a high above-ground landfill in the Blackwell Forest Preserve.

DATA COLLECTION AND ANALYSIS. The investigation of each site included field examination supplemented by study of maps and air photos, surveying, searching for leachate springs, and discussion with operators.

At each site, except Blackwell, initial subsurface information was obtained by drilling a series of four holes to bedrock with standard rotary equipment. Drill cuttings were collected and described, and an electric log, with a conventional self potential and resistivity curve, was run for each hole. Subsequent borings were made by a hollow-stem auger rig, an air drilling rig, two small power augers, and by wash boring.

After each boring had been completed, one or more piezometers or well points were installed and the hole was backfilled.

A piezometer is a screen or permeable plastic tip fastened to the end of a pipe or tube. This screen or tip is installed in a boring, and the annulus above it is sealed so that water level measurements or water samples obtained from this installation apply only to a restricted area in the bottom part of the boring below the seal in the annulus. A well point is similar to a piezometer except that there is no seal in the annulus and therefore measurements or water samples obtained from a well point may reflect conditions over a large vertical interval.

Many of the piezometers installed by contract boring are multiple completions; that is, several piezometers, at different depths, are installed in one bore hole and separated hydraulically from one another by an impermeable sealing plug above and below the screen.

Drilling, sampling, and piezometer construction procedures are described in some detail in appendix A, and descriptions of samples from

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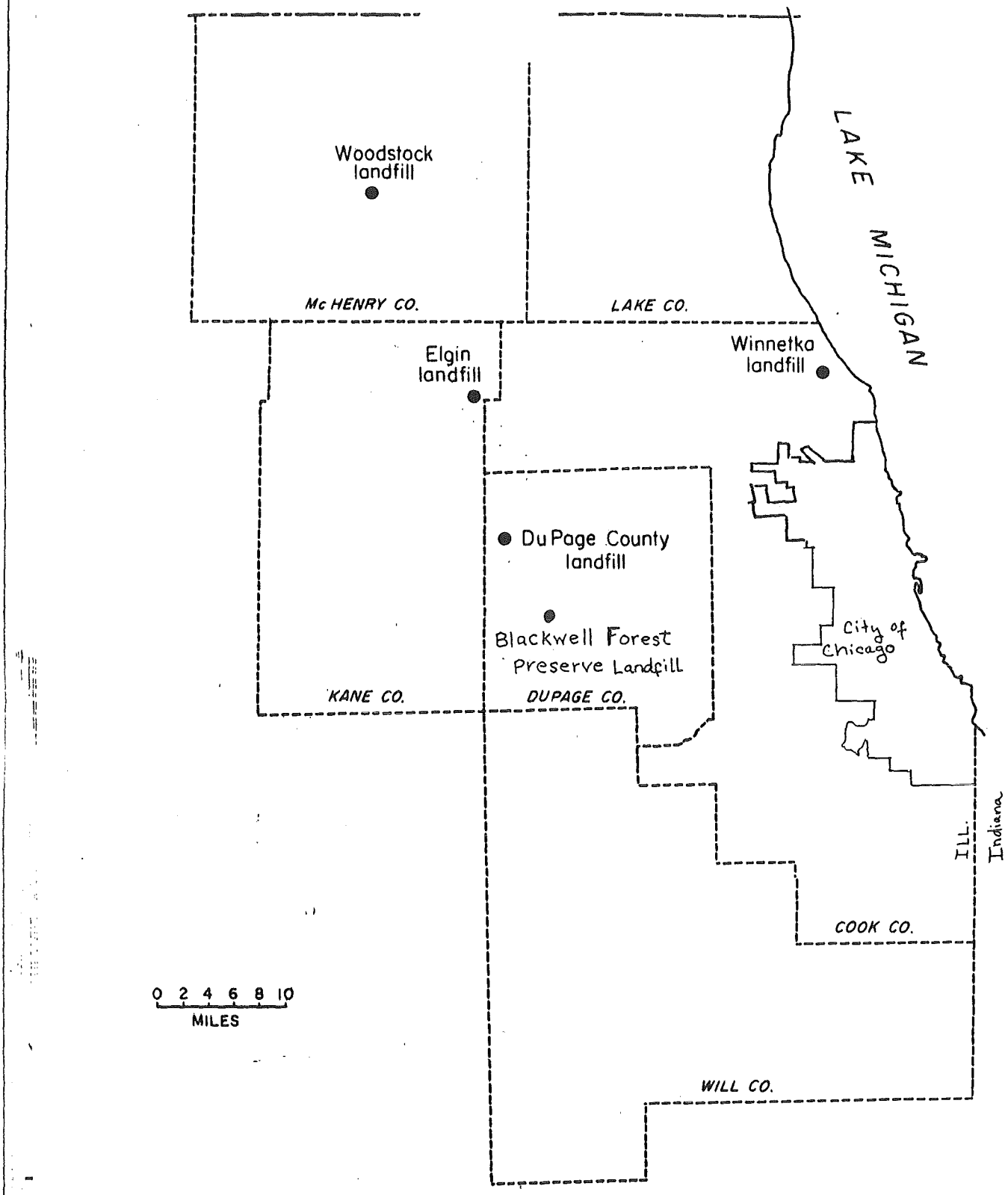


Figure 2. Solid waste disposal sites in northeastern Illinois investigated during the first two years of the study. These sites were chosen on the basis of their hydrogeologic environment, age, ease of access, and extent of fill.

the various contract borings are given in appendix B. Table 3 gives construction details of the various well points and piezometers, and tables 4 and 5 give the results of textural and clay-mineral analysis.

After a preliminary determination of the flow system had been made, additional well points and piezometers were located to give the maximum amount of information on both the hydrology and the composition of the ground water. During the last year most of the installations were located to sample leachate of various ages and to investigate changes in the composition of affected ground water over short horizontal and vertical distances within the same geologic unit.

The steps used for collecting samples from the well points and piezometers varied with the sampling point involved and are discussed in appendix A.

Water quality analyses by the Illinois Department of Public Health are presented in table 6, by Allied Laboratories in table 7, and by the State Geological Survey in table 8. Table 9 presents the results of more detailed chemical analyses, most of which were by Tenco Hydro/Aerosciences, Inc. The laboratory procedures used in the chemical analyses are discussed in appendix C.

Analyses of soluble salts in the materials associated with the landfills are presented in tables 10 and 11, chemical analyses of the till itself in table 12, and analyses of cation exchange capacity and exchangeable cations in table 13.

Under the direction of Professor I. Edgar Odom, Department of Geology, Northern Illinois University, extracts of soluble salts were obtained from the materials underlying the landfills and submitted to a fluorescence analysis. These data are presented in appendix D.

Gas samples were pumped from a perforated iron pipe driven approximately 3 feet into the ground. The pipe hoses and pump were flushed with landfill gas and then the sample was collected by displacing water in a submerged mason jar. The results of the analyses of these gases are presented in table 14.

The Illinois State Geological Survey also conducted approximately 200 field conductivity measurements, 300 field sodium chloride tests with a Hach Kit, and 50 field tests for methane. These data are on file at the State Geological Survey.

Hydrographs, or graphs of water levels, were necessary in the hydrogeologic analysis. Water levels were recorded by float-activated recorders in borings with 4-inch-diameter casing and by electronically activated recorders in borings with smaller diameter casings.

In the second study year three recorders were available. These were moved about to gather specific data. During the last year eight permanent recorder installations were constructed: two each at the old DuPage County, Winnetka, and Woodstock landfills and one each at the Elgin and Blackwell landfills. In other piezometers periodic measurements of water levels were made with a measuring tape, and hydrographs were constructed from these measurements. These hydrographs were begun when the well was completed and have been continued to the present, with measurements at various intervals.

Microbarographs were obtained by recording barometers installed at each site. The records were necessary for correcting the hydrographs for barometric effect. Precipitation records from automatic rain gauges and manual rain gauges at each site were also obtained and checked against those from the U.S. Weather Bureau stations at Wheaton, Aurora, Elgin, O'Hare Field, and Antioch. Hydrographs, microbarographs, and rainfall data from the investigation are on file at the Illinois State Geological Survey. The hydrographs are interpreted in some detail in appendix E.

Slug tests were run to determine the permeability of materials associated with the landfills. This is accomplished by lowering metal cylinders into a boring to displace the water level upward and then measuring the subsequent decline in water level with a steel tape.

Results were checked by measuring the rise in water level after the metal cylinders had been removed. Slug tests were also run by adding or removing water from the bore hole, but this method is less convenient. The results of these tests are presented in table 15.

Pumping tests were conducted to verify the results obtained from the slug tests, and, in addition, a sample of the till similar to that at the DuPage County site was subjected to a laboratory permeability test. The results of permeability testing are discussed in appendix F.

To calculate the amount of water infiltrating into the landfill, the effective porosity or specific yield of refuse was determined by filling a 110-gallon container with water and refuse and then measuring the amount of water that would drain from the mixture. This procedure is discussed further in appendix E.

Resistivity and temperature studies as well as a study of effect of storage on leachate were also conducted. These are described in appendix F and G of the interim report of this project (Hughes *et al.*, 1968).

Also included as appendices are calculations of the flow into and out of the landfills and discussions of the analytical methods used in the water balance estimate and permeability calculations (appendix H).

THE OLD DUPAGE COUNTY LANDFILL

GENERAL DESCRIPTION. The old DuPage County landfill is located in the NW¼ of sec. 32, T. 40 N., R. 9 E., DuPage County, on both sides of the Chicago Great Western Railroad where it crosses Powis Road, south and east of the county airport. Figure 3 is a map of the general area with a cross section showing the topography and general geologic sequence.

The old DuPage County landfill lies on a flat upland area between the Minooka Moraine on the west and the West Chicago Moraine on the east. The elevation is about 750 feet above mean sea level. The area was originally swampy and much of the drainage was through tiles emptying into Kress Creek, which flows to the south along the eastern side of the fill area.

Before filling operations began, the southeastern part of the landfill was used as a holding area for livestock enroute to Chicago. Filling, which was by the trench and fill method, began in September 1952 and was completed in November 1966. Initially, there was controlled burning of wood or paper on the north side of the fill, but this was discontinued. Figure 4 shows the history of the filled areas.

According to the operator, trenches were dug to the top of the water table and were as much as 6 feet deep. At times these trenches contained water. On the south side of the railway, refuse was piled 6 to 8 feet above the original ground surface in a single lift, or layer, and north of the railway, refuse was piled about 15 feet above original ground surface in two lifts.

Household and garden refuse was the major component of the fill, but small amounts of spent battery acid, construction debris, and sewage sludge were also buried at this site. The daily cover material was at least 6 inches thick and the final cover 2 to 3 feet thick. The cover material is primarily silt loam, clay, silty clay loam, and clay loam (designation of soils from U.S. Department of Agriculture classification of soils) although many stones are present in some parts.

Fine-textured waste material from an asphalt plant is being used to fill low areas on the north side of the railway.

Weeds cover most of the surface of the landfill. The east half of the south side supports a fairly dense growth of trees, predominantly cottonwoods but with some white ash and black cherry. Trunk diameters of the trees on the berms between the filled trenches are up to 4 inches at 4 feet above ground level. Smaller trees are present over the trenches, but most of these die before their trunks reach 2 inches in diameter. An unsuccessful attempt at farming was made on the western part of the south side of the fill, but according to the farmer the cover material was too stony. We hope to investigate further the factors affecting plant growth on landfills.

The central part of the landfill is relatively flat, but slopes increase towards the edges, be-

Table 3

PIEZOMETER AND SAMPLING POINT DATA
OLD DUPAGE COUNTY LANDFILL

Well No.	Screened interval (ft.)	Sand Pack interval (ft.)	Well rating[1]	Principle unit measured or sampled	Sealed	Comments
MM 1	10.40-13.40	?	3	Base of upper sand	Partially	Steel pipe used
2	9-9.5	0-9.5	3	About middle upper sand	No	Replaced by MM 49 6/68
3	8.3-8.8	?	3	Same	No	Destroyed 4/69
4	8.4-8.9	?	Dry	Same	No	Destroyed 4/69
5	9.5-10.0	?	2	Same	No	Destroyed 4/69
6	9.0-9.5	?	3	Same	No	
7	18.6-19.1	?-19.1	4	4 ft. below top of upper till	Partially	Reduced 1967
8	9.4-9.9	?-9.9	2	About middle of upper sand	No	Reset and wirescreen replaced with 6 in. PVC plastic screen 6/68
9	19.9-20.4	?	4	8 ft. below top of upper till	Possibly	
10	9.1-9.6	?	4	About middle of upper sand	No	
11	14.6-15.1	?	3	Near base of upper sand	No	
12	12.1-12.6	?	2	Same	No	
13	11.68-12.18	?		Same	No	Destroyed late 1966
14	11.5-12.0	0-12.0	3	Same	No	Reset with new wire screen 9/66
15	6.4-6.9	?	3	About middle of upper sand	No	
16A	9.5-10.0	?	3	Same Same	No	Separated from fill by ditch and railroad embankment.
16B	18.8-19.3	?	3	Base of upper sand	No	Separated from fill by ditch and railroad embankment.
17	8.1-8.6	?	3	Middle of upper sand	No	Separated from fill by ditch and railroad embankment.
18	14.0-14.5	?	3	Near base of upper sand	No	Destroyed 4/69
19	15.5-16.0	?	3	Base of upper sand	No	
20	12.5-13.0	?-13.0	2	Same	No	
21	8.1-8.6	?	3	Same	No	
22	9.1-9.6	?	2	Near base of upper sand	No	Probably affected by septic field-destroyed
23	7.0-7.5	?	3	About middle of upper sand	No	
24	5.5-6.0	?	3	Same	No	
25	18.0-18.5	?	4	5 ft. below top of upper till	Possibly	Reduced
26	18.3-18.8	?	4	Same	No	
27	18.2-18.7	?	4	Same	No	Reduced
28	7.8-8.2	?	3	Near base of upper sand	No	Destroyed 5/68
29	19.0-19.5	17.0-21.0	2	16 ft. above upper till in upper sand	No	

[1]Well ratings as follows:
1 + Pumping rate > 5 gpm.
1 Pumping rate 1-5 gpm.

[2]Can be bailed at 1/5 gt/min. to 1 gpm.

[3]Will recover in 1 to 2 hours when bailed dry.

[4]Requires more than one day to recover after being bailed dry.

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Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA
OLD DUPAGE COUNTY LANDFILL – CONTINUED

Well No.	Screened interval (ft.)	Sand pack interval (ft.)	Well rating	Principle unit measured or sampled	Sealed	Comments
MM 30	7.6-8.1	2.0-10.2	Dry	Refuse	No	Generally above zone of saturation—gas
31	18.8-19.3	17.3-22.0		7 ft. below refuse in upper sand	No	
32	11.7-12.2	?-13.2	3	Near base of refuse	No	
33	11.4-11.9	0-13.0	3	Near base of upper sand	No	
34	11.2-11.7	0-11.7	1	About middle of upper sand	No	
35	10.0-10.5	0-10.5	2	Same	No	Destroyed 9/69
36	12.5-13.0	12.0-13.0	3	Near base of upper sand	No	Destroyed 9/69
37	7.0-7.5	0-7.5	2	About middle of upper sand	No	Destroyed 9/69
38	3.5-4.0	0-4.0	2	Near top of upper sand	No	Pipe raised
39	10.8-11.3	0-14.0	3	Near base of upper sand	No	Destroyed
40	11.0-11.5	0-12.0	3	Base of upper sand	No	Destroyed 6/68
41	11.0-11.5	0-12.0	3	Same	No	Destroyed 6/68
42	11.8-12.3	0-12.30	3	Base of upper sand	No	
43				Same	No	Destroyed 8/68
44	13.8-14.3	0-13.27	2	Same	No	Replaces MM 2
45	6.7-7.2	0-7.15	2	Middle of upper sand	No	
46	6.6-7.1	0-7.12	1	Same	No	
47	14.8-15.3	0-15.31	1	Base of upper sand	No	
48	5.0-5.5	0-5.5	2	Middle of upper sand	No	
49	16.0-16.5	0-16.56	2	Base of upper sand	No	
50	6.8-7.25	0-7.25	1	Near base of upper sand	No	
51	4.9-5.4	0-5.42	2	Near top of upper sand	No	
52	1.4-1.9	0-1.92	2	In landfill	No	
53	8.1-8.6	0-7.55	2	Near base of upper sand	No	Destroyed 4/69
54	8.3-8.8	5.78-8.8	2	Near middle of upper sand	No	
55	6.8-7.3	0-7.30	2	Same	No	
56	6.3-6.8	0-6.80	2	Same	No	
57	12.5-13.0	0-13.08	1	Near base of upper sand	No	
58	12.3-12.8	0-12.83	1	Same	No	
59	14.2-14.7	0-14.7	1	Same	No	
60	12.3-12.8	0-12.74	1	Same	No	
61	6.2-7.2	0-7.20	1	In refuse	No	Destroyed 4/69
62	10.8-11.8	0-11.80	1	In refuse, near base	No	
63	15.8-16.8	0-16.85	1	4 ft. below refuse in upper sand	No	
64	19.0-20.0	18.57-20.07	4	6 ft. below top of upper till	Yes	Sealed in till, reduced ½ in. pipe 8/69
65	8.85-9.85	0-9.85	2-3	Near middle of upper sand	No	
66	15.9-16.9	14.0-16.9	4?	In upper till near top	Possibly	Sealed in till ?
67	15.5-16.5	0-16.5	2-3	5 ft. below refuse in upper sand	Yes	Destroyed 8/69

Table 3 (Continued)

67	15.5-16.5	0-16.5	2-3	5 ft. below refuse in upper	Yes	Destroyed 8/69

Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

OLD DUPAGE COUNTY LANDFILL – CONTINUED

Well No.	Screened interval (ft.)	Sand pack interval (ft.)	Well rating	Principle unit measured or sampled	Sealed	Comments
68	10.1-10.64	9.64-10.64	1	Near base of upper sand	Yes	
68A	4.5-5.0	0-5.00		Near middle of upper sand	No	
69	9.3-10.3	9.17-10.30	1	Near base of upper sand	Yes	
70	8.8-9.8	8.80-9.80	1	Same	Yes	
71	7.0-10.0	9.00-10.00	1	Same	No	
71A	5.47-5.87	0-5.87		Near middle of upper sand	No	
72	7.3-10.30	9.30-10.30	1	Near top of upper sand	No	
73	7.68-8.18	1-8.18	1	In refuse	No	
74	7.60-8.10	1-8.10	1	Same	No	
75	8.64-9.14	8.14-9.14	1	Same	No	
76	12.14-12.64	0-12.64	1	In middle sand	No	
77	13.50-14.00	1.0-14.00	1	In refuse	No	
78	13.83-14.33	1-14.33	1	In refuse	No	
79	10.90-11.40	1-11.40	1	Middle of upper sand	No	
80	6.01-6.51	3-6.51	1	Same	No	
81	11.70-12.20	0-12.20	1	Same	No	
LW 1A	72.0-75.0	70.0-75.0	2	Top of silurian	Yes	Crack in piezometer near surface
1B	29.5-31.0	-33.0	4	16 ft. below top of till	Yes	
2A	71.0-75.0	-75.5	3	Top of silurian	Yes	Partially plugged
2B	38.0-41.0	-41.0	1	24 ft. below top of till in interbedded sand	Yes	
3A	68.5-71.5	-73.0	3	Top of dolomite	Yes	
3B	17.5-20.5	-20.0	4	3.5 ft. below top of till	Partially	Reduced
3C	39.5-42.5	-45.0	1	20.5 ft. below top of till in interbedded sand	Yes	
3D	47.5-49.0	47.5-50.0	4	Top of lower till	Yes	
4A	90.0-93.0	85.0-93.0	2	Top of dolomite	Yes	
4B	48.0-51.0	45.5-51.0	3	13 ft. below top of till	Yes	
4C	28.5-31.5	-32.0	3	Base of upper sand	Yes	
5A	47.0-50.0	47.0-50.0	1	21 ft. below top of till in interbedded sand	Yes	
5B	20.0-23.0	18.0-23.0	2	Base of upper sand	Yes	
5C	13.0-13.5	12.0-13.5	2	1 ft. below refuse	Possibly	

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Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

OLD DUPAGE COUNTY LANDFILL—CONTINUED

Well No.	Screened interval (ft.)	Sand pack interval (ft.)	Well rating	Principle unit measured or sampled	Sealed	Comments
6A	45.5-48.5	41.0-48.5	1	17.33 ft. below top of till in interbedded sand	Yes	
6B	18.0-21.0	15.0-21.0	2	Lower part of upper sand	Yes	
6C	7.5-8.0	5.0-11.0	2	Upper part of upper sand	Possibly	
7	5.2-9.2	0-9.17	1-2	Refuse	No	4 in. observation well
8						Caved and abandoned--samples only
9						Caved and abandoned--samples only
10	39.1-39.6	38.12-39.62	4	12.22 ft. below top of upper till	Partly	
LW 11A	29.0-30.0	28.20-30.03	4	2.30 ft. below top of till	Yes	2 in. sampling well, sealed in clay, reduced 8/69
11B	23.8-24.8		3	Base of upper sand	Possibly	
12A	33.6-34.6	33.37-34.57	4	7.47 ft. below top of upper till	Yes	2 in. sampling well, sealed in clay, reduced 8/69
12B	14.8-15.3		3	Near base of refuse	Possibly	Possibly sealed in refuse
13	9.7-13.7			In refuse	No	4 in. observation well
14	39.2-39.8	38.26-39.26	4	15.19 ft. below top of till	Yes	Sealed in till, reduced
15	29.2-30.2	29.14-30.31	4	4.31 ft. below top of till	Yes	2 in. sampling well, sealed in clay, reduced
16	26.2-27.2	25.92-27.00	4	2.6 ft. below top of till	Yes	2 in. sampling well, sealed in clay, reduced

Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

WINNETKA LANDFILL

Well No.	Screened interval (ft.)	Sand pack interval (ft.)	Well rating	Principle unit measured or sampled	Sealed	Comments
MM 1	13.5-14.0	12.0-14.0	3	Upper part of till	Partly	
2	4.5-5.0	0.5-5.0	3	Upper part of alluvium	No	
3	10.5-11.5	9.0-11.0	3	Upper part of till	Partly	
4	16.5-17.5	15.0-17.0	4	Upper part of till	Partly	Buried by fill
5	4.0-4.5	0.5-4.5	3	Upper part of alluvium	No	
6	5.5-6.00	0.5-6.0	2	Alluvium	No	Buried by fill
7	17.5-18.0	16.0-18.0	4	Upper part of till	Partly	Reduced with 8 ft. of ½ in. tubing
8	5.0-5.5	0.5-5.5	2	Alluvium	No	
9	4.5-5.0	0.5-5.0	3	Alluvium	No	
10	4.5-5.0	0.5-5.0	2	Refuse	No	
11	8.5-9.0	0.5-9.0	3	Refuse	No	
12	8.5-9.0	0.5-9.0	2	Alluvium	No	
13	17.0-17.5	16.0-18.0	4	Upper part of till	Partly	Reduced with 12 ft. of ½ in. tubing
14	7.5-8.0	0.5-8.0	4	Alluvium	No	Reduced with 8 ft. of ½ in. tubing
15	10.5-12.0	9.8-12.0				Plugged with Bentonite at 5 ft.
16	10.5-12.0	10.0-12.0	4	Base of alluvium	Yes	
17	10.5-12.0	10.0-12.0	4	Base of alluvium	Yes	
18	10.5-12.0	10.0-12.0				Pulled piezometer off while back filling
19	10.5-12.0	10.0-12.0	4	Base of alluvium	Yes	
20	10.5-12.0	10.0-12.0				Plugged dry at 8 ft.
21	10.5-12.0	10.0-12.0	4	Base of alluvium	Yes	
22	10.5-12.0	9.7-12.0				Tubing pulled off
23	10.5-12.0	10.0-12.0	4	Base of alluvium		
24	8.56-9.06	0.5-9.06	3	Alluvium	No	
25	5.71-6.21	1.0-6.21	3	Alluvium	No	
26	8.83-9.13	1.0-9.13	2-3	Alluvium	No	
27	10.62-11.12	1.0-11.12	3-4	Alluvium	No	
28	8.77-9.27	1.0-9.27	3	Alluvium	No	
29	0.48-3.48	0-3.48	1-2	Refuse	No	

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Table 3 (Continued)
PIEZOMETER AND SAMPLING POINT DATA

WINNETKA LANDFILL – CONTINUED

Well No.	Screened interval (ft.)	Sand Pack interval (ft.)	Well rating	Principle unit measured or sampled	Sealed	Comments
MM 30	2.64-5.64	0-5.64	1-2	Refuse		Flowing at ground level
31	6.00-9.00	1.0-9.0	1-2	Refuse		
32	3.44-6.44	1.0-6.44	1-2	Refuse		
33	0.30-3.30	0.0-3.30	3	Alluvium	No	Some surface leakage
34	8.45-8.95	1.0-8.95	3	Alluvium	No	
35	8.28-8.78	1.0-8.78	2	Alluvium	No	Over sewer
36	8.46-8.96	1.0-8.96	3	Alluvium	No	
37	5.38-8.38	1.0-8.38	3	Alluvium	No	
38	8.14-11.14	1.0-11.14	3	Alluvium	No	
39	6.31-9.31	1.0-9.31	2	Alluvium	No	
40	13.13-16.13	1.0-16.13	2	Refuse	No	Slotted for gas sample
41	5.62-6.12	1.0-6.12	2-3	Alluvium	No	In ditch surface leakage
42	8.86-9.36	1.0-9.36	3	Alluvium	No	
43	9.30-12.30	1.0-12.30	2-3	Alluvium	No	Destroyed
44	19.61-20.11	17.11-20.11	4	Upper part of till	Yes	
45	17.11-18.11	15.11-18.11	4	Upper part of till	Yes	
46	19.79-20.79	17.79-20.79	4	Upper part of till	Yes	
47	19.99-20.99	19.49-20.99	4	Upper part of till	Yes	
48	29.82-30.32	27.32-30.32	4	Upper part of till	Probably	
49	29.82-30.36	27.86-30.36	4	Upper part of till	Probably	Reduced
50	6.87-7.37	0.00-7.37	3	Alluvium	No	Injection testarray
51	6.39-6.89	0.00-6.89	3	Alluvium	No	Injection testarray
52	6.61-7.11	0.00-7.11	3	Alluvium	No	Injection testarray
53	6.55-7.05	0.00-7.05	3	Alluvium	No	Injection testarray
54	6.60-7.10	0.00-7.10	3	Alluvium	No	Injection testarray
55	8.0-8.5	7.0-8.5	?	Alluvium	Probably	
56	8.0-8.5	7.0-8.5	?	Alluvium	Probably	
LW 1A	120.5-123.5	110.0-124.0	2	Upper part of silurion	Partially	
1B	95.5-98.5	92.0-99.0	3	Near base of till	Partially	
1C	83.0-86.0	79.0-99.0	3	Near middle of till	Partially	
1D	54.5-57.5	55.0-57.5	3	Upper part of till	Partially	
1E	12.0-15.0	1.0-15.0	2	Base of refuse	No	
2A	121.5-124.5	112.0-124.5	1	Upper part of silurion	Yes	
2B	67.5-70.5	65.0-70.5	2	Near middle of till	Yes	
2C	34.0-37.0	30.0-37.0	2	Near top of till	Partly	
2D	7.5-10.5	1.0-10.5	3	Base of alluvium	No	
3A	115.0-118.0	112.0-118.0	1	Upper part of silurion	Yes	
3B	63.5-66.5	54.0-66.5	2	Near middle of till	Partially	
3C	27.5-30.5	24.0-30.5	3	Upper part of till	Partially	
3D	11.0-13.0	8.5-13.5	2	Base of alluvium	Partially	
3E	4.0-4.5	2.0-4.5	Dry	Top of alluvium	No	
4A	123.5-126.5	118.0-126.5	1	Top of silurion	Yes	

Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

WINNETKA LANDFILL – CONTINUED

Well No.	Screened interval (ft.)	Sand pack interval (ft.)	Well rating	Principle unit measured or sampled	Sealed	Comments
4B	82.0-85.0	77.0-85.0	3	Near base of till	Yes	
4C	55.0-58.0	44.5-58.5	2	Near middle of till	Partly	
4D	32.0-35.0	30.0-35.0	3	Upper part of till	Partly	
4E	13.0-16.0	11.0-16.0	2	Base of alluvium	No	
5A	32.0-35.0	30.5-36.0	4	19.5 ft. below top of till	Probably	
5B	9.5-12.5	0.0-12.5	2	Base of refuse	No	
6A	55.5-58.5	52.0-58.5	2	Near middle of till	Yes	
6B	27.5-30.5	24.5-31.5	4	Near top of till	Yes	
7A	92.0-95.0	88.0-95.0	3	Lower part of till	Partially	
7B	42.0-45.0	38.0-45.0	3	Near middle of till	Partially	
7C	9.5-12.5	6.0-12.5	3	Base of alluvium	No	
8A	60.0-63.0	55.0-66.0	2	Near middle of till	Yes	
8B	26.0-29.0	23.0-30.0	3	Upper part of till	Probably	
8C	11.5-12.00	0.5-12.0	3	Base of alluvium	No	
9A	64.0-66.0	57.5-66.0	2	Lower part of till	Questionable	
9B	10.0-10.5	0.5-10.5	3	Base of alluvium	No	
10A	35.30-35.80	34.80-35.80	4	Till, 23.3 ft. below refuse	Yes	Reduced
10B	11.31-11.81	?-11.81	2-3	Base of refuse	No	
11	14.91-15.91	14.91-15.91	4	Till, 0.41 ft. below refuse	Yes	
12	19.89-20.89	19.89-20.89	4	Till, 9.4 ft. below refuse	Yes	Reduced
13	3.75-8.00	0.00-8.00	1	Base of refuse	No	
14	33.49-33.99	33.32-33.99	4	Till, 19.5 ft. below refuse	Yes	Reduced
15	24.46-25.46	24.45-25.46	4	Till, 11.13 ft. below refuse	Yes	Reduced
16	19.38-20.38	19.20-20.38	4	Till, 5.93 ft. below refuse	Yes	
17	14.58-19.38	0.00-19.38	2	Base of refuse	No.	

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Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

ELGIN LANDFILL

Well No.		Screened interval (ft.)	Sand pack interval (ft.)	Material set in	Well rating	Sealed	Comments
LW	1A	41.0-44.0	37.0-44.0	Dolomite	1	Yes	Buried, 8/68
	1B	23.0-26.0	20.0-26.0	Gravel	2	Yes	Buried, 8/68
	1C	7.5-10.5	3.0-10.5	Sand and gravel	1	No	Buried, 8/68
	2A	60.0-63.0	53.0-63.0	Dolomite	1	Yes	
	2B	46.0-49.0	39.5-49.5	Sand and gravel	1	Yes	
	2C	8.0-11.0	7.0-11.0	Sand and gravel	?	No	Foot valve removed
	3A	55.0-58.0	51.0-58.0	Dolomite	2	Yes	
	3B	31.5-34.5	27.0-34.5	Sand and gravel	1	Yes	
	3C	8.0-11.0	-11.0	Sand and gravel	3	No	Foot valve removed
	4A	46.5-49.5	-52.0	Dolomite	1	Partly	
	4B	34.5-37.5	-37.5	Sand & pea gravel	1	Partly	
	4C	20.5-23.5	19.0-23.5	Sand & pea gravel	1	Partly	
	4D	8.5-11.5	0.0-11.5	Sand & pea gravel	3	No	
	5A	18.5-21.5	17.5-21.5	Silty sand	2	Partly	
	5B	10.5-13.5	6.0-13.5	Sand and gravel	1	No	
	6A	38.0-41.0	35.0-41.0	Silty sand	1	Yes	
	6B	18.5-21.5	-21.5	Sand and gravel	2	No	
	7A	30.0-33.0	28.0-33.0	Silty sand	2	Partly	
	7B	22.0-25.0	18.0-25.0	Sand and gravel	3	No	
	8A	33.5-36.5	31.0-36.5	Sand	1	Yes	
	8B	15.0-18.0	10.0-18.0	Sand and gravel	1	No	
	9A	28.0-31.0	25.0-31.5	Sand and gravel	1	Yes	
	9B	12.0-15.0	11.0-15.0	Sand and gravel	1	No	
	10	15.97-16.47	11-16.47	Sand and gravel	?	Partly	
	11	9.86-10.36	0-10.36	Sand and gravel	?	No	
Well	1	4.90-7.90	0-7.90	Sand and gravel	2	No	Foot valve removed
Well	2	17.8-19.8	0-19.8	Sand and gravel	1	No	Lost

Table 3 (Continued)

PIEZOMETER AND SAMPLING POINT DATA

WOODSTOCK LANDFILL

Well No.		Screened interval (ft.)	Sand pack interval (ft.)	Material set in	Well rating	Sealed	Comments
MM	1	7.5-8.0	0.0-8.0	Sand	1	No	
	2	17.0-17.5	11.0-18.0	Gravelly sand	3	Partly	
	3	6.5-7.0	0.5-7.0	Silt	3	No	
	4	18.5-19.0	12.0-21.0	Gravel	1	Partly	
	5	10.5-11.0	8.5-11.0	Silty sand	3	Partly	
	6	6.0-6.5	0.5-6.5	Sand and gravel	1	No	Buried, 1968
	7	8.5-9.0	0.5-9.0	Organic silt	2	No	
	8	15.0-15.5	14.0-15.5	Organic silt	3	Partly	
	9	8.5-9.0	0.5-9.0	Organic silt	2	No	
	10	8.0-8.5	0.5-8.5	Organic silt	3	No	
LW	1A	220.5-223.5	209.0-223.5	Sand and gravel	4	Yes	Reduced
	1B	31.0-34.0	30.0-34.0	Sand and gravel	2	Partly	
	1C	22.0-25.0	-25.0	Silt	2	Partly	
	1D	11.5-14.5	-14.5	Refuse	3	No	
	2A	145.0-148.0	-148.0	Sand and gravel	2	Yes	Destroyed, 10/69
	2B	76.0-79.0	-79.0	Sand and gravel	2	No	Destroyed, 10/69
	2C	53.5-56.5	-56.5	Sand and gravel	2	No	Destroyed, 10/69
	2D	8.5-9.0	-9.0	Till	2	Probably	Destroyed, 10/69
	2E	4.5-5.0	-5.0	Sand and gravel	1+	No	Destroyed, 10/69
	3A	192.0-195.0	180.0-195.0	Sand and gravel	2	Partly	
	3B	162.0-165.0	158.0-169.0	Clay over sand and gravel	3	Partly	
	3C	101.5-104.5	98.0-104.5	Sandy till	3	Partly	
	3D	62.0-65.0	55.0-65.0	Sand and gravel	1+	Partly	
	3E	19.0-22.0	-22.0	Sand and gravel	1	Probably	
	3F	7.0-7.5	-7.5	Sand and gravel	2	No	
	4A	118.0-121.0	113.0-121.0	Sand	2	Probably	
	4B	102.0-105.0	98.0-105.0	Silty sand	1+	Probably	
	4C	70.0-73.0	65.0-73.0	Sand	1	Yes	
	4D	26.5-29.5	-29.5	Sand and gravel	1	Yes	
	4E	13.0-13.5	11.0-13.5	Sandy silty till	Dry	No	
	5A	44.0-47.0	43.0-51.0	Sand	1	Yes	
	5B	18.5-21.5	18.0-21.5	Sandy silt	1	Yes	
	5C	9.5-10.0	8.0-10.0	Sandy silt	2	No	
	6A	31.0-34.0	22.0-34.0	Sand and gravel	1+	Yes	
	6B	8.0-11.0	6.0-11.0	Refuse	3	No	
	7	9.79-13.79	0-13.79	Refuse	?	No	
	8	13.08-17.08	0-17.08	Refuse	?	No	

TABLE 15

PERMEABILITY VALUES OBTAINED FROM SLUG TESTS

Well No.	Material set in	K permeability (cm/sec)[1]		Comments
		DUPAGE COUNTY		
MM 73		-		Water level rose after slugging
MM 75	Refuse	7.3×10^{-4}		
MM 77		$\geq 7.4 \times 10^{-5}$	(est)	Too fast for accurate measurement
MM 78		$\geq 7.4 \times 10^{-3}$	(est)	Too fast for accurate measurement
MM 5		2.7×10^{-4}		
MM 21		1.4×10^{-3}		
MM 29		1.3×10^{-5}		Possibly plugged screen
MM 44		2.4×10^{-3}		
MM 46		1.6×10^{-3}		
MM 47		1.3×10^{-3}		
MM 49		1.0×10^{-3}		
MM 58		1.7×10^{-3}		
MM 59		2.1×10^{-2}		Possibly refuse
MM 63		$> 7.4 \times 10^{-3}$	(est)	Too fast for accurate measurement
MM 68		1.35×10^{-3}		
MM 69	Surficial	9.5×10^{-4}		
MM 70	sand	1.8×10^{-5}		
MM 71		1.8×10^{-3}		
MM 76		$> 7.4 \times 10^{-3}$	(est)	Too fast for accurate measurement
LW 4C		5.1×10^{-4}		
LW 4C		5.0×10^{-4}		
LW 5B		1.8×10^{-4}		
LW 6B		1.6×10^{-3}		
LW 6B		2.2×10^{-3}		
MM 7		1.9×10^{-7}		
MM 64		5.3×10^{-6}		
LW 1B		6.3×10^{-7}		
LW 3D	Glacial	9.0×10^{-7}		
LW 11A	till	1.1×10^{-7}		
LW 12A		5.8×10^{-8}		
LW 14		2.3×10^{-8}		
LW 15		9.6×10^{-9}		
LW 16		1.4×10^{-7}		

[1] 1 cm/sec = 2.12×10^{4} gpd/ft^2

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TABLE 15 (Continued)
PERMEABILITY VALUES OBTAINED FROM SLUG TESTS

Well No.	Material set in	K permeability (cm/sec)[1]	Comments
		DUPAGE COUNTY	
LW 3C	Interbedded sand	4.7×10^{-4}	
LW 6A		5.7×10^{-3}	
		WINNETKA SITE	
MM10	Refuse	6.0×10^{-3}	
MM11		-	Water level did not drop after being raised by slugs
MM30		$> 8.5 \times 10^{-3}$	Too fast for accurate measurement
LW 1C		-	Too slow—screen probably clogged
LW 10B		2.2×10^{-5}	
MM12	Alluvium	6.4×10^{-4}	
MM13		1.2×10^{-4}	
MM14		2.3×10^{-4}	
MM33		2.5×10^{-4}	
MM37		2.6×10^{-4}	
MM50		7.3×10^{-5}	
MM52		4.9×10^{-5}	
MM16	near top of glacial till	1.0×10^{-7}	
MM17		3.2×10^{-7}	
MM19		1.0×10^{-7}	
MM21		2.1×10^{-7}	
MM23		8.1×10^{-8}	
MM48		1.4×10^{-5}	Leaking seal.

[1] 1 cm/sec = 2.12×10^{4} gpd/ft^2.

TABLE 15 (Continued)
PERMEABILITY VALUES OBTAINED FROM SLUG TESTS–CONTINUED

Well No.	Material set in	K permeability (cm/sec)[1]	Comments
		WINNETKA SITE—continued	
LW 6B		1.3×10^{-6}	
LW 9A		5.5×10^{-5}	Well completed in thin sand stringer at a depth of approximately 60 feet
LW 10A			Water level rose instead of dropping after slugging
LW 10A	Deeper glacial till	3.4×10^{-7}	
LW 12		3.5×10^{-7}	
LW 15		2.6×10^{-9}	
		2.9×10^{-9}	
LW 16		6.4×10^{-8}	
		ELGIN	
LW 4C	Sand and gravel	-	Too fast—water level dropped below original level
LW 6B		-	
LW 8B		$> 2.7 \times 10^{-3}$	
		WOODSTOCK	
MM 2		2.0×10^{-4}	
MM 3		1.7×10^{-4}	
MM 4	Sand and gravel	2.9×10^{-4}	
LW 1C		1.1×10^{-4}	
LW 3E		$> 4.4 \times 10^{-3}$ (est)	Water level dropped too fast for accurate measurement
LW 6A		$> 2.7 \times 10^{-3}$ (est)	

[1] 1 cm/sec = 2.12×10^{4} gpd/ft^2.

B799

Curriculum Vitae

STAMM ECONOMIC RESEARCH

GARRY M. STAMM, M.A. President and Principal

EXPERIENCE AND ACCOMPLISHMENTS WITH THE FIRM

Garry founded the firm of Stamm Economic Research in 1975, after spending a number of years in responsible government positions. He pioneered the development of practical applications for economic concepts to assist both private decision-making and public policy formulation, principally in Ontario and Alberta. His responsibilities and achievements include:

- Project management and direction of a large number of studies related to urban and regional economics, develop ment, and planning.
- Development of operations research methods and computer models related to the areas of work undertaken by the firm including: retail market analysis, housing projections, employment based population projections, municipal finance analysis, and development impact analysis.
- Development of communications methods and skills designed for courts, board, and tribunal testimony, and public forum presentation.
- Frequently giving testimony on major matters of public policy as well as private cases; including testimony to the Ontario Energy Board Hearings into into setting of electricity rates, the Niagara Escarpment Hearing, and the Ontario Municipal Board for both municipalities and private sector land companies.

PAST EXPERIENCE

Prior to establishing the firm, Garry had become known in his field with a number of considerable achievements.

- While with the Government of Ontario he directed the preparation of the Toronto-Centred Region development concept (1970). This project planned the human settlement patterns in the area around Toronto, attempting to come to grips with many major areas of public policies and programs.
- For the Government of New Brunswick he was involved in the establishment of the New Brunswick Housing Corporation, the introduction of the first comprehensive urban development policies for the province, and extensive involvement in federal-provincial negotiations.

EDUCATION

University of Alberta, B.A.(Hon.) Econ., 1966

University of Toronto, M.A. Economics, 1971

B-863
(Relate B-719)

May 18, 1988

TABLE 1

MAXIMUM LEACHATE MOUNDING HEADS BASED ON THE MOORE EQUATION

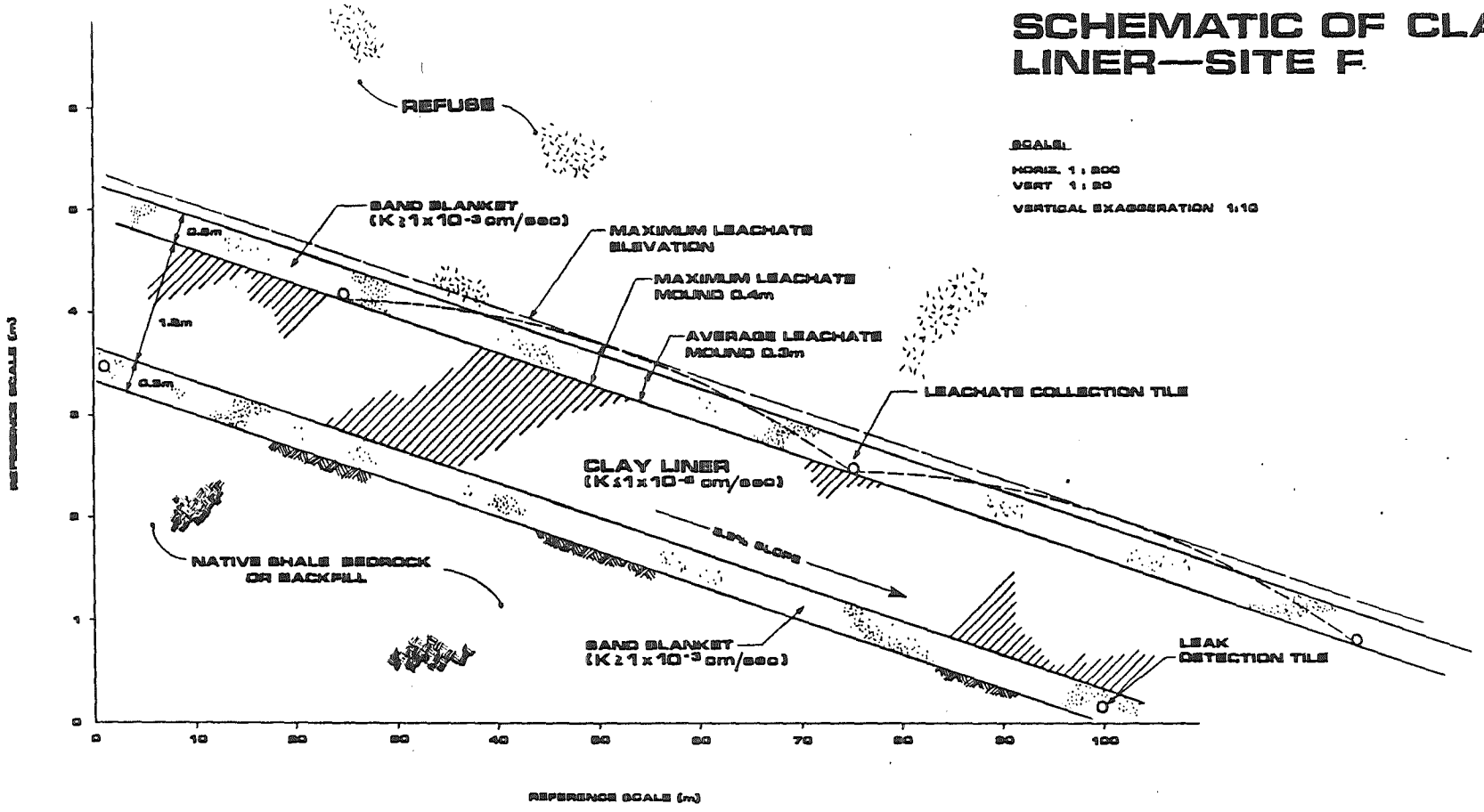
	Tile Spacing (m)	Slope (%)	Scenario 1	2	3	4	5	6	7	8
Hydraulic Conductivity (cm/sec)			0.01	0.001	0.0001	0.00001	0.01	0.001	0.0001	0.00001
Infiltration (mm/yr)			150	150	150	150	300	300	300	300
			Mounding Heads (m)							
Site D - CRA Design	20	0.5	0.043	0.178	0.643	2.132	0.067	0.266	0.928	3.035
	40	0.5	0.087	0.357	1.286	4.264	0.134	0.532	1.856	6.070
	60	0.5	0.130	0.535	1.929	6.396	0.201	0.798	2.784	9.105
	80	0.5	0.174	0.713	2.573	8.528	0.268	1.064	3.711	12.140
	100	0.5	0.217	0.891	3.216	10.660	0.335	1.329	4.639	15.176
	200	0.5	0.435	1.783	6.432	21.321	0.670	2.659	9.278	30.351
	480	0.5	1.043	4.278	15.436	51.170	1.607	6.381	22.268	72.843

Note: To calculate the average leachate head between tiles, multiply the above numbers by the factor 0.785 (refer to Exhibit M-442, page 17)

B 864

SCHEMATIC OF CLAY LINER—SITE F

SCALE:
HORIZ. 1 : 200
VERT 1 : 20
VERTICAL EXAGGERATION 1:10



The Corporation of the City of Burlington

HALTON ENVIRONMENTAL ASSESSMENT

SCHEMATIC OF CLAY LINER — SITE F

CRA Consulting Engineers
CONESTOGA-ROVERS & ASSOCIATES LIMITED
651 Colby Drive, Waterloo, Ontario Canada N2V 1C2

1354-10

HYPOTHETICAL GROUND WATER INSTALLATIONS

M-729

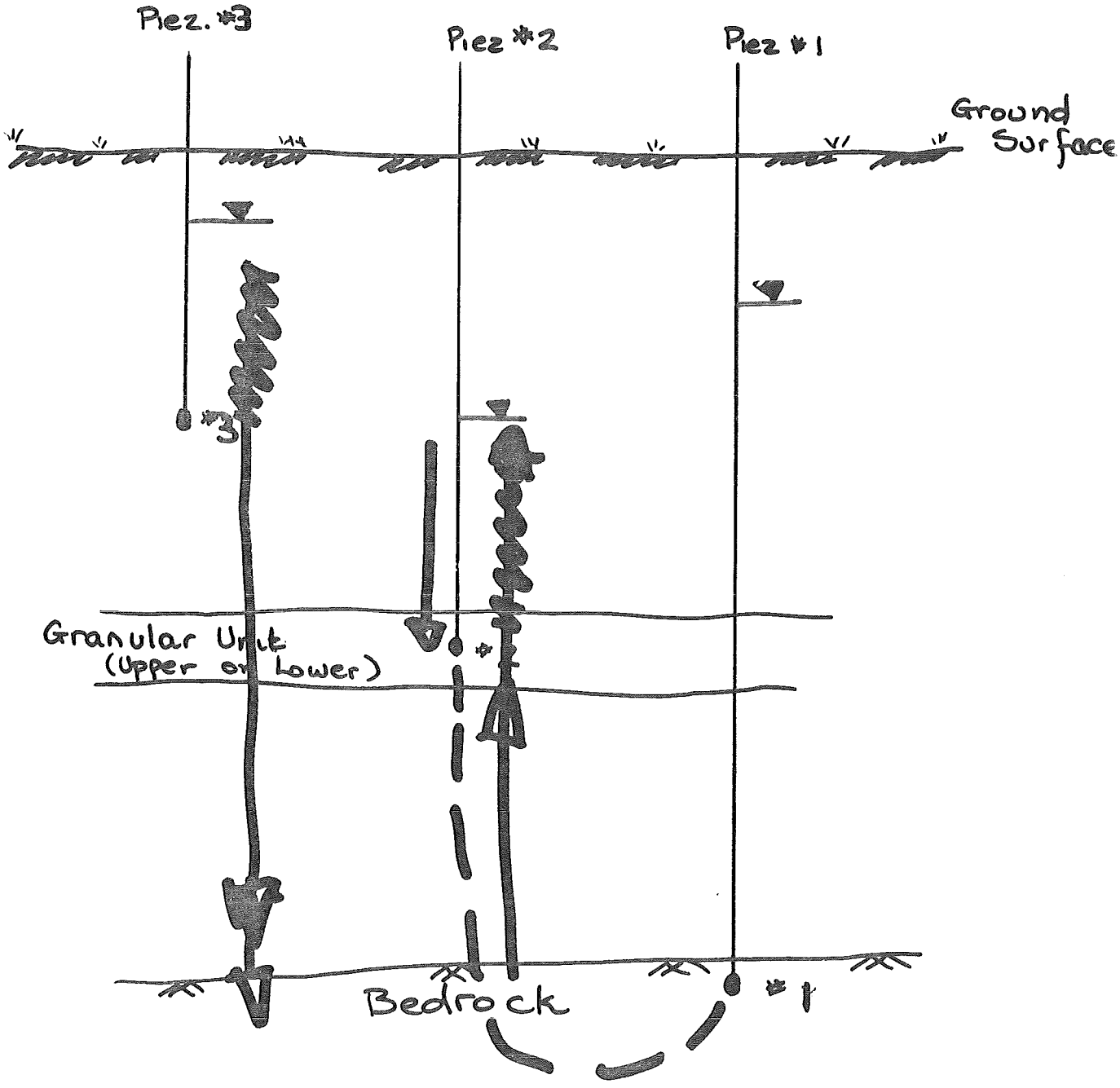


Exhibit H-841B.

ASSESSMENT RATIOS

	1981	1985
BURLINGTON	75:25	74:26
OAKVILLE	69:31	71:29
HALTON HILLS	76:24	76:24
MILTON	78:22	77:23
MISSISSAUGA	69:31	66:34
BRAMPTON	68:32	67:33
CALEDON	89:11	89:11

SOURCE: MINISTRY OF MUNICIPAL AFFAIRS: 'SUMMARY OF MUNICIPAL STATISTICS'

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Exhibit H-842

WASTE/CAPITA RATIOS FOR REGIONALLY-MANAGED WASTES IN ONTARIO

	Population (1986 Census unless stated)	Regionally-Managed Waste (tons)	Tons/ Capita	Index
Haldimand-Norfolk Region[3]	88,400 (1985)	71,773	.812	93.1
Halton Region[4]	271,389	236,738	.872	100.0
Hamilton-Wentworth Region[5]	423,398	371,200	.877	100.6
Durham Region[2]	326,179	293,891	.901	103.3
Ottawa-Carleton Region[7]	606,639	549,497	.906	103.9
Waterloo Region[9]	306,012 (1982)	279,128	.912	104.6
Niagara Region[6]	370,132	342,370	.925	106.1
York Region[10]	350,602	330,750	.943	108.1
Peel Region[8]	565,871 (1985)	656,716	1.161	133.1
Metropolitan Toronto[1]	2,192,721	2,809,280	1.281	146.9

FOOTNOTES:

1 2,548,100 tonnes x 1.1025 = 2,809,280 tons
Metro Table 5.16.

2 253,240 tonnes divided by 0.95 to give total waste = 266,568 tonnes x 1.1025 = 293,891 (Metro p. 46 and Table 2.9).

3 65,100 x 1.1025 = 71,773 tons
Proctor & Redfern, Table 7-5.

4 214,~~728~~ 515 tonnes x 1.1025 = 236,~~738~~ 503 tons

5 single spread sheet table: 305,885.6 x 1.1025 = ~~371,200~~ 337,239 tons

6 310,540 tonnes x 1.1025 = 342,370 tons
Gore & Storrie, Table 4-3.

7 498,410 tonnes x 1.1025 = 549,497 tons
MacLaren, Table 3.13.

8 345,946 x 249,715 = 595,661 tonnes x 1.1025 = 656,716 tons

9 156,836 + 96,341 = 253,177 tonnes x 1.1025 = 279,128 tons
MacLaren, Tables 2.4 and 2.3. Population from Table 2.1.

10 300,000 tonnes x 1.1025 = 330,750 tons

Exhibit H-843

COMPONENT 4:

SOLID WASTE MANAGEMENT SYSTEM INVENTORY

DISCUSSION PAPER NO. 4.1

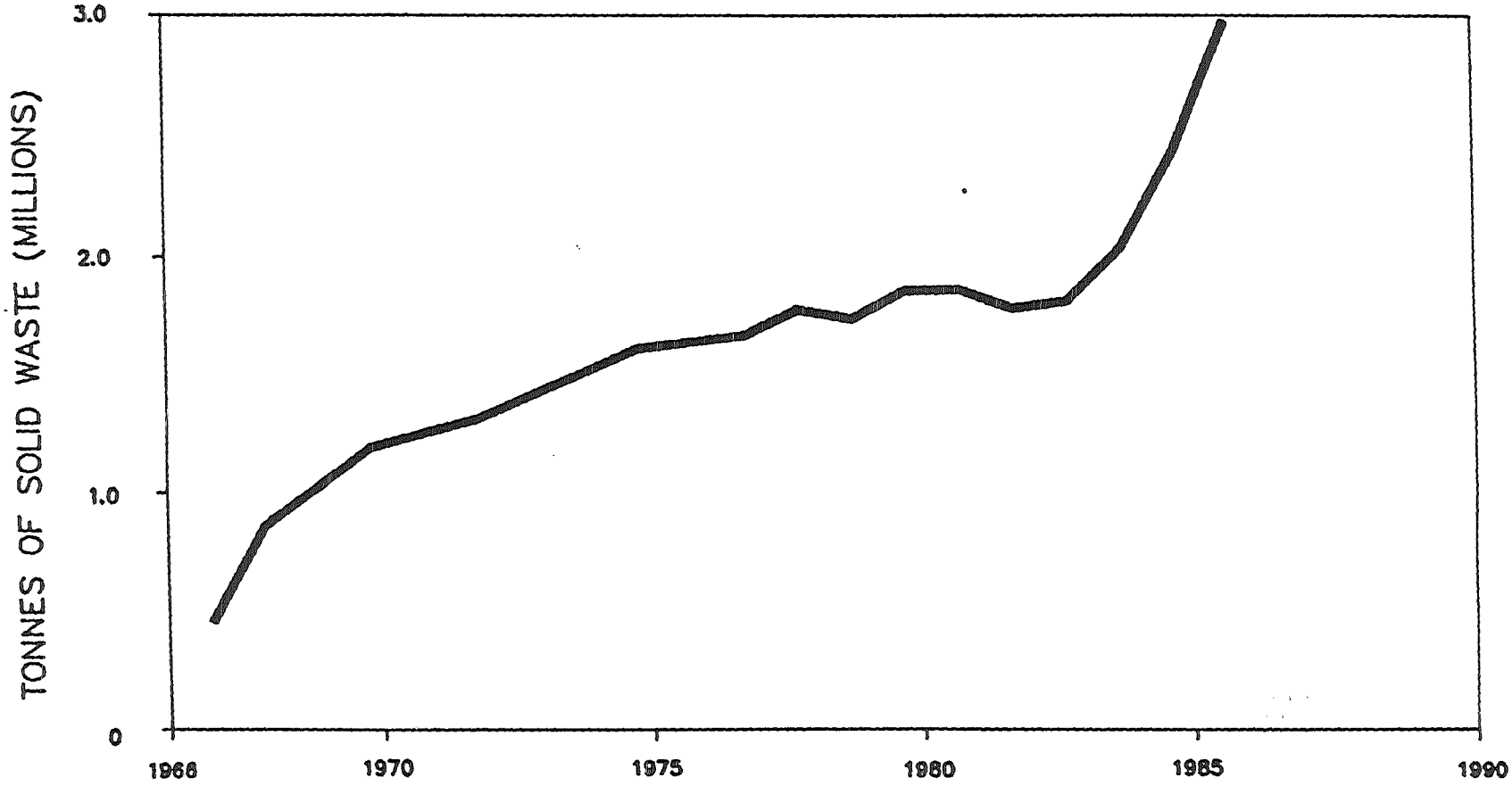
SOLID WASTE MANAGEMENT SYSTEM INVENTORY, BASE YEAR 1986

METROPOLITAN TORONTO
DEPARTMENT OF WORKS
REFUSE DISPOSAL DIVISION

February, 1988

FIGURE 2.1

ANNUAL TOTALS OF SOLID WASTE MANAGED BY METROPOLITAN TORONTO



SOURCE : METROPOLITAN TORONTO

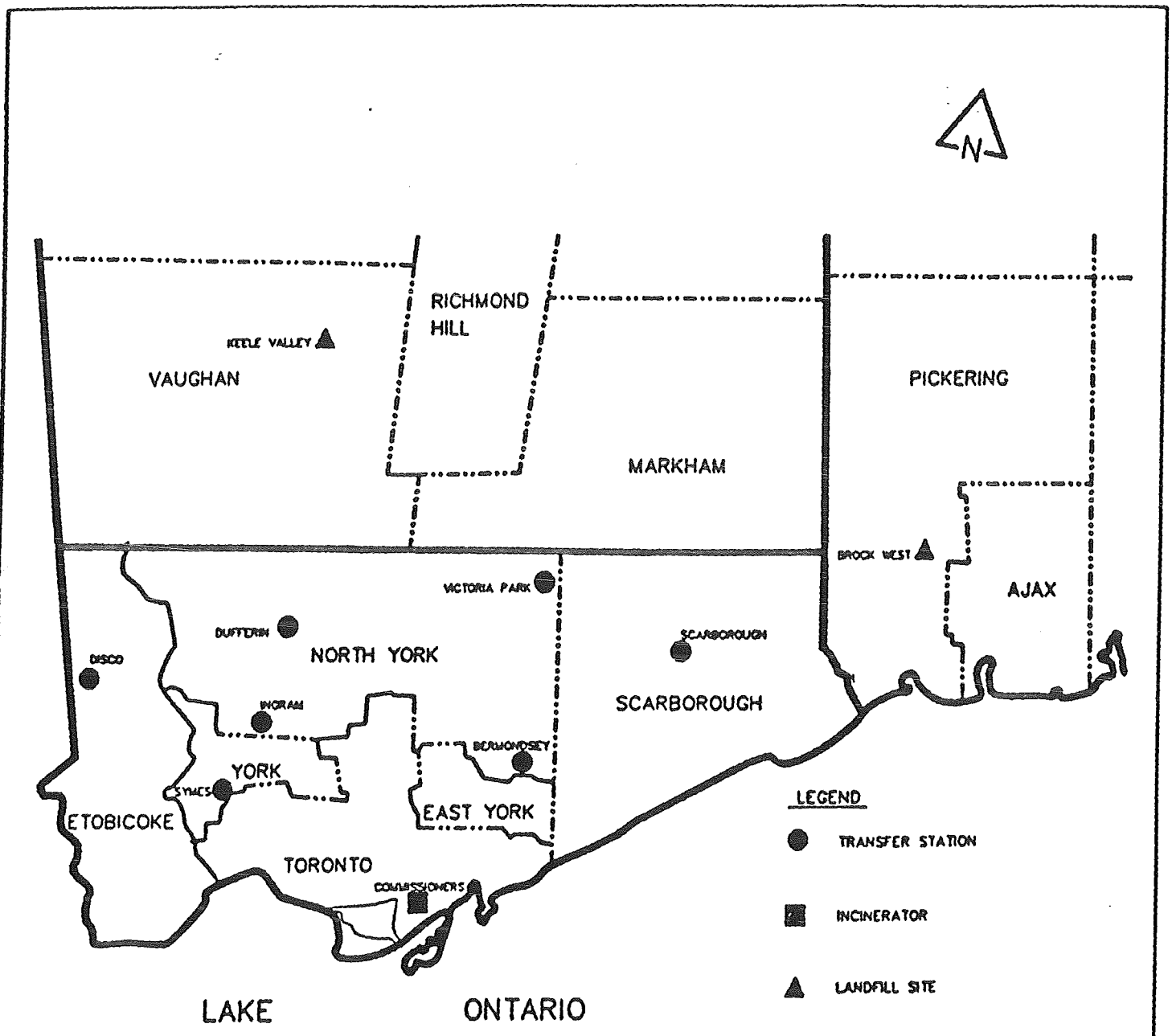


FIGURE 2.2
METROPOLITAN TORONTO
WASTE MANAGEMENT FACILITIES

DATE: JANUARY 1988

SCALE: NOT TO SCALE

DRAWING No.
1600 - 3019

TABLE 2.4

SOURCES AND DISTRIBUTION OF SOLID WASTE HANDLED BY METROPOLITAN TORONTO TRANSFER STATIONS
(1986)

SOURCE	TRANSFER STATIONS								TOTAL
	BERM.	DISCO	INGRAM	SYMES	VICT.PK.	DUFF.	SCARB.	COMM.	T/STNS
PRIVATE(PD)	46,833	85,428	95,782	5,693	31,325	54,482	64,538		384,081
EAST YORK	32,070							295	32,365
ETOBICOKE		113,227	7,434						120,661
NORTH YORK	33,132		44,573		66,078	80,122	9		223,914
SCARBOROUGH	32,228				19,610		92,018		143,856
TORONTO	46,013		84,683	77,575				6,102	214,373
YORK			42,358	15,135					57,493
METRO	608	409	5,160	554	5	20	317		7,073
OTHER(UNPD)	6,902	1,396	31,687	662	2,461	162	14,074		57,344
TOTAL TONNES	197,786	200,460	311,677	99,619	119,479	134,786	170,956	6,397	1,241,160

SOURCE: METROPOLITAN TORONTO WORKS DEPARTMENT REFUSE DISPOSAL DIVISION, 1986 ANNUAL REPORT

NOTES: (1) PRIVATE (PAID) INCLUDES COMMERCIAL/INDUSTRIAL SOLID WASTE, ALSO SOME MUNICIPAL WASTE FROM REGIONS OF DURHAM AND YORK

(2) METRO; DENOTES SOLID WASTE RECEIVED FROM METROPOLITAN CORPORATION DEPARTMENTS

(3) OTHER (UNPAID); DENOTES SOLID WASTE FROM LOCAL BOARDS WITHIN METROPOLITAN TORONTO, WHICH IS ACCEPTED WITHOUT CHARGE; ALSO INCLUDES MUNICIPAL SOLID WASTE RECEIVED FROM SMALL VEHICLES, HAVING A GROSS VEHICLE WEIGHT OF LESS THAN 3,000 kg. (e.g. HOUSEHOLDERS)

The quantity of solid waste managed by Metro facilities during the period 1977 to 1986 is summarized in Table 2.5. The quantity managed between 1967 and 1986 is illustrated in Figure 2.1. From 1984 to 1986, there was a significant increase in the solid waste handled at Metro's solid waste management facilities. This increase may be attributed to an overall rise in economic conditions, as well as other factors including:

- the closure in recent years of a number of landfills in Durham and York (e.g., Town of Aurora Landfill, Whitchurch-Stouffville Landfill, Town of Vaughan Landfill, Darlington Landfill);
- the increased residential, commercial, and industrial growth in Durham and York;
- an increase in the per capita municipal solid waste generation rate for Metro, Durham, and York;
- an increase in the commercial/industrial per employee solid waste generation rate in Metro, Durham, and York; and
- higher tipping fees in the Regions of Peel and Halton.

2.2 Description of Metropolitan Toronto Solid Waste Management Facilities

2.2.1 Landfill Sites

Brock West Landfill

The Brock West Landfill site, located in the Town of Pickering in Durham, west of Brock Road, north of Concession 3, was opened in 1975. The total area of the site is about 125 hectares, of which 65 hectares

TABLE 2.5

ANNUAL TOTAL SOLID WASTE
MANAGED AT METROPOLITAN TORONTO WORKS
DEPARTMENT FACILITIES

YEAR	MUNICIPAL** SOLID WASTE COLLECTED	SOLID WASTE COLLECTED* BY PRIVATE HAULERS	TOTAL SOLID WASTE MANAGED
1977	876,251	659,381	1,860,471
1978	846,085	635,130	1,841,364
1979	867,497	604,706	1,821,135
1980	861,271	697,596	1,949,591
1981	872,046	707,635	1,942,141
1982	885,050	603,961	1,830,352
1983	872,943	597,164	1,851,914
1984	910,315	852,703	2,064,805
1985	946,984	1,288,587	2,484,605
1986	1,007,243	1,692,760	2,989,896

SOURCE: METROPOLITAN TORONTO WORKS DEPARTMENT REFUSE DISPOSAL DIVISION, 1986 ANNUAL REPORT

*TOTALS INCLUDE SOME MUNICIPAL SOLID WASTE MANAGED BY PRIVATE CONTRACTORS, ON BEHALF OF CERTAIN AREA MUNICIPALITIES WITHIN THE AREA OF STUDY

**TOTALS DO NOT INCLUDE SOLID WASTE RECEIVED FROM METROPOLITAN TORONTO DEPARTMENTS, LOCAL BOARDS, ETC.

have been designated for landfilling. The remaining area consists of service areas, buffer zones, and a perimeter drainage network accommodating surface water run-off from the site.

The landfill is operated from 7 a.m. to 6 p.m., Monday to Friday, and from 7 a.m. to 12:30 p.m. on Saturdays. Personnel employed at the site in 1986, consisted of 1 works supervisor (grade 1), 2 works supervisors (grade 2), 1 works foreman, 1 engineer, 4 heavy equipment operators, 1 truck driver, 5 landfill site controllers, 4 labourers, 4 weighmasters, and 1 maintenance man. There is, as well, one Ministry of the Environment inspector on site.

Metro operates the site under Provisional Certificate of Approval No. A390402 which allows for domestic, commercial, non-hazardous solid industrial waste, as well as dewatered sewage sludge (from the Humber Sewage Treatment Plant) and incinerator ash to be deposited at the site. The landfill receives solid waste primarily from Metro and Durham (principally from the Towns of Ajax, Pickering, Whitby, and the City of Oshawa). Some waste is also received from the Region of York. During 1986, Metro transfer vehicles hauled wastes received at the Scarborough, Victoria Park, and Bermondsey Transfer Stations to the Brock West Landfill. As of December 31, 1986, the Brock West site had received approximately 11,200,000 tonnes of solid waste. Based on the current rate of landfilling (i.e., taking into account diversion of waste to the Keele Valley site from the Victoria Park and Bermondsey Transfer Stations), it is expected that the site will be filled by 1991.

Computerized electronic weighscales, located 0.7 km from the site entrance, record the weight of the incoming solid waste.

Keele Valley Landfill

The Keele Valley Landfill site is located in the Town of Vaughan in

Victoria Park Transfer Station

The Victoria Park Transfer Station is located at the southwest corner of McNicoll Avenue and Victoria Park Avenue in the City of North York. Its hours of operation are 7 a.m. to 4 p.m., Monday to Friday. The plant staff consists of 1 works supervisor, 1 works foreman, 1 maintenance man, 4 heavy equipment operators, 6 refuse plant operators, 2 labourers, and 2 weighmasters.

The facility receives municipal waste from the Cities of North York and Scarborough, as indicated in Table 2.4 and Figure 2.3, as well as commercial and industrial waste from private haulage contractors. The site is operated under Provisional Certificate of Approval No. A280707.

The weight of incoming solid waste is recorded on computerized electronic weighscales. Waste collection vehicles discharge their loads onto a tipping floor where a bulldozer feeds the waste into one of four hoppers located on top of hydraulic compaction units. The waste is then pushed into open-ended fully enclosed transfer trailers each having a capacity of $57m^3$ with a 20 tonne payload. The waste was hauled to the Brock West Landfill site in 1986. The Victoria Park Transfer Station utilizes tractors and trailers, supplied under contract by a private hauler.

2.3 Description of The Region of Durham Solid Waste Management Facilities

According to the Regional Municipality of Durham Act, R.S.O., 1982, Section 144(2), the Regional Council of Durham is "to provide facilities for the purpose of receiving, dumping, and disposing of waste and no area municipality shall provide such facilities". In addition, Section 144(7) states that:

> "All waste facilities and lands of a local municipality, to the extent that they were used for the purposes of receiving, dumping and disposing of waste on the 1st day of January, 1974, are vested in the Regional Corporation without compensation".

In this regard, Durham is required to provide waste management facilities for the Region to handle solid waste generated in the area. A list of the waste management facilities operated in Durham in 1986, and associated operating costs, is summarized in Table 2.7. As well, a recycling centre was operated in the City of Oshawa in 1986.

The Region of Durham (established in 1974) is composed of eight Area Municipalities; Ajax, Brock, Newcastle, Oshawa, Pickering, Scugog, Uxbridge, and Whitby. Collection of domestic solid waste in the Towns of Ajax, Newcastle, Pickering, Whitby, and the City of Oshawa is performed by area municipal fleets. Domestic solid waste is disposed of by area residents and/or by private haulage contractors in the Townships of Scugog and Uxbridge. Private waste management firms service major commercial and industrial establishments throughout the Region.

Approximately 95% of the total solid waste generated in Durham in 1986, was landfilled. It has been estimated that about 3 to 4% of the municipal waste stream was recycled.[1] Details of the landfill sites operated in the Region are provided in Table 2.8. Metro's Brock West Landfill accepted about 69% of the solid waste generated in Durham in 1986 (Table 2.9). In addition, the site received 5,910 tonnes of ash

---

[1] Metropolitan Toronto Department of Works, "Status Report on Solid Waste Reduction and Recycling"; December, 1987, p.30.

TABLE 2.7

REGIONAL MUNICIPALITY OF DURHAM
WASTE MANAGEMENT FACILITIES
OPERATING COSTS
(1986)

WASTE MANAGEMENT FACILITY	OPERATING COSTS 1986
1) LANDFILL SITES	
BROCK	$77,739.00
DARLINGTON	$212,482.00
HALE	N/A
SCOTT	$48,484.00
SCUGOG	$230,392.00
UXBRIDGE	$155,266.00
2) TRANSFER STATIONS	
CARTWRIGHT	$39,575.00
OSHAWA	$377,961.00
3) OTHER	$2,911,515.00*
TOTAL EXPENDITURE	$4,053,414.00

SOURCE: DURHAM REGION WORKS DEPARTMENT (1987)
*INCLUDES LANDFILL SITE PAYMENTS TO METROPOLITAN TORONTO

TABLE 2.8

REGIONAL MUNICIPALITY OF DURHAM
LANDFILL SITES OPERATED
IN 1986

LANDFILL/ LOCATION	AREA LICENSED FOR SOLID WASTE DISPOSAL	SOLID WASTE TONNAGE DISPOSED IN 1986 (TONNES)	OWNER/ OPERATOR	ESTIMATED SITE CAPACITY FROM JANUARY, 1988
BROCK LANDFILL (TOWNSHIP OF BROCK)	40.5 HECTARES	5,200	DURHAM REGION	25 YRS
DARLINGTON LANDFILL (TOWN OF NEWCASTLE)	8.1 HECTARES	17,240	DURHAM REGION	CLOSED IN AUG., 1987
HALE LANDFILL (TOWN OF NEWCASTLE)	8.1 HECTARES	40,000*	PRIVATE OWNER	1-2 YRS
SCOTT LANDFILL (TOWNSHIP OF SCOTT)	1.62 HECTARES	1,900	DURHAM REGION	2 - 5 YRS
SCUGOG LANDFILL (TOWNSHIP OF SCUGOG)	20.2 HECTARES	9,120	DURHAM REGION	2 - 4 YRS
UXBRIDGE LANDFILL (TOWNSHIP OF UXBRIDGE)	20 HECTARES	5,990	PRIVATE OWNER	2 - 3 YRS

SOURCE: INFORMATION BASED ON MINISTRY OF THE ENVIRONMENT RECORDS (1983) AND DISCUSSIONS WITH DURHAM REGION OFFICIALS

*TONNAGE BASED ON THAT REPORTED IN WASTE MANAGEMENT STUDY - THE REGIONAL MUNICIPALITY OF DURHAM; MAY, 1985, BY MacLAREN ENGINEERS

TABLE 2.9

TOTAL SOLID WASTE QUANTITIES MANAGED
IN REGION OF DURHAM
(1986)

LANDFILL SITE	SOLID WASTE SOURCE/TYPE		WASTE DEPOSITED (TONNES)
BROCK WEST	AJAX		14,507
	PICKERING		15,426
	OSHAWA		43,992
	WHITBY		16,167
	COMMERICIAL/INDUSTRIAL		83,704
		SUB-TOTAL	173,796
DARLINGTON	NEWCASTLE		4,905
	OSHAWA TRANSFER STA.		80
	CARTWRIGHT TRANSFER STA.		1,907
	COMMERCIAL/INDUSTRIAL		10,345
		SUB-TOTAL	17,237
SCUGOG	SCUGOG		3,038
	OSHAWA TRANSFER STA.		699
	COMMERCIAL/INDUSTRIAL		5,381
		SUB-TOTAL	9,118
HALE	NEWCASTLE REGION OF NORTHUM- BERLAND	SUB-TOTAL	40,000
SCOTT	---	SUB-TOTAL	1,900
BROCK	---	SUB-TOTAL	5,200
UXBRIDGE	---	SUB-TOTAL	5,989
TOTAL SOLID WASTE DEPOSITED IN REGION OF DURHAM IN 1986		GRAND TOTAL	253,240 TONNES

SOURCE: REGION OF DURHAM WORKS DEPARTMENT (1987)

residue from the Duffin Creek sewage treatment plant, located in the Town of Pickering.

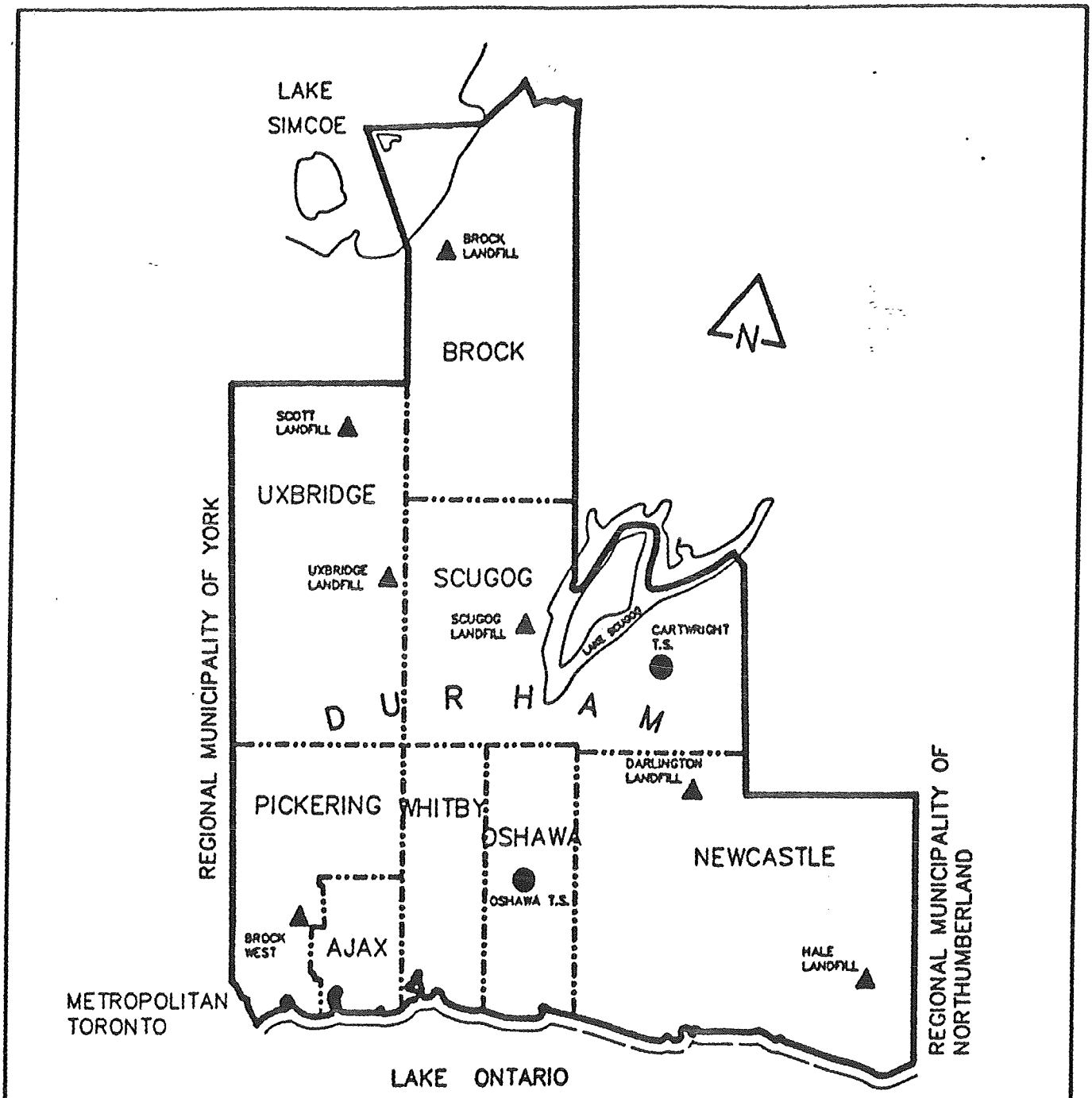
The waste management facilities operated in Durham in 1986 are shown in Figure 2.4. In addition to Metro's Brock West Landfill, there were six other sites operated in 1986, in Durham. During 1986, the Darlington Landfill, located in the Town of Newcastle, received about 7% of the total solid waste generated in the Region from the Town of Newcastle. The Hale Landfill accepted an estimated 40,000 tonnes of solid waste, of which about 10% originated outside the Region. The remaining landfill sites, shown in Table 2.8, received municipal and light commercial solid waste primarily from the Area Municipalities in which they are located.

There are two transfer stations in Durham; the Cartwright Transfer Station and the Oshawa Transfer Station. During 1986, the two transfer stations (facilities shown in Figure 2.4) handled a combined total of about 10,900 tonnes of municipal, commercial, and industrial solid waste (Table 2.9). In a two month study conducted in the summer of 1987 at the Oshawa Transfer Station, it was estimated that almost 60% of the solid waste handled at the facility originated from the City of Oshawa, approximately 25% from the Town of Whitby and 10% from the Town of Newcastle. The solid waste handled at the Cartwright Transfer Station was generated primarily in the Township of Scugog.

In 1986, Durham operated a recycling centre in the Town of Whitby. The centre has been in operation since 1976 and co-ordinates recycling programmes operating in the Towns of Ajax, Newcastle, Pickering, Whitby, and the City of Oshawa.

2.4 Description of The Region of York Solid Waste Management Facilities

Under Section 169, Subsection (2) of the Regional Municipality of York



LEGEND

- LANDFILL SITE
- TRANSFER STATION
- AREA MUNICIPAL BOUNDARY
- REGIONAL MUNICIPAL BOUNDARY

FIGURE 2.4
WASTE MANAGEMENT FACILITIES
IN THE REGION OF DURHAM

DATE: JANUARY 1988

SCALE: NOT TO SCALE

DRAWING No.
1600 – 301(

Act R.S.O., 1980, the Regional Corporation:

> "Shall provide facilities for the receiving dumping, and disposing of waste, and no such facilities shall be provided in the Regional Area by any person or any municipality including a metropolitan or regional municipality, or by any local board thereof, without the consent of the Regional Council".

However, the document also indicates that the approval of the Area Municipality or the Ontario Municipal Board must be provided (Clause 169, Subsection (8)) for the Regional Council to operate a waste management facility in a particular Area Municipality.

In 1986, a total of three landfills were operated in York. They are shown in Figure 2.5 and described in Table 2.10. The two municipally-owned landfill sites in King Township disposed of all solid wastes generated within the Township. The Schomberg site received mainly solid waste from the western portion of the Township with the Holland landing site accepting solid waste originating from the eastern part of the Township. It is estimated that the two landfill sites received an estimated combined total of approximately 7,000 tonnes of municipal and light commercial solid waste in 1986. Weighscales are not employed at these facilities. Estimated total tonnages of solid waste were based upon waste collection vehicle load counts.

The Town of Georgina reported that the Georgina Landfill site managed about 15,000 tonnes of solid waste in 1986 composed of 65% to 70% domestic waste, 20% to 25% bulky material, and 10% commercial/industrial waste. The landfill primarily services the Town

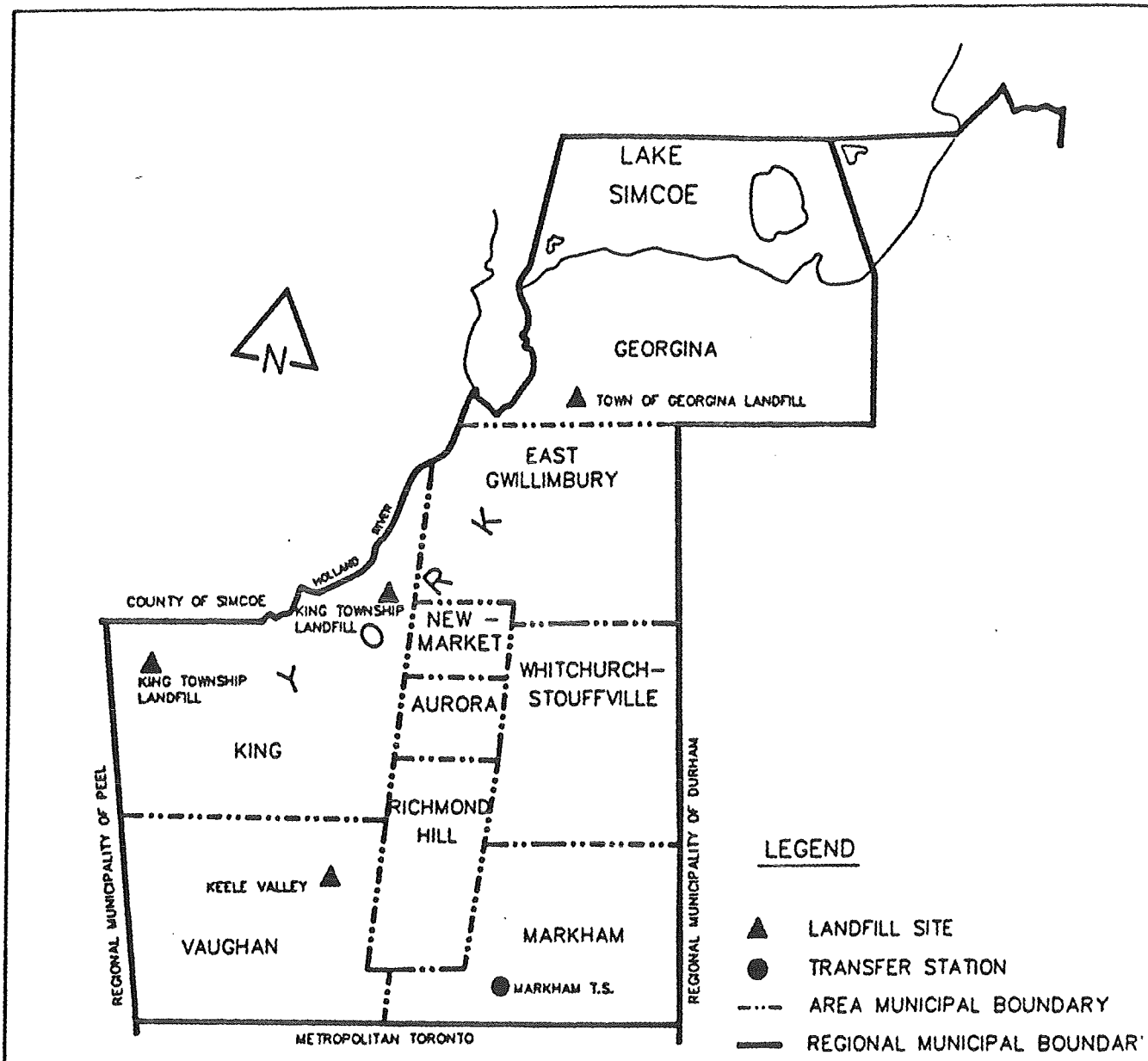


FIGURE 2.5
WASTE MANAGEMENT FACILITIES
IN THE REGION OF YORK

DATE: JANUARY 1988

SCALE: NOT TO SCALE

DRAWING No.
1600 – 301

TABLE 2.10

REGIONAL MUNICIPALITY OF YORK
LANDFILL SITES OPERATED
IN 1986

LANDFILL SITE/LOCATION	OWNER/OPERATOR	TOTAL AREA OF LANDFILL
KING TOWNSHIP (near Schomberg)	Township of King	2.9 Hectares
KING TOWNSHIP (near Holland Landing)	Township of King	3.1 Hectares
TOWN OF GEORGINA	Town of Georgina/ Private Sector Operator	10 Hectares

SOURCE: YORK REGION AREA MUNICIPAL WORKS DEPARTMENTS

NOTE: KEELE VALLEY LANDFILL SITE OPERATED IN YORK REGION BY METROPOLITAN TORONTO DEPARTMENT OF WORKS

of Georgina. Approximately 1% of the waste received at the Georgina Landfill was reported as having originated from outside the municipality. The landfill site capacity is expected to be reached by 1990.

During 1986, solid waste generated in the remaining seven York Area Municipalities was delivered to the Keele Valley Landfill site. Domestic solid waste collection was provided primarily by private haulers under contract to the various Area Municipalities. Solid waste collection, from commercial and industrial establishments, was performed by private haulers under contract to commercial and industrial generators in the Region.

In 1986, one privately-owned transfer station, the Markham Transfer Station, was operated in York Region. The transfer station is located in the Town of Markham, near Woodbine and Steeles Avenue. The operator reported that the facility handled approximately 500 tonnes of commercial and industrial solid waste per day in 1986. The operator also provides residential curbside solid waste collection for the Towns of Vaughan, Markham, and Richmond Hill. It was reported by the operator that the Markham Transfer Station handles a portion of the collected domestic waste which is subsequently hauled to the Keele Valley Landfill for disposal.

- o Corrugated Cardboard
- o Brush
- o Construction Rubble
- o Asbestos
- o Metal

* Sewage Sludge was only accepted at the Brock West Landfill site.

5.3 SOLID WASTE UNIT GENERATION AREAS

The Study Area was divided into smaller unit areas to facilitate the collection of data pertaining to population, employment and solid waste generation. This information is required to assist in the evaluation of the alternate solid waste management approaches within the Study Area.

Accordingly, the Study Area has been divided into solid waste collections zones, hereafter referred to as unit generation areas (U.G.A.'s). Metro has been divided into 18 U.G.A.'s, Durham has been divided into 8 U.G.A.'s and York has been divided into 9 U.G.A.'s.

The solid waste unit generation areas are shown on Figures 5.1 and 5.2 for Metro, Durham, and York. Metro's U.G.A.'s (Figure 5.1) coincide with area municipal solid waste collection districts and municipal boundaries. The U.G.A.'s for Durham and York (Figure 5.2) correspond to area municipal boundaries.

5.4 Municipal Solid Waste Generation

5.4.1 Metropolitan Toronto

Municipal waste generation for Metro's Area Municipalities, for the period between 1977 and 1986, are reported in Table 5.2. These data indicate that waste generation did not change significantly between 1977 and 1984. An increase in municipal waste generation occurred in 1985 and in 1986. A recent study [3] reported that between 1970 and 1984, municipal waste generation rates increased from 0.40 tonnes/cap/year to 0.51 tonnes/cap/year in the United States. Municipal waste generation rates are shown in Table 5.3 for Metro's Area Municipalities for the time interval 1977 to 1986.

Seasonal municipal waste generation, from Metro's weighscale records, generally indicates that waste generation is at its minimum during the months of January and February and at its maximum during the Spring and Autumn months. These higher levels may be attributed to the collection of yard wastes and "spring cleaning".

The total amount of municipal solid waste originating from Metro was estimated to be approximately 1,252,000 tonnes. This municipal waste was managed as follows:

o	Solid waste handled at Metro Transfer Stations prior to ultimate landfill disposal	921,618 Tonnes * (Table 2.6)
o	Solid waste hauled directly to Metro Landfill Sites	207,986 Tonnes **
o	Solid waste incinerated	122,925 Tonnes
	Total Municipal Solid Waste	1,252,529 Tonnes

[3] Franklin Associates Ltd., Characterization of Municipal Solid Waste in the United States, 1960 to 2000, Final Report; July, 1986.

* Includes 64,176 Tonnes Apartment Waste Collected by Private Haulers.

** Includes 43,485 Tonnes of Incinerator Ash and 61,611 Tonnes of Sludge.

Domestic waste generation rates for 1986 are shown in Tables 5.4 to 5.9 for Metro's Area Municipalities. The waste generation rates ranged from 0.38 to 0.49 tonnes/cap/year. Domestic waste generation rates for Metro's unit generation areas are summarized in Table 5.10. The domestic waste generation rate for Metro was determined to be 0.44 tonnes/cap/year in 1986.

5.4.2 Region of Durham

Previous waste management studies [4] for Durham have indicated generally lower total solid waste generation rates than Metro. This is not unusual since rural areas tend to exhibit lower waste generation rates than urban areas. During the period between 1980 and 1985, it is estimated, from previous studies and from Metro's weighscale records, that Durham generated approximately 100,000 tonnes of domestic solid waste per year.

During 1986, it was determined that Durham's Area Municipalities generated about 116,000 tonnes of domestic waste. Domestic waste generation factors for the various Area Municipalities are reported in Table 5.11. The values ranged from 0.32 to 0.40 tonnes/cap/year. The domestic waste generation factor for Durham was determined to be 0.36 tonnes/cap/year.

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[4] MacLaren Engineers in Association with Resource Integration Systems Ltd., Waste Management Study - The Regional Municipality of Durham; May, 1985.

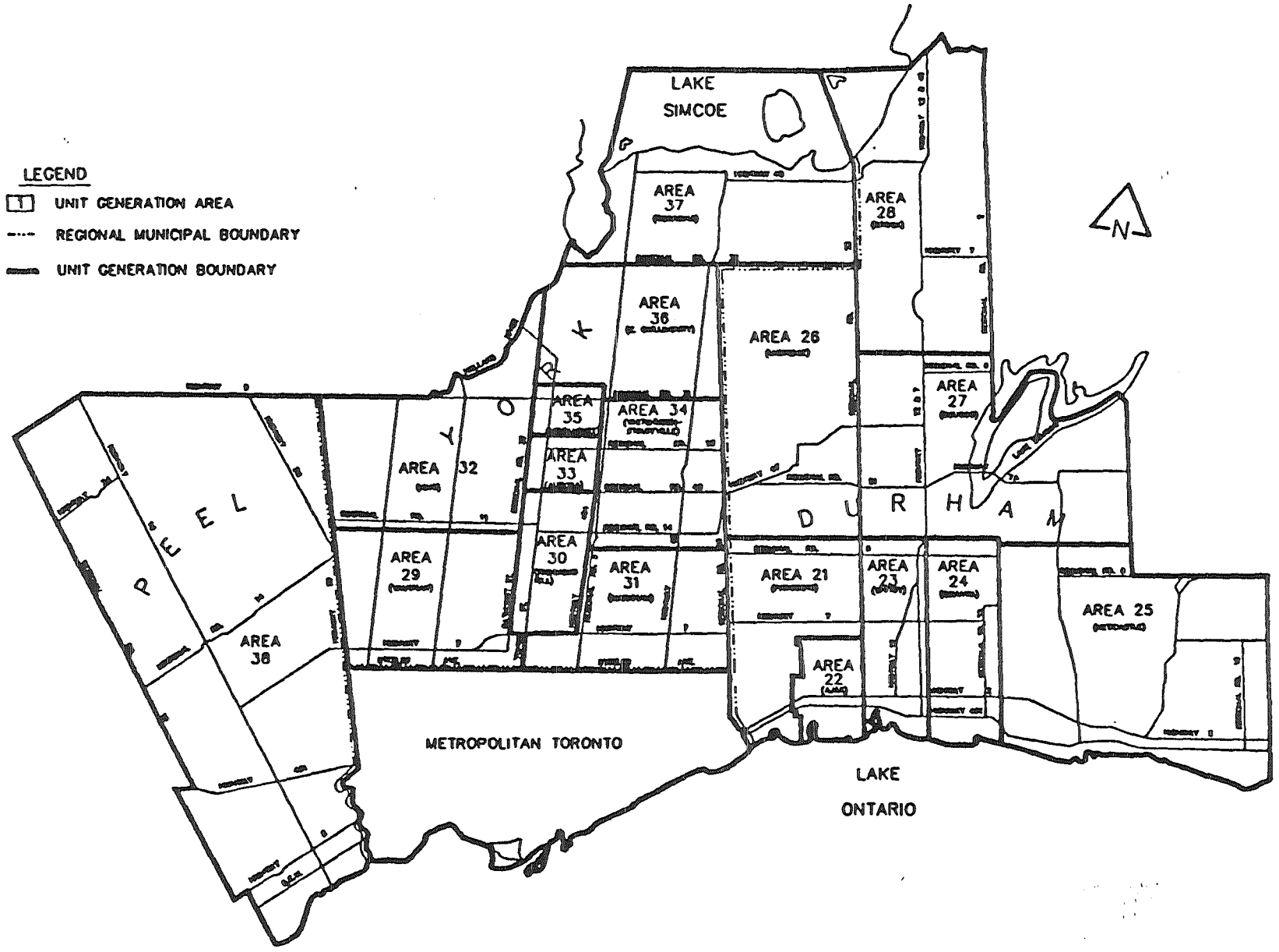


FIGURE 5.2
SOLID WASTE ENVIRONMENTAL ASSESSMENT PLAN
UNIT GENERATION AREAS WITHIN DURHAM AND YORK

DATE: JANUARY 1988
SCALE: NOT TO SCALE
DRAWING No. 1600 - 3012

TABLE 5.2

METROPOLITAN TORONTO MUNICIPAL SOLID WASTE GENERATION*
BY AREA MUNICIPALITY

AREA MUNICIPALITY	TONNES									
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
EAST YORK	38,877	37,151	41,736	42,156	42,873	44,144	43,501	44,155	42,885	49,316
ETOBICOKE	110,667	104,403	115,984	110,198	104,110	112,856	112,069	112,691	132,770	135,167
NORTH YORK	208,746	198,193	199,478	200,988	204,330	202,195	200,665	207,708	213,047	236,633
SCARBOROUGH	149,618	148,122	157,368	164,188	172,596	167,053	163,915	174,223	179,948	184,255
TORONTO	308,365	300,371	293,708	285,379	294,796	301,495	295,937	307,624	314,000	335,225
YORK	59,978	57,845	59,223	58,362	53,341	57,307	56,856	63,914	64,334	66,647
TOTAL MUNICIPAL SOLID WASTE (TONNES)	876,251	846,085	867,497	861,271	872,046	885,050	872,943	910,315	946,984	1,007,243

SOURCE: METROPOLITAN TORONTO WORKS DEPARTMENT REFUSE DISPOSAL DIVISION ANNUAL REPORTS

*TOTALS INCLUDE STREET SWEEPINGS, CATCH BASIN CLEANINGS BUT DO NOT INCLUDE SOLID WASTE RECEIVED FROM METROPOLITAN DEPARTMENTS, LOCAL BOARDS, ETC.

TABLE 5.3

ESTIMATED PER CAPITA MUNICIPAL*
SOLID WASTE GENERATION RATE
FOR METROPOLITAN TORONTO AREA MUNICIPALITIES

AREA MUNICIPALITY	TONNES/CAP/YEAR									
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
EAST YORK	0.38	0.36	0.41	0.42	0.43	0.44	0.44	0.45	0.44	0.51
ETOBICOKE	0.38	0.36	0.40	0.38	0.35	0.38	0.38	0.38	0.45	0.46
NORTH YORK	0.37	0.36	0.36	0.36	0.37	0.36	0.36	0.37	0.38	0.43
SCARBOROUGH	0.38	0.37	0.38	0.38	0.40	0.38	0.37	0.39	0.39	0.40
TORONTO	0.47	0.47	0.46	0.45	0.48	0.49	0.50	0.52	0.52	0.57
YORK	0.44	0.43	0.44	0.44	0.41	0.43	0.42	0.48	0.48	0.50
METROPOLITAN TORONTO	0.40	0.39	0.41	0.41	0.41	0.41	0.41	0.43	0.44	0.48

SOURCE: METROPOLITAN TORONTO WORKS DEPARTMENT
REFUSE DISPOSAL DIVISION ANNUAL REPORTS

*TOTALS DO NOT INCLUDE SOLID WASTE RECEIVED FROM METROPOLITAN DEPARTMENTS, LOCAL BOARDS, ETC.

TABLE 5.10

METROPOLITAN TORONTO DOMESTIC WASTE GENERATION RATES

METROPOLITAN TORONTO UNIT GENERATION AREA	1986 POPULATION	DOMESTIC SOLID WASTE GENERATED IN 1986 (TONNES)	DOMESTIC WASTE GENERATION RATE (TONNES/CAP/YEAR)
EAST YORK	97,051	46,625	0.48
ETOBICOKE			
SOUTH ETOBICOKE	49,509	27,759	0.37
CENTRAL ETOBICOKE	173,063	74,338	0.43
NORTH ETOBICOKE	74,817	23,705	0.48
SUB-TOTAL	297,389	125,802	0.42
NORTH YORK			
BERMONDSEY	90,655	35,655	0.39
EMERY & FINCH	173,318	71,467	0.41
INGRAM	87,533	39,936	0.46
ORIOLE	96,031	45,269	0.47
NORTON	103,781	40,613	0.39
SUB-TOTAL	551,318	232,940	0.42
SCARBOROUGH			
ELLESMERE	114,372	46,193	0.40
MORNINGSIDE	116,990	42,014	0.36
NASHDENE	127,437	46,953	0.37
UPTON	98,942	40,058	0.40
SUB-TOTAL	457,741	175,218	0.38
TORONTO			
EAST TORONTO	192,539	95,531	0.50
NORTH TORONTO	123,182	64,444	0.52
NORTHWEST TORONTO (SYMES)	141,351	71,367	0.51
WEST TORONTO	133,955	59,304	0.44
SUB-TOTAL	591,027	290,646	0.49
YORK	132,673	57,298	0.43
METROPOLITAN TORONTO	2,127,199	928,529	0.44

SOURCE: METROPOLITAN TORONTO AREA MUNICIPALITY WORKS DEPARTMENTS (1986)

TABLE 5.11

DURHAM REGION DOMESTIC WASTE GENERATION RATES

DURHAM REGION UNIT GENERATION AREAS	1986 POPULATION	DOMESTIC SOLID WASTE GENERATED IN 1986 (TONNES)	DOMESTIC WASTE GENERATION RATE (TONNES/CAP/YEAR)
AJAX	36,550	14,500	0.40
BROCK	10,003	3,500	0.35
NEWCASTLE	34,073	13,000	0.38
OSHAWA	123,651	43,990	0.36
CKERING	48,959	15,430	0.32
SCUGOG	15,229	5,300	0.35
UXBRIDGE	11,895	4,000	0.34
WHITBY	45,819	16,160	0.35
DURHAM REGION	326,179	115,880	0.36

SOURCE: DURHAM REGION WORKS DEPARTMENT STAFF (1987)

TABLE 5.17

TOTAL SOLID WASTE MANAGED IN METROPOLITAN TORONTO AND REGIONS OF DURHAM AND YORK IN 1986

SOLID WASTE TYPE AND MANAGEMENT	TONNES
MUNICIPAL, COMMERCIAL, AND INDUSTRIAL SOLID WASTE INCINERATED AND LANDFILLED	3,177,840 (SEE TABLE 5.16)
MUNICIPAL SOLID WASTE RECYCLED	23,134*
COMMERCIAL AND INDUSTRIAL SOLID WASTE RECYCLED	1,500,000*
SOLID WASTE EXPORTED	83,500
ESTIMATED TONNAGE OF CLEAN FILL MANAGED	2,227,800**
ESTIMATED TOTAL	7,012,000 TONNES

*TONNAGES REPORTED IN DISCUSSION PAPER NO. 1.1 "STATUS REPORT ON SOLID WASTE REDUCTION AND RECYCLING", DECEMBER, 1987

**TONNAGE AS REPORTED BY TORONTO HARBOUR COMMISSION AND METROPOLITAN TORONTO REGIONAL CONSERVATION AUTHORITY STAFF (1987)

Exhibit 4 - 84 (2)

The Regional Municipality of Haldimand - Norfolk

ENVIRONMENTAL ASSESSMENT WASTE MANAGEMENT

PHASE ONE REPORT

Proctor & Redfern Limited

Morrison Beatty Limited

December, 1984

6.0 STUDY AREA POPULATION

Table 6-1 provides an overview of population change for each of the Area Municipalities over the past five years (1979 to 1983). Generally, population in the Region has increased slightly over the five-year period, with the City of Nanticoke experiencing the largest growth in population. Three of the six municipalities have experienced a decrease in population, the most notable changes occurring in the Town of Dunnville and the Township of Norfolk. In comparison, population in the Province of Ontario over the past five years has increased an average of 0.86 percent.

Study area population is also described in terms of the percentage of people living in urban or rural areas. Table 6-2 provides a summary of this distribution. Approximately 43 percent of the population resides within the urban areas or hamlets of the region.

Although there is a significant influx of seasonal visitors to the Region during the summer months, this is not considered for the purposes of this report. It is felt that the impact of seasonal visitors with respect to waste management is not comparatively significant. Further, the waste generated and requiring management by a seasonal population is accounted for in estimating waste generated and waste disposed of by landfill site in Sections 7.0 and 8.0 of this Phase One Report.

The estimation of municipal waste generation and the projection of waste quantities is primarily a function of population and forecasted growth. Population projections prepared by the Department of Planning and Development for the Housing Statement were used for this Phase One Report and are reproduced in Table 6-3[1]. These population projections are considered by the Region to be 'most likely', meaning the projection 'is expected to most closely approximate the reality'. As such, the 'most likely' scenario for the future is based on a continuation of the slow economic and population growth of the past several years.

---

1 Regional Municipality of Haldimand-Norfolk, Department of Planning and Development, 'Municipal Housing Statement', June, 1982.

The population projections estimated in Table 6-3 provide the basis for the waste quantity forecasts prepared in Section 7.3 of this Report.

Table 6-4 provides an estimate of full-time employment for each Area Municipality. Employment is identified by production and non-production (i.e. administrative and sales) employees. Seasonal and part-time staff are not identified in Table 6-4. The employment estimates do not include self-employed farmers and other associated employment. Appendix E provides a list by municipalities of the industries considered.

TABLE 6-1

POPULATION BY AREA MUNICIPALITY

(1979 - 1983)

Municipality	YEAR 1979	1980	1981	1982	1983	Average Annual Change
Delhi	15,030	15,080	15,053	14,923	14,994	-0.06%
Dunnville	11,470	11,413	11,125	11,226	11,199	-0.59%
Haldimand	16,428	16,573	16,405	16,626	16,733	+0.46%
Nanticoke	19,104	19,369	19,498	19,583	19,911	+1.06%
Norfolk	11,081	10,928	10,840	10,769	10,859	-0.50%
Simcoe	14,149	14,181	14,008	14,084	14,166	+0.30%
Total - Region	87,262	87,544	86,929	87,211	87,862	+0.17%

Source: Regional Municipality of Haldimand-Norfolk
Department of Planning and Development.

TABLE 6-2

DISTRIBUTION OF URBAN AND RURAL POPULATION
BY AREA MUNICIPALITY

Municipality	1983 Population	Percentage Distribution Urban	Rural
Delhi	14,994	26	74
Dunnville	11,199	47	53
Haldimand	16,733	47	53
Nanticoke	19,911	40	60
Norfolk	10,859	7	93
Simcoe	14,166	87	13
Total - Region	87,862	43%	57%

Source: Regional Municipality of Haldimand-Norfolk
Department of Planning and Development.

TABLE 6-3

POPULATION PROJECTIONS FOR AREA MUNICIPALITIES

(1985 - 2010)

Municipality	1983	1985	1990	1995	2000	2005	2010
Delhi	14,994	15,350	15,800	16,200	16,500	16,700	16,900
Dunnville	11,199	11,750	12,100	12,400	12,600	12,800	12,900
Haldimand	16,733	17,200	17,700	18,100	18,450	18,700	18,850
Nanticoke	19,911	20,800	21,400	21,950	22,300	22,600	22,850
Norfolk	10,859	10,850	11,200	11,450	11,650	11,800	11,900
Simcoe	14,166	14,450	14,900	15,250	15,550	15,700	15,900
Total - Region	87,862	90,400	93,100	95,350	97,050	98,300	99,300

Source: Regional Municipality of Haldimand-Norfolk Department of Planning and Development, 'Municipal Housing Statement', June, 1982.

TABLE 6-4

EMPLOYMENT (FULL-TIME) BY AREA MUNICIPALITY

1 9 8 3

Municipality	Production	Other*	Total
Delhi	320	141	461
Dunnville	746	137	883
Haldimand	782	160	942
Nanticoke	2,334	856	3,190
Norfolk	191	92	283
Simcoe	1,900	524	2,424
TOTAL REGION	6,273	1,910	8,183

Source: Regional Municipality of Haldimand-Norfolk Department of Planning and Development.

Also Refer to Appendix E for August, 1984 List of Industries for Area Municipalities.

* Includes administrative, sales and other non-production type employment.

7.0 WASTE GENERATION CHARACTERISTICS

This section provides an overview and evaluation of waste generation in the region. The definition of waste, for the purposes of this environmental assessment study, includes all solid, non-hazardous waste generated by domestic, commercial and industrial sources that is directed to waste management facilities located in the Haldimand-Norfolk Region and will likely require management in the future. This definition also includes those solid wastes which are recycled, reused, reclaimed or recovered.

For the purposes of reporting waste by type, the following categories will be used in the environmental assessment study. It should be noted that these categories and descriptions do not necessarily reflect the sources of waste generation but rather describe the type of waste generated.

- **domestic/commercial waste** which includes all solid, non-hazardous waste generated in the home, by commercial businesses and sometimes by industrial establishments,

- **industrial waste** includes non-hazardous, solid waste generated by industry and considered relatively inert. This category also describes other inert waste types not necessarily generated by industry such as brush, trees, demolition material, bulky goods and the like,

- **total waste** includes both domestic/commercial and industrial waste.

Within the Region these wastes are currently disposed of by landfill. There are seven regional waste disposal sites and one private site located throughout the Region and eight waste transfer sites. All of these sites are licenced to receive both domestic/commercial and industrial wastes.

Waste received and then disposed of at all of the waste disposal facilities in the Region is not weighed. As such the quantity of waste generated in the Region is estimated on the basis of documentation prepared in the earlier Regional Waste Management Study[1]. These estimates are considered the most reliable and available data and are considered adequate for the purposes of this Phase One Study. However, these data should be continually reviewed and updated as new information becomes available.

Domestic/commercial and industrial waste can be further described by waste composition as either processable or non-processable. Processable wastes are those wastes considered potentially suitable for management by means other than landfill disposal. Although a residue may require subsequent disposal, these wastes can be directed to an energy-from-waste facility or recycled, reused, or reclaimed. The paper, glass, metal and plastic components, are examples of processable waste.

Non-processable wastes include those wastes which require disposal by landfill because suitable alternative management methods do not presently exist. Construction and demolition debris is a typical example of a non-processable waste.

The generation of solid waste is generally a function of population, employment and type of industry. In turn, each of these factors is influenced by a variety of considerations such as the extent of municipal collection operations and the rate of economic growth. In the context of waste management analysis, each of these factors must be considered.

The overview of waste generation considers these factors by examining past trends in waste generation on a per capita basis and by waste type and source. This provides a framework in which anomolies can be identified and future trends determined.

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1 Gore & Storrie Limited, 'Regional Municipality of Haldimand-Norfolk Waste Management Study', February, 1982.

Therefore, this section evaluates waste generation by source of generation (by municipality), by category of waste generated (domestic/commercial, or industrial), and by waste composition (processable or non-processable). These considerations are then referenced to forecast future generation for the study area.

7.1 Waste Generation by Source

Table 7-1 and Figure 7-1 summarize waste generation for each of the Area Municipalities by type of waste generated. In 1983 approximately 63,400 tonnes of total waste were generated in the Region. This includes 49,100 tonnes of domestic/commercial waste (77%), and 14,300 tonnes of industrial waste (23%).

In consideration of the Area Municipal populations, the urban/rural nature of the Region and the respective municipal waste collection practices, the estimates of waste generation provided in Table 7-1 appear reasonable and are consistent between the Area Municipalities. The highest per capita waste generation rate is in the Town of Simcoe. This is primarily due to the predominance of the urban population and the number of industries in the Town. Other more agriculturally oriented municipalities with significantly less urban development, have much lower per capita waste generation rates. The population in the Township of Norfolk, for example, is estimated to generate 0.40 tonnes of total waste per year, whereas the Simcoe estimate is 1.00 tonne per capita per year (Table 7-1).

The City of Nanticoke, with the largest population, generates the most waste. Approximately 15,900 tonnes of total waste was generated in 1983. Accordingly, the Township of Norfolk, with the smallest population is estimated to have generated only 4,300 tonnes in 1983.

Table 7-2 provides an overview of domestic/commercial waste generation by Area Municipality from 1979 to 1983. Generally, the change in waste generation over the five-year period reflects the growth in population documented in Table 6-1. Waste generation is increasing, but at a slow rate, in the order of 0.1 percent for the

prepared for the Regional Municipality of Niagara which suggested[1]:

- 80 percent of domestic/commercial waste is processable,
- 40 percent of industrial waste is processable.

A detailed examination of waste composition has not been undertaken in the Haldimand-Norfolk Region. It is proposed that the estimates identified in the Regional Niagara study are reasonable and adequate for the purposes of this Phase One Study.

The estimates provided in Table 7-3 identify that about 122 tonnes per day (365 days per year) of processable waste is generated in the Regional Municipality of Haldimand-Norfolk. This is further considered by Area Municipality in Table 7-4.

7.3 Waste Projections

Table 7-5 presents waste quantity projections for the Region by waste category. Waste quantity projections for each of the study Area Municipalities are included in Appendix G.

The waste generation projections have been prepared in consideration of the 'most likely' scenario of population growth estimated by the Regional Department of Planning and Development[2]. This waste generation estimate also assumes no increase in per capita waste generation rates and is based on 1983 per capita waste generation rates (Table 7-1) and population forecasts to the year 2010 (Table 6-3).

In considering the estimates provided in Table 7-5, several factors should be considered that may affect the accuracy of the projections:

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1 Proctor & Redfern Limited, Regional Municipality of Niagara, 'Waste Quantity Determination and Transportation Study', March, 1981.

2 Regional Municipality of Haldimand-Norfolk, Department of Planning and Development, 'Municipality of Haldimand-Norfolk Municipal Housing Statement', June, 1982.

TABLE 7-4

PROCESSABLE WASTE GENERATION BY MUNICIPALITY

1983 (Tonnes)

Municipality	Total Processable Waste	Tonnes Per Day* (TPD)
Delhi	6,900	19
Dunnville	4,900	13
Haldimand	9,300	25
Nanticoke	11,100	30
Norfolk	3,400	9
Simcoe	9,400	26
Total - Region	45,000	122

*Based on 365 days per year.

TABLE 7-5

WASTE GENERATION PROJECTIONS FOR THE REGION

1985 - 2010 (Tonnes)*

Waste Type	1985	1990	1995	2000	2005	2010
Domestic/ Commercial	50,600	52,100	53,400	54,300	55,000	55,600
Industrial	14,500	14,900	15,300	15,500	15,700	15,900
Total - Region	65,100	67,000	68,700	69,800	70,700	71,500

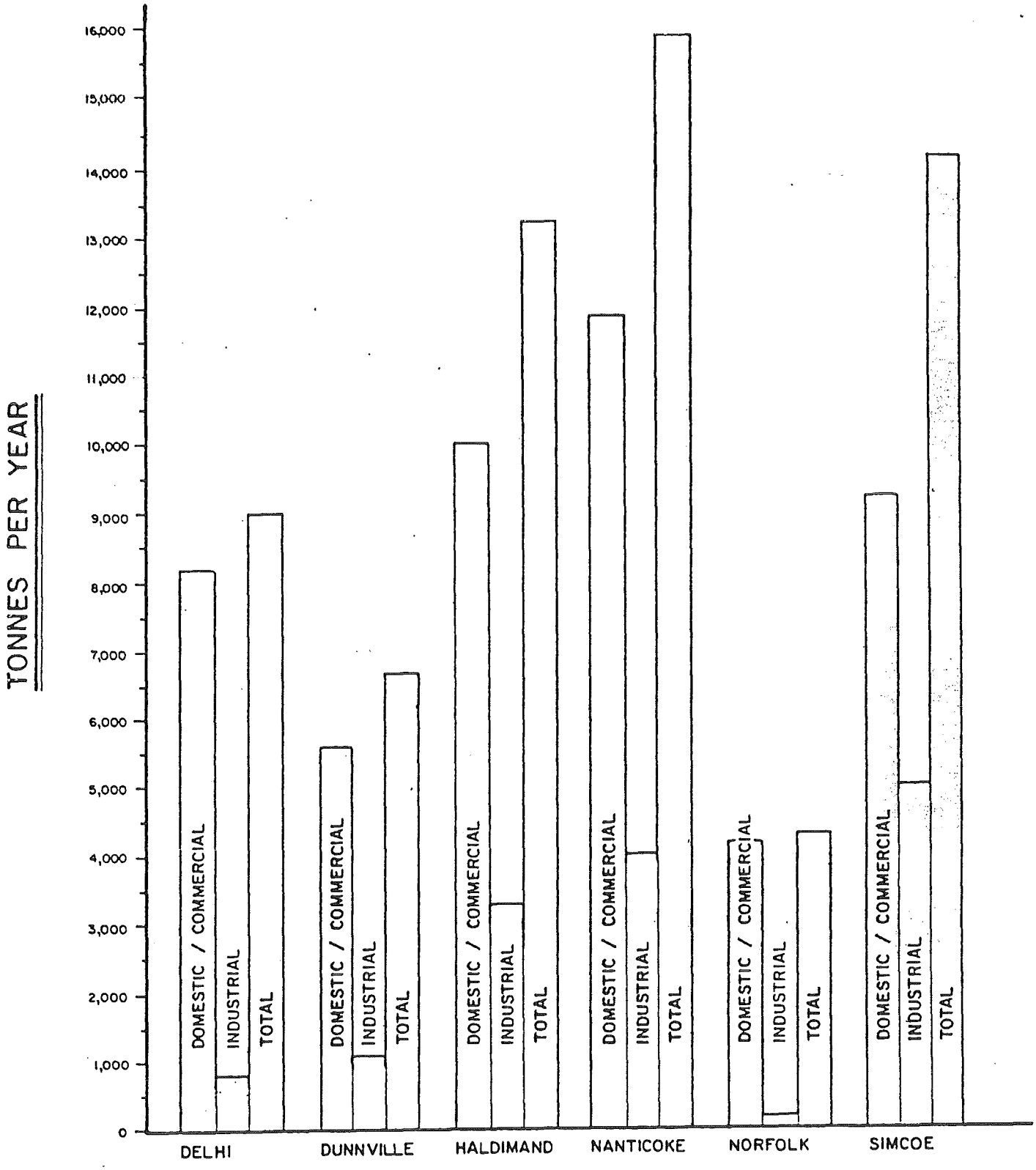
* No increase in per capita waste generation rates considered. Also refer to Appendix G for area municipalities projections.

- the accuracy of the 1983 waste estimates presented in Table 7-1,
- the validity of the assumption that per capita waste generation rates will neither increase nor decrease from the 1983 base rates,
- the accuracy of the population projections presented in Table 6-3,
- the implementation of new waste management policies or the development of competing programs (i.e. source separation) which could have an impact on solid waste generation,
- the relative proportion of domestic/commercial and industrial waste generated will remain the same.

In Table 7-5, waste generation increases about 1.5 percent per year over the 25-year period 1985 to 2010. Considering these estimates, it is projected that about 71,500 tonnes of total waste will be generated in the Region by 2010.

FIGURE 7-1

WASTE GENERATION BY AREA MUNICIPALITY



AUGUST, 1984

TABLE 7-1

TOTAL WASTE GENERATION BY AREA MUNICIPALITY

1983 (Tonnes)

Municipality (1983 Population)	Domestic/ Commercial	Industrial	Total	Tonnes per Capita per Year
Delhi (14,994)	8,200	800	9,000	0.60
Dunnville (11,199)	5,600	1,100	6,700	0.60
Haldimand (16,733)	10,000	3,300	13,300	0.80
Nanticoke (19,911)	11,900	4,000	15,900	0.80
Norfolk (10,859)	4,200	100	4,300	0.40
Simcoe (14,166)	9,200	5,000	14,200	1.00
Total - Region (87,862)	49,100	14,300	63,400	0.72

Source: Gore & Storrie Ltd., Regional Municipality of Haldimand-Norfolk Waste Management Study, February, 1982.

TABLE 7-2

DOMESTIC AND COMMERCIAL WASTE GENERATION
BY AREA MUNICIPALITY
1979 TO 1983

Municipality	1979	1980	1981	1982	1983	% Average Annual Change
Delhi	8,300	8,300	8,300	8,200	8,200	-0.3%
Dunnville	5,700	5,700	5,600	5,600	5,600	-0.4%
Haldimand	9,900	9,900	9,800	10,000	10,000	+0.2%
Nanticoke	11,500	11,600	11,700	11,800	11,900	+0.9%
Norfolk	4,300	4,300	4,200	4,200	4,200	-0.6%
Simcoe	9,200	9,200	9,100	9,200	9,200	0
Total - Region	48,900	49,000	48,700	49,000	49,100	+0.1%

Source: Gore & Storrie Ltd., Regional Municipality of Haldimand-Norfolk Waste Management Study, February, 1982.

Region over the past five years. This is the result of both the slow growth rate in population and the economy.

The quantity of waste estimated by type in Table 7-1 for 1983 is considered representative for the region. These estimates will be used as the basis for estimating future waste generation and documenting waste systems needs.

7.2 Waste Generation by Type and Composition

The composition of domestic/commercial and industrial waste can be categorized as either processable or non-processable. These categorizations provide an overview of the quantity and source of waste which could possibly be diverted from disposal by landfill.

Following further study of alternative waste management methods in Phase Two, these waste categorizations might be further refined to consider:

- **available waste.** Not all processable waste may be available due to haul economics, demand from competing waste management programs and uses, relative tipping fees and the like. An understanding of the availability of waste is necessary in evaluating the technical feasibility of an alternative,

- **components of the waste stream.** Resource recovery projects must consider the quantity of each of the available waste stream components. Generally these include paper, glass, plastic, metal, organics and other miscellaneous items,

- **the combustible proportion of the waste stream.** All processable waste is not combustible. The proportion of the combustible fraction of the total waste stream is considered to be in the order of 60 percent based on previous studies.

Table 7-3 estimates the quantity of processable waste generated by area municipalities in 1983. Of total waste generated in the study area, approximately 70 percent is considered processable. This was determined on the basis of a study

TABLE 7-3

ESTIMATE OF PROCESSABLE WASTE

1983 (Tonnes)

Municipality	Total Waste Generated	PROCESSABLE			NON-PROCESSABLE		
		Domestic/ Commercial	Industrial	Total	Domestic/ Commercial	Industrial	Total
Delhi	9,000	6,600	300	6,900	1,600	500	2,100
Dunnville	6,700	4,500	400	4,900	1,100	700	1,800
Haldimand	13,300	8,000	1,300	9,300	2,000	2,000	4,000
Nanticoke	15,900	9,500	1,600	11,100	2,400	2,400	4,800
Norfolk	4,300	3,400	--	3,400	800	100	900
Simcoe	14,200	7,400	2,000	9,400	1,800	3,000	4,800
Total - Region	63,400	39,400	5,600	45,000	9,700	8,700	18,400

The Regional Municipality of Haldimand - Norfolk

ENVIRONMENTAL ASSESSMENT WASTE MANAGEMENT

PHASE TWO REPORT VOLUME I

Evaluation of Waste Management Approaches

The Proctor & Redfern Group

April, 1987

4.0 WASTE QUANTITIES AND CHARACTERISTICS

The Phase One Report defined waste by category (i.e. domestic/commercial or industrial) and by type (i.e. processable or non-processable). These definitions are included in Appendix G to this Report, Glossary of Terms. Waste generation was estimated for waste type and waste category by source. Projections of waste generation were made to the year 2010.

Total waste generated in the Region was estimated to be 63,400 tonnes in 1983 and is summarized in Table 4-1. It was estimated that approximately 70 percent, or 45,000 tonnes, of waste generated annually could potentially be diverted to management approaches other than landfill disposal. However, it was noted in the Phase One Report that further evaluation would be necessary to determine the quantity of waste available to an alternative waste management approach, and for estimating the 'recyclable'[1] and combustible[2] components of the waste stream.

4.1 Waste Characteristics

The characteristics of solid waste generated in the Region were not described in the Phase One report. A review of Regional disposal policies indicates that only solid non-hazardous waste is accepted for disposal at existing waste disposal facilities. However, there is no specific information about the composition or characteristics of waste generated and requiring management. This section of the Report describes the characteristics of wastes generated in the Region and provides an estimate of processable and combustible waste types.

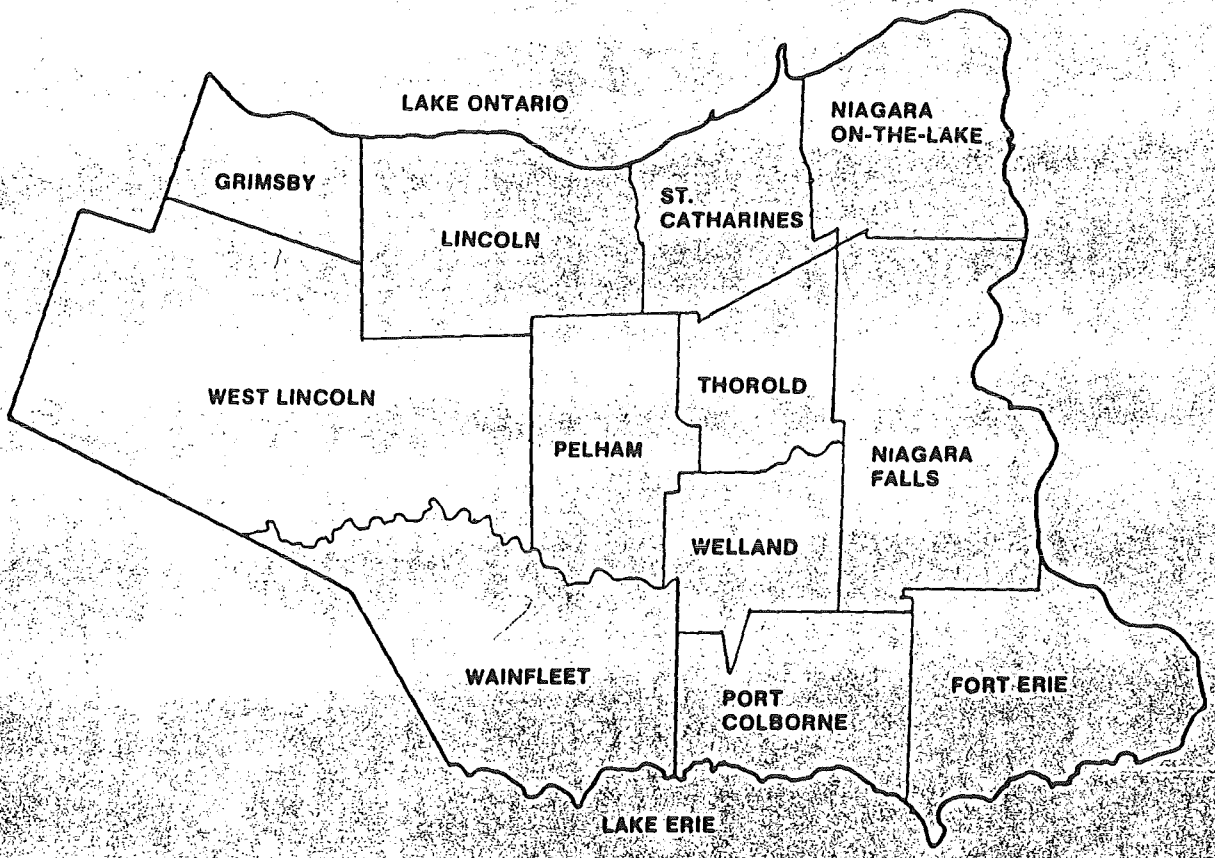
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1 In this Report, the term 'recycle' includes waste recycle, reuse and reduction, including source separation unless otherwise noted.

2 Combustible waste is defined as that portion of total waste considered suitable, with or without pre-processing, for diversion to an incineration or energy-from-waste facility.

Exhibit H-846

REGIONAL MUNICIPALITY OF NIAGARA
WASTE MANAGEMENT MASTER PLAN
DRAFT REPORT - STAGE 3



GORE & STORRIE LIMITED

IN ASSOCIATION WITH
WOODS GORDON
MORRISON BEATTY LIMITED

AUGUST 1986

4. DATA UPDATING

4.1 Population Statistics and Projections

The Regional Municipality of Niagara has been divided into 33 waste generation areas. The 33 areas were carefully delineated to match as closely as possible municipal boundaries and urban areas boundaries as well as previous transportation study zones.

Figure 4.1 entitled, "Waste Generation Areas" (folded in pouch at back of report) shows the 33 areas.

The Planning and Development Department of the Region updated their population forecasts based on 1982 assessed population. Table 4.1 entitled "Population Forecast: 1982-2010" contains the actual 1982 assessed population and the Region's projections for the year 2010 for each of the 33 areas. Appendix F entitled "Population Projections: 1986 to 2010" contains annual population projections.

It should be recognized that a considerable degree of uncertainity surrounds any such figures. The three demographic variables of mortality rates, birth rates and particularly migration which is influenced by economic conditions can individually or in combination change the rate of population growth.

The population forecasts and distribution provided in Table 4.1 were given careful consideration. Following the considerations of recent trends in actual population growth, available residential land, and of future service capabilities it was concluded that some municipalities are likely to grow at a rate higher than the average and others at a rate lower than the average. The average overall growth rate was calculated to be just over 5 percent with 2 and 10 percent being the low and high rates for the 25 year study period. The municipalities by category are as follows:

high: Thorold, Pelham and Grimsby
medium: St. Catharines, Niagara Falls, Lincoln, West Lincoln and Welland
low: Fort Erie, Port Colborne, Wainfleet and Niagara-on-the-Lake

TABLE 4.1

POPULATION FORECAST: 1982-2010

Municipality	Waste Generation Areas	Assessed Population 1982	Projected Population 2010
St. Catharines	W-1	62,913	61,050
	W-2	18,744	20,700
	W-3	34,430	37,300
	W-4	5,369	9,650
	W-5	2,021	1,900
		123,477	130,600
Thorold	W-6	11,564	12,750
	W-7	2,354	2,800
	W-8	1,495	1,400
		15,413	16,950
Niagara Falls	W-9	67,490	72,100
	W-10	933	850
	W-11	1,899	1,800
		70,322	74,750
Pelham	W-12	3,777	4,400
	W-13	6,481	6,950
	W-14	934	900
		11,192	12,250
Grimsby	W-15	13,812	15,400
	W-16	2,061	2,000
		15,873	17,400
Lincoln	W-17	7,418	7,350
	W-18	6,689	7,600
		14,107	14,950
West Lincoln	W-19	3,527	3,450
	W-20	4,087	4,100
	W-21	2,202	2,800
		9,816	10,350
Fort Erie	W-22	14,210	14,350
	W-23	7,448	7,750
	W-24	2,151	2,500
		23,809	24,600
Port Colborne	W-25	15,888	16,200
	W-26	3,289	3,400
		18,977	19,600
Welland	W-27	19,595	23,200
	W-28	24,212	23,350
	W-29	1,495	1,300
		45,302	47,850
Wainfleet	W-30	2,414	2,350
	W-31	3,576	3,750
		5,990	6,100
Niagara-on-the-Lake	W-32	6,389	7,000
	W-33	5,748	5,400
		12,137	12,400
Region Total		366,415	387,800

Source: Planning and Development Department, Regional Municipality of Niagara
September, 1985

The distribution to individual waste generation areas within a municipality was based on the potential for suburban subdivision development, for redevelopment and infilling in central areas and outside the urban areas, a small amount of hamlet and rural development.

It is noted that these population figures do not, in all cases, agree with 1985 current information. Population forecasts are subject to increasing uncertainty as the forecast period extends further into the future and/or the size of the area decreases. Therefore, the population total for the Niagara Region may be considered more certain than the totals of the individual municipalities or generation areas. Some variations from the figures shown here are to be expected as will occur with other forecasts in this study. These population figures were one of many assumptions used to derive the system costs. When the Consultants work is finalized Niagara will be able to utilize the Solid Waste Management Planning Model (S.W.A.M.P.) to update and re-evaluate all alternatives using current information and revised projections. The overall impact is considered to be insignificant.

4.2 Waste Quantity Statistics and Projections

Waste quantities generated within the Region were compiled using data from a number of sources including:

a) actual weight records from the Glenridge Landfill Site which serves the City of St. Catharines.

b) Actual weight records from the Park Road Landfill Site which serves the municipalities of Grimsby, Lincoln, West Lincoln and Pelham.

c) volume utilization surveys for the Mountain Road Landfill Site which serves the City of Niagara Falls.

From these data sources a reasonably accurate scenario of the non-hazardous solid waste generated and disposed of within the Regional Municipality of Niagara for the year 1984 was developed.

The waste stream has been divided into two categories: municipal and private. The municipal waste category includes all waste collected by the municipality either with their own forces or under contract. The private waste category addressess all other solid waste. At present the area municipalities are responsible for the collection and disposal of the municipal waste category and the disposal only of the private waste category.

Table 4.2 entitled "Municipal Waste Quantity Projections" and Table 4.3 entitled "Private Waste Quantity Projections" provide the relevant data. Table 4.4 entitled "Total Waste Quantity Projections" combines the municipal and private waste quantity projections into one projection.

Annual projections by waste generation area are contained in Appendix G.

In total, approximately 8 million tonnes of waste will be generated within the Region from 1986 to 2010. The municipal category accounts for 3.5 million tonnes and the private category for 4.5 million tonnes.

It should be noted that one-third of the wet paper mill waste from Ontario Paper is currently being composted. The balance is used in the agricultural community as an agricultural mulch and land cover. The wet paper mill waste quantity is therefore not included in the above estimate.

Additionally, it has been determined that foundry sands have a surprisingly small impact on volume utilization at landfill sites. After factoring for the density of the foundry sands it is estimated that the in-place volume displaced annually represents the volume occupied by 5,300 tonnes of municipal waste. Over the study period of 25 years this represents an impact of less than 150,000 tonnes. This tonnage is <u>not</u> included in the private category.

TABLE 4.2

MUNICIPAL WASTE QUANTITY PROJECTIONS

Municipality	Waste Generation Areas	1986	1990	1995	2000	2005	2010
St. Catharines	W-1	17,850	17,780	17,680	17,590	17,490	17,400
	W-2	5,420	5,500	5,590	5,690	5,800	5,900
	W-3	9,920	10,040	10,180	10,330	10,480	10,630
	W-4	1,660	1,810	2,010	2,230	2,480	2,750
	W-5	540	530	530	520	510	510
		35,390	35,660	35,990	36,360	36,760	37,190
Thorold	W-6	4,240	4,300	4,380	4,460	4,540	4,610
	W-7	650	660	680	700	730	750
	W-8	400	390	390	380	380	370
		5,290	5,350	5,450	5,540	5,650	5,730
Niagara Falls	W-9	40,330	40,710	41,200	41,690	42,180	42,680
	W-10	360	360	350	350	340	340
	W-11	740	740	730	720	720	710
		41,430	41,810	42,280	42,760	43,240	43,730
Pelham	W-12	1,030	1,060	1,090	1,120	1,150	1,180
	W-13	2,370	2,390	2,420	2,450	2,480	2,510
	W-14	250	250	250	240	240	240
		3,650	3,700	3,760	3,810	3,870	3,930
Grimsby	W-15	5,080	5,160	5,260	5,360	5,470	5,570
	W-16	550	550	540	540	540	540
		5,630	5,710	5,800	5,900	6,010	6,110
Lincoln	W-17	1,980	1,980	1,980	1,980	1,970	1,970
	W-18	1,830	1,860	1,900	1,950	1,900	2,040
		3,810	3,840	3,880	3,930	3,960	4,010
West Lincoln	W-19	940	940	940	930	930	920
	W-20	1,100	1,100	1,100	1,100	1,100	1,100
	W-21	610	630	660	690	720	750
		2,650	2,670	2,700	2,720	2,750	2,770
Fort Erie	W-22	5,150	5,160	5,170	5,180	5,190	5,190
	W-23	2,710	2,730	2,750	2,770	2,790	2,800
	W-24	590	600	620	630	650	670
		8,450	8,490	8,540	8,580	8,630	8,660
Port Colborne	W-25	5,770	5,780	5,800	5,820	5,840	5,860
	W-26	890	890	890	900	910	910
		6,660	6,670	6,690	6,720	6,750	6,770
Welland	W-27	7,270	7,440	7,670	7,910	8,150	8,400
	W-28	8,720	8,670	8,620	8,560	8,510	8,450
	W-29	390	380	380	370	360	350
		16,380	16,490	16,670	16,840	17,020	17,200
Wainfleet *	W-30	640	640	640	640	630	630
	W-31	960	970	980	990	1,000	1,010
		1,600	1,610	1,620	1,630	1,630	1,640
Niagara-on-the-Lake	W-32	2,340	2,370	2,410	2,450	2,490	2,530
	W-33	1,530	1,510	1,500	1,480	1,460	1,450
		3,870	3,880	3,910	3,930	3,950	3,980
Region Total		134,810	135,880	137,290	138,720	140,220	141,720

* Wainfleet does not currently provide any waste collection service

TABLE 4.3

PRIVATE WASTE QUANTITY PROJECTIONS

Municipality	Waste Generation Areas	1986	1990	1995	2000	2005	2010
St. Catharines	W-1	39,280	39,110	38,900	38,690	38,490	38,280
	W-2	11,920	12,090	12,300	12,530	12,750	12,980
	W-3	21,840	22,090	22,410	22,730	23,060	23,390
	W-4	3,660	3,980	4,420	4,910	5,450	6,050
	W-5	420	420	410	410	400	400
		77,120	77,690	78,440	79,270	80,150	81,100
Thorold	W-6	6,390	6,480	6,600	6,710	6,830	6,950
	W-7	500	510	530	540	560	580
	W-8	310	310	300	300	300	290
		7,200	7,300	7,430	7,550	7,690	7,820
Niagara Falls	W-9	21,460	21,660	21,920	22,180	22,440	22,710
	W-10	80	80	80	80	70	70
	W-11	160	160	160	160	150	150
		21,700	21,900	22,160	22,420	22,660	22,930
Pelham	W-12	810	830	850	870	900	920
	W-13	3,570	3,610	3,650	3,700	3,740	3,790
	W-14	190	190	190	190	190	180
		4,570	4,630	4,690	4,760	4,830	4,890
Grimsby	W-15	7,650	7,770	7,920	8,080	8,240	8,400
	W-16	430	430	430	420	420	420
		8,080	8,200	8,350	8,500	8,660	8,820
Lincoln	W-17	1,550	1,550	1,540	1,540	1,540	1,540
	W-18	1,420	1,450	1,480	1,510	1,550	1,580
		2,970	3,000	3,020	3,050	3,090	3,120
West Lincoln	W-19	740	740	730	730	730	730
	W-20	850	850	850	850	850	850
	W-21	480	500	520	540	560	590
		2,070	2,090	2,100	2,120	2,140	2,170
Fort Erie	W-22	7,760	7,770	7,780	7,800	7,810	7,820
	W-23	4,080	4,100	4,130	4,160	4,190	4,220
	W-24	460	470	480	500	510	520
		12,300	12,340	12,390	12,460	12,510	12,560
Port Colborne	W-25	8,680	8,700	8,730	8,760	8,790	8,830
	W-26	690	690	700	700	710	710
		9,370	9,390	9,430	9,460	9,500	9,540
Welland	W-27	10,940	11,210	11,550	11,900	12,270	12,640
	W-28	13,130	13,060	12,980	12,890	12,810	12,730
	W-29	310	300	300	290	280	270
		24,380	24,570	24,830	25,080	25,360	25,640
Wainfleet	W-30	500	500	500	490	490	490
	W-31	750	750	760	770	770	780
		1,250	1,250	1,260	1,260	1,260	1,270
Niagara-on-the-Lake	W-32	3,530	3,580	3,630	3,690	3,760	3,820
	W-33	1,190	1,180	1,170	1,150	1,140	1,130
		4,720	4,760	4,800	4,840	4,900	4,950
Region Total		175,730	177,120	178,900	180,770	182,750	184,810

TABLE 4.4

TOTAL WASTE QUANTITY PROJECTIONS

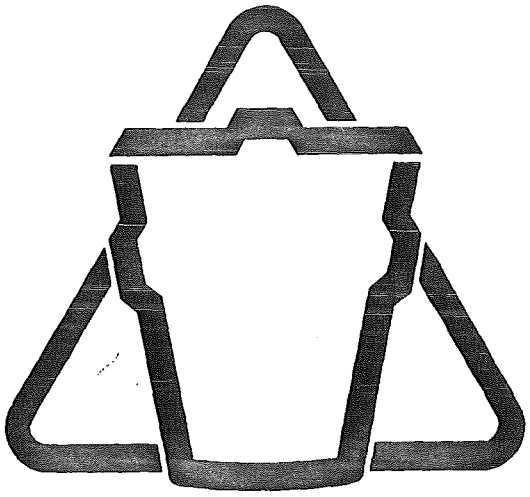
Municipality	Waste Generation Areas	1986	1990	1995	2000	2005	2010
St. Catharines	W-1	57,130	56,890	56,500	56,280	55,980	55,680
	W-2	17,340	17,590	17,890	18,220	18,550	18,880
	W-3	31,760	32,130	32,590	33,060	33,540	34,020
	W-4	5,320	5,790	6,430	7,140	7,930	8,800
	W-5	960	950	940	930	910	910
		112,510	113,350	114,430	115,630	116,910	118,290
Thorold	W-6	10,630	10,780	10,980	11,170	11,370	11,560
	W-7	1,150	1,170	1,210	1,240	1,290	1,330
	W-8	710	700	690	680	680	660
		12,490	12,650	12,880	13,090	13,340	13,550
Niagara Falls	W-9	61,790	62,370	63,120	63,870	64,620	65,390
	W-10	440	440	430	430	410	410
	W-11	900	900	890	880	870	860
		63,130	63,710	64,440	65,180	65,900	66,660
Pelham	W-12	1,840	1,890	1,940	1,990	2,050	2,100
	W-13	5,940	6,000	6,070	6,150	6,220	6,300
	W-14	440	440	440	430	430	420
		8,220	8,330	8,450	8,570	8,700	8,820
Grimsby	W-15	12,730	12,930	13,180	13,440	13,710	13,970
	W-16	980	980	970	960	960	960
		13,710	13,910	14,150	14,400	14,670	14,930
Lincoln	W-17	3,530	3,530	3,520	3,520	3,510	3,510
	W-18	3,250	3,310	3,380	3,460	3,540	3,620
		6,780	6,840	6,900	6,980	7,050	7,130
West Lincoln	W-19	1,680	1,680	1,670	1,660	1,660	1,650
	W-20	1,950	1,950	1,950	1,950	1,950	1,950
	W-21	1,090	1,130	1,180	1,230	1,280	1,340
		4,720	4,760	4,800	4,840	4,890	4,940
Fort Erie	W-22	12,910	12,930	12,950	12,980	13,000	13,010
	W-23	6,790	6,830	6,880	6,930	6,980	7,020
	W-24	1,050	1,070	1,100	1,130	1,160	1,190
		20,750	20,830	20,930	21,040	21,140	21,220
Port Colborne	W-25	14,450	14,480	14,530	14,580	14,630	14,690
	W-26	1,580	1,580	1,590	1,600	1,620	1,620
		16,030	16,060	16,120	16,180	16,250	16,310
Welland	W-27	18,210	18,650	19,220	19,810	20,420	21,040
	W-28	21,850	21,730	21,600	21,450	21,320	21,180
	W-29	700	680	680	660	640	620
		40,760	41,060	41,500	41,920	42,380	42,840
Wainfleet	W-30	1,140	1,140	1,140	1,130	1,120	1,120
	W-31	1,710	1,720	1,740	1,760	1,770	1,790
		2,850	2,860	2,880	2,890	2,890	2,910
Niagara-on-the-Lake	W-32	5,870	5,950	6,040	6,140	6,250	6,350
	W-33	2,720	2,690	2,670	2,630	2,600	2,580
		8,590	8,640	8,710	8,770	8,850	8,930
Region Total		310,540	313,000	316,190	319,490	322,970	326,530

Exhibit A-847

Waste Management Master Plan

Stage 2
Interim Report to

The Regional Municipality of Ottawa-Carleton



WASTEPLAN • ACTIONDÉCHETS

September 1985

MacLaren Engineers
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4.0 WASTE HANDLING AND PROCESSING OPTIONS - THE 4 R's CENTRALIZED

4.1 General

In Stage 1, a number of centralized waste management alternatives were presented and their general advantages/disadvantages discussed. The following section further refines this set of alternatives based upon continued technical studies and input obtained through the public review of the Stage 1 Report. Site selection alternatives for the various waste technologies are then either illustrated or criteria for their subsequent establishment proposed. General criteria for the comparative evaluation of waste management systems involving these options are then presented. (Data provided in Stage 1 regarding the characteristics of the various centralized waste management alternatives are summarized on Table 7.1, presented later in this report.)

A major conclusion drawn during the public review of Stage 1 was the need to further investigate all known methods available to reduce the amount of waste requiring landfill disposal, while minimizing the use of non-renewable resources. In the public's mind, the focus for the study should be first and foremost on the reduction technologies, with landfill seen as the least desirable solution. Hence the Region's commitment to at-source waste separation as outlined in the previous section. As a continuation of this philosophy, centralized waste processing and recovery technologies are now further investigated.

Waste quantities recovered and remaining after the implementation of the source separation, Regional recycling program are detailed on Table 4.1. Remaining waste quantities shown on this table have been used to assess the potential scope for the centralized waste processing options.

Centralized waste processing can offer both economies of scale and reduced environmental impacts over the establishment of smaller, multiple processing facilities. All of the technologies discussed herein are in a sense

TABLE 4.1

SOLID WASTE QUANTITIES RECOVERED AND REMAINING
AFTER SOURCE SEPARATION AND REDUCTION TARGETS REACHED

Waste Category	Waste Classification	ANNUAL SOLID WASTE GENERATED					
		1986	1991	1996	2001	2006	2011
NON-RECOVERED QUANTITY							
Municipal	Residential and Light Commercial	198,310	197,110	187,580	179,420	184,820	189,130
	Commercial/ Industrial	113,160	109,150	103,600	96,620	101,920	107,230
Special[1]	Construction/ Demolition	136,500	142,990	149,210	155,420	159,740	163,240
	Biomedical	520	550	560	590	600	620
	Water and Sewage Treatment Sludges	71,170	68,970	77,030	82,270	85,710	90,590
	SUB-TOTAL	519,660	518,770	517,980	514,320	532,790	550,810
RECOVERED QUANTITY							
Municipal	Residential and Light Commercial	25,930	41,770	57,880	76,350	78,650	80,480
	Commercial/ Industrial	24,510	37,610	52,180	68,260	72,010	75,760
	SUB-TOTAL	50,440	79,380	110,060	144,610	150,660	156,240
TOTAL SOLID WASTE GENERATED		570,100	598,150	628,040	658,930	683,450	707,050
PORTION OF WASTE RECOVERED							
- Relative to Municipal Waste Quantities		14%	21%	27%	34%	34%	34%
- Relative to Total Solid Waste Generated		9%	13%	18%	22%	22%	22%

1. Exclusive of non-solid (liquid) and hazardous wastes.

"proven" with varying degrees of success in the present market place. The technologies include resource recovery plants, compost or refuse derived fuel producing facilities and energy from waste incinerators. Each has at least a limited amount of experience in North America (and generally more in Europe) with the most notable provincial experience being provided by the Ministry of the Environment's Experimental Resource Recovery Plant. The use of transfer stations is also outlined.

Technologies discussed in Stage 1, but eliminated from current considerations, include incineration without energy recovery, gasification or pyrolysis, hydrapulping, plasma-arc technology and baling. Straight incineration is less cost effective than EFW while offering no significant process advantages. Similarly, baling is also not cost effective for the increased waste densities achieved. The other technologies were eliminated based either on poor track records (gasification, hydrapulping) or because they were realistically impractical (plasma-arc technology). The study process will be updated if necessary to include these technologies, should new information be made available to warrant their reassessment.

In order to provide meaningful cost information for decision making, a cost per tonne estimate was developed for each of the chosen alternatives. This estimate includes the cost of building, operating, financing, closing and caring for a facility over a 20 year time frame. The quantitative value of indirect variables such as the value to society of increased employment or the cost of undesirable environmental impacts such as increased noise levels are not included in the determination of the cost per tonne.

Details on the methodology employed in developing the cost per tonne figures are provided in Appendix C.

Exhibit H-848

Waste Management Master Plan Update for The Regional Municipality of Peel Stage 3

Preliminary Report

The Regional Municipality of Peel

December 1986
34403

MacLaren Plansearch
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4.0 QUANTITIES OF WASTE FOR DISPOSAL

In order to establish a waste management system it is essential to estimate the quantities of waste which may be generated and must be dealt with over the study period.

The Stage 1 Report, April 1984 contained the following analyses:

- Chapter 2 - Existing Solid Waste Management System Quantities and Characteristics of Waste System.

The waste quantities were derived from the Region's records of waste disposal over 2.5 years, 1980-82, which showed a relatively constant generation rate.

- Chapter 3 - Solid Waste Quantity Projections

These projections were based on population and employment estimates and the assumption that the generation rates would not increase in the future. The study period was from 1984 to 2004.

The Stage 2 Preliminary Report, January 1985, Section 1.3, updated the waste quantities for a 40 year study period, 1984-2024. This estimate was based on the latest population projections from the Region's Planning Department and the waste generation rates derived in the Stage 1 Final Report. It was recognized that these projections would be reviewed in Stage 3.

The Stage 2 Final Report, March 1986, Chapter 4, revised the projected waste quantities to the new study period, i.e. from January 1987 to December 2026. The basis of the projection was the same as used in the Stage 2 Preliminary Report and was used for estimating the relative capacities of waste system components.

In this Stage 3 Preliminary Report, a review of the waste quantity projections for the study period 1987 to 2026 has been carried out as described in the following sections.

In essence, the results are as follows:

- The analysis of the waste generation rates for 1983 through 1985 generally show an annual increase. This was not anticipated and may in fact be due to a short term condition related to economic recovery or to a conservative (low) estimate of populations in 1983 through 1985. It was decided to use the average for the six years (1980-1985) of data to be conservative

- Population - now projected to be 1,118,500 for year 2026 (Table 4.5)
  - Stage 2 was projected as 1,077,600 for year 2024

- Employment Level - now projected to be 578,228 for year 2026 (Table 4.6)
  - Stage 2 was projected as 618,700 for year 2024

  The lower projected employment level is due mainly to a re-assessment of the Brampton growth curve: employment maturity lags population maturity

- The estimated total wastes which will be generated from January 1987 to December 2026 is now 38,765,000 tonnes (Table 4.7) compared with 38,064,000 tonnes in Table 4.1 of the Stage 2 Final Report.

4.1 Waste Generation Rates

Records of the quantities of waste requiring disposal together with estimates of population and employment for the interval 1980 through 1985 were assembled. The data are grouped by type of waste and by municipality.

The data on quantities of waste were extracted from the records of waste disposal at Britannia and other sites maintained by the Public Works Department of the Region. The population and employment records were supplied by the Planning Department of the Region of Peel.

Table 4.1 illustrates the quantities of "population related" or "tax supported" waste, population estimates and the resulting per capita generation rates.

Table 4.2 illustrates the quantities of "employment related" or "revenue supported" waste, estimates of employment levels and the resulting per employee generation rates.

Definitions of "population related" (i.e. "tax supported") and "employment related" (i.e. "revenue supported") waste are provided on the individual tables.

These generation rates were compared with waste generation rates experienced in Metro Toronto, the Region of Ottawa-Carleton and the Region of Waterloo **(Table 4.3)**. Data from other studies documenting generation rates are shown on **Table 4.4**.

These data on waste generation rates were analyzed and the following conclusions and decisions were reached:

i) Although there is considerable variation in waste quantities from municipality-to-municipality and from study-to-study it was concluded

that the generation rates determined for the Region of Peel are reasonable and within the expected range based on the comparison to Metro and other studies.

ii) For the purposes of projecting future waste quantities uniform generation rates will be assumed (i.e. no increase over time). The factors underlying this decision are as follows:

- Very recent upturn in per capita waste generation is assumed to represent "catch-up" for the last recession and is not indicative of long-term trend. The "upturn" may also reflect a low estimate of population

- Representatives of the Waste Management Branch of the Ministry of the Environment agreed that it was their understanding that per capita municipal waste generation rates were remaining constant

- Variations in the per employee generation rates appear to be related to the general level of economic activity and are generally assumed to remain constant over the longer term.

iii) That separate generation rates would be used for each waste type (population related and employment related) within each of the three municipalities (Mississauga, Brampton and Caledon). This decision was made because the individual generation rates represent the current best available data and reflect the individual factors that prevail within each of the municipalities.

iv) That generation rates used in projecting future waste quantities be the weighted average of the generation rates that prevailed over the past six years (six years represents the period for which generally reliable data on waste quantities are available). The Caledon per capita waste generation rate is based on the average for the years 1983 through 1985

as the pre-1983 waste quantity data exclude quantities delivered by private automobiles. The decision to use a generation rate based on longer term average of historical data was made because this approach overcomes the problems associated with variability encountered in the data from year-to-year. The decision is also consistent with the previous assumptions that the generation rates would be held constant over the study time-frame.

The validity of the preceding basis for projecting waste quantities over the next 40 years will be checked on a regular basis (at least every five years) from the Region's ongoing records.

4.2 Population and Employment Projections

Projections of future population and employment were provided by the Socio-Economic Analysis Section (SEAS) of the Region of Peel Planning Department. **Table 4.5** summarizes the population projections while **Table 4.6** summarizes the employment projections. The basis of these projections is detailed in the following sub sections:

Population Growth in Peel Region, 1974 to 1985:

There are two sources of data on existing population counts for Peel Region and its three constituent area municipalities, Brampton, Caledon and Mississauga:

- The Standard Assessment System (SAS) of the Ontario Ministry of Revenue based on September enumerations

- The Census of Canada which is conducted every 5 years in June by Statistics Canada.

The Ministry of Revenue, as a cost-saving measure, in 1981 reduced the previous annual enumeration to an enumeration in municipal election years only, that is, every third year. Thus SAS population counts were available for the years 1974 to 1980, inclusive and for the years 1982 and 1985 when a comprehensive enumeration was carried out. SEAS developed estimates of the population for the intervening years (1981, 1983 and 1984), based on past trends, when a complete enumeration was not done.

Population Growth in Peel Region, 1985 to 2026:

The report to Planning Committee, dated January 13, 1986 and titled "1985 Population Enumeration by the Ontario Ministry of Revenue" (Council Resolution P-4-86) tabled the results of the September 1985 enumeration, as follows:

1985 SAS

Municipality	Population
Brampton	177,675
Caledon	28,701
Mississauga	359,495
Peel Region - Total	565,871

This report suggested that there were problems with the 1985 population counts, as evidenced by the under-count on the Under 1 age group as compared with Vital Statistics reports on births. An adjustment was proposed therefore, to the population count for Peel Region, as follows:

1985 (adjusted)

Municipality	Population
Brampton	178,641
Caledon	28,822
Mississauga	362,093
Peel Region - Total	569,556

These adjusted totals for 1985 formed the base year for the projection of population growth to the year 2026.

A very simple method has been chosen by SEAS, in consultation with Regional Finance Department staff, to project population growth. A straight line projection is used in which a constant annual increment of 20,500 people is added to the Region's population each year. Since population projections are prepared and reviewed on an annual basis as input to the next year's

Regional Budget and four-year capital forecast, experience has shown that this simple method does as well as, if not better, than other more complex models.

The breakdown of this annual population increment by area municipality is, as follows:

1985-2026

Municipality	Annual Population Increment
Brampton	7,000
Caledon	500
Mississauga	13,000
Peel Region - Total	20,500

The ultimate capacity or mature state population levels set out in the respective area municipal plans for Brampton, Caledon and Mississauga establish the control totals over the long term. That is, the projected populations are directly tied to the official plan policies to accommodate urban growth as approved by the local and Regional councils. Under the above assumption, therefore, Brampton achieves its capacity population in the year 2009 and sustains that population level for the remainder of the planning period. Mississauga achieves its ultimate population in the year 2013 and sustains that population level for the remainder of the planning period. Caledon, growing at a much lower rate does not reach its mature state population within the waste management planning period.

In the year 2026, the population of Peel Region is projected to be 1,118,500.

Employment Growth in Peel Region, 1981 to 1985

The 1981 Census of Canada provides the most recent estimates of employment at the municipal level as measured by the employed labour force at the place of work. Statistics Canada collected the data as part of the long form (2B) of the Census questionnaire which was distributed to every fifth household thus representing a 20% sample. The census results were then expanded to represent the places of work of the total employed labour force. These 1981 employment levels are as follows:

1981 Employment Levels (Canada Census)

Municipality	Employment
Brampton	58,555
Caledon	6,405
Mississauga	164,935
Peel Region - Total	229,895

Preparation of estimates of employment in Peel Region and its area municipalities for the years 1982 to 1985 is based on the following assumption of growth in employment opportunities per year:

Estimated Employment Growth in Peel for 1982-85

Municipality	Employment/Year
Brampton	3,000
Caledon	340
Mississauga	7,000
Peel Region - Total	10,340

This assumption is derived from the ten-year trend in employment growth in Peel Region as reported in the results of the 1971 and 1981 Censuses, adjusted for the downturn in the general Canadian economy that occurred in the latter half of 1981 and first half of 1982. Again the simple method of straight line projection has been used. The results of the surveys of employment conducted by SEAS and the Planning Department of the City of Mississauga this year will be used to review current estimates of employment, early in 1987.

Employment Growth in Peel Region, 1985 to 2026

The area municipal official plans set goals about the need to continue to create employment opportunities as the residential population grows. Estimates of the desired employment levels at "capacity" or "mature" state were developed based on the size of the "capacity", "ultimate" or "mature" state resident labour force. The standard method of estimating future employment levels is to examine the relationship between population and employment. This relationship establishes the activity rate. The Activity Rates (Employment divided by Population) were calculated as follows:

Long-term Plan

Municipality	Activity Rate
Brampton	.55
Caledon	.52
Mississauga	.56
Peel Region - Total	.56

Using the Long-term Plan Activity Rates as control totals, the Activity Rates for the intervening years (1986 to 2026) were then extrapolated on a linear basis. According to these calculations, the ultimate employment

level for Mississauga would be achieved by 2013 and would be sustained for the remainder of the planning period. The "capacity" or "mature" state levels of employment for Brampton and Caledon would not be reached until after 2026, even though Brampton achieves earlier maturity in population growth.

The Activity Rates were then applied to the Population estimates for each year to produce the employment estimates (Activity Rate times Population). The employment levels for the year 2026 are as follows:

2026

Municipality	Employment
Brampton	148,746
Caledon	23,483
Mississauga	406,000
Peel Region - Total	578,228

Population Estimates by Unit Generation Area (1) (UGA), 1982-2026

The Ontario Ministry of Revenue's year-end Standard Assessment System Files for 1982 and 1985 were used to create the Regional Planning Files for those two years. The Regional Planning Files have the capability of producing small-area data on population and housing. The geographic level used to develop estimates of population by Unit Generation Area (UGA) was the 1981 Peel Traffic Zone system. The estimate of population growth in each traffic zone was based on a comparison of residential land use measurements (existing and designated, based on the 1985 aerial photographs) with the data from the Regional Planning Files and planning documents.

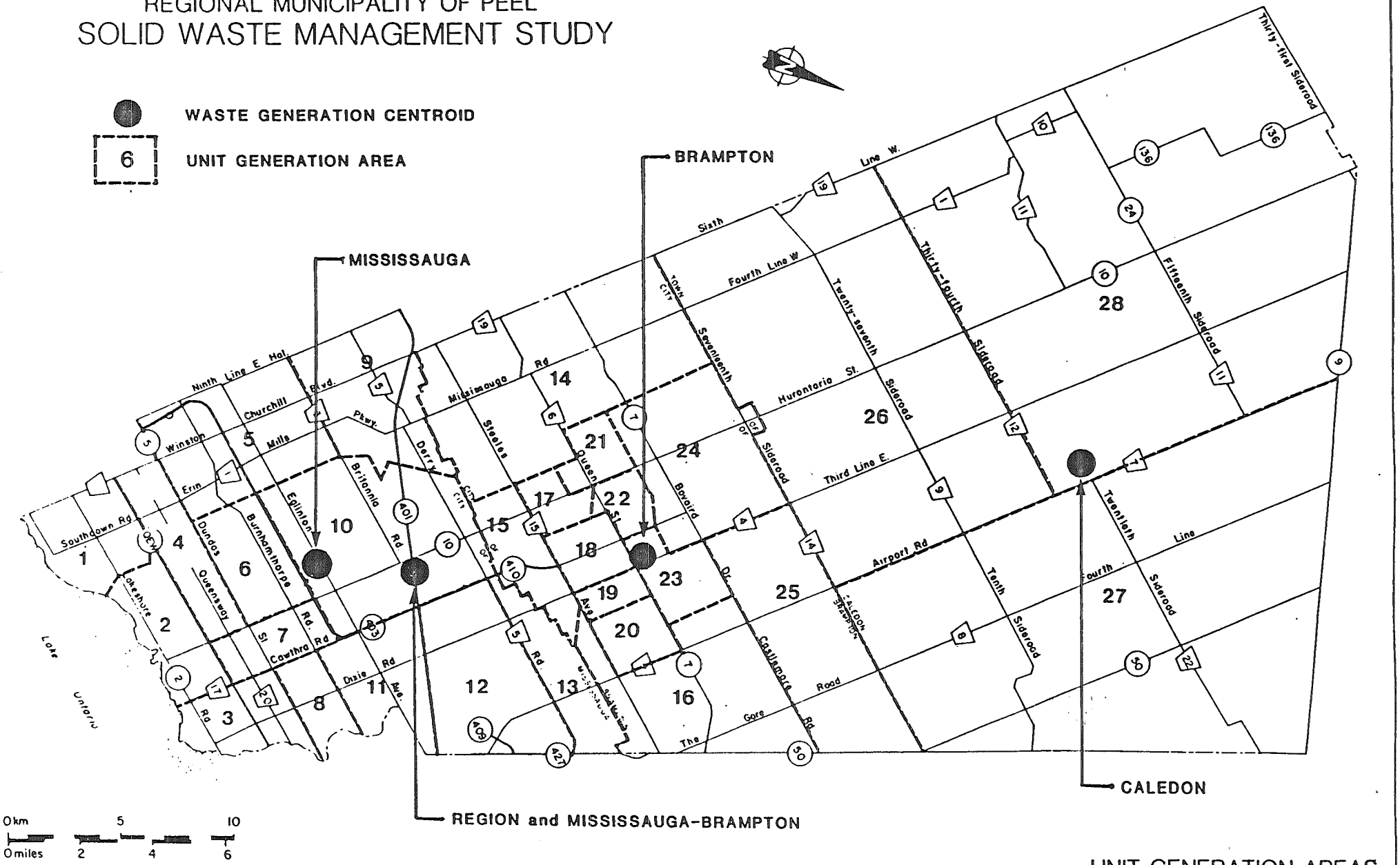
1 See Figure 4.1

Employment Estimates by UGA, 1982 to 2026

The 1980 Economic Structure report prepared by the Region of Peel, based on a Survey of all Employers, formed the basis for the preparation of Employment estimates by UGA. Land-use measurements (existing and designated, based on the 1982 and 1985 aerial photographs) were then used to develop projections by extrapolating on a linear basis between existing development and capacity levels for the years 1985 - 2026, taking into account past trends and capacities. The 1986 Surveys of Employers being conducted by SEAS and the Planning Department of the City of Mississauga should serve as the basis of a review of these estimates, early in 1987.

REGIONAL MUNICIPALITY OF PEEL

SOLID WASTE MANAGEMENT STUDY



UNIT GENERATION AREAS

Figure 4.1

4.3 Waste Quantity Projections

The quantities of wastes which will be generated in the future were projected by multiplying the unit generation in Section 4.1, by the population and employment projections presented in Section 4.2. This was done for each of the 28 unit generation areas in the Region to provide input to the haulage cost model. The summations of these estimates for the Region as a whole and for each municipality are presented in **Table 4.7.**

These wastes generated will not all require disposal by the Region as they will be reduced by the quantities of waste which will be recycled. In the Stage 2 Final report the projected quantities of waste to be recycled, reduced and reused were identified as a percent of the waste generated. (See page 4-3 of the Stage 2 Final Report.) These percentage factors, which increase during the interval 1986 through 2001, were then applied to the projections of generated waste to yield the projections of waste to be reduced, reused and recycled. The quantities of waste remaining and which will require disposal are illustrated in **Table 4.8.**

Of the wastes that require disposal (i.e. post-recycling activities) virtually all the population related wastes plus a portion of the employment related waste are assumed to be available for reduction through incineration processes. Fifty percent of the employment related waste will be recycled or incinerated and the remainder landfilled.

When considering the quantities of waste to be reduced by incineration, it should be noted that a portion of the quantities directed to these facilities is converted to ash and non-combustibles or residue and these residues eventually require landfilling.

In the following Part B of this report, the various approaches for disposing of these generated wastes are identified in detail.

TABLE 4.1

POPULATION RELATED WASTE GENERATION RATES

	Brampton			Mississauga			Caledon			Peel Region		
year	population	waste quantities (tonnes)	generation rate (tonnes/ capita/yr)	population	waste quantities (tonnes)	generation rate (tonnes/ capita/yr)	population	waste quantities (tonnes)	generation rate (tonnes/ capita/yr)	population	waste quantities (tonnes)	generation rate (tonnes/ capita/yr)
1980	140,649	46,611	0.33	298,045	126,701	0.43	25,979	10,250	0.40	472,385	183,562	0.389
1981	149,000	47,218	0.32	315,000	140,143	0.44	26,200	11,324	0.43	490,731	198,685	0.405
1982	154,981	50,237	0.32	324,853	148,023	0.46	26,645	9,090	0.34	511,145	207,350	0.406
1983	162,500	53,449	0.33	338,000	147,439	0.44	27,500	15,159	0.55	528,000	216,047	0.409
1984	169,500	58,669	0.35	351,000	158,660	0.45	28,000	18,168	0.65	548,500	235,497	0.429
1985	178,641	63,001	0.35	362,093	166,007	0.46	28,822	20,707	0.72	569,556	249,715	0.438
total	959,973	319,185		1,996,087	886,973		164,257	84,698		3,120,317	1,290,856	
avg.			0.33			0.45			0.52			0.41

Population related wastes are also referred to as tax supported wastes and include the following types of wastes as described in the Stage 1 Report, Section 2.2:

- Residential
- Municipal (Public Works; Parks and Recreation)
- Drop-Off Bins (Public Waste Drop-Off Bins)
- Farm Waste*
- Non-Profit
- Spill Cleanup*

* Wastes from these sources may not be processed in EFW facilities.

TABLE 4.2

EMPLOYMENT RELATED WASTE GENERATION RATES

	Brampton			Mississauga			Caledon			Peel Region		
year	employment	waste quantities (tonnes)	generation rate (tonnes/ Emp/yr)	employment	waste quantities (tonnes)	generation rate (tonnes/ Emp/yr)	employment	waste quantities (tonnes)	generation rate (tonnes/ Emp/yr)	employment	waste quantities (tonnes)	generation rate (tonnes/ Emp/yr)
1980	51,267	80,143	1.56	157,046	179,415	1.14	5,249	2,527	0.48	213,562	262,085	1.23
1981	57,391	77,330	1.35	164,869	207,614	1.26	5,562	2,521	0.45	227,822	287,465	1.26
1982	63,515	74,337	1.17	172,692	181,158	1.05	5,875	3,374	0.57	242,082	258,869	1.07
1983	64,555	84,498	1.31	178,935	200,846	1.12	7,085	4,515	0.64	250,575	289,859	1.16
1984	67,555	94,920	1.41	185,935	226,938	1.22	7,425	6,379	0.86	260,915	328,237	1.27
1985	71,555	93,618	1.31	192,935	245,204	1.27	7,765	7,124	0.92	272,255	345,946	1.27
total	375,838	504,846		1,052,412	1,241,175		38,961	26,440		1,467,211	1,772,461	
avg.			1.34			1.18			0.68			1.21

Notes: Employment related wastes are also referred to as revenue supported wastes and include the following types of wastes as described in the Stage 1 Report, Section 2.2:

- Industrial
- Commercial
- Institutional
- Construction
- Transfer Station (commercial sources)
- Slag
- Industrial Sludge
- Grit/Screenings
- Fly Ash

Actual historic quantities have been adjusted to reflect conditions that will prevail in the future (e.g. heat treated sewage quantities which are no longer landfilled are not included).

TABLE 4.3

PER CAPITA WASTE GENERATION RATES FOR PEEL, METRO TORONTO, OTTAWA-CARLETON AND WATERLOO REGIONS

(Tonnes/Capita/yr)

	PEEL		METRO TORONTO		OTTAWA-CARLETON	WATERLOO REGION
YEAR	MUNICIPAL(1)	TOTAL REFUSE	MUNICIPAL	TOTAL (2) REFUSE	MUNICIPAL	MUNICIPAL
1976			0.401	0.802		
1977			0.405	0.825		
1978			0.397	0.815		0.456
1979			0.407	0.811	0.369	0.460
1980	0.389	0.943	0.402	0.865	0.376	0.471
1981	0.405	0.991	0.408	0.871	0.405	0.453
1982	0.406	0.912	0.414	0.833	0.382	0.478
1983	0.409	0.958	0.414	0.846	0.370	0.504
1984	0.429	1.028	0.424	0.945	0.380	
1985	0.438	1.046	0.440	1.135		

(1) Referred to as Population-related waste by Region of Peel and in Table 4.1.
(2) Some values may be overestimated as some wastes from outside Metro may be included.

TABLE 4.4

PER CAPITA WASTE GENERATION RATES FROM OTHER STUDIES

Municipal Generation Rate	Commercial Industrial Generation Rate	Total Urban Solid Waste Generation Rate	Source	Comments
0.467 to 0.343 tonnes/ capita/year.			Bird & Hale Ltd., Municipal Refuse Statistics for Canadian Communities of over 100,000 (1976-77), Waste Management Branch, Environmental Protection Service, Environment Canada.	Defines general municipal refuse as residential, commercial and housekeeping wastes from industries, (likely excludes heavy industrial wastes). Based on data from 9 municipalities.
0.465 tonnes/capita/year.	0.265 tonnes/ capita/year	0.730 tonnes/ capita/year	Ontario Waste Management Advisory Board, Urban Solid Waste Generation in Ontario, July 1976.	Defines municipal waste as residential, household waste, residential trash and commercial refuse.
		Edmonton - 0.854 tonnes/ capita/year Calgary - 0.949 tonnes/ capita/year Red Deer - 0.748 tonnes/ capita/year	Environment Council of Alberta, Municipal Solid Waste, Alberta's Untapped Resource, November 1985.	Total Urban Solid Waste generation rate for 1984 (excluding construction and demolition rubble):
0.117 and 0.350 tonnes/ capita/year for domestic (residential) solid waste			Rhyner Charles, Domestic Solid Waste and Household Characteristics, Waste Age, April 1976.	

TABLE 4.5

PROJECTION OF POPULATION LEVELS

(x 1000)

Year	Region of Peel	City of Brampton	City of Mississauga	Town of Caledon
1986	591	186	375	29.5
1991	693	221	440	32.0
1996	796	256	505	34.5
2001	898	291	570	37.0
2006	1,001	326	635	39.5
2011	1,086	344	700	42.0
2016	1,114	344	725	44.5
2021	1,116	344	725	47.0
2026	1,119	344	725	49.5

TABLE 4.6

PROJECTION OF EMPLOYMENT LEVELS

(x 1000)

Year	Region of Peel	City of Brampton	City of Mississauga	Town of Caledon
1986	283	75	200	8.1
1991	336	90	237	9.6
1996	391	105	275	11.1
2001	446	120	313	12.9
2006	502	136	352	14.8
2011	553	145	391	16.8
2016	571	146	406	18.9
2021	574	147	406	21.1
2026	578	149	406	23.5

TABLE 4.7

PROJECTION OF WASTE QUANTITIES GENERATED IN REGION

(x 1000 Tonnes)

By Waste Type

Year	Population Related Wastes	Employment Related Wastes	Total Generation
1987	254	354	608
1991	287	406	693
1996	329	472	801
2001	371	539	910
2006	409	600	1,009
2011	441	654	1,095
2016	461	688	1,149
2021	463	691	1,154
2026	464	695	1,159
Total Jan. 1987 to Dec. 2026	15,704	23,061	38,765

By Municipality

Year	Brampton	Mississauga	Caledon	Peel
1987	168	416	25	608
1991	193	473	27	693
1996	225	546	30	801
2001	257	620	32	910
2006	283	691	35	1,009
2011	299	758	38	1,095
2016	309	798	41	1,149
2021	311	798	45	1,154
2026	313	798	48	1,159
Total Jan. 1987 to Dec. 2026	10,664	26,666	1,435	38,765

TABLE 4.8

PROJECTION OF WASTE QUANTITIES REQUIRING DISPOSAL(1)

(x 1000 Tonnes)

By Waste Type

Year	Population Related Wastes	Employment Related Wastes	Total Requiring Disposal
1987	223	331	554
1991	218	337	555
1996	239	383	622
2001	259	425	684
2006	285	475	760
2011	308	517	825
2016	322	543	865
2021	323	546	869
2026	324	549	872
Total Jan. 1987 to Dec. 2026	11,206	18,478	29,684

By Municipality

Year	Brampton	Mississauga	Caledon	Peel
1987	153	379	22	554
1991	155	379	21	555
1996	175	425	22	622
2001	194	467	23	684
2006	214	520	26	760
2011	226	571	28	825
2016	234	601	30	865
2021	235	601	32	869
2026	236	601	34	872
Total Jan. 1987 to Dec. 2026	8,199	20,423	1,062	29,684

Notes (1) Table 4.7 quantities less recycled quantities removed through reduction, reuse, recycling and recovery of materials (4 Rs).

Exhibit H-849

The Regional Municipality of York

Waste Management Study

Final Report 1980

Gore & Storrie Limited
Consulting Engineers
Toronto, Ontario

CHAPTER 3

SOLID WASTES QUANTITIES

3.1 GENERAL

Because it is a fact that Metro Toronto wastes are and will likely continue to be disposed of in York Region, it is necessary not only to estimate the York Region waste generation quantities but to understand the potential quantities that will enter York from Metro. In this Chapter we have developed projections for York Region quantities and have from work done by others considered the range of quantities from Metro.

In 1975 tabulations of the data collected were provided to the Region. This included tables on:

- present and future population for the major urban centres;
- solid waste generation estimates and projections for household and commercial refuse and industrial refuse;
- special wastes including agricultural waste, manure, sewage treatment sludge and septic tank and holding tank waste.

Much of this information has not required to be updated to 1980.

Because of changed conditions, goals and policies, it is essential only to update the following:

- population projections to 2001;
- broad estimates of solid waste generation for the nine municipalities because of the changes since 1975;
- potential wastes from Metro Toronto.

TABLE 1

REGION OF YORK

1981-2001 POPULATION PROJECTIONS FOR THE 9 MUNICIPALITIES

Ref. No.	Municipalities	1979* Year End	1981	1986
	TOWNS			
001	Markham	68,333	72,650	84,650
002	Richmond Hill	35,729	39,400	50,300
003	Newmarket	26,662	27,800	30,800
004	Vaughan	21,868	25,700	38,600
005	Aurora	15,421	16,350	18,850
006	Whitchurch-Stouffville	13,422	13,900	15,250
	TOWNSHIPS			
007	Georgina	19,045	20,200	23,300
008	King	14,901	15,450	16,850
009	East Gwillimbury	11,889	12,450	14,050
	REGION OF YORK	227,270	243,900	292,650

Ref. No.	Municipalities	1991	1996	2001*
	TOWNS			
001	Markham	98,650	115,000	134,000
002	Richmond Hill	64,150	81,900	104,500
003	Newmarket	34,150	37,900	42,000
004	Vaughan	57,900	86,950	130,500
005	Aurora	21,750	25,100	29,000
006	Whitchurch-Stouffville	16,700	18,250	20,000
	TOWNSHIPS			
007	Georgina	26,950	31,150	36,000
008	King	18,450	20,150	22,000
009	East Gwillimbury	15,800	17,750	20,000
	REGION OF YORK	354,500	434,150	538,000

* Provided by Region - 1979 and 2001

3.2 *PRESENT POPULATION PROJECTIONS*

Figure 1, opposite page 3-1, shows the most recent population growth projections to 2001. Also illustrated are the projections used in the 1975 report. The data for the development of Figure 1 is given in Table 1, opposite.

The population projections to the year 2001 are lower than predicted in 1975. It may be that these new predictions may be changed to lower numbers in the next few years. This possible change is not of concern to the outcome of this study because of the most likely acceptance of landfill as the solution and its relative insensitivity to modest changes in annual solid waste generation rates.

3.3 *SOLID WASTE GENERATION IN REGION AND ELSEWHERE*

Table 2 opposite page 3-3 shows the estimated solid waste generation for the next 20 years in the Region of York. It has been derived from application of present and estimated future per capita rates of refuse generation to the population numbers presented in Table 1.

The overall refuse generation rates applied include the refuse generated by households, commercial facilities, institutions, and the industries in the York Region.

The 1974-1975 study work on the industrial waste component was arrived at from an extensive survey and questionnaire to all industries in the Region. This survey was essential because industrial waste generation can vary appreciably between types of industry. It is not necessarily correlated to a number of employees, a number of acres of industrial land occupied or to an industrial sales volume, as assumed in some Waste Management Studies in past years.

TABLE 2

REGION OF YORK

OVERALL PROJECTED MUNICIPAL REFUSE GENERATION

HOUSEHOLD REFUSE, COMMERCIAL AND INDUSTRIAL WASTES

Tons (Imperial) per Year

Ref. No.	Municipalities	1979 Year End	Year 1981 Low	Year 1981 High	Year 1986 Low	Year 1986 High
	TOWNS					
001	Markham	55,600	60,200	60,700	70,300	77,800
002	Richmond Hill	29,100	32,600	32,900	41,700	46,300
003	Newmarket	21,700	23,000	23,200	25,600	28,300
004	Vaughan	17,800	21,200	21,500	32,000	35,500
005	Aurora	12,500	13,600	13,700	15,600	17,300
006	Whitchurch-Stouffville	10,900	11,500	11,600	12,700	14,000
	TOWNSHIPS					
007	Georgina	15,500	16,800	16,900	19,300	21,400
008	King	12,200	12,800	13,000	14,000	15,500
009	East Gwillimbury	9,700	10,300	10,500	11,800	12,900
	REGION OF YORK	185,000	202,000	204,000	243,000	269,000

Ref. No.	Municipalities	Year 1991 L	Year 1991 H	Year 1996 L	Year 1996 H	Year 2001 L	Year 2001 H
	TOWNS						
001	Markham	81,800	99,100	95,400	126,400	111,200	162,100
002	Richmond Hill	53,100	64,400	67,900	90,100	86,700	126,400
003	Newmarket	28,300	34,300	31,400	41,600	34,900	50,800
004	Vaughan	48,000	58,200	72,100	95,500	108,300	157,900
005	Aurora	18,100	21,900	20,800	27,500	24,200	35,100
006	Whitchurch-Stouffville	13,900	16,700	15,100	20,100	16,700	24,200
	TOWNSHIPS						
007	Georgina	22,400	27,100	25,900	34,200	29,900	43,600
008	King	15,300	18,500	16,700	22,200	18,400	26,600
009	East Gwillimbury	13,100	15,800	14,700	19,400	16,700	24,200
	REGION OF YORK	294,000	356,000	360,000	477,000	447,000	650,000

- High projection is the product of Regional population projections and the highest anticipated generation rates. Low projection numbers are based on estimated minimal generation rates.

The present household and commercial rates have been derived from the data on the waste collection and disposal assembled in the 1974-1975 study by updating where needed. In general, these rates are fairly uniform in this part of Canada. They tend to change only with population density. It is found that the highest per capita rates for household refuse are found in the larger cities such as Metropolitan Toronto, and the lowest are found in rural areas.

Some years ago, the Toronto per capita rate of total refuse generation including household, commercial and industrial wastes was almost 1 ton per capita per year. About 50% of this is residential household waste. Now the most recent review of the Metro waste generation indicates a lower rate to 0.9 tons. We estimate that the Regional rate is about 0.83 tons per capita per year. Current data from the Hamilton-Wentworth operations confirms this trend to lower rates.

In the York Region there was practically no weighing of refuse prior to 1974-1975. There are better records now because of new weigh scales at the private sites being installed. We find that the per capita weight generation has not appreciably changed in the Region in the last five years.

There has been a geographical shift in the disposal quantities with respect to the waste received from Metro Toronto. In 1974-1975 the largest portion of the Metro solid waste imported into York went to the private landfill site in Vaughan at an approximate rate of 150,000* tons per year. This has been closed in 1976 and the Vaughan municipal site does not accept Metro Toronto wastes. The change means that most of the Metro wastes are now going to the three private sites in the eastern part of the Region at the rate of approximately 200,000* tons per year. This means there is a major shift from west to east of the refuse inflow into York Region from Metro Toronto.

*Approximations based on limited records (no weighscales in 1974-1975; geographical origin of wastes not always clear in records)

TABLE 3

DATA PRESENTED IN THE AUGUST, 1980

METRO TORONTO WASTE MASTER PLAN REPORT

METRO QUANTITIES (1978)	WEIGHT		PER CAPITA RATE
	In Tonnes (Metric)	In Tons (Imperial)	In Tons (Imp.) Per Capita Per Year
Municipality collected refuse	871,291*	959,800	0.45
Privately collected refuse at commercial and industrial facilities, etc.	±863,000**	950,700	0.45
Sub-total	±1,734,291	1,910,500	0.90
Disposed at Metro Incinerators and landfill facilities	1,514,291	1,668,500	
Balance disposed by private collectors at private (non-Metro) facilities, i.e., mainly disposed in York Region	220,000***	242,000	

* - Metro Report, Page III-3, Second Paragraph

** - Metro Report, Page III-3, First Paragraph

*** - Metro Report, Page III-2, Last Paragraph

Note: There are some discrepancies between various tabulations in this 1980 report, but the above fits closest to Metro data in our own files.

Table 3, opposite, shows the recorded disposal quantities for Metro Toronto in 1978 for collection and disposal at Metro facilities. From these figures it appears that about 242,000 tons per year presently must be disposed in the York Region. This is about the same as found five years ago.

It is to be appreciated that the disposal records at sites in York Region show the total refuse disposed by the York Region collectors, together with that of the private haulers from Metro Toronto*. Consequently, the York Region site records are not kept such that the actual generation in the York Region is separated from the wastes brought in from outside.

Apart from the Metro Toronto import there is occasionally some waste shipment to the Region of York facilities from other places such as from Orangeville to the Aurora site. For instance, the firm of York Sanitation Limited owns the Aurora and Highway No. 48 sites in York; they also own the Bradford site outside York and can shift wastes between these sites as required.

3.4 *TWO SETS OF PROJECTIONS FOR YORK WASTE*

For resource recovery it is better to consider the minimum waste projections, and for landfilling to consider maximum waste projections. The waste projections for the period of 1981 to 2001 shown in Table 2 provide both the high and the low figures. (1981 - 202,000 to 204,000 T/yr)
(2001 - 447,000 to 650,000 T/yr)

The low projection is arrived at from the lower projections for population growth and the consideration of the present waste generation rate, with a slight downward trend in this rate expected by the year 2001.

The high projection is derived from the Region's actual population forecasts and considering a steadily increasing refuse generation rate of 2 1/2% per year. This growth rate would likely take place if the Gross National Product would grow at about the same rate. This does not appear

*In some instances the York Region collector and the private sector hauler from Metro Toronto is the same firm because Steeles Avenue is no barrier to waste collector trucks.

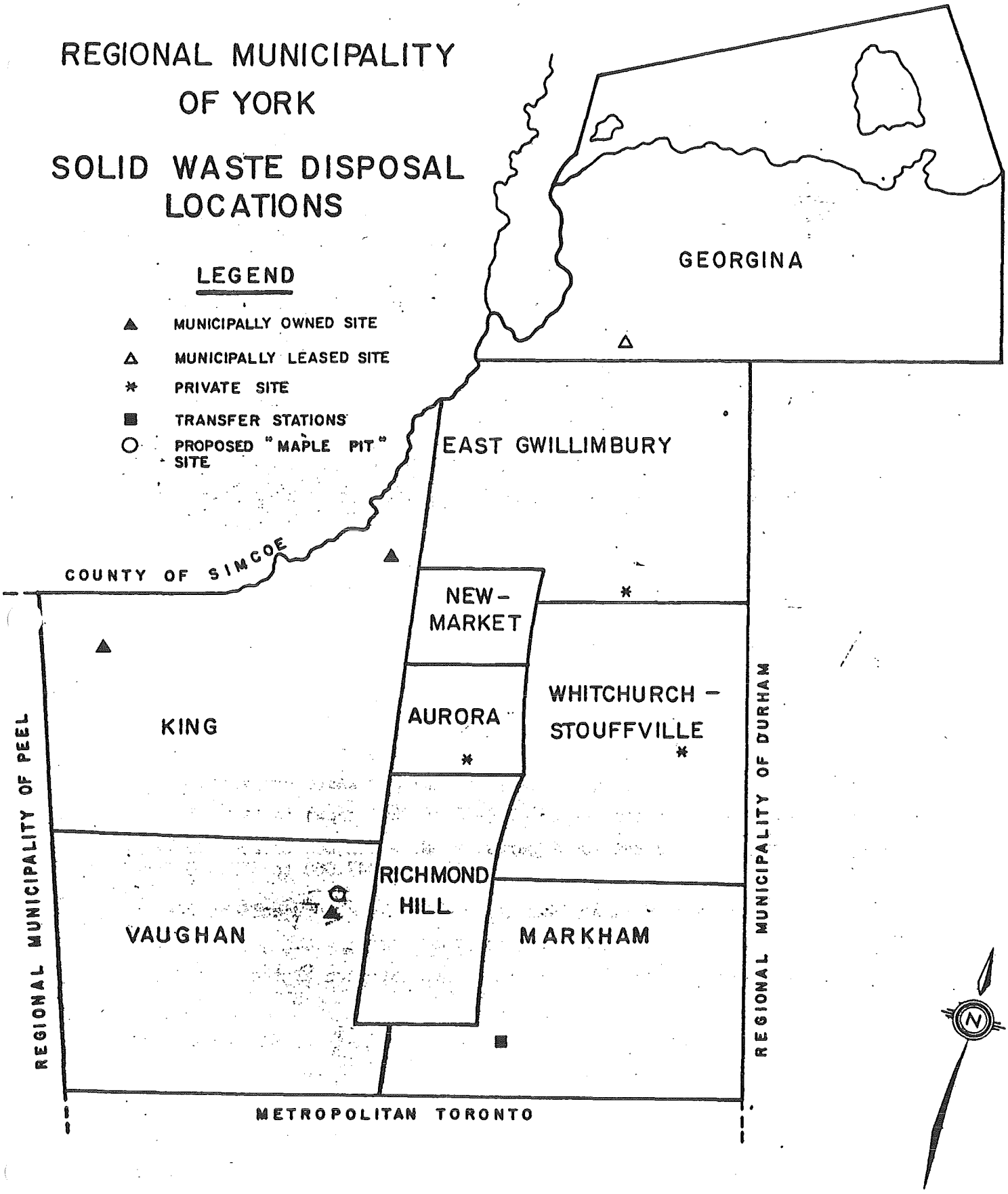

REGIONAL MUNICIPALITY OF YORK
SOLID WASTE DISPOSAL LOCATIONS
LEGEND
MUNICIPALLY OWNED SITE
MUNICIPALLY LEASED SITE
PRIVATE SITE
TRANSFER STATIONS
PROPOSED "MAPLE PIT" SITE
GEORGINA
EAST GWILLIMBURY
COUNTY OF SIMCOE
NEW-MARKET
KING
AURORA
WHITCHURCH-STOUFFVILLE
RICHMOND HILL
VAUGHAN
MARKHAM
REGIONAL MUNICIPALITY OF PEEL
REGIONAL MUNICIPALITY OF DURHAM
METROPOLITAN TORONTO
N

FIGURE 2

to be the case considering the performance of the Canadian economy, especially in Ontario. However, the use of the higher rates of generation is safer in considering the Region's needs for landfill capacities.

3.5 PROJECTIONS FOR WASTES IMPORTED TO YORK

Although the waste collection and disposal practices within York Region does not provide accurate refuse generation data, the present state-of-the-art provides enough background to confirm the data in hand and to be able to project the Region's generation rates with enough confidence.

The projection of waste quantities imported to York from Metro Toronto is difficult to predict. This is particularly a concern because the present import from Metro Toronto equals the generation in all of the York Region. Developments in policies with respect to Metro's disposal practice will have an appreciable affect on projections, and the extent of landfill space that York will have to compete for or otherwise control.

We see the following factors affecting these projections:

- Metro Toronto and the private haulers in Metro have been under considerable pressure to find landfill sites or to establish other means of waste disposal in the last decade. Reports and proposals on incineration, resource recovery, long distance rail haul, etc., have been produced. The specific solutions to their problems were not offered by the Province because they did not see that to be their role.
- York Region is very accessible to Metro; the hydrogeology is considered as good or better than Peel and Durham, and Peel has not made its sites available for Metro wastes.
- Proposals for disposal by rail or long distance road haul to other areas in Ontario has invoked extensive opposition.
- The private sector has seen excellent opportunities to combine gravel pit rehabilitation with refuse disposal. This is the "Maple Pits" situation.
- The provisional approval of the "Maple Pits" landfill application is for 245 of the 928 acre Maple site and a development in Phase 1 to be available by December 1981.

TABLE 4

REGION OF YORK

(20-YEAR)(1981-2001)ACCUMULATION OF

OVERALL PROJECTED MUNICIPAL REFUSE GENERATION

HOUSEHOLD REFUSE, COMMERCIAL AND INDUSTRIAL WASTES

Ref. No.	Municipalities	Imperial 1981-2001 (Million tons) Low	High
	TOWNS		
001	Markham	1.7	2.1
002	Richmond Hill	1.1	1.4
003	Newmarket	0.6	0.7
004	Vaughan	1.1	1.4
005	Aurora	0.3	0.5
006	Whitchurch-Stouffville	0.3	0.3
	TOWNSHIPS		
007	Georgina	0.4	0.6
008	King	0.3	0.4
009	East Gwillimbury	0.3	0.3
	REGION OF YORK - TOTALS	6.1	7.7

The low estimate for Metro Toronto wastes import is 6.3 million tons, making the total disposal in the Region minimum 12.4 million tons in 20 years.

The high estimate for Metro is 13.6 million tons for a potential total to be disposed in the Region of maximum 21.3 million tons in 20 years.

- The 1980 Metro Toronto Report shows this 245 acre area has a capacity rating of about 25 million tonnes* and can meet the needs of the York Region plus Metro Toronto over the next 20 years.

It can be appreciated, then, that once the Maple Pits become a major Metro disposal facility, there will be pressures to dispose there as much as can be handled to relieve Metro's other facilities. This makes it difficult to project the future annual import of Metro solid waste into the Region.

3.6 SOLID WASTE COLLECTION AND HAULAGE PRACTICE IN YORK

In the 1974-1975 study considerable data on the collection and haulage of solid waste in the Region was assembled. The most pertinent of this information has been appended in Appendix "D" in this report. They are:

Table A - Particulars of Existing Disposal Sites
Table B - Municipal Collection and Disposal Information
Table C - Survey of Solid Waste Procedures in York Region

Details of the collection practice and current costs of all municipalities in the Region are given in Tables B and C in Appendix "D".

There is an appreciable variety of collection and haulage practice in the nine municipalities of the Region, which makes it somewhat difficult to appreciate the overall costs and waste quantities in each of the nine municipalities. This information is needed in developing a comprehensive management plan and will be discussed later in this report.

*equivalent to 27.5 million Imperial tons

TABLE 5

EXISTING LANDFILL SITE - SUMMARY

1. Municipally Owned Sites

   a) Township of King - east and west sides (Schomberg and Holland Landing)

   b) Township of Georgina

   c) Town of Vaughan

   - total acreage of the four sites ± 100 acres

   - estimated lifetime left: - 2 sites nearly filled
     - 2 sites with 5-10 year life

   - estimated capacity left ± 0.1 million tons

2. Privately Owned Sites (Handling 80-90 percent of all Disposal Wastes)

   a) York Sanitation Site No. 1 - Aurora

   b) " " No. 2 - E. Gwillimbury

   c) " " No. 4 - Bremner Site on Hwy No. 48*

   d) Disposal services - Vaughan Site - closed

   (Note: York Sanitation and Disposal Services are subsidiaries of Waste Management Inc. of Chicago, Illinois)

   - total acreage of the 3 sites ± 280 acres

   - estimated life time left 5 - 10 years

   - estimated capacity left ±2.1 million tons**

* The present application before the Board is for an 80 acres - 2.5 million ton capacity extension, with the public hearing expected to start in February 1981.

** Some estimates show a present residue capacity for the Hwy 48 site of 2 million tons plus 1 million in total at the other sites.

Exhibit 4 - 850

OPTION #1

C. N. WATSON REPLICATION OF CRA'S RECOMMENDED WASTE QUANTITY FORECAST (Table 5.7)
(in imperial tons)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
YEAR	POPULATION FORECAST	GENER. RATE	WASTE GENERATED	SOURCE SEPAR.	SOURCE SEPARATION TONS	DISPOSABLE WASTE	CONTINGENCY (5%)	DISPOSABLE WASTE FORECAST	EFW COM.	EFW ASH	EFW NON-COMB.	EFW CONT.	EFW LANDFILL	LANDFILLED WASTE
1988	290,425	0.900	87,040	0.09	7,834	79,207	3,960	83,167	0	0	0	0	0	83,167
1989	299,945	0.917	275,050	0.1	27,505	247,545	12,377	259,922	0	0	0	0	0	259,922
1990	309,469	0.934	289,044	0.12	34,685	254,359	12,718	267,077	0	0	0	0	0	267,077
1991	318,983	0.951	303,353	0.12	36,402	266,950	13,348	280,298	0	0	0	0	0	280,298
1992	325,994	0.968	315,562	0.12	37,867	277,695	13,885	291,579	0	0	0	0	0	291,579
1993	333,005	0.985	328,010	0.12	39,361	288,649	14,432	303,081	0	0	0	0	0	303,081
1994	340,017	1.003	341,037	0.12	40,924	300,113	15,006	315,118	0	0	0	0	0	315,118
1995	347,028	1.02	353,969	0.12	42,476	311,492	15,575	327,067	0	0	0	0	0	327,067
1996	354,039	1.038	367,492	0.12	44,099	323,393	16,170	339,563	0	0	0	0	0	339,563
1997	361,599	1.056	381,849	0.12	45,822	336,027	16,801	352,828	0	0	0	0	0	352,828
1998	369,159	1.074	396,477	0.12	47,577	348,900	17,445	366,345	0	0	0	0	0	366,345
1999	376,719	1.082	407,610	0.12	48,913	358,697	17,935	376,632	0	0	0	0	0	376,632
2000	384,279	1.09	418,864	0.12	50,264	368,600	18,430	387,030	0	0	0	0	0	387,030
2001	391,839	1.098	430,239	0.12	51,629	378,611	18,931	397,541	0	0	0	0	0	397,541
2002	396,985	1.107	439,462	0.12	52,735	386,727	19,336	406,063	0	0	0	0	0	406,063
2003	402,131	1.115	448,376	0.12	53,805	394,571	19,729	414,299	0	0	0	0	0	414,299
2004	407,277	1.123	457,372	0.12	54,885	402,487	20,124	422,612	0	0	0	0	0	422,612
2005	412,423	1.132	466,863	0.12	56,024	410,839	20,542	431,381	0	0	0	0	0	431,381
2006	417,569	1.14	476,029	0.12	57,123	418,905	20,945	439,850	0	0	0	0	0	439,850
2007	422,919	1.149	485,934	0.12	58,312	427,622	21,381	449,003	0	0	0	0	0	449,003
2008	428,268	1.157	330,007	0.12	39,601	290,406	14,520	304,927	0	0	0	0	0	304,927
			7,799,639		927,844	6,871,794	343,590	7,215,384	0	0	0	0	0	7,215,384
CRA ACTUAL			7,801,218		928,058	6,873,159	343,658	7,216,817						7,216,817

OPTION #2

CRA Recommended, Substituting C. N. Watson's Waste Generation Rates

(1) YEAR	(2) POPULATION FORECAST	(3) GENER. RATE	(4) WASTE GENERATED	(5) ADDIT. SOURCE SEPAR.	(6) SOURCE SEPARATION TONS	(7) DISPOSABLE WASTE	(8) CONTINGENCY (5%)	(9) DISPOSABLE WASTE FORECAST	(10) EFW COM.	(11) EFW ASH	(12) EFW NON-COMB.	(13) EFW CONT.	(14) EFW LANDFILL	(15) LANDFILLED WASTE
1988	290425	0.800	77369	0.044	3404	73965	3698	77663	0	0	0	0	0	77663
1989	299945	0.800	239956	0.054	12958	226998	11350	238348	0	0	0	0	0	238348
1990	309469	0.800	247575	0.074	18321	229255	11463	240717	0	0	0	0	0	240717
1991	318983	0.800	255186	0.074	18884	236303	11815	248118	0	0	0	0	0	248118
1992	325994	0.800	260795	0.074	19299	241496	12075	253571	0	0	0	0	0	253571
1993	333005	0.800	266404	0.074	19714	246690	12335	259025	0	0	0	0	0	259025
1994	340017	0.800	272014	0.074	20129	251885	12594	264479	0	0	0	0	0	264479
1995	347028	0.800	277622	0.074	20544	257078	12854	269932	0	0	0	0	0	269932
1996	354039	0.800	283231	0.074	20959	262272	13114	275386	0	0	0	0	0	275386
1997	361599	0.800	289279	0.074	21407	267873	13394	281266	0	0	0	0	0	281266
1998	369159	0.800	295327	0.074	21854	273473	13674	287147	0	0	0	0	0	287147
1999	376719	0.800	301375	0.074	22302	279073	13954	293027	0	0	0	0	0	293027
2000	384279	0.800	307423	0.074	22749	284674	14234	298908	0	0	0	0	0	298908
2001	391839	0.800	313471	0.074	23197	290274	14514	304788	0	0	0	0	0	304788
2002	396985	0.800	317588	0.074	23502	294086	14704	308791	0	0	0	0	0	308791
2003	402131	0.800	321705	0.074	23806	297899	14895	312794	0	0	0	0	0	312794
2004	407277	0.800	325822	0.074	24111	301711	15086	316796	0	0	0	0	0	316796
2005	412423	0.800	329938	0.074	24415	305523	15276	320799	0	0	0	0	0	320799
2006	417569	0.800	334055	0.074	24720	309335	15467	324802	0	0	0	0	0	324802
2007	422919	0.800	338335	0.074	25037	313298	15665	328963	0	0	0	0	0	328963
2008	428268	0.800	228181	0.074	16885	211296	10565	221861	0	0	0	0	0	221861
			5882654		428196	5454457	272723	5727180	0	0	0	0	0	5727180

OPTION #3

CRA Recommended, Substitituting C. N. Watson's Waste Generation Rates and EFW Assumptions

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
YEAR	POPUL. FORE.	GENER. RATE	WASTE GENERATED	ADDIT. SOURCE SEPAR.	SOURCE SEPARATION TONS	DISPOSABLE WASTE	CONTINGENCY (5%)	DISPOSABLE WASTE FORECAST	EFW COM.	EFW ASH	EFW NON-COMB.	EFW CONT.	EFW LANDFILL	LANDFILLED WASTE
1988	290425	0.800	77369	0.044	3404	73965	3698	77663	0	0	0	0	0	77663
1989	299945	0.800	239956	0.054	12958	226998	11350	238348	0	0	0	0	0	238348
1990	309469	0.800	247575	0.074	18321	229255	11463	240717	0	0	0	0	0	240717
1991	318983	0.800	255186	0.074	18884	236303	11815	248118	0	0	0	0	0	248118
1992	325994	0.800	260795	0.074	19299	241496	12075	253571	0	0	0	0	0	253571
1993	333005	0.800	266404	0.074	19714	246690	12335	259025	0	0	0	0	0	259025
1994	340017	0.800	272014	0.074	20129	251885	12594	264479	0	0	0	0	0	264479
1995	347028	0.800	277622	0.074	20544	257078	12854	269932	0	0	0	0	0	269932
1996	354039	0.800	283231	0.074	20959	262272	13114	275386	43668	5581	5546	3254	14381	246098
1997	361599	0.800	289279	0.074	21407	267873	13394	281266	133936	17117	17010	9981	44108	191438
1998	369159	0.800	295327	0.074	21854	273473	13674	287147	136736	17475	17366	10190	45030	195440
1999	376719	0.800	301375	0.074	22302	279073	13954	293027	139537	17833	17721	10398	45952	199443
2000	384279	0.800	307423	0.074	22749	284674	14234	298908	142337	18191	18077	10607	46874	203445
2001	391839	0.800	313471	0.074	23197	290274	14514	304788	145137	18549	18432	10816	47797	207447
2002	396985	0.800	317588	0.074	23502	294086	14704	308791	147043	18792	18674	10958	48424	210172
2003	402131	0.800	321705	0.074	23806	297899	14895	312794	148949	19036	18917	11100	49052	212896
2004	407277	0.800	325822	0.074	24111	301711	15086	316796	150855	19279	19159	11242	49680	215621
2005	412423	0.800	329938	0.074	24415	305523	15276	320799	152761	19523	19401	11384	50307	218345
2006	417569	0.800	334055	0.074	24720	309335	15467	324802	154668	19767	19643	11526	50935	221069
2007	422919	0.800	338335	0.074	25037	313298	15665	328963	156649	20020	19894	11673	51588	223902
2008	428268	0.800	228181	0.074	16885	211296	10565	221861	105648	13502	13417	7873	34792	151005
			5882654		428196	5454457	272723	5727180	1757926	224663	223257	131001	578920	4548175

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187 King Street East
Toronto, Ontario
M5A 1J5

MARKET FEASIBILITY and IMPACT STUDY

Convenience Commercial Centre Development

Part of Lot 1, Concession 3 W.H.S.

East Credit Secondary Plan Area

City of Mississauga

April 1986

G.M. STAMM, ECONOMIC RESEARCH ASSOCIATES

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Part I

INTRODUCTION AND SUMMARY OF FINDINGS

1.1 Introduction

The firm of G.M. Stamm, Economic Research Associates was retained by Kee Group Inc. to prepare a feasibility and market impact analysis for a site at the southwest corner of the intersection of Second Line West and the proposed east-west collector route between Eglinton Avenue and Bristol Road in the developing area of Mississauga. Figure 1.1 shows the location of the site in the context of Missisauga as a whole.

- The purpose of the analysis is to demonstrate that the development of this site as a Convenience Commercial Centre is feasible and appropriate in terms of the market and the impact on existing and designated retail centres. Currently the site's land use designation under the East Credit Secondary Plan is low density residential.

Figure 1.2 shows the site in the context of the East Credit Secondary Plan Area.

The remainder of this part of the report presents a summary of our findings. Part II provides a description of the context of the site to provide an understanding of the broader view of the area as well as the local neighbourhood context. The next part of the report, Part III, provides a description of the trade area delineated, and the zone structure adopted for the analysis. The competitive retail structure is the subject of Part IV of the report. Trade area population, income and expenditure estimates to 1996 are presented in Part V. Having established the framework for analysis the projected market potential of the trade area is presented in Part VI and includes a discussion of the feasibility and impact of the proposed convenience centre.

Planning and traffic considerations, such as flows, parkin requirements, access and egress and other items are not considered i this report.

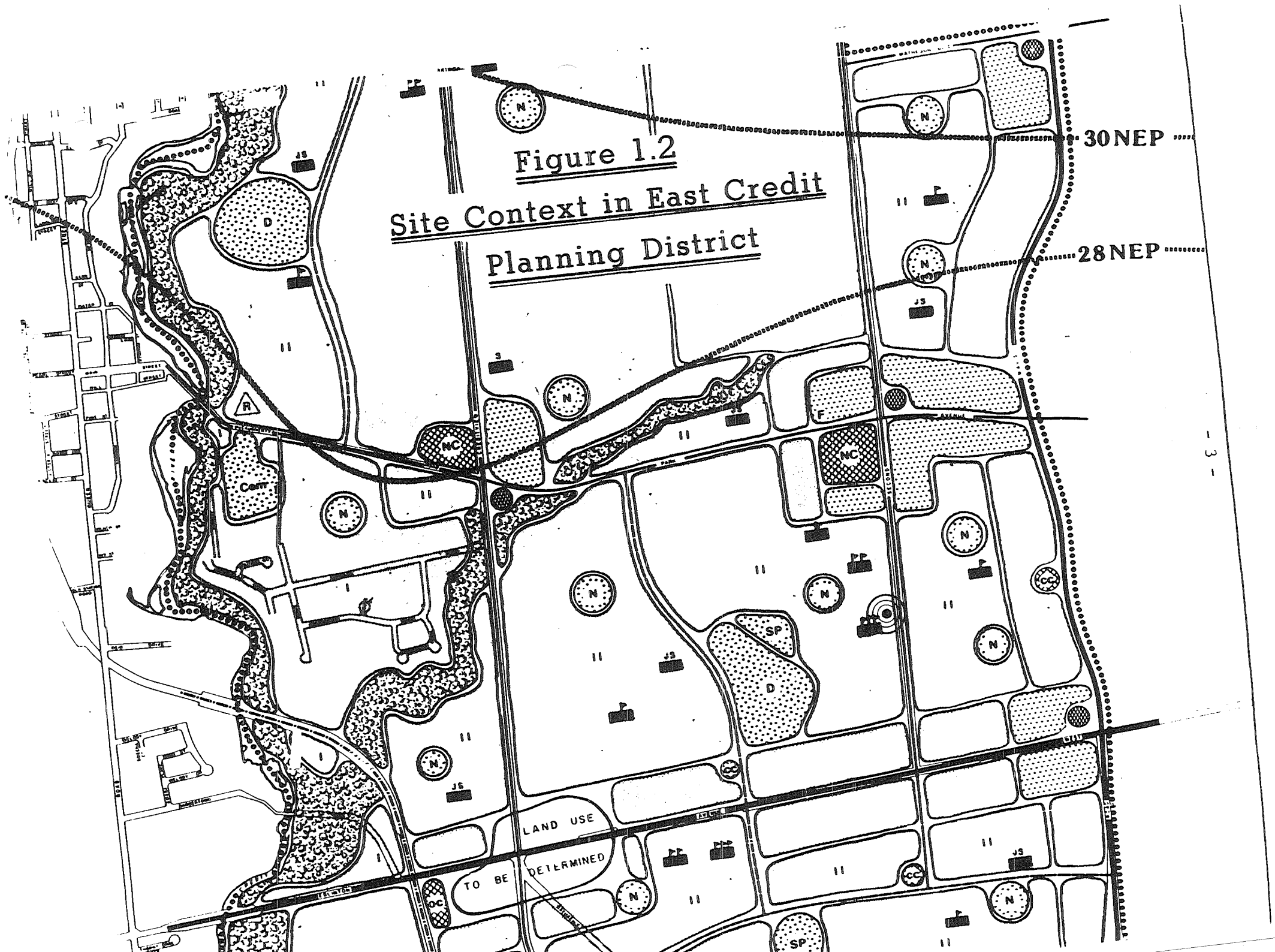


Figure 1.2

Site Context in East Credit

Planning District

It should be noted that all dollar figures in this report are expressed in constant 1985 dollars.

1.2 Basic Assumptions

In preparing this study a number of assumptions with respect to the development of the City of Mississauga and the trade area in particular were made. City of Mississauga documents were used.

First, information from the City of Mississauga policy and planning documents was used in the market analysis including the following:

a. The "ultimate" population data for the areas under analysis were provided in the East Credit Secondary Plan.

b. The population data which was provided on a neighbourhood basis in the secondary plans was, in some instances, broken down further for the purposes of analysis; this breakdown was determined through land use measurements (undertaken by this firm using the secondary plan land use plans) combined with housing density data from the secondary plan documents.

c. The distribution of future retail facilities was determined from the East Credit Secondary Plan and the Hurontario Secondary Plan.

d. The size of the proposed retail facilities have been determined according to the commercial policies of the City as set out in OPA 52.

Second, the analysis assumes the "ultimate" population of the trade area for the site under analysis.

Third, per capita personal disposable income (PDI) has been estimated based on (i) the 1981 Census income data, (ii) Ontario Economic Accounts data on personal disposable income to 1985, and (iii) estimates of future income growth. The 1981 census data, which reports 1980 income, has been adjusted to reflect 1981 income in 1981. In this report we have assumed the average PDI (Personal Disposable Income) level for the City of Mississauga as applicable to the area under examination. The

PDI estimate used in the analysis is the level of PDI expected at the approximate time that the "ultimate" population of the trade area is reached, ie., in this case the year 1996.

Since no information with respect to housing prices is available, we have made the assumptions that the future income of the "hole in the doughnut" area will replicate the structure of existing Mississauga residents with respect to the income levels relative to regional, provincial and national averages. We have accrued to that income the normal PDI growth expectations which we have used for the trade area as whole.

1.3 Summary of Findings

There are some characteristics of the site and its surroundings that merit mention at the outset.

1. The site is located within the municipal boundaries of one of the fastest growing municipalities in the Toronto Region. The City of Mississauga grew from a population of 250,035 in 1976 to 315,056 in 1981, or at an annual rate of just less than 5%. Rapid-paced growth has continued since 1981.

2. The site is located within a large tract of undeveloped land which has become known as "the hole in the doughnut". Development of this large tract of land has now begun, and is accelerating. Development is underway to the south of Eglinton Avenue and east of Mavis Road. From a market point of view, the development of East Credit neighbourhood 2 could proceed immediately.

3. The location of the site is of key importance in assessing potential retail and/or commercial uses for the site. The market share that this site can attract is largely a function of its location and accessibility within the community. The subject site is central to an area which is designated residential and contains low, medium and high density residential areas. The site is highly accessible, being located at the intersection of major and minor collector routes. These locational characteristics make the site attractive to both pedestrian and automobile traffic.

4. The trade area for the proposed Convenience Commercial Centre is bounded by Eglinton Avenue to the south, Mavis Road to the east, the proposed collector route located between Creditview Road and Second Line West to the west, and by a combination of Bristol Road and a greenbelt north of Bristol Road and east of Second Line West.

With respect to the market for a convenience commercial centre, the findings of the analysis are as follows:

5. Trade area population estimates, which have been prepared based on the secondary plans, indicate an ultimate population of 10,674. It is expected that this population will be realized by the early to mid 1990's based on the current status of subdivision development activity in the area.

6. Total personal disposable income (PDI) in the trade area will reach $190.9 million by 1996, or $17,881 per capita. By the year 2006 the PDI will have risen to $216.1 million with a per capita income of $20,247.

7. Total DSTM (Department Store Type Merchandise) expenditures in the trade area will reach $28.7 million by 1996, or $2,691 per capita; and $31.9 million or $2,991 by the year 2006. The convenience DSTM component (ie., pharmacy, florists, gift and book stores) of the total DSTM expenditures will be on the order of $5.6 million by 1996 and $6.3 million by 2006.

8. The trade area's total Food and Convenience Type Merchandise (FCTM) expenditures will be $14.8 million in 1996, with a per capita expenditure of $1,387. The convenience component (which includes convenience stores, small grocery stores, bake shops, butcher shops and other specialty food stores) will have expenditures of $3.8 million. By 2006 the convenience component will not have risen appreciably.

9. Personal service expenditures, which include dry cleaners and personal services (eg. hairdressers, barbers, other beauty services etc.), of the type which would consider a convenience centre location, are

estimated to reach $10.8 million in the trade area by 1996, and $12.2 million by the year 2006.

10. For restaurant services the trade area has been drawn to incorporate a larger geographic territory. The estimated total restaurant expenditures are $18.0 million by 1996 and $20.3 million by the year 2006. From these totals a "local" share pertaining to local restaurant spending can be estimated.

From these retail expenditure estimates, emanating from the trade area zones, the convenience centre will be able to draw its trade. Findings with repect to the development potential are as follows:

11. While two **neighbourhood commercial** facilities and one **connvenience commercial** centre are proposed for the periphery of the trade area, there is limited **convenience commercial** competition designated in and around the site. The site is in an excellent position to capture a significant portion of trade area convenience expenditures. The central location in a primarily residential area is highly accessible by pedestrian and vehicular traffic along proposed major and minor collector routes.

The development potential of the site has been examined and is summarized as follows:

12. Based on the market share that the proposed convenience commercial centre is expected to attract, an estimate of the supportable space has been determined.

- Under the "high" scenario, the market could support approximately 34,853 square feet (3,239 square metres) by 1996. This increases to 40,590 square feet (3,771 square metres) by 2006. In addition to this convenience commercial space, a restaurant of approximately 2,100 square feet is supportable at the site under this scenario.

- The "medium" scenario indicates that the supportable floor space would be approximately 26,140 square feet (2,429 square metres) by 1996, rising to 28,837 square feet (2,679 square metres) by 2006. This

scenario does not include a restaurant.

- Under the "low" scenario, the supportable space is 17,427 square feet (1,619 square metres) in 1996, increasing to 19,225 square feet (1,786 square metres) by 2006. A restaurant is not included under this scenario.

13. There has been no provision for inflow expenditures from outside the trade area in this analysis. While the site is located along a major collector route it has a central location in a primarily residential area; it is unlikely that a convenience commercial development at the site would experience sizeable inflow from outside the trade area.

With respect to impact, the finding is as follows:

14. There will be no adverse impact on any existing centre. With respect to designated or proposed commercial centres, the development of a convenience commercial centre at the subject site will not have an adverse impact on the opportunities to develop the other centres as shown in the secondary plan.

Part II

THE CONTEXT OF THE SITE

2.1 Introduction

In order to discuss the commercial potential of the subject site it is important to recognize the context in which development is proposed. The site and its immediate surroundings are currently greenfield; subdivision development is pending. At a macro level, the area is within a large tract of largely undeveloped land surrounded by an area that has grown very rapidly over the past decade. The existing and proposed development pattern and the phasing of the proposed development is vital to the strategic planning of retail development.

In this Part of the report we examine the context into which the proposed development will be placed. By examining the general pattern of development in (i) the City of Mississauga, (ii) the secondary plan area relevant to the site, and (iii) the site specific characteristics and surroundings, we will be able to undertake an analysis of the Convenience Commercial uses for the site.

2.2 An Overview of the City of Mississauga

Amalgamated in 1974, the City of Mississauga has developed in recent years by determining the location of its "core" area to be at Burnhamthorpe Road and Hurontario Street, and by planning its development in a manner which will bring land use and structural cohesion to the City. As a major part of that process, the City has put in place the Secondary Plans for the area which has become known as the "hole-in-the-doughnut", the area in which the subject site sits. This area is now developing very rapidly.

Figure 1.1, shown in Part I of the report, provides visual information on the distribution of developed and undeveloped lands relative to the location of the site. A discussion of the development environment and prospects for the area are useful in understanding the larger context of the market.

One of the most significant, planned land uses in the City of Mississauga is the City Centre. As was stated above, the City Centre was created in order to give the City a focal point; this is to be the downtown of Mississauga. Located at the approximate geographic centre of the City, the City Centre houses Square One regional shopping centre, one of the largest shopping centres in the Toronto Region. With almost one million square feet of retail space and a major expansion underway, Square One provides the nucleus of the City Centre. In addition to the retail space at the City Centre there is a large inventory of office space.

Mississauga has developed rapidly during the decade since its incorporation as a City. The population of the City increased from 250,035 in 1976 to 315,056, in 1981 according to Census data, for an annual growth rate of 4.7%. By comparison the Toronto Census Metropolitan Area (CMA) grew from 2,803,101 to 2,998,947 during the same period, or at an annual rate of 1.4%

The development pattern of the City has resulted in the developed lands encircling a piece of almost wholly undeveloped lands. This area has become known as the "hole in the doughnut". This area is bounded by Highway 403 to the south and east, the Credit River to the west and the City of Brampton to the north. This is the largest tract of land within the City that remains to be developed.

Figure 2.1 shows the location of the secondary planning areas for Mississauga. Of particular interest in this study is the East Credit Planning Area, highlighted in Figure 2.1, which constitutes a portion of the undeveloped lands in the "hole in the doughnut", south of Highway 401. The Secondary Plan for this area has been approved. Details of the Secondary Plan for this area are discussed in further detail below.

2.3 A General Description of the East Credit Secondary Plan Area

In order to determine appropriate uses for the site, consideration of the broader community within which the site is located is also required. The main features of the East Credit Secondary Plan area which affect the site have been examined for the purposes of this analysis. Figures 2.2 and 2.3 show the land use plan and the neighbourhood structure for the East Credit Secondary Plan area respectively.

The larger East Credit Secondary Plan area is based on a transportation system that has Eglinton Avenue and Britannia Road as its major east-

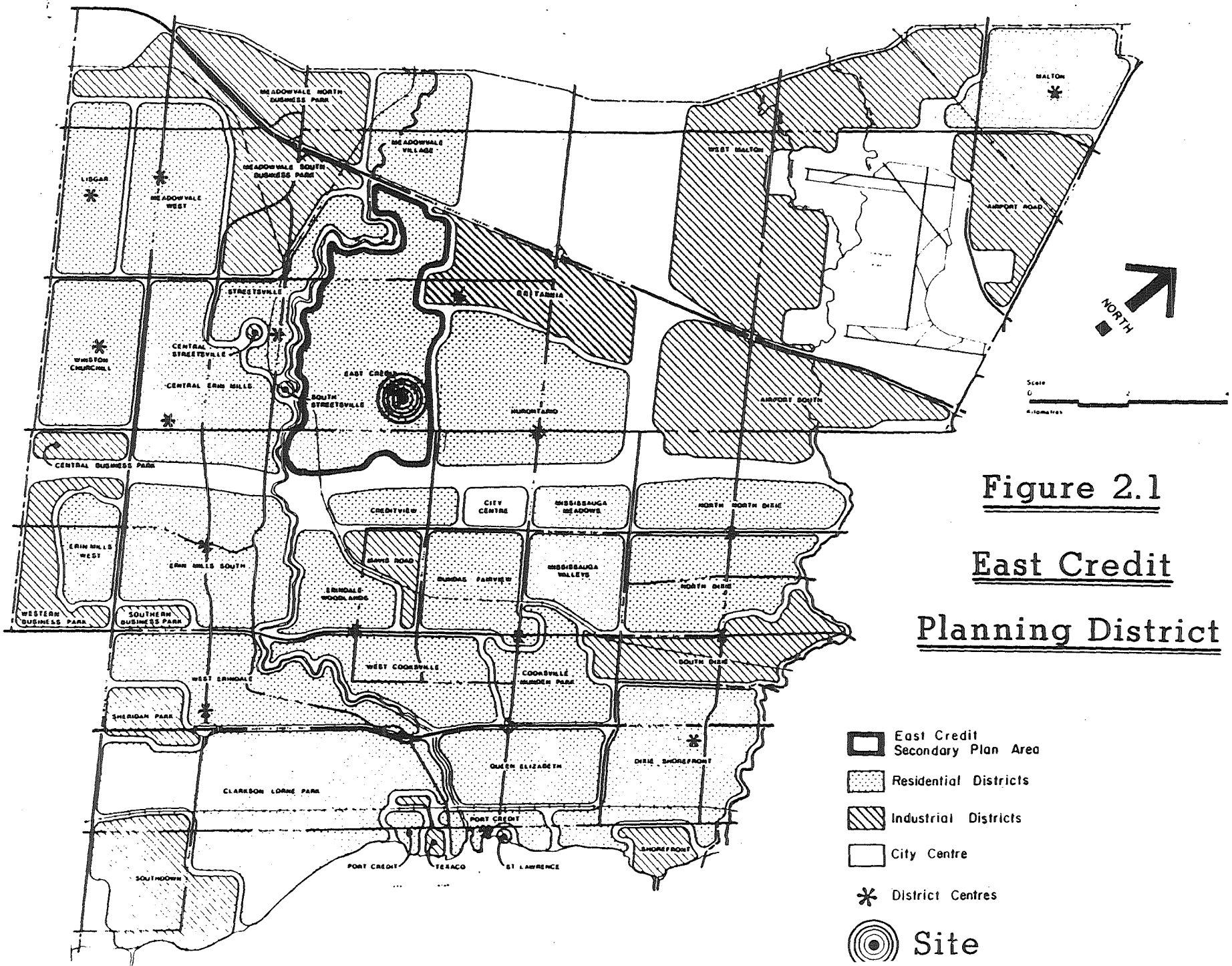


Figure 2.1

East Credit Planning District

Figure 2.2
East Credit Land Use Plan

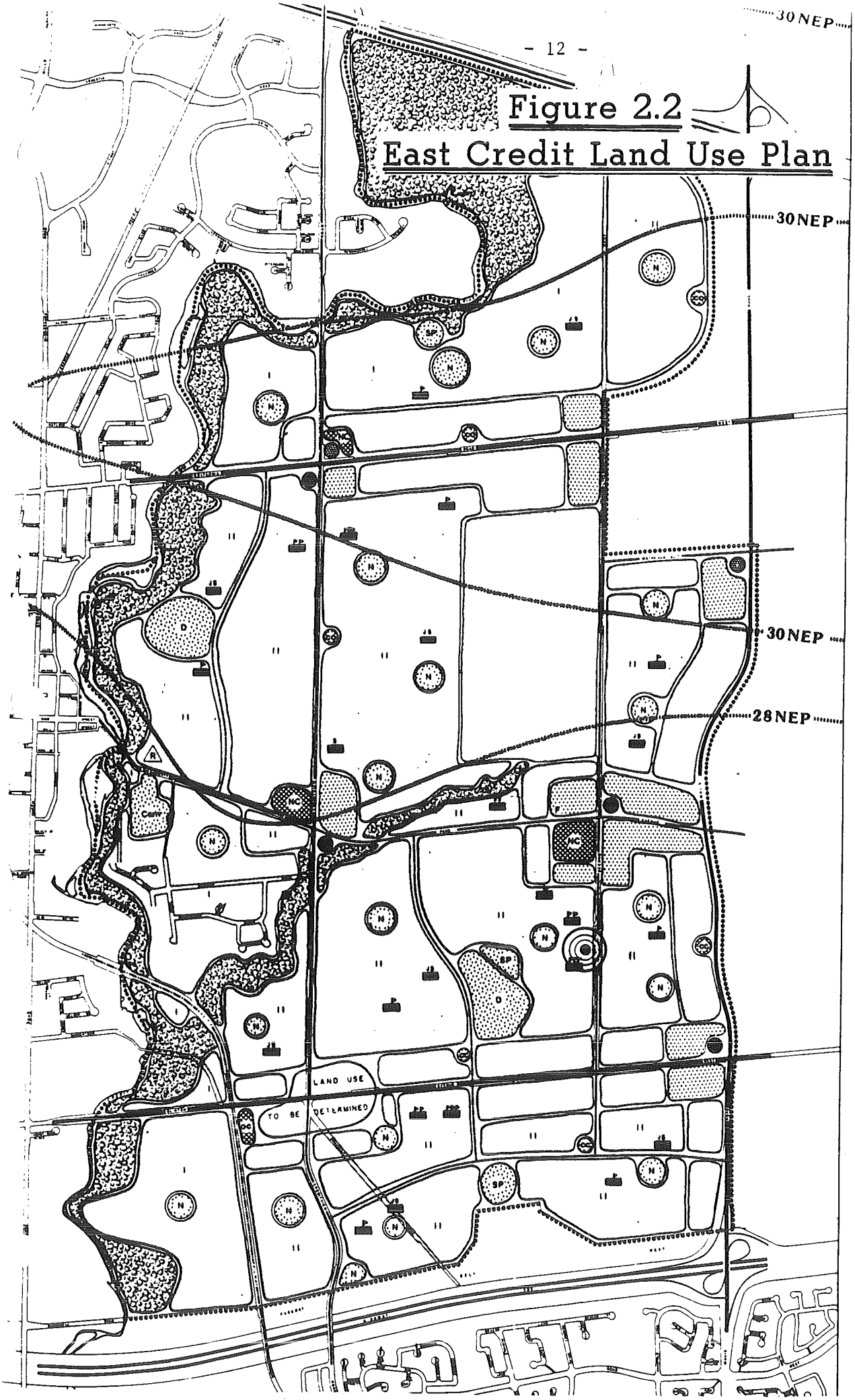
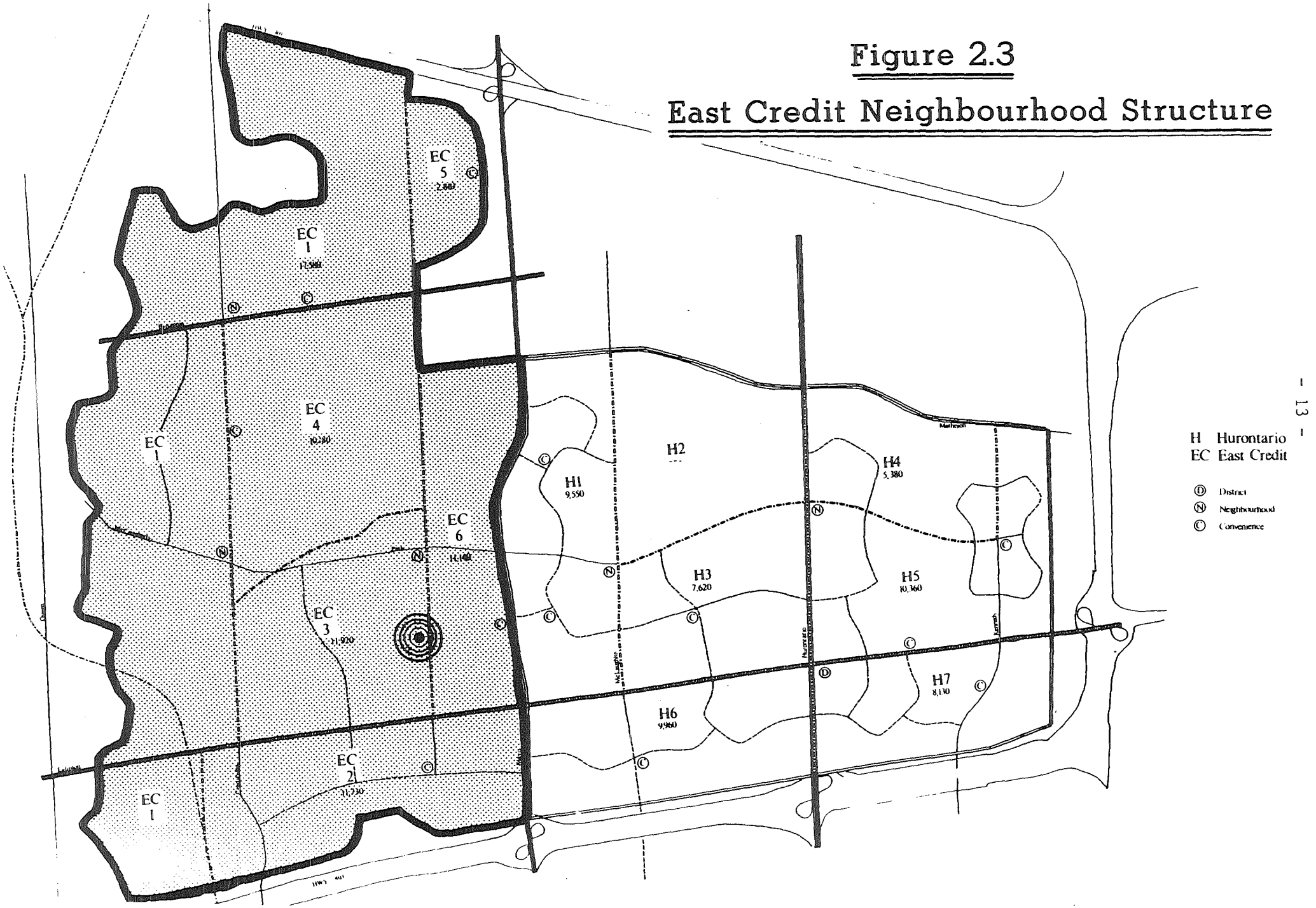


Figure 2.3

East Credit Neighbourhood Structure



west arterial roads. The north-south arterials are Mavis Road and Creditview Road. Access to Highway 403 and the area to the south of Highway 403, where the City Centre and the developed area of Mississauga are located, is provided along Mavis Road. Highway 403 is the southern boundary of the secondary plan. McCaugherty Road/ Bristol Road and Second Line West will act as collector routes for the secondary plan area.

Generally the residential structure of the area is such that designated medium density residential areas are situated along arterials and collectors. High density residential designations are found at the intersection of the arterial roads or at the intersection of arterial and major collector roads. The majority of the remaining lands within residential areas are designated for low density housing or associated neighbourhood uses such as schools and parks.

- The commercial structure of the East Credit Secondary Plan Area is very important in this analysis. Within the boundaries of the East Credit Secondary Planning Area, there is no provision for a regional centre because of the proximity to the established Square One super-regional shopping centre; but, the plans call for three Neighbourhood Centres and numerous Convenience Commercial Centres. Highway commercial designations are found throughout the area, usually at the intersection of arterial roads or arterial and collector roads. No district commercial centres are planned for the East Credit Secondary Plan area.

The land use designation of lands in the vicinity of the intersection of Eglinton Avenue and Creditview Road has not yet been determined. It is expected that the lands will contain a commercial component, most likely a neighbourhood centre. This would bring the number of neighbourhood centres in the East Credit Secondary Plan area to four.

This represents a synopsis of the Secondary Plan in and around the area of the site and provides background from which we have drawn some of our conclusions regarding the commercial uses for the sites.

2.4 A Description of the Site and Its Immediate Surroundings

The subject site is located in the East Credit 3 neighbourhood at the southwest corner of the intersection of Second Line West and the

proposed east-west collector to be located between Eglinton Avenue and Bristol Road. Figure 2.2 shows the land use designations of the area surrounding the subject site according to the East Credit Secondary Plan.

The site is central to the area bounded by Mavis Road, Eglinton Avenue West, Bristol Road, and the proposed collector to the west of the site between Second Line West and Creditview Road. Its location at the intersection of a major north-south collector and a proposed collector road provides good accessibility by both pedestrian and automobile movement.

Draft subdivision plans for the area are currently being prepared and have not been finalized. The nature of the proposed housing stock and densities is difficult to gauge. The characteristics of the adjacent development east of Mavis Road is used as a guide. From these draft plans of subdivision and the development currently underway the proposed neighbourhood can be described as mainly family-oriented. Housing densities are expected to range from low to high, with the majority being single family detached or semi-detached houses. The single family housing continues the trend to smaller houses with lot frontages ranging from 9.75 m to 12 m, with corner lots being slightly larger. Medium density residential areas are designated along Eglinton Avenue immediately east and west of Second Line West (approximately 500 metres south of the site) and along Mavis and Bristol Roads. High density residential uses are designated for the intersections of Second Line West and Bristol Road, approximately 400 metres north of the subject site, and Eglinton Avenue and Mavis Road.

The plans for a family orientation of the neighbourhood is found in the population and housing distribution by neighbourhood data in the appendix of the East Credit Secondary Plan which indicates an overall density of 3.16 persons per housing unit, similar to the average 1981 Mississauga density of 3.18 persons per unit. The East Credit Secondary Plan is more oriented to single family housing development than the Hurontario Secondary Planning Area.

- Of the planned housing stock in the East Credit Secondary Plan area, 81% will be developed as low and medium density dwelling types. In the Hurontario Secondary Plan area, only 54% of the housing stock is planned for low and medium density dwelling types.

The commercial designations or proposals for the area include the

following:

(1) a neighbourhood commercial centre designation at the southwest corner of the intersection of Bristol Road and Second Line West;

(2) a proposed neighbourhood centre on the southeast corner of Mavis Road and Eglinton Avenue;

(3) a convenience commercial centre designation on the west side of Mavis Road between Bristol Road and Eglinton Avenue West;

(4) a convenience commercial centre designation north of Eglinton Avenue along the proposed collector road between Second Line West and Creditview Road;

(5) a convenience commercial designation on Second Line West south of Eglinton Avenue and the proposed east-west collector;

(6) a highway commercial site on the northeast corner of Bristol Road and Second Line West; and

(7) a highway commercial designation on the northwest corner of Mavis Road and Eglinton Avenue.

- In summary, within the context of the designated land use pattern in and around the site, a convenience commercial centre at the subject site could provide for the convenience needs of the local population. The centrality of the site in a residential area and its location at the intersection of a major and a minor collector make the site highly accessible to both pedestrian and automobile traffic.

Part III

A DESCRIPTION OF THE TRADE AREA

3.1 Introduction

In order to evaluate the market opportunities available in the area, it is necessary to analyze the anticipated expenditure patterns of the population which could reasonably be expected to patronize the retail facilities in the area. For the purposes of making reliable estimates of market support, a trade area is defined.

The trade area is a geographical area from which retail facilities could normally expect to derive all but a small proportion of their sales volume. The geographic extent of the trade area is largely a function of:

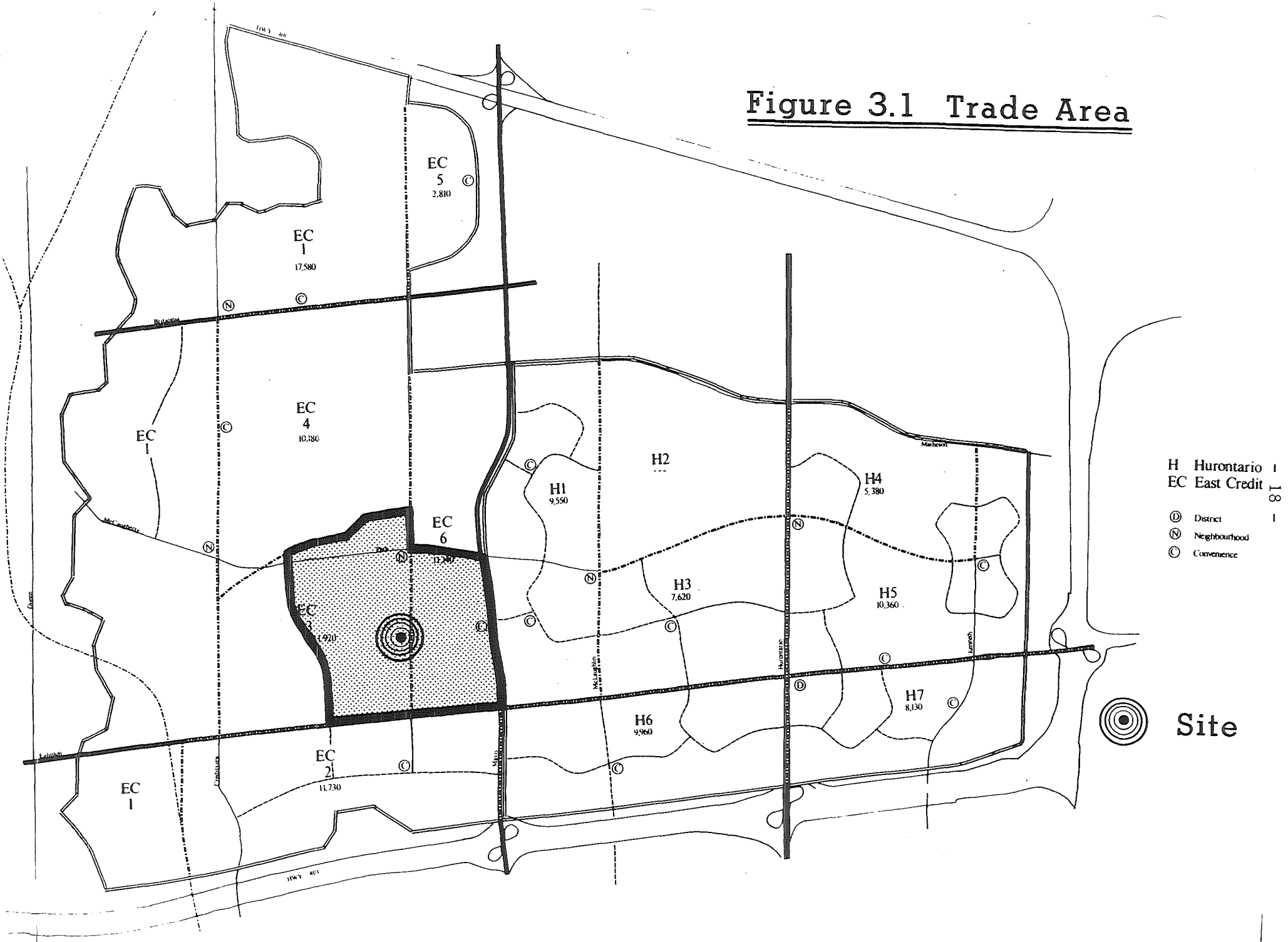
- the pattern of accessibility provided by the proposed road and sidewalk network;
- the size, type and character of existing retail facilities and proposed retail developments; and,
- the strength and location of competing retail facilities.

3.2 The Geographic Extent of the Trade Area

The extent of the trade area depends upon the type of retail and/or commercial activity that is contemplated for the site. For example, the trade area for a department store would be much larger than for a jug milk convenience store. A Convenience Commercial Centre is proposed for the subject site; an appropriate trade area for such commercial use has been delineated for the purposes of this analysis.

The delineation of the trade area for this report is shown on Figure 3.1. The trade area for the Convenience Commercial Centre is bounded to the east by Mavis Road, to the west by the proposed collector route located between Creditview Road and Second Line West, to the south by

Figure 3.1 Trade Area



Eglinton Avenue, and to the north by a combination of Bristol Road and a greenbelt are north of Bristol Road and east of Second Line West.

By focussing the analysis on a defined trade area, population, income, and expenditures can be identified and measured.

3.3 The Zone Structure

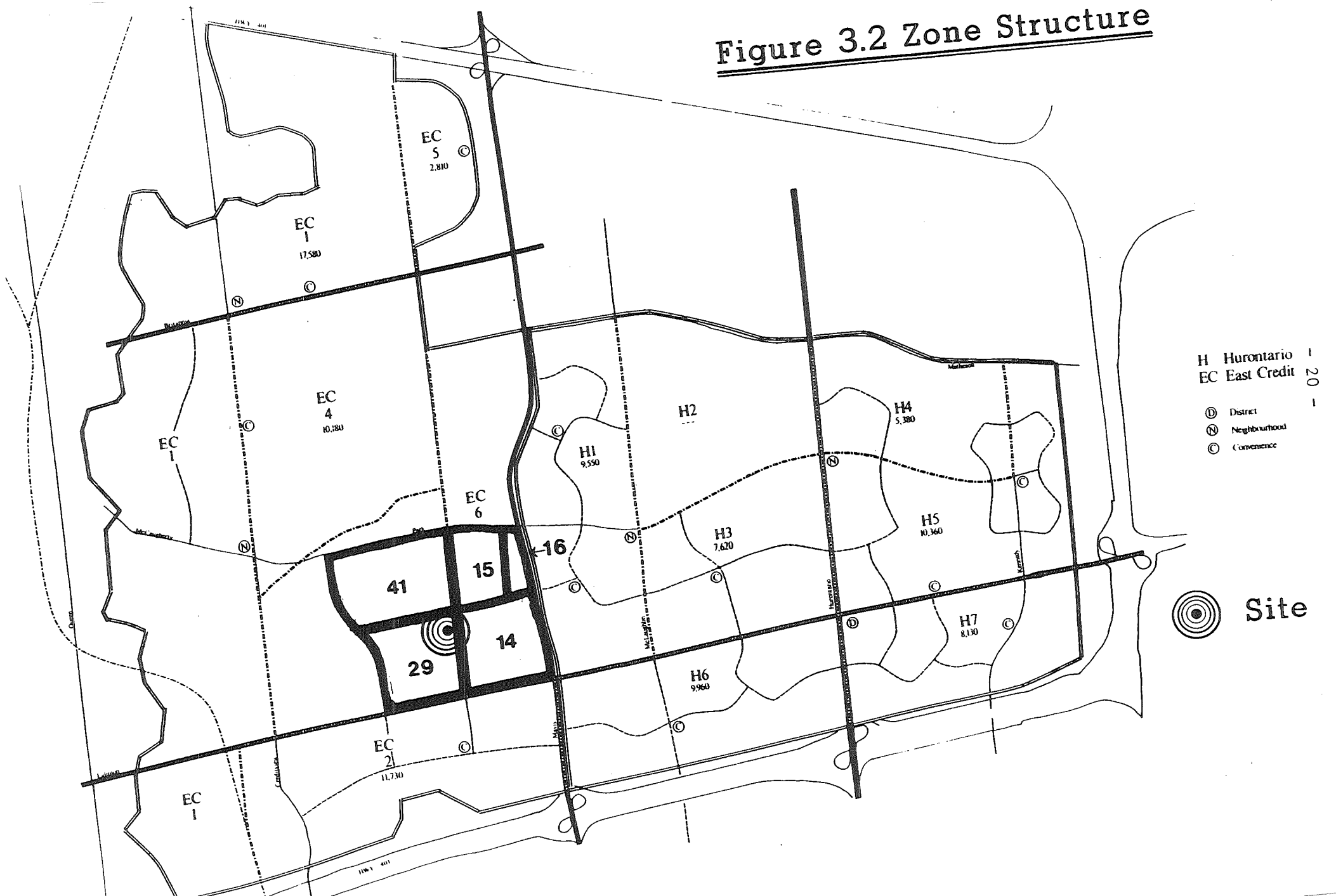
The limited trade area is further divided into a zone market structure. This zone structure is shown on Figure 3.2. The boundaries of the zones reflect man-made and natural delimiters and take the following into account:

- accessibility patterns of distance from retail business areas;
- expected land use development;
- time/distance decision for shoppers.

The creation of a zone structure allows for the analysis of the flow of expenditures from residential areas to a variety of business areas.

A single numbering system for all residential zones within the entire East Credit and Hurontario Secondary Planning Areas has been adopted. In this case, five residential zones comprise the trade area - zones 14, 15, 16, 29 and 41. The zone structure for both secondary plan areas is shown on Figure A.1.

Figure 3.2 Zone Structure



Part IV

COMPETITIVE RETAIL STRUCTURE

4.1 Introduction

This Part of the report describes the proposed retail facilities in the trade area and identifies important competing shopping destinations beyond the boundaries of the trade area. The location of existing and proposed retail facilities in and around the trade area is important in the analysis of the feasibility and impact of commercial development in the vicinity of the subject site.

The major DSTM and FCTM facilities (existing and proposed) which are important in determining the pattern of shopping in the trade area are shown on Figure 4.1.

4.2 The Competitive Retail Structure

Existing and Proposed Regional Centres

The shopping complex at Square One is only of peripheral importance to the analysis of the proposed conenience commercial centre. The fact of its existence sets the tone for the development of the hierarchy of centres which will emerge in the entire East Credit secondary plan area.

In the City's efforts to establish a focal point of the larger urban community, the City Centre was created. The City Centre responded to the need for a central area with commercial and retail functions, comparable to a downtown. The starting block for this concept was Square One, a regional shopping centre. When this centre opened in 1973, it was the largest shopping centre in Canada, and one of the largest in North America (before the days of West Edmonton Mall), containing just under 1 million square feet of space. With the recent expansion about to open, the site will offer over 200 merchants, including three department stores in a much larger space (GLA).

Another regional centre is designated for the north-west corner of the intersection of Erin Mills Parkway and Eglinton Avenue West.

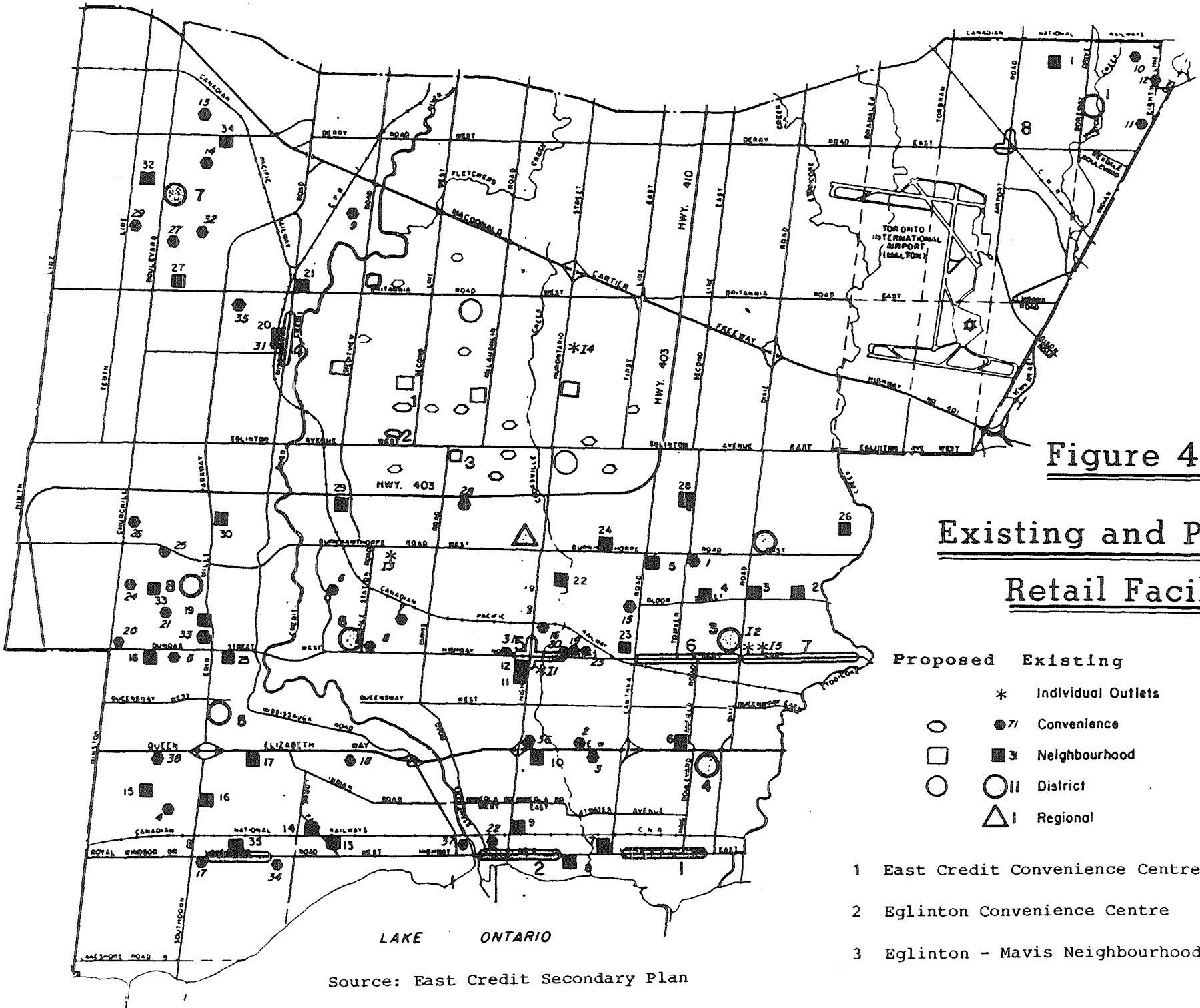


Figure 4.1

Existing and Proposed Retail Facilities

Proposed Existing

* Individual Outlets

Convenience

Neighbourhood

District

Regional

1 East Credit Convenience Centre

2 Eglinton Convenience Centre

3 Eglinton - Mavis Neighbourhood Centre

Source: East Credit Secondary Plan

The Proposed District Commercial Centres

Two District Commercial Centres are proposed which would have a competitive impact on the convenience centre. One is located at the south-east corner of Eglinton Avenue and Highway 10, 3.0 km east of the site, and approximately 1 km north of the City Centre. The other is proposed for the southeast corner of Britannia Road and Mavis Road, approximately 3.5 km north of the site and 1.5 km south of Highway 401.

A typical District Commercial Centre usually consists of a discount/promotional department store, a supermarket, and ancillary DSTM and FCTM stores and services. This is consistent with OPA 52 which amended the section of the City of Mississauga's Official Plan dealing with the "commercial" designations. A District Commercial Centre is to range in size from 9,300 square meters (100,100 square feet) to 46,500 square meters (500,520 square feet) of Gross Leasable Area (GLA). The size and character of District Centres is intended to reflect a trade area population of approximately 50,000 persons.

- The nature of these two development is very flexible since the size range is so very great. The location of the centres on Hurontario Street (Highway 10) and Mavis Road, each eventually with interchanges on Highway 401, gives both sites the market prospect of attracting various types of "off centre" retail conglomerate uses. Without having particular proposals to examine, the matter of impact would be very difficult to determine. As a general view however, it is highly unlikley that a community convenience centre of 1,800 square metres could affect a centre which is not planned for convenience activities.

It is expected that District Commercial Centres will draw substanially from the trade area, but only along certain merchandise lines, with particular emphasis on Department Store Type Merchandise (DSTM), whether sold through a "shopping mall" environment or a "retail conglomerate" environment.

Proposed Neighbourhood Commercial Centres

The commercial structure as shown on the Secondary Plan shows three

Neighbourhood Commercial Centres proposed within the East Credit Secondary Plan area, located at the following intersections:

1. the southwest corner of Bristol Road and Second Line West,

2. the northeast corner of Britannia Road and Creditview Road and,

3. the northwest corner of McCaugherty Road and Creditview Road.

In addition, a fourth neighbourhood commercial centre is expected to be developed at the intersection of Creditview Road and Eglinton Avenue.

Typically, a Neighbourhood Commercial Centre consists of a supermarket plus other ancillary FCTM operations, an ancillary DSTM component plus personal service activities. The orientation of these retail activities is towards the immediate needs of the surrounding neighbourhoods or community.

According to the City of Mississauga's commercial designations definitions, a Neighbourhood Commercial Centre will not generally exceed 6,500 square meters (70,000 square feet), however, there is an allowance to develop a neighbourhood centre up to 9,300 square meters (100,100 square feet), dependent upon the market support for such a facility. Within the centre there will be a supermarket of approximately 3,300 square meters (35,520 square feet). Again, if supported by market evidence that a larger supermarket would be viable, allowance for a larger supermarket will be considered. Generally, the neighbourhood centre is intended to serve the needs of a population of approximately 20,000 persons.

- In addition to these proposed facilities in the East Credit Planning Area a "neighbourhood commercial centre" range of functions is proposed for the southeast quadrant of the Mavis Road and Eglinton Avenue intersection.

As presently structured, all of the neighbourhood commercial sites proposed for the East Credit and Hurontario Secondary Plan areas are proposed for locations on either Bristol Road (four sites) or Creditview Road (two sites). The concept behind the proposal to develop the southeast corner of Eglinton Avenue and Mavis Road is the improvement of

the commercial service level to the southern neighbourhood of the Hurontario Secondary Plan Area and the adjacent neighbourhood in the East Credit Secondary Plan Area. For the purposes this analysis it has been assumed that the proposed amendment will proceed.

Proposed Convenience Commercial Centres

A Convenience Commercial Centre will generally not exceed a Gross Leasable Area (GLA) of approximately 930 square meters (10,010 square feet), however, consideration will be given to allowing development of such a centre up to a limit of 1,800 square meters (19,400 square feet).

It is more difficult to comment on the exact location of the proposed Convenience Commercial Centres because of the recent review of the Convenience Centre category contained in OPA 52 to the City of Mississauga Official Plan. It is stated in the plan that "...the Primary Plan is amended stating that **Convenience Centres are designated in Secondary Plans as "possible" sites which could be moved, added to, or deleted** without amending the Secondary Plan..." (emphasis added).

For the purposes of this analysis, the following Convenience Commercial Centres designated in the East Credit Secondary Plan have been taken into consideration:

1. the site located in Neighbourhood 6 on the west side of Mavis Road midway between Eglinton Avenue and Bristol Road,

2. the centre located in Neighbourhood 3 north of Eglinton Avenue, between Creditview Road and Second Line West,

3. the centre located in Neighbourhood 2 on Second Line West, south of Eglinton Avenue and the proposed east-west collector, and

4. the centre located in the southern portion of Hurontario Neighbourhood 1, located east of Mavis Road between Eglinton Avenue and Bristol Road on a proposed collector road.

Conclusion

The site in Neighbourhood 3 of the East Credit Secondary Planning area will serve portions of Neighbourhoods 4 and 6. In the context of development the subject site is centrally located in a residential area which has designated convenience commercial sites at peripheral locations.

- A convenience commercial centre at the subject site would fill a void in the commercial structure as designated in the East Credit Secondary Plan and would serve the convenience-oriented needs of the surrounding population.

Part V

POPULATION, INCOME AND EXPENDITURE ESTIMATES:

5.1 Introduction

This Part of the report takes the collected information on the trade area and prepares the basis for a market analysis. The data presented here were drawn from a variety of sources including: the East Credit Secondary Plan, the 1981 Census of Canada, personal disposable income trends derived from Ontario Economic Accounts, and Urban Family Expenditure statistics provided by Statistics Canada.

All values are stated in 1985 constant dollars.

5.2 Population Estimates

Having delineated a trade area for the Convenience Commercial Centre, the population of that trade area must be determined in order to establish the market from which a proposed Convenience Commercial Centre at the site could draw.

The steps taken in the estimation of these populations is explained below.

1. The first step in estimating the population was to measure the residential lands which would house the population. The exercise began with the measurement of the total area within each neighbourhood. This was measured from the East Credit Secondary Plan Land Use Plan (Schedule 2) using a grid overlay containing one-one hundredth square inch blocks.

2. Specific land use measurements were then estimated from the Secondary Plan Land Use Plan and deducted from the total area of the neighbourhood. These uses included neighbourhood commercial, special parks, greenbelt (where applicable) and schools (the measurements of which were given in the appendices of the Secondary

Plans). This yielded a "net" area of the neighbourhood.

3. From this "net" area seven percent was deducted for neighbourhood parks and convenience commercial uses to yield a "net net" area.

4. From this "net net" area twenty percent was deducted for roads. This resulting "net net net" area constituted the residential lands available in each neighbourhood (in hectares).

5. The various housing densities (low, medium and high) were measured (in square inches) for each neighbourhood from the Secondary Plan Area Land Use Plan.

6. By definition, the sum of the areas in each housing density category would total 100% of residential lands. The measurements of each housing density were converted into a percentage proportion of total residential land in each neighbourhood.

7. These proportions were then applied to the "net net net" area of the neighbourhood to determine the land area of the three housing densities, in hectares, for each neighbourhood.

8. Appendix D from the East Credit Secondary Plan provided data on the ultimate number of units and populations of each neighbourhood. Given this information and the land area of each housing density type calculated above, housing and population densities for each neighbourhood were determined.

9. The ultimate populations and housing units for each trade area zone was estimated according to the neighbourhood densities applicable to each zone.

The results are shown in Table 5.1 and the distribution is graphically shown on Figure 5.1. The ultimate population of the trade area is expected to be 10,674 and it is expected that this population will be reached by 1996.

The ultimate population of the East Credit Secondary Plan Area is 65,360, not including the "lands not yet designated" surrounding the

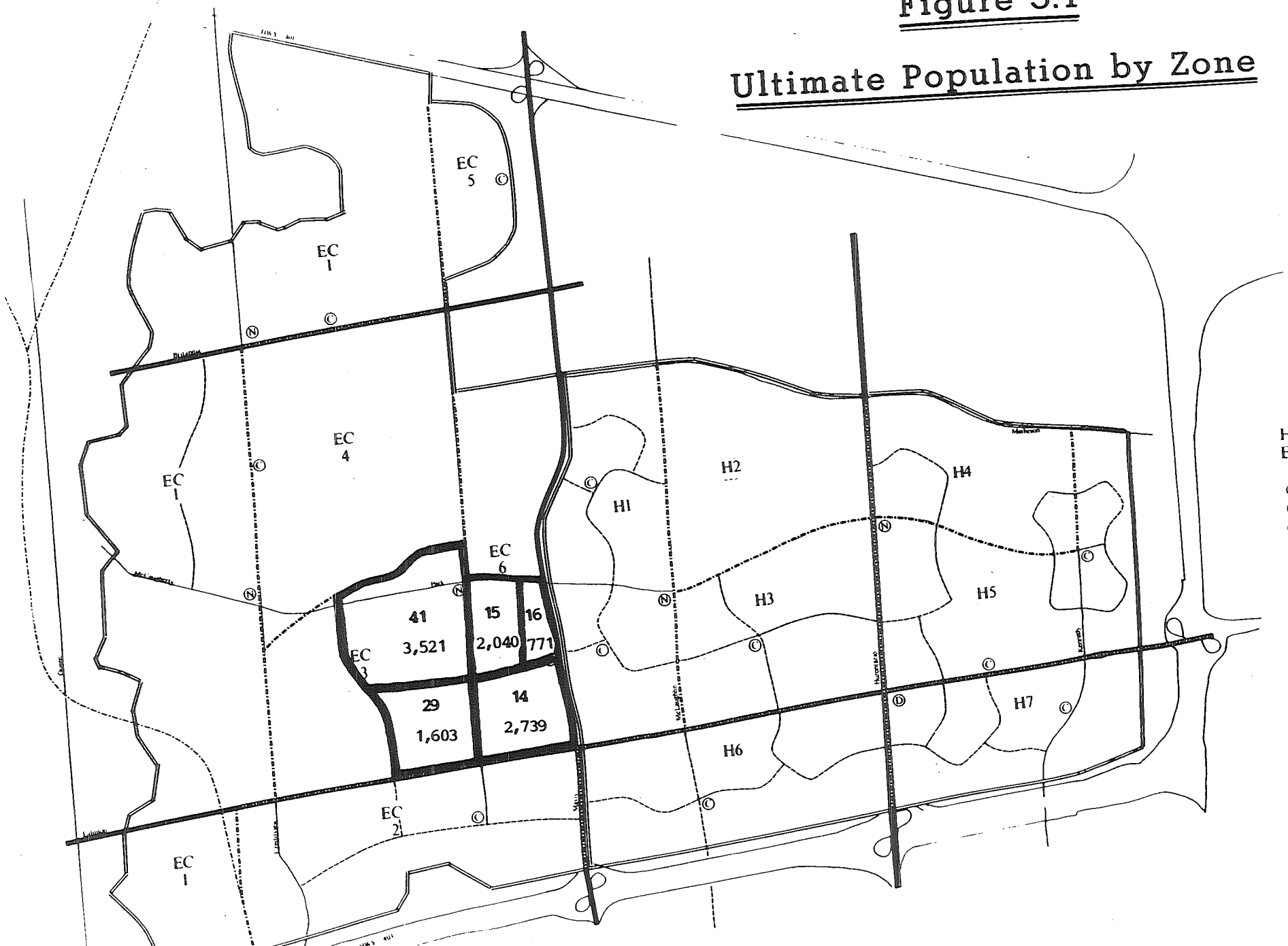
Table 5.1

Ultimate Population Distribution by Zone

Zone	Population
14.	2,739
15.	2,040
16.	771
29.	1,603
41.	3,521
Trade Area Total	10,674

Figure 5.1

Ultimate Population by Zone



intersection of Eglinton Avenue and Creditview Road. The Hurontario Secondary Plan calls for a population of 53,000, assuming that the "lands not yet designated" between Bristol Road and Matheson Boulevard will be partially used for residential purposes housing 2,000 persons. The combined population for the two secondary plan areas is therefore over 118,000.

5.3 Income Estimates

In addition to population growth, per capita disposable income (PDI) and expenditure levels are of importance in the determination of sales potential. Average per capita PDI levels determine the expenditure habits of the residents in a given trade area.

PDI is the "spendable" income left in the hands of the population after all deductions for taxes and various income transfers are considered. It is this income which is used by the population to acquire shelter, services, food, clothing, transportation and other goods and services.

- The income levels assumed for the trade area were those prevailing in the developed part of Mississauga, adjusted for the normal growth of income.

Income information was taken from the 1981 Census and has been reconciled against Economic Accounts reported by the Province of Ontario and is expressed in 1985 dollar terms.

Mississauga had an average household income of $45,966 in 1981, or an average personal disposable income (PDI) per capita of $14,438 (in 1985 dollars).

- The Mississauga average household income was 24% higher than the average of $37,062 for the province as a whole.

- The Mississauga per capita income was 13% higher than that of the provincial per capita average income ($12,761).

The average PDI per capita was assumed to be applicable uniformly across the entire trade area. While individual areas are likely to vary from the average, such variation cannot be properly estimated without at least having subdivision plans which specify the lot sizes, and permit estimates of house prices, and therefore likely income ranges.

The 1986 PDI was then projected through to 1996 and 2006 using a constant income increase of 1.25% annually (in real terms).

- The average PDI per capita for the trade area for 1996 has been estimated at $17,881. By 2006 average PDI is expected to reach approximately $20,247 per capita.

- The total PDI in 1996, assuming the development of the small trade area is in place, would be $190.9 million. By 2006 this will rise to approximately $216.1 million in real terms.

5.4 DSTM Expenditure Estimates: Convenience Component

From family expenditure patterns determined from information published by Statistics Canada, and the trade area data, DSTM and FCTM expenditures for the trade area can be derived. Tables 5.2 and 5.3 show the estimates for both per capita and total DSTM expenditures by zone for 1996 and 2006 respectively.

Department Store Type Merchandise (DSTM) includes general merchandise, apparel and accessories, hardware and home furnishings and other merchandise that is usually sold by a department store.

- In 1996, the average DSTM expenditure per capita in the trade area is expected to be $2,691. DSTM expenditures for the trade area will total $28.7 million. For 2006 it has been estimated that the per capita DSTM expenditure in the trade area will be $2,991 with total DSTM expenditures reaching $31.9 million.

Very little of this will be sold through convenience centres as most of it requires a "comparison" environment. We have identified the store types, such as pharmacies, books and stationary stores, florists and various types of personal accessories stores which are found in centres of this type. Generally speaking these are independent stores, not attached to chains.

- In our view only 19.6% of the DSTM merchandise is sold through store types which would consider a "convenience centre" location, and of that subtotal, the convenience centres would only accrue a small proportion in the type

TABLE 5.2:

EAST CREDIT CONVENIENCE CENTRE
TRADE AREA POPULATION, INCOME AND EXPENDITURES BY ZONE, 1996
(IN 1985 DOLLARS)

ZONE:	POPULATION	P.D.I. PER CAPITA	TOTAL P.D.I.	DSTM EXP. PER CAPITA	TOTAL DSTM EXP.	FCTM EXP. PER CAPITA	TOTAL FCTM EXP.
14 Z14	2739.	17881	48977155	2691	7371903.	1386	3797643.
15 Z15	2040.	17881	36478056	2691	5490574.	1386	2828474.
16 Z16	771.	17881	13786559	2691	2075114.	1386	1068997.
29 Z29	1603.	17881	28663884	2691	4314407.	1386	2222571.
41 Z41	3521.	17881	62960409	2691	9476624.	1386	4881891.
TOTAL TRADE AREA	10674.	17881	190866063	2691	28728622.	1386	14799576.

ZONE:	POPULATION	P.D.I. PER CAPITA	TOTAL P.D.I.	SERVICE EXP. P.C.	TOTAL SERVICE EXPENDITURE
14 Z14	2739.	17881	48977155	1008	2760912
15 Z15	2040.	17881	36478056	1008	2056320
16 Z16	771.	17881	13786559	1008	777168
29 Z29	1603.	17881	28663884	1008	1615824
41 Z41	3521.	17881	62960409	1008	3549168
TOTAL TRADE AREA	10674.	17881	190866063	1008	10759392

Source: G.M. Stamm, Economic Research Associates

TABLE 5.3:

EAST CREDIT CONVENIENCE CENTRE
TRADE AREA POPULATION, INCOME AND EXPENDITURES BY ZONE, 2006
(IN 1985 DOLLARS)

ZONE:	POPULATION	P.D.I. PER CAPITA	TOTAL P.D.I.	DSTM EXP. PER CAPITA	TOTAL DSTM EXP.	FCTM EXP. PER CAPITA	TOTAL FCTM EXP.
14 Z14	2739.	20247	55455468	2991	8192563	1405	3850451
15 Z15	2040.	20247	41303086	2991	6101799	1405	2867805
16 Z16	771.	20247	15610137	2991	2306121	1405	1083862
29 Z29	1603.	20247	32455317	2991	4794698	1405	2253477
41 Z41	3521.	20247	71288317	2991	10531586	1405	4949776
TOTAL TRADE AREA	10674.	20247	216112325	2991	31926767	1405	15005371

ZONE:	POPULATION	P.D.I. PER CAPITA	TOTAL P.D.I.	SERVICE EXP. P.C.	TOTAL SERVICE EXPENDITURE
14 Z14	2739.	20247	55455468	1142	3127938
15 Z15	2040.	20247	41303086	1142	2329680
16 Z16	771.	20247	15610137	1142	880482
29 Z29	1603.	20247	32455317	1142	1830626
41 Z41	3521.	20247	71288317	1142	4020982
TOTAL TRADE AREA	10674.	20247	216112325	1142	12189708

of "greenfield" development which is occurring in the vicinity of the subject area.

5.5 FCTM Expenditure Estimates: Convenience Component

Using a similar analysis, FCTM expenditures from the trade area were estimated. Food and Convenience Type Merchandise (FCTM) includes supermarkets, grocery stores, bakeries, delicatessens, jug milk stores, fruit stores and similar food retail outlets. It does not include food services such as restaurants. Tables 5.2 and 5.3, show the estimates for both per capita and total FCTM expenditures by zone for 1996 and 2006 respectively.

- By 1996 it is expected that per capita FCTM expenditures will be $1,386, totalling $14.8 million for the trade area. During the five year period, FCTM expenditures are not expected to increase dramatically. By 2006 per capita FCTM expenditures will be $1,405, for a total FCTM expenditure level in the trade area of $15.0 million.

With supermarkets dominating this category of merchandising, only 26% of the sales in this category of stores can be considered for the convenience component of the analysis. Of this category of stores a significantly larger proportion would consider a "convenience centre" location.

5.6 Service Expenditures

Services that would normally be associated with a Convenience Commercial Centre include a dry cleaner, hairdressers and other personal care services. Direct health services are also included in the estimates of expenditures presented below. A list of services included in the estimate of service expenditures is provided in Table 5.4.

According to the 1982 Family Expenditure in Canada publication from Statistics Canada, and after adjusting for economic changes with respect to the level of personal disposable income and consumption patterns, the proportion of income spent on personal services is over 5.6% for residents of the Toronto area.

- In 1996, it is estimated that the service expenditures

Table 5.4

TYPES OF PERSONAL "SERVICE" EXPENDITURES

- Veterinary services
- Landscaping services
- Furniture related services
- Clothing related services
- Direct health care costs (ie., non-OHIP)
- Personal care services
- Photographic services
- Home entertainment rentals
- Home entertainment services
- Education services
- Legal services
- Financial services (excl. banks etc.)
- Other

in the trade area will be at the rate of $1,008 per capita for a total of $10.8 million. By the year 2006, this total expenditure will increase only slightly to $12.2 million.

Once again, the convenience centre will lay claim to only a small proportion of the total sales, as the larger centers will take the lion's share. The proportion will depend upon the relative location of other centres in the trade area vicinity. We estimate a range of between 10% and 20%.

5.7 Restaurant Expenditures

Restaurants also locate in convenience centres, but only at advantageous locations. The nature of this type of commercial use is such that it draws from a wider trade area.

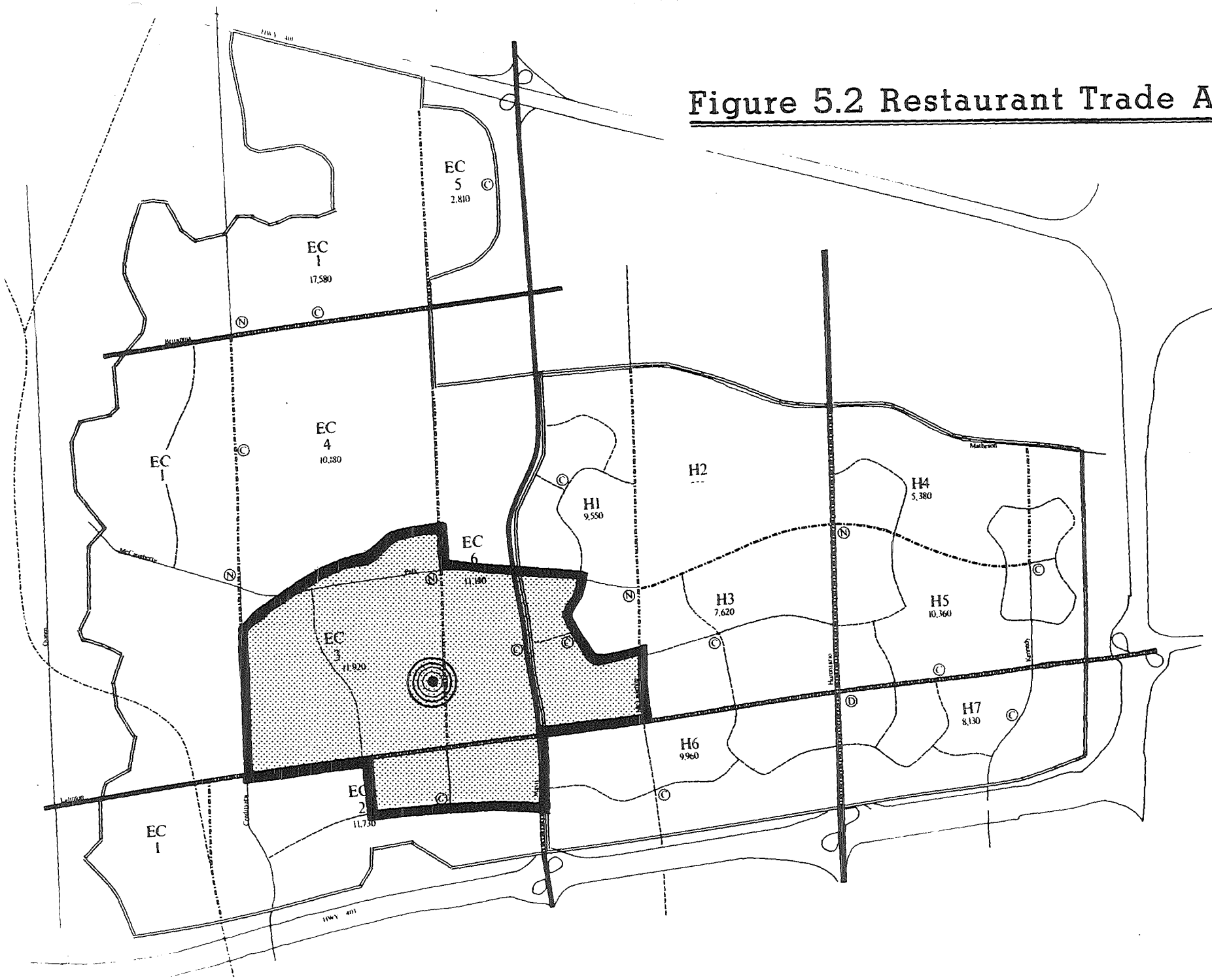
Figure 5.2 shows the trade area delineated for the purposes of the "local" restaurant market analysis and includes portions of the East Credit 2, 3, 4, and 6 neighbourhoods and Hurontario 1 neighbourhoods, with an ultimate population of 24,450.

The 1982 Family Expenditure in Canada publication from Statistics Canada provides information on family expenditures in restaurants. From this a per capita figure has been derived. The 1982 data likely reflects the economic conditions of the time, ie., recessionary. The data has been updated to reflect current trends for the purposes of this analysis.

Restaurant expenditures (defined as food purchased from restaurants locally and on day trips) total approximately 4.11% of income in the Toronto area. As was the case with service expenditures, this proportion has been applied to the restaurant trade area because of the proximity of Mississauga to Toronto.

- Based on the income projections for the restaurant trade area, restaurant expenditures will total approximately $18.0 million by the 1996, and $20.3 million by the year 2006.

Figure 5.2 Restaurant Trade Area



Part VI

TRADE AREA MARKET SHARE AND OPPORTUNITY

6.1 Introduction

This Part of the report converts the estimates of sales potential into parameters of retail space. There are two important steps involved in this analysis: (i) the estimate of the "share" of the market in the applicable categories which can be drawn to the proposed convenience commercial centre, and (ii) the conversion of the estimated sales potential into retail space.

The results have been summarized on Tables 6.1 and 6.2 for the years 1996 and 2006. Since the results are relatively similar, varying only for reasons of income growth, they will be discussed together.

Given the total expenditures, by type, which would relate to a "convenience" centre site, the market share of the site by expenditure type has been estimated using "low-medium-high" scenarios.

- All of the estimates are conservative and presume that the neighbourhood centres will provide the great majority of the convenience functions.

- All estimates assume that the corner of Mavis Road and Eglinton Avenue will develop into a larger neighbourhood shopping centre. Should these assumptions not be valid, then the size range of the centre would be considerably larger.

Within those over-riding assumptions, the high scenario would prevail if one or more of the proposed neighbourhood or convenience commercial facilities would not proceed. We have included a "local" restaurant in the centre space demand estimates with the high alternative.

The low scenario makes the assumption that the following commercial developments proceed and are developed:

a) the convenience centre just north of Eglinton between

TABLE 6.1

MARKET SHARE ANALYSIS (1996) - EAST CREDIT CONVENIENCE CENTRE SITE

Store Type	Market Share		Total Sales ($million)	Supportable Space
Convenience FCTM				
Total: $3.848 million	hi	40%	$1.539	7,696
Performance standard:	med	30%	$1.154	5,771
$200/sq.ft.	lo	20%	$.770	3,848
Convenience DSTM				
Total: $5.639 million	hi	20%	$1.127	5,639
Performance standard	med	15%	$.846	4,230
$200/sq.ft.	lo	10%	$.564	2,820
Personal Services				
Total: $10.759 million	hi	20%	$2.152	21,518
Performance standard:	med	15%	$1.614	16,139
$100/sq.ft.	lo	10%	$1.076	10,759
Restaurant Service				
Total: $17.969 million	hi	3%	$.539	2,156
Performance standard:				
$250/sq.ft.				

Supportable DSTM, FCTM and Personal Service space = high 34,853 sq.ft. (3,239 sq.m.)

Convenience FCTM has been estimated using 26% of FCTM expenditures. Convenience DSTM is defined as 19.63% of total DSTM, consisting of pharmacy, books amd stationery, florists, and all personal accessory expenditure. Personal service expenditures include such activities as hairdressers, photographer studios, home entertainment rentals, and so forth.

medium 26,140 sq.ft. (2,429 sq.m.)

low 17,427 sq.ft. (1,619 sq.m.

G.M. Stamm, Economic Research Associates

TABLE 6.2

MARKET SHARE ANALYSIS (2006) - EAST CREDIT CONVENIENCE CENTRE SITE

Store Type	Market Share		Total Sales ($million)	Supportable Space
Convenience FCTM				
Total: $3.901 million	hi	40%	$1.561	7,803
Performance standard:	med	30%	$1.170	5,852
$200/sq.ft.	lo	20%	$ .780	3,901
Convenience DSTM				
Total: $6.267 million	hi	20%	$1.253	6,267
Performance standard:	med	15%	$.940	4,700
$200/sq.ft.	lo	10%	$.627	3,134
Personal Services				
Total: $12.190 million	hi	20%	$2.438	24,379
Performance standard:	med	15%	$1.828	18,285
$100/sq.ft.	lo	10%	$1.219	12,190
Restaurant Service				
Total: $20.34 million	hi	3%	$.610	2,141
Performance standard:				
$285/sq.ft				

Supportable DSTM, FCTM and Personal Service space = high 38,449 sq.ft. (3,572 sq.m.)

medium 28,837 sq.ft. (2,679 sq.m.)

low 19,225 sq.ft. (1,786 sq.m.)

Convenience FCTM has been estimated using 26% of FCTM expenditures. Convenience DSTM is defined as 19.63% of total DSTM, consisting of pharmacy, books amd stationery, florists, and all personal accessory expenditure. Personal service expenditures include such activities as hairdressers, photographer studios, home entertainment rentals, and so forth.

G.M. Stamm, Economic Research Associates

Second Line West and Creditview Road is developed and takes on a similar range of convenience functions,

b) the convenience centre on the west side of Mavis Road between Eglinton Avenue and Bristol Road is developed and takes on a similar range of convenience functions,

c) the convenience centre at the foot of Second Line West and the proposed east-west collector in Neighbourhood 2 of the East Credit Secondary Plan area is developed,

d) a neighbourhood centre is developed at the southeast corner of Eglinton Avenue and Mavis Road, taking on the full range of convenience functions,

e) a neighbourhood centre is developed at the southwest corner of Bristol Road and Second Line West,

f) a neighbourhood commercial centre is developed near or at the intersection of Creditview Road and Eglinton Avenue and takes on the full range of neighbourhood functions, and

g) the proposed highway commercial developments at the northwest corner of Eglinton Avenue and Mavis Road and at the northeast corner of Second Line West and Bristol Road sell some of the same merchandise through approved outlets.

The medium estimate is the middle ground between the high and low estimates.

6.2 The Estimates of Supportable Floor Space

Using the high estimate, a commercial convenience centre at the subject site would capture total sales of $4.82 million in sales, in 1996 and $5.25 million by the year 2006.

The breakdown of this total, for 1996 by store type is as follows: $1.54 million in Convenience/Food expenditures, $1.13 million in Convenience DSTM expenditures, and approximately $2.15 million in personal service expenditures. This estimate does not include expenditures resulting from inflow traffic, although a Mavis Road

location would encourage such inflow.

- The estimate of $1.54 million in Convenience FCTM sales in 1996 assumes that 40% of the trade area's expenditures for non-supermarket food and convenience merchandise would occur at the proposed convenience centre, leaving the remaining 60% to go to the convenience facilities in the neighbourhood centres, the convenience centres, and elsewhere.

The retail industry has performance standards which provide a guide for the "average" sales per square foot required to make a retail facility viable. Unfortunately the individual store types which comprise the "average" are often very different, and so the actual mix will cause significant variation in supportable space. We have used $200 per square foot based on industry experience.

- The estimate for "convenience DSTM" is much lower with only 20% of the market for such goods being satisfied from the convenience centre, leaving 80% to occur elsewhere. (Typical of these goods are non-drug pharmacy wares, and gift shops.)

- For the "personal services" category a similarly low 20% has been used.

On that basis, the centre could support for the above three use categories approximately 34,853 square feet (3,238 square meters) by 1996, and over 38,449 square feet (3,572 square meters) by the year 2006.

- The market for a "local" restaurant serving an extended trade area has also been considered in this analysis. It has been determined that a restaurant of approximately 2,100 square feet could be supported at the site. This assumes sales of between $200 and $300 per square foot. With a market of $18.0 million identified for 1996, the penetration into the extended trade area would be approximately 3%; that penetration rate is certainly feasible.

- The centre would total approximately 37,009 square feet (3,439 square metres) by 1996, and about 40,590 square feet (3,772 square metres) by the year 2006, if a 2,100

square foot (195 square metre) restaurant facility were included.

For the medium estimate we have calculated the supportable floor space at 26,140 square feet (2,429 square metres), and 28,837 square feet (2,679 square metres) by the year 2006. No restaurant would be included.

For the low estimate the supportable space is 17,427 square feet (1,619 square meters) in 1996, and 19,225 square feet (1,786 square metres) by 2006. No restaurant would be included.

6.3 A Comment on Impact

There is no existing retail facility that would draw from the trade area which would be adversely impacted.

APPENDICES

APPENDIX 1

HURONTARIO AND EAST CREDIT SECONDARY PLAN AREAS
"ULTIMATE" POPULATION, INCOME AND EXPENDITURES BY ZONE, 1996 (IN 1985$)

ZONE:	POPULATION	P.D.I. PER CAPITA	TOTAL P.D.I.	DSTM EXP. PER CAPITA	TOTAL DSTM EXP.	FCTM EXP. PER CAPITA	TOTAL FCTM EXP.
1 Z1	909.	17881.408	16254200.	2691.458	2446536.	1386.507	1260335.
2 Z2	974.	17881.408	17416492.	2691.458	2621480.	1386.507	1350457.
3 Z3	2187.	17881.408	39106640.	2691.458	5886219.	1386.507	3032290.
4 Z4	1690.	17881.408	30219580.	2691.458	4548565.	1386.507	2343196.
5 Z5	1456.	17881.408	26035331.	2691.458	3918763.	1386.507	2018754.
6 Z6	1592.	17881.408	28467202.	2691.458	4284802.	1386.507	2207319.
7 Z7	1388.	17881.408	24819395.	2691.458	3735744.	1386.507	1924471.
8 Z8	758.	17881.408	13554108.	2691.458	2040125.	1386.507	1050972.
9 Z9	650.	17881.408	11622916.	2691.458	1749448.	1386.507	901229.
10 Z10	1370.	17881.408	24497530.	2691.458	3687298.	1386.507	1899514.
11 Z11	1370.	17881.408	24497530.	2691.458	3687298.	1386.507	1899514.
12 Z12	2740.	17881.408	48995059.	2691.458	7374596.	1386.507	3799028.
13 Z13	5590.	17881.408	99957073.	2691.458	15045252.	1386.507	7750572.
14 Z14	2739.	17881.408	48977178.	2691.458	7371904.	1386.507	3797642.
15 Z15	2040.	17881.408	36478073.	2691.458	5490575.	1386.507	2828474.
16 Z16	771.	17881.408	13786566.	2691.458	2075114.	1386.507	1068997.
17 Z17	2311.	17881.408	41323935.	2691.458	6219960.	1386.507	3204217.
18 Z18	2183.	17881.408	39035115.	2691.458	5875454.	1386.507	3026744.
19 Z19	1636.	17881.408	29253984.	2691.458	4403226.	1386.507	2268325.
20 Z20	982.	17881.408	17559543.	2691.458	2643012.	1386.507	1361550.
21 Z21	700.	17881.408	12516986.	2691.458	1884021.	1386.507	970555.
22 Z22	700.	17881.408	12516986.	2691.458	1884021.	1386.507	970555.
23 Z23	2167.	17881.408	38749012.	2691.458	5832390.	1386.507	3004560.
24 Z24	2645.	17881.408	47296325.	2691.458	7118907.	1386.507	3667310.
25 Z25	2852.	17881.408	50997777.	2691.458	7676039.	1386.507	3954317.
26 Z26	8130.	17881.408	145375851.	2691.458	21881556.	1386.507	11272299.
27 Z27	10360.	17881.408	185251392.	2691.458	27883508.	1386.507	14364208.
28 Z28	5380.	17881.408	96201978.	2691.458	14480045.	1386.507	7459406.
29 Z29	1603.	17881.408	28663898.	2691.458	4314408.	1386.507	2222570.
30 Z30	3920.	17881.408	70095121.	2691.458	10550516.	1386.507	5435106.
31 Z31	1680.	17881.408	30040766.	2691.458	4521650.	1386.507	2329331.
32 Z32	6796.	17881.408	121522052.	2691.458	18291150.	1386.507	9422699.
33 Z33	10180.	17881.408	182032738.	2691.458	27399046.	1386.507	14114637.
34 Z34	2810.	17881.408	50246758.	2691.458	7562998.	1386.507	3896084.
35 Z35	7032.	17881.408	125742064.	2691.458	18926334.	1386.507	9749914.
36 Z36	4395.	17881.408	78588790.	2691.458	11828959.	1386.507	6093697.
37 Z37	3516.	17881.408	62871032.	2691.458	9463167.	1386.507	4874957.
38 Z38	2637.	17881.408	47153274.	2691.458	7097376.	1386.507	3656218.
39 Z39	1100.	17881.408	19669549.	2691.458	2960604.	1386.507	1525157.
40 Z40	900.	17881.408	16093268.	2691.458	2422313.	1386.507	1247856.
41 Z41	3521.	17881.408	62960439.	2691.458	9476625.	1386.507	4881890.
	118340.	17881.408	2116443506.	2691.458	318560999.	1386.507	164106920.

APPENDIX 2

HURONTARIO & EAST CREDIT SECONDARY PLAN AREAS
"ULTIMATE" POPULATION, INCOME AND EXPENDITURES BY ZONE, 2006 (IN 1985$)

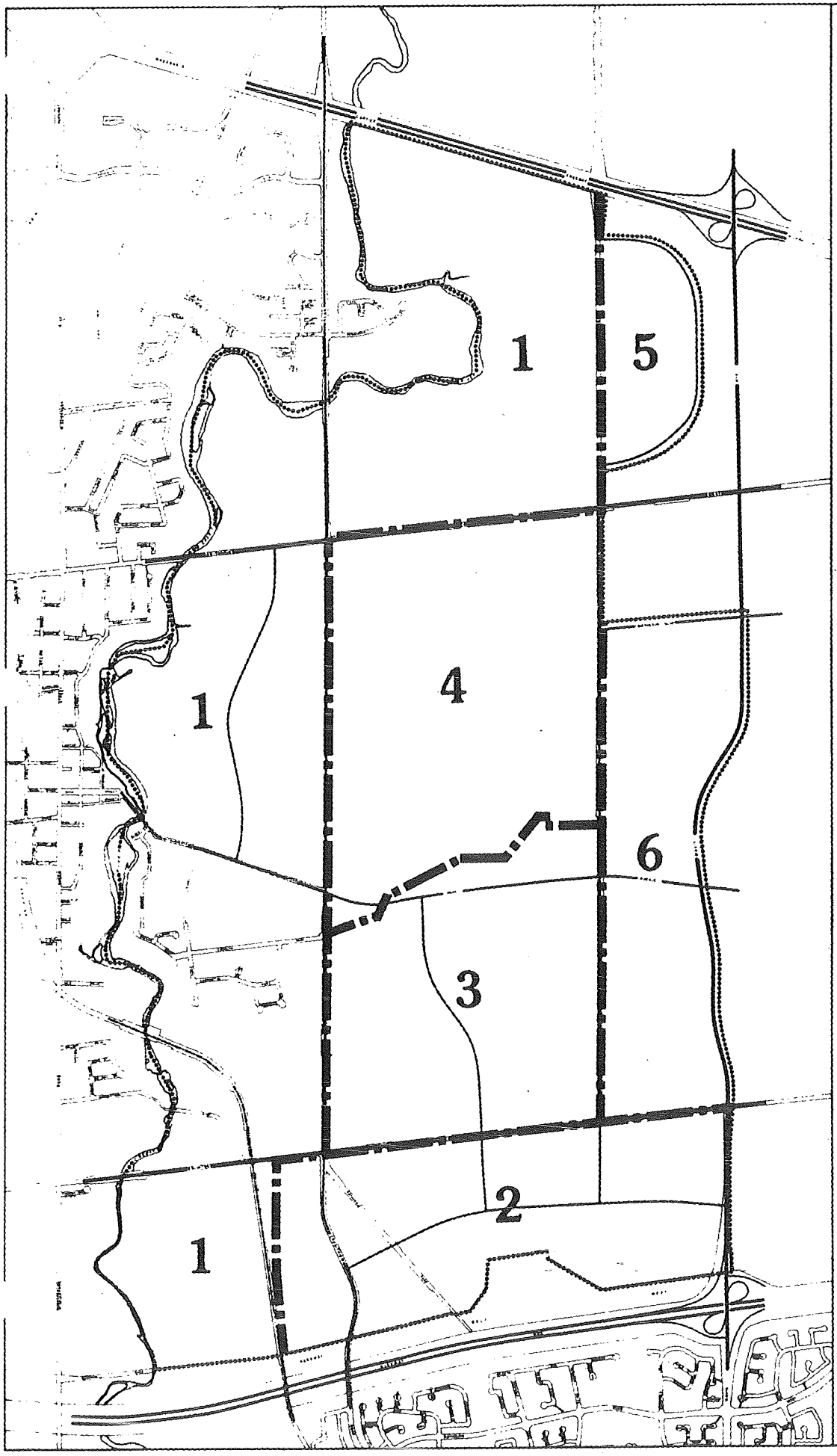
ZONE:	POPULATION	P.D.I. PER CAPITA	TOTAL P.D.I.	DSTM EXP. PER CAPITA	TOTAL DSTM EXP.	FCTM EXP. PER CAPITA	TOTAL FCTM EXP.
1 Z1	909.	20246.611	18404169.	2991.078	2718890.	1405.787	1277861.
2 Z2	974.	20246.611	19720199.	2991.078	2913310.	1405.787	1369237.
3 Z3	2187.	20246.611	44279337.	2991.078	6541488.	1405.787	3074457.
4 Z4	1690.	20246.611	34216772.	2991.078	5054922.	1405.787	2375781.
5 Z5	1456.	20246.611	29479065.	2991.078	4355010.	1405.787	2046826.
6 Z6	1592.	20246.611	32232604.	2991.078	4761797.	1405.787	2238014.
7 Z7	1388.	20246.611	28102295.	2991.078	4151617.	1405.787	1951233.
8 Z8	758.	20246.611	15346931.	2991.078	2267237.	1405.787	1065587.
9 Z9	650.	20246.611	13160297.	2991.078	1944201.	1405.787	913762.
10 Z10	1370.	20246.611	27737856.	2991.078	4097777.	1405.787	1925929.
11 Z11	1370.	20246.611	27737856.	2991.078	4097777.	1405.787	1925929.
12 Z12	2740.	20246.611	55475713.	2991.078	8195554.	1405.787	3851857.
13 Z13	5590.	20246.611	113178553.	2991.078	16720127.	1405.787	7858352.
14 Z14	2739.	20246.611	55455466.	2991.078	8192563.	1405.787	3850452.
15 Z15	2040.	20246.611	41303085.	2991.078	6101800.	1405.787	2867806.
16 Z16	771.	20246.611	15610137.	2991.078	2306121.	1405.787	1083862.
17 Z17	2311.	20246.611	46789917.	2991.078	6912382.	1405.787	3248775.
18 Z18	2183.	20246.611	44198351.	2991.078	6529524.	1405.787	3068834.
19 Z19	1636.	20246.611	33123455.	2991.078	4893404.	1405.787	2299868.
20 Z20	982.	20246.611	19882172.	2991.078	2937239.	1405.787	1380483.
21 Z21	700.	20246.611	14172627.	2991.078	2093755.	1405.787	984051.
22 Z22	700.	20246.611	14172627.	2991.078	2093755.	1405.787	984051.
23 Z23	2167.	20246.611	43874405.	2991.078	6481667.	1405.787	3046341.
24 Z24	2645.	20246.611	53552285.	2991.078	7911402.	1405.787	3718308.
25 Z25	2852.	20246.611	57743333.	2991.078	8530555.	1405.787	4009305.
26 Z26	8130.	20246.611	164604943.	2991.078	24317466.	1405.787	11429051.
27 Z27	10360.	20246.611	209754885.	2991.078	30987570.	1405.787	14563957.
28 Z28	5380.	20246.611	108926765.	2991.078	16092000.	1405.787	7563136.
29 Z29	1603.	20246.611	32455317.	2991.078	4794698.	1405.787	2253477.
30 Z30	3920.	20246.611	79366713.	2991.078	11725026.	1405.787	5510687.
31 Z31	1680.	20246.611	34014306.	2991.078	5025012.	1405.787	2361723.
32 Z32	6796.	20246.611	137595965.	2991.078	20327366.	1405.787	9553731.
33 Z33	10180.	20246.611	206110495.	2991.078	30449176.	1405.787	14310915.
34 Z34	2810.	20246.611	56892976.	2991.078	8404930.	1405.787	3950263.
35 Z35	7032.	20246.611	142374165.	2991.078	21033262.	1405.787	9885497.
36 Z36	4395.	20246.611	88983853.	2991.078	13145788.	1405.787	6178436.
37 Z37	3516.	20246.611	71187083.	2991.078	10516631.	1405.787	4942749.
38 Z38	2637.	20246.611	53390312.	2991.078	7887473.	1405.787	3707061.
39 Z39	1100.	20246.611	22271272.	2991.078	3290186.	1405.787	1546366.
40 Z40	900.	20246.611	18221949.	2991.078	2691970.	1405.787	1265209.
	3521.	20246.611	71288316.	2991.078	10531586.	1405.787	4949777.
			2384388820.	2991.078	354024010.	1405.787	166388992.

Figure A.1

Zone Structure in East Credit and Hurontario Planning Districts



M-857



Neighbourhood Stru
Schedule 6
East Credit
Secondary Plar
Amendment 26
City of Mississauga Ja

M-852.

POPULATION AND HOUSING DISTRIBUTION BY NEIGHBOURHOOD (JANUARY 1984)

	Neighbourhood	Low	Medium	High	Total
Ultimate Units	1	4 510	480	260	5 250
	2	2 350	960	280	3 590
	3	2 550	690	460	3 700
	4	1 630	600	1 230	3 460
	5	830	-	-	830
	6	1 300	970	1 610	3 880
	Total	13 170	3 700	3 840	20 710
	P.P.U. Factor	3.40	3.28	2.19	
Ultimate Population	1	15 450	1 570	560	17 580
	2	7 960	3 160	610	11 730
	3	8 650	2 270	1 000	11 920
	4	5 530	1 970	2 680	10 180
	5	2 810	-	-	2 810
	6	4 420	3 190	3 530	11 140
	Total	44 820	12 160	8 380	65 360

(The ultimate gross residential density of the District is 59 persons per ha)

Ex. B-867

P.80R Site D

	A	B	C	D	E	F
1				LEACHATE COLLECTION SYSTEM		
2	CRA costs for the Revised leachate collection system					
3						
4						
5						Costs
6	Perforated Leachate Collection Pipe					
7	Cell 1	1880	m			
8	Cell 2	1820	m			
9	Cell 3	2700	m			
10	Total length	6400	m @	$35.00	=	$224,000.00
11						
12	Perforated Perimeter Collectors					
13	Cell 1	560	m			
14	Cell 2	570	m			
15	Cell 3	1190	m			
16	Total length	2320	m @	$40.00	=	$92,800.00
17						
18	Leachate Forcemain					
19	8 in main	1610	m@	$90.00	=	$144,900.00
20	12 in main	1240	m@	$130.00	=	$161,200.00
21						
22	Solid Leachate	795	m@	$110.00		$ 87,500.00
23	Header					
24						
25	Manholes					
26	26 Shallow	156	m@	$600.00	=	$93,600.00
27	2 Deep	36	m@	$600.00	=	$21,600.00
28						
29	Leachate Lift Stations					
30	Prefabricated					
31	Stations	4	@	25,000.00	=	$100,000.00
32	Main Lift					
33	Station	1	@	$200,000.00	=	$200,000.00
34						
35	French Drains					
36	Cell 1	5940				
37	Cell 2	5852				
38	Cell 3	10458				
39	Total Length	22250	m@	$30.00	=	$667,500.00
40						
41	Granular base					
42	Clear Stone (Sand)	90,000	c.m.@	$19.50	=	$1,755,000
43						
44	Hydro service					
45	to lift stations	2850	m@	$70.00	=	$199,500.00

Subtotal	3,757,600
Contingency (15%)	563,640
Subtotal	4,321,240
Engineering (15%)	648,186
GRAND TOTAL	$4,969,426

EX 868

Relates to C.6.3 p. 83 of B-860

C. 6.3

Liptons (2) $400,000

Forum (4400 m)

0/m · 2200 m, 5 m deep
0/m 1200 m, 7½ M deep } $361,000
5/m 1000 M, 3-6 M deep

Ord sewer 5000 m at $100/m 500,000

125,000

Mall 50 x 2500/m 387,000

B Ranch.

B870

RICHARD G. SHEPHERD, B.A.Sc., P. Eng.

EDUCATION:

B.A.Sc. University of Waterloo 1975

Numerous continuing education courses and seminars in hydrogeology, waste management, construction management and health & safety: 1980 to present.

EMPLOYMENT:

1983-Present	Principal Conestoga-Rovers & Associates Limited
1981-1983	Associate Conestoga-Rovers & Associates Limited
1979-81	Senior Engineer Conestoga-Rovers & Associates
1976-79	Engineering Services Manager Malawi/Canada Railway Project
1975-76	Project Engineer, Steed and Evans Co. Ltd. Kitchener
1974-75	Project Supervisor, Steed and Evans Co. Ltd., Kitchener
1974-75	University of Waterloo, Department of Civil Engineering
1973	Construction Layout Supervisor, Steed and Evans Co. Ltd., Kitchener
1971-72	Design Technician, City of Brantford Engineering Department
1968-71	Survey party chief, J.D. Lee Engineering Limited, Kingston and Brantford

PROFESSIONAL AFFILIATIONS:

Association of Professional Engineers of Ontario
Canadian Society of Civil Engineers

Richard G. Shepherd

PROFILE OF PROFESSIONAL ACTIVITIES:

- Corporate responsibility for all construction and project management of remedial construction related to remedial action implementation

- Senior Engineering Supervisor or Project Manager responsible for one or more of the following: investigations/site characterization/remedial investigations/feasibility studies/remedial design/permitting/contract documents and specifications/bid negotiations and contract award/contract administration/remedial construction supervision and inspection for the following hazardous waste sites/clients.

  - Remedial Investigation/Feasibility Study for PCB storage and processing Site, Baldwin, Florida (generator group) 1987
  - Remedial Investigation/Feasibility Study for hazardous waste landfill, Chester County, South Carolina (generator group) 1987
  - Site and hydrogeologic investigation, design of remedial measures and management of remedial construction for leaking underground storage tanks, at Manufacturing facilities Modesto and Sacremento, California (Kraft, Inc.) 1987
  - Investigation, design and implementation of remedial measures at PCB contaminated capacitor plant, Bridgeport, Connecticutt, (Farley-Northwest Industries, Inc.) 1986
  - Overview and critique of government RI/FS program, Miami County Landfill, Troy, Ohio (Generator Group), 1987
  - Design and implementation of aquifer remediation program, Middleport, New York (FMC Corporation), 1987
  - Investigation and design of closure for three RCRA surface impoundments and five container storage areas, Middleport, New York (FMC Corporation), 1986
  - Site and hydrogeologic investigation, design of remedial measures and management of remedial construction at former PCB contaminated capacitor plant, Crawfordsville, Indiana (Kraft, Inc.), 1986
  - Cleanup and demolition of a world-class oil refinery, East Chicago, Indiana (U.S. Federal Court, Northern District, Illinois), 1985
  - Provision of Quality Control/Quality Assurance services for closure of sludge lagoons, Calvert City, Kentucky (B.F. Goodrich), 1986
  - Site investigation, design of remedial measures and management of remedial construction, PCB contaminated capacitor plant, Totawa, New Jersey (Farley-Northwest Industries Inc.), 1986
  - Design and construction inspection of hazardous gas exclusion system beneath office building, Minnesota, Minneapolis (FMC Corporation), 1986
  - Design and construction management of aquifer remediation, Fridley, Minnesota (FMC Corporation), 1986
  - RCRA Part B Application, surface impoundments and container storage areas, Middleport, New York (FMC Corporation), 1985
  - Excavation, sampling, analysis and disposal of drummed hazardous wastes and contaminated soils at two Superfund sites in New Hampshire and New York, 1985
  - Investigation and design of remedial measures at five PCB contaminated manufacturing plants and warehousing in Tennessee, Kentucky and Indiana (Owner Confidential), 1985

- Design and management of Phase 2 remedial construction, Chem-Dyne Site, Hamilton, Ohio (Chem-Dyne Site Trust), 1986
- Design and management of Phase 1 remedial construction, Chem-Dyne Site, Hamilton, Ohio (Chem-Dyne Site Trust), 1985
- Supplemental RI/FS for North Hollywood Dump, Memphis, Tennessee (Generator Group), 1985/87
- RI/FS for pesticide plant facility, Marshall, Illinois (Velsicol Chemical Corporation), 1985/87
- Groundwater monitoring program, North Hollywood Dump, Memphis, Tennessee (Generator Group), 1984
- Coordinator and supervisor of remediation/retrofit/rehabilitation projects at manufacturing plant facility complex, Poughkeepsie, New York (IBM Corporation), 1984/87
- RI/FS for pesticide plant facility, Middleport, New York (FMC Corporation), 1984/87
- Post-closure monitoring, remediated landfill and plant site, St. Louis, Michigan (Velsicol Chemical Corporation), 1983/88
- Construction of upgradient cutoff wall and collection trench, LaBounty Landfill Site, Charles City, Iowa (Salsbury Laboratories), 1984/85
- RI/FS for Groundwater Remediation, Fridley, Minnesota (FMC Corporation), 1985/86
- Site Investigations for Overburden and Groundwater Remediation and Facility Demolition; Chem-Dyne, Hamilton, Ohio, 1983/85 (Generator Group)
- Remediation of two sites previously used for land disposal of solvents, Poughkeepsie, New York (IBM Corporation), 1983/85
- Phase I Remedial Design and Construction, North Hollywood Dump, Memphis, Tennessee (Generator Group), 1983/85
- Remedial investigation, design of remedial measures and management of remedial construction for remediation of hazardous waste landfill, Fridley, Minnesota (FMC Corporation), 1982/84
- Design of remedial measures and management of remedial construction for Remediation of PCB lagoons, Kittanning, Pennsylvania (Union Carbide), 1984
- Hazardous waste lagoon stabilization and securement, Marshall, Illinois (Velsicol Chemical Corporation), 1982/83
- Remediation of PCB contaminated plant property, London, Ontario (Westinghouse), 1983/84
- Demolition and Securement of Chemical Plant, St. Louis, Michigan (Velsicol Chemical Corporation), 1981/82
- Remediation of former hazardous waste landfill (Golf Course Site), 1983 St. Louis, Michigan (Velsicol Chemical Corporation)
- Remediation of Chemical Plant Site, St. Louis, Michigan (Velsicol Chemical Corporation), 1982/84
- Securement of low level radioactive soils, St. Louis, Michigan (Velsicol Chemical Corporation), 1982
- Closure of LaBounty Landfill Site, Charles City, Iowa (Salsbury Laboratories), 1982/83
- Securement of Hazardous Waste Landfill, Hardeman County, Tennessee (Velsicol Chemical Corporation), 1981/82

- Closure of Contaminated Process Equipment storage yard, Midland, Michigan (Commercial Metals Corporation), 1984
- Spill Containment for Hazardous Waste disposal facility, Breckenridge, Michigan (Velsicol Chemical Corporation), 1984
- As sub-consultant to Camp Dresser McKee under the Superfund Zone 1 program, responsible for the remediation of surficial drummed and tanked wastes at the following sites:
  - PAS, Oswego, New York
  - Bluff Road, Columbia, South Carolina
  - Epping, New Hampshire
- Provision of Health, Safety and Air Monitoring Services during remedial construction at the following sites (Sevenson Construction Corporation)
  - Gilson Road, Nashua, New Hampshire
  - Demolition of Refinery, Toledo, Ohio
- Demolition and Securement of Contaminated Warehousing structures, St. Louis, Michigan (Velsicol Chemical Corporation), 1982
- Containment and Cleanup of Chemical train derailment spill, Mississauga, Ontario (Region of Peel), 1981
- Leachate treatment facility, Love Canal, Niagara Falls, New York (New York State), 1980
- Final Cover, Love Canal, Niagara Falls, New York (State of New York), 1980

- Technical Specialist/Project Engineer for the following projects:
  - Remedial investigation/Feasibility Study, WDE Site, Andover, Minnesota (Generator Group)
  - Design of containment wall, Niagara Falls, New York (Dupont)
  - Evaluation and Development of Sludge Stabilization technology at several sites (Velsicol Chemical Corporation)
  - Remedial investigation/feasibility study, Wauconda Sand and Gravel Site, Illinois (Generator Group)
  - Remedial construction, Twin City Arsenal, Minneapolis, Minnesota (Honeywell)
  - Remedial investigation/feasibility study, Lone Pine landfill, New Jersey (Generator Group)
  - Remedial action cleanup, Hempstead, New York (Sevenson Construction Corporation)
  - Evaluation of remedial plans and specifications for the following Superfund Sites (Camp Dresser McKee)
    - Kin Buc Landfill
    - Gilson Road
    - Silresin Landfill
    - Lipari Landfill
  - Evaluation and development of feasibility of utilizing waste heat from a nuclear facility, Ontario (Industrial Venture Group)

- Resident Engineering Supervisor for the following projects:
  - Remedial Construction, Southern Sector, Love Canal, Niagara Falls, New York (City of Niagara Falls)
  - Remedial Construction, North and Central Sectors, Niagara Falls, New York (State of New York)

- Technical negotiator for the following
  - Consent Judgement for Site Remediation of several sites in Michigan (Velsicol Chemical Corporation)
  - Consent Order for Site Remediation, Fridley, Minnesota (FMC Corporation)
  - Agreement for Site Remediation, North Hollywood Dump, Memphis, Tennessee (Velsicol Chemical Corporation/Generator Group)
  - Agreement for Site Remediation at two sites in New York State (IBM Corporation)
  - Consent Judgment for Site Remediation, Chem-Dyne, Hamilton, Ohio (Generator Group)
  - Consent Order for Site Remediation, Crawfordsville, Indiana (Kraft, Inc.)
  - Consent Order for Site Remediation, Bridgeport, Connecticutt (Farley-Northwest Industries, Inc.)

- Appointed as Special Master to the U.S. Federal District Court to manage and administer the cleanup and disposal of drummed and tanked hazardous wastes at, and demolition of, an oil refinery in East Chicago, Indiana

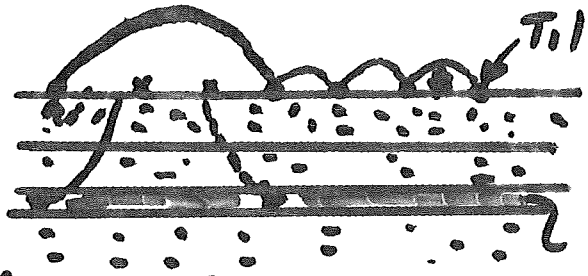
- Expert witness in litigation involving PCB and volatile organic contamination of building, soil and groundwater in Waynesboro, Tennessee, 1986/87

- Expert witness in litigation involving remediation of drummed waste landfill, Picillio Site, Rhode Island, 1987

- Expert witness in litigation involving petroleum product spill and cleanup, Michigan, 1984/85

SCHEMATIC SHOWING FAILURE OF SEVERAL TILES (FRENCH DRAINS)

(a)

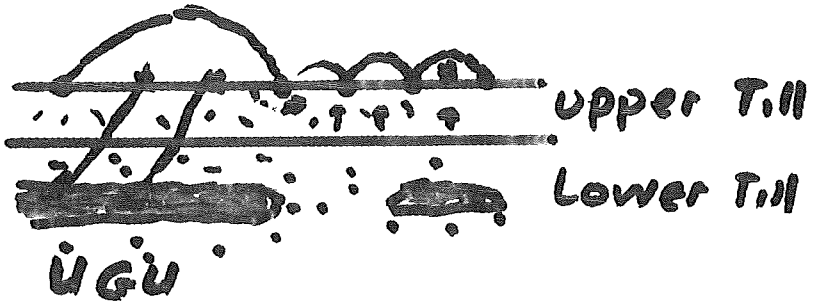


× "Failed" Tiles

+ Monitor S.W of Cell #1 CRA E. B860D2R

K of Waste 10^{-4}

(b)

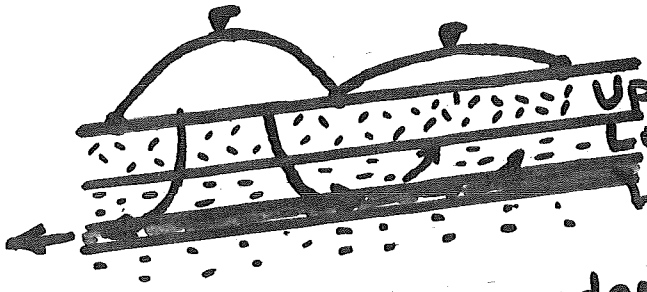


N.T.

SCHEMATIC SHOWING PARTIAL FAILURE OF HYDRAULIC TRAP

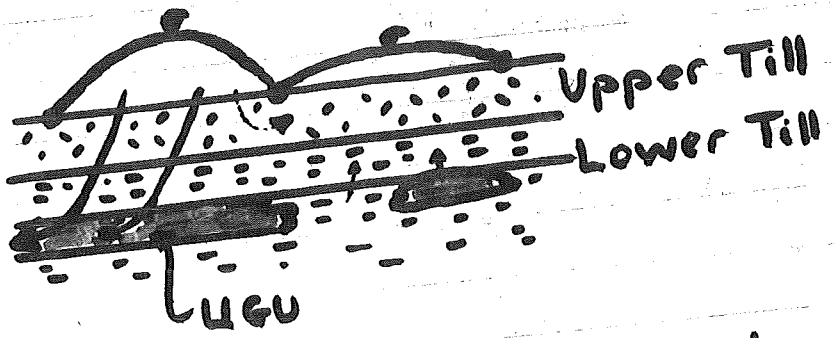
M-875

(a)



. UGU Extends under most of the site

(b)



. UGU only extends under part of site

B-881

Investigations for Landfill Sites in Areas I, II, and VI in the City of Brampton

Hydrogeological Report

THE REGIONAL MUNICIPALITY OF PEEL

MacLaren Plansearch

March 1987

4. LINER CONSIDERATIONS

4.1 Introduction

A liner will be required beneath any landfill developed on Area I and II and possibly along some of the sides of an excavation in Area VI. The following discussion outlines the general requirements for liner construction, and the availability of potential sources.

Only natural soil liners are addressed at this time as it is understood that the Ontario Ministry of the Environment does not consider flexible synthetic membranes suitable for lining below a landfill. It should also be noted that bentonite mixtures have some particular problems, such as the possibility of an increase in hydraulic conductivity due to chemical reaction with the leachate. Although this may occur to a lesser extent in other clays, the problem is much more pronounced with sodium-saturated bentonite.

4.2 Natural Soil Liner Designs

The role of a liner, in the context of the present study, is to restrict and control the migration of contaminants into the surrounding environment through the bottom or sides of the landfill. No liner is completely impermeable and contaminants can migrate through a natural soil liner by several mechanisms, including:

- advection - transport of contaminants in solution by water moving through the soil

- dispersion - movement of contaminants by mechanical mixing and molecular diffusion

- diffusion - molecular migration of contaminants in response to concentration gradient (i.e. migration from an area of greater to lesser concentration).

Migration by diffusion away from the landfill (i.e. the contaminant source) can occur even when groundwater flow is towards the landfill, though this is likely to be a very slow process.

The rate of migration is a function of many factors, including:

- hydraulic conductivity of the liner with regard to the leachate (this can vary for different chemical species within the leachate)

- the driving head or hydraulic gradient (i.e. the depth of leachate above the liner relative to the surrounding groundwater)

- the nature of the surrounding soil or rock and the initial degree of saturation (i.e. whether the landfill is above or below the water table).

The actual liner design will depend on specific conditions at the site and the performance (i.e. degree of contaminant migration control) required. The more sensitive the surrounding environment (e.g. the presence of an aquifer) and the less ability the underlying soil has to act as a back-up containment system, the more stringent will be the performance standards required. This is necessary to ensure that the liner adequately controls the rate of contaminant migration and that relevant groundwater quality standards are maintained. Final field testing will involve the construction of test liner sections to prove material and construction techniques.

A review of the appropriate literature indicates the following general factors are considered desirable in liner designs (a selected bibliography is given in Appendix 9):

- clayey soil, with plasticity index of greater than 10-15

- non-reactive soil (i.e. leachate does not increase hydraulic conductivity)

- soil [illegible]ion capacity
- reco[illegible]ic conductivity of less than 10^{-7} cm/sec (laboratory values) lower than those achieved in the field)
- a [illegible] ranging from 0.6 m to 1.56 m.

Often [illegible]e design is control of the buildup of leachate above the liner [illegible]n system (eg., french drains; perforated pipe system in a gran[illegible] sloping of liner surface), and a monitoring system below the l[illegible] granular blanket monitored by wells, lysimeters, or other metho[illegible]nine if any liner failure occurs.

In C[illegible] Keele Valley Landfill, in the Town of Vaughan, provides a case[illegible] a liner system accepted by the Ontario Ministry of the Env[illegible]The site is in a former sand and gravel pit, above the water tab[illegible].2 m thick liner is constructed of clayey silt till (probably Ha[illegible] with a minimum of 19-20% clay fraction, a plasticity index gr[illegible] or equal to 10, and the material compacted by a push-foot r[illegible]bout 2% wet of the optimum density moisture content (this latter achieves the lowest hydraulic conductivity values). The conductivity must not exceed 10^{-8} cm/sec. The material is from property adjacent to the landfill. The liner overlies recom-[illegible]n-situ sands, and its performance is monitored by wells below the [illegible]ysimeters immediately below and within the liner, and various trans-[illegible]nd conductivity arrays within the liner. All cables, pipes, etc., to the side, rather than through the liner, and thus the logistical [illegible]ms of installation and maintenance increase with the size of the site. [illegible]chate collection system overlies the liner.

Material Search

[illegible] a liner were to be installed at a site in Brampton then it would [illegible]cessary to identify adequate quantities of suitable material. As part

the current investigation a preliminary search was carried out. When conducting the search, the Keele Valley specifications were used as a guideline, and a preliminary conceptual design of a 1.2 m thick liner with hydraulic conductivity of 10^{-8} cm/sec or less was used. Thus a volume of 1.5 to 2 million m^3 of material was estimated to be required. It should be noted that at the detailed design stage these requirements could change.

A granular monitoring layer may be required below any liner installation. This material is available off-site from various pits in Peel Region.

4.3.1 On-site Search

Area I

There appear to be no on-site source. Halton Till occurs at the surface in Area I, but borehole log descriptions and grain size analyses indicate that it has insufficient clay, and contains numerous sand seams. Only one borehole (PL-12) shows surface sandy clayey silt till with adequate clay content (approximately 21-22% clay, about 3 m deep). This borehole is north of Sub-area IB.

Area II

An initial review of the borehole descriptions and grain size analyses identified pockets in the surface Halton Till which might be potential liner material sources. These occur in Sub-area II-B (2 boreholes), the overlapping area of IIB and II-C (1 borehole) and II-F (1 borehole). All data on II-E indicates that the soil is too sandy and/or too variable. So samples collected during the drilling of borehole II-10 (from 0.6 to 3 and borehole II-11 (1.8 to 4.6 m) were retrieved from storage and the grain size distributions determined. The samples were then mixed and subjected grain size analysis, determination of plasticity index and the Standard Proctor compaction test. These samples represent material in the gen

vicinity of, and to the depths identified as potential source materials. Analyses from the combined bulk sample identified an average clay content of approximately 17%, plasticity index of 7, and minimum permeability of approximately 3 x 10^{-8} cm/sec (Appendix 8). These values are just below the criteria established for the Keele Valley materials. Modifications of the Standard Proctor test method to more closely imitate the compactive effort of a push-foot roller in the field might decrease the achieved laboratory hydraulic conductivity.

It is possible that the Queenston Shale bedrock, if crushed, could serve as a source of liner material and thus a sample of shale core from one boring in Area IIB was crushed and tested. The results of the testing done on the sample also did not meet the Keele Valley specifications. It would appear based on observations of the shale in other exposures, that natural weathering of excavated shale would have increased the breakdown of the intact bedrock and improved the compacted permeability performance.

However, while the one preliminary test of on-site overburden material from II-B did not meet the Keele Valley specifications, pockets (probably less than 5 m deep) of suitable liner material may possibly be found on site as a result of a more detailed program including the digging of test pits and further laboratory analyses. Small pockets of suitable material, probably less than 4 m deep may also occur in part of II-C and II-F. Any final determination will require additional field and lab testing.

In summary, some material may be available in IIB but not enough for a complete liner. In Sub-areas IIC, 1IE and IIF all or most of the liner material would have to be imported.

Area VI

Review of the borehole logs and grain size curves indicates that there will be enough suitable material to carry out any lining of the sides of the ex-

cavation if this should prove necessary due to variability of the shallow soils. If any lining of the bottom of the northeast part of VIB were required then it appears that the upper 5 m of material in that area would be suitable for that purpose. No testing was carried out at this time and field test pits and laboratory analysis would be necessary if lining material were to be required.

4.3.2 Existing Licensed Off-Site Properties

Methodology

A search was made of existing licensed pit and quarry operations in York, Peel and Halton Regions to identify any potential sources of liner material (Figure 4.1). Licensed pits and quarries were identified using the relevant Aggregate Resources Papers (ARIP), and in discussions with Pits and Quarries staff at the Ministry of Natural Resources, Maple and Cambridge District Offices. Where a possible source of suitable overburden was identified, the pit was contacted to see if non-granular material was available and if it was, a site visit was made. Samples of material identified as representative by pit staff/owners were examined. Winter conditions at the time of the search impeded visual assessment of volumes and overall homogeneity of the non-granular materials.

Overburden Sources

Only one relatively small source of potentially suitable overburden material was identified in the search area.

Four operations were examined in the field - a shale quarry with stripped Halton Till overburden in Burlington, and three sand and gravel operations (Albion Sand and Gravel, Georgetown; J. Dick Construction Ltd. and Bolton Sand and Gravel, both near Bolton). Only the shale quarry appeared to have potentially suitable material. The suitability assessment is based on

existing geological map data because the frozen ground prevented the collection of a good sample. Assessment of the quantity available would require drilling of the stockpiles to determine uniformity and texture; weathered shale is probably included in the stockpiles. Samples from the three gravel pits appeared to be too silty, sandy, or variable to meet the criteria. The remaining pits and quarries in the search area did not have any non-granular materials available, or non-granular material occurred in scattered lenses of varying extent and textures within the deposit. Such material as occurred was often required for final site rehabilitation.

Queenston Shale Bedrock

There are several large scale quarries in the search area, mining the Queenston shale for use in manufacturing clay tile and brick products. The shale is generally ripped or blasted, then stockpiled and allowed to weather for several months to break down. The weathered shale, after some additional crushing, may be suitable for liner material. Testing will be required to identify optimum pre-treatment and actual suitability of the shale for liner use.

There are several quarries relatively close to the study sites. The closest quarry is a 160 ac site, at Cheltenham, less than 10 km from Area II. However, this property is still in the process of obtaining a license for extraction. None of these quarries reported excess weathered shale or till stripped from the site.

Other Off-Site Sources

New Excavation

Based on the geological data available on the Halton Till and Wildfield Till (White, 1975), it is likely that suitable liner material occurs in these deposits. However the identification and development of a new excavation to extract the soil material other than at the landfill site would require:

i) detailed field sampling and laboratory testing to prove that there were adequate volumes of suitable material

ii) licensing the property according to the Pits and Quarries Control Act, administered by Ontario Ministry of Natural Resources, and possibly meeting the requirements of the Environmental Assessment Act.

If objections are raised to the excavation, the site would require OMB approval and, in addition, would require final rehabilitation. Based on existing knowledge of the regional geology it is estimated that to obtain the necessary volume of material a site of about 40 ha (100 ac) would be required.

Other Sources

Several large properties in east Brampton are scheduled for industrial development over the next few years in an area of surface till potentially suitable for liner material. The majority of developments will not generate excess fill, although some major excavations for large structure foundations or on-site surface drainage facilities may be required. However this type of source cannot be considered a reliable source of material for site lining.

4.4 Cost Estimates

Based upon the results of this liner investigation and given that no specific existing sources have been identified four options for obtaining liner source material have been considered to provide a range of potential lining costs. These options are:

1. Drawing the material from an existing shale quarry (haul distance estimated at 31 km, using an average distance from several sources)

2. Developing a source from within the shale bedrock (within 3 km)

3. Developing a source from the overburden within a reasonable distance from the site (within 15 km), and

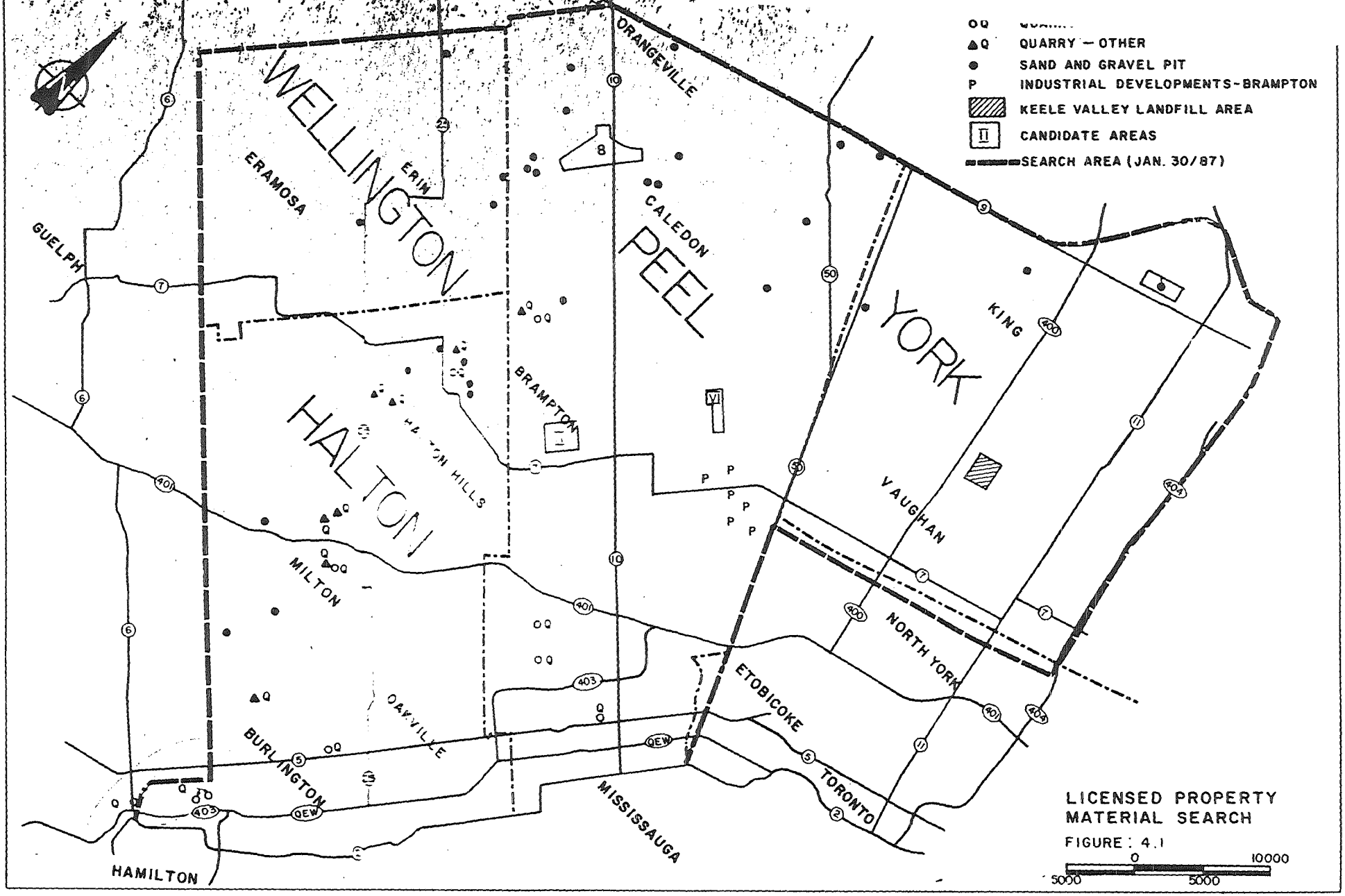
4. Drawing from an existing source possibly as far as 75 km.

For each of the above options an estimate has been prepared of the cost to install a natural clay liner approximately 1.2 metres thick to cover the base and side walls of a landfill occupying 400 acres in size. The cost estimate includes purchasing the material, loading, hauling, dumping, spreading and compacting the material and, in the case of a shale source, crushing it.

The cost estimate also includes allowances for a granular sub base, monitoring the performance, and for the new sources, the costs for licensing the source. The estimated cost for each option is as follows:

Option 1 Existing Shale Quarry	$54/m^2 of placed liner
Option 2 New Shale Source	$51/m^2 of placed liner
Option 3 New Overburden Source	$40/m^2 of placed liner
Option 4 Existing Long Distance Source	$79/m^2 of placed liner

These costs provide a basis for sub-area comparison recognizing that actual costs will be subject to final site design requirements and location of an adequate source(s) of liner material.


QUARRY — OTHER
SAND AND GRAVEL PIT
P INDUSTRIAL DEVELOPMENTS-BRAMPTON
KEELE VALLEY LANDFILL AREA
CANDIDATE AREAS
SEARCH AREA (JAN. 30/87)
WELLINGTON
HALTON
PEEL
YORK
ERAMOSA
ERIN
CALEDON
ORANGEVILLE
GUELPH
BRAMPTON
MILTON
OAKVILLE
BURLINGTON
HAMILTON
MISSISSAUGA
ETOBICOKE
NORTH YORK
VAUGHAN
KING
TORONTO
LICENSED PROPERTY
MATERIAL SEARCH
FIGURE : 4.1
0
10000
5000
5000

APPENDIX 8

RESULTS OF LABORATORY TESTING ON POTENTIAL LINER MATERIAL

Warnock Hersey Professional Services Ltd.
3210 American Drive, Mississauga, Ontario L4V 1B3 (416) 678-7820 Telex 06-968801

Janet Haynes

November 24, 1986

Maclaren Plan Search
33 Yonge Street
Toronto, Ontario
M5E 1E7

Dear Ms. Haines,

The following is a covering letter summarizing the results of the assigned testing on samples of glacial till and shale core delivered to our laboroatory. Initial preparation of the samples included breaking down of the two glacial till samples, and crushing of the shale core to approximately minus 5mm by means of a simple laboratory jaw crusher. Grading analysis were subsequently performed on each of the samples, after which the glacial till was combined in a single sample with another grading analysis performed on the combined sample.

Standard Proctor tests were carried out on two materials; namely the crushed shale and combined glacial till and the results used in preparation of permeability specimens at optimum moisture content, 2% above optimum and 4% above optimum.

The testing results are summarized below with the laboratory work sheets also attached.

Grading Analysis (see attached distribution curve)

Samples	2-10	Glacial Till
	2-11	Glacial Till
	2-7	Combined glacial till Crushed shale

/Cont'd....

Standard Proctor (ASTM -D-698)

	Combined Glacial till	Crushed Shale
Maximum Wet density gm/cc	2.252	2.353
Maximum Dry Density gm/cc	2.019	2.179
Optimum Moisture Content	11.5	8.0

Permeability Tests

Glacial Till	Hydraulic Conductivity K(cm/sec)	Hydraulic Head
Prepared at 11.0% M.C.	3.2×10^{-8}	230cm
Prepared at 13.0% M.C.	3.9×10^{-8}	230cm
Prepared at 15.0% M.C.	5.2×10^{-8}	230cm

Crushed Shale		
Prepared at 8.5% M.C	1.7×10^{-6}	80cm
Prepared at 10.0%M.C.	9.2×10^{-7}	230cm
Prepared at 7.4% M.C.	7.4×10^{-5}	80cm

Atterberg Limit Test

Combined Glacial till sample (pass #40 sieve)

Liquid Limit	23.4%
Plastic Limit	16.2%
Plasticity Index	7.2%

If you have any questions, please feel free to contact the undersigned.

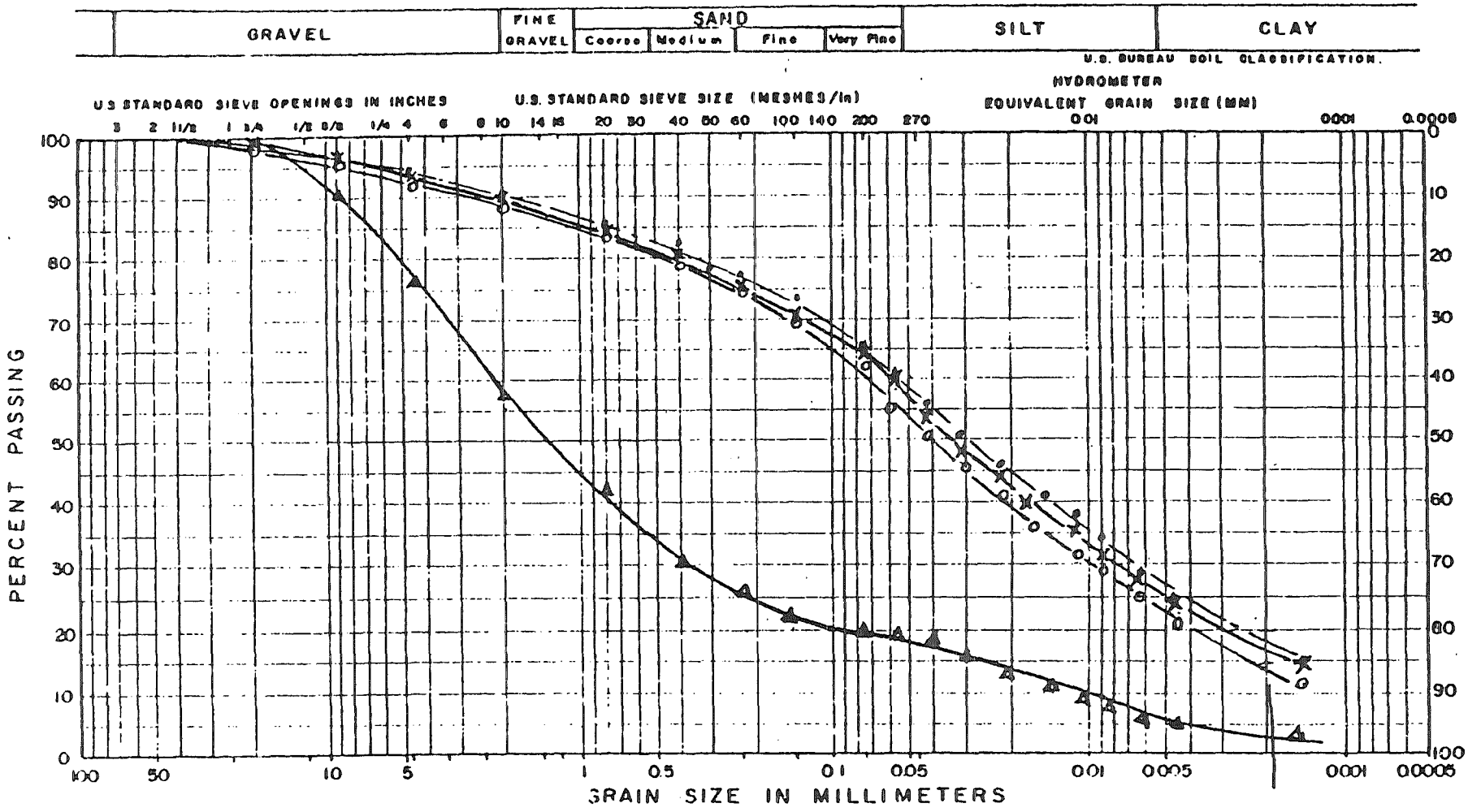
Sincerely yours,

WARNOCK HERSEY PROFESSIONAL SERVICES LTD

B.D'Onofrio, P.Eng.,
Asst. Manager
Geotechnical Services

BD/sa

GRAIN SIZE DISTRIBUTION



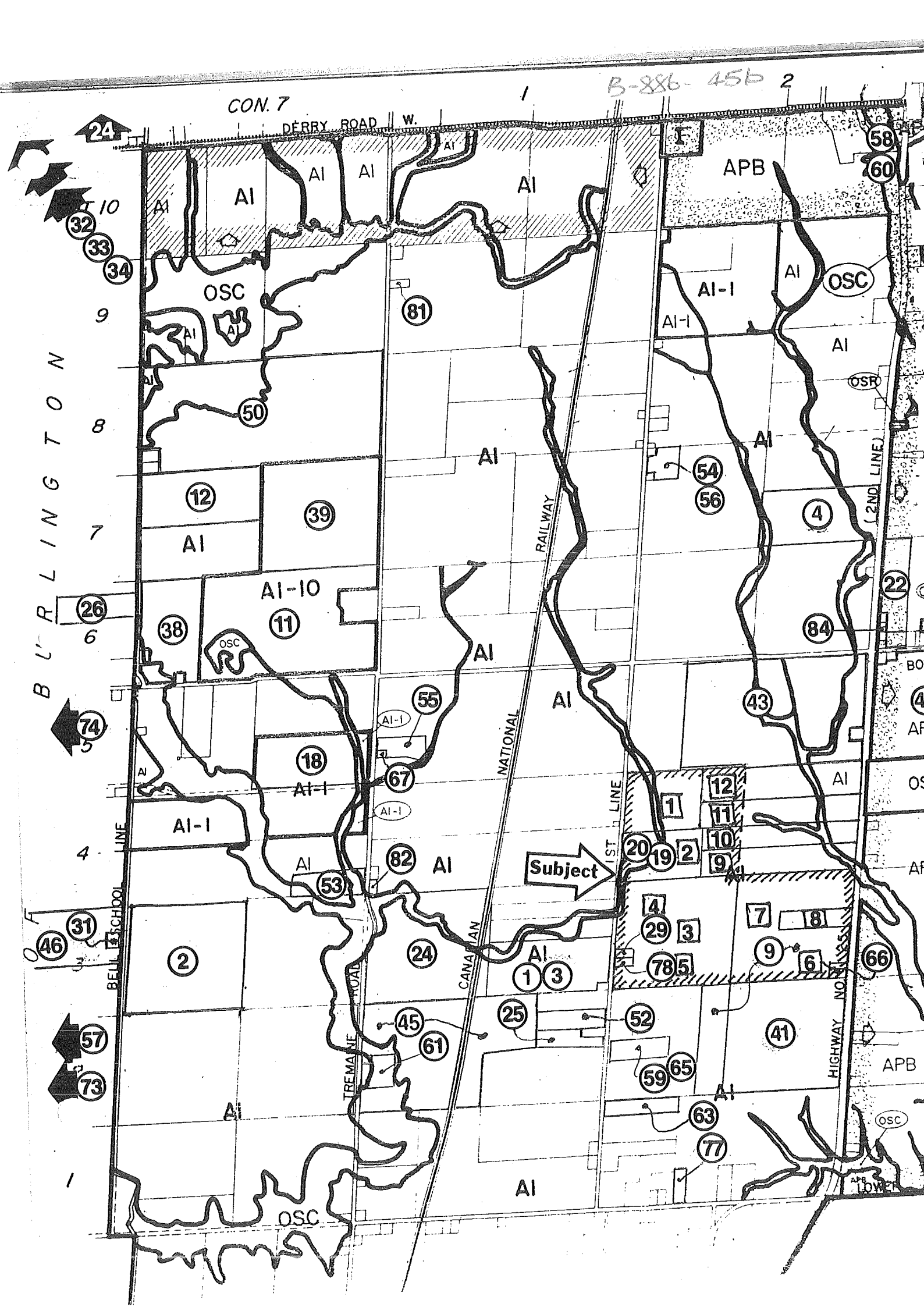
GRAVEL		SAND			CLAY & SILT
Coarse	Fine	Coarse	Medium	Fine	

UNIFIED CLASSIFICATION

BOREHOLE No	SAMPLE No	DEPTH	DESCRIPTION
2-10		2'-10'	GLACIAL TILL
2-11		6'-15'	GLACIAL TILL
			COMBINED GLACIAL TILL
2-7		9'-15'	CRUSHED SHALE

CRUSHED SHALE

APPENDIX
FIGURE
PROJECT 502327324 90


B-886-45b
CON. 7
DERRY ROAD W.
BRLINGTON
Subject
RAILWAY
NATIONAL
CANADIAN
TREMAINE ROAD
BELL SCHOOL LINE
1ST LINE
(2ND LINE)
HIGHWAY
AI
AI-1
AI-10
APB
OSC
OSR

H-902

Item No. ____

CITY OF BURLINGTON

CAO 21/85 March 22, 1985

The Chairman and Members of the
Solid Waste Management Committee

Subject: City's Response to Walker Wright Young Associates Ltd. Phase 2 Stage 2C Landfill Environmental Assessment Study Reports for the Region of Halton
File: 60-75-1

RECOMMENDATION:

WHEREAS the principal recommendation of the Draft Environmental Assessment Study Phase 2 Stage 2C Report prepared by Walker Wright Young Associates Ltd., namely, that the Escarpment Site F in Burlington "be selected as the preferred site for landfill in Halton", is based on incomplete information and inadequate analysis;

AND WHEREAS, should the Region's EA submission identify the undertaking as landfill at one preferred site, it would risk having to conduct another Landfill EA Study were the EA Board to not approve the undertaking as submitted;

AND WHEREAS, in the opinion of the City's professional consultants, a close review of the information available to Walker Wright Young Associates Ltd., within a more systematic and more reliable framework for comparatively evaluating the six candidate sites, demonstrates conclusively:

(1) that none of the six sites, including the Escarpment Site, is clearly preferable to all of the others and
(2) that Sites A and D, form a very tight grouping as "most preferred" sites, with Site E and Escarpment Site F being close "second most preferred" sites;

THEREFORE BE IT RESOLVED THAT the Region of Halton be urged in its EA submission, to identify the undertaking as the Provision of a Landfill Site by two alternative methods being the establishment of a landfill site at Site A or Site D.

AND FURTHER THAT the Region of Halton be advised that, should it identify the undertaking as the Provision of a Landfill Site at Escarpment Site F only, the City of Burlington, by all means at its disposal, will oppose such an undertaking, and will promote alternatives to the undertaking.

AND FURTHER THAT the Region of Halton be requested to hear a presentation on this matter from the City's consultants Ecoplans Ltd. and Conestoga-Rovers Associates, and from the City's Assistant Director of Public Works -- Transportation, at the Regional Council meeting of April 3, 1985.

AND FURTHER THAT a meeting be held on April 1, 1985 at 7:00 p.m. at Aldershot High school to present the City's position on this matter to members of the public.

REPORT:

I. PURPOSE:

The purpose of this report is to respond to the Region's request for comments on the Walker Wright Young Associates Ltd. Landfill EA Study Phase 2 Stage 2C Report (hereafter, the WWY 2C Report), by March 26, 1985.

This report is based in part on reports prepared by its consultants (Ecoplans Ltd. and Conestoga-Rovers, hereafter Ecoplans/CRA), and by the Transportation Division of the City of Burlington's Public Works Department. These reports are attached and are intended to form part of the City's response.

II. INTRODUCTION:

WWY's 2C Report was presented to a special meeting of Regional Council on February 6, 1985. The target date set by the Region for submissions from interested parties is March 26, 1985. This report, together with the Ecoplans/CRA Report and the Public Works Report 65/85 which are attached, constitutes the City's submission.

Since the Landfill Environmental Assessment Study began over two years ago, the City of Burlington has been a close observer of the Study process, and has made half a dozen major submisions in response to requests from the Region. There is no need to review those submissions in detail here. Collectively, our objectives have been to keep the costs of the Study within reasonable limits, and to ensure that WWY's analysis was fair, systematic, and understandable to the broad cross-section of interested observers.

Concern with the treatment of the Escarpment Site F in Burlington (also known variously as the NSP Site, Pit and Quarry Site 1 or P&Q 1, and as Site F to WWY) has figured largely in the City's submissions. However, no City submission has been been motivated by a desire to prevent the establishment of a permanent landfill site. On the contrary, during this period the City's stated policy, which arose from the Acres Report, has been to consider a role for the Escarpment Site subject to a number of conditions.

The City's policy with respect to Escarpment Site F has stood in stark contrast to the Town of Milton's unconditional opposition to landfill in its territory on any terms. It is also relevant to note that during this period the City has agreed to a second expansion of the Region's Burlington landfill site, and to the operation at this site of an open air transfer station needed to support the Interim Export Option.

Regretably, the City's persistent open-mindedness with respect to landfill in Burlington, its accommodation of the Region's disposal problems, and its constructive efforts in support of the Landfill Environmental Assessment Study, have gone unappreciated. The failure of both the Region and WWY to respond positively to the City's concerns and suggestions led the City to decide to retain its own environmental consultants early in 1984. Neither the submissions prepared by the City alone, nor those prepared with the help of the City's consultants, have altered in any significant way the receptivity of either the Region or of WWY.

What the WWY 2C Report Should Have Been.

The 2C Report is the climax of more than two years of information gathering and analysis. As the account of the step in the analysis that finally recommends the preferred site for the Region's next landfill, the Report should be persuasive in the eyes of the majority of interested parties. Every reader should be able to follow the analysis. Whether a particular reader agrees or disagrees with the conclusion of the analysis, that reader should agree that the conclusion follows from the evidence presented. As the point of departure for the preparation of the Region's Environmental Assessment submission, the Report should be factually correct in virtually every detail. The WWY Report fails to meet these requirements.

III. THE WWY 2C REPORT IN SUMMARY

In essence, the WWY 2C Report presents and evaluates information gathered on each of the six candidate sites under five priority categories. Each site is compared with every site and the Escarpment Site F is recommended as the preferred site for landfill in Halton. The 2C Report comprises a "Summary" report and 13 "Technical" reports; the information in the former is derived from the latter.

IV. THE PREPARATION AND NATURE OF THIS RESPONSE

This response is based upon the WWY 2C Report itself, on information presented at public meetings held at the Region, and in Burlington, Milton, and Oakville, during the period between February 6, 1985 and the time of writing, on information obtained from the City's environmental and legal consultants, some of which had been obtained from the Region's consultants and staff, on information received from citizens, and on information contained in various authoritative reports, hearings, and journals.

The general objectives of this report are to demonstrate conclusively:

(1) that the information and analysis presented by WWY to support the concluding preference for the Escarpment Site F are seriously deficient;

(2) that no one site can, on the basis of any systematic analysis of the information presented by WWY, be shown logically and consistently to be better than all of the others;

(3) that Sites A and D, and then Sites E and Escarpment Site F, on the basis of systematic analyses of the information presented by WWY, are consistently better than the other two candidate sites, and that Site A is consistently better than Site D and, that both Sites A and D are consistently better than Sites E and the Escarpment Site F, by margins that are relatively insensitive to changes in factor weightings; and

(4) that the collection of further information on certain aspects of certain sites would be a rational course of action if one's objective were to establish a clear preference for one site with a view to effectively defending one's preference in subsequent proceedings.

A number of factors make it impossible to address these objectives individually or in any particular order. Among them are that, like the categories defined by WWY, these objectives overlap. Good examples may pertain to several critical points. The methods of presentation and analysis in the WWY 2C Report, also do not lend themselves to orderly review.

V. COMMENTS ON THE 2C REPORT

(a) Evidence and Inference

Before commenting on the 2C Report directly we would like to review several fundamental facts and principles about landfill in general, and about landfill in Halton. These facts and principles have been accepted for several years.

Hydrogeology is paramount in the siting of a landfill. Hydrogeologically, tills are superior to fractured shale. From first principles, then, Sites A to E are hydrogeologically superior to the Escarpment Site. At the Interim Expansion Hearings in 1984 the Region's hydrogeology consultant, Mr. R. Leech of Gartner Lee Associates, said that he personally would not recommend the siting of a landfill on shale in the Escarpment Site F area, and that tills are "definitely preferable".

There are short-term and long-term risks to human health and safety and to the environment associated with landfill sites. The engineering and the operation of a site can affect these risks. The Escarpment Site F is known, both from the Region's experience with the current site and its two expansions, and for its extreme terrain, to be the most difficult of the six candidate sites by far to engineer and to operate. Again, from first principles the Escarpment Site F cannot be preferred to the other candidate sites.

Another major risk factor associated with landfill sites is transportation. Transportation risk is a function of haul distance and of the probability of conflicts with non-haulage vehicles, with pedestrians, and with private property. The landfill that is known to minimize transportation risk is the site that is located closest to the centroid of waste generation. The Escarpment Site is not the closest candidate site to this centroid.

It is clear then that WWY's selection of the Escarpment Site as the preferred site for Halton violates accepted and fundamental facts and principles.

On our reading the inconsistencies just noted between evidence and inference are compounded and multiplied in the 2C Report. Collectively they create an enormous gap between the evidence collected and presented, and the principal conclusion reached. Given the sensitivity of the 2C task, one should have thought that WWY would have gone to great lengths to have the preferred site emerge as fairly as possible from the analysis.

Among the inconsistencies and anomalies catalogued in the reports attached to this report are the following:

- acknowledging the "unique characteristics" of quarry sites and then evaluating the Escarpment Site F against non-quarry sites as if nothing about quarry sites is "unique".

- defining the social impact boundaries for the Escarpment Site F, effectively minimizing the uniquely social impacts of the only urban candidate site;

- using several social impact indicators based on the same resident/residence counts within arbitrarily defined social impact boundaries to inflate the impacts of certain sites through "double counting" of the same people.

• exaggerating the impact of landfill upon community facilities at other sites, while ignoring the same impacts on similar facilities at the Escarpment Site F (e.g. Milton District Hospital versus Joseph Brant Hospital)

• selectively employing mitigating measures having their own high social impacts, to reduce or to nullify otherwise significant impacts (e.g. terminating Bayview Park)

• elaborately defining hydrogeological impacts so as to reflect the highest concern for groundwater resources, and dismissing the groundwater below the Escarpment Site F when its quality compares favourably with the groundwater at other sites

• dismissing C.R.O.W.'s public plea of October 9, 1984, to drop Sites B and C from further competition, and then dismissing them early in the 2C Report upon cursory consideration of essentially the same information and analysis used by C.R.O.W. (Concerned Residents Over Waste is an Oakville citizens' group.)

• dismissing as "rather crude", systematic forms of comparative analysis that would have allowed others to test the sensitivity and reliability of WWY's comparative judgements.

As noted above illustrations of these inconsistencies can be found in the attached Ecoplans/CRA report and in the Public Works report. Those reports also contain point-by-point comments and criticisms of the 2C report.

(b) How to Evaluate Competing Sites

WWY use methods of ranking the sites on factors and sub-factors that are inappropriate and inferior in a number of respects. The factor and sub-factor rank-orderings (i.e. from 1 for the lowest impact to 6 for the highest impact) assume that the assigned ranks are equidistant from one another. Moreover the information that is used to rank the sites on the factors and sub-factors tends to be chosen selectively, rather than systematically. And finally, the combining of the factor rankings through the "pairings technique" does not allow the consistent and reliable application of factor weightings.

The attached report by Ecoplans/CRA provides a detailed critique of these techniques and proposes an alternate methodology that allows for consistent and reliable application of factor weightings. It also allows for the determination of the sensitivity of the results to changes in the underlying data and assumptions.

The Ecoplans/CRA analysis clearly shows that the selection of a preferred site is critically dependent upon the assigning of factor rankings and weightings. By changing these parameters within reasonable limits, the overall rankings of Sites A, D and Escarpment Site F vary. This precise sensitivity testing was not possible within the WWY "pairings" method.

Many sensitivity runs show that, while Sites A and D, and Sites E and Escarpment Site F, consistently emerge as the best and second-best pairs, the rank score of none of the sites is considerably greater than all other sites. This result contradicts WWY's claims that the Escarpment Site F is the best site, and that Site D is the second best site.

VI. OTHER CONSIDERATIONS

(a) Bayview Park

WWY's analysis recommends the transfer of activities from Bayview Park as a mitigating measure. The move of Bayview Park activities are rationalized on the grounds that the Aldershot area will be left with more than sufficient park land after the move. This reasoning ignores the information supplied to WWY by the City that Bayview Park is a unique regional escarpment facility that attracts international equestrian competitors. Despite the fact that the City could not provide equivalent facilities for these activities elsewhere in its current parks system, no provision is made for defraying the City's costs in obtaining alternative facilities. These costs are estimated at between $600,000 and $900,000.

(b) The Role of Transfer Stations in the Disposal System

In January 1983 Regional Council approved the formation of a Transfer Station Task Force of staff from the Region and from area municipalities. The work of that Task Force was suspended several months later in recognition of the fact that the need for a transfer station in Halton is a function of the location of the landfill site(s) selected. This is to say that the issue of the need for a transfer station was to be addressed by WWY. Once a transfer station was shown to be required, the Task Force was to address the issues of transfer station operations and financing.

The 2C Report concludes that there is a need for a transfer station in Halton Hills to support the proposed Escarpment Site F landfill. Subsequent correspondence from WWY in response to a question from Alderman McLaughlin has implied an answer to the question of transfer station financing. Its implication is that the Region is to finance the proposed Halton Hills transfer station. The City finds this implication quite improper since financing responsiblity is not addressed in any detail in the 2C Report, and since it encroaches upon the mandate of the Transfer Station Task Force.

It should also be noted that the social impacts associated with the establishment of the proposed transfer station have not been considered in the WWY 2C Report. Since the Escarpment Site F is the only site requiring a transfer station, these impacts might properly be combined with those of the landfill site in the determination of overall impact.

(c) Capital Financing Implications

The City's consultants identify a number of additional costs for works which may be required in the development of the Escarpment Site F (see Table 3.1). These costs total $4.3-22.9 million depending on the strength of the need for, and on the nature of the construction of, a liner. These costs are in addition to those costs identified by WWY for the Escarpment Site F. In WWY's own terms, the Escarpment Site F would cost $19.1 million more than Site A in 1984 dollars. With the inclusion of the costs noted above, this differential would be $23.4-42 million.

The additional costs identified above for the Escarpment Site F are significant, and may require additional Regional capital financing through the issuance of debentures. Such additional debentures may be a source of concern given the proximity of the Region's current and projected debt levels to its approved debt limits.

VII. BURLINGTON PUBLIC OPINION

For several years a sizable number of people in the Aldershot/ Ward 1 area of Burlington have been opposed to continued landfilling in the Escarpment Site F area. Their concern for the social and environmental impacts of landfill in that location led to the formation of the Solid Waste Management Committee of the West Burlington Citizens' Group. The City has on record a petition from 1983, containing the names of 3500 west Burlington residents who opposed further landfilling.

The City received from Mr. A. Coome on March 14, 1985, a list of the names of 767 citizens from west Burlington who oppose the establishment of a new landfill at the Escarpment Site F.

On February 26, 1985, about 500 people attended MMY's first public open house on the 2C Report, at Aldershot High School. From the demeanour of the vast majority, which was relatively civil considering the circumstances, it would be inappropriate to form an opinion of the breadth or intensity of opposition to the Escarpment Site F as a landfill site.

In its newspaper advertisements of the Aldershot High School meeting, the City included a mail-in coupon with which citizens could indicate whether they supported, opposed, or were indifferent to, the new Burlington landfill proposed by the Region. At this writing a total of 251 coupons has been received. Ward 1 residents sent 98 (39%) of these coupons, while 153 (61%) came from residents in other parts of the City. Only 4 (1.6%) of the responses favour the Region's proposal, 3 (1.2%) are indifferent, and 244 (97%) are opposed to a landfill at the Escarpment Site.

VIII. DIVISIONAL COURT DECISION ON HYDRO EA

The City's outside legal counsel has indicated that the Ontario Divisional Court has issued a decision with respect to undertakings in the Environmental Assessment process which has implications to the Halton Landfill E.A. Very briefly, the Court decided that the Environmental Assessment Board does have the authority to require the proponent, as a condition of approval of the undertaking to use one specific method of carrying out the undertaking. This indicates that the Board may consider a somewhat broader definition of the undertaking with variants of the undertaking being considered as alternate methods for the undertaking. This is a very important decision for Halton's E.A. The Region could now define the undertaking as the provision of a landfill site, and present a number of alternate sites for that landfill as alternate methods of carrying out the undertaking. The Board could then select one of the proposed sites as the preferred method for carrying out the undertaking.

The use of a broader definition of the undertaking would be of definite benefit to the Region of Halton in this situation. The Region can now go forward with a broad undertaking and not risk refusal of the Board to approve a landfill for Halton unless all sites are deemed inappropriate by the Board. Proceeding with an undertaking limited to one site only, places the Region at significant risk if that single site is refused by the Board.

IX. CONCLUSIONS

This report and its attachments have presented compelling evidence of the inadequacy of the WWY draft 2C report. The WWY 2C report was prepared on the basis of incomplete information and employed inadequate methods of analysis to generate its conclusion. The selection of the Escarpment Site F as the preferred location of a landfill in Halton is an error. The reports of Ecoplans/CRA and the City's Public Works Department critically demonstrate that Sites A and D are superior locations and, on the basis of WWY's present information, ought to be the preferred site(s).

To remedy the error made by WWY, and in consideration of the tight time schedules within which the Region is working, the City of Burlington recommends that the Region define the undertaking in its EA submission as the Provision of Landfill at Site A or Site D.

The reason for identifying Site A and D is because they emerge consistently from the systematic analyses of Ecoplans/CRA and the City's Transportation Division as the two best sites.

Should the Region reject this remedy and identify the Undertaking as the Provision of Landfill at Escarpment Site F only, the City of Burlington by every means at its disposal, will oppose the Undertaking and will promote alternatives to it.

Respectfully submitted,

Michael H. Boggs
Chief Administrative Officer

2221u
attch.

APPROVED BY C.A.O.
Date

Ministry of
Municipal
Affairs

Ontario

777 Bay Street
Toronto, Ontario
M5G 2E5

H-904

November 6, 1987

Ms. H. MacRae
Clerk
City of Burlington
426 Brant Street
L7R 3Z6

Dear Ms. MacRae:

RE: Proposed Amendment No. 401-025
Parkway Belt West Plan
Lot 1, Conc. 1
City of Burlington
Dr. Ecclestone

Please be advised that the application by Dr. Ecclestone to delete the above referenced property from the Parkway Belt West Plan has been withdrawn.

The subject property was sold to Geofcott Group Inc. who indicated their intention to develop the subject property in accordance with the appropriate policies of the Parkway Belt West Plan, therefore they are not proceeding with Dr. Ecclestone's application.

Given the above we have closed the amendment file and would advise that you update your records accordingly.

Should you have any questions on the above, please call Fareed Amin at 585-7310.

Yours truly,

J. Thurgood

J. Thurgood
Senior Planner
Parkway Belt Unit.

cc. Gary Goodman, Director of Planning

Ministry of Municipal Affairs
Ontario

For Office Use Only

Ont. Reg. No.	
Parkway Belt File No.	
Munic. File No.	550-02-5/88

Parkway Belt West

Application for Amendment to the Land Use Regulations Made Under the Parkway Belt Planning and Development Act, 1973

Please complete (type or print) in duplicate and submit to the clerk's office in the local municipality in which the subject proper located. If the property is located within more than one municipality, application forms should be submitted to each municipa The applicant must sign and date each form in the place assigned below.

If you need more information or assistance in completing this form, please contact:

Plans Administration Branch
Central and South West
777 Bay Street
Toronto, Ontario
M5G 2E5

Local Municipality	Regional Municipality
City of Burlington	Halton

April 21, 1988
Date

X
Signature of Applicant

X to complete ☐ on the form.

1. Property Owner

Name	Business Telephone
Geofcott Development Limited	639-7941
Address	**Municipality** / **Residence Telephone**
3455 Harvester Road Unit #35	Burlington / Postal Code L7N 3P2

2. Applicant (If other than Owner)

Name	Business Telephone
As Above	
Address	**Municipality** / **Residence Telephon** / **Postal Code**

3. Location of Property

Address	Municipality	Township Lot
Northeast Corner of North Service Road and King Road	Burlington	1
		Concession 1
Former Township East Flamborough	Registered Plan No. (If applicable)	Lot No.

4. Previous Application

Has an application for an amendment to the Land Use Regulation been submitted previously for this property?

☐ Yes ☐ No ☒ Don't Know

If yes, indicate name of (former) applicant _____

5. Size of Property

Acres (Hectares)	Square Feet (Metres)
45.5 (18.4)	1,982,640 (184,187)

6. Existing and Proposed Land Uses

	Existing	Proposed
Residential	☐	☐
Commercial	☐	☐
Agricultural	☐	☐
Industrial	☐	☒
Institutional	☐	☐
Recreational	☐	☐
Vacant	☒	

Further explanation if required, of the proposed use

See Attached Report

7. Land Severance

Is a land severance required in connection with this property?

☐ Yes ☒ No

If you have applied for severance, it is:

☐ Granted ☐ Refused ☐ Pending

If granted, when? _____

Further explanation if required, of the severance application

8. Plan of Subdivision (if applicable)

☐ Existing ☐ Proposed

Subdivision File Number _____

Further explanation if required

9. Proposed Construction Details

☒ New Building(s) ☐ Addition(s)

Number of storeys

1 and 2 Storeys

Proposed ground floor area (sq. ft.)

231,000 Sq. Ft.

Proposed total floor area (sq. ft.)

290,000 Sq. Ft.

Maximum height above ground

2 Storeys (35 Feet)

Further explanation if required, of the proposed use

See Attached Report and Site Plan

10. Ownership of Neighbouring Properties

Does the owner of the subject property or the applicant own any properties adjacent to the property named in this application?

☐ Yes ☒ No

If yes, describe size, location and present use

11. Legal Description

A legal (metes and bounds) or Registered Plan description of the subject property is not required until (and if) provincial approval in principle is granted for this application. Before final approval is granted, however, a legal description must be submitted. (The legal description can usually be found on the property deed).

To Be Provided

12. Site Map (see sample illustration on last page)

Attach a sketch map to scale showing:

- lot and concession for subject property
- locations and names of all streets, roads, highways within or abutting the property
- boundaries and dimensions of subject property
- natural and man-made features such as buildings, railways, pipelines, water courses, drainage ditches, wooded areas and slopes both within and adjacent to the property
- areas of the subject property that are swampy or subject to erosion or flooding
- existing easements and rights-of-way
- location, use, height, length and width of all existing and proposed structures on the subject property and whether permanent (P) or temporary (T) or existing or proposed
- distance of subject property from nearest road intersection
- the nature of the existing uses of land and structures on the adjacent properties
- distances from the property boundaries of existing and proposed buildings on subject property

Draw Site Plan in this space (and attach a survey plan or Registered Plan, if available).

See Attached Plan

13. Additional Information

Use the space below to provide other information you wish to submit to support or clarify this application. Attach a separate sheet if necessary.

See Attached Report

and Site Plan

May 3, 1988
Project 88404

PLANNING REPORT

GEOFCOTT DEVELOPMENT LIMITED

INTRODUCTION:

Geofcott Development Limited, the Owners of a 18.4-hecatare parcel of land at the northeast corner of King Road and the North Service Road, are interested in developing a prestige industrial/ office complex as shown on the attached Site Plan. As the subject property is within the area of the Parkway Belt West Plan, an amendment to the Parkway Belt Land Use Regulations is necessary to permit the proposed development.

SITE DESCRIPTION:

The site is Part of Lot 1, Concession 1, former Township of East Flamborough, now in the City of Burlington. The site has approximately 330 metres' frontage on the North Service Road and 560 metres' frontage on King Road, resulting in a site area of 18.4 hectares. As can be determined from the topographic features shown on the attached Site Plan, the site is characterized by two treed ravines, that is, Indian Creek along the west edge adjacent to King Road, and a similar sized ravine feature bisecting the centre of the site from north to southeast. The intervening plateau areas can be described as open fields sloping at approximately 4 percent grade from north to south. The property does not have any improvements, although presumably the field areas may have been used for agriculture in the past.

PARKWAY BELT WEST PLAN:

The policies which govern the development of this property are contained in the Parkway Belt West Plan. These same policies have also been adopted by the City of Burlington and form a integral portion of the Burlington Official Plan. The Parkway Belt West Plan designates the site as a "Special Complementary Use Area" within the "Escarpment Link" policies of the Plan. The Escarpment Link section of the Plan (Section 6) contains specific policies which are applicable to the subject site, mainly, Policies 6.2.3 (f) and 6.2.3 (q) and which are attached to this letter for easy reference.

The salient requirements of the Parkway Belt West Plan include:-

- o Maintenace of the open space character of the area.
- o Strict control of uses.
- o 23.1 percent maximum lot coverage.
- o Single storey for industrial buildings; two stories for office buildings.
- o No outside operations or storage.
- o 400-foot (122-metre) setback from North Service Road and King Road.
- o Natural landscaping.

DETAILS OF DEVELOPMENT:

In order to provide for the appropriate development of the site, we have carefully considered the constraints defined by the Parkway Belt West Plan and have developed the attached Site Plan. This Site Plan includes the following features:-

1. Mixed prestige industrial/office use of 26,940 square metres (290,000 square feet) with all operations to be wholly-enclosed within the buildings. Use restrictions similar to the MB2 Zone of Zoning By-law 4000-3 of the City of Burlington would be considered appropriate.

2. 400-foot (122-metre) setback maintained from King Road and the North Service Road.

3. All buildings have been arranged to take advantage of scenic ravines and natural areas.

4. Building coverage is 11.6 percent with the combined building and parking coverage not to exceed 23.1 percent of the site area.

5. Industrial buildings are one storey; office buildings are two stories.

6. Building materials will be selected to enhance and blend with the natural landscape.

7. Parking and internal roadway areas will be paved and landscaped to blend with the natural landscape. The roadway crossing of the ravine will be strictly in compliance with the Halton Region Conservation Authority requirements. One level of underground parking will be provided enclosed within each office building in Phases 1 and 2 leaving the front yard of the site free from parking.

8. All required landscaping will be sensitive to the natural terrain and will include indigenous plant and tree species.

9. The two ravine areas will be preserved in a natural state.

10. Development of the site will be phased as shown on the Site Plan.

11. All site construction will be strictly within the requirements of the Halton Region Conservation Authority in order to protect the natural environment of the ravine areas.

12. Only the open field areas will be developed. Buildings will be sited to preserve as much open space as possible.

13. The topography of the site in relation to the North Service Road and the natural tree screening from King Road will screen the majority of the site development from view. The only building area open to view will be set back from the intersection of the North Service Road and King Road.

14. Development will be by Plan of Condominium to ensure adherence to strict development controls and harmony of landscape and design.

15. A Site Plan and Development Agreement pursuant to Section 40 of The Planning Act will be a prerequisite of development in accordance with the provisions of Policy 5.1.4 of the Parkway Belt West Plan.

16. Municipal water is available east of the site along the North Service Road. Sanitary sewers have been extended from south of Highway 403 to the North Service Road west of King Road. The prestige type of development proposed can be characterized as "Dry Industry" requiring municipal services only for sanitary facilities. Storm drainage of the site will be in compliance with Conservation Authority requirements.

CONCLUSIONS:

In summary, we have carefully considered all of the applicable policies of the Parkway Belt West Plan as it applies to the subject site. We feel the proposed development would comply with the criteria of the Parkway Belt West Plan and would request approval of the necessary amendment to the Parkway Belt Land Use Regulations to permit the proposed use.

Respectfully Submitted

MILLER O'DELL & PAUL

Per:

Donald J. Logan, MCIP
Planning Consultant

DJL:lph

6.2.3
Implementing Actions

In cases of discrepancy between the following specific implementing actions for this Link and the provisions of Part 5, the following implementing actions will prevail.

a) Restrict the number and location of transportation routes, ensuring that, in the construction, expansion, and reconstruction of any transportation, communication, and utility facility, the objective of preserving the Niagara Escarpment and other objectives of the Plan are met to the maximum possible degree.

b) Acquire a right-of-way varying in width between approximately 400 feet and approximately 600 feet between Highway 5 and the Southern Link for the construction of Highway 403.

c) Acquire a right-of-way approximately 100 feet wide for inter-urban transit south of that part of Highway 403 which lies west of the Queen Elizabeth Way.

d) Acquire a right-of-way approximately 100 feet wide for inter-urban transit from the lot line between Lots 4 and 5, Concession 1, N.D.S., City of Burlington to the Southern Link.

e) Acquire a right-of-way approximately 100 feet wide for future utilities between the Southern Link and the Hamilton-Dundas Urban Area.

f) Require that official plans, development agreements, plans of subdivision, subdivision agreements, and zoning and other by-laws be used to ensure that, in addition to achieving the provisions of Subsection 5.1.4, all development and re-development in the Link must result in:

i) Minimum damage to wooded areas, hedgerows, and orchards;

ii) Protection of slopes from major cuts, major fills, and erosion;

iii) Protection of watercourses which drain the area and of associated ravines;

iv) Location and design of buildings and structures so as to attain the maximum visual and physical harmony with the natural characteristics of major creek and stream valleys;

v) Location and design of buildings and structures so as to visually compatible with the existing natural landscape, maintaining to the maximum possible degree an uninterrup sight line between Highway 403 and the Niagara Escarpme

vi) Minimum provision of public water and sewage service

vii) Buildings and structures clustered where appropriate s to minimize their effect on the open-space character of th area.

g) Support eventual recreational use of the landfill sites.

h) Seek the eventual rehabilitation of the clay pit located in Lo Concession 2, City of Burlington (formerly Township of East Flamborough).

i) Study the possibility of a low-speed two-lane scenic road network and associated facilities which would mainly utilize existing roads but occasionally be supplemented with minor construction to give access to various segments of the Link.

j) Acquire lands for the following Public Open Space Areas:

i) Niagara Escarpment;

ii) Bronte Creek;

iii) Hopkins Creek;

iv) Grindstone Creek.

k) Develop recreational trails and associated facilities in the following areas:

i) Niagara Escarpment;

ii) Hopkins Creek between the Niagara Escarpment and Paradise;

iii) Grindstone Creek between the Niagara Escarpment north and Hidden Valley Park and the Royal Botanical on the south;

iv) Niagara Escarpment to the Southern Link and the Burlington-Oakville Mini-belt Link.

l) Ensure that the design, development, and use of the P Space Areas minimize any detrimental effect on woodl hedgerows, and the following prominent natural featur

i) Niagara Escarpment;

ii) Cootes Paradise;

iii) Hopkins Creek Valley, including Borer's Falls

iv) Grindstone Creek Valley;

v) Bronte Creek Valley.

ix) Ample landscaping, tree planting, and berms are provi on the 400-foot-setback area set out in Clause (viii) above well as on the remaining lands.

x) Wooded areas, hedgerows, and trees are protected to t maximum possible degree.

xi) The creation of new lots is strictly limited.

xii) Any other conditions required to secure the provision the Plan are satisfied.

q) In the Special Complementary Use Area located north of Highway 403, between the Burlington Landfill Site and the Burlington-Guelph Electric Transmission Line, permit uses se in Subsection 5.5.1.

Subject to Subsection 5.1.3, the Plan permits some further industrial development in this area. The Plan does not permit beyond those set out in Subsection 5.5.1 until a comprehensi restricted area by-law and development agreements under Se 35a of the Planning Act have been prepared in consultation v municipal authorities, Provincial ministries, and other concer persons or agencies, and subsequently approved by the appr riate authorities.

Buildings and structures associated with such industrial use have a maximum lot coverage of 20%, exclusive of parking, shall meet the following conditions:

i) No uses are permitted which might create obnoxious s odours, fumes, or vibrations.

ii) All uses except parking are enclosed.

iii) Buildings or structures for industrial purposes do r exceed a maximum of one storey in height, and build structures for associated office uses do not exceed a of two storeys.

iv) Adequate parking facilities are provided on the la employees and visitors. These facilities shall be lanc suitably screened, and paved with a dust-free all-we surface.

v) No outside storage of goods or materials is perr

vi) The open-space character of the area is secur maximum possible degree.

vii) Setbacks for buildings and structures along North Service Road and King Road are not less than 400 feet from the centre line of these roads.

viii) Ample landscaping, tree planting, and berms are provided on the 400-foot-setback areas set out in Clause (vii) above, as well as on the remaining lands.

ix) Wooded areas, hedgerows, and trees are protected to the maximum possible degree.

x) The creation of new lots is strictly limited.

xi) Any other conditions required to secure the provisions of the Plan are satisfied.

r) In the Special Complementary Use Area west of Brant Street and south of Highway 5, permit uses set out in Subsection 5.5.1.

Subject to Subsection 5.1.3, the Plan permits some further urban development in this area. The Plan does not permit uses beyond those set out in Subsection 5.5.1 until a comprehensive restricted area by-law and development agreements under Section 35a of The Planning Act have been prepared in consultation with municipal authorities, Provincial ministries, and other concerned persons or agencies, and subsequently approved by the appropriate authorities.

Should further residential development be permitted under such by-law and development agreements, this development shall have similar characteristics to that generally existing in the Beaufort Heights subdivision on the date of adoption of the Plan. Should the provision of communal sewage facilities be deemed necessary by appropriate authorities, a somewhat higher density, as may be decided by the municipality, may be permitted in the area located southeast of the existing Beaufort Heights subdivision.

Such development shall meet to the maximum possible degree the following conditions:

i) Protect wooded areas, hedgerows, and trees.

ii) Develop and maintain an appearance of natural landscape for the area when it is viewed from points of observation which are located outside the area and face the Niagara Escarpment.

iii) Protect the brow of the Niagara Escarpment by strongly discouraging construction of any buildings and structures adjacent to the brow.

iv) Satisfy any other conditions required to secure the provisions of the Plan.

H-905

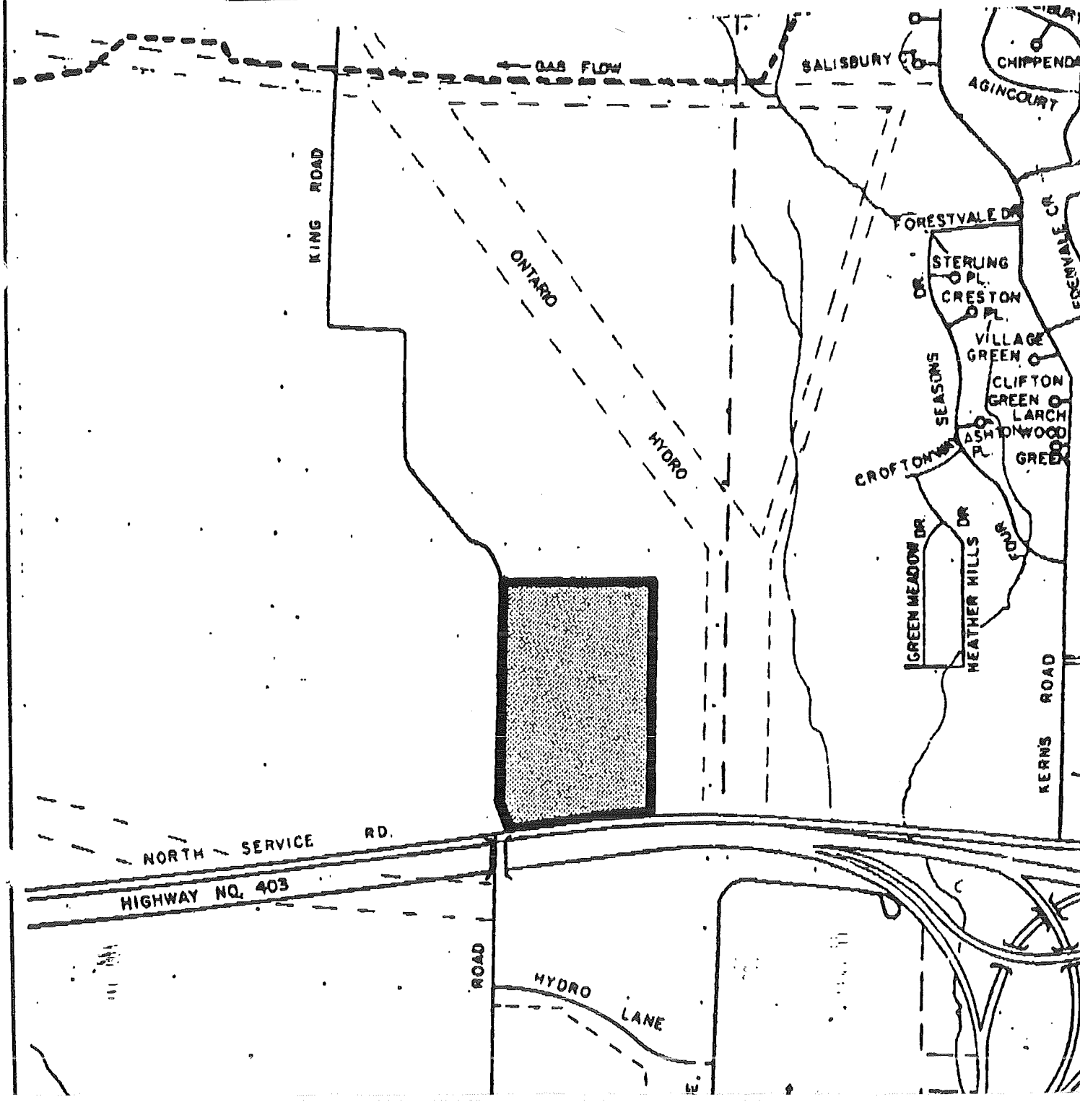
Sketch No. 1

LOCATION SKETCH

Application by GEOFCOTT DEV. LTD. for Parkway Belt exemption and rezoning to permit industrial development

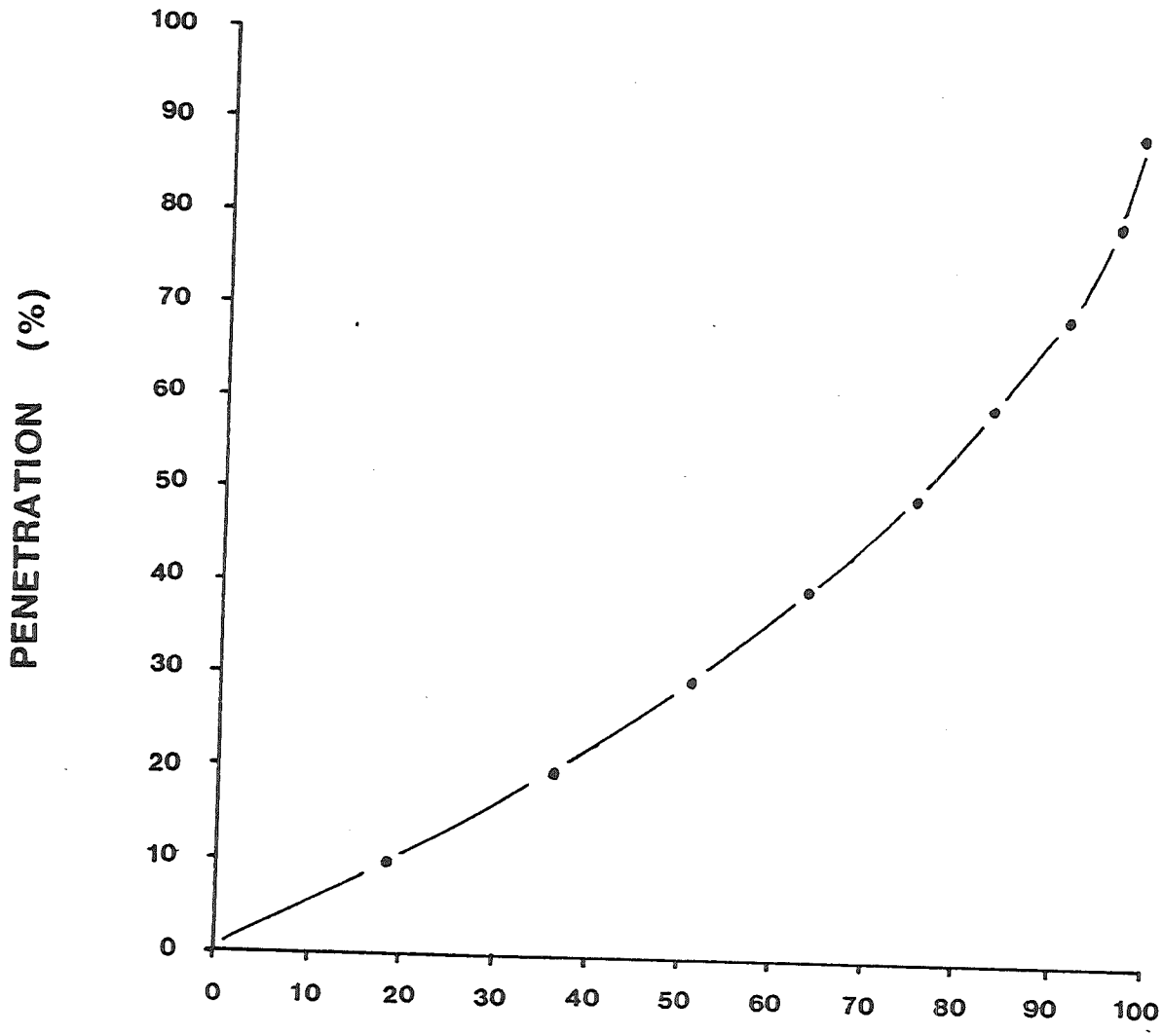
File: 550-02-5/88

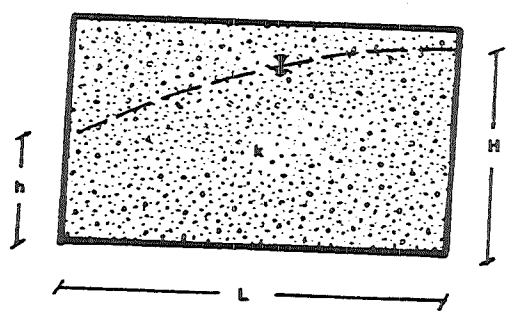
AREA AFFECTED



WB907

FLOW TO DRAIN vs. DEPTH OF PENETRATION





$$Q = k \frac{(H^2 - h^2)}{2L}$$

ASSUME H = 10m
h = 1 TO 10m

TERRAPROBE LIMITED

MR-908

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
HALTON	MILTON	CON 2	2

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
WALTER MR. R.A	5208 HWY 25 RR#1 MILTON	DAY 5 MO MAY YR 88

LOT 2X5

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	TOP SOIL		SOFT	0'	2'
BROWN	CLAY	STONES	FIRM	2'	15'
RED	CLAY	STONES	FIRM	15'	23'
RED	CLAY	SILT	FIRM	23	32'
RED	SAND	GRAVEL	LOOSE	32'	36'

WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
32'	☐ FRESH ☐ SULPHUR ☑ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL

CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
30"	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	3"	0'	12'
30"	☐ STEEL ☑ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	16 GAUG	12'	34'
FILTER BED	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	PEA STONE	34'	36'

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	DEPTH SET AT - FEET TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☐ PUMP ☐ BAILER	5 GPM	1 HOURS — MINS

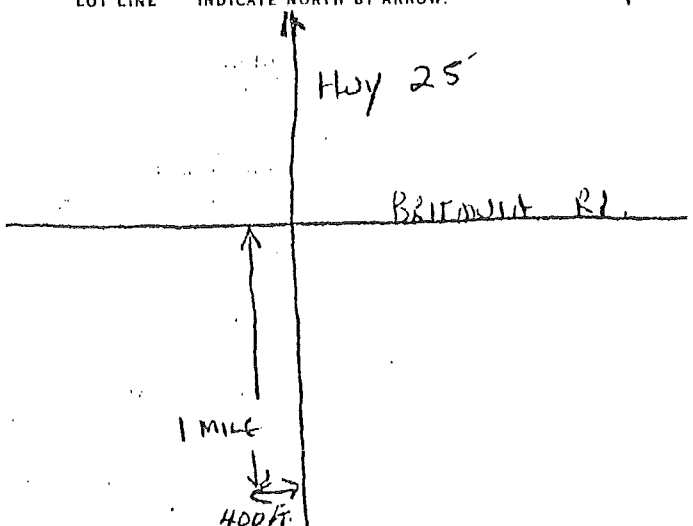
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☑ PUMPING ☐ RECOVERY	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
10'7" FEET	13'3" FEET		11'1" FEET	11'10" FEET	12'9" FEET	13'3" FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	28 FEET	☐ CLEAR ☑ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☐ DEEP	28 FEET	5 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



FINAL STATUS OF WELL	
	☑ WATER SUPPLY ☐ ABANDONED, INSUFFICIENT SUPPLY
	☐ OBSERVATION WELL ☐ ABANDONED POOR QUALITY
	☐ TEST HOLE ☐ UNFINISHED
	☐ RECHARGE WELL

WATER USE	
	☑ DOMESTIC ☐ COMMERCIAL
	☑ STOCK ☐ MUNICIPAL
	☐ IRRIGATION ☐ PUBLIC SUPPLY
	☐ INDUSTRIAL ☐ COOLING OR AIR CONDITIONING
	☐ OTHER ☐ NOT USED

WB 910

PRESENTATION TO HALTON REGIONAL COUNCIL

BY

THE WEST BURLINGTON CITIZENS GROUP - MAY 7, 1986

Thank you for the opportunity of appearing before you in regard to the West Burlington Citizens Group's request for funding assistance with respect to the Environmental Assessment Hearing slated for later this year. As you are aware, the regional solicitor recommended that funding not be approved. However, at the Solid Waste Management Committee meeting on April 28th, it was agreed by all that there are no legal restrictions and that the Region may grant funds if it so desires. At that time, there were several concerns expressed and I would like to take a moment to comment on them.

One thought was that the Region would be setting a precedent - true - it may set a precedent with the Region but, as you also know, other municipalities have already provided funding as part of the public participation process. Let us examine an excerpt from the General Guidelines for the Preparation of Environmental Assessments:

> " During the planning process....the proponent is strongly advised to involve the public.....It can be of great assistance to the proponent in preparing the environmental assessment document, and in facilitating its passage through the review process and public hearings..of the Environmental Assessment Board. The proponent is likely to be on firmer ground if evidence can be presented of previous consultation with those likely to be affected by the undertaking."

This clearly indicates the importance of public consultation. However,

.....2

listen to a quote from the West Burlington Citizens Group's submission to the Minister of the Environment regarding this aspect of the Region's Environmental Assessment document:

> " ...it is noted that the Tremaine-Britannia Interest Group raised the issue that while the Region acknowledged the input from public and interest groups, these concerns were not always addressed during the study process. The West Burlington Citizens Group has also raised this concern many times during the past three years...The group maintains that the Region's consultant did not reply satisfactorily to the concerns raised by it and the general characterization of the consultant's attitude was one of intransigence.....The West Burlington Citizens Group contends that consultation and participation must mean more than an opportunity to have input into the process, but should involve a meaningful dialogue where concerns are dealt with in a substantive and timely fashion. "

Therefore, as the Region enters the hearing process it does not have a good track record with regard to public participation. The provision of funding to the West Burlington Citizens Group and to any other group involved in this hearing would indicate that the Region really cares and is not just paying lip service to this important item.

Another concern expressed was that the cost of providing the group with funds would add to the tax burden. While this attitude is to be commended as nobody wants to see their taxes going up, it hardly seems appropriate at this time in view of the money that has been already spent, and will continue to be spent, before a new landfill site is in place. Without any additional outlay to us, taxpayers are looking at a 5 million dollar

.....3

price tag - that's where you might see taxpayer revolt!

A third point was that because the City of Burlington and the West Burlington Citizens Group were both opposing the escarpment site "F" proposal, there was basically no difference in their stand and therefore we could be represented by the City. While it is true that there is agreement on our opposition, both parties will approach the hearing as separate entities, a fact that is borne out by the City's grant to us in order for us to appear independently.

The idea of intervenor funding is a relatively new concept in Ontario and its role in the environmental assessment process is currently under consideration by the provincial government. In addition, a newly formed organization "The Canadian Environmental Defence Fund" has been created in an attempt to help redress the unfair odds of the David and Goliath situation in which citizens' groups find themselves when they oppose large government agencies and corporations. However, funding from such as these may or may not be available in time for the hearing.

Although there is a likelihood that the original motion will be passed here today, I would like to think that one of you might make the following:

.....4

WHEREAS The Environmental Assessment process includes citizen participation as as part of the process, and,

WHEREAS the hearing is part of the above and therefore citizen participation should be a part of it, and,

WHEREAS there is no intervenor funding in place at this time,

It is hereby recommended that Regional Council grant a maximum of $15,000 each to the West Burlington Citizens Group and to any other group that is concerned about any other designated site and who wishes to be a part of the hearing process.

NSP NEWSLETTER WB 911
National Sewer Pipe Limited
No.3 December 1982

GARBAGE!



Roger L Christensen

Executive Vice-President

A SUBJECT OF CRITICAL IMPORTANCE TO EVERY CITIZEN OF BURLINGTON

As early as March 1984 - only a little more than a year away - the current Halton Region landfill sites will be filled, leaving Burlington without garbage disposal unless decisions are made *now*. Over three years ago, NSP put forth a proposal to turn its Aldershot shale quarry into a safe sanitary landfill site. It is in your own interest as a citizen to know that this proposal is the logical, economical solution to waste disposal for Burlington.

HERE ARE THE REASONS>

Savings to the Taxpayer

The interim report prepared by Acres Consulting Service Limited for the City of Burlington estimates an annual saving of $590,000.00 in transportation charges alone (compared to the other alternative). Projected over the approximate lifetime of the site, this amounts to a total saving to Burlington ratepayers of over $7,000,000.00.

Site Location

The NSP site is a logical location since it is situated between the old Burlington waste disposal site and the current Regional Site.

Business Integrity & Stability

NSP is a long term, responsible, established company, founded in this area in 1860 and still operated by the same family, now in its fifth generation.

The operation of the site would be controlled by a binding contractural agreement with the Region.

Pollution Control

NSP has spent $400,000.00 to determine the site's viability - hydrogeology, flora and fauna, noise, hydrology and traffic studies.

The site is located in deep shale and there is no drinkable water in the shale and no wells adjacent to the site nor downstream from it.

No hazardous wastes, liquid or solid, will be dumped on the site.

The NSP site would conform to Ministry of the Environment standards.

Afterwards

When the NSP sanitary landfill site is full and combined with the present Halton Region landfill site and Bayview Park, it can be turned into one of the largest - over 200 acres - most attractive open spaces in the area.

You are urged to contact your City Alderman and find out where she or he stands on this important issue.

IF YOU HAVE ANY QUESTIONS PLEASE FILL OUT THE ATTACHED POSTAGE PAID FORM BELOW or phone Roger Christensen, 822-7900

WB
912

National Sewer Pipe Limited

December 1984

FACT SHEET
CANDIDATE SITE "F" (P&Q NO. 1) LANDFILL PROPOSAL FOR HALTON REGION

- Situated between one existing landfill and one former landfill
- Landfilling has been an existing land use in the area since 1941
- No adjacent residential land use —

  Nearest residences (3) — 2,400 ft.

  Nearest subdivision — 3,000 ft. (South side CNR)

  Nearest subdivision — 4,200 ft. (Forestvale)
- Traffic patterns are already established
- Noise levels are already established
- Hydrogeologically safe
- Existing groundwater is of extremely poor quality
- Municipal water system in use downstream of site
- Allows rehabilitation of a topographical scar
- Compatible with licensed shale removal
- No loss of prime agricultural land
- Adjacent to existing sanitary sewer which permits collection of leachate and treatment at Burlington Sewage Treatment Plant
- Can make use of existing regional infrastructure, i.e. — access road, weigh scales, building, etc.
- Recycling and resource recovery area available
- E.F.W. (Energy from Waste) site available near Hydro sub station
- Permits substantial savings in garbage collection costs to City of Burlington
- Permits substantial savings in resolution of the existing leachate problem from the former Bayview landfill site
- No expropriation of property, — Candidate Site "F" is available NOW.
- No impact on adjacent property values
- With optimum use of Candidate Site "F", this location could last approximately 20 years and accommodate 12,000,000 cu. yds. (This is 100% of requirement)
- If land adjacent to Site "F", west of King Road is used, then capacity could be 20,000,000 cu. yds.
- Burlington accounts for 43% of residential waste in the Region (1982)

For further information call N.S.P. - 1-822-7900

WB921

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M925

SHERMAN
SAND & GRAVEL LIMITED

7204 WALKER'S LINE
MILTON, ONTARIO L9T 2X6
(416) 844-1441
(416) 878-8801

August 15, 1988

David Estrin
Barristers & Solicitors
22 Scollard Street
TORONTO, Ontario
M5R 1E9

Attention: Ms. K. Clarke

Dear Ms. Clarke:

This will confirm that the sample of sand which you picked up at our site office in Milton on August 3, 1988 met the MTC gradation requirements for winter sand as defined by Ontario Provincial Standard Specification No. 1004. This will further confirm that the sand for which Sherman Sand & Gravel submitted a tender to the Town of Halton Hills in or about September, 1987 (Tender P-87-3) was also winter sand which met the above noted gradation requirements.

Yours very truly,

SHERMAN SAND & GRAVEL LIMITED

J. D. Lauder
Vice-President

JDL/ldm

DELIVERED VIA PUROLATOR COURIER SERVICE

David Estrin M926 RECEIVED AUG 15 1988

Barristers & Solicitors

David Estrin, B.A., LL.B.
Harry Dahme, B.Sc., LL.B.

Offices in:

TORONTO: 22 Scollard Street, M5R 1E9
(416) 927-8226
MARKDALE: General Delivery, NOC 1HO
(519) 986-3670

your file

our file

Please reply to: Toronto

(Fax) 927-8017

August 15, 1988

TO:

ALL PARTIES TO THE HALTON LANDFILL HEARING

We are forwarding herewith the Witness Statement of Dr. Kerry Rowe who will be giving reply evidence for the Town of Milton.

A further Witness Statement of Brian Gray, Vice-President, Geotechnical Engineering, Peto MacCallum Ltd., Consulting Engineers, will be available tomorrow. Mr. Gray will also be giving reply evidence for the Town of Milton.

Yours very truly,

K. Clarke.

K. Clarke

KC:sbr
encl.

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Ms. Toby Vigod
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Coalition

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Regional Municipality
of Halton

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Ontario Ministry
of Natural Resources

M926.

REPLY EVIDENCE

WITNESS STATEMENT OF RONALD KERRY ROWE

→ yes - 2 volume monitoring

1. The Halton Regional landfill-Burlington 1987 monitoring report (Exhibit H625) was introduced into evidence subsequent to Dr. Rowe's evidence. In the context of this new data, Dr. Rowe will discuss additional modelling which he has performed using CRA's hydraulic conductivity of $2x10^{-4}$ cm/s. Based on a comparison of the observed and calculated plume south of the existing Burlington landfill site, he will conclude that a continuous zone with a hydraulic conductivity of $2x10^{-4}$ is totally inconsistent with the observed migration as indicated in the Halton Regional landfill-Burlington 1987 monitoring report.

2. Dr. Rowe will discuss Mr. Petrie's comments on page 26183 of the transcript concerning the appropriateness of interpreting the results of modelling as reported in Exhibit M440 with respect to the monitoring data south of the Burlington landfill. He will conclude, that the additional data reported in the Halton Regional landfill-Burlington 1987 monitoring report (Exhibit H625) is consistent with very small exfiltrations from the Burlington landfill passing into the rock and south in the fractured and weathered upper portion of the rockmass. Based on this additional modelling and data, Dr. Rowe will reaffirm his opinion that the proposed Halton landfill at Site F would have minimal effect on groundwater quality southeast of the Highway 403.

3. Dr. Rowe will comment on CRA's statement on page 125 of Exhibit B617 that:

> "The sensitivity analysis as undertaken by CRA has demonstrated that a similar fit of the water levels can be achieved with significantly different hydraulic conductivities. The values for the hydraulic conductivities which were used in some of the better fit simulations are physically realizable. For these same simulations, however, the infiltration varied by an order of magnitude."

Dr. Rowe will indicate that it is well known to modellers, that there is no unique set of hydraulic conductivities which will give rise to a specific head distribution. He will indicate that even the simplest hydrogeologic characterization could be modelled with totally different hydraulic conductivities and yet give precisely the same heads. The infiltration would vary in proportion to the change in the hydraulic conductivity of the key units.

Dr. Rowe will then comment on Mr. Petrie's conclusion on page 28726 of the transcript that:

> "...Based on the differences of two models that were both supposed to represent the site and recognizing the differences, that the site is complex."

Dr. Rowe will indicate that this is not a valid conclusion to draw from the results of the modelling.

4. Dr. Rowe will indicate that modelling is a tool which should be used in conjunction with a realistic hydrogeologic interpretation. Given the consensus of hydrogeologic opinion expressed at this hearing, that the shale is anisotropic, Dr. Rowe will indicate that it is quite unrealistic to model the shale as being isotropic. In his opinion, CRA's so-called calibrated model does not provide a realistic representation of the flow system and the calculated infiltration is not an appropriate number to be considered when performing an impact assessment.

5. Flow modelling conducted by CRA with respect to the Hyde Park landfill involved the use of an equivalent porous medium model and modelling techniques which are similar to that adopted by both Trow and CRA in their modelling of flow in the environs of Site F. It is indicated that CRA considered anisotropy in their modelling at Hyde Park, but did not consider anisotropy when attempting to deduce their own calibrated model at Site F. Dr. Rowe will indicate that in his opinion the use of an equivalent porous media model is equally applicable at Hyde Park and at Site F. However, he will also reiterate that to get meaningful results it is necessary to consider anisotropy.

6. Mr. Petrie's opinion expressed on page 25935 of the transcript that:

> "The flushing of chloride by migrating water would be expected to take some time, and I am talking geologic age at this point, and also since the retreat of the ice sheets there has been infiltration into this rock for some thousands of years."

will be commented upon with respect to Appendix C of Exhibit M440. Dr. Rowe will conclude that the available data relating to chloride profiles in the shale is generally consistent with a relatively low infiltration rate that is likely to be of the order of 1 mm/a. He will, however, note that at some locations in the environs of Site F, the infiltration into the deeper portion of the shale may be locally higher than 1 mm/a.

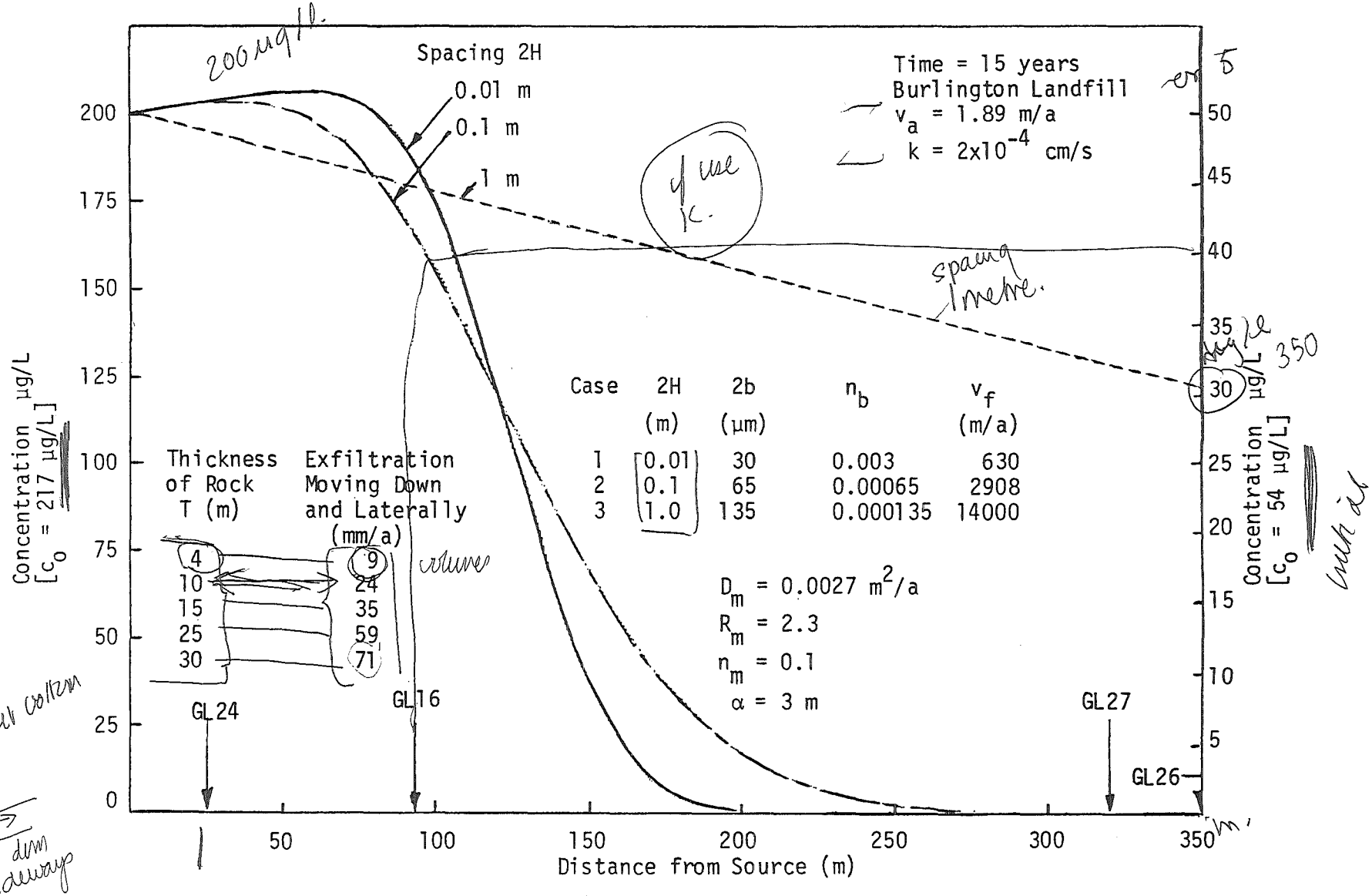
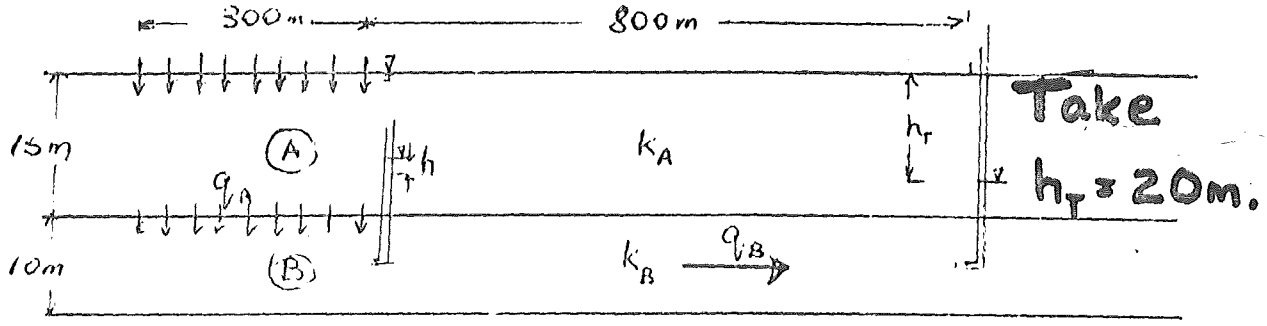


Figure 1 Calculated Migration of 1,1-Dichloroethane South of the Burlington Landfill Based on CRA's k = 2x10^{-4} cm/s, i = 0.03, v_a = 1.89 m/a (page 156, Ex. B617).

NOTE: Modelling was performed using the techniques and approach described in Exhibit M440.

M927

Simple calculation showing that there is no unique set of hydraulic conductivities which give rise to a given head distribution.



Flow down through unit A $q_A = 300\ k_A(h_T-h)/15$ Darcy's Law

Flow along unit B $q_B = 10\ k_B\ h/800$ Darcy's Law

$\therefore$ For continuity of Flow (water balance)

$$q_A = q_B$$

$$\therefore\ 300\ k_A(h_T-h)/15 = 10\ k_B h/800$$

$$\therefore\ (20\ k_A + \frac{k_B}{80})h = 20\ k_A h_T \quad \text{i.e.} \quad (20 + \frac{k_B}{80k_A})h = 20\ h_T \qquad (1)$$

Suppose $k_A = 10^{-8}$ cm/s ; $k_B = 10^{-4}$ cm/s As in the "better fit model"

then from (1) $h = 0.138\ h_T$ $\therefore$ $h = 2.76$ m

$q_B = 1.09\ m^3/m/a$: infiltration $= k_A(h_T-h)/15 = 0.0036$ m/a
$\equiv 3.6$ mm/a

Suppose $k_A = 10^{-7}$ cm/s ; $k_B = 10^{-3}$ cm/s

then from (1) $h = 0.138\ h_T$ $\therefore$ $h = 2.76$ m

$q_B = 10.9\ m^3/m/a$: infiltration $= k_A(h_T-h)/15 = 0.036$ m/a
$\equiv 36$ mm/a

ie Exactly the same head distribution
but one order of magnitude increase
in infiltration.

E928

BEFORE THE JOINT BOARD

IN THE MATTER OF The Regional Municipality of Halton's Landfill Environmental Assessment

WITNESS STATEMENT

OF

GEORGE M. HUGHES

Supervisor

Landfill Disposal Technology Unit

Waste Management Branch

Ministry of the Environment

June , 1988

Witness Statement of George M. Huges

I. Qualifications

1. My Curriculum Vitae is attached as Appendix "A" to this Witness Statement.

II. Involvement With Halton Landfill E.A.

2. With the exception of brief discussions pertaining to the interpretation of Ministry policy and guidelines and occasional technical advice, I have had no involvement with the Halton Landfill Environmental Assessment. I have not reviewed any of the documents in evidence before the Joint Board.

3. I am not sufficiently knowledgeable about either Sites D or F to comment on their hydrogeologic suitability for sanitary landfilling. I am in a position to explain two Ministry policies which are applicable to the consideration of the hydrogeologic suitability of the two sites.

III. Reasonable Use Policy

4. Ministry Policy 15 - 08, the "Incorporation of the

Reasonable Use Concept into MOE Groundwater Management Activities", is before the Joint Board as Exhibit E - 154.

5. Policy 15 - 08 explains and clarifies a statement in Policy 15 - 01, "Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment", which is also found at page 27 of the Ministry's "Blue Book". The statement is as follows:

> "Degradation of ground water quality will be controlled to protect both existing and potential, reasonable uses of water on adjacent property."

6. Included with Exhibit E - 154 is a guideline document that is referred to in Policy 15 - 08. The guideline document describes the methods the Ministry uses to,

a) define the reasonable uses of ground water, and

b) determine the levels to which ground water degradation will be controlled to achieve protection of those reasonable uses.

7 When the Ministry has the jurisdiction to deal with the approval of a landfill site under Part V of the Environmental Protection Act, the responsibility for making a determination on what constitutes the reasonable use of ground water would normally rest with the Regional Director. When the jurisdiction is with the Environmental Assessment Board or a Joint Board, the responsibility rests with the Board.

8. A determination as to what constitutes reasonable use is case specific and is based on the present use of the ground water, the future potential use of the ground water and the amount and quality of ground water available for use. In most cases, the potential reasonable use of ground water in Ontario will be domestic consumption.

9. I am informed that certain witnesses before the Joint Board have stated that the only reasonable use of ground water downgradient of site F is leachate attenuation. In my opinion, such a determination is possible within the confines of the policy and guideline, although I am unable to give an opinion on whether such a determination is appropriate in this case.

10. The basic approach to the determination of what level of degradation is acceptable is set out at page 16 of the guideline document as follows:

> "Quality cannot be degraded by an amount in excess of 50% of the difference between background and the quality criteria for any designated reasonable use except drinking water. In the case of drinking water, the quality must not be degraded by an amount in excess of 50% of the difference between background and the Provincial Drinking Water Objectives for non-health related parameters and in excess of 25% of the difference between background and the Provincial Drinking Water Objectives for health-related parameters. Background is considered to be quality of the ground water prior to any man made contamination."

It is the policy of the Ministry of the Environment that such increases in levels of contamination at the site boundary will have no more than a negligible impact on the use of ground water on property adjacent to a landfill site.

11. Provincial objectives for drinking water are set out in the Ministry publication Ontario Drinking Water Objectives, which is popularly referred to as the "Green Book". Where Ontario Criteria have not been developed, (eg. for most organic chemicals), it is appropriate to use criteria developed in other jurisdictions or by the World Health Organization.

12. When it is predicted that boundary criteria established using the above formula will be exceeded, it is acceptable to the Ministry, in exceptional cases, to permit the limited impairment of ground water off-site through the designation of a "Contaminant Attenuation Zone". Circumstances considered suitable for such a designation are set out at pages 14 and 15 of the guideline document included with Exhibit E - 154.

IV. Engineered Facilities Policy

13. Ministry Policy 14 - 15, "Engineered Facilities at Landfills that Received Municipal and Non - Hazardous Wastes", was recently approved by the Minister and is now official Ministry policy. The policy and accompanying guideline document is attached as Appendix "B" to this Witness Statement.

14. The "Ministry Interim Guideline on Engineered Facilities at Landfills" dated July 13, 1987 is currently before the Joint Board as Exhibit N - 475. Policy 14 - 15 and the accompanying guideline replace that document.

15. The essence of the Engineered Facilities Policy is that an applicant seeking approval for a landfill must address in the application,

a) the engineered facilities that are to be used at the site,

b) the length of time over which those facilities are required, and

c) how maintenance or replacement of those facilities will be provided for, if necessary.

An applicant should demonstrate that engineered facilities can function for as long as they are needed.

16. The policy and guidance apply to all engineered facilities associated with the control of contaminants produced by landfills including liners, leachate collection systems, covers, gas collection, interception and venting facilities, monitoring facilities, leachate treatment facilities, facilities for the control of contaminated ground water and facilities for "stabilizing" a landfill.

George M. Hughes

CURRICULUM VITAE

GEORGE M. HUGHES,
#9-65 INVERLOCHY BLVD.
THORNHILL, ONTARIO
L3T 1R4
TELEPHONE NO. (416) 889-6072
BORN: SYDNEY, NOVA SCOTIA, AUGUST 14, 1929, CANADIAN CITIZEN.

EDUCATION

Ph.D., University of Illinois, Urbana, Illinois, 1962, Department of Geology. Thesis - The Glacial Geology of the Redwater and Bonnyville Areas, Alberta, Canada.

M.Sc., University of Alberta, Edmonton, 1958. Thesis - Study of Pleistocene Lake Edmonton and Associated Deposits.

Graduate Studies, University of Alberta, Edmonton, 1951-1952.

B.Sc., University of Alberta, Edmonton; Faculty of Arts and Science, Dept. of Geology, 1951.

EMPLOYMENT

SEPTEMBER 1983 - PRESENT	Supervisor, Landfill Disposal Technology Unit, Waste Management Branch, Ontario Ministry of the Environment, Toronto, Ontario.
NOVEMBER 1974 - SEPTEMBER 1983	Chief, Ground Water Protection, Water Resources Branch, Ontario Ministry of the Environment, Toronto, Ontario.
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MEMBERSHIP IN ORGANIZATIONS

National Water Well Association
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International Association of Hydrogeologists
Association of Professional Engineers of Ontario
American Institute of Hydrogeology

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POLICY TITLE	ENGINEERED FACILITIES AT LANDFILLS THAT RECEIVE MUNICIPAL AND NON-HAZARDOUS WASTES	NO 14-15-01

Legislative Authority

The Environmental Protection Act

Statement of Principles

In order to protect the environment and human health, the Ministry will review and evaluate applications for new landfills and landfill expansions in accordance with the following position statement:

An engineered facility must function as long as necessary for the protection of the environment.

If periodic or continuous maintenance or replacement is required, evidence must be provided by the applicant that this can and will be accomplished.

This policy is written in accordance with the Ministry's current policy 15-08 entitled "The Incorporation of the Reasonable Use Concept into the Ground Water Management Activities of the Ministry of the Environment".

Definitions

Contaminating Life Span	It is defined as the period of time during which the landfill will produce contaminants at levels that could have unacceptable impact if they were discharged into the surrounding environment.

Point of Contact

Director, Waste Management Branch

Effective Date

May 11, 1988

1.0	Scope	This policy applies to applicants for new or expanded landfill sites which receive municipal and non-hazardous wastes and to Ministry staff responsible for the review and evaluation of such proposals.
2.0	MOE Responsibility	The Ministry will review and evaluate all applications for new and expanded landfill sites in accordance with the covering statement of principles and the Ministry's governing Guideline document (noted below).
3.0	Applicant's Responsibility	The applicant will be responsible for providing Ministry staff with sufficient evidence to adequately review and evaluate his/her proposal.
3.1	Service Life	It is the applicant's responsibility to define the service life of an engineered facility and indicate the frequency of replacement and the number of times it must be replaced.
3.2	Contaminating Life Span	In doing so, the applicant must address the contaminating life span of the landfill, equate this with the proposed service life of the engineered facility and support any procedures he/she intends to use ensure that the service life of the facility exceeds the contaminating life span of the landfill.
4.0	Further Guidance	Further guidance with respect to the use of landfill liners, leachate collection and treatment facilities, landfill covers and rapid stabilization and leachate recycling is provided in the Ministry's "Guideline on Engineered Facilities at Landfills that Receive Municipal and Non-Hazardous Wastes" dated March 1988.

Copies of the above noted document can be obtained from the Ministry's Waste Management Branch

MINISTRY GUIDELINE

FOR ENGINEERED FACILITIES AT LANDFILLS

THAT RECEIVE MUNICIPAL AND NON HAZARDOUS WASTE

(APRIL 20, 1988)

This document addresses engineered facilities at sites receiving municipal and non hazardous wastes. Engineered facilities at sites receiving hazardous wastes, as defined by Regulation 309, will be dealt with on a case-by-case basis.

Some level of engineering is necessary for all modern landfills both for the protection of the environment from the discharge of unacceptable levels of liquid and gaseous contaminants, and for aesthetic reasons. The specific engineered facilities that are required on a particular landfill depend on the environmental conditions that are present and the type of waste, and thus can only be judged on a case-by-case basis. In some cases, this may entail only simple ditching or grading for the control of surface run off, in others complex leachate and gas control facilities may be required. (The scope of the term "engineered facility" is discussed at the end of this document).

The Ministry's "Reasonable Use" Policy (MOE Policy 15-08: The Incorporation of the Reasonable Use Concept into the Ground Water Management Activities of the Ministry of the Environment), sets limits to the level of ground-water contamination and applies to discharges from landfills. Landfills, including those with engineered facilities, must meet the requirements of this Policy.

POSITION STATEMENT

It is the Ministry's position that there are limitations to engineered facilities and it prefers sites in environments with characteristics that provide a high degree of natural protection (e.g. thick clay deposits.)

The acceptability of an engineered facility for a new landfill or a landfill that is expanding will be judged in accordance with the following:

> "AN ENGINEERED FACILITY MUST FUNCTION AS LONG AS NECESSARY FOR THE PROTECTION OF THE ENVIRONMENT. IF PERIODIC OR CONTINUOUS MAINTENANCE OR REPLACEMENT OF AN ENGINEERED FACILITY OR ITS PARTS IS REQUIRED, EVIDENCE MUST BE PROVIDED BY THE APPLICANT THAT THIS CAN AND WILL BE ACCOMPLISHED. IT IS THE APPLICANT'S RESPONSIBILITY TO DEFINE THE SERVICE LIFE OF AN ENGINEERED FACILITY AND INDICATE THE FREQUENCY OF REPLACEMENT AND THE NUMBER OF

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TIMES IT MUST BE REPLACED. IN SO DOING, THE APPLICANT MUST ADDRESS THE CONTAMINATING LIFESPAN' (i.e. THE TIME PERIOD DURING WHICH THE LANDFILL WILL PRODUCE CONTAMINANTS AT LEVELS THAT COULD HAVE AN UNACCEPTABLE IMPACT IF THEY WERE TO BE DISCHARGED INTO THE SURROUNDING ENVIRONMENT) OF THE LANDFILL, EQUATE THIS WITH THE SERVICE LIFE OF THE PROPOSED ENGINEERED FACILITY, AND SUPPORT ANY PROCEDURES HE INTENDS TO USE TO ENSURE THAT THE SERVICE LIFE OF THE FACILITY EXCEEDS THE CONTAMINATING LIFESPAN OF THE LANDFILL". THE MINISTRY WILL REVIEW AND EVALUATE THE APPLICANT'S PROPOSAL.

Engineered facilities (or combinations of facilities) will meet the following requirements:

1. It must be possible to monitor the engineered facility to verify that it performs to specification. Monitoring must be able to warn of failure sufficiently in advance to allow contingency measures to be taken. Contingency measures are designed to accommodate any failure in the design of a landfill and are not a part of the normal operation during the life of the facility.

2. The contaminating lifespan of the landfill must be addressed in the contexts of the service lives of the various engineered facilities that are used to control contamination.

3. Provision must be made for the maintenance of an engineered facility and its operation for as long as is required under the Position Statement. A detailed outline of how funding will be provided, who will bear the short-term and ultimate responsibility for the facility, the length of time that the facility will be operating, and recommendations as to the conditions under which the facility can be closed down or no longer monitored or maintained must be provided in an application.

4. Manuals on the design of various types of engineered contaminant control facilities, such as covers and liners, are available. However, some of these are very specialized and are new technologies. Under these circumstances the Ministry will require technical supporting data on the performance of these systems.

5. If an applicant cannot specify the time period for the decommissioning of an engineered facility the Ministry will consider that the facility will be required indefinitely and provisions for its perpetual care, maintenance and replacement must be provided. This is the responsibility of the applicant.

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The Ministry will apply this Guideline to specific types of engineered facilities as discussed in the following pages. Other types of engineered facilities will be addressed if the need arises.

LANDFILL LINERS

Synthetic Membrane Liners: To function properly, a synthetic membrane liner must retain its integrity (i.e. function as designed) for the contaminating lifespan of the landfill. The state-of-the-art does not allow precise determination of rates of attenuation or degradation of leachate in lined landfills. Therefore, in the absence of data or site-specific information to the contrary, where complete attenuation of the contaminants in the leachate is necessary, the Ministry will require that the containment facilities be maintained in perpetuity. At the present time, synthetic membrane liners cannot meet this requirement and in addition they cannot be replaced when they fail.

The Ministry is also concerned about the difficulty in providing monitoring systems for landfills with synthetic membrane liners. Such systems must have appropriately long service lives and provide sufficiently early warning of failure to allow effective contingency actions, should these be necessary.

For these reasons, the Ministry will not support proposals that depend upon synthetic membrane liners to confine leachate in landfills in perpetuity.

Earth and Clay Liners: Earth and clay liners may serve to reduce leachate discharge and confine leachate for collection and to attenuate some of the contaminants in leachate migrating out of a landfill. They may be used alone or in conjunction with synthetic membrane or other types of liners. Applicants proposing to use earth or clay liners should address these matters in their submissions to the Ministry.

LEACHATE COLLECTION FACILITIES AND LEACHATE TREATMENT FACILITIES

To serve effectively leachate collection facilities and leachate treatment facilities must function for the contaminating lifespan of the landfill. The state-of-the-art does not allow precise determination of rates of attentuation or degradation of leachate within landfills. Therefore in the absence of data or site specific information to the contrary, where the complete attenuation of the contaminants in the leachate is necessary, the Ministry will require that these collection facilities and treatment facilities be maintained in perpetuity.

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Leachate collection facilities and leachate treatment facilities must be designed, constructed, operated and monitored by professional staff and require competent technical staff for their continued maintenance, repair and replacement. Where approved, the Ministry will require that adequate resources be dedicated to the maintenance of any leachate collection, treatment, transporting and disposal facilities for as long as the leachate remains a potential hazard to the environment.

LANDFILL COVERS

Synthetic Membrane Covers: Synthetic membrane covers are used to prevent or significantly decrease infiltration into a landfill in order to reduce the rate of leachate production. This reduction of infiltration retards decomposition and extends the contaminating lifespan of a landfill. Consequently, this type of cover is not encouraged by the Ministry in situations where it would delay stabilization of the wastes. An applicant proposing such a cover must establish the contaminating lifespan of the landfill and provide for maintenance and periodic replacement of the cover as long as required. In the absence of evidence to the contrary, this will be considered to be in perpetuity.

Synthetic membrane covers will impede the upward venting of gases, and in particular methane, and in so doing may increase the distance these gases migrate laterally. These concerns should also be addressed in submissions to the Ministry.

"Clay" Covers: Clay covers (covers incorporating fine textured earth materials) are also intended to reduce infiltration into landfills. Such covers require maintenance to ensure proper growth of vegetation and to prevent failure by erosion and fissuring. Resources for these maintenance activities should be identified by an applicant.

RAPID STABILIZATION AND LEACHATE RECYCLING

Rapid stabilization of a landfill is a process intended to accelerate the biodegradation of the waste and reduce the time period during which settlement is most rapid and the landfill produces its most highly contaminating leachate. Although the technology has been known for 15 to 20 years, and has been used in some operating landfills there is little documented information from practical successful operations.

While rapid stabilization will accelerate the biological degradation and leaching of a landfill it does not create a contaminant-free waste. A "stabilized" landfill still produces methane and a contaminating leachate.

Leachate recycling, entails pumping the leachate produced from a landfill, back into the landfill. This is the basis for most rapid stabilization operations but is also used as a means of delaying the handling and disposal of leachate by temporarily storing this leachate in the landfill. In most instances this will be a short-term measure and leachate, will eventually accumulate to a volume that exceeds the storage capacity of the landfill. Disposal must then be made in a manner acceptable to the Ministry.

The Ministry is also concerned that leachate recycling will create added head on the base of the landfill and this will cause an increase in the amount of leachate discharge to the surrounding soils. These matters should be addressed by an applicant.

An important aspect of this Guideline is the requirement that, if the contaminating lifespan of the landfill is not addressed in an applicant's submission, the Ministry will assume that certain engineered facilities must function in perpetuity. Rapid stabilization of the landfill is the only known method of shortening this contaminating lifespan so that contaminants released to the environment can be attenuated by natural processes. In light of the shortage of practical field data on this process, submissions should be conservative and supported by practical contingency measures in the event that stabilization is not as effective as predicted.

CONCLUDING STATEMENT

It is recognized that this Guideline will restrict the use of engineered facilities as a means of landfilling in sensitive hydrogeologic environments. It is felt, however, that the level of control required by this Guideline is necessary to protect Ontario's clean environment and valuable ground and surface water resources. Where some reasonable level of natural protection is present or where practical contingency measures are possible, the Ministry will actively consider an applicant's proposal for engineered facilities so that new technology can be field tested and proven.

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SCOPE OF THE TERM ENGINEERED FACILITY

This guideline applies to all engineered facilities associated with the control of contaminants produced from landfills that receive municipal and non-hazardous wastes. This includes the design, installation and maintenance of:

a) Liners, or combinations of liners beneath landfills (plastic, membrane, earth, clay, etc.)

b) Landfill covers, (plastic, membrane, earth, clay, etc.)

c) Leachate collection facilities (drains, tiles, ditches, etc.)

d) Gas collection, interception and venting facilities.

e) Monitoring facilities (for ground and surface waters and for gas)

f) Leachate treatment facilities

g) Facilities for the control of contaminated ground water (purge wells, grout curtains, etc.)

h) Facilities for "stabilizing" a landfill or decreasing the time during which the landfill produces contaminants.

This Guideline applies to the assessment of new landfills or landfills requiring expansion. Although some of the principles on which the Guideline is based are applicable to closed landfills or landfills requiring remedial measures for contaminant control, the Guideline itself is not intended to be applicable to them. They must be dealt with on a case-by-case basis.

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Original Background $+ \frac{5}{\text{or}\ 25}$ (DWO - Original Background) = Trivial Increase

For Chloride

eg $50 + .5\ (250-50) = 150$

Trivial Increase − Present Background − Other = Maximum Dischar

For Chloride

eg $150 - 75 - 50 = 25$

- Drinking Water Objective - Blue Book

B-930

MUNICIPAL–INDUSTRIAL STRATEGY FOR ABATEMENT

(MISA)

A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters

June 1986

Ontario

Ministry of the Environment

Hon. Jim Bradley
Minister

Rod McLeod
Deputy Minister

MUNICIPAL-INDUSTRIAL STRATEGY FOR ABATEMENT (MISA)

A Policy and Program Statement of
the Government of Ontario
on Controlling Municipal and Industrial
Discharges into Surface Waters

June 1986

Ontario Ministry of the Environment

MINISTER'S FOREWORD

I am pleased to release the Government's White Paper entitled "Municipal-Industrial Strategy for Abatement (MISA)." This Paper describes my Ministry's new program to reduce the flow of toxic chemicals into our waterways.

The water pollution control system I inherited regulated only a limited number of conventional contaminants.

Yet scores of persistent toxic substances -- some thought to be cancer-causing or able to mutate genetic structure -- are of prime concern today. These chemicals are not adequately addressed by the pollution control system now in place. Furthermore, that system's major criterion governing industrial waste water discharges was concentration -- in other words, if you dilute, you could pollute.

That system was up-to-date a decade ago, but it is inadequate now and I am replacing it. A new set of tough measures designed to deal with persistent toxic chemicals will take its place.

For the first time, the total amount of each toxic contaminant from each polluter will be capped. This will be done by requiring each direct discharger to meet standards attainable by the best available pollution abatement technology.

MISA's best available technology provision will require pollution reductions -- sometimes great, sometimes small, depending on current performance -- from virtually every major discharger of contaminants into Ontario waterways.

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STRENGTHENING OUR POLLUTION CONTROL SYSTEM

The Toxics Issue

Like many industrialized areas, Ontario is faced with the challenge of dealing effectively with the increasing presence of toxic contaminants in the lakes, rivers and streams of its aquatic environment.

High mercury levels in fish, dioxin in the Niagara River, the perchloroethylene spill in the St. Clair River -- all have focussed attention over the past decade on toxic contaminants and the potential risks they pose to aquatic life, public health and drinking water quality. The problems of toxic contaminants are of particular public concern in the Great Lakes System, where 800 different chemical compounds have been found.

Water pollution control efforts in Ontario have been hampered by outdated control concepts.

Until now, controls were aimed at the conventional pollutants such as biodegradable wastes, suspended solids, ammonia, phosphorus, some metals, oils, grease and phenols.

The newer, more complex pollutants have escaped specific control and present a threat to our drinking water, fisheries, and wild life.

There are two main groups of toxic contaminants of concern: toxic metals, such as mercury, lead and arsenic; and toxic organics (carbon-based compounds), such as dioxins, PCBs and chlorinated benzenes.

These target compounds will be used to focus our control programs in a manageable and effective manner. **Toxic contaminants must be reduced, at source, before they escape into the environment.**

This will be achieved by establishing regulations for each industrial sector and the municipal sector. First, a monitoring regulation will be established requiring each company to monitor its effluent for a wide range of contaminants. The self-monitoring program will be policed by the Ministry taking samples from time to time on unannounced visits. As well, all samples taken by the companies will be duplicated, with the duplicate sample being available for the Ministry.

The MISA program will cover all major toxic polluters of waterways within three years as it encompasses eight industrial sectors, including (in alphabetical order):

- electric power generation
- industrial minerals
- inorganic chemicals
- iron and steel
- metal mining and refining
- organic chemicals
- petroleum refining
- pulp and paper

These sectors comprise some 200 of Ontario's 300 direct dischargers. Most of the remaining direct dischargers will be covered as other minor sectors are brought under the program. The municipal sector, consisting of 400 sewage treatment plants taking waste water from some 12,000 industries, will also be covered. The first two sectors to

The industries, municipalities and the public will be consulted on the development of the MISA program. There will be 60-days for interested parties to submit written comments on this White Paper.

The Ministry, as well, will continue to consult with the industries, municipalities and the public as the regulations are being developed.

After the regulations are in place, there will be scheduled, periodic reviews to examine and upgrade them as knowledge and technology improve.

THE MISA SOLUTION

The Ontario Ministry of the Environment is developing the Municipal-Industrial Strategy for Abatement (MISA) to protect Ontario's water quality. This program is being undertaken in full consultation with Environment Canada, municipalities, affected industries, interest groups and the general public.

Goal

MISA's ultimate goal is the virtual elimination of toxic contaminants in municipal and industrial discharges into waterways. The fulfilment of this goal is necessary to reduce the risk of damage to the ecosystem and to protect public health by minimizing the presence of toxics in drinking water, fish and wildlife.

This goal will be achieved by:

1. Identifying and measuring the discharge of toxic substances in addition to conventional contaminants in municipal and industrial effluents. The result will be the build-up of a comprehensive data base on contaminant discharges across Ontario.

2. Increasing the emphasis on control technology to achieve greater reductions of pollution at source. Best available technology (BAT) effluent limits will be set for each industrial sector and the municipal sector as the minimum pollution control requirement for each discharger in that sector.

contaminant levels in their effluents. After validation of these assessments by the Ministry, and taking into account other pertinent information, effluent limits will be set to protect water quality at the site in question. (See Appendix, p. 39, for details.)

For a given site, the requirements of the two approaches will be compared, and the discharger will be required to comply with the more stringent of the two limits. These will be imposed through regulations and appropriate control documents.*

Toxic loadings will be further reduced in future, as individual dischargers are periodically examined, and new technology is developed. By requiring ever more stringent levels within an appropriate time-frame, MISA will progressively reduce the total loadings of toxic substances to Ontario's surface waters.

With the adoption of monitoring and effluent limits regulations, Ontario's water quality management program will be brought more in line with similar Ministry programs for controlling toxic emissions to air and toxic waste disposal to land, which are already governed by regulations under The Environmental Protection Act. Ontario Regulation 308 for air quality management is currently being revised. Ontario

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* A control document is any written instrument that carries statutory authority. These include Minister's reports, licences, permits, certificates of approval, control orders, orders, requirements and directions and program approvals.

be required of them, and the public to know what is being done to protect water quality.

- Abatement of toxic chemical discharges from industrial and municipal plants can then be scheduled. Enforcement of these requirements will be facilitated and strengthened by giving effluent limits a legal status.

sector have already agreed to cooperate with the Ministry in this work.

They will be involved through individual sector technical committees made up of Ministry, Environment Canada and respective sector representatives. The sector committees supervise the work of consultants engaged at the expense of the respective industries for the pre-regulation monitoring program, make recommendations regarding the program, and advise on the content of the monitoring regulation. The Ministry anticipates that the sector committees will also continue to advise on the development of the effluent limits regulations. Industrial sectors are typically represented on committees by their industry associations. The municipal sector is represented on committees by the Municipal Engineers' Association of Ontario.

General Public and Interest Groups. The general public and interest groups have significant opportunities for involvement throughout the MISA development process:

- Public review of, and comment on, this White Paper are invited for a 60-day period following its publication.

- Regulations will be drafted in the first instance with advice from technical committees with municipal and industrial representation.

  An advisory committee, including public interest group representatives, will review the draft regulations, and provide advice and recommendations to the Minister of the Environment on the contents of the regulations.

- There will be a formal period for public review of, and comment on, the draft regulations.

development, see Appendix, p. 31). In the case of municipal sewage treatment plants, pre-treatment for industries discharging into sanitary sewers will also be considered.

In establishing the appropriate control technology, factors other than water quality, such as air quality and solid waste disposal, should be taken into account. For example, it would be unacceptable to have a treatment process that would reduce pollution in water while significantly aggravating air quality or sludge disposal problems.

Once effluent limits are set, the actual choice of methods or technologies to be used will generally be up to the individual discharger as long as sector effluent limits are met.

Regulations setting out effluent limits will also require that industries have programs in place for controlling on-site spills and leaks, as well as the run-off from raw materials storage and handling areas. The term "Best Management Practice" is applied to these programs.

Water Quality Impact

The calculation of effluent limits involves the collection and analysis of data on water quality, effluent quality, sediments, aquatic life, and local stream flow and lake currents. This information is incorporated into modelling and other assessment techniques selected by the Ministry to permit evaluation of impacts on the receiving water body that correspond to a given set of effluent limits.

Through this process, the effluent limits required for protection of receiving-water quality at a given site will be determined. In all cases, a preliminary assessment of

Abatement responses include:

- **Notification of violation** to the discharger, including a request to explain the violation and remedy the problem. Where the Ministry makes a written abatement request for action to reduce, prevent or eliminate pollution, a reasonable time to comply will be specified.

- **Control orders**, including orders under the EP Act and requirements and directions under the OWR Act. Control orders require specified abatement actions to be accomplished under a given schedule.

Irrespective of their routes to abatement, and the fact that the Ministry may issue a control order, dischargers must apply to the Ministry for certificates of approval for proposed works to be constructed for abatement programs. (For more details on abatement and enforcement procedures, see Appendix, p. 45.)

Pre-Regulation Phase

As mentioned previously, the Ministry will administer preliminary effluent monitoring programs designed to lead to effective and practicable monitoring and effluent limits regulations. Pre-regulation monitoring will provide a wide range of information regarding location of monitoring points; understanding of plant processes, including effects of operations on toxic loads; designation of substances to be tested, and frequency of monitoring and sampling, analytical and reporting procedures and related quality-control requirements; and exploration of biomonitoring techniques for measuring the impact of toxics. Existing data bases assembled by industries are being made available to the Ministry of the Environment.

Guiding the MISA process through the pre-regulation phase are a number of committees made up of representatives of the Ontario and federal governments, the public and, in turn, the municipal sector and each industrial sector (see Figure 2).

The overall efforts of the pre-regulation phase are being conducted on a joint basis by representatives of the Ontario Ministry of the Environment and Environment Canada. Together they have formed an Ontario/Canada Steering Committee supported by technical working groups to deal with the following items: regulation development, industrial sector effluent characterization* and limits, municipal sector effluent characterization and limits, toxicity testing and other forms of biomonitoring, pilot site studies and receiving-water assessment modelling, data management systems development, and sampling and analytical procedures.

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* A process to identify the presence and level of the chemical compounds in an effluent.

The process is complemented by individual sector technical committees made up of Ministry, Environment Canada and respective sector representatives. (See p. 13 for sector committee composition and functions.)

Monitoring Regulations

Monitoring regulations will first require direct dischargers in eight major industrial sectors and the municipal sector to monitor for toxic contaminants. These regulations will be phased in on a sector basis and will be completed within two years. Remaining dischargers in the minor sectors will also be required to monitor similarly at a later stage. The regulations will require industries and municipalities to monitor their own discharges. A high degree of accuracy will be ensured in three ways:

1. requirements for the discharger to follow established sampling procedures, flow measurement procedures and laboratory analytical procedures;

2. requirements for a quality-assurance and quality-control program to be followed by the discharger's laboratory and checked by the Ministry laboratory;

3. additional audit samples to be randomly collected by the Ministry and analyzed in its laboratory to verify that the samples collected by the discharger are representative.

These requirements will be backed up by random on-site inspections by Ministry staff, and by the penalty provisions of The Environmental Protection Act relating to non-compliance with regulation requirements and to knowingly giving false information.

To provide for more stringent effluent limits to be applied as abatement technology improves, a requirement for regular review of those limits will be incorporated in the regulation and/or in the appropriate control documents.

Socio-economic impact studies will be done for each industrial sector and the municipal sector as the effluent limits regulation for that sector is prepared. This economic impact will be one of the factors considered by both the joint technical committees and the advisory committee (Figure 2) as the regulations are developed, and by the Government when it promulgates the regulations described above.

Abatement and Enforcement

The Ministry will improve and strengthen existing abatement and enforcement (summarized on p. 16 and described in detail in Appendix, p. 45) as follows:

1. Stiffer penalties for violation of environmental laws are being proposed.

2. Effluent limits regulations will outline specific abatement responsibilities and include steps to be followed when violations occur.

3. Existing control documents will be revised to be compatible with the effluent limits regulation. Periodic review of control documents will be introduced.

4. Control of industries discharging to municipal sewer systems will be reinforced; they may be required to pre-treat their wastewater at source.

regulations are expected to be in force nine to twelve months after monitoring regulations. Figure 3 is an implementation schedule for the phasing in of the MISA program.

Public Participation

As has been indicated (see p. 12), the municipalities, affected industries and interest groups have important roles in the development of the MISA program. Their representatives will participate on committees to be established on a sector basis. Each committee will be activated as the pre-regulation monitoring phase for that particular sector is being initiated. The general public will be invited to review and comment on the draft regulations as they are developed.

DEVELOPMENT OF COMPLEMENTARY PROGRAMS

The BAT approach for setting effluent limits will be complemented by the water quality impact approach for setting more stringent site-specific effluent limits needed to protect particularly sensitive receiving water bodies. For the water quality impact approach to be effective in setting effluents limits for toxics, existing water management policies and procedures must be revised and new receiving water quality impact assessment techniques must be developed.

Review of Existing Policies and Procedures. A number of related policies, guidelines and implementation procedures in the MOE publication "Water Management" (1984 edition) will be reviewed and revised to reflect the changes brought on by the MISA program. These will include such issues as mixing zones, receiving-stream design flows, definitions of technical terms (e.g., lethality, persistence) and development of additional ambient water quality objectives. All of these policies and procedures are essential to support the MISA program, and revisions will be completed by the end of 1988.

Pilot Studies. The Ministry of the Environment is conducting field studies at a number of pilot sites across the province to assess and evaluate the impact of various discharges on receiving-water environments. Water bodies with different beneficial uses (e.g., drinking water supply, fish habitats) are included in those sites selected. Special modelling and other assessment techniques, including the use of aquatic organisms as indicators of impacts on water quality, are being developed. These pilot studies will also be completed by the end of 1988.

FUTURE LOAD REDUCTIONS

The Ministry of the Environment will monitor improvements in abatement technology that will provide the basis for setting progressively more stringent effluent limits. Industry will be encouraged to carry out research and development into new technology and improvement in the operation of existing technology. New options for control (e.g., more in-plant recycling, further substitution and replacement of toxic chemicals in processes) will be encouraged. Some of these alternatives may save money as well as reduce toxic loadings. The BAT levels will be revised periodically to reflect recent advances in technologies and their economic viability. These new BAT limits will then be incorporated in revisions of effluent limits regulations.

Water quality impact effluent limits will be continually reviewed and updated as ongoing scientific studies indicate further environmental impacts.

New and expanded municipal or industrial treatment plants will be required to meet more stringent limits than older established plants.

Effluent limits for existing systems achieving BAT levels will be reviewed periodically; their limits will be reduced if the updated BAT levels or water quality impact effluent limits have become more stringent. In this way, the total loadings of toxic substances to Ontario's surface waters will continually be brought closer to virtual elimination, and receiving water quality will be improved.

A P P E N D I X

For the Control of Toxic (or Priority) Pollutants

- **Best Available Technology Economically Achievable (BAT)**, established as the principal national (U.S.) means of controlling direct discharges of toxic (or priority) pollutants. This represents the best existing economically achievable performance of plants in the industrial category or subcategory.

- **New Source Performance Standards (NSPS)**, based on **Best Available Demonstrated Technology (BADT)**. This requirement may be more stringent than BAT and was considered reasonable in view of the higher performance achievable for newly designed industrial plants. New plants would have more options to use less polluting processes, improved recycling of process streams, reduced water use and more efficient treatment processes at lower cost.

For the Control of Industrial Dischargers into Sanitary Sewers

- **Pretreatment Standards for Existing Sources (PSES) and Pretreatment Standards for New Sources (PSNS)**, designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of municipal sewage treatment plants.

In setting out requirements for industries to achieve best available technology, the Clean Water Act gave the Environmental Protection Agency the responsibility for determining what the technology included and what the effluent performance should be. The factors considered in establishing the best available technology economically achievable (BAT) level of control include: the costs of

In establishing BAT, NSPS, PSES and PSNS, EPA was required to consider non-water quality environmental impacts, including air pollution, solid waste disposal and energy consumption. It was considered undesirable to eliminate or reduce one form of pollution (in water) if another (in air or on land) was aggravated, or if energy consumption was increased significantly.

The U.S. EPA followed a systematic approach in establishing effluent limits. A comprehensive study of the toxic pollutant problem in each industrial sector was preceded by an intensive evaluation by the EPA of the kinds of data and supporting information that should be assembled as a basis for the development of regulations. All major decisions on the identity of pollutants and the establishment of effluent limitations and standards of performance for each subcategory had to be supportable by documented evidence collected from operating production facilities. Similarly, the necessary information on production rates, processes, raw materials, water use, waste sources and treatment technologies in practice had to be acquired with sufficient detail and breadth of coverage to permit the analysis of the engineering and economic variables that are characteristics of each subcategory. Toxic pollutant control regulations would be based on the application of best available technology for treatment and reliable performance evaluations for the removal of specific waste substances.

EPA first established industrial sector definitions and broke each sector or category down to subcategories, when sufficient differences in age, raw materials and products, processes or waste stream were justified. Screening and verification sampling programs were then carried out to establish the presence of toxics and other pollutants in wastewater and treated water, and to evaluate the environmental significance. Engineering evaluations were

3. Review of existing treatment technologies in use and the status of each industry with respect to compliance with existing guidelines or control orders.

4. In order to establish best available technology for each sector, a review will first be made of EPA documents for their definition of best available technology for control of toxics and best conventional technology for control of conventional pollutants. Use of EPA data is considered valid since EPA used a large data base for most sectors, and most industries use similar processes in North America.

   Secondly, consideration will be given to technology in use in Ontario and other Canadian provinces that is applicable for each sector, including recent research and demonstration programs in control technology. The review will also establish if substantial differences exist between Ontario industries and U.S. sectors because of differences in raw materials, processes, economics or operating conditions. Several levels and kinds of technology may be defined in this step for consideration in subsequent steps.

5. The performance level for the defined technologies will be established in statistical terms for removal efficiencies of conventional and toxic contaminants. Relationships to units of industrial production, gross water use and pollutant loadings to the treatment system will be established. Final performance levels will be established in units of concentration (mg/l) and either mass loading (Kg/day) or load per unit of production (Kg/day/production unit). Performance will be established statistically for normally well operated plants in terms of long-term average (LTA) performance

10. Best management practices for each sector will be defined.

11. Municipal and industrial input to the above steps will be provided by frequent opportunities to comment on the requirements before the regulation is drafted. Opportunities for formal review will also occur when the regulation is circulated in draft form.

12. The Ministry will specify the details of information to be submitted by each industry necessary to identify the effluent requirements of that industry.

13. The Ministry will have in place, through prior implementation of a monitoring regulation for each sector, a data base system and reporting procedure. Sampling, flow measurement and analytical protocols will also have been established.

14. The effluent limits will be framed in terms of performance only. The industry or municipality will have the option to choose the means of achieving the effluent limits. An exception to this is being considered in the case of volatile organic compounds where the industry may not have the option of using technologies that would result in air pollution, but would be required to remove these compounds using specific technologies.

Modelling and other innovative assessment techniques (currently under development through the MISA Pilot Site program) will provide dischargers and the Ministry with the tools for developing these water quality impact effluent requirements.

These assessment techniques will permit the evaluation of the receiving-water impacts, which will result in a given set of effluent limits. In general, it will be the responsibility of dischargers to assess the water quality impacts associated with various effluent levels. Based on this and other pertinent information, the Ministry will specify the effluent requirements that must be met to protect water quality at the site in question. The discharger's assessment will be carefully reviewed and checked for accuracy by the Ministry. The key steps in implementing this approach are outlined below.

Preliminary Assessment

The discharger will carry out studies using several assumed effluent levels above and below the BAT limits to determine the resulting receiving water quality impacts. General requirements established by the Ministry regarding size of mixing zone, toxicity, calculation of design flows, etc., will be used. Existing or readily collected chemical, physical and biological information will also be employed to yield an initial indication of whether the BAT effluent limits are sufficient to protect water quality. If it does, the BAT limits will be imposed. If not, or if the results are inconclusive, then a detailed study will be required to set water quality impact effluent limits. (See Figure 4).

Prioritizing Sensitive Receiving Waters

Using a variety of information, including knowledge of areas of concern and impacts on water uses, the Ministry will initially prioritize areas where more stringent effluent limits than those imposed by technology will be needed. Guidelines will be available for both existing and proposed dischargers to enable them to make such a determination themselves, and to get them ready for the detailed water quality impact study.

Detailed Water Quality Impact Study

A detailed water-quality assessment may take various forms, depending on the characteristics of the receiving water and the discharge, and whether the study site represents a simple or complex situation. For example, streamflow variability, current patterns, presence of sensitive aquatic life, bathing beaches and water supply intakes will help identify the extent of detailed water quality assessments.

An evaluation of the site-specific conditions and a review of the data already available will show what additional data are needed. Activities to generate these data could include monitoring of ambient water or effluent, biota, sediment, flows and currents. Such data will be combined with the appropriate BAT effluent limits and other pertinent information, such as the PWQO, interim water quality guidelines and biomonitoring results for assessment purposes.

Models can include complex mathematical relationships that incorporate functions for such factors as volatilization, biodegradation, adsorption and sedimentation. Models can reflect a steady-state condition (i.e., a "snapshot"), usually when factors such as waste loading, streamflow, current patterns or temperature reflect a worst-case situation. Other models are called dynamic. They can accommodate changing conditions (waste input, flow, etc.) over a period ranging from hours to months.

Establishment of Effluent Requirements

Using the results of the above studies by dischargers and any other information deemed necessary, the Ministry will establish the effluent limits that will protect water quality. Interim controls based on BAT will be established for industries and municipalities where receiving-water assessments have not been completed.

2. **BAT Effluent Limits Regulation.** This regulation will set out requirements for specified effluent limits defined in statistical terms. In addition, the regulation will include requirements to notify the Ministry of known violations of requirements, spills and leaks, upsets, bypasses and of any basic change in the operation of the industrial processes or the treatment system that would increase loading or concentrations.

3. **Violation Reporting.** The Ministry will become aware of effluent limit violations in one of three ways: (a) the discharger will notify the Ministry; (b) a review of submitted data by Ministry staff will identify violations; (c) Ministry sampling during inspections will lead to identification of violations.

   The Ministry will process the monitoring data submitted by the discharger on a timely basis and screen the data to identify violations. The existing "Occurrence Reporting System for Violations of Ministry Legislation" will be utilized for bringing violations forward for review.

4. **Violation Evaluation.** Violations will be evaluated for abatement and enforcement actions. They will be classified by type and severity, frequency of violation, actual or anticipated environmental damages and the environmental history of the dischargers. Appropriate abatement and enforcement responses will be laid out in accordance with the Ministry's policies on "Pollution Abatement Program" and "Uniform Environmental Enforcement."

5. **Enforcement.** The Ministry will follow established principles of prosecution, which include the proper exercise of prosecutorial discretion in achieving its objectives of abating pollution sources.

For cases where compliance with written requests is not forthcoming, formal abatement or enforcement proceedings will result. This does not prevent the application of these proceedings at an earlier time, if progress has not been made on an abatement program.

8. **Abatement Options.** The discharger has the responsibility of choosing the best combination of technology and techniques for meeting effluent limits. Industries may meet the limits by combinations of external treatment, in-plant treatment, recycling and reuse, and substitution or replacement of chemicals or processes. Municipalities may choose either: (a) to upgrade treatment facilities or (b) to locate sources of contaminants in the industries or commercial establishments discharging to the system and to control them through application of the municipal sewer-use bylaw.

   The Ministry is looking further into modifications of the model sewer-use bylaw: (a) to improve control of toxics; (b) to review means of strengthening regulatory components; (c) to give consideration for specific, pre-treatment requirements for certain industries and types of pollutants.

9. **Certificate of Approval.** Irrespective of the route taken to achieve abatement, the discharger must make application to the Ministry for a certificate of approval (C. of A.) of the proposed works to be constructed for the abatement program. The proposal will be reviewed by Ministry staff and approval given if it is considered capable of achieving the desired effluent limits and meets other requirements of the abatement program.

RELATED ISSUES

There are several other initiatives regarding the control of toxics that are being, or will be, developed in parallel to the monitoring and effluent limits regulations. These initiatives are complementary to the MISA thrust for improved abatement; when completed, they will be integrated into the MISA Program.

Sludge Production and Utilization

Background. Treatment processes in STPs and industrial operations remove toxic chemicals by three principal mechanisms: stripping; adsorption on to organic and inorganic solids with subsequent sedimentation in clarifiers; biochemical oxidation/reduction. In the case of biological treatment processes, all three mechanisms occur to a varying degree. Many persistent toxic compounds have a propensity to concentrate in sludge. Thus, it is imperative that strict controls be applied to sludge utilization/disposal so as to minimize the release of these contaminants to the environment.

Sludge Utilization in Agriculture. The guidelines for the agricultural utilization of sewage sludge are contained in the publication "Guidelines for Sewage Sludge Utilization on Agricultural Lands". These guidelines set allowable limits for the concentrations of only 11 heavy metals in sludges applied to soil. The guidelines also specify the operating conditions for the spreading of sludge and the physical site characteristics needed to minimize pollutant runoff and groundwater contamination.

etc.) are being examined in light of the continuing need to update effluent limits to reflect state-of-the-art advances in control technology (economically achievable) or more severe receiving-water constraints.

Stiffer Penalties. To further back up the force of regulations and to ensure abatement measures to follow, it is proposed that the penalty provisions contained within Ontario's environmental legislation be stiffened. At the present time, the maximum fine for conviction of the first offence under The Ontario Water Resources Act and The Environmental Protection Act is $5,000 and for each subsequent conviction it is $10,000 for each day the offence continues. Anyone who contravenes the Municipal Act (Sewer-Use Bylaw) can be fined up to $2,000 upon conviction.

Non-Point Sources

The toxic contaminants problem in Ontario will not be solved completely by controlling the point source discharges from municipalities and industries. Point sources are more amenable to the regular monitoring and control approach, but non-point source discharges must also be considered. Urban runoff, such as stormwater and combined sewer overflows, will be addressed by the Urban Drainage Management Program and by extending the existing Ministry Municipal Pollution Control Program to cover that area. Runoff from industrial sites will be addressed on a site-specific basis as part of the MISA Program. Agricultural runoff is being addressed mostly through best management practices, such as controlled application of pesticides, soil conservation practices and good manure/fertilizer handling and animal husbandry. These programs are now being implemented.

WB 931

ADVICE TO APPLICANTS AND TO CONSULTANTS IN PREPARING HYDROGEOLOGIC REPORTS FOR PROPOSED LANDFILL SITES

ONTARIO MINISTRY OF THE ENVIRONMENT
WATER RESOURCES BRANCH

JULY, 1984

Prepared by

WATER MANAGEMENT STEERING COMMITTEE
WORKING GROUP V

ADVICE TO APPLICANTS AND TO CONSULTANTS IN PREPARING
HYDROGEOLOGIC REPORTS FOR PROPOSED LANDFILL SITES

PART I - MINISTRY POLICY AND SUGGESTED APPROACH

The Ministry's policy with respect to landfill sites is to control ground-water quality to protect both existing and potential reasonable uses of water on adjacent property. It should be noted that of the numerous factors and concerns to be dealt with by a proponent, this document deals only with those related to hydrogeology.

This document suggests an appropriate approach for the preparation of hydrogeologic reports on site investigations undertaken to support applications for approval under Part V of the Environmental Protection Act. Note that approval of a landfill site can involve proceedings under the Environmental Protection Act (Part V), the Environmental Assessment Act or the Consolidated Hearings Act. In many cases it will be up to the applicant to choose which way he will proceed in order to best suit his needs and his circumstances. It is only under the Environmental Protection Act that the approval decision remains with the Ministry of the Environment Director. In such cases, the Ministry is in a position to insist that the scope of site investigations encompass the suggestions in this document. Under the Environmental Assessment Act and Consolidated Hearings Act the Ministry role is different, and the suggestions in this document will form part of the Ministry's advice to the appropriate decision-maker.

a) Ground Water Use

The uses of ground water in the vicinity of the site should be assessed and an estimate made of the existing and possible needs and uses for this ground water in the future. Both the quality and quantity of the ground waters should be described in terms of their

suitability for these uses (i.e., a technical assessment of what the resource could be used for based on its quantity and quality). This assessment can generally be based on an office review of records and will seldom involve any significant amount of field work. It does not involve a planning assessment based on potential development in the area although any such existing assessment should be considered. The purpose of this assessment is to determine existing and potential reasonable uses so that acceptable discharge levels can be specified. If sought, this specification will be made in accordance with the commitment in Part II of this document "The Role of the Ministry".

There should also be some discussion provided of any other existing and potential sources of contaminants in the vicinity so that these contaminants can be considered in the determination of an acceptable discharge from the site.

b) Surface Waters

The quality, amount and existing and potential uses of surface waters in the vicinity of the site should also be addressed with respect to any impacts on these surface waters that might occur directly or as a result of an impact on the quality or quantity of the ground water caused by the proposed site. The Ministry's policy on surface waters is presented in the booklet "Water Management Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment", November, 1978.

c) Site Impact on Water Use

The impact of the proposed landfill operation on the ground and surface waters and their uses on and off site should be assessed. As it is difficult for the Ministry to support sites which have not been evaluated in quantitative terms, this assessment should have a quantitative basis with the level of contamination being addressed as well as the length of time the contamination will be present within the site. Discussions with the Ministry, as outlined in

Part V of this document, can be held in order to consider the appropriate extent and sophistication of the analysis needed for this assessment

The Ministry considers the state-of-the-art in the prediction of contaminant attenuation to be relatively inaccurate and thus such calculations and estimates should incorporate a large safety factor. An estimate of the confidence level or the expected range for all estimates and a worst case estimate (maximum possible impact) of the effect of the landfill on the environment should be provided. The worst case estimate is necessary input to determine the magnitude of the safety factor that will be required and the consequences of failure. It is not intended to be a probable estimate of site impact.

d) Site Contingency Plans

The Ministry considers a contingency plan to be a plan designed to accommodate any failure in the design of a landfill. As failure may develop in a number of ways, it may be appropriate to address several contingency plans for a site. A contingency plan is considered to be a backup measure only.

It would also be appropriate for the Applicant to address the cost of the contingency plans and the method(s) by which they will be funded as well as the likelihood that the various plans will have to be implemented.

Proposed measures with a high level of probability of being implemented are not contingency plans but are considered to be a part of the landfill design and should be funded accordingly.

e) Monitoring Program

The purpose of a monitoring program is to determine:

1. if the landfill is operating as designed and predicted monitoring results are being obtained.

2. if the contingency plans should be implemented, and
3. if contingency plans are functioning as expected.

If the landfill is not operating as designed, a proper monitoring program should, by early detection of any failure, allow some options with respect to contingency plans and decrease the cost of implementing any contingency plan.

A predictive monitoring program may be appropriate. Predictive monitoring requires that anticipated monitoring results be specified in advance. This allows the level of understanding of the hydrogeologic system to be appraised by comparing the predictions with the monitoring results.

Monitoring plans and contingency plans are inseparable. In the event that a monitoring plan and contingency plan are required the purpose or objective of the monitoring plan should be discussed. Conditions (monitoring results) which would initiate a predetermined response should, in so far as is possible, be specified (e.g. contaminant levels which would initiate the activation of a contingency plan).

It is recognized that there is considerable uncertainty in predicting monitoring results and in any predictive monitoring program, new predictions can be made to accommodate the monitoring data as they are collected. Review and reassessment of the levels that would initiate contingency measures will be necessary in most cases. A major advantage to the predictive monitoring approach is that it ensures that there is a regular organized review of monitoring data as they are collected and that the Ministry can be alerted of significant monitoring results.

f) Maintenance

The long-term maintenance of a landfill, including leachate and gas control facilities, monitoring devices, the landfill cover, vegetation, etc. and the assignment of responsibility for conducting these operations should be addressed. Where known, the uses of a

site after filling has been completed should be specified, particularly those uses that may affect the hydrogeologic regime and the production and migration of leachate and gas. Any constraints to future uses of the site should also be specified.

Any future uses of landfilled sites (for 25 years after closure) must be approved by the Minister of the Environment under current legislation. There is an advantage to an applicant who is going through a Hearing process to make an early commitment to future use.

g) New Technology

Where a proposal involves emerging technology that has not been subjected to performance testing at normal landfills, this technology should be identified and any references or data (or experience) available on this technology should be provided.

h) Data

All of the hydrogeologic data that have been collected should be provided. It is not necessary to provide all of these data in final form (e.g. legible copies of handwritten field records are acceptable). All data are required because:

i) they are necessary for a complete review of the Applicant's assessment; and,

ii) a complete record of all testing and test results is desirable for future reference in the event that problems which require remedial action develop over the long term.

a) Contact with the Ministry

The Ministry's Regional offices will be the first Ministry contact for matters dealing with proposed landfill sites. The Regional office of the Ministry will either provide direction to applicants and consultants on technical matters and Ministry procedures or indicate the group in the Ministry where such direction may be obtained.

b) Guidance from the Ministry

Before a consultant is selected, the applicant may meet with the Ministry personnel to determine the Ministry's general position on the site. Following this meeting the Ministry will provide preliminary written comments on the anticipated scope of a site investigation. These preliminary comments are intended to aid the applicant in the preparation of the terms of reference for the site investigation and together with this document should be provided to prospective bidders.

After a consultant has been selected by the applicant the consultant may wish to meet with the Ministry for his benefit to discuss the proposed investigation and to determine the Ministry's position and general views on the proposal.

General guidance as to the extent and sophistication of the site assessment recommended by the Ministry will be provided on a case-by-case basis by Ministry personnel in discussions with the applicant or his consultant. This will be done in accordance with Ministry policy and guidelines. Where appropriate, preliminary agreement should be reached on critical issues as well as the specific objectives of the consultant's work plan. In these discussions, consideration will be given to such factors as the sensitivity of the environment, the consequences of site failure, the margin of safety provided in the design, and the present and planned land uses and ground-water uses in the vicinity.

In order to allow the consultant to proceed with the investigation and design of the landfill, he may ask that a preliminary opinion be provided at as early a stage as possible as to the level of contamination, if any, that can leave the site and the magnitude of the safety factor that should be used in the site assessment based on the sensitivity of the environment. The results of the completed site investigations may indicate that this preliminary opinion should be modified. Some uncertainty cannot be avoided in the absence of firm data on the quality and quantity of the ground-water resource and the complexity of the hydrogeologic system at the site. These firm data cannot be obtained without a field investigation. While the Ministry wants to be as helpful as possible it is expected that request for guidance would be accompanied by sufficient data.

Ministry personnel will provide guidance on the level of protection that should be provided for that specific environment. Particular methods by which this can be achieved will seldom be specified. It is felt that this field is properly the responsiblity of the applicant or his consultant. The Ministry has no set of universally applicable methods or requirements which must apply to all sites. It is not the Ministry's responsibility to specify methodology or to direct the applicant or his consultant, step-by-step, in site assessment. The Ministry will only provide general advice on its current policy and what it considers to be acceptable practice.

c) Scope of Ministry Assessment

The Ministry will conduct a detailed review of hydrogeologic reports presented by an applicant or his consultant, and will assume a high level of responsibility for the assessment of their conceptual suitability and technical soundness. This will include an examination of the "raw" data and of the site. A report of this review will be prepared in which concerns and deficiencies are identified. The applicant or his consultant will be given an opportunity to respond to the Ministry's review before the Ministry's review is finalized. The intent of this step is to avoid misunderstandings on technical matters, to allow the applicant to

respond to the Ministry's technical concerns, and to identify the real issues before a final position on the reports is established by the Ministry. The Ministry must always be open to new information which could bring about a modification of its position.

d) Level of Presentation

The following examples do not represent a listing of required data or designate avenues of investigations which must be followed. They illustrate examples of the level of detail which should be presented in reports (not in investigations) to facilitate the review of these reports.

i On cross sections, data such as the stratigraphy, the position of piezometer seals and screens, flow lines and equipotential lines and values should be presented where appropriate.

ii Calculations and the sources of data used for calculations should be shown and, where appropriate, references should be provided for the equations that are used. For example, measurements and graphs for permeability testing and water balance data should be provided.

iii Where appropriate, epm charge balances for chemical analyses should be provided together with percent discrepancies and, where necessary, explanations of these discrepancies.

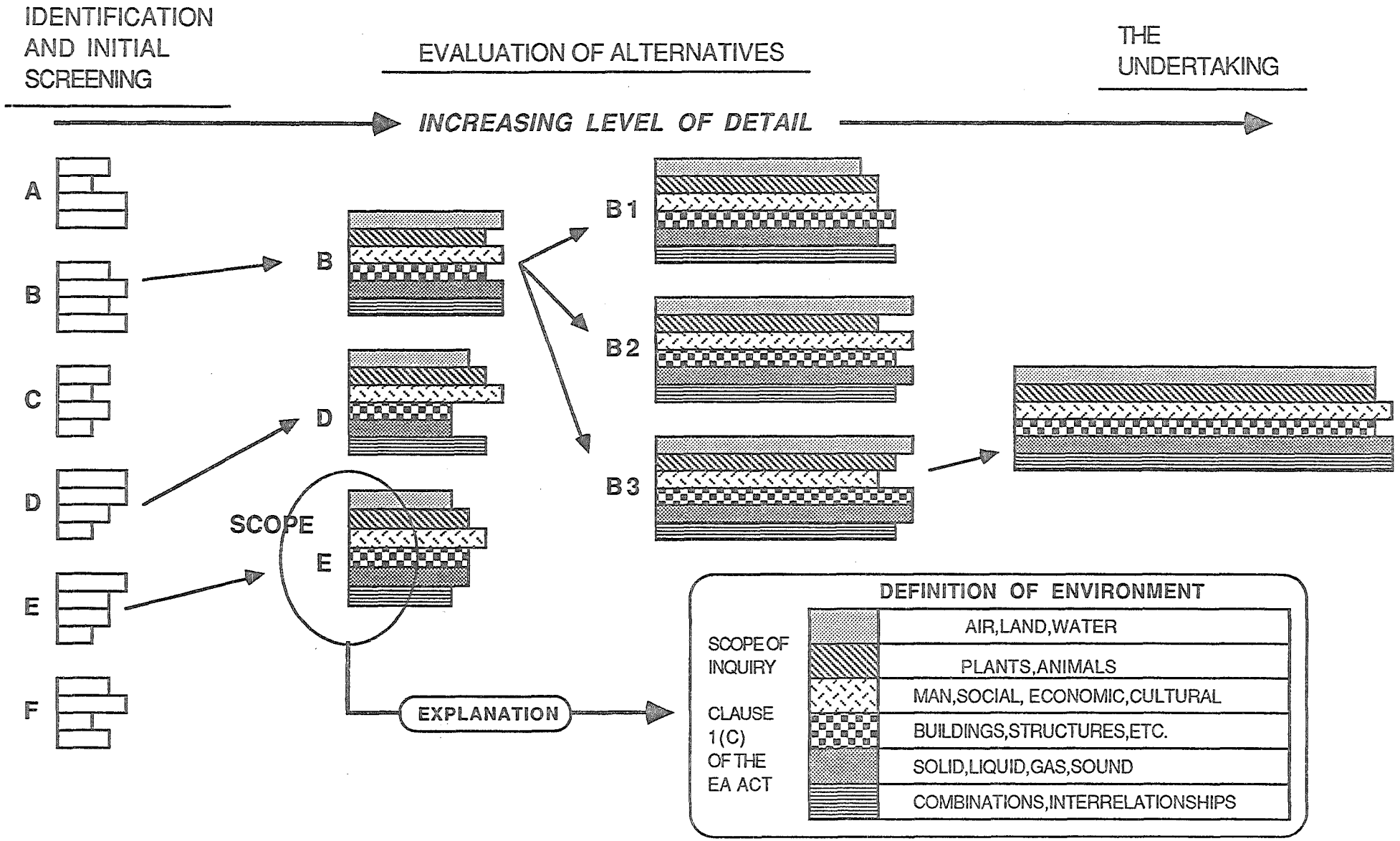
iv The methods used in drilling and constructing any well points and piezometers should be described as well as any testing or analyses used to determine the validity of the data obtained from these installations and,

v Methods used in developing monitoring wells and obtaining and analyzing samples should be identified.

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E934

LEVEL OF DETAIL OF EXAMINATION OF ALTERNATIVES IN A PARTICULAR STUDY



WB 935

ENVIRONMENTAL ASSESSMENT ACT

SUBMISSION AND NOTICE REQUIRING A HEARING
(SECTION 7(2) OF THE ACT)

RE: Environmental Assessment received from the Regional Municipality of Halton for the landfill component of Halton's Solid Waste Management System.
EA File No. 1-82-0006-000

TO: The Honourable James Bradley
Minister of the Environment
135 St. Clair Avenue West
15th Floor
Toronto, Ontario
M4V 1P5

FROM: The West Burlington Citizens Group
c/o June Anderson, President
685 Inverness Avenue
Burlington, Ontario
L7T 3S9

DATE: April 10, 1986

SUBMISSION

(a) We make the attached submission relating to the undertaking, the environmental assessment and the review thereof.

HEARING

(b) We require a hearing by the Environmental Assessment Board with respect to the undertaking, the environmental assessment and the review thereof.

Respectfully submitted,

Toby Vigod

Toby Vigod
Counsel
Canadian Environmental Law Association

Solicitor for the West Burlington Citizens Group

SUBMISSION TO THE MINISTER OF THE ENVIRONMENT
REGARDING THE REGIONAL MUNICIPALITY OF HALTON"S
SOLID WASTE MANAGEMENT SYSTEM
EA FILE NO. 1-82-0006-000

I. INTRODUCTION

The West Burlington Citizens Group (WBCG) is a ratepayers association of approximately 400 members living in the West Burlington area (formerly the Village of Aldershot). The association can trace its origins back 25 years, though its membership has varied throughout this time. The main objective of the WBCG is to maintain the quality of life in West Burlington. The WBCG has an active solid waste management committee which has been involved in solid waste issues in Halton Region since 1983. In 1984, the WBCG actively participated at the hearings involving the expansion of the existing Regional site located adjacent to the proposed undertaking at Escarpment Site "F". The group played a significant role in obtaining important conditions relating to the operation and monitoring of this site.

The WBCG has voiced its opposition to the establishment of the Regional landfill at Escarpment Site "F" (the north half of Lots 2 and 3 north of Highway 403 in Concession I, and the south half of Lot 3, Concession II in the City of Burlington) since the proposal was first put forward by a private company, National Sewer Pipe in the early 1980's. The WBCG has taken an active role in setting out its concerns both orally and in writing to the Region since 1983. One member of the group calculated that

the WBCG has made over 45 presentations to the City of Burlington, Halton Regional Council and Halton's consultants from early 1983 to the present. Specific reference should be made to the written submissions made by the WBCG to Halton's consultants Walker Wright Young Associates Limited which are contained in their Compilation of Submissions, Phase 2, Stage 2C Report, April, 1985, at 374. These submissions will not be repeated in their entirety but should be read in conjunction with this submission.

Pursuant to s. 7(2) of the Environmental Assessment Act (EAA), the WBCG is pleased to make the following submissions with respect to the proposed undertaking, the environmental assessment and the review regarding the proposal to establish a landfill facility at Escarpment Site "F" in the City of Burlington.

II. POSITION OF THE WBCG AND RELIEF SOUGHT

A. The fundamental position of the WBCG is that Escarpment Site "F" is inappropriate for the establishment of a landfill. The group also maintains that the selection of this site as a preferred site has not been based on carefully documented data and that the basic proposition that hydrogeology is the paramount concern for the siting of a landfill has been ignored.

B. The WBCG concurs with the Environmental Assessment Branch's conclusion that the Region of Halton's environmental assessment

does not meet the requirements of section 5(3) of the Environmental Assessment Act.

C. The WBCG further recommends that you do not accept the environmental assessment as presently written as it does not meet the requirements of section 5(3) of the EAA.

D. The WBCG also respectfully requests that you, pursuant to s. 11 of the EAA, order additional studies to upgrade the quality of the environmental assessment in regard to the proposed Escarpment Site "F". Such studies would include:

- EFW facility
- transfer station
- liner feasibility for Escarpment Site "F"
- leachate treatment (we understand a study is due in July, 1986)
- detailed engineering, and
- monitoring program.

It is our submission that these studies should be filed and reviewed prior to any hearing taking place.

E. The WBCG maintains that the undertaking in respect to Escarpment Site "F" must be amended to include a proposal for an Energy from Waste Facility. If this is not included, the environmental assessment fails to meet a crucial term of the proposed undertaking and a stated need of the Region of Halton - i.e., to landfill 11.3 million cubic yards of solid waste. The undertaking should also be amended to include a proposal for a

transfer station which is necessary if landfilling is to take place at Escarpment Site "F". An addendum to the environmental assessment should be prepared to deal with these two items prior to any hearing taking place.

F. The WBCG further maintains that a hearing is premature at this time given the failure of the environmental assessment to meet the requirements of section 5(3) of the EAA and therefore does not provide an adequate basis upon which to approve or reject the undertaking.

G. The WBCG, pursuant to s. 7(2)(b) of the EAA, requests a hearing before the Environmental Assessment Board, should the Region continue to pursue Site "F" as a possible location for its landfill site.

H. The WBCG respectfully requests that intervenor funding be made available to them. The group does not have the resources necessary to retain expert witnesses and participate fully in a case of this magnitude. The group has embarked on a fundraising campaign and had obtained a commitment by the City of Burlington to fund the group up to a maximum amount of $12,000. However, this sum will not be adequate to fully participate in the hearing. While the group has retained the services of a hydrogeologist to do a preliminary review, it will be necessary to retain other experts prior to the hearing to review the extensive documentation. Therefore, the WBCG is requesting a commitment in

principle from your office to fund experts in regard to this case. We would be happy to submit a detailed budget at your request.

The following are the WBCG's major comments on the proposed undertaking by the Region of Halton to landfill 11.3 million cubic yards of solid waste at Escarpment Site "F".

III. THE REGION FAILED TO ADEQUATELY DEFINE THE UNDERTAKING

A. The environmental assessment documentation focussed solely on the landfill component, and failed to include in the assessment a proposal for an energy from waste facility, which is necessary if there is to be a landfill at Escarpment Site "F". By the Region's own calculations, an EFW facility is a necessity in the case of Escarpment Site "F" to meet the 11.3 million cubic yards stated capacity. The Region states that "100% of Halton's solid waste will be landfilled for the initial eight years (1988-1996) of the planning period. In the latter part of the planning period (1997-2008) 50% of the solid waste will be handled by EFW facility(ies) and 50%, plus ash residue and non-combustible materials, will be landfilled." The area of Escarpment Site "F" is only 87 hectares (215 acres), including buffer zones. This can be compared to Site "D" which is aprroximately 185 hectares (457 acres). It should be noted that on page 2 of the January, 1985 Draft Summary Report it is stated that a site of approximately 250-300 acres is required to accommodate the needed capacity of 11.3 million cubic yards. Therefore, even on this

basis, Escarpment Site "F" is too small. Further, it has come to our attention that the City of Burlington is in the process of expropriating a portion (up to 40 acres) of the 87 hectares at Escarpment Site "F" to be used in conjunction with the cleanup of the adjacent leaky Bayview landfill. This would further reduce the capacity of Escarpment Site "F" below the required 11.3 million cubic yards. Finally, the projected capacity of 11.3 million cubic yards is based on an EFW facility being in place by 1997. In the case of Escarpment Site "F" as opposed to the other candidate sites, the EFW facility is a necessity as there is no capacity at the site to take the additional waste that would be generated should an EFW facility not be established.

It is therefore our submission that Escarpment Site "F" should not and cannot be considered in isolation of an EFW proposal. Unless the Region includes an EFW proposal in its definition of the undertaking at Escarpment Site "F" and provides documentation of its location, design and environmental impact, the site should not go forward. It should be noted that your Ministry has commented in its review of the environmental assessment that consideration should be given to including the EFW in the definition of the undertaking. It is our submission that in the case of Escarpment Site "F" this must be done.

B. In addition, the Region of Halton failed to include an analysis of a Georgetown Transfer Station as a key component of the landfill proposal at Escarpment Site "F". This is despite

the fact that the Region has indicated that if Escarpment Site "F" is selected as the method for landfilling, a permanent transfer station will be required near Georgetown.

In summary, an addendum to the environmental assessment should be prepared to deal with an EFW facility and a transfer station as an integral part of proposed Escarpment Site "F" prior to any hearing taking place.

IV. THE REGION'S DECISION-MAKING AND SITE SELECTION PROCESS IS FUNDAMENTALLY FLAWED

As the Review notes on page 27, the lack of both clarity and consistency in the documented decision-making process makes it difficult to trace the proponent's planning process. The problem was particularly evident in the selection of candidate areas and sites. The WBCG contends that the site selection process is fundamentally flawed and that had a logical process of site selection been followed Escarpment Site "F" would never have been selected.

Stage 2A: The WBCG concurs with the reviewers that Walker Wright's conclusions regarding the hydrogeological suitability of the seven pits and quarries sites did not follow from the evidence provided and the methodology presented during the Stage 2A phase. The Region's consultants have stated that hydrogeologic suitability is the most important consideration for the siting of the landfill. This approach has consistently been

taken by all jurisdictions in North America in the 1980s. Yet the seven pits and quarries sites, including Escarpment Site "F", were not subject to the same hydrogeological evaluation. If they had been, they could never have been included as potential sites as pits and quarries are not natural attenuation sites. The Region did not and has never clearly explained their reasons for deciding to include pits and quarries at all.

Stage 2B: The WBCG agrees with the Review's conclusions that the Region failed to clearly explain their weighting system. Again the seven pits and quarries sites were subjected to a separate evaluation system from the clay/till plain candidate areas with the key factor of hydrogeologic suitability applied in a different manner. It is also curious as to why the other six pits and quarries sites were eliminated in short order while Escarpment Site "F" continued through the site selection process.

Stage 2C: The use of the final "pair analysis" was inappropriate because not all the sites were of a similar nature. Five were located on a clay till plain, while Escarpment Site "F" was located in a shale quarry.

V. HYDROGEOLOGICAL CONCERNS WERE NOT ADEQUATELY EXAMINED

The Region's consultant states that the hydrogeological factors were the most important considerations when selecting the preferred site location. However, the Region seems to have

ignored their own criteria when Escarpment Site "F" was considered. The environmental assessment fails to describe the fractured shale which underlies Escarpment Site "F" and also fails to acknowledge the high permeability and low leachate attenuation capacity of fractured shale. The Region lists attenuation capability of Escarpment Site "F" as a moderate to high constraint, despite the fact that a significant portion of the site consists of only 0-1 metre of overburden. Clearly this factor should be a high constraint. Further, despite the lack of overburden, the Region's consultant concluded that a liner not be required for Escarpment Site "F", while at the same time they noted that a liner would be necessary for Sites "B" and "C" which would also have limited overburden.

The complexity of the groundwater flow system through the fractured shale is also similarly dismissed by the Region. The Region assumed throughout its environmental assessment that because of poor groundwater quality, the escape of leachate would not create a significant impact. The Region's consultant, Hydrology Consultants, defines impacts on the basis of loss of use. If a resource has little or no use, then the Region assumes contamination can be permitted. However, impact more precisely refers to a perceptible change in the quality of the water beyond the site boundaries, regardless of the existing quality or use of the water. Indeed Escarpment Site "F", because of the complex groundwater flow system and the occurrence of high probability of surface runoff, has potential for future impact on Lake Ontario.

It should be noted that Burlington Bay has been identified as an area of concern by the International Joint Commission and is to be the subject of a remedial action plan. We already know that leachate from the existing landfills adjacent to Escarpment Site "F" is moving off-site towards the Bay. An additional landfill with the same potential for off-site impacts should not be sited on fractured shale in this area.

As mentioned earlier, different criteria were used to evaluate Site "D" as compared with Escarpment Site "F". Site "D" is located in an area where the till thickness and slope is in accord with normally accepted criteria for landfill site development. Escarpment Site "F" does not meet these normal critera.

The final rankings presented in the report are dependent on the assumed efficiency of the proposed conceptual designs, but that conceptual design was discussed only briefly in the report. The brief discussion does not include the amount of leachate which might require treatment or be discharged to the ground or surface water. This is of considerable concern as the Region has stated that Escarpment Site "F" does not require a liner.

The poor quality of the hydrogeological and hydrological investigations makes it difficult to truly ascertain the exact impacts on the environment of the alternative sites.

Hydrogeologic-Hydrologic Assessment and Conceptual Design, Final Technical Report No. 7: The approach taken by the Region's consultant in Report No. 7 was to examine each candidate site from a hydrogeologic and engineering standpoint but not to develop on any site the level of detail required for approval under the Environmental Protection Act. It would seem that this approach is questionable and did not lead to the best site being selected as the preferred site. Not only is the preferred site selected on the basis of imperfect information, but engineering feasibilty and mitigation measures required to make a candidate site suitable for landfilling are also discussed on the basis of insufficient information.

The Region's ranking of the sites are based on the worst case scenario that considers the potential impact of a landfill system failure on water resources. However, the Region fails to adequately examine the worse case scenario of leachate migration from Escarpment Site "F" - namely the impact on surface water and Lake Ontario. It should also be noted that your Ministry's general approach, as outlined in the 1984 revised Water Management Programme (the "Blue Book"), is to limit actual groundwater/surface water impact at site boundaries, rather than the subjective impact on water resources. Further, the Region's rationale for choosing Escarpment Site "F" seems to hinge largely on poor water quality and lack of groundwater use. However, this appears to be the case for most of the other candidate sites as Halton Region generally has poor groundwater quality. Further,

it is our submission this is not a valid criterion. Finally, it appears that with future increased urbanization planned around other sites, the number of well water users may decrease and therefore undue emphasis may have been placed on this factor by the consultant.

In the distinctions between sites, the Region's consultants have made many inconsistent statements which, if examined closely, would lead to a conclusion that Escarpment Site "F" is an inappropriate site for the establishment of a landfill. For example, reference is made to the unsuitability of sites "A", "B" and "C" because of the presence of shale bedrock and the fact that a large portion of these sites have no overburden. Reference is made to the fact that Site "B" is not suitable because waste would lie directly on the shale bedrock over one-half of the site. A similar situation will exist on Escarpment Site "F", but there is no reference to it in the summary.

The Selection Criteria and Use of Selection Criteria: The Region based their ranking of candidate sites on the following criteria:

1. natural attenuation capability
2. geologic complexity
3. overburden thickness
4. complexity of groundwater flow system
5. buried valley-aquifer complexes

6. type and distribution of aquifers, and
7. drainage.

On page 8 of Report No. 7, a short discussion is provided for each criterion on what is desirable and what is not. Three other criteria are also used, but no elaboration of these criteria is provided. They are:

1. proximity to existing water supply wells
2. location of aquifers, and
3. existing water quality.

It appears that the Region used different criteria for evaluation of the suitability of sites with different conditions. In the sites located in till plains, the general concept of site selection was to identify sites with the best natural attenuation. Engineered backup systems would be available if unacceptable impacts occur. On sites with little or no overburden the evaluation was based on the ability of landfill design to compensate for the sites' inability to attenuate landfill contaminants.

A site's natural attenuation capability is generally regarded as the first line of defence against leachate break out. Engineered solutions and leachate treatment usually serve as back up systems. The Region selected Escarpment Site "F" though it has little or no attenuation capability, thereby violating its own first criterion. The rationale for doing this is that loss of some

leachate to groundwater would not pose a problem because the natural groundwater quality is poor. In addition, a leachate underdrain system would be installed at Escarpment Site "F" to collect most of the leachate for treatment at a sewage treatment plant. Despite this assurance, the Region fails to provide information of how effective the leachate treatment system will be, given the complex groundwater flow system through the fractured shale. The Region has also admitted, on page 57 of Report No. 7, that a relatively small portion of the leachate which bypasses the leachate collection system will find its way into Burlington Bay and Hamilton Harbour. This appears to be a clear admission of off-site migration and is unacceptable. Further, recent studies have shown that flow in fractured shale is very difficult to predict. A key point is that the system is very complex and there is a lack of ability to make accurate predictions. Lack of understanding will also hamper engineering design and interpretation of long term monitoring and performance evaluation.

General Engineering Criteria: Report No. 7 lists six general engineering criteria. The first criterion establishes that landfills are to be surrounded by a 100 metre wide buffer zone. Escarpment Site "F" violates the buffer zone criterion by having buffer zones smaller than 100 metres. Further, the depth of cut is to average about 4.5 metres. Such a cut at Site "F" would mean drilling into bedrock.

VI. MITIGATION MEASURES WERE NOT ADEQUATELY CONSIDERED

Again, the WBCG agrees with the Review's conclusions that mitigation measures were not considered early on in the evaluation process and that a net effects analysis of alternative waste disposal technologies could not be performed.

VII. BIOPHYSICAL AND NATURAL ENVIRONMENT ASSESSMENT IS NOT ADEQUATE

The Region fails to discuss methods for protecting a significant oak-hickory forest located on Escarpment Site "F", nor will it provide protection for regionally rare species also occurring at the site.

The Presence of a Permanent Stream on Site "F": On page 5-3 of the Biophysical Assessment (Phase 2, Stage 2C, June, 1985) report the consultant claims there exists one permanently flowing tributary of Indian Creek in the base of the eastern-most ravine at Escarpment Site "F".

This finding contradicts the Final Technical Report No. 7 which states that only several intermittent tributaries of Indian Creek rise at the north limits of the site (page 50). The Region's hydrogeology consultants define major streams as those that are perennial streams (page 8). They state that it is desirable to

locate a site suitably set back from watercourses because there is a potential danger that contaminants may leach from landfills and migrate to surface waters.

The definition of permanent and perennial are synonymous. Therefore, if the biophysical consultants' observations are correct then Hydrology Consultants understated the significance of the streams present on Escarpment Site "F" and the constraints they impose on landfilling.

Hydrology Consultants further understated the significance of streams present on Escarpment Site "F" by not reporting in Table 1 that any streams run through the site. This contrasts with the following comments made in regard to the other sites:

Site A: some minor stream tributaries flow across the site

Site B: a major stream and several tributaries flow across the site

Site C: a major stream complex is to the east of the site and several tributaries flow across the site

Site D: some minor stream tributaries flow across the site, and

Site E: no significant stream or tributary flow across the site.

VIII. THE SOCIAL IMPACT ANALYSIS IS INADEQUATE

The social impact assessment was inadequate for several reasons which will be discussed below.

The consultant's final ranking with respect to the impact of a landfill on population is questionable because its results are based on study areas of varying sizes. For example, the following study areas were used for each site:

Site A: 3.1 Km

Site B: 2.3 Km

Site C: 2.5 Km

Site D: 2.1 Km

Site E: 1.4 Km

Site F: 1.0 Km

As a result, Escarpment Site "F" was found to be the best suited for landfilling because it had the least population impact. This conclusion is untenable because the impacts for Escarpment Site "F" were based on a smaller study area. As a result, a significant portion of Burlington's population was not queried on possible social impacts. For example, if a study area the size of that which was used for Site "A" (3.1 Km) was applied to Escarpment Site "F", it would extend south from Escarpment Site "F" to the lake. If the study area for Escarpment Site "F" was increased to 2.1 Km (the size of Site "D"'s study area), it would include the area two-thirds of the way to the lake. The use of a smaller study area for Escarpment Site "F" unfairly understates the impact on the population of a landfill at Escarpment Site "F". The use of the smaller study area also exempts from consideration the impact of a landfill at Escarpment Site "F" on the Maplehurst School, which is located 1.6 Km away.

During public meetings repeated efforts by the West Burlington Citizens Group to have the consultant correct the flaw in the social impact assessment were rejected. The consultant stated during a public meeting in Burlington that the study areas were selected before she joined the project.

In addition, the consultant ignored the difference between urban and rural communities by focusing only on householders. Questionnaires from industries and businesses were excluded on the grounds that the social impact assessment intended to focus on individuals and households (page 2-1). In urban settings there are far more industries and businesses than in rural communities. The consultant stated that the impacts of the landfill on commercial and industrial properties was to be considered as part of the economic assessment. However, the economic assessment did not seriously consider the impact of landfilling on local businesses. In fact, they were rejected from further consideration (page 6-1, Economic Assessment). Therefore, the social impacts on commercial and industrial property are still waiting to be done. Proximity to a landfill could have a negative impact on clients of a business and they may decide to shop elsewhere.

IX. VISUAL IMPACT ASSESSMENT IS FLAWED

The findings of the Visual Impact Assessment require further elaboration and clarification. The consultant defines the limit

of visibility as the continuous area within which the proposed landfill may be seen. The consultant states the limit of visibility for Escarpment Site "F" is 505 hectares (page 5-17). However, the consultant points out that the limit of visibility for Escarpment Site "F" may be greater than 505 hectares because it is visible from various tall buildings, the Burlington Skyway and by boaters on Lake Ontario. The consultant also points to the difficulty in calculating the limit of visibility for Site "F" because it is the most visible site (pages 5-17, 6-1). Despite the fact that the limit of visibilty for Escarpment Site "F" is greater than the 505 hectares, that figure is used in Figure 1, Visual Assessment (page 6-5). As a result, the limit of visibility is understated for Site "F" in comparison with the other sites.

In addition, it appears that the consultant understated the degree of visual impact from Escarpment Site "F" on various residents or employees of tall buildings. The consultant defines high visual impacts as being "usually associated with candidate sites that are not screened by vegetation or topography. High Visual Impacts usually occur in close proximity to candidate site." Views from various tall buildings in Burlington offer a complete view of the site and very little screening can be provided by vegetation or topography. As a result of these factors, the consultant's determination for areas of high visual impacts are understated for Escarpment Site Site "F" (page A5-18). Substantially more than the nine residences surrounding

Escarpment Site "F" are affected by the high visual impacts from the landfill site.

X. A NOTE ON PUBLIC PARTICIPATION

On page 20 of the Review, it is noted that the Tremaine-Britannia Interest Group raised the issue that while the Region acknowledged the input from the public and interest groups, these concerns were not always addressed during the study process. The WBCG has also raised this concern many times during the past three years and agrees with the sentiment expressed. The group maintains that the Region's consultant did not reply satisfactorily to the concerns raised by it and that the general characterization of the consultant's attitude was one of intransigence. Often the Region did not reply at all to concerns raised. The WBCG felt that the consultant had made a preordained decision that Escarpment Site "F" was to be the preferred site and then tried to justify its decision after the choice had already been made. The WBCG contends that consultation and participation must mean more than an opportunity to have input into the process, but should involve a meaningful dialogue where concerns are dealt with in a substantive and timely fashion.

April 10, 1986

N-470

Keros Cartwright
Hydrogeologist
310 West John Street
Champaign, Illinois 61820

was asked to compare to site D - smaller site

old data - not reviewed. Review data - pumping test

EVALUATION OF THE NATIONAL SEWER PIPE LTD.
BURLINGTON LANDFILL SITE
November 15, 1982

Background

I have reviewed all the hydrogeologic data, three reports by Morrison Beatty Ltd., and two reports by J. A. Cherry, the engineering drawings of the site by Proctor and Redfern Ltd., as well as other documents. I also made field surveys of the site and surrounding area on May 18, 1981, and Septebmer 15 and 16, 1981.

Following my first review I posed several questions, which I felt needed clarification, to Brian Beatty concerning his report. I also suggested that three more piezometer nests be drilled, and that the existing piezometer network be re-sampled. The work resulting from these suggestions is included in the Morrison Beatty Ltd. "Phase III Hydrologic Investigations."

Based on the hydrogeology of the site, which is summarized below, it is my opinion that the proposed landfill site is suitable for municipal waste.

Hydrogeology

The landfill site is underlain by the Queenston Shale, and burial is to ta place in this shale unit. Southeast of the landfill site, but still on NSP propert a thin veneer of lake and glacial sediments overlie the shale. The overlap takes place near the abrupt change in topography from eroded uplands to the nearly flat land of the lake plain, and the thickness of sediments over the shale increases southward toward Lake Ontario.

The Queenston Shale transmits groundwater almost exclusively through fractures in the rock. The fractures decrease in size with depth, resulting in a rapid reduction in hydraulic conductivity (permeability). Small quantities of groundwater are available from the shale; however, development of this water is unlikely because of the limited quantity, poor quality (high salinity), and presence of high quality lake water in the immediate area.

The precise groundwater flow paths have not been defined. Each investigator has described the flow paths in slightly different terms. However, there is little significant difference between the descriptions. There are sufficient data to indicate three general flow patterns:

1) Regional groundwater flow system from the highland north of the Niagara Escarpment to Lake Ontario;
2) Intermediate groundwater system in which the direction of flow is similar to that of the regional pattern, but recharge occurs within the shale outcrop region;
3) Local groundwater system consisting of paths a few meters to a few tens of meters in length, the direction of which is governed by local topographic features.

The intermediate groundwater system interacts to some degree with the regional and local groundwater flow systems; the degree of this interaction is not well defined by the data. The local and intermediate groundwater flow needs to be considered in evaluating leachate migration at the proposed site.

The regional groundwater flow path originates from the region north of the Niagara Escarpment and passes under the site relatively uneffected by the landfills present in the area. This system contains highly brackish water as indicated by the deepest piezometers.

The intermediate groundwater flow path is the most probable pathway for any leachate that may migrate from the proposed landfill. Some of the groundwater in this system originates in the proposed disposal area and migrates toward the lake. With the reduced hydraulic conductivities with depth, the movement of water in this zone is relatively slow. Water in this zone is also brackish; although some leachate from the existing Bayview Landfill may have become mixed into this water, it cannot be distinguished from the background water quality.

The local groundwater flows in the site area are, in general, perpendicular to the surface streams on the property, flowing from the topographic highs to the streams. This pattern is well documented in the Morrison Beatty Report and is evidenced by the discharge areas along the streams. Much of this system will be elimated during landfill construction in the landfill area. To the south, where topography changes to the gentle slope toward the lake, the local groundwater flows probably are southward toward the lake. The water quality in this zone is better in the two deeper flow paths; however, even this water is not high quality drinking water.

Some groundwater discharges between the CN Railroad tracks and the site. Water levels in the piezometers in this region (OW 13-79, 16-81, 17-81 and 18-81) indicate both recharge and discharge in this region. Field reconnaissance suggests groundwater is discharging in several areas. It is likely that the recharge/discha relationships change with the seasons and climatic factors. The abrupt change in slope from the hilly topography to the flat lake plain probably is the principal control of this system. Between the CN tracks and the lake, urban development has altered the relationship of groundwater and surface water by controlling the drai Almost no groundwater, if any, discharges in this area.

Water Quality

Analyses of water from piezometers installed in the area show saline groundwater to be present over the whole area. Water in the upper 5 to 10 meters probably is potable, although low in quality. The salinity increases considerably with depth.

There are now two sets of chemical analysis of water from most of the piezometers. While some appear to have large differences between the analyses, there is general agreement indicating the quality of groundwater found at the site. Variations of the magnitude of those found here are not often reported. The meaning of these variations, if any, is not clear; I do not believe it is significant.

Leachates migrating from the existing Bayview landfill can be detected only a few tens of meters from the old landfill; there is no indication of any extensive migration. Migration from the Bayview site probably has been mainly in the local groundwater flow system. Only a limited amount may have entered the intermediate flow system. The metals contained in some analyses were attributed to old leachate (since the metals are not present in the leachate now) by Morrison Beatty Ltd. report. While this could be a correct interpretation of the data, it seems more likely that the metals came from the shale and are either natural or the results of geochemical reactions with the leachate. The presence of metals in saline waters is not a surprising occurrence.

The chemical data strongly suggest that leachate can be attenuated and assimilated in the shale as it slowly migrates toward the southeast. However, the volume of leachate that can be transmitted by the intermediate groundwater flow system is limited, and, if this quantity is exceeded, discharge may occur between the site and Highway 403. Any discharge that may occur in this area is easily eliminated by reducing the level of the leachate in the site by means of the contrc gates on the leachate collection system.

Design Considerations

There are two aspects of the landfill design that need careful attention if the site is to utilize natural attenuation and assimilation. These are the design of the berm-rock interface, and the final cover.

Quarrying operations are planned, which will remove the upper several meters of the weathered shale. This zone is the most permeable, and the removal of this zone will reduce the amount of leachate that can be transmitted to the groundwater system. The maximum area of shale, especially in the southeastern part of the fill, should be available to accept leachate. The perimeter berm must be keyed deep enough into the rock to prevent leachate springs from developing at the toe of the landfill and still not prevent lateral migration of the leachate. A modified design similar to that suggested by Morrison Beatty on August 10, 1981, should be included in the final design.

Since the most permeable zone of the bedrock will be removed, the leachate that can leave the site through the groundwater system will be greatly reduced (probably to less than one inch of infiltration). Thus, the design and maintenance of the final cover are critical to maintaining the water balance. The cover will have to be designed to maximize surface runoff without excessive erosion and to inhibit infiltration. A heavy clay or layered type of cover will most likely be necessary. At present, most landfill covers do not seem to restrict infiltration to the degree required here. However, surveys are underway to assess existing cov and considerable research is taking place on cover design. I am sure a cover can designed for the site which will fulfill the need.

An internal leachate collection system should be installed in the landf During the operation of the landfill, it may not be possible to limit infiltr to the same extent as after closure. Thus, it is likely that the leachate coll system will have to be used during much of the operating life of the landfill.

would also be in place should monitoring indicate it necessary at some future time.

Conclusion

In conclusion, the site appears to be well suited for the disposal of municipal waste. The existence of two sanitary landfills on adjacent land provides a unique opportunity to assess the effects of a landfill in this environment. The old Bayview Landfill is especially instructive, since it has been in existence for a considerable period of time.

Leachate from the Bayview Landfill is traceable only a few 10's of meters from the waste. Some leachate may have become mixed with the deeper brackish groundwaters; however, they are indistinguishable from the poor quality water already present in the aquifer. There is no indication of extensive migration of leachate from the old Bayview Landfill.

Considering the carefully engineered plans for the proposed landfill, the new landfill should have little or no impact on the groundwater in the area around the landfill. I believe the proposed landfill is well sited and well engineered for the site.

H-936-T2R

TABLE 2: Indicators of Maximum Depth of Fracturing in Lambton County

Indicator	Lambton County Study Sites									
	Roy	Dow	Ess	Dup	PC	UC	RP	CIL	T	Allen
tritium	6.1	8.1	12.9	8.0	13.0	8.1	8.1	9.6	7.7	7.8
w.levels	4.8	6.5	9.6	9.6	9.8	5.0	6.6	5.0	3.9	15.6
test pits		>4.5	>5.6			>4.5				
cores			5.0			9.3	9.2	2.1		

The maximum depth of fracturing should be seen as a conservative estimate based on the line of evidence indicated

From Ruland

MIGRATION OF CONTAMINANTS THROUGH THE UNWEATHERED UPPER TILL

FLUX OR DARCY VELOCITY

$$V_a = 10^{-7} \text{ cm/s} \times 0.85 = 8.5 \times 10^{-8} \text{ cm}^3/\text{cm}^2/\text{s} = 2.7 \times 10^{-2} \text{ m}^3/\text{m}^2/\text{a}$$

LINEAR GROUNDWATER VELOCITY

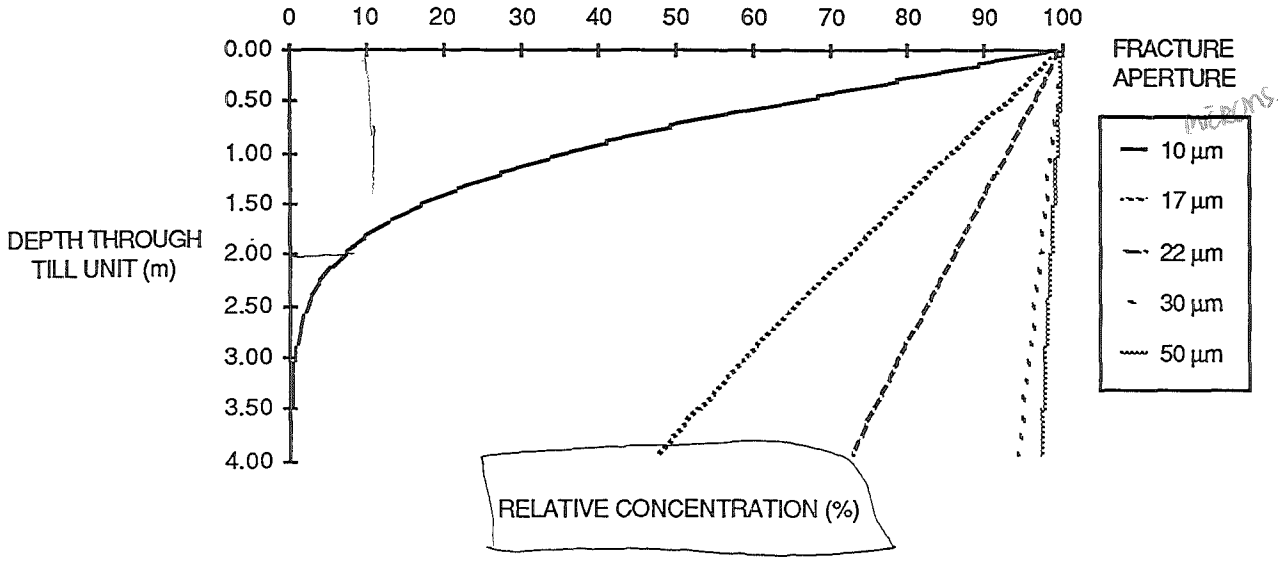
For the case where the till is unfractured

$$V = \frac{10^{-7} \text{ cm/s} \times 0.85}{0.25} = 3.4 \times 10^{-7} \text{ cm/s} = 0.1 \text{ m/a}$$

For the case where the till is weakly fractured (2H = 1 m and 2b = 10 μm)

$$V = \frac{10^{-7} \text{ cm/s} \times 0.85}{0.00001} = 8.5 \times 10^{-3} \text{ cm/s} = 2700 \text{ m/a}$$

RESULTS OF SINGLE CRACK MODEL FOR MIGRATION THROUGH THE UNWEATHERED UPPER TILL
TRAVEL TIME 1 YEAR



K	Spacing (m)
10^{-7}	1
10^{-7}	5
$10^{-7}/10^{-6}$	10/1
10^{-6}	5
10^{-6}	10

(1 frac every 5 metres)

applies to 2 cases

H938

EVALUATION OF CONTAMINANT MIGRATION THROUGH FRACTURED UNWEATHERD UPPER TILL USING A SINGLE CRACK MATRIX DIFFUSION MODEL

The graph from Hoek and Bray Exhibit H-244 was used to estimate the fracture apertures and fracture porosities for hydraulic conductivities of 1×10^{-6} cm/s and 1×10^{-7} cm/s and fracture spacings of 1 m, 5 m and 10 m.

K (cm/s)	Fracture Spacing (m)	Estimated Aperture (μm)	Estimated Porosity
1×10^{-7}	1	10	1.0×10^{-5}
	5	17	3.4×10^{-6}
	10	22	2.2×10^{-6}
1×10^{-6}	1	22	2.2×10^{-5}
	5	30	6.0×10^{-6}
	10	50	5.0×10^{-6}

For the condition of failure of the hydraulic trap hypothesized by THCL for a 6 m leachate mound the hydraulic gradient across the unweathered upper till was 0.85. With this gradient and the above hydraulic conductivities and porosities, fracture velocities can be calculated.

K (cm/s)	Fracture Spacing (m)	Aperture (μm)	Estimated Velocity (cm/s)	(m/a)
1×10^{-7}	1	10	8.5×10^{-3}	2700
	5	17	2.5×10^{-2}	7900
	10	22	3.9×10^{-2}	12000
1×10^{-6}	1	22	3.9×10^{-2}	12000
	5	30	1.4×10^{-1}	44000
	10	50	1.7×10^{-1}	54000

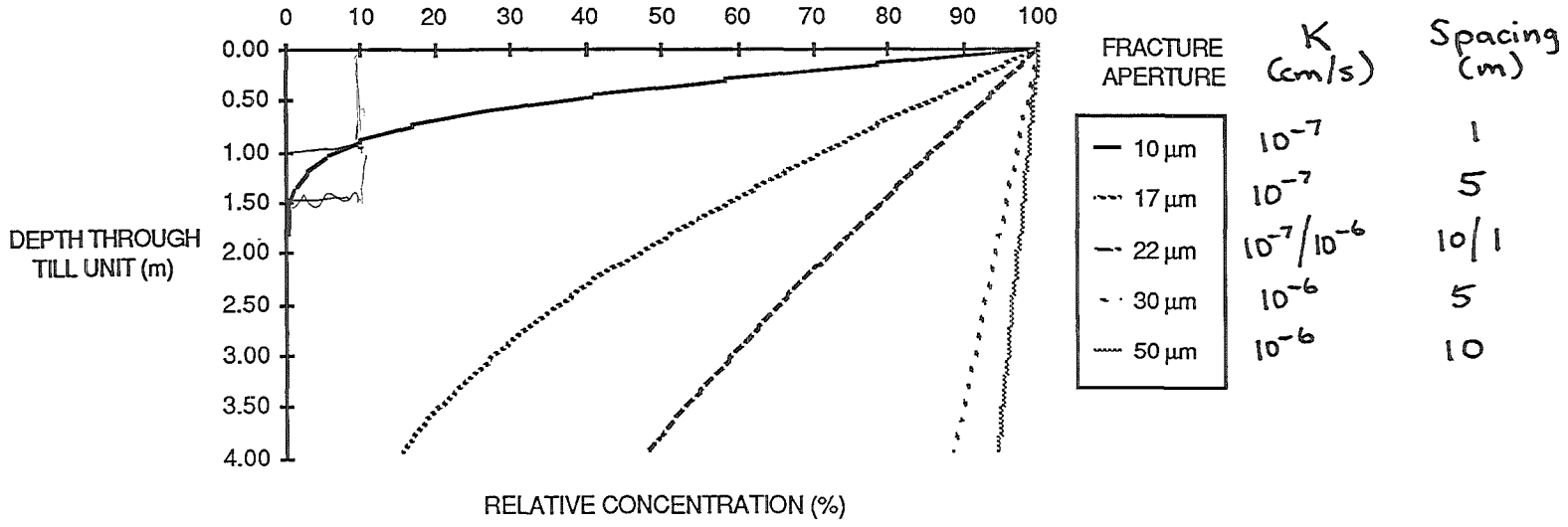
The effect of matrix diffusion during transport along the fractures can be simluated using a single crack model developed by Tang, Frind and Sudicky (1981) "Contaminant Transport in Fractured Porous Media: Analytical Solution for a Single Fracture", Water Resources Research, v. 17, no. 3, p. 555-564. This single crack model is a more simplified model than the multiple crack model used by Dr. Rowe, but is this case where the fracture spacing is large and the travel times of interest are

short there will be no interaction between adjacent fractures so that a single crack model is a suitable approximation.

From the 6 cases above it can be seen that there are only 5 discrete fracture velocties calculated, one for each different fracture aperture. These 5 cases were simulated using the above fracture velocities, fracture apertures and a matrix diffusion coefficient of 6×10^{-6} cm/s for a none adsorbed constituent such as chloride.

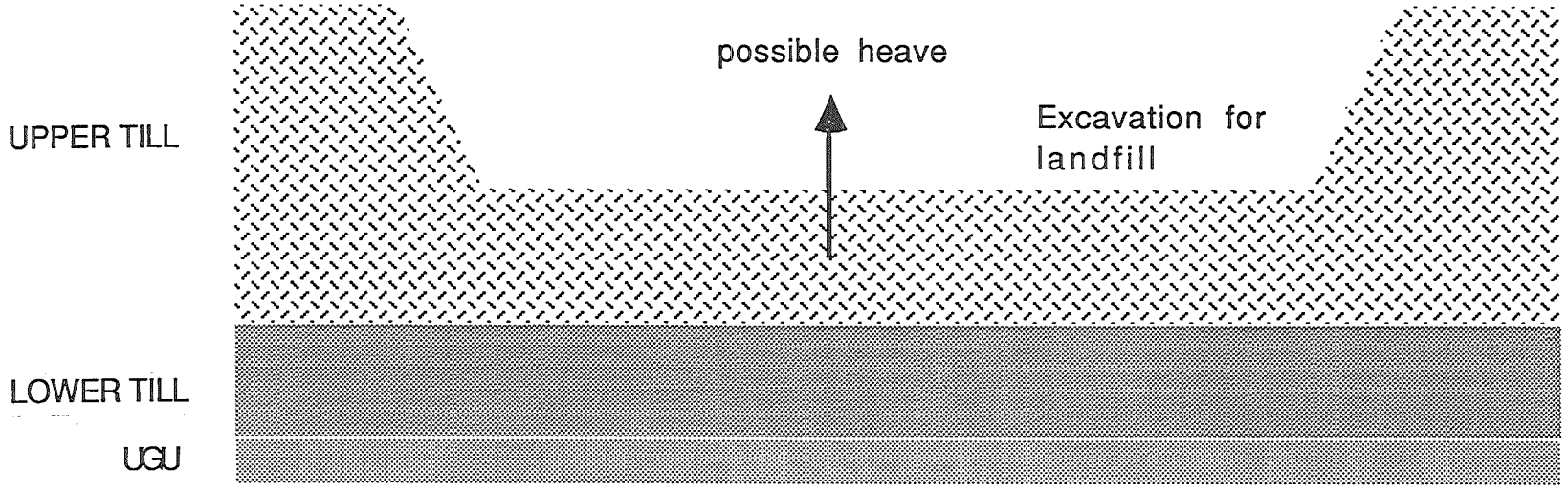
H938R

RESULTS OF SINGLE CRACK MODEL FOR MIGRATION THROUGH THE UNWEATHERED UPPER TILL
TRAVEL TIME 1 YEAR



H93/

POSSIBILITY FOR HEAVING AND STRESS RELIEF IN UNWEATHERED
UPPER TILL DUE TO EXCAVATION FOR LANDFILL



H-940

TABLE B2.2

COMPARISON OF HYDROGEOLOGIC DESIGN CONSTRAINTS TO TROW BASE ELEVATION DESIGN

Cell No.	Maximum Base of Upper Till (m)	Base of Landfill (m)	Maximum Leachate Level	Design Piezometric Elevation (m)	Minimum Upper Till Thickness (m)	Minimum Hydraulic Trap Head (m)
1	176.0	179.5	181.0	181.2	3.5	0.2
2	175.9	178.5 - 179.5	181.0	181.5	2.6	0.5
3	175.2	178.0 - 179.5	181.0	181.5	2.8	0.5
4	175.5	178.5 - 179.1	180.6	corrected. → 181.0 ~~181.2~~	3.0	0.4 ~~0.6~~
5	175.4	179.0	180.5	180.8	3.6	0.3

Sept 1987 Geocon Monitoring Report M-438

Notes:

1) "Maximum Base of Upper Till" (see Table B2.1, page 37).

2) "Base of Landfill from Trow Drawing No.2, Exhibit H-41.

3) "Maximum Leachate Level" is highest elevation of base of landfill plus leachate mound of 1.5 m.

4) "Design Piezometric Elevation" is equal to the lowest measured piezometric elevation in strata below the upper till, as measured in April 1986 (see Table B2.1, page 37).

5) "Minimum Upper Till Thickness" is the difference between the maximum base of the Upper Till and the minimum base of the landfill.

6) "Minimum Hydraulic Trap Head" is determined by subtracting the "Maximum Leachate Level" from the "Design Piezometric Elevation". A value less than 0.4 m under "Minimum Hydraulic Trap Head" implies that the trap design criteria has not been met.

From B-680

H-941

RANGE OF VELOCITIES IN THE UGU FOR FAILURE OF HYDRAULIC TRAP

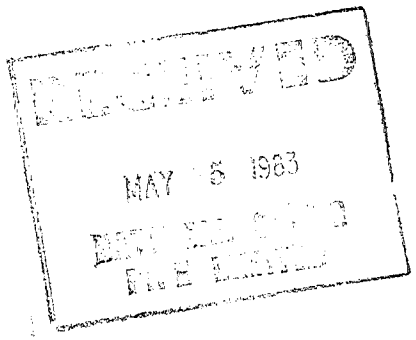
From M-440, p. 27

K of Upper Till (cm/s)	Leachate Mound	Linear Velocity in UGU (m/a)
Total Failure Scenario		
4×10^{-7}	Case 2 - 3.7 m	30
4×10^{-7}	Case 10 - 9.8 m	89
8×10^{-7}	Case 3 - 3.7 m	28
8×10^{-7}	Case 6 - 4.8 m	56
Partial Failure Scenario		
4×10^{-7}	Case 11 - 4.6 m	8
8×10^{-7}	Case 12 - 4.6 m	15

H942

THE OPINIONS ABOUT SITE F

Author	Characteristics	Reference	Exfiltration (mm/a)
Charlesworth and Rowe	25 m of shale at 4.5 x 10^{-6} cm/s	M-440, p. 28	1
Petrie	1. Too complex to interpret	B-617	not reported
	2. 15 m of shale at 2 x 10^{-4} cm/s	B-617, p. 156	50
	3. 30 m of shale at 2 x 10^{-4} cm/s	B-617, p. 156	100
	4. Weathered mantle with layered high K and low K zones	B-617, p. 114	not reported
	5. CRA FLOWNET model	B-617, p. 131	21.5
CRA	Shallow active zone with 80% of flow in upper 6 m	H-675, p. 18	100
Bowen	Shallow active zone of unspecified depth	WB-906, p. 6-7	10-20
THCL	Weathered zone, weakly fractured zone and highly fractured zone	H-40, p. 63 H-221 H-40, p. 74	13.7 1.2 21.7



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You will greatly assist us by filling out this QUESTIONNAIRE

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	YES	NO
IS GARBAGE DISPOSAL A MAJOR CONCERN?	(✓)	( )
DO YOU FEEL YOU ARE BEING PROPERLY INFORMED ON GARBAGE DISPOSAL FOR THIS AREA?	( )	(✓)
DO YOU FAVOUR THE **NSP** SITE?	(·)	(✓)
HAVE YOU CONTACTED YOUR ALDERMAN ?	(✓)	( )
DOES HE OR SHE FAVOUR THE **NSP** SITE?	( )	(✓)
IN YOUR OPINION WILL THE **NSP** SANITARY LANDFILL SITE SAVE MONEY ?	( )	(✓)
WOULD YOU ATTEND A PRESENTATION BY NSP IN YOUR AREA?	( )	(✓)

Your reply to the last question is extremely important for us to make the necessary arrangements.
(Optional)

Name JOHN H. CONNELL

Address 389 DORCHESTER CRES.

Phone BURLINGTON, ONTARIO L7T 2X3

Comments

WE HAVE MORE THAN OUR SHARE OF WASTE ALREADY!!

N-944

NSP NEWSLETTER NO.4

National Sewer Pipe — April 1983

BURLINGTON GARBAGE DISPOSAL

Survey shows citizens want:

ACTION!

Clarification on:
ENVIRONMENTAL STANDARDS
POLLUTION PREVENTION
RESOURCE RECOVERY
PERPETUAL CARE

Where is the NSP site?

In answer to the many questions asking where the NSP proposed sanitary waste disposal site is located, a map is printed on the back of this NEWSLETTER.

Replies both written and phoned, to NSP NEWSLETTER No. 3, reveal a growing concern over a decision for a new sanitary landfill site for Burlington, almost a " what-can-I-do-to-help-speed-things-up?" sense of urgency.

Well, you CAN help.

Most NEWSLETTER readers agree that the NSP proposal to turn its shale quarry into a modern sanitary landfill site is a logical, economical, practial answer to garbage disposal for the area. But despite the fact that the Regional site will be filled by March 1984, only a year from now, this has been stalled again and again by political indecision. And that is costing you, as a taxpayer, money.

Here is what *you* can do about it.

Phone your Alderman ...

Ward 1
Walter Mulkewich 529-2564
Jack Cowman 634-6455

Ward 2
Joan Little 634-5924
A.J. (Tony) Whitworth
(Home) 335-8932 (Office)398-4461.Ext.319

Ask him or her:

What does she or he think will be done about garbage disposal when the present site is filled a year from now?(NSP can have its site operating by then)

Is he or she for or against a privately owned and operated site? WHY?

Fill out the attached postage-paid questionnaire and mail it to NSP. This will help us.

Here are some of the questions raised by NEWSLETTER readers:

ENVIRONMENTAL STANDARDS

Q. "Why not outdo [Ministry of the Environmental] standards? In most cases [they] are far too low ..."

A. We agree that they are less than is required at times. **It has always been NSP's policy to exceed them.** Dr. John Cherry (consultant for Halton Region) states that more "hydrogeological data has been obtained from the Bayview [NSP] site than any other landfill site on shale in Ontario or elsewhere in Canada."

POLLUTION PREVENTION

Q. Can you guarantee [that] no hazardous wastes, liquid or solid, will be dumped on the site?"

A. **Yes. Only non-hazardous waste will be dumped on the site.** On a modern sanitary landfill site great care is taken to prevent pollution. Garbage is not simply dumped, it is compacted and covered daily with clean fill.

RESOURCE RECOVERY

Q. "What plans do you have for resource recovery? Explain RDF and EFW".

A. NSP is willing to make its adjoining property available as a resource facility to handle the Region's garbage. RDF stands for Refuse Derived Fuel, EFW for Energy From Waste.

PERPETUAL CARE

Q. "What will happen when the site is filled?"

A. **NSP plans to set up a Perpetual Care Fund jointly with the Government.** After the site is closed this will ensure: environmental and methane gas monitoring, leachate collection and treatment, remedial works and maintenance of the site.

IF YOU HAVE ANY QUESTIONS CALL ROGER CHRISTENSEN AT 1-822-7900

You will greatly assist us by filling out this **QUESTIONNAIRE**

	YES	NO
IS GARBAGE DISPOSAL A MAJOR CONCERN?	( )	( )
DO YOU FEEL YOU ARE BEING PROPERLY INFORMED ON GARBAGE DISPOSAL FOR THIS AREA?	( )	( )
DO YOU FAVOUR THE **NSP** SITE?	( )	( )
HAVE YOU CONTACTED YOUR ALDERMAN ?	( )	( )
DOES HE OR SHE FAVOUR THE **NSP** SITE?	( )	( )
IN YOUR OPINION WILL THE **NSP** SANITARY LANDFILL SITE SAVE MONEY ?	( )	( )
WOULD YOU ATTEND A PRESENTATION BY NSP IN YOUR AREA?	( )	( )

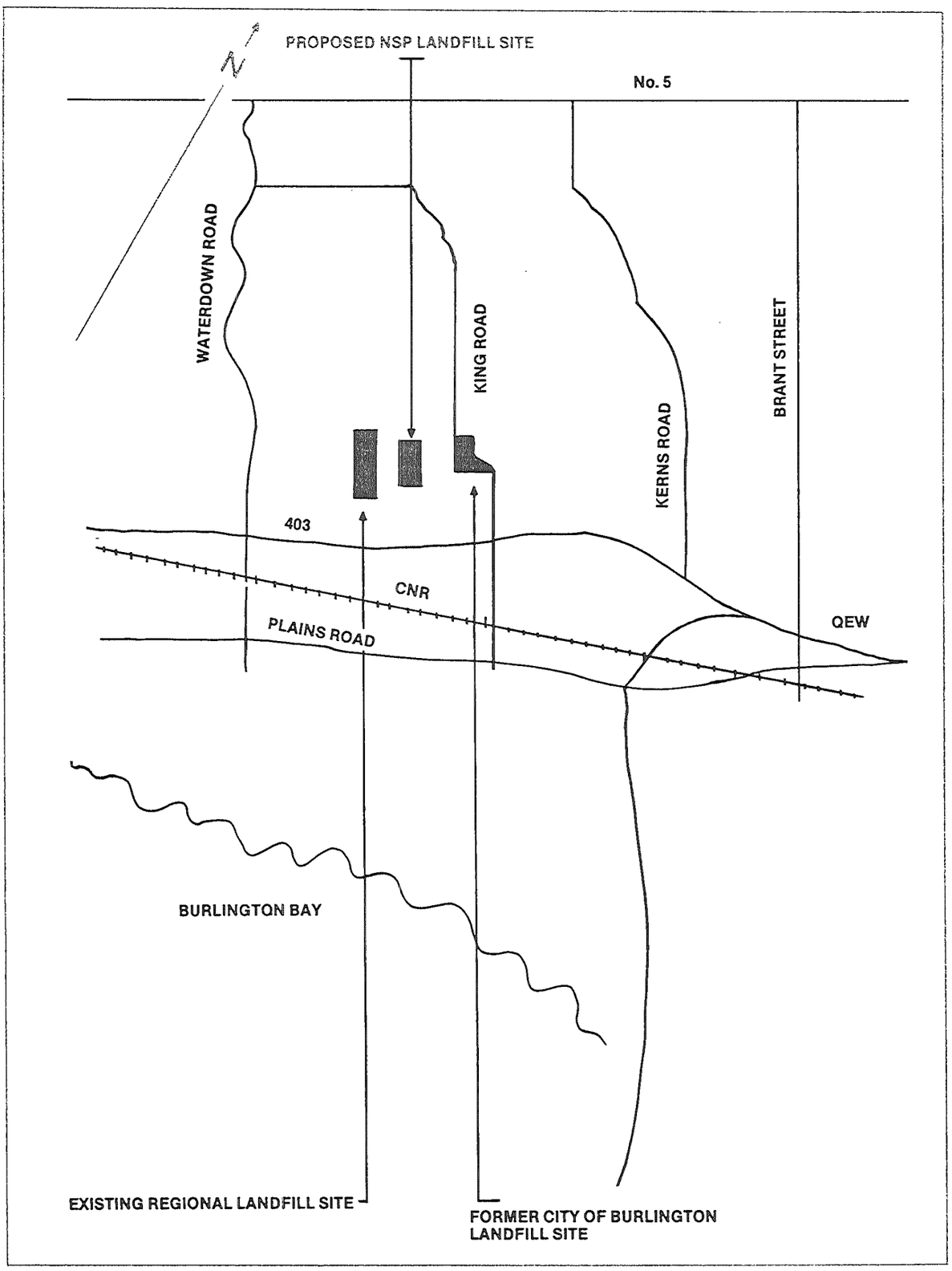
Your reply to the last question is extremely important for us to make the necessary arrangements.
(Optional)

Name _____

Address _____

Phone _____

Comments _____



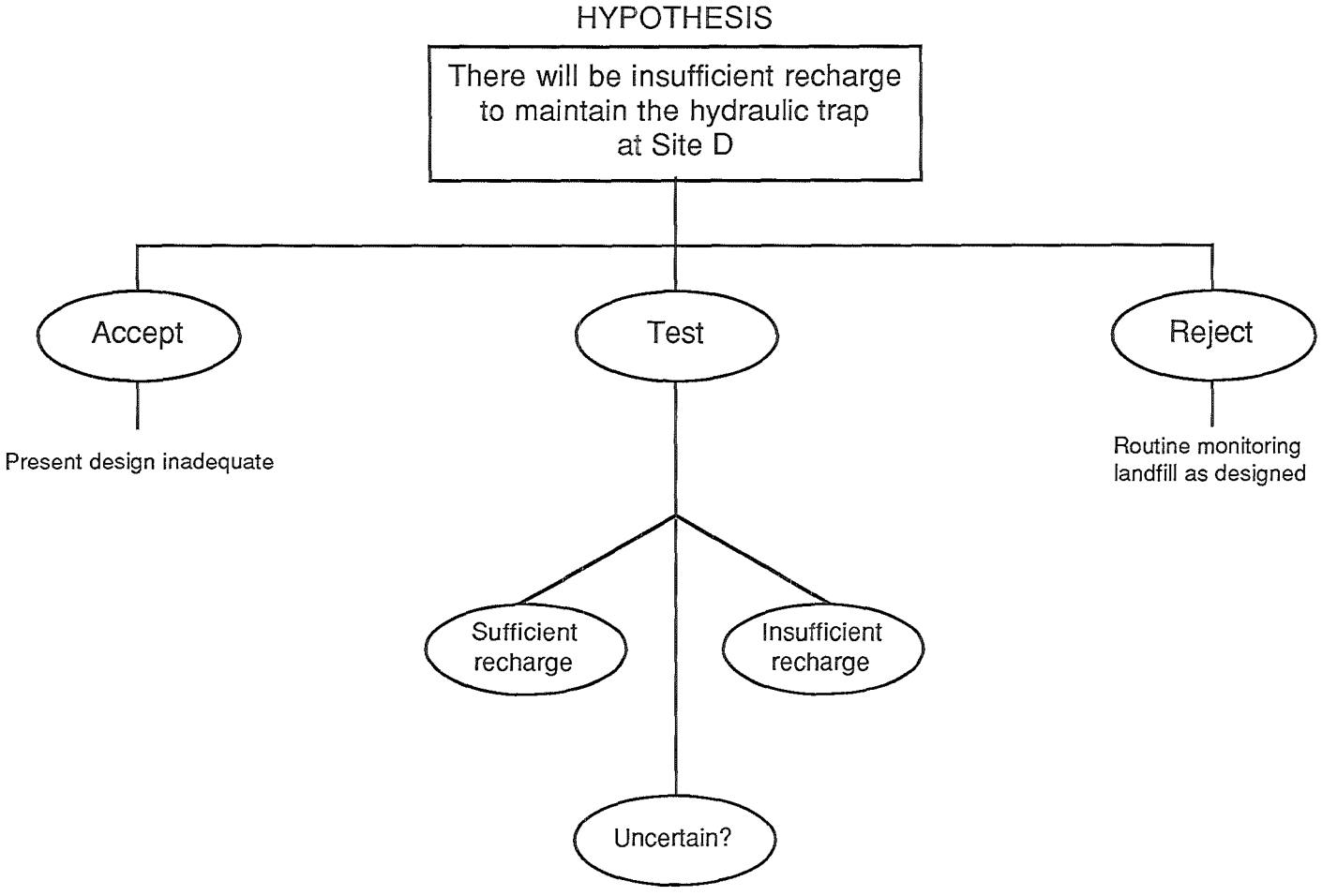
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EXHIBIT MR-948



b 949

volume by parcel

Summary of Volume Estimates

VOLUME ESTIMATE - TROW

Parcel No.	Total Capacity (m3)	Total Cut (m3)	Estimated Clay (m3)	Estimated Shale (m3)	Estimated Topsoil (m3)	Estimated Infill (m3)
1	1,557,920	195,250	0	195,250	0	118,770
2	1,652,040	322,160	0	322,160	0	47,350
3	1,197,570	511,140	107,540	400,900	2,700	7,000
4	296,210	203,540	199,250	2,290	2,000	0
Cell #1	4,703,740	1,232,090	306,790	920,600	4,700	173,120
5	781,760	90,420	87,140	2,660	620	27,000
6	1,458,050	256,140	192,590	63,550	0	55,670
7	1,140,050	223,710	143,910	79,800	0	67,700
Cell #2	3,379,860	570,270	423,640	146,010	620	150,370
TOTAL	8,083,600	1,802,360	730,430	1,066,610	5,320	323,490

EXTRA VOLUME BY DROPPING THE BASE BY 1 METER

1	72,000	31,600	0	31,600	0	(40,400)
2	72,000	42,650	0	42,650	0	(29,350)
3	71,500	66,850	6,500	60,350	0	(4,650)
4	45,000	45,000	40,000	5,000	0	0
Cell #1	260,500	186,100	46,500	139,600	0	(74,400)
5	69,250	59,250	56,250	3,000	0	(10,000)
6	81,250	69,700	59,700	10,000	0	(11,550)
7	79,000	57,950	23,050	34,900	0	(21,050)
Cell #2	229,500	186,900	139,000	47,900	0	(42,600)
TOTAL	490,000	373,000	185,500	187,500	0	(117,000)

TOTAL VOLUME GIVEN BASE DROPPED BY 1 METER

1	1,629,920	226,850	0	226,850	0	78,370
2	1,724,040	364,810	0	364,810	0	18,000
3	1,269,070	577,990	114,040	461,250	2,700	2,350
4	341,210	248,540	239,250	7,290	2,000	0
Cell #1	4,964,240	1,418,190	353,290	1,060,200	4,700	98,720
5	851,010	149,670	143,390	5,660	620	17,000
6	1,539,300	325,840	252,290	73,550	0	44,120
7	1,219,050	281,660	166,960	114,700	0	46,650
Cell #2	3,609,360	757,170	562,640	193,910	620	107,770
TOTAL	8,573,600	2,175,360	915,930	1,254,110	5,320	206,490

The total volume for the site includes the liner, the daily and final cover and the refuse volumes

B. 951

CASE 1 - flushing time if till is fractured.

Volume of water stored in 1 m of UGU

1 m x 0.3 (porosity of UGU) = 0.3 m^3/m^2 of UGU

If all the infiltration migrates directly down the fractures

CASE A:

1×10^{-7} x 0.2 (vertical gradient

= 0.0063 $m^3/a/m^2$ = infiltration

$0.3 \div 0.0063 = 47.6$ years

CASE B:

$1 \times 10^{-6} \times 0.2 = 0.063$ $m^3/a/m^2$

$0.3 \div 0.063 = 4.8$ years

B 952

CASE 2 - Flushing time if the till is not fractured

Volume of water stored in 11 m of till

$11\ m \times 0.25$ (till porosity) $= 2.75\ m^3 / m^2$ of till

Volume of water stored in 1 m of UGU

$1\ m \times 0.3$ (UGU porosity) $= 0.3\ m^3 / m^2$ of UGU

Infiltration into site

CASE A: $K = 1 \times 10^{-7}$ cm/sec

$1 \times 10\text{-}7$ cm/sec $\times 0.2 = 0.0063\ m^3/a/m^2$

CASE B: $K = 1 \times 10^{-6}$ cm/sec

$1 \times 10\text{-}6$ cm/sec $\times 0.2 = 0.063\ m^3/a/m^2$

Time to flush 11 m of till and 1 m of UGU assuming no fracture

CASE A

$(2.75 + 0.3) \div 0.0063 = 484$ years

CASE B

$(2.75 + 0.3) \div 0.063 = 48.4$ years

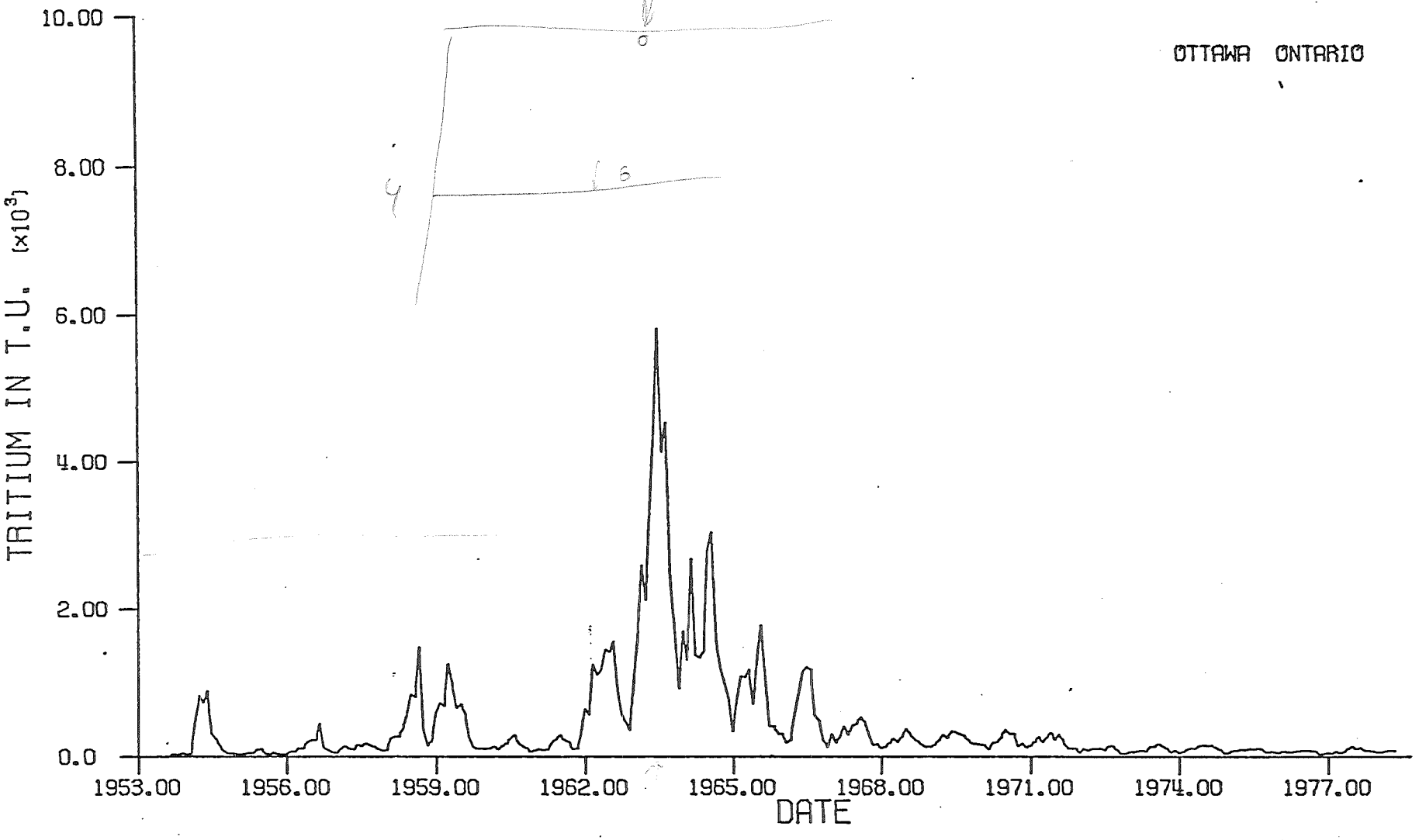


Figure 1. Monthly tritium concentrations at Ottawa.

H-954

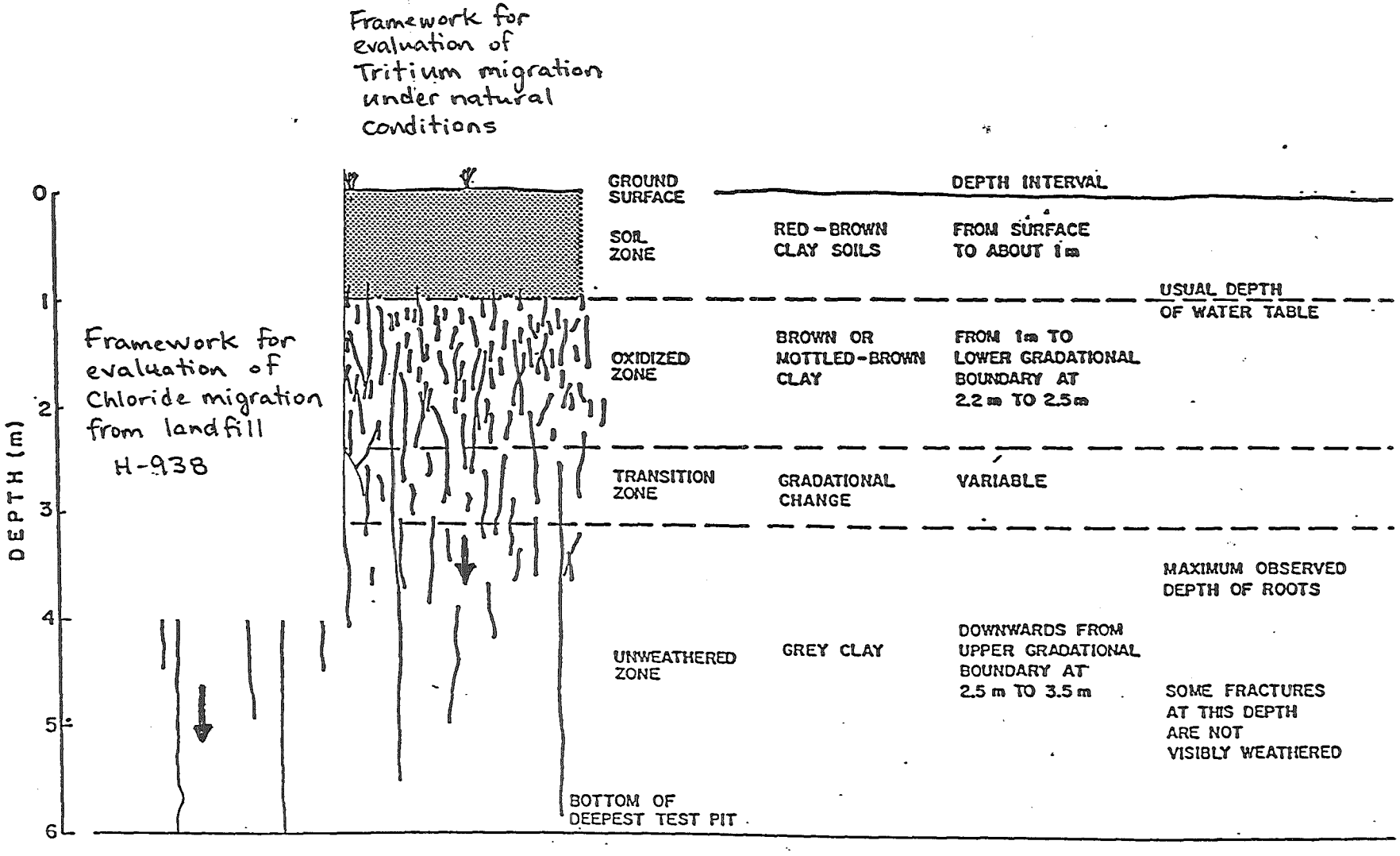


Figure 2: Typical test pit cross-section

B-955
GROUNDWATER FLOW IN THE ACTIVE ZONE - SITE F

$K = 10^{-4}$ cm/s

$i = 0.03$

$n_f = 0.001$

$$\text{Velocity} = \frac{(10^{-4})(0.03)}{0.001}$$

No matrix diffusion

$= 3 \times 10^{-3}$ cm/s

= 950 m/a

WB956

Journal of Contaminant Hydrology, 1 (1986) 65—76
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

AN EVALUATION OF CONTAMINANT MIGRATION PATTERNS AT TWO WASTE DISPOSAL SITES ON FRACTURED POROUS MEDIA IN TERMS OF THE EQUIVALENT POROUS MEDIUM (EPM) MODEL

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(Received January 20, 1985; revised and accepted September 15, 1985)

ABSTRACT

Pankow, J.F., Johnson, R.L., Hewetson, J.P. and Cherry, J.A., 1986. An evaluation of contaminant migration patterns at two waste disposal sites on fractured porous media in terms of the equivalent porous medium (EPM) model. In: D.L. Macalady (Editor), Transport and Transformations of Organic Contaminants. J. Contam. Hydrol., 1: 65—76.

Contamination has occurred in many non-indurated and bedrock systems wherein the roundwater flows almost exclusively through a network of connected, open fractures. he matrix surrounding the fractures often possesses porosity which allows contaminant iffusion into the matrix. If the diffusion rates are fast relative to the fracture ground- ater velocity, transport effects may be predicted by considering the system to be an quivalent porous medium (EPM). The rapidity with which fracture/immobile-matrix quilibrium is established will be determined in part by the: fracture aperture ($2b$); terfracture spacing ($2B$); porosity in the immobile matrix (θ_{im}); and the matrix diffusion oefficient (D'). Two systems which are characterized by very different values of the bove parameters have been studied by our laboratories. At Alkali Lake, Oregon, the PM approach describes contaminant transport well. At Bayview Park, Ontario, the PM approach is not appropriate. Several features of the two sites are compared to ustrate the different nature of these two sites. These features include: (1) natural haracteristics of the groundwater systems; (2) contaminant distributions; (3) observed ansport; and (4) computed fracture/immobile-matrix diffusion times.

TRODUCTION

The method used for the prediction of contaminant migration pathways d rates will depend heavily upon the hydrogeological nature of the ground- ter system under investigation. The vast majority of the information that rrently exists pertains to non-indurated porous media where water and utes move exclusively through pore channels between soil grains (Bear, 72; Fried, 1975; Freeze and Cherry, 1979). In many instances, however, ntamination has also occurred in systems wherein the groundwater flows

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almost exclusively through a permeable network of connected, open fractures (e.g., joints and bedding plane openings). Long flow paths and relatively rapid flow velocities can exist.

Both non-indurated and bedrock systems can be fractured. Even in rock the matrix material surrounding the fractures often possesses some porosity. Such porosity allows for the diffusive transport of contaminants from the fractures into the matrix due to the concentration gradient between the fracture and the matrix. This transport will take place both for compounds which sorb directly to the matrix material, as well as for non-sorbing compounds. The latter will diffuse into the matrix due to the presence of pore water in the matrix (Feenstra et al., 1984; Johnson et al., 1985).

The permeabilities of fractured systems are such that groundwater can move at rates from a few meters per year to hundreds of meters per year. When the interfracture spacings are small in comparison to the scale of the system being studied, and when there is some degree of interconnection between the fractures, good results can often be obtained in modeling the *groundwater* flow in such a system as an equivalent porous medium (EPM): Darcy's law, pumping drawdown tests, and Hvorslev's interpretation of slug tests have all been applied successfully (Barker and Black, 1983; Gerhart, 1984). The modeling of flow in a large, complex cross-sectional system containing various till and shale units, some of them fractured, has been described by Frind and Matanga (1981).

Contaminant transport in such systems, however, is greatly complicated because the fracture systems are typically both complex and spatially variable. Therefore, the relative validity of the EPM approach for modeling *contaminant transport* is sometimes difficult to establish. Unfortunately, the variable number density, orientation, aperture, and continuity of fractures also make such systems too complex to model exactly. When the EPM approach cannot be used for transport modeling, current efforts are consequently limited to the simulation of transport in idealized systems of fractures. Within these restrictions, models have been developed which consider the effects of advection, dispersion, sorption, and molecular diffusion both for a single fracture and for systems composed of multiple parallel fractures (Tang et al., 1980; Sudicky and Frind, 1984). Sorption may occur both to the fracture walls and to the matrix material. With organic compounds, the class of contaminants of interest here, the greatest potential for sorption exists within the matrix material.

The processes of sorption and dispersion in fractured porous systems are more complicated than in simple porous systems because they are influenced by the rates of molecular diffusion into and out of the matrix. Indeed, as mentioned above, even non-sorbing compounds will partition to the matrix. If the rates of diffusion are slow relative to the groundwater flow rate in the fractures, partition equilibrium between the fractures and the porous matrix will not be present, and retardation effects predicted on the basis of equilibrium partitioning of the solutes to the porous matrix (i.e., the EPM-

TABLE 1

Properties of the Alkali Lake

Parameter	
fracture aperture	
interfracture spacing	
matrix porosity	
matrix diffusion coefficient	
matrix retardation factor	
calculated fracture groundwa velocity	
EPM groundwater velocity	
observed contaminant front	
tracer velocity	
fraction organic carbon (matrix)	
hydraulic gradient	

" Johnson (1984) and Panke noted; " calculated based on

approach) will not be v slow sorption/desorptio caused by slow diffusion the sorbing grains and rapidly (e.g., Schwarzenl

The rapidity with w be determined by the (Table 1). They include porosity of the immobile (D'). Our laboratories porous systems which a parameters. In one case EPM approach will wo other case (Bayview Pa appropriate.

TWO WASTE DISPOSAL SI

The Alkali Lake, Ore al. (1984b), Johnson (1 fractured porous soil. T and eolian deposits. Th portion of the groundw

TABLE 1

Properties of the Alkali Lake and Bayview Park groundwater systems

Parameter	Symbol	Alkali Lake[a]	Bayview Park[b]
fracture aperture	$2b$	150 μm	1—50 μm
interfracture spacing	$2B$	0.3 cm	5—35 cm
matrix porosity	θ_{im}	0.65	0.05
matrix diffusion coefficient	D'	0.1 cm^2 per day	0.0032 cm^2 per day
matrix retardation factor	R_{ns}	14.0	50—5000[c]
calculated fracture groundwater velocity	v_f	1 m per day	0.1—1.0 m per day[c]
EPM groundwater velocity	v_{EPM}	0.07 m per day	2.0×10^{-4} to 2.0×10^{-3} m per day[c]
observed contaminant front velocity	v_{cf}	0.09 m per day	0.1 m per day
tracer velocity	v_{tr}	0.06 m per day	NA[d]
fraction organic carbon (matrix)	f_{oc}	0.018	0.001
hydraulic gradient	dh/dl	0.001	0.05

[a] Johnson (1984) and Pankow et al. (1984b); [b] Hewetson et al. (1985) unless otherwise noted; [c] calculated based on data from Hewetson et al. (1985); [d] NA = not available.

approach) will not be valid. This is entirely analogous to the situation of slow sorption/desorption kinetics in non-indurated porous media (e.g., as caused by slow diffusion within individual grains) when equilibrium between the sorbing grains and the intergranular groundwater is not established rapidly (e.g., Schwarzenbach and Westall, 1981).

The rapidity with which fracture/matrix equilibrium is established will be determined by the values of a number of hydrogeological parameters (Table 1). They include: fracture aperture ($2b$); interfracture spacing ($2B$); porosity of the immobile matrix region (θ_{im}); and matrix diffusion coefficient (D'). Our laboratories have been involved in the study of two fractured porous systems which are characterized by very different values of the above parameters. In one case (Alkali Lake, Oregon), it may be argued that the EPM approach will work well in describing contaminant transport. In the other case (Bayview Park, Burlington, Ontario), the EPM approach is not appropriate.

TWO WASTE DISPOSAL SITES ON FRACTURED POROUS MEDIA — A COMPARISON

The Alkali Lake, Oregon system (Fig. 1a) has been studied by Pankow et al. (1984b), Johnson (1984), and Johnson et al. (1985). It is composed of a fractured porous soil. The soil components include alluvium, lake sediments, and eolian deposits. The depth to groundwater is in the range 0.6—1.0 m. A portion of the groundwater has been severely contaminated with a variety of



Fig. 1(a) Map showing the location of Alkali Lake, Oregon; (b) map showing the location of Burlington, Ontario.

chlorophenolic compounds from an inactive chemical waste disposal site. In the zone of contamination, the values of $2b$ and $2B$ are both small, and the values of θ_{im} and D' are large (Table 1). Such features increase the likelihood that use of the EPM approach will be appropriate.

The inactive Bayview Park landfill in Burlington, Ontario (Fig. 1b) has been studied by Cherry et al. (1985), Hewetson and Cherry (1985), and Hewetson et al. (1985). It has caused groundwater contamination in the underlying fractured porous bedrock. The bedrock is red Paleozoic shale of the Queenston Formation, and it is essentially lithologically continuous to depths of over 100 m. The depth to groundwater is in the range 10—45 m. In the zone of contamination, the shale is characterized by large values of $2B$, and small θ_{im} and D' values (Table 1). Such features tend to prevent a system from behaving as an EPM.

Alkali Lake specific conductance versus Bayview Park tritium

Specific conductance distributions obtained at the Alkali Lake site in April 1983 are presented in Fig. 2a. The naturally-high salinity of the groundwater is a result of the closed basin character of the Alkali Lake area. The disposal site itself does not contribute to the salinity of the groundwater. To the east and hydraulically upgradient of the site are freshwater springs. The effect of these springs is to create a tongue of low conductance water which flows from east to west, approximately co-axially through the site (Pankow et al., 1984b). The high degree of regularity in the isopleths provides evidence for a reasonably uniform flow pattern through the site and into the downgradient region of this water table aquifer. This uniformity is a necessary but not sufficient condition for the argument that this system behaves as an EPM with respect to groundwater flow and solute (e.g., specific conductance) transport.

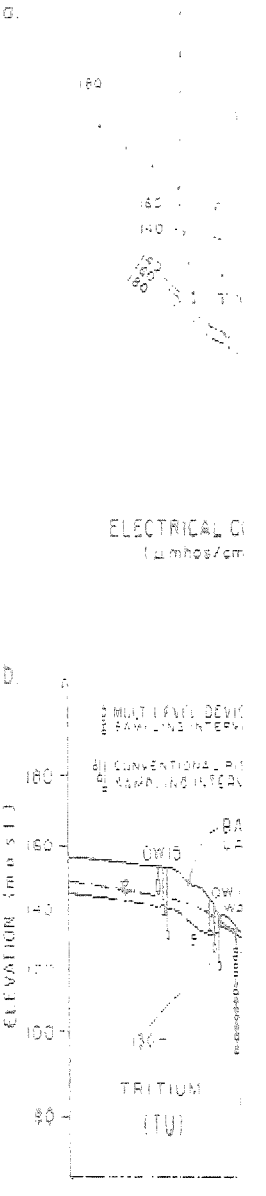


Fig. 2(a) Electrical co
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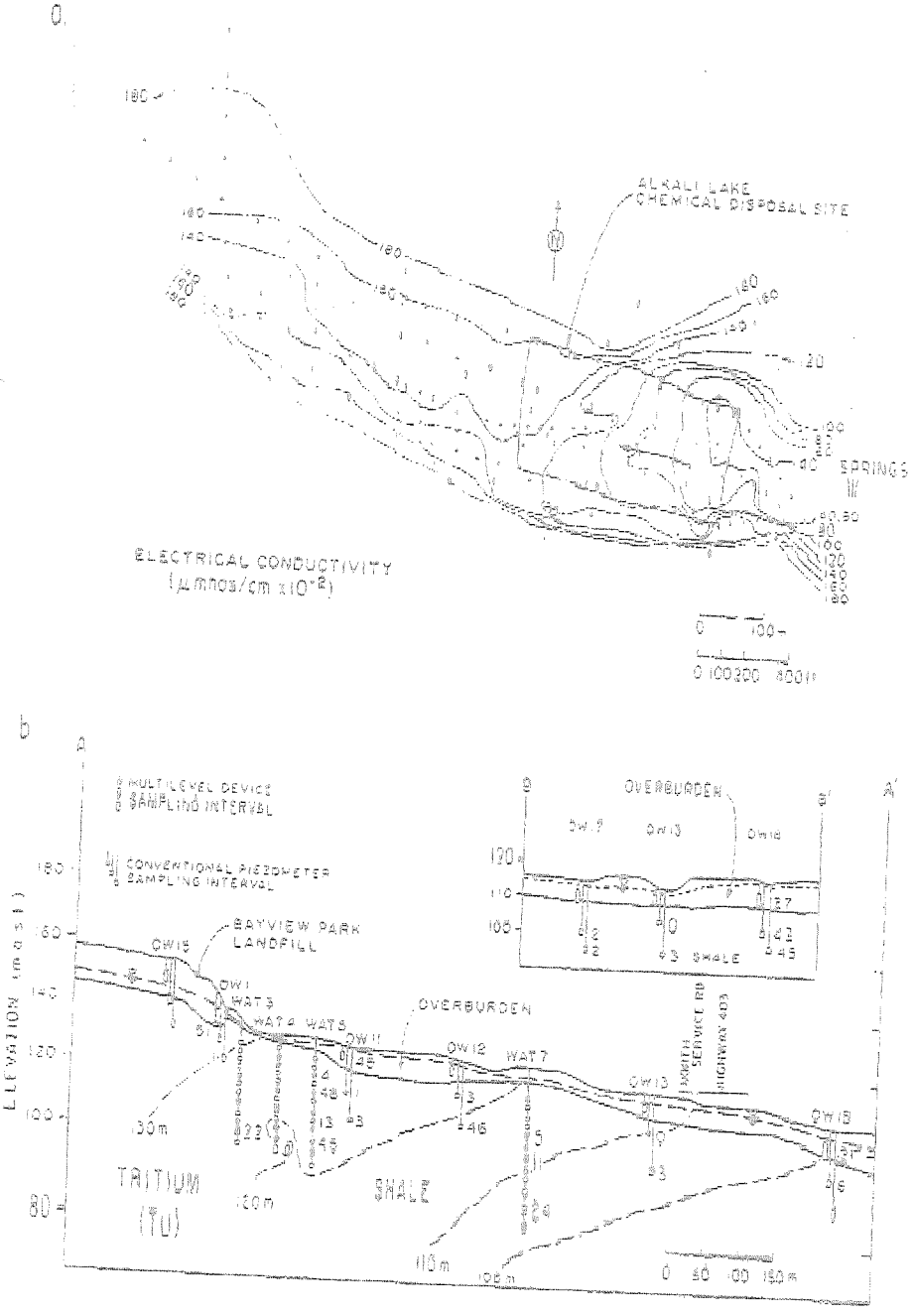


Fig. 2(a) Electrical conductivity contours at Alkali Lake, Oregon, April 1983. Plan view. Contour values are $\mu mhos\ cm^{-1} \times 10^{-2}$. Boundaries of the site are given. Arrow shows groundwater flow direction. Data from Pankow et al. (1984b). Reprinted with permission of Water Well Journal Publishing Co. © 1984. All rights reserved. (b) Tritium values at the Bayview Park landfill, Ontario. Cross-sectional view. m.a.s.l. = meters above sea level. Data from Hewetson and Cherry (1985).

Cherry, 1979). After 1952, tritium levels in precipitation have been continuously above the pre-1952 level. Water that recharged the groundwater zone prior to 1952 originally contained 10–20 tritium units (TU) and now, as a result of radioactive decay, contains less than 8 TU. In typical porous medium systems, the input of post-1952 precipitation has generally led to regular concentration isopleths since surface water infiltration and groundwater flow there are typically not restricted to narrow zones (e.g., Egboka

et al., 1983). At Bayview Park, on the other hand, where the flow occurs in fractures in bedrock, the tritium patterns are highly erratic. Figure 2b presents tritium data for this site for the period 1983—1984 along with concurrent hydraulic head isopleths (Hewetson and Cherry, 1985). Water from level 11 of the multi-level WAT3 device (Cherry et al., 1985) was found to contain 22 TU. At nearly the same level in the aquifer, the tritium content was only 4 TU at WAT4 but 45 TU at WAT5. Further downgradient at level 3 of OW12, the tritium content was 46 TU. At a shallower level at OW12 (where one might expect high concentrations due to infiltration), the level was only 8 TU. Other erratic variations such as those found at monitoring nests OW13, OW16, and OW17 along transect B—B' (approximately perpendicular to the A—A' transect) are also present. Such behavior indicates that: (1) groundwater transport is occurring in restricted zones; and (2) local equilibrium is not attained either between the fractures and the matrix or from fracture to fracture.

Alkali Lake contaminant distributions versus Bayview Park contaminant distributions

The patterns exhibited by the concentration distributions of eight chlorophenolic contaminants present at Alkali Lake (Johnson et al., 1985) reflect the same type of regularity found there for the specific conductance. Data for 2,6-dichlorophenol obtained in April 1984 are presented in Fig. 3a. This compound has been shown to be non-sorbing in the Alkali Lake groundwater system (pH = 10) (Johnson et al., 1985). As observed for the specific conductance isopleths, the 2,6-dichlorophenol data indicate an approximately symmetrical zone co-axial with the site.

In contrast to the situation at Alkali Lake, the organic contaminant distributions at Bayview Park contain numerous irregularities (Hewetson et al., 1985). Concentration data obtained by Pankow et al. (1984a, 1985) in 1983 and 1984 for 1,1,1-trichloroethane (1,1,1-T) are presented in Fig. 3b. As an example of the irregularities, at level 3 of piezometer nest OW1, the 1,1,1-T value was 19 $\mu g\,l^{-1}$, and only 1.8 $\mu g\,l^{-1}$ at approximately the same depth at nearby WAT3. If the EPM approach were valid at Bayview Park, then such variabilities might be rationalized in terms of hypothetically varying sorption properties (i.e., organic carbon contents) of the shale. However, this possibility seems less likely when the 1,1,1-T and tritium values are compared. Indeed, since tritium input to the system began in 1953, and since the landfill was operated between 1961 and 1974, one would expect tritium everywhere that compounds such as 1,1,1-T were found. This expectation would remain unaffected by the presence or absence of variable sorption. That this expectation is not met may be seen by comparing the relatively high levels of 1,1,1-T at level 3 of nest OW1 and

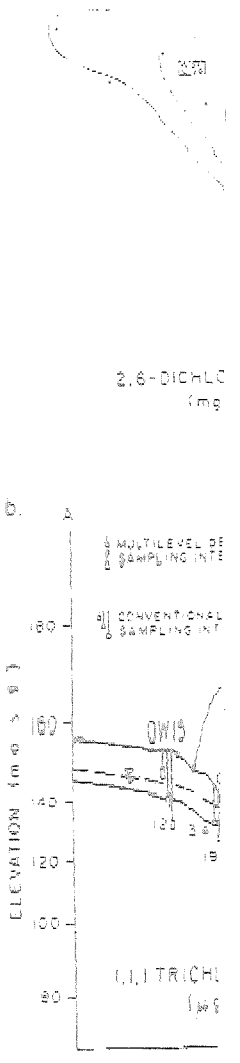
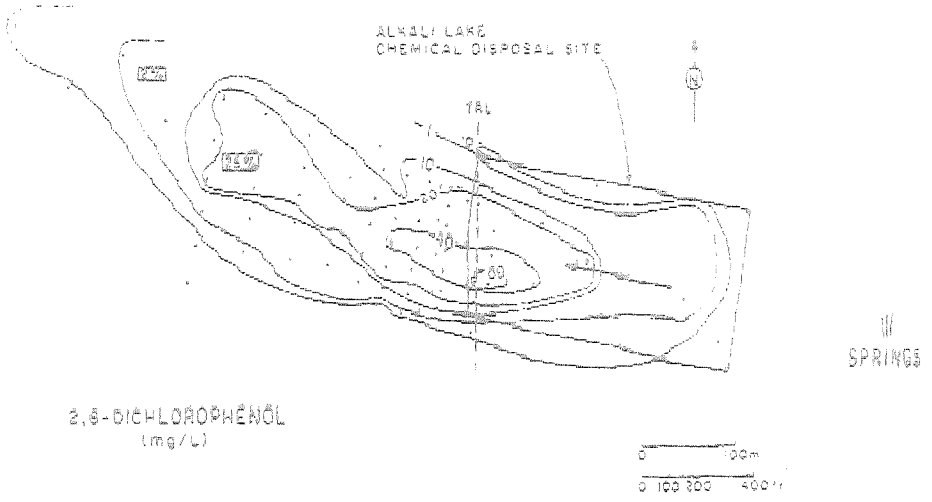


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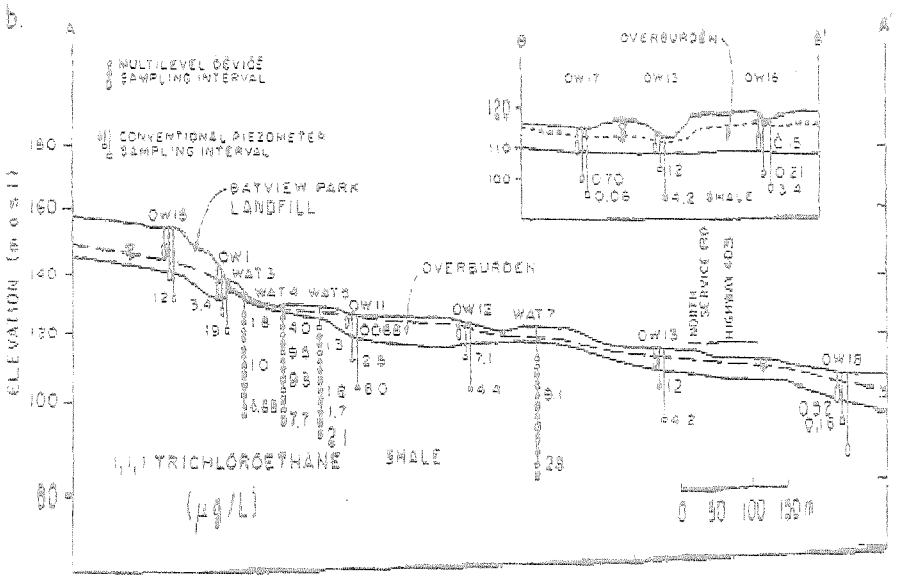


Fig. 3(a) 2,6-Dichlorophenol groundwater concentration distributions ($mg\,l^{-1}$) at Alkali Lake, Oregon, April 1984. Plan view. Boundaries of the site are given. Arrow shows groundwater flow direction. *TRL* = transport reference line. Data from Johnson et al. (1985). Reprinted with permission of Water Well Journal Publishing Co. © 1984. All rights reserved. (b) 1,1,1-Trichloroethane values ($\mu g\,l^{-1}$) at the Bayview Park landfill, Ontario. Cross-sectional view. m.a.s.l. = meters above sea level. Data from Hewetson et al. (1985).

Another explanation for these irregularities might come from invoking the spillage of 1,1,1-T at the quarry which preceded both (1) the landfill, and (2) the input of tritium to the system. However, if such spillage had

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WD-957

Robert M. Quigley[1] *and R. Kerry Rowe*[1]

Leachate Migration Through Clay Below a Domestic Waste Landfill, Sarnia, Ontario, Canada: Chemical Interpretation and Modelling Philosophies

REFERENCE: Quigley, R. M. and Rowe, R. K., **"Leachate Migration Through Clay Below a Domestic Waste Landfill, Sarnia, Ontario, Canada: Chemical Interpretation and Modelling Philosophies,"** *Hazardous and Industrial Solid Waste Testing and Disposal: Sixth Volume, ASTM STP 933*, D. Lorenzen, R. A. Conway, L. P. Jackson, A. Hamza, C. L. Perket, and W. J. Lacy, Eds., American Society for Testing and Materials, Philadelphia, 1986, pp. 93–103.

ABSTRACT: The results of field and laboratory investigations of a domestic waste landfill overlying 30 m of natural clay are presented. Four study phases extending over a ten-year period will be summarized.

Concentration profiles for several soluble constituents (sodium, potassium, calcium, magnesium, Cl^- and dissolved organic carbon) show migration to a maximum depth of ~ 1.5 m in 15 years. This compares to an advective or seepage advance estimated to be only 3 to 5 cm, indicating migration primarily by diffusion. Concentration profiles for the heavy metals (iron, lead, zinc, and copper) indicate rapid field attenuation with migration to only 10 cm in the carbonate-rich clayey soil.

Graphed solutions to the coupled advection/diffusion equation using constant values for C_o, D, and V_s are only partially successful in predicting the observed chemical profiles because of apparent chemical partitioning at the waste/clay interface. A better fit is obtained by employing an artificial "effective" interface about 25 cm above the observed interface; however, this does not resolve the interface problems.

Recently, new analytical and numerical procedures have been developed for modelling this and other contaminant migration problems. These techniques automatically take into account time-dependent concentration variations within the landfill (for example, because of mass transport into the soil) and allow for a sharp drop in concentration because of surface effects (such as surface smear, drying, and interface partitioning). The numerical solution allows consideration of the effects of a thin but finite interface layer with properties different from those of the underlying soil. Both of these techniques are used in the field case resulting in much superior predictions than earlier models.

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Comments are presented on the significance of this work relative to chemical fluxes through thin clay liners.

KEY WORDS: wastes, diffusion, domestic waste leachate, chemical profiles, modelling, clay barriers

Clay barriers, natural or compacted, are a frequently used method of successfully retarding the migration of chemicals from waste disposal sites. The quantity of chemicals (chemical fluxes) exiting from such liners may be kept very small if advective flow is very slow and chemical diffusion is the main transport mechanism.

The purpose of this paper is to present actual field chemical profiles for a variety of dissolved chemical species migrating primarily by diffusion through thick natural clay deposits below a 15-year old domestic waste landfill and to model these profiles. Typical methods used to estimate the time-rate of migration are discussed. These are followed by a new method to handle waste-clay interface effects (partitioning at the interface) and variable input concentrations (reflecting changes in the leachate). These are followed by examples of chemical flux calculations through thin clay liners to illustrate the significance of correctly modelling the migration profiles.

Site Geology and Soil Conditions

The present soil conditions at the landfill site are illustrated on Fig. 1. Approximately 7.5 m of domestic solid waste, with a 0.5 m clay cover, overlies a homogeneous, massive grey silty clay. The waste projects about 2 m above the surrounding ground surface and was placed in a borrow trench excavated about 5.5 m into the original clay.

The calculated effective stresses shown on Fig. 1 incorporate the effects of a slight downward gradient ($i = \Delta h_t/\Delta L = 0.25$) generated by a small groundwater mound in the waste and drainage into bedrock at ~30 m depth. The variability of this gradient with time and depth is discussed extensively by Goodall and Quigley [*1*]. From extensive laboratory and field measurements of hydraulic conductivity, the average linearized downward pore fluid velocity is believed to be about 0.24 cm/annum [*1*].

The soil in the 3-m zone directly below the waste contains ~34% carbonate, ~25% illite, ~24% chlorite, ~15% quartz and feldspar, and ~2% smectite. About 40 to 45% of the soil is <2 μm in size, and the cation exchange capacity of the <74-μm fraction is ~15 meq/100 g [*2,3*].

The in-situ vertical effective stress plots σ_v' on Fig. 1 show that the clays are overconsolidated by about 90 kPa with a slight increase near the interface. This overconsolidation results in water content values w_n of about 23%, which are mid-way between plastic limits w_p, averaging 11% and liquid limits w_L averaging 32%. In most of our water content profiles there is indication of

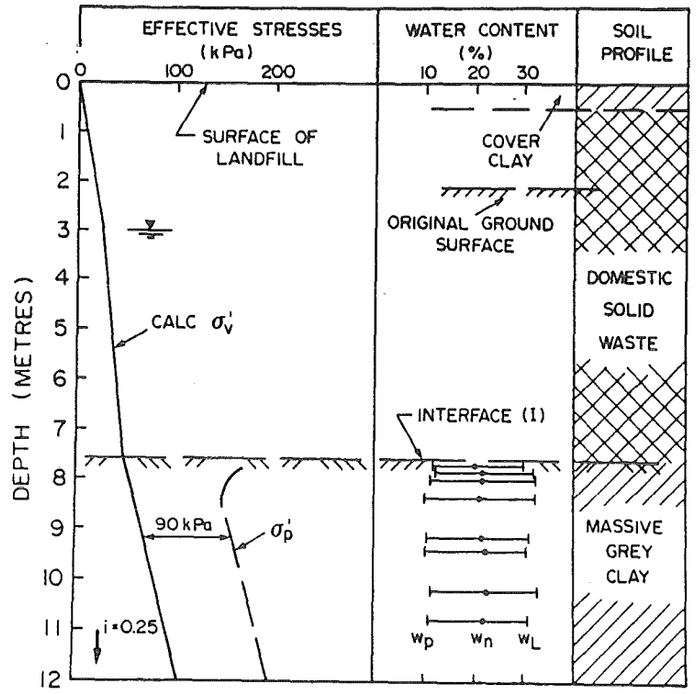


FIG. 1—*Soil conditions at Confederation Road landfill site, 1967 to present (σ_v') = vertical effective stress; σ_p' = preconsolidation pressure; w_p = plastic limit; w_n = natural water content; and w_L = liquid limit).*

a water content reduction of 2 or 3% very near the interface as discussed later.

Visually the clay at the interface is a homogeneous grey clay with scattered pebbles and no evidence of staining by the presently overlying black organic sludges. The particulates forming the sludge are generally not identifiable after 15 years and seem to have collected in a firm mat 0.2 to 0.5 m thick. Also, no fissures have ever been encountered in tube samples of the clay even though the base of the landfill probably did not quite penetrate to the bottom of the preconsolidated desiccation crust that exists around the site.

The nature of this crust is further illustrated on Fig. 2 by the preconsolidation versus depth profile drawn from a combination of oedometer measurements and in-situ vane strength results. The upper, 4-m-thick portion of the crust, which has been completely removed at the site, was a stiff to hard, brown oxidized, and fissured clay. The lower portion of the crust was a grey clay about 2.5 m thick with widely spaced brown fissures in the upper 1.5 m.

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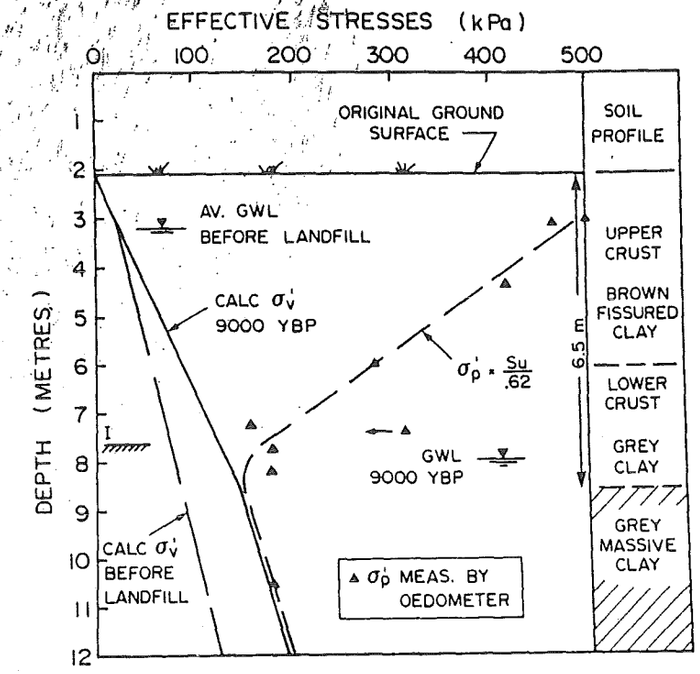


FIG. 2—*Soil conditions 9000 years before present (YBP) and before cutting landfill trench in 1966 (1 is waste/clay interface; S_u = undrained shear strength, GWL = ground-water level; see also the legend on Fig. 1).*

All but 1 m of the crust is believed to have been excavated as shown by the figure. A persistent slight decrease in water content of the clays near the interface would in part be due to the effects of the crust.

Chemical Profiles

The range in chemical concentration of Na^+ and $C\ell^-$ in the clay below the waste is presented in Fig. 3 in milligrams per litre of pore fluid. The data indicate overall migration of up to 1.5 m with the erroneous visual impression that $C\ell^-$ is in advance of Na^+. If the same data are plotted in more useful "ground-water" units of mol/m³, however, the rates of migration of Na^+ and $C\ell^-$ look quite similar (Fig. 4). Since advective transport is believed to have advanced only ~3 cm [2], the mechanism of transport must be chemical diffusion from the waste.

The width of the concentration versus depth zones is related to a combination of factors, the most important being scatter in the chemical data associated with sample contamination during tube sampling and a wide variation in

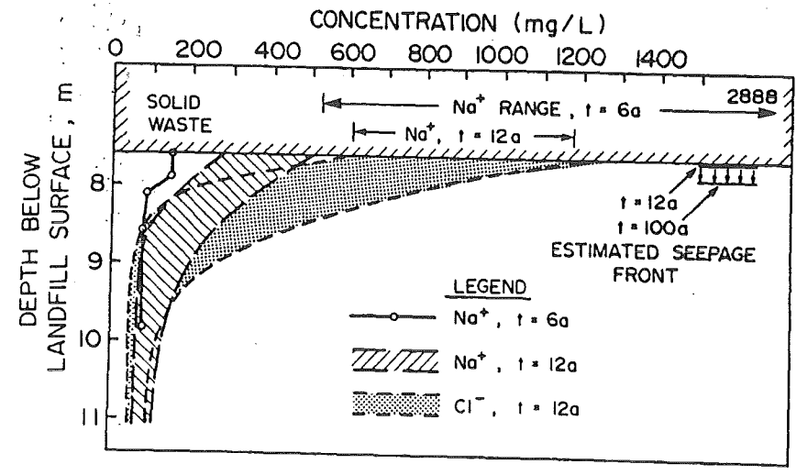


FIG. 3—*Pore fluid concentration of Na^+ and $C\ell^-$ (mg/L) in clay below waste after 6 and 12 years of diffusion* (t = 6a *and* 12a) [2].

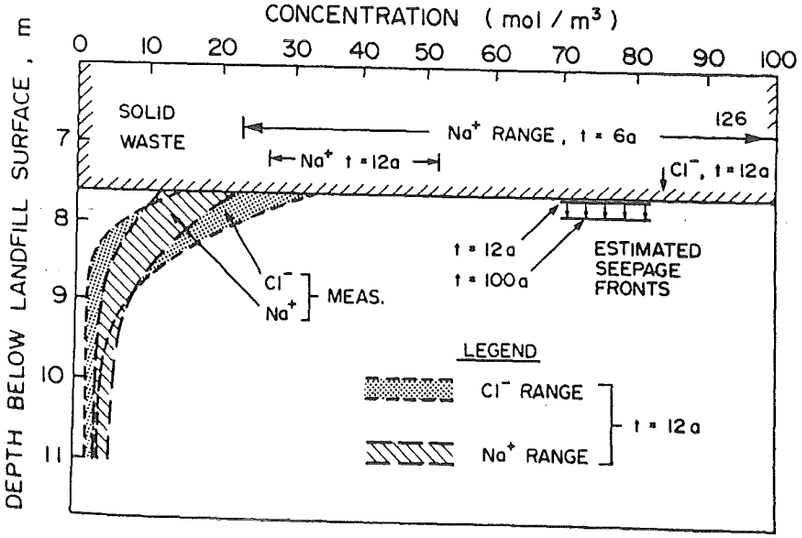


FIG. 4—*Pore fluid concentration of Na^+ and $C\ell^-$ (mol/m³) in clay below waste at* t = 12 *years* (t = 12a) [2].

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concentration of Na^+ and Cl^- in the waste from one original dumping spot to another.

Profiles illustrating heavy metal migration are summarized on Fig. 5*a*, which shows total concentrations for copper, lead, zinc, and iron. All of the profiles suggest migration of mobile species to only 10 or 15 cm below the interface, beyond which they stay at background levels. The lead and copper profiles are nearly identical with interface values of ~ 100 μg/g, zinc values at 150 μg/g, and iron values at 40 000 μg/g. Close examination of the interface showed no discoloration in the "metal" migration zone within which *Eh* values of −300 mV indicated strongly reducing conditions. Selective dissolution techniques presently in progress suggest that the migrated metals exist as a complex assemblage of carbonates, hydroxides, and organics.

A final profile for dissolved organic carbon is shown on Fig. 5*b*. In this case migration of the dissolved (< 0.45 μm) organic carbon-based compounds appears to have advanced about 1.1 m with maximum values of ~ 40 mol/m³ near the interface.

Prediction

Early attempts at prediction were carried out without knowing that the clay in the region of the interface was probably less "transmissible" than the clays

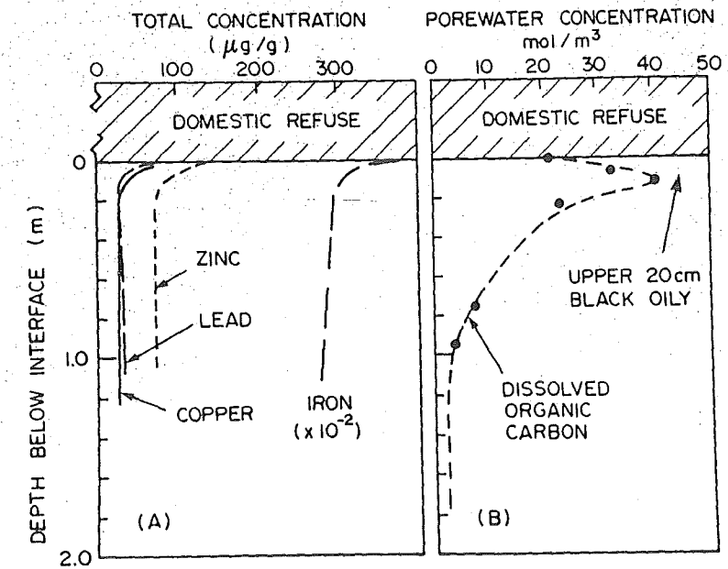


FIG. 5—(a) *Total concentration of heavy metals and* (b) *concentration of dissolved organic carbon* [3].

a metre lower caused by the remaining remnant of the crust and the possibility of partial void plugging by bacteria or precipitated metals. The earliest predictions at $t = 6$ annum [*1*] used an error function technique and ignored the effects of advection. Later predictions [*2*] employed the graphical solution to the one-dimensional contaminant transport equation for coupled diffusion and advection presented by Ogata [*4*]. These predictions assume constant values for influent concentration C_o, diffusion coefficient D, average linearized seepage velocity V_s, and an infinite clay thickness below the waste. Predictions for Na^+ and Cl^- are plotted on Fig. 6 for $t = 12$ years ($t = 12a$). Input parameters were as shown in Table 1. Although the calculations gave reasonable estimates for the depth of migration, the measured concentrations were well below those predicted in the upper 0.5 m of clay suggesting either very pronounced partitioning at the interface or an "effective interface" above the clay-waste interface observed in the field.

Since the black solid waste sludge seemed to be packed rather firmly against the clay, the next prediction attempt involved shifting the "effective" chemical interface 25 cm above the observed interface and the predictions repeated as shown on Fig. 7 [*3*]. Using $C_o = 86$ mol/m³, the erratic values

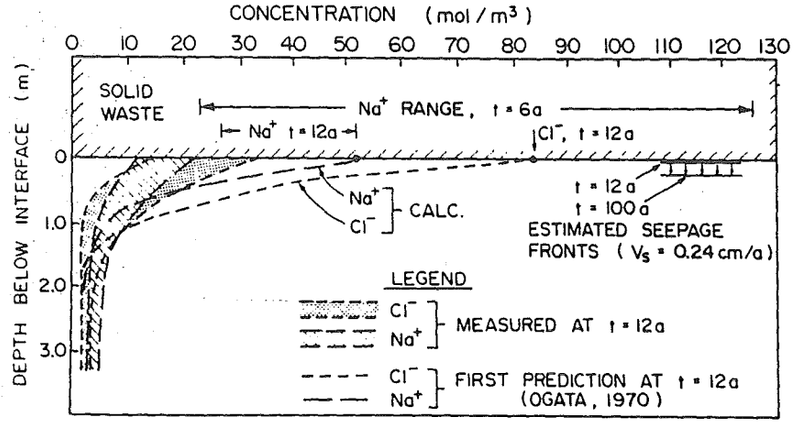


FIG. 6—*Predicted* Na^+ and Cl^- *profiles using constant values for* C_o, D, *and* V_s [4].

TABLE 1—*Input parameters.*

Na^+	Cl^-
$C_o = 51$ mol/m³	$C_o = 84$ mol/m³
$D = 3.5 \times 10^{-6}$ cm²/s	$D = 6 \times 10^{-6}$ cm²/s
$V_s = 0.24$ cm/*a*	$V_s = 0.24$ cm/*a*

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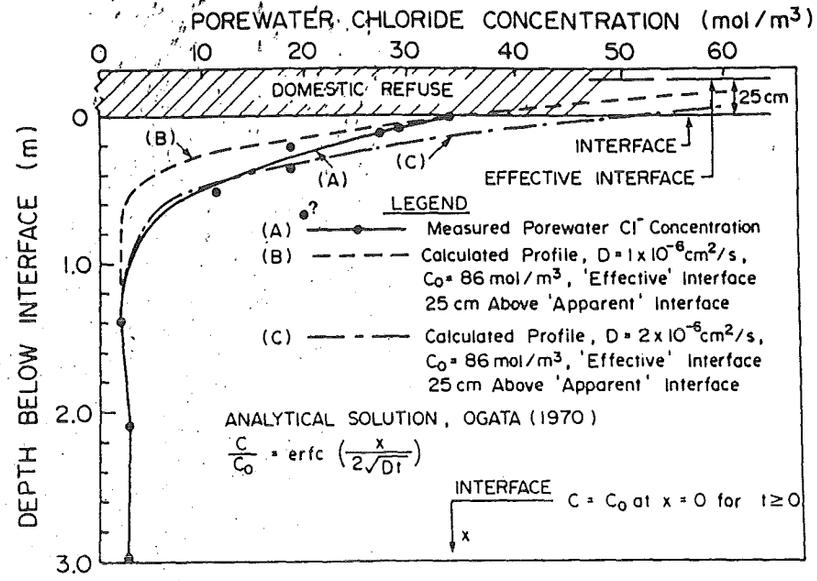


FIG. 7—*Predicted Cl^- profile using "effective" interface 25 cm above observed interface (borehole 83-2, t = 15a).*

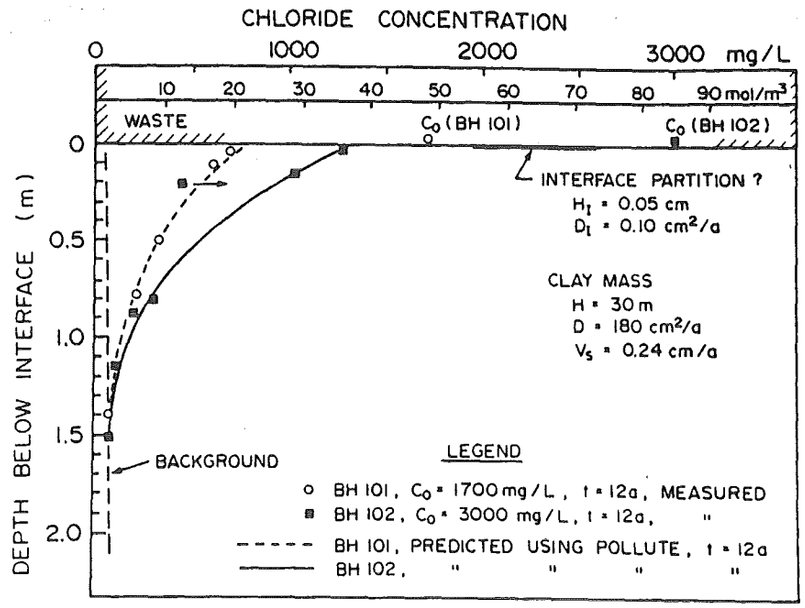


FIG. 8—*Predicted chloride profiles for Boreholes 101 and 102, using POLLUTE* [2,6].

plotted for the measured chloride profile (A) could be encased reasonably well by two predicted profiles (B) and (C) using values for $D = 1 \times 10^{-6}$ and 2×10^{-6} cm²/s, respectively. These calculations suggest that the sludge mat could indeed have a thickness within the visually estimated range of 0.2 to 0.5 m. As in all of our work to date, there continued to be considerable scatter in our measured values.

A third prediction approach was carried out using computer program, POLLUTE, proposed by Rowe and Booker [5]. This technique permits consideration of a thin interface layer (of thickness H_I) with a diffusion coefficient D_I considerably less than that in the rest of the soil. This technique also allows consideration of the variation of source concentration with time (caused by mass transport into the clay) as well as horizontal flow in an aquifer beneath the clay liner (if present). Calculations were performed varying the ratio D_I/H_I and the dispersion coefficient in the clay to obtain a fit with the data at BH 102 at the Sarnia site after twelve years [6]. The best fit was obtained for $D_I/H_I = 0.02$ m/a and $D = 0.018$ m²/a (5.7×10^{-6} cm²/s) as shown in Fig. 8. These parameters were then used to predict the concentration profile at BH 101, and the resulting predictions, also shown in Fig. 8, are in very good agreement with the observed concentration profile. The value of D determined for the main body of the clay is quite consistent with what would be expected in the absence of these data and is, in fact, quite close to the value adopted in the initial attempts to predict the profile shown in Fig. 6.

It is of some interest to note that the precise thickness of the interface layer H_I is not a critical quantity. Essentially, the same concentration profile is obtained for a range of values of H_I provided that the ratio D_I/H_I remains constant (typical values used were $H_I = 0.01$ m and $D_I = 0.0002$ m²/a).

Discussion

It is clear that a reasonable modelling of the concentration profiles at the Sarnia site requires consideration of some form of interface. However, it can also be seen that the backfigured diffusion coefficient of the clay may vary substantially depending upon the assumptions that are made concerning the interface. This may have a substantial effect on the fluxes predicted at any particular time.

Since the chemical diffusion flux F exiting from the base of a liner is directly related to the concentration gradient, $\partial c/\partial x$ at the interface ($F =$

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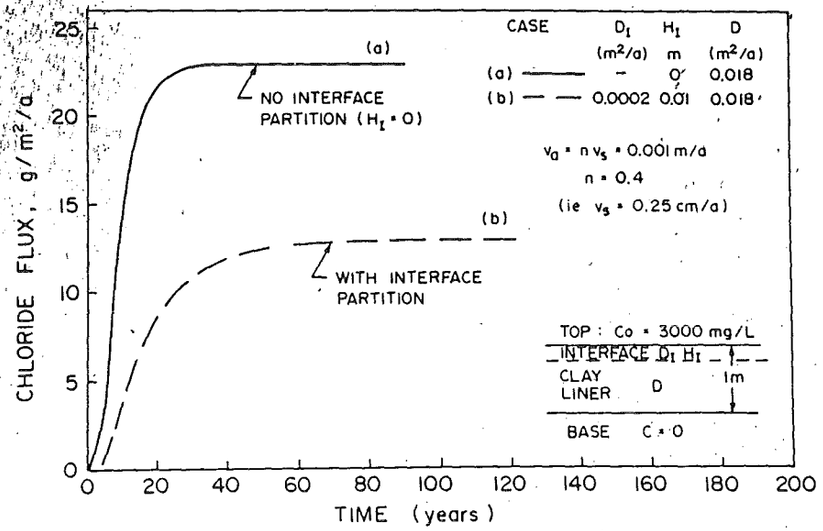


FIG. 9—*Chloride flux-time plots for a 1-m-thick liner:* (a) *no interface partition and* (b) *with interface partition.*

$D\,[\partial c/\partial x]$), it is important to obtain a correct value. From the previous discussion, predictions of $\partial c/\partial x$ using POLLUTE [7] and a thin interface partition yield lower, more correct values than the simpler Ogata predictions. The significance of this relative to predicted fluxes of chloride through a 1-m-thick clay liner is illustrated on Fig. 9. For these calculations, it was assumed that the influent concentration was constant at C_o = 3000 mg/L, and the base concentration was zero because of a high horizontal flushing velocity in an underlying aquifer. For the case of no interface partitioning, an ultimate chloride flux of 23 g/m²/a is calculated. For the possible case of a thin interface, an ultimate chloride flux of 13 g/m²/a is calculated. This represents a large difference that could be very significant is satisfying environmental conditions for a proposed landfill facility.

Finally, for purposes of design, it is generally conservative to neglect the presence of an interface when calculating concentration profiles and fluxes. However, the results presented here show that particular care should be exercised when backfiguring parameters from field data for situations where an interface effect may be present. It also appears that considerable attention must still be given to the effect of a mat of organic particulates that may settle or deposit on top of a clay barrier.

Conclusions

Using measured field values of sodium and chloride concentration profiles in clay below a domestic waste landfill site, a series of modelling efforts were made resulting in the following conclusions:

1. A chemical partition may occur at the waste-clay interface at some sites resulting in an abrupt drop in concentration in the upper 10 mm of clay compared to values in the waste leachate.
2. A new program, POLLUTE, may be used to model both the interface effects and any reduction in leachate concentration caused by migration into the barrier clays.
3. A proper chemical profile (concentration gradient) is required for calculation of chemical flux through clay barriers. In the absence of field data, computer program, POLLUTE, may be very useful for predicting these gradients.

Acknowledgments

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SEP 19 '88 13:37

Toby

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WB-958

Item	Feenstra	Bowen
1. Area of discharge from active flow zone	< several hundred metres to the southeast, southwest and south without a perimeter drain	< several hundred metres to the southeast, southwest and south without a perimeter drain
2. Receptor	surface water	surface water
3. Perimeter drains	typically 4 to 5 m into the shale	depth of active flow zone
4. Total exfiltration	10 to 20 mm/a	10 to 20 mm/.a

SEP-19-88 MON 13:33 APPLIED GROUNDWATER P.

Part of this WB 958

ITEM	FEENSTRA	BOWEN
areas of discharge from active zone	100s of metres to sw or se	within 100s of m of the site
location	surface water south of site don't know exactly where	- onto adjacent creek valleys and surface water courses - precise size of discharge zone cannot be determined with certainty from existing data (p.6-7)
perimeter drains	4m into shale	need to fully penetrate the zone (p.9)
infiltration	10-20 mm/a	10-20 mm/a (p.7)

discharge - { NSP – interol. triangle
perim. 3 M into fill
TROWS 10-20mm/a

Active PB
inactive F.

sandwich. T
or wedge

were in fractured zone.