COUNTY OF
LAMBTON

LAMBTON COUNTY
WASTE MANAGEMENT MASTER PLAN

VOLUME 4

SITE SELECTION APPENDICES

M.M. DILLON LIMITED • FEBRUARY 1995

Lambton County Waste Management Master Plan
Volume 4 - Site Selection Appendices

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LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
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APPENDIX 4A
AGRICULTURE IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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1.0 INTRODUCTION

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from an agricultural perspective. The purpose of this impact assessment was to identify the order of preference of the sites (i.e. best site(s) or worst site(s)), with respect to agriculture considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill component was considered to be the most significant in identifying and comparing potential agricultural impacts.

The key considerations addressed in this study were:

- the potential removal of agricultural land; and
- the potential disruption of agriculture, including nuisance effects such as noise, dust debris and rodents.

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the assessment and comparison of the potential agricultural impacts of the sites;
- the collection of data for the four sites according to the criteria and indicators identified;
- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to agricultural considerations; and
- the comparison of the sites' advantages and disadvantages to identify, from an agricultural perspective, the most preferred/least preferred site(s).

2.0 STUDY APPROACH

2.1 Method

The four sites were analyzed and compared by examining data collected through field visits, farmer interviews, comments received from the Lambton County Ontario Ministry of Agriculture and Food (OMAF) agricultural representative and air photo interpretation. Two factors and nine indicators (see Table 1) were used in assessing each site and comparing the four sites. Documentation included determining land use designations, soil capability, the type of farming operations, their size, the machinery movement from each farm as well as identifying any abandoned farm land in the area. Farmers were also asked if the existing Moore Township disposal site had any effect on their farming operations.

Precise weighting of criteria and indicators was found to be unnecessary. Three indicators, "cleared agricultural land designated for agriculture within site", "amount of cleared agricultural land designated for agriculture within 500 m from the site boundary", and "number of farm units within 1,000 m study area", were considered the most important indicators. One indicator, "number of potential farm units within 1,000 m study area" was found to be a good summary indicator and was central to identifying which site is best with respect to agriculture.

2.2 Study Area Used

The study area used in the site analysis included the site and an area within 1 km of each site. This provided a broader area for study than the 500 m from the perimeter of a fill area within which the most significant adverse environmental effects are considered to occur (Ontario Ministry of the Environment 1987). This broader study area provided a more conservative basis for the assessment and comparison of the sites.

2.3 Time Frame

It was assumed that the landfill will operate for 20 years from its opening date.

TABLE 1
AGRICULTURE INDICATORS FOR EVALUATION OF SHORT LIST SITES

Evaluation Criteria	Indicators	Rationale	Data Sources
Removal of Agriculture	Cleared agricultural land designated for agriculture within site.	Designated agricultural land shows a long term commitment by the municipality to retain such land for agricultural purposes.	Official planning documents. Field visits.
	Cleared agricultural land designated for other uses within site.	Lands which have been designated other than agricultural still have potential to produce excellent yields and contribute to the agricultural economy of the area.	Official planning documents. Field visits.
	Number of potential farm units removed (1 farm unit = 40 ha of cleared agricultural land)[1].	Use of this indicator provides a total area of cleared agricultural land that would be removed by the facility in the form of farm equivalents. It is a sum of the two indicators above.	Air photo interpretation.
Disruption of Agriculture	Amount of cleared agricultural land designated for agriculture within 500 m from site boundary.	Nuisance effects from landfill may have moderate effect on the growing of crops, cultivation and other farm related activities.	Farmer interviews. Air photo interpretation (1:5,000 scale).
	Amount of cleared agricultural land designated for agriculture > 500 m but ≤ 1,000 m from site boundary.	Nuisance effects from landfill may have minimum effects on the growing of crops, cultivation and other farm related activities.	Farmer interviews. Air photo interpretation.
	Amount of cleared agricultural land designated for other uses within 500 m from site boundary.	Nuisance effects from landfill may have moderate effect on growing crops, cultivation, raising livestock and other farm related activities.	Farmer interviews. Air photo interpretation.
	Amount of cleared agricultural land designated for other uses > 500 m but ≤ 1000 m from site boundary.	Nuisance effects from landfill may have minimum effect on growing crops, cultivation, raising livestock and other farm related activities.	Farmer interviews. Air photo interpretation.
	Number of potential farm units within 1,000 m study area. (Note: 1 farm unit = 40 ha of cleared agricultural land).	Use of this indicator provides a total area of cleared agricultural land that would be disrupted by the facility in the form of farm equivalents. It is a sum of the four indicators above.	Air photo interpretation.
	Number of farmers using haul route to move equipment.	Waste hauling may interfere with slow moving farm equipment with wide or tall loads.	Farmer interviews.

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[1] The largest proportion (25%) of farms in Lambton County are between 28 and 52 ha. Although the average farm area in Lambton is approximately 80 ha, the median area of these farms is approximately 40 ha. (OMAF 1992). Therefore, 1 farm unit = 40 ha of cleared agricultural land disregarding land use designation.

2.4 Key Assumptions

Secondary data sources (soils, drainage and Canada Land Inventory mapping) were assumed to be reasonably correct. Soil capability and drainage characteristics were assumed to be relatively equal throughout all areas studied, so this information was not useful in the comparative evaluation.

The existing landfill at Site K was visited and observations were made regarding litter and rodent control and odour. While it was assumed that there will be control of nuisance effects associated with the new facility, it was also assumed that occasional problems could occur.

2.5 Data Collection

Information on soils and their drainage characteristics was derived from Lambton County soil mapping (Matthews *et al.* 1957), Moore Township drainage mapping (OMAF 1981) and Sarnia area Canada Land Inventory mapping (OMAF undated). Additional data was collected through field visits to the sites that took place (June 13-14, 1991, to Site H and I); (May 27-28 and August 24-25, 1993, all sites). During the 1993 visits, farmers within the study area were interviewed where possible (see Schedule I). The Lambton County agricultural representative was also contacted several times during the progress of this project. His opinions are outlined in a letter attached to this report (Schedule II).

3.0 COMPARISON OF SITES - ANALYSIS AND RESULTS

3.1 Existing Conditions at Each Site

3.1.1 Site H

Agriculture on Site H

The majority of the site has been cleared of forest and 68 ha of soybeans are presently being grown. The Canada Land Inventory mapping of soils indicates that the site has a predominant capability rating of Class 2 with the limitation being excessive moisture. However, the OMAF (1981) drainage map shows drainage tile has been installed and this site is drained by the Wylie Drain that runs north/south on the east side of the site and the Johnston Drain on the south side. Field visits confirmed that drainage tile was in place. The soil is Brookston clay (Matthews *et al.* 1957). This soil is by nature poorly drained, but with the installation of tile drains can produce good yields of fall wheat, alfalfa, corn and soybeans.

Agricultural Activity Within 1,000 m of Site H

There are no farm structures within 1,000 m of the site. Cropping occurs immediately to the west and to the east (Site I) and near the northern perimeter of the 1,000 m study zone.

3.1.2 Site I

Agriculture on Site I

This site is identical to Site H in terms of the soil type and the crop being grown. At the present time, 75 ha of soybeans are being grown. The site has tile drains installed which drain to the Rankin Drain east of the site and to the Johnston Drain south of the site. The only interference to these agricultural lands has been the installation of large hydro towers located on the eastern side of the property. These towers do not significantly interfere with farming operations.

Agricultural Activity Within 1,000 m of Site I

There are no farm structures within 1,000 m of the site. Cropping occurs immediately to the west (Site H) and extends eastward to Highway 40.

3.1.3 Site D

Agriculture on Site D

The majority of the site has been cleared of forest and 57.7 ha of soybeans are being grown. The Canada Land Inventory mapping of soils indicates that the site has a predominant capability of Class 3 with the limitations being undesirable soil structure and/or low permeability. The soil is Caistor clay. This is a fine textured soil with a low organic matter content. Because of the fine texture, water does not move through the soil easily and may pond at the surface. OMAF (1981) drainage mapping shows that agricultural drains have been installed with the majority of the drainage to the Coyle Drain east of the site and some drainage to the Wheeler Drain west of the site.

The only interference on these agricultural lands is a number of drainage swales throughout the site. These swales are vegetated with grass and trees. Such swales may interfere with cultivation/harvesting operations, especially when large equipment is used.

Agricultural Activity Within 1,000 m of Site D

There are four agricultural structures within 1,000 m of the site used for equipment storage. To the west and south of the site, either cash crops (soybeans) or wheat, alfalfa and corn for local beef production are being grown in rotation. To the northwest and north sides there are crop fields in which soybeans, improved hay and wheat are being grown. These fields belong to a large 180 ha beef farm located on Moore Township Road 6/7. To the northeast of the site there are crop fields for a dairy operation.

3.1.4 Site K

Agriculture on Site K

This site has the smallest area (14.9 ha) in terms of cleared agricultural land but is the only site on which cleared agricultural land is designated for agricultural use. Most of the cleared agricultural land is located at the southwestern part of the site. The majority of this area has only been cleared in the last decade and as a result, the dark organic soil has produced excellent yields of corn. This area is tile drained and water drains to the Coyle Drain on the west side of the site. The soil is Caistor clay. The Canada Land Inventory rating of this soil is Class 3, with the limitations being undesirable soil structure and/or low permeability.

At the northern boundary on the eastern side there is another area that has been cleared. This small (3.2 ha) meadow may be used for hay. The dominant soil is Caistor clay, however, some Brookston clay has been mapped through a part of this field.

The farmer who owns the fields to the south of the existing Moore Township landfill was interviewed and asked if the existing landfill causes any problems for his farming operation. He indicated that a large quantity of debris (plastic bags) accumulates in his fields and jams equipment during cultivation and harvesting operation. He also indicated that the Coyle Drain to the west of the property was becoming wider and as a result more maintenance is required on the small bridges that are used to access the fields.

Agricultural Activity Within 1,000 m of Site K

While Site K has the smallest area of cleared agricultural land on site, it has the largest amount of cleared agricultural land (592.2 ha) within its 1,000 m study zone. There are two farm structures used for equipment storage.

To the north of the site there are crop fields for a dairy farm as well as several cash crop operations. To the south and east of the site, fields are being used to grow forage crops for two local beef operations (located at the corner of Moore Township Roads 6/7 and 18/19, and Highway 80 and Moore Township Road 18/19), as well as cash crops for another area farm.

3.2 Net Effects and Data Analysis

Three indicators, "cleared agricultural land designated for agriculture within site", "amount of cleared agricultural land designated for agriculture within 500 m from site boundary", and "number of potential farm units within 1,000 m study area", were considered the most important indicators. One indicator, "number of potential farm units within 1,000 m study area", was found to be a good summary indicator and was central to identifying which site is best with respect to agriculture. Table 2 shows the data collected for each site according to the criteria and indicators.

As Table 2 shows, all sites contain viable agricultural land. From 14.9 to 75.0 ha of cleared agricultural land will be removed, depending on the site chosen.

TABLE 2
DATA FOR EVALUATION OF SITES

Evaluation Indicators	**Sites**			
	H	**I**	**D**	**K**
Removal of Agriculture				
Cleared agricultural land designated for agriculture within site (ha).	0.0	0.0	0.0	11.7
Cleared agricultural land designated for other uses within site (ha).	68.0	75.0	57.7	3.2
Number of potential farm units removed (1 farm unit = 40 ha) of cleared agricultural land.	1.7	1.8	1.4	0.4
Disruption of Agriculture				
Amount of cleared agricultural land designated for agriculture within 500 m from site boundary (ha).	0.0	0.0	13.4	170.9
Amount of cleared agricultural land designated for agriculture > 500 m but ≤ 1,000 m from site boundary (ha).	0.0	9.7	161.0	286.0
Amount of cleared agricultural land designated for other uses within 500 m from site boundary (ha).	80.8	110.4	111.3	27.4
Amount of cleared agricultural land designated for other uses > 500 m but ≤ 1,000 m from site boundary (ha).	97.2	114.0	143.2	107.9
Number of potential farm units within 1,000 m study area (1 farm unit = 40 ha of cleared agricultural land).	4.4	5.8	10.7	14.8
Number of farmers using haul route to move equipment.	2	2	4	4
SITE RANKING	**1**	**2**	**3**	**4**

From an agricultural perspective, Site H would be the best site to build the waste management facility. Although 68.0 ha would be removed from agricultural production, the site is designated for industrial use, somewhat isolated from the farming community and only 4.4 potential farm units within 1,000 m would be affected by the facility. In comparison to other sites, Site I is a close second, as 5.8 potential farm units would be affected within 1,000 m and 75.0 ha designated for industrial use would be removed from production. Sites D and K are in third and fourth place respectively. Building the facility on these sites would affect 10.7 and 14.7 potential farm units within 1,000 m respectively.

During the analysis the sites, the criteria and indicators were reviewed to ensure that the interests of the farm community both on and off site were represented. All four sites are located in areas where intensive agriculture is occurring and the only significant areas of non-farm use include the chemical plant located to the south of Sites H and I and the existing Moore Township landfill facility located on Site K.

Tables 3 to 6 outline the possible environmental effects of a waste management facility on the site, the mitigative measures that could be implemented to lessen the environmental impacts, and the net effects.

Table 7 provides a summary of the advantages and disadvantages of the sites for facility siting from an agricultural perspective.

To check the agricultural ranking of the sites, the opinions of the interviewed farmers and the Lambton County agricultural representative were reviewed. These comments were not addressed in the evaluation, but they generally matched the evaluation results. The majority of farmers accessible for interviews (near Sites D and K) strongly recommended that the landfill not be situated in the area of D and K as it would create a number of problems for existing farms including:

- interference with farm machinery movement;
- an increase in the rodent population in the area (rats and mice may invade livestock barns in the winter where it is warmer and there is a good supply of food); and
- an increase in the amount of debris blowing across fields (this point was raised by two farmers that live near the existing landfill).

TABLE 3
AGRICULTURE IMPACT ASSESSMENT: NET EFFECTS FOR SITE H

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Removal of Agriculture				
Cleared agricultural land designated for agriculture within site (ha)	0.0	· none	· not required	· none
Cleared agricultural land designated for other uses within site (ha)	68.0	· lands which have been designated other than agricultural will no longer be able to contribute to agriculture economy	· not required	· 68.0 ha of land will be removed from agricultural production
Number of potential farm units removed (1 farm unit = 40 ha) of cleared agricultural land	1.7	· as above	· not required	· as above
2. Disruption of Agriculture				
Amount of cleared agricultural land designated for agriculture within 500 m from site boundary	0.0	· none	· not required	· none
Amount of cleared agricultural land designated for agriculture > 500 m but ≤ 1000 m from site boundary	0.0	· none	· not required	· none
Amount of cleared agricultural land designated for other uses within 500 m from site boundary (ha)	80.8	· moderate nuisance effect on growing crops, cultivation, raising livestock, and other farm related activities	· pest control · maintain buffer between operations and adjacent farms · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· low nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Amount of cleared agricultural land designated for other uses > 500 m but ≤ 1000 m from site boundary (ha)	97.2	· low nuisance effect on growing crops, cultivation, raising livestock and other farm-related activities	· as above	· minimum nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Number of potential farm units within 1000 m of study area (1 farm unit = 40 ha of cleared agricultural land)	4.4	· as above	· as above	· as above
Number of farmers using haul route to move equipment	2.0	· waste hauling may interfere with slow moving farm equipment with wide or tall loads which may endanger operator safety	· road shoulder widening · select routes with adequate capacity · truck scheduling to offset peak road loadings · speed limits · driver training to encourage safety and courtesy · complaint recording system	· waste hauling operations would have less of an impact on slow moving farm equipment

TABLE 4
AGRICULTURE IMPACT ASSESSMENT: NET EFFECTS FOR SITE I

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Removal of Agriculture				
Cleared agricultural land designated for agriculture within site (ha)	0.0	· none	· not required	· none
Cleared agricultural land designated for other uses within site (ha)	75.0	· lands which have been designated other than agricultural will no longer be able to contribute to agriculture economy	· not required	· 75.0 ha of land will be removed from agricultural production
Number of potential farm units removed (1 farm unit = 40 ha) of cleared agricultural land	1.8	· as above	· not required	· as above
2. Disruption of Agriculture				
Amount of cleared agricultural land designated for agriculture within 500 m from site boundary	0.0	· none	· not required	· none
Amount of cleared agricultural land designated for agriculture > 500 m but ≤ 1000 m from site boundary	9.7	· low nuisance effect on growing crops, cultivation and other farm-related activities on appropriately designated lands	· pest control · maintain buffer between operations and adjacent farms · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· minimum nuisance effect on growing crops, cultivation, and other farm-related activities on appropriately designated lands
Amount of cleared agricultural land designated for other uses within 500 m from site boundary (ha)	110.4	· moderate nuisance effect on growing crops, cultivation, raising livestock, and other farm related activities	· as above	· low nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Amount of cleared agricultural land designated for other uses > 500 m but ≤ 1000 m from site boundary (ha)	114.0	· low nuisance effect on growing crops, cultivation, raising livestock and other farm-related activities	· as above	· minimum nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Number of potential farm units within 1000 m of study area (1 farm unit = 40 ha of cleared agricultural land)	5.8	· as above	· as above	· as above
Number of farmers using haul route to move equipment	2.0	· waste hauling may interfere with slow moving farm equipment with wide or tall loads which may endanger operator safety	· road shoulder widening · select routes with adequate capacity · truck scheduling to offset peak road loadings · speed limits · driver training to encourage safety and courtesy · complaint recording system	· waste hauling operations would have less of an impact on slow moving farm equipment

TABLE 5
AGRICULTURE IMPACT ASSESSMENT: NET EFFECTS FOR SITE D

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Removal of Agriculture				
Cleared agricultural land designated for agriculture within site (ha)	0.0	· none	· not required	· none
Cleared agricultural land designated for other uses within site (ha)	57.7	· lands which have been designated other than agricultural will no longer be able to contribute to agriculture economy	· not required	· 57.7 ha of land will be removed from agricultural production
Number of potential farm units removed (1 farm unit = 40 ha) of cleared agricultural land	1.4	· as above	· not required	· as above
2. Disruption of Agriculture				
Amount of cleared agricultural land designated for agriculture within 500 m from site boundary	13.4	· moderate nuisance effect on growing crops, cultivation and other farm-related activities on appropriately designated lands	· avoid major farm operations and services · rodent control · maintain buffer between site and adjacent farms · screening and good housekeeping · dust suppression	· low nuisance effect on growing crops, cultivation, raising livestock and other farm-related activities on appropriately designated lands
Amount of cleared agricultural land designated for agriculture > 500 m but ≤ 1000 m from site boundary	161.0	· low nuisance effect on growing crops, cultivation and other farm-related activities on appropriately designated lands	· pest control · maintain buffer between operations and adjacent farms · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· minimum nuisance effect on growing crops, cultivation, and other farm-related activities on appropriately designated lands
Amount of cleared agricultural land designated for other uses within 500 m from site boundary (ha)	111.3	· moderate nuisance effect on growing crops, cultivation, raising livestock, and other farm related activities on appropriately designated lands	· as above	· low nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Amount of cleared agricultural land designated for other uses > 500 m but ≤ 1000 m from site boundary (ha)	143.2	· low nuisance effect on growing crops, cultivation, raising livestock and other farm-related activities	· as above	· minimum nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Number of potential farm units within 1000 m of study area (1 farm unit = 40 ha of cleared agricultural land)	10.7	· as above	· as above	· as above
Number of farmers using haul route to move equipment	4.0	· waste hauling may interfere with slow moving farm equipment with wide or tall loads which may endanger operator safety	· road shoulder widening · select routes with adequate capacity · truck scheduling to offset peak road loadings · speed limits · driver training to encourage safety and courtesy · complaint recording system	· waste hauling operations would have less of an impact on slow moving farm equipment

TABLE 6
AGRICULTURE IMPACT ASSESSMENT: NET EFFECTS FOR SITE K

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Removal of Agriculture				
Cleared agricultural land designated for agriculture within site (ha)	11.7	· appropriately designated lands will no longer contribute to agricultural economy	· none yet requested	· 11.7 ha of appropriately designated land will be removed from agricultural production
Cleared agricultural land designated for other uses within site (ha)	3.2	· lands which have been designated other than agricultural will no longer be able to contribute to agriculture economy	· not required	· 3.2 ha of other land will be removed from agricultural production
Number of potential farm units removed (1 farm unit = 40 ha) of cleared agricultural land	0.4	· as above	· as above	· as above
2. Disruption of Agriculture				
Amount of cleared agricultural land designated for agriculture within 500 m from site boundary	170.9	· moderate nuisance effect on growing crops, cultivation and other farm-related activities an appropriately designated lands	· pest control · maintain buffer between operations and adjacent farms · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· low nuisance effect on growing crops, cultivation, raising livestock and other farm-related activities on appropriately designated lands
Amount of cleared agricultural land designated for agriculture > 500 m but ≤ 1000 m from site boundary	286.0	· low nuisance effect on growing crops, cultivation and other farm-related activities on appropriately designated lands	· as above	· minimum nuisance effect on growing crops, cultivation, and other farm-related activities on appropriately designated lands
Amount of cleared agricultural land designated for other uses within 500 m from site boundary (ha)	27.4	· moderate nuisance effect on growing crops, cultivation, raising livestock, and other farm related activities	· as above	· low nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Amount of cleared agricultural land designated for other uses > 500 m but ≤ 1000 m from site boundary (ha)	107.9	· low nuisance effect on growing crops, cultivation, raising livestock and other farm-related activities	· as above	· minimum nuisance effect on growing crops, cultivation, raising livestock and other farm related activities
Number of potential farm units within 1000 m of study area (1 farm unit = 40 ha of cleared agricultural land)	14.8	· as above	· as above	· as above
Number of farmers using haul route to move equipment	4.0	· waste hauling may interfere with slow moving farm equipment with wide or tall loads which may endanger operator safety	· road shoulder widening · select routes with adequate capacity · truck scheduling to offset peak road loadings · speed limits · driver training to encourage safety and courtesy · complaint recording system	· waste hauling operations would have less of an impact on slow moving farm equipment

TABLE 7
ADVANTAGES AND DISADVANTAGES OF EACH SITE FOR FACILITY SITING

Advantages/ Disadvantages	**SITES**			
	H	**I**	**D**	**K**
Advantages	Site does not contain land designated for agriculture.	Site does not contain land designated for agriculture.	Site does not contain land designated for agriculture.	Site has lowest area of cleared agricultural land (14.9 ha).
	Area is isolated from intensive areas of agricultural activity.	Area is isolated from intensive areas of agricultural activity.	Forests on the west and east sides would help act as a buffer.	
	Site is isolated by industrial area to the south, St. Clair River to the west and large forested area to the north.	Site is isolated by industrial area to south and large forested area to the north.		
	Landfill located at this site would have minimum effect on adjacent agricultural operations.	Landfill located at this site would have minimum effects on adjacent agricultural operations.		
Disadvantages	Site is cleared and tile drained and is being used for a high value crop.	Site is cleared and tile drained and is being used for a high value crop.	Site is cleared and tile drained and is being used for a high value crop.	Site contains some land designated for agriculture.
	68.0 ha of cropland would be removed.	75.0 ha of cropland would be removed.	57.7 ha of cropland would be removed.	Site is situated in an area of highly intensive agriculture.
		Fields to the west (Site H) will be isolated and may become abandoned in future.	Site is situated in an area of highly intensive agriculture.	Nuisance effects of existing landfill have already been seen by local farmers.
			10.7 farm units would be potentially affected by nuisance effects of the landfill facility.	14.7 farm units would be potentially affected by nuisance effects from the landfill.

The local agricultural representative was asked to visit each site. Sites H and I were visited in the summer of 1991 and D and K in the summer of 1993. Comments received from this representative suggested that, from an agricultural perspective, either Site H or I would make a logical place to site the facility, as each would have a minimum impact on adjacent farms and no viable farms are within the 1 km study area boundaries.

Sites D and K are least preferred as the facility would have the greatest impact on the farming community concentrated in this area. The majority of these farms are run by full time farmers and many of the farms in the area are larger than the County average. The agricultural representative's ranking of the sites is similar to that reached through the evaluation (OMAF 1993).

Summary

Based on the data collected through field visits, farmer interviews, discussions with the Lambton County agricultural representative and air photo interpretation, an agricultural preference ranking for site selection was determined. Farmer and agricultural representative opinions were considered when ranking the sites. Site H is most preferred from an agricultural perspective, for the siting of the waste management facility. Site I is a close second. Sites D and K are the third and fourth preferences respectively.

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SCHEDULE I

DESCRIPTION OF FARM INTERVIEWS

SCHEDULE I

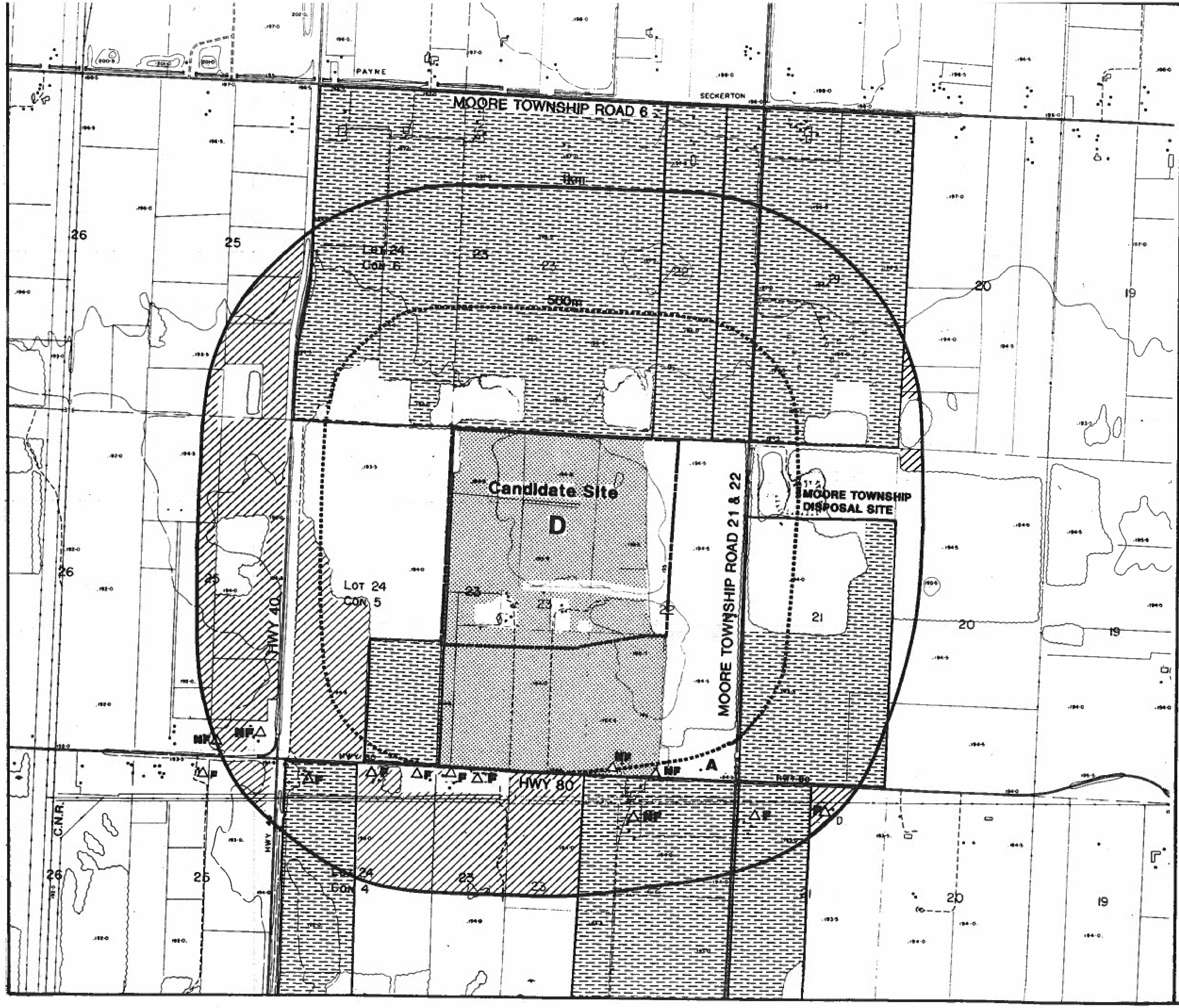
Interviews were conducted on a "drop-in basis" and were informal. The agricultural specialist briefly outlined to each farmer the purpose of his visit and proceeded to ask the following questions using an air photo of the study sites:

1. What is the location of all lands that are rented, owned or leased?
2. What is the type of operation that is being operated and its size?
3. Is the existing landfill operation causing any nuisance affects to the farm?
4. Which roads are commonly used to transport machinery to fields that are rented, leased or owned?

Most farmers had additional comments on the best place to site the landfill and asked when the decision would be made.

Although only nine farmers were interviewed, the lands that were farmed by the farmers interviewed did comprise a major portion of the study areas for Sites D and K. No interviews were conducted for Sites H and I as the farm operators for their respective study areas were not readily available during investigations.

During the long list site evaluation, owners and/or tenants of the long list sites were asked to respond to a questionnaire regarding agricultural production on the sites. Figures 1 to 4 show the farmed lands of the short list sites for which interviews were conducted or completed questionnaires were received.



LEGEND

▤	FARMED LAND RENTED/OWNED BY FARMERS PERSONALLY INTERVIEWED
▒	FARMED LAND FOR WHICH COMPLETED QUESTIONNAIRE WAS RECEIVED
▨	OTHER FARMED LAND WITHIN STUDY AREA
△	RESIDENCE (F - FARM, NF - NON-FARM)
A	INDICATES ABANDONED LAND USE

APPROXIMATE AREA (ALL USES) WITHIN 1km BOUNDARY = 740 ha

APPROXIMATE FARMED AREA (ALL DESIGNATIONS) WITHIN 1km BOUNDARY = 486 ha

APPROXIMATE FARMED AREA WITHIN STUDY AREA OWNED/RENTED BY FARMERS PERSONALLY INTERVIEWED = 293 ha OR 60% OF FARMED AREA

APPROXIMATE FARMED AREA WITHIN STUDY AREA FOR WHICH COMPLETED QUESTIONNAIRE WAS RECEIVED = 100 ha OR 21% OF FARMED AREA

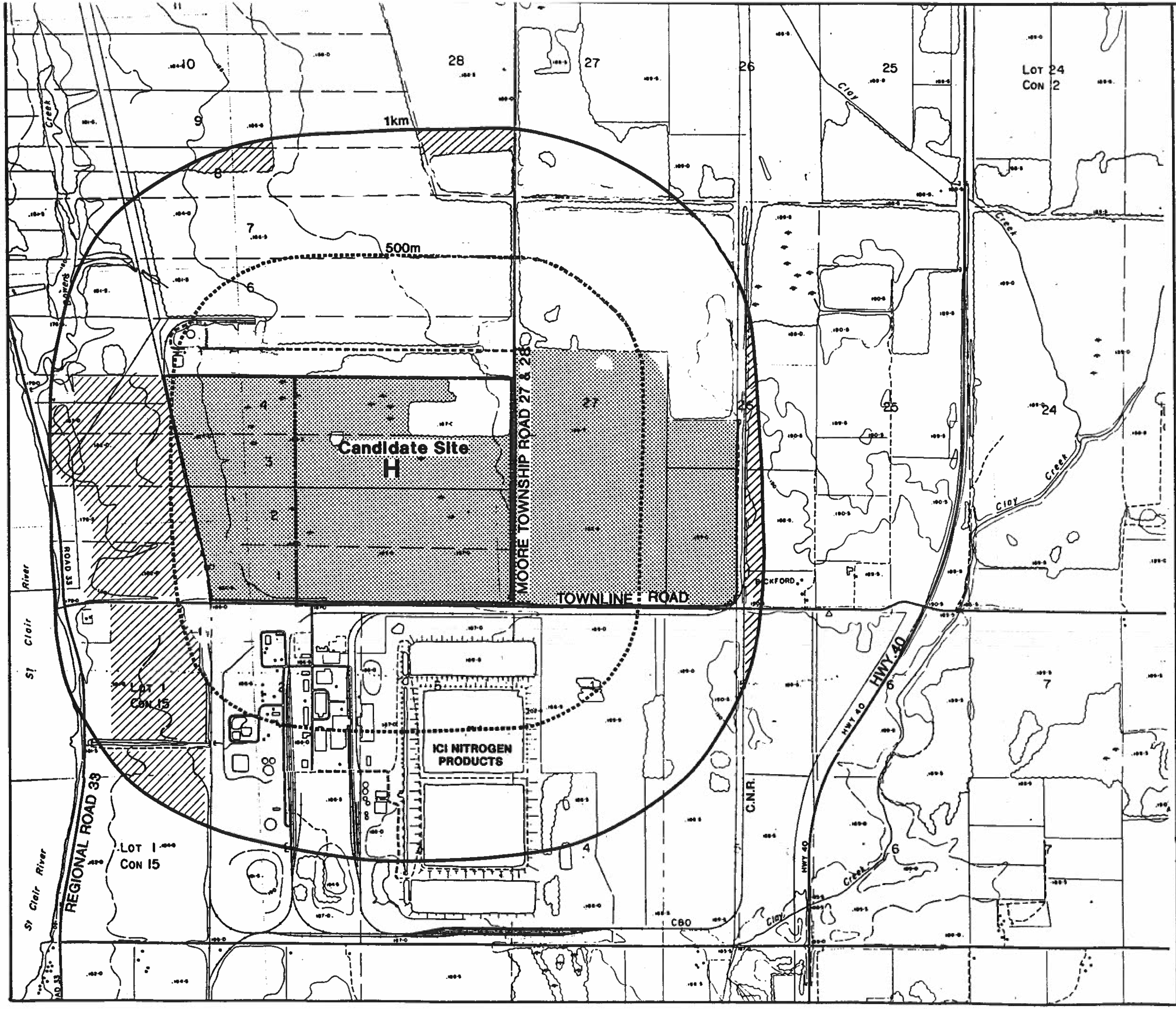
100 0 500 1km

AGRICULTURE
SHORT LIST EVALUATION
SITE D

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928

FIGURE No. 1



LEGEND

▩ FARMED LAND FOR WHICH COMPLETED QUESTIONNAIRE WAS RECEIVED

▨ OTHER FARMED LAND WITHIN STUDY AREA

△ RESIDENCE (F - FARM, NF - NON-FARM)

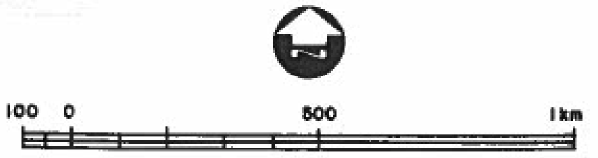
A INDICATES ABANDONED LAND USE

APPROXIMATE AREA (ALL USES) WITHIN 1km BOUNDARY = 740 ha

APPROXIMATE FARMED AREA (ALL DESIGNATIONS) WITHIN 1km BOUNDARY = 248 ha

APPROXIMATE FARMED AREA WITHIN STUDY AREA OWNED/RENTED BY FARMERS PERSONALLY INTERVIEWED = 0 ha OR 0 % OF FARMED AREA

APPROXIMATE FARMED AREA WITHIN STUDY AREA FOR WHICH COMPLETED QUESTIONNAIRE WAS RECEIVED = 193 ha OR 78 % OF FARMED AREA

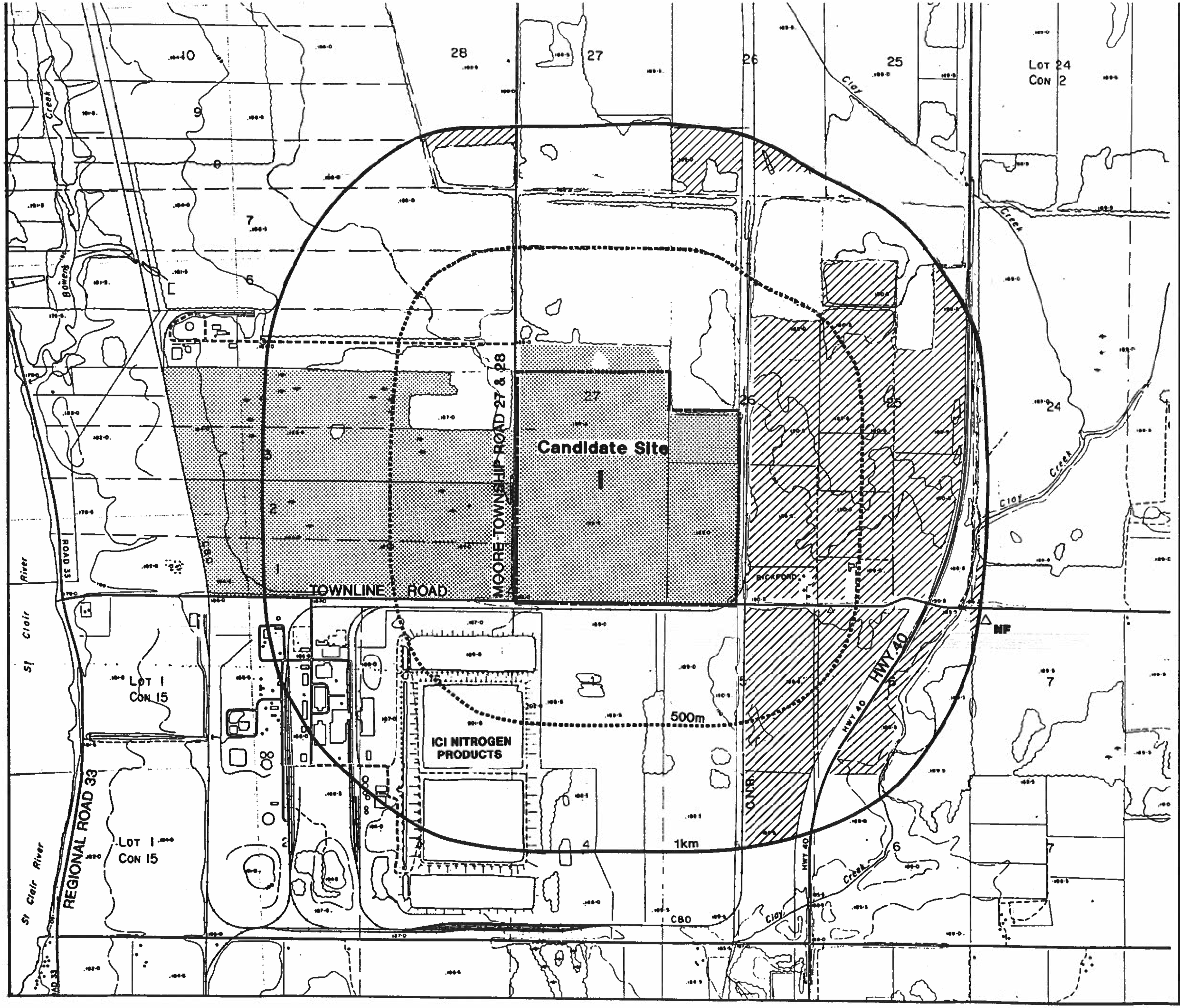


AGRICULTURE
SHORT LIST EVALUATION
SITE H

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928

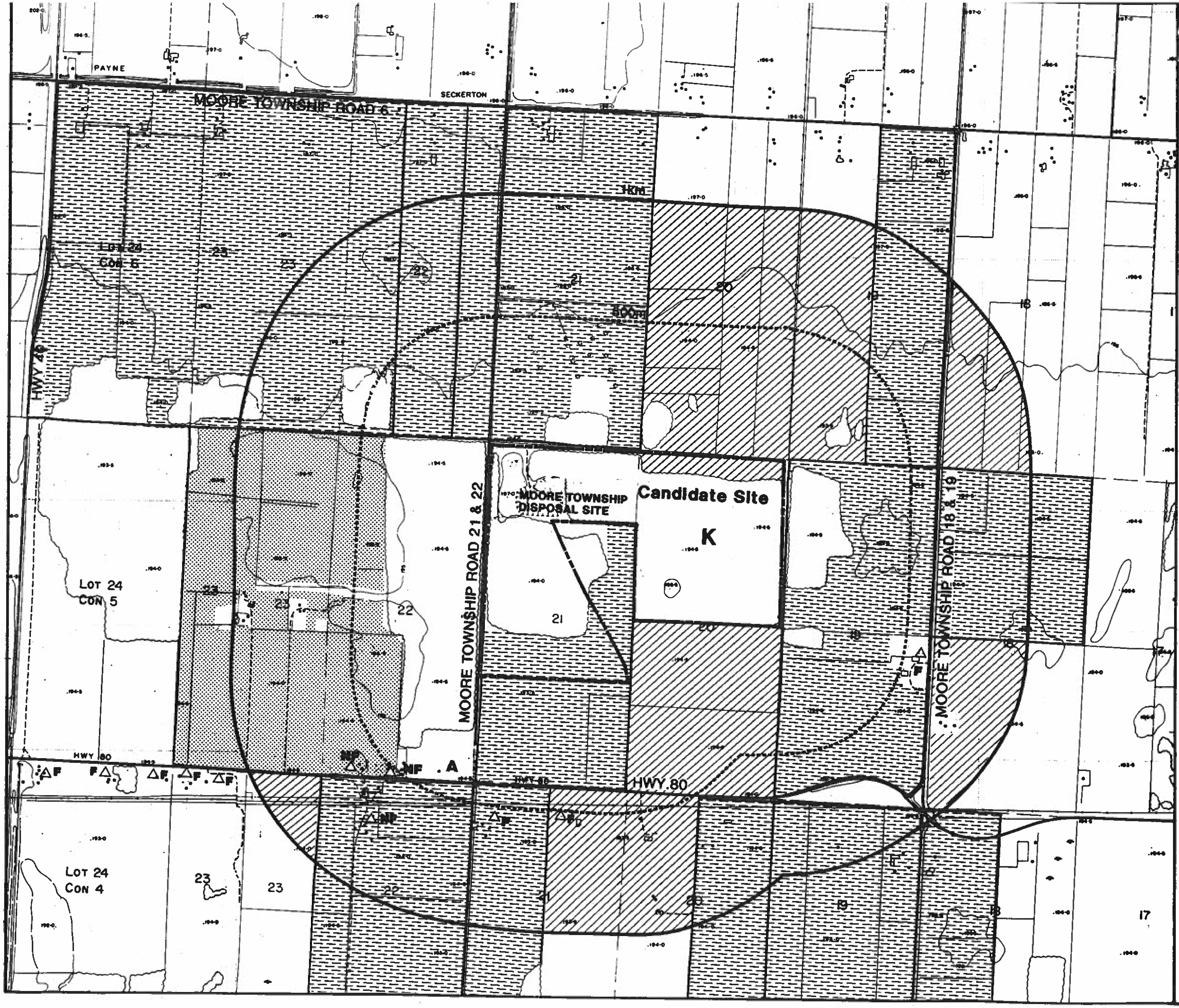
FIGURE No. 2



AGRICULTURE
SHORT LIST EVALUATION
SITE I

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 3



LEGEND

▤ FARMED LAND RENTED/OWNED BY FARMERS PERSONALLY INTERVIEWED

▩ FARMED LAND FOR WHICH COMPLETED QUESTIONNAIRE WAS RECEIVED

▨ OTHER FARMED LAND WITHIN STUDY AREA

△ RESIDENCE (F - FARM, NF - NON-FARM)

A INDICATES ABANDONED LAND USE

APPROXIMATE AREA (ALL USES) WITHIN 1km BOUNDARY = 890 ha

APPROXIMATE FARMED AREA (ALL DESIGNATIONS) WITHIN 1km BOUNDARY = 607 ha

APPROXIMATE FARMED AREA WITHIN STUDY AREA OWNED/RENTED BY FARMERS PERSONALLY INTERVIEWED = 360 ha OR 59 % OF FARMED AREA

APPROXIMATE FARMED AREA WITHIN STUDY AREA FOR WHICH COMPLETED QUESTIONNAIRE WAS RECEIVED = 86 ha OR 14 % OF FARMED AREA

100 0 500 1km

AGRICULTURE
SHORT LIST EVALUATION
SITE K

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 4

SCHEDULE II

LETTER FROM ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Ontario

Ministry of
Agriculture
and Food

Ministère de
l'Agriculture et
de l'Alimentation

P.O. Box 730
Petrolia, Ontario.
N0N 1R0

Agriculture & Rural Services

(519) 882-0180
1-800-265-1441

RECEIVED
JUL 26 1993
M.M. DILLON LTD.
TORONTO OFFICE

July 23, 1993.

Tom Young
M M Dillon Ltd.
100 Shepard Ave. E.
Toronto, Ontario.
M2N 6N5

Dear Tom:

I've taken the opportunity to inspect the agriculture in close proximity to sites D, K, H and I in Moore Township in Lambton County. All of the sites have good potential to produce the three main cash crops of our county namely corn, soybeans and wheat. The most negative impact on agriculture from both the aspect of taking the land out of production and impacting on surrounding agricultural operations would result from selection of site D or K, and the least would be from site H or I.

SITE D AND K

The corn and soybeans currently being grown around these sites shows the strong potential for crop production in that area. With respect to site K there is a question as to why it has a major indentation in it, because there will be an obvious impact on agriculture in that area being surrounded on three sides by a dump site. The farmsteads along the sixth line of Moore are the ones where the most impact from the dump would be seen. The sixth line development tends to be more traditional in terms of the smaller land holdings of one to two hundred acres rather than the larger less concentrated farms in other parts of the county. There are several very active commercial farms in that area including Mel Anderson's dairy farm, and Donald Anderson's beef farm.

SITE H AND I

In this general area there is less agricultural potential due to the land use in the close proximity, namely the Chemical Plants and by-product storage ponds. There are very few farmsteads anywhere near site H and I and the impact on neighbouring producers would be minimal certainly in comparison to site D and K.

As a result of my investigations and working knowledge of the areas involved, to have the least possible impact on agriculture in the areas surrounding the sites my recommendation for selection of sites would be:

First - H
Second - I
Third - D
Fourth - K

If I can be of further assistance to you, feel free to contact me.

Yours sincerely,

Bryan

Bryan Boyle
Agricultural Representative,
Lambton County.

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4B
BIOLOGY IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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Figure 3 Site H - Biology Short List Evaluation

Figure 4 Site I - Biology Short List Evaluation

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LIST OF SCHEDULES

Schedule I Species List

1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from a biological perspective. The purpose of this impact assessment was to identify the order of preference of the sites (i.e. best site(s) or worst site(s), if any) with respect to biological considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill component was considered to be the most significant in identifying and comparing potential biological impacts.

The key considerations addressed in this study were:

- the potential for loss of biological systems; and
- the potential for disruption of biological systems;

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the assessment and comparison of the potential biological impacts of the sites;
- the collection of data for the four sites according to the criteria and indicators identified;
- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to biological considerations; and
- the comparison of the sites' advantages and disadvantages to identify, from a biological perspective, the most preferred/least preferred site(s).

1.2 Biology Report Organization

This report is organized into four sections:

- Section 1 provides an introduction;
- Section 2 describes the study approach;
- Section 3 provides the site comparison and evaluation results; and
- Section 4 provides a summary.

2.0 STUDY APPROACH

2.1 Method

The basic method used in the detailed Biology comparison of the short list sites involved identifying units of habitat, classifying them into indicators (habitat types), measuring their area (or length), multiplying the indicator areas by the indicator and impact study zone weights, and summing the weighted scores. For easier comparison, the summed scores were normalized on a 0.0 to 1.0 scale by dividing each site score by the largest site score.

In the detailed comparison of the short list sites, the Biology evaluation becomes a more system-driven analysis. Rather than individual features alone, the combination of features becomes the focus. The overall Biology site ranking reflects the combination of a number of features. There is only one criterion, i.e. to compare potential for loss or disruption of biological systems. Indicators are habitat types which have meaning only after weighting according to assumed habitat value and impact magnitude.

Results were considered by observing site scores and potential variations with different weights. Where there was uncertainty about the real biological significance of an indicated difference in scores, sites were ranked equally. Site scores could have been modified by observations of significant species, but this did not seem necessary with the data collected.

All sites have some biological features on them or in close proximity. Consequently, all sites have some biological concerns associated with them, no matter how relatively minor. Sites with higher scores have higher relative impact associated with them and lower biological preference in site selection. Preferred sites would have relatively low impacts on natural habitats representative of pre-settlement conditions and would maintain future options with such habitats that exist in the area.

2.2 Study Area Used In Analysis

The study area used in the analysis consisted of each site plus a 1 km band around each site. This provides a broader area for study than the distance of 500 m from the perimeter of a fill area within which the most significant adverse environmental effects are considered to occur (Ontario Ministry of the Environment 1987). The off-site band was separated into three impact study zones. A 1-200 m impact study zone was differentiated because most off-site impacts are expected to be of greatest magnitude in close proximity to the site. Thus, there was a total of four impact study zones. Impact study zones were given progressively less weight due to probable less impact the further they occurred from the site according to the following weighting scale:

On-site	1.00
1-200 m from site	0.10
201-500 m from site	0.05
501-1,000 m from site	0.01

An additional impact study zone along haul routes was considered but not used in the numerical evaluation due to lack of information about the extent and relative impact value of such a study zone. If it had been used, there would not have been a change in Biology ranking of sites. The least preferred site had the most valuable habitat along its potential haul route and the most preferred site had the least valuable habitat along its potential haul route.

2.3 Dates of Data Collection

Sites H and I were visited on June 13 and 14 respectively in 1991 and all four sites were visited on the following dates in 1993:

May 27	Sites D and K
May 28	Sites H and I
June 19	Sites D and K
June 20	Sites H and I
June 21	Site H and vicinity, Site K
June 22	Sites D, H, and I
August 24	Sites H and I
August 25	Sites D and K
October 15	Sites D, H, I and K

Lists of species documented during site visits were compiled and are presented in Schedule I.

Secondary source data had been collected over several previous years of the site selection process. A check for updated agency information was made with the Ontario Ministry of Natural Resources (OMNR) Chatham office in July 1993. Further site investigations are recommended for the recommended site.

2.4 Key Assumptions

Key assumptions include the sufficiency of data collection for comparative purposes and the reasonableness of the weights that were used. At this stage, it was assumed that any on-site habitats would be either removed or very strongly impacted. Examination of preliminary facility characteristics and design indicated this to be a reasonable assumption. In the site selection process, the key mitigation measure is site avoidance. Detailed examination of further potential mitigation measures will not occur until a single site is selected.

The biological importance of all drains in similar physiographic conditions was not used in the evaluation and therefore was assumed equal. If biological evaluation of drains had been used, there is not likely to have been a change in the Biology ranking of sites. The major drain, Coyle Drain with permanent flow possible, flows along the west boundary of Site K (OMAF 1981). Investigations of the Rankin Drain east of Site I in 1991 identified some small fish, but flow was insufficient for fish habitat during 1993 investigations at this Drain. Surface water was also considered as a separate criteria group whose results are documented in a separate Appendix.

2.5 Data Collection

The key criterion, indicators, rationale and data sources are presented in Table 1. Indicators are derived from actual habitat types encountered. Other habitat types, including hedgerows, old fields and specimen trees, comprise such a small proportion of the study areas and are of such relatively low biological value that they were not deemed worthy of indicator status for this site comparison. These other habitat types may be described in more detail when a single site is selected.

TABLE 1
BIOLOGY INDICATORS FOR EVALUATION OF SHORT LIST SITES

Criterion	Indicators	Rationale	Data Sources
Compare potential for loss or disruption of biological systems	Amount and type of biological systems potentially affected: a) regional life science Area of Natural and Scientific Interest b) candidate sensitive area c) high quality forest d) medium quality forest e) shrub woodland f) ponds and open wetlands g) permanent natural streams	Biological systems represented by various habitat types provide the basic form and function for biological processes and diversity in the natural environment. Their identification allows the attribution of biological values and directs focus for protection, enhancement or monitoring actions.	• Topographic maps (scales of 1:10,000 and 1:50,000). • Aerial photographs (April 1992 at scale of 1:5,000). • OMNR Forest Resources Inventory Maps (1978, 1:10,000 scale). • Site visits and roadside checks. • Life science ANSI report (Lindsay 1984). • OMNR Sensitive Areas Reports (1977/78). • Government review agencies and the public.

Seven indicators were identified in the study areas. Definitions for the indicators and relative weights used within each impact study zone are described in Section 3.1.

3.0 COMPARISON OF RESULTS: ANALYSIS AND RESULTS

3.1 Existing Conditions With Respect to the Four Sites

Descriptions of the indicators (habitat types) and relative weights used are provided below.

a) Regionally Significant Life Science Area of Natural and Scientific Interest

One regionally significant life science Area of Natural and Scientific Interest (ANSI) known as Clay Creek Woodland occurs in the extreme east of the outer impact study zone of Site I. Life science ANSIs were selected by the OMNR to protect outstanding landscapes, environments and biotic communities not represented in Provincial Parks. A cabinet-approved policy for ANSIs was established in 1983 (OMNR 1983, 1987). Those which contribute to a lesser degree to the provincial protection objective than provincially significant life science ANSIs are considered to be regionally significant ANSIs. Clay Creek woodland is described as a large woodland of about 320 ha situated along Clay Creek and the Coyle Drain (Lindsay 1984). It is particularly noteworthy for its large size in the largely deforested area known as the Deciduous Forest Region (Rowe 1972). This indicator was given a relative weight of 8 per unit area (hectares).

b) Candidate Sensitive Area

OMNR Sensitive Areas Reports from 1977/78 describe an area known as Bickford Woods which is located in the study areas of Sites H and I. The area presumably did not have the quality to become an ANSI but was described to contain 105 ha with a "good sense of completeness" in the vegetation growth layers and included a concentration of swamp white oak and a good variety of other oaks and plant communities. More current examination indicates that it does contain a variety of communities ranging from hawthorn woodland to mature oak. Great Blue Herons were seen flying to and from the Bickford Woods area and a nesting colony may exist there but could not be confirmed.

During previous steps in the landfill siting, an attempt was made to avoid such areas but it appears that 4 ha in the northeast corner of Site H form an isolated part of this candidate sensitive area. The forest on-site could be considered high quality, with a component of sycamore (rare in the county according to Tiedje and Tiedje 1992) as well as oak and hickory. This indicator was given a relative weight of 4 per ha. Documented Environmentally Sensitive Areas (Hoffman *et al.* 1979/80) have been avoided in short list site selection.

c) High Quality Forest

Remaining wooded areas were categorized as "high quality forest", "medium quality forest" and "shrub woodland" in accordance with Figure 1. Both tree height and species composition were considered. The most valued (i.e. "high quality") forest is defined by a function of stand height and the proportion of tree species which are either most representative of stable forest composition in the Deciduous Forest Region (OMNR Site Region 7E) or known to be indicative of highly productive sites (Hills 1959; Braun 1964; Burger 1976; Leak 1982). These species include hard maples (sugar or black maple), oaks, hickories, walnuts, beech, sycamore, tulip-tree and/or white ash if it occurs with hard maple.

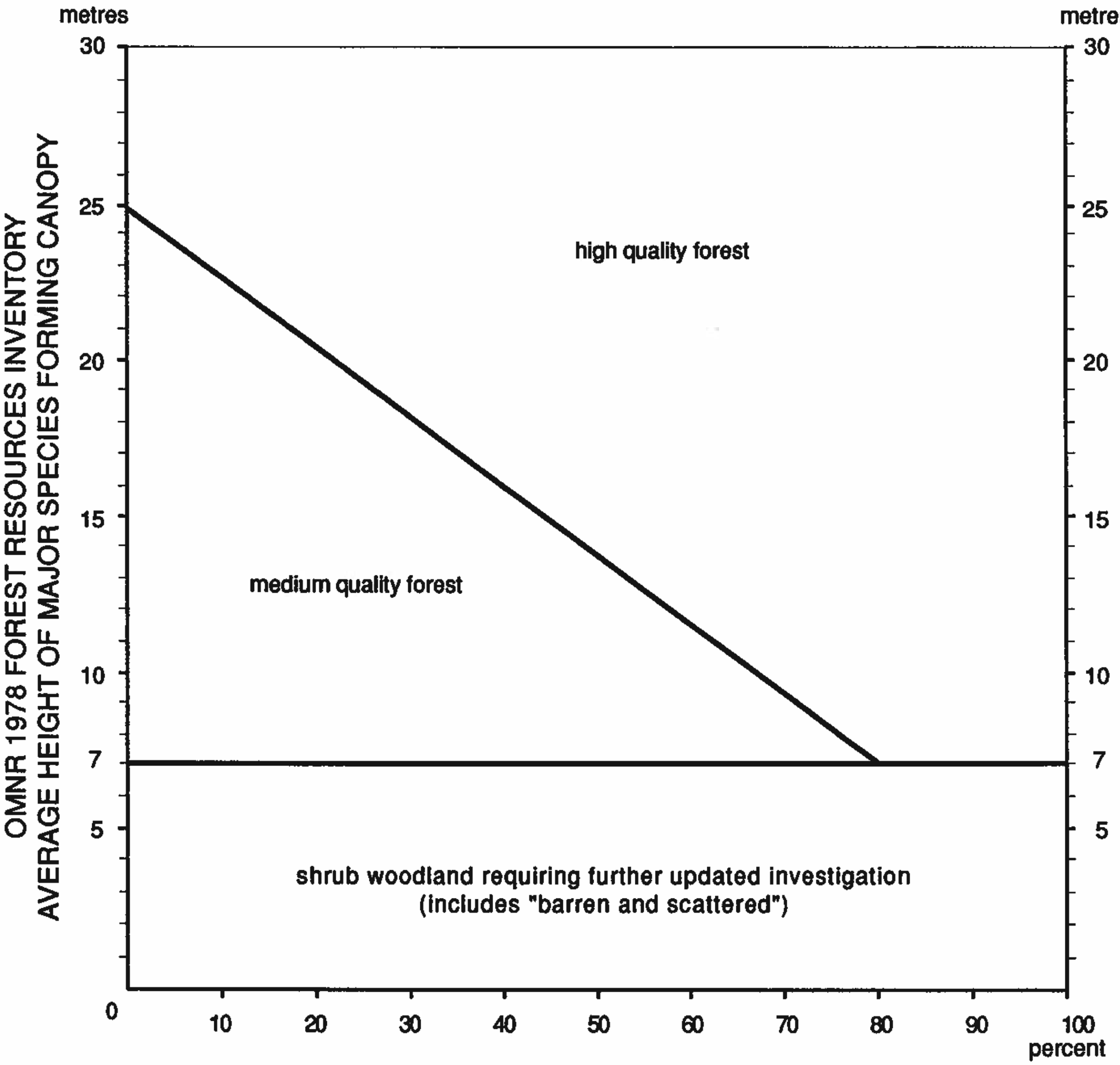
The designation of forest type was based on OMNR Forest Resource Inventory data complemented by aerial photography interpretation and site visit data (where available). This indicator was given a relative weight of 4 per ha.

d) Medium Quality Forest

Medium quality forest is also defined by a function of stand height and composition (see Figure 1). It is typically dominated by species other than those mentioned above describing "high quality" forest, often species such as soft maples, poplars, elms or red ash. These stands have often been cut for merchantable timber in the recent past and/or occur on poorly drained soils that limit the growth of many tree species. Wetland areas are common in the remaining naturally vegetated parts of the St. Clair clay plains physiographic region (Matthews *et al.* 1957, Chapman and Putnam 1984) and have generally not been classified by the OMNR using the Ontario wetland evaluation system (OMNR 1993). This indicator was given a relative weight of 2 per ha.

e) Shrub Woodland

Shrub woodland is typically dominated by hawthorns and prickly-ash, although scattered taller trees may occur. It is typically in long term succession from abandoned agricultural land to more mature forest. No significant areas of old field, an earlier successional type, were identified. Shrub woodland was given a relative weight of 1 per ha.



PROPORTION OF SPECIES INDICATING REPRESENTATIVE STABLE COMPOSITION OR HIGHLY PRODUCTIVE SITES:

ANY COMBINATION OF HARD MAPLES, OAKS, HICKORIES, WALNUTS, BEECH, SYCAMORE OR TULIP-TREE; INCLUDES WHITE ASH IF ASSOCIATED WITH HARD MAPLE

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
GUIDELINE FOR INITIAL DETERMINATION OF FOREST QUALITY
USING OMNR 1978 FOREST RESOURCES INVENTORY

FIGURE 1

f) Ponds and Open Wetlands

Ponds and open wetlands (naturally vegetated) form a small proportion of the study areas. Units of this indicator were given a relative weight of 4 per ha. The largest areas of this indicator are artificial evaporation ponds associated with the chemical plant south of Sites H and I. Only the older ponds of this complex, prior to recent pond expansion, were measured for the evaluation. The ponds are not natural but a reconnaissance visit indicated use by the provincially significant Ruddy Duck and Black Tern, as well as the regionally significant Lesser Scaup (OMNR 1993).

g) Permanent Natural Streams

Permanent natural streams in the study areas included the St. Clair River, Bowens Creek and Clay Creek. These were avoided with a buffer of at least 500 m during site definition. For comparative purposes, each 100 m length of such streams was made equivalent in weight to 2 ha of high quality forest. In recognition of its significance and public concern, the St. Clair River was also double-counted as both a permanent natural stream and a measurable ponded area. This is consistent with the emphasis in the Chatham District Fisheries Management Plan (OMNR 1990).

Table 2 provides the raw data together with the numerical site evaluation. Figures 2 to 5, show the habitats identified and used in the Biology evaluation of the four sites.

3.2 Mitigative Measures and Net Effects

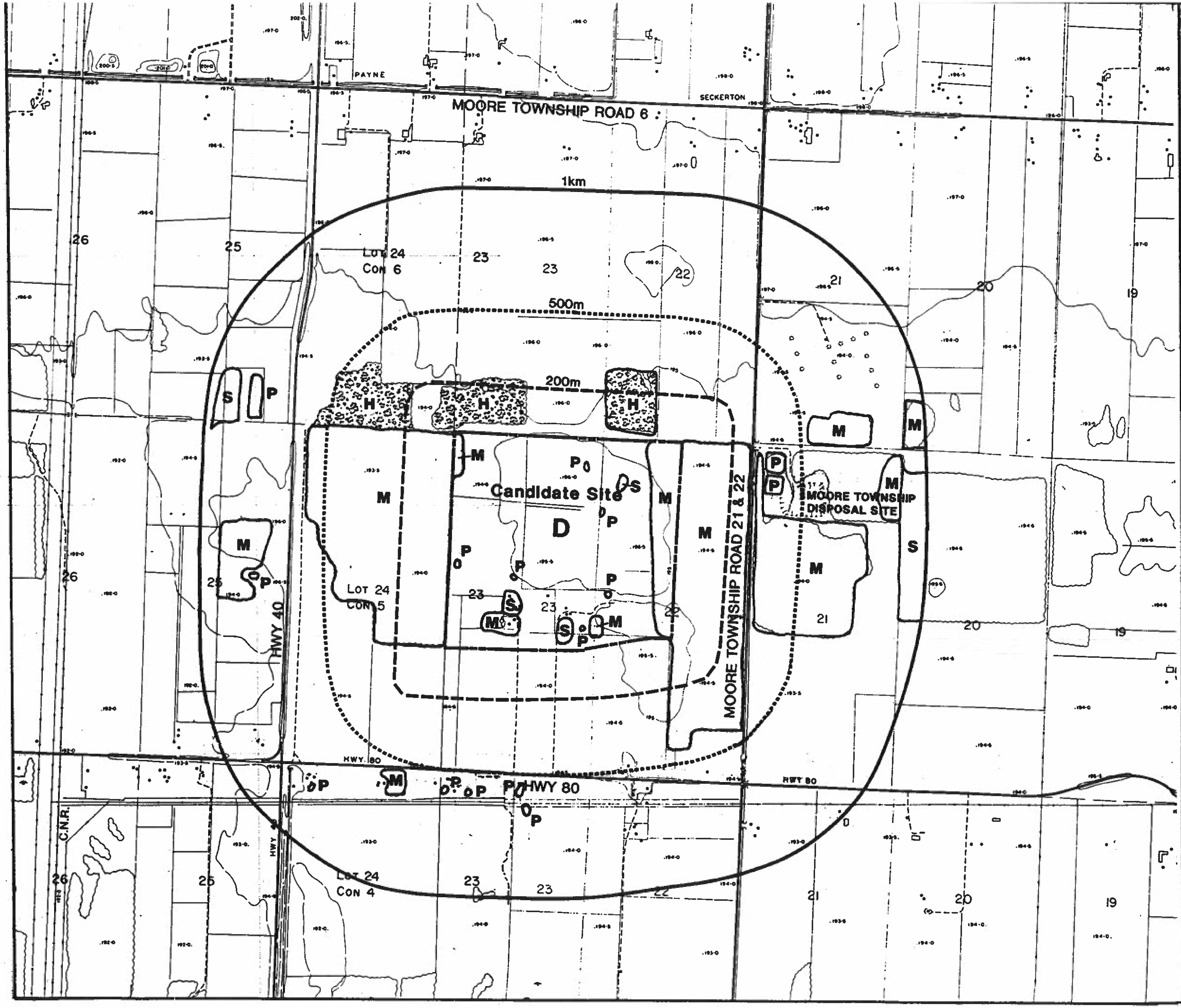
Tables 3 to 6 outline the possible environmental effects of a waste management facility on the sites, the mitigative measures that could be implemented to lessen the environmental impacts, and the net effects.

3.3 Advantages and Disadvantages of the Four Sites

Site K is clearly the site containing the most significant biological habitat. It contains a large and diverse forest classified as medium quality per average unit of area, although there are some sections with high quality characteristics (maturing oak and hickory) and other sections of noteworthy swamp wetland. A large shrub woodland provides significant transitional habitat. Noteworthy plants include Wild Crab Apple, which is rare

TABLE 2
BIOLOGY EVALUATION OF SHORT LIST SITES

IMPACT STUDY ZONES AND INDICATORS	Zone Weight	Indicator Weight	SITE D		SITE H		SITE I		SITE K	
			Amount ha or m	Wtd Amount	Amount ha or m	Wtd Amount	Amount ha or m	Wtd Amount	Amount ha or m	Wtd Amount
ON-SITE	1.00									
CANDIDATE SENSITIVE AREA		4	0.0	0.000	4.1	16.400	0.0	0.000	0.0	0.000
HIGH QUALITY FOREST		4	0.0	0.000	0.0	0.000	0.0	0.000	0.0	0.000
MEDIUM QUALITY FOREST		2	8.9	17.800	3.1	6.200	0.0	0.000	20.2	40.400
SHRUB WOODLAND		1	1.4	1.400	0.0	0.000	0.0	0.000	36.0	36.000
PONDS AND OPEN WETLANDS		4	0.6	2.400	0.2	0.800	0.0	0.000	0.8	3.200
0 m - 200 m ZONE	0.10									
CANDIDATE SENSITIVE AREA		4	0.0	0.000	1.6	0.640	4.0	1.600	0.0	0.000
HIGH QUALITY FOREST		4	9.8	3.920	0.0	0.000	6.6	2.640	0.0	0.000
MEDIUM QUALITY FOREST		2	38.2	7.640	2.1	0.420	4.5	0.900	41.5	8.300
SHRUB WOODLAND		1	0.0	0.000	14.6	1.460	3.5	0.350	0.2	0.020
PONDS AND OPEN WETLANDS		4	0.0	0.000	3.1	1.240	2.1	0.840	0.0	0.000
200 m - 500 m ZONE	0.05									
CANDIDATE SENSITIVE AREA		4	0.0	0.000	22.0	4.400	11.9	2.380	0.0	0.000
HIGH QUALITY FOREST		4	8.5	1.700	2.8	0.560	21.1	4.220	1.7	0.340
MEDIUM QUALITY FOREST		2	49.3	4.930	12.2	1.220	8.8	0.880	25.6	2.560
SHRUB WOODLAND		1	0.0	0.000	8.3	0.415	3.0	0.150	0.1	0.005
PONDS AND OPEN WETLANDS		4	0.8	0.160	11.5	2.300	11.3	2.260	0.1	0.020
500 m - 1000 m ZONE	0.01									
REGIONAL LIFE SCIENCE ANSI		8	0.0	0.000	0.0	0.000	5.0	0.400	0.0	0.000
CANDIDATE SENSITIVE AREA		4	0.0	0.000	36.1	1.444	39.2	1.564	0.0	0.000
HIGH QUALITY FOREST		4	0.0	0.000	37.0	1.480	41.3	1.652	4.2	0.168
MEDIUM QUALITY FOREST		2	25.5	0.510	22.4	0.448	23.4	0.468	0.7	0.014
SHRUB WOODLAND		1	6.7	0.067	38.1	0.381	14.2	0.142	1.1	0.011
PONDS AND OPEN WETLANDS		4	1.5	0.060	23.0	0.920	20.4	0.816	0.7	0.028
PERMANENT NATURAL STREAMS		8/100 m	0	0.000	1,500	1.200	1,300	1.040	0	0.000
TOTAL SCORE				40.587		41.928		22.302		91.066
NORMALIZED SCORE				0.446		0.460		0.245		1.000
BIOLOGY PREFERENCE RANK				**2**		**2**		**1**		**4**



LEGEND

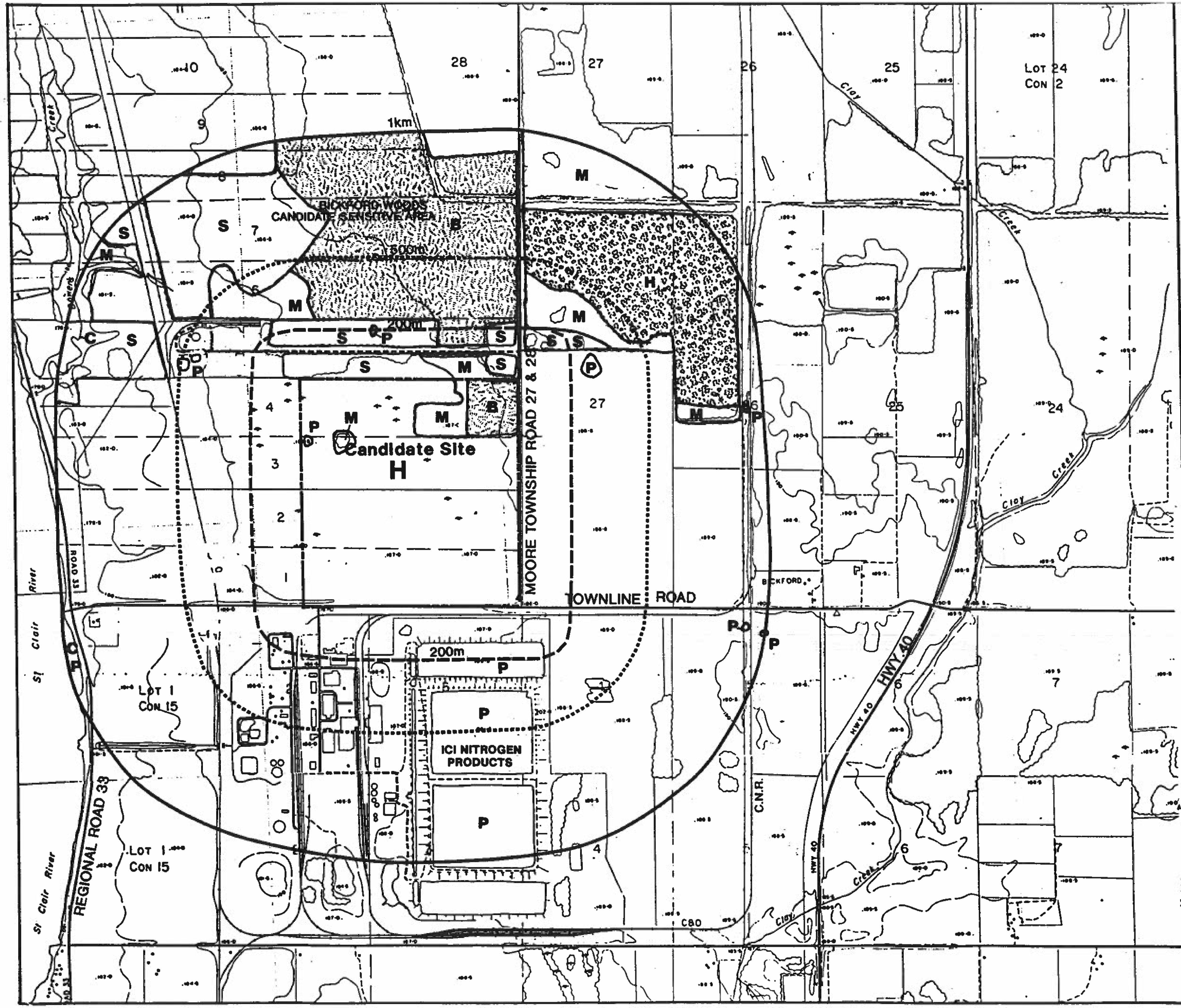
- ▨ H - HIGH QUALITY FOREST
- M - MEDIUM QUALITY FOREST
- S - SHRUB WOODLAND
- P - PONDS AND OPEN WETLANDS

BIOLOGY
SHORT LIST EVALUATION
SITE D

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928

FIGURE No. 2



LEGEND

▨ B - BICKFORD WOODS CANDIDATE SENSITIVE AREA

▨ H - HIGH QUALITY FOREST

M - MEDIUM QUALITY FOREST

S - SHRUB WOODLAND

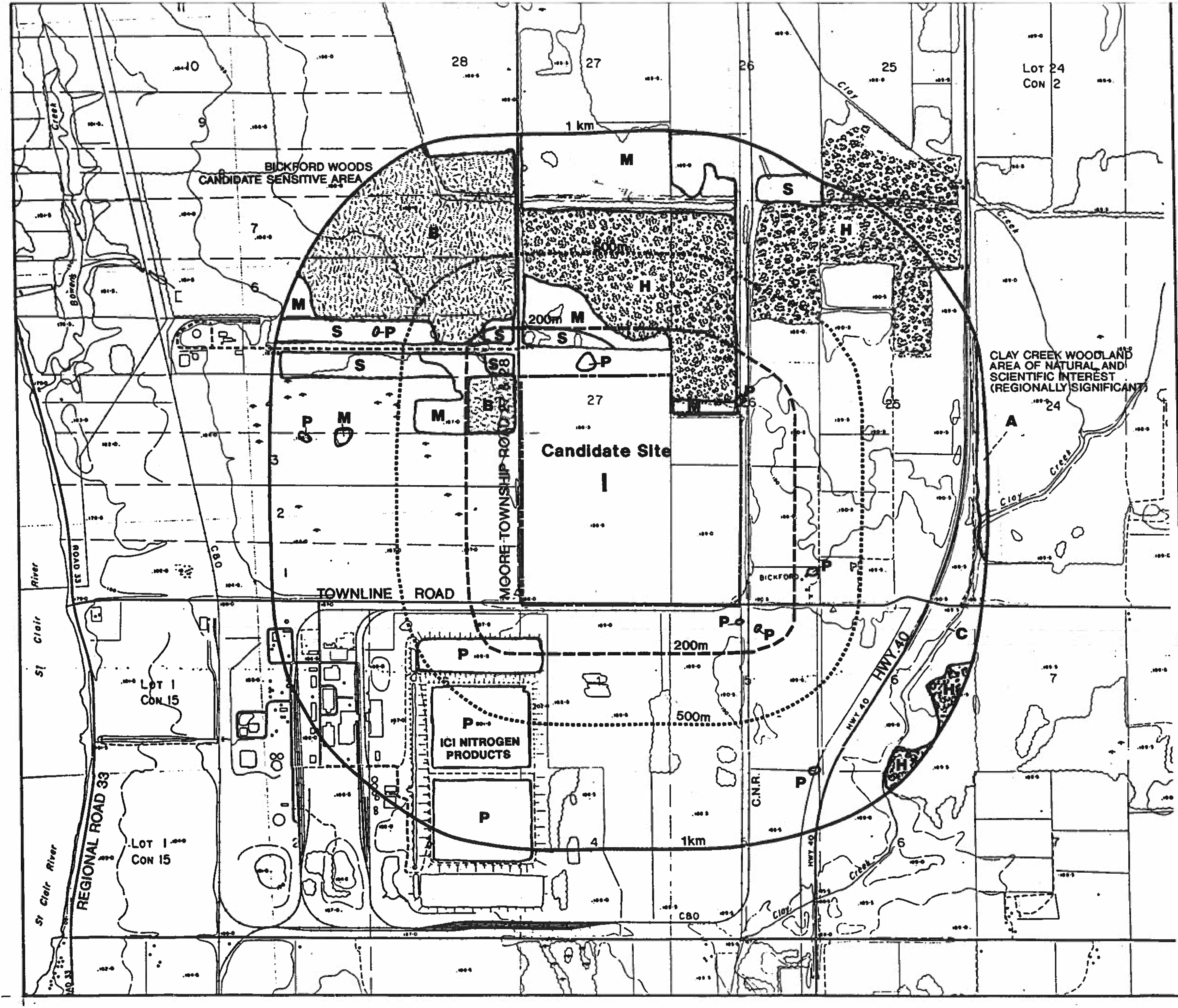
P - PONDS AND OPEN WETLANDS

C - PERMANENT NATURAL STREAMS

BIOLOGY
SHORT LIST EVALUATION
SITE H

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 3



LEGEND

A - REGIONAL LIFE SCIENCE AREA OF NATURAL AND SCIENTIFIC INTEREST

▨ **B** - BICKFORD WOODS CANDIDATE SENSITIVE AREA

▩ **H** - HIGH QUALITY FOREST

M - MEDIUM QUALITY FOREST

S - SHRUB WOODLAND

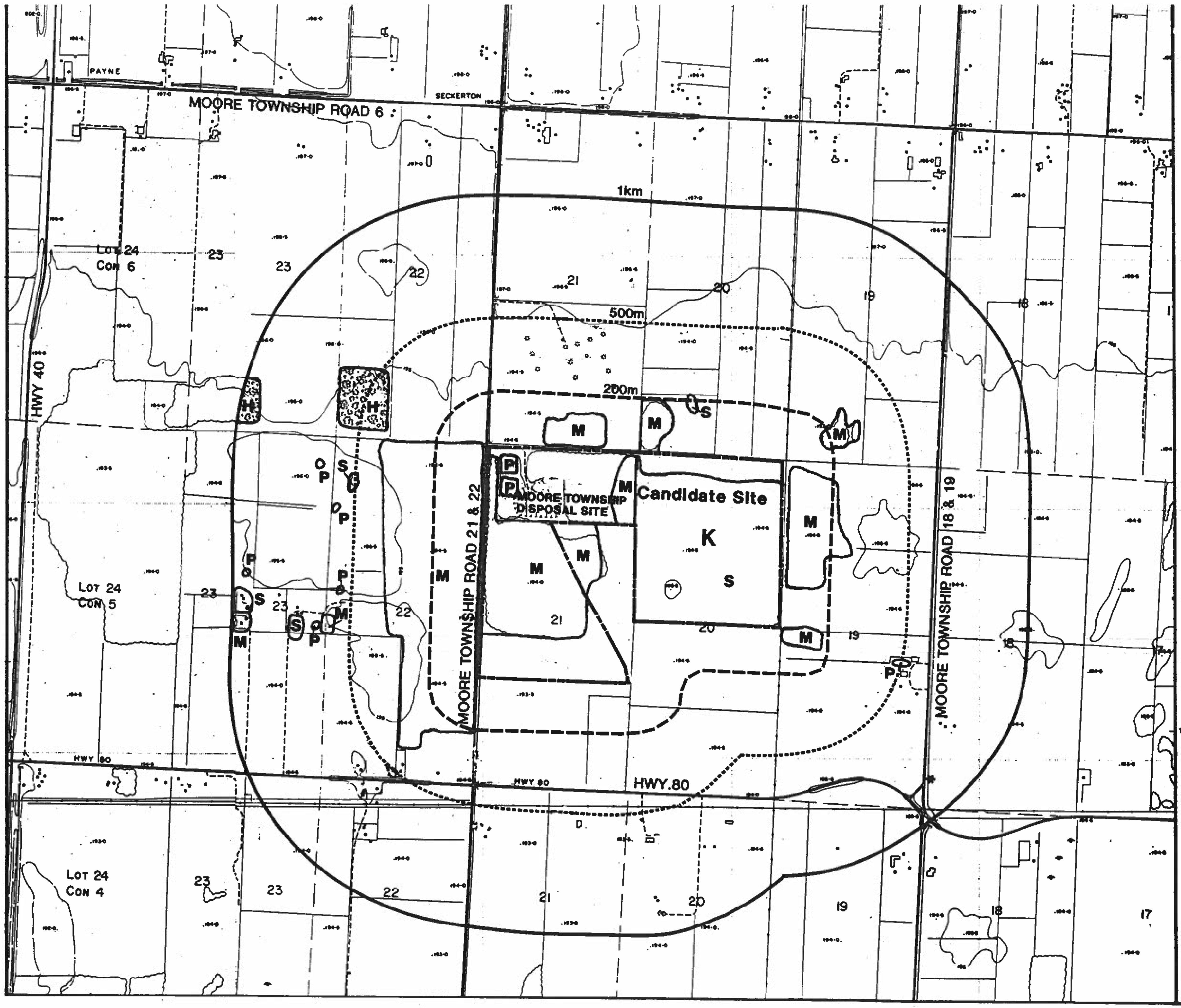
P - PONDS AND OPEN WETLANDS

C - PERMANENT NATURAL STREAMS

BIOLOGY
SHORT LIST EVALUATION
SITE I

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 4



LEGEND

- H- HIGH QUALITY FOREST
- M- MEDIUM QUALITY FOREST
- S- SHRUB WOODLAND
- P- PONDS AND OPEN WETLANDS

BIOLOGY
SHORT LIST EVALUATION
SITE K

**LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN**

Project No.9928 FIGURE No. 5

TABLE 3
BIOLOGY IMPACT ASSESSMENT: NET EFFECTS FOR SITE D

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
Compare Potential for Loss or Disruption of Biological Systems				
Regional life science Area of Natural and Scientific Interest (ANSI) on-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area on-site (ha)	0.0	· none	· none required	· none
High quality forest on-site (ha)	0.0	· none	· none required	· none
Medium quality forest on-site (ha)	8.9	· 8.9 ha of medium quality forest will be removed	· minimize forest removal · re-establish forest on equitable lands	· 8.9 ha of medium quality forest is open to remove
Shrub woodland on-site (ha)	1.4	· 1.4 ha of shrub woodland will be removed	· minimize shrub woodland removal · re-establish in suitable areas	· 1.4 ha of shrub woodland is open to removal
Ponds and open wetlands on-site (ha)	0.6	· 0.6 ha of ponds and open wetlands will be removed	· minimize removal of ponds and open wetlands · re-establish on suitable areas	· 0.6 ha of ponds and open wetlands is open to removal
Regional life science ANSI off-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area off-site (ha)	0.0	· none	· none required	· none
High quality forest off-site (ha)	18.3	· 18.3 ha of high quality forest will be disrupted	· pest control · maintain buffer between operations and adjacent habitats · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· with effective implementation of the recommended mitigative measures, the disruption effects will be minimized
Medium quality forest off-site (ha)	113.0	· 113 ha of medium quality forest will be disrupted	· as above	· as above
Shrub woodland off-site (ha)	6.7	· 6.7 ha of shrub woodland will be disrupted	· as above	· as above
Ponds and open wetlands off-site (ha)	2.3	· 2.3 ha of ponds and open wetlands will be disrupted	· as above	· as above
Permanent natural streams off-site (m)	0	· none	· none required	· none

TABLE 4
BIOLOGY IMPACT ASSESSMENT: NET EFFECTS FOR SITE H

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
Compare Potential for Loss or Disruption of Biological Systems				
Regional life science Area of Natural and Scientific Interest (ANSI) on-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area on-site (ha)	4.1	· 4.1 ha of candidate sensitive area will be removed	· minimize forest removal	· 4.1 ha of candidate sensitive area is open to removal
High quality forest on-site (ha)	0.0	· none	· none required	· none
Medium quality forest on-site (ha)	3.1	· 3.1 ha of medium quality forest will be removed	· minimize forest removal · re-establish forest on suitable lands	· 3.1 ha of medium quality forest is open to removal
Shrub woodland on-site (ha)	0.0	· none	· none required	· none
Ponds and open wetlands on-site (ha)	0.2	· 0.2 ha of ponds and wetlands will removed	· minimize removal · re-establish in suitable areas	· 0.2 ha of ponds and wetlands is open to removal
Regional life science ANSI off-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area off-site (ha)	59.7	· 59.7 ha of candidate sensitive area will be disrupted	· pest control · maintain buffer between operations and adjacent habitats · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· with effective implementation of the recommenced mitigative measures, the disruption effects will be minimized
High quality forest off-site (ha)	39.8	· 39.8 ha of high quality forest will be disrupted	· as above	· as above
Medium quality forest off-site (ha)	36.7	· 36.7 ha of medium quality forest will be disrupted	· as above	· as above
Shrub woodland off-site (ha)	61.0	· 61.0 ha of shrub woodland will be disrupted	· as above	· as above
Ponds and open wetlands off-site (ha)	37.6	· 37.6 ha of ponds and open wetlands will be disrupted	· as above	· as above
Permanent natural streams off-site (m)	1500	· 1500 m of permanent natural streams will be disrupted	· as above	· as above

TABLE 5
BIOLOGY IMPACT ASSESSMENT: NET EFFECTS FOR SITE I

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
Compare Potential for Loss or Disruption of Biological Systems				
Regional life science Area of Natural and Scientific Interest (ANSI) on-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area on-site (ha)	0.0	· none	· none required	· none
High quality forest on-site (ha)	0.0	· none	· none required	· none
Medium quality forest on-site (ha)	0.0	· none	· none required	· none
Shrub woodland on-site (ha)	0.0	· none	· none required	· none
Ponds and open wetlands on-site (ha)	0.0	· none	· none required	· none
Regional life science ANSI off-site (ha)	5.0	· 5.0 ha of regional life science ANSI will be disrupted	· pest control · maintain buffer between operations and adjacent habitats · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· with effective implementation of the recommended mitigative measures, the disruption effects will be minimized
Candidate sensitive area off-site (ha)	55.1	· 55.1 ha of candidate sensitive area will be disrupted	· as above	· as above
High quality forest off-site (ha)	69.0	· 69 ha of high quality forest will be disrupted	· as above	· as above
Medium quality forest off-site (ha)	36.7	· 36.7 ha of medium quality forest will be disrupted	· as above	· as above
Shrub woodland off-site (ha)	20.7	· 20.7 ha of shrub woodland will be disrupted	· as above	· as above
Ponds and open wetlands off-site (ha)	33.8	· 33.8 ha of ponds and open wetlands will be disrupted	· as above	· as above
Permanent natural streams off-site (m)	1300	· 1300 m of permanent natural streams will be disrupted	· as above	· as above

TABLE 6
BIOLOGY IMPACT ASSESSMENT: NET EFFECTS FOR SITE K

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
Compare Potential for Loss or Disruption of Biological Systems				
Regional life science Area of Natural and Scientific Interest (ANSI) on-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area on-site (ha)	0.0	· none	· none required	· none
High quality forest on-site (ha)	0.0	· none	· none required	· none
Medium quality forest on-site (ha)	20.2	· 20.2 ha of medium quality forest will be removed	· minimize forest removal · re-establish forest on suitable lands	· 20.2 ha of medium quality forest is open to removal
Shrub woodland on-site (ha)	36.0	· 36.0 ha of shrub woodland will be removed	· minimize forest removal · re-establish forest on suitable lands	· 36.0 ha of shrub woodland is open to removal
Ponds and open wetlands on-site (ha)	0.8	· 0.8 ha of ponds and open wetlands will be removed	· minimize forest removal · re-establish forest on suitable lands	· 0.8 ha of ponds and open wetlands is open to removal
Regional life science ANSI off-site (ha)	0.0	· none	· none required	· none
Candidate sensitive area off-site (ha)	0.0	· none	· none required	· none
High quality forest off-site (ha)	5.9	· 5.9 ha high quality forest will be disrupted	· pest control · maintain buffer between operations and adjacent habitats · screening and good housekeeping · dust suppression · litter control · leachate and surface drainage control	· with effective implementation of the recommended mitigative measures, the disruption effects will be minimized
Medium quality forest off-site (ha)	67.8	· 67.8 of medium quality forest will be disrupted	· as above	· as above
Shrub woodland off-site (ha)	1.4	· 1.4 ha of shrub woodland will be disrupted	· as above	· as above
Ponds and open wetlands off-site (ha)	0.8	· 0.8 ha of ponds and open wetlands will be disrupted	· as above	· as above
Permanent natural streams off-site (m)	0.0	· none	· none required	· none

in Lambton according to Tiedge and Tiedge (1992). Noteworthy bird species breeding on the site include Yellow-throated Vireo and Nashville Warbler. Yellow-throated Vireo is a bird of extensive southern deciduous woodlands and the Nashville Warbler is rare in Lambton County according to atlas (Cadman *et al.* 1987) data. Although not of direct biological interest, Site K is also the only site underlain by hydrocarbon gas resources according to the OMNR.

Site I is almost entirely cultivated and almost devoid of natural areas on-site (except for some hedgerows and specimen trees). Its vicinity does contain noteworthy forests and chemical plant evaporation ponds used by species such as the provincially significant Ruddy Duck and Black Tern, as well as Lesser Scaup that is rare in the Site Region (Windsor to Toronto), according to OMNR (1993).

Sites D and H both have noteworthy blocks of forest near their edges whose exclusion would significantly improve the impact level. Forest on Site H has a noteworthy component of sycamore (rare in Lambton) and has the same chemical plant evaporation ponds in its vicinity as Site I. Site D has some interesting small ponds used by Great Blue Herons as well as intermittent watercourses whose value may not be sufficiently reflected in the numerical evaluation.

3.4 Conclusions

Site I is biologically the most preferred site for facility siting. Sites D and H are in second preference and cannot be significantly differentiated at this level of analysis. Mitigation measures proposed for Sites D and H would include exclusion of the wooded blocks from the facility operating area. Site K is biologically the least preferred site. Site K consists predominantly of valuable biological habitats that could not be avoided by facility operations.

4.0 SUMMARY

Biology comparison of the four short list sites involved identifying units of habitat, classifying them into indicators (habitat types), measuring their area (or length), multiplying by indicator and impact study zone weights and summing the weighted scores.

The impact study zones used in the analysis consisted of each site plus three concentric ring zones around each site. Indicators were given progressively less weight due to probable less impact the further they occurred from the sites. Indicators within each zone were weighted in order of recognized biological value in terms of pre-settlement representativeness and maintaining future options.

Site I is biologically the most preferred site for site selection. Sites D and H are in second preference and cannot be significantly differentiated at this level of analysis. Mitigation measures proposed for Sites D and H would include exclusion of the wooded blocks from the facility operating area. Site K is biologically the least preferred site. Site K consists predominantly of valuable biological habitats that could not be avoided by facility operations.

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SCHEDULE I

SPECIES LIST

LIST OF VASCULAR PLANTS AT EACH SITE

Family	Scientific Name	Common Name	Status N = Native I = Introduced	Site Observed			
				D	H	I	K
PTERIDOPHYTES							
EQUISETACEAE	*Equisetum arvense*	Field Horsetail	N	√	√	√	√
DRYOPTERIDACEAE	*Dryopteris carthusiana*	Spinulose Wood Fern	N				√
	Onoclea sensibilis	Sensitive Fern	N	√	√		√
GYMNOSPERMS							
PINACEAE	*Picea abies*	Norway Spruce	I	√			
	Pinus nigra	Austrian Pine	I	√			
ANGIOSPERMS - MONOCOTYLEDONS							
ALISMATACEAE	*Alisma plantago-aquatica*	Water-plantain	N	√	√	√	√
ARACEAE	*Arisaema triphyllum*	Jack-in-the-pulpit	N	√	√		√
	Symplocarpus foetidus	Skunk-cabbage	N	√			
CYPERACEAE	*Carex cristatella*	Crested Sedge	N	√			
	Carex granularis	Granular Sedge	N				√
	Carex lupulina	Hop Sedge	N		√		√
	Carex stipata	Awl-fruited Sedge	N	√	√		√
	Carex vulpinoidea	Fox Sedge	N	√		√	√
	Cyperus esculentus	Yellow Nut Sedge	N	√			
	Eleocharis obtusa	Blunt Spike-rush	N		√		
	Scirpus atrovirens	Dark Green Bulrush	N	√	√		√
	Scirpus validus	Soft-stem Bulrush	N		√	√	
GRAMINEAE	*Agrostis gigantea*	Redtop	I	√	√		
	Aqrostis perennans	Autumn Bent Grass	N	√			
	Agrostis stolonifera	Creeping Bent	I/N	√			
	Bromus inermis	Smooth Brome	I	√	√	√	√
	Bromus latiglumis	Tall Brome	N	√	√	√	√
	Dactylis glomerata	Orchard Grass	I	√	√	√	√
	Digitaria sanguinalis	Large Crab Grass	I	√			√
	Echinocloa crusgalli	Barnyard Grass	I	√	√	√	√
	Elymus repens	Quack Grass	I	√	√	√	√
	Elymus virginicus	Virginia Wild-rye	N	√		√	√
	Festuca pratensis	Meadow Fescue	I		√	√	√
	Glyceria striata	Fowl Manna Grass	N				√
	Hordeum jubatum	Foxtail Barley	N	√		√	√
	Hystrix patula	Bottle Brush Grass	N	√			
	Leersia oryzoides	Rice Cut Grass	N		√	√	
	Lolium perenne	Perennial Rye Grass	I		√		
	Panicum capillare	Witch Grass	N	√	√		
	Phalaris arundinacea	Reed Canary Grass	N	√	√	√	√
	Phleum pratense	Timothy	I	√	√	√	√
	Phragmites australis	Common Reed	N	√	√	√	√

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	Scientific Name	Common Name	Status N = Native I = Introduced	Site Observed			
				D	H	I	K
GRAMINEAE (CONT'D)	*Poa annua*	Annual Blue Grass	I	√	√	√	
	Poa compressa	Canada Blue Grass	N	√			
	Poa pratensis	Kentucky Blue Grass	N	√	√	√	
	Setaria faberi	Giant Foxtail	I	√			
	Setaria pumila	Yellow Foxtail	I	√	√	√	√
	Setaria viridis	Green Foxtail	I	√	√	√	√
	Triticum aestivum	Wheat	I		√	√	
	Zea mays	Corn	I				√
IRIDACEAE	*Iris versicolor*	Wild Blue Flag	N	√			√
	Sisyrinchium angustifolium	Narrow-leaved Blue-eyed-grass	N				√
JUNCACEAE	*Juncus acuminatus*	Sharp-fruited Rush	N		√		
	Juncus dudleyi	Dudley's Rush	N	√			
	Juncus effusus	Soft Rush	N	√		√	√
LEMNACEAE	*Lemna minor*	Common Duckweed	N	√	√	√	√
LILIACEAE	*Asparagus officinalis*	Garden Asparagus	I				√
	Erythronium americanum	Yellow Trout Lily	N	√	√		√
	Hemerocallis fulva	Orange Day-lily	I		√		
	Maianthemum racemosum	False Solomon's-seal	N				√
	Trillium grandiflorum	White Trillium	N		√		
POTAMOGETONACEAE	*Potamogeton* sp.	Pondweed	N				√
TYPHACEAE	*Typha angustifolia*	Narrow-leaved Cattail	N	√	√	√	√
	Typha latifolia	Common Cattail	N	√	√	√	√
ANGIOSPERMS - DICOTYLEDONS							
ACERACEAE	*Acer negundo*	Manitoba Maple	N	√	√		
	Acer nigrum	Black Maple	N				√
	Acer rubrum	Red Maple	N	√	√		√
	Acer saccharinum	Silver Maple	N	√	√	√	√
	Acer saccharum	Sugar Maple	N				√
AMARANTHACEAE	*Amaranthus retroflexus*	Redroot Pigweed	I	√	√	√	√
ANACARDIACEAE	*Rhus radicans*	Poison-ivy	N	√	√	√	√
APOCYNACEAE	*Apocynum androsaemifolium*	Spreading Dogbane	N	√	√	√	√
	Apocynum cannabinum	Indian Hemp	N		√		
ASCLEPIADACEAE	*Asclepias incarnata*	Swamp Milkweed	N		√	√	
	Asclepias syriaca	Common Milkweed	N	√	√	√	√
	Cynanchum rossicum	Dog-strangling Vine	I	√	√	√	√
BALSAMINACEAE	*Impatiens capensis*	Spotted Jewelweed	N	√	√	√	√

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	Scientific Name	Common Name	Status N = Native I = Introduced	Site Observed			
				D	H	I	K
BERBERIDACEAE	*Berberis vulgaris*	Common Barberry	I				√
	Podophyllum peltatum	May-apple	N		√		√
BETULACEAE	*Betula papyrifera*	White Birch	N				√
	Carpinus caroliniana	Blue-beech	N	√	√		√
	Ostrya virginiana	Hop-hornbeam	N	√		√	√
BIGNONIACEAE	*Catalpa speciosa*	Catalpa	I	√			√
CANNABACEAE	*Cannabis sativa*	Marijuana	I		√		
CAPRIFOLIACEAE	*Lonicera tatarica*	Tartarian Honeysuckle	I			√	√
	Sambucus canadensis	Common Elder	N	√			√
	Sambucus racemosa ssp. *pubens*	Red-berried Elder	N				√
	Viburnum lentago	Nannyberry	N	√			√
	Viburnum rafinesquianum	Downy Arrow-wood	N				√
CELASTRACEAE	*Celastrus scandens*	Bittersweet	N			√	
	Euonymus obovata	Running Strawberry-bush	N				√
CHENOPODIACEAE	*Chenopodium album*	Lamb's-quarters	I	√	√	√	√
COMPOSITAE	*Achillea millefolium*	Common Yarrow	N/I	√	√	√	√
	Ambrosia artemisiifolia	Common Ragweed	N	√	√	√	√
	Ambrosia trifida	Giant Ragweed	N	√		√	√
	Arctium minus	Burdock	I	√	√	√	√
	Aster cordifolius	Heart-leaved Aster	N				√
	Aster ericoides	Heath Aster	N	√	√		
	Aster lanceolatus	Tall White Aster	N	√	√		√
	Aster lateriflorus	One-sided Aster	N	√			
	Aster macrophyllus	Large-leaved Aster	N			√	
	Aster novae-angliae	New England Aster	N	√	√	√	√
	Aster pilosus	Frost Aster	N	√		√	
	Aster puniceus	Purple-stemmed Aster	N			√	
	Bidens cernua	Nodding Beggarticks	N			√	√
	Bidens tripartita	Beggarticks	I	√			
	Chrysanthemum leucanthemum	Ox-eye Daisy	I		√	√	√
	Cichorium intybus	Chicory	I	√	√	√	√
	Cirsium arvense	Canada Thistle	I	√	√	√	√
	Cirsium vulgare	Bull Thistle	I	√	√	√	√
	Conyza canadensis	Horseweed (Canada Fleabane)	N		√	√	
	Erigeron annuus	Daisy Fleabane	N	√	√		√
	Erigeron philadelphicus	Philadelphia Fleabane	N		√	√	√
	Eupatorium perfoliatum	Boneset	N	√			

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	Scientific Name	Common Name	Status N = Native I = Introduced	Site Observed			
				D	H	I	K
COMPOSITAE (CONT'D)	*Eupatorium rugosum*	White Snakeroot	N				√
	Euthamia graminifolia	Grass-leaved Goldenrod	N	√	√		√
	Hieracium aurantiacum	Orange Hawkweed	I				√
	Hieracium caespitosum	Yellow Hawkweed	I				√
	Inula helenium	Elecampane	I	√	√	√	
	Lactuca serriola	Prickly Lettuce	I	√	√	√	√
	Solidago altissima	Late Goldenrod	N	√	√	√	√
	Solidago canadensis	Canada Goldenrod	N	√	√	√	√
	Sonchus arvensis	Perennial Sow-thistle	I	√			
	Sonchus asper	Spiny Sow-thistle	I	√		√	
	Sonchus oleraceus	Annual Sow-thistle	I			√	
	Taraxacum officinale	Common Dandelion	I	√	√	√	√
	Tragopogon pratensis	Meadow Goat's-beard	I	√		√	
	Tussilago farfara	Coltsfoot	I	√		√	
	Xanthium strumarium	Cocklebur	N/I	√	√	√	
CONVOLVULACEAE	*Convolvulus arvensis*	Field Bindweed	I		√	√	
CORNACEAE	*Cornus amomum*	Silky Dogwood	N	√			√
	Cornus foemina racemosa	Grey Dogwood	N	√	√	√	√
	Cornus stolonifera	Red-osier Dogwood	N				√
CRUCIFERAE	*Alliaria petiolata*	Garlic Mustard	I	√	√	√	√
	Barbarea vulgaris	Yellow Rocket	I		√	√	
	Hesperis matronalis	Dame's Rocket	I	√	√	√	√
	Lepidium campestre	Field Pepper-grass	I		√	√	
	Thlaspi arvense	Penny Cress	I		√	√	
DIPSACACEAE	*Dipsacus fullonum*	Teasel	I	√	√	√	√
EUPHORBIACEAE	*Acalypha virginica*	Three-seeded Mercury	N	√			√
FAGACEAE	*Fagus grandifolia*	American Beech	N		√		√
	Quercus alba	White Oak	N		√		√
	Quercus bicolor	Swamp White Oak	N	√	√		√
	Quercus macrocarpa	Bur Oak	N	√	√	√	√
	Quercus rubra	Red Oak	N	√	√		√
GERANIACEAE	*Geranium maculatum*	Wild Geranium	N	√	√	√	√
	Geranium robertianum	Herb Robert	I		√		√
GROSSULARIACEAE	*Ribes americanum*	Wild Black Currant	N	√	√	√	√
	Ribes cynosbati	Prickly Gooseberry	N		√	√	√
	Ribes rubrum	Red Currant	I	√			
GUTTIFERAE	*Hypericum perforatum*	Common St. John's-wort	I	√			√

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	Scientific Name	Common Name	Status N = Native I = Introduced	Site Observed			
				D	H	I	K
JUGLANDACEAE	*Carya cordiformis*	Bitternut Hickory	N		√		
	Carya ovata	Shagbark Hickory	N	√	√		√
	Juglans nigra	Black Walnut	N	√			√
LABIATAE	*Leonurus cardiaca*	Motherwort	I	√		√	√
	Lycopus americanus	American Water-horehound	N	√	√	√	√
	Mentha arvensis	Field Mint	N	√		√	√
	Mentha spicata	Spearmint	I				√
	Nepeta cataria	Catnip	I	√	√	√	
	Prunella vulgaris	Heal-all	N	√			√
	Scutellaria galericulata	Common Skullcap	N	√	√		
LEGUMINOSAE	*Amphicarpa bracteata*	Hog-peanut	N				√
	Gleditsia triacanthos	Honey Locust	N	√			
	Lathyrus sylvestris	Sweet Pea	I			√	√
	Lotus corniculatus	Birdsfoot Trefoil	I	√		√	√
	Medicago lupulina	Black Medic	I			√	
	Medicago sativa	Alfalfa	I	√			√
	Melilotus alba	White Sweet-clover	I	√	√	√	√
	Melilotus officinalis	Yellow Sweet-clover	I	√	√	√	√
	Trifolium hybridum	Alsike Clover	I	√			√
	Trifolium pratense	Red Clover	I	√	√	√	√
	Trifolium repens	White Clover	I	√	√	√	√
	Vicia cracca	Bird Vetch	I	√	√	√	√
	Vicia sativa	Common Vetch	I		√	√	
LYTHRACEAE	*Lythrum salicaria*	Purple Loosestrife	I	√			
MALVACEAE	*Abutilon theophrasti*	Velvetleaf	I	√	√	√	
	Malva neglecta	Common Mallow	I		√	√	
OLEACEAE	*Fraxinus americana*	White Ash	N	√	√	√	√
	Fraxinus nigra	Black Ash	N				√
	Fraxinus pennsylvanica	Red/Green Ash	N	√	√	√	√
ONAGRACEAE	*Circaea lutetiana*	Enchanter's-nightshade	N	√	√		√
	Oenothera biennis/ parviflora	Evening-primrose	N	√	√	√	√
OXALIDACEAE	*Oxalis stricta*	Wood-sorrel	N	√	√	√	√
PLANTAGINACEAE	*Plantago major*	Broad-leaved Plantain	I	√	√	√	√
PLATANACEAE	*Platanus occidentalis*	Sycamore	N, rare in county		√		
POLYGONACEAE	*Polygonum lapathifolium*	Nodding Smartweed	N	√	√		√
	Polygonum hydropiperoides	Mild Waterpepper	N		√		
	Polygonum persicaria	Lady's Thumb	I	√			

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	**Scientific Name**	**Common Name**	**Status** **N = Native** **I = Introduced**	**Site Observed**			
				D	**H**	**I**	**K**
POLYGONACEAE (CONT'D)	*Polygonum virginianum*	Jumpseed	N	√			
	Rumex crispus	Curly Dock	I	√	√	√	√
	Rumex obtusifolius	Bitter (Broad) Dock	I	√	√	√	√
	Rumex verticillatus	Water Dock	N				√
PRIMULACEAE	*Lysimachia ciliata*	Fringed Loosestrife	N	√		√	√
	Lysimachia vulgaris	Garden Loosestrife	I			√	
RANUNCULACEAE	*Actaea rubra*	Red Baneberry	N	√			√
	Anemone canadensis	Canada Anemone	N	√			√
	Clematis virginiana	Virgin's-bower	N		√	√	
	Ranunculus abortivus	Small-flowered Buttercup	N		√		
	Ranunculus pensylvanicus	Bristly Crowfoot	N		√	√	
	Ranunculus sceleratus	Cursed Crowfoot	I				√
RHAMNACEAE	*Rhamnus cathartica*	Purging Buckthorn	I	√			√
	Rhamnus frangula	Glossy Buckthorn	I				√
ROSACEAE	*Agrimonia gryposepala*	Agrimony	N	√	√		√
	Amelanchier arborea	Serviceberry	N				√
	Crataegus calpodendron	Late-flowering Hawthorn	N			√	√
	Crataegus corusca	Hawthorn	N			√	
	Crataegus crus-galli	Cockspur Hawthorn	N	√	√	√	√
	Crataegus pedicellata	Scarlet Thorn	N			√	
	Crataegus punctata	Dotted Hawthorn	N		√		√
	Fragaria virginiana	Common Strawberry	N	√	√	√	√
	Geum aleppicum	Yellow Avens	N	√	√	√	√
	Geum canadense	White Avens	N	√	√		
	Geum laciniatum	Cut-leaved Avens	N		√	√	
	Malus coronaria	Wild Crab Apple	N, rare in county				√
	Malus pumila	Apple	I	√	√	√	√
	Potentilla norvegica	Rough Cinquefoil	N/I	√	√	√	√
	Potentilla recta	Rough-fruited Cinquefoil	I	√		√	√
	Prunus nigra	Canada Plum	N			√	
	Prunus serotina	Wild Black Cherry	N		√		√
	Prunus virginiana	Choke Cherry	N	√	√	√	√
	Pyrus communis	Pear	I	√	√		
	Rosa multiflora	Multiflora Rose	I	√	√	√	√
	Rosa rubiginosa	Sweetbriar	I	√			
	Rosa palustris	Swamp Rose	N	√			√
	Rubus allegheniensis	Common Blackberry	N				√

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	Scientific Name	Common Name	Status N = Native I = Introduced	Site Observed			
				D	H	I	K
ROSACEAE (CONT'D)	*Rubus idaeus*	Wild Red Raspberry	N	√	√	√	√
	Rubus occidentalis	Black Raspberry	N				√
	Spiraea alba	Meadowsweet	N	√	√	√	√
RUBIACEAE	*Cephalanthus occidentalis*	Buttonbush	N	√	√	√	√
	Galium aparine	Cleavers	N/I	√	√	√	√
	Galium mollugo	Wild Madder	I				√
	Galium palustre	Marsh Bedstraw	N				√
RUTACEAE	*Zanthoxylum americanum*	Prickly-ash	N	√	√	√	√
SALICACEAE	*Populus x canadensis*	Carolina Poplar	N		√	√	√
	Populus deltoides	Cottonwood	N	√	√		√
	Populus tremuloides	Trembling Aspen	N	√			√
	Salix alba	White Willow	I	√			
	Salix fragilis	Crack Willow	I	√	√	√	√
	Salix petiolaris	Slender Willow	N	√			
	Salix x rubens	Hybrid Willow			√		
SAXIFRAGACEAE	*Penthorum sedoides*	Ditch Stonecrop	N	√	√		
SCROPHULARIACEAE	*Mimulus ringens*	Monkey-flower	N	√			√
	Verbascum thapsus	Common Mullein	I		√	√	√
	Veronica serpyllifolia	Thyme-leaved Speedwell	I	√			
SOLANACEAE	*Solanum dulcamara*	Climbing Nightshade	I	√	√	√	√
	Solanum ptycanthum	Eastern Black Nightshade	I	√			
TILIACEAE	*Tilia americana*	Basswood	N		√	√	√
ULMACEAE	*Ulmus americana*	White Elm	N	√	√	√	√
UMBELLIFERAE	*Cicuta maculata*	Spotted Water-hemlock	N	√	√	√	√
	Cryptotaenia canadensis	Honewort	N		√		
	Daucus carota	Wild Carrot	I	√	√	√	√
	Osmorhiza claytonii	Sweet Cicely	N		√	√	√
	Sanicula trifoliata	Black Snakeroot	N		√		√
	Sium sauve	Water-parsnip	N	√	√	√	
URTICACEAE	*Boehmeria cylindrica*	False Nettle	N				√
	Laportea canadensis	Wood Nettle	N	√			√
	Pilea pumila	Clearweed	N	√	√		
	Urtica dioica	Stinging Nettle	N	√	√	√	√
VERBENACEAE	*Verbena hastata*	Blue Vervain	N	√	√	√	√
	Verbena urticifolia	White Vervain	N			√	
VIOLACEAE	*Viola affinis*	Marsh Violet	N		√		
	Viola canadensis	Canada Violet	N				√
	Viola sororia	Common Blue Violet	N				√

LIST OF VASCULAR PLANTS AT EACH SITE
(Continued)

Family	**Scientific Name**	**Common Name**	**Status** **N = Native** **I = Introduced**	**Site Observed**			
				D	**H**	**I**	**K**
VITACEAE	*Parthenocissus inserta*	Virginia Creeper	N	√	√	√	√
	Vitis riparia	Riverbank Grape	N	√	√	√	√

COMPARISON OF BIRD SPECIES AT EACH SITE

KEY

A	Species present and probably breeding.
B	Species expected based on habitat considerations.
C	Species present and probably not breeding.
D	Species identified off-site within 1 km of site.

Common Name	**Scientific Name**	**Site**			
		D	**H**	**I**	**K**
Great Blue Heron	*Ardea herodias*	C	C	C	
Canada Goose	*Branta canadensis*		D	D	A
Green-winged Teal	*Anas crecca*		D	D	
Mallard	*Anas platyrhynchos*	B	D	A	A
Blue-winged Teal	*Anas discors*		D	D	A
Gadwall	*Anas strepera*		D	D	
Lesser Scaup	*Aythya affinis*		D	D	
Ruddy Duck	*Oxyura jamaicensis*		D	D	
Turkey Vulture	*Cathartes aura*		A		A
Northern Harrier	*Circus cyaneus*	A			
Red-tailed Hawk	*Buteo jamaicensis*	B	A	B	B
American Kestrel	*Falco sparverius*	B	A		B
Killdeer	*Charadrius vociferus*	A	A	A	A
Spotted Sandpiper	*Actitis macularia*	A			A
American Woodcock	*Scolopas minor*				B
Black Tern	*Chlidonias niger*		D	D	
Rock Dove	*Columba livia*	B	B		
Mourning Dove	*Zenaida macroura*	A	A	A	A
Black-billed Cuckoo	*Coccyzus erythropthalmus*				A
Eastern Screech Owl	*Otus asio*				A
Great Horned Owl	*Bubo virginianus*	A	A	A	B
Ruby-throated Hummingbird	*Archilochus colubris*				A
Downy Woodpecker	*Picoides pubescens*		B		A
Northern Flicker	*Colaptes auratus*	B	A		A
Eastern Wood-Peewee	*Contopus virens*	A	A		A
Willow Flycatcher	*Empidonax traillii*	A			A
Least Flycatcher	*Empidonax minimus*				A
Great Crested Flycatcher	*Myriachus crinitus*				A
Eastern Kingbird	*Tyrannus tyrannus*		A	A	A

COMPARISON OF BIRD SPECIES AT EACH SITE
(Continued)

Common Name	Scientific Name	Site			
		D	H	I	K
Horned Lark	*Eremophila alpestris*		A	A	
Tree Swallow	*Tachycineta bicolor*	B	A	C	B
Barn Swallow	*Hirundo rustica*	A	C	C	B
Blue Jay	*Cyanoscitta cristata*	A	B		A
American Crow	*Corvus brachyrhynchos*	A	A	A	A
Black-capped Chickadee	*Parus atricapillus*	A			A
White-breasted Nuthatch	*Sitta carolinensis*		B		A
House Wren	*Troglodytes aedon*		B		A
Veery	*Catharus fuscescens*				B
Wood Thrush	*Hylocichla mustelina*	A	B		A
American Robin	*Turdus migratorius*	A	A	A	A
Gray Catbird	*Dumetella carolinensis*	A	A		A
Brown Thrasher	*Toxostoma rufum*				B
Cedar Waxwing	*Bombycilla cedrorum*		B		A
European Starling	*Sturnus vulgaris*	A			A
Yellow-throated Vireo	*Vireo flavifrons*				A
Warbling Vireo	*Vireo gilvus*		A		A
Red-eyed Vireo	*Vireo olivaceus*		A		A
Blue-winged Warbler	*Vermivora pinus*				B
Nashville Warbler	*Vermivora ruficapilla*				A
Yellow Warbler	*Dendroica petechia*	A	A	C	A
American Redstart	*Setophaga ruticilla*		A		A
Ovenbird	*Seiurus aurocapillus*				A
Common Yellowthroat	*Geothylpis trichas*	A	A		A
Scarlet Tanager	*Piranga rubra*				A
Northern Cardinal	*Cardinalis cardinalis*	A	B	B	A
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	B	A		A
Indigo Bunting	*Passerina cyanea*	A	A	A	A
Field Sparrow	*Spizella pusilla*				A
Vesper Sparrow	*Pooecetes gramineus*	A	A	A	A
Savannah Sparrow	*Passerculus sandwichensis*	B	A	A	A
Song Sparrow	*Melospiza melodia*	A	A	A	A
Red-winged Blackbird	*Agelaius phoeniceus*	A	A	A	A

COMPARISON OF BIRD SPECIES AT EACH SITE
(Continued)

Common Name	Scientific Name	Site			
		D	H	I	K
Eastern Meadowlark	*Sturnella magna*	B	A		B
Common Grackle	*Quiscalus quiscula*	A	A	A	A
Brown-headed Cowbird	*Molothrus ater*	A	A	A	A
Northern Oriole	*Icterus galbula*	A	A	B	A
House Finch	*Carpodacus mexicanus*		A	A	
American Goldfinch	*Carduelis tristis*	A	A	A	A

Note: For purposes of this study, the presence of pairs of birds or singing males in June, in suitable habitat, has been taken as "probably breeding". In some cases, definitive evidence such as nest with eggs was observed but was not necessary.

OTHER WILD VERTEBRATES OBSERVED AT EACH SITE

Common Name	Scientific Name	Site			
		D	H	I	K
AMPHIBIANS					
Salamander	*(unidentified species)*		√		
American Toad	*Bufo americanus*	√	√	√	√
Gray Treefrog	*Hyla versicolor*	√	√		√
Northern Leopard Frog	*Rana palustris*	√	√	√	√
Green Frog	*Rana clamitans*	√	√	√	√
REPTILES					
Common Garter Snake	*Thamnophis sirtalis*		√		
MAMMALS					
Eastern Cottontail	*Sylvagus floridanus*				√
Woodchuck	*Marmota monax*		√		
Grey Squirrel	*Sciurus carolinenis*		√		
European Hare	*Lepus europaeus*		√	√	
Raccoon	*Procyon lotor*				√
White-tailed Deer	*Odocoileus virginianus*	√	√	√	√

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4C
DESIGN AND OPERATIONS ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Site D, H, I and K - from a design and operations perspective. The purpose of this assessment was to identify the order of preference of the sites (i.e. best sites(s) or worst site(s)) with respect to design and operations considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

The key considerations addressed in this study were:

- the potential landfill capacity of each site; and
- the potential differences in site development costs at the four sites, including the cost of clearing and grubbing, fencing, power servicing, road works and leachate treatment.

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the design and operations assessment;
- the collection of data for the four sites according to the criteria and indicators identified;
- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to design and operations considerations;
- the comparison of the sites' advantages and disadvantages to identify, from a design and operations perspective, the most preferred/least preferred site(s).

1.2 Technical Report Organization

The report is organized into four chapters.

Chapter 1 - Introduction

A description of the purpose and objectives of the site comparison and the organization of the report.

Chapter 2 - Study Approach

An outline of the study methodology and a description of the study area, time frame, and assumptions used to make the site comparisons.

Chapter 3 - Comparison of the Sites: Analysis and Results

A description of the existing site conditions, a comparison of the sites based on the design and operations criteria, and the results of the study.

Chapter 4 - Summary

A summary of the results and conclusions of the site comparison based on design and operations.

2.0 STUDY APPROACH

2.1 Overview of Method Used to Assess and Compare the Four Sites

The four potential sites were evaluated under the two headings of Service and Cost.

The criterion under the heading of Service is to compare the potential landfill capacity of each site.

Under the heading of Cost, the criterion is to compare the site development costs. For each site, the following indicators of cost were measured:

- clearing and grubbing;
- fencing;
- power servicing;
- access/on-site road development; and
- leachate treatment.

The cost indicators were selected to identify potential differences in site development costs. Capital costs for features common to each site were not considered. Operating, closure, and post-closure costs were also not considered because these costs would be common to each site regardless of the site location.

For each indicator, a cost was estimated and the total site development cost for each site was tabulated. An evaluation was made based on potential landfill capacity and site development costs to identify significant differences between the sites.

Common service-related criteria such as reliability and flexibility were not considered in the site comparison. An assessment of reliability was not undertaken because each of the sites were considered equal at this stage in the site selection process. In terms of design and operations, the measure of reliability would relate to the design of leachate or gas control systems. Because the hydrogeological evaluation determined that the sites were hydrogeologically similar, the design of leachate or gas control works would be the same for each site. Therefore, a reliability criterion would not lead to the identification of significant differences between the sites.

Flexibility is often measured in the site layout, landfill development direction, and design and operation of the leachate control system. It was assumed that each of the sites may be considered equal in terms of flexibility. Site layout is largely a function of useful site area which is being measured by potential landfill capacity. Landfill development direction is not likely to be critical given the remote locations of the potential sites, and design and operation of the leachate control systems can be considered the same for each site.

2.2 Study Area

The study area considered under the criterion to compare the potential landfill capacity, was limited to the proposed property limits of each site.

For most of the indicators under cost, the study area was limited to the proposed site boundaries. However, to compare the costs of power servicing, the distance to the appropriate power source determined the size of the study area for that indicator. The distance beyond the site's boundaries to the nearest access road defined the study area for evaluating the capital cost of access road development. The study area for evaluating the cost of leachate treatment was defined by the haul distance from the site to the final leachate treatment location.

2.3 Time Frame

The time frame used to evaluate the potential landfill capacity was the proposed 20-year life span of the proposed landfill facility. Site development costs were estimated using 1993 dollars. Other than leachate treatment, the cost of each indicator was a one-time capital cost.

For leachate treatment, the cost was estimated based on the present value cost for hauling leachate to the Leachate Treatment Facility at the Sarnia Landfill over a period of one hundred years.

2.4 Key Assumptions

The potential landfill capacity was estimated for each site based on the generic composite facility characteristic assumptions included in Schedule I. Figures showing the site location, size, and the preliminary layout of site features are also appended to Schedule I.

Costing assumptions for the comparison of site development costs criterion are described below for each indicator. Effort was made to use realistic cost estimates for each indicator; however, because the comparison of costs between sites is relative, the accuracy of the unit costs should not influence the comparative evaluation because the same unit costs were applied to each site.

Land purchase costs were not included in the site development costs because the purchase price will be negotiated at the time of purchase.

Clearing and Grubbing

An assessment was made on each site by the natural environment group to identify areas of medium quality forest and shrub woodland on the 1:10000 mapping. Separate costs were used for clearing and grubbing depending on the type of vegetation.

Fencing

The cost of supplying and installing chain-link fencing was estimated assuming the fence would be located around the entire perimeter of each site.

Power Servicing

It was assumed that a 500 kVA service would be required for each site. An estimate was prepared in conjunction with Ontario Hydro to bring power service from the nearest available line to the proposed Materials Recovery Facility at each site. It was assumed that an overhead line would be used to bring power into each site.

Road Works

The road works cost estimate was prepared assuming that access and on-site roads would be upgraded or constructed to a paved roadway suitable for heavy truck traffic.

Leachate Treatment

Leachate treatment costs assume that leachate from the waste disposal facility will be trucked to the existing Leachate Treatment Facility (LTF) at the Sarnia Landfill Site.

It was assumed for the purposes of this site comparison, that the leachate from the sites would be hauled to treatment for 100 years. A cost of leachate haulage to the Sarnia LTF was estimated for Site H assuming the leachate would be transported in a 9000 gallon (41 m^3) truck. The quantity of leachate was estimated in year 20 assuming a leachate generation rate of 200 mm/year. After applying the generation rate to the 1,000,000 tonne landfill area, daily leachate production was estimated at about 73 m^3/day (16,000 imperial gallons per day).

Truck operating costs and the driver's salary including benefits were estimated for Site H at $110,000 for year 20. Truck operating costs were assumed to be $1.60 per kilometre. A linear increase in truck and salary cost was assumed for years 0 to 20 and a uniform cost of leachate disposal was assumed for years 21 to 100 after the landfill is expected to close. The present value of these annual costs was calculated using a discount rate of 6% to arrive at the 100-year cost estimate of $1.08 million. The leachate disposal cost estimate for Site H was adjusted for each of the other sites according to the haul distance to the LTF.

The rationale for selecting leachate treatment at the existing landfill site, as opposed to building a new leachate treatment facility on-site and pumping effluent from the treatment to a municipal sewage treatment plant (STP), is primarily cost savings. The cost of treating leachate at the existing LTF at the Sarnia Landfill is very low in comparison to capital and operating costs for a new treatment facility and the cost of installing a forcemain for effluent to an existing sewage treatment plant (STP) such as Corunna. This is based on the assumption that on-site pre-treatment of the leachate would be necessary to meet the sewer use by-law allowing discharge to a STP.

A key assumption supporting the trucking of leachate to the LTF is available capacity. Currently, the LTF is treating between 4000 and 5000 imperial gallons per day (Igpd) (18 to 23 m^3/day). The amount of leachate generated is expected to increase slightly with the contribution of the 5-year expansion of the site, then decline upon site closure when the site will be covered with a low permeability cap. The LTF is sized to treat between 10,000 and 30,000 Igpd. Given the current flows, it appears that the LTF would be able to accommodate the extra leachate that would be generated by the long-term site.

2.5 Data Collection

The potential landfill capacity for each of the sites was computed using the composite facility characteristic assumptions included in Schedule I. Features including the access roads, scales, on-site roads, materials recovery facility, storm water management ponds, and stockpile areas were plotted on each 1:10000 scale site plan and the remaining space was allocated as potential landfill areas. For each site, separate blocks of land were allocated for landfill development.

Data sources for estimating site development costs were 1:10000 scale mapping, and discussions with Ontario Hydro for power servicing costs. Clearing and grubbing, fencing, and access/on-site road unit costs were estimated based on experience on other projects.

Evaluation criteria, indicators, rationale, and data sources are summarized on Table 1.

TABLE 1
EVALUATION CRITERIA

Evaluation Criteria	Indicators	Rationale	Data Sources
1. Compare Potential Landfill Capacity	• estimated maximum landfill capacity	• flexibility in site layout and development	• 1:10000 mapping • facility characteristics assumptions
2. Compare Site Development Costs	• clearing & grubbing • fencing • power servicing • road works • leachate treatment	• minimize cost to Lambton County	• 1:10000 mapping • County of Lambton • Ontario Hydro

3.0 COMPARISON OF SITES: ANALYSIS AND RESULTS

3.1 Existing Conditions

From a design and operations perspective, the features affecting potential landfill capacity are the shape, topography, geology, and hydrogeology of the site. The hydrogeological investigations suggest that geology and hydrogeology of the sites are nearly identical. The topography for each of the sites is also similar. Because of these similarities, design assumptions concerning the buffer width, maximum depth, height, and slopes are common for each site. As a result, the features having the most influence concerning the potential landfill capacity, at this early design stage, are the shape and size of the sites.

For the comparison of site development costs, the site features affecting this criterion are the site size and shape, woodlot area, distance from the site to the nearest access road, power source, and haul distance to the Sarnia LTF. Haul routes to the LTF were along the Moore-Sombra Townline, Highways 40 and 80, County Road 31, and along Churchill and Blackwell Sideroads.

A description of each of the four potential sites and the existing features of the sites that affect the site comparison follows. Each of the sites is shown in plan on the figures appended to Schedule I.

Site D

Site D is approximately 76 hectares in size. The shape of the property resembles a square with a small triangle of area removed from the southeast corner of the site.

The southern border of the site is located approximately 500 m north of Highway 80. There is a border of medium quality forest along the east edge of the site ranging in width from 50 to 100 m from the east limit of the site. The site is approximately 21.7 km from the Sarnia LTF and the nearest power supply is an existing 8 kV 3-phase line at Highway 80, about 500 m to the south of the site.

Site H

Site H is nearly square and is about 79 hectares in size. The site is located adjacent to the Moore-Sombra Townline and is approximately 29.3 km from the Sarnia LTF. A medium quality forest is present in the northeast corner of the property. The closest power supply to the site is a 16.2/27.6 kV line located approximately 1.5 km to the west of the site at the junction of Highway 80 and the St. Clair Parkway (County Road 33).

Site I

Site I is approximately 77 hectares. The site is nearly square, however, the perimeter of the site dips down in the northeast corner of the site to omit a small rectangular shaped parcel of land. There are no woodlots within the site property. The site is also located along the Moore-Sombra Townline. The distance to the closest power supply is 2 km to a 16.2/27.6 kV line at the junction of Highway 80 and the St. Clair Parkway (County Road 33). The Sarnia LTF is located approximately 28.4 km from the site.

Site K

Site K is the most irregularly shaped site. The area of the site is approximately 86 hectares. The site is as wide as 1.2 km along the north side and as narrow as 300 m across the middle of the property. A large proportion of the site is treed. There is 36 ha of shrub woodland and 20 ha of medium quality forest.

The Moore Township landfill site is located on the property. Access to the site is via the Moore Township 21/22 Sideroad. The closest power supply is the 8 kV line located along Highway 80 to the south.

3.2 Advantages/Disadvantages of the Four Sites

The criterion and indicators listed in Table 1 were applied to each site. The methods used to evaluate the criteria and the results of the evaluation are presented below.

Criterion 1 - Compare potential landfill capacity

The potential landfill capacity criterion identified Site H as having the largest potential capacity of 2.1 million tonnes. Sites I and D were identified as having a potential capacity of 1.9 million tonnes. Potential capacity at Site K was estimated to be 1.4 million tonnes.

As stated earlier, the criteria influencing potential landfill capacity is the site area and shape. This is demonstrated when comparing Sites K and H. Even though Site K is larger in area, the shape of the site reduces the potential landfill capacity because the space available for landfill development is too small in the narrow areas of the site.

The results of the potential landfill capacity evaluation are presented in Table 2.

TABLE 2
CRITERION 1 - COMPARE POTENTIAL LANDFILL CAPACITY

Block	Site D	Site H	Site I	Site K
Block 2	1,000,000 t	1,000,000 t	1,000,000 t	1,000,000 t
Blocks 2 & 3	1,400,000 t	1,600,000 t	1,600,000 t	1,100,000 t
Blocks 2,3 & 4	1,900,000 t	2,100,000 t	1,900,000 t	1,400,000 t

Criterion 2 - Compare Site Development Costs

Indicator 1 - Clearing and Grubbing

Clearing and grubbing costs to remove vegetation within the developed parts of the site were highest on Site K which has the most area of vegetative cover. Sites D and H had 0.5 and 4.6 hectares of forest respectively, and for Site I there are no clearing and grubbing costs expected.

Indicator 2 - Fencing

Fencing costs were estimated by applying a cost per metre to the measured perimeter of each site. Site K had the largest perimeter and the perimeter of Sites H, I, and D were about the same.

Indicator 3 - Power Servicing

Power servicing costs were estimated assuming that a 500 kVA service would be required at each site. For sites H and I, the nearest power service was located at the junction of Highway 80 and the St. Clair Parkway (County Road 33). The cost to bring power to Site H and I includes the cost for Ontario Hydro to extend the existing 16.2/27.6 kV line by approximately 1.5 km for Site H and 2.0 km for Site I. The cost to extend the power line is $51,000 for Site H and $67,900 for Site I. Costs to bring power from the Ontario Hydro lines into each of the sites were estimated assuming overhead lines. The total power servicing costs were $55,000 and $72,000 for Sites H and I respectively.

The costs to bring power into Sites D and K were estimated assuming that overhead lines would be brought in from the existing 8 kV, 3-phase line along Highway 80. The costs for Sites K and D were $41,000 and $24,000 for this indicator.

Indicator 4 - Road Works

The difference in the total cost of road works between sites is largely a function of the distance from the site boundary from the nearest road. Site K had the highest road cost because the access road from Highway 80 must be upgraded. Because Site D is located 500 m from the nearest access point (Highway 80), the new road construction cost is high. Costs for road development for Sites H and I were similar.

Indicator 5 - Leachate Treatment

The cost to haul leachate to the Sarnia LTF was calculated for Site H based on the assumptions stated earlier. A comparison cost was estimated for each of the other three sites based on the measured haul distance to the LTF. As expected, the estimated leachate treatment cost for Site H was highest ($1.08 million) followed by Sites I, K, and D. The sites in close proximity to each other (Sites H and I, and Sites D and K) had similar leachate treatment costs. There is about a $200,000 difference in the cost between the two pairs of sites.

The site development costs for each of the sites are presented in Table 3. Table 3 shows each of the indicators, the appropriate unit cost for each (if applicable), the measured quantity, the cost for each indicator, and the total site development cost for each site.

3.3 Conclusions and Comparison of Sites

The comparison of the potential landfill capacity criterion shows that Site H has the highest potential capacity of 2.1 million tonnes. Sites I and D follow closely behind with potential landfill capacities of 1.9 million tonnes. Site K has the least potential capacity of 1.4 million tonnes. Accordingly, the ranking of sites based on this criterion from most to least preferred would be, H, I and D, and then K. Because the difference in potential capacity between Site H and Sites D and I is 200,000 tonnes, which is less than 10 per cent of 2.1 million tonnes, the difference is not very significant if consideration is given to the level of accuracy

TABLE 3
CRITERION 2 - COMPARE SITE DEVELOPMENT COSTS

Indicator	Unit Cost	Units	Site D		Site H		Site I		Site K	
			Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Clearing & Grubbing										
Medium Quality Forest	$7,000	ha	0.5	$4	4.6	$32	0	$0	10.5	$74
Shrub Woodland	$5,000	ha	0	$0	0	$0	0	$0	24.0	$120
Fencing	$50	m	3,500	$175	3,600	$180	3,600	$180	4,800	$240
Power Servicing	L.S.	---		$24		$55		$72		$41
Road Works										
Road Upgrade	$330	m							1,100	$363
Road Construction	$400	m	1,770	$708	1,270	$508	1,290	$516	1,440	$576
Leachate Treatment	P.V.	---		$800		$1,080		$1,047		$804
TOTAL				$1,711		$1,855		$1,815		$2,218

Notes:

1. *Dollar values in thousands.*
2. *L.S. means lump sum cost.*
3. *P.V. means present value cost.*

SCHEDULE I

June 23, 1993

LAMBTON COUNTY WMMP
COMPOSITE FACILITY CHARACTERISTIC ASSUMPTIONS FOR COMPARATIVE EVALUATION OF SITES H, I, D, K

CHARACTERISTIC

1. Waste Quantities

	Generated	With Diversion
• Total tonnage (20 year)	2,000,000 t	1,000,000 t
• Average annual tonnage	100,000 t	50,000 t
• Maximum annual tonnage	106,000 t (2015)	61,000 t (1996)
• Assumed landfill waste density	700 kg/m^3	
• Landfill waste volume	2,860,000 m^3	1,430,000 m^3
• Assumed waste to cover ratio	4:1	
• Daily/Intermediate cover volume	720,000 m^3	360,000 m^3
• Final cover volume*	300,000 m^3	160,000 m^3
• Total air space required*	3,880,000 m^3	1,950,000 m^3

* For a single fill area.

2. Location and Layout

• For access road, scales, on-site roads, materials recovery facility, composting facility, leachate treatment facility, storm water management pond, stockpile, fill area	See Plan

3. Landfill Capacity

	Site D	Site H	Site I	Site K
• Block 2	1,000,000 t	1,000,000 t	1,000,000 t	1,000,000 t
• Blocks 2 & 3	1,400,000 t	1,600,000 t	1,600,000 t	1,100,000 t
• Blocks 2, 3 & 4	1,900,000 t	2,100,000 t	1,900,000 t	1,400,000 t

4. Landfill Dimensions

• Distance to closest property boundary					100 m
• Above ground top slopes					20:1
• Above ground side slopes					5:1
• Below ground (excavation) side slopes					3:1
• Maximum height above grade					17 m
• Excavation depth					5 m
• Maximum width of fill area**					300 m
		Site D	Site H	Site I	Site K
• Length of fill area	Block 2	440 m	440 m	440 m	440 m
•	Blocks 2 & 3	580 m	670 m	670 m	480 m
	Block 4	270 m	260 m	160 m	480 m
• Maximum elevation (m asl)	Blocks 2 & 3	213.5	204.0	205.5	211.5
	Block 4	211.5	203.0	202.5	211.5

** Block 4 increases width at Site K to 390 m

5. Materials Recovery Facility Building

• Building Dimensions	75 m W x 100 m L x 9 m H

6. Composting Building

• Building Dimensions	75 m W x 110 m L x 9 m H

7. Curing Building

• Building Dimensions	60 m W x 70 m L x 9 m H

June 23, 1993

LAMBTON COUNTY WMMP
COMPOSITE FACILITY CHARACTERISTIC ASSUMPTIONS FOR COMPARATIVE EVALUATION OF SITES H, I, D, K

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* For a single fill area.

2. Location and Layout

• For access road, scales, on-site roads, materials recovery facility, composting facility, leachate treatment facility, storm water management pond, stockpile, fill area	See Plan

3. Landfill Capacity

	Site D	Site H	Site I	Site K
• Block 2	1,000,000 t	1,000,000 t	1,000,000 t	1,000,000 t
• Blocks 2 & 3	1,400,000 t	1,600,000 t	1,600,000 t	1,100,000 t
• Blocks 2, 3 & 4	1,900,000 t	2,100,000 t	1,900,000 t	1,400,000 t

4. Landfill Dimensions

• Distance to closest property boundary					100 m
• Above ground top slopes					20:1
• Above ground side slopes					5:1
• Below ground (excavation) side slopes					3:1
• Maximum height above grade					17 m
• Excavation depth					5 m
• Maximum width of fill area**					300 m
		Site D	Site H	Site I	Site K
• Length of fill area	Block 2	440 m	440 m	440 m	440 m
•	Blocks 2 & 3	580 m	670 m	670 m	480 m
	Block 4	270 m	260 m	160 m	480 m
• Maximum elevation (m asl)	Blocks 2 & 3	213.5	204.0	205.5	211.5
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** Block 4 increases width at Site K to 390 m

5. Materials Recovery Facility Building

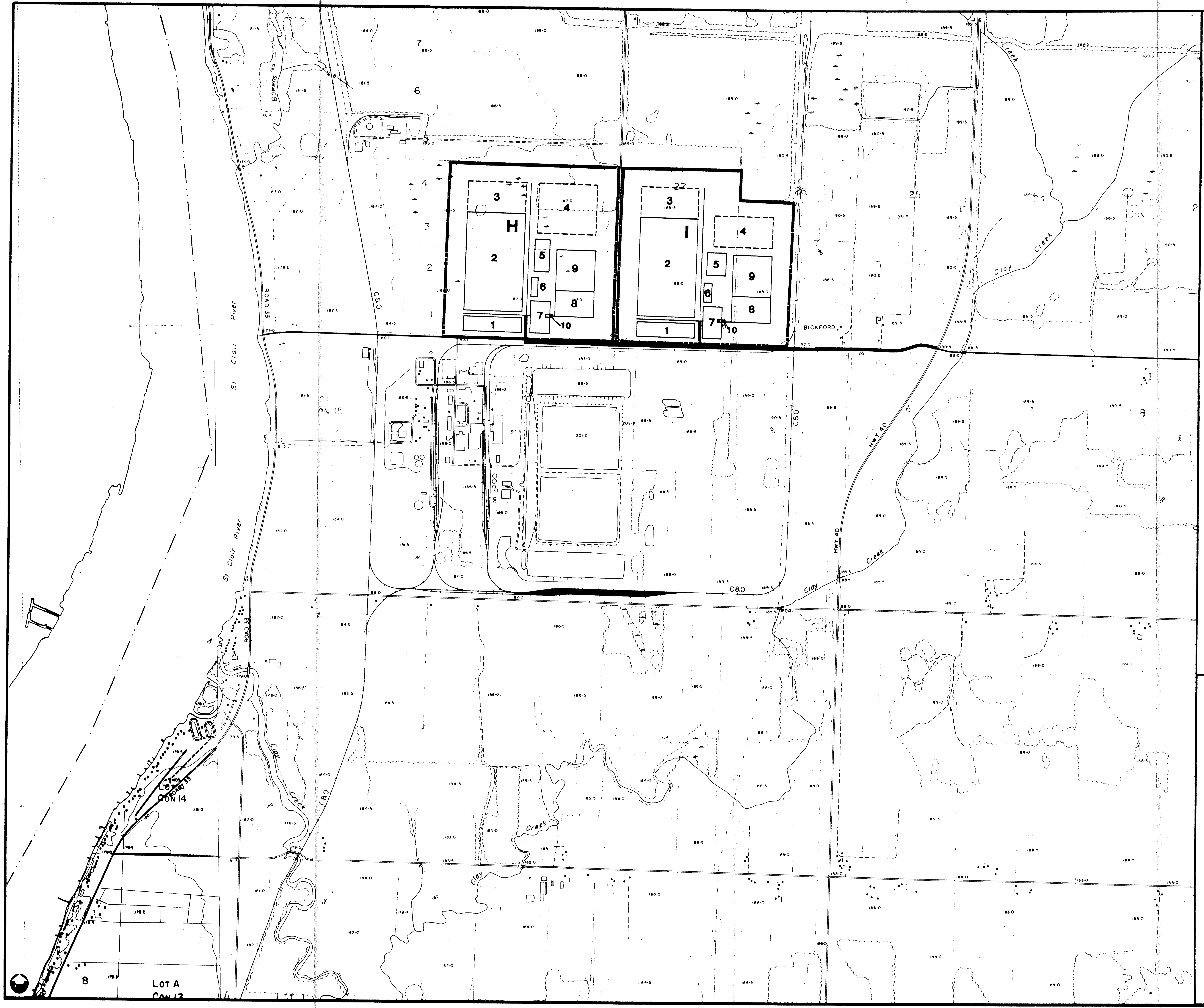
- Building Dimensions 75 m W x 100 m L x 9 m H

6. Composting Building

- Building Dimensions 75 m W x 110 m L x 9 m H

7. Curing Building

- Building Dimensions 60 m W x 70 m L x 9 m H



LEGEND:

1. Storm water management pond
2. Minimum landfill area
   (assuming provincial waste diversion targets are met)
3,4. Possible landfill extension
5. Stockpile area
6. Landfill equipment compound & maintenance building
7. Leachate treatment facility
8. Materials recovery facility
9. Composting facility
10. Weigh Scales

▬ Access Route

▬ Site Boundary

LAMBTON COUNTY

Waste Management Master Plan

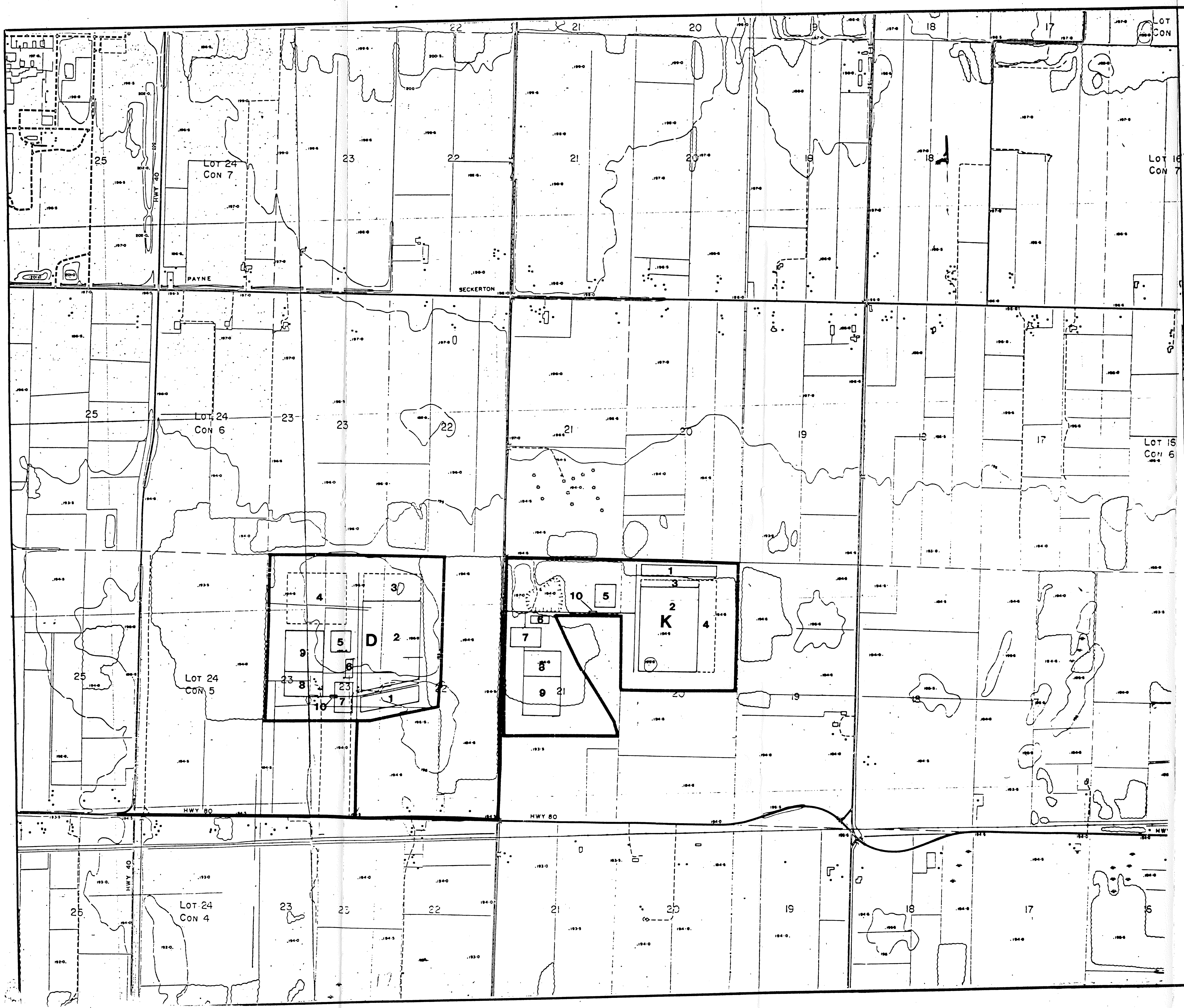
Detailed Comparison Of Sites

CONCEPTUAL SITE LAYOUTS FOR SITES H and I

DILLON

23 June 1993

Figure 1



LEGEND:

1.	Storm water management pond
2.	Minimum landfill area (assuming provincial waste diversion targets are met)
3,4.	Possible landfill extension
5.	Stockpile area
6.	Landfill equipment compound & maintenance building
7.	Leachate treatment facility
8.	Materials recovery facility
9.	Composting facility
10.	Weigh Scales
▬	Access Route
▬	Site Boundary

LAMBTON COUNTY

Waste Management Master Plan
Detailed Comparison Of Sites

CONCEPTUAL SITE LAYOUTS
FOR SITES D and K

DILLON

23 June 1993

Figure 2

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4D
HYDROGEOLOGIC IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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Schedule IV In Situ Hydraulic Conductivity Tests
Schedule V Well Development/Purging Records
Schedule VI Ground Water Chemical Analysis
Schedule VII Geophysical Borehole Logging

1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from a hydrogeologic perspective. The purpose of this impact assessment was to identify the order of preference of the sites (i.e. best site(s) or worst site(s), if any) with respect to hydrogeologic considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill component was considered to be of most significant in identifying and comparing potential hydrogeologic impacts.

The key considerations addressed in this study were:

- the potential for the natural protection of ground water resources from the impacts of landfill leachate;
- the ability, at the site, to monitor ground water and implement contingency measures; and
- the potential for disrupting ground water supplies and resources.

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the assessment and comparison of the potential hydrogeologic impacts of the sites;
- the collection of data for the four sites according to the criteria and indicators identified;
- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to hydrogeologic considerations; and
- the comparison of the sites' advantages and disadvantages to identify, from a hydrogeologic perspective, the most preferred/least preferred site(s), if any.

1.2 Technical Report Organization

This report is organized in the following manner:

Chapter 1 - Introduction

A statement of the purpose and objectives of the hydrogeologic investigations in relation to the overall detailed comparison of sites.

Chapter 2 - Study Approach

A description of the methodology used in the investigation as well as rationale for the chosen methodology.

Chapter 3 - Comparison of Sites: Analysis and Results

A description of the results of the investigation, an analysis of hydrogeologic conditions based on information collected, and a comparison of the sites from a hydrogeologic perspective.

Chapter 4 - Summary

A summary of the results of the investigations and of the comparison of the sites from a hydrogeologic perspective.

2.0 STUDY APPROACH

2.1 Study Methodology Overview

The approach used to investigate the site-specific hydrogeologic conditions at each site consisted of the drilling of boreholes, and the installation of monitoring wells at each drilling location.

Soil samples were collected continuously throughout the drilling of the boreholes which allowed documentation of the overburden stratigraphy. Soil samples were also analyzed to determine the composition of the soil.

Monitoring wells were installed in the boreholes for three main purposes:

i) to allow testing of the wells to determine the hydraulic conductivity of the soils surrounding the well screen,

ii) to determine static water levels in the different hydrostratigraphic units to determine the direction of ground water flow, and

iii) to allow the collection of ground water samples to determine the general ground water chemistry at each site.

2.2 Study Area

The Study Area for the site investigations was within the site boundaries with the exception of exception of one drilling location on Site I (location 5), which was located to the north of site boundary so that the wells would be along the fence-line of the field and not in the middle of it. Data for ground water use in the vicinity of the site consisted of wells on record within 1 km and potential residential ground water users within 1 km.

2.3 Time Frame

The proposed opening year is 1996. It is expected that hydrogeologic investigations will have been completed by the end of 1994 to ensure that all necessary ground water monitoring facilities are in place and that at least 1 year's monitoring data has been collected prior to site opening for the generation of appropriate background ground water quality data.

2.4 Key Assumptions

The key assumption for this study are that data collected from the site-specific investigations are more suitable than regional studies for comparison of geological and hydrogeologic conditions. Also, data collected for the comparison of the long-list of sites on wells on record within 1 km of the sites and potential residential ground water users within 1 km of the site was used in this study.

2.5 Data Collection

2.5.1 Overview of Hydrogeology and Geology

To put the four sites in perspective, the following is an overview of the regional hydrogeology and geology. All of the sites are located within the southeastern corner of Moore Township. All of the sites are located in the St. Clair Clay Plain Physiographic Region. The St. Clair Clay Plain covers much of Essex, Kent and Lambton Counties.

The overburden is typically greater than 30 m thick and consists of a clayey till which has a consistent texture throughout the St. Clair Clay Plain. Typically, the tills are composed of 40-60% clay, 30-40% silt, 5-10% sand and less than 5% gravel. The tills generally contain carbonate, quartz, feldspars and shale fragments most likely derived from the underlying bedrock *(Desaulniers et al., 1981)*.

The upper 2-5 m of the till is highly fractured and weathered. This zone is typically brown (oxidized) and fractured from repeated wetting and drying caused by rainfall and seasonal water table fluctuations. Where considerable weathering has taken place, minor amounts of the clay minerals smectite and vermiculite commonly occur *(Desaulniers et al., 1981)*. The post-glacial weathering process has resulted in mottling, oxidation, leaching and precipitation of carbonates and hydroxides and changes in clay mineralogy *(Dusseault and Vorauer, 1986)*. Fractures are essentially vertical and decrease in frequency with depth. *Ruland et al., 1989*, reported that fracture spacing observed at six locations in the Sarnia area steadily increases from one fracture every 2.5 cm near surface, to one fracture every 0.5 m to 2.0 m at a depth of 4.5 m. These fractures have been postulated to be formed by desiccation (a process of dehydration through evaporation and water table lowering) and fluctuating glacial lake levels. Less abundant sub-horizontal fractures exist, related to stress relief. These fractures are mottled grey and contain coatings of manganese oxide and iron oxide. A deep root zone was also noted within the region.

Below the weathered soils, the till becomes a massive grey silty clay to clayey silt till. The lack of stratification within the overburden tends to exclude a lacustrine origin and a normally consolidated state below a surface crust excludes a lodgement till origin *(Vorauer et al., 1986)*. The clay plain has been referred to consist of "water-laid" till *(Dusseault and Vorauer, 1986)*, formed by glacial advance during the Wisconsinan, or last, Ice Age.

Beneath the clayey till, and above the bedrock, a thin discontinuous layer of interbedded sands and gravels is found. The bedrock is part of the Port Lambton Group Shale *(Ontario Geologic Survey, 1991)*. This shale is a greenish-grey silty shale and is generally flat-lying.

Hydrogeology

The consistent geology of the St. Clair Plain results in a consistency in hydrogeology over the area.

Ground water resources are utilized from wells installed in two hydrostratigraphic units: shallow dug or bored wells that receive water from surficial sand or gravel or from the weathered till; and deep wells drilled to the basal gravel aquifer consisting of black shale sands and gravels and weathered bedrock.

The shallow wells are large diameter (typically 0.75 m in diameter). These wells typically have very poor hydraulic properties and rely on their large diameters for storage. Some residents in Lambton County use these shallow wells as cisterns and have water transported by truck to fill them.

It has been estimated that 90% of all wells in Lambton County obtain water from the basal aquifer (OWRC, 1969).

Ground water quality is generally poor with natural concentrations of several parameters not meeting Ontario Drinking Water Objectives, principally sodium, iron, chloride and hardness.

Ground water yield is generally poor with no municipal wells in use. Yields vary from 5 to 50 L/min and are only suitable for domestic or livestock purposes. An extensive surface water supply system exists in Lambton County with water obtained from Lake Huron.

The ground water flow direction in the basal aquifer has been shown to be east-to-west towards the St. Clair River, generally following the topography of the bedrock surface *(Vandenburg et al., 1977)*.

The clayey till overburden of the St. Clair Clay Plain is an aquitard. The till typically has low hydraulic conductivity values of approximately 1 x 10^{-8} cm/s. Table 1 summarizes hydraulic conductivity values for the clayey till throughout the St. Clair Plain (which are located on Figure 1). The surficial weathered clay has higher bulk hydraulic conductivity values in the range of 10^{-6} to 10^{-5} cm/s with flow occurring chiefly in the fractures *(D'Astous et al., 1988).*

Hydraulic gradients that cause downward ground water flow are typical of the aquitard. However, the low hydraulic conductivity of the aquitard means that downward linear velocities are limited to 5 to 50 mm/year (based on a hydraulic conductivity of 10^{-8} to 10^{-7} cm/s, a hydraulic gradient of 0.5 and a porosity of 0.3). Isotopic data of the basal gravel aquifer indicates ground water is almost as old as the deposits themselves and supports relatively minimal recharge through the clayey till (*Desaulniers et al., 1981*).

2.5.2 Site Investigations

The preceding section provided an overview of the secondary source data on hydrogeologic conditions in the vicinity of the four sites. As stated, the geology and hydrogeology in the area of the four sites is consistent for all sites. The methodology for site comparison was to collect a range of site specific data from each of the four sites. This data was then used to assess hydrogeologic conditions at the four sites which allowed comparison between the sites.

Drilling Program

Boreholes were drilled at ten locations throughout the four sites. The locations of the boreholes are shown on Figures 2, 3, 4 and 5. Borehole logs are contained in Schedule I. Boreholes were drilled and monitoring wells were installed at Sites D, H, and I between May 8-22, 1991, by Davidson Environmental Well Drilling of Waterloo. The same work was undertaken at Site K between May 11-14, 1993, by At-Cost Soil Drilling Inc. of Maple. All of the drilling was supervised by M.M. Dillon Limited staff.

The boreholes were drilled using 215 mm diameter hollow-stem augers. In the deep boreholes, soil samples were taken continuously throughout the borehole depth using a 1.5 m long, 88 mm inside diameter, wire-line split-tube sampler. The soil samples are stored in 1.5 m long PVC split sleeves.

TABLE 1: Summary of Regional Hydraulic Conductivity Data

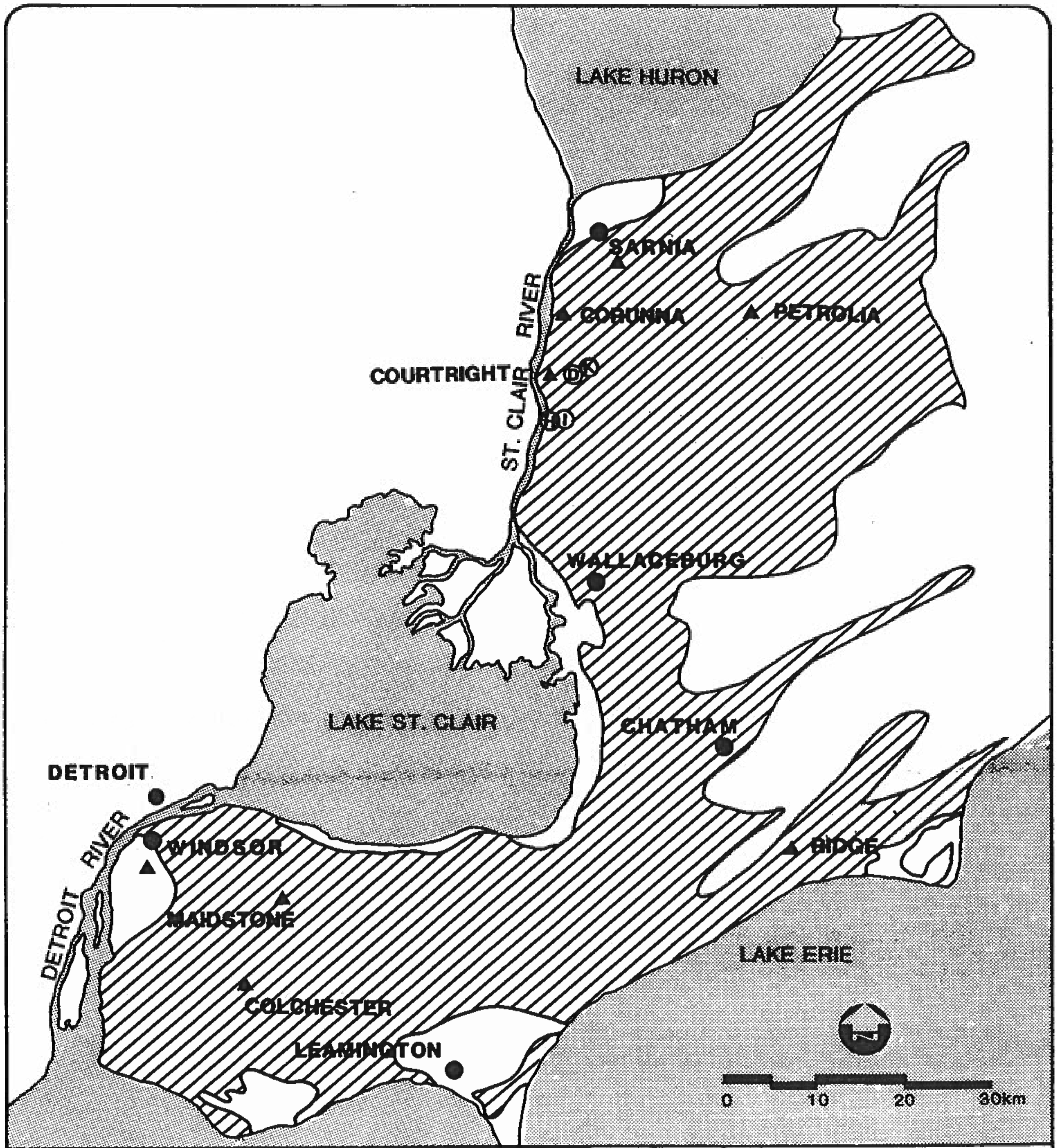
Location	FRACTURED TILL UNIT***			GREY CLAY TILL UNIT		
	Range of Values (cm/s)	Average* (cm/s)	No. Tests**	Range of Values (cm/s)	Average* (cm/s)	No. Tests**
Ridge[1]	1.0×10^{-5}	1.0×10^{-5}	1	1.0×10^{-7} - 1.0×10^{-8}	3.1×10^{-8}	5
Corunna[2]	1.0×10^{-5} - 1.0×10^{-9}	2.4×10^{-7}	15	1.0×10^{-6} - 1.1×10^{-9}	2.3×10^{-8}	49
Courtright[3]	9.0×10^{-8} - 1.3×10^{-8}	8.2×10^{-8}	46	5.0×10^{-8} - 1.0×10^{-9}	7.9×10^{-9}	3
Colchester[4]	1.4×10^{-2} - 1.5×10^{-8}	5.8×10^{-7}	15	4.5×10^{-7} - 5.8×10^{-9}	2.3×10^{-8}	37
Maidstone[5]	2.7×10^{-7} - 1.1×10^{-8}	4.6×10^{-8}	13	8.8×10^{-6} - 4.2×10^{-9}	5.5×10^{-8}	35
Sarnia[6]	1.7×10^{-6} - 1.0×10^{-7}	3.7×10^{-7}	4	8.0×10^{-6} - 2.1×10^{-9}	2.7×10^{-8}	63
Windsor[7]	2.0×10^{-6} - 1.5×10^{-9}	2.2×10^{-7}	14	1.2×10^{-6} - 1.3×10^{-8}	6.8×10^{-8}	28
Petrolia[8]	-	-	-	3.0×10^{-8} - 7.0×10^{-8}	5.0×10^{-8}	5
Total	1.4×10^{-2} - 1.0×10^{-9}	1.5×10^{-7}	108	8.8×10^{-6} - 1.0×10^{-9}	3.2×10^{-8}	225

* Geometric Mean

** Tests performed include: Hazen analysis, triaxial permeameter, field rising and falling head, in-situ constant head, tracer, 1-dimensional consolidation and 3-dimensional consolidation.

*** Upper 2-5 m.

1. Ridge; Blenheim (Gartner Lee, 1981)
2. Petrosar, Tricil, Polysar; Corunna (Golder Associates, 1985; Conestoga-Rogers, 1980; Hydrology Consultants, 1984; D'Astous et al., 1989; Johnson et al., 1986).
3. Lambton; Courtright (Harding, 1986; Desaulniers, 1986).
4. Essex County No. 1; Colchester Township (Orpwood, 1984; Desaulniers et al., 1981; Terraqua Investigations, 1988).
5. Essex County No. 3; Maidstone Township (Dillon, 1988b; Vorauer et al., 1986; Dusseault et al., 1986).
6. Sarnia, Welland Chemical, Confederation Road, Blackwell Road; Sarnia (Conestoga-Rovers, 1985; O.H. Materials, 1984; Quigley et al., 1985; Goodall et al., 1977; Crooks et al., 1984; Desaulniers et al., 1981).
7. Western Windsor Inert; Windsor (Dillon, 1988a; Golder Associates, 1969; Golder Associates, 1974; Associated Geotechnical Services, 1977; Orpwood, 1984).
8. Petrolia; Petrolia (Conestoga-Rovers, 1983).



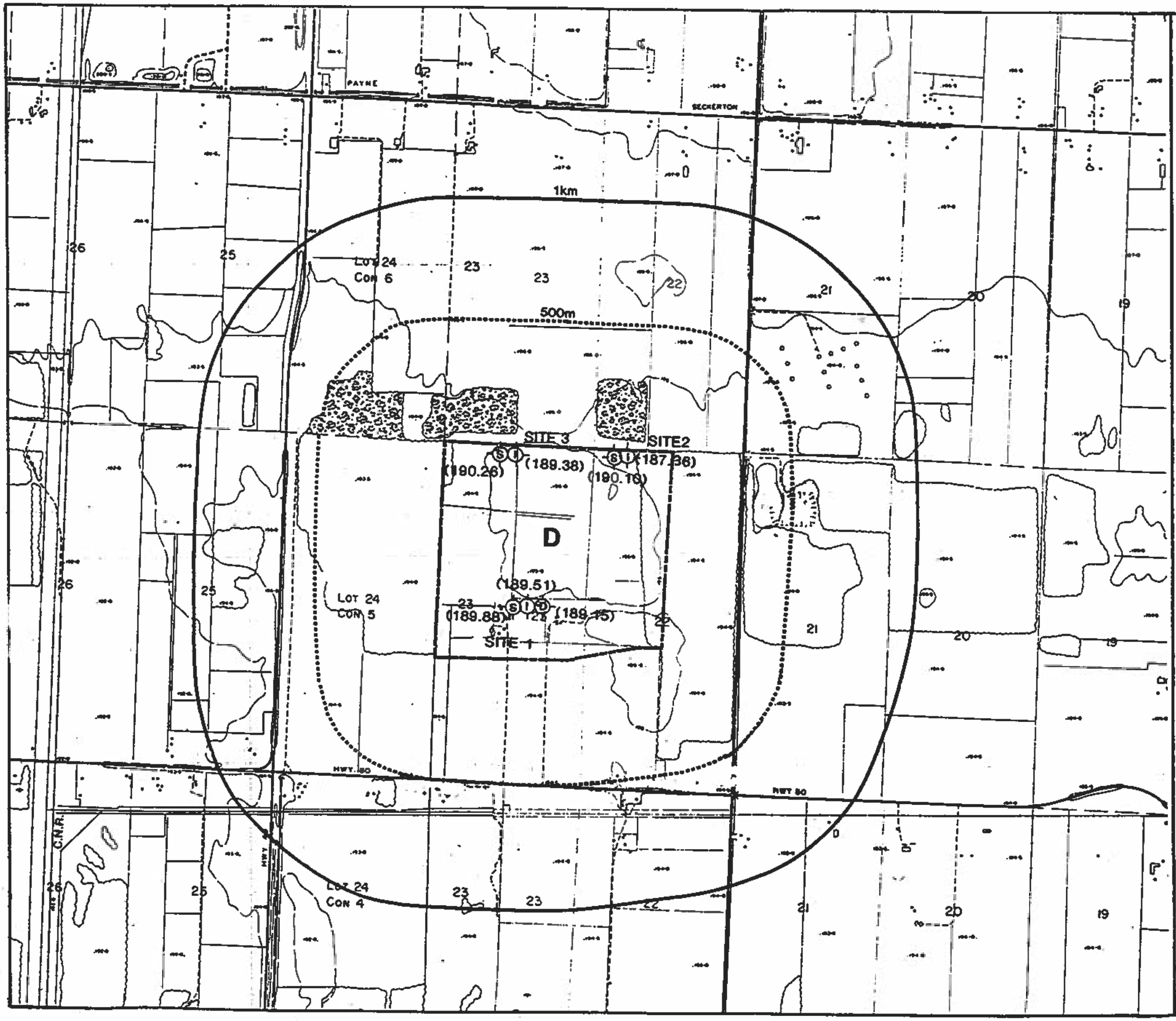
LEGEND:

- ▲ TEST SITES
- ▨ ST.CLAIR CLAY PLAIN*
- ● MAJOR POPULATION CENTRE
- Ⓘ SITES

THE ST.CLAIR CLAY PLAIN

FIGURE 1

*SOURCE: Physiography of Southern Ontario, MNR 1984



LEGEND

EXISTING MONITORING WELLS

○ BOREHOLE/MONITORING WELL

● BOREHOLE LOCATION

(185.06) WATER LEVEL IN MASL.

100 0 500 1km

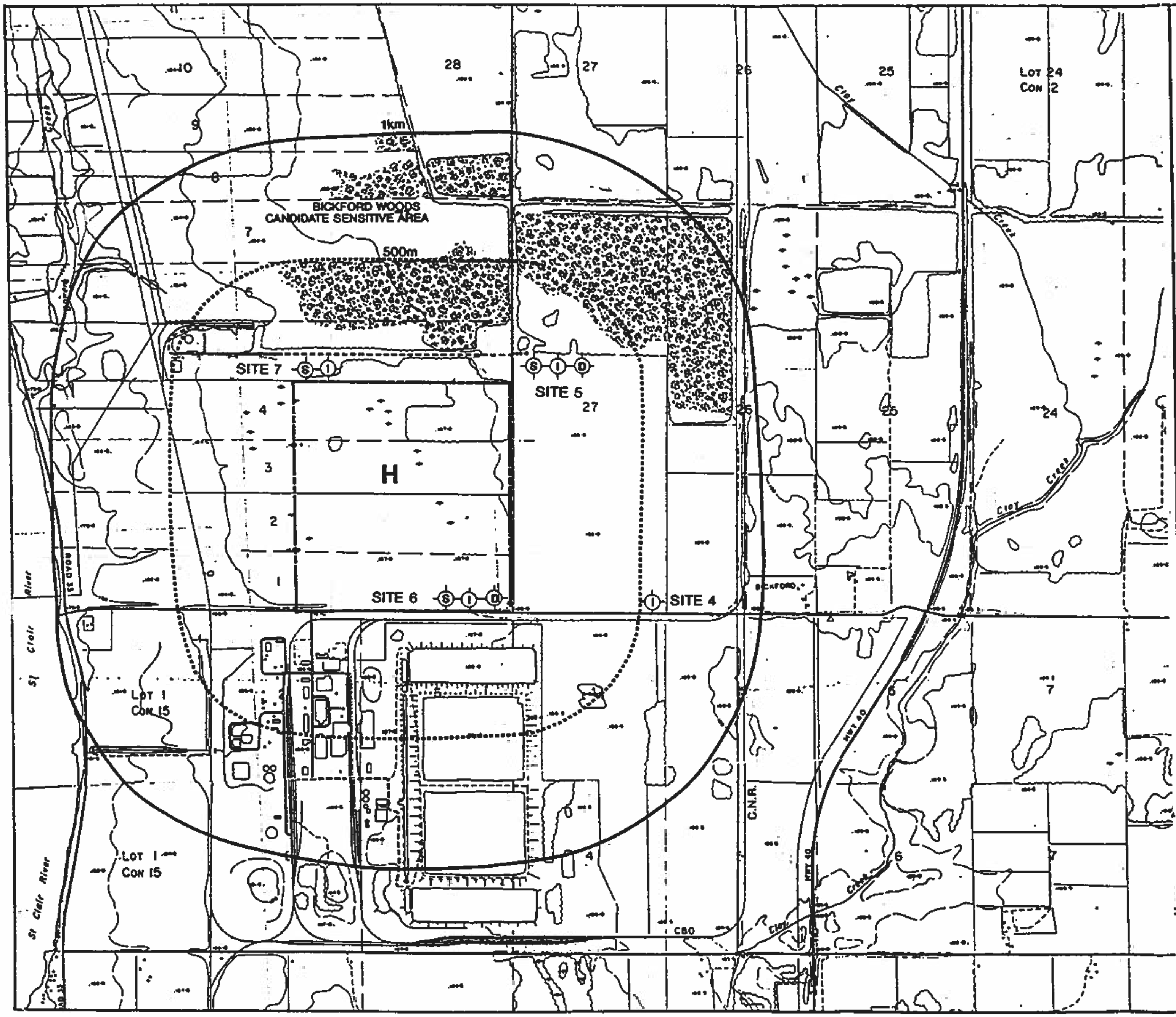
Scale 1:15,000

SITE D
LOCATION OF
MONITORING WELLS

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928-37-01

FIGURE 2



LEGEND.

EXISTING MONITORING WELLS:

- Ⓢ SHALLOW
- Ⓘ INTERMEDIATE DEPTH
- Ⓓ DEEP

100 0 500 1km

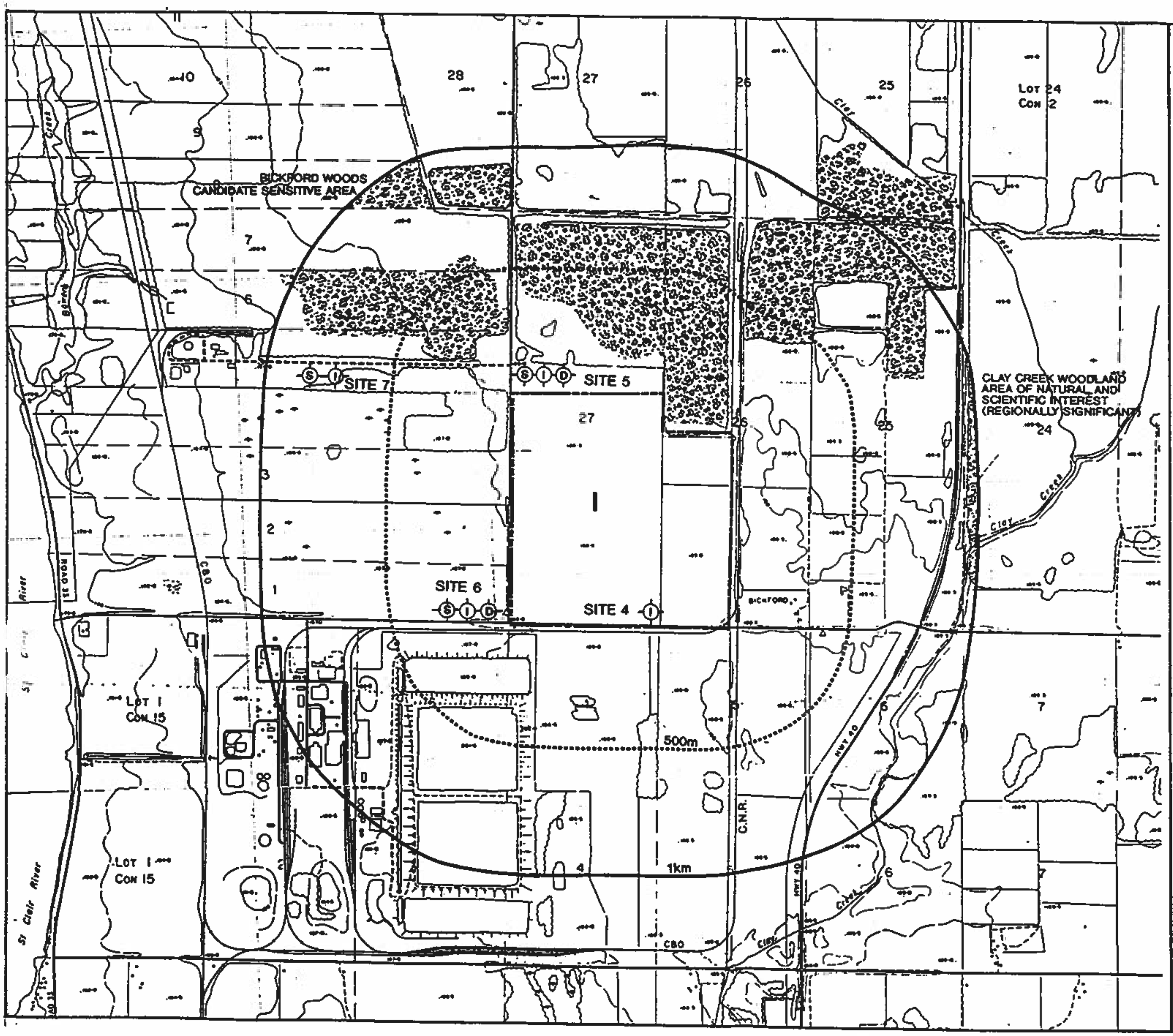
Scale 1:15,000

SITE H
LOCATION OF MONITORING WELLS

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN

Project No.9928-37-01

FIGURE 3



LEGEND

EXISTING MONITORING WELLS:

- Ⓢ SHALLOW
- Ⓘ INTERMEDIATE DEPTH
- Ⓓ DEEP

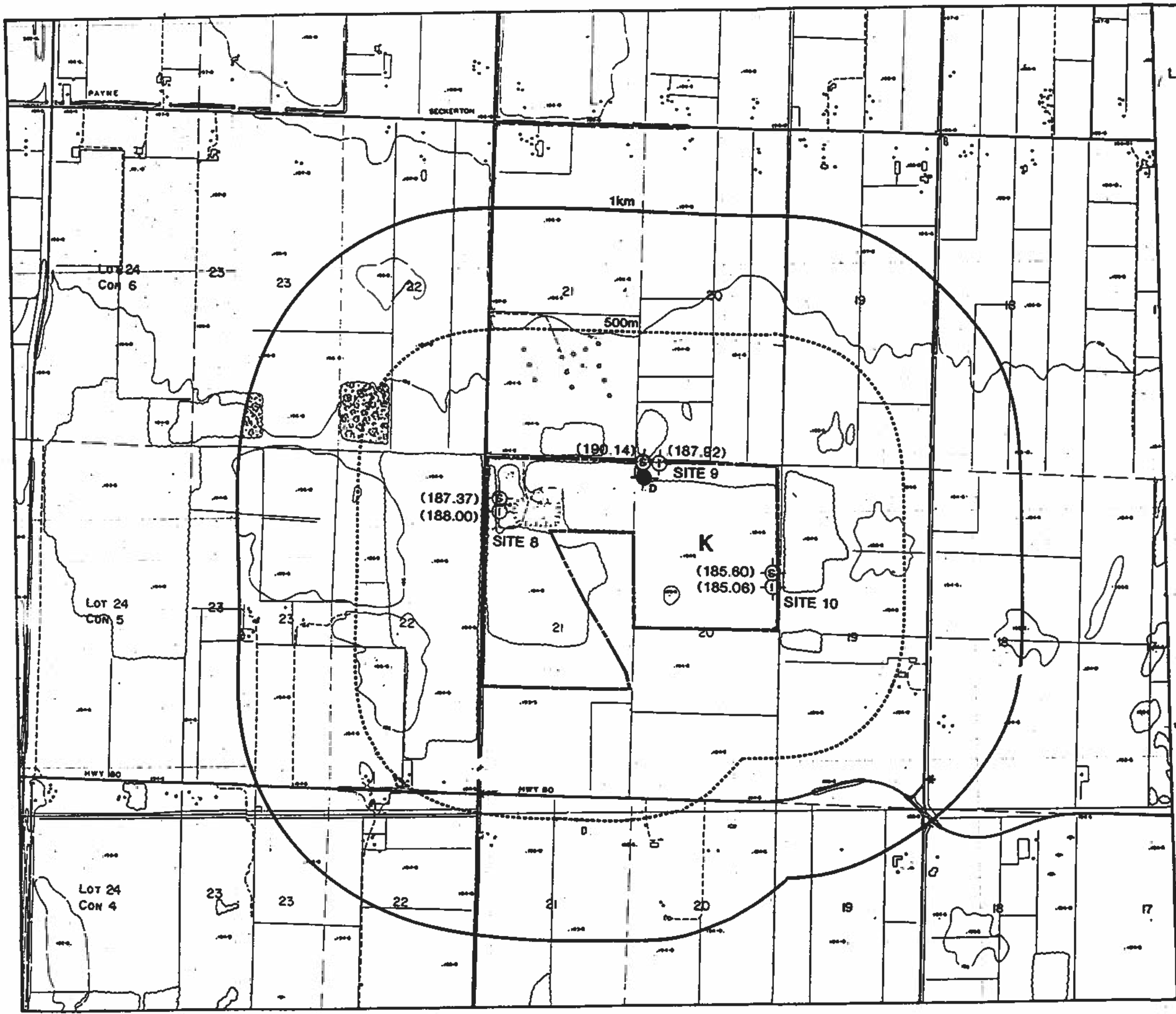
100 0 500 1km

Scale 1:15,000

SITE I
LOCATION OF MONITORING WELLS
LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN

Project No.9928-37-01

FIGURE 4



LEGEND

EXISTING MONITORING WELLS

- ○ BOREHOLE/MONITORING WELL
- ● BOREHOLE LOCATION
- (185.06) WATER LEVEL IN MASL.

100 0 500 1km

Scale 1:15,000

SITE K
LOCATION OF
MONITORING WELLS

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928-37-01 **FIGURE 5**

Shallow ("S") and intermediate depth ("I") boreholes were drilled at each location chosen for the drilling of the deep boreholes. The purpose of the shallower boreholes was to allow monitoring wells to be installed in them and were drilled without soil sampling.

At six other locations (BH2I, BH3I, BH4I, BH7I, BH8I, and BH10I), an intermediate depth borehole was the deepest borehole drilled and soil samples were taken at intervals shown on the borehole logs (see Schedule I). A monitoring well was installed in each of these boreholes. A shallow monitoring well was also installed at each of these locations in a separate borehole which was drilled without soil sampling, with the exception of location 4. Only an intermediate depth monitoring well was installed at this location.

Installation of Monitoring Wells

Monitoring wells, consisting of 1.5 m long, 51 mm diameter, No. 10, PVC well screens connected to riser pipes, were installed within the boreholes. Each monitoring well was installed in a separate borehole. Monitoring wells are designated with a letter suffix (S, I, D) after the location number. "S" designates a shallow well approximately 8m deep; "I" designates an intermediate depth well approximately 16 m deep; and a "D" suffix designates a deep borehole drilled to bedrock approximately 40 m deep. For example, BH1D designates the deep borehole/monitoring well at location "1".

A silica sand filter pack was placed around the well screen which typically extended 0.9 m above the top of the screen. Typically, a 0.3 m seal of bentonite "chips" was then placed in the borehole annulus and then the annulus was sealed to ground surface using bentonite grout. In some of the shallow boreholes, bentonite chips were used to seal the entire borehole annulus. The wells had a lockable steel protective casing installed at surface. Table 2 summarizes installation details for the wells. Monitoring well installation details are also shown on the borehole logs (see Schedule I).

A deep borehole was drilled to bedrock at each of the four sites: BH1D, BH5D, BH6D, and BH9D. A monitoring well was installed in each of the boreholes with the exception of BH9D at Site K. At this borehole, a pocket of natural gas was found and the borehole was abandoned by sealing with cement. No monitoring well was installed in this borehole.

Laboratory Analyses of Soil Samples

Selected soil samples were submitted for grain size distribution analyses to Golder Associates Ltd. Grain size distribution curves are included in Schedule II. Table 3 summarizes the results of the laboratory tests.

TABLE 2

SUMMARY OF MONITORING WELL INSTALLATION DETAILS

Well No.	Northing (approx)	Easting (approx)	Ground Elevation (masl)	Elevation Top of Pipe (masl)	Stickup (m)	Dia. (mm)	Hole Bottom		Screen Bottom		Screen Top		Top of Sand Pack	
							Depth (m)	Elevation (masl)	Depth (m)	Elevation (masl)	Depth (m)	Elevation (masl)	Depth (m)	Elevation (masl)
1S	41670	85080	190.31	191.21	0.85	51	7.62	182.69	7.41	182.90	5.89	184.42	1.22	189.09
1I	41670	85080	190.36	191.24	0.86	51	15.85	174.51	15.06	175.30	13.54	176.82	12.45	177.91
1D	41670	85080	190.42	191.18	0.75	51	56.08	134.34	49.54	140.88	48.02	142.40	42.21	148.21
2S	42230	85580	190.58	191.59	1.04	51	7.64	182.94	7.64	182.94	6.12	184.46	1.22	189.36
2I	42230	85580	190.62	191.54	0.95	51	15.85	174.77	15.19	175.43	13.67	176.95	12.50	178.12
3S	42250	85020	190.72	191.62	0.91	51	7.67	183.05	7.67	183.05	6.15	184.57	1.52	189.20
3I	42250	85020	190.72	191.60	0.88	51	15.85	174.87	15.25	175.47	13.73	176.99	12.65	178.07
4I	35650	82650	186.18	187.08	0.88	51	15.85	170.33	15.28	170.90	13.76	172.42	12.50	173.68
5S	36630	82180	187.17	188.14	0.96	51	7.62	179.55	7.39	179.78	5.87	181.30	1.22	185.95
5I	36630	82180	187.33	188.14	0.81	51	15.85	171.48	15.06	172.27	13.54	173.79	12.65	174.68
5D	36630	82180	187.35	188.05	0.70	51	45.11	142.24	44.75	142.60	43.23	144.12	40.23	147.12
6S	35700	82040	186.06	187.09	1.03	51	7.62	178.44	7.48	178.58	5.96	180.10	1.42	184.64
6I	35700	82040	186.02	187.19	1.17	51	15.85	170.17	14.96	171.06	13.44	172.58	12.32	173.70
6D	35700	82040	186.01	187.14	1.13	51	46.84	139.17	45.85	140.16	44.33	141.68	42.06	143.95
7S	36650	81600	186.49	187.31	0.82	51	7.62	178.87	7.58	178.91	6.06	180.43	0.74	185.75
7I	36650	81600	186.44	187.38	0.94	51	15.85	170.59	15.58	170.86	12.53	173.91	11.48	174.96
8S	42070	86070	191.76	192.42	0.66	51	7.54	184.21	7.54	184.21	4.50	187.26	3.58	188.17
8I	42070	86070	191.59	192.49	0.89	51	15.09	176.51	13.11	178.48	11.58	180.01	10.87	180.72
9S	42170	86640	192.19	193.03	0.83	51	6.10	186.10	6.02	186.17	2.97	189.22	2.13	190.06
9I	42170	86640	192.26	192.93	0.67	51	12.19	180.07	12.19	180.07	10.67	181.59	9.25	183.02
10S	41720	87180	190.85	191.59	0.74	51	7.62	183.23	7.62	183.23	4.57	186.28	2.85	188.00
10I	41720	87180	190.78	191.56	0.77	51	14.99	175.80	14.99	175.80	13.46	177.32	12.85	177.93

TABLE 3
SUMMARY OF LABORATORY TESTING OF SOIL

Borehole Number	Site	Sample Number	Depth (m)	Clay Content (%)	Silt Content (%)
BH1D	D	2	2.7	42	52
BH1D	D	4	5.2	34	64
BH1D	D	7	10.1	45	42
BH1D	D	12	17.7	50	39
BH1D	D	15	22.3	49	40
BH2I	D	9	5.2	52	37
BH3I	D	9	5.2	39	48
BH4I	I	7	4.6	46	35
BH4I	I	12	12.2	51	36
BH5D	I	4	5.5	54	36
BH5D	I	8	11.6	51	32
BH5D	I	14	20.4	57	42
BH6D	H	4	5.5	58	35
BH6D	H	8	11.6	56	34
BH6D	H	15	22.0	63	30
BH7I	H	9	5.2	53	35
BH8I	K	3	6.1	56	35
BH9D	K	3	5.2	54	37
BH9D	K	7	11.9	35	50
BH9D	K	10	15.9	57	37
BH9D	K	24	37.8	8	21
BH10I	K	3	5.2	48	40

Water Level Monitoring

Water level measurements in the monitoring wells can be used to assess ground water flow directions and vertical and horizontal hydraulic gradients.

Water level measurements were completed using an electric water level meter on several occasions. This data is presented in Schedule III.

Well Development and Purging

Monitoring wells at the four deep borehole locations (BH1, BH5, BH6, BH9) were selected for in situ hydraulic conductivity testing and water sampling. Prior to in situ testing and water sampling the wells were developed. Development consisted of manually pumping water using dedicated WaTerra pump systems.

The purpose of well development was to remove any remnant effects from the drilling process. A target of two well casing volumes was set for well development because it prescribed the removal of a significant amount of water while remaining within the time frame of the study. Two well volumes were targeted for development because the wells were found to be extremely slow to recover to static water level after pumping. Also, no drilling fluid was used in the drilling of the boreholes and therefore there was less disturbance of the hydrogeologic environment than would be the case if drilling fluid was used. Schedule IV contains a summary of the development program.

In-Situ Tests of Hydraulic Conductivity

In-situ tests of hydraulic conductivity generally involve the monitoring of the recovery of water level after an instantaneous change of water level in a well from static conditions. The change in water level is caused by adding, or removing, a volume of water in the well. These tests are commonly called slug tests and were developed specifically for use in small diameter monitoring wells. In-situ tests were completed on monitoring wells BH1S, BH1I, BH1D, BH5S, BH5I, BH6S, BH6I, BH6D, BH9S, BH9I. Schedule V contains the results of the in situ tests of hydraulic conductivity that were performed.

In this study, the slug test involved the removal of water from the monitoring well using the WaTerra pump. Recovery of water level was monitored using an electric water level meter. Monitoring well BH5D did not have a test completed on it because the WaTerra sampling system became stuck in the well.

Water Sampling

Water samples were taken on July 15, 1992, from all monitoring wells where in-situ tests were completed. Fenwick Laboratories performed the chemical analyses for major ions and general ground water chemistry. Results of the chemical analyses are contained in Schedule VI.

Geophysical Testing

A borehole geophysical logging survey was conducted by Hyd-Eng Geophysics Inc. of Mississauga. Geophysical logging was completed on May 29, 1991, on the three deep borehole locations (BH1D, BH5D, BH6D) at Sites D, I, and H respectively. Geophysical logging was planned for BH9D at Site K but due to difficulties with the naturally-occurring gas encountered, logging was not undertaken.

The purpose of the geophysical logging was to provide data regarding any changes in overburden material with depth. Geophysical methods can detect changes in overburden composition. This information is used to correlate and confirm the lithology as determined by soil sampling when drilling the borehole.

All of the logging was conducted through the 51 mm PVC monitoring wells. Both natural gamma and apparent conductivity logs were collected at each site. The results of the geophysical survey are included in Schedule VII.

2.5.3 Factors/Indicators/Rationale

Evaluation criteria for the comparison of the sites are:

- The potential for natural protection of ground water resources from landfill leachate.
- The predictability of site conditions so that simple and reliable monitoring of ground water can be accomplished and simple contingency measures implemented.
- The potential for disrupting ground water supplies and resources.

The various indicators for these criteria as well as the rationale for the criteria is presented in Table 4.

TABLE 4
EVALUATION CRITERIA

Evaluation Criteria	Indicators	Rationale	Data Sources
1. Compare potential for natural protection of ground water resources from impacts from landfill leachate	• Thickness of attenuation layer • Nature and permeability of attenuation layer	• Conditions that have a higher degree of natural protection are preferred.	• Site specific data including: · Borehole logs · Hydraulic conductivity · Water levels · Grain size data · Geophysical data · Ground water chemistry
2. Ability to monitor ground water and implement contingency measures	• Number of ground water pathways • Nature of ground water migration pathways (medium, thickness, permeability, extent, and continuity) • Local ground water flow directions (convergent, divergent, uniform) • Depth to ground water migration pathways	• Sites for which simple and reliable monitoring of site performance and simple contingency measures can be implemented are preferred	• Same as above
3. Compare potential for disrupting ground water supplies and resources	• Presence of ground water resources in vicinity of site • Number of wells on record in vicinity of the sites • Quality and quantity of on-site ground water resources	• It is desirable to minimize the potential for disruption to ground water supplies and resources. Sites that are more remote from good quality, high yield ground water resources are preferred.	Same as above

When evaluating the results of the investigations, a "concept" of the hydrogeologic conditions at each site is developed. The data from the different aspects of the investigation are then reviewed. If the data converges to support the concept of site conditions, then it can be concluded that the site conditions are predictable. Predictable site conditions allow for simple and reliable monitoring of landfill site performance, and also indicate that simple contingency measures can be implemented. When the data from the different sources do not converge but instead tend to be contradictory and not supportive of the concept of conditions at the site, it is an indication that conditions at the site are complex and not predictable.

2.5.4 Data Sources

As indicated in Table 4, data sources used for evaluation of criteria and indicators comprise data generated by field investigations.

3.0 COMPARISON OF SITES: ANALYSIS AND RESULTS

This chapter presents an analysis of the data collected in the site investigations. This analysis is presented by geological conditions, and hydrogeologic conditions. Site-specific conditions are discussed for each topic. A comparison of conditions at each site is then made.

3.1 Existing Conditions With Respect to the Four Sites

Geological Conditions

The site-specific investigations support the interpretations made in the review of regional data. The overburden soils at all sites were found to be similar and to consist of relatively homogeneous clay-rich water-laid till. The results of the soil testing confirms the field descriptions of this soil as a silty clay till.

Site D

At Site D, in the deep borehole (BH1D), weathered and fractured till was identified to 2.7 m below ground surface (bgs) with some thin grey fine-grained silty sand seams identified in the interval 5.3-5.8m bgs. The soils beneath this depth were consistently an unweathered silty clay till. At 17.0 m bgs, a 4 cm grey fine-grained sand seam was identified.

The two boreholes drilled to 16 m at Site D (BH2I, BH3I) also identified the same overburden stratigraphy as was identified in BH1D. The weathered zone was identified at BH3I to a depth of 6.0 m bgs.

Bedrock at Site D, was encountered in BH1D at 42.5 m bgs (147.9 m asl) and consisted of a fissile grey clayey shale.

Interpretation of results from the geophysical logging of BH1D indicated that, between 34-43 m bgs, a zone of higher porewater conductivity occurs. This corresponds to the basal aquifer that is known to have a high conductivity. Molecular diffusion of dissolved constituents (eg. chloride) from the basal aquifer is probably the reason the porewater of the overlying clay soils (ie. 34-41 bgs) were also identified to have highly conductive porewater. The interpretation of the geophysical data is presented in detail in Schedule VII.

Site H

The deep borehole drilled at Site H (BH6D) indicated that weathered silty clay till extended to approximately 4.9m bgs, below this depth the overburden was a consistent grey silty clay till. Between 29.0-31.1 m bgs, silt layers approximately 50-150 mm thick were found. The other borehole location drilled at Site H (BH7I), identified similar stratigraphy with the weathered zone extending to a depth of 3.2 m bgs.

In BH6D, a layer of fine-grained sand with gravel was found (the basal aquifer) at 43.5 m bgs and bedrock (inferred by auger refusal) was encountered at 46.2 m bgs (139.8m asl). The geophysical logging of BH6D, indicated two zones of conductive porewater: one at 6 m bgs which is associated with the weathered till, and the other at 42 m bgs with is associated with the basal aquifer.

Site I

At Site 5, the deep borehole BH5D had very similar stratigraphy to BH6D which was expected due to their relatively close proximity. The weathered clay till extended to 4.3 m bgs. At 31.7-33.2 m bgs, the soil matrix has a higher silt content, which corresponds to the silt layers found near this depth at BH6D. Similar overburden stratigraphy was identified at BH4I.

At BH5D, between 42.0-45.1 m bgs, an interbedded zone of sand with gravel with layers of clay till and silt till was found. Bedrock, consisting of a grey fissile shale, was found at 45.1 m bgs (142.3 m asl).

Geophysical logging of BH5D indicated the same two high conductive porewater zones: a shallow zone which corresponds to the weathered till, and a deep zone that corresponds to the basal aquifer.

Site K

At Site K, at the deep borehole BH9D, the weathered zone extended to 3.9 m bgs. The overburden then became a massive grey silty clay till. A 25 mm thick fine-grained sand seam was found at 12.0 m bgs, and a 10 mm thick sand seam was identified at 12.5 m bgs. At 32.6 m bgs, a zone of laminated homogeneous clays was found which are of lacustrine origin. Beneath this zone, at 36.1 m bgs, silty clay till was found. Immediately beneath these soils, a silty fine-to-medium grained sand (basal aquifer) was found. Bedrock, consisting of a greenish-grey shale, was found beneath the sands at 39.9m bgs.

Boreholes BH8I and BH10I, also drilled at Site K, identified similar stratigraphy as BH9D. At BH8I, the weathered soil zone extended to 4.6 m bgs. At BH10I, the weathered zone was 4.3 m thick.

When bedrock was encountered in BH9D, a significant pocket of naturally-occurring gas was found. This made the installation of a monitoring well not possible and the borehole was sealed with cement. Therefore, geophysical logging of this borehole was not possible.

Hydrogeologic Conditions

The hydrogeologic conditions at all sites are similar. The weathered silty clay till is fractured and ground water flow occurs chiefly in these fractures with flow chiefly horizontal towards drainage ditches and municipal drains. The unweathered silty clay till is an effective aquitard limiting recharge to the underlying basal aquifer. No significant sand seams were found beneath the weathered till in the overburden.

Hydrogeologic conditions were evaluated using three main data sources; water levels in monitoring wells which are used to determine hydraulic gradients and therefore ground water flow directions; in situ hydraulic conductivity tests which indicate the ability of the different soil units to transmit ground water; and water chemistry, which can be used to differentiate between hydrostratigraphic units.

Table 5 presents the vertical gradients determined by water levels at wells installed at the same location. For example, the vertical hydraulic gradient between BH1S and BH1I is determined by dividing the difference in water levels of the two wells by the mean distance between the completion intervals of the wells.

Table 6 summarizes the horizontal gradients for each hydrostratigraphic zone, which were determined by triangulating water levels between three wells. The horizontal gradients at Site H and Site I were calculated from monitoring wells installed at both sites. Horizontal gradients are quite small and the direction of ground water flow may be erroneous because of the lack of sufficient data (ie. only three wells were used).

Table 7 is a summary of the results of the in situ hydraulic conductivity testing completed at each of the four deep borehole locations. Due to the low permeability of the soils at these sites, the tests are still on-going and only interim results are presented.

TABLE 5
SUMMARY OF VERTICAL HYDRAULIC GRADIENTS

BH No.	Completion Interval		Formation	Static Water Level (masl)	Vertical Gradients
	Bottom (masl)	Top (masl)			
1S	182.90	189.09	Weathered Till	189.88	0.04
1I	175.30	177.91	Unweathered Till	189.51	
1I	175.30	177.91	Unweathered Till	189.51	0.01
1D	140.88	148.21	Basal Aquifer	189.15	
2S	182.94	189.36	Weathered Till	190.10	0.3
2I	175.43	178.12	Unweathered Till	187.36	
3S	183.05	189.20	Weathered Till	190.26	0.09
3I	175.47	178.07	Unweathered Till	189.38	
5S	179.78	185.95	Weathered Till	186.66	0.2
5I	172.27	174.68	Unweathered Till	184.63	
5I	172.27	174.68	Unweathered Till	184.63	0.1
5D	142.60	147.12	Basal Aquifer	180.99	
6S	178.58	184.64	Weathered Till	185.10	0.2
6I	171.06	173.70	Unweathered Till	183.51	
6I	171.06	173.70	Unweathered Till	183.51	0.08
6D	140.16	143.95	Basal Aquifer	181.21	
7S	178.91	185.75	Weathered Till	185.24	0.6
7I	170.86	174.96	Unweathered Till	179.46	
8S	184.21	188.17	Weathered Till	187.37	−0.1
8I	178.48	180.72	Unweathered Till	188.00	
9S	186.17	190.06	Weathered Till	190.14	0.3
9I	180.07	183.02	Unweathered Till	187.92	
10S	183.23	188.00	Weathered Till	185.60	0.06
10I	175.80	177.93	Unweathered Till	185.06	

TABLE 6
SUMMARY OF HORIZONTAL HYDRAULIC GRADIENTS

Borehole Numbers	Formation	Horizontal Gradient	Direction
BH1S BH2S BH3S	Weathered Till	0.00068	N 23° W
BH1I BH2I BH3I	Unweathered Till	0.0033	S 80° W
BH5S BH6S BH7S	Weathered Till	0.00284	S 65° W
BH5I BH6I BH7I	Unweathered Till	0.009	EAST
BH8S BH9S BH10S	Weathered Till	0.012	N 15° E
BH8I BH9I BH10I	Unweathered Till	0.0009	N 20° W

TABLE 7
SUMMARY OF HYDRAULIC CONDUCTIVITY DATA

BH No.	Completion Interval		Formation	Hydraulic Conductivity (cm/s)
	Bottom (masl)	Top (masl)		
1S	182.90	189.09	Weathered Till	$5.8x10^{-7}$
1I	175.30	177.91	Unweathered Till	$2.7x10^{-8}$
1D	140.88	148.21	Basal Aquifer	$3.2x10^{-8}$
5S	179.78	185.95	Weathered Till	$2.0x10^{-8}$
5I	172.27	174.68	Unweathered Till	$4.3x10^{-8}$
6S	178.58	184.64	Weathered Till	$2.8x10^{-8}$
6I	171.06	173.70	Unweathered Till	$4.5x10^{-8}$
6D	140.16	143.95	Basal Aquifer	$3.2x10^{-6}$
9S	186.17	190.06	Weathered Till	$2.9x10^{-7}$
9I	180.07	183.02	Unweathered Till	$3.5x10^{-7}$

Site D

There is a vertical gradient between the weathered till and the unweathered till ranging from .01 to 0.3 at this site. The vertical gradient between the unweathered till and the basal aquifer (BH1I and BH1D) is 0.01, which is due to the high piezometric head in the basal aquifer. This is the lowest gradient measured at any of the sites.

The horizontal gradient in the weathered till is very small at 0.0007 and in the unweathered till it is 0.003. The small horizontal gradients indicate that flow in the overburden is mainly downwards, controlled by the vertical gradients.

The hydraulic conductivity of the weathered till, as measured by an in situ test in BH1S, is 5.8 x 10^{-7} cm/s. The hydraulic conductivity of the unweathered till (as measured in BH1I) is 2.7 x 10^{-8} cm/s. The basal aquifer also had a very low hydraulic conductivity of 3.2 x 10^{-8} cm/s, which would indicate that the basal aquifer does not have a significant yield at this location.

Site H

There is a higher vertical hydraulic gradient at Site H as compared to Site D with a range of 0.2 to 0.6 between the weathered and unweathered till. However the hydraulic gradient between the unweathered till and the basal aquifer (between BH6I and BH6D) is significantly less at 0.08.

The horizontal gradients at this site are 0.0028 and 0.009 respectively for the weathered and unweathered till respectively.

The hydraulic conductivity of the weathered till as measured in 2.8 x 10^{-8} cm/s, and the hydraulic conductivity of the weathered till is 4.5 x 10^{-8} cm/s. The basal aquifer had a conductivity of 3.2 x 10^{-6} cm/s (as measured in BH6D) which, while two orders-of-magnitude higher than BH1D (at Site D), is still relatively low.

Site I

The hydrogeologic conditions at Site I are similar to those at Site H, which is expected due to their close proximity to one another. The hydraulic conductivity of both the weathered and unweathered till is essentially identical to that measured at Site H.

The vertical hydraulic gradients at borehole location 5 ranged from 0.2 between the weathered and unweathered till, and 0.1 between the unweathered till and the basal aquifer.

Site K

The vertical hydraulic gradients reported in Table 5 may be erroneous because the wells may have not had time to recover to static level after drilling. They do suggest that the gradients are slightly less when compared to Sites H and I and slightly greater when compared to Site D. Preliminary results from the in situ testing indicate hydraulic conductivities in the 10^{-7} cm/s range which, while an order-of-magnitude higher than the other sites, is still relatively low.

Ground Water Quality

Water samples were taken from all of the wells in which in-situ hydraulic conductivity testing was completed. These wells were submitted to Fenwick Laboratories Ontario Limited for analyses for general ground water parameters. The results of this analyses are summarized in Schedule VI.

The purpose of this testing was to determine major ion ratios so that an evaluation could be made in terms of ground water quality evolution. As water moves through the ground, increases in total dissolved solids and major ions occur. It has been shown that as ground water moves within the ground water flow regime, it tends to evolve chemically toward the composition of seawater. These changes occur as ground water moves from shallow zones that are recharged by precipitation through intermediate zones and finally into zones where the water is old (Freeze and Cherry, 1979).

The evolution of ground water quality is usually evaluated by using graphs that illustrate the ratio of major ions. Figure 6 is a Durov diagram that is useful for visually describing differences in ground water flow systems. As ground water quality evolves, differentions are dominant. For example in shallow ground water zones, bicarbonate (HCO_3^-) is the dominant anion, while for "old" ground water zones, chloride (Cl^-), is the dominant anion.

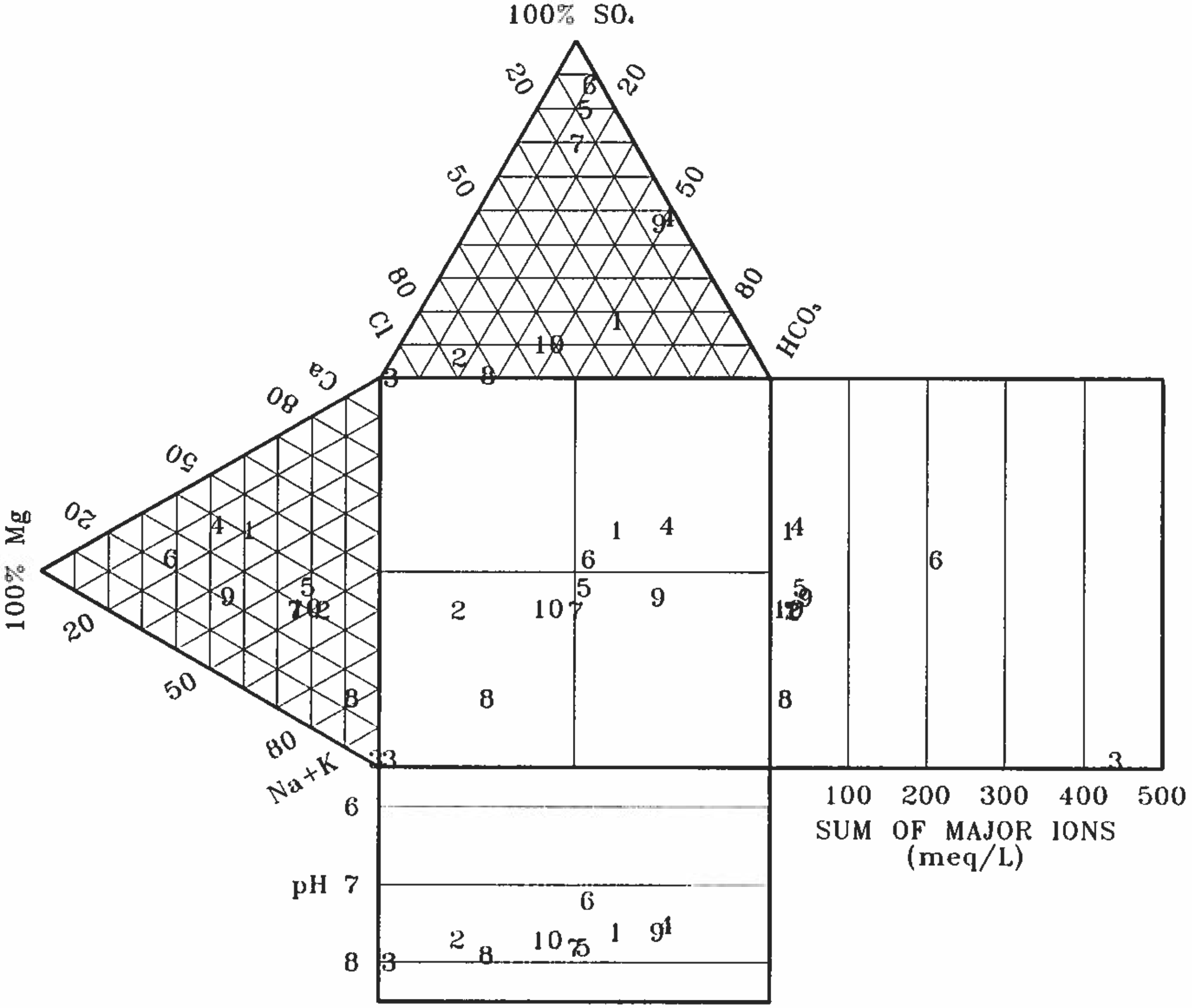
As Figure 6 illustrates, comparison of results from shallow wells ("S" series wells), to intermediate depth wells ("I" series wells), and deep wells ("D" series wells) clearly show the trend for ground water to evolve from a calcium-bicarbonate ($Ca:HCO_3^-$) type water for the shallow wells to a sodium-chloride ($Na:Cl$) type water for the deep wells. This trend is consistent with other studies conducted in the St. Clair Clay Plain (see Section 2.5.2), where ground water in the basal aquifer has been identified to very "old" ground water. The trend

FIGURE 6

Ground Water Chemistry
Durov Diagram

LEGEND

1	BH1S July 1993
2	BH1I July 1993
3	BH1D July 1993
4	BH5S July 1993
5	BH5I July 1993
6	BH6S July 1993
7	BH6I July 1993
8	BH6D July 1993
9	BH9S July 1993
10	BH9I July 1993



was consistent for all sites. This condition is an indication that the clay-rich till overlying the aquifer is of low permeability preventing the rapid recharge of ground water to the aquifer.

The relatively high concentrations of dissolved solids in monitoring well BH1D is an indication that this well was installed at a deeper depth into the black shale bedrock than BH6D.

The relatively high dissolved solids in BH6S is inconsistent with the other shallow wells, but because it conforms to the major ion trend is considered not to be significant in terms of the comparison of sites.

3.2 Net Effects and Advantages/Disadvantages of the Four Sites

As indicated in Section 2.5.3, three overall criterion were selected to evaluate the sites, and are outlined in Table 4. The methods used to evaluate these criteria are discussed below. The results of this evaluation are presented in Table 8.

Tables 9 to 12 outline the possible environmental effects of a waste management facility on the sites, the mitigative measures that could be implemented to lessen the environmental impacts, and the net effects.

Criterion 1 - Compare potential for site to provide natural protection from leachate

This criterion is based on the principle that a landfill site should be located in a setting with sufficient natural protection to minimize off-site impacts. The natural attenuation capability of a site is a key measure of its ability to provide natural protection of ground water resources from the impact of landfill leachate. Attenuation of leachate refers to the reduction of the concentrations of contaminants from leachate on the ground water system through physical and chemical/biological reduction as well as dilution within the ground water flow system. Geologic materials in an attenuation layer which are low permeability, have significant percentage of clay minerals and are relatively unfractured, offer good natural attenuation capability because of their ability to reduce the concentrations of contaminants. Two indicators were considered in the evaluation of the potential for the site to provide natural protection from leachate:

- Indicator 1 Thickness of Attenuation Layer.
- Indicator 2 Nature and Relative Permeability of the Attenuation Layer.

TABLE 8
EVALUATION OF SHORT LIST OF SITES FOR GEOLOGY / HYDROGEOLOGY

Sites	D	H	I	K
CRITERION 1: COMPARE POTENTIAL FOR SITE TO PROVIDE NATURAL PROTECTION FROM LEACHATE				
Criterion Preference Level	1	1	1	1
INDICATOR 1 – THICKNESS OF THE ATTENUATION LAYER				
Minimum Thickness (m)	37.5	38.5	37.0	32.5
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
INDICATOR 2 – NATURE AND PERMEABILITY OF THE ATTENUATION LAYER				
Indicator Preference Level	1	1	1	2
Subindicator 2a – Clay Content of the Attenuation Layer Indicated by Soil Testing				
Arithmetic Mean (%)	44	58	52	50
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
Subindicator 2b – Permeability (Hydraulic Conductivity) of the Attenuation Layer Indicated by Well Testing				
In–situ Tests (cm/s)	2.7×10^{-8}	4.5×10^{-8}	4.3×10^{-8}	3.5×10^{-7}
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)

Notes:

1(N/A)	No significant difference between sites – all ranked equally

TABLE 8 (cont.)
EVALUATION OF SHORT LIST OF SITES FOR GEOLOGY / HYDROGEOLOGY

Sites	D	H	I	K
CRITERION 2: COMPARE ABILITY TO MONITOR GROUND WATER AND IMPLEMENT CONTINGENCY MEASURES				
Criterion Preference Level	1	1	1	1
INDICATOR 1 – NUMBER OF GROUND WATER MIGRATION PATHWAYS				
Number of Pathways	2	2	2	2
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
INDICATOR 2 – NATURE OF MONITORING LAYERS				
Hydrostratigraphic Unit	WT/BA	WT/BA	WT/BA	WT/BA
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
INDICATOR 3 – GROUND WATER FLOW DIRECTION				
Inferred Condition	Uniform	Uniform	Uniform	Uniform
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
INDICATOR 4 – DEPTH TO GROUND WATER MIGRATION PATHWAYS				
Indicator Preference Level	1	1	1	1
Sub–Indicator 4a – Depth to Weathered and Fractured Till				
Depth (m)	0	0	0	0
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
Sub–Indicator 4b – Depth to Basal Aquifer				
Depth (m)	37.5	38.5	37.0	32.5
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)

Notes:

1(N/A)	No significant difference between sites – all ranked equally
WT/BA	Weathered Till and Basal Aquifer

TABLE 8 (cont.)

EVALUATION OF SHORT LIST OF SITES FOR GEOLOGY / HYDROGEOLOGY

Sites	D	H	I	K
CRITERION 3: COMPARE POTENTIAL FOR DISRUPTING GROUND WATER SUPPLIES AND RESOURCES				
Criterion Preference Level	1	1	1	1
INDICATOR 1 – GROUND WATER RESOURCES IN THE VICINITY OF THE SITES				
Indicator Preference Level	1	1	1	1
Subindicator 1a – Ground Water Resource Quality				
Water Type	Na:Cl	Na:Cl	Na:Cl	no data
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
Subindicator 1b – Ground Water Resource Quantity				
Estimated Transmissivty	low	low	low	low
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
INDICATOR 2 – GROUND WATER USE IN THE VICINITY OF THE SITES				
Wells on Record	1	6	4	3
Residences Nearby	9	0	0	8
Indicator Score	1 (N/A)	1 (N/A)	1 (N/A)	1 (N/A)
SITE RANK	1	1	1	1

Notes:

1(N/A)	No significant difference between sites – all ranked equally
Na:Cl	Sodium Chloride type water quality

TABLE 9
HYDROGEOLOGIC IMPACT ASSESSMENT: NET EFFECTS FOR SITE D

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Compare potential for natural protection of ground water resources from impacts from landfill leachate:		· natural protection of ground water resources from impacts from landfill leachate, result in negligible environmental effects	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · preventative inspection and maintenance program for all landfill design components	· low risk of contamination due to natural protection of ground water resources from impacts from landfill leachate
• minimum thickness of attenuation layer (m)	37.5			
• nature and permeability of attenuation layer				
· clay content (arithmetic mean)	44%			
· permeability (hydraulic conductivity) cm/s	2.7 x 10^{-8}			
2. Ability to monitor ground water and implement contingency measures		· site geology is highly consistent and permits reliable prediction of impacts, reliable monitoring and effective implementation of contingency measures	· as above	· negligible net effects due to sites ability to monitor ground water and implement contingency measures
• number of ground water migration pathways	2			
• nature of monitoring layers	weathered till and basal aquifer			
• ground water flow direction	uniform			
• depth to ground water migration pathways				
· depth to weather and fractured till (m)	0			
· depth to basal aquifer (m)	37.5			
3. Compare potential for disrupting ground water supplies and resources		· there is almost no potential for disrupting ground water supplies and resources. As a result of the data collected, it is not possible to differentiate between sites	· as above	· almost no potential for disrupting ground water supplies and resources
• presence of ground water resources in vicinity of site				
· ground water resource quality	sodium chloride type water quality			
· ground water resource quantity	low			
• ground water use in the vicinity of the sites	1 well on record 9 residences nearby			

TABLE 10
HYDROGEOLOGIC IMPACT ASSESSMENT: NET EFFECTS FOR SITE H

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Compare potential for natural protection of ground water resources from impacts from landfill leachate:** • minimum thickness of attenuation layer (m)	38.5	· natural protection of ground water resources from impacts from landfill leachate, result in negligible environmental effects	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · preventative inspection and maintenance program for all landfill design components	· low risk of contamination due to natural protection of ground water resources from impacts from landfill leachate
• nature and permeability of attenuation layer · clay content (arithmetic mean)	58%			
· permeability (hydraulic conductivity) cm/s	4.5×10^{-8}			
2. **Ability to monitor ground water and implement contingency measures** • number of ground water migration pathways	2	· site geology is highly consistent and permits reliable prediction of impacts, reliable monitoring and effective implementation of contingency measures	· as above	· negligible net effects due to sites ability to monitor ground water and implement contingency measures
• nature of monitoring layers	weathered till and basal aquifer			
• ground water flow direction	uniform			
• depth to ground water migration pathways · depth to weathered and fractured till (m)	0			
· depth to local aquifer (m)	38.5			
3. **Compare potential for disrupting ground water supplies and resources** • presence of ground water resources in vicinity of site · ground water resource quality	sodium chloride	· there is almost no potential for disrupting ground water supplies and resources. As a result of the data collected, it is not possible to differentiate between sites	· as above	· almost no potential for disrupting ground water supplies and resources
· ground water resource quantity	low			
• ground water use in the vicinity of the sites	6 wells on record 0 residences nearby			

TABLE 11
HYDROGEOLOGIC IMPACT ASSESSMENT: NET EFFECTS FOR SITE I

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Compare potential for natural protection of ground water resources from impacts from landfill leachate: • minimum thickness of attenuation layer (m)	37.0	· natural protection of ground water resources from impacts from landfill leachate, result in negligible environmental effects	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · preventative inspection and maintenance program for all landfill design components	· low risk of contamination due to natural protection of ground water resources from impacts from landfill leachate
• nature and permeability of attenuation layer · clay content (arithmetic mean)	52%			
· permeability (hydraulic conductivity) cm/s	4.3×10^{-8}			
2. Ability to monitor ground water and implement contingency measures • number of ground water migration pathways	2	· site geology is highly consistent and permits reliable prediction of impacts, reliable monitoring and effective implementation of contingency measures	· as above	· negligible net effects due to sites ability to monitor ground water and implement contingency measures
• nature of monitoring layers	weathered till and basal aquifer			
• ground water flow direction	uniform			
• depth to ground water migration pathways · depth to weathered and fractured till (m)	0			
· depth to basal aquifer (m)	37.0			
3. Compare potential for disrupting ground water supplies and resources • presence of ground water resources in vicinity of site		· there is almost no potential for disrupting ground water supplies and resources. As a result of the data collected, it is not possible to differentiate between sites	· as above	· almost no potential for disrupting ground water supplies and resources
· ground water resource quality	sodium chloride			
· ground water resource quantity	low			
• ground water use in the vicinity of the sites	4 wells on record 0 residences nearby			

TABLE 12
HYDROGEOLOGIC IMPACT ASSESSMENT: NET EFFECTS FOR SITE K

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Compare potential for natural protection of ground water resources from impacts from landfill leachate:** • minimum thickness of attenuation layer (m)	32.5	· natural protection of ground water resources from impacts from landfill leachate, result in negligible environmental effects	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · preventative inspection and maintenance program for all landfill design components	· low risk of contamination due to natural protection of ground water resources from impacts from landfill leachate
• nature and permeability of attenuation layer · clay content (arithmetic mean)	50%			
· permeability (hydraulic conductivity) cm/s	3.5×10^{-7}			
2. **Ability to monitor ground water and implement contingency measures** • number of ground water migration pathways	2	· site geology is highly consistent and permits reliable prediction of impacts, reliable monitoring and effective implementation of contingency measures	· as above	· negligible net effects due to sites ability to monitor ground water and implement contingency measures
• nature of monitoring layers	weathered till and basal aquifer			
• ground water flow direction	uniform			
• depth to ground water migration pathways · depth to weathered and till (m)	0			
· depth to basal aquifer (m)	32.5			
3. **Compare potential for disrupting ground water supplies and resources** • presence of ground water resources in vicinity of site		· there is almost no potential for disrupting ground water supplies and resources. As a result of the data collected, it is not possible to differentiate between sites	· as above	· almost no potential for disrupting ground water supplies and resources
· ground water resource quality	no data			
· ground water resource quantity	low			
• ground water use in the vicinity of the sites	3 wells on record 8 residences nearby			

Indicator 1 - Thickness of Attenuation Layer

The potential for attenuation is related to the thickness of the attenuation layer underlying the landfill. The minimum thickness is measured between the proposed landfill base and the basal aquifer. The surficial weathered and fractured clayey silt till which extends from surface to up to 10 m in the St. Clair Clay Plain is not considered to be a competent attenuation layer. However, the method used to identify the depth of the weathered and fractured layer used in this study (examination of soil cores) does not conclusively determine the depth of the hydraulically active fractures. It is considered that the depth of hydraulically active fractures does not vary significantly within the area of the short-listed sites and therefore would not influence the comparison of the sites. More detailed tests (eg. see D'Astous et al., 1988) will be completed on the selected site to determine the depth of fracturing and appropriate measures to mitigate the potential for leachate migration in the weathered and fractured clayey silt will be incorporated into the design of the landfill.

Indicator 1 was evaluated by subtracting the depth of the proposed landfill (5 m) from the depth to the basal aquifer identified in the deepest borehole ("D" series) drilled at each site. The thickness of the attenuation layer at the different sites ranged from 32.5 m to 38.5 m. It is considered that attenuation layers greater than 30 m thick are very adequate to protect ground water resources and differentiation beyond 30 m is not significant.

Indicator 2 - Nature and Relative Permeability of Attenuation Layer

Geological materials which have relatively low permeability, including soils with significant proportions of clay or silt grain size particles are considered to represent favourable conditions for leachate attenuation. The following subindicators were used to evaluate this indicator:

- Subindicator 2a	Clay content of the Attenuation Layer, as indicated by Soil Testing
- Subindicator 2b	Permeability of the Attenuation Layer, as indicated by Well Testing

Subindicator 2a - Clay content of the attenuation layer, as indicated by soil testing

Soil samples collected within the attenuation layer were submitted to geotechnical testing laboratories for analysis of grain size. Results of this testing identified relative content of clay, silt, sand and gravel and the average content of clay was determined by calculation.

The average clay content of the soil samples for the different sites ranged from 44% to 58%. Soils with this high clay content have excellent attenuation properties and the differences between the clay content of the different sites are not significant. Therefore, it is not possible to differentiate between the sites based on this subindicator.

Subindicator 2b - Permeability of the attenuation layer as indicated by well testing

Monitoring wells were installed in the attenuation layer. Quantitative estimates of hydraulic conductivity were obtained from the performance of response tests in these wells (see Table 7). Only data from wells installed in the intermediate depth wells ("I" series) were used for this subindicator. One test was complete on each site. Three tests resulted in a hydraulic conductivity estimates in the 10^{-8} cm/s range (for Sites D, H and I) while on e test from Site K was in the 10^{-7} cm/s range. While this difference may be significant, the lack of supporting data (eg. more tests) suggest that the results should not used to differentiate between the sites. Attenuation layers with hydraulic conductivities in the 10^{-7} cm/s range or less are considered to have very adequate attenuative characteristics.

Criterion 2 - Compare the ability to monitor ground water and implement contingency measures

This criterion is based on the principle that a site should be sufficiently understandable to permit reliable prediction of impact, reliable monitoring and effective implementation of contingency measures. Thus it can be predicted where, when and to what extent ground water impacts might occur at the site in the unexpected event of a failure of the facility to operate as designed. Also, ground water monitoring wells can be placed in appropriate locations and at appropriate depths to allow effective monitoring of ground water and so that effective contingency measures can be designed and implemented, if required.

To evaluate this criterion the number of ground water migration pathways, the nature and extent of the principal monitoring layer and ground water flow directions within this layer are evaluated.

Indicator 1 - Number of Ground Water Migration Pathways

This indicator addresses the requirement for complex monitoring programs when there are a number of potential ground water pathways. The investigations completed at all of the four sites identified only three hydrostratigraphic units:

- Weathered and fractured clayey silt till;
- Unweathered clayey silt till; and
- Basal aquifer.

The expected ground water migration pathways for these units are horizontal movement of ground water in the surficial weathered soils and vertical movement through the unweathered soils to the basal aquifer. Because of the consistency of these hydrostratigraphical units over all of the sites the number of ground water migration pathways at all sites are the same.

Elsewhere in Lambton County, significant glaciolacustrine soils have been identified within the unweathered till. These soils typically comprise interbedded layers of sands, silts and clays. The soil cores recovered in the investigations were carefully inspected for significant sand layers. For all sites, no significant sand layers were identified in the soil cores. Therefore, the use of a sub-indicator relating to the presence of sand layers to compare the sites is not possible.

Indicator 2 - Nature of Monitoring Layers

Monitoring layers are the hydrostratigraphic units where impacts are expected to occur. For the short-listed sites, the monitoring layers are the surficial weathered clayey silt till and the basal aquifer. No significant differences in these units were identified between sites in the investigations. Therefore it is not possible to differentiate between sites using this indicator.

Indicator 3 - Ground Water Flow Direction

There is insufficient data to conclusively determine the ground water flow direction. However, uniform flow direction can be inferred by the level topography and consistent geology at all sites. Since all sites are inferred to have a uniform flow direction, it is not possible to differentiate between sites using this indicator.

Indicator 4 - Depth to Ground Water Migration Pathways

The depth to ground water migration pathways can be divided into the depth to the weathered and fractured clay silt till and the depth to the basal aquifer.

Subindicator 4a - Depth to Weathered and Fractured Till

Since the weathered and fractured till occurs from ground surface, the depth to this migration pathway will be zero for all sites.

Subindicator 4b - Depth to Basal Aquifer

The depth to the basal aquifer is the same as Criterion 4 - Indicator 1, Thickness of Attenuation Layer. The depth to the basal aquifer at the different sites ranged from 32.5 m to 38.5 m. It is considered that depths of greater than 30 m are not significant and differentiation beyond 30 m is not significant.

Criterion 3 - Compare potential for disrupting ground water supplies and resources

This criterion addresses the potential for a landfill site to have a negative impact on ground water resources and ground water users. The evaluation completed for the long-list of sites (Step 5), included a compilation of the number of wells on record within 1 km of the site as well as the number of potential users based on the number of residences within 1 km. Also, since the completion of Step 5, the municipal water supply grid has been expanded, indicating that the municipal water supply is available in the vicinity of all sites.

Indicator 1 - Ground Water Resources in the Vicinity of the Sites

The evaluation of ground water resources can be completed by comparing the quality and expected quantity of the resources at the different sites. For all sites, the source of ground water is the basal aquifer consisting of a sand layer overlying and hydraulically connected to the upper fractured portion of the black shale bedrock.

Subindicator 1a - Ground Water Resource Quality

The testing completed on water samples taken from the basal aquifer wells installed for this study, indicated that the basal aquifer water quality had relatively high concentrations of sodium and chloride, consistent with results from regional studies of the aquifer.

Only two wells were sampled in this study, BH1D and BH6D, from Sites D and H, respectively. BH6D is sufficiently close to Site I to represent conditions there. The sampling system installed within the well installed at Site I (BH5D) is stuck in the well and no sample could be taken. Problems caused by the naturally occurring gas at Site K (BH9D) prevented the installation of a monitoring well.

The concentrations of sodium and chloride at Site D (BH1D), were significantly higher than at Site H (BH6D). However, BH1D is installed at a deeper depth within the bedrock, which may explain the higher concentrations. Based on these factors it is not possible to differentiate between the sites based on this subindicator.

Subindicator 1b - Ground Water Resource Quantity

This subindicator can be evaluated by comparing the expected transmissivity of the basal aquifer at the different sites. Transmissivity is based on the thickness of the aquifer and the aquifer's hydraulic conductivity. Since the thickness of the aquifer was similar to all sites, hydraulic conductivity data can be used to differentiate between the sites. Wells response tests to determine hydraulic conductivity were completed in the two wells accessible for testing (BH1D and BH6D). However, the results of these tests cannot be compared because the BH1D was installed deeper within the bedrock than BH6D and are not representative of the same hydrogeologic conditions. However, the results do indicate that the basal aquifer has a relatively low permeability and the inspection of soil core from the aquifer at all four sites indicate similar characteristics, indicating that the nature of the basal aquifer is not different between the sites. Based on these factors it is not possible to differentiate between the sites based on this subindicator.

Indicator 2 - Ground Water Use in the Vicinity of the Sites

Sites H and I have more wells on record within 1 km (6 and 4, respectively) compared to Sites D and K (1 and 3 wells). However, Sites D and K have more potential residential users of ground water (9 and 8, respectively), while Sites H and I do not have nay potential residential users within 1 km. The presence of a municipal water supply will limit future ground water users. These factors, along with the relatively minor use of ground water in the vicinity of the sites, make it not practical to differentiate between sites based on significant differences of ground water use between the sites.

3.3 Conclusions and Comparison of Sites

A comparison of the geological conditions at the four different sites indicates that all sites have significant thickness of consistent low permeability clay soils overlying the basal aquifer. There were no significant layers of higher permeability soils encountered in the drilling of boreholes at any site. Comparison of laboratory analyses of soils indicates that there is no significant change in overburden composition between the sites. Overall, it is considered that there are no significant differences in geological conditions at the four sites.

A comparison of hydrogeologic conditions at the site indicates that the overburden soils have very low hydraulic conductivities. Vertical gradients, which induce downward movement of ground water, are somewhat higher at Sites H and I than at Site D. The data does indicate that vertical gradients are variable at each site. The reason for the low gradient measured at Site D is the relatively high piezometric head in the basal aquifer. The monitoring well (1D) installed in the basal aquifer at Site D, was drilled to a deeper depth than at Sites H and I, which may explain, in part, the higher piezometric head in the basal aquifer at Site D. Due to these reasons, it is considered that the differences in vertical gradients are not sufficient reason to rank any site as preferred over the others.

All sites have a considerable thickness (greater than 38 m) of low permeability overburden that would provide significant natural protection of the basal aquifer from impacts from landfill leachate. Similarly all site were found to have predictable geological and hydrogeologic conditions with no significant sand seams or other complicating features found at any site.

Based on the results of these investigations, hydrogeologic conditions at all of the identified sites have the same potential to limit contaminant migration from a landfill and protect ground water resources.

4.0 SUMMARY

Site-specific investigations were completed at four sites identified for site comparison for the County of Lambton Waste Management Master Plan. The purpose of these investigations was to collect site-specific information from each of the sites to allow comparison of hydrogeologic conditions between the sites.

These investigations included the drilling of one borehole/monitoring well to bedrock at each of the sites as well as the installation of monitoring wells within the overburden at other locations. A total of 22 monitoring wells were installed in the investigations.

Soil samples were taken continuously in the deep boreholes. Selected soil samples were analyzed to determine their grain size composition. As well, water levels in the monitoring wells were measured to determined hydraulic gradients which were used to determine ground water flow directions.

In situ hydraulic conductivity tests were completed on selected wells to determine the hydraulic conductivity of the various hydrostratigraphic units. Geophysical logging of the deep boreholes was also completed to detect changes in overburden composition.
Ground water samples were also submitted for laboratory analyses.

Geological conditions at the four sites are very similar with every site having a significant thickness of clay till overlying the basal aquifer. There were no significant sand seams encountered in any borehole at any site.

Overall, the results of the investigations indicate that all sites have similar suitable hydrogeologic conditions and no site is preferred over the others.

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SCHEDULE I

BOREHOLE LOGS

LIST OF ABBREVIATIONS
& TERMS USED IN BOREHOLE LOGS

This form summarizes both field and selected lab test results on samples obtained from each borehole. An explanation of the various columns of the log follows.

DEPTH

All depths are given in metres (feet) measured from the ground surface unless otherwise noted.

ELEVATION/DEPTH

This column gives the elevation and depth of inferred geologic contacts. The elevation is referred to the datum shown in the general heading.

SYMBOLIC LOG

The symbolic log column displays standard hatching symbols used for description of soil and rock strata.

SOIL DESCRIPTION

A description of the soil strata using standard terminology is contained in this column. The terminology used for describing soils/strata is based on proportions of particle sizes present:

Term	Example	(%)
Trace	Trace sand	1 - 10
Some	Some sand	10 - 20
Adjective	Sandy	20 - 35
And	And sand	35 - 50
Noun	Sand	>50

Grain Size Classification*

* Based on Unified Soil Classification
System ASTM D2487-85

Clay	<0.002 mm
Silt	0.002 - 0.075 mm
Sand	0.075 - 4.75 mm
Gravel	4.75 - 75 mm
Cobbles	75 - 200 mm
Boulder	>200 mm

Relative Density (Non-cohesive Soils)

	N (SPT)
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very dense	>50

Consistency (Cohesive Soils)

	N(SPT)	Undrained Shear Strength (kPA)
Very soft	<2	0 to 12
Soft	2 - 4	12 to 25
Firm	4 - 8	25 to 50
Stiff	8 - 15	50 to 100
Very stiff	15 - 30	100 to 200
Hard	- >30	Over 200

Dilatancy

None - No visible change in specimen.

Slow - Water appears slowly on surface of specimen during shaking and does not disappear or disappears slowly upon squeezing.

Rapid - Water appears quickly on the surface of specimen during shaking and disappears quickly upon squeezing.

Plasticity

	Liquid Limit (%)
Low plasticity	<30
Medium plasticity	30 - 50
High plasticity	>50

LIST OF ABBREVIATIONS
& TERMS USED IN BOREHOLE LOGS
(continued)

SAMPLE NO.

Samples are numbered numerically in the order in which they were obtained in the borehole.

INTERVAL

The interval over which a sample was taken is indicated. The symbol represents the type of sampling method used. See form which follows for symbol descriptions.

SAMPLE TYPE

The first letter describes the sampling method and the second, the shipping container.

Sampling Method

A - Split Tube
B - Thin Wall Tube
C - Piston Sampler
D - Core Barrel
X - Denotes sample extracted from core, taken for laboratory analysis
E - Auger
F - Wash
G - Shovel

Shipping Container

N - Insert
O - Tube
P - Water Content Tin
Q - Plastic Jar
R - Glass Jar
S - Plastic bag
T - Cloth Bag
U - Wooden Core Box
Y - Plastic Core Box
Z - Discarded

'N' VALUE (BLOW COUNT)

The 'N' value obtained from the Standard Penetration Test (SPT). This test is carried out in accordance with ASTM D1586-84 and the 'N' value corresponds to the sum of the number of blows required by a 63.5 kg (140-lbs) hammer dropped 760 mm (30 in.) to drive a 50-mm (2-in.) split tube sampler the second and third 150 mm (6 in.) of penetration.

% RECOVERY

The percentage of the sample actually recovered based on field measurements is identified in this column. In the case of rock, the length of rock core as a percentage of each core run is given.

LABORATORY ANALYSIS OF SOILS

Letter denotes analysis performed.

GEOTECHNICAL

a. Grain Size
b. Moisture Content
c. Wet Density
d. Atterberg Limit(s)
e. Permeability
f. Cation Exchange Capacity
g. Mineralogical Identification
h. Other geotechnical

CHEMICAL

i. Oils and Grease
j. TOC
k. Hydrocarbon (s)
l. Organic Compound(s)
m. Major Ion(s)
n. Nutrient(s)
o. Metal(s)
p. Other chemical

TEST DATA PLOTS

A column is reserved for plotting field and/or laboratory test data against depth, 'N' values, moisture contents and field vane shear strength are commonly plotted.

MONITOR INSTALLATION DETAILS

This column displays the details of ground water monitor construction. See form which follows for description of symbols used to represent backfill materials.

LIST OF SYMBOLS
USED IN BOREHOLE LOG

Sample Interval	Sampling Method
▩	Split Tube
▥	Thin Wall Tube
▥	Piston Sample
▥	Core Barrel
▨	Auger
▧	Wash
▒	Shovel
■	Sample Extracted for lab analysis
□	Other

Monitor Installation Details

▨	Cement
▦	Bentonite-pelletized
■	Bentonite-powdered
░	Sand
░	Gravel
▩	Drill Cuttings
▓	Caved Materials
▦	Other Fill Materials
□	Open Hole

PROJECT No. 92 9928 37 01
DATUM: Geodetic

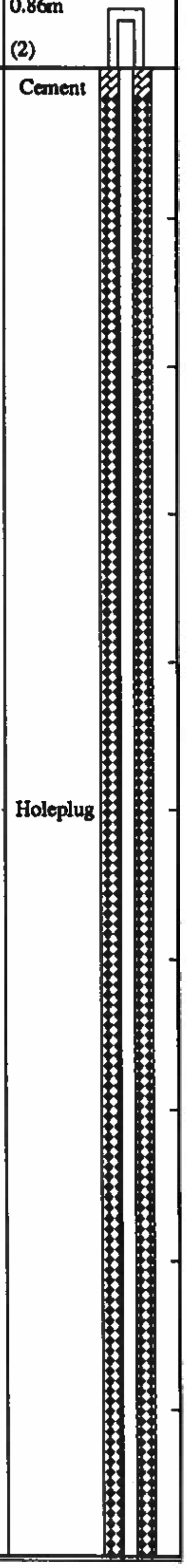
BOREHOLE No. **1S**
Sheet 1 of 1

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **18 May 1991**
INSPECTOR: **SJW**

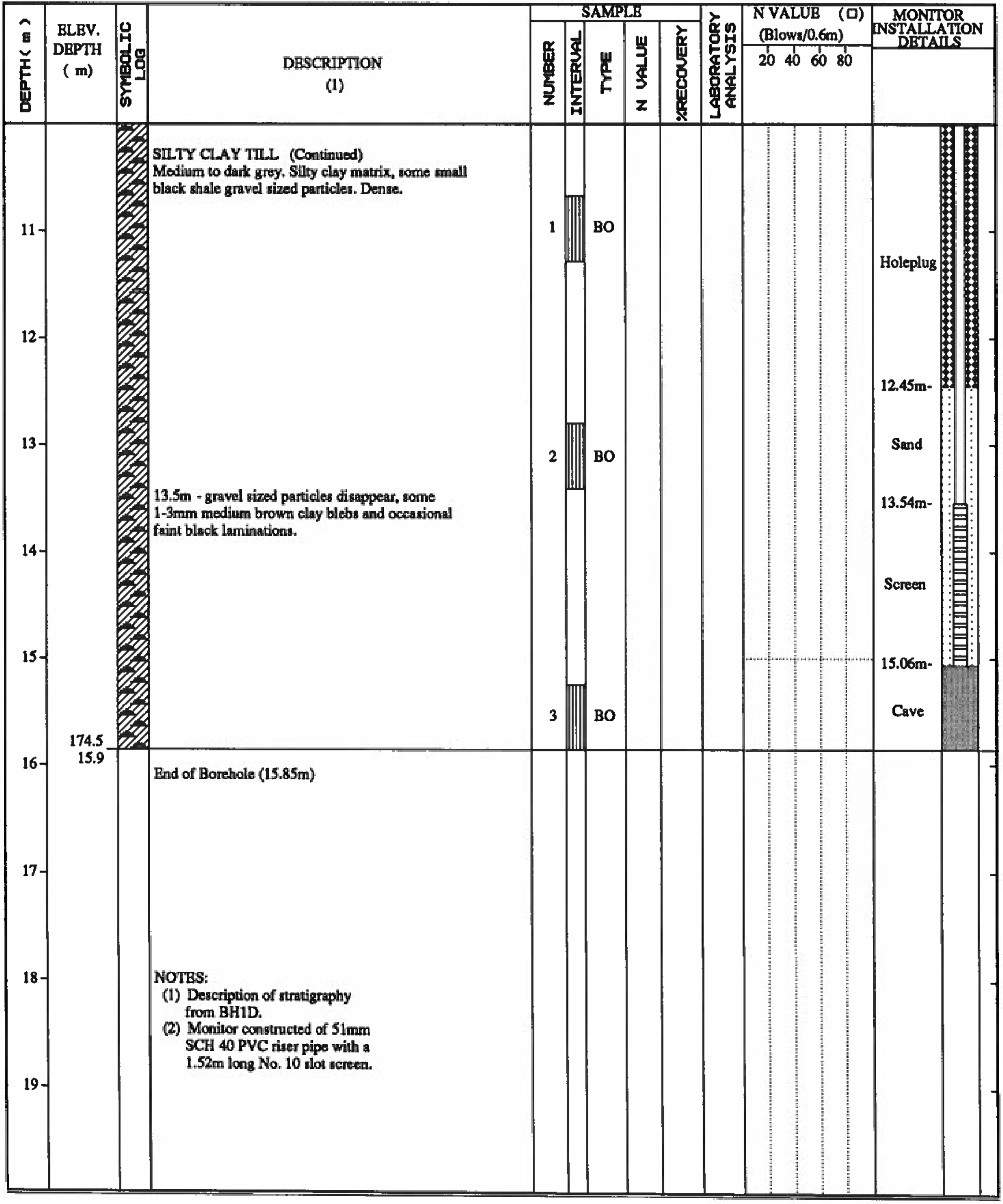
DEPTH (m)	ELEV. DEPTH (m) 190.31	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (☐) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.85m (2)
			TOPSOIL Dark brown. Silty clay, trace gravel.								Cement
1 2	190.0 0.4		WEATHERED SILTY CLAY TILL Light to medium grey (becoming reddish brown with depth) clay matrix with some silt (disappears with depth). Orange oxidation stains (decrease and disappear with depth). 1.3m - Colour is medium reddish brown.								Holeplug 1.22m -
3 4 5 6 7	187.6 2.7		SILTY CLAY TILL Medium greyish brown clay matrix. 3.5m - 5cm grey fine-grained sand and silt seam. 3.7m - becoming medium to dark grey. 5.3m - 5.8m Occasional stringers of grey fine-grained sand and silt. 7.3m - appearence of a few small black shale gravel sized particles.								Sand 5.89m - Screen 7.41m - Cave
8 9	182.7 7.6		End of Borehole (7.62m) NOTES: (1) Description of stratigraphy from BH1D. (2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								

DILLON	PROJECT No. 92 9928 37 01 DATUM: Geodetic	BOREHOLE No. 11 Sheet 1 of 2
PROJECT: LOCATION:	**LAMBTON SITE PROOFING** **Moore Township, Lambton County, Ontario**	DATE: 18 May 1991 INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m) 190.36	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE					LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.86m (2)
				NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY			
			TOPSOIL Dark brown. Silty clay, trace gravel.								 Cement
1 2	190.0 0.4		WEATHERED SILTY CLAY TILL Light to medium grey (becoming reddish brown with depth) clay matrix with some silt(disappears with depth). Orange oxidation stains (decrease and disappear with depth). 1.3m - Colour is medium reddish brown.								
3	187.5 2.8		SILTY CLAY TILL Medium greyish brown clay matrix. 3.5m - 5cm grey fine-grained sand and silt seam. 3.7m - becoming medium to dark grey.								
4											
5											Holeplug
			5.3m - 5.8m Occasional stringers of grey fine-grained sand and silt.								
6											
7			7.3m - appearence of a few small black shale gravel sized particles.								
8											
9			9.1m - gravel sized particle content increases.								

DILLON

PROJECT No. 92 9928 37 01 DATUM: Geodetic		BOREHOLE No. 1I Sheet 2 of 2
PROJECT:	LAMBTON SITE PROOFING	DATE: 18 May 1991
LOCATION:	Moore Township, Lambton County, Ontario	INSPECTOR: SJW



SILTY CLAY TILL (Continued)
Medium to dark grey. Silty clay matrix, some small black shale gravel sized particles. Dense.

13.5m - gravel sized particles disappear, some 1-3mm medium brown clay blebs and occasional faint black laminations.

End of Borehole (15.85m)

NOTES:
(1) Description of stratigraphy from BH1D.
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. **1D**
Sheet 1 of 3

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

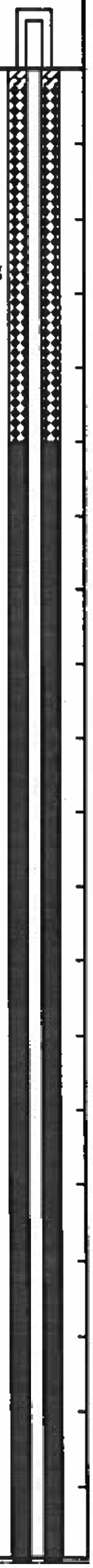
DATE: **16 May 1991**
INSPECTOR: **SJW**

ELEV. DEPTH (m)	DESCRIPTION
190.42	
190.1 0.4	TOPSOIL Dark brown. Silty clay, trace gravel.
	WEATHERED SILTY CLAY TILL Light to medium grey (becoming reddish brown with depth) clay matrix with some silt(disappears with depth). Orange oxidation stains (decrease and disappear with depth).
187.7 2.7	SILTY CLAY TILL Medium greyish brown clay matrix. 3.5m - 5cm grey fine-grained sand and silt seam. 3.7m - becoming medium to dark grey. 5.3m - 5.8m Occasional stringers of grey fine-grained sand and silt. 7.3m - appearence of a few small black shale gravel sized particles. 9.1m - gravel sized particle content increases. 13.5m - gravel sized particles disappear, some 1-3mm medium brown clay blebs and occasional faint black laminations. 17.0m - 4cm grey fine-grained sand seam.

SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
1		AO		90	
2		AO		100	a
3		AO		100	
4		AO		100	a
5		AO		100	
6		AO		100	
7		AO		100	a
8		AO		100	
9		AO		100	
10		AO		100	
11		AO		100	
12		AO		100	a
13		AO		100	

N VALUE (□) (Blows/0.6m) 20 40 60 80

MONITOR INSTALLATION DETAILS



Stickup 0.75m
(1)
Cement
Holeplug
5.0m -
Volclay Grout

DILLON	PROJECT No. 92 9928 37 01 DATUM: Geodetic	BOREHOLE No. 1D Sheet 2 of 3
PROJECT: LOCATION:	LAMBTON SITE PROOFING Moore Township, Lambton County, Ontario	DATE: 16 May 1991 INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (☐) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
21			SILT CLAY TILL (Continued) Medium to dark grey clay with no to some silt and no to some small black shale gravel sized particles.	14		AO		100			
22				15		AO		100	a		
23 24				16		AO		100			
25				17		AO		100			
26 27				18		AO		100			
28				19		AO		100			
29 30				20		AO		100			Volclay Grout
31				21		AO		100			
32 33			33.2 m - gravel sized particles disappear.	22		AO		100			
34			33.5m - 0.5cm to 3cm brownish clay laminations/layers.	23		AO		100			
35 36				24		AO		100			
37				25		AO		100			
38 39			38.7m - gravel sized particles reappear. Darker grey silt patches. 39.3m - 1cm grey / black sand and silt layer with some clay and gravel.	26		AO		100			39.52m-

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 1D
Sheet 3 of 3

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: 16 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
			SILTY CLAY / CLAYEY SILT Dark grey. Silty clay to clayey silt matrix with gravel sized particles. Dense.	27		AO		100			
41											Holeplug
				28		AO		100			
42			42.1m - gravel sized particles disappear.								42.21m-
	147.9 42.5										
43				29		AO		95			
			SHALE Mottled light, medium and dark grey weathered shale. Dense, crumbly, dry.								
44											
				30		AO		100			
45											
											Sand
46											
				31		AO		100			
47											
48											48.02m-
49											Screen
											49.54m-
50											
51											
52											
											Cave
53											
54											
55											
56	134.3 56.1										
			End of Borehole (56.08m)								
57			NOTES: (1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								
58											
59											

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

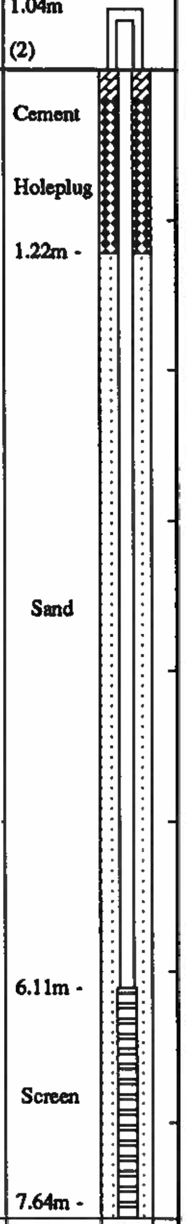
BOREHOLE No. **2S**
Sheet 1 of 1

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: 21 May 1991
INSPECTOR: SJW

ELEV. DEPTH (m) 190.58	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80
	TOPSOIL Dark brown silty clay.							
190.1 0.5	WEATHERED SILTY CLAY TILL Mottled medium brown and medium grey (grey colour diminishes with depth) clay matrix. Numerous orange oxidation stains (decrease and disappear with depth).							
187.9 2.7	SILTY CLAY TILL Medium greyish brown clay matrix. Occasional paler grey silt laminations and inclusions. 3.7m - colour becoming medium to dark grey, with occasional small black shale gravel sized particles. 4.0m - 2cm brown clay layer. 4.9m - laminations disappear.							
182.9 7.6	End of Borehole (7.64m)							

MONITOR INSTALLATION DETAILS



NOTES:
(1) Description of stratigraphy from BH2L
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

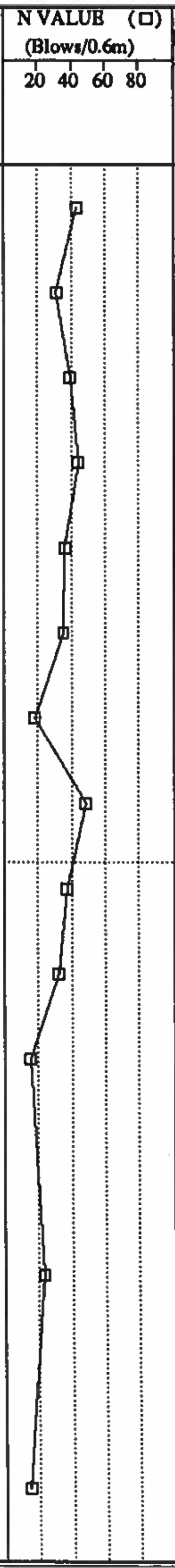
BOREHOLE No. 21
Sheet 1 of 2

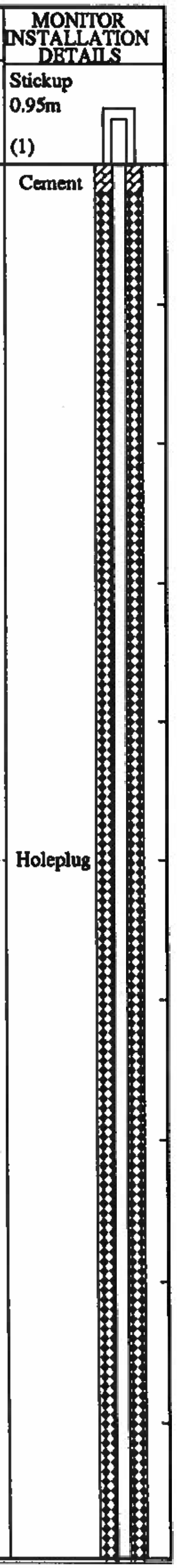
PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 21 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION
	190.62	
		TOPSOIL Dark brown silty clay.
	190.2 0.5	**WEATHERED SILTY CLAY TILL** Mottled medium brown and medium grey (grey colour diminishes with depth) clay matrix. Numerous orange oxidation stains (decrease and disappear with depth).
1		
2		
	187.9 2.7	**SILTY CLAY TILL** Medium greyish brown clay matrix. Occasional paler grey silt laminations and inclusions.
3		
		3.7m - colour becoming medium to dark grey, with occasional small black shale gravel sized particles. 4.0m - 2cm brown clay layer.
4		
		4.9m - laminations disappear.
5		
6		
7		
8		
9		
		9.15m - occasional pale grey blebs 1-2mm in diameter.

SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
1	▨	AQ	43	27	
2	▨	AQ	31	33	
3	▨	AQ	39	38	
4	▨	AQ	44	63	
5	▨	AQ	36	63	
6	▨	AQ	35	63	
7	▨	AQ	18	54	
8	▨	AQ	48	79	
9	▨	AQ	37	81	a
10	▨	AQ	32	71	
11	▨	AQ	15	60	
12	▨	AQ	23	81	
13	▨	AQ	14	71	





DILLON

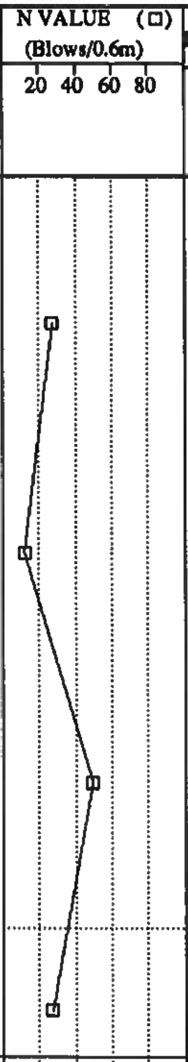
PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 2I
Sheet 2 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 21 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	MONITOR INSTALLATION DETAILS
		10.7m - faint black laminations appear, less gravel sized particles.						
11			14	AQ	27	92		Holeplug
		SILTY CLAY TILL (Continued) Medium to dark grey clay with no silt or gravel sized particles.						
12			15	AQ	12	71		12.50m-
13								Sand
								13.54m-
14			16	AQ	49	54		Screen
15								15.19m-
			17	AQ	27	63		Cave
	174.8 15.9							
16		End of Borehole (15.85m)						
17								
18		NOTES: (1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.						
19								



DILLON

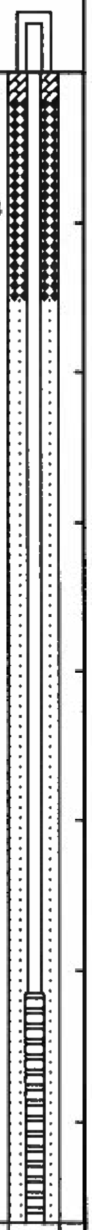
PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 3S
Sheet 1 of 1

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 21 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m) 190.72	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.91m (2)
1 2 3 4 5	190.6 0.1		**WEATHERED SILTY CLAY TILL** Mottled medium brown and medium grey (grey colour diminishes with depth) clay matrix with no stones. Numerous orange oxidation laminated stains (diminishing and disappearing with depth). 1.2m - appearence of occasional small black shale stones. 1.8m - colour becoming medium reddish brown. Occasional medium brown clay blebs and lighter grey silt and clay layers / inclusions. 2.45m - colour becoming medium brown (reddish tinge has disappeared).								Cement Holeplug 1.52m - Sand
6 7	184.7 6.0		**SILTY CLAY TILL** Medium to dark grey clay matrix with occasional small black shale gravel sized particles. Dense. Occasional faint lack laminations, medium brown clay blebs and grey silt layers.								6.15m - Screen
8 9	183.1 7.7		End of Borehole (7.67m) NOTES: (1) Description of stratigraphy from BH3L (2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								



PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 31
Sheet 1 of 2

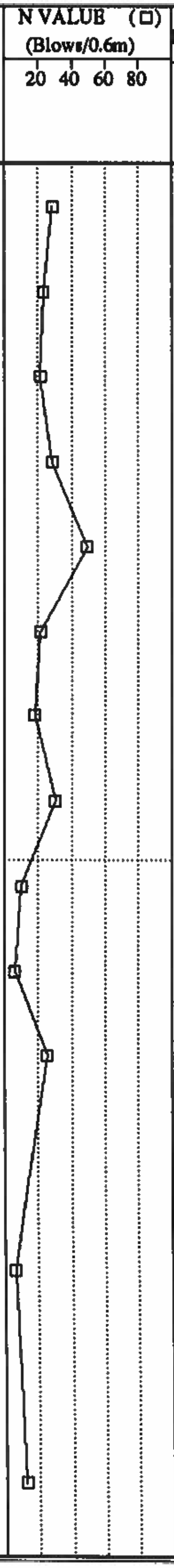
PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

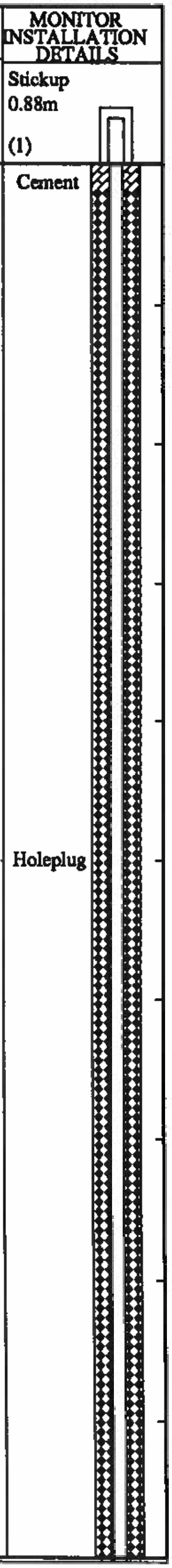
DATE: 22 May 1991
INSPECTOR: SJW

ELEV. DEPTH (m): 190.72

ELEV. / DEPTH (m)	DESCRIPTION
190.6 0.1	**WEATHERED SILTY CLAY TILL** Mottled medium brown and medium grey (grey colour diminishes with depth) clay matrix with no stones. Numerous orange oxidation laminated stains (diminishing and disappearing with depth). 1.2m - appearence of occasional small black shale gravel sized particles. 1.8m - colour becoming medium reddish brown. Occasional medium brown clay blebs and lighter grey silt and clay layers / inclusions. 2.45m - colour becoming medium brown (reddish tinge has disappeared).
184.7 6.0	**SILTY CLAY TILL** Medium to dark grey clay matrix with occasional small black shale gravel sized particles. Dense. Occasional faint black laminations, medium brown clay blebs and grey silt layers.

SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY
1	AQ	28	15
2	AQ	23	40
3	AQ	21	48
4	AQ	28	58
5	AQ	49	63
6	AQ	21	60
7	AQ	18	56
8	AQ	30	63
9	AQ	10	46
10	AQ	6	38
11	AQ	25	79
12	AQ	6	63
13	AQ	12	58





DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

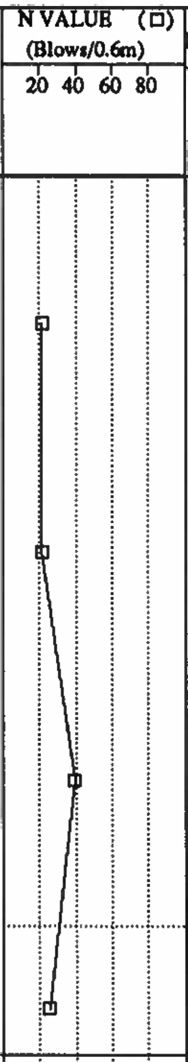
BOREHOLE No. 31
Sheet 2 of 2

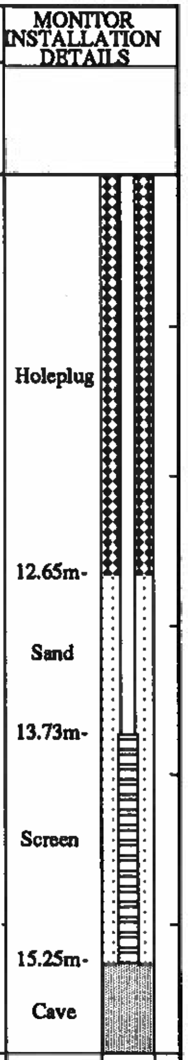
PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 22 May 1991
INSPECTOR: SJW

ELEV. DEPTH (m)	DESCRIPTION
	SILTY CLAY TILL (Continued) Medium to dark grey clay matrix with occasional small black shale gravel sized particles. Occasional faint black laminations, medium brown clay blebs and grey silt layers.
	13.7m - 9cm grey fine-grained sand seam with some silt. SILT TILL Medium grey silt matrix with fine-grained sand, clay and small black shale gravel sized particles. 14.3m - 1cm grey fine-grained sand seam.
	SILTY CLAY TILL As above with no gravel sized particles, no clay blebs and no silt layers.
174.9 15.9	End of Borehole (15.85m)

DEPTH (m)	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
11	14	AQ	21	100	
12.5	15	AQ	21	96	
14	16	AQ	39	73	
15.5	17	AQ	25	73	





NOTES:
(1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

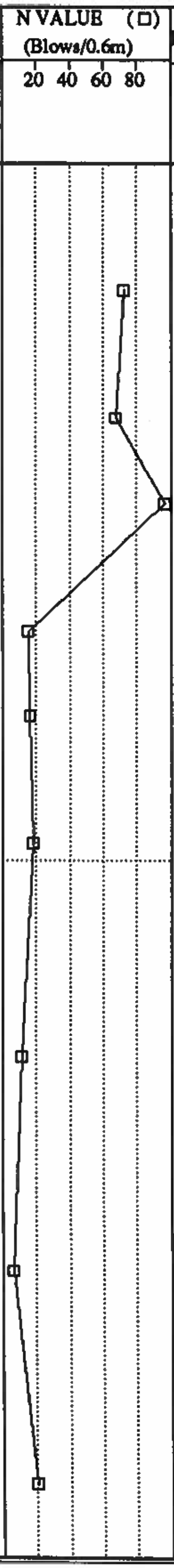
BOREHOLE No. 4I
Sheet 1 of 2

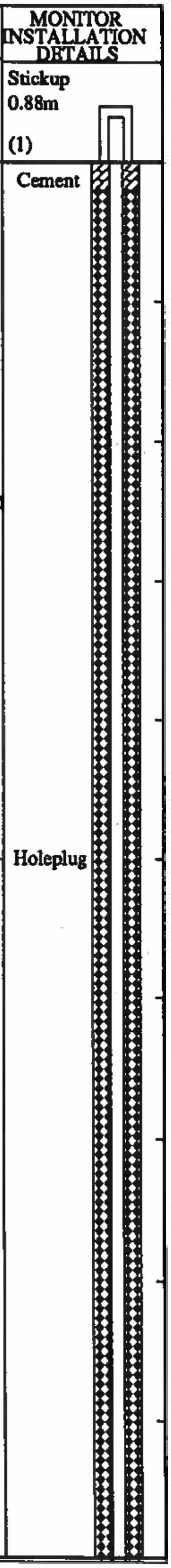
PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 18 May 1991
INSPECTOR: SJW

ELEV. DEPTH (m)	DESCRIPTION
186.18	**WEATHERED SILTY CLAY TILL** Mottled medium brown, medium grey (grey colour diminishes with depth) clay matrix. Dense. Numerous orange oxidation stains / laminations (diminish and disappear with depth). 2.2m - colour becoming a uniform medium brown.
183.4 2.8	**SILT CLAY TILL** Medium to dark grey clay matrix with some small black shale gravel sized pieces. Dense. 9.1m - appearence of occasional faint black laminations.

SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
1	AQ			
2	AQ	72		
3	AQ	67		
4	AQ	96		
5	AQ	15		
6	AQ	16		
7	AQ	18		
8	AQ	11		
9	AQ	6		
10	AQ	20		





DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9

DILLON

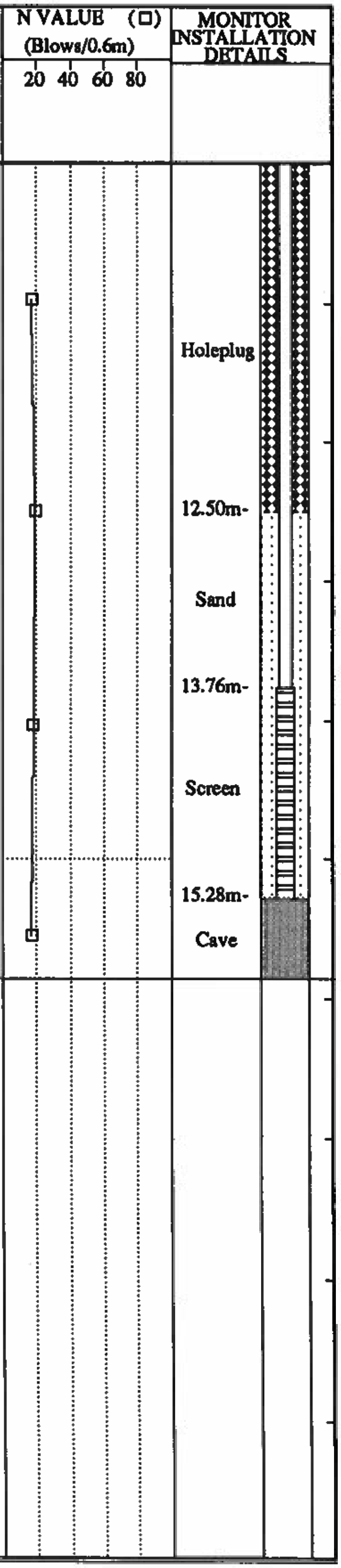
PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 41
Sheet 2 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 18 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE N VALUE	%RECOVERY	LABORATORY ANALYSIS
11		SILTY CLAY TILL (Continued) Medium to dark grey clay matrix with some small black shale gravel pieces. Dense. Occasional faint black laminations.	11	AQ	17		
12			12	AQ	19		
14			13	AQ	18		
15		15.4m - Additional laminations of brown clay.	14	AQ	17		
16	170.3 15.9	End of Borehole (15.85m)					
17							
18		NOTES: (1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.					
19							



DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. **5D**
Sheet 1 of 3

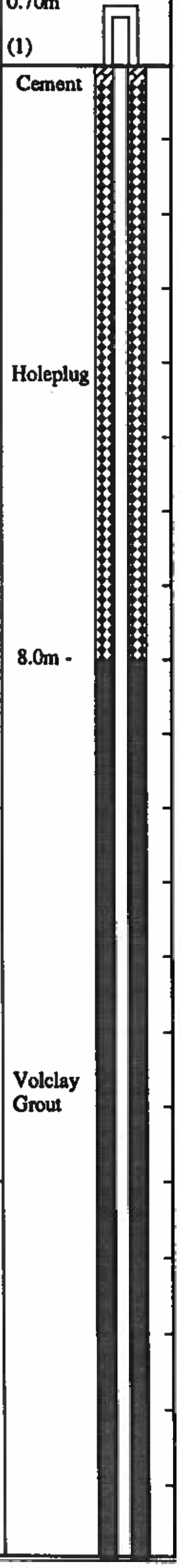
PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **14 May 1991**
INSPECTOR: **SJW**

DEPTH (m)	ELEV. DEPTH (m) 187.35	DESCRIPTION
	187.2 0.2	TOPSOIL Dark to medium brown silty clay.
1		1.0m - sand seam (thickness unknown) WEATHERED SILTY CLAY TILL Mottled medium brown, medium grey (grey colour diminishes with depth) clay matrix with some silt (disappears with depth) and a few small black shale gravel sized particles. Numerous orange oxidation stains (diminish and disappear with depth). 3.1m - colour is uniform dark brown.
4	183.1 4.3	CLAY TILL Medium to dark grey clay matrix with small black shale gravel sized particles. Occasional medium brown clay blebs 2-5mm in diameter.
7		7.3m - appearence of occasional faint black laminations. 7.9m - 2.5cm very dark grey silt layer.
18		18.0m - gravel content decreased to occasional.
19		19.5m - change to medium greyish brown clay, soft. Disappearance of gravel and laminations. Occasional dark grey silty clay bleb 2-5mm in

SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80
1		AO		94		
2		AO		100		
3		AO		100		
4		AO		100		
5		AO		100		
6		AO		100		
7		AO		100		
8		AO		100		
9		AO		100		
10		AO		100		
11		AO		84		
12		AO		100		
13		AO		92		

MONITOR INSTALLATION DETAILS
Stickup 0.70m
(1)



DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. **5D**
Sheet 2 of 3

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **14 May 1991**
INSPECTOR: **SJW**

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
		diameter.	14		AO		100			
21										
22			15		AO		100			
23			16		AO		100			
24		23.8m - reappearence of faint black laminations.								
25			17		AO		87			
26		25.6m - colour change back to medium to dark grey. Reappearence of gravel. Occasional brownish clay laminations. 26.1m - 4cm grey silt patch. 26.7m - 4cm grey silt and fine-grained sand seam	18		AO		100			
27		SILTY CLAY TILL With patches of darker grey silt with some fine-grained sand.								
28			19		AO		59			
29		29m - till becoming very gravelly.								
30			20		AO		100			Volclay Grout
31		31.1m - grey fine sand seam (thickness unknown).	21		AO		100			
32	155.7 31.7	31.3m - 2.5cm dark grey to black fine-grained sand seam, moist. 31.5m - 6cm grey fine-grained sand seam.								
33		SILT TILL Medium to dark grey silt matrix with little clay and numerous small black shale gravel sized pieces (disappear with depth).	22		AO		52			
34	154.1 33.2		23		AO		100			
35		SILTY CLAY TILL Medium to dark grey clay matrix.								
36			24	▨	AS		17			
37			25		AO		100			
38										
39			26		AO		100			39.62m-

DILLON

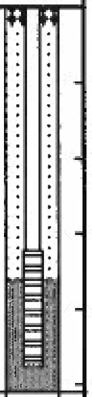
PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. **5D**
Sheet 3 of 3

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **14 May 1991**
INSPECTOR: **SJW**

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
			27		AO		100			40.23m-
41		40.85m - occasional grey silt blebs, brown clay blebs and laminations.								
			28		AO		100			Sand
42	145.4 42.0	SAND SILT AND GRAVEL Medium reddish brown fine-grained sand (increases with depth), silt and gravel(some black shale and limestone).								
	144.8 42.6	Dense. 42.3m - 2.5cm fine-grained black shale sand seam.								
43			29		AO		72			43.23m-
	143.5 43.8	CLAY TILL Dark grey clay matrix with small black shale gravel and some fine-grained sand.								43.61m-
44										Screen
	143.2 44.1	SILT TILL Dark grey silt matrix with black shale gravel sized particles.	30		AO		53			44.75m-
45	142.4 45.0	SAND and SILT Grey fine-grained sand and silt.								Cave
	142.2 45.1	BEDROCK Grey fissile shale.								
46		End of Borehole (45.11m)								
47										
48										
49										
50										
51										
52										
53										
54										
55										
56		NOTES: (1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								
57										
58										
59										



DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 5I
Sheet 1 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 9 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.81m (2)
	187.33										
	187.1 0.2		TOPSOIL Dark to medium brown silty clay.								Cement
1			1.0m - sand seam (thickness unknown)								
			WEATHERED SILTY CLAY TILL Mottled medium brown, medium grey (grey colour diminishes with depth) clay matrix with some silt and a few small black shale gravel sized particles. Numerous orange oxidation stains (diminish and disappear with depth).								
2											
3			3.1m - colour is uniform dark brown.								
4											
	183.1 4.3		CLAY TILL Medium to dark grey clay matrix with small black shale gravel sized particles. Occasional medium brown clay blebs 2-5mm in diameter.								
5											Holeplug
6											
7			7.3m - appearence of occasional faint black laminations.								
8			7.9m - 2.5cm very dark grey silt layer.								
9											

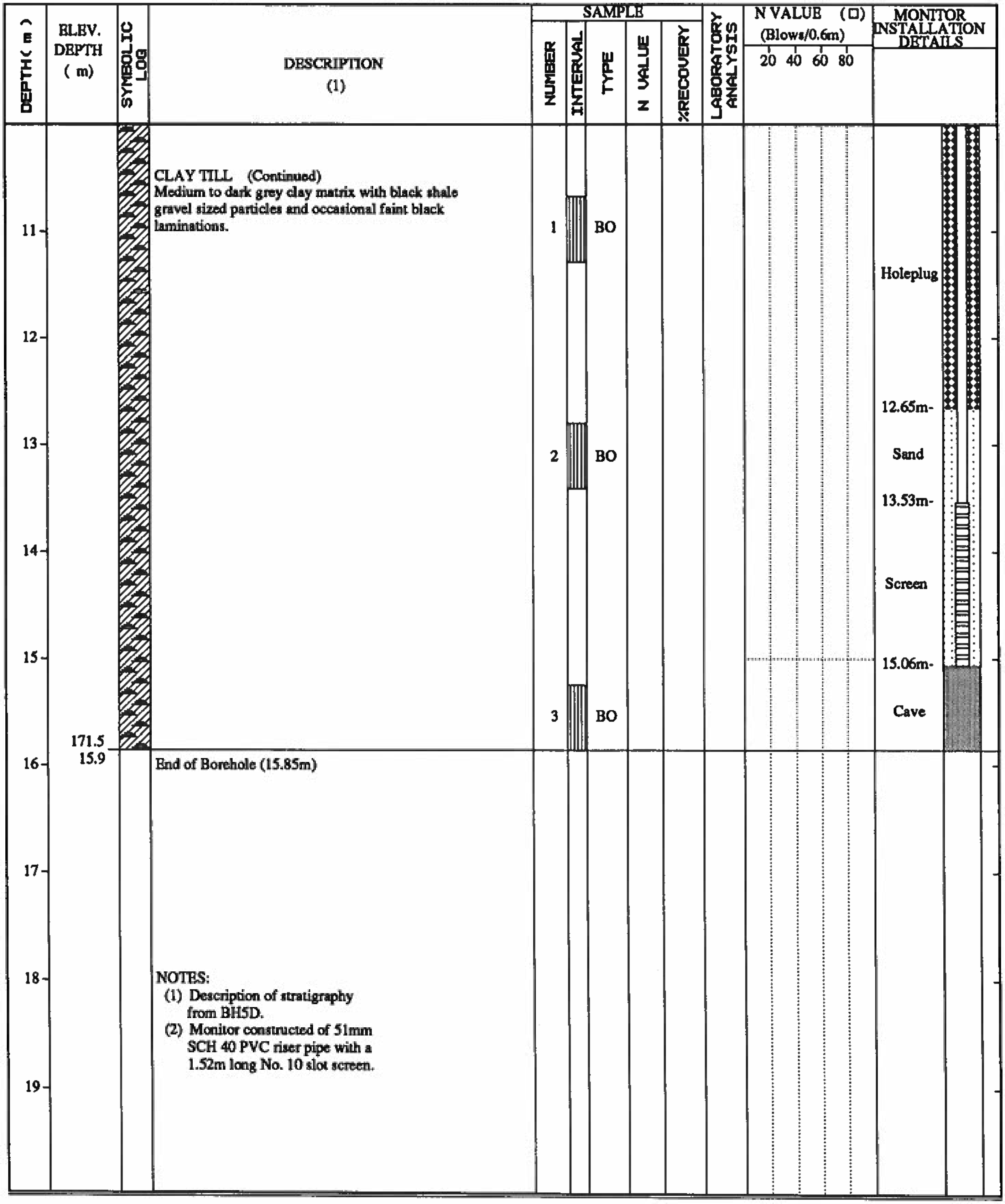
DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 5I
Sheet 2 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

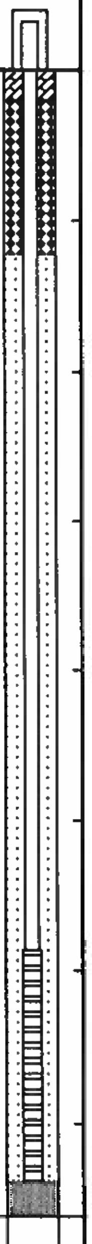
DATE: 9 May 1991
INSPECTOR: SJW



DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE TYPE	MONITOR INSTALLATION DETAILS
		CLAY TILL (Continued) Medium to dark grey clay matrix with black shale gravel sized particles and occasional faint black laminations.			
11			1	BO	Holeplug
12					12.65m-
13			2	BO	Sand
					13.53m-
14					Screen
15					15.06m-
			3	BO	Cave
16	171.5 15.9	End of Borehole (15.85m)			
17					
18		NOTES: (1) Description of stratigraphy from BH5D. (2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.			
19					

PROJECT No.	92 9928 37 01	BOREHOLE No.	5S
DATUM:	Geodetic	Sheet	1 of 1

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**
DATE: **9 May 1991**
INSPECTOR: **SJW**



DEPTH (m)	ELEV. DEPTH (m) 187.17	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.96m (2)
	187.0 0.2		TOPSOIL Dark to medium brown silty clay.								Cement
1 2 3 4	182.9 4.3		1.0m - sand seam (thickness unknown) WEATHERED SILTY CLAY TILL Mottled medium brown, medium grey (grey colour diminishes with depth) clay matrix with some silt (disappears with depth) and a few small black shale gravel sized particles. Numerous orange oxidation stains (diminish and disappear with depth). 3.1m - colour is uniform dark brown.								Holeplug 1.22m - Sand
5 6 7	179.6 7.6		CLAY TILL Medium to dark grey clay matrix with black shale gravel sized particles. Occasional medium brown clay blebs 2-5mm in diameter. 7.3m - appearence of occasional faint black laminations.								5.87m - Screen 7.39m - Cave
8 9			End of Borehole (7.62m) NOTES: (1) Description of stratigraphy from BH5D. (2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								

DILLON

PROJECT No.	92 9928 37 01	BOREHOLE No.	6D
DATUM:	Geodetic	Sheet	1 of 3
PROJECT:	LAMBTON SITE PROOFING	DATE:	8 May 1991
LOCATION:	Moore Township, Lambton County, Ontario	INSPECTOR:	SJW

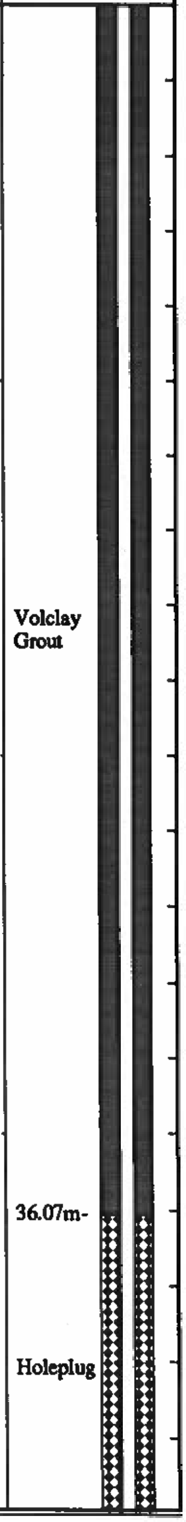
DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	186.01										Stickup 1.13m (2)
	185.8 0.2		TOPSOIL Dark brown.								Cement
			WEATHERED SILTY CLAY TILL Mottled medium reddish brown medium grey clay matrix (grey colour diminishes with depth) with some small angular black shale gravel sized particles. 2.25m - depth of mottling. Colour now medium to dark brown with occasional orange oxidation stains.	1		AO		75			
1											Holeplug
2				2		AO		100			1.80m -
3											
				3		AO		100			
4											
	181.1 4.9		Approximate depth of weathering.								
5				4		AO		100			
			SILTY CLAY TILL Medium reddish brown grey clay matrix with some small angular black shale gravel sized particles. 5.8m - colour now uniform medium grey.								
6											
				5		AO		100			
7											
8				6		AO		100			
9											
				7		AO		100			
10											
11				8		AO		100			Volclay Grout
12											
				9		AO		100			
13											
14				10		AO		100			
			14.65m - increased silt content.								
15											
				11		AO		100			
16											
17				12		AO		100			
18			18.0m - less silt and gravel sized particles.								
				13		AO		93			
19											

DILLON	PROJECT No. 92 9928 37 01 DATUM: Geodetic	BOREHOLE No. 6D Sheet 2 of 3

PROJECT:	LAMBTON SITE PROOFING	DATE: 8 May 1991
LOCATION:	Moore Township, Lambton County, Ontario	INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80
			SILTY CLAY TILL (Continued)	14		AS		37		
21			21.05m - appearence of faint black laminations and occasional silt blebs.							
				15		AO		93		
22										
23			23.2m - 0.5cm fine-grained sand and silt lens.	16		AO		100		
24										
				17		AO		78		
25										
26				18		AO		100		
27										
28				19		AO		68		
29			29m (approx) - 0.15m medium grey silt layer.							
				20		AO		100		
30			30.45m - 10cm silt layer (as above).							
31			31.1m - thin silt seam. 31.5m - silt content increased.	21		AO		100		
32				22		AO		100		
33										
34				23		AO		100		
35										
				24		AO		100		
36			36.3m - appearence of medium brown clay blebs.							
37				25		AO		100		
38										
				26		AO		100		
39			38.7m - disappearence of clay blebs. 39.3m - decreased gravel sized particle content.							

MONITOR INSTALLATION DETAILS



DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 6D
Sheet 3 of 3

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 8 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
41			SILTY CLAY TILL (Continued)	27		AO		100			Holeplug 40.84m-
42			41.8m - 1-2cm grey silt layer.	28		AO		100			Cave 42.06m-
43			42.4m - gravel sized particle content reduced to a few with occasional silt blebs.	29		AO		78			Sand
44	142.5 43.5		SAND Grey fine-grained sand with silt and small gravel sized particles.	30	▨	AQ		23			44.32m-
45			44.8m - colour change to brown, no gravel.	31	▨	AQ		32			Screen
46			45.3m - Black shale sand. Fine to medium-grained with gravel.								45.85m- Cave
47	139.8 46.2		End of Borehole (46.23m)								
48											
49											
50											
51											
52											
53											
54											
55											
56											
57											
58											
59											

NOTES:
(1) Borehole terminated due to auger refusal, assumed bedrock surface.
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

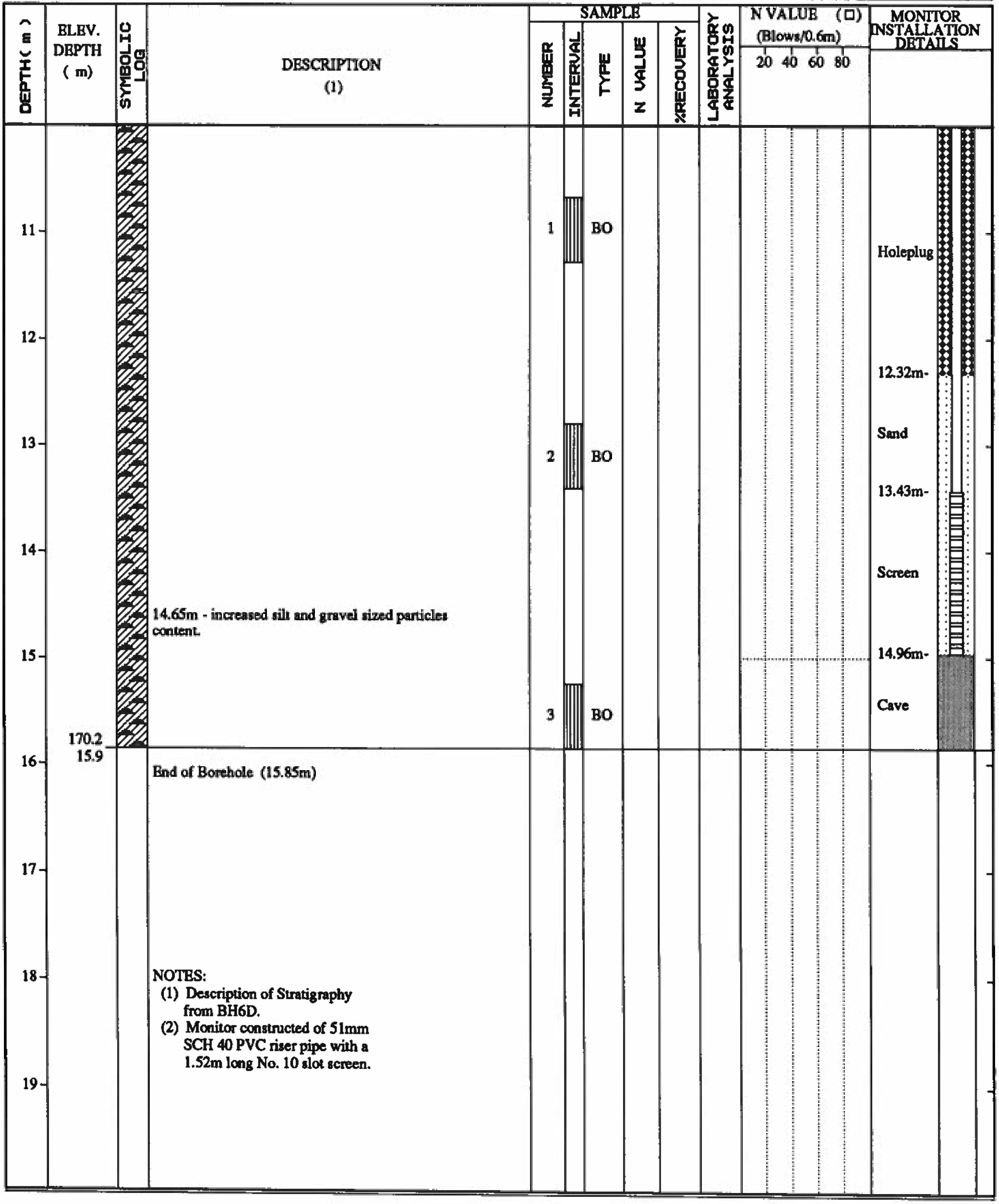
BOREHOLE No. 61
Sheet 1 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 8 May 1991
INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m) 186.02	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 1.17m (2)
	185.8 0.2		TOPSOIL Dark brown.								Cement
1			WEATHERED SILTY CLAY TILL Mottled medium reddish brown medium grey clay matrix (grey colour diminishes with depth) with some small angular black shale gravel sized particles.								
2			2.25m - depth of mottling. Colour now medium to dark brown with occasional orange oxidation stains.								
3											
4			Approximate depth of weathering.								
5	181.1 4.9		SILTY CLAY TILL Medium reddish brown grey clay matrix with some small angular black shale gravel sized particles. 5.8m - colour now uniform medium grey.								Holeplug
6											
7											
8											
9											

DILLON	**PROJECT No.** 92 9928 37 01 DATUM: Geodetic	**BOREHOLE No.** 6I Sheet 2 of 2
PROJECT:	**LAMBTON SITE PROOFING**	**DATE:** 8 May 1991
LOCATION:	**Moore Township, Lambton County, Ontario**	**INSPECTOR:** SJW



14.65m - increased silt and gravel sized particles content.

End of Borehole (15.85m)

NOTES:
(1) Description of Stratigraphy from BH6D.
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. **6S**
Sheet 1 of 1

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **8 May 1991**
INSPECTOR: **SJW**

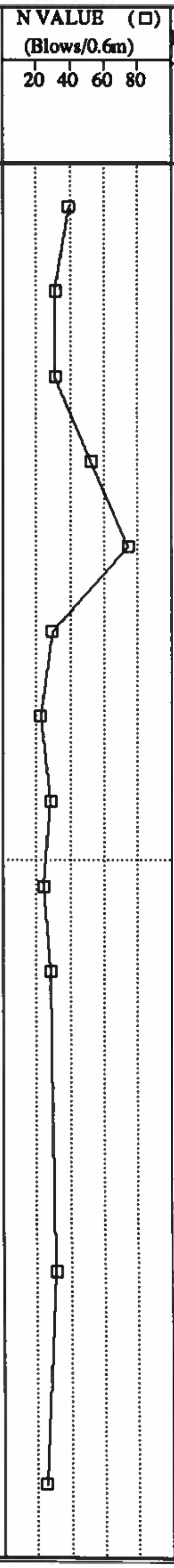
DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	186.06										Stickup 1.03m (2)
			TOPSOIL Dark brown.								Cement
	185.9 0.2		WEATHERED SILTY CLAY TILL Mottled medium reddish brown medium grey clay matrix (grey colour diminishes with depth) with some small angular black shale gravel sized particles.								
1											Holeplug 1.42m -
2			2.25m - depth of mottling. Colour now medium to dark brown with occasional orange oxidation stains.								
3											Sand
4			Approximate depth of weathering.								
5	181.2 4.9		SILTY CLAY TILL Medium reddish brown grey clay matrix with some small angular black shale gravel sized particles. 5.8m - colour now uniform medium grey.								
6											5.95m -
7											Screen 7.48m -
	178.4 7.6		End of Borehole (7.62m)								
8											
9											

NOTES:
(1) Description of Stratigraphy from BH6D.
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

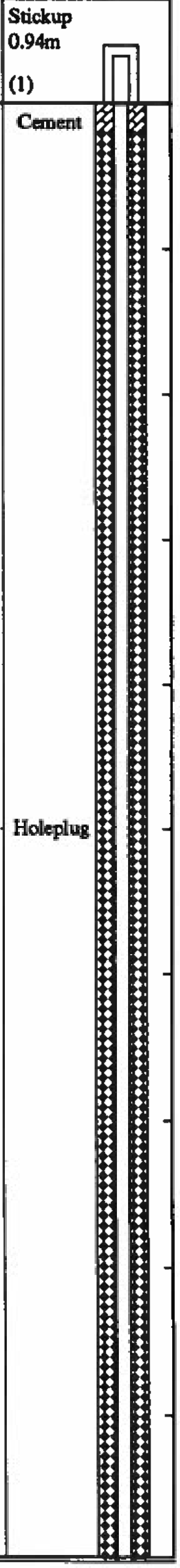
DILLON	PROJECT No. 92 9928 37 01 DATUM: Geodetic	BOREHOLE No. 71 Sheet 1 of 2
PROJECT:	LAMBTON SITE PROOFING	DATE: 22 May 1991
LOCATION:	Moore Township, Lambton County, Ontario	INSPECTOR: SJW

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS
	186.44						
	186.0 0.4	**TOPSOIL** Dark brown silty clay.	1	AQ	39	21	
1		**WEATHERED SILTY CLAY TILL** Mottled medium brown, medium grey (grey colour diminishes with depth) clay matrix. Numerous orange oxidation stains / laminations (diminish and disappear with depth).	2	AQ	31	33	
		1.8m - change to medium reddish brown.	3	AQ	31	21	
2			4	AQ	52	38	
		2.7m to 3.0m - 2-3mm vertical grey fracture.	5	AQ	74	52	
3	183.3 3.2		6	AQ	29	42	
4		**SILTY CLAY TILL** Medium to dark grey clay matrix with some small black shale gravel sized particles.	7	AQ	22	40	
		4.3m - less gravel sized particles, faint black laminations.	8	AQ	28	67	
5			9	AQ	24	54	
			10	AQ	28	56	
6							
7		7.6m - pale grey clay blebs 1-3mm in diameter.					
8			11	AQ	31	88	
9		9.45m - 1cm grey silty clay layer.	12	AQ	25	71	

N VALUE (□)
(Blows/0.6m)



MONITOR INSTALLATION DETAILS



DILLON	PROJECT No. 92 9928 37 01 DATUM: Geodetic	BOREHOLE No. 71 Sheet 2 of 2	
PROJECT:	LAMBTON SITE PROOFING	DATE:	22 May 1991
LOCATION:	Moore Township, Lambton County, Ontario	INSPECTOR:	SJW

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
		▨	SILTY CLAY TILL (Continued) Medium to dark grey clay matrix with occasional small black shale gravel sized particles.								Holeplug
11		▨		13	▩	AQ	21	100		□	
		▨									11.48m-
12		▨									Sand
		▨		14	▩	AQ	24	100		□	12.53m-
13		▨									
14		▨		15	▩	AQ	29	100		□	Screen
15		▨	15.25m - gravel sized particles disappear, faint black laminations appear.								
		▨		16	▩	AQ	27	100		□	15.58m-
	170.6 15.9										Cave
16			End of Borehole (15.85m)								
17											
18			NOTES: (1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								
19											

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

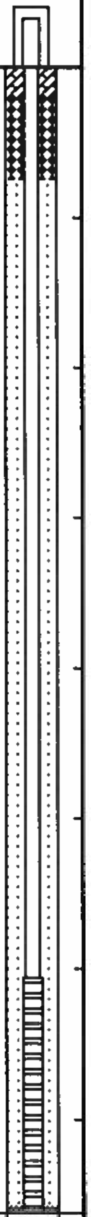
BOREHOLE No. **7S**
Sheet 1 of 1

PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **22 May 1991**
INSPECTOR: **SJW**

ELEV. DEPTH (m)	DESCRIPTION (1)	SAMPLE: NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (☐) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
186.49									Stickup 0.82m (2)
	TOPSOIL Dark brown silty clay.								Cement Holeplug
186.1 0.4	**WEATHERED SILTY CLAY TILL** Mottled medium brown, medium grey (grey colour diminishes with depth) clay matrix with some silt and small black shale gravel sized particles (below 1m in depth). Numerous orange oxidation stains / laminations (diminish and disappear with depth). 1.8m - colour change to medium reddish brown. 2.7m to 3.0m - 2-3mm vertical grey clay strip.								0.74m -
183.3 3.2	**SILTY CLAY TILL** Medium to dark grey clay matrix with some small black shale gravel sized particles. 4.3m - less gravel sized particles, faint black laminations.								Sand 6.06m - Screen 7.58m -
178.9 7.6	End of Borehole (7.62m)								

DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9



NOTES:
(1) Description of stratigraphy from BH7I
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 3.05m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 8I
Sheet 1 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 11 May 1993
INSPECTOR: RFK

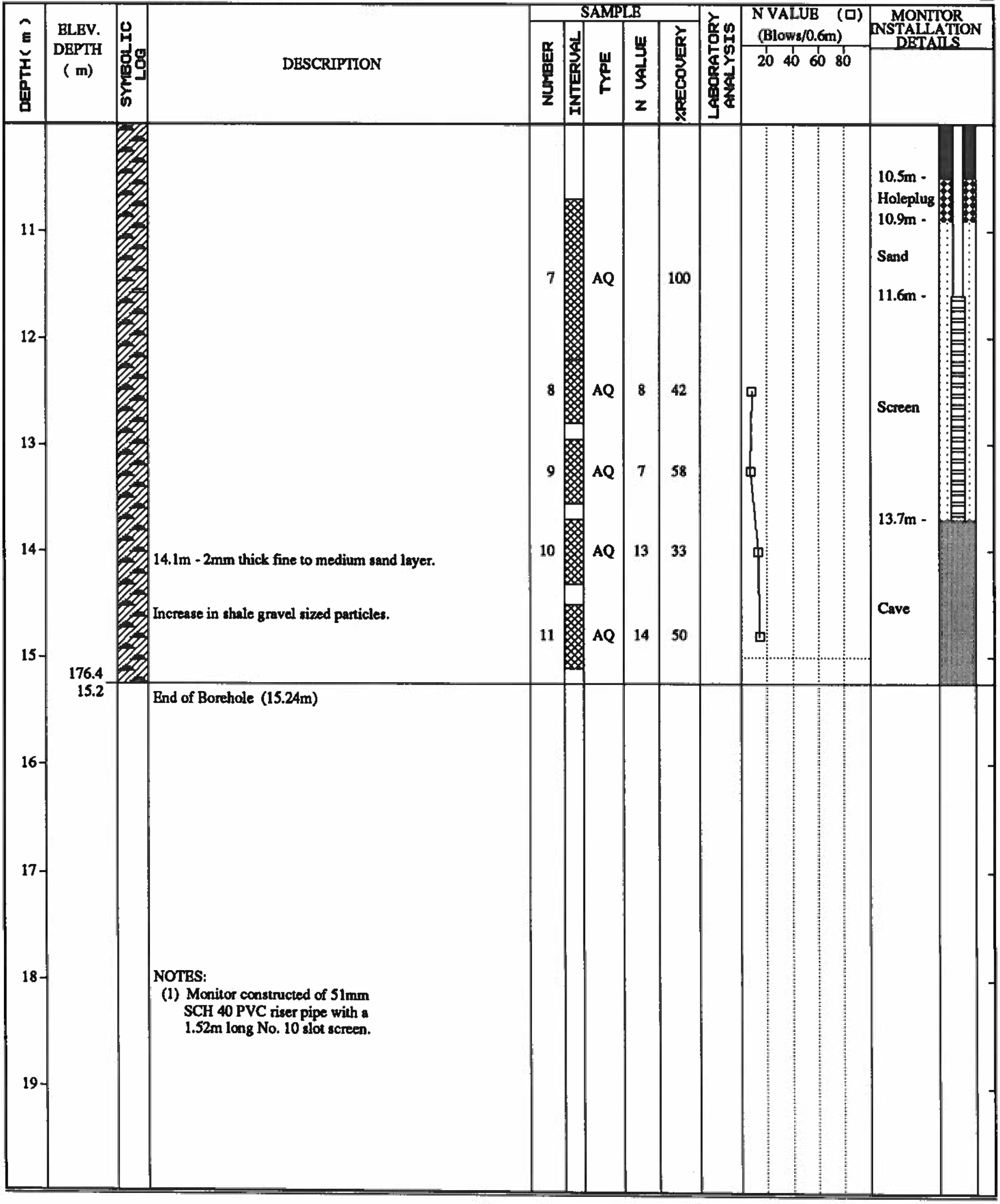
DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	191.59		WEATHERED SILTY CLAY TILL Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.								Stickup 0.89m (1)
1											
2											
				1		AO		75			
3											
				2		E		30			
4											
	187.0 4.6		SILTY CLAY TILL Medium grey. Silty clay matrix with limestone & shale gravel sized particles (2-5mm).								
5											Grout
				3		AO		100	a		
6											
				4		AO		100			
7											
8											
				5		AO		100			
9											
				6		AO		100			

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 8I
Sheet 2 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 11 May 1993
INSPECTOR: RFK



ELEV. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY
		7	AQ		100
		8	AQ	8	42
		9	AQ	7	58
	14.1m - 2mm thick fine to medium sand layer.	10	AQ	13	33
	Increase in shale gravel sized particles.	11	AQ	14	50
176.4 15.2	End of Borehole (15.24m)				

NOTES:
(1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

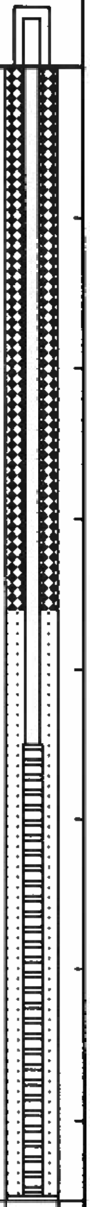
PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 8S
Sheet 1 of 1

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 12 May 1993
INSPECTOR: RFK

DEPTH (m)	ELEV. DEPTH (m) 191.76	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.66m (2)
		▨	**WEATHERED SILTY CLAY TILL** Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.								
1		▨									
2		▨									Holeplug
3		▨									
		▨									3.6m -
4		▨									Sand
	187.2 4.6	▨	**SILTY CLAY TILL** Medium grey. Silty clay matrix with limestone & shale gravel sized particles (2-5mm).								4.5m -
5		▨									
		▨									Screen
6		▨									
7		▨									
	184.2 7.5		End of Borehole (7.54m) NOTES: (1) Description of stratigraphy from BH8-I. (2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.								
8											
9											



PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 9D
Sheet 1 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 14 May 1993
INSPECTOR: RFK

ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (☐) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
191.45								
	WEATHERED SILTY CLAY TILL Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.							
		1	AO		67			
		2	AO		70			
187.5 3.9	3.8m - laminations.							
	SILTY CLAY TILL Medium grey. Silty clay matrix with limestone gravel sized particles.							
		3	AO		80	a		
		4	AO		100			
		5	AO		100			
		6	AO		100			Cement
		7	AO		100	a		
	12.0m - 25mm thick fine to medium sand layer.							
	12.5m - 10mm thick sand layer.							
		8	AO		80			
	14.3m - decreased number of gravel sized particles.	9	AO		100			
		10	AO		100	a		
	17.4m - Increased number of gravel sized particles.	11	AO		60			
		12	AO		40			
	19.3m - increased silt content.							

DILLON	PROJECT No. 92 9928 37 01 DATUM: Geodetic	BOREHOLE No. 9D Sheet 2 of 2
PROJECT:	LAMBTON SITE PROOFING	DATE: 14 May 1993
LOCATION:	Moore Township, Lambton County, Ontario	INSPECTOR: RFK

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
				13		AO		60			
21											
22			21.6m - decreased gravel sized particles (shale).	14		AO		70			
23											
				15		AO		60			
24											
25				16		AO		40			
26											
				17		AO		30			
27											
28			28.0 m - clay and silt lamination\layers.	18		AO		40			
29											
				19		AO		50			
30											Cement
31				20		AO		50			
32											
	158.8 32.6		CLAY Dark grey. Clay. Laminated. Shell fragments.	21		AO		90			
33											
34				22		AO		80			
35											
				23		AO		100			
36	155.3 36.1		SILTY CLAY TILL								
37				24		AO		50			
	153.9 37.5		SILTY SAND Dark grey. Silty fine to medium sand. Methane detected.								
38	153.7 37.7		SHALE Grey. Shale. Fissile.								
39	153.6 37.9		End of Borehole (37.85m)								

DILLON

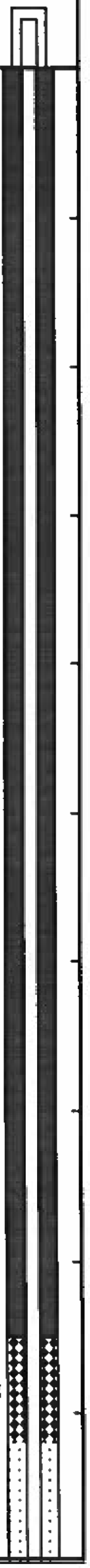
PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 91
Sheet 1 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 14 May 1993
INSPECTOR: RFK

DEPTH (m)	ELEV. DEPTH (m) 192.26	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stickup 0.67m (2)
		▨	**WEATHERED SILTY CLAY TILL** Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.								
1		▨									
2		▨									
3		▨									
		▨	3.8m - laminations.								
4	188.4 3.9	▨	**SILTY CLAY TILL** Medium grey. Silty clay matrix with limestone gravel sized particles.								Grout
5		▨									
6		▨									
7		▨									
8		▨									8.5m -
9		▨									Holeplug 9.2m -



DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 9I
Sheet 2 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 14 May 1993
INSPECTOR: RFK

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
											Sand
											10.7m -
11											
											Screen
			12.0m - 25mm thick fine to medium sand layer.								
12	180.1 12.2										
			End of Borehole (12.19m)								
13											
14											
15											
16											
17											
18			NOTES:								
19											

NOTES:
(1) Description of Stratigraphy from BH9D.
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

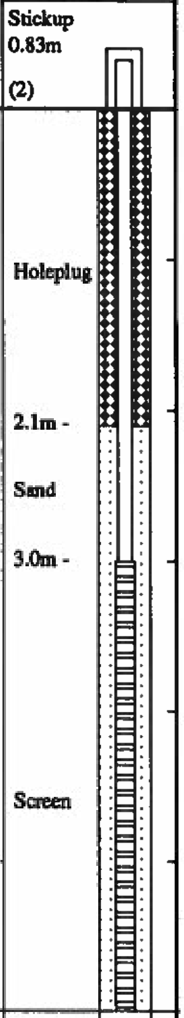
BOREHOLE No. 9S
Sheet 1 of 1

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 14 May 1993
INSPECTOR: RFK

DEPTH (m)	ELEV. DEPTH (m) 192.19	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80
		▨	WEATHERED SILTY CLAY TILL Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.							
1		▨								
2		▨								
3		▨								
	188.3	▨	3.8m - laminations.							
4	3.9	▨	SILTY CLAY TILL Medium grey. Silty clay matrix with limestone gravel sized particles.							
5		▨								
6	186.2 6.0		End of Borehole (6.0m)							
7										
8			NOTES: (1) Description of Stratigraphy from BH9D. (2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.							
9										

MONITOR INSTALLATION DETAILS



DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 101
Sheet 1 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 12 May 1993
INSPECTOR: RFK

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	190.78								Stickup 0.77m (1)
		WEATHERED SILTY CLAY TILL Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.							
1									
2			1	AO		80			
3			2	AO		50			
4	186.6 4.2	**SILTY CLAY TILL** Medium grey. Silty clay matrix with shale & limestone gravel sized particles.							
5			3	AO		100	a		Grout
6			4	AO		70			
7									
8		8.2m - Flat angular shale gravel sized particles.	5	AO		100			
9			6	AO		70			

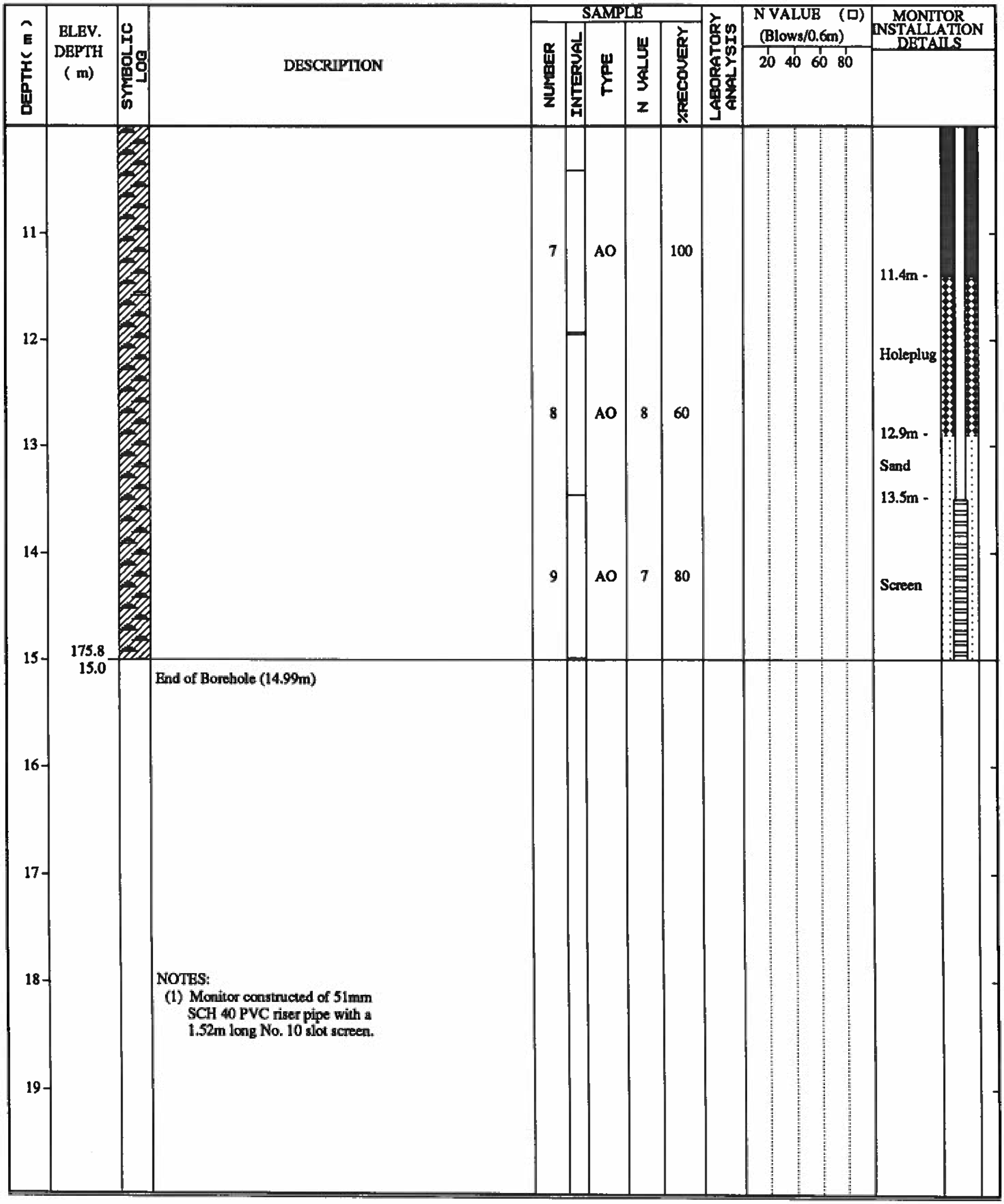
DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. 101
Sheet 2 of 2

PROJECT: LAMBTON SITE PROOFING
LOCATION: Moore Township, Lambton County, Ontario

DATE: 12 May 1993
INSPECTOR: RFK



DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY
11			7	AO		100
12–13			8	AO	8	60
14			9	AO	7	80
15	175.8 15.0	End of Borehole (14.99m)				

NOTES:
(1) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

DILLON

PROJECT No. 92 9928 37 01
DATUM: Geodetic

BOREHOLE No. **10S**
Sheet 1 of 1

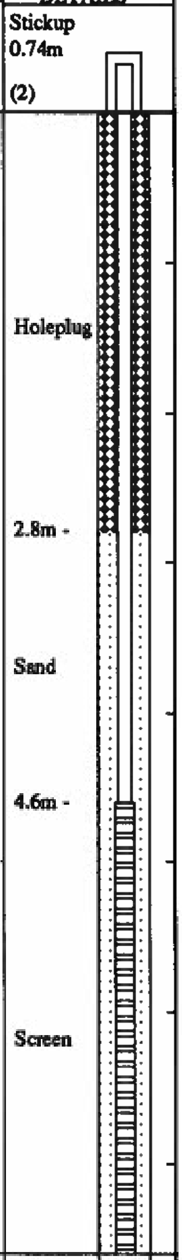
PROJECT: **LAMBTON SITE PROOFING**
LOCATION: **Moore Township, Lambton County, Ontario**

DATE: **12 May 1993**
INSPECTOR: **RFK**

DEPTH (m)	ELEV. DEPTH (m) 190.85	SYMBOLIC LOG	DESCRIPTION (1)	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.6m) 20 40 60 80
0–4.2		▨	WEATHERED SILTY CLAY TILL Brown/grey, mottled. Silty clay matrix. Oxidation stains. Fractures.							
4.2–7.6	186.7 4.2	▨	SILTY CLAY TILL Medium grey. Silty clay matrix with shale & limestone gravel sized particles.							
7.6	183.3 7.6		End of Borehole (7.62m)							

NOTES:
(1) Description of Stratigraphy from BH10I.
(2) Monitor constructed of 51mm SCH 40 PVC riser pipe with a 1.52m long No. 10 slot screen.

MONITOR INSTALLATION DETAILS



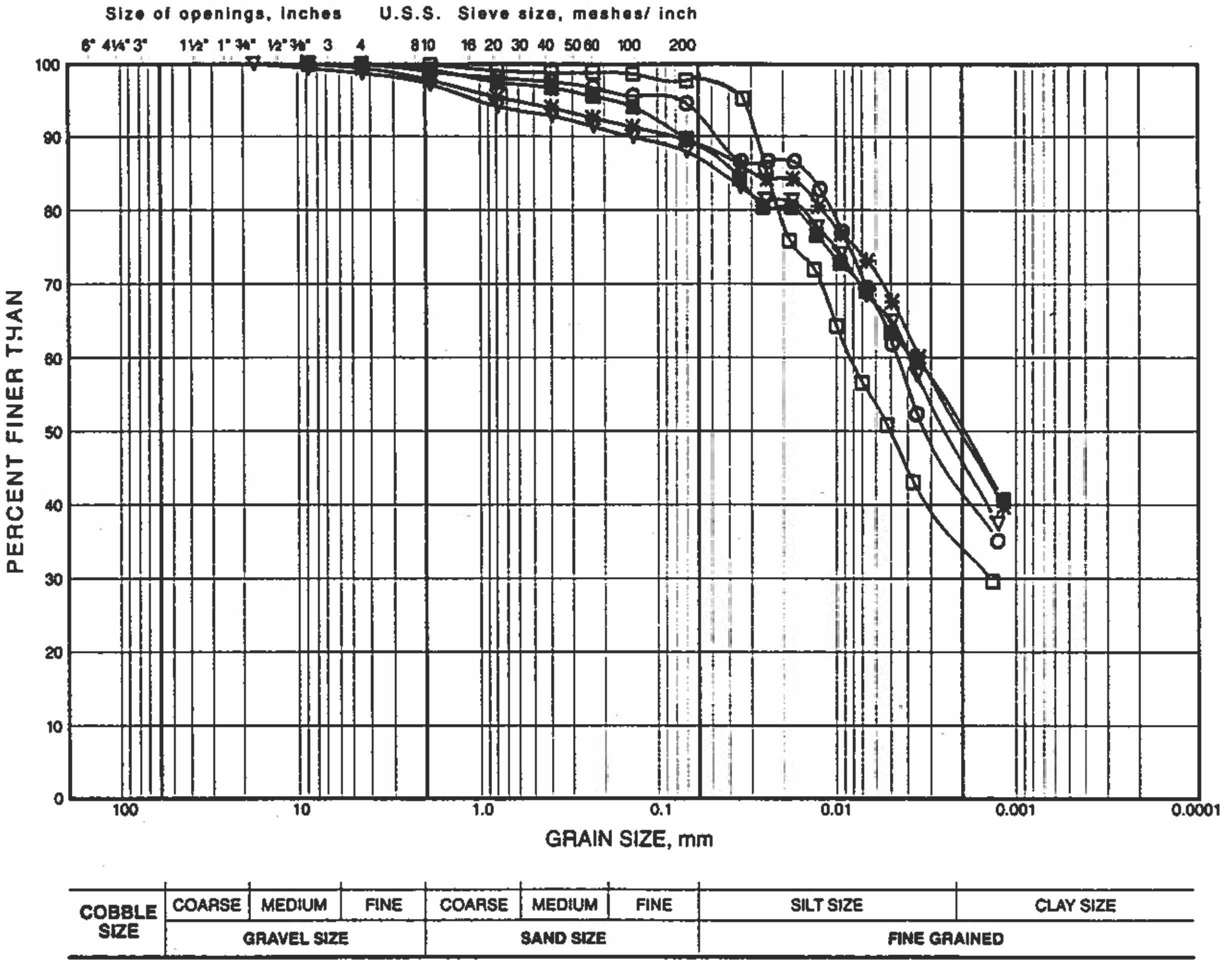
SCHEDULE II

RESULTS OF LABORATORY TESTS ON SOIL SAMPLES

GRAIN SIZE DISTRIBUTION

FIGURE 1

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV
○	1D	2	
□	1D	4	
▽	1D	7	
■	1D	12	
✱	1D	15	

FORM PRODUCED FEB 1989

Form G.A. - GSD

Project 931-3159

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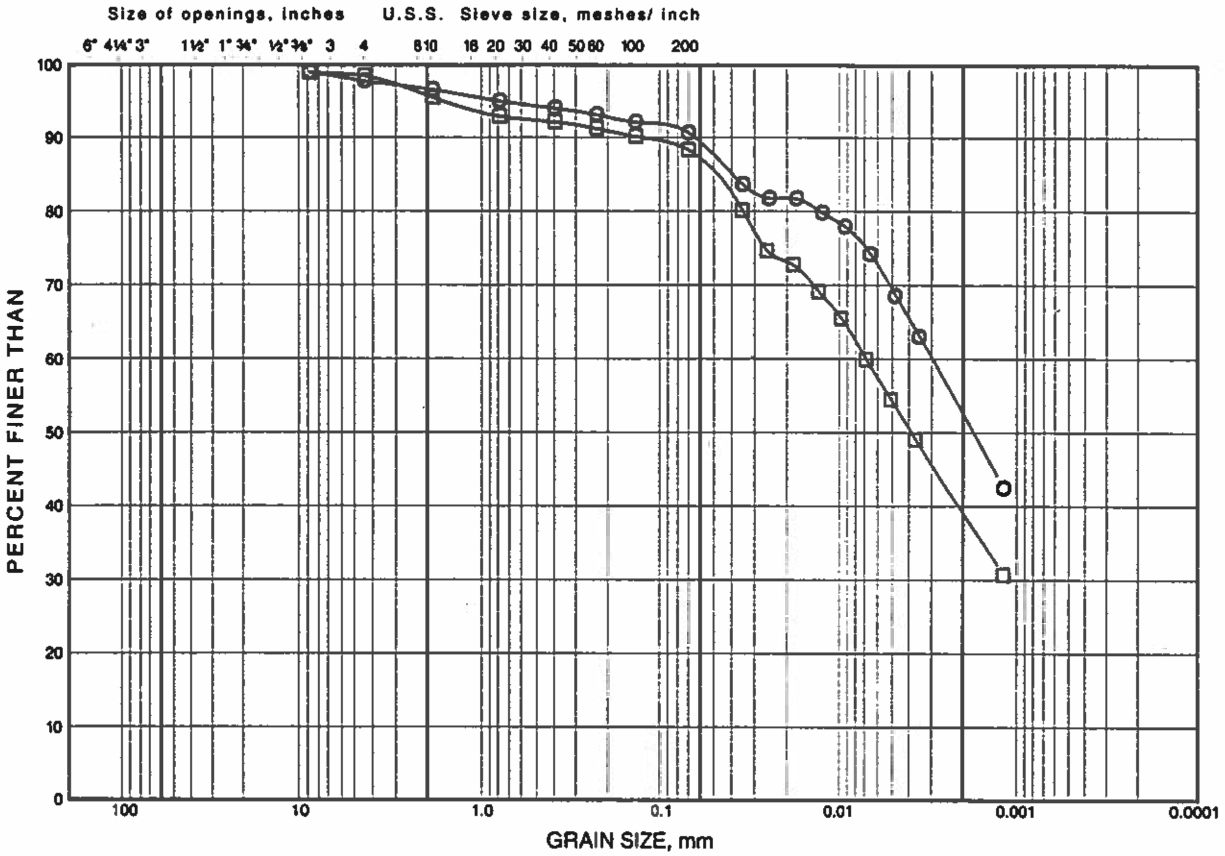
FORM PRODUCED FEB 1989

GRAIN SIZE DISTRIBUTION

FIGURE 2

SILTY CLAY



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV. (m)
○	21	9	
□	31	9	

Form G.A. - GSD

Project.........................

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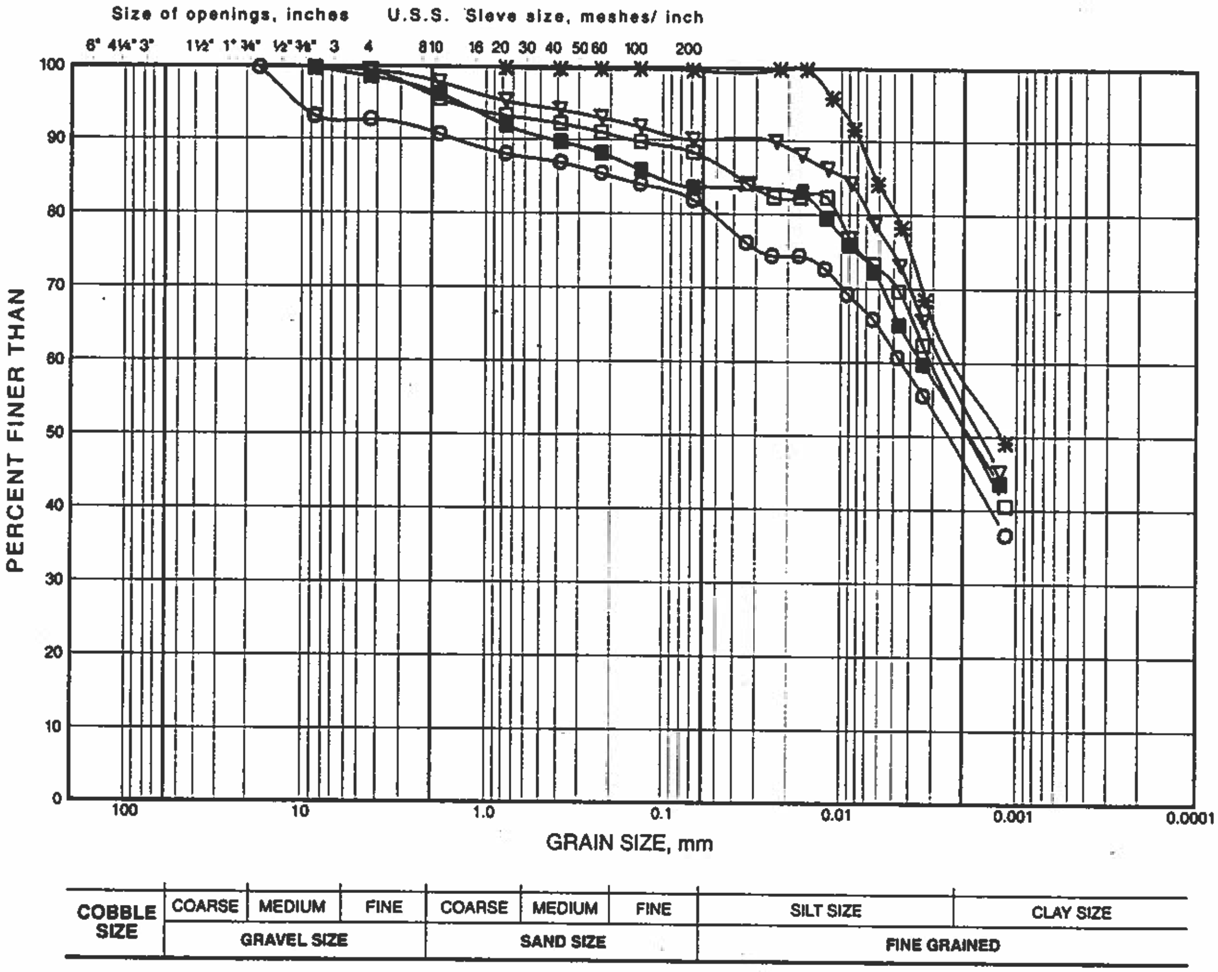
GRAIN SIZE DISTRIBUTION

FIGURE 3

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV. (m)
○	4I	7	
□	4I	12	
▽	5D	4	
■	5D	8	
✱	5D	14	

Project 931-3159

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FORM PRODUCED FEB 1989

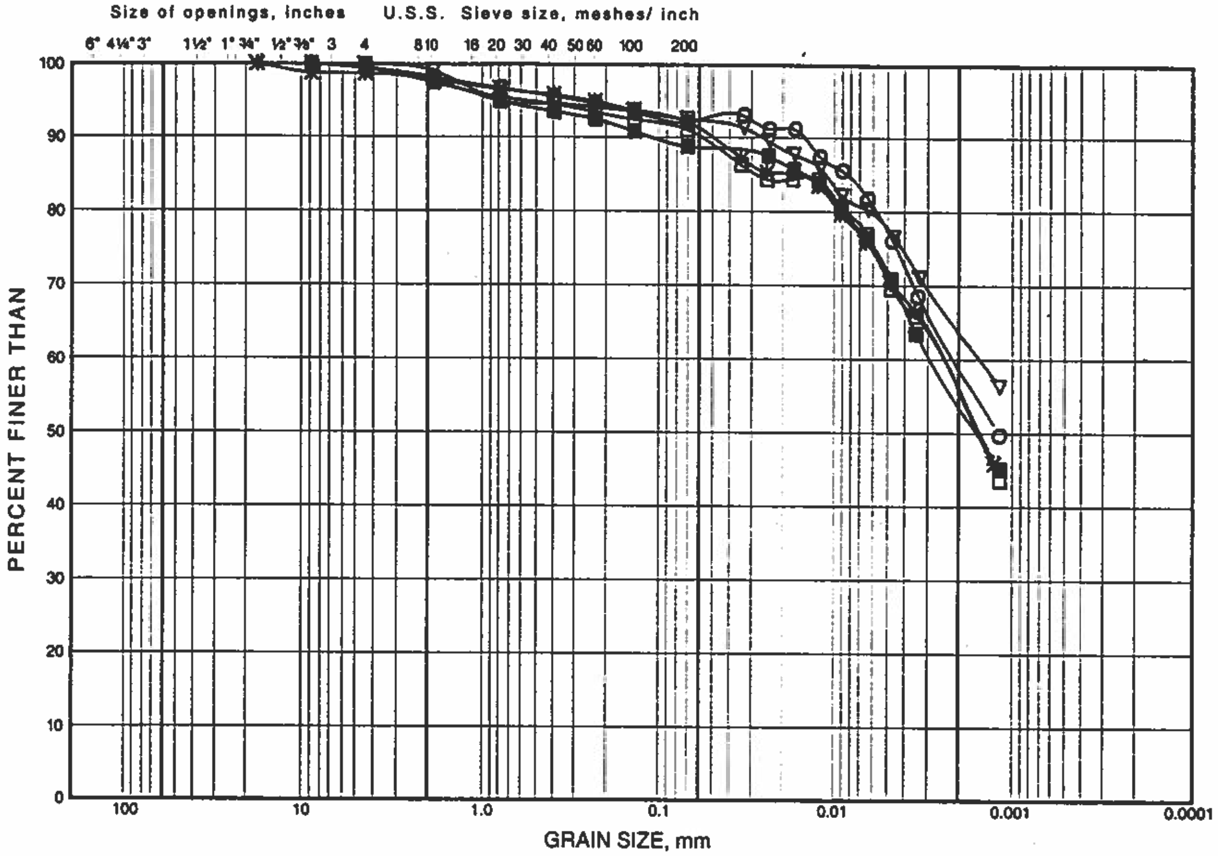
Form G.A. - GSD

GRAIN SIZE DISTRIBUTION

FIGURE 4

FORM PRODUCED FEB 1989

SILTY CLAY



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV. (m)
○	6D	4	
□	6D	8	
▽	6D	15	
■	7I	9	
✱	8I	3	

Form G.A. - GSD

Project 931-3159

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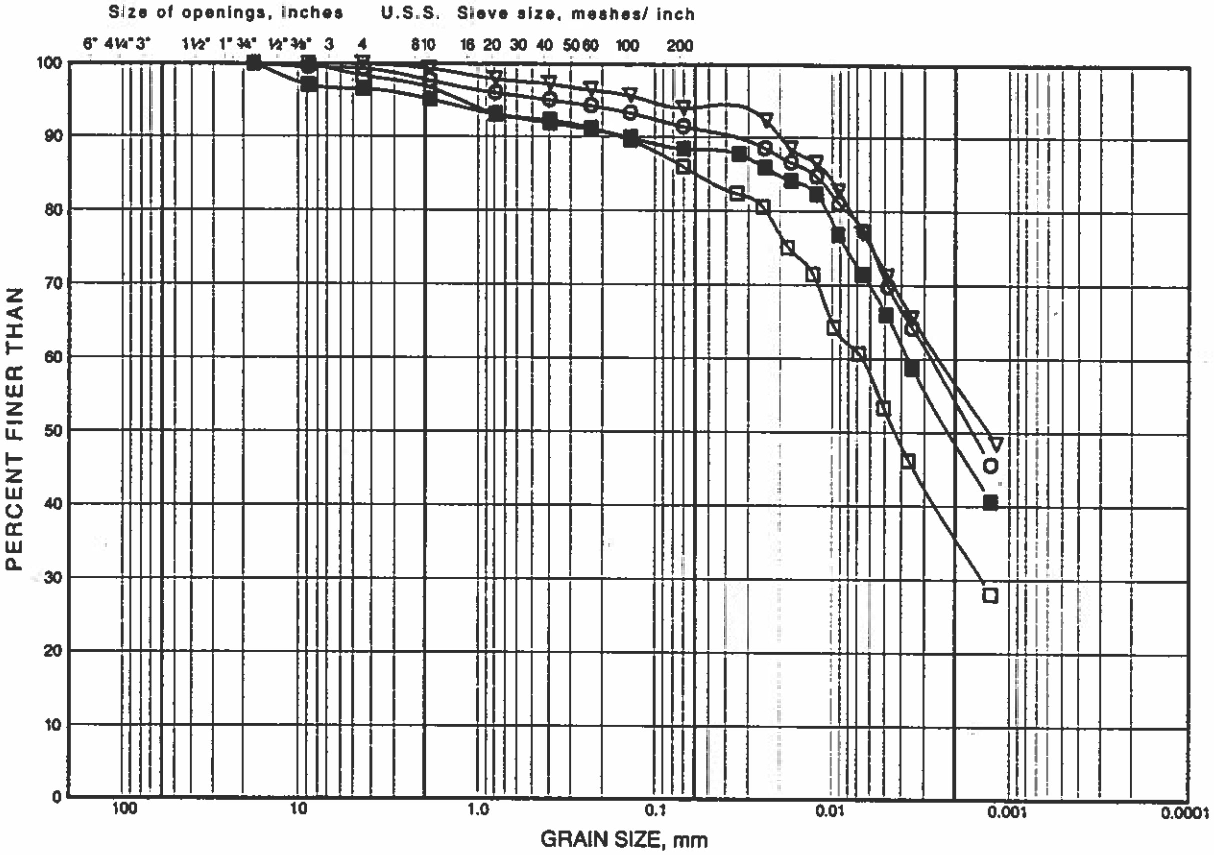
GRAIN SIZE DISTRIBUTION

FIGURE 5

SILTY CLAY



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV. (m)
○	9D	3	
□	9D	7	
▽	9D	10	
■	10I	3	

FORM PRODUCED FEB 1989

Form G.A. - GSD

Project 931-3159

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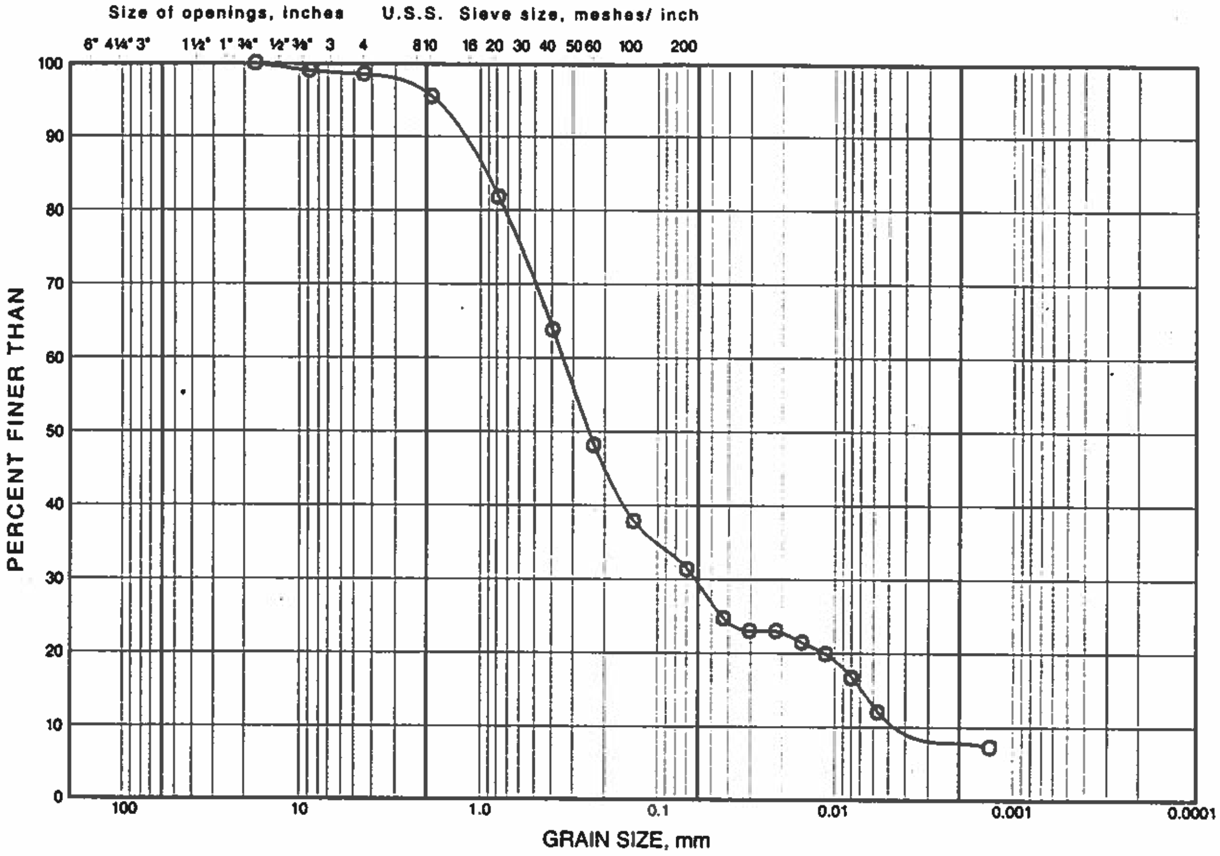
FORM PRODUCED FEB 1989

GRAIN SIZE DISTRIBUTION

FIGURE 6

SILTY SAND



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV. (m)
o	90	24	

Form G.A. - GSD

Project 931-3159

Golder Associates

SCHEDULE III

WATER LEVEL MONITORING

TABLE C.1
WATER LEVEL ELEVATIONS

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	DATE Water elevations in metres above sea level (m asl)										
			1991					1993					
			13–May	17–May	22–May	23–May	13–Aug	13–May	02–Jun	10–Jun	11–Jun	17–Jun	18–Jun
1S	190.31	191.21				187.180	189.040	189.880	189.585 *	189.300	189.310 *	189.430	189.440
1I	190.36	191.24				DRY	185.150	189.510	189.480	189.460	189.460	189.450	189.450
1D	190.42	191.18				143.630	186.860	189.150	189.100 *	184.380	184.680 *	179.390	180.100
2S	190.58	191.59			DRY		187.270	190.100	189.545	189.390	189.350	189.220	189.190
2I	190.62	191.54			DRY		186.000	187.360	187.370	187.360	187.380	187.385	187.390
3S	190.72	191.62			DRY		189.370	190.260	189.980	189.910	189.880	189.860	189.860
3I	190.72	191.60			DRY		188.570	189.380	189.350	189.330	189.330	189.320	189.320
4I	186.18	187.08	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
5S	187.17	188.14	181.160	183.790		185.400	185.260	186.660	186.290 *	183.670 *	181.250	182.490	182.670
5I	187.33	188.14	DRY	172.540		173.030	183.310	184.630	184.620 *	178.360 *	175.010	177.850	178.220
5D	187.35	188.05		185.385		185.145	180.450	180.990	180.990	180.970	180.970	180.970	180.970
6S	186.06	187.09	DRY	DRY		DRY	182.980	185.100	185.030	185.000	184.970	184.960	184.960
6I	186.02	187.19	184.870	184.460		184.080	183.770	183.510	183.520 *	176.940	177.170	178.940	179.200
6D	186.01	187.14	165.095	175.580		180.830	182.010	181.210	182.160 *	182.130 *	166.960	180.290	180.900
7S	186.49	187.31				DRY	182.990	185.240	184.810	184.660	184.630	184.580	184.570
7I	186.44	187.38				DRY	177.940	179.460	179.470	179.480	179.460	179.470	179.470
8S	191.76	192.42							185.420		185.930	186.280	186.320
8I	191.59	192.49							182.820		184.910	185.920	186.070
9S	192.19	193.03							190.460		190.340	190.250	190.240
9I	192.26	192.93							182.900		184.990	186.000	186.150
10S	190.85	191.59							184.110		184.550	184.800	184.840
10I	190.78	191.56							178.340		180.800	182.100	182.300

* MONITOR PURGED

TABLE C.1 (cont.)
WATER LEVEL ELEVATIONS

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	DATE Water elevations in metres above sea level (m asl)								
			1993								
			09–Jul	15–Jul	16–Jul	17–Jul	19–Jul	22–Jul	27–Jul	05–Aug	24–Aug
1S	190.31	191.21	189.460	189.390	188.150	189.000	189.310	189.280	189.250	189.080	188.750
1I	190.36	191.24	189.440	189.910	181.260	181.650	182.290	183.090	184.160	185.570	187.290
1D	190.42	191.18	186.820	185.790	174.310	175.950	178.400	180.850	183.550	185.840	187.300
2S	190.58	191.59	189.240	189.010	188.990	188.970	188.950	188.880	188.790	188.530	187.930
2I	190.62	191.54	187.430	187.450	187.450	187.450	187.460	187.460	187.480	187.510	187.540
3S	190.72	191.62	189.950	189.870	189.860	189.860	189.860	189.800	189.760	189.620	189.390
3I	190.72	191.60	189.300	189.270	189.270	189.260	189.260	189.240	189.210	189.170	189.100
4I	186.18	187.08	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
5S	187.17	188.14	184.900	185.160	184.210	184.350	184.540	184.720	184.930	185.110	185.110
5I	187.33	188.14	182.550	183.060	175.800	176.390	177.360	178.530	180.030	181.750	183.390
5D	187.35	188.05	180.970	180.970	180.970	180.970	180.970	180.970	180.970	180.970	180.950
6S	186.06	187.09	184.980	184.940	182.350	182.520	182.840	183.310	183.500	183.700	184.000
6I	186.02	187.19	182.100	181.770	174.770	175.340	176.280	177.430	178.930	180.720	182.570
6D	186.01	187.14	182.120	182.060	182.040	182.060	182.140	182.050	182.130	182.050	182.110
7S	186.49	187.31	184.360	184.360	184.360	184.350	184.320	184.260	184.170	183.990	183.650
7I	186.44	187.38	179.500	179.460	179.470	179.470	179.490	179.460	179.470	179.430	179.400
8S	191.76	192.42	187.370	187.610	187.630	187.660	187.730	187.840	187.990	188.230	188.570
8I	191.59	192.49	188.000	188.300	188.320	188.360	188.460	188.550	188.700	188.890	189.140
9S	192.19	193.03	190.140	190.010	188.220	189.030	189.920	189.860	189.820	189.690	189.500
9I	192.26	192.93	187.920	188.220	183.250	183.580	184.190	184.870	185.820	186.950	188.090
10S	190.85	191.59	185.600	185.790	185.810	185.840	185.900	185.980	186.100	186.370	187.310
10I	190.78	191.56	185.060	185.570	185.620	185.680	185.810	185.970	186.240	186.570	187.000

* MONITOR PURGED

SCHEDULE IV

IN SITU HYDRAULIC CONDUCTIVITY TESTS

PROJECT NAME: LAMBTON WMMP

MONITORING WELL:	1-S		DATE:	19 JULY 93
STATIC WATER LEVEL:	1.63	(m)	CONDUCTED BY:	RJT & GCG
DRAWDOWN AT t=0 (Ho):	4.79	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	6.42	4.80	1.000
1	6.41	4.79	0.998
1.5	6.40	4.77	0.995
2	6.38	4.76	0.992
2.5	6.37	4.75	0.990
3	6.37	4.75	0.990
3.5	6.36	4.74	0.987
4	6.36	4.73	0.986
4.5	6.35	4.73	0.985
5	6.34	4.72	0.983
6	6.33	4.71	0.981
7	6.32	4.70	0.979
8	6.31	4.69	0.977
9	6.30	4.68	0.975
10	6.29	4.67	0.973
12.5	6.27	4.65	0.969
15	6.25	4.63	0.965
19	6.21	4.59	0.956
30	6.13	4.51	0.940
45	6.03	4.41	0.919
193	5.21	3.59	0.748
1084	3.06	1.44	0.299
1208	2.86	1.24	0.258
1296	2.78	1.16	0.241
1378	2.71	1.09	0.226
2530	2.21	0.59	0.122
2670	2.17	0.55	0.114
2758	2.15	0.53	0.109
2831	2.14	0.52	0.107
5317	1.90	0.28	0.057
5430	1.90	0.28	0.057
9715	1.93	0.30	0.064
16900	1.96	0.34	0.070

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

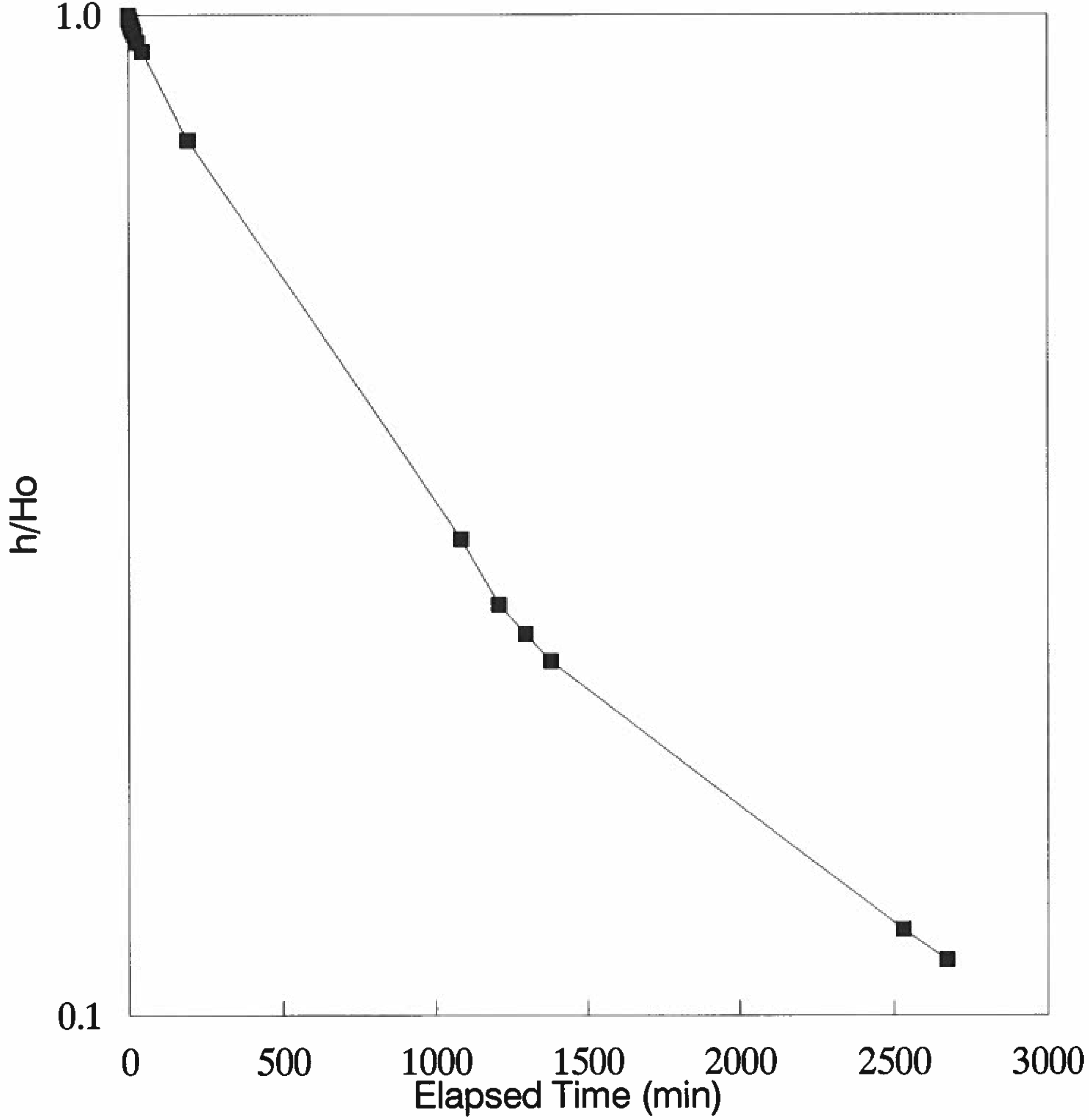
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	6.19 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	950 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 5.8E-07 cm/s

Monitoring Well 1S

July 15th to August 5th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL:	1–I		DATE:	19 JULY 93
STATIC WATER LEVEL:	1.33	(m)	CONDUCTED BY:	RJT & GCG
DRAWDOWN AT t=0 (Ho):	9.57	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	10.85	9.52	1.000
1	10.82	9.49	0.997
1.5	10.80	9.47	0.995
2	10.78	9.45	0.993
2.5	10.77	9.44	0.992
3	10.76	9.43	0.991
3.5	10.76	9.43	0.990
4	10.75	9.42	0.989
4.5	10.75	9.42	0.989
5	10.74	9.41	0.988
6	10.74	9.41	0.988
7	10.73	9.40	0.987
8	10.73	9.40	0.987
9	10.72	9.39	0.986
10	10.72	9.39	0.986
12.5	10.71	9.38	0.985
16.5	10.70	9.37	0.984
18	10.69	9.36	0.983
22	10.68	9.35	0.982
25	10.67	9.34	0.981
30	10.66	9.33	0.980
45	10.61	9.28	0.975
60	10.60	9.27	0.974
210	10.40	9.07	0.953
757	9.98	8.65	0.909
883	9.94	8.61	0.904
970	9.91	8.58	0.901
1053	9.89	8.56	0.899
2205	9.59	8.26	0.868
2343	9.55	8.22	0.863
2431	9.53	8.20	0.861
2505	9.51	8.18	0.859
4991	8.95	7.62	0.800
5073	8.93	7.60	0.798
9731	8.15	6.82	0.716
16917	7.08	5.75	0.604
29885	5.67	4.34	0.456
57219	3.95	2.62	0.275

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

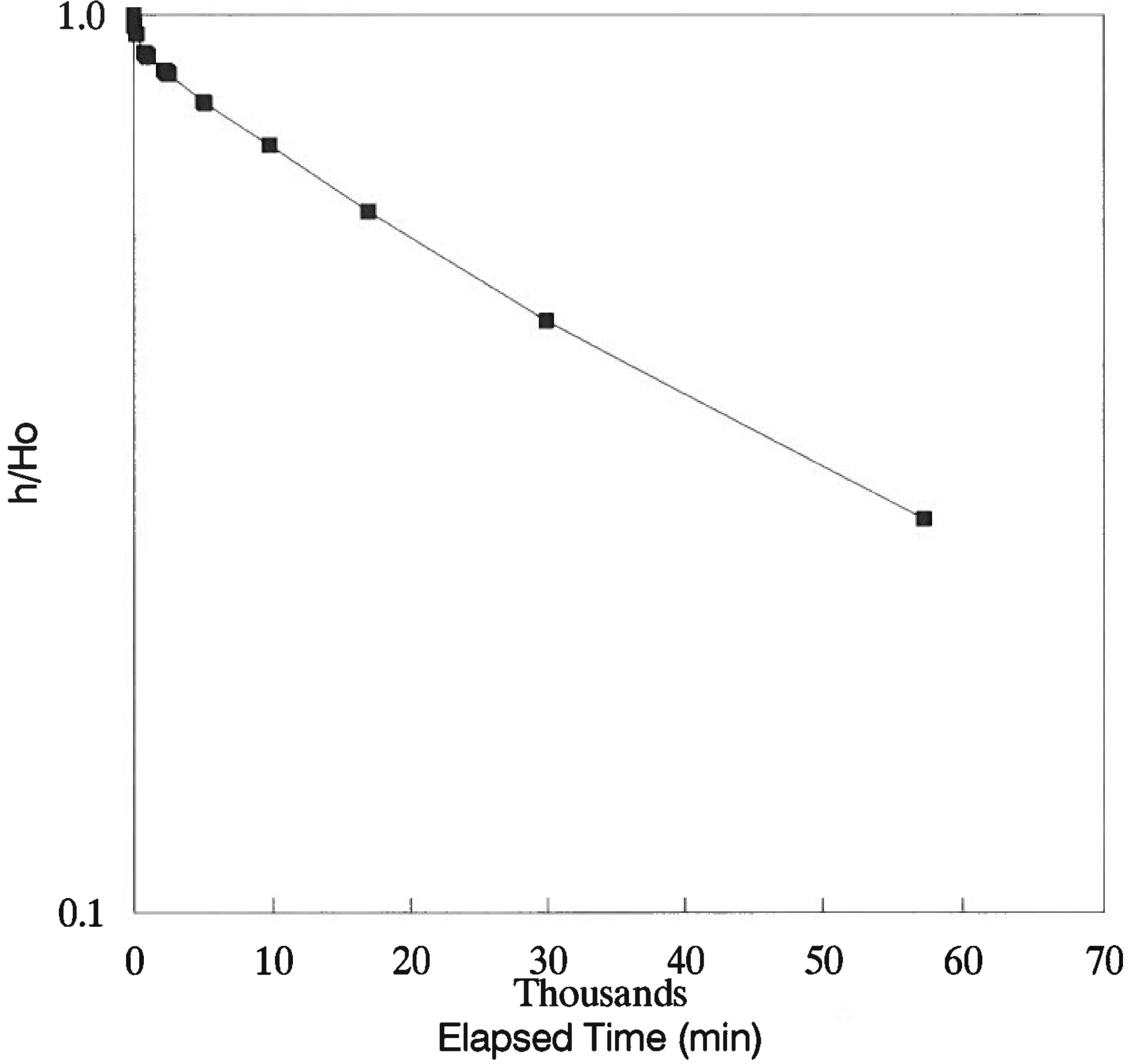
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	2.61 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	38000 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 2.7E–08 cm/s

Monitoring Well 1I

July 15th to August 24th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL: 1–D
STATIC WATER LEVEL: 2.08 (m)
DRAWDOWN AT t=0 (Ho): 17.90 (m)

DATE: 19 JULY 93
CONDUCTED BY: RJT & GCG
MEASURING POINT: Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	19.94	17.86	1.000
1.5	19.92	17.84	0.999
2	19.90	17.82	0.998
2.5	19.85	17.77	0.995
3	19.81	17.73	0.993
3.5	19.80	17.72	0.992
4	19.78	17.70	0.991
4.5	19.76	17.68	0.990
5	19.75	17.67	0.989
6	19.71	17.63	0.987
7	19.68	17.60	0.985
8	19.66	17.58	0.984
9	19.61	17.53	0.982
10	19.59	17.51	0.980
12.5	19.54	17.46	0.978
15	19.50	17.42	0.975
17.5	19.47	17.39	0.974
20	19.43	17.35	0.971
25	19.34	17.26	0.966
30	19.28	17.20	0.963
38	19.19	17.11	0.958
47	19.12	17.04	0.954
62	19.00	16.92	0.947
79	18.93	16.85	0.943
238	18.35	16.27	0.911
1129	16.87	14.79	0.828
1254	16.72	14.64	0.820
1342	16.62	14.54	0.814
1425	16.52	14.44	0.809
2577	15.23	13.15	0.736
2715	15.10	13.02	0.729
2802	15.01	12.93	0.724
2876	14.94	12.86	0.720
5362	12.78	10.70	0.599
5444	12.71	10.63	0.595
9759	10.33	8.25	0.462
16945	7.63	5.55	0.311
29913	5.34	3.26	0.183
57247	3.88	1.80	0.101

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

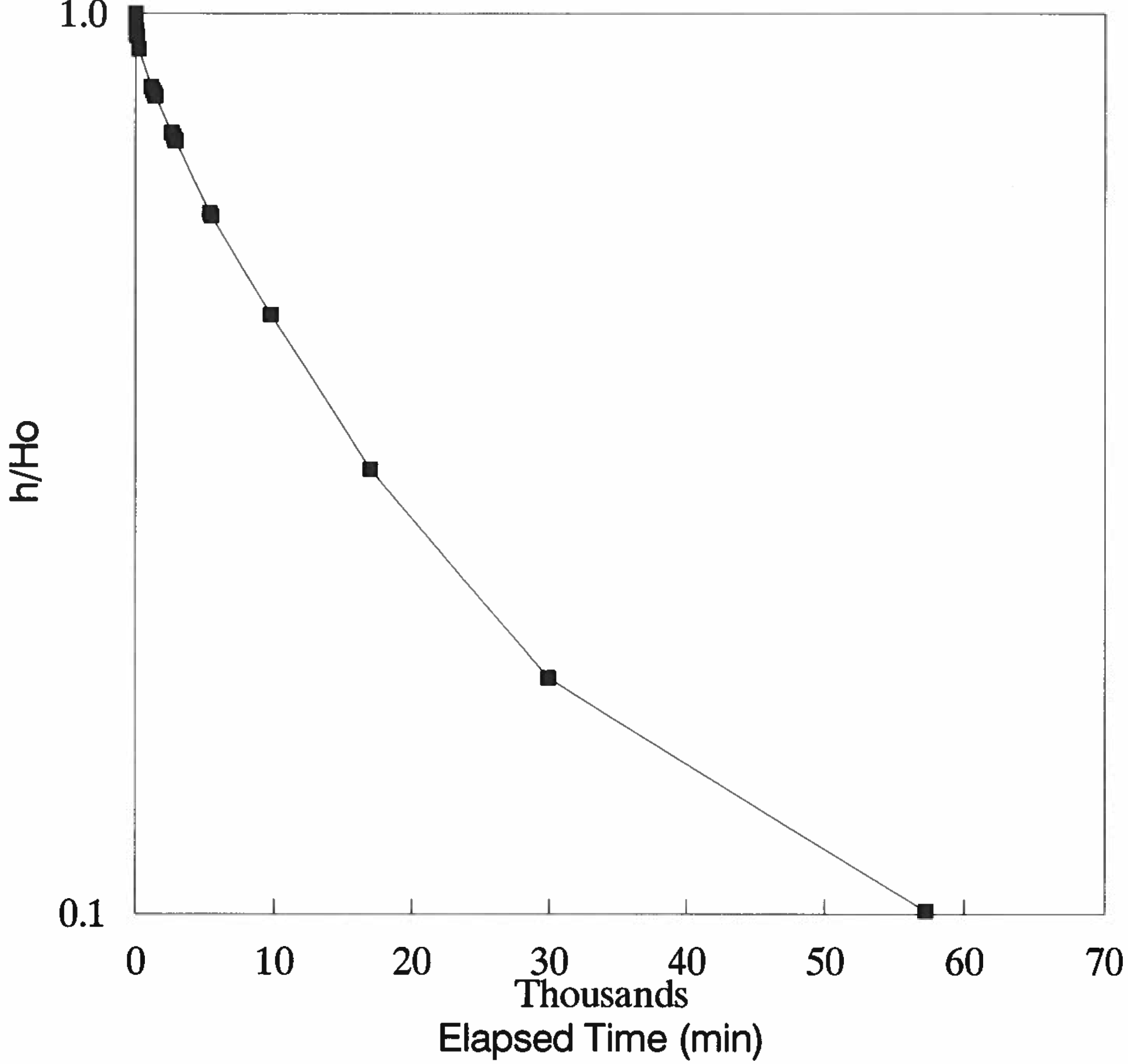
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	10.02 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	12000 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 3.2E–08 cm/s

Monitoring Well 1D

July 15th to August 24th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL: 5-I
STATIC WATER LEVEL: 3.52 (m)
DRAWDOWN AT t=0 (Ho): 9.95 (m)

DATE: 19 JULY 93
CONDUCTED BY: RJT & GCG
MEASURING POINT: Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.7	13.46	9.94	1.000
1	13.45	9.93	0.999
2	13.38	9.86	0.992
2.5	13.35	9.83	0.989
3	13.34	9.82	0.988
3.5	13.33	9.81	0.987
4	13.32	9.80	0.986
4.5	13.31	9.79	0.985
5	13.31	9.79	0.984
6	13.29	9.77	0.983
7	13.28	9.76	0.982
8	13.27	9.75	0.981
9	13.27	9.75	0.981
10	13.26	9.74	0.980
12.5	13.25	9.73	0.979
15	13.24	9.72	0.978
17.5	13.23	9.71	0.977
20	13.22	9.70	0.976
25	13.20	9.68	0.974
30	13.19	9.67	0.973
45	13.16	9.64	0.970
60	13.14	9.62	0.967
75	13.12	9.60	0.966
90	13.10	9.58	0.964
501	12.78	9.26	0.932
1109	12.34	8.82	0.887
1134	12.34	8.82	0.887
1286	12.26	8.74	0.879
1379	12.22	8.70	0.875
2571	11.75	8.23	0.828
2596	11.74	8.22	0.827
2745	11.68	8.16	0.821
2816	11.65	8.13	0.818
5419	10.78	7.26	0.730
5430	10.77	7.25	0.729
10035	9.61	6.09	0.613
17217	8.11	4.59	0.462
30180	6.39	2.87	0.289
57559	4.75	1.23	0.124

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

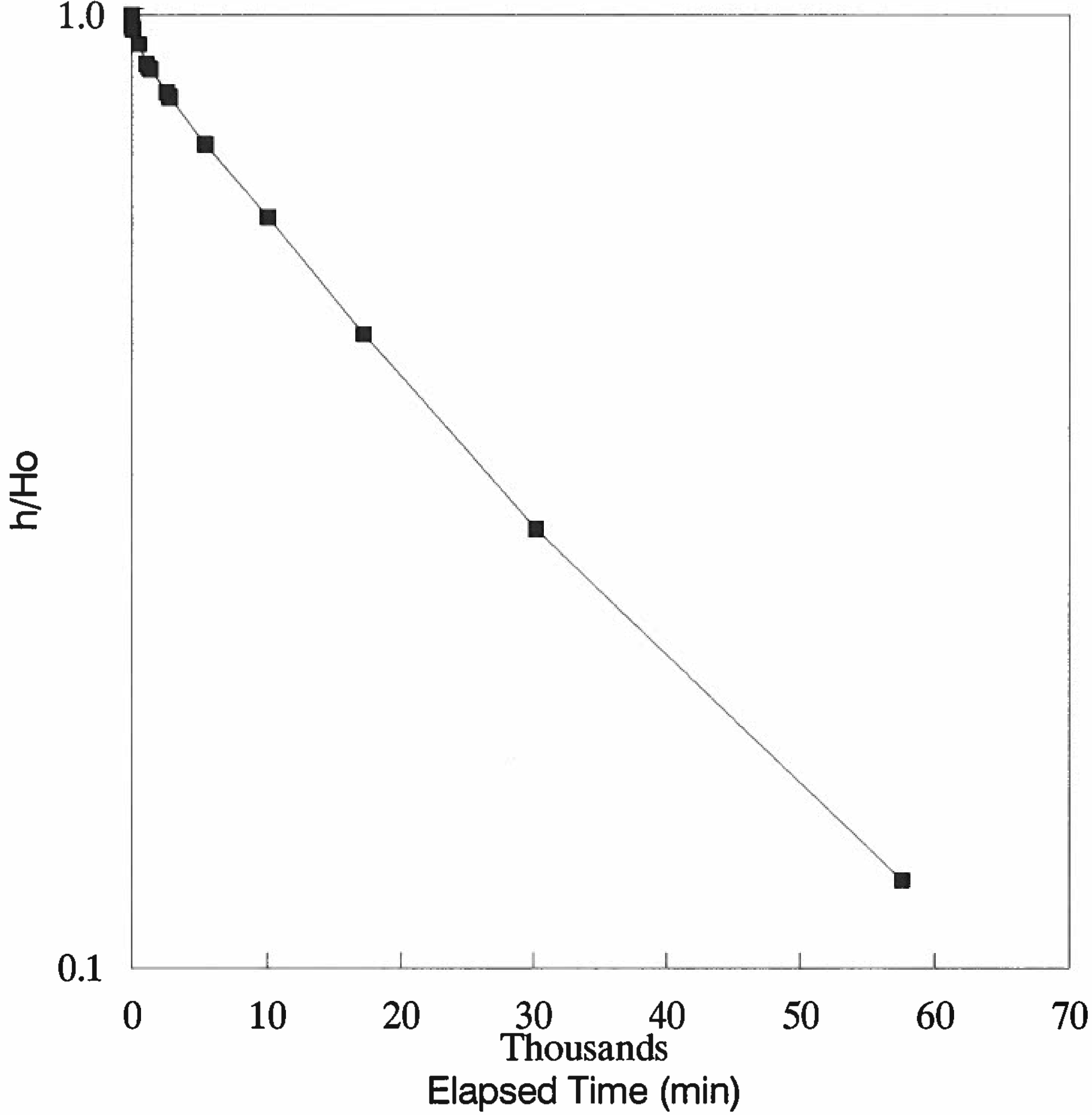
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	2.41 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	25000 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 4.3E-08 cm/s

Monitoring Well 5I

July 15th to August 24th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL: 5-S
STATIC WATER LEVEL: 1.85 (m)
DRAWDOWN AT t=0 (Ho): 2.70 (m)

DATE: 19 JULY 93
CONDUCTED BY: RJT & GCG
MEASURING POINT: Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	4.24	2.39	1.000
1	4.21	2.36	0.987
1.5	4.21	2.36	0.987
2	4.21	2.36	0.987
2.5	4.21	2.36	0.985
3	4.20	2.35	0.983
3.5	4.20	2.35	0.981
4	4.19	2.34	0.979
4.5	4.19	2.34	0.979
5	4.19	2.34	0.979
6	4.17	2.32	0.971
7	4.16	2.31	0.967
8	4.16	2.31	0.964
9	4.15	2.30	0.962
10	4.15	2.30	0.960
12.5	4.14	2.29	0.958
15	4.13	2.28	0.954
17.5	4.12	2.27	0.950
20	4.12	2.27	0.950
25	4.11	2.26	0.946
30	4.10	2.25	0.941
45	4.09	2.24	0.937
60	4.08	2.23	0.933
465	4.01	2.16	0.904
1075	3.93	2.08	0.870
1098	3.93	2.08	0.868
1252	3.91	2.06	0.862
1346	3.91	2.06	0.862
2536	3.79	1.94	0.812
2561	3.78	1.93	0.808
2712	3.77	1.92	0.803
2782	3.77	1.92	0.803
5384	3.60	1.75	0.732
5395	3.59	1.74	0.728
9996	3.42	1.57	0.657
17180	3.21	1.36	0.569
30143	3.03	1.18	0.494
57522	3.03	1.18	0.494

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

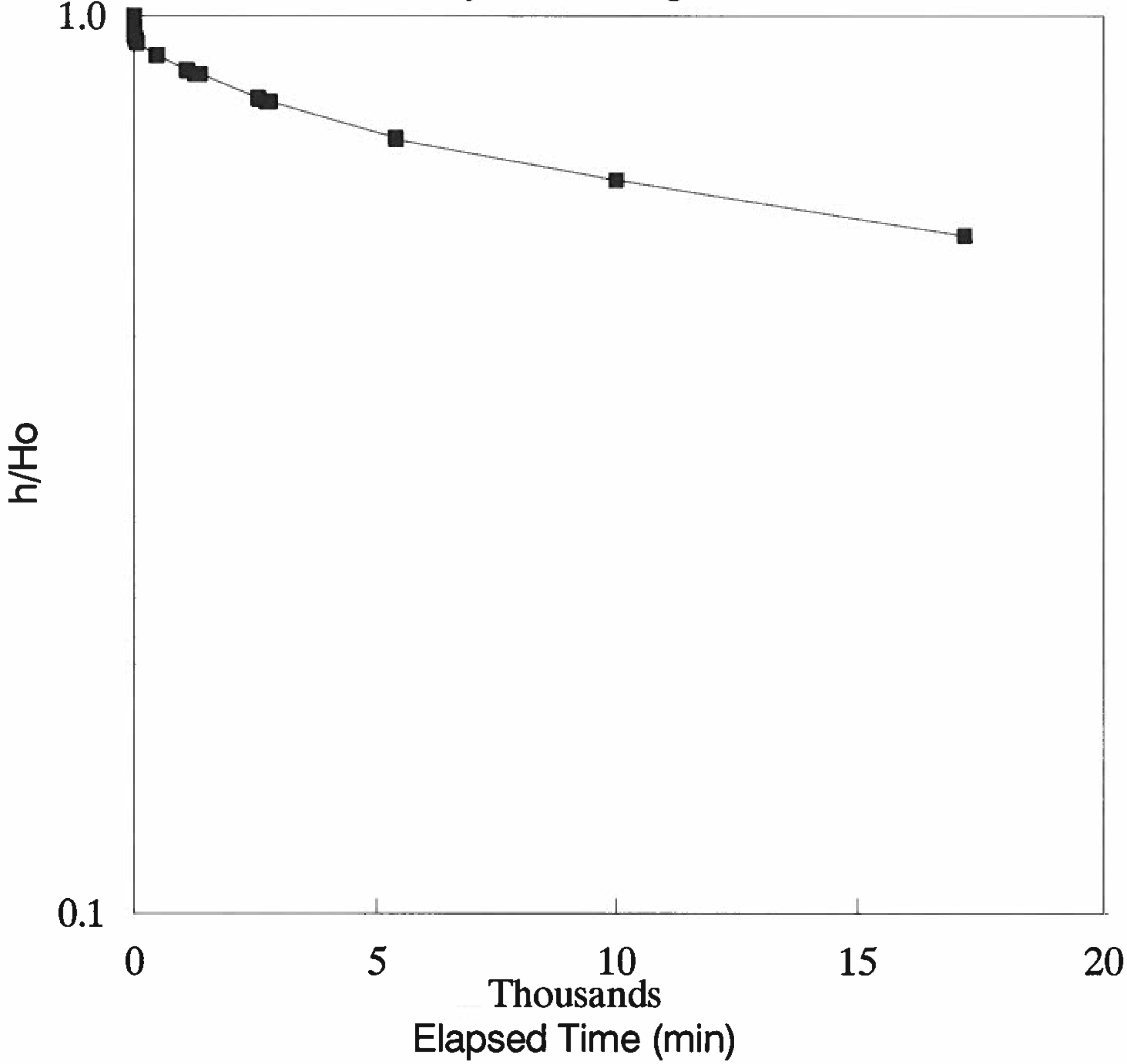
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	6.17 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	28000 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 2.0E-08 cm/s

Monitoring Well 5S

July 15th to August 24th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL:	6–S		DATE:	19 JULY 93
STATIC WATER LEVEL:	2.03	(m)	CONDUCTED BY:	RJT & GCG
DRAWDOWN AT t=0 (Ho):	3.23	(m)	MEASURING POINT:	Top of pipe

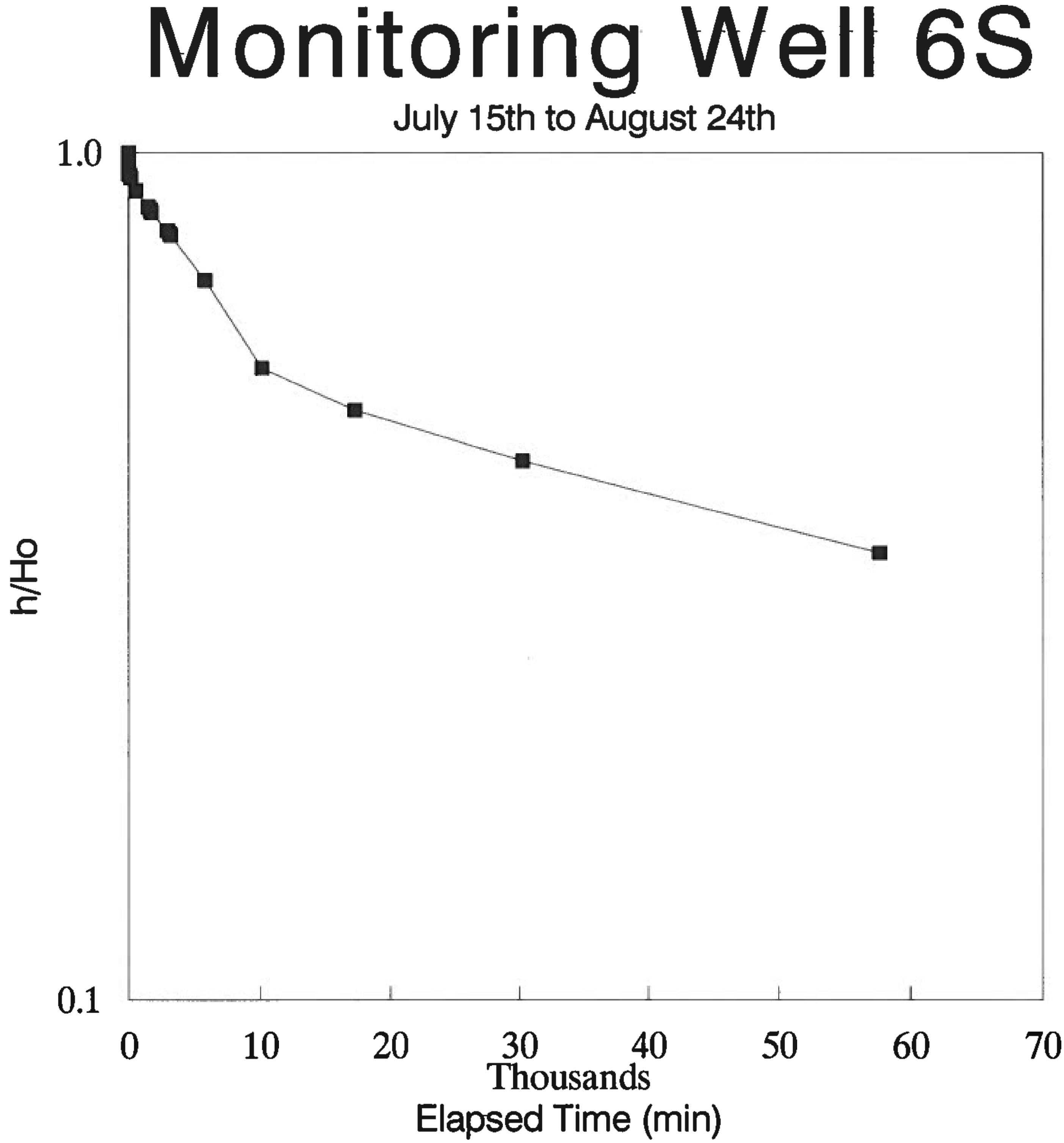
ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	5.17	3.14	1.000
1	5.06	3.03	0.965
1.5	5.06	3.03	0.965
2	5.05	3.02	0.962
2.5	5.04	3.01	0.959
3	5.04	3.01	0.959
3.5	5.03	3.00	0.955
4	5.03	3.00	0.955
4.5	5.03	3.00	0.954
5	5.02	2.99	0.952
6.25	5.02	2.99	0.951
9	5.01	2.98	0.949
11.25	5.01	2.98	0.949
12.5	5.01	2.98	0.949
15	5.01	2.98	0.947
20	5.00	2.97	0.946
25	5.00	2.97	0.946
30	5.00	2.97	0.944
45	4.99	2.96	0.943
98	4.98	2.95	0.939
144	4.96	2.93	0.933
568	4.86	2.83	0.901
1460	4.74	2.71	0.863
1498	4.74	2.71	0.863
1635	4.72	2.69	0.857
1729	4.70	2.67	0.850
2910	4.57	2.54	0.809
2960	4.57	2.54	0.809
3096	4.55	2.52	0.803
3167	4.54	2.51	0.799
5768	4.25	2.22	0.707
5793	4.25	2.22	0.707
10099	3.78	1.75	0.557
17278	3.59	1.56	0.497
30244	3.39	1.36	0.433
57624	3.09	1.06	0.338

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	6.06 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	20000 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 2.8E–08 cm/s


Monitoring Well 6S
July 15th to August 24th
1.0
0.1
h/Ho
0
10
20
30
40
50
60
70
Thousands
Elapsed Time (min)

PROJECT NAME: LAMBTON WMMP

MONITORING WELL: 6–I
STATIC WATER LEVEL: 3.67 (m)
DRAWDOWN AT t=0 (Ho): 9.89 (m)

DATE: 19 JULY 93
CONDUCTED BY: RJT & GCG
MEASURING POINT: Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	13.45	9.78	1.000
1.5	13.39	9.72	0.994
2.17	13.39	9.72	0.994
2.5	13.38	9.71	0.993
3	13.38	9.71	0.993
3.5	13.38	9.71	0.993
4	13.37	9.70	0.992
4.5	13.37	9.70	0.992
5	13.36	9.69	0.991
6	13.36	9.69	0.991
7	13.35	9.68	0.990
8	13.35	9.68	0.990
9	13.35	9.68	0.990
10	13.34	9.67	0.989
12.5	13.34	9.67	0.988
15	13.33	9.66	0.988
20	13.32	9.65	0.987
32	13.32	9.65	0.986
45	13.30	9.63	0.984
60	13.27	9.60	0.982
75	13.25	9.58	0.980
120	13.20	9.53	0.974
166	13.14	9.47	0.968
591	12.85	9.18	0.939
1483	12.42	8.75	0.895
1523	12.40	8.73	0.893
1661	12.34	8.67	0.887
1754	12.30	8.63	0.882
2936	11.85	8.18	0.836
2986	11.83	8.16	0.834
3122	11.78	8.11	0.829
3193	11.76	8.09	0.827
5794	10.91	7.24	0.740
5818	10.90	7.23	0.739
10124	9.76	6.09	0.623
17304	8.26	4.59	0.469
30269	6.47	2.80	0.286
57649	4.62	0.95	0.097

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

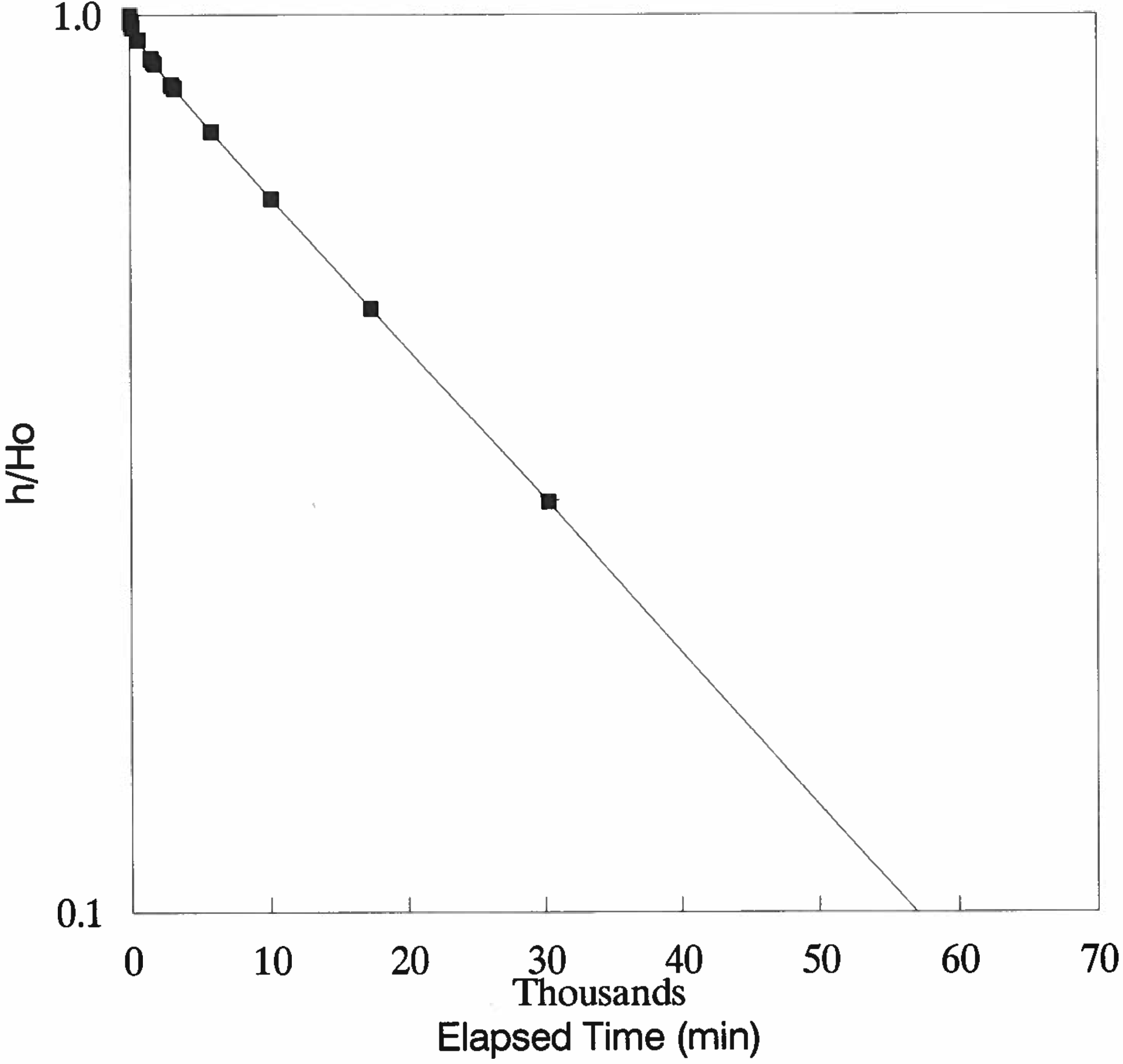
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	2.64 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	22500 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 4.5E–08 cm/s

Monitoring Well 6I

July 15th to August 24th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL: 6−D
STATIC WATER LEVEL: 4.98 (m)
DRAWDOWN AT t=0 (Ho): 17.67 (m)

DATE: 19 JULY 93
CONDUCTED BY: RJT & GCG
MEASURING POINT: Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	21.30	16.32	1.000
2.5	21.00	16.02	0.982
4	20.78	15.80	0.968
5.5	19.77	14.79	0.906
6	19.75	14.77	0.905
7	19.61	14.63	0.896
8	19.54	14.56	0.892
9	19.47	14.49	0.888
10	19.42	14.44	0.885
12.5	19.27	14.29	0.876
15	19.10	14.12	0.865
17.5	18.94	13.96	0.855
20	18.77	13.79	0.845
22.5	18.64	13.66	0.837
25	18.49	13.51	0.828
27.5	18.35	13.37	0.819
30	18.21	13.23	0.811
35	17.94	12.96	0.794
40	17.70	12.72	0.779
45	17.45	12.47	0.764
60	16.78	11.80	0.723
76	15.98	11.00	0.674
94	15.21	10.23	0.627
105	14.78	9.80	0.600
120	14.19	9.21	0.564
162	12.92	7.94	0.487
213	11.34	6.36	0.390
637	5.66	0.68	0.042

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r): 0.03175 m

Length of Sand Pack (L): 3.79 m

Diameter of Pack (D): 0.2159 m

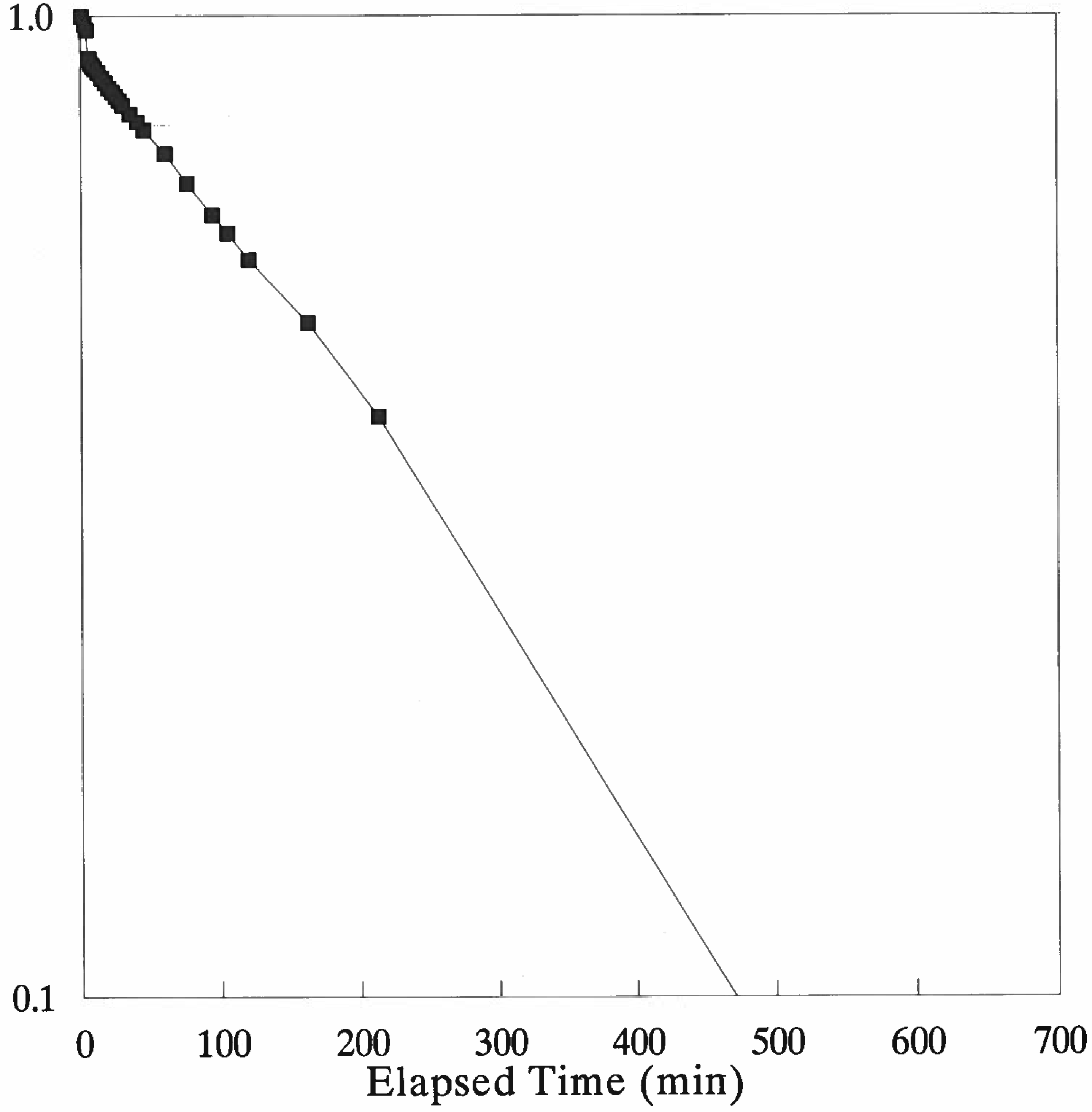
Basic Time Lag (To): 250 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 3.2E−06 cm/s

Monitoring Well 6D

July 15th to July 27th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL:	9-I		DATE:	19 JULY 93
STATIC WATER LEVEL:	4.71	(m)	CONDUCTED BY:	RJT & GCG
DRAWDOWN AT t=0 (Ho):	5.95	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	10.57	5.86	1.000
1	10.54	5.83	0.995
1.5	10.54	5.83	0.995
2	10.54	5.83	0.995
2.5	10.54	5.83	0.994
3	10.53	5.82	0.993
3.5	10.53	5.82	0.993
4	10.53	5.82	0.993
4.5	10.53	5.82	0.993
5	10.53	5.82	0.992
6	10.52	5.81	0.991
7	10.52	5.81	0.991
8	10.52	5.81	0.991
9	10.52	5.81	0.991
10	10.52	5.81	0.991
15	10.51	5.80	0.990
25	10.48	5.77	0.985
30	10.48	5.77	0.985
45	10.44	5.73	0.978
60	10.42	5.71	0.974
100	10.37	5.66	0.966
999	9.68	4.97	0.848
1135	9.64	4.93	0.841
1214	9.62	4.91	0.838
1287	9.60	4.89	0.834
2403	9.35	4.64	0.792
2597	9.31	4.60	0.785
2683	9.28	4.57	0.780
2757	9.28	4.57	0.780
5311	8.74	4.03	0.688
5345	8.74	4.03	0.688
9589	8.06	3.35	0.572
16784	7.11	2.40	0.410
29758	5.98	1.27	0.217
57217	4.84	0.13	0.022

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

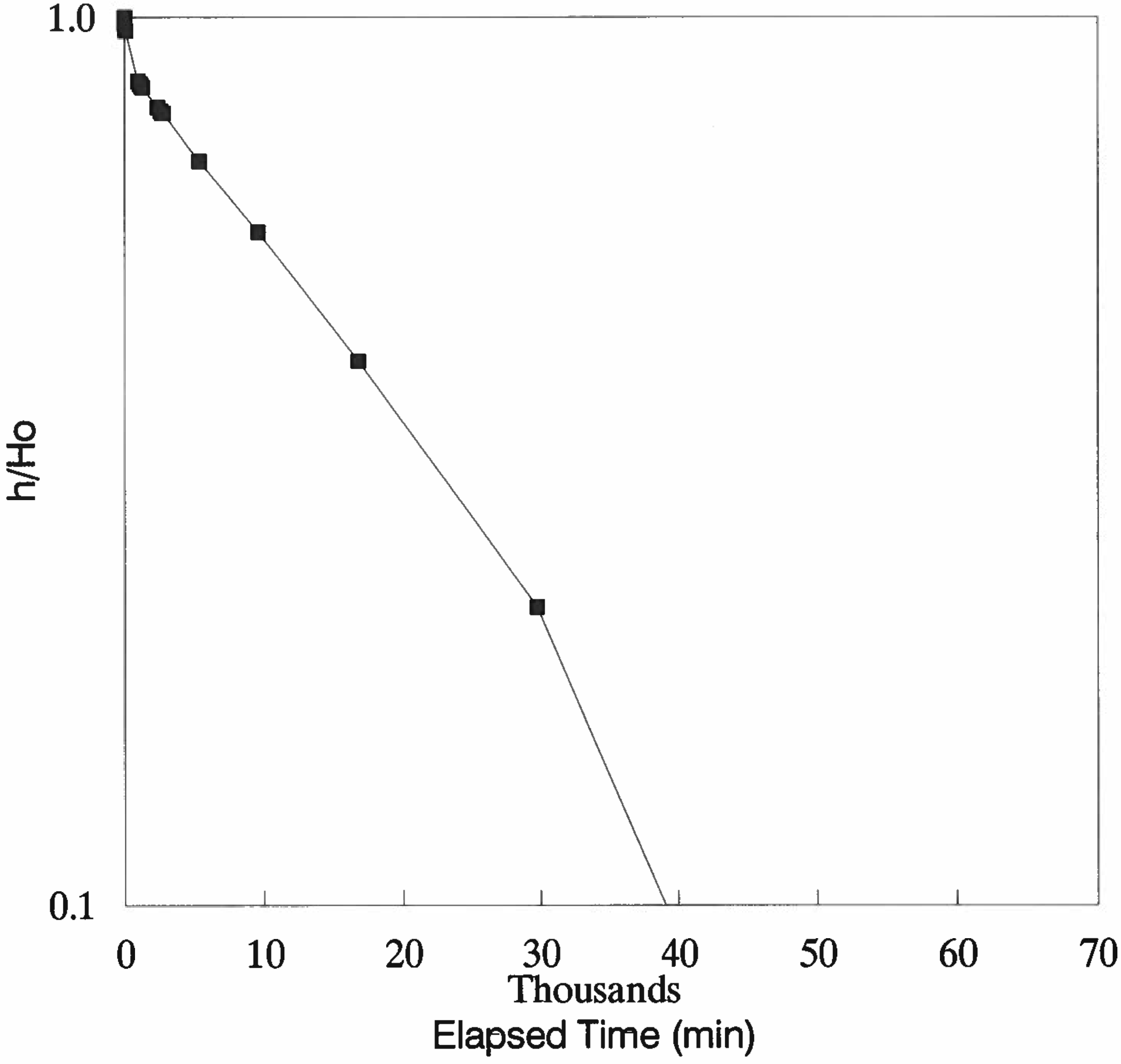
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	4.54 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	20000 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 3.5E-08 cm/s

Monitoring Well 9I

July 15th to August 24th



PROJECT NAME: LAMBTON WMMP

MONITORING WELL:	9–S		DATE:	19 JULY 93
STATIC WATER LEVEL:	2.57	(m)	CONDUCTED BY:	RJT & GCG
DRAWDOWN AT t=0 (Ho):	3.09	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.5	5.64	3.07	1.000
1	5.63	3.06	0.997
1.5	5.62	3.05	0.993
2	5.62	3.05	0.993
2.5	5.60	3.03	0.987
3	5.60	3.03	0.987
3.5	5.60	3.03	0.987
4	5.59	3.02	0.984
4.5	5.59	3.02	0.982
5	5.58	3.01	0.980
7.5	5.58	3.01	0.979
10	5.56	2.99	0.974
15	5.55	2.98	0.971
20	5.54	2.97	0.967
25	5.53	2.96	0.964
30	5.53	2.96	0.963
45	5.51	2.94	0.956
84	5.47	2.90	0.945
982	4.81	2.24	0.730
1121	4.73	2.16	0.704
1198	4.68	2.11	0.687
1271	4.63	2.06	0.671
2387	4.00	1.43	0.466
2580	3.84	1.27	0.414
2666	3.76	1.19	0.388
2741	3.70	1.13	0.368
5294	3.11	0.54	0.176
5328	3.11	0.54	0.176

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

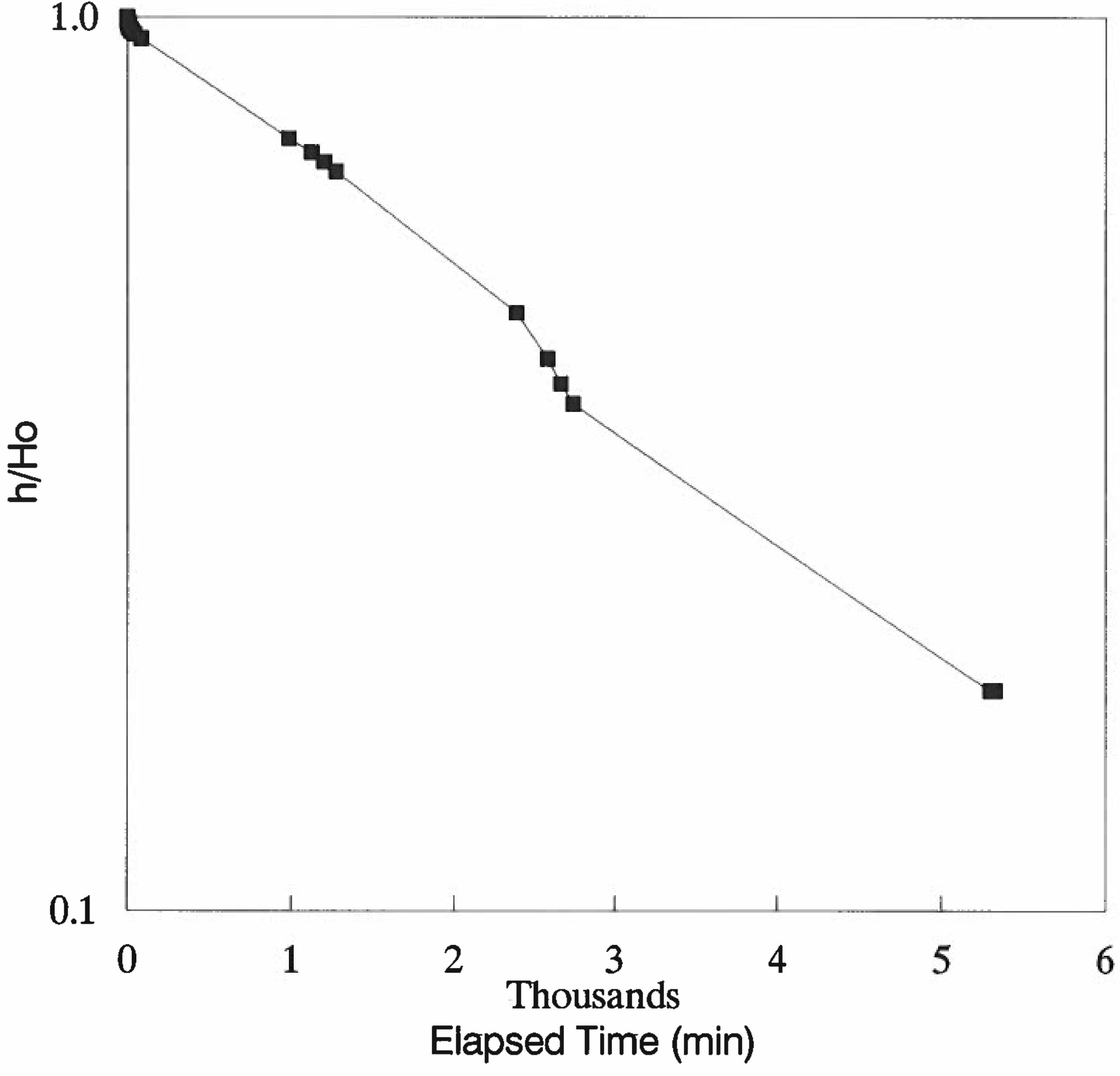
Installation Radius (r):	0.03175 m
Length of Sand Pack (L):	3.89 m
Diameter of Pack (D):	0.2159 m
Basic Time Lag (To):	2700 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 2.9E–07 cm/s

Monitoring Well 9S

July 15th to July 27th



SCHEDULE V

WELL DEVELOPMENT/PURGING RECORDS

BH 1S

LAMBTON SITE PROOFING
COURTRIGHT, LAMBTON, ONTARIO
GROUND WATER DEVELOPMENT / PURGING RECORD

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	ELEV'N BOTTOM SCREEN (m asl)	STATIC WATER LEVEL (m asl)	WELL VOLUME (L)	DATE PURGED	VOLUME PUMPED (L)	WATER LEVEL BEFORE (m asl)	TIME	WATER LEVEL AFTER (m asl)	DATE	TIME
1S	190.31	191.21	182.9	189.43	13.06	02–Jun	34.0	189.59	09:00 AM	183.96	02–Jun	09:00 AM
										189.30	10–Jun	03:50 PM
						11–Jun	22.0	189.31	09:27 AM	184.49	11–Jun	09:43 AM
										184.71	11–Jun	10:06 AM
										185.50	11–Jun	12:10 PM
										189.43	17–Jun	04:56 PM
										189.46	09–Jul	01:21 PM

LAMBTON SITE PROOFING
COURTRIGHT, LAMBTON, ONTARIO
GROUND WATER DEVELOPMENT / PURGING RECORD

BH 1D

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	ELEV'N BOTTOM SCREEN (m asl)	STATIC WATER LEVEL (m asl)	WELL VOLUME (L)	DATE PURGED	VOLUME PUMPED (L)	WATER LEVEL BEFORE (m asl)	TIME	WATER LEVEL AFTER (m asl)	DATE	TIME	TOTAL VOLUME PUMPED (L)	TOTAL WELL VOLUMES REMOVED
1D	190.42	191.18	140.88	189.1	96.44	02–Jun	24.0	189.10	09:00 AM	174.78	02–Jun	09:00 AM		
										184.38	10–Jun	03:55 PM		
						11–Jun	42.0	184.68	09:30 AM	170.45	11–Jun	10:04 AM		
										171.83	11–Jun	12:14 PM		
										179.39	17–Jun	04:55 PM		
										186.82	09–Jul	01:25 PM		

BH 5S

LAMBTON SITE PROOFING
COURTRIGHT, LAMBTON, ONTARIO
GROUND WATER DEVELOPMENT / PURGING RECORD

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	ELEV'N BOTTOM SCREEN (m asl)	STATIC WATER LEVEL (m asl)	WELL VOLUME (L)	DATE PURGED	VOLUME PUMPED (L)	WATER LEVEL BEFORE (m asl)	TIME	WATER LEVEL AFTER (m asl)	DATE	TIME
5S	187.17	188.14	179.78	186.29	13.02	02–Jun	34.0	186.29	02:30 PM	180.99	02–Jun	02:30 PM
						10–Jun	31.0	183.67	05:00 PM	180.76	10–Jun	05:21 PM
										181.25	11–Jun	03:36 PM
										182.49	17–Jun	02:00 PM
										184.90	09–Jul	03:17 PM

LAMBTON SITE PROOFING
COURTRIGHT, LAMBTON, ONTARIO
GROUND WATER DEVELOPMENT / PURGING RECORD

BH 5I

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	ELEV'N BOTTOM SCREEN (m asl)	STATIC WATER LEVEL (m asl)	WELL VOLUME (L)	DATE PURGED	VOLUME PUMPED (L)	WATER LEVEL BEFORE (m asl)	TIME	WATER LEVEL AFTER (m asl)	DATE	TIME
5I	187.33	188.14	172.27	184.62	24.7	02–Jun	30.0	184.62	02:30 PM	173.64	02–Jun	02:30 PM
						10–Jun	11.0	178.36	05:00 PM	174.29	10–Jun	05:31 PM
										175.01	11–Jun	03:32 PM
										177.85	17–Jun	02:00 PM
										182.55	09–Jul	03:15 PM

BH 6I

LAMBTON SITE PROOFING
COURTRIGHT, LAMBTON, ONTARIO
GROUND WATER DEVELOPMENT / PURGING RECORD

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	ELEV'N BOTTOM SCREEN (m asl)	STATIC WATER LEVEL (m asl)	WELL VOLUME (L)	DATE PURGED	VOLUME PUMPED (L)	WATER LEVEL BEFORE (m asl)	TIME	WATER LEVEL AFTER (m asl)	DATE	TIME
6I	186.02	187.19	171.06	183.52	24.92	02–Jun	26.0	186.11	12:00 PM	171.99	02–Jun	12:00 PM
										176.94	10–Jun	04:30 PM
										176.83	10–Jun	04:55 PM
										177.17	11–Jun	03:12 PM
										178.94	17–Jun	12:17 PM
										182.10	09–Jul	03:29 PM

LAMBTON SITE PROOFING
COURTRIGHT, LAMBTON, ONTARIO
GROUND WATER DEVELOPMENT / PURGING RECORD

BH 6D

BH No.	GROUND ELEV'N (masl)	ELEV'N TOP OF PIPE (masl)	ELEV'N BOTTOM SCREEN (m asl)	STATIC WATER LEVEL (m asl)	WELL VOLUME (L)	DATE PURGED	VOLUME PUMPED (L)	WATER LEVEL BEFORE (m asl)	TIME	WATER LEVEL AFTER (m asl)	DATE	TIME
6D	186.01	187.14	140.16	182.16	84	02–Jun	26.0	182.16	12:00 PM	165.64	02–Jun	01:00 PM
						10–Jun	46.0	182.13	04:30 PM	160.95	10–Jun	04:51 PM
										166.96	11–Jun	03:13 PM
										180.29	17–Jun	12:16 PM
										182.12	09–Jul	03:31 PM

SCHEDULE VI

GROUND WATER CHEMICAL ANALYSIS

TABLE F.1
SUMMARY OF GROUND WATER CHEMISTRY

PARAMETER	WELL DESIGNATION									
	BH 1S	BH 1I	BH 1D	BH 5S	BH 5I	BH 6S	BH 6I	BH 6D	BH 9S	BH 9I
SODIUM	53.2	175	5090	59.6	195	409	146	176	174	128
POTASSIUM	3.4	2.5	15.6	4	2.7	15.1	3.1	4.4	5.5	6.3
CALCIUM	99.9	94.6	69.7	147	140	515	75.4	27	96.5	70.9
MAGNESIUM	56	30.2	22.7	112	50.3	856	40.8	9.7	124	31.1
HARDNESS (as CaCO3)	480	361	267	828	557	4810	356	107	751	305
ALKALINITY (as CaCO3)	285	122	283	412	120	488	110	129	550	216
SULFATE	90	42	15	384	736	4080	478	4	507	56
CHLORIDE	119	387	7340	12.4	52.6	104	75.4	242	44.3	209
REACTIVE SILICA	11.3	11.2	7	4.3	7.4	13.7	8.2	10.5	14.7	7.4
ORTHO PHOSPHORUS (as P)	0.02	0.02	0.02	< 0.01	< 0.01	< 0.01	0.87	< 0.01	< 0.01	< 0.01
NITRATE + NITRITE (as N)	0.17	< 0.05	< 0.05	0.17	0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
AMMONIA (as N)	0.05	0.36	2.3	< 0.05	0.31	0.06	< 0.05	< 0.05	0.08	0.34
IRON	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02
MANGANESE	0.07	0.15	0.1	0.06	0.07	0.41	0.04	0.03	0.25	0.09
COPPER	< 0.01	< 0.01	0.01	0.02	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
ZINC	< 0.01	0.02	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
COLOR (TCU)	5	4	9	6	3	12	7	5	12	7
TURBIDITY (NTU)	0.36	0.24	0.69	0.51	0.27	1.36	0.71	0.44	0.32	0.32
SPECIFIC CONDUCTANCE	1140	1630	25500	1850	2100	10200	1430	1040	2020	1220
pH (UNIT)	7.6	7.7	8	7.5	7.8	7.2	7.8	7.9	7.6	7.7
TOTAL ORGANIC CARBON	1.9	0.7	1.9	1.9	3.1	1.9	1.9	2.4	7.1	5.1

**NOTE: – mg/L IS THE UNIT FOR ALL PARAMATERS UNLESS OTHERWISE SPECIFIED

–umho/cm IS THE UNIT FOR SPECIFIC CONDUCTANCE

SCHEDULE VII

GEOPHYSICAL BOREHOLE LOGGING

Hyd-Eng
GEOPHYSICS
INC.

Mr. Mark Samis, M.Sc.
M.M. Dillon Limited
47 Shepherd Avenue E.
Box 185, Station A
Willowdale, Ont.
M2N 6H5

June 5, 1991.

Dear Mr. Samis;

This letter reports the results of the borehole geophysical logging survey south of Sarnia, Ontario. Hyd-Eng Geophysics Inc. was retained to geophysically log three boreholes and interpret the results of the survey. Two holes are located off the Moore-Sombria Townline Road on sites H and I, while the third is located on Site D near Highway 80. All the logging was done through 2 inch PVC monitors. Field work was completed on the 29th of May, 1991.

Both natural gamma and apparent conductivity logs were collected at each installation. The instruments used were the EM39 conductivity and gamma probes manufactured by Geonics Limited. The gamma probe measures the natural gamma radiation emitted by the subsurface in counts per second (cps). Potassium, uranium and thorium all emit gamma radiation. However, it is primarily to the potassium bound in clays that the probe is responding. In uncontaminated materials the gamma levels can usually be directly related to clay content.

The apparent conductivity is measured using the principles of electromagnetic (EM) induction. An EM field is created by passing a current through a transmitter coil. As the field passes through the ground it induces a small current flow within the material. These ground currents create their own EM field, the properties of which are a function of the bulk conductivity of the subsurface. Receiver coils are used to measure the combined fields. The instrument converts the EM field properties into apparent conductivity measurements of the subsurface in units of milliSiemans per metre (mS/m). The instrument is focused so that its measuring radius is from approximately .1 to 1 metre radius around the instrument.

Generally the bulk apparent conductivity of subsurface materials increase with clay content, porewater conductivity and water content. Under uncontaminated conditions, the conductivity and gamma logs are usually subparallel. For units in which the porewater conductivity is anomalously high, the apparent conductivity log will indicate higher levels than would be expected based on the gamma log.

The results of the survey are presented in Figures 1 through 3. Each diagram includes the gamma and apparent conductivity logs, interpreted relative lithologies and porewater conductivity. The natural gamma response shown in these diagrams is an overlay of the results collected from two passes of the instrument. This allows one to distinguish subtle but repeatable variation due to geology from random noise effects.

NOTE: The interpretation of material texture is a relative scale based primarily on the gamma log response. Most of the materials measured by this survey had gamma levels indicative of clays. Where the gamma log exhibits a change which does not warrant the identification of a different overburden material, the sediment texture has been described relative to the clay level response. Contacts which are separated by dashed lines are less distinct than those which are defined by solid lines.

A brief discussion of the interpretation of each log follows:

BH1D (Figure 1) was drilled primarily through clay, although several thin layers exist with a higher percentage of silt in the overburden material. The natural gamma log demonstrates many subtle changes in the gamma response which have been shown to be a result of either a slightly higher silt content, or conversely, a higher percentage of fines in the overburden. Between 34 and 43 metres in depth there are anomalous readings which show the groundwater to have a higher porewater conductivity than would be expected based on the natural gamma response. There is also a second anomaly which appears below 47 metres. The lower limit cannot be established because the apparent conductivity probe did not reach background readings below the anomaly.

BH5D (Figure 2) was drilled through clays with several layers of slightly finer textured materials. The overburden material at this location showed more variability above 35 metres than did BH1D. Below 35 metres both BH5D and BH6D demonstrate a more uniform texture. The apparent conductivity log of this hole shows two anomalies. The top of the first anomaly is masked by the steel casing and consequently its upper limit cannot be defined. This anomaly decreases to background levels by 10 metres in depth. The second anomaly exists between 43 and 45 metres depth.

BH6D (Figure 3) is very similar to BH5D. Between 21 and 25 metres depth lies a silty clay layer (marked with an "A") which is very similar to the zone marked with an "A" on Figure 2 (BH5D). There are also two apparent conductivity anomalies intersected by this hole. The first is between 5 and 7 metres, while the second is between 41 and 43 metres.

I hope the information presented is useful in your further investigations of the site. If any questions arise regarding either the survey or its interpretation please do not hesitate to contact me.

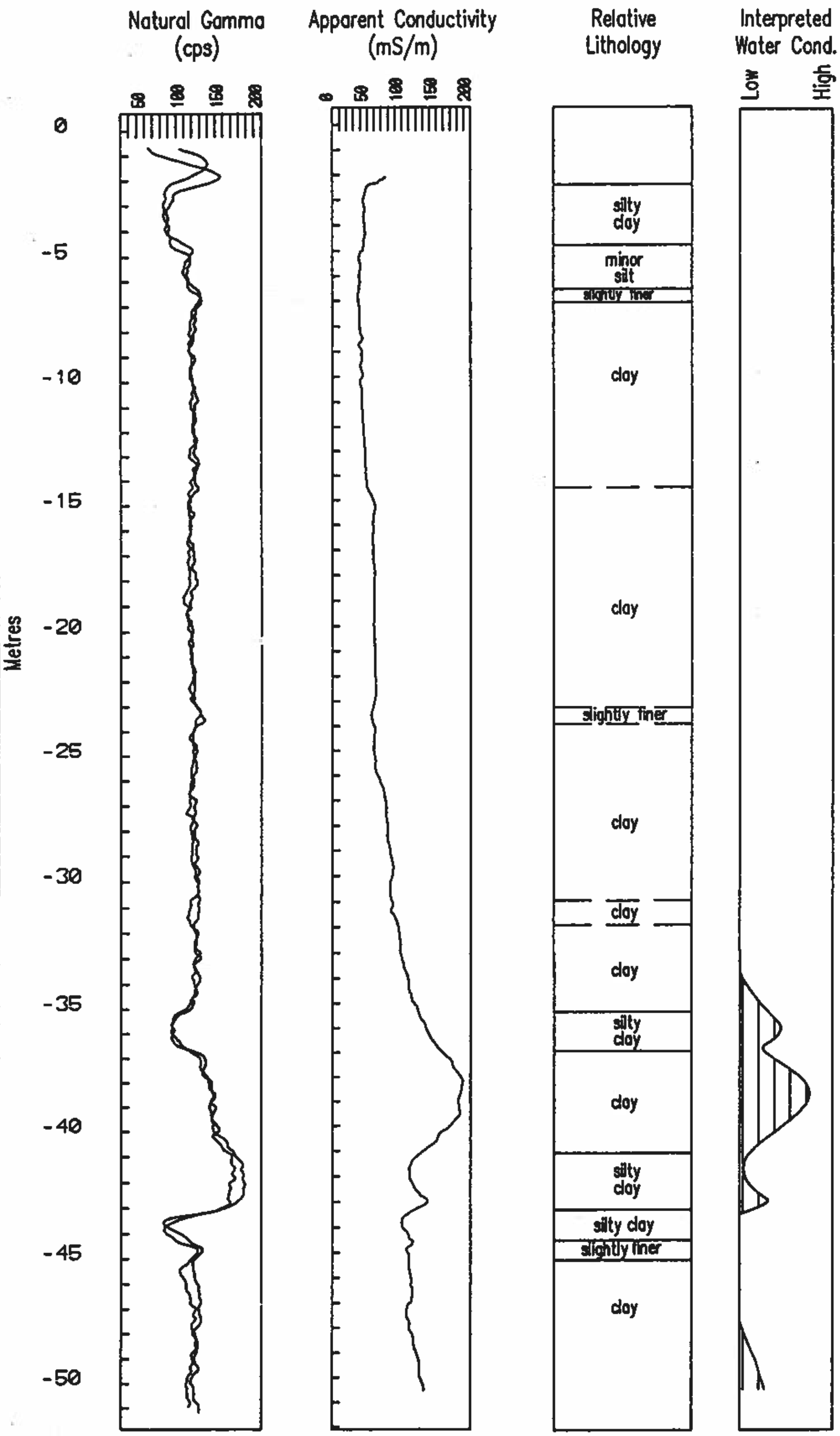
Sincerely,

P.Pehme.

Hyd-Eng
GEOPHYSICS
INC.

Figure 1; BH1D Sarnia

Referenced to Top of Casing

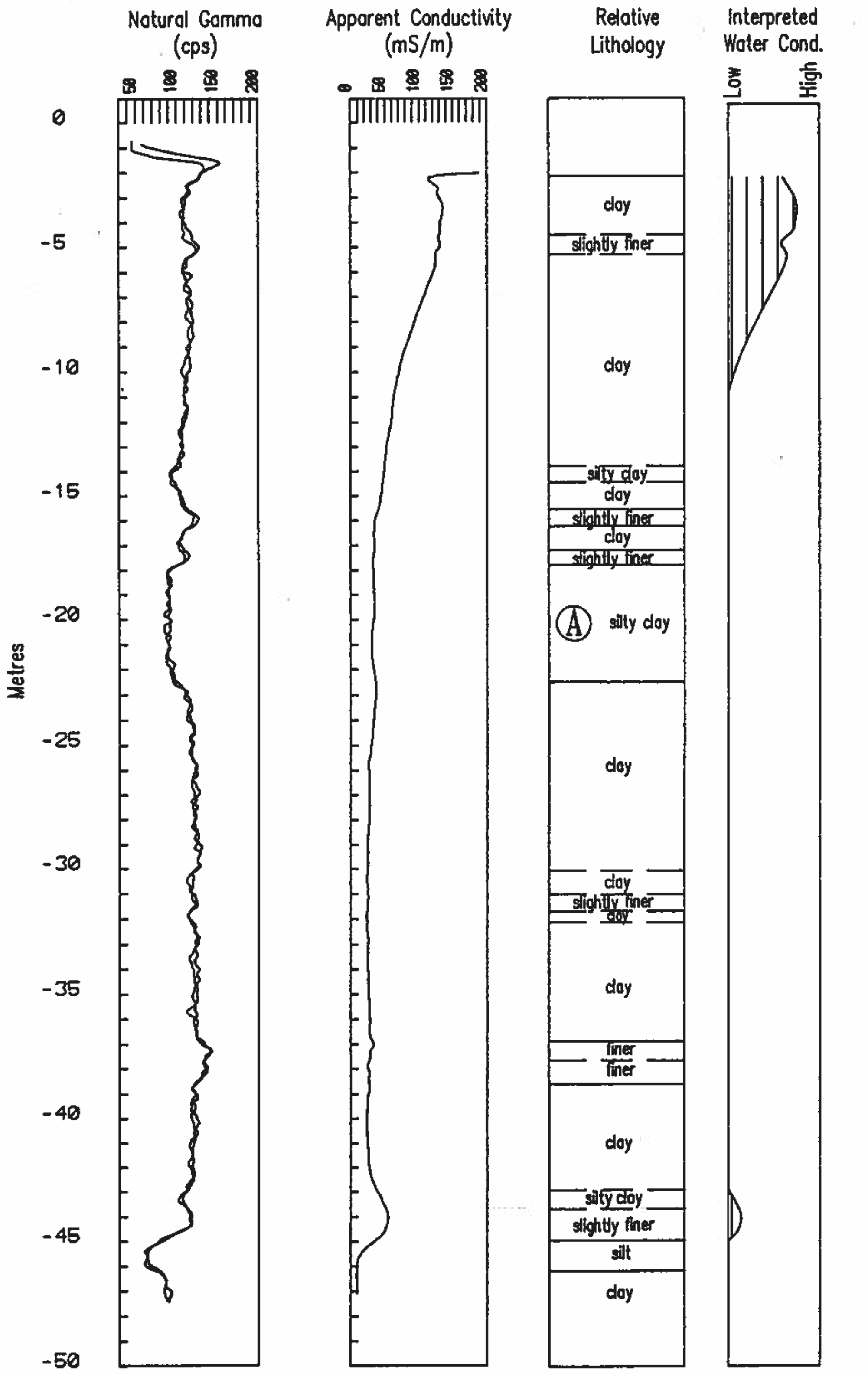


NOTE: The grain sizes presented in the geophysical interpretation are intended to explain apparent contacts and are a relative comparison only.

Hyd-Eng Geophysics Inc.

Figure 2; BH5D Sarnia

Referenced to Top of Casing



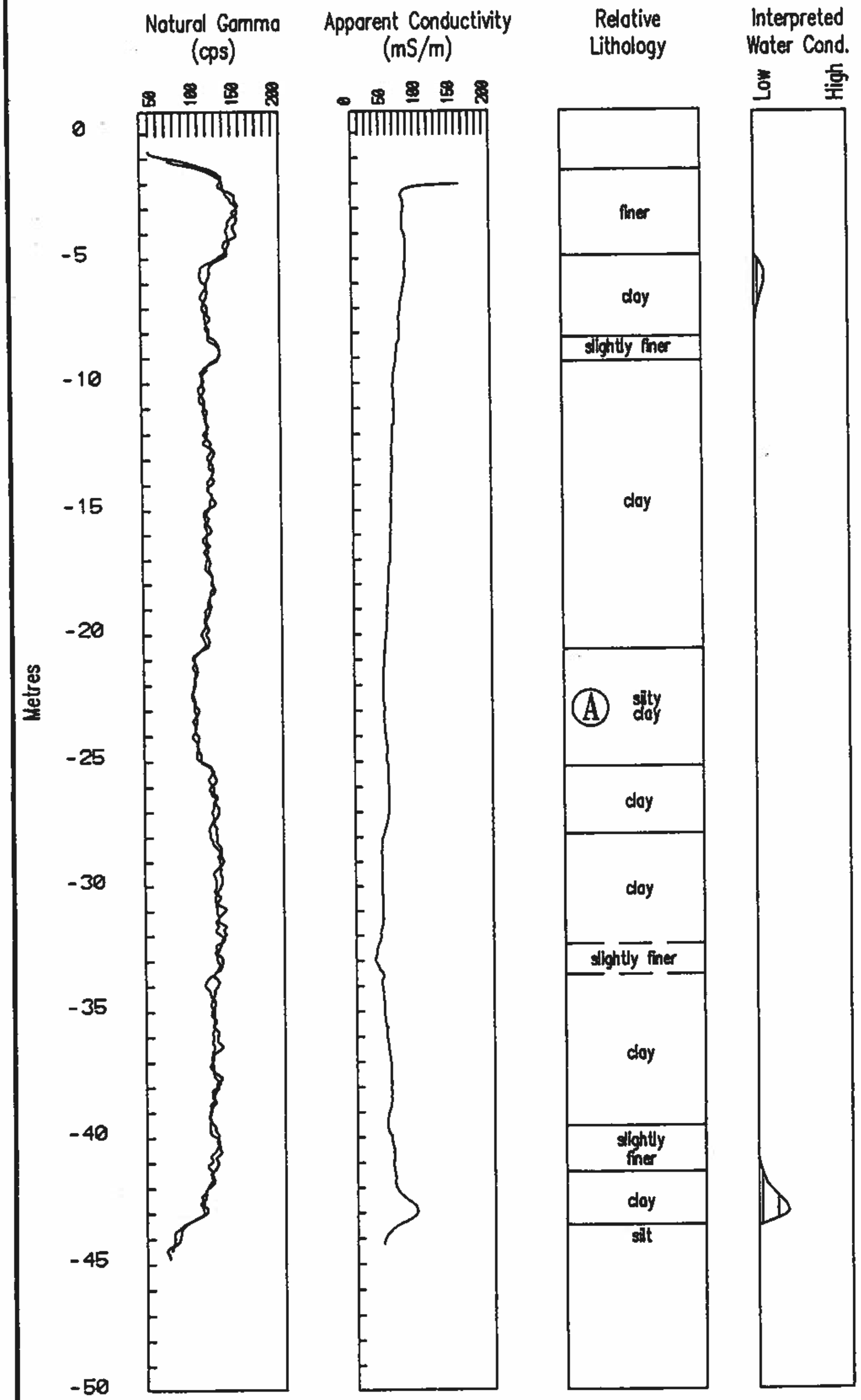
NOTE: The grain sizes presented in the geophysical interpretation are intended to explain apparent contacts and are a relative comparison only.

Ⓐ Marker Horizon

Hyd-Eng
GEOPHYSICS
INC.

Figure 3; BH6D Sarnia

Referenced to Top of Casing



NOTE: The grain sizes presented in the geophysical interpretation are intended to explain apparent contacts and are a relative comparison only.

Ⓐ Marker Horizon

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4E
LAND USE IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from a land use perspective. The purpose of this impact assessment was to identify the order of preference of the sites (i.e. from most to least preferred) with respect to land use considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill component was considered to be the most significant in identifying and comparing potential land use impacts.

The key considerations addressed in this study were:

- impacts on urban structure;
- conformity to County and local municipal planning policies; and
- compatibility with surrounding existing, potential and future land uses.

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the assessment and comparison of the potential land use impacts of the sites;

- the collection of data for the four sites according to the criteria and indicators identified;

- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to land use considerations; and

- the comparison of the sites' advantages and disadvantages to identify, from a land use perspective, the most preferred/least preferred site(s), if any.

1.2 Report Organization

The remaining sections of this report consist of the following:

- Section 2, Study Approach;
- Section 3, Existing and Future Conditions;
- Section 4, Comparison of Sites; and
- Section 5, Summary.

2.0 STUDY APPROACH

2.1 Methodology

This impact assessment was conducted in two phases:

Phase 1 - Existing Conditions

This phase involved an extensive analysis of the Study Area's[1] existing land use patterns and future development potential. Information sources included:

- Field surveys of existing land uses.
- Property ownerships from the Townships of Moore and Sombra Assessment Maps and Roll.
- Municipal planning documents including: the County of Lambton, the Township of Moore, the Township of Sombra Official Plans and the Townships' Zoning By-laws, and other local planning documents, such as the St. Clair Parkway Master Plan.
- Provincial Policy Statements and other relevant provincial policies and guidelines.
- Discussions with staff of the Lambton County Planning and Development Department, Townships of Moore and Sombra, the Sarnia-Lambton Economic Development Commission and the St. Clair Parkway Commission.

Phase 2 - Impact Evaluation and Management and Identification of Preferred Site

Phase 2 involved the following:

- Preparation of evaluation criteria and indicators to evaluate the impacts of Sites D, K, H and I on existing, potential and future land uses. These are discussed further in Section 2.4 of this assessment.

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[1] The Study Area for the assessment is described in Section 2.2a).

- The identification and evaluation of impacts, possible measures to mitigate these impacts and the resulting net impacts of the four sites.

- A comparative evaluation of the net impacts of the four sites.

- The identification of the advantages and disadvantages of the four sites, based on the comparative evaluation.

- The identification of a preferred site, from a land use perspective.

2.2 Study Parameters

a) Study Area

The Study Area for the assessment consisted of a larger Study Area and smaller Study Areas. The larger Study Area included the southwestern portion of Moore Township and the northwestern portion of Sombra Township. The major considerations in the larger Study Area were the existing urban structure of Moore and Sombra Townships, generalized land use patterns and the expected future urban structure of the two Townships. The smaller Study Areas consisted of the lands within 1 km of the four sites. The major considerations in these smaller areas were more detailed matters such as existing land uses, property ownerships, designations and development proposals.

The rationale for the larger Study Area is based on the Ontario Ministry of Environment and Energy's (MOEE) *Proposed Municipal Landfill Regulations*. This document states that land uses within 3 km of alternative landfill sites, particularly sensitive agricultural, recreational, institutional and residential lands, should be considered when dealing with land use compatibility. The 1 km smaller Study Areas are consistent with MOEE's *Land Use on or Near Landfills and Dumps* (November 18, 1987), from the MOEE Policy Manual. Section 5.3 of the policy states that "MOEE considers the most significant adverse environmental effects to be normally within 500 m of the perimeter of a fill area". To account for all of the adverse impacts, this 500 m area has been increased to 1 km around the entire site. To evaluate the impacts of truck traffic, the 1 km Study Areas for each site were extended along the haul routes to Highway 40.

b) Time Frame

The waste management facility is designed to serve the County's long-term waste management needs for a 20 year period, until the year 2016. The land use impact assessment is also based on a 20 year time frame.

2.3 Assumptions

The evaluations of the four sites are based on the conceptual site layouts and the facility characteristics included in Volume 4, Appendix 4C, "Design and Operations Assessment", to Chapter 9 of the Master Plan.

The conceptual site layouts show the main features of the sites including the landfill, the materials recovery facility (MRF) and the composting facility. Also shown are the access routes to the sites and related ancillary uses such as a storm water management pond, stockpile area, equipment compound and maintenance building, leachate treatment facility and weigh scales. The main features of the sites are:

- Each site is 75 hectares (ha), approximately.
- The average annual tonnage to each site will be approximately 100,000 tonnes (50,000 tonnes with diversion).
- The capacity of Site H without diversion is 21 years (42 years with diversion). The capacity of Sites I and D is 19 years (38 years with diversion), while the capacity of Site K is 14 years (28 years with diversion).
- The distance from the landfilled area to the closest property boundary is 100 m.
- The maximum height above grade will be 17 m.
- The buildings will have the following dimensions:
    - MRF building: 75 m W x 100 m L x 9 m H;
    - composting building: 75 m W x 110 m L x 9 m H; and
    - curing building: 60 m W x 70 m L x 9 m H.

2.4 Data Collection

Table 2.1 presents the criteria and indicators developed for the land use assessment. Rationales and data sources for the criteria are also presented.

TABLE 2.1
RATIONALE AND DATA SOURCES FOR CRITERIA AND INDICATORS FOR LAND USE IMPACT ASSESSMENT

Criteria	Indicators	Rationale	Data Sources
1. Impacts on Urban Structure	• Potential Changes to Existing Urban Structure	• The facility should not significantly change the existing urban structure of a municipality and: · be generally compatible with and a continuation of the existing land use pattern. · not result in "pockets" of land uses which are isolated from similar types of land uses. • Significant changes could result in: · short-term adverse impacts on adjacent lands which are not compatible with the facility. · long-term adverse impacts in cases where the future land uses of adjoining lands are not compatible with the facility. · unnecessary and costly extensions of urban services and road improvements.	• Land use mapping and field surveys of generalized existing land use. • Information regarding services and roads from the affected municipalities.
2. Conformity to Lambton County Official Plan	• Conformity to "Economic Anchor" Designations	• The County Plan is not a detailed land use plan but a "long range management plan which outlines County policy on a number of broad settlement and resource management issues". It should be given regard to in landfill siting.	• Lambton County Official Plan and background studies.
3. Conformity to Township Official Plan	• Conformity to Structure Plan Designations • Consistency with Intent of On-site Land Use Designations	• All development and public facilities should: · generally conform to the future urban structure as identified in a local municipal Official Plan. · generally conform to the major policy directions of the Plan. · be basically consistent with the intent of the on-site land use designation and not constitute a significant departure from the designation.	• Township of Moore Official Plan and background study and discussions with staff of Moore Township and the Lambton County Planning and Development Department.
4. Compatibility with Official Plan Land Use Designations in Surrounding 1 km Area	• Compatibility with Township Official Plan Land Use Designations	• To avoid adverse impacts over the short and long-term, the facility should be basically compatible with the uses allowed by the Official Plan on the surrounding lands.	• Townships of Moore and Sombra Official Plans and discussions with staff of Moore and Sombra Townships and the Lambton County Planning and Development Department.

TABLE 2.1
RATIONALE AND DATA SOURCES FOR CRITERIA AND INDICATORS FOR LAND USE IMPACT ASSESSMENT
(Continued)

Criteria	Indicators	Rationale	Data Sources
5. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	• Loss of Existing On-Site Land Uses • Number of Property Owners Affected • Existing Uses within 1,000 m	• The facility should: · be located on vacant land and not displace any existing land uses. · affect a minimum of property owners. · be compatible with the surrounding existing land uses.	• Field surveys of existing land use, property ownerships, discussions with site owners regarding their plans for the property, and discussions with municipal and County staff.
6. Compatibility with Proposed Land Uses On-Site and in Surrounding 1 km Area	• Loss of On-Site Proposed Uses • Impacts on Proposed Uses in Surrounding Area	• The facility should: · not interfere with the owner's proposed plans for the property. · be compatible with any uses which are proposed for lands in the surrounding area.	• Development applications and discussions with municipal and County staff.
7. Potential Impacts on Development Potential of Property Occupied by the Site	• Loss of On-Site Development Opportunities • Impact of Loss of Property on Development Potential of Remaining Property • Impacts of Loss of On-Site Development Opportunities on Municipal Supply of Land	• This evaluation criteria relates to the development potential of the property occupied by the site according to the Official Plan and Zoning By-law. • The facility should not adversely affect the development potential of the property which remains after the facility is developed. For example, the remaining property should not be landlocked, have inadequate frontage or lot depth or be too small to accommodate the potential development. • Also, the loss of developable land should not adversely affect the municipality's supply of land for the particular use.	• Property ownerships, the Moore Township Official Plan and Zoning By-law, supply of industrial land data from the Sarnia-Lambton Economic Development Commission and the Lambton County Planning and Development Department and discussions with property owners.

TABLE 2.1
RATIONALE AND DATA SOURCES FOR CRITERIA AND INDICATORS FOR LAND USE IMPACT ASSESSMENT
(Continued)

Criteria	Indicators	Rationale	Data Sources
8. Potential Impacts on Development Opportunities in Surrounding 1 km Area	• Impact on Residential Development Opportunities • Impact on Farm-related Commercial and Industrial Development Opportunities • Impact on Industrial Development Opportunities	• In addition to being compatible with existing uses, the facility should also be compatible with uses which could potentially be developed in the surrounding area as permitted by the existing Official Plan and Zoning By-law. • The identification of potential land uses also helps to determine the changes that should be made to local planning documents to help make the surrounding area more compatible with the facility and to prevent future adverse impacts. Ideally, very few changes should be necessary. If many changes are necessary, this would tend to show that the facility is generally incompatible with the surrounding area. • The impacts of the facility could discourage some types of uses and encourage others. For example, residential uses would be greatly discouraged, while moderate and heavy industrial uses may be attracted to the lands around the facility.	• Field surveys of existing land uses, property ownerships including size and frontages, Townships of Moore and Sombra Official Plans and Zoning By-laws and discussions with municipal and County staff.
9. Impacts on Future (Year 2016) Urban Structure	• Potential Changes to Future Urban Structure	• Since the facility has a long-term site life, it is important to determine the most likely future land uses in the surrounding area. This helps to identify: · the ability of the site to fit into the future urban structure. · any discrepancies which may exist between future land uses, as designated in the Official Plan, and what is most likely to occur. This is especially relevant to Moore Township where the Official Plan includes large tracts of land designated for industrial development. Not all of these lands may be developed for industrial uses in the long-term. The resulting situation may be that the facility, although located in an area designated for industrial development, could be located in an area which remains predominantly agricultural, even over the long-term.	• Information on past and current development activity from the Sarnia-Lambton Economic Development Commission, the Townships and the Lambton County Planning and Development Department, the municipal Official Plans and discussions with Township and County staff.

3.0 EXISTING AND FUTURE CONDITIONS

3.1 Location and Setting

The Township of Moore is located on the St. Clair River, between the City of Sarnia and the Township of Sombra. Its 1991 census population was 10,664, or 8.3% of the County's population of 128,943. According to projections prepared by Dillon for the Waste Management Master Plan, the population of Moore is expected to grow at a moderate rate of 1% per year, resulting in a near 2016 population of 13,677. This projection is slightly lower than that included in the 1986 "Background Research Report" to the Township of Moore Official Plan which projected a year 2011 population of between 12,000 and 15,000.

Sites D, K, H, and I are located in the Township of Moore on the following lands:

- Site D - Part of Lots 22 and 23, Concession 5, on Highway 80, east of Highway 40;
- Site K - Part of Lots 20 and 21, Concession 5, on Moore Sideroad 21-22, north of Highway 80. Site K includes the existing Moore Township Landfill Site;
- Site H - Part of Lots 1, 2, 3 and 4, Front Concession, on the Moore-Sombra Townline Road, west of Highway 40;
- Site I - Part of Lots 26 and 27, Concession 1, also on the Moore-Sombra Townline Road, west of Highway 40.

The Township of Moore consists of three distinct areas. These areas and the location of the four sites are described as follows:

Riverfront Communities

The residential communities of Corunna, Mooretown and Courtright are located on the St. Clair Parkway (County Road 33), along the shore of the St. Clair River. The lands along the Parkway also include riverside parks owned and operated by the St. Clair Parkway Commission.

Chemical Valley

The communities along the river are surrounded by an industrial area which forms part of the Chemical Valley. The Chemical Valley is located along Highway 40 in the City of Sarnia and the Townships of Moore and Sombra and consists of large-scale, heavy industries, most of which are related to the petrochemical industry. This area originated with the discovery of oil in Oil Springs in 1857 and, since the Second World War, has become one of Canada's major petrochemical centres. Moore's first petrochemical industry was the Canadian Oil Refinery which relocated to the riverfront from Petrolia in the early 1950's.

Changes in the nature of development in the Chemical Valley, over the last 20 years, are described in the Township of Moore Official Plan as follows:

> "In the 1970's, several "world scale" petrochemical plants were proposed and built in the Township. ... However, in the early 1980's, the petrochemical industry commenced a period of consolidation and restructuring, and the likelihood of the development of an additional five or six large-scale plants went from the proposal stage to a distant dream." (Section 3.2.1)

The major petrochemical industries in Moore are Novacor Chemicals Ltd., which employs over 1,000 people, Ethyl Canada Inc., DuPont Canada Inc. and Shell Canada Products Inc. Terra Lambton Works, which manufactures nitrogen products, is located in Sombra on the Moore-Sombra Townline Road. Sites H and I are located on the north side of the Townline Road, across from Terra.

According to an estimate provided by the Lambton County Planning and Development Department, there is approximately 5,665 ha of land designated for industrial development in the Moore Township Official Plan. Of this total, 2,193 ha is vacant and available for industrial development, according to the current (undated) "Industrial Overview" prepared by the Sarnia-Lambton Economic Development Commission. Only a small portion of the vacant lands is serviced (101 ha), while the remainder (2,092 ha) is not serviced. Based on these figures, Moore Township includes about 3,472 ha of developed industrial land.

The developed part of Moore's portion of the Chemical Valley is located in the northwest portion of the Township, generally west of Moore Road 6 and Sideroad 21-22. The vacant lands have, for the most part, been purchased by the area's major industrial corporations for future use and are rented for farmland. Site D is located in this area. However, as stated in Section 3.2.1 of the Township's Official Plan, the likelihood of these lands developing into "world scale" petrochemical plants has become remote and it is more probable that this area will be developed with "smaller industries using or supplying existing industry with feedstock and other supplies and services".

According to the Lambton County Planning and Development Department, only a "minimal amount" of land has been developed with industrial uses in Moore over the last ten years. In the last five years, approximately 10 ha of land, in the Moore Township Industrial Park, have been developed.

Agricultural Area

The remainder of the Township is agricultural. Section 3.1 of the Township Official Plan describes this area as follows:

> "The balance of the Township, lying to the east of Highway 40, may be regarded as a separate community that in many ways represents a traditional agricultural township, centred on the community of Brigden."

Site K is located in the agricultural portion of the Township on the eastern boundary of Chemical Valley.

3.2 Provincial Policy Statements and Guidelines

a) Ontario Foodland Guidelines

The Ontario Foodland Guidelines (1978) is a statement of the Ontario Government on planning for agriculture. The guidelines define "high priority farmland" as lands which are not designated for urban use in an approved Official Plan, where soil Classes 1, 2, 3 and 4 predominate. Since Sites D, H and I are designated for industrial uses in the Township of Moore Official Plan, the Ontario Foodland Guidelines do not apply to these sites.

Approximately three-quarters of Site K is designated "Waste Disposal Area" in the Township's Official Plan, while the remainder is designated "Agricultural". According to the Canada Land Inventory of Soil Capability for Agriculture, the portion of Site K which is designated "Agricultural" consists of Class 3 Soils. As a result, the Foodland Guidelines apply to this part of Site K.

Section 3.13 of the Guidelines state that the use of high priority farmland for agricultural uses must be given priority over alternative uses. If the land is to be used for another purpose, the requirement must be justified and documented. According to Section 3.14 of the Guidelines, this "justification documentation" must cover "four basic issues" including: the necessity for the proposed non-agricultural land use; the amount of land needed and the availability of other lands; reasons for the choice of location; and the consideration which was given to alternate locations.

These matters are addressed in Volume 1 of the Waste Management Master Plan. If Site K is selected as the preferred site, the "justification documentation" would be submitted along with the required Official Plan Amendment Application.

The impacts of Sites D, K, H and I on agriculture are evaluated in the "Agriculture Impact Assessment" included in Volume 4, Appendix 4A of the Master Plan Report.

b) Provincial Policy Statement on Wetlands

The Provincial Policy Statement on Wetlands was approved by the Ontario Government, under the *Planning Act*, in 1992. The goal of the Statement is to ensure that wetlands are identified and adequately protected through the land use planning process and to achieve no loss of provincially significant wetlands. According to the "Biology Impact Assessment" included in Volume 4, Appendix 4C of the Master Plan, none of the sites are located on provincially significant wetlands.

c) Growth and Settlement Policy Guidelines

The "Growth and Settlement Policy Guidelines" were issued in September 1992. The goal of the Guidelines is "to foster land use planning practices and policies which result in efficient, economically viable, sustainable and environmentally sound growth and settlement patterns" (page 3).

Section 8 of the Guidelines requires that sensitive land uses (such as residences, schools, hospitals) be adequately separated from major facilities, including waste management facilities, "to prevent the adverse effects of associated emissions such as noise, odour and other contaminants". The impacts of the four sites on sensitive land uses are addressed in Section 4 of this impact assessment.

3.3 St. Clair Parkway Commission Master Plan

The St. Clair Parkway Commission was created by special legislation in 1966. It is funded by the Province, the Counties of Lambton and Kent and the Cities of Sarnia and Chatham. The Commission has developed and is responsible for a network of parks and recreational facilities, located along the St. Clair Parkway from Sarnia to Chatham. It currently owns and manages 22 facilities, including the Sarnia Bay Marina, the Parkway Golf Course in Mooretown and the Mitchell Bay Marine Park.

The St. Clair Parkway Master Plan covers the Commission's existing and proposed facilities. Sites D, K, H and I have no impacts on these facilities. Of the four sites, Site H is located the closest to some of the Commission's existing facilities, including Seagar Park, about 1.5 km north of Site H, and Cathcart Park, about 2 km south of the site. Seagar Park offers picnicking, swimming and fishing. Cathcart Park is a 10 ha campground.

3.4 Lambton County Official Plan

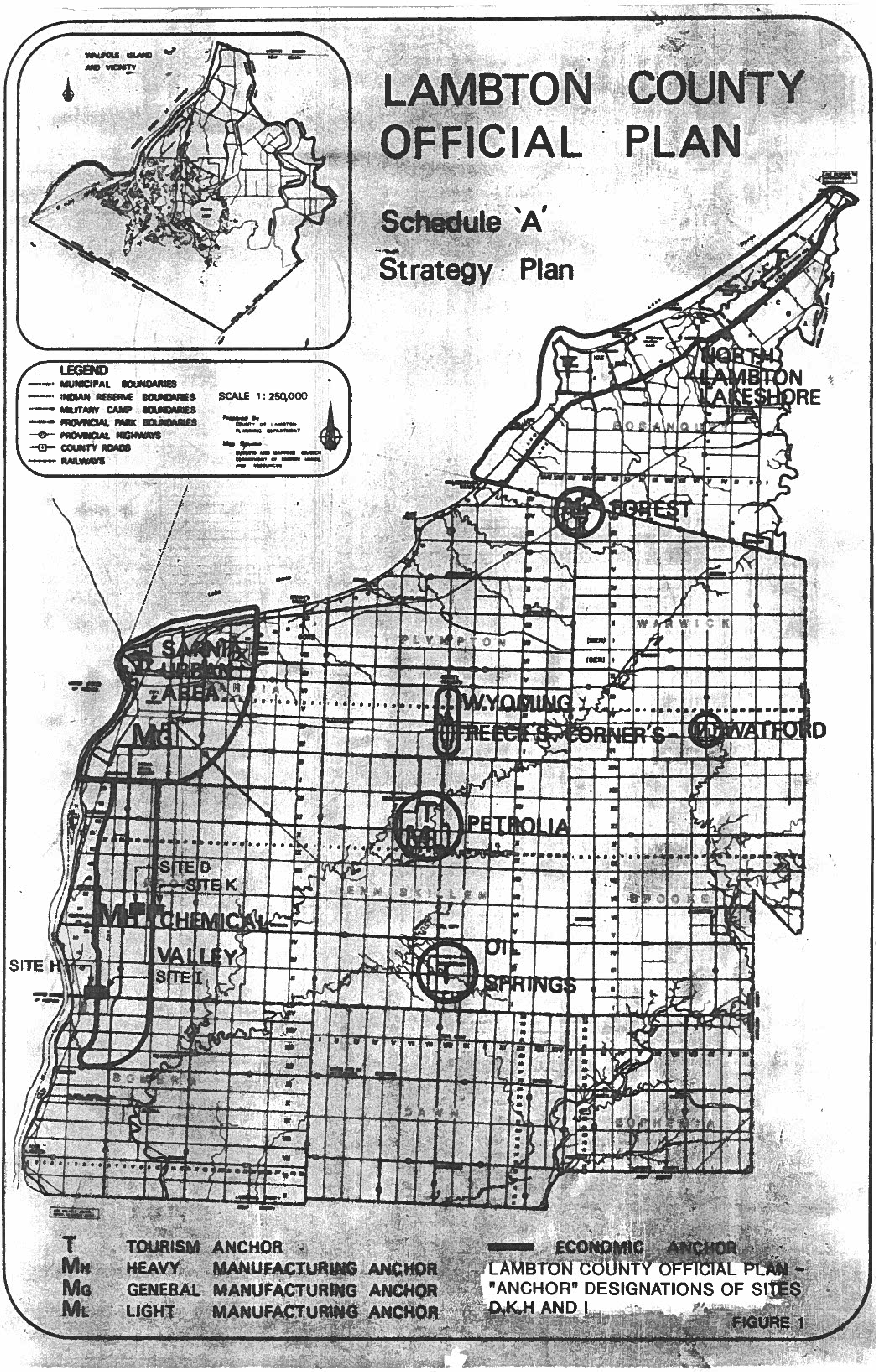
The County Plan was approved by the Province on September 2, 1982. The Plan is not a detailed land use plan, but a "long range management plan which outlines County policy on a number of broad settlement and resource management issues" (Part B, Section 1).

a) Strategy Plan

Schedule "A" to the County Plan, "Strategy Plan", is shown on Figure 1. It designates "anchors" for various economic activities, including tourism and heavy, general and light manufacturing. Part E, Section 12 of the County Plan states that "in anchor areas, as a general principle, proposed and existing anchor uses and activities should be given priority over other land uses".

Sites D and I and approximately half of Site K are located in the area shown as "Chemical Valley - Heavy Manufacturing Anchor" on Schedule "A". Part D, Section 2.6.1 of the County Plan describes the Chemical Valley as follows:

> "... petroleum related industries are concentrated in the Sarnia Urban Area primarily in the Chemical Valley. This concentration has resulted from the discovery of oil locally in the 19th century and the transportation advantages of the Sarnia area. Petroleum chemical and chemical firms located in the area because of the availability of petroleum from local refineries, natural storage in salt caverns and the transportation advantages."



LAMBTON COUNTY OFFICIAL PLAN - "ANCHOR" DESIGNATIONS OF SITES D,K,H AND I

FIGURE 1

Part D, Section 2.6.4 of the Plan includes policies which apply to manufacturing. The following policies are relevant:

- "The County recognizes manufacturing as an industrial sector with a strong potential for future growth." (Subsection a)).
- "The defined anchors represent those areas which the County views as having the greatest potential to attract manufacturing firms for various reasons." (Subsection b)).

Site H and the eastern half of Site K are located outside of the "Chemical Valley - Heavy Manufacturing Anchor" on the western and eastern boundaries of the area, respectively. Part E, Section 12 of the County Plan states that "as a general principle, the highest priority land use shall be agriculture in those parts of the County which are not within urban settlement areas or defined anchor areas". The County Plan does not, however, prohibit industrial or similar development on Site H or the eastern part of Site K. Part E, Section 12 of the Plan states that "the location and nature of specific anchor uses shall be defined" in the local Official Plans.

b) Landfill Policies

Part D, Section 2.12 of the County Plan includes policies which apply to landfill sites. The following policies are relevant:

- Section 2.12.3 a) includes a list of matters which should be considered "in evaluating potential landfill sites". These are:
    - "the compatibility of the landfill operation with adjacent land uses and the potential for conflict";
    - "the nature of bedrock and soil conditions and the likelihood of ground water contamination";
    - "the opportunity and necessity for future expansion";
    - "site access".

- Section 2.12.3 b) states that "the local municipalities should not preclude landfill sites from being located in areas where they are most suitable from an environmental and a land use perspective." Volume 1 of the Waste Management Master Plan summarizes the site selection process and the short-listing of Sites D, K, H and I.

- Section 2.12.3 d) "encourages local municipalities to examine the potential for establishing joint municipal operations for the disposal of domestic solid wastes. The County and/or local municipalities may wish at some future time to undertake a detailed study into the benefits and costs of joint municipal landfill operations." The co-operative approach envisioned by the County Plan was realized on January 1, 1991, when the restructured County of Lambton assumed waste management responsibilities. The Waste Management Master Plan includes detailed strategies for the implementation of these responsibilities.

- Section 2.12.3 f) endorses "the principles of recycling". This matter is dealt with in the "Waste Collection and Diversion" section of the Master Plan.

3.5 Township of Moore Official Plan

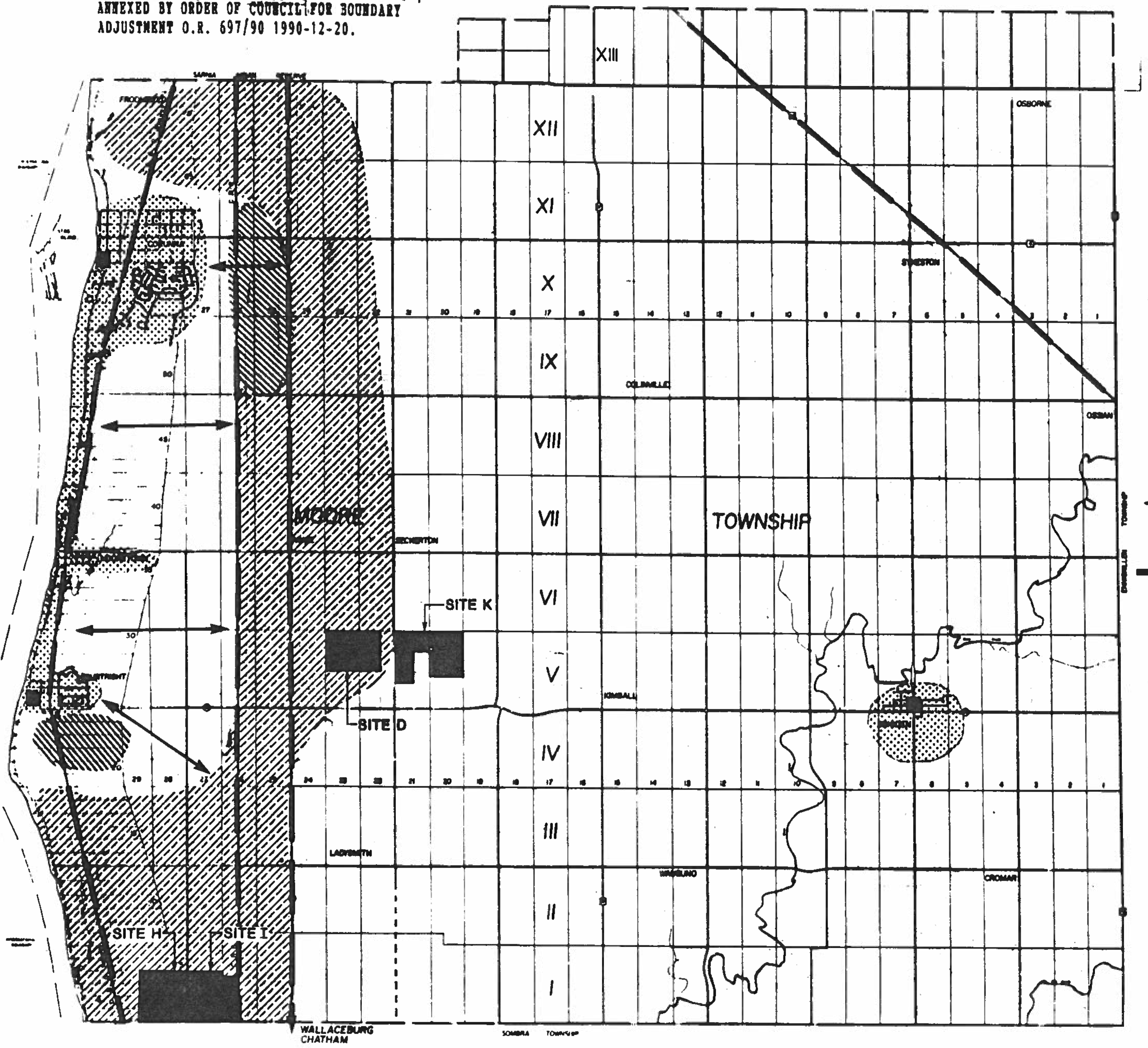
a) Structure Plan

The Township's Official Plan was approved by the Province on May 1, 1990. The land use designations and policies of the Plan are based on a "Structure Plan" which is shown on Figure 2. Sites D, H and I are part of the "Major Industrial" area shown on the Structure Plan. Site K is located on the eastern boundary of the "Major Industrial" area in the rural portion of the Township.

b) On-Site Land Use Designations and Policies

The Township's Land Use Plan (Schedule "D-1") and the location of the four sites is shown on Figure 3.

CONCESSION 13, LANDS AFFECTED BY O.P.A. #1,
ANNEXED BY ORDER OF COUNCIL FOR BOUNDARY
ADJUSTMENT O.R. 697/90 1990-12-20.



OFFICIAL PLAN

OF THE

MOORE PLANNING AREA

SCHEDULE 'A'

STRUCTURE PLAN

LEGEND

- ░ URBAN - SETTLEMENT AREA
- ▨ MAJOR INDUSTRIAL
- ■ COMMERCIAL CENTRE
- ↔ BUFFER - RESIDENTIAL TO HEAVY INDUSTRY
- ▧ LIGHT INDUSTRY
- ━ • MAJOR TRANSPORTATION

COUNTY OF LAMBTON
PLANNING DEPARTMENT

SCALE 1:50,000

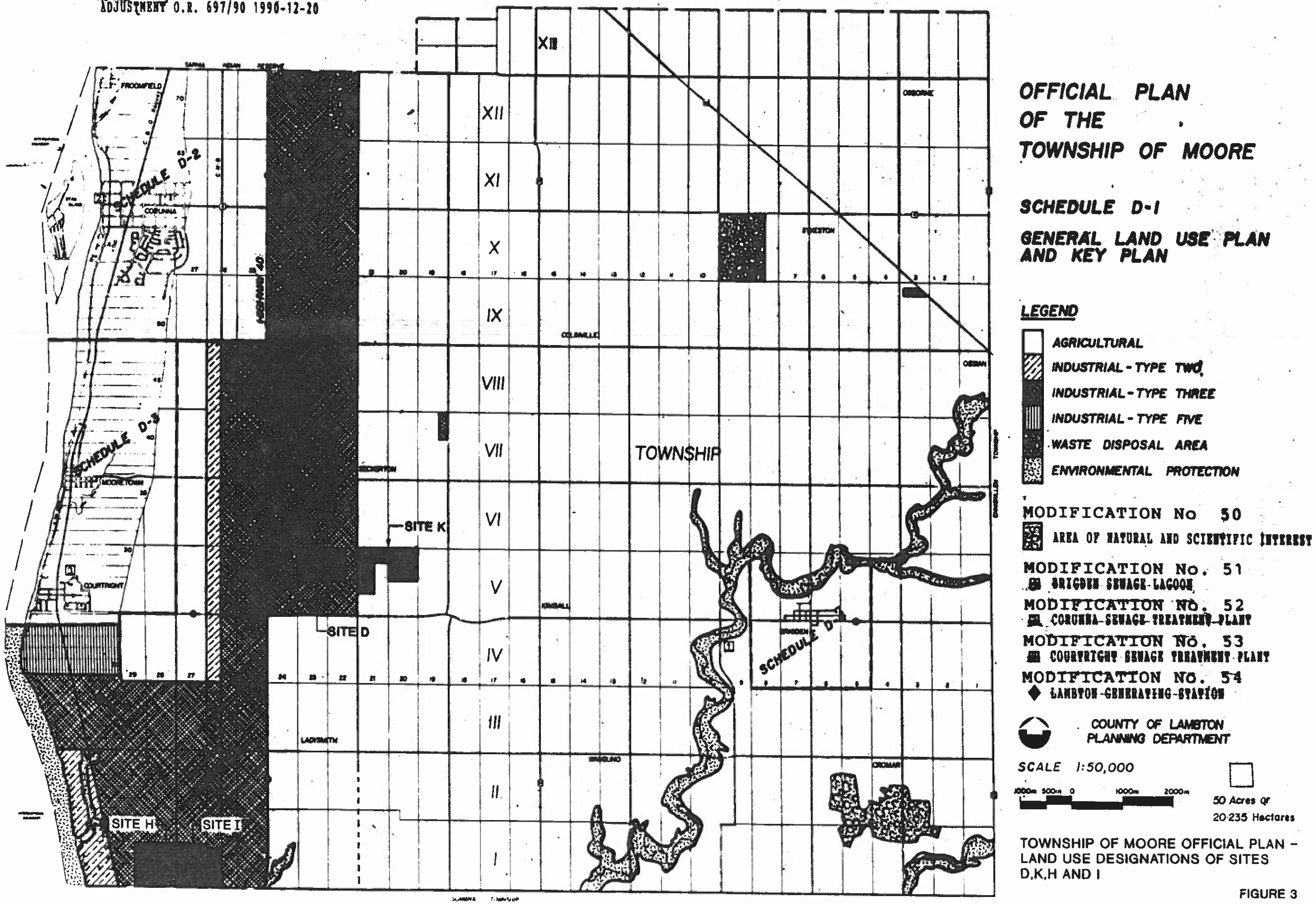
1000m 500m 0 1000m 2000m

☐ 50 Acres or 20.235 Hectares

TOWNSHIP OF MOORE OFFICIAL PLAN
"STRUCTURE PLAN" DESIGNATIONS OF
SITES D,K,H AND I

FIGURE 2

CONCESSION 13, LANDS AFFECTED BY O.P.A.
ANNEXED BY ORDER OF COUNCIL FOR BOUNDARY
ADJUSTMENT O.R. 697/90 1990-12-20



TOWNSHIP OF MOORE OFFICIAL PLAN – LAND USE DESIGNATIONS OF SITES D,K,H AND I

FIGURE 3

i) Sites D, H and I

These three sites are designated "Industrial - Type 3". This is the heaviest industrial land use designation of the five industrial designations included in the Township's Official Plan and is intended "to accommodate large scale or heavy industries". The Plan describes these industries as "high impact uses, inherently incompatible with residential uses (with) the potential ... (for) harmful environmental impacts" (Section 9.7.1). Permitted uses include "Industrial Type 1" uses (light industries) and Type 2 uses (moderate scale industries) and "petrochemical refining, chemical refining, metal stamping, metal plating or finishing, metal coating or moulding, tank farms, scrap yards and any other use in which volatile materials are required". Agricultural uses, including farm related dwellings, are also allowed in the area designated "Industrial - Type 3" (Section 9.7.2).

Other relevant policies include the following:

- berming may be required to reduce noise, visual and other impacts (Section 9.7.4);
- the Plan includes "environmental protection measures". "Storm run-off containment and treatment systems" may be required to "ensure that surface water or ground water running off the site is not contaminated". (Section 9.7.5);
- Section 9.7.6 states that "the Township considers Type 3 uses to be incompatible with residential uses", and for this reason, "no new Type 3 industrial development shall be permitted within 1.6 km of a residential designation".

ii) Site K

The Township's Official Plan includes a "Waste Disposal Area" land use designation which applies to existing facilities, such as the Moore Township Landfill Site, the Tricil and Unitech disposal facilities and facilities which serve Dow Canada, Ontario Hydro and Shell Canada. According to Section 9.10.1 of the Plan, "the processing and disposal of waste is considered (to be) an industrial use".

Approximately three-quarters of Site K (the existing Moore Township Landfill Site) is designated "Waste Disposal Area". The remainder of Site K (about 17 hectares on Sideroad 21-22) is designated "Agricultural".

The following policies apply to areas designated "Waste Disposal Area":

- All sites are subject to site plan control pursuant to Section 41 of the *Planning Act* (Section 9.10.3).
- Landscaping is required around the perimeter of all sites, "to reduce any undesirable impacts". Berming is required around that portion of the site used for waste treatment or disposal (Section 9.10.4).
- "Road Access and Improvements" policies (Section 9.10.5) include the following:
  - all sites shall be located on roads capable of safely handling the vehicular traffic generated;
  - waste shall not be transported through residential or commercial areas;
  - as a condition to approval, the Township may require new service roads or the upgrading of existing roads.
- Fencing is required around all sites, to prevent public access or trespass (Section 9.10.6).
- All sites shall have "surface water containment systems to prevent any discharge of untreated or contaminated water from running off the site" (Section 9.10.7).

As mentioned, about 17 hectares of Site K are designated "Agricultural" on Schedule "D-1" to the Township's Official Plan. According to Section 5.1 of the Plan, the objectives of the "Agricultural" policies are "to identify and protect the land base for long-term agricultural use, allow compatible and appropriate land uses in the rural areas, and to restrict incompatible or inappropriate land uses from the agricultural areas and direct them to more appropriate designations". Farming uses, including all types of agriculture and farm dwellings, is the predominant land use permitted in the "Agricultural" area. Other relevant policies are:

- Other uses permitted in the "Agricultural" area include farm-related industrial uses, such as grain dryers, feed mills, etc., farm-related commercial uses, including trucking and drilling services and farm machinery repairs, "buildings or structures required (for) pumping equipment and storage facilities for pumped material" and the extraction of aggregate resources (Sections 5.2 a) to h)).

- Farm-related severances, to create a new farm, are allowed, provided that the severed and retained parcels are a minimum of 40 hectares each (Section 5.6 b)). Also allowed, are severances to create lots for farm-related dwellings provided that the retained lot is at least 40 hectares, the severed lot is a maximum of 0.4 hectares and the dwelling is intended for a retiring farmer or a member of the farmer's immediate family, who is also a farmer. Another type of severance which is allowed is the severance of surplus farm dwellings.

- Section 5.2 e) of the Township's Plan allows non-farm related dwellings on existing lots of record or on lots created by consent for land severance. New uses of this type are discouraged and Section 5.6 of the Plan, "Severance Policies", does not specifically provide for severances of this type.

- Section 5.6 d) of the Plan allows severances for the permitted farm-related commercial and industrial uses. The parcel to be severed must be at least 20 hectares, located on the poorest soils and located on a road that can accommodate the traffic generated by the use.

- Only one severance is allowed per conveyable farm holding (as it existed on December 8, 1987).

- Section 5.4 of the Plan reinforces the "right to farm" concept.

c) Roads Policies

Schedule "B" to the Township of Moore Official Plan is a "Roads Plan" which establishes a hierarchy of roads. The main access routes to Sites D, K, H and I and the Official Plan policies which apply to these roads are summarized as follows:

- Access to Site D would be provided by Highway 40, Highway 80 and a new access road from Highway 80 to the site. Highways 40 and 80 are designated as "Provincial Highways" on Schedule "B". According to

Section 4.2.2 a) of the Official Plan, one of the main functions of Highway 40 is to serve industrial uses in the Chemical Valley. Highway 80 is described as "a minor highway" which "provides access to adjoining properties, primarily rural".

- Access to Site K would be provided by Highways 40 and 80 and by Sideroad 21-22 which is designated as a "Local Road" on Schedule "B". Section 4.2.4 d) of the Plan states that "local roads are primarily intended to provide access to abutting properties".
- The access route to Sites H and I would be Highway 40 and the Moore-Sombra Townline Road. The Townline Road is a "Collector Road", the purpose of which is "to connect local roads to arterial roads and to provide access to abutting properties. These roads carry low to moderate traffic volumes" (Section 4.2.4 c)).

3.6 Surrounding Official Plan Land Use Designations and Policies

The Township of Moore Official Plan applies to the lands surrounding Sites D, K and some of the lands around Sites H and I. The Township of Sombra Official Plan applies to the remaining lands around Sites H and I.

The Official Plan for the Township of Sombra Mainland Planning Area was approved by the Province on September 8, 1975. Figures 4 and 5 show the land use schedules (Schedules "A-1" and "A-2") to the Plan. The Township has requested the County of Lambton Planning and Development Department to prepare a new Official Plan for the Township. The background report to the new Plan will be completed by the Fall of 1993.

a) Site D

As shown on Figure 6, approximately two-thirds of the 1 km area surrounding Site D is designated "Industrial - Type 3" (the heavy industrial designation) on Schedule "D-1" to the Township of Moore Official Plan. The remaining one-third is designated "Agricultural", south of Highway 80 and east of Sideroad 21-22, and "Waste Disposal Area". This designation applies to the Moore Township Landfill Site (Site K).

SCHEDULE A-1
LAND USE PLAN
TOWNSHIP OF SOMBRA

The Official Plan of the Sombra Mainland Planning Area

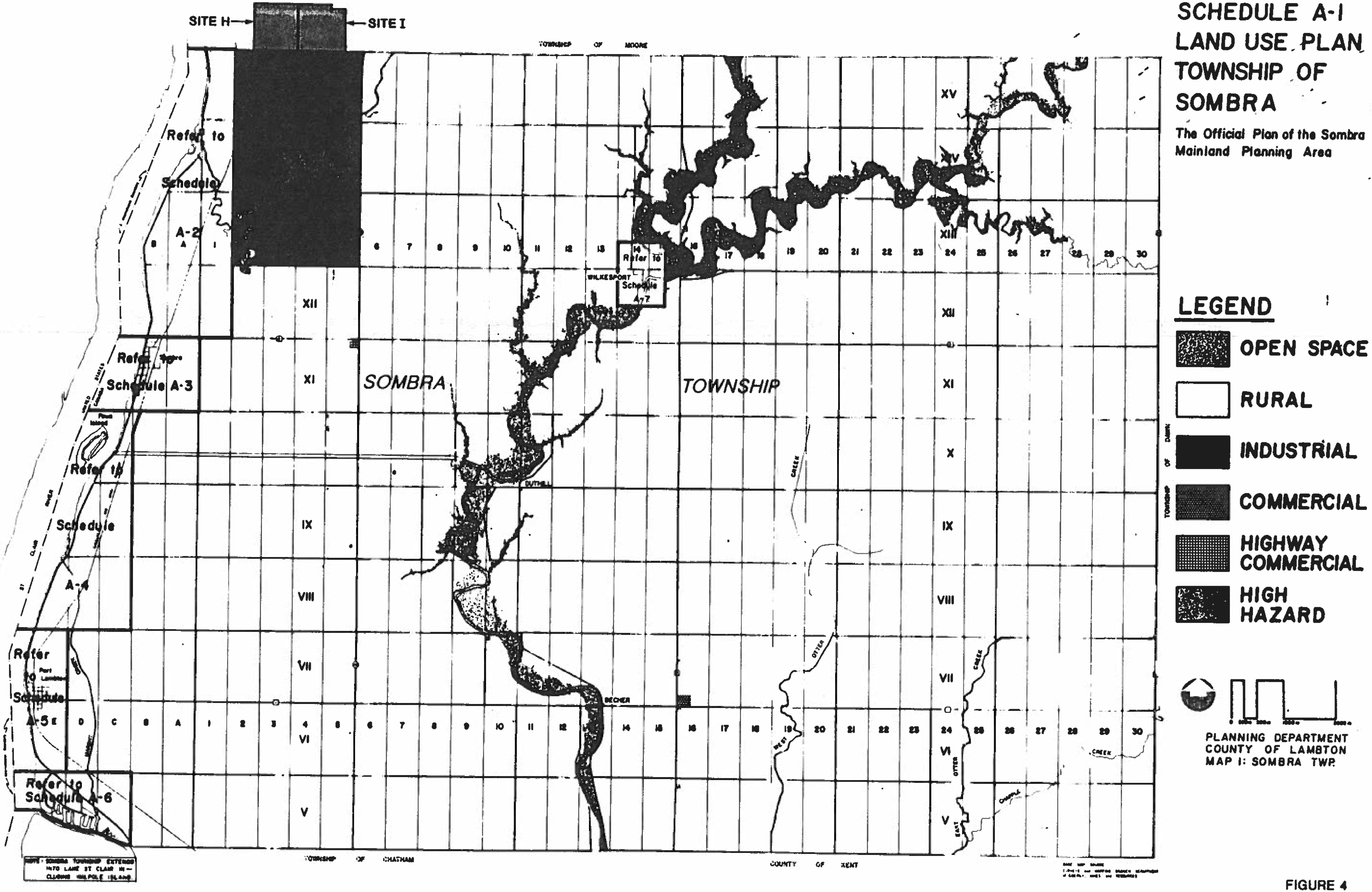


FIGURE 4

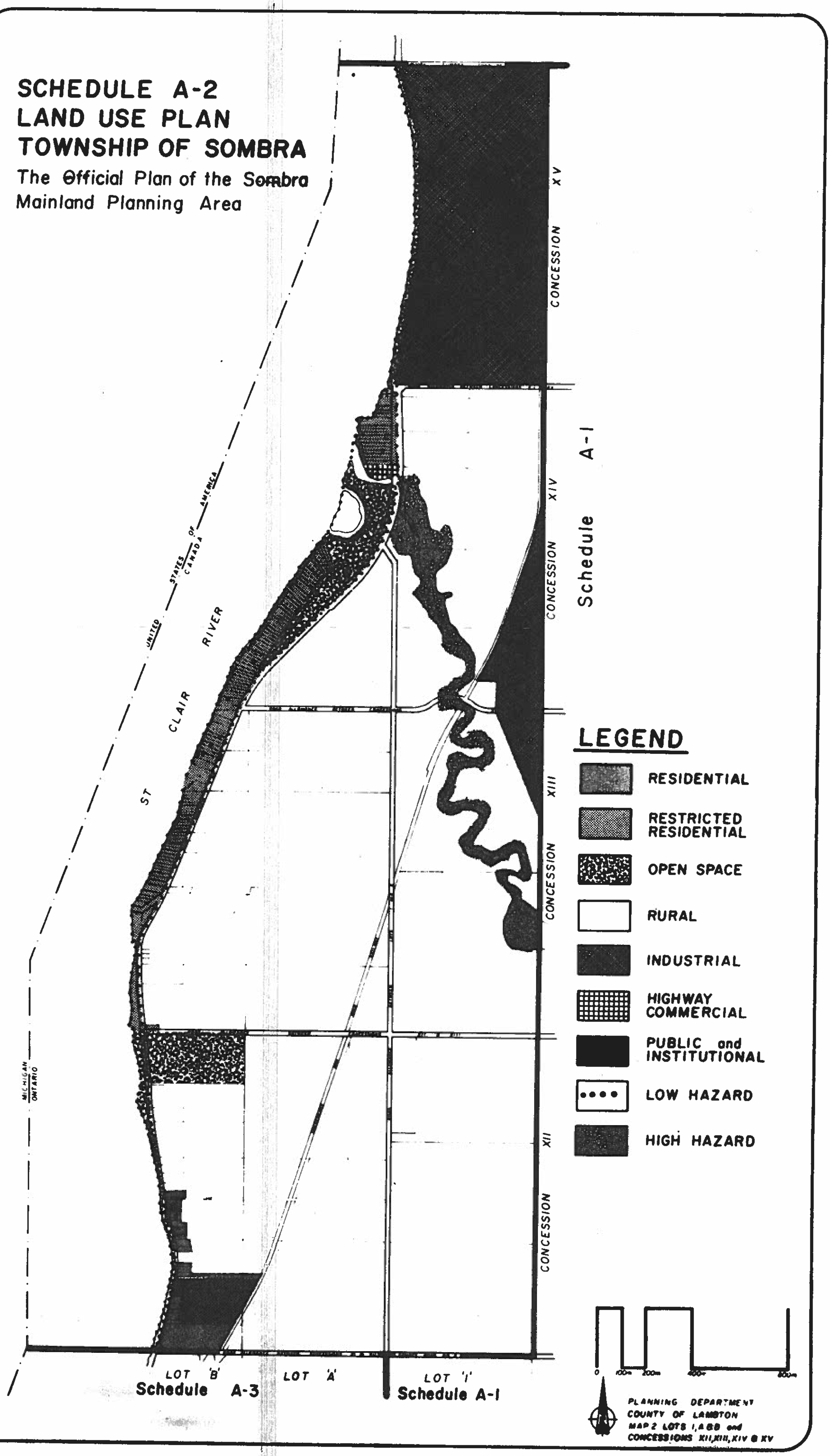
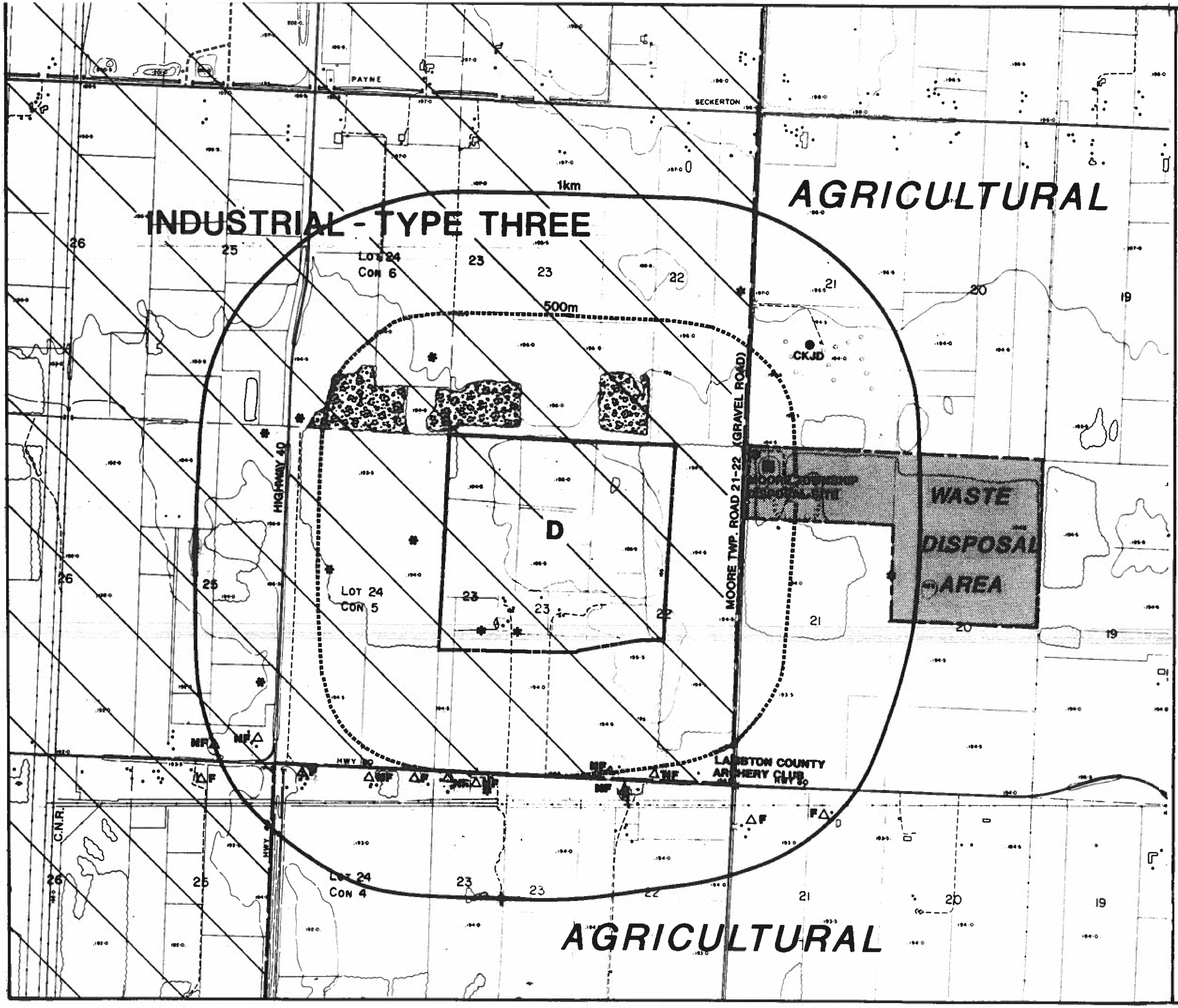


FIGURE 5

SCHEDULE A-2
LAND USE PLAN
TOWNSHIP OF SOMBRA

The Official Plan of the Sombra Mainland Planning Area



LEGEND

- △ RESIDENCE(F-FARM,NF-NON-FARM)
- ▲ INDICATES ABANDONED LAND USE
- ▲ COMMERCIAL
- ■ INDUSTRIAL
- ◆ INSTITUTIONAL
- ● RADIO ANTENNA
- ☐ AGRICULTURAL
- ▨ HIGH QUALITY FOREST
- ✱ WELLS

DILLON
Consulting Engineers • Planners
Environmental Scientists

100 0 500 1km
Scale 1:15,000

OFFICIAL PLAN LAND USE DESIGNATIONS SURROUNDING SITE D

SOURCE: TOWNSHIP OF MOORE
OFFICIAL PLAN

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928

FIGURE No. 6

b) Site K

About two-thirds of the 1 km area around Site K is designated "Agricultural" (see Figure 7). The remainder, northwest of Highway 80 and Sideroad 21-22 is part of the "Industrial - Type 3" land use designation.

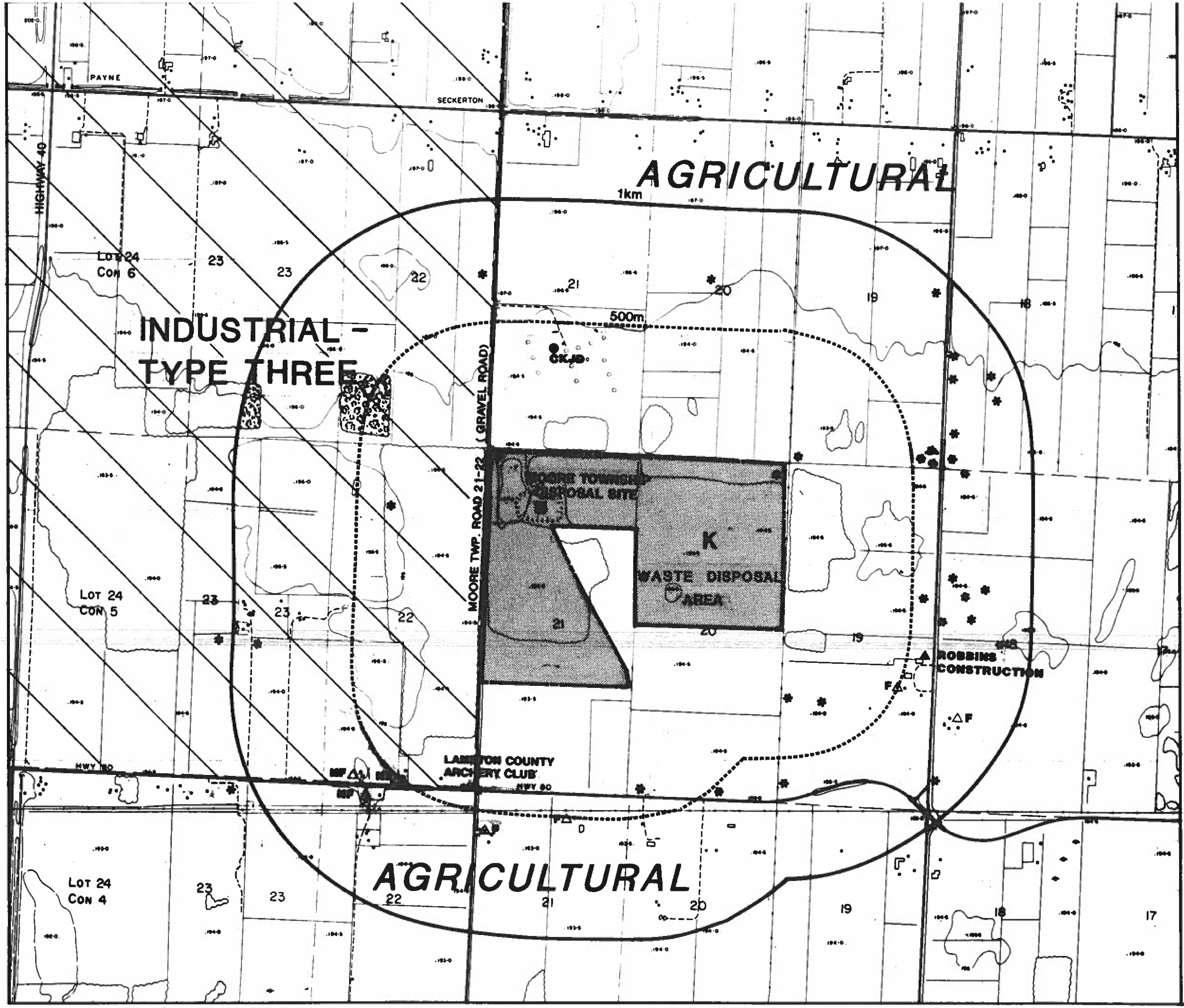
c) Site H

Almost all of the lands within 1 km of Site H are designated for industrial uses in the Moore and Sombra Official Plans (see Figure 8). The industrial designations which apply to this area are:

- The lands east of the C&O Rail Line are designated "Industrial - Type 3", in the Moore Township Official Plan.

- The lands west of the C&O Rail Line, to the St. Clair Parkway, are designated "Industrial - Type 2" in the Moore Township Official Plan. This designation allows "industrial uses which are moderate in scale", including Type 1 (light) industrial uses and "large scale warehousing and storage" (Section 9.6.2). Also permitted are "agricultural uses and intensive use recreational uses".

- The lands south of Site H in Sombra Township are designated "Industrial" in Sombra's Official Plan. Permitted uses include "manufacturing, processing, warehousing, wholesaling, repairing and servicing, transportation terminals and facilities." Other uses, such as agriculture, public buildings and utilities and service commercial uses are allowed as long as "they will not interfere with, or detract from the primary industrial function of the area" (Section 2.1 d)).



LEGEND

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* WELLS

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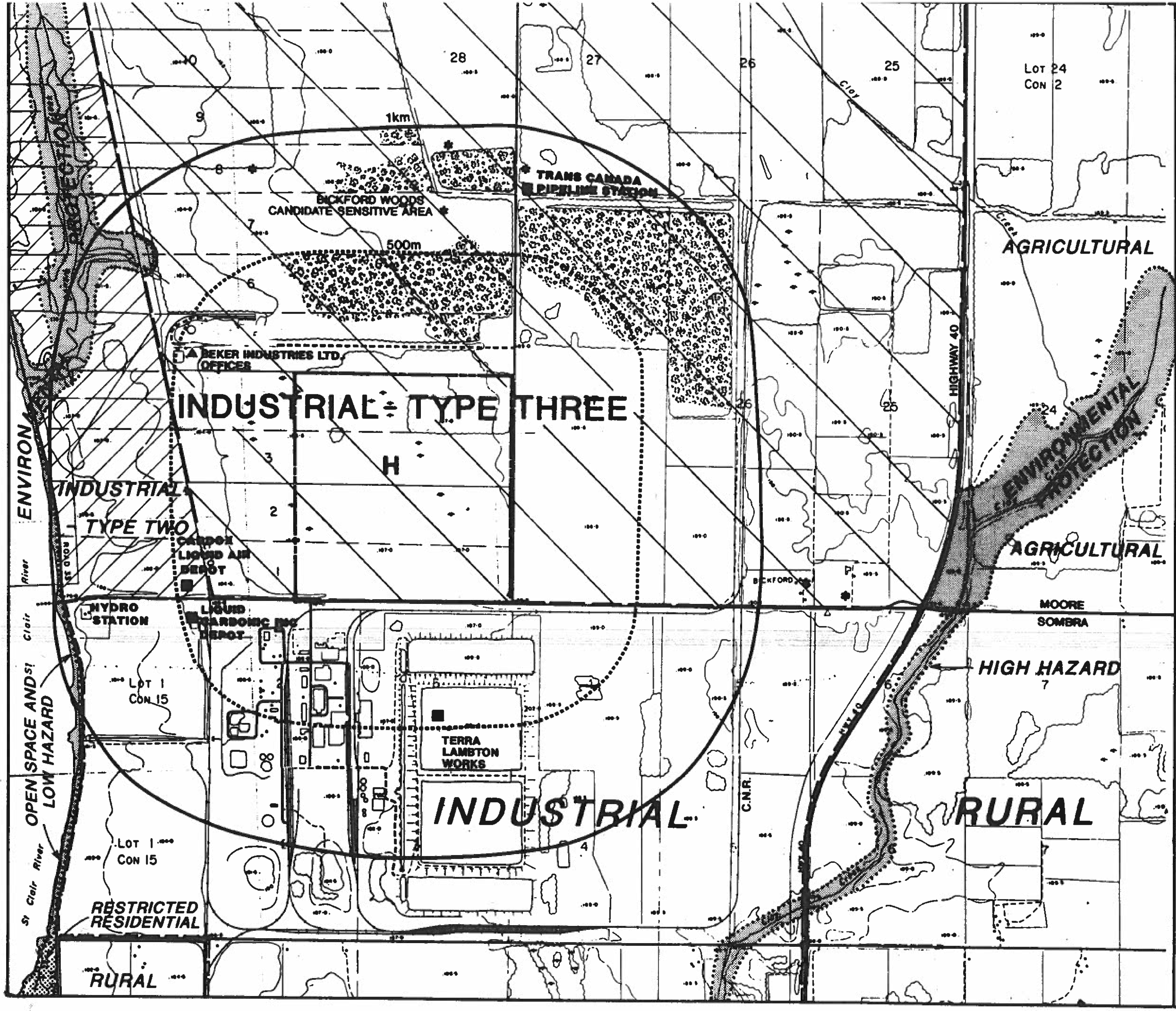
100 0 500 1km
Scale 1:15,000

OFFICIAL PLAN LAND USE DESIGNATIONS SURROUNDING SITE K

SOURCE: TOWNSHIP OF MOORE
OFFICIAL PLAN

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 7



LEGEND

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▲ COMMERCIAL

■ INDUSTRIAL

◆ INSTITUTIONAL

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✱ WELLS

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Scale 1:15,000

OFFICIAL PLAN LAND USE DESIGNATIONS SURROUNDING SITE H

SOURCES: TOWNSHIP OF MOORE OFFICIAL PLAN AND SOMBRA MAINLAND PLANNING AREA OFFICIAL PLAN

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928

FIGURE No. 8

The remaining lands in the surrounding 1 km area are designated as follows:

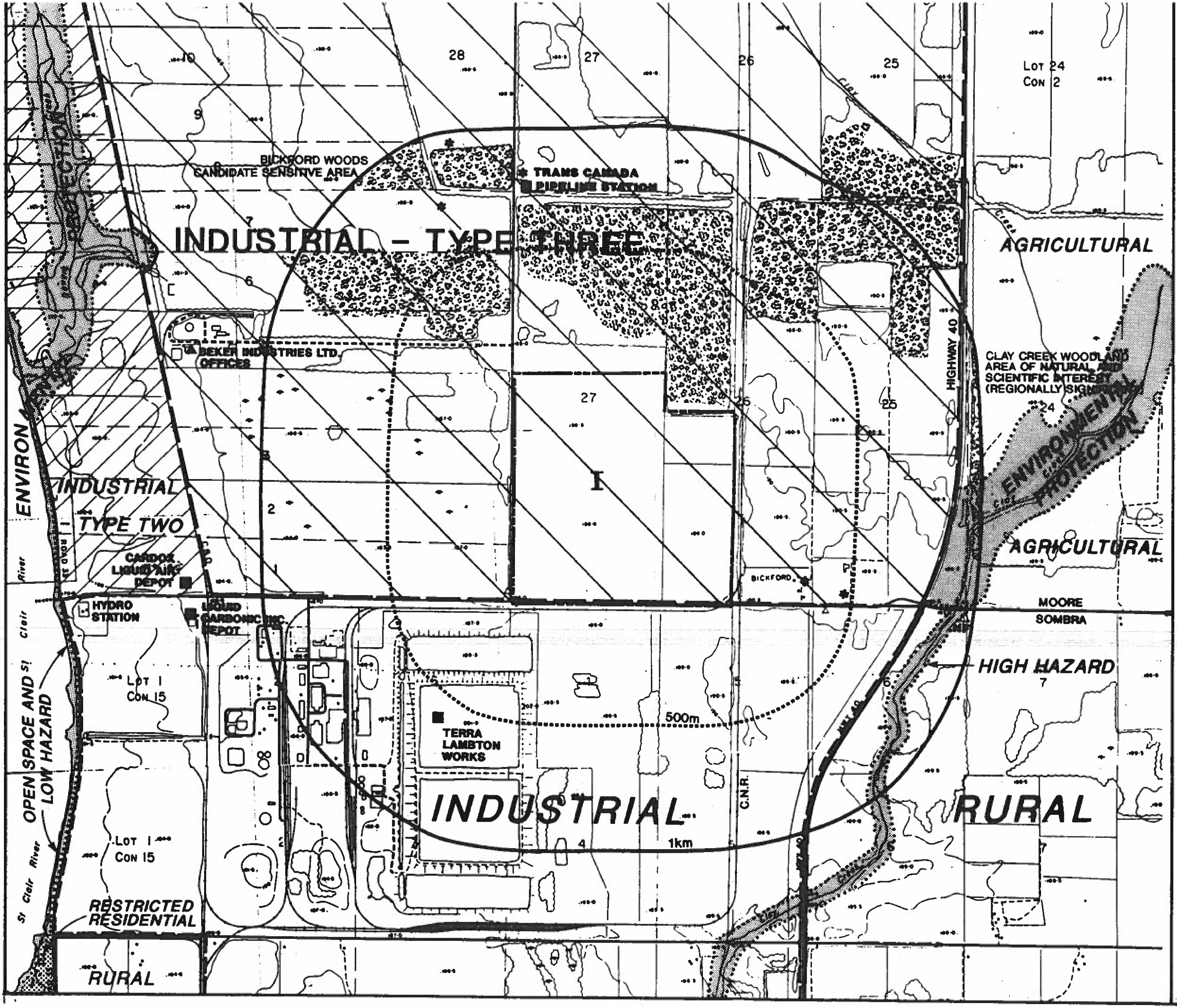
- A small area along the St. Clair River is designated "Open Space" on Schedule "A-2" to Sombra's Official Plan. The main permitted uses in this area are "parks, fairgrounds, public or private recreational lands, reforested or conservation areas" (Section 2.1 e)). This area is also part of the "Low Hazard" designation (Schedule "A-2"). According to Section 2.1 f) ii) of the Plan, the "Low Hazard" area includes "lands which have physical/environmental hazards such as flood susceptibility, steep slopes (and) erosion".

- Bowen's Creek and its valleylands and the lands along the St. Clair River are designated "Environmental Protection" on Schedule "D-1" to Moore's Plan. According to Section 7.1 of the Plan, the objectives of this designation are "to restrict development in the floodplain to prevent damage due to flooding, to allow marine related uses ... and to minimize erosion". Section 7.2.2 of the Plan categorizes the "Environmental Protection" area along the river as a "waterfront industrial area" where docking facilities and water intakes or outlets for industrial uses are permitted. With respect to "inland areas", including Bowen's Creek, no buildings or structures are permitted in the areas designated "Environmental Protection" (Section 7.3.2).

d) Site I

Similar to Site H, almost all of the lands within 1 km of Site I are designated "Industrial - Type 3" on Schedule "D-1" to Moore Township's Official Plan and "Industrial" on Schedule "A-1" to Sombra's Plan (see Figure 9). However, the area surrounding Site I includes slightly less designated industrial land than the area around Site H. The 1 km area also includes small areas, to the east of Highway 40, which are designated "Agricultural" and "Environmental Protection" (Clay Creek) in Moore's Official Plan and "Rural" and "High Hazard" in Sombra's Official Plan.

The policies which apply to the industrial designations and the "Environmental Protection" designation have already been described. The following is a summary of the policies for the "Rural" and "High Hazard" designations:



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100 0 500 1km
Scale 1:15,000

OFFICIAL PLAN LAND USE DESIGNATIONS SURROUNDING SITE I

SOURCES: TOWNSHIP OF MOORE OFFICIAL PLAN AND SOMBRA MAINLAND PLANNING AREA OFFICIAL PLAN

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 9

- The lands east of Highway 40 are designated "Rural" on Schedule "A-1" to the Township's Plan. Section 2.1 h) i) of the Plan allows "agricultural uses, forested or fallow lands" and several "ancillary uses" including public and private recreation, farmers' market, cemeteries, veterinarian offices and kennels, gas and petroleum extraction and storage, existing churches and schools and single family dwellings. Farm-related dwellings, for a farmer, a retiring farmer or a member of a farmer's immediate family, are allowed provided they meet the minimum lot area and frontage requirements of the Plan. New lots for non-farm related dwellings may be created by consent for land severance, provided they are located on an existing (meaning on the date of Plan adoption) lot which is at least 20 ha and constitutes "infilling" between two non-farm related dwellings (Section 2.1 h) ii)). The minimum lot size for a non-farm related dwelling is 0.5 ha.

- Clay Creek and its valleylands are designated "High Hazard" on Schedule "A-1" to Sombra's Plan. Section 2.1 f) i) of the Plan states that development of these lands is "impractical" because of flood susceptibility, erosion and/or steep slopes. Permitted uses in this area include agriculture, conservation, forestry, public and private parks and similar uses.

3.7 Required Official Plan Amendment

The Moore Township Official Plan recognizes existing waste disposal sites only and requires an Official Plan Amendment for any new sites (Section 9.10.2).

Since Sites D, H and I are all designated "Industrial - Type 3", an Official Plan Amendment would be required to redesignate the preferred site to "Waste Disposal Area". Since a County-owned long-term waste management facility on Site K would probably be considered as a "new site", under Section 9.10.2 of the Township's Plan, an Amendment would likely be required for Site K. The Amendment would also redesignate the "Agricultural" portion of the site (about 17 ha) to the "Waste Disposal Area".

3.8 On-Site and Surrounding Zoning

The Township of Moore's Comprehensive Zoning By-law is By-law 31 of 1991, passed on September 10, 1991. The zoning of the four sites and the surrounding lands is shown on Figures 10, 11, 12 and 13, on pages 38, 42, 46 and 50, respectively.

i) Site D

Site D is zoned "Agricultural 1 (A.1) Zone" on Schedule "A" to By-law 31 of 1991. The A.1 Zone (Section 10.1 of the By-law) allows agriculture, including a maximum of two farm-related dwellings and a variety of other uses, including animal hospital, antennae, cemetery, church, conservation, farm produce outlet, forestry, group homes, kennels, passive recreation, resource extraction and riding schools. A non-farm related one-family dwelling is also allowed. The minimum lot area required for agricultural uses, including a farm-related dwelling, is 40 ha.

Almost all of the lands surrounding Site D, within 1 km, are also zoned A.1. Lands west of Highway 40 (about one-tenth of the surrounding 1 km area) are zoned "General Industrial 2.1 (M2.1) Zone" on Schedule "A" to the By-law. The M2.1 Zone (Section 24.1 of the By-law) is a heavy industrial zone which allows the following uses:

- automotive repair establishment;
- "dangerous industrial use". This is defined as any industry which has the potential to be injurious to health or dangerous to life or property because of fire, explosion, toxic gases or fumes. Permitted uses of this type include an oil refinery, petrochemical plant or chemical plant (Section 3);
- general industrial use;
- industrial training school;
- light industrial use;
- resource extraction, including aggregates, natural gas, brine and salt (Section 3). Petroleum wells and related works and pipelines are allowed in all zones by Section 6.1.6 of the By-law;
- truck transport terminal;
- also allowed as a "Special Permitted Use" in the M2.1 Zone is agriculture, including farm-related dwellings, and the existing one-family dwellings.

A minimum lot area of 40 hectares is required for a "dangerous industrial use" and agricultural uses. A minimum lot area of 6,000 m² is required for all of the other uses permitted in the M2.1 Zone.

ii) Site K

Site K is zoned "Agricultural 1 (A.1) Zone" on Schedule "A" to By-law 31 of 1991. Sections 6.1.1 and 6.1.2 of the Township's By-law allow County and Township public services in all zones, with the exception of "sanitary landfill areas". As a result, it appears that the Moore Township Landfill Site is an existing legal non-conforming use.

Almost all of the lands surrounding Site K are also zoned A.1. Robbins Construction, on the west side of the 18-19 Sideroad, is zoned "Agricultural 4 (A.4) Zone". The A.4 Zone allows a contractor's yard (Section 10.4.1).

iii) Site H

Site H is zoned "General Industrial 2.1 (M2.1) Zone" on Schedule "F" to By-law 31 of 1991. The zoning on the surrounding lands consists of the following:

- Most of the lands in the Moore Township portion of the surrounding area are zoned M2.1 on Schedule "F". The remaining area is zoned A.1 in the northeast portion of the 1 km area, "Environmental Protection 2 (EP.2) Zone", along the St. Clair River, and "Environmental Protection 3 (EP.3) Zone", along Bowen's Creek (Schedules "A" and "F"). The EP.2 Zone allows passive recreation and industrial docks (Section 22.2.1), while the EP.3 Zone allows active and passive recreation and agriculture, exclusive of buildings and structures.

- Almost all of the surrounding lands in Sombra Township are zoned "General Industrial 1 (MG.1) Zone" on Zoning Maps 1 and 2 in the Township's Comprehensive Zoning By-law 15 of 1984 (passed on April 30, 1984). Small areas along the St. Clair River are zoned "Open Space 1 (OS.1) Zone" and "Hazard Lands 1 (HL.1) Zone".

Sombra's MG.1 Zone (Section 14.1) allows the following uses:

- general industrial use;
- resource extraction, including gas, petroleum, brine or salt;
- truck transport terminal;
- light industrial use, merchandise service shop and warehouse;
- "dangerous industrial use". The definition of this use is quite similar to that included in the Moore Township Zoning By-law and includes "an oil refinery, petrochemical plant or chemical plant" (Section 18);
- agriculture. This is defined as not including an accessory farm dwelling.

iv) Site I

Approximately three-quarters of Site I is zoned "Industrial 2.1 (M2.1) Zone" on Schedule "A" to Moore's Zoning By-law. The remaining one-quarter is zoned A.1.

Approximately two-thirds of the lands within 1 km of Site I are zoned M2.1 in Moore's Zoning By-law and MG.1 in Sombra's By-law. The remaining one-third is zoned for agriculture, including the A.1 Zone in Moore's By-law and the "Agricultural 1 (AG.1) Zone" in Sombra's By-law. The lands zoned AG.1 in Sombra Township consist of a small area east of Highway 40.

The AG.1 Zone provisions are included in Section 4.1 of Sombra's Zoning By-law and include the following:

- Permitted uses include agriculture, with not more than one farm-related dwelling, cemetery, conservation, group home, kennel, non-farm related one-family dwelling, resource extraction and veterinary establishment. Also allowed are existing churches and schools.
- The minimum lot area for an agricultural use, including a farm-related dwelling, is 19.5 ha.

3.9 Required Zoning By-law Amendment

All four sites require a rezoning to allow a waste management facility. The Tricil and Unitech Waste Disposal Sites are zoned "Restricted Industrial 3.1 (M3.1) Zone" on Schedule "A" to Moore Township's Zoning By-law 31 of 1991. Section 25.1.1 of the By-law allows these two sites "as specified and approved by" their respective Certificates of Approval. The required rezoning for the preferred site for the facility will probably be to a special M3 Zone.

Section 7.20 of Moore's Zoning By-law includes height restrictions for landfilling operations. This section states that "no landfilling of waste shall be permitted to a height above the original ground level".

3.10 Existing, Potential and Future Land Uses

This section of the report describes the following for each of the four sites and the lands within 1 km:

- existing land uses, property ownerships and services;
- current development activity;
- potential land uses which could be developed according to the policies and provisions of the relevant Official Plans and Zoning By-laws; and
- potential future (year 2016) land uses.

a) Site D

i) Existing Land Uses, Property Ownerships and Services

Site D is located in the undeveloped portion of the Chemical Valley in Moore Township, approximately 1.1 km east of Highway 40. The closest major industrial use is Novacor Plastics Division at Highway 40 and Moore Road 6, approximately 1.5 km away. Although the site and approximately two-thirds of the surrounding 1 km area are designated for heavy industrial uses in the Township's Official Plan, Site D is located in a predominantly agricultural area. This area includes many feed and cash crop farms and livestock operations.

The former hamlets of Payne and Seckerton are located on Moore Road 6, north of Site D. Payne consisted of a post-office located on the farm of Joseph Payne. Seckerton also included a post-office.

Site D is part of a 394 acre parcel of land owned by 166814 Canada Ltd. in Trust which is owned by Novacor Petrochemical Inc. and is part of Novacor's industrial land "bank". The company has no short-term plans or definite long-term plans for the property. Most of Site D is leased to a local farmer for the production of cash crops. The southeast corner of the property, at Highway 80 and Sideroad 21-22, is leased to the Lambton County Archery Club which uses the trailer currently parked on the property.

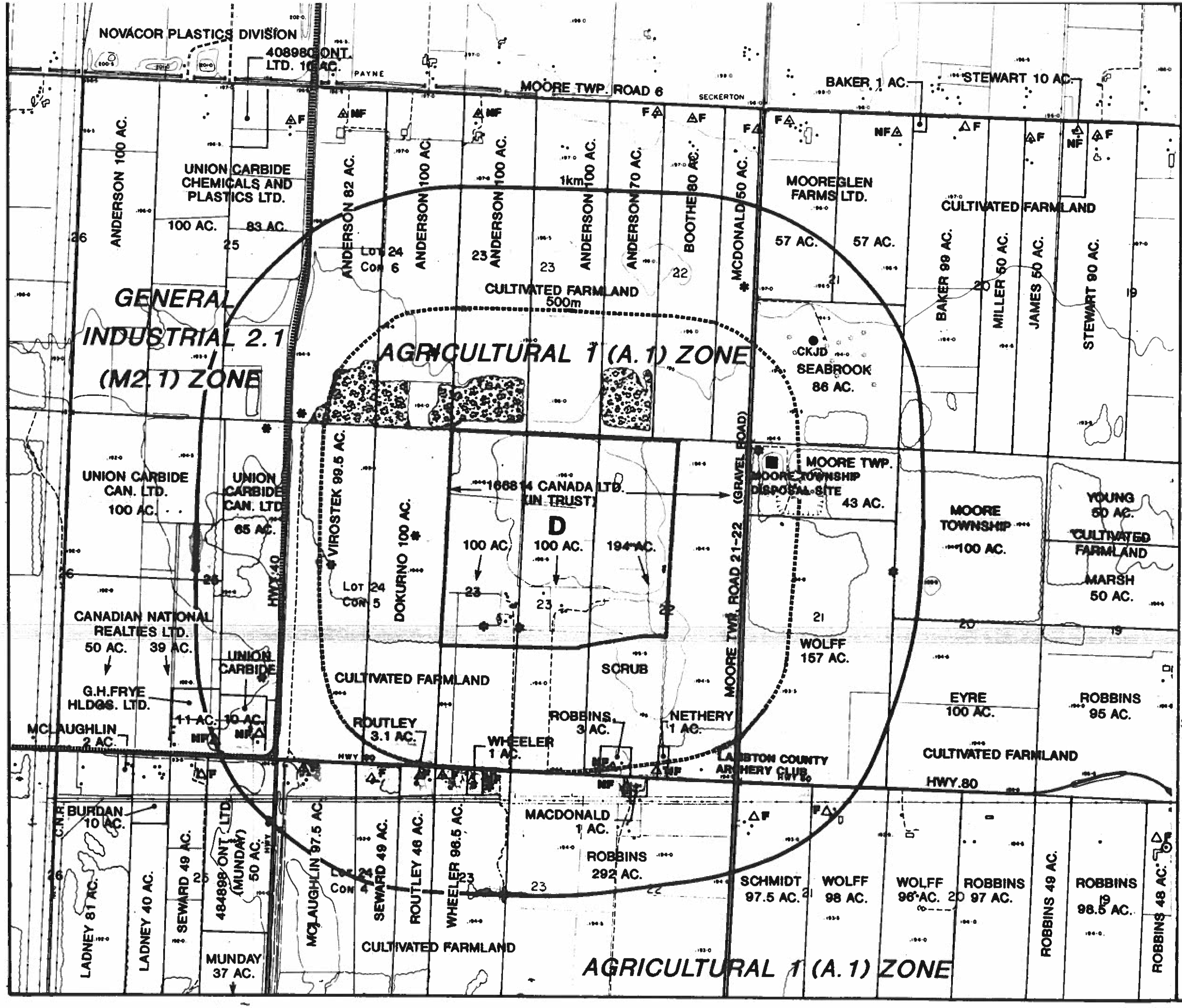
Existing land uses and property ownerships within 1 km of Site D are shown on Figure 10 and consist of the following:

- The predominant land use is agriculture. There are about 20 farm parcels in the 1 km area surrounding Site D. West of Highway 40, the farmland is owned by large corporations such as Union Carbide Canada Ltd. (now owned by Linde Corporation) and Canadian National Realties Ltd. These lands are leased to local farmers.
- Six farm related single family houses are located within 500 m to 1 km of Site D.
- The 500 m to 1 km area also includes six non-farm related single family houses.
- Other uses include the CKJD Radio tower located on an 86 acre property which is rented for farmland and the Moore Township Landfill Site.

A 250 mm MOEE trunk water line is located along Highway 80. Municipal sewage treatment facilities are not available in this area and all properties are serviced by individual septic tank and tile bed systems.

ii) Current Development Activity

According to the Lambton County Planning and Development Department, Site D and the surrounding lands are not currently the subject of any applications for Official Plan or Zoning By-law Amendments, consent for land severance or Plan of Subdivision or Site Plan approval.



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- * WELLS

100 0 500 1km

Scale 1:15,000

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EXISTING LAND USES, PROPERTY OWNERSHIPS AND ZONING – SITE D

SOURCES: M.M.DILLON LTD.,LAND USE SURVEYS OCTOBER 7,1992 AND JUNE 15,1993; PROPERTY OWNERSHIPS FROM MINISTRY OF REVENUE,LAMBTON-KENT REGIONAL ASSESSMENT OFFICE,MOORE TOWNSHIP ASSESSMENT ROLL; TOWNSHIP OF MOORE COMPREHENSIVE ZONING BY-LAW 31 OF 1991.

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN

Project No.9928

FIGURE No. 10

iii) Potential Development

The Moore Township Official Plan land use and severance policies and Zoning By-law provisions which apply to Site D and the surrounding 1 km area are explained in Sections 3.5, 3.6 and 3.8 of this report. These policies and provisions allow the following development opportunities on Site D and the surrounding 1 km area:

- The Zoning By-law allows a maximum of two farm related houses on properties which meet the minimum lot area requirement of 40 hectares. Based on this, an additional 17 farm related houses could be built in the 1 km area. This applies to properties owned by Virostek, Dukurno, 166814 Canada Ltd. in Trust (three properties), Wolff (two properties), Schmidt (Part of Lot 21, Concession 4), Robbins (Part of Lots 22 and 23, Concession 4), and McLaughlin (Part of Lot 24, Concession 4). These properties are shown on Figure 10.

- The 292 acre Robbins farm could be severed to create an additional farm. Two farm related houses could be built on the new farm.

- The severance policies of the Plan also allow severances to create lots for retiring farmers or immediate farm family members, provided the retained lot is at least 40 hectares. One lot of this type could be severed from the Wolff property (Part of Lot 21, Concession 5).

- Severances for farm related commercial and industrial uses are also allowed on parcels of land which are a minimum of 20 hectares. Seven lots of this type could be created on property owned by McDonald, Seabrook, Moore Glen Farms, Schmidt, Wheeler, Seward and McLaughlin.

- Industrial development, including light, moderate and heavy industrial uses are permitted on the lands owned by G.H. Frye Holdings Ltd., Canadian National Realties, Union Carbide, and 484898 Ontario Ltd., west of Highway 40. The Township's Zoning By-law requires a minimum lot area of 40 hectares for a "dangerous industrial use" and 6,000 m^2 for the other types of industries permitted in this area. Based on the minimum lot area requirements, and assuming that about 20% of the land would be required for new roads, these lands (about 60 hectares) could accommodate one "dangerous industrial use" or about 80 of other types of industrial uses allowed in this area.

In summary, Site D and the surrounding lands could accommodate 20 farm related houses, seven farm related commercial and industrial uses and one "dangerous industrial use" or about 80 light and moderate industrial uses.

iv) Potential Future Land Uses

As mentioned in Section 3.1 of this report, there are approximately 3,472 ha of developed industrial land and 2,193 ha of vacant industrial land in Moore Township. The developed lands have taken approximately 40 years to develop, resulting in an average annual consumption of about 87 ha per year. In the past ten years, however, only 10 ha of land have been developed for industrial uses. Based on the 40 year trend, it will take about 25 years for the vacant 2,193 ha of land to be developed. If the recent trends continue (10 ha over ten years), it will be a very long time before this area is developed.

Site D is located near the eastern boundary of the Township's industrial area, about 1.5 km away from the closest major industrial use. As a result, this area could be one of the last areas to be developed. Based on this, it is most likely that the lands surrounding Site D will not be developed for industrial uses for at least another 20 years, or until about the year 2013. Until that time, the lands surrounding Site D will remain predominantly agriculture, with some industrial development likely on lands west of Highway 40.

A waste management facility on Site D would contribute to the character change of the area from agricultural to more industrial in nature. The facility would also require road improvements and other servicing improvements. The change in the character of the area and the required improvements could attract other industries to the area, especially those which could make use of the materials (metal, cardboard, glass, etc.) recovered at the MRF plant. As a result, the facility could encourage the premature development of an industrial area on lands which would otherwise have remained agricultural over the long term.

b) Site K

i) Existing Land Uses, Property Ownerships and Services

Site K is located in the agricultural part of the Township on the eastern boundary of the undeveloped portion of the Chemical Valley, approximately 2 km east of Highway 40. The closest major industrial use is Novacor Plastics Division which is about 2.3 km away from Site K. Although the lands northwest of Highway 80 and the 21-22 Sideroad are designated for heavy industrial uses in the Township's Official Plan, Site K is located in a predominantly agricultural area. The former hamlet of Seckerton is located north of the site.

Site K is 75 hectares. This area consists of the 18 hectare existing Moore Township Landfill Site, an adjacent 40 hectares owned by the Township and an additional 17 hectares on the 21-22 Sideroad. This additional area is owned by a local farmer (Wolff) and consists of a woodlot and cultivated farmland.

The Moore Township Landfill Site is owned and operated by the County and serves the Township only. The average amount of waste disposed at the site is about 4,000 tonnes a year. (In comparison, the average tonnage to the County's long-term facility will be about 100,000 tonnes a year, or 50,000 tonnes with diversion.) The site is entirely screened by existing woodlots and is not visible from the adjoining roads.

Figure 11 shows existing land uses and property ownerships within 1 km of Site K. These consist of the following:

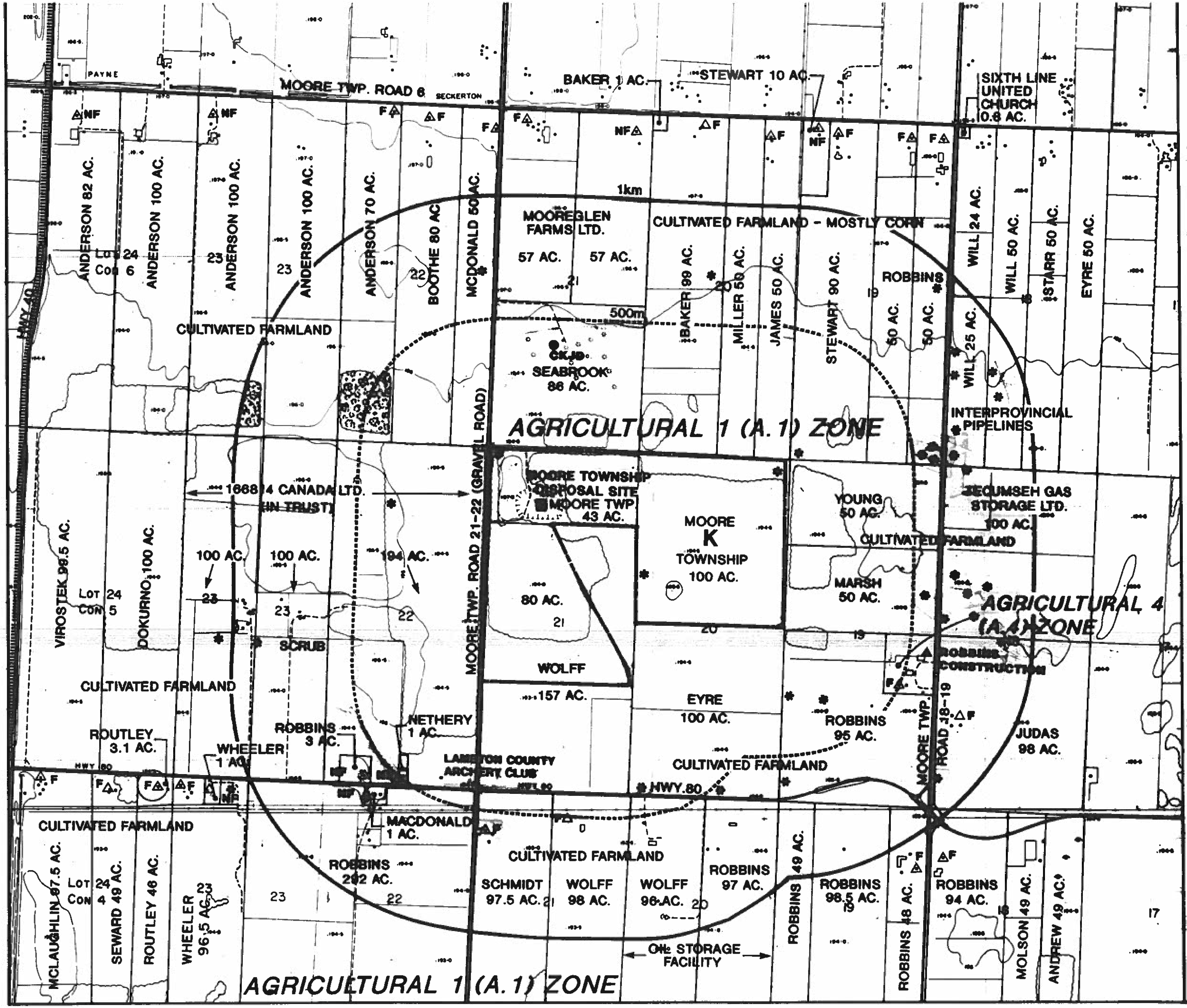
- Similar to Site D, the predominant land use is agriculture. There are 31 farm parcels in the 1 km area around Site K.

- Four farm related single family houses are located within 500 m to 1 km of Site K.

- The 1 km area also includes three non-farm related single family houses on Highway 80.

- Other uses include the CKJD Radio tower, Robbins Construction, a Tecumseh Gas Storage facility, an oil storage facility on the south side of Highway 80 and the Lambton County Archery Club. Most of the lands occupied by the radio tower and the oil and gas storage facilities consist of cultivated farmland.

Similar to Site D, the properties along Highway 80 are serviced by a municipal water supply system and individual septic tank and tile bed systems.



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Scale 1:15,000

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EXISTING LAND USES, PROPERTY OWNERSHIPS AND ZONING - SITE K

SOURCES: M.M.DILLON LTD.,LAND USE SURVEYS OCTOBER 7,1992 AND JUNE 15,1993; PROPERTY OWNERSHIPS FROM MINISTRY OF REVENUE,LAMBTON-KENT REGIONAL ASSESSMENT OFFICE,MOORE TOWNSHIP ASSESSMENT ROLL; TOWNSHIP OF MOORE COMPREHENSIVE ZONING BY-LAW 31 OF 1991.

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 11

ii) Current Development Activity

According to the Lambton County Planning and Development Department, there is no current development activity on the lands surrounding Site K.

iii) Potential Development

The land uses which could be developed on Site K (that portion not occupied by the existing site) and the surrounding 1 km area consist of the following:

- Moore's Zoning By-law allows a maximum of two farm related houses on properties which have a minimum lot area of 40 hectares. Based on this, an additional 20 farm related houses could be built in the 1 km area on properties owned by Tecumseh Gas Storage, Judas, Robbins (four properties), Wolff (2 properties), Schmidt, 166814 Canada Ltd., in Trust (2 properties) and Eyre. These properties are shown on Figure 11.

- The 292 acre Robbins farm could be severed to create an additional farm. Two farm related houses could be built on the new farm.

- Based on the Plan's policies which allow the creation of lots for retiring farmers or immediate farm family members, an additional six houses of this type could be built on property owned by Wolff (2 properties), Eyre, Tecumseh Gas Storage, Judas and Robbins (Part Lot 19, Concession 4).

- The Official Plan also allows severances of parcels which are a minimum of 20 ha for farm related commercial and industrial uses. Eleven lots for this type of use could be severed from property owned by McDonald, Seabrook, Robbins (five properties), Young, Marsh, Wolff (Part of Lot 20, Concession 4) and Schmidt.

In summary, Site K and the surrounding lands could accommodate an additional 28 farm related houses and 11 farm related commercial and industrial uses. No non-farm related industrial uses are allowed in this area.

iv) Potential Future Uses

Site K is even farther away (2.3 km) from the closest existing industrial use than Site D and is located on the eastern boundary of the Township's industrial area. It is surrounded on three sides by lands which are designated for long-term agricultural use in the Township's Official Plan.

As mentioned in Section 3.10 a) iv), it is most likely that the lands surrounding Site D will not be developed for industrial uses for at least another 20 years, or until around the year 2013. Until that time, the lands surrounding Site D will remain predominantly agricultural, with some industrial development likely on lands west of Highway 40. Assuming that this development scenario is realistic, the lands surrounding Site K will probably remain predominantly agricultural over the long term, with little or no industrial development east of Highway 40.

Similar to all of the sites, a waste management facility on Site K would contribute to the character change of the area from agricultural to more industrial in nature. Although Site K includes an existing landfill site, the site functions more like a small "rural dump" which appears to have had few negative impacts on the surrounding area. In contrast, the County's long-term waste management facility will be similar to a large scale industrial use. This type of facility could attract other industries to the lands designated for industrial uses on the west side of the 21-22 Sideroad. Similar to Site D, a waste management facility on Site K could encourage the premature development of an industrial area on lands which would otherwise have remained agricultural over the long term.

c) Site H

i) Existing Land Uses, Property Ownerships and Services

This site is located in the Chemical Valley portion of Moore Township, approximately 1.6 km west of Highway 40. Although a large portion of this part of the Chemical Valley is undeveloped, the character of this area is predominantly industrial. Terra Lambton Works, a major chemical plant, is located in Sombra Township on the south side of the Moore-Sombra Townline, across the road from Site H. Terra Canada International is a manufacturer of nitrogen fertilizer products and currently employs about 270 people at the Lambton Works. The plant was originally opened in 1967 by CIL Inc. and operated for many years by CIL, then by ICI Canada Inc. Terra recently bought the Lambton Works from ICI.

Site H consists of 75 ha, 54 ha of which are owned by Terra Canada International. The remaining 21 ha are owned by Monsanto. The 54 ha Terra property is part of a 114 ha parcel which extends from the eastern boundary of Site H to the St. Clair River. The 21 ha owned by Monsanto is part of 42 ha parcel which also extends from the eastern boundary of Site H to the river. ICI Canada Inc. owns 222 ha of adjoining property to the east, while Monsanto owns another 55 hectares of property to the north.

Terra is planning to use Sites H and I for contingency plans related to their Phosphate Decommissioning Project. From 1967 to 1986, part of the Lambton Works was used to produce phosphates. For a number of reasons, the phosphate plant was closed in 1986. To restore the area to an "environmentally secure condition"[2], Terra and ICI propose to dispose waste water and a gypsum stack, left over from the phosphate operation, on Sites H and I. The waste water is contained in the ponds located on the Lambton Works property.

Most of Site H consists of cultivated farmland which is rented by local farmers. Existing land uses and property ownerships within 1 km of Site H are shown on Figure 12 and consist of the following:

- Most of the lands around Site H (about two-thirds) consist of cultivated farmland and woodlots located on property owned by industrial corporations and private individuals for future industrial use.

- Most of the remaining lands around Site H are occupied by existing industrial uses. The largest is the Terra Lambton Works which occupies a 365 hectare site. The site includes process operations, cooling and prilling towers, ammonia storage tanks, raw material storage, maintenance buildings, warehousing and the waste water ponds. Other existing industrial uses include Cardox Liquid Air, Liquid Carbonic Inc. and an Ontario Hydro Station. Also located in this area is the former Beker Industries plant, a small chemical plant which was closed in 1980. The plant is now rented for offices.

- Other uses are Reynolds Cemetery, a restored pioneer cemetery, and the Lambton Works Ball Diamond. The ball diamond is owned by Terra and includes washrooms, a snack bar and picnic tables.

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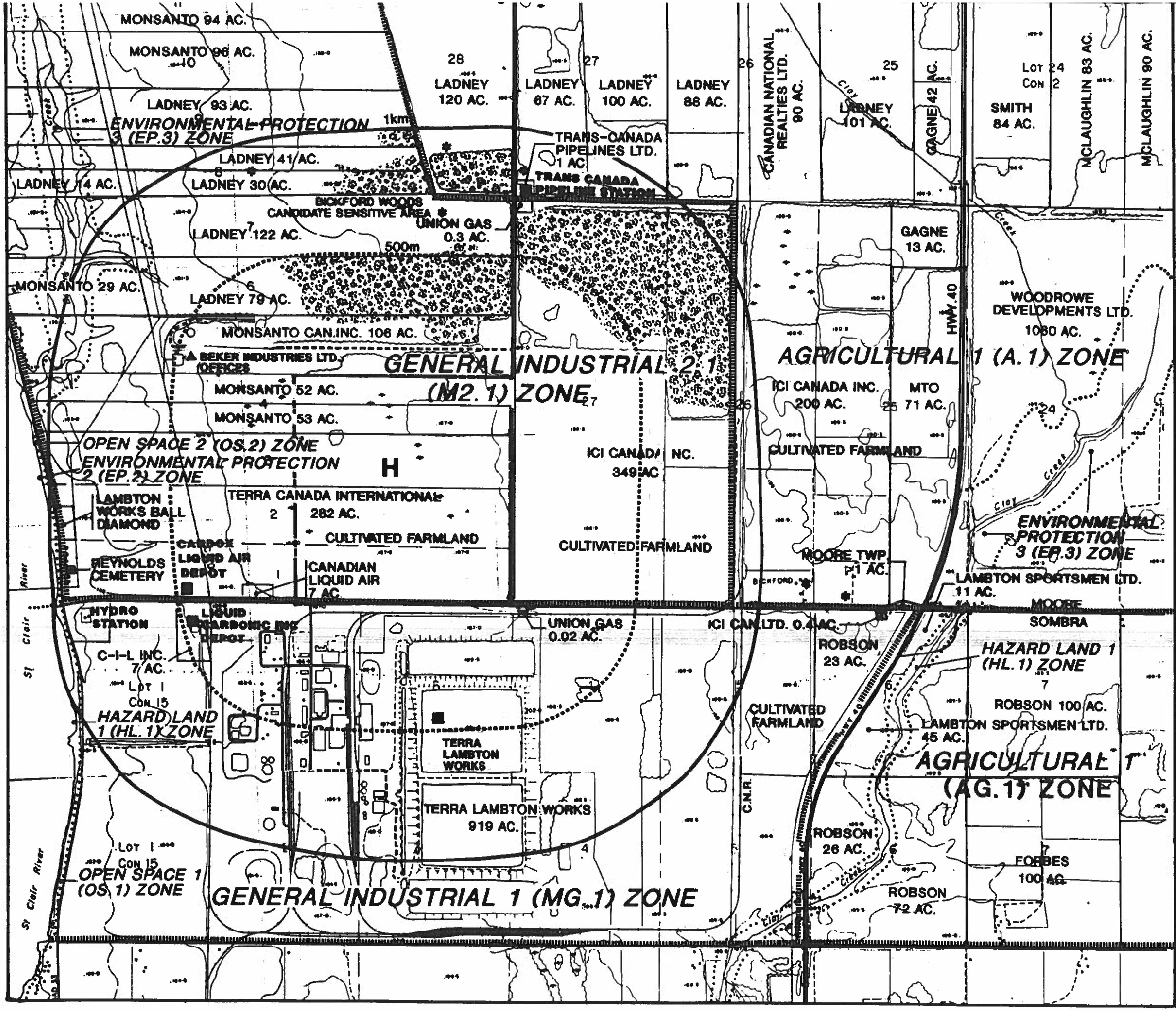
[2] "ICI Canada Information Sheet Update on Pond Water Treatment" attached to a letter dated April 16, 1991, from P.S. Forkes, Manufacturing Manager, to J.J. Kutyba, County of Lambton.



LEGEND

△ RESIDENCE(F-FARM,NF-NON-FARM)
A INDICATES ABANDONED LAND USE
▲ COMMERCIAL
■ INDUSTRIAL
◆ INSTITUTIONAL
● RADIO ANTENNA
□ AGRICULTURAL
▨ HIGH QUALITY FOREST
* WELLS

DILLON
Consulting Engineers • Planners
Environmental Scientists

100 0 500 1km
Scale 1:15,000

EXISTING LAND USES, PROPERTY OWNERSHIPS AND ZONING – SITE H

SOURCES: M.M.DILLON LTD.,LAND USE SURVEYS JUNE 10,1991 AND JUNE 15,1993; PROPERTY OWNERSHIPS FROM MINISTRY OF REVENUE,LAMBTON-KENT REGIONAL ASSESSMENT OFFICE,MOORE TOWNSHIP AND SOMBRA TOWNSHIP ASSESSMENT ROLLS; TOWNSHIP OF MOORE COMPREHENSIVE ZONING BY-LAW 31 OF 1991; TOWNSHIP OF SOMBRA COMPREHENSIVE ZONING BY-LAW 15 OF 1984.

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No. 12

The properties along Townline Road are serviced by a 600 mm MOEE trunk water line. Municipal sanitary sewage treatment facilities are currently not available and all properties are serviced by individual sewage disposal systems. The Township of Sombra is currently constructing a sanitary trunk sewer along County Rd. 33 from the Sombra Lagoon to the 15th Concession Road (the southern boundary of Terra Lambton Works). According to the Township Clerk, Terra is interested in extending the sewer to their plant. This means that sewage treatment may become available to the properties on Townline Road near County Road 33.

ii) Current Development Activity

According to the Lambton County Planning and Development Department:

- There is no current development activity which affects Site H and the Moore Township portion of the surrounding 1 km area.
- In 1993, Sombra Township granted ICI a consent to sever the Lambton Works from their property and convey it to Terra Industries. The severance simply provided for a change in ownership.

iii) Potential Development

Site H and most of the lands in the Moore Township portion of the surrounding 1 km area are zoned "General Industrial 2.1 (M2.1) Zone". This zone allows a variety of industrial uses and agriculture, including farm dwellings, as a "Special Permitted Use". The remaining lands in Moore are zoned "Agricultural 1 (A.1) Zone". All of the lands in the Sombra Township portion of the surrounding 1 km area are already occupied by the Terra Lambton Works and are not available for potential development.

The following uses could be developed on Site H and the surrounding area:

- Approximately 40 ha of land along the CN Rail Line in the Moore portion of the surrounding area are zoned "Agricultural 1 (A.1) Zone". Based on the Township's Zoning By-law, these lands could accommodate a farm, including two farm related houses. However, this would require a severance which would likely not be approved because the lands are designated for industrial uses in Moore's Official Plan.

- About 400 ha of vacant land are available for industrial development on Site H and the surrounding 1 km area. The Township's Zoning By-law requires a minimum lot area of 40 ha for a "dangerous industrial use" and 6,000 m^2 for light and moderate industries. Based on these minimum lot area requirements and assuming 20% of the land would be required for new roads, the 400 ha could accommodate about eight "dangerous industrial uses" or over 500 of the other types of industrial uses.

- Of these potential development opportunities, Site H itself could accommodate one "dangerous" industrial use or about 100 of the other types of uses.

In summary, Site H and the lands within 1 km could accommodate about eight "dangerous industrial uses" or over 500 light and moderate industrial uses.

iv) Potential Future Land Uses

Potential future land uses of Site H and the surrounding area, over the next 20 years, are predominantly industrial. This is based on the existing industrial Official Plan land use designations and zoning, the available services, including a large diameter water main and rail, road and river access, the presence of existing industrial uses and the existing industrial character of the area. Although the Official Plan and Zoning By-law allow light industrial uses in this area, this type of use may be discouraged by the existing heavy industrial development which is already located in this area. As a result, the surrounding area will most likely include moderate and heavy industries in the future.

A waste management facility on Site H may encourage industrial development to occur faster in this area, than may otherwise occur without the facility. Similar to the other alternative sites, the facility could attract other industries to the area, especially those which could make use of the material recovered at the MRF plant. In addition, Site H would have no negative impacts on the future moderate and heavy industries located in the area.

d) Site I

i) Existing Land Uses, Property Ownerships and Services

This site is located on the eastern boundary of Site H, about 0.7 km west of Highway 40. Although the area surrounding Site I is also predominantly industrial, it is slightly less industrial in character than Site H because it is located closer to Moore and Sombra's agricultural areas and includes fewer existing industries.

The former hamlet of Bickford is located east of Site I. Bickford was the Watson Station on the Pere Marquette (now CN) Railway and included a post office. The hamlet was named after E.O. Bickford, an official with the former Erie and Huron Railway.

Site I is part of a 141 ha property owned by ICI Canada Inc. As mentioned, Terra and ICI are planning to use Site I for contingency plans for their Phosphate Decommissioning Project.

Figure 13 shows existing land uses and property ownerships within 1 km of Site I. These consist of the following:

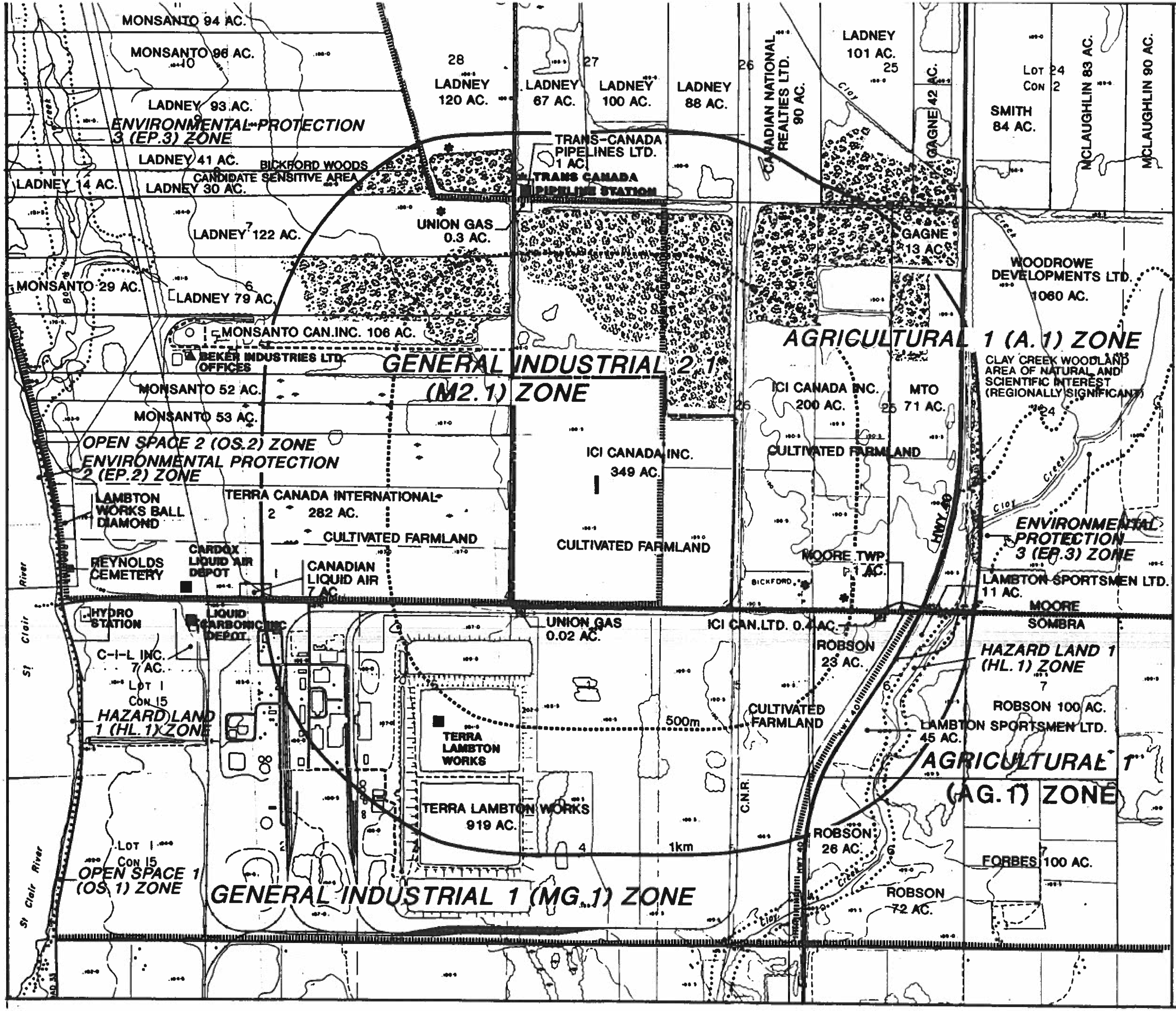
- Approximately two-thirds of the surrounding lands consist of rented farmland. Most of these lands are owned by industrial corporations and private individuals for future industrial uses.
- Most of the remaining lands are occupied by the Terra Lambton Works.
- The 1 km area also includes a rented non-farm related single family house.

Similar to Site H, the properties along Townline Road to Highway 40 are serviced by a municipal water supply system and individual sewage disposal systems.

ii) Current Development Activity

According to the Lambton County Planning and Development Department, there is no current development activity in the Moore Township portion of the 1 km area surrounding Site I.

The Lambton Sportsmen Ltd. own about 19 ha southeast of Highway 40 and the Townline Road and are proposing a recreational gun club for these lands. The required Official



LEGEND

△	RESIDENCE(F–FARM,NF–NON–FARM)
▲	INDICATES ABANDONED LAND USE
▲	COMMERCIAL
■	INDUSTRIAL
◆	INSTITUTIONAL
●	RADIO ANTENNA
□	AGRICULTURAL
▨	HIGH QUALITY FOREST
*	WELLS

DILLON
Consulting Engineers · Planners
Environmental Scientists

100 0 500 1km
Scale 1:15,000

EXISTING LAND USES, PROPERTY OWNERSHIPS AND ZONING – SITE I

SOURCES: M.M.DILLON LTD.,LAND USE SURVEYS JUNE 10,1991 AND JUNE 15,1993; PROPERTY OWNERSHIPS FROM MINISTRY OF REVENUE,LAMBTON-KENT REGIONAL ASSESSMENT OFFICE,MOORE TOWNSHIP AND SOMBRA TOWNSHIP ASSESSMENT ROLLS; TOWNSHIP OF MOORE COMPREHENSIVE ZONING BY-LAW 31 OF 1991; TOWNSHIP OF SOMBRA COMPREHENSIVE ZONING BY-LAW 15 OF 1984.

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928 FIGURE No.13

Plan Amendment was adopted by Sombra Township Council as Amendment 28. Surrounding residents objected to the amendment and it has been referred to the Ontario Municipal Board. No date has been set for the hearing.

iii) Potential Development

The existing Official Plan policies and Zoning By-law provisions allow the following development opportunities on Site I and the surrounding 1 km area:

- Approximately 140 ha of land, including part of Site I and lands to the east, are zoned "Agricultural 1 (A.1) Zone" in Moore's Zoning By-law. The 80 ha parcel east of Site I could be used for a new farm, including two farm related houses. A new farm on Site I itself would not be allowed because this would require a severance and the site is designated for industrial uses in Moore's Plan.

- Light, moderate and heavy industrial uses are permitted on Site I and about two-thirds of the surrounding 1 km area. The Moore Township portion of this area includes about 280 ha of vacant land. Based on the minimum lot area requirements for a "dangerous industrial use" (40 ha) and the other industrial uses (6,000 m^2), and assuming 20% of the land would be required for new roads, these vacant lands could accommodate four or five "dangerous industrial uses" or as many as 350 of the other types of permitted industries. Of these potential uses, Site I itself could accommodate one "dangerous industrial use" or about 70 of the other types of industrial uses.

- Almost all of the industrial lands in the Sombra Township portion of the surrounding 1 km area are already occupied by the Terra Lambton Works. Only a small parcel of land (9 ha) is available for industrial development. The Township's By-law requires a minimum lot area of 1,395 m^2 for a light industrial use and 8,000 m^2 for moderate industrial uses. Based on these requirements, and assuming 20% of the land would be required for a new road, the 9 ha parcel could accommodate about 50 light industrial uses or about nine moderate industrial uses.

- The lands east of Highway 40 in the Sombra portion of the surrounding area are mostly occupied by the Lambton Sportsmen Ltd. proposed recreational gun club.

In summary, Site I and the surrounding 1 km area could accommodate one new farm with two farm houses, four or five "dangerous industrial uses" or as many as 350 light and moderate industrial uses in the Moore Township portion and 50 light industrial uses or nine moderate industrial uses in the Sombra Township portion.

iv) Potential Future Land Uses

Similar to Site H, the most likely future land use of Site I and the surrounding area is industrial. The development of Site I may take a little longer, however, because it is located closer to the agricultural area and the area includes fewer existing industrial uses.

4.0 COMPARATIVE EVALUATION

The following presents the comparative evaluation of the short list of sites from a land use perspective.

In addition to the evaluation criteria presented in Table 2.1, consideration was also given to zoning by-laws and County and Township Official Plan landfill policies.

With respect to zoning, all sites will require a zoning by-law amendment. Also, the inconsistency of some sites which are zoned agriculture but designated in the Official Plan for industrial uses was not considered to be significant, as the Official Plan states that not all lands designated for a particular use will be zoned for such use.

In terms of addressing landfill compatibility with zoning in the surrounding area, as zoning primarily reflects existing uses, its consideration would duplicate the *compatibility with existing uses* criterion. Also, as zoning is subject to change, Official Plan designations were considered to be much more applicable for the purposes of addressing the potential for impact of a landfill facility on future land uses over the 20 year period.

It should be noted that zoning was taken into account in the criteria addressing potential impacts on development potential of property on-site and in the site vicinity. Zoning was used to determine the type and number of allowable uses.

The County also has policies related to landfilling in their Official Plan. These policies address such issues as compatibility with surrounding land uses, ground water protection, expansion potential and access. It was felt that these policies have largely been addressed by other land use criteria and other disciplines. It was therefore not necessary to address them again.

Similarly, Moore Township has policies in regard to Waste Disposal Areas. For the most part, these policies address landfill design issues and access. Again, it was felt that these policies have been largely addressed through other land use criteria and disciplines and to address them again could be considered as double-counting.

4.1 Evaluation of Impacts

a) Site D

The potential impacts of Site D, including mitigating measures and the resulting net impacts, are presented in Table 4.1. The following summarizes the site's net impacts:

- The existing urban structure of Moore will be changed by introducing a heavy industrial type use into an agricultural area.
- Site D conforms to the Lambton County Official Plan "Economic Anchor" designation ("Chemical Valley - Heavy Manufacturing Anchor").
- The site conforms to the Moore Township Official Plan "Structure Plan" designation ("Major Industrial") and is consistent with the intent of the existing on-site land use designation ("Industrial-Type 3" heavy industry).
- Site D is compatible with the Moore Township Official Plan land use designations on two-thirds of the surrounding area ("Industrial-Type 3" and "Waste Disposal Area") but is not compatible with the "Agricultural" designation on the remaining one-third.
- Site D is not compatible with the existing residential and agricultural uses in the site vicinity.
- There are no proposed land uses either on-site or in the site vicinity.
- The site would discourage the farm-related houses and farm-related commercial and industrial uses which are allowed on most of the surrounding lands by the existing Official Plan and Zoning By-law. On the other hand, it could encourage the development of industrial uses which are allowed on the lands west of Highway 40. This may not be a positive impact, however, because it would create an isolated "pocket" of industrial uses.
- Site D could change the future urban structure of Moore Township. By the year 2016, the surrounding lands, without the facility, are expected to be agricultural with some industry west of Highway 40. The facility could, however, attract other industrial uses thereby prematurely and unnecessarily extending the Chemical Valley area to the east. This could result in several negative changes to the future

urban structure of Moore, including a marked change in the agricultural character of this area, an isolated "pocket" of industrial uses, vacant or under-utilized industrial lands in other parts of Moore and unnecessary and costly service extensions and road improvements.

Although Site D and most of the surrounding area are designated for industrial development in the Lambton County and Moore Township Official Plans, this development may not occur for another 20 years or so. Site D has significant adverse impacts on the surrounding farmlands and residential uses. Since this area will not be developed with industrial uses for some time, these impacts could continue over a large part of the facility's site life (19 years, without diversion, 38 years, with diversion).

b) Site K

The potential impacts of Site K, including mitigating measures and the resulting net impacts, are presented in Table 4.2. The following summarizes the site's net impacts.

- The existing urban structure of Moore Township will be changed. Although it continues the existing waste disposal use of the Moore Township Landfill Site, the use of the site would be significantly intensified. Similar to Site D, Site K introduces a heavy industrial type use into an agricultural area.

- Half of the site does not conform to the Lambton County Official Plan "Economic Anchor" designation, since it is located outside of the "Chemical Valley-Heavy Manufacturing Anchor" in the agricultural area.

- Site K does not conform to the Moore Township Official Plan "Structure Plan" since it is located outside of the "Major Industrial" area in the agricultural area. It is, however, consistent with the intent of the "Waste Disposal Area" land use designation (which applies to three-quarters of the site) but is not consistent with the intent of the "Agriculture" designation which applies to the remaining one-quarter.

- Site K is not compatible with the Moore Township Official Plan "Agriculture" land use designation on two-thirds of the surrounding area, but is compatible with the remaining one-third which is designated "Industrial-Type 3".

- Site K is not compatible with the existing residential and agricultural uses in the site vicinity.

- The adverse impacts of the facility would discourage the farm-related houses and farm-related commercial and industrial uses which are allowed on most of the surrounding lands by the existing Official Plan and Zoning By-law. There are no existing industrial development opportunities within 1 km of Site K.

- Similar to Site D, Site K could change the future urban structure of Moore Township, but even more so. It is most likely that the lands within 1 km of Site K will still be agricultural by the year 2016. If the facility is located on Site K, it could attract other industrial uses to the surrounding lands. This would unnecessarily extend the Chemical Valley area into what would have otherwise been an agricultural area well into the future. This could result in the same negative changes to Moore's future urban structure as Site D.

Although most of Site K is designated "Waste Disposal Area", the existing waste disposal use of the site would be significantly intensified. This would make the site incompatible with the surrounding existing and most likely future land uses. The site also significantly changes the existing and future urban structure of the Township by introducing a heavy industrial type use into an agricultural area.

c) Site H

The net impacts of Site H are presented in Table 4.3 and summarized below:

- Site H fits into the existing urban structure of Moore and Sombra Townships.

- Site H does not conform to the Lambton County Official Plan "Economic Anchor" designation since it is located outside of the "Heavy Manufacturing Anchor". This is not significant, however, because the County Plan states that the location of specific anchor uses shall be defined in local Official Plans and the site is designated "Industrial-Type 3" (heavy industry) in the Moore Township Official Plan.

- Site H conforms to the Moore Township Official Plan "Structure Plan" designation ("Major Industrial") and is consistent with the intent of the existing on-site land use designation ("Industrial-Type 3").

- The site is compatible with the industrial land use designations which apply to almost all of the surrounding lands.

- The use of this site changes Terra's and ICI's plans to dispose pond water.

- The development of the facility on Site H would displace some existing industrial development opportunities, including one "dangerous industrial use" or about 100 light and moderate industrial uses. Site H has no adverse impacts on the industrial development potential of the remaining properties owned by Terra and Monsanto. Most of the surrounding area is zoned for industrial uses and Site H would encourage this type of development.

- Without the facility, by the year 2016, the lands surrounding Site H are expected to be developed with mostly moderate and heavy industrial uses with some light uses also possible. With the facility, the surrounding lands are also expected to be industrial but with fewer light industrial uses which may be discouraged by the facility. However, they may already be discouraged by the heavy industrial character of the area. Since there are no significant differences between the "with" and "without the facility" development scenarios, the facility fits into the future urban structure of Moore and Sombra Townships.

In summary, Site H fits into the existing and future urban structure of Moore and Sombra Townships. It has few adverse impacts on the surrounding existing land uses. Its only significant adverse impact is that it changes Terra's and ICI's plans to use this site to dispose pond water.

d) Site I

The net impacts of Site H are presented in Table 4.4 and summarized below:

- Site I fits into and does not change the existing urban structure of Moore and Sombra Townships.

- Site I conforms to the Lambton County Official Plan "Economic Anchor" designation ("Chemical Valley-Heavy Manufacturing Anchor").

- The site conforms to the Moore Township Official Plan "Structure Plan" designation ("Major Industrial") and is consistent with the intent of the existing on-site land use designation ("Industrial-Type 3").

- Site I is compatible with the industrial land use designations which apply to most of the surrounding lands in Moore and Sombra Townships. It is not compatible with the small areas east of Highway 40 which are designated for long-term agricultural use. This, however, is not identified to be a major concern.

- Site I displaces one "dangerous industrial use" or about 70 light and moderate industrial uses. The site could also adversely affect the development potential of approximately 23 hectares of lands owned by ICI which is zoned for agricultural uses and designated for industrial development. With the development of Site I, these lands would have no road access. This is not significant, however, because the development of the 23 ha could be combined with the development of industrial lands to the west.

- Site I changes Terra's and ICI's proposal to dispose pond water.

- The adverse impacts of Site I would discourage the development of the farm-related houses which are allowed on some of the surrounding lands. These uses may already be discouraged by the industrial character of the area. Site I may, however, encourage the development of the industrial uses which are allowed on about two-thirds of the surrounding area.

- Site I will not result in any negative changes to the future urban structure of Moore and Sombra Townships.

In summary, Site I fits into the existing and future urban structure of Moore and Sombra Townships. It has few adverse impacts on the surrounding existing land uses. Its only significant adverse impact is that it changes Terra's and ICI's plans to use this site to dispose pond water.

4.2 Comparative Evaluation of Net Impacts

The following comparative criteria evaluates the four sites on the basis of each criterion. Table 4.5 summarizes the comparison.

With respect to the criterion, *Impacts on existing urban structure*, sites H and I were considered preferred as both these sites are located in heavy industrial areas. With respect to Sites D and K, Site K is slightly preferred as the site is a continuation of an existing waste disposal use although in an agricultural area.

In considering the criterion, *Conformity to Lambton County Official Plan*, Sites D and I were identified as preferred as they are located in the "Chemical Valley - Heavy Manufacturing Anchor" designation. Half of Site K is within this designation whereas Site I is outside of it and thus, less preferred. This, however, is not considered to be a major disadvantage as the County Plan states that the location of specific anchor uses shall be defined in local municipal Official Plans.

Sites D, H and I were considered to be most preferred with respect to the criterion, *Conformity to Township of Moore Official Plan*, as the sites are designated "Major Industrial". Site K was identified to be least preferred as it is located in the agricultural portion of the Township.

With respect to the criterion, *Compatibility with surrounding Official Plan land use designations in surrounding 1 km area*, Sites H and I were identified as most preferred as lands in the surrounding area are primarily designated "Industrial Type 3". Site D is considered second most preferred as 2/3 of the lands are "Industrial Type 3" and 1/3 are "Agricultural". Site K is considered to be least preferred as 2/3 of the surrounding lands are designated "Agricultural".

The next criterion considered was *Compatibility with existing land uses and on-site and in surrounding 1 km area*. Sites H and I were considered to be most preferred as land uses in the vicinity are predominately industrial. There is only 1 residence within 1 km of Site I. Sites D and K have predominately residential and agricultural uses in the site vicinity and are thus considered to be less preferred.

With respect to the criterion, *Compatibility with proposed land uses on-site and in surrounding 1 km area*, Sites D and K were considered to be most preferred as there are no identified proposed land uses either on-site or in the vicinity. Sites H and I were considered to be less preferred due to Terra Canada International plans to develop the sites for pond water disposal.

In considering the criterion, *Potential impacts on development potential of property occupied by site*, Sites H and I were considered less preferred as the sites will displace potential "Dangerous Industrial Uses". Sites D and K were identified to be most preferred as they result in no loss of potential development.

The potential for impact on residential and farm-related commercial and industrial development opportunities were addressed through the criterion, *Potential impacts on existing development opportunities in surrounding 1 km area*. Under this criterion, Site H and I were considered to be most preferred as there is very limited potential for this type of development activity within 1000 m of these sites. Site D was identified as second most preferred closely followed by Site K as least preferred as it has the greatest potential for residential and farm-related development activity. All sites are expected to encourage industrial development.

Finally, with respect to the criterion *Impacts on future urban structure*, Sites H and I were clearly preferred as landfill development at either Sites D or K could prematurely introduce heavy industrial type uses in an area which is predominantly agricultural in nature.

4.3 Advantages and Disadvantages

The advantages and disadvantages of each site are shown on Tables 4.6 to 4.9. The four sites' major advantages and disadvantages consist of the following:

a) Site D

Although the site conforms to the County's and Township's long-range plans for these lands, Site D has many disadvantages. It changes the existing urban structure of Moore Township and is incompatible with the surrounding agricultural area and residential uses. Although this area is designated for industrial development, it is likely to remain agricultural over the next 20 years. As a result, Site D will also be incompatible with the future urban structure of Moore.

b) Site K

The only advantage of Site K is that it makes use of any existing waste disposal facility.

Site K has many of the same disadvantages as Site D. Like Site D, it changes the existing urban structure of the Township and is incompatible with the surrounding agricultural area and residential uses. Site K has the added disadvantages of:

- Not conforming to the Moore Township Official Plan "Structure Plan".

- Part of the site is designated for long-term agricultural use in the Township's Plan.

- Potential greater impact to the future urban structure of Moore Township as most of the lands surrounding Site K are expected to remain in agricultural use.

c) Site H

Site H has a number of advantages and few disadvantages.

With respect to advantages, Site H fits into the existing and future urban structures of Moore and Sombra Townships, it has the longest site life, it conforms to the Moore Township Official Plan and is compatible with the surrounding Official Plan land use designations. It also has minimal adverse impacts on the surrounding existing land uses.

In terms of disadvantages, the development of Site H will result in the loss of land that has development potential for "Dangerous Industrial Uses".

d) Site I

Site I has generally the same advantages as Site H.

Site I was identified to have some minor disadvantages as compared to Site H which included:

- being outside the "Chemical Valley - Heavy Manufacturing Anchor" designation. This, however, is not considered a major disadvantage as the County Plan states that the location of specific anchor uses shall be defined in local municipal Official Plans.
- The lands around Site I have more potential for new residential uses (2 potential houses).
- Site I is closer to the agricultural portions of Moore and Sombra Townships. Some of the lands within 1 km of Site I are designated for long-term agricultural use.

Overall, however, the differences between Sites H and I are considered slight.

4.4 Identification of Preferred Site and Ranking of Sites

Overall from a land use perspective, Sites H and I were identified to be most preferred for a landfill. They were preferred with respect to the following criteria:

- *impacts on existing urban structure;*
- *conformity to Township of Moore Official Plan;*
- *compatibility with surrounding Official Plan land use designations in surrounding 1 km area;*
- *compatibility with existing land uses on-site and in surrounding 1 km area;*
- *potential impacts on existing development opportunities in surrounding 1 km area; and*
- *impacts on future urban structure.*

Site I was also identified to be a preferred site with respect to the criterion, *Conformity to Lambton County Official Plan.*

The only disadvantages of Sites H and I were respect to the criterion:

- *compatibility with proposed land uses on-site and in surrounding 1 km area; and*
- *potential impacts on development potential of property occupied on-site.*

These disadvantages were associated with the proposed pond water disposal on-site by Terra Canada International and the loss of land which could be developed for "Dangerous Industrial Uses". These disadvantages were not considered to off-set the many strong advantages of Sites H and I, particularly their location within an industrial designated area (both County and Township) and that they fit into the existing and future urban structure of Moore and Sombra Townships.

Distinguishing between Sites H and I was found to be difficult and were thus considered equivalent.

Sites D and K were considered to be less preferred than Sites H and I due to:

- greater potential for impacts on urban structure;
- incompatibility with surrounding land use designations; and
- greater potential for impacts and development opportunities.

Of the two sites, Site D was identified to be more preferred as it was ranked higher for the following criteria:

- *conformity to Lambton County Official Plan;*
- *conformity to Township of Moore Official Plan;*
- *compatibility with surround Official Plan land use designations in surrounding 1 km area; and*
- *potential impacts on existing development opportunities in surrounding 1 km area.*

The only advantage which Site K has over Site D is with respect to the criterion, *Impacts on existing urban structure*, as Site K continues on existing waste disposal use although within an agricultural area. This one advantage was not considered to offset its disadvantages. As a result, Site K was identified to be least preferred from a land use perspective.

The overall site ranking is as follows:

LAND USE SITE RANKINGS

	Site	**Ranking**
Most Preferred	Site H	1
	Site I	1
	Site D	3
Least Preferred	Site K	4

TABLE 4.1
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE D

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
1. Impacts on Existing Urban Structure	Potential Changes to Existing Urban Structure	• Introduces a heavy industrial type use into an agricultural area	• none are possible	• same
2. Conformity to Lambton County Official Plan	Conformity to Economic Anchor Designations	• Conforms; located in "Chemical Valley - Heavy Manufacturing Anchor"	• not required	• same
3. Conformity to Township of Moore Official Plan	Conformity to Structure Plan Designations	• Conforms; located in "Major Industrial" area	• not required	• same
	Consistency with Intent of On-Site Land Use Designations	• "Industrial-Type 3" (heavy industry) • Consistent with intent to accommodate large scale or heavy industries; also, the Plan states that the processing and disposal of waste is considered to be an "industrial use"	• not required	• same
4. Compatibility with Official Plan Land Use Designations in Surrounding 1 km Area	Compatibility with Township Official Plan Land Use Designations	• Compatible with "Industrial Type 3" and "Waste Disposal Area" (2/3 of area) but not compatible with "Agricultural" area (remaining 1/3)	• potential impacts on agricultural area can be reduced but not eliminated entirely	• same, but reduced by mitigating measures
5. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Existing Land Uses On-Site	• Requires 57.7 ha of cultivated farmland	• none are possible	• same
	Number of Property Owners Affected	• 1 (166814 Canada Limited)	• none are possible	• same
	Existing Uses within 1,000 m	• Potential incompatibility with surrounding land uses: · 12 residences · agricultural lands · contractor's yard · archery club	• some of these impacts can be reduced but not eliminated entirely	• same, but reduced by mitigating measures
6. Compatibility with Proposed Land Uses On-Site and in Surrounding 1 km Area	Loss of On-Site Proposed Uses	• None; Novacor Petrochemicals Inc. has no immediate or short range (5 year) plans to develop the property.	• not required	• same
	Impacts on Proposed Uses in Surrounding 1 km Area	• None; there is no current development activity	• not required	• same

TABLE 4.1
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE D
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
7. Potential Impacts on Development Potential of Property Occupied by Site	Loss of On-site Development Opportunities	• None; the 75 ha site can only be used for farmland.	• not required	• same
	Impact of Loss of Property on Development Potential of Remaining Property	• No adverse impacts; requires 75 ha of 159 ha 166814 Canada Ltd. property, leaving 84 ha for farming or future industrial development; these lands will have adequate access and lot depths	• not required	• same
	Impact of Loss of On-site Development Opportunities on Municipal Supply of Land	• No adverse impacts; the Township appears to have an adequate supply of agricultural land and industrial land to last well into the future	• not required	• same
8. Potential Impacts on Development Opportunities in Surrounding 1 km Area	Impact on Residential Development Opportunities	• 20 farm related houses • Adverse impacts of the facility would discourage new houses	• impacts can be reduced but not eliminated entirely; would still discourage new houses	• same
	Impact on Farm-related Commercial and Industrial Development Opportunities	• About 7 uses of this type could be discouraged from the facility	• impacts can be reduced but not eliminated	• same
	Impact on Industrial Development Opportunities	• 1 "dangerous" (heavy) industrial use or about 80 light and moderate industrial uses. • The facility would encourage the development of moderate and heavy uses but discourage light industry	• not required	• same

TABLE 4.1
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE D
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
9. Impacts on Future (Year 2016) Urban Structure	Potential Changes to Future Urban Structure (with the facility)	• Could prematurely introduce a heavy industrial type use and other uses attracted by the facility into an area which are expected to be predominantly agricultural in the future; this will prematurely and unnecessarily extend the Chemical Valley area to the east, resulting in the following negative changes: · marked changes in the character of the area · an isolated "pocket" of industrial uses · vacant or under-utilized industrial lands in other parts of Moore · unnecessary and costly extensions of services and road improvements	• none are possible	• same

TABLE 4.2
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE K

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
1. Impacts on Existing Urban Structure	Potential Changes to Existing Urban Structure	• Continues existing waste disposal use of site but the use is significantly intensified; introduces a heavy industrial type use into an agricultural area	• none are possible	• same
2. Conformity to Lambton County Official Plan	Conformity to Economic Anchor Designations	• Western 1/2 of site conforms to "Chemical Valley - Heavy Manufacturing Anchor"; eastern 1/2 does not conform since it is located in the agricultural area; this is not significant, however, because the County Plan states that the location of specific anchor uses shall be defined in local Official Plans	• not applicable	• same
3. Conformity to Township of Moore Official Plan	Conformity to Structure Plan Designations	• Does not conform since it is located in agricultural portion of Township	• none are possible	• same
	Consistency with Intent of On-Site Land Use Designations	• "Waste Disposal Area" (on 3/4 of site) and "Agriculture" (remaining 1/4) • Consistent with and conforms to "Waste Disposal Area" policies but not consistent with intent of "Agriculture" policies to protect the land base for long-term agriculture use	• not applicable	• same
4. Compatibility with Surrounding Official Plan Land Use Designations in Surrounding 1 km Area	Compatibility with Township Official Plan Land Use Designations	• Not compatible with "Agricultural" area (2/3 of area); compatible with "Industrial-Type 3" area (remaining 1/3)	• potential impacts on agricultural area can be reduced but not eliminated entirely	• same, but reduced by mitigating measures
5. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Existing Land Uses On-site	• Requires 14.9 hectares of cultivated farmland	• none are possible	• same
	Number of Property Owners Affected	• 2 (Wolff and Township of Moore)	• none are possible	• same

TABLE 4.2
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE K
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
	Existing Uses within 1,000 m	• Potential incompatibility with surrounding land uses: · 8 residences · agricultural lands · 1 commercial use · archery club	• some of these impacts can be reduced but not eliminated entirely	• same, but reduced by mitigating measures
6. Compatibility with Proposed Land Uses On-Site and in Surrounding 1 km Area	Loss of On-Site Proposed Uses	• None; there are no new uses proposed for this site	• not required	• same
	Impacts on Proposed Uses in Surrounding 1 km Area	• None; there is no current development activity	• not required	• same
7. Potential Impacts on Development Potential of Property Occupied by Site	Loss of On-site Development Opportunities	• None; the 75 ha site consists of the existing 18 ha landfill site; remaining lands can only be used for farmland	• not required	• same
	Impact of Loss of Property on Development Potential of Remaining Property	• None; requires 17 ha owned by a local farmer (see Agricultural Impact Assessment); property has no potential for urban development	• not required	• same
	Impact of Loss of On-site Development Opportunities on Municipal Supply of Land	• No adverse impacts; the Township appears to have an adequate supply of agricultural land	• not required	• same
8. Potential Impacts on Development Opportunities in Surrounding 1 km Area	Impact on Residential Development Opportunities	• 28 farm related houses • Adverse impacts of the facility would discourage new houses	• impacts can be reduced but not eliminated entirely; would still discourage new houses	• same
	Impact on Farm-related Commercial and Industrial Development Opportunities	• About 11 uses of this type • The facility would detract from the agricultural character of the area, thereby discouraging new uses of this type.	• impacts can be reduced but not eliminated	• same
	Impact on Industrial Development Opportunities	• None.	• not required	• same

TABLE 4.2
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE K
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
9. Impacts on Future (Year 2016) Urban Structure	Potential Changes to Future Urban Structure of Moore Township (with the facility)	• Could prematurely introduce a heavy industrial type use and other uses attracted by the facility into an area which is expected to be agricultural in the future; unnecessarily extends the Chemical Valley area to the east, resulting in the following negative changes: · marked changes in the character of the area · an isolated "pocket" of industrial uses · vacant or under-utilized industrial lands in other parts of Moore · unnecessary and costly extensions of services and road improvements	• none are possible	• same

TABLE 4.3
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE H

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
1. Impacts on Existing Urban Structure	Potential Changes to Existing Urban Structure of Moore Township	• None; introduces a heavy industrial type used into the Moore portion of the Chemical Valley, a heavy industrial area	• not required	• same
	Potential Changes to Existing Urban Structure of Sombra Township	• None; introduces a heavy industrial type use into the Sombra portion of Chemical Valley, a heavy industrial area	• not required	• same
2. Conformity to Lambton County Official Plan	Conformity to Economic Anchor Designations	• Does not conform since it is located outside of the Chemical Valley area in agricultural area; this is not significant, however, because the County Plan states that the location of specific anchor uses shall be defined in local municipal Official Plans	• not required	• same
3. Conformity to Township of Moore Official Plan	Conformity to Structure Plan Designations	• Conforms; located in "Major Industrial" area	• not required	• same
	Consistency with Intent of On-Site Land Use Designations	• "Industrial-Type 3" (heavy industry) • Consistent with intent to accommodate large scale or heavy industries; also, the Plan states that "the processing and disposal of waste is considered (to be) an industrial use"	• not applicable	• same

TABLE 4.3
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE H
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
4. Compatibility with surrounding Official Plan Land Use Designations in Surrounding 1 km Area	Compatibility with Township Official Plan Land Use Designations	• Moore Township compatible with "Industrial Type 3" but slightly less compatible with "Industrial Type 2" area (moderate industry) (2/3 of surrounding 1 km area); also compatible with very small area designated Environmental Protection (Bowen's Creek and St. Clair River) which allows industrial docking and water intakes (for remaining 1/3 of surrounding area, see next indicator) • Sombra Township compatible with "Industrial" area (1/3 of surrounding area), "Low Hazard" area along the river and very small area on river designated "Open Space"	• not required	• same
5. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Existing Land Uses On-Site	• Requires 68 ha of cultivated farmland	• none are possible	• same
	Number of Property Owners Affected	• 2 (Terra Canada International and Monsanto)	• none are possible	• same
	Existing Uses within 1,000 m	• Generally compatible with surrounding land uses · vacant industrial lands and plants · agricultural lands · Terra Industrial Plant · recreation park	• mitigation measures should reduce impacts	• same, but reduced by mitigating measures
6. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Loss of On-Site Proposed Uses	• Changes Terra Canada International plans to dispose pond water on Sites H and I	• none are possible	• same
	Impacts on Proposed Uses	• None; there is no current development activity	• not required	• same

TABLE 4.3
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE H
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
7. Potential Impacts on Development Potential of Property Occupied by Site	Loss of On-site Development Opportunities	• Displaces 1 "Dangerous Industrial Use" or about 100 light and moderate industrial uses	• none are possible	• same
	Impact of Loss of Property on Development Potential of Remaining Property	• No adverse impacts on Terra Property; requires 54 ha of 114 ha property, leaving 60 ha for industrial development with frontages on Townline Road and County Road 33 and adequate lot depths.	• not required	• same
		• No adverse impacts on Monsanto property; requires 21 ha of 42 ha property, leaving 21 ha for industrial development; does not restrict the type of uses allowed because Monsanto owns an adjacent 55 ha of land	• not required	• same
	Impact of Loss of On-site Development Opportunities on Municipal Supply of Land	• None; the Township has an adequate supply of industrial land	• not required	• same
8. Potential Impacts on Development Opportunities in Surrounding 1 km Area	Impact on Residential Development Opportunities	• None	• not required	• same
	Impact on Farm-related Commercial and Industrial Development Opportunities	• None	• None	• same
	Impact on Industrial Development Opportunities	• About 7 "dangerous" (heavy) industrial uses or about 400 light and moderate industrial uses. • The facility would encourage the development of moderate and heavy uses but discourage light industry; however, existing heavy industrial character of area may already discourage light industry	• not required	• same
9. Impacts on Future (Year 2016) Urban Structure	Potential Changes to Future Urban Structure (with the facility)	• No adverse changes, fits into future urban structure	• none required	• same

TABLE 4.4
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE I

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
1. Impacts on Existing Urban Structure	Potential Changes to Existing Urban Structure	• None; introduces a heavy industrial type use into the Moore portion of the Chemical Valley, a heavy industrial area	• not required	• same
2. Conformity to Lambton County Official Plan	Conformity to Economic Anchor Designations	• Conforms; located in "Chemical Valley -Heavy Manufacturing Anchor"	• not required	• same
3. Conformity to Township of Moore Official Plan	Conformity to Structure Plan Designations	• Conforms; located in "Major Industrial" area	• not required	• same
	Consistency with Intent of On-Site Land Use Designations	• "Industrial-Type 3" (heavy industry) • Consistent with intent to accommodate large scale or heavy industries; also, the Plan states that "the processing and disposal of waste is considered (to be) an industrial use"	• not applicable	• same
4. Compatibility with Official Plan Land Use Designations in Surrounding 1 km Area	Compatibility with Township Official Plan Land Use Designations	• Moore Township compatible with "Industrial Type 3" area (on 2/3 of surrounding area) and very small area designated "Environmental Protection" (Clay Creek); not compatible with small area designated "Agricultural" on lands east of Hwy 40 (for remaining 1/3 of surrounding area, see next indicator) • Sombra Township compatible with "Industrial" area and "High Hazard" area (Clay Creek) (1/3 of surrounding area) but not compatible with small area designated "Rural" east of Hwy 40	• some impacts on agricultural area can be reduced but not eliminated entirely. Hwy 40 constitutes a significant barrier which would minimize most impacts	• same, but reduced by mitigating measures
5. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Existing Land Uses On-site	• Requires 75 ha of cultivated farmland	• none are possible	• same
	Number of Property Owners Affected	• 1 (ICI Canada Inc.)	• none are possible	• same

TABLE 4.4
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE I
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
	Existing Uses within 1,000 m	• Generally compatible with surrounding land uses: · vacant industrial land and plants · agricultural lands · Terra Industrial Plant · 1 residence	• mitigation measures should reduce impacts	• same, but reduced by mitigating measures
6. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Loss of On-Site Proposed Uses	• Changes Terra and ICI plans to dispose pond water on Site I	• none are possible	• same
	Impacts on Proposed Uses in Surrounding 1 km Area	• Compatible with Lambton Sportsmen Ltd. proposed gun club	• not required	• same
7. Potential Impacts on Development Potential of Property Occupied by Site	Loss of On-site Development Opportunities	• Displaces 1 "Dangerous Industrial Use" or about 70 light and moderate industrial uses that could be built on part of site zoned for industrial uses	• none are possible	• same
	Impact of Loss of Property on Development Potential of Remaining Property	• Isolates a 23 ha parcel of property owned by ICI Canada Inc. and zoned A.1, on the north part of Lot 26, leaving no road access to this property; this is not significant, however, because these lands are designated for industrial development and could be combined with the development of the industrial lands to the west	• not required	• same
		• No adverse impacts on remaining 43 ha of ICI Canada Inc. property zoned for industrial uses; fronts onto Sideroad 27-28 and has an adequate lot depth	• not required	• same
	Impact of Loss of On-site Development Opportunities on Municipal Supply of Land	• No adverse impacts; the Township appears to have an adequate supply of industrial land	• not required	• same

TABLE 4.4
IMPACTS, MITIGATING MEASURES AND NET IMPACTS OF SITE I
(Continued)

Evaluation Criteria	Indicators	Impacts	Mitigating Measures	Net Impacts
8. Potential Impacts on Development Opportunities in Surrounding 1 km Area	Impact on Residential Development Opportunities	• 2 farm related houses • Impacts of the facility would discourage new houses; however, these are probably already discouraged by industrial character of area	• one possible mitigation measure would be to amend the existing planning documents to prevent new residential development • impacts can be reduced but not eliminated entirely; would still discourage new houses	• same
	Impact on Farm-related Commercial and Industrial Development Opportunities	• None	• not required	• same
	Impact on Industrial Development Opportunities	• 3 or 4 "dangerous" (heavy) industrial uses or about 280 light and moderate industrial uses in Moore and 50 light industrial uses or 9 moderate industrial uses in Sombra • The facility would encourage the development of moderate and heavy uses but discourage light industry; however, existing heavy industrial character of area may already discourage light industry	• not required	• same
9. Impacts on Future (Year 2016) Urban Structure	Potential Changes to Future Urban Structure (with the facility)	• No adverse changes, fits into future urban structure	• none required	• same

TABLE 4.5
COMPARATIVE EVALUATION OF NET IMPACTS OF SITES D, K, H AND I

Evaluation Criteria	Indicators	Net Impacts				Preferred Site(s)	Least Preferred Site(s)
		Site D	Site K	Site H	Site I		
1. Impacts on Existing Urban Structure	Potential Changes to Existing Urban Structure	• Introduces a heavy industrial type use into an agricultural area	• Intensified use of site makes it unable to fit into existing agricultural area; introduces a heavy industrial type use into an agricultural area	• None, introduces a heavy industrial type use into the Moore portion of the Chemical Valley, a heavy industrial area	• Same as H	H, I	D, K
2. Conformity to Lambton County Official Plan	Conformity to Economic Anchor Designations (Schedule "A")	• Conforms, designated "Chemical Valley - Heavy Manufacturing Anchor"	• 1/2 of site conforms to "Chemical Valley - Heavy Manufacturing Anchor"; remaining 1/2 does not conform to agricultural area	• Does not conform, located outside of Chemical Valley designation in agricultural area	• Conforms, same as D	D, I	H
3. Conformity to Township of Moore Official Plan	Conformity to Structure Plan Designations (Schedule "A")	• Conforms, designated "Major Industrial".	• Does not conform, located in agricultural portion of the Township	• Same as D	• Same as D	D, H, I	K
	Consistency with Intent of On-Site Land Use Designations	• "Industrial-Type 3" (heavy industry) • Consistent with intent to accommodate large scale or heavy industries	• Waste Disposal Area" (3/4) and "Agriculture" (1/4) • Consistent with intent of "Waste Disposal Area" policies but not consistent with intent of "Agriculture" policies	• Same as D	• Same as D	D, H, I	K
4. Compatibility with Official Plan Land Use Designations in Surrounding 1 km Area	Compatibility with Township Official Plan Land Use Designations	• Moore Township compatible with "Industrial-Type 3" area and "Waste Disposal Area" (2/3 of surrounding 1 km area) but not compatible with "Agricultural" area (remaining 1/3)	• Moore Township not compatible with "Agricultural" area (2/3 of surrounding 1 km area); compatible with "Industrial-Type 3" area (remaining 1/3)	• Moore Township compatible with "Industrial-Type 3" area but slightly less compatible with "Industrial-Type 2" area (moderate industry); also compatible with very small area designated "Environmental Protection" which allows industrial docking and water intakes	• Moore Township compatible with "Industrial-Type 3" area and very small area designated "Environmental Protection" (Clay Creek); not compatible with small area designated "Agricultural" east of Hwy 40	H	K

TABLE 4.5
COMPARATIVE EVALUATION OF NET IMPACTS OF SITES D, K, H AND I
(Continued)

Evaluation Criteria	Indicators	Net Impacts				Preferred Site(s)	Least Preferred Site(s)
		Site D	Site K	Site H	Site I		
				• Sombra Township compatible with "Industrial" area, "Low Hazard" area along river and very small area on river designated "Open Space"	• Sombra Township compatible with "Industrial" area and "High Hazard" area (Clay Creek) but not compatible with small area designated "Rural" east of Hwy 40		
5. Compatibility with Existing Land Uses On-Site and in Surrounding 1 km Area	Number of Property Owners Affected	• 1 (166814 Canada Limited)	• 2 (Wolff and Township of Moore)	• 2 (Terra Canada International and Monsanto)	• 1 (IC Canada Inc. owned by Terra Canada International)	D, I	H, K
	Existing Uses On-Site	• Requires 58 ha of farmland	• Requires 15 ha of farmland	• Requires 68 ha of farmland	• Requires 75 ha of farmland	K	D, H, I
	Existing Uses within 1,000 m	• Potential incompatibility with surrounding land uses: · 12 residences · agricultural lands · contractor's yard · CKJD Radio Antenna · archery club	• Potential incompatibility with surrounding land uses: · 8 residences · oil storage facility · commercial use (Robbins Construction · CKJD Radio Antenna · agricultural lands · archery club	• Generally compatible with surrounding land uses: · vacant industrial lands and plants · agricultural lands · Terra Industrial Plant · recreational park	• Generally compatible with surrounding land uses: · 1 residence · Terra Industrial Plant · vacant industrial lands · recreational park	H, I	D, K
6. Compatibility with Proposed Land Uses On-Site and in Surrounding 1 km Area	Loss of On-Site Proposed Uses	• None	• None	• Changes Terra and ICI plans to dispose pond water on Sites H and I	• Same as H	D, K	H, I
	Impacts on Proposed Uses in Surrounding 1 km Area	• None; there is no current development activity	• Same as D	• Same as D	• Compatible with Lambton Sportsmen proposed gun club	K, D, H, I	--

TABLE 4.5
COMPARATIVE EVALUATION OF NET IMPACTS OF SITES D, K, H AND I
(Continued)

Evaluation Criteria	Indicators	Net Impacts				Preferred Site(s)	Least Preferred Site(s)
		Site D	Site K	Site H	Site I		
7. Potential Impacts on Development Potential of Property Occupied by Site	Loss of Existing On-Site Development Opportunities	• None	• None	• Displaces 1 "Dangerous Industrial Use" or about 100 light and moderate industrial uses	• Displaces 1 "Dangerous Industrial Use" or about 70 light and moderate industrial uses	D, K	H, I
	Impact of Loss of Property on Development Potential of Remaining Property	• No adverse impacts	• No adverse impacts	• No adverse impacts	• Isolates a 23 ha parcel of land zoned for agricultural uses on north part of Lot 26, resulting in no road access to this property; not significant, however, since the property is designated for industrial uses and its development could be combined with lands to the west	D, K, H	I
8. Potential Impacts on Development Opportunities in Surrounding 1 km Area	Impact on Residential Development Opportunities	• Adverse impacts of the facility would discourage the 20 farm related houses allowed in surrounding 1 km area	• Same as D, but affects about 28 potential houses	• None	• Same as D but only affects 2 potential houses	H	K
	Impact on Farm-related Commercial and Industrial Development Opportunities	• Detracts from the agricultural character of the area, thereby discouraging the 7 uses of this type which are allowed in the surrounding area	• Same as D, but affects about 11 potential uses of this type	• None	• None	H, I	D, K

TABLE 4.5
COMPARATIVE EVALUATION OF NET IMPACTS OF SITES D, K, H AND I
(Continued)

Evaluation Criteria	Indicators	Net Impacts				Preferred Site(s)	Least Preferred Site(s)
		Site D	Site K	Site H	Site I		
	Impact on Industrial Development Opportunities	• Encourages the development of moderate and heavy uses but may discourage light industry (1 "Dangerous" (heavy) industrial use or about 80 light and moderate industrial uses are allowed in the surrounding 1 km area)	• None	• Same as D; however, existing heavy industrial character of area may already discourage light industry (about 8 "Dangerous" industrial uses or about 500 light and moderate uses are allowed in the surrounding 1 km area)	• Same as D; however, existing heavy industrial character of area may already discourage light industry (4 or 5 "Dangerous" industrial uses or about 250 light and moderate uses in Moore; 50 light industrial uses or 9 moderate industrial uses in Sombra)	H, I	D
9. Impacts on Future (Year 2016) Urban Structure	Potential Changes to Future Urban Structure	• Prematurely introduces a heavy industrial type use and other uses attracted by the facility into an area which will be predominantly agricultural in the future; this will unnecessarily and prematurely extend the Chemical Valley area to the east	• Prematurely introduces a heavy industrial type use and other uses attracted by the facility into an area which will be predominantly agricultural in the future; this will unnecessarily and prematurely extend the Chemical Valley area to the east	• No adverse changes, fits into future urban structure	• Same as H	H, I	D, K

TABLE 4.6
ADVANTAGES AND DISADVANTAGES OF SITE D

Advantages	Disadvantages
• Conforms to Lambton County Official Plan "Economic Anchor" designation ("Chemical Valley-Heavy Manufacturing Anchor").	• Introduces a heavy industrial type use into an existing agricultural area.
• Conforms to Moore Township Official Plan Structure Plan designation ("Major Industrial").	• Not compatible with Moore Township Official Plan "Agriculture" land use designation on one-third of surrounding area.
• Consistent with intent of Moore Township Official Plan on-site land use designation ("Industrial-Type 3").	• Incompatible with surrounding agricultural and residential land uses
• Compatible with surrounding Moore Township Official Plan land use designations on two-thirds of surrounding area ("Industrial-Type 3" and "Waste Disposal Area").	• Adverse impacts of the facility would discourage the farm-related houses and farm-related commercial and industrial uses allowed by the existing zoning on nine-tenths of the surrounding area.
• Does not displace any on-site proposed uses or development opportunities.	• Year 2016 future use of the surrounding area, without the facility, is expected to be agriculture with some industry west of Highway 40. Prematurely introduces a heavy industrial type use and other uses attracted by the facility into an area which will be predominantly agricultural in the future; unnecessarily extends the Chemical Valley to the east.

TABLE 4.7
ADVANTAGES AND DISADVANTAGES OF SITE K

Advantages	Disadvantages
• Makes use of an existing waste disposal facility. • Western one-half of site conforms to Lambton County Official Plan Economic Anchor designation ("Chemical Valley-Heavy Manufacturing Anchor"). • Three-quarters of site conforms to Moore Township Official Plan on-site land use designation ("Waste Disposal Area"). • Compatible with Moore Township Official Plan "Industrial-Type 3" land use designation on one-third of surrounding area. • Does not displace any on-site proposed uses or development opportunities.	• Existing waste disposal use is significantly intensified; introduces a heavy industrial type use into an existing agricultural area. • Eastern one-half of site does not conform to Lambton County Official Plan Economic Anchor designation (outside of anchor in agricultural area). This is not significant, however, because County Plan states that the specific location of anchor uses will be determined in local municipal Official Plans. • Does not conform to Moore Township Official Plan Structure Plan designation (outside of "Major Industrial" area in agricultural portion of the Township). • Not consistent with intent of Moore Township Official Plan on-site "Agriculture" land use designation on one-quarter of the site. • Incompatible with surrounding agricultural and residential land uses. • Not compatible with Moore Township Official Plan "Agriculture" land use designation on two-thirds of surrounding area. • Adverse impacts of the facility would discourage the farm-related houses and farm-related commercial and industrial uses allowed by the existing zoning in the surrounding area. • Year 2016 future use of the surrounding area, without the facility, is expected to be agriculture. Introduces a heavy industrial type use and other uses attracted by the facility into an area which will be agricultural in the future; unnecessarily extends Chemical Valley to the east.

TABLE 4.8
ADVANTAGES AND DISADVANTAGES OF SITE H

Advantages	Disadvantages
• Introduces a heavy industrial type use into the Moore and Sombra portions of the Chemical Valley, a heavy industrial area. • Conforms to Moore Township Official Plan Structure Plan designation ("Major Industrial").	• Does not conform to Lambton County Official Plan Economic Anchor designation (located outside of anchor in agricultural area). This is not significant, however, because County Plan states that the specific location of anchor uses will be determined by local municipal Official Plans.
• Consistent with intent of Moore Township Official Plan on-site land use designation ("Industrial-Type 3").	• Displaces some on-site industrial development opportunities.
• Compatible with surrounding Moore Township Official Plan land use designations, with the exception that it may be slightly less compatible with "Industrial-Type 2" (moderate industry) designation on some of the surrounding area.	• Changes Terra's and ICI's plans to dispose pond water on site.
• Compatible with surrounding Sombra Township Official Plan land use designations.	
• Compatible with existing industrial uses in surrounding area.	
• The facility would encourage the development of the industrial uses allowed by the existing zoning, but discourage light industry. However, these may already be discouraged by the existing heavy industrial character of the area.	
• Year 2016 future use of the surrounding area, without the facility, is expected to be heavy and moderate industries, with some light uses also possible. Fits into future urban structure. However, could discourage light industry but these may already be discouraged.	

TABLE 4.9
ADVANTAGES AND DISADVANTAGES OF SITE I

Advantages	Disadvantages
• Introduces a heavy industrial type use into the Moore and Sombra portions of Chemical Valley, a heavy industrial area. • Conforms to Lambton County Official Plan Economic Anchor designation ("Chemical Valley-Heavy Manufacturing Anchor"). • Conforms to Moore Township Official Plan Structure Plan designation ("Major Industrial"). • Consistent with intent of Moore Township Official Plan on-site land use designation ("Industrial-Type 3"). • Compatible with surrounding Moore and Sombra Township Official Plans land use designations, with the exception of small areas designated "Agriculture" and "Rural" east of Highway 40. • Compatible with existing industrial uses in surrounding area. • The facility would encourage the development of the industrial uses which are allowed by the existing zoning, but discourage light industry. However, light industry may already be discouraged by the heavy industrial character of the area. • Year 2016 future use of the surrounding area, without the facility, is expected to be heavy and moderate industries with some light uses also possible. Fits into future urban structure. However, could discourage light industry but these may already be discouraged by heavy industrial character of the area.	• Not compatible with small areas east of Highway 40 designated "Agriculture" in Moore Township Official Plan and "Rural" in Sombra Township Official Plan. • Displaces some on-site development opportunities for industrial uses. • Changes Terra's and ICI's plans to dispose pond water on site. • Adverse impacts of the facility would discourage the farm-related houses which are currently allowed in part (one-quarter) of the surrounding area zoned A.1.

5.0 SUMMARY

The purpose of the land use impact assessment is to identify, from a land use perspective, a preferred site for Lambton County's long-term waste management facility. The Study Area for the assessment consisted of the lands within 1 km of the sites, when dealing with detailed land use issues such as compatibility with adjacent uses, and larger areas, when dealing with broader issues, such as impacts on existing and future urban structure. The assessment determined the existing, potential and future (year 2016) land use conditions of the four short-listed sites and the surrounding areas and identified, evaluated and compared the impacts of the sites on these land use conditions.

Based on the assessment, Sites H and I were identified as the preferred sites. Sites D and K were identified as the least preferred sites, with Site K as the worst site.

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Telephone Discussions and Correspondence With:

- Mr. Steve Evans, Senior Planner, Lambton County Planning and Development Department
- Mr. Dave Posliff, Planner, Lambton County Planning and Development Department
- Mr. Mike Ireland, Development Officer, Sarnia-Lambton Economic Development Commission

- Mrs. Beth Lockhart, Property Manager, Novacor Petrochemicals Inc.
- Mr. Dan Gutteridge, Director of Parks and Property, The St. Clair Parkway Commission
- Mr. Ron Whitman, Clerk, Township of Moore
- Mr. John DeMars, Clerk-Administrator, Township of Sombra

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4F
SOCIAL IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from a social perspective, including visual impacts. The purpose of this impact assessment was to identify the relative order of preference of the sites (i.e. best to worst sites) with respect to social considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill was considered to be the most significant component of the waste management facility in identifying and comparing potential social impacts.

The key considerations addressed in this study were:

- the potential for disruption (e.g. visual, noise, and odour) to individuals in the vicinity of the sites and along the access routes;

- the potential for disruption of community and recreation features in the vicinity of the sites and along the access routes; and

- the potential for disruption to communities in the vicinity of the sites.

In pursuit of the study purpose outlined above, there are several study objectives:

- to identify the existing social conditions;

- to identify the social impacts that might occur in the vicinity of the site and within the community(s) associated with the sites;

- to investigate the nature, significance and acceptability of the potential impacts;

- to identify any differences between the four candidate sites with respect to social considerations and clarify decision trade-offs; and

- to describe the advantages and disadvantages of each site from a social perspective, and rank the sites in their order of preference.

1.2 Scope of Study

Social impacts can occur on individuals and on communities as a whole. The day-to-day lives of individuals living near the facility may be disrupted. Nuisance effects such as noise, dust and odour from either on-site operations or landfill truck traffic may reduce the use and enjoyment of people's property. As a result of these potential effects, residents may become less satisfied with their community, and may in extreme cases, decide to move elsewhere. These individual effects can then have large ramifications on the community. For example, people withdrawing from community activities or opting to move away can affect a community's closeness or cohesiveness.

People may also have strong concerns about their health and safety, and develop fears regarding the facility. This may result in feelings of loss of control, depression and on-going stress.

The nature and significance of potential social impacts will depend upon: the nature of the landfilling operations, the proximity and social characteristics of the people and community(ies) in the vicinity of the operations, and the willingness/capability of the County to respond to people's issues/concerns through the implementation of impact management measures. Social characteristics such as population structure, community character, residents' daily activities and past experiences will influence the public's perception, acceptance and response to a proposed undertaking. Since the characteristics of one community will be different from the next, the social impacts of a landfill site in one area can be expected to be different from the impacts of a landfill in another area.

The activities outlined below form the basis of the approach adopted for this study. All of these activities are examined in more detail in subsequent sections.

> <u>Scoping</u> involves the narrowing down or focusing of all issues of concern relevant to the proposed project.
>
> <u>Profiling</u> involves the description of the existing social conditions in the area likely to be affected.

Projection involves the determination of the impacts which may occur should the undertaking proceed.

Assessment is the attachment of meaning or significance to the forecasted impacts by determining their relative importance, taking into account the views of those who may be affected.

Recommendation involves identifying the option(s) which has the least potential for social impacts.

1.3 Report Organization

Chapter 2.0, entitled "Study Approach", outlines the boundaries of the assessment in terms of study boundaries, key assumptions and public issues of concern.

Chapter 3.0, entitled "Existing Social Conditions", profiles residents, features and the community in the vicinity of each site and along access routes.

Chapter 4.0, entitled "Potential Social Impacts", addresses the projected social impacts of each of the candidate waste management facility sites.

Chapter 5.0, entitled "Comparative Evaluation", discusses the results of the comparative evaluation of the candidate sites.

2.0 STUDY APPROACH

2.1 Study Design

The study design determines what is going to be studied and how is it to be studied. By setting the study design, an overall study approach or framework can be followed. The study design involved:

- scoping of public issues;
- setting the study boundaries;
- specifying key assumptions; and
- choosing the appropriate evaluation criteria and data sources.

2.2 Scoping of Public Concerns

By recognizing the key public concerns, the study can be focused on the issues which are of most relevance to the communities involved. These issues are then verified through the data collection activities undertaken as part of the SIA.

The following outlines the activities and resources utilized to scope out the SIA:

- review of comments from the March 30, 1993 open house;
- review of comments from the April 21, 1993 local residents meeting;
- discussions with other study team members;
- review of available mapping; and
- field visits in the vicinity of the sites.

Key issues identified as a result of the scoping activities include:

- residents felt that sites H and I are more appropriate than Sites D and K as there are fewer residents in the vicinity and the lands are of a more industrial character;

- concerns for the loss of agricultural land (Sites D and K);

- potential for increases in traffic endangering children and farmers (Sites D and K);

- property values will decrease and compensation will not cover people's losses (Sites D and K);

- Sites H and I were indicated to be too close to the St. Clair River;

- since Site K is next to an existing landfill, it might be the better site;

- leachate migration leading to ground water contamination (Sites D and K);

- stigma of having a landfill in the local community (Sites D and K).

2.3 Study Boundaries

Three types of boundaries were identified to be of relevance to this SIA:

- social units;
- geographic areas; and
- time horizon.

2.3.1 Social Units

Boundaries for data collection and analysis can be defined through social structure typologies. Three different types of social structures were initially defined:

- individuals/households;
- facilities; and
- communities.

The focus of the SIA was on residents now located within the study zones and not on future residents. Residents currently living within the area will have to cope with any effects which result from the development and operation of the facility. Future residents, however, will choose to live in the area with full recognition that a landfill is currently in operation.

Potential impacts to community or recreation features such as in the vicinity of the sites were also addressed. Emphasis was placed on trying to understand the importance of the feature within the community and how its operation might be affected.

"Community" is probably the most complex social unit to define. For the purposes of this assessment, community is defined simply as a collective group of individuals who share a common geographic area, exhibit common ties and interact with one another.

2.3.2 Geographic Areas

The boundaries of the SIA Study Areas were determined for the purpose of data collection. For the purposes of this assessment, four geographic areas were established.

The "facility site area" was defined as the 75 ha area of land required for the waste management facility. As there are no residences or established community/recreational features, it was not recognized as a Study Area on its own, but was combined with the site vicinity area.

1) Site Vicinity

The site vicinity is defined as the area directly surrounding each of the proposed sites and deals with those impacts which may be experienced by individuals living near the facility. The following was considered in establishing the site vicinity Study Area:

i) Ontario Ministry of Environment and Energy's (MOEE) concern for land use within 500 m of the fill area.

In this policy document (07-07), it is stated that: "the most significant adverse environmental effects are normally within 500 m of the perimeter of a fill area."[1] This estimate is based on <u>average</u> distances at existing landfills over which nuisances such as noise, litter, dust, methane gas, and leachate tend to disperse.

ii) Need for a Margin of Error

As it is possible that impacts could exceed the 500 m MOEE guideline, it was decided to add an additional 500 m to the primary Study Area as a safety criteria. This was done in recognition that the MOEE 500 m guideline is based on an average dispersion distance of landfill effects.

The site vicinity Study Area used in the SIA was measured from the outer perimeter of the 75 ha land parcel. Thus, the Study Area takes into account the potential for impacts from the landfill, MRF and composting facility. Also, even though conceptual designs for the composite facility have been

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[1] Ministry of the Environment, <u>Land Use On or Near Landfills and Dumps</u>, (No. 07-07) Environmental Approvals and Land Use Planning Branch, Toronto, Ontario. 1987.

developed, they may change in the future. By assuming that the Study Area follows the composite facility boundaries, the position of the landfill within the composite facility site can be changed without having to change the location of the Study Area. By taking into account the outer boundary of the facility, an additional margin of error is realized.

iii) Other Landfill Assessments

Information on the extent of social effects from operating municipal landfills is somewhat limited. A review of a sample of recently completed detailed assessments for municipal landfills revealed that most nuisance effects are projected to remain largely within 1,000 m of the fill area and that the most significant effects are projected to remain within 500 m of the fill area.[2] Although, these projected distances are largely due to the nature of the landfill design and operations, they do illustrate that landfill effects generally remain within the immediate vicinity of the landfill.

Also, work recently completed as part of the Interim Waste Authority landfill site search process indicates that the most significant nuisance effects (based on noise, dust and odour technical studies) from landfill operations are expected to largely remain within 500 m of the fill area.[3]

Based on MOEE's policy, the need for a margin of error, and other landfill studies, the site vicinity Study Area is defined as the area within 1 km (1,000 m) of the landfill site boundaries. It should be noted that data was, however, collected within an area of 1.5 km from each candidate site and used for social profiling.

2) Local Community Study Area

The community was defined taking into account the resident's perception regarding the social boundaries for their community (i.e. who was part of the community and who was not).

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[2] Although they have not been approved by the Province, the following municipal landfill assessments were consulted: Sarnia Landfill Expansion, Durham P1 Landfill, Steetley South Quarry Landfill Development.

[3] Interim Waste Authority Landfill Site Search, EA Document.

This was accomplished by asking residents to define their community during the resident telephone interviews. Section 3.0 discusses the "community" as defined by the local residents for each candidate site.

3) Access Route Study Area

In addition to the site vicinity Study Area, an access route Study Area was also considered. For Sites D and K an access route was defined as Highway 80 east of Highway 40 to the site entrance for Site D and Township Road 22 for Site K. The Site K access point is the same as used for the existing Moore Township landfill which is off of Township Road 22. For Sites H and I, the access route was defined as Townline Road west of Highway 40 to the site entrance.

Consideration was given for nuisance and safety effects for individuals who live directly adjacent to the preferred access route.

In summary, four main Study Areas were identified:

- the site vicinity Study Area (on site and 0 - 1,000 m from the site boundary);
- the local community Study Area(s); and
- the access route Study Area.

2.3.3 Time Horizon

The assumed time horizon for the SIA relates to the future conditions for individuals and the community currently in proximity of each of the candidate landfill sites. This period served as the main basis of the assessment. It includes both construction and operation periods with an assumed planning period of 20 years.

2.4 Facility Design Assumptions

Table 1 lists the assumptions recognized regarding the design and operation of the waste management facility in the social impact assessment. These assumptions were based on the facility characteristic assumptions provided by the Design and Operations discipline.

TABLE 1
DESIGN AND OPERATION ASSUMPTIONS

Total Site Area	185 acres (75 ha)
Landfill Site Area	33 acres (13.2 ha)
Maximum Landfill Height	56 ft. (17 m)
Landfill Visibility	Up to 3 km away
Buildings on Site	3 three-storey buildings
Waste Trucks	25 to 40 trucks daily
Facilities on Site	Landfill, MRF, Centralized Composting

2.5 Evaluation Criteria

Based on the scoping exercise, a list of evaluation criteria was developed for use in the assessment. The criteria were used as a framework for profiling the area and for the comparative evaluation of candidate sites. It should be highlighted that as there were no residents or community features located on-site, the potential for displacement was not applicable. Table 2 summarizes the criteria and their associated indicators. The indicators define what is to be measured. The data sources for each of the evaluation criteria are also specified.

2.6 Data Collection

The following describes the methods used to gather data for the social impact assessment.

Field Survey

An initial roadside field survey was conducted within approximately 1,500 m of each of the candidate sites and along the access routes. These field surveys were used to identify the number and location of residences and community/recreation features, and to characterize the nature of the area.

TABLE 2
CRITERIA/INDICATORS/INFORMATION SOURCES

Criteria	Indicators	Definition	Data Source
Potential for disruption to individuals in the site vicinity study area.	Number of residences/residents Number of vulnerable residents: • age • health • number home during facility operating hours Uses of property (by residents and non-residents)	This criterion deals with the potential for disruption to existing residents who live in the vicinity of the facility and those individuals who are involved in social/recreation activities in the vicinity of the facility. Individuals may experience disruption to their daily activities and use and enjoyment of property. These disruption effects may be generated through nuisance effects resulting from the waste management facility.	Field Survey, Assessment Roll, Land Use Assessment Site Vicinity Resident Interviews
Potential for disruption of community and recreation features in the site vicinity study area	Number of features in the site vicinity Characteristics of features • hours of operation • outdoor vs. indoor use • expansion plans	This criterion deals with the potential disruption to community and recreation features in the vicinity of the facility. The concern is with the potential change in demand for the feature and/or change in its quality. Community and recreation features contribute to the cohesion of an area and disruption of the features could lead to changes in resident interactions.	Field Survey, Assessment Roll, Land Use Assessment Interviews with Owners/Operators of Features
Potential for disruption of residents in the access route study area	Number of residents within the access route study area Number of vulnerable residents: • age • health • number home during facility operating hours Uses of property Uses of shoulder of road	This criterion deals with the potential for disruption to existing residents who live along the facility access routes. Residents may experience disruption to their daily activities and use, and enjoyment of property. These disruption effects may be generated through nuisance effects resulting from the waste management facility related traffic (noise, dust, congestion, etc.).	Field Survey, Assessment Roll, Land Use Assessment Access Route Resident Interviews
Potential for disruption to community and recreation features in the access route study area	Number of features Characteristics of features	This criterion deals with the potential for disruption to community/ recreation features located along the access routes. The concern is with the change in the potential demand of the feature on its level of service and/or change in its quality.	Field Survey, Assessment Roll, Land Use Assessment Interviews with owners/operators of feature

TABLE 2
CRITERIA/INDICATORS/INFORMATION SOURCES
(Continued)

Criteria	Indicators	Definition	Data Source
Potential for disruption to communities in vicinity of sites	Community cohesion Community character	This criterion refers to the potential disruption to existing residents in the vicinity of the facility. Residents may experience disruption to their daily activities and use and enjoyment of property. These disruption effects may be generated through nuisance effects often associated with the waste management facilities (i.e. noise, odour, dust, traffic disturbance, etc.). Community cohesion refers to the level of interaction or "tightness" among the members of a community. Level of cohesion is dependent upon such criteria as length of residence, attachment to the community, level of involvement in community activities and shared values.[1] Community cohesion could decrease if local residents opt to move out due to facility-related effects. The development of the facility may have implications for community character which can be described as physical in nature (land uses, environmental quality) or socio-cultural (way of life, local values). The change in community character could influence the resident's satisfaction with the community and future orientation of the community. A change in community character may also be attributed to the stigma of having an unwanted land use such as a waste management facility within the community.	Site Vicinity Resident Interviews, Field Survey Land Use Information, Results of Public Consultation Activities

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1. *Finsterbusch, Kurt.* *__Understanding Social Impacts__.* *Beverly Hills, California: Safe Publications, 1980.*

Non-Resident Property Owner Survey

Non-resident property owners were defined as those who own property but do not live or lease a residence on that property. All properties within 1,500 m of each candidate site were identified. It was not necessary that the entire parcel be within the Study Area (1,500 m) to be included. Rather, any land parcel which had a portion of it located within the Study Area was included in the survey.

Non-resident property owners were mailed a letter asking them to complete the enclosed self-administered questionnaire. A self-addressed pre-paid return envelope was also included. A follow-up letter was sent to those property owners who had not returned the questionnaire by the requested due date.

The main purpose of the questionnaire was to obtain information with respect to what the property was used for, how those activities could be affected by the facility, future plans for the property and length of ownership. A copy of the questionnaire and covering letter is contained within Schedule I.

The following summarizes the response rate per site for the Non-Resident Property Owner Survey. These responses refer to individual property parcels, not the number of owners who responded.

Site	Number of Properties (within 1,500 m)	Number of Responses
D	42	25 (59%)
K	41	27 (66%)
H	34	14 (41%)
I	38	10 (26%)

Resident Telephone Interviews

The resident telephone interviews served as the main data collection method used in this SIA. An attempt was made to interview all residents located within 1,500 m of each of the four candidate sites. As there were no residents on-site or within 500 m of each candidate sites, the interviews were organized by those who live within 500-1,000 m of each site and within 1,000-1,500 m. Results of the interviews within 500-1,000 m were used in the site comparisons. Results of interviews with residents within 1,000-1,500 m were used only to characterize the larger area and to be used as a sensitivity to the results obtained in the 500-1,000 m Study Area.

Names and addresses of residents were acquired through the assessment roll data. The focus of the interviews was on those individuals who live at the residence. Thus, individuals who rent their residence rather than own, were treated no different in the interview process.

At least four attempts to contact each household were made at different times of the day. In cases where telephone numbers were not listed, either a neighbour was asked for the phone number, or a letter was sent to the resident requesting them to call (collect) a member of the SIA study team if they wished to be interviewed.

The aim of the interviews was to gather information regarding:

- residents socio-economic characteristics, day-to-day activities, cohesion and level of satisfaction with the community; and
- confirm and prioritize resident issues/concerns regarding the proposed facility.

The telephone interviews were guided by a structured interview form. The interview form was pre-tested with members of the Lambton County WMMP Public Advisory Committee. A copy of the interview form and letters sent is contained in Schedule II.

The following presents the resident telephone interview response rate.

	SITES			
	D	**K**	**H**	**I**
Total number of households				
500-1,000 m	12	8	0	1
1,000-1,500 m	18	25	4	0
Number of interviews completed				
500-1,000 m	11 (92%)	5 (62%)	0	0 (0%)
1,000-1,500 m	10 (55%)	16 (64%)	1 (25%)	0

It should also be noted that the residents telephone interviews also included those residents located along the access routes. All identified residents along the access routes were interviewed.

Interviews with Community/Recreation Feature Operators

Operators of community/recreation features located in the Study Area were also interviewed. These features included: ICI Employees Social and Recreation Club, Sixth Line United Church, and Lambton Bowhunters Archery Range. A representative for the Lambton Sportsman Ltd. Shooting Range was also contacted. It should be noted that this is a proposed facility which has not been built. Although less extensive than the resident interviews, a standard set of questions guided each interview. The focus of the interviews was to characterize the nature of the facility and identify concerns of those interviewed with respect to the development and operation of the proposed waste management facility. A copy of the interview form is contained in Schedule III.

Secondary Data Sources

A number of secondary data sources were also used. This included available topographic mapping and air photos, assessment roll mapping, census data and media releases.

Information from Other Disciplines

Information from the Land Use, Visual Analyses, Transportation and Hydrogeology disciplines were used in this study. The Design and Operations Report also provided an initial conceptual characterization of the waste management facility and its related operations. These provided the technical basis upon which to project potential social impacts.

Public Consultation

Comments and concerns raised at various public consultation activities were also reviewed and used as input in the analysis. Public consultation activities provide a mechanism for the identification of attitudes, perceptions and values of the candidate sites and in the larger community. Results of the following activities were reviewed:

- Public Advisory Committee Meetings;
- March 30, 1993 WMMP Public Open House;
- April 21, 1993 Local Residents Meeting;
- Comments submitted verbally and written.

3.0 EXISTING SOCIAL CONDITIONS

This section describes the existing social conditions in the vicinity of each candidate site. The description is organized by Site Vicinity (0-1,000 m and 1,000-1,500 m), along the access routes and the local community. The main Study Area in the vicinity of each site is from 0-1,000 m and is referred to as the "site vicinity Study Area". The characteristics of the area 1,000-1,500 m from each site are noted to help to describe the larger area and noted where the characteristics significantly differed from the 0-1,000 m Study Area.

3.1 Site D

Although Site D is located on industrial designated lands, surrounding land uses are rural and predominantly under agricultural uses. Located between Highway 40 and Moore Township Road 21 and 22 north of Highway 80, Site D will not result in the displacement of any key social features. There are also currently no residences within 500 m of the site boundary although there are 12 residences within 500-1,000 m of the site and 18 residences within 1,000-1,500 m. The residents in the vicinity of the site are either along Highway 80 to the south or north of the site along Moore Township Road 6.

In terms of community recreation features, only one was identified in the vicinity of Site D. This included the Lambton Bowhunters Club which uses property southeast of Site D. This property is within 1,000 m of the site.*

Figure 1 illustrates the location of Site D and surrounding land uses.

***Note:** (A portion of the property which the Lambton Bowhunters Club uses is within 500 m of Site D).

3.1.1 Resident and Land Use Characteristics in the Site Vicinity

The following characterization of the local area is based upon information obtained through the resident telephone interviews, landowner mail-back survey, field visits and results of other technical studies. This characterization is predominantly based on properties and residents/features located within 1,000 m of the site, although in some cases, reference is also made to the area within 1,000-1,500 m from Site D.

Of the total 12 residences within 500-1,000 m from Site D, 11 interviews were completed representing a 92% response rate. Similarly, of the 18 residences located within 1,000-1,500 m of Site D, 10 interviews were completed representing a 55% response rate.

LEGEND

R△ RESIDENCE
▲ INDICATES ABANDONED LAND USE
▲ COMMERCIAL
■ INDUSTRIAL
◆ INSTITUTIONAL
● RADIO ANTENNA
☐ AGRICULTURAL
▨ HIGH QUALITY FOREST
✱ COMMUNITY FEATURES

100 0 500 1km
Scale 1:15,000

CANDIDATE SITE D

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN

Project No.9928

FIGURE No. 1

Household Characteristics

All residences within the site vicinity Study Area are single family detached dwellings. Of the 11 interviewed, 9 own their residence and 2 rent. Almost half of the residents (5) have lived in their current residence for more than 20 years. Of those which own their residence, only 4 indicated that their property was owned by another family member prior to them. Of these 4, 1 residence has been in the family 10-20 years, 2 for 21-50 years and one greater than 100 years.

When asked how long residents have lived in the "community", 9 (75%) indicated that they have lived in the community for at least 20 years.

An average of 3.7 people live in each household. This is slightly higher than Moore Township average of 3.1 persons per household.

In terms of age distribution, 46% are under the age of 20, one individual is between the ages of 20-24, 16 or 41% of the individuals are between the ages of 25-64 and 4 individuals (10%) are 65 years and over.

Use of Property

Of those interviewed, 54% indicated that either themselves or members of their household are involved in farming activity. It should also be noted that in the 1,000-1,500 m Study Area, 70% of the respondents are involved in farming.

Residents in the vicinity of Site D were also asked what types of activities members of their household are involved in on or near their property. The following summarizes the most frequently cited responses:

Activity	Percent Involved
Gardening/landscaping	100%
Entertaining	100%
Children's Activities	100%
Relaxation	100%
Bicycling	91%
Nature Appreciation	91%
Hunting	54%

Residents were also asked as to whether they were planning any future changes on improvements to their property in the near future. Five of the 11 respondents indicated that they were planning either house renovations or expansions.

Property owners were also asked through the property owner mail-back questionnaire whether any social activities occur on their property located in the vicinity of Site D.

Of the 18 properties for which questionnaires were returned (within 0-1,000 m) 50% of the properties are used for social and recreation activities. The activities which occur on the property include hunting, skiing, snowmobiling and camping/picnicking. Many of the respondents indicated that these activities occurred on a weekly basis during the appropriate seasons.

Seventeen of the 18 respondents indicated that their property is used for farming activity (includes leasing of land to farmers) while 4 respondents indicated that their property is used for other business activities.

A little over a quarter of the respondents have plans to improve or change their property in the next 5 years. Most of these plans included the upgrading of land (e.g. tile drainage) for agricultural activity.

Community Feature Characteristics

The only community feature within 1,000 m of Site D is the Lambton Bowhunters Club. The club property is southeast of Site D at the northwest corner of the Highway 80/Moore Township Road 21 and 22 intersection. Leased from NOVA, the property is used for archery target practice and competitions. The club has 80 members with the facility predominantly being used in spring, summer and fall. The club representative who was contacted did not think that the facility would affect the club and did not see any reason why the club could not co-exist with the waste management facility.

3.1.2 Community Characteristics

In addition to characterizing the residents in the vicinity of Site D, an attempt was also made to define and profile the local community as defined by the residents. Information was also obtained with respect to resident's satisfaction with their community and their level of involvement in it.

Site D is located in a rural area which has traditionally been based on agricultural activity. The closest built-up areas are in the communities of Courtright and Mooretown which are approximately 6 km west of Site D and Corruna which is further north.

Site D is also located on industrial lands which forms part of the "Chemical Valley". The Chemical Valley is located in the City of Sarnia and the Townships of Moore and Sombra and consists of large-scale, heavy industries, most of which re related to the petro chemical industry.

To help identify the "community" as defined by the residents, the respondents were asked to identify the village/town/city which they consider to be most closely associated with. A total of 63% responded with the Village of Courtright as the village/town/city which they are most closely associated with. The remaining responses were divided between Corunna, Sombra and Sarnia. Surprisingly, of the 10 residents who responded to the interview who are located 1,000-1,500 m from the landfill, 50% of them indicated to be most closely associated with Mooretown and 38% responded with Corruna.

When asked where residents shop for groceries and household items, more than 90% in both the 500-1,000 m and 1,000-1,500 m Study Areas responded with Corruna.

Respondents were also asked to define their community. Most responded with either Moore Township or the area west of Site D over to the St. Clair River.

To gain an appreciation as to how satisfied residents are with their community, residents were asked to indicate their satisfaction level on a 5 point scale ranging from "very dissatisfied" to "very satisfied". More than 70% of the residents in both the 500-1,000 m and 1,000-1,500 m Study Area indicated that they were "very satisfied". This is supported by the question as to "whether they would recommend someone else to move into this area", as 7 of the 11 respondents indicated that they would.

When asked what residents liked based about the area, the most frequent responses were: sense of community (81%); rural farming community (54%); quiet and peaceful (45%); and open space (45%).

When asked what respondents disliked most about the community, the most frequent response was the industrial character of the area and problems associated with that.

Information was also obtained with respect to residents involvement in their community. Seventy-two percent of the respondents indicated that they belong to community associations. These included agricultural groups, sports clubs, church groups and local service clubs.

All the respondents felt that they were part of the community with 27% describing their community as "very close-knit" and 64% describing it as "somewhat close-knit". When asked how their community's closeness has changed over the past 5 years, most indicated that it has either increased (27%) or stayed the same (64%).

Apparently half of the respondents have relatives living in the community and 80% of the respondents had 2 or more of their closest friends in the community as well.

Finally, as another measure of community closeness, respondents were asked questions regarding their level of interaction with neighbours. Ninety percent indicated that they visit with neighbours at least 2-3 times a week and when asked how often they ask for help or provide help to neighbours, 63% responded with at least 2-3 times a month.

3.1.3 Resident and Land Use Characteristics Along the Access Route

Recognizing that most of the vehicles accessing the facility at Site D will be coming from the west via Highway 40, the main access route will be along Highway 80 east to the site to a point south of the site where the site access road entrance will be located. There are a total of five residences located along the access route to Site D. As all of these residents fall within the Site D 500-1,000 m Study Area, the resident characteristics as previously discussed are applicable.

When asked what type of activities occur along the access route, all of the respondents indicated the following: walking along the shoulder, picking up mail/newspaper and bicycle riding.

3.2 Site K

Site K is located approximately 300 m due east of Site D on the east side of Moore Township Road 21 and 22 north of Highway 80. A key feature of Site K is that it is adjacent to the existing Moore Township landfill. In fact, the existing landfill is to be included as part of the total site area. As with Site D, Site K will not result in the displacement of any residences or community features.

Within 1,000 m of Site K, there are a total of 8 residences plus an additional 25 residences within 1,000-1,500 m of the site. As Site K is close to Site D, they share many of the same residences within their Study Areas. As a result, the resident characterization for Site K is similar to Site D.

In terms of community/recreation features, there are two features in the vicinity of Site K. These include the Lambton Bowhunters Club which is within 1,000 m of the Site K and the Sixth Line United Church which is northeast of Site K within the 1,000-1,500 m Study Area.

Figure 2 illustrates the location of Site K and surrounding land uses.

3.2.1 Resident and Land Use Characteristics in the Site Vicinity

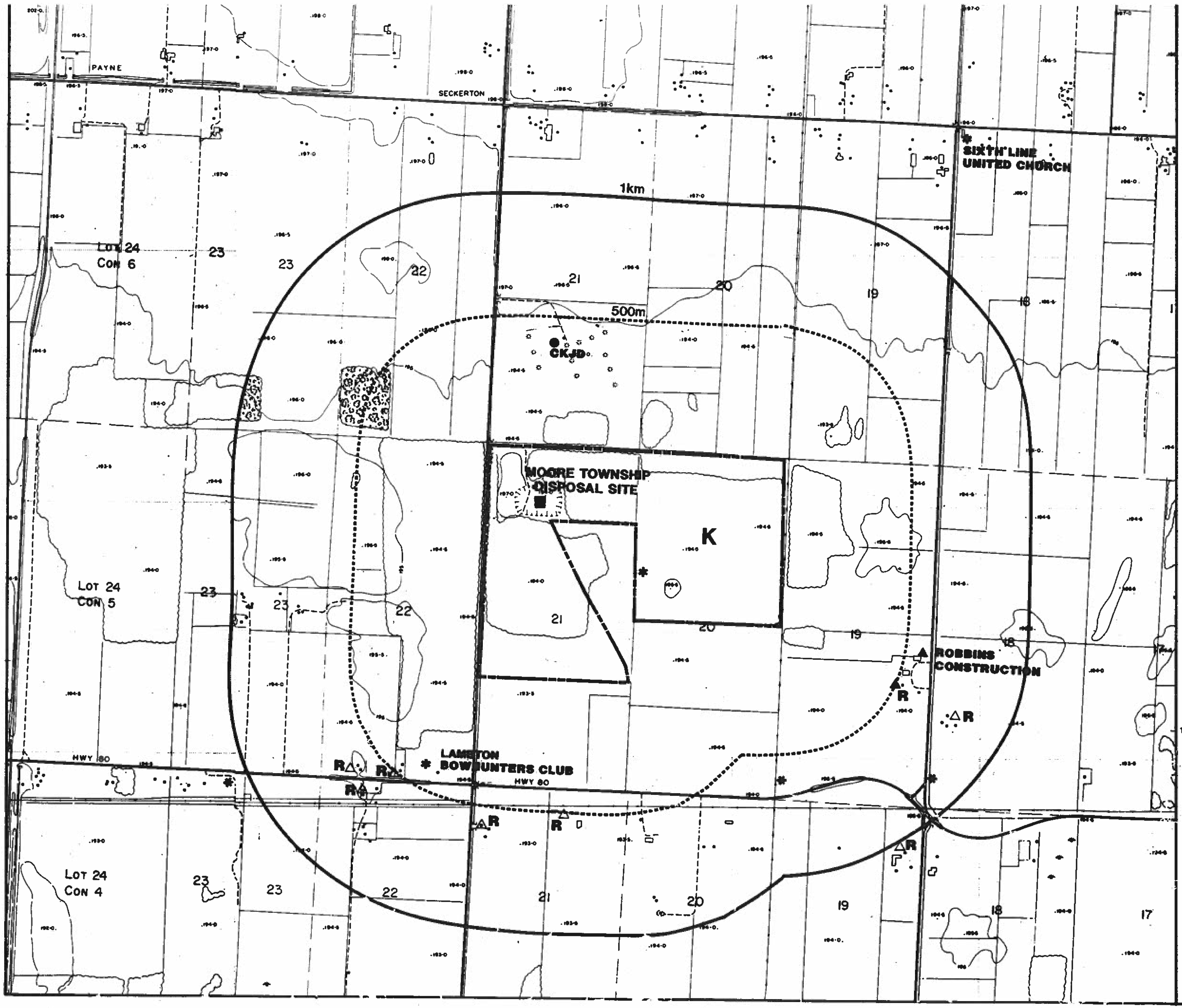
Of the 8 residences within 500-1,000 m of Site K, five residents were interviewed representing a 62% response rate. Similarly, of the 25 residences within 1,000-1,500 m of the site, 16 residents were interviewed which represents a 64% response rate.

Household and Property Characteristics

Of the five residents interviewed, all own their residence. Three of the residents have lived at their current address for 6-10 years while 2 have lived their for over 20 years. Only one respondent indicated that their property was previously owned by another family member and has been in the family for 21-50 years.

An average of 2.8 people live in each household, which is lower than the Moore Township average.

In terms of age distribution, 35% are under the age of 14, 57% are between the ages of 25-64 and 7% (1 individual) is over the age of 65.



LEGEND

R△	RESIDENCE
A	INDICATES ABANDONED LAND USE
▲	COMMERCIAL
■	INDUSTRIAL
◆	INSTITUTIONAL
●	RADIO ANTENNA
☐	AGRICULTURAL
▨	HIGH QUALITY FOREST
*	COMMUNITY FEATURES

100 0 500 1km

Scale 1:15,000

CANDIDATE SITE K

LAMBTON COUNTY
WASTE MANAGEMENT
MASTER PLAN

Project No.9928

FIGURE No. 2

Use of Property

Two of the five respondents indicated that members of their household are involved in farming activity. In the 1,000-1,500 m Study Area, 87% of the respondents indicated that they are involved in farming activity. As the 1,000-1,500 m Study Area primarily includes residences to the north of the site along Moore Township Road 6, it would appear that the area is much more agriculturally oriented. This was also consistent with the Site D responses.

When asked what types of activities members of the respondent's households are involved in, on or near their property, most indicated the following: gardening/landscaping, entertaining, children's activities, bicycling, nature appreciation and relaxation.

When asked whether they were planning any future changes or improvements to their property, three of the five respondents indicated that they were. Similarly, in the 1,000-1,500 m Study Area, approximately 70% of the respondents have future plans for their property. These plans included house renovations and extensions.

Property owners in the vicinity of Site K were asked to specify any social or recreation activities which occur on or near their property through the mail-back questionnaire. Of the 19 properties within 1,000 m for which questionnaires were returned, a little less than half are used for social and recreation activities. These activities include hunting, snowmobiling, skiing and picnicking/camping. Depending on the season, activities occur on these properties on a weekly basis in many cases.

Ninety-five percent of the respondents indicated that their property is used for farming activity and half indicated that their property is used for business activity other than farming.

Approximately half of the respondents have plans to improve or change their property over the next five years.

Finally, 88% of the owners have owned their properties for greater than 10 years.

Community Feature Characteristics

There are two community features in the vicinity of Site K. The first is the Lambton Bowhunters Club which is within 1,000 m of the site to the southwest. Leased from NOVA, the property is used for archery target practice and competitions. The club has 80 members with the facility predominantly being used in spring, summer and fall. The representative who was contacted did not think that the facility would affect the club and did not see any reason why the club could not co-exist with the waste management facility. It should be noted that prior to this interview, a petition against site D was submitted by the club. It is the assessor's understanding that the petition was based on the misconception that the proposed facility would displace the club.

The second feature is the Sixth Line United Church which is northeast of Site K within the 1,000-1,500 m Study Area. The church is regularly used for Sunday services but also has meeting rooms which are used by the community during evenings throughout the week.

The church employs one individual on a full-time basis and there are no immediate future plans for the facility such as expansions or closure.

3.2.2 Community Characteristics

As with Site D, an attempt was made to define and profile the local community as defined by the local residents. Information was also obtained on resident's satisfaction with their community and their level of involvement in it.

Located in a rural agricultural area, Site K is located next to the existing Moore Township landfill mostly on lands designated for waste disposal purposes. The closest built-up areas are the communities of Mooretown, Courtright and Corunna which are located west of Site K. As discussed in Section 3.1.2 for Site D, Site K is also on the edge of the "Chemical Valley" industrial area.

Residents were asked to indicate the village/town/city which they most closely associate with. Three of the five respondents indicated Courtright. In the 1,000-1,500 m Study Area respondents were generally equally split between Courtright, Corruna, Brigden and Mooretown. When asked where they shop, 80% indicated Corruna. Finally, respondents were also asked to define their community. Most responded with either Moore Township or the area from Brigden west to the St. Clair River.

All of the residents indicated that they were generally very satisfied with their community. Although only half of the respondents in the 500-1,000 m Study Area indicated that they would recommend someone else to move into this area, all except one resident in the 1,000-1,500 m Study Area responded that they would.

When asked what residents like most about the area, the most frequent responses were: rural farming community and sense of community (62%).

When asked what respondents in the vicinity of Site K disliked most about the area, there were no common responses. Some residents (3) indicated that there was nothing they disliked about the area. In the 1,000-1,500 m Study Area, residents indicated that they disliked the industrial character of the area.

To gain an appreciation of the residents involvement in their community, they were asked whether they belong to any community groups. Two of the five respondents indicated that they did, while all of the 16 respondents in the 1,000-1,500 m Study Area indicated that they did.

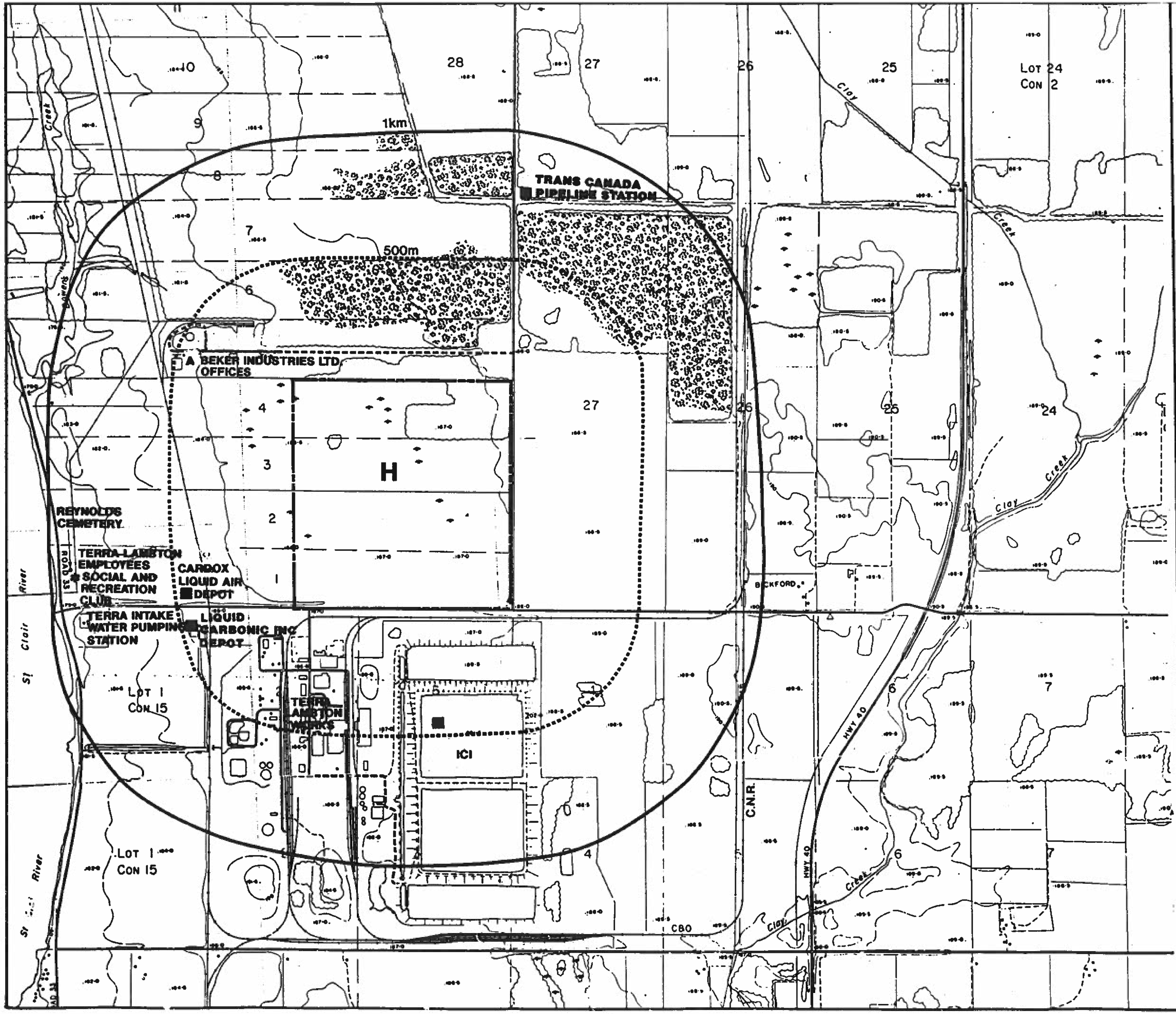
All of the respondents felt that they are part of the community with all except one describing it as either "very close knit" or "somewhat close knit". Three of the five also felt that the community's closeness had not changed over the past 5 years. These responses were generally the same as those for the 1,000-1,500 m Study Area.

In the 500-1,000 m Study Area, only two of the five respondents have relatives living in the community while in the 1,000-1,500 m Study Area, 67% of the respondents indicated that they have relatives in the area.

As a final measure of community closeness, respondents were asked questions regarding their level of interaction with neighbours. Eighty percent indicated that they visit with neighbours at least 2-3 times a week.

3.2.3 Resident and Land Use Characteristics Along the Access Route

As with Site D, most of the waste vehicles accessing the proposed facility at Site K will be coming from the west via Highway 40. As a result, the main access route to the site will be along Highway 80 to Moore Township Road 21 and 22 where the site will be accessed at the current entrance for the existing Moore Township landfill.



LEGEND

R△	RESIDENCE
A	INDICATES ABANDONED LAND USE
▲	COMMERCIAL
■	INDUSTRIAL
◆	INSTITUTIONAL
●	RADIO ANTENNA
☐	AGRICULTURAL
▨	HIGH QUALITY FOREST
*	COMMUNITY FEATURES

100 0 500 1km

Scale 1:15,000

CANDIDATE SITE H

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN

Project No.9928

FIGURE No. 3

There are a total of 8 residences along the access route, all of which are adjacent to Highway 80. As these residents all fall within the Site D 500-1,000 m Study Area, their characteristics are discussed in Section 3.1.1.

Resident characteristics which can be described in relation to the access route is their use of Highway 80. When asked what type of activities occur along the access route, the following activities were indicated most frequently: moving farm machinery, walking along shoulder, kids waiting for school buses, picking up mail, and bicycle riding.

3.3 Site H

Site H is located between the St. Clair River and Hwy. 40 north of the Moore-Sombra town line. The IC&I/Terra chemical plant is located directly south of Site H.

Land uses in the vicinity of Site H are primarily designated for industrial uses. Vacant cleared lands not used for industry are used for agricultural purposes. Site H is also generally within the "chemical valley", an area consisting of large scale heavy industries which extend south of Sarnia along the St. Clair River into Sombra Township.

Within 500-1,000 m of Site H there are no residences, although within 1,000-1,500 m there are four residences.

In terms of community/recreation features, there is one feature within 1,000 m of the site. This includes the ICI Lambton Employees Social and Recreation Club. The St. Clair River Parkway is also within 1,000 m of the site. There are, however, no facilities associated with the Parkway in this area although Seagar Park is just beyond 1.5 km to the northwest of Site H.

Figure 3 illustrates the location of Site H and surrounding land uses.

3.3.1 Resident and Land Use Characteristics in the Site Vicinity

Household Characteristics

As there are no residences within 1,000 m of Site H, there are no residents to characterize. Within the 1,000-1,500 m Study Area there are four residences. As only one of these residents was interviewed, it was not considered to be representative of this area. As a result, the one response is not discussed.

Use of Property

The following is based on the results of the mail-back questionnaire which was sent to property owners in the vicinity (within 1,500 m) of Site H. Questionnaires were returned for nine properties in the 1,000-1,500 m Study Area. Within 1,000 m of the site, only one of the nine properties is used for social or recreational activities, which included family activities and camping. The respondent also indicated that they are clearing land to build a house on the property. Similarly, in the 1,000-1,500 m Study Area, two of the five properties from which responses were obtained indicated that social and recreational activities occur.

Approximately half of the properties within 1,000 m of Site H are used for farming activity and 77% are used for some form of business activities.

Only two of the nine respondents indicated that they have future plans for their property.

Community Feature Characteristics

Within 1,000 m of Site H, there is one key community feature: the ICI Lambton Employees Social and Recreation Club. The Employees club is located along the St. Clair River Parkway west of Site H. The property contains baseball diamonds, "picnic" pavilion and a storage area. The facility is used in all seasons except winter for ball games/tournaments and family picnics. Hours of operation include all day on Saturday and Sunday and 5-8 p.m. during the week. There are currently no expansion plans for the facility.

It should also be noted that the Reynolds Pioneer Cemetery is located just south of the ICI Lambton Employees club. The cemetery is no longer used and consists of a historic marker to indicate the location of this cemetery. As it is not actively used or promoted as a historic feature, it was not considered in the analysis.

3.3.2 Community Characteristics

As previously indicated, Site H is located in an industrial area with few residents in its immediate vicinity. Within 1,500 m of the site there are only four residences, all of which are between 1,000-1,500 m from the site. As only one of these residents was interviewed, it is difficult to characterize the social "community" this site is located within. There are a number of residences along the St. Clair River located west of the site including a cluster of residences south of the site at the mouth of Clay Creek.

However, as most of these residences are beyond the 1,500 m Study Area, they were not interviewed.

Based on the information which was obtained the lands within 1,000 m of Site H are primarily of industrial character.

3.3.3 Resident and Land Use Characteristics Along the Access Route

The main access route to Site H will be west along the Townline Road via Hwy. 40 to the site entrance. There are currently no residences or community features along this section of the Townline Road.

3.4 Site I

Site I is adjacent to the west side of Site H which is located between the St. Clair River and Hwy. 40 north of the Moore-Sombra Township town line.

As with Site H, lands in the vicinity of Site I are primarily designated for industrial uses. Lands not currently developed are used for agriculture. There is one residence within 500-1,000 m of the site and there are no residences within 1,000-1,500 m of the site.

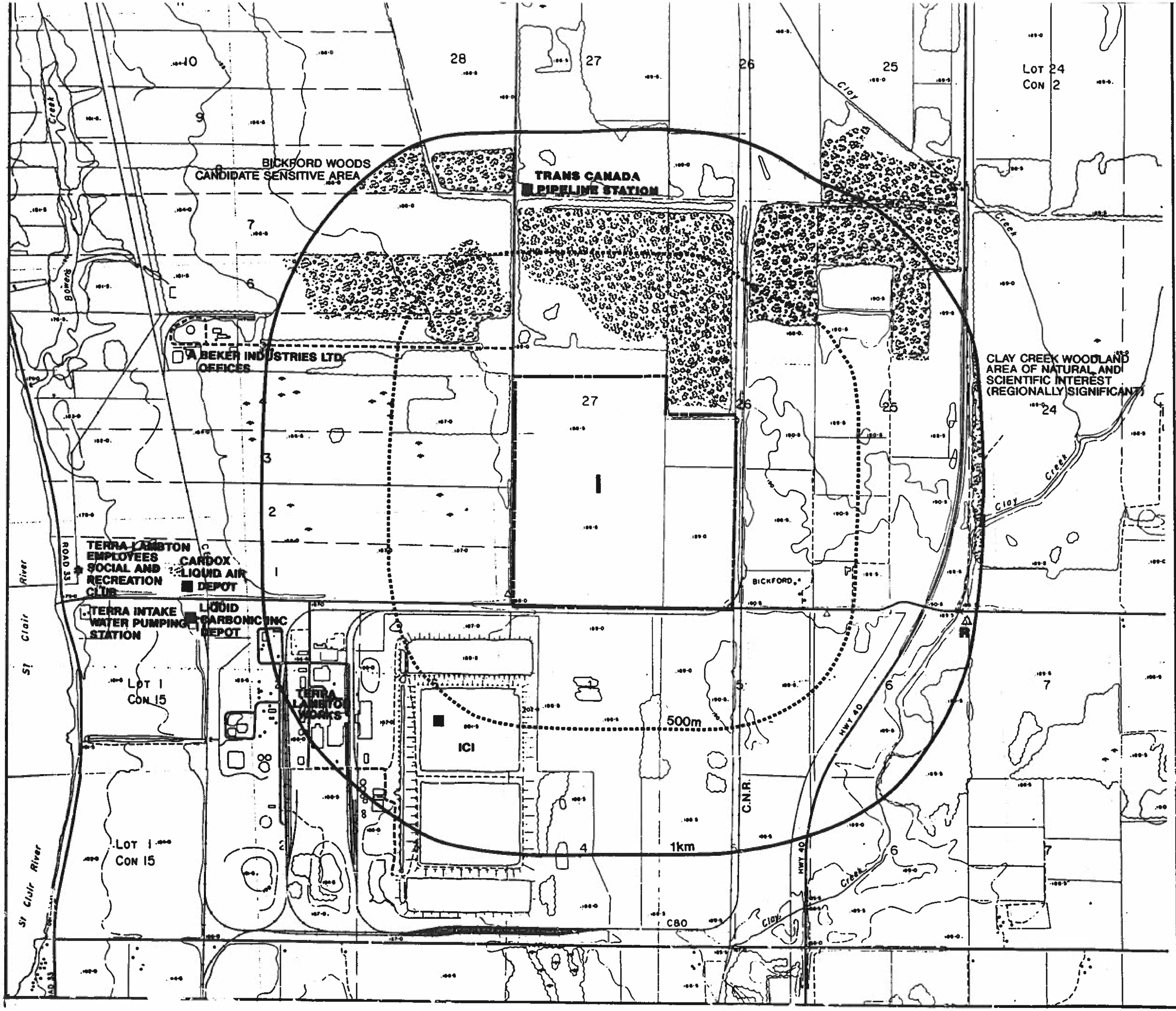
There are no community/recreation features located in the vicinity of the site. There is a proposal by Lambton Sportsman Ltd. to develop a shooting range southeast of the site on the east side of Hwy. 40. The main activities to occur on the property are trap/skeet and target shooting. The proposal has had some opposition by residents in the area. Within 1,500 m of the site there is the IC&I Lambton Employees Social and Recreation Club.

Figure 4 illustrates the location of Site I and surrounding land uses.

3.4.1 Resident and Land Use Characteristics in the Site Vicinity

Household and Property Characteristics

The one residence within 1,000 m of the site was not interviewed. As a result, it is not possible to characterize this residence. There are no residences 1,000-1,500 m from Site I.



LEGEND

R△	RESIDENCE
A	INDICATES ABANDONED LAND USE
▲	COMMERCIAL
■	INDUSTRIAL
◆	INSTITUTIONAL
●	RADIO ANTENNA
□	AGRICULTURAL
▨	HIGH QUALITY FOREST
*	COMMUNITY FEATURES

CANDIDATE SITE I

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN

Project No.9928

FIGURE No. 4

Use of Property

The following is based on the results of the mail-back questionnaire which was sent to property owners in the vicinity (within 1,500 m) of Site H. Questionnaires were returned for 14 properties within 1,500 m of the site.

All of the respondents indicated that no recreation or social activities occur on their properties. Only one of the properties in the 0-1,000 m area is used for farming activity while all properties in the 1,000-1,500 m Study Area were indicated to be used for farming activity. Within 1,000 m of the site, all of the properties were indicated to be used for some form of business activity.

Except for one property, owners had no future plans for improving their property in the next five years.

Community Feature Characteristics

There are no community features within 1,000 m of Site I. The ICI Lambton Employees Social and Recreation Club and Reynolds cemetery (within 1,500 m) is described in Section 3.3.1.

3.4.2 Community Characteristics

Site I is located in an industrial area with only one residence within 1,000 m of its boundaries and no residences within 1,000-1,500 m of its boundaries. Recognizing that there is only one residence and that this residence was not interviewed (could not be reached), it is difficult to characterize the social "community" this site is located within.

There are a number of residences along the St. Clair River located west of the site including a cluster of residences south of the site at the mouth of Clay Creek. However, as most of these residences are beyond the 1,500 m Study Area, they were not interviewed.

Based on the information which was obtained the lands within 1,000 m of Site H are primarily of industrial character.

3.4.3 Resident and Land Use Characteristics Along the Access Route

The main access route to Site I will be west along the Townline Road via Hwy. 40 to the site entrance. There are currently no residences or community features along this section of the Townline Road.

4.0 POTENTIAL SOCIAL IMPACTS

4.1 Introduction

This section examines the issues/concerns of residents living in the vicinity of the candidate sites and the potential for social impacts of each site. The following was considered in the assessment of potential social impacts:

- results of the work by other technical disciplines (hydrogeology, land use, visual);
- the concerns and characteristics/attitudes of residents and feature operators in the Study Areas; and
- the potential implications and significance of effects.

4.2 Issues and Concerns

What an individual perceives or anticipates may happen to them can be just as important as an actual effect itself. If an individual believes that there will be a change in their way of life and act on those beliefs, the consequences could be significant. One criteria which can influence how individuals respond to "perceived" effects are the responses of the proponent to public concerns. If individuals feel that their concerns have been recognized and addressed to their satisfaction, then the significance of the perceived effects may be greatly reduced.

The following discusses the concerns and issues which were identified. As the one residence in the Study Area of Site I could not be reached and there are no residences in the 500-1,000 m Study Area for Site H, the following issues and concerns are based on the interviews held with residents in the vicinity of Sites D and K.

For both sites D and K, all of the residents interviewed indicated concerns with respect to the proposed waste management facility.

Tables 3 and 4 outline the most frequently cited concerns identified by residents through an open ended question in the interview.

TABLE 3
SITE D LOCAL RESIDENT CONCERNS

Concern	Number of Responses	% of Those With This Concern
Odour	9	82%
Litter	8	73%
Traffic Nuisance Effects	8	73%
Ground Water Quality	7	64%
Visual Effects	7	64%
Vermin	7	64%
Noise	7	64%
Property Value Decrease	7	64%
Gulls	5	45%
Waste Trucks	5	45%
Impact on Agriculture	5	45%
Less Desirable Place to Live	5	45%

TABLE 4
SITE K LOCAL RESIDENT CONCERNS

Concern	Number of Responses	% of Those With This Concern
Property Value Decrease	4	80%
Ground Water Quality	3	60%
Visual Impact	3	60%
Odour	3	60%
Vermin	3	60%
Litter	3	60%
Gulls	3	60%
Impact on Agriculture Operations	3	60%

For the most part, the concerns and their priority is very similar for both Sites D and K.

The non-resident property owners were also asked to identify their concerns through the mail-back questionnaire. The following outlines the key concerns and comments which they raised:

- Sites D and K are more appropriate as they are away from the St. Clair River Parkway recreation area;
- Sites H and I should be chosen as there are fewer residents living in its vicinity and is less of a farming area;
- select Site K as it is adjacent to an existing landfill; no need to start another landfill in Moore Township;
- concerned about odours, litter, gulls, traffic problems, land values, runoff from site;
- these sites have been selected on the basis of lowest public opposition, least transportation cost and blue clay (which is available everywhere); and
- ruining prospects for future community growth in a high demand area (Sites D and K).

Finally, concerns were also obtained through the various public consultation activities as part of the WMMP. For the most part, these concerns were similar to those which have already been discussed.

4.3 Impact Analysis

The following section presents the interpretation of the data and analyzes the potential for social impacts for each site. As previously mentioned, the analysis is based on three Study Areas:

- site vicinity (0-1,000 m);
- access route (and lands adjacent to it); and
- community (as defined by the residents).

In projecting the potential for nuisance effects from the facility, it has been assumed that the most significant effects will remain within 1,000 m of the facility. This would include effects such as noise, litter, dust and odour. The only effect expected to exceed 1,000 m is visual. Based on the visual analysis, it is projected that the landfill portion of the facility for Sites D and K may be seen up to 3 km away. This is mainly due to the flat uniform topography of the larger area. As part of the site selection process, a separate visual impact assessment was undertaken. This assessment is documented in Schedule IV. The potential for visual impact is taken into account in assessing the potential for social impacts.

With respect to the access route study zone, it includes all residences and features which have direct access onto the preferred waste access route.

It should also be noted that the comparative evaluation was based on the data collected. That is, net effects of each site were not determined. In conducting the impact analysis however, it was assumed that the County would be a responsible proponent and develop an appropriate impact management program. This would include, but not be limited to, appropriate mitigation measures to minimize off-site effects, contingency measures to address unexpected problems, keeping the community informed and involved in operations and develop a compensation policy.

The impact analysis and ultimately the site comparative evaluation was based on the following criteria:

1) Potential for disruption of residents in the site vicinity Study Area (0-1,000 m);

2) Potential for disruption of community/recreation features in the site vicinity Study Area (0-1,000 m);

3) Potential for disruption of residents in the access route Study Area;

4) Potential for disruption of community/recreation features in the access route Study Area; and

5) Potential for disruption to communities in the site vicinity.

The following discusses the data and interprets the results of the analysis by each criterion for all sites.

4.3.1 Criteria 1 - Disruption of Residents in the Site Vicinity Study Area

Residents living in the vicinity of the site may experience nuisance effects from the waste management facility. The following examines the indicators considered under Criteria 1 including their rationale for use and results of the analysis.

Indicator 1.1 - Number of Residences/Residents

The number of residences/residents in the site vicinity served as a "base" measure of potential impact. It is supported under the assumption that the potential for disruption to residents will proportionally increase with the number of residences/residents in the Study Area (0-1,000 m).

Based on the field visits and assessment roll data, Site D has the greatest number of residences/residents with 12/37 (based on Moore Township average of 3.1 persons per household). Site K followed with eight residences or 25 residents. Sites H and I had the fewest number. Site H had no residences while Site I had one residence or an estimated three residents within the site vicinity Study Area.

Indicator 1.2 - Number of Vulnerable Residents

Residents' vulnerability was assessed on the basis of the following measures:

- %/# of children 0-14 years old;
- %/# of seniors > 65 years old;
- %/# individuals with respiratory health problems; and
- %/# of individuals home during facility operating hours.

Children and seniors are considered to be the age groups of people who are most sensitive to environmental effects. Landfill operations during the day may cause difficulty for children playing outside or sleeping. Similarly, seniors tend to be home during the day and are generally less mobile relying more on their own property for day-to-day activities and enjoyment. Those with respiratory health problems are also sensitive to effects such as dust. Finally, individuals who are home most of the time when the facility is operating are likely to be affected more significantly than those who are not. The following summarizes the results of the analysis for the indicator "Number of Vulnerable Residents".

As a greater proportion of residents were interviewed for Site D than Site K (92% vs 62%), the impact for Site K may be higher than the data indicates although recognizing that Site K has fewer residents in its vicinity than Site D. No attempt was made to estimate data for those not interviewed, however, proportions are indicated which provide an additional measure as to how the sites compare. It should be noted that percentages are those of the number of households interviewed and the number of residents for households interviewed, not of the total estimated population in the Study Area. Both absolute numbers and "proportion of" were taken into account in the analysis.

Number of Vulnerable Residents	**SITES**			
	D	**K**	**H***	**I****
#/% of children 0-14 years old	13/32%	5/36%	NA	0/0%
#/% of seniors > 65 years old	4/10%	1/7%	NA	0/0%
#/% of individuals with respiratory health problems	8/19%	6/43%	NA	0/0%
#/% of individuals home during facility operating hours	17/41%	5/36%	NA	0/0%

* *There are no residences in the Site H Study Area (0-1,000 m).*
** *Although there is one residence in the vicinity of Site I, as this individual was not interviewed, information is not available.*

Indicator 1.3 - Use of Property

Those residents who use their property for outdoor activities may experience disruption to their use and enjoyment of property and thus are considered to be a vulnerable population group.

The results of the interviews indicated that all of the respondents are involved with at least one outdoor activity on a regular basis.

Indicator 1.4 - Use of Property by Non-Resident Owners

Owners of property in the vicinity of each site may also be affected by the facility if they use their property for social/recreation activities and/or have plans for future residences. These individuals may find that their use and enjoyment of property is disrupted. The following measures were used in this indicator:

- #/% of owners involved in outdoor social/recreation activities on their property; and
- #/% of owners with plans for future residence on their property.

With respect to the first measures, Site D had the most owners who use their property for social/recreation activities at 9 or 50% of the total non-resident property responses. Site K was second with 8/42%, followed by Site H and I with 1/11% and 0 respectively.

With respect to the second measure, Sites D, K and H each has a property owner who plans to build a residence on their property in the near future. Site I has none.

4.3.2 Criteria 2 - Potential for Disruption of Community/ Recreation Features in the Site Vicinity Study Area

Nuisance effects such as noise, dust, odour, litter could lead to the disruption of the operations of community/recreation features. This could lead to a decrease in the demand for the facility and/or change the quality or experience of the service.

The following examines the two indicators considered under Criteria 2 including their rationale for use and results of the analysis.

Indicator 2.1 - Number of Features

As with number of residents, the number of features serves as a "baseline" of the potential for effect from each site to community/recreation features. It is based on the assumption that the potential for effect increases with the proportion of features in the Study Area.

Only Site I had no features within 1,000 m of its boundaries. Sites D and K both have the Lambton Bowhunters Club in their vicinity while Site H has the ICI Lambton Employees Club within its vicinity.

Indicator 2.2 - Characteristics of Feature

This indicator considers the characteristics of each feature. It is key as it helps to determine how sensitive a feature is to the potential effects of a waste management facility. Features which open during the waste management facility operating hours and are predominantly based outdoors would tend to be the most sensitive. Other characteristics which need to be taken into account include whether the operator feels their facility may be affected and plans for expansion.

The following presents the measures and corresponding data for each site.

Characteristics of Features	**SITES**			
	D	**K**	**H**	**I**
# with hours of operation during facility operating hours	1	1	1	1
# predominantly based outdoors	1	1	1	1
# who perceive operations of the feature will be affected by proposed facility	0	0	1	0
# with plans for expansion	1	1	0	1

4.3.3 Criteria 3 - Potential for Disruption of Residents in the Access Route Study Area

Residents who live along the facility access route may be disrupted by traffic associated with the waste management facility. Effects such as noise, dust, traffic congestion, concern for safety could be experienced. For the purpose of the short list of sites comparative evaluation, all roads to be used to access the sites off of Highway 40 were considered. This included Highway 80 to access Sites D and K. It should be noted that this differs from the long list of sites comparative evaluation which only considered non-provincial highways in the analysis. In the long list evaluation, the focus was on the sections of the access routes which have the greatest potential for impact (e.g. local and County roads). It did not assume that there would be no impacts along sections of provincial highways travelled by waste traffic, only that these impacts should be of less significance. In this short list analysis, Highway 80 is taken into account, although recognizing that it is a provincial highway and designated for large volumes of traffic.

The following examines the indicators considered under Criteria 3 including their rationale for use and results of the analysis.

Indicator 3.1 - Number of Residences/Residents

The number of residences/residents along the access route is a base measure as to the extent of effects which residents may experience.

Both Sites H and I have no residences along each of their access routes. Site D has 5 residences (22 residents) and Site K has 8 residences (33 residents), all of which are located along Highway 80.

Indicator 3.2 - Number of Vulnerable Residents

Resident vulnerability to nuisances created by vehicles associated with the facility was assessed on the basis of the following measures:

- #/% of children 0-14 years old;
- #/% of seniors > 65 years old;
- #/% with respiratory health problems; and
- #/% of individuals home during facility operating hours.

The rationale for using these measures is the same as that discussed under Section 4.3.1.

The following summarizes the results of the analysis of the indicator "Number of Vulnerable Residents".

Number of Vulnerable Residents	SITES			
	D	K	H	I
#/% of children 0-14 years old	7/32%	12/36%	0/0%	0/0%
#/% of seniors > 65 years old	2/9%	2/6%	0/0%	0/0%
#/% with respiratory health problems	2/9%	8/24%	0/0%	0/0%
#/% of individuals home during facility operating hours	11/50%	17/51%	0/0%	0/0%

Indicator 3.3 - Use of Property

Those residents who use their property for outdoor activities may experience disruption from traffic to their use and enjoyment of property and thus are considered to be a vulnerable population group.

As sites H and I have no residences along their access routes, this indicator was not applicable. With respect to Site D, 5 households are involved in sensitive outdoor activities while Site K has 8 households.

Indicator 3.4 - Use of Roadway Shoulder

Residents who use the shoulder of the roadway for activities such as bicycling or children waiting for school buses may experience disruption to these activities. The measures considered in this indicator are the #/% of households which use the shoulder of the access route roadway and #/% who feel waste traffic would affect them. The following summarizes the data for this indicator:

Use of Roadway Shoulder	**SITES**			
	D	**K**	**H**	**I**
#/% of households which use the shoulder of the access roadway	5/100%	8/100%	0/0%	0/0%
#/% who feel waste traffic would affect them	5/100%	8/100%	0/0%	0/0%

4.3.4 Criteria 4 - Potential for Disruption of Community/ Recreation Features in the Access Route Study Area

Vehicles travelling to the waste management facility could lead to the disruption of use and enjoyment of community/recreation features along the designated access route. Nuisances such as noise, dust and traffic congestion could lower the demand for the facility and/or change the level of service it provides.

The two indicators considered within this criteria as follows:

- Indicator 4.1 - Number of Features; and
- Indicator 4.2 - Characteristics of Features.

The only site to have a community/feature along its access route is Site K. The feature is the Lambton Bowhunters Club. Although the feature is open during the operating hours of the waste management facility and is based outdoors, the representative for the club did not believe that their operations would be affected.

4.3.5 Criteria 5 - Potential for Disruption To Communities in the Site Vicinity

In addition to the potential for impacts on individuals and community/recreation features, the potential for collective impacts on a community as a whole was examined. Community impacts may result from the landfill's incompatibility with the existing community character or affect the cohesiveness of a community by residents becoming less satisfied with the community and opting to move away. The assessment of community impacts was based on the results of the residents interviews, land use and visual assessments and the SIA's assessors judgement regarding the compatibility of the facility within the existing community.

Indicator 5.1 - Impact on Community Character

Community character refers to the distinctive physical, socio-cultural or economic qualities of a community. The character of a community may be by direct facility effects on the community's environment or on the aesthetic qualities of an area. Impacts on community character can also result from a landfill's incompatibility with surrounding land uses.

The character of an area and its potential for change was addressed through a variety of measures which included the following:

- residents' perceived character of their community;
- experience with facilities of similar nature;
- stability/growth experience;
- land use characteristics; and
- visual impact of facility.

The following examines the potential for change in the character of communities in the vicinity of each site.

SITE D

Based on the interviews with residents in the vicinity of Site D, the characteristics of the area which they most closely associated with included: rural farming community, quiet and peaceful and open space. Thus, it would appear that residents in the vicinity of Site D enjoy the rural farming character of the area.

Recognizing that the Moore Township landfill is within the Study Area of Site D, and is a facility similar in nature to the proposed facility, residents were also asked to identify their experience to date with this facility. Eight of the 11 respondents interviewed in the 0-1,000 m Study Area indicated that they have experienced effects in the past. The most common effects being noise, litter and odour. Similarly, four of the ten residents interviewed in the 1,000-1,500 m Study Area indicated that they have experienced effects from the landfill in the past.

To gain an understanding as to the communities' stability and past/future growth, information was collected with respect to the length of residence and land use discipline. With respect to length of residence, of those within 1,000 m of the site, only one respondent had lived there for 3-5 years. Forty-five percent have lived there for 6-15 years and the remaining have lived in the area for more than 20 years. It would therefore seem that the area is fairly stable.

In terms of development activity, their has been very little over the past few years. Lands within 1,000 m of Site D are as of July 1993, not subject to any proposed or approved development applications.

Lands in the vicinity of the site are predominantly designated for industrial uses although agriculture is the predominant existing use. As discussed in the Land Use Assessment, it is expected that the lands in the vicinity of Site D would likely not be developed for at least another 20 years. The rationale being that the lands are on the outer eastern boundary of the industrial land block in Moore Township. It is therefore anticipated that the lands would remain in predominantly agricultural use.

Site D was considered to be the second least preferred site on the basis of the visual assessment. There will be 45 viewers of the facility. Forty-one of these views will be unscreened. Schedule IV discusses the results of the visual assessment in more detail.

In summary, the "community" in the vicinity of Site D is primarily rural and agriculturally based. Despite the industrial designation of the surrounding lands, its rural character is likely to remain for the next 20 years.

Given the high potential for visibility of the proposed waste management facility, and that the facility is not compatible with the rural character of this area, it is anticipated that the character of the surrounding community could be affected if the facility was developed.

SITE K

As Site K is so close to Site D, it shares many of the same characteristics. Residents in the area value the same characteristics as those in the vicinity of Site K and indicated a similar experience to date with the existing Moore Township landfill. The residents also have lived in the area for generally the same length of time as well.

From a development potential point of view, as with Site D, despite the industrial designation of most lands in the vicinity of the site, the area is likely to remain agriculturally based.

The most obvious difference with Site K as compared to Site D, is that Site K is located adjacent to the existing Moore Township Waste Disposal Site and located on lands designated for waste disposal. Based on the information collected, it would appear that the existing landfill has not had a tremendous influence on the character of the area. The existing Moore Township landfill, however, is of a much smaller scale and is buffered from view. The proposed facility will generate a greater volume of traffic and will be visible throughout the community. Site K was considered to be the least preferred site on the basis of the visual assessment. There will be approximately 66 viewers of the facility of which 56 views will be unscreened. It is therefore projected that the character of the community could be influenced if the facility is developed at Site K.

SITE H

As there are no residences in the vicinity of Site H, information with respect to residents' perception of community character and stability of the area was not applicable.

Lands in the vicinity of Site H are designated for industrial uses. Recognizing the heavy industrial nature of the ICI/Terra facility south of Site H, it is anticipated that the area will remain industrial in character. As suggested in the Land Use Assessment, it is anticipated that the development of the waste management facility could encourage new industrial development in the area thus reinforcing the industrial nature of this area. Site H was most preferred from a visual perspective as it has the fewest number of viewers (19) with only 3 unscreened views.

It is anticipated that development of the facility at Site H would not result in significant impacts to the character of the area.

SITE I

As Site I is just east of Site H, lands in its vicinity have basically the same characteristics. The only exception is that there is one residence within 1,000 m of Site I. Nevertheless, it is anticipated the lands in the vicinity are likely to become more industrial in character (although perhaps lighter industrial uses as Site I is closer to agricultural areas). With respect to the potential for visual impact on the area, Site I was second most preferred with 27 viewers of which only 6 views are unscreened.

It is anticipated that development of the facility at Site I would not result in significant impacts to the character of the area.

Indicator 5.2 - Impact on Community Cohesion

The cohesiveness of a community is a measure of how close a community is on the level of interaction among its members. It is based upon resident's commitment to one another and their community as a whole. The cohesiveness of a community can be directed by residents' withdrawal and ultimately moving from the area due to disruption effects experienced and the stigma of having to live near a waste management facility. The following measures were initially taken into account in assessing the potential for community cohesion impacts:

- amount of social interaction;
- extent of social activities;
- level of satisfaction with community;
- sense of belonging;
- potential for out-migration; and
- potential for change in level of satisfaction.

The first four measures determine the level of cohesion in the community while the last two measures are directed as to how that level of cohesion could change.

As Site H has no residences in its vicinity and there is only one residence within 1,000 m of Site I, there is next to no potential for cohesion effects in the vicinity of these sites. With respect to Sites D and K, the first four measures of this indicator were discussed in Chapter 3.0. For the most part, the sites could not be distinguished on the basis of these measures. The residents indicated a strong sense of belonging with the community, a high level of interaction with each other and a high level of satisfaction with their community.

In fact, when asked what residents liked about the area, many responded with a "strong sense of community".

In assessing the potential for change in cohesion the following considerations were taken into account: potential for change in their level of satisfaction and the potential for out-migration of residents. With respect to the first, 80% (4) of the respondents in the vicinity of Site K thought that their level of satisfaction with the community would decrease if the facility was developed. Of those, 75% (3) felt that they would become "considerably" or "very" dissatisfied.

With respect to Site D, 100% (11) of the respondents felt that their level of community satisfaction would decrease. Of these, 82% (9) indicated that they would become "considerably" to "very" dissatisfied.

Finally, residents were also asked if they thought they would move if the facility was developed. For Site D, 64% (7) said they would move, of which three residents have already contacted real estate agents. With respect to Site K, three of the five respondents (60%) indicated that they would move, of which only one has contacted a real estate agent to date.

Ultimately, the potential for impact on community cohesion will depend on the effects generated by the facility, its visibility throughout the area and how well Lambton County responds to the concerns of residents. Based on the interview results, there would appear to be the potential for decreases of resident satisfaction and out-migration for both Sites D and K, thus potentially affecting community cohesion.

5.0 COMPARATIVE EVALUATION

5.1 Introduction

This chapter discusses the results of the comparative evaluation. The purpose of the evaluation is to rank the relative priority of the four candidate sites in terms of their potential for social impacts.

Taking into account the data based on the sub-indicators, the sites were first ranked at the indicator level. Then using the indicator rankings, rankings were established for each criteria. Finally, using the criteria ranking, site preferences were established on the basis of the overall social discipline. Due to the consistency in the site rankings at both the indicator and criteria level, neither weights nor a quantitative evaluation method was required. The final evaluation was done through a qualitative trade-off analysis.

The following discusses the results of the site comparative evaluation by criteria. Table 5 summarizes the data considered in the comparative evaluation. Tables 6 to 9 outline the possible environmental effects of a waste management facility on the sites, the mitigative measures that could be implemented to lessen the environmental impacts, and the net effects.

5.2 Criteria 1 - Potential for Disruption to Individuals in the Site Vicinity Study Area

Indicator 1.1 - Number of Residences/Residents

Sites H and I had zero and one residence respectively within 1,000 m of their boundaries. They were considered equal and most preferred with respect to this indicator. Although Site I has one residence within 1,000 m of its boundaries, the residence is just on the 1,000 m contour, is buffered by a woodlot, and is separated by Highway 40. It is therefore anticipated that effects to this residence would be minimal. Site K was third most preferred with eight residences (estimated 25 residents) and Site D least preferred with 12 residences (estimated 37 residents).

Indicator 1.2 - Number of Vulnerable Residents

Sites H and I were considered to be most preferred with respect to this indicator as there are no residences in the vicinity of Site H and only one for Site I.

TABLE 5
SOCIAL DATA SUMMARY TABLE

Criteria/Indicator/Sub-Indicator	SITES			
	D	K	H	I
1. Potential for Disruption to Individuals in the Site Vicinity Study Area (within 1,000 m of site boundary) • Number of residences/residents (estimated)	12/37	8/25	0/0	1/3
RANKING*	4	3	1	1
• Number of vulnerable residents				
· Number/percentage of children 0-14 years old	13/32%	5/36%	0/0%	NA**
· Number/percentage of seniors > 65 years old	4/10%	1/7%	0/0%	N/A
· Number/percentage of individuals with respiratory health problems	8/19%	6/43%	0/0%	NA
· Number/percentage home during facility operating hours	17/41%	5/36%	0/0%	NA
RANKING*	4	3	1	1
• Use of property				
· Number/percentage of households involved in outdoor sensitive activities	11/100%	5/100%	0/0%	NA
· Number/percentage of respondents who feel that outdoor activities would be affected by facility operations	10/91%	4/80%	0/0%	NA
RANKING*	4	3	1	1
• Use of property by non-resident owners				
· Number/percentage of owners involved in outdoor social/ recreation activities on their property	9/50%	8/42%	1/11%	0/0%
· Number/percentage of owners with plans for future residences on their property	1/5%	1/5%	1/11%	0/0%

* "1" represents most preferred and "4" represents least preferred.

** N/A - One residence in the vicinity of Site I but was not available for an interview.

TABLE 5
SOCIAL DATA SUMMARY TABLE
(Continued)

Criteria/Indicator/Sub-Indicator	SITES			
	D	K	H	I
RANKING*	3	3	1	1
CRITERIA #1 RANKING	4	3	1	1
2. Potential for Disruption of Community/Recreation Features in the Site Vicinity Study Area (within 1,000 m of site boundary)				
• Number of features	1	1	1	0
RANKING*	2	2	2	1
• Characteristics of features				
· Number with hours of operation during facility operating hours	1	1	1	0
· Number predominantly based outdoors	1	1	1	0
· Number who perceive operations of the feature will be affected by proposed facility	0	0	1	0
· Number with plans for expansion	1	1	0	0
RANKING*	2	2	2	1
CRITERIA #2 RANKING	2	2	2	1

TABLE 5
SOCIAL DATA SUMMARY TABLE
(Continued)

Criteria/Indicator/Sub-Indicator	SITES			
	D	K	H	I
3. Potential for Disruption of Residents in the Access Route Study Area				
• Number of residences/residents	5/22	8/33	0	0
RANKING*	3	4	1	1
• Number of vulnerable residents				
· Number/percentage of children 0-14 years old	7/32%	12/36%	0/0%	0/0%
· Number/percentage of seniors > 65 years old	2/9%	2/6%	0/0%	0/0%
· Number/percentage with respiratory health problems	2/9%	8/24%	0/0%	0/0%
· Number/percentage home during facility operating hours	11/50%	17/51%	0/0%	0/0%
RANKING*	3	4	1	1
• Use of Property				
· Number/percentage of households involved in outdoor sensitive activities	5/100%	8/100%	0/0%	0/0%
RANKING*	3	3	1	1
• Use of roadway shoulder				
· Number/percentage of households which use shoulder of access route roadway	5/100%	8/100%	0/0%	0/0%
· Number/percentage who feel waste traffic would affect them	5/100%	8/100%	0/0%	0/0%
RANKING*	3	3	1	1
CRITERIA #3 RANKING	3	4	1	1

TABLE 5
SOCIAL DATA SUMMARY TABLE
(Continued)

Criteria/Indicator/Sub-Indicator	SITES			
	D	K	H	I
4. Potential for Disruption of Community/Recreation Features in the Access Route Study Area				
• Number of features	0	1	0	0
RANKING*	1	4	1	1
• Characteristics of Features				
· Number with hours of operation during facility operating hours	0	1	0	0
· Number predominantly based outdoors	0	1	0	0
· Number concerned about waste management facility traffic	0	0	0	0
RANKING*	1	4	1	1
CRITERIA #4 RANKING	1	4	1	1
5. Potential for Disruption to Communities in the Site Vicinity				
• Community character	See Description in Text (Section 4.3.5)			
• Community cohesion				
CRITERIA #5 RANKING	3	3	1	1
TOTAL SOCIAL IMPACT RANKING	3	4	2	1

TABLE 6
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE D

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Potential for disruption to individuals in the site vicinity study area (within 1000m of site boundary)**		· potential disruption to 37 residents in the site vicinity study area include the effects of noise, air quality, dust, visual impacts, public health and safety, and loss of satisfaction with place	· on-site controls to reduce nuisance impacts · establish controls on operating times · provisions of monitoring results to community including interest groups and First Nations where affected · establish complaint recording and response program · open discussions with residents and interest groups including First Nations where affected to determine how well their concerns are being dealt with · provision of contingency planning · site screening through berming and vegetation plantings in affected viewsheds · use housekeeping, operating procedures and schedules to minimize nuisance effects · minimize working face · daily cover of refuse · paved access roads, chemical suppress and watering of temporary on-site access roads · on-site speed limits · vehicle inspection and preventative maintenance program · reduce organics of waste stream · shredding or baling of waste · provision to install gas pumping equipment to collect and burn landfill gas to reduce safety and health risks, odour nuisance and methane emissions to the atmosphere	· nearby 37 residents may still be exposed to occasional nuisance levels of dust, odour, noise, litter and visual impacts. This exposure should be less than without mitigative measures. Compensation may be provided.
• number of residences/residents (estimated)	12/37			
• number of vulnerable residents				
· number of children 0-14 years old	13			
· number of seniors >65 years old	4			
· number of individuals with respiratory health problems	8			
· number home during facility operating hours	17			
• use of property				
· number of households involved in outdoor sensitive activities	11			
· number of respondents [to survey] who feel that outdoor activities would be affected by facility operations	10			
• use of property by non-resident owners				
· number of owners involved in outdoor social/ recreation activities on their property	9			
· number of owners with plans for future residences on their property	1			

TABLE 6
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE D
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
			· provision to install low permeability cover to limit infiltration and reduce gas generation should air monitoring program indicate serious odour problems · retro-fitting affected properties with central air-conditioning units · water or vegetate exposed soils · equipment specifications to minimize engine noise · implement bird control systems · discourage loafing or nesting by eliminating casual ponding and permitting on-site vegetation to grow tall · vector control programs	
2. **Potential for disruption of community/ recreation features in the site vicinity study area (within 1000m of site boundary)** • number of features	1	· one community/recreation feature in the site vicinity study area will be potentially disrupted and exposed to nuisance effects such as noise, dust, odour, litter, and visual impacts	· maintain buffer between site and adjacent development	· nearby feature may still be exposed to occasional nuisance levels of noise, dust, odour, litter and visual impacts
• characteristics of features · number with hours of operation during facility operating hours	1			
· number predominantly based outdoors	1			
· number who perceive operations of the feature will be affected by proposed facility	0			
· number with plans for expansion	1			
3. **Potential for disruption of residents in the access route study area** • number of residences/residents	5/22	· potential disruption to 22 residents in the access route study area include the effects of noise, dust, air quality, visual impacts, and vibration	· regulate operating hours · vehicle specifications to comply with noise regulations · vehicles cleaned and covered	· litter from small vehicles may be a nuisance at some times · dust and mud impacts very low

TABLE 6
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE D
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
• number of vulnerable residents · number of children 0-14 years old	7		· monitoring of routes and vehicles arriving at the site · paved roadways on site · proper site drainage · good housekeeping of roads and off-site · reduce traffic by use of transfer stations for Municipal systems and/or to reduce the number of private vehicles to the site · specify noise attenuation requirements for future residential development abutting main truck routes	
· number of seniors >65 years old	2			
· number with respiratory health problems	2			
· number home during facility operating hours	11			
• use of property · number of households involved in outdoor sensitive activities	5			
• use of roadway shoulder · number of households which use shoulder of access route roadway	5			
· number who feel waste traffic would affect them	5			
4. **Potential for disruption of community/recreation features in the access route study area** • number of features	0	· none	· not required	· none
• characteristics of features · number with hours of operation during facility operating hours	0			
· number predominantly based outdoors	0			
· number concerned about waste management facility traffic	0			

TABLE 6
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE D
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
5. **Potential for disruption to communities in the site vicinity**		· most common effects such as noise, litter, and odour may be experienced by this area that is generally quiet and peaceful	· site with few unique/distinctive community characteristics on-site or within site vicinity	· the cohesiveness of communities may still be affected by the relocation of residents, facilities or services
• community character	not applicable	· presence of a facility would be incompatible with this rural farming community	· avoid resident displacements	· some nuisance effects may still be experienced by communities in the vicinity of the site and along waste haul route
• community cohesion	not applicable	· community is fairly stable in terms of number of residents and their length of stay	· site to minimize visual impact and implement site screening through berming and vegetation plantings in affected viewshed	· character of a community may still be affected as a result of views of the landfill facility
		· visual impacts to 45 viewers; 41 of these views would be unscreened	· minimize number of communities along waste haul route	· sense of "community" may still be diminished
		· strong sense of community would be impacted, i.e. satisfaction with the community	· avoid communities whose cohesiveness may be affected or communities who may not be able to deal with change as a result of the landfill facility · provide some level of community control in landfill operations · involve community in landfill monitoring	

TABLE 7
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE K

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Potential for disruption to individuals in the site vicinity study area (within 1000m of site boundary)** • number of residences/residents (estimated)	8/25	· potential disruption to 25 residents in the site vicinity study area include the effects of noise, air quality, dust, visual impacts, public health and safety, and loss of satisfaction with place	· on-site controls to reduce nuisance impacts · establish controls on operating times · provisions of monitoring results to community including interest groups and First Nations where affected · establish complaint recording and response program	· nearby 25 residents may still be exposed to occasional nuisance levels of dust, odour, noise, litter and visual impacts. This exposure should be less than without mitigative measures. Compensation may be provided.
• number of vulnerable residents · number of children 0-14 years old	5		· open discussions with residents and interest groups including First Nations where affected to determine how well their concerns are being dealt with · provision of contingency planning	
· number of seniors >65 years old	1		· site screening through berming and vegetation plantings in affected viewsheds	
· number of individuals with respiratory health problems	6		· use housekeeping, operating procedures and schedules to minimize nuisance effects	
· number home during facility operating hours	5		· minimize working face	
• use of property · number of households involved in outdoor sensitive activities	5		· daily cover of refuse · paved access roads, chemical suppress and watering of temporary on-site access roads	
· number of respondents [to survey] who feel that outdoor activities would be affected by facility operations	4		· on-site speed limits · vehicle inspection and preventative maintenance program	
• use of property by non-resident owners · number of owners involved in outdoor social/ recreation activities on their property	8		· reduce organics of waste stream · shredding or baling of waste	
· number of owners with plans for future residences on their property	1		· provision to install gas pumping equipment to collect and burn landfill gas to reduce safety and health risks, odour nuisance and methane emissions to the atmosphere	

TABLE 7
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE K
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
			· provision to install low permeability cover to limit infiltration and reduce gas generation should air monitoring program indicate serious odour problems · retro-fitting affected properties with central air-conditioning units · water or vegetate exposed soils · equipment specifications to minimize engine noise · implement bird control systems · discourage loafing or nesting by eliminating casual ponding and permitting on-site vegetation to grow tall · vector control programs	
2. **Potential for disruption of community/ recreation features in the site vicinity study area (within 1000m of site boundary)** • number of features	1	· one community/recreation feature in the site vicinity study area will be potentially disrupted and exposed to nuisance effects such as noise, dust, odour, litter, and visual impacts	· maintain buffer between site and adjacent development	· nearby feature may still be exposed to occasional nuisance levels of noise, dust, odour, litter and visual impacts
• characteristics of features · number with hours of operation during facility operating hours	1			
· number predominantly based outdoors	1			
· number who perceive operations of the feature will be affected by proposed facility	0			
· number with plans for expansion	1			
3. **Potential for disruption of residents in the access route study area** • number of residences/residents	8/33	· potential disruption to 33 residents in the access route study area include the effects of noise, dust, air quality, visual impacts, and vibration	· regulate operating hours · vehicle specifications to comply with noise regulations · vehicles cleaned and covered	· litter from small vehicles may be a nuisance at some times · dust and mud impacts very low

TABLE 7
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE K
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
• number of vulnerable residents · number of children 0-14 years old	12		· monitoring of routes and vehicles arriving at the site · paved roadways on site · proper site drainage · good housekeeping of roads and off-site · reduce traffic by use of transfer stations for Municipal systems and/or to reduce the number of private vehicles to the site · specify noise attenuation requirements for future residential development abutting main truck routes	
· number of seniors >65 years old	2			
· number with respiratory health problems	8			
· number home during facility operating hours	17			
• use of property · number of households involved in outdoor sensitive activities	8			
• use of roadway shoulder · number of households which use shoulder of access route roadway	8			
· number who feel waste traffic would affect them	8			
4. **Potential for disruption of community/recreation features in the access route study area** • number of features	1	· one community/recreation feature in the access route study area will potentially be disrupted with nuisance effects such as odours, dust, noise, vibration, visual impacts, and air quality	· regulate operating hours · vehicle specifications to comply with noise regulations · vehicles cleaned and covered · monitoring of routes and vehicles arriving at the site · paved roadways on site · proper site drainage · good housekeeping of roads on and off-site	· litter from small vehicles may be a nuisance at some times · dust and mud impacts very low
• characteristics of features · number with hours of operation during facility operating hours	1			
· number predominantly based outdoors	1			

TABLE 7
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE K
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
· number concerned about waste management facility traffic	0		· reduce traffic by use of transfer stations for Municipal systems and/or to reduce the number of private vehicles to the site · specify noise attenuation requirements for future residential developments abutting main truck routes	
5. **Potential for disruption to communities in the site vicinity** • community character	not applicable	· presence of a facility would be incompatible with this rural farming community	· avoid resident displacements	· some nuisance effects may still be experienced by communities in the vicinity of the site and along waste haul route
• community cohesion	not applicable	· community is fairly stable in terms of number of residents and their length of stay · visual impacts to 66 viewers; 56 of these views would be unscreened · strong sense of community would be impacted, i.e. satisfaction with the community	· site to minimize visual impact and implement site screening through berming and vegetation plantings in affected viewshed · minimize number of communities along waste haul route · avoid communities whose cohesiveness may be affected or communities who may not be able to deal with change as a result of the landfill facility · provide some level of community control in landfill operations · involve community in landfill monitoring	· character of a community may still be affected as a result of views of the landfill facility · sense of "community" may still be diminished

TABLE 8
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE H

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Potential for disruption to individuals in the site vicinity study area (within 1000m of site boundary)**		· potential disruption to one non-resident owner who uses his property for outdoor activity and who has plans for future expansion of his property. Nuisance effects may include noise, air quality, dust, visual impacts, public health and safety, and loss of satisfaction with place	· on-site controls to reduce nuisance impacts · establish controls on operating times · provisions of monitoring results to community including interest groups and First Nations where affected · establish complaint recording and response program · open discussions with residents and interest groups including First Nations where affected to determine how well their concerns are being dealt with · provision of contingency planning · site screening through berming and vegetation plantings in affected viewsheds · use housekeeping, operating procedures and schedules to minimize nuisance effects · minimize working face · daily cover of refuse · paved access roads, chemical suppress and watering of temporary on-site access roads · on-site speed limits · vehicle inspection and preventative maintenance program · reduce organics of waste stream · shredding or baling of waste	· non-resident owner may still be exposed to occasional nuisance levels of dust, odour, noise, litter and visual impacts. This exposure should be less than without mitigative measures. Compensation may be provided.
• number of residences/residents (estimated)	0/0			
• number of vulnerable residents				
· number of children 0-14 years old	0			
· number of seniors >65 years old	0			
· number of individuals with respiratory health problems	0			
· number home during facility operating hours	0			
• use of property				
· number of households involved in outdoor sensitive activities	0			
· number of respondents [to survey] who feel that outdoor activities would be affected by facility operations	0			
• use of property by non-resident owners				
· number of owners involved in outdoor social/ recreation activities on their property	1			

TABLE 8
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE H
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
· number of owners with plans for future residences on their property	1		· provision to install gas pumping equipment to collect and burn landfill gas to reduce safety and health risks, odour nuisance and methane emissions to the atmosphere · provision to install low permeability cover to limit infiltration and reduce gas generation should air monitoring program indicate serious odour problems · retro-fitting affected properties with central air-conditioning units · water or vegetate exposed soils · equipment specifications to minimize engine noise · implement bird control systems · discourage loafing or nesting by eliminating casual ponding and permitting on-site vegetation to grow tall · vector control programs	
2. **Potential for disruption of community/ recreation features in the site vicinity study area (within 1000m of site boundary)**		· one community/recreation feature in the site vicinity study area will be potentially disrupted and exposed to nuisance effects such as noise, dust, odour, litter, and visual impacts	· maintain buffer between site and adjacent development	· nearby feature may still be exposed to occasional nuisance levels of noise, dust, odour, litter and visual impacts
• number of features	1			
• characteristics of features · number of hours of operation during facility operating hours	1			
· number of predominantly based outdoors	1			
· number who perceive operations of the feature will be affected by proposed facility	1			
· number with plans for expansion	0			

TABLE 8
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE H
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
3. **Potential for disruption of residents in the access route study area** • number of residences/residents	0/0	· none	· none required	· none
• number of vulnerable residents · number of children 0-14 years old	0			
· number of seniors >65 years old	0			
· number with respiratory health problems	0			
· number home during facility operating hours	0			
• use of property · number of households involved in outdoor sensitive activities	0			
• use of roadway shoulder · number of households which use shoulder of access route roadway	0			
· number who feel waste traffic would affect them	0			
4. **Potential for disruption of community/recreation features in the access route study area** • number of features	0	· none	· none required	· none
• characteristics of features · number with hours of operation during facility operating hours	0			
· number of predominantly based outdoors	0			
· number concerned about waste management facility traffic	0			

TABLE 8
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE H
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
5. **Potential for disruption to communities in the site vicinity**		· No residences in the vicinity of Site H · 19 viewers with only 3 unscreened views	· none required	· No significant impacts to character of the area
• community character	not applicable			
• community cohesion	not applicable			

TABLE 9
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE I

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Potential for disruption to individuals in the site vicinity study area (within 1000m of site boundary)**		· potential disruption to 1 resident in the site vicinity study area include the effects of noise, air quality, dust, visual impacts, public health and safety, and loss of satisfaction with place	· on-site controls to reduce nuisance impacts · establish controls on operating times · provisions of monitoring results to community including interest groups and First Nations where affected	· nearby resident may still be exposed to occasional nuisance levels of dust, odour, noise, litter and visual impacts. This exposure should be less than without mitigative measures. Compensation may be provided.
• number of residences/residents (estimated)	1/3		· establish complaint recording and response program	
• number of vulnerable residents			· open discussions with residents and interest groups including First Nations where affected to determine how well their concerns are being dealt with	
· number of children 0-14 years old	N/A*		· provision of contingency planning	
· number of seniors >65 years old	N/A*		· site screening through berming and vegetation plantings in affected viewsheds	
· number of individuals with respiratory health problems	N/A*		· use housekeeping, operating procedures and schedules to minimize nuisance effects	
· number home during facility operating hours	N/A*		· minimize working face	
• use of property			· daily cover of refuse	
· number of households involved in outdoor sensitive activities	N/A*		· paved access roads, chemical suppress and watering of temporary on-site access roads	
· number of respondents [to survey] who feel that outdoor activities would be affected by facility operations	N/A*		· on-site speed limits · vehicle inspection and preventative maintenance program	
• use of property by non-resident owners			· reduce organics of waste stream	
· number of owners involved in outdoor social/ recreation activities on their property	0		· shredding or baling of waste	

*N/A - one residence in the vicinity of Site I but was not available for interview.

TABLE 9
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE I
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
· number of owners with plans for future residences on their property	0		· provision to install gas pumping equipment to collect and burn landfill gas to reduce safety and health risks, odour nuisance and methane emissions to the atmosphere · provision to install low permeability cover to limit infiltration and reduce gas generation should air monitoring program indicate serious odour problems · retro-fitting affected properties with central air-conditioning units · water or vegetate exposed soils · equipment specifications to minimize engine noise · implement bird control systems · discourage loafing or nesting by eliminating casual ponding and permitting on-site vegetation to grow tall · vector control programs	
2. **Potential for disruption of community/ recreation features in the site vicinity study area (within 1000m of site boundary)**		· none	· none required	· none
• number of features	0			
• characteristics of features				
· number of hours of operation during facility operating hours	0			
· number of predominantly based outdoors	0			
· number who perceive operations of the feature will be affected by proposed facility	0			
· number with plans for expansion	0			

TABLE 9
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE I
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
3. **Potential for disruption of residents in the access route study area** • number of residences/residents	0	· none	· none required	· none
• number of vulnerable residents · number of children 0-14 years old	0			
· number of seniors >65 years old	0			
· number with respiratory health problems	0			
· number home during facility operating hours	0			
• use of property · number of households involved in outdoor sensitive activities	0			
• use of roadway shoulder · number of households which use shoulder of access route roadway	0			
· number who feel waste traffic would affect them	0			
4. **Potential for disruption of community/recreation features in the access route study area** • number of features	0	· none	· none required	· none
• characteristics of features · number with hours of operation during facility operating hours	0			
· number of predominantly based outdoors	0			
· number concerned about waste management facility traffic	0			

TABLE 9
SOCIAL IMPACT ASSESSMENT: NET EFFECTS FOR SITE I
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
5. **Potential for disruption to communities in the site vicinity**		· on residence within 1000 m of site; gives an indication of no potential for community cohesion in the area	· none required	· no significant impact to character of the area
• community character	not applicable	· 27 viewers of which 6 views are unscreened		· no potential for community cohesion
• community cohesion	not applicable			

With respect to Site D and K, Site D has more vulnerable residents than Site K on the basis of all sub-indicators. In two instances, Site D has more than double the number of vulnerable residents. Therefore, Site K is more preferred than Site D making Site D the least preferred site on the basis of this indicator.

Indicator 1.3 - Use of Property

This indicator considered the number of households that are involved in outdoor activities and the number of respondents who feel these activities would be affected by the proposed facility.

Site H and I were considered to be most preferred due to the limited number of residences in their vicinity. Site K was ranked second most preferred and Site D was considered to be least preferred as it has twice as many residents (as compared to Site K) involved in outdoor activities and who believe their activities would be affected.

Indicator 1.4 - Use of Property by Non-Resident Owners

Sites H and I were considered to be most preferred as there is only one property which is used for social/recreation activities in the vicinity of Site H and more in the vicinity of Site I.

Sites D and K were considered equal and least preferred as they had nine and eight owners respectively who indicated that their property is used for social/recreation activities.

Criteria 1 - Overall Ranking

As sites H and I are consistently the most preferred sites for all indicators, they are the most preferred sites. As Site D has approximately twice the number of residents, vulnerable residents and those who use their property for outdoor activities, Site D is less preferred than Site K, making Site D the least preferred site on the basis of Criteria 1.

5.3 Criteria 2 - Potential for Disruption of Community/ Recreation Features in the Site Vicinity Study Area

Indicator 2.1 - Number of Features

Site I is the most preferred site with respect to this indicator as there are no features within the site vicinity Study Area. Although there is a proposal to construct a shooting range by Lambton Sportsman Ltd. in the vicinity of Site I, as it is only a proposed facility, it was not considered.

Sites D, K and H each have a feature within 1,000 m of their site boundaries and are thus least preferred. Sites D and K have the same feature (Lambton Bow Hunters Club) while Site H has the ICI Lambton Employees Social and Recreation Club. It should also be recognized that the St. Clair River Parkway is also within 1,000 m of Site H. Although there are no features or specific parks in this area, it is an additional consideration which has been raised by the public.

Indicator 2.2 - Characteristics of Features

This indicator took into account hours of operation, whether activities occurred outdoors, expansion plans and whether the operator perceived that their facility would be affected.

Site I was identified to be most preferred as there are no features associated with it. With respect to the remaining sites, all the features would appear to be equally sensitive, however, Site H is less preferred than sites D and K as it has more features associated with it. Sites D and K are considered equal and second most preferred.

Criteria 2 - Summary

Overall, Site I is most preferred as it has no features associated with it. Sites D and K are second most preferred as they have the same facility in their vicinity. Site H is least preferred as it has the greatest number of features.

5.4 Criteria 3 - Potential for Disruption of Residents in the Access Route Study Area

Indicator 3.1 - Number of Residences/Residents

As Sites H and I have no residences located along the access route, they are considered to be the most preferred with respect to this indicator. Site D is third most preferred with 22 residents and Site K least preferred with 33 residents.

Indicator 3.2 - Number of Vulnerable Residents

Sites H and I were most preferred as they have no vulnerable residents along their access route. As Site K has close to double the number of vulnerable residents for three of the four sub-indicators, as compared to Site D, Site K is the least preferred site.

Indicator 3.3 - Use of the Property

Site H and I have no residences and are thus most preferred. As sites D and K have five and eight households along the access route which are involved in outdoor activities, they are considered equal and least preferred.

Indicator 3.4 - Use of Roadway Shoulder

Sites H and I were considered to be the most preferred sites with respect to this indicator as there are no residences along the access route. As Sites D and K have five and eight households which use the roadway shoulder, they were considered similar and ranked equally as least preferred.

Criteria 3 - Summary

Overall, Sites H and I are considered equal and ranked most preferred as there are no residences along the access routes. Site K is considered to be less preferred than Site D as it has more residents and more vulnerable residents along its access route. Site K is therefore the least preferred site with respect to this criteria.

5.5 Criteria 4 - Potential for Disruption of Community/ Recreation Features in the Access Route Area

As Site K is the only site which has a feature along its access route (Lambton Bowhunters Club) it was identified as the least preferred site with respect to this criteria. Sites D, H and I are equally most preferred.

5.6 Criteria 5 - Potential for Disruption to Communities in the Site Vicinity

This criteria took into account the potential for effects on community character and cohesion. The discussion of the potential for effects is discussed in the previous chapter in Section 4.3.5.

Overall, Sites H and I are considered equal and most preferred. This is largely due to the fact that there are few residences in their vicinity, few properties in which social/recreation activities occur and within an industrial designated area with existing heavy industrial activities.

Although Sites D and K are also on industrial designated lands, the area has a "defined" community in its vicinity, is primarily an agricultural rural area and both sites may result in impacts on the character and cohesion of the surrounding community. As Sites D and K are located next to one another, and generally would affect the same community, no distinction can be made between the two on the basis of this criteria. They are therefore considered to be equal and least preferred.

5.7 Overall Social Evaluation

The following summarizes the site rankings by criteria ("1" equals most preferred and "4" least preferred).

Criteria	SITES			
	D	**K**	**H**	**I**
1. Potential for disruption to individuals in the site vicinity Study Area	4	3	1	1
2. Potential for disruption of community/recreation features in the site vicinity Study Area	2	2	2	1
3. Potential for disruption of residents in the access route Study Area	3	4	1	1
4. Potential for disruption of community/recreation features in the access route Study Area	1	4	1	1
5. Potential for disruption to communities in the site vicinity	3	3	1	1
Overall Social Ranking	4	3	2	1

Overall, from a social perspective, Site I is the preferred site as it was most preferred on the basis of all criteria. Site H is considered slightly less preferred due to its proximity to the ICI Lambton Employees Social and Recreation Club and the St. Clair River Parkway which was identified as a public concern.

With respect to Sites D and K, they were considered equal with respect to Criteria 2 and 5, thus, these criteria were discounted. In terms of Criteria 1, Site K is more preferred as there is less potential for impacts to residents in the site vicinity. However, as Site K has a longer access route, there is a greater potential for impacts to individuals and features along the route. Thus, Site K is less preferred than Site D on the basis of Criteria 3 and 4.

Therefore, the trade-off is between a greater potential for impact to individuals in the vicinity of Site D versus a greater potential for impact to residents and features along the access route to Site K. Recognizing that the residents/features along the access route are located on a provincial Highway and that the increase in traffic is only to be 5% above of the existing background level, the potential for impact to individuals in the vicinity of the site is anticipated to be greater. As a result, Site K is slightly more preferred than Site D. The overall site ranking is as follows:[4]

Most Preferred	Site I
	Site H
	Site K
Least Preferred	Site D.

---

[4] Note: As the distinction between Sites H and I, and Sites D and K is small, a sensitivity should be run assuming that Sites H and I are equal and preferred over Sites K and D which are equal and least preferred.

SCHEDULE I

NON-RESIDENT PROPERTY SURVEY

Our File: 92-9928-37-06

August 23, 1993

1~

County of Lambton
Waste Management Master Plan

Dear 2~:

The County of Lambton is currently preparing the Lambton County Waste Management Master Plan. The aim of the Master Plan is to define the best system for the long-term management of wastes within Lambton County from 1991 to 2016.

The waste management system will include the following components: recycling and source separation, backyard composting, centralized composting, a materials recovery facility (MRF) and landfill.

A site selection process began in 1990. Its goal is to select a site for a centralized waste management facility which will include a composting area, MRF and a new landfill. Four candidate sites have now been identified for detailed investigations to select the single preferred site.

The site selection process is being led by staff from the County of Lambton and the consulting firm of M.M. Dillon Limited (Dillon). Members of the public from across the County have been involved through site selection workshops, the Public Advisory Committee, the Master Plan Steering Committee and public meetings.

Dillon is currently conducting the social impact assessment to assist in the selection of one of the four candidate sites. For each site, the possible effects of the proposed facility on peoples way of life and their communities will be assessed. This information will assist in the comparison of the sites, and in the selection of a preferred site. Your assistance is needed.

... Continued

As you own property in the vicinity of the candidate sites, a questionnaire is enclosed to obtain your views and concerns to help us understand the potential for social impacts. We would like to contact you by telephone to discuss the enclosed questionnaire. However, our database indicates that your telephone number is not listed. Please contact Jim Kutyba, County of Lambton at (519) 845-0801 or Don P. McKinnon, Dillon (Toronto) at (416) 229-4646 (you may call collect) with a number where you can be reached. A Dillon staff member will then contact you to discuss the questionnaire.

The completed surveys will be treated as confidential. Answers will be presented in aggregate form only, and names and addresses will be excluded from the survey results. Individual surveys will remain the property of the County of Lambton.

Your participation in this survey is very important. Your participation will enable an accurate representation of your views and will assist in the correct determination of the preferred site for this facility.

If you have any immediate questions or concerns, please contact Jim Kutyba, County of Lambton at (519) 845-0801 or Don P. McKinnon, Dillon (Toronto) at (416) 229-4646 (you may call collect).

Yours truly,

M.M. DILLON LIMITED

Don P. McKinnon, M.E.S.
for Catherine J. Fletcher, M.Sc.
Project Manager

ceb/mf
Encl.

As you own property in the vicinity of the candidate sites, a questionnaire is enclosed to obtain your views and concerns to help us understand the potential for social impacts. We ask that you return the completed questionnaire by mail to M.M. Dillon Limited no later than **August 26, 1993**.

The completed surveys will be treated as confidential. Answers will be presented in aggregate form only, and names and addresses will be excluded from the survey results. Individual surveys will remain the property of the County of Lambton.

Your participation in this survey is very important. Your participation will enable an accurate representation of your views and will assist in the correct determination of the preferred site for this facility.

If you have any immediate questions or concerns, please contact Jim Kutyba, County of Lambton at (519) 845-0801 or Don P. McKinnon, Dillon (Toronto) at (416) 229-4646 (you may call collect).

Yours truly,

M.M. DILLON LIMITED

Don P. McKinnon, M.E.S.
for Catherine J. Fletcher, M.Sc.
Project Manager

ceb/mf

Location Code ___________

NON-RESIDENT PROPERTY SURVEY
LAMBTON COUNTY WASTE MANAGEMENT
MASTER PLAN

The purpose of this survey is to collect information from individuals who own property within the vicinity of the candidate waste management facility sites. A survey will also be conducted with people who live within the vicinity of the candidate waste management facility sites and either own or rent property.

If you own more than one property in the vicinity of the candidate sites you have been provided with a survey form for each property. The assessment roll # and legal description of each property appear on labels enclosed with the surveys. **Please place the property label on the front page of the survey form(s).** We have enclosed maps of the candidate sites which are closest to your property. **Please indicate on the maps the locations of your property(s) and return it with the survey form.**

In answering questions about the potential effects of the facility, the questions should be answered in reference to the candidate facility site which is closest to your property (see attached maps).

Location Code ___________

We would like to describe the proposed facility to help you answer the questions:

- The County of Lambton propose to construct a landfill, material recycling facility and a composting facility together on one site.

- There are four proposed sites:

    - Site D is located in Lots 22 and 23, Concession 5, which is north of Highway 80, east of Highway 40, south of Moore Township Road 6, and west of Moore Township Road 21.

    - Site K located in Lots 20 and 21, Concession 5, which is north of Highway 80, east of Moore Township Road 21, south of Moore Township Road 6, and west of Moore Sideroad 19. Site K is east of the existing Moore Township landfill.

    - Site H is located in Lots 1, 2, 3 and 4, Front Concession, which is north of Townline Road, east of the St. Clair River, south of Moore Township Road 2, and west of Moore Township Road 27.

    - Site I is located in Lots 26 and 27, Concession 1, which is north of Townline Road, east of Moore Township Road 27, south of Moore Township Road 2, and west of Highway 40.

- A total site area of approximately 185 acres (75 ha) is required.

- The landfill site is approximate 33 acres (13.2 ha) and will reach a maximum height of approximately 56 ft. (17 m).

- There will be three buildings on site:

    - a material recovery facility building;
    - a composting building; and
    - a curing building;

Location Code ____________

- Approximately 25-40 municipal trucks a day will travel to the waste management facility as well as private vehicles. The proposed routes are:
    - Site D - Highway 80 east of Highway 40 to the site access road;
    - Site K - Highway 80 east of Highway 40 to Moore Township Road 22 and then north to the site access road;
    - Site H - Townline Road east of Highway 40 to the site access
    - Site I - Townline Road east of Highway 40 to the site access.
- Due to the topography of the land the landfill will be seen up to 3 km away.

Location Code __________

IF YOU REQUIRE ADDITIONAL SPACE, PLEASE WRITE ON THE REVERSE SIDE OF THE PAGE.

1. Please provide your name, address, and telephone number in case we need to contact you.

NAME: ____

ADDRESS: ____

____

____

TELEPHONE NO: ____

Place label here

PLEASE RETURN THE COMPLETED SURVEY IN THE POSTAGE PAID ENVELOPE PROVIDED BY AUGUST 26, 1993.

Location Code ____________

IF YOU REQUIRE ADDITIONAL SPACE, PLEASE WRITE ON THE REVERSE SIDE OF THE PAGE.

1. Please provide your name, address, and telephone number in case we need to contact you.

NAME: ______________________________

ADDRESS: ______________________________

____

____

TELEPHONE NO: ______________________________

Place label here

PLEASE RETURN THE COMPLETED SURVEY IN THE POSTAGE PAID ENVELOPE PROVIDED BY SEPTEMBER 8, 1993.

Location Code ___________

2a. Is the property used for any outdoor social or recreational activities?

Yes ☐ No ☐

If **no**, go to question 3a.

2b. If **yes**, who uses the property and for what activities?

____

____

____

____

____

2c. If **yes**, how often are these activities undertaken?

____

____

____

____

____

2d. Do you think that the proposed facility would affect these activities?

Yes ☐ No ☐ Don't Know ☐

Location Code ____________

2e. If yes, please indicate how.

____

____

____

____

____

3a. Is the property currently used for any farming activities?

Yes ☐ No ☐

3b. If this property is used for farming activities, do you (the property owner) farm the property or is it rented or leased to others for farming purposes?

Owner farms property ☐

Rented or leased to others ☐

3c. If the property is rented or leased for farming activities, please provide the names and addresses of the farmer(s) who rent or lease the land.

Name	Address	Phone #

Location Code ____________

4a. Is the property used for any business activity other than farming?

Yes ☐ No ☐

Please describe the business activity.

4b. If yes, is the property used by you (the property owner), or is it rented, or leased to someone else for business activity?

Used by you (the property owner) for business activity ☐

Rented or leased to others for business activity ☐

4c. If the property is rented or leased for business activity, please provide the name, a contact person's name, and address of the business(es) who rents or leases the property.

Contact	Business Name	Address	Phone #

5a. Do you, or did you have, any plans prior to the announcement of the proposed waste management facility sites, to improve or change your property in the next 2-3 years?

Yes ☐ No ☐

Location Code ____________

5b. If yes, for what activities?

____

____

____

____

____

5c. Would the proposed waste management facility affect these plans in any way?

Yes ☐ No ☐

5d. If yes, in what ways would the proposed waste management facility affect these plans?

____

____

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Location Code ____________

6. How many years have you owned this property?

Less than 1 year ☐
1 to 5 years ☐
6 to 10 years ☐
11 to 20 years ☐
More than 20 years ☐

7a. Was this property previously owned by a family member?

Yes ☐ No ☐

7b. If yes, how many years has your family owned this property?

Less than 1 year	☐	1 to 5 years	☐
6 to 10 years	☐	11 to 20 years	☐
21 to 50 years	☐	51 to 75 years	☐
76 to 100 years	☐	More than 100 years	☐

Location Code ____________

8. Please provide any other comments or concerns you may have on the Lambton County Waste Management Master Plan.

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THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY.

SCHEDULE II

RESIDENT INTERVIEW FORM

Our File: 92-9928-37-06

July 26, 1993

1~

County of Lambton
Waste Management Master Plan

Dear 2~:

The County of Lambton is currently preparing the Lambton County Waste Management Master Plan. The aim of the Master Plan is to define the best system for the long-term management of wastes within Lambton County from 1991 to 2016.

The waste management system will include the following components: recycling and source separation, backyard composting, centralized composting, a materials recovery facility (MRF) and landfill.

A site selection process began in 1990. Its goal is to select a site for a centralized waste management facility which will include a composting area, MRF and a new landfill. Four potential sites have now been identified for detailed investigations to select the preferred site.

The site selection process is being led by staff from the County of Lambton and the consulting firm of M.M. Dillon Limited (Dillon). Members of the public from across the County have been involved through site selection workshops, the Public Advisory Committee, the Master Plan Steering Committee and public meetings.

Dillon is currently conducting the social impact assessment to assist in the selection of one of the four potential sites. For each site, the possible effects of the proposed facility on peoples way of life and their communities will be assessed. This information will assist in the comparison of the sites, and in the selection of a preferred site. Your assistance will be needed.

A telephone survey will be conducted to obtain your views and concerns to help us understand the potential for social impacts. A Dillon staff member will contact you within the next few weeks. If we cannot reach you by telephone, we will mail you the survey and ask that you return the completed survey by mail to M.M. Dillon Limited or the County of Lambton.

... Continued

The completed surveys will be treated as confidential. Answers will be presented in aggregate form only, and names and addresses will be excluded from the survey results. Individual surveys will remain the property of the County of Lambton.

Your participation in this survey is very important. Your participation will enable an accurate representation of your views and will assist in the correct determination of the preferred site for this facility.

If you have any immediate questions or concerns, please contact Jim Kutyba, County of Lambton at (519) 845-0801 or Don P. McKinnon, Dillon (Toronto) at (416) 229-4646 (you may call collect).

Yours truly,

M.M. DILLON LIMITED

Don P. McKinnon, M.E.S.
for Catherine J. Fletcher, M.Sc.
Project Manager

ceb/mf

Our File: 92-9928

July 29, 1993

1~

County of Lambton
Waste Management Master Plan

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... Continued

We would like to conduct a telephone survey to obtain your views and concerns to help us understand the potential for social impacts. However, our database indicates that your telephone number is not listed. Please contact Jim Kutyba, County of Lambton at (519) 845-0801 or Don P. McKinnon, Dillon (Toronto) at (416) 229-4646 (you may call collect) with a number where you can be reached. A Dillon staff member will then contact you to conduct the survey by telephone.

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M.M. DILLON LIMITED

Don P. McKinnon, M.E.S.
for Catherine J. Fletcher, M.Sc.
Project Manager

ceb/mf

Location Code ____________

LAMBTON WMMP SIA
RESIDENTS INTERVIEW FORM

RECORD OF CALLS

DATE:	________________	TIME:	________________
	________________		________________
	________________		________________
	________________		________________

INTERVIEWER: ____________________

Date of Interview: ______ / ______ / 93 ______

RESPONDENT'S NAME: ______________________________

____

ADDRESS: ______________________________

____

____

TELEPHONE NO: ______________________________

LOCATION:	Site ________	500-1000 m ☐	1001-1500 m ☐
	Site ________	500-1000 m ☐	1001-1500 m ☐

FOLLOW UP COMMENTS: ______________________________

____

____

____

____

Location Code ____________

Hello, my name is ______________________________ and I am calling on behalf of Lambton County. I would like to speak with someone who might be considered one of the heads of this household.

(Interviewer note: Repeat the first sentence if you are speaking to a new person.)

You may recall, we sent you a letter approximately a week ago.

I represent M.M. Dillon Limited and we are the consulting firm who are conducting the environmental assessment work for the County of Lambton waste management facility (e.g. landfill) site selection process. The County is currently considering four alternative sites and is undertaking a site comparative evaluation process to select one of these sites. This waste management facility will serve the County of Lambton only.

One part of the environmental assessment work is a study to determine whether there are likely to be any social impacts resulting from the facility operations. Basically, we are trying to determine what potential effects there may be on the day-to-day lives of residents in the vicinity of the site and on the community as a whole. This will assist us in selecting the preferred site.

For this purpose, we are conducting telephone interviews with residents who live in the vicinity of the proposed sites. Would you be willing to answer a few questions?

YES ☐ NO ☐

It should take approximately 30 minutes. Is this a convenient time for you?

YES ☐ NO ☐

If **not**, when would be a more convenient time to call you? ____________________________

(Interviewer note: The respondent should be told that their cooperation is appreciated and they need not feel obligated to answer all or any questions. **Also, all responses will be confidential and only released in aggregate form.**)

Location Code ___________

I would like to describe the proposed waste management facility to help you answer the questions:

- The County of Lambton propose to construct a landfill, material recycling facility and a composting facility together on one site. It is proposed that this facility will serve the County for 20 years.

- There are four proposed sites which were established by the consultant with input from members of the public from across the County. The sites closest to you are:

  (Interviewer note: ONLY DESCRIBE SITES CLOSEST TO THEM)

  - Site D is located in Lots 22 and 23, Concession 5, which is north of Highway 80, east of Highway 40, south of Moore Township Road 6, and west of Moore Township Road 21.

  - Site K located in Lots 20 and 21, Concession 5, which is north of Highway 80, east of Moore Township Road 21, south of Moore Township Road 6, and west of Moore Sideroad 19. Site K is east of the existing Moore Township landfill.

  - Site H is located in Lots 1, 2, 3 and 4, Front Concession, which is north of Townline Road, east of the St. Clair River, south of Moore Township Road 2, and west of Moore Township Road 27.

  - Site I is located in Lots 26 and 27, Concession 1, which is north of Townsline Road, east of Moore Township Road 27, south of Moore Township Road 2, and west of Highway 40.

- A total site area of approximately 185 acres (75 ha) is required.

- The landfill site will be approximately 33 acres (13.2 ha) and will reach a maximum height of approximately 56 ft. (17 m).

- There will be three buildings on site:

  - a material recovery facility building;
  - a composting building; and
  - a curing building;

  all of which are approximately 3 storeys high.

Location Code ____________

- Approximately 25 to 40 garbage and recycling trucks a day will travel to the facility as well as private vehicles. The main proposed routes are for:

  (Interviewer note: ONLY DESCRIBE SITES CLOSEST TO THEM)
  - Site D - Highway 80 east of Highway 40 to the site access road;
  - Site K - Highway 80 east of Highway 40 to Moore Township Road 22 and then north to the site access road;
  - Site H - Townline Road east of Highway 40 to the site access
  - Site I - Townline Road east of Highway 40 to the site access.

- Since the area is so flat, the landfill may be seen up to 3 km away.

(Interviewer note: STRESS THAT ~~THESE QUESTIONS PERTAIN TO A SPECIFIC SITE~~).

Their ~~[illegible]~~ responses are to be based on the site closest to them. Identify this site for them. Also make sure that they are aware of their proximity to the alternative adjacent site.

Location Code ___________

RESIDENT CONCERNS

1. Prior to receiving our letter, were you aware that Lambton County is proposing to develop a waste management facility in your area?

YES ☐ 1 NO ☐ 2

2. Do you have any concerns about the proposed waste management facility?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

If no, don't know or **no response**, go to Question 5a.

Location Code ____________

3. If yes, what concerns do you have:

(Interviewer note: DO NOT READ THIS LIST - JUST CHECK OFF ALL THAT ARE MENTIONED. CONCERNS ARE TO BE SPECIFIC TO THE LANDFILL FACILITY, NOT THE SITING PROCESS.)

Surface water quality ☐ 1
Ground water quality (well water) ☐ 2
Visual impact ☐ 3
Odour ☐ 4
Vermin ☐ 5
Dust ☐ 6
Noise ☐ 7
Litter ☐ 8
Traffic nuisance effects ☐ 9
Traffic accidents ☐ 10
Waste trucks ☐ 11
Gulls ☐ 12

Property value decrease ☐ 13
Negative effects on local economy ☐ 14
Impact on agricultural operations ☐ 15
Impact on future development ☐ 16
Less desirable place to live ☐ 17
Uncertainty or stress ☐ 18
Effect on community cohesion (closeness) ☐ 19
Compensation ☐ 20
Materials being disposed of ☐ 21
Natural Ecosystems ☐ 22
Other (please specify): ☐ 23

Interviewer note: TRY TO GET RESPONDENT TO EXPAND ON CONCERNS AS INDICATED.

____

____

____

____

____

____

____

____

Location Code ___________

4a. Which 2 issues concern you the most?

(<u>Interviewer note</u>: WRITE IN THE NUMBERS OF THE TWO CONCERNS FROM THE LIST ABOVE)

☐ 1 ____________________ ☐ 2 ____________________

4b. 1. Why ____________________ 2. Why ____________________

5a. Do you think that this is a good site for the facility.

(<u>Interviewer note</u>: TRY TO OBTAIN COMMENTS ON BOTH SITES, IF APPLICABLE)

Site _______ Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

Site _______ Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

5b. Why or why not?

Location Code ____________

ACTIVITIES ON PROPERTY

6a. Could you please tell me if you or other members of your household are involved in any of the following activities on or near your property?
(Interviewer note: READ OFF THE LISTED ACTIVITIES.)

6b. If the proposed waste management facility is approved, which of these activities, if any, do you think would be affected?
(Interviewer note: GO THROUGH JUST THE ACTIVITIES WHICH THEY ARE INVOLVED IN.)

6c. How do you think the activity would be affected?
(Interviewer note: READ OFF THE FOLLOWING AND FILL IN THE BOX ON PAGE 9 FOR EACH ACTIVITY INVOLVED IN.)

1. Activity would stop
2. Would continue activity but less frequently
3. Would do activity at another location (off property)
4. Would continue activity but enjoy less
5. Other ______________________________
____
____
6. Don't know

Location Code ____________

6a Check Activities Here		6b Activity may be affected?			6c How affected/adjusted?
		Yes	No	Don't Know	
☐ 1	Gardening/Landscaping	☐ 1	☐ 2	☐ 3	☐
☐ 2	Entertaining Friends and Relatives (e.g. outdoor barbecues)	☐ 1	☐ 2	☐ 3	☐
☐ 3	Snowmobiling	☐ 1	☐ 2	☐ 3	☐
☐ 4	Cross-Country Skiing	☐ 1	☐ 2	☐ 3	☐
☐ 5	Children's Activities (playing)	☐ 1	☐ 2	☐ 3	☐
☐ 6	Swimming	☐ 1	☐ 2	☐ 3	☐
☐ 7	Horseback Riding	☐ 1	☐ 2	☐ 3	☐
☐ 8	Bicycling	☐ 1	☐ 2	☐ 3	☐
☐ 9	Hunting	☐ 1	☐ 2	☐ 3	☐
☐ 10	Fishing	☐ 1	☐ 2	☐ 3	☐
☐ 11	Nature Appreciation	☐ 1	☐ 2	☐ 3	☐

Location Code ____________

☐ 12	**Relaxation**	☐ 1	☐ 2	☐ 3	☐	____________ ____________ ____________
	Other (specify)					
☐ 13	________	☐ 1	☐ 2	☐ 3	☐	____________ ____________ ____________
☐ 14	________	☐ 1	☐ 2	☐ 3	☐	____________ ____________ ____________
☐ 15	________	☐ 1	☐ 2	☐ 3	☐	____________ ____________ ____________
☐ 16	**No Response**					

7. Prior to learning about the proposed waste management facility, were you planning any future changes or improvements to your property in the next year (e.g. an addition to your house, landscaping, etc.)?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

If no, don't know, or no response, go to Question 13.

8. If yes, what were your plans?

House Renovation	☐ 1
House Extension	☐ 2
Build New House	☐ 3
Build New Garage/Shed	☐ 4
Landscaping	☐ 5
Swimming Pool	☐ 6
Farm or Business Improvement/Change	☐ 7

Location Code ____________

Other (please specify) ☐ 8

____

____

____

____

____

____

9. If **yes**, would the proposed waste management facility affect these plans in any way if it was developed?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

10. If **yes**, in what way(s)? (Do not read the list.)

Wait and see ☐ 1

Cancel ☐ 2

Move ☐ 3

Down-scale plans ☐ 4

Other (please specify): ☐ 5

____

____

____

PROBLEMS EXPERIENCED

11. Living at this location, do you, or have you experienced in the past any effects from [the existing Moore Township landfill (Sites D and K)] or [the surrounding industries (Sites H and I)]?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

If **yes**, go to next Question 12. If **no, don't know** or **no response**, go to Question 13.

Location Code ____________

12. What effects have you actually experienced from these facilities? (UNPROMPTED)

Visual Intrusion	☐ 1
Health and Safety	☐ 2
Surface Water Quality	☐ 3
Drinking Water Quality (ground water)	☐ 4
Odour	☐ 5
Rats, Vermin Seagulls, Flies	☐ 6
Dust	☐ 7
Noise	☐ 8
Litter	☐ 9
Negative Image	☐ 10
Traffic Nuisance Effects	☐ 11
Traffic Accidents	☐ 12
Property Value Decrease	☐ 13
Impact on Agricultural Operations	☐ 14
Uncertainty and stress	☐ 15
Effort and time consumed	☐ 16
Hard on family life	☐ 17
Loss of neighbours	☐ 18
Other	☐ 19

Comments:

Location Code ____________

HAUL ROUTES

Interviewer note: ONLY ASK QUESTIONS 13a TO 15 FOR RESIDENTS LIVING ALONG HIGHWAY 80 BETWEEN HIGHWAY 40 AND MOORE TOWNSHIP ROAD 22.

13a. Are you experiencing any traffic problems?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

13b. If yes, please explain.

____

____

____

____

Location Code ____________

14. Do you, or any members of your household regularly undertake any of the following activities along (Highway 80/Moore Township Road 22)?

Driving along	☐ 1
Moving from machinery	☐ 2
Walking along shoulder	☐ 3
Kids waiting for school bus	☐ 4
Horseback riding	☐ 5
Snowmobiling	☐ 6
Parking	☐ 7
Picking up mail/newspaper	☐ 8
Bicycle riding	☐ 9
Other	____________________

15. Do you feel that an increase of 25 to 40 waste and recycling trucks travelling on (Highway 80/Moore Township Road 22, Townline Road) during the day would present a problem for you? Please explain.

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

Please explain:
(Interviewer note: GET RESPONDENT TO EXPLAIN IN REFERENCE TO THE ACTIVITIES UNDERTAKEN ALONG HIGHWAY 80/MOORE TOWNSHIP ROAD 22 AND/OR EFFECTS EXPERIENCED ON THEIR PROPERTY)

Location Code ____________

COMMUNITY SATISFACTION

Interviewer note: Tell the respondent: "The next few questions will provide us with an idea of how satisfied you are with this area as a place to live and what you like or dislike about the area. When you respond, we would like you to think about how you felt about this area prior to learning about the proposed facility."

16. Which village/town/city do you consider yourself most closely associated with?

____

____

____

17. Where do you shop for your groceries and household items?

____

____

____

18. How would you describe the geographic boundaries of your "community"?

____

____

____

____

19. On a scale of 1 to 5, with 1 being Very Dissatisfied and 5 being Very Satisfied, generally, how satisfied are you with your community as a place to live?

VERY DISSATISFIED VERY SATISFIED

1 2 3 4 5

Location Code ____________

20. What characteristics do you like about the community as a place to live? (<u>Interviewer note</u>: DO NOT PROMPT)

	Q. #18	Q. #19
Rural Character	☐ 1	☐ 1
(No crime)	☐ 2	☐ 2
Accessible to Transportation Facilities	☐ 3	☐ 3
Quiet and Peaceful	☐ 4	☐ 4
Close to Family	☐ 5	☐ 5
Lack of Industrial Development	☐ 6	☐ 6
Clean Air	☐ 7	☐ 7
Large Lots	☐ 8	☐ 8
Rural Farming Community	☐ 9	☐ 9
Way of Life	☐ 10	☐ 10
Open Space	☐ 11	☐ 11
Natural Features of Area	☐ 12	☐ 12
Heritage Community	☐ 13	☐ 13
Quality of Facilities and Services	☐ 14	☐ 14
Good Place to Raise Children	☐ 15	☐ 15
Sense of Community: We Know Everybody	☐ 16	☐ 16
Minimal Traffic	☐ 17	☐ 17
No Response	☐ 18	☐ 18

Comments ____

____

____

____

____

____

Location Code ____________

21. Which three community characteristics do you appreciate the most?
(Interviewer note: REPEAT THOSE THAT THEY LISTED AND CHECK THREE BOXES IN SECOND COLUMN.)

22. What characteristics do you dislike about the community as a place to live? (UNPROMPTED)

No stores close by ☐ 1
Traffic ☐ 2
Neighbours ☐ 3
Lack of urban services (sewage/water, public transportation) ☐ 4
Odours ☐ 5
Dust ☐ 6
Noise ☐ 7
Water quality ☐ 8
Lack of political influence ☐ 9
Isolated ☐ 10
No response ☐ 11
Other (specify ☐ 12

23a. Do you think that the proposed waste management facility would affect your satisfaction with this area as a place to live?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

Location Code ____________

23b. If yes, you will become either:

☐ 1 Somewhat less satisfied
☐ 2 Considerably less satisfied
☐ 3 Very dissatisfied

24. What do you think will happen to this area if the waste management facility proposal is approved?

____

____

____

____

25. Often when talking about a community, people speak of a feeling of belonging, or being part of their community. Do you feel that you are a part of this community?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

26a. Would you describe your community as either:

☐ 1 Very close-knit
☐ 2 Somewhat close-knit
☐ 3 Not very close-knit

26b. Has the community's closeness increased, decreased or remained the same over the past 5 years?

☐ 1 Increased
☐ 2 Decreased
☐ 3 No change

Location Code ____________

27. Would you recommend someone else to move into this area?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

28. How often do you visit with neighbours?

☐ 1 Daily
☐ 2 Two to three times a week
☐ 3 Once a week
☐ 4 Two to three times a month
☐ 5 Once a month
☐ 6 Never

29. How often do you ask for help or help your neighbours?

☐ 1 Daily
☐ 2 Two to three times a week
☐ 3 Once a week
☐ 4 Two to three times a month
☐ 5 Once a month
☐ 6 Never

30a. Are you or any member of your household presently active members of community groups or associations?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

Location Code ____________

30b. If yes, please indicate the names of the groups or associations and indicate whether you or other household members are presently on the executive of these groups or associations.

a. Name of Group on Site?	b. On Executive	
	Yes	No
1. ______________________________	☐ 1	☐ 2
2. ______________________________	☐ 1	☐ 2
3. ______________________________	☐ 1	☐ 2
4. ______________________________	☐ 1	☐ 2
5. ______________________________	☐ 1	☐ 2

30c. Does the group or association meet within 3 km of the proposed site, if yes, where?

Yes	No	
☐ 1	☐ 2	______________________________
☐ 1	☐ 2	______________________________
☐ 1	☐ 2	______________________________
☐ 1	☐ 2	______________________________

31. Of your three closest friends, how many live in this community?

☐ 1 ☐ 2 ☐ 3

32a. Do you have relatives living in this community other than in your household?

Yes ☐ 1 No ☐ 2

32b. If yes, how many households of your relatives live in this community?

____

Location Code ____________

33. Forgetting about the waste management facility for a moment, if you chose to move from this property, would you stay in this community?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

34a. If the proposed waste management facility is approved, do you think you would move?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

If no, don't know, or no response, go to Question 35a.

34b. If **yes**, have you taken any steps towards moving such as contacting a real estate agent?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

If no, don't know or **no response**, go to Question 35a .

34c. If **yes**, what steps have you taken? (Interviewer note: DO NOT READ LIST)

☐ 1 Contacted real estate agent
☐ 2 Looking at other houses
☐ 3 Just sold
☐ 4 Have/are trying to sell through a private sale
☐ 5 Other (please specify):

____

____

____

____

Location Code ____________

35a. Do you think that your property value would change if the landfill is located here?

Yes ☐ 1 No (Go to Q.36a) ☐ 2 Don't know (Go to Q.36a) ☐ 3

35b. If yes, do you think the value would:

Increase ☐ 1

Decrease ☐ 2

35c. Do you think the change would be:

Minor (less than 5%) ☐ 1 Moderate (5%-15%) ☐ 2 Major (more than 15%) ☐ 3

35d. Do you think the change in property value would be a short-term or a long-term one?

Short-Term (3 years or less) ☐ 1 Long-Term (more than 3 years) ☐ 2

35e. Why do you think the value of your property would change?

____

____

____

____

Location Code ____________

35f. How would a change in property value affect you?

____

____

____

AGRICULTURE

36a. Do you or any members of your household currently farm or operate a business within 1 km of the proposed site?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

(Interviewer note: ATTEMPT TO SEPARATE "OTHER BUSINESS" FROM AGRI-BUSINESS. AGRI-BUSINESS IS DEFINED AS ANY BUSINESS THAT SUPPORTS AGRICULTURE (E.G. FARM EQUIPMENT SALES AND REPAIRS, ETC.).

36b. Please specify:

Farming ☐ 1 (Go to 36c)

Agri-business ☐ 2

Other Business ☐ 3

Please state type: ______________________________________

36c. Certain farmers have been contacted by the Agriculture Team, if you have not been contacted, would you mind if another person more familiar with agriculture phoned you?

Yes ☐ 1 No ☐ 2

Location Code ____________

DEMOGRAPHIC DATA

Interviewer note: PLEASE EXPLAIN TO THE RESPONDENT "NOW WE WOULD LIKE TO ASK YOU SOME GENERAL QUESTIONS ABOUT YOUR HOUSEHOLD".

37. How many people live in your household? ______________________________

38. What are the ages of each member of your household?

(Interviewer note: CHECK THE APPROPRIATE AGE GROUP FOR EACH MEMBER.)

AGE GROUP (Years)

	0-4	5-9	10-14	15-19	20-24	25-40	41-64	65+
Person a (respondent)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Person b (respondent's spouse)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Other members of respondent's household:								
Person c	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Person d	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Person e	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Person f	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Person g	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8
Person h	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8

39a. Do you or other members of your family have any health problems that you think should be taken into account?

Yes ☐ 1 No ☐ 2

Location Code ____________

39b. If yes, please indicate who, what kind of problem, and your concern.

____

____

____

____

____

____

40. As landfill operations will occur during the day, are you or any members of your household mostly at home during the daytime (7 a.m. to 5 p.m.)? (e.g. out in the fields farming, or in the house)

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

If no, don't know or **no response,** go to Question 42.

41. If yes, how many members of your household are home most of the daytime?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Location Code ___________

42. How many years have you lived at this location:

☐ 1 Less than one year
☐ 2 1 - 2 years
☐ 3 3 - 5 years
☐ 4 6 - 10 years
☐ 5 11 - 15 years
☐ 6 16 - 20 years
☐ 7 More than 20 years
☐ 8 Always lived here
☐ 9 No response

43. How long have you lived in this community? (as defined by them)

☐ 1 Less than one year
☐ 2 1 - 2 years
☐ 3 3 - 5 years
☐ 4 6 - 10 years
☐ 5 11 - 15 years
☐ 6 16 - 20 years
☐ 7 More than 20 years
☐ 8 Always lived here
☐ 9 No response

Location Code ____________

44. Is this dwelling:

☐ 1 Owned

☐ 2 Rented (Go to Q.46.)

☐ 3 No response

45a. Was this property owned by another member of your family before you moved here?

Yes ☐ 1 No ☐ 2 Don't Know ☐ 3 No Response ☐ 4

45b. If yes, how many years has this property been owned by members of your family:

Less than 1 year	☐ 1
1-5 years	☐ 2
6-10 years	☐ 3
10-20 years	☐ 4
21-50 years	☐ 5
51-100 years	☐ 6
More than 100 years	☐ 7

46. Do you have any other comments that you would like to make?

____

____

____

____

Location Code ____________

47. If we require more information, could we contact you again?

Yes ☐ 1 No ☐ 2

B:\9928QUES\RBS-SRVY.PT1&2

SCHEDULE III

COMMUNITY FEATURE SURVEY

Location Code ____________

COMMUNITY FEATURE SURVEY
LAMBTON COUNTY WMMP

DATE AND TIME OF CALLS: ____________ ____________

____________ ____________

____________ ____________

____________ ____________

DATE AND TIME OF INTERVIEW: ____________ ____________

INTERVIEWER: ____________

RESPONDENT'S NAME: ____________

Name of owner/responsible authority
(if different from respondent's name) ____________

ADDRESS: ____________

____

____

TELEPHONE NO: ____________

Location Code ____________

Hello, my name is ____________________________ and I represent M.M. Dillon Limited. I would like to speak to the owner or manager of this facility.

(Interviewer note: Repeat the first sentence if you are speaking to a new person.)

I represent M.M. Dillon Limited and we are the consulting firm who are conducting the environmental assessment work for the County of Lambton waste management facility site selection process. The County is currently considering four candidate sites and is undertaking a site comparative evaluation process to select one of these sites.

One part of the environmental assessment work is a study to determine whether there are likely to be any social impacts resulting from the facility operations.

To assist in selecting the preferred site, we are conducting a telephone survey with operators of community facilities located in the vicinity of the candidate sites. Would you be willing to answer a few questions?

YES ☐ NO ☐

Is this a convenient time for you? (It should take 15-20 minutes.)

YES ☐ NO ☐

If not, when would be a more convenient time to call you? ____________________________

(Interviewer note: The respondent should be told that their cooperation is appreciated and they need not feel obligated to answer all or any questions. **Also, all responses will be confidential and only released in aggregate form.**)

Location Code ___________

I would like to describe the proposed waste management facility to help you answer the questions:

- The County of Lambton propose to construct a landfill, material recycling facility and a composting facility together on one site. It is proposed that this facility will serve the County for 20 years.

- There are four proposed sites which were established by the consultant with input from members of the public from across the County. The sites closest to you are:

  (Interviewer note: ONLY DESCRIBE SITES CLOSEST TO THEM)

  - Site D is located in Lots 22 and 23, Concession 5, which is north of Highway 80, east of Highway 40, south of Moore Township Road 6, and west of Moore Township Road 21.

  - Site K located in Lots 20 and 21, Concession 5, which is north of Highway 80, east of Moore Township Road 21, south of Moore Township Road 6, and west of Moore Sideroad 19. Site K is east of the existing Moore Township landfill.

  - Site H is located in Lots 1, 2, 3 and 4, Front Concession, which is north of Townline Road, east of the St. Clair River, south of Moore Township Road 2, and west of Moore Township Road 27.

  - Site I is located in Lots 26 and 27, Concession 1, which is north of Townsline Road, east of Moore Township Road 27, south of Moore Township Road 2, and west of Highway 40.

- A total site area of approximately 185 acres (75 ha) is required.

- The landfill site will be approximately 33 acres (13.2 ha) and will reach a maximum height of approximately 56 ft. (17 m).

- There will be three buildings on site:

  - a material recovery facility building;
  - a composting building; and
  - a curing building;

  all of which are approximately 3 storeys high.

Location Code ___________

- Approximately 25 to 40 garbage and recycling trucks a day will travel to the facility as well as private vehicles. The main proposed routes are for:

  (Interviewer note: ONLY DESCRIBE SITES CLOSEST TO THEM)

  - Site D - Highway 80 east of Highway 40 to the site access road;
  - Site K - Highway 80 east of Highway 40 to Moore Township Road 22 and then north to the site access road;
  - Site H - Townline Road east of Highway 40 to the site access
  - Site I - Townline Road east of Highway 40 to the site access.

- Since the area is so flat, the landfill may be seen up to 3 km away.

(Interviewer note: Stress that their responses are to be based on the site closest to them. **Identify this site for them.** Also, make sure that they are aware of their proximity to the alternative adjacent site.

Location Code ____________

1. What types of activities/programs take place at this facility?

2. Are these activities/programs held indoors, outdoors or both?

Activity	Indoor	Outdoor
1. ________________________	☐	☐
2. ________________________	☐	☐
3. ________________________	☐	☐
4. ________________________	☐	☐
5. ________________________	☐	☐

3. What would you say the percentage is of activities/programs that are indoor? ____________%

4. Please list the types of indoor and outdoor facilities that you have?

Location Code ____________

5. Are any of your activities/programs seasonal? If so, what are the activities, and which season do they take place?

Yes ☐ No ☐ Don't Know ☐ No Response ☐

Activities	Winter	Spring	Summer	Autumn
____________________	☐	☐	☐	☐
____________________	☐	☐	☐	☐
____________________	☐	☐	☐	☐
____________________	☐	☐	☐	☐
____________________	☐	☐	☐	☐

6a. Overall, which season is your busy season?

Winter ☐
Spring ☐
Summer ☐
Autumn ☐
Evenly used throughout the year ☐

6b. Approximately how many people use the facility in each season?

Winter ____________________
Spring ____________________
Summer ____________________
Autumn ____________________
Year-round ____________________

Location Code ____________

7. How many people does this facility employ?

Full-time ____________________
Part-time ____________________
Seasonal ____________________
Other ____________________

8. What are the hours of operation of this facility?

a) Saturday ____________________ to ____________________
b) Sunday ____________________ to ____________________
c) Monday ____________________ to ____________________
d) Tuesday ____________________ to ____________________
e) Wednesday ____________________ to ____________________
f) Thursday ____________________ to ____________________
g) Friday ____________________ to ____________________
h) Holidays ____________________ to ____________________

9. Do the hours of operation change with the season? Please explain.

____
____
____
____
____

Location Code ___________

10. Are there other facilities in the area similar to your facility?

☐ Yes ☐ No

If yes, where is the facility (approximate distance away) and what is the name of the facility?

____

11. Prior to the announcement of the proposed waste management facility, where there any immediate future plans for this facility? (expansion, closure)

____

____

____

____

____

12. If the proposed waste management facility were located near your facility, would these future plans be changed?

____

____

____

____

____

Location Code ____________

13. In your opinion, would landfilling, composting or recycling operations interfere with the operation of your facility?

Yes ☐ No ☐

If yes, please explain.

____

____

____

____

____

14. Do you have other concerns or comments about the proposed waste management facility?

____

____

____

____

____

THANK YOU FOR TAKING THE TIME TO HELP US COMPLETE THIS SURVEY.

SCHEDULE IV

DETAILED COMPARISON OF SITES VISUAL IMPACT ASSESSMENT

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1.0 INTRODUCTION

1.1 Purpose and Objectives

The visual impact assessment component of the EA document for the Lambton Waste Management Master Plan is prepared to document the extent of visual impact associated with each of the four candidate landfill sites and to recommend a preferred site from a visual perspective, if possible.

The visual impact assessment quantifies impact by depicting the area from which the landfill would be visible (viewshed), describing partially screened and unscreened views and determining the numbers and types of viewers which would be affected.

1.2 Technical Report Organization

This report is organized into three main sections:

- Chapter 1 discusses the purpose and objectives of the report;
- Chapter 2 describes the methodology, study area, time frame and key assumptions; and
- Chapter 3 outlines the comparison of the candidate sites.

Maps illustrating the viewshed for each of the candidate sites are appended to this document.

2.0 STUDY APPROACH

2.1 Overview of Methodology

In order to determine the extent of visual impact for each of the candidate sites it was necessary to establish the limits of the viewshed (area from which the landfill would be visible), and estimate the numbers of potential viewers within the Study Area. Cross sections of the landscape including vegetation and topography were used to determine the limits of the viewshed. See Figure 1.

The Study Area

The Study Area was limited to within 3 km of the landfill site. The viewshed, in some instances, went beyond 3 km, but views beyond 3 km were not considered to have significant visual impacts. Beyond 3.0 km, the landfill would become part of the horizon with limited definition of features and textures, and consequently have minimum visual impact.

Defining the Viewshed

OBM (Ontario Base Maps) at a scale of 1:10,000 were used to construct the cross sections in order to define the limits of the viewshed. Woodlots were overlaid onto the topographic sections along with the proposed landfills to complete the representation. Woodlot heights were determined during site visits conducted in July of 1992. Generally, hedgerows were discounted in the analysis because of their limited screening potential and lack of permanence relative to woodlots. However, if hedgerows were of significant height and density, they were included in the analysis. Where applicable, the limits of the viewshed were confirmed using trigonometry (see Figure 2).

Numbers and Types of Viewers

Based on Ontario Base Maps at 1:10,000 scale, the numbers and types of viewers within the viewshed were roughly estimated for each of the four candidate sites. Those viewers which had unscreened or partially screened views were identified (see Table 2).

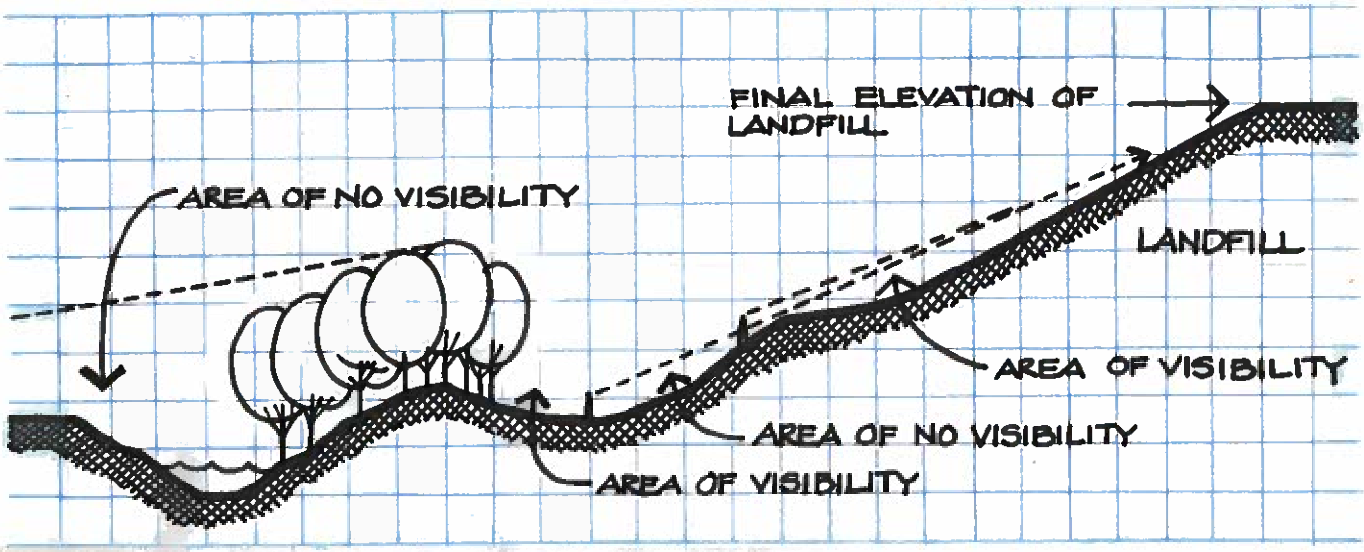
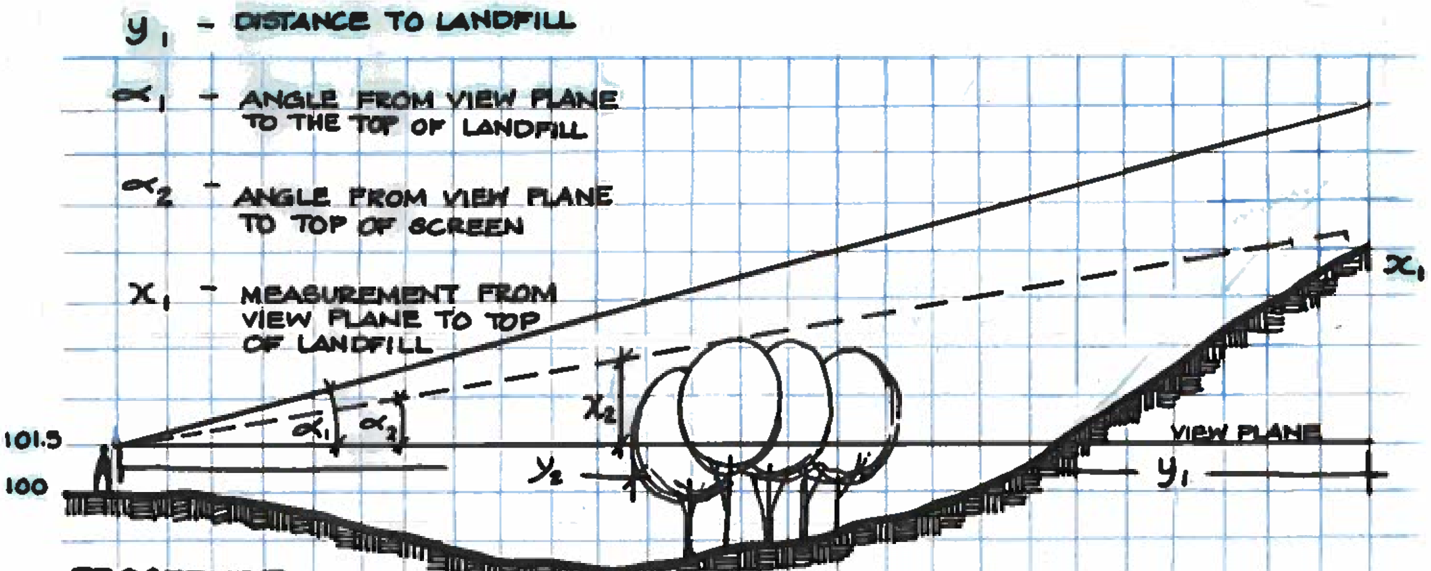


Figure 1 Visual Cross-section to Determine Viewshed



y_1 - DISTANCE TO LANDFILL

α_1 - ANGLE FROM VIEW PLANE TO THE TOP OF LANDFILL

α_2 - ANGLE FROM VIEW PLANE TO TOP OF SCREEN

x_1 - MEASUREMENT FROM VIEW PLANE TO TOP OF LANDFILL

PROCEDURE

1. ESTABLISH ELEVATION OF VIEW PLANE (ADD 1.5m TO GROUND ELEVATION AT VIEW).
2. DETERMINE x (ELEVATION OF LANDFILL − ELEVATION OF VIEW PLANE).
3. MEASURE y.
4. CALCULATE α_1 $\left(\text{Tan } \alpha_1 = y/x\right)$.
5. REPEAT PROCESS FOR α_2, (IF α_2 IS GREATER THAN α_1 THE LANDFILL IS SCREENED FROM VIEW).

Figure 2 Calculation of Visibility using Trigonometry

2.2 Time Frame

Field visits were conducted in the summer of 1992. All woodlots and hedgerows (dense enough and tall enough to provide screening of the landfill) were incorporated in the analysis.

Analysis of impact was determined based on existing visual resources and the change to those resources as a result of the completed landfill. Mitigation was not considered to have a significant difference in net effects for each site, and therefore was not considered in the assessment of sites.

Mitigation should be assumed to be a combination of plantings and berming, implemented at the outset of the construction and operation of the landfill.

2.3 Key Assumptions

The following assumptions were made and carried throughout the analysis:

- maximum visual impact will occur when the landfill reaches its final elevation;
- viewsheds are generated based on no mitigation;
- screening in the form of vegetation is only effective if it will be dense enough to be visually impenetrable in winter;
- the character of the landscape is similar around each of the four candidate sites and therefore change to landscape character is not a criteria for evaluating the sites;
- all vegetation within the limits of the sites will be removed.

2.4 Data Collection

There is one criteria for visually evaluating the sites. The data sources for the indicators relevant to that criteria are tabled below:

Criteria	Indicators	Rationale	Data Sources
Extent of Visibility (viewshed)	• types of viewers[1] • number of viewers[2]	The greater the extent of viewshed, the greater the impact	Viewshed generated from 1:10,000 Ontario Base Mapping Field studies conducted July 1992

[1] *Viewer is defined here as being a resident or user of a park with a potential view.*

[2] *Individual viewers are not calculated for each residence, farm or park within the viewshed. However, the number of parks, farms and residences are estimated from OBM's, as being viewer per residence, farm or park.*

3.0 COMPARISON OF SITES: ANALYSIS AND RESULTS

3.1 Existing Conditions

The four candidate sites are located in an area which is uniformly flat and part of the St. Clair River basin. There are numerous woodlots usually centred between side roads. All woodlots are approximately the same age and stage of development. There are few hedgerows. Land use is primarily agricultural and rural residential with minor exceptions. The following is a description of existing conditions for each of the candidate sites.

Sites D and K

Sites D and K are flanked by large woodlots on the east and west boundaries of the site, and smaller woodlots to the north. A hydro right-of-way and rail line run north/south approximately 1.5 km from the site. Northwest of the site near the study limit is the Terra International plant. Residences are clustered along Highway 80 and Moore Township Road 6. The residences are rural and the principle land use is agriculture.

Site H and I

Both sites are situated approximately 1.0 km from the St. Clair River, adjacent to the Terra International site.

Extensive woodlots flank the northern limits of the sites and isolated woodlots dot the landscape to the south. Bowen's Creek empties into the St. Clair River west of both sites, and Clay Creek meanders across the land south of the sites. The sites are located on either side of Moore Township Roads 27 and 28, north of Townline Road. Land use is a mix of agricultural, rural, residential, recreational (along St. Clair River) and industrial (hydro right-of-way rail lines and industrial plant to south of Site H). The topography throughout the Study Areas for each of these sites is flat, with the exception of berming around the Hydro switching station and the Terra International plant.

3.2 Advantages/Disadvantages of the Sites

Sites H & I and Sites K & D are very similar in terms of potential viewers and extent of visibility. Although they have fewer permanent viewers, sites H and I are situated close to the St. Clair River and will therefore have greater exposure to viewers who are enjoying the recreational feature of the river and its surrounding landscape. The following table summarizes the advantages and disadvantages for each of the four candidate sites.

TABLE 1
SUMMARY OF ADVANTAGES AND DISADVANTAGES

Site	Advantages	Disadvantages
H and I	· excellent screening to the north due to large woodlots · adjacent to industrial plant which is compatible in terms of visual impact · limited visibility to south and east	· open visibility from St. Clair River · approximately 19 viewers (H) and 27 viewers (I) · open visibility from Regional Road 33
K	· limited visibility to the south · flat landscape and many woodlots limit visibility	· visibility from farms up to 3.0 km distant from the landfill · 66 viewers
D	· visibility is limited by existing woodlots	· visibility from farms up to 3.0 km distant from the landfill · 45 viewers

Viewshed and Potential Viewers

Vegetation in each of the four candidate site Study Areas prevents extensive visibility. Viewsheds are limited to open fields and the St. Clair River. The following table describes the numbers and types of viewers associated with each of the four candidate sites:

TABLE 2
POTENTIAL NUMBER OF VIEWERS AND SITE RANKING

Site	Approximate Number of Viewers	Types of Viewers	Number Unscreened	Number Partially Screened	% of Total Views Which Are Partially Screened	Site Ranking
H	19	residents of 19 residences users of St. Clair River*	3	16	84.2%	1 (preferred)
I	27	users of 1 park residents of 27 residences users of St. Clair River*	6	21	77.8%	2
K	66	residents of 66 residences	56	10	15.2%	4 (least preferred)
D	45	residents of 45 residences	41	4	8.8%	3

**Users of St. Clair River will have views which are partially screened.*

3.3 Conclusion

Site H is the preferred site to I, K and D sites due to the relatively small number of potential viewers and the extent of the viewshed which is partially screened.

Site I is preferable to Sites K and D due to the relatively few number of potential viewers and the fact that 81.5% of the potential viewers are partially screened. Views from the St. Clair River are partially screened by vegetation along the shoreline, berming around Terra International and the plant itself which dominates the landscape. Visibility extends to the United States, beyond the 3.0 km Study Area. These views will be mitigated by vegetation, distance and the compatibility of the landfill with the adjacent industrial landscape of Terra International.

Sites K and D are comparable from a visual impact perspective. Site K does have a greater number of potential viewers than Site D and therefore would be the least preferred site. Each of the candidate sites has the same potential for mitigation based on existing conditions. Proposed mitigation should include:

- berming around the perimeter of the site;
- planting on the berm and surrounding buffer are including shrubs and trees in a coniferous/deciduous mixture; and
- screen fencing incorporated within the landscaping.

Based on the impacts associated with the number of potential unscreened viewers, the following is the ranking of the candidate sites from preferred to least preferred: H, I, D and K.

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4G
SURFACE WATER IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from a surface water perspective. The purpose of this impact assessment was to identify the order of preference of the sites (i.e. best site(s) or worst site(s)), with respect to surface water considerations. The results of this study contributed to the multi-criteria comparison of the four sites and the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill component was considered to be the most significant in identifying and comparing potential surface impacts.

The key considerations addressed in this study were:

- the potential of the sites to impair surface water quality; and
- the potential flood hazards which could affect the sites.

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the assessment and comparison of the potential surface water impacts of the sites;
- the collection of data regarding the four sites according to the criteria and indicators identified;
- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to surface water considerations; and
- the comparison of the sites' advantages and disadvantages to identify, from a surface water perspective, the most preferred/least preferred site(s), if any.

1.2 Report Organization

The remaining sections of this report are organized as follows:

- Section 2 describes the study approach, outlines the criteria and indicators used, and the respective weights assigned to each.
- Section 3 outlines the data sources, the interpretation and application of the data, and the results of the comparative evaluation.
- Section 4 provides a summary of findings and the relative ranking of the candidate sites from the surface water perspective.

2.0 STUDY APPROACH

2.1 Methodology

The methodology used in the comparative evaluation involved developing appropriate surface water criteria and indicators that could be applied to each candidate site for a detailed comparative evaluation. For each indicator, the physical attributes of each site were obtained using direct measurements from various map sources. The direct measurements (length, area, number, etc.) were then ranked using indicator potential effects levels. The potential effects values were then multiplied by assigned indicator weights and summed to produce an overall surface water site score. For ease of comparison, the summed scores were normalized on a 0.0 to 1.0 scale by dividing each site score by the highest site score.

Sites with larger scores potentially have higher surface water impacts and are considered less suitable for site development. Smaller scores are indicative of low potential for surface water impacts, therefore, sites with low scores are more preferred for site development.

2.2 Evaluation Criteria/Indicators and Weighting

2.2.1 Discussion of Criteria and Indicators

Criterion 1 - Compare potential for impairment of surface water quality

This criterion is used to evaluate the potential for impairment of surface water quality based on the candidate sites location in the subwatershed within the immediate vicinity and local watersheds, the sensitivity of downstream water usage, the hydrologic/hydraulic characteristics of each site and the anticipated changes due to site development.

To undertake the comparative evaluation of the four candidate sites, three indicators were applied to consider the different aspects that relate to surface water quality.

Indicator 1 - Number of watersheds and subwatersheds receiving surface water from site

This indicator identifies the number of large and small watersheds which are possible recipients of controlled or uncontrolled surface water discharges from a candidate site.

As the number of possible receiving watersheds and subwatersheds increases, the number of possible locations where there is potential for surface water impairment increases, as does the potential for effects on public health and safety and the natural environment.

Indicator 2 - Characteristics of downstream surface water usage

This indicator focuses on the downstream usage of surface water including recreation (e.g., swimming, angling), agriculture users (e.g., irrigation, livestock watering) and potable water supplies. In the unforeseen event downstream watercourses experience changes in flow or contaminant inputs from the site, these are the uses which may be potentially impacted. This indicator does not include the potential direct impacts to the natural environment which are being assessed by the Biology criteria group.

Indicator 3 - Number of watercourses receiving surface water discharges

This indicator identifies the number of watercourses that could be potentially affected by surface water discharge from storm drainage on each of the candidate sites. Although storm water management facilities will be used to control surface runoff from the preferred site, and a monitoring program will be in place to monitor the quality of storm drainage, the potential for downstream degradation in surface water quality was considered to be directly related to the number of discharge locations.

Criterion 2 - Compare potential flood hazard

This criterion measures the potential flood hazard and disruption of the natural watercourse systems that may result due to development of a candidate site for landfill purposes. Sites having large upstream drainage areas, and long and numerous streams crossing through the site present a greater potential for flood related impacts and disruption of natural watercourse systems.

To evaluate the potential impacts on a comparative basis, four indicators were applied to consider different site aspects related to flood hazard and watercourse system alteration.

Indicator 1 - Total peak flow conveyed through and adjacent to the site

This indicator measures the potential flood hazard at the site and the flood hazard potential of peak flows leaving the site through drainage systems which may be altered by site development. The total peak flow conveyed through or immediately adjacent to the site is an indicator of potential flood hazard to the site and to areas downstream of the candidate site.

Indicator 2 - Total length of on-site and adjacent watercourses

This indicator measures the relative flood hazard created by the necessary alterations to existing drainage systems on-site or along the site perimeter. Diversion of watercourses with large flood flows creates a potential flood hazard to the perimeter berms, to downstream watercourses, and to adjacent off-site areas.

Indicator 3 - The number of watercourses entering site and receiving surface water runoff from the site

This indicator measures the number of locations where existing upstream or downstream flood conditions could potentially be altered by site development. The design of the site drainage system will incorporate measures to address existing upstream and downstream flow constraints, but it will be preferable to minimize the number of locations potentially affected by a change in backwater conditions and/or flow velocities, rates, depths or volumes.

Indicator 4 - Availability of a suitable outlet

Inadequate topographic relief in a receiving watercourse(s) may increase the level of difficulty for achieving proper site drainage, which is necessary to ensure the safe delivery of surface runoff through the downstream drainage system. This may lead to an increase in potential flood hazard effects on-site and downstream associated with large flood plain widths and areas with ponded surface water.

2.2.2 Criteria Weights

Criterion 1 - Compare potential for impairment of surface water quality

The presence of the landfill site will create the possibility for surface water quality impairment in the downstream watersheds and subwatersheds receiving runoff from the site.

The potential for surface water quality impairment is of public health and safety interest, and will be minimized by use of storm water management techniques and by the design of appropriate conveyance and containment systems. Overall, there should be no impairment of surface water runoff quality as a result of site development.

The water quality criterion is ranked as the most important criterion and was given a weight of 56 out of 100. This ranking recognizes that there are numerous man-made uses which benefit from the surface water resource (e.g. potable supply, recreation, irrigation and livestock watering). Although there should be no impairment in runoff water quality, the potential effects on these multiple uses exceeds those associated with water quantity considerations. This ranking is also supported by the need for water quality monitoring (and possible intervention or corrective action) at the site.

The three indicators used for evaluating the potential for impairment of surface water quality are presented in Table 1. The weights assigned to each indicator is also presented in Table 1. As can be noted, Indicator 2 (characteristics of downstream surface water usage) has the highest weight, and the other two indicators have essentially equivalent but lower weight.

Criterion 2 - Compare potential flood hazard

The presence of the landfill site creates the potential for alteration of upstream and downstream flood hazards.

The potential for alteration of the flood hazard is of public health and safety interest, and will be minimized by use of storm water management techniques and by the design of appropriate water conveyance and containment systems. Overall, there should be no increase in the flood hazard as a result of site development.

The potential for modification of the flood hazard ranks second and is given a weight of 44 out of 100. This weighting recognizes that the potential for modification of flood risk and water quality is similar (similarly low), and that the risk of loss of life or property damage as a result of flooding is of considerable importance. However, its lower ranking recognizes that the potential effects of site development on man-made uses which benefit from the surface water resource exceed potential effects associated with flood levels and flows. This weighting also addresses site comparisons in relation to Conservation Authority policies respecting delineation of areas which may be regulated under the *Conservation Authorities Act.*

TABLE 1
SURFACE WATER CRITERION AND INDICATOR WEIGHTS

Evaluation Criterion	Criterion Weight	Indicators	Indicator Rank	Indicator Weight
1. Compare potential for impairment of surface water quality	0.56	1) number of watersheds and subwatersheds receiving surface water from site	2	0.15
		2) characteristics of downstream surface water usage	1	0.25
		3) number of watercourses receiving surface water discharges	2	0.16
				0.56
2. Compare potential flood hazard	0.44	1) total peak flow conveyed through or adjacent to the site	1	0.18
		2) length of on-site/adjacent watercourses	1	0.18
		3) the number of watercourses entering the site and receiving surface runoff from the site	3	0.04
		4) availability of suitable outlet (receiving watercourse)	3	0.04
				0.44

There are four indicators used for evaluating the potential for alteration of the flood hazard. The ranks and weights for the indicators are presented in Table 1, which shows that indicators 1 and 2 were considered equal and given the highest rank and weight. Indicators 3 and 4 were also assigned similar ranks and weights, which are lower than the first two indicators.

3.0 COMPARATIVE EVALUATION OF THE SHORT LIST OF CANDIDATE SITES

The comparative evaluation of the short list of candidate sites was based on four key considerations:

- the setting of the candidate sites on the short list relative to their location in the subwatersheds within the immediate vicinity and local watersheds;
- the existing hydrologic characteristics of each of the candidate sites;
- the anticipated changes in the hydrologic characteristics due to site development; and
- the statutes, policies, guidelines and regulations that apply to the management, protection and conservation of surface water resources.

3.1 Data Collection

The principal methods of acquiring the necessary data for the individual sites involved: the use of secondary source information, including maps and aerial photographs, site inspections and photographs; and discussions with the local Conservation Authorities, the Ministry of Natural Resources and the Ministry of Environment and Energy. The specific data sources and the information each provided are summarized in Table 2.

TABLE 2
SURFACE WATER DATA SOURCES

Data Source	Information Obtained
Ontario Base Mapping (OBM 1:10,000 scale) of each candidate site (primary data source)	Used to delineate watershed/subwatershed boundaries, define site drainage patterns, identify existing land uses, on-site streams/watercourses, determine external drainage area and inflow and outlet points for the site.
Ontario Ministry of Agriculture and Food (OMAF 1:25,000 scale) Artificial Drainage Map of Lambton County	Used as required to supplement 1:10,000 scale mapping for defining direction of surface drainage, to identify on-site drains/watercourses and in determining external drainage areas.
National Topographic System Map Sheets (NTS 1:50,000 scale) of the study area	Used as required to supplement the 1:10,000 scale mapping, particularly in regards to establishing watershed/subwatershed boundaries and watercourse extent.
Ontario Ministry of Agriculture and Food (OMAF 1:63,360 scale) Soil Map of Lambton County	Used to define the hydrologic characteristics of the soils within the watersheds/subwatersheds in order to determine peak flows conveyed through and adjacent to the candidate sites.
Aerial Photography	Aerial photographs were used to assist in defining site characteristics, such as on-site storage elements and drainage boundaries.
Contact with local Conservation Authority, Ministry of Natural Resources and Township staff	Discussions were held to confirm current CA/MNR interests in general (and the candidate sites specifically) and obtain an impression of future direction for surface water management strategy from the CA/MNR perspective. Discussions were also held with local Township staff to confirm local drainage features within the study area.
Site Inspection	Roadside and on-site surveys were conducted for each of the candidate sites to confirm site features and drainage characteristics obtained from the mapping sources; the information obtained typically included location of roadway stream/watercourse crossings, high/low points along roads and photographic records.
Other Disciplines	Preliminary site layout provided by the Design and Operation Criteria Group.

3.2 Data Interpretation

The data interpretation component of the detailed comparative evaluation involved the determination of the applicable indicator values for the candidate sites from the previously defined data sources.

All indicators are physically based, measurable attributes of a candidate site for which a numerical value was established. The indicator values were primarily obtained by direct measurements on the 1:10,000 scale OBM mapping and supplemented by information on the 1:25,000 artificial drainage mapping and 1:50,000 NTS mapping.

As discussed, separate and distinct indicators for each criterion were established and applied for the potential water quality and flood hazard aspects of the surface water resources. A discussion of the criteria and indicators applied, together with the method of deriving the applicable numerical values, is presented below:

Criterion 1 - Compare potential for impairment of surface water quality

This criterion is used to evaluate the potential for impairment of surface water quality based on the candidate sites location in the subwatersheds within the immediate vicinity and local watersheds, the sensitivity of downstream water usage, the hydrologic characteristics of each site and the anticipated changes due to site development.

To undertake the comparative evaluation of the four candidate sites, three indicators were applied to consider the different aspects that relate to surface water quality.

Indicator 1 - Number of watersheds and subwatersheds receiving water from site

The potential for surface water contamination increases with the number of watersheds and subwatersheds which receive runoff from a candidate site.

The watershed unit is generally adopted by the local Conservation Authorities for developing management strategies for surface water resources and the administration of policies, guidelines and regulations. Typically, the watershed unit forms the basis for watershed management plans, and flood and fill line mapping studies carried out by a Conservation Authority. In this context, a watershed is the topographically defined area drained by a watercourse or system of connecting watercourses such that all outflow is discharged through a single outlet to a major body of water (i.e., St. Clair River for Lambton County).

Subwatersheds are smaller drainage areas within a watershed. They are also often used as the basis for planning studies and the development of surface water resources. At present, however, there are no set criteria or guidelines for defining a subwatershed. Several Conservation Authorities within Ontario are in the process of defining subwatershed units within the watersheds in their jurisdictional area and one CA (Credit Valley CA) has completed the process. In the absence of general criteria, but given that Credit Valley CA has used approximately 5 km^2 as the minimum area for defining a subwatershed, a subwatershed was taken to be the topographically-defined area that comprises a minimum area of 5 km^2 of land which is drained by a watercourse such that all outflow is discharged through a single outlet.

Each candidate site was assigned a potential effect level using a five level system which encompasses all possible watershed and subwatershed combinations that could occur in the Lambton area. The approach systematically groups the various numbers of watershed and subwatershed combinations which may receive runoff from a candidate site, and assigns each group a potential effect level for input to the evaluation of sites.

The following table summarizes the way in which the potential effect levels were assigned to each combination of watersheds and subwatersheds which may receive runoff from the site.

Potential Effect Level	Number of Watersheds/Subwatersheds
1 - Lowest*	1 watershed and 1 subwatershed
2 - Low	1 watershed and 2 subwatersheds
3 - Medium	1 watershed and 3 or more subwatersheds
4 - High	2 watersheds and 2 subwatersheds
5 - Highest**	2 or more watersheds and 3 or more subwatersheds

* *more suitable for site development*
** *less suitable for site development*

The table illustrates that the potential for impairment of surface water quality is greater for candidate sites that lie within two watersheds. Similarly, within watersheds, the potential for impairment of surface water quality is greater for sites which may contribute surface runoff to larger numbers of subwatersheds.

Indicator 2 - Characteristics of downstream surface water usage

This indicator accounts for the various downstream water uses which may be affected by landfill development. Based on potential risk to public health and safety, drinking water usage was identified as the highest priority use followed by contact recreation (e.g. swimming). Agricultural usage, fishing and other uses, although considered important, were deemed to be of lower priority relative to drinking water and contact recreational usage.

The activities undertaken to identify downstream water usages included: a review of aerial photography and topographic mapping; field surveys of the downstream watersheds at watercourse crossings and, review and discussions with the MOEE and local Conservation Authority concerning surface water-taking permits.

On completing the data analysis for this indicator, it became apparent that it was not possible to assign discrete ranks to each site based on the available data sources. In order to differentiate between sites, a set of potential effect levels (shown below) were developed based on the length of watercourse(s) receiving site runoff under developed conditions.

Potential Effect Level	Length of Receiving Watercourse(s) (km)
1*	0 - 2.5
2	2.5 - 5.0
3	5.0 - 7.5
4	7.5 - 10.0
5**	over 10.0

* *more suitable for site development*
** *less suitable for site development*

The potential effect levels were based on the approximate distance between concession roads. The length of watercourse receiving surface water is representative of the potential uses which may occur downstream of the candidate sites. The greater the watercourse length, the greater the potential uses and, therefore, the greater the potential effects.

Indicator 3 - Number of watercourses receiving surface water discharge

This indicator considers the number of watercourses that will receive surface runoff from the candidate site based on the preliminary facility layout concept prepared by the Design and Operation Criteria Group. Minimizing the number of watercourses receiving flow reduces the extent of potential contamination, maximizes the ability to reliably monitor the performance of surface water management systems, and reduces the reliance on control and contingency measures.

For this indicator, the potential effect levels, shown below, were based on a count of the number of locations where discharge of site drainage will occur following development of the site.

Potential Effect Level	Number of Watercourses Receiving Surface Water Discharge
1*	1
2	2
3	3
4	4
5**	5 or more

*	*more suitable for site development*
**	*less suitable for site development*

Criterion 2 - Compare potential flood hazard

Indicator 1 - Total peak flow conveyed through and adjacent to the site

The total peak flow represents the magnitude of the potential flood risk at the site that must be properly managed and safely conveyed to the downstream watercourses.

The peak flow at each of the existing drainage outlets and adjacent watercourses from the candidate site was calculated for the Regional Storm using the OTTHYMO computer program. The potential impact levels developed for this indicator are presented below.

Potential Effect Level	Peak Flow Through and Adjacent to Site (m^3/s)
1*	0 - 20
2	20 - 40
3	40 - 60
4	60 - 80
5**	Over 80

* *more suitable for site development*
** *less suitable for site development*

Indicator 2 - Total length of on-site and adjacent watercourses

This indicator was applied as a comparative measure of the flood storage capacity that may be eliminated and would have to be replaced due to site development. Consideration was given to both on-site and off-site storage. The length of on-site streams on a comparative basis is indicative of the volume of flood plain storage. For each candidate site, the total length of all watercourses which are identified on the 1:10,000 scale OBM mapping and/or 1:25,000 scale artificial drainage and 1:50,000 scale NTS mapping was calculated by direct measurements on the mapping.

In certain cases, the flood plains of adjacent unmapped watercourses may potentially be affected. To account for the potential loss in flood plain storage, a measurement was made of the length of watercourse potentially affected and added to the length of on-site watercourses.

The total length of on-site and adjacent watercourses were the assigned a potential effect level based on the ranges provided below.

Potential Effect Level	Total Length of On-Site and Adjacent Watercourses (m)
1*	0 - 500
2	500 - 1000
3	1000 - 1500
4	1500 - 2000
5**	Over 2000

* *more suitable for site development*
** *less suitable for site development*

Indicator 3 - Number of watercourses entering site and receiving surface runoff from the site

This indicator provides a measure of the number of locations where an increase in potential flood hazard may occur due to site development.

At each location where a watercourse currently enters a candidate site, there is an increased level of potential flood risk due to backwater effects. For each candidate site, a count was made of the total number of watercourse entry points.

Downstream watercourses that will receive surface water runoff once a candidate site is developed, could potentially experience increases in flow rates, velocity and volume due to site development. As a result, the potential for flood-hazard associated effects is increased along these receiving streams. For each candidate site, a count was made of the number of such watercourses that could be affected and summed with the number of watercourse entry points. A receiving watercourse was identified based on the information presented on the 1:10,000 topographic mapping and/or 1:25,000 artificial and 1:50,000 scale NTS mapping.

For this indicator, the potential effect levels, shown below, were based on the total number of watercourse entry points and receiving watercourses.

Potential Effect Level	Number of Watercourses Entering the Site and Receiving Site Runoff
1*	1
2	2
3	3
4	4
5**	5 or more

* *more suitable for site development*
** *less suitable for site development*

Indicator 4 - Availability of a suitable outlet

This indicator provides a measure of the average slope of the receiving watercourse from the site, downstream to a major waterbody (e.g., St. Clair River, Clay Creek, Bower's Creek). Design and Operations conceptual site layout was used to identify the receiving watercourse under fully developed conditions and average slopes were obtained from measurements on the 1:10,000 OBM mapping.

The potential effect levels for this indicator are summarized below:

Potential Effect Level	**Availability of a Suitable Outlet Average Slope of Receiving Watercourses (%)**
1*	0.50 or more
2**	0.0 to 0.50

* *more suitable for site development*
** *less suitable for site development*

3.2.1 Results of Data Interpretation and Net Effects

The results of data interpretation analyses for both Criterion 1 (surface water quality) and Criterion 2 (flood hazard) are summarized in Tables 3 and 4.

Tables 5 to 8 outline the possible environmental effects of a waste management facility on the site, the mitigative measures that would be implemented to lessen the environmental impacts, and the net effects.

TABLE 3
SUMMARY OF CRITERION/INDICATOR DATA

Site Ref.	CRITERION 1 - WATER QUALITY						CRITERION 2 - POTENTIAL FLOOD HAZARD					
	Indicator 1				Indicator 2	Indicator 3	Indicator 1	Indicator 2			Indicator 3	Indicator 4
	No. of Watersheds	Watershed Name	No. of Subwatersheds	Subwatershed Name	Characteristics of Downstream Surface Water Usage (Length of Receiving Watercourses) (km)	No. of Water-courses Receiving Surface Water Discharge	Peak Flow Through and Adjacent to Site (m^3/s)	Length of On-Site Watercourses (m)	Length of Adjacent Watercourses (m)	Total (m)	No. of Watercourses Entering Site and Recei-ving Site Runoff	Availability of a Suitable Outlet (%)
D	1	Clay Creek	2	Coyle Drain & Wheeler Drain	16.5	1	72	0	700	700	3	0.09
K	1	Clay Creek	1	Coyle Drain	17.3	1	72	640	950	1590	2	0.09
H	2	Johnston Drain & Bowen's Creek	2	Trib. of Bowen's Creek & Johnston Drain	1.0	1	27	0	1750	1750	3	0.8
I	1	Johnston Drain	1	Johnston Drain	1.8	1	23	0	1600	1600	2	0.5

TABLE 4
SUMMARY OF POTENTIAL EFFECT LEVELS

Site Ref.	CRITERION 1 - WATER QUALITY						CRITERION 2 - POTENTIAL FLOOD HAZARD							
	Indicator 1		Indicator 2		Indicator 3		Indicator 1		Indicator 2		Indicator 3		Indicator 4	
	Impact Level	Score	Impact Level	Score	Impact Level	Score	Impact Level	Score	Impact Level	Score	Impact Level	Score	Impact Level	Score
D	2	0.30	5	1.25	1	0.16	4	0.72	2	0.36	3	0.12	2	0.08
K	1	0.15	5	1.25	1	0.16	4	0.72	4	0.72	2	0.08	2	0.08
H	4	0.60	1	0.25	1	0.16	2	0.36	4	0.72	3	0.12	1	0.04
I	1	0.15	1	0.25	1	0.16	2	0.36	4	0.72	2	0.08	1	0.04

TABLE 5
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE D

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Compare potential for impairment of surface water quality** • number of watersheds and subwatersheds receiving surface water from site	1 watershed 2 subwatersheds	· potential for impairment of surface water quality	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · transportation in vehicles designed to avoid spillage · preventative inspection and maintenance program for all landfill design components · limit materials accepted at landfill · provision of low permeability liner, including leak detection system and monitoring program · provision of contingency measures, e.g. cut-off walls, purge wells, etc. · isolation of surface water from refuse · provision of site drainage system with conveyance capacities to carry flows from severe storm events · implementation of surface water monitoring program pre- and post-closure · provision to intercept, collect and treat contaminated surface waters within the buffer zone should monitoring program detect on-site surface water contamination with potential to mitigate off-site · provision to recycle contaminated surface water within landfill if upset occurs in retention/treatment system (e.g. during extreme runoff) · re-route existing watercourses around site · provision of storm water management for release of pre-development flows · additional measures, as for ground water (hydrogeology)	· low risk of surface water quality impairment
• characteristics of downstream surface water usage (length of receiving water course in km)	16.5			
• number of watercourses receiving surface water discharges	1			

TABLE 5
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE D
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
2. **Compare potential flood hazard**		· potential for flood hazard	· provision of storm water management to maintain pre-development flows	· negligible net effects anticipated
• total peak flow through and adjacent to site (m^3/s)	72			
• length of on-site/adjacent watercourses (m)	0 on-site 700 adjacent			
• number of watercourses entering site and receiving surface runoff from the site	3			
• availability of suitable outlet (receiving watercourse) - %	0.09			

TABLE 6
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE K

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Compare potential for impairment of surface water quality**		· potential for impairment of surface water quality	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · transportation in vehicles designed to avoid spillage · preventative inspection and maintenance program for all landfill design components · limit materials accepted at landfill · provision of low permeability liner, including leak detection system and monitoring program · provision of contingency measures, e.g. cut-off walls, purge wells, etc. · isolation of surface water from refuse · provision of site drainage system with conveyance capacities to carry flows from severe storm events · implementation of surface water monitoring program pre- and post-closure · provision to intercept, collect and treat contaminated surface waters within the buffer zone should monitoring program detect on-site surface water contamination with potential to mitigate off-site · provision to recycle contaminated surface water within landfill if upset occurs in retention/treatment system (e.g. during extreme runoff) · re-route existing watercourses around site · provision of storm water management for release of pre-development flows · additional measures, as for ground water (hydrogeology)	· low risk of surface water quality impairment
• number of watersheds and subwatersheds receiving surface water from site	1 watershed 1 subwatershed			
• characteristics of downstream surface water usage (length of receiving water course in km)	17.3			
• number of watercourses receiving surface water discharges	1			

TABLE 6
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE K
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
2. **Compare potential flood hazard**		· potential for flood hazard	· provision of storm water management to maintain pre-development flows	· negligible net effects anticipated
• total peak flow through and adjacent to site (m^3/s)	72			
• length of on-site/adjacent watercourses (m)	640 on-site 970 adjacent			
• number of watercourses entering site and receiving surface runoff from the site	2			
• availability of suitable outlet (receiving watercourse) - %	0.09			

TABLE 7
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE H

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Compare potential for impairment of surface water quality** • number of watersheds and subwatersheds receiving surface water from site	2 watersheds 2 subwatersheds	· potential for impairment of surface water quality	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · transportation in vehicles designed to avoid spillage · preventative inspection and maintenance program for all landfill design components · limit materials accepted at landfill · provision of low permeability liner, including leak detection system and monitoring program · provision of contingency measures, e.g. cut-off walls, purge wells, etc. · isolation of surface water from refuse · provision of site drainage system with conveyance capacities to carry flows from severe storm events · implementation of surface water monitoring program pre- and post-closure · provision to intercept, collect and treat contaminated surface waters within the buffer zone should monitoring program detect on-site surface water contamination with potential to mitigate off-site · provision to recycle contaminated surface water within landfill if upset occurs in retention/treatment system (e.g. during extreme runoff) · re-route existing watercourses around site · provision of storm water management for release of pre-development flows · additional measures, as for ground water (hydrogeology)	· low risk of surface water quality impairment
• characteristics of downstream surface water usage (length of receiving water course in km)	1.0			
• number of watercourses receiving surface water discharges	1			

TABLE 7
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE H
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
2. **Compare potential flood hazard** • total peak flow through and adjacent to site (m^3/s)	27	· potential for flood hazard	· provision of storm water management to maintain pre-development flows	· negligible net effects anticipated
• length of on-site/adjacent watercourses (m)	0 on-site 1,750 adjacent			
• number of watercourses entering site and receiving surface runoff from the site	3			
• availability of suitable outlet (receiving watercourse) - %	0.8			

TABLE 8
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE I

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. **Compare potential for impairment of surface water quality** • number of watersheds and subwatersheds receiving surface water from site	1 watershed 1 subwatershed	· potential for impairment of surface water quality	· provision of leachate collection system and disposal/treatment · ground water monitoring program pre- and post-closure · transportation in vehicles designed to avoid spillage · preventative inspection and maintenance program for all landfill design components · limit materials accepted at landfill · provision of low permeability liner, including leak detection system and monitoring program · provision of contingency measures, e.g. cut-off walls, purge wells, etc. · isolation of surface water from refuse · provision of site drainage system with conveyance capacities to carry flows from severe storm events · implementation of surface water monitoring program pre- and post-closure · provision to intercept, collect and treat contaminated surface waters within the buffer zone should monitoring program detect on-site surface water contamination with potential to mitigate off-site · provision to recycle contaminated surface water within landfill if upset occurs in retention/treatment system (e.g. during extreme runoff) · re-route existing watercourses around site · provision of storm water management for release of pre-development flows · additional measures, as for ground water (hydrogeology)	· low risk of surface water quality impairment
• characteristics of downstream surface water usage (length of receiving water course in km)	1.8			
• number of watercourses receiving surface water discharges	1			

TABLE 8
SURFACE WATER IMPACT ASSESSMENT: NET EFFECTS FOR SITE I
(Continued)

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
2. **Compare potential flood hazard** • total peak flow through and adjacent to site (m^3/s)	23	· potential for flood hazard	· provision of storm water management to maintain pre-development flows	· negligible net effects anticipated
• length of on-site/adjacent watercourses (m)	0 on-site 1,600 adjacent			
• number of watercourses entering site and receiving surface runoff from the site	2			
• availability of suitable outlet (receiving watercourse) - %	0.5			

3.3 Evaluation of Sites by Criteria and Indicators

A weighted potential effect was used by the Surface Water criteria group to determine the relative ranking of each candidate site using the weights for indicators within Criteria 1 and 2.

Table 9 presents the final overall score and ranking for each candidate site based on site comparisons for both criterion.

Overall site scores have been normalized on a 0.0 to 1.0 scale by dividing each site score by the highest site score and ranked based on the normalized score.

TABLE 9
SUMMARY OF SURFACE WATER WEIGHTED IMPACT LEVEL ANALYSIS

Site Reference Number	Water Quality Score	Flood Hazard Score	Overall Score	Normalized Score	Site Rank
D	1.71	1.28	2.99	0.95	3
K	1.56	1.60	3.16	1.00	4**
H	1.01	1.24	2.25	0.71	2
I	0.56	1.20	1.76	0.56	1*

* *most suitable for site development*
** *least suitable for site development*

4.0 SUMMARY OF FINDINGS

Relative Rank 1 - Site I

- Site I, which ranks first overall, is considered to be the most preferred for landfill site development from a surface water perspective.

- Site I contributes surface runoff to a single watershed and a single subwatershed and discharges surface runoff to only one watercourse. In addition, there are no identified downstream usages of surface water and the length of watercourse is limited. Accordingly, the potential for impairment of surface water quality is rated the lowest.

- In regards to potential flood hazard (Criterion 2), Site I exhibits a low peak flow through and/or adjacent to the site and has favourable outlet conditions, which combined provides the lowest relative rank for this criterion.

- Together, these two ratings result in the lowest potential for surface water effects and places candidate Site I as the most suitable for site development.

Relative Rank 2 - Site H

- Site H contributes surface runoff to two watersheds and two subwatersheds which is indicative of a higher potential for impairment of surface water quality. However, there are no identified downstream usages of surface water and the length of watercourse is limited. Therefore, Site H ranks second to only Site I with regards to Criterion 1.

- The potential flood hazard effects (Criterion 2) associated with this site are considered low. Peak flows through and/or adjacent to the site are minimal and suitable outlet conditions prevail.

- Overall, Site H was given a relative rank of 2 and is second to only Site I with regards to surface water.

Relative Rank 3 - Sites D and K

- Sites D and K have a relative rank of third and fourth overall, but are judged to be of equal ranking with regards to surface water.

- For surface water quality (Criterion 1), Site K ranks more favourably than Site D because it contributes surface runoff to a single watershed and single subwatershed.

- In regards to potential flood hazards (Criterion 2) Site D ranks more favourable due to the smaller length of on-site and adjacent watercourses.

- The combined site scores for both candidate sites are relatively close and therefore were ranked similarly.

- Overall, Sites D and K maintain the highest potential for surface water effects under both Criterion 1 and 2 and are therefore regarded as least suitable for site development.

LAMBTON COUNTY WASTE MANAGEMENT MASTER PLAN
DETAILED COMPARISON OF SITES

APPENDIX 4H
TRANSPORTATION IMPACT ASSESSMENT

M.M. DILLON LIMITED
FEBRUARY 1995

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1.0 INTRODUCTION

1.1 Purpose and Objectives

This report documents the assessment conducted to compare the four short-listed sites - Sites D, H, I and K - from a transportation perspective. The purpose of this impact assessment was to identify the order of preference of the sites (i.e. best site(s), if any; worst site(s), if any) with respect to transportation considerations. The results of this study contributed to the multi-criteria comparison of the four sites towards the identification of the recommended site.

A primary focus in comparing the sites was to address potential impacts of the landfill component of the proposed composite waste management facility. Although the composite facility as a whole was taken into account, the landfill component was considered to be of most significance in identifying and comparing potential transportation impacts.

The key considerations addressed in this study were:

- the potential for impacts to traffic safety along haul routes; and
- the potential for impacts to traffic safety operations along haul routes.

The comparison of the four sites involved the following steps:

- the identification of criteria and indicators appropriate for the assessment and comparison of the potential transportation impacts of the sites;

- the collection of data regarding the four sites according to the criteria and indicators identified;

- the analysis of the site data to identify the advantages and disadvantages of the sites with respect to transportation considerations; and

- the comparison of the sites' advantages and disadvantages to identify, from a transportation perspective, the most preferred/least preferred site(s), if any.

1.2 Report Organization

This report is structured in four chapters with technical data provided in the three attached schedules. Chapter 1 outlines the purpose and objectives of the report. Chapter 2 documents the scope and methods employed. Chapter 3 provides the analysis of the four short list sites and the comparison between sites. A summary of the rank order by the transportation discipline is provided as Chapter 4.

The attached schedules provide the background data to support the analysis. Schedule I contains transportation related data for Lambton County and for each site. Schedule II summarizes the calculation of each site's indicator scores. Schedule III provides the summary page of the comparative evaluation.

2.0 STUDY APPROACH

2.1 Overview of Method

Lambton County's waste quantities were distributed across each of the 20 municipal jurisdictions. These waste quantities were then converted to waste haul vehicle volumes on the basis of existing collection practices. A set of representative haul routes were selected from each municipal waste centroid to each candidate site based on minimizing the distance travelled while maximizing the use of higher order roads. The impacts on road users were then assessed using the transportation discipline criteria and indicators.

2.2 Study Area

The Study Area for the analysis included all roads within Lambton County. From these roads the haul routes from each waste centroid to each candidate site were selected. Figure 1 illustrates the haul routes used for the analysis of the candidate sites.

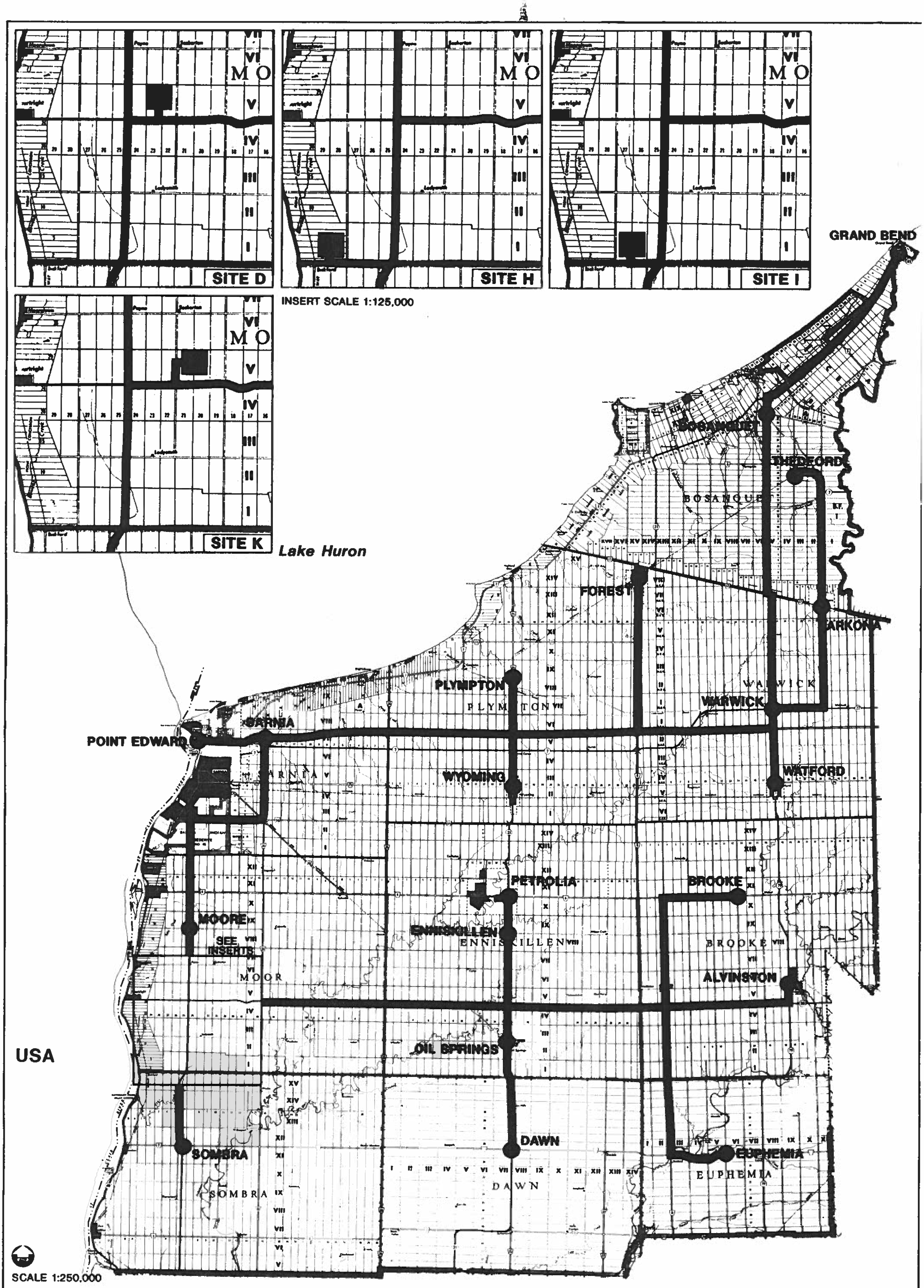
2.3 Time Frame

The horizon year addressed in the transportation assessment was the proposed opening year of the landfill, 1996.

2.4 Key Assumption

The basis for the development of the specific indicators to be used was an understanding that the traffic volumes being estimated would not have significant impacts on the background traffic. In the peak year, 11,000 waste haul vehicles are expected to use the landfill. To convert the peak annual waste haul vehicle volumes to a peak hour design volume, several calculations were made to develop an estimate:

- The annual waste haul vehicle volume (11,000 vehicles in the peak year) was divided by the number of operating days (250 assuming only weekday operation) to determine the average daily waste haul vehicle volume (44 vehicles);



LAMBTON COUNTY W.M.M.P.
TRANSPORTATION ASSESSMENT
SHORT LIST EVALUATION

HAUL ROUTES

▬	HAUL ROUTE
■	CANDIDATE SITE
●	MUNICIPAL WASTE CENTROID

DILLON

FIGURE 1

- The average daily waste haul vehicle volume (44 vehicles) is multiplied by a design day factor (assumed to be 1.5 which is higher than seen at other landfills previously studied) to obtain a design day waste haul vehicle volume (66 vehicles); and

- The design day waste haul vehicles volume (66 vehicles) were then multiplied by a peak hour factor (assumed to be 0.15 which is higher than seen at other landfills previously studied) to obtain a design hour waste haul vehicle volume (10 vehicles).

With the low observed background traffic volumes in the site vicinity, ten vehicles in an hour (or one every six minutes) would have minimal impacts. Further away from the site, the traffic volumes will be lower as the vehicles are more dispersed. As a result of this analysis, it was considered reasonable to assume that no mitigation would be necessary along the haul routes for reasons of traffic safety or traffic operations. For the detailed analysis of the preferred site, site vicinity impacts will be reviewed in detail.

Mitigation of the structural quality of some roads was required at some sites. Road upgrades were identified to carry heavy vehicles. Site D requires a new access road be built from Highway 80 to the site access and Site K requires reconstruction of an existing road (Moore Township Sideroad 21-22) from Highway 80 to the site access. Sites H and I require no structural upgrades.

2.5 Data Collection

Table 1 lists the criteria, indicators, rationale and data sources for the transportation discipline. The transportation criteria address the two major aspects of road use, traffic safety and traffic operations, as separate criterion. For traffic safety, an estimate of the annual potential number of accidents is the primary indicator. In addition, the increased presence of vehicles at intersections and at level railway crossings are also used as indicators of safety. For traffic operations, travel along one and two-plus lane roads (in one direction) account for service disruptions along haul routes. In addition, the presence of vehicles at intersections was also used as an indicator of impact on traffic operations.

TABLE 1
TRANSPORTATION EVALUATION CRITERIA

Criteria	Indicators	Rationale	Data Sources[1]
1. Compare potential for impacts to traffic safety along haul routes.	a) Potential number of annual accidents	Accidents are a safety concern because of injury and damage-related consequences. This indicator measures the potential number of accidents along the haul routes to each site.	• Average accident rate data from the 1989, 1990, and 1991 Provincial Highways Traffic Volumes Reports
	b) Annual number of potential at-grade vehicle/train conflicts	At-grade railway crossings are a safety concern, particularly for trucks, because a truck-with-train type accident may have serious injury and damage-related consequences. A potential vehicle/train conflict is the product of the waste haul vehicle traffic volumes and train traffic volumes. This gives an indication of the number of instances that a vehicle/train collision might occur and is representative of an increase in transportation risk.	• Field inspection • Consultation with CN, MTO and Moore Township
	c) Annual number of waste haul vehicles travelling through intersections	Intersections where a waste haul vehicle may slow or stop are an important traffic safety concern because of injury and damage-related consequences. Intersections typically have higher accident rates than other sections of road. Truck movements in particular cause safety concerns at intersections as trucks are less manoeuvrable, are slower accelerating/decelerating and can obstruct the vision of other traffic.	• Field inspection

Criteria	Indicators	Rationale	Data Sources[1]
2. Compare potential for impacts to traffic operations along haul routes	a) Annual vehicle-kilometres travelled on single-lane (in one direction) public roads	Additional waste haul vehicles on these roads presents the potential to delay road users. On single-lane (in one direction) roads, it is difficult to pass trucks.	• Field inspection
	b) Annual vehicle-kilometres travelled on multi-lane (in one direction) public roads	Additional waste haul vehicles on these roads presents the potential to delay road users. On multi-lane (in one direction) roads, it may be difficult to pass trucks.	• Field inspection
	c) Annual number of waste haul vehicles travelling through intersections	Intersections where waste haul vehicles may slow or stop are an important traffic operation concern because of the potential increase in delay to road users	• Field inspection

[1] *For all indicators, the following data were also used:*

- *Location of waste centroids and site access;*
- *Annual traffic volumes for each waste centroid;*
- *Energy Mines and Resources Canada, 1:50,000 topographic maps;*
- *Province of Ontario Road Map, 1990-1991, Ontario Ministry of Transportation, 1990;*
- *Ontario Transportation Map Series, Map 1, Ontario Ministry of Transportation, June 1, 1983; and*
- *City Plan of Sarnia/Port Huron, Map Art, 1988.*

The following sections provide further descriptions of the data collected.

Waste Generation Centroids

For each local municipality, a waste generation centroid was developed to represent the origin point for all of the municipality's waste. This level of abstraction was necessary to simplify the calculation of the indicators related to the haul routes. By using municipal waste centroids, the abstraction adequately captures the transportation of waste from source points spread across the region. This was considered appropriate to allow for a comparative evaluation of sites. The waste centroid locations are illustrated in Figure 1 and are listed in Schedule I.

Site Access Points

A site access point was required to represent the destination point for all waste. The conceptual site design drawings prepared by the design and operations discipline included the conceptual site access points. These were used in the selection of haul routes.

Haul Routes

Waste haul routes for each site were selected based on the following:

- Minimizing the distance travelled between each municipal waste centroid and each candidate site access point; while

- Maximizing the use of roads that are generally more desirable for truck traffic.

The road network under consideration was the existing road network with any additions or deletions that likely would be completed by the 1996 horizon year. No significant changes to the road network that might affect the selection of haul routes are expected to be completed by the horizon year. Therefore, the existing road network was used.

Annual Waste Haul Vehicle Volumes

The annual waste haul vehicles volumes, by local municipality, were calculated from information provided by the project engineer. This data included the estimated annual waste quantities by local municipality for 1996 and the average load size by local municipality. From this the annual waste haul vehicle volumes by local municipality were calculated. For each municipality, the minimum waste haul vehicle volume was assumed to be 52 (ie. once a week pick-up). Schedule I includes a table listing the waste quantity, average load size and the waste haul vehicle volumes by local municipality.

Average Accident Rates

For the traffic safety analysis average accident rates were used for the various road classes. The 1988, 1989, and 1990 Provincial Highways Traffic Volumes Reports provided the most recent three years of accident statistics for Ontario. Annual accident statistics were averaged over the three years for freeways (0.7 accidents/million vehicle km) and highways (1.0 accidents/million vehicle km). For regional and local roads the 'all-road' accident statistics were used (3.1 accidents/million vehicle km).

Train Volumes

Annual train volumes for at-grade crossings along the haul routes were estimated from data gathered from the Ministry of Transportation for Ontario, the Works Department of Moore Township, and Canadian National Railway. Three at-grade crossings are present along the haul routes. The location and estimated daily train volumes are:

- Highway 40 (Churchill Road) east of Scott Street - 8 trains/day;
- Moore/Sombra Townline east of Highway 40 (1st crossing) - 2 trains/day; and
- Moore/Sombra Townline east of Highway 40 (2nd crossing) - 2 trains/day.

Other Data

The balance of the information used in this study was derived from field inspection along the haul routes and various map sources. This information includes:

- number of lanes on the roads along the haul routes;
- distances for vehicle-kilometre calculations;
- intersection traffic controls (ie. signals or stop signs); and
- intersection geometry.

The data required for the calculation of indicator values were then tallied. This information is provided in Schedule I for each site.

Calculation of Indicator Scores

For each site, the indicators were calculated for each waste centroid-candidate site pairing and then summed for all waste centroids to a particular candidate site to determine the overall candidate site raw data value. This was repeated for each candidate site. Schedule II provides the calculated indicator raw data for each site.

To calculate Criteria 1, Indicator a, Potential number of annual accidents, for any waste centroid-candidate site pairing, the following steps were used:

- Determine the distance travelled from the waste centroid to the candidate site by the three road classifications (ie. freeway, highway, and county or local road);
- Multiple the distance for each road classification by the average accident rate for that road class. The result is the accident potential/million vehicles; and
- Multiple this by the annual number of waste haul vehicles from the waste centroid, divide by one million and double to account for the return trip. The result is the annual accident potential for the waste centroid-candidate site pairing.

To calculate Criteria 1, Indicator b, Annual number of potential at-grade vehicle/train conflicts, for any waste centroid-candidate site pairing, the following steps were used:

- Determine the location of all at-grade rail crossings along the haul route travelled;
- Sum the average daily train volumes for all crossings;
- Multiple the average daily train volumes by 365 days. The result is the annual conflicting train volume along the haul route; and
- Multiple this by the annual number of waste haul vehicles from the waste centroid and double to account for the return trip. The result is the annual vehicle/train conflict potential.

To calculate Criteria 1, Indicator c, Annual number of waste haul vehicles travelling through intersections, for any waste centroid-candidate site pairing, the following steps were used:

- Determine the location of all intersection were waste haul vehicles may be required to slow or stop;

- If the waste haul vehicles may slow or stop when both travelling to and returning from the landfill, then assign the intersection a value of one. If the waste haul vehicles may slow or stop either when travelling to or returning from the candidate site, then assign the intersection a value of one-half;

- Sum the assigned intersection values to obtain the number of intersections where waste haul vehicles may slow or stop; and

- Multiple the number of intersections by the annual number of waste haul vehicles from the waste centroid and double to account for the return trip. The result is the annual number of waste haul vehicles travelling through intersections.

Criteria 2, Indicator a, Annual vehicle-kilometre travelled on single-lane (in one direction) public roads, for any waste centroid-candidate site pairing, the following steps were used:

- Determine the distance travelled from the waste centroid to the candidate site on single lane roads in the direction of travel. (Note: In the Study Area, the number of lanes on each section of road was the same in both directions.); and

- Multiple this distance by the annual number of waste haul vehicles from the waste centroid and double to account for the return trip. The result is the annual vehicle-kilometres travelled on one-lane roads.

Criteria 2, Indicator b, Annual vehicle-kilometres travelled on multi-lane (in one direction) public roads, for any waste centroid-candidate site pairing, the following steps were used:

- Determine the distance travelled from the waste centroid to the candidate site on multi-lane roads in the direction of travel. (Note: In the Study Area, the number of lanes on each section of road was the same in both directions.); and

- Multiple this distance by the annual number of waste haul vehicles from the waste centroid and double to account for the return trip. The result is the annual vehicle-kilometres travelled on multi-lane roads.

To calculate Criteria 2, Indicator c, Annual number of waste haul vehicles travelling through intersections, for any waste centroid-candidate site pairing, the same steps as for Criteria 1, Indicator c were used.

3.0 COMPARISON OF SITES

3.1 Existing Conditions

The four candidate sites are located in close proximity to each other in Moore Township. Primary access routes to all the sites would use Highways 40 and 80. Field observations and discussions with the Ministry of Transportation for Ontario have indicated that these highways have ample available capacity and can accommodate the low volumes of traffic to be attracted by the new landfill site. Although Highway 40 is a staged freeway, in the site vicinity there are no widenings scheduled in the next five years nor are any anticipated in the foreseeable future.

3.2 Mitigative Measures and Net Effects

Tables 2 to 5 outline the possible environmental effects of a waste management facility on the site, the mitigative measures that could be implemented to lessen the environmental impacts, and the net effects.

3.3 Advantages/Disadvantages

The majority of the waste is generated in the Sarnia area. Therefore, the sites situated closer to Sarnia would tend to minimize the overall transportation impacts (Sites D and K) and the sites situated further away would tend to maximize the overall transportation impacts (Sites H and I). Sites H and I also have the disadvantage of two additional railway level crossings situated on the Moore/Sombra Townline.

3.4 Comparison of Sites

The evaluation of candidate sites occurred at four levels of analysis:

- indicator level;
- criteria level;
- discipline level; and
- multi-disciplinary level.

TABLE 2
TRANSPORTATION IMPACT ASSESSMENT: NET EFFECTS FOR SITE D

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Compare potential for impacts to traffic safety along haul routes		· potential for impacts to traffic safety along haul routes	· with the low observed background traffic volumes in the site vicinity, 10 additional vehicles in an hour would have minimal impacts · further away from the site, the traffic volumes will be lower as the vehicles are more dispersed · it was considered reasonable to assume that no mitigation would be necessary for reasons of traffic safety or traffic operations · for the detailed analysis of the preferred site, site vicinity impacts will be reviewed in detail	· minimal safety impacts
• potential number of annual accidents	0.710			
• annual number of potential at-grade haul vehicles/train conflicts	128,672			
• annual number of waste haul vehicles travelling through intersections	156,969			
2. Compare potential for impacts to traffic operations along haul routes		· potential for impacts to traffic operations along haul routes	· as above · mitigation of the structural quality of a road was required to carry heavy vehicles · Site D requires a new access road be built from Highway 80 to the site access	· minimal operations impacts
• annual vehicle-kilometres travelled on single-lane (in one direction) public roads	345,065.2			
• annual vehicle-kilometres travelled on multi-lane (in one direction) public roads	318,717.8			
• annual number of waste haul vehicles travelling through intersections	156,969.0			

TABLE 3
TRANSPORTATION IMPACT ASSESSMENT: NET EFFECTS FOR SITE H

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Compare potential for impacts to traffic safety along haul routes • potential number of annual accidents	0.899	· potential for impacts to traffic safety along haul routes	· with the low observed background traffic volumes in the site vicinity, 10 additional vehicles in an hour would have minimal impacts · further away from the site, the traffic volumes will be lower as the vehicles are more dispersed · it was considered reasonable to assume that no mitigation would be necessary for reasons of traffic safety or traffic operations · for the detailed analysis of the preferred site, site vicinity impacts will be reviewed in detail	· minimal safety impacts
• annual number of potential at-grade vehicle/train conflicts	209,096			
• annual number of waste haul vehicles travelling through intersections	160,613			
2. Compare potential for impacts to traffic operations along haul routes • annual vehicle-kilometres travelled on single-lane (in one direction) public roads	461,948.8	· potential for impacts to traffic operations along haul routes	· as above	· minimal operations impact
• annual vehicle-kilometres travelled on multi-lane (in one direction) public roads	318,717.8			
• annual number of waste haul vehicles travelling through intersections	160,613.0			

TABLE 4
TRANSPORTATION IMPACT ASSESSMENT: NET EFFECTS FOR SITE I

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Compare potential for impacts to traffic safety along haul routes		· potential for impacts to traffic safety along haul routes	· with the low observed background traffic volumes in the site vicinity, 10 additional vehicles in an hour would have minimal impacts · further away from the site, the traffic volumes will be lower as the vehicles are more dispersed · it was considered reasonable to assume that no mitigation would be necessary for reasons of traffic safety or traffic operations · for the detailed analysis of the preferred site, site vicinity impacts will be reviewed in detail	· minimal safety impacts
• potential number of annual accidents	0.842			
• annual number of potential at-grade vehicle/train conflicts	209,096			
• annual number of waste haul vehicles travelling through intersections	160,613			
2. Compare potential for impacts to traffic operations along haul routes		· potential for impacts to traffic operations along haul routes	· as above	· minimal operations impact
• annual vehicle-kilometres travelled on single-lane (in one direction) public roads	443,853.4			
• annual vehicle-kilometres travelled on multi-lane (in one direction) public roads	318,717.8			
• annual number of waste haul vehicles travelling through intersections	160,613.0			

TABLE 5
TRANSPORTATION IMPACT ASSESSMENT: NET EFFECTS FOR SITE K

Criteria/Indicator	Data	Environmental Effects	Mitigation/Enhancement	Net Effects
1. Compare potential for impacts to traffic safety along haul routes		· potential for impacts to traffic safety along haul routes	· with the low observed background traffic volumes in the site vicinity, 10 additional vehicles in an hour would have minimal impacts · further away from the site, the traffic volumes will be lower as the vehicles are more dispersed · it was considered reasonable to assume that no mitigation would be necessary for reasons of traffic safety or traffic operations · for the detailed analysis of the preferred site, site vicinity impacts will be reviewed in detail	· minimal safety impacts
• potential number of annual accidents	0.763			
• annual number of potential at-grade vehicle/train conflicts	128,672			
• annual number of waste haul vehicles travelling through intersections	177,075			
2. Compare potential for impacts to traffic operations along haul routes		· potential for impacts to traffic operations along haul routes	· as above · mitigation of the structural quality of a road was required to carry heavy vehicles · Site K requires reconstruction of an existing road from Highway 80 to the site access	· minimal operations impact
• annual vehicle-kilometres travelled on single-lane (in one direction) public roads	368,652.2			
• annual vehicle-kilometres travelled on multi-lane (in one direction) public roads	318,717.8			
• annual number of waste haul vehicles travelling through intersections	177,075.0			

The indicator, criteria, and discipline evaluations were conducted by the discipline responsible. The criteria group results for each site were provided to the project manager for the overall multi-disciplinary site evaluation and comparison.

Indicators represent the first level of analysis and measure actual candidate site data. Indicators were combined to determine criteria scores. Criteria represent the second level of analysis. Criteria scores were combined in the third level of analysis to determine the score for the discipline for each candidate site. The final step is to convert the discipline score into values for use by the project manager in the multi-disciplinary analysis.

The evaluation method used to develop discipline scores for each candidate site was based on the Simple Additive Weighting Method (SAWM). The SAWM incorporates normalized data. Normalizing the data allows individual indicators and criteria, which use different scales and units of measurement, to be compared using a common scale. The normalized scores are then weighted according to their relative importance. The normalization method used is calculated as: the raw score divided by the maximum score multiplied by 10.

To corroborate the logical advantages/disadvantages described in section 3.2 the SAWM was used. Schedule III contains the SAWM site comparison analysis for the anticipated landfill traffic volumes expected.

Site D is ranked first for every indicator which results in a ranking of first overall. It is the closest site to the major sources of waste.

Site K is ranked second overall. It is ranked second for both the traffic safety and traffic operations criteria. Although it ranks last for both indicators measuring the annual number of vehicles through intersections (Indicators 1c and 2c), the other advantages in traffic safety and traffic operations result in a ranking of second overall.

Site I is ranked third for both the traffic safety and traffic operations criteria, while Site H is ranked fourth for both. These two sites are further away from the major sources of waste than Site D and Site K, with Site H being the furthest.

The SAWM evaluation showed that for both the traffic safety and traffic operations criteria (and therefore the site ranking), Site D is preferred, followed by sites K, I, and H. The differences between the ranked sites are small, however, in the context of the four sites being analyzed they are distinguishable.

4.0 SUMMARY

The transportation discipline ranked the candidate sites as follows:

Site D	1st
Site K	2nd
Site I	3rd
Site H	4th.

SCHEDULE I

INPUT DATA

Lambton County W.M.M.P.

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Municipal Waste Centroid Locations

Municipality	Waste Centroid Location
Sarnia	Highway 402/Highway 40
Forest	King Street/Highway 21/Main Street
Petrolia	Lambton Road 4/Highway 21
Alvinston	Lambton Road 23/Brooke Township Concession 5-6/Highway 79
Arkona	Highway 7/Highway 79/Lambton Road 12
Grand Bend	Highway 81/Highway 21
Oil Springs	Enniskillen Township Concession 2/Highway 21
Point Edward	Highway 402/Highway 40B
Thedford	Highway 79/King Street
Watford	Lambton Road 39/Warwick Township Concession 4-5 S.E.R./Highway 79
Wyoming	Plympton Concession Road 2/ Highway 21
Bosanquet	Lambton Road 18/Highway 79
Brooke	Lambton Road 4/Brooke Township Road 12-13
Dawn	Lambton Road 2/Highway 21
Enniskillen	Enniskillen Township Concession 8/Highway 21
Euphemia	Lambton Road 2/Euphemia Township Concession 5-6
Moore	Moore Road 8/Highway 40
Plympton	Plympton Concession Road 8/Lambton Road 30
Sombra	Lambton Road 2/Highway 40
Warwick	Highway 7/Highway 79/Lambton Road 9

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Vehicle Volumes by Centroid

Centroid	Annual Waste Quantity (tonnes/year)	Average Load Size (tonnes/load)	Annual Vehicle Volumes
Sarnia	60625	10	6100
Forest	2306	11	210
Petrolia	3782	9	420
Alvinston	746	9	82
Arkona	436	9	52
Grand Bend	1528	7	218
Oil Springs	582	9	65
Point Edward	1895	9	210
Thedford	642	7	92
Watford	1230	9	135
Wyoming	1834	9	200
Bosanquet	3960	12	330
Brooke	726	9	80
Dawn	651	9	72
Enniskillen	1280	9	140
Euphemia	390	7	52
Moore	8182	9	910
Plympton	3459	9	385
Sombra	1695	9	190
Warwick	1002	9	110

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Site D: Site Data

Centroid	Haul Route Km on Freeways		Haul Route Km on Highways		Haul Route Km on Regional/Local Roads		# Trains Crossing Haul Route	Number of Intersections on Haul Route
	1 lane	2+ lanes	1 lane	2+ lanes	1 lane	2+ lanes		
Sarnia	0.0	0.0	12.9	13.1	0.5	0.0	8	8.5
Forest	0.0	27.9	23.3	13.1	1.8	0.0	8	9.0
Petrolia	0.0	0.0	30.7	0.0	0.5	0.0	0	2.0
Alvinston	0.0	0.0	44.9	0.0	0.5	0.0	0	3.0
Arkona	0.0	38.1	25.7	13.1	0.5	0.0	8	10.5
Grand Bend	0.0	38.1	33.5	13.1	19.3	1.0	8	15.0
Oil Springs	0.0	0.0	25.3	0.0	0.5	0.0	0	2.0
Point Edward	0.0	4.7	12.9	13.1	0.5	0.0	8	9.0
Thedford	0.0	38.1	35.5	13.1	2.3	0.0	8	11.5
Watford	0.0	38.1	16.9	13.1	0.5	0.0	8	9.0
Wyoming	0.0	18.6	16.0	13.1	1.0	0.0	8	10.0
Bosanquet	0.0	38.1	18.2	13.1	19.3	0.0	8	14.5
Brooke	0.0	0.0	34.3	0.0	14.1	0.0	0	4.0
Dawn	0.0	0.0	33.4	0.0	0.5	0.0	0	2.0
Enniskillen	0.0	0.0	28.0	0.0	0.5	0.0	0	2.0
Euphemia	0.0	0.0	34.3	0.0	16.5	0.0	0	4.0
Moore	0.0	0.0	6.1	0.4	0.5	0.0	0	3.0
Plympton	0.0	18.6	12.9	13.1	4.7	0.0	8	9.5
Sombra	0.0	0.0	12.0	0.0	0.5	0.0	0	2.0
Warwick	0.0	38.1	14.3	13.1	0.5	0.0	8	9.5

Lambton County W.M.M.P.

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Site H: Site Data

Centroid	Haul Route Km on Freeways		Haul Route Km on Highways		Haul Route Km on Regional/Local Roads		# Trains Crossing Haul Route	Number of Intersections on Haul Route
	1 lane	2+ lanes	1 lane	2+ lanes	1 lane	2+ lanes		
Sarnia	0.0	0.0	17.1	13.1	2.1	0.0	12	8.5
Forest	0.0	27.9	27.5	13.1	3.4	0.0	12	9.0
Petrolia	0.0	0.0	37.3	0.0	2.1	0.0	4	4.0
Alvinston	0.0	0.0	51.5	0.0	2.1	0.0	4	5.0
Arkona	0.0	38.1	29.9	13.1	2.1	0.0	12	10.5
Grand Bend	0.0	38.1	37.7	13.1	20.9	1.0	12	15.0
Oil Springs	0.0	0.0	31.9	0.0	2.1	0.0	4	4.0
Point Edward	0.0	4.7	17.1	13.1	2.1	0.0	12	9.0
Thedford	0.0	38.1	39.7	13.1	3.9	0.0	12	11.5
Watford	0.0	38.1	21.1	13.1	2.1	0.0	12	9.0
Wyoming	0.0	18.6	20.2	13.1	2.6	0.0	12	10.0
Bosanquet	0.0	38.1	22.4	13.1	20.9	0.0	12	14.5
Brooke	0.0	0.0	40.9	0.0	15.7	0.0	4	6.0
Dawn	0.0	0.0	40.0	0.0	2.1	0.0	4	4.0
Enniskillen	0.0	0.0	34.6	0.0	2.1	0.0	4	4.0
Euphemia	0.0	0.0	40.9	0.0	18.1	0.0	4	6.0
Moore	0.0	0.0	10.3	0.4	2.1	0.0	4	3.0
Plympton	0.0	18.6	17.1	13.1	6.3	0.0	12	9.5
Sombra	0.0	0.0	5.4	0.0	2.1	0.0	4	2.0
Warwick	0.0	38.1	18.5	13.1	2.1	0.0	12	9.5

Lambton County W.M.M.P.

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Site I: Site Data

Centroid	Haul Route Km on Freeways		Haul Route Km on Highways		Haul Route Km on Regional/Local Roads		# Trains Crossing Haul Route	Number of Intersections on Haul Route
	1 lane	2+ lanes	1 lane	2+ lanes	1 lane	2+ lanes		
Sarnia	0.0	0.0	17.1	13.1	1.2	0.0	12	8.5
Forest	0.0	27.9	27.5	13.1	2.5	0.0	12	9.0
Petrolia	0.0	0.0	37.3	0.0	1.2	0.0	4	4.0
Alvinston	0.0	0.0	51.5	0.0	1.2	0.0	4	5.0
Arkona	0.0	38.1	29.9	13.1	1.2	0.0	12	10.5
Grand Bend	0.0	38.1	37.7	13.1	20.0	1.0	12	15.0
Oil Springs	0.0	0.0	31.9	0.0	1.2	0.0	4	4.0
Point Edward	0.0	4.7	17.1	13.1	1.2	0.0	12	9.0
Thedford	0.0	38.1	39.7	13.1	3.0	0.0	12	11.5
Watford	0.0	38.1	21.1	13.1	1.2	0.0	12	9.0
Wyoming	0.0	18.6	20.2	13.1	1.7	0.0	12	10.0
Bosanquet	0.0	38.1	22.4	13.1	20.0	0.0	12	14.5
Brooke	0.0	0.0	40.9	0.0	14.8	0.0	4	6.0
Dawn	0.0	0.0	40.0	0.0	1.2	0.0	4	4.0
Enniskillen	0.0	0.0	34.6	0.0	1.2	0.0	4	4.0
Euphemia	0.0	0.0	40.9	0.0	17.2	0.0	4	6.0
Moore	0.0	0.0	10.3	0.4	1.2	0.0	4	3.0
Plympton	0.0	18.6	17.1	13.1	5.4	0.0	12	9.5
Sombra	0.0	0.0	5.4	0.0	1.2	0.0	4	2.0
Warwick	0.0	38.1	18.5	13.1	1.2	0.0	12	9.5

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Site K: Site Data

Centroid	Haul Route Km on Freeways		Haul Route Km on Highways		Haul Route Km on Regional/Local Roads		# Trains Crossing Haul Route	Number of Intersections on Haul Route
	1 lane	2+ lanes	1 lane	2+ lanes	1 lane	2+ lanes		
Sarnia	0.0	0.0	13.6	13.1	1.1	0.0	8	9.5
Forest	0.0	27.9	24.0	13.1	2.4	0.0	8	10.0
Petrolia	0.0	0.0	30.0	0.0	1.1	0.0	0	3.0
Alvinston	0.0	0.0	44.2	0.0	1.1	0.0	0	4.0
Arkona	0.0	38.1	26.4	13.1	1.1	0.0	8	11.5
Grand Bend	0.0	38.1	34.2	13.1	19.9	1.0	8	16.0
Oil Springs	0.0	0.0	24.6	0.0	1.1	0.0	0	3.0
Point Edward	0.0	4.7	13.6	13.1	1.1	0.0	8	10.0
Thedford	0.0	38.1	36.2	13.1	2.9	0.0	8	12.5
Watford	0.0	38.1	17.6	13.1	1.1	0.0	8	10.0
Wyoming	0.0	18.6	16.7	13.1	1.6	0.0	8	11.0
Bosanquet	0.0	38.1	18.9	13.1	19.9	0.0	8	15.5
Brooke	0.0	0.0	33.6	0.0	14.7	0.0	0	5.0
Dawn	0.0	0.0	32.7	0.0	1.1	0.0	0	3.0
Enniskillen	0.0	0.0	27.3	0.0	1.1	0.0	0	3.0
Euphemia	0.0	0.0	33.6	0.0	17.1	0.0	0	5.0
Moore	0.0	0.0	6.8	0.4	1.1	0.0	0	4.0
Plympton	0.0	18.6	13.6	13.1	5.3	0.0	8	10.5
Sombra	0.0	0.0	12.7	0.0	1.1	0.0	0	3.0
Warwick	0.0	38.1	15.0	13.1	1.1	0.0	8	10.5

SCHEDULE II

INDICATOR CALCULATIONS

Lambton County W.M.M.P.

92–9928–37–08

Site D: Indicator Calculations

Centroid	Traffic Safety			Traffic Operations		
	Potential Accidents	Potential Haul Veh./Train Conflicts	# Haul Vehicles Travelling Thru Intersections	Vehicle-Km Travelled on 1 lane Roads	Vehicle-Km Travelled on 2+ lane Roads	# Haul Vehicles Travelling Thru Intersections
Sarnia	0.336	97600	103700	163480.0	159820.0	103700.0
Forest	0.026	3360	3780	10542.0	17220.0	3780.0
Petrolia	0.027	0	1680	26208.0	0.0	1680.0
Alvinston	0.008	0	492	7445.6	0.0	492.0
Arkona	0.007	832	1092	2724.8	5324.8	1092.0
Grand Bend	0.059	3488	6540	23020.8	22759.2	6540.0
Oil Springs	0.003	0	260	3354.0	0.0	260.0
Point Edward	0.013	3360	3780	5628.0	7476.0	3780.0
Thedford	0.015	1472	2116	6955.2	9420.8	2116.0
Watford	0.016	2160	2430	4698.0	13824.0	2430.0
Wyoming	0.018	3200	4000	6800.0	12680.0	4000.0
Bosanquet	0.078	5280	9570	24750.0	33792.0	9570.0
Brooke	0.012	0	640	7744.0	0.0	640.0
Dawn	0.005	0	288	4881.6	0.0	288.0
Enniskillen	0.008	0	560	7980.0	0.0	560.0
Euphemia	0.009	0	416	5283.2	0.0	416.0
Moore	0.015	0	5460	12012.0	728.0	5460.0
Plympton	0.041	6160	7315	13552.0	24409.0	7315.0
Sombra	0.005	0	760	4750.0	0.0	760.0
Warwick	0.012	1760	2090	3256.0	11264.0	2090.0
Total	0.714	128672	156969	345065.2	318717.8	156969.0

Lambton County W.M.M.P.

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Site H: Indicator Calculations

Centroid	Traffic Safety			Traffic Operations		
	Potential Accidents	Potential Haul Veh./Train Conflicts	# Haul Vehicles Travelling Thru Intersections	Vehicle-Km Travelled on 1 lane Roads	Vehicle-Km Travelled on 2+ lane Roads	# Haul Vehicles Travelling Thru Intersections
Sarnia	0.448	146400	103700	234240.0	159820.0	103700.0
Forest	0.030	5040	3780	12978.0	17220.0	3780.0
Petrolia	0.037	3360	3360	33096.0	0.0	3360.0
Alvinston	0.010	656	820	8790.4	0.0	820.0
Arkona	0.008	1248	1092	3328.0	5324.8	1092.0
Grand Bend	0.063	5232	6540	25549.6	22759.2	6540.0
Oil Springs	0.005	520	520	4420.0	0.0	520.0
Point Edward	0.017	5040	3780	8064.0	7476.0	3780.0
Thedford	0.017	2208	2116	8022.4	9420.8	2116.0
Watford	0.018	3240	2430	6264.0	13824.0	2430.0
Wyoming	0.022	4800	4000	9120.0	12680.0	4000.0
Bosanquet	0.084	7920	9570	28578.0	33792.0	9570.0
Brooke	0.014	640	960	9056.0	0.0	960.0
Dawn	0.007	576	576	6062.4	0.0	576.0
Enniskillen	0.012	1120	1120	10276.0	0.0	1120.0
Euphemia	0.010	416	624	6136.0	0.0	624.0
Moore	0.031	7280	5460	22568.0	728.0	5460.0
Plympton	0.048	9240	7315	18018.0	24409.0	7315.0
Sombra	0.005	1520	760	2850.0	0.0	760.0
Warwick	0.014	2640	2090	4532.0	11264.0	2090.0
Total	0.899	209096	160613	461948.8	318717.8	160613.0

Lambton County W.M.M.P.

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Site I: Indicator Calculations

Centroid	Traffic Safety			Traffic Operations		
	Potential Accidents	Potential Haul Veh./Train Conflicts	# Haul Vehicles Travelling Thru Intersections	Vehicle-Km Travelled on 1 lane Roads	Vehicle-Km Travelled on 2+ lane Roads	# Haul Vehicles Travelling Thru Intersections
Sarnia	0.414	146400	103700	223260.0	159820.0	103700.0
Forest	0.029	5040	3780	12600.0	17220.0	3780.0
Petrolia	0.034	3360	3360	32340.0	0.0	3360.0
Alvinston	0.009	656	820	8642.8	0.0	820.0
Arkona	0.008	1248	1092	3234.4	5324.8	1092.0
Grand Bend	0.062	5232	6540	25157.2	22759.2	6540.0
Oil Springs	0.005	520	520	4303.0	0.0	520.0
Point Edward	0.016	5040	3780	7686.0	7476.0	3780.0
Thedford	0.016	2208	2116	7856.8	9420.8	2116.0
Watford	0.017	3240	2430	6021.0	13824.0	2430.0
Wyoming	0.021	4800	4000	8760.0	12680.0	4000.0
Bosanquet	0.082	7920	9570	27984.0	33792.0	9570.0
Brooke	0.014	640	960	8912.0	0.0	960.0
Dawn	0.006	576	576	5932.8	0.0	576.0
Enniskillen	0.011	1120	1120	10024.0	0.0	1120.0
Euphemia	0.010	416	624	6042.4	0.0	624.0
Moore	0.026	7280	5460	20930.0	728.0	5460.0
Plympton	0.046	9240	7315	17325.0	24409.0	7315.0
Sombra	0.003	1520	760	2508.0	0.0	760.0
Warwick	0.014	2640	2090	4334.0	11264.0	2090.0
Total	0.842	209096	160613	443853.4	318717.8	160613.0

Lambton County W.M.M.P.

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Site K: Indicator Calculations

Centroid	Traffic Safety			Traffic Operations		
	Potential Accidents	Potential Haul Veh./Train Conflicts	# Haul Vehicles Travelling Thru Intersections	Vehicle-Km Travelled on 1 lane Roads	Vehicle-Km Travelled on 2+ lane Roads	# Haul Vehicles Travelling Thru Intersections
Sarnia	0.367	97600	115900	179340.0	159820.0	115900.0
Forest	0.027	3360	4200	11088.0	17220.0	4200.0
Petrolia	0.028	0	2520	26124.0	0.0	2520.0
Alvinston	0.008	0	656	7429.2	0.0	656.0
Arkona	0.007	832	1196	2860.0	5324.8	1196.0
Grand Bend	0.060	3488	6976	23587.6	22759.2	6976.0
Oil Springs	0.004	0	390	3341.0	0.0	390.0
Point Edward	0.014	3360	4200	6174.0	7476.0	4200.0
Thedford	0.016	1472	2300	7194.4	9420.8	2300.0
Watford	0.016	2160	2700	5049.0	13824.0	2700.0
Wyoming	0.019	3200	4400	7320.0	12680.0	4400.0
Bosanquet	0.079	5280	10230	25608.0	33792.0	10230.0
Brooke	0.013	0	800	7728.0	0.0	800.0
Dawn	0.005	0	432	4867.2	0.0	432.0
Enniskillen	0.009	0	840	7952.0	0.0	840.0
Euphemia	0.009	0	520	5272.8	0.0	520.0
Moore	0.019	0	7280	14378.0	728.0	7280.0
Plympton	0.043	6160	8085	14553.0	24409.0	8085.0
Sombra	0.006	0	1140	5244.0	0.0	1140.0
Warwick	0.013	1760	2310	3542.0	11264.0	2310.0
Total	0.763	128672	177075	368652.2	318717.8	177075.0

SCHEDULE III

SITE COMPARISON

Lambton County W.M.M.P.

Comparative Analysis

Standardization Method : $\frac{\text{Raw Score}}{\text{Maximum Score}}$ **X 10**

Criteria/Indicator	*Weight Factor*	*Site*			
		D	*H*	*I*	*K*
Raw Indicator Score					
1 - Traffic Safety					
a - Potential Accidents		0.714	0.899	0.842	0.763
b - Potential Vehicle/Train Conflicts		128672	209096	209096	128672
c - Number of Haul Vehicles Travelling Thru Intersections		156969	160613	160613	177075
2 - Traffic Operations					
a - Vehicle-Km Travelled on One-lane Roads		345065.2	461948.8	443853.4	368652.2
a - Vehicle-Km Travelled on Multi-lane Roads		318717.8	318717.8	318717.8	318717.8
c - Number of Haul Vehicles Travelling Thru Intersections		156969.0	160613.0	160613.0	177075.0
Standardized Indicator Score					
1 - Traffic Safety					
a - Potential Accidents	0.60	7.94	10.00	9.37	8.49
b - Potential Vehicle/Train Conflicts	0.15	6.15	10.00	10.00	6.15
c - Number of Haul Vehicles Travelling Thru Intersections	0.25	8.86	9.07	9.07	10.00
2 - Traffic Operations					
a - Vehicle-Km Travelled on One-lane Roads	0.40	7.47	10.00	9.61	7.98
a - Vehicle-Km Travelled on Multi-lane Roads	0.20	10.00	10.00	10.00	10.00
c - Number of Haul Vehicles Travelling Thru Intersections	0.40	8.86	9.07	9.07	10.00
Criteria Score					
1 - Traffic Safety		7.90	9.77	9.39	8.52
2 - Traffic Operations		8.53	9.63	9.47	9.19
Standardized Criteria Score					
1 - Traffic Safety	0.55	8.09	10.00	9.61	8.72
2 - Traffic Operations	0.45	8.86	10.00	9.84	9.55
Total Score		8.439	10.000	9.713	9.091
Ranking		1	4	3	2