EXECUTIVE SUMMARY REPORTS
HALTON REGION
LANDFILL TECHNICAL STUDY

OCTOBER 1986

THE REGIONAL MUNICIPALITY OF HALTON

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EXECUTIVE SUMMARY

Site D is one of two sites selected by the Region of Halton to be site specifically investigated for potential use as a landfill facility. The design and operations report and the accompanying reports on hydrogeology, waste quantities, visual, noise, transportation, heritage, biophysical, agricultural, wind, after use, air quality and leachate treatability and toxicology are intended to form the basis for an application for approval to operate a waste disposal site under the Environmental Protection Act.

Site Description

Site D is located in the Town of Milton on part of Lots 3 and 4, Concession II in the geographical Township of Trafalgar. It is bounded on the west by First Line and on the east by Highway 25. The site is approximately three km south of the built-up area of the Town of Milton. The total proposed site is about 126 ha of which 53 ha will be used for landfilling purposes.

The site is located on a generally flat terrain over a dense clayey silt till of thicknesses in excess of 15 m. The highest elevation found on the site is about 186.2 m ASL. Surface drainage features include swales draining the west area of the property which eventually flows into Bronte Creek and swales draining the east area which flow to a tributary of the Sixteen Mile Creek. There are no perennial streams on the site. The site and the surrounding area are primarily agricultural but includes a number of estate residential uses as well as a private airfield located in the north part of the proposed site.

Design Parameters

Various considerations were given in the development of the conceptual design and operations of the proposed landfill site. The basis for the considerations are found in other studies comprising the detailed investigations undertaken for the site. These have been submitted in separate documents.

Basic design parameters include the following.

- top elevations to generally respect a height of 15 m from existing ground or a height which can be mitigated from a visual perspective.

- 100 m minimum buffer around the actual fill area.
- excavations in accordance with recommended depths as specified in the Hydrogeologic Report.
- cut slopes at 1:1.
- side slopes at 4:1 except in areas of visual sensitivity where slopes would be reduced.
- 4:1 waste to cover ratio.
- in-place waste compaction density of 600 kg/m^3.
- 20-year site capacity requirement of 3.82 M t or a volume of 7.96 M m^3.
- a leachate collection system.
- agricultural after use.

The types of wastes that can be accepted for landfilling will be strictly controlled and will include municipal, commercial and solid, non-hazardous industrial wastes. Liquid wastes or restricted wastes as defined by Regulation 309 of the Environmental Protection Act will not be landfilled.

Design Concept

The design concept calls for the development of five cells ranging in size from 9.5 ha to 12.1 ha. The depth of excavation varies from cell to cell depending on the hydrogeological requirements that will ensure a hydraulic

trap. The hydraulic trap will assure a positive collection of generated leachates by creating a discharge condition at the base of the landfill. The average depth of the excavation is 3.8 m.

The leachate is proposed to be collected by a series of perforated pipes laid on the base of the excavations at 30 m intervals. These will drain the leachates to header pipes which will eventually lead to a future pumping station. Manholes will be placed along the headers at spacings which will allow for maintenance of the headers as well as to provide observation points for the build up of the leachates.

The design concept proposes that the leachates be temporarily stored in the cells. The manholes within the landfill, will be used to monitor the build up of the leachate. The leachate will then be pumped out and trucked to the nearest discharge point and will be treated at the South-West Water Pollution Control Plant. At the maximum leachate production levels, it is anticipated that about 26 truck loads per day (based on 22 m^3 capacity trucks) will be required to be hauled.

The final contours allow for a 20-year site life and have been designed to permit an agricultural after use as well, while satisfying visual concerns. Using the base and final contours, the available volumes are estimated to be 8.23 M m^3.

Surface drainage will be controlled on the site by means of ditches and retention ponds. Perimeter ditches will be installed to control storm water from entering the excavations and to control the run-off from the filled areas of the site. Retention ponds will be used to control the discharge of the storm water off-site and to monitor the quality of the collected water to minimize the discharge of contaminated storm water. In addition, the retention ponds will be designed to store adequate supplies of water in case of on-site fires.

A number of site facilities are envisaged. These include weigh scales and scalehouse, bulk bin area for individuals, maintenance and storage facilities and perimeter fencing. Lockable gates will be provided at all entrances to the site. A primary road will be constructed from Highway 25 for the haul vehicles. Site facilities will be fully serviced.

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Site Operations

Prior to the filling of Cell 1, the site will be prepared by implementing the following works.

- access road
- scale and scalehouse
- bulk bin area
- perimeter roads and ditches
- maintenance and storage facilities
- retention ponds
- Cell 1 excavation
- installation of leachate collection system
- screening berms on west and east sides of the site from the excavated materials from Cell 1
- temporary access roads to working face.

The first cell will be filled from the northwest of the site progressing in a north to south, west to east direction. Daily lifts have been designed to maximize the in-place density of the wastes in addition to minimizing the cover material requirements. Daily cover material requirements for Cell 1 will be met by the progressive excavation of Cell 2. The filling will thus occur sequentially in cells from a north to south direction. Final grades will be achieved as soon as possible and final cover placed. As

filling occurs, there will be a need to store excess excavated materials. Separate stockpiles will be created to differentiate between topsoil and overburden.

The site will be staffed to adequately control the in-coming materials, spread and compact the wastes and to carry out all the necessary repairs and maintenance of the site. Suitable equipment will be on site to meet the operating needs. The site will operate six days a week from 8 a.m. to 5:30 p.m. The site will be closed and the gates locked at all other times including Sundays and specified statutory holidays.

Routine maintenance will be carried out as part of the regularly scheduled activities at the site. These include litter pick-ups, area grading to minimize localized settlements of the fill, road grading, dust control, fencing repairs, and drainage ditches and storm water retention pond maintenance.

The operations program will include monitoring of the landfill. The program includes monitoring leachate production levels and build up in the cells, gas monitoring and storm water run-off quality monitoring in the retention ponds.

Although not anticipated to be required, contingency plans can be implemented in the event the control systems proposed for the landfill do not afford the expected control of the site. Implementation will occur should the results of the monitoring program show a need.

Contingency plans for the leachate collection system involve the installation of a perimeter drain in the affected areas of the fill and connection to the main headers of the system. A secondary contingency system is proposed which incorporates a series of purge wells to pump the contaminated water.

A gas contingency plan will be incorporated in case of off-site migration of combustible gases and/or the production of undesirable odours. If monitoring shows the need, a collection and disposal system comprising a series of perforated collection tiles and headers, will be implemented to control the gases.

Storm waters collected in the retention ponds or temporarily found in the base of the excavations may be contaminated due to unanticipated contact with the wastes. If monitoring confirms that the run-off is contaminated, the water will be considered as leachate and discharged to the leachate collection system.

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EXECUTIVE SUMMARY

Site F is one of two preferred sites selected by the Region of Halton to be site specifically investigated for potential use as a landfill facility. The design and operations report and the accompanying reports on hydrogeology, waste quantities, visual, noise, transportation, heritage, biophysical, agricultural, wind, after use, air quality and leachate treatability and toxicology, are intended to form the basis for an application for approval to operate a waste disposal site under the Environmental Protection Act.

Site Description

Site F is located in the City of Burlington immediately west of King Road and north of North Service Road and Highway 403. It is situated between the existing Regional landfill site and the closed Bayview landfill site on the slope of the Niagara Escarpment.

The site is characterized by severe differences in topography ranging from a high elevation of 182 m ASL at the north to about 114 m ASL in the south. The north part of the site is an area of open space while the centre of the

site has been stripped of overburden by past quarrying operations. The exposed shale has been further eroded by run-off creating deep valleys. The south part of the site is a combination of open space, heavily wooded areas and rock outcrops. Most of the site drains to the Indian Creek watershed.

The surrounding land uses include the existing Regional landfill site and the closed Bayview site. The latter accommodates an equestrian area and the Burlington Rod and Rifle Club facility. There are no other buildings in the immediate vicinity of the proposed site.

Design Parameters

Various considerations were given in the development of the conceptual design and operations of the proposed site. The other studies comprising the detailed investigations of the site have been submitted under separate covers. Basic design parameters include the following.

- 100 m buffer north of the landfill area, 50 m between the landfill and the Hydro right of way to the south, 30 to 50 m along Bayview Park to the east and varying buffer width along the west
- 1:1 cut slopes for excavation
- 4:1 side slopes for the finished slopes

- 4:1 waste to cover ratio
- minimum 20-year site capacity or about 7.96 M m^3
- compacted refuse density of 600 kg/m^3
- shale extraction and use as a resource to be desirable
- top contours to be lower than the proposed top contours at the existing Regional site
- leachate collection system and connection to the existing sanitary sewer located on the North Service Road
- maximize the saving of the oak-hickory forest complex
- reforestation after use

The types of wastes that can be accepted will be strictly controlled and will include municipal, commercial, and solid, non-hazardous industrial wastes. Liquid wastes or restricted wastes as defined by Regulation 309 of the Environmental Protection Act will not be landfilled.

Design Concepts

Three landfilling options were considered. Option 1 proposed landfilling on the entire Site F property. Option 2 segmented the site to two landfill areas primarily to avoid and preserve the main oak-hickory forest complex identified as being significant. Option 3 limited the areal extent of the landfill while preserving a smaller oak-

hickory area. Option 3 was selected as the preferred design concept.

The preferred concept involves the development of about 50 ha out of a total area of 96 ha. Base contours vary from 176 m ASL in the north to 118 m ASL in the south falling at an average slope of about 4.4 percent. Storm run-off will be diverted around the fill areas by means of ditches and gabion lined channels and will be controlled by means of retention ponds.

The leachate collection system is intended to service the landfill by a series of perforated pipes and headers which will be connected to the existing sanitary sewer line located west of the site on the North Service Road. Due to the variable nature of the existing ground, some of the deeply incised valleys require filling. Hence the bottom of these valleys will also be drained with perforated pipes to intercept leachates that may by-pass the upper primary collection system.

The connection to the existing sewer on the North Service Road is dependent on the upgrading of downstream sections to accommodate the additional leachate flows from Site F. An alternative connection is the proposed sewer to be constructed as part of the City of Burlington's plans for

remedial works to be implemented at the closed Bayview site. Both of these potential connections are feasible. The final selection will be dependent on the economics of the options.

The proposed landfilling will commence immediately north of the oak-hickory forest complex, at about the middle of the fill area, and will progress in a northerly direction to the top of the site. Once the north half of the site is filled to final grades, filling will then start at the south end of the site and progress north to meet the previously filled areas. This sequence of filling will allow the oak-hickory forest to be used for screening purposes for as long as possible. The final proposed contours will feature a top elevation of about 185 m ASL near the north end of the site sloping south at about a 5 percent grade. The total available capacity is estimated to be 8.25 M m^3.

Since the site is adjacent to the existing Regional landfill site, it is proposed that the existing site facilities be used as much as possible. These include the present scales and scalehouse, bulk bin area and the main access road. New structures will be limited to the construction of a maintenance and storage area, perimeter fencing and access roads.

Surface drainage will be controlled by means of ditches and retention ponds. Perimeter ditches will be constructed to prevent the water from entering the excavations and to control run-off from the filled areas. Retention ponds will be used to control the discharge of the storm water off-site and to monitor the quality of the collected water.

Prior to the start of landfilling, the site will be prepared by implementing the following works.

- perimeter fencing and gates
- storm drainage ditches, diversion channels and retention ponds
- excavation of part of first cell
- leachate collection system in excavated areas and connection to the existing sanitary sewer
- construction of dykes
- perimeter roads
- screening berm adjacent to the equestrian facility on the closed Bayview site

Site Operations

The first fill area will be landfilled from the west to east direction. Daily cover requirements will be met by the progressive excavation of the adjacent fill area to the north. Any excess shale materials from the excavation will be stored for later use.

The proposed after use envisions the site to be re-vegetated and reforested. The site will be progressively completed and re-vegetated to meet the after use design.

Staffing will be adequate to control in-coming wastes, spread and compact the wastes and to carry out the necessary repairs to and maintenance of the site. Suitable equipment will be available to carry out the functions.

The site will operate six days a week from 8:00 a.m. to 5:30 p.m. Saturday operations will be modified during the period when noise concerns pre-dominate.

Routine maintenance will be carried out as part of the regularly scheduled activities at the site. These include litter pick-ups, area grading to minimize localized settlements of fill, road grading, dust control, fencing repairs, and drainage ditch and storm water retention pond maintenance.

The operations program will include monitoring of the landfill. The program will monitor leachate production in terms of quantity, quality, gas migration and storm water run-off quality in the retention ponds.

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Although not anticipated to be required, contingency plans can be implemented in the event the control systems proposed for the landfill do not afford the expected control over the life of the site or after closure. Implementation will occur if monitoring shows the need. Contingency plans accommodate the possibilities of failure of the leachate collection system, undesirable gas build up and off-site migration, and contaminated storm water.

Contingency plans for the leachate collection system comprise the installation of a series of purge wells to pump the contaminated water and to dispose of the leachate to the sanitary sewer system.

Contingency plans will be incorporated in case of off-site migration of combustible gases or the production of undesirable odours. A gas collection and incineration system comprising a series of perforated collection tiles and headers, connected to incinerators, will be implemented, if monitoring shows the need.

Storm waters collected in the retention ponds or temporarily found in the base of the excavations may be contaminated due to unanticipated contact with the wastes. If monitoring confirms that the run-off is contaminated, the water will be considered as leachate and discharged to the leachate collection system.

i) EXECUTIVE SUMMARY

In Stage 2C of the Environmental Assessment studies undertaken to locate a suitable sanitary landfill in Halton, preliminary studies were undertaken on six potential landfill sites. As a result of considering numerous environmental factors, two sites, Site D in Milton and Site F in Burlington, were selected for detailed environmental evaluations. This report documents the results of detailed hydrogeologic - hydrologic studies at Site D in Milton.

Extensive hydrogeologic and hydrochemical studies on Site D show that with the proper engineering works, the lands proposed for sanitary landfill are hydrogeologically suitable for waste disposal.

The site is underlain by glacial tills, an upper clayey till and a lower silty till that extend from ground surface to an average depth of about 20 metres. The overburden is underlain by red and green shale of the Queenston Formation.

Below a depth of about 3 m, the Upper Till is unfractured and massive. The Lower Till contains two granular units, one of sand and gravel and the other silt. These zones extend off-site. Adequate domestic water supplies are obtained from the granular units and from the bedrock. None

of these zones are a major aquifer capable of providing municipal supplies.

Three conceptual paths of contaminant migration were identified namely: the weathered zone in the Upper Till, the granular units at depth and the shale bedrock.

The glacial tills at the site have good contaminant attenuating capabilities, however, groundwater flow systems are short and without leachate controls, unacceptable chemical impacts could occur at the property boundaries in time. In addition, without leachate control, the low hydraulic conductivity soils will create leachate mounding within the fill which will ultimately cause the discharge of leachate to surface water courses.

To control leachate, a tile collection system will be installed beneath the waste. Hydrogeologic conditions are favourable to construct this facility as a hydraulic containment system from which essentially no leachate can escape. This involves installing the tile drains sufficiently deep to lower the water table within the landfill below the hydraulic heads in all important underlying hydrogeologic units. With the collection system in operation all leachate and some groundwater will flow into the "hydraulic trap" within the landfill. The leachate will be transported to a suitable treatment facility.

The site will require long-term maintenance and monitoring to verify the integrity of the design.

In the unlikely event that undesirable contaminants emerge from the cells in the future, site conditions are favourable for the installation of engineered systems such as toe drains, perimeter tiles and purge wells to arrest their progress. The operation of such contingency systems will not significantly affect the availability of groundwater in the area.

i) EXECUTIVE SUMMARY

In Stage 2C of the Environmental Assessment studies undertaken to locate a suitable landfill site in Halton, preliminary studies were undertaken on six potential landfill sites. As a result of considering all appropriate environmental factors, two sites, Site D in Milton and Site F in Burlington, were selected for detailed environmental evaluations. This report documents the results of detailed hydrogeologic - hydrologic studies at Site F in Burlington.

Extensive hydrogeologic and hydrochemical studies on Site F show that with the proper engineering works, the lands proposed for landfill are hydrogeologically suitable for waste disposal.

The bedrock of Site F consists of Upper Ordovician red shales of the Queenston Formation. Four zones were identified within the shale bedrock. An uppermost Weathered or Fractured Shale is underlain by a Weakly Fractured Massive Shale Unit (calcite cemented). A Highly Fractured Shale Unit is found at the lower contact of the Weakly Fractured Shale Unit. This unit is in turn underlain by a Moderately Fractured Shale Unit which has undergone less calcite cementation.

The overburden on site is composed entirely of the Halton Till, which is silt to clayey in texture. The overburden thins from more than 18 m in the north end of the site to less than 1 m, or is absent altogether, towards the central portion of the site.

Groundwater movement in the upper shale bedrock is generally southeasterly towards Hamilton Harbour. There is an indication of a deep groundwater flow system at depths greater than 30 m that discharges to Hamilton Harbour. Data show strong downward groundwater gradients on Site F and generally lateral to weak upward gradients between drilling site HC9-85 (just south of Hwy 403) and Hamilton Harbour.

A computer simulation of the groundwater flow systems in the area indicates that leachate would migrate laterally through the Weathered Shale Unit to discharge on-site and through the underlying Highly Weathered Shale Unit to discharge off-site.

Leachate migrating laterally through the Weathered Shale Unit discharges locally and will be collected by the leachate underdrain system and treated. The leachate collection system will have a good capture efficiency and about 95 percent of the leachate produced at the site would be collected by the system. The underdrain system will also prevent toe discharges of leachate and will protect surface water from impairment.

The leachate underdrain system will not be able to overcome the vertical recharge gradients at the site and a small quantity of leachate (5 percent of the total or approximately 4.2 gpm) will exfiltrate the base of the landfill into the underlying shale units. The leachate will be attenuated by the Weakly Fractured Massive Shale Unit which has a low hydraulic conductivity and good attenuation characteristics. When the attenuated leachate enters the Highly Fractured Shale Unit it will move off-site in a southerly direction to ultimately discharge in the vicinity of the CNR tracks. In the discharge area, any remaining leachate contaminants will be further treated by attenuation as they pass through about 8 m of clayey glacial till and lacustrine sediments.

Leachate movement into the groundwater flow system is not expected to have a large impact on the Highly Fractured Shale Unit because it contains water that has naturally high concentrations of inorganic constituents such as chloride. Chloride concentrations in excess of 10,000 mg/L have been measured in this unit. Such concentrations of chloride make the water unsuitable for human consumption.

The attenuating capacity of the hydrogeologic system at Site F can be judged by observation of the two adjacent landfill sites where chemical data show no significant contaminant concentrations in groundwater beyond the limit

of the landfills. Some surface water contamination has been observed where environmental controls are absent or inadequate.

Long-term monitoring and maintenance will be required to verify the integrity of the proposed landfill design and the attenuating capacity of the hydrogeologic system.

In the unlikely event that unexpected contaminants were to escape the primary control system and the attenuating environment, site conditions are favourable for the installation of engineered systems such as perimeter tiles and purge wells to collect all water borne contaminants with potential to discharge for treatment.

The high hydraulic conductivity and lateral continuity of the Highly Fractured Shale Unit makes it feasible to install an effective purge well system that would prevent leachate from coming to surface between Site F and Hamilton Harbour.

1.0 EXECUTIVE SUMMARY

1.1 Environmental Assessment Study

The Stage 2C Environmental Assessment Study completed a comparative assessment of six Site Plan Areas. The transportation component considered two traffic aspects:

- traffic safety
- traffic service and operations

The evaluation emphasis was on traffic safety. No major negative transportation impacts were identified. Sites D and F were considered "most preferred" and differences between them, relative to transportation, were considered insignificant.

Essentially, during the Environmental Assessment Study, all the sites were considered acceptable from a transportation standpoint and the differences with respect to Traffic Safety and Traffic Service/Operations were not considered significant.

1.2 Conclusions of Technical Study

The following are the main conclusions of the technical transportation assessment of establishing a landfill site at Site D.

1. For the critical analysis year (1996), when future waste delivered to the site will be at a peak (no energy from waste facility in place) a weekday total of 410 landfill vehicle arrivals has been predicted. This is representative of a high volume delivery day. This compares

with a May average of 320 daily vehicles over the 1983 to 1985 period, an increase of approximately 30 percent. May is typically one of the highest refuse delivery months during the year. Saturday arrivals for a similar design condition have been predicted at 660 vehicles per day, an increase of approximately 20 percent over the 560 average of the 1983-1985 period. The number of predicted arrivals drops off considerably after 1996 with the assumption of the operation of an energy from waste facility. Additional vehicles, up to a maximum of approximately 20 per day in 2008, will be removing collected leachate from the site.

2. A survey of major haulers in the Region, representing approximately 90 percent of the existing landfill truck traffic revealed that strict adherence to specific routes is not followed by all drivers or haulage companies because of customer fluctuations, traffic problems, driver preferences, etc.

3. Highway 25 is considered appropriate as the main haulage route to Site D. There is a general concern (due to the potential for traffic conflicts) related to the number of entrances, the nature of certain pockets of adjacent roadside development (e.g. hamlet of Palermo) and the mix of users on the road (high speed through trips, recreational trips, agricultural trips, school buses, urban trips, etc.). However, the combination of good existing road standards and a relatively low landfill component in the total traffic stream (less than 4% additional large trucks) should result in a small or minimal reduction in the level of traffic service afforded drivers of Highway 25.

4. Highway 25 should be widened at the Site D entrance with the addition of right and left turn lanes. The estimated cost of this work is $100,000. The entrance should be located approximately 150 metres north of the south property limit of Site D.

5. No significant negative traffic or transportation effects have been identified with the establishment of a landfill site at Site D.

1.3 Transfer and Container Stations

Since no significant transportation related impacts have been identified, no specific mitigation measures are proposed. The continued operation of the existing transfer station in Georgetown cannot be justified from strictly a traffic safety standpoint. Other considerations, including economics, may indicate the general desirability of transfer stations for certain lengths of haul. However, without a local transfer station to maintain the level of service provided to Halton Hills, particularly in the Georgetown and Acton areas, Halton should assess the role of container stations in lieu of a transfer station.

Presently, Halton sponsors four container facilities in the following locations:

- Burlington (at the present landfill site)
- Oakville (on North Service Road between Highway 25 and Third Line)
- Milton (on Steeles Avenue west of the James Snow Parkway)
- Halton Hills (at the present transfer station in Georgetown)

These facilities are temporary and are in operation for the acceptance of small loads (up to 150 kilograms) of residential wastes from private citizens.

Permanent container stations in more locations, possibly accepting larger loads and perhaps some non-residential waste could be effective in providing an adequate level of service to the areas of Halton remote from Site D and should be considered.

1.4 Review Committee

It is recommended that Halton consider the establishment of a review committee to monitor waste haulage practices in the Region. The committee would be composed of representatives from Halton, local municipalities and major hauling companies. Additional representation could come from the school boards, police force, community groups, etc. The purpose of the committee would be to discuss concerns, haulage routes and general haulage practices with the aim of assessing haulage operations to improve general traffic safety.

1.0 EXECUTIVE SUMMARY

1.1 Environmental Assessment Study

The Stage 2C Environmental Assessment Study completed a comparative assessment of six Site Plan Areas. The transportation component considered two traffic aspects:

- traffic safety
- traffic service and operations

The evaluation emphasis was on traffic safety. No major negative transportation impacts were identified. Sites D and F were considered "most preferred" and differences between them, relative to transportation, were considered insignificant.

Essentially, during the Environmental Assessment Study, all the sites were considered acceptable from a transportation standpoint and the differences with respect to Traffic Safety and Traffic Service/Operations were not considered significant.

1.2 Conclusions of Technical Study

The following are the main conclusions of the technical transportation assessment of establishing a landfill site at Site F.

1. For the critical analysis year (1996), when future waste delivered to the site will be at a peak (no energy from waste facility in place) a weekday total of 410 landfill vehicle arrivals has been predicted. This is representative of a high volume delivery day. This compares with a May average of 320 daily vehicles over the 1983 - 1985 period, an increase of approximately 30 percent. May is typically one of the highest refuse delivery months during the year.

Saturday arrivals for a similar design condition have been predicted at 660 vehicles per day, an increase of approximately 20 percent over the 560 average of 1983 - 1985 period. The number of predicted arrivals drops off considerably after 1996 with the assumption of the operation of an energy from waste facility.

2. A survey of major haulers in the Region, representing approximately 90 percent of the truck traffic to the existing site generally confirmed the main haulage routes that had been identified for Site F. These were the same routes identified during the Stage 2C Study. However, strict adherence to specific routes is not followed by all drivers or haulage companies because of customer fluctuations, traffic problems, driver preferences, etc.

3. Most haulage vehicle trips to proposed Site F will utilize the Q.E.W., Brant Street between the Q.E.W. and the North Service Road, and the North Service Road. These road sections are considered appropriate for haulage vehicles. A number of haulage vehicle trips will access the North Service Road from the north, utilizing Brant Street south from Highway 5. A general concern exists with this as a component route due to the urban nature of the road and potential conflict with pedestrians. However, access from the south (utilizing the Q.E.W.) is expected to become more attractive with the opening of the Brant Street/Q.E.W. interchange (1988/89). In addition, with the relatively high volumes of background traffic on Brant Street (18,400, 20,800, 24,300 and 27,800 average vehicles per day in 1983, 1988, 1996 and 2008 respectively), the minor landfill bound component from the north should not noticeably affect road or pedestrian safety. It is estimated that the large truck component of landfill bound vehicles using Brant Street north of the North Service Road will be less than one percent of the total traffic utilizing this road section.

4. No significant negative traffic or transportation effects have been identified with the establishment of a landfill operation at Site F.

5. The proposed entrance to Site F, off the North Service Road, is the same location as the entrance to the existing Regional Landfill site. No improvements to this entrance are considered necessary.

1.3 Transfer and Container Stations

Since no significant transportation related impacts have been identified, no specific mitigation measures are proposed. The continued operation of the existing transfer station in Georgetown cannot be justified from strictly a traffic safety standpoint. Other considerations, including economics, may indicate the general desirability of transfer stations for certain lengths of haul. However, without a local transfer station to maintain the level of service provided to Halton Hills, particularly in the Georgetown and Acton areas, Halton should assess the role of container stations in lieu of a transfer station.

Presently, Halton sponsors four container facilities in the following locations:

- Burlington (at the present landfill site)
- Oakville (on North Service Road between Highway 25 and Third Line)
- Milton (on Steeles Avenue west of the James Snow Parkway)
- Halton Hills (at the present transfer station in Georgetown)

These facilities are temporary and are in operation for the acceptance of small loads (up to 150 kilograms) of residential wastes from private citizens. Permanent container stations in more locations, possibly accepting larger loads and perhaps some non-residential waste could be

effective in providing an adequate level of service to the areas of Halton remote from Site F and should be considered.

1.4 Review Committee

It is recommended that Halton consider the establishment of a review committee to monitor waste haulage practices in the Region. The committee would be comprised of representatives from Halton, local municipalities and major hauling companies. Additional representation could come from the school boards, police force, community groups, etc. The purpose of the committee would be to discuss concerns, haulage routes and general haulage practices with the aim of assessing haulage operations to improve general traffic safety.

EXECUTIVE SUMMARY

Purpose

This report describes and analyses the biological resources of Site D, a candidate site for landfilling of municipal waste of the Regional Municipality of Halton.

Findings of Stage 2C

Site D has been identified by studies conducted under the Environmental Assessment Act as potentially being suitable to support a municipal landfill. The biological investigation of this Stage 2C study (Bird and Hale Limited, 1985) included a review of existing data, discussions with government agency personnel and other knowledgeable individuals, and field investigations. Inventory of the vegetation community types, wildlife habitat and species, and consideration of landforms, soils, drainage and environmental impact produced no evidence that it should not be developed as a landfill site. At the time of the publication of the Stage 2C report, using the available plant species authorities, no plants were classified as provincially rare, and three species Carex laxiculmis (sedge), Allium tricoccum (wild leek), and Geum laciniatum (rough avens) were referred to as "significant". Thus, the study concluded that from a biophysical perspective, Site D

exhibited only minor constraints to the development of a landfill site. Furthermore, when the Site was evaluated, considering all factors that comprise the "environment" as defined by the Environmental Assessment Act, it was determined to be acceptable for landfilling, based on the level of detail available (Walker Wright Young Associates, 1985).

Characteristics of the Site

The relatively flat site of clayey till soils is drained by natural intermittent channels and ditches. There are no perennial drainage channels on the site. A drainage divide results in, eventually, the southwestern portion draining into the Bronte Creek system and the north and eastern portion draining into the 16 Mile Creek.

Most of the site is utilized for agriculture. There are two small areas of naturally occurring vegetation, with areas of approximately 7 ha and 2.8 ha within the Site Plan Area, and which are referred to as woodlots D1 and D2, respectively, in this report and on the maps. These areas contain plant communities typical to Halton, including wet-mesic deciduous forest, mesic upland deciduous forest, mesic deciduous successional forest, upland thicket, hedgerow thicket, lowland swamp thicket, dry meadow, wet meadow, cattail marsh, and graminoid-

forb marsh cover types. Approximately 4.5 ha of natural vegetation, comprising approximately 2 ha of D1 and all of D2 (2.8 ha) would be eliminated to accommodate a landfill operation. This loss would not constitute a loss of regional representation of these cover types.

No provincially rare species are confirmed as occurring on the site. The report of Crataegus corusca (hawthorn) is not likely. Various levels of regional significance can be attached to an additional forty-one native species, as follows: two regionally rare species (Potamogetan natans [common floating pondweed]), Sanicula gregaria [black snakeroot]); six regionally scarce species; and, thirty-three regionally occasional species (see Appendix B for definitions of significance terms). Landfilling will result in the loss of all known representatives on the site of one regionally rare plant (black snakeroot), three regionally scarce species, and nine regionally occasional species.

The mammal, bird, reptile and amphibian species found on the site are common to the area and, due to their mobility, ranges, seasonal movements and activities, can adapt to a small area loss of habitat. The on-site habitats for these species are common throughout Halton and therefore their elimination would not be detrimental

to the survival of the particular species, and would only have minimum effect on members of the species.

Consequences of Landfilling

The natural vegetation communities on the site are common in Halton, and are not part of a larger forest stand or wildlife corridor and therefore loss of a portion of them would neither disrupt nor impact on a larger, more integrated forest ecosystem. A landfill will result in the loss of the significant floral species that add to the biological diversity of Halton.

The creation of a landfill will not cause vermin problems as long as standard operating procedures are in place. These include uniform compaction of the waste and the cover material, applying sufficient depth of cover, minimizing the size of the working face, grading the site to prevent water ponding, keeping the grass on the stabilized areas of the landfill and adjacent fields sufficiently long to discourage loafing by birds, and keeping the roadways, buildings, equipment and areas on and adjacent to the site clean of garbage. In addition, periodic inspection of the site by a pest control contractor is recommended so that problems do not develop.

The proximity of the Site to the Burlington Airpark may increase the potential for bird-plane collisions as the population of gulls in the vicinity may increase. Recommended methods to prevent this problem include implementing similar site management techniques as for the landfill (for example eliminating ponded water, maintaining longer grass, and clean up of any garbage), use of a pyrotechnic device when birds congregate, and application of worm repelling chemicals to the runways.

EXECUTIVE SUMMARY

Purpose

This report describes and analyses the biological resources of Site F, a candidate site for landfilling of municipal waste of the Regional Municipality of Halton.

Findings of Stage 2C

Site F had been identified by studies conducted under the auspices of the Environmental Assessment Act as potentially being suitable to support a municipal landfill. The biological investigation of this Stage 2C study (Bird and Hale Limited, 1985) included a review of existing data, discussions with government agency personnel and other knowledgeable individuals, and field investigations. The study concluded that of the six sites that were investigated, Site F, with the presence of rare plant species and a diversity of vegetation community types, had the most severe constraints, from the perspective of the biological characteristics. However, when the Site was evaluated, considering all factors that comprise the "environment" as defined by the Environmental Assessment Act, it was determined to be acceptable for landfilling based on the level of detail available (Walker Wright Young Associates, 1985).

The information sources for the current study were similar to those for the Stage 2C study, but the investigations were carried to a greater level of detail.

Characteristics of the Site

Site F is a diverse environment supporting a variety of terrain, vegetation communities, and floral and faunal species.

The terrain ranges from a series of parallel, deeply incised valleys and ridges in the central area, giving way to generally flat terraces in the northwest and southeast. The overall slope of the land is from the northwest to the southeast, with an overall drop in elevation of approximately 68 m. Drainage is from the ridge and upland areas to the valley bottoms, where there are intermittent streams that transmit water off the Site into the Falcon Creek and Indian Creek drainage systems.

The vegetation is composed of twenty-one different vegetation habitat types which fall into the categories of forest, plantation, shrub thicket, meadow, wetland meadow, anthropogenic, and open water, non of which are uncommon or unusual in Halton. These habitat types are quite diverse and

consequently support a large number of diverse plant species. Many of the forest habitat areas are typical of the Deciduous Forest Region and the Carolinian Floristic Zone. In particular, areas support associations of oak and hickory. Although hickory is a common component of the deciduous forest stands in southwest Ontario, this association is reaching the northern limits of its range in Halton.

A total of 116 significant native plant species are recorded from the Site: four provincially rare; eight provincially uncommon; thirteen regionally rare; twenty-eight regionally scarce; and, sixty-three regionally occasional. This large number of significant plant species gives the Site biological importance in having a rich, significant, natural flora.

The mammal, bird, reptile and amphibian species found on the Site, and anticipated to be present, are common to Halton Region and expected for the area.

Consequences of Landfilling

The final proposed areal extent of the landfill, under the preferred Option 3 (see Figure 1, page 105), mitigates, to a certain extent, the loss of biological resources from the area that would be landfilled. A substantial portion of the natural vegetation communities will not be disturbed. In

this area, all but some of the anthropogenic habitat types are represented. However, the area that would be utilized for landfilling has a more diverse terrain, and supports a greater number of habitat combination types. In addition, there is a greater concentration of significant species in this area. Specific site locations are known for 27 of the 116 significant native species; of these, Landfill Option 3 will result in the loss of all known representatives of at least 14 species, as shown in Table 5, page 113. This includes 2 of the provincially rare species: Carex gracillescens (sedge) and Frasera caroliniensis (American columbo). In addition, although the specific location is not known for the provincially rare species Sphenopholis nitida (nodding wedge grass), field notes indicate that it is located within the boundaries of Option 3. The specific site location of the fourth provincially rare species, Crataegus corusca (hawthorn)(which, in addition, is a tentative record), is not known.

There is no natural wildlife movement corridor to the south of the Site, and east-west movement will be maintained because of the presence of Sassafras Woods and the block of land that is not proposed for landfilling. Due to the mobility, ranges, seasonal movements and activities of the wildlife species, and the availability of similar habitats in

the area that is not proposed for landfilling, and the nearby Sassafras Woods, the landfill would not be detrimental to the survival of a particular species, and would only have minimal effect on the members of the species.

The creation of a landfill will not cause vermin problems as long as the necessary operating procedures are in place. These include uniform compaction of the waste and cover material, applying sufficient depth of cover, minimizing the size of the working face, grading the site to prevent water ponding, keeping the grass on stabilized areas of the landfill and adjacent fields sufficiently long to discourage loafing by birds, and keeping the roadways, buildings, equipment and areas on and adjacent to the site clean of garbage. In addition, periodic inspection of the site by a pest control contractor is recommended so that problems do not develop.

Birds, and specifically gulls, already occur in the area. Increased congregations of birds may be expected in the vicinity of the landfill but, again, good housekeeping practices will help ensure that gull populations do not become a problem.

Considering the biological characteristics of the Site, as

discussed throughout this report and as summarized above, it can be seen that Site F has major biological constraints to the development of a municipal landfill site. However, in light of the mitigation introduced by the reduction of the areal extent of the landfill (through the implementation of the proposed Option 3 design), if when evaluating all aspects of the "environment", as defined in the Environmental Assessment Act, Site F is found acceptable as a landfill site, there are no biological conditions within the Option 3 area that would absolutely preclude its use as a landfill site.

1.0 Executive Summary

The Site D After-use concerns the selection and description of the recommended after-use for the proposed Regional Landfill at a concept level of detail.

Review of Stage 2C Study

In Phase 2, Stage 2C of Halton's Environmental Assessment reference to possible after-use options for the recommended sites recognized the Environmental Protection Act requirement for Ministry of Environment approval for uses of lands on completed landfills for a minimum period of 25 years after closure. The after-uses suggested in the Stage 2C study identified for Site D included active recreation, golf course, agriculture, horticulture and a possible site for the Region's Museum and related facilities. These after-uses were generally consistent with after-uses on other landfills and comments from a range of persons not on the consultant team. They were also generally compatible with the current planning designations for the site.

Evaluation of Features

The features of Site D and its surrounding landscape were considered in the evaluation of the after-use concepts. Consultants identified site constraints for potential

limitations and guidelines for after-use. These constraints included measures to reduce impact on local intermittant watercourses, revegetation to establish habitat, soil and cover specifications to sustain plant growth, vegetation screens, final contour shape and grades, the height of the landfill, staged rehabilitation and the use of native plant material.

Site D has three heritage structures that were the subject of special measures proposed to maintain them. The site setting was predominately agricultural.

In addition to these site constraints the analysis recognized that there was little potential for linking after-use with existing features. The agricultural setting and the site's relative distance from significant population concentrations directed after-use towards concepts that were self-supporting or agricultural. The site was less suitable for locating industrial support and conservation oriented after-uses.

Evaluation of After-use Concepts

After use concepts were organized in a "long list" of potential activities consisting of conservation, passive recreation, active recreation, agriculture and commercial industrial categories. The specific after-use concepts in

each category were evaluated in two stages: screening, and concept evaluation.

The criteria were developed to evaluate and screen tne after-use concepts. After screening one passive recreation (picknicking) three active recreation (sports fields - including archery, golf course and botanical garden/museum) and one each of agriculture (agricultural rehabilitation) and commercial/industrial (greenhouses) after uses were retained.

The concept evaluation stage consisted of a review of the strengths and weaknesses of each of the concepts in terms of five general objectives: compatibility, environmental disruption, public/municipal preference, flexibility and public benefit. The result of the evaluation was that agricultural rehabilitation was considered the most appropriate concept for after-use. Its major advantages were its compatibility with the surrounding land-use and landscape character; protection of agricultural resources; good planning and design flexibility. Both the selection of evaluation objectives and the concept itself were consistent with the Phase 2, Stage 2C Environmental Assessment

Recommended Mitigative Measures

The concept involves establishing a cash crop enterprize on the landfilled and buffer area. A program of soil rehabilitation, interim cover crops and a crop rotation schedule is proposed. No livestock will be included. Steeper slopes or areas that are not routinely cultivated will be planted with permanent forage or cover crop species.

Mitigative measures are proposed and include: a topsoil/subsoil depth of 1.5 m; contouring to avoid slopes over 5 percent; progressive rehabilitation, erosion control and perimetre screen plantings.

An economic analysis was undertaken to establish the long term viability of the agricultural enterprize.

1.0 Executive Summary

The Site F After-use Report concerns the selection and description of the recommended after-use for the proposed Regional Landfill at a concept level of detail.

Review of Stage 2C Study

In the Phase 2, Stage 2C of Halton's Environmental Assessment studies references to possible after-use options for the recommended sites recognized the Environmental Protection Act provision for Ministry of the Environment approval for uses of lands on completed landfills for a minimum period of 25 years after closure. The after-uses identified for Site F generally included passive recreation, conservation and some active recreation activities. Reference was also made to possibily locating the Halton Region Museum at the landfill site. The after-uses that were identified were generally consistent with public comment, the preferences of the Town of Burlington and land use policies as expressed in the Parkway Belt West Plan (incorporated in municipal Official Plans).

Evaluation of Features

The features of Site F and the surrounding landscape were considered in the evaluation of the after-use concepts. Site constraints identified potential limitations to after-use options. The constraints that were discussed included the need to integrate after-use with the biophysical (e.g. Sassafrass Woods Environmentally Sensitive Area) and land use characteristics of the area; the need to minimize the height of the landfill, integrate contours and establish perimeter screen of vegetation. Existing natural vegetation and rare plants should be protected where feasible and incorporated into the after-use concept. The shortage of indigenous topsoil and the setting of the site constrained agricultural rehabilitation.

There were no heritage structures identified on Site F.

In addition to the site constraints the analysis recognized that the public use of surrounding open space at Bayview Park and the Bruce Trail would preclude some after-use activities, such as hunting. The setting of Site F provides opportunities for passive recreation linkages. The

Site setting was less suitable for industrial support and commercial after-uses.

Evaluation of After-Use Concepts

The after-use proposals were organized in a "long list" of potential activities including: conservation, passive recreation, active recreation, agriculture and industrial/commercial concepts. The specific after-uses were evaluated in two stages - screening and concept evaluation.

Ten screening criteria were developed to evaluate the after-use proposal. No active recreation, agricultural or commercial/industrial after-uses were retained after screening. The conservation and passive recreation uses included: natural area reforestation, buffer area, biking and ski trails, outdoor education, interpretive trails and viewing areas, and picnicking.

Concept evaluation involved setting five objectives for examining the relative strengths and weaknesses of each concept. The natural area reforestation was considered the most appropriate concept for after-use. Its major strengths were its compatibility with the area, protection/integration

with local natural vegetation (eg. Sassafrass Woods ESA); flexibility protection of valuable natural resources and minimal environmental disruption. Both the objectives used to evaluate the concept and the concept itself were consistent with the Stage 2C Study.

Recommended Mitigative Measures

The concept involved importing sufficient topsoil to allow the establishment of native indigenous trees and shrubs on the site. Local surface water features, visual characteristics and contours will be integrated with the surroundings where possible. The after-use plan may allow for compatible multiple use of the site in the future.

Mitigative measures were proposed in the form of development guidelines. These included minimum topsoil need of 0.5 to 1.5 m over refuse; control of methane and carbon dioxide gas in the soil; soil structure and fertility needs; the use of native species, visual buffering requirements; protection and incorporation of existing vegetation on site; reclamation staging; and a series of environmental protection measures.

HERITAGE FEATURES ASSESSMENT

Halton Region Landfill Technical Study

1.0 Executive Summary

A. Site D

i) Review of Stage 2C Studies

Three heritage features were identified within Site D in a study completed for Halton Region as part of the Environmental Assessment, being called the Stage 2C Study, Selection of Preferred Site, Heritage Features Assessment (June 1985). These three features were identified on the "Ford farm", and were rated "high" significance and worthy of preservation. Site D (tied with Site B) was considered the next to least preferable for landfilling of the six candidate sites from a heritage perspective.

ii) Evaluation of Heritage Features

Descriptions of the three heritage features, which consist of a farm residence, outbuildings, and landscape plantings, are included in the text and in Appendix C of this report (also see Map 1). Further

detailed investigations confirmed the evaluation of the Stage 2C Report.

iii) Evaluation of Impact of Landfilling

The impact of landfilling is such that two heritage features, namely the outbuildings and landscape plantings, will be demolished to accommodate the perimeter berm. The third feature, the farm residence, can be preserved as it is not physically affected by the landfill proposal.

iv) Recommended Mitigative Measures

It is recommended that the "Ford farm" residence be preserved and rehabilitated for future use and that the other heritage features be documented before demolition. Consultation with heritage interest groups to ascertain interest in the use of materials from the features to be demolished should occur.

B. Site F

i) Review of Stage 2C Studies

No heritage features were identified within Site F in the study prepared for Halton Region as part of its Environmental Assessment, being the Stage 2C, Selection of Preferred Site, Heritage Features Assessment (June 1985). Site F was considered to be

the most preferable for landfilling of the six candidate sites from a heritage perspective.

ii) Evaluation of Heritage Features

Consistent with the Stage 2C Report, no heritage features were identified on Site F. Therefore, no map is included in this report for Site F.

iii) Evaluation of Impact of Landfilling

No features were identified, therefore, no impact of landfilling is predicted.

iv) Recommended Mitigative Measures

None are applicable.

C. Comparative Analysis

Site D will result in the greater impact on heritage features as no heritage features exist on Site F. Two significant heritage features will be demolished on Site D.

VISUAL ANALYSIS - SITE D

Halton Region Landfill Technical Study

1.0 Executive Summary - Site D

1.1 Review of Visual Assessment, Phase 2, Stage 2C - Halton's Landfill Envirofnmental Assessment

The object of the Stage 2C report in Halton's Landfill Environmental Assessment was to analyze the visual impact of locating a municipal landfill on each of six candidate sites. The study refined the boundaries of the candidate sites to form site plan areas. The six site plan areas were ranked in order of increasing visual impact.

Background information was reviewed including topographic maps and aerial photographs. Several assumptions relating to the design parameters of the proposed landfill were established after discussions with the project consultants. Field reconnaissance of the six sites was undertaken to characterize the landscape around each site and collect data on features that would be visually affected by the proposed landfill.

The analysis used six factors to rate the site plan areas: degree of visibility, number of residences, length and designation of roadways, designated viewing areas, other land uses, and opportunity for mitigation. An evaluation system was devised that rated the site plan areas relative to one another using high and medium to low impact categories. This comparative evaluation ranked the site plan areas from most visually desirable to least visually desirable as: Site A or B, Site C, Site F, Site E, and Site D. In addition to the ranking, preliminary mitigative measures were suggested for each site that would reduce the visual impact of locating a sanitary landfill at Site D.

1.2 Evaluation of Features

In this detailed technical study an analysis was undertaken to determine the visual impacts associated with locating a sanitary landfill on Site D. The method involved a review of background literature, maps and aerial photographs, construction of cross-sections through the landfill and surrounding landscape, and extensive field reconnaissance in both winter and summer during 1985 and 1986. The field program involved the measurement of viewsheds, identification of residences, roadways, and other land uses potentially affected by the proposed landfill and determination of the intensity of impacts associated with various features.

The five features evaluated to determine the impacts of the landfill are discussed below.

1.2.1 Visual Characteristics

Site D is situated in a predominantly rural landscape, on a flat clay plain. The Niagara Escarpment lies approximately 6 km to the north and west and provides distant views onto the site. The nearest urban centre is the Town of Milton, 3.7 km to the north. To the east lies the Sixteen Mile Creek valley and to the south is a prominent ridge. These four features basically define the 3533 ha viewshed of Site D.

1.2.2 Designated Viewing Areas

There are two provincially recognized viewing areas within the viewshed of Site D. Mount Nemo and Rattlesnake Point are both prominent lookouts on the Niagara Escarpment which offer distant views to the site.

1.2.3 Residences

Approximately 125+ residences were identified in the Site D viewshed, 69 of which are subject to high visual impacts from the proposed landfill. Many of the residences in the medium to low category are situated on the slopes of the Niagara Escarpment and are very distant from the site.

1.2.4 Other Visual Concerns

Four land uses were evaluated in this category, the Milton District Hospital, St. Clair Masonic Temple, Boyne Community Centre, and orchards and "U-Pick-it" farms on the escarpment slopes. All four have very limited and/or distant views of the site.

1.2.5 Roadways

Roadways were divided into major roadways or secondary roadways based on their designation in the Region of Halton Official Plan. The impact of the landfill on roadways was based on the proximity of the road to Site D and the posted travelling speed for the road. (At faster speeds exposure time to the landfill is reduced and greater concentration is required to ensure safe vehicle operation). In total, 39.15 km of roadway is affected by the proposed landfill.

1.3 Evaluation of Impact of Landfill on Features

The landfill can be viewed from an area encompassing approximately 3533 ha of the surrounding rural landscape. Since the site is situated on a flat plain, and assuming the maximum height of the landfill will be about 15 m, the existing visual characteristics of the landscape are altered, creating a visual impact. The impact will be most

noticeable when existing long views across the plain are terminated at the landfill (either by screening vegetation, berms, or the landfill itself).

The impact of the landfill on the two designated viewing areas is slight. The wide expanse of the plain offers a broad vista from the lookouts and existing landscape patterns dissect the view. This combination of fragmented views and a wide vista makes it difficult to discern Site D. For this reason the impact was rated as medium to low, despite the two lookouts being provincially significant.

The 125+ residences which will receive visual impacts were evaluated on the basis of their proximity to the proposed landfill. The percentage of existing views from these residences, if looking towards Site D, that would be occupied by the proposed landfill was also used to quantify visual impacts. The evaluation indicated that 69 houses which fell within 1 km of the site would receive high impacts. All other residences in the viewshed were placed in the medium to low category. The four features which were addressed under "Other Visual Concerns" were all rated in the medium to low category. All four are either distant from the site (e.g. the orchards and "U-pick-it" farms) or

had partially screened views of the site (Milton District Hospital, St. Clair Masonic Temple and Boyne Community Centre).

1.4 Recommended Mitigative Measures

Seven mitigative measures were suggested to ameliorate visual impacts of locating a landfill on Site D. Four of these relating to design recommendations are: limit the height of the landfill to 15 m, reduce side slopes along the west and north sides, move the service area further away from Highway 25, and contour the top of the landfill with topographic variation to help it blend with the surrounding landscape. The other three recommendations all relate to screening views onto the landfill with vegetation.

VISUAL ANALYSIS - SITE F

Halton Region Landfill Technical Study

1.0 Executive Summary - Site F

1.1 Review of Visual Assessment, Phase 2, Stage 2C - Halton's Environmental Assessment

The object of the Stage 2C report for Halton's Landfill Environmental Assessment was to analyze the visual impacts of locating a municipal landfill on each of six candidate sites. The study refined the boundaries of the candidate sites to form site plan areas. The six site plan areas were ranked in order of increasing visual impact.

Background information was reviewed including topographic maps and aerial photographs. Several assumptions relating to the design parameters of the proposed landfill were established after discussions with the project consultants. Field reconnaissance of the six sites was undertaken to characterize the landscape around each site and collect data on features that would be visually affected by the proposed landfill.

The analysis used six factors to rate the site plan areas; degree of visibility, number of residences, length and designation of roadways, designated viewing areas, other land uses and opportunity for mitigation. An evaluation system was devised that rated the site plan areas relative to one another using high and medium to low impact categories. This comparative evaluation ranked the site plan areas from most visually desirable to least visually desirable as Site A or B, Site C, Site F, Site E and Site D. In addition to the ranking, preliminary mitigative measures were suggested that would reduce the visual impact of locating a sanitary landfill site at each site.

1.2 Evaluation of Features

In this detailed technical study an analysis was undertaken to determine the visual impacts associated with locating a sanitary landfill on Site F. The method involved a review of background literature, maps and aerial photographs, construction of cross-sections through the landfill and surrounding landscape, and extensive field reconnaissance in both winter and summer during 1985 and 1986. The field program involved measurement of viewsheds, identification of residences, roadways, and other land uses potentially affected by the proposed landfill and determination of the

intensity of impacts associated with various features.

The five features evaluated to determine the impacts of the landfill are discussed below.

1.2.1 Visual Characteristics

Site F is located on tne edge of a highly urbanized area, on the south facing slope of the Niagara Escarpment. Visual limits are bounded by the Niagara Escarpment in the north, woods and topographic relief to the east and west and an urban area to the south. The total viewshed encompasses 566+ ha.

1.2.2 Designated Viewing Area

There is only one designated viewing area, Bayview Park, witnin the viewshed of Site F. It is located along the eastern boundary of the site.

1.2.3 Residences

There are 159+ residences within the viewshed of Site F. All but nine of these are located in the urban area to the southn of the site. The exact number of residences which have views onto the site could not be determined since it was not feasible to secure access to so many private properties.

1.2.4 Other Visual Concerns

Nine features were evaluated in this category, the equestrian facilities in Bayview Park, the Burlington Rod and Rifle Club, the Cumis and Tridon industrial facilities, Burlington Bay, James N. Allan Burlington Bay Skyway bridge, commercial businesses on Plains Road and two schools on Plains Road, the Holy Rosary and Maplehurst. These were evaluated based on their proximity to the proposed landfill and visual access to the site. All but the Burlington Rod and Rifle Club had distant or limited views to the site.

1.2.5 Roadways

Roadways were divided into major and secondary roadways based on their designation in the Region of Halton Official Plan. The impact of the landfill on roadways was based on the proximity of the roadway to Site F and the posted travelling speed for the road (at faster speeds the exposure time to the landfill is reduced and greater concentration is required to ensure safe vehicle operation). In total 13.9+ km of roadway is affected by the proposed landfill.

1.3 Evaluation of Impact of Landfill on Features

The landfill can be viewed from an area encompassing approximately 566+ ha of the surrounding urban/ suburban landscape. The area surrounding the landfill has

considerable topographic relief and the form of the landfill imposes only a moderate impact in that respect. Much of the adjacent land (to the west, north, and east) and some of the site is wooded. Thus, when the landfill is in operation it will be more noticeable owing to the discontinuity with the surrounding woods. In the long term this can be mitigated by planting the entire landfill site after its closure.

The visual impact of the proposed landfill on Bayview Park and its associated facilities will be difficult to mitigate totally because tney are adjacent to the landfill. The visual impact is therefore considered to be high.

The 159+ residences which are likely to receive impacts were evaluated on the basis of their proximity to the proposed landfill. The proportion of existing views for these residences, if looking towards Site F, that would be occupied by the proposed landfill, was also used to quantify visual impacts. The evaluation indicated that nine houses which fell within 1 km of the site would receive high impacts. All other residences were placed in the medium to low category.

Of the eight features evaluated under "Other Visual Concerns", all but one ranked in the medium to low

category. The Burlington Rod and Rifle Club and the equestrian facility in Bayview Park were evaluated as receiving high visual impact as it is adjacent to tne east boundary. All the other features were distant from the site and/or partially screened from the landfill.

Of the major roadways which receive impacts from the proposed landfill, 2.3 km were rated as receiving high visual impact and 5.1 km medium to low impact. The secondary roads contained 5.4 km of high visual impact and 1.1 km of medium to low impact.

1.4 Recommended Mitigative Measures

Seven mitigative measures are suggested to ameliorate visual impacts of locating a landfill on Site F. Three of these relate to design recommendations. These are; i) limiting the height of the landfill, ii) setting back the service area from the access road, and iii) contouring the top of the landfill to blend with the surrounding landscape. The other four recommendations all relate to screening views onto the landfill with vegetation.

EXECUTIVE SUMMARY

A. INTRODUCTION

The Stage 2C study of Halton's Landfill Environmental Assessment assessed six candidate sites with respect to suitability for a municipal landfill site. The study concluded that the top ranked sites are Site D in Milton and Site F in Burlington, for landfill purposes.

The purpose of this study is to analyse the wind and snow effects by model techniques, and to suggest methods to minimize or eliminate any detrimental effects by distributing the wind energy in a manner that diffuses the turbulence and eddy currents. This analysis involves the examination of landfill contours provided by the site design consultants, for three discrete points in time, and recommending appropriate mitigative measures.

B. EVALUATION OF FEATURES

Model analysis is a technique used to predict the conditions created by wind over terrain which has been altered by landfill operations. Through the use of a scaled model of a site and with projected contours of the landfill for existing conditions, three year and final (twenty year) conditions, both visual and measurable criteria are established. Measurable criteria are the depths of snow, and the location of drifts. The visual criteria include areas of turbulence, eddy currents, scoured areas, etc. This information is used to identify potential problem areas

such as drifts over roads or buildings, or areas of turbulence where litter could be lifted upwards and scattered over the surrounding areas.

The three year contours represent the configuration of the site during operations at year three. The twenty year contours represent the final contours prior to closure of the site. This time period will meet the need for the landfill component of Halton's Solid Waste Management System for the twenty year planning period (1988-2008).

The weather data were obtained from the weather recording station located at the Royal Botanical Gardens, Hamilton, Ontario. The weather data, in particular, wind direction, frequency and velocities are recorded for twenty years and indicate definitively, the required wind information for studies in the specific geographical region, wherein Site D is located. From a "Wind Rose", which is a plot of the weather data recorded at the Royal Botanical Gardens, Site D has prevailing winds emanating from the south-west, west and north-west as well as from the north-east.

These wind directions would normally be a concern to property owners on the leeside of the site as turbulence or eddy currents within the site can have a tendency to cyclone particle matter upwards. This action can carry litter downstream from the site.

The contours of the land area of Site D and in the vicinity of the site

do not incur turbulence nor eddies since the landform is generally smooth and flat. The existing contours of the site were modelled and studied in the open channel water flume or "Wind Simulator" and no turbulent areas were recorded. The smooth flow of wind over landfill sites is desirable to prevent eddies from lifting the loose material and carrying it beyond the site.

C. EVALUATION OF IMPACT OF THE LANDFILL ON FEATURES

The purpose of the model analysis was to determine the impact of wind and snow deposition on the landfill and surrounding area. The existing terrain at the present site, causes no critical wind patterns. Abrupt changes in the contours of the landfill can induce turbulence which will cyclone loose material upward and carry it beyond the site. The model analysis has shown that mitigating devices will dissipate the energy of the wind and therefore, limit the impact on features such as houses and roads near the site.

D. RECOMMENDED MITIGATIVE MEASURES

At Site D, it is recommended that landfilling be carried out from the westerly portion of the site. Site D is oriented in a manner which provides an excellent opportunity to carry out landfilling from the west to the east and this technique should be used in order for the remaining mitigative measures to be effective. Landscaping should consist of tree and grass planting and should be applied as a section of the site is completed. Grass should be planted on the completed sections of the

landfill site and snow fences, or tree planting, consisting of double rows of close planted coniferous trees should be located along the completed sections in a north to south direction. Coniferous trees are the best alternative as they provide a year-round porosity of 50% however, to be compatible with the proposed agricultural afteruse, temporary snow fences are also an acceptable mitigative measure. These fences should be the conventional 1.2 m. wood slat snow fences. The earth berm located on the west side of the site should incorporate a staggered double row of coniferous trees, 3 metres in height, along the top edge. Figure 6 gives the planting details of these trees, which will provide a year round porosity of 50%. The porous barrier created will significantly dissipate the wind energy, thereby reducing or eliminating the scatter of litter.

Contours within the landfill area should be developed in a smooth manner. Slopes less than 3:1 are preferred. Slopes less than 3:1 are also preferred for earth stockpiles.

The wind analysis indicates that Site D is viable as a landfill site and that there will be no adverse effects on the site itself, or on the surrounding land. In summary the following measures are recommended to mitigate air and snow turbulence:

1) A double row of close planted coniferous trees should be planted on

the earth berm on the west side of the site.

2) The landfilling sequence should progress from the west to the east.

3) Grass should be planted as each section of the landfill is completed.

4) Snow fences or coniferous trees should be placed as each section of the landfill is completed.

5) Smooth contour profiles are recommended during landfilling operations.

6) Smooth contours and gentle slopes for earth stockpiles are recommended.

EXECUTIVE SUMMARY

A. INTRODUCTION

The Stage 2C study of Halton's Landfill Environmental Assessment assessed six candidate sites with respect to suitability for a municipal landfill site. The study concluded that the top ranked sites are Site D in Milton and Site F in Burlington, for landfill purposes.

The purpose of this study is to analyse the wind and snow effects by model techniques, and to suggest methods to minimize or eliminate any detrimental effects by distributing the wind energy in a manner that diffuses the turbulence and eddy currents. This analysis involves the examination of landfill contours provided by the site design consultants for three discrete points in time, and recommending appropriate mitigative measures.

B. EVALUATION OF FEATURES

Model analysis is a technique used to predict the conditions created by wind over terrain which has been altered by landfill operations. Through the use of a scaled model of a site and with projected contours of the landfill for existing conditions, three year and final (twenty year) conditions, both visual and measurable criteria are established. Measurable criteria are the depths of snow, and the locations of drifts. The visual criteria include areas of turbulence, eddy currents, scoured

areas, etc. This information is used to identify potential problem areas such as drifts over roads or buildings, or areas of turbulence where litter could be lifted upwards and scattered over the surrounding areas.

The three year contours represent the configuration of the site during operations at year three. The twenty year contours represent the final contours prior to closure of the site. This time period will meet the need for the landfill component of Halton's Solid Waste Management System for the twenty year planning period (1988-2008).

The weather data were obtained from the weather recording station located at the Royal Botanical Gardens, Hamilton, Ontario. The weather data, in particular, wind direction, frequency and velocities are recorded for twenty years and indicate, definitively, the required wind information for studies in the specific geographical region, wherein Site F is located. From a "Wind Rose", which is a plot of the weather data recorded at the Royal Botanical Gardens, Site F has prevailing winds emanating from the south-west, west and north-west as well as from the north-east.

These wind directions would normally be a concern to property owners on the leeside of the site as turbulence or eddy currents within the site can have a tendency to cyclone loose particle matter upwards. This action can carry litter downstream from the site.

The existing contours of the site were modelled and studied in the open channel water flume or "Wind Simulator" and no turbulent areas were recorded. The smooth flow of wind over landfill sites is desirable to prevent eddies from lifting the loose material and carrying it beyond the site.

C. EVALUATION OF IMPACT OF THE LANDFILL ON FEATURES

The model analysis determined the impact of wind and snow deposition on the landfill and surrounding area. The existing terrain at the present site causes no critical wind patterns. Abrupt changes in the contours of the landfill can induce turbulence which will cyclone loose material upward and carry it beyond the site. The model analysis has shown that mitigating devices will dissipate the energy of the wind and therefore, limit the impact on features such as houses and roads near the site.

D. RECOMMENDED MITIGATIVE MEASURES.

At Site F, it is recommended that landfilling be carried out from the westerly portion of the site. Site F is oriented in a manner which provides an excellent opportunity to carry out landfilling from the west to the east and from the north to the south. Landscaping should consist of tree and grass planting and should be applied as a section of the site is completed. Grass should be planted on the completed sections of the landfill site and snow fences, or tree planting, consisting of double rows of close planted coniferous trees should be located along

the completed sections in a north to south direction. Coniferous trees are the best alternative as they provide a year-round porosity of 50%, however, temporary snow fences are also an acceptable mitigative measure. These fences should be conventional 1.2 m. wood slat snow fences.

A staggered double row of coniferous trees should be placed on the west and south sides of the site as indicated in Figure 6 at the beginning of landfilling operations. Figure 6 gives the planting details of these trees, which will provide a year round porosity of 50%. The porous barrier created will significantly dissipate the wind energy, thereby reducing or eliminating the scatter of litter.

Contours within the landfill area should be developed in a smooth manner. Slopes less than 3:1 are preferred. Slopes less than 3:1 are also preferred for earth stockpiles.

The wind analysis indicates that Site F is viable as a landfill site and that there will be no adverse effects on the site itself, or on the surrounding land. In summary, the following measures are recommended to mitigate air and snow turbulence:

MITIGATIVE MEASURES

1. A double row of close planted coniferous trees should be planted on

the west and south sides of the site.

2. The landfilling sequence should progress from the west to the east, and the north to the south.

3. Grass should be planted as each section of the landfill is completed.

4. Snow fences or coniferous trees should be placed as each section of the landfill is completed.

5. Smooth contour profiles are recommended during landfilling operations.

6. Smooth contours and gentle slopes for earth stockpiles are recommended.

EXECUTIVE SUMMARY

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

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

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

EXECUTIVE SUMMARY

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

Site F is predicted to have an acceptable impact on the ambient air quality in the area surrounding it. No impact is predicted at any existing residential area near Site F. It is possible that there may be infrequent occurrences of elevated levels of total suspended particulate matter on the Bayview Park area, and on the existing Regional landfill in Burlington. However, because most events at Bayview Park take place on weekends, the activity level at the landfill site is reduced on Saturday and the site is closed on Sunday, it is unlikely that there will be adverse impacts on the primary park users. Odour from fresh garbage is predicted to be undetectable at site boundaries.

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

NOISE ANALYSIS
SITE D

EXECUTIVE SUMMARY

A review of the noise aspects of Site D has re-identified one area in the south west corner of the site where the sound levels would be excessive unless mitigation is provided. These areas were first identified during the Stage 2C Noise Report as requiring mitigative measures. Measures were suggested in the Stage 2C Report to minimize the noise in these locations.

The extra traffic on Highway #25 as a result of landfill operation at Site D, will not significantly add to the sound already present from current traffic volumes, and will become even less of a factor as the non-landfill traffic volume on the highway increase in the future as noted in the Transportation Analysis Report for the Site.

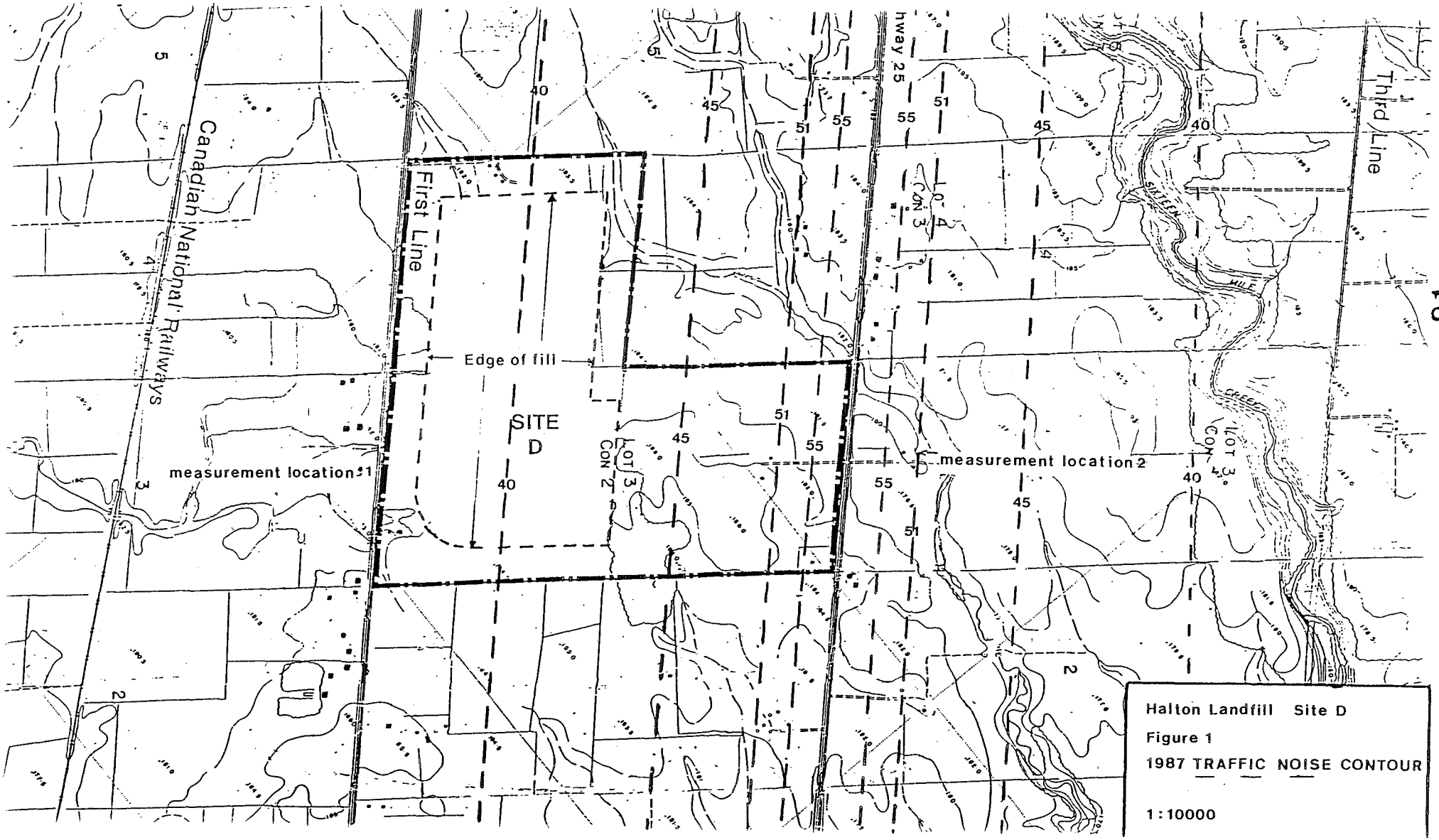
MITIGATION

Development of a detailed site design for Site D has identified the availability of large amounts of excess cover material. This material can be utilized as a large berm along the southern portion of the western property line of the site to provide a noise barrier between the land filling and the residents. The eight to nine metre high berm recommended will allow the site to operate within the Ministry of the Environment's noise guidelines for landfill sites.

In the Stage 2C report it was noted that some homes to the southeast of the site would require mitigation measures. The detailed site plan developed by the design and operation consultant shows that the site area to be filled has been reduced from that identified in the Stage 2C report, allowing operations to move back from the eastern edge of the site. With the presence of high background noise from Highway #25 traffic, the sound levels at the residences east of the landfill will not be significantly affected by landfill operation.

CONCLUSION

The site appears to have no noise problems which would preclude its meeting the MOE noise criteria during landfilling operations. During the construction and eventual removal of the western berms, there will be a 2 month construction period when the MOE criteria are exceeded.



Halton Landfill Site D

Figure 1

1987 TRAFFIC NOISE CONTOUR

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HALTON REGIONAL LANDFILL TECHNICAL STUDY

NOISE ANALYSIS

EXECUTIVE SUMMARY

SITE F

Development of a detailed site design for Site F has lead to a significant reduction in the area required for Landfill purposes relative to the original Environmental Assessment scheme previously prepared for Stage 2C . Figure 1 of the main report (after page 1) shows the proposed area of landfilling, the general area and the nearest residences. Instead of land filling operations starting at the southern end of the site and proceeding to the north, as per the Stage 2C report, it is now proposed that the landfilling commence in the middle of the site, proceed northward for 10 to 12 years, then start at the south end and proceed northward to the middle. For the residences most affected by the landfill noise, the three closest to the north end of the site, this operational plan results in the noise effects being greatest about one half way through the life of the site. Even during the noisiest two years, the sound of landfilling will only be slightly higher than the traffic noise already present in the area.

Highway 403 and the railway corridor, located between the urban area of Burlington and the proposed landfill site will continue to produce a much larger quantity of sound energy than the landfill operation. These two sound sources generate sufficient noise to mask or cover the sound of the landfill virtually all the time in the noise sensitive areas in the urban area of Burlington to the south of the site. Areas to the east and west of the site, already developed or being planned for residential use are beyond 500 metres distance from the landfill activity. At this distance the sound levels will not exceed 55 decibels (dB) L_{eq} (Leq represents a form of average sound level), the Ministry of the Environment's criterion for landfill noise in residential areas, and, as in the case of the homes to the south, will have noise levels dominated by sound from Highway 403.

For the three closest residences located to the north of the site, the sound of initial excavation will be noticeable for several months, then the sound will drop below the background traffic noise for several years. By year 7 or so, the sound of the land fill noise will start to dominate the background sound, reaching a peak in years 10 and 11, when it will equal the Ministry of the Environment's 55dB Leq criterion. As landfilling shifts

to the south end of the site at about year 12, the sound levels at these residences will drop to well below the traffic noise to which they are exposed.

A concern at the time of the Stage 2C Environmental Assessment work was the effect of Saturday landfilling operations on some of the uses of Bayview Park located to the east of the proposed landfill site. Of particular concern was the horse ring. In the Stage 2C Noise report of the Environmental Assessment, it had been projected that the sound levels in the area of the horse ring on Saturdays would be sufficient to significantly affect the facility's usefulness. The concern has been addressed in review of actual Saturday operations at the current landfill site. Saturday landfilling operations involve mostly small vehicles and some 40 heavy vehicles or about 30% of the weekday level of noise energy generation. With this volume of traffic and only one compacting machine operating for a total period of one to two hours throughout Saturday, the sound levels in the Bayview Park at the horse ring will not exceed 55 dB Leq (the Ministry of Environment criterion for residential areas adjacent to landfill sites) on Saturdays. There will remain several Fridays each year when the horse ring is in operation. At the time when landfilling is closest to the facility, the

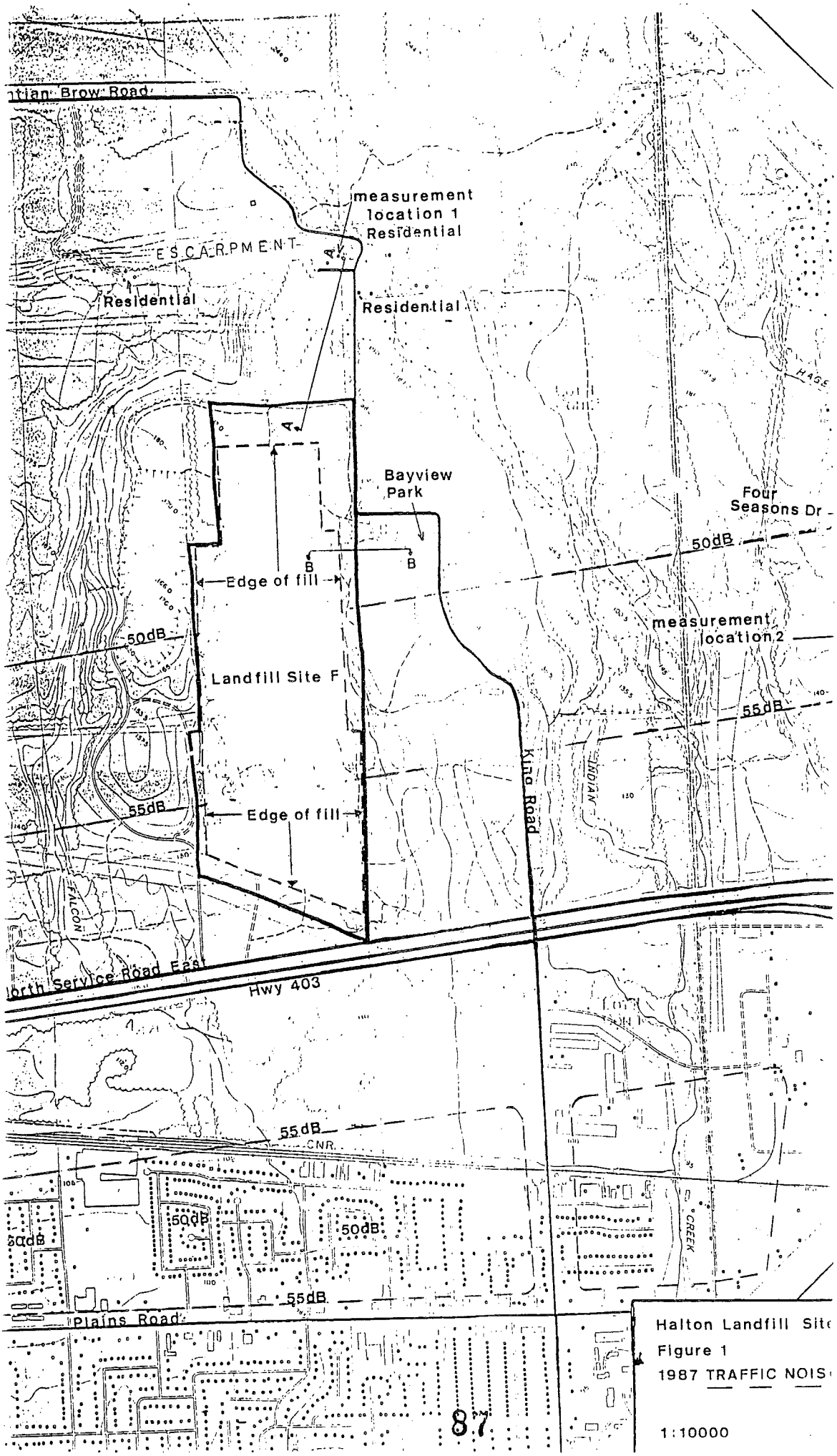
sound of landfilling will be as high as 60dB. This sound level, which would necessitate raised voices during conversation at 2 metres, will be present sporadically during years 10 and 11 assuming that the site is filled at the rate projected in the site design data. For the balance of the life of the site, the horse ring area will remain below 55 dB L_{eq} (ie below the sound level requiring raised voices for short range conversation) at all times.

Due to the limited extent of inconvenience caused by the noise on only 16 Fridays, no special mitigation measures are being recommended to reduce the noise in the horse ring on Fridays. To limit the noise on Saturdays during the period that landfilling is within 500 m of the horse ring, it is recommended that the cover material to be used on Saturdays, be placed near the face of landfilling on the previous Friday. This measure will minimize the amount of equipment operating near the park on Saturdays. It is no longer recommended that consideration be given to moving this facility as was noted in the Noise report for Stage 2C of the Environmental assessment report.

Traffic noise impact of this site is minimal due to the large amount of traffic already present on Highway #403. The vehicles travelling along the North Service Road to

the landfill site represent a very small increment in sound energy relative to the sound of the high speed traffic on the highway.

The site can be developed to meet the Ministry of the Environment noise criterion for landfill sites with only a very minor modification to the procedures that would be used to operate the site if there were no noise sensitive neighbours. As noted above, a minor operational change for 10% of the site's projected life is recommended to minimize the sound generated on Saturdays when there are horse ring activities in Bayview Park.



Halton Landfill Site

Figure 1

1987 TRAFFIC NOISE

1:10000

EXECUTIVE SUMMARY

REGION OF HALTON

E.P.A. REVIEW OF WASTE QUANTITIES PROJECTION

PREPARED BY C.N. WATSON AND ASSOCIATES LTD.

JANUARY, 1986

This review of the waste quantities projection and its impact on the size of the new landfill site is an update of March, 1983, October, 1983, and November, 1984 reports prepared as part of the Environmental Assessment (E.A.). The following issues were addressed in the review:

- The timing for the opening of the new landfill and the Energy from Waste (EFW) plant(s);
- Current directions in monthly waste totals and other factors (i.e. source separation) to determine any impacts on future landfilled waste quantities;
- Impact of a revised Regional population projection on waste quantities;
- Calculation of annual landfill waste quantities.

The report projects Halton's total landfilled waste quantities over the forecast period (September, 1988 to September, 2008) to be 4,208,000 imperial tons (including all contingencies except the contingency for the volume requirement*). A comparison of the key findings of the projections used in the Stage 2C E.A. work and this revised forecast is set out below:

	Projection Used in Stage 2C (E.A.) November, 1984	Revised Projection January, 1986	% Difference
"Most Probable" Long Term Waste Forecast	4,965,370 tons	4,683,175 tons	- 5.7%
Waste to EFW	1,575,991 tons	1,477,449 tons	- 6.3%
"Most Probable" Waste to Landfill (including plant residue)	4,111,731 tons	3,582,180 tons	-12.9%
Total Landfilled Waste 20 Year (including all contingencies except volume*)	4,922,000 tons	4,208,000 tons	-14.5%

* The volume contingency covers the possibility of lower landfill densities and new waste (i.e. clean fill) being accepted at the site. Hydrology Consultants will make provisions for this (as required) in their calculations of landfill volume.

In each case, the revised projection is lower than the November, 1984 projection, with declines of 13% and 15%, respectively, in the "most probable" waste to landfill forecast (excludes contingencies) and the total landfilled waste (includes contingencies except volume) over the 20 year forecast period. The major reasons for this decline are:

- The quantity expected to be handled by source separation increased significantly. In the November, 1984 projection, the 2008 share recovered by source separation was 8%, while the corresponding figure in this projection is 15.9% as a result of the vigorous Regional program which is underway.

- The projected opening date of the landfill site changed from January 1, 1987 to September 1, 1988. This resulted in the exclusion of 300,000 tons of waste from the Interim Planning Period*, which could no longer be handled by the new landfill site.

- The Planning Department completed a revised long term population forecast. The high end forecast was revised downward from 409,500 to 362,600, a reduction of 11.5%. The new forecasts are generally in line with recent projections prepared by the Ministry of Treasury and Economics in August, 1985.

- The high waste per capita figure was reduced from 0.855 tons per capita in the November, 1984 forecast to 0.834 tons per capita, which is the highest level ever attained in the Region since records have been kept. The 1985 level was 0.796.

- The plant residue assumption was reduced slightly from 26.9% of total waste to the plant to 25.48%, based on a refinement of the calculation in the E.F.W. Financial Report by Regional Staff.

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* The Interim Planning Period occurred prior to the 20 year long term forecast period and, therefore, represented additional waste.

1. SUMMARY REPORT

Pollutech Limited on behalf of the Regional Municipality of Halton, conducted detailed leachate treatability and toxicity evaluations as part of Halton's submission under the Environmental Protection Act.

The major tasks undertaken by Pollutech during the study as part of this submission were as follows:

- A detailed literature review was undertaken with the assistance of a computerized literature search to determine what was reported elsewhere in Canada, United States and Europe with regards to the quantity and quality of municipal (non-industrial) landfill leachates, the treatability of landfill leachates and the health or toxicity impact of sanitary landfill leachate.

- Detailed characterization of landfill leachate produced in the Regional Municipality of Halton through collection and analysis of landfill leachate at the closed Oakville site, the closed Georgetown site, the closed Bayview Park site and the operating Burlington landfill site.

- Detailed laboratory scale treatability studies were undertaken to determine the impact of the sanitary landfill leachate on three Regional Municipality of Halton Water Pollution Control Plants, giving due consideration to plant operation, effluent quality attainable, trace organic and trace metal contaminants escaping the water pollution control plants into the lake, and the impact of the landfill leachate treatment on the Region's sludge utilization program.

- Detailed health risk assessments were carried our for the major compounds of an organic or inorganic nature that were identified in the leachate, such that the leachate could be examined under "worse case" conditions.

Literature Survey

The computerized literature survey encompassing eight (8) data bases as part of three (3) computer access routes indicated that there were in excess of 700 articles dealing with any of the key words selected for the literature survey. By utilizing combined key word searching the list of technically relevant documents was reduced to 96 of which 68 were attainable through library services and reviewed in detail by Pollutech staff. In addition to these, some 54 articles, texts or other documents were collected from other sources and reviewed as part of the study. A detailed printout from the computer literature search and a summary listing of references for all of those articles attained and reviewed is on file at Pollutech. The conclusions drawn from the literature survey were as follows:

- The quantity and quality of landfill leachate is highly variable and is dependent to great degree on the age of the landfill site, the design of the landfill site in terms of rainfall penetration, the extent to which industrial inputs into the landfill sites were controlled, and the extent to which energy from waste-type facilities were utilized in conjunction with the sanitary landfilling practices.

- There was not a great deal of data available on full-scale studies evaluating the treatability of landfill leachate. The general concensus of the numerous laboratory scale and pilot scale studies was that landfill leachate is best treated in conjunction with domestic sewage at municipal water pollution control plants. Separate physical/chemical treatment or separate biological treatment does not provide an effective means of complete treatment. There were no reported successes with the treatability of the landfill leachate at the landfill sites. Treatment of raw landfill leachate in conjunction with municipal sewage was reported to be successful at concentrations not exceeding 10 percent of the volumetric flow to the municipal water pollution control plants.

- The toxicity of landfill leachate in terms of standard bioassay techniques (LC_{50}) was reported as being in the range of 4.9 to 7.0 percent which means the leachate must be diluted 14 to 20 times to ensure 50 percent of the fish survive the test.

- Recirculation of landfill leachate was reported to reduce the total strength of the leachate which reduces the loading to municipal treatment plants and reduces the natural leachate toxicity.

Characterization of Regional Leachates

Collection and analysis of landfill leachate from four existing landfill sites within the Regional Municipality of Halton provided information on what type of landfill leachate could be expected at varying ages of the landfill sites from within Regional boundaries. The older landfill sites located in Oakville and Georgetown had not maintained the same level of control on the input of refuse as was being experienced at the existing Burlington landfill site. Therefore, the leachate quality could have significantly different characteristics. Additionally, the Burlington landfill site being an open active site at the time of this study was expected to have significantly higher concentrations of organic and inorganic chemicals representative of a young, active site. Leachate characterization was carried out using wet chemistry methods as outlined in "Standard Methods For The Examination Of Water And Waste Water, 16th Edition" in conjunction with approved methods for the analysis of trace organics and trace metals as outlined for the United States Environmental Protection Agency. Analytical results indicating what organic and inorganic chemicals were found during the initial survey are as outlined in Summary Tables 1, 2 and 3. Only those contaminants having levels above the method detection limit in any one of the four landfill sites are included in this Table.

The analyses of the raw leachate from the four landfills studied to date showed a wide variation in trace organic compounds present. The following total micrograms per litre of grouped organic compounds were detected:

Organics Classification (ug/L)	SITE Burlington	Georgetown	Oakville	Bayview
Purgeables	23,426	167	116	663
Base Neutrals	56	198	0	411
Acid Extractables	1,042	45	0	0
PCB/Pesticides	0	0	0	0

The major classes of organics isolated were:

- straight chain chlorinated hydrocarbons
- chlorinated benzene derivatives
- straight chain organic acids
- phthalates

The inorganic species isolated in other than trace concentrations were:

- Zinc
- Boron
- Iron
- Manganese
- Calcium

- Silica
- Magnesium
- Sodium

Trace amounts of cobalt, aluminum, nickel, chromium, barium, arsenic, antimony and mercury were also detected.

For organics the Burlington leachate was five times stronger than Bayview leachate and fifteen times stronger than Oakville or Georgetown leachate. Burlington leachate was approximately three times more concentrated relative to the major inorganic species present.

Detailed Treatability Studies

In our Oakville Laboratory we used several physical, chemical and biological treatment procedures to determine the best way to treat the collected leachate. The prime purpose of these tests was to determine whether the leachate can be collected and treated at existing or proposed Regional water pollution control plants, or whether pretreatment or separate treatment of the leachate would be required. A "typical" Regional sewage treatment process is shown in Summary Figure 1. The ultimate aim was to indicate whether the leachate should be pretreated at the landfill site prior to discharge to the sanitary sewer system, whether the leachate could be discharged untreated into the municipal sanitary sewer system for subsequent treatment at Regional facilities, or whether extra facilities are required at the Regional water pollution control plants to handle the leachate. If none of these options are suitable this will indicate that the leachate should be collected and sent to contract waste treatment facilities for final treatment.

Bench scale laboratory treatability studies using physical/chemical treatment supported references in the literature review. Very little treatment could be attained with physical/chemical treatment. The use of physical/chemical treatment would only be practical if it was determined from the biological studies that the leachate had to be pretreated prior to discharge to the municipal sewage plants. The physical/chemical treatment utilized as part of this study included treatment with lime, ferric chloride, aluminum sulphate, organic polyelectrolytes and combinations of all compounds.

In the bench-scale biological treatability studies there were six biological sewage treatment plant simulators used to evaluate the impact of the leachate on the Region's water pollution control plants. These test units, as depicted in Summary Figure 2, consist of three pairs of units representing the three pollution control plants where the leachate could ultimately be discharged (SKYWAY, OAKVILLE SOUTH-WEST, MID HALTON). In each test unit pair there was a "control", which was operated without leachate, and a "test" which contained leachate. Each pair of the models was operated under conditions to closely simulate the operation of the full scale plant. This included retention time in the process, chemical addition, and several operating conditions (pH, oxygen, temperature).

Each model unit consisted of a "biological reactor" (where the waste is mixed with active microorganisms in the presence of air) and a "settling tank" (where the microorganisms were settled out from the liquid). The solids-free liquid (effluent) overflowed into a collection tank from where samples were taken for analysis. The settled microorganisms were recycled from the bottom of the settling tank back into the biological

reactor to maintain an actively growing population in the biological reactor. Excess microorganisms were harvested or removed from the system, samples of which are also analyzed. In a full scale system the clear liquid (effluent) would typically be discharged into Lake Ontario, and the settled solids (sludge) concentrated for disposal.

The bench scale biological treatability study, utilizing the mixture of sanitary sewage and landfill leachate, indicated that a leachate similar in nature to that used in the study could be treated effectively at select Regional water pollution control plants at levels as high as 2.5 percent of the hydraulic flow into the water pollution control facility. The model representing the Mid Halton plant could only accommodate 1.0 percent of leachate flow by volume. Specific water pollution control plants already receiving sanitary landfill leachate (Skyway) or a mixture of industrial waste (Oakville SW) acclimatized easier to the sanitary landfill leachate. A summary of the impact of the sanitary landfill leachate on Halton's water pollution control plants is outlined in Summary Table 4. This data is shown as a percent change for the test unit (organic load, oxygen requirements, sludge production, sludge settling) relative to the control unit. Actual effluent quality for the control units and test units is provided in Summary Table 5 for the maximum leachate input of 2.5 percent of the volumetric flow rate.

Although the effluent quality can be maintained some modifications to existing operating procedures will be required.

These include:

- providing increased sludge handling and disposal

- ensuring adequate aeration is available

- implementing solids control and monitoring for sludge settleability

Without these provisions, the plants would not be able to produce an acceptable effluent.

Health Risk Assessment

On the basis of trace organic and trace metal contaminants found in representative samples of leachate a health risk evaluation was conducted to look at the scenario of raw leachate escaping into Lake Ontario in an untreated form or alternatively raw leachate entering ground or surface waters in the near vicinity of the landfill sites. Where a health risk was identified on the basis of untreated leachate, the risk evaluation was also reviewed for leachate treated at the water pollution control plants. Where the health risk evaluation of the raw leachate showed a non-significant impact there was no need to complete the treated leachate evaluation.

The procedures that were used in assessing the potential health risks consisted of:

- The identification of potential hazards from a selected group of chemicals identified as important components arising from the landfills.

- The evaluation of the potential exposure levels of human populations to these chemicals.

- The estimation of the potential risks of adverse health effects based on the potential hazards the exposure levels anticipated.

- The comparison of these estimated potential risks with other risks imposed on society from chemicals and other sources.

In order to identify the potential hazards associated with chemicals in various effluents and emissions from the landfills, a detailed toxicity profile was developed on each of the selected chemicals. These toxicity profiles provided a procedure for the systematic collation and critical review of the toxicological and epidemiological data available on each chemical. Particular attention was given to the assessment of the validity of the available data and its interpretation relative to current knowledge on the mechanisms of action of chemicals on biological and human systems.

An overview of the results from the health risk assessment is outlined in Summary Table 6 for the 28 organic and 7 inorganic compounds carried through this part of the study.

As a result of this detailed treatability and toxicity evaluation, it became apparent that there would be minimal change in the effluent quality with controlled discharge of this landfill leachate into the sanitary sewer system for subsequent treatment at select water pollution control plants. With containment and treatment, acceptable levels of organic and inorganic contaminants, as shown in Summary Table 6 would not be exceeded in the effluent from the water pollution control plants. The majority of the contaminants are at acceptable levels in the influent to the treatment plants. Many of the components are not associated with the new leachate but are in the background sewage.

With regard to health effects, the possibility exists for skin irritations from some of the individual components of the undiluted leachate. The extent to which this is possible would depend on the sensitivity of the individual as well as concentrations and length of exposure upon cessation of contact. In the case of Site D, where leachate will be loaded on trucks on the surface, there is more potential for contact by individuals than at Site F where leachate will be discharged directly into the sewers.

Ecological Assessment

A part of the program carried out by Pollutech staff involved a review of the ecological data provided by other consultants and determination of the impact of the leachate quality on the natural environment in the event of leachate escape from the sanitary landfill site. Typical items of importance were as follows:

- What would be the impact of the leachate entering any nearby waterways in terms of degradation of the surface water quality or the occurrence of fish kills in the waterways?

- What impact would any leachate springs or leachate release from the landfill site have on the surrounding vegetation?

- Would there be any potential impact from the release of leachate into nearby water courses or surface on the area relative to water consumption by existing wildlife or a transient wildlife?

The results of the fish toxicity data, as provided in Summary Table 7 indicates that for the raw leachate the LC_{50} would dictate a 150 to 300 times dilution to allow for discharge to the natural environment by Ontario Ministry of the Environment Standards. After dilution in the raw sewage, the required dilution drops to the range of 25 to 60 times dilution. After biological treatment at the municipal plant there is no requirement for further dilution.

The addition of leachate to the raw sewage at the 5.0 percent level results in an approximate doubling of the LC_{50}. For the treated effluents, however, there is no difference in the LC_{50} for the control or test effluents.

Impact of EFW Facility

Pollutech staff were directed by the Regional Municipality of Halton to consider the impact of Halton's plan to institute a program of refuse incineration as part of an on-going energy from waste program. Since representative samples could not be obtained from an existing EFW plant, this part of the program was primarily a review of known information on EFW facilities and the impact of such a facility on the landfilling program.

The study results show that the EFW facility does not impact on the evaluation of Site D versus Site F, in terms of leachate treatability.

Conclusions

The "Leachate Treatability and Toxicology" study included the review of a number of topics associated with the leachate handling and disposal. Each of the topics listed has been summarized, and details are provided in the main body of the report:

- Literature
- Characterization of Regional Leachates
- Detailed Treatability Studies
- Health Risk Assessment
- Ecological Assessment
- Impact of EFW Facility

Each of these components of the evaluation interact with all other sections and no one topic should be extracted from this report and dealt with as a separate entity.

- Provided that quantity of leachate flow is regulated within the limits prescribed, there would be no concern with discharge of this landfill leachate into the sanitary sewer system for subsequent treatment at select Regional water pollution control facilities. With such treatment there should be no associated health risks from the effluent from the treatment plant and no associated ecological impacts.

- The Site F leachate would be discharged to the Skyway Water Pollution Control Plant, by direct discharge to the existing sanitary sewer system. The Site D leachate would be collected for subsequent transport and could be treated at any of the three plants.

- Operation of an "Energy From Waste" facility in the Regional Municipality of Halton would have the same impact on the landfill leachate at either Site D or Site F.

- The trace organic and trace inorganic contaminants in the landfill leachate could impact on the Halton's sludge utilization program, however the impact would be equal

from either landfill site. The difference depends on the sludge disposal methods currently practiced at the treatment plants. (Skyway incineration, Oakville S.W. by land spreading).

- The Skyway Water Pollution Control Plant currently receives landfill leachate from the operating Burlington site facility and is proposed to receive leachate from the Bayview site. Therefore the Skyway WPCP is acclimatized for the treatment of landfill leachate. The Oakville South-West Plant is partially acclimatized, whereas the Mid Halton plant would need to be acclimatized.

- Leachate from Site F would be discharged directly to the water pollution control plant as compared to on-site ponding or tanking of the leachate on Site D prior to trucking to the sewage plants. Therefore, the potential for human health risk is minimized utilizing the Site F procedure of direct discharge of the landfill leachate to the sanitary sewers.

- The effluent quality at the Skyway water pollution control plant can be kept within Ministry of the Environment guidelines, provided that the loading of leachate does not exceed 2.5 percent of the volumetric flow and plant operations are adjusted to accommodate the increased load (oxygen supply, chemical addition, sludge handling). At the Oakville South West plant the leachate addition

should be restricted to 2.5 percent under peak conditions due to existing sludge settling difficulties. The proposed Mid Halton plant would be restricted to 1.0 percent until the facility could become acclimatized.

- The addition of the leachate at any of the treatment plants will result in as much as a 100 percent increase in oxygen demand and a 55 to 100 percent increase in sludge production. Routine testing of the leachate impact will be required (i.e. microbiological examination, settling tests) to ensure acceptable full-scale levels of leachate are not exceeded. Current plant capacities show the Skyway (at 50% of design) and Mid Halton (yet to be constructed) plants as better suited to accommodate increased loadings, but the Oakville South West plant is currently approaching design loadings.

- The level of trace organic contaminants in the effluent of the test units did not show a significant increase over that for the control units at levels of leachate addition of 2.5 percent by volume.

The comparative evaluation of the data associated with the leachate treatability evaluation has been summarized and outlined in Summary Table 8 for the three Regional water pollution control plants. The concerns for toxicity for leachate escape to the natural environment are shown in Summary Table 9.

SUMMARY TABLE 1

Regional Municipality of Halton
Landfill Leachate Analysis
(Trace Organics)

ANALYSIS	CONCENTRATIONS IN ppb (ug/L) BURLINGTON	GEORGETOWN	OAKVILLE	BAYVIEW
Acetic Acid	43.2	N.D.	N.D.	N.D.
Acetic Acid, Phenyl	5.3	N.D.	N.D.	N.D.
Benzene	149.0	3.2	N.D.	6.1
Benzene, 1,2,Dichloro	N.D.	N.D.	N.D.	N.D.
Benzene, 1,3,Dichloro	N.D.	N.D.	N.D.	N.D.
Benzene, 1,4,Dichloro	N.D.	N.D.	N.D.	24.0
Benzene, chloro	N.D.	N.D.	N.D.	46.0
Benzene, Ethyl	404.0	4.9	N.D.	26.0
Butyric Acid	229.2	13.9	N.D.	N.D.
Butyric Acid, Iso	43.3	2.5	N.D.	N.D.
Camphor	66.5	4.7	N.D.	250.0
Cresol	168.0	N.D.	N.D.	N.D.
Ethane, 1,1,1,Trichloro	1388.0	N.D.	N.D.	N.D.
Ethane, 1,2,Dichloro	2967.0	8.0	N.D.	N.D.
Ether, Diethyl	1265.0	26.6	68.9	12.0
Ethylene, 1,1,2,2 Tetrachloro	222.0	N.D.	N.D.	N.D.
Ethylene, 1,1,2, Trichloro	940.0	2.5	1.2	N.D.
Ethylene, 1,1, Dichloro	4216.0	2.1	11.1	N.D.
1,3,3 Trimethyl Norboranone	79.6	4.2	8.4	N.D.
Heptanoic Acid	11.0	N.D.	N.D.	N.D.

N.D. indicates result below machine detection limit

SUMMARY TABLE 1 (Cont'd.)

Regional Municipality of Halton
Landfill Leachate Analysis
(Trace Organics)

ANALYSIS	CONCENTRATIONS IN ppb (ug/L) BURLINGTON	GEORGETOWN	OAKVILLE	BAYVIEW
Trichlorofluro Methane	52.2	3.6	3.6	N.D.
Octanoic Acid	11.3	N.D.	N.D.	N.D.
Phenol	N.D.	N.D.	N.D.	N.D.
Phthalate, Bis(2-ethyl Hexyl)	6.0	198.0	N.D.	387.0
Phthalate, Butyl Benzyl	18.0	N.D.	N.D.	N.D.
Phthalate, Diethyl	21.0	5.0	N.D.	N.D.
Phthalate, Dimethyl	11.0	N.D.	N.D.	N.D.
Propionic Acid	127.5	8.4	N.D.	N.D.
Styrene	80.9	N.D.	N.D.	N.D.
Sulphide, Dimethyl	1084.0	2.0	2.0	2.0
Toluene	891.0	2.7	N.D.	188.0
Valeric Acid, Iso	90.6	5.7	N.D.	N.D.
Xylene	5245.0	90.3	N.D	130.0

N.D. indicates results below machine detection limit

SUMMARY TABLE 2

Regional Municipality of Halton
Landfill Leachate Analysis
(Trace Metals)

ANALYSIS	Concentrations in ppm (mg/L) BURLINGTON	GEORGETOWN	OAKVILLE	BAYVIEW
Cobalt	0.04	N.D.	N.D.	0.04
Zinc	4.6	N.D.	0.3	0.02
Cadmium	N.D.	N.D.	N.D.	0.01
Boron	6.2	3.1	5.2	N.D.
Silica	14	12	14	14
Iron	110	29	28	5
Manganese	7.9	1.6	1.4	0.2
Calcium	570	220	240	112
Magnesium	400	94	220	410
Aluminum	0.61	N.D.	N.D.	1.45
Nickel	0.11	0.03	0.07	0.09
Chromium	0.08	0.05	0.03	0.02
Sodium	790	310	680	1240
Barium	1.4	0.9	0.9	5.1
Arsenic	0.0077	0.0059	0.0041	0.014
Antimony	0.0053	0.0011	0.0041	0.002
Mercury	0.00200	0.00005	0.00073	0.0001

N.D. indicates result below machine detection limit

SUMMARY TABLE 3

Regional Municipality of Halton
Landfill Leachate Analysis
(Routine Chemical Parameters)

ANALYSIS	Concentrations in ppm (mg/L) BURLINGTON	GEORGETOWN	OAKVILLE	BAYVIEW
Chemical Oxygen Demand	5300	203	500	948
BOD_5	4274	26	55	*
Kjeldahl Nitrogen	330	135	186	400
Nitrate-Nitrogen	2.9	1.0	1.2	4.9
Total Phosphorus	0.80	0.00	0.82	0.20
Soluble Phosphorus	0.30	0.00	0.10	0.10
Sulphate	0.0	0.0	0.0	0.0
Chloride	1219	368	942	2861
Total Solids	7598	1918	4004	7090
pH	6.7	7.0	7.0	7.4
Suspended Solids	112	74	78	25
Alkalinity (as CaCO3)	4053	1458	2450	3043
Hardness (as CaCO3)	2960	820	1390	1840
Cyanide	0.006	0.004	0.00	0.14

* BOD_5 Interference From Suspected Toxicity

SUMMARY TABLE 4

Regional Municipality of Halton
WPCP Leachate Impact As Percent of Control

CONTROL	SKYWAY	OAKVILLE SW	MID-HALTON
Influent Strength	1	1	1
Effluent Quality	1	1	1
Sludge Production	1	1	1
Oxygen Consumption	1	1	1
Sludge Settling	1	1	1

1% LEACHATE	SKYWAY	OAKVILLE SW	MID-HALTON
Influent Strength	1.87	1.36	1.51
Effluent Quality	1	1.17	1
Sludge Production	1.19	1.32	1.19
Oxygen Consumption	1.33	1.10	1.11
Sludge Settling	1.04	1.42	1.80

2.5% LEACHATE	SKYWAY	OAKVILLE SW	MID-HALTON
Influent Strength	2.12	1.68	1.44
Effluent Quality	1	1	1
Sludge Production	1.47	1.44	1.36
Oxygen Consumption	2.20	1.80	1.73
Sludge Settling	1.59	1.41	1.91

5.0% LEACHATE	SKYWAY	OAKVILLE SW	MID-HALTON
Influent Strength	1.96	1.90	2.49
Effluent Quality	1	1	1
Sludge Production	2.04	1.70	1.56
Oxygen Consumption	2.08	1.89	2.07
Sludge Settling	2.60	1.45	7.26

SUMMARY TABLE 5

Regional Municipality of Halton
WPCP Simulator Analysis
(At 2.5% Leachate by Volume)

ANALYSIS	SKYWAY		SOUTH-WEST		MID-HALTON	
	Control	Test	Control	Test	Control	Test
ROUTINE: (mg/L)						
BOD_5	5	5	5	5	5	5
COD	19	26	22	29	19	26
Ammonia	0.26	0.23	0.34	0.31	0.27	0.40
Phosphorus	0.44	0.27	0.66	0.40	0.79	0.63

SUMMARY TABLE 6
Regional Municipality of Halton
Health Risk Assessment

Contaminant	Maximum Conc. Influent (ppb)	Likely Conc. Effluent (ppb)	Safety Level (ppb)	Ranking
TRACE ORGANICS: (ug/L)				
Acetic Acid, Phenyl	N.D.	N.D.	*	1
Acetophenone	5.30	0.82	*	*
Aldehyde, Indoline Carbox	N.D.	N.D.	*	1
Benzene	1.20	N.D.	18.2	2
Benzene, Ethyl	2.31	N.D.	47.6×10^3	2
Benzoic Acid	N.D.	N.D.	18.2	1
Butanone-2 (MEK)	5.96	N.D.	6.3×10^5	1,5
Camphor	56.0	N.D.	*	*,3
Cresol - O, M, P	120.0	N.D.	7.7×10^3	2
Ethane, 1,1,Dichloro	6.86	1.95	3.5	3
Ethane, 1,2, Dichloro	10.9	N.D.	3.5	1
Ether, Diethyl	28.8	2.58	1.12×10^3	2
Ethylene, 1,1,2,2, Tetrachloro	12.4	0.79	9	3,5
Ethylene, 1,1,2, Trichloro	6.29	1.64	12.2	2
Ethylene, 1,1, Dichloro	1.13	0.52	3.5	2
Ethylene, cis 1,2 Dichloro	N.D.	N.D.	3.5	1
Ethylene, Trans 1,2, Dichloro	N.D.	N.D.	3.5	1
Ethylene, Tris, 1,2,Dichloro	N.D.	N.D.	3.5	1
Indole, 3-methyl	62.5	0.24	*	*
Methylene Chloride	L.C.	L.C.	*	*
Norboranone, 1,3,3-Trimethyl	65	<1	*	*,5
Phenol	85.2	N.D.	1×10^3	2
Phthalate, BIS (Ethyl Hexyl)	62.9	N.D.	98 - 1750	2
Phthalate, Butyl Benzyl	24.1	N.D.	98 - 1750	2,5
Phthalate, Diethyl	18.1	N.D.	98 - 1750	2,5
Phthalate, Dimethyl	23.8	N.D.	98 - 1750	2,5
Styrene	56	<1	93	2,5
Xylene	24.2	<0.3	11.4×10^3	2,5
TRACE METALS (mg/L)				
Arsenic	0.003	<0.002	0.05	2,5
Barium	0.16	0.05	1.0	2,5
Chromium	0.16	0.072	0.05	4,5
Cobalt	0.01	<0.01	*	*
Magnesium	43.6	40.0	*	*
Manganese	0.54	0.04	*	*
Nickel	0.15	0.15	5	2,5

RANKING CODES:

1. No Health Risk, None Detected
2. No Health Risk at Maximum Concentration Possible (untreated)
3. No Health Risk at Likely Concentration (treated)
4. No Health Risk After Lake Dilution
5. Significant portion of contaminant not associated with leachate

* Inconclusive Health Data

N.D. Indicates below machine detection limit

SUMMARY TABLE 7

Regional Municipality of Halton
Bioassay Test Results

	LC_{50} (%)	LC_{50} Dilution	Dilution Standard
Burlington	7.1	14	282
Georgetown	13.0	8	154
Oakville	7.1	14	282
Mix 1	13.3	8	150
Mix 2	8.2	12	244

NOTES:

1. Mix 1 consists of 1/3 Burlington, 1/6 Georgetown, 1/6 Oakville
2. Mix 2 consits of 1/3 Burlington, 1/9 Georgetown, 1/9 Oakville, 1/9 Bayview
3. LC_{50} is the percent leachate in distilled water at which point 50 percent lethality OF TEST FISH occurs
4. "LC_{50}" Dilution" refers to the minimum dilution required to ensure that 50 percent of the test fish survive.
5. Dilution standard refers to twenty times the dilution already found for the LC_{50}, as per Ministry of the Environment Blue Book Guidelines

SUMMARY TABLE 8

Regional Municipality of Halton
Comparative Analysis
Leachate Treatability

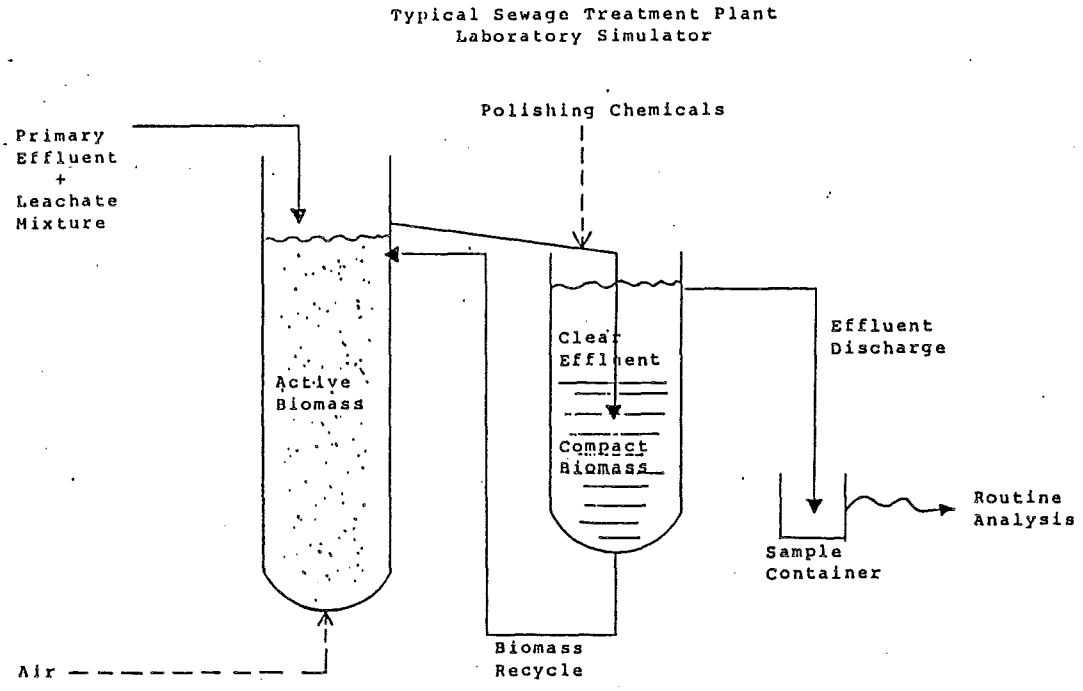
COMPARISON	BURLINGTON SKYWAY	OAKVILLE SOUTH-WEST	PROPOSED MID-HALTON
Acclimatization to handle leachate	Good	Fair	Very Poor
Ability to treat trace organics	Good	Good	Good
Health risk assessment results	Good	Good	Good
Ease of WPCP operation	Fair	Fair	Poor
MOE Standard Effluent Criteria	Good	Good	Good
Co-existence with Regional sludge disposal practices	Good (incineration)	Fair (landspreading)	Fair (landspreading) Good (incineration)
Adaptability of WPCP	Good (50% design)	Poor (near design)	Good (incorporate modifications)

SUMMARY TABLE 9

Regional Municipality of Halton
Comparative Analysis
Leachate Toxicology in Natural Environment

COMPARISON	SITE "F" BURLINGTON	SITE "D" MILTON
Toxicology if escape to groundwater	No drinking water sources. (wrong)	Subsurface Wells.
Toxicology if escape to nearby water courses	Little occurrence for fish kills in Indian Creek.	Possibility of fish kills in Sixteen Mile Creek.
Toxicology to wildlife and domestic animals if escape	No nearby farms. Transient wildlife.	Nearby farm utilizing surface waters for lifestock.
Toxicology with respect to recreation purposes	Multiple uses around downstream ponds.	Horses, hiking and fishing around 16 Mile Creek.

SUMMARY FIGURE 1
A LAB BDG UNIT



SUMMARY FIGURE 2
A FULL-SCALE WPCP SKETCH

Generalized Schematic of a Sewage Treatment Plant