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The Corporation of the
City of Burlington

EVALUATION OF HALTON REGION LANDFILL TECHNICAL STUDIES

Site F - Burlington

DESIGN AND OPERATIONS REPORT

- **Part A - Landfill Design Criteria**
- **Part B - Critique of Trow Technical Studies**
- **Part C - Recommended Design Amendments**

February 1988
Ref. No. 1354 - 10

CONESTOGA-ROVERS & ASSOCIATES

B-861

CRA
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March 1, 1988 Reference No. 1354-10

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Suite 1600, Exchange Tower
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Dear Mike:

Re: Site F - Design and Operations Report
Halton Environmental Assessment

Enclosed is our report entitled "Evaluation of Halton Region Landfill Technical Studies, Site F - Burlington, Design and Operations Report".

This report was prepared on behalf of the City of Burlington as part of the on-going Environmental Assessment process for the establishment of a new landfill site in the Region of Halton.

Should you have any questions, please do not hesitate to contact out office.

Yours very truly,

CONESTOGA-ROVERS & ASSOCIATES

Anthony J. Crutcher, P.Eng.

AJC/dvs

Encl.

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EXECUTIVE SUMMARY

As part of the ongoing Environmental Assessment (EA) process to obtain a new landfill site, the Regional Municipality of Halton (Halton) retained the services of Trow Hydrology Consultants Ltd. (Trow) to provide design and operations reports for the two candidate landfill sites; Site D in Milton (Exhibit H-41) and Site F in Burlington (Exhibit H-42). The intent was that the reports would form the basis for an application under the Environmental Protection Act (EPA) for the operation of a sanitary landfill site.

Subsequent to the release by Halton of the Trow design reports, the City of Burlington (Burlington) directed Conestoga-Rovers & Associates (CRA) to review and comment on the Trow design reports. As a consequence of this review, and in light of the recommended expanded site capacity requirement detailed in the CRA report entitled, "Evaluation of Halton Region's Waste Quantity Projections", March 1988, Burlington also requested CRA to evaluate the feasibility of expanding the landfills to accommodate the expanded site capacity requirements.

The report presented herein was written to document all of the above noted work undertaken by CRA for Site F. Comments on Site D are incorporated under a separate report. This report is structured as follows:

Part A - Landfill Design Criteria

Part B - Critique of Trow Technical Studies

Part C - Recommended Design Amendments

Part A, "Landfill Design Criteria", provides the philosophy and design criteria which provide the guidelines for landfilling at Site F. Included is information pertaining to landfilling in general, and pertaining to Site F specifically. Part B, "Critique of Trow Technical Studies", assesses the design provided by Trow in their report entitled, "Design and Operations Report - Site F" (Exhibit H-42). The focus of the review is the conceptual design provided by Trow; however, the review also includes an assessment of the degree of adherence to established design criteria, a discussion of the level of detail provided, and a review of the cost estimate. Part C, "Recommended Design Amendments", provides a number of suggested design amendments including amendments to the clay liner, more detailed calculations specific to Stormwater Management, and an assessment of the site expandability.

Based on the design criteria provided in Part A of this report, CRA identified a number of areas where the Trow design could be modified to more precisely adhere to the design criteria detailed in Part A. These are summarized as follows:

1. The overall design provided by Trow did not include a liner system, although as an "assumption" Trow provided a conceptual liner design.

2. The location of the leachate collection system manholes did not maximize accessibility to perforated collectors.

3. The location of the main access road and the bulk-bin area were in conflict with uses established in the End-Use Plan for the existing Burlington Landfill Site.

4. The criteria employed for determining the extent of paved roads was not clearly defined; however, based on the criteria detailed in Part A of this report, additional paving would be beneficial.

5. The stormwater management calculations presented by Trow were considered to be insufficient to adequately assess the feasibility of stormwater management at Site F.

Apart from these design aspects requiring revision, CRA also concluded that the preparation and operation of a landfill at Site F, would be relatively difficult and subject to a number of uncertainties which would ultimately affect performance and cost. These difficulties and uncertainties related specifically to the complex terrain and the need to excavate shale and its use as a cover material.

complex terrain

Part C of this report, "Recommended Design Amendments", provides design revisions which address each of the identified comments, including incorporation of a liner system into the proposed site design. Part C also provides more detailed stormwater management calculations which confirm that it is feasible to manage stormwater at Site F. The proposed design changes would increase the capital cost of Site F by $17.7 million from $9.6 million to $27.3 million.

Finally, Part C provides a general discussion regarding the availability of additional capacity at Site F. The Site capacity could potentially be increased by raising the height of the landfill, or by expanding to the east or to the west. Expansion to the west would either necessitate "blending" Site F with the existing landfill, while expansion to the east would necessitate "blending" with Bayview Park or expanding to the south of Bayview Park. After considering each of these expansion options, it was concluded that there are limited opportunities for expanding Site F.

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PART A - LANDFILL DESIGN CRITERIA

A.1.0 INTRODUCTION

The purpose of a municipal landfill site is to provide an environmentally safe and efficient disposal site for the disposal of non-hazardous solid domestic, commercial, and industrial waste. To assist with landfill design, the Ministry of the Environment (MOE) publishes guidelines entitled, "Guidelines for the Establishment, Operation, Management, Maintenance and Closure of Landfilling Sites in Ontario", (Guidelines). Adherence to the principles of the guidelines is necessary before receiving a Certificate of Approval under Part V of the Environmental Protection Act (EPA).

As outlined in the Guidelines, the design of a landfill site will be constrained by physical considerations such as size requirement, land availability and site topography; by the need to mitigate potential off site impacts such as groundwater contamination, visual impact and land use compatibility; and by specified engineering design criteria.

Each of these three types of constraints will be discussed separately in the following sections. Because each site has its own constraints and because the rigors of

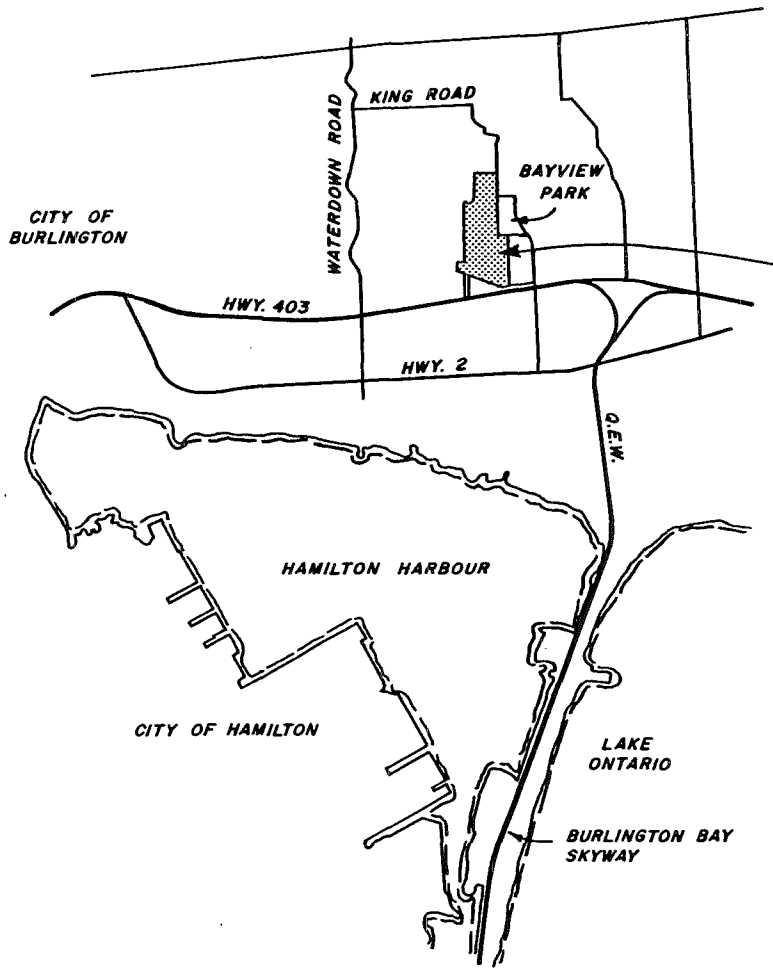
landfill design are in a state of flux, the constraints presented in this report have various sources. Some are based on the findings presented in the completed Halton EA submission and Technical Studies, some are based on standard engineering practice, while others are based on CRA's experience with landfills elsewhere in Ontario.

A.2.0 PHYSICAL CONSTRAINTS

A.2.1 SITE DESCRIPTION

Site F is illustrated in Figure A2.1 (page 4). The site is situated on the Niagara Escarpment in the City of Burlington. It is west of King Road and north of Highway 403. As proposed in the Technical Studies, the total site area was approximately 96 ha. Of the total, approximately 65 ha is available for landfilling while the remainder was allocated to buffer requirements and site services. As part of the Consolidated Board Hearing, Counsel for the Region of Halton indicated that the east property boundary had been revised (October 28, 1987; Volume 50, page 11475) to approximately 75 ha, with 50 ha available for landfilling. Figure A2.1 illustrates the revised boundaries.

The topography of the site is highly variable. Overall the site slopes to the south at a grade of approximately five percent. Over the site length of approximately 1500 metres, this corresponds to a drop in elevation of 70 metres from the north to the south. In addition to the overall slope, the central part of the site is characterized by a number of deeply cut ravines where the side slopes are often in the order of 50 percent.



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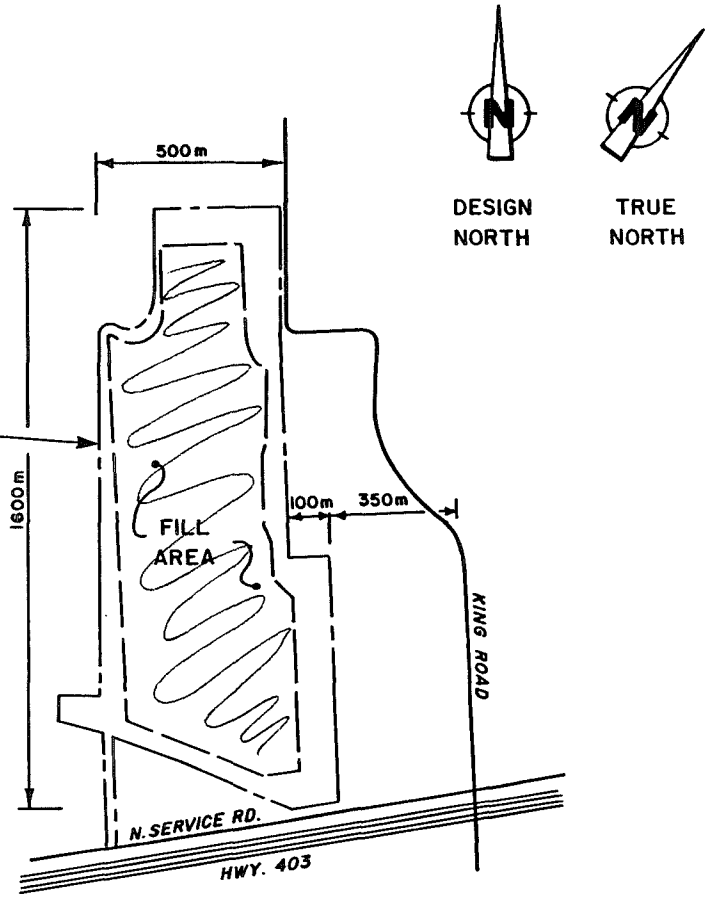
SITE F



SCALE 1:20000 METRIC

figure A2.1

LOCATION MAP
SITE F - DESIGN AND OPERATION
City of Burlington

CRA

NOTE: DIMENSIONS ARE APPROXIMATE.

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No major water courses traverse the Site, although several tributaries of Indian Creek originate in the numerous site ravines. Low permeability tills mantle the northern and southern parts of the site, while the surficial soils in the central part of the site are weathered shales from the Queenston formation. The existing vegetative cover is dominated by natural forest, although some sections can be characterized as scrub bush, and meadow.

A.2.2 SITE CAPACITY

The site capacity requirement was initially calculated as 3.8 million tonnes, in the report entitled, "EPA Review of Waste Quantities Projection" (Exhibit H-15). This report was prepared in February 1986 by C.N. Watson and Associates Ltd for the Region of Halton. The capacity requirement translates to a site volume requirement of 7.9 million cubic metres. The volume calculation is based on a waste: cover soil ratio of 4:1 and a refuse density of 600 kg/m^3.

In the CRA report entitled, "Evaluation of Halton's Waste Quantity Projections", March 1988, the recommended site capacity requirement was increased to 5.7 million tonnes. However, for the purposes of the review presented in Part B of this report, the site capacity of 3.8 million tonnes was accepted as a given design criteria. Part C of this report addresses the possibilities for expansion of Site F.

A.3.0 OFF-SITE IMPACT CONSTRAINTS

A.3.1 GENERAL

A wide spectrum of environmental, physical and social factors must be considered during development of a landfill site in the conceptual and final design stages. The design factors range from the environmental aspects of biophysical, agricultural, wind and air quality, to the physical aspects of site capacity, hydrogeology, aggregate resource, transportation and stormwater control, to the social aspects of noise, archaeology, heritage, visual and after-use planning.

Each of the above listed aspects were studied by various members of the Halton E.A. Team. The individual conclusions and recommendations were then forwarded to Trow for consideration in completing their landfill design. For reference purposes, each of the above listed aspects are summarized in the following sub-sections. It should be noted that each set of recommendations represents an independent assessment of a specific aspect, and that any landfill design would have to "trade off" conflicting recommendations.

From the perspective of landfill design, hydrogeology provides the most significant set of design constraints. This is because the fundamental design aspects

(lateral extent, depth of excavation, base contours, and leachate collection system) form an integral part of the hydrogeologic assessment of the potential for leachate migration.

The initial hydrogeologic assessment was undertaken by Trow Hydrology Consultants (Trow) on behalf of the Region of Halton. Thereafter, CRA completed an independent evaluation on behalf of the City of Burlington. Recommendations from both of these studies are summarized in the design constraints presented herein. This is because the Trow hydrogeologic recommendations provided the basis for the Trow Site F landfill design; whereas, the CRA hydrogeologic recommendations provide the basis for the review of the Trow landfill design presented in Part B of this report.

A.3.2 HYDROGEOLOGY

The major findings of the Trow hydrogeological investigation formed the basis of the Trow Site F landfill design, and as summarized in the Trow "Design and Operations Report", September 1986 (Exhibit H-42), are as follows:

1. The landfill will be predominantly founded in the Queenston shale.

2. The leachate collection system will be installed at 50 m spacings which is estimated to collect 95 percent of the leachate produced.

3. A liner would not be a cost effective method of providing added protection from leachate migration.

4. Natural attenuation can be considered as the primary back-up to the leachate collection system.

5. Secondary contingencies include purge wells and a perimeter drain system.

6. Shale found at the site is suitable for use as a resource.

7. A gas control system will not be required.

As discussed, CRA also conducted a hydrogeologic evaluation of Site F. This evaluation provides a basis for the review of the Trow landfill design as presented in Part B of this report. The major findings of the CRA hydrogeologic study as they relate to landfilling are summarized as follows:

1. The site does not meet the criteria of ability to predict or monitor future contaminant distribution.

2. The escape of leachate from the proposed landfill in unknown amounts is not in the public interest.

3. While contingency purge wells can be considered, the contaminant level at which this option would be implemented may not readily be determined from the monitoring program.

Based on these findings, the CRA hydrogeologic study recommends that the landfill design include the following:

1. A leachate collection system
2. A liner
3. An underdrain system beneath the liner

Installation of a liner allows for a substantially reduced and predictable leachate loss from the landfill. The underdrain system provides the capacity to monitor the performance of the liner. This underdrain also functions as a contingency system in the event of a liner failure.

A.3.3 TRANSPORTATION

In their report entitled "Transportation Analysis - Site F", August 1986 (Exhibit H-33), Giffels and

Associates Limited analyzed and reported on the impacts of transportation around Site F during landfill operation. The report did not identify any significant negative traffic or transportation effects caused by the establishment of a landfill at Site F.

A.3.4 BIOPHYSICAL

The biophysical aspects of the landfill site were analysed and summarized by Bird and Hale Limited in their report entitled "Biophysical Analysis Report", August 1986 (Exhibit H-18). In total, 116 significant native plant species were identified, including numerous provincially or regionally rare or scarce species. Given this diversity, Bird and Hale Limited indicated that this "large number of significant plant species gives the Site biological importance in having a rich, significant, natural flora". Although the assessment identified "that Site F has major biophysical constraints, to the development of a municipal landfill site", it was concluded that they were not sufficient to preclude Site F for landfilling. However, it was also recommended that the identified Oak-Hickory complexes should be preserved to an extent which was feasible.

A.3.5 AFTER-USE

The Landplan Collaborative Ltd. (Exhibit H-21) developed a conceptual end use plan for Site F. The concept entailed establishing indigenous trees and shrubs on the site. To enable this rehabilitation plan, a number of measures were proposed. Of particular note was the need to provide a minimum of 0.5 to 1.5 metres topsoil over the refuse.

A.3.6 VISUAL IMPACT

The visual impact analysis was performed by The Landplan Collaborative Ltd. in their report entitled "Visual Analysis - Site D", August 1986, (Exhibit H-24). In this report it was recommended that:

1. The south, east and west sides of the site should be heavily screened with vegetation to reduce visual impacts on Bayview Park, the existing Regional landfill site and views from the south.

2. The height of the landfill should be kept as low as possible to allow visual access to the Niagara Escarpment from south of the site.

3. The existing woodlots and hedgerows adjacent to the boundary of the site should be preserved and incorporated into an overall planting scheme.

4. Progressive rehabilitation along the side slopes of the landfill will help to screen the site.

5. Continuation of rehabilitation of the existing Regional landfill site will help screen views from residences in the northwest.

6. The service area should be set back and screened from either the North Service Road or King Road.

7. The top of the landfill should reflect topographic variation similar to the surrounding "natural slopes" of the foot of the Niagara Escarpment.

A.3.7 WIND IMPACT

The analysis of the wind impact on the landfill design and operation was studied by F.H. Theakston and Associates, and included in a report entitled "Wind Analysis Report", September 1986. The Theakston report concluded that existing buildings in the vicinity of the landfill would not be adversely affected by the change in wind patterns. The report also recommended that landfilling

should proceed from west to east and from north to south, that progressive rehabilitation should occur during operation, that all landfill slopes should be limited to a maximum of 3:1, and that litter fences and vegetative planting should be used to reduce the impact of air movement.

A.3.8 AIR QUALITY

Senes Consultants Limited studied the impact of the proposed landfill operations on the air quality surrounding the site (Exhibit H-29, H-29A). The report concluded that, with the exception of infrequent impact in Bayview Park, the landfill site operation will not cause off-site dust and odour problems. As well, the report recommended that where possible, paved roads should be used and that non-paved roads be watered during dry periods.

A.3.9 NOISE IMPACT

Barman Coulter Swallow Associates analyzed the noise component of the landfill operation on the surrounding environment (Exhibit H-36). The report concluded that for short periods of time, the landfill activity will be noticeable to the three residences immediately to the north of the site, and that there would be sporadic impact on users of Bayview Park.

A.3.10 HERITAGE FEATURES

The Landplan Collaborative Ltd. conducted a heritage feature assessment of Site F. The report concluded that no heritage features are located on the Site.

A.4.0 ENGINEERING DESIGN CRITERIA

Engineering design criteria, as presented in this report fall in one of three categories: general design parameters which are independent of site location; design factors which represent a synthesis of the recommendations detailed in Section A.2.0; and site specific design and operation considerations. Each set of criteria is discussed separately, below.

A.4.1 GENERAL DESIGN PARAMETERS

The design parameters employed by Trow in completing site design, are summarized as follows:

- A minimum 100 m buffer zone where the proposed site does not abut the existing Burlington landfill or the existing Bayview Park,

- Excavation slopes of 1:1, landfill side slopes of 4:1 except where visual concerns govern, and a minimum top slope of 5 percent to facilitate runoff,

- A waste to cover ratio of 4:1,

- A compaction density of 600 kg/m^3,

- A site volume capacity of 3.8 million tonnes (8.2 Mm^3),

- A leachate generation rate of 0.45 m/yr during site operation and 0.30 m/yr after site closure,

- A leachate collection system,

- A minimum 1.0 metre clay cap.

The above listed parameters are consistent with industry-wide accepted values.

A.4.2 OFF-SITE IMPACT CONSIDERATIONS

Based on the recommendations listed in Section A.2.0, three alternative site plans can be considered. These are illustrated on Trow Drawings 2, 3 and 4 (Exhibit H-42B). Option 1 reflected the results of the Stage 2C work and used virtually all of the site area for landfilling. Option 2, was effectively two separate landfill sites; one to the north and one to the east. Option 3 limits landfilling to the western two-thirds of the site.

Consideration of three alternative site plans is predicated on the need to balance the various constraints to landfilling. As discussed in the Trow Design and

Operations Report, evaluation of the three alternatives should consider site capacity, preservation of the oak hickory complexes, Bayview Park remediation, preservation of the shale resource, height of the landfill, and engineering considerations related to leachate production and soil balance.

Based on the evaluation presented in the Trow Design Report (Exhibit H-42), Option 3 was selected as the preferred Site, thus it is Option 3 which is addressed in this report.

A.4.3 SITE SPECIFIC CONSIDERATIONS

The components of a landfill design can be grouped as follows:

- base contours, soil balance and leachate collection,
- final contours,
- leachate disposal,
- site service facilities and site servicing requirements,
- access and service roads,
- stormwater collection and control,
- site closure details,
- contingency plans,
- site development plans including soil storage requirements,

- operation and maintenance of the site,
- ability to expand site,
- cost estimate.

Requirements for each of these groups is provided in the following sub-sections.

A.4.3.1 Base Contours, Soil Balance, Leachate Collection System

Establishment of base contours is influenced by both hydrogeologic and engineering design considerations. As discussed in Section A.3.2, the hydrogeological considerations are:

- placement of a low permeability liner, including an underlying leak detection system, and
- placement and maintenance of an effective leachate collection system.

Engineering details for each of these hydrogeologic considerations can be considered separately. Related to placement of the low permeability liner, the following should be considered.

1. The liner should be constructed of a clayey till, 1.0 to 1.5 m thick, and with a hydraulic conductivity not greater than 1.0×10^{-8} cm/s.

2. The liner should be underlain by a 0.3 m sand blanket containing monitoring equipment to detect any leachate leakage from the base of the liner, and containing a perforated pipe collection/pumping system.

3. A 0.3 m granular blanket should be placed on top of the liner to facilitate drainage, minimize leachate head buildup and to protect the liner from heavy equipment damage.

The above are typically considered acceptable by the MOE for approval of a landfill site. For example, the Certificate of Approval (A230610) and approval drawings for Metropolitan Toronto's Keele Valley Landfill Site specify a 1.2 meter thick liner with a hydraulic conductivity of 1.0×10^{-8} cm/s (WMI 1980). An underdrain is not required since the site is underlain by sand, although a 0.30 m granular blanket is placed over the liner. As another example, the Walker Brothers Landfill in Niagara Falls which overlays shale, has a sand blanket placed above a 1.5 m liner which has a hydraulic conductivity of 2×10^{-8} cm/s (Goodings 1987).

hydrogeo. different.

Related to placement and maintenance of an effective leachate collection system, the following should be considered (Bass 1986):

1. The collection pipes should be adequately sized to ensure free drainage from the landfill.

2. The strength of the collection pipes shall be selected to minimize the likelihood of collapse.

3. Manholes and cleanouts should be sufficiently spaced to ensure access for regular cleaning.

4. The drainage layer and pipe network should be designed to minimize the impact on leachate mounding caused by localized clogging of the collection system.

5. The drainage and filter layers of the collection system should be designed to minimize the likelihood of clogging.

6. Where practical, the slope of the collection system shall be set to 2.0 percent.

A.4.3.2 Final Contours

Final contours will be influenced by the area of the site, the capacity of the site and the elevation of the base contours. Beyond these considerations, landfill contours should be influenced by general design parameters

listed in Section A.4.1 and off-site impact considerations listed in Section A.4.2.

A.4.3.3 Waste Types

The Environmental Protection Act, and Regulation 309 specifically, provides a tool for grouping wastes. In general four categories exist: inert waste, non-hazardous industrial waste, municipal refuse, and hazardous industrial waste. The landfill design requirement will vary depending on the type of wastes accepted. For example, minimal engineering is required for an inert waste site while state-of-the-art engineering is required for a hazardous industrial waste site.

A.4.3.4 Leachate Disposal

Ultimately, all collected leachate must be treated. Alternatives include an on-site treatment facility, construction of a sewer/forcemain to transport leachate to an existing secondary (biological) treatment facility, or haulage of leachate to an existing secondary treatment facility. Regardless of the method selected, a common collection point will be required.

Each of these options for leachate treatment and disposal have to be determined to be acceptable from an environmental impact perspective. Based on information presented in the Guidelines, it is not expected that design details are required as part of the EA submission although conceptual layouts and cost comparisons should be included.

A.4.3.5 Site Servicing

Site servicing requirements include potable water, sufficient storage or flow rate capacity for fire protection, and electricity.

Potable water requirements will be minimal and can be provided from the existing watermain. Sufficient water for fire protection can be provided by on-site storage ponds, or by connection to the existing watermain. The storage pond could be incorporated with the required stormwater retention ponds.

Electricity will be required for the service of buildings.

A.4.3.6 Site Service Facilities

As summarized in the "Trow Design and Operations Report - Site F", required site service facilities include:

- weigh scale and scale house
- maintenance building
- site office
- staff and visitors parking
- bulk bin pick-up area

The site plans should accommodate space for the above facilities, although, based on the Guidelines, specific designs are not required. In locating these facilities, the following should be considered:

- all facilities should be placed to make efficient use of existing space,
- the maintenance building should be located as near as possible to the landfilling area,
- the bulk bin pick-up area should be paved and accessible to casual users.

A.4.3.7 Access and Service Roads

The access road, from the main road to the weigh scales, will be in use for the entire life of the site. Virtually all traffic entering or leaving the site will use this road. Therefore, the access road should be paved and designed to carry heavy truck traffic. The road should be sufficiently long to accommodate an incoming truck queue, without backing onto the main road.

The approach roads to the maintenance building and the bulk bin pick-up area will also be heavily used, and required for the entire life of the site.

For emergency purposes, an alternative entrance to the site is desirable. This entrance will receive minimal use and could be a single lane gravel top road.

Secondary service roads are required to deliver the waste trucks from the weigh scales to the active site area. Since the active site area will constantly change over the life of the site, the specific requirements for service roads will also change.

Since some service roads may only be in use for several months while others may be used for several years

or more, the need for paving these roads will vary. A suggested criteria would be to pave all roads which will be in active use for four years or more. This criteria is based on CRA experience.

The designs provided for the EA should illustrate the location of all roads, the extent of paving and should provide typical cross-sections. Additional details can be provided in the final design.

A.4.3.8 Stormwater Collection and Central Management

As a consequence of landfilling, site drainage patterns, particularly during storms, will be substantially different than would occur during existing site conditions.

Given the above, the Halton Region Conservation Authority (HRCA) provided the following list of conditions (Exhibit H-239):

1. Drainage plan to maintain the naturally existing catchment areas for the Indian and Falcon Creeks.

2. The perimeter ditches be designed to convey, as a minimum, the 50 year storm with erosion control protection up to the 5 year storm conditions.

3. The storm water management system be designed such that there are no increases in post development flow rates over predevelopment flow rates for a range of storms up to and including the 1:100 year storm.

4. The storm water management system be designed to prevent any potential increase in erosion along the Bronte and Sixteen Mile Creek tributaries should any change in the flows result in the final design.

Furthermore, the HRCA specified that in the final design stage the above calculations should be carried out with the "appropriate" hydrologic and hydraulic computer modeling methods, as specified in:

(a) "Flood Plain Management in Ontario, Technical Guidelines", Ministry of Natural Resources, and
(b) "Storm Water Management Guidelines, Central Region", Ministry of Natural Resources.

A.4.3.9 Monitoring and Contingency Plans

The hydrogeologic and landfill engineering design criteria assume that the system will operate as designed. Margins of safety are built in to allow for some variability; however, the possibility remains that the system will fail to operate as designed. In the case of Site F, failure refers specifically to failure of the leachate collection system and liner. Given this possibility, monitoring is required to track the possible egress of leachate from the site. Should monitoring identify a failure in the system, then a contingency (back-up) system must be initiated to prevent the off-site migration of leachate.

The EA submission and Technical Studies should provide a conceptual contingency plan.

A.4.3.10 Landfill Construction and Operation Costs

The Guidelines indicate that, based on the level of detail in the design, cost estimates should be provided for each component. This cost estimate will allow a comparison of design options and will enable a complete economic and financial assessment of waste disposal alternatives.

A.4.3.11 Site Development Plans

Site development from the initial site clearing to placement of final cover, requires integration of all on-site activities. For example; the sequence of site filling, berm construction, soil stockpiling, stormwater management, base excavation, placement of the liner and leachate collection system, road construction, and placement of the final cover, are all interrelated activities. Therefore, sequential site development plans are required to illustrate the integration and balancing of the above activities.

A.4.3.12 Landfill Operation

The day to day operation of a landfill will vary as the site develops, and will vary with changing weather conditions. Correspondingly, the operation of a landfill requires specific machinery and staff.

As described in the Guidelines, the submission should address the day to day operation of the site, specifically the method of waste placement, compaction and covering. The submission should also address equipment and staffing needs.

PART B - CRITIQUE OF TROW TECHNICAL STUDIES

B.1.0 INTRODUCTION

In September 1986, the Regional Municipality of Halton (Halton) released the technical reports for the proposed Halton Regional Landfill Site. These reports were prepared as part of the ongoing Environmental Assessment (EA) process. Included was the "Design and Operations Report", prepared by Trow Hydrology Consultants (Trow)(Exhibits H-42, H-42A and H-42B); completed for Site F in Burlington.

Part B of the report presented herein, represents a review of the Trow Design and Operations Report for Site F. Specifically, CRA reviewed:

- base excavation, leachate collection system, leachate disposal
- final contour plan, soil balance,
- waste types,
- site servicing, site service facilities,
- access and service roads,
- stormwater collection and control,
- site development plans,
- landfill operation, and
- landfill construction and operation costs.

For each of the listed design components, CRA reviewed the adherence to the design criteria, the practicality and completeness of the design, and undertook an independent check of material quantities.

With regards to each of the nine landfill aspects listed on the previous page, CRA comments can be listed in one of four categories: substantive comments leading to the recommendation of design changes, minor comments leading to the recommendations of design amendments, insufficient detail to provide an assessment, and agreement with the existing design concept and design detail. Where applicable, comments are provided regarding the relative merits of landfilling at Site F.

Based on a review of the leachate collection system and the conceptual liner design, CRA has identified a number of design changes which would improve the collection system's capacity to intercept and collect leachate. The approach used in the review was to first consider the leachate collection system independently of the liner system. This approach was employed since the need for a liner was not part of the Trow design criteria, and therefore, not considered in the Trow Design & Operations Report. As presented in Section B.3.0, the Trow conceptual liner design was then reviewed. An integrated review of the leachate collection system and the liner is not included since Trow

did not detail how the incorporation of a liner would impact on the base contours and leachate collection system.

Based on a review of the site service facilities, the access and service roads, the site soil balance, and the site operation, minor comments are provided. Details of these comments are included in Section B.4.0, and where applicable, are incorporated in the recommended design amendments presented in Part C of this report. A number of comments are also provided regarding inherent difficulties in operating a landfill at Site F.

Based on a review of the Stormwater Management Plan, it was concluded that the methodology and criteria employed may not sufficiently identify the extent of the site Stormwater Management requirements. Details of this review are included in Section B.4.0, while Part C of this report provides a more detailed assessment of the Site F Stormwater Management requirements.

With regard to leachate disposal, the base preparation plans, the final contour plan, site services, waste types, and the site development plans, CRA is in general agreement with the presented design and has no further comment.

With the exception of the estimated cost of the clay liner, CRA was also in general agreement with the landfill cost estimate provided by Trow. The overall cost estimate is discussed in Section B.5.0. The primary purpose of this discussion is to provide a basis for comparing the revised cost estimate resulting from the proposed design changes presented in Part C of this report.

B.2.0 REVIEW OF LEACHATE COLLECTION SYSTEM

B.2.1 LEACHATE GENERATION RATE

For the purposes of design, Trow assumed a leachate generation rate of 0.45 m/yr while the site was active and 0.30 m/yr after site closure. These rates represent guideline values provided by the MOE and are therefore acceptable for design purposes. In practice, these values represent the upper range of expected generation rates.

B.2.2 LEACHATE COLLECTION SYSTEM

The leachate collection system (LCS) is illustrated in Trow Drawing No. 2(Exhibit H-42). For ease of reference, the plan is reproduced schematically in Figure B.2.1 (page 34). The system consists of:

Perforated Collection Pipes:

- diameter of 0.15 meters
- spacing of 50 meters
- slope of 2 percent
- pipes placed in stone-filled trenches cut below the base of the landfill, with trenches extending 0.5 m below the base
- alternate collectors accessible for maintenance

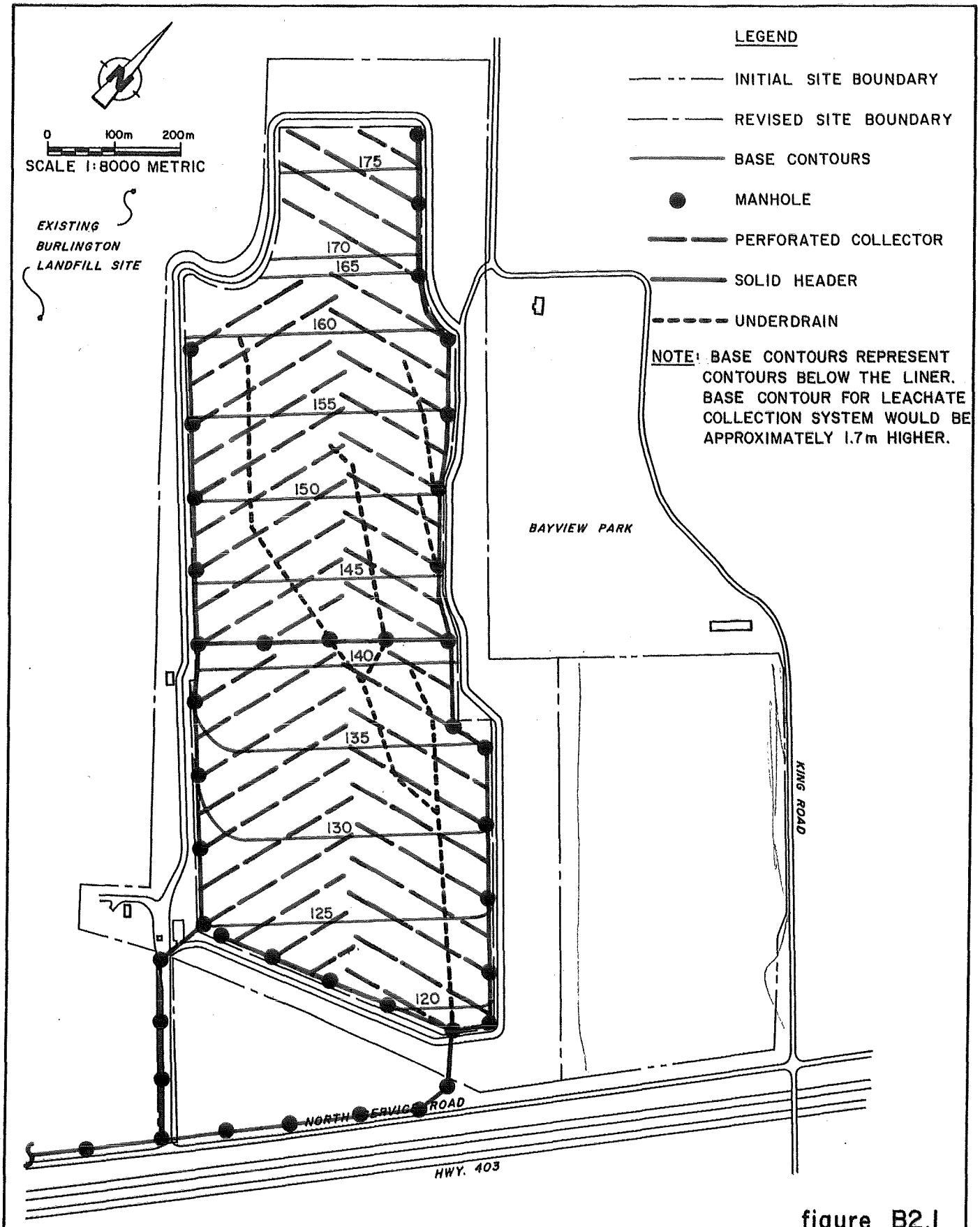

figure B2.1

TROW LEACHATE COLLECTION SYSTEM
SITE F-DESIGN AND OPERATION
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Solid Header System:

- diameter of 0.30 meters
- independent systems extend from north to south along the east and west boundaries of the landfilling area
- a west to east section along the southern limit of the landfilling area connecting to the eastern solid header
- manholes placed every 110 m, with alternate perforated collectors connecting at these points
- from the downgradient end of the collection system, the west and east headers continue an additional distance of approximately 300 m and 500 m respectively, before combining at the site entrance from the North Service Road.

Based on the leachate collection system design criteria and the design illustrated in Figure B.2.1 (page 34), the following were noted:

1. Only alternate collection pipes are accessible for cleaning,
2. The collectors which can be cleaned are only accessible at the downgradient end,
3. A perforated collector has not been provided around the site perimeter,
4. The underdrain system placed along the existing valley floors cannot be cleaned.

In light of the above information, it can be concluded that the leachate system as it is presently conceptualized, requires some design revisions before it will meet the design criteria.

B.3.0 CLAY LINER

A clay liner was not included in the Trow Design and Operations Report for Site F, although it was described in a follow-up letter addressed to C.N. Watson and Associates dated October 20, 1987.

As presented in the follow-up letter, the proposed liner and design consisted of a 0.3 m sand mat placed directly on the excavated base. The sand mat was overlain by 1.0 metre of imported clay. For protection, an additional 0.3 metre layer of sand was placed over the clay liner.

Although the design called for imported clay, the letter indicated that on-site clayey till may suffice. The letter also indicated that if on-site fill were used, design refinements or imported daily interim or final cover soil would be required to maintain the soil balance requirements.

In comparing the proposed Trow liner design to the criteria detailed in Part A of this report, the following were noted:

1. The liner thickness of 1.0 metres is at least 0.2 m less than what has been used at landfill sites elsewhere in Ontario.

2. The underlying sand blanket did not include the contingency underdrain system or the monitoring equipment necessary to detect at an early stage any leachate seepage through the liner.

Because of these considerations, it is recommended that the liner design for Site F be modified in order to adhere to the design criteria presented in Part A. As discussed in Part A, these criteria were derived from existing practice for landfills in Ontario.

B.4.0 REVIEW OF ADDITIONAL DESIGN COMPONENTS

At the outset of Part B of this Report, it was noted that CRA was in general agreement with a number of design components, although minor variances from the design objectives were noted. These components included the site service facilities, the access and service roads, the stormwater management plan, the site operation, and the overall soil balance. Each of these components is discussed in the following sub-sections.

B.4.1 SITE SERVICE FACILITIES

The layout of site service facilities is provided in Drawing No. 6-r of the Trow Design and Operations Report (Exhibit H-42B). The facilities include the weigh scale and scale house, the maintenance building, the site office, staff and visitors parking, and the bulk bin pick-up area.

It is proposed to use the existing weigh scale, and scale house. The scale house would also continue to serve as the site office. There is some question whether this facility will be sufficient given the expected expansion of space requirements if Site F became operational. Therefore, it is proposed by CRA that consideration be given to expanding or replacing the existing facility.

It is proposed by Trow that the bulk-bin area be maintained in its present location. This would be in conflict with the end-use plan for the existing Burlington Landfill site which called for a parking lot where the bulk-bins are presently located. **Given this conflict, it is recommended that either an alternative location for the bulk-bins be identified, or that consideration be given to maintaining the existing bulk-bin area, by constructing a parking lot as part of the Burlington Landfill End-use Plan. The cost of the parking lot should be incorporated with the Site F costs.**

It was also noted that the existing bulk bin area is not paved. Based on the design criteria provided in Section A, it is recommended the bulk bin area be paved.

B.4.2 ACCESS AND SERVICE ROAD

The existing access road to the Burlington Landfill Site was incorporated into the Site F design. As with the bulk bin area, this is in conflict with the end-use plan for the Burlington Landfill Site. **Therefore, it is recommended that consideration be given to relocating the entrance to the landfill site, or that a new road be constructed as part of the Burlington Landfill End Use Plan. The cost of this access road should be included as part of the Site F costs.**

Apart from the access road, the only additional aspect of the site access and service roads relates to paving. **To adhere to these recommended design criteria provided in Part A, the east and west service roads leading from the maintenance building should be paved over distances where they will be in use for at least four years.**

B.4.3 STORMWATER MANAGEMENT

The Trow Design and Operation Report provided a brief description of the layout of the proposed Stormwater Management system. Details of the design criteria and calculation methodology were provided in the Witness Statement of Ralph E. Crysler (Exhibit H-8B-1). In completing a review of the design the following questions were addressed:

1. Did the design criteria adhere to those provided by the Halton Region Conservation Authority?

2. Was the methodology and level of detail sufficient to adequately assess the suitability and economic feasibility of the proposed Stormwater Management Plan?

3. Is the conceptual layout sufficient to collect and attenuate runoff from the site?

Referring to the first question, the provided design did not adhere to the criteria provided by the Conservation Authority. However, through a resolution of Regional Council, Halton indicated that the final design would adhere to criteria and that the appropriate modeling techniques would be employed.

In completing the stormwater management calculations, Trow used the Rational Method. The Rational Method is a well established, but simplified, technique for estimating flood peaks. As applied by Trow, it is often used to estimate flood hydrographs, although this was not originally its intended use. Referring to Site F in particular, the complexity of the site topography suggests that results developed with the Rational Method should be viewed with caution.

In addition to concerns with the modeling technique, the CRA review identified a number of concerns with the level of detail employed by Trow in completing the calculations. Specific concerns included:

1. An existing dam, with a head pond capacity of approximately 2,100 m^3 is situated along one of the primary site streams. It appears that the Trow pre-development calculations did not incorporate this pond. During storms events with a high probability of

occurrence, the pond would provide substantial attenuation. It may also provide substantial attenuation during design storm conditions. If so, then the pre-development peak flows would be considerably lower than what would occur without the dam in place. The effect of this pond should to be addressed.

2. Site topography and vegetation varies significantly across the site. It is not apparent that this variability was adequately considered in the calculations.

3. Development of the site will result in infilling of the existing creek beds. Since site development will progress from downstream to upstream, without mitigation the landfill would serve as a receiving body for upgradient runoff. From details provided by Trow, it is understood that this runoff would be retained behind temporary dykes and pumped to the perimeter drains. Design of this retention and interception system requires careful consideration and should be discussed in detail. However, the Trow Design and Operation Report and the Crysler Witness Statement did not provide substantial details.

Referring to the third question regarding the conceptual layout, the review concluded that the provided plan would perform its intended objective of collecting and attenuating runoff from the site.

In summary, the CRA review of the Trow stormwater management plan identified concerns with the methodology employed and the level of detail provided. There is concern that the design changes resulting from more detailed calculations could affect the site feasibility from the perspective of operation and flood control. **Therefore, it is recommended that more detailed calculations be completed for the stormwater management of Site F.**

B.4.4 SITE OPERATIONS

A review of operations for Site F was reviewed from two perspectives:

1. Was the operation plan provided by Trow adequate?
2. How would the inherent characteristics of Site F affect landfill operation?

With regard to the operation plan, CRA was in general agreement with the provided details, although consideration should be given to provide an equipment inventory more specific to the excavation of shale.

From the perspective of operation, Site F does not typify a landfill site. It exhibits a number of unique characteristics which will contribute to operational difficulties and uncertainties. For example:

1. Because of the variability of the existing topography, preparation of the base will require substantial earthworks operations, including tree removal, stripping, cutting, filling, and berm construction.

2. Excavation of shale is more difficult than the excavation of clay. Furthermore, where weathering or fracturing is minimal, excavation will be more difficult and more specialized equipment will be required.

3. Excavated shale will have to be used for daily cover. Uncertainties exist regarding the suitability of excavated shale as a daily cover.

4. Limestone lenses occur sporadically in the site. Depending on the size of the lenses, blasting may be required.

In summary, the site terrain and presence of shale will render Site F difficult to operate. Furthermore, uncertainties regarding excavation of the shale and its use as a cover material may ultimately add substantially to the cost of landfilling at Site F.

B.4.5 SOIL BALANCE AND BASE CONTOURS

Soil balance calculations provided by Trow indicated that the revised site design ensured an overall soil balance. However, a detailed soil balance calculation completed by CRA for the revised Trow design indicates that there will be a shortage of approximately 270,000 m^3. Based on this shortfall, the base of the landfill site should be lowered by an additional 0.5 m from the contours provided in Trow Drawing No. 5-r (Exhibit H-42B), and as presented herein as Figure B.2.1 (page 34). This revision of the base contours would not substantially affect the cost estimate for Site F, since the site soil requirements had been assumed balanced and had been incorporated into the operating cost estimate.

B.5.0 REVIEW OF TROW COST ESTIMATE

To undertake a review of the Trow cost estimate, CRA completed independent calculations of all material quantities, researched unit prices for system components, and ultimately tallied an independent assessment of capital and operation costs.

Although the cost of individual items varied, with the exception of the clay liner, the overall landfill cost estimate calculated by CRA was close to the Trow landfill cost estimate. Therefore, the Trow cost estimate was accepted. For information purposes a summary of the Trow landfill costs is attached as Table B5.1 (page 48). The information presented in this table will be used in developing costs for the recommended design amendments provided in Part C of this report.

A summary of the clay liner costs are included in Table B5.2 (page 49). A review of the cost of the liner suggests that, because of the unit price of materials, the Trow cost estimate may be low. Therefore, it is suggested that this cost estimate be reviewed as part of the liner design revisions presented in Part C of this report.

TABLE B5.1

TROW - COST SUMMARY

A)	Clearing, Grubbing and Cell Excavation	$ 1,546,000
B)	Leachate Collection System	1,581,500
C)	Access Roads	398,000
D)	Site Services	940,000
E)	Stormwater Management	100,000
F)	Site Closure	2,695,000
	Subtotal	$ 7,260,500
	Contingency (15%)	1,089,100
	Subtotal	$ 8,349,600
	Engineering (15%)	1,252,400
	GRAND TOTAL	$ 9,602,000

Source: H-45 (Schedule K)

TABLE B5.2

TROW - CLAY LINER COST

Sand Underlain (0.3 m @ $4.50/m^3)	$ 742,500
Clay Base (1.0 m @ $8.50/m^3)	$4,675,000
Granular Pad (0.3 m @ $4.50/m^3)	$ 742,500
Subtotal	$6,160,000
Contingency (15%)	$ 924,000
Subtotal	$7,084,000
Engineering (15%)	$1,066,000
GRAND TOTAL	$8,150,000

Source: ?

B.6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the critique of the Trow design for Site F, it was concluded that the design demonstrates that it is feasible to construct a landfill which will adhere to the design criteria presented in Part A; although:

1. A clay liner and leak detection system with underdrain will be required.

2. The physiographic setting of Site F will make it a relatively difficult site to prepare and operate.

3. Potential difficulties with the excavation and use of the shale as a cover material enhance the extent of uncertainties, and therefore the risk of substantial additional costs.

Based on the review of the Trow design for Site F, the following are recommended:

1. The leachate collection system be modified to facilitate cleaning of the collection pipes, and to provide a collector about the site perimeter.

2. The thickness of the proposed liner be increased in order to more closely adhere to existing practice in

Ontario, and that monitoring equipment and an underdrain system be incorporated with the underlying clay blanket.

3. Changes related to the site service facilities, access and service roads, site operations, and the overall site soil balance should be incorporated into the design.

4. The conceptual-level stormwater management requires more detailed study in order to assess whether the proposed system represents an adequate base for assessing the feasibility of stormwater management at Site F.

5. Consideration be given to expanding the site capacity from 3.8 million tonnes to as much as 6.6 million tonnes, as recommended in the CRA report entitled, "Evaluation of Halton Region's Waste Quantity Projections", March 1988.

PART C - RECOMMENDED DESIGN AMENDMENTS

C.1.0 DESIGN OBJECTIVE

Part B of this report presented a review of the Site F Design and Operations Report prepared by Trow Hydrology Consultants (Trow), and submitted as part the Region of Halton's (Halton) EA submission.

Apart from inherent difficulties in developing and operating the site, the review identified that the Trow conceptual design was technically acceptable, but could be improved. In particular, the design did not achieve the hydrogeologic design objectives of providing an engineered liner (as recommended by CRA), and providing a leachate collection system which in the long term will effectively collect leachate.

In addition to concerns with the landfill base and leachate collection system, a number of recommended design amendments were identified which would provide an improvement of the overall design of a landfill for Site F.

In light of these noted comments by CRA, the report (Part C) presented herein, provides suggested design changes for Site F. Although the recommended design changes focus on the clay liner and the leachate collection system,

revisions are also described for the design and layout of the site facilities, the layout of the access road, and the base contours. Changes to the layout of the access road and site facilities are provided since access road and the bulk-bin area conflict with the end use plan for the Burlington Landfill Site. Changes to the base contours are required in order to provide an overall site soil balance. More detailed stormwater management calculations are provided in response to the concern that the Trow approach was too conceptual and may not have sufficiently addressed stormwater management concerns.

Apart from comments on the Trow landfill design, Part B of this report also identified the need to consider expanding the site capacity from 3.8 million tonnes to as much as 6.6 million tonnes as recommended in the CRA report entitled, "Evaluation of Halton's Region Waste Quantity Projections" March 1988. Potential for expansion is also presented in Section C.5.0.

C.2.0 DESIGN REVISIONS

C.2.1 LEACHATE COLLECTION SYSTEM

Based on the design criteria provided in Part A of this report, the Trow design for the leachate collection system requires revisions to:

1. Enhance the accessibility of the perforated collectors for cleaning and maintenance.
2. Provide a perforated perimeter drain.

Figure C.2.1 (page 55) provides a conceptual layout of proposed revisions to the leachate collection system. Details are not included, but unless otherwise noted would be as provided by Trow. Features of this system include:

1. Parallel header lines extending the full length of the landfill along the eastern and western limits of fill.

2. To facilitate maintenance of the perforated collectors, place manholes at the end of each perforated collection pipe.

3. Perforated collectors placed in a granular bed on top of the clay liner, and extending from the mid-point of the site to the collection headers located along the eastern and western limits of the landfill.

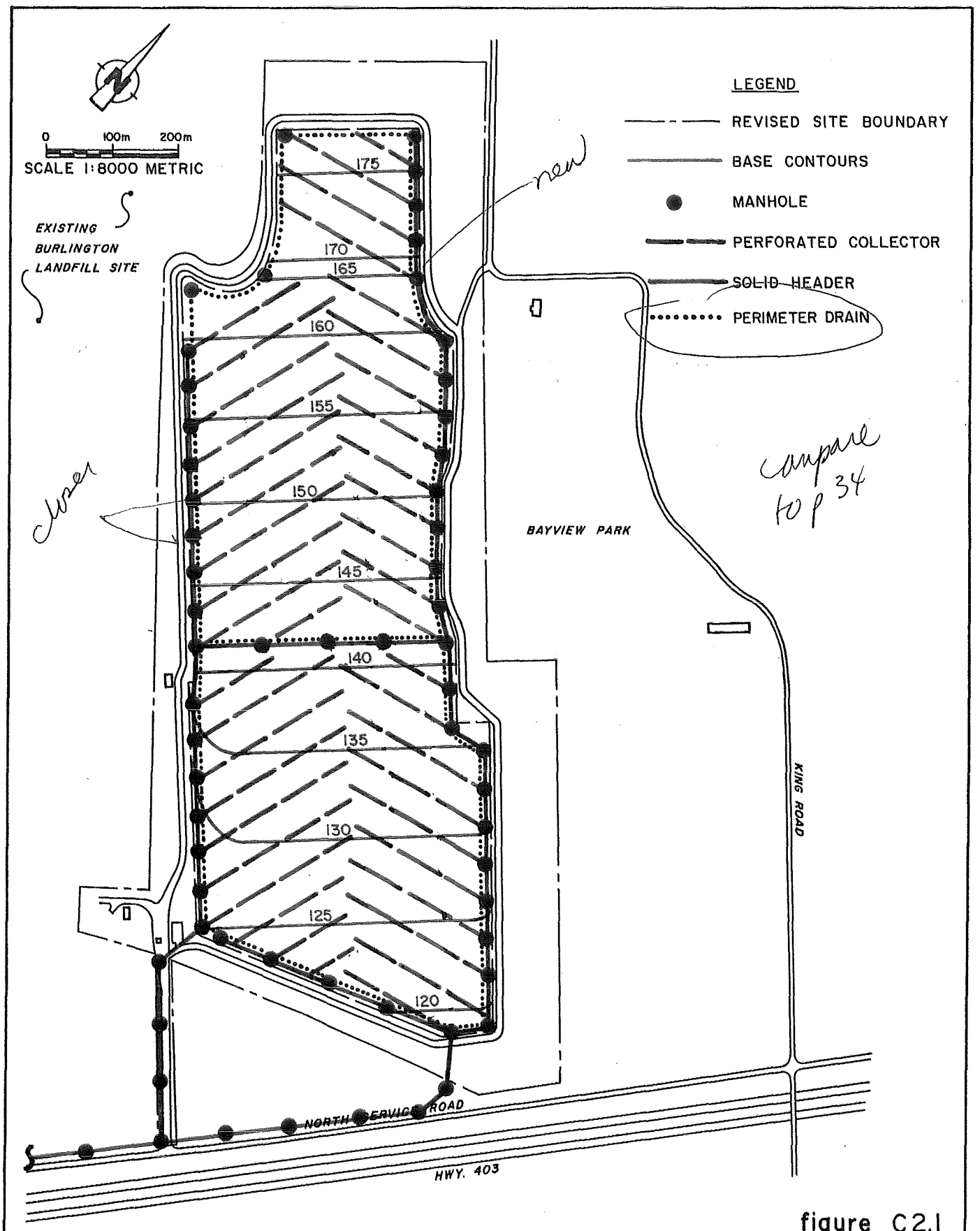

figure C2.1

REVISED LEACHATE COLLECTION SYSTEM
SITE F - DESIGN AND OPERATION
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4. A perforated drain around the perimeter of the base of the site.

5. A temporary east-west header at the southern limit of Cell No. 1.

Features 2 and 4 represent revisions to the Trow Design. The underdrain system included in the Trow design was removed since the underdrain system of the liner system would serve the same purpose. By providing these design modifications, the leachate collection system will adhere to design criteria provided in Part A of this report.

C.2.2 CLAY LINER

Based on the design criteria provided in Part A of this report, CRA would recommend that the design of the clay liner be revised as follows:

1. Provide an underdrain system and monitoring capability in the sand blanket underlying the clay liner.
2. Increase the thickness of the clay liner from 1.0 m to a minimum of 1.2 m (see Section A.4.3.1).

The layout of the proposed underdrain system would be similar to that of the leachate collection system,

except that the drain spacing would likely be increased from 50 meters to 100 meters. Depending on monitoring results, the collected groundwater will either be pumped to the sanitary sewer, or released to a natural water course. Since it is a gravity flow system, perforated collectors could be monitored at each manhole, thus direct monitoring of the underdrain system would not be required.

These revisions to the liner system would minimize the likelihood of failure. As well, any failure would be detected at the earliest possible stage, and active pumping of the underdrain system would serve as the first level of contingency.

C.2.3 ACCESS ROAD AND SITE FACILITIES

It was indicated in Part B, that the proposed locations of the access road and bulk-bin area were in conflict with the end-use plan of the existing Burlington Landfill Site. A review of the site plan indicates that there are no alternative locations within the site property unless the limit of refuse is altered. Therefore, it is recommended that the access road and bulk-bin areas be maintained as proposed, and that an alternative access road and parking lot be provided for the Burlington Landfill Site. Costs for these additional facilities should be attributed to the cost of developing Site F.

The access road should be paved with two lanes. It would extend approximately 380 metres north from the North Service Road to connect to proposed roads within the end-use plan. The parking lot should be located in the vicinity of the bulk-bin area and would not require paving.

Based on the Part A design criteria, the east and west service roads should be paved where they will be in use for four years or more. In the case of the west service road, paving should extend approximately 450 metres from the maintenance building to the mid-point of Cell No. 1. The east service road should be paved from its junction with the west service road, easterly across the southern limit of Cell No. 1 and northerly to the mid-point of Cell No. 1. This is a distance of approximately 810 metres.

C.3.0 STORMWATER COLLECTION AND CONTROL MANAGEMENT

In Part B of this report, it was recommended that more detailed calculations be completed to evaluate the feasibility of the stormwater management system proposed for Site F. In response to this recommendation, CRA undertook preliminary level design calculations for the management of stormwater runoff from Site F.

Hydrologic conditions at Site F were modeled using an interactive computer program called "Micro Interactive Design of Urban Stormwater Systems (MIDUSS)" developed by Dr. Alan A. Smith, 1986. MIDUSS has been recommended by the MNR and Grand River Conservation Authority as an acceptable tool for modeling hydrologic conditions of urban and rural drainage basins.

The preliminary stormwater management calculations completed by CRA indicated that the pond sizes recommended by Trow were reasonable and that any refinements to their sizes could be accommodated within the site topography. A detailed evaluation at the final landfill design stage would be required to verify and refine the provided design.

C.4.0 REVISED COST ESTIMATE

As discussed in Section B.4.0, with the exception of the clay liner, CRA was generally in agreement with the Trow cost estimate. However, given the proposed design changes, a cost update is required.

Table C.4.1 (page 61) provides a comparison of the cost estimate for the Trow leachate collection system to the cost estimate for the recommended design amendment. To maintain consistency, CRA typically employed the unit prices provided by Trow and included in Schedule K. As the table indicates, the leachate collection system for the recommended design would increase from $1.58 million to $1.84 million.

Table C.4.2 (page 62) provides a comparison of the clay liner cost estimate as provided by Trow and by CRA. As discussed in Section C.2.2, the primary cost difference results from differences in the unit price of sand and the installation of a leak detection system in the CRA design. The unit cost estimate used by CRA were based on unit prices provided by local suppliers. Exclusive of contingencies and engineering, the revised cost is $13.4 million, as compared to $6.2 million for the Trow design. Given the high cost of materials the normal engineering allowance has been reduced from 15 percent to

TABLE C4.1

COST COMPARISON - LEACHATE COLLECTION SYSTEM

Component System	Trow Design	Alternative Design
150 mm Perforated Leachate Collection Pipe	$ 366,800.	$ 366,800.
150 mm Perimeter Drain		128,000.
200 mm Perforated Leachate Collection Pipe	91,800.	91,800.
200 mm Solid Headers	286,400.	286,400.
300 mm Main Headers	75,000.	75,000.
Manholes	287,000.	420,000.
Pumping Station	100,000.	100,000.
Sewer Upgrading	374,500.	374,500.
Sub-Total	$1,581,500.	$1,842,500.
Contingency (15%)	237,200.	276,400.
Sub-Total	$1,818,700.	$2,118,900.
Engineering (15%)	272,800.	317,800.
Grand Total	$2,091,500.	$2,436,700.

TABLE C4.2

COST COMPARISON - CLAY LINER

System Component	TROW Thickness (m)	TROW Unit Price	TROW Total Cost	CRA Thickness (m)	CRA Unit Price	CRA Total Cost
Sand Underdrain Pad	0.3	$4.50	$ 742,500.	0.3	$22.50	$ 3,375,000.
Monitoring/Contingency Pumping	--	--	--	--	--	327,300.
Clay Liner	1.0	8.50	4,675,000.	1.2	12.00	7,200,000.
Sand Drainage/ Protection Pad	0.3	4.50	742,500.	0.3	16.50	2,475,000.
Sub-Total			$6,160,000.			$13,377,300.
Contingency (15%)			924,000.			2,006,600.
Sub-Total			$7,084,000.			$15,383,900.
Engineering (10%)			708,400.			1,538,400.
Grand Total			$7,792,400.			$16,922,300.

10 percent for both Trow and CRA estimates. Therefore the total estimated cost of liner is $7,792,400 as calculated by Trow and $16,922,300 as calculated by CRA.

As summarized in Table C.4.3 (page 64), changes to the access road, the bulk-bin area and the stormwater management plan would result in additional costs for Site F of $327,200.

Table C.4.4 (page 65) contains a summary of the Trow cost estimate, the value of the design changes and a cost estimate with the design revisions. As the Grand Total indicates, the net increased cost of the recommended design would be approximately $17.7 million, from $9.6 million for the Trow design to $27.3 million for the revised design.

TABLE C4.3

ADDITIONAL COST ADJUSTMENTS

1.	Paving of Service Roads (1,260 m @ $120/m)	$151,200
2.	Alternate Access Road for Burlington End-Use (380 m @ $200/m)	76,000
3.	Paving of Bulk-Bin Area and Alternate Parking Lot for Burlington End-Use	50,000
4.	Lump Sum Additional for Stormwater Management	50,000
	TOTAL	$327,200

Note:

Costs exclusive of contingencies and engineering

TABLE C.4.4

REVISED CAPITAL COST SUMMARY

		Trow Design	Cost Adjustment	Revised Design
A1)	Clearing, Grubbing and Cell 1 Excavation	$1,546,000	$ --	$ 1,546,000
B)	Leachate Collection System	1,581,500	261,000	1,842,500
C)	Service and Access Roads	398,000	226,200	624,200
D)	Site Services	940,000	50,000	990,000
E)	Stormwater Management	100,000	50,000	150,000
F)	Site Closure	2,695,000	--	2,695,000
G)	Liner System	Ø	13,377,300	13,377,300
	Subtotal	$7,260,500		$21,225,000
	15% Contingency	1,089,100		3,183,750
	Subtotal	$8,349,600		$24,408,750
	15% Engineering	1,252,400		2,892,100
	GRAND TOTAL	$9,602,000		$27,300,850

take less yrs.??

C.5.0 SITE EXPANSION

C.5.1 DESIGN OBJECTIVE

In the Conclusions of the Report entitled "Evaluation of Halton Region's Waste Quantity Projections", March 1988, CRA recommended that the capacity of the proposed Halton Landfill Site be increased from 3.8 million tonnes to 6.6 million tonnes. The reasons for the recommended increase in site capacity are well documented in the above noted report. Briefly, they are as follows:

- The planning period for the proposed landfill site would extend 20 years, from September 1988 to August 2008.

- The annual waste generation rate would initially be 0.82 tonnes/capita (0.9 tons/capita), increasing by 0.01 tons/capita/yr for the first ten years, and by 0.75 ~~0.5~~ percent per year for each year of the planning period.

corrected MC424

- Source separation would increase to 12 percent in 1989 and would remain at 12 percent until the end of the planning period.

- The capacity would be based on the worst case scenario where no EFW plant would be constructed during the planning period.

- A contingency of 5 percent should be included to allow for higher than expected waste generation.

The objective of this section of the Report is to address the possibilities for expanding Site F. A brief discussion is provided of the alternatives available for expansion, including potential capacity and potential concerns which would have to be addressed. Considerations for expansion of the site could take the form of:

1. Increasing the height of the landfill,

2. Landfilling to the west in the buffer zone between Site F and the existing Burlington Landfill Site,

3. Landfilling to the east in the buffer zone between Site F and Bayview Park,

4. Landfilling to the east in the lands to the south of Bayview Park.

The expansion potential and corresponding constraints for the first three options are discussed in the following Section (C5.2). The fourth option (landfilling to the east in the lands to the south of Bayview Park), was considered by Trow as a landfilling alternative, but was rejected primarily due to biophysical constraints.

Furthermore, during the Consolidated Hearing, Counsel for Halton indicated the property boundaries for Site F had been revised (October 28, 1987, Volume 50, page 11475). Based on this, no further consideration was given to the option of expanding to the south of Bayview Park.

C.5.2 DESIGN ALTERNATIVES

C.5.2.1 Increase Height

The final contours proposed by Trow are shown in Figure C.5.1 (page 69). As the figure illustrates, Site F is long and narrow with side slopes generally ranging between five and 25 percent. By increasing the side slopes to approximately 25 percent, and by peaking the site down the middle, the site capacity could be increased by approximately 20 percent (800,000 tonnes). This would result in a 10 to 15 meter increase in the elevation along the north-south centre line of the site. Vertical expansion to this extent would result in an even more significant visual impact as compared to the present design due to the height increase and abrupt shape of the site. It would also result in compromising the after-use plan due to the steep side slopes extending over the entire site. Finally, impacts such as wind and noise would have to be reevaluated.

Given the limited amount of waste that could be accommodated (800,000 tonnes) and the above constraints, it was concluded that any significant vertical expansion would not be feasible.

C.5.2.2 Expansion to the West

Additional capacity could be gained by tying Site F to the existing Burlington landfill site. This would eliminate the proposed valley between the two sites and could facilitate further vertical expansion given that the width of the site would effectively double. Tying the two sites together without increasing the overall height would provide an additional capacity of approximately 25 percent (1.0 million tonnes). With the two sites tied together, consideration could be given to vertical expansion, however, this was ruled out for the reason given in Section C.5.2.1.

In expanding to the west, a number of concerns would have to be addressed. These are listed as follows:

1. The leachate header system for both Site F and the existing Burlington Landfill site would be buried under as much as twenty metres of waste and thus would not be accessible for maintenance.

2. The proposed after-use of the existing Burlington Landfill Site would have to be delayed (10 to 20 years) until after Site F was filled.

3. Leachate production would increase since the aerial extend of landfilling would be expanded.

4. The connecting of the two sites would increase the visual impact of the landfill site.

5. The feasibility of stormwater management for both sites would have to be addressed since the west perimeter ditch would be filled with waste.

6. To some extent, tying the two sites together represents expansion of the existing site. At the Hearing for the final expansion of the existing site (1984), a commitment was given that the site would not be further expanded.

Given the above, it may be possible to expand to the west, however, the limited increase in site capacity (1,000,000 tonnes) must be viewed in the context of these significant constraints, and the overall feasibility would have to be determined from an engineering point of view.

C.5.2.3 Expansion to the East

Additional capacity could be gained by filling the valley between Site F and Bayview Park. This easterly expansion would likely necessitate Halton to acquire Bayview Park, partly to provide a buffer zone and service corridor, but also for liability reasons since it would not be possible to distinguish between leachate migration from Site F and leachate migration from Bayview Park. Tying into Bayview Park would increase the site capacity by approximately 15 percent (600,000 tonnes).

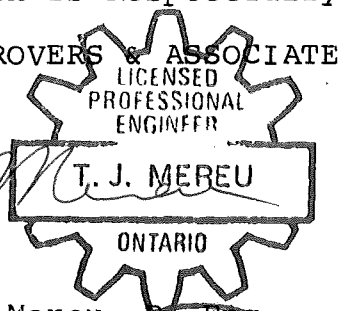
In expanding to Bayview Park, a number of concerns would have to be addressed. These are listed as follows:

1. The leachate collection system and waste from Site F would overlap the Bayview Park perimeter collection system. This overlap would pose technical difficulties for the design of the Site F leachate collection system, and will necessitate modifications to the Bayview Park perimeter collection system.

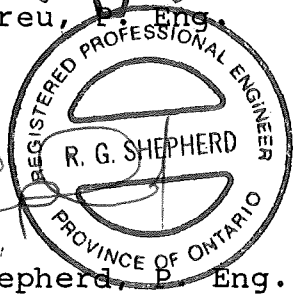
2. Much of Bayview Park could not be used for recreational purposes during the filling of Site F.

All of Which is Respectfully Submitted,

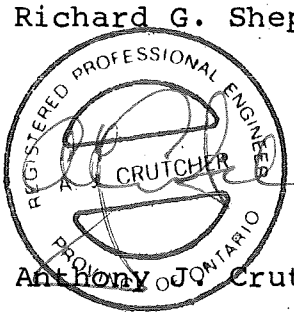
CONESTOGA-ROVERS & ASSOCIATES



Timothy J. Mereu, P. Eng.



Richard G. Shepherd, P. Eng.



Anthony J. Crutcher, P. Eng.