

M 882

**HALTON REGION ENVIRONMENTAL ASSESSMENT
LANDFILL COMPONENT OF
SOLID WASTE MANAGEMENT**

**Comments on the After Uses Proposed
for Sites D and F**

**Prepared for
The City of Burlington**

March, 1988



ECOPLANS_{LTD}
ENVIRONMENTAL PLANNERS
AND CONSULTING ECOLOGISTS

WITNESS STATEMENT

REVIEW AND COMMENTARY OF THE AFTER USES PROPOSED FOR SITES D AND F

of

Cameron M. Kitchen, Ph.D, M.C.I.P.

of

Ecoplans Ltd.
544 Conestogo Road West
Waterloo, Ontario
N2L 4E2

In the matter of the Consolidated Hearing for the Environmental Assessment of the proposed Halton Regional Landfill Component of Solid Waste Management.

Role and Responsibility.

I am an environmental consultant and professional planner specializing in the environmental area. Since 1979, I have been president of the environmental consulting firm, Ecoplans Ltd. In March, 1970, I was one of the founding members of the Company.

My responsibilities in this project have included the following items for which separate witness statements have been prepared.

1. Review and Comment on the After Uses Proposed for Sites D and F.
2. Review and Comment on the Biophysical Resources Component of the Environmental Assessment.
3. Review and Comment on the Visual Resources Component of the Environmental Assessment.

Ecoplans Ltd. was first retained by the City of Burlington in 1984, and has been involved with the environmental assessment process on a continuous basis from that time. I have been responsible for Ecoplans Ltd.'s work throughout this period.

After Uses Proposed for Sites D and F

The after uses proposed for Site D and Site F are agriculture and natural area restoration respectively.

The review of the after uses proposed for Sites D and F involved the following activities:

- . review of agriculture and after use documents prepared by the Region (Landplan Collaborative Ltd.; Exhibits H-20 and H-21) >
- . visits to both Site D and Site F >
- . review of agricultural report prepared on behalf of the Town of Milton (Smith Hoffman Associates; Exhibit M-372) >
- . attendance at Hearings during periods when agriculture and after use issues were discussed >
- . review of transcripts and exhibits presented at the Hearing >
- . review of Design and Operations reports for Site D (Exhibit H-41) and Site F (Exhibit H-42) as they relate to the proposed after uses >
- . original investigations completed by Ecoplans Ltd. >

In general terms, I agree that the after uses proposed for the two sites are appropriate. However, the after uses were not developed to the same level of detail in the documentation. The agriculture after use program for Site D was described in considerable detail by both the Region and the Town of Milton. The difficulties and unknowns likely to be confronted in this after use program were discussed in some detail. [The after use proposed for Site F was not developed beyond the conceptual level,

perhaps leaving the unfortunate and incorrect impression that the natural area after use rehabilitation program involves few implementation difficulties and unknowns.

The review of the after uses includes the following elements:

- . a brief discussion of the agricultural after use proposed for Site D (Section 2.0)
- . Site F: Natural Area Concept (Section 3.0)
- . Site F: Regional Site Closure and After Use Costs (Section 4.0)
- . Site F: Site Closure and After Use: Alternative Cost Estimates (Section 5.0).

Based on a review of the agriculture and agricultural after use documentation for Site D, I do not think that I can contribute additional insight to the Board in respect to the proposed agricultural after use program at Site D. In respect to Site F, I have reached four main conclusions which are as follows:

1. The process of after use identification and description has not been developed to the same extent for the two sites. The lack of details about the after use plan for Site F may leave the impression that the Natural Use Concept is readily implemented and trouble-free. In fact, it is a complex process with many unknowns.
2. If the Natural Area Concept extends beyond a simple "greening" of the landfill mound, the process must be considered experimental. There are relatively large gaps in our understanding of the ecological processes that influence the development of a viable ecological system. Any plant community that develops on the site will not replace, in natural quality terms, the community that will be lost. We cannot equate the replacement community with the high natural value ecosystem that will be lost.
3. If the Natural Area Concept is to be implemented effectively, it will require a commitment to manage extending over a period of years. A number of related management sub-issues include: topsoil sufficiency and depth, plant material, special treatment and ongoing management philosophy.

4. The implementation and management of the Natural Area Concept will lead to the after use costs substantially higher than those proposed by the Region. Based on alternative cost estimates, the after use cost could exceed \$5,177,325 (\$3,611,040 topsoil plus \$1,566,285 plant material) compared to the Regional estimate of \$2,150,000 which is comprised of \$1,598,000 for after use and \$552,000 for site closure soils purchase.

The overall conclusion of the report is that the Natural Area is an appropriate after use for Site F, and that the rehabilitation programs must be viewed as experimental. In terms of applied experience, less is known about natural area restoration than is known about agricultural rehabilitation. The natural area concept or naturalization plantings are commonly described as low cost/low maintenance systems. This is true only when they are compared to conventional landscaping and over a longer time frame. There may be substantial costs associated with the implementation and management of the natural area concept. Based on my experience with similar projects, it is my opinion that the after use costs are underestimated.

CAMERON M. KITCHEN

Position: President, Ecoplans Ltd.

EDUCATION

1967 B.A. Geography/Biology
(Hons) Queen's University, Kingston, Ontario

1969 M.A. Regional Planning and Resources Development,
University of Waterloo, Waterloo, Ontario

1983 Ph.D. University of Glasgow, Glasgow, Scotland,
Faculty of Science (Geography)

PROFESSIONAL AFFILIATIONS

Member Canadian Institute of Planners
Member Ontario Professional Planners Institute
Member Ontario Society for Environmental Management
(President, 1984-1988)
Member Canadian Association of Geographers
Member Canadian Land Reclamation Association
Member Canadian Society for Landscape Ecology and Management
Member Federation of Ontario Naturalists

EXPERIENCE

1979-present President, Ecoplans Ltd.

1983-1985 Adjunct Associate Professor (sessional appointment), School
of Urban and Regional Planning, University of Waterloo.

1978-1981 Sessional Lecturer, Department of Geography, Wilfrid Laurier
University.

1978-1979 Sessional Lecturer, Land Resources Department, University of
Guelph.

1977-1979 Senior Environmental Planner, Vice-President, Ecoplans Ltd.

1975-1977 Canada Council Fellowship, University of Glasgow, Glasgow,
Scotland.

1972-1975 Assistant Professor, School of Urban and Regional Planning,
University of Waterloo. (Cross Appointment with Geography
Department).

1970-present Director and Co-founder Ecoplans Ltd.

1970-1977 Environmental Planner (part time), Ecoplans Ltd.

1969-1972 Lecturer, School of Urban and Regional Planning, University
of Waterloo.

EXPERIENCE

Dr. Kitchen is President of Ecoplans Ltd., Environmental Planners, Consulting Ecologists. His professional experience derives from acting as a Consultant to both the public sector (local municipality, County and Regional Municipalities, provincial and state governments and the Federal government) and the private sector (individual landowners, developers, major corridor operators). The scale of the projects range from sites less than one hectare to projects involving many thousands of hectares. Consulting services have included environmental studies in the following general areas. In each of the projects listed Dr. Kitchen was either project manager or a major participant.

TYPICAL PROJECT AND PROJECTS TYPES**Urban, Institutional, Industrial Projects**

1. Erin Mills New Town: Secondary Plans, Draft Plans of Subdivision, Arborist Reports (17 years).
2. North Pickering Community Project with Plantown Ltd.
3. Townsend New Town Project: Ontario Ministry of Housing
4. Malvern New Town (Urban Tree Management) for Ministry of Housing (Ontario Housing Corporation).
5. Utica University Campus Study (SUNY) for New York State University Construction Fund.
6. Edwardsburgh Industrial Site Appraisal with M. M. Dillon for Ministry of Industry and Tourism.
7. Pelham South New Community Environmental Appraisal and General Impact Analysis.
8. Environmental Impact Statement for E.S.P.A. 59 and Cambridge West Community.
9. Glen Abbey (Oakville) New Community: Secondary and Draft Plans of Subdivision, Arborist Report.
10. Environmental Information Report - Heritage Glen Lands, City of Barrie.

Engineering and Servicing Projects

1. Pickering Sewage Treatment Plan Site Analysis for Ontario Ministry of the Environment.
2. York-Durham Sewer (Ajax Pumping Station) for the Ministry of the Environment.
3. Mimico Landfill Environmental Impact Study for Metropolitan Toronto Region Conservation Authority.
4. Windsor Area Resource Recovery Project for the Ministry of the Environment.
5. Environmental Impact Statement for Storm Water Drainage System, Tapscott Industrial District, Scarborough.
6. Environmental Appraisal of Alternative Water Storage Sites for Regional Municipality of Waterloo.
7. Biophysical Inventory of Woodlands Surrounding the Burlington Landfill Site for Region of Halton.
8. Environmental Assessment of Alternative Sewage Treatment Plant Sites for the Town of Kemptville.
9. After Use Plan for Existing Regional Landfill Site for the Region of Waterloo.
10. Biological Inventory of the Proposed Sanitary Landfill Site, Township of Sydenham, for Henderson Paddon Associates.

Landscape Architectural/Restoration Studies

1. Byron Gravel Pit Renovation/Design Project, London, Ontario for Eli Comay and Associates.
2. Nordheimer/Cedarvale Ravine Study (rehabilitation), Toronto for Toronto Transit Commission.
3. Thames River Slope Rehabilitation, Design, Implementation and Monitoring for Union Gas Limited.
4. Pond Mills Station Design (Natural Landscaping) for Union Gas Limited.
5. Rehabilitation of Oakville-Bronte Creek Slopes, 1980, for Trans-Northern Pipe Lines Ltd.

6. Landscape Specifications for Pipeline Facilities for TransCanada PipeLines Ltd.
7. Information Requirements for Pipeline Development and Reclamation Application for Land Reclamation Division, Department of the Environment, Province of Alberta.
8. Rosedale Ravine Slope Rehabilitation Study for Manufacturers Life.

Corridor Studies

1. Environmental Assessment for Oil Pipeline from Nanticoke to Hamilton for Interprovincial Pipe Line Ltd. and Trans-Northern Pipe Line Company (including rehabilitation and tree planting).
2. Environmental Site Supervision, Nanticoke to Hamilton Oil Pipeline for Trans-Northern Pipe Line Company and Interprovincial Pipe Line Limited.
3. Environmental Assessment for Oil Products Pipeline -Clarkson-Oakville Loop. Trans-Northern Pipe Line Company.
4. Environmental Assessment for Oil Products Pipeline - Toronto Airport Junction to North Toronto Pump and Metering Station Loop. Trans-Northern Pipe Line Company.
5. Environmental Assessment for Gas Pipeline - Maple-Lisgar Loop for TransCanada PipeLines Limited.
6. Resource Mapping in North Central Ontario Regions 5, 6, 7A for Ontario Hydro.
7. Highway 8 By-Pass (Cambridge) for Ministry of Transportation and Communications.
8. Highway 11 (Sundridge) for Ontario Ministry of Transportation and Communications.
9. Highway 17 (Sault Ste. Marie section) for Ministry of Transportation and Communications.
10. Queen Elizabeth Way Highway Project (Hamilton section) for Ministry of Transportation and Communications.
11. Highway 406 (St. Catharines) for Ministry of Transportation and Communications.
12. Highway 402 (London) for Ministry of Transportation and Communications.

13. Highway 7 (Stratford Section) for Ministry of Transportation and Communications.
14. Environmental Assessment for Highway 89 Extension, Pickering Design Study for Ministry of Transportation and Communications.
15. Hamilton GO Rail Extension Study Environmental Assessment for Ministry of Transport.
16. Ontario Hydro - Study on the Economic Impact of Electric Transmission Corridor on Rural Property Values.
17. Pipeline Requalification Environmental Inspection and Management in Western Canada for TransCanada Pipelines Ltd.
18. Highway 416 (Region of Ottawa-Carleton) Corridor Study for Ministry of Transportation and Communications.
19. Queen Elizabeth Way (St. Catharines), Preliminary Design from Niagara Road 24 to Highway 405 for Ministry of Transportation and Communications.
20. Highway 6: Joint Utility-Highway Corridor, Environmental Assessment of Water Resources and Woodlots for Ministry of Transportation and Communication.
21. Blackburn Hamlet Bypass Environmental Study for Regional Municipality of Ottawa-Carleton.
22. Highway 8 East-West Arterial (Cambridge) for Regional Municipality of Waterloo.
23. Highway 89 Extension, Reg. Road 12 to Highway 7, Type II Environmental Assessment for Ministry of Transportation and Communications.
24. Highway 89 Extension, Madill Section, Highway 400 to Highway 11. -Environmental Assessment for Ministry of Transportation and Communications.
25. Highway 403 Woodstock, Type II Environmental Assessment for Ministry of Transportation and Communications.
26. Environmental Assessment, Temiscaming Extention for TransCanada PipeLines Ltd.
27. Environmental Assessment, North Line Phase I, Toronto to North Bay for Trans-Northern Pipe Lines Limited.
28. Environmental Assessment, North Line Phase II, Toronto to North Bay for Trans-Northern Pipe Lines Limited.

29. Environmental Assessment, Ottawa Lateral for Trans-Northern Pipe Lines Limited.
30. Environmental Assessment, Kerwood-Caradoc (NPS 42) Trafalgar Line for Union Gas Limited.
31. Environmental Assessment, Caradoc-Lobo (NPS 42) Trafalgar Line for Union Gas Limited.
32. Sydenham River Monitoring Program, Trafalgar System (NPS 42) for Union Gas Limited.
33. Environmental Assessment, Hamilton Reinforcement Line for Union Gas Limited.
34. Environmental Assessment, Propane Transfer Site, Flamborough Township for Interprovincial Pipe Line Limited.
35. Environmental Assessment of Dorval Drive/Upper Middle Road crossing of Sixteen Mile Creek for Town of Oakville.

Recreation, Parks and Open Space Studies

1. Aquatic Park (Toronto Outer Harbour) for Metropolitan Toronto and Region Conservation Authority.
2. Ecological Appraisal of the Metropolitan Toronto Zoo Project Site for Metropolitan Toronto and Region Conservation Authority.
3. Port Aberdeen Recreational Community Impact Analysis for Hedonics Corp.
4. Schneider Creek (Kitchener) Open Space Study (Vegetation and Wildlife) for the City of Kitchener.
5. Kitchener Parks and Open Space Study for the City of Kitchener.
6. Radium Springs, British Columbia. Land Management Study (for 17,000 acres).
7. Gatineau Park Inventory Methodology for National Capital Commission, Ottawa, Ontario.
8. Wetland Vegetation Impact and Management Study for the CJCL Tower rebuilding project on the Toronto Islands (Centre Island) for Telemedia Communications Inc.
9. Steckle's Woods E.S.P.A. 29: Environmental Impact Statement and Restoration Plan for the Regional Municipality of Waterloo.

10. Tommy Thompson Park Master Plan: Biological Model Development for Metropolitan Toronto Region Conservation Authority.
11. Milliken District Park: Master Planting Plan, Buffer Afforestation Area for City of Scarborough.
12. Pine Grove Sector Development Plan, National Capital Commission Greenbelt for National Capital Commission.
13. Riverside Park Interpretive Trail for the Handicapped, for the City of Cambridge.

Others

1. Albert Street Widening Study (Urban Forestry) for City of Waterloo and Downtown Ratepayers Association.
2. Central Ontario Aggregate Study (Ecological Impact) for Ontario Ministry of Natural Resources.
3. Seminar on Environmental Planning for the Urban Development Institute, Toronto (including preparation of background papers).
4. Agriculture in the Niagara Peninsula. A comprehensive report prepared for various landowners in the region as evidence in the O.M.B. hearing on the Regional Official Plan. Expert testimony was also provided.
5. Speyside Gravel Pit Environmental Assessment and N.E.C. Hearings for Standard Aggregates, a Division of Standard Industries Limited.
6. Class Environmental Assessment for Transit, for Ministry of Transportation and Communications and O.U.T.A.

PUBLICATIONS

"An Ecological Approach to Improving Urban Design", unpublished M.A. Thesis, University of Waterloo, 1969.

"Ecological Concepts in Subdivision Design", in A. G. McLellan (ed.) The Waterloo County Area: Selected Geographical Essays, Department of Geography Publication No. 1, University of Waterloo, 1971, pp. 255-265.

"Ecology and Urban Development", in R.R. Krueger and R.C. Bryfogle, Urban Problems: A Canadian Reader, Holt, Rinehart and Winston, Toronto, 1971, pp.282-186.

"The Role of Ecological Appraisal in Urban Development", in R.R. Krueger and R.C. Bryfogle, Urban Problems: A Canadian Reader (revised), Holt, Rinehart and Winston, Toronto, 1975, pp.254-263.

"Ecology and Urban Development: The Theory and Practice of Ecoplanning in Canada", in G.R. McBoyle and E. Sommerville (eds.), Canada's Natural Environment: Essays in Applied Geography, Methuen Press, Toronto, 1976, pp.217-240.

"Environmental Planning and Urban Development", (pp.29-42) and "Urban Development and Environmental Assessment", (pp.79-112), in R.S. Dorney, S.G. Rich and C.M. Kitchen, Environmental Planning, Ecoplans Ltd., Waterloo, Ontario, November, 1978.

"Environmental Management: A Project-Oriented Approach. The Port Aberdeen Recreational Community (Ontario)." Unpublished Ph.D. Thesis, University of Glasgow, Glasgow, Scotland, 1982.

A Tree Saving Manual For Developers, Builders, Designers, Arborists and Landscape Contractors. Working Paper 18, School of Urban and Regional Planning, University of Waterloo. 59 pp., 1984, with R. S. Dorney.

"Effects of Tree Conservation in the Urbanizing Fringe of Southern Ontario". Urban Ecology 9(1986) 289-308, with R. S. Dorney and Brent Evered.

HALTON REGION ENVIRONMENTAL ASSESSMENT
LANDFILL COMPONENT OF SOLID WASTE MANAGEMENT
COMMENTS ON THE AFTER USES PROPOSED FOR SITES D AND F

Prepared for
The City of Burlington

Ecoplans Ltd.
544 Conestogo Road
Waterloo, Ontario
N2L 4E2

March, 1988

EXECUTIVE SUMMARY
REGION OF HALTON LANDFILL STUDY
COMMENTS ON THE AFTER USE PROPOSED FOR SITES D AND F

This report provides a review and commentary on aspects of the after uses proposed for Site D and Site F by the Regional Municipality of Halton. The greatest emphasis is placed on the after use proposed for Site F. Ecological Services for Planning (Regional Municipality of Halton) and Smith Hoffman (Town of Milton) have examined the agricultural aspects of the two sites and the agricultural after use proposed for Site D. The writer has reviewed the agricultural after use reports and thinks that he can provide little additional insight to the Board in this respect.

For Site F, additional analysis of the after use is necessary to bring the concept to near the same level of detail as provided for Site D. The lack of detail in the Region's After Use report for Site F could lead to the impression that the natural area concept can be implemented easily and inexpensively.

The report arrives at four main conclusions:

1. The process of after use identification and description has not been developed to the same extent for the two sites. The lack of detail applied to Site F may leave the impression that the Natural Use Concept is readily implemented and trouble-free. In fact, it is a complex process with many unknowns.

2. If the Natural Area Concept extends beyond a simple "greening" of the landfill mound, the process must be considered experimental. There are relatively large gaps in our knowledge base about ecological processes that influence the development of a viable ecological system. Any plant community that develops on the site will not replace, in qualitative terms, the community that will be lost. We cannot equate the replacement community with the one that will be lost.
3. If the Natural Area Concept is to be implemented effectively, it will require a commitment to management over a period of years. A number of sub-issues include: topsoil sufficiency and depth, plant material, special treatment and management philosophy, all of which have a cost implication.
4. The implementation and management of the Natural Area Concept will lead to the after use costs substantially higher than those proposed by the Region. Based on alternative cost estimates, the after use cost could exceed \$5,177,325 (\$3,611,040 topsoil plus \$1,566,285 plant material) compared to the Regional estimate of \$2,150,000 which is comprised of \$1,598,000 for after use and \$552,000 for site closure soils purchase.

The overall conclusion of the report is that the Natural Area is an appropriate after use for Site F, but that the rehabilitation program is experimental. In terms of applied experience, less is known about natural area restoration than is known about agricultural rehabilitation. The natural area concept or naturalization plantings are commonly described as low cost/low maintenance systems. This is true when compared to conventional landscaping and over a longer time frame; however, there may be substantial costs associated with the implementation and management of these systems. Based on our experience with similar projects, the after use costs are underestimated.

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	
1.0 INTRODUCTION	1
2.0 SITE D: AFTER USE	3
3.0 SITE F: NATURAL AREA CONCEPT	5
3.1 Introduction	5
3.2 Concept Plan - Level of Detail	6
3.3 Natural Area Concept: Complexity and Implementation	7
3.4 Natural Area Concept: The Issues Related to Implementation	8
3.4.1 Soil Cover Sufficiency	9
3.4.2 Depth of Topsoil over Clay Cap	11
3.4.3 Plant Material: Type/Size	13
3.4.4 Special Treatment	14
3.4.5 Maintenance of Planting Areas	14
3.4.6 Summary: After Use Issues	15
4.0 SITE CLOSURE AND AFTER USE	16
4.1 Introduction	16
4.2 Site Closure: Cost	17
4.3 After Use Cost	19
5.0 SITE CLOSURE AND AFTER USE: ALTERNATIVE COST ESTIMATES	20
5.1 Introduction	20
5.2 Basis of Cost Estimates	20
5.3 Soil Depth: Alternative Depth Configurations	22
5.4 Alternative approaches to Planting Design	24
5.5 Special Treatment and Maintenance	29
5.6 Summary: After Use Costs	30
6.0 SUMMARY	31

LIST OF APPENDICES

- Appendix A Estimate of Soil Deficit at Site D based on
Smith, Hoffman Data
- Appendix B Response to Request of Information from
D. Stevens (May 25, 1987)
- Appendix C Landplan Collaborative: Confirmation of Cost
Estimate for Site F After Use (January 30, 1987,
Exhibit H-291)
- Appendix D Exhibit H-20A. Table 4 Revised Relative Land
Rehabilitation Cost Requirements by Site
- Appendix E Contractor Quotations - Supplies/Topsoil
- Appendix F Soil Quantity and Costing Calculations
Alternative Topsoil and Subsoil Depths
- Appendix G Representative Species List - Naturalistic Planting
- Appendix H Proposed Management Program for Naturalistic Planting

REGION OF HALTON LANDFILL STUDY
COMMENTS ON AFTER USE REPORTS FOR SITE D AND F

1.0 INTRODUCTION

The purpose of this report is to provide a review and elaboration of the after use proposed for Site F and to a lesser extent, the after use of Site D by the Region of Halton. The review is based on an examination of the After Use reports prepared by Landplan Collaborative Ltd. including the enclosed reports by Ecological Service for Planning and Farm Analytics.

These after uses are outlined in the following reports:

- . After Use Report - Site D
Halton Region Landfill technical Study
Schedule E - D (September, 1986) (Exhibit H-20)
- . After Use Report - Site F
Halton Region Landfill Technical Study
Schedule E - F (September, 1986) (Exhibit H-21)

The after use proposed for Site D is agriculture; a Natural Area Concept is proposed for Site F.

The review of the after uses proposed for Site D and Site F involved the following activities:

- . review of agriculture and after use documents prepared by the Region (Landplan Collaborative Ltd.)
- . visits to both Site D and Site F
- . review of agricultural report prepared on behalf of the Town of Milton (Smith Hoffman Associates)
- . attendance at Hearing during periods when agriculture and after use issues were discussed
- . review of transcripts and exhibits presented at the Hearing

- . review of Design and Operations reports for Site D (Exhibit H-41) and Site F (Exhibit H-42) as they relate to the proposed after use.

Original research was also completed.

In general terms, Ecoplans Ltd. agrees that the after uses proposed for the two sites are appropriate. The After Use reports (Exhibits H-20 and H-21, page 1) states that the after use proposals have been taken to a concept level of detail. Based on our review of the documents and the evidence presented, it is apparent that the agricultural after use program for Site D has been developed beyond the concept stage. However, for Site F, the natural area approach has been left at a concept level of development. We are concerned that the level of detail and debate devoted to the agricultural after use and the minimal discussion of the natural area approach beyond the concept level of detail may leave the impression that while the agricultural rehabilitation appears constrained by difficulties and unknowns, the natural area concept can be implemented without difficulty and is free of unknowns.

This report is separated into several sections. Section 2.0 briefly describes the after use proposed for Site D. Section 3.0 provides a more detailed discussion of the after use proposed for Site F. The concept is discussed under the following headings:

- . Concept Plan - Level of Detail
- . Complexity and Implementation
- . Issues Related to Implementation

Section 4.0 reviews the Regional estimates for Site Closure and After Use. Section 5.0 presents several alternative cost estimates for components of the after use for Site F. The conclusions are presented in Section 6.0.

2.0 SITE D: AFTER USE

For Site D, the agricultural after use has been extended well beyond a Concept Plan level of detail. The Ecological Services for Planning report, an appendix to Exhibit H-20 and H-21, provides information relating to the agricultural rehabilitation of both Site D and Site F. Section 3.0 of the Ecological Services for Planning Report (pages 5 to 16) discusses the feasibility of restoring both Site D and Site F to an agricultural after use. This section concludes that "... rehabilitation of Site F to an agricultural after use is not recommended" (page 17). Section 4.0 (pages 18 to 26) provides a detailed program for agricultural rehabilitation at Site D. The Summary and Recommendation section of the Ecological Services for Planning report recommended "... that Site D be rehabilitated to an agricultural after use ..." (page 1) and states that "Implementation of the proposed program will lead to satisfactory rehabilitation of Site D for arable agricultural production." (page 2). Appendix A to the Ecological Services for Planning report is an "Economic Analysis of Rehabilitating Landfill Sites for Agricultural Production", prepared by Farm Analytistics (January, 1986).

The information contained in the Ecological Services for Planning report, particularly Section 4.0, extends the agricultural rehabilitation proposal well beyond the concept plan stage as discussed in the Landplan Collaborative report. In fact, a detailed agricultural rehabilitation program has been developed for Site D. The rehabilitation program addresses issues related to soil stripping and stockpiling, reapplication

of soil material, soil restoration, post rehabilitation land management and post-rehabilitation monitoring. (See also Exhibit H-105, Site D Agricultural After Use.)

On behalf of the Town of Milton, Smith Hoffman prepared an independent soils and agriculture report which focusses mainly on Site D. The report is entitled: Agricultural Characteristics and Impacts of the Proposed Halton Region Landfill Site D (October, 1987) (Exhibit M-372). Smith Hoffman also reviewed the rehabilitation of Site D to an agricultural after use (Section 4.0 of Smith Hoffman Report, pages 36-62). Section 4.4 deals specifically with the rehabilitation of Site D to an agricultural after use. Section 4.5 identifies several areas of concern with the proposed scheme including availability of topsoil, cropping choice, agricultural capability, economics, off site and community impacts (not rehabilitation issues) and miscellaneous impacts.]

A concern highlighted in the Smith Hoffman report is an apparent shortage of topsoil required to achieve the 20 cm of topsoil recommended by Ecological Services for Planning, 1986 (Exhibit H-20, Figure 1, page 18). Depth of topsoil measures taken by Smith Hoffman indicate topsoil depths which range from 5 to 32 cm, with a mean depth of 17.88 cm. Based on this observation, Smith Hoffman states that "some soil will probably need to be taken from other areas on or off site if the 20 cm depth specified in the rehabilitation plan is to be maintained." (Exhibit M-372, Vol. 48; Transcripts, Vol. 71, page 16611, Line 13). [If it is assumed that 20 cm of topsoil is required for the 53 hectare landfill mound, a topsoil deficit of approximately 13,483 cubic metres will result. (See Appendix A for calculation.) At \$12/cubic metre, the cost of the imported soil delivered to the site would be in the order of \$161,798.] This assumes that a full 20

comment on this
 cm (12 inches) is required for the whole of the landfill mound. Sections of the landfill mound (side slopes) may not require the full complement of topsoil as these areas will be returned to permanent grass or forage.

It is our opinion that the proposed after use for Site D has been presented to the Board in considerable detail during the presentations by the Region and the Town of Milton. We do not intend to provide further comment as the previous consultants have presented considerable information to the Board.

3.0 SITE F: NATURAL AREA CONCEPT

3.1 Introduction

The After Use report for Site F recommends that a natural area concept be adopted as the after use for Site F. The natural area concept is described as follows (Exhibit H-21, Schedule E-F, page 37):

"The natural area concept is to restore Site F to self maintaining, essentially natural ecosystems that are representative of the latter stages of plant succession in the area. The concept involves extensive reforestation of native primarily indigenous species of trees and shrubs, using where possible existing vegetation on site."

The After Use report suggests that the advantages of the proposed after use concept are:

- . compatibility with the surrounding area
- . protection/integration with local vegetation
- . flexibility
- . protection of natural resources
- . minimal environmental disruption.

The following sections will discuss several of the major issues we have identified related to after use proposed for Site F.

3.2 Concept Plan - Level of Detail

Unlike the after use approach proposed for Site D, the after use concept for Site F has not been developed beyond a concept level of detail. The natural area concept has an attractive, evocative image. It evokes the image of an instant forest evolving naturally on the landfill mound. However, the implementation approach that will be adopted in establishing the forest community has not been described in the after use report. From practical experience in naturalistic planting programs, the basic approach to the planting program is fundamental to the success of the planting system. The site conditions to be created, the species mix, and the short and long term management of the plant community must be known before the concept can be evaluated. (In fact, we are surprised at the lack of critical comment on the part of the review agencies as to what is meant by the Natural Area Concept.) It would appear that each of the reviewers has an image of what is to be created and assumes that everyone else has a similar image. //

Generally, Ecoplans agrees that a Natural Area Concept, involving extensive reforestation, is an appropriate after use for Site F. However, it is our opinion that the approach should have been discussed in greater detail even at the concept stage. The Natural Area Concept, if it is to succeed, must be managed. Although this approach to rehabilitation is a low implementation and low maintenance cost approach, it can contribute to

relatively high costs in the early stages of development. Implementation approaches and management are critical elements to the overall success or failure of the overall rehabilitation process.

The lack of detail, when compared to the treatment of Site D, may leave the unfortunate impression that the implementation of a Natural Area Concept is relatively straightforward and without problems. In reality the rehabilitation of a landfill area to a naturalistic plant community is complex. Its long term success confronts many of the same problems faced by agricultural rehabilitation such as soil availability and site preparation, species selection, and short and long term management.

The Natural Area Concept has an attractive image, but it does require considerable human intervention and investment.

3.3 Natural Area Concept: Complexity and Implementation

As indicated above, the Natural Area Concept conveys an attractive image to the reviewer. Based on our interpretation of the term 'Natural Area Concept', it is our understanding that the objective of the rehabilitation of the landfill mound extends well beyond the simple objective of "greening" the mound. We assume that the Natural Area Concept involves the establishment of a forest system that bears some resemblance to a natural functioning forest ecosystem (not a plantation).

The creation of naturalistic plantings are experimental. Few functioning systems have been established long enough or at a large enough scale to evaluate their overall success. We do not know if they will conform to a model (natural) forest community. Small area experimental plots indicate that simplistic replications are possible. In any case, the

initial planting will be a simplistic version of a natural system. It is not possible to replicate the complex nature of a naturally evolved biological system and it may take 70 to 100 years for the replacement forest to mature. Even at this point in its evolution, it will not resemble the diverse forest system that will be removed to accommodate the landfill site. The successional dynamics, site conditions and different set of environmental influences will not lead to a replication of the lost community.

Initially, the rehabilitation vegetation community will be a relatively simplistic replacement of a previously diverse natural ecosystem. It will require several years of positive management intervention to direct the rehabilitation planting program in a desired successional direction and ongoing management as the tree community matures.

3.4 Natural Area Concept: The Issues Related to Implementation

The After Use report (Exhibit H-21) did not specify how much of the landfill mound (50.2 hectares) will be rehabilitated to woodland vegetation. However, response to information requests (Appendix B) and evidence given by Mr. D. Stevens, Landplan Collaborative, indicate that approximately 60% (30 hectares) of the landfill mound will be planted to woody vegetation. The remainder will be rehabilitated to a meadow-like vegetation community. Other areas of the larger site such as temporary spoil storage areas will also require rehabilitation.

A number of basic issues have been identified that relate to the overall revegetation program and its ultimate success. The issues are outlined below:

- . sufficient topsoil to allow the establishment of native indigenous trees and shrubs on site must be obtained on or off site
- . minimum cover (including A, B, C soil horizons) needed is 0.5 to 1.0 m, over cap (greater depths recommended in after use report)
- . control of methane and CO² in the soil
- . structure and fertility needs of the plant community
- . use of native/non-native species
- . protection and incorporation of existing vegetation on site
- . reclamation staging
- . environmental protection measures.

From this longer list, the major issues faced in the rehabilitation programme are elaborated, including the following:

- . sufficiency of topsoil on site
- . depth of soil and topsoil required over the clay cap
- . type/size of plant material to be used
- . special treatment for gas and leachate, if any
- . maintenance of the planting system, including weed control, replacement, fertilization, watering, deer and rodent control.
- . rehabilitation phasing.

These concerns have not been addressed in the After Use report, but their resolution will be critical to the success of the after use program and to the cost of the rehabilitation effort.

3.4.1 Soil Cover Sufficiency

The sufficiency of topsoil at Site F is a critical issue. It would appear that there will be a substantial shortfall of topsoil required for rehabilitation purposes at Site F. Dr. McIntosh (May 7, 1987; Exhibit

H-20A) indicated that 138,000 cubic metres of soil cover are available on site, including topsoil (A Horizon) and subsoil (B and C Horizon). If a full metre of cover soil is required for the 50.2 hectare landfill mound (equivalent to agricultural requirements), a total of 502,000 cubic metres would be required for rehabilitation, leading to a soil deficit of approximately 364,000 ($502,000 \text{ m}^3 - 138,000 \text{ m}^3$) cubic metres. It is not expected that the soil depth recommended for agriculture will be needed for the whole of the landfill mound for effective rehabilitation to the Natural Area Concept. However, we do anticipate a soil cover deficit of considerable magnitude.

It is not clear from the documentation whether the 50.2 hectares refers to the basal area of the landfill mound or to its total surface area. If it represents basal area only, the soil deficit may be even greater because the surface area of the landfill mound will be greater than the basal area measurement. A preliminary calculation of the mound surface area indicates that up to 5 additional hectares of land surface may be created by the mound. This additional area would also require rehabilitation. However, in the following commentary, the 50.2 hectare area figure will be used as the basis of all the quantity and cost calculations. In a latter section, several alternative soil depth configurations will be developed.

3.4.2 Depth of Topsoil over Clay Cap

The After Use report (Exhibit H-21, Schedule E-F) contains several comments about the depths of soil cover that are required to sustain tree growth. The following citations taken from the After Use report indicate the range of soil depths under consideration.

Page 45

"The total 2 m of cover (cap and topsoil) is essential to accommodate after establishment of trees in certain areas of the site."

Page 46

"Gilman et al. (1983) recommend a minimum of 90 cm of good soil cover for acceptable growth of wood plants. The top 20 cm of this should be topsoil to accommodate fine feeder roots."

Page 48

"... it is recommended that the site be covered with sufficient topsoil to support woody growth. A minimum of approximately 1.5 m of soil cover with at least 30 cm of topsoil (A/Ap horizon material) should be used. Some areas will require less soil cover. Deep rooted species may require 2 m of cover over refuse or special methods such as gas venting or insulation to insure growth."

It is not clear whether the depths cited on page 48 include the compacted clay cap. However, in direct examination, Mr. Stevens indicated "that a certain amount of topsoil has to be provided and our current thinking is that 1 metre more or less for forested vegetation over the cap is required." (Transcripts, Vol. 14, page 3283, Lines 12-15.)

The Design and Operations Report indicates that 20 cm of soil cover will be placed over 2 m of compacted subsoil presumably as part of the site closure program. (Exhibit H-42B, Schedule A-F, Drawing 8r of 11 [Landfill Operation and Site Appearance at End of Year 3]).

In a response to a request for additional information about the proposed after use, dated May 25, 1987, it was indicated that the soil depths "... should range from approximately 20 cm to 100 cm depending on vegetation and location." (Appendix B.) It is assumed that this indicates the depth of cover over the compacted subsoil/clay cap.

The existing documentation shows some inconsistency in stating the proposed cover conditions for the landfill site.

The Landfill Closure and After Use Report for the existing Regional Landfill Site at Burlington recommended in 1985 that the following soil conditions be established. The relevant section has been reproduced below.

"Topsoil and Revegetation"

After the final clay cover has been spread a minimum of 300 mm of topsoil (A Horizon) suitable for preserving soil moisture and providing a suitable growing medium for herbaceous cover will be installed. The topsoiled area will then be seeded with an appropriate herbaceous seed mixture corresponding to site conditions. Designated planting areas for woody vegetation will require an additional 700 mm of cover soil consisting of B or C Horizon from a typical upland soil. This will provide a minimum planting depth of 1000 mm (700 mm cover soil plus 300 mm topsoil) above the 600 mm final clay cover. (Emphasis added.)

As planting of woody vegetation will take place over a number of growing seasons, the preparation of planting beds will require that just prior to planting 300 mm of topsoil be removed, the 700 mm of cover soil added, and the topsoil replaced. When the planting of woody vegetation occurs within the same season as topsoil is to be spread, the 700 mm of cover material should be added first and the topsoil placed in a single operation."

Regional Municipality of Halton,
Regional Sanitary Landfill Site:
Burlington Landfill Closure and After
Use Report, December, 1985, p. 7.

Assuming the above approach is reasonable, it could be applied to the proposed forest areas at Site F. The authors of the report are not identified. The Master Plan (enclosed in report) indicating the proposed tree and shrub planting areas was prepared by Landplan Collaborative Ltd. Landplan's involvement was confirmed by Mr. Stevens in evidence (Transcripts, Vol. 14, page 3387, line 21 to page 3389, line 5). If this approach is adopted for 60% of the proposed landfill site, a substantial soil deficit will be created. The approach to applying the soil cover is an expensive procedure involving repeated soil stripping and application.

3.4.3 Plant Material: Type/Size

The plant material has not been specified except in the most general terms (native species, shrubs, trees). A May 25, 1987 Interrogatory Response (Appendix B) states:

"The size of the plant material has not been specified at this stage of concept development. We anticipate that a range of plant material will be used including seedlings, small and medium sized stock and larger stock (up to say 100 mm bole diameter) as needs and plant material supply become more precisely known."

An understanding of plant material proposed is essential to developing a reasonable cost estimate. A basic rule is that the larger the plant material, the more expensive it will be.

3.4.4 Special Treatment

Management requirements for controlling gas and leachate in the planting zones were not identified at the Concept Plan stage. Cost estimates for potential treatments vary widely. However, gas venting for larger trees will cost in excess of \$10 per tree.

3.4.5 Maintenance of Planting Areas

The after use concept for Site F is generally silent on the pre and post installation management requirements for the rehabilitation program. There is no comment on weed control, plant replacement, rodent control inter alia., all of which will affect the success of the rehabilitation program. It has been our experience based on research and applied work that initial management procedures (years 0 to 5) are critical to the successful establishment of a naturalistic planting system. There may be a significant cost element associated with this component of the rehabilitation plan.

The May 25, 1987 response stated:

"The nature of the maintenance will be formulated once the detailed planting plan and specifications are set. We anticipate that a low maintenance approach will be used." (Appendix B, Page 2.)

The low maintenance approach is a valid concept, but there is a cost associated with a low maintenance approach. It is a low maintenance and low cost approach only in comparison with more traditional landscaping approaches.

3.4.6 Summary: After Use Issues

Based on the preceding discussion, it can be assumed that an absolute minimum of 20 cm of soil cover will be used over the compacted subsoil; a preference for 30 cm minimum of soil cover even in the future meadow areas is indicated in the After Use report. The After Use report and other proponent responses recommend that up to one metre of soil cover (with 20 to 30 cm topsoil) be used in the areas to be planted to trees. Greater depths were recommended for areas supporting deeper rooted tree species. If the one metre or more of topsoil is required a substantial soil deficit at Site F will ensue.

The responses also indicated that a range of tree and shrub sizes will be used ranging from seedling to specimen-sized trees (100 mm bole diameter). The size specification will have a considerable bearing on the cost of the planting. Management and special treatments for gas and leachate were not discussed but were deferred to a later stage of planning. They are critical to the success of the after use program.

4.0 SITE CLOSURE AND AFTER USE

4.1 Introduction

When the landfill site has reached its approved capacity, the site will be closed and the area rehabilitated. There are two components to this final phase of the landfill life history: site closure and after use. Site closure involves the placement of the final cover (2 metres compacted subsoil and .2 metres topsoil), mass grading (removal of berms, etc.) and placement of imported topsoil and hydroseeding. The Design and Operations Report (Exhibit H-42, page 102) indicates that in addition to the placement of final cover, the site closure activities will include ongoing site management, including:

- continued leachate collection and disposal
- area grading to minimize adverse effects from differential settlement
- reapplication of cover to eroded areas
- maintenance and repair to revegetated areas
- leachate and gas monitoring
- storm water monitoring.

After use involves activities required to establish the recommended after use on the closed landfill site. Activities include the placement of recommended soil cover, purchase and installation of plant material, maintenance, monitoring, and the design and construction of recreation facilities. The activities associated with site closure and after use may overlap to some extent, particularly in the area of soil placement.

In respect to After Use the Design and Operations Report (Exhibit H-42, page 95) for the period following Year 11 Operations states that:

"While the contours will have been reached for all of Cell 1 with the exception of the area where Cells meet it is not expected that the area will be revegetated for after use. Instead, the completed area will have the required depth of final cover placed and then hydroseeded. In this way localized settlements and depressions can be rectified as they occur without the loss of valuable imported topsoil."

Based on the above, it would appear that the after use program for Site F will not be implemented until the end of the landfill operation. The final phase of the landfill operation is described as follows:

"Once the filling has been completed to final grades, the stockpiles and berms will be dismantled and used to augment the final cover depths as well as to create the landforms as specified in the after use report." (Exhibit H-42, page 96.)

Although the After Use report indicates a phased rehabilitation program, the Design and Operations Report specify an end-of-operation implementation.

4.2 Site Closure: Cost

Consultants for the Region of Halton have presented site closure cost. The figures below are taken from Schedule K (Economic Impact and Affordability Analysis [C.N. Watson and Associates], Exhibit H-45, pages 3-3, A-8). The site closure costs are stated as follows:

Components of Cost

1. Final Cover

50.2 ha at \$40,000/ha	\$2,000,000
------------------------	-------------

2. Mass Grading

	200,000
--	---------

3. Imported Topsoil and Hydroseeding

50.2 ha at \$15,000/ha	<u>750,000</u>
------------------------	----------------

	\$2,950,000
--	-------------

It is not our intent to comment on the site closure costs other than to examine the provision of imported topsoil to the site. The report contains no internal breakdown of the cost under Item 3 (Imported Topsoil and Hydroseeding). Our enquiries indicate that hydroseeding costs range from \$0.24/m² (\$2400/ha) to \$0.40/m² (\$4000/ha). If these costs are representative, the imported soil component of the \$15,000 per hectare allocation is between \$11,000 and \$12,600 per hectare or between \$552,200 and \$632,520 for the total site. It is assumed that the \$750,000 budgeted for topsoil and hydroseeding will be required to establish the 20 cm cover specified in the Design and Operations Report.

4.3 After Use Cost

Landplan Collaborative Ltd. provided the following cost breakdown for the proposed after use costs for Site F (Exhibit H-291, January 30, 1987, Appendix C). The cost elements are as follows:

Soil	\$1,088,000
Spreading	378,000
Plant Material	112,000
Maintenance	<u>20,000</u>
Total	\$1,598,000

The after use estimate indicates that a total of \$112,000 has been allocated for the purchase of plant material for the 30 hectare afforestation area or \$3,750 per hectare. It is not clear whether the \$112,000 includes any provision for the installation cost for the plant material. An additional \$20,000 has been allocated for maintenance which is equivalent to about one person year for the maintenance for the 30 hectare (or 50.2 hectare) site. No provision is made for trails and other recreational facilities anticipated in the after use concept.

The above is the most detailed estimate of after use cost available for review. It is the reasonableness of these estimates that will be addressed in following sections.

Both the Site Closure and After Use estimates have made provision for the purchase of imported soil material. The amount allocated is in the order of \$1.7 million (\$1,088,000 [After Use]; \$552,000 [Site Closure]).

The volumes and cost per cubic metres have not been indicated in either case. The only cost estimate for imported soil is \$7.19/m³ (Exhibit H-21A, page 14, Appendix D). This estimate does not include delivery or spreading costs.

5.0 SITE CLOSURE AND AFTER USE: ALTERNATIVE COST ESTIMATES

5.1 Introduction

In the following sections, several alternative approaches to the costing of the After Use concept for Site F are formulated. The purpose of this exercise is to test the reasonableness of the Regional cost estimates. The estimates have been developed using independent research and experience with similar undertakings. Ecoplans Ltd. staff also operated its own nursery (Natural Woodland Nursery), growing native plant species for a period of 5 years. The costs of materials, supplies and activities were derived from trade journals and catalogues, supplier contacts and ongoing experience with similar projects (Appendix E).

5.2 Basis of Cost Estimates

In order to develop the alternatives, it was necessary to develop a number of base conditions. An alteration in one or more of the base conditions will affect the final cost estimate. The cost estimates are not meant to be exact estimates, but are intended to provide orders of magnitude in the cost estimates.

The base conditions are outlined below:

- . Required soil cover will be purchased and will not arrive as waste material.
- . Topsoil (20 cm): 27,600 cubic metres
B & C horizon (80 cm): 110,400 cubic metres

Available soil cover on site: 138,000 cubic metres

(Source: Agricultural Impact and Rehabilitation Report, Exhibit H-20A.)

- . Available on site topsoil and subsoil will provide 0.27 metres of cover if spread evenly over 50.2 hectare mound (0.05 metres Ap horizon; 0.22 metres B and C horizon).
- . Soil spreading compaction factor: 20% (to achieve 20 cm cover depth requires 24 cm of soil delivered).
- . Soil costs delivered to site: 1987 cost estimates based on suppliers' quotations.
 - . \$9.15 to \$11.11 per cubic metre (unscreened)
 - . \$12.00 to \$17.00 per cubic metre (screened)
- (Topsoil cost for 1986 rehabilitation work at existing Regional landfill site - \$12.75 per cubic metre.)
- . Soil spreading cost: \$1.70 to \$3.50 per cubic metre: assume \$2.00 per cubic metre. (Higher per metre³/costs cited by suppliers - \$2.50 to \$3.50.)
- . 30 hectares of the site will be planted to trees and shrubs; the 30 hectares will require greater soil cover depths than is available on site (>27 cm).
- . Commercial nursery and MNR nursery stock available and used for rehabilitation.
- . Minimal use of salvage stock due to availability problem, low survival rates, scale of salvage operation required.
- . Hydroseeding: quotations for 1987 range from \$2,400 to \$4,000 per hectare; \$2,400 used in calculations.

5.3 Soil Depth: Alternative Depth Configurations

A number of alternative soil depth configurations have been developed for Site F. The costs include soil purchase, soil spreading, and subsoiling. Hydroseeding costs have not been included in the calculation. Details of the calculation are included in Appendix F. The cost estimate will vary depending on the amount of cover material that is available at the time of site closure or has been stockpiled.

Soil Alternative A

20 cm of topsoil over 22 cm of subsoil which is available on site:
5 cm of topsoil available on site. Total soil cover depth: 42 cm
over 50.2 hectare site.

\$1,229,126.00

Soil Alternative B

30 cm of topsoil over 22 cm of subsoil available on site: 5 cm of
topsoil available on site. 30 cm of topsoil applied to whole of
landfill site (50.2 hectares). Total depth of cover: 52 cm.

\$2,012,246.00

Soil Alternative C

30 cm of topsoil over 22 cm for meadow zone:
or 20 hectares; total depth 52 cm
30 cm of topsoil over 70 cm of subsoil in
tree planting zone:
or 30.2 hectares; total depth 100 cm

\$3,611,040.00

Soil Alternative A provides a minimum depth of soil cover providing both subsoil and topsoil profiles for the landfill site. It provides for 20 cm of topsoil over 22 cm of subsoil which is available on site and the compacted subsoil material. It does not meet the topsoil and subsoil

depths recommended in the After Use report, particularly in the tree planting zones where 30 cm of topsoil and 70 cm of subsoil are recommended. The cost of the topsoil required is less than that provided in the Regional estimates.

Alternative B extends the 30 cm topsoil cover to the 50.2 hectare site. This is the depth of topsoil recommended for the existing Burlington site. However, there is no provision for extra subsoil depth in the tree planting zones. In these areas, up to 52 cm of topsoil/subsoil will overlie the compacted subsoil cap. A full metre has been recommended in the After Use report. The cost, at \$2.01 million, approximates the soil costs included in the Regional estimates.

Alternative C meets the soil depths specifications as presented in the after use report. It provides for a full metre of topsoil/subsoil in the tree planting zone and 52 cm of topsoil/subsoil in the non-tree vegetation area. This soil depth does not include the compacted subsoil layer (cap). The total depth to refuse is 1.52 metres to 2 metres. The cost of the imported soil, at \$3.6 million, exceeds by approximately \$1.5 million the estimate provided by the Region.

There are numerous soil depth configurations which may affect the soil cost. For example, if minimal depths of topsoil over subsoil (5 cm topsoil over 22 cm subsoil) are acceptable for the future meadow areas, soil import costs can be reduced. However, this may limit future vegetation management in these areas. A major unknown is the amount of suitable material that will be available at minimal cost arriving as waste or surplus material.

Based on the after use report recommendation, literature review and personal experience, Soil Alternative C is an appropriate soil depth strategy.

5.4 Alternative Approaches to Planting Design

There are several approaches to the implementation of the planting program. The planting options reflect the use of different types of plant material (size, age) and planting densities. It has been assumed that an adequate soil depth has been provided for good tree growth and survival.

One potential approach to planting design has been developed to illustrate the potential costs associated with a large scale planting. The planting option selected reflects the approach indicated in a response (May 25, 1987, Appendix B) to a request for information. The response stated:

"We anticipate that a range of plant material will be used including seedlings, small and medium size stock and larger stock (up to, say, 100 mm bole diameter) as needs and plant material supply become more precisely known."

Based on the philosophy outlined in the above statement, a mixed planting approach has been developed. The planting includes areas planted to Standard Forestry Stock as might be provided by the Ministry of Natural Resources. The individual trees are 30 cm to 36 cm (12 to 14 inches) in height. It has been assumed that 25% of the woodland planting zone of the site will be planted with this size of material. Other sections of the landfill site (50%) will be planted with small and medium sized stock (1 to 2 metre whips); a further 25% of the site will be planted to larger stock (40 mm bole diameter [1.5 inch]). We have not included any 100 mm (4 inch) plant material as they are extremely expensive (\$100+ per tree FOB [wholesale] at nursery gate). Larger specimen trees (60 mm to 100 mm bole

diameter) are only appropriate for higher profile locations (interpretive node or demonstration area) due to their high purchase and installation costs and high maintenance requirement.

It must be realized that the cost of the plant material component will vary dramatically depending on the density of the planting and the size of the material installed. It is obvious that the least expensive approach would be to use Standard Forestry Stock where the total cost and cost per hectare are relatively low. This approach may be appropriate for relatively larger blocks of the site provided a variable species mix is used. The planting should not result in the restored site looking like a massive plantation.

As the size of the plant material increases, the cost of the plant stock and installation escalates rapidly - from a few cents or dollars per unit to more than \$100 for a specimen sized tree. Using larger stock, cost per hectare could easily exceed \$100,000.

The following cost breakdown assumes that the woodland area of the landfill will be planted in the following fashion.

Area A	25%	7.5 hectares	Standard Forestry Stock (30 to 36 cm)
Area B	50%	15 hectares	1 to 2 metre whips
Area C	25%	7.5 hectares	40 mm bole diameter

The costs assume that the planting is installed by a contractor and includes cost of the plant material and installation. The per unit costs for the larger stock are based on a landscape contractor's statement of cost for installation of plant material on a southern Ontario landfill site.

Area A (25%: 7.5 hectares))

Plant Material: Standard Forestry Stock
 Plant Size: 30 cm (12 inch) to 36 cm (14 inch)
 Number of Trees/Hectare: 2470 (2 m x 2 m spacing)
 Plant Material Cost: \$0.40 per unit average (\$0.05 if MNR stock available)
 Tree Cost: 2,470 x 7.5 hectares x \$0.40 = \$7,410

Planting Cost (1)

Machine Planting (20-30% slopes) \$200/ha x 7.5 = \$1,500.00

Hand Planting \$370/ha x 7.5 = \$2,775.00

Total Cost \$8,910 to \$10,185.00

Cost/Hectare (\$1,358.00)

(1) Based on MNR Cost Statement

Area B (50%: 15 hectares)

Plant Material: Nursery Stock
 Plant Size : 1 to 2 metre whips, bare root
 Number of Trees/Hectare: 2,470 (2 X 2 metre spacing)
 Plant Material Cost/Unit Installed:

Trees \$20-\$30 per unit

Shrubs \$ 8-\$12 per unit

Total Number of Plants: 2,470 x 15 hectares = 37,050

Trees: 80% x 37,050 = 29,640

Shrubs: 20% x 37,050 = 7,410

Cost: Trees 29,640 x \$25 = \$741,000

Shrubs 7,410 x \$10 = 74,100

Total Cost \$815,100

Cost/Hectare (\$ 54,340)

Area C (25%: 7.5 hectares)

Plant Material: Nursery Stock
 Plant Size: 40 mm bole diameter (1.5 inch bare root)
 Number of Trees/Hectare: 2,470 (2 X 2 metre spacing)
 Plant Material: Cost/Unit installed by contractor

Trees: \$45 to \$50

Shrubs: \$ 8 to \$12

Total Number of Plants: 2,470 x 7.5 hectares 18,525

Trees: 80% x 18,525 14,820

Shrubs: 20% x 18,525 3,705

Cost:

Trees: 14,820 x \$47.50 \$703,950

Shrubs: 3,705 x \$10 37,050

Total Cost: \$741,000

Cost/Hectare (\$98,800)

Total Cost	Area A	\$ 10,185.00
	Area B	815,100.00
	Area C	<u>741,000.00</u>

Site Cost \$1,566,285.00

Cost/Hectare (\$ \$52,209.50)

A change in the area devoted to each type of planting would affect the cost. In the above example, the larger stock (1-2 metre whips) was emphasized to provide a more rapid development of the forest system. Without maintenance, the smaller stock is slow in developing due to grass and weed competition. Using the same per hectare costs for the different sized plant material, an alternative spatial arrangement would provide the following results.

Area A	Standard Forestry Stock	15 ha (50%)	\$ 20,370.00
Area B	1 to 2 metre Whips	7.5 ha (25%)	407,550.00
Area C	40 mm bole diameter	7.5 ha (25%)	<u>741,000.00</u>
Total Cost			\$1,168,920.00
Cost/Hectare			(\$38,964.00)

The cost of the plant material can be reduced only by reducing the number of trees planted and the size of the material used.

A representative species list that might be used in a naturalistic planting regime has been prepared (Appendix G). The list was prepared to give the Board some idea of potential tree species, species mix, size and cost of a typical planting. The costs were derived from 1987-1988 wholesale nursery catalogues.

The cost of the plant material varies directly with the size of plant material, the spacing of the planting, source of the plant material and the means of installation. The above figures have assumed contract installation. Lower cost might be achieved using other sources of labour such as volunteer or student labour. This type of labour may be useful in certain areas, however there are problems associated with this type of labour force including continuity, organizing labour when needed, and higher mortality particularly of the larger plant sizes. It is unlikely that salvaged plant material will play a significant role in the planting program due to its sporadic availability, low survival rate and cost of salvaging (labour).

Based on the above figures, the \$112,000 allocated to plant material by the Region in the after use cost estimate would appear to be unrealistically low. At normal planting densities (2,470 units per hectare

for 30 hectares) this dollar value would require that the trees and shrubs be purchased and installed at an average cost of \$1.51 per unit; at 1,200 trees per hectare (3 m X 3 m spacing), the per unit cost would be \$3.11. It is unlikely that even salvaged, no cost stock could be planted at these low levels.

5.5 Special Treatment and Maintenance

The cost estimates do not include any provision for special treatment for gas and leachate concerns in the tree planting zones, site preparation (tilling, weed suppression, wood chipping), maintenance (weed control, rodent and deer control, replacement planting) and monitoring. A framework for post-construction management of a naturalistic planting is included as Appendix H.

The potential cost estimates described to this point do not include provision for most of the following activities:

- . Site preparation
 - Tilling \$300 per hectare
 - Herbicide \$0.50/sq metre
 - Wood chips \$3.00/sq metre
- . Gas Venting or other special treatment
 - Minimal venting: \$10/tree for specimen trees
- . Maintenance: weed control, watering, rodents, tree replacement
 - 30 ha x 5 days/year x 7.5 hr x \$12/hr = \$13,500.00
- . Recreational Facilities
 - . Trails \$10 per metre lineal distance
 - . Picnic Areas \$1,000 per table area
 - . Signage To be determined

5.6 Summary: After Use Costs

The cost estimates outlined in the previous sections indicate that the implementation cost for the Natural Area Concept for Site F After Use may be substantially higher than those proposed by the proponent. Based on our calculations, the cost to place a full metre of topsoil/subsoil in the tree planting zones is approximately \$3,611,000 or approximately \$1,513,000 more than that provided for in the Regional estimate (\$2,098,000 for topsoil purchase and spreading).

The Regional estimates for planting material are substantially below what is required to provide a reasonably quick establishment of forest cover. The Regional estimate provides only \$112,000 for plant material or \$3,733 per hectare. Alternative estimates of plant material cost are much higher, up to \$1.56 million. While it is agreed that lower costs can be achieved by using less expensive stock (salvaged or contract growing) and low cost labour, we do not believe that \$3,733 per hectare cost is a realistic estimate for the type of rehabilitation anticipated in the After Use report. The Regional cost estimates provide only \$1.51 to \$3.11 to purchase, transport and plant an individual tree, depending on the plant density anticipated. We believe this is an unreasonably low estimate.

There is no provision for special treatment which may be required and a totally inadequate allocation of money to the maintenance of the planting program. The \$20,000 allocation provides for approximately one person year for the 30 hectare afforestation area.

While we agree that the Natural Area Concept is an appropriate after use for Site F, we do not believe that the cost estimates provide a realistic indication of the costs associated with the concept. In addition, no provision is included in this estimate for other after use components such as post-construction management, trails, picnic areas, and parking, which realistically should be included in the after use cost profile.

We believe that the after use for Site F (including Site Closure topsoil cost [\$552,000]) could exceed \$5 million.

6.0 SUMMARY

Based on our review of the After Use reports, we think that the after uses proposed for Site D and Site F are appropriate and should be implemented. The after use program for Site D has been explored in considerable detail by Regional and Town of Milton consultants before the Board. Smith Hoffman, acting for the Town of Milton, identified a potential deficit of topsoil. If proven, a deficit of approximately 13,500 cubic metres would result.

The preceding report has not examined the agricultural after use in great detail. However, we do think that it is a feasible after use. The state-of-the-art in agricultural rehabilitation is developing rapidly; by the time the site is nearing closure, our understanding of agricultural rehabilitation will be more advanced.

For Site F, Ecoplans Ltd. maintains that the after use proposed for Site F is appropriate. Four major conclusions are derived from our review of the natural area after use concept. They are as follows:

1. The after use concept for Site F has not been examined with the same rigour as the after use proposed for Site D. We are concerned that the lack of detailed assessment may leave the impression that while the agricultural rehabilitation faces many difficulties and unknowns, the natural area after use at Site F can be readily implemented and faces few unknowns.
2. From our theoretical and practical experience, natural area restoration is highly experimental and faces many unknowns. If the Natural Area Concept extends beyond a simple "greening" of the mound, the rehabilitation process must be considered experimental, particularly at the scale recommended for Site F. There are many unknowns about the ecological processes involved in the re-creation of natural areas. The plant community that develops on the landfill mound over several decades will not replicate the high natural value woodland lost to the landfill operation.
3. Based on our review and independent research, it is our opinion that the cost estimates for the after use are underestimated. The purchase, delivery and spreading of topsoil, the purchase and installation of plant material, and ongoing maintenance, will add to the overall cost of the landfill operation.
4. The implementation and management of the Natural Area Concept will lead to costs substantially higher than that provided by the Region. Alternative estimates identify costs in excess of \$5.0 millions, excluding management and recreational development. The Regional cost estimates total \$2,150,000.

Natural area restoration remains an experimental process. A great deal of additional research is required.

APPENDIX A

Estimate of Soil Deficit at Site D
based on Smith Hoffman Data

APPENDIX A

ESTIMATE OF SOIL DEFICIT AT SITE D BASED ON SMITH HOFFMAN DATA

Area of Landfill Requiring Topsoil	53 hectares
Depth of Topsoil Required	20 cm
Depth of Topsoil Available	17.88 cm
Deficit	2.12 cm
Compaction Factor	20% (see Appendix E)
Cost Good Topsoil	\$12 (Low End of Range See Appendix E)
Volume of Topsoil Required:	
53 ha X 10,000 m x 0.0212 m X 1.20 =	13,483.20 cubic metres
Cost of Topsoil Imported	
13,483.20 cubic metres X \$12 =	\$161,798.40

APPENDIX B

Response to Request of Information
from D. Stevens (May 25, 1987)

APPENDIX B

Wei and Fields

May 25 1987

Attn: Mr. M. J. McQuaid

Re: Halton Environmental Assessment Hearing - Request
of Information from D. Stevens.

The following ^{are} ~~also~~ the responses to your list of regarding
interrogatories to Mr. Stevens submitted on May 11, 1987 ^{at} ~~the~~
after use of Site F.

- (i) The area (%) of Site F planted to trees and
shrubs is approximately 60%.
- (ii) The size of the plant material has not been
specified ~~at~~ at this stage of concept development.
we anticipate that a range of plant material
will be used including seedlings, small and
medium ^{size} stock and larger stock (up to, say, 100 mm
bole diameter) as needs and plant material supply
become more precisely known.
- (iii) The after-care concept proposed for ~~the~~ site F
includes areas of field vegetation, forest, ~~and~~ shrub
and ~~habitat~~ ^{and} ~~habitat~~. Depths of soil stored range from approximately
20 cm to 100 cm. Depending on vegetation and

- (IV) The availability of suitable soil and subsoil has not been precisely assessed. The data on soil availability found in the appendix to the after-use report are representative in this regard.
- (V) Details on the implementation have not been established as ~~the~~ the after-use is presented at a concept level of detail. A planting plan, specifications and an implementation ~~and~~ program will be formulated once the site is approved for landfilling.
- (VI) The nature of the maintenance will be formulated once the detailed planting plan and specifications are set. We anticipate that a low maintenance approach will be used.

If there are any further questions on our proposed after-use concept please do not hesitate to contact us.

Yours,

RL

APPENDIX C

Landplan Collaborative: Confirmation of
Cost Estimate for Site F After Use
(January 30, 1987, Exhibit H-291)

APPENDIX C

January 30, 1987.

landplan

landscape architects
environmental scientists

C. N. Watson and Associates Ltd.,
211-2 Dunbloor Rd.,
ISLINGTON, Ontario.
M9A 2E4

319 WOOLWICH STREET,
GUELPH, ONTARIO
N1H 3W4
(519) 824-8664

TORONTO, ONT.
SASKATOON, SASK.

Attention: Ms. C. Kilgour

Dear Sirs:

RE: CONFIRMATION OF COST ESTIMATE FOR SITE F AFTER USE
OUR FILE: G86076

As we discussed recently by telephone, this will confirm our cost estimate (October 15, 1986) of \$ 1,598,000 for Option 3 (preferred) for Site F After-use.

The revised breakdown is:

Soil	\$ 1,088,000.
Spreading	378,000.
Plant Material	112,000.
Maintenance	20,000.
Total	<u>\$ 1,598,000.</u>

Yours very truly,

THE LANDPLAN COLLABORATIVE LTD.,


Denis G. Stevens.
DGS/cb.

APPENDIX D

Exhibit H-20A. Table 4 Revised
Relative Land Rehabilitation Cost Requirements by Site

Table 2 - Revised - Soil Cover
Requirements for Rehabilitation
- Site F ($m^3 \times 1000$) (p.10)

	<u>Ap horizon*</u>	<u>B+C horizon**</u>	<u>Total</u>
Soil Required (50.2 ha)	100.4	401.6	502.0
Soil Available onsite (13.8 ha - exclusive of buffers)	27.6	110.4	138.0
Soil Required offsite	72.8	291.2	364.0

* Assume Ap horizon (topsoil) depth - 20 cm

** Assume B+C horizon depth - 80 cm.

(Agricultural Impact and
Rehabilitation Report)
Exhibit #20

7/05/87

Table 4: Revised - Relative Land Rehabilitation Cost Requirements by Site. (P15)

	<u>Site D</u>	<u>Site F</u>
• Additional topsoil/subsoil - 364,000 m ³ @ \$7.19	**	\$2,617,160
• Topsoil haulage - * TONNES @ \$5/tonne/km (Assuming 50 km round trip)	**	\$1,542,358
• Agricultural subsoiling - Site D - 51.9 ha @ \$432/ha	\$22,421	
- Site F - 50.2 ha @ \$432/ha		\$21,686
• Total investment cost	<u>\$22,421</u>	<u>\$4,181,204</u>

* exclusive of spreading

** Adequate topsoil/subsoil available.

(Agricultural Impact and
Rehabilitation Report)
Exhibit #20

APPENDIX E

Contractor Quotations - Supplies/Topsoil

APPENDIX E

TOPSOIL PRICES: BASED ON TELEPHONE QUOTATIONS: FEBRUARY 5, 6, 7, 1987

1. Westmount Trucking and Excavating Inc.
Kitchener
 - \$7/yard³ unscreened topsoil
(\$9.15/m³) delivered in region
 - \$9.50/yard³ screened topsoil
(\$12.40/m³) delivered in region
2. Kieswetter Cartage and Excavating Co. Ltd.
Kitchener
 - \$7/yard³ unscreened topsoil
(\$9.15/m³) delivered in region
3. Geo. Dietrich Construction Ltd.
St. Clements
 - \$8.50/yard³ unscreened topsoil
(\$11.11/m³) delivered in region
 - \$11.50/yard³ screened topsoil
(\$15.00/m³) delivered in region
4. B. and B. Kieswetter Excavating Inc.
Kitchener
 - \$8.00/yard³ unscreened topsoil
(\$10.45/m³) delivered in region
 - \$13.00/yard³ screened topsoil
(\$17.00/m³) delivered in region
 - \$41/hour (1986 price) for haulage outside region
 - 20-25% reduction in price for large quantities
5. Greco Aggregates
Mississauga
 - \$15.00/yard³ screened topsoil
(\$19.60/m³)
 - 7 yards³ delivered \$130

6. Estimates for Topsoil Spreading and Tree Planting

Bruce Evans Ltd., Toronto
4 February 1987

\$3.50/m ³	spreading topsoil
\$100-\$125	40 mm caliper tree planted
\$20	1 to 2 m whips, planted

M.N.R. - Cambridge - Cliff Holland
6 February 1987

Tree planting by machine (for slope 20-30%)

\$80/1,000 trees
or
\$80/acre @ 1,000/acre
\$200/ha @ 2,470/ha

Planting by hand

\$150/acre @ 1,000/acre
\$370/ha @ 2,470/ha

M.N.R. stock: \$0.05

Crushed Stone/Sand

\$20 to \$21.50 per cubic metre

Ray Peister - McLean-Peister Ltd., Kitchener
5 February 1987

- 1) Topsoil volumes must be increased by 20% to allow for compaction
- 2) \$2.50/m³ spread and prepared.
- 3) Caliper size trees
 - 40 mm bare root - \$45-50 each planted and staked
 - 40 mm string ball - \$90- 200 each planted and staked
 - Whips 5-6 ft. - \$30 each planted and staked
 - Shrubs - \$8-12 each planted and staked
 - Hydroseeding - \$.40/m²

Maclean-Peister Ltd. has experience in planting on 3 landfill sites including:

Brampton Professor's Lake (not mass planting)

8 inches (20 cm) of topsoil
PVC vents on each tree - \$10 (larger trees)
few losses

Erindale Park (1986?)

Planted 2,000 shrubs, bare-root
800 trees, caliper

4 inches topsoil
16 trees to replace after 1 year.

APPENDIX F

Soil Quantity and Costing Calculations
Alternative Topsoil and Subsoil Depths

APPENDIX F

TABLE 1

SUMMARY: SITE CLOSURE AND AFTER USE COST ESTIMATES
ALTERNATIVE TOPSOIL AND SUBSOIL DEPTHS

<u>Soil Depth Alternative A</u>	<u>Soil Depth Alternative B</u>	<u>Soil Depth Alternative C</u>
20 cm of Topsoil over 22 cm of Subsoil Available on Site	30 cm of Topsoil over 22 cm existing on Site subsoil and shale 30 cm of Topsoil applied to 50.2 hectare	30 cm of Topsoil over 50.2 hectare landfill 70 cm of Subsoil in areas to be planted to Woody Vegetation 30 hectares (22 cm available on site) Total Depth: 1 metre over 30 hectares
Topsoil Requirement	Topsoil Requirement	Topsoil Requirement
120,480 m ³ (502,000 m ³ x .24 m) - 27,600 m ³ = 92,880 m ³	180,720 m ³ (502,000 x .36 m) - 27,600 = 153,120 cubic metres	See Alternative B \$1,684,320
		Subsoil Requirement 70 cm - 22 cm - 48 cm x 1.2 (compaction) = 56 cm 300,000 m ³ x .576 m = 172,800 cubic metres
Cost of Topsoil Delivered to Site 92,880 m ³ x \$11/cubic metre = \$1,021,680	Cost of Topsoil Delivered to Site 153,120 m ³ x \$11 = \$1,684,320	Cost of Subsoil Delivered to Site 172,800 m ³ x \$9.15/m ³ = \$1,581,120
Topsoil Spreading 92,880 m ³ x \$2/m = 185,760	Topsoil Spreading 153,120 m ³ x \$2/m ³ = 306,240	
Subsoiling \$432/ha x 50.2 ha = 21,686.40	Subsoiling \$432/ha x 50.2 ha = 21,686.40	Subsoil spreading 172,800 m ³ x \$2/m ³ = 345,600
Hydroseeding - Site Closure cost NA	Hydroseeding - Site Closure Cost NA	Hydroseeding NA
 Total Cost \$1,229,126.40	 Total Cost \$2,012,246.40	 Total Cost \$3,611,040

APPENDIX G

Representative Species List
- Naturalistic Planting

APPENDIX G

Representative Naturalistic Species List

Planting: Nursery Stock 1-2 metre Whips - Bare Root

Number of trees required: 2,470 (2m o/c.)

	<u>%</u>	<u>Number</u>	<u>Cost/Unit</u>	<u>Cost</u>
Trembling Aspen	25	616	2.25	\$ 1,386.00
Balsam Poplar	15	372	2.25	837.00
Black Locust	10	240	8.00	1,920.00
Silver Maple	5	123	4.50	553.50
Sugar Maple	10	247	16.00	3,952.00
Red Oak	5	123	14.75	1,814.25
White Ash	5	123	7.75	953.25
Black Walnut	5	123	11.00	1,353.00
White Oak	5	123	11.00	1,353.00
White Cedar	5	123	9.00	1,107.00
White Pine	5	123	30.00	3,690.00
Larch	5	123	15.00	<u>1,845.00</u>
Sub-Total				\$20,764.00

Shrub material is available from \$2.50 per unit and up. Again no site preparation, installation and maintenance costs are included. Tree planting costs are generally assumed to double the plant material cost.

APPENDIX H

Proposed Management Program
for Naturalistic Planting

MANAGEMENT PHILOSOPHY AND APPROACH

The forest buffer system must be managed within an overall philosophic approach. The basic principles of the management system has been discussed in earlier sections of this report and include the following:

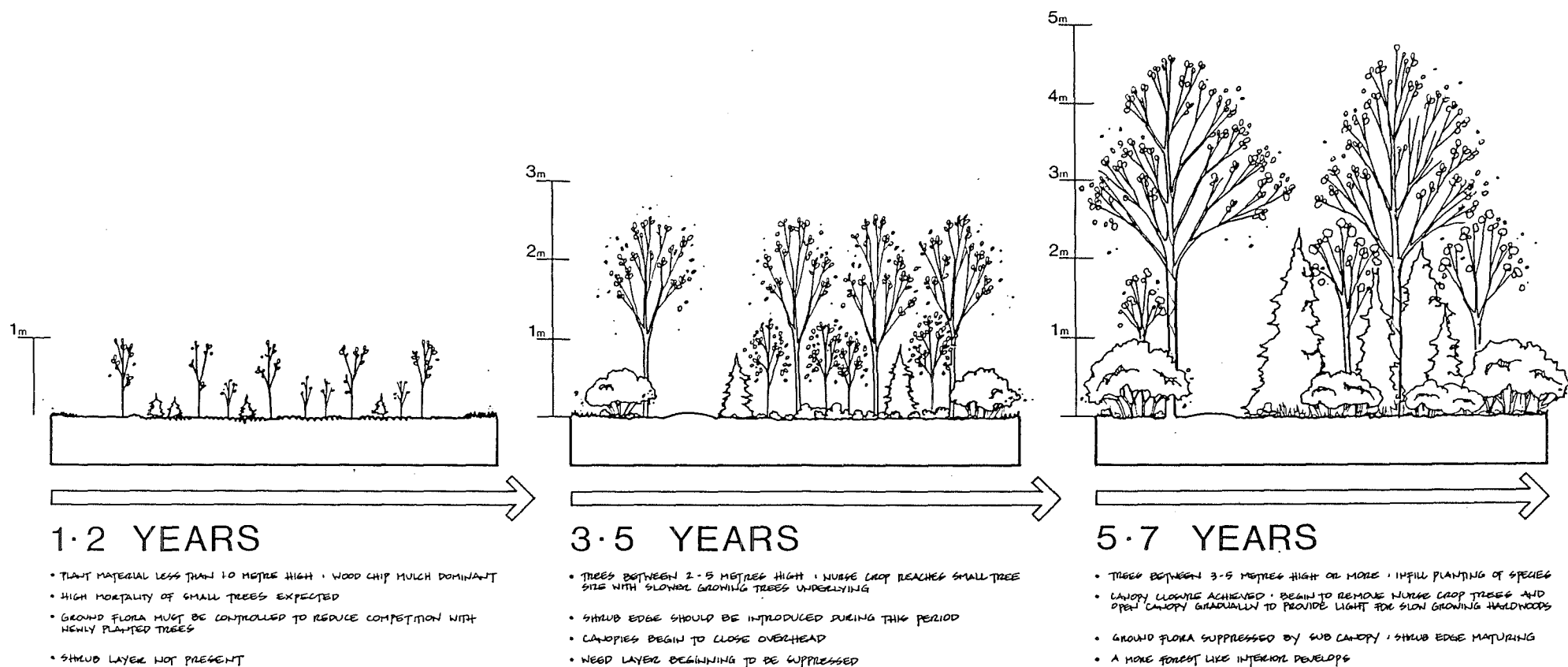
- . the creation of a forest buffer relying predominantly on natural processes - natural succession
- . low-cost installation
- . low-cost maintenance

An underlying principle of the approach adapted has been to create a biological system that in a relatively short period of time will become largely a self sustaining and self regulating system. When the forest buffer system reaches that stage of development, a low maintenance cost biological system will have been achieved. However at no stage should the forest buffer be considered completely maintenance free. The level of management input will vary with the stage of forest development but generally decreases with time.

Figure illustrates schematically cross-sectional profiles of the forest buffer at three time periods following installation: 1-2 years, 3 to 5 years and 5 to 7 years. It is expected that canopy closure will be achieved in the 5 to 6 year time frame. Management activities can be separated into two distinct phases as illustrated on the cross-sectional profiles. The two phases are:

- . Management until canopy closure
- . Management following stand closure.

FIGURE
VISUAL APPEARANCE OF
SYSTEM UNDER MANAGEMENT



The first phase will extend through the first 5 to 6 years; the second phase is much longer, extending beyond canopy closure indefinitely into the future.

Management Until Canopy Closure

There must be a strong management commitment during the first years of growth of the forest system. Maintenance activities required during the initial period are:

- . Weed and grass control to reduce competition for small trees: hand cultivation or spot spraying may be required on periodic basis. The significance of this management activity must be emphasized. It is the key to rapid development of the forest system.
- . Replacement and supplemental planting: additional trees planted to replace those that die and to diversify species mix. The perimeter shrub system should be installed during this phase. The edge shrubs provide the same function as the canopy trees in creating the conditions for forest succession. The edge structure affects light, moisture and wind conditions within the forest system. The shrub line

also provides an early definition of the forest edge, an important management requirement. It is the transition between the forest and non-forest environment (the ecotone).

- . Monitor for rodent and rabbit damage, disease and insect damage: control if necessary.
- . Maintain grass turf surrounding forest zones to reduce rodent habitat.
- . Monitor moisture condition: supplement when necessary.
- . Monitor species survival: Hybrid poplar clones (requested by MNR as condition of receiving plant material).

The pre-canopy closure phase is the period during which the highest level (and most expensive level) of management is required. The fundamental requirement is to control ground level competition until the trees take hold and a canopy begins to form. Once the canopy forms, the tree system will begin to suppress the unwanted ground flora. Depending on the pre-planting ground treatment, weed suppression may be required two to three times during the growing season. Weed suppression also avoids potential weed by-law problems associated with uncontrolled growth of weeds and negative public response.

Management Following Stand Closure

When the canopy closes, the management requirement changes in nature becoming less intensive and more flexible in terms of timing. Rather than attempt to develop a detailed management at this point in time, it is more appropriate to develop stand management plans for the range of planting zones following stand closure when the character of the system is apparent. The plan should outline the management objectives and strategies for each zone. The level of management input (time, manpower) and associated cost will depend on the resources available at that point in time.

Following canopy closure, a fundamental component of the management programme is the phased removal of the pioneer nurse crop species. This must be undertaken even though it involves girdling, coppicing or the removal of apparently healthy trees, or the selective removal of limbs which injure buds of shade tolerant trees. The removal assists in speeding up the successional sequence by encouraging the more rapid growth of the shade tolerant hardwoods after they are well established. The necessity of the thinning of the nursery crop must be communicated to the public to avoid public relations difficulties.

The management process following canopy closure can be broken down into a number of stages and substages. Only general time frames have been indicated. The actual timing of the proposed activity can only be determined as the system matures to the stage where a particular activity is required. The annual management requirements can only be determined on a site specific basis. Table 5 identifies the stages and a general time frame in which the management function may be initiated.

In devising a management plan for the area it is difficult to give precise time frames for the different management phases. In the later stages it may be desirable to diversify the planting in terms of age, structure and species composition to more closely resemble the range of conditions found in natural woodlands. Management requirements are very flexible (annual and seasonal) in the latter stages of development.

Management Requirements and Monitoring

It may be appropriate to designate an individual (annually or on longer term) who will have management responsibility for the forest buffer system. Preferably this person would have some background in a related discipline such as forestry, horticulture, botany or landscape architecture. With this type of background, it is thought that the individual would have a basic understanding of the principles underlying the forest buffer system. The City may be eligible for job creation grants, available from senior government levels.

The responsibilities of the forest buffer manager would include the following:

- . trash control
- . weed control - inspection for weed growth: mechanical or chemical weeding when necessary (monthly basis during growing season)

- . inspection
 - water when necessary
 - disease control
 - rodent damage
 - growth and survival
- . supervision and/or installation of supplemental planting,
collection and planting of seeds, nuts, acorns
- . organizing outdoor education, public seminars, etc.

Due to the innovative nature of the afforestation programme, an ongoing monitoring and reporting program should be designed. Components of the monitoring programme would include:

- . Prior to Canopy Closure: survival, growth rates, clone survival (Hybrid Poplar).
- . Ground Maintenance Procedures: cost, effectiveness
- . Post Canopy Closure: thinning procedures
- . Cost Evaluation
- . Visual/Social Effectiveness
- . Public Education Response.

The hybrid poplar planting will require monitoring for the first three years (survival, growth rate). Post installation evaluation was a condition of the trees being provided by MNR (Brockville). The information derived will be integrated into the Ontario Hybrid Poplar Programme. A letter from MNR outlining the monitoring requirements is included in Appendix .

Table

WILLIAM

AFFORESTATION PROJECT

ALTERNATIVE MANAGEMENT STRATEGY

Factor	Alternative	Description	Page 1 of 5
Species Selection/Associations	. Site Conditions	. Species suitable for site: moisture, soils, salt conditions, disease, local hardness.	
	. Native/Non-Native Species	. Generally favour native species, although in some situations non-native species may be used where appropriate (Salt Tolerance, Growth Rates).	
	. Species Availability	. Many native species not available from Ontario Ministry of Natural Resources or commercial nursery; some species may be available on special order from commercial nursery (alder).	
	. Cost	. MNR Stock - no cost or minimal cost, but small (2 year). . Commercial nursery - cost escalates rapidly with size.	
	. Mono-culture/ Mixed Planting	. Special Purpose Planting - Road Side Mix.	
	. Aesthetics	. Species mix for visual effect. . Fall/Winter/Summer colour. . Wildlife	
Site Preparation	. Critical factor in woodland establishment	. Reduce competition for small reforestation stock. . Avoid visual effect of grass/weed system - negative public image.	
	. Chemical Treatment	. Application of herbicide - fall before spring plant. . Till soils following application - week to 10 days. . Second application of herbicide in spring preceding planting. . Application of herbicide until tree canopy closes and begins to suppress weeds naturally. . Acceptability to public and City policy.	
	. Mechanical Treatment	. Plowing, discing, rototilling planting beds, preferably in fall preceding. . Regular cultivation during growing season. . Application of mulch (wood chips, leaf litter) to suppress weeds. Spot mechanical weeding will be required where weeds penetrate mulch.	
	. No Treatment	. Planting stock planted directly into existing turf. . Moderate to High mortality and slow growth due to competition for moisture, nutrients, and light.	

Factor	Alternative	Description	Page 3 of 5
Planting Technique	. Mass Planting	Option 1 . Large area planting with relatively close spacing, 1 metre to 1.5 metre centres - random (10,000 to 4,444 trees/hectare). . Difficult to cultivate within planted area.	
		Option 2 . Large area planting; maintain grassed strips (2 m) between planting beds. Spacing 1.0 m to 1.2 m in planting beds.	
		Option 3 . Large area planting; 3 metre spacing to permit cultivation between stems, slower canopy development.	
	. Nodal Planting	. Small area planting, replicate planting systems, variable sized nodes.	
	. Nuclear Planting	. Concentrated planting systems which ultimately will spread to colonize areas between nuclear planting.	
Planting/ Phasing	. Pioneer Nurse Crop	. Area planted totally (100%) to nurse crop; climax species planted at later date, nurse crop gradually removed as climax species mature.	
	. Mixed Pioneer/ Climax Species	. Nurse species and climax species planted at same time; nurse crop gradually removed as climax species mature.	
	. Phased Planting	. Initial basic mix of nurse crop and climax species; additional plantings at later date - additional tree species to diversify and to create desired ecological or visual effect; shrub edge, herbaceous level development.	
	. No Pioneer Nurse Crop	. Climax species - generally slow growth. Forest appearance slow to emerge. Vulnerable to rodent impacts.	
	. Edge Planting	. Outer "skin" of woodland planted at same time as nurse crop.	
	. Herb Planting	. Planted into woodland anytime after canopy closure or after nurse crop removal.	

Weed Control

- To ensure success ongoing weed control will be required until the forest system begins to control weed growth within confines of woodland block.

Techniques	. To be applied following site preparation; prior to plant installation.	
	. Wood Chip Mulch	. Intermediate weed control - City source of wood chips.
	. Leaves	. Intermediate weed control - City source of leaf mulch.
	. Straw	. Visual effect not preferred - Rodent habitat, can burn.
	. Plastic Sheeting	. Effective, but visually intrusive, creates dry environment for rodents.
	. Soil Fertility	. Fertilization will encourage weed growth.
	. Weed Control Fabric	. Effective but expensive.
	. Mechanical Weed Control	. Labour intensive, but may be appropriate in association with wood chip mulch.

Rodent and Rabbit Control

- Many small trees will be destroyed by rodents or rabbits. Passive or active animal control may be required.

- | | |
|-------------------------------|---|
| . Species selection | . Pioneer species less susceptible to rodent or rabbit impact. |
| . Plastic Collars | . Expensive, only feasible for larger tree stock. Rabbit damage above snowline may still occur. |
| . Poison/Repellents | . Scoot - yearly application until trees reach maturity, expensive. Rodent poison - selective sites. |
| . Predators | . Encourage natural predators, provide habitat, nest boxes for owls, observation posts. |
| . Habitat Control | . Compact snow adjacent to woodland edge, prevents rodents (mice) from reaching trees during winter. |
| . Isolation of Planting Zones | . Bare ground or short grass area maintained adjacent to treed area will discourage movement of rodents.
. Periodic mowing of grass in park area will help control rodent populations. |

6.2 Park Design Considerations

In addition to the management strategies outlined in Table a number of design conditions were also assessed in developing the planting design. The design conditions include the following:

- . **Park Elements:** The planting design should reflect other park elements as outlined in the Master Plan. Elements include: pathways, viewing points, picnic areas, activity areas, separation zones. The entry points to the Park are considered significant.
- . **Edges:** The forest edges, both interior and exterior, are functional elements in the design process performing both ecological and visual functions. The exterior woodland edge separates the forest buffer and park from the exterior roads and adjacent urban activities. It also forms a part of the ecological outer skin of the woodland unit.

The interior edge provides the transition between the park activity areas and the woodland buffer zone. It also acts as an important ecological component of the woodland system.
- . **Diversity:** The ecological principle of diversity and its relationship to stability, especially in mid-succession tree stands, is a design consideration (simplicity versus complexity). Also visual diversity is a consideration in park design.

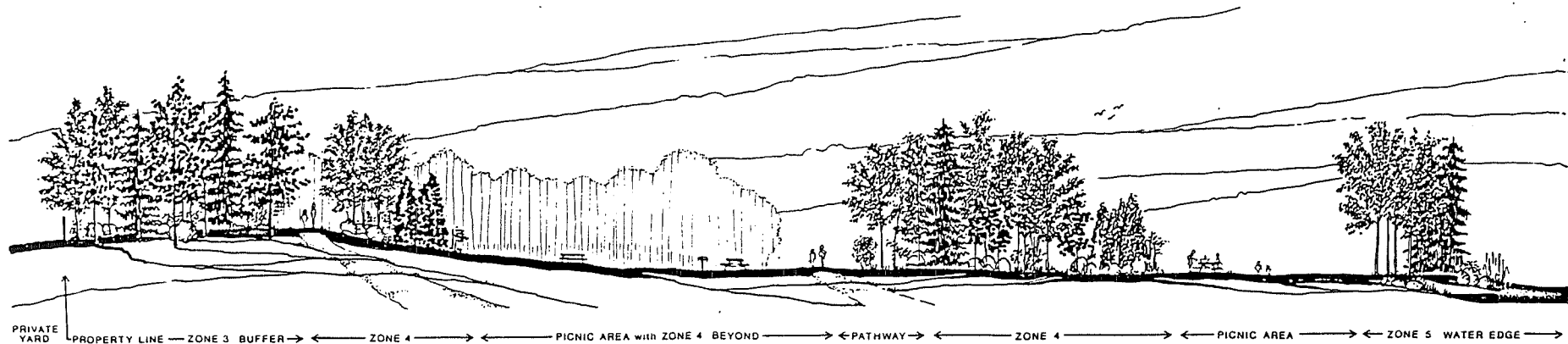
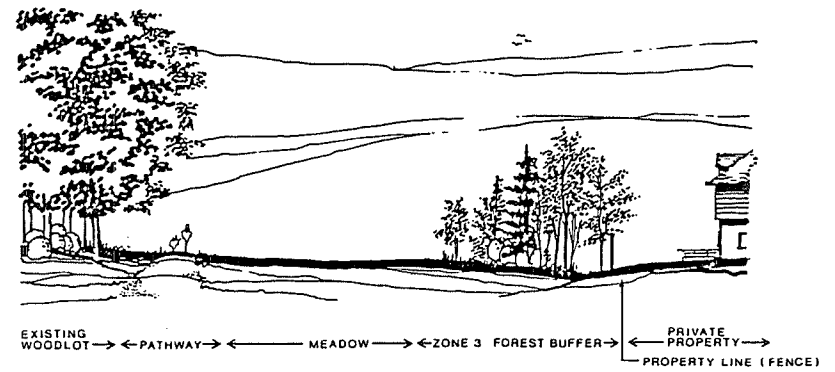
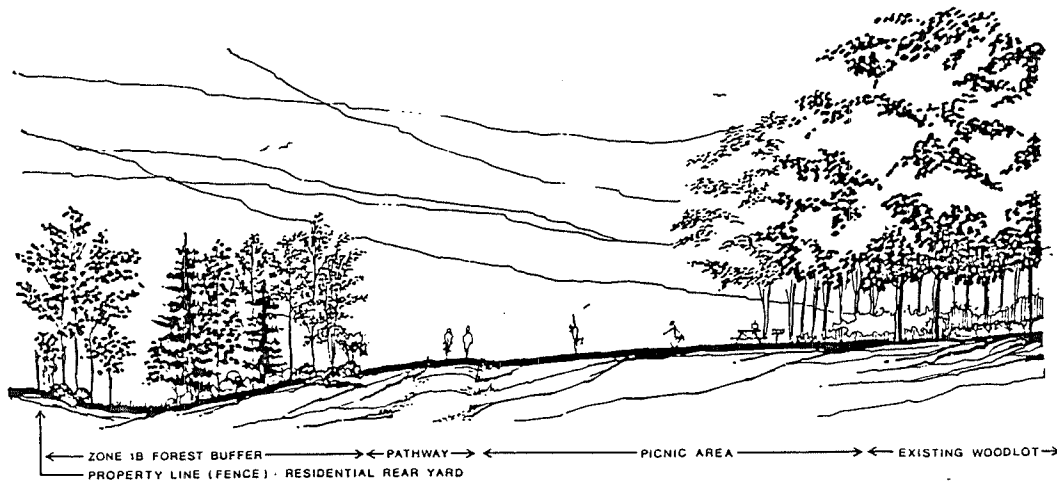


FIGURE 6 AFFORESTATION PLAN

FIGURE 6 FOREST BUFFER PLANTING SECTIONS APPROX. YEAR 10

REFER TO ILLUSTRATIVE SITE PLAN FIGURE



