M-373

APPENDICES TO "AGRICULTURAL CHARACTERISTICS AND IMPACTS OF THE PROPOSED HALTON REGION LANDFILL SITE D"

Prepared for:

TOWN OF MILTON

By:

SMITH, HOFFMAN ASSOCIATES LIMITED

OCTOBER, 1987.

INDEX

APPENDICES TO "AGRICULTURAL CHARACTERISTICS AND IMPACTS OF THE PROPOSED HALTON REGION LANDFILL SITE D"

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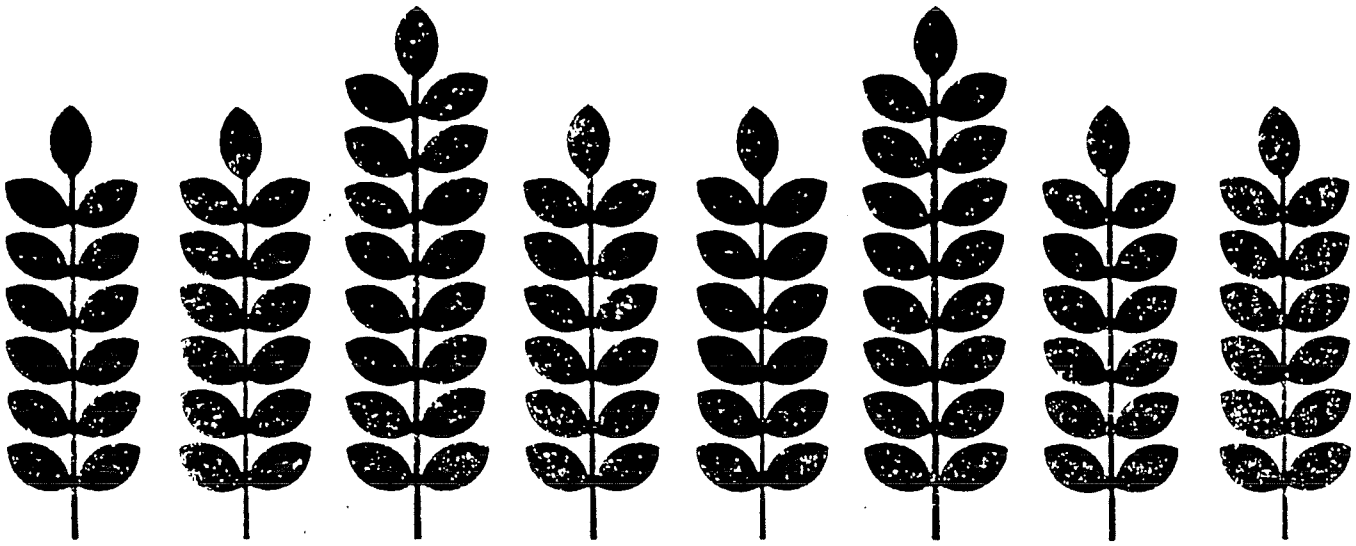

agricultural land evaluation system

planning & development department • regional municipality of halton

HALTON AGRICULTURAL LAND EVALUATION SYSTEM

TECHNICAL REPORT

Halton Planning and Development Department

April 1987

Foreword

The development of the Halton Agricultural Land Evaluation System has taken place during a period of over three years, although intensive work on the project was not continuous for that entire period.

In the earlier stages of the project, much valuable advice and assistance was received from the faculty at the University of Guelph. Dr. Stephen S. Rodd and Professor George Penfold provided helpful guidance as advisors to the summer students who carried out initial research, and Mr. Penfold has continued in that role through subsequent summers. Mr. Penfold has also assisted staff, at staff's request, in liaising with the agricultural community as part of the Outreach function of the University of Guelph. Without their expertise and willingness to contribute, this project would never have advanced to its present stage.

A meaningful Agricultural Land Evaluation System would not be possible without the advice and direction of the local farming community. This essential component of the project has been provided through the Halton Agricultural Advisory Committee (HAAC), a volunteer committee of local farmers and Regional Council and Ministry of Agriculture and Food representatives established by Halton Council in 1978 to provide advice to Council and staff on any matters affecting agriculture in Halton. HAAC has been directly involved in this project from the beginning, and has played a lead role in refining the format and content of the system, and in assessing the results of its application to Halton farmlands.

The latter stage of the project has been funded through a Community Planning Grant from the Minister of Municipal Affairs, which has greatly expedited progress on the development of the system and its application. The grant was approved by the Minister to further the commitment made by Halton Council to the identification of agricultural areas in the Regional Official Plan. Also behind the grant approval is the Province's hope that the process of developing the system, the content and format of the system, and the system methodology as described in this report may be of use to other municipalities.

Overall direction of the project has been provided by Mr. Peter Langdon, B.E.S., M.C.I.P., a Planner with the Halton Planning and Development Department. Other Departmental staff and students who have worked on the project include, in alphabetical order, Jeff Brewitt, Kathy Day, Ann Howard, Sharon Jensen, Heather Robinson, and Glenn Wellings. Their contributions have been considerable.

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1. Background

The Regional Official Plan was adopted by Halton Council on September 6, 1978, and partly approved by the Minister of Housing, with modifications, on August 1, 1980. The policies of that Plan, in accordance with the Ontario Food Land Guidelines, seek to protect prime agricultural soils in the rural area for agricultural uses. Prime agricultural soils are defined as Classes 1 to 4 soils in the Canada Land Inventory of Soil Capability for Agriculture. Through experience in applying the policies to various development applications, it became apparent to staff that protecting land for agriculture on the basis of soil capability alone was an inadequate approach to protecting the agricultural industry and community.

Firstly, there are areas of prime agricultural soils in Halton where agriculture is only a marginal or a non-existent activity, with little expectation for any improvement, due to socio-economic factors such as small, discontinuous areas, high degree of land fragmentation, and the existence of surrounding incompatible land uses. The strict application of the policies to protect prime agricultural soils in these circumstances appeared unreasonable. Such an approach was undermining the credibility of the Official Plan and of planning staff, in the eyes of Council, the Land Division Committee and the Area Municipalities. Secondly, the literal emphasis on soil protection as opposed to protection of healthy, viable agricultural areas lent support to those development applications located on lesser quality soils, but which would nevertheless have significant direct and indirect adverse impact on surrounding agricultural operations and on the agricultural community.

To address the problem of including socio-economic factors in evaluating agricultural lands, two summer students were hired in 1984 to carry out research on existing agricultural land evaluation systems and to propose a system applicable in Halton. Another summer student furthered the work in 1985 and the system was applied to test areas. The Halton Agricultural Advisory Committee (HAAC) was directly involved in this work from the outset.

In the spring of 1986, Planning and Development staff presented a report to Council (DPD 73/86) regarding the summary and analysis of comments received in response to the circulation of the eight discussion papers in the Rural Development Policies Review series (December 1983). Support had been received from a number of sources in response to that circulation for the identification in the Regional Official Plan of agricultural areas. Through report DPD 73/86, Halton Council endorsed in principle that approach, with the implementation still to be worked out.

3. Summary of the System Development Process

It was discovered very early in the project that there was no existing municipal agricultural land evaluation system which a municipality such as Halton could easily use or adapt. For that reason, the process followed by Halton in developing the system was not pre-determined. The process has been one of trial and error, with objectives, assumptions and proposals having to be re-defined and re-evaluated frequently.

The initial research investigated the merits of a number of existing land evaluation systems and rating schemes, and considered the factors utilized in local agricultural impact studies. Those existing evaluation systems designed for use at a municipal level were primarily oriented toward site-specific agricultural impact rather than overall land evaluation, and those that were land evaluation oriented were developed primarily for large-scale areas (national, provincial scales) rather than for municipalities. Some were also very complex. Based on this initial research, it was determined that a point scoring, or rating system, would be most appropriate for Halton. A long list of factors which appeared to be appropriate for Halton was compiled, including both physical and socio-economic criteria. The initial measurement parameters, termed decision units, associated with each factor were determined utilizing a combination of judgement, expert advice, past research, and a comparison of Halton and provincial agricultural statistics and census information. In total, 74 separate items (decision units) were included on this initial list. The refined list of factors and decision units is attached as Appendix B.

Based on the required level of detail for municipal-scale use and the mapping scale of much of the available mapped data (such as Canada Land Inventory Agricultural Soil Class at 1:50000), it was determined that the appropriate size of a land unit (evaluation unit) to which the system would be applied should be 100 acres. This size also conveniently suited the existing pattern of original township lots and concessions in Halton. A single township lot in Halton is generally close to 200 acres in size. The evaluation units were delineated simply by dividing each original township lot in half.

The next major step in the process was to attempt to determine the relative importance of these factors. This was truly a trial and error process. The expertise of HAAC was relied on for this purpose. First, for each factor and decision unit in the list, HAAC determined by ballot whether there was a positive, neutral, or negative influence on the long-term potential of land for remaining in agriculture. The actual number of positive "votes" determined the degree of positive influence. This generated much discussion and debate on several of the factors. The positive

regarding the factors and weights. The exercise became one of trying various adjustments to the combination, or formula, until the results satisfactorily matched the subjective opinions of the agricultural community (through HAAC), the Ministry of Agriculture and Food, and Regional and local planning staff, based on their respective knowledge of the rural areas. The development of the system has been experimental in nature. Only if the results coincide with the consensus of knowledgeable opinion can the system be said to be useful or working satisfactorily. That situation has been achieved, although to date no comments from the public or landowners have been sought.

4. Description of the Agricultural Land Evaluation System

The most up to date list of factors, decision units and weights is attached as Appendix B to this report. The factors are divided into three categories: A) Physical Characteristics, B) Land Use/Improvements, and C) Ownership/Fragmentation. This list of factors and weights is applied to each 100 acre evaluation unit. The method of scoring is to calculate the score for each decision unit and total all the scores for the evaluation unit. The maximum possible score is 1000, with maximum possible scores for each of the three categories being 400, 400 and 200 respectively. For those decision units where data is recorded as a percentage of the area, the score is calculated by multiplying the percentage of the area by the applicable weight.

The determination was made during the development (to date) of the system that there would be no negative weights. It is assumed that if a factor contributes absolutely nothing to long-term agricultural potential, then the weight is zero. A negative influence on agricultural potential is, therefore, treated as a lack of positive influence.

The data for each 100 acre evaluation unit is stored in a microcomputer (Tandy 6000) data bank. When data is entered, the data base management program (Profile 16) automatically calculates the scores for each decision unit and the sub-total and total scores for the evaluation unit. The decision unit titles, the data, the scores, and the sub-total and total scores all appear on a single screen for ease of reference and updating. Sample print-outs of such individual screens or records are contained in Appendix F. Each such screen constitutes one record in the system, and a particular record or evaluation unit can be accessed by lot and concession number, by a grid reference (row and column number), or by record number.

This computerized system facilitates changes to data, to the weights, or to the list of factors with relative ease, making updating and testing very convenient.

6. Interpretation of Scores

It was a necessary, and extremely important task to determine a threshold score above which lands are considered to have a high long-term agricultural potential. There is no mathematical or technical means of determining such a value. It must be determined by relating the scores to actual field conditions and subjectively choosing a value. The opinions of the Halton Agricultural Advisory Committee (HAAC) and Ministry of Agriculture and Food (OMAF) staff were used for this purpose. After deliberating over maps illustrating threshold values from 500 to 600 in 25 point intervals, HAAC chose 550 as the appropriate value. OMAF staff subsequently supported this value after their own field inspections.

It is emphasized that such a decision was made by HAAC after individual members reviewed in detail the scores associated with those lands with which they had detailed knowledge. In many areas the HAAC members reviewed the results in conjunction with their own field inspections. Representation on HAAC is Region-wide and all areas of the Region were considered at a detailed level before the 550 value was finally chosen as the threshold value.

On the Regional base map attached as Appendix D, those half-lots with scores of 550 and greater have been indicated.

7. General Discussion of Results

As would be expected based on soil capability and knowledge of existing land uses, the bulk of the area below the Niagara Escarpment has been indicated as having a good long-term potential for remaining in agriculture. Perhaps of greater informative value are the results of the evaluation system in the areas above the Niagara Escarpment. There is a large total area of land containing prime agricultural soils above the Escarpment, but when socio-economic factors are taken into consideration, much of that area is not considered to have a good long-term agricultural potential. Until the Agricultural Land Evaluation System was utilized, there was no consistent, rational means of making such a determination for any particular local area within the more marginal agricultural lands above the Escarpment.

The average score for all those cells (1489 in total) where a number value appears on the maps is 559. The minimum score is 46 and the maximum score is 858. The remaining 358 cells have letter codes indicating an existing predominant land use which precludes agriculture.

This minimum score raises the question of why some evaluation units would not, by virtue of having Class 7 soils, have a zero

appropriate, the decision units associated with that factor might be adjusted to reflect the average values in that municipality.

The appropriate list of factors and the associated weights would have to be assessed by the agricultural experts, preferably including the agricultural community, in the particular municipality. The list of factors in the Halton system would appear to be a good basis upon which to begin discussion and may even be appropriate for other municipalities or areas, but that determination would have to be made on a case-by-case basis.

Consideration of an appropriate threshold value would also have to be made on a case-by-case basis, especially if the factor/decision unit/weight combination was altered. In fact, that decision might be the most difficult one, since it has such potentially significant policy implications. The threshold value is what gives meaning to the scores.

9. Concluding Comments

The purpose and objectives of the project as outlined in Section 2 have been achieved to a large degree. The evaluation methodology is consistently applied for the entire rural area in Halton Region and is as objective as possible. Socio-economic factors are incorporated: the maximum possible score of 1000 comprises 60% socio-economic factors and 40% physical (climate and soils) factors. The system is relatively easy for municipal planning staff to use; even for those with little background in use of computers. The evaluation model is relatively simple and easy to understand. The computerized data base enables fast and efficient changes to the factors, the weights, or the data itself, and as previously discussed, enables selective sorting, searching, and mapping of individual data or scores, or of combinations of such information.

In Halton, the data base itself and the original air photos with field notes have proven useful as a source of land use information for the Development Review planners in evaluating the merits of specific development applications. If and when the Evaluation System becomes better known and accepted, the data and evaluation scores themselves may possibly play a larger role in site evaluation for development applications. It is possible, as an extension of this project, that models for site impact evaluation could be developed.

As would be expected, the data collection and compilation was the single most time consuming and costly task in the process. To obtain and record the necessary data and create the computer data bank took an estimated 140 man-days of work (There are 1848 evaluation units in the data base). The field work necessary to collect the data pertaining to agricultural land use and agricultural

10. APPENDICES

APPENDIX A

Recommendations Adopted by Halton Council Through Report DPD 73/86

Date of Council adoption: June 4, 1986

A. Recommendations Pertaining to the Identification of "Agricultural" Areas in the Regional Official Plan

1. That Council accepts in principle the proposed policy approach to Halton's rural area whereby "agricultural" areas are identified by way of a map in the Regional Official Plan, with policy distinctions made between the "agricultural" and the "non-agricultural" areas. (p.11)

2. That Halton staff pursue discussions with the Area Municipalities, the Ministry of Agriculture and Food, the Halton Agricultural Advisory Committee and other interested agencies concerning both a consistent approach to the identification of "agricultural" areas in the Regional Official Plan and the appropriate development and severance policies for both the "agricultural" and "non-agricultural" areas. (p.11)

3. That the principle be accepted that the Official Plan policies prohibit Rural Estate developments in the identified "agricultural" areas. (p.23)

4. That the principle be accepted that land which is currently farmed or contains good quality agricultural soils may be included in the "non-agricultural" areas, due to such reasons as relatively small or isolated areas, existing fragmentation patterns, or proximity to incompatible development. (p.11)

5. That for "non-agricultural" areas, the issue of permitting additional rural development in areas outside Hamlets, Rural Clusters, Rural Estate plans of subdivision, and residential infilling be further considered by staff, with such investigation to include consultation with Area Municipalities and other interested parties. The investigation will address clarification of the term "non-farm development" and the feasibility of effectively controlling such development to protect such matters of Regional interest as the safety and efficiency of major roads, Environmentally Sensitive Areas, Hazard Lands, aquifer recharge areas, mineral resources and significant wooded areas. (p.18)

6. That the principle be accepted that the identified "agricultural" areas will include some pockets of low quality agricultural land upon which non-farm development is not permitted, on the basis that indirect adverse im-

residential plans of subdivision adjacent to Hamlets or Rural Cluster be considered only in the context of expansions to the Hamlet or Rural Cluster designations of the local official plans and not as distinct Rural Estate designations. (p.23)

11. That staff pursue further discussions with staff of all three Conservation Authorities and the Area Municipalities regarding: an expanded definition of Hazard Lands to encompass the entire creek system; and a policy to encourage any new lot containing Hazard Lands to be of sufficient size to accommodate outside the Hazard Lands the complete development plans for the lot. (p.30)

12. That the Regional Plan policies not be amended to require explicit assessment of indirect impacts on agriculture of individual non-farm development applications, as was recommended in the 1983 Rural Development Policies Review Papers, given the difficulties of identifying and measuring indirect impacts caused by individual uses. (p.16) (Current policies do not explicitly define the type of impacts which must be evaluated)

13. That the policies not be amended to establish a 20 ha (50 acre) minimum farm parcel size for severances as was recommended in the 1983 Rural Development Policies Review Papers. (p.33) (Current policies base minimum parcel size for farm severances on viability without a specified minimum lot size figure)

14. That the policies be amended to permit local official plans to establish minimum farm severance sizes notwithstanding the viability of smaller proposed farm severances. (p.33)

15. That staff prepare for Council's consideration, after consultation with the Area Municipalities, H.A.A.C. and O.M.A.F., draft Viability Evaluation Guidelines for farm severances, which stipulate the necessary information required of applicants and which, if feasible, establish viability criteria. (p.33)

16. That further consideration of actual Regional Plan policy amendments regarding farm retirement and farm help severances await the release of the final Provincial Policy Statement on Foodland Preservation. (p.41)

17. That staff undertake an analysis of the results to date of the current Regional Plan policies regarding severances and second dwellings for farm help. (p.43).

APPENDIX B

List of Evalution Factors and Weights

HALTON AGRICULTURAL LAND EVALUATION SYSTEM

Evaluation Factors and Weights
(for application to each 100 acre evaluation unit)

Revised 87 05 01

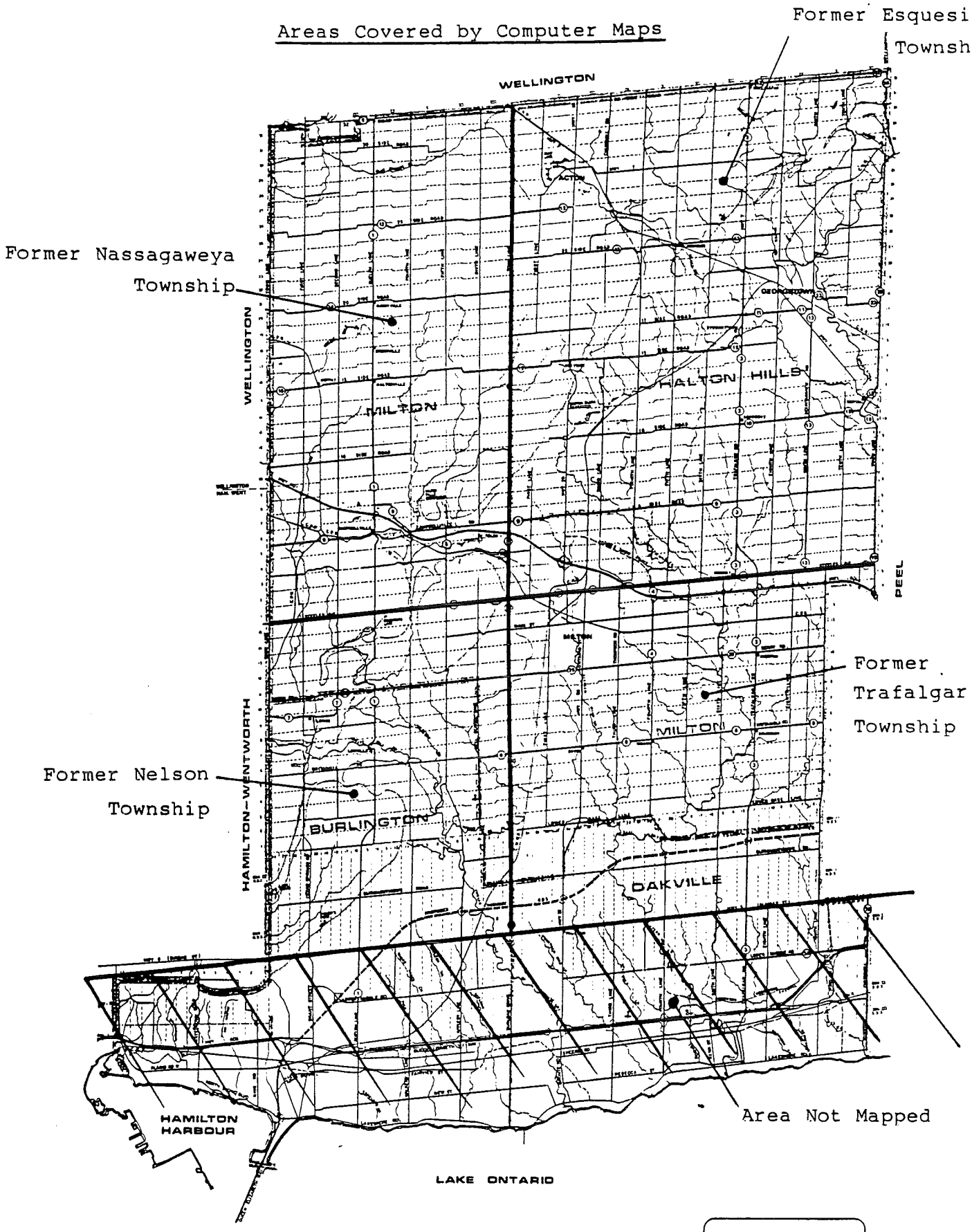
Category	Factor	Decision Unit	Weighting (x % land area where applicable)
A. Physical Characteristics			
1. Climate	Corn Heat Units (% land area)	>2900	40
		2700-2900	20
		<2700	0
2. Soils	Specialty Crop Capability (% land area)	present	80
		absent	0
	General Field Crop Capability (% land area)	Class 1	280
		Class 2	240
		Class 3	195
		Class 4	155
		Class 5	110
		Class 6	70
		Class 7	0
	Maximum Subtotal, Category "A"		400
B. Land Use/ Improvements			
1. Land Use	Type of Land Use -- Agricultural (% land area)	Specialty Crops	160
		General Field Crops	150
		Improved Pasture	110
		Unimproved Pasture	60
		Abandoned/Idle	50
		Forest, Marsh	0
	Type of Land Use -- Non-agricultural (total no. of buildings, lots)	Compatible (including 1 residence or 1 church or 1 vacant)	50

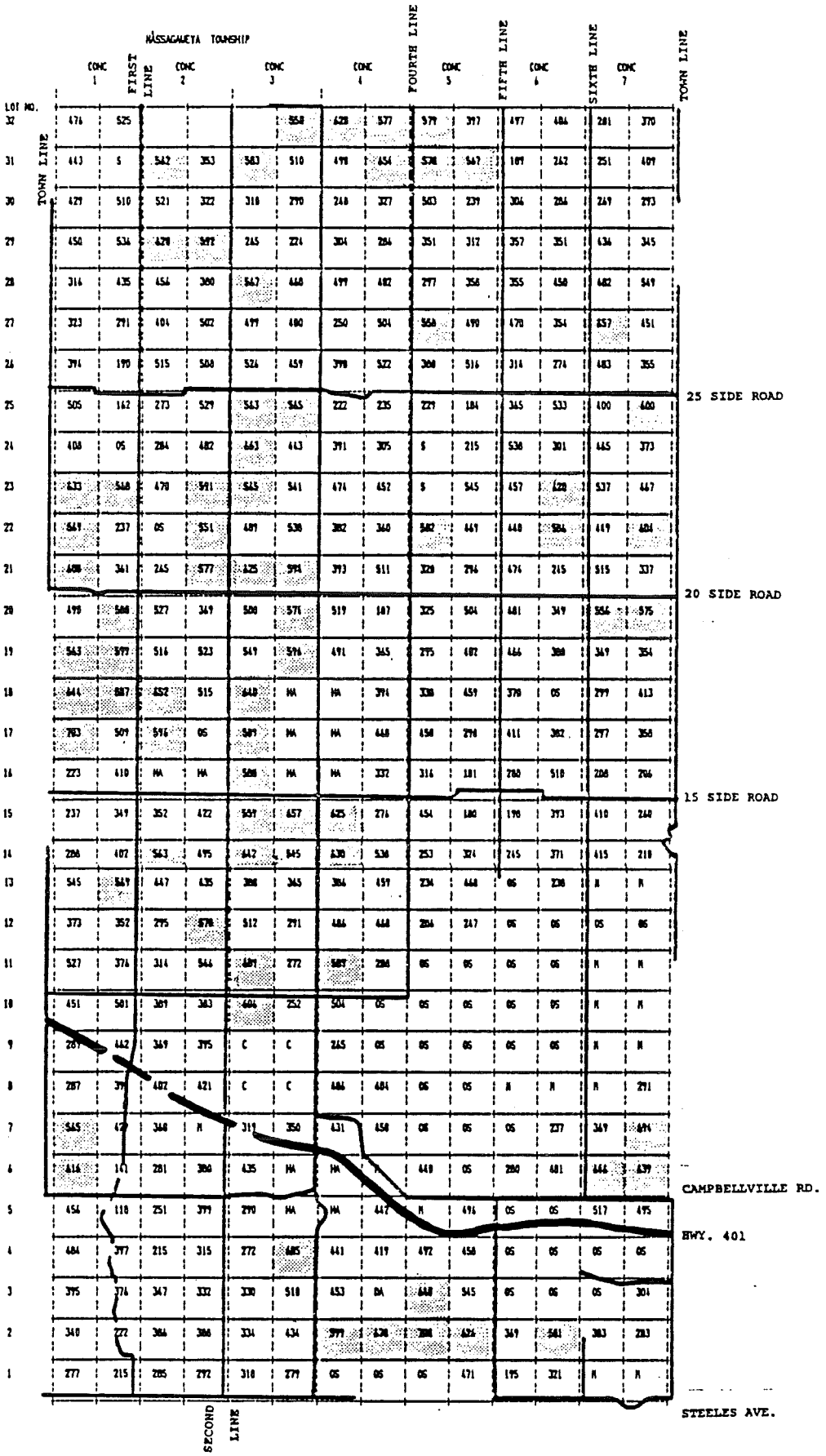
Category	Factor	Decision Unit	Weighting (x % land area where applicable)
C. Ownership and Fragmentation Patterns			
1. Degree of Fragmentation	% land area in parcels under 10 acres in size	0% 0-25% >25%	49 25 0
	Size of largest property.	>75 acres 50-75 acres <50 acres	49 25 0
	% land area in parcels under 70 acres in size (within 1000 ac block/ concession)	<=20% >20%	39 0
	Farm size pattern (% farms less than 70 acres in Enumeration Area)	<40% 40-60% >60%	24 15 0
2. Ownership Patterns	Ownership pattern	1 owner 2-4 owners >4 owners	10 5 0
	Off-farm work pattern (% farmers with >229 days off-farm work in Enumeration Area)	<=50% >50%	10 0
	Tenure pattern (% purely tenant farmers in Enumeration Area)	<15% >=15%	19 0
	Maximum Subtotal, Category "C"		200
	Maximum Total Score		1000

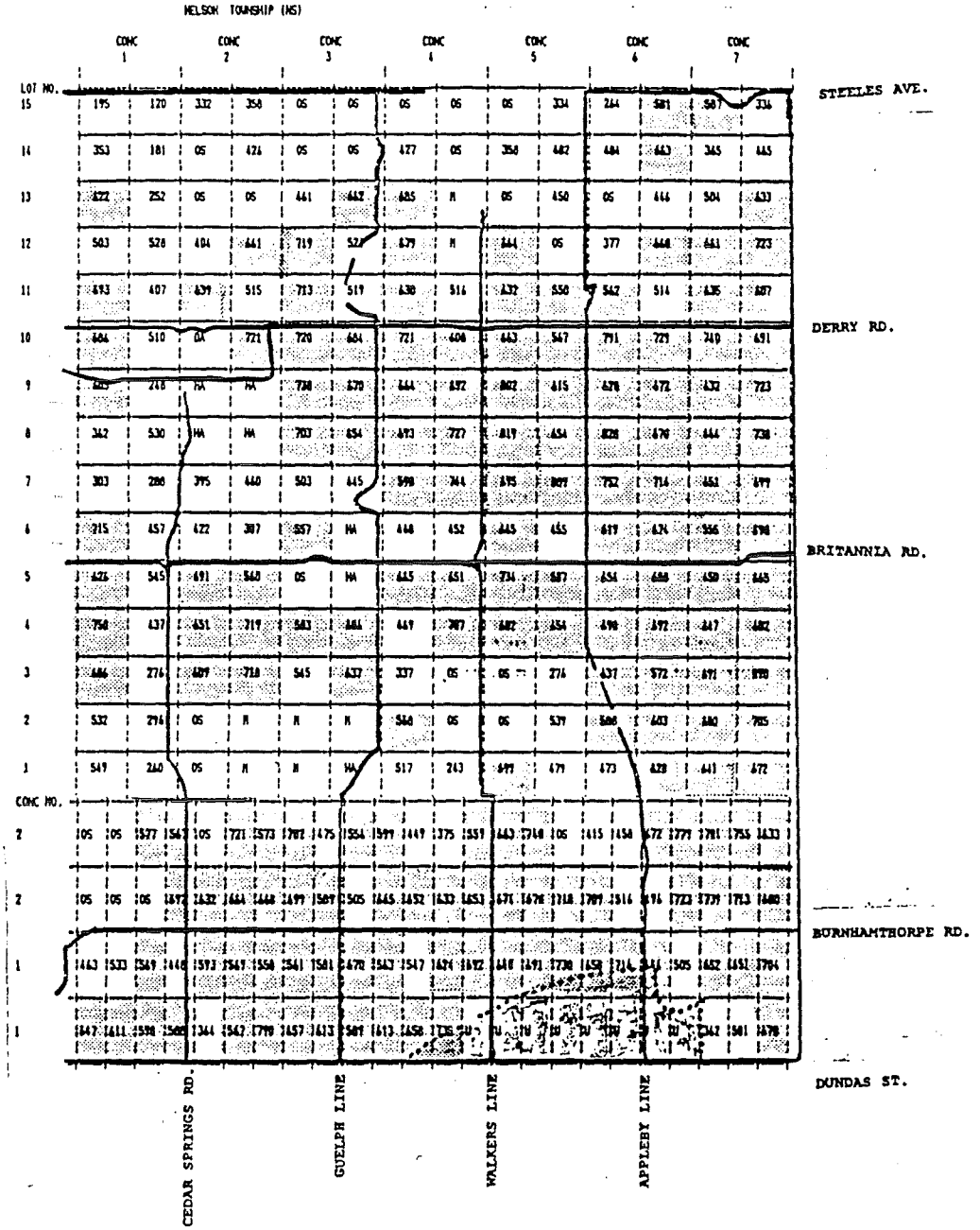
APPENDIX C

Computer Maps of Evaluation System Results

Areas Covered by Computer Maps



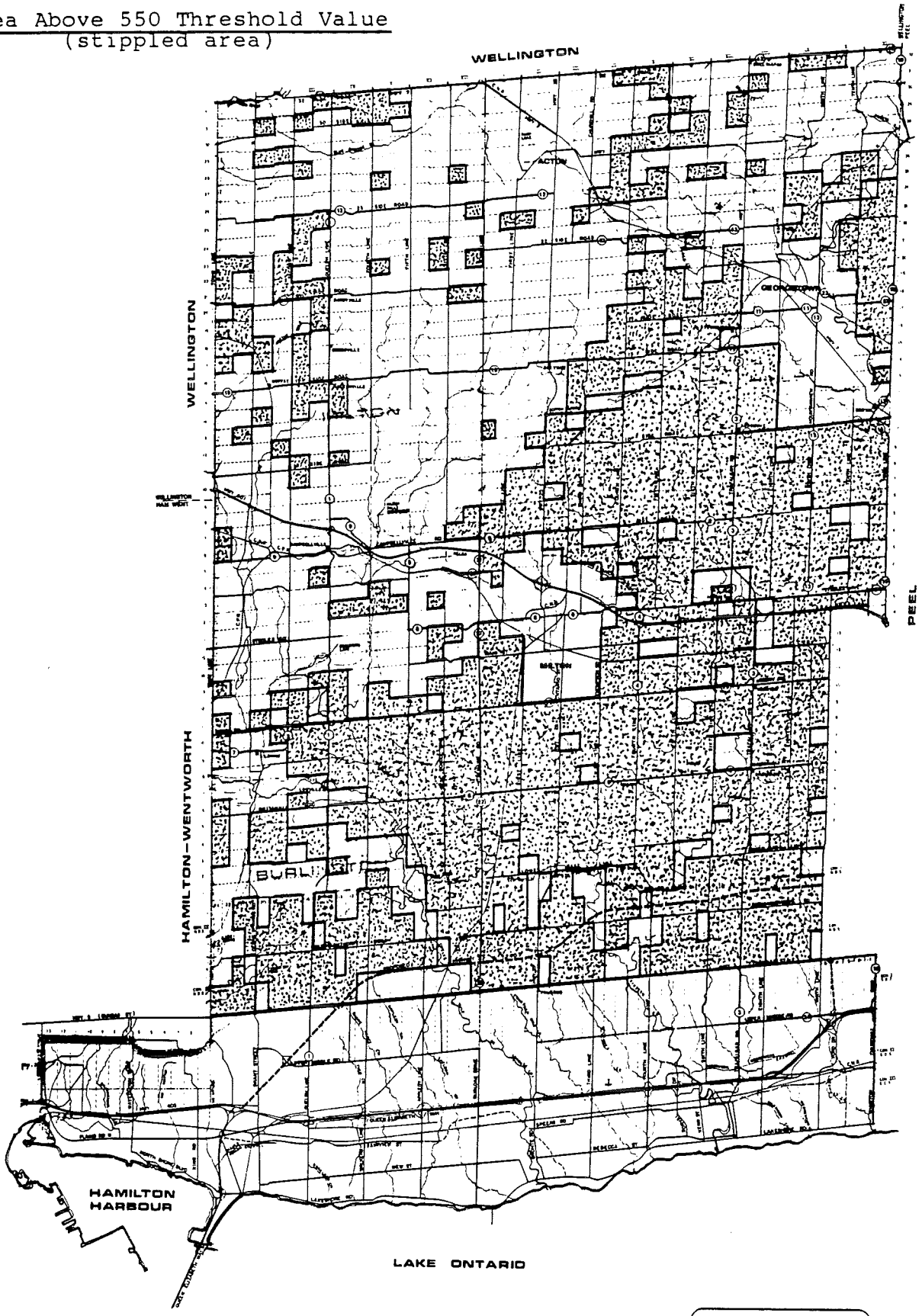

NASSAGAWEYA TOWNSHIP
CONC 1
FIRST LINE
CONC 2
CONC 3
CONC 4
FOURTH LINE
CONC 5
FIFTH LINE
CONC 6
SIXTH LINE
CONC 7
TOWN LINE
LOT NO.
TOWN LINE
25 SIDE ROAD
20 SIDE ROAD
15 SIDE ROAD
CAMPBELLVILLE RD.
HWY. 401
STEELES AVE.
SECOND LINE


NELSON TOWNSHIP (NS)
CONC 1
CONC 2
CONC 3
CONC 4
CONC 5
CONC 6
CONC 7
LOT NO.
CONC NO.
STEELES AVE.
DERRY RD.
BRITANNIA RD.
BURNHAMTHORPE RD.
DUNDAS ST.
CEDAR SPRINGS RD.
GUELPH LINE
WALKERS LINE
APPLEBY LINE

APPENDIX D

Map of Areas Above 550 Threshold Value

Area Above 550 Threshold Value
(stippled area)



APPENDIX E

Discussion of Evaluation Factors and Data Sources

Discussion of Evaluation Factors and Data Sources

A1. Climate

Corn Heat Units (CHU) is a common and recognized measure of the climatic environment affecting the suitability of an area to grow general crops. This information is in mapped form and available through Ministry of Agriculture and Food Publication No. 296: Ontario Field Crop Recommendations.

A2. Soils

A2a. Specialty Crop Capability

The presence or absence of specialty crop capability for each soil type is indicated in Soils of Halton County: Report No. 43 of the Ontario Soils Survey. Specialty soils are generally the sandier soils, and the presence of specialty crop capability can occur in a number of the Canada Land Inventory (CLI) Soil Capability Classes.

A2b. General Field Crop Capability

General Field Crop Capability (CLI Soils Class) was obtained from the Canada Land Inventory maps at the 1:50000 scale. It is interesting to note that through trial and error during this project, it was found that the CLI rating was more accurate than that contained in Soils of Halton County. This was confirmed in a telephone discussion with the Ontario Institute of Pedology in Guelph.

B1. Land Use

B1a. Agricultural Land Use

The primary source of agricultural land use data was field inspection in combination with aerial photographs at a scale of 1:5000. The distinction between improved and unimproved pasture was made later, primarily by utilizing the Agricultural Resource Inventory (ARI) mapping produced by the Ontario Ministry of Agriculture and Food at a scale of 1:50000, because at the time of field inspection there was only a "Pasture" category in the list of factors. On the ARI map, the "Grazing System" was classed as unimproved pasture and the "Pasture System" was classed as improved pasture.

B2c. Road Access

This factor deals with what is in fact a negative "improvement" not directly associated with the agricultural operations. For movement of farm machinery and equipment, local roads are considered superior in that traffic volumes and speeds are generally lower than on the Regional arterials and Provincial highways. Therefore, if an evaluation unit has access to a local road, the positive influence on long-term agricultural potential is considered greater than for arterials or highways.

C1. Degree of Fragmentation

In general, the smaller the farm parcel, the less likely it is to be a viable unit and the less flexibility it has for future changes in agricultural uses. Also, smaller parcels are more likely to be purchased by non-farm interests. A highly fragmented area is likely to have a greater number of non-farm land uses. Consequently, an area which is highly fragmented will have a lower long-term agricultural potential than an area with low fragmentation. These factors provide a measure of both the fragmentation of the evaluation unit itself and the fragmentation in the area.

C1a. Per cent Area in Parcels Under 10 Acres

This factor applies to the evaluation unit itself. It is calculated using assessment maps and rolls by expressing the total area of all those lots of less than 10 acres as a percentage of the total area of the evaluation unit.

C1b. Size of Largest Property

Using the assessment maps and rolls, this factor requires a determination of the size of the largest lot within the evaluation unit. It is recognized that many existing lots will transcend the boundaries of the evaluation units (half-lots), so an arbitrary decision was made to err on the conservative side in such cases. Only that portion of the property within the evaluation unit is considered for the purposes of this factor. For example, if only 10 acres of a 90 acre parcel extend into the evaluation unit in question, then for the purposes of this factor, that portion is considered to be a 10 acre property.

C1c. Percent Area of Concession Block in Lots Under 70 Acres

This factor is calculated from assessment maps and rolls, and represents, of the total area of the concession block (generally about 1000 acres) within which the evaluation unit is located, the percentage that is in lots of less than 70 acres in size. The intent is to provide a measure of the degree of land fragmentation in the surrounding area. It follows that all evaluation units

conservationists who maintain their rented farms and lands very well, but the high land values mean that it is unlikely that the lands will return to ownership by farmers in the foreseeable future, if ever. The percentage of purely tenant farmers in the EA is obtained from the Census information.

APPENDIX F

Sample Computer Records of Evaluation Unit Data

Sample Computer Records of Evaluation Unit Data

DATA & SCORE MUN: MIL. CONC & LOT: ES01/02W. ROW: 31. COL: 15.

A PHYSICAL	DATA	SCOR	B USE & IMPRVMNT	DATA	SCOR	C OWN & FRAG	DATA	SCOR
CHU > 2900 (%)	.	0	Spec Crop(%area)	.	0	%Area-Lots<10	14.	25
CHU 2700-2900	100.	20	GenFldCrop	35.	53	Size Lgst Lot	84.	49
CHU <2700	.	0	Pasture (Imprvd)	.	0	%1000ac Blk		
Soil % Spec	55.	44	Past. (Unimprvd)	.	0	Lots < 70ac	46.	0
CLI Class 1	45.	126	Aband/Idle	.	0	EA% Farms<70a	56.	15
2	.	0	No.NonFarm Uses	4.	30	No. of Owners	5.	0
3	30.	59	Cont >=500ac="Y"	Y.	69	EA%>229 Ofm	71.	0
4	25.	39	300-499="2",100-			EA% Tnant Fm	16.	0
5	.	0	299="3",<100="4"			C SUBTOTAL	n/a	89
6	.	0	Ag Bldgs -Spec,					
7	.	0	Lvstk,Other,Aban	.		Use Flag	.	n/a
Soil Subtotal	n/a	267	Access-Loc,Reg,					
			Prov	R.	3	TOTAL SCORE	531	
			Tile Drnge %Area	.	0			
A SUBTOTAL	n/a	287	B SUBTOTAL	n/a	155	Rec No. 456 Updtd by peterl on 10/21/86		

DATA & SCORE MUN: HHS. CONC & LOT: ES06/08E. ROW: 25. COL: 26.

A PHYSICAL	DATA	SCOR	B USE & IMPRVMNT	DATA	SCOR	C OWN & FRAG	DATA	SCOR
CHU > 2900 (%)	.	0	Spec Crop(%area)	.	0	%Area-Lots<10	0.	49
CHU 2700-2900	100.	20	GenFldCrop	80.	120	Size Lgst Lot	50.	25
CHU <2700	.	0	Pasture (Imprvd)	.	0	%1000ac Blk		
Soil % Spec	80.	64	Past. (Unimprvd)	.	0	Lots < 70ac	12.	39
CLI Class 1	55.	154	Aband/Idle	.	0	EA% Farms<70a	36.	24
2	.	0	No.NonFarm Uses	.	50	No. of Owners	2.	5
3	45.	88	Cont >=500ac="Y"	Y.	69	EA%>229 Ofm	67.	0
4	.	0	300-499="2",100-			EA% Tnant Fm	8.	19
5	.	0	299="3",<100="4"			C SUBTOTAL	n/a	161
6	.	0	Ag Bldgs -Spec,					
7	.	0	Lvstk,Other,Aban	0.	30	Use Flag	.	n/a
Soil Subtotal	n/a	306	Access-Loc,Reg,					
			Prov	L.	6	TOTAL SCORE	762	
			Tile Drnge %Area	.	0			
A SUBTOTAL	n/a	326	B SUBTOTAL	n/a	275	Rec No. 789 Updtd by peterl on 10/30/86		

THE REGIONAL MUNICIPALITY OF HALTON

THE FOLLOWING RESOLUTION WAS APPROVED BY REGIONAL COUNCIL AT ITS MEETING HELD May 20, 1987.

THAT Report DPD 61/87 regarding the Halton Agricultural Mapping and Policy Development Project and the Community Planning Grant be received.

THAT a copy of Report DPD 61/87 be forwarded to the Minister of Municipal Affairs together with a request that the remaining $1,500.00 portion of the Community Planning Grant be released to Halton Region.

THAT Halton Council expresses its thanks and appreciation to the Minister of Municipal Affairs for making available the Community Planning Grant and thereby furthering progress toward the identification of agricultural areas in the Regional Official Plan.

CERTIFIED A TRUE COPY
REGIONAL MUNICIPALITY OF HALTON
.....
Regional Clerk

Report No. DPD 61/87

Re: Halton Agricultural Mapping and Policy Development Project and the Community Planning Grant

RECOMMENDATIONS

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3. THAT Halton Council expresses its thanks and appreciation to the Minister of Municipal Affairs for making available the Community Planning Grant and thereby furthering progress toward the identification of agricultural areas in the Regional Official Plan.

EXECUTIVE SUMMARY

In June 1986, (through DPD 120/86), Council authorized the application to the Ministry of Municipal Affairs for a $10,000 Community Planning Grant for the Halton Agricultural Mapping and Policy Development Project. The grant was approved and the funded portion of the Project is now completed. Of the total grant, $8,500.00 was forwarded by the Minister in June 1986, with the balance to be forwarded when Council accepts and submits the report to the Ministry.

Also in June 1986, (through DPD 73/86), Council adopted a series of recommendations (attached as Schedule A), regarding the future direction of Regional Plan Settlement and Agriculture Policies. A major thrust of these

recommendations was to pursue a "two-designation" approach to the rural area, whereby agricultural areas would be identified in the Regional Plan with appropriate Settlement and Agriculture Policies.

The Community Planning Grant was approved to further the development of the Halton Agricultural Land Evaluation System and the appropriate Regional Plan policies. The Agricultural Land Evaluation System is intended to be a tool for the consistent, rational evaluation of the long-term potential of land for remaining in agricultural use, considering both physical capability and socio-economic factors such as degree of fragmentation.

The Technical Report on the Halton Agricultural Land Evaluation System accompanies this report under separate cover. The Evaluation System involves a set of factor and associated weights which are applied to each half of original Township lots (approximately 100 acre evaluation units) in the rural area to obtain a point score for each evaluation unit out of a possible 1000 point maximum. The results are mapped and a determination made that a score of 550 or greater is the threshold value above which the lands are considered to have a good potential for remaining in agriculture over the long term.

The Halton Agricultural Advisory Committee (HAAC) has been primarily responsible for determining the combination of factors and weights in the Evaluation System and for choosing the 550 threshold value, based on their intimate knowledge of actual conditions. Staff of the Ontario Ministry of Agriculture and Food (OMAF) have indicated their support after their own field inspections to confirm the results.

The Evaluation System, the mapped results, and preliminary policy principles have been circulated to the Area Municipal planning staff, OMAF, and Niagara Escarpment Commission (NEC) and the responses received have indicated general support with some suggestions for fine-tuning of the Evaluation System. The thrust of Settlement policies proposed for those areas not identified as agricultural areas is to allow local official plans to permit additional non-farm severances where the overlaying of the Niagara Escarpment and the Parkway Belt Plans and the Regional Resource Management Policies would indicate no concerns, plus the additional stipulation that they not be on Regional roads or Provincial highways.

There have been indications from Ministry of Natural Resources (MNR) staff that there is room for flexibility in the Forestry polices, in terms of setting out criteria for identifying those wooded areas where residential development would be acceptable. Development in wooded areas is currently an area of policy conflict between the Milton and

Regional Official Plans, and this approach offers an avenue for compromise in both Plans to achieve a resolution acceptable to MNR, the Town, and the Region. Regional Plan policies currently discourage development in all wooded areas, while Milton's policies encourage residential development in wooded areas.

Further work and discussion are required to refine the agricultural area mapping and the proposed policies, but the Halton Agricultural Land Evaluation System will provide a good basis for pursuing that task.

REGIONAL MUNICIPALITY OF HALTON

Report To Chairman and Members of the Planning and Public Works Committee

From R. Mohammed, Director of Planning and Development

Date 87 05 13

Report No. DPD 61/87

Re: Halton Agricultural Mapping and Policy Development Project and the Community Planning Grant

RECOMMENDATIONS

1. THAT Report DPD 61/87 regarding the Halton Agricultural Mapping and Policy Development Project and the Community Planning Grant be received.

2. THAT a copy of Report DPD 61/87 be forwarded to the Minister of Municipal Affairs together with a request that the remaining $1,500.00 portion of the Community Planning Grant be released to Halton Region.

3. THAT Halton Council expresses its thanks and appreciation to the Minister of Municipal Affairs for making available the Community Planning Grant and thereby furthering progress toward the identification of agricultural areas in the Regional Official Plan.

REPORT

Background

On June 4, 1986 (through DPD 120/86), Halton Council passed a resolution authorizing the Director of Planning and Development to make application to the Ministry of Municipal Affairs for a Community Planning Grant of $10,000.00 for the Halton Agricultural Mapping and Policy Development Project. In a letter dated July 25, 1986, the Minister of Municipal Affairs wrote to the Regional Chairman to advise the application had been approved. A cheque for $8,500.00 was attached, with the balance to be forwarded upon completion of the project. The Minister indicated that a Council resolution accepting the project report would be required to obtain the remaining $1,500.00.

Also on June 4, 1986, Halton Council (through DPD 73/86), received the summary and analysis of comments in response to the circulation of the eight discussion papers in the Rural Development Policies Review series, and adopted a set of recommendations regarding rural polices in the Regional Plan. That set of recommendations is attached as Schedule A to this report. The first seven of those recommendations pertain to the identification in the Regional Plan, by way of a map, of agricultural areas, with policy distinctions between the agricultural areas and the remaining rural area. This approach was termed the "two-designation" approach.

In the main body of report DPD 73/86, staff described the ongoing research into an Agricultural Land Evaluation System for Halton, to be used as a tool for the consistent, rational identification of agricultural areas. The Community Planning Grant was sought to enable the research and development of the Evaluation System to progress to a point where it could be used to help implement the two-designation approach.

The Halton Agricultural Land Evaluation System has progressed to such a point, and the purpose of this report is to forward to Council the Technical Report on the Evaluation System (under separate cover) and to generate a Council request to the Minister for the remaining $1,500.00 of the grant money. The policy aspects of the Project are discussed in a later section of this staff report.

The purpose, description, and results of the Halton Agricultural Land Evaluation System are all contained in the Technical Report. Very briefly, the Evaluation System consists of a set of factors and weights which are applied to each 100 acre evaluation unit in the rural area to obtain for each evaluation unit a score out of a maximum possible 1000 points. The threshold value is the score above which an evaluation unit would have a good, or high, potential for remaining in agricultural use in the long term, and has been established at 550 by HAAC.

Responses to Preliminary Circulation

The Halton Agricultural Land Evaluation System and the preliminary policy proposals developed to date have been circulated for comments to planning staff of the Area Municipalities, the Halton Agricultural Advisory Committee (HAAC), the Ontario Ministry of Agriculture and Food, and the Niagara Escarpment Commission (NEC). The responses received are attached as Schedule B to this report. HAAC has been directly involved in the development of the Evaluation System but did not make any comments regarding the preliminary policy proposals.

OMAF were very supportive of the Evaluation System and have conducted their own field visits to verify the results in northern Milton and Halton Hills. OMAF staff felt that the results of the Evaluation System accurately portrayed the actual conditions and had no concerns with using the 550 threshold value to identify those lands with long-term agricultural potential.

The specific comments received from Burlington, Halton Hills, and NEC staff pertain to "fine-tuning" of the System and with policy issues, and will be dealt with in future discussions and System refinements. Milton comments were generally supportive and Oakville staff had no concerns. The point is made in the attached Technical Report that there will always exist arguments, pro and con, on the content of the list of evaluation factors and the associated weights. There is no definitive set of evaluation criteria and weights. The efforts of staff in this Project have been directed toward achieving a consensus on an acceptable set of criteria and weights. It is only by comparing the Evaluation System results with actual conditions that the merits of the System itself can be judged. The thrust of feedback to date from the Halton Agricultural Advisory Committee (HAAC), from OMAF, and from the Area Municipality and NEC staff is generally supportive of the Evaluation System results, with comments pertaining mainly to particular data, factors, and weights as suggestions for improvements. Only Halton Hills staff have made specific comments pertaining to the proposed policy approach.

Towards Delineation of an Agricultural Area

The mapped results of the Halton Agricultural Land Evaluation System, using the 550 threshold value, will be an extremely useful tool in delineating agricultural areas for the Regional Official Plan. There are, however, outstanding issues associated with such boundary delineation which require further work on the part of Halton staff and further discussion amongst the various agencies involved. The major issues are discussed below:

a) Minimum Size of Mapped Areas

The continuity of an agricultural area does play a role in its long-term agricultural potential, and continuity is a factor included in the Halton Agricultural Land Evaluation System. The issue has been raised of what is the minimum size of an agricultural area which should be mapped in the Regional Plan. It does not seem reasonable to Halton or OMAF staff or to other staff with whom the issue has been discussed that single, isolated 100 acre parcels would merit Regional Plan identification as agricultural areas. On the other hand, OMAF staff initially suggested a much larger minimum area (1000 acres), but have since identified through their field inspections areas where there are viable farming operations existing within a much smaller area and which would appear to be worthy of identification as agricultural areas. Individual HAAC members have suggested a 250 acre minimum size. It is apparent that further discussion is required on this issue. It is possible that there does not have to be a firm minimum area, but instead each area can be considered on its own particular merits.

The question has also been raised as to what is the minimum size of a "non-agricultural" area which should be identified within a larger agricultural area. This is very important because non-farm development in the midst of an agricultural area can have significant adverse impact on the agricultural community even if the development is not located directly on good quality agricultural lands. Further discussion on this issue is also required.

b) Buffer Area

HAAC members have suggested the need for a buffer area to be delineated around the identified agricultural areas to prevent the adverse effects of non-farm development adjacent to the agricultural area. While supportable in theory, staff foresees the delineation of a buffer area as a source of practical problems in the implementation of the "two-designation" approach. Such a buffer area could be expected to include significant amounts of marginal or non- agricultural lands and significant numbers of existing non-farm residences or other development. A blanket policy restricting non-farm development in such areas may not be feasible or desirable. OMAF staff have expressed preliminary doubts over the practicality of a buffer area.

As an alternative to defining a buffer area, Planning and Development staff currently foresee a written policy approach as being more workable, whereby those major development applications situated near, and with potentially adverse

effects on, the agricultural areas would be required to have an Agricultural Impact Assessment carried out, and the results of such a study would be considered in evaluating the merits of the proposal. The cumulative impact of individual non-farm residential severances would also need to be addressed in some manner through such written policies, in staff's opinion, but to require impact studies for individual residential severances would not appear to be practical.

c) Detailed Boundary Delineation

The decisions made regarding the two issues discussed above, particularly the minimum size of mapped areas, will have an impact on the detailed delineation of agricultural area boundaries. Staff has already begun work on delineating such boundaries, utilizing aerial photos, assessment maps and OMAF's Agricultural Resource Inventory (ARI) maps, in conjunction with field inspections. Staff would prefer, wherever possible, to utilize identifiable features as the boundaries, such as lot and concession lines, roads, railways, or river valleys, or other natural barriers. This may not be feasible at all locations, such as where a farm parcel at the boundary is bisected by the township lot line. In addition, HAAC has indicated that they would further consider the buffer area issue after the boundaries of the agricultural area have been delineated in draft. Thus, there is further work required to delineate the actual boundaries of the agricultural areas for the proposed Regional Plan designation.

Policy Directions

Part of the Project for which the Community Planning Grant was approved involved the drafting, and subsequent discussion amongst interested agencies, of the Regional Plan Settlement, Agriculture, and other policies associated with the "two-designation" approach. To date, staff has developed a set of policy principles which have been presented to OMAF, HAAC, NEC, and Area Municipal planning staff with no significant adverse reaction from any of them. The drafting of an actual amendment is a very complex task given the scope of the changes, and has yet to be done. The future amendment will have very important ramifications for Halton, the Area Municipalities, and the agricultural industry. It is expected to be a controversial amendment which must be drafted in a very careful and sensitive manner. The proposed wording and maps in such an amendment will require considerable refinement and dialogue before they are in a form suitable for public comment.

In addition, the Regional Plan Review exercise is ongoing, and it would be inefficient to draft in detail such a major

amendment without consideration of other changes which may arise from that Review exercise.

Regarding the proposed policy principles developed to date, Halton Council has previously provided some direction on general principles applicable to the "two-designation" approach (see recommendations in attached Schedule A). These principles are summarized as follows:

- Identify agricultural areas in Regional Plan

- Agricultural areas will include some pockets of low quality soils or non-farmable lands

- Lands not identified as agricultural areas will include some pockets of high quality soils and farmed land

- Rural Estate subdivisions to be prohibited in agricultural areas

- Non-farm development restrictions to be relaxed in "non-agricultural" (rural) areas, if it is possible to do so while still protecting matters of Regional interest

- Policies regarding land fragmentation in agricultural areas to be clarified and strengthened.

To complement the above, staff has been investigating and discussing with appropriate agencies the principles of more detailed policies. One very important principle to be maintained is that regardless of any relaxation of Regional Plan Settlement Policies, local official plans may be more restrictive toward rural development than the Regional Plan. This exercise is not intended to permit any non-farm development not desired by the local municipalities.

With regard to relaxing the development policies in the areas not identified as agricultural, it is intended to go beyond the infilling proposed through OPA No. 13. The thrust of the proposed policies is to allow local official plans to permit additional severances in those locations not on Regional roads or Provincial highways and where the overlaying of the Niagara Escarpment Plan, Parkway Belt Plan, and the Resource Management policies of The Regional Plan would indicate no significant Regional concerns. Staff does not foresee relaxing the policies with respect to development in Environmentally Sensitive Areas, Hazard Lands, or on Provincial or Regional roads. The Niagara Escarpment or Parkway Belt Plan policies cannot be relaxed by any Regional Plan revisions, since they are higher tier Provincial plans. The policies regarding wetlands and mineral resource deposits will be governed largely by Provincial guidelines and policies. Hydrogeological concerns will have to be addressed, as at present, where conditions warrant.

One existing Resource Management policy area, namely Forestry policies, appears to have a significant potential to accommodate revisions which may permit additional development in some wooded areas. Current Regional Plan policies discourage development in all wooded areas. This would be particularly significant in northern Milton (formerly Nassagaweya Township), where a great deal of wooded lands exist. The Milton Official Plan is currently in direct conflict with the Regional Plan in that it encourages residential development in wooded areas. Preliminary discussions with Ministry of Natural Resources (MNR) and Milton planning staff have indicated that MNR would be willing to consider Regional Plan Forestry policies which set out criteria for determining whether development in a particular wooded area would be acceptable. Such criteria might include the quality of the wood from a timber production standpoint, the size of the woodlot, the existing degree of land fragmentation and the size and design of the proposed development. Further discussion with MNR and local staff will occur on this issue through the Regional Plan Review exercise.

The result of the above is a proposed approach to settlement outside identified agricultural areas whereby the local official plans may permit additional rural residential development on local roads where the "sieve", or overlay, of Regional Plan policies applicable to rural resources permits such development. There is a substantial area of land which could be considered for development through such an approach as compared with current policies which would not permit non-farm residential severances unless in Hamlets and Rural Clusters, or through infilling under proposed OPA No. 13.

In agricultural areas, development in Hamlets and Rural Clusters, plus infilling as per Regional OPA No. 13 (if in conformity with the final Foodland Preservation Policy Statement), will be permitted. Justifiable expansions to Hamlets and Rural Clusters would be permitted without Regional Plan amendments. Non-farm development deemed incompatible with agriculture, as per the proposed Policy Statement, would not be permitted outside Hamlets and Rural Clusters over and above the proposed infilling provisions of OPA No. 13. Therefore, such development would require a Regional Plan amendment and that amendment would have to be adequately justified.

As far as such Regional Plan amendments are concerned, it is not anticipated at this preliminary stage in policy formulation that a Regional Plan Agricultural Area map amendment would be required where a development proposal was considered to be justified in an agricultural area. Rather, a textual amendment would apply to the property in question

as a specific exception. Periodically, perhaps during the Regional Plan Review required every five years by The Planning Act, the extent of the agricultural area could be reviewed in light of updated information, including the cumulative effect of any such Regional Plan textual amendments.

It is anticipated that the Agricultural Area map would be an additional policy map in the Regional Plan, similar to the existing Mineral Resource, Environmentally Sensitive Area, and Hazard Lands maps.

Balance of Community Planning Grant Funds

As previously indicated, $1,500.00 of the $10,000.00 Community Planning Grant funds are to be forwarded to Halton upon the completion of the project. The funded portion of the project is now complete. Consequently, staff is recommending that this report be forwarded to the Minister of Municipal Affairs, that he be requested to release the $1,500.00, and that he be thanked for making the grant available to Halton.

Respectfully submitted,

R. Mohammed
Director of Planning and Development

PL.sc

A. Recommendations Pertaining to the Identification of "Agricultural" Areas in the Regional Official Plan

1. That Council accepts in principle the proposed policy approach to Halton's rural area whereby "agricultural" areas are identified by way of a map in the Regional Official Plan, with policy distinctions made between the "agricultural" and the "non-agricultural" areas. (p.11)

2. That Halton staff pursue discussions with the Area Municipalities, the Ministry of Agriculture and Food, the Halton Agricultural Advisory Committee and other interested agencies concerning both a consistent approach to the identification of "agricultural" areas in the Regional Official Plan and the appropriate development and severance policies for both the "agricultural" and "non-agricultural" areas. (p.11)

3. That the principle be accepted that the Official Plan policies prohibit Rural Estate developments in the identified "agricultural" areas. (p.23)

4. That the principle be accepted that land which is currently farmed or contains good quality agricultural soils may be included in the "non-agricultural" areas, due to such reasons as relatively small or isolated areas, existing fragmentation patterns, or proximity to incompatible development. (p.11)

5. That for "non-agricultural" areas, the issue of permitting additional rural development in areas outside Hamlets, Rural Clusters, Rural Estate plans of subdivision, and residential infilling be further considered by staff, with such investigation to include consultation with Area Municipalities and other interested parties. The investigation will address clarification of the term "non-farm development" and the feasibility of effectively controlling such development to protect such matters of Regional interest as the safety and efficiency of major roads, Environmentally Sensitive Areas, Hazard Lands, aquifer recharge areas, mineral resources and significant wooded areas. (p.18)

6. That the principle be accepted that the identified "agricultural" areas will include some pockets of low quality agricultural land upon which non-farm development is not permitted, on the basis that indirect adverse im-

pacts on agriculture would occur if such lands were developed, and further, that this principle be explicitly stated in the Official Plan. (p.16)

7. That current policies which attempt to reduce the fragmentation of farmland be clarified and strengthened in identified "agricultural" areas by including the following:

   a) in every severance application for the creation of smaller farm parcels, the applicant is required to submit sufficiently detailed information regarding the specific nature of the intended farming operation(s) on the retained and severed lots to enable reasonable evaluation of agricultural viability. Further, such severances will only be permitted where specific, concrete proposals for farm operations are made and where it has been demonstrated that the operations have a reasonable chance of viability. (p.33)

   b) explicit recognition that existing farm parcels which may not be viable farm units by themselves can make valuable contributions to the viability of larger farming operations, and therefore, further fragmentation of such parcels for other than specific, viable farm operations should be prohibited. (p.38)

B. <u>Recommendations Pertaining to the Entire Rural Area</u>

8. That the Settlement policies of the Regional Official Plan be amended to permit, but not require, local official plans to permit consideration of residential infilling between non-farm residences existing at the date of adoption of the policy and not more than 100 m apart on the same side of the road. (p.18)

9. That the policies regarding Rural Estate plans of subdivision outside Hamlets and Rural Clusters be amended to prohibit abutting plans of subdivision which, if approved, would result in excess of 20 units in total for all abutting Rural Estate plans of subdivision. (p.23)

10. That the Settlement policies of the Regional Plan be amended: firstly, to explicitly clarify that local official plans are not required to permit Rural Estate plans of subdivision; and secondly, to require that

residential plans of subdivision adjacent to Hamlets or Rural Cluster be considered only in the context of expansions to the Hamlet or Rural Cluster designations of the local official plans and not as distinct Rural Estate designations. (p.23)

11. That staff pursue further discussions with staff of all three Conservation Authorities and the Area Municipalities regarding: an expanded definition of Hazard Lands to encompass the entire creek system; and a policy to encourage any new lot containing Hazard Lands to be of sufficient size to accommodate outside the Hazard Lands the complete development plans for the lot. (p.30)

12. That the Regional Plan policies not be amended to require explicit assessment of indirect impacts on agriculture of individual non-farm development applications, as was recommended in the 1983 Rural Development Policies Review Papers, given the difficulties of identifying and measuring indirect impacts caused by individual uses. (p.16) (Current policies do not explicitly define the type of impacts which must be evaluated)

13. That the policies not be amended to establish a 20 ha (50 acre) minimum farm parcel size for severances as was recommended in the 1983 Rural Development Policies Review Papers. (p.33) (Current policies base minimum parcel size for farm severances on viability without a specified minimum lot size figure)

14. That the policies be amended to permit local official plans to establish minimum farm severance sizes notwithstanding the viability of smaller proposed farm severances. (p.33)

15. That staff prepare for Council's consideration, after consultation with the Area Municipalities, H.A.A.C. and O.M.A.F., draft Viability Evaluation Guidelines for farm severances, which stipulate the necessary information required of applicants and which, if feasible, establish viability criteria. (p.33)

16. That further consideration of actual Regional Plan policy amendments regarding farm retirement and farm help severances await the release of the final Provincial Policy Statement on Foodland Preservation. (p.41)

17. That staff undertake an analysis of the results to date of the current Regional Plan policies regarding severances and second dwellings for farm help. (p.43).

The Corporation of the
City of Burlington

City Hall:
426 Brant Street, Burlington, Ontario, Canada
Mailing Address:
P.O. Box 5013, Burlington, Ontario, Canada L7R 3Z6

Telephone: 335-7641
File No.: 150-05-21

February 19, 1987

Region of Halton
Planning and Development Department

Attention: Peter Langdon

RE: Halton Agricultural Land Evaluation and Mapping Project
Regional File: AG06A
Burlington File: 150-05-21

The agricultural mapping of the rural area of Burlington does not raise major concerns to this department. The following comments are offered for your review during the finalizaion of this study:

1. Specialty Crop Capability

Only a small portion of Halton has a specialty crop production capability. The weighting system proposed would cause lands with general field crop capability to lose 80 possible points. A bonus points approach for specialty crop capability would be more appropriate. A generalized map identifying areas where specialty crop production is possible could be added as an appendix.

2. Abandoned/Idle Agricultural Land

The weighting system has a 100 point difference between abandoned idle land and general field crop use. In many instances lands proposed for development will have been previously taken out of agricultural production. This should not be made a benefit to the development proponent in terms of lowering his potential score in determining agricultural capability.

3. Tile Drainage

A large part of rural Burlington does not have the capability for tile drainage due to the shallow soil depth to overburden resulting in the use of surface drainage and contour cultivation methods. The proposed weighting system therefore penalizes these lands by 55 points. It is suggested that this category not be used for lands where tile drainage is not possible and a map showing these areas should be prepared.

4. Regional Arterial Roads

In some locations Regional roads have the same character as a local paved road with Derry Road west of Guelph Line given as an example. It is not known if Derry Road would be considered as a Regional arterial road and be given a different weighting factor than a local road.

5. Mapping

a) The term "Developed Area" is not defined. Is there a residential component at these locations?

b) In fitting the maps together, the Hwy. 403 does not line up where the maps joined in Milton.

c) The mapping for lands in Burlington raises only one area of concern. The lands at the southwest corner of Britannia Road and Guelph Line have been identified as Hamlet area. These lands are predominantly used for a golf course with a church and the H.R.C.A. headquarters being the other uses. An Open Space identification would appear to be more appropriate for this block.

6. The use of the 550 points mark as determing agricultural viability should be used only if supported by the Ministry of Agriculture and Food. Based on the material forwarded, it is expected that further review by O.M.A.F. and other bodies will be needed if the Region intends to adopt this analysis as Regional Official Plan policy.

Yours truly

John Conn

John Conn
Planning Assistant
Planning Department - Policy

JC/prd
1113t

56

Town of Halton Hills

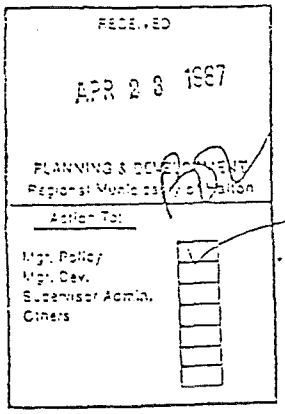
P.O. BOX 128
HALTON HILLS (GEORGETOWN)
ONTARIO L7G 4T1

87-187

File No.

Dept. Planning

April 16, 1987



The Regional Municipality of Halton
Planning and Development Department
1151 Bronte Road, P. O. Box 7000
OAKVILLE, Ontario.
L6J 6E1.

ATTENTION : RASH MOHAMMED
REGIONAL PLANNING DIRECTOR

Dear Rash:

REF : PROPOSED AGRICULTURAL
LAND EVALUATION SYSTEM

First of all, please accept my apologies for being late in responding to your most interesting preliminary report on the proposed Agricultural Land Evaluation System.

I accept for the time being the suitability of the list of factors, their relative weightings and the proposed threshold value as matters which are best determined by working closely with them. From a preliminary view the 550 threshold seems to produce a mapping system which reflects my own general understanding of the better quality agricultural land in Halton Hills. It occurs to me that it might be a mistake to judge the individual cell on the numerical value alone. Instead, it seems to represent a valid technique for a comparative evaluation for broader areas. It illustrates for instance the general concentration of good agricultural land and the relative importance of land, above and below the Escarpment.

Buffer Areas.

I agree with your reservations about a buffer area, but from a different perspective. If a buffer for agricultural uses from non-farm uses is a valid notion then it also follows that a buffer for non-farm uses from agricultural uses is also valid. The effect of these 2 buffers near an urban area is to create a no-mans land in which virtually nothing can occur; a sort of "de-militarized zone".

...../2

Without urbanization of some form there is no issue. However, one of our principle collective issues is to create urban and suburban communities suitable for people to live in. That is our first priority. I am interested in your idea of a belt of estate residential development surrounding more urban uses as a kind of "buffer" to the agricultural community. As you know I much prefer estate residential development "near" urban areas rather than forced out into the agricultural community in an effort to avoid the potential request for the extension of services. In my opinion the question of services can readily be overcome by good urban (suburban?) design.

Minimum Size

I concur with your staff that the minimum size should be somewhere in the 500 to 1000 acre range. A review of the blocks or concentrations in Halton Hills would support the larger size. I don't believe the converse, however, is true. It seems to me that it doesn't take 1000 acres of buffer around a non-farm use to buffer the farm community from the perceived negative impacts. Instead I believe the scale is much more intimate than that. This issue strikes me as much more of a territorial power struggle than it is a land use planning and evaluation system matter.

Sensitivity Analysis

I support your thoughts on sensitivity analysis as it goes a long way to reduce my concerns as to the relative values for the list of factors, relative weightings and threshold values.

Detailed Boundary Studies

I have not given this any thought at this time as I regard the system to be too fluid to judge effectively. I note your are working on more detailed delineation of the boundary which may help in this regard.

Ecologistics Ltd.

May I draw your attention to an Agricultural Impact Assessment by D.R. Cressman dated March 1986 a copy of which should be in your office which is prepared for a specific development proposal. While not commenting on the validity of the specific application of that study, I suggest that

...../3

you may find his approach of interest, useful and somewhat similar to your own. I suggest that your reveiw and comments as to the general aspects of his approach would be useful at this time.

Policy Directions

It is just a little soon for me to get into the specifics of your policy directions other than those which have been forwarded to you on Official Plan Amendment #13. I note with interest reference to the locals being allowed to be "more restrictive", and I have recently run into a most perverse interpretation of what more restrictive means. The range of interpretive options here should be discussed and clarified; ie. more restrictive for whom?

I hope that these preliminary thoughts are of some use to you and if I can be of further assistance please let me know.

Yours truly,

Ian S. Keith
Director of Planning.

ISK:cmb

AG06 A 59

The Corporation of the
TOWN of MILTON

R.J.L. Zsadanyi
Director of Planning

January 26, 1987 File 2905

Mr. Peter Langdon
Planner
Region of Halton

Re: Halton Agricultural Land Evaluation and Mapping Project (AG06A)

Dear Peter:

By this letter I will confirm my support for the excellent work which you have carried out re the above. I certainly believe that the indexing system that you have developed will enable us to eventually put into place a much better formula for determining where rural non-farm development can realistically be located. It is important that this issue of the severance deferral in the Milton Official Plan be attended to as quickly as possible; on the other hand, because of the detailed nature of the work you are carrying out, I would hesitate to jeopardize the ultimate findings by having to rush the project along unduly.

The use of the 550 index also appears quite realistic to me. One of the first areas that I looked at insofar as this particular standard was concerned, relates to that agricultural pocket of land in western Nassagaweya in the vicinity of #20 Side Road. The 550 index clearly points up this particular pocket of agricultural activity and, being familiar with the area, I also believe that it delimits it fairly accurately.

Please do not consider these comments as the final ones that I will be submitting to you on this work. I hope that these interim comments will be of assistance and should you have any questions with regard to the content of this letter, please feel free to get in touch with me.

Yours sincerely,

R.J.L. Zsadanyi, M.C.I.P.
Director of Planning

60.

THE CORPORATION OF THE TOWN OF OAKVILLE

OAKVILLE
ONTARIO

TELEPHONE 845-6601
P.O. BOX 310
L6J 5A6

February 5, 1987

Mr. Peter Langdon, Planner
Regional Municipality of Halton
Planning Department
1151 Bronte Road
Oakville, Ontario

Dear Mr. Langdon:

Re: Halton Agricultural Land ~~Evaluation~~ and Mapping Project - File: AG06A

We have received the information that you sent us. We cannot comment on the accuracy or reliability of the maps because we have limited expertise in this area.

The lands north of Highway No. 5 in Oakville give us some concern in terms of long term agricultural use. There are many arguments that could be made to expand the Urban Area of Oakville North to the Parkway Belt. Although our Official Plan shows the lands as agricultural, we would not wish to rule out the possibility of future urban use for the lands.

Thank you for the opportunity to comment on this work.

Yours truly,

Ron Foy,
Planning Director

LG:ba

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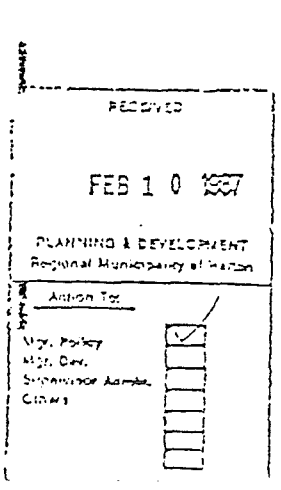


AG06 A

61

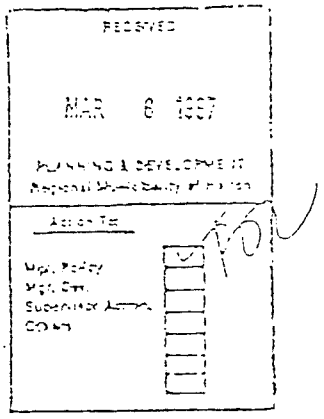
Ontario

Niagara
Escarpment
Commission

416/877-5191

232 Guelph Street
Georgetown, Ontario
L7G 4B1

March 3, 1987



Mr. Peter Langdon
Planner
Regional Municipality of Halton
P.O. Box 7000
1151 Bronte Road
Oakville, Ontario
L6J 6E1

Dear Peter:

Re: Halton Agricultural Land Evaluation and Mapping Project

I have now had an opportunity to review the Halton Agricultural Land Evaluation and Mapping Project. Unfortunately, I was unable to meet the February 6 deadline.

I found the approach taken innovative and it would appear, on face value to be an effective way to address a complex issue. Generally, I do not have any major concerns but provide the following comments for your consideration.

Map Unit: The 40 ha (100 ac.) mapping unit appears to be appropriate.

Scoring: Incompatible uses are given a plus (+) score with lower values assigned to less compatible uses (e.g., residential uses).

Since such uses have a negative impact on the viability of adjoining agricultural uses, was any consideration given to assigning a negative (-) value to incompatible uses?

Threshold Value: The threshold value appears to be reasonable, however, a detailed field check by Ontario Ministry of Agriculture and Food would be an appropriate means of verifying its credibility.

Buffer Areas: Uses adjacent to good agricultural land can have a significant impact on agricultural operation. Buffer areas, therefore, are important and would serve to protect the good agricultural land from being encroached upon by incompatible uses.

A policy approach which requires review of proposed adjacent uses could address this issue.

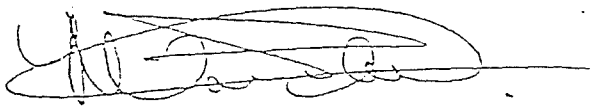
Mapped Area: As an observation, 400 ha (1000 ac.) as the minimum size for mapping would appear to be too large since reasonably large pockets of good agricultural land would be missed and, therefore, vulnerable to loss over time.

On the other hand, 40 ha seems too small for your purposes.

I would be inclined to favour the 90 ha (250 ac.) figure as most appropriate for mapping purposes.

I hope you find these comments helpful and once again I apologize for the delay.

Yours truly,



Marion Plaunt
Senior Planner
Plan Administration

MP/bt

Ontario

Ministry of
Agriculture
and Food

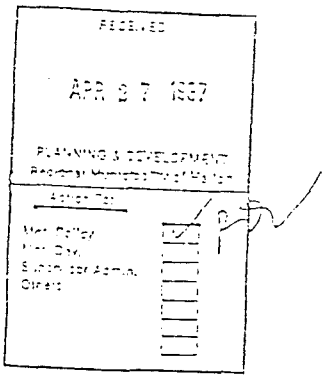
416/965-
9433

Legislative Buildings
Queen's Park
Toronto, Ontario

M7A 2B2

Foodland Preservation

10 April 1987



Mr. Peter Langdon
Planner
Planning and Development Dept.
Region of Halton
1151 Bronte Road, P.O. Box 7000
Oakville, Ontario
L6J 6E1

Dear Mr. Langdon,

Re: Agricultural Land Evaluation System
Region of Halton

Staff of the Ontario Ministry of Agriculture and Food have reviewed the above proposal, and consideration has been given to it in view of the present goals and objectives of the Ministry. We offer the following observations for your consideration.

Further to meeting with you staff undertook a field visit to the former Townships of Esquesing and Nassagaweya to review the results of the analysis done by the Region. Staff felt that the results adequately reflected the intensity of agriculture taking place in these areas. The 550 threshold level appears to be an appropriate one to use.

We would like to express our support for this exercise undertaken by the Region. The two designation approach is, of course, supported by the Foodland Guidelines in sections 4A.1 and 4A.2.

We hope to continue working with the Region in the "fine tuning" of the two-designation system.

If you have any questions, please contact Shirley Bailey, District Manager (Central Ontario) or Heather Gariepy, Land Use Specialist at (416) 965-9433.

Yours truly,

for DONALD DUNN
Director

G:HAGDESIG.HG

HALTON FEDERATION OF AGRICULTURE BRIEF TO COUNCIL
APRIL 22, 1987

-and-

HALTON STAFF COMMENTS ON THE FEDERATION OF AGRICULTURE BRIEF
REPORT NO. DPD 88/87

DPD 88/87
SCHEDULE A

HALTON FEDERATION OF AGRICULTURE

Brief to Council April 22, 1987

Mr. Chairman, Ladies and Gentlemen of Council:

We are very pleased to be here today, partly due to a challenge given to us by your Chairman and partly due to misconceptions which we feel are presented to you from time to time by so-called farmers.

In today's agricultural economy there is no denying we are not running at full capacity. But as your business development director has been quoted as saying "Agriculture quietly continues to be one of the largest industries in dollar value in the region."

We appear before you this afternoon to help improve your understanding of the importance of agriculture to this region. To do this we would like to present an overview of agriculture in Ontario, as a whole, with statistical Halton data for 1986 and evidence of how agriculture impacts other industries. Finally we would like to reinforce some policies that we from time to time send in your direction.

First of all paraphrase our own regional offical plan "Agriculture will be protected and encouraged".

PART ONE - THE ONTARIO OVERVIEW

Many of our comments on agriculture in Ontario will be taken from "Directions for Sustainable Agriculture", a task force report of the Ontario Institute of Agrologist. The balance is from various Ontario Ministry of Agriculture and Food research papers.

Agriculture in Canada accounts for more than 10% of the countries total economic activity. It contributes approximately 6 billon dollars to our balance of trade, and employs almost 1.5 million people

. In Ontario this means approximately one person in five.

Using 1973 as a base (100) Direct employment in agriculture productivity has risen to 127.4 in 1983, while other industries have only achieved an index of 110.7 in the same time frame. But in real terms net farming incomes when compared to 1973 is down 36% in 1984 and 45% in 1985. Today almost 1/3 of Canadian agricultural borrowers are in financial distress. To alleviate any fears, we are not here seeking a handout.

Why is Agriculture in Canada floundering today:

1. This phenomenal increase in productivity
2. A five fold increase in capital investment over the same period
3. A period of wild interest rates
4. An agricultural trade war between the United States and the European Economic Community
5. The usual risks of weather, diseases and insects,
6. Fluctuating exchange rates.

Agriculture in Ontario is built on 82,450 farm units, 36,000 or 44% of which report sales of $25,000 or more per year. Farm units are predominantly family owned and operated with a labour force of 143,000 people. Directly related to this, 102,000 people are employed in the food and beverage industry, and 245,000 in the retail distribution of foods and bevrage products. In all, the agriculture and food industry in Ontario contributes more than $8 billion to the gross provincial product, and exports agricultural products valued at almost $2 billion annually.

Agriculture in Ontario is integrated closely with other industrial sectors (e.g. dairies, feed mills etc.) and is a vital component of society, both urban and rural. It operates in a nationwide context and any policy for sustainable agriculture in Ontario must be part of a Canadian national policy. Canada must have a food policy that reflects both national needs and national interests.

Canadian society should support the following objectives and the Canadian agriculture and food system should commit itself to achieving them:

1) To produce an adequate supply of wholesome and nutritious food.
2) To preserve the agricultural resource base.
3) To attain self-sufficiency for Canada in products we produce efficiently.
4) To improve Canada's balance of payments through exports.
5) To enable capable farmers to continue in production through sufficient returns to management, labour, risk, and capital.
6) To recognize the contributions of the agricultural Industry to the welfare and fabric of Canadian society.

As Canada's population expands, so too do the competing demands for land. This is especially significant near population centres like Halton,where industrial and housing developments are growing rapidly. This pressure to use agricultural land for such expansion is high. Agriculture must recognize the merits of these competing demands and society must recognize the value and uniqueness of good productive land. Not all of the land now tilled in Canada is needed for our own self-suffuciency but the best soils will be essential for a competitive Canadian agriculture in the future. While it may not be possible to keep all of the prime foodland for agriculture production, good equitable policies are needed to ensure that the best agricultural land is not converted to other uses. Where land is converted, however, farmland and the operation of the farmland adjacent to these developments must be protected from harassment.

This is a very touchy issue within this region. This federation is on record before the Honourable Jack Riddell as opposing his most recent draft of the Foodland Preservation Policy. Not because we do not want to see land preserved, but because of the inequities that his policy paper would have achieved in Halton, and because we all too often have seen how rules can be bent or changed if the stakes are high enough. Before a "Foodland Preservation Policy" is brought in, a "Right to Farm" legislation should be enacted.

Agriculturalists are stewards of the land. Modern equipment, new crop developments and market opportunities have contributed greatly to the efficiency of the industry of agriculture. At the same time these factors have contributed to intensive land use and the cropping of land not well suited to annual cultivation.

In some areas additional research is needed to develop appropriate methods to improve soil quality. Our industry needs a close interaction with extension workers who can advise on steps to be taken to correct these problems. In addition, financial incentives may be needed to convert to alternative crops or to retire land to forestry or recreational uses.

We in agriculture have done a poor job of communicating to the public the importance of agriculture's role in sustaining a sound economy and a healthy Canadian population. An abundant and inexpensive supply of food is taken for granted by the majority of consumers who know little about the risks involved in food production or the labour, management or capital requirements of this industry. A health conscious public is concerned about contaminants in food. They are alarmed by reports linking red meat with heart disease or eggs with cholesterol levels. In general, the consumer has a poor understanding about food requirements for good nutrition and about the degree of inspection and monitoring done in Canada to ensure that our

foods are safe. This requires an educational program both in the media and in the school system. Such a program would include:

1 information on nutritional requirements for human health,
2. foods appropriate to meet these requirements
3. the essential nature of the agricultural industry,
4. the employment created,
5. agricultural efficiency,
6. the role of agricultural exports to our economy.

As each generation of Canadians get further removed from the farm, so does their understanding of the complexity of the agricultural industry. In order to assist in educating the public about this industry, we within the Halton Federation are persuing an "Agriculture in the classroom approach".
As far as Ontario trade is concerned we import 2.97 billion dollars of agricultural and food commodities. On the other hand, we only export 1.84 billion dollars of agricultural and food commodities. In terms of value the most important food commodities imported were:

1.	fresh and processed fruit	$595 million
2.	vegetables	$313 million
3..	Imports of plantation crops (coffee and tea)	$293 million
TOTAL		$1201 Billion.

HALTON AT A GLANCE

	HALTON	PROVINCE	COUNTY as % of PROVINCE
POPULATION			
-farm population	3,280	289,000	1.13
-rural non-farm population	18,500	1,300,000	1.42
-total population	273,000	9,077,000	3.01
COUNTY AREA BY SOIL CLASS			
-class 1 & 2	115,000	9,672,800	1.19
-class 3 & 4	56,000	4,908,300	1.14
-class 5 & 6	27,600	3,911,700	0.71
NUMBER OF FARMS			
-total number	950	81,500	1.17
-with sales greater $2,500	730	69,425	1.05
-with sales greater $25,000	290	36,000	0.81
MAJOR FARM TYPES (with sales over $2,500)			
-total farms	730	69,425	1.05
cattle	140	19,615	0.71
dairy	90	12,974	0.69
hogs	40	5,166	0.77
poulty	40	1,895	2.11
wheat & grains	120	14,739	0.81
fruits & vegetables	80	4,356	1.84
other	220	10,680	2.06
sheep	40		
TOTAL AREA ON FARMS (acres)			
-total area	129,000	14,920,000	0.86
-cropland	82,000	9,027,500	0.91
winter wheat	8,500	625,000	1.36
oats,barley,mixed grain	14,000	1,420,000	0.99
corn (grain & silage)	17,500	2,480,000	0.71
soybeans	4,500	1,000,000	0.45
dry white beans		105,000	
tobacco		85,000	
hay	24,000	2,650,000	0.91
fruits	900	70,800	1.27
vegetables	1,400	150,200	0.93
potatoes	100	38,400	0.26
other	11,100	403,100	2.75
-pasture	13,000	1,620,000	0.80
LIVESTOCK ON FARMS, July 1, 1985 (# head)			
-hogs	18,100	3,415,000	0.53
-sheep and lambs	2,800	237,000	1.18
-dairy cattle	5,500	810,000	0.68
-other cattle	9,700	1,708,000	0.57

MILK SHIPMENTS, 1986 (kilolitres)			
-Group I & II	13,354	2,339,500	0.53
-Gross Value	6,540,000		
CAPITAL VALUE, ($ million)			
-land and buldings	526	21,014	2.50
-machinery/equipment	41	3,705	1.11
-livestock and poultry	14	2,086	0.67
FARM CASH RECEIPTS ($ million)	75	5,180	1.45

N. Roller (965-1064), Economics and Policy Coordination Branch, OMAF.
Updated October 1986

PART TWO - HALTON COUNTY

There are before you some facts and figures about agriculture in the region and a comparison with the provincial statistics. Please note as a percentage of total land area, Halton represents less than 1% but there are many of these statistics in which we excel and produce way more than our land base would indicate.

The data is compiled by two means. Some from the 1981 National Census,(unfortunately the most recent 1986 data is not available) and the rest from 1985 and 1986 actual data collected by the Ontario Ministry of Agriculture and Food. Some conclusions that can be drawn from this information are:

1. The farm cash receipts of 75 million dollars are down substantially (9.65%) from 1985 when it was 83 million dollars. This reflects general farm conditions although the overall province showed a 1.16% increase. Other factors which played a part in Halton's lower cash receipts were the actual loss of land from production and the decrease in corn acreage from 27,000 acres to 17,500 acres. A large increase in the category "other" from 3,100 acres to 11,100 acres, indicates that more land is fallow or new cropping alternatives such as canola are being planted. These new crop alternatives tend to be less profitable in the first few years until production methods are established and markets developed.

2. Two bright spots in Haltons agriculture economy are the poultry and fruit and vegetable industries.

Poultry is an intensive agribusiness requiring a smaller landbase than most other commodities. Halton producers are also close to the largest processor in Ontario. (Maple Lodge Farms)

Fruit and vegetable prodution is higher than the provincial average because of the proximity to ready markets, the access to good productive Class 1 land and climatic conditions created by Lake Ontario and the Niagara Escarpment.

As you may have noticed there are no figures in these tables for horses. Horses and their industry require oats, hay and straw; pay taxes and bring a lot of dollars into the county via visitors, breeding fees, employment and track winnings. They are certainly recognized by our federation as a legitimate agricultural use of land and as much a part of agriculture as corn growing. People who raise horses generally utilize the land as well as any other farmer. Some build their enterprise on small lots, others are conscious of putting training tracks where they do not destroy any more land than is necessary. Some of the larger breeding establishments are really improving property values with excellent fencing, buildings and property maintenance.

PART THREE - INDIRECT BENEFITS

Direct employment in the agri-food chain in Ontario and Canada is comprised of:

	Canada	Ontario	%
Agriculture.....	490,000	127,000	25.9
Processing.....	230,000	84,000	36.52
Wholesale.....	55,000	17,000	30.9
Retail.....	215,000	83,000	38.6
Restaurants.....	370,000	150,000	40.5
Selected Ag-rel. Manuf	50,000	24,000	48.0
Total.....	1,410,000	485,000	34.3

TOTAL EMPLOYED LABOUR FORCE IN ONTARIO = 4,402,000

AGRI-FOOD AS A PERCENT OF TOTAL = 11%

If employment indirectly related to the agri-food sector is included (such as employment generated by agriculture and food processing service industries, finance, transportation and government), then approximately 1 in 5 jobs in Ontario depends upon the agri-food industry.

In Halton there are:

3 milk processors, Neilson's, Oakville Dairy and McCain's Dairygold

3 milk transportation companies

3 direct farm machinery dealerships

4 indirect farm machinery dealers selling farm brand name products to farmers and town folk alike

3 importers of Ag and Ag related equipment

7 feedmills

2 Agricultural Chemical Companies

1 seed house (Dominion)

12 veterinarians, directly large animal or horse related

3 farm building and granary manufacturers

At least 8 suppliers of diesel and gas who report agricultural sales as 25-40% of their business

Numerous food and beverage manufacturers and distributors

Head Office Case International Agricultural Equipment

These are just some of the many people depending on agriculture.

Other County Benefits:

Chudleighs Apple Farm draws 150,000 visitors per year

The Ontario Agricultural Museum, 40,000+ visitors per year

11 pick your own operations

Leaver Mushrooms

Meadowglen Mushrooms

Mohawk Racetrack

Farm gates sales

PART FOUR - LEGISLATION

Just recently agriculture has had a lot of legislation pertaining to it appear in the press.

1. The spills bill and all of its ramifications:
   a) Environmental pollution of water courses
   b) Air pollution due to fire of farm chemical storage
   c) The possible licencing of farmer operators to apply pesticides.

2. The right to farm legislation -- coexistence of urban with rural.

3. Foodland Preservation Policy:
   a) Severance policy
   b) Industrial usage
   c) Dump site requirements
   d) Infilling and expansion.

4. Canadian Special Grains Program: A Federal Government program to assist producers in a falling world market price and overproduction. It is a necessary program if farmers are to remain in business, producing a quality product for the public at a reasonable cost. The farmer must have the money to buy goods and services or unemployment could follow. Unemployment would also increase if the average consumer's cost of living were to rise too quickly. .If consumers have to spend too much on the essentials (food), then their buying power is decreased and as a

result other goods and service industries would suffer.

More locally, we are pleased to be part of a forward-thinking region. You have sought agricultural advice through your advisory committee, but we in the Halton Federation of Agriculture would also like to have input from time to time. We also commend you on your sludge utilization program. A joint venture that mutually benefits the region and the region's agricultural industry.

We have recently sent a request to council to hire an independent agricultural impact assessor to work on subdivision applications, and rezoning applications where the fees would be charged back to the applicant by the region. This would overcome misrepresentations as are seen in some applications.

We have also asked you that when road construction and residential development projects are undertaken adequate fences, gates, culverts and entrances are installed to accommodate today's farming requirements.

We would like your continued support for the present deer hunting season. We hope that you have all received copies of the Wildlife Survey that has been presented to you. In that survey you will have noticed there is a great increase in the amount of trespass damage. We would ask for your support for a greater awareness program about the negative aspects of trespassing and for tougher legislation to apprehend people who trespass on private property.

We in Halton Federation of Agriculture feel that development should be done in an orderiy fashion to minimize the impact on present agriculture. As far as overall planning is concerned, less productive (class 4 to class 7) land could and should be built upon to save the better class 1 land, remembering that existing farm enterprises need protection.

We would definitely prefer infilling and usage of already separated lots rather than the tremendous increase in land grabbing and separations that are under way at the mement.

We realize that weed inspection and the weed act are municiple matters however, we do have some concern that this issue is not being dealt with evenly across the region.

With less land being cultavated within the region it may be appropriate to take a hardnosed approach to changing the taxable assessment on speculative land that is sitting idle; even if it is only for a short period of time.

Ladies and Gentlemen, thank you for your attention.

If there are any questions, please feel free to ask.

REGIONAL MUNICIPALITY OF HALTON

Report To Chairman and Members of the Planning and Public Works Committee

From R. Mohammed, Director of Planning and Development

Date 87 06 08

Report No. DPD 88/87

Re: Staff Comments on Halton Federation of Agriculture's April 22, 1987 Brief to Council

RECOMMENDATIONS

1. THAT Report DPD 88/87 regarding staff comments on the Halton Federation of Agriculture's April 22, 1987 Brief to Council be received.

2. THAT the Regional Clerk forward a copy of the Brief to the Area Municipalities for their information.

3. THAT the Regional Chairman, on behalf of Council, thank Halton Federation of Agriculture for their informative brief and encourage the Federation to continue communicating with Council and staff on agricultural issues.

REPORT

On April 22, 1987, Mr. Norm Biggar, President of the Halton Federation of Agriculture (HFA), presented a brief to Council on behalf of HFA on the importance of the agriculture industry to Canada, Ontario and Halton, and highlighting current

problems and issues facing the industry in Halton. The brief is attached as Schedule A to this report. In response, Council passed the following resolution:

> "That the written comments of the Halton Federation of Agriculture be received and referred to the Director of Planning and Development for review and to report to the Planning and Public Works Committee."

The brief contains a great deal of interesting information; some in the form of statistics and some expressed as issues and concerns. This staff report attempts to address specific points in the brief that are pertinent to Regional programs and policies affecting agriculture.

General Comments

The overall thrust of the brief is to reinforce the Agriculture goals and objectives of the Regional Official Plan, which strive to encourage, promote and protect the agricultural industry in Halton by retaining the agricultural land base, protecting farms from incompatible activities, preserving the farming community as an important social resource, and consulting the agricultural community when considering or developing programs and policies affecting agriculture.

The importance of agriculture to Halton's economy is emphasized in the brief, and the statistics point out that while Halton possesses less than 1% of the agricultural land in Ontario, in many respects Halton is more productive in a Provincial context than this land base would indicate. The total farm cash receipts in Halton in 1986 were $75 million, which still represents 1.45% of the Provincial total in spite of a drop of $8 million from the previous year and an increase in the Provincial total of 1.16% over 1985. This significant contribution to the local economy is occurring at a time when the Canadian agricultural industry in general is going through very tough economic times. An improvement in the agricultural sector of the economy would thus auger well for Halton.

Horse Farms

The brief emphasizes the importance of horse farms to Halton, in terms of agricultural products consumed, taxes paid, visitors attracted, breeding fees and employment generated. These same points were made in a 1983 study by the Milton Planning Department entitled Horse Farming in Milton. Regional staff certainly recognizes the importance of the horse industry to Halton.

In the past, it has been criticized that Regional staff and/or Council refuse to recognize horse farms as appropriate agricultural or rural activities. This perception stems from the definition of "agriculture" contained in The Regional Official Plan, which includes the production of "food, fibre and their by-products", and has been interpreted to exclude horse farms. However, this definition affects only severance applications i.e., creation of smaller farm parcels and retirement and farm help lots. Staff has concerns with the fragmentation of good agricultural land for purposes such as riding or boarding stables and non-commercial hobby farms, together with retirement and farm help lots for such uses.

After looking at definitions used by other municipalities in Ontario, and the situation in Halton, staff does agree that at least commercial horse breeding operations should be considered as agricultural operations for the purpose of agriculturally-related severances. While this matter will be reviewed in more detail with the Halton Agricultural Advisory Committee (HAAC), the Ministry of Agriculture and Food and through the Regional Plan Review process, a preliminary suggestion for a solution to this problem is to simply add the words "and livestock breeding operations" to the existing definition of "agriculture" in the Regional Official Plan.

The "Spills Bill"

The brief indicates some concerns over the "Spills Bill", without elaboration. Staff feel that some explanation of this issue may be helpful. The "Spills Bill" comprises Part IX of The Environmental Protection Act plus Ontario Regulation 618/85 made pursuant to the Environmental Protection Act. Farmers are concerned with the provisions pertaining to the liabilities and responsibilities involved with the handling of "pollutants" should a spill or other uncontrolled release of such pollutants occur. Farmers use toxic chemicals in their operations for fertilizers, herbicides, fungicides, insecticides etc. The implications of most concern to HFA are the provisions which hold the owners of the chemicals financially responsible for clean-up operations and damages should an accident occur during transportation or storage; an accident over which they may not have any control if the chemicals have not yet been delivered to the farm. If the chemicals have been paid for prior to delivery, the farmer may be considered as the owner and be held liable.

Right-to-Farm Legislation and Foodland Preservation Policy Statement

Halton Council has adopted positions on both of these Provincial policy proposals, generally supporting the principles

contained within them, through reports DPD 131/86 and DPD 17/87. The Ministry of Agriculture and Food has indicated to staff that it is definitely the Minister's intention to bring in the Right-to-Farm legislation and the Foodland Preservation Policy Statement simultaneously, which, while not precisely the approval sequence desired by HFA (approve Right-to-Farm legislation first), it is better than the reverse sequence which initially appeared to be the Minister's intention.

Preservation of Agricultural Land Base

HFA has stated that "while it may not be possible to keep all of the prime foodland for agriculture production, good equitable policies are needed to ensure that the best agricultural land is not converted to other uses." This approach is in line with the principles contained in the current Food Land Guidelines and the proposed Foodland Preservation Policy Statement at the Provincial level, and the proposed approach in the Regional Official Plan endorsed in principle by Council whereby "agricultural areas" will be identified on a map. Work is proceeding on this "two-designation" approach.

HFA also encourages development to occur on "less productive (Class 4 to Class 7)" land. The Region's proposed "two-designation" approach is attempting to further this objective by relaxing development restrictions in the rural (non-agricultural) areas, thus allowing for some response to the demand for rural lots.

Independent Agricultural Assessments for Development Proposals

HFA has previously requested Halton Council, through correspondence to the Regional Chairman, to have the required agricultural impact studies for development proposals carried out by consultants hired by the Region, with costs charged to the proponent. This procedure would, in HFA's view, "overcome misrepresentations as are seen in some applications". Staff has sought the comments of the Halton Agricultural Advisory Committee (HAAC) on this proposal, and HAAC was fully in support of the HFA position. Because the Area Municipalities in some cases also require such studies, and because one study should satisfy both Regional and local requirements, staff is currently seeking the comments of local planning staff on this matter.

Planning and Development staff consider the proposal to have merit but must also consider how such an approach would be implemented. This matter will be the subject of a further staff report after a detailed review.

Road Construction

Through HAAC and Halton's public participation programs, the agricultural community has provided their input to Halton's previous and ongoing road reconstruction programs, most notably on Steeles Avenue in Halton Hills and Guelph Line in Burlington and Milton. Feedback from HAAC would indicate that they are pleased with the responsiveness of the Regional Public Works Department in this regard.

Deer Hunt

HFA has requested continued Regional Council support for the annual deer hunt. The Wildlife Damage Survey referred to in the HFA brief will be forwarded to Council in July of this year as part of a package of material relating to the deer hunt.

Trespassing

The HFA brief also refers to the "great increase" in the amount of trespass damage on farms, and has requested Council support for a greater public awareness program about the trespassing issue and for "tougher legislation" against trespassing. Through HAAC, Halton Council has already taken some action in this regard. The brochure entitled "Get Permission First", dealing with the damages, hazards and penalties associated with trespassing on farm property, was produced by HAAC and distributed to public school children in both the 1985-86 and 1986-87 school years.

Residential Severances

HFA has stated it would prefer infilling and use of existing lots rather than the "tremendous increase in land grabbing and separations" currently underway. Regional OPA No. 13 will permit limited infilling if approved in its present form, and will thus provide some limited relief from the pressures for severances. No further relaxation of current severance policies is foreseen for the "agricultural areas". A future intended relaxation of the severance policies in the rural (non-agricultural) areas, under the "two designation" approach, may also help direct the pressures for residential severances away from agricultural areas.

Weed Inspection and Control

HFA is concerned about inconsistent weed control programs in the four Area Municipalities, and recognizes this to be primarily a local responsibility. In the past, at HAAC's request, Regional staff has communicated with the local weed

inspectors, and they have attended HAAC meetings. Regional staff will continue to help foster better communications between the agricultural community and the local weed inspectors.

Tax Treatment of Idle Agricultural Land

HFA has suggested a "hardnosed approach to changing the taxable assessment on speculative land that is sitting idle; even if it is only for a short period of time." This problem is not peculiar to Halton Region. The issue of property assessment and monitoring of land use for this purpose is one best addressed by the Provincial and Area Municipal governments. Under market value assessment, there is a much greater incentive to keep lands in agricultural production. Staff at the Assessment Branch of the Ontario Ministry of Revenue have provided a concrete example. In Oakville, north of Highway No. 5, the lands have a market value of $12,000 per acre. However, if in agricultural production, they are assessed at only $1,600 per acre. Thus, the property taxes will be substantially less on farmed land. By moving to market value assessment, municipalities would be encouraging agricultural production. There is not nearly the same incentive under the old property assessment system.

Concluding Staff Comments

In conclusion, staff views the HFA brief as an excellent summary of the current state and importance of agriculture in Halton, and the major issues and problems concerning the industry. The positions and actions taken by Council with regard to many of these matters illustrates the past and ongoing commitment by Council and staff to promoting and protecting the agricultural industry, in recognition of the industry's economic and social contributions to Halton. This type of communication can only serve to further the mutual interests of HFA and Halton Region.

Staff recommends that the HFA brief be forwarded to the Area Municipalities for their information, and that the HFA be thanked for their brief and be encouraged to continue to communicate with Council and staff on agricultural issues.

Respectfully submitted,

APPROVED BY C.A.O.

R. Mohammed
Director of Planning and Development

PL.ko

Greater London Council

HOFFMAN

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MINERALS SUB COMMITTEE
PUBLIC SERVICES AND FIRE
BRIGADE COMMITTEE

Report (1.11.82) by

Controller of Transportation
and Development
Scientific Adviser

LANDFILL GAS GENERATION PROBLEMS AT MINERAL WORKING SITES FILLED WITH "INERT" WASTE.

Summary: A report on the various problems caused by landfill gas generation on backfilled mineral working sites and the measures available to minimize those problems.

Introduction

1 This report, prepared in response to a request by the Chairman of the Minerals Sub Committee for a paper on Methane problems in London, has been expanded to cover enforcement difficulties. A technical note on the composition of landfill gas, its generation and problems is included as an Appendix to this report.

2 The risk of groundwater and/or surface water pollution if waste is deposited in permeable strata (e.g. sand and gravel) and leached from the site has been recognised for many years. When the water table level is close to the base of the site being filled (as is the case in the Greater London area) it is usual to deposit only inert waste (earth, construction waste, builders rubble etc.) to minimise the risk. It is also well known that land reclaimed with inert backfill is less susceptible to uneven settlement than land backfilled by waste with an organic content (e.g. household waste) and therefore successful land restoration is easier to achieve using inert waste. The problems that can occur with the generation of methane gas from organic waste have only been recognised more recently and their importance in connection with backfilling with inert waste seemed minor. Extensive research has been carried out in recent years to seek ways to overcome methane problems with relation to land uses on sites and on adjoining land when household waste is used as backfill. Since it is necessary to vent the methane gas from the site it has been realised that for large deep household waste landfills it is economical and technically feasible to extract the gas and use it as a fuel. The Joint GLC/NCB venture at Aveley is such an example as is the use of waste derived methane from backfilled clay pits as fuel in brick making kilns at Stewarthy, Bedfordshire.

Inert Backfill

3 The fact that it is not possible to totally exclude all organic matter from a site where only genuine inert waste (earth, brick rubble etc.) is permitted has been accepted for some time. Even the closer day to day control of operations since the advent of site licensing cannot guarantee the total exclusion of all organic matter. Indeed, unless control is strict it is possible that a substantial quantity of organic waste could be included. The situation is worsened because the term 'inert' has, in some quarters, been defined to include paper, cardboard, sawdust and wood which are all organic and can be slowly decomposed to produce pollution products and eventually methane gas. As an example of this general lack of understanding when the Secretary of State allowed a gravel working appeal in September 1979 for on a site north of Heathrow (LB Hillingdon) a condition was imposed restricting the filling to 'inert' materials as listed in an appendix to the decision. (The reason for the restriction to inert waste was that after use proposed for the site was agriculture.) Included in the list of permitted materials were organic materials such as paper, cardboard, wood and sawdust which could all give rise to gas generation, that could be most harmful to the plant growth capability of the reclaimed land. Because of the considerable percentage of organic matter that can be present in so called "inert" filling materials the Water Authorities have often found it necessary to insist that sites, being backfilled in areas with permeable strata and sensitive water resources, are clay lined and clay capped to minimise the risk of water pollution. However, the clay cell is primarily designed to prevent water pollution and is unlikely to confine landfill gas indefinitely and to avoid problems the gas must be vented to atmosphere.

4 The inherent difficulty of controlling filling materials has not been assisted by the Secretary of State's decision in August 1980, in relation to an appeal against conditions imposed on a site licence issued by the GLC which modified a "non-putrescible waste only" condition to "The type of waste authorized to be accepted at the facility shall not be deemed to be infringed if minimal quantities of putrescible waste are brought onto the site mixed with other wastes". This modification did not give any definition of what was meant by "minimal".

5 It is clear that landfill gas generation from "inert" waste, a factor which was ignored until very recently, must now be taken into proper consideration when operational schemes for mineral workings are being evaluated. It is most important that for any future mineral extraction and filling proposals, provision should be made by the imposition of planning conditions to ensure that the excavations are properly sealed (on the lines described in paras 9 and 10 below) to minimize potential pollution problems. Factors to be taken into account in this, will be the range of potential land uses and proposals on the site and adjoining land after filling, the types of waste proposed etc.

The London Experience

6 Many reclaimed mineral workings in London are suffering the effects of landfill gas generation. The following are examples of major sites:-

(i) Heston Airport (LB Hounslow)
This site was worked for sand and gravel before 1967 and has been mainly backfilled with "inert" waste. The site was acquired by the GLC for housing development but it was discovered that some of the fill material was burning underground and that methane was present in some parts of the site at 20% - 30% concentrations. It was apparent that residential development would not be possible for probably a very long period until gas generation had ceased. Consequently it was decided to develop the site for use as a golf course and tennis centre with light industrial warehousing.

(ii) Hornchurch Airfield (LB Havering)
This site was excavated in the period up to 1977. Filling to a higher level than was envisaged in the original planning consent was completed in 1980. The backfill included some organic matter which has given rise to the generation of methane with consequent problems for the land uses of the site and adjoining land.

7 It is probably fair to say that virtually all the filled pits in London have suffered to some extent from the results of land-fill gas generation. In many instances the only evidence might have been limited die-back in plant growth. Indeed when this occurred some two years after the completion of filling on part of the first half of the Bush Farm Agricultural Restoration experiment site (LB Havering) it was thought to be due to drainage problems. However the area affected increased, a fact confirmed by infra-red aerial photography and tests revealed quite high concentrations of gas in these areas. The backfill at the Bush Farm site comprised a mix of inert and commercial/industrial waste but not household refuse. Since this discovery, continued comprehensive monitoring of gas concentration has taken place and various gas control measures have been taken on the second half of the experiment site. Performance will continue to be monitored. This should in due course provide useful information on the long term effects of landfill gases on soils and vegetation.

Preventative and remedial measures

8 As set out in more detail in the appendix, the methane and other gases generated in a landfill site tend to diffuse up through the soil cover over the backfilling, and laterally into any permeable strata in adjoining areas. Measures to deal with this problem are described below:-

(i) The sealing of pits

9 For reasons already discussed Water Authorities often require that when waste with an organic content is being deposited in areas of permeable strata it must be sealed in a clay cell. Most of the sand and gravel deposits in the London area are underlain by clay so that sealing of the bottom of the excavation may not be necessary. The sides of the pit can be sealed with puddled clay linings which must be keyed into the underlying clay to ensure there is no leakage. It is normal practice to divide the pit into a number of cells by building clay bunds. After the cell walls are erected any water is pumped out before filling commences and as soon as the cell is completely filled the impermeable covering layer completes the sealing off of the cell. This capping layer stops rainwater from collecting in the cell. Without the capping water levels in the cell would rise and overflow with the attendant ground water pollution risk. With the cell system it will be necessary to incorporate a gas venting system since it is doubtful whether the clay cell will remain impermeable to methane indefinitely. If large quantities of gas are to be vented to atmosphere there may be an odour problem and flaring the gas may need to be considered.

10 There are a number of inherent practical problems. Firstly there are the difficulties of ensuring that there is a proper seal between sides and the bottom and capping of the cell. There is also the danger of the clay cap drying out with resultant shrinkage cracking which would allow the ingress of water and the escape of gas. A further problem is that roots could penetrate and rupture the capping of a cell. It is therefore essential that there should be an adequate thickness of covering and soil over the capping to contain the root growth of grass and other crops, and in any case it is probably wise to assume that some methane emission will occur however carefully the capping is completed. If tree planting schemes are required it will be necessary to ensure that the trees are sufficiently far away from the cells, or in specially made pockets of methane-free topsoil.

11 When a "cell" system is being planned it is very important to provide adequate slopes for the surface capping to promote surface run-off and drainage when the soil covering layer is spread over the site.

(ii) "Cut-off" trenching

12 Where there is lateral diffusion of methane from an existing back-filled gravel pit, trenches can be excavated around the landfill site and filled with coarse aggregate. These trenches will provide a path of least resistance as an escape for gas seeping laterally from the site. As an additional precaution special construction safeguards may be necessary for new buildings and ancillary works near the site to avoid "gas traps" where methane concentrations can build up. Such measures have been necessary on some Council operated sites outside the Greater London area.

(iii) Collection systems and flering

13 For large household refuse landfill sites the collection and piping of the gas for industrial use involves the incorporation of a series of perforated pipes within the fill and the gas would be "sucked out" and pumped to wherever it was being used. Then, of course, a gas dehumidifying plant may be required in order to rid the methane of its moisture and further moisture filters installed to prevent the corrosion of pipelines. It may also be necessary to install a treatment plant to cleanse the gas of its impurities, but this will depend on what use is proposed for the gas. The joint GLC/NCB scheme at Aveley has already been mentioned but other uses include the heating of site buildings and neighbouring houses and where large quantities of gas are at hand, it can also be used for industrial heating ie greenhouses, drying plants, brickworks, swimming pools etc. In certain cases gas engines can be driven for generating electricity. At the type of filled gravel pit found in the Greater London Area methane is unlikely to be produced in marketable quantities.

14 Should it prove necessary to burn the gases off, a series of recovery systems are commercially available and may be installed if it is thought there may be sufficient quantities of gases generated. This method is used at a former Council operated site at Merstham, Surrey, but is expensive and the equipment may be cumbersome. A problem with this method is that methane within a landfill is usually at low pressure it may not therefore be able to keep the burners alight continuously without the installation of a pumping system to maintain the gas pressure. Any flaring system would be likely to be the subject of local concern.

Enforcement problems

15 Prior to the coming into operation of the Site Licensing provisions of the Control of Pollution Act 1974 enforcement of controls over land fill sites depended mainly on planning legislation and in some areas the powers available under local legislation such as Surrey, Essex and Middlesex County Council Acts. Planning enforcement procedures are generally cumbersome. In cases where unauthorized waste materials have been tipped the length of time that enforcement can take means that the offending material will have long since been covered with further filling material. Enforcement in such cases is generally ineffectual.

16 In the late 1960s and early 1970s a growing awareness that greater control of waste disposal processes was necessary, resulted firstly in the Deposit of Poisonous Waste Act 1972 and in 1974 the Control of Pollution Act giving, in England the County Councils and the Greater London Council the duty to licence waste disposal operations. The Act's Site Licensing provisions apply to "controlled" wastes which are defined as "household, industrial and commercial waste" but the Secretary of State has the power to issue regulations to prescribe other categories of waste. Regulations issued in 1976 expanded the definition of industrial waste to include, inter alia, construction and demolition building waste.

17 The primary aim of site licensing is to ensure that waste disposal is carried out with no unacceptable risk to the environment, and to public health, safety and amenity. Conditions can be imposed by Waste Dispoal Authorities relating to a wide variety of aspects such as the duration of the licence and the kinds and quantities of waste to be disposed of and the methods of its deposit. It is a prerequisite for the issue of a waste disposal site licence that there is valid planning permission for the operations which are the subject of the site licence applications. It is nevertheless difficult under licencing arrangements to decide to what extent, if any, putrescible material e.g. wood and paper in industrial and commercial waste shall be restricted, and having licenced a site with conditions to this effect to monitor activity sufficiently closely to ensure that no contraventions occur.

18 The major differences between the two systems of control are that a site licence is normally issued to the operator responsible for the disposal operations and cannot change hands without the consent of the waste disposal authority: it relates to a specific site (as does a planning permission) but there is the difference that the planning permission "runs with the land" whereas the site licence is current only until the waste disposal operations are completed and enures only for the benefit of the site operator. Therefore enforcement of a site licence can only be effective while the site is still being used for disposal and while the licence is still valid.

19 This is a very unsatisfactory situation as the consequences of tipping incorrect types of material may not become apparent for perhaps years after tipping has been completed. This is especially so when gas is being generated from a landfill when the effects may continue for years, making effective restoration impossible. Enforcement may be possible under planning powers because the planning permission runs with the land but enforcement action can only be taken within four years from the date of any breach becoming known to the Mineral Planning Authority. The enforcement of planning powers however may not put the burden of responsibility at the door of the guilty operator.

20 The Town and Country Planning (Minerals) Act (1981) gives the Mineral Planning Authority powers to impose a 5 year after-care requirement, where former mineral working land is to be restored for agricultural, forestry or amenity after-uses. This is a recognition of the fact that the refilling of a mineral excavation and the replacement of the soil cover does not leave the reclaimed land in a proper state for the planned after-use. Part of the stabilizing process will obviously relate to changing conditions in the back-fill. It could be argued that site licence control should also continue for a lengthy period after the completion of the tipping operations, whether these are in excavations or surface tipping on virgin land. It could also be argued that the thicker the layer of deposit the longer the period of site licence control should last. For this to be effective the site licence would need to be made to relate to the land rather than a particular operation.

21 Legislative changes would be necessary to the Control of Pollution Act if enforcement action under the Control of Pollution Act powers is to be made possible to remedy the longer term problems at tipping sites, such as continued leaching of polluted ground water and methane generation. It is necessary that the Waste Disposal Authority should have powers to require longer term remedial and palliative measures to be taken. These are the sorts of matters which the Control of Pollution site licensing system was set up to control and there should be provisions to extend the period of time during which enforcement action can be taken.

22 There are inevitable problems in the monitoring and enforcement of planning and site licence conditions designed to prevent or minimize methane generation problems. Even if a Clerk of Works were to be stationed full time at land fill sites it would still not be possible to guarantee that "inert" waste brought onto the site as back fill did not contain organic or putrescible material. It is however important that site operators should be left in no doubt of the need for stricter control of the loads of waste material accepted at their sites. It is even more important that consideration should be given by the Department of the Environment to the need to amend the Control of Pollution Act powers so that enforcement action can be taken within an adequate period after the completion of the filling operation. To this end it may be necessary for the site licence to relate to a site rather than to a particular site operation.

Conclusion

23 This report is submitted for the information of the Committee. The problems of Control of Pollution Act powers of enforcement and other problems vis-à-vis planning powers have not been explained in detail. The Committee might wish to have a further comprehensive report on this subject which is likely to be of growing importance in the future.

APPENDIX 1

With modern safeguards the landfill of waste is an economical and reliable method of reclaiming mineral excavations. The reclaimed land can be brought into community use as, for example, playing fields or agricultural land. However, if the waste deposited contains a proportion of organic matter additional problems have to be overcome before satisfactory restoration can be achieved. Organic matter is decomposed by bacteria in the presence of oxygen to produce eventually carbon dioxide gas and water. However, in the predominantly anaerobic conditions within a landfill the major final decomposition product is methane gas. The decomposition processes are complex and many intermediate products are produced en route to the formation of landfill gas which is mainly a mixture of methane and carbon dioxide but with small amounts of many other components.

Given certain geological conditions (e.g. permeable strata and a high water table) rainwater percolating through a landfill can transport (leach) material from the landfill through surrounding strata and pollute groundwater and/or surface water. Pollution will occur if the leachate reaches the groundwater table and in areas where the water table is near the base of the landfill the only way to prevent this is by lining the site and capping it with an impermeable material (usually clay but plastic membrances have been used in various parts of the country and the GLC will soon begin depositing household waste in a site lined with an impermeable plastic membrance at Coney Hill). If the water table level is many metres below the base of the site the leachate can be attenuated (weakened) by natural processes as it moves through the unsaturated layer towards the water table and pollution can be prevented in this manner. However, within the GLC area the water table is high in the mineral extraction areas and the clay cell technique must be used. For this reason the Water Authorities will often insist on a clay lining to landfill sites to protect water resources from the risk of pollution by leachate. This encapsulation of the waste would not of course be necessary if it could be guaranteed that it was non-hazardous and contained no organic matter.

The 'inert' waste used to fill mineral extractions has often officially contained proportions of paper, wood shavings etc. which can be decomposed slowly to form methane gas and other polluting decomposition products. This confusion over the term 'inert' has arisen because within the waste disposal industry it has come to mean waste of a non-hazardous nature with no putrescible content rather than being strictly defined as a waste that is non-reactive and therefore cannot be decomposed. Paper, cardboard, sawdust, wood etc. are certainly not inert in the true sense of the word. It is likely that methane produced from so called inert waste has contributed in the past to problems related to restoring land to agricultural use although until recently the fact has gone largely unrecognised.

It has come to be accepted that the total exclusion of organic waste from a site supposed to be receiving only inert waste cannot be achieved even with close control of the operation and, in these circumstances, the Water Authorities have asked for the clay cell system as an extra safeguard to prevent water pollution. Waste Disposal Operators, faced with increased costs of constructing the cells, attempt to offset these costs by seeking permission to deposit a wider variety of wastes. These wastes will often contain a significant percentage of organic matter but refusal to allow deposit is difficult since the waste is to be encapsulated in clay cells but of course their use will substantially increase the quantity of gas generated within the

cell. As previously mentioned the bacterial decomposition of organic matter in the landfill will eventually produce a landfill gas (mainly a mixture of methane and carbon dioxide) - the time taken to complete the decomposition depends on many factors e.g. temperature and moisture content of the waste, the nature of the waste (food waste degrades rapidly, paper much more slowly and wood very slowly indeed), and the degree of compaction of the waste within the landfill. In certain conditions (e.g. low moisture content as can occur in clay cells) the decomposition process could take many years.

Landfill gas can cause the following problems:

(i) Although methane is an odourless gas, trace components give landfill gas a characteristic bad odour and its emission from a site can cause a smell nuisance.

(ii) The landfill gas will move from the landfill through permeable strata and if its upward progress is barred by an impermeable layer (e.g. clay) it will move laterally if possible. This can lead to land at the site and/or land adjoining the site being effected in one of two ways:-

(a) Methane is a combustible gas and at concentrations in air between 5% - 15% is explosive. Its accumulation in the basements of buildings and in any poorly ventilated areas can be a hazard.

(b) Methane moving into agricultural land tends to starve crop roots of their oxygen supply and may in extreme conditions cause crop failure.

In the past, where mineral excavations have been reclaimed using 'inert' waste it is likely that methane has contributed to problems of restoring land to agricultural use. Restoration to playing fields or public open space is less problematic since some grass appears less sensitive to methane than deeper rooting crops but even so the presence of methane in the soil makes tree growth difficult. It is unlikely that the clay cell technique currently in use and whose purpose was primarily to prevent water ingress and leachate production can prevent methane migration indefinitely and it is therefore important that a methane venting system to atmosphere be incorporated into cell design. The design of this venting system is difficult given that the permeability of wastes deposited may vary greatly and movement of gas in certain directions may be impeded by impermeable layers thus making it impossible to predict the flow pattern of the gas through the landfill. It must be concluded that if it is the intention to restore reclaimed land that was originally Grade I agricultural land back to its original quality it will be necessary to severely restrict the amount of organic matter deposited until such times as the effectiveness of methane venting in preventing methane migration into the soil layer has been proven.

Contaminated Soil

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THE EFFECTS OF GASES EMITTED FROM LANDFILLS ON SOILS AND CROPS

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1. INTRODUCTION

The main site being investigated is the Joint Agricultural Land Restoration Experiment at Bush Farm, Essex, England. The Experiment, set up by the Ready Mixed Concrete Group in 1974, demonstrates the feasibility of restoring land back to high quality agriculture once gravel extraction and landfilling with industrial waste has been carried out.

As the restoration at Bush Farm progressed it became evident that the anaerobic decomposition of the refuse had led to localized contamination of the soil by gas, consisting mainly of carbon dioxide and methane, emanating from the landfill. The effects of this 'landfill gas' on the soil can readily be seen in the field. The soil appears grey/greeney blue in colour and has a foul odour. Crops growing in gassed soils tend to die at the 'seedling stage' or sustain only limited growth thereby appearing stunted when compared to the surrounding crop growing in uncontaminated soil.

Although the visual effects of landfill gas on plant growth have been widely reported in the literature, there has been very little research carried out on the mechanisms involved or on possible remedial treatments that could be used. This project was therefore set up with the ultimate aim of identifying some practical cost-effective measures that can be easily implemented in the field to alleviate the stresses imposed on crops by landfill gas.

The research involves three distinct approaches, namely: (a) site monitoring, (b) sample analysis in the laboratory and (c) the use of a controlled environment in which to grow plants in soil artificially contaminated by gas.

2. SITE MONITORING

A major part of the research involves monitoring various physical and chemical parameters of the root-soil environment at the Bush Farm Experimental Site.

2.1 Use of permanent sampling probes

Permanently installed sampling probes have been designed so that the landfill gas content of the soil profile can be measured over time. Each probe consists of a length of stainless steel capillary tubing closed at one end by a three-way tap for the withdrawal of gas samples, and extending through the soil profile into a 60 ml porous ceramic diffusion chamber in which gas equilibrates with the surrounding soil. A thermocouple wire probe is fitted alongside the capillary tubing for temperature readings.

Gas samples are withdrawn from the probe by means of greased glass syringes, and brought back to the laboratory for gas chromatographic analysis.

Soil water content is being measured using a neutron probe and access tubes.

72 gas-temperature probes have been installed at Bush Farm together with 15 neutron probe access tubes. The probes have been laid out on a random stratified basis with transects, consisting of six probes at 30 cm depth and six probes at 75 cm depth, running across six bare patches.

Monitoring at Bush Farm was started in May 1984 and was initially carried out every two weeks, but is now being undertaken on a monthly basis.

2.2 Gas survey

A rapid, extensive soil gas survey was carried out in August 1985 to supplement the data obtained from the permanent gas sampling probes. The survey is to be repeated periodically throughout the 1985-86 growing season. The survey involves harvesting vegetation and the abstraction of gas samples by means of a temporary gas probe, at various sample points across the site.

2.3 Results

1. Methane values have reached as high as 91% at 75 cm depth.
2. Carbon dioxide values have reached as high as 42% at 75cm depth.
3. Oxygen concentrations frequently drop to 0% at depths of 30cm and 75 cm.
4. Ethylene values have exceeded 30 ppm in many probes.
5. The ratio of carbon dioxide to methane at Bush Farm seems to be higher in gassed soil overlying younger refuse. Here, values of carbon dioxide typically range between 30 and 40% throughout the year. In contrast gassed soils overlying older refuse consist of carbon dioxide at concentrations of between 12 and 18%. Methane values in gassed soils during the winter months associated with younger refuse seldom exceed 60% whereas methane values in gassed soils associated with older refuse generally reach 75-85%. Such trends correspond with the literature which has shown that early decomposition of refuse is associated with high values of carbon dioxide and that methane levels increase with time.
6. Interesting seasonal effects have been found to exist in relation to the composition of the gas down the soil profile in gassed areas. In winter the ratio of carbon dioxide to methane tends to be constant down profile and the landfill gas is merely diluted by air ingress, as it passes upwards. In summer however, a very different relationship exists, and carbon dioxide increases relative to methane in shallow depths. Thus, for example, a probe at 30 cm depth consisted of 18% methane and 12% carbon dioxide, whereas gas in the corresponding probe at 75 cm depth consisted of 43% methane and only 7% carbon dioxide. Here landfill gas is not merely being diluted at shallow depths, the gas is actually changing in composition. It is considered that the methane is being oxidized to carbon dioxide as it passes upwards through the soil profile.
7. Soil temperature differences have been found to exist between gassed and ungassed soil. The temperature of gassed soil is generally 1 to 3°C higher than ungassed soil, and it is likely that this is associted with the oxidation of methane mentioned above.

3. SAMPLE ANALYSIS IN THE LABORATORY

3.1 Analysis of crop growth

Hand harvesting of the wheat growing in sample plots around each set of probes was carried out in August 1984 and August 1985. The quantifiable measures of crop growth chosen for analysis, include the number of fertile tillers, the number of grains per ear and the one thousand grain weight. The results of these measures for each sample plot have been correlated with the appropriate gas and temperature readings obtained fom the probes.

3.2 Mineral analysis of vegetation and soils

It has been shown from the gas monitoring shown above, that the roots of plants growing in soils contaminated by landfill gas, suffer from a lack of oxygen. This condition, also found in waterlogged soils, disrupts many of the physiological processes taking place within the plant including the uptake of minerals.

Mineral analysis of the crop and soils is therefore being carried out to determine whether plants growing in gas contaminated soils do in fact suffer from impaired mineral uptake and whether this takes the form of nutrient deficiency or metal toxicity.

4. THE USE OF A CONTROLLED ENVIRONMENT IN WHICH TO GROW PLANTS IN SOIL ARTIFICALLY CONTAMINATED BY GAS

This aspect of the research involves experimental work carried out in a controlled environment (growth room) in which plants are grown in soil artificially contaminated by gas. Variables are held constant so that the effect on plant growth, of systematically varying individual parameters, can be distinguished and measured.

Experiments have been designed to study the following aspects:

1. The effect on crop growth of different concentrations and combinations of nitrogen, methane, oxygen, carbon dioxide and ethylene within the soil.
2. The effect of various gases on plants at different stages of development.
3. The tolerance of different crops to landfill gas.
4. Remedial treatments such as liming and fertilization.

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JOINT AGRICULTURAL LAND RESTORATION EXPERIMENTS

PROGRESS REPORT No. 2 (1977 to 1982)

FOR

BUSH FARM, UPMINSTER, ESSEX.

This work, forming part of the Joint Agricultural Restoration Experiments, is reported with the assistance of a research contract from the Department of the Environment. The views expressed in the report are those of the Bush Farm Working Party.

December 1982

APPENDIX B

REVISED CODE OF PRACTICE

REVISED CODE OF PRACTICE

INTRODUCTION

1. The Bush Farm Working Party recognised the need to lay down criteria to assist the Site Supervisor in carrying out his site duties. A Code of Practice was therefore produced at the outset, to serve as a guide to the correct implementation of the Experiment programme and to narrow the area of doubt where matters of judgement were involved and immediate decisions were required.

2. The principle aim of the Bush Farm Experiment is to investigate the feasibility of restoring land back to a high standard of agricultural quality after gravel extraction under viable, commercial conditions and without unnecessary loss of agricultural production in the process. As set out in Appendix F of Progress Report No. 1 (February 1978), the Code of Practice represented the Working Party's initial recommendations on the best means of achieving this aim.

3. Inevitably, as site works progressed, the Code was amended in the light of experience and developed in response to the need for additional guidance on specific matters.

4. In this Progress Report No. 2 the original Code is produced, with amendments and additions of substance shown in italics. On page 42 of this Appendix, a Commentary summarises the reasons for the main changes. The effectiveness and shortcomings of the Code, as it has been applied to site operations between 1974–1982 are discussed in the relevant appendices.

5. In a further progress report, to be published at the end of the study, a detailed Code of Practice will be produced to represent, with the benefit of hindsight, the criteria the Working Party would have adopted at at the outset of the Experiment. This Code will also reflect changes in legislative controls and general improvements in restoration standards by the Industry, which have occurred since the Experiment started in 1974.

6. The Code of Practice is a detailed working document. It is emphasised that the Code used at Bush Farm was designed specifically for the site and, whilst many of its provisions will have general relevance, it is not the Working Party's intention to recommend application of the detailed set of guidelines to any other restoration project.

STRUCTURE OF THE CODE OF PRACTICE

7. The Code comprises seven sections:–

SECTION I – General Notes

REINSTATEMENT OPERATIONS

SECTION II – Instructions to Site Supervisor on soil moving operations

SECTION III – Instructions to Site Supervisor on filling operations

POST REINSTATEMENT OPERATIONS (AFTER CARE)

SECTION IV – Initial Management of Reinstated Soil

SECTION V – Land Drainage

SECTION VI – Deep Cultivations

SECTION VII – Cropping and Medium/Long Term Agricultural Management.

ANNEX 1 – Soil Movements : General Precautions

ANNEX 2 – A Discussion of the Need for Restorative Cropping.

SYNOPSIS

8. SECTION I sets out how the Code is to be administered and

SECTION II deals with the supervision of soil movements under three main headings:–

(i) General precautions for soil moving,

(ii) Soil movement by earthscrapers including criteria to prevent working in unsuitable conditions, and

(iii) Soil movement by loader and dumper which was used to reinstate the First and Third Quarters of the Experiment.

9. SECTION III deals with the filling operations and contains:–

(i) A list of permitted wastes,

(ii) General instructions on site layout and preparation,

(iii) Details of the methods of filling to be employed on each half of the Experiment, and

(iv) General instructions on the day to day operations.

10. SECTION IV discusses the general precautions to be taken when managing reinstated soils. The aim of this management is to improve the soil condition by instituting an appropriate soil management and cropping programme.

11. SECTION V deals with the need for artificial drainage and the timing of its installation for the alternative reinstatement methods employed.

12. SECTION VI assesses the need for deep cultivation where soils have been reinstated by earthscraper.

13. SECTION VII gives guidance for the agricultural management and cropping of the reinstated land during the after care period.

SECTION I – GENERAL NOTES

14. Responsibility for the success of the Experiment rests with the Joint Working Party, which has appointed a Technical Sub-Committee with membership as listed in Appendix A page 23.

15. Any member of the Sub-Committee may request the Site Supervisor to stop or modify any action on site which is causing serious concern and where immediate remedial action is necessary to avoid serious damage to the project. Any such occurrence or when difficulties are encountered must be reported immediately to the Chairman of the Technical Sub-Committee or to the General Manager of the St. Albans Sand and Gravel Company Limited.

16. Most of the processes of the Experiment are part of an integrated programme. The decisions affecting these may be difficult to reverse. It is, therefore, the collective responsibility of the Technical Sub-Committee guiding the Experiment to ensure, as far as possible, that the main responsibility for decisions affecting different processes is vested with those members best suited to deal with that process. However, it may be possible to delegate such responsibilities to assistants, or to the supervisor on site.

17. The aim of this Code of Practice is to provide a guide to the correct implementation of the experimental programme and to narrow the area of doubt on matters of judgement.

SECTION II – INSTRUCTIONS TO SITE SUPERVISOR ON SOIL MOVEMENT

GENERAL PRECAUTIONS (1)

18. Vehicles concerned with soil movement and tipping will confine themselves strictly to the land prescribed. No vehicles other than for purposes of agriculture will go onto adjoining fields, unworked margins etc.

19. All machines concerned with bulk movement of soil must keep strictly to the stripping area of the immediate contract or clearly defined routes for transport between field and spoil heap or for access. No running must take place over any other land.

20. *Topsoil and subsoil will be handled and stored separately.*

SOIL MOVEMENT BY EARTHSCRAPERS

Loading from Fields

21. Soil should be removed at the maximum depth or layer which operating conditions for the machine will allow, i.e. steady forward traction without excessive wheel slip. Under suitably dry soil conditions, it will be normal practice for teeth to be fitted to blades or scrapers in order to produce a shatter of the soil.

Movement of Machines to and from Stripping and Placement Areas

22. *Movement of all machines and especially loaded scrapers should avoid tracking on undisturbed or reinstated land. Where tracking must unavoidably cross agricultural land, it is preferable to run on the topsoil rather than subsoil, as damage to the former can be remedied more easily than damage to the subsoil.*

23. To reduce damaging traffic to the minimum for each category of soil, i.e. topsoil or subsoil, stripping must start at the nearest point to the entrance and exit for scrapers and progress to the farthest point. Soil replacement should commence at the farthest point and work towards the entrance point.

Soil Placement on Storage Site

24. Where possible, storage piles are to be short and wide, rather than long and narrow, in order to minimise repeated running over the soil.

25. Soil is to be deposited in the thickest layers which will still allow steady forward traction, to avoid subjecting every layer of the heap to severe surface compaction.

26. *Completed soil heaps are to be slightly domed to avoid the occurrence of standing water on the soil.*

Soil Removal from Storage Site

27. *Operations will depend on the access to and shape of the storage heap. As under normal practise, machines should remove soil from the heap while tracking down a slope in order to reduce the draft requirements.*

Soil Reinstatement

28. *Soil reinstatement operations should be carried out with the aim of minimising the passage of wheels over previously reinstated soils, and in particular the passage of loaded scraper wheels. Soil replacement should be carried out on a strip basis across the area, working towards the entrance point, so that tracking on reinstated soil is largely avoided. Subsoil should be laid to 0.9m depth, and topsoil to 0.3m depth. Actual operations will depend on soil conditions, but the following principles should be observed:–*

    (i) Reinstaternent strips should be about 10 metres wide.

    (ii) Earthscrapers should approach the reinstatement point on the fill surface, and the soil should be discharged as the machine moves onto the previously reinstated soils. As soon as the earthscraper is empty, the machine should turn off the subsoil onto the fill surface to return to the stripping point.

    (iii) Levelling and grading of the subsoil before topsoil placement will depend on the condition of the subsoil. Where levelling is not required, topsoil should be placed as each 30–40m of subsoil is completed. Where levelling is required, each subsoil strip should be completed and the subsoil levelled by earthscraper. Laying of topsoil on the subsoil strip should then proceed by laying topsoil nearest the approach point. Further topsoil should be laid by approaching the reinstatement area on the topsoil surface.

(1) See also Annex 1

Criteria to Prevent Working in Unsuitable Conditions

General

29. Occasions will arise when earthscrapers could effectively operate but protection of soil structure demands that soil must not be moved.

30. Rainfall will immediately cause machines to damage the structure of exposed soil. Under conditions of continued working and only light rainfall, the points of soil removal and deposition may not have time to become wet. Substantial rainfall will soon wet the soil surface so much that earthscrapers must stop work, on grounds of both machine operation and damage to the soil.

Soil Stripping and Direct Reinstatement

31. Soil stripping and direct reinstatement will be subject to the following conditions, which will apply to all undisturbed soil in the field to be used ultimately for reinstatement as agricultural soil:–

(i) Soil operations may only commence upon the approval of the company's advisors once soil conditions have been assessed.

(ii) No soil operations will take place during rain or in the presence of standing water.

(iii) *Soil moving operations should normally only take place between the months of May and October and during this period* the rainfall criteria set out in Table B1 should be observed. Rainfall must be read twice daily before and after work at 07.30 and 18.00 hours by means of a rain gauge set up on site. The gauge is to be emptied after each reading. Readings are to be recorded even if there is no working.

Rainfall Amount (mm)	For reading taken at 07.30 hours	For reading taken at 18.00 hours
0 – 1	May be ignored	May be ignored
1.1 – 3	Soil operations may commence at midday	May be ignored
3.1 – 5	Soil operations may commence next day	Soil operations may commence midday next day
5.1 – 7.5	Soil operations may commence midday next day	Soil operations may commence day after next
7.6 – 10	Soil operations may commence after 48 hours	Soil operations may commence after 48 hours
10.1 or more	Soil operations may commence after 3 days	Soil operations may commence after 3 days

TABLE B1 : Rainfall Criteria : Soil Stripping and Direct Reinstatement by Earthscraper

(iv) If rainfall during soil operations is in excess of 1.5mm operations must be suspended for that day.

(v) *If the drying period determined from the rainfall readings taken at 07.30 and 18.00 hours each day is interrupted by further rainfall, then for each additional 5mm of rainfall (or part therefore) per 12 hours (amounts less that 1mm may be ignored), 12 hours drying time is to be added to the original drying time.*

(vi) Continued rain will percolate into and wet the subsoil, causing it to become soft and plastic. Vehicle wheels will squeeze and compact the soil and damage its structure. In these circumstances, all soil movements must stop. The time at which stopping is necessary will obviously be earlier on clay soils than on free draining soils.

(vii) Work may also have to be stopped if soil is uncovered which is found to be still too wet. Temporary transfer of earthscraper to other areas while the wet layers dry out may allow work to continue without serious interruptions.

Reinstatement from Storage Heaps

32. *The reinstatement of filled land using soils from storage heaps will be subject to the following conditions:–*

(i) A limited area of the storage heap should be exposed at one time so that any rainfall during reinstatement work will affect only a very small proportion of the total volume of soil to be moved.

(ii) The rainfall criteria set out in Table B2 below shall be used when moving soils from storage heaps and reinstating them on filled land. These criteria apply to the period May to October only.

Amount of Rainfall mm	For reading taken at 07.00 hours	Amount of Rainfall mm	For reading taken at 18.00 hours
0 – 3	May be ignored	0 – 5	May be ignored
3.1 – 7	Soil operations may commence at midday	5.1 – 10	Soil operations may commence midday of next day
>7	Soil operations may commence next day	> 10	Soil operations may commence the day after next

TABLE B2 : Rainfall Criteria : Soil Reinstatement from Storage Heaps using Earthscraper

(iii) If rainfall during soil operations is in excess of 3.0mm, operations must be suspended for that day.

Restarting Work

33. Restarting work after a temporary suspension due to rain will normally depend on drying of the soil from the surface, unless the rain was so heavy and prolonged as to wet the soil through the entire profile. If the drying period determined from the rainfall readings taken at 07.30 and 18.00 hours each day is interrupted by further rainfall, then the additional drying time shown in Table B3 below should be added on.

Soil Movement Type	Additional Rainfall Amount (mm) Or Part Thereof	Extra Hours To Be Added To Original Drying Time	Maximum Rainfall Amounts Which May Be Ignored
Soil stripping and direct reinstatement	15mm per 12 hours	12 hours	1mm
Soil reinstatement from storage heaps	10mm per 12 hours	12 hours	3mm

TABLE B3 : Additional Drying Time to be Added before Starting Work if Dry Period is Interrupted by Further Rainfall

SOIL MOVEMENT BY LOADER AND DUMPER

Loading From Storage Heap and Undisturbed Ground

34. *Loading of dump trucks may be carried out using either tracked or wheeled loaders, or a tracked back-acting shovel. In order to avoid compaction of the soil, tracked or wheeled loaders and dump trucks must operate only on the gravel and fill surface. In some circumstances a tracked loader may operate on the subsoil surface or on the storage heap.*

Movement of Machines To and From Stripping and Placement Areas

35. At no time should dump trucks travel over reinstated soil and, in cases where soil transportation unavoidably involves crossing undisturbed or previously restored land, running is to be concentrated on clearly defined tracks.

Soil Reinstatement

36. Soil reinstatement by the loader and dumper method shall be subject to the following conditions:–

(i) *Where gas generation from the fill is not anticipated (for example, where only non biodegradable materials have been used),* prior to the reinstatement of each subsoil strip, the fill surface to be covered by that strip is to be scarified to a depth of about 150mm with a spacing between tines of 200–300mm. As far as possible, dump trucks are to avoid compaction of the scarified section of the fill surface.

(ii) Reinstatement will proceed by laying a strip of subsoil to the required depth along the border of the area to be reinstated. Dump trucks shall tip subsoil loads in a line such that a back-acter, working from the fill surface, can easily level the heaps. The width of the strip shall be dictated by the reach of the back-acter.

(iii) Upon completion of the subsoil strip, topsoil will be reinstated over the subsoil. Topsoil will be tipped alongside the subsoil strip and be lifted and spread over the subsoil, to the required depth. This operation must not involve repeated running over the topsoil or subsoil by loaders. However, static operation by a tracked back-acter from the soil surface, if this gives an increased speed of working as compared to working from the fill surface, is permitted.

(iv) Soil reinstatement will progress on this strip system. The next subsoil strip will not be placed until the preceding strip has received topsoil.

(v) After reinstatement of a suitably large area, final levelling as necessary must be carried out using a light tracked dozer. The number of passes necessary to obtain an even surface should be kept to a minimum.

(vi) In order to achieve a minimum settled depth of 1.2m, *the depth of soil at the time of reinstatement will depend on the texture and consistency of the soil. Hard lumpy clay soils will settle more than loose, sandy soils. As a guide, the following depths of subsoil and topsoil are to be reinstated.*

Subsoil	*0.9–1.0 m*
Topsoil	*0.3 m*

So long as the fill surface (prior to soil reinstatement) is at the correct level, soil depths should be checked frequently by the operator, by placing a measure against the reinstated soil profile.

Criteria for Prevention of Work under Unsuitable Conditions

General

37. Soil movement by the loader and dumper method has the potential of causing less compaction to the soil, as it does not involve heavy wheel loads passing over the soil. However, the soil is still liable to compaction by the various operations, and work must be suspended when the soil is in an unsuitable condition.

Soil Stripping and Direct Reinstatement

38. Soil stripping and direct reinstatement by dumper and loader will be subject to the following conditions:–

(i) Soil operations may only commence upon the approval of the company's advisors once soil conditions have been assessed.

(ii) No soil operations will take place during rain or in the presence of standing water.

(iii) Soil moving operations should normally only take place between the months of May and October, and during this period the rainfall criteria set out in Table B4 should be observed. Rainfall must be read twice daily before and after work at 07.30 and 18.00 hours by means of a rain gauge set up on site. The gauge is to be emptied after each reading. Readings are to be recorded even if there is no working.

Rainfall Amount	For Reading Taken at 07.30 hours	Rainfall Amount	For Reading Taken at 18.00 hours
0 – 2mm	May be ignored	0 – 3mm	May be ignored
2.1 – 4mm	Soil operations may commence at midday	3.1 – 6mm	Soil operations may commence midday of the next day
4.1 – 6mm	Soil operations may commence next day	6.1 – 8mm	Soil operations may commence the day after next
6.1 – 9mm	Soil operations may commence midday next day	8.1 –10mm	Soil operations may commence after 48 hours
9.1 –12mm	Soil operations may commence after 48 hours	10.1mm or more	Soil operations may commence after 3 days
12.1mm or more	Soil operations may commence after 3 days		

TABLE B4 . Rainfall Criteria; Soil Stripping and Direct Reinstatement by Loader and Dumper

(iv) If rainfall during soil operations is in excess of 2.0mm, operations must be suspended for that day.

Soil Reinstatement from Storage Heaps Using the Dumper and Loader Method

39. *The removal of soils from storage for agricultural reinstatement may be carried out with less stringent restrictions than those set out in para. 38 above. An important advantage of the loader and dumper system is that it avoids compaction of the soil so some rainfall during soil moving operations should not affect the standard of soil reinstatement. Soil moisture in a storage heap is not affected significantly by day to day rainfall and the condition of the fill surface, rather than soil conditions, is likely to be the major determinant of whether or not operations proceed. Accordingly, soil movements from storage to reinstatement will be subject to the following conditions:–*

(i) Soil moving must be discontinued during heavy rain or when tracking conditions are unsuitable and normally between November and April.

Restarting Work

40. Restarting work after a temporary suspension due to rain will normally depend on drying of the soil from the surface, unless the rain was so heavy and prolonged as to wet the soil through the entire profile. In terms of operational stoppages due to the criteria listed under table B4 if the drying period determined from the rainfall readings taken at 07.30 and 18.00 hours each day is interrupted by further rainfall, then additional drying time should be added on. For each additional 5mm of rainfall (or part thereof) per 12 hours (amounts less than 1mm may be ignored), 12 hours drying time is to be added on to the original drying period.

SECTION III INSTRUCTIONS TO SITE SUPERVISOR ON FILLING OPERATIONS

PERMITTED FILLING MATERIALS

41. The type of filling materials to be used shall be confined to the classes permitted by the Greater London Council and as determined by the Technical Sub-Committee as follows:—

GRADE A MATERIALS

Waste concrete

Cement slurry

Builders' rubble

Hardcore

Excavated Materials (except stabilised soil)

Fly Ash (small quantities, well dispersed)

Clinker (small quantities)

Foundry Sand (not containing cyanides or cyanogene)

Ashes (well dispersed)

Glass

GRADE B MATERIALS

Plastic rejects, foam, bottles and plastic coated cloth

Plastic laminated extruded vinyl

Polythene packaging, low density polythenes

Polystyrene packaging and blocks

High impact polystyrenes

Raw P.V.C. Carbon Paper

Sawdust, sanderdust, wood offcuts and hardboard (small quantities)

Waste paper and cardboard (well dispersed)

Cork and rubber mixtures

Rubber tyres (cut of shredded and well dispersed)

Waste bentonite (spread through tip)

Soot and Chimney wastes (small quanitites, well dispersed)

Contents of skips (office, shop and supermarket waste)

Tins

Civic Amenities Act domestic rubbish (large and bulky objects first crushed and broken up)

SITE LAYOUT

Boundaries

42 The Experiment Site should have clearly defined boundaries, which are secured against unauthorised access at all times (especially outside working hours) by a suitable fence.

Notices

43. A Notice Board identifying the site should be prominently displayed at or near the entrance to the site with details of opening hours, where drivers and visitors must report and the name of the landfill manager.

Roads

44. The route to and from the site should be clearly defined by signs denoting direction to be followed and speed limits to be observed – normally those in operation on the parent site.

Site Office

45. The site office, clearly marked, should be situated at or near the entrance to the site and be equipped with adequate heating, lighting, furniture (including a detailed wall plan of the site), telephone, first-aid cabinet, fire fighting equipment, statutory notices, day book and visitors book.

Stores

46. A tool locker store or compound should also be provided for hand tools, tow ropes, grease guns, lubricants, level poles, portable lighting etc.

Car Park

47. The car parking area for staff and visitors should be adjacent to the entrance and clearly marked out and signposted.

Wheel Washing

48. Arrangements should be made to utilise such wheel cleaning equipment as exists on the parent site.

SITE PREPARATION AND SUBSEQUENT CONTROL

Dewatering and Levelling

49. Before filling takes place, the excavation will be dewatered and the floor levelled by spreading the heaps of rejected material or removing them for subsequent use as cover. Care will be taken not to breach any temporary drainage channel constructed by the gravel extractors for the purpose of dewatering the excavation. Depth poles and level indicators will then be erected as directed.

Litter Prevention

50. Mobile litter screens will be used at all times to mitigate the effects of wind and will be regularly moved and cleared of trapped litter.

Flies and other Pests etc.

51. Regular spraying of the site with fly and other pest insecticides will be carried out in consultation with the Local Health Authority. Any evidence of vermin, rats, rabbits etc. will be reported to above Authority for their attention or that of a private contractor.

Reporting on Arrival

52. On arrival all drivers and other visitors must (as requested on the Notice Board) report to the site office before proceeding onto the site, unless otherwise instructed by the Landfill Manager.

Procedure at Site Office

53. Visitors will sign the Visitors Book. Drivers delivering fill materials will have their loads and documents checked by the Landfill Manager who will enter the details in the Day Book.

Load Classification

54. Drivers will then have their load tickets endorsed classifying their loads as "A" material, "B" material or "Cover" and be directed to the tipping area.

Arrival at Tipping Area

55. Drivers will hand their endorsed load tickets (or separate chit) to the fill personnel who will direct them where to unload. It is imperative that drivers comply with these instructions. No driver will tip directly over the face of the fill unless specifically instructed to do so by the Landfill Manager.

Safety

56. After unloading, drivers will lower bodies and secure the tailboards of their vehicles etc. before leaving the tipping area.

Duties of Site Personnel

57. Detailed duties for the Fill Manager and Plant Operator will be typed or printed, mounted on mill board and varnished and both operatives will be responsible for having them regularly accessible in office or cab. respectively at all times.

FILLING OPERATIONS

Commencement

58. Filling will not commence until extraction has created a void large enough to accommodate a filling operation of such proportion that will ensure the prompt and efficient handling of fill material and will not inhibit the aims of the experiment. The base of the fill will never approach nearer that 9.0 metres from the working gravel face. Thereafter, gravel extraction and filling operations will proceed simultaneously, if possible.

Rate of Fill

59. Ideally, rate of fill should equal, but not exceed, that of extraction. Small increases are acceptable if space is available but must never be at the expense of encroaching on the 9.0 metres wide void in front of the working gravel face.

Method (First and Second Quarters)

60. Filling will be carried out in layers approximately 1.8 metres deep, as indicated by level poles, and 27 metres wide (to match the width of extraction, unless otherwise determined). Filling will start from one side of the excavation and progress to the other, keeping parallel with the gravel face yet sufficiently far away, so that it does not interfere with the extraction of minerals and risk the pollution of any water at the gravel face which may be draining to the Company's reservoir.

61. When the first layer has been completed, subsequent layers will be placed on top, starting from the opposite side of the site to the previous layer.

62. The topmost layer of fill will slope upwards (1:66 (1.5%)) to the centre as marked by level poles and descend (1:66 (1.5%)) to the other side of the excavation.

63. On the completion of each topmost layer, the same method of filling will be resumed in the next 27 metres wide strip of excavation, until the entire excavation is filled. No space will be allowed between strips, to ensure an integrated filling operation.

Method (Third and Fourth Quarters)

64. *Filling will be carried out in layers approximately 1.8 metres deep, as indicated by level poles. The first layer will be placed over the entire floor of the excavated area.*

65. *When the first layer has been completed, subsequent layers will be placed in strips, each 35 metres wide. Four strips will be possible, each comprising three layers. The second layers of strips 1, 2, 3 and 4 will be laid in succession, followed by the third layer in similar sequence.*

66. *The topmost layer of fill will slope upwards (1:66 (1.5%)) to the centre, as marked by level poles, and descend (1:66 (1.5%)) to the other side of the excavation.*

67. *No space will be allowed between strips, to ensure an integrated filling operation.*

68. *Two 150mm layers of clay subsoil will be placed upon the fill surface. Each layer will be compacted with a vibrating roller in order to create a seal to prevent landfill gases diffusing into the soil horizon.*

Treatment of Fill Materials (First and Second Quarters)

69. Lorries will be unloaded on the surface of the fill according to the classification of their loads. No lorry will be unloaded over the fill face except on the direct instructions of the Landfill Manager.

70. The loads classified as "cover" will be placed to one side for covering the flank face of the fill (that parallel to the gravel face), the progressing face and the surface at the end of the working day.

71. Those loads designated "A" material and "B" material will be tipped in groups in the ratio (in cubic metres) in which they are to be placed in the void (this information will be known by the Landfill Manager).

72. As soon as a grouping has been completed to the satisfaction of the Landfill Manager, the bulk materials will be run over by the bulldozer until they are reduced to a uniform size and thoroughly mixed with "A" and "B" materials in the group. When this is completed to the satisfaction of the Landfill Manager, the mixed material will be dozed into the void.

73. Large objects (such as lamp standards, concrete slabs, tree trunks etc.) will be extracted and laid horizontally in the bottom of the tip or the bottom of the intermediate layers. They will not be included in the final layer. Other material to be excluded from the final layer will be notified to the Landfill Manager.

74. All materials will be levelled and tip faces graded and covered at the end of each day's work.

Treatment of fill materials (Third and Fourth Quarters)

75. *Lorries will be unloaded in accordance with the instructions of the Landfill Manager.*

76. *The loads classified as "cover" will be placed to one side for covering the flank face of the fill (that parallel to the gravel face), the progressing face and the surface at the end of the working day.*

77. *Those loads designated "A" materials and "B" materials will be tipped in accordance with the instructions of the Landfill Manager.*

78. *As material is placed in the site, it will be run over repeatedly by the compactor, in order to maximise consolidation.*

79. *Paragraphs 73 and 74 apply here.*

GENERAL INSTRUCTIONS, RECORDS & MISCELLANEOUS ITEMS

80. The following general instructions were given to the Site Supervisor to control filling operations:

(i) No filling will take place in water. Filling will be suspended until dewatering is accomplished.

(ii) No burning of waste on site will be allowed and accidental fires will be extinguished without delay.

(iii) Totting will be at the discretion of the Operating Company but will be strictly controlled.

(iv) No extraneous materials will be left on the filled area overnight. All tools, plant and stores will be secured.

Day Book

81. This will be in sheet or book form and will be a daily record in chronological order of the arrival of every vehicle delivering fill material (including cover) to the site and will show in columns the date and time of arrival, the number of the vehicle, the name of the carrier, the source and description of the material, and the yardage of the load, entered in appropriate "A" material or "B" material and "Cover" columns. There will also be a column for cash received or accounts rendered and space for remarks.

Summary Sheet or Book

82. This will be a weekly summary based on Day Sheet/Book daily totals which, in turn, will provide monthly/quarterly totals. Both the Day Sheet/Book and the summary will be brought up to date at the end of each working day and be available for reference by authorised persons at all times.

Diary

83. A diary will be kept to record weather notes, 'key' dates and data readings referred to below.

Weather Notes

84 These will include conditions during the night before and refer in general terms to frost, snow, whether dry or rainy, windy and, if possible, a minimum and maximum temperature.

'Key Dates

85. The date and times of the start, suspension, re-start and finish etc. of particular operations, such as stripping, extraction of gravel, backfilling, transferring topsoil etc.

Data Readings

86. Dates and times of test readings, sampling and surveys etc., together with any appropriate comment (Separate record sheet/books will be compiled as and when required, recording details of sampling surveys, temperature and moisture readings etc.).

Visitors Book

87. A visitors book will be available in the site office which all visitors should sign. (A space could be reserved in the diary for use as a visitor's record if a separate book is not thought to be necessary.).

Wall Plan

88. A large scale wall plan (1:200) of the site will be hung in the site office to show progress (weekly) of extraction, fill and restoration etc. It should be covered with clear plastic which will serve to protect and for marking the necessary progress by chinagraph pencil.

Statutory Notices

89. The obligatory statutory notices will be displayed on the walls of the site office, together with illustrated posters dealing with First Aid and resuscitation for electric shock, and a list of telephone numbers for police, fire and ambulance. An accident book will be kept in a safe place with the offices.

First Aid

90. A wall mounted first aid box will be fixed in a prominent position within the office.

POST REINSTATEMENT OPERATIONS (AFTERCARE)

SECTION IV – INITIAL MANAGEMENT OF REINSTATED SOILS

GENERAL

91. Conventional bulk movement of soils will inevitably affect soil structure. Reinstatement of soils involving heavy machinery running over successive layers compacts the soil, causing damage to soil structure and soil drainage (see Annex I). Procedures which avoid heavy wheel loads on the soil are not likely to seriously affect soil structure and so should be adopted. All operations should be designed to prevent damage to the soil structures and, where damage is found, to alleviate this as quickly as possible so as to prevent accumulative adverse effects.

92. In the management of reinstated soils, the aim should be to restore or improve the soil structure and so maintain a healthy soil environment. Soil structure is the most important physical property of a soil, as it has a direct effect on drainage, soil aeration, permeability to water, bearing strength, root penetration, crop growth and overall soil fertility. Good soil structure is easily and rapidly destroyed by bad soil management, e.g. by cultivation when the soil is too moist.

93. Improvement in soil structure can be achieved by eliminating any adverse conditions. These may be, for example, poor drainage, consolidated layers in the soil and unsuitable rotation of crops. Careful management is therefore necessary to restore a damaged soil to a good structural condition suitable for high productivity of crops. The use of a restorative crop, such as grass with its extensive root action, aids the re-establishment of a good soil structure, provided any serious adverse conditions have first of all been eliminated. A ley can increase the organic content of the soil and this is a considerable aid to maintaining satisfactory soil conditions when the soil is brought back to arable cropping.

94. Cultivations, soil handling and management must be related to the soil type, as each varies in its strength and resistance to damage. Different soil types possess differing soil structures.

MANAGEMENT

95. In the management of restored soils, the following general conditions should be observed:–

(i) All cultivations and vehicle movement should be avoided when the soil is wet.

(ii) Heavy wheel loads (i.e. high ground pressures) should be avoided under all soil conditions.

(iii) Where the reinstated soil is in a very loose uncompacted state, machinery with a low bearing pressure should be used to avoid making serious ruts in the ground.

(iv) Drainage conditions should be assessed and, where necessary, a suitable drainage system installed as soon as practicable, otherwise there can be rapid deterioration of the soil (See Section V).

(v) In compacted reinstated soils, deep cultivations, and where necessary subsoiling, should be carried out to relieve compaction and assist in drainage. This must be carried out when the soil is suitably dry (See Section VI). The operations of drainage and deep cultivations must be considered together, if drainage is required.

(vi) After reinstatement, but prior to sowing and cultivating, a full soil analysis should be carried out to assess the fertility level and soil condition. The analysis should include the following: pH, nutrient status and organic matter status and, based on the results, appropriate quantities of lime and fertilizer should be applied.

(vii) The necessary measures should be taken to avoid general weed infestation of the restored soils. This may involve chemical spraying, cultivations or physical removal, according to conditions.

(viii) The soil should be cultivated and a restorative crop sown in early autumn *when optimum soil conditions are likely to occur.* Over-cultivation is to be avoided. The incorporation of farmyard manure and/or sewage sludge (with a low content of toxic metals) into the soil prior to sowing could be beneficial to soil structure improvement. Minimum cultivations consistent with obtaining a seedbed suitable for grass seed establishment should be adopted.

(ix) Where grass is to be sown as a restorative crop, the *seed mixture is to be selected according to seed bed conditions, time of year, anticipated length of the ley and nutrient levels.* Grass seed should be broadcast at the specified rate per hectare, harrowed into the soil and rolled. In cases where the reinstated soil is in a loose state, cage wheels should be used to avoid causing ruts.

(x) Animal grazing should be avoided for the first year and thereafter animal grazing should be avoided during wet soil conditions. *If employed, facilities must be available to support the animals during wet periods.*

SECTION V – LAND DRAINAGE

GENERAL

96. The need for drainage should be assessed by a qualified person, and have regard to the following factors:–

(i) soil type – generally heavy soils require drainage whereas sandy soils may not.

(ii) soil conditions – a compacted reinstated soil may require drainage, whereas the same soil in an undisturbed or loose condition may not.

(iii) gradient – steeper slopes may not need additional drainage.

(iv) nature of fill and permeability of the fill material.

(v) depth of water table – drainage may be necessary to draw down the water table or prevent it from rising into the root zone.

97. *In order to take account of possible future land settlement, all pipe drains are to be installed with the maximum practical gradient. Gradients in the order of 1:133 to 1:100 (0.75–1.0%) are desirable.*

98. *Perforated plastic land drainage pipes should be used in preference to tile drains, as the former are likely to provide continuity of drainage in the event of subsidence.*

99. *The drainage of reinstated land may be faciliated by reinstating the land with a slope, either a single slope or in a domed profile, depending on local topography. Land gradients of 1:100 to 1:66 (1–1.5%) are adequate.*

REINSTATEMENT WITH LOADER AND DUMPER

100. *Where the fill surface is adequately permeable* but further settlement is expected to take place in soils that will require drainage, land drains should not be installed in the same season that the soils are reinstated. Thereafter the timing, spacing and general specification will be on the basis of normal agricultural drainage practices. *However, where the fill surface is impermeable, it is necessary to install a drainage system in the same season as reinstatement.*

REINSTATEMENT WITH EARTHSCRAPER

101. In soils that require drainage and when it is considered that the majority of the fill settlement has occurred, the full drainage scheme should be installed soon after reinstatement. This could be in the autumn of the year of reinstatement.

102. In soils that require drainage and the majority of fill settlement has not taken place, then a basic drainage scheme should be installed in the autumn of the year of reinstatement and augmented if necessary when it is considered that the majority of the fill settlement has occurred. The drainage specification will be dependent on soil conditions and will be on the basis of normal agricultural drainage practice.

PROGRAMMING

103. Drainage operations must only take place when the soil is dry. Operations must be so ordered that the running of machinery over the soil surface is minimised and, if in a standing crop, damage to the crop is minimised.

MAINTENANCE

104. A drainage system must be maintained regularly once it has been installed. All outfall ditches must be inspected and any obstructions to flow such as weed growth or bank slippages must be removed. A blocked outfall can result in the pipes soon becoming silted up. The line of a non-functioning drain should be inspected to identify if it has been interrupted by settlement which if identified can be corrected by laying a new section of pipe.

SECTION VI – DEEP CULTIVATIONS

GENERAL

105. Where the subsoil is compacted and drainage is consequently impeded, deep cultivation will be required when soil conditions are suitable for a bursting of the compacted layer(s). Deep cultivation can relieve compaction, although it must be related to drainage of the site.

106. To avoid smearing and compaction of the topsoil, tracked tractors should be used for deep cultivation. To maximise the fissuring effect in the soil, deep cultivations should be carried out when the subsoil is dry.

107. The depth, spacing and type of tines will depend upon soil conditions. Subsoilers, preferably with winged tines, should be pulled just below the compacted layer so that the maximum effect can be achieved. Spacing should be no more than one metre but, where this gives insufficient shattering of the pan, a closer spacing may be required. The effect of the subsoiler should always be checked by digging to expose the profile through which the subsoiler has travelled. In cases where compaction is in the upper more intense, cultivation is beneficial.

DEEP CULTIVATIONS AND CROPPING

108. *Choice of implements for loosening soil under long term grass should ensure that the ley does not sustain serious damage. Using a conventional subsoiler, sod damage may be reduced by subsoiling when compact layers are dry (to maximise fissuring) but the upper 100mm is moist. In addition to the subsoiler, compaction may be relieved using a mole plough, either as such or fitted with a subsoiler blade, or specialised soil loosening equipment.*

109. *Where the land is under arable cropping, subsoiling should be carried out, where appropriate, following harvest, according to soil conditions.*

SECTION VII – CROPPING & MEDIUM/LONG TERM AGRICULTURAL MANAGEMENT

GENERAL

110. This section provides guidelines for the management of the reinstated land. It is assumed that the particular conditions set out below will be continued with observance of normal agricultural practice.

GRASS CROP MANAGEMENT

111. The initial period of restorative cropping will be dependent on soil conditions as reviewed each year by examination. Grass should be managed so as to encourage deep and extensive roots. In particular, adequate amounts of lime and fertilizer should be applied and damage to the redeveloping soil structure should be avoided. However, if damage occurs it should be remedied and the grass should be cut before it becomes mature and forms seed heads, as this would reduce root vigour. Initially the grass should be cut regularly. If necessary, deep cultivations to break up consolidated layers in the soil may be carried out when the soil is dry. Drainage as necessary may be installed in the grass crop.

PLOUGHING AND REGRADING

112. When it is considered that either the land is ready for arable cropping or that the grass ley should be renewed, the land may be ploughed. If there are large depressions, due to soil and/or fill settlement since reinstatement, then topsoil should be imported before ploughing and spread in the affected areas. *However, where depressions are less than 400mm importation of soil should be avoided for a few years as any levelling operations involve considerable machinery movement. Successive cultivations may remove shallow depressions.*

113. *Generally, with reinstated soils, the initial cropping should commence with an autumn-sown crop, drilled early, in order to optimise establishment before the onset of winter and to avoid the need to cultivate the land when wet in the spring.*

FUTURE CROPPING

114. Where it is considered that the soil structure has not developed adequately and could still be damaged by normal agricultural cropping, the ley should be continued if still in a useful productive condition; otherwise the land should be resown to grass and the same management applied as in para. 111. Alternately, a cereal crop could be taken before resowing the grass.

115. Where it is considered that the land is sufficiently restored, arable or horticultural cropping may be entered into. However, in the initial years, crops such as sugar beet or potatoes, which may involve harvesting in wet conditions, should be avoided.

116. *Depending on soil conditions, cropping in the first few years following reinstatement should be regarded as aimed at improving the soil condition. The primary objective in crop management during this stage should be aimed at restoration of the soil, the secondary objective being to optimise yields.*

COMMENTARY ON THE AMENDMENTS TO THE CODE OF PRACTICE

GENERAL

117. Certain amendments have been made to the original Code of Practice drawn up at the beginning of the Experiment in 1974. These amendments have arisen from the experience gained since the commencement of the Experiment and they have been identified in this appendix in italics. The reason for the main amendments are discussed below under reference to the paragraph number in the appendix.

SECTION II – INSTRUCTIONS TO SITE SUPERVISOR ON SOIL MOVEMENT

Paragraph 20

118. This has been added for the sake of clarification.

Paragraphs 22, 26, 27 and 28

119. These additional paragraphs give further details on how to reduce soil damage to a minimum when it is being moved by earthscraper. Topsoil is generally less susceptible to damage than subsoil and compaction may be eliminated more quickly, so where machines have to unavoidably cross agricultural land, it is preferable to run on topsoil. Paragraph 28 has been added to give guidance to soil reinstatement using earthscrapers.

Paragraph 31 (iii) and (v)

120. The rainfall criteria have been refined and clarified in the light of experience.

Paragraph 32

121. This section of the Code has been amended to cover the soil reinstatement operations on the Fourth Quarter of the Experiment, where stored soils were replaced by scraper in the summer of 1981. The day to day rainfall does not affect the moisture of the soil within a storage heap significantly because of its small surface to volume ratio. Soil moving operations may therefore operate under less stringent conditions than required for direct reinstatment operations.

Paragraph 34

122. This amendment was made because in 1977 when the soils from the Third Quarter were being directly replaced on the First Quarter a tracked loader was used for loading topsoil and subsoil as no other machine was readily available. The loader had to operate from the subsoil surface but as this was hard and dry only the surface layer suffered minor compaction. This was readily eradicated by the subsequent excavation and movement of the subsoil.

Paragraph 36 (i)

123. The fill surface should only be scarified to allow the drainage of excess water out of the soil profile where the fill is non-biodegradable. Landfill gases are likely to be generated where the fill is biodegradable, the loosening of its surface will facilitate the uncontrolled movement of gas into the soil profile with the consequent detrimental effect on the soil.

Paragraph 36 (vi)

124. It was found that soils replaced on the 1st Quarter by the loader and dumper method did not settle significantly and, therefore, no allowance was made for soil settlement during the reinstatement of the 3rd Quarter.

Paragraph 39

125. The reason for this amendment is self evident.

SECTION III – FILLING OPERATIONS

Paragraphs 64–68 and 75–79

126. These paragraphs have been added to the Code to give guidance on the revised method of filling employed on the Third and Fourth Quarters. Because the progress of filling was slow, it was possible to complete the first layer of filling over the whole void before commencing the upper layers and thereby reduce differential settlement. The first 2.0 metre layer raised the filled levels above the water table, so it was possible to dispense with the continuous dewatering of the site.

127. A compactor was used to maximise the consolidation of the fill layers and as a consequence the long period of initial settlement prior to soil replacement would no longer be required. A seal was placed over the fill to stop landfill gases diffusing up into the soil horizon.

128. Filling operations were completed on the Third and Fourth Quarters in Spring 1981, but it will not be possible to assess the success of the method employed for some years.

SECTION IV – GENERAL MANAGEMENT OF REINSTATED SOILS

Paragraph 95 (viii)

129. Soil is normally driest in Autumn and, therefore, will suffer least damage from machinery if cultivated then.

Paragraph 95 (ix)

130. It is now recommended that the seed mixture should be selected to suit the conditions.

Paragraph 95 (x)

131. This paragraph has been amended to emphasise the importance of having facilities available so that animals may be removed from the land during wet periods.

SECTION V – LAND DRAINAGE

Paragraphs 97–99

132. These sections have been added to provide guidance on the type of drainage pipes most suitable for draining newly reinstated soils. They also give guidance on the optimum fill surface and final surface profiles required to permit an effective artificial drainage system to be installed. It is most important to decide at an early stage if an artificial drainage system will be required, in order that the restoration scheme can be designed to accommodate it.

Paragraph 100

133. The Code has been extended to give guidance on the installation of a drainage system in soils placed over an impermeable fill surface. This should be installed in the same season as reinstatement so as to avoid water-logging in the replaced soils which can be very detrimental, particularly where the soils are weakly structured. Soil structure cannot be restored while it is in a waterlogged state.

134. The installation of a permanent drainage system in the same year as reinstatement will only be successful where filling has taken place in a way to minimise settlement and the surface gradients of the reinstated land are adequate to permit drains within a minimum fall of 1:100 (1%) to be installed.

SECTION IV – DEEP CULTIVATIONS

Paragraphs 108 and 109

135. This section has been added to give guidance on the use of subsoiling implements under long term grass ley and under cereal crops. Where soil is compact the re-establishment of natural soil structure is aided by root action and the drying out of the subsoil layers which this induces. However, to assist the penetration of roots, mechanical action, in the form of some type of subsoiling, may be required.

SECTION VII – CROPPING AND AGRICULTURAL MANAGEMENT

Paragraph 112

136. Additional guidance on the treatment of surface depressions caused by settlement is given in this section of the Code. It is suggested that such depressions should not be filled until it is evident that most of the settlement has taken place unless they give rise to severe cultivation problems. Premature infilling would result in unnecessary machine movement over the soil and the disturbance of routine agricultural operations.

Paragraph 113

137. This section has been added to recommend the use of Autumn sown crops during the period of restorative cropping where it is decided that these would preserve and improve the soil structure. Soil conditions are usually more suitable for cultivation during the Autumn.

Paragraph 116

138. This section has been added to emphasise that attempts to obtain crop yields or cash returns from reinstated land during the period of restorative cropping may conflict with the objective of re-establishing a stable soil condition during the first few years following reinstatement. For example, the cultivation of shallow rooting market garden crops may have the potential of optimising cash returns in the short term, but will not assist in the restoration of the soil.

SOIL MOVEMENTS : GENERAL PRECAUTIONS

139. Protection of both topsoil and subsoil is vital to the future growth of crops. To retain its fertility the soil must achieve a correct balance of mineral particles, organic matter, air spaces and biological activity.

140. Topsoil contains much of the soil fertility and plant nutrients and, when restored, must be capable of producing a tilth into which crops can be successfully sown. It must support the crop up to maturity and through harvesting, and remain friable enough for ploughing and cultivations at most times of the year. However, the topsoil, when reinstated (unlike the subsoil), remains readily accessible to cultivations and improving materials, such as lime, fertilizer and farmyard manure, can be easily added and incorporated.

141. Subsoil provides some nutrients and most of the rooting space for crops, and holds most of the moisture available to plants. Damage to the subsoil structure can be irreparable and, because of its inaccessibility below the topsoil, remedial treatments are few and limited in effectiveness.

142. Unless the soil is thoroughly dry, bulk movement is almost bound to cause damage to soil structure.

143. For all soil types, the amount of damage concerned will vary according to a number of factors. In general damage to soil structure during movement will increase in relation to the following factors:—

(i) fine textured soils containing clay and silt. Sandy free-draining soils are less subject to damage.

(ii) an increase in the moisture content of the soil.

(iii) the direct surface compaction caused by rubber tyres, metal tracks, scraper blades, shovel actions, etc.

(iv) repetition of the compactive effect, both in relation to the amount of surface covered and the various levels at which compaction is applied through the soil profile. Soil is best removed or spread in substantial layers.

(v) the shearing or kneading action on the soil. This may be caused by wheel-slip or excessive slewing, whether by rubber tyred or tracked vehicles or when packing soil into the box of earth scrapers.

144. Soil movements only start when the soil is in a suitable dry condition, normally between the months of May and October. The later in the season that any programme of soil movement starts, the greater the risk that it may have to be stopped unfinished due to the onset of bad weather, and postponed until the following year. Moisture loss from soil storage heaps during the summer period is not significant so that soil reinstatement from storage heaps may commence earlier in the summer period.

145. The soil will dry in the spring due to three main factors:—

(i) Drainage of excess water downwards.

(ii) Surface evaporation.

(iii) Transpiration by plants growing in the soil.

Transpiration by plants provides the main means of moisture loss from the soil below the top 100mm when the soil is below field capacity. It is therefore beneficial if the land which is to be stripped is under a crop prior to soil stripping to dry out the soil earlier in the season.

146. The moisture content of the soil and its suitability for bulk movement can be assessed by field or laboratory techniques. All assessments should be to the full depth of the soil to be moved, using a spade or soil auger, because a dry surface layer may mask a wet subsoil.

147. A suitably dry soil will crumble and shatter under the action of the cutting blade and elevator movement of the elevating earthscraper, and wheel markings will be light. Apart from the obvious wetness, deep wheel tread markings and a polishing of the scraped surface indicate excessive soil moisture.

148. Prior to soil moving, either from storage or undisturbed land, all weed growth should be sprayed to provide a clear start for the restorative cropping. In particular, where couch grass is present, a suitable herbicide should be used as couch is very persistent and cannot be selectively controlled in a grass sward.

A DISCUSSION OF THE NEED FOR RESTORATIVE CROPPING

SOIL STRUCTURE

149. Soils, in their undisturbed state, have a structure formed by the individual soil particles packing or joining together to form clods or crumbs (peds). The size distribution and form of the peds and pore spaces, between them determine the kind of structure. The type of soil structure (described in the field by the shape and size of the peds), is a function of the soil type. The distinct (coarse) prismatic structure in the subsoil at Bush Farm is typical of a sandy clay loam/clay loam. The cracks between, and pores within, the soil peds allow retention and drainage of water, and the development of plant roots through the soil. Damage to the soil structure limits the amount of nutrients and moisture available to the crops, which reduce potential yields.

150. The movement and reinstatement of soils largely destroys the natural soil structure. The soil structure must, therefore, be redeveloped to provide drainage and maximise the volume plant roots may explore to extract nutrients and moisture.

SOIL STRUCTURE DEVELOPMENT

151. The most effective agents for the creation of structural units are plant roots. Plant roots force their way into soil pores and then swell, making the pores larger. This causes shearing in the soil. Plant roots extract moisture and if the soil shrinks as it loses moisture, further cracking will occur. Soil fauna such as earthworms, larvae of insects and ants also assist in creating channels and structural pores. The addition of organic matter assists in the stabilisation of soil structure. However, clay is the most important component resisting the collapse of soil structure.

152. The establishment of a stable aggregation of particles in the topsoil is relatively quickly achieved due to the level of soil organic matter, the aggregation of the soil by the crop roots, and the loosening of the soil by routine cultivations. Structure development in the subsoil, however, is a slower process. Crop roots are not as numerous as in the topsoil, and, with the exception of subsoiling (which may penetrate the subsoil by 150–200mm), routine cultivations do not penetrate the subsoil.

153. In order to assist in the penetration of a compact subsoil by crop roots, regular subsoiling should be carried out when the soil is suitably dry. Subsoiling tends to fracture the soil, creating lumps of soil within the profile. It is within these lumps that the structure development process must take place in order for plant roots to utilise the soil volume to its potential. This is analagous to a situation where if the soil was considered to be made up of broken bricks, the plant roots would quickly use up any moisture or nutrients on the surface of the bricks if they were not able to penetrate the individual bricks to extract further moisture and nutrients.

GRASS AS A RESTORATIVE CROP

154. In order to improve reinstated land it must be managed to enhance soil structure development. Grass is commonly favoured as a restorative crop as it has a very extensive rooting system which enlarges with each season of growth. Grass has the advantage that, once established, it does not require cultivations or operations which may damage the soil when in a wet condition. However, one disadvantage of grass may be that the rate of root development with depth is slow compared to an Autumn sown cereal crop.

MANAGEMENT OF GRASS LEY

155. The management of grass should be aimed at encouraging root development by regular cutting or grazing which also ensures maximum yields. Grassland management may present problems where the reinstated land is in an area of arable farming or in the urban fringe and the system of farming is not orientated to grass use either by livestock grazing or conservation. In many circumstances, therefore, it may only be possible to take one or two haycuts. Where grazing is to be considered, facilities must be available to remove the stock during the winter period and any prolonged wet periods to avoid damage by poaching.

AUTUMN GROWN CEREALS AS A RESTORATIVE CROP

156. Cereals have been grown as a pioneer crop on newly reinstated land with varying degrees of success, depending on soil type and the weather for the particular season. In general, however, there is a degree of risk involved under this management, in that the soil structure may collapse due to the lack of establishment of a stabilising root system. Soils, particularly those with a low organic matter content in the topsoil and/or with an inherently weak structure, are vulnerable to collapse in the first few years following reinstatement and therefore grass is recommended during this period.

157. In situations where the objective is to restore the land to arable cropping, once it is considered that the soil structure, at least in the upper layers, has developed adequately, arable cropping should commence with an Autumn sown cereal. Autumn cereals develop relatively deep rooting systems of benefit to the subsoil and do not require cultivations or harvesting to take place at wet times of the year. Root crops or winter harvested crops should be avoided as they generally do not provide a root system of benefit to the structure of the soil and often require harvesting under unsuitable soil conditions.

REPORT

ON INVESTIGATIONS OF CAUSE OF VEGETATION INJURY ON PROPERTIES ADJACENT TO SANITARY LANDFILL SITE

(Berrill and Trustrum)

TOWN OF MISSISSAUGA, ONTARIO

Submitted to, Waste Management Branch,
Ministry of the Environment for Ontario

Submitted by, Professor Z. A. Patrick,
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January, 1973.

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Pathology

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Introduction

This investigation was undertaken to determine the cause and mechanisms resulting in injury and mortality of mature trees, shrubs, and other vegetation on properties adjacent to the Berrill and Trustrum. Sanitary Landfill Site, located in the town of Mississauga, Ontario.

This report is concerned primarily with investigations outlined in Section 5 of the Research Contract Proposal submitted in April 1972, to the Waste Management Branch, Ontario Ministry of the Environment.

A report on investigations outlined in Section 3 of the proposal is also submitted. Investigations outlined in Section 2 were not completed and only results of preliminary analysis of hydrogen cyanide in samples collected by Professor J. C. Van Loon in April 1972, are included.

As indicated in the "Overall Summary Report", investigations on various aspects of the problem were conducted by the Hydrology Consultants Limited and by the Phytotoxicology Section, Air Management Branch. Attempts were made not to duplicate these investigations.

Objectives

The primary objectives of the studies were: -

1) To determine whether phytotoxic substances are present in soil on private properties adjacent to the Berrill and Trustrum Landfill Site.

2) To identify some of the toxic compounds and evaluate their toxicity.

3) To determine whether some of the gases as well as other factors identified in the investigations of Hydrology Consultants Ltd., could be directly responsible for the vegetation damage observed on private properties adjacent to the Berrill and Trustrum Landfill Site.

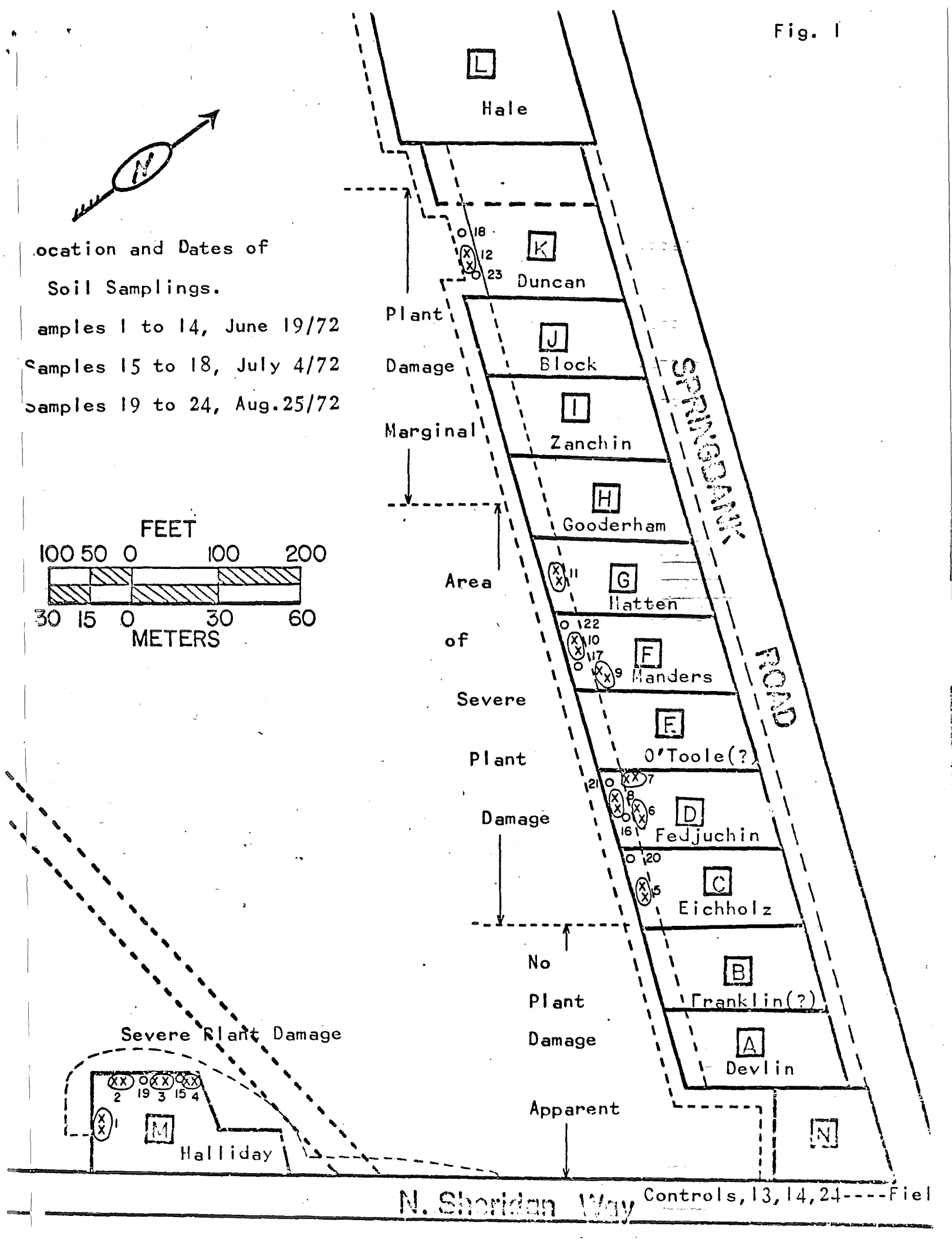
Methods

Soil samples were obtained from the affected sites on June 19, 1972 (Samples 1 to 14); July 4 (Samples 15 to 18) and August 25 (Samples 19 to 24). The locations from which these samples were obtained are shown in Fig. 1. Where possible these samples were obtained near the gas sampling probes of Hydrology Consultants Ltd., on the private properties. The samples were collected in plastic bags at depths of 8 to 18 inches and taken to the laboratory for analysis.

During the soil samplings it was noted that the soil on the private properties, especially those from Halliday, Eichholz, Fedjuchin and Manders properties had a hard consistency, it was layered, dark black with fluffy white inclusions, and had a foul odor. The physical characteristics of these soils were different from the "normal" soils obtained in a field in the same area but approximately 1000 feet from the landfill site.

In the laboratory a portion of each sample was used in bio-assays to determine the effect on growth of lettuce seed. Another portion of each sample was used for chemical analysis; primarily

Fig. 1


N
ocation and Dates of
Soil Samplings.
amples 1 to 14, June 19/72
Samples 15 to 18, July 4/72
Samples 19 to 24, Aug.25/72
FEET
100 50 0 100 200
30 15 0 30 60
METERS
Plant
Damage
Marginal
Area
of
Severe
Plant
Damage
No
Plant
Damage
Apparent
Severe Plant Damage
L
Hale
K
Duncan
J
Block
I
Zanchin
H
Gooderham
G
Hatten
F
Manders
E
O'Toole(?)
D
Fedjuchin
C
Eichholz
B
Franklin(?)
A
Devlin
M
Halliday
N
SHERIDAN
ROAD
N. Sheridan Way
Controls, 13, 14, 24----Fiel

to determine the presence of phytotoxic phenolics.

Each of the soil samples were extracted with water, 1 : 1 ratio by weight, and re-extracted with ether. The ether fraction was evaporated to dryness and re-dissolved in 100% ethanol for use in chromatographic analyses.

The crude aqueous extracts were concentrated to half volume and used in the lettuce seed bioassays. In other bioassays a wet paste of the soil obtained from the various locations was also used.

Chromatography, gas and paper, were used as the principal methods to identify the phytotoxins.

In gas chromatography, a Pye Unican series 105 FID gas chromatograph was used. The analytical column was 5 ft. long 4 mm I.D., packed with 10% cyclohexane dimethanol succinate on 100-120 mesh celite. The programmed temperature was set from 100°C to 235°C at an increasing rate of 3°C per minute. The purified extracts were injected into the column in the usual manner. The peaks obtained for each sample were identified by comparing them to peak areas and retention distances of known standards run under the same conditions.

For paper chromatography, the final alcoholic solution of the ether fraction was spotted on Whatman 3MM paper. The papers were developed by one dimensional descending chromatography with 3 solvent systems, namely, 2% acetic acid; 1-butanol:acetic acid: water (4:1:5, vol/vol/vol); and benzene:acetic acid:water (125:72:3, vol/vol/vol). After developing, the papers were examined under short wavelength ultraviolet light, and/or with specific spray

reagents. The various spots were identified by their Rf values, reaction to specific spray reagents, and/or reaction under short wavelength U.V. light. The identifications were confirmed by comparison with known standards treated in a similar manner.

Precise details as to the extraction procedures, gas and paper chromatography, and bioassay tests are available on request.

Additional samples of plant material were also obtained from the various affected properties and examined in the laboratory for possible specific infectious causal agents. Field observations were also carried out on the vegetation on the private properties to evaluate symptoms of possible adverse effects.

Results

Analysis of soil samples for phytotoxins.

The various soil samples, obtained from private properties at locations indicated in Fig. 1, were analysed for the presence of phenolic type compounds. The results of the analyses are presented in Table 1.

As is shown in Table 1, the soils on private properties adjacent to the Berrill and Trustrum landfill site contain up to four times the concentration of total phenols as compared to normal or control soils. Of the compounds that were identified at least 10 of these are known to be toxic to vegetation (7). There were also indications that other compounds which we could not identify were also present in these soil samples. Studies of similar situations (3, 7, 10, 11) indicate that many different compounds, including organic and inorganic gases as well as other

TABLE I. Identification of phytotoxins in extracts of soil samples obtained from properties adjacent to Mississauga landfill site

Compounds	Sample Nos. (Halliday; 1,2,3,4,15,19) 1	2	3	4	15	19
1. Phenyl acetic acid	10	14	10	10	4	8
2. o-coumaric acid	50	50	50	50	25	25
3. p-hydroxybenzoic acid	75	75	50	75	50	20
4. vanillic acid	30	40	20	40	15	15
5. p-hydroxybenzaldehyde	12	18	12	12	5	6
6. p-coumaric acid	45	45	45	30	20	15
7. feroulic acid	10	10	15	8	5	10
8. t-cinnamic acid	15	15	10	15	8	5
9. 4-phenylbutyric acid	60	60	50	50	25	21
10. benzoic acid	3	5	8	3	3	2
11. phenols (unidentified)	90	100	90	80	65	65
Total phenols (ppm)	400	422	360	373	225	192
Additional unidentified phytotoxins	6	7	6	5	3	3

*Composite results of paper and gas chromatographic analyses. Gas chromatograph, Pye Unican series 105 FID, column 5 ft., 4 mm ID, packed with 10% cyclohexane dimethanol succinate on 100-120 mesh celite; temp. programmed 100°C to 235°C, at 3°C per minute.

hard consistency, it was layered and somewhat greasy, it was dark black with fluffy white inclusions and had a foul odor.

Lettuce seed bioassays of soils and aqueous extracts from affected sites.

Tests were carried out to determine whether soils from private properties adjacent to the landfill site and aqueous extracts of these soils were toxic to plants. Lettuce seed was used for these tests and effect of the various soil samples on germination and growth of lettuce was determined. The results of some of these tests are presented in Table 2. It is evident that aqueous extracts of some of the soils inhibited root growth of lettuce seedlings. For example, the average growth of radicles in extracts of field soil was approximately 7.5 mm after 72 hours and only 1.6 mm in extracts of soil sample S 1. Other extracts showed varying degrees of radicle growth inhibition and some were not inhibitory.

In general, however, the results of these tests are not conclusive. The main reason may be that the soils were disturbed during sampling and the extracts were not of the same concentration as might occur in undisturbed soil. It is also possible that some of the toxic compounds are relatively unstable. They would be effective as toxic agents to plant roots only if they were produced continuously and migrated to the private properties. The results of Table 1 and 2 suggest that this occurs. It also shows that the soils on private properties adjacent to the landfill site have a different composition from the relatively normal soils obtained

TABLE 2.

Lettuce seed bioassay using aqueous extracts from various soil samples obtained on the dates shown

Sample and location	Growth of radicle, average of 10 seeds		
	June 19	July 4	Aug. 25
Halliday, S1	1.62	not tested	not tested
" S2	4.06	3.74	6.34
Eichholz, S5	8.73	not tested	7.30
Fedjuchin, S6	5.13	not tested	not tested
" S7	7.76	not tested	not tested
" S8	4.23	6.05	7.41
Manders, S9	10.96	not tested	not tested
" S10	5.02	7.76	7.30
Duncan, S12	10.26	8.13	7.91
Control (field soil)	7.76	7.81	7.35
Control (greenhouse soil)	7.58	7.73	7.76

Extracts, 1:1 ratio, soil to water

Lettuce seed, "Great Lakes", incubated at 22°C for 72 hrs.

TABLE 3.

Field bioassay with tomato plants in pots

and/or carnation flower cuttings

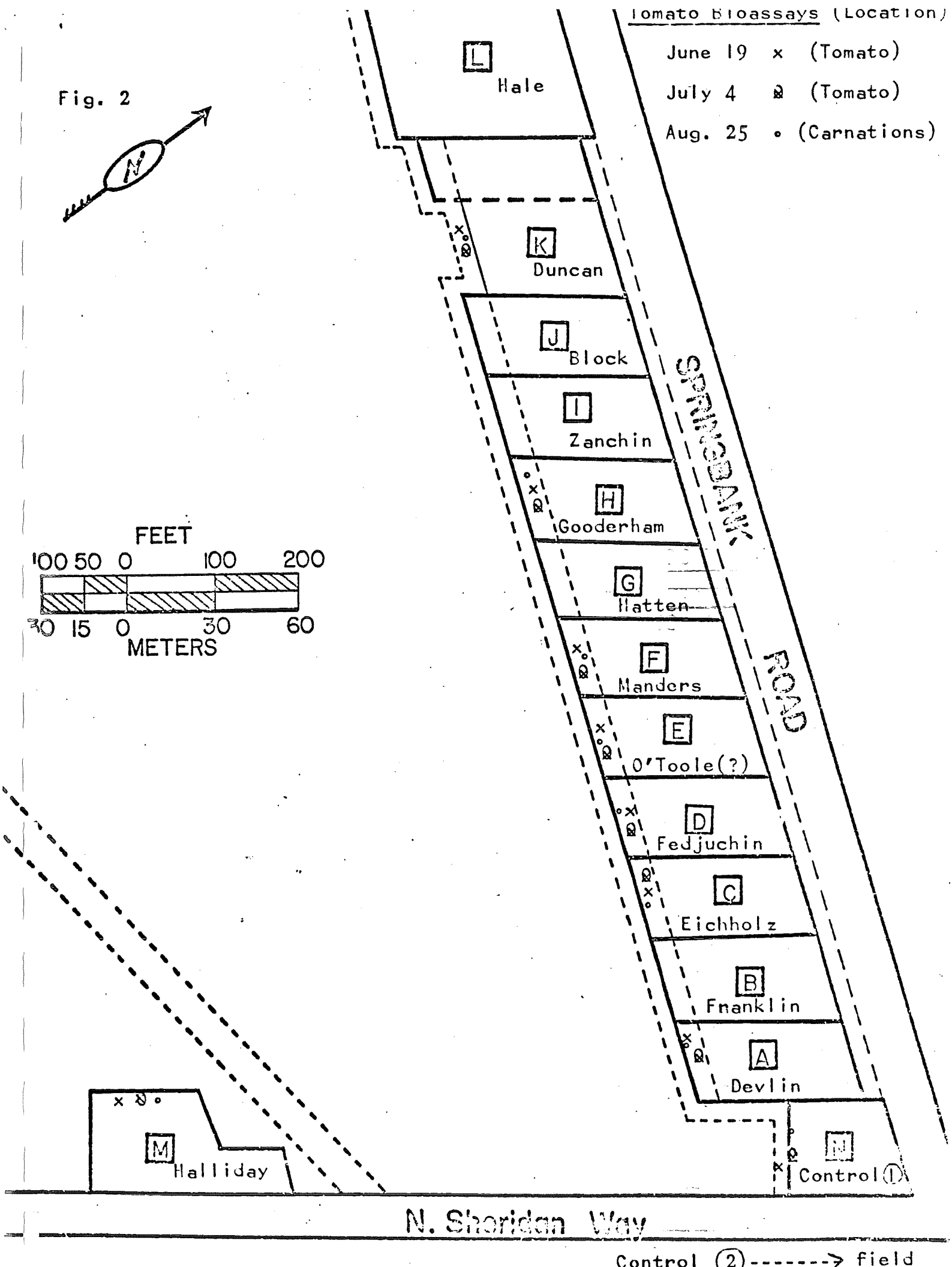
Location	Results and date of test June 19	July 4	Aug. 25
Halliday (near sample 2 (S2))	+++	++	+
Deslin (near probe 46 (P46))	-	-	-
Eichholz (near S5)	++	+	-
Fedjuchin (near S6)	+++	+++	+
Manders (near S10)	++	(+? (soil disturbed by bulldozer	-?)
O'Toole (near P25)	-	-	-
Gooderham (near P18)	++	-	-
Duncan (near S23)	+++	++	+
Control (near P48)	-	-	-
Control (open field, N. Sheridan Way E)	-	-	-

(+++); (++); (+) = severity of epinasty; severe to mild respectively.

(-) = no effect

plants enclosed in plastic bags in contact with soil and exposed for approx. 4 hrs. in the afternoon

Fig. 2


Tomato Bioassays (Location)
June 19 x (Tomato)
July 4 ⊠ (Tomato)
Aug. 25 ∘ (Carnations)
N
L Hale
K Duncan
J Block
I Zanchin
H Gooderham
G Hatten
F Manders
E O'Toole(?)
D Fedjuchin
C Eichholz
B Fnanklin
A Devlin
M Halliday
N Control ①
SHERIDAN ROAD
FEET
100 50 0 100 200
30 15 0 30 60
METERS
N. Sheridan Way
Control ② -------→ field

(Fig. 3). The downward curvature of the leaves of the plant on the right is an indication of the presence of ethylene or other unsaturated hydrocarbons. The plant on the left is the control showing normal growth. This photograph was taken at the experiment site.

As indicated earlier, it is known that ethylene and other unsaturated hydrocarbons are highly toxic to vegetation in minute quantities (4, 5, 8, 9). Ethylene, for example, will produce a biological response at concentrations of 0.1 ppm. As shown in the analyses of Hydrology Consultants Ltd. (3), ethylene readings as high as 140 ppm were obtained at the affected sites. The high ethylene levels also persisted for relatively long periods (3).

We consider, therefore, the results presented in Table 3 to be highly significant. It is evident that substances that produce ethylene type damage are present in soils of properties that are adjacent to the landfill operation. The fact that a positive test could be obtained in less than four hours indicates that at times these substances are produced and migrate at relatively high rates. The amounts of ethylene produced as indicated in the gas analyses (3) would be highly toxic to vegetation in the area. This factor alone would bring about the vegetation damage observed on the private properties.

Other symptoms of ethylene and unsaturated hydrocarbon type of injury that were also observed on trees that were still alive at the back of the properties adjacent to the landfill site, were, yellowing of the leaves, dieback of the twigs and extensive root injury.

Other mechanisms operating in the Berrill-Trustrum landfill site that have adverse effects on vegetation on adjoining properties.

As shown in the studies of Hydrology Consultants Ltd. (3), various gases eminate from the landfill. Because of the particular soil conditions in the Berrill-Trustrum landfill site and adjacent properties (2, 3) many of these migrate onto private properties that surround the landfill site. This lateral migration is especially pronounced during the winter months when the ground surface is frozen, and during wet periods.

Of the gases that were identified (3) methane is produced in relatively large quantities, amounts up to 59% of the soil-air volume were detected on some of the properties adjacent to the landfill site. Considerable amounts of ethylene, carbon dioxide, ethane, and propane were also detected at various times. Similarly, soil-gas samples, which contained methane in concentrations above 0.5% contained at least 20 other components (3). Phytotoxic phenolics (Table I) and other unidentified compounds were also found at the affected sites. Carbon monoxide, which is a by-product of the oxidation of methane, would also occur although no analysis were carried out to confirm this. There is also the possibility that hydrogen cyanide and hydrogen sulphide would also be found in these gases. Studies on this aspect, however, were not completed. As indicated elsewhere (see "Overall Summary") the composition of gases eminating from the landfill resembles the composition of natural gas. There is considerable evidence

that natural gas is highly toxic to vegetation. Severe damage to trees was obtained when leaks in gas lines occurred (4, 5, 9).

Regarding the phytotoxicity of the methane component of the gases, although the information is controversial (5, 9), it is generally believed that methane alone is not injurious to plants. However, because of the intensity of methane production, it displaces the oxygen and nitrogen portion of the soil air. This results in virtually total displacement of oxygen from the soil for extended periods of time (3). As shown in the report of the Hydrology Consultants Ltd. (3), the oxygen content of the soil is at times reduced to 0.58%, nitrogen 5%, and carbon dioxide readings were often as high as 51%. The composition of soil-air in normal soils is in the range of 22% oxygen, 80% nitrogen and 0.5% carbondioxide. Oxygen is essential for normal functioning of plant roots (4, 9), therefore, absence of oxygen from the soil-air results in root asphyxiation and finally death of trees and shrubs. This factor alone, namely the extremely low oxygen levels in the soil which is maintained for relatively long periods, would be sufficient to cause the death of the trees observed on the private properties.

Furthermore, the presence of methane in the soil results in a marked increase in populations of methane-consuming bacteria (5, 10, 11). These organisms also consume oxygen and produce large amounts of carbon dioxide and probably other products. As long as methane is present in the soil all oxygen will be consumed. Also, the dying populations of methane-utilizing bacteria require oxygen. All these factors, as well as oxidation

of reduced products formed during the anaerobic period, contribute to the depletion of the oxygen content of the soil and this low level is maintained for a long period (3). The lack of oxygen in the soil atmosphere for relatively extended periods, as indicated in the reports (3), is highly injurious to plant roots especially of mature trees which have root systems extending to various depths into the soil. The more shallow rooted vegetation such as shrubs and some grasses would not be injured to the same extent. But these also will be killed if the unfavorable conditions are maintained for extended periods of a week or more. As indicated in the reports (3) and our observations, within a distance of approximately 50 to 75 feet from the landfill property line the soil atmosphere on private properties often contained no oxygen, less than 10% nitrogen and as much as 88% carbon dioxide and methane combined, as well as the highly toxic, ethylene. It is highly doubtful that trees could survive with their roots in such a soil atmosphere or in the presence of high concentrations of toxic gases such as ethylene. The observations show that many of the trees did not survive and there was no evidence that plant pathogenic organisms were involved (6). The evidence points to the landfill as being the direct cause of vegetation mortality.

Discussion and Conclusions

It is concluded that the tree mortality and other vegetation damage evident on the private properties adjacent to the Berrill and Trustrum landfill site is directly due to the deleterious factors emitting from the above mentioned landfill operation. We believe that this conclusion is adequately supported by the present investigation and the experimental evidence presented in the reports of the Hydrology Consultants Ltd. (3), Bird and Hale (2), and the Phytotoxicology Section (6).

This evidence is summarized briefly. The biodynamics of the Berrill and Trustrum landfill operation involves the long term decomposition of the organic portion of the garbage. This results in the production of various gases including, methane, carbon dioxide, ethylene, phytotoxic phenolics, and many other unidentified substances (3). Because of the particular soil conditions in the landfill site and adjacent private properties (2, 3), there appears to be considerable lateral migration of these substances onto the private properties. The migration is especially heavy during the winter and spring periods when the surface of the soil is frozen or wet and migration of the gases to the surface of the soil is hindered. The landfill produced gases as they migrate, displace the oxygen and nitrogen in the soil atmosphere and around plant roots. This results in virtually total absence of oxygen from the soil atmosphere and also a marked increase in the carbon dioxide concentration. This results in the creation of soil conditions that are highly unfavorable

system, with proper barriers, at the periphery of the landfill operation. Such a venting system and barrier should be of sufficient efficiency so that it can intercept and vent the gases at all times, especially during periods of peak production and during periods when the ground surface is sealed by frost or rain. The venting system as suggested gy the Hydrology Consultants Ltd. (3) would probably fulfill these requirements.

Summary

1. It is concluded that the tree mortality and other vegetation damage evident on the private properties adjacent to the Berrill and Trustrum landfill site is directly due to the deleterious factors emanating from the above mentioned landfill operation.
2. The main causal factor responsible for the death of mature trees on the private properties is root asphyxiation brought about by the absence of oxygen in the root zone.
3. The absence of oxygen in the soil atmosphere is the direct result of oxygen displacement by lateral migration of the landfill produced gases and by microbial oxidation of methane.
4. Other mechanisms including presence of ethylene and phytotoxic phenolics at the affected sites aggravate the plant mortality problem.
5. An adequate venting system with proper barriers at the periphery of the landfill operation, to intercept and vent these substances, may eventually remedy the problem and prevent future plant mortality.

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