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The Corporation of the
City of Burlington

STAND BY

FINANCIAL LOCATION EVALUATION MODEL

Region of Halton Landfill Environmental Assessment

May 1988
851005

G.M. STAMM, ECONOMIC RESEARCH ASSOCIATES

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PART 1

INTRODUCTION, EVALUATION, CRITERIA AND FINDINGS

1.1 Introduction

The firm of G.M. Stamm, Economic Research Associates was retained by the City of Burlington to examine the economic and financial aspects of the selection of the most suitable site for landfill purposes as between two sites which have been put forward . The economic and financial analysis was to be conducted within the larger study program involving numerous other components and a number of consulting firms. These included hydrogeology, planning, and transportation, among others.

- The economic and financial evaluation was tied to the assessments made in the other components, and required from these other components the majority of the input data needed to perform the financial evaluation.

- It became clear very early on that the analysis of the other components would develop and change as the work progressed, and that the cost data would be revised and updated as the work was undertaken. At the beginning of any research program there are unresolved issues that firm up as the work progresses. At various stages, conclusions are arrived at and issues are resolved. **The decision was taken to develop a computer model which would allow the process of financial evaluation to be re-iterated as necessary; and to evaluate alternatives as presented.**

This report sets out the basic methods employed in building the model and the actual applications of what we have termed the **Financial Landfill Location Evaluation Model**.

The model makes it possible to ascertain the financial outcome differences as between alternative sites, and trace the effects on the outcome of different sets of cost estimates.

- It is important to stress that the outcome of the model is a function of the validity of (a) the approach used, (b) the application of concepts employed, and (c) the input data fed into the model. Of itself the model possesses no inherent evaluation function. It is **not** a "black box" based on preconceived evaluation criteria.

1.2 The Use of the Model in the Evaluation Procedure

Any evaluation procedure requires the establishment of "criteria" for judgement as to the preferred solution over the non-preferred solution. Generally, these criteria are then "weighted" to permit a sorting out of the value judgements used in decision-making. (For a comparison of evaluation criteria as applied by Stamm versus Watson, see Appendix B).

- Generally speaking, the use of a "cost" consideration as a method of placing a "value" on any particular set of public objectives permits an individual or a group to sort out the preferences and alternatives based on examining the "cost" of each objective. **This is convenient because it permits the distillation and aggregation of value-based objectives into a common element of dollar cost.**

Consumers, businesses and governments are constantly engaged in the process of "optimizing" the value received for the expenditure of specific budgets, or conversely **minimizing the financial costs associated with meeting certain value objectives.** (Conventional economic methods are replete with alternative technical approaches to simulate "optimization" that takes place in the economy.)

The application of this method to the matter of determining the preferred choice with respect to the two landfill sites is a three step exercise.

1. A set of "sufficiency" criteria with respect to all physical and social aspects of the alternatives must be created as "design standards".

2. Both of the alternative solutions, Site D and Site F, should be "designed" to operate at the level of sufficiency set out by the criteria, and those designs should be "costed". At this stage, it will have been established that both sites are capable of being used for the intended purpose provided enough money is spent. It will also have been established that **the cost expenditures will have brought the two sites to a position of providing essentially equal value benefit with respect to the landfill function.** From the perspective of the public, the service received (i.e. the management of the waste generated) is the "same" regardless of which site is chosen. (There may yet be a few differences for which costs cannot be established, but the major environmental matters can be related to costs).

3. The third step is to determine which solution, of those which derive more or less equal benefit value to the public, is the **least costly** in true economic cost terms. That must now be the preferred solution. In the event that the two sites should come out to cost the same, then either choice is suitable, as with a more or less equal benefit value, and more or less equal costs, neither site can be preferred to the other.

The important point is that the analysis of costs is juxtaposed to the consideration of all other public objectives. **Lower cost is not a distinct objective by itself, and is not meaningful without regard to what the lower cost implies in terms of the achievement of public objectives.** Lower costs is only meaningful in the context of reaching the same set of public objectives through alternative solutions.

1.3 Process of the Model: Managing the Possibilities

In evaluating the alternative sites, it is necessary to consider varying sets of realistic inputs with respect to:

- the level of waste generation,
- the future distribution of waste origin,
- the long term economic conditions,
- the operating cost conditions,
- the capital cost conditions.

The number of possible outcomes, using realistic alternative sets of input factors can quickly become very large.

For example, if there are only four data inputs in each set , each with three different possibilities in the range (high, medium and low) then there would be 81 distinct outcomes.

The number of possible outcomes increases exponentially with each addition of a new factor.

- *The problem becomes one of properly "managing" the evaluation process by restricting the discussion of issues to only those realistic alternatives pertaining to the most important factors.*

To achieve this goal, it is necessary to determine how sensitive the results are to specific sets of input data. This will isolate the cost elements that are most important. While some factors are important under all circumstances, others are important under specific conditions only. For example, the issue of interest rate with respect to debenturing is important insofar as there are large sums of up-front costs. Equally significant to the evaluation process is the determination of the relevant ranges of value for each of the selected cost elements. The preferred site is highly dependent on the alternatives examined and on the assumptions made.

1.4 A Summary of Salient Findings

In summarizing the cost comparisons, including the consideration of the time trajectories of nominal costs and financing through debentures, a number of the cost areas turned out to be most important.

1. One major area is the matter of the need for a clay liner at Site F, and the expense of that liner. If the public objectives with respect to protection of the environment cannot be accomplished without the construction of a clay liner, then the degree of cost difference to meet the more or less **equal** level of public benefit will be high.

2. The capacity constraints, and the expansion potential of the two sites, together with the matter of the proposed Energy From Waste

(EFW) Plant have a major bearing on the economic analysis. **If the EFW plant were to materialize, the transportation economics would be very much dependent on the location of the EFW plant.** Alternatively, if the EFW plant were not to materialize the transportation economics would be very different.

In this study we have drawn our findings on the prudent assumption that all of the waste would require transport to the landfill selected, and that the EFW plant would not be in place during the projection period.

- Public policy on these types of issues must consider the economic cost of "risk". With EFW technology in a formative stage of development; with the potential waste treatment as a proportion of total waste not established; with the matter of optimal location for such a facility not dealt with; with the disposition of the treated waste not determinable; with the transportation costs of the treated wastes not determinable, the assumption of such a plant must be considered as a very high risk. Prudence requires the assumption that the EFW plant will not be in place.

1.5 Recommendations

From the analysis conducted in this report is is clear that Site "D", near Milton enjoys very significant cost advantages over Site "F". While the actual differences in cost depend on the specific scenario adopted, the differences are on the order of $16.6 million in present value, without consideration of land value and off-site impact and $19.1 million including land values and off-site impact.

- We recommend the selection of Site D on the basis of the economic evaluation.

PART 2

DESCRIPTION OF THE MODEL

2.1 Introduction

This part of the report provides a review of the basic elements contained in the Financial Landfill Location Evaluation Model. The basic concept underlying the model, the calculation procedures, and the types of information required are discussed.

The entire process of financial calculations necessary for the evaluation of a landfill site has been programmed into the computer model.

- To compare the real cost of different landfill sites, the 'present value' of each candidate site is calculated.

Under different assumptions, the financial flow required for each of the candidate sites varies over the 20 year planning period. To achieve a meaningful comparison between the different sites, a common value base is required. The application of the concept of **Present Value** provides such a common value. By calculating the 'present value' of the stream of annual cash flow associated with use and operation of each of the sites, the total amount of money in **constant present day dollars** associated with Sites D and F over the respective lives of the sites can be calculated. Hence, the 'Present Value' method provides the means to compare the real costs between the different candidate sites. Since that concept underlies much of the formal model, the concept will be explained in some detail.

2.2 The Concept of Present Value

The "present value" of a "future value", (expressed in dollar terms for simplicity) is most easily explained as being the amount in dollars that has to be invested **today** in order to yield a given amount of dollars at a future date. The key to the determination is the rate at which the dollars can earn further dollars, an earnings rate expressed as a certain rate of interest. Figure 2.1 illustrates the concept.

Figure 2.1 illustrates the quantity of investment money which must be put into an interest-bearing investment at the end of 1987 in order to grow to the **future value** of $1,000 at the end of 1991. This investment amount varies very significantly according to the rates of interest. The sum required will be much higher at a constant interest rate of 5% versus 10%.

At 5% interest rate, $814.51 is required in 1987 but at 10%, this amount is only $656.10. This difference of almost 20% in present value is based on a four year period. The difference becomes very much larger over a period of 20 years.

- The key is that any **future** expenditure can be readily converted into a **present value,** through the use of a "discount" rate. A future "stream" of nominal dollar expenditures can similarly be calculated into a single present value.

2.3 Procedures of the Model

The **sequential operations** of the model is shown in a flow chart in Figure 2.2. There are four main components which must be dealt with:

1. projection of the amount of waste by zone and total,
2. haul cost of waste,
3. capital costs and,
4. operating costs.

In order to take into account the complexities involved in the proper calculation of each of these costs, a calculation procedure has been developed, and a "module" program produced. The calculation relationships around which the model is constructed can be explained with the discussion of each "module" described below.

2.4 Projection of the Amount of Waste by Zone and Total

The first module projects the total amount of waste generated by "zone", and the second module estimates the haul cost associated with transporting this waste to the landfill site. For comparative purposes, calculations for this analysis have been made using a similar zone structure as applied by the Region (see Figure 2.3).

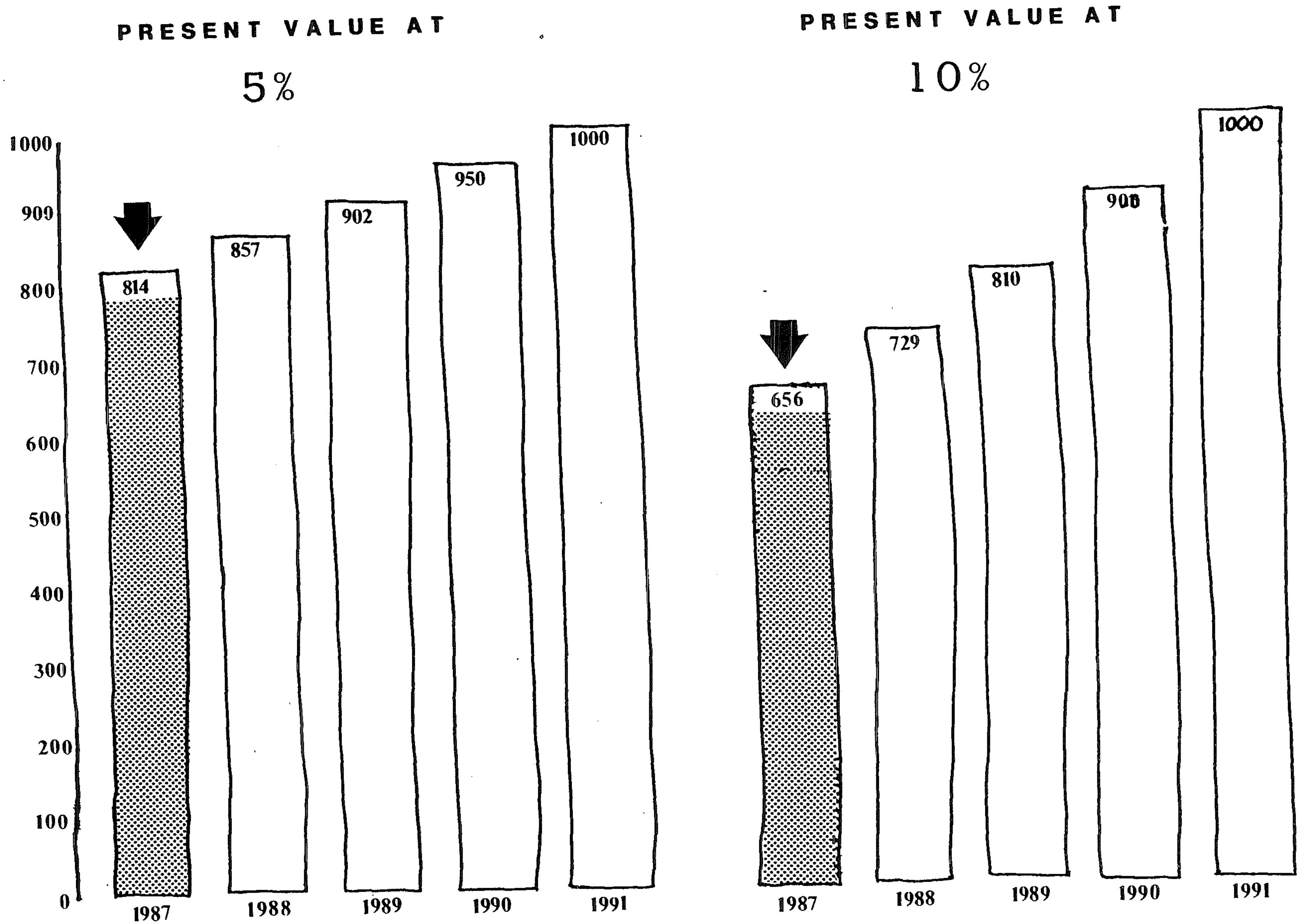


FIGURE 2.1
IMPACT OF INTEREST RATE ON PRESENT VALUE

FIGURE 2.2
FLOWCHART OF THE MODEL

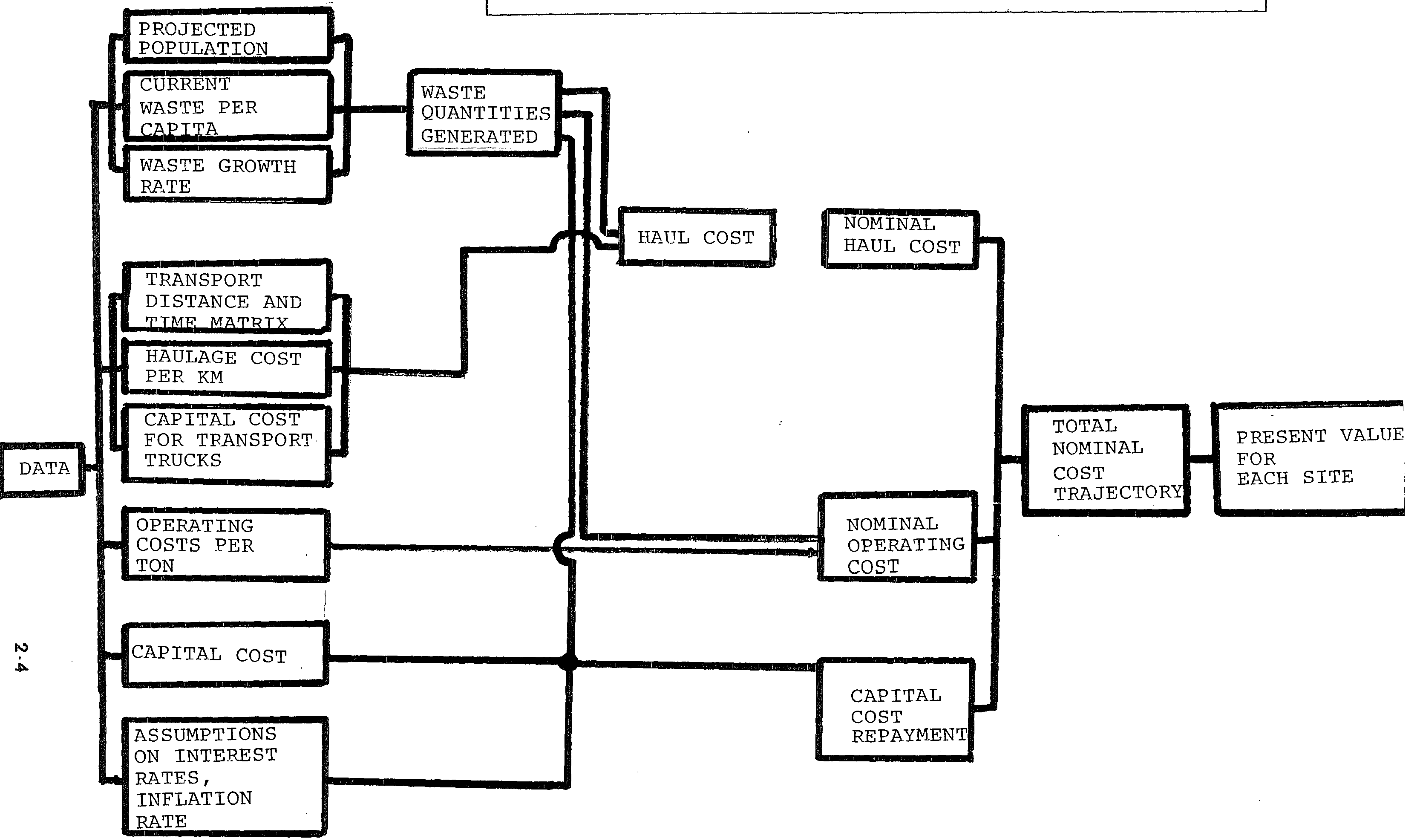
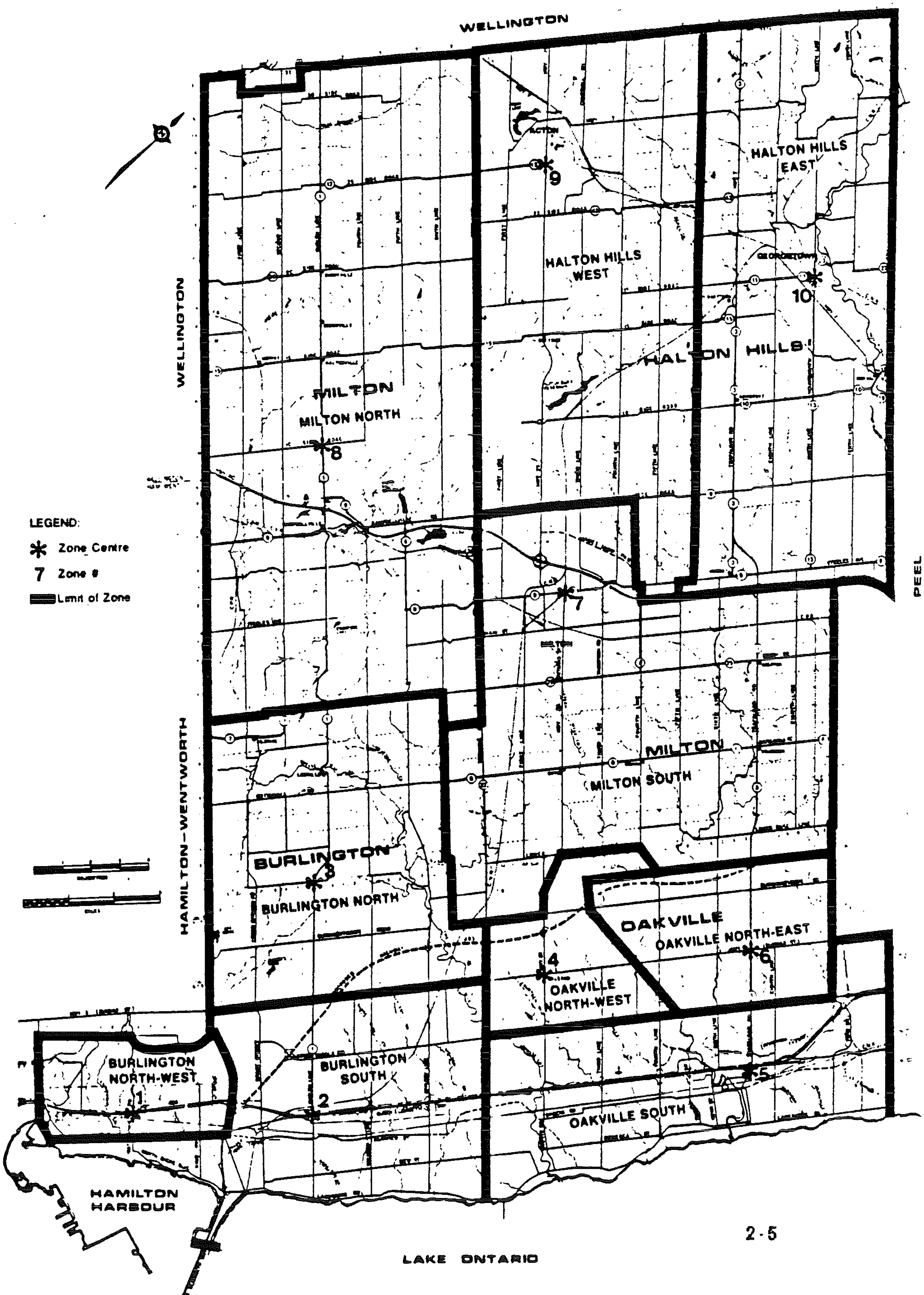


FIGURE 2.3
ZONE STRUCTURE OF THE REGION



The total waste generated over the time period of the projection by zone is a function of:

- the size of the total population by zone by year,
- current waste generation rate per capita,
- future growth of waste generation per capita.

The use of population to estimate the level of waste generated is a proxy variable insofar as waste is actually related to the type of economic function being carried out on an area of the land use. It is possible, and probably more accurate to create a waste generation model which takes the economic land use rather than the population as the basic starting point.

* We have adopted the simplistic approach of using the population as a proxy variable simply to facilitiate comparisons with work done by the Region of Halton.

Clearly the amount of waste generated per capita is not constant, but something which changes fundamentally with the economic standard of living.

* Just as the rising income per capita brings about increases in the purchase of goods and service, the rising income brings about the increase in waste generation per capita as the increased purchases are depreciated into waste.

* Moreover, when a region grows and becomes more self contained with respect to a fuller range of urban services, the "centre-periphery" effect has to be taken into account and the waste generation level will rise disproportionately.

A trajectory of growth rates in waste generation per capita is required for the model.

2.5 Haul Cost Calculations

Ultimately the calculation of the haul cost is a function of three major elements:

(i) the amount of waste to be hauled,
(ii) the total haul distances and times, and
(iii) the cost of the haulage over the distances established.

The haul cost is a function of the total amount of waste which must be hauled from each zone and the cost per distance and time unit of hauling the waste. It is therefore dependent upon the information from the above and:

- transport distance and time matrices,
- operating haul cost per tonne-km for distance related costs,
- operating haul cost per tonne-minute for time related costs,
- capital cost for trucks.

This analysis can be handled through either the direct application of an algorithm which tallies the labour hours, wage rates, fuel requirements, fuel prices and other actual costs, or through a simplified algorithm which uses a cost per distance unit and/or a cost per time unit.

- The latter approach has been used to permit the input into the model of the Region's processed data, and therefore facilitate comparisons.

2.6 Capital Cost Calculations

To prepare either Site D or Site F, capital costs at the site will be incurred. Most of these will be incurred in the first phases of the project, while some will be incurred in subsequent years over a phased program.

The amount of capital costs is dependent on the type of design selected, the terrain at the site and other features; and the environmental and physical objectives stated in the environmental assessments. The elements contained in the capital cost calculation have been prepared by Conestoga Rovers and Associates consultants and a detailed list is presented in Part 3.

The list of costs includes such items as:

- road engineering works,
- site preparation,
- leachate collection system,
- clay liner,
- stormwater management,
- leachate forcemain,
- after-use development.

The module permits these capital costs to be divided into six broader categories which are then subject to changes as cost estimates change. The time trajectory of these costs are input. The actual capital injections needed over the course of the operation of the landfill sites will vary with inflation, and are therefore subject to the inflation trajectory used by the model.

- In order to generate a "present value" of the capital costs, the fact of municipal financing has to be considered. The capital cost module therefore includes routines which convert the capital costs into future payment schedules based on normal debenture practices. These can then be added to the nominal operating costs during the present value calculation procedure.

If "reserve" funds are used rather than debentures, the comparison is still completely valid. In effect the municipality will "forego" the interest earnings potential at the same rate as the municipal financing rate.

2.7 Operating Costs Module

The operations of the landfill site on a day-to-day basis require the normal operating costs exclusive of debt servicing and haul costs. There are two major groups of such costs: (i) fixed annual operating costs and (ii) variable operating costs.

These fixed operating costs are categorized and include:

- site preparation on a continual basis,
- leachate collection maintenance and extension,
- closure activities on a continual basis,
- liner extension on a continual basis, and
- after-use activities on a continual basis.

The level of each of these costs is **not** a close and direct function of the waste being processed, but rather a preset schedule of costs or a continuing cost variable independent of the level of waste being processed.

The "variable operating costs", i.e. those which are directly related to the volume of waste being processed, are left in a single category.

2.8 Summary of the Calculation Procedure: Present Value

In summary, the process of the model, set into operation, undertakes the following calculations:

1. exogenous population projections by zone by Census years are interpolated into single year projections; and then,

2. waste volumes by year by zone of origin are forecast based on zone population projections, the initial level of waste per capita and the annual waste growth rates, and then,

3. haul costs per ton by year are calculated from each of the zones to the landfill sites, from which,

4. the total haul costs by year for each site are calculated, and then,

5. the total for capital costs per year are summed, and the capital cost debt repayment schedule for each year for each site are calculated on a debenture basis,

6. and the on-site and off-site operating costs by year are calculated based on the annual volumes; and then,

7. the total of nominal cash flow associated with each site for each year is estimated where these include the inflation estimates; and,

8. the total of nominal cash flow by year is then discounted into a "real value" by the discount rate of inflation, and from which,

9. the "present value" for the full use of each landfill site operation is estimated using a real discount factor.

2.9 Output of the Model

The **output** of the model consists of a series of tables, for each iteration the following are shown:

- single year projected population by waste generation zones, (interpolated from the census year projections),

- total waste tonnage generated by year by zone,

- total and cumulative waste tonnage by year for both sites, showing waste hauled and landfilled,

- a matrix of the distances from the waste generation centroids of all zones to both landfill sites "D" and "F",

- a matrix of the time from the waste generation centroids of all zones to both landfill sites "D" and "F",

- a matrix of the haul cost per ton from all zones to both landfill sites,

- capital costs by year for both sites,

- operating cost by year for both sites, including variable operating costs based on the volumes processed,

- total haulage cost to each landfill site,

- interest and inflation trajectories used,

- capital cost repayment schedule, and

- the annual cost for each cost item in "nominal" and "real" dollar value, and,

- the **"present value"** associated with each site.

This full disclosure of the calculation process of the model facilitates the detailed evaluation of every step, the verification of the calculation procedure, and comparison with comparable analyses.

- Ultimately the results of each iteration of the model are distilled into two numbers, the **present value** of selecting Site D, and the **present value** of selecting Site F.

PART 3

THE INPUT DATA - A GENERAL DISCUSSION

3.1 Introduction

As pointed out earlier, specific information and assumptions are required as inputs in running the model. This section examines each of these inputs and gives a **brief summary** of the data used in the evaluation process. The following input factors are discussed:

- population projections,
- waste generation rates per capita,
- transportation costs,
- inflation interest rate assumptions,
- capital and operating costs, and,
- the impact of (i) source separation and (ii) Energy From Waste plants.

3.2 Population Projections

Both the growth of population and spatial distribution of that growth, are key factors to the cost evaluation.

For geographic reference, 10 waste generating zones were used in the Region's study for the assessment of the two landfill sites, Site D and Site F. This zone structure for population projections has been adopted only to facilitate the comparisons and analysis of costs with work done by the Region. The firm has prepared a set of population projections for the purpose of this and other studies (Exhibit B-801).

The method of undertaking independent population projections for each zone was based on the following considerations:

1. regional population projections based on the growth of the Toronto Region as a whole, with the Region of Halton as a major component of the "growth frontier",

2. a review of current Official Plans and capital works programs; (as a determinant of future growth possibilities),

3. a segmentation of the Halton Region into smaller projection zones to better estimate changes in population,

4. an examination of aerial photographs, to estimate land availability for future housing development, and

5. estimates of population change in existing developed areas of the Region.

A better summary discussion of the population projections are to be found in Stamm's Population Projections for Halton Region Report (Exhibit B-801).

On the basis of the population projection by each zone, and the use of a projection of waste per capita, the amount and distribution of waste that will be generated in Halton Region can be estimated.

- It is our view that the population used in the Region of Halton's estimate of waste quantities is too low (Exhibit H-15). More recent projections by the Region anticipate a higher population growth for the year 2011.

While our population projections are generally higher than those used by the Region for its waste quantity estimates, a major discrepancy exists in the distribution of this population among the municipalities.

- The Region's projection shows the City of Burlington maintaining a larger share of the Region's population than Oakville for 2011. By contrast, our projections indicate that Oakville would absorb a larger share of the population growth and would likely reach a population level higher than Burlington in the future. The growth in Oakville would take place by virtue of its adjacency to Mississauga, with its rapid economic and employment growth impact on Halton, the opening of Highway 403, together with the impending land shortages in the Mississauga area.

* **In sum, the projections are similar with respect to absolute growth in both Burlington and the rest of the Region, but differ with respect to the growth in Oakville.** Stamm medium and high projections show that Oakville would reach a higher total population than Burlington in the year 2011.

Three sets of population projections for Halton Region have been prepared by Stamm, a low, medium and high projection. These are shown in the Table 3.1, Table 3.2 and Table 3.3.

* A total population of 404,807 for 2011 is projected for Halton Region in the low projection set. Much of the growth experienced in the Region will take place in Oakville and to a lesser extent in Burlington.

* A somewhat higher estimate, of 444,317 for 2011, is projected for the Region in the medium set. Again, Oakville will assume high growth and larger in proportion than the first set. The other municipalities will assume slightly higher growth estimates as well.

* The last projection set would see growth in Halton Region reaching 492,000 by 2011.

These projections can be compared to a number of set of projections prepared by the Region of Halton.

The December 1985 population projections prepared by Region's Planning Department put 389,000 as the "medium" estimate for Halton for 2011 (Exhibit H-15). The Region's "high" projection set would see 438,000 exceeded by the year 2011. The March 1987 population projections prepared by the same source puts 403,900 as the "medium" projection and 459,000 as the "high" projection for 2011 (Exhibit B-90). For comparative purposes, we undertook to distribute the area municipal totals into the 10 zones in order to utilize the Region's data for comparative purposes.

Table 3.1

Stamm Population Projection Low

		1986	1991	1996	2001	2006	2011
1	Burlington NW	5147.	6000.	6950.	8500.	8500.	8500.
2	Burlington S	107838.	118420.	128950.	136440.	143300.	146200.
3	Burlington N	3688.	4240.	4880.	5500.	6300.	7500.
	Burlington	116673.	128660.	140780.	150440.	158100.	162200.
4	Oakville NW	321.	350.	400.	500.	600.	1000.
5	Oakville S	83006.	90150.	96100.	98200.	99500.	101000.
6	Oakville NE	3780.	11000.	21000.	30500.	39400.	52300.
	Oakville	87107.	101500.	117500.	129200.	139500.	154300.
7	Milton S	26937.	27400.	27962.	29744.	31525.	33257.
8	Milton N	5100.	5600.	5900.	6300.	6700.	7150.
	Milton	32037.	33000.	33862.	36044.	38225.	40407.
9	Halton Hills W	12000.	13400.	14800.	15600.	16200.	16400.
10	Halton Hills E	23570.	25600.	28400.	29900.	31000.	31500.
	Halton Hills	35570.	39000.	43200.	45500.	47200.	47900.
Total Halton Region		271387.	302160.	335342.	361184.	383025.	404807.

Source: Statistics Canada 1986
Projections by Stamm Economic Research Associates

TABLE 3.2

Stamm Population Projection Medium

		1986	1991	1996	2001	2006	2011
1	Burlington NW	5147.	6250.	7120.	8500.	8500.	8500.
2	Burlington S	107838.	127286.	134111.	141274.	145500.	150328.
3	Burlington N	3688.	4640.	5580.	6528.	7500.	8600.
	Burlington	116673.	138176.	146811.	156302.	161500.	167428.
4	Oakville NW	321.	1137.	6008.	9641.	14867.	20093.
5	Oakville S	83006.	93007.	98169.	100054.	101000.	103434.
6	Oakville NE	3780.	14663.	25335.	42379.	51892.	61405.
	Oakville	87107.	108807.	129512.	152074.	167759.	184932.
7	Milton S	26937.	27400.	28316.	30613.	32885.	35257.
8	Milton N	5100.	5600.	6200.	6950.	7725.	8400.
	Milton	32037.	33000.	34516.	37563.	40610.	43657.
9	Halton Hills W	12000.	13400.	14800.	15700.	16400.	16600.
10	Halton Hills E	23570.	25600.	28400.	30200.	31300.	31700.
	Halton Hills	35570.	39000.	43200.	45900.	47700.	48300.
Total Halton Region		271387.	318983.	354039.	391839.	417569.	444317.

Source: Statistics Canada 1986
Projections by Stamm Economic Research Associates

TABLE 3.3

Stamm Population Projection High

		1986	1991	1996	2001	2006	2011
1	Burlington NW	5147.	6400.	7320.	8500.	8500.	8500.
2	Burlington S	107838.	128960.	136400.	142950.	151600.	160000.
3	Burlington N	3688.	4840.	5980.	6800.	8100.	9500.
	Burlington	116673.	140200.	149700.	158250.	168200.	178000.
4	Oakville NW	321.	2137.	8008.	13500.	21050.	30566.
5	Oakville S	83006.	93007.	98169.	100054.	101000.	103434.
6	Oakville NE	3780.	18663.	28995.	43330.	57665.	70000.
	Oakville	87107.	113807.	135172.	156884.	179715.	204000.
7	Milton S	26937.	30050.	32600.	36000.	39800.	43257.
8	Milton N	5100.	6000.	7654.	8569.	10000.	11743.
	Milton	32037.	36050.	40254.	44569.	49800.	55000.
9	Halton Hills W	12000.	13600.	15100.	15900.	17100.	18300.
10	Halton Hills E	23570.	26600.	29700.	31150.	34000.	36700.
	Halton Hills	35570.	40200.	44800.	47050.	51100.	55000.
Total Halton Region		271387.	330257.	369926.	406753.	448815.	492000.

Source: Statistics Canada 1986
Projections by Stamm Economic Research Associates

In the "Urban Structure Review Report" (Exhibit B-542) prepared by IBI Group for the Region in November 1987, it is suggested that a range of 386,000 to 474,000 people for Halton is anticipated for 2011. The "most likely" estimate for 2011 is 430,000.

- The "medium" projection prepared by Stamm at 444,317 for 2011 is just slightly higher than this "most likely" estimate of 430,000.

It should be noted that the issue of social "risk" would suggest the use of "high" projections because of the environmentally and economically adverse possibilities associated with having inadequate capacity. The use of a "high" figure would at best simply extend the life of the capacity planned, because it is certain that waste will still be produced past the horizon year.

3.3 Waste Generation per Capita

The rate of waste generation is an important component in the economic evaluation of landfill sites. Waste generation includes the waste product of households as well as that of industrial and commercial activities. As different types and quantities of waste are generated by various uses, the residential, commercial, and industrial mix in a community can alter waste generation rates significantly. For example, waste generation rates in rural areas are generally lower than those of urban areas. The scale and type of commercial and industrial activities in an urban area also affect the amount of waste produced.

A more detailed discussion of waste generation rates can be found in Stamm's Waste Generation Report (Exhibit B-833), which provides some guidelines to Ontario experience. There are also scientific journal articles which deal with the matter of income generation in relation to such variable as household incomes.

- With respect to residential waste, a **positive** relationship between household income levels and waste generation has been proven. An increase in incomes would generate more wastes, as a greater consumption level for goods would accompany rising incomes. However, rising incomes do not necessarily lead to proportional increases in the generation of solid wastes. Thus, a 10 percent rise in income does not necessarily result in a 10 percent increase in the amount of waste produced.

- Both commercial and industrial wastes are related to the level of economic activites as well as employment in an area. Offices, restaurants, shopping centres and food retail stores are the main sources of commercial waste.

While more waste would be produced with increased employment in an area, higher levels of services would draw greater number of consumers and subsequently produce more waste. Thus, regional level shopping centres that serve a larger trade area would generate more waste per square foot of retail space than a local shopping strip. Additionally, periods of economic prosperity will tend to generate more waste than would be anticipated during a recession.

The rate of waste generation is important in determining the quantity of waste likely to be produced in the Region of Halton. Per capita waste generation rates are the simplest estimates of waste generation levels in an area. This is calculated by summing the total amount of waste being landfilled and the amount source separated and dividing this sum by the total population. All solid wastes generated in an area, whether produced by residential, industrial or commercial establishments, are included in the per capita rate. Measurements of waste generation pertaining to different sectors are not as readily available. Generally, commercial and industrial waste rates are expressed on a per employee basis.

While per capita waste rates do not necessarily give the best estimates for total waste generated in an area, they do reflect implicitly the level of waste generated by the different sectors. For example, per capita generation rates are significantly higher in Peel Region than in Halton. In 1986, the annual rate for Peel was 1.16 ton/capita and 0.874 ton/capita for Halton (excluding source separation).

- This difference can be explained in part by different levels of industrial activity, square footage of office and retail space in the two regions, and other consumption patterns. At present, Peel Region has a more developed urbanized economic activity pattern than does the Region of Halton. As Halton Region takes on a greater range of activities domestically the waste generation rates pre capita would rise considerably.

- The level of waste generation in Halton will not be constant over the 20-year planning horizon for the landfill site. Given the rise in disposable income, the increase in commercial activity anticipated in the region, both residential and commercial waste generation rates would likely assume a higher level. We have assumed a very low growth rate in order to be conservative.

- Given the time lag involved in establishing new landfill sites, and the lengthy environmental assessment period, a higher estimate of the rate of waste generation should be used.

For the above reasons, the following waste generation scenarios for Halton Region have been applied in our analysis. The basic for these rates are discussed in our Waste Generation Report and are further discussed in the Conestoga-Rovers and Associates report entitled EVALUATION OF HALTON REGION'S WASTE QUANTITY PROJECTION (Exhibit B-835).

- A starting waste generation of 0.9 ton per capita has been recommended for 1988.

- To account for the centre-periphery effect, an increase of .01 ton per capita is added to the base rate for the next 10 years.

- To reflect the forseeable rising income levels, an additional rate of increase ranging from 0.5% to 1.0% per year is anticipated.

The waste generation rates for three different scenarios, low, medium and high, based on the above considerations are shown in Table 3.4.

3.4 Transportation and Haul Costs

Haulage costs are costs associated with transporting the waste from where it is being generated to the disposal site. **Collection costs are not included in the haulage cost calculations.** As discussed earlier, there are ten waste generating zones defined for the Halton Region. The haulage cost component for each of the

TABLE 3.4

WASTE GENERATION RATES FOR HALTON REGION 1988-2008
THREE SCENARIOS

Year	Low Tons per Capita	Medium Tons per Capita	High Tons per Capita
1988	.900	.900	.900
1989	.915	.917	.919
1990	.929	.934	.938
1991	.944	.951	.958
1992	.959	.968	.978
1993	.973	.985	.997
1994	.988	1.003	1.018
1995	1.003	1.020	1.038
1996	1.018	1.038	1.058
1997	1.034	1.056	1.079
1998	1.049	1.074	1.100
1999	1.054	1.082	1.111
2000	1.059	1.090	1.122
2001	1.065	1.098	1.133
2002	1.070	1.107	1.144
2003	1.075	1.115	1.156
2004	1.081	1.123	1.167
2005	1.086	1.132	1.179
2006	1.092	1.140	1.191
2007	1.097	1.149	1.203
2008	1.102	1.157	1.215

candidate sites was based on the distance and amount of time required to haul waste from the centroid of each waste zone to the alternate landfill sites.

- Information on haul route time and distance calculations from each of the ten zones to Site D and Site F has been provided by McCormick Rankin in a report entitled TRAFFIC IMPACT ASSESSMENT HAUL ROUTE TIME AND DISTANCE and is shown here on Table 3.5.

- The times and distances listed are based on haul routes outlined in the Region's Transportation Analysis Reports for Site D and Site F (Exhibit H-32 and H-33). The time and distance matrices for the two landfill sites are assumed to be constant during the entire period of landfill operation.

For comparative purposes, we have used a similar transport cost structure to that outlined in the Region's analysis. Haulage cost is separated into three components: labour cost, fuel and maintenance cost, and capital costs of vehicles. Fuel and maintenance costs are based on two-way trip distances from waste generating zones to landfill sites. Labour costs and capital costs of vehicles are calculated from two-way trip times with an additional 15 minutes drop-off time at the site included. All costs were assumed to increase directly with inflation.

Waste generated in the Region is being hauled both privately and municipally. Generally, municipalities are responsible for hauling residential waste and some commercial waste. Although private haulers have contracts mostly with retail, commercial and industrial establishments, they are responsible for hauling some residential waste generated in large apartment buildings. This overlap makes it difficult to estimate wastes generated by the different sectors.

- That would only be significant for the analysis of the Region's cash flow. The actual **economics** should properly disregard whether the public pays for these services through a private sector or public sector vehicle. The decision as to which site should be chosen should be transparent with respect to that issue, and therefore the total haul costs have been included.

TABLE 3.5

TRANSPORT MATRIX

(Time and Distance Matrices from centroids of zones to landfill site)

Waste Zone		SITE D TIME (mins.)	SITE D DISTANCE (km.)	SITE F TIME (mins.)	SITE F DISTANCE (km.)
1	Burlington N.W.	20.2	24.7	1.4	1.5
2	Burlington S.	12.0	17.6	6.5	5.6
3	Burlington N.	16.8	19.5	14.5	13.7
4	Oakville N.W.	4.6	5.7	14.9	17.6
5	Oakville S.	12.6	17.9	16.7	21.8
6	Oakville N.E.	9.2	13.0	20.0	24.8
7	Milton S.	8.7	7.6	27.4	30.9
8	Milton N.	18.3	19.9	28.2	29.8
9	Halton Hills W.	21.9	23.4	41.4	46.7
10	Halton Hills E.	24.0	26.0	38.3	49.8

Source: McCormick Rankin

The City of Burlington has reviewed haulage rates per distance and time unit applied by the Region and has concluded that those are within the range of reasonable estimates. On their instruction, to facilitite comparisons, we have applied the same haulage cost structure as used in Region's Economic Report (Exhibit H-45). The data on which the calculations are based is shown on Table 3.6.

The following equation is used to calculate the haulage cost per tonne from each zone to the different landfill site.

Haulage Cost = (haul distance X gas and maintenance rate)
+ (haul time X labour rate)
+ (haul time X capital cost rate)

The haulage cost is expressed as a rate per tonne, that is the cost required to haul one ton of waste from each of the waste generating zones to the landfill site. The haulage cost rate per ton is different for each of the zones to the respective landfill site. Given the uncertainty about future road improvements, this rate is assumed to remain the same for the entire operation period of the landfill site. Table 3.7 gives the haulage cost rate for each of the zones to the two candidate landfill sites. These rates are then multiplied with the total waste tonnage generated in each of the zones to give total haulage costs associated with the individual site.

3.5 Inflation and Interest Rates

Inflation and interest rate assumptions have major impacts on the financial projections because of the matter of debt service.

- Insofar as the provision of the waste disposal service will involve the use of borrowed capital, the cost of that financial lending service must be included and added to the present value of costs.

- As debentures in Ontario do not have a floating rate, hence, it is **not** appropriate to use a "real rate of interest" as the method by which this factor is included. Rather, it has a fixed rate, which enforces a specific nominal dollar schedule of payments. Regardless of subsequent changes in inflation, the schedule will

TABLE 3.6
TRANSPORT COST STRUCTURE

	Region ($ 1986)	Stamm Estimates ($ 1986) @
Gas and Maintenance distance in km x	$.10/km ton	$.1454/km tonne
Labour time in minutes x	$.06/ton minute	$.0872/tonne minute
Capital Costs time in minutes x	$.03/ton minute	$.0436/tonne minute

Region's cost structure was outlined in Watson's letter of August 24, 1987.

@ Each of these costs has been converted to cost per tonne. These costs were then increased by 15% to account for overheads, and on top of that, another 15% was added to reflect minor hauler costs.

TABLE 3.7

TRANSPORT COST MATRIX ($ PER TON)

FROM EACH OF THE ZONES TO THE CANDIDATE LANDFILL SITES

	SITE D	SITE F
ZONE 1	14.55	2.51
ZONE 2	10.70	5.26
ZONE 3	12.59	9.97
ZONE 4	4.72	11.24
ZONE 5	11.12	13.21
ZONE 6	8.62	15.13
ZONE 7	6.51	18.55
ZONE 8	13.30	19.17
ZONE 9	15.12	27.15
ZONE 10	17.60	29.23

remain, therefore causing "real rates of interest" to adjust constantly.

Given that up-front costs for capital outlays are to be debentured, the trajectory for interest rates (the debenture debt rates) would alter the cost repayment schedule quite significantly. The higher the interest rate and inflation, the greater the annual repayment becomes. The equation used to calculate the capital cost repayment schedule is shown below. Capital costs that are incurred after the initial year are converted into nominal dollars first and this amount then becomes the debenture.

$$\text{Payment} = \frac{\text{nominal capital cost}}{\dfrac{1-(1+\hat{i})^{-N}}{(\hat{i})}}$$

where N = the number of years for the debenture
$\hat{i}$ = (1 + interest discount rate at year m)
x (1 + inflation discount rate at year m) - 1
m = the year at which debenture occurs

The matter of inflation is also critical for the selection of an appropriate "discount rate" to be used for the process of calculating the present value.

- The present value economic discount rate is a "real" rate, and should be applied to future values which are "real". The process is handled in the model by a "joint" discounting which incorporates both the real discount rate and the inflation rate.

The following equation has been used to convert to present value the stream of total annual cash flows associated with the individual landfill site. Included in the total annual cash flow is the capital cost repayment, nominal operating costs, and nominal haulage costs.

$$\textbf{Present Value} = \sum_{\text{year } i} \frac{\text{total annual cash flow at year } i}{(1+\text{inflation discount rate})^{i-1} * (1+\text{economic discount rate})^{i-1}}$$

Reasonable economic assumptions for inflation and interest rates have been utilized in the analysis. Inflation is assumed to be 4 % annually, while the real interest rate is assumed to be 5 % over the entire study period. Thus the joint discount rate is 9.2%.

3.6 Capital and Operating Costs

The Region is responsible for both capital and operating costs associated with the development of landfill sites. These costs include: site acquisition, site preparation, site approval costs, after-use, leachate collection, leachate removal and site services, to name a few of the largest cost items. Table 3.8 and Table 3.9 give a full list of capital and operating costs that are included in our economic analysis for Site D and Site F.

The site acquisition cost has been estimated for the City of Burlington.

- The matter of "land" costs has been dealt with here as a nominal dollar economic value. The market value of land does **not** in many cases represent the actual **long term** economic value. The use of the site aquisition costs are conceptually only adequate if they were truly representative of long term economic use potential. The more approriate method of including "land" costs is to examine the "alternative economic use" of the land. This conforms to the "opportunity cost" concept of economic analysis methods.

As directed by City of Burlington, costs for off-site road improvement, landscaping for buffer, archaeological investigations and post 1986 approval costs employed are the same as those outlined in the Region's Economic Report (Exhibit H-45, p.2-3 and p.3-3). Except for the approval costs, these are minor costs. Post 1986 approval costs are the same for both sites.

The "after-use" costs associated with the sites have been provided by Ecoplans in a report entitled COMMENTS ON THE AFTER USE PROPOSED FOR SITES D & F. For Site D, this cost comprised of expenditures for sub soiling, fertilizer, etc., in order to prepare the site for agricultural after-use. For Site F, this cost included the cost for rehabilitation of the area to the current level of forestation.

Table 3.8

Capital Cost Summary
With CRA Design for Site D

		Cost (in constant $1986)
1.	Clearing, Grubbing and Cell 1 Excavation	1,525,000
2.	Leachate Collection System	2,793,000
3.	Service and Access Roads	910,000
4.	Site Services	968,000
5.	Stormwater Management	129,000
6.	Site Closure	2,790,000
7.	Leachate Forcemain	1,818,000
8.	15% Contingency	1,482,450
9.	15% Engineering	1,704,820
10.	Leachate Hauling or Forcemain operation	115,385
11.	Off-site Road Improvement Costs	130,000
12.	Landscaping for Buffer	150,000
13.	Approval Costs (post 1986)	1,538,000
14.	Archaeological Investigation & Salvage	66,000
15.	Land Acquisition Cost and Off-Site Impact	2,886,740
16.	After-Use	208,655

Sources:

Item 1A. to 9. - Conestoga-Rovers Associates

Item 11. to 14. - As set out in Watson's Schedule K Report (Exhibit H-45)

Item 15. - Prepared for the City of Burlington, Appraisal Report. Part 4 of this report elaborates on the high/medium/low scenarios of land acquisition costs

Item 16. - Ecoplans

Table 3.9

Capital Cost Summary
With CRA Design for Site F

(Costs in Constant $1986)

1A.	Clearing, Grubbing and Cell 1 Excavation	1,546,000
2.	Leachate Collection System	1,842,500
3.	Service and Access Roads	624,200
4.	Site Services	990,000
5.	Stormwater Management	150,000
6.	Site Closure	2,695,000
7.	Liner System	13,377,300
8.	15% Contingency	3,183,750
9.	15% Engineering	2,892,100
10.	Off-site Road Improvement Costs	-
11.	Landscaping for Buffer	100,000
12.	Approval Costs (post 1986)	1,538,000
13.	Archaeological Investigation & Salvage	89,000
14.	Land Acquisition Cost	6,763,582
15.	After-Use	3,050,991

Sources:
Item 1A. to 9. - Conestoga-Rovers Associates
Item 10. to 13. - As set out in Watson's Schedule K Report (Exhibit H-45)
Item 14. - Prepared for the City of Burlington, Appraisal Report. Part 4 elaborates on the high/medium/low scenarios of land acquisition costs.
Item 15. - Ecoplans, Alternative B, adjusted to $1986

The remaining items pertaining to capital costs and operating costs have been provided by Conestoga-Rovers & Associates (CRA). These costs are based on the site design recommended by that firm as set out in their design and operations reports.

The assumed timing for all costs are outlined in Appendix A. Dependent on the length of operation at the landfill sites, operating cost schedules vary accordingly. In the model, all costs that have to be paid up-front and debentured are counted as capital costs. Costs that are to be paid out of the Region's annual budget as the costs are incurred are treated as operating costs.

PART 4

A DISCUSSION OF THE RESULTS

4.1 Introduction

This part of the report discusses the results of the iterative operation of the financial evaluation model.

In order to evaluate the impacts of varying cost factors on the present value of the candidate landfill sites, a number of alternatives have been set up and tested. The major inputs have been allowed to vary, and the costs associated with each alternative have been constructed into input files. The model has then been operated to calculate the results in the manner discussed in Part 2.

The three different forecasts of waste quantities to be landfilled are not "input" into the model, but generated internally using the projections of population and the trajectories of waste generation growth per capita. Source separation rates, also supplied externally, are used to "discount" the waste being generated to that being hauled and landfilled.

For each case, the full set of capital and operating costs have been generated by the consultants retained by the City of Burlington to look at those matters. In all scenarios, capital and operating cost assumptions used are based on site design suggested by Conestoga-Rovers & Associates.

Conforming to our view that an EFW plant should not be assumed until the feasibility has been documented, and more definite plans made, we have assumed that an EFW plant will not be built within the period of use of the landfill.

Finally, since the landfill site planning aims at a given weight of waste, the cost analysis with respect to haulage and on-site costs is only taken forward to that period. Other costs, which will continue thereafter are calculated and applied.

4.2 A Note on the Number of Outcomes and Probability

Prior to discussing the results, it is important to divert to a short preamble on the difficulties associated with such an analysis.

- The number of permutations and combinations of "input" data and assumptions multiply the number of possible outcomes very rapidly. For example, if three factors are variable, and each has three possible values, then there will be a total of 81 outcomes to the analysis.

Very quickly the number of possible outcomes will have grown to a point at which organized discussion and review becomes very difficult. The emphasis must then move to finding a way to restrict the numbers of outcomes to (a) the more probable and (b) concentrate on those which deal with the more significant sets of input factors. If, for example, it can be shown that one of the three sets of factors has only a "minor" impact on changing the results, while the other two have a "major" impact, then one could restrict the subsequent discussion to the analysis of the impact of the more significant factors only, without the probability of the actual outcome lying outside the range discussed.

The determination of more significant factors is undertaken through the process of "sensitivity testing". The model can be repeatedly run while changes are made to only one variable while all others are held constant. This will establish the significance of the individual factors.

A subsequent step is to determine the realistic "range" of possible outcomes that have a reasonable **probability** of occurring. A common procedure used can be described as follows: For each of the input variables the reasonable "low" is used, and the computed result of using the "lows" is deemed to be a reasonable "low" outcome. At the other end, the reasonable "high" inputs are used, and the computed result using these inputs is deemed to be a reasonable "high".

- **It is critical to a sound evaluation of the results to recognize that the above, often used method is inappropriate.** The sequential "stringing" together of a set of input factors each with a relatively low probability of occurring will create a probability of the outcome which is very much lower than that of any individual inputs. Insofar as "probability" of outcome is a measure of "reasonableness", the outcome of "reasonable" inputs may not in fact be "reasonable.

For reference on this matter, see Mendenhall, Scheaffer, Wackerly, Mathematical Statistics with Applications, 2nd edition, Duxbury Press, 1981, pp 45 to 50. While we have not placed scientific probabilities on the likelihood of any of the input factors, the interpretation of the results must nevertheless bear the above discussion in mind in the decision process.

4.3 A Note on Assumptions with Respect to Source Separation and Contingency

Source separation and contingency affect the total of amount of waste that has to be hauled and landfilled. Three sets of assumptions have been made with respect to source separation. These sets have been constructed to be comparable to the assumptions made by Conestoga-Rovers in their report entitled Evaluation of Halton Region's Waste Quantity Projections. The first set, consistent with the high waste estimate to be hauled and landfilled assumes source separation of 9% in 1989 and 10% thereafter. The second set, consistent with the medium waste estimate assumes source separation of 9% in 1989, 10% in 1990, and 12% thereafter. The third set is consistent with the increasing rate of source separation which increases to 15.9% by the year 2008.

In each case a 5% contingency after source separation has been used.

4.4 A Summary Comparison of the Three Scenarios

Table 4.1 outlines the summary of the "present value" calculations with respect to the operations of the two sites under the three different alternatives. **To this point the land cost and other "off-site impact" costs have not been considered.** Such costs are always expressed in "present value" terms and can therefore be added on.

The main findings are as follows:

1. In all cases the use of Site F is more expensive than the use of Site D.

2. The degree of difference in costs is in the range of $14.6 million to $16.5 million which represents a difference of between 27% and 30% as taken on the cost base of Site F.

TABLE 4.1

SUMMARY COST COMPARISON
Exluding Aquisition and Off-site Impact Costs)

SITES "D" AND "F"

(COSTS IN $,000)

ALTERNATIVE	SITE "D"	SITE "F"	DIFFERENCE
HIGH	55,525	72,011	16,486
MEDIUM	54,966	70,592	15,626
LOW	54,222	68,870	14,648

Source: STAMM ECONOMIC RESEARCH

This is a very large degree of difference in total cost for the provision of a public service with a more or less equivalent "benefit" to the public.

4.5 The Difference in the Cost Structure

For purposes of determining the most significant reasons for the differences in the overall costs, the comparison by cost category is shown for the use of Site D and Site F for the Medium case.

Table 4.2 summarizes the cost structures.

1. The differences in the capital costs category are minimal in relation to the overall difference.

2. The operating costs show a major difference of $12.0 million; the main reason for which is that the inclusion of the liner at Site F more than offsets the leachate collection system at Site D.

3. The haul cost differences alone are present valued at over $3.3 million, with Site F being more expensive.

For the alternative operations, the distribution of the cost differences are similar. It should be noted that the transportation cost differences become somewhat more important as the population rises. With the "low" alternative the haulage cost differences account for $3.2 million while for the "high" alternative they account for a difference of $3.8 million.

4.6 Sensitivity Analysis

In order to isolate the more important factors which account for the significant differences in costs, a number of variations on the alternatives were tested. For purposes of this analysis, the matter of land acquisition costs and off-site impact costs were disregarded. Such differences would have to be added back in separately. This process led to the following observations, using the medium case as the basis:

TABLE 4.2
SCHEDULE "A"

PRESENT VALUE MATRIX FOR SITE D
(IN 1986 DOLLARS)

YEAR	CAPITAL COST REPAYMENT	TOTAL OPER. COST (NOMINAL)	HAUL COST (NOMINAL)	BALANCE	TOTAL NOMINAL COST	INFLATION DISCOUNT FACTOR	NOMINAL COST IN REAL $	INTEREST DISCOUNT FACTOR
1987	.0	.0	.0		0.	1.040	0.	1.050
1988	.0	.0	.0		0.	1.082	0.	1.102
1989	504850.0	1929892.0	2869242.0		5303983.	1.125	4715222.	1.158
1990	1029894.0	2466298.0	3095410.0		6591602.	1.170	5634530.	1.216
1991	1029894.0	5835523.0	3299368.0		10164780.	1.217	8354714.	1.276
1992	1029894.0	3237095.0	3561999.0		7828987.	1.265	6187364.	1.340
1993	1029894.0	3452179.0	3842950.0		8325023.	1.316	6326336.	1.407
1994	1029894.0	3681486.0	4144147.0		8855527.	1.369	6470650.	1.477
1995	1029894.0	3925930.0	4466947.0		9422770.	1.423	6620316.	1.551
1996	1029894.0	4186760.0	4813266.0		10029920.	1.480	6775858.	1.629
1997	1029894.0	4469423.0	5187056.0		10686370.	1.539	6941667.	1.710
1998	1029894.0	4770250.0	5586366.0		11386510.	1.601	7111984.	1.796
1999	525044.0	5057957.0	5958301.0		11541300.	1.665	6931411.	1.886
2000	.0	4721656.0	6353027.0		11074680.	1.732	6395358.	1.980
2001	.0	4288128.0	5549531.0		9837658.	1.801	5462506.	2.079
2002	.0	500085.6	.0		500086.	1.873	267000.	2.183
2003	.0	97394.9	.0		97395.	1.948	50000.	2.292
2004	.0	101290.7	.0		101291.	2.026	50000.	2.407
2005	.0	105342.4	.0		105342.	2.107	50000.	2.527
2006	.0	109556.1	.0		109556.	2.191	50000.	2.653
2007	.0	113938.3	.0		113938.	2.279	50000.	2.786
2008	.0	118495.8	.0		118496.	2.370	50000.	2.925
2009	.0	.0	.0		0.	2.465	0.	3.072
2010	.0	.0	.0		0.	2.563	0.	3.225
2011	.0	.0	.0	.0	0.	2.666	0.	3.386
PRESENT VALUE	5258291.0	23811720.0	25895850.0				54965860.	

SOURCE: STAMM ECONOMIC RESEARCH

TABLE 4.2
SCHEDULE "B"

PRESENT VALUE MATRIX FOR SITE F
(IN 1986 DOLLARS)

YEAR COST	CAPITAL COST	TOTAL OPER. (NOMINAL)	HAUL COST COST (NOMINAL)	BALANCE DISCOUNT	TOTAL NOMINAL COST IN	INFLATION DISCOUNT FACTOR	NOMINAL REAL $	INTEREST REPAYMENT FACTOR
1987	.0	.0	.0		0.	1.040	0.	1.050
1988	.0	.0	.0		0.	1.082	0.	1.102
1989	407996.1	2338902.0	3195343.0		5942240.	1.125	5282631.	1.158
1990	1093865.0	4429252.0	3442627.0		8965744.	1.170	7663957.	1.216
1991	1093865.0	5064010.0	3664851.0		9822726.	1.217	8073567.	1.276
1992	1093865.0	5370552.0	3974176.0		10438590.	1.265	8249774.	1.340
1993	1093865.0	5695669.0	4305903.0		11095440.	1.316	8431622.	1.407
1994	1093865.0	6041033.0	4662343.0		11797240.	1.369	8620131.	1.477
1995	1093865.0	6407897.0	5045192.0		12546950.	1.423	8815327.	1.551
1996	1093865.0	6895829.0	5456789.0		13446480.	1.480	9083966.	1.629
1997	1093865.0	7460568.0	5906262.0		14460690.	1.539	9393395.	1.710
1998	1093865.0	7664283.0	6387632.0		15145780.	1.601	9460014.	1.796
1999	685868.8	8095707.0	6840381.0		15621960.	1.665	9382148.	1.886
2000	.0	5680433.0	7321821.0		13002250.	1.732	7508482.	1.980
2001	.0	5105698.0	6419655.0		11525350.	1.801	6399623.	2.079
2002	.0	6004832.0	.0		6004832.	1.873	3206031.	2.183
2003	.0	68176.5	.0		68176.	1.948	35000.	2.292
2004	.0	70903.5	.0		70904.	2.026	35000.	2.407
2005	.0	73739.7	.0		73740.	2.107	35000.	2.527
2006	.0	76689.2	.0		76689.	2.191	35000.	2.653
2007	.0	79756.8	.0		79757.	2.279	35000.	2.786
2008	.0	82947.1	.0		82947.	2.370	35000.	2.925
2009	.0	.0	.0		0.	2.465	0.	3.072
2010	.0	.0	.0		0.	2.563	0.	3.225
2011	.0	.0	.0	.0	0.	2.666	0.	3.386
PRESENT VALUE	5527279.0	35813400.0	29251730.0				70592410.	

SOURCE: STAMM ECONOMIC RESEARCH

1. In the event that no liner were required at Site F, the cost comparison changes. In that case, the "present value" of the use of Site F exceeds that of Site D by an amount of $4,695,440.

2. The variation of inflation rates leaves the relative financial position unaltered provided that the same constant rate is applied throughout the period of the analysis.

3. Varying the "real rates of interest" upwards has the effect of increasing the repayment charges for the debts incurred for both cases. However, that also reduces the overall "present values" because the applied discount rates are increased. This leads to increased discounting. The relative difference between the present values of Sites D and F are affected also. With the medium scenario, but a real interest rate of 6% rather than 5%, the present value of the costs of Site F reduce to $65.0 million, those of Site D to $51.0 million, and the difference reduces to $14.1 million from $15.8 million, (excluding land acquisition and off-site impact costs).

4. To test the effect of the projections of waste per capita, the medium alternative was run with the high projection of waste per capita. The effect was that the present value of the costs are slightly higher for both cases, and the cost difference is marginally greater.

5. Finally, the sensitivity of the relative costs to distribution of population was tested. The test run used the Region's "high" population which is only slightly higher than the Stamm medium projection, but which shows a distribution skewed towards Burlington. That projection is discussed in the report entitled Population Projections for Halton Region (Exhibit B-801, p.4-8). All other inputs are those used for the medium alternative. The results show a present value of costs for Site F at $70.9 million, compared with those at Site D at $54.8 million, with a difference of $16.1 million. Clearly the differences of distribution of population do not significantly impact the cost within the period under consideration. This is so for two reasons. (1) First, the distance relationships to the two sites are not that dissimilar overall. (2) The variation in

distribution occurs with greater magnitude towards the end of the period, and those differences are subject to the greatest "present value" consideration. For that reason the transportation costs favour the use of Site D by an amount of $3.4 million.

The use of sensitivity testing shows that Site F remains the more economical alternative even if the assumptions and conditions are permitted to vary as noted above.

4.7 Land Acquisition Costs and Off-Site Costs

The land acquisition costs and off-site impact costs have been estimated by the appraisal firm of Davis, Hicks, O'Brian retained by the City of Burlington. The basis for those estimates will not be discussed in this report.

1. The off-site property value impact at Site D is set at $500,000, (Spring 1988 dollars) while there is no impact at Site F.

2. The land value at Site D is set at $2,571,000, while that of Site F varies from a low of $1,035,300 to a medium of $7,195,300 and a high of $9,895,300 (Spring 1988 dollars).

The net difference can be used to adjust the differences calculated above since these costs are stated in present value terms. The only adjustment necessary is the conversion to 1986 dollars; and a discount of 6% has been used for that purpose. In the medium case, these costs add (in 1986 dollars) $6,763,582 to the cost of Site F and $2,886,740 to the cost of Site D.

- With the inclusion of these costs, the "present value" of Sites D and F rise to $57,852,600 for Site D and $77,355,992 for Site F for the medium case. The difference in economic cost between the use of the two sites will have risen to $19.1 million under the assumption that the medium current market prices of the sites are an accurate reflection of the long term economic value of the lands.

If the higher value of land were used the difference would be commensurately more, while the use of the lower figure would reduce the difference.

4.8 Conclusion

Our conclusion from the analysis is that Site D is preferred to Site F from the viewpoint of the economic outcome. In coming to that finding, it should be re-iterated that the cost calculations **include** mitigation of the intangible factors as they are reflected in the land costs and off-site impact. As noted in Part 1, the decision-making process, if it accepts land acquisition costs and the off-site impact costs as a fair reflection of the social disruption and dislocation, should not double count those factors.

PART FIVE

A DISCUSSION OF TIPPING FEES

5.1 Introduction

The previous sections of this report examined the economic issues through the use of the present valuation of all of the defined economic costs associated with the landfill service. Another way of looking at the costs to the public (excluding the haulage cost), is the tipping fees that would be required to operate the landfill site.

- The "tipping fee" represents one of a number of methods through which the responsible authority can recover the costs of the landfill waste management operation. In essence, the fee represents the "price" paid for the service by the customer base of the service.

In this analysis, the tipping fee will be based on a valid flow of costs associated with the production of the service, distributed in a fair and equitable manner among the users of the service.

5.2 Calculation Procedure

The method used to determine the tipping fee schedule required for Halton Region involves the following steps:

1. The annual cash flow requirement in nominal dollars is established for the acquisition and off site impact costs on the basis that the costs will be met over a 10 year debenture period with a rate of interest charged at a rate of inflation at 4% and a rate of real interest of 5%, for a nominal rate of 9.2%.

2. The annual cash flow requirement of the capital costs are taken from the previous analysis of Part 4.

3. The annual operating cash flow requirement is taken from the same source, with the exception of the after use costs which will occur at the end of the period.

4. Finally a charge has been introduced which will act as a sinking fund and accumulate the funds to meet (i) the ongoing operating costs which will continue after the landfill has been completed, and (ii) the after-use costs.

5. These costs are added together to provide the annual nominal cash flow requirement, and the sum is divided by the total tons of waste landfilled in each year.

It should be noted that no "overhead" cost has been included. To that extent the tipping fee estimated will be below that actually required. However, since such overheads would be the same for either case, the difference as between the tipping fees estimated for Site D and those estimated for Site F will be the same.

5.3 A Discussion of the Results

The two sets of calculations which show the actual derivation of tipping fees are shown as Table 5.1 and 5.2.

The first column on each Table show the debenture payments required to meet the "medium" costs of the land acquisition costs and off-site impact costs. The second column shows the capital costs annualized while the third column shows the operating costs up to the end year of the landfill. The fourth column shows the annuity which would create the necessary funds to (i) meet the ongoing operating costs to the year 2008 for leachate collection, and (ii) meet the after-use costs. The amount has been estimated as a "fund value" as at the end year of the landfill lifecycle, and the annuity requirement has been based on that fund requirement assuming equal annual installments.

- It is clear from this analysis that the tipping fees necessary for the operation of Site F are much greater than that required for the operation of Site D. The results show that on average (unweighted), the tipping fees for the selection of Site F would be the order of 50% above those of Site D. These are for costs

TABLE 5.1
TIPPING FEE CALCULATION
SITE F

YEAR	AQUISITION REPAYMENTS	CAPITAL REPAYMENTS	OPERATING COST	AFTERUSE FUND	TOTAL CHARGES	WASTE LANDFILLED	COST/ TON
1989	1053072	407966	2338902	275093	4075033	262950	15.497
1990	1053072	1093865	4429252	275093	6851282	273135	25.084
1991	1053072	1093865	5064010	275093	7486040	280290	26.708
1992	1053072	1093865	5370552	275093	7792582	291578	26.726
1993	1053072	1093865	5695669	275093	8117699	303092	26.783
1994	1053072	1093865	6041033	275093	8463063	314889	26.876
1995	1053072	1093865	6407897	275093	8829927	326974	27.005
1996	1053072	1093865	6895829	275093	9317859	339384	27.455
1997	1053072	1093865	7460568	275093	9882598	352628	28.026
1998	1053072	1093865	7664283	275093	10086313	366120	27.549
1999	0	685868	8095707	275093	9056668	376420	24.060
2000	0	0	5680433	275093	5955526	386854	15.395
2001	0	0	5105698	275093	5380791	325687	16.521

TABLE 5.2
TIPPING FEE CALCULATION
SITE D

YEAR	AQUISITION REPAYMENTS	CAPITAL REPAYMENTS	OPERATING COST	AFTERUSE FUND	TOTAL CHARGES	WASTE LANDFILLED	COST/ TON
1989	449458	504850	1929892	45661	2929861	262950	11.14
1990	449458	1029894	2466298	45661	3991311	273135	14.61
1991	449458	1029894	5835523	45661	7360536	280290	26.26
1992	449458	1029894	3237095	45661	4762108	291578	16.33
1993	449458	1029894	3452179	45661	4977192	303092	16.42
1994	449458	1029894	3681486	45661	5206499	314889	16.53
1995	449458	1029894	3925930	45661	5450943	326974	16.67
1996	449458	1029894	4186760	45661	5711773	339384	16.83
1997	449458	1029894	4469423	45661	5994436	352628	17.00
1998	449458	1029894	4770250	45661	6295263	366120	17.19
1999	449458	525044	5057957	45661	6078120	376420	16.15
2000	0	0	4721656	45661	4767317	386854	12.32
2001	0	0	4288128	45661	4333789	325687	13.31

directly related to provision of the service, exclusive of overhead costs.

APPENDIX A

TIMING OF ALL COSTS

TABLE A2B

Distribution of Costs
CRA Costs
Site D: Scenario Stamm/CRA Recommended

Year	Clear, Grub, Exc	Leachate Collection System	Roads	Site Services	Stormwater Management	Closure	Leachate Forcemain	Annual Contingency
1987	0.	0.	0.	0.	0.	0.	0.	0.
1988	927734.	714469.	601738.	640090.	85300.	0.	0.	0.
1989	927734.	714469.	601738.	640090.	85300.	0.	0.	230000.
1990	15870.	354121.	0.	0.	0.	0.	0.	195000.
1991	15870.	354121.	0.	0.	0.	335915.	2311830.	195000.
1992	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1993	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1994	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1995	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1996	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1997	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1998	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
1999	15870.	354121.	0.	0.	0.	335915.	10000.	195000.
2000	0.	0.	0.	0.	0.	335915.	10000.	195000.
2001	0.	0.	0.	0.	0.	335915.	10000.	195000.
2002	0.	0.	0.	0.	0.	0.	10000.	40000.
2003	0.	0.	0.	0.	0.	0.	10000.	40000.
2004	0.	0.	0.	0.	0.	0.	10000.	40000.
2005	0.	0.	0.	0.	0.	0.	10000.	40000.
2006	0.	0.	0.	0.	0.	0.	10000.	40000.
2007	0.	0.	0.	0.	0.	0.	10000.	40000.
2008	0.	0.	0.	0.	0.	0.	10000.	40000.

TABLE A4B

Distribution of Costs
CRA Costs
Site - D: Scenario Stamm/CRA Low

Year	Clear, Grub, Exc	Leachate Collection System	Roads	Site Services	Stormwater Management	Closure	Leachate Forcemain	Annual Contingency
1987	0.	0.	0.	0.	0.	0.	0.	0.
1988	927734.	714469.	601738.	640090.	85300.	0.	0.	0.
1989	927734.	714469.	601738.	640090.	85300.	0.	0.	230000.
1990	11900.	272260.	0.	0.	0.	0.	0.	195000.
1991	11900.	272260.	0.	0.	0.	245985.	2311830.	195000.
1992	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1993	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1994	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1995	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1996	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1997	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1998	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
1999	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
2000	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
2001	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
2002	11900.	272260.	0.	0.	0.	245985.	10000.	195000.
2003	0.	0.	0.	0.	0.	245985.	10000.	195000.
2004	0.	0.	0.	0.	0.	245985.	10000.	195000.
2005	0.	0.	0.	0.	0.	245985.	10000.	195000.
2006	0.	0.	0.	0.	0.	0.	10000.	40000.
2007	0.	0.	0.	0.	0.	0.	10000.	40000.
2008	0.	0.	0.	0.	0.	0.	10000.	40000.

TABLE A3B

Distribution of Costs
CRA Costs
Site D: Scenario Stamm/CRA High

Year	Clear, Grub, Exc	Leachate Collection System	Roads	Site Services	Stormwater Management	Closure	Leachate Forcemain	Annual Contingency
1987	0.	0.	0.	0.	0.	0.	0.	0.
1988	927734.	714496.	601738.	640090.	85300.	0.	0.	0.
1989	927734.	714496.	601738.	640090.	85300.	0.	0.	230000.
1990	18515.	393270.	0.	0.	0.	0.	0.	195000.
1991	18515.	393270.	0.	0.	0.	368978.	2311830.	195000.
1992	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1993	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1994	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1995	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1996	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1997	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1998	18515.	393270.	0.	0.	0.	368978.	10000.	195000.
1999	0.	0.	0.	0.	0.	368978.	10000.	195000.
2000	0.	0.	0.	0.	0.	368978.	10000.	195000.
2001	0.	0.	0.	0.	0.	0.	10000.	40000.
2002	0.	0.	0.	0.	0.	0.	10000.	40000.
2003	0.	0.	0.	0.	0.	0.	10000.	40000.
2004	0.	0.	0.	0.	0.	0.	10000.	40000.
2005	0.	0.	0.	0.	0.	0.	10000.	40000.
2006	0.	0.	0.	0.	0.	0.	10000.	40000.
2007	0.	0.	0.	0.	0.	0.	10000.	40000.
2008	0.	0.	0.	0.	0.	0.	10000.	40000.

TABLE A3A

Distribution of Costs
CRA Costs
Site F: Scenario Stamm/CRA High

Year	Clear, Grub,Exc	Leachate Collection System	Liner	Roads	Site Services	Stormwater Management	Closure	Annual Contingency
1987	0.	0.	0.	0.	0.	0.	0.	0.
1988	784243.	560740.	0.	333931.	621575.	99185.	0.	0.
1989	784243.	560740.	1627105.	333931.	621575.	99185.	0.	165000.
1990	52900.	146798.	1627105.	0.	0.	0.	0.	140000.
1991	52900.	146798.	1627105.	0.	0.	0.	357075.	140000.
1992	52900.	146798.	1627105.	0.	0.	0.	357075.	140000.
1993	52900.	146798.	1627105.	0.	0.	0.	357075.	140000.
1994	52900.	146798.	1627105.	0.	0.	0.	357075.	140000.
1995	52900.	146798.	1627105.	0.	0.	0.	357075.	140000.
1996	52900.	146798.	1627105.	0.	66125.	0.	357075.	140000.
1997	52900.	146798.	1627105.	157378.	0.	0.	357075.	140000.
1998	52900.	146798.	1627105.	0.	0.	0.	357075.	140000.
1999	0.	0.	0.	0.	0.	0.	357075.	140000.
2000	0.	0.	0.	0.	0.	0.	357075.	140000.
2001	0.	0.	0.	0.	0.	0.	0.	35000.
2002	0.	0.	0.	0.	0.	0.	0.	35000.
2003	0.	0.	0.	0.	0.	0.	0.	35000.
2004	0.	0.	0.	0.	0.	0.	0.	35000.
2005	0.	0.	0.	0.	0.	0.	0.	35000.
2006	0.	0.	0.	0.	0.	0.	0.	35000.
2007	0.	0.	0.	0.	0.	0.	0.	35000.
2008	0.	0.	0.	0.	0.	0.	0.	35000.

TABLE A4A

Distribution of Costs
CRA Costs
Site F: Scenario Stamm/CRA Low

Year	Clear, Grub, Exc	Leachate Collection System	Liner	Roads	Site Services	Stormwater Management	Closure	Annual Contingency
1987	0.	0.	0.	0.	0.	0.	0.	0.
1988	784243.	560740.	0.	333931.	621575.	99185.	0.	0.
1989	784243.	560740.	1162220.	333931.	621575.	99185.	0.	165000.
1990	37030.	101833.	1162220.	0.	0.	0.	0.	140000.
1991	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1992	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1993	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1994	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1995	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1996	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1997	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
1998	37030.	101833.	1162220.	0.	66125.	0.	238050.	140000.
1999	37030.	101833.	1162220.	157378.	0.	0.	238050.	140000.
2000	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
2001	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
2002	37030.	101833.	1162220.	0.	0.	0.	238050.	140000.
2003	0.	0.	0.	0.	0.	0.	238050.	140000.
2004	0.	0.	0.	0.	0.	0.	238050.	140000.
2005	0.	0.	0.	0.	0.	0.	238050.	140000.
2006	0.	0.	0.	0.	0.	0.	0.	35000.
2007	0.	0.	0.	0.	0.	0.	0.	35000.
2008	0.	0.	0.	0.	0.	0.	0.	35000.

TABLE A2A

Distribution of Costs
CRA Costs
Site F: Scenario Stamm/CRA Recommended

Year	Clear, Grub,Exc	Leachate Collection System	Liner	Roads	Site Services	Stormwater Management	Closure	Annual Contingency
1987	0.	0.	0.	0.	0.	0.	0.	0.
1988	784243.	560740.	0.	333931.	621575.	99185.	0.	0.
1989	784243.	560740.	1479185.	333931.	621575.	99185.	0.	165000.
1990	47610.	130928.	1479185.	0.	0.	0.	0.	140000.
1991	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
1992	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
1993	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
1994	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
1995	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
1996	47610.	130928.	1479185.	0.	66125.	0.	324013.	140000.
1997	47610.	130928.	1479185.	157378.	0.	0.	324013.	140000.
1998	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
1999	47610.	130928.	1479185.	0.	0.	0.	324013.	140000.
2000	0.	0.	0.	0.	0.	0.	324013.	140000.
2001	0.	0.	0.	0.	0.	0.	324013.	140000.
2002	0.	0.	0.	0.	0.	0.	0.	35000.
2003	0.	0.	0.	0.	0.	0.	0.	35000.
2004	0.	0.	0.	0.	0.	0.	0.	35000.
2005	0.	0.	0.	0.	0.	0.	0.	35000.
2006	0.	0.	0.	0.	0.	0.	0.	35000.
2007	0.	0.	0.	0.	0.	0.	0.	35000.
2008	0.	0.	0.	0.	0.	0.	0.	35000.

APPENDIX B

A NOTE ON THE WATSON EVALUATION TECHNIQUE

B.1 Introduction

As stated in Part 1 of this report, the issue at hand in selecting the most suitable landfill site is the allocation of society's economic resources to achieve certain objectives. It has been stated as our position that: given two alternatives which deliver an identical service (waste landfilling) and are equally suitable from the viewpoint of physical impact of use, **having been made so by the expenditure on engineering works**; the alternative which requires the lowest level of economic resource should be preferred.

Further, it is our position that whether the cost is to be channelled through the private sector or the public sector is not material.

- The cost is borne by the public, either through local taxation or user fees paid to private contractors. In assessing the matter the important issue is the **total amount of resource expended, not the channel.**

Clearly it makes little sense to adopt a solution which saves every householder $100 per year on the local tax bill if that solution requires the householder to incur added charges on $150 through the private sector. The householder is made **worse-off** by a solution which may be to the financial best interest of the municipality. Very often the distribution of the cost aspects can be properly negotiated between all of the parties to assure the optimal outcome for the public.

B.2 Watson Evaluation Criteria

In Watson's overview of economic component of landfill site comparison, (Exhibit H-284) the flowchart indicates nine evaluation criteria on which the selection of a suitable landfill site are based. These are:

1. Present Value of Overall Costs
2. Present Value of Regional Cost Portion

3. Regional Debt Requirement
4. Future Tipping Fee Impact
5. Present Value of Municipal Haul Cost
6. Distribution of Municipal Haul Cost
7. Present Value of Private Haul Cost
8. Potential Off-site Property Value Impact
9. Other Considerations; e.g. tax losses, indirect economics.etc.

In our view these criteria include a number that should bear no relation whatever to the choice of site selection. Others create a severe problem of double counting.

1. Criteria 2, 5 and 7 are all components of the Criterion 1, the present value of the Overall Costs. Hence, they are parts and parcels of the same thing and by counting these as separate criteria, a double-counting with respect to these items occurs. **The same public pays all of the bills, and only the total charge is a valid consideration.**

2. Criterion 3, the matter of regional debt requirement relates to the financial considerations of the municipal corporation. This deals with the mechanics of funding, and not the level of funding. It is not appropriate, in our view, to base the choice on the selection of requiring the least regional debt if that implies that the public will, over the lifecycle of the project pay a greater level of total resource. Furthermore, that matter can be dealt with as part of the "present value" accounting of future expenditure obligations, and is therefore already part of Criterion 1.

3. Criterion 4, which deals with the impact on tipping fees is again a matter of "double-counting". Clearly the solution which requires the lowest overall cost over the lifecycle of the project will require the lower level of tipping fees over the life of the project, provided that tipping fees are properly related to nominal costs. Again, this is a matter of double counting.

4. Criterion 6, the distribution of the municipal haul costs deals with a completely separate issue. Choosing a site with an "equal" haul cost per ton for all municipalities is a partial analysis. Once again,

It would be undesirable to arrange such an "equity" position at the cost of having a higher overall public cost. That matter is the outgrowth of the Region of Halton Act which places the responsibility for the hauling of landfill waste onto the local municipality. If equalization of haul cost were a desired public objective then either the responsibility can be shifted to the Region, and the haul cost equalized through the taxation levy system (although that has its own inequities), or intermunicipal agreements can redistribute the burden of haul cost differentials. It is certainly not a reason to select a site which will require a higher level of economic resource.

5. Criterion 8, the potential off-site property value impact is a clear case of double-counting. These costs are included in the estimates by the appraisers, and such valuation is therefore included in the cost analysis when property acquisition costs and off-site land value impact costs are included. It is not a separate and independent criterion.

6. Finally, the 'other considerations' of Criterion 9 are not completely defined. We disagree that the matter of tax losses should ever be considered. A landfill site selection ought to be based on the fundamentals of true economic cost, and not vagaries of the tax laws. The tax laws can introduce false economies into the picture. The indirect economics ought to be considered, but should be specified and costed, in which case they become part of the cost structure under Criterion 1.

In our view the only valid criterion is the first criterion, to which can and should be added **only** those considerations which have not been drawn into the cost analysis.