Durham/York
Residual Waste Study

Annex E-2:

Supporting Technical Document on Facility Land Requirements

Report on Selection of Preferred Residuals Processing System

May 30, 2006

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Annex E-2: Facility Land Requirements

Annex E-2 provides the land requirements for the facilities associated with the four (4) Durham/York Residual Waste Study residuals processing systems. Portions of this report are based on information and methodologies developed by the Niagara-Hamilton WastePlan Study. The land area requirements for each of the four System Alternatives were estimated based on the following:

- For planning purposes, the total site size was based on building requirements (configured in a slightly rectangular layout) plus a 100m on-site buffer (from the building perimeter to the property line). A 100m on-site buffer was chosen as a reasonably conservative dimension, for comparative purposes only, to ensure minimal off-site noise, odour and emissions impacts and a comfortable dimension to accommodate other site features (see below).

  Following approval of the preferred system, the next step of the EA Study will be the evaluation of "Alternative Methods", which includes both facility siting and the competitive process to implement the preferred system. In Step 3 of the evaluation process, the minimum site size requirements (including buffer zones) will be defined, based on the technology and nature of the areas that remain after the application of siting constraints. It is quite possible that less than a 100m on-site buffer may be required.
- Facility sizes are based on the maximum system capacity (400,000 tpy) throughput level (it is assumed that the minimum system capacity (250,000 tpy) facilities might be expanded to the larger size, thus the land area requirements for the 250,000 tpy facilities are based on the larger throughput). The details behind the rationale for the minimum and maximum system capacity estimates are provided in Section 7 of the "*Additional At-Source Diversion and Residual Quantities to be Managed"* report.
- Roads, parking, scalehouse and scales, stormwater management pond(s), and other site works are located within the 100m on-site buffer. The odour control device (biofilter assumed) would be located within the 100 m on-site buffer, on the upwind side of the building.
- Tip floors are based on 2-days storage of material in a pit and the floor area would be large enough that trucks can unload fully inside the building.
- Processing areas are based on other similar facilities scaled up or down as appropriate.

The four (4) Durham/York Residual Waste Study System Alternatives are:

- 1 – Mechanical and Biological Treatment with Biogas Recovery
- 2a – Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash/Char
- 2b – Thermal Treatment of Solid Recovered Fuel
- 2c – Thermal Treatment of Solid Recovered Fuel with Biogas Recovery

The land requirements associated with these alternatives are shown in Table 1 below.

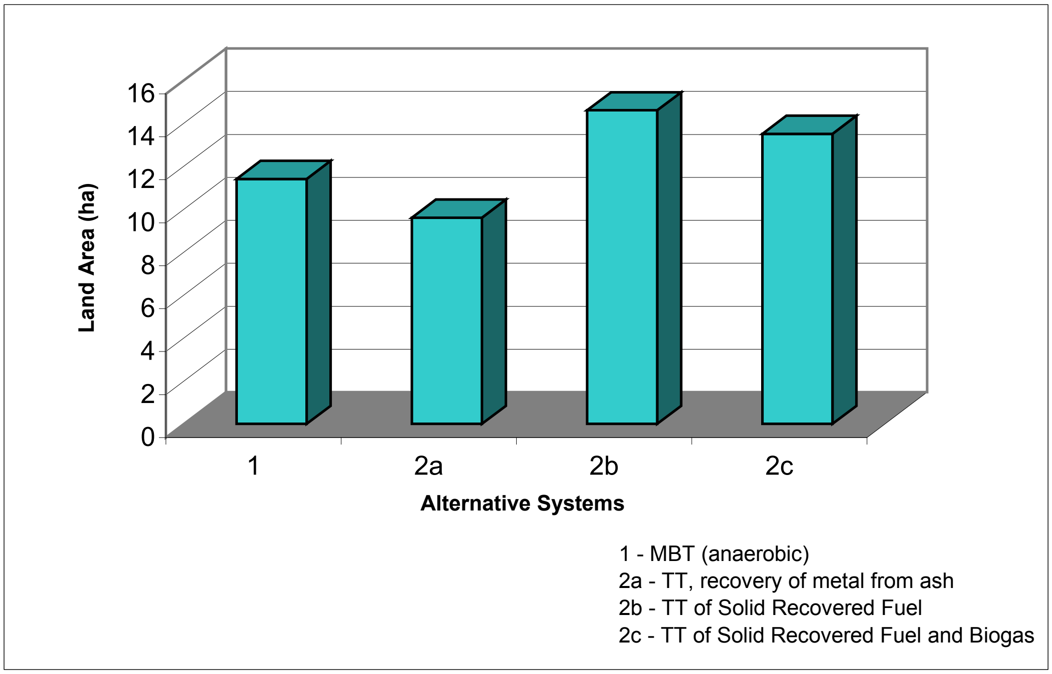
Table 1 Summary of Land Requirements for New Facilities (ha)

System	Post Diversion Waste Qty (tonnes/yr)	MT Component (tonnes/yr)	MT Processing Facility Area (m^2)	BT Component (tonnes/yr)	BT Processing Facility Area (m^2)	SRF Component (tonnes/yr)	SRF Processing Facility Area (m^2)	TT Component (tonnes/yr)	TT Processing Facility Area (m^2)	Sum of Processing Facility Areas (m2)	Typical Configuration	Typical Configuration with 100m On-site Buffer	Site Size with 100m On-site Buffer (ha)
1	400,000	400,000	15,200 [1]	150,000 (AD)	3,500 [2]	-	-	-	-	18,700	120m x 155m	320m x 355m	11.4
2a	400,000	-	-	-	-	-	-	400,000	12,000	12,000	120m x 100m	320m x 300m	9.6
2b	400,000	400,000	15,200 [1]	150,000 (biodrying)	6,500	275,000	1,500	215,000	10,000	33,200	170m x 195m	370m x 395m	14.6
2c	400,000	400,000	15,200 [1]	150,000 (AD)	3,500 [2]	175,000	1,100	140,000	8,000	27,800	150m x 185m	350m x 385m	13.5

Notes:
1. Facility areas for administration, employee amenity areas are included in the Mechanical Treatment facility areas.
2. Digesters located in the 100m on-site buffer.

Figure 1 summarizes the land area requirements for each system.

Figure 1 Comparative Land Area Requirements



The specific assumptions associated with these estimates of the land requirements for the facilities utilized in the four (4) system alternatives are detailed below.

1. Mechanical and Biological Treatment

1.1 System 1 Mechanical Biological Treatment (MBT) with Biogas Recovery

In this system, incoming post diversion waste is assumed to be received on a tipping floor and materials that are unacceptable for mechanical processing (e.g., mattresses) are removed. Some of these unacceptable materials such as large metal parts may be set aside for recycling, but most of the materials are assumed to be sent directly to landfill disposal.

The balance of the post diversion waste stream is assumed to be processed – mechanically treated - to remove recyclables, primarily metal and plastic containers. A relatively small quantity of these recyclable materials remain in the post diversion waste as the vast majority of these materials are assumed to be recovered through at-source diversion programs (e.g., blue box recycling). Mechanical treatment separates the waste stream into a number of fractions, from which some recyclables are removed. A large portion of the material is sent to landfill after removal of recyclables. A portion of the material is sent to biological treatment.

The portion of the remaining material stream that contains the highest percentage of organic materials (heavy, fines) is biologically treated via anaerobic digestion (AD) to breakdown organic materials. This process converts carbon-containing compounds to biogas (primarily methane and carbon dioxide), which in turn can be used to produce energy for in-plant consumption and sold to external users.

The residual materials, including stabilized organic material – digestate from the AD process – are assumed to be landfilled.

The estimated land requirement for System 1, based on the 400,000 tonnes per year throughput, is 11.4 hectares.

2. Thermal Treatment

2.1 System 2a) Thermal Treatment of Mixed Waste with Recovery of Materials from Ash/Char

There are two main types of commercially available thermal treatment technologies: combustion and gasification. Depending on the technology, incoming waste may be received on either a flat tipping floor or into a receiving pit. The waste is inspected and any unacceptable items are removed.

In combustion technologies, hydrocarbons in the waste stream are converted to thermal energy, carbon dioxide, and water. Ash is discharged from the bottom of the grate and is quenched. Exhaust gases from combustion are cleaned prior to being emitted to the atmosphere. The process is exothermic (i.e., requires little to no external energy once combustion has been initiated).

Gasification technologies involve the thermal breakdown of solid materials into a synthetic gas (syngas) and a solid char residue. The process is endothermic (i.e., requires external energy). The syngas (mainly comprised of hydrogen, carbon monoxide, carbon dioxide, and nitrogen) must undergo a cleaning process before it is utilized. After cleaning, the syngas may be used as fuel for reciprocating engines or gas turbines, or it can be combusted in a steam boiler to generate steam.

After thermal treatment, mechanical treatment is utilized to recover metals (aluminum ferrous) from the ash or char.

The residual materials, including materials unacceptable for thermal processing and ash or char, are assumed to be landfilled. In addition, residue from the flue gas or syngas cleanup process also requires management.

The estimated land requirement for System 2a, based on the 400,000 tonnes per year throughput, is 9.6 hectares.

2.2 System 2b) Thermal Treatment of Solid Recovered Fuel

This system combines mechanical, biological (aerobic), and thermal treatment.

After removal of some unacceptable materials (similar to 2a) the incoming post diversion waste is processed and a portion of the material is separated into “large, dry, light” streams of plastic and paper materials. The other portion of the material includes more “small, wet, heavy” material including food waste residue, which is sent to biological treatment (aerobic composting) for bio-drying.

The waste is then processed mechanically to remove non-combustible materials and to recover some recyclable resources. A solid fuel is recovered and is fed into the thermal process to produce energy.

As mentioned under System 2a, the main thermal technologies are combustion or gasification. Combustion is an exothermic reaction in which hydrocarbons in the waste stream are converted to thermal energy, carbon dioxide, and water. The exhaust gases are cleaned prior to release into the atmosphere and the ash is discharged and quenched. Gasification is an endothermic reaction in which solid material is thermally broken down into syngas and a solid char residue. The syngas is cleaned before it is utilized for the generation of energy.

The materials requiring landfill disposal include the residuals from the recovery of solid fuel, the unacceptable waste and the ash/char from the thermal treatment. In addition, residue from the flue gas or syngas cleanup process also requires management.

The estimated land requirement for System 2b, based on the 400,000 tonnes per year throughput, is 14.6 hectares.

2.3 System 2c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery

This system is a variation of System 2b that involves the separation of the organic material (e.g., food waste) from the rest of the post diversion waste and the subsequent anaerobic digestion of this organic fraction of the waste stream to produce biogas. Energy is thus produced from both the solid recovered fuel and the biogas.

The residuals from anaerobic digestion, ash/char from the thermal treatment process and the residues from the mechanical treatment process all require landfilling. A small amount of waste from the air pollution control/gas clean-up system also requires management.

The estimated land requirement for System 2c, based on the 400,000 tonnes per year throughput, is 13.5 hectares.

3. Volume of Air Space Required for Landfill Disposal of Residuals

Each system generates residual waste that must be landfilled. Tables 2 and 3 below summarize the minimum and maximum tonnes of residual waste requiring landfill disposal from each component, the in-place densities for each component and the resulting total landfill air space requirements per year. Figure 2 illustrates the 2011 air space requirements for landfill.

Table 2 Minimum Annual Air Space Requirement for Landfill

			Breakdown of Residue Components									
System	Post Diversion Waste Qty (tonnes/yr)	Approx Qty to LF in First Year (tonnes/yr)	MSW Component (tonnes/yr)	MSW In-Place Density (kg/m^3)	MT Component (tonnes/yr)	MT In-Place Density (kg/m^3)	BT Component (tonnes/yr)	BT In-Place Density (kg/m^3)	SRF / TT Component (tonnes/yr)	SRF / TT In-Place Density (kg/m^3)	Weighted Average In-Place Density (kg/m^3)	Total Air Space Required (m^3/yr)
1	250,000	192,366	59,274	700	86,924	450	46,168	1,040	0	1,200	670	287,000
2a	250,000	56,131	7,471	700	0	450	0	1,040	48,660	1,200	1,130	50,000
2b	250,000	79,340	35,346	700	0	450	0	1,040	43,994	1,200	980	81,000
2c	250,000	111,536	35,346	700	0	450	46,168	1,040	30,022	1,200	980	114,000

Notes: MSW component density based on consultant's experience from several medium to large conventional MSW landfills
MT component density based on weighted average of individual components/densities making up the overall MT residue stream
BT component density based on 80% (digestate) x 800 kg/m3 + 20% (grit/glass) x 2,000 kg/m3 = 1,040 kg/m3
SRF / TT density based on typical values published for several EFW facilities ("Yellow Book")

MT = Mechanical Treatment
BT = Biological Treatment
TT = Thermal Treatment
LF = Landfill
SRF = Solid Recovered Fuel

Figure 2 Total Air Space Required for Minimum System Capacity in 2011

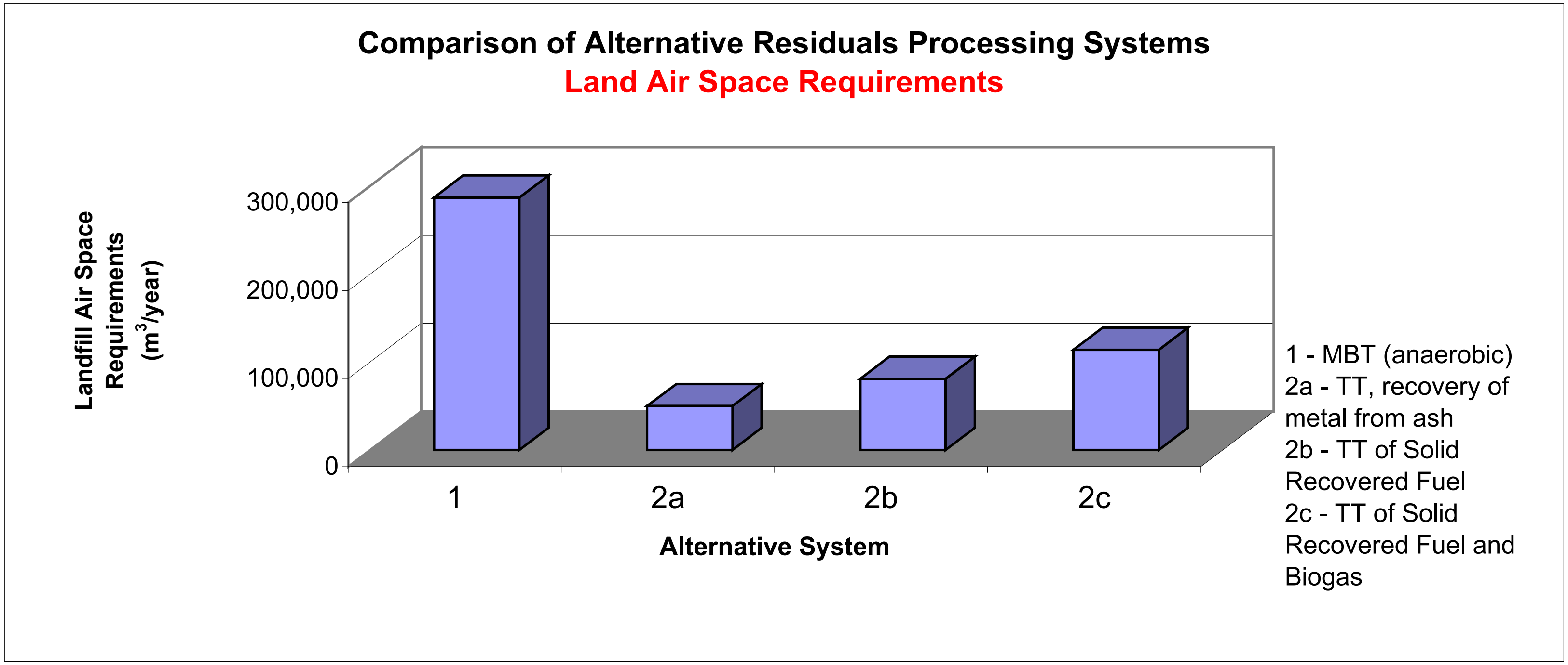


Table 3 Maximum Annual Air Space Requirement for Landfill

System	Post Diversion Waste Qty (tonnes/yr)	Approx Qty to LF in First Year (tonnes/yr)	Breakdown of Residue Components: MSW Component (tonnes/yr)	MSW In-Place Density (kg/m^3)	MT Component (tonnes/yr)	MT In-Place Density (kg/m^3)	BT Component (tonnes/yr)	BT In-Place Density (kg/m^3)	SRF / TT Component (tonnes/yr)	SRF / TT In-Place Density (kg/m^3)	Weighted Average In-Place Density (kg/m^3)	Total Air Space Required (m^3/yr)
1	400,000	307,785	94,838	700	139,078	450	73,869	1,040	0	1,200	670	459,000
2a	400,000	89,809	11,953	700	0	450	0	1,040	77,856	1,200	1,130	79,000
2b	400,000	126,944	56,553	700	0	450	0	1,040	70,391	1,200	980	130,000
2c	400,000	178,457	56,553	700	0	450	73,869	1,040	48,035	1,200	980	182,000

Notes: MSW component density based on consultant's experience from several medium to large conventional MSW landfills
MT component density based on weighted average of individual components/densities making up the overall MT residue stream
BT component density based on 80% (digestate) x 800 kg/m3 + 20% (grit/glass) x 2,000 kg/m3 = 1,040 kg/m3
SRF / TT density based on typical values published for several EFW facilities ("Yellow Book")

MT = Mechanical Treatment
BT = Biological Treatment
TT = Thermal Treatment
LF = Landfill
SRF = Solid Recovered Fuel