REPORT

ORGANIC WASTE DIVERSION FROM LANDFILL

by

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BACKGROUND

To meet its aspirational goal of Zero Waste by 2040, Auckland Council has set an interim target to reduce organic waste sent to landfill. Approximately 50% of the kerbside collected refuse stream (40% food waste (FW) and 10% garden waste (GW)) is of organic nature. The purpose of this study is to assess the likely environmental effects from landfilling of kerbside organics (KSO) compared to anaerobic digestion or composting and application to land. To achieve this following four scenarios are compared:

- Landfilling of KSO material assuming 90% gas recovery efficiency.
- Aerobic composting of KSO and application of product to land.
- Anaerobic digestion of KSO with energy recovery and application of digestate to land.
- Anaerobic digestion of KSO followed by aerobic composting of digestate prior to application to land.

APPROACH

A literature review was conducted to perform mass balances for carbon, nutrients (nitrogen), and global warming potential (GWP) for the four scenarios schematically illustrated in Figure 1. The assumptions made along with the mass balance calculations for the four scenarios are respectively presented in Tables 1, 2 and 3 for carbon, nitrogen, and GWP. The major assumptions are:

- ***KSO:*** ~250k tons of KSO are produced each year and 40% of KSO is FW and 10% is GW.

- ***Carbon balance:***
  - *Landfills:* 90% of gas produced is captured; 76 kg of CH_4 and 180 kg of CO_2 are produced per ton FW, and 99 kg of CH_4 and 232 kg of CO_2 are produced per ton GW; 1% of total carbon is lost in leachate.
  - *Composting:* 1 kg of CH_4 and 115 kg of CO_2 are produced per ton FW, and 3 kg of CH_4 and 194 kg of CO_2 are produced per ton GW; 350 kg/ton-FW and 200 kg/ton-GW of carbon are retained in compost.
  - *Anaerobic digestion:* 70 kg of CH_4 and 50 kg of CO_2 are produced per ton FW, and 50 kg of CH_4 and 30 kg of CO_2 are produced per ton GW; 0.6 ton of digestate is produced per ton of organic waste.
  - *Anaerobic digestion followed by composting of digestate:* 52 g of CH4 is assumed to be produced per ton of digestate.

- ***Nitrogen balance:*** N_2O is considered to be small, and unless explicitly stated is ignored.
  - *Landfills:* 1.54 kg of NH_4^+ and 10.6 kg of NO_3^- per ton FW, and 1.08 kg of NH_4^+ and 7.4 kg of NO_3^- per ton GW, are released in leachate.

- *Composting:* 7.5% of nitrogen in FW and GW is lost via N_2O emissions, and 92.5% of nitrogen is assumed to be retained in compost. Nitrogen concentration in compost is assumed as 0.0062 kg/kg of food or garden waste.
- *Anaerobic digestion:* 40% of nitrogen in FW and GW is released in leachate and the remainder in digestate. Nitrogen concentration in digestate is assumed to be 0.004 kg/kg of food or garden waste.
- *Anaerobic digestion followed by composting of digestate:* 7.5% of nitrogen is released during the composting of digestate.

- ***Phosphorous balance:*** 2 ton of phosphorous per ton FW or GW.
  - *Landfills:* 0.011 ton of PO_4^{3-} per ton of FW or GW are released in leachate.
  - *Composting:* 1.8 kg/ton of phosphorous is assumed to be retained in compost.
  - *Anaerobic digestion:* 40% of phosphorous in FW and GW is released in leachate and the remainder in digestate. Phosphorous concentration in digestate is assumed to be 0.0012 kg/kg of food or garden waste.
  - *Anaerobic digestion followed by composting of digestate:* Same assumptions as composting or anaerobic digestion.

- ***Global Warming Potential:***
  - *Landfills:* 10% of CH_4 escape to atmosphere and has a GWP of 62 g-CO_2(equivalent)/g CH_4. The aerobic zone gives a carbon sequestration benefit of 272 kgCO_2(equivalent)/ton of waste; energy production on-site results in lowering GWP by 32 kgCO_2(equivalent)/ton of waste.
  - *Composting:* CH_4 release during composting corresponds to GWP of 62 ton CO_2/ton of waste. Carbon sequestration and fertilizer offset correspond to GWP reductions of 22 kgCO_2(equivalent)/ton and 36 kgCO_2(equivalent)/ton of waste, respectively.
  - *Anaerobic digestion:* Electricity production, carbon sequestration, and fertilizer offset respectively lower the GWP by 132 kgCO_2(equivalent)/ton, 22 kgCO_2(equivalent)/ton, and 36 kgCO_2(equivalent)/ton of waste.
  - *Anaerobic digestion followed by composting of digestate:* 52 g of CH4 is assumed to be produced per ton of digestate.

RESULTS

The carbon mass balance (Table 1) shows that 46,000 tons/yr of carbon (78% of carbon in food and garden waste deposited in landfills) is lost via retention in the landfill. In comparison, composting, anaerobic digestion, and anaerobic digestion followed by compositing result in 4,000 tons /yr (8%), 2,600 ton/yr (5%), and 2,600 tons/yr (5%) of carbon lost from the system. The nitrogen mass balance (Table 2) shows that 413 tons/yr of nitrogen (50% of nitrogen in food and garden waste deposited in landfills) is lost via retention in the landfill. In comparison, composting, anaerobic digestion, and anaerobic digestion followed by compositing result in 56 tons /yr (8%), 0 tons/yr (0%), and 34 tons/yr (5%) of nitrogen lost from the system. Phosphorous mass balance (Table 3) shows that phosphorous loss primarily occurs via retention of food waste in landfill, and that small loss of phosphorous from anaerobic digestion can occur due to the discharge of phosphate in leachate. The GWP calculations presented in Table 4 show that landfill use results in environmental impact equivalent to emission of 24,600 tons/yr of CO_2, while composting corresponds to emissions equivalent to 3000 tons/ yr of CO_2, and the anaerobic digestion variants cause a reduction in CO_2 emissions of 21,250 tons/yr. These calculations show that anaerobic digestion or anaerobic digestion followed by composting are the best options for disposal of food and garden waste. This conclusion is consistent with Defra (Ref. 15) which states that for food waste anaerobic digestion is environmentally better than composting and other recovery options, and that for garden waste (and

for mixtures of food waste) dry anaerobic digestion followed by composting is environmentally better than composting alone.

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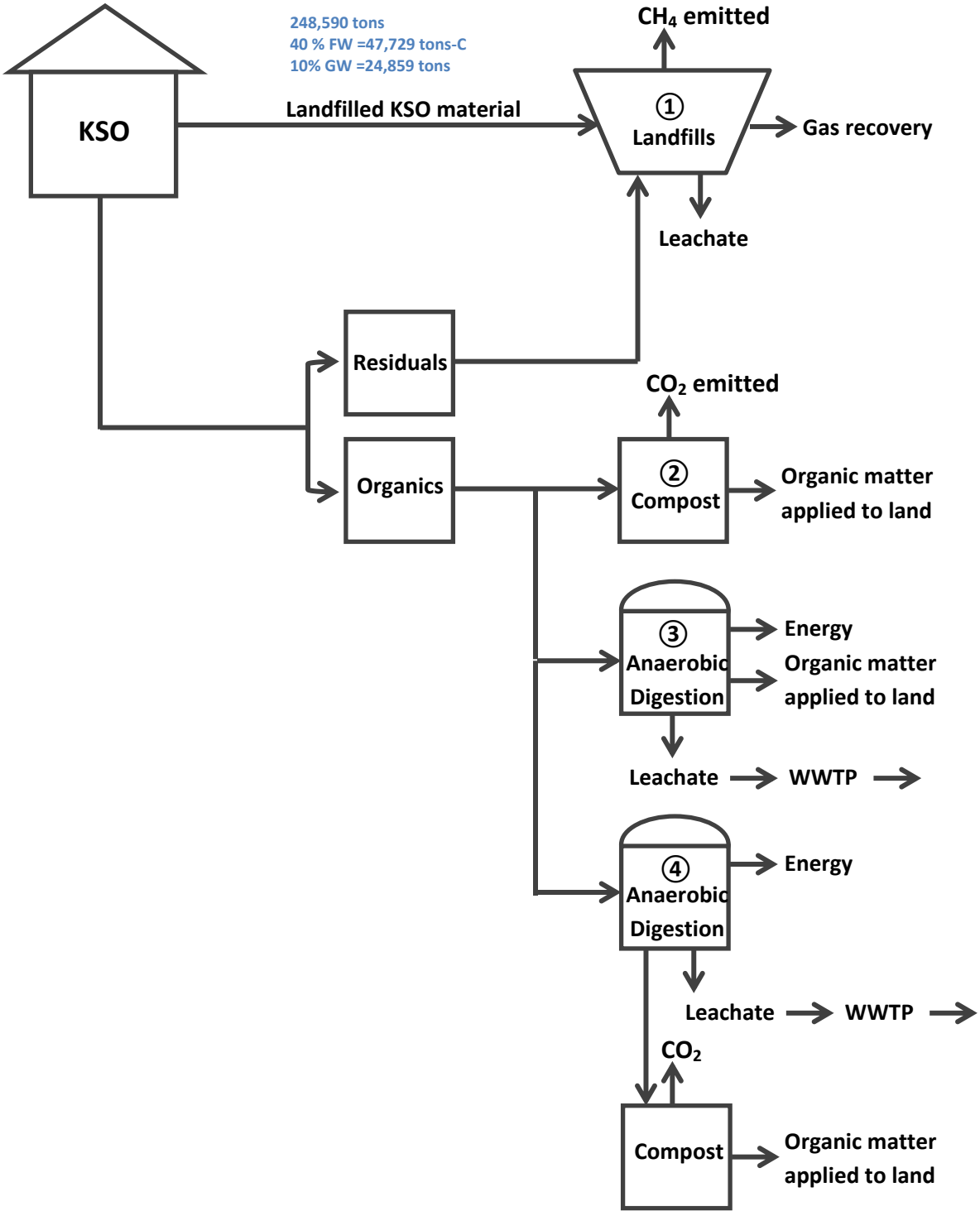

Figure 1. Schematic illustration of the four scenarios for KSO disposal considered in this study.

Table 1. Carbon mass balance for the four scenarios.

SCENARIO 1- LANDFILL MASS BALANCE

		Wet Waste					Carbon				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	Food Waste (FW)	40	% of KSO	99,436	tons/yr	2	48	%	47,729	tons-C/yr	3
Output	CH4 produced	76,622	g/ton	7,619	tons/yr	1	0.75	g-C/g-CH4	5,714	tons-C/yr	
Output	CH4 released	10	% of biogas produced	762	tons/yr		0.75	g-C/g-CH4	571	tons-C/yr	
Output	CH4 captured	90	% of biogas produced	6,857	tons/yr		0.75	g-C/g-CH4	5,143	tons-C/yr	
Output	CO2 released	180,183	g/ton	17,917	tons/yr	1	0.27	g-C/g-CO2	4,886	tons-C/yr	
Input	Garden Waste (GW)	10	% of KSO	24,859	tons/yr	2	47.8	%	11,883	tons-C/yr	3
Output	CH4 produced	98,514	g/ton	2,449	tons/yr	1, 4	0.75	g-C/g-CH4	1,837	tons-C/yr	
Output	CH4 released	10	% of biogas produced	245	tons/yr		0.75	g-C/g-CH4	184	tons-C/yr	
Output	CH4 captured	90	% of biogas produced	2,204	tons/yr		0.75	g-C/g-CH4	1,653	tons-C/yr	
Output	CO2 released	231,664	g/ton	5,759	tons/yr	1	0.27	g-C/g-CO2	1,571	tons-C/yr	
MB	Total C released (g)								14,008	tons-C/yr	
Output	Leachate C released	1%	total C loss			5			140	tons-C/yr	
	C lost via retention in landfill + emissions							**78%**	**46,219**	**tons-C/yr**	

SCENARIO 2 - COMPOST MASS BALANCE

		Wet Waste					Carbon				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	48	%	42,956	tons-C/yr	3
Output	CH4 produced	1	kg/ton	89	tons/yr	6	0.75	g-C/g-CH4	67	tons-C/yr	
Output	CO2 produced	115	kg/ton	10,292	tons/yr	7	0.27	g-C/g-CO2	2,807	tons-C/yr	
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	47.8	%	10,694	tons-C/yr	3
Output	CH4 produced	3	kg/ton	67	tons/yr	6	0.75	g-C/g-CH4	50	tons-C/yr	
Output	CO2 produced	194	kg/ton	4,340	tons/yr	7	0.27	g-C/g-CO2	1,184	tons-C/yr	
MB	**Total C lost**								**4,108**	**tons-C/yr**	
Output	Compost - FW						350	kg-C/ton ww	31,322	tons-C/yr	6
Output	Compost - GW						200	kg-C/ton ww	4,475	tons-C/yr	6
	Total C lost							**8%**	**4,108**	**tons-C/yr**	

SCENARIO 3 - ANAEROBIC DIGESTION MASS BALANCE

		Wet Waste					Carbon				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	48	%	42,956	tons-C/yr	3
Output	CH4 produced	0.07	kg/kg	6,625	tons/yr	8	0.75	g-C/g-CH4	4,969	tons-C/yr	
Output	CO2 produced	0.05	kg/kg	4,417	tons/yr	8	0.27	g-C/g-CO2	1,205	tons-C/yr	
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	47.8	%	10,694	tons-C/yr	3
Output	CH4 produced	0.050	kg/kg	1,126	tons/yr	9	0.75	g-C/g-CH4	845	tons-C/yr	
Output	CO2 produced	0.034	kg/kg	751	tons/yr	9	0.27	g-C/g-CO2	205	tons-C/yr	
Output	Leachate	0.331	ton (dry)/ton	37,063	tons/yr	10	41.83	% of solids	15,504	tons-C/yr	11
Output	Solid digestate	0.605	ton/ton	67,727	tons/yr	10	41.83	% of solids	28,330	tons-C/yr	6
	Total C lost								**5%**	**2,594**	**tons-C/yr**

SCENARIO 4 - ANAEROBIC DIGESTION W/ COMPOSTING OF DIGESTATE MASS BALANCE

		Wet Waste					Carbon				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	48	%	42,956	tons-C/yr	3
Output	CH4 produced	0.07	kg/kg	6,625	tons/yr	8	0.75	g-C/g-CH4	4,969	tons-C/yr	
Output	CO2 produced	0.05	kg/kg	4,417	tons/yr	8	0.27	g-C/g-CO2	1,205	tons-C/yr	
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	47.8	%	10,694	tons-C/yr	3
Output	CH4 produced	0.050	kg/kg	1,126	tons/yr	9	0.75	g-C/g-CH4	845	tons-C/yr	
Output	CO2 produced	0.034	kg/kg	751	tons/yr	9	0.27	g-C/g-CO2	205	tons-C/yr	
Output	Leachate	0.331	ton (dry)/ton	37,063	tons/yr	12	41.83	% of solids	15,504	tons-C/yr	11
Output	Solid digestate	0.605	ton/ton	67,727	tons/yr	10	41.83	% of solids	28,330	tons-C/yr	6
Output	CH4 from composting of solid digestate	52	g/ton digestate	3.52	tons/yr	8	0.75	g-C/g-CH4	2.64	tons-C/yr	
	Total C lost								**5%**	**2,597**	**tons-C/yr**

Table 2. Nitrogen mass balance for the four scenarios.

SCENARIO 1- LANDFILL MASS BALANCE

		Wet Waste					Nitrogen				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	Food Waste (FW)	40	% of KSO	99,436	tons/yr	2	0.0067	kg/kg	666	tons-N/yr	5
Output	NH4 in leachate	1.54E-03	kg/kg	153	tons/yr	4	0.7778	g-N/g-NH4	119	tons-N/yr	
Output	NO3 in leachate	1.06E-02	kg/kg	1,054	tons/yr	4	0.2258	g-N/g-NO3	238	tons-N/yr	
Input	Garden Waste (GW)	10	% of KSO	24,859	tons/yr	2	0.0067	kg/kg	167	tons-N/yr	5
Output	NH4 in leachate	1.08E-03	kg/kg	27	tons/yr	4	0.7778	g-N/g-NH4	21	tons-N/yr	
Output	NO3 in leachate	7.44E-03	kg/kg	185	tons/yr	4	0.2258	g-N/g-NO3	42	tons-N/yr	
MB	Total N released								420	tons-N/yr	
MB	**N lost to landfill**							**50%**	**413**	**tons-N/yr**	

SCENARIO 2 - COMPOST MASS BALANCE

		Wet Waste					Nitrogen				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	0.0067	kg/kg	600	tons-N/yr	5
Output	Total N lost as N2O	7.5	%			6	7.5	%	45	tons-N/yr	5
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	0.0067	kg/kg	150	tons-N/yr	5
Output	Total N lost as N2O	7.5	%			6	7.5	%	11	tons-N/yr	5
MB	Total N lost								56	tons-N/yr	
Output	Compost - FW						92.5	%	555	tons-N/yr	6
Output	Compost - GW						92.5	%	139	tons-N/yr	6
TOTAL	**N lost as N2O**							**8%**	**56**		

SCENARIO 3 - ANAEROBIC DIGESTION MASS BALANCE											
		Wet Waste					Nitrogen				
Qualifier	Parameter	Basis	Unit	Amount	Unit	Ref.	Basis	Unit	Amount	Unit	Ref.
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	0.0067	kg/kg	600	tons-N/yr	5
Output	Leachate						40	%	240	tons-N/yr	11
Output	Solid digestate						60	%	360	tons-N/yr	11
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	0.0067	kg/kg	150	tons-N/yr	5
Output	Leachate						40	%	60	tons-N/yr	11
Output	Solid digestate						60	%	90	tons-N/yr	11
Output	Leachate						40	%	300	tons-N/yr	
Output	Solid digestate						60	%	450	tons-N/yr	
TOTAL	**N lost (assuming leachate is used as spray on farm land)**							**0%**	**0**		

SCENARIO 4 - ANAEROBIC DIGESTION W/ COMPOSTING OF DIGESTATE MASS BALANCE											
		Wet Waste					Nitrogen				
Qualifier	Parameter	Basis	Unit	Amount	Unit	Ref.	Basis	Unit	Amount	Unit	Ref.
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	0.0067	kg/kg	600	tons-N/yr	5
Output	Leachate						40	%	240	tons-N/yr	11
Output	Solid digestate						60	%	360	tons-N/yr	11
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	0.0067	kg/kg	150	tons-N/yr	5
Output	CH4 produced						40	%	60	tons-N/yr	11
Output	CO2 produced						60	%	90	tons-N/yr	11
Output	Leachate						40	%	300	tons-N/yr	
Output	Solid digestate						60	%	450	tons-N/yr	
Output	N2O from composting of solid digestate	7.5	%			6	7.5	%	33.73	tons-N/yr	
TOTAL	**N lost (assuming leachate is used as spray on farm land)**							**5%**	**34**		

Table 3. Phosphorous mass balance for the four scenarios.

SCENARIO 1- LANDFILL MASS BALANCE

		Wet Waste					Phosphorous				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	Food Waste (FW)	40	% of KSO	99,436	tons/yr	2	0.002	kg/kg	199	tons-P/yr	5
Output	PO4 in leachate	1.10E-05	kg/kg	1.09	tons/yr	4	0.3263	g-P/g-PO4	0.36	tons-P/yr	
Input	Garden Waste (GW)	10	% of KSO	24,859	tons/yr	2	0.002	kg/kg	50	tons-P/yr	5
Output	PO4 in leachate	1.10E-05	kg/kg	0.27	tons/yr	4	0.2258	g-P/g-PO4	0.06	tons-P/yr	
MB	Total P released								0.42	tons-P/yr	
MB	**P lost to landfill**							**100%**	**248**	**tons-P/yr**	

SCENARIO 2 - COMPOST MASS BALANCE

		Wet Waste					Phosphorous				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	0.002	kg/kg	179	tons-P/yr	5
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	0.002	kg/kg	45	tons-P/yr	5
Output	Compost - FW						1.8	kg/ton	161	tons-P/yr	12
Output	Compost - GW						1.8	kg/ton	40	tons-P/yr	12
TOTAL	**P lost**							**10%**	**22**		

SCENARIO 3 - ANAEROBIC DIGESTION MASS BALANCE											
		Wet Waste					Phosphorous				
Qualifier	Parameter	Basis	Unit	Amount	Unit	Ref.	Basis	Unit	Amount	Unit	Ref.
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	0.002	kg/kg	179	tons-P/yr	5
Output	Leachate						40	%	72	tons-P/yr	11
Output	Solid digestate						60	%	107	tons-P/yr	11
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	0.002	kg/kg	45	tons-P/yr	5
Output	Leachate						40	%	18	tons-P/yr	11
Output	Solid digestate						60	%	27	tons-P/yr	11
Output	Leachate						40	%	89	tons-P/yr	
Output	Solid digestate						60	%	134	tons-P/yr	
TOTAL	**P lost (assuming leachate is used as spray on farm land)**								**0%**	**0**	

SCENARIO 4 - ANAEROBIC DIGESTION W/ COMPOSTING OF DIGESTATE MASS BALANCE											
		Wet Waste					Phosphorous				
Qualifier	Parameter	Basis	Unit	Amount	Unit	Ref.	Basis	Unit	Amount	Unit	Ref.
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2	0.002	kg/kg	179	tons-P/yr	5
Output	Leachate						40	%	72	tons-P/yr	11
Output	Solid digestate						60	%	107	tons-P/yr	11
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2	0.002	kg/kg	45	tons-P/yr	5
Output	CH4 produced						40	%	18	tons-P/yr	11
Output	CO2 produced						60	%	27	tons-P/yr	11
Output	Leachate						40	%	89	tons-P/yr	
Output	Solid digestate						60	%	134	tons-P/yr	
TOTAL	**P lost (assuming leachate is used as spray on farm land)**								**0%**	**0**	

Table 4. GWP mass balance for the four scenarios.

SCENARIO 1- LANDFILL MASS BALANCE

		Wet Waste					GWP t-CO_2e				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	Food Waste (FW)	40	% of KSO	99,436	tons/yr	2					
Output	CH4 produced	76,622	g/ton	7,619	tons/yr	14					
Output	Energy Generation (landfill gas)						-32	GWP $kgCO_2e$/t-FW	-3,182	tons-CO_2e/yr	14
Output	Short-cycle carbon sequestration						-272	GWP $kgCO_2e$/t-FW	-27,047	tons-CO_2e/yr	14
Output	Methane from leaking landfill gas	10	%	762	tons/yr		62	gCO_2e/gCH_4	47,238	tons-CO_2e/yr	1
Input	Garden Waste (GW)	10	% of KSO	24,859	tons/yr	2					
Output	CH4 produced	98,514	g/ton	2,449	tons/yr	1, 4	0.75	g-C/g-CH4	1,837	tons-C/yr	
Output	Energy Generation (landfill gas)						-32	GWP $kgCO_2e$/t-GW	-795	tons-CO_2e/yr	14
Output	Short-cycle carbon sequestration						-272	GWP $kgCO_2e$/t-GW	-6,762	tons-CO_2e/yr	14
Output	Methane from leaking landfill gas	10	%	245	tons/yr		62	gCO_2e/gCH_4	15,184	tons-CO_2e/yr	1
MB	**GWP (GWP kgCO2e/t FW)**								**24,636**	**tons-CO_2e/yr**	

SCENARIO 2 - COMPOST MASS BALANCE

		Wet Waste					GWP t-CO_2e				
Qualifier	**Parameter**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**	**Basis**	**Unit**	**Amount**	**Unit**	**Ref.**
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2					
Output	CH4 produced	1	kg/ton	89	tons/yr	6	62	gCO_2e/gCH_4	5,549	tons-CO_2e/yr	1
Output	C sequestered in soil						-22	$kgCO_2e$/t-FW	-1,969	tons-CO_2e/yr	13
Output	Fertiliser offset						-36	$kgCO_2e$/t-FW	-3,222	tons-CO_2e/yr	13
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2					
Output	CH4 produced	3	kg/ton	67	tons/yr	6	62	gCO_2e/gCH_4	4,161	tons-CO_2e/yr	1
Output	C sequestered in soil						-22	$kgCO_2e$/t-GW	-492	tons-CO_2e/yr	13
Output	Fertiliser offset						-36	$kgCO_2e$/t-GW	-805	tons-CO_2e/yr	13
MB	**GWP (GWP kgCO2e/t FW)**								**3,222**	**tons-CO_2e/yr**	

SCENARIO 3 - ANAEROBIC DIGESTION MASS BALANCE											
		Wet Waste					GWP t-CO_2e				
Qualifier	Parameter	Basis	Unit	Amount	Unit	Ref.	Basis	Unit	Amount	Unit	Ref.
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2					
Output	Electricity produced						-132	kgCO_2e/t-FW	-11,813	tons-CO_2e/yr	1
Output	C sequestered in soil						-22	kgCO_2e/t-FW	-1,969	tons-CO_2e/yr	13
Output	Fertiliser offset						-36	kgCO_2e/t-FW	-3,222	tons-CO_2e/yr	13
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2					
Output	Electricity produced						-132	kgCO_2e/t-GW	-2,953	tons-CO_2e/yr	
Output	C sequestered in soil						-22	kgCO_2e/t-GW	-492	tons-CO_2e/yr	
Output	Fertiliser offset						-36	kgCO_2e/t-GW	-805	tons-CO_2e/yr	11
MB	**GWP (GWP kgCO2e/t FW)**								**-21,254**	**tons-CO_2e/yr**	

SCENARIO 4 - ANAEROBIC DIGESTION W/ COMPOSTING OF DIGESTATE MASS BALANCE											
		Wet Waste					GWP t-CO_2e				
Qualifier	Parameter	Basis	Unit	Amount	Unit	Ref.	Basis	Unit	Amount	Unit	Ref.
Input	KSO			248,590	tons/yr	1					
Input	After KSO rejects	90	%ww (10% rejects)	223,731	tons/yr	5					
Input	Food Waste (FW)	40	% of KSO	89,492	tons/yr	2					
Output	Electricity produced						-132	kgCO_2e/t-FW	-11,813	tons-CO_2e/yr	1
Output	C sequestered in soil						-22	kgCO_2e/t-FW	-1,969	tons-CO_2e/yr	13
Output	Fertiliser offset						-36	kgCO_2e/t-FW	-3,222	tons-CO_2e/yr	13
Input	Garden Waste (GW)	10	% of KSO	22,373	tons/yr	2					
Output	Electricity produced						-132	kgCO_2e/t-GW	-2,953	tons-CO_2e/yr	
Output	Carbon sequesterisation in soil						-22	kgCO_2e/t-GW	-492	tons-CO_2e/yr	
Output	Fertiliser offset						-36	kgCO_2e/t-GW	-805	tons-CO_2e/yr	11
Output	Leachate	0.331	ton (dry)/ton	29,651	tons/yr	12					
Output	Solid digestate	0.605	ton/ton	54,182	tons/yr	10					
Output	CH4 from composting of solid digestate	52	g/ton digestate	2.8	tons/yr	8	62	gCO_2e/gCH_4	175	tons-CO_2e/yr	1
Output	C sequestered in soil						-22	kgCO_2e/t	-62	tons-CO_2e/yr	13
Output	Fertiliser offset						-36	kgCO_2e/t	-101	tons-CO_2e/yr	13
MB	**GWP (GWP kgCO2e/t FW)**								**-21,243**	**tons-CO_2e/yr**	