APPENDIX B: CARBON DIOXIDE EQUIVALENT EMISSION FACTORS

Exhibit B-1
Net GHG Emissions from Source Reduction and MSW Management Options - Emissions Counted from a Waste Generation Reference Point ($MTCO_2E$/Ton)[a]

Material	Source Reduction[b]	Recycling	Composting[c]	Combustion[d]	Landfilling[e]
Aluminum Cans	-8.23	-13.57	NA	0.06	0.04
Steel Cans	-3.18	-1.79	NA	-1.53	0.04
Copper Wire	-7.34	-4.92	NA	0.05	0.04
Glass	-0.57	-0.28	NA	0.05	0.04
HDPE	-1.79	-1.39	NA	0.93	0.04
LDPE	-2.27	-1.69	NA	0.93	0.04
PET	-2.09	-1.54	NA	1.08	0.04
Corrugated Cardboard	-5.59	-3.11	NA	-0.65	0.40
Magazines/Third-class Mail	-8.65	-3.07	NA	-0.47	-0.30
Newspaper	-4.87	-2.79	NA	-0.74	-0.87
Office Paper	-8.00	-2.85	NA	-0.62	1.94
Phonebooks	-6.32	-2.66	NA	-0.74	-0.87
Textbooks	-9.17	-3.11	NA	-0.62	1.94
Dimensional Lumber	-2.02	-2.46	NA	-0.78	-0.49
Medium-density Fiberboard	-2.22	-2.47	NA	-0.78	-0.49
Food Discards	NA	NA	-0.20	-0.18	0.72
Yard Trimmings	NA	NA	-0.20	-0.22	-0.22
Mixed Paper					
Broad Definition	NA	-3.54	NA	-0.65	0.35
Residential Definition	NA	-3.54	NA	-0.65	0.25
Office Paper Definition	NA	-3.42	NA	-0.59	0.47
Mixed Metals	NA	-5.25	NA	-1.06	0.04
Mixed Plastics	NA	-1.49	NA	0.99	0.04
Mixed Recyclables	NA	-2.91	NA	-0.61	0.14
Mixed Organics	NA	NA	-0.20	-0.20	0.24
Mixed MSW as Disposed	NA	NA	NA	-0.12	0.42
Carpet	-3.99	-7.18	NA	0.39	0.04
Personal Computers	-55.47	-2.26	NA	-0.20	0.04
Clay Bricks	-0.28	NA	NA	NA	0.04
Concrete	NA	-0.01	NA	NA	0.04
Fly Ash	NA	-0.87	NA	NA	0.04
Tires	-3.98	-1.82[f]	NA	0.18	0.04

Note that totals may not add due to rounding, and more digits may be displayed than are significant.

NA: Not applicable, or in the case of composting of paper, not analyzed.

[a]MTCE/ton: Metric tons of carbon equivalent per short ton of material. Material tonnages are on an as-managed (wet weight) basis.

[b]Source reduction assumes initial production using the current mix of virgin and recycled inputs.

[c]There is considerable uncertainty in our estimate of net GHG emissions from composting;

The values of zero are plausible values based on assumptions and a bounding analysis.

[d]Values are for mass burn facilities with national average rate of ferrous recovery.

[e]Values reflect estimated national average methane recovery in year 2004.

[f] Recycling of tires, as modeled in this analysis, consists only of retreading the tires.

Exhibit B-2
GHG Emissions of MSW Management Options Compared to Landfilling[a] ($MTCO_2E$/Ton)
(Management Option Net Emissions Minus Landfilling Net Emissions)

Material	Source Reduction[b] (Current Mix)	Source Reduction (100% Virgin Inputs)	Recycling	Composting[c]	Combustion[d]
Aluminum Cans	-8.27	-15.68	-13.61	NA	0.02
Steel Cans	-3.21	-3.73	-1.83	NA	-1.57
Copper Wire	-7.38	-7.44	-4.96	NA	0.02
Glass	-0.61	-0.68	-0.32	NA	0.01
HDPE	-1.82	-2.00	-1.43	NA	0.89
LDPE	-2.31	-2.39	-1.73	NA	0.89
PET	-2.13	-2.19	-1.58	NA	1.04
Corrugated Cardboard	-5.99	-8.49	-3.51	NA	-1.05
Magazines/Third-class Mail	-8.35	-8.65	-2.77	NA	-0.17
Newspaper	-4.01	-5.09	-1.92	NA	0.13
Office Paper	-9.94	-10.23	-4.79	NA	-2.57
Phonebooks	-5.45	-5.45	-1.79	NA	0.13
Textbooks	-11.11	-11.41	-5.05	NA	-2.57
Dimensional Lumber	-1.53	NA	-1.97	NA	-0.29
Medium-density Fiberboard	-1.73	NA	-1.98	NA	-0.29
Food Discards	NA	NA	NA	-0.92	-0.90
Yard Trimmings	NA	NA	NA	0.02	0.00
Mixed Paper					
Broad Definition	NA	NA	-3.89	NA	-1.00
Residential Definition	NA	NA	-3.79	NA	-0.90
Office Paper Definition	NA	NA	-3.88	NA	-1.06
Mixed Metals	NA	NA	-5.29	NA	-1.10
Mixed Plastics	NA	NA	-1.53	NA	0.95
Mixed Recyclables	NA	NA	-3.05	NA	-0.75
Mixed Organics	NA	NA	NA	-0.43	-0.43
Mixed MSW as Disposed	NA	NA	NA	NA	-0.55
Carpet	-4.03	-4.03	-7.22	NA	0.35
Personal Computers	-55.51	-55.51	-2.30	NA	-0.24
Clay Bricks	-0.32	-0.32	-0.04	NA	-0.04
Concrete	-0.04	-0.04	-0.05	NA	-0.04
Fly Ash	-0.04	-0.04	-0.91	NA	-0.04
Tires	-4.02	-4.02	-1.86[e]	NA	0.14

Note that totals may not add due to rounding, and more digits may be displayed than are significant.

NA: Not applicable, or in the case of composting of paper, not analyzed.

[a]Values for landfilling reflect projected national average methane recovery in year 2004.

[b]Source reduction assumes initial production using the current mix of virgin and recycled inputs.

[c]Calculation is based on assuming zero net emissions for composting.

[d]Values are for mass burn facilities with national average rate of ferrous recovery.

[e] Recycling of tires, as modeled in this analysis, consists only of retreading the tires.

Exhibit B-3
GHG Emissions for Source Reduction (MTCO2E/Ton of Material Source Reduced)
Emissions Measured from a Waste Generation Reference Point[a]

Material	(a) Raw Materials Acquisition and Manufacturing		(b) Forest Carbon Sequestration		(c)	(d) Net Emissions (d = a + b + c)	
	Source Reduction Displaces Current Mix of Virgin and Recycled Inputs	Source Reduction Displaces Virgin Inputs	Source Reduction Displaces Current Mix of Virgin and Recycled Inputs	Source Reduction Displaces Virgin Inputs	Waste Management Emissions	Source Reduction Displaces Current Mix of Virgin and Recycled Inputs	Source Reduction Displaces Virgin Inputs
Aluminum Cans	-8.23	-15.64	0.00	0.00	0.00	-8.23	-15.64
Steel Cans	-3.18	-3.69	0.00	0.00	0.00	-3.18	-3.69
Copper Wire	-7.34	-7.40	0.00	0.00	0.00	-7.34	-7.40
Glass	-0.57	-0.65	0.00	0.00	0.00	-0.57	-0.65
HDPE	-1.79	-1.97	0.00	0.00	0.00	-1.79	-1.97
LDPE	-2.27	-2.35	0.00	0.00	0.00	-2.27	-2.35
PET	-2.09	-2.15	0.00	0.00	0.00	-2.09	-2.15
Corrugated Cardboard	-0.86	-0.83	-4.73	-7.26	0.00	-5.59	-8.09
Magazines/Third-class Mail	-1.69	-1.69	-6.96	-7.26	0.00	-8.65	-8.95
Newspaper	-1.92	-2.12	-2.95	-3.83	0.00	-4.87	-5.95
Office Paper	-1.04	-1.02	-6.96	-7.26	0.00	-8.00	-8.28
Phonebooks	-2.49	-2.49	-3.83	-3.83	0.00	-6.32	-6.32
Textbooks	-2.20	-2.21	-6.96	-7.26	0.00	-9.17	-9.47
Dimensional Lumber	-0.18	-0.18	-1.84	-1.84	0.00	-2.02	-2.02
Medium-density Fiberboard	-0.37	-0.37	-1.84	-1.84	0.00	-2.22	-2.22
Food Discards	NA	NA	NA	NA	NA	NA	NA
Yard Trimmings	NA	NA	NA	NA	NA	NA	NA
Mixed Paper							
Broad Definition	NA	NA	NA	NA	NA	NA	NA
Residential Definition	NA	NA	NA	NA	NA	NA	NA
Office Paper Definition	NA	NA	NA	NA	NA	NA	NA
Mixed Plastics	NA	NA	NA	NA	0.00	NA	NA
Mixed Recyclables	NA	NA	NA	NA	0.00	NA	NA
Mixed Organics	NA	NA	NA	NA	0.00	NA	NA
Mixed MSW (as disposed)	NA	NA	NA	NA	NA	NA	NA
Carpet	-3.99	-3.99	0.00	0.00	0.00	-3.99	-3.99
Personal Computers	-55.47	-55.47	0.00	0.00	0.00	-55.47	-55.47
Clay Bricks	-0.28	-0.28	0.00	0.00	0.00	-0.28	-0.28
Concrete	NA	NA	NA	NA	NA	NA	NA
Fly Ash	NA	NA	NA	NA	NA	NA	NA
Tires	-13.97	-13.97	0.00	0.00	0.00	-13.97	-13.97

Note that totals may not add due to rounding and more digits may be displayed than are significant.
NA: Not applicable, or in the case of composting of paper, not analyzed.
[a] Under the accounting convention used in this analysis, emissions are quantified from a waste generation reference point (once the material has already undergone the raw materials acquisition and manufacturing phase).

Exhibit B-4
Recycling (GHG Emissions in MTCO2E/Ton)
Emissions Measured from a Waste Generation Reference Point[a]

	Raw Materials Acquisition and Manufacturing (RMAM)		Recycled Input Credit[b]					
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h) (h = b+c+d+e+f+g)
Material	RMAM Emissions Not Included in Baseline (Current Mix of Inputs)	Waste Generation Baseline	Process Energy	Transportation Energy	Process Non-Energy	Forest Carbon Sequestration	Waste Management Emissions	Net Emissions
Aluminum Cans	8.23	0.00	-10.70	-0.44	-2.43	0.00	0.00	-13.57
Steel Cans	3.18	0.00	-1.75	-0.04	0.00	0.00	0.00	-1.79
Copper Wire	7.34	0.00	-4.86	-0.06	0.00	0.00	0.00	-4.92
Glass	0.57	0.00	-0.12	-0.02	-0.14	0.00	0.00	-0.28
HDPE	1.79	0.00	-1.25	0.00	-0.15	0.00	0.00	-1.39
LDPE	2.27	0.00	-1.55	0.00	-0.15	0.00	0.00	-1.69
PET	2.09	0.00	-1.46	0.00	-0.08	0.00	0.00	-1.54
Corrugated Cardboard	0.86	0.00	0.00	-0.05	-0.01	-3.06	0.00	-3.11
Magazines/Third-class Mail	1.69	0.00	-0.01	0.00	0.00	-3.06	0.00	-3.07
Newspaper	1.92	0.00	-0.75	-0.03	0.00	-2.02	0.00	-2.79
Office Paper	1.04	0.00	0.22	0.00	-0.02	-3.06	0.00	-2.85
Phonebooks	2.49	0.00	-0.64	0.00	0.00	-2.02	0.00	-2.66
Textbooks	2.20	0.00	-0.05	0.00	0.00	-3.06	0.00	-3.11
Dimensional Lumber	0.18	0.00	0.07	0.01	0.00	-2.53	0.00	-2.46
Medium-density Fiberboard	0.37	0.00	0.05	0.01	0.00	-2.53	0.00	-2.47
Food Discards	NA	0.00	NA	NA	NA	NA	NA	NA
Yard Trimmings	NA	0.00	NA	NA	NA	NA	NA	NA
Mixed Paper								
Broad Definition	1.06	0.00	-0.37	-0.11	-0.01	-3.06	0.00	-3.54
Residential Definition	1.06	0.00	-0.37	-0.11	-0.01	-3.06	0.00	-3.54
Office Paper Definition	3.24	0.00	-0.29	-0.07	0.00	-3.06	0.00	-3.42
Mixed Metals	NA	0.00	-4.38	-0.16	-0.71	0.00	0.00	-5.25
Mixed Plastics	NA	0.00	-1.38	0.00	-0.12	0.00	0.00	-1.49
Mixed Recyclables	NA	0.00	-0.40	-0.04	-0.05	-2.42	0.00	-2.91
Mixed Organics	NA	NA	NA	NA	NA	NA	NA	NA
Mixed MSW (as disposed)	NA	NA	NA	NA	NA	NA	NA	NA
Carpet	3.99	0.00	-5.38	-0.06	-1.74	0.00	0.00	-7.18
Personal Computers	55.47	0.00	-1.49	-0.04	-0.73	0.00	0.00	-2.26
Clay Bricks	0.28	0.00	NA	NA	NA	NA	NA	NA
Concrete	NA	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01
Fly Ash	NA	0.00	-0.42	0.00	-0.45	0.00	0.00	-0.87
Tires[c]	13.97	0.00	-6.40	0.00	0.00	0.00	0.00	-6.40

Note that totals may not add due to rounding and more digits may be displayed than are significant.
NA: Not applicable, or in the case of composting of paper, not analyzed.
[a] Under the accounting convention used in this analysis, emissions are quantified from a waste generation reference point (once the material has already undergone the raw materials acquisition and manufacturing phase).
[b] Material that is recycled after use is then substituted for virgin inputs in the production of new products. This credit represents the difference in emissions that results from using recycled inputs
[c] Recycling of tires, as modeled in this analysis, consists only of retreading the tires.

Exhibit B-5
Composting (GHG Emissions in MTCO2E/Ton)
Values are for Mass Burn Facilities with National Average Rate of Ferrous Recovery. Emissions Measured from a Waste Generation Reference Point[a]

	Raw Materials Acquisition and Manufacturing (RMAM)				
	(a)	(b)	(c)	(d)	(e) (e = b+c+d)
Material	RMAM Emissions Not Included in Baseline[b]	Waste Generation Baseline	Transportation to Composting	Soil Carbon Sequestration	Net Emissions (Post-Consumer)
Aluminum Cans	-8.23	0.00	NA	NA	NA
Steel Cans	-3.18	0.00	NA	NA	NA
Copper Wire	-7.34	0.00	NA	NA	NA
Glass	-0.57	0.00	NA	NA	NA
HDPE	-1.79	0.00	NA	NA	NA
LDPE	-2.27	0.00	NA	NA	NA
PET	-2.09	0.00	NA	NA	NA
Corrugated Cardboard	-0.86	0.00	NA	NA	NA
Magazines/Third-class Mail	-1.69	0.00	NA	NA	NA
Newspaper	-1.92	0.00	NA	NA	NA
Office Paper	-1.04	0.00	NA	NA	NA
Phonebooks	-2.49	0.00	NA	NA	NA
Textbooks	-2.20	0.00	NA	NA	NA
Dimensional Lumber	-0.18	0.00	NA	NA	NA
Medium-density Fiberboard	-0.37	0.00	NA	NA	NA
Food Discards	NA	0.00	0.04	-0.24	-0.20
Yard Trimmings	NA	0.00	0.04	-0.24	-0.20
Mixed Paper					
Broad Definition	1.06	0.00	NA	NA	NA
Residential Definition	1.06	0.00	NA	NA	NA
Office Paper Definition	3.24	0.00	NA	NA	NA
Mixed Metals	NA	0.00	NA	NA	NA
Mixed Plastics	NA	0.00	NA	NA	NA
Mixed Recyclables	NA	0.00	NA	NA	NA
Mixed Organics	NA	0.00	0.04	-0.24	-0.20
Mixed MSW (as disposed)	NA	NA	NA	NA	NA
Carpet	-3.99	0.00	NA	NA	NA
Personal Computers	-55.47	0.00	NA	NA	NA
Clay Bricks	-0.28	0.00	NA	NA	NA
Concrete	NA	0.00	NA	NA	NA
Fly Ash	NA	0.00	NA	NA	NA
Tires	-13.97	0.00	NA	NA	NA

Note that totals may not add due to rounding and more digits may be displayed than are significant.
NA: Not applicable, or in the case of composting of paper, not analyzed.
[a] Under the accounting convention used in this analysis, emissions are quantified from a waste generation reference point (once the material has already undergone the raw materials acquisition and manufacturing phase).

Exhibit B-6
Combustion (GHG Emissions in MTCO2E/Ton)
Values are for Mass Burn Facilities with National Average Rate of Ferrous Recovery. Emissions Measured from a Waste Generation Reference Point[a]

	Raw Materials Acquisition and Manufacturing (RMAM)							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h) (h = b+c+d+e+f+g)
Material	RMAM Emissions Not Included in Baseline[b]	Waste Generation Baseline	Transportation to Combustion	CO_2 from Combustion	N_2O from Combustion	Avoided Utility Emissions	Ferrous Recovery	Net Emissions (Postconsumer)
Aluminum Cans	-8.23	0.00	0.03	0.00	0.00	0.03	0.00	0.06
Steel Cans	-3.18	0.00	0.03	0.00	0.00	0.02	-1.58	-1.53
Copper Wire	-7.34	0.00	0.03	0.00	0.00	0.03	0.00	0.05
Glass	-0.57	0.00	0.03	0.00	0.00	0.02	0.00	0.05
HDPE	-1.79	0.00	0.03	2.79	0.00	-1.89	0.00	0.93
LDPE	-2.27	0.00	0.03	2.79	0.00	-1.89	0.00	0.93
PET	-2.09	0.00	0.03	2.04	0.00	-0.98	0.00	1.08
Corrugated Cardboard	-0.86	0.00	0.03	0.00	0.04	-0.71	0.00	-0.65
Magazines/Third-class Mail	-1.69	0.00	0.03	0.00	0.04	-0.53	0.00	-0.47
Newspaper	-1.92	0.00	0.03	0.00	0.04	-0.81	0.00	-0.74
Office Paper	-1.04	0.00	0.03	0.00	0.04	-0.69	0.00	-0.62
Phonebooks	-2.49	0.00	0.03	0.00	0.04	-0.81	0.00	-0.74
Textbooks	-2.20	0.00	0.03	0.00	0.04	-0.69	0.00	-0.62
Dimensional Lumber	-0.18	0.00	0.03	0.00	0.04	-0.84	0.00	-0.78
Medium-density Fiberboard	-0.37	0.00	0.03	0.00	0.04	-0.84	0.00	-0.78
Food Discards	NA	0.00	0.03	0.00	0.04	-0.24	0.00	-0.18
Yard Trimmings	NA	0.00	0.03	0.00	0.04	-0.28	0.00	-0.22
Mixed Paper								
Broad Definition	1.06	0.00	0.03	0.00	0.04	-0.72	0.00	-0.65
Residential Definition	1.06	0.00	0.03	0.00	0.04	-0.71	0.00	-0.65
Office Paper Definition	3.24	0.00	0.03	0.00	0.04	-0.66	0.00	-0.59
Mixed Metals	NA	0.00	0.03	0.00	0.00	0.02	-1.12	-1.06
Mixed Plastics	NA	0.00	0.03	2.49	0.00	-1.53	0.00	0.99
Mixed Recyclables	NA	0.00	0.03	0.06	0.03	-0.67	-0.05	-0.61
Mixed Organics	NA	0.00	0.03	0.00	0.04	-0.26	0.00	-0.20
Mixed MSW (as disposed)	NA	0.00	0.03	0.37	0.04	-0.51	-0.05	-0.12
Carpet	-3.99	0.00	0.03	1.72	0.00	-1.36	0.00	0.39
Personal Computers	-55.47	0.00	0.03	0.38	0.00	-0.16	-0.45	-0.20
Clay Bricks	-0.28	0.00	0.03	NA	NA	NA	NA	0.03
Concrete	NA	0.00	NA	NA	NA	NA	NA	NA
Fly Ash	NA	0.00	NA	NA	NA	NA	NA	NA
Tires	-13.97	0.00	0.03	7.53	0.00	-7.25	-0.13	0.18

Note that totals may not add due to rounding, and more digits may be displayed than are significant.

[a] Under the accounting convention used in this analysis, emissions are quantified from a waste generation reference point (once the material has already undergone the raw materials acquisition and manufacturing phase).

Exhibit B-7
Landfilling (GHG Emissions in MTCO2E/Ton)
Values for Landfill Methane and Net Emissions Reflect Projected National Average Methane Recovery in year 2003.
Emissions Measured from a Waste Generation Reference Point[a]

Material	Raw Materials Acquisition and Manufacturing (RMAM)		(c)	(d)	(e)	(f)	(g) (g=b+c+d+e+f)
	(a)	(b)					
	RMAM Emissions Not Included in Baseline[b]	Waste Generation Baseline	Transportation to Landfill	Net Landfill CH_4	Avoided Utility Emissions	Landfill Carbon Sequestration	Net Emissions
Aluminum Cans	8.23	0.00	0.04	0.00	0.00	0.00	0.04
Steel Cans	3.18	0.00	0.04	0.00	0.00	0.00	0.04
Glass	7.34	0.00	0.04	0.00	0.00	0.00	0.04
Copper Wire	0.57	0.00	0.04	0.00	0.00	0.00	0.04
HDPE	1.79	0.00	0.04	0.00	0.00	0.00	0.04
LDPE	2.27	0.00	0.04	0.00	0.00	0.00	0.04
PET	2.09	0.00	0.04	0.00	0.00	0.00	0.04
Corrugated Cardboard	0.86	0.00	0.04	1.26	-0.08	-0.82	0.40
Magazines/Third-class Mail	1.69	0.00	0.04	0.51	-0.03	-0.82	-0.30
Newspaper	1.92	0.00	0.04	0.45	-0.03	-1.33	-0.87
Office Paper	1.04	0.00	0.04	2.20	-0.13	-0.16	1.94
Phonebooks	2.49	0.00	0.04	0.45	-0.03	-1.33	-0.87
Textbooks	2.20	0.00	0.04	2.20	-0.13	-0.16	1.94
Dimensional Lumber	0.18	0.00	0.04	0.65	-0.04	-1.14	-0.49
Medium-density Fiberboard	0.37	0.00	0.04	0.65	-0.04	-1.14	-0.49
Food Discards	NA	0.00	0.04	0.82	-0.05	-0.08	0.72
Yard Trimmings	NA	0.00	0.04	0.48	-0.03	-0.71	-0.22
Mixed Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Broad Definition	1.06	0.00	0.04	1.19	-0.07	-0.81	0.35
Residential Definition	1.06	0.00	0.04	1.13	-0.07	-0.84	0.25
Office Paper Definition	3.24	0.00	0.04	1.18	-0.07	-0.67	0.47
Mixed Metals	NA	0.00	0.04	0.00	0.00	0.00	0.04
Mixed Plastics	NA	0.00	0.04	0.00	0.00	0.00	0.04
Mixed Recyclables	NA	0.00	0.04	0.94	-0.06	-0.78	0.14
Mixed Organics	NA	0.00	0.04	0.64	-0.04	-0.41	0.24
Mixed MSW (as disposed)	NA	0.00	0.04	1.06	-0.07	-0.61	0.42
Carpet	3.99	0.00	0.04	0.00	0.00	0.00	0.04
Personal Computers	55.47	0.00	0.04	0.00	0.00	0.00	0.04
Clay Bricks	0.28	0.00	0.04	0.00	0.00	0.00	0.04
Concrete	NA	0.00	0.04	0.00	0.00	0.00	0.04
Fly Ash	NA	0.00	0.04	0.00	0.00	0.00	0.04
Tires	13.97	0.00	0.04	0.00	0.00	0.00	0.04

Note that totals may not add due to rounding and more digits may be displayed than are significant.
NA: Not applicable, or in the case of composting of paper, not analyzed.
[a] Under the accounting convention used in this analysis, emissions are quantified from a waste generation reference point (once the material has already undergone the raw materials acquisition and manufacturing phase).