Excerpts from

MASSACHUSETTS RECYCLE 2000: BASELINE REPORT

Prepared for:

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V. ARE THERE ECONOMIC AND ENVIRONMENTAL BENEFITS OF RECYCLING?

A. Background

Recycling waste materials creates a variety of economic and environmental benefits both locally and globally. Table V-1 provides a summary of those benefits for Massachusetts. Derivation of the data in Table V-1 is detailed in Attachment D.

The first column shows the market revenues generated when collected recyclables have been processed and packaged for sell to manufacturers who will use the materials in producing new products. The prices for each material are the average dock price at the Springfield MRF for 1996. On average, curbside recycled materials generated $64 per ton in revenues from end-use markets in 1996. Revenues for individual materials ranged from lows of $11 for glass and $15 per ton for mixed paper, to $865 per ton for aluminum cans. These revenues provide cash that could be used to offset costs of curbside collection and materials processing.

The second column in Table V-1 shows estimates for garbage collection and disposal costs that are saved when materials are diverted from the trash and instead recycled. According to Solid Waste Digest the average tip fee for all Massachusetts disposal facilities in the 1996-97 period was $59 per ton. That amount plus an estimated savings of 33% in garbage collection costs accounts for the per ton avoided trash costs shown in the second column. Less voluminous materials such as glass and newspapers don't occupy as much space for each ton of material in the garbage truck and so have lower per ton garbage collection costs than more space intensive materials such as aluminum cans and plastic bottles. On average curbside recycling saves about $88 per ton in garbage collection and disposal costs.

Taken together recycling revenues and avoided trash costs provide the monetary benefits available to local municipalities to help offset the costs of curbside or drop-off recycling collection programs and the costs of processing materials for sale on recycling markets. As indicated in Table V-1, market revenues and garbage cost savings from recycling amounted to $152 per ton of collected recyclables in 1996. It is important to note that the material sales revenues shown in the first column of Table V-1 are what the market pays for materials that have been processed at a materials recovery facility. The municipality collecting recyclables will receive substantially less when they deliver unprocessed recyclables to a processing facility.

Table V-1
Economic and Environmental Benefits Per Ton Recycled

Material	1996 Material Sales Revenue	Avoided Trash Costs	Employment	Public Health & Environment	Total Benefits Per Ton
Newspapers	$38	$72	$60 – 179	$32	$202 – 321
Cardboard	45	97	60 – 179	32	228 – 353
Mixed Paper	15	78	60 – 179	32	179 – 304
Glass	11	69	1 – 3	24	105 – 107
Steel Cans	74	93	20 – 59	13	200 – 239
Alum. Cans	865	109	32 – 96	933	1,939 – 2,003
PET Bottles	170	111	180 – 541	270	731 – 1,092
HDPE Bottles	212	108	178 – 535	127	625 – 982
Average	**$64**	**$88**	**$55 – 164**	**$63**	**$270 – 379**

Sources: Estimates calculated from Springfield MRF 1996 prices; *Solid Waste Digest*'s Solid Waste Price Index for Massachusetts' disposal fees; Barbara Stevens, "Recycling Collection Costs by the numbers: a national survey," *Resource Recycling* (9/94), for garbage collection cost savings; DEP and ISP, "Turning Wastepaper into Jobs," (2/96), Brenda Platt, Institute for Local Self-Reliance, personal communications 1997, and Michael James Shore, "The Impact of Recycling on Jobs on North Carolina, 1994, for job impacts from recycling; and Brian Zuckerman and Frank Ackerman, "The 1994 Update of the Tellus *Packaging Study* Impact Assessment Method," EPA, "Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste," Final Report , 9/98, and Proctor & Redfern Ltd and ORTECH International, "Estimation of the Effects of Various Municipal Waste Management Strategies on Greenhouse Gas Emissions," Environment Canada, 2/94, for public health and environmental benefits.

B. Additional Benefits from Recycling

In addition to revenues and avoided trash costs, recycling provides two other important benefits – jobs in industries that use recycled materials to manufacture new products, and savings in raw materials acquisition and processing.

The third column of Table V-1 gives estimates for the income generated by jobs in recycled-content manufacturing industries. The typical job is assumed to pay $25,000 annually, and the spending of this income in Massachusetts is estimated to generate an additional 65% of a job for each recycled-content manufacturing job. However, recycled materials often are sold to manufacturers outside of Massachusetts. To account for this fact, the table shows a range for employment benefits assuming between 25% and 75% of collected recyclables are actually used in manufacturing facilities located in the state. As a result of recycling, each ton diverted from trash is estimated to yield between $55 and $164 in job opportunities in Massachusetts.

Glass recycling has the lowest job benefits per ton diverted. Recycled glass substitutes for the batch of virgin glassmaking materials (glass sand, soda ash and limestone) in Massachusetts' glass container manufacturing industry on a one-to-one basis. Each job that is added from usage of recycled glass is offset by loss of a job using virgin materials to produce new glass containers.

On the other hand, plastic bottles require labor intensive efforts to clean, wash, flake and pelletize bottles that are delivered in bales from the MRF to the plastics processing and manufacturing facility. There is little likelihood that this processing and manufacturing activity causes any job losses in virgin chemicals and polymer manufacturing in Massachusetts.

Finally, the fourth column of Table V-1 gives estimates of environmental benefits yielded by Massachusetts' recycling programs. These benefits arise from reduced use of virgin raw materials whenever recycled materials are used to manufacture new products. Use of virgin raw materials and fuels in manufacturing products releases harmful pollutants that impair human health. Acquisition of raw materials diminishes productivity in natural resource industries, destroys species habitat and impairs ecosystems. It also diminishes our enjoyment of previously pristine, wild places.

Most of these environmental impacts of virgin material and fuel resource use have not been specifically quantified. However, the public health impacts of certain hazards released during virgin materials use have been estimated, as have the greenhouse gas releases associated with virgin versus recycled materials use in manufacturing. These estimates are the basis for the net public health and environmental benefits from recycling shown in Table V-1. That is, recycling has negative environmental impacts, but they pale in significance compared with the impacts of virgin materials acquisition and manufacturing activities.

It should be emphasized that the employment, public health and environmental benefit estimates shown in Table V-1 are for the net benefit obtained when recycled materials replace virgin materials in manufacturing products. That is, employment benefits include a deduction for job losses in garbage collection and disposal, as well as for job losses in manufacturing operations using virgin feedstock. Similarly, public health and environmental benefits include a deduction for the impacts of recycling collection and processing, as well as for emissions from manufacturing operations using recycled feedstock.

As indicated in Table V-1, recycling's net environmental benefits are estimated to average about $63 per ton. They range from lower benefits per ton for paper, glass and steel cans, to higher benefits for plastics and aluminum. These higher benefits are due primarily to the energy intensity and hazardous pollution releases associated with using virgin plastic or aluminum materials in manufacturing.

Attachment D
Derivation of Estimates of Recycling's Environmental and Economic Benefits Per ton

1) Material Sales Revenues Minus Processing Costs

Table D-1 shows sales revenue per ton for materials recycled through the Springfield MRF – newspapers, cardboard, mixed paper (including high grades), glass food and beverage containers, tin-plated steel food and beverage containers, aluminum cans, PET plastic bottles and HDPE plastic bottles. In 1996 revenues to the Springfield MRF ranged from $865 per ton for aluminum cans to $11 per ton for glass food and beverage containers. Based on estimated tons diverted in the state of Massachusetts in 1996, the average ton of diverted materials was worth $64 in 1996, and $72 per ton over the period 1992 through 1998.

Table D-1
Material Sales Revenue

Material	1996 Diversion (tons)	1996 Avg. Revenue ($/ton)	1992-98 Avg. Revenue ($/ton)
Newspaper	144,000	$38	$43
Cardboard	600,000	45	58
Mixed Paper	281,000	15	14
Glass Containers	102,000	11	15
Steel Cans	41,000	74	48
Aluminum Cans	37,000	865	885
PET Bottles	17,000	170	203
HDPE Bottles	18,000	212	218
Average/Total	**1,240,000**	**$64**	**$72**

Sources: Diversion tons from "Recycling 2000: Recommendations for Increasing Recycling in the Commonwealth of Massachusetts," Appendix A; prices from average revenues (FOB dock) at the Springfield MRF.

Based on 1998 Municipal Recycling Report Card data, regional tipping fees for recyclables varied from a low of $1 per ton on average in the West to a high of $55 per ton in the Northeast region. Based on a variety of estimates of processing costs for recyclables (e.g., National Solid Wastes Management Association, "Processing Costs for Residential Recyclables at Material Recovery Facilities," Washington, DC, August 1992), the average processing cost per ton for the types of materials listed in Table B-1 is estimated to be about $50.

Thus, communities in the Northeast region may have to pay on average $55 per ton to get rid of recyclables collected through curbside or drop-off recycling programs, whereas communities in the West region may only pay on average a dollar per ton. Furthermore, some communities may negotiate with a processor to share market revenues (and take much of the risk of market downturns). In this case the community would receive some or all of the net $14 to $22 per ton difference between estimated processing costs of $50 and revenues which averaged $64 in 1996 and $72 over the seven years from 1992 through 1998. Assuming a 75/25 community/processor split, for example, risk sharing communities would be paid about $16 per ton for their recyclables in years when market revenues average $72.

On this basis a representative range for material sales revenues minus processing costs in Massachusetts is $(55) to $16 per ton.

2) Avoided Trash Costs

Table D-2 shows estimated trash collection and disposal costs that are avoided by recycling the various materials listed in the table. Disposal costs averaged $59 per ton at Massachusetts' incinerators, landfills and transfer stations in mid-1997. On average, then, $59 is saved when a ton of material is diverted from garbage into recycling.

The table also shows estimated collection costs when each of the materials listed in the table is collected in trash. Estimates for individual materials are based on the assumption that trash collection costs are proportional to the relative volume to weight ratio for an individual material compared with the average for all trash materials combined. One ton of plastic bottles, for example, or cardboard, takes up relatively more space in the garbage truck than the average ton of mixed trash. Trash collection costs for these less dense materials are for this reason estimated to be higher than the $53 per ton cost for the average ton of trash.

There are substantial trash collection costs that may not decrease when more materials are removed from the trash stream for recycling. At the same time, garbage collection routes can be redesigned and trips to the transfer station or disposal facility decreased, as more tons are recycled. To be conservative, the estimates for avoided collection costs shown in the table assume that just 33% of trash collection costs vary directly with the amount of trash collected.

On this basis the average ton of material recycled in Massachusetts in fiscal 1996 resulted in a savings of $88, $59 in avoided disposal costs and $29 in avoided trash collection costs.

Table D-2
Avoided Trash Costs

Material	1996 Diversion (tons)	Disposal Costs ($/ton)	Collection Costs ($/ton)	Avoided Collection Costs ($/ton)	Avoided Collection/Disposal Costs ($/ton)
Newspaper	144,000	$59	$38	$13	$72
Cardboard	600,000	59	114	38	97
Mixed Paper	281,000	59	57	19	78
Glass Containers	102,000	59	30	10	69
Steel Cans	41,000	59	103	34	93
Aluminum Cans	37,000	59	151	50	109
PET Bottles	17,000	59	155	52	111
HDPE Bottles	18,000	59	148	49	108
Average/Total	**1,240,000**	**$59**	**$87**	**$29**	**$88**

Sources: Diversion tons from "Recycling 2000: Recommendations for Increasing Recycling in the Commonwealth of Massachusetts," Appendix A; disposal costs from *Solid Waste Digest*, Solid Waste Price Index, September 1997, for Massachusetts incinerators, landfills and transfer stations; trash collection costs based on survey data in Barbara Stevens, "Recycling collection costs by the numbers: a national survey," *Resource Recycling*, September 1994, and Sound Resource Management Group, *The Economics of Recycling and Recycled Materials*, Clean Washington Center, June 30, 1993, Tables A-5 and A-6, pp. 29-30. The latter source provided weight to volume conversion ratios to distribute Stevens' $53 per ton average refuse collection cost estimate across the individual materials shown in Table D-2.

3) Net Employment Benefits

Table D-3 shows estimated jobs in manufacturing in Massachusetts associated with recycling paper, glass, metals and plastics. As shown in the table, the mix of materials recycled in Massachusetts in 1996 yielded almost 6 jobs for every 1000 tons diverted, or just over 7,000 jobs in total. Interestingly, this is comparable to the estimate by a 1994 study that Massachusetts had over 8,000 jobs in recycling processing and manufacturing industries (Roy F. Weston, Inc., "Value Added to Recyclable Materials in the Northeast," prepared for the Northeast Recycling Council of the Council of State Governments, May 8, 1994, Table 1-1).

Of course, job gains from recycling may be associated with job losses in Massachusetts industries that manufacture products from competing virgin materials. Such is the case for Massachusetts' glass containers plant where increased manufacturing of glass containers from recycled glass results in decreased manufacturing of glass containers from virgin glass sand, calcium carbonate and sodium carbonate. This offsetting job loss is shown in Table B-3. Other manufacturing industries using recycled materials, however, do not on preliminary examination of the state's employment patterns appear to be associated with offsetting job decreases in virgin material manufacturing industries.

In addition, there may be job losses in garbage collection and disposal when materials are diverted from the trash into recycling. Based on studies by the Institute for Local Self-Reliance, trash handling job losses do not appear to be a significant offset to manufacturing job gains when more materials are recycled.

Finally, a recent study for the Recycle Iowa Program estimated that every job created by recycling resulted in an additional job in non-recycling-related sectors of Iowa's economy. To adjust for the fact that a larger state like Iowa might capture a larger portion of the indirect employment (ripple) effects than a smaller state such as Massachusetts, it was assumed that each recycling manufacturing job would induce only about 65% of an additional job.

Applying this indirect economic benefits multiplier of 1.65 to the estimates shown in Table D-3 yields a net jobs impact of about 8.9 jobs for every 1,000 tons diverted from trash. At an estimated income of $25,000 per job, these jobs are worth about $220 for each ton of material recycled in Massachusetts. This estimate assumes that all materials recycled in Massachusetts are actually used in manufacturing industries in the state. However, many recycled materials are actually exported to end-use manufacturers outside of Massachusetts. Assuming between 25% and 75% of recycled materials are actually used in state, recycling's net employment benefits amount to between $55 and $164 per ton of material recycled.

Table D-3
Net Direct Employment Gains from Recycling

Material	1996 Diversion (tons)	Job Gains in Manufacturing (jobs/1000 tons)	Job Losses in Virgin Mfg. (jobs/1000 tons)	Job Losses in Trash Handling (jobs/1000 tons)	Net Direct Job Gains (jobs/1000 tons)
Newspaper	144,000	5.8	0	.01	5.8
Cardboard	600,000	5.8	0	.01	5.8
Mixed Paper	281,000	5.8	0	.01	5.8
Glass Containers	102,000	2.3	2.2	.01	0.1
Steel Cans	41,000	1.9	0	.01	1.9
Aluminum Cans	37,000	3.1	0	.01	3.1
PET Bottles	17,000	17.5	0	.01	17.5
HDPE Bottles	18,000	17.3	0	.01	17.3
Average/Total	**1,240,000**	**5.6**	**0.2**	**.01**	**5.4**

Sources: Diversion tons from "Recycling 2000: Recommendations for Increasing Recycling in the Commonwealth of Massachusetts," Appendix A; job impacts based on Massachusetts DEP and ISP, "Turning Wastepaper into Jobs," (2/96), Brenda Platt, Institute for Local Self-Reliance, personal communications 1997, and Michael James Shore, "The Impact of Recycling on Jobs in North Carolina, 1994.

4) Net Environmental Benefits

Fewer hazardous substances and pollutants are emitted when products are manufactured with recycled materials instead of virgin wood, metal and petroleum resources. In addition, fewer hazards and pollutants are released when materials are collected for recycling instead of collected in the trash and disposed in a landfill or incinerator.

Table D-4 shows estimates of the per ton benefit from reduced releases when materials are recycled and used in place of virgin materials in manufacturing new products. These benefit estimates are based on savings in expenditures on public health when releases of hazardous substances are reduced, and on the reduction in expenditures required to attain regulatory limits for criteria air pollutants. The table also shows public health benefits from reduced emissions at landfills and incinerators, net of increased emissions as a result of collecting materials for recycling and trash on separate trucks.

On average, materials recycled in Massachusetts in fiscal 1996 yielded a benefit of $48 per ton by reducing hazardous substances and pollutants released when virgin materials are used to manufacture new products. An additional $2 per ton benefit accrued as a result of collecting fewer materials for disposal in landfills and incinerators. Both of these figures are net of the increase in releases from manufacturing products with recycled materials and from collecting materials in recycling trucks. It is instructive to note that these figures also suggest that it is much more hazardous to the public's health to live near a virgin materials refining and manufacturing facility than it is to live next to a landfill or incinerator that is operated in conformance with disposal facility emissions standards.

Table D-4
Net Benefit from Reduced Releases of Hazards, Pollutants & Greenhouse Gases(GHG)

Material	1996 Diversion (tons)	Net Benefit from Lower Manufacturing Emissions ($/ton)	Net Benefit from Lower Trash Management Emissions ($/ton)	Net Benefit from Lower GHG Emissions ($/ton)	Total Net Environmental Benefit ($/ton)
Newspaper	144,000	$18	$2	$12	$32
Cardboard	600,000	18	2	12	32
Mixed Paper	281,000	18	2	12	32
Glass Containers	102,000	22	1	1	24
Steel Cans	41,000	2	1	10	13
Aluminum Cans	37,000	852	3	78	933
PET Bottles	17,000	252	3	15	270
HDPE Bottles	18,000	113	3	11	127
Average/Total	**1,240,000**	**$48**	**$2**	**$13**	**$63**

Sources: Diversion tons from "Recycling 2000: Recommendations for Increasing Recycling in the Commonwealth of Massachusetts," Appendix A; estimates of net manufacturing benefits are from Brian Zuckerman and Frank Ackerman, "The 1994 Update of the Tellus *Packaging Study* Impact Assessment Method," Tellus Institute, Table 2: estimates of solid waste management system benefits are from the Tellus *Packaging Study*, Report #4, "Impacts of Production and Disposal of Packaging Materials – Methods and Case Studies," Table 2.15; and estimates of net benefits from GHG reductions are based on US EPA, *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste*, Final Report, September 1998, Exhibit ES-4.

Table D-4 also shows the benefit in reduced emissions of greenhouse gases (GHG) as a result of recycling. As with releases of hazardous substances and pollutants, the majority of GHG benefits from recycling are the result of replacing virgin manufacturing feedstock with recycled materials at manufacturing operations. In this case the significant energy savings associated with using recycled rather than virgin materials account for much of the reduction in GHG emissions. Emissions of greenhouse gases were estimated to incur a cost of $8 per ton of carbon dioxide equivalents, based on the California Energy Commission's control cost estimate that $8 must be spent on reforestation to grow enough trees to absorb a ton of carbon dioxide each year.[1]

Finally, Table D-4 shows that the combined environmental benefits of recycling are worth $63 per ton, based on the mix of materials recycled in Massachusetts in fiscal 1996.

[1] California Energy Commission, Committee Order for Final Policy Analysis, Docket No. 88-ER-8, March 27, 1990, as reported in the Tellus *Packaging Study*, Report #4, "Impacts of Production and Disposal of Packaging Materials - Methods and Case Studies," p. 1-5.