

TASK B

ANALYSIS OF MANDATORY CURBSIDE RECYCLING PROGRAM COSTS

DELAWARE SOLID WASTE AUTHORITY

*Analysis of Statewide Curbside Collection Costs and Quantities
For Single Stream Collection of Recyclables (without glass)
From Households Using Existing Haulers*

October 28, 2004

FINAL

Prepared By:

DSM ENVIRONMENTAL SERVICES, INC.

23 Thrasher Road, PO Box 466

Ascutney, VT 05030

Tel/Fax: (802) 674-2840 / (802) 674-6915

www.dsmenvironmental.com

TABLE OF CONTENTS

Introduction	1
Critical Issues and Variables for Use in Cost Model.....	2
Hauler Response	2
Bins versus Carts.....	3
Household Behavior.....	3
Housing Density	5
Alternative Systems Analyzed	6
Description of Cost Model.....	7
Results	8
APPENDIX A	12

Introduction

The Delaware Solid Waste Authority (DSWA), Delaware Department of Natural Resources & Environmental Control (DNREC), and the Recycling Public Advisory Council (RPAC) entered into a Memorandum of Agreement (MOA) on January 6th, 2004 which includes a requirement that the three parties “collectively pursue...a thorough evaluation of the feasibility and costs associated with various statewide mandatory curbside recycling alternatives which would serve the purpose of diverting significant quantities of residential solid wastes from land filling...”

A September 3, 2004 Memorandum entitled *Mandatory Curbside Recycling Program – Adopted Program Elements* from F. Michael Parkowski to the MOA members describes the mandatory curbside program elements that have been agreed on by the MOA members. Critical elements for the residential program include:

- Public and private haulers are required to provide curbside collection services for recyclable materials.
- Residents are required to make arrangements for recycling services with the company of their choosing.
- Residents are required to source separate recyclables in a single stream except for yard waste. The single stream of recyclable materials will not include glass.
- Residents who self haul and do not use trash collection services are exempt from the curbside separation requirement, but are required to use the Recycle Delaware drop-offs.
- DSWA will construct and operate a single stream MRF, which is assumed to be located at Pigeon Point.
- Transfer points operated by DSWA for recyclables will be available to haulers in Kent and Sussex Counties.

DSM Environmental Services, Inc. (DSM) has been contracted to provide an estimate for the MOA members of the most likely collection costs for the residential source separated materials based on the system outlined above with the added provision that:

- The cost of separate collection of recyclables must be included in the haulers' bill for refuse collection *whether or not the household uses the service*.
- Recyclables will be accepted by DSWA for processing *at no cost to the haulers*.
- DSWA will be responsible for implementation of an education and enforcement program.

Critical Issues and Variables for Use in Cost Model

Private haulers provide subscription refuse collection to roughly 75 percent of the households in Delaware. The remaining 25 percent of the households receive refuse collection under organized collection systems where a municipality either collects the refuse using municipal employees or enters into a contract with a single private hauler for refuse collection.¹

Because of the variety of collection systems that exist in Delaware, and the wide variety of potential responses to the requirement to collect recyclables separately, estimates of curbside recycling collection costs (and prices) are inherently risky for the State of Delaware. Private haulers and municipalities may all respond differently to the mandatory recycling requirement, both in the short run, and over time as haulers and households gain experience with source separation and haulers replace existing collection equipment with new equipment purchased to more efficiently collect refuse and recycling.

Because of these variables it was agreed that DSM would provide a range of estimates, and that all estimates would be conservative to assure that the decision on implementing mandatory source separation would not be based on unrealistically low costs. As such, DSM concentrated on estimating costs over the first three-year period of implementation. This period is likely to have higher prices, because haulers and households will be adjusting to the new requirements. Over time, as participation and recovery rates grow, competition to collect recyclables increase, and haulers become more familiar with quantities set out and with new collection technologies, it is likely that per household costs will tend to fall.

DSM developed a cost model for RPAC in 2003² to estimate the cost of alternative recycling collection systems for New Castle County. This model has been used as the basis to develop DSM's best estimate of costs (and prices) that households will experience over the first several years should the Legislature go forward with mandatory recycling in Delaware.

The model estimates costs based on the number of trucks that must be used to collect recyclables on any given week. The number of trucks depends on both the haulers response to the mandatory source separation requirement, and household response. Each is discussed below.

Hauler Response

Costs, household participation and recovery rates will depend on decisions haulers make about how they offer the recycling collection service. For example, in the short run haulers may choose to minimize their investment cost by utilizing, to the extent possible, existing rear loading packer trucks on their lightest days of the week. Under this assumption therefore, haulers will not offer curbside recycling collection to all of their customers on the same day as refuse collection. This will reduce participation by households, but will be the lowest cost solution for the haulers given the uncertainties associated with the new program.

Other haulers will choose to offer the service on the same day of the week as refuse collection using newly purchased rear loading packer trucks (either used or new) which will increase participation and recovery of recyclables, but at a potentially higher cost because more new trucks will be required. Rear loading packer trucks can be used with single stream collection systems, and allow for relatively large loads of recyclables. They have the added benefit of being interchangeable, collecting recyclables one day and refuse the next, or even switching during the

¹ Some households do not receive curbside collection, self-hauling to DSWA facilities instead. Data DSM has obtained from DSWA on usage makes it difficult to know how many households that is, although it appears to be less than one percent of the population based on the number of recorded trips.

² See *Evaluation of Enhanced Residential Waste and Recyclables Collection and Processing for New Castle County*, Final Report, October 15, 2003 prepared for the Delaware Recycling Public Advisory Council.

collection day. However, unless rear-loading trucks are specified with low entry, right side drive capacity, they will require both a driver and a laborer because of the inefficiency of the driver getting out on the traffic side of the road to collect recyclables on the curbside. This significantly increases operating costs, and therefore the price that the hauler must charge to the households.

Over time, it is likely that haulers will collect recyclables with refuse on the same day of the week using either right side drive side loading compactor trucks, or split, co-collection trucks – especially in the rural areas. This is one of the benefits of single stream collection – the ability to cut collection costs by using single compartment compactor trucks or switching to co-collection trucks on some of their routes. However, until haulers have a better sense of the impact of recycling on refuse quantities, they may not be willing to invest in split trucks with fixed compartment sizes because packing out either side of the truck prematurely reduces collection efficiency.

Alternatively, haulers may choose to or offer recycling collection every other week in more “rural” areas as a way to reduce collection costs. Households in rural areas tend to have more storage capacity for recyclables, and because collection costs are higher in rural areas with longer distances between stops, this is a logical way to minimize costs while still providing the collection service.

Finally, the City of Wilmington, which currently offers refuse collection twice weekly, faces two potential options. One is to collect refuse one day of the week and recyclables on the second day of the week. The other option is to convert to split trucks with recyclables on one side and refuse on the other. Just as with the private haulers, Wilmington will face uncertainty in the short run as to what is the correct split. For example, in higher income areas with larger household size, the tested 60/40 split (refuse to recyclables) will probably be sufficient, while in lower income neighborhoods with smaller household size and/or more apartment buildings with renters as opposed to home owners, the split might be as low as 75/25 refuse to recyclables.

It is also likely that over time haulers will begin to adjust refuse collection prices to account for reductions in refuse collected associated with both recycling and the proposed ban on yard waste disposal. Together, these two activities could reduce residential refuse collection quantities by as much as 25 – 30 percent. This represents a direct savings to the haulers through reduced tipping fees. It also offers an indirect benefit associated with the increased number of households which can be collected before the refuse truck packs out and must leave the route to go to the landfill, potentially reducing the number of refuse trucks which the hauler must operate on any given day.

Bins versus Carts

Haulers and municipalities will also face decisions about what type of storage container to provide to households in which to set out their recyclables. Small, 14 – 18 gallon “blue” bins have been the standard for the past 15 years. These bins are low cost, and provide a visual reminder to households to set out their recyclables on the day of collection. However, as per household generation of recyclables has grown – especially with the switch to light weight, higher volume plastic packaging – the 14 to 18 gallon bins are often too small to hold all a household’s recyclables for even one week. As a consequence, haulers and municipalities around the country are experimenting with 32 – 96 gallon rolling carts for recyclables. These carts have been demonstrated to increase household participation and set out of recyclables. However, carts are also significantly more costly, which may be a deterrent to many haulers, especially in the short run.

Household Behavior

Ultimately the number of trucks required to collect recyclables will depend on the number of participating households (participation rate), the amount of recyclables set out by participating

households (capture rate), and how often households set out recyclables for collection (set-out rate). Household behavior will depend on a number of factors including:

- *How well the DSWA enforces limitations on haulers bringing non source-separated residential refuse to the landfill:* If haulers can deliver residential refuse with significant amounts of recyclables to the landfill, then at least some haulers are likely to attempt to gain a competitive advantage by offering households a lower cost for refuse only collection.
- *Same day collection service:* Households will place more recyclables at the curb if recyclables are collected on the same day as refuse collection.
- *Weekly collection:* Participation and recovery rates are higher for weekly collection programs than bi-weekly collection programs, although costs are also higher.
- *Bins versus carts:* Households will place more recyclables out for recycling if larger carts are offered.
- *Demographic factors:* Demographics such as economics, housing density, home ownership and social characteristics all impact recycling participation and collection costs. These are discussed in more detail below.

Demographic Factors

Based on capture rate data DSM has collected in other areas of the United States, it is clear that household demographics is an important factor in estimating recycling behavior and quantities. For this reason, the demographics of the State of Delaware -- by Incorporated Area, by County and statewide -- were examined to understand factors that might influence recycling recovery and collection costs. Demographic factors reviewed included:

- ◆ *Owner occupied housing rate:* Communities with high rates of owner occupied homes tend to have greater participation in recycling programs mainly because they are easier to target with educational materials and new recycling initiatives and their tenure in the community tends to be longer. Delaware's rate of owner occupied housing (72.3 percent) is slightly higher than the average rate in the United States (66.2 percent). Sussex County has the highest rate in the state.
- ◆ *Median household income:* Households with higher incomes generally have high recycling participation rates and set out more material for recycling (as well as generate more recyclable materials in the first place). On average, Delaware ranks higher than the United States with respect to mean household income (roughly 13 percent greater than the US as a whole as reported by the Census 2000).
- ◆ *Education:* Based on analysis done by SERA, Inc., education levels correlated positively with recycling diversion. That is, communities that on average attained higher education levels also diverted more material. In this respect, Delaware is like the rest of the United States with about 25 percent of the population with a bachelors' degree or greater.
- ◆ *Primary language spoken at home:* Education programs must be bilingual when English is not the primary language spoken at home to ensure the appropriate messages about recycling reach the household. In the case of Delaware, only about 10 percent of the population speaks a language other than English at home as compared with an average of 18 percent nationwide.

- ◆ *Type of housing structures:* In general, neighborhoods with single-family homes have much higher participation rates in curbside recycling programs than neighborhoods with multi-unit buildings, particularly when recycling containers are shared. This may be due to a variety of factors including availability of recycling bins, storage and set-out location of bins, and the fact that carts or bins might need to be shared. Delaware is slightly below the national average with respect to the number of multi-family households.

In conclusion, on average, Delaware's demographics point to slightly above average recycling recovery. While in certain areas of Delaware recycling participation (and recovery) is expected to be lower than average because of demographic factors, other areas have characteristics that would be expected to result in higher recovery rates. For example, recycling collection programs in some incorporated areas -- such as Wilmington where owner occupied housing is about 50 percent -- may experience lower recovery rates than the rest of New Castle county where the average owner occupancy housing rates in Incorporated Areas and census designated population areas (CDPs) is about 72.4 percent.

Housing Density

Housing density is a significant determinant of collection stop time, which in turn impacts on the number of trucks required. DSM examined the number of households living in urban, suburban and rural areas of Delaware in the year 2005. Projections were taken from the *Delaware Population Consortium, Population Projections, September 29, 2004* for the total number of households in each county in 2005.

A breakdown between urban, suburban and rural households was then made by analyzing the Census 2000 data for Delaware for incorporated areas, CDPs, and the rest of the county. Incorporated areas were termed "urban", CDPs were termed "suburban" and the balance of households were termed "rural" with the exception of New Castle County and part of Sussex County.

That is, assumptions were made to adjust for the more suburban New Castle County not yet identified as a CDP. DSM assumed 95% of the households not residing in an Incorporated Area or a CDP in 2005 still resided in a "suburban" setting.

In the case of Sussex County, DSM assumed 25% of households not residing in the CDP or incorporated areas in 2005 resided in a "suburban" area.

DSM applied the projected household growth for each county equally across all groups -- urban, suburban and rural. The greatest growth is expected in Sussex County (14% over 2000 census household count) followed by Kent County (11% increase) and lastly New Castle County, which is expected to experience a more modest 4.7 percent growth in households from 2000 to 2005.³

Finally, DSM used the 2000 census to estimate the seasonal population in Delaware that may use a curbside collection program during summer months or vacation periods. Vacant household unit counts for seasonal, recreation or occasional use were assumed to be occupied four months out of the year. These units are mostly located in Sussex County, which has a large summer beach population.⁴

³ DE Population Consortium. September 29, 2004.

⁴ US Census 2000, New Castle, Kent and Sussex Counties category "For seasonal, recreational, or occasional use" defined as "vacant units used or intended for use only in certain seasons, for weekends, or other occasional use throughout the year. Seasonal units include those used for summer or winter sports or

Table 1 presents the estimated breakdown of households by county, and by urban, suburban and rural areas.

TABLE 1.
Total Number of Households, By County (2005)

COUNTY	Urban	Suburban	Rural	Total Households ⁵	Seasonal Use Households
New Castle County	49,000	144,000	5,000	198,000	700
Kent County	22,000	6,000	24,000	52,000	400
Sussex County	18,000	14,000	40,000	72,000	25,000

Alternative Systems Analyzed

Given all the variables described above and the demographics of Delaware, DSM has attempted to frame the likely range of costs and prices by analyzing three collection alternatives:

- System 1 - Lowest Cost Recycling Collection:** Haulers offer collection on the lightest day of refuse collection in more urban and suburban areas, with every other week recycling collection in rural areas. This means that some haulers offer recycling collection to their customers on a different day of the week from refuse collection. All households are provided with 14 – 18 gallon blue bins for recycling. While this system results in the lowest level of diversion, it also is the lowest cost system to implement, resulting in the lowest cost to households.
- System 2 – Conventional, Higher Cost Collection:** All haulers offer weekly collection of recyclables on the same day as refuse collection using rear loading refuse compactor trucks purchased specifically for this collection system. Different haulers offer different storage containers, with some offering blue bins and some carts. Because households receive collection weekly, on the same day as refuse collection, and because the cost of recycling collection is included in the cost of refuse collection, there is an incentive to recycle, increasing participation and recovery of recyclables. In addition, it is assumed that haulers offering subscription service are not able to use existing refuse packer trucks, but most purchase all new trucks for recycling collection.
- System 3 – Combined:** Haulers offer weekly collection in urban and suburban areas on the same day as refuse collection, but offer every other week collection in rural areas. All haulers use rear-loading packer trucks with a driver and a loader, and all trucks are newly purchased to provide this additional service. All households receive one blue bin.

recreation, such as beach cottages and hunting cabins... Interval ownership units, sometimes called shared-ownership or time-sharing condominiums, also are included in this category.”

⁵ Excluding seasonal households

Description of Cost Model

The cost model is an *Excel* spreadsheet model divided into a series of separate, but linked worksheets. The worksheets in the model include:

- Households:** Household counts by county and by housing density, as shown in Table 1, are supplemented by DSM's best estimate of the number of households served by subscription service and the number served by organized collection in each county. The result is an estimate of the number of households in each county served by organized and subscription collection service in the urban/suburban areas and by subscription service in the more rural areas. Seasonal households are included for Sussex County, only, because they represent such a large percentage of total households in Sussex County. They are assumed to receive collection service 4 months of the year.
- Generation:** The model uses DSWA adjusted Franklin Associates (2002) data on recyclables generation by county. This is the same report used by DSM in the 2003 RPAC analysis, which DSWA has subsequently expanded (7/14/04) to the other two counties. No attempt has been made to verify the reasonableness of the Franklin data over and above the analysis DSM carried out for RPAC in 2003. Glass containers have been subtracted from per capita generation because of the assumption that the curbside program will not accept glass. Because glass is a heavy material, removing it from the recycling stream reduces the amount of material recovered (by weight) by about 15 – 20 percent.
- Recovery:** Expected recovery rates are then calculated by housing density for the three systems analyzed. There are two factors that affect the recovery rate calculation -- the participation rate (the percentage of households that set out recyclables at least one time per month) and the capture rate (the percentage of each type of recyclable material that a participating household is likely to set out for recycling based on DSM sort data). The participation rate multiplied by the capture rate equals the recovery rate. Assumed **Recovery Rates** vary from a low of 50 percent in rural areas with every other week collection to a high of 64 percent in urban areas with organized, weekly collection on the same day of the week as refuse collection. The participation and capture rates used to calculate the recovery rates in each system are shown below:

	Systems 1 & 3 Assumptions			System 2 Assumptions		
	<i>Participation Rate</i>	<i>Capture Rate</i>	<i>Recovery Rate</i>	<i>Participation Rate</i>	<i>Capture Rate</i>	<i>Recovery Rate</i>
Organized	85%	75%	64%	85%	75%	64%
Subscription	75%	67%	50%	85%	75%	64%
Rural	75%	67%	50%	85%	75%	64%

- Cost Assumptions:** Assumptions about capital and operating costs for trucks, bins and laborers are specified in the Cost Assumptions worksheet. In the short term most haulers are assumed to maximize their existing rear-loading packer fleet (25 percent of the trucks required for subscription collection in System 1 are expected to come from existing fleets) and buy additional rear loading packers to provide recycling collection service. The rear load packer trucks are assumed to be smaller, single axle vehicles because of the low quantities of recyclables versus refuse. These rear loaders require both a driver and a laborer to efficiently service stops. In the long run, haulers (and municipal collection crews) would be expected to transition to right side drive, single compartment trucks (and in some rural and urban areas even dual compartment trucks where refuse and recycling would be co-collected) and on these trucks only a single driver would be required to

service stops. In System 1 and 3, one bin is assumed to be provided to each household, while in System 2, it is assumed that 50 percent of the households would be provided with carts. Replacement costs for both carts and bins are assumed to be at 10% of the capital cost of containers per year.

- *Trucks Required:* Households who participate in recycling do not set out material on 100 percent of the available collection days. The **set-out rate** for recycling is almost always lower for recycling than for refuse and is assumed to be 75 percent on weekly collection routes and 85 percent on every other week collection routes. The set-out rate divided by the maximum number of stops a truck is assumed to be able to make yields the number of trucks required each day. The number of stops a truck can make are assumed to range from a low of 375 per day in rural areas with subscription service to a high of 600 per day in incorporated areas with organized collection.
- *Cost Analysis:* System-wide costs are calculated by multiplying the number of trucks required under each system by the annual capital and operating cost for each truck. Costs to transfer recyclables from Sussex and Kent Counties are included based on DSWA transfer cost estimates. The total system cost is then divided by the number of households served to calculate a per-household cost (or price).⁶ As discussed above, it should be emphasized that the per-household cost is relatively low because all households, whether they participate or not, get charged for the recycling collection service.

Results

Table 2 summarizes estimated per household prices per month that private haulers and municipalities would have to charge to offer curbside collection of recyclables throughout Delaware. As illustrated by Table 2, per household prices vary by county, by level of service (weekly versus bi-weekly), and by type of service (subscription versus organized collection). However, the range is relatively small for the lower cost systems, with all households falling in the \$2.65 to \$3.65 (rounded) range. The range is greater for the higher cost system (\$3.45 to \$6.90, rounded), because it is not efficient to collect recyclables weekly from rural households unless the truck is co-collecting refuse and recyclables.

In System 1, the difference in per household costs between organized and subscription service in New Castle County is not greater because it has been assumed that companies providing subscription service utilize some existing truck capacity, while all new trucks are assumed for organized collection. In Kent and Sussex Counties, the difference is not greater because a large percentage of subscription service customers are assumed to receive every other week collection to lower their costs.

Costs are slightly higher in Sussex County in all systems for subscription service because seasonal households are assumed to be billed for only four months of the year (because they receive service four months out of the year) but incur some of the same costs as year round households. For example, extra trucks need to be available to serve them during that time and bins and carts need to be purchased even though they are used only four months of the year.

It should be noted that the model assumes that private haulers will pass along savings in avoided tipping fees associated with delivery of recyclables to the MRF at no charge to the haulers versus delivery to the landfill as a component of refuse.

⁶ It is assumed that seasonal households pay for collection only 4 months of the year, and do not receive service the remaining 8 months.

Table 3 summarizes estimated statewide annual collection and transfer costs associated with the proposed mandatory program. As illustrated by Table 3, statewide annual costs range from a low of \$13.9 million to a high of \$20.5 million.

TABLE 2
Summary of Estimated Per Month Household Costs
For Mandatory Curbside Collection of Recyclables

County	Subscription	Organized
	(\$/month)	(\$/month)
System 1		
New Castle County	\$3.66	\$3.01
Kent County (1)	\$3.39	\$3.59
Sussex County (1)	\$3.65	\$2.66
System 2		
New Castle County	\$4.88	\$3.44
Kent County (2)	\$6.64	\$4.02
Sussex County (2)	\$6.92	\$3.09
System 3		
New Castle County	\$3.80	\$3.01
Kent County (1)	\$3.46	\$3.59
Sussex County (1)	\$4.00	\$2.66
(1) Rural subscription service receives <i>every other week</i> recycling collection, which significantly lowers subscription costs.		
(2) Weekly collection is provided to all households - subscription and organized.		
(3) In New Castle County, subscription route density is assumed to be greater.		

TABLE 3.
Summary of Total Estimated System Costs
Rounded, Annual

County	Subscription	Organized	Total
	(\$/year)	(\$/year)	(\$/year)
System 1			
New Castle County	\$6,660,000	\$1,680,000	\$8,340,000
Kent County	\$1,026,000	\$1,155,000	\$2,181,000
Sussex County	\$3,241,000	\$201,000	\$3,442,000
Total, System 1	\$10,927,000	\$3,036,000	\$13,963,000
System 2			
New Castle County	\$8,877,000	\$1,918,000	\$10,795,000
Kent County	\$2,009,000	\$1,293,000	\$3,302,000
Sussex County	\$6,145,000	\$234,000	\$6,378,000
Total, System 2	\$17,030,000	\$3,445,000	\$20,475,000
System 3			
New Castle County	\$6,904,000	\$1,680,000	\$8,584,000
Kent County	\$1,047,000	\$1,155,000	\$2,202,000
Sussex County	\$3,286,000	\$201,000	\$3,488,000
Total, System 3	\$11,237,000	\$3,036,000	\$14,274,000

Table 4 presents estimated annual tons diverted from disposal, the associated per ton costs, and the expected number of new collection trucks that would be required. Costs have been rounded to reflect the uncertainties associated with the estimates.

It should be noted here that the high cost per ton is primarily the result of:

- Exclusion of glass, which is the heaviest recyclable, even though it does not take much volume capacity in the landfill; and,
- The fact that the trucks are underutilized because stops, not truck capacity are the limiting factor when all trucks are assumed to be compaction trucks collecting single stream recyclables.

This second point is critical, because if the stops that could be made per day were increased on some of the subscription routes, per ton and per household costs would decrease. For example in System 2 in Sussex County, 14 trucks are assumed to be required to service 40,000 households with weekly service making an average of 375 stops per day on a route size of slightly less than 600. This compares with organized areas in New Castle County where 10 trucks are assumed to be required to service 46,500 households making an average of 600 stops per day on routes of about 950 households.

As illustrated by Table 4, system-wide costs to implement the mandatory curbside collection program are estimated to range from \$13.9 million to \$20.5 million annually to divert between 54,000 (rounded) and 63,000 (rounded) tons of recyclables from landfill. Clearly, if viewed solely on a per ton basis, it would be less expensive to landfill the recyclables. However, in addition to the environmental benefits associated with recycling, which are beyond the scope of this analysis, there are also landfill capacity savings.

**TABLE 4.
Summary of Total Costs, Tons Diverted, and Truck Requirements**

System	Total	Tons	Cost Per	Trucks
	Cost	Diverted	Ton	Required
	(\$/year)	(tons/year)	(\$/ton)	(#)
System 1	\$13,963,000	53,644	\$260	71
System 2	\$20,475,000	62,636	\$327	112
System 3	\$14,274,000	53,644	\$266	83

Because issues associated with the impact of recycling on expansion of DSWA’s Cherry Island landfill have played an important role in the MOA, an attempt has been made to estimate the cost per cubic yard of landfill capacity saved associated with the proposed mandatory residential curbside collection program. Table 5 illustrates the cost per cubic yard of landfill capacity saved associated with mandatory recycling, based on some very rough estimates of in-place densities of the recyclable materials⁷. These per yard costs can be compared against construction and operational costs per yard for DSWA landfills as another method of assessing the value of a mandatory residential recycling program.

⁷ DSM has assumed an in-place density of 600 pounds/cubic yard for mixed recyclables without glass. DSM has been unable to find any reliable data on in-place densities for typical residential recyclables.

**TABLE 5.
Cost Per Cubic Yard Diverted**

System	Yards	Cost Per
	Diverted	Yard
	(yd3)	(\$/yd3)
System 1	178,813	\$78.00
System 2	211,808	\$97.00
System 3	178,813	\$80.00

These summary tables are produced from the Excel spreadsheet model used to estimate costs. The entire model is reprinted in Appendix A.

APPENDIX A

Statewide Residential Recyclables Curbside Collection Cost Model

Cost Analysis, System 1

County	Per Truck	Subscription	Organized
New Castle County			
Trucks Required		37	10
Minus Existing Trucks		9	
New Trucks Required		28	10
Plus Backup Trucks		5	2
Total Trucks Required		33	12
Costs/Truck	(\$)	(\$)	(\$)
Capital	\$22,253	\$731,786	\$257,272
O&M	\$182,300	\$6,831,693	\$1,801,352
Bins		\$301,016	\$92,391
Bin Replacement		\$30,102	\$9,239
Total		\$7,894,596	\$2,160,254
Less Avoided Tip Fees		\$1,234,430	\$480,693
Net Costs		\$6,660,166	\$1,679,561
Cost Per HH Per Month		\$3.66	\$3.01
Kent County			
Trucks Required		5	6
Minus Existing Trucks		1	
New Trucks Required		4	6
Plus Backup Trucks		1	1
Total		5	7
Costs/Truck			
Capital	\$22,253	\$111,267	\$148,277.33
O&M	\$182,300	\$926,084	\$1,038,198.50
Bins		\$50,070	\$53,249
Bin Replacement		\$5,007	\$5,325
Total Collection Cost		\$1,092,428	\$1,245,050
Transfer Cost		\$129,020	\$174,075
Total Collection & Transfer		\$1,221,448	\$1,419,125
Less Avoided Tip Fees		\$195,485	\$263,750
Net Costs		\$1,025,963	\$1,155,375
Cost Per HH Per Month		\$3.39	\$3.59
Sussex County			
Trucks Required		16	1
Minus Existing Trucks		4	
New Trucks Required		12	
Plus Backup Trucks		2	
Total		14	
Costs/Truck			
Capital	\$22,253	\$312,337	\$22,253
O&M	\$182,300	\$2,915,868	\$182,300
Bins		\$180,212	\$12,518
Bin Replacement		\$18,021	\$1,252
Total Collection Cost		\$3,426,438	\$218,323
Transfer Cost		\$272,146	\$33,107
Total Collection & Transfer		\$3,698,584	\$251,430
Less Avoided Tip Fees		\$457,670	\$50,162
Net Costs		\$3,240,914	\$201,267
Cost Per HH Per Month		\$3.65	\$2.66

Cost Analysis, System 2

County	Per Truck	Subscription	Organized
New Castle County			
Trucks Required		43	10
Backup Trucks		7	2
New Trucks Required		51	12
Costs/Truck	(\$)	(\$)	(\$)
Capital	\$22,253	\$1,124,990	\$257,272
O&M	\$182,300	\$7,876,879	\$1,801,352
Bins		\$150,508	\$46,196
Bin Replacement		\$15,051	\$4,620
Carts		\$827,794	\$254,075
Cart Replacement		\$115,891	\$35,571
Total		\$10,111,113	\$2,399,085
Less Avoided Tip Fees		\$1,234,430	\$480,693
Net Costs		\$8,876,684	\$1,918,392
Cost Per HH Per Month		\$4.88	\$3.44
Kent County			
Trucks Required		9	6
Backup Trucks		2	1
New Trucks Required		11	7
Costs/Truck			
Capital	\$22,253	\$238,493	\$148,277
O&M	\$182,300	\$1,669,868	\$1,038,198.50
Bins		\$25,035	\$26,625
Bin Replacement		\$2,504	\$2,662
Carts		\$137,693	\$146,435
Cart Replacement		\$19,277	\$20,501
Total Collection Cost		\$2,092,869	\$1,382,699
Transfer Cost		\$163,682	\$174,075
Total Collection & Transfer		\$2,256,552	\$1,556,773
Less Avoided Tip Fees		\$248,003	\$263,750
Net Costs		\$2,008,548	\$1,293,024
Cost Per HH Per Month		\$6.64	\$4.02
Sussex County			
Trucks Required		27	1
Backup Trucks		5	
New Trucks Required		32	
Costs/Truck			
Capital	\$22,253	\$707,151	\$22,253
O&M	\$182,300	\$4,951,282	\$182,300
Bins		\$90,106	\$6,259
Bin Replacement		\$9,011	\$626
Carts		\$495,584	\$34,423
Cart Replacement		\$69,382	\$4,819
Total Collection Cost		\$6,322,515	\$250,680
Transfer Cost		\$345,260	\$33,107
Total Collection & Transfer		\$6,667,775	\$283,787
Less Avoided Tip Fees		\$523,121	\$50,162
Net Costs		\$6,144,654	\$233,625
Cost Per HH Per Month		\$6.92	\$3.09

Cost Analysis, System 3

County	Per Truck	Subscription	Organized
New Castle County			
Trucks Required		37	10
Plus Backup Trucks		6	2
Total Trucks Required		44	12
Costs/Truck	(\$)	(\$)	(\$)
Capital	\$22,253	\$975,714	\$257,272
O&M	\$182,300	\$6,831,693	\$1,801,352
Bins		\$301,016	\$92,391
Bin Replacement		\$30,102	\$9,239
Total		\$8,138,525	\$2,160,254
Less Avoided Tip Fees		\$1,234,430	\$480,693
Net Costs		\$6,904,095	\$1,679,561
Cost Per HH Per Month		\$3.80	\$3.01

Kent County			
Trucks Required		5	6
Plus Backup Trucks		1	1
Total		6	7
Costs/Truck			
Capital	\$22,253	\$132,265	\$148,277.33
O&M	\$182,300	\$926,084	\$1,038,198.50
Bins		\$50,070	\$53,249
Bin Replacement		\$5,007	\$5,325
Total Collection Cost		\$1,113,426	\$1,245,050
Transfer Cost		\$129,020	\$174,075
Total Collection & Transfer		\$1,242,446	\$1,419,125
Less Avoided Tip Fees		\$195,485	\$263,750
Net Costs		\$1,046,961	\$1,155,375
Cost Per HH Per Month		\$3.46	\$3.59

Sussex County			
Trucks Required		16	1
Minus Existing Trucks		4	
New Trucks Required		12	
Plus Backup Trucks		2	
Total		14	
Costs/Truck			
Capital	\$22,253	\$312,337	\$22,253
O&M	\$182,300	\$2,915,868	\$182,300
Bins		\$180,212	\$12,518
Bin Replacement		\$18,021	\$1,252
Total Collection Cost		\$3,426,438	\$218,323
Transfer Cost		\$272,146	\$33,107
Total Collection & Transfer		\$3,698,584	\$251,430
Less Avoided Tip Fees		\$412,343	\$50,162
Net Costs		\$3,286,242	\$201,267
Cost Per HH Per Month		\$4.00	\$2.66

\$103,319

96364.9

9250.096

Summary Of Per Household Costs

TABLE 2.
Summary of Estimated Per Month Household Costs
For Mandatory Curbside Collection of Recyclables

County	Subscription (\$/month)	Organized (\$/month)
System 1		
New Castle County	\$3.66	\$3.01
Kent County (1)	\$3.39	\$3.59
Sussex County (1)	\$3.65	\$2.66
System 2		
New Castle County	\$4.88	\$3.44
Kent County (2)	\$6.64	\$4.02
Sussex County (2)	\$6.92	\$3.09
System 3		
New Castle County	\$3.80	\$3.01
Kent County (1)	\$3.46	\$3.59
Sussex County (1)	\$4.00	\$2.66

Explanation for difference in costs

No use of existing trucks assumed in organized collection.

Carts add another 41 cents on average per household.
 Weekly collection significantly increases subscription costs.
 Weekly collection significantly increases subscription costs.

- (1) Rural subscription service receives *every other week* recycling collection which significantly lowers subscription costs.
- (2) Weekly collection is provided to all households - subscription and organized.
- (3) In New Castle County, subscription route density is assumed to be greater.

Summary of Total Costs

Calculations from Spreadsheets

County	Subscription (\$/year)	Organized (\$/year)	Total (\$/year)
System 1			
New Castle County	\$6,660,166	\$1,679,561	\$8,339,728
Kent County	\$1,025,963	\$1,155,375	\$2,181,338
Sussex County	\$3,240,914	\$201,267	\$3,442,182
Total, System 1	\$10,927,043	\$3,036,204	\$13,963,247
System 2			
New Castle County	\$8,876,684	\$1,918,392	\$10,795,076
Kent County	\$2,008,548	\$1,293,024	\$3,301,572
Sussex County	\$6,144,654	\$233,625	\$6,378,279
Total, System 2	\$17,029,886	\$3,445,041	\$20,474,927
System 3			
New Castle County	\$6,904,095	\$1,679,561	\$8,583,656
Kent County	\$1,046,961	\$1,155,375	\$2,202,336
Sussex County	\$3,286,242	\$201,267	\$3,487,509
Total, System 3	\$11,237,298	\$3,036,204	\$14,273,501

Rounded for Report

TABLE 3.
Summary of Total Estimated System Costs
Rounded, Annual

County	Subscription (\$/year)	Organized (\$/year)	Total (\$/year)
System 1			
New Castle County	\$6,660,000	\$1,680,000	\$8,340,000
Kent County	\$1,026,000	\$1,155,000	\$2,181,000
Sussex County	\$3,241,000	\$201,000	\$3,442,000
Total, System 1	\$10,927,000	\$3,036,000	\$13,963,000
System 2			
New Castle County	\$8,877,000	\$1,918,000	\$10,795,000
Kent County	\$2,009,000	\$1,293,000	\$3,302,000
Sussex County	\$6,145,000	\$234,000	\$6,378,000
Total, System 2	\$17,030,000	\$3,445,000	\$20,475,000
System 3			
New Castle County	\$6,904,000	\$1,680,000	\$8,584,000
Kent County	\$1,047,000	\$1,155,000	\$2,202,000
Sussex County	\$3,286,000	\$201,000	\$3,488,000
Total, System 3	\$11,237,000	\$3,036,000	\$14,274,000

TABLE 4.
Summary of Total Costs, Tons Diverted, and Truck Requirements

System	Total Cost	Tons Diverted	Cost Per Ton	Trucks Required
	(\$/year)	(tons/year)	(\$/ton)	(#)
System 1	\$13,963,000	53,644	\$260	71
System 2	\$20,475,000	62,636	\$327	112
System 3	\$14,274,000	53,644	\$266	83

TABLE 5.
Cost Per Cubic Yard Diverted

System	Yards Diverted	Cost Per Yard
	(yd3)	(\$/yd3)
System 1	178,813	\$78.09
System 2	211,808	\$96.67
System 3	178,813	\$79.83

Households

Households	New Castle County		Kent County		Sussex County		Total Households	
	(households)	(%)	(households)	(%)	(households)	(%)	(households)	(%)
Urban	49,000	25%	22,000	42%	18,000	22%	89,000	27%
Suburban	144,000	73%	6,000	12%	14,000	17%	164,000	50%
Rural	5,000	3%	24,000	46%	40,000	50%	69,000	21%
Seasonal (1) (2)	233	0%	133	0%	8,333	10%	8,700	3%
Total:	198,233	100%	52,133	100%	80,333	100%	330,700	100%
Households Generating Recyclables for Analysis								
Organized Collection	46,500	23%	26,800	52%	6,300	8%	79,600	24%
Subscription, non-rural	146,500	74%	1,200	2%	25,700	32%	173,400	52%
Rural Collection	5,000	3%	24,000	46%	40,000	50%	69,000	21%
Seasonal Collection	0	0%	0	0%	8,333	10%	8,300	3%
Total:	198,000	100%	52,000	100%	80,333	100%	330,300	100%
Seasonal Households (US Census)	700		400		25,000		26,100	
Total Service Points (For Analysis):	198,000		52,000		97,000		347,000	

(1) Seasonal households assumed to receive service four months of the year (and generate 1/3 of an average household's recyclables).

(2) Seasonal households are excluded from the analysis in New Castle and Kent Counties because they represent less than 1 percent of the material collected in these counties.

Generation

Material	Statewide <i>(tons)</i>	NCC <i>(tons)</i>	Kent <i>(tons)</i>	Sussex <i>(tons)</i>
Paper				
News, mags, phone books	34,210	21,894	5,474	6,842
Mixed Paper:	24,700	15,808	3,952	4,940
Cardboard	9,800	6,272	1,568	1,960
Boxboard	13,940	8,922	2,230	2,788
Sub-Total, Paper	82,650	52,896	13,224	16,530
Bottles and Cans				
Steel Cans	6,460	4,134	1,034	1,292
Aluminum Cans	3,235	2,070	518	647
Plastic Bottles	7,991	5,114	1,279	1,598
Sub-Total, Bottles & Cans	17,686	11,318	2,831	3,537
Total, All Recyclables	100,336	64,214	16,055	20,067

Generation by Collection Method:

	<i>(tons)</i>	<i>(tons)</i>	<i>(tons)</i>
Urban/Suburban	62,594	8,664	10,075
<i>Organized</i>	15,081	8,275	1,574
<i>Subscription, non seasonal</i>	47,512	371	6,420
<i>Subscription, seasonal</i>	0	0	2,082
Rural	1,620	7,410	9,992

Recovery

	Recovery	Quantity Recovered			Total	Assumptions			In-Place Density
		NCC	Kent	Sussex		Participation	Capture	Recovery	
	Rate	(tons)	(tons)	(tons)	(tons)	Rate	Rate	Rate	(yd3)
Recovery, System 1									
Organized	0.64	9,614	5,275	1,003		0.85	0.75	0.64	
Subscription	0.50	23,875	186	3,226		0.75	0.67	0.50	
Seasonal	0.44	0	0	907		0.65	0.67	0.44	
Rural	0.50	814	3,724	5,021		0.75	0.67	0.50	
<i>Total, System 1:</i>		<i>34,302</i>	<i>9,185</i>	<i>10,157</i>	53,644				<i>178,813</i>
Recovery, System 2									
Organized	0.64	9,614	5,275	1,003		0.85	0.75	0.64	
Subscription	0.64	30,289	236	4,093		0.85	0.75	0.64	
Seasonal	0.44	0	0	907		0.65	0.67	0.44	
Rural	0.64	1,033	4,724	6,370		0.85	0.75	0.64	
<i>Total, System 2:</i>		<i>40,935</i>	<i>10,235</i>	<i>12,372</i>	63,542				<i>211,808</i>

Trucks Required, Low Cost (System 1 and 3)

Low Cost and Recovery

<i>Step One: Calculate Number of Trucks Required</i>	Total Households (households)	Participating Households (%)	Set Out Rate (%)	Stops Required/ Week	Stops Truck/ Week	Trucks Required	Recyclables Recovery (tons/year)	Recyclables Per Week (tons/week)	Pounds/ Set-Out (pounds)	Weight/ Truck (tons)	Average Weight When Packed (tons)	Trips Per Day
New Castle County												
Urban/Suburban												
Organized	46,500	85%	75%	29,644	3,000	10	9,614	185	12	3.7	5	0.7
Subscription	146,500	75%	75%	82,406	2,250	37	23,875	459	11	2.5	5	0.5
Rural (Every other week collection)	2,500	75%	85%	1,594	1,875	1	814	16	20	3.7	5	0.7
Total:				113,644		47						
Kent												
Urban/Suburban												
Organized	26,800	85%	75%	17,085	3,000	6	5,275	101	12	3.6	5	0.7
Subscription	1,200	75%	75%	675	2,250	1	186	4	11	0.7	5	0.1
Rural (Every other week collection)	12,000	75%	85%	7,650	1,875	4	3,724	72	19	3.5	5	0.7
Total:				25,410		11						
Sussex												
Urban/Suburban												
Organized	6,300	85%	75%	4,016	3,000	1	1,003	19	10	2.9	5	0.6
Subscription	25,700	75%	75%	14,456	2,250	6	3,226	62	9	1.9	5	0.4
Rural (Every other week collection)												
Seasonal	12,500	65%	75%	6,094	2,200	3	907	17	6	1.3	5	0.3
Year-Round	20,000	75%	85%	12,750	1,875	7	5,021	97	15	2.8	5	0.6
Total:		64%		37,316		17						
Total Trucks Required:						75	53,644					

Trucks Required, System 2

Higher Cost and Recovery

Calculating Weekly Set-Out Rate

Trucks Required, Conventional (System 2 and 3)

Conventional, Higher Cost Collection

	Total Households	Participating Households	Set Out Rate	Stops Required/Week	Stops Truck/Week	Trucks Required	Recyclables (tons)	Recyclables Per Week (tons)	Pounds/Set-Out	Weight/Truck	Average Weight Packed	Trips Per Day
Step One: Calculate Number of Trucks Required												
New Castle County												
Urban/Suburban	193,000											
Organized	46,500	0.85	0.75	29,644	3,000	10	9,614	185	12	3.7	5	0.7
Subscription	146,500	0.85	0.75	93,394	2,250	42	30,289	582	12	2.8	5	0.6
Rural	5,000	0.85	0.75	3,188	1,875	2	1,033	20	12	2.3	5	0.5
Total:				126,225		53						
Kent												
Urban/Suburban	28,000											
Organized	26,800	0.85	0.75	17,085	3,000	6	5,275	101	12	3.6	5	0.7
Subscription	1,200	0.85	0.75	765	2,250	1	236	5	12	0.9	5	0.2
Rural	24,000	0.85	0.75	15,300	1,875	8	4,724	91	12	2.2	5	0.4
Total:				33,150		15						
Sussex												
Urban/Suburban	32,000											
Organized	6,300	0.85	0.75	4,016	3,000	1	1,003	19	10	2.9	5	0.6
Subscription	25,700	0.85	0.75	16,384	2,250	7	4,093	79	10	2.2	5	0.4
Rural												
Seasonal	25,000	0.65	0.85	13,813	2,200	6	3,981	77	11	2.4	5	0.5
Year-Round	40,000	0.85	0.75	25,500	1,875	14	2,389	46	4	0.7	5	0.1
Total:				59,713		28						
Total Trucks Required:						96	62,636					

Cost Assumptions

Stops

Stops urban/suburban
Stops rural

Subscription		Organized	
<i>per day</i>	<i>per week</i>	<i>per day</i>	<i>per week</i>
450	2250	600	3000
375	1875	440	2200

Cost

Dual Compartment Compactor Truck Capital Cost

\$170,000 Assume a 20% residual value at end of 7 years

Seven year amortization

\$27,020

Single Compartment Compactor Truck

\$140,000 Assume a 20% residual value at end of 7 years

Seven year amortization

\$22,253

16 Gallon Blue Bin delivered

\$10

Seven year amortization

\$2

30 Gallon Cart delivered

\$55

Seven year amortization

\$11

Labor

Driver

\$45,000

Thrower

\$35,000

Administrative Overhead, supervisory, billing & profit

\$75,000

Equipment O&M (tires, fuel, maintenance)

\$27,300

Total Operating Cost Per Truck Per Year

\$182,300