Solid waste management options for Maine: The economics of pay-by-the-bag systems

State and federal environmental mandates during the last three decades have changed the nature of the debate over solid waste disposal, but not the basic question: What do we do about the garbage we produce? Unlike years past, however, disposal options are now fewer and more costly. This has resulted in a shift in focus away from solutions that simply try to deal with the output of the disposal process--the trash--to those that focus on inputs--reducing the volume of materials going into the waste stream. Among the volume reduction strategies are recycling, which focuses on specific input materials, and volume-based fees, such as pay-by-the-bag (PB) solid waste disposal systems. This article is based on a report of the Margaret Chase Smith Center for Public Policy, University of Maine entitled: "Solid waste management systems for Maine: The economics of pay-by-the-bag systems." In addition to the three authors identified above, the Smith Policy Center gratefully acknowledges the contributions of Chris Spruce, Robert McKay, and Jeff Young to this work. The research was partially supported by the Maine Waste Management Agency, Regional Waste Systems, Hannaford Brothers, and the Smith Policy Center's Project for the Study of Regulation and the Environment (PURE). Finally, the editors would like to thank Chris Spruce for his significant work in preparing this article for Maine Policy Review.

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Introduction

In Maine, as has happened in other states, solid waste management has been influenced by the growing trend to apply market-based incentives to addressing environmental problems. Changes in solid waste management approaches are, in part, driven by rising costs associated with solid waste disposal. Municipalities, upon which the burden of waste disposal primarily falls, now must seek innovative ways to reduce solid waste generation in order to cope with these increasing costs.

One method adopted by numerous municipalities in Maine is known as *variable cost pricing*. Alternatively, this system is referred to as "unit pricing," "volume-based fees," and "pay-by-the-bag" (PB). Under this system, waste collection fees are based on the volume of solid waste disposal. A household's solid waste disposal costs change with the number of bags of waste disposed since each bag is assessed a fee. As a result, the less trash set out for disposal, the lower the cost to the household.

Variable cost pricing for municipal solid waste disposal differs from the traditional method of charging a fixed annual fee to each household for waste disposal services, which in Maine is usually incorporated into the local property tax. The latter approach provides little incentive for households to reduce solid waste generation because the tax is not visible and is instead implicit in the property tax. Thus, the taxpayer often does not associate the magnitude of the tax with the quantity of household waste requiring disposal.

More than 50 municipalities have adopted pay-by the-bag programs in Maine. This report summarizes the findings of a study of those PB programs, published by the Smith Policy Center in June 1995. The study analyzed the impact of PB systems on solid waste disposal and costs in 29 Maine municipalities, and compared these with a group of non-PB, or "control" towns that utilized traditional solid waste pricing. Most significant among the study's findings was that the communities with PB programs generated less than half the residential solid waste per capita than the so-called

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control towns. The study also found that communities with PB programs spent more than 40 percent less per person on solid waste management than those municipalities without PB programs. In general, the study suggested that variable cost pricing programs do result in the reduction of both the volume of solid waste disposed and the cost of solid waste management.

Studying the impact of PB programs

Evidence from other states indicates that, in general, PB systems are effective in reducing solid waste generation (Morris, 1990; Guerrieri, 1994). Many public officials, however, continue to be skeptical about the viability of these programs in Maine. An important concern underlying the Smith Center study focused on the cost-effectiveness of PB systems relative to conventional pricing systems. Additionally, little research had been conducted on the impact of various features of PB programs that might influence the success of such programs. For example, the potential for PB programs to reduce solid waste could be influenced by the demographic characteristics of municipalities, such as the population, the percentage of renters, the age distribution, and average household income. Research was needed to suggest how these factors might interact with the economic incentives provided by PB programs. Further, it was apparent that researchers had not considered the impact of PB programs on forms of waste diversion, including waste shifting to neighboring towns. (Waste shifting, or diversion, can occur when someone living in a PB municipality brings their trash to a non-PB neighboring municipality for disposal. While this hauling of trash bags to a friend or family member's house may appear trivial, it does occur, and some non-PB municipalities believe they are receiving significant quantities of trash from PB municipalities.)

The Smith Center study investigated the impact of PB programs on residential solid waste disposal and on solid waste management costs. It also considered the impact of the adoption of PB programs on waste shifting to neighboring municipalities and the frequency of illegal dumping in PB communities.

The research approach

The study included a sample of pay-by-the-bag municipalities, comprised of the 29 Maine municipalities that had PB systems in place for at least one year and that had recorded data on solid waste tonnages. The control group, or non-PB towns, was comprised of municipalities that utilized conventional solid waste pricing systems but which were similar to the PB municipalities in terms of population, median household income, and location (see Table 1). In addition, these towns were at least 30 miles distant from any PB town. This significantly reduced the possibility that solid waste tonnages in control towns would be influenced by waste diversion from PB municipalities.

The methodology used to analyze the impact of PB programs contrasted the effect of solid waste pricing systems on solid waste disposal and solid waste management costs, after controlling for other demographic and program characteristics that might have influenced these variables (such as mandatory recycling ordinances or town composting programs). Utilizing this approach, solid waste disposal and costs were compared among the two groups for a given year. (A multivariate regression analysis was employed. The research team concluded that the cross-sectional comparison was appropriate because over time, shifts in the level of economic activity can affect solid waste disposal. In the team's opinion, cross-sectional analysis avoided the difficulties associated with controlling for the level of economic activity.)

Several categories of data were required to carry out the analyses. Monthly municipal solid waste (MSW) tonnage data for the period 1993-94 were obtained from municipalities and regional incinerators. In some

Table 1. Maine municipalities included in the study

Pay-by-the bag towns	Control Towns	Neighboring Towns
Appleton	Bethel	Abbot
Arundel	Brewer	Alton
Belfast	Bristol, S. Bristol	Belgrade
Bowdoinham	Brownville	Belmont
Castine	Cornville	Biddeford
Dixmont	Dedham	Bowdoin
Dresden	Eddington	Brownfield
Durham	Embden	Brunswick
Falmouth	Frankfort	Burnham
Fryeburg	Hampden	Carmel
Hudson	Harrison	Casco
Knox	Hartford	Cumberland
Liberty	Hollis	Eastbrook
Monson	Industry	Freedom
Palermo	Lee	Friendship
Raymond	Limington	Gardiner
Richmond	Machiasport	Glenburn
Searsmont	Mattawamkeag	Gouldsboro
Sidney	Mechanic Falls	Jefferson
Somerville	Minot	Kenduskeag
Sullivan	Newport	Lovell
Thorndike	North Berwick	Lyman
Topsham	Parkman	Monmouth
Troy	Parsonsfield	Montville
Union	Readfield	New Gloucester
Unity	Smithfield	Penobscot
Warren	Stonington	Plymouth
Washington	York	Poland
Winter Harbor		Portland
		Pownal
		Searsport
		Vassalboro
		Waldo
		Waldoboro
		Willimantic
		Windsor
		Yarmouth

instances, waste disposal tonnages received from the municipalities included residential and commercial waste combined. Since this study focused on the impact of PB programs on residential waste disposal, the waste stream needed to be split into its residential and commercial components. A 1994 Criner et al. study contained estimates of how the commercial component of a municipality's waste stream varies with municipal size. That research indicated that the share of commercial waste in municipal solid waste is greater, the larger the municipality. For example, in towns with a population of less than 1,000 persons, commercial waste is estimated to comprise eight percent of MSW, while in municipalities with populations exceeding 10,000 persons, commercial waste is estimated at 69 percent of MSW. In situations where municipal waste data was combined, its residential fraction was estimated based on the results contained in Criner, et al.

Data on characteristics of solid waste management programs and costs were obtained through a mail survey administered to public officials, and supplemented by telephone and personal interviews. Among the categories of information sought were expenditures on educational activities related to recycling, the existence of town-operated composting programs, descriptive data on solid waste ordinances, and the type of solid waste and recyclable collection methods utilized. Data collection was conducted from July to December, 1994.

Demographic data required to assess the factors that influence waste generation and disposal were obtained from the 1990 U.S. Census. Factors examined included median household income, average household size, and the number of renters. Population data were obtained from the *1994 Maine Municipal Directory.* These data, more current than the 1990 Census population data, were adjusted where necessary to reflect changes in population due to the influx of summer residents. In those cases, town officials provided adjusted population estimates from which weighted averages of annual populations were calculated.

Monthly solid waste tonnage data were also obtained for municipalities bordering towns that had adopted PB programs. This was done to assess the extent of waste shifting. Information on the extent of illegal dumping was obtained from personal or telephone interviews with public officials, road crews, and a sample of commercial establishments conducted on a random sample of half the PB towns.

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Characteristics of sampled communities

Pay-by-the-bag and control municipalities were similar with regard to several demographic characteristics that may affect solid waste generation and disposal (See Table 2). For example, the average (or median) income in PB towns was $27,709 compared to $27,216 in non-PB towns. While the average population of the sample of PB municipalities was slightly lower than that of the comparison towns (2,521 to 2,628), the distribution of municipalities by population group was very similar.

At the time the study was conducted, more than 50 Maine municipalities had adopted PB programs. (The first program was implemented in 1989, but within the last year, 21 municipalities have adopted this program.) The characteristics of PB programs showed some variation, but the underlying concept of utilizing price incentives to induce waste reduction was common to all PB towns in the study. The typical town sold to households a program instrument that was used to quantify the amount of waste requiring disposal. This included plastic bags, stickers, tokens, punch cards, or tags that residents used or attached to the disposed item(s). In the majority of PB municipalities in the

sample, the program instrument was sold at the town office while, in three cases, private businesses had been authorized to sell these items.

The method of collecting solid waste differed substantially among PB municipalities with 38 percent offering curbside collection, usually through the services of a private hauler (See Table 3). In some cases, municipalities contracted directly with private haulers for these services, and in other cases, residents contracted with haulers. The different methods of solid waste collection have implications for convenience and may influence household behavior regarding solid waste generation. Municipalities with curbside pick-up may encourage solid waste generation because residents do not have to haul waste to the disposal site themselves. In those towns without curbside pick-up, residents may try to minimize the number of trips to the transfer station and thus take steps to further reduce their solid waste.

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Fees for solid waste disposal in PB programs were based on weight or volume. The majority of PB towns in the sample (72 percent) utilized the volume-based system of assessing fees. Half of these applied a $1 fee for each 30-33 gallon bag that bore an imprint

Table 2. Characteristics of sampled communities

Characteristic	Pay-by-the-bag municipalities	Control municipalities
No. of municipalities in the sample*	29	31
Average (median) household income	$27,709	$27,216
Average population	2,521	2,628
Average household size (in persons)	2.845	2.721
No. of municipalities by population group		
Less than 1000 persons	7	8
1000 - 2000 persons	10	10
2001 - 5000 persons	9	9
5001+ persons	3	3

* In some cases, two or more municipalities pool their solid waste for the purpose of disposal and therefore only pooled solid waste tonnages were available. As a result, the number of observations in the statistical analyses are fewer than the number of municipalities in the sample.

identifying it as a program instrument. (Only marked bags were allowed at the transfer station or were picked up by haulers.) The remainder of the towns using the volume-based system required stickers that were sold at a cost ranging from $0.50 to $2.00 per sticker and placed on bags of 30-35 gallon capacity. (A variation on this system was to charge $1 per bag for the first two bags; the disposal cost for each additional bag was set at $2 per bag.)

Weight-based systems operated in 21 percent of the PB towns. In those municipalities where residents were responsible for transporting solid waste to the transfer station, the weighing was done at the station and residents paid accordingly. Otherwise, trucks conducting curbside pick-up were equipped with scales to weigh solid waste. The fee ranged from $0.02 to $0.06 per pound. Municipalities with weight-based PB programs generally set limits on the weight per bag (usually 25-35 lbs.). If bags of solid waste exceeded this limit, the bags were not picked up or residents were charged an additional fee.

The remaining PB towns (seven percent) had solid waste restrictions that were both volume- and weight-based. For instance, in one case, a fee of $1 was applied to bags that were less than 30 gallons *and* less than 35 pounds. Additionally, in three of the PB towns in the sample, residents were given a number of "free" bags per week which did not require tags or stickers. Fees were only applied to solid waste that exceeded this limit.

A number of towns had developed programs to complement their PB programs. Almost half the PB towns in the study had instituted town-operated composting programs to facilitate reductions in solid waste disposal. In some cases, public demonstrations were also held in which residents were trained in methods of home composting. In addition, more than half of all PB towns in the sample had educational programs to encourage recycling and composting. The goal of these programs was to enhance awareness about solid waste disposal costs and options, so that municipal residents reduced the amount of solid waste requiring disposal. The study found that on average, PB towns spent $0.21 per capita on these educational activities, which included newspaper advertisements, residential mailings, and volunteer presentations at schools and town halls to distribute information on the details of recycling and composting.

Conventional pricing systems used by the control group were similar in that solid waste disposal did not require the payment of a unit fee. Nevertheless, a number of the non-PB towns had undertaken measures to reduce solid waste generation. A small percentage of those towns (13 percent) had a mandatory recycling ordinance. In addition, approximately a third had adopted town-run composting programs. Some municipalities also had educational programs to encourage recycling and composting and spent on average $0.16 per capita for this activity.

Table 3 summarizes comparative features of the sample of pay-by-the-bag towns and those of the non-PB towns in the study. Expenditures on recycling and composting education were fairly similar, with PB towns spending $0.21 per capita for the year compared to $0.16 in the non-PB towns. The percentage of municipalities with mandatory recycling ordinances was also similar, while almost twice as many of the PB municipalities (relative to the group of non-PB towns) had town composting programs. The percentage of non-PB municipalities that collected solid waste curbside was double that of PB towns, with the majority of the latter group requiring residents to drop off their solid waste at transfer stations. A larger percentage of control towns collected recyclables curbside (40 percent) than PB towns (31 percent). Further, municipalities in the study hauled their waste for disposal to either a commercial landfill or a regional incinerator. As shown in Table 3, the PB municipalities utilized the incinerators more heavily with only seven percent shipping waste to commercial landfills, while 25.8% of the non-PB municipalities shipped to commercial landfills. (Those towns with publicly-owned landfills were excluded from the non-PB group because of the lack of data on solid waste tonnages.)

Of primary interest were the differences in per capita solid waste tonnages between PB towns and the non-PB group. The per capita quantity of solid waste disposed in PB towns in 1993 was 0.189 tons compared to an average of 0.429 tons per capita for non-PB towns. Thus, the per capita quantity of solid waste disposed in PB towns was less than half that of control towns.

Table 3. Comparative features of pay-by-the-bag and control municipalities

Characteristic	Pay-by-the-bag municipalities	Control municipalities
Percentage of municipalities which collect solid waste curbside	38.0%	64.5%
Percentage of municipalities with town composting program	28.5%	29.0%
Per capita recycling educational expenditures	$0.21	$0.16
Percentage of municipalities with mandatory recycling	13.8%	13.0%
Percentage of municipalities which collect recyclables curbside	31.0%	40.0%
Percentage of municipalities using commercial landfill	7.0%	25.8%
Average annual residential waste disposal (in tons per person)	0.189	0.429
Average annual municipal solid waste management costs per capita	$23.51	$41.20
Average annual municipal plus total household solid waste management costs	$31.17	$41.20

Significantly, net municipal solid waste management costs were also lower in PB towns than in the non-PB towns. The annual average per capita expenditure in PB towns was $23.51 compared to $41.20 in the control group. Even when the household's cost of bags and stickers was added to the municipality's cost in PB towns, the average total per capita expenditures on solid waste management were lower ($31.17) than in the control towns ($41.20).

The effects of PB programs and mandatory recycling on solid waste disposal

The analysis of PB programs indicated that they have a significant negative effect on residential solid waste tonnages. Municipalities that adopt PB programs can expect annual per capita solid waste tonnages to be 0.227 tons lower than under a conventional pricing system. Further analysis showed that curbside pick-up raises annual per capita solid waste 0.123 tons. These

results suggest that the most powerful method to reduce residential solid waste disposal is to adopt pay-by-the bag incentive programs. The study also examined the impact of other factors that might influence solid waste tonnages in the sample municipalities, including median household income, the percentage of renters, expenditures on recycling education, population, and average household size. None of these factors was found to have a significant impact on solid waste tonnages.

Mandatory recycling programs were found to substantially reduce per capita solid waste in non-PB towns. The analysis indicated that mandatory recycling programs can lower per capita solid waste by 0.228 tons per year, a magnitude that is comparable to that of PB programs. This finding may be of particular interest to municipalities concerned with the negative and regressive economic effects of PB programs on low income and/or large households. This result should be interpreted with caution, however, since the number of non-PB towns in the sample that had mandatory recycling programs was very small.

In summary, the analysis indicated that an important determinant of solid waste disposal is the type of solid waste pricing system. Pay-by-the-bag programs contributed to an annual reduction of 0.226 tons of solid waste per capita. Curbside collection in PB towns was found to be directly related to per capita solid waste disposal tonnages. This may be explained by the fact that in municipalities without curbside pick-up, residents may try to minimize the number of trips to the transfer station and may therefore take steps to reduce their solid waste. A second explanation may be that curbside pick-up is more likely to be the method of collection in large municipalities in which residents have fewer alternatives for reducing solid waste generation. Finally, the results suggested that both mandatory recycling programs and PB programs can reduce residential solid waste--that is, both market-based incentives and local ordinances that simply mandate that households sort and recycle solid waste can be effective in reducing the quantity of solid waste requiring disposal.

The impact of PB programs on solid waste management costs

While PB systems may lead to reductions in per capita solid waste, there has previously been little research conducted to determine the cost-effectiveness of these programs--that is, to determine whether the savings generated by the programs outweigh the costs of running the programs. It is possible, for example, that the administrative and management costs of running PB programs outweigh the cost savings. To address this question, the study used an econometric model to assess the impact of PB programs on municipal solid waste management costs. The results of that analysis indicated that PB programs are cost effective and that the adoption of a PB program can result in a reduction in annual per capita costs of $19.86 at the level of the municipality. Of course, some of the cost is shifted onto individual households which are required to pay per bag of waste disposed. Taking into consideration total costs (municipal and household costs), PB programs continue to be cost effective and in the study were associated with an annual cost reduction of $12.67 per capita. The analysis also showed that the measured costs of curbside pick-up were greater than for drop-off. Finally, municipalities disposing of their waste at landfills had significantly lower costs than those contracting with incinerators.

Waste diversion

Pay-by-the-bag programs may have some unintended effects, of which the problem of waste diversion may be the most prominent--and the most worrisome in some cases. Forms of waste diversion that cause concern include illegal dumping along roadsides and in commercial dumpsters, waste diversion to neighboring towns without PB programs, and backyard burning. The study examined the incidence of these forms of waste diversion in Maine.

Information on the effects of PB programs on the amount of illegal dumping and other forms of waste diversion was obtained by means of a survey that was conducted on a 50 percent random sample of PB towns. Interviews were conducted with public officials, road crews, and a sample of commercial establishments in person and by telephone. These groups were asked a

series of questions designed to elicit information about changes in the incidence of roadside dumping, backyard burning, and illegal dumping in commercial dumpsters after the implementation of PB programs.

Less than half of all PB towns surveyed reported initial increases in the incidence of roadside dumping after the adoption of PB programs. Most of those towns reporting this problem indicated that the magnitude of the problem was relatively small--an occasional bag of waste found on the roadside and in one case, a truckload found in an abandoned gravel pit. Public officials were not able to quantify the amount of solid waste found on roadsides. In a number of cases, public officials were able to identify the source of the solid waste (by searching the waste for identification), and either fined the individuals responsible or gave them a warning. Three quarters of those towns reporting initial increases in roadside dumping said that the problem had abated.

A survey of commercial establishments in pay-by-the-bag towns to determine changes in the incidence of illegal dumping in dumpsters found little evidence of this problem. The majority of those firms interviewed (60 percent) said that there was no increase in illegal dumping after the adoption of the PB program. A number of firms noted that the problem existed *before* the adoption of these programs and was largely related to the influx of tourists and summer residents. Among those firms reporting an increase in illegal dumping induced by the adoption of PB programs, a frequent response was to place locks on dumpsters.

The study examined solid waste data in a number of towns that border on towns with pay-by-the-bag programs to determine whether the adoption of PB led to waste "shifting," whereby residents of PB towns might shift their waste to nearby non-PB towns. There were insufficient data to test for evidence of waste shifting in 13 neighboring municipalities. There was strong evidence of waste shifting in only one municipality, suggesting that this is not a widespread negative effect of PB programs.

A more frequent problem induced by the adoption of PB programs is the apparent increase in backyard or barrel burning. Slightly more than half the sample of PB towns receiving in-depth interviews noted an increase in the incidence of this practice with 30 percent indicating that the problem continues. (None of those municipalities reporting continuing problems with backyard burning have curbside pick-up of recyclables). This may reflect the rural character of the sample of PB towns as well as the difficulty of monitoring this practice (unlike, for example, roadside dumping).

Conclusions

The results of the study suggested that pay-by-the-bag programs are associated with relatively lower per capita solid waste tonnages relative to conventional pricing systems. Pay-by-the-bag towns also have lower municipal solid waste management costs per capita. Even when household expenditures on bags and stickers were included in solid waste management costs, PB municipalities spent less on solid waste management per capita than towns with conventional pricing systems. In total, a PB system was estimated to lower each person's waste management cost an average of $10 per year.

The study also found that residential per capita solid waste tonnages are lower in those non-PB towns with a mandatory recycling program than in the non-PB towns without such a program. For municipalities concerned about the negative impact of PB programs on low income households because of the higher cost per household of waste disposal, this finding may suggest an attractive alternative. With PB programs as the primary focus of the study, the relationship between mandatory recyling programs and solid waste tonnages was not fully analyzed. Further study may yield more meaningful results.

The study findings also indicated that waste diversion and waste shifting are not serious or extensive problems. While there is some evidence that these practices exist, a large percentage of the PB towns reported that illegal dumping declined within several months of the adoption of the program. This may be, in part, a result of some commercial establishments having taken measures to reduce the incidence of illegal dumping. Thus, continued monitoring of this practice may be useful.

The research team also found some evidence of an increase in backyard burning in PB municipalities after the adoption of unit pricing programs. This practice may explain the relatively large difference in per capita solid

waste tonnages between towns with conventional pricing and unit pricing programs. However, data limitations prevented an estimation of the quantity of waste diverted in this fashion. To the extent that this poses environmental hazards, an evaluation of the scope and frequency of this practice may be an important area of future research.

Since 1989, solid waste pricing and management systems used by Maine municipalities have changed greatly. These shifts are related to the closure of town landfills, the rising costs of incinerator disposal and the state-mandated requirement that towns recycle 35 percent of solid waste. A number of towns in Maine have only recently closed public landfills and now rely on private landfills or incinerators for waste disposal. It appears that the bulk of infrastructure adjustments have been made, but solid waste programs are still in flux.

For example, recycling markets are not yet fully developed, with the result that some towns have revenues from the sale of recyclables, while others have recycling contracts that impose a net cost. Recycling tonnage data are sparse, making it difficult to analyze the impact of PB and mandatory recycling programs on quantities of waste recycled. Also, solid waste tonnage data are as yet still very difficult to obtain since in the past many towns did not record these data. In the next several years, as the recycling market becomes more fully developed and recordkeeping on quantities of waste recycled is more systematic, research in this area should be more feasible than at present.

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