

BY JANE KATZ PHOTOGRAPHS BY JOSHUA PAUL

The images in the media were vivid—and, well, disgusting. In March 1987, the *Mobro 4000*, the garbage barge from Islip, Long Island, sailed down the coast piled high with 3,100 tons of rotting garbage, medical waste, old tires, cardboard containers, and other trash from local schools and businesses, looking for a place to discharge its cargo. Wandering all the way from New York to North Carolina, Alabama, Louisiana, Texas, Mexico, and Belize, no community wanted to let it unload.

The story was front-page news for weeks and resulted in considerable public debate and finger pointing. Society

What a



The generation and disposal of trash imposes costs on society and the environment. Should we be doing more?

At the Central Landfill in Johnston, Rhode Island, trucks are required by law to dump at least six inches of dirt over the day's trash.

aste



Cans and other metal items ready to be compacted and baled for recycling at the Wellesley Municipal Recycling and Disposal Facility, Wellesley, Massachusetts.



was creating trash faster than we could find space to put it. Eventually, we would all be buried under a giant pile of garbage, victims of our own excessive consumption and wastefulness. A senior administrator at the Environmental Protection Agency warned of a “deluge of garbage.” What’s more, we were using up resources, polluting the environment, and pushing these costs on to future generations.

Communities began to take serious notice. At the time, almost 80 percent of trash was destined for landfill; another 10 percent was incinerated; only about 10 percent was recycled. Nearly 3,000 municipal landfills had closed between 1982 and 1987; many more were scheduled to close over the next several years. There seemed to be a limited number of alternatives. We could reduce the amount of trash we generated, or increase the amount we recycled or burned.

In an effort to reduce trash production, many communities began to charge households for the amount of trash they generated; others began recycling efforts in earnest. In 1988, less than 1,000 communities had curbside recycling programs; by 2000, at least half the population could leave their bottles, cans, and newspapers at the curb.

Fifteen years later, the subject of trash seems to have lost some of its heat. In the media, it now takes a back seat to articles on global warming and depletion of the ozone layer. What happened? Have our policies worked? Or are we still going to be buried under our own trash?

MORE TRASH

The world certainly hasn’t stopped producing trash or, as it’s known technically, municipal solid waste—that is, all the solid waste generated by households, institutions (such as schools and hospitals), and businesses, except for industry and agriculture. Municipal solid waste includes such materials as containers, food scraps, construction materials, medical waste, miscellaneous inorganic trash, including hazardous materials such as aerosol cans, paint, pesticides, and batteries. It also includes sludge and ash generated by sewage treatment and incinerators.

According to the Environmental Protection Agency (EPA), the United States generated 231 million tons of municipal waste in 1999, up from 88 tons in 1960 and up almost one-third since the furor over the *Mobro 4000* in 1987. On a per capita basis, the numbers are a little less dramatic. In 1999, the average American produced 4.64 pounds per person per day, up from 4 pounds in 1987. About 38 percent (by weight) is paper; 23 percent is food and yard waste; another 11 percent is plastic.

World production of waste tends to grow along with world population and GDP, say David Beede of the U.S. Department of Commerce and David Bloom of Harvard—with population growth having a larger impact than income. However, they point out that technological improvements in product and container design are likely to slow the growth of waste, as designs evolve to use more aluminum and plastic (and less steel and

glass), and to require less material overall.

High-income economies, such as the United States and European nations, account for more than their share of waste per capita, note Beede and Bloom. These nations contain about one-sixth of the population, yet generate more than one-fourth of its municipal waste. However, developing countries produce more waste per dollar of GDP; they account for less than one-half the world’s GDP, but produce nearly three-quarters of its municipal waste. Here is one way to think about it: High-income countries produce and consume more per person; low-income countries create more waste from a given amount of production. Paper is the largest component (by weight) in high-income countries, food waste predominates in low-income countries.

Historical evidence suggests that, on a per person basis, modern household waste production may not be much higher than early last century, when coal ash and horse manure were significant sources of waste. Coal ash production alone created an estimated 3.3 pounds of waste per person per day in Manhattan in the early 1900s. Today, however, a greater share of waste comes from industry—iron and steel production, power generation, pulp and paper industries, and oil and gas extraction, which are not included in municipal waste calculations. Historians also note that nineteenth-century cities were hardly pristine. In Boston, for example, trash and human waste were routinely dumped into local waterways or primitive sewers that flowed into Boston Harbor, creating “foul air” as the tide came in, particularly on warm summer nights.

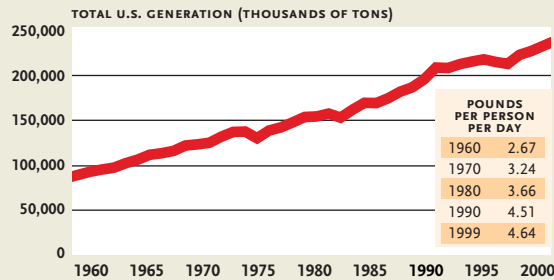
Whatever the historical figures, few dispute that collecting and disposing of garbage takes scarce resources, or that the generation and disposal of trash imposes costs on society and the environment. Post *Mobro*, researchers have made attempts to estimate these costs. These estimates should be thought of as rough guides at best. Their accuracy depends on the state of scientific knowledge and our ability to accurately assess the environmental and health risks posed by trash. For example, something thought safe at one point in time could later be found harmful. Accurate estimates also depend on valuing the benefits to individuals outside the local community, including future generations—obviously no easy task.

Researchers generally make such estimates by looking at the alternative—disposal in a modern, state-of-the-art landfill. That is, they assume that the benefits of reducing waste are equal to the full social cost of disposing of that waste. They figure social cost by taking landfill operating costs and adding in transportation costs and environmental costs (truck noise, unsightliness or odor, and harm to human health or the environment). In reviewing the evidence to date, Economist Thomas Kinman concludes that reducing garbage does not offer “huge” benefits. He cites calculations by Robin Jenkins that suggest that the social benefits of reducing municipal waste appear to be about about 60 cents for each 32-gallon bag of trash that is eliminated. However, this figure doesn’t include any contribution that landfills make to acid rain or global warming (landfills account for 28 percent of U.S. methane emissions). Consequently, it may underestimate the benefits of trash reduction.

Some firms were slow to produce with recycled materials because it required investing in expensive new equipment

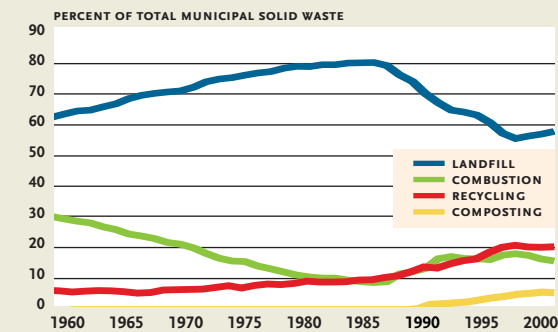
PILING UP

Total municipal solid waste generated in the United States has grown substantially, nearly doubling since 1970. Per capita increases have been much smaller. Waste per person per day has barely risen over the last decade, even during a period of strong economic growth.



WHERE DOES WASTE GO?

At the time the *Mobro* set sail in 1987, the United States sent about 140 million tons of municipal waste to the nation's landfills, an all-time high. But as a share of total waste, the amount going to landfills had already peaked, in part because increased use of incineration and in part because of a rise in recycling. Americans now recycle or compost about 28 percent of all municipal solid waste, up dramatically from 6 percent in 1960.



SOURCE: Franklin Associates, Ltd.

CHARGING BY THE BAG

In the late 1980s, local communities got serious about trying to reduce trash generation, in part, because of the *Mobro*. By 1999, more than 4,000 communities had introduced programs that assessed households' "per unit" of garbage collected. Some charged for each can or bag; others set a base rate and levied additional fees per unit, or for collections above a specified level. Municipalities that adopted these policies hoped to encourage households to consume less, throw away less, recycle more, and buy items with less packaging. They also hoped producers would feel pressure to be more economical and environmentally aware in product and package design.

Economists were pleased. They had long argued that per-unit charges would reduce overall garbage generation at a lower cost than setting a maximum quantity standard (that is, lim-

iting the amount of garbage a household can throw away). Charging per unit encourages households and firms that can adjust at least cost to do so—for example, those who can easily compost or buy products with less packaging. And it does not force a specific standard on those who would find reducing their generation of trash extremely difficult or costly (that is, more costly than paying the imposed price per bag). In this view, so long as households face the full cost of their consumption and disposal decisions, they can make socially efficient choices.

Yet, in communities that adopted per unit fees, trash collections have declined, but the drop in tonnage has been relatively small. Why? It turned out that the incentives created by these programs have been complicated.

First, most programs charge by the bag, not by weight, giving households an incentive to pack trash bags more tightly and even buy compactors. Indeed, Thomas Kinnaman and Don Fullerton actually measured trash collection in Charlottesville, Virginia, both before and after the town started charging \$0.80 per 32-gallon bag of trash. They found that garbage decreased by 37 percent by volume (number of bags), but only 14 percent by weight. The reason: weight per bag increased by one-third, rising from 15 to 20 pounds per bag.

Pricing per unit also may encourage illegal trash disposal, such as throwing waste in commercial dumpsters, taking it to a town that does not charge per bag, tossing it in an empty lot, or burning it without a permit. Again, Fullerton and Kinnaman estimated that more than one-quarter of the reduction in garbage that follows the introduction of pricing by the bag may be the result of illegal dumping. Other studies find illegal dumping is less significant.

Beyond the simple issue of trash reduction, many programs don't differentiate between what is in the bags. So food waste and other relatively innocuous trash is charged the same fee as more hazardous garbage. Most states now ban batteries and whole tires from regular landfill, and some have even more stringent rules. Vermont bans oil-based paint, large quantities of latex paint, paint thinner, and mercury devices; Massachusetts bans cathode ray tubes (which contain several pounds of lead to protect viewers from radiation). But as with pricing by the bag, households often ignore or evade these regulations. After televisions and computer monitors were banned from regular garbage pickup (because of cathode ray tubes), many communities reported finding them abandoned in empty lots and on the street. "The sidewalks are growing TVs," an official from Beverly, Massachusetts, told the *Boston Globe*.

Reducing cheating would make trash generation more responsive to fees and increase the pressure from consumers to improve package design. But monitoring and tracking down cheaters is difficult—and the costs of doing so might not outweigh the benefits. The decentralized nature of the production and disposal of household garbage—precisely what makes user fees efficient—also raises monitoring and enforcement costs. Others point out that simple administrative costs—distributing bags, keeping records, collecting the fee, and so on—could easily exceed the estimated \$3 to \$13 per person per year bene-

fits. On the plus side, however, most analysts who have looked at the question believe that charging by the bag does increase the amount of trash that households and businesses recycle.

USE IT AGAIN

Recycling not only decreases the amount of garbage headed for landfills, but also reduces energy use (and the resultant air and water emissions) as compared with manufacturing items from virgin materials. After the *Mobro*, many communities introduced curbside recycling programs, which are convenient for households since they don't require people to transport trash themselves. Nationally, 9,700 communities operated curbside recycling programs by 2000, up from about 1,000 in 1989. In Massachusetts, 159 of 351 communities (78 percent of the population) had curbside pickup; Connecticut served 100 percent of its residents. By contrast, less than 20 percent of people living in Kentucky, Mississippi, North Dakota, and Virginia could leave recyclables at the curb.

In many communities, recycling was made mandatory—at least for single-family homes. However, monitoring and enforcement—making sure people separate their paper, bottles, and plastic containers—is costly, and even when violations are discovered, punishment is generally light.

Some towns set goals for the percent of waste they want to recycle, but reaching these goals has proved difficult; towns often later relax standards or extend deadlines.

In most curbside programs, a separate fleet of trucks collects recyclables (garbage trucks are not equipped to handle both jobs) and unloads at a material-recovery center. These centers can be simple or highly automated, with magnets to extract ferrous metals, blowers to separate light materials (such as plastics) by weight, and magnets suspended above a conveyor belt that sort and separate aluminum. Biodegradable material, such as food and yard waste, can be composted or converted (through natural microbial breakdown) into methane gas that can be captured and used as fuel.

By many measures, recycling programs have been a huge success. The nation's recycling rate, only about 10 percent in 1980, reached 22 percent in 1999, with an additional 6 percent composted. According to press accounts, some people in communities without curbside programs are so intent on recycling, they carry their bottles and cans to nearby towns. And most analysts credit the increase in recycling with the decline in the percentage of municipal waste that reaches landfills (see chart).

However, increased use of recycled materials has been stubbornly slow, and the economics remain somewhat fragile. Certain products, particularly metals, are cost-effective to reuse; others, such as glass and certain kinds of paper, are still less expensive to produce from virgin material. Plastic—a petroleum product—would seem an obvious candidate for recycling. But it is costly to collect, transport, sort, and clean discarded plastics; and whenever oil prices drop, the price of recycled plas-

tic drops, too. Prices for many recycled materials have remained stable over the past decade but, like other commodities, they can be volatile—and tend to be particularly low when the economy slows. In a recent article in the *New York Times*, New York City Mayor Michael Bloomberg claimed that 40 percent of the cans and bottles collected in the city were never recycled.

Why has it proved so hard to increase the demand for recycled goods? To some degree, it is the “chicken and egg” problem. In capital-intensive industries, firms have been slow to adopt the use of recycled materials because it required investing in expensive new equipment. In the paper industry, for example, existing equipment was suitable for virgin paper only. Without a steady and reliable supply of recycled paper, firms were reluctant to commit themselves to investing in new machines. And before they would do so, an industry for de-inking newsprint also needed to evolve. In the case of plastic bottles, recycling has been complicated by the introduction of technology that allows production of bottles with barrier labels or colors that keep products fresher (by keeping oxygen out and carbon dioxide in). However, these bottles can cause hazing and spoil otherwise good batches of clear recycled plastic. And the equipment to sort them out is expensive.

Moreover, appeals for the environment alone are not always enough to sway consumer buying decisions. A recent poll cited in the *Wall Street Journal* found that only 29 percent of shoppers had recently purchased a product with a label claiming it was environmentally safe or biodegradable. Gerber switched from glass to plastic bottles after 70 percent of its customers said they would prefer the convenience of plastic. And Seventh Generation, a firm that makes napkins, tissues, and other household products, recently changed its slogan from “products for a healthy planet” to “safer for you and the environment” because it found that “personal wellness” and safety were stronger consumer draws.

Over the long run, however, reductions in the cost of collection and separation may make recycling more cost-effective. Firms are currently tinkering with optical recognition technology and electric charges that can efficiently separate plastics, and with solvents that remove labels. Industry-wide standards for new materials (such as the plastic barrier bottles) could reduce material incompatibility in the recycling process. Costs may drop with the next generation of garbage trucks that can pick up trash and recyclables at once. And new uses for recycled materials may be developed, encouraged by more reliable supplies. Even now, one can buy bathroom tiles made from recycled glass, ground-cover from recycled tires, and “wood” decking made from recycled plastic.

A number of studies have tried to assess whether recycling is socially efficient. To answer this question, they look, not at whether revenues from selling recycled material cover the costs of the programs, but at whether the benefits of recycling are greater than the cost of the alternative—putting the waste in landfills. Although the exact figures vary, studies generally conclude that the costs of at least some recycling efforts exceed the social benefits. However, most of these studies don't take into account the reduction in air and water emissions due to reduced

Although many town dumps had closed, landfill capacity was not a national problem at the time the *Mobro* set sail

These refrigerators, at Rhode Island's Central Landfill, are waiting to have chlorofluorocarbons (CFCs) removed; later the steel will be recycled. The tires behind them will be sent to Connecticut to be burned for energy. In the background, the grassy hill is landfill space already filled to capacity.



energy use from manufacturing from recycled (rather than virgin) materials or any benefit from the conserving of nonrenewable resources. It is not clear whether doing so would change their conclusions.

UP IN SMOKE

After energy prices rose during the 1970s, some thought that burning our trash would solve both the energy problem and the garbage problem in one fell swoop. In 1985, only about 7 percent of the nation's municipal waste was burned; by the mid-1990s, the figure rose to more than 17 percent.

Since then, the number of incinerators and percent of waste disposed of in this way has declined. Garbage incinerators exhibit scale economies; it takes a lot of trash to make them cost-effective. Some places thought that they could achieve the scale economies by requiring local communities to use area facilities. But the Supreme Court struck down these laws, forcing incinerators to compete directly with cheaper landfill operators. In 1994, the Supreme Court also ruled that some incinerator ash was toxic and must be disposed of as hazardous waste, raising costs even more. Concerns about safety and public reluctance to site the facilities has also contributed to the decline.

Today, about 15 percent of the nation's municipal waste is burned, just a little more than at the time of the *Mobro*. Incineration remains more prominent in the New England and Mid-Atlantic states where land and landfills are costly, and

high population densities produce a lot of trash. In 2000, Connecticut incinerated almost two-thirds of its solid waste; Massachusetts burned one-third.

NOT IN MY BACKYARD

Trash that is neither recycled nor incinerated is destined for the town dump—or its modern-day equivalent, the sanitary landfill. While it was the fear of running out of space that was most prominent in the controversy surrounding the *Mobro*, this concern was not grounded in fact. What *was* going on? The waste disposal industry, especially landfill, was undergoing restructuring—precisely because of more stringent environmental regulations.

In the nation's early days, people threw their garbage any place that was handy. But by the nineteenth century, most U.S. cities had established a town dump. Even into the 1970s, most towns maintained a dump, charging only a few dollars per ton for waste disposal. However, many were open pits that attracted flies and rats, and produced air pollution and noxious smells. Although improvements (such as covering the pits with dirt) were made in some localities, the EPA estimated that as many as 14,000 communities still were using open dumps in 1972.

By the 1970s, concerns over pollution and groundwater contamination, and improvements in technology resulted in pressure to clean up. Federal legislation was passed that imposed

standards on the construction, operation, and closure of landfills. Today, rules require operators to line the landfill with a thick clay or plastic shield, collect and treat any material that leaches out, monitor groundwater, and cover new layers of garbage with six inches of dirt within hours.

These new sanitary landfills are considerably cleaner and safer, but also more expensive. Construction costs rose as high as \$500,000 per acre, and made large landfills far more economical than small ones. One 1994 study found that the average cost of operating a sanitary landfill decreased 70 percent as capacity rose from 250 to 2,976 tons per day—and this was before all current regulations were in place. Expanding existing landfills became both cost-effective and politically attractive, as opposition from local residents made it harder to site new dumps. These larger regional facilities could also be located away from population centers in places where land costs were low and the threat to local residents was minimized.

The industry began to restructure. Many town dumps closed; others transformed themselves and got out of the burial business. In upscale Wellesley, Massachusetts, residents drop off trash and recyclables and take home abandoned treasures from the Wellesley Municipal Recycling and Disposal facility, which features picnic tables, a park bench, and a collection of recycled books—including a librarian. After recycling, the remaining waste is taken to a landfill in Fall River.

Despite many closings, the increasingly large scale of the remaining facilities meant that landfill capacity was not a national problem at the time of the *Mobro*. In 1986, 42 states had landfill capacity sufficient to last at least five years; many had capacity for more than ten years. So while some landfills near population centers were due to close or be filled, the nation's total landfill space was more than sufficient. Since then, capacity has continued to increase, rising to about 20 years' worth in 1997. Even the landfill methane emissions thought to contribute to global warming have begun to decline—the result of a reduction in the volume of waste in landfills and an increase in the amount of methane captured and used as fuel.

ACROSS STATE LINES:

HOW THE *MOBRO* 4000 GOT STRANDED

So while the *Mobro* focused public attention on trash disposal, the nation did not generally face a shortage in landfill capacity. What many communities *did* face were higher prices for disposal, precisely because of improvements in environmental regulations. The new, more stringent standards for landfills raised the cost of building and operating them. In the New England and Mid-Atlantic states, fees paid to landfills ran as high as \$50 to \$100 a ton. On Long Island, the short-run problem was particularly acute. All landfills were scheduled to close by 1990 because the high water table meant that leaking chemicals threatened the water supply. Islip's landfill stopped accepting commercial waste and disposal fees skyrocketed.

This created the opportunity to transport trash to less populated areas where land was cheaper and the potential risk to local residents was small. Some states began to “specialize” in trash disposal. By 2000, more than 30 million tons of trash, or

Modern sanitary landfills are much cleaner and safer than town dumps, but are also more costly to build and operate

TOSSED OUT IN 1999

	WEIGHT GENERATED (MILLIONS OF TONS)	PERCENT OF TOTAL
TOTAL U.S. MUNICIPAL SOLID WASTE	230	100
Paper and paperboard	88	38
Yard trimmings	28	12
Food waste	25	11
Plastics	24	11
Metals	18	8
Glass	13	5
Wood	12	5
Textiles	9	4
Rubber and leather	6	3
Miscellaneous other	7	3
BY SELECTED PRODUCTS		
Containers and packaging	76	33
Corrugated boxes	31	14
Glass bottles and jars	11	5
Plastic packaging	7	3
Cans (steel and aluminum)	7	3
Plastic bottles	4	2
Milk cartons	< 1	< 1
Newspapers	14	6
Furniture and furnishings	8	3
Office papers	8	3
Appliances	5	2
Disposable diapers	3	1
Consumer electronics	2	1

SOURCE: Franklin Associates, Ltd.

about 8 to 9 percent of the nation's municipal waste, was transported across state lines. The nation's three largest net importers of trash were Pennsylvania (12.2 million tons), Virginia (3.9 million tons), and Michigan (2.8 million tons). In New England, only Maine (475,000 tons) and New Hampshire (114,000 tons) were net importers.

Most economists do not view this as a problem, assuming that pollution costs from transporting the garbage are taken into account. From their standpoint, waste disposal is an industry like any other, with underlying regional costs and other differences that make geographic variation and concentration something to be expected. However, analysts have expressed concern that encouraging the importation of out-of-state trash may undercut a state's efforts to reduce its own trash production.

And the circumstances that produced the *Mobro 4000*? Its fate was a consequence of stronger environmental policies and entrepreneurial incompetence, not a shortage of landfill space. As local landfill closures and increased tipping fees began to encourage trash shipments, Salvatore Avellino, reputed mob boss of Long Island's trash-hauling business, arranged to dispose of Islip's trash for \$86 a ton. He planned to load the trash on a barge, ship it to Louisiana, then bury it in a local landfill for \$5 a ton. Later, the methane would be captured and the profits split with farmers and local public officials. Unfortunately, his partner in this venture neglected to "sufficiently nail down" an agreement before the *Mobro* set sail. When the partner tried

to make a quick deal with a dump in North Carolina (which had extra capacity), state regulators got nervous and refused, worrying that the boat contained toxic waste. (There had been earlier instances of organized crime members hiding hazardous waste inside normal-looking bales of trash.)

Once the media frenzy began, no community was willing to take the trash, even though many places had extra capacity and accepted shipments both before and afterward. After two months at sea, the *Mobro* returned to Brooklyn, where its cargo was incinerated. Mr. Avellino eventually went to prison on an unrelated matter after pleading guilty to conspiring to murder two trash haulers in August 1987.

TOXIC AVENGER

There was bound to be a backlash. The outlines of the *Mobro* story and landfill issues became more widely known; articles appearing in the *New York Times* and the *Wall Street Journal* came down particularly hard on curbside recycling programs, which are actually quite popular among voters. Recently, the subject has been in the news again, after New York City Mayor Bloomberg proposed cutting back recycling to save money.

Some environmental activists have argued that overemphasizing household trash merely assuages the guilt of out-of-control consumers, while diverting money and effort from more serious environmental threats—air and water pollution produced by industrial and agricultural waste, automobiles, and long-run climate change. EPA estimates suggest the cancer risk from properly operated modern landfills would average fewer than 0.08 cases per year. Many analysts argue that these hazards are dwarfed by industrial and agricultural sources of pollution, such as industrial waste dumps and wastes from large animal-feeding operations. Collection, monitoring, and enforcement are often more cost-effective than for households, since the toxic material is produced in fewer, larger locations.

Others point out that it might make sense for local governments and households to focus on the proper disposal of hazardous waste. Cleaning an area contaminated by hazardous waste is considerably more expensive than disposing of it properly in the first place, since the surrounding material must also be treated as hazardous. And then there is the prospect of destroying the ozone layer and causing long-run climate change. The recent spectacular and unexpected collapse of the Larsen B Ice Shelf in Antarctica only underscores the view that perhaps we ought to concentrate more resources on understanding and preventing global warming.

Still, it is easy to overstate the case against policies intended to reduce trash and encourage recycling. While the improvement in landfill regulation began prior to the *Mobro*, continued public support has helped in passing the current, even more stringent, standards. The best evidence to date suggests that the net benefits of recycling programs are not enormous, but then neither are the net costs. Over time, the benefits of recycling might rise and the costs drop. And while it is important to focus on the most pressing environmental problems, public support of recycling is heartening in its good intentions. We certainly don't want to toss those out in the trash. ✱