though many Garbage Project studies have relied on garbage weight for comparative purposes, volume is the critical variable when it comes to landfill management: Landfills close not because they are too heavy but because they are too full. And yet reliable data on the volume taken up by plastics, paper, organic material, and other kinds of garbage once it has been deposited in a landfill did not exist in 1987. The Garbage Project set out to fill the gap, applying its usual sorting and weighing procedures to excavated garbage, and then adding a final step: a volume measurement. Measuring volume was not a completely straightforward process. Because most garbage tends to puff up with air once it has been extracted from deep inside a landfill, all of the garbage exhumed was subjected to compaction, so that the data on garbage volume would reflect the volume that garbage occupies when it is squashed and under pressure inside a landfill. The compactor used by the Garbage Project is a thirty-gallon cannister with a hydraulic piston that squeezes out air from plastic bags, newspapers, cereal boxes, mowed grass, hot dogs, and everything else at a relatively gentle pressure of 0.9 pounds per square inch. The data on garbage volume that emerged from the Garbage Project's landfill excavations were the first such data in existence.

What do the numbers reveal? Briefly, that the kinds of garbage that loom largest in the popular imagination as the chief villains in the filling up and closing down of landfills—fast-food packaging, expanded polystyrene foam (the material that coffee cups are made from), and disposable diapers, to name three on many people's most-unwanted list—do not deserve the blame they have received. They may be highly visible as litter, but they are not responsible for an inordinate contribution to landfill garbage. The same goes for plastics. But one kind of garbage whose reputation has thus far been largely unbesmirched—plain old paper—merits increased attention.

Over the years, Garbage Project representatives have asked a variety of people who have never seen the inside of a landfill to estimate what percentage of a landfill's contents is made up of fast-food packaging, expanded polystyrene foam, and disposable diapers. In September of 1989, for example, this very question was asked of a group attending the biennial meeting of the National Audubon Society, and the results were generally consistent with those obtained from surveys conducted at universities, at business meetings, and at conferences of state and local government officials: Estimates at the Audubon meeting of the volume of fast-food packaging fell mainly between 20 and 30 percent of a typical landfill's contents; of expanded polystyrene foam, between 25 and 40 percent; and of disposable diapers, between 25 and 45 percent. The overall estimate, then, of the proportion of a landfill's volume that is taken up by fast-food packaging, foam in general, and disposable diapers ranged from a suspiciously high 70 percent to an obviously impossible 125 percent.

Needless to say, fast-food packaging has few friends. It is designed to be bright, those bold reds and yellows being among the most attention-getting colors on a marketer's palette; this, coupled with the propensity of human beings to litter, means that fast-food packaging gets noticed. It is also greasy and smelly, and on some level it seems to symbolize, as do fast-food restaurants themselves, certain attributes of modern America to which modern Americans remain imperfectly reconciled. But is there really all that much fast-food packaging? Is it "straining" the capacity of America's landfills, as a 1988 editorial in *The New York Times* contended?

The physical reality inside a landfill is, in fact, quite different from the picture painted by many commentators. Of the more than fourteen tons of garbage from landfills that the Garbage Project has sorted, fewer than a hundred pounds was found to consist of fast-food packaging of any kind—that is, containers or wrappers for hamburgers, pizzas, chicken, fish, and convenience-store sandwiches, plus all the accessories, such as cups, lids, straws, sauce containers, and so on, plus all the boxes and bags used to deliver food and other raw materials to the fast-food restaurant. In other words, less than one-half of one percent of the weight of the materials excavated from nine municipal landfills over a period of five years (1985–89) consisted of fast-food packaging. As for the amount of space that fast-food packaging takes up in landfills—a more important indicator than weight—the Garbage Project estimate after sorting is that it accounts for no more than one-third of one percent of the total volume of a landfill's contents.

What about expanded polystyrene foam—the substance that most people are referring to when they say Styrofoam (which is a registered trademark of the Dow Chemical Corporation, and is baby blue

in color and used chiefly to insulate buildings)? Expanded polystyrene foam is, of course, used for many things. Only about 10 percent of all foam plastics that were manufactured in the period 1980–89 were used for fast-food packaging. Most foam was (and is) blown into egg cartons, meat trays, coffee cups (the fast-food kind, yes, but mainly the plain kind that sit stacked upside down beside the office coffee pot), "peanuts" for packing, and the molded forms that protect electronic appliances in their shipping cases. All the expanded polystyrene foam that is thrown away in America every year, from the lowliest packing peanut to the most sophisticated molded carton, accounts for no more than 1 percent of the volume of garbage landfilled between 1980 and 1989.

Expanded polystyrene foam has been the focus of many vocal campaigns around the country to ban it outright. It is worth remembering that if foam were banned, the relatively small amount of space that it takes up in landfills would not be saved. Eggs, hamburgers, coffee, and stereos must still be put in *something*. The most likely replacement for foam is some form of coated cardboard, which can be difficult to recycle and takes up almost as much room as foam in a landfill. Indeed, in cases where cardboard replaced foam, it could often happen that a larger volume of cardboard would be needed to fulfill the same function fulfilled by a smaller volume of foam. No one burns fingers holding a foam cup filled with coffee, because the foam's insulating qualities are so effective. But people burn their fingers so frequently with plastic- or wax-coated cardboard coffee cups (and all cardboard hot-drink cups are coated) that they often put one such cup inside another for the added protection.

As for disposable diapers, the debate over their potential impact on the environment is sufficiently vociferous and complex to warrant its own chapter (see chapter seven). Suffice it to say for present purposes, though, that the pattern displayed by fast-food packaging and expanded polystyrene foam is apparent with respect to diapers, too. People *think* that disposable diapers are a big part of the garbage problem; they are not a very significant factor at all.

The three garbage categories that, as we saw, the Audubon respondents believed accounted for 70 to 125 percent of all garbage actually account, together, for only about 3 percent. The survey responses would probably have been even more skewed if respondents had also been asked to guess the proportion of a typical landfill's contents that is made up of plastic. Plastic is surrounded by a maelstrom of mythology; into the very word Americans seem to have distilled all of their guilt over the environmental degradation they have wrought and the culture of consumption they invented and inhabit. Plastic has become an object of scorn—who can forget the famous scene in *The Graduate* (or quote it properly)?—no doubt in large measure because its development corresponded chronologically with, and then powerfully reinforced, the emergence of the very consumerist ethic that is now despised. (What Mr. McGuire, a neighbor, says to Benjamin Braddock is: "I just want to say one word to you. Just one word. Are you listening? . . . Plastics. There is a great future in plastics. Think about it.") Plastic is the Great Satan of garbage. It is the apotheosis of the cheap, the inauthentic; even the attempts to replace or transform plastic—such as the recent ill-fated experiments with "biodegradable" plastic, which will be discussed in chapter seven—seem somehow inauthentic.

There are legitimate causes for concern about plastic, particularly with respect to its manufacture. For the moment the issue is the volume of plastics in landfills. Two statistics have received wide circulation. The first, which appears repeatedly in the press, is that while plastics may make up only 7 percent of all municipal solid waste by weight, they make up some 30 percent of municipal solid waste by volume. This 30 percent figure has a history: It comes from a report published by, and available (for $300) from, the International Plastics Consultants Corporation (IPCC), based in Stamford, Connecticut, a group that was set up to promote the recycling of plastic. The IPCC's methodology for estimating the volume in landfills occupied by plastics begins by accepting the Franklin Associates' materials-flows assumptions and their weight data on various garbage categories. To estimate the volume of various categories of garbage after such garbage has been crushed and compacted, the researchers obtained from the pertinent trade associations and businesses whatever data they had on the bulk density (that is, the volume per unit weight) of items that have been squashed and baled for transport, usually for shipment to recycling facilities.

There were, of course, a few problems. While the bulk density of some types of paper items, such as newsprint and corrugated cardboard, could be evaluated with a certain precision, because these items get recycled and records are kept, the IPCC had to assume that the bulk density of nonrecycled paper items for which they had no data, such as cereal boxes, paper towels, and tissues, was the same as that of recyclable paper. Similarly, the IPCC had to assume that the bulk density of all nonrecycled plastics, from toothbrushes to tables, was the same as the bulk density for the kinds of recyclable plastic for which it had data—primarily PET (polyethylene terephthalate) plastic soda bottles, the kind that most soft drinks now come in. And, of course, there being no trade associations for yard waste, food waste, and many other kinds of garbage, the International Plastics Consultants Corporation had to settle for reasonable estimates of the bulk density of all these garbage categories. The IPCC ended up by concluding that plastics made up 27 percent of a typical landfill's contents, a figure that in news reports was then rounded up to 30 percent.

The second estimate that one encounters with some regularity for the volume of plastics in landfills is 20 percent. The provenance of this figure is a 1988 Franklin Associates study of landfill constituents by weight and volume. This figure is inflated because Franklin Associates (as its researchers readily admit) excluded the huge category "construction and demolition debris"—which accounts for about 12 percent by volume of a typical landfill's contents—from their estimation of the total landfill pie, thereby reducing the size of the pie and magnifying the relative proportions of the other constituents. The problem with construction and demolition debris, insofar as Franklin is concerned, is the same one faced by the IPCC: no one keeps records on it. There is no trade association for construction and demolition debris in Washington, and, because local communities are not normally responsible for collecting and carting away such debris, as they are other kinds of garbage, very often not even haphazard documentation exists. And besides, the federal government does not technically consider construction and demolition debris to be municipal solid waste (though it ends up in municipal landfills). For these reasons construction and demolition debris was simply left out of the picture. By Franklin's account, not one ounce of construction and demolition debris—not one cinderblock, two-by-four, or rebar rod—has technically entered American landfills during the past thirty years.

The Garbage Project's methodology has not been quite as sophisticated as that of Franklin or the IPPC: Garbage Project personnel simply measured by weight and volume everything exhumed from sample municipal-solid-waste landfills. The results differ from the Franklin and IPCC numbers. In landfill after landfill the volume of all plastics—foam, film, and rigid; toys, utensils, and packages—from the 1980s amounted to between 20 and 24 percent of all garbage, as sorted; when compacted along with everything else, in order to replicate actual conditions inside a landfill, the volume of plastics was reduced to under 16 percent.

Even if its share of total garbage is, at the moment, relatively low, is it not the case that plastics take up a larger proportion of landfill space with every passing year? Unquestionably a larger number of physical objects are made of plastic today than were in 1970 or 1950. But a curious phenomenon becomes apparent when garbage deposits from our own time are compared with those from strata characteristic of, say, the 1970s. While the number of individual plastic objects to be found in a deposit of garbage of a constant size has increased considerably in the course of a decade and a half—more than doubling—the proportion of landfill space taken up by these plastics has not changed; at some landfills, the proportion of space taken up by plastics was actually a little less in the 1980s than it was in the 1970s.

The explanation appears to be a strategy that is known in the plastics industry as "light-weighting"—making objects in such a way that the objects retain all the necessary functional characteristics but require the use of less resin. The concept of light-weighting is not limited to the making of plastics; the makers of glass bottles have been light-weighting their wares for decades, with the result that bottles today are 25 percent lighter than they were in 1984. (That is why bottles in landfills are likely to show up broken in the upper, more-recent, strata, whereas lower strata, holding garbage from many years ago, contain many more whole bottles.) Environmentalists might hail light-weighting as an example of source reduction. Businessmen embrace it for a different reason: sheer profit. Using

fewer raw materials for a product that is lighter and therefore cheaper to transport usually translates into a competitive edge, and companies that rely heavily on plastics have been light-weighting ever since plastics were introduced. PET soda bottles had a weight of 67 grams in 1974; the weight today is 48 grams, for a reduction of 30 percent. High-density polyethylene (HDPE) milk jugs in the mid-1960s had a weight of 120 grams; the weight today is about 65 grams, for a reduction of more than 45 percent. Plastic grocery bags had a thickness of 30 microns in 1976; the thickness today is at most 18 microns, for a reduction of 40 percent. Even the plastic in disposable diapers has been light-weighted, although the super-absorbent material that was added at the same time (1986) ensures that even if diapers enter the house lighter they will leave it heavier than ever. When plastic gets lighter, in most cases it also gets thinner and more crushable. The result, of course, is that many more plastic items can be squeezed into a given volume of landfill space today than could have been squeezed into it ten or twenty years ago.

This fact has frequently been met with skepticism. In 1989, Robert Krulwich, of the CBS network's "Saturday Night with Connie Chung" program, conducted a tour of the Garbage Project's operations in Tucson, and he expressed surprise when told about the light-weighting of plastics. He asked for a crushed PET soda bottle from 1989 and tried to blow it up. The light plastic container inflated easily. He was then given a crushed PET soda bottle found in a stratum dating back to 1981—a bottle whose plastic would be considerably thicker and stiffer. Try as he might, Krulwich could not make the flattened container inflate.

One item that has not been light-weighted during the past few decades is your typical daily newspaper—the messenger that repeatedly carries warnings about the garbage crisis. A year's worth of copies of *The New York Times,* for example, weighs about 520 pounds and occupies a volume of about 1.5 cubic yards. A year's worth of *The Times* is the equivalent, by weight, of 12,480 empty aluminum cans or 48,793 Big Mac clamshell containers. It is the equivalent, by volume, of 18,660 crushed aluminum cans or 14,969 crushed Big Mac clamshells.

Newspapers epitomize the part of the garbage problem that gets the least amount of attention: paper. During the 1970s futurists and other writers, perceiving the advent of an electronic society, heralded the new paperless workplace, the new paperless culture. "One of the most startling features of the Computer Revolution," Christopher Evans wrote in *The Micro Revolution* (1979) "is that print and paper technology will appear as primitive as the pre-Caxtonian handcopying of manuscripts seems to us. In sum, the 1980s will see the book as we know it, and as our ancestors created and cherished it, begin a slow but steady slide into oblivion." Predictions like that one were never quite believable even in their heyday, when the consequences of the advent of copying machines were already apparent. It is obvious by now that computers, far from making paper obsolete, have made it possible to generate lengthy hard-copy documents more easily than ever before. A computer with a printer is, in effect, a printing press, and there are now fifty-five million of these printing presses in American homes and offices, where twenty years ago there had been only typewriters. With respect to paper, advancing technology is not a contraceptive but a fertility drug. For one thing, as technology in general has become more and more sophisticated, with more and more components, the engineering specifications needed to describe complex systems have necessarily become more and more voluminous. One environmental consulting group recently publicized the assertion that if all the paper stored on a typical American aircraft carrier were removed, the ship would rise three inches in the water. Garbage Project researchers have been unable to substantiate that claim, but it is definitely the case that, prognostications to the contrary, paper has managed to hold its own among the components of the U.S. solid-waste stream. Edward Tenner, an executive editor at Princeton University Press, recently observed: "The paperless office, the leafless library, the inkless newspaper, the cashless, checkless society—all have gone the way of the Empire State Building's dirigible mooring, the backyard helipad, the nuclear-powered convertible, the vitamin-pill dinner, and the Paperwork Reduction Act of 1980."

For all the competition since the 1950s from plastic, metal, construction-and-demolition debris, and non-paperaceous organics, paper's contribution to a landfill's contents has remained relatively even, at well over 40 percent (see Figure 4-B). Newspapers alone

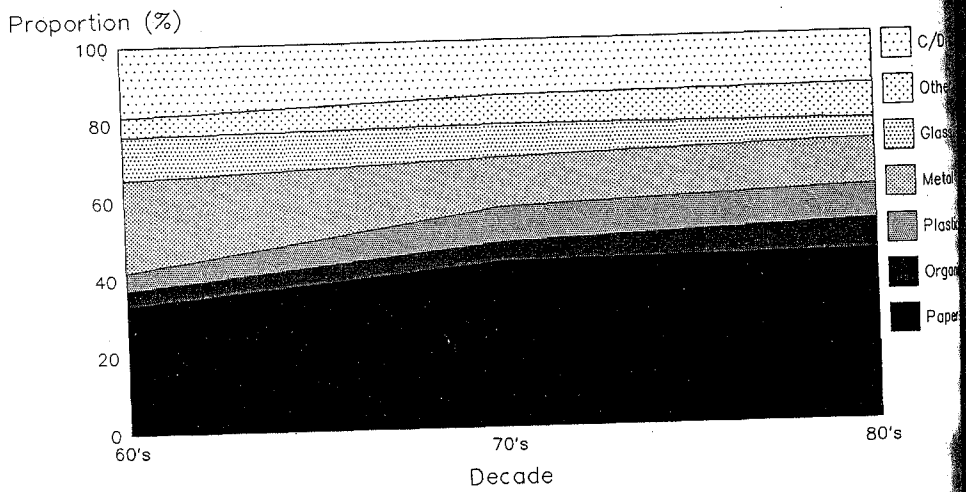

Figure 4-B. Garbage Project excavations of landfills yield a picture of their changing composition over time; the data here reflect volumes that have been compaction-corrected. Paper is the single biggest constituent of a typical landfill. A voluminous but usually overlooked constituent of landfills is construction-and-demolition debris, which accounts for an average of about 12 percent of total content. The graph excludes soil used for cover.

SOURCE: The Garbage Project

may take up some 13 percent or more of the space in the average landfill—nearly as much as all plastics. Paper used in the packaging of consumer goods has grown in volume by about a third since 1960. Non-packaging paper—computer paper, stationery, paper plates and cups, junk mail—has doubled in volume. The volume of discarded magazines has likewise doubled, to about 1.2 percent—about as much as all the thrown-away fast-food packaging and expanded polystyrene foam combined.

One noteworthy contributor to a landfill's paper content is the telephone book. Dig a trench through a landfill and telephone books can be seen to stud some strata like currants in a cake. They are thrown out regularly, once a year; in the city of Phoenix, that means almost twelve pounds of phone books annually (one yellow pages and one white pages) for every business and household. And their

expansion in number seems to know no bounds. First there are the normal "Baby Bell" phonebooks published by the seven regional phone companies, often two or three of them per household in a city of average size. Then come the many competing brands of Yellow Pages published by rivals to the Bell system companies: Reuben H. Donnelly and GTE Directories are the biggest, but there are some two hundred other yellow pages publishers. And then there are phonebooks that target specific businesses, or senior citizens, or juveniles, or members of different ethnic groups. Miniature, paperback book–sized phonebooks have recently appeared for people who have car phones, to ride beside them on the front seat. In most cases phonebooks are made of paper of such low quality that recycling is difficult, although some end uses do exist.

The avalanche of paper, like everything else about garbage, needs to be seen in perspective. Paper is not inherently a bad thing. There are many uses for paper that end up *limiting* the generation of garbage. The skillful packaging of food products, to give just one example, cuts down markedly on the wastage of foods. But for all paper's virtues, an inarguable fact remains: If garbage volume is ever to be significantly reduced, paper is the foe that must be faced. The task of getting some control over paper is made all the more necessary by the fact that paper and many other organics, as we will see in the next chapter, tend not so much to degrade in landfills as to mummify. They do not, in other words, take up appreciably less and less space as time goes by.

The following chart, which contrasts the findings of a 1990 Roper Poll with recent Garbage Project data, helps to summarize the difference between mental and material realities with respect to landfills. The percentages in the Roper column indicate the proportion of respondents identifying a particular item as a major cause of garbage problems.

	Roper (%)	Actual Volume in Landfills (%)
Disposable diapers	41	<2
Plastic bottles	29	<1

	Roper (%)	Actual Volume in Landfills (%)
Large appliances	24	<2
Newspapers	11	~13
All paper	6	>40
Food and yard waste	3	~7
Construction debris	0	~12

Misperceptions such as these are not harmless. They can lead to policies and actions that are counterproductive.

In commemoration of Earth Day, 1990, the New York Public Interest Research Group launched a campaign against the use of certain highly visible and famously odious forms of garbage, such as fast-food containers, aseptic packaging (juice boxes), and disposable diapers, and it urged members of allied environmental groups to spread the word "through newsletters and other publications." One can appreciate the good intentions—as well as the irony of the means of communication employed.

Popular misconceptions about what landfills are filled with are matched by popular misconceptions about how fast they are filling up. There can be no disputing the fact that there is, for the time being, an acute shortage of landfills still available to take deposits, especially in the northeastern United States. Since 1978, according to the Environmental Protection Agency, some fourteen thousand landfills have been shut down nationwide (leaving some six thousand in operation). Still, as the University of Pennsylvania's Iraj Zandi has shown, these figures do somewhat overstate the problem—and even the EPA is half-hearted about offering them. Many of the shut-down "landfills" were actually open dumps being closed for environmental reasons, and whatever the nature of the sites, they have tended to be relatively small, whereas those that remain open are quite large. In 1988, for example, 70 percent of the nation's landfills—the smaller ones—handled less than 5 percent of the municipal solid waste that was landfilled; that same year, fewer than five hundred landfills, or about 8 percent of the total—the bigger ones—handled nearly 75 percent of the nation's landfilled garbage. "It appears," Zandi writes, "that the trend is toward operating fewer but larger landfills. This phenomenon coincides with the trend in the rest of the industrialized world." (As of 1990, some 42 percent of all landfills were under ten acres in size, 51 percent were between ten and 100 acres in size, and 6 percent were larger than 100 acres. Most new landfills being created are of the large variety.)

That said, the situation regionally is in many cases dire. In New Jersey, the number of landfills has dropped from more than three hundred to about a dozen during the past fifteen years, and more than half of New Jersey's municipal solid waste must now be exported to landfills in other states—for the most part, states in the Midwest, whose many depressed rural counties and private landfill owners are willing to take the money that comes with the garbage, even if the relentless convoys of eighteen-wheel tractor trailers unnerve and anger local residents (see Figure 4-C). The customary formulation of the problem that we face (it appears in virtually every article on the subject) is that 50 percent of the landfills now in use will close down within five years. As it happens, that has long been the general state of affairs—it was true in 1970 and 1960—because the waste-management industry has never seen the need to maintain excess capacity beyond roughly that level. In the past, however, new landfill capacity was rarely hard to obtain. The difference today is that in many places used-up capacity is simply not being replaced. In 1976, for example, the state of Texas awarded some five hundred permits for landfills; last year the state awarded only fifty. The inevitable result in such cases is scarcity, ruinously high tipping fees (the amount that landfills charge customers for dumping garbage—upwards of $125 a ton in the most congested areas), and a desperate search by communities for alternatives.

Why are more permits not being granted? The reasons usually have nothing to do with the claim that one frequently hears: that we are running out of room for them. Yes, it is sometimes the case that we *have* run out of room. In the congested northeast there is not all that much space left for landfills, at least not safe ones. Some 1,350 twenty-ton tractor trailers laden with garbage now leave Long Island every day, bound for distant repositories. In the nation as a whole,

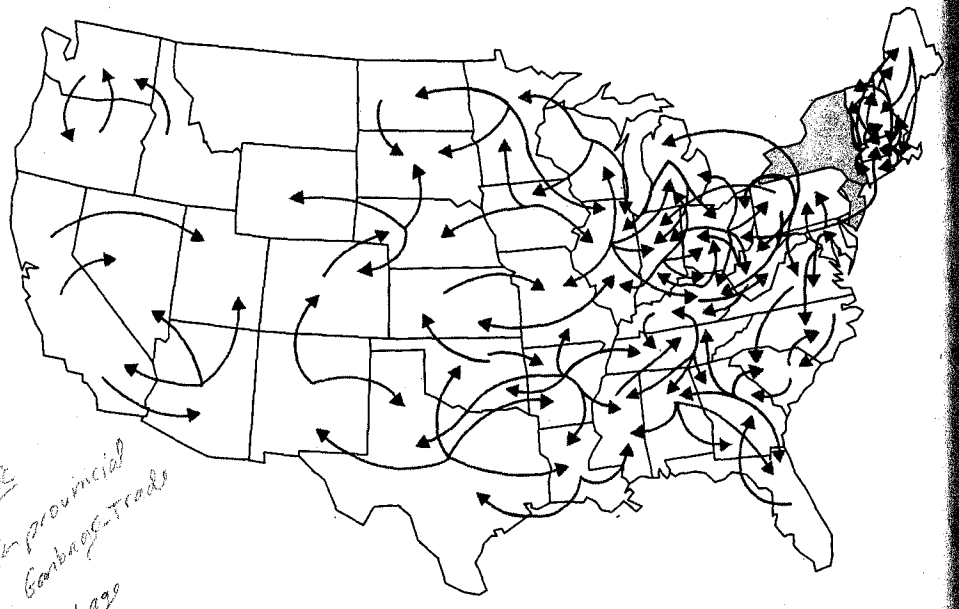

Figure 4-C. Interstate traffic in garbage has grown increasingly heavy and complex. In order to remain comprehensible, this map does not show the movement of garbage out of New York and New Jersey, the two biggest garbage-exporting states in the country. New York's garbage is trucked as far away as New Mexico.

SOURCE: National Solid Wastes Management Association

however, there is room aplenty. The United States is a big country, heavily urbanized but with enormous tracts of empty countryside. A. Clark Wiseman, in a study published by the Washington-based think tank Resources for the Future, has calculated that if the current rate of generation were maintained, all of America's garbage for the next one thousand years would fit into a landfill space 120 feet deep and forty-four miles square—a patch of land representing less than 0.1 percent of the surface area of the United States, or equivalent in size to three Oklahoma Citys. Such a landfill is for any number of reasons completely impractical, of course; the point here is simply that the total amount of space is not all that large. Few nations are as substantially endowed with uncongested territory as this one is,

and there is appropriate land available even in relatively populous areas. Recently Browning Ferris Industries, one of the nation's two biggest full-service garbage disposal companies (the other is Waste Management, Inc.), commissioned an environmental survey of eastern New York State with the express aim of determining where landfills might safely be located. The survey pinpointed sites that constituted only 1 percent of the region's land area, but that still represented two hundred square miles of territory. And yet with all this potentially available land, the state of New York has since 1982 closed down 298 landfills and opened only six.

The obstacles to new sanitary landfills these days are to some extent monetary—as noted earlier, landfills are expensive—and, more important, psychological and political. Nobody wants a garbage dump in his or her neighborhood. The focus of NIMBY ("not in my back yard") protests is ostensibly community safety. In truth, however, problematic but existing landfills on inappropriate sites tend to draw less heat than well-planned but as yet only proposed landfills intended for appropriate sites. The key variables are property values and political clout. In metropolitan areas in particular, many existing landfills are to be found in socioeconomically depressed locations. Many new landfills, in contrast, are proposed not for congested metropolitan areas but for the far hinterland just beyond the older suburbs: in the heartland of the exurban gentry. The inhabitants are people who have the money, the knowledge, and the will to fight. And few politicians see making a principled case for a local landfill as the way to further their careers.

These are real problems—landfills filling up, difficulties opening replacements—and as so often seems to be the case with this nation's intractable ills, the only meager solace one can find is in the fact that they are nothing new. "Appropriate places for garbage are becoming scarcer year by year. . . . Already the inhabitants in proximity to the public dumps are beginning to complain." Those words were written by the chief health officer of Washington, D.C.—in 1889.