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Characterization of Products Containing Lead and Cadmium in Municipal Solid Waste in the United States, 1970 to 2000

Final Report

Executive Summary

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Final Report

Executive Summary

Prepared for
United States
Environmental Protection Agency
Municipal Solid Waste Program
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EXECUTIVE SUMMARY

As disposal of municipal solid waste (MSW) has become an issue of increasing importance in the United States, combustion of wastes has been recognized as one of several alternative management approaches. A concern associated with municipal waste combustion, however, is that heavy metals (lead and cadmium in particular) have been found in analytical tests of the ash from these facilities. This report characterizes the sources of lead and cadmium in products disposed in MSW over the time period 1970 to 1986, with projections to the year 2000.

LEAD IN MUNICIPAL SOLID WASTE

Lead is widespread in the municipal waste stream; it is in both the combustible and noncombustible portions of MSW. Discards of lead in MSW are overwhelmingly greater than discards of cadmium (Figure 1).

Lead-acid batteries (primarily batteries for automobiles) rank first, by a wide margin, of the products containing lead that enter the waste stream. Trends in quantities of lead discarded in products in MSW (ranked by tonnage discarded in 1986) are shown in Table 1. The last two columns on the table indicate whether the total tonnage of lead in a product is generally increasing or decreasing, and whether the percentage of total MSW lead contained in a product is increasing or decreasing.

Changing trends in discards of lead are illustrated in Figure 2. Lead discards in batteries are shown to be growing steadily, as are discards in consumer electronics. Discards of leaded solder in cans and lead in pigments, however, virtually "disappear" from the graphic between 1970 and 1986. Lead discards in other products are shown to be relatively small.

Findings about the individual products in MSW that contain lead are:

* Lead-acid Batteries contributed 65 percent of the lead in MSW in 1986; this percentage has ranged between 50 and 85 percent during the 1970 to 1986 period studied. The tonnages in Table 1 represent discards after recycling, but of all the products considered, only lead-acid batteries are recycled to a significant extent. Recycling rates, which have ranged from 52 to 80 percent, have a major effect on the tonnage of lead-acid batteries discarded.

* Consumer Electronics (television sets, radios, and video cassette recorders) accounted for 27 percent of lead discards in MSW in 1986. They contribute lead from soldered circuit boards, leaded glass in television sets, and plated steel chassis. Leaded glass accounts for most of the lead in these products.

* Glass and Ceramics, as reported here, include lead in products such as glass containers, tableware and cookware, and other items such as

Figure 1. Relative discards of lead and cadmium in MSW, 1986.

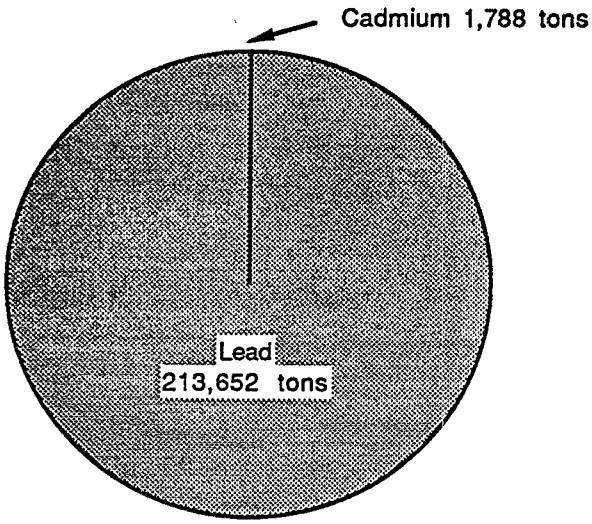
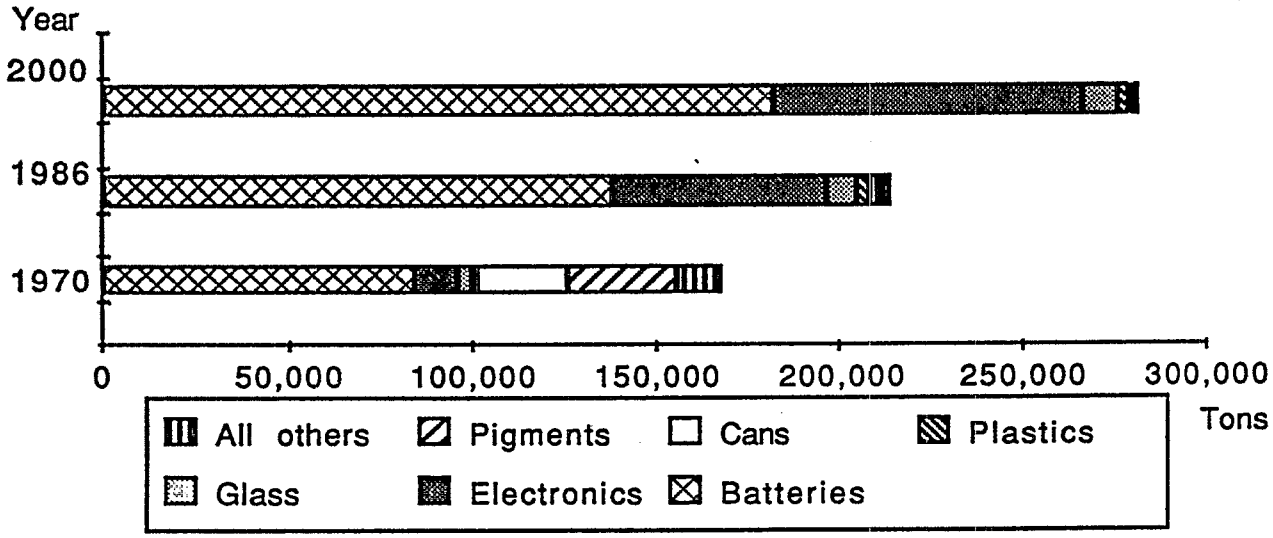


Table 1

LEAD IN PRODUCTS DISCARDED IN MSW, 1970 TO 2000
(In short tons)

Products	1970	1986	2000	Tonnage	Percentage
Lead-acid batteries	83,825	138,043	181,546	Increasing	Variable
Consumer electronics	12,233	58,536	85,032	Increasing	Increasing
Glass and ceramics	3,465	7,956	8,910	Increasing	Increasing; stable after 1986
Plastics	1,613	3,577	3,228	Increasing; decreasing after 1986	Fairly stable
Soldered cans	24,117	2,052	787	Decreasing	Decreasing
Pigments	27,020	1,131	682	Decreasing	Decreasing
All others	12,567	2,537	1,701	Decreasing	Decreasing
Totals	164,840	213,652	281,887		

Figure 2. Lead in discards of products in MSW, 1970, 1986, anc 2000.



optical glass. These contributed 4 percent of lead discards in 1986. (Leaded glass in light bulbs is included in the "All Other" category in Table 1.)

* Plastics use lead in two ways: As a heat stabilizer (primarily in polyvinyl chloride resins) and as a component of pigments in many resins. This category, which includes products such as nonfood packaging, clothing and footwear, housewares, records, furniture, appliances, and other miscellaneous products, accounted for about 2 percent of lead discards in 1986. Plastics in consumer electronics products are counted under that category.

* Soldered Cans have experienced a large decline in usage since 1970, when they contributed 14 percent of the lead in MSW. Leaded solder is currently used in steel food cans, general purpose cans (like aerosols), and shipping containers.

* Pigments containing lead compounds have declined greatly since 1970, dropping from 18 percent of total lead discards to less than one percent. This category includes pigments used in paints, printing inks, textile dyes, etc. Pigments used in plastics, glass and ceramics, and rubber products are accounted for in those categories.

* All Others include brass and bronze products, light bulbs (which contain lead in solder and in glass), rubber products, used oil, collapsible tubes, and lead foil wine bottle wrappers. Collapsible tubes contributed over 5 percent of total lead discards in 1970, but their use has declined dramatically since then. None of the other items has exceeded one percent of the total since 1970.

CADMIUM IN MUNICIPAL SOLID WASTE

Like lead, cadmium is widespread in products discarded into MSW, although it occurs in much smaller quantities overall. Since 1980, nickel-cadmium household batteries have been the Number 1 contributor of cadmium in MSW.

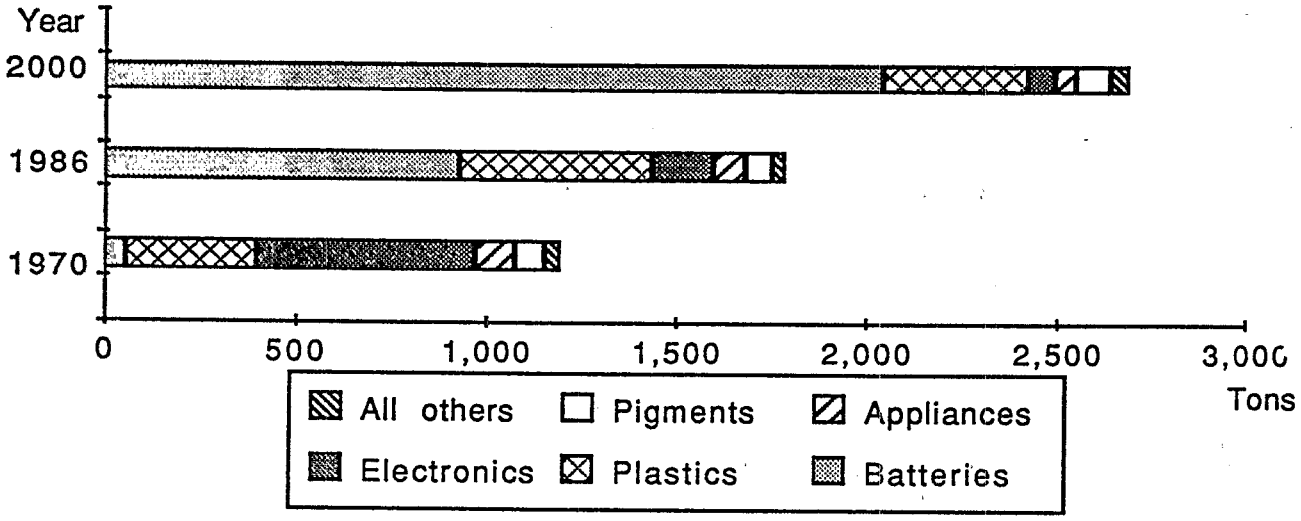
Trends in quantities of cadmium discarded in products in MSW (ranked by tonnage discarded in 1986) are shown in Table 2.

Trends in discards of cadmium in products in MSW are illustrated in Figure 3. Discards of cadmium in household batteries were small in 1970, but then increased dramatically. Cadmium discards in plastics are relatively stable. Discards of cadmium in consumer electronics are shown to decrease over time, while the other categories are relatively small.

Findings about cadmium discards in individual products in MSW are:

* Household Batteries (rechargeable nickel-cadmium batteries) have accounted for more than half of cadmium discards in the U.S. since 1980. This growth is projected to continue unless they are replaced by another type of battery.

Figure 3. Cadmium in discards of products in MSW, 1970, 1986, and 2000.



* Plastics continue to be an important source of cadmium in MSW, contributing 28 percent of discards in 1986. Cadmium is used in stabilizers in polyvinyl chloride resins and in pigments in a wide variety of plastic resins. Cadmium is found in nonfood packaging, footwear, housewares, records, furniture, and other plastic products.

Table 2

CADMIUM IN PRODUCTS DISCARDED IN MSW, 1970 TO 2000
(In short tons)

Products	1970	1986	2000	Tonnage	Percentage
Household batteries	53	930	2,035	Increasing	Increasing
Plastics	342	502	380	Variable	Variable; decreasing after 1986
Consumer electronics	571	161	67	Decreasing	Decreasing
Appliances	107	88	57	Decreasing	Decreasing
Pigments	79	70	93	Variable	Variable
Glass and ceramics	32	29	37	Variable	Variable
All others	12	8	11	Variable	Variable
Totals	1,196	1,788	2,684		

* Consumer Electronics (television sets and radios) formerly had cadmium-plated steel chassis in many cases. These chassis have been replaced by circuit boards, so cadmium discards in consumer electronics are declining as the older units are replaced. They contributed 9 percent of the total in 1986.

* Appliances (dishwashers and washing machines) formerly had cadmium-plated parts to resist corrosion. This source of cadmium is declining as cadmium-plated parts are replaced by plastics, which are themselves another source of cadmium discards in appliances. Cadmium discards from appliances accounted for about 5 percent of total in 1986.

* Pigments used in printing inks, textile dyes, and paints may contain cadmium compounds, although this is not a large source of cadmium in MSW (about 4 percent of total).

* Glass and Ceramics may contain cadmium as a pigment, as a glaze, or as a phosphor. This is a relatively small source of cadmium in MSW.

* All other sources of cadmium include rubber products, used oil, and electric blankets and heating pads. These contribute very small amounts of

* This characterization identifies the sources of lead and cadmium in MSW; it does not tell us whether these are the major sources of leachable lead and cadmium in MWC ash.

* The MSW characterization presented here may not correlate well with the waste input at any particular MWC facility.

* The identified compounds of lead and cadmium may recombine with other materials in the combustion chamber to form new compounds; this issue is beyond the scope of this study.

* In addition to MSW, other nonhazardous wastes contain lead and cadmium; these wastes may in some instances be incinerated along with MSW. These wastes, which were identified but not characterized in this study, include: municipal sludge, construction and demolition wastes, industrial and military wastes, and automotive and other transportation equipment wastes.