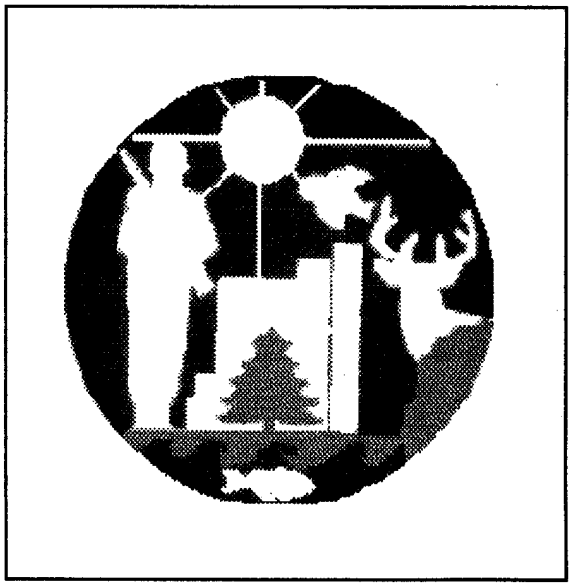
US Army Corps
of Engineers
Construction Engineering
Research Laboratories

USACERL Technical Report EP-95/06
April 1995

Army Materiel Command Solid Waste Survey and Analysis

by
Janet L. Brandhorst and Matthew E. Snyder

Installations within the U.S. Army Materiel Command (AMC) have a number of solid waste disposal problems not shared by installations under other Major Army Commands (MACOMs). Compared to installations under other MACOMS AMC's industrial-type activities produce unusually high amounts of waste cardboard packaging, film plastics, styrofoam packing materials, and wood pallets. Different types of AMC installations have differing solid waste disposal needs, depending on installation population, facility use, etc. In many cases, waste management is conducted on an *ad hoc* basis. Often, information on state-of-the-art waste management procedures is not available to local personnel. This report summarizes the findings of a study of current AMC waste management practices, based on surveys of different types and sizes of installations. The study was conducted to gain an understanding of waste streams at the installation level. The findings of this study will be used in development of a waste generation model to help installation personnel develop customized, integrated solid waste management plans.



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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	April 1995	Final

4. TITLE AND SUBTITLE
Army Materiel Command Solid Waste Survey and Analysis

5. FUNDING NUMBERS
Reimbursable Order No.
B228C820B

6. AUTHOR(S)
Janet L. Brandhorst and Matthew E. Snyder

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Construction Engineering Research Laboratories (USACERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
EP-95\06

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Headquarters, Army Materiel Command
ATTN: AMCEN-A
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
Installations within the U.S. Army Materiel Command (AMC) have a number of solid waste disposal problems not shared by installations under other Major Army Commands (MACOMs). Compared to installations under other MACOMS AMC's industrial-type activities produce unusually high amounts of waste cardboard packaging, film plastics, styrofoam packing materials, and wood pallets. Different types of AMC installations have differing solid waste disposal needs, depending on installation population, facility use, etc. In many cases, waste management is conducted on an ad hoc basis. Often, information on state-of-the-art waste management procedures is not available to local personnel. This report summarizes the findings of a study of current AMC waste management practices, based on surveys of different types and sizes of installations. The study was conducted to gain an understanding of waste streams at the installation level. The findings of this study will be used in development of a waste generation model to help installation personnel develop customized, integrated solid waste management plans.

14. SUBJECT TERMS
solid wastes
waste disposal
waste management
Army Materiel Command

15. NUMBER OF PAGES
112

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

Foreword

This study was conducted for Headquarters, Army Materiel Command (AMC) under the Reimbursable Work Unit "Solid Waste Analysis for AMC"; Customer Reimbursable Order No. B228C820B. The technical monitor was Richard Smith, AMCEN-A.

The work was performed by the Pollution Prevention Division (EP) of the Environmental Sustainment Laboratory (EL), U.S. Army Construction Engineering Research Laboratories (USACERL). Dr. Edgar Smith is Acting Chief, CECER-EP, and William Goran is Chief, CECER-EL. The USACERL technical editor was Gordon L. Cohen, Information Management Office.

LTC David J. Rehbein is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

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1 Introduction

Background

Installations within the U.S. Army Materiel Command (AMC) have a number of solid-waste disposal problems not shared by installations under other Major Army Commands (MACOMs). AMC oversees a variety of industrial-type installations, including Army Ammunition Plants (AAPs), Army Depots (ADs), and Research, Development, and Engineering Centers (RDECs). Compared to installations outside of AMC, these activities produce unusually high amounts of waste cardboard packaging, film plastics, styrofoam packing materials, and wood pallets.

Different types of AMC installations have differing solid-waste disposal needs. In many cases, waste management is conducted on an *ad hoc* basis. Often, information on state-of-the-art waste management procedures is not available to local personnel. Furthermore, some installations host large numbers of personnel, who generate substantial amounts of municipal solid waste (MSW); in other cases, installation populations are small. Some installations have a large amount of building space while others do not. Even when AMC facilities appear to be of comparable size from one installation to the next, mismatches between building type and personnel activities affect solid waste generation and composition.

To remain in compliance with the changing body of Federal, state, and local environmental regulations, AMC installation personnel require waste management guidance and planning tools that reflect best management practices while addressing the needs of a specific installation. Development of an integrated solid-waste plan at the installation level requires an understanding of the installation's waste stream so the most appropriate management methods—source reduction, reuse/recycling, composting, incineration, and landfilling—can be implemented. USACERL was tasked to investigate the status of waste management programs across a variety of AMC installations, focusing on eight criteria, including use of waste-reduction strategies, recycling programs, etc.

Objective

The overall objective of this research is to develop a modeling tool that will help installation waste management personnel develop effective, integrated solid-waste management plans.

The objective of this report is to summarize the findings of a study of current AMC waste management practices, which was conducted in support of the overall research.

Approach

Data were collected for this project to identify installation waste management successes and failures, along with probable reasons for such successes and failures. To compile data pertaining to solid waste management practices on AMC installations, the AMC Municipal Solid Waste Survey was designed, executed, and evaluated to provide an overview of the current status of solid waste management in AMC. The survey was created to gather information on basic components of solid waste management:

- general information
- procurement
- waste reduction/reuse
- environmental educational programs
- recycling/composting
- solid waste collection/transfer
- incineration
- landfilling.

This six-page survey was initially mailed out to AMC's eight Major Subordinate Commands (MSCs). The MSCs reviewed and distributed the surveys to all installations under their command. Fifty-two installations completed and returned surveys for analysis; a list of the participating installations and their respective MSCs is presented in Appendix A. The data reported through the surveys were entered into a spreadsheet for evaluation. Analysis of the surveys was conducted on a question-by-question basis, basing all calculations on the percentage of installations that answered the question.

To conduct detailed case studies site visits were conducted at five installations: Redstone Arsenal, Sierra Army Depot, Lone Star Army Ammunition Plant, Red River Army Depot, and White Sands Missile Range. These case studies provide a more

detailed snapshot of solid waste management strategies in action on AMC installations.

Mode of Technology Transfer

The findings of this research will feed into the development of a management toolkit to help installations create customized integrated solid waste management plans. It is recommended that the findings of this study be transferred to the user through the AMC Environmental Lessons Learned Workshop, which introduces to the Ammunition and Logistics communities Army environmental issues, and addresses AMCCOM guidance on those issues.

2 Overview of Solid Waste Management Issues

Integrated Solid Waste Management

Integrated solid waste management (ISWM) involves combining techniques and programs to manage the MSW stream. An ISWM system is designed to address specific local solid waste problems. Its operation relies on local resources, economics, and environmental impacts. No step-by-step method for selecting the specific components and systems is currently available for AMC installations. ISWM can be approached by considering the hierarchy of integrated waste management, which illustrates the relationships between source reduction, recycling, incineration, and landfilling alternatives. Although every community (installation) will use different strategies involving these four approches the hierarchy is a useful tool for goal-setting and planning (EPA 503-SW-89-072).

The Integrated Solid Waste Management Hierarchy

Under an integrated solid waste management program, the various approaches to waste management can be prioritized into a hierarchy, with the most environmentally sound approaches being considered the most desirable when feasible. Discussion of this hierarchy follows.

Source Reduction

Source reduction is the first option to consider in the solid waste management hierarchy. Source reduction is a front-end, nontraditional waste management approach that concentrates on eliminating waste volumes before they are generated. This may be accomplished through the design and manufacture of products, advantageously minimizing volume and toxic content while increasing useful life. However, before source-reduction programs are implemented, installations should research the potential environmental impacts of the program to ensure that source-reduction measures address the environmental problem at hand and do not have side-effects more detrimental than the current practice. The program should not simply transfer a problem from one environmental medium to another.

Source-reduction options include product reuse, reduced toxicity, increased product lifetime, and decreased consumption. Although the quantification of benefits achieved through source reduction is difficult, the benefits are clear in concept. Through implementation of source reduction activities, landfill capacity and natural resources are conserved, less energy is used during product manufacture, and air, water, and land pollution are reduced.

Recycling and Composting

Recycling—including composting—is the second step in the hierarchy. These options can save energy and natural resources, reduce the depletion of landfill space, provide useful products, and generate economic benefits. Separation and collection of post-consumer materials are only the first steps in recycling. Post-consumer materials must also be reprocessed or remanufactured. Most importantly, only when the materials are reused is the recycling loop complete.

Reuse is a means of recycling in which an item is used over, either for its original purpose or a new purpose, because it still holds a useful value or useful life. A common example is the reuse of containers, pallets, and other packaging materials.

Recycling alone cannot solve an installation's MSW management problem, but it can eliminate a significant portion of the waste stream, saving on disposal in landfills or incineration facilities. Because dozens of recycling options are available, recycling program development requires strategic planning. One of the most difficult, but important tasks decisionmakers must deal with is finding markets for the recyclable materials collected. Recycling programs must be designed with the flexibility to handle market fluctuations and the unpredictability of demand.

Recycling impacts on waste-to-energy facilities can be extremely beneficial, despite the traditional tension that has been expressed by advocates of the two options. Decisionmakers should recognize the benefits associated with combining recycling with energy recovery. The two alternatives can, in fact, complement each other. Recycling programs can reduce the overall waste stream, which means the installation may operate a smaller capacity incineration facility. Air emissions and MWC ash are the main environmental concerns for such facilities. Many problem materials can be removed from the MWC feed stream through recycling. Recycling can also have a positive impact on composting operations by preventing harmful materials (e.g., metals) from being composted.

Composting is an increasingly popular municipal waste management alternative as communities look for new ways to handle large amounts of organic waste that

otherwise would be landfilled. Landscape waste, including leaves, grass clippings, and woody materials, may comprise 17-18 percent of a community's annual waste stream. The large quantity of this type of waste, along with the fact that it is usually separated from other solid waste, makes it a good subject for landfill diversion efforts.

Food-waste composting is another alternative successful in diverting large quantities of the waste stream from landfills. When food waste is collected and source-separated, processing can create a high-quality compost material. Approximately 10 to 15 percent of all waste generated by residential and commercial facilities is food waste. Furthermore, diverting food waste from commercial or institutional sources, such as dining facilities, can alleviate about 38 percent of the waste steam generated by such facilities (Newell, Markstahler, and Snyder 1993). In some cases, starting a food-waste collection program can significantly reduce a commercial or institutional MSW stream.

Incineration and Landfilling

Below source reduction and recycling in the integrated solid waste management hierarchy are incineration and landfilling. These options are ranked at the same level because both approaches permanently remove resources from use. Waste incineration can reduce the bulk of municipal waste, while providing energy as a side benefit. Landfilling is the only actual pure "disposal" technique.

State-of-the-art MWC has two functions: (1) reduction in the quantity of waste subject to final disposal and (2) energy recovery. Modern incineration facilities are no longer simple "garbage burners." Instead, waste-to-energy units are designed to produce steam and electricity, and they can be used in conjunction with source reduction, recycling, and composting programs. Although MWC can recover energy for further use while reducing the waste quantities of waste that have to be landfilled, source reduction, recycling, and composting can help reduce the need for incineration facilities by reducing waste quantities before incineration is required. In some situations, both political and economical obstacles can create siting difficulties for such facilities. For example the State of Rhode Island has banned MWC.

Emissions from MWC facilities contain a mixture of pollutants that pose health-related risks. Particular areas of concern are particulates, acid gases, nitrogen oxides, trace metals, and dioxins, and furans. Environmental Protection Agency (EPA) regulations pertaining to MWC air emissions must be researched and addressed before considering the siting of a MWC.

Although waste volume is reduced through incineration, even the most advanced facilities leave residuals (bottom ash and fly ash), and disposal of these wastes may

require plant shutdown. Proper ash management addresses the full "life cycle" of ash, from generation during incineration to its ultimate disposal. Worker safety is also important in managing MWC ash. Disposal of nonhazardous MWC ash can take place at an MSW landfill, an ash monofill (a facility that accepts ash only), or a co-fill (a facility that accepts several diverse waste streams).

Landfills are a necessary component of any municipal solid waste management system, but with the increase in state and Federal requirements for landfill siting and operation, the feasibility of siting such facilities—both economically and politically—has significantly decreased. Despite the capacity and environmental concerns surrounding landfill operation, every waste management system must have access to a landfill. Source reduction and recycling (including composting) can divert significant portions of the waste stream from final disposal, but not all materials are recyclable.

Standard Army practice is to use solid-waste collection and disposal services offered by municipal utility systems, regional and cooperative systems, private utility companies, and the private sector before owning, constructing, operating, and maintaining separate solid waste systems. When the life-cycle cost (LCC) is less than 125 percent of the LCC of a Government-Owned, Government-Operated (GOGO) facility, installations use existing out-of-house services. However, if the LCC is greater than 125 percent, approval by Headquarters, Department of the Army (HQDA) is required to use such services. As part of the revised Army Regulation (AR) 420-47, installations will also be required to provide a comparative analysis for HQDA for approval before locating new landfills or major expansions of existing landfills on Army installations where a regional system exists (Sobke, 29 March 1993).

Solid Waste Regulation

Federal regulation of solid waste is primarily governed by the Resource Conservation and Recovery Act (RCRA, PL 94-272), the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA, PL 96-410), and the Clean Air Act (CAA, PL 102-187). Two other Federal actions of importance to Federal agencies are the pending Federal Facilities Compliance Act (FFCA, PL 102-386) and Executive Order (EO) 12780 (56 FR 56289).

In 1965, the Solid Waste Disposal Act (SWDA, PL 102-508) was passed to improve solid waste disposal methods. In 1970, it was amended by RCRA. This Act is amended by Congress to reflect changing needs. Municipal solid waste is regulated under Subtitle D of RCRA. The primary goal of Subtitle D is to encourage solid-waste management practices that promote environmentally sound disposal methods and

maximize reuse and conservation opportunities for natural and recoverable resources. In 1991, Federal and state regulatory agencies cited Army installations with more than 550 RCRA violations.

Under CERCLA (or "Superfund"), installations must consider the potential long-term liability for current and past waste-disposal practices. CERCLA also applies to some environmental cleanup efforts. Therefore, installations must carefully determine the overall program impact of Superfund requirements on current landfill activity.

The Clean Air Act focuses on incineration facilities and the need to meet source performance standards in order to limit individual pollutant emissions into the air. These facilities must meet the standards using the best available technology.

The FFCA gives state governments the authority to assess fines and penalties against Federal facilities for past violations of solid- and hazardous-waste laws. The FFCA also amends provisions of RCRA that pertain to solid and hazardous waste. The FFCA does not apply to underground storage tank provisions of RCRA and does not amend other environmental statutes such as the CAA and CERCLA. The FFCA, however, does require annual inspections of treatment, storage, and disposal facilities under Subchapter C of RCRA. The amount of penalties assessed against the Army under the FFCA could be substantial. The penalties can rise as high as $25,000 per violation per day, depending on the potential for harm and the extent of noncompliance (DAFA-ELC).

On 31 October 1991, President George Bush signed Executive Order 12780, promoting cost-effective source reduction and recycling of reusable materials from waste generated by Federal facilities. A component of this effort is the implementation of Federal procurement preference programs favoring the purchase of designated items produced using recovered materials.

EO 12780 requires that an Affirmative Procurement Program (APP) be established at all Army installations. The APP shall include a preference program, a promotion program, procedures for obtaining and verifying recovered material content, an annual review, and continual monitoring. Army installations are required to purchase recycled paper and paper products, lubricating oils, retread tires, building insulation, and cement and concrete containing flyash if available at a reasonable cost. The *Recycled Products Guide* issued by GSA/FSS lists available products with recycled material content. Envelopes, paper, printing paper, art/drafting materials, office supplies, forms, household products, packing/shipping materials, and insulation products are among the various product types available through GSA.

National Solid Waste Management Trends

The most obvious problem with solid waste management today is that the nation continues to generate large quantities of garbage without fully understanding and addressing the environmental and economic consequences. Illustrating this is the fact that landfilling is the most widely used waste management method in the United States. In 1991, approximately 80 percent of all solid waste was buried in landfills. At the current rate of use, over 80 percent of the landfills will be closed within the next 20 years.

As noted in the previous section, it is becoming increasingly difficult to open, expand, and operate landfills. For example, landfills in New Jersey began to close under court order in 1984 and 1985. As MSW began to accumulate, few landfill sites remained. At one landfill in East Brunswick, approximately 1,100 truckloads of waste (one-third of the state's total waste stream) lined up each day outside the site in 1986, reducing the facility's life expectancy from 9 to 3 years. As facilities began to close, the state looked past its borders. In 1985, New Jersey exported about 8 percent of its waste stream. By 1988, an estimated 50 percent of the landfill waste stream was being exported to ten different states. The additional transportation rates caused the disposal rates to soar 300 to 1,000 percent higher in some regions (Woods, September 1922).

Difficulty in siting new landfills has largely resulted from increased concern among citizens and government of the adverse environmental impacts associated with landfill location, design and operation. Many government entities are now obligated to committing considerable resources to the restoration and cleanup of areas harmed by past disposal practices.

In 1988, the average waste generation rate per person in the United States was 1,460 lb*/year while the average national tipping fee for landfilling was $26.93 per ton (EPA, January 1992). This fee does not include MSW handling, transportation, or collection costs. Table 1 presents estimated MSW generation and disposal costs at Army installations using this national average and assuming an Army population of 760,000. Based on one-third, one-half, or three-quarters of the 760,000 Army personnel living on military installations and contributing to MSW generation, estimates of waste generation and disposal costs were made. Table 1 provides a general picture of the magnitude of MSW generation and disposal at Army installations. The figures are

* U.S. standard units of measure are used in this report. A table of metric conversion factors may be found on page 78.

Table 1. MSW generation and disposal cost estimates for Army installations.

Army Personnel Living on Base (%)	MSW Generated (tons)	Landfill Tipping Fee (millions of dollars)
33	183,084	4.9
50	277,500	7.4
75	416,100	11.2

Note: Figures based on 1988 tipping fees as estimated by EPA (January 1992).

only estimates but could be refined using the actual number of military personnel and family members living on post (Science Applications International Corp., 26 June 1992).

The solid waste crisis in this nation is a crisis of many dimensions. It may be described as a natural resource crisis, and economic crisis, or even a national security crisis. Valuable natural resources are being depleted significantly faster than they can be regenerated, which may ultimately cause severe changes in the environment (e.g., global warming). From an economic standpoint, landfilling is a very expensive method of managing solid waste, considering the ever-increasing landfill disposal and tipping fees. The national security aspect of the waste management crisis is often overlooked: the only domestic source of tin is recycled cans, and more than half of U.S. petroleum and plastic items are currently imported.

The solid-waste crisis now has the attention of lawmakers and a growing segment of the public. In increasing numbers, state governments are joining the fight against the solid waste dilemma and utilizing alternative methods of dealing with the solid waste stream and reducing solid waste.

While not all states are under the same degree of pressure to reduce waste, many state legislatures are expressing great interest in source reduction, recycling and composting. Several comprehensive state mandates in these areas were enacted in 1992, as shown in Table 2. The shaded areas illustrate whether the waste-reduction goal for that state can be reached by any or all of the three waste reduction methods listed: source reduction, recycling, or composting. The "Other" category referred to in Table 2 represents incineration or reuse, depending on the state.

By the end of 1991, 41 states and the District of Columbia had initialized waste reduction goals. Of those 41, 34 were nonbinding legislative "goals." Analysis of Table 2 shows that, by the end of 1991, 39 states had set waste-reduction goals of 25 percent or greater; and, 12 states initiated goals of 50 percent or greater, with New York state working toward a 60 percent reduction in waste by the year 2000.

Table 2. Solid waste management goals by state.

State Symbol*	Source Reduction	(a) Recycling	Composting	Other	Mandated	Deadline
AL		25%			Yes	1991
AR		40%			Yes	2000
CA		50% (b)			Yes	2000
CT	(c)	25%			Yes	1991
DE		21%		50% (e)	No	2000
DC		45%			Yes	1994
FL		30%			Yes	1995
GA		25%			Yes	1996
HI		50%			Yes	2000
IL		25%			Yes	2000
IN		50%			Yes	2000
IA		50%			Yes	2000
KY		25%			Yes	1997
LA		25%			Yes	1992
ME		50%			No	1994
MD		20% (d)			Yes	1994
MA	10%	25%	21%	48% (e)	Yes	2000
MI	8-12%	20-30%	8-12%	35-45% (e) 4-6% (f)	No	2005
MN	(g)				Yes	1996
MS		25%			Yes	1996
MO		40%			Yes	1998
MT		25%			No	1996
NE		25%			Yes	n/a
NV		25%			Yes	1994
NH		40%			Yes	2000
NJ		25% (h)			Yes	1990
NM		50%			Yes	2000
NY		60%			No	2000
NC		25%			Yes	1993
ND		40%			Yes	2000
OH		25%			Yes	1994
OR		50%			Yes	2000

State Symbol*	Source Reduction	(a) Recycling	Composting	Other	Mandated	Deadline
PA (j)		25%			Yes	1997
RI		15% (k)			Yes	1993
SC		30%			Yes	1997
SD		50%			No	2005
TN		25%			Yes	1996
TX		40%			Yes	1994
VT		40%			No	2000
VA		25%			Yes	1995
WA		50%			Yes	1995
WV						

*Source: J. Glenn "The State of Garbage in America," *BioCycle* Vol 33, no.5, (May 1992), p 29. (Reproduced with permission of *BioCycle*, 419 State Ave., Emmaus, PA 18049.)

Notes: (a) Includes yard waste composting; (b) may include 10 percent waste transformation; (c) goal is no change in waste generation rate; (d) 15% goal for counties under 100,000; 20% goal for counties over 100,000; (e) incineration; (f) reuse; (g) 45% goal in the seven-county, Twin Cities area; 30% in greater Minnesota; (h) does not include leaf composting as part of the goal; in 1990, a solid waste management task force recommended a 60% recycling goal, although currently not mandated by law; (i) goal was developed pursuant to the state's solid waste goal, but currently is not mandated by law; (j) goal is to reduce the amount of waste generated; (k) ultimate goal is to recycle as much as possible.

State waste-reduction goals also show some regional variation. The western United States, on average, has the highest mandated waste-reduction goals while the southern region has the lowest. The west-central, east-central, south-central, northeast, and mid-Atlantic regions, on average, have approximately similar waste reduction goals, but they differ in the waste reduction methods used. The east-central, northeast, and mid-Atlantic regions are the only areas using incineration, and the east-central region alone employs reuse as a method of meeting the state's waste reduction goal.

Table 3 summarizes key elements addressed by regulations for the four states in which the AMC installations participating in the case studies are located. Redstone Arsenal (RASA) is located in Huntsville, AL; Sierra Army Depot (SIAD) is located in Herlong, CA; White Sands Missile Range (WSMR) is located outside of Las Cruces, NM; and both Lone Star Army Ammunition Plant (LSAAP) and Red River Army Depot (RRAD) are both located near Texarkana, TX.

Table 3. Legislative mandates affecting AMC installations involved in case studies.

State	Source Reduction	Recycling	Composting	Mandated	Deadline	Installation
Alabama		25%		Yes	1991	RASA
California		50%		Yes	2000	SIAD
New Mexico		50%		Yes	2000	WSMR
Texas		40%		Yes	1994	LSAAP & RRAD

Table 3 illustrates wide differences in the level of progressive solid-waste management goals for each state. While California and New Mexico had reached 50 percent of their mandated recycling goals when the data were collected, Alabama had only reached 25 percent of the goal. The south-central and western regions generally have more progressive waste reduction legislation than the southern region.

Alabama state legislation also required counties to develop recycling programs by May 1992 (Act 82-1989). This Act required a 25 percent specified waste-reduction goal by May 1992, involving both counties and cities.

California Act Assembly Bill 939-1989 requires cities and counties to develop recycling programs, but specifies no deadline. Also in California, a packaging/product tax of $0.25 per new tire is in effect. By the year 2000, California is mandated to reduce waste by 50 percent, allowing for 10 percent waste transformation.

The only significant aspect of New Mexico's law specifies that the state will provide tax credits to businesses that produce goods using recycled materials. Like California, New Mexico has mandated a 50 percent reduction in waste by 2000.

Recycled-content standards approved by Texas in 1991 included a goal of 30 percent recycled content in newsprint by 2001. Disposal bans for Texas include vehicle batteries, tires, and motor oil. Texas also has a state mandatory deposit law on vehicle batteries. All vehicle batteries must be taken back (SB 1340 - 1991) as of September 1991. The Texas state recycling law, House Bill 1340, offers several unique clauses:

> Under this legislation all government entities, including schools, are required to develop recycling programs for at least aluminum, high-grade paper, and corrugated cardboard. In addition, the Department of Health must develop a program that will compost at least 15 percent of the state's solid waste stream by January 1, 1994 (Glenn, May 1992).

A market development study was also required by 1993 and the law mandates that all government entities give preference to purchasing recycled products. Beyond these general provisions, the Texas law addresses procurement of rerefined oil, reclaimed asphalt and fossil fuel ash-based products. Also provided for are the recovery of vehicle batteries, used tires and used oil. In addition, disposal bans are placed on both batteries and oil. The tire and oil programs are funded through advance disposal fees of $2 per tire and $0.20 per quart of oil.

To summarize, it appears evident that both the government and private sector are being driven by laws and regulations to reassess and update their solid-waste management programs. In addition, the rising costs of landfilling are also driving changes in MSW plans. Available land is becoming scarce, and the growing environmental concerns of government and the public are pressuring landfill disposal costs and tipping fees to rise.

3 Overall Survey Findings

Overall Summary of Waste Survey

The Municipal Solid Waste Survey prepared and distributed for this study (see Chapter 1) was filled out and returned by 52 AMC installations. The overall findings illustrate the major solid waste management trends at AMC installations, and also provide helpful information about AMC installations with successful MSW programs.

In broad terms, based on analysis of the survey findings, it was found that a typical AMC installation:

- has an average of 280 active military personnel and 2,263 civilian personnel, with approximately 5 percent of active military personnel living off-post; the averages of on-post military personnel are 131 in family housing, 40 in bachelor officers' quarters (BOQ), and 13 in batchelor enlisted quarters (BEQ).
- anticipates no change(s) from Base Realignment and Closure (BRAC) activities.
- has been procuring paper products containing recycled content for less than 2 years.
- is just as likely as not to offer educational programs on recycling, reuse, composting, household hazardous waste, source reduction, process change, material substitutions, and resale.
- uses a limited variety of waste-reduction methods mostly e-mail (electronic mail) and duplex photocopying for paper reduction, reduction of styrofoam use in offices and institutional facilities on base, and resale shops.
- does not have a program addressing handling and reduction of household hazardous waste.
- is likely not to have an operational onsite recycling center; those that do operate recycling programs have generally done so for 3 years or less, offer in-house training for its two or more employees, accept aluminum cans, office paper, newsprint, magazines, metals, plastics, glass, and other (wood, rubber, etc.), use recycling dropoffs, does not buy back recyclable materials, spends an average of $146,500 per year to run the facility, and is currently generating profit.
- collects recyclables from on-post housing, offices, and classrooms, but does not collect recyclables from clubs, dining facilities, the commissary, or the post exchange (PX). Housing recyclables collected include old corrugated cardboard

(OCC), plastic, aluminum, newspaper, and metals, while office/classroom recyclables include only paper, aluminum cans, OCC, and possibly newspaper.

- collects scrap metals on base, most commonly aluminum, copper, brass, and steel; processing of collected scrap metals is most often handled by the Defense Reutilization and Marketing Office (DRMO) site on base.
- does not compost landscape or food waste generated on-post.
- collects an average of 8,109 tons per year of solid, which is typically landfilled either on- or off-post.
- collects and separates lumber, cardboard boxes, furniture, white goods, construction debris, special waste, bulk waste, residential waste, and office waste from general refuse before disposal.
- contracts out solid waste collection, at an average cost of $211,900 per year.
- does not incinerate for MSW.
- is just as likely as not to operate an on-post sanitary landfill, less than 50 percent of AMC installations with active sanitary landfills weigh solid waste entering the landfill, and the average remaining capacity for AMC onsite sanitary landfills is 14 years.
- inspects solid waste entering the landfill at some point in the disposal process.
- can feasibly landfill solid waste on-post at a lower cost than using a local landfill.

This profile of solid waste management at the "typical" AMC installation is based on averages and trends calculated from the survey findings. The following section gives a more detailed description of the survey results, broken down into the question categories of solid waste management appearing on the survey form.

AMC Solid Waste Survey Results

As noted earlier, all calculations are based on data collected from 52 installations. Averages for each question are based on the number of answers received for that question. See Appendix A for a copy of the survey questionnaire.

General Information

The first section of the survey covered general information, including questions about installation population, dependents living on base, active military living on base, and possible BRAC inputs. These values may help determine waste-generation rates, which may be applied to development of the algorithm for installation use, and provide correlations between installation population numbers and waste-stream characteristics.

Questions 1.1 – 1.5 produced the following averages:

- 280 active military personnel on AMC installations
- 243 dependents on base
- 131 active military in family housing
- 40 active military in BOQ and 13 active military in BEQ
- 2,263 civilian employees.

Stratford Army Engine Plant, Redstone Arsenal, and Aberdeen Proving Ground reported the largest numbers of active military personnel, with numbers ranging between 2,500 and 5,500. The remaining installations that answered the question have numbers of active military personnel of less than 1,000. Figure 1 illustrates the averages of active military in family housing, BOQ, and BEQ.

Question 1.6 asked about potential BRAC impacts. Figure 2 illustrates the averages of AMC installations anticipating change through BRAC.

Procurement

Section 2.0 of the questionnaire focused on the procurement of products made from recycled materials. All 50 states and the District of Columbia now have some

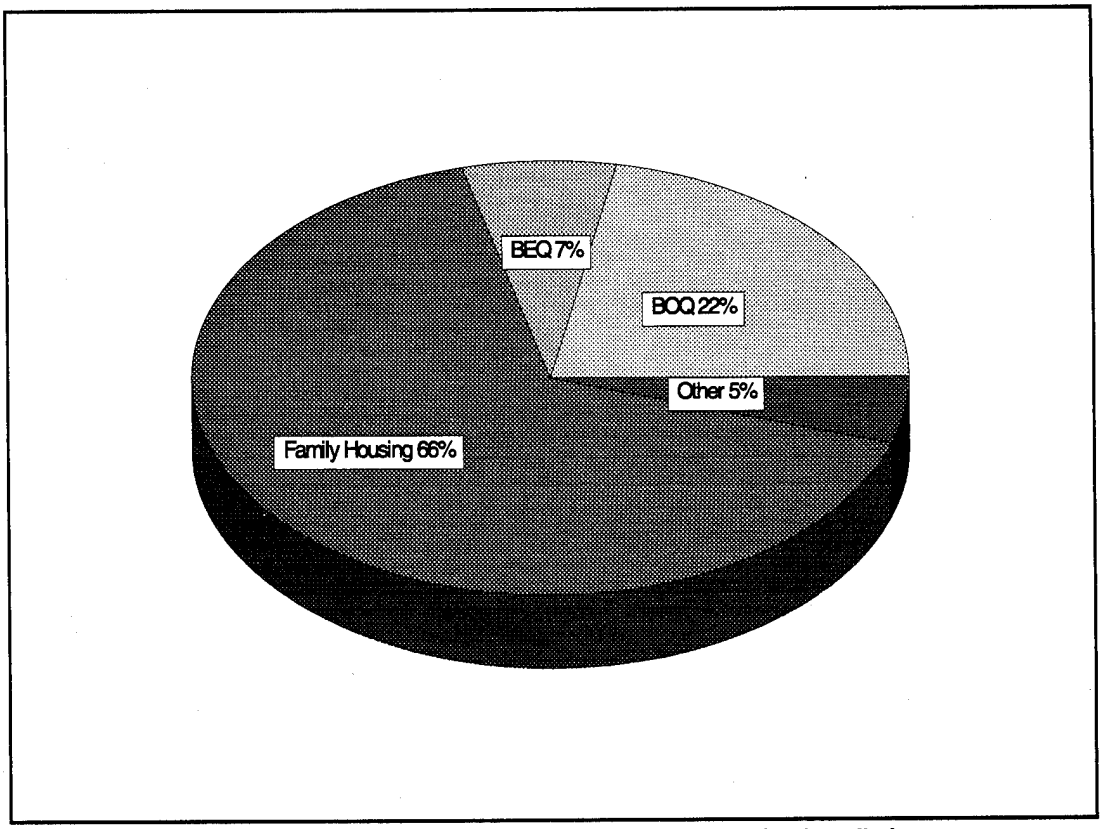

Figure 1. AMC housing category occupancy percentages for responding installations.

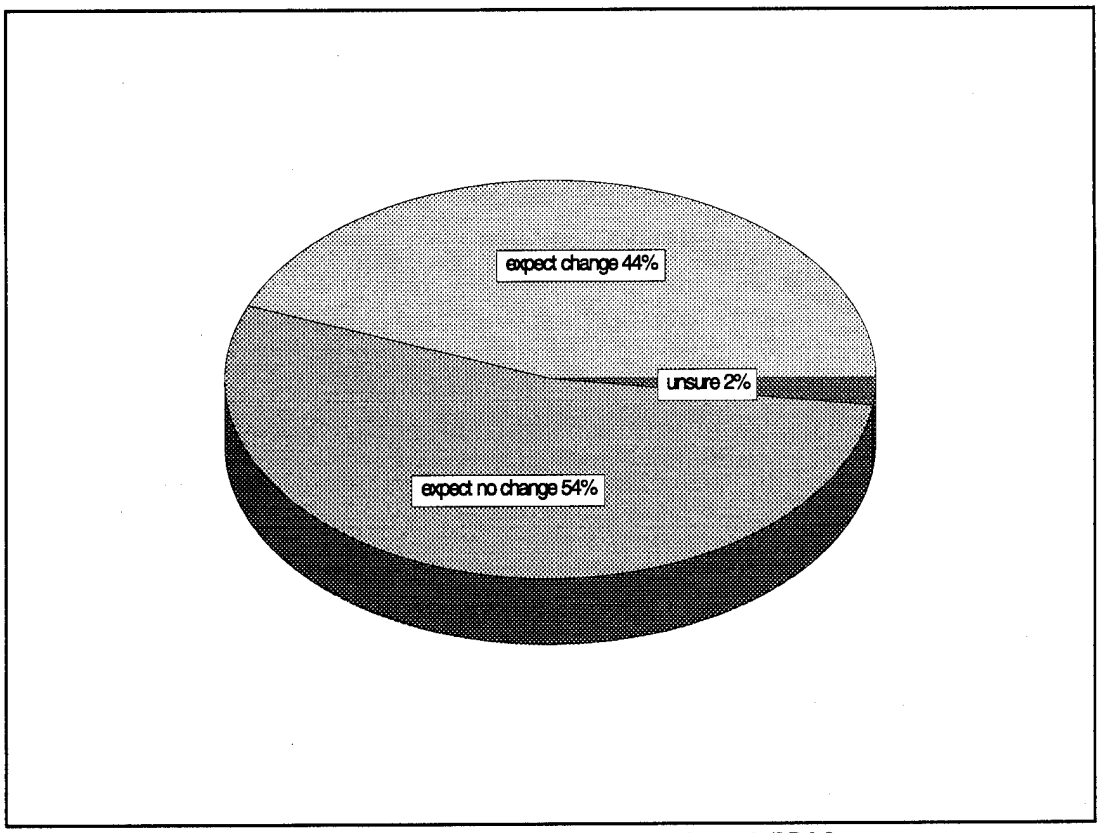

Figure 2. Percentages of AMC installations expecting change through BRAC.

regulation or order requiring states to buy recycled paper, and more than 30 states require the purchase of other types of recycled products. Most recommendations for the purchase of recycled products require the purchasing agent to review product specifications, and where appropriate, revise specifications to include recycled content paper and paper products, refined oil, plastic products, auto parts, compost material, aggregate insulation, solvents, and rubber products. For example, the State of California has set a goal of 20 percent total purchases being recycled products by the end of 1993, 40 percent by 1995, and a 5 percent price preference. New Mexico also has specifications for several recycled materials such as paper, plastic, glass, construction materials, furnishings, and compost, including a 5 percent price preference for recycled products (Keller, 16 June 1992).

All installations answered Question 2.1, "Does the installation purchase products made from recycled materials?" Figure 3 represents the percentages of installations that procure paper and other products made from recycled materials.

The four percent "Other" category in Figure 3 includes cardboard fillers, separators, tolled brass, remelt lead, and toner cartridges. Based on answers from 50 surveys, 30 installations (or 60 percent of all AMC installations) procure products made from

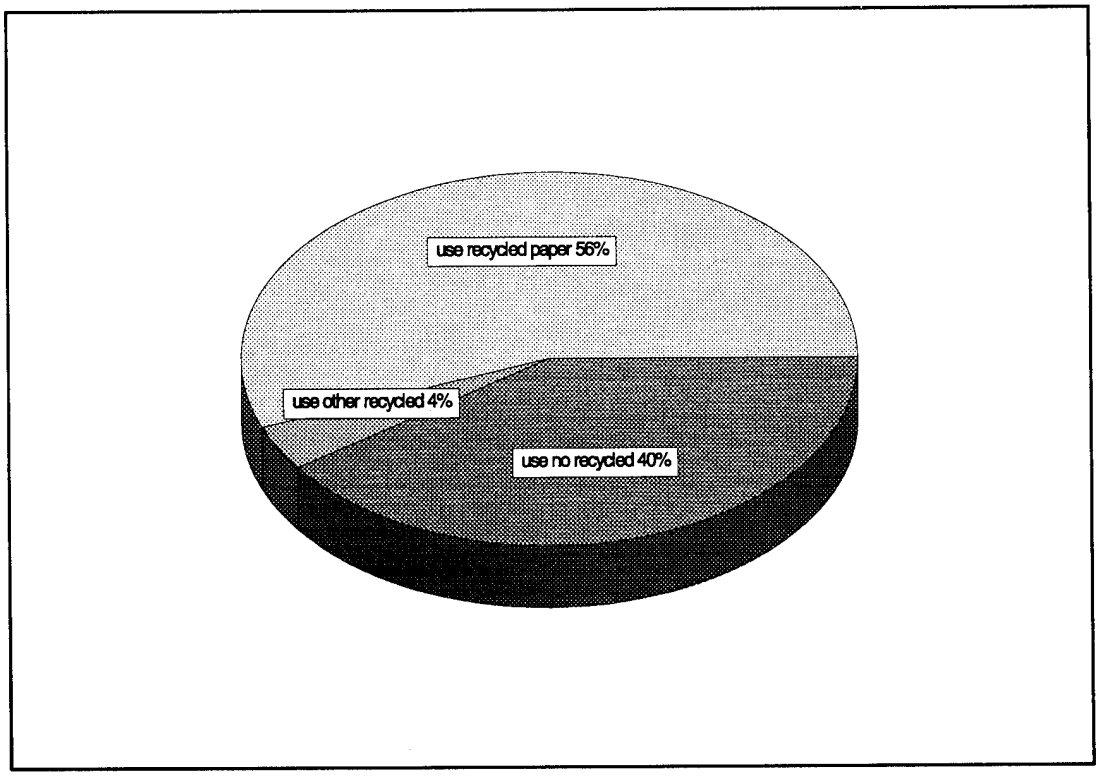

Figure 3. Percentages of installations that use recycled products.

recycled materials. Of these 30 installations, 80 percent included the duration of time these types of products had been procured, as shown in Figure 4.

Waste Reduction/Reuse and Solid Waste Education

The third section surveyed source reduction and reuse programs, specifically educational programs offered, waste reduction methods used, and methods for handling small-scale household hazardous waste disposal.

Question 3.1.1. asked "Are educational programs provided concerning Recycling/Solid Waste Management?" Based on data reported by 48 of the 52 installations polled, 44 percent of the installations offer some variety of educational program, 46 percent do not offer educational programs, and 10 percent are in the process of initiating a program. Topics covered among the programs include recycling, reuse, composting, waste minimization, cost savings, proper procedures for handling prohibitions from the solid waste stream, process changes, material substitutions, resale shops, treatment, and disposal. Of the installations with educational programs, 43 percent have offered them for 1 year or less, 38 percent have offered programs between 2 and 4 years, and 19 percent have offered them for more than 4 years. Volunteer AAP reported the longest-running educational program—10 years. It covers domestic waste programs, and currently is not mandatory training.

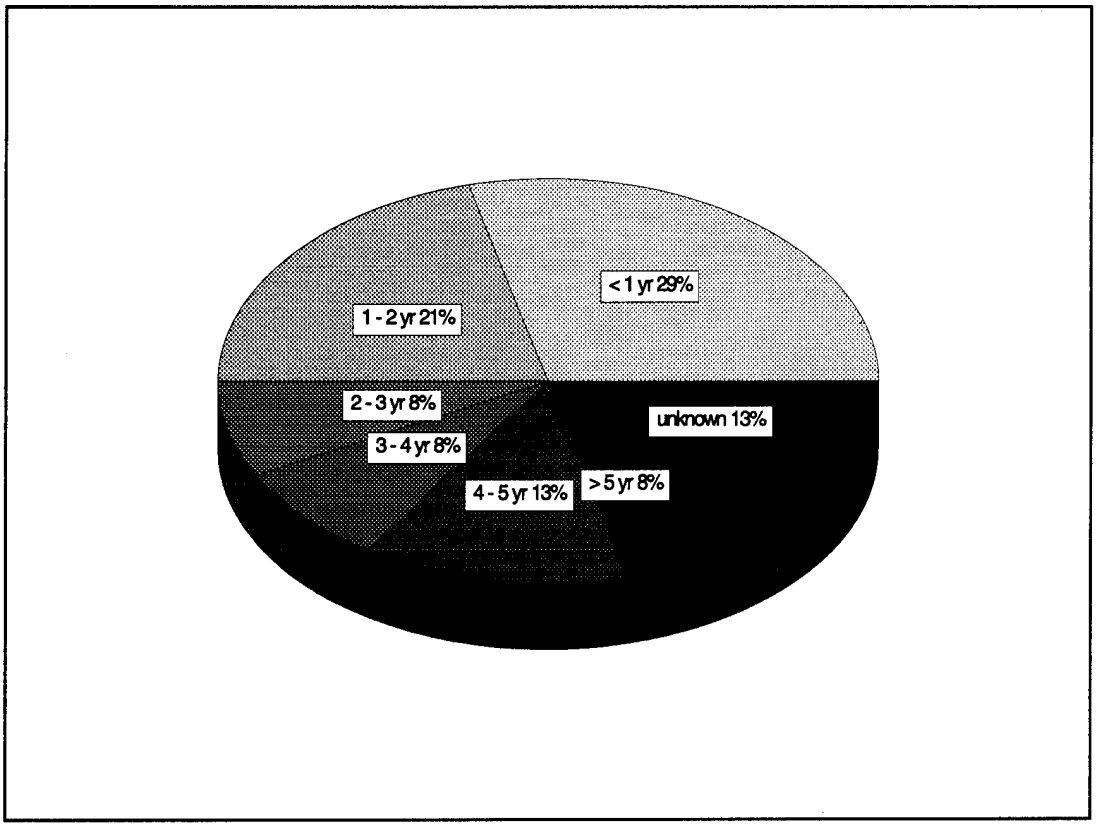

Figure 4. Amounts of time responding installations have been procuring recycled products.

Waste-reduction policies were surveyed to evaluate what methods are used to reduce solid-waste generation on installations. Specific examples of waste-reduction methods were listed on the questionnaire, and the participant was asked to report any others not listed. Forty-seven installations answered the waste-reduction portion of the survey. Fifteen of the 47 installations reported not using any waste-reduction methods. Thirty-two installations reported valid waste-reduction methodologies in use. Figure 5 summarizes the findings. Sixty-six percent use e-mail for paper reduction, 28 percent are trying to reduce styrofoam use in schools and offices, 34 percent are using duplex photocopying to reduce paper waste, 22 percent are running resale shops to reduce waste, 13 percent are trying to identify reuse possibilities, and 13 percent of the installations order standard pallets only. Only 6 percent of the installations reported reusing pallets.

Section 3.0 also covered household hazardous waste generation (Questions 3.2.3 – 3.2.7). The reader should note that household hazardous waste was the only facet of hazardous waste surveyed. Fifty installations completed the section, with 42 installations reporting no household hazardous waste dropoff (neither permanent or temporary), 6 that operate permanent dropoff sites, and 2 that open a temporary dropoff site throughout the year. Participation rates for the six permanent dropoffs varied dramatically. Indiana AAP reported the highest participation rate—almost 100

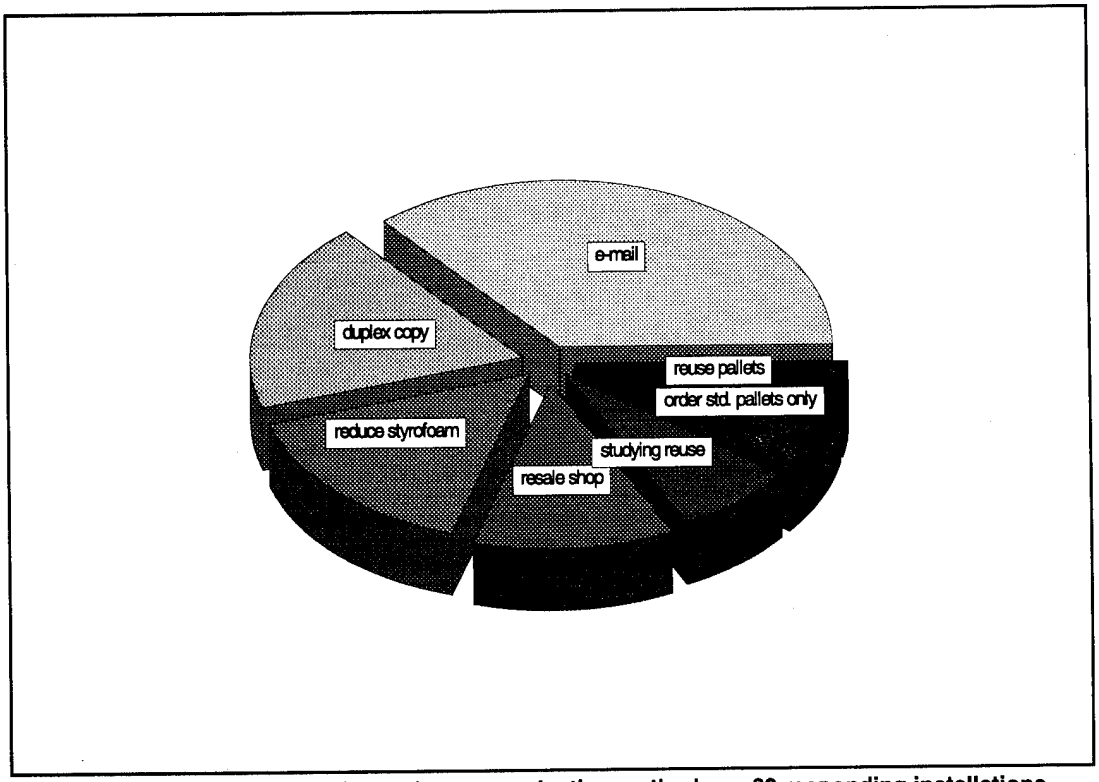

Figure 5. Seven most frequently used source-reduction methods on 32 responding installations.

percent. Natick Research, Development, and Engineering Center reported the second highest with 80–90 percent participation, while the other four installations reported participation rates of 50 percent or less.

Recycling/Composting

Section 4 surveyed recycling and composting programs to determine what types of programs are operated, the number of employees required to run such programs, what items are accepted through recycling centers and compost programs, and what recycling collection methods used. Recycling and composting are important features of any SWM plan because they can significantly divert large quantities of the waste stream from incineration and landfilling. While the characteristics of recycling and composting programs will often vary across installations, depending on operations and geographic considerations, they are necessary components of successful solid-waste management programs.

In response to survey Section 4.1, only 18 of 49 AMC installations surveyed reported operational recycling centers (Badger AAP, Indiana AAP, Lake City AAP, Louisiana AAP, Rock Island Arsenal, Twin Cities AAP, Volunteer AAP, C.M. Price Support Center, Anniston AD, Corpus Christi AD, Letterkenny AD, Red River AD, Sacramento AD, Seneca AD, Tooele AD, Aberdeen Proving Ground, White Sands Missile Range,

and Natick Research, Development, and Engineering Center). Of these 18, six have been up and running for 1 year or less, seven between 2 and 3 years, three between 4 and 5 years, and two for more than 5 years. Figure 6 represents the number of installations in each category. Lake City AAP reported the longest operating AMC recycling center—started in 1942. Based on answers from 49 installations, the typical AMC recycling center has operated for 5 years (not including scrap metal programs, many of which have operated for years).

The calculated average for the number of employees per installation recycling center is 6. Of the 18 installations with recycling centers, 13 provide training for their employees.

Based on figures from the 18 recycling centers, the average amount of material processed per year is 1,352 tons. Twelve of the installations process less than 1,000 tons per year, and five process between 1,000 and 10,000 tons per year. Red River Army Depot processes about 7,380 tons of recyclables per year, while Lake City Army Depot reported processing 3,695 tons per year—the two highest processing totals in the survey.

Figure 7 illustrates the number of installations that accept different recyclable commodities. Thirteen of the 18 recycling centers have recycling dropoffs, and only 2 installations (Corpus Christi Army Depot and White Sands Missile Range) buy back

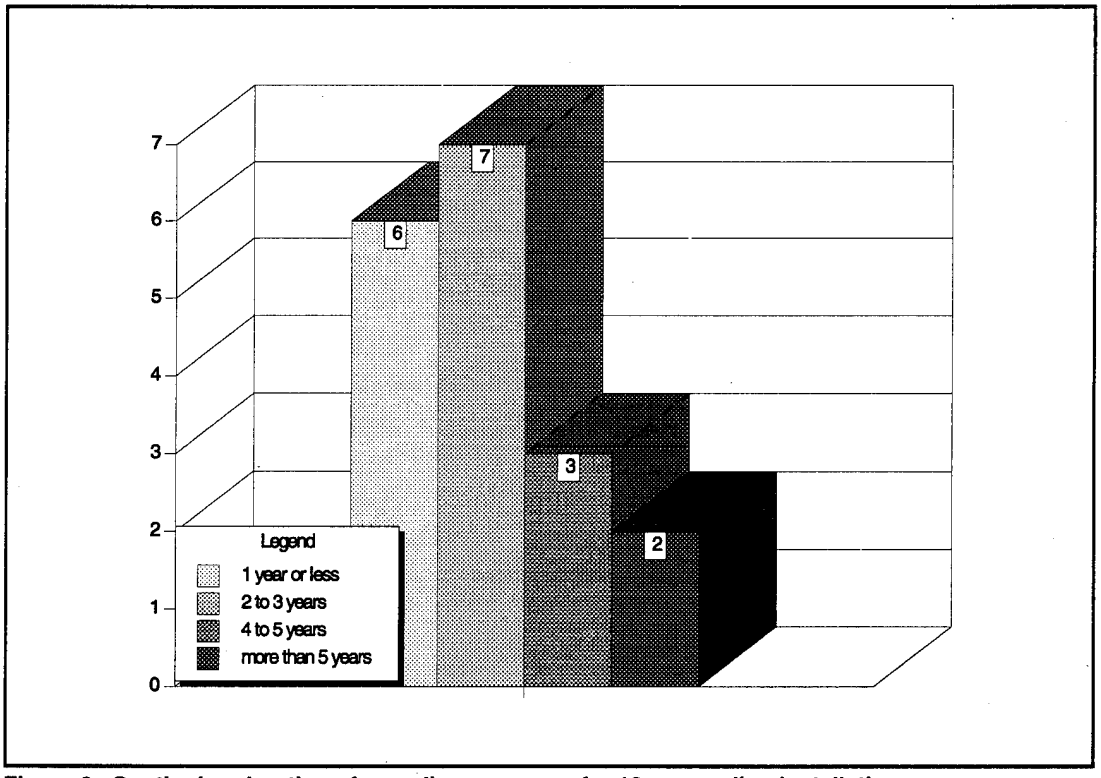

Figure 6. Continuing duration of recycling programs for 18 responding installations.

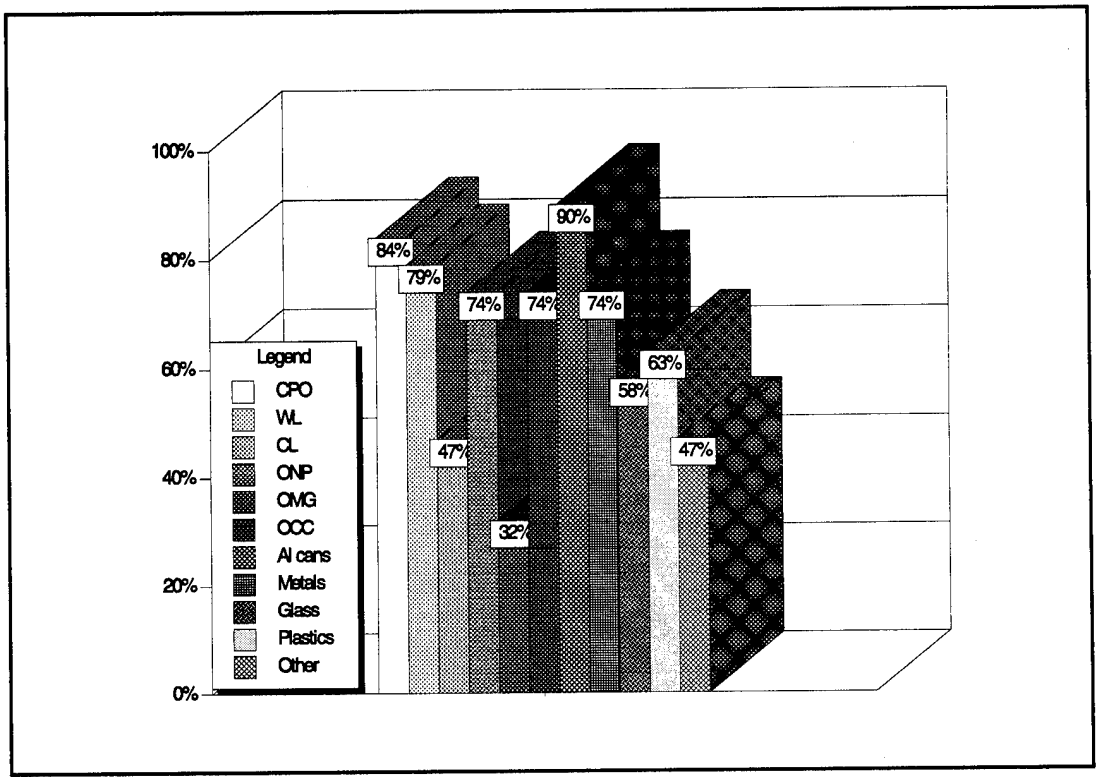

Figure 7. Percentages of installation recycling centers accepting various recyclable materials.

Note: CPO=computer printout; WL=white ledger; CL=colored paper; ONP=old newspapers; OMG=old magazines and catalogs; OCC=old corrugated cardboard; Al=aluminum). "Other" includes film plastics, paper bags, precious metals, wood, tires, batteried, toner cartridges, film, styrofoam, carbon paper, food scraps, rubber, textiles, magnetic tape, electrical wire, and canvas.

certain recyclables. White Sands Missile Range buys back aluminum cans only, at $0.20/lb.

Based on values reported from 16 of the 18 installations with recycling centers, the average cost per year to run a recycling center is $146,500 per year. Currently, 47 percent AMC installations with recycling centers are generating profits, 32 percent are breaking even, and 21 percent reported losses.

Section 4.2 covered recycling collection, and was broken down into six categories: household, office/classroom, clubs/dining facilities, commissary, post exchange (PX), and scrap metals. Each category was surveyed for collection method used, types of recyclables collected, amount of recyclables collected, number of times collected, collection cost, number of people serviced, approximate participation rate, and processing cost.

Household Recycling. Eighteen installations reported collecting household recyclables. Of these, eight installations use curbside collection, six use recycling

dropoff, and two use both curbside and dropoff collection. Two installations did not report the type of collection method used. The methods used for collecting household recyclables are displayed in Figure 8.

Only seven installations reported the amount of recyclables collected from households. Averaging these values resulted in 78.76 tons of recyclables from housing collected per year per installation. The average number of people serviced with household collection is 779, based on values from 13 installations.

Sixteen of the 18 installations reported on the processing of household recyclables on- and offsite. Eleven installations process their recyclables offsite, 5 installations process recyclables onsite, and two did not report.

In response to Question 4.1.11 (annual processing costs for recycling), most installations reported that this cost was either unknown or unavailable. It appears that most installations do not track processing costs according to type of site (e.g., housing, offices/classrooms, commissary, etc.).

Office/Classroom Recycling. Thirty-four out of 46 installations use office/classroom recycling collection. Figure 9 presents the percent of these installations that accept and collect certain recyclable commodities. Seventeen installations (50 percent) using

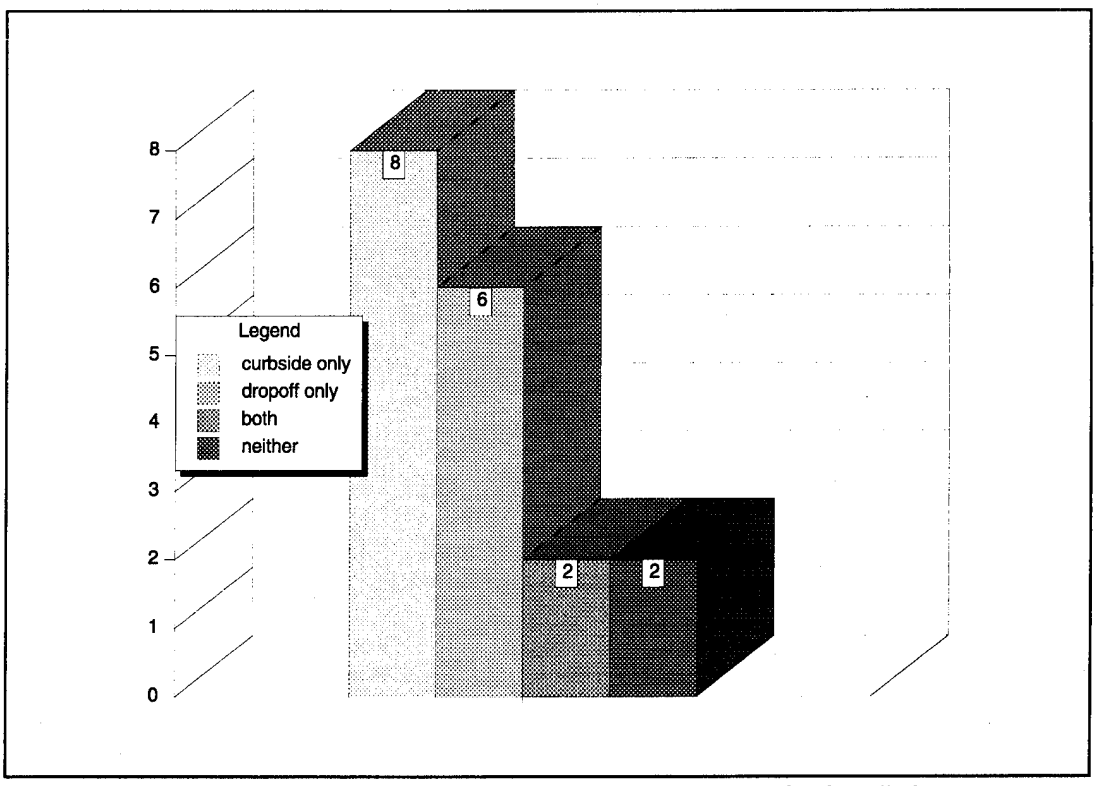

Figure 8. Types of household recycling collection offered by 18 responding installations.

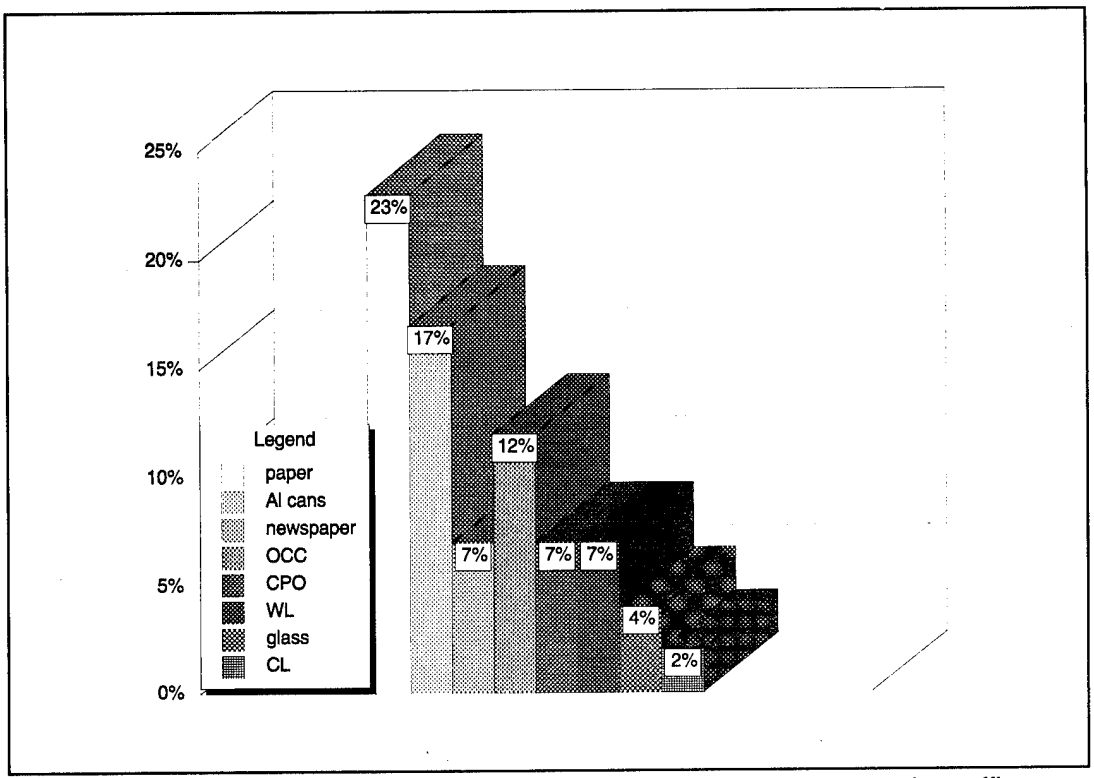

Figure 9. Percentages of 34 responding installations accepting various recyclables from offices and classrooms.

office/classroom collection reported amounts of recyclables collected per year through this channel, with an average of 112 tons per installation per year. Fifty-nine percent of these installations collect less than 100 tons of recyclables from offices and classrooms per year, and recyclables are collected an average of twice a week.

Based on the cost data reported by six installations, the average collection cost is $39,380 per year. The average number of people serviced with office/classroom collection is 1,273 (based on data from 19 installations), with an average participation rate of 78 percent (based on answers from 26 installations). Twenty-five out of 32 installations (78 percent) reported that recyclables collected from offices and classrooms are processed offsite. Most installations do not track collection costs specifically for offices and classrooms.

Club/Dining Facility Recycling. Fifteen of 45 installations collect recyclables from clubs and dining facilities, or approximately 33 percent of the AMC installations that returned surveys. Figure 10 summarizes the percentage of these 15 installations that accept and collect certain recyclable commodities.

Only four installations gave quantifiable answers for the amount of recyclables collected per year through clubs and dining facilities; the average is 2.2 tons per year.

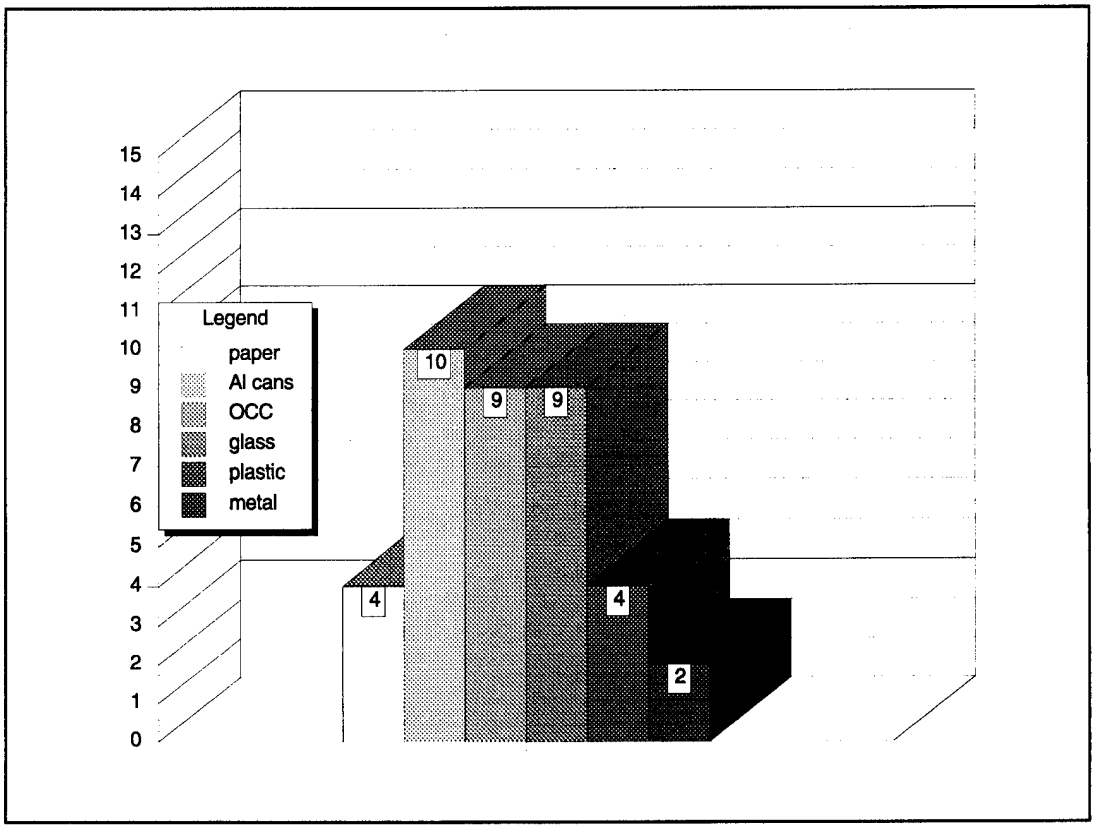

Figure 10. Percentages of 15 responding installations accepting various recyclables from clubs and dining facilities.

Recyclables are collected from clubs and dining facilities an average of 2.5 times per week.

The lack of quantifiable values reported for the club/dining facility collection implies that collection costs are not tracked on a source generator level. The average number of people serviced under club/dining facility collection is 1,011 (based on data from 11 installations). Seven out of 13 installations (54 percent) process the recyclables collected from clubs/dining facilities offsite.

Commissary Recycling. Ten out of 46 AMC installations collect recyclables from the commissary. All of these 10 installations collect old corrugated cardboard, 3 collect aluminum cans, and 2 collect paper products. Fifty percent of the installations using this collection method reported values for the amount of recyclables collected, averaging 152.4 tons per year. Based on data from seven installations, recyclables are collected from the commissary an average of three times per week. As for all other recycling categories, collection costs for commissary recycling are not calculated independently of the general collection costs. The number of people serviced with commissary recycling collection also appeared difficult for many installations to estimate. The most commonly used answer to this survey item was "basewide." Four

out of 10 installations using this collection method (40 percent) process the collected recyclables offsite.

PX Recycling. Ten out of 43 installations (23 percent) collect recyclables from the PX. Figure 11 presents the percentage of these installations that accept certain recyclable commodities. Forty percent of the installations with PX recycling collection gave answers for the amount of recyclables collected annually. These values average 17.4 tons per year. Based on data from 19 installations, recyclables are collected from the PX an average of twice a week. Collection costs for PX recycling collection are currently not measured on AMC installations.

Four out of nine installations that answered the question about on- or offsite processing reported using offsite processing. The actual PX related processing cost was not submitted by any survey respondents.

Scrap Metal Recycling. Forty-three of the 49 installations responding to this section collect scrap metals. Figure 12 illustrates the percentage of these installations that collect various types of metals. Several AMC installations have participated in scrap metal recycling for several years. The average amount of scrap metal collected on the 43 installations is 754.8 tons per year. Twenty-four out of 30 installations reported that they also sell other scrap materials. Figure 13 presents the various commodities

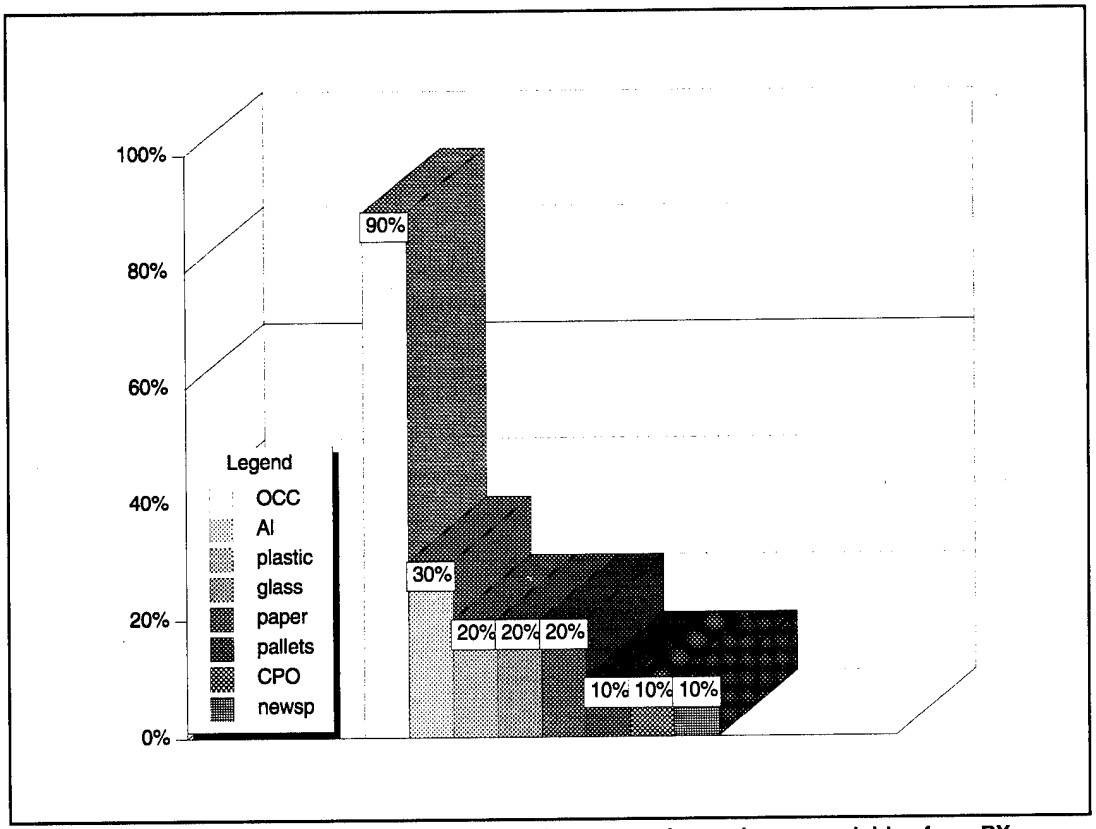

Figure 11. Percentages of 10 responding installations accepting various recyclables from PX.

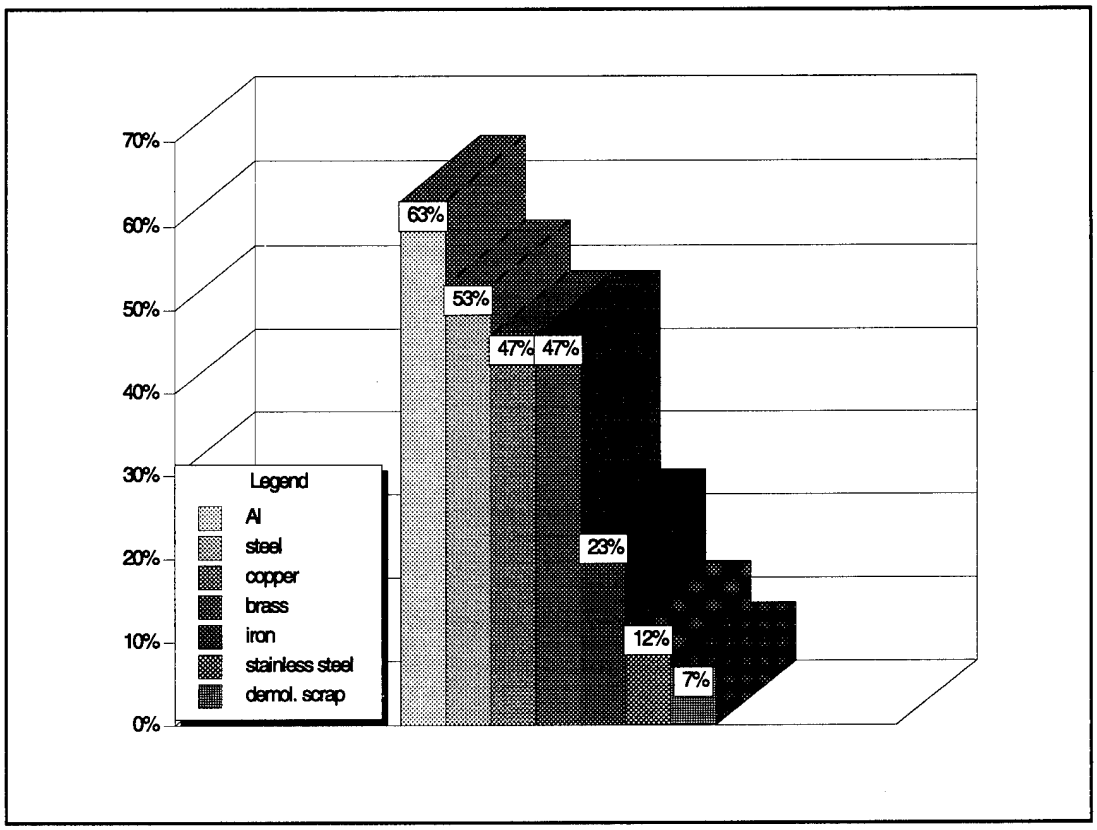

Figure 12. Percentages of 43 responding installations recycling various scrap metals.

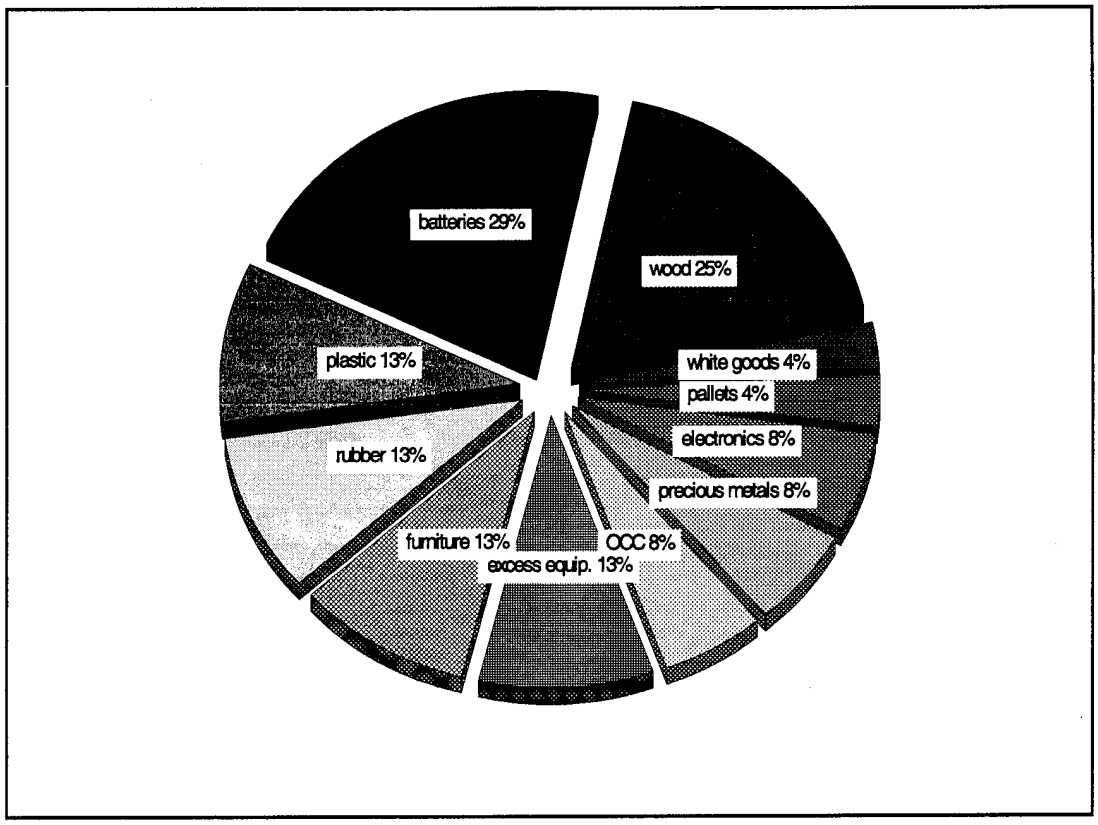

Figure 13. Percentages of responding installations recycling "other" scrap materials.

that made up this "other" category, along with the number of installations that sell each commodity.

Composting. Twenty percent of the respondents to this question, or 10 out of 49 installations, run and operate compost programs. All 10 programs use the static-pile composting method, but, two of the 10 are aerated. Most installations use the compost for grounds improvement and gardens. Two of the installations did not use the compost on base, but made it available for community use. Of the 39 installations that reported not having composting programs, three (Sierra Army Depot, Tooele Army Depot, and Anniston Army Depot) reported that they are evaluating the idea of starting a compost program.

Solid Waste Collection/Transfer

This topic—Section 5.0 of the survey—is broken down into program status/plans (5.1), operations and maintenance (5.2), and collection costs (5.3). Each installation was asked to state the amount of waste collected per week or month in cubic yards or tons. Because the installations were given a choice between these two units, a conversion was required to convert all values to common units. For this purpose, 1 cu yd was specified to equal 500 lb (1 cu yd = 500 lb); the standard conversion was used for tons—1 ton = 2,000 lb.

This conversion factor is currently used by Sierra AD environmental staff to estimate waste-generation rates. Although individual waste streams can differ substantially, this conversion falls near the middle of the typical range for compacted MSW: 300 to 650 pounds per cubic yard. Uncompacted waste would have a conversion rate of approximately 100 to 300 lb/cu yd (ILENR/RR-91/10). Even with the values converted to the identical units, they vary in actual mass depending on whether they are based on compacted or uncompacted quantities. The average amount of solid waste collected per year, based on values reported by 37 installations, is 8,109 tons per year.

Forty-six installations reported on where the solid waste is taken after collection. Figure 14 represents the percentage of installations that landfill waste (both on- and offsite) or transport the waste to a transfer station.

One of the installations that use an off-post transfer station sorts waste; the other does not. Both installations that use on-post transfer stations sort the waste.

The average distance to the landfill reported by 34 installations is 8.9 miles. Section 5.2 also questioned installations about what types of waste are collected and separated from general refuse. Forty-six installations responded, with the results shown in

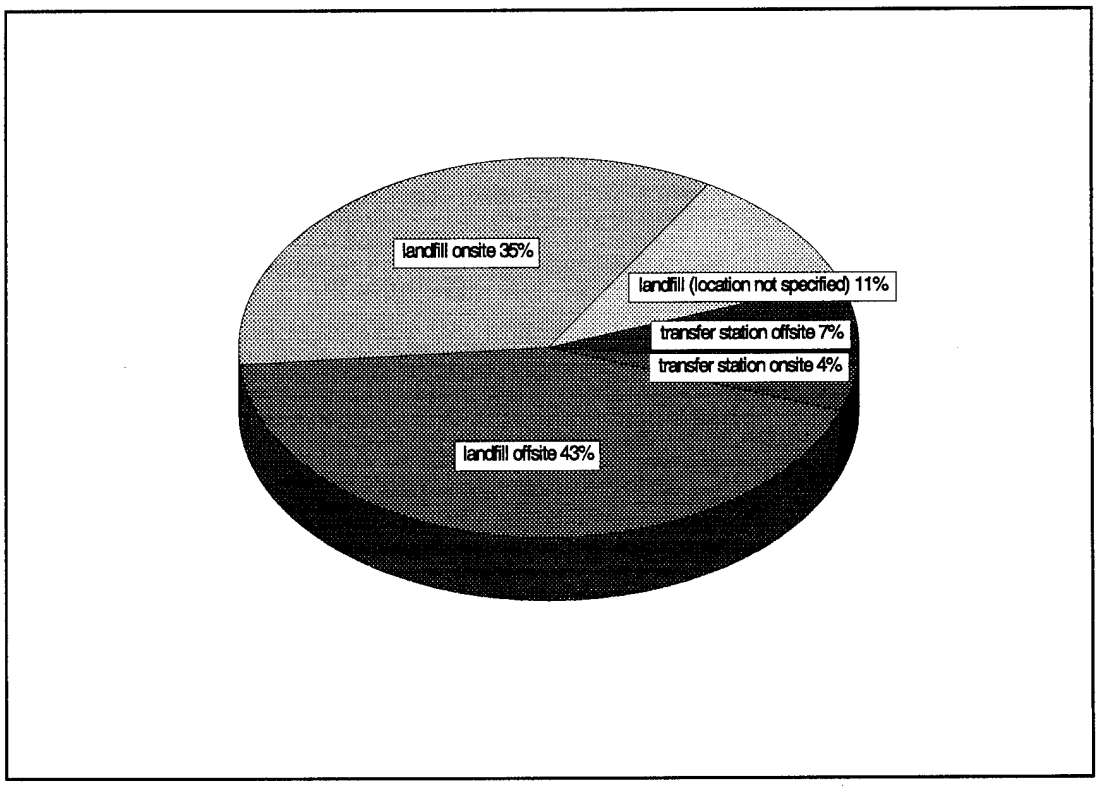

Figure 14. Percentages of responding installations using various solid waste disposal sites.

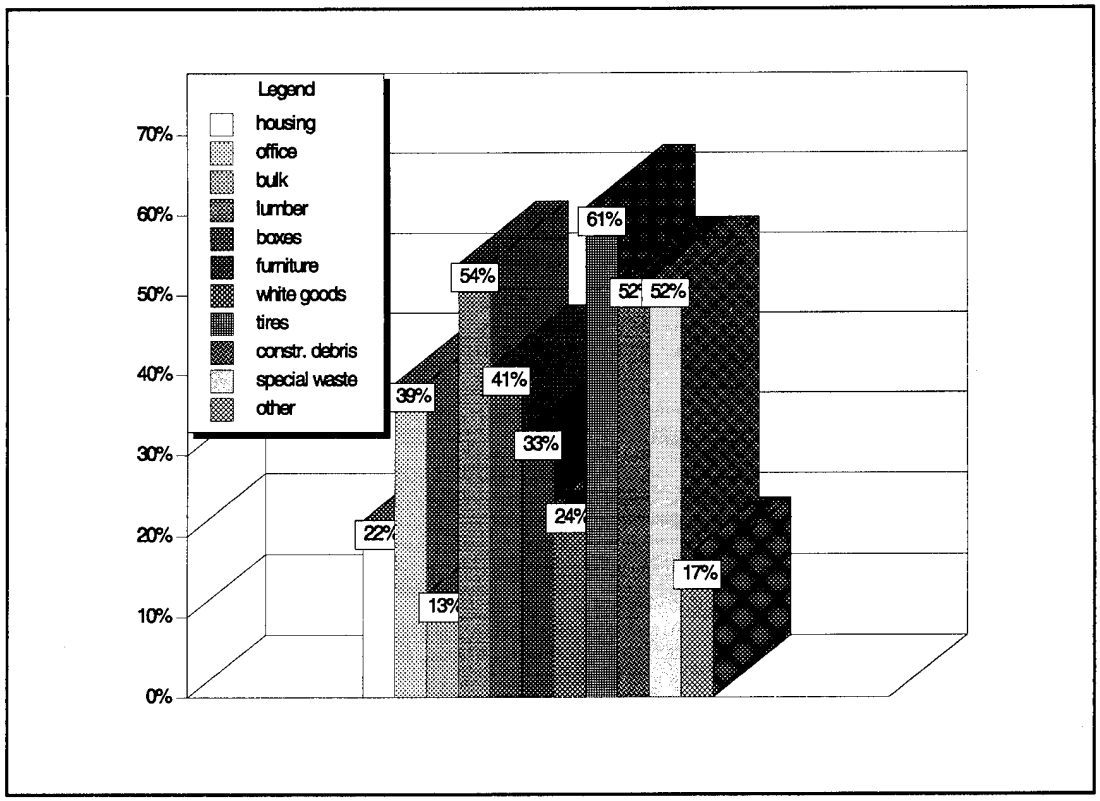

Figure 15. Percentages of responding installations that separate various wastes from general refuse.

Figure 15. The "other" category referred to in Figure 15 includes telephone books, industrial waste treatment sludge, nonhazardous ash from open burning, magnetic tapes and toner cartridges, residual/industrial waste, office equipment and furniture, batteries, metals, leaves, paint, thinners, and acidic solutions.

Twenty-two installations use in-house solid waste collection, based on answers from 34 installations. The average number of employees is three and the average number of trucks used is two. Solid waste is collected an average of two times a week, and 74 percent of AMC installations contract for solid-waste collection.

The average annual in-house operations and maintenance (O&M) cost for waste collection is $47,637, based on values from 23 installations. (Note: two of these values included landfill costs). The average contract cost is $211,900, based on data reported by 30 installations.

Incineration

Only six installations reported having operational onsite incinerators for MSW (Hawthorne AAP, Holston AAP, Iowa AAP, Pine Bluff Arsenal, Fort Monmouth, and Vint Hills Farm Station.) Three installations use a local or regional incinerator (Stratford Army Engine Plant, Redstone Arsenal, and Aberdeen Proving Ground.) Several installations have operated an incinerator since 1971 but it has since been closed for the following reasons: economics (Fort Monmouth), explosion damage (Vint Hill Farms Station), and EPA regulations (Navajo Depot Activity). Five installations anticipate going to an off-post facility for incineration (Longhorn AAP Plant, Twin Cities AAP, Stratford Army Engine Plant, Red River AD, and Tooele AD). Redstone Arsenal and Aberdeen Proving Ground reported that they will continue to use offsite incinerators.

The average amount of solid waste incinerated is 5,220 tons per year. No preprocessing (removal of recyclables, toxins) was reported for any of the incinerator sites. Of the installations with onsite incinerators, 71 percent are mass burn facilities, with various rated capacities, all of which dispose of ash in on-post landfills.

Landfilling

Twenty-three installations reported having an active sanitary landfill onsite. Thirty-three installations have closed landfills for various reasons, as shown in Figure 16. The remaining capacities for 22 installation landfills are shown in Table 4. Figure 17 shows percentages of the responding installations falling into four ranges of remaining capacity.

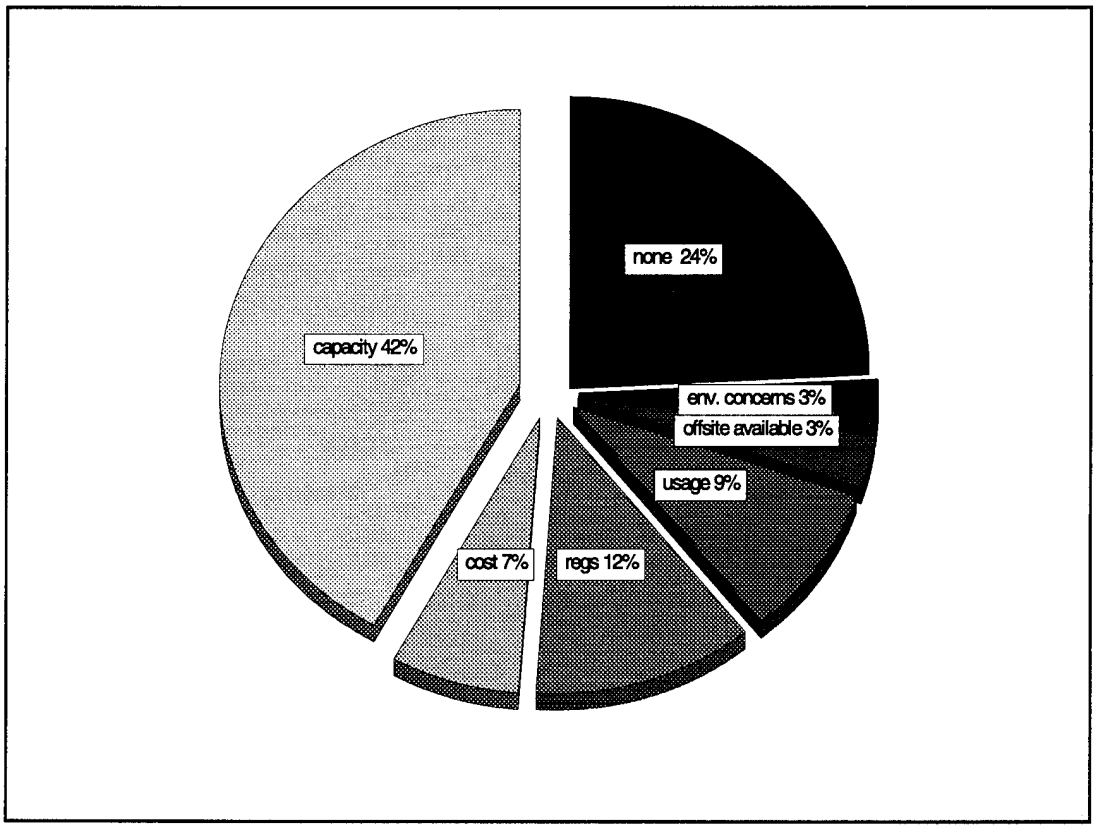

Figure 16. Reasons why 33 responding installations have closed onsite landfills.

Eleven installations are expecting changes in the remaining capacity of their landfills: Badger AAP due to greater demolition waste, Hawthorne AAP because of the absence of residential waste, Indiana AAP due to plant inactivity, Lake City AAP because of vertical expansion plans, Volunteer AAP because of closure, Red River AD due to a 1993 contract change-over, Umatilla AD because of an October 1993 closure, Redstone Arsenal because increased capacity due to wood chipper purchase, and Aberdeen Proving Ground because of a reduction in the waste stream. Anniston AD, Umatilla AD, and White Sands Missile Range all presented possible changes due to new EPA regulations on liners and leachate assessment.

Table 4. Remaining capacities for 22 onsite installation landfills.

Years capacity remaining	No. installations
0	2
0.5	2
1	2
2	3
3.5	1
7	1
8	2
10	3
12	1
15	2
25	1
50	1
70	1

Nine installations have plans to build or expand their landfills in the years noted: (Badger AAP (1996), Houston AAP (1995), Lake City AAP (1993), Lone Star AAP (1993), Louisiana AAP (1995), Milan AAP (1993), Pine Bluff (1993) Arsenal, Red River Army Depot (1993), and Aberdeen Proving Ground (1996)).

The average annual amount of MSW landfilled on-base, as reported by 30 installations, was 4,629 tons. Approximately 46 percent or 10 out of 22 AMC installations weigh solid waste before landfilling.

Twenty-one of 22 installations (95 percent) reported that inspections are conducted for hazardous waste or banned materials at the landfills. Inspection methods ranged from load inspections to random inspections, as shown in Figure 18.

The average off-post landfill tipping fee is $46.35 per ton, while the average equivalent on-post cost is $36.42 per ton—a difference of almost $10 per ton.

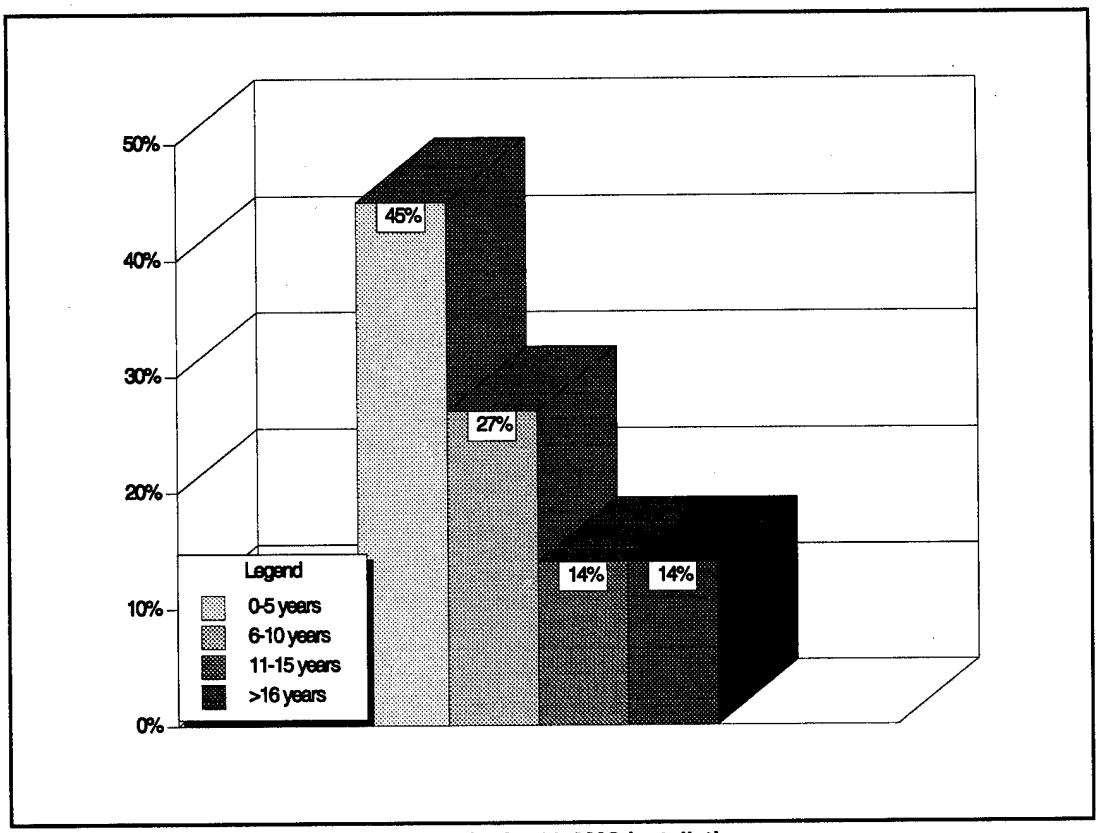

Figure 17. Remaining onsite landfill capacity for 22 AMC installations.

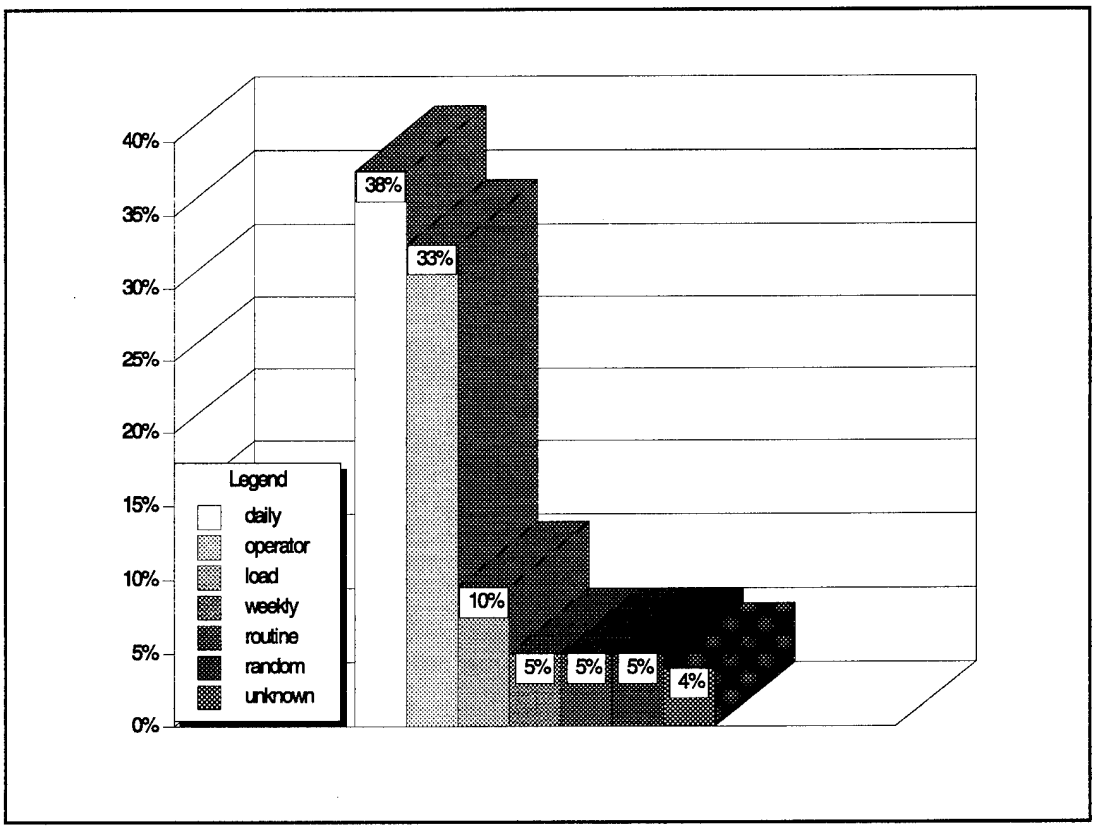

Figure 18. Types of waste inspections conducted by 22 responding installations.

4 Case Study Findings

As noted in Chapter 1, five detailed case studies were conducted to provide site-specific examples and data supporting the general survey findings. These case studies included interviews with installation personnel, visual inspections of installation solid waste streams, and alteration of the standard collection routes so the researchers could effectively evaluate solid waste characteristics. Three goals were reached through work on the case studies: (1) definition of AMC waste-stream characteristics (2) identification of unique SWM strategies, and (3) better understanding of recycling markets.

Redstone Arsenal (RASA) Case Study

Overview of Redstone Solid Waste Management Program

Based on the findings of the case study, the solid waste management environment at Redstone Arsenal may be summarized as follows. It:

- was one of the three largest AMC installations surveyed
- accommodates two large tenant organizations—Thiokol Incorporated and the Marshall Space Flight Center
- does not procure products made from recycled materials
- uses e-mail, reduction of styrofoam in schools and offices, and an on-post resale shop as the only means of source reduction on base
- offers nonmandatory educational programs to promote recycling
- has monthly access to a temporary household hazardous waste dropoff site
- contracts out family housing curbside recycling collection to a local vendor
- has conducted a study evaluating the feasibility of opening an onsite recycling center
- contracts out office paper recycling to a local vendor
- contracts cardboard collection at the commissary through DRMO
- processes all scrap metals generated on RASA through DRMO
- collects refuse in-house and uses the Huntsville Solid Waste Authority for disposal

- has a 25-year contract with the Huntsville Solid Waste Authority to tip up to 50 tons of refuse per day for no fee in exchange for purchasing steam generated by the Authority-operated onsite incinerator/cogeneration facility
- possesses a waste stream composed predominantly of office-type waste, but includes more housing and troop waste than a typical AMC installation
- does not compost landscape or food waste on-post
- does not operate an active on-post MSW landfill; the landfill now accepts only inert materials.

RASA Case Study Findings

RASA Mission. Established in 1941 as a manufacturing center for conventional and chemical munitions, Redstone Arsenal was incorporated into the Army's Ballistic Missile Agency in the 1950s. Today, the U.S. Army Missile Command (MICOM) uses Redstone for missile development, research, and logistics. Redstone Arsenal contains the project offices of MICOM's research and development efforts, laboratories for performing basic research on solid- and liquid studded rocket engines, test areas for research, development, and production testing of missiles and rockets, and a Government-Owned, Contractor-Operated (GOCO) propellant manufacturing plant. Marshall Space Flight Center is also a tenant at Redstone.

General Information. Redstone Arsenal personnel and housing numbers were provided by the installation Directorate of Public Works (DPW):

• Active military personnel	3,044
• Civilian personnel	20,098
• Active military living on-post	1,017
• Dependents living on-post	1,473

Redstone Arsenal anticipates no changes resulting from BRAC activities.

Procurement. All items must be purchased through the self-service store, if available there. For example, the Acquisition Department of Redstone Arsenal processes small orders for paper products through the self-service store, but large orders or items not in stock are ordered through General Services Administration (GSA). Building 7471 is Base Supply, headed by Acquisition. Base Supply houses backup stock for bulk users of paper products, such as the Procurement, Acquisition, and Requisition departments. The head of Base Supply said that paper products containing recycled content could be ordered, but were not because they caused maintenance downtime on printers and copiers due to the difference in paper grade. This problem was the only

apparent constraint preventing the procurement of recycled paper products on Redstone Arsenal.

Waste Reduction/Reuse. Redstone uses e-mail for paper reduction, styrofoam reduction in schools and offices, and an on-post thrift shop as its only methods of source reduction. The thrift shop reuses brown paper bags, hangers, plastic products, furniture, clothing, and miscellaneous household goods. Aluminum cans are collected by one of the volunteer employees. All surplus items are donated to a local rescue mission. A bulletin is printed and distributed every day to explain what items are currently accepted. The thrift store hours are 10 a.m. to 6 p.m. on Wednesdays and 10 a.m. to 2 p.m. on Fridays. The store staff includes five paid employees and 30 volunteers. They bring in approximately 50 consignments a day of 20 articles each, resulting in about 700 receipts per day. In addition to the thrift shop on base, the arsenal also has a household Salvation Army dropoff.

Educational Programs. Nonmandatory educational programs have been provided by Redstone for 2 or 3 years. The DPW conducts a "Recycling Kids" program at the installation day-care center and publishes articles in the *Redstone Rocket* (post newspaper).

Small-Scale Hazardous Waste. The Huntsville Solid Waste Authority, in conjunction with the county health department, holds a household hazardous waste (HHW) swap the first Saturday of every month for all residents of Madison County, including Redstone residents. The program began in May 1992. The county health department performs a cursory inspection of the HHW, and sorts and separates it to recycle pesticides and other reusable hazardous wastes. Most of the HHW that can be reused is donated to local businesses and agencies that can make use of the products. HHW that cannot be reused is disposed of by the Solid Waste Authority at no charge to Madison County residents.

Recycling and Computing. Currently, Redstone has a recycling program but not an operational recycling center. The arsenal's recycling program manager has prepared an information paper estimating the cost of converting an arsenal building into a recycling center and waste-to-alcohol facility. An initial capital investment of about $830,000 was estimated to be the startup cost.

Market Analysis. Current market prices in the RASA vicinity for commonly recycled commodities are shown in Table 5.

Household Recyclable Collection. Redstone is under a 5-year contract with Browning-Ferris, Inc. (BFI), in Huntsville for curbside recycling. BFI provides

Table 5. Recyclable materials and their corresponding market prices as quoted by local vendors in early 1993.

Recyclable Material	Market Price
Aluminum	$ 0.24/lb
Steel cans	$ 0.05/lb (100 lb minimum)
Clear glass	$10.00/ton
Green glass	$ 5.00/ton
Brown glass	(taken on donation, with a 1 ton minimum)
PET	$10/ton (1 ton minimum)
Newspaper	$ 0.01/lb (100 lb minimum)
White ledger	$ 0.01/lb
CPO	$ 0.04/lb (free of groundwood)
OCC	$25.00/ton

curbside recycling collection for the city of Huntsville, and extends this program onto the installation at a cost of $1.38 per house per month. Redstone has 1,171 on-post housing units, resulting in a yearly cost of $19,392 to run the curbside program. The annual turnover rate in housing is approximately 50 percent, so education programs are needed to inform the steady stream of new residents about waste management and recycling at Redstone. BFI has helped with recycling kickoffs at local schools and at Earth Day Open House held at the steam plant. Newspaper, magazines, plastic, aluminum, steel, clear glass, green glass, and brown glass are collected curbside. Figure 19 illustrates the percent volume composition by material for the Redstone curbside recycling program.

Residents set out recycling bins and BFI separates the materials *en route* into clear glass, green glass, brown glass, newspaper, high-density polyethylene (HDPE), polyethylene terephtholate (PET), mixed paper, and metals. BFI uses special rear-loader trucks that have separate compartments on the side for each recyclable; this allows the contractor to collect regular MSW and segregate recyclables on the same route. However, BFI is only contracted to collect recyclables for the Redstone curbside program; Redstone contracts out regular refuse collection to the Military Waste Management Corporation which is located on-post. BFI is located in Huntsville, approximately 10 miles from RASA. BFI recently lost its market for brown glass and is searching for another.

BFI tracks the volumes (by material) collected on Redstone and calculates the percentage of each material. A monthly report is sent to Redstone's Recycling Program Manager, including the volumes and percentages by material, and participation rates.

These reports help the recycling program manager monitor the curbside program and track the percentage of waste reclaimed. The average amount of recyclables collected per month is 13,606 lb, plus approximately 9 gal of used motor oil per month (1992). Newspaper and clear glass make up 75 percent of all recyclables collected per month from the Redstone housing area. The average participation rate in the household curbside program for 1992 was 51 percent. The monthly averages for each material collected utilizing the household curbside program are listed in Table 6.

Commissary personnel discussed the recycling of cardboard with BFI, but the bales contained plastic package wrapping. BFI offered to buy the OCC bales if someone at the commissary would remove the plastic wrapping. The commissary declined the offer due to the lack of manpower to remove the plastic. Clubs, dining facilities, and the PX are not serviced with recyclable collection, but cardboard generated by the commissary is currently recycled through DRMO.

White office paper is the only recyclable collected from office and classroom buildings at Redstone. Office paper recycling is conducted at only 32 out of 600 office buildings. Six or seven more buildings may be added to the list depending on the recycling

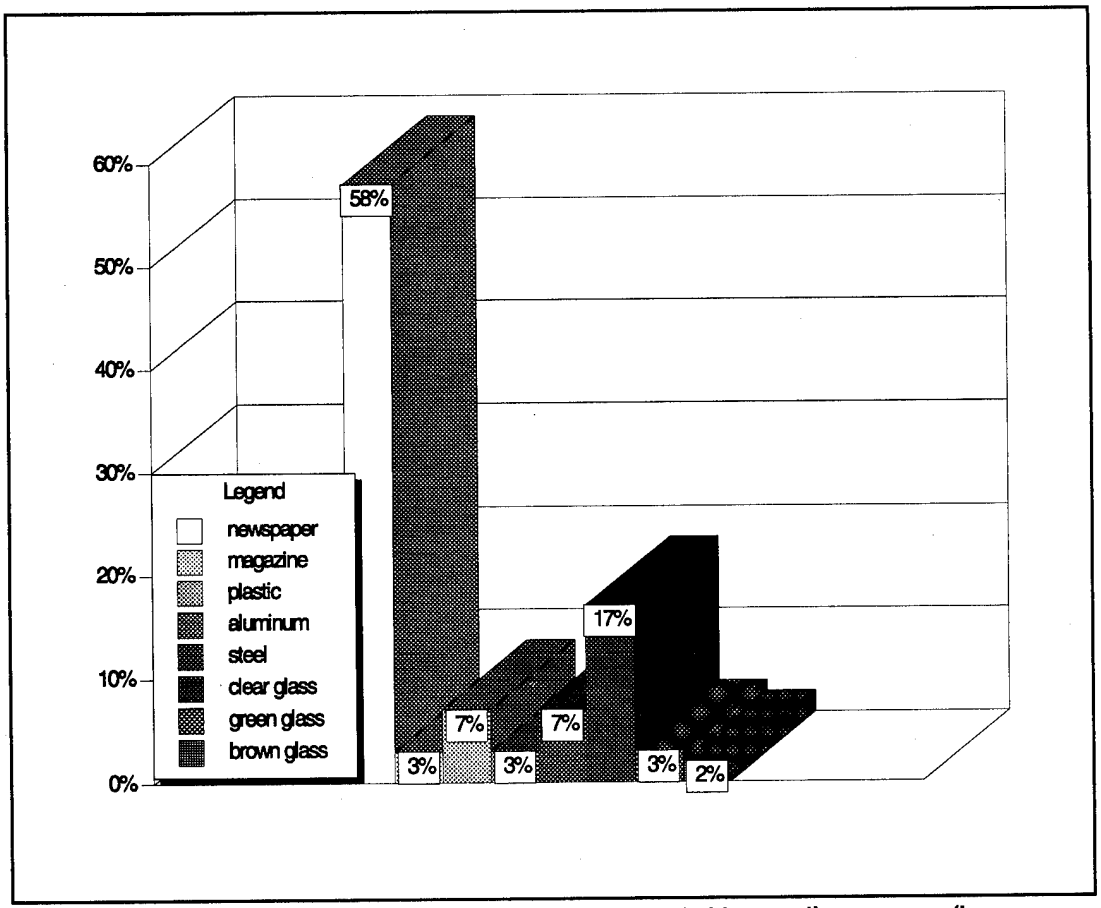

Figure 19. Volume composition percentages for Redstone curbside recycling program (by material).

Table 6. Monthly average weights of household recyclables collected at Redstone.

Material	Average Amount Collected per Month (lbs)
Newspaper	7,924
Magazines	388
Plastic	911
Aluminum	434
Steel	906
Clear glass	2,384
Brown glass	229
Green glass	431

program manager's survey of office waste generated per building, currently under study. Office paper for recycling is collected by a local vendor under a DRMO contract. Approximately 5 percent of paper generated on the arsenal is picked up for recycling.

All scrap metals generated on Redstone are processed through DRMO. If items brought in from the arsenal go directly to scrap at DRMO, the money generated by the sale goes back to the recycling program. If items brought in are not scrapped, they go through a screening period; when the screening period passes, the items can be downgraded to scrap, but the money generated from their sale is not reimbursed to the arsenal recycling program. Table 7 presents the amounts reimbursed to the recycling program for various scrap categories as of January 1993. DRMO also donated 19,000 gal of used oil to Auburn University for fuel in 1992.

The commissary bales cardboard under a contract with DRMO, and DRMO has a 3-year contract with South Central Recycling to collect and sell waste paper for the installation. The baler used by DRMO, donated by another base, produces 1,000 lb bales. Last year DRMO hired two summer employees to separate metals, and over 2 months generated an additional $35,000. The monetary benefits from metal segregation often cancel out the added cost for extra manpower required to segregate. Current market prices from Redstone DRMO are presented in Table 8. There seems to be no viability for precious metals at Redstone.

Composting. RASA currently does not compost landscape waste on-post. However, every fall some local off-post solid waste haulers collect bagged leaves on their normal collection routes in Huntsville. The leaves are taken directly to the local botanical gardens, where they are composted for use on the gardens. The composting is done using a low-technology static-pile system. Currently, leaves are the only "green waste" composted in Huntsville. Brush and yard waste go to the inert landfill. The

incinerator manager estimated that a composting program will be needed onsite in 3 to 5 years. Redstone is currently trying to purchase a wood chipper/tub grinder to help reduce the volume of wood waste going to the inert fill.

Table 7. Categorized reimbursements to RASA recycling program, FY92.

Commodity	Proceeds (dollars)	Amount generated (lb)
Copper-bearing material	15,128	79,360
Copper wire/cable	13,868	40,640
Copper (clean)	1,524	1,960
Light steel (baled)	12,291	475,470
Light steel (unprepared)	8,289	689,969
Heavy steel (prepared)	15,106	458,040
Heavy steel (unprepared)	38,377	1,413,011
Mixed metal/scrap	17,517	903,954
Electronic scrap	10,512	110,642
Fired brass	3,693	6,092
Aluminum (clean)	20,723	62,850
Aluminum (irony)	7,012	21,040
Batteries, lead-acid	3,487	60,668
Textile scrap	1,195	7,420
Rubber tires	3,438	22,840
Scrap paper	3,123	240,100
Total	**175,283**	**4,594,056**

Solid Waste Collection and Transfer. Military Waste Management (MWM) is contracted for Redstone refuse collection. MWM operates with five trucks: two front-loaders (one 24 cu yd and one 34 cu yd), two rear-loaders, and one flatbed. The arsenal provides MWM with a facility and all utilities (except telephone). Martin Road is the divider between the north and south pickup routes. The smaller (24 cu yd) truck is used for south-side collection because of the greater distance between pickup points south of Martin Road—less fuel is required to run the smaller truck. Less driving time is required for collection of the north side, so the larger truck is used. MWM operates from 7a.m. to 3:30 p.m. Monday through Friday. A rear-loader collects household waste, which is collected and hauled separately from other refuse. The other rear loader is used to collect boxes on the arsenal. Wednesday is housing bulk pickup, collected with the flatbed truck. Rubble is collected on a call-in basis, and

Table 8. Redstone DRMO scrap metal market prices January 1993.

Scrap Metal Commodity	Market Price
Light metal (unbaled)	$21.00/ton
Light metal (baled)	$56.00/ton
Aluminum (with attachments)	$0.23/lb
Aluminum (clean)	$0.40/lb
Electronics	$0.03/lb
Wire dividers	$0.34lb
Stainless steel	$0.43lb

"white goods" (refrigerators, air conditioners, etc.) are taken to DRMO. However, scrapped white goods are not landfilled until all chlorofluorocarbons (CFCs) are removed. All demolition and cleanup waste is transported directly to the on-post landfill. Housing, bulk waste, cardboard boxes, furniture, white goods, construction and special waste are all collected and separated from general refuse. Scrap wood up to 50 in. long can be burned in the incinerator. When loads of refuse are taken to the incinerator, load weights are recorded and the refuse is dumped into the pit. There are no truck scales on the arsenal, so all weighing is completed at the incinerator/steam plant (co-generation facility). MWM gets receipts on the weights taken for each load, and these are turned in to the DPW Refuse Handler (Systems Analysis Branch).

MWM is paid by the pickup point, and payment for additional lifts per week compensates for additional can pickup. For example, commissary waste is collected 6 days a week, and each additional can adds six additional lifts per week to the pickup point, which currently has six bins. It costs $4.06/lift/month, so $4.06 x 24 additional lifts/can/month/ x 6 cans = $584.64 more each month when one can is added to each commissary, club, and dining facility pickup point. Overall solid waste collection costs for Redstone are about $500,000 per year, including on-post landfilling costs. The DPW Refuse Handler calculated the number of people per building and building square footage to determine bin placement and capacity required for each pickup point. The calculation assumed 1 cu yd of solid waste generated per week by every 10 people.

Marshall Space Flight Center, located on the arsenal, uses steam generated by the incinerator, but the Center's refuse collection is serviced by Mark Dunning Industries not MWM. MWM does collect refuse for Thiokol Incorporated, also a tenant on the arsenal.

During the site visit, MWM allowed the researchers to alter collection routes for that week to record weights for separate source generators on Redstone. The six source generator categories were food service, commissary, PX, BEQ/BOQ, administrative, manufacturing, and storage. Visual inspections were also conducted to estimate composition trends by different source generators. In 1 week 34.52 tons of refuse were collected at Redstone. Seventy-five percent was generated from administrative and storage buildings. Volume composition estimates made from the visual inspections (included in Appendix B) indicate that administrative and storage buildings typically generate at least 60 percent office paper— usually high-grade. In general, approximately 45 percent of all Redstone refuse (excluding housing refuse) is office paper. A correlation was also performed, as illustrated in Appendix B, to evaluate the relationship between square footage and tonnage collected per source generator. The correlation coefficients show that there is not a strong positive correlation between building square footage and tonnage generated by each category of source generator.

Incineration. Redstone Arsenal is under a 25-year contract with the Huntsville Solid Waste Authority to purchase steam from the Authority-operated waste-to-energy (WTE) facility located on the installation. The Authority is a public entity, financed through revenue-backed bonds. Under the steam contract, Redstone is allowed to dispose of up to 50 tons of solid waste per day without a tipping fee. In 1988 the tipping fee was $10.50 per ton; in 1993 it was $30.50. This amounts to a 290 percent increase over 5 years, and a similar increase is likely to continue.

Approximately 170 tons of refuse per week is incinerated on Redstone Arsenal, including the 10 tons of refuse collected per day from Marshall Space Flight Center. No preprocessing (removal of recyclables, toxins) is conducted at the incinerator site. WTE plant personnel pull out white goods on the tip floor; the Authority is contemplating back-end metal separation for ash. All bottom ash is disposed of in a monofill operated by the Authority. Tires and sewage are the "hot fuel" for the incinerator. The facility receives 45,000 to 50,000 tires per month, mostly from the Dunlop Tire Plant in Huntsville. Redstone's contract with the Solid Waste Authority does not permit sludge incineration. The current rated capacity of the incinerator is 690 tons per day. If expansion is required, the incinerator has space for one more boiler with a capacity of 550 tons per day. The BFI curbside recycling program has reduced the amount of waste routed to the incinerator by 5 to 18 percent.

The Solid Waste Authority runs the regional landfill. There are currently no bans on the landfilling of tires, white goods, or batteries. Dry cell batteries, along with recyclables, are separated at curbside. Approximately 20 batteries are found per ton of waste. The incinerator has no problem with contamination in Redstone refuse. New technology is being considered to process fly ash so it does not have to be buried in the landfill. The incinerator inspects all loads collected from area hospitals. Hospital refuse is dumped on the tip floor and visually inspected. If the operator sees possible unauthorized waste, a front-loader is used to spread the refuse out more evenly for closer inspection. If red-bag waste (infectious or hazardous medical waste) is found within a load, the hospital responsible is called to come and collect the load.

Landfilling. On 30 April 1992, Redstone's on-post landfill stopped accepting MSW and now accepts only inert material. The portion of the landfill containing MSW was capped, inspected by the state, and surveyed to determine benchmark parameters. The sanitary fill was only open between 1 and 2 years, and only 25 percent of the fill contains MSW. The landfill does not have gas flares, but has a clay liner and is capped according to Subpart D of RCRA. The fill also includes a 22,500 sq ft trench (surface area measure) for asbestos.

The landfill currently accepts asphalt, concrete, steel, and lumber. Anything that will burn and is small enough to process through the incinerator, including wood pallets, is burned rather than sent to the landfill. If brush and tree limbs do not meet the incinerator's size limit, they are sent to the landfill. The landfill receives 90 percent of concrete, asphalt, brush, tree trunks, and limbs. Approximately 54 tons per year are landfilled on Redstone. DPW personnel estimate that the purchase of a wood chipper could reduce the landfilled wood waste to one-eighth its current volume, adding approximately 25 years to the landfill capacity. The wood chips may be used for mulch on the installation, which would further reduce volume dumped in the landfill. Weights are not taken at the landfill, but operators inspect a minimum of one full load per day for hazardous or banned materials.

Discussion of Redstone Findings

Based on the information collected at Redstone Arsenal, several recommendations can be made to improve the existing effort and to prevent noncompliance (and related costs):

1. The procurement of products made from recycled materials is becoming a more prevalent issue with lawmakers and government agencies. Redstone Arsenal can procure paper products made from recycled materials through the GSA/FSS* guide, and should systematically take advantage of this opportunity to reuse natural resources and avoid added waste generation.

2. Redstone DRMO does not track the quantities and dollar amounts by commodity reimbursed to the Redstone recycling program. DRMO did calculate the amount of each commodity that is generated by Redstone and processed by DRMO, along with the reimbursement received by the recycling program from each commodity. It is recommended that DRMO continue to track the breakdown of reimbursables by commodity to make it easier for Redstone to track recovery of materials through resale at DRMO.

3. Redstone has several options to enhance source reduction on base, including promoting use of the on-post thrift store, reducing styrofoam use on base by using nondisposable dishes, using two-sided copies whenever feasible, reusing one-sided copies for note pads, etc.

* FSS: Federal Supply Service.

4. The purchase of a wood chipper or tub grinder could cut the volume of wood to one-eighth its current volume, and using the wood chips for on-post landscaping and composting could reduce the volume landfilled even further.

5. Increased education on recycling benefits and material preparation could increase participation in the curbside recycling program. Making residents aware of their impact on reducing Redstone's waste stream (and the natural resources that are spared) may increase interest in this program. Education is the key to making the household curbside program work; early education for new residents will help eliminate contaminants in the recyclables and create a more productive program overall.

6. With the possibility of mandatory recycling, the opening of an on-post recycling center would greatly enhance current recycling efforts by increasing the types of commodities recycled, reducing landfill use, reducing the amount of waste incinerated, and generating revenue for the base recycling program.

7. Cardboard and office paper make up a large percentage of the waste generated on the installation. By capturing these items for recycling, Redstone could greatly reduce the amount of waste being landfilled or incinerated.

8. The purchase of on-post truck scales would allow the arsenal to track its waste stream generation to enhance future waste management efforts.

9. The recycling of asphalt, concrete, and other construction debris could significantly reduce the Redstone waste stream.

10. The structure of Redstone's contract with the Huntsville Solid Waste Authority is an impediment to SW reduction and recycling. The contract allows Redstone to dispose of up to 50 tons per day of solid waste at no out-of-pocket cost, since disposal costs are included in the price of steam that the installation purchases. This arrangement provides no incentive for Redstone to effectively manage waste because any reduction in volume would not be perceived to reflect a cost savings. But, at the same time, the installation's high steam costs make it clear that the installation is being charged fully for disposal, not just the amount of steam used.

Sierra Army Depot (SIAD) Case Study

Overview of Sierra Solid Waste Management Program

Based on the findings of the case study, the solid waste management environment at Sierra Army Depot may be summarized as follows. It:

- was one of the smallest AMC installations surveyed, and the smallest for which a case study was conducted
- expects an extension of mission due to BRAC
- hosts a variety of Department of Defense (DoD) tenants
- procures paper products made with recycled content
- uses styrofoam reduction procedures in schools and offices as its only means of source reduction
- does not offer educational programs to promote recycling, source reduction, reuse, etc.
- does not offer a program for handling small-scale household hazardous waste generation
- has a recycling program for office paper, glass, and aluminum cans, but does not operate a recycling center
- handles all solid waste collection in-house
- may implement a composting program for wood and landscape waste generated on base
- collects office recyclables daily
- collects housing recyclables (including glass, newspaper, plastic, and cardboard) using recycling dropoff containers in the housing area
- has one recycling coordinator to handle all recycling responsibilities, including collection, segregation, and storage
- processes all recyclables through DRMO
- generates a waste steam primarily consisting of paper products and cardboard
- operates an on-post sanitary landfill.

Case Study Results for SIAD

SIAD Mission. SIAD is located near Herlong, CA, in the southern portion of Lassen County, near the California-Nevada state line. Herlong has a population of 1,870, and is approximately 40 miles from the nearest recycling markets. Sierra is a GOGO installation. Its mission is to store and maintain ammunition and explosives assigned to it. The depot hosts a number of DoD tenants.

General Information. Sierra is small compared to most AMC installations. The installation covers almost 96,000 acres, but the work force is relatively small. Personnel numbers as of November 1992 were provided by the Guest Housing office:

- Military personnel living in government quarters 143
- Military dependents living in government quarters 290
- Military personnel living off-post 5
- Military dependents living off-post 5
- Civilian personnel 600

Sierra anticipates an expansion of its mission due to the closing of other installations mandated by BRAC.

Procurement. Sierra is one of the 56 percent of AMC installations surveyed that procure paper products containing recycled content; recycled paper products have been purchased for 1–2 years. Legislation to increase the state of California's purchasing of recycled products was recently reintroduced. Assembly Bill (AB) 11, a rewrite of AB 2446, requires the state to use substantially more recycled paper and other recycled products. It also authorizes the California Department of General Services to establish price preferences for paper products, compost, glass, oil, plastic, solvents and paint, paving materials, and tires. AB 11 clarifies cost by specifying that a percentage of the total amount budgeted for products must be spent on products made from recycled materials. If a recycled product costs more than its virgin counterpart, state agencies would be required to buy less of the product. This, in turn, would promote waste reduction at the source (White, 9 March 1993).

Waste Reduction/Reuse. The only waste-reduction procedure used on-base is the reduction of styrofoam in schools and offices. In the area of small-scale hazardous waste generation, Sierra currently has no household hazardous waste dropoff program. In addition, the installation has no procedures in place for decreasing the amount of hazardous waste generated (e.g., paint swaps, information on less toxic substitutions, reuse possibilities, etc.).

Environmental Education Programs. Currently, Sierra Army Depot does not offer educational programs related to recycling, composting, and source reduction. Sierra publishes a monthly newspaper called *The Challenge* which could be used to advertise recycling options on the installation.

Recycling/Composting. Sierra has a recycling program but no recycling center. The recycling program recycling coordinator had been on staff for approximately 5 months at the time of the case study. The recycling coordinator handles all recycling on base,

including collection and separation of office paper, aluminum cans, and plastic. The installation has eight dropoffs for aluminum and plastic. The coordinator stores the separated recyclables in an empty tank located at the DRMO storage site. A year ago, a proposal was made to the SIAD Recycling Committee to incorporate recycling dropoff containers and a residential curbside bag program to facilitate the collection of recyclables. The Directorate of Personnel and Community Activities (DPCA) currently handles all recycling funds, and decided that this type of program would not be cost-effective at that time. Instead, DPCA purchased the eight containers used for aluminum and plastic collection.

SIAD is unique among the five installations studied in depth in that the DPCA—not the Environmental Office—is responsible for the budget and administration of the recycling program. According to DPCA personnel, the initial budget for the recycling program in 1986 was $500,000, but at the time of the survey the budget had fallen to about $100,000. Proceeds from the recycling program are allocated by a Recycling Committee consisting of DPCA personnel, based on ideas submitted to the committee by installation personnel. However, DPCA personnel said that there are no plans to expand the recycling program because money is tight. DPCA's budget constraints apparently are inhibiting growth of the program. Also, DPCA appears to have problems effectively publicizing the recycling program, probably due to lack of staff knowledge in this area. The problems appear to be rooted in a lack of clear communication between DPCA and the Environmental Office. Enhancement of the recycling program is feasible if DPCA and the environmental staff can improve their lines of communication—perhaps by including members of the environmental staff on the Recycling Committee.

The commissary has its own baler for cardboard and a separate contract with DRMO; therefore, the baler is restricted to commissary use only. The baled corrugated cardboard is hauled to DRMO when there is a full semi-trailer load. The Sierra DRMO uses old tires to create boundary lines on post when necessary, and also bales and sells tin cans, newspaper, light steel, and cardboard. A horizontal baler has been ordered. They store unsegregated office paper, and resell refrigerators and other white goods if possible—or send them for repair in Reno, NV. Bulk landscape waste is chipped and mulched. SIAD generates a large quantity of wood waste from the ammunition areas. The environmental staff said that Sierra is currently considering a composting program.

Household recyclables are collected at dropoffs. These recyclables include glass, newspaper, plastic, and cardboard. Due to the short history of recycling on Sierra, amounts of recyclables collected were not available. Household recyclables are

collected daily or on a call-in basis. The participation rate for recycling by SIAD residents and personnel is about 25 percent.

High-grade paper, magazines/catalogs, computer printout, and cardboard are collected from offices and classrooms on a daily basis. Approximately 900 people are serviced with office/classroom collection, and the participation rate is 70 percent. Clubs and dining facilities are also serviced daily, but the number serviced is difficult to estimate due to the services rendered by these facilities. Cardboard is the only recyclable collected from the commissary and PX. The material is baled, and collection is handled by DRMO on a call-in basis. Again, it is difficult to determine the number of people serviced or the participation rate due to the services provided by these facilities.

Scrap metals collected by the recycling coordinator consist mainly of metal drums and metal banding. The amounts collected had not been calculated due to the short history of the recycling program, but the budgeting department provided a list of scrap metal sales for the Sierra recycling program (FY92), including quantities and reimbursable amounts generated for each commodity (Table 9).

Sierra offers a recycler/reclaimer for all wet lead-acid batteries, which are picked up at the generation point and hauled at no cost to the installation. This project has provided safety benefits from reduced personnel exposure to battery-draining operations. While costs savings are minimal, Sierra Army Depot has been able to reduce this waste stream from 1,299 kg to 812 kg since implementation.

Table 9. Sierra Army Depot scrap metal recycling program statistics, FY 92.

Commodity	Quantity	$ Amount
Heavy steel	519 tons	17,608.19
Aluminum, scrap	17,593 lb	5,473.82
Lumber	N/A	4,850.00
Copper, insulation wire	4,380 lb	1,865.88
Light steel, shell case	66 tons	659.28
Steel, light unprepared	87 tons	435.45
Steel	105 tons	209.48
Aluminum, irony scrap	880 lb	165.35
SAID Total		**31,555.20**
AMCCOM Proceeds/Transfers		
Brass, shell cases	431,836 lb	337,839.90
Source: SIAD budget office.		

Solid Waste Collection/Transfer. Approximately 20 tons of MSW are collected each week on SIAD. All installation solid waste collection is handled in-house by a single driver, who follows a set collection route for the week. The hauler estimated that 21 to 23 percent of the waste stream volume is household waste, including barracks; and 10 to 12 percent of the waste stream volume is contributed from warehouse operations. Buildings 640 and 403 are sporadic generators, depending on demilitarization and repack operations, but are not necessarily affected seasonally. The commissary bales 90 percent of its cardboard, which represents approximately 70 percent of all cardboard generated on the depot. The PX also generates cardboard.

All waste collected is taken to the on-post landfill, located approximately 3 miles from the cantonment area. Lumber, furniture, tires, construction waste, and special waste are collected and separated from general refuse. The installation reuses all lumber that is longer than 3 ft through public sales at DRMO. Wood waste from trees or storm damage is chipped and used for mulch on the installation. Ammunition and general supply areas are outside the cantonment area, and entail mostly demilitarization and inspection activities (unpacking and repacking). All collection is handled by a single hauler using a 20 yd compactor truck. The specified pick-up points are serviced twice a week (Mondays and Thursdays). A conversion factor is used by the hauler to estimate weights of loads, because actual weights currently are not taken, but truck scales are available onsite. The following conversion factor is based on the monthly total of cubic yards taken from the time production sheet: (monthly total cubic yards) (500 lb/cubic yard) (ton/2000 lb) = tonnage.

Solid Waste Generation Analysis. Because SIAD is relatively small, the researchers were able to work with the Building and Grounds Division and the trash haulers to modify the collection route and practices for analytical purposes. First, the researchers and haulers designed a one-time "experimental" trash route intended to collect a representative "snapshot" of the installation's waste composition. Trash was hauled from "pure" source generators. That is, residential dumpsters were selected by location to avoid the likelihood that the trash would include waste from other types of sources—a gas station, for instance. Trash was collected from seven types of generators:

1. barracks (with dining facility)
2. housing
3. school
4. office
5. shop

6. warehouse
7. demil/repack operations.

One mobile dumpster was filled from the experimental trash route and emptied at a location where the researchers could hand-sort the waste into composition categories. It should be noted that this collection was conducted during the Thanksgiving holiday, so some areas of the installation were closed and normal trash generation patterns were altered somewhat. It also should be noted that four other categories of waste generator—commissary, PX, restaurant, and downtown—were not included in the sorting project because their dumpsters had already been emptied for the week. Within these constraints, however, the most representative sample possible was specified, collected, and analyzed.

To determine the relative percentages of various materials in the solid waste stream, two sorters spent 8 hours (1 December 1992) sorting the load (collected from seven source generators) into the following categories: mixed paper, high-grade paper, cardboard, aluminum, wood, film plastics, marked plastics (1 to 6), other plastics, yard waste, newspaper, miscellaneous steel, glass, textiles, food waste, magazine/catalog, polystyrene, and other miscellaneous (e.g., foil laminate, batteries, aerosol cans, etc.). The landfill cards for the seven generators are included in Appendix C, including total weight, composition, and volume information. Truck tare weight and load weights were taken for each load before they arrived at the landfill. Loads were dumped, hand-sorted into categories, and placed into a separate box or drum for weighing. It should be noted that the Thanksgiving holiday may have skewed the composition values resulting from the hand-sort—specifically the housing and school compositions (e.g., additional food waste and containers generated from holiday festivities). Table 10 presents the composition percentages resulting from the hand-sort of the seven source-generator loads.

For 2 weeks during the same time period, the Building and Grounds haulers altered their usual collection route so they could weigh the waste within each of 10 generator categories:

1. barracks (with dining facility)
2. housing
3. school
4. office
5. commissary
6 PX
7. restaurant
8. downtown

Table 10. Sierra waste stream composition for seven source generators.

Waste Category	(Run #1) Barracks (percent load)	(Run #2) Office (percent load)	(Run #3) Housing (percent est)*	(Run #4) School (percent load)	(Run #5) Machine Shop (percent load)	(Run #6) Warehouse (percent load)	(Run #7) Demil, Repack Operations (percent load by vol)**
Mixed paper	10.4	21.4	41.3	17.2	9.5	24.7	trace
High grade paper	6.0	45.5		7.2	13.5	---	---
Cardboard	8.4	10.6		4.3	21.6	23.5	70.0
Newspaper	2.4	6.5		15.8	1.4	6.2	---
Magazine/ Catalog	1.6	2.4		4.3	2.7	---	---
Textile	0.4	---	2.0	1.4	---	---	trace
Mixed plastic	4.8	4.9	2.1	1.4	14.9	3.7	---
Marked plastic (#1-#6)	4.0	0.4		1.4	---	7.4	---
Film plastic	1.6	0.4		1.4	1.4	1.2	---
glass	20.7	---	7.3	12.9	1.4	2.5	---
wood	---	---	1.7	---	---	---	---
food waste	10.0	7.3	5.3	21.5	5.4	8.6	trace
polystyrene	1.2	0.4		---	1.3	2.5	trace
Aluminum	4.4	0.4		1.1	---	1.2	---
Misc. steel	4.4	---	6.0	---	4.1	---	---
Foil laminate	0.4	---		1.4	---	---	---
Aerosol cans	2.4	---		1.4	---	---	---
Batteries	0.8	---		---	---	---	---
Inerts (ceramics)	0.8	---	---	---	---	---	---
Yard waste (without grass cuttings)			21.5				
Other	15.5	---	0.5	8.6	23.1	---	20

*Housing percentages are wet weight estimates based on the composition of residential refuse in the City of Los Angeles.

**Percentage composition values for Building 640 are based on visual inspection only Source: City of Los Angeles, Bureau of Sanitation Study (City of Los Angeles, 1970-71).

***All data fall within ranges for each source generated, as reported in Schanche, Greep, and Donahue, October 1975.

9. shop
10. demil/repack operations.

Waste was not collected from the warehouse during this period because it had already been collected for the sorting project. The warehouse generates waste only sporadically, and must call to have its dumpster emptied.

Collection from the demil/repack operations—Buildings 640 and 403—is not regularly scheduled, but is requested on a call-in basis as needed. The researchers considered it important to establish some baseline data on this generator category while they had the opportunity, so they made it a point to include demil/repack in both the composition and weight studies. (Not all AMC installations have demil/repack operations—these operations are usually found only on Army depots.)

Incineration. Incineration is not used on SIAD for waste disposal, but Sierra does use open burning/open detonation (OB/OD) of propellants and ordnance on a seasonal basis.

Landfill. Sierra operates an on-post sanitary landfill, which has an estimated remaining capacity of 70 years based on the current rate of use. The remaining capacity is anticipated to change if the work load increases for the ammunition area, but there are no plans to construct or expand the landfill. Approximately 20 tons per week are landfilled (100 percent of the refuse collected by the DPW). Weights are not taken at the landfill, but truck scales are available in the cantonment area. Visual inspections by the landfill operator and the environmental staff are conducted to prevent hazardous waste or banned materials from entering the landfill. SIAD uses separate trenches for both asbestos and fiberglass ammunition packing material. A report sent to the California Regional Water Quality Control Board—Lohontan Region for the July to December 1991 monitoring period, documents the disposal volume as 5,572 cu yd; the area used for disposal as 0.1 acres; the total area used before and during the monitoring period as 10.6 acres; and the percentage of the total volume of the site used for waste disposal as 27 percent.

Sierra's landfill is exempt from many new EPA landfill regulations due to the arid climate and small volume of solid waste landfilled.

Discussion of Sierra Findings

1. SIAD currently does not offer educational programs covering recycling, reuse, composting, or source reduction. Education and awareness are the first steps in developing successful recycling programs. Sierra could greatly benefit by taking

aggressive action to increase awareness of source reduction and recycling options available on-post.

2. California AB 939 - 1989 requires cities and counties to develop recycling programs. Although the installation operates a recycling program, it needs to invest more in the program to reach the 50 percent waste reduction mandate by 2000. Currently, the SIAD recycling program employs only one individual, who is responsible for all collection, segregation, and storage of recyclable commodities. By investing more manpower and space for recycling, the installation feasibly could cut its waste stream in half by 2000.

3. A market analysis is needed to determine which commodities generated on base can be eliminated through recycling. Investigating opportunities to partner with other area counties to market commodities would be very beneficial.

4. Cardboard and office paper make up a large percentage of the waste stream, so recycling these items could increase landfill life significantly.

5. Sierra should begin tracking the weight of refuse collected on-post and landfilled quantities. Truck scales are already available on base for such purposes.

6. SIAD's remote location results in weak recycling markets. Therefore, the installation needs to emphasize source reduction, reuse, and composting in order to meet state regulatory goals.

Lone Star Army Ammunition Plant (LSAAP) Case Study

Overview of Lone Star Solid Waste Management Program

The following is a summary of facts about Lone Star Army Ammunition Plant pertaining to solid waste management, as gathered from the case study. Lone Star:

- is a GOCO facility with 1,302 personnel
- has no housing facilities
- does not procure products made with recycled materials
- offers educational programs pertaining to methods for waste minimization and overall environmental enhancement
- uses e-mail, styrofoam reduction in offices, duplex photocopying, paper reuse, and laundered shop rags as methods to reduce the waste stream
- does not collect recyclables or operate a recycling center

- is considering the acquisition of baling equipment for cardboard and paper products generated at the production facilities
- processes all scrap metal through DRMO
- generates a waste stream composed primarily of cardboard, packaging materials (paper and plastic), and office-type waste
- does not compost landscape or food waste
- has an active sanitary landfill on-post that is shared and operated by neighboring Red River Army Depot, and also has a rubble-only landfill.

Lone Star Case Study Findings

Lone Star Mission. LSAAP is located in the east-central portion of Bowie County, TX, approximately 12 miles west of Texarkana. The installation shares a common border with Red River Army Depot. Lone Star is a Government-Owned, Contract-Operated (GOCO) installation whose primary mission is load, assembly, and pack (LAP) operations for ammunition items. Day and Zimmerman, Inc. (DZI), is the contract operator of Lone Star.

General Information. Lone Star has only two active military personnel and 1300 civilian employees. There is no housing on base; the facility is strictly production-oriented. Lone Star anticipates a reduction in workload and personnel due to BRAC activities.

Procurement. LSAAP currently does not procure products made from recycled materials. Military specifications for packing ammunition is the only constraint on the purchase of recycled products. The purchasing department can buy products listed in the GSA *Recycled Products Guide*, but, at this time, the department makes no special requests for recycled products.

Waste Reduction/Reuse. Educational programs on solid waste management have been available on Lone Star for 5 years. The programs which are not mandatory, cover waste minimization, and its cost benefits, and overall environmental enhancement. The installation plans to continue these programs. E-mail, styrofoam reduction in offices, duplex photocopying, reuse of paper as note pads, and the laundering of shop towels are all practiced on Lone Star. Because Lone Star is a production facility without housing, the installation is not faced with small-scale hazardous waste generation and disposal.

Recycling/Composting. LSAAP does not operate a recycling center, but phone books are collected once a year by the Environmental Office. The participation rate is approximately 90 percent. The phone books are processed in Shreveport, LA at no cost

to the installation. The installation is trying to acquire funds to buy baling equipment to reduce the volume of paper and cardboard in the waste stream. Scrap metals and other commodities are also collected on the installation. Scrap quantities sold in 1992 through DRMO included 544 tons of ferrous metal, 22 tons of nonferrous metal, half a ton of plastic, 300 tires, and 34,000 lb of forklift batteries. Current market prices at DRMO are listed in Table 11.

Table 11. Recyclable materials and their respective market prices as quoted by the LSAAP DRMO.

Recyclable Material	Market Price
Clean Aluminum	$ 0.38/lb
Clean Brass	$ 0.70-0.75/lb
Copper	$ 0.85-1.00/lb
Stainless Steel	$ 0.40/lb
Aluminum	$ 0.50/lb (DRMO scrapyard price)
Steel	$ 0.40/lb (DRMO scrapyard price)
Lead	$ 0.30-0.40/lb

The total amount reimbursed to Lone Star was unavailable. The scrapyard conducts routine sales every Thursday. The 1992 revenue at the scrapyard was $62,000 (1992). The scrapyard operates with five full-time and one part-time employee. Ninety-nine percent of metal sold by the pound are processed through the scrapyard, while 90 percent of all items sold are processed through the retail shop. The retail shop consists mainly of government surplus items, and only installation personnel are permitted to purchase these items.

LSAAP's main waste reduction concern is the amount of wooden ammunition boxes generated. Personnel hope to get funding for a wood chipper to divert large quantities of wood from the landfill.

Solid Waste Collection/Transfer. Approximately 900 cu yd per month of uncompacted solid waste is collected on Lone Star. Covered semi-truck trailers are used outside the production line buildings for refuse collection. As they are filled, they are picked up and dumped. All trailers are picked up on call-in basis, so the collection route depends on the operation and productivity of production lines on LSAAP. Packing material consisting of cardboard and film plastics make up the bulk of production line waste. The transportation department hauls the refuse to the landfill. LSAAP's collection supervisor explained that they pick up half of the installation in rotation every day, but they pick up Area I everyday. Area I generates mainly office waste (e.g., high-grade paper, mixed paper, cardboard, etc.) Because Lone Star is contractor-operated,

it was impossible to alter the collection route in order to take weights for source-generated refuse without amending the contract.

The Lone Star solid waste collection system comprises the following routes:

- B line—6 trailers (M77 grenades)
- F line—3 trailers (gator, MOPMS volcano)
- G line—1 trailer (tracer, PEPs, pyrotechnic mixes)
- P line—1 trailer (detonator line)
- Q line—1 trailer (detonator line)
- R line—2 trailers(artillery primers).

In total, 14 trailers are dedicated to trash pickup. Occasionally, other trailers are added for special trash pickup needs. Offices waste collection is under janitorial contract and goes to the landfill.

LSAAP currently does not compost. A brush hog is used for mowing, and grass cuttings are left in place. The installation will begin composting wood waste if a wood chipper is acquired.

Incineration. LSAAP does not have an incinerator on-post and does not use incineration for disposal of solid waste.

Landfilling. LSAAP has a sanitary landfill on-post which is operated by neighboring Red River Army Depot. Both installations share the landfill. The current sanitary landfill was scheduled to close sometime in 1993, with a new one planned to open on Lone Star in October 1994. It has not yet been determined who will operate the new landfill. LSAAP also operates a rubble fill. The installation has closed two landfills in the past, due to capacity limitations, but has not had any closures due to regulatory requirements.

The current landfill accepts some construction waste. Tires go to the salvage yard to be retreaded, if possible, or recycled. Texas has a tire tax of $2 per tire, which is used to pay for recycling. The following is an inventory list provided by the landfill operator for the sanitary landfill: paper, cardboard, office waste, scrap coveralls, guard and fireman uniforms, barrier bags, plastic, liners, fluorescent glass tubes, glass bottles and broken glass, miscellaneous polyvinyl chloride (PVC) pipe and fittings, plastic tubing, commode seats, scrap wood, plastic jugs, wooden ladder, scrap fiberglass insulation, aluminum jacketing, gravel and felt from roofing, rubber pads, nylon tape with stiffener-plastic attached (plastic item), fire hose, scrap wood, styrofoam, buggy

wheels, empty cans, rags (nonhazardous), scrap wood utility poles (if not TCLP*-hazardous), pallets (non-PCP**), boxes (non-PCP). Medical wastes consisting of urine and blood—and anything that touches them—are disposed of offsite.

The estimated amounts of solid waste landfilled for FY92 are 36,173 lb in the construction fill and 2,345,624 lb in the sanitary fill. Lone Star does not generate any housing waste—most production areas generate cardboard and loose packing materials that are sent to the landfill uncompacted. Lone Star estimates are inexact because actual weights are not taken; the waste hauler's estimates for waste volume are based on percentage of truck van capacity used per load. Table 12 lists specific wastes and quantities in the sanitary fill.

Table 12. Waste types and quantities in Lone Star sanitary landfill.

Waste Type	Weight (lb)	Volume (cu yd)
Asbestos	26,025	43
Construction debris	18,000	30
Fiberglass	4,277	19
Paper	1,768,305	3,521
Rubber	210	0
Styrofoam	11,000	18
Wood	217,905	1,402
Other	499,648	1,193
Unspecified	109,165	191
Total	**2,654,535**	**6,417**
Source: Lone Star Landfill Report for 1992 (February 1993).		

Lone Star and Red River have conducted studies of how to reduce amounts of paper put into the waste stream. One study was initiated by Charles McMichael of Red River's Budgeting and Cost Accounting Branch. The study concluded that recycling retrievable paper products would have the following benefits:

- it would reduce the quantity of material landfilled in the RRAD-operated landfill, thus extending landfill life
- it would provide paper to be pelletized for the solid-fuel furnace at the Red River boiler plant, reducing the coal fuel requirements

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* TCLP: Toxicity Characteristic Leaching Procedure

** PCP: pentachlorophenol

- it would provide Lone Star employees with an opportunity to contribute to "Recycling for America."

Estimated values of weights of paper were 28,000 lb per week for Red River and 18,000 lb per week for Lone Star. The current price for cardboard at the time of the study was $40 per ton (in 35,000 lb lots). The study also estimated that an 8,000–10,000 sq ft building needed for storage would cost $300,000 (although this estimate seems excessive to the authors). Areas B-2, B-4, and B-44 were looked at as possible source generators of bulk quantities of waste cardboard on Lone Star. Area B-2 unpacks ammo components and disposes of the waste boxes into two trailers parked at an outside dock. Two unfilled trailer loads of loose cardboard and foil liners are deposited into the landfill daily. Area B-4 disposes of waste cardboard into a van at ground level next to the building. Less than a van load per day is accumulated for disposal at the landfill. Potential disposal cost savings for cardboard could be achieved with a recycling program. Buildings B-13, B-44, F-15, and F-26 were also inspected for waste cardboard generation. Lone Star is investigating the purchase of balers at some of these plant areas.

Market Analysis. Recycling markets were surveyed around the Texarkana area. The findings are presented in Table 13.

Table 13. Prices quoted by Texarkana-area vendors for key recyclables, 1993.

Recyclable Material	Market Price
Aluminum	$ 0.21/lb
Glass (clear or brown)	$ 0.50/100 lb
Tin	$ 1.50/ 100 lb
Cardboard	$ 0.50/100 lb
White ledger	$ 1.00/100 lb
Computer Printout (CPO)	$ 1.00/ 100 lb

Discussion of Lone Star Findings

Because LSAAP is a contractor-operated installation, it is somewhat difficult to institute progressive solid waste management practices. Nevertheless, it is subject to state and Federal regulations pertaining to solid waste management, and changes in procedures are required:

1. LSAAP must implement new policies specifying procurement of products made from recycled materials. Several paper-product alternatives are available in the GSA/FSS Recycled Products Guide.

2. Texas state recycling law HB 1340 requires all government organizations to develop recycling programs for at least aluminum, high-grade paper, and corrugated cardboard. Lone Star does not now operate a recycling program, but all three of the above commodities could easily be captured for recycling.

3. Lone Star is applying for funding for cardboard balers to be placed at the production facilities that generate the largest quantities. This would significantly help Lone Star capture cardboard for recycling, which would divert a large portion of the waste stream from landfills.

4. Lone Star would benefit by expanding employee education on solid waste management and implementing standard waste-reduction methods, such as styrofoam reduction in dining facilities and the purchase of standard pallets exclusively.

5. Two wood chippers operated by Red River could also possibly be used for Lone Star's wood waste.

Red River Army Depot (RRAD) Case Study

Overview of Red River Solid Waste Management Program

Based on the findings of this case study, the solid waste management environment at Red River Army Depot may be summarized as follows. Red River

- is an average size AMC installation
- shares a border with neighboring Lone Star Army Ammunition Plant
- hosts a tenant rubber facility that retreads Army vehicle tires
- does not anticipate any changes from BRAC
- does not procure products made with recycled materials
- does not offer educational programs encouraging source reduction or recycling
- uses standard waste-reduction methods such as e-mail, styrofoam reduction in offices and classrooms, duplex photocopying, standard pallet purchases, and an on-post thrift store
- operates a recycling center geared toward hazardous waste reclamation
- does not run a separate program for household hazardous waste, but attempts to collect hazardous waste at the generation point
- processes scrap metal collected through DRMO

- is trying to market the large quantities of recyclable cardboard generated on-post
- houses an on-post boiler plant that provides steam power for the installation including one boiler that burns wood chips
- operates two wood chippers to process large quantities of wood and wood pallets
- contracts for solid waste collection
- operates and shares the sanitary landfill located at Lone Star.

Red River Case Study Findings

RRAD Mission. Red River Army Depot occupies 35,000 acres with 1,385 buildings and 2.7 millions sq ft of covered storage. It stores a variety of vehicles and supplies, manages and demilitarizes ammunition, and maintains rebuild programs for the M-113 and Bradley combat vehicles. The depot operates a road-wheel and tank-track rebuild program unique in the United States. Many diverse operations are supported by the landfill.

General Information. Red River has 24 active military personnel and 3,639 civilian employees. Four of the military personnel live in BOQ/BEQ and 26 live in family housing, with a total of 65 dependents. RRAD does not anticipate a change in military mission from BRAC activities.

Procurement. According to the purchasing department, Red River does not procure products made from recycled materials.

Waste Reduction/Reuse. RRAD does not offer educational programs on recycling or solid waste management. Nonetheless, the base uses several source reduction methods: e-mail, styrofoam reduction in offices, duplex photocopying, exclusive use of standard pallet, and a resale shop. Red River uses the standard 40 by 48 in. pallet that is also used by Texarkana grocery markets, which enhances reuse possibilities. RRAD's resale shop is run by the Red River Army Depot's Women's Club. Fourteen volunteers run the facility which sells used items on consignment by item owners. The items received are ticketed and put on sale. If the items do not sell after 2 months they are transferred to RRAD property. If RRAD cannot sell the items, they go into a "nickel barrel." Finally, any remaining unsold items are donated to charity. The resale shop is not allowed to advertise, but sales have grown over the past 8 years. Proceeds from the resale shop are donated to United Fund Organizations and other charitable cases.

Red River operates 27 housing units, 26 of which were occupied at the time of this study. The installation does not collect household hazardous waste through dropoff

sites, but does make efforts to collect household hazardous waste at the generation point.

Recycling/Composting. The installation has operated an on-post recycling center with appropriated funds for 5 years. The center is staffed with six full-time employees, and it processes an estimated 7,380 tons of recyclables per year. The center accepts aluminum cans, rubber, canvas, electrical wire, computer scrap, metals, and precious metals. The center does not operate dropoffs, and does not pay recyclers for the material. No onsite processing is conducted at the recycling center; so the center does not use any processing equipment. The estimated annual cost to run the center is $100,000, with a return of $1,853,000 (calendar year 1992) from scrap metal sales through DRMO.

Red River has tried to sell cardboard on a term-sale basis, but the program was dropped because generation amounts did not coincide with the terms of the sale. Balers for cardboard had been placed at the supply area because of the high amounts that area generates. However, a lack of communication with DRMO caused the sale to terminate. RRAD tried to sell cardboard and paper bales a few years ago, but the program was dropped because the buyer would not accept bales containing carbon paper. Five stationary compactors are used in the supply area to collect mostly cardboard and plastic packaging material, which are currently landfilled. There is a large volume of retrievable cardboard that could easily be processed at generation sites to reduce the solid waste stream.

Red River purchased a wood chipper in the previous year to process broken wooden pallets. Then wood chips are used to fire one of the burners in the boiler plant on RRAD, providing steam for the installation.

Solid Waste Collection/Transfer. About 615 tons of waste are collected monthly and hauled to an on-post transfer station. The transfer station is at a central location where all dumpsters are brought to be picked up and landfilled. The landfill is about 2 miles away from the installation's cantonment area. Furniture, white goods, and tires are collected and separated from general refuse at the transfer station. Tri-State, Inc., is the contractor in charge of collecting and hauling the installation's solid waste. The contractor operates according to set routes and schedules. The researchers were unable to source-segregate and weigh Red River's solid waste. The annual cost of the waste-collection contract is $350,000.

Incineration. The installation has two inactive incinerators for demilitarization purposes. One is permanently closed and the other has been inactive for 2 years.

Landfilling. The installation operates and shares a sanitary landfill located on Lone Star Army Ammunition Plant, but the landfill has less than a year of remaining capacity. Lone Star has sited a new landfill that will also be shared with Red River, but it has not been decided whether RRAD will operate it. Approximately 1,411 cu yds of waste are landfilled weekly by RRAD alone. Because weights are not taken at the landfill, they can only be estimated. Daily and weekly inspections of manifest and the landfill are conducted by the environmental staff and landfill operator. Appendix E includes a landfill report, provided by the operator, which is categorized by source and type of refuse.

A static-pile composting method is used on the installation for leaves, trees, and brush. The compost is used for landscaping and is available to all personnel for home use.

Discussion of RRAD Case Study Findings

1. Due to regulatory requirements, Red River will have to alter existing procurement policies to mandate the purchase of products—specifically, office supplies—made from recycled materials. GSA/FSS Recycled Products Guide offers several alternative paper products made with recycled materials.

2. Given the small size of the Red River housing area, educational programs should be focused on installation personnel to increase awareness of recycling opportunities, source reduction methods, and reuse possibilities.

3. Waste reduction methods are already being employed at Red River. Increasing publicity for the onsite resale store would also help to reduce waste. Many individuals questioned for this case study did not know about the resale shop, or its positive impacts on installation solid waste reduction.

4. The installation's recycling center focuses on metal reclamation and resale. While these areas of recycling are important, it is also necessary for Red River to look closer at its solid waste stream. Large amounts of cardboard and office paper could easily be retrieved from the waste stream if personnel used the stationary compactors already located on the installation.

5. Red River's DRMO currently does not track money earned by the recycling center, broken down by commodity. The DRMO should conduct this kind of breakdown so the installation can accurately track recovery rates and revenues.

6. The use of a transfer station offers a good opportunity to pull recyclables out of the waste stream.

White Sands Missile Range (WSMR) Case Study

Overview of WSMR Solid Waste Management Program

The solid waste management environment at White Sands Missile Range is summarized below, as identified from the case study findings. White Sands:

- is an average size AMC installation
- does not anticipate any changes from BRAC
- has not taken steps to increase procurement of products made with recycled materials
- recently began offering educational programs on the benefits of recycling
- uses e-mail, duplex photocopying, and an on-post resale store as its only means of source reduction
- is considering implementation of a household hazardous waste minimization plan
- operates an on-post recycling center
- provides recycling dropoff containers around the post for collection of aluminum, tin, newspaper, clear glass, brown glass, and plastic
- processes all scrap metal generated on base at on off-post DRMO site
- does not compost landscape or food waste on-post
- handles solid waste collection in-house
- possesses a waste stream composed primarily of cardboard, paper, and residential-type waste.

White Sands Case Study Findings

WSMR Mission. White Sands is an outdoor laboratory consisting of a large complex of test ranges, launch sites, impact areas, and instrumentation sites, along with the support facilities required to develop and test missiles and rockets. WSMR is a GOGO installation located in south-central New Mexico, 26 miles east of Las Cruces.

General Information. White Sands employs 993 active military personnel, 4,433 civilian employees, and 3,375 contract employees. Twenty-five military personnel live in BOQ, 32 live in BEQ, and 1342 in Family Housing. WSMR does not anticipate any changes from BRAC, but cutbacks in the workforce are expected.

Procurement. The White Sands purchasing department does not currently request office paper or supplies made from recycled materials. The purchasing department orders office supplies through GSA. Currently, no steps are being taken to increase the procurement of products containing recycled materials.

Waste Reduction/Reuse. Educational programs on recycling and solid waste management began at WSMR over the past years. The programs are not mandatory. They have included school field trips to the installation recycling center, a public service television commercial, and White Sands Week. White Sands uses e-mail, duplex photocopying, and an on-post resale shop to reduce waste generation. A proposed household hazardous waste minimization plan includes many methods for source reduction and disposal of solid waste.

The plan would provide for the implementation of dropoffs and other reuse possibilities. Hazardous waste generated on White Sands is currently handled on a call-in basis by the environmental staff or the installation solid waste haulers.

Recycling/Composting. The recycling center has been in operation for approximately one year. The center staffs two full-time Non-Appropriated Funds (NAF) employees, both of whom received in-house training on recycling in general and the center's equipment (a baler and a can crusher). The center accepts computer printout, white ledger, colored ledger, newspaper, corrugated cardboard, aluminum cans, glass, plastic, and tin. Dropoffs are provided for aluminum, tin, newspaper, clear glass, brown glass, and plastic. The center also buys back aluminum cans at $0.20/lb. A 1.5 ton truck is parked at the commissary for cardboard collection. All wood goes to the scrap yard. Table 14 shows the amounts of various commodities processed in FY93.

The recycling center's annual budget is $297,000. The recycling center currently combines its commodities with those of Fort Bliss (located near El Paso, TX) before sale.

Recycling Collection. WSMR collects recyclables from housing, offices, clubs, dining facilities, the commissary, and the PX. For household collection there are dropoff bins that accept aluminum, tin, newspaper, clear glass, brown glass, and plastic. The amounts collected through this channel have not been tracked so far; collected

Table 14. Waste types and weights processed by White Sands Recycling Center, FY93.

Commodity	Processed Pounds
Newspaper	18,940
Corrugated cardboard	117,120
White ledger	44,492
Computer printout	46,400
Aluminum	19,038 (accumulated amount only)
Total	**240,590**

amounts are tracked by commodity only, not by source. Household dropoffs are serviced weekly by the recycling center staff. Staff estimates that about 1340 residents are served by the dropoffs, but the participation rate is only about 25 percent. Household recyclables are processed onsite. Aluminum, white ledger, and computer printout are collected from the office areas twice a week. Cardboard is collected daily from the dining hall, commissary, and PX. Aluminum, glass, and a small amount of office paper are collected from the clubs twice a week.

Plans for the recycling center include the possible addition of a flex employee, recruiting volunteers, conducting a curbside collection feasibility study that includes a pilot program using color-coded bags for different recyclables, and the purchase of tandem-axle utility trailers for collecting corrugated cardboard.

Table 15 lists the types and weights of scrap metal processed through DRMO. White Sands has generated approximately 150 tons of scrap metal since 1 October 1992. Additionally, 118,980 lb of paper were processed during the same period. Wood and lumber are given away because there are no solid markets for selling it.

WSMR does not have a composting program. The dry climate surrounding WSMR is not particularly conducive to a strong composting program.

Solid Waste Collection/Transfer. In-house solid waste haulers collect approximately 900 cu yd of solid waste on WSMR weekly. The waste collected is taken to the onsite landfill approximately 4 miles from the cantonment area. Housing, lumber, cardboard boxes, furniture, white goods, tires, construction waste, and special waste are all collected and separated from general refuse. The in-house collection staff includes five employees; all are qualified equipment operators, but only two drive the trucks. Three

Table 15. Scrap metal types and weights processed through White Sands DRMO.

Scrap Metal Commodity	Quantity Processed (lb)
Heavy steel (unprepared)	439,200
Light steel (unprepared)	246,600
Light steel	13,850
Aluminum (inert)	26,500
Aluminum (irony)	13,220
Aluminum (helicopter parts)	47,600
Copper and Lead (cable)	24,870
Steel (heavy rocket motors)	206,110
Total	**1,017,980**

regular 100 cu yd dumpster trucks, two 80 cu yd back-loaders, and one 80 cu yd side-loader are used for trash collection. The total in-house collection cost was unavailable.

Incineration. White Sands does not have an MSW incinerator and does not use a local or regional incinerator. The installation has no plans to consider using incineration for solid waste disposal.

Landfilling. White Sands operates a sanitary landfill on-post, with a remaining capacity of approximately 50 years. If new permits require liners, or if leachate regulations change, environmental personnel expect to make some changes to the landfill. About 175,000 cu yd (including contractor waste) are landfilled each year at the sanitary landfill. The results of a landfill waste-stream survey, conducted on contract for White Sands, can be found in Appendix F.

Market Analysis. Prices provided by recycling markets surveyed in the area surrounding WSMR are shown in Table 16.

Table 16. Local market prices for key recyclables collected at White Sands, 1993.

Recyclable Material	Market Price
Aluminum	$ 0.25/lb
Copper	$ 0.30/lb
Cardboard	$30.00/ton
White ledger	$ 4.50/ton
Computer printout (CPO)	$ 4.90/ton
Newspaper	$ 5.00/ton

Discussion of Case Study Findings

1. Because recycled-content products are available through GSA/FSS, the White Sands purchasing department could immediately begin ordering such products with no change to current procurement policy.

2. A proposed household hazardous waste minimization plan includes several opportunities to increase educational awareness on the installation and guide the implementation of such a program. The plan includes steps required to set up a household hazardous waste dropoff and offers alternative methods of retrieving hazardous waste for possible reuse.

3. Based on the amounts of recyclables processed onsite, the recycling center is significantly decreasing the amount of waste landfilled on-base. More education about recycling should increase participation across the installation.

4. Using less styrofoam in dining facilities would improve the installation's source reduction success.

5. White Sands' recycling efforts would benefit if amounts of various metals processed through DRMO were tracked separately by commodity.

5 Summary and Recommendations

Summary

Based on the findings of the survey and the five detailed case studies, AMC installation-level solid waste management programs vary widely from location to location. Most installations rely heavily on current regulations to guide the progression of their waste management efforts. However, while conducting the five case studies the authors observed that each program also reflects the personal preferences of the installation recycling coordinator, who plays an important role in making waste management decisions. The recycling coordinator is responsible chiefly for running and operating the installation recycling program, but the position also can be central to effective promotion of integrated solid waste management. The authors observed that the overall level of responsibility assigned to an individual recycling coodinator appears to directly affect the level of participation and overall success of several AMC installation recycling programs. Obtaining top-level support for new programs also strongly influences a program's long-term success.

General Recommendations for AMC Installations

The findings of this study make it clear that most of the following solid waste management recommendations are in use by at least a small number of AMC installations. Many of the recommendations are used by a considerable number of installations. The recommendations that follow comprise a set of core procedures and strategies that may be applied by any AMC installation to improve one or more aspects of its solid waste management program. The recommendations are organized under the headings of Source reduction, Recycling, Procurement, and Solid Waste Characterization.

Source Reduction

Because most source reduction methods require little change in staff procedures or behavior, and in accord with the waste management hierarchy discussed in Chapter 2, it is recommended that source reduction be considered the first step in improving solid waste management.

In offices:

- use two-sided copies instead of single-sided
- use discarded single-sided documents for drafts and notes
- reuse office supplies such as paper clips, binder clips, rubber bands, three-ring binders, etc.
- use electronic mail instead of paper interoffice memoranda
- reduce the number of routed copies by using routing slips instead of making multiple copies
- post information on announcement boards rather than distributing multiple copies
- purchase a plain-paper fax machine (thermal fax paper is not recyclable)
- donate excess office furniture and supplies to charitable organizations
- use reusable mugs rather than styrofoam products.

In office kitchens, post restaurants, and cafeterias:

- provide reusable mugs, utensils, and containers instead of plastic when feasible
- use bulk-packaged condiments rather than single-serving packets
- donate unused food products to charities and food banks.

In shipping and receiving departments:

- use two-way containers
- reuse pallets
- reuse foam packaging peanuts and bubble packs received with packages
- reuse newspaper as a packing material
- reuse plastic bags received for waste disposal or other purposes.

On landscaped properties:

- leave grass clippings on lawn where feasible
- compost collected grass clippings, leaves, and brush
- use compost as mulch, bedding, or soil conditioner

Basewide:

- encourage installation environmental staff to organize and exchange ideas for new source reduction opportunities
- involve managers and workers in all departments in the process of identifying new areas for source reduction.

Recycling

Launching or expanding a recycling program is recommended to enhance the value of the installation waste management program. A recommended sequence for planning a new recycling program comprises the following steps:

1. Appoint a recycling coordinator, who will be responsible for providing leadership, organizing a recycling committee, initiating a program kickoff event, publicizing the program, implementing initial and ongoing employee education, evaluating program progress on a regular basis, tracking program successes and needs, monitoring markets for new recycling opportunities, and managing employee efforts.

2. Identify sources, types, and amounts of recyclable materials in the waste stream. This involves determining the weight and volume of the waste stream by weighing waste containers, examining supply purchase orders, using waste generation rates from published sources and similar facilities, and reviewing waste disposal receipts and records.

3. Identify markets for recycled materials by interviewing the current waste hauler, other waste haulers, specialized recycling vendors, and county and municipal solid waste agencies. Community dropoffs or buy-back recycling centers may also accept collected recyclables.

4. Determine collection, processing, and storage requirements by evaluating where the waste and recyclables are generated, what types of containers are available for collection, potential locations for collection and storage of recyclables, and size requirements for collection containers based on generation rates at specific locations.

5. Conduct an economic analysis to compare the relative costs and savings of a recycling program.

Appendix G lists typical recyclable and unrecyclable materials in the commercial, industrial, and institutional waste streams (Illinois Department of Energy and Natural Resources 1991).

To launch a recycling program, it is necessary to develop contracts with haulers and markets for purchase, transportation, and processing of recyclables. Ongoing education and promotion of the program is recommended, and the program must be continually monitored.

Procurement

It is recommended that AMC installations immediately begin procuring items made from recycled materials in accord with Executive Order 12780, which includes policies that promote the purchase of designated items made from recovered materials. Table 17 lists recycled-content products available through GSA that are commonly applicable to everyday installation needs.

Solid Waste Characterization

To promote progress toward integrated solid waste management, it is highly recommended that installations with truck scales begin using them to track weights and composition of MSW landfilled. There are no current requirements for tracking actual amounts of MSW generated and landfilled, but with upcoming mandates on source reduction and recycling, tracking weights of MSW collected will greatly assist in analyzing the effects of both source reduction and recycling efforts on installations. Inaccurate estimates make it difficult to accurately conduct a solid waste characterization study of a particular waste stream. The tracking of recyclables and scrap metals sold is also necessary to accurately calculate the benefits of recycling programs and estimate the reduction in the waste stream. It is also highly recommended that all AMC installations track by commodity amounts of recyclables and scrap metals sold, as well as dollars reimbursed for each material.

Metric Conversion Factors

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 sq ft	=	0.093 m^2
1 cu ft	=	0.028 m^3
1 cu yd	=	0.7646 m^3
1 mi	=	1.61 km
1 lb	=	0.453 kg
1 ton	=	907.1848 kg
1 gal	=	3.78 L
1 psi	=	6.89 kPa
°F	=	(°C × 1.8) +32

Table 17. Products available through GSA made with recycled materials.

Type of Product	Product
Office Products	Photocopypaper Stationery, Including envelopes Continuous-feed printer paper Computer paper Non-thermal facsimile (fax) paper Business cards Card stock (for example, covers and tabs) Padded envelopes (that uses ground newspapers for padding) Corrugated boxes Kraft paper and bags Laser printer cartridges
Miscellaneous Supplies	Paper towels Toilet tissue Napkins Office furniture Wastebaskets Planters, picnic tables, and other outdoor furniture Compost
Construction Products	Plastic lumber Cellulose insulation (Made of treated, shredded newspaper) Wheel stops made with recycled plastics Roofing felt Rigid roof insulation Carpet made of recycled plastics Plastic pipe materials Glasphalt (asphalt using crushed glass in aggregate) Rubberized asphalt Aggregate from crushed concrete
Motor Vehicle Products	Recycled motor oil Retreaded tires Recycled antifreeze
Source: Camp Dresser & McKee Inc. 1991.	

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Appendix A: AMC Waste Survey Form and List of Participants

Survey Form

AMC MUNICIPAL SOLID WASTE SURVEY

Installation:_____
Survey filled out by:_____
Job title/position:_____
Mailing address:_____
_____
Phone # (commercial):_____
FAX #:_____

All questions in this survey are directed at Municipal Solid Waste (MSW) and specifically named special wastes only. Toxic and hazardous materials, other than those specifically listed, are not addressed by this study.

1.0 General Information

1.1 Number of Active Military Personnel:_____
1.2 Number of Dependents living on Base:_____
1.3 Number of Active Military living on base: BOQ/BEQ: _____
1.4 Family Housing:_____
1.5 Number of Civilian Employees:_____
1.6 Is there any anticipated change from Base Realignment and Closure? Y/N.
Please describe briefly _____
_____

2.0 Procurement

2.1 Does the installation purchase products made from recycled materials? Y/N.
2.2 If so, what types of products? (please list):_____
_____
2.3 How long have these products been purchased?_____

2.4 Are there constraints preventing the procurement of recycled materials? Y/N.

2.5 If so, please explain briefly:_____

_____

2.6 Are steps being taken to increase the procurement of products containing recycled materials? Y/N. If so, explain briefly:_____

_____

2.7 Is anything being done to reduce waste generation by influencing either individual buying habits or appropriated funds purchases? Y/N. If so, please explain briefly:_____

_____

_____

3.0 Waste Reduction/Reuse

3.1 Program Status/Plans

3.1.1 Are educational programs provided concerning Recycling/Solid Waste Management? Y/N.

3.1.2 How long have the programs been available?_____

3.1.3 Are the educational programs mandatory? Y/N.

3.1.4 What is covered in the programs:_____

_____

3.1.5 Are there plans for continuing education in the area of Solid Waste Management at the installation? Y/N. If so, please explain briefly:_____

_____

3.2 Operations

3.2.1 What methods are being used to reduce Solid Waste generation, specifically through waste reduction and reuse (some examples are e-mail, styrofoam reduction in schools and offices, duplex photocopying, resale shops, purchasing standard pallets only, etc.)? Y/N.

3.2.2 If the above examples apply, please circle; otherwise list existing methods below:_____

_____

Small-scale hazardous waste generation:

3.2.3 Is there a household hazardous waste dropoff? Y/N.

3.2.4 If so, is it a permanent site or opened for temporary periods throughout the year?_____

3.2.5 What is the estimated participation rate?_____

3.2.6 If there is not a household hazardous waste dropoff, are the hazardous wastes separated from the waste stream at any point? Y/N. Briefly explain:_____

_____

3.2.7 What methods are used to decrease the amount of household hazardous waste generated on the installation (some examples are paint swaps, information on less toxic substitutions, information on reuse possibilities, etc.)? (Please list below):_____

_____

_____

_____

4.0 Recycling/Composting

4.1 Recycling Processing

4.1.1 Is there a Recycling Center on the installation? Y/N.
4.1.2 How long has the Recycling Center been operational?_____

Skip the remainder of section 4.1 if the installation does not have a Recycling Center and currently does not compost.

4.1.3 How many employees work at the Recycling Center?_____
Number of part-time employees:_____
Number of full-time employees:_____
4.1.4 Is training provided for the employees? Y/N._____
4.1.5 Any planned changes for the Recycling Center?_____

_____
4.1.6 How many tons per year are processed?_____
4.1.7 Please mark all items accepted by the Recycling Center:
Computer paper, white ledger, colored ledger, newspaper, magazines, OCC (old corrugated cardboard), aluminum cans, metal(s), glass (clear/brown/green), plastics (HDPE/PET), other (_____)
4.1.8 Does the Recycling Center have dropoffs? Y/N.
4.1.9 What types of processing equipment are used at the Recycling Center?_____
4.1.10 Does the Recycling Center buy back any materials? Y/N._____
4.1.11 What is the estimated cost per year to run the Recycling Center?_____
4.1.12 What is the current status of the Recycling Center? (Denote with a X): generating profit breaking even losing money

4.2 Recycling Collection

<u>Household (if applicable)</u>:

4.2.1 What collection method is used? Curbside/Dropoff (please circle one).
What recyclables are collected?_____

_____
How much is collected?_____
How often is it collected?_____

4.2.2 Who handles collection?_____
What is the collection cost?_____
How many people are serviced?_____
What is the approximate participation rate?_____
4.2.3 Where are the recyclables processed? Onsite/Offsite (please circle one)
4.2.4 What is the estimated processing cost?_____

Office/Classroom:

4.2.5 What recyclables are collected?_____
_____
How much is collected?_____
How often is it collected?_____
4.2.6 Who handles collection?_____
What is the collection cost?_____
How many are serviced?_____
What is the estimated participation rate?_____
4.2.7 Where are the recyclables processed? Onsite/Offsite (please circle one)
4.2.8 What is the estimated processing cost?_____

Clubs/Dining Facilities:

4.2.9 What recyclables are collected?_____
_____
How much is collected?_____
How often is it collected?_____
4.2.10 Who handles collection?_____
What is the collection cost?_____
How many are serviced?_____
What is the estimated participation rate?_____
4.2.11 Where are the recyclables processed? Onsite/Offsite (please circle one)
4.2.12 What is the estimated processing cost?_____

Commissary:

4.2.13 What recyclables are collected?_____
_____
How much is collected?_____
How often is it collected?_____
4.2.14 Who handles collection?_____
What is the collection cost?_____
How many are serviced?_____
What is the estimated participation rate?_____
4.2.15 Where are the recyclables processed? Onsite/Offsite (please circle one)
4.2.16 What is the estimated processing cost?_____

PX:

4.2.17 What recyclables are collected?_____
_____
How much is collected?_____
How often is it collected?_____
4.2.18 Who handles collection?_____
What is the collection cost?_____
How many are serviced?_____
What is the estimated participation rate?_____
4.2.19 Where are the recyclables processed? Onsite/Offsite (please circle one)
4.2.20 What is the estimated processing cost?_____

Scrap Metals:

4.2.21 What scrap metal(s) are collected?_____
_____
How much is collected?_____
_____
What other materials are sold for scrap value?_____

4.3 Compost

4.3.1 Does the installation compost? Y/N.
4.3.2 What items are collected or accepted for composting?_____
_____
4.3.3 What type of composting is used? (Denote with a **X**)
___ static pile, ___ aerated static pile, ___ windrows,
___ aerated windrows, ___ in-vessel.
4.3.4 Is the finished compost used on the installation? Y/N.
4.3.5 How is the finished compost used?_____
_____

5.0 Solid Waste Collection/Transfer

5.1 Program Status/Plans

5.1.1 How much waste is collected per week/month? _____ yards/tons
5.1.2 How is installation SW collection done? Contract/In-house (please circle one)
5.1.3 Where is the SW taken? (denote with a **X**):
Transfer station, On-post/ Off-post
Landfill, On-post/ Off-post
5.1.4 Any planned changes? Y/N. If so, please explain briefly:_____
_____
5.1.5 If transfer station: any sorting (metals, cardboard, haz. waste, etc.), compactors used? Y/N.
5.1.6 What is the distance to the landfill? _____

5.2 Operations and Maintenance

5.2.1 What types of waste are collected and separated from general refuse? (Denote with a **X**):
housing, office, bulk, lumber, boxes, furniture, white goods, tires, construction waste, special waste, other (_____)

5.2.2 In-house Collection (if applicable):
Number of people:_____
Number of trucks:_____
How many times (per week or month) are the pickup sites serviced?
Please explain briefly:_____
_____
_____

5.2.3 Contract (if applicable):
Number and size of containers emptied per week:_____,_____
How many times per week are the pickup sites serviced?
Please explain briefly: _____
_____
_____

5.3 Cost

5.3.1 In-House (if applicable)
What is the estimated operation and maintenance cost per year for In-house Collection?_____

5.3.2 Contract (if applicable):
Contract cost:_____

Is landfilling included in this cost? Y/N.

6.0 Incineration

6.1 Program Status/Plans

6.1.1 Does the installation have a MSW incinerator? Y/N.

6.1.2 Does the installation's MSW go to a local/regional incinerator? Y/N.

6.1.3 Has the installation had an incinerator since 1971 that has since been closed? Y/N.

6.1.4 When and why was it closed? _____

6.1.5 Does the installation plan to:
Construct an incinerator? Y/N.
Use an off-post facility? Y/N.
In what year will the planned facility be used? _____

Skip the remainder of Section 6 if the installation's MSW is not currently or planned to be incinerated on or off base.

6.2 Operations

6.2.1 How much waste (per week, month or year) is incinerated? _____
6.2.2 What, if any, pre-processing (removal of recyclables, toxins) is done to the waste at the incinerator site? _____
6.2.3 What kind of incinerator is being used? (Denote with a **X**)
Mass Burn
Refuse Derived Fuel
densified Refuse Derived Fuel
6.2.4 What is the rated capacity of the incinerator (tons per day)?
_____
6.2.5 Where is the ash currently disposed? (Denote with a **X**):
On-post/ Off-post
Monofill/ Sanitary Landfill

6.3 Cost

6.3.1 What is the tipping fee?_____
6.3.2 What is the total facility cost?_____

7.0 Landfilling

7.1 Landfill Status/Plans

7.1.1 Does the installation have an active Sanitary Landfill? Y/N.
7.1.2 Does the installation have a closed landfill? Y/N.
When and why was it closed? _____
Was the closed landfill used for anything other than MSW? Y/N.
If so, what was it used for?_____
7.1.3 What is the remaining capacity of the landfill (in years) at the current rate of use? _____.
Is this anticipated to change for any reason? Y/N. If Yes, then what changes are planned? _____
_____
7.1.4 Does the installation plan to construct or expand a landfill? Y/N.
In what year will the planned facility be used? _____
_____

7.2 Operations

7.2.1 How much waste (per year, month or week) is landfilled? _____ yards/tons

7.2.2 Is the waste weighed at the landfill? Y/N.
7.2.3 What, if any, inspection is done for hazardous waste or banned materials at the landfill? _____
_____

7.3 Cost

7.3.1 For off-post landfills, what is the tipping fee? _____

7.3.2 For on-post landfills, has an equivalent cost (per ton or yard) been calculated? Y/N. What is the cost? _____

If additional space is required, please attach extra pages to end of survey, and mail or FAX the survey to:

USACERL-EPI
Matthew E. Snyder (217/373-3483)
P.O. Box 9005 (FAX# 217/373-3490)
Champaign, IL 61826-9005

List of Installations Participating in Survey

MSC	Installation
AMCCOM	Badger Army Ammunition Plant
	Crane Army Ammunition Activity
	Hawthorne Army Ammunition Plant
	Houston Army Ammunition Plant
	Indiana Army Ammunition Plant
	Iowa Army Ammunition Plant
	Joliet Army Ammunition Plant
	Kansas Army Ammunition Plant
	Lake City Army Ammunition Plant
	Lone Star Army Ammunition Plant
	Longhorn Army Ammunition Plant
	Louisiana Army Ammunition Plant
	Milan Army Ammunition Plant
	Mississippi Army Ammunition Plant
	Newport Army Ammunition Plant
	Pine Bluff Arsenal
	Radford Army Ammunition Plant
	Ravenna Army Ammunition Plant
	Riverbank Army Ammunition Plant
	Rock Island Arsenal
	Scranton Army Ammunition Plant
	Sunflower Army Ammunition Plant
	Twin Cities Army Ammunition Plant
	Volunteer Army Ammunition Plant
	Watervliet Arsenal
ATCOM	C.M. Price Support Center
	Natick Research, Development and Engineering Center
	St. Louis Army Ammunition Plant
	Stratford Army Engine Plant
CECOM	Ft. Monmouth Main Post
	Vint Hills Farms Station
DESCOM	Anniston Army Depot
	Corpus Christi Army Depot
	Ft. Wingate Depot Activity

	Letterkenny Army Depot
	Lexington-Blue Grass Army Depot
	Navajo Depot Activity
	Pueblo Depot Activity
	Red River Army Depot
	Sacramento Army Depot
	Savanna Army Depot
	Seneca Army Depot
	Sierra Army Depot
	Tobyhanna Army Depot
	Tooele Army Depot
	Umatilla Depot Activity
LABCOM	Adelphi (Harry Diamond Lab) Laboratory Center
MICOM	Redstone Arsenal
TACOM	Detroit Arsenal Tank Plant
TECOM	Aberdeen Proving Ground
	White Sands Missile Range
	Yuma Proving Grounds

Appendix B: RASA Case Study Data

Visual Inspection

A visual inspection of RASA refuse bins was conducted to evaluate waste stream characteristics and possible source generators. Table B1 includes building number and function and refuse composition information (volumes were estimated when possible). Building function was determined using the "Space Utilization Report Sorted by Building Number" report supplied to us by the installation DPW.

Table B1. Results of RASA refuse bin visual inspections conducted in January 1993.

Building Number and (Function)	Load Volume	Refuse Composition (some with percent volume estimates)
B5250 (Administrative)	N/A	high grade office paper, aluminum cans, and OCC.
B3629 (Administrative)	< 1/4 full	high grade office paper (30 percent), briar bush (50 percent), lunch waste, oil can, and newspaper.
B3618, B3619 (Supply)	1/2 full	OCC (20 percent), high grade office paper (60 percent), plastic wrapping, carbon paper, lunch waste, and wood.
S3616, S3617 (Medical Supply, Autocraft Shop)	1/4 full	plastic oil containers, OCC, newspaper, aerosol cans, oily shop rags, plastic (film) wrapping, paper towel, and used oil filters
B3613, S3614 (Administrative, Warehouse Supplies)	1 full bag of refuse	paper towel, lunch waste with styrofoam, newspaper, and some office paper.
B3651, B3652 (Administrative, Warehouse)	1 full bag of refuse and two OCC boxes	OCC box containing plastic cups in plastic (film) wrapping, OCC boxes, and a desk top.
B3653 (Backup Storage for Self Help Store)	< 1/4 full	paper towel, rubber gloves, lunch waste, and OCC.
B3654 (Warehouse)	N/A	six wood pallets behind building
B3660 (Soldering Shop)	empty	N/A
B3657 (Thrift Shop/ Consignment)	1/4 full	OCC boxes, metal hangers, and lunch waste.
B8027 (Administrative)	2 empty yellow computer paper bins	N/A
Cafeteria at B8027	1/2 full	OCC boxes and food waste.

Building Number and (Function)	Load Volume	Refuse Composition (some with percent volume estimates)
B8026, B8028 (Warehouse, Steam Heat Plant)	3/4 full	OCC (70 percent), plastic (canvas-like) covering, several 3-ring binders, office envelopes, and some wire strapping. Note: there was a pile of pallets behind B8028.
B8019 (Administrative)	< 3/4 full	tree limbs, office paper, lunch waste, and plastic containers
B8022 (Warehouse)	3/4 full	OCC, lunch waste (food and styrofoam), and trace of plastic wrap in B8022 bin.
B8024 (Warehouse)	< 1/2 full	OCC (90 percent), sawdust, and trace of paper.
S5415 (Warehouse)	3/4 full	office paper (70 percent), lunch waste, tree limbs, and paper towels.
B5427 (Oil/Water Separator)	full	mixed paper (70 percent), lunch waste, one housing garbage bag, plastic (film) wrapping, one OCC box, and two oil cans.
B5488 (Storage - Warehouse)	3/4 full	OCC and office paper (90 percent), metal office waste can, 30 air filters (new), lunch waste, and paper towels.
S5489	1/4 full	15 five-gallon plastic paint can with plastic lids, 15 sheets of pressed wood (12*12 in.), packaging paper, lunch waste, and misc. metal.
B5688 (Storage)	< 3/4 full	office paper (85 percent), OCC, and lunch waste.
B5297 (not included in Space Utilization Report)	< 1/2 full	office paper (90 percent), OCC (9 percent), and some plastic bags.
Thiokol Inc. (Manufacturing)	N/A	33 percent file folders and bond paper (boxed for office cleanup) and 66 percent standard office waste (high grade office paper, bottles, styrofoam cups, coffee grounds, etc.)
** "Lunch waste" includes such items as paper towel, food waste, styrofoam containers, coffee grounds, newspaper, etc.)*		

Source Generator Weights and Related Data

The RASA collection schedule was broken down into six basic source generator categories: Food Service, Commissary, BEQ/BOQ, Administration, Manufacturing, and Storage. These categories were then broken into sections by the SW hauler to make collection easier. Each category of waste included a list of buildings to collect refuse from and weigh separately. Therefore, the hauler collected each section and took the load to the Solid Waste Authority for disposal. The hauler then received weigh cards for each load. Table B2 represents the source generator categories, with coinciding tonnages and square footage values for each category weighed.

Table B2. Quantities of RASA solid wastes, by source.

Source Generator Category and date collected/weighed	Tonnage	Square Footage (a)
Food Service (1/13/93)	1.37	119,240
Commissary (1/13/93)	1.53	79,900
PX (1/13/93)	0.79	69,297
BEQ/BOQ (1/13/93)	2.27	549,192
Administration 1 (b) (1/13/93)	3.92	814,901
Administration 2 (c) (1/13/93)	4.05	1,211,019
Manufacturing (1/14/93)	2.74	383,318
Storage (1/14/93)	5.2	222,916
Administration 1 (d) (1/14/93)	5.99	1,497,323
Administration 2 (e) (1/14/93)	6.66	543,001
TOTALS	34.52	5,500,107

(a) *Square footage values for each RASA building were taken from the "Space Utilization Report Sorted by Building Number" document received from DEH.* (b) *The Administration categories were broken into two section by the SW hauler for collection purposes; Administration 1 (1/13) includes 45 buildings;* (c) *(1/13) includes Administration 2 15 buildings;* (d) *Administration 1 (1/14) includes 26 buildings; and (e) Administration 2 includes 38 buildings.*

After receiving the weights of refuse by each source generator, a correlation was calculated between tonnage and square footage. The first attempt at finding a correlation resulted in a positive correlation of 0.612885. Upon taking out the BEQ/BOQ (1/13/93), Administration 2 (1/13/93), and Storage (1/14/93) sections, a positive correlation of 0.780659 was found. Overall, there did not seem to be a direct correlation between square footage and tonnage generated by each source category.

Altered Collection Route—of SW Generated by Various Sources on RASA

Date: Wednesday, 13 January 1993

Source Categories	Building Numbers
Food Service	107,130,114,1500,3231,3438,3400
Commissary	3224
PX	3220,3240

BEQ/BOQ	3410,3411,3412,3413,3434,3435, 3436,3480,3481,3496,3497, 3498,3499,3500
Administration 1	111,112,376,3145,3148,3203,3206, 3207,3214,3215,3304,3306, 3308,3345,3348,3421,3437,3465, 3471,3483,3491,3495,3610, 3623,3627,3635,3636,3641,3650, 3651,3652,3655,3670,3707, 3708,3711,3714,3749,3775,3777, 4197,4381,4484,4488,4489
Administration 2	4500,4505,4566,4722,4803,4810, 4813,5201,5250,5400,5435, 7103,8022,8027,8973

Date: Thursday, 14 January 1993

Source Categories	**Building Numbers**
Manufacturing	7309,7338,7344,7347,7351,7352, 7354,7363,7368,7416,7420,7421, 7225,7471,7554,7571,7574,7576, 7601,7611,7612,7625,7649,7660, 7691,7627,7740,7742
Storage	3613,3614,3615,3616,3617,3619, 3629,5412,5421,5424,5487,5488, 5489,5493,5494,5497,5499,5510, 5568,5570,5573,7205,7235,7247, 7444,7443
Administration 1	4505,5127,5129,5250,5400,5410, 5428,5435,5438,5451,6160,7112, 7120,7132,7184,7142,7155,7156, 7158,7163,7290,7617,8022,8024, 8027,8038
Administration 2	1103,2575,2592,3222,3300,3309,

3320,3325,3328,3332,3338,3363,
3367,3422,3444,3448,3453,3454,
3489,3466,3467,3476,

3490,3531,3534,3542,3544,3548,
3554,3562,3568,3639,3646,
3652,3707,3777,4488,4489

Analysis of the Redstone Arsenal solid waste stream concluded that 74 percent of RASA refuse is office type waste, consisting of more than 50 percent high grade paper, along with mixed office paper and cardboard. Residential waste makes us the remaining 26 percent, not including rubble which is landfilled. An estimated 45 percent of family housing waste consists of paper products.

Appendix C: SIAD Case Study Data

WEIGH CARD

Waste Category Date_____

1 Barracks
2 Housing
3 Office
4 School
5 PX
6 Commissary
7 Shop
8 Downtown
9 Restaurant
* Break out 640
* Break out 403

Total volume capacity of cans _____ yd^3

Total (uncompacted) volume of cans _____ yd^3

Load (gross) weight _____ lb.

Tare weight of truck _____ lb.

Weather

1 Rain
2 Snow
3 Dry

Comments (predominant items, anomalies, etc.):_____

Figure C1. Sample weigh card used in SIAD case study.

Figure C1 shows a sample weigh card used by the driver taking weights for this study. (The weigh cards and collected data are on file with the AMC Environmental staff.)

Weights were taken by the SIAD driver over a two week collection period. The driver's standard collection route was altered to collect weights by source generator. Barracks with dining facility, housing, office, school, PX, commissary, shop, downtown,

restaurant, and buildings 640 and 403 made up the eleven source generator categories. Figure C2 illustrates the percent volume breakdown by source generator for the RASA waste stream. The weight to volume measurements taken by the SIAD driver were analyzed for a possible correlation. Volumes were measured in cubic yards, while weights were taken in pounds. A positive correlation coefficient of 0.977208066 was calculated, resulting in a correlation for SIAD volumes and weights of approximately [volume (62.2) = weight].

From analysis of Figure C2, the housing area, barracks with dining facilities, offices, and building 640 (demilitarization and repack) source generators make up 66.5 percent of the volume of the SIAD solid waste stream. From the hand sort conducted at the SIAD landfill as illustrated in Figure C2, we calculated estimated compositions of the SW stream by source generator. Residential waste based on national averages consists mostly of mixed paper products (41.3 percent), and yard waste without grass clippings (21.5 percent). The SIAD barracks with dining facilities consist mostly of glass, food waste, mixed paper, and cardboard. SIAD office waste predominantly consists of high grade paper, mixed paper, and cardboard. Building 640 houses demilitarization and repack operations and generates approximately 70 percent cardboard (by volume).

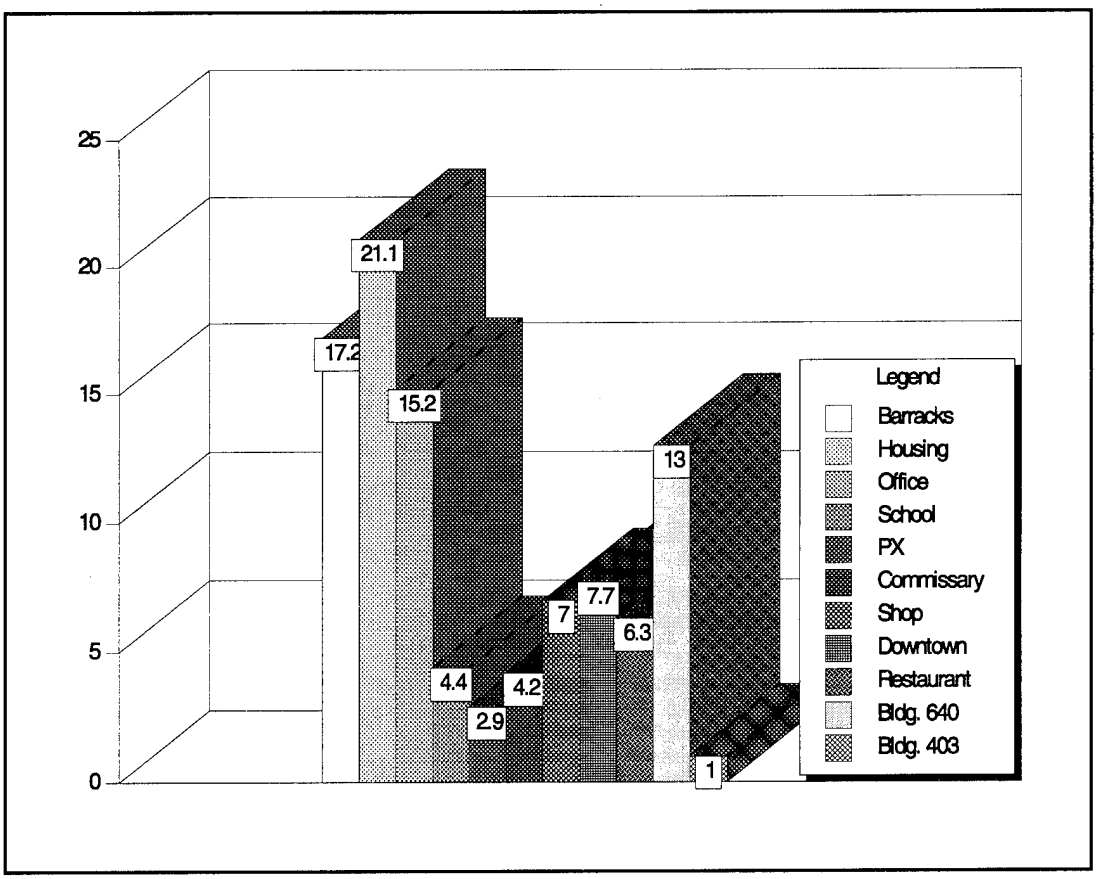


Figure C2. SIAD solid waste volume by source generator, as percentage of total waste stream.

Cardboard and paper products consist of a large percentage of the SIAD waste stream; therefore, source reduction methods concentrating in these areas and recycling programs designed to capture such items will inevitably significantly reduce the amount of solid waste generated and landfilled. The purchase of paper products containing recycled content will also greatly assist in saving valuable resources.

Appendix D: LSAAP Case Study Data

Table D1 summarizes Lone Star's landfill waste stream for FY92.

Table D1. LSAAP landfill report by source and type for FY92.

Waste Type	Weight	Total Yards	Loads
Asbestos	26,025	43	1
Concr/Constr debris	18,000	30	8
Fiberglass	4,277	12	7
Paper	1,768,305	574	2947
Rubber	210	0	0
Styrofoam	11,000	0	18
Wood	217,905	1039	363
Other	449,648	360	833
Miscellaneous	109,165	10	181
Totals	**2,654,535**	**1995**	**4424**

Records kept by LSAAP personnel resulted in 2,345,624 lb of uncompacted solid waste landfilled in the MSW landfill, and 36,173 lb of waste in the clean fill. Both of these estimates appear to be relatively low. LSAAP tracks waste volumes by allowing the driver to estimate the percent volume of the truck van capacity that was used for each uncompacted load. LSAAP truck vans, used for solid waste collection, are 35 cu yd vans; they estimate that a full 35 cu yd van would convert to a weight of 2,000 pounds. Weights are then calculated based upon the percent capacity of each van load. This method does not take into consideration differing densities of waste collected; therefore, resulting in only rough estimates of waste collected.

LSAAP is broken into several areas, 21 of which are serviced with solid waste collection. Table D2 presents each area, function, and estimated MSW amounts.

Table D2. Waste generation breakdown by LSAAP installation area.

Area	MSW Generated (lb)	Type of MSW	Square Footage
A	11,600	lumber, wood products	20,271
B	1,090,000	paper, OCC, styrofoam, barrier bags	244,031
D	26,690	paper, OCC, wood	269,625
F	484,600	paper, OCC, plastic, styrofoam	181,894
G	632,130	paper, plastic, OCC, office waste	235,442
H	9,852	plastic, OCC, insulation	177,507
I	250	plastic, wood, rubber, glass, office waste	279,406
K	1,100	OCC	98,251
M	150	glass jars	43,331
O	69,400	paper, OCC	82,701
P	10 ,815	paper, OCC, office waste, plastic	106,649
Q	13,640	paper, OCC	60,557
R	21,861	paper, OCC, barrier bags,	93,963
U	120,040	wood boxes	462,929
T	40	paper, OCC	37,167
W	3,000	scrap wood (dunnage)	156,761
U-V-W	2,500	wood pallets	733,487
ALL	86,120	paper	n/a
Demoli-tion	45	n/a	n/a
Plantwide	830	paper, plastic, wood	n/a
MWS	80	n/a	n/a
TOTAL	**2,584,743**		**3,283,972**

Table D2 MSW generation amounts were calculated from values taken directly from the Waste Disposal Cards used the waste hauler on LSAAP for FY92. Paper, cardboard, and wood products make up the bulk of MSW on LSAAP, all of which are easy targets for recycling. The elimination of these waste types from the waste stream would significantly reduce the amount of MSW landfilled by LSAAP.

Appendix E: RRAD Case Study Data

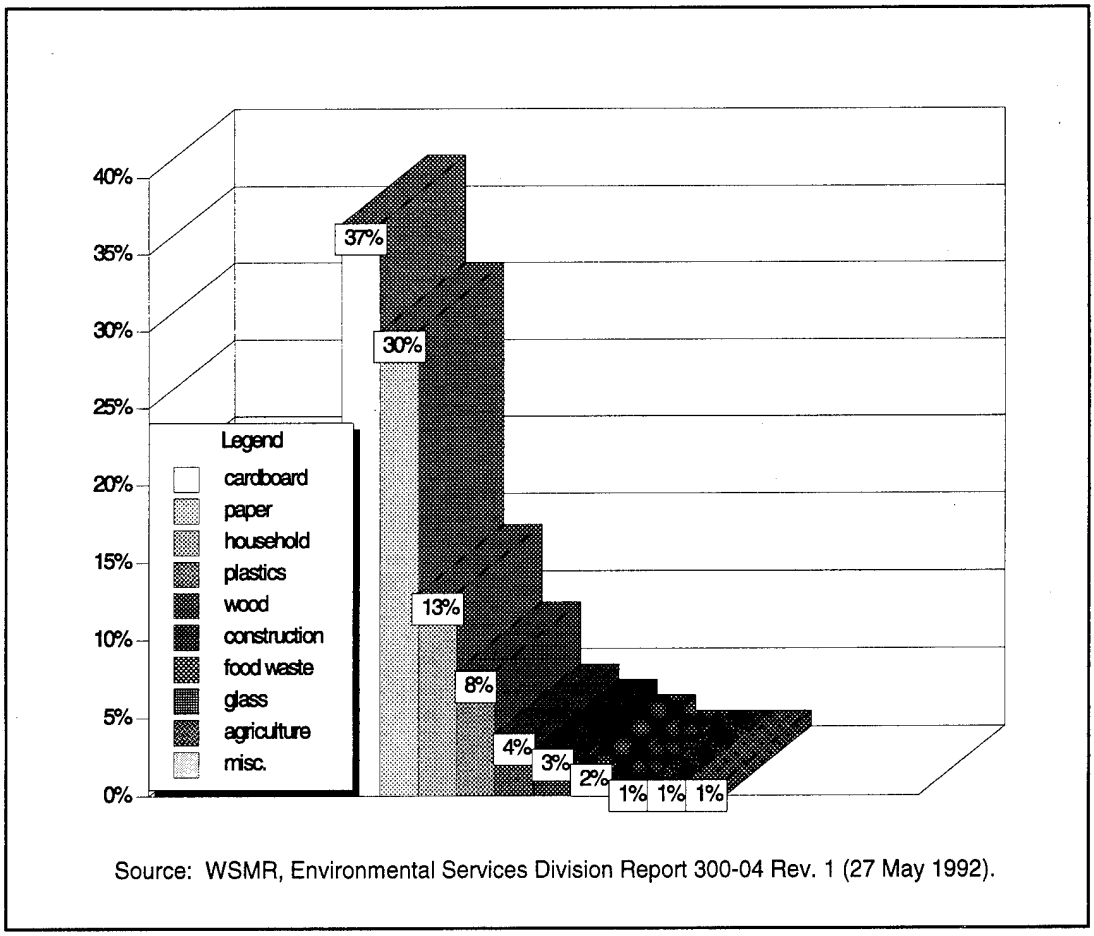
Table E1. Landfill report by source and type refuse for February 11, 1993.

Source	Type	Weight (lbs)	Volume (cubic yards)
AMMO	Concr/Constr	0	5
	Debris	0	98
	Other	154	1,464
	Paper	0	90
	Rubber	0	155
	Styrofoam	3,003	4,326
	Wood	0	120
	Wheel Abrator Resid		
	Total	**3,157**	**6,258**
CONTRACTOR	Asbestos	35,065	71
	Concr/Constr	0	9,003
	Debris	0	94
	Fiberglass	193	2,590
	Other	0	768
	Paper	0	49
	Rubber	0	5
	Styrofoam	0	1,955
	Wood	0	40
	Wheel Abrator Resid	0	377
	Miscellaneous		
	Total	**35,258**	**14,952**
DEH	Asbestos		200
	Concr/Constr		448
	Debris		6
	Fiberglass		421
	Other		157
	Paper		274
	Phosphate Sludge		7
	Styrofoam		95
	Sewer Sludge		1,427
	Wood		46
	Miscellaneous		
	Total		**3,081**
OL	Wood		2

Source	Type	Weight (lbs)	Volume (cubic yards)
MISC	Asbestos	37,614	63
	Concr/Constr	0	14
	Debris	0	3
	Fiberglass	2,000	640
	Other	3	1,195
	Paper	0	20
	Phosphate Sludge	3,290	29
	Rubber	0	87
	Styrofoam	0	16
	Security Containers	35	7,480
	Wood	0	65
	Miscellaneous		
	Total	**42,942**	**9,612**
TRI-STATE	Ash	0	1,740
	Concr/Constr	0	166
	Debris	0	4,905
	Fiberglass	39	438
	Other	3,298	22,582
	Paper	0	3,516
	Rubber	0	40
	Styrofoam	0	142
	Security Containers	0	20,707
	Wood	0	7,394
	Wheel Abrator Resid	0	996
	Miscellaneous		
	Total	**3,337**	**62,626**
SHOPS	Asbestos	16,025	27
	Concr/Constr	0	3
	Debris	1,000	261
	Other	3	785
	Paper	0	7
	Phosphate Sludge	103	907
	Rubber	0	28
	Styrofoam	4	3,708
	Wood	0	55
	Wheel Abrator Resid	1,000	89
	Miscellaneous		
	Total	**18,135**	**5,870**
	GRAND TOTAL	**102,829**	**102,399**

Appendix F: WSMR Case Study Data

White Sands Missile Range conducted a landfill waste stream survey, collecting a total of 49 landfill observation forms over approximately 1 month, excluding weekends and holidays. Figure F1 illustrates the different types of waste entering the landfill and their corresponding percentages. The greatest part of the WSMR waste stream consists of cardboard, paper, and household waste.



Source: WSMR, Environmental Services Division Report 300-04 Rev. 1 (27 May 1992).

Figure F1. Percent composition of WSMR solid waste stream (by material).

Appendix G: Typical Recyclable and Nonrecyclable Materials

Materials Typically Classified as Nonrecyclable

Waste Stream Category	Recyclable Materials
Offices & General	Paper White and Colored Photocopier Paper Cardboard and Chipboard White and Colored Typing, Writing, Letterhead, and Scratch Paper Computer Printout Paper (White Bond and Green Bar) Index Cards Newspapers, Magazines, and Books Tabulating Cards Envelopes Without Plastic Windows Telephone Books Adding Machine Tape Non-Paper Aluminum Cans Tin Cans Brown, Green, and Clear Glass Furniture Batteries Laser Printer Toner Cartridges Typewriter Ribbons
Schools	Paper (as listed above) Clothing School Directories Student Handbooks Polystyrene Foam Cups

Waste Stream Category	Recyclable Materials
Restaurants & Retail	Paper (as listed above) Aluminum Cans Aluminum Foil Brown, Clear, and Green Glass Bottles Milk Jugs Tin Cans Plastic Grocery Bags Polystyrene Foam Packing Material Plastic Pails
Hospitals	Paper (as listed above) Saline Solution Bottles Formula Bottles X-Ray Film Sterile Water Bottles
Source: Camp Dresser & McKee, Inc. 1991.	

Materials Typically Classified as Nonrecyclable

Self-adhering note slips
Paper with insoluble glue (e.g., copier paper ream wrappers)
Carbon paper and other sensitized paper
Glossy or slick paper
Binder clips
Blueprint paper
Rubber bands
Food wrappings
Napkins
Paper towels
Wax paper
Chemically coated paper, gummed or pressure-sensitive labels, adhe sives, and tablet bindings
Envelopes with plastic windows
File folders
Film and photographs
Thermal facsimile (fax) paper
Paper cups with wax coating
Tissues
Cellophane tape

(Source: Camp Dresser & McKee, Inc. 1991.)

Note: Local markets or future markets will possibly accept some of these materials either alone or as part of a larger category of materials (for example, mixed paper). It is important to check and monitor available markets to determine the full range of materials accepted.

Abbreviations and Acronyms

AB	Assembly Bill
AAP	Army Ammunition Plant
AD	Army Depot
AEPI	Army Environmental Policy Institute
AMC	Army Materiel Command
AMCCOM	Armament, Munitions, and Chemical Command
ATCOM	Aviation and Troop Command
BEQ	bachelor enlisted quarters
BFI	Browning-Ferris, Inc.
BOQ	bachelor officers' quarters
BRAC	Base Realignment and Closure
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liabilities Act
DESCOM	Depot Command
DOD	Department of Defense
DPCA	Directorate of Personnel and Community Activities
DPW	Directorate of Public Works
DZI	Day and Zimmerman, Inc.
EPA	Environmental Protection Agency
FFCA	Federal Facilities Compliance Act
FSS	Federal Supply Service
GOCO	Government Owned, Contractor Operated

GOGO	Government Owned, Government Operated
HDPE	high-density polyethylene
HHW	hazardous household waste
HQDA	Headquarters, Department of the Army
ISWM	integrated solid waste management
LABCOM	U.S. Army Laboratory Command
LAP	load, assembly, and pack
LCC	life-cycle cost
LSAAP	Lone Star Army Ammunition Plant
MACOM	Major Army Command
MICOM	U.S. Army Missile Command
MSC	Major Subordinate Command
MSW	municipal solid waste
MWC	municipal waste combustion
MWM	Military Waste Management
NOV	Notice of Violation
O&M	operations and maintenance
OB/OD	open burning/open detonation
OCC	old corrugated cardboard
PET	polyethylene terephthalate
PVC	poly(vinyl chloride)
PX	post exchange
RASA	Redstone Arsenal
RCRA	Resource Conservation and Recovery Act
RDEC	Research, Development, and Engineering Center
RRAD	Red River Army Depot
SIAD	Sierra Army Depot
TACOM	U.S. Army Tank and Automotive Command

TCLP	Toxicity Characteristic Leaching Procedure
TECOM	Test and Evaluation Command
USACERL	U.S. Army Construction Engineering Research Laboratories
WSMR	White Sands Missile Range
WTE	waste to energy

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