Field Study of Solid Waste Reduction, Management, and Disposal Issues at Fort Benning, Georgia

AEPI

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ABSTRACT

US Army installations are facing the problem of diminished landfill capacity in addition to increasingly stringent solid waste regulations at both the state and federal levels. Improved solid waste management practices are necessary to address this situation. In addition to the difficulties in implementing an effective integrated solid waste management plan, US Army installations face internal barriers to the implementation of the necessary corrective measures. The Army Environmental Policy Institute (AEPI) supports the Army Secretariat by analyzing environmental issues that may have significant future impact on the United States Army. The AEPI develops alternate policies and strategies to enable the Army to comply with future requirements.

The AEPI has recently commissioned a number of solid waste studies. This paper is a continuation of those studies, and is meant to provide detailed information through an in-depth case study of Fort Benning, with emphasis on the identification of significant management issues. Specifically, the focus of this project was to review and document existing policies; document current waste management issues, practices, and facilities; and find ways to improve coordination between those organizations involved in waste disposal, reduction, and recycling at Fort Benning.

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ACRONYMS

AAA	Army Auditing Agency
AC	Assistant Commandant
ACE	Assistant Chief of Engineers
AEHA	Army Environmental Hygiene Agency
AEHSC	Army Engineering and Housing Support Center
AEMIS	Army Environmental Management Information System
AEPI	Army Environmental Policy Institute
AER	American Energy Recyclers, Inc.
APC	Account Processing Code
AR	Army Regulation
ASA(IL&E)	Assistant Secretary of the Army for Installations, Logistics, and Environment
ASA(RDA)	Assistant Secretary of the Army for Research, Development, and Acquisition
BOSS	Better Opportunities for Single Soldiers (recycling group)
C&D	Construction & Demolition
COE	Corp of Engineers
CY	cubic yards
DAO	Defense Accounting Office
DCA	Directorate of Community Affairs
DCSOPS	Deputy Chief of Staff for Operations and Plans
DCSLOG	Deputy Chief of Staff for Logistics
DEH	Directorate of Engineering and Housing
DENTEAC	Dental Activity Command
DLA	Defense Logistics Agency
DoD	Department of Defense
DOIM	Directorate of Information Management
DOL	Directorate of Logistics
DOT	Directorate of Operations and Training
DPCA	Directorate of Personnel and Community Activities
DPW	Directorate of Public Works
DRMO	Defense Reutilization and Marketing Office
DRP	DoD Recycling Program
EPA	United States Environmental Protection Agency
FAC	Fiscal Action Code
FFCA	Federal Facilities Compliance Act
FORSCOM	Forces Command
FPMR	Federal Property Management Regulations
GSA	General Services Administration
MEDDAC	Medical Activity Command
MOI	Memorandum of Instruction

MRF	Materials Recovery Facility
MWR	Morale, Welfare, and Recreation
NAF	Non-Appropriated Funds
NAHB	National Association of Home Builders
OCC	Old Corrugated Containers
ONP	Old News Paper
POC	Point of Contact
RCRA	Resource Conservation and Recovery Act
RRRP	Resource Recovery Recycling Program
SSSC	Self Service Supply Center
TISA	Troop Issue Support Activity
TRADOC	Training and Doctrine Command

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CHAPTER 1. EXECUTIVE SUMMARY

Every day Americans throw away millions of pounds of garbage which ultimately is disposed of in a sanitary landfill. As old landfills close, the cost of hauling and dumping garbage to remaining landfills increases, making the importance of extending the life of existing ones more apparent. Disposal of municipal solid waste in landfills is drawing increased attention because of land value, potential health risks of improperly lined and inappropriately sited landfills, continuing liability, and the market value of items in the waste stream. Municipal solid waste management has great potential for reducing the amount of useful material that is discarded into landfills. Economically and environmentally sound alternatives of waste disposal must be developed to deal with the increasing waste stream and diminishing landfill space.

US Army installations are facing the problem of diminished landfill capacity in addition to increasingly stringent solid waste regulations at both the state and federal levels. Improved solid waste management practices are necessary to address this situation. In addition to the difficulties in implementing an effective integrated solid waste management plan, US Army installations face internal barriers to the implementation of the necessary corrective measures. The Army Environmental Policy Institute has commissioned several solid waste studies in an effort to identify solid waste management problems and solutions, including the following topics: source reduction trends and tools, approaches to waste characterization studies, barriers to improved solid waste management practices, the benefits of source reduction, cost-effective source reduction and recycling of non-hazardous non-municipal waste, and military participation with the private and civilian sectors for integrated solid waste management.

This paper presents an in-depth case study of Fort Benning, with the goal being the identification of significant management issues. Specifically, the focus of this project was to review and document existing policies, document current waste management issues, practices, and facilities, and to find ways to improve coordination between those organizations involved in waste reduction and recycling at Fort Benning. The information compiled in this study is to be used in the development of a model solid waste program for the Army. The following paragraphs briefly summarize several of the more important solid waste management issues encountered during the course of this research.

One of the Army's stated goals for solid waste management is to reduce the volume of wastes going to the landfill through waste minimization, resource recovery, and recycling [AR-200-1: 1-26.a(2)(d)]. Typically, yard waste comprises approximately 17% of the municipal solid waste stream by weight. Since Army installation waste streams are very much like municipal ones, a significant reduction of landfill disposal can be achieved by implementing a simple yard waste composting program.

A yard waste composting program can help solid waste managers meet mandated reduction goals. Due to the voluminous nature of yard waste, it has been shown that the diversion of yard wastes from a landfill can increase the life expectancy of the landfill by as much as 25%[1]. This extension of landfill life may be crucial for those installations that are rapidly approaching capacity limits on their existing landfills. Furthermore, composting is a beneficial way for wastes to be reutilized, and is relatively inexpensive to implement. Additionally, in most states there are relatively few regulations governing the implementation of a yard waste composting program. Composting of yard wastes can and should play an major part of solid waste management for the Army and should be implemented at all appropriate installations as soon as possible.

The Army should facilitate the yard waste composting program by disseminating the necessary information. Solid waste managers need to have a means of communicating the knowledge of what works for other bases and communities. In this way a network of successful composting initiatives can be built and can serve as models for those just starting their program. One of the best ways to learn how to build a strong composting program is to visit sites that have established programs, and to talk to as many people as possible.

Fort Benning Construction and Demolition (C&D) activities have produced significant amounts of waste. From September of 1993 to April of 1995, the monthly average of refuse from contractors and other authorized users going to the sanitary landfill was 1,023 tons[2]. Historically the most prominent disposal method for C&D debris at Fort Benning is landfilling. Fort Benning has yet to organize a permanent recycling effort of C&D debris. Fort Benning is currently demolishing several World War II barracks. These wastes are going to the landfill and rapidly depleting the remaining capacity. With the amount of construction and demolition performed on Army installations, a recovery program needs to be developed. It is very unlikely that a C&D recovery operation will be cost-effective for any installation. However, proceeds from the recycling program may be used to offset some of the costs of a program, and the avoidance costs and beneficial reuse of materials can be used to justify a program. Another alternative for construction and demolition debris is to look to regionalization. By working with the surrounding communities, Army installations can take advantage of economies of scale and make a C&D recycling program more cost-effective. The recommendations for C&D debris are summarized below[3]:

- Develop and implement advanced planning techniques for source reduction and recycling.
  - For construction projects: improve techniques for ordering appropriate quantities of building materials and work with suppliers to stock surplus materials.
  - For demolition projects: plan for the salvage of valuable building products prior to the onset of demolition, train workers on salvage techniques, and properly store recovered materials to prevent damage or contamination.
- Closely monitor materials entering the landfill to ensure that only materials that must be landfilled enter the site.

- Keep usable rubble products separate from other waste and deposit it at locations designated for each project.
- Use rubble products available on base when technically feasible as opposed to bringing in virgin materials from off-post sources.
- After reusing rubble on-post to the greatest extent possible, investigate off-post disposal alternatives.
- Require Fort Benning contractors to provide for the disposal of asphalt off-base.
- Integrate processing and marketing of C&D land clearing wood waste and clean untreated dimensional scrap lumber with yard waste processing operations.
- Keep treated wood separate from wood to be processed.
- To the extent possible, keep wood waste free of dirt and other debris.
- Direct contractors to keep wood waste segregated from other material and to transport these materials to the wood waste processing facility.
- Initiate a monitoring program to more closely determine the nature of metals currently being disposed.
- Assess the extent to which incoming metal can be diverted to a storage area at the demolition landfill or directly to DRMO for marketing.
- Instruct those involved in generation and transportation of metals to take clean loads to a designated location.
- Ban marketable metal grades from disposal in the landfills.

There are several areas of interest that have major implications in the recycling arena. One of the more important decisions that needs to be made by solid waste managers is identifying which items will be targeted for improved recycling rates. Typically, a waste characterization study is used to analyze the waste stream to determine composition. On Fort Benning the greatest "bang for the buck" in the recycling arena is going to come from recycling corrugated containers and paper. Paper is the major contributor to solid waste by either weight or volume. In 1990, paper typically constituted 34% by weight of waste sent for disposal[4]. Old corrugated containers (OCC) also comprised a large portion of the waste stream. Except for food and yard waste, OCC is still the largest single material category that we discard. In 1990, OCC comprised 8.1% of landfilled MSW by volume[5]. Without a waste characterization study, it is impossible to say conclusively what the percentages at Fort Benning are, but with the amount of paper and cardboard produced from the office areas and activities, the percent of paper and cardboard by weight is probably greater than the national average. This statement is true of Fort McPherson, where paper and cardboard was 41% of the total waste stream in 1991[6].

Fort Benning can greatly reduce its waste stream by targeting paper and OCC. Increased recycling participation from offices and activities is essential. The recycled paper market has been very good recently, and paper recycling programs have excellent potential for producing significant revenues. Fort Benning should look to successful recycling

programs that are currently working. Section 3.4 of this report discusses how Coca-Cola has achieved excellent recycling rates in its offices.

The most significant issue facing the Army in the area of household hazardous wastes is liability. The regulatory landscape has changed significantly over the past several years. The implications of the Superfund Amendments and Reauthorization Act (SARA) regulations add another dimension for decision-makers. The question that arises is, "Is it cost-effective to manage a possible liability or take the chance that the landfill will become a Superfund site sometime in the future?" Federal, state, and local landfill regulations are forcing solid waste managers to examine the contents of the loads more carefully before the loads enter a facility. Additionally, more attention is being paid to the amount of wastes generated, as well as the types of wastes. Fort Benning does not have a household hazardous waste program.

Various methods have been employed in an effort to mitigate the impact of hazardous wastes that are generated in the home. A common method is to have a hazardous waste collection day. Unfortunately these events are often poorly attended, and the costs become prohibitive when measured against the amount of pollution prevented.

There are four areas that must be given attention to put together a successful household hazardous waste program that maximizes the amount of pollution prevented while minimizing the associated costs. The four areas are public awareness, collection, decommissioning, and disposal[7]. Public awareness of this issue will be the first step in controlling household hazardous wastes for all installations.

Illegal dumping continues to be a problem for the Army. The Army seems to be satisfied with taking a "clean-up" approach to dealing with this problem. There is no funding for prevention or prosecution. As landfill space becomes more scarce, this problem is likely to become more severe and actions should be taken now to reduce it.

A significant management issue facing the Army is coordination among organizations. The bureaucratic nature of the Army and the fragmentation of responsibilities among several agencies creates significant barriers to effective solid waste management. To meet changing solid waste regulations, coordinated management of solid waste programs will be required, and new programs may be necessary. Coordination is mandatory to achieve waste reduction goals, material specific disposal bans, and environmentally sound disposal systems. To improve coordination, a solid waste management team comprised of the appropriate management level representatives from each of the organizations with solid waste management responsibilities should be established.

The Department of Public Works (DPW) is the obvious lead agency for the Solid Waste Team because solid waste management is DPW's responsibility. Furthermore it is the EPA's and most states' goal to reduce the solid waste stream through source reduction, reuse, recycling, and composting on a per capita basis. Since DPW, more specifically Department of Public Works Environmental (DPWE), is responsible for disposal, it has the most to gain

from reduction goal attainment both in reducing the cost of disposal and in saving landfill space for the future. By having DPW the lead agency of the Solid Waste Team, it could focus its efforts on improving solid waste management practices at Fort Benning. A secondary and less important function of the team would be to make recommendations for the disposition of excess recycle funds. The solid waste team should work to integrate a public education plan that integrates promotion and education activities pertaining to all solid waste, recycling, and salvage services. An integrated educational and promotional strategy will provide opportunities for delivering multiple service messages and minimize redundant communications. The opportunity for contradictory messages can also be minimized. The team should meet at regular intervals, quarterly at a minimum, and be available for special meetings as required. The team should agree on responsibilities and goals, and plan actions specifying who will perform specific functions. All results of these actions should be documented. Team members should discuss their interdependence and how potential conflicts are to be resolved. The major recommendations provided for public education are summarized below[8].

- Establish a public education plan that integrates promotion and education activities pertaining to all solid waste, recycling, and salvage services.
- Establish an annual planning process which establishes public education and publicity needs for the upcoming year. Plan should be developed in coordination with PAO, DPWE, and DRMO.
- Conduct a survey of recycling program participants to assess comprehension of program guidelines, levels of satisfaction, and other attitudes toward recycling programs.
- Expand recycling promotion and education to include barracks residents (bachelor troops) and commercial/institutional establishments.
- Establish a Benning-specific recycling logo and slogan and use it consistently on promotional and educational materials wherever possible. A uniform, consistent color scheme is also recommended.
- Develop messages that address all solid waste management services in an integrated fashion.
- Use pictures and graphics to help clarify the types of materials collected, their preparation, and the contaminants to be avoided. Design signs to coordinate with the printed materials to be prepared.
- Aggressively seek to gain coverage of recycling and waste reduction activities by the local television and radio stations.
- Assign a staff person the responsibility for coordinating all public education, outreach, and publicity.
- Establish a speakers' bureau to make presentations to neighborhood, environmental, and civic groups. Presentations and speeches should be expanded to include barracks residents and workers at on-post businesses and institutions.

- In addition to the existing special events and incentives, Fort Benning may want to consider:
  - Establishing a contest involving a cash giveaway to randomly selected households who participate in the recycling program.
  - Establishing discounts for admission to events for attendees who bring recyclables.
  - Creating a recycling "mascot" who makes appearances at special events and appears in T.V. public service announcements, brochures, photographs, etc.

Another area of concern is the relationship among organizations. There are potential conflicts between organizations with solid waste management responsibilities. This conflict stems from those instances when one organization must depend on another organization in order to carry out its mission, but has no control over the other organization. This problem is compounded when the other organization does not share the dependence to achieve its own mission. This relationship exists between the Directorate of Community Affairs (DCA) and the Defense Reutilization and Marketing Office (DRMO). DCA relies on the DRMO to market materials purchased with appropriated funds, receives the revenues from the sale of these materials, needs the revenues to continue operations, and can only hope that DRMO is getting the best prices they possibly can for materials. The DRMO, on the other hand, does not see the revenue from the sale of these materials and has little incentive, besides an altruistic one, to maximize revenues.

The Army is having serious problems implementing a municipal source reduction program. The U.S. EPA defines source reduction as any practice which decreases the quantity or the toxicity of solid waste before it enters the waste stream. Examples of source reduction activities include reducing per capita waste generation rates, eliminating toxins in packaging, using less material to make a package or product, and purchasing more durable products. Source reduction is addressed in the Department of Defense (DoD) directive 4165.6, which states that "the military is committed to a rigorous schedule of waste minimization and quantities of solid waste materials are to be reduced at the source whenever possible." However, there is very little source reduction being practiced at Fort Benning. Education seems to be a large barrier to source reduction. Many managers do not have a clear idea of what source reduction entails, and have been given no goals or direction on how to achieve it.

The most important factors limiting source reduction at Fort Benning are a lack of specific source reduction goals, and a lack of information on ways to achieve source reduction. Major commands need to develop a structure for implementing a source reduction program. Specific examples of source reduction activities that apply to most installations would be beneficial. Since source reduction goals are typically hard to quantify, it is harder to measure progress. A method for measuring waste avoidance through source reduction needs to be developed as a tool for solid waste managers on Army installations.

The recycling program at Fort Benning is currently diverting significant amounts of materials from the sanitary landfill, but there are several factors that are limiting higher rates of recycling. One of the most important factors is public education. Public education is the key to improved participation from all parties in the recycling. Special attention needs to be directed toward activities and office areas, as they produce large quantities of paper and cardboard which are still going to the sanitary landfill. The second and third most important factors to improved recycling rates are improving recyclable markets, and manpower. Fort Benning is currently trying to alleviate some of the marketing problems by going to direct marketing for certain items. This tactic will eliminate the problems associated with the DRMO.

Another issue facing the managers of Resource Recovery and Recycling Program (RRRP) activities is the tracking of funds. The Directorate of Community Affairs (DCA) relies on the DRMO to provide information on the amount and sale price of recyclables sold for accounting purposes. This information is provided to DCA on DLA form 1367. There have been problems in the past with incorrect information provided by the DRMO. This lack of correct information creates significant accounting difficulties and increases the complexity of running the recycling program. Additionally, the return time on accounts receivable is typically six months, and often is as long as a full year. This issue creates serious budgeting and operational problems.

Despite the solid waste management problems at Fort Benning, there are proactive personnel working hard to improve the system. There has been much improvement in the solid waste program in the last two years, including the implementation of yard waste composting this year. The Army has the personnel and the structure to effectively accomplish specific goals. Given the necessary direction and goals, Fort Benning could have a model solid waste program for other installations to implement.

CHAPTER 2. INTRODUCTION

Solid waste management is increasingly becoming a controversial responsibility facing state and local officials as well as private contractors. Solid waste management is concerned with the generation, onsite storage, collection, transfer and transport, processing and recovery, and disposal of the solid waste from a technological society[9]. Landfills today are filling up faster than new ones can be sited and built. Every day, Americans throw away millions of pounds of garbage, and most of the things thrown away end up in a landfill. As old landfills close, the cost of hauling and dumping garbage to remaining landfills increases, making the importance of extending the life of existing landfills more apparent. The average cost for dumping garbage at US landfills is about $30/ton. In many states this figure exceeds $100/ton[10].

Disposal of municipal solid waste in landfills is drawing increased attention because of land value, potential health risks of improperly lined and inappropriately sited landfills, continuing liability, and the market value of items in the waste stream. Municipal solid waste management has great potential for reducing the amount of useful material that is carelessly discarded into landfills. Economically and environmentally sound alternatives of waste disposal must be developed to deal with the increasing waste stream and diminishing landfill space.

US Army installations are facing the problem of diminished landfill capacity in addition to increasingly stringent solid waste regulations at both the state and federal levels. Improved solid waste management practices are necessary to address this situation. In addition to the difficulties in implementing an effective integrated solid waste management plan, US Army installations face internal barriers to the implementation of the necessary corrective measures. The Army Environmental Policy Institute has recently commissioned a number of solid waste studies. The studies were conducted mainly as surveys of several installations and addressed several aspects of the problem. These reports include *Source Reduction Trends and Tools for Use at U.S. Army Installations, Approaches to Waste Characterization Studies for Army Environmental Managers, Barriers to Improved Solid Waste Management Practices at U.S. Army Installations, The Benefits of Source Reduction, Cost Effective Source Reduction and Recycling of Non-Hazardous, Non-Municipal Waste at U.S. Army Installations,* and *Military Participation with the Private and Civilian Sectors for Integrated Solid Waste Management: Issues, Alternatives, and Recommendations.* This paper presents an in-depth case study of Fort Benning, with the goal of identifying significant management issues. Specifically, the focus of this project was to review existing policy, and to find ways to improve coordination between those organizations involved in waste reduction and recycling at Fort Benning.

Chapter 3 is a literature review providing a brief summary of current issues of interest to AEPI and Fort Benning. The case study of Fort Benning, which is the most significant part of this research, begins in Chapter 4.

CHAPTER 3. LITERATURE REVIEW

The following literature review is meant to provide a summary of current information on solid waste reduction, management, and disposal issues for several specific waste streams. The waste streams included here were chosen based on their typical weight percentage concentration to the total waste stream, or because of their prevalence on U.S. Army Installations. The main focus of the literature review was placed on current issues, practices, and trends in each area of interest.

3.1 Yard Waste

The problem of municipal solid waste management has been drawing attention nationwide. Landfills today are reaching their design capacity at a faster rate than new ones can be sited and built. In response, yard waste composting facilities are proliferating across the nation. With yard waste comprising approximately 17% of the municipal solid waste stream, composting can be an effective means to reduce landfill disposal and help organizations to meet mandated reduction goals. The diversion of yard wastes from a landfill can increase its life expectancy by as much as 25%[11]. Furthermore, composting is a beneficial way for wastes to be reutilized, instead of "disposed."

Composting is a nationally recognized method of safely and effectively converting organic wastes into a useful material. Composting is effective in converting a wide range of materials, including yard trimmings; food scraps; food processing byproducts; non-recyclable paper; municipal sewage sludge; and other clean, source-separated, decomposable organic material into marketable end products. Yard trimmings include leaves, grass, brush, stumps, and wood. Composting is one of many options available for citizens and public officials alike to expand and improve the process of reducing pollution while protecting the environment. Composting program benefits include holding the line on waste disposal costs, extending landfill life, saving natural resources, and reducing the environmental hazards and pollution related to burning and landfilling[12]. Composting of yard wastes can play an major part in solid waste management and is in line with the Army's effort of environmental stewardship.

3.1.1 Basics of Composting

Composting is the decomposition of organic materials by naturally occurring organisms in the soil. Composting occurs as microorganisms, mainly bacteria and fungi, decompose the organic material using the nutrients present as a food source[13]. What distinguishes composting as a waste management tool from a naturally occurring process is that it is carried out under controlled environments. The first and most basic principle of composting is that it is a biological process. A critical limitation, therefore, is the potential capacity and performance of the microbiological components. The biological limitations include: the presence of a suitable microbial population, the rate and efficiency of the microbial activity, the substrate being utilized, and environmental factors.

The major environmental factors affecting composting processes include oxygen concentration/aeration, moisture content, temperature, pH level, and nutrient concentration

and availability. The major chemical factor is oxygen concentration and availability of carbon, nitrogen, hydrogen, sulfur, and trace amounts of micronutrients. Carbon is used by microbes as a source of energy through metabolic oxidation, and as a component for cell synthesis. It is the oxidation of carbon that accounts for the greatest part of the loss of mass and generation of heat that are so characteristic of composting. Of the microbial macronutrients, nitrogen ranks with carbon in terms of its importance. Nitrogen is a major constituent of protoplasm. No microbial growth takes place without nitrogen[14]. The ratio of carbon to nitrogen (C/N ratio) is an important nutritional factor. Generally, the optimum ratio ranges from 19-30. When the ratio goes above 30, there is a corresponding slowing of microbial activity. At ratios less than 19, excess nitrogen is lost to the atmosphere in the form of ammonia, and the pH level may rise to inhibitory levels. Intermediate between macro and micro nutrients are elements such as phosphorus, potassium, and calcium. Usually these elements are present in adequate concentrations.

A commonly overlooked principle in composting is the limiting factor. The limiting factor may be defined as the one that is in lowest supply or is exhausted most rapidly. It thus becomes the factor that limits growth and activities of the organisms of interest. A corollary of the limiting factor is that unless each and every factor is adequately met, problems will arise[15]. Therefore, in the design of a composting operation, every nutritional, environmental, or operational need must be met.

Of the previously mentioned environmental factors, the most critical are moisture content, aeration, and temperature. Aeration and moisture content are interdependent. Air with oxygen contents greater than 5% are required for the microorganisms to sustain life, while moisture content of the composting pile is critical to the survival of the microorganisms present. Both moisture and air must occupy the interstices between composting particles. Because of this relationship, moisture content over 60% may cause oxygen deficiencies. Loss of oxygen content at high moisture contents can be corrected by aeration. Over-aeration tends to decrease moisture contents to inhibitory levels. Most modern composting processes are aerobic for three important reasons: first, aeration reduces objectionable odors; secondly, public health and crop safety come from the high temperatures that are the natural concomitants of a properly conducted aerobic compost operation; and finally, aerobic composting is more rapid than anaerobic.

3.1.2 Planning Issues

Planning is the crucial step in developing a successful composting program. Many issues must be addressed in the planning stages. The following is a brief discussion of several of these issues.

A first step in planning is to decide what materials are compostable, and which of these materials to include in the program. Compostable materials typically include leaves, grass, wood, brush, food, and paper wastes. The most common material in compost operation is leaves, and grass is sometimes added but requires more stringent management. Wood and brush are typically chipped separately. The regulatory and management requirements for the

composting of food and paper wastes makes these items harder to justify in the composting operation.

The volume of the materials to be composted must be estimated. Several of the planning factors are directly dependent on this estimation. It is important to take into consideration the effect of seasons on the amount of compostable materials being produced. For example, in the fall, leaves will account for a large percentage of the waste stream.

The method of collection must be decided. The three most typical methods of collection include drop off, curbside collection, and bulk collection. The method of collection will have a pronounced effect on the density of the material when it reaches the composting facility. One important factor to consider when choosing the method of collection is the type of existing equipment and collection. It is often possible to retrofit existing equipment for use in the composting effort.

The site selection process needs to take several issues into consideration. The site needs to be suitable for long-term composting that is cost-efficient and well designed. The location of the site should be strategically located to minimize the distance of the collection routes. Entrance to the site needs to be adequate for large vehicles and should not increase traffic in residential areas. Some possible sites that may be appropriate include: unused paved areas, such as parking lots; the buffer area of a landfill or wastewater treatment plant; the buffer area around industrial installations and institution; utility right of ways; and municipally-owned land used for buffer areas or storage[16]. The typical land requirements are dependent on the type of composting. Static pile composting occupies about one acre/8,000-12,000 cubic yards of incoming material compared to windrow and turn composting, which uses one acre/3,000-3,500 cubic yards of incoming material.

The compost pad is the largest portion of the site and is where the windrows are formed and the actual composting is conducted. A curing area is needed to allow the compost to stabilize before sending for the end use. In the curing piles, the need for oxygen decreases and the compost is recolonized by soil–dwelling microorganisms. Once curing has occurred, the compost will not generate foul odors.

The staging and processing area receives the most traffic and is the busiest area of the site. The traffic needs to be well managed to alleviate any problems of congestion and confusion. Space is required to unload incoming yard waste, mix and blend materials, chip brush, store reject material, shred compost, and load trucks for distribution. If plastic bags are separated from yard waste, they need to be collected and disposed of properly [17].

A buffer area must be provided to mitigate potential disturbances, such as noise, odor, and dust, to surrounding areas. Berms can be provided to help achieve noise reduction and visual screening of the site. Additionally, existing trees and topography should be utilized.

The sloping and grading of the site is important to handle year-round weather conditions. The minimum slope for a site is 1 percent, with the optimum being between 2 and

3 percent[18]. These slopes will allow for proper drainage and prevent erosion. The compost pad area needs to be graded to minimize ponding and to help maintain a stable base for equipment operation. Initial site preparation may require surfacing with gravel or compacted sand to allow for year-round use.

The separation of ground and surface water needs to be considered in the planning stage. Siting a facility within a 100–year floodplain is not recommended. The increased possibility of water on the site would create operational problems and could hamper the composting process itself. Additionally, leaching could become a source of contamination for nearby surface waters. The depth of the groundwater at the site should be a minimum of 24 inches throughout the year.

Soil percolation rates should yield a good infiltration rate to avoid standing water and potential leacheate problems. Low percolation rates can cause difficulties for equipment operations in wet seasons. Impervious surfaces such as concrete and asphalt offer advantages for vehicles and mud and dust prevention, but the additional run-off must be managed.

A water supply is needed to add moisture to the windrows and for fire protection. Sources for water could include fire hydrants, water trucks, and nearby lakes, streams, or wells. Another possibility for a water source is a holding pond that could be used for run-off collection as well as the water source for reapplication to the compost piles.

Security should be provided to prevent illegal dumping and to contain debris. Typically the site is fenced.

The end use of the product should be decided in the planning stage so that the marketability of the end compost product will be established. A market survey will ensure a product that is beneficial to the end users.

The program management of a compost site can be established in one of three ways: publicly owned and operated, publicly owned and privately operated, or privately owned and operated. The budget for the project will ultimately play a large part in controlling the planning and design of a compost facility, which are often constrained by the amount of capital available.

The process management of the site needs to be considered in the planning states. Once the type of composting process is chosen, the proper employee training and site monitoring is crucial to ensure a trouble-free operation. Employees should be knowledgeable of the entire composting process and understand how their specific duties affect the process.

Permits are now required by several states, and contact with local and state authorities will be necessary to comply with regulations. Typical permits require a plan which requires a schematic layout of the site, a listing of equipment and personnel with their qualifications, an explanation of the composting process, monitoring and record keeping techniques, provisions

for control of odors and leacheate, and a contingency plan if the composting program temporarily ceases[19].

Education of the public, or those participating in the program, is critical to the overall success of the project. Finally, during the planning stage, an implementation schedule needs to be prepared. Typically a leaf compost facility may take up to a year or more to select, design, and build.

3.1.3 Environmental and Public Health Impacts of Yard Waste Composting

The majority of those promoting composting assume that it is an environmentally benign process, without any data to confirm their beliefs. In the absence of data, the government regulators have proposed a wide range of constraints, including well and water setback distances, management restrictions, and in some cases even impermeable liners under the site. These restrictions appear to have been imposed without adequate regard to other mitigating measures. A study was performed to help provide some of the missing information about yard waste composting so that facilities can operate in an environmentally sound and economically efficient way. The study was performed at the Croton Park, New York, composting facility[20].

The study was able to demonstrate that municipal leaf composting can be practiced in an environmentally benign manner, but there are a few potential problem areas. For leaf composting, the primary concerns are BOD and phenol concentrations found in water runoff and percolation. These concerns can and should be mitigated through proper facility design and management. BOD and phenols are both natural products of decomposition, but the concentrated levels generated by large-scale composting should not be discharged into surface water supplies. Alternatives to surface discharge include such simple technologies as soil treatment, filter strips, or recirculation, so that sophisticated collection and treatment systems should not be needed.

These simple and low-cost treatment alternatives have been proven effective for a variety of wastewater's and organic wastes. Soil treatment forces the percolation of water through the soil profile, where these organic compounds can be adsorbed and degraded. Vegetative filter strips slow the motion of runoff so that many particles can settle out, while others are physically filtered and adsorbed onto plants. Recirculation would involve pumping the runoff water back into the compost windrows, where the organic compounds could further degrade and the water would be evaporated through the composting process. This last alternative should work very well during the initial stages of leaf composting, when water often needs to be added, but may not be appropriate if the moisture content of the compost was already high[21].

Compost facilities that handle high nitrogen material such as grass clippings need to ensure that excess nitrogen is not escaping in runoff. While many of the same simple treatment technologies described above would be effective for moderate levels of nitrogen, prevention is the best strategy. Maintaining the carbon to nitrogen ratio above 30:1 in the

initial mix should ensure low levels of nitrogen in runoff, and will also help minimize the odors which sometimes accompany grass clipping compost sites.

The current arbitrary restriction on the distance between compost sites and neighboring water systems does not account for either the nature of the material composted or the type of runoff treatment system. It may be possible to develop design and management guidelines that provide greater flexibility in sting facilities, and yet protect water quality even more effectively than at present. A number of other parameters were monitored in the study and do not appear to be a problem. Heavy metals and pesticides were found at concentrations well below the permitted levels. By designing sites which incorporate relatively simple water quality protection measures, compost facilities can become efficient without sacrificing environmental quality.

The major public health concerns of composting in general deal with the destruction of plant and animal pathogens. These concerns are most important and must be considered extensively when excretory wastes of humans or animals are composted. However, in yard waste composting the destruction of pathogens is generally not an issue. A specific public health issue that is associated with the design and operation of composting facilities for yard waste is the threat of a fungus called *Aspergillus fumigatus*[22]. The concern is that the fungus creates a risk of infection or allergic response. It is found throughout the world in common materials such as hay, grain, decaying vegetation, compost, and soil. The fungus is also found in commercial soil potting products and wood chip piles in the forest product industry. *Aspergillus fumigatus* was found to be the fourth most common mold in households present in all seasons[23]. Studies showed no trend to allergic response or infection of workers at compost sites in the United States versus those not involved in compost-related activities as determined by antibody methods. The lack of increased antibodies to *Aspergillus* supports the conclusion that, though *Aspergillus* colonization is more common in compost workers, infection with the organism is not.

One of the most significant aspects in the maintenance of good environmental and health conditions at a composting site is the provision of sound operator training. Coupled with good training is the need for good operation and maintenance manuals. These manuals need to be clear, concise, and specific to the facility[24].

3.1.4 Yard Waste Composting Methods

There are four common methods of yard waste composting: passive leaf piles, windrow and turn, aerated static pile, and in-vessel composting. The methods vary in equipment required, operation cost, land required, time to compost, and end product use. Each method has its own distinct advantages and disadvantages. The most common method for leaf composting is windrow and turn[25].

In passive leaf piles, leaves are deposited in piles ranging in height from 9 to 12 ft and are left undisturbed for a minimum of two to three years. Leaf piles that are too small (less than 6 ft high) should be combined. An optional measure is to turn and aerate the leaf pile in

the early spring or late fall. Although process management is minimal, the leaf piles should be maintained to avoid unsightly appearance and should be combined after there is a noticeable volume reduction from the original leaf pile size. Odor may be a problem when these piles are disturbed, as anaerobic conditions may exist in the oxygen starved center of the pile. Because of this factor, wind directions should be considered before work on the piles is undertaken. Compost consistency for end use is fair, as this method of composting may retain clumps of uncomposted leaves.

In the windrow and turn method, leaves are deposited on a compacted pad to form a triangular-shaped windrow measuring 10 to 20 feet at the base, with a height of 6 to 12 ft or higher. The windrow length can be up to several hundred feet long or as long as the site allows. In this process, the windrows are turned periodically with a front-end bucket loader or a special turning machine and water is added as needed. The frequency of windrow turning is determined by the temperature and moisture content in the windrow. Windrows are combined as they shrink in size. The leaves compost through the winter and spring, cure over the summer, and are available for end use by the end of the next collection season. The finished compost can be removed from the composting site to make room for incoming leaves. The consistency of compost for end use is good, as periodic turning will result in fewer clumps of undecomposed leaves.

The use of specialized windrow-turning machines improves aeration, resulting in a shorter time requirement for composting. The turning machine is either self-propelled or machine-driven. If machine-driven, it is important that the drive method selected be properly matched to the machine. The selected machine limits the windrow height from 5 to 7 feet. Windrow width varies from 14 to 18 ft to give a trapezoidal-shaped pile.

In the aerated static pile, the windrow configuration is similar to that described for windrow and turn except that the windrow is stationary (static pile) and has a base of wood chips or some other porous material. Since the leaves are not turned in this process, it is particularly important that non-compostable materials are removed before windrow formation. The leaves are also put through a tub grinder or shredder before forming the windrow. A perforated plastic pipe is placed over or in the base material and air is forced through the pile into leaves using an air blower. After the windrow is formed, a 4 to 6 ft layer of compost, wood chips, sawdust, or an equivalent porous material is placed over the pile to help retain process heat, moisture, and odor. In order to manage windrow temperature, the air movement is controlled either by a timer switch or manually. Experience with this method for composting leaves is limited. Generally it is used for sewage sludge composting.

In-vessel composting encompasses a variety of systems involving mechanical agitation, forced aeration, and enclosure within a building. These systems are designed and supplied by consultants or commercial suppliers. They are generally not economically feasible for composting leaves alone, but may be appropriate if sludge disposal is an issue. The advantages include fast processing, avoidance of weather problems, and better process and odor control[26].

An alternative way of describing yard waste composting methods is by the level of technology. There are four levels of technology: minimal-level, low-level, intermediate-level, and high-level. The actual processes are very similar to the four methods described above. The minimal-level technology is similar to the static leaf pile method. It is a low-cost alternative, requiring more land but less labor and capital. A large buffer zone is needed since the compost piles will probably become anaerobic and cause foul odors.

The low-level technology corresponds to the windrow and turn method, with the exception that only front-end loaders are used to turn the compost. This level of technology is the most common method of composting yard trimmings. The overall objective is to have windrows of sufficient size to ensure temperatures that are high enough to decompose the material while at the same time keeping the size small enough so anaerobic conditions do not occur. A smaller buffer zone is required since the frequency of turning will decrease the possibility of odor problems. The land area required for the actual composting process is larger due to the formation of windrows.

Intermediate-level technology is also similar to the windrow and turn method. The major distinction from the low-level technology is that intermediate-level technologies use windrow turning machines which can straddle the windrow or can be pulled by a front-end loader down each side of the windrow. Since turning machines are used, the total time to produce a finished product is reduced from six to four months. The windrow sizes are limited to smaller dimensions to accommodate the equipment, thus increasing the land requirements.

High-level technology incorporates a forced aeration system with intermediate-level technology operations. The composting process is started by adding moisture and nitrogen to speed the process. Windrows at least ten feet high by 20 feet wide are formed and aerated by forced pressure blowers at the base. After composting for 2-10 weeks under these controlled, optimal conditions, the automated system is removed. Other organic material can be incorporated using this type of technology. Food and paper waste can be incorporated into the process, although at this time many companies and communities have chosen not to add these wastes.

3.2 Food Wastes

Food wastes have traditionally been disposed of in the municipal solid waste stream. Recent efforts in the composting of municipal solid wastes has met with several problems, including unacceptable proportions of inorganic materials and heavy metal concentrations. Source separation of food wastes and other organics for composting has grown in part due to the desire to manufacture higher quality composts. Food wastes consist of a wide variety of kitchen wastes, vegetable wastes, and food processing scraps. These wastes can vary widely in their characteristics and many will be too wet to have the necessary porosity needed for composting. In these cases a bulking agent will be needed or dewatering could be used to help reduce the amount of bulking material required. Others may need grinding to help reduce particle size[27]. The composting of source–separated organics has been successful at over 40 different plants in Germany and is now being employed in the United States and

Canada[28]. The organic waste source separation movement appears to be a variation on the well-established industry of municipal solid waste composting. It is apparent that the shift was caused by public demand for quality compost, particularly the demands of agriculture and home owners for composts which are unquestionably compatible with production of food production for direct human consumption. This public demand for "clean" composts may indicate an inherent distrust of the pollutant levels embodied in compost quality regulations of government[29].

Those that mistrust pollution levels set for composts are also suspicious of compost which is produced from mixed composting programs, even though there has been limited research on such variations in compost quality. However, studies have indicated that heavy metal content from organic waste lies far below permitted limits for metals in agricultural topsoils, and that separation at the source provides a compost with low levels of contamination for both heavy metals and organic pollutants[30]. These findings are expected to open markets in agriculture, forestry, nurseries, and household uses.

There are several Canadian communities, ranging from Metro Toronto's $2 million back yard composting effort, to weekly curbside collection in Ryley, Alberta, that are successfully composting food wastes. Ryley, a rural village to the east of Edmonton, has 200 households that are converting 30,000 pounds, or 30% of the waste stream into compost. The product is eagerly utilized by residents for vegetable and flower gardens. Food waste, except for meat and bones, is kept separate from the rest of the garbage and then collected weekly. After shredding, the waste is windrowed on a concrete pad, turned by a front-end loader for two weeks, and then cured for four weeks before being distributed for end use. Food wastes are stockpiled in the cold winter months, and no problems with vermin or other animals has been reported. No permit was required by the local government (in Canada).

The town of Mississauga, Ontario, has started a food waste composting pilot program with about 1,200 households, including five townhouse complexes to test techniques and equipment for curbside collection of food wastes. The pilot study has shown participation rates as high as 76% last August, but only 46% in February. Speculation is that homeowners may participate more during the yard waste season, even though Mississauga wants to collect food waste during the winter.

On a larger scale, there have been at least two food waste composting projects in the Metro Toronto area, one with backyard composting bins and the other a curbside collection from households. The curbside collection was conducted by Pollution Probe for 72 households for eight weeks during 1988. Collection was once each week with two vehicles, one for wet material, and the other for dry wastes and recyclables. An ongoing backyard composting program is also being sponsored by Metro Toronto, with 20,000 backyard composters distributed to residents in 1990, for a total of about 10% of the households in the region. The cost of the containers was over $2 million, with residents being asked to contribute $25 to units that sell for $100. The success of the program is still being assessed.

At the Frost Valley YMCA in Claryville, New York, James Marion is heading an environmental education center that has set up an aerated static pile for composting a mix of food waste combined with paper and wood chips. The compostable wastes from the kitchen and dining area are brought to the composting facility, where they are sorted to remove any plastic, metal, glass, or other non-compostable material. Wastes are shredded and placed in a mixer with additional components (such as wood chips, water, etc.) that will make up the aerated static pile. After 5 weeks the pile is broken up and screened to remove larger particles. The coarse fraction is mixed with new waste for further composting. The process is housed in a 100 by 45 ft building, and the waste to compost process is expected to take about 6 weeks. It has been estimated that 25% of the current waste can be recycled in the composting process[31]

It is clear that the composting of food wastes is an excellent alternative to landfilling. A cost/benefit analysis is needed on a case-by-case basis to assess the feasibility of implementing such a program.

3.3 Construction and Demolition Debris

Construction and Demolition (C&D) activities produce a significant amount of waste. The construction of a single family home can produce as much as seven tons of debris, and this is just a fraction of the 45 million tons of C&D debris generated annually in the United States[32]. Construction and Demolition debris is defined by the New York State solid waste management regulations (6 NYCRR Part 360) as uncontaminated solid waste resulting from the construction, remodeling, repair, and demolition of structures and roads; and uncontaminated solid waste consisting of vegetation resulting from land clearing and grubbing, utility line maintenance, and seasonal and storm-related cleanup. Such waste includes, but is not limited to bricks, concrete and other masonry materials, soil, rock, wood, wall coverings, plaster, drywall, plumbing fixtures, non-asbestos insulation, roofing shingles, asphaltic pavement, glass, plastics that are not sealed in a manner that conceal other wastes, electrical wiring and components containing no hazardous liquids, and metals that are incidental to any of the above. There is an industry consensus that more than 50% of these materials are recyclable[33]

There are several prominent problems facing the recovery of construction and demolition debris. A major obstacle to recycling the construction waste stream is the segmented nature of the construction industry and the large number of small companies. Changing the practices of many small companies, most around 10 employees, is a daunting proposition[34]. Demolition sites generally have fewer contractors on-site and are easier to organize. The demolition debris is usually commingled and therefore requires more processing. Another problem is the lack of space for sorting and storing recyclables. Bins are usually accessible to the public and often contaminated by unauthorized dumping. An even larger concern is the prevalent attitude among contractors that landfill space is limitless. The typical contractor does not view the waste as either a problem nor an opportunity, with the cost of disposal simply passed to the client.

Perhaps the most significant barrier to C&D recycling is the lack of established markets. An obstacle to the establishment of dependable markets is the lack of reliable information on C&D waste compositions and volumes. The 1988 report by Franklin and Associates, "Characterization of Municipal Solid Waste in the United States," lists C&D with "other wastes," not included in their estimate of waste types. This is probably partially due to the variability of the C&D waste stream, given that the activities that produce the waste are largely driven by economic conditions.

Canada is taking steps to address this problem. The Council of Ontario Construction Association (COCA) and the Toronto Home Builder Association (THBA) have both been involved in collecting and distributing this type of data. THBA has published *Making a Molehill out of a Mountain*, which is a study of residential construction waste composition, source separation, and 3R opportunities. The study also lists firms presently recycling construction wastes. Continued work by the COCA includes plans to work with architects, engineers, and suppliers to minimize waste generation through optimization of source separation, and education of the industry. Another goal is to quantify the construction demolition waste stream so that data needed for developing recycling and reuse markets can be gathered.

The United States is facing its own problems with C&D debris. There has been a rampant increase in the amount of illegal dumping, particularly in the Northeast. One explanation for the recent increase in illegal dump sites is that the previously used legal landfills are being shut down. In the Northeast, closure of landfills and inability of solid waste incinerators to handle and combust many of these materials have added to the problem. Many states are also requiring lined landfills for leacheate collection for new C&D landfills, making it more expensive to site new facilities. In addition to the added expense, there is growing public opposition to new landfills for C&D because of concerns over traffic and pollution. Whatever the reasons, back roads, particularly in state forest lands, are receiving a substantial amount of these materials. To help address this issue, the EPA and National Association of Home Builders (NAHB) Research Center are working together to evaluate techniques and technologies for improved handling of C&D debris. The issues they are addressing include reducing the amount of C&D generated, recovering C&D materials, and encouraging the development of markets for products made from reclaimed C&D materials. The research hopes to demonstrate that it is financially attractive to reduce and recycle up to 50% of the C&D waste generated.

There are a number of existing C&D recycling operations that are overcoming many of these problems. There are recycling operations in New Jersey, California, New York, and Pennsylvania. The primary materials being handled are stumps, asphalt, and concrete. Using crushing, shredding, and screening equipment, both stationary and mobile, the stumps are converted into wood chips, topsoil, and mulch. Asphalt and concrete are converted into crushed aggregate for use as stabilizer, select fill, asphalt blends, and road base. Several states have experimented with recycled concrete as pavement, roadbase, and shoulders[35].

The government could promote the recycling of this valuable resource. State and local governments could purchase recycled C&D debris, particularly in road construction. Another potential role for state and local government is to require that demolition and construction sites source separate materials to be delivered to recycling facilities for processing. Regulations could require that building designs incorporate a minimal percentage of secondary materials, which could include C&D products. Similarly, materials for which there are no likely reuse should be discouraged for use in construction[16].

3.4 Paper/Corrugated/Newsprint

3.4.1 Paper

Paper is the major contributor to solid waste both in weight and volume. In 1990, paper constituted 32% by weight and 31% by volume of waste sent to disposal, according to the U.S. EPA. Paper is also the most recycled portion of the waste stream. Of the 29 million tons of recycled municipal solid wastes in 1990, EPA reported that 21 million tons were paper products. The American Forest and Paper Association (AFPA, Washington, D.C.) recently announced that it has met its 40% recovery goal for 1995, and now has a 50% recovery rate set for the year 2000[17]. There are several grades of paper including but not limited to newspaper, corrugated, mixed, and high-grade deinking.

High-grade deinking grades consist of papers like computer printout, sorted white office papers, printing plant scrap, printing converting scrap, and the like. Deinking grades are in very high demand and limited supply. These papers are primarily recycled into tissues and writing papers.

Mixed paper, a "catch-all" category for uncontaminated waste paper that does not fit into other categories, includes unsorted office papers, magazines, envelopes, direct mail items, and other household papers. There are three categories of mixed paper: hard mixed, soft mixed, and mixed. Hard mixed is essentially an office mix, which is mostly high-grade deinking grades with some newspaper, colored paper, etc. Soft mixed is what you would expect from residential collection. It is like hard mixed but with more contamination of the high-grade deinking grades.

Mixed paper is defined by the Institute of Scrap Recycling Institute (Washington, D.C.) in the *1993 Paperstock Guidelines* as "a mixture of various qualities of paper not limited as to type of packing or fiber content." It is this last grade of mixed paper to which prices given in the *Official Board Markets, The Yellow Sheet* refer. Historically, demands for this grade of paper have been low because of technical problems in using mixed papers in other products, and the products typically produced from mixed paper have declined or not grown in demand. Mixed paper markets include printing and writing paper, towel and tissue paper, paperboard packaging, and non-paper uses. Of the markets, printing and writing paper has the highest value and packaging the least.

Despite the low demand today, mixed paper has been called the "grade of the future."[38] In order to reach ever-increasing goals of paper recycling, mixed paper recycling must grow more than other grades. Mills using waste paper have very specific requirements that dictate the "mix" of paper they will buy. Wastepaper dealers and brokers and mill waste paper buyers stress that collectors and processors have the needs of a specific end user in mind, and not produce a "generic" bale of mixed paper in the hope that someone wants it.

Paper recycling in the workplace is following the same track that residential recycling programs followed. In its early stages of development, residential curbside collection programs were so poorly funded that many times nothing more than newspaper was collected. This same track is being followed by commercial recycling, with many programs focusing on a single recyclable item. In the case of offices, the target is white ledger paper or computer paper, which brings the highest market value. The evolution of recycling in the workplace has brought it to the "role model" phase, with a few companies refining and expanding programs that will serve as examples for others.

One such "role model" program is the Coca-Cola Company that has its headquarters in Atlanta, Georgia. The program that Coca-Cola started in 1987 with aluminum cans has grown into a system that recycles a full array of materials, including aluminum cans, white office paper, computer paper, corrugated boxes, glass, Polyethylene Terephthalate (PET) soft drink bottles, newspapers, and telephone directories. The program also includes these same items as well as other rigid plastic containers that employees can bring from home. Since 1987, more than 500 tons of materials have been recycled at the complex[39].

To collect the aluminum cans, corrugated boxes with removable plastic bags were placed at more than 70 refreshment centers located throughout the 1.8-million-square-foot complex. The bags are collected weekly by cleaning personnel and are removed to the complex's loading dock, where they are picked up by a local recycler. After the aluminum collection was established, attention was given to the paper and corrugated boxes. There are generally two sources of office paper, purchased paper and paper received in correspondence. Purchased office paper ends up filed, sent as correspondence, or discarded. Coca-Cola found that the amount of paper discarded is roughly equal to the amount purchased[40]. Using this information, the amount of paper available for recycling can be estimated. In Coca-Cola's case, that figure was approximately 1 million pounds annually.

In addition to helping determine the amount of paper available for recycling, the purchasing habits of the company have also helped expand the amount of paper that fits into the white office paper recycling system. In a number of instances, various offices utilized colored paper. By changing purchasing practices, offices can increase the amount that fits into the recycling program. Operationally, the office paper recycling program is relatively straightforward. Each of the employees is given a legal-sized collection folder (made from recycled plastic). These folders are used to collect recyclable paper at the employees' work stations. When it is convenient for them, the employees empty the folders into 23-gallon storage containers that are located in copier or computer rooms. The placement of the storage containers in these locations was done for two reasons. First, these are the areas that are

frequented by employees most often, making it convenient for them to deposit the paper. Secondly, there is also a considerable amount of paper generated in these rooms, so having the containers in these locations increases the likelihood that it will be collected. The paper can be collected nightly by the custodial staff, using 95-gallon wheeled carts. The carts were leased to avoid confusion over who owned what carts.

The total capital cost for the program implemented at Coca-Cola ran about $25,000. Collection takes between 12 and 15 hours weekly, with ongoing management estimated at 10 percent of one building management staff person's time. The revenues from the sale of materials have generated over $50,000. Seven elements were identified with the success of the program:

- Secure top management approval
- Appoint a program coordinator
- Understand the facility's waste components and disposal charges
- Obtain support of building management and cleaning personnel
- Use cooperative and reliable recyclers
- Provide employees with convenient collection locations
- Educate new employees about the program.

The program at Coca-Cola also serves to dispel myths about recycling in the office setting. The first is that a recycling program will be unsightly and offensive in an office setting. The complex at Coca-Cola is about as attractive as any. The second is that there is not enough room to place recycling bins and storage areas. There are many areas that are not useable for anything else that serve very well for recycling.

3.4.2 Corrugated

Corrugated boxes (also known as old corrugated containers, or OCC) are used to ship products to factories, warehouses, retail stores, offices, and homes. Corrugated boxes have a fluted corrugated medium layer sandwiched between layers of linerboard[41]. Corrugated waste paper consists of box plant cuttings, which are about 15% of current recovery, and old corrugated containers (OCC), which account for 85% of current recovery. OCC compromises approximately 12% of our total waste generation and accounts for 37% of all packaging and 73% of all paper packaging[42]. Except for food and yard waste, OCC is still the largest single material category that we discard. In 1990, OCC comprised 8.1% of landfilled MSW by volume. Unbaled OCC has a density of 350 pounds per cubic yard, and baled OCC has a density of 1,000 to 1,200 pounds per cubic yard[43]. Corrugated has been and will continue to be the highest tonnage of waste paper grades. Corrugated recovery is expected to increase and, with current techniques, is expected to reach practical recovery levels of 60 to 65%[44].

3.4.3 Newsprint

Newsprint is typically called Old News Paper (ONP) in the waste paper industry. The most significant trend in this grade of paper is that there is an increase in planned domestic capacity to utilize ONP. Due to increased market demands, it is expected that recovery will reach 51.2 % by 1995[45].

Products made from recycled newsprint may require pulping or they may be dry-processed. Products which require pulping include recycled newsprint, roofing felt, paperboard (boxboard, cones, tubes), construction paper, molded pulp products (egg cartons), and tissue (brown paper towels). Cellulose insulation, animal bedding, and cushioning material for packaging may be processed dry. Cellulose insulation is produced by grinding ONP and mixing it with fire-retardant and anti-corrosion chemicals. The residential waste stream offers an abundant potential source of old newspapers[46].

3.4.4 Recycled Paper Market

The markets for, and the use of, recycled paper are expected to see significant growth through the year 2001 and beyond. An expected rise of 8.2% between 1988 and 2001 was projected from a multi-client study of recycled fiber use worldwide[47]. With strong growth in demand and a greater interest by customers in securing supplies of the correct grades, the wastepaper business has a very bright future throughout the world. The main threat is oversupply of certain grades, which may be caused by government-imposed mandatory separation and collection requirements. If the market becomes oversupply-driven, there is a danger of price and structural breakdown, which would not benefit anyone.

There are several other issues that will have to be addressed for the paper recycling industry to enjoy continued success. One challenge will be to adjust to the appearance of new players in the collection and marketing of wastepaper as a result of the introduction of mandatory collection policies. There is also a need to minimize paper sorting through source separation. Such separation will improve the collection economy and recycled fiber use. An important factor for long-term planning is the expected increase of impingement of legislation on the industry's business area as governments take a greater interest in recycling. Lastly, there is a need for investment in equipment and education to get greater quantities of the higher grades of paper, particularly from offices.

3.5 Household Hazardous Wastes

The problem of household hazardous waste is an issue that is starting to get the attention it deserves. After years of throwing away paints, pesticides, solvents, waste oil, automotive wastes, and other hazardous wastes, Americans are taking notice. Hazardous

wastes have been defined as wastes or combinations of wastes that pose a substantial present or potential hazard to humans or other living organisms because:

1. Such wastes are nondegradable or persistent in nature
2. Can be biologically magnified
3. Can be lethal
4. May otherwise cause or tend to cause detrimental cumulative effects[48]

Often these hazardous substances end up in storm sewers, dumped along fence lines, or buried in someone's back yard.

The average household contains approximately 63 different chemical materials, ranging from flammable liquids to aerosols containing a nerve gas component[49]. When stored or handled improperly, many of these containers will deteriorate, or the materials themselves will become unstable. The household hazardous waste that winds up in the municipal stream can cause hazardous conditions for workers. If municipal sanitation workers combine certain household products, the results can be disastrous. Explosions may occur; inhalation of fumes can lead to respiratory damage; and sprayed or spilled liquids can injure exposed skin areas[50]. Landfill workers, equipment operators, and other workers face similar potential dangers.

The regulatory landscape has changed significantly over the past several years. Federal, state, and local landfill regulations are forcing solid waste managers to examine the contents of the loads more carefully before allowing the loads to enter a facility. Additionally, more attention is being paid to the amount of wastes generated, as well as the types of wastes. With landfill space at a premium and new sites increasingly difficult to site, facility operators are more inclined to limit the amount of materials they will accept. The implications of the Superfund Amendments and Reauthorization Act (SARA) regulations add another dimension for decision-makers. The question that arises is this: "Is it cost-effective to manage a possible liability or take the chance that the landfill will become a Superfund site sometime in the future?"

Various methods have been employed in an effort to mitigate the impact of hazardous wastes that are generated in the home. A common method is to have a hazardous waste collection day. Unfortunately these events are often poorly attended, and the costs become prohibitive when measured against the amount of pollution prevented.

There are four areas that must be given attention to put together a successful household hazardous waste program that maximizes the amount of pollution prevented while minimizing the associated costs. The four areas are public awareness, collection, decommissioning, and disposal[51].

3.5.1 Public Awareness

The premise behind the public education campaign is that a good citizen will not pollute. In addition to the inherent good citizen premise, it is also a good idea to provide added incentive. It has been shown that another effective approach is to highlight the dangers that are associated with household hazardous wastes that are not handled in an environmentally sound manner[52]. Community buy-in and a feeling of ownership are essential to the success of any program. There is also a need for an educational approach. The Water Pollution Control Federation has begun to address this concept by providing a chart which separates the wastes into four basic categories:

1. Wastes that can be poured down the drain with plenty of water in sewered areas.
2. Material that cannot be poured down the drain but can be safely disposed of in a sanitary landfill.
3. Wastes that should be collected at a community-wide collection day or given to a licensed hazardous waste contractor.
4. Items that can be recycled[53].

This level of knowledge is often difficult to convey; however, one of the goals of a household hazardous waste program is to educate the public so that they can identify the wastes appropriately and safely. Another factor of public education is to ensure that collection days do not become overburdened with materials that could be safely disposed of by other means.

When assembling a public education team, there are several places to look for members. It is a good idea to pick those who are presently affected by improper hazardous waste materials disposal. Members can be drawn from public agencies, the community, and regulatory bodies. Public agency members include representatives from public works, solid waste, sanitation, highways, and public health departments. Police and fire department officials, risk managers, safety officers, public utility administrators, municipal administrators, and other appointed officials might also be appropriate. Include members from the local EPA and the State Department. Other regulators might come from local zoning departments. Community representatives can be elected officials, utility companies, local businesses, public and private schools, universities and colleges, community organizations, and public interest groups[54].

Next to disposal and staffing, advertising can be the biggest expense. Regardless of the community method, some basic marketing strategies will help you consider how and why money is spent. Know the audience and what it needs to hear. One effective way of spreading the word is to include notices with employee paychecks.

3.5.2 Collection

One of the largest costs associated with household hazardous waste is collection. There are four basic procedures currently in use:

1. Area-wide collection days (amnesty days)
2. Fixed site drop off centers
3. Mobile drop off centers
4. Waste collection in connection with the refuse collection

Area-wide collection days are the most common. These days can be handled by either breaking the individual containers down and commingling the waste, or the waste can be roughly segregated, taken to a fixed site and decommissioned. The second method has been shown to be more cost-effective as fewer people are needed for the collection, and the wastes can be decommissioned over a period of days[55]. In many ways, the one-day program is more difficult to implement than a permanent collection facility. Selecting a site, organizing volunteer and paid staffs, managing a budget, and scheduling hours of operation must be based on limited information about the nature of the customer demand. On any given day, participation could increase by 20 to 30 percent and the poundage per household could increase 50 percent beyond initial projections.

Dramatic increases in the number of vehicles often lead to logistical problems. Also, larger amounts of disposed materials usually require more staff time, space, and handling equipment. Proper location and site design are essential to effectively operating a one-day program. Sites must be:

- Well-known to the public
- Centrally located
- Easily accessible (near a major artery or highway)
- Spacious enough to accommodate traffic and materials overflow
- Covered and securable
- Equipped with on-site utilities
- Paved and contained to prevent run-off
- Removed from parks, residences, and environmentally sensitive areas

The site should include clearly marked signs to guide the public to the site. Use a variety of techniques, such as mixing traffic cones and signs to help identify the area.

A fixed-site drop off center serves as a location to collect household hazardous wastes during the workday throughout the week, and serves as a place to segregate and bulk wastes until an economical volume is collected for disposal at a licensed facility. This option allows

greater convenience to the citizens at very little additional cost to the operation[56]. By utilizing the personnel responsible for decommissioning for collection, the mobilization and collected labor can be eliminated. Thus, the cost per participant can be estimated at less than $40/participant. Additional considerations for a fixed site are the regulatory requirements, such as large-quantity storage regulations, local codes, and ordinances. These requirements will determine where the facility can be located, how large it can be, and kinds of construction materials that can be used.

A mobile unit has the advantages both of the area-wide day scenario and the fixed-site scenario. There are mobile facilities that have separate compartments for storing segregated wastes. These units can be parked on an ongoing basis at municipal facilities. Municipalities can oversee the public awareness aspects and man the physical collection of the wastes. Once the mobile unit is filled with waste, a second unit is dropped off at the location, and the first unit is returned for decommissioning. This method can be very cost-effective because it limits the amount of technical aspects that must be handled by the staff. The staff can operate the collection station and load trucks, while trained professionals can handle the decommissioning, manifesting, and transporting of the waste to a licensed facility.

The last form of collection, curbside collection, is becoming more common. In this form of collection, the wastes that are considered hazardous are placed within a special container and are handled by either the refuse collection individuals or by a separate vehicle. This technique is more expensive, but should yield higher participation in household hazardous waste collection.

3.5.3 Decommissioning

The single most important aspect to limiting the cost of household hazardous waste collection is decommissioning lab-packed waste prior to disposal[57]. Decommissioning requires additional manpower cost, but substantially reduces the disposal costs. The single largest contributor to the waste stream is paint. Latex paint is much less of a hazard than oil-based paint. Thus latex paint is either commingled to generate a recyclable paint or is stabilized to be disposed of in a landfill. Empty paint containers can be shredded in a hammermill, mixed with lime, and landfilled.

The contents of oil-based paints can be consolidated into 55-gallon drums and transported to a solvent recovery facility where the solvents are recovered. The solvents, paint solids, and resins are recycled in three different manners. Waste kerosene, gasoline, fuel oil, diesel fuel, and motor oil can all be recycled.

The maintenance of clear and concise records is critical to the quick and cost-effective disposal of household hazardous wastes. Good records allow the acceptance of the waste at licensed treatment facilities. Documenting that certain disposal costs can be quite high (such as for aerosol cans) will promote the analysis of additional treatment technologies.

Fort Benning is located in the lower Piedmont Region of central Georgia and Alabama, approximately six miles southeast of Columbus, Georgia (See Appendix 1). The missions of Fort Benning, according to the Command Data Summary developed and published by the Directorate of Resource Management, are as follows:

- Train infantry to fight and win on the battlefield.
- Train and commission officers for all branches through OCS.
- Develop infantry concepts and doctrine that achieve decisive success with minimum casualties.
- Develop the mounted and dismounted infantry force with strong organization and modernized equipment as an integral part of the combined arms.
- Provide overall battle direction, oversight, and integration for the Combined ARMS Dismounted Battlespace Arena.
- Conduct specialized infantry training for soldiers of the infantry force in support of joint and combined arms operations.
- Develop and be prepared to implement deployment and mobilization plans.
- Assist and support tenant units at the installation.
- Operate and maintain the installation.
- Maintain soldier, family, and civilian systems.
- Protect the force.

Fort Benning consists of approximately 181,626 acres. Table 4.1 presents an approximate breakdown of land use by category.

Table 4.1 Land Use by Category

	ACRES	PERCENTAGE
Housing	1,482	0 82%
Administration	2,104	1.16%
Industrial	0	0 00%
Disposal/Transfer Facilities	56	0 03%
Training, Firing Ranges/Impact Areas	162,549	89.50%
Wetlands	15,435	8 50%
Total	181,626	100.00%

The population statistics, as developed and published by the Directorate of Resource Management, are presented in Table 4.2.

Table 4.2 Population Statistics

	FY 94	FY 95
Military	21,892	20,034
Dependents	9,856	9,570
Civilian Employees	7,175	7,039
Total Population	38,923	36,643

Fort Benning, in terms of population, land use, and waste generation, is very much like a small town.

4.1 Waste Management Organizations and Responsibilities

This section will provide an overview of DoD and Army policies intended to ensure installation compliance with regulators, as well as a look at organizations and responsibilities specific to Fort Benning. The information on the overview on DoD and Army policies was obtained from the AEPI publication, *Analysis of U.S. Army Solid Waste Management Policy*[58].

Army solid waste initiatives have focused primarily on finding cost-effective solutions to disposal problems, while maintaining compliance and initiating recycling programs. The policy of DoD and the Army for solid waste is set forth in AR 40-5. AEPI analysis concluded that these policies do not provide sufficient guidance to achieve a leadership role in solid waste management (SWM)[59].

Army and DoD guidance is fragmented and overlapping. Table 4.3 (see footnote on table for source) reviews Army and DoD policy and regulations and the areas of waste management they affect. Various DoD and Army regulations define duties and assign responsibilities to carry out solid waste policy formulation and implementation. General and specific responsibilities are spelled out in AR 200-1 and AR 420-7, although other DoD and Army regulations also define responsibilities. The following is a brief overview:

- Assistant Secretary of the Army for Installation, Logistics, and Environment develops SWM policy and initiates proactive efforts to identify more efficient and cost-effective means of treating and disposing waste.
- Overall SWM policy and program management responsibility rests with the Deputy Assistant Secretary of the Army for Installations and Housing.
- The Deputy Assistant Secretary of the Army for Environmental Safety and Occupational Health oversees the environmental aspects of SWM.
- The Office of Assistant Chief of Engineers administers, directs, implements, and monitors the Army solid waste program, including waste minimization.

- The Community and Family Support Center is responsible for overseeing non-appropriated funded recycling activities.
- Assistant Secretary of the Army for Research, Development, and Acquisition (ASA[RDA]) will establish policies directing the Army procurement, accounting, and reporting system to emphasize waste minimization through source recovery, recycling, identification of requirements and specifications for source reduction, and waste disposal pursuant to Federal Acquisition Regulations (AR200-1).
- Assistant Secretary of the Army for Installations, Logistics, and Environment (ASA [IL&E]), Corps of Engineers, and Defense Logistics Agency will implement materials substitution initiatives that will contribute to a reduction in solid waste (AR200-1).
- Deputy Chief of Staff for Operations and Plans (DCSOPS) will evaluate the life cycle cost of equipment for source reduction, material reclamation, resource recovery, recycling, and waste management. DCSOPS also authorizes and ensures that specialized personnel and equipment are available to support installation waste management.
- Deputy Chief of Staff for Logistics (DCSLOG) ensures that the Army Logistical staff maintains equipment to extend its useful life and to reduce and recycle wastes; ensures that material is designed, procured, and used to minimize the amount of waste generated; and coordinates with ASA, RDA.
- Major Commands (MACOMs) are charged with overall implementation schemes including: best method of disposal; efficient organization of collection and disposal; establishing waste management; developing resource recovery, recycling, and waste disposal programs according to AR420-47; and reporting to HQDA.
- Installations: In addition to overall requirements to comply with federal and state regulations, installations are charged with establishing and executing programs, maintaining a database(s) of current information on recyclable markets, and monitoring to reduce amount of waste disposal by landfilling or incineration.

Table 4.3 DoD and Army Solid Waste Policies

	Responsibilities	Minimization	Recycling	Incineration	Disposal
DoD					
Memorandum for Resource Recovery Coordinating Committee: DoD Recycling Policy for DoD Recycling Program (DRP), 20 Nov 1991	■	■	■		
DoD Directive 4165.60: Solid Waste Management--Collection, Disposal, Resource Recovery, and Recycling Program, 4 Oct 1976	■	■	■	■	■
DoD Instruction 7310 1: Disposition of Proceeds from DoD Sales of Surplus Personal Property, Jul 1989			■		
DoD Memorandum: 10 Oct 1989	■				
Army					
AR 40-5. Preventative Medicine, 15 Oct 1990	■				
AR 200-1. Environmental Protection and Enhancement, updated May 1991	■	■	■	■	■
AR420-47· Solid and Hazardous Waste Management, 1 Jan 1985	■	■	■	■	■
Sobke, John F., Major General, ACE, Memorandum 19 May 1992				■	■
Offringa, Peter, Major General, ACE, Memorandum 5 Sept 1991					■
Tn 420-47-02: Installation Recycling Guide, 1 Sep 1991 (USA-EHSC)			■		

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4.1.1 Fort Benning Responsibilities

One of the goals of this project was to describe the responsibilities of those in charge of solid waste management. The following descriptions of the responsibilities for various management levels were given in "Fort Benning and Camp Frank B. Merrill Integrated Solid Waste Plan: 90% Submittal," by Polyengineering, Inc., Dothan, Alabama.

4.1.1.1 Installation Commander

The installation commander is responsible for establishing an organizational structure to plan, execute, and monitor the solid waste program.

1. Program, budget, and defend resource requirements to manage the solid waste program, including funds for equipment, studies, operational costs, maintenance costs, treatment storage or disposal, waste minimization, and personal training.
2. Determine the most cost-effective and efficient means of waste treatment, storage, or disposal including use of:
   - Regional facility on non-Army owned property for resource recovery, treatment, or disposal
   - Industrial waste water treatment plants, where applicable
   - Waste disposal services other than the DRMO
3. Identify a person to be responsible for daily management of solid waste.
4. Through Installation Solid Waste Board or other established procedure, ensure that the proceeds from the recycling program are used in accordance with Public Law 152 and Instruction 7310.1.
5. Ensure sufficient funding levels to comply with RCRA requirements and support pollution prevention initiatives.
6. Ensure that all required training is approved, resourced, accomplished, and documented.
7. Maintain routine liaison with the Defense Property Disposal Service activity servicing the installation to maintain current information on markets for solid waste materials.
8. Establish waste monitoring procedures to reduce production of waste at the installation and limit the amount of waste material needing landfill or incineration.
9. Have overall responsibility for the hazardous waste management system, to include compliance by tenant activities and subinstallation.
10. Serve as the "owner" of any RCRA hazardous waste facility within the Command, including those operated by tenants and subinstallations, unless the State requires otherwise.
11. Have responsibility to regulatory authorities for property applying for required permits and renewals.

12. Normally delegate the application process to the Facilities Engineer but sign as the facility owner.
13. Chair or appoint a chairperson for the Installation Hazardous Waste Management Board.
14. Ensure that the Facility Engineer has enough support to carry out his/her functions.
15. Ensure that all hazardous waste generators and facility operators comply with regulatory requirements for hazardous wastes.

4.1.1.2 Directors

1. Serve as the Installation Commander's expert representative for the management of solid waste (unless otherwise designated by the Commander).
2. Advise all waste-generating activities of state, federal, and Army solid waste management requirements for managing solid waste, including requirements for permits, reporting, and record keeping.
3. Monitor installation compliance with local, state, federal, and Army solid waste management requirements, including tenant activities and subinstallations, and recommend changes in policies or procedures to improve program management to the Commander as necessary.
4. Advise the Commander, in coordination with waste-generating activities, on the most cost-effective and efficient means of waste storage, treatment, and disposal, to include the siting of new waste management facilities and the need to modify existing facilities.
5. Establish, monitor, and execute programs in waste management, including waste minimization, resource recovery, and recycling, in compliance with state and federal solid waste laws and regulations and the requirements of Army regulations.
6. Periodically review such factors as number and location of pickup stations, truck routes, type of equipment, scheduling, supervision, and use of personnel to effectively manage solid wastes.
7. Identify the solid waste activities which are carried out by contract, review the responsibilities, and monitor the performance of the contractor.

4.1.1.3 Chief Environmental Management Office/Environmental Coordinator

1. Periodically review all applicable state, federal, and Army requirements for managing solid wastes.
2. Serve as the installation point of contact for questions, complaints, or other notification regarding solid waste management or recycling.
3. Maintain coordination as necessary with state and federal solid waste regulators.
4. Monitor installation compliance with local, state, federal and Army solid waste management requirements, including tenant activities and subinstallation, and

recommend changes in policies or procedures to improve program management to the Commander when necessary.

5. Assist in advising the Commander, in coordination with waste-generating activities, on the most cost-effective and efficient means of waste storage, treatment, and disposal, to include the siting of new waste management facilities and the need to modify existing facilities.

4.1.1.4 Director of Logistics/Director of Supply

1. Advise procuring activities on procedures for integrating waste reduction and recycling program goals into installation procurement programs to achieve federally mandated and Army endorsed goals and objectives.
2. Advise waste-generating activities on proper requirements for packaging, labeling, and shipping of solid waste to ensure compliance with federal, state, Army, and DoD requirements.
3. Ensure environmentally safe on-post and off-post transportation of solid wastes.
4. Actively support the Directorate of Engineering and Housing (DEH) in measuring progress to meet federal and Army waste reduction goals and requirements.
5. Communicate regularly with the Defense Logistics Agency (DLA) activity serving the installation to maintain current information on markets for excess or unserviceable materials and recycling materials.

4.1.1.5 Installation Safety Manager

1. Monitor the storage, packaging, transportation, treatment, and disposal of solid and hazardous waste standards and oversee personnel training requirements to ensure compliance with federal, state, and Army safety standards
2. Serve as a member of the Installation Hazardous Waste Management Board.

4.1.1.6 Hazardous Waste Management Board

Installations are encouraged to form a Solid Waste Management Board, a forum for planning, identifying needs and objectives, and coordinating between various installation elements. The Solid Waste Management Board may be a subcommittee of the installation Environmental Quality Control Committee (EQCC). Participation should include Commander (or representative); Recycling Program Manager; Engineering and Environmental Offices; DRMO; Morale, Welfare, and Recreation; Logistics, Supply, and Services; Safety Office; Public Affairs; and Finance and Accounting.

4.1.1.7 QWRP Manager

1. Formally establish the Qualifying Waste Recycling Program (QWRP) as directed by the installation commander.
2. Develop and implement the recycling program, including program organization, promotion, procurement of equipment, securing of contracts, hiring of personnel, establishment of operating procedures, and data collection/record keeping.

4.1.1.8 Defense Reutilization and Marketing Office

1. Serve as the local representative of the Defense Logistics Agency.
2. Perform market research with assistance from the Defense Reutilization and Marketing Region (DRMR) concerning resale value and recycling opportunities for waste generated at the installation.
3. Determine which items are reused, resold, or recycled.
4. Advise generating activities on the required turn-in procedures, including packaging, labeling, and transporting of material to facilitate sales/recycling.
5. Assume accountability for materials properly turned in for disposal, resale, or recycling.
6. Periodically conduct sales.
7. Maintain records concerning types and quantities of materials turned in, and proceeds for various resale/recycling activities.

4.1.1.9 Contractors

See Section 4.3.1.

4.1.1.10 Chief of Engineers (COE)/Facilities Engineer

The Chief of Engineers will:

1. Provide guidance and direction to the major Army commands (MACOM) on the implementation of this regulation.
2. Ensure this regulation is consistent with the current federal regulations governing solid and hazardous waste management, resource conservation, and recycling.

The Facilities Engineer is:

1. Responsible, under the direction of the installation commander, for the following:
   - Regular and systematic collection of solid waste from designated pickup stations and disposal of solid wastes according to TM 5-634.

- Managing the solid waste management program according to AR 420-10.
- Collecting solid waste, such as bulk waste, which requires handling procedures other than normal FE collection and transportation operations. Additional cost related to collection procedures will be reimbursed by the generator.

2. The Facilities Engineer will act as the installation commander's representative for the management of hazardous waste disposal.

4.1.2 Qualifying Recycling Program

A significant part of the solid waste management effort has gone towards recycling. Due to some past abuses and the inherent bureaucracy of the system, recycling in the Army has become regulated, and recycle managers are wary of their actions being misconstrued as inappropriate. Some of these past abuses were reported to Congress in December of 1993. The following is an excerpt from that report.

> *"We found widespread abuse in DOD's recycling program. Millions of dollars are being used annually for MWR activities that should be used instead to offset the need for appropriated funds or be returned to the U.S. Treasury. This is occurring because Military bases are routinely receiving money from the sale of aircraft, vehicles, and other materials that DOD policy specifically excludes from the recycling program and then are using the proceeds to fund Morale, Welfare, and Recreation activities. Although the purpose of the program is to reduce the volume of items going to the wastestream, about 90% of the program's proceeds appear to represent excluded items and items that would not go into the waste stream.[61]"*

The policies and regulations governing recycling within the Army and the Department of Defense are described in the following excerpt from the Installation Recycling Guide published by the U.S. Army Engineering and Housing Support Center:

> The Military Construction and Codification Act (PL 97-214), effective 1 October 1982, defines solid waste recycling in the Department of Defense. Recyclable materials are defined as "materials that normally have been or would have been discarded and that may be reused only after undergoing some kind of physical or chemical processing." The legislation also increased the incentives for participation in installation recycling programs by increasing the options for the use of sales proceeds.
>
> Section 203 of the Federal Property and Administrative Service Act of 1949 (40 USC 484) governs the procedures for the sale of recyclable materials in the Army. The sale of recyclable material that was purchased (originally) with appropriated funds is the responsibility of the DRMO (Defense Reutilization and Marketing Office).

> Army Regulation 420-47, 1 January 1984, Solid and Hazardous Waste Management, describes the responsibilities, requirements and procedures for solid waste management at Army installations. The installation solid waste recycling program is a segment of the solid waste management program and should include, at a minimum, waste minimization, resource recovery, recycling, and waste disposal.
>
> Army Regulation 200-1, Environmental Protection and Enhancement, 23 April 1990 (revised May 1991), covers the areas of source separation, resource recovery, and recycling. The objectives of this regulation are to promote the protection of public health and the environment and to conserve valuable material and energy resources.

There is considerable flexibility for the installation commander in implementing these regulations. The primary mechanism for their implementation is the Qualifying Waste Recycling Plan (QWRP), which defines installation-specific roles and responsibilities, although recycling programs can be implemented without a QWRP, if the annual costs of the programs do not exceed the costs of routine waste disposal. This restriction is waived for programs operated as part of a QWRP.

Currently at Fort Benning, the three organizations with a major involvement in recycling are the Directorate of Community Affairs (DCA), Department of Public Works (DPW), and the DRMO. DRMO is the local arm of the Defense Reutilization and Marketing Service (DRMS), which has primary responsibility for the sale, donation, reutilization, and disposal of material in the Department of Defense. The DRMO has responsibility for the recycling, storage, sale, and disposal of excess and surplus material which is purchased with appropriated funds. DRMO does not operate any collection programs, functioning only as a receiver and marketer for recyclables.

A Memorandum of Instruction (MOI) for the operation of a qualifying recycling program was distributed to establish policy and procedures for operation of the Fort Benning Resource Recovery and Recycling Program (RRRP). This MOI (ATZB-EHN-P 200) applies to all activities generating recyclable material at Fort Benning, satellite facilities, and supported reserve centers. There have been problems with the committee structure set forth in the MOI, and there are efforts to rectify those problems. The major problem is a failure to follow the procedures in the existing MOI. Additionally, the committees outlined in the MOI have not met in over a year.

The MOI sets forth the following policy regarding recyclables:

> Fort Benning has an established source separation and recycling program to reduce the waste stream, prevent pollution, and conserve natural resources. Financial incentives are available in the form of proceeds from sales of recycled materials. All items accept obvious trash shall be turned in to the DRMO by all military, civilian, or contractors performing work at the installation.

Recyclable materials are defined as "materials that normally have been or would be discarded and materials that may be reused after undergoing some type of physical or chemical processing." Recyclable materials do not include:

1. Precious-metal-bearing scrap
2. Those items that may be used again for their original purpose or function without any special processing

All proceeds from the sale of recycling materials will be deposited in the Budget Clearing Account (see section 4.1.2.2).

4.1.2.1 Responsibilities

The MOI sets forth the responsibilities for several positions. The present descriptions are included in the following sections.

4.1.2.1.1 Responsibilities of the Recycle Manager

1. Manage operation of the RRRP.
2. Ensure that material is being properly segregated at generating activities.
3. Prepare an annual operating budget and a construction/equipment purchase budget.
4. Provide monthly variance analysis of budgeted to actual performance.
5. Conduct research and initiate expansion of RRRP.
6. Establish and maintain tracking chart for turn-ins on work sheet to track and report quantities of material processed.
7. Manage and optimize collections due in from the sale of recyclables.
8. Maintain status of recycle projects to ensure timely processing and completion of projects.
9. Meet with DCA monthly to review and update status of recycle funds prior to monthly financial reporting. Keep DCA informed of all actions affecting the financial status of the recycle fund.
10. Ensure all documents/actions requiring recycle funds are provided to DCA prior to processing.
11. Prepare annual operating budget in July of each year for the next fiscal year, to be reviewed by the Recycle Working Group and approved by the Chief of Staff.

4.1.2.1.2 Responsibilities of the Defense Accounting Office (DAO)

1. Ensure that checks received from the proceeds of the sale of recyclable material are deposited into the budget clearing account.
2. Submit quarterly Recycling Program Status Report to HQ TRADOC, Finance and Account Division, Proceeds Branch.

3. Provide DCA monthly information of transactions made to the budget clearing account (collections, disbursements, and balance) and status of reimbursable orders set up against the budget clearing account.
4. If the uncommitted balance in the RRRP account at the end of the fiscal year exceeds $2 million, DAO will return the excess amount to the U.S. Treasury.

4.1.2.1.3 Responsibilities of the Defense Reutilization and Marketing Office (DRMO)

1. Ensure that material is weighed properly.
2. Segregate material into piles.
3. Administer the sale of material and direct proceeds into the RRRP.
4. Track and report quantities of material processed to the Recycle Manager.
5. Ensure the proper Account Processing Code (APC) is noted on turn-in transactions to identify proceeds from metals, paper, etc., deposited in the recycle account.

4.1.2.1.4 Responsibilities of the Directorate of Logistics (DOL), Supply and Services

1. Create DD Form 1348-1, DoD single line item release/receipt document.
2. Keep a log of DD forms 1348-1 processed.
3. Ensure all condition code H turn-in documents contain complete accounting classification.
4. Maintain accountable copy for all recyclable material.

4.1.2.1.5 Responsibilities of the Directorate of Community Activities (DCA)

1. Provide financial management for the recycle fund using the annual operating and cash flow budgets.
2. Maintain monthly financial data and prepare monthly reports to be sent through the Director of Public Works to the Chief of Staff. A copy of the reports will be furnished to the DRM and the Recycle Working Group.
3. Review all actions affecting the recycle fund prior to processing to ensure availability of funds and update of budgeted data.
4. Provide quarterly reports to the RWG on the aluminum can program.
5. Provide to Program Resource Advisory Committee (PRAC) and Recycle Working Group (RWG) quarterly summary of recycle funds expended for MWR projects.

4.1.2.1.6 Responsibilities of the Department of Public Works (DPW)

1. Oversee the Fort Benning recycle program; is designated as the Program Director for the recycle program.
2. Serve as Chairman of the Recycle Working Group (RWG) and schedule meetings. Written reports/minutes covering formal RWG meetings will be furnished to the committee members by DPW.
3. Identify waste reduction in coordination with the Recycle Manager.
4. Provide technical and environmental review on proposed projects for pollution abatement.
5. Monitor landfill for disposal of recyclables.
6. Solicit quarterly projects for pollution abatement, energy, and occupational safety and health from all activities.
7. Review submitted projects and work orders for validity and prepare estimates (reimbursable).
8. Submit to Safety, DPW-Environmental and Energy for review.
9. Be lead presenter and organizer for Recycle Senior PRAC.
10. The Energy and Utilities Division will provide technical review of projects submitted for energy and prepare cost/benefit rationale for energy projects.
11. The Housing Division will provide guidance for expansion of RRRP to family housing.

4.1.2.1.7 Responsibilities of Safety

1. Provide technical review of projects submitted for funding as occupational safety and health activities.
2. Assign risk assessment codes for all projects.

4.1.2.1.8 Responsibilities of the Public Affairs Office (PAO)

1. Prepare publicity for the RRRP as directed by the Recycle Manager.
2. Publicize projects funded with recycle funds.

4.1.2.2 Handling of Funds

The following is a detailed description of how funds are to be handled. These procedures were set forth in the MOI for the Operation of a Qualifying Recycling Program:

The Defense Logistics Agency (DLA) has directed the servicing DRMO to return 100% of the proceeds from sales of recyclable materials to the installations. If an item is determined to be a recyclable material, the unit, activity, contractor, or directorate turning an item in to DRMO shall insert the accounting (TID). The DOL, Supply and Services Division,

monitors and approves all turn-ins to DRMO (AR 710-2) and shall review all turn-in documents to ensure the fund citation is annotated on the appropriate TIDs. The accounting classification will be inserted into the remarks block of the DD 1348. All proceeds may be withdrawn from the account as follows:

1. Proceeds will first be applied to cover all costs of operating, maintaining, and establishing the qualifying recycle program for the current fiscal year. Funds held in escrow will not, at any one time, exceed six months' projected operating costs. This requirement includes the purchase of new or replacement equipment for recycling purposes. Military personnel expenses may not be reimbursed from the proceeds. It will be the responsibility of each activity incurring expenses in support of the program to provide a memorandum detailing cost to DCA and the Recycle Manager. Each activity will also prepare an FB (DRM) Form 119 and 117 and forward through DCA to DRM-Program and Analysis Division to the Defense Accounting Office (DAO), identifying the APC with Fiscal Action Code (FAC) assigned on FB (FIN) Form 125. The accounting procedures will increase the activities' available funds and will automatically create an earning when receipt is processed. Activities should process earnings as they occur and not wait until the end of the fiscal year. The activity should submit a memorandum through DCA to the DAO for notification of when the receipt is processed to assist the DAO in processing the collection from the Budget Clearing Account. It is very important that only one APC be used for each FB (DRM) Form 119 established. Therefore, limited use of this procedure should be practiced. Any new expenses, i.e., new equipment or additional personnel in support of the program, shall be presented to the committee for approval prior to incurring expenses.
2. If a balance remains in the account, the managing activity may apply up to 50% of the remaining balance to fund projects for pollution abatement, energy conservation, and occupational safety and health activities. A project funded from recycling proceeds may not be carried out for an amount greater than 50% of the amount established by law as the maximum amount for a minor construction project, currently $300,000. Proposed occupational safety and health activities will be presented to the Recycle Work Group. Any activity/unit may submit projects and prioritized, at a minimum, biannually by the Recycle Work Group. Each proposed project shall include the following documentation prior to the submittal: work order form DA 4283 with valid work order number; project description and how it will impact pollution abatement, energy conservation, or occupational safety and validated estimated cost form DPW; and any special clearances, permits, etc., required to implement the project. Copies of this documentation will be provided by the DPW to the committee prior to the committee meetings. The list of recommended projects by priority will be submitted by the Recycle Working Group to the PRAC and forwarded to the Commanding General for final approval. Proponents of projects approved by the Commanding General for funding shall initiate action within 90 days of approval notification from DPW. Once the Commanding General approves projects, the funds released for each project will be certified by DRM-Accounting Services Division.

3. FB (DRM) 119 (Appropriation Reimbursement Control) will be used for each project.
4. Any proceeds remaining after 1. and 2. above are accomplished by the end of the third month of each quarter in the fiscal year may be transferred to Nonappropriated Funds (NAF) for use in the MWR areas. Transfers will be initiated at the end of the quarter after all collections and disbursements are captured. Funds will be transferred to the Installation Morale and Welfare Recreation Fund by DAO processing an SF 1049 (Public Voucher for Refunds) according to AR 37-103. Quarterly, the DCA shall submit a list of completed projects and costs to the Recycle Working Group, due by the 20th of the month at the end of each quarter (20 Jan, 20 April, 20 July, 20 Oct).
5. Any funds received through a recycling effort not sold through DRMO, i.e., an NAF contract, will be reported quarterly to the Recycle Working Group. Reports will include revenue received, expenditures, and amount recycled (pounds, etc., of a particular item). Funds received through NSF disposition of recyclable materials, as authorized under paragraph 12-20, AR 215-1, will be used to pay NAF costs of administering the program, and any residual amounts will be dispersed in accordance with prevailing regulations governing NAF.
6. An amount of funds should remain in the Budget Clearing Account after item (1) and item (2) above have been reimbursed to maintain the solubility of the recycle program.
7. If the uncommitted balance in the account at the end of any fiscal year exceeds $2 million, the excess amount will be returned to the U.S. Treasury as miscellaneous receipts.

4.1.2.3 Organization

The MOI for a qualifying recycling program has provisions for how the management structure for the program will be laid out. The MOI calls for the Fort Benning RRRP to utilize two committees. The Program Resource Advisory Committee (PRAC), and the Recycle Working Group (RWG).

The PRAC serves as the recommending body for the disposition of funds. The PRAC consists of The Chief of Staff (votes in case of a tie), Director of Resource Manager, and the following program directors: DCA, DOL, AC, DOIM, DOT, MEDDAC, and DENTEAC. The Director of Resource Management provides financial overwatch for the recycle fund and is responsible for calling PRACs as needed for recommendations to the Commanding General on the distribution of funds.

The DCA will be responsible for the financial management of the recycle fund. DCA will prepare monthly financial reports to be provided through DPW to the Chief of Staff and the Commanding General. A copy of the report will be furnished to DRM and the Recycle Working Group. Reports will include a monthly and year-to-date summary of the recycle operating budget and status of recycle project.

The Recycle Working Group consists of representatives from DPW, DOT, DOL-Supply and Services Division, DCA, and DRM. Advisory committee members include DPW-Energy, DPW-Environmental, DPW-Housing, Safety, PAO, DAO, and DRMO. The purpose of the committee is to ensure RRRP fund requests are for authorized projects, provide funding guidance for RRRP activities, and prepare an annual budget. The descriptions of the responsibilities of each member are included in the above sections.

4.2 Characterization of Wastes and Waste Generation

4.2.1 Waste Characterization

Records of waste accepted at the First Division Road Sanitary Landfill date back to January, 1989. The units of measurements were changed from cubic yards to tons in 1993, the following categories of waste were initially recorded:

- Family housing
- Administration
- Chattahoochee County
- Troop units
- Contractors

In November 1991, asbestos waste was recorded separately from other waste. In January 1994, when the Fort Benning Materials Recovery Facility began operations, recycled material was recorded.

4.2.2 Waste Categories

Family Housing: Family housing waste is collected from the 4,094 housing units located on-post. Family housing waste generally consists of food wastes, metal, plastics, paper, glass, yard waste, etc. Since the residents of the housing units voluntarily participate in a recycling program, the family housing waste collected at Fort Benning consists mostly of food wastes and yard wastes with a small percentage of metal, plastics, paper, and glass.

Administration Area: Administration area waste is collected from various size storage containers located on the main post area, as well as at other strategic locations on-post. Administration area waste generally consists of office paper products, food wastes (from mess halls and restaurants), cardboard, and cans from motor pool areas, etc.

Troop Units: Troop unit waste is generated by Army troops that have been on field exercises. Troop units collect their own waste. This waste category also includes other waste generated and collected by other government agencies that is not collected by the contractor MDI.

Contractors and Other Users: Waste accepted at the landfill from contractors and other users is generated from contractor activity on Fort Benning, such as construction, demolition, and other contractor-related activities, and consists mostly of construction/ demolition wastes.

Recyclable Material: The recyclables recorded consists of material collected from family housing areas, administration areas, troop units, and contractors and delivered to the Fort Benning Material Recovery Facility to be packaged and sold.

Yard Waste: Yard waste material recorded consists of leaves, limbs, grass clippings, etc., collected from the Family Housing Areas. Individual households are responsible for yard maintenance up to 50ft around their residence. Outside family housing areas, grounds are maintained by a private contractor. It is important to note that material of this nature generated from grounds maintenance is currently disposed of in several ways. Some of the yard waste from grounds maintenance is kept in a pile near the maintenance building and is reused periodically around post for various projects. Some of the bagged yard waste is inadvertently disposed of in the sanitary landfill. Yard waste is also disposed of in various areas around post.

4.2.3 Waste Quantification

Records of solid waste tonnage began in 1993. Upon review of the data, it is apparent that a large quantity of contractor waste was generated before April 1994, probably due to the demolition of several WWII barracks at that time. Table 4-2 depicts a summary of the solid waste data pertaining to waste generated on the post.

Table 4.2 Annual Average Tonnage Data

	Tons
Family Housing	3,562
Administration Areas	11,953
Troop Units	2,128
Contractors and Other Users	2,765
Asbestos Wastes	22
Recycle Material	538
Yard Waste	769
Total	21,699

Figure 4.1 shows the trend of total solid waste to the 1st Division Rd. Landfill for September 1993 to March 1995. There is a significant decrease from the Fall of 1993 to the Spring of 1993. Looking at Figure 4.2, which shows contributions of solid waste by areas, it is apparent that this decrease, approximately 2,000 tons/month, is due to construction and demolition activities. WWII barracks were being removed during this period. The waste contribution from the other areas is fairly consistent over the two-year period. Other solid waste generation data obtained during the course of the study is included in Appendix 2.

The contract under which this work was performed called for the description of items found in the following sections 4.2.4 - 4.2.10.

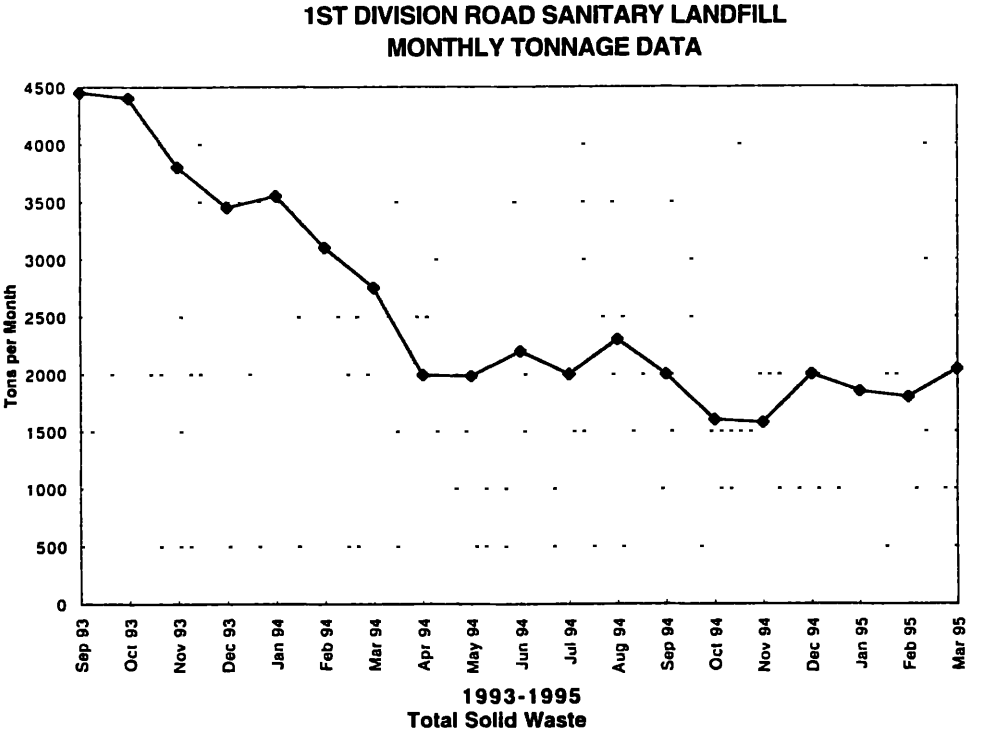

Figure 4.1 – Total Monthly Solid Waste

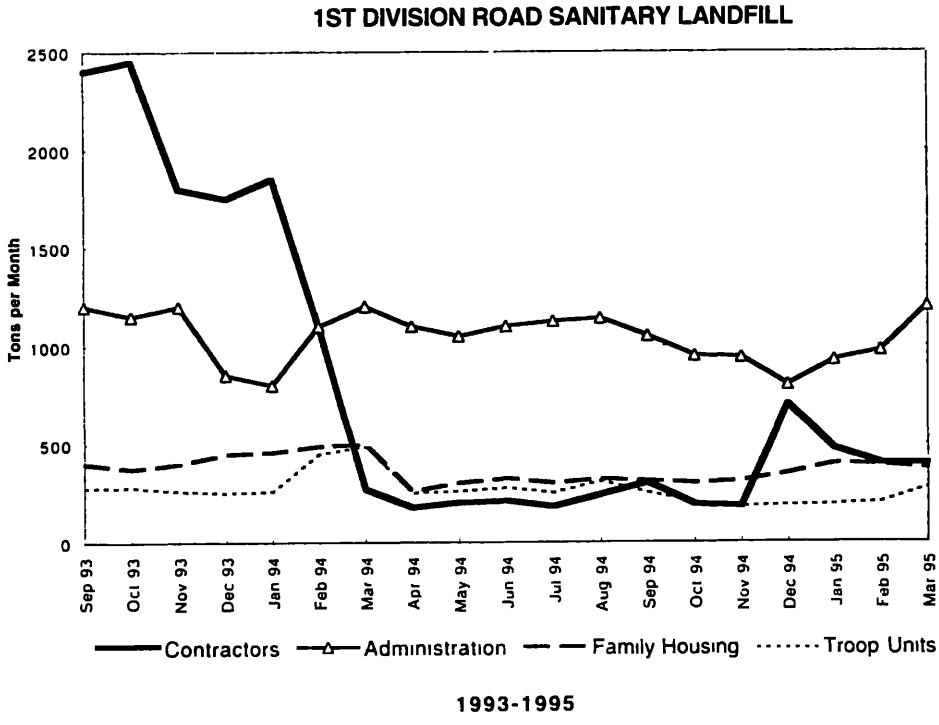

Figure 4.2 – Monthly Solid Waste by Area

4.2.4 Waste Oil/Tires/Lead-acid Batteries/Antifreeze

Fort Benning has two service stations for Privately Owned Vehicles (POVs), and two purely military stations. Records for used oil disposal are available only as far back as October 1, 1988, and the data available is very limited. 1988 was the year when the General Services Administration (GSA) first came to Fort Benning. The GSA had based its yearly disposal of waste oil from automotive fluid recovery (non-hazardous) manifests. The yearly volume of disposed waste oil was 4,448 gallons. This oil is picked up by a private contractor and transported to the energy facility. Effective January 1, 1995, Cobb Automotive (GSA's Automotive Maintenance Contractor) has the responsibility of picking up the used oil. Cobb Automotive also uses Atlanta Oil Services to remove used oil. The waste oil is burned in the energy recovery plant (steam) on base, or disposed of through DRMO.

The GSA also provided information about the disposal of used tires. From October 1, 1988, through September 30, 1993, all large tires were sold at auctions by GSA. Approximately 1,700 tires were sold at auctions. From October 1, 1993, through July 11, 1995, 263 large tires were recycled through AER (American Energy Recyclers, Inc.) of Montgomery, Alabama, and Hoffman Tire, Inc., of Mobile, Alabama. All small tires were picked up by the major tire contractors on a one-for-one basis; that is, the contractor is obligated to take away one used tire for each of the same size of tire that was purchased. The number of tires purchased average between 2,000 and 2,500 per year.

Lead acid batteries are typically handled by GSA's automotive maintenance contractor, Cobb Automotive. It is estimated that approximately 100 batteries per year are handled by the contractor.

Antifreeze is handled by the Director of Logistics (DOL). The maintenance division runs its own recycling operation. Antifreeze that is contaminated or that can not be brought up to the required standards are sent to the DRMO for handling.

4.2.5 Coal Fired Plants

Fort Benning currently operates no coal-fired plants.

4.2.6 Wastewater Treatment Sludge

Fort Benning has two wastewater treatment facilities. Since mid 1970s, liquid sludge has been routinely land applied. An anaerobic digestion process is used to stabilize the sludge prior to land application. Wastewater enters the wastewater treatment plant and settles in primary settling basin(s). After settling in the primary basin(s), the sludge is pumped directly into the primary anaerobic digester. The digestion period for sludge in the primary digester ranges from 3 to 7 days. The primary and secondary digesters' temperature is approximately 92°F. During the digestion period, the sludge in the digester is mixed/recirculated from bottom to top via the feed lines. No nutrients are added into the digester. The pH within the digester ranges from 6.5 to 7.2 and is adjusted with lime as necessary to maintain a pH within the range from 6.5 to 7.

The sludge is periodically applied to the designated areas via a 1,600-gallon "Big Wheel," or a 5,000-gallon tanker. The "Big Wheel" is equipped with a rear-rotating spreader which is driven by a power take-off. The 5,000-gallon tanker truck is used to transport sludge to a site, after which it is transferred to the Big Wheel for application. On occasion, the tanker truck is used to apply sludge by opening the discharge valve and driving the vehicle throughout the site.

Field latrines are located at ranges and bivouac training areas listed in Technical Exhibit No. 4. Latrines are pumped of all solid and liquid matter on a monthly basis, and the wastes are discharged into the Fort Benning Sanitary Sewer System in manholes located near the main treatment plant. Disposal manholes are designated by Chief, Mechanical/Sanitation Branch, FMOD, DPW.

4.2.7 Industrial Processes/Special Wastes

There are no industrial processes adding special wastes to Fort Benning's municipal waste stream. However, constatine wire, which is a type of razor wire, is posing serious disposal problems. The wire cannot be chopped or bailed, consists of different types of metals, and is extremely difficult to handle. No solutions to this problem have yet been found. Special wastes from the Army hospital have traditionally been incinerated, and the ashes are sent to the sanitary landfill. However, Fort Benning is in the process of discontinuing this practice and will utilize an autoclave for its bio-medical wastes.

4.2.8 Food Wastes

Food wastes are generated primarily in the family housing areas and administrative areas, where the mess halls and restaurants are located. With the exception of oil and grease, all food wastes are being disposed of in the sanitary landfill. The option of using food wastes as pig feed was investigated. However, to meet current regulations, the food waste must be sterilized through cooking to prevent the spread of diseases. The economics of sterilizing the food make this option unattractive. Once a yard waste composting program is established, the addition of food wastes may be considered.

4.2.9 Construction and Demolition Debris

There are currently two inert landfills used for specified C&D debris at Fort Benning. Both sites are unfenced but are inaccessible due to the natural terrain and vegetation. Both sites are gated, and one is used primarily for the disposal of trees and vegetation. The other had been used for concrete, asphalt, dirt, brick, and stone, but is now closed. There are two unused inert landfill sites approved. These sites can be used only for vegetative waste, earth and earth-like products, concrete without rebar, brick, stone, and cured asphalt. There are no measurements of how much waste has gone into the inert landfills. In the past, C&D was handled by informing contractors of acceptable materials to bring to the inert landfills. The contractor was responsible for delivering the acceptable material to the designated locations. Before cover was applied, the material was checked to make sure it met specifications, and if it did not, the contractor was held responsible for removing the material.

The current trend in handling C&D debris is to require the contractor to dispose of the materials off-site. Fort Benning is actively reusing concrete rubble for erosion control and slope stabilization. Apparently the state regulator had a problem with the way the C&D debris was being used. The main complaint is the fact that there was some exposed rebar in the rubble. This problem is being mitigated by placing clean fill over the C&D debris.

4.2.10 Illegal Dumping

Fort Benning has experienced the most illegal dumping on the north end of base, near the Columbus/Muscogee County Landfill. Due to the remoteness of the location and its proximity to a public landfill, it is very easy for individuals to illegally dispose of wastes. The exact frequency of occurrence is unknown because of the time it takes to discover a site. However, on average there are 4 to 5 complaints per week of illegal dumping. The severity of these incidents range from isolated car batteries to large loads of roofing shingles. A large amount of the waste discovered comes from construction and remodeling. Those frequently reporting illegal dumping incidents include private citizens, Fort Benning personnel, and the military police. Signs forbidding dumping are posted around problem areas. It has been suggested that these signs may actually be detrimental, as they inform the customers of the landfill that there is a convenient place to dump close by. There is currently no money allocated for enforcement.

4.3 Current Waste Reduction and Disposal Practices

4.3.1 Solid Waste Storage and Collection

Various types of storage containers are used at Fort Benning. The type and size are as follows: 6, and 8 c.y. containers are the flip-top type and are not compacting. The 30 and 32 c.y. containers are of the compacting type. The maintenance program includes a regular pickup schedule for the containers to be cleaned and inspected for needed repairs. The containers are scheduled for repair once a month, as necessary. The frequency of the residential collection program is two times a week. The frequency of the non-residential areas ranges between one and six times a week. This variation is attributed to the demand on the container by the type and the volume of solid waste being generated.

Storage requirements are subjected to the average waste stream being generated at the location it is being utilized. The food waste should be bagged and all recyclable materials separated by specific category of recyclable material.

The scope of work, as it appears in section C.1.1 of the contract DABT10-92-B-0063, for the solid waste collection services reads:

> "The contractor shall furnish all labor, supervision, facilities, tools, materials, equipment, containers and vehicles as required and necessary for the performance of all operations incidental to the collection, transportation, disposal, and management of solid waste generated at Fort Benning, Georgia and Alabama. Areas which regularly generate solid waste include, but are not necessarily limited to: Family housing areas, administrative office buildings, dining facilities, medical facilities, training facilities, training areas and others. This contract includes all functions, tasks and responsibilities normally inherent to a refuse collection and solid waste management activity. All work under this contract shall be performed in accordance with the standards as contained or referenced herein. The Contractor shall schedule and manage all operations so as to maximize responsiveness, efficiency, and economy to the Fort Benning community."

Fort Benning contracts with Mark Dunning Industries, Inc., for its waste collection. This process includes curbside pickup in the housing areas as well as storage container collection from the non-residential areas. The contractor provides a certified landfill operator. Collection schedules for the solid waste on Fort Benning vary widely. The collection vehicle inspection process should include, but is not limited to, leaks from materials laden with fluid, and blowing materials as the vehicle travels on its collection routine. The mechanical inspection process should be part of a regular preventative maintenance program.

4.3.2 Source Reduction Programs

The source reduction program at Fort Benning is limited. Discussions with Fort Benning personal indicate little awareness of source reduction, its benefits, and implementation procedures. Current source reduction efforts appear to be limited to the provision of catalogs from the General Services Administration agents which indicate which products consist of recycled products, are easily recycled, or are low in toxicity.

4.3.3 Resource Recovery Program

The Recycling Program at Fort Benning is a designated "Qualifying Waste Recycling Program". The recycling program consists of a curbside pickup of recyclables from the residential areas, office buildings, individual units, and Fort Benning schools. Fort Benning residents are participating at a rate of approximately 62%, which is on par with the national average for similarly sized recycling programs. The recyclables are transferred to the Materials Recovery Facility (MRF), a facility designed for the separation of the serviceable/non-serviceable materials for proper marketing. The MRF is located at the intersection of 1st Division and Cusseta Road. The MRF is in need of a loading dock, both for the safety of workers and for efficiency of loading and unloading. There are six full-time (40 hrs/wk) workers at the MRF consisting of one manager, one supervisor, and four workers. The following is a list of the MRF equipment:

- Can conveyor separator
- Aluminum can condenser w/magnetic separator
- International glass granulator
- Cleated inground conveyor belt
- Horizontal bailer w/fluffer attachment
- Ball & Jewel plastic granulator
- Two forklifts
- Four-ton covered flatbed truck
- 1/2-ton pick-up
- 3/4-ton truck with fifth wheel
- Voluntary recycling station w/collection trailer
- Recyclable oil igloos
- Oil filter crusher
- Oil can and drum crusher
- Miscellaneous equipment: hand trucks, pallet jack, bandsaw, etc.

The bailer is an International model #4430-50, and has a Provita conveyer. The bailer is 48" wide, and is capable of an operating pressure of 25,000-lbs. The platen face pressure is 95 psi and the bails are secured with 4 ties. There are two 4,000-lb. forklifts, one propane, and one gasoline fueled. Both lifts break frequently and do not have pneumatic tires, which

limits the utility of the lift. Larger pneumatic tires are needed for outside work, particularly in the presence of mud. There are plans to purchase a 6,000-lb. forklift with pneumatic tires in the near future. The 82" bandsaw is used to saw the bindings off hardbound books and large periodicals to recover the paper.

Currently Fort Benning's source recovery program receives and/or collects the following items:

- **Glass containers (clear/brown/green)**

  Glass is primarily collected from family housing and service establishments serving beverages in glass containers. Most of the glass containers received are beer bottles. The glass is sorted by color into three categories, clear, amber, and green. Twenty percent breakage is allowed in the mix. The volume of glass handled is about 40,000 pounds per month. The market for glass is very limited, in part due to the freight costs. Recycled glass is currently being stored in tri-wall boxes for future sale or reuse. If no markets become available, the glass may be crushed and used as daily cover at the sanitary landfill (pending regulatory approval).

- **Metal cans**

  Metals are sorted to separate aluminum, mainly aluminum cans, from other metals. Aluminum is condensed into cubes and palletized for marketing. All others are taken to DRMO and marketed as scrap metal. The source of the metal cans is primarily the curbside collection at family housing. An organization called Better Opportunities for Single Soldiers (BOSS), handles the aluminum collection. BOSS was formed before the formal recycling effort started, and it was allowed to continue its efforts even after the curbside collection started. BOSS places aluminum can collection containers in barracks, offices, the commissary, and other various locations to promote the recycling of aluminum. The organization is responsible for the servicing of these collection containers and delivering the aluminum collected to the MRF. Currently BOSS receives the revenues from both the aluminum collected in its bins, and in the curbside collection. The aluminum is picked up once a month by a local salvage yard.

- **Plastic containers**

  Most plastics are collected from the family housing areas. All types of plastics are accepted. Plastics are sorted into three types, (1) Polyethylene terephthalate (PET) and (2) High-Density Polyethylene (HDPE) white, (3) HDPE clear, and mixed. Once sorted, the plastics are bailed for marketing through the DRMO. Currently there is no market for the mixed bails, and as a consequence, they have been landfilled. The MRF manager is seeking a potential buyer of the mixed bails, and might have found one. If mixed bails are accepted, the previously non-acceptable plastics will not have to be landfilled. Problems associated with the handling of plastics at the MRF are malodorous smells, insects, tops left on containers, and

the very large volume of plastics required to create a bail. Currently, it takes about a week and a half to receive enough plastics for one bail.

- **Used motor oil**

  Used motor oil is collected and reused as a supplemental fuel at the installation's boiler facility. In the past, recyclable oil igloos were provided at two service stations and two fire stations for individuals to dispose of their waste oil. However, due to misuse of the igloos, i.e., placing of antifreeze, fuels, and other items other than waste oil in the igloos, this service was discontinued. The service station personnel also complained of having to clean up around the igloos. Currently the only place to dispose of waste oil is at the MRF, which is a considerable distance from the population centers of Fort Benning, and the Automotive Hobby Shops. There are two Automotive Hobby Shops provided as an area for military personnel to work on their own vehicles. However, there is a $2 fee for the disposal of waste oil, which has deterred many from using the facility.

- **Paper products/containers**

  All types of paper products, including newsprint, are accepted and processed. The majority of the paper comes from offices and family housing units. In the offices, the boxes that paper comes in are used as a collection receptacle. These boxes are placed near each copy machine. Every Tuesday the **boxes** are placed in the hallways for pickup. Janitorial service personnel move the boxes to a loading dock where MRF personnel can collect them. Paper is sorted into three types: corrugated, office paper, and mixed. For the most part the paper is source separated, and a minimal amount of sorting is required for quality control when it reaches the MRF. Cardboard is collected on demand by MRF personnel using a one-ton pickup. All types are bailed and marketed. Paper is picked up by the buyer every two weeks

- **Other items**

  Some other items that are handled in much less volume include wooden pallets, plastic targets, Christmas trees, phone books, cinder blocks, and used oil filters. Currently the wooden pallets are stockpiled for reuse on the base. There are companies in Columbus that buy used pallets, but the DRMO has not been able to secure a contract. One possible reason for this may be because business owners do not want the paperwork headache that is associated with the DRMO. Once the DRMO signs the papers declaring that the pallets have "no market value," they must be legally disposed of. If they are not reused around the base, then legally they should be landfilled. Christmas trees are collected and used for erosion control and for fish habitat.

Notably absent are corrugated containers and yard waste. Fort Benning currently accepts corrugated containers in the resource recovery program, but has plans to actively

collect and directly market it in the near future. Additionally, Fort Benning's DPWE has a plan approved for yard waste composting.

The contractor that handles solid waste collection is also responsible for the collection of segregated recyclables from all Fort Benning Family Housing areas. The collected materials are delivered to the Material Recovery Facility (MRF), which is building 4000. Collection points for family housing areas are the same as for refuse collection. Cans (aluminum and steel), plastic, glass, and newspapers are picked up by the contractor. Occupants of Fort Benning's family housing are issued a brown container by DPW's Family Housing Branch. The occupant is responsible for placing recyclables in this container and having it at the curbside prior to 0730 hours on the scheduled pickup date. Newspapers are placed in brown paper bags or tied in bundles and placed at the curb. Recyclables are picked up once a week and the contractor is responsible for delivering segregated recyclables to the MRF. The contractor is responsible for notifying residents of non-conforming recyclables. The following restrictions apply to the collection of recyclables:

- **Cans:** must be free of solid or liquid wastes.
- **Plastic:** bottles must be free of solid or liquid waste and must have the caps removed.
- **Glass:** only the following containers are included–soft drink, beer, juice, ketchup, wine, liquor, and food. Containers must be free of solid or liquid wastes and must have the caps removed. Unacceptable items include mirrors, ceramics, cups, plates, crystal, light bulbs, window glass, heat resistant ovenware, and drinking glasses.
- **Newspaper:** must be placed in brown paper bags or bundled and tied.

4.3.4 Existing Solid Waste Facilities

There are several municipal solid waste management facilities located on and in the general region of Fort Benning. The locations of these facilities are shown in Appendix 1. First Division Road Landfill is the only sanitary landfill in operation at Fort Benning. There is one active inert landfill on Fort Benning and none in the general region. The Cusetta Road inert landfill is for untreated wood and vegetation waste. Much of the material at this site is suitable for erosion control, or could be used as a fuel source or composted. This site is in the process of closing, and the GA EPD will be notified when closure requirements are completed. There are no transfer stations located on Fort Benning. There is one Materials Recovery Facility (as described in section 4.3.3) on Fort Benning.

The First Division Road Landfill operates between 0700 and 1600 hours Monday through Friday and 0700 to 1200 on Saturday. There are 13 full-time workers, one part-time worker, and one full-time manager at the site. The equipment at the First Division Road Landfill consists of a highwheel D7 dozer, tract front-end loader, farm tractor for site maintenance, and a water truck. A Cardinal electric scale was installed in 1993. The disposal rates for 1993 and 1994 were 44,000 and 28,000-tons, respectively. There has been less than

10,000 tons disposed of in the landfill for the first five months of 1995. The 30-acre site is fenced and secured with a gate. There is an operator shed that is approximately 120 square feet, and a wash platform. The wash platform is provided only for the washing of vehicles, not refuse containers. Water and electricity are available at the site, and telephone service is provided through the contractor. The landfill is unlined and a contractor, Polyengineering, is currently preparing closure and post-closure plans These plans are to include explosive gas and groundwater monitoring, and an operating record. The plan is due on September 15, 1995.

CHAPTER 5. MANAGEMENT ANALYSIS/COORDINATION BETWEEN ORGANIZATIONS

Section 4.1 describes both DoD policies and Fort Benning's descriptions of the responsibilities for various management levels. One aim of this research was to analyze the management structure from an operational viewpoint. Operational in this context means the organizations that are responsible for accomplishing solid waste management on a day-to-day basis. In the course of this research, it was discovered that Fort Benning was interested in revising the Memorandum of Instruction (MOI) for the Qualifying Recycling Program (section 4.1.2). In consultation with AEPI, it was decided that the most beneficial approach to analyzing the management structure would be to help Fort Benning staff review the existing MOI. The MOI sets forth responsibilities for the operation of the recycling program and includes the main organizations that are responsible for solid waste management. The goal of this approach was to provide AEPI with insight into the management structure, and to provide Fort Benning with assistance on reviewing the MOI for the qualifying recycling program.

As previously mentioned, the major organizations involved in solid waste management are Department of Public Works (DPW), the Defense Reutilization and Marketing Office (DRMO), the Directorate of Community Affairs (DCA), and the Directorate of Logistics (DOL). Of these organizations, DPW definitely has the proprietary role in accomplishing solid waste management. DPW handles all contracting and management of solid waste disposal. The other organizations' responsibilities lie within the scope of the recycling and source reduction mission. DOL's role in the recycling arena is somewhat questionable and will be discussed in detail. Table 5.1 gives a brief job description and the contact (if available) of various groups at Fort Benning.

Through discussion with personnel in the DCA, MRF, DPW, and DRMO, it became clear that good lines of communication are open between the organizations responsible for solid waste management, specifically recycling. One of the major problems with the recycling program seemed to be the failure to comply with the existing memorandum of instruction for the recycling program. Many organizational and institutional problems with the management structure were noted and will be discussed in detail in the following sections.

ORGANIZATIONS

NAME	RESPONSIBILITIES	CONTACT	PHONE #
DPWE Contract Administration Division	Solid waste collection contracts	M. Machovec	(706) 545-5171
DPWE Contract Inspection Division	Inspection of contracted services Quality control	Richard Chancy	(706) 545-7177
DPWEnr Div	Solid waste disposal	Walter Nichols	(706) 545-1007
Mark Dunning Industries	Recyclables collection and delivery to MRF Operation of landfill Solid waste collection	Paul Webb	(706) 544-6030
DPWEnr Div	Construction and demolition waste disposal	Walter Nichols	(706) 545-1007
DPWEnr Div	Public education-recycling	Walter Nichols	(706) 545-1007
DPWEnr Div	Public education-solid waste collection and disposal	Walter Nichols	(706) 545-1007
NAF	Marketing of materials purchased with non-appropriated funds	Debbie Adison	(706) 545-3700
DRMO	Marketing of recycled materials purchased with appropriated funds	Fred Hiers	(706) 545-6079
DCA Directorate of Community Activities	Accounting/tracking of proceeds from recycling/morale and welfare expenditures	Debbie Adison	(706) 545-3700
RRRP Resource Recovery Recycling Program	MRF	Tom Moore	(706) 544-6142
DAO Defense Accounting Office	Checks and balances		
PAO	Public education		

5.1 Coordination Amongst Organizations

A significant management issue facing the Army is coordination among organizations. To meet changing solid waste regulations, coordinated management of solid waste programs will be required, and new programs, such as household hazardous waste and structured source reduction, may be necessary. Coordination is mandatory to achieve waste reduction goals, material specific disposal bans, and environmentally sound disposal systems.

There are potential conflicts between the entities with solid waste management responsibilities. This conflict stems from a non-reciprocal dependency between organizations. One organization must depend on another organization in order to carry out its mission, but has no control over the other organization. This problem is compounded when the other organization does not share the dependence to achieve its own mission. This relationship exists between DCA/DPW and the DRMO. DCA/DPW relies on the DRMO to market materials purchased with appropriated funds, receives the revenues from the sale of these materials, needs the revenues to continue operations, and can only hope that DRMO is getting the best prices it possibly can for materials. Additionally, DCA relies on DRMO to provide information on the amount and sale price of recyclables sold for accounting purposes. This information is provided to DCA on DLA form 1367. There have been problems in the past with incorrect information provided by the DRMO. Lack of correct information creates significant accounting difficulties and increases the complexity of running the recycling program. The DRMO, on the other hand, does not see the revenue from the sale of these materials and has little incentive to maximize revenues. Additionally, the DRMO perceives no problems with the existing recycling system. It is important to note that DCA serves as the accounting body for the MRF, which is under control of DPW. In this way, a large factor in the success of the recycling program lies with the DRMO.

The responsibilities of the DRMO are discussed in sections 4.1.2.1.3 and 4.1.1.8. There are several problems associated with the DRMO's role in recycling. The following is a brief discussion of those concerns. One concern is that the DRMO is too big and serves too many "customers" to understand local recycling markets, and its list of vendors is out of date. For example, if the DRMO is selling brass from spent ammunition at a significantly higher price than scrap paper, then the importance of getting a good price for the paper may be diminished. For illustrative purposes, say the brass is selling for $100/ton, and the paper for $10/ton. The DRMO logically will spend more effort on getting a better price for the brass because it is worth more. However, the importance of securing the best possible market value for the paper is critical to the recycling program.

Another complaint along these same lines is that the DRMO does not have any incentive to market materials since it does not see the revenue. Yet another problem is that potential buyers of recyclables do not like dealing with the DRMO because of the paperwork and procedures involved. The new "Retail Sales Program" is basically a cash-and-carry type operation. That is, the buyer must pay with a certified check when picking up merchandise. Therefore, a potential buyer must make one trip to inspect the material, and then send a truck on a second trip to pay and pick up the material. Since the volumes of recyclables sold by DRMO, out-of-town buyers are less likely to go through the hassle to buy them.

Another problem area with the DRMO lies in handling the revenues from recycling. A chief complaint is that it is very difficult to track revenues through the DRMO. Return of revenues frequently take up to a full year through the DRMO, making the operation of the recycling program more difficult. This particular problem is not the fault of DRMO. The DRMO forwards the sales receipt on to another agency and is no longer in control of when revenues will be returned. However, this problem stems from the need to sell materials

through the DRMO. The DRMO is definitely not the only problem with the recycling program, but it was cited by almost every one of the Fort Benning personnel interviewed as being a barrier to improved recycling.

The aforementioned problem with DOL's role in recycling comes from an organizational viewpoint. Currently there are seven employees employed out of recycling funds working for DOL. There are only five personnel from DPW working at the MRF. These seven employees from DOL account for 60 percent of the total labor costs of the recycling program. Two of these employees handle the brass from spent ammunition. The other positions relation to recycling is ambiguous. In any case it makes no sense to have recycling employees under DOL. These employees should be managed by the materials recycling facility to maximize the benefit of these employees to the program. The recycling needs of DOL can be handled by the same employees through the MRF, and they can be utilized for other recycling–related work.

CHAPTER 6. ARMY IMPLICATIONS

The following section is meant to provide a very brief summary of some of the important issues raised during the course of the research that have significant implications to the Army. Most of the material in this section is covered in more detail in the text of the report, and will be redundant if you are reviewing the entire document.

6.1 Yard Wastes

With yard waste comprising approximately 17% of the municipal solid waste stream, composting can be an effective means to reduce landfill disposal. Since Army installation waste streams are very much like municipal ones, a significant reduction of landfill disposal can be achieved by implementing a simple yard waste composting program. A yard waste composting program can help solid waste managers meet mandated reduction goals. It has been shown that the diversion of yard wastes from a landfill can increase its life expectancy by as much as 25%[62]. This extension of landfill life may be crucial for those installations that are rapidly approaching capacity limits on their existing landfills. Furthermore, composting is a beneficial way for wastes to be reutilized, and is relatively inexpensive to implement. Additionally, in most states there are relatively few regulatory hoops to jump through. Composting of yard wastes can and should play a major part of solid waste management for the Army and should be implemented at all appropriate installations as soon as possible.

The Army should facilitate the yard waste composting program by disseminating the necessary information. Solid waste managers need to have a means of communicating the knowledge of what works for other bases and communities. In this way a network of successful composting initiatives can be built, and can serve as models for those just starting their program. One of the best ways to learn how to build a strong composting program is to visit sites that have established programs, and to talk to as many people as possible.

6.2 Construction and Demolition Debris

Construction and Demolition (C&D) activities produce a significant amount of waste. The most prominent disposal method for C&D debris at Fort Benning is landfilling. Very little has been done to organize a permanent recycling effort of C&D debris. Fort Benning is currently demolishing several World War II barracks. These wastes are going to the landfill and rapidly depleting the remaining capacity. With the amount of construction and demolition performed on Army installations, a recovery program needs to be developed. In a Memorandum for Commanders on November 17, 1995, TRADOC Engineer George Morgan stated that: TRADOC is considering the demolition of 1/3 of all TRADOC infrastructure due to downsizing and high maintenance costs. It was also mentioned that the buildings being considered for demolition were not limited to WWII era structures. It is very unlikely that a C&D recovery operation will be cost-effective for any installation. However, proceeds from the recycling program may be used to offset some of the costs of a program, and the avoidance costs and beneficial reuse of materials can be used to justify a program.

Another alternative is to look to regionalization. By working with the surrounding communities, Army installations can take advantage of economies of scale and make a C&D recycling program more cost-effective.

6.3 Recycling

There are several areas of interest that have major implications in the recycling arena. One of the more important decisions that needs to be made is what items will be targeted for improved recycling rates. Typically, a waste characterization study is used to analyze the waste stream to determine composition. On most installations the greatest "bang for the buck" is going to come from recycling corrugated and paper. Paper is the major contributor to solid waste by either weight or volume. In 1990, paper constituted 32% by weight and 31% by volume of waste sent to disposal, according to the U.S. EPA. Old corrugated containers (OCC) also comprise a large portion of the waste stream. Except for food and yard waste, OCC is still the largest single material category that we discard. In 1990, OCC comprised 8.1% of landfilled MSW by volume.

The Army can greatly reduce its waste stream by targeting paper and corrugated. Increased recycling participation from offices and activities is essential. The recycled paper market has been very good recently, and paper recycling programs have excellent potential for producing significant revenues. The Army should look to successful recycling programs that are currently working. Section 3.4 of this report discusses how Coca-Cola has achieved excellent recycling rates in its offices.

6.4 Household Hazardous Wastes

The most significant issue facing the Army in the area of household hazardous wastes is liability. The regulatory landscape has changed significantly over the past several years. The implications of the Superfund Amendments and Reauthorization Act (SARA) regulations add another dimension for decision-makers. The question that arises is, "Is it cost-effective to manage a possible liability or take the chance that the landfill will become a Superfund site sometime in the future?" Federal, state, and local landfill regulations are forcing solid waste managers to examine the contents of the loads more carefully before the loads are allowed to enter a facility. Additionally, more attention is being paid to the amount of wastes generated, as well as the types of wastes. Most Army installations do not have a household hazardous waste program.

Various methods have been employed in an effort to mitigate the impact of hazardous wastes that are generated in the home. A common method is to have a hazardous waste collection day. Unfortunately these events are often poorly attended, and the costs become prohibitive when measured against the amount of pollution prevented.

There are four areas that must be given attention to put together a successful household hazardous waste program that maximizes the amount of pollution prevented while minimizing the associated costs. The four areas are public awareness, collection,

decommissioning, and disposal[63]. Public awareness of this issue will be the first step in controlling household hazardous wastes for all installations.

6.5 Illegal Dumping

Illegal dumping continues to be a problem for the Army. The Army seems to be satisfied with taking reactionary approach to dealing with this problem. There is no funding for prevention or prosecution. As landfill space becomes more scarce, this problem is likely to become more severe, and actions should be taken now to reduce it.

6.6 Management Issues

A significant management issue facing the Army is coordination among organizations. In order to meet changing solid waste regulations, coordinated management of solid waste programs will be required, and new programs may be necessary. Coordination is mandatory to achieve waste reduction goals, material specific disposal bans, and environmentally sound disposal systems. In order to improve coordination, a solid waste management team comprised of the appropriate management level representatives from each of the organizations with solid waste management responsibilities should be established.

Another area of concern is the relationship among organizations. There are potential conflicts among the entities with solid waste management responsibilities. This conflict stems from when one organization must depend on another organization in order to carry out its mission, but has no control over the other organization. This is compounded when the other organization does not share the dependence to achieve its own mission. This relationship exists between DCA and the DRMO. DCA relies on the DRMO to market materials purchased with appropriated funds, receives the revenues from the sale of these materials, needs the revenues to continue operations, and can only hope that DRMO is getting the best prices they possibly can for materials. The DRMO, on the other hand, does not see the revenue from the sale of these materials and has little incentive to maximize revenues.

6.7 Source Reduction

The U.S. EPA defines source reduction as any practice which decreases the quantity or the toxicity of solid waste before it enters the waste stream. Examples of source reduction activities include reducing per capita waste generation rates, eliminating toxins in packaging, using less material to make a package or product, and purchasing more durable products. Source reduction is addressed in DoD directive 4165.6, which states that "the military is committed to a rigorous schedule of waste minimization and quantities of solid waste materials are to be reduced at the source whenever possible." However, there is very little source reduction being practiced at most installations. Education seems to be a large barrier for source reduction. Many managers do not have a clear idea of what source reduction entails, and have been given no goals or direction on how to achieve it.

Major commands need to develop a structure for implementing a source reduction program. Specific examples of source reduction activities that apply to most installations would be beneficial. Since source reduction goals are typically hard to quantify, it is harder to measure progress. A method for measuring waste avoidance through source reduction needs to be developed as a tool for solid waste managers on Army installations.

6.8 Accounting for Recycling Revenues

A significant issue facing the managers of RRRP programs is the tracking of funds. DCA relies on DRMO to provide information on the amount and sale price of recyclables sold for accounting purposes. This information is provided to DCA on DLA form 1367. There have been problems in the past with incorrect information provided by the DRMO. Lack of correct information creates significant accounting difficulties and increases the complexity of running the recycling program. Additionally the return time on accounts receivable is typically six months, and often is as long as a full year. This long return time creates serious budgeting and operational problems.

6.9 Contracting

The downsizing of the government and budgetary reductions make the expansion of solid waste management programs difficult. However, the Army can require private business to comply with its solid waste management plan through contracting. For example, gas stations located on the installation could be required to accept used oil from privately owned vehicles as a price of doing business on base. The gas stations would then be responsible for the maintenance and operation of oil "igloos," reducing the amount of manhours that the Army expends. The handling of cardboard is another example of how contracting may be used to help the solid waste management effort The government spends appropriated funds to buy boxes when personnel move. The contracted movers collect the boxes after the move has been completed and sell them. They are effectively paid twice for the same boxes. The Army could specify in the contract that boxes are to be collected by the movers and delivered to the MRF to be recycled by the Army, or be given a discount when the boxes are first purchased. These types of contracting clauses could produce significant revenues that could be used for other solid waste projects.

6.10 Appropriated Funds

An important question that needs to be addressed by Army policy makers is the issue of when an item that is purchased with appropriated funds no longer becomes the property of the DRMO. Policy needs to state that when an item enters the waste stream and is headed for the landfill, then that item is no longer in the domain of the DRMO. Additionally, the issue of "mining" landfill has been raised. If a contractor wanted to "mine" a military landfill to recover valuable materials, is the material that is in the landfill that was originally purchased with appropriated funds still the property of the government?

6.11 Avoidance Cost

The Army needs to develop policy concerning the inclusion of avoidance cost when performing cost-benefit analysis on recycling office. The savings to the Army in terms of landfill space and future liability are significant, and should be factored into cost accounting. For example, say Fort Benning was looking at implementing a program consisting of collecting cardboard from all activities weekly. When conducting the cost-benefit analysis for this program, the weight of the cardboard diverted from the landfill should be computed into the cost analysis based on the current tipping fees.

CHAPTER 7. RECOMMENDATIONS

7.1 Public Education Planning

Currently Fort Benning's recycling program suffers from some misconceptions about the value of the recycling program and a lack of participation. These problems seem to persist both in residential and office areas. Apparently an article was published in the installation newspaper, *The Bayonet*, which portrayed the recycling efforts on base in a negative way. It is therefore important to overcome this negative press and to convey the necessity and worth of source reduction and recycling. The direct benefits of the recycling programs, i.e., the BOSS program and the possibility of recycling revenues being used for MWR purposes, need to be emphasized. Additionally, the avoidance costs of recycling can be stressed. Since Fort Benning is in the process of closing one of its landfills, this is an opportune time to stress how much it costs to close a landfill. This would be an excellent and tangible reinforcement of the cost avoidance to Fort Benning residents and personnel. Participation in waste reduction and recycling programs at Fort Benning will be difficult to achieve without strong promotion and education. Army guidelines support this view:

> *"The primary key to a successful recycling program is a strong educational program that gets information to everyone in the community and attempts to elicit everyone's participation...Keys to community involvement include strong educational and training programs, publicity and support from the command level, and grass roots involvement.*[64]*"*

The following topics were included in a solid waste study performed for Fort Bragg[65] This information is being provided because it is directly applicable to Fort Benning's planning efforts for public education.

Most recycling programs include some element of public education. At a minimum, this education may involve signs on drop-off containers or fliers passed out during curbside bin distribution. Fort Benning's recycling program should implement a public education strategy that incorporates these elements as well as additional activities designed to promote participation and increase program performance. Currently the public education program at Fort Benning consists mainly of a biweekly article published in the *Bayonet*, which is the installation's newspaper. This article is written by personnel in the DPW's Environmental section.

It is recommended that Fort Benning use the "Solid Waste Team" (discussed in section 7.3) to establish a public education plan that integrates promotion and education activities pertaining to all solid waste, recycling, and salvage services. An integrated educational and promotional strategy will provide opportunities for delivering multiple service messages and minimize redundant communications. The opportunity for delivering contradictory messages will also be minimized, while a unified educational campaign, including uniform appearance of printed materials, will be possible. By consolidating and

coordinating educational programs and materials for all solid waste services, Fort Benning can more effectively control overall service delivery.

7.1.1 Planning Fort Benning's Public Education Strategy

The process of planning a public education program focuses on the basics of a public relations campaign. As with the development of most plans, a very important initial step is to identify specific program goals and objectives. Recommended education and promotion goals for Fort Benning include[66]:

- Educate all solid waste generators about source reduction and recycling and their benefits.
- Generate pride and ownership in the recycling program.
- Achieve highest practical participation rates in source reduction and material recovery programs from residential and non-residential generators.
- Maximize quality of materials presented for recovery and recycling through education of separation requirements and contaminant issues.
- Inform and motivate waste generators to properly manage their waste.

Education and promotion objectives should include general objectives, such as those pertaining to increasing overall support for recycling, as well as program-specific objectives, such as those outlining how the program works, which materials are accepted, how they should be prepared, etc[67].

The success of Fort Benning's public education program can be better determined by developing objectives that are measurable—for example, objectives specifying desired participation rates, tonnage, contaminant levels, or participant attitudes measured by a survey[68].

7.1.2 Public Education Methods

Target Audiences: In order to avoid the common pitfalls of promotion campaigns, program promotion efforts should be focused on motivating target populations which have a convenient means to participate, as opposed to directing the message to the public at large. As with marketing of any product or service, the key to success is carefully identifying each target audience and selecting incentives likely to be effective for each group.

Choosing target audiences for each message will increase the probability of participation among different groups. The Army guide recommends that the installation community be categorized into the following groups[69]:

- Military and civilian workforce
  - Both APF and NAF employees
  - Single soldiers
- Family housing residents
  - Community life offices
  - Mayor organizations
- Dependent school students
  - Curricula

Themes and Messages: Effective promotion should include themes and messages which have relevance to specific target audiences and focus on specific aspects and successes of the program. Themes should be simple and consistently presented to effectively change and reinforce behavior. One means of consistently presenting information and uniting an overall campaign is to develop a logo and slogan, or catch-phrase, and use it on printed materials and publicity whenever possible[70].

It is recommended that Fort Benning establish a specific recycling logo and slogan and use it consistently on promotional and educational materials wherever possible. Instead of the generic three-arrow recycling symbol, a customized graphic representing Fort Benning will be more effective. Fort Benning may want to sponsor a contest to develop an integrated logo and slogan for the recycling program.

Messages developed in planning and implementing a public education program fall into two basic categories: general messages and service-specific messages. These messages may be delivered separately or combined in single educational pieces and presentations[71].

General Messages. General messages answer broad questions such as: "Why recycle? Why reuse waste?" or convey simple directives such as "Recycle" or "Don't Litter".

Service-Specific Messages. While general messages have broad-based appeal, service-specific messages are designed to answer who, what, when, where and how questions related to specific programs or services. Service-specific messages are essential to smooth operation and high participation in waste management and recycling programs. Service-specific messages should be simple, direct, unambiguous, and include a point of contact and phone number for questions[72].

Printed Materials: The production of take-home items such as brochures, booklets, flyers, grocery bags, refrigerator magnets and other printed material can be very valuable in promoting and ensuring proper participation if carefully designed and effectively distributed. However, it is important to take steps to ensure that the materials prepared will be used. Having the materials become out-of-date before all supplies are used only adds to solid waste management needs. A realistic distribution plan and timetable should be prepared in advance of publishing printed materials to keep content current throughout the distribution period and determine the appropriate quantity to be printed[73].

Signs: Simple pictures and graphics (color-coded in the case of glass) should be used to help clarify the types of materials collected, preparation requirements, and the contaminants to be avoided. Signs should be designed to coordinate with the printed materials to be prepared[74].

Newspaper, Radio and Television: In tackling the issue of media coverage, Fort Benning should seek extensive free media coverage to the extent available, such as news stories, editorials, and public service announcements (PSAs) rather than involving significant use of paid advertisements. There are several drawbacks, however, in relying on free media coverage entirely, including the inability to fully control the informational content released, the extent to which media coverage is provided, and the time that coverage is released.

These drawbacks can be mitigated by conducting periodic briefings with the news media at Fort Benning and in Columbus. Information packets for media representatives should be distributed that include pertinent facts and figures to be communicated plus a listing of ways in which the media could provide ongoing assistance. Issue periodic news releases when events or decisions likely to elicit media coverage occur[75].

Newspaper. Currently, DPWE promotes recycling by placing frequent small articles in the installations newspaper, reminding residents to recycle. Depending on the availability of staff time, Fort Benning may want to initiate an environmental column in the installation's newspaper, which could include recycling hints and "how to's", discussions of waste management issues, and where to get more information.

Radio. In addition to public service announcements, radio stations will often promote good causes to increase their community service air time and demonstrate their support for their listening community. Fort Benning should increase efforts to reach radio audiences through PSAs, by providing recycling program representatives to discuss recycling and solid waste issues on talk show programs, and by soliciting radio coverage of special events such as recycling drives and award ceremonies.

Direct Contact: One-on-one communication is highly effective in gaining support and motivating individuals to take action. Direct contact can take the form of telephone assistance or meetings with program participants. Fort Benning's recycling program could publicize its phone number on most fliers and could be available by phone to answer questions from post

residents. It is recommended that Fort Benning assign a staff person the responsibility for coordinating all public education, outreach, and publicity[76].

Speakers Bureaus: Speakers Bureaus comprised of trained volunteers can also be effective in making presentations to neighborhood, environmental, and civic groups. Speakers bureaus will free staff and enable speakers to reach groups of people instead of addressing information needs on an individual basis. These organizations can be very effective if the speakers are properly trained and equipped. The use of slide/audio presentations can take a large amount of the burden off the speakers in delivering accurate information in an entertaining fashion. Fact sheets can assist the speakers in fielding questions after the presentations. It is recommended that Fort Benning establish a speakers bureau to make presentations to neighborhood, environmental, and civic groups.

Special Events and Incentive Programs: An annual award program could be initiated which rewards the neighborhood with the highest recycling participation. The mayor of the winning neighborhood receives a plaque from the Garrison Commander and Chief of Staff. In addition to the existing special events and incentives, Fort Benning may want to consider[77]:

- Establishing a contest involving a cash giveaway to randomly selected households who participate in the recycling program;
- Establishing discounts for admission to events for attendees who bring recyclables; and
- Creating a recycling "mascot" who makes appearances at special events and appears in T.V. public service announcements, brochures, photographs, etc.

7.1.3 Educating the General Public

Education on the need to reduce the generation of waste is imperative to a sound waste reduction program. The more information people acquire on the practice, the more likely they are to participate.

Education on source reduction helps the public to realize why it is important and increases their desire to learn more about the practice. Communication of information on the amount of packaging disposed of each year may convince others of the immediate need to purchase goods with less packaging.

Educational information can be disseminated in a variety of ways such as school programs, publications, fairs, public speaking engagements, displays, technical assistance, waste education handbook(s), award programs, etc.

Education should focus on the fact that the cost of packaging accounts for $1 of every $10 spent at the store and that by selecting products with longer lives and those which can be repaired, the amount of waste generated will decrease.

The following suggestions may be conveyed to the public via flyers or brochures distributed at retail outlets or by mail[78], and the PX may be used as a role model to facilitate the following:

- Buy reusable items in place of disposables.
- Buy durable goods and appliances.
- Buy only what you need and buy in bulk to save packaging and trips to the store.
- Avoid excess packaging.
- Repair worn and damaged goods.
- Give items no longer needed to neighbors, friends, or charities.

7.2 Recycling Program

The recycling program at Fort Benning is currently diverting significant amounts of materials from the sanitary landfill. The current program has been a success for the solid waste managers at Fort Benning, but there are several areas that need improving. The most important of these is public education on the recycling program. This issue is addressed in detail in section 7.1. Public education will improve all aspects of the program.

Fort Benning needs to achieve better recycling participation from all parties, but particularly from the activities and office buildings. There is still a very significant amount of paper and cardboard going to the sanitary landfill. Successful office recycling programs should be studied and emulated to reduce the amount of paper going to the landfill.

There are several potential changes or improvements to the Material Recycling Facility that could improve safety and efficiency. The MRF is in need of a loading dock, both for the safety of workers and for efficiency of loading and unloading. Additionally, a loading dock enables brokers of recycling materials to drop off their trailers to be loaded directly. Adding a loading dock would make the materials from the MRF more marketable, increase the storage capacity of the MRF, and reduce man hours spent moving and loading material. All of these changes increase efficiency, and improve chances of getting better prices for materials (particularly newspaper). If Fort Benning is committed to recycling as a solid waste management tool, a loading dock should be added as soon as possible.

Another item the MRF is in need of is an additional bailer. The existing bailer has been unreliable, and every time it breaks there is a stop in production. Additionally, there is a capacity problem with the existing bailer. As more materials are recovered, the existing bailer will not be enough. Adding a second bailer will improve production capacity, as well as eliminate down time at the MRF. This addition should improve the efficiency of the existing labor source.

A cost-effective way of getting cheaper labor at the MRF needs to be explored. Part-time workers working near minimum wage may be an option. Fort Sill and Fort Stewart have used troop labor to enhance their recycling program. Soldiers can work directly in the MRF,

or participate in other ways. Delivery of recyclables to market, or pickup of recyclables from different activities, may be used as troop exercises. Very often troops are idle. It would be a benefit to the base and to the program if everyone contributed to the recycling program.

An important recommendation for the recycling program is direct marketing of materials. This method is already being pursued at Fort Benning and approval has been granted. Direct marketing of material bypasses the DRMO and the aforementioned associated problems. Those materials which are not easily marketable should still be handled through DRMO.

Fort Benning has a "recycle manager" position which is currently unfilled. The MRF manager, Tom Moore, is currently performing some of these duties but cannot perform both jobs at once. Mr. Moore has been very proactive with the recycling program and has been instrumental in pursuing the direct marketing of recyclables. The recycle manager position needs to be filled.

The recycle manager should coordinate solid waste management activities, including: disposal, recycling, waste reduction, yard waste, construction and demolition debris management, reuse and public education. Additionally the recycle manager should act as a catalyst to make sure the MOI is being adhered to, and actively achieve coordination between organizations. The recycle manager should provide staff support to the Solid Waste Team (see section 7.3), prepare annual reports, monitor progress of programs, and assist with program expansions and new programs in the area of solid waste management. This effort may include market research for direct marketing of recyclables, ways of expanding markets, and vendor selection. The recycle manager must treat recyclables as his commodity, and research market specifications to make his commodity more valuable. Included in this research may be contamination issues, and quality control.

In the area of non-residential recycling, the recycle manager must ensure that there are recycling coordinators in each activity and that they are actively performing their duties. The coordinator should work with each activity to ensure there is the appropriate combination of containers and collection vehicles and provide ongoing technical assistance and education to non-residential facility managers. He must also determine the storage and collection limitations at each site. The results of a post-wide solid waste audit would be particularly useful for the recycle manager.

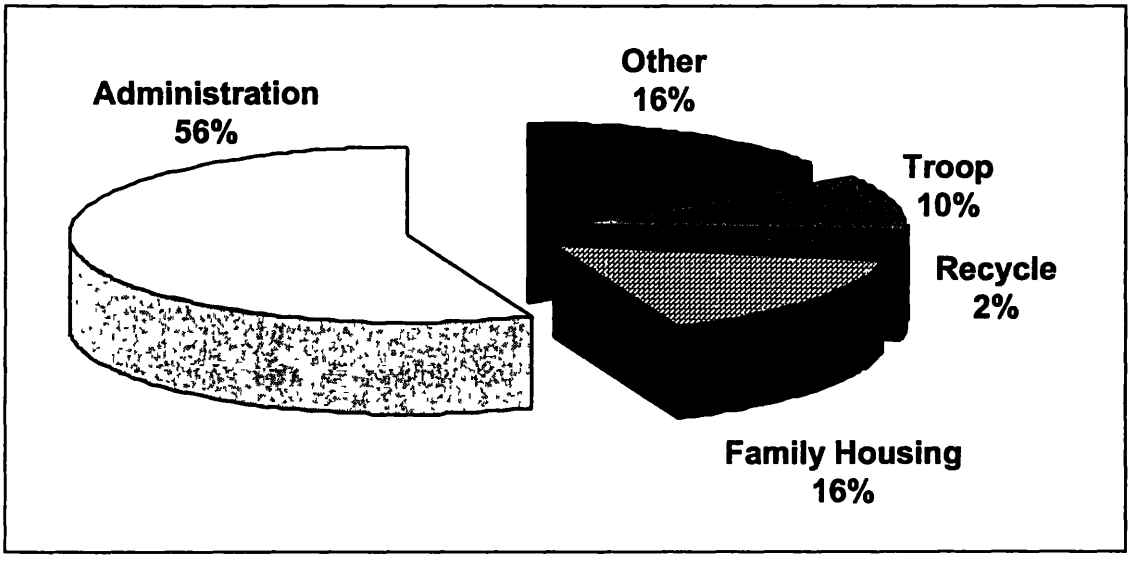

Figure 7.1- Fort Benning Waste by Area

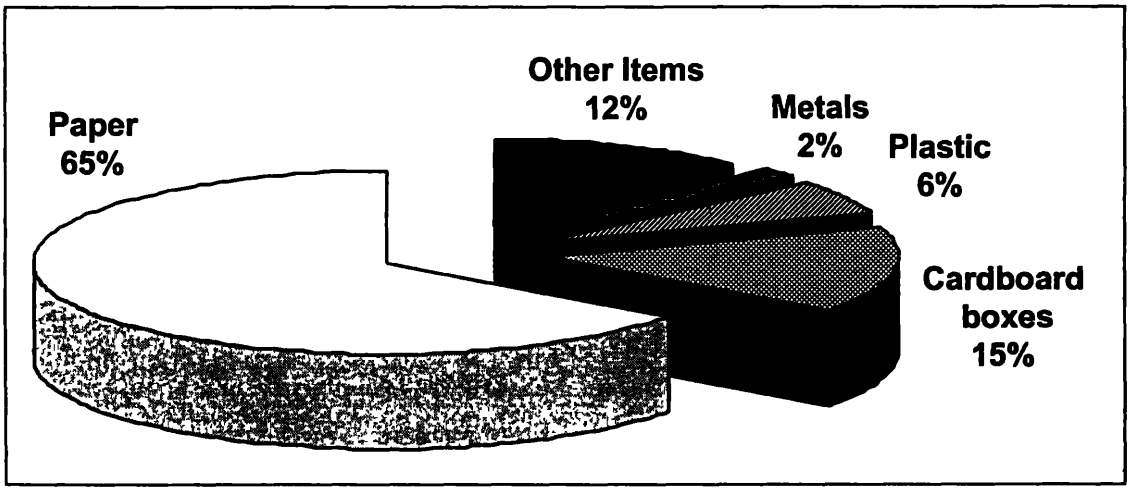

Figure 7.2-Average Office Waste Stream Composition

7.3 Management Structure

As mentioned in Section 5, Management Analysis, one aim of this research was to analyze the management structure from an operational viewpoint by helping Fort Benning review their Memorandum of Instruction (MOI) for the Qualifying Recycling Program (see section 4.1.2). As previously discussed, the major organizations involved in recycling are DPW (see Sections 4.1.2.1.6 and 4.1.1.3), DRMO (see Sections 4.1.1.8 and 4.1.2.1.3), DCA (see Section 4.1.2.1.5), and DOL (see Sections 4.1.2.1.4 and 4.1.1.4). The duties of recycling are fragmented among these organizations. Of these organizations, DPW definitely has the proprietary role in accomplishing solid waste management. It follows that DPW, more specifically those currently managing the Resource Recovery and Recycling Program (RRRP), should be given an extensive managerial role in the supervision of the recycling program to consolidate and streamline the management effort The placement of all employees funded with recycling monies under the direction of DPW should be included in this consolidation. Specifically, the seven DOL employees that are accomplishing recycling duties should be placed under the direction of the RRRP. The position of recycle manager (Section 4.1.2.1.1) needs to be filled with a proactive employee to ensure the goals of the RRRP are being met.

The management structure as defined in the MOI is plagued by a committee structure that increases the complexity and difficulty of the management effort The MOI calls for the Fort Benning RRRP to utilize two committees, The Program Resource Advisory Committee (PRAC) and the Recycle Working Group (RWG).

The PRAC serves as the recommending body for the disposition of funds. The PRAC consists of the Chief of Staff (votes in case of a tie); Director of Resource Manager; and the following program directors: DCA, DOL, AC, DOIM, DOT, MEDDAC, and DENTEAC. The Director of Resource Management provides financial overwatch for the recycle fund and is responsible for calling PRACs as needed for recommendations to the Commanding General on the distribution of funds.

The Recycle Working Group (RWG) consists of representatives from DPW, DOT, DOL-Supply and Services Division, DCA, and DRM. Advisory committee members include DPW-Energy, DPW-Environmental, DPW-Housing, Safety, PAO, DAO, and DRMO. The purpose of the committee is to ensure RRRP fund requests are for authorized projects, provide funding guidance for RRRP activities, and prepare an annual budget. The descriptions of the responsibilities of each member are included in the above sections. Currently, it has been nearly a year since the RWG met, which is indicative of the inefficiency of this type of management structure.

The committee structure should be done away with at the RWG level and be replaced with a "Solid Waste Team (SWT)." The team should consist of an appropriate management level representative from each organization, and DPW should be the lead. This reasoning

behind this is that DPW has a vested interest in solid waste management and it is their job description as stated by AR-200-1:

- Prepare all required reports on solid and hazardous waste [1-26.a.(2)(c)].
- Monitor installation compliance with the local, state, federal, or host nation solid waste and hazardous waste requirements, including activities of tenants and subinstallations, and recommend changes in policies or procedures to improve program management to the IC when it is necessary or advisable [1-26.a.(2)(d)].
- Establish, monitor, and execute programs in waste management, including **waste minimization, resource recovery, and recycling** [1-26.a(2)(g)].
- Ensure regular and systematic collection of solid waste from designated pickup stations and disposal of solid wastes to provide efficient and cost-effective service per the requirements of AR 420-47, AR 420-10, and TM 5-634 [1-26.a.(2)(h)].
- Periodically review such factors as number and location of pickup stations, truck routes, type of equipment, scheduling, supervision, and **use of personnel to effectively manage solid wastes** [1-26.a.(2)(i)].

DPW is the obvious lead agency for the Solid Waste Team because solid waste management is DPW's responsibility. Furthermore it is the EPA's and most states' goal to reduce the solid waste stream through source reduction, reuse, recycling, and composting on a per capita basis. Since DPW, more specifically DPWE, is responsible for disposal, it has the most to gain from reduction goal attainment, both in reducing the cost of disposal and in saving landfill space for the future. As the lead agency of the Solid Waste Team, the DPW could focus its efforts on improving solid waste management practices at Fort Benning. A secondary, and less important, function of the team would be to make recommendations for the disposition of excess recycle funds.

As stated in the current MOI, the purpose of the RWG is to ensure RRRP fund requests are for authorized projects, provide funding guidance for RRRP activities, and prepare an annual budget. These duties should be performed by DPW because it has the most to gain by the success of the program. Recommendations for funding could go before the team members for a vote before being forwarded.

The purpose of the solid waste team would be much more extensive than the RWG. The solid waste team should work to integrate a public education plan that integrates promotion and education activities pertaining to all solid waste, recycling, and salvage services. An integrated educational and promotional strategy will provide opportunities for delivering multiple service messages and minimize redundant communications. The opportunity for contradictory messages can also be minimized. The team should meet on regular intervals, quarterly at a minimum, and be available for special meetings as required. The team should agree on responsibilities, goals, and plan actions, specifying who will perform specific functions. All results of these actions should be documented. Team members should discuss their interdependence and how potential conflicts are to be resolved.

If possible, the removal of the PRAC from the solid waste management chain would streamline the procedure for recycle fund distribution. The Solid Waste Team will have an intimate knowledge of the problems and needs of the program, and will be in a position to make recommendations to the Commanding General on the distribution of the recycling funds.

7.4 Yard Waste

The following topics were included in a solid waste study performed for Fort Bragg. This information is being provided because it is directly applicable to Fort Benning's planning efforts for a yard waste composting plan.

7.4.1 Yard and Wood Waste Collection System Options

1. **Family Housing Grounds.** In the family housing neighborhoods, individual households are responsible for yard maintenance up to 50 feet around their residence. Although yard waste had previously been commingled with household garbage and disposed of together at the sanitary landfill, new contracts should change collection operations to provide for separate collection of yard waste.

The new collection routine could provide for once-per-week household garbage collection and a once-per-week "special collection" of "leaves, pine needles, limbs, pine cones, twigs, and similar materials" along with "furniture, tires, packing boxes and crates, metals, scrap lumber". The contract could require the collector to dispose of metals (including white goods), batteries and other "miscellaneous/recyclable items" at an off-post location. Tires will be taken to the DRMO tire disposal yard.

Family housing occupants could be instructed to place yard waste either in bags or boxes at the curb (or designated collection point). Residents may also put yard waste in a cart or other container that is provided by the resident, but *not* in the government-issued garbage container. Placing leaves and grass clippings loose at the curb is not permitted, and consequently the new contract does not require the hauler to have a leaf vacuum. Exceptions are limbs and branches, which may be stacked loose at the curb. Yard waste set out or mixed with household garbage on garbage day is to be rejected by the collector[79].

7.4.2 Collection Options

As noted, Fort Benning is undertaking separate collection of yard and wood waste in the family housing neighborhoods. Materials, including leaves, grass, and small limbs (less than 1" in diameter and less than three feet long), are set out on Monday morning.

In the long-term, Fort Benning could choose from a number of options for the separate collection of yard waste[80].

1. **Source Reduction.** Source reduction is at the top of the State's waste management hierarchy. Examples of source reduction in yard waste management are backyard composting and leaving grass clippings on the lawn instead of bagging them. These techniques, while not

an option for every citizen, reduce the amount of materials requiring separate collection and processing and therefore represent the lowest cost option for Fort Benning. Promotion and education of source reduction programs should be considered by Fort Benning as part of a comprehensive yard waste management system.

2. **Bulk (loose) Collection.** This method refers to systems that collect yard waste (usually leaves) piled loosely at the curb. Typically it involves using mobile equipment such as vacuum trucks. In addition to vacuum systems, special loaders and grappling systems are used in some communities to collect one or more yard waste materials set out loose at the curb. These systems are normally not used, however, for collection of all yard waste materials.

3. **Containerized Collection.** This method requires residents to place yard waste in various types of containers including:

- *Rigid containers.* These are refuse cans and carts of varying capacity. Many programs require a specific type of container, such as a 90-gallon plastic cart that is compatible with semi-automated collection equipment. There are several advantages to rigid carts including a built-in source reduction feature since carts are reusable and do not generate trash in the form of bags. In some cases, carts can be labeled with messages–such as "We Compost"–to reinforce program educational and promotional efforts.
- *Paper yard waste bags.* These bags have the advantage of decomposing along with the yard waste in a composting operation, thereby requiring no bag breaking and removal ("debagging") at any point in the process. Several programs limit bags to paper for this reason. Special large-capacity (30 gallon) yard waste paper bags are designed to stand upright (facilitating loading) and resist water damage, and can be imprinted with program messages.
- *Degradable plastic bags.* Typically these bags are a mixture of plastic and corn starch, the latter ingredient decomposing under the right conditions (exposure to water and air). Other degradable plastic bags will break down from prolonged exposure to sunlight (photo-degradable). Some concern has been expressed by environmentalists regarding the possible release of residual chemicals from the degradation of the cornstarch/polyethylene bags. Because of their limited track record in composting programs, use of these bags should be carefully studied prior to being adopted post-wide as a means of avoiding debagging.
- *Plastic bags.* These bags have the advantage of being universally available and are the least expensive bag type. Use of clear bags can facilitate screening of contaminants by curbside collectors. The major disadvantage of plastic bags is the fact they do not decompose and therefore must be removed at some point in the collection or processing operation. As discussed below, debagging can be both time consuming and costly, though mechanical methods may accelerate this operation.

4. **Debagging Considerations.** Fort Benning should be aware that yard waste collection directly affects the processing operation. What may be technically feasible on the collection side (for example, collecting grass in plastic bags) may create a technical problem at the yard waste processing facility (how to break and remove the plastic bags).

Operationally it would be clearly advantageous if yard waste did not have to be removed from bags at the processing site a time-consuming and potentially expensive task if done with manual labor. While the operation may be accelerated by the use of mechanical "debagging" systems, this technology has a limited operational track record and should be examined in greater detail.

Debagging can also be done at the curb, with collectors breaking bags and dumping the loose yard waste into the truck. Encouraging residents to leave bags untied at the curb will accelerate this operation. New truck-mounted bag-breaking equipment is also available to assist curbside debagging. Bags removed at the curb, of course, must either be left at the curb (usually unacceptable) or stored on the truck.

Debagging can be avoided altogether by requiring households to store yard waste in either rigid containers, paper bags, or a combination of both. With plastic bags eliminated, all waste can go directly into shredding, grinding and composting operations. Paper bags will decompose along with the yard waste they contain. These advantages must be weighed against the extra cost of paper bags, their availability to the public, and the potential for contaminants (non-yard waste) to be hidden from view inside the bag.

Degradable plastic bags are considered by some to be equivalent to paper bags that is, no debagging would be required while the translucent version allows for screening of contaminants. However, many composting operations have reported that degradable plastic bags do not decompose quickly or completely enough, creating a final product littered with bits of plastic. This type of bag should be examined very critically prior to implementation of its use.

7.4.3 Yard and Wood Waste Collection Recommendations

As Fort Benning begins yard waste collection under a new contract, options available may be limited to adjustments to the existing system. During the period that service is contracted at a set charge, cost savings resulting from attempts to increase collection efficiencies will accrue to the contractor. However, as savings are realized over time, the cost to Fort Benning of future contracts may be contained or even reduced[81].

The following recommendations focus on actions that are feasible in the short term to improve collection efficiencies and ensure compliance with state regulations[82].

1. *Prohibit Disposal of Yard Waste in Sanitary Landfill.* To ensure post-wide compliance with a state ban on the disposal of yard waste in sanitary landfills, Fort Benning should formally prohibit the disposal of grass clippings, leaves, brush, and other "vegetative

matter resulting from landscaping maintenance" in the sanitary landfill. This policy should be communicated in writing to all contractors and post personnel that regularly use the landfill. To ensure compliance, Fort Benning may want to consider assessing fines for contractors or post personnel who violate the ban.

2. *Promote Backyard Composting and Other Source Reduction Measures.* Yard waste that never reaches the curb means fewer stops for collection crews, fuel savings, and less material to process at the yard waste facility. Fort Benning should take every opportunity to promote backyard composting and other ways of processing yard waste at the home, including backyard shredding of brush and limbs for mulch and leaving grass clippings on the lawn.

3. *Require or Encourage Residents to Place Yard Waste in Permanent Containers (carts or cans) to Increase Collection Efficiency.* Fort Benning may want to explore the long-term cost savings of storing yard waste in permanent containers such as rollout carts or cans. The advantages, noted above, include increased collection efficiencies because removal of plastic bags would be avoided. Exceptions to this requirement would include fall leaf collection periods in which the collector could utilize a vacuum truck for collection of other items that are too large to fit into containers.

4. *If Plastic Bags are Permitted for Storage of Yard Waste, Consider Requiring Only Clear Plastic.* Plastic bags commonly available in stores are opaque and can hide garbage and other materials that will reduce the value of the compost or mulch product or require additional labor to clean up. Clear bags will enable the vehicle attendant to spot contaminants immediately.

7.4.4 Yard and Wood Waste Processing

Currently Fort Benning is planning to own and operate its own composting facility. This management option assumes Fort Benning will invest in the development of a yard waste processing facility at an on-post location. Establishing a processing facility would entail preparing a site, purchasing processing and maintenance equipment, employing operators, providing ongoing maintenance of equipment, and marketing and removal of the end product(s).

Advantages of a Fort Benning-owned-and-operated facility include greater control over the amount and types of waste processed and the ability to relocate equipment under special circumstances. While a privately-run operation may agree to accept, for example, only yard waste—such as leaves, grass clippings, and branches—a Fort Benning-owned/operated facility could introduce additional waste items such as pallets, lumber, and other C&D waste[83].

Another advantage of a Fort Benning owned/operated facility would be the potential for better control over production of end products and closer coordination with on-post users. For example, should an end-user on the post require a large quantity of wood chips in a short time period, chip production could be accelerated until the need was met. However, private processors may be just as able to provide for production changes as required by Fort Benning[84].

Disadvantages of a Fort Benning-owned-and-operated facility include the requirement of investing in processing and maintenance equipment, obtaining a yard waste processing facility permit, hiring and training staff to operate specialized equipment, and the responsibility of marketing and moving finished products. All of these duties will require substantial commitment in resources and personnel, particularly with regard to equipment maintenance, which is typically quite high, and in establishing and maintaining outlets for the finished organic products[85].

7.4.5 Recommendations for Processing and Marketing of Yard and Wood Waste

The following recommendations are divided between processing and marketing activities. The objective in both areas is to implement technically sound, cost-effective programs that comply with all state and federal regulations concerning yard and wood waste management. For either area, processing or marketing, the post horticulturist should play a major role in management decisions. The post horticulturist possesses considerable expertise regarding the products to be generated from a compost operation. In addition, the horticulturist would play a major role in the consumption or use of the materials[86].

Processing Recommendations

1. *Implement plans for establishing yard and wood waste processing capabilities for Fort Benning as soon as possible.*
2. *Establish on-post processing operations initially.* Although off-post yard and wood waste processing is a feasible option, Fort Benning would be better served in the short term by establishing on-post capacity for processing and stockpiling yard and wood waste. This recommendation is important because negotiations with outside processing facilities would not be required, and Fort Benning could move quickly in establishing on-post processing capacity. Concerns about transportation logistics and costs would also be avoided. Moreover, Fort Benning would be in a position to closely monitor the types and quantities of yard and wood waste received and adjust the degree of separation and processing accordingly. Finally, a Fort Benning facility would be more convenient as a supply of organic products to on-post horticulture and landscaping projects.
3. *During start-up period, contract with a private processor for selected processing services while maintaining general management of the facility under Fort Benning.* This management strategy may be the preferred one because Fort Benning could avoid costly initial investments in major processing equipment during the start-up period when flexibility—for example, the ability to change equipment configurations and

materials flow—is most important. Later, as processing needs and market outlets stabilize, Fort Benning can choose to take over the contracted services using Fort Benning equipment and personnel, or alternatively, contract a greater share of facility management to a private processor.

4. *Chip limbs and brush on site where possible.* Groundskeeping staff and Fort Benning's contractor should be encouraged to process and reuse as much wood waste at the point of generation as possible.

7.4.6 Markets

1. *Coordinate operations planning with horticulture and landscaping programs in determining the mix of products that could best be utilized on post.* By substituting outside purchases of mulch and soil amendments with organic materials generated on-post, Fort Benning may reduce costs. These efforts should be expanded as processing operations and new products come on-line. Compost, for example, is an excellent substitute for peat moss. Compost could also be used as a low-cost, though less attractive, alternative to mulch products currently used (pine straw, shredded bark, bark nuggets). Savings generated by avoiding purchases of outside organic products should be weighed against the revenue potential of selling processed yard and wood waste off-post.

2. *Coordinate operations planning with the Corps of Engineers for use of compost and mulch products on Corps projects.* Currently Corps construction projects specify mulch for tree and shrub plantings and various soil amendments (peat moss, compost) for large beds—but it is left to the contractor to determine the source of these products. Project specifications and drawings should indicate use of post-produced mulch and compost to the extent these materials are available.

3. *Fort Benning should also investigate boiler fuel as a potential market outlet for processed wood and yard waste.*

4. *Evaluate alternative uses of wood chips and sawdust on post.* There may be on-post applications for wood chips and sawdust generated by groundskeeping operations as well as carpentry shops on Fort Benning. These applications may include use in troop exercise and training pits and for erosion control on tank trails.

5. *Evaluate potential of using compost and mulch products for revegetation and erosion control projects on ranges.* There are open ranges on Fort Benning that might provide outlets for organic products. These areas include current and old flight landing zones, drop zones, and rifle and grenade ranges. Mulch and compost could be used in the construction of berms on rifle and grenade ranges, on bare grounds needing a vegetative cover, and other erosion control projects involving regrading and building up ground cover.

6. *Evaluate application of compost in conjunction with current land application of wastewater biosolids (sludge) to ranges and bare grounds* Currently, wastewater biosolids are disposed of through a land application program. There would seem to be some potential for combining this operation with the land application of compost.

7. *Evaluate use of processed yard waste as daily cover at the sanitary landfill as a "safety valve" outlet.* To ensure a final outlet for processed yard and wood waste, Fort Benning should consider using minimally-processed compost as a source of daily cover at the sanitary landfill.

7.5 Construction and Demolition Debris Recommendations

Fort Benning currently is using some of its C&D for slope stabilization on the 1st Division Road Landfill and for erosion control measures. However, the state regulator has been uncooperative in promoting and accepting these uses. The main complaint was that the rubble had some exposed rebar. This problem is being mitigated by covering the concrete rubble with clean earth, leaving no rebar exposed.

The following information was included in a solid waste study for Fort Bragg, and may be useful for Fort Benning personnel[87].

Clean rubble can be used for fill material, rip rap, as a subbase for road construction, or milled for use as an aggregate in concrete production. Asphalt, if milled, can be used to repair and resurface roads and bridges. Untreated wood waste can be used as firewood or shredded for use as mulch, as a bulking agent in sludge composting operations, or as fuel for wood-fired boilers. However, concerns over the potential presence of treated wood and metal present strong barriers to successful marketing of such material. Treated wood such as plywood, pressure-treated laminate, or creosote-treated wood has some limited potential applications. A major barrier to the use of any construction or demolition wood waste is the prevalence of readily available and inexpensive alternatives such as timber byproducts and shredded landscape waste. Scrap metal can be marketed through conventional metals outlets for use in manufacturing new metal goods. Information on potentially recyclable C&D materials, their sources, and potential uses is summarized in Table 7.1.

Table 7.1 Predominant Construction and Demolition Materials With Recycling Potential

Waste Type	Source	End-Use
Rubble Concrete Cinder block Brick	Bridges/overpass repair Curb/sidewalk repair Construction of building foundations/supports	Fill Road subbase Rip rap Concrete aggregate
Asphalt	Road/building demolition	Road and bridge resurfacing
Wood Untreated	Land clearing Building construction and demolition	Boiler fuel Compost bulking agent Mulch
Metal Structural steel Ferrous pipe/conduit Appliances Aluminum (gutters, storm doors, window frames, etc) Brass and copper fixtures and tubing	Building construction, remodeling, demolition	New metal products

[88]

7.5.1 Recycling Options

The successful recycling of C&D waste will be largely dependent upon the degree to which recovered material can meet market specifications and the overall cost-effectiveness of recycling C&D waste in comparison to disposal alternatives.

Processing: Central to any system for preparing materials for market is the processing method to be utilized. In some areas of the United States, entrepreneurs have established processing operations for commingled C&D waste. Such operations typically utilize mechanical and gravity separation devices in conjunction with manual sorting to separate the incoming waste mixture by material type. Grinding systems are utilized to shred wood waste, rubble, and other materials to produce marketable products. Capital costs vary from $2 to $5 million, depending upon the equipment utilized and the types and quantity of materials processed. This factor, plus the relatively low value of the finished products, means that such facilities must be located in regions where the cost of disposal alternatives is in the vicinity of $50 per ton (Apotheker, Resource Recycling, August, 1992). The ability of commingled processors to market recovered materials has been limited to 50 to 80 percent of the incoming stream, with product marketability threatened by increasing supplies of clean materials recovered from other recycling operations.

Processing of source-separated C&D waste can usually be accomplished at a lower capital cost and with a greater recovery rate than the processing of commingled materials. For wood waste and rubble, processing typically consists of visually screening incoming loads of

source-separated material for contaminants, grinding or shredding the materials, and removing ferrous metal using a magnetic separator. Costs typically run between $10 and $25 per ton (Apotheker, Resource Recycling, August, 1992). Clean scrap metal can be marketed without processing to private scrap metal dealers who prepare metals for shipment to end users.

7.5.2 Recovery

Techniques for recovering C&D materials are varied. Selection of the most cost-effective method must be approached on a project-specific basis, as no one technique will work under all circumstances. For construction work, one of the most effective measures is for owners to expect construction contractors and subcontractors to assume responsibility for managing their own waste materials, as opposed to throwing scrap in a common pile or container on the job site. Placing responsibility for waste management upon the generator provides incentive for waste reduction as well as recycling in order to minimize waste management costs as well as minimize the risks associated with improper waste disposal.

For demolition projects, advance planning is needed on how to perform demolition work in phases to allow for the recovery of salvageable or recyclable building materials and on how to store, transport, and market those materials. Invitation for Bid documents for demolition as well as construction projects can include a requirement that an acceptable waste management plan for the project be submitted in advance of as well as adhered to during the project and that marketable C&D materials are to be recovered and recycled whenever feasible.

Segregated C&D materials can be stored on job sites in temporary wire or plastic fencing enclosures or divided rolloff containers. The number and type of storage containers needed is dependent upon the materials to be recovered and the degree of source-separation required. Materials may be transported from each job site directly by construction or demolition contractors, by contract haulers, or by the processor who will receive the material. Materials collection can be made on an on-call or scheduled basis.

Of prime importance is the need for quality control, e.g., minimizing contaminants which will affect the marketability of the material. Training personnel on proper sorting and storage techniques and the importance of quality control can be critical to long-term program success.

7.5.3 Strategy Recommendations

C&D debris entering the municipal solid waste landfill needs to be segregated and recycled. If recycling of certain materials is not feasible, permission should be requested from the State to dispose of them in a proper area of the landfill. Diversion of C&D waste from the municipal solid waste landfill can be counted towards the waste reduction goal.

It is recommended that Fort Benning determine the true cost of operating the construction and demolition landfill on a per-ton basis against which the cost of recycling alternatives could be weighed. Source reduction is a strategy that in many instances will be cost-effective and should be pursued whenever possible.

The primary strategy for reducing C&D waste is through the use of advanced planning techniques to minimize the generation of waste materials during demolition and construction work. For construction projects, this strategy involves improving techniques for ordering appropriate quantities of building materials, working with suppliers to allow re-stocking of surplus materials, and efficient use of construction materials to minimize scrap generation. For demolition projects, the strategy involves planning for the salvage of valuable building products prior to the onset of demolition, and training workers on salvage techniques. Proper storage of recovered materials is critical to prevent these items from becoming damaged or contaminated and therefore becoming waste.

As long as Fort Benning personnel and its contractors have free and easy access to landfills, it will be difficult to motivate waste generators to source reduce or recycle material. If charging tipping fees at the landfill is not an option, at a minimum, close monitoring of incoming materials is needed to ensure that only materials that must be landfilled enter the facility.

The recommendations are summarized below:

- Develop and implement advanced planning techniques for source reduction and recycling.
  - For construction projects: improve techniques for ordering appropriate quantities of building materials and work with suppliers to stock surplus materials.
  - For demolition projects: plan for the salvage of valuable building products prior to the onset of demolition, train workers on salvage techniques, properly store recovered materials to prevent damage or contamination.
- Closely monitor materials entering the landfill to ensure that only materials that must be landfilled enter the site.
- Keep usable rubble products separate from other waste and deposit the rubble products at locations designated for each project.
- Use rubble products available on base when technically feasible as opposed to bringing in virgin materials from off-post sources.
- After reusing rubble on-post to the greatest extent possible, investigate off-post disposal alternatives.
- Require Fort Benning contractors to provide for the off-base disposal of asphalt.
- Integrate processing and marketing of C&D land clearing wood waste and clean untreated dimensional scrap lumber with yard waste processing operations.

- Keep treated wood separate from wood to be processed.
- To the extent possible, keep wood waste free of dirt and other debris.
- Direct contractors to keep wood waste segregated from other material and to transport these materials to the wood waste processing facility.
- Initiate a monitoring program to more closely determine the nature of metals currently being disposed.
- Assess the extent to which incoming metal can be diverted to a storage area at the demolition landfill or directly to DRMO for marketing.
- Instruct those involved in generation and transportation of metals to take clean loads to a designated location.
- Ban marketable metal grades from disposal in the landfills.

CHAPTER 8. AREAS FOR FURTHER RESEARCH

This research was conducted with the hope that there would be a continuing relationship between the AEPI, Fort Benning, and the Georgia Institute of Technology. With this goal in mind, a number of areas for further research and analysis were identified. These topics were chosen because they were major areas of concern or interest of Fort Benning personnel, or were in line with AEPI's research interests.

8.1 Waste Generation and Characterization Study

Typically the goal of solid waste generation and characterization studies are to identify recyclable material in the waste stream, determine base generation levels, and establish the types of waste disposed of. Weight should be the measurement standard for the generation study for the following reasons: goals are by weight, tip fees are increasingly by weight, and weight is an exact result instead of a volume approximation. Characterization of wastes by activities enable solid waste mangers to readily identify solutions. Fort Benning would greatly benefit by a waste generation and characterization study. A study would be particularly beneficial for the recycling program, because it would identify the areas producing the most recyclable materials.

8.2 Regionalization

A possible course of action to take advantage of economies of scale is regionalization. This strategy would include participation of Fort Benning with regional recycling cooperatives, regional off-base land fills, and on-base regional composting.

8.3 Source Reduction, Specific Goals and Implementation Plan

Previous AEPI research has shown that lack of manpower is the reason most often cited for failure to start solid waste source reduction. This barrier is cited more frequently than for recycling, even though recycling is more labor intensive. The perceived need for additional manpower may be due partly to the confusion about what source reduction entails, and indicates a lack of information about source reduction. Additionally, lack of a specific source reduction goal, like the established recycling goals, hinders the effort to start source reduction programs. It is also more difficult to educate people about source reduction, and results of source reduction cannot be seen as easily as for recycling.

It is apparent that further research into source reduction to develop specific goals, and guidelines to achieve those goals, would be extremely beneficial on an Army-wide basis.

8.4 Composting of Food Waste and Wastewater Treatment Sludge

The municipal waste generated by the Army is already pre-sorted relative to the waste generated by a city of comparable size. There are fewer stores, restaurants, and other services, compared to a city of equal size. This fact greatly simplifies source separation. In line with this thinking, Army installations serve food in centralized dining facilities. The possibility of composting food waste, or co-composting food waste, yard waste, and wastewater treatment

sludge is an option worth investigating. Additionally, there is a well-established effort to use compost for treating hazardous wastes such as explosives and propellants.

8.5 Management Issues

One of the goals of this research was to address solid waste management issues. The topic is very broad, and this issues covered in this paper are by no means comprehensive. Additional analysis of the structure and interactions between the agencies responsible for solid waste management in the Army would be very useful from a policy viewpoint.

8.6 Public Education

In addition to the need to develop a stronger and more integrated public education program, Fort Benning personnel have expressed interest in researching how to target information for specific groups. The need to reach military personnel, both transitional and permanent, and civilian populations is critical to the success of the recycling program. These issues, along with the overall public education program, could be the basis for further research.

CHAPTER 9. CONCLUSIONS

The Army's stated commitment to the first three levels of EPA's solid waste management hierarchy–(1) source reduction, (2) reuse, (3) recycling, (4) incineration, and (5) landfilling–seems to be failing at the operational level. While most installation have established recycling programs, reuse and source reduction programs are very limited. Guidance to installation solid waste managers on how to effectively implement effective solid waste management needs to come from the top down. A prime example of this need is the source reduction issue. Source reduction is addressed in DoD directive 4165.6, which states that "the military is committed to a rigorous schedule of waste minimization and quantities of solid waste materials are to be reduced at the source whenever possible." However, there is very little source reduction being practiced at most installations. Education seems to be a large barrier for source reduction. Many managers do not have a clear idea of what source reduction entails, and have been given no goals or direction on how to achieve it. Specific examples of source reduction activities that apply to most installations would be beneficial. Major commands need to develop a structure for implementing the necessary programs for an effective solid waste management program. This type of guidance could be provided in a solid waste management model that could be used throughout the Army.

The model should include policy changes to implement a management structure that will streamline the solid waste management effort The delegation of solid waste management responsibilities among the different agencies needs to be reexamined. The consolidation of these duties to primarily one organization would greatly simplify the entire management process, and would be more economically efficient. The model should also address direct marketing of recyclables and the possibility of regionalization. The areas covered in Section 6 (Army Implications)–yard wastes, construction and demolition debris, recycling, household hazardous wastes, illegal dumping, management issues, source reduction, accounting issues, and contracting–should be addressed specifically in an overall solid waste management model. Steps for creating, funding, implementing, and running programs will be of great assistance to the personnel carrying out these tasks. The Army personnel encountered during the course of this study were working hard to implement an environmentally sound solid waste management program, but they need the tools, guidance, and support to accomplish them.

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[66]ibid 17-3.

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[69] ıbıd 17-4.

[70] ıbıd 17-5.

[71] ıbıd 17-5.

[72] ıbıd 17-5.

[73] ıbıd 17-6.

[74] ıbıd 17-6.

[75] ıbıd 17-7.

[76] ıbıd 17-8.

[77] ıbıd 17-9.

[78] ıbıd 17-12.

[79]ıbıd 15-2.

[80] ıbıd 15-4.

[81] ıbıd 15-6.

[82] ıbıd 15-6.

[83] ıbıd 15-13.

[84] ıbıd 15-13.

[85] ıbıd 15-13.

[86] ıbıd 15-15.

[87] ıbıd 16-1.

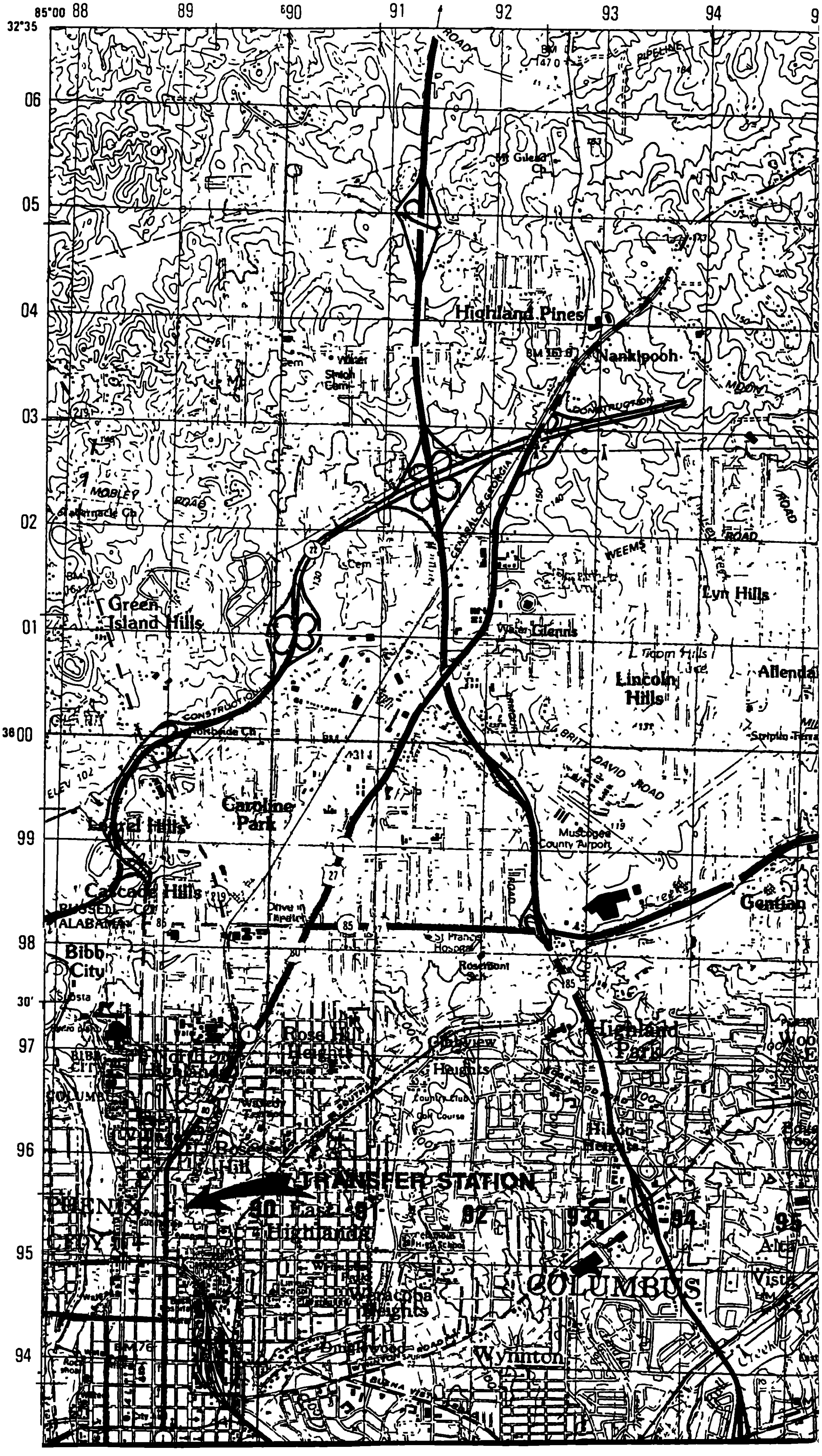
[88] ıbıd 16-3.

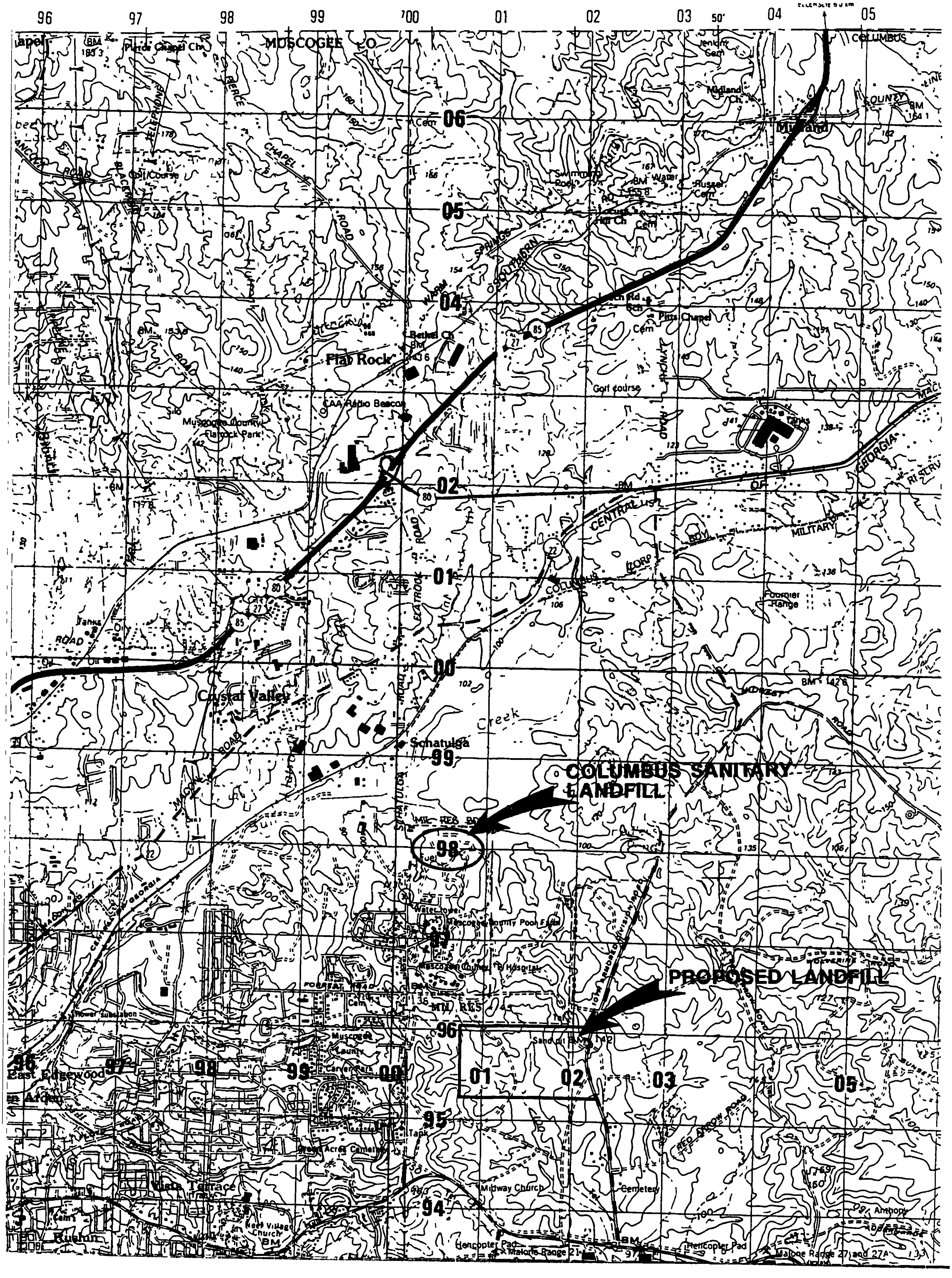
APPENDIX 1

FORT BENNING LOCATION AND FACILITY MAPS


SALEM WASTE DISPOSAL INC
COLUMBUS
PHENIX CITY
RUSSELL COUNTY
FORT BENNING
MILITARY RESERVATION
CHATTAHOOCHEE COUNTY
STEWART COUNTY
Salem
Fort Mitchell
Lawson AAF
Hatchechubbee
Lookout Tower

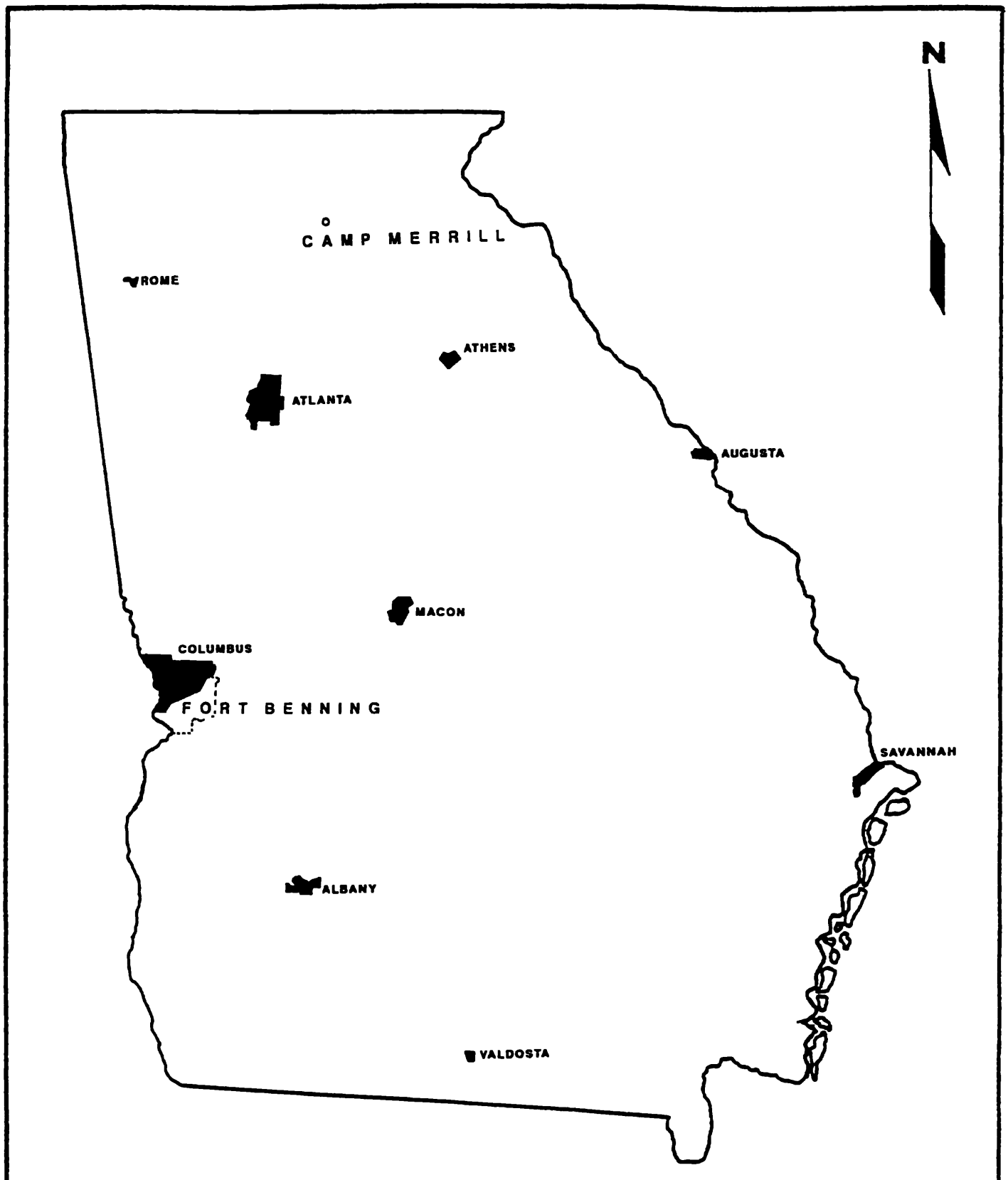

SOUTHERN STATES
RESERVATION
MARION CO
Talbotton
Butler
667
Ellaville
La Grosse


TRANSFER STATION
Highland Pines
Nankipooh
Green Island Hills
Lincoln Hills
Lyn Hills
Caroline Park
Laurel Hills
Cascade Hills
Muscogee County Airport
Gentian
Bibb City
Rose Hill Heights
Highland Park
East Highlands
COLUMBUS
Wynnton
PHENIX CITY
RUSSELL CO
ALABAMA
CONSTRUCTION
MOBLEY ROAD
WEEMS ROAD
BRITT DAVID ROAD
CENTRAL OF GEORGIA
PIPELINE
St Francis Hospital
Glenns
Allenda
Wacocha Heights
Buena Vista Road


COLUMBUS SANITARY LANDFILL
PROPOSED LANDFILL
MUSCOGEE CO
COLUMBUS
Midland
Flat Rock
Crystal Valley
Schatulga
Vista Terrace
East Edgewood
Golf course
Fournier Range
Midway Church
Cemetery
Helicopter Pad
Creek
Bethel Ch
Pitts Chapel
CAA Radio Beacon
Muscogee County Flatrock Park
Muscogee County Poor Farm
Muscogee County TB Hospital
Water tower
Great Acres Cemetery
Tanks
Power substation
Sand pit
RED ARROW ROAD
FLATROCK ROAD
SCHATULGA ROAD
MIL RES
CENTRAL OF GEORGIA
MILITARY RESERVATION
96
97
98
99
700
01
02
03
04
05
06


PHENIX CITY
Riverland Terrace
Oakland Park
Carter Acres
MIL RES
Custer Road Terrace
Substation
Main Post
Water treatment plant
Sewage treatment plant
Tanks
ALABAMA
GEORGIA
FORT BENNING
Youth activity center
Smith Hill
Ebbert Hill
Golf Course
Faith Middle School
DIXIE ROAD
Grandstand
Wagner Range
Humphreys Hill
Singleton Hill
Elliott Hill
Parks trap and skeet range
Roosevelt Range
Farnsworth Range
43RD Engineer Battalion Motor Pool
Heliport
Water pollution control plant
Engineers Landing
Fire station
Lawson Field
Control tower
Track
Fort Mitchell
Bradley Landing
Power substation
RUSSELL CO
CHATTAHOOCHEE CO
Grandstaff Range
Powell Hill
Uchee Creek Recreation Area
85°01'30"
25'
20'

SAND HILL AREA
MIL RES
Watson Hill
Malone Range
Helicopter Pad
MALONE MOUT
Tracks
88
Cleveland Hill
87
Baseball Field
Track Field
COUNTY
Ammunition storage area
Ordnance magazine area
Detrow Hill
Walker
Brown Demolition Range
Wadsworth Hill
86
Borrow pit
Colyer Hill
Selby Hill
Higley Hill
85
Manila Heliport (abandoned)
Swimming pool
B E N N I N G M I L I T A R Y R E
Maintenance facility
Firetower
Griswold Hill
Kelley Hill Barracks
Harmony Church
TV Maintenance and gunnery training facility
Strickland Ridge
Journey Hill
Small arms weapons pool
EIGHTH DIVISION ROAD
Leyte Heliport
Grandstand
Victory Lodge
Turner Hill
97
98
00
01
02
03
04
05
06
Booker Range
Track
Tracking Range
Martin Range
Baroman Hill
81
BM 103
Fuel
Theater
Fire Station
80
Buchanan Range
Grandstand
Reese
Ryans Hill
Todd Field West (abandoned)
79
Coolidge Range
Grandstand
YANKEE ROAD
Range
Grandstand
Galloway Range
Grandstands
Miles Chapel
Structures
77
Cole Range
Grandstands
Warner Range
Bucks Hill
76
Structures



APPENDIX 1

FT. BENNING & CAMP MERRILL

MILITARY INSTALLATION LOCATION MAP

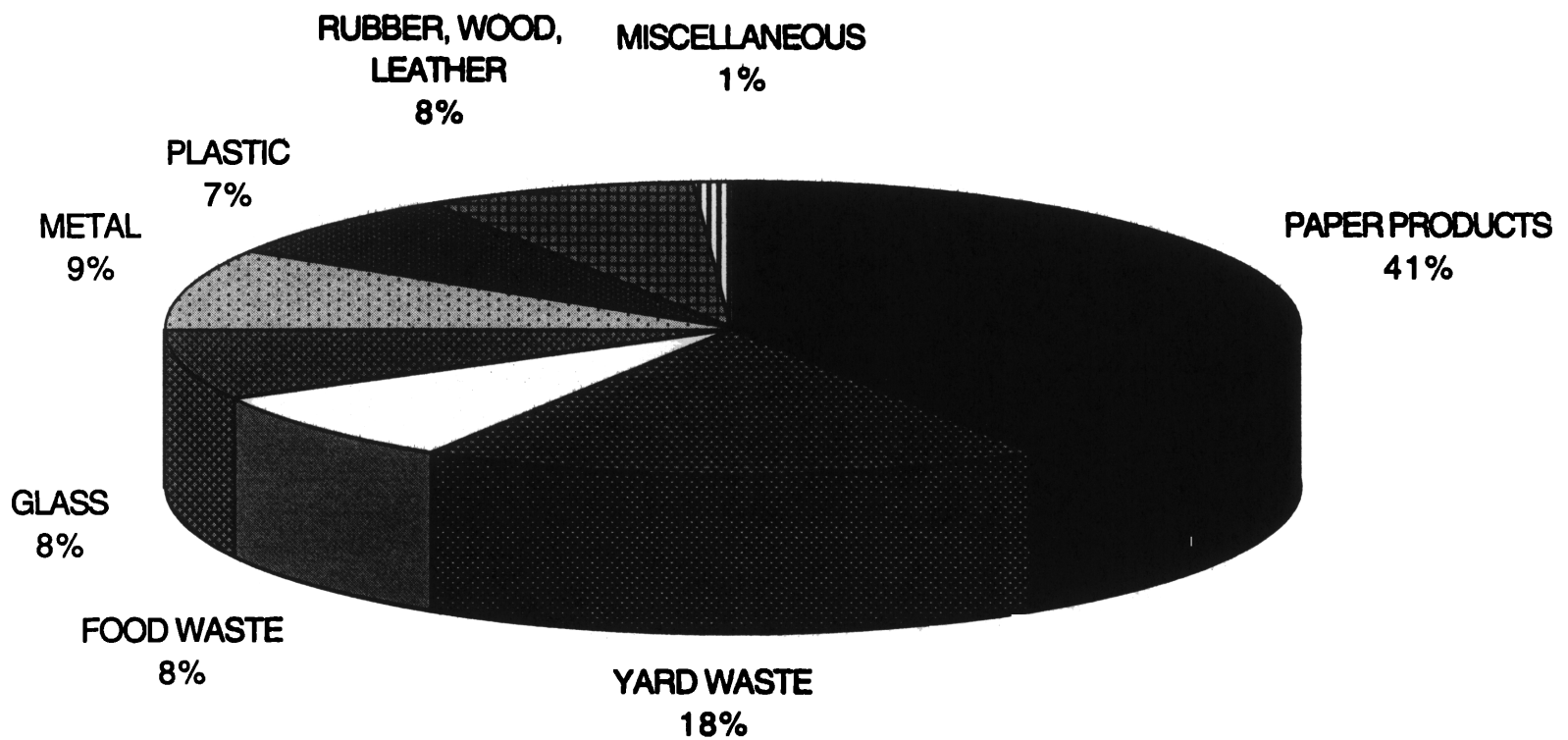
SCALE: 1"=2,000,000'

JOB NO. 15-062

APPENDIX 2

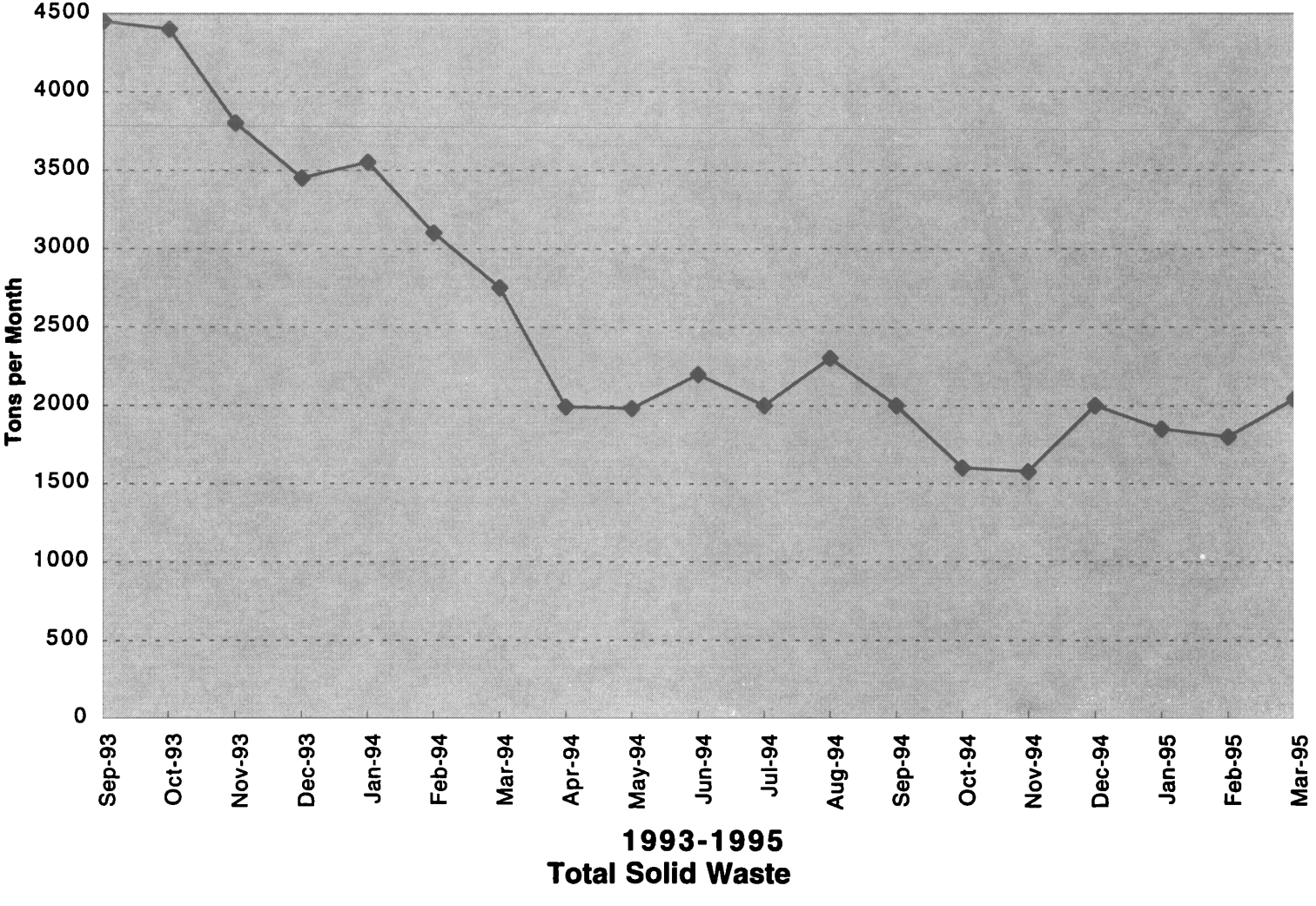
FORT BENNING SOLID WASTE DATA

U.S. SOLID WASTE
(PERCENT BY WEIGHT)



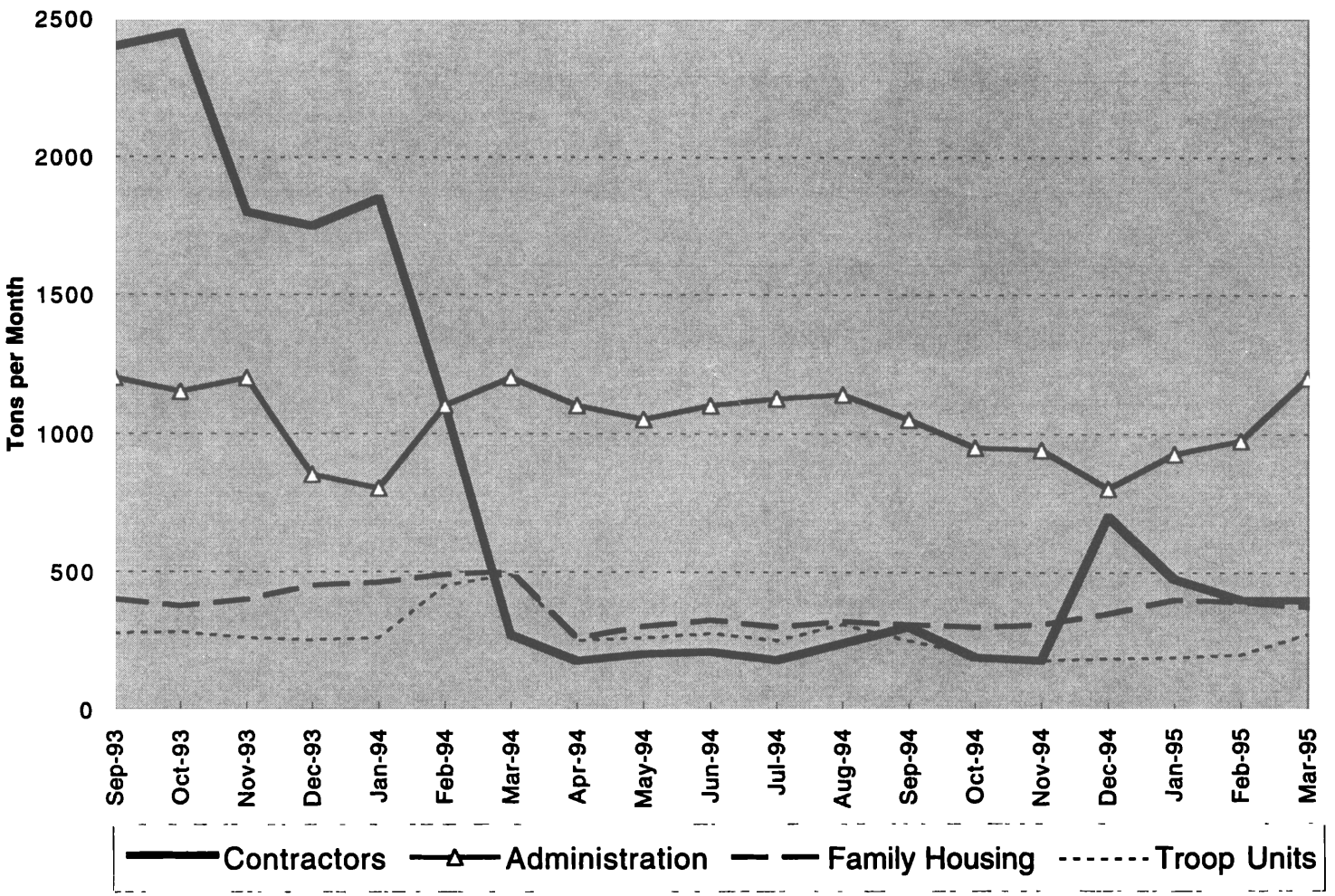
SOURCE: U.S. EPA

1ST DIVISION ROAD SANITARY LANDFILL
MONTHLY TONNAGE DATA



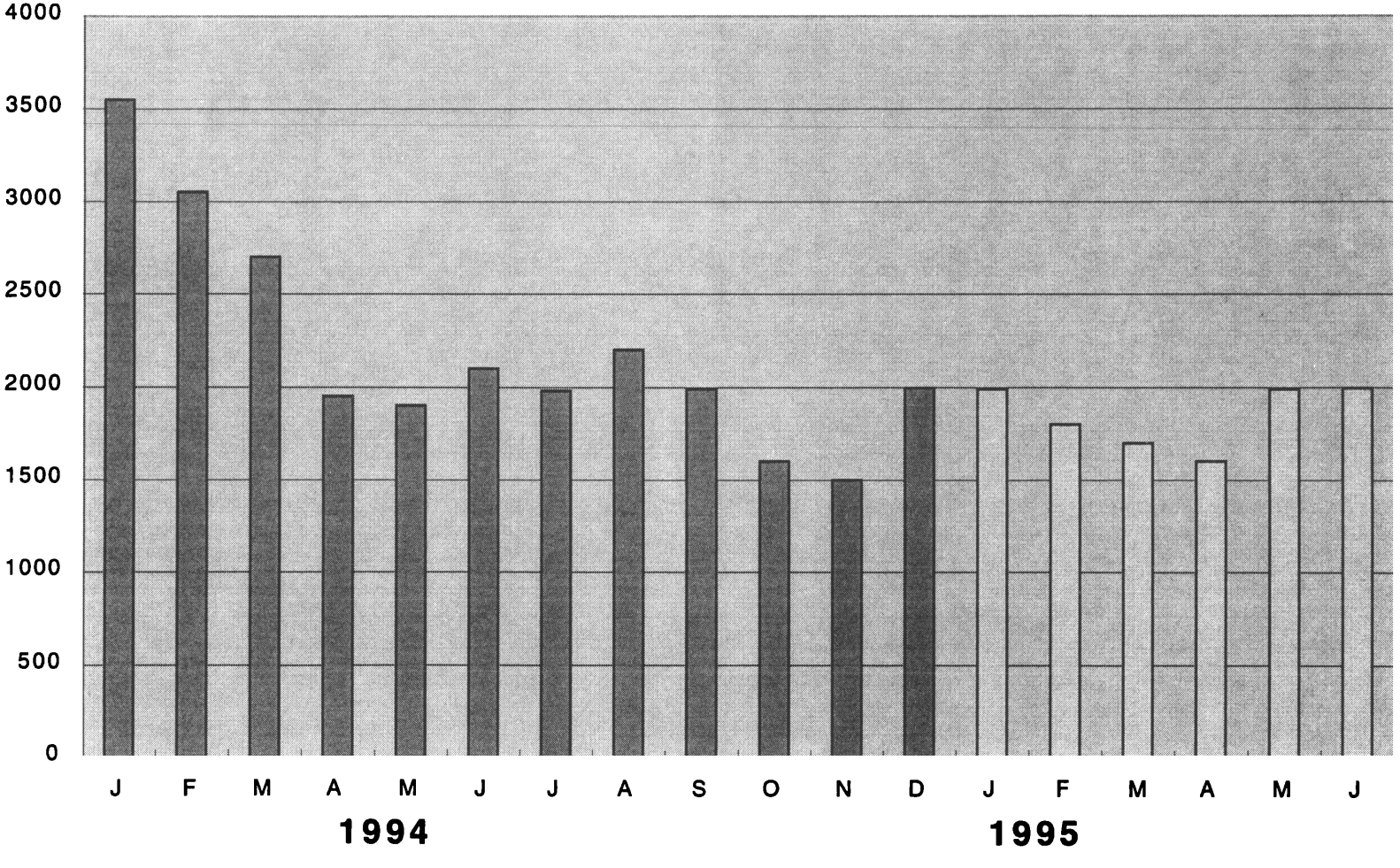
1993-1995
Total Solid Waste

1ST DIVISION ROAD SANITARY LANDFILL



1993-1995

FORT BENNING SOLID WASTE DISPOSAL
JAN94-JUN95
SLF TONS



FORT BENNING SOLID WASTE SOURCES
OCT94-MAY95

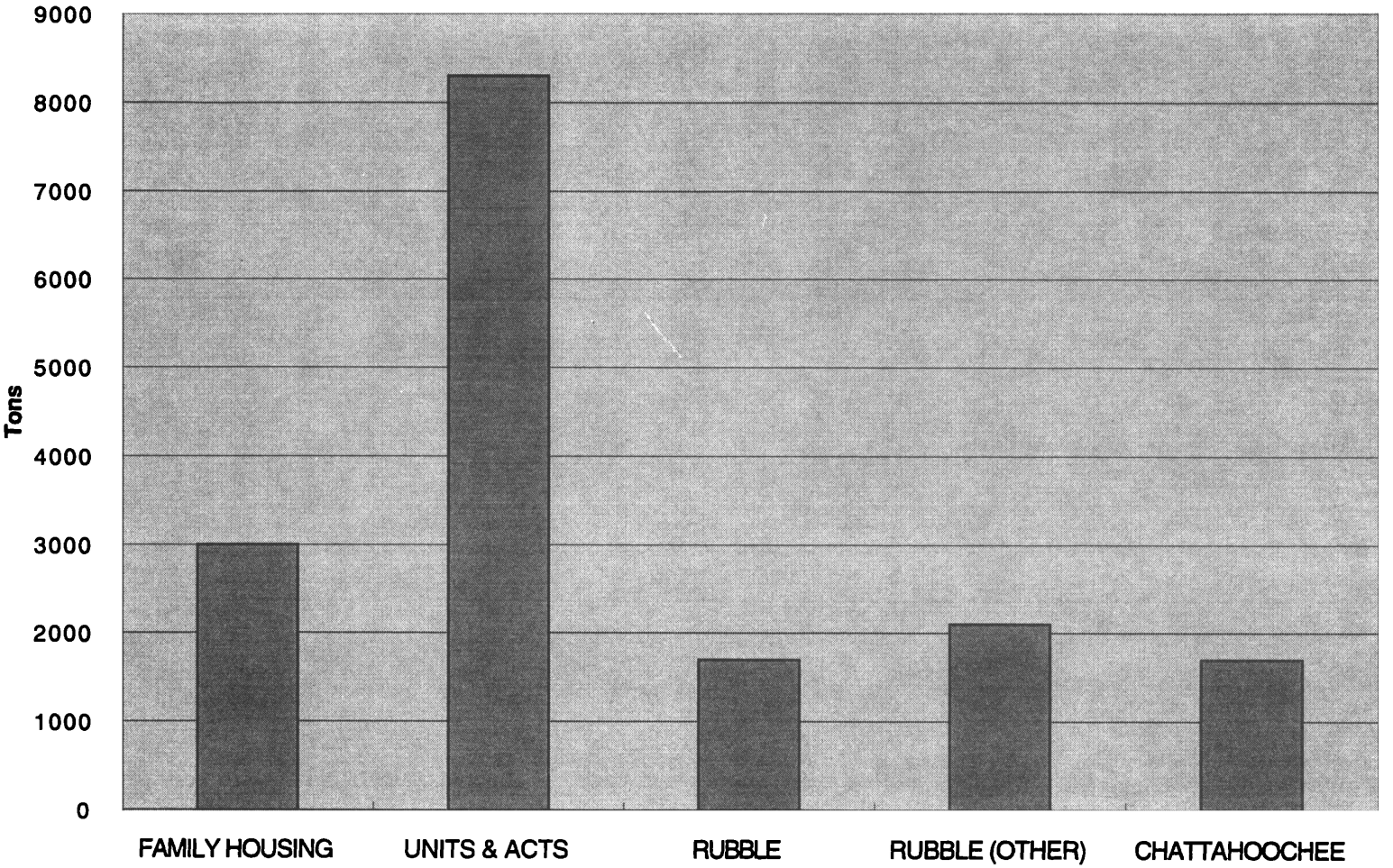
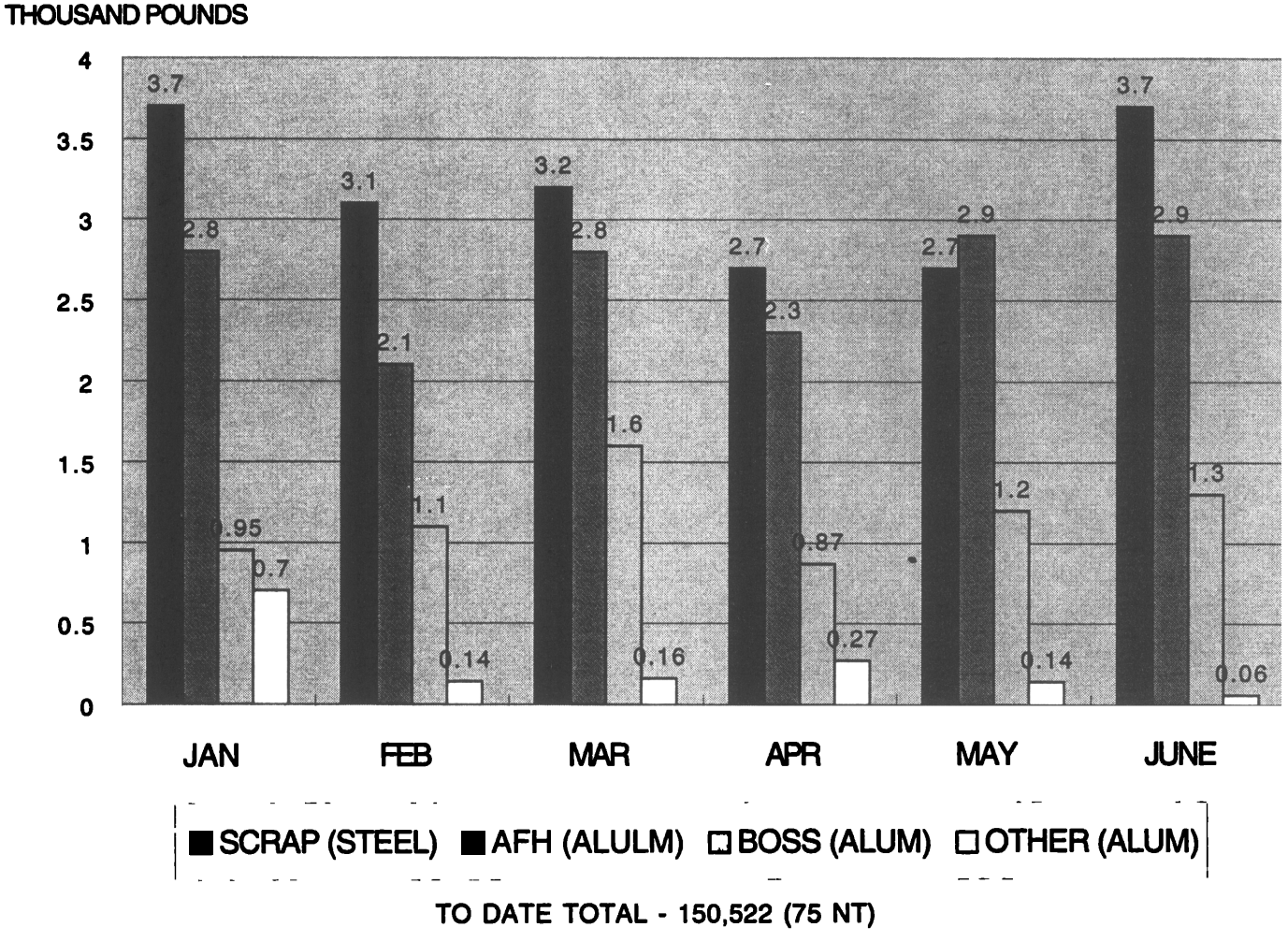


Chart created from SLF scale data

APPENDIX 3

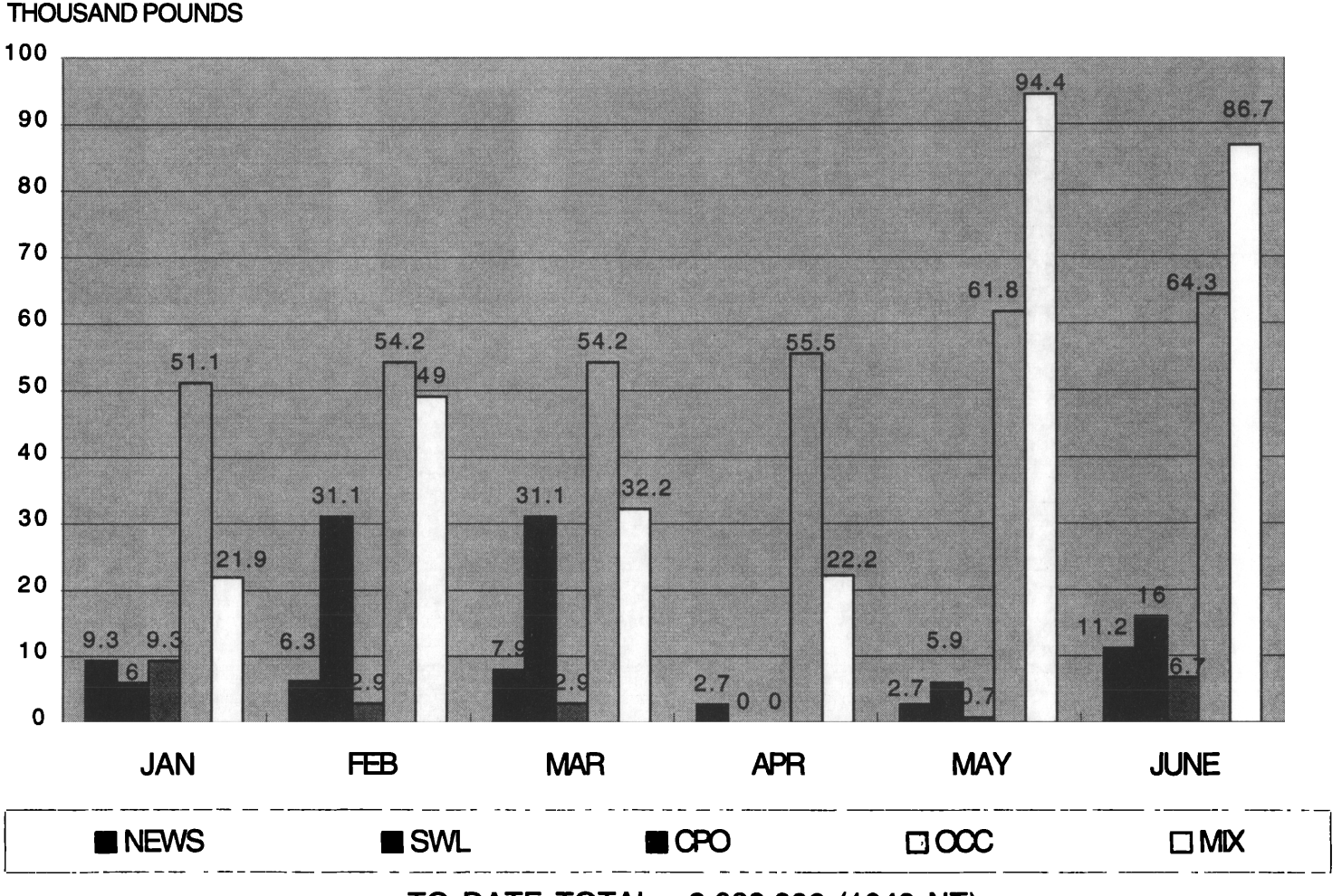
FORT BENNING RECYCLING DATA

PROCESSED RECYCLABLE METALS
(2nd & 3rd Quarter Production)



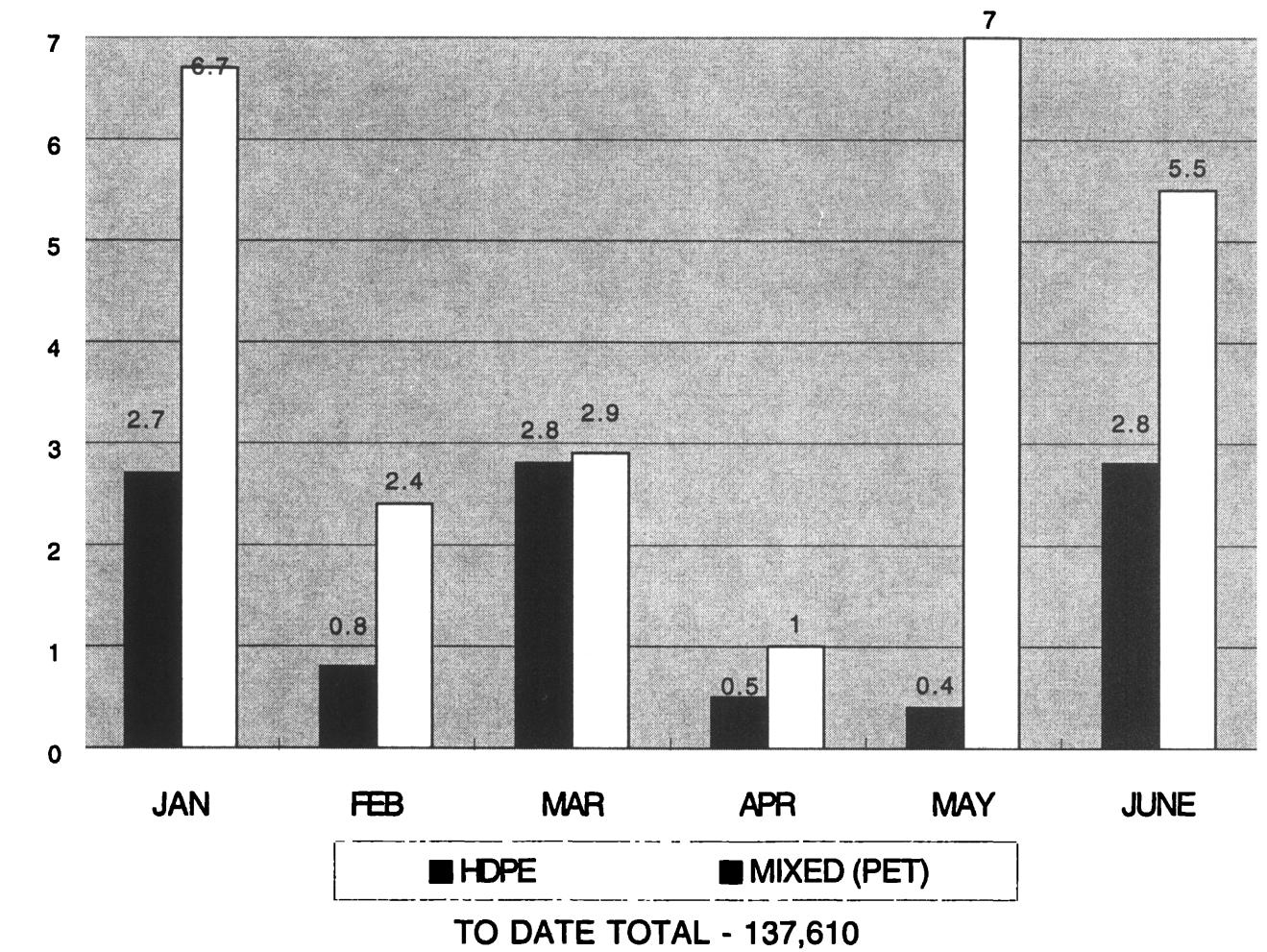
TO DATE TOTAL - 150,522 (75 NT)

PROCESSED RECYCLABLE PAPER
(2nd & 3rd Quarter Prodution)



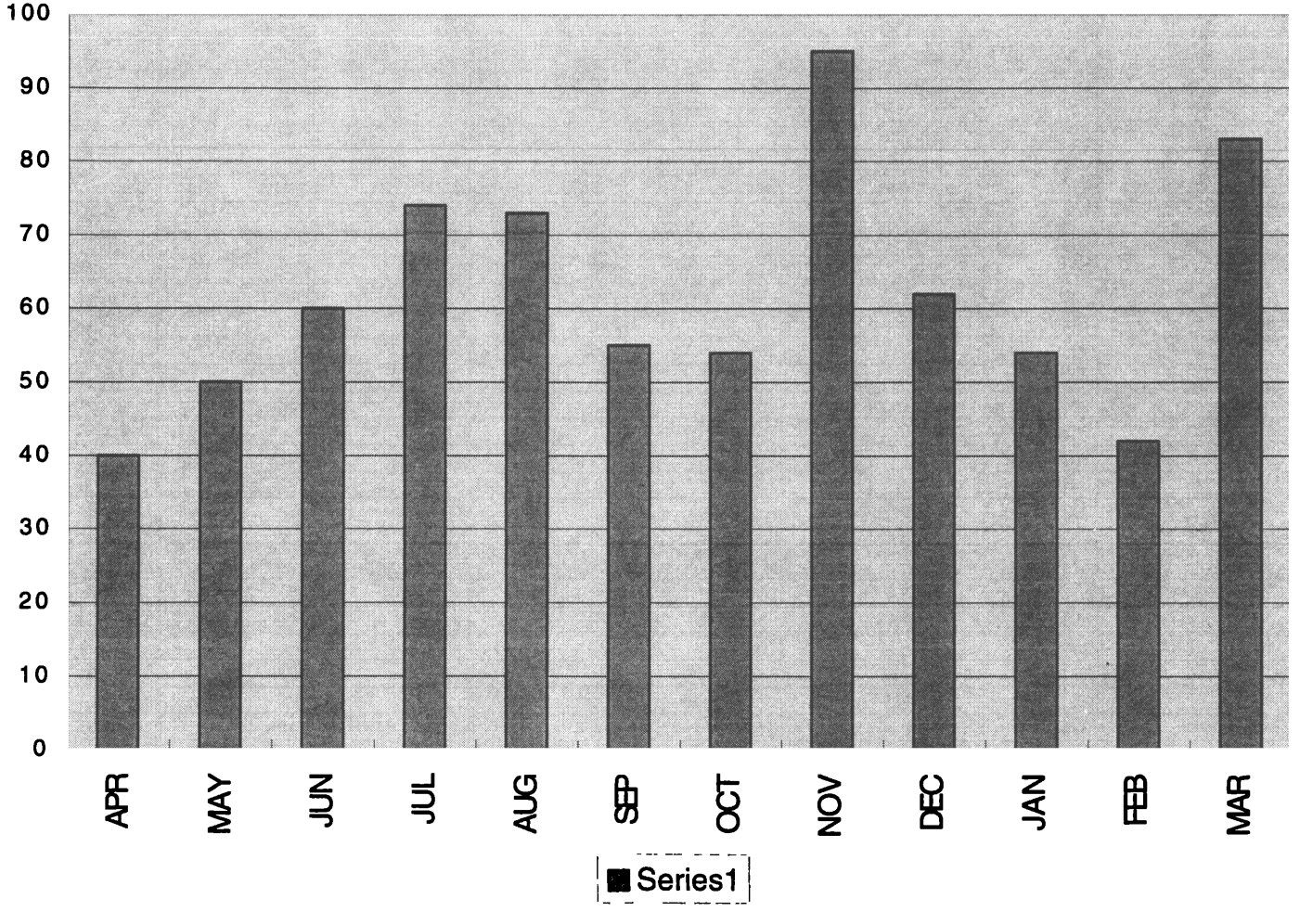
TO DATE TOTAL - 2,089,906 (1049 NT)

PROCESSED RECYCLABLE PLASTIC
(2nd & 3rd Quarter Production)



TO DATE TOTAL - 137,610

YARD WASTE TONAGE TO SLF
Yard Waste from Family Housing



Note: Does not include waste to inert landfill

Total Annual Tonnage

MONTH	YEAR	REFUSE COLLECTION & DISPOSAL FAM, H8G (TONS)	YARD WASTE (TONS)	COLLECTION & DISPOSAL OTHER THAN FAM H8G (TONS)	REFUSE DISPOSAL TROOP UNITS (TONS)	DISPOSAL CONTRACTORS & OTHER AUTH USERS (TONS)	REFUSE DISPOSAL CHATTAHOOCHEE COUNTY (TONS)	ASBESTOS WASTE (TONS)	RECYCLE MATERIAL (TONS)	TOTAL SOLID WASTE (TONS)
SEPTEMBER	1993	443		1,175	270	2,404	135	18		4,445
OCTOBER	1993	382		1,138	274	2,442	136	5		4,377
NOVEMBER	1993	476		1,160	216	1,821	152	6		3,831
DECEMBER	1993	399		906	203	1,763	161	6		3,438
JANUARY	1994	403		852	245	1,893	133	35	15	3,576
FEBRUARY	1994	346		1,041	453	1,081	149	0	17	3,087
MARCH	1994	519		1,221	491	324	172	2	25	2,754
APRIL	1994	330	40	1,048	222	111	204	1	28	1,984
MAY	1994	292	52	1,013	225	133	162	0	55	1,932
JUNE	1994	335	60	1,105	262	154	180	5	85	2,186
JULY	1994	299	76	1,123	201	76	184	0	51	2,010
AUGUST	1994	324	75	1,161	305	178	186	3	48	2,280
SEPTEMBER	1994	296	57	1,011	206	240	160	0	45	2,015
OCTOBER	1994	246	55	934	113	116	144	0	36	1,644
NOVEMBER	1994	258	97	895	71	93	156	0	39	1,609
DECEMBER	1994	285	69	744	91	632	161	0	37	2,019
JANUARY	1995	292	56	852	124	355	166	1	37	1,883
FEBRUARY	1995	258	44	868	136	287	149	3	34	1,779
MARCH	1995	311	88	1,198	172	390	185	8	42	2,395
APRIL	1995									
TOTALS		6,494	769	19,445	4,280	14,493	3,075	93	594	49,244
DAILY AVERAGE		11	2	34	7	25	5	0	1	85
MONTHLY AVERAGE		312	64	1,023	225	763	162	5	10	2,564
ANNUAL AVERAGE		4,102	769	12,281	2,703	9,153	1,912	59	176	31,155

RECYCLE EARNINGS

FOR PERIOD OCT 93-31 OCT 94

STATUS AS OF 5 DEC 94

	MRF		DRMO		TOTAL	
	ACTUAL	BUDGETED	ACTUAL	BUDGETED	ACTUAL	BUDGETED
MATERIALS RECYCLED IN FY94	34,241	185	371,394	703,000	405,636	887,500
CASH RECEIVED FOR MATERIALS RECYCLED IN FY94	7,237	184,500	285,651	703,000	292,888	887,500
FY94 ACCOUNTS RECEIVABLE	27,004	0	85,743	0	112,747	0
CASH RECEIVED FOR MATERIAL RECYCLED IN FY93	9,968	0	66,872	0	76,840	0
TOTAL CASH RECEIVED IN FY94	17,205	0	352,523	0	369,728	0

INDEX