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The economic feasibility of rural recycling : a case study approach

Lowell Kenneth Shaw

To the Graduate Council:

I am submitting herewith a thesis written by Lowell Kenneth Shaw entitled "The economic feasibility of rural recycling : a case study approach." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

William M. Park, Major Professor

We have read this thesis and recommend its acceptance:

Luther H. Keller, Ray G. Huffaker

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Carolyn R. Hodges

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To the Graduate Council:

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Date May 6th, 1988

THE ECONOMIC FEASIBILITY OF RURAL RECYCLING: A CASE STUDY APPROACH

A Thesis

Presented for the

Master of Science

Degree

University of Tennessee, Knoxville

Lowell Kenneth Shaw

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ABSTRACT

Rural community decision makers have come under increased pressure to deal with solid waste disposal in a cost effective and acceptable manner. As siting of new landfills has become more difficult due to environmental restrictions and public opposition, alternative disposal methods have received increased attention. Recycling can be viewed as a way to divert materials from the solid waste stream to be landfilled, as well as providing other benefits. While some research has been done on rural solid waste collection and landfill disposal systems, very little attention has been given to the potential for rural recycling. Rural recycling has generally been viewed as impractical due to relatively small supplies of materials and large distances to industry markets. This research was designed to assess the economic feasibility of rural recycling by analyzing three case study recycling operations, one each in Alabama, North Carolina, and Tennessee.

Economic feasibility, defined as "breaking even" when only sales revenues from recyclable materials and full operating costs are considered, would be very difficult to achieve for communities the size of those studied, given the market prices present during the study period. However, from a local accounting stance, outside funding sources, such as grants provided by the Tennessee Valley Authority for equipment or special local and state subsidies for labor, helped

to reduce net costs of operation for each center. In addition, each center generated considerable landfill cost savings by diverting recyclable materials out of the solid waste stream. When these cost savings were taken into account, net costs of operation were greatly reduced. In fact, in the case of one center, landfill cost savings more than offset net operating costs. The need to site new landfills was also delayed, thereby postponing the political or protest costs generally associated with landfill siting efforts. Other local benefits included supplemental income for residents and improved aesthetics from reduced litter.

The quantity of recyclable materials collected plays a key role in influencing economic feasibility. Analyses of each center demonstrated the potential for substantial economies of size within their existing scales. The net cost per ton of recycled material processed was also reduced as the quantity collected increased and more efficient large-scale equipment was introduced. From statistical analyses and personal surveys of those responsible for managing or overseeing each center, it could be concluded that several factors were critical in influencing the volume of material collected. These included education of local residents and publicity about recycling activities, prices offered for materials, the variety of materials accepted, and the accessibility of the center.

While economic feasibility in a strict sense may be difficult to achieve for rural recycling centers, the continued operation of the three centers studied here for over four years suggests they have achieved feasibility in a broader sense, given the availability of outside funding and the indirect benefits generated. Local political and community support has been important to the "success" of these centers from the time of their establishment up to the present.

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INTRODUCTION

Solid waste disposal has become an important issue in society today. What to do with increasing waste volume is a question both urban and rural communities must answer. The amount of household waste generated per year in the United States reached 136.1 million metric tons in 1985 (Pollock). Disposal by landfilling or incineration is generating increasing concern due to cost and environmental considerations.

Resource recovery is receiving increasing attention as a solid waste disposal alternative. The industrial sector can benefit from recycling as a result of energy cost savings. A good example is aluminum, one of the most energy-intensive materials in common use. Recycling aluminum requires only five percent as much energy as producing it from bauxite. Society also benefits through reductions in air and water pollution by 95 and 97 percent respectively when aluminum scrap is recycled (Pollock). Recycling also conserves natural resources and in 1980 generated 15 billion dollars in revenue from the sale of recyclable materials (National Association of Recycling Industries, Incorporated).

Problem Statement

Local governments in rural areas are responsible for the management and operation of solid waste systems in accordance with federal and state regulations. In the not too distant past many rural areas faced the serious problem of open dumping. In an effort to protect public health and safety, the federal Resource Conservation and Recovery Act was passed in 1976. A major objective of the act was the closure of all open dumps in the country within five years after Environmental Protection Agency standards were published in the Federal Register (Guedry and Austin). Landfilling is now the common method of solid waste disposal in rural areas, since the costs of incineration on a small scale are prohibitive. However, siting new landfills is frequently met with stiff political opposition from local residents and environmental groups. Thus, local governments in rural areas have increasingly looked to recycling as a method of disposing of a portion of their solid waste.

As with other waste disposal methods, recycling presents special concerns for rural areas. It has been argued that rural communities could not generate a sufficient volume of recyclable materials to make the establishment of resource recovery facilities practical. Rural communities' location relative to urban recyclable material markets is believed to make the costs involved in delivery of small volumes of recyclable material prohibitive (Church, Park, and Markley).

A few primarily rural counties have established recycling facilities and their experiences provide some insight into the validity of the above arguments. The following three recycling centers were evaluated in this study: the Athens-Limestone Recycling Center located in Limestone County, Alabama; the Grainger County Recycling Center located in Grainger County, Tennessee; and the Watauga County Recycling Center located in Watauga County, North Carolina.

Research Objectives

The overall objective of this study was to describe and analyze the manner in which three rural communities addressed their solid waste disposal needs through recycling. Specifically, the primary objectives were as follows:

A. to identify the expenditures necessary to begin recycling operations;

B. to determine the economic feasibility of each recycling center;

C. to investigate the extent to which economies of size exist for each center;

D. to identify significant factors associated with recyclable material volume collections at each center.

The secondary objective of this study was to document the perceptions held by those responsible for center operations concerning the center's external environment.

Procedures for Accomplishing Objectives

The three recycling centers listed above were selected because they were located in largely rural areas with total county populations under 50,000, and sufficient data were available to permit in-depth economic analysis. Also, centers in different states were chosen to consider possible regional variations among recycling centers. The counties differed in their demographic characteristics and the approach taken in initiating and operating their respective centers. However, all three were "buy-back" operations in which collectors were provided a financial incentive to participate through payments for recyclable materials. The case study approach was used for this investigation because of the relatively few number of public recycling facilities in rural areas. For instance, in Tennessee while 43 counties out of a total of 95 had some type of resource recovery facility, only 29 of these were rural counties and most facilities were private.

The study periods among the three recycling centers selected varied according to the time they began their operations. Approximately three years of data were available for the Athens-Limestone Recycling Center, beginning in October, 1983 and ending in September, 1986. The recycling center in Grainger County had data available for the three-year period from July, 1983 through June, 1986. Data for only two years were available from the Watauga County Recycling Center, beginning in July, 1985 and ending in June, 1987.

Information was obtained principally through accounting statements provided by the Clean Community Commission in Limestone County, the Grainger County Executive Office, and the Watauga County Finance Office. Additional data were gathered from recycling center logsheets which recorded the names and addresses of residents bringing materials, the type of material brought, how much each item weighed, and the total payment made. Computer print-outs were available from Watauga County listing the type of material, its weight, the price per pound on each item, and the addresses of the resident. Personal correspondence with other agencies and individuals provided additional data for this study.

To accomplish objective A, financial statements from each center were evaluated. Expenditures on equipment and centers currently being used were identified. The purpose of this was to determine the start-up costs associated with each center.

Objective B was accomplished by analyzing financial records from each resource recovery center. Revenues were based on recyclable material sales figures for each center. However, in the case of the Athens-Limestone Recycling Center, income from transportation freight allowances and interest earnings were also added to recyclable material sales. Specific expense accounts differed among recycling centers. However, there were enough similarities between accounts to establish general expense categories, allowing cost comparisons

to be made more easily. Six expense categories were established: recyclable material purchases, labor, equipment, facility, transportation, and miscellaneous.

To accomplish objective C, estimates of average annual net cost per ton of material processed for the actual amount of material processed were determined for each center. The estimates were then compared with hypothetical average annual net cost per ton estimates associated with the estimated maximum and minimum material processing capacity levels for each center. Individuals responsible for center operations were asked to estimate the maximum and minimum material processing capacities given existing equipment and facilities. Thus, only labor and other variable costs were assumed to change. Equipment and facility expenses were assumed to remain unchanged. Variable expenses for recyclable material purchases, labor, transportation, and miscellaneous were adjusted by the same percentage as the hypothetical changes in recyclable materials processed. This allowed estimates of net cost per ton of material processed to be made for material processing levels well above and below the actual levels within the period studied. On this basis a hypothetical short-run average cost curve could be identified, providing a general indication of the economies of size within the existing scale of each recycling center operation.

To accomplish objective D, multiple regression models were developed for the Athens-Limestone and Grainger County

Recycling Centers to identify factors that were significant in explaining variation in recyclable material collections (in pounds). These single-equation models were designed to identify the supply function for recyclable materials under the assumption that demand at the local center level was perfectly elastic. Independent variables included in the models were recyclable material prices per pound, a time trend variable, seasonal dummy variables for spring, summer, and fall, and a monthly unemployment rate variable.

The secondary objective of this study was to document the perceptions held by those responsible for center operations concerning the center's external environment. The external environment examined in this study included the amount of community and political support provided for the recycling center, knowledge received by participants regarding center activities, and the availability of solid waste disposal alternatives in the county. Data for this analysis were acquired through personal interviews with center managers and other county officials. General topics covered in the questionnaire included the influence of environmental laws and ordinances on program design and operations, the amount of materials available for collection and the significance of weather conditions on material quantities collected. In addition, each center manager was asked to rate the significance of center accessibility, recyclable material prices paid, hours of operation, the

variety of materials accepted by the center, center appearance, and education of residents in attracting recyclable material collections to the center.

Thesis Outline

The remainder of the thesis consists of the following components. A literature review of studies on rural solid waste disposal and recycling is presented in Chapter II. The Athens-Limestone Recycling Center is the focus of Chapter III, including discussions of history, start-up costs, economic feasibility, economies of size, material collection model, and survey findings. The Grainger County and Watauga County Recycling Centers are similarly analyzed in Chapters IV and V, respectively. A summary of the findings from the analysis of the three recycling facilities is provided in Chapter VI, along with some conclusions and implications.

CHAPTER II

LITERATURE REVIEW

A review of literature relevant to this study is reported in this chapter. Literature pertaining to rural solid waste disposal in general is discussed first. This is followed by an examination of literature addressing recycling specifically as a solid waste disposal alternative. Reports concerning the recycling industry often focuses on program design and operating guidelines, such as the Environmental Protection Agency publication Operating A Recycling Program: A Citizen's Guide, or simply describe existing programs in various forms, for instance, State Support for Recycling: A Twelve-State Survey by Marianne Freedman. There has been a general lack of research analyzing the feasibility of rural recycling facility operations. This is due in part to the relatively small number of recycling centers in operation.

Solid Waste Disposal Studies

J. R. Russell examined the costs of solid waste management systems of rural cities in the Southeastern United States, specifically the four state region of Georgia, Alabama, South Carolina, and North Carolina. Only cities with populations of 10,000 or less were considered in the study. Questionnaires were gathered from 47 cities

in which no solid waste was collected outside city limits. Data focused on the size of the operating unit, management, financing, and cost of operations.

Russell found that collection vehicles represented a major investment within solid waste systems. However, there was a wide variation in size and cost among city sizes. Many cities having populations under 4,000 appeared to have excess equipment investment. Labor cost was the largest component of total annual collection costs for all communities studied. Labor costs also varied depending on the hourly wages and number of hours worked. Variable costs accounted for 71 to 95 percent of total costs. The results of Russell's research indicate that collection costs were high but could vary considerably. The major limitation of this study was the focus on cities with populations of 10,000 or less.

Leo Guedry and Liang Huam, in their study "Economic Analysis of Rural Parish-Wide Solid Waste Collection and Disposal Systems in Louisiana," evaluated solid waste collection systems on a larger scale. The objective of their study was to determine the physical and economic characteristics of rural Louisiana solid waste management systems in parishes, as a basis for assessing the impact of anticipated changes in federal and state regulations affecting such systems. The study included 22 nonmetropolitan parishes. Questionnaires were used to obtain information on

physical characteristics, collection frequency, and types of equipment used in each parish. Cost information was also obtained and was categorized as either capital investment or annual costs. Finally, data on parish population and economic characteristics were gathered. The study also summarized federal and state solid waste disposal laws governing solid waste collection and disposal systems.

Physical characteristics of existing solid waste collection systems were identified and described in the study. These were parish-wide bin collection, parish-wide house-to-house collection, and multiple house-to-house collection. Bin collection involved the placing of containers at strategic points for waste collection from parish residents. The house-to-house method of collection involved residential pick-up of household refuse either at the curb or in alleyways. Multiple house-to-house collection served residents within municipal limits, and six systems provided services to residents on the periphery. Multiple systems were divided into three population groups: 28 municipalities served populations of less than 3,000 persons, 14 municipalities served populations between 3,000 to 10,000, and 6 municipalities served populations greater than 10,000. Operating and investment costs associated with each type of collection system above were determined. The study investigated methods of financing solid waste collection and disposal in rural parish-wide systems. Revenue sharing and user fees were

discussed. Finally, the Guedry and Huam study examined model budgets for solid waste systems in rural parishes which satisfied existing state and federal regulations.

Guedry and Huam concluded that the parish-wide and municipal collection systems surveyed were using the types and levels of physical inputs common to most rural solid waste systems and were performing the functions that were considered adequate for their respective communities. Some form of cooperation between small municipalities was necessary to take advantage of economies of size, since the high cost of equipment, land, and labor made it difficult for those municipalities to operate efficiently. Average investment costs per system in parish-wide bin collection systems were higher than parish-wide house-to-house collection systems due to the larger collection trucks and investment in bins.

Church, Markley, and Park studied alternative solid waste collection systems in rural Tennessee counties. Their study compared "green box" collection systems with convenience center collection systems for three counties which had recently shifted from the former to the latter. Under the "green box" system, metal waste containers are placed in various sites throughout the county for residents to dispose of their trash. These containers are then emptied and the waste disposed of in a public landfill. Problems of scavanging, vandalism, and accumulated trash around containers are present under the "green box" system. The convenience

center system was developed to reduce these problems by decreasing the number of disposal sites, keeping an attendant at each site, and fencing in the facility area. Annual costs were compared between the two systems. Major cost categories used in the study were total annual equipment cost, total annual labor cost, and total annual site cost. Three rural counties in Tennessee were evaluated: Jefferson, Grainger, and Wilson Counties. In all three counties, the convenience center system proved to be less expensive to operate using county funds.

In Jefferson County, the convenience center system required less equipment than did the "green box" system, both in terms of trucks and containers. Labor costs under the convenience center system were also lower than under the "green box" system, due to the need to pay service workers overtime wages to clean up around containers. In addition, truck drivers under the "green box" system were more expensive than convenience center attendants, who were paid relatively lower wages. However, total annual site costs under the convenience center increased compared to the "green box" system, due to higher site development costs and the use of utilities at the center. The decreased equipment and labor costs more than outweighed the increased site costs to make the convenience center system less expensive in Jefferson County.

In Grainger County, total annual equipment cost under the convenience center decreased compared to the "green box" total annual equipment cost. This was due to fewer collection sites requiring service, reduced maintenance cost resulting from vandalism, and reduced depreciation costs resulting from increased useful life on equipment and the elimination of one truck. However, labor costs were higher under the convenience center system because of the requirements for center attendants. In addition, site costs increased for the convenience center system resulting from site development costs and utilities used at the center. However, the decrease in equipment cost more than compensated for increases in labor and site costs, making the convenience center system less expensive overall.

Finally, in Wilson County, the convenience center system experienced higher equipment costs than the "green box" system, due to increased operating cost for trucks and increased depreciation costs resulting from more expensive trucks and containers. Labor costs were lower for the convenience center than for the "green box" system, because of the elimination of overtime pay for clean up around containers. However, site costs were higher for the convenience center system due to site development costs. Overall, the decrease in labor costs more than compensated for increases in equipment and site costs, making the convenience center system less expensive.

Direct comparisons among the findings from these studies is not possible. However, each provides some insights into alternative methods for solid waste collection in rural areas and the costs associated with these methods.

Resource Recovery Studies

A paper by Joseph J. Miller entitled "Does Curbside Recycling Make Sense for a Small Community?" addressed the economics of curbside recycling and examined the benefits and costs that curbside recycling may provide for municipalities considering this option. Collection and processing equipment costs, secondary material market conditions, and the effect of local waste collection rates were considered in Miller's paper, based on data from manufacturers' data and nationwide surveys. In addition, overall costs of curbside recycling programs were presented for selected small communities having populations less than 100,000 throughout California. Collection, materials processing, shipping, and efforts to create public awareness constituted the major cost components associated with curbside recycling.

Curbside recycling programs are typically labor intensive and the manpower requirement is the single most important factor. Curbside recycling programs utilizing compartmentalized collection trucks, horizontal bailers, can separators, glass crushers, floor scales, and forklifts involve labor costs

amounting to 50 to 60 percent of total operating costs according to Miller. Variable expenses, including utility fees and equipment maintenance costs, typically account for 15 to 20 percent of curbside operating costs, based on surveys of a number of existing programs. Public awareness efforts and equipment amortization comprised 5 to 10 percent and 10 to 30 percent of typical annual costs of curbside recycling programs, respectively, according to Miller.

Joseph Miller stated that the success of any recycling program depended on adequate public awareness about available recycling outlets. The most successful programs are those that are convenient, highly visible within the community, provide dependable service, and provide tangible reminders to recycle. The highest participation rates for curbside recycling programs are those cities where citizens are provided with containers to separate and store their recyclables.

Case studies of four curbside recycling programs were examined briefly in the Miller paper. These programs were in Palo Alto, Downey, Santa Rosa, and Burbank, California. Populations, operational parameters (materials collected, materials recovered, collection equipment, collection crew size, and processing equipment), waste disposal rates, and net cost per ton were examined.

Palo Alto had a population of 57,000 in 1981. Newsprint, ferrous and nonferrous metals, glass, and corrugated board

were collected, with 2,800 tons of material recovered per year. Equipment used included two modified vans with two trailer bin systems, one collection worker per vehicle, a forklift, a bailer, a magnetic separator, and 15 to 40 cubic yard bins.

Downey had a population of 90,000 in 1981. Newsprint, ferrous and nonferrous metals, and glass were collected, with 900 tons of material recovered per year. Equipment used included a 37 cubic yard collection truck, with one collection worker per truck. No processing equipment was utilized.

Santa Rosa had a population of 83,000 in 1981. Newsprint, ferrous and nonferrous metals, and glass were collected, with 2,600 tons of material recovered per year. Equipment used included two multimaterial collection vehicles with one collection worker and one alternate worker per truck. No processing equipment was used.

Burbank had a population of 85,000 in 1981. Newsprint, ferrous and nonferrous metals, and glass were collected, with 1,000 tons of material recovered per year. Equipment used included two multimaterial collection vehicles with one collection worker per vehicle, and a bailer, a can crusher, a glass crusher, and a truck scale.

Net costs per ton were $(92.04), $(44.26), and $(40.93) for the Palo Alto, Downey, and Santa Rosa programs,

respectively. No net cost per ton figure was given for the Burbank curbside recycling program.

Miller concluded that his results were fairly typical of many municipal curbside recycling programs. Without considering landfill disposal cost savings, recycling programs were not economically self-sustaining. Operating costs generally exceeded direct revenues from the sale of recovered materials.

Miller examined recycling programs on the west coast of the United States with much larger populations than populations of counties examined in this study. Also, these areas would not be representative of demographic and economic conditions found in the southeastern United States.

A rural recycling study was conducted in October, 1986 by the Minnesota Project, a nonprofit community organization focusing on rural community development issues. Seven multi-material recycling programs, which had been in existence for a period of time, were selected as case studies. A predetermined set of questions was used to interview key individuals in each case. An attempt was made to examine the history, evolution, mechanics and impact of each recycling program by interviewing people with different perspectives. The seven recycling programs were located in Wisconsin, Minnesota, California, New Hampshire, and Maine. In each case study information on the following items was obtained: county population, estimated daily and annual tonnages of

solid waste generated in each county, who operated the recycling program, what type of program it was (drop-off, buy-back, or curbside), the types and amounts of various recyclable materials collected at each center, the distance away from markets, yearly program costs, and estimated percentages processed from the total solid waste stream.

Conclusions related to the impact of recycling by the seven programs studied revealed the following. Records of recycling tonnages, recycling expenses, and recycling revenues were rarely collected in a manner in which they were comparable across programs. Moreover, it was difficult to compare the cost of recycling with the cost of other solid waste management alternatives. Recycling programs would benefit from consistent record keeping and reporting. Tonnages of recyclables handled may be related to population figures, for example, as pounds recycled per capita for comparison purposes. The net cost of recycling operations should be reduced by the avoided costs of trash disposal, when compared to the cost of other solid waste management alternatives. Estimates of participation rates in recycling programs were rarely indicative of recycling impact. Work provided to disabled adults, jobs and income, and community involvement should all be considered in evaluating the success of recycling programs.

The Minnesota Project case studies varied in program design, such as drop-off facilities, use of developmentally disabled adults, and curbside recyclable collection. This

made comparisons among the seven programs difficult. In addition, all but one program were located in the northeast or upper midwest areas, suggesting the findings may not be applicable given conditions in the southeastern United States.

Summary

The review of literature presented in this chapter indicates a strong need for additional research into rural resource recovery programs in the southeast. Studies presented by Russell, Guedry and Huam, and Church, Markley, and Park focused primarily on costs involved in solid waste collection for landfill disposal in rural counties or small towns. Resource recovery centers in rural areas generally require residents to bring recyclable material collections to the center. The only other study of rural recycling focused on facilities in the northeast and upper midwest regions of the United States and was limited in its ability to generalize due to data limitations and differing program characteristics.

CHAPTER III

ATHENS-LIMESTONE RECYCLING CENTER

History

The Athens-Limestone Recycling Center is located in Athens, Alabama. The population of Limestone County in 1984 was 47,300 while the city of Athens had a population of 14,000. Over 68 percent of the population of Limestone County was classified as rural according to the Alabama Department of Economic Affairs in 1984. Additional demographic and economic characteristics can be found in Appendix A of this study.

The Athens-Limestone Center began in 1977 as a fund-raising campaign for the Athens High School Science Club. The Clean Community Commission, a non-profit, volunteer organization affiliated with the Keep America Beautiful program, handled publicity and community education as the project grew. The Commission soon assumed full responsibility for the Center when the city of Athens felt it could no longer fund the pick-up of corrugated board, the principal recyclable material processed by the recycling center. The Center, located on city property in a city-owned structure, was directed by a volunteer Recycling Board which was organized under the Clean Community Commission. The Board decided to hire a full-time manager to operate the Center on a day-to-day

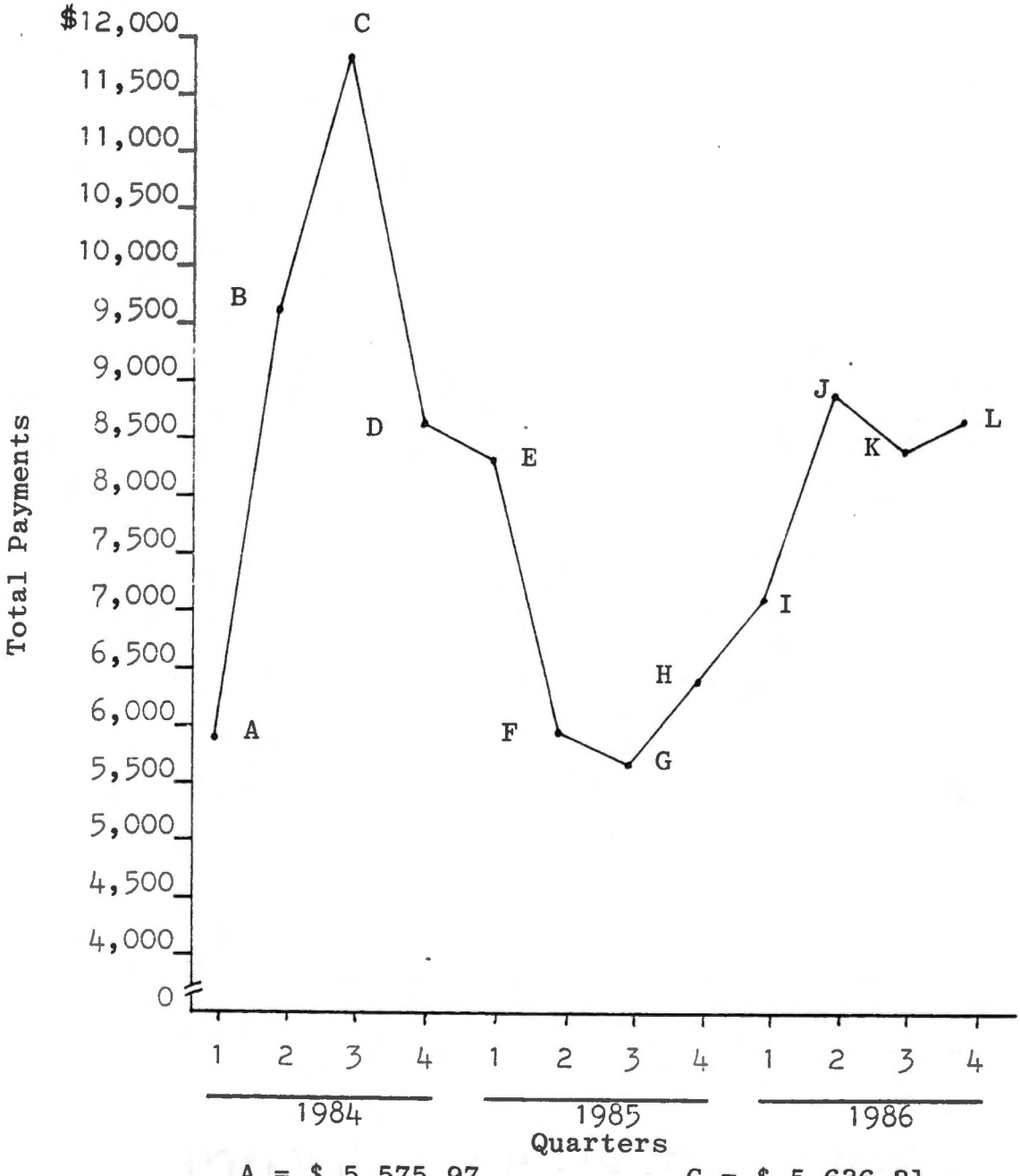
basis in 1978. The city of Athens provided $51,900 to purchase new equipment, make repairs on existing equipment, and enlarge the Center. The Recycling Board specified that $18,000 of this money was to be reserved for a cash flow fund. As recyclable material volumes increased, the Tennessee Valley Authority was requested in 1983 to assist in acquiring additional equipment. The Center received $50,000 in demonstration grant funds which were used to purchase the needed equipment and further modify the existing building.

Information on recyclable material collections between October, 1983 and September, 1986 is provided in Table 1. The Athens-Limestone Recycling Center recycled approximately 2,526 tons of corrugated board, 65 tons of aluminum cans, 436 tons of newsprint, and 114 tons of glass over this period. The Center paid collectors a total of $94,627 over this period while receiving $199,457 from recyclable material sales. Corrugated board accounted for 80.4 percent of the total volume collected and 65.6 percent of total payments made. Newsprint accounted for 13.9 percent of the total recyclable volume, while glass and aluminum cans accounted for 3.6 and 2.1 percent, respectively.

A quarterly trend in total payments to participants is shown in Figure 1. The high level of payments in the third quarter of fiscal 1984 may be attributed to a strong promotional effort made during the year. Total payments fell

Table 1. Limestone County Recyclable Material Collections: October 1, 1983 to September 30, 1986

Material	Tons Collected	Percent of Total	Payment to Collectors	Percent of Total
Corrugated Board	2,526	80.4	$62,083	65.6
Aluminum Cans	65	2.1	21,535	22.8
Newsprint	436	13.9	8,725	9.2
Glass	114	3.6	2,284	2.4
Total	3,141	100.0	$94,627	100.0



A =	$ 5,575.97	G =	$ 5,636.21
B =	9,643.31	H =	6,483.48
C =	11,712.49	I =	7,208.39
D =	8,663.69	J =	8,867.79
E =	8,375.60	K =	8,196.83
F =	5,902.40	L =	8,360.64

Figure 1. Athens-Limestone Recycling Payments Trend October 1, 1983 to September 30, 1986.

below $6,000 in the second and third quarters of 1985, due in part to lower per pound prices for corrugated board and aluminum cans. Total payments increased gradually to between $8,000 and $9,000 per quarter in 1986. The variation in total payments made to collectors in Figure 1 is a function of both prices paid and quantities of recyclable materials collected.

The greatest variation in price occurred for aluminum cans (Figure 2). A high of $ .22 per pound was paid for aluminum cans in the first and second quarters of fiscal 1984; a low of $ .13 per pound was paid in the fourth and first quarters of fiscal 1985 and 1986, respectively. Corrugated board prices showed slight variation from a high of $ .016 per pound in fiscal year 1984 to a low of $ .01 per pound during most of fiscal years 1985 and 1986. Newsprint and glass prices per pound did not change at all between October, 1983 and September, 1986, being constant at $ .01 per pound.

A trend for corrugated board collections in tons is shown in Figure 3. Trends for newsprint, glass, and aluminum can collections are presented in Figure 4. The quantity of corrugated board was shown separately because of the relatively large difference in total tonnages collected compared to the other recyclable materials received at the Center. Quantities of corrugated board and newsprint were more variable than other materials during this period.

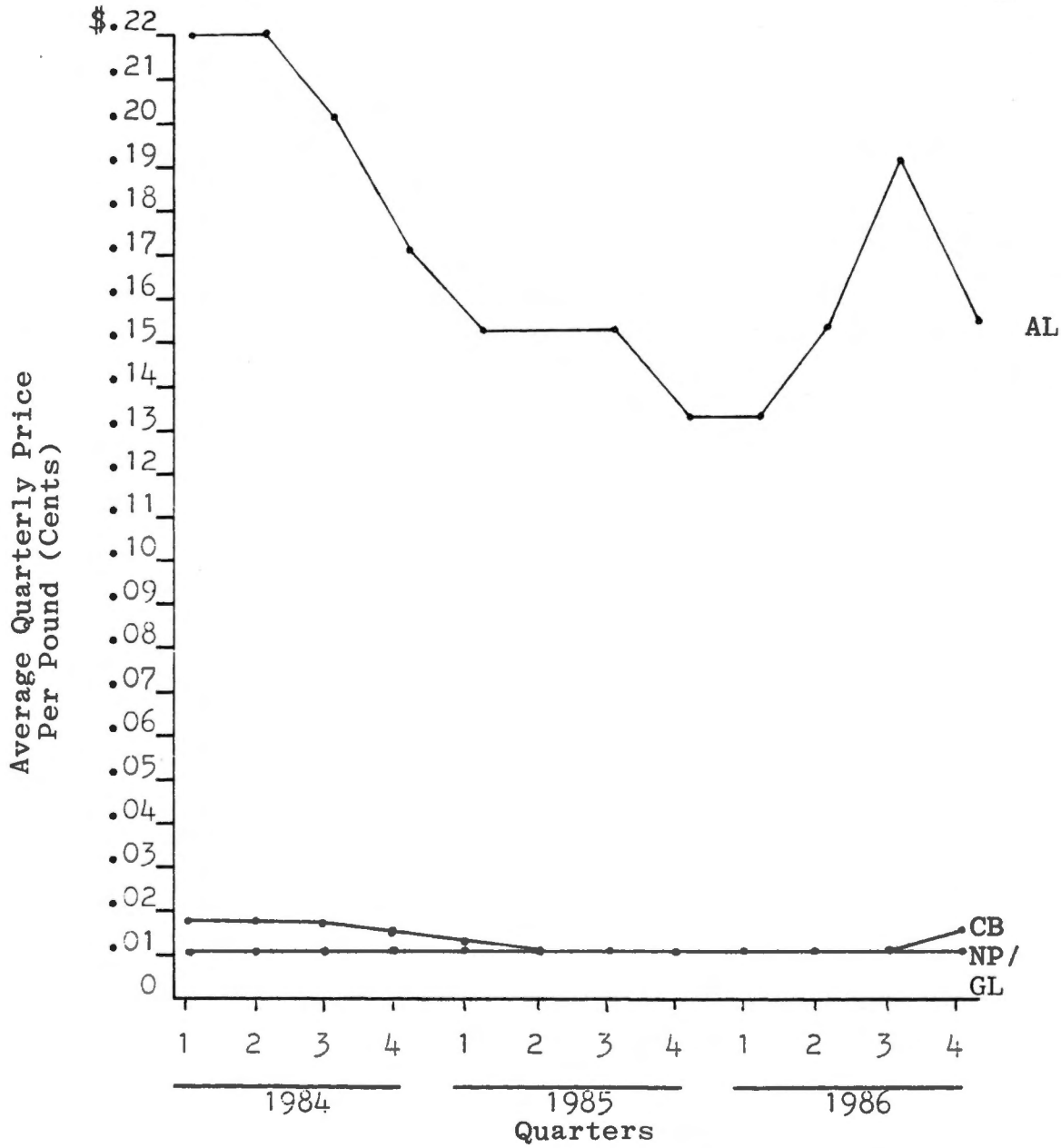


Figure 2. Athens-Limestone Average Quarterly Price Paid Per Pound to Participants Collecting Recyclable Materials Between October 1, 1983 and September 30, 1986.

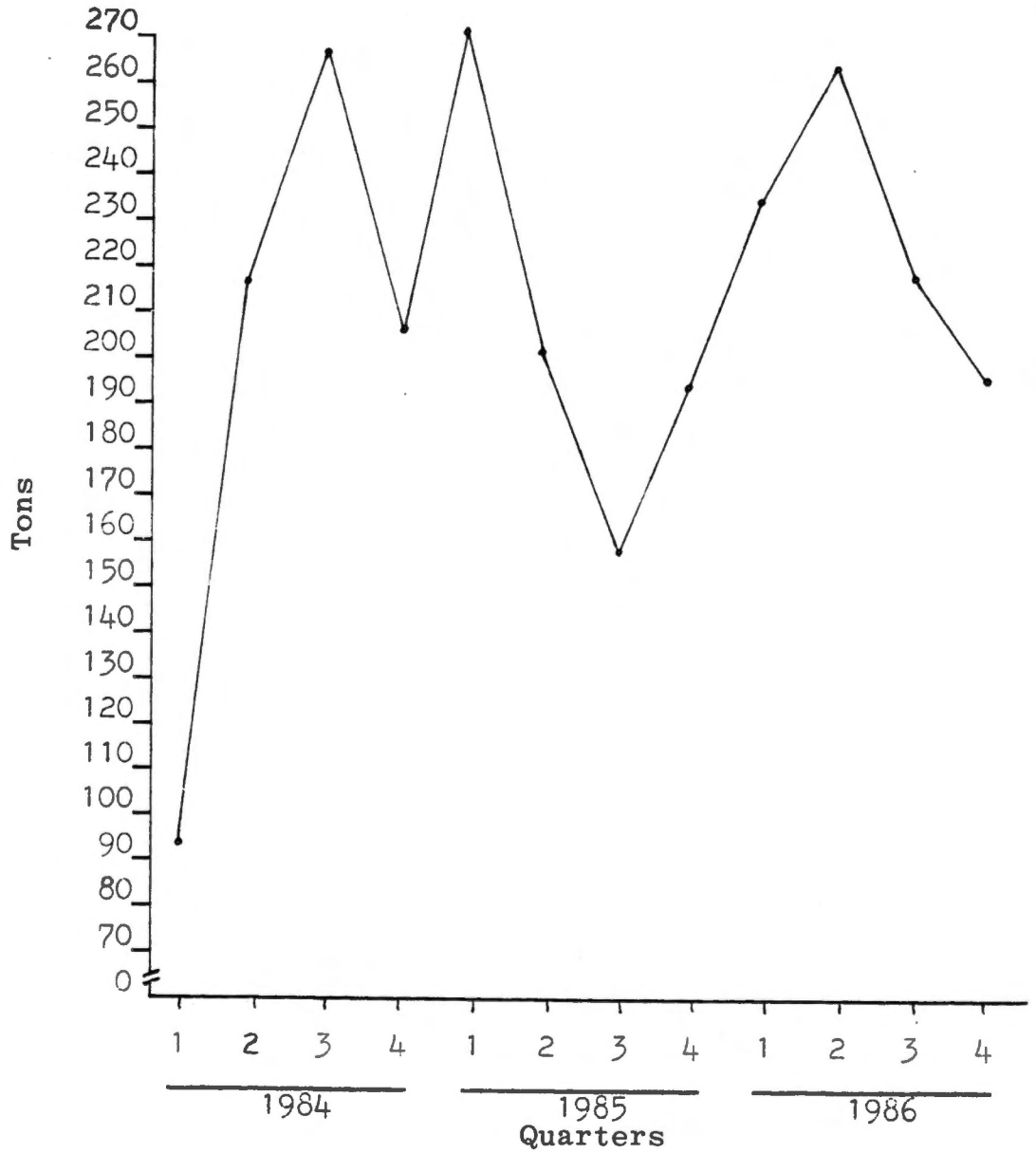


Figure 3. Athens-Limestone Recyclable Material Collections for Corrugated Board (in Tons) Per Quarter Between October 1, 1983 and September 30, 1986.

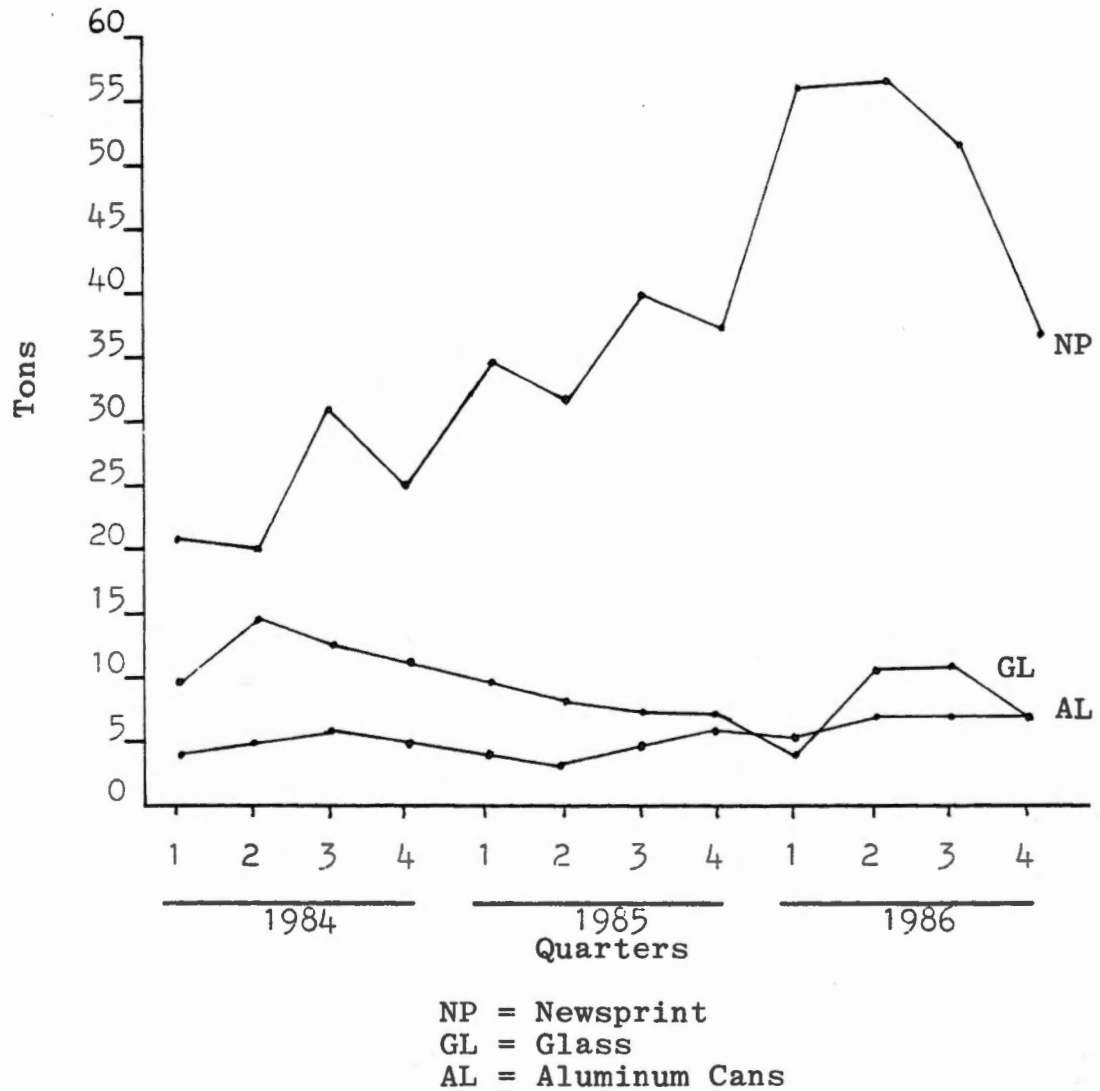


Figure 4. Athens-Limestone Recyclable Material Collections for Newsprint, Glass, and Aluminum Cans (in Tons) Per Quarter Between October 1, 1983 and September 30, 1986.

The nearest alternative recycling center available to county residents is located in Huntsville, Alabama, which is twenty-five miles from the city of Athens. Although the Huntsville Recycling Center accepted a few more recycling materials, the prices for corrugated board, newsprint, and glass were nearly the same as those offered at the Athens-Limestone Center. Aluminum can prices per pound were somewhat higher at the Huntsville Recycling Center. However, even the variable costs of transporting materials to Huntsville from Athens would likely offset any slight price gains; thus, the Athens-Limestone Center was treated as a separate market.

Transportation costs must also be addressed by the Athens-Limestone Center, which pays freight expenses to haul materials to other markets. However, the Center does receive a freight allowance on the transportation of corrugated board to a market ninety miles away. The company accepting corrugated board from the Athens-Limestone facility has agreed to provide a freight allowance to the Center for delivery, rather than pick up the material themselves. Independent haulers were paid to transport newsprint and glass to markets fifteen and two hundred miles distant, respectively. The Athens-Limestone Center hauls computer, office, and ledger paper to newly created markets roughly twenty-five miles away.

Initial Center Costs

Total costs needed to begin an operation like the current Athens-Limestone Recycling Center were examined. Two cost categories were examined, equipment and facility expenses. Each of these areas is discussed in more detail in the next section of this chapter on economic feasibility.

Equipment used at the Athens-Limestone Center is listed in Appendix C. The most expensive single item was the horizontal bailing press with a conveyor, purchased at a cost of $29,570. Prior to its purchase by the Tennessee Valley Authority, a vertical bailing press was used to process newsprint and corrugated board for shipment. However, as recyclable material quantities increased, storage of newsprint and corrugated board became unmanageable. The vertical bailing press was only able to process limited amounts of these materials each day. Since corrugated board comprised the largest percentage of recyclable material quantities collected and the largest percentage of revenue received from resale, the Athens-Limestone Recycling Board decided that investment in the horizontal bailing press was justified. Total investment in equipment for the Center was $58,629.

Facility cost for the Athens-Limestone building was not available since the structure had been donated by the city of Athens to the Clean Community Commission. The Commission leases the structure to the recycling center for one dollar

annually. The Athens-Limestone Center facility is similar in design and square feet to the Watauga County Center. The Watauga County Center facility had an estimated total construction cost of $42,000. However, the Athens-Limestone Center has some additional improvements, such as a paved parking area and a loading dock for recyclable material collections which would increase its cost. Constructing a facility with these added improvements might increase the cost of the Athens-Limestone Center to between $45,000 and $55,000. This estimated capital cost for the facility is reasonably consistent with the estimated $500 per month lease value for the facility suggested by the Clean Community Commission Coordinator.

Total equipment and facility start-up costs for an operation like that of the Athens-Limestone Recycling Center would thus be approximately $103,629 to $113,629. The purpose of analyzing initial center costs was to provide a general picture of the total funds necessary to begin a recycling center such as is now in operation in Limestone County.

Economic Feasibility

In this section revenues, costs, and net returns for the Athens-Limestone Center between October, 1983 and September, 1986 are analyzed. Average annual costs and returns for the Athens-Limestone Recycling Center are presented in Figure 5. Column (1) in Figure 5 represents

Revenues	(1) Costs Covered by the Center	(2) Costs Covered by Other Sources	(3)[a] Revenues, Total Costs, and Returns
Sale of Materials			$68,874
Freight Allowance			11,464
Interest			411
Total			$80,749
Costs			
Purchase of Materials	$38,438	$ -0-[b]	$38,438
Labor	22,628	4,020[c]	26,648
Equipment	2,952	3,022[d]	5,974
Facility	6,443	721	7,164
Transportation	8,816	-0-	8,816
Miscellaneous	3,183	-0-	3,183
Total	$82,460	$7,763	$90,223
Net Returns			$(9,474)
Estimated Landfill Cost Savings			$11,517[e]

[a]Costs under column (3) are the summation of column (1), costs covered by the Center, and column (2), costs covered from other sources.

[b]Costs for one part-time employee covered by the Green Thumb Program.

[c]Costs for equipment depreciation covered by the Tennessee Valley Authority.

[d]Costs for facility covered by the Tennessee Valley Authority.

[e]Over the three-year period between October 1, 1983 and September 30, 1986, 3,141 tons of recyclable materials were diverted from the Limestone County landfill. At a cost of $11 per ton, the county saved $34,551. Landfill cost savings thus averaged $11,517 on an annual basis.

Figure 5. Average Annual Returns for the Athens-Limestone Recycling Center: October 1, 1983 to September 30, 1986.

costs incurred which were covered by the Center. Column (2) represents costs incurred which were covered from other sources. Column (3) represents total costs incurred. Total revenues are also included under column (3) of Figure 5.

Revenue sources included resale of recyclable materials, freight allowances, and interest earnings. Recyclable material sales totalled $81,598, $54,379, and $70,646 in fiscal years 1984, 1985, and 1986, respectively, with fluctuations due primarily to variations in prices rather than volume. Between October, 1983 and April, 1985, the Athens-Limestone Center received a $12 per ton freight allowance when corrugated board was delivered to market by an independent hauler. This increased to $13 per ton between May, 1985 and September, 1986. The Center received an average of $125 in freight allowances per truck load. Interest earnings totalled $384, $128, and $258 for fiscal years 1984, 1985, and 1986, respectively.

Costs were grouped into six categories for each resource recovery center: purchase of recyclable materials, labor, equipment, facility, transportation, and miscellaneous costs. The purchase of recyclable materials cost averaged $38,438 annually and accounted for 42.6 percent of the total annual average cost in column (3). The $38,438 recyclable material purchase cost was also listed under column (1), because all costs associated with the purchase of recyclable materials from collectors were covered by the Center.

Labor costs covered by the Center are indicated in column (1) of Figure 5. These included salary cost for the center manager, extra help wages, and payroll taxes. On an annual average basis these costs amounted to $19,496, $1,872, and $1,260, respectively. Total costs covered by the Center were $22,628. Labor cost for the Athens-Limestone Recycling Center was unusual in that part of the labor cost was funded from an outside source. In column (2), labor costs for one employee were covered by the Green Thumb Program. Under the Green Thumb Program, low income individuals were hired to work for various employers at minimum wages. The employee at the Athens-Limestone Center worked an average of 24 hours per week for 50 weeks annually at $3.35 per hour. This amounted to $4,020 on an annual average basis. Because the Green Thumb Program compensated the Athens-Limestone employee, the $4,020 was shown under column (2) as a cost covered by other sources. Total labor costs in column (3) came to $26,648 and amounted to 29.5 percent of total annual average cost in column (3).

Equipment depreciation costs and maintenance and repair costs paid by the Athens-Limestone Center amounted to $1,345 and $1,607, respectively. Total equipment cost covered by the Center was $2,952 under column (1) of Figure 5. Equipment cost in column (2) represents equipment depreciation expense covered with funds from the Tennessee Valley Authority (TVA). Total equipment cost funded by the TVA amounted to

$40,569.70. This represents 69.2 percent of total equipment purchase cost of $58,628.70. Equipment depreciation based on the total purchase cost was $4,367. Because 69.2 percent of the total equipment investment was covered by the TVA, 69.2 percent of total depreciation expense was also attributed to TVA. This amounted to $3,022 on an annual average basis as indicated under column (2). Total equipment cost came to $5,974 and amounted to 6.6 percent of total annual average cost as shown in column (3).

Facility cost was also unusual for the Athens-Limestone facility, due to the donation of the structure to the Clean Community Commission. Originally, the property and structure had been used by the city of Athens as an incinerator plant for solid waste disposal. The site was later abandoned following strict Environmental Protection Agency guidelines on air pollution emissions. As the Athens-Limestone Recycling project grew, more space was needed to handle the greater quantities of recyclable materials collected. Because the structure and property were donated, no building cost figures were available. However, a coordinator with the Commission who was familiar with the Athens-Limestone facility estimated that the building could be leased for $500 monthly or $6,000 annually. Thus, only $5,279 of the $6,000 annual cost from above is considered to be a cost covered by the Center. Other facility costs included utilities and insurance and amounted to $827 and $337, respectively, on an annual average

basis. Total facility cost covered by the Center came to $6,443, as indicated in column (1).

However, the TVA did provide $7,000 in demonstration grant monies for facility improvements. Amortizing the $7,000 at six percent over a period of fifteen years results in an annual facility cost of $721 under column (2) of Figure 5 for costs covered with funds from outside sources. Total facility cost came to $7,164 and amounted to 7.9 percent of total annual average cost in column (3).

Transportation cost was derived from the cost of transporting office, computer, and ledger paper directly to markets by the Athens-Limestone Center. In addition, costs paid to independent haulers to transport aluminum cans, glass, newsprint, and corrugated board to markets were included under the transportation cost heading. Only corrugated board received a freight allowance per ton. All transportation cost was covered by the facility; therefore, no figure is listed under column (2). Transportation costs covered by the facility included freight transportation cost and gas cost. These totalled $8,478 and $338, respectively, on an annual average basis. Total transportation cost came to $8,816 and amounted to 9.8 percent of the total annual average cost in column (3).

The miscellaneous cost category for the Athens-Limestone Center included such costs as operating supplies, office supplies, advertising, travel, bank charges, accounting,

licenses, tools, Clean Community Commission fees, and miscellaneous costs. The Athens-Limestone Center contributed nominal sums, $1,000 in fiscal year 1985 and $500 in 1986, to be used by the Commission for its organizational activities. The Clean Community Commission promotes anti-litter campaigns and gives awards for landscape beautification efforts by local businesses, in addition to providing administrative and educational assistance to the recycling program. All miscellaneous costs were covered directly by the Center and amounted to $3,183, which was 3.5 percent of total annual average cost in column (3).

The $82,460 total in column (1) represents that portion of costs which were covered by the Athens-Limestone Recycling Center. The $7,763 total in column (2) represents that portion of costs which were funded by outside sources. The total cost of $90,223 shown in column (3) represents what the recycling center would cost to operate on an annual average basis if all costs, including those funded by the Green Thumb Program and the Tennessee Valley Authority, were included.

The recycling center thus operated on an annual average basis at a net loss of $9,474 when all costs are considered. However, if the costs covered from other sources are eliminated, the net loss would be reduced to $1,711. This clearly shows the influence of outside funding on the economic feasibility of the Athens-Limestone Center.

Estimated landfill cost savings are also shown in Figure 5. These cost savings may not show up in a municipality's budget in the short-run, but they do represent a factor to be considered in viewing recycling as a solid waste disposal alternative. The city of Athens Sanitation Department has recently provided additional funding for the recycling program, acknowledging the reduced amount of solid waste which has to be disposed of in the Limestone County landfill. According to the Athens Sanitation Department, the cost of disposing of a ton of solid waste in the county landfill was estimated to be $11 in 1987. The national average landfill cost per ton in 1976 was estimated to be $30 by the Environmental Protection Agency in the publication, Material and Energy from Municipal Waste. While the Athens estimate of $11 per ton appeared to be somewhat low, it was used to value the landfill cost savings. Between October, 1983 and September, 1986, the Athens-Limestone Recycling Center processed 3,141 tons of recyclable materials. Landfill cost savings thus amounted to $34,551 during this period. Averaging this figure over three years resulted in an annual average cost savings of $11,517. This fully offsets the net loss of $9,474 in column (3).

Economies of Size

Traditional economic thought defines economies of size as the explanation for the downward sloping part of the

average total cost curve of production. Short-run average total cost curves are based on a particular scale or plant size. Within the range of production levels possible, as volume is increased, fixed costs for facilities and equipment are spread over more units and average total cost is reduced. The long-run average total cost curve is an envelope of short-run average total cost curves. Reduction in average total cost along the long-run average total cost curve are also generated by availability of more efficient large-scale equipment. Since only three rural recycling centers were examined in this study, it was not possible to derive a long-run average total cost curve for the industry as a whole. Thus, only short-run average cost curves for these three recycling facilities were investigated.

Economies of size cost curves are typically based on total operating costs and revenues are considered separately. However, recycling addresses solid waste disposal, not just materials processing. For this reason, revenues are included as an offset to operating costs in the economies of size analysis in this study. In addition, other forms of solid waste disposal utilize revenue offsets to determine net cost, such as the revenue received from steam sold as a by-product of solid waste incineration. Including revenues resulting from recyclable material sales permits the comparison of recycling to incineration or landfilling as a solid waste disposal alternative.

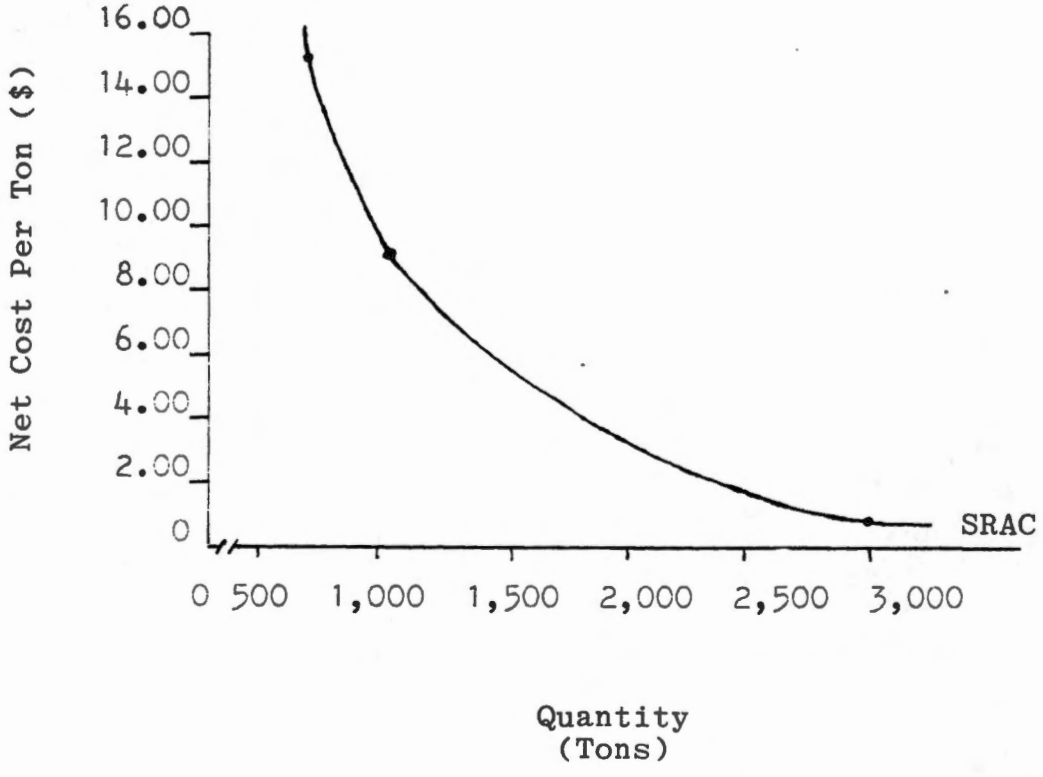
To examine potential economies of size within the existing plant size for the Athens-Limestone Center, hypothetical situations involving the amount of recyclable materials processed are compared to the actual situation analyzed in the previous section. An analysis incorporating hypothetical data was used to determine how much costs could be reduced within a given scale. Using hypothetical data allowed only a cursory investigation and suggests the possible value of conducting more complete economies of size research studies on a larger scale.

Several assumptions were made for each recycling center studied. First, equipment cost and facility cost were treated as fixed costs and assumed to remain constant over a range of volume specified by managers or others involved with the centers. Second, variable costs associated with recyclable material purchases, labor, transportation, and miscellaneous were assumed to change as recyclable volume changed. Third, since actual revenue and cost data under conditions of maximum and minimum recyclable material quantities received were not available for each center, thus, revenue and variable costs were assumed to change in proportion to the hypothetical changes in volume, unless better estimates were available. Under actual conditions, not all costs would change proportionately with changes in volume. In addition, outside factors such as the availability of recyclable material markets and market prices offered per

pound could have an impact on recycling center revenues and costs under higher or lower volume conditions. These factors were assumed to remain constant in this analysis. The purpose of conducting this investigation was to provide a tentative indication of the magnitude of potential economies of size.

The results of this type of analysis are presented in Figure 6 for the Athens-Limestone Center, where the vertical axis indicates net cost per ton and the horizontal axis indicates volume in terms of average annual tonnage or recyclable materials processed. The actual average annual tonnage processed was 1,047. Given the total net cost of $9,474 from Figure 5, the net cost per ton was calculated to be $9.05.

A part-time coordinator with the Clean Community Commission provided estimates of maximum and minimum recycling center capacities for recyclable material processing. Because the coordinator was familiar with the Athens-Limestone Recycling Center operations, the estimates were considered to be reasonably accurate. The coordinator determined that the maximum processing capacity was 3,000 tons annually. Dividing 3,000 by 1,047 indicated that 2.865 times as much volume could be processed by the Center, compared to the actual annual average volume. Assuming variable costs would increase proportionately, they were multiplied by the 2.865 figure. With equipment and facility costs remaining constant, total costs increased to $233,987. Revenues were also multiplied by 2.865, resulting in an increase to $231,346.



SRAC = Short-run average cost curve.

Figure 6. Estimated Economies of Size for the Athens-Limestone Recycling Center.

Thus, total net cost under this scenario was $2,641. Dividing this amount by the hypothetical 3,000 tons processed resulted in a net cost per ton of $ .88.

A similar procedure was followed to determine the net cost per ton for a volume well below the actual annual average. The Clean Community Commission Coordinator suggested that the minimum level of recyclable materials that the Commission would be willing to see processed over the long run by the Center was 700 tons annually. Dividing the 700 ton minimum by the 1,047 ton average indicates that only .669 times as much volume would be processed at the Center, compared to the actual annual average. Again, variable costs were assumed to decrease proportionately, so they were multiplied by .669. Total costs fell to $64,708. Revenues were also multiplied by .669, resulting in a decrease to $54,021. Net total cost decreased to $10,687. Dividing this amount by 700 tons resulted in a net cost per ton of $15.27. Thus, as reflected in Figure 6, there appears to be substantial potential for exploiting economies of size within the existing scale of the Athens-Limestone Center.

Volume Collection Factors

An exploratory regression model was developed for the Athens-Limestone Recycling Center to investigate whether particular variables are strongly associated with variation

in the amount of recyclable materials collected. Information of this type would be helpful to center managers, particularly in light of the potential economies of size to be exploited. In economic terms, what is needed is an estimate of the supply function for recyclable materials. Price offered per pound for various materials, the awareness of the recycling center and its activities by participants, seasonal labor requirements and weather conditions, and monthly unemployment rates in the county could be expected to have a relationship to the quantity of recyclable materials collected at the center. As price per pound increases, as participant awareness of the center grows, as weather conditions improve and more seasonal labor becomes available, and when unemployment rates rise, the quantity of materials collected could be expected to increase. The supply curve relating price and quantity supplied would be upward sloping to the right. A change in one or more of the other variables would cause the supply curve to shift to the left or right, decreasing or increasing recyclable materials supplied at a given price.

Demand for recyclable materials faced by the Athens-Limestone Recycling Center manager is perfectly elastic or horizontal. Though the price offered may vary from month to month based on regional or national market conditions, this price offered to the Center by recycling industries each month remains constant over a normal range of volume. In other words, the Center is small relative to the market

and functions as a price-taker. Therefore, in order to increase revenues, the center manager can only attempt to resell as much materials as possible in any given month.

The Athens-Limestone Recycling Center has a pricing strategy of offering collectors a price equal to 50 percent of its expected resale price. Thus, the Center demand curve facing collectors is perfectly elastic as well at the current price and only a single equation model is needed to identify the supply curve.

The Athens-Limestone regression model was specified as follows:

$$VOLUME = a + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6$$

where:

VOLUME = the monthly amount of recyclable material collections (in pounds) made over a 42 month period, beginning in October, 1983 and ending in March, 1987.

B_i = the coefficients of the independent variables where i = 1, 2, . . . 6.

X_1 = the average price per pound of corrugated board.

X_2 = a time trend variable, the natural log of the month number beginning with 2 and ending with 43.

X_3 = a seasonal dummy variable for spring months.

X_4 = a seasonal dummy variable for summer months.

X_5 = a seasonal dummy variable for fall months.

X_6 = the monthly unemployment rate for Limestone County.

The model results are presented in Table 2.

Table 2. Results of Multiple Regression Analysis of Factors Related to the Amount of Materials Collected at the Athens-Limestone Recycling Center

Dependent Variable - Amount of Material Collected (Pounds)

Independent Variables	Limestone County (n = 42) Coefficient	T-Value	Significance Level
Intercept	5194.45	0.09	.9299
X_1 Price of Corrugated Board	-505943.77	-0.31	.7554
X_2 Time Trend	33793.97	4.49	.0001
X_3 Spring Months Dummy	24314.93	1.77	.0853
X_4 Summer Months Dummy	-23607.89	-1.68	.1019
X_5 Fall Months Dummy	6690.94	0.45	.6578
X_6 Monthly Unemployment Rate	9318.36	1.72	.0949

$R^2 = .45$

The price of corrugated board per pound was included in the model because corrugated board constituted 80 percent of the total quantity of recyclable materials collected and accounted for 65 percent of total payments made to recyclable material collectors. Changes in price could result in considerable changes in total recyclable material volumes collected. A positive relationship between price and quantity collected would be expected. The price per pound of aluminum cans was not included in the model because quantities of aluminum cans collected constituted only two percent of the total by weight. The prices of glass and newsprint per pound did not vary at all, so they were not included in the model. The price variable was insignificant in the model, perhaps due to statistical limitations associated with the relatively small variation in price per pound over the period studied. A conceptual explanation would be that supply is perfectly inelastic over the range of prices considered, due to lack of alternative outlets for selling recyclable materials.

The time trend variable was included in the model to capture the likely effect of public awareness of the center and its activities on the quantity of materials collected over time. The variable was given a natural logarithm form because recyclable material collection were expected to increase sharply in the initial months, then gradually increase at a decreasing rate in later months. The time trend variable

was highly significant in the model, with the coefficient positive as expected. Thus, awareness apparently did increase due in part to the effort by the Athens-Limestone Recycling Board to keep the public informed through regular reminders in the local newspaper.

Seasonal months dummy variables for spring, summer, and fall were included in the model because of the possible effects of farming activities and climate on recycling activity. Thus, the winter months of December, January, and February serve as a base of comparison. Positive coefficients for the spring, summer, or fall months dummy variables would indicate higher recyclable material collections on average during those months as compared to winter months.

During the spring months of March, April, and May, the importance of planting activities by full and part-time farmers could result in a high opportunity cost for time spent on recyclable material collection. However, the inventory of recyclable materials would probably be greater in the spring since the weather in winter months might discourage collections. In addition, the weather would be warmer, thereby making the spring months more attractive for collecting recyclables. The latter effects would be expected to dominate the former, suggesting the likelihood of a positive sign. The spring seasonal dummy variable turned out to exhibit a positive coefficient with a moderate

level of significance. The coefficient value of 24,315 indicates that on average, 24,315 more pounds of recyclable material were collected in spring months as compared to winter months.

The summer months seasonal dummy variable might be expected to have a positive relationship with the quantity of recyclable materials collected. This is because farming activity would decrease after spring planting and not increase until fall harvest. In addition, the weather, the long daylight hours available for material collection, and the additional labor of school children on summer vacation would provide a large potential for increased recyclable material collections. However, the coefficient of the summer months variable was negative, with a moderate level of significance. The reason why this variable did not have the expected sign is not clear. Perhaps other activities took precedence for Limestone County residents or inventories of recyclable material were drawn down during the spring season.

What to expect with regard to the fall months seasonal dummy variable was uncertain because, while weather would be better than in the winter months, farming activities, school activities, and a reduction in the availability of materials after the spring and summer months would tend to reduce collections. The fall months dummy variable did not prove significant at all in the model, reflecting the fact that collections were not significantly different in the fall

months as compared to the winter months, which is not an unreasonable finding.

Finally, the monthly unemployment rate variable was expected to exhibit a positive relationship to recyclable material collections. This is because as unemployment rates increased, the incentive to recycle in order to supplement income would also increase. This variable was included in the model because of the relatively high unemployment rate for Limestone County in 1984 (Appendix A). The coefficient of the monthly unemployment rate variable was positive and of moderate significance in the model.

One other variable that would have been appropriate to include in the model was special promotional effort. However, the Athens-Limestone Center did not spend significant sums of money on advertising, and no other measure of promotional effort was available. The time trend variable was expected to capture the result of periodic publicity about the Center.

The Athens-Limestone regression model had an r-square of .45, indicating that independent variables collectively explained 45 percent of the variability in recyclable material volume. The reason for the relatively low r-square value is not clear. However, this suggests the possibility that important variables were excluded from the model or that random elements play an important part in the time pattern of collections.

Interview Findings

This section highlights important opinions expressed in the survey given to the Athens-Limestone Center manager and the chairman of the Athens-Limestone Recycling Board. A questionnaire was given to both the center manager and Board chairman simultaneously at the interview. They were asked to respond to questions regarding community education and political support, environmental ordinances, solid waste disposal facilities present in the county, seasonal factors for farm labor and climate, and general opinion questions. A sample survey is found in Appendix E of this study. The Center manager and Board chairman arrived at concensus responses, based on their knowledge of center operations and experience living in the community.

Under the topic of community education and political support, the manager and chairman explained how they began an advertising campaign for the recycling center approximately three weeks prior to the facility's opening. The methods of notifying the public involved newspapers, radio, word-of-mouth, and television. According to the center manager and chairman, recyclable material collections increased immediately after their advertising effort. They firmly believed that advertising on an on-going basis has had a great deal to do with the Center's success. However, the Center manager and Board chairman felt that community

political support was very weak initially. Between October, 1983 and September, 1986, city and county political support increased greatly.

Under the category of environmental ordinances, the manager and chairman noted that the State of Alabama and the city of Athens had ordinances against littering, dumping, and scavanging. They both felt that a mandatory recycling ordinance for specified materials would have a great impact on increasing recyclable material collections at the Center by residents.

Considering the topic of solid waste disposal facilities present in the county, the Center manager and Board chairman felt that recyclable material collections would increase at the Center if there were satellite stations throughout the county to facilitate recyclable material collections. Materials would be transferred to the recycling center for processing. The county did not have a convenience center system established, where an attendant present could receive collections.

Under the category of seasonal factors for farm labor and climate, neither the Center manager nor the Board chairman could specify which months required the most agricultural labor, thereby likely reducing participation rates for recyclable material collections. However, they did express the opinion that material collections were best for aluminum cans during the summer months, while corrugated board and

glass collections were best during the winter months. These opinions seem somewhat at odds with the findings of the previous section.

Finally, under the general opinion category, six questions concerning which factors contributed the most in attracting resident collections at the Center were asked. The Center manager and Board chairman were asked to rate these factors in importance on a scale from one to ten, with one being not important and ten being very important. Both the Center manager and Board chairman felt center accessibility, the prices paid to collectors, the variety of materials accepted by the center, and education of residents on center activities had the most significance in increasing recyclable material collections. These factors rated an eight or higher. The other two factors, hours of operation and center appearance, were rated a five, respectively.

Results from interviews of individuals from each recycling center have been summarized in Appendix B. The purpose of this was to determine if there were similar perceptions among the respondents on what factors were most important in attracting collections to their respective centers.

CHAPTER IV

GRAINGER COUNTY RECYCLING CENTER

History

The Grainger County Recycling Center is located in Grainger County, Tennessee near the town of Rutledge. The total population of Grainger County in 1984 was 17,300. According to the Tennessee Department of Employment Security, the county is classified as 100 percent rural. The Tennessee Department of Employment Security considers any community having 2,500 residents or more as urban. Rutledge, the largest town in Grainger County had a total population of 1,058 in 1987. Additional demographic and economic characteristics for Grainger County can be found in Appendix A.

The Grainger County Recycling Center opened in February, 1983. The county was experiencing a problem with roadside litter. Prior to the Grainger County Recycling Center, road crews were used to pick up the trash. It was hoped that after the Center opened, county residents would collect recyclable materials from roadways and take them to the Center for payment. The Center is operated by the county government. However, the Center receives funds from the Tennessee Highway Beautification Litter Abatement Grant Program. These funds amounted to $13,975, $14,563, and $13,927 for fiscal years 1984, 1985, and 1986, respectively.

The funds were used primarily for the salary of the Center manager but also for occasional operating supplies when needed. The Center initially received $20,000 for equipment purchases from the Tennessee Valley Authority (TVA) to serve as a demonstration project for rural recycling. Another $7,000 was provided by the TVA to purchase additional equipment later.

The Center accepted aluminum, glass, and paper initially. Later this list was expanded to batteries, brass, copper, radiators, and plastic. Between July, 1983 and June, 1986, the Grainger County Recycling Center processed 414 tons of recyclable materials. Payment to county residents amounted to $40,055 over this period. The recyclable material quantities and payment amounts for the Center are presented in Table 3.

The distribution of county participants by total payments received between February, 1983 and June, 1986, is shown in Table 4. The 990 county participants recycling materials accounted for 5.3 percent of the total county population, based on 1984 population figures. Between February, 1983 and June, 1986, 659 participants or 66.5 percent earned $25 or less, while 27 participants or 2.7 percent earned $200 or more. For the majority of those recycling, earnings constituted a relatively small percentage of total income, but for a few the income supplement was not insignificant.

Table 3. Grainger County Recycling Center Collections: July 1, 1983 to June 30, 1986

Material	Pounds Collected	Percent of Total	Payments to Collectors	Percent of Total
Aluminum Cans	23,668	2.8	$21,976	54.9
Aluminum Scrap	20,068	2.4	4,000	10.0
Paper	55,450	6.6	555	1.4
Newsprint	246,300	29.4	2,686	6.7
Corrugated Board	81,446	9.7	976	2.4
Mixed Paper	40,804	4.9	257	.6
Copper #1	2,644	.3	951	2.4
Copper #2	3,978	.5	1,208	3.0
Glass	304,595	36.4	3,636	9.0
Plastic	51,750	6.2	1,231	3.1
Batteries	3,803	.5	2,008	5.0
Radiators	1,181	.1	265	.7
Brass	1,528	.2	306	.8
Total	837,215	100.0	$40,055	100.0

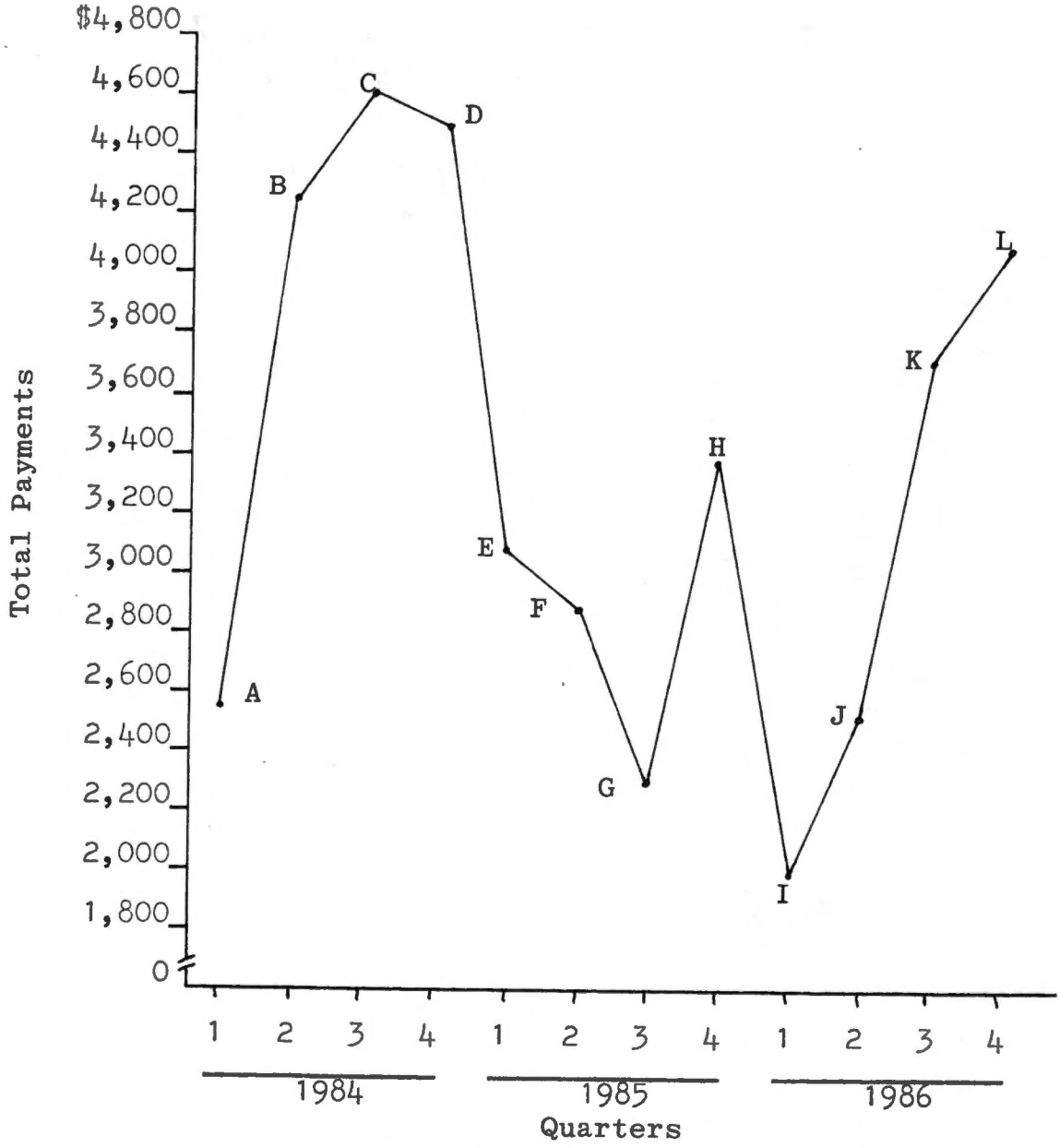
Table 4. Distribution of Participants from Grainger County by Total Payment Received between February 1, 1983 and June 30, 1986[a]

Total Payment ($)	No. of Participants	Percent Total
≤ $5.00	224	22.6
5.01 - 25.00	435	43.9
25.01 - 50.00	141	14.2
50.01 - 100.00	112	11.3
100.01 - 125.00	25	2.6
125.01 - 150.00	16	1.6
150.01 - 175.00	4	.4
175.01 - 200.00	6	.7
200.01 - 250.00	4	.4
250.01 - 300.00	9	.9
> 300.00	14	1.4
Total	990	100.0

[a]This data on participation covers 40 months, starting from the time the Grainger County Center opened, while the other analyses in this chapter are based on the three fiscal years starting July 1, 1983.

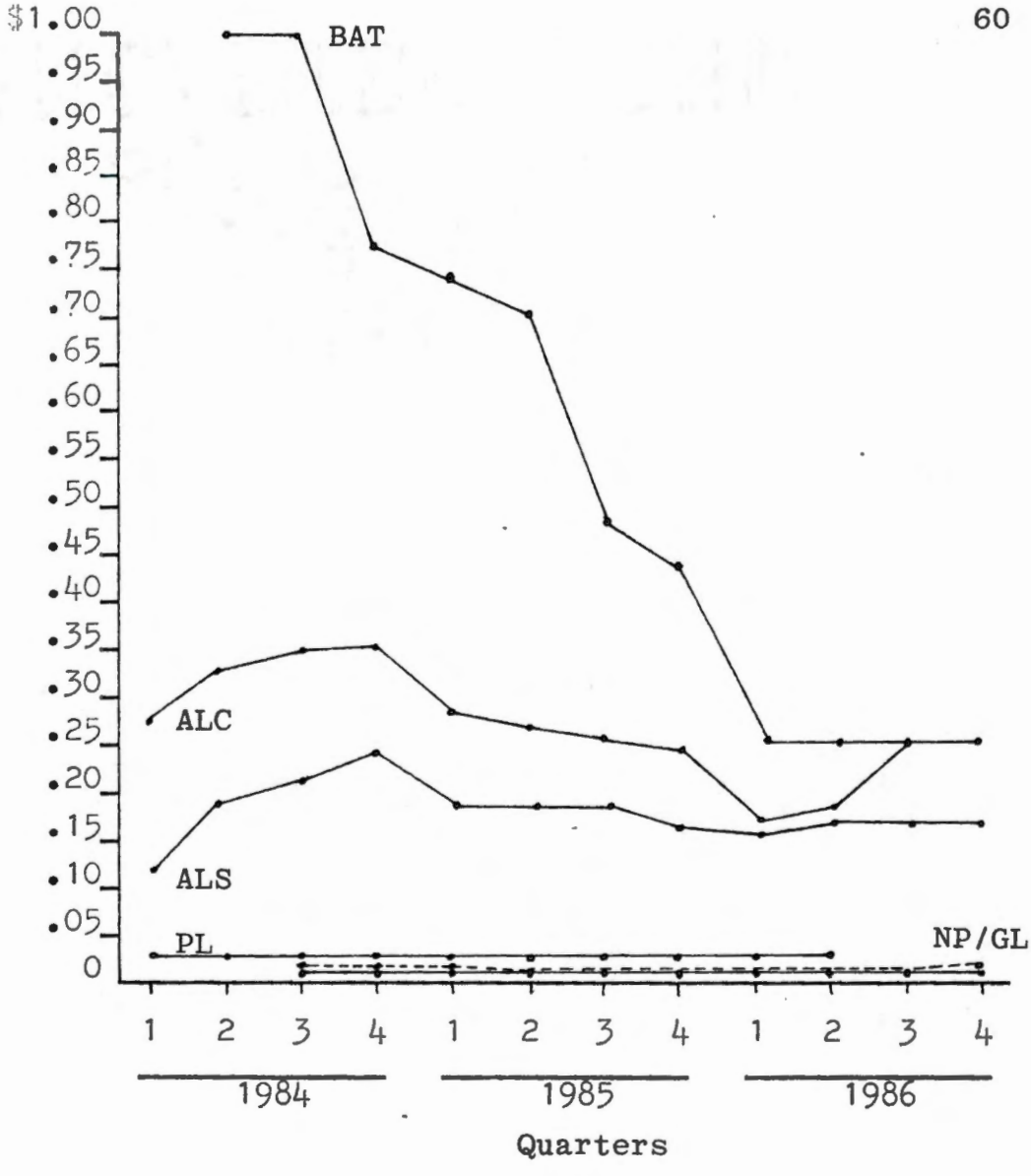
The trend over time of total payments made to participants is presented in Figure 7. Total payments fell substantially in fiscal year 1985 and the early part of fiscal year 1986, due to both lower prices and lower collections. The greatest variation in price between July, 1983 and June, 1986 occurred for batteries and aluminum cans (Figure 8). A high price of $1.00 per pound was paid for batteries in the second and third quarters of fiscal 1984; a low of $ .25 per pound was paid in fiscal 1986. Aluminum can prices showed some variation from a high of $ .35 per pound in the third and fourth quarters of fiscal 1984 to a low of $ .18 per pound in the first quarter of fiscal year 1986. The amount of glass and newsprint collected between July, 1983 and June, 1986 is shown in Figure 9. The amount of aluminum cans, aluminum scrap, corrugated board, mixed paper, copper, plastic, batteries, radiators, and brass collected between July, 1983 and June, 1986 is represented in Figure 10.

The nearest alternative recycling center is located in Morristown, Tennessee, approximately twenty-one miles from Rutledge. A second recycling center is located in Knoxville, Tennessee, twenty-eight miles from Rutledge. Thus, a round trip to Morristown or Knoxville with small recyclable material quantities would be prohibitively costly, except for county residents near the edge of the county nearest to these other centers.



A =	$2,581.90	G =	$2,369.65
B =	4,287.30	H =	3,407.34
C =	4,603.23	I =	2,003.20
D =	4,561.11	J =	2,504.60
E =	3,076.04	K =	3,728.80
F =	2,856.24	L =	4,074.84

Figure 7. Grainger County Recycling Payments Trend: July 1, 1983 to June 30, 1986.



ALC = Aluminum Cans
ALS = Aluminum Scrap
NP = Newsprint
GL = Glass
PL = Plastic
BAT = Batteries

Figure 8. Grainger County Average Quarterly Price Paid Per Pound to Participants Collecting Recyclable Materials Accounting for Five Percent or More by Weight or by Payments Between July 1, 1983 and June 30, 1986.

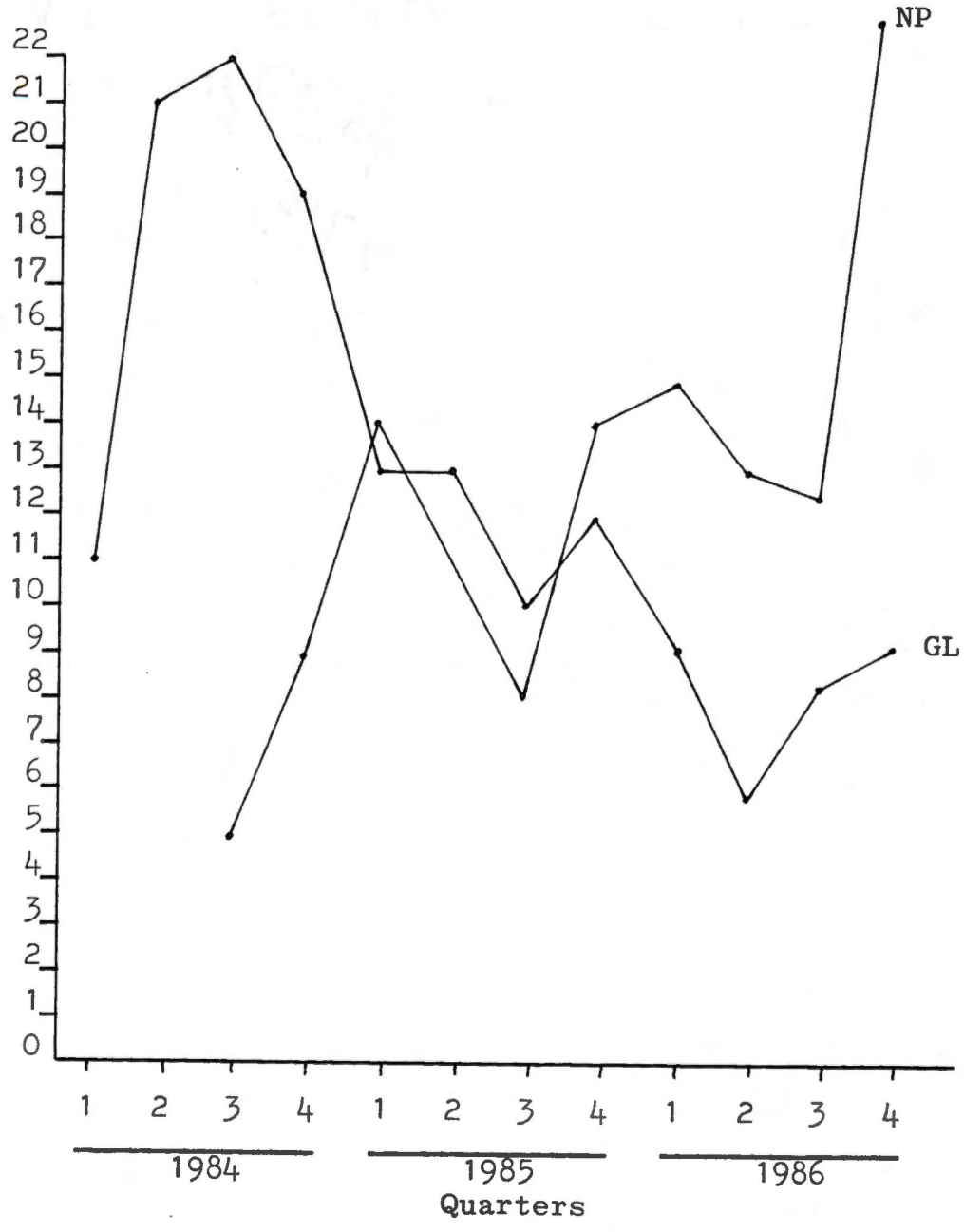


Figure 9. Grainger County Recyclable Material Collections for Glass and Newsprint (in Tons) Per Quarter between July 1, 1983 and June 30, 1986.

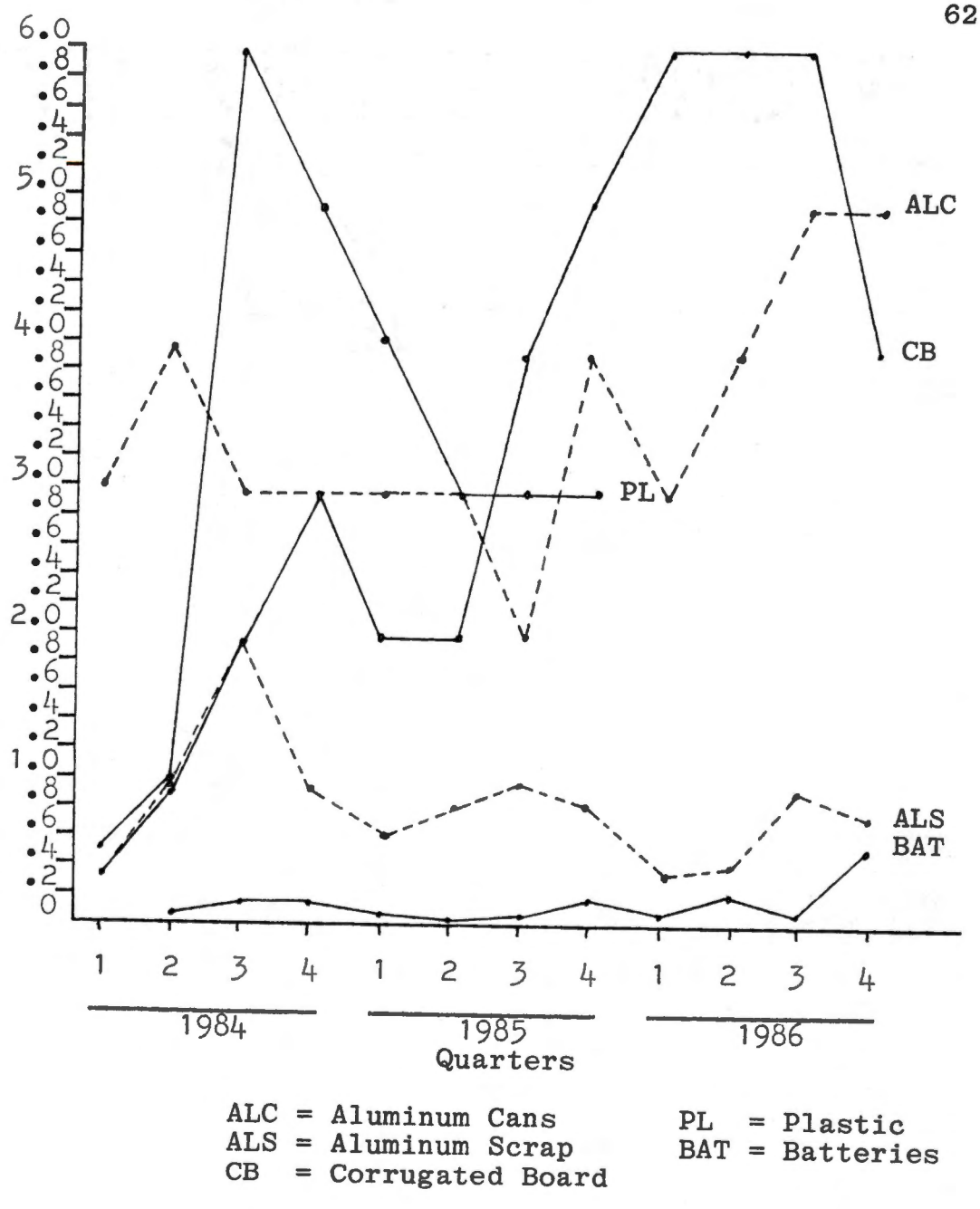


Figure 10. Grainger County Recyclable Material Collections Accounting for Five Percent or More by Weight or by Payments Per Quarter Between July 1, 1983 and June 30, 1986.

Transportation cost must also be addressed by the Grainger County Recycling Center, which pays freight expenses to haul materials to markets. The Center pays for transportation costs on all recyclable materials except glass and plastic, which are picked up by the buyers. Glass and plastic buyers transport these materials from the recycling center to their processing plants 139 and 86 miles away, respectively. The markets for aluminum, paper, and miscellaneous recyclables are 48, 44, and 26 miles distant, respectively.

Initial Center Costs

This section examines total costs needed to begin an operation the scale of the Grainger County Recycling Center. The two cost categories examined are equipment and facility. Each of these cost areas is discussed further in the next section of this chapter.

Initial equipment cost amounted to $27,000 and was covered with Tennessee Valley Authority demonstration grant funds. A full equipment list for Grainger County is found in Appendix C of this study.

The Grainger County Recycling Center is located in an old schoolhouse, which, though not designed as a recycling facility, serves adequately, and is similar in square feet to the Watauga County Center. The Watauga County Center facility had an estimated total construction cost of

$42,000. Since the Grainger County Center processes about ten percent less volume than the Watauga County Center, constructing a new facility to meet the Grainger County Center's needs would probably cost between $30,000 and $40,000. This estimated capital cost for the facility is reasonably consistent with the estimated $400 per month lease value for the facility (Markley and Park).

Total initial costs for both equipment and facility would thus be $60,600. The purpose of analyzing the initial requirements for equipment and facility was to provide a general picture of the total funds necessary to begin an operation similar to the Grainger County Center.

Economic Feasibility

This section discusses the sources and amounts of revenues and costs for the Grainger County Center between July, 1983 and June, 1986. Average annual returns for the Grainger County Recycling Center are shown in Figure 11. Column (1) in Figure 11 represents costs incurred which were covered by the Center. Column (2) represents costs incurred by the Grainger County Center which were covered from other sources. Column (3) represents total costs incurred by the Center. Total revenues are also included under column (3) of Figure 11.

Average revenue of $15,187 came from recyclable material sales. Recyclable material sales totalled $17,506, $12,709,

Revenues	(1) Costs Covered by the Center	(2) Costs Covered by Other Sources	(3)[a] Revenues, Total Costs, and Returns
Sale of Materials			$15,187
Excess Inventory[b]			1,508
Total			16,695
Costs			
Purchase of Materials	$13,351	$ -0-	$13,351
Labor	4,940	9,754[c]	14,694
Equipment	791	2,780[d]	3,571
Facility	5,225	-0-	5,225
Transportation	940	-0-	940
Miscellaneous	292	-0-	292
Total	$25,539	$12,534	$38,073
Net Returns			$(21,378)
Estimated Landfill Cost Savings			$ 1,794[e]

[a]Costs under column (3) are the summation of column (1), costs covered by the Center, and column (2), costs covered from other sources.

[b]An estimated inventory accumulation totalling $4,524 between July 1, 1983 and June 30, 1986 was averaged over three years and added to the actual recyclable material sales average of $15,187.

[c]Costs for the Center manager covered by Tennessee Litter Abatement Grant funds.

[d]Costs for equipment totalling $27,000 covered by the Tennessee Valley Authority amortized at six percent for fifteen years for an annual average of $2,780.

[e]Over the three-year period between July 1, 1983 and June 30, 1986, 414 tons of recyclable materials were diverted from the Grainger County landfill. At a cost of $13 per ton, the county saved $5,382. Landfill cost savings thus averaged $1,794 on an annual basis.

Figure 11. Average Annual Returns for the Grainger County Recycling Center: July 1, 1983 to June 30, 1986.

and $15,345 in fiscal years 1984, 1985, and 1986, respectively. Between July, 1983 and November, 1984, the Grainger County Center accumulated an inventory of purchased materials valued at $4,524. It was assumed an inventory of equal value was on hand as of June 30, 1986. On an average annual basis, this would amount to $1,508. An adjustment of this amount was made to actual revenues of $15,187 to arrive at the $16,695 total shown in Figure 11.

Total costs are grouped into the following categories: purchase of recyclable materials, labor, equipment, facility, transportation, and miscellaneous costs. The purchase of recyclable materials averaged $13,351 per year, as shown in Figure 11. This accounted for 35.1 percent of the total annual average cost shown in column (3). The $13,351 recyclable material purchase cost was also listed under column (1), because all costs associated with the purchase of recyclable materials from collectors were covered by the Center. It is of interest to note that the margin between sales and purchases of recyclable material is much narrower than was the case for the Athens-Limestone Center. The difference is attributable to a conscious decision on the part of the Grainger County Center to pay collectors as high a price as reasonably possible, particularly for their primary material, aluminum cans.

Labor costs covered by the Center are indicated in column (1) of Figure 11. These included part-time employee wages and social security and retirement contributions. Annual average

costs for these types of labor costs were $3,726, $805, and $409, respectively. Total labor costs covered by the Center were $4,940 in column (1). Part of the labor cost for the Grainger County Recycling Center was funded by an outside source. Labor costs of $9,754 for the Center manager were covered by the Tennessee Litter Abatement Grant Program and are shown under column (2) of Figure 11. Total labor cost came to $14,694 and amounted to 38.6 percent of the total annual average costs in column (3).

Equipment cost shown in column (1) represents annual average maintenance and repair costs totalling $791. This cost was covered by the Grainger County Center. Equipment cost in column (2) represents annual equipment depreciation costs of $2,780. This figure is placed in column (2), reflecting the fact that equipment was purchased with Tennessee Valley Authority funds.[1] Total equipment cost came to $3,571 and amounted to 9.4 percent of the total annual average cost in column (3).

Facility cost for the Grainger County Center in column (1) was based on an estimated annual rental cost of $4,800, due to the donation of the structure to the Center by Grainger County, plus annual utility costs of $425. Total facility

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[1]This assumed six percent real interest rate is considered reasonable, given the average interest rate of 9.51 percent for municipal revenue bonds and the average inflation rate (measured by the deflator) of 3.35 percent over the 1983-86 period. Subtracting the inflation rate from the interest rate indicates a real interest rate of 6.16 percent over this period.

cost covered by the Center came to $5,225. No outside funding sources were used for facility costs. Total annual facility expense in column (3) amounted to $5,225 and accounted for 13.7 percent of total costs.

All transportation cost in column (1) was covered by the Center and was derived from the cost of transporting all recyclable materials purchased except glass and plastic, which were picked up by buyers, to their respective markets. Included under transportation cost were gas and lubricant costs. These totalled $930 and $10, respectively, on an annual average basis. Total transportation cost covered by the facility came to $940. No outside funding sources were used for transportation costs. Total annual transportation cost for the Grainger County Center in column (3) was $940 and accounted for 2.5 percent of total costs.

The miscellaneous cost category in column (1) totalled $292. No outside funding sources were used for this cost. The miscellaneous cost figure accounted for .8 percent of total costs in column (3).

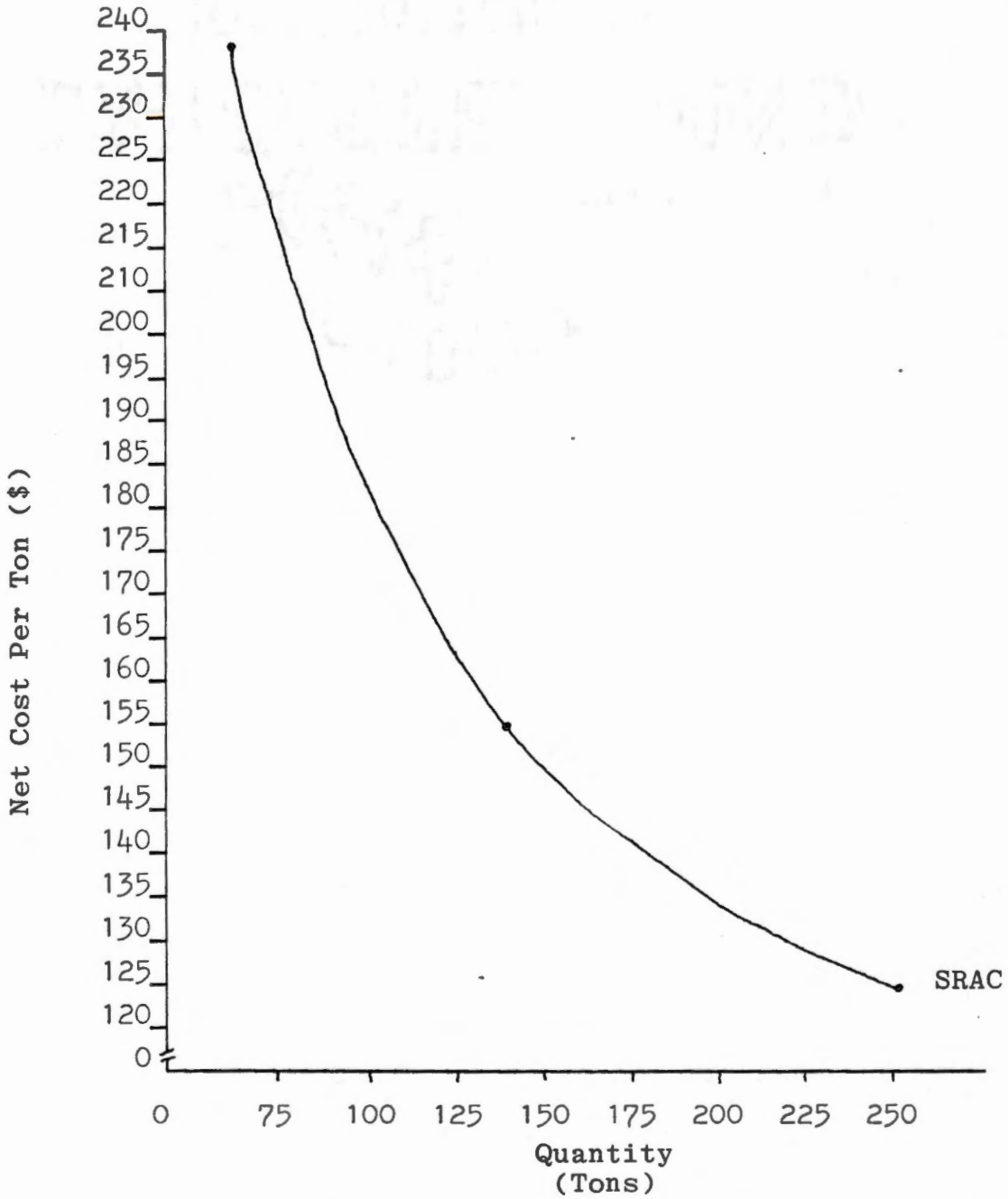
The $25,539 total in column (1) represents that portion of costs which were covered by the Grainger County Center. The $12,534 total in column (2) represents that portion of costs which were funded by outside sources. The total annual average cost of $38,073 in column (3) represents what the recycling center costs to operate on an annual average basis

if all costs, including those covered by outside sources, were considered.

Net returns for the Grainger County Recycling Center on an annual average basis reflect a net loss of $21,378. However, more than half of this loss was offset by outside funds. Estimated landfill cost savings are also presented in Figure 11. Between July, 1983 and June 1986, the Grainger County Recycling Center processed 414 tons of recyclable materials. Total landfill cost savings between July, 1983 and June, 1986, based on a disposal cost of $13 per ton, amounted to $5,382, or $1,794 on an annual average basis. In addition, it should be noted that the $4,800 estimated rental cost for the facility was not a cash expense; and, moreover, the opportunity cost of using the isolated and run-down former school building is probably quite small.

Economies of Size

The average annual tonnage of recyclable materials processed at the Grainger County Recycling Center was derived by dividing the total amount actually processed between July, 1983 and June, 1986, 414 tons, by three. This resulted in an annual tonnage processed of 138. The net annual average cost of recycling of $21,378 was obtained from Figure 11. Thus, annual average net cost per ton was calculated to be $155 (Figure 12).



SRAC = Short-run average cost curve.

Figure 12. Estimated Economies of Size for the Grainger County Recycling Center.

No maximum recycling capacity for the Grainger County Center could be obtained from the manager. A reasonable maximum annual tonnage level was assumed by taking the largest monthly quantity of materials processed between July, 1983 and June, 1986 and multiplying that amount by twelve. The largest quantity processed in a single month was 21 tons. This resulted in a hypothetical maximum annual recycling capacity of 252 tons. Dividing 252 tons by 138 tons indicates that 1.826 as much volume could reasonably be processed by the Center. Assuming other costs such as the purchase of recyclable materials, transportation, and other costs would also increase proportionately, they were multiplied by the 1.826 figure. However, it was assumed that equipment and facility costs would remain constant. Total costs thus increased to $62,255. Revenues would also increase as more recyclable materials were sold. Multiplying the actual revenue figure of $16,695 by 1.826 would result in an increase to $30,485. Net returns for this level of activity would thus be $31,770. Dividing this amount by the 252 tons assumed to be processed results in a net cost per ton of $126.

A similar procedure was followed to derive a net cost per ton for a minimal level of activity. The smallest monthly quantity of materials processed, 5 tons, was multiplied by twelve, resulting in a hypothetical minimum capacity of 60 tons annually. Dividing 60 tons by the 138 ton actual annual average indicates that only .435 as much volume would be processed at

the Center. Again, the purchase of recyclable materials, transportation, and other costs were assumed to decrease proportionately. New cost figures were found by multiplying the costs in Figure 11 by .435. Equipment and facility cost were assumed to remain constant as they had in the maximum tonnage situation. Total costs would fall to $21,532. Revenues were also multiplied by .435, resulting in a decrease to $7,262. Subtracting total costs from revenues leaves a net annual average cost of $14,270. Dividing this amount by 60 tons would result in a net cost per ton of $238. Thus, there appears to be a great deal of potential for exploiting economies of size within the existing scale of the Grainger County Recycling Center.

Volume Collection Factors

A multiple regression model was developed for the Grainger County Recycling Center to investigate factors related to the amount of recyclable materials collected. The economic rationale for the Grainger County model is similar to that described for the Athens-Limestone model in Chapter III. The Grainger County regression model was specified as follows:

$$VOLUME = a + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6$$

where:

VOLUME = the monthly amount of recyclable material collections (in pounds) made over a 40 month period, beginning in March, 1983 and ending in June, 1986.

B_i = the coefficients of the independent variables, where i = 1, 2, . . . 6.

X_1 = the average price per pound of aluminum cans.

X_2 = a time trend variable, the natural log of the month number beginning with 2 and ending with 41.

X_3 = a seasonal dummy variable for spring months.

X_4 = a seasonal dummy variable for summer months.

X_5 = a seasonal dummy variable for fall months.

X_6 = the monthly unemployment rate for Grainger County.

The results are presented in Table 5.

One might ask why only the price of aluminum cans was included in the model. Glass and newsprint were not included in the model because prices per pound for these materials varied only slightly over the period even though these materials combined to make up 65.8 percent of the total quantity collected by weight. While aluminum cans accounted for only 3 percent of total quantities collected by weight, they represented 55 percent of total payments. A positive relationship was expected between the aluminun can price and the quantity of all materials collected by weight because the aluminum can price incentive was believed to drive the decision to recycle in general. That is, if people decide to collect aluminum cans, they also tend to collect paper, glass, and other materials since they are making a trip to the Center anyway. The price variable for aluminum cans was highly significant in the model, with a positive sign as expected.

Table 5. Results of Multiple Regression Analysis of Factors Related to the Amount of Materials Collected at the Grainger County Recycling Center.

Dependent Variable - Amount of Material Collected (Pounds)

Independent Variables	Grainger County (n = 40) Coefficient	T-Value	Significance Level
Intercept	-5640.11	-0.52	.6081
X_1 Price of Aluminum Cans	79129.16	4.32	.0001
X_2 Time Trend	5204.71	3.67	.0008
X_3 Spring Months Dummy	7326.26	2.59	.0141
X_4 Summer Months Dummy	4775.17	1.61	.1171
X_5 Fall Months Dummy	1590.63	0.48	.6377
X_6 Monthly Unemployment Rate	-787.48	-1.42	.1645

$R^2 = .53$

The time trend variable, X_2, in a natural logarithm form, was moderately significant in the model, with a positive sign as expected. As in the Athens-Limestone model, this variable was included to reflect the likelihood that participation rates would increase, though at a decreasing rate, as Center awareness grew on the part of Grainger County residents over time.

The three seasonal dummy variables for the spring, summer, and fall months (X_3, X_4, and X_5, respectively) were included in the model to account for any influences due to climate or agricultural labor requirements. Volumes in the spring, summer, and fall season months were thus compared against the winter season months as the base period. The expected signs might be positive for spring due to the accumulation of recyclable material availability over the winter months and increasing warm weather, positive for summer due to longer day-light hours and less agricultural labor requirements between planting and harvest, and negative for fall due to the reduced recyclable material availability after the spring and summer months, increased farming activity with harvest, and cooler weather.

The spring months dummy variable was highly significant in the model with a positive coefficient as expected. The summer months seasonal dummy variable was moderately significant with a positive coefficient as expected. The fall months seasonal dummy variable was insignificant, reflecting no difference from the winter months.

The monthly unemployment rate variable, X_6, for the Grainger County model demonstrated only a very weak level of significance, but with the opposite sign to that which was expected. As unemployment rates increase, so should the incentive to collect recyclable materials to supplement income.

Interview Findings

This section highlights important opinions expressed by the Grainger County Executive, since at the time the interview was given the county was in the process of hiring another Center manager. However, the Grainger County Executive was aware of the recycling program, and had access to financial information and recyclable material collection logsheets for the facility. Responses were based on knowledge the Grainger County Executive had about Center operations and activities and from living and working with the Grainger County community. The Executive was asked to respond to questions regarding community education and political support, environmental ordinances, solid waste disposal facilities present in the county, seasonal factors for farm labor and climate, and general opinion questions.

Under the topic of community education and political support, the County Executive noted that an advertising campaign was started for the Grainger County Recycling Center approximately three weeks prior to the facility's opening. The

methods of notifying the public involved newspapers and flyers. According to the Executive, the recyclable material collection response was good following the advertising effort. The County Executive believed education of county residents regarding Center activities on an on-going basis was very important to the Center's success.

Under the category of environmental ordinances, the Grainger County Executive noted that the county has a no-dumping ordinance, although it is seldom enforced. The County Executive felt that if a mandatory recycling ordinance for specified materials was enacted, it would have a great impact on increasing recyclable material collections at the Center by residents.

Considering the topic of solid waste disposal facilities in the county, the Executive felt that recyclable material collections would increase at the Center if there were more recycling and convenience centers established in the county. Grainger County already had a mix of six convenience centers and a "green box" collection system for solid waste disposal.

Under the category of seasonal factors for farm labor and climate, the Grainger County Executive specified April, May, June, August, September, and November as the months which required the most agricultural labor, thus reducing the amount of time some county residents could devote to recyclable material collection. In addition, the County Executive believed that recyclable material collections were best during the summer months, although no specific materials were identified.

Finally, under the general opinion category, six questions concerning which factors contributed the most in attracting resident collections at the Center were addressed. The Grainger County Executive was asked to rate these factors in importance on a scale from one to ten. The County Executive felt center accessibility, hours of operation, the variety of materials accepted by the center, and center appearance were most important in increasing recyclable material collections. These factors rated an eight or higher. The other two factors, prices paid to collectors and education of residents on center activities, were rated a five and seven, respectively. Responses to these questions for each center have been summarized in Appendix B.

CHAPTER V

WATAUGA COUNTY RECYCLING CENTER

History

The Watauga County Recycling Center is located in Boone, North Carolina. The total population of Watauga County in 1984 was 34,084. Watauga County's population is 68 percent rural according to the Employment Security Commission of North Carolina. Additional demographic and economic characteristics for Watauga County can be found in Appendix A.

The Center began operations in February, 1984. According to the Center manager, the recycling could add up to a year of additional life to the county landfill, which is expected to reach full capacity within twelve to fourteen years. The Center received an initial grant of $25,000 from the Tennessee Valley Authority with matching funds from Watauga County to construct a building and purchase some equipment.

Materials accepted by the Watauga County Recycling Center include aluminum cans, aluminum foil, bi-metal cans, brass, corrugated board, computer paper, clean scrap aluminum, copper #1, copper #2, glass, irony scrap aluminum, newsprint, radiators, and stainless steel. Recyclable material collections and payments to participants between February 1, 1987 and June 30, 1987 are indicated in Tables 6 and 7, respectively. Data of this type were available only for this five-month

Table 6. Watauga County Recycling Center Collections: February 1, 1987 to June 30, 1987

Material	Pounds	Percent Total	Payment	Percent Total
Aluminum Foil	197	.1	$ 6	.1
Aluminum Cans	16,801	8.9	4,416	37.0
Bi-Metal Cans	2,830	1.5	156	1.3
Brass	786	.4	138	1.2
Corrugated Board	5,650	3.0	53	.4
Computer Paper	18,513	9.8	633	5.3
Clean Scrap Aluminum	9,043	4.7	1,552	13.0
Copper #1	6,055	3.2	2,251	18.9
Copper #2	2,376	1.2	694	5.8
Glass	44,565	23.5	889	7.5
Irony Scrap Aluminum	1,939	1.0	105	.9
Newsprint	78,918	41.6	646	5.4
Radiator	1,761	.9	356	3.0
Stainless Steel	311	.2	28	.2
Total	189,745	100.0	$11,923	100.0

Table 7. Distribution of Participants from Watauga County by Total Payment Received Between February 1, 1987 and June 30, 1987

Total Payment	No. of Participants	Percent of Total
≤ $5.00	196	37.5
5.01 - 25.00	215	41.2
25.01 - 50.00	65	12.5
50.01 - 100.00	28	5.3
100.01 - 125.00	5	1.0
125.01 - 150.00	6	1.1
150.01 - 175.00	2	.4
175.01 - 200.00	2	.4
200.01 - 250.00	1	.2
250.01 - 300.00	0	0
> 300.00	2	.4
Total	522	100.0

period. As such no discussion of quarterly trends is provided. Note that aluminum and copper #1 accounted for 37 percent and 19 percent, respectively, of total payments. In Table 7, the 522 participants recycling materials accounted for 1.5 percent of the total county population in 1984. Between February, 1987 and June, 1987, 411 participants or 78.7 percent earned $25 or less, while 46 participants or 8.8 percent earned $100 or more.

The greatest variation in price occurred for aluminum cans, copper #1, and copper #2 between February, 1987 and June, 1987 (Figure 13). A low of $ .21 per pound was paid for aluminum cans in February and March of fiscal 1987; a high of $ .30 per pound was paid in May and June. Copper #1 and copper #2 showed some variation from lows of $ .35 and $ .25 per pound, respectively, in February and March to highs of $ .40 and $ .30 per pound, respectively, in May and June. Prices per pound for aluminum foil, bi-metal cans, brass, computer paper, clean scrap aluminum, radiators, and stainless steel did not change between February, 1987 and June, 1987.

Trends in the amount of glass and newsprint collected between February, 1987 and June, 1987 are shown in Figure 14. Trends for the other recyclable materials collected at the Watauga County facility are presented in Figure 15. The quantity of glass and newsprint was shown separately because of the relatively large difference in total tonnages collected compared to the other recyclable materials received at the

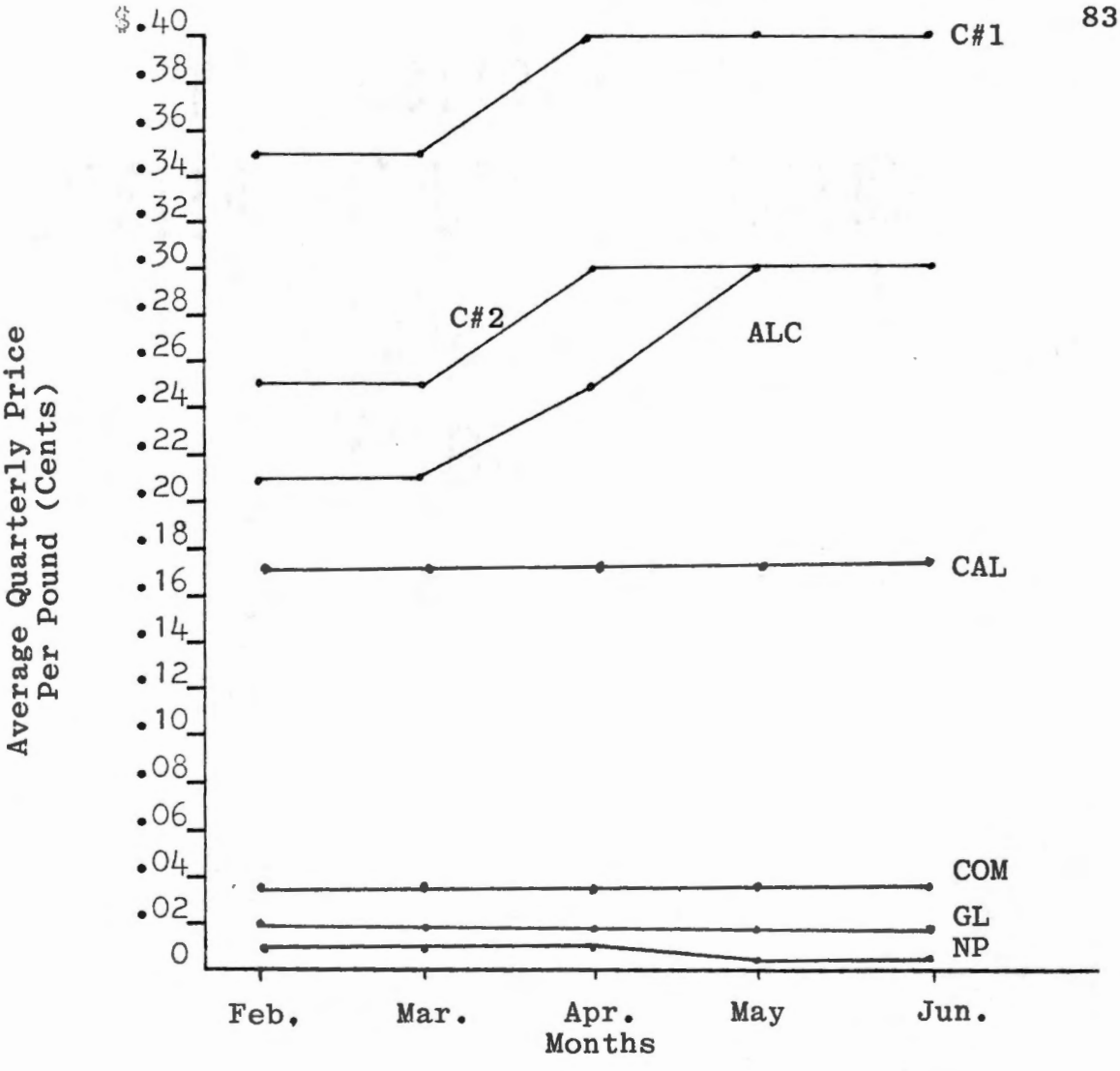


Figure 13. Watauga County Average Monthly Price Paid to Participants Collecting Recyclable Materials Accounting for Five Percent or More by Weight or by Payments Between February 1, 1987 and June 30, 1987.

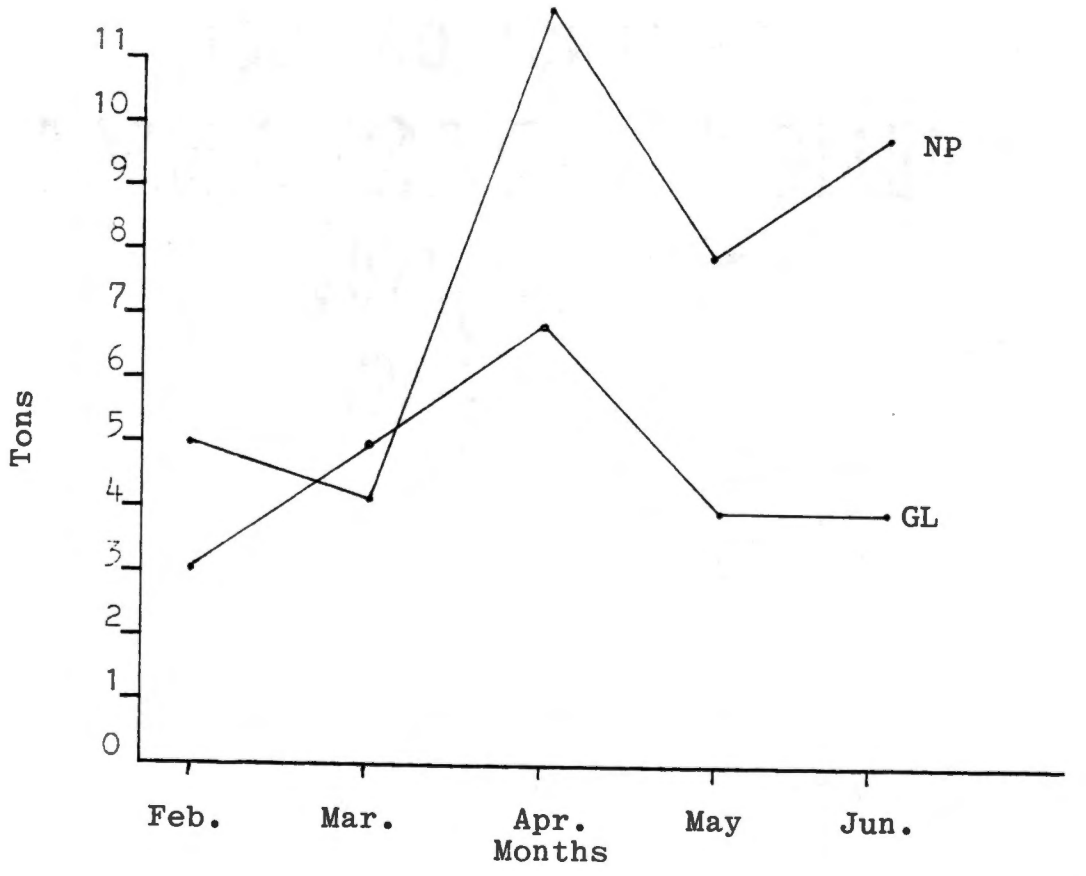
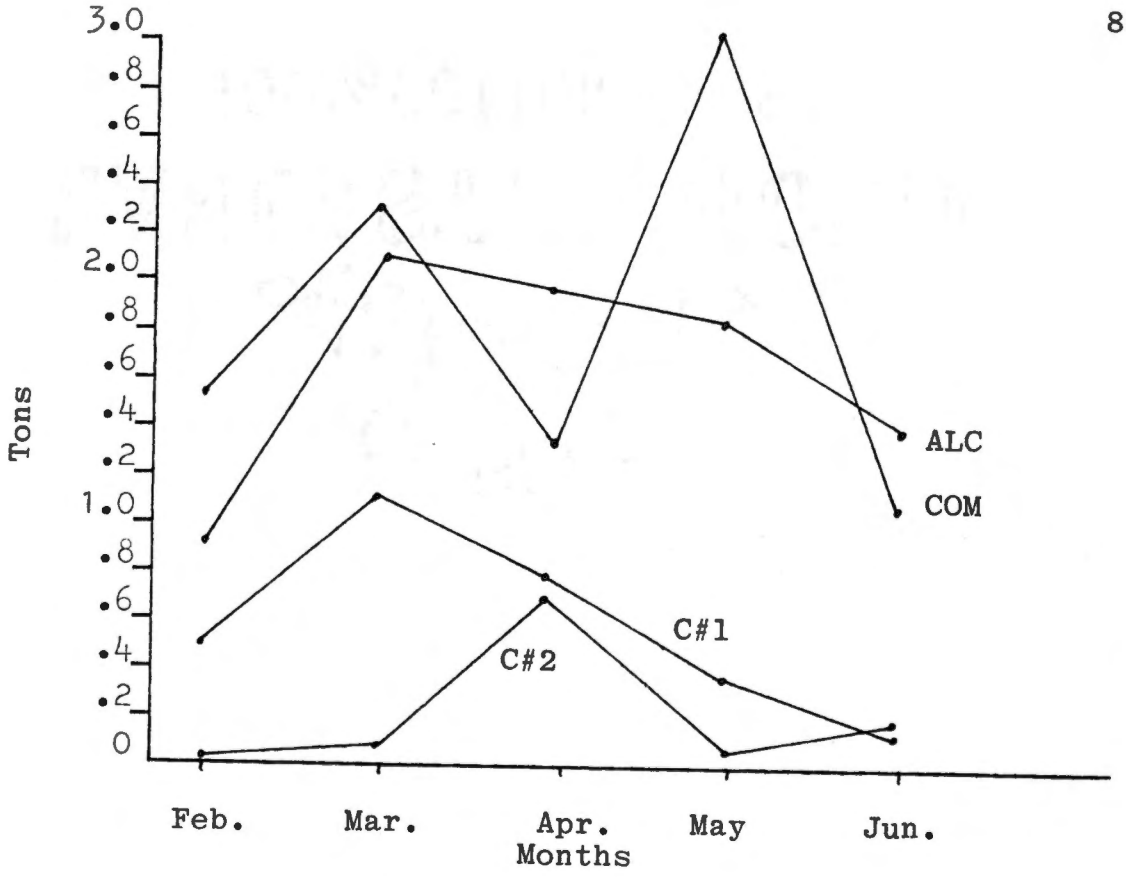


Figure 14. Watauga County Recyclable Material Collections for Glass and Newsprint (in Tons) Per Month Between February 1, 1987 and June 30, 1987.



ALC = Aluminum Cans
COM = Computer Paper
C#1 = Copper #1
C#2 = Copper #2

Figure 15. Watauga County Recyclable Material Collections Accounting for Five Percent or More by Weight or by Payments Per Month Between February 1, 1987 and June 30, 1987.

Center. Glass and newsprint revealed the most variation in tonnages received during this period.

The nearest alternative recycling center is located in West Jefferson, North Carolina, which is twenty-two miles from Boone. Another recycling center alternative is located in Elizabethton, Tennessee, forty-five miles from Boone. Prices paid to collectors for the various recyclable materials were virtually identical at all three centers. Thus, even considering only variable costs of transportation, there would be little competition from these other centers.

Transportation cost must also be addressed by the Watauga County Recycling Center, which must pay freight expenses to haul materials to market. The Center pays the transportation cost for glass only. All other materials are transported to markets by the buyers. Buyers for aluminum cans, paper materials, and other materials are located 164, 80, and 33 miles away, respectively.

Initial Center Costs

This section examines total costs needed to begin an operation such as the Watauga Center Recycling Center. The two cost categories examined are equipment and facility. Each of these expense areas is discussed further in the next section of this chapter.

Initial equipment cost amounted to $41,193. One piece of equipment was purchased with funds provided by the Tennessee

Valley Authority, while the remaining equipment was purchased with funds provided by Watauga County. The horizontal bailing press comprised the largest expenditure, amounting to $22,645. A full equipment list for Watauga County is found in Appendix C of this study.

Facility cost amounted to $42,000 for the building. This figure was approximate because the structure had been constructed with both Tennessee Valley Authority and Watauga County funds. The Watauga County Recycling Center manager believed this figure was reasonably accurate.

Total initial costs for equipment and facility thus amounted to $83,193. The purpose of analyzing the initial requirements for equipment and facility was to provide a general picture of the total funds necessary to begin an operation like the Watauga County Center.

Economic Feasibility

This section discusses the sources of revenues and costs present for the Watauga County Center between July, 1985 and June, 1987. Average annual returns for the Watauga County Recycling Center are shown in Figure 16. Column (1) of Figure 16, represents costs incurred which were covered by the Center. Column (2) represents costs incurred by the Watauga County Center which were covered from other sources. Column (3) represents total costs incurred by the Center. Total revenues are also included under column (3) of Figure 16.

Revenues	(1) Costs Covered by the Center	(2) Costs Covered by Other Sources	(3)[a] Revenues, Total Costs, and Returns
Sales of Materials			$26,741
Costs			
Purchase of Materials	$21,992	$ -0-	$21,992
Labor	19,100	-0-	19,100
Equipment	2,280	498[b]	2,778
Facility	5,706	1,751[c]	7,457
Transportation	336	-0-	336
Miscellaneous	1,613	-0-	1,613
Total	$51,027	$2,249	$53,276
Net Returns			$(26,535)
Estimated Landfill Cost Savings			$ 6,598[d]

[a]Costs under column (3) are the summation of column (1), costs covered by the facility, and column (2), costs covered by other sources.

[b]Costs for equipment depreciation covered by the Tennessee Valley Authority.

[c]Costs for facility covered by the Tennessee Valley Authority.

[d]Over the two-year period between July 1, 1985 and June 30, 1987, an estimated 455 tons of recyclable materials were diverted from the Watauga County landfill. At a cost of $29 per ton, the county saved $13,195. Landfill cost savings thus averaged $6,598 on an annual basis.

Figure 16. Average Annual Returns for the Watauga County Recycling Center: July 1, 1985 to June 30, 1987.

Average revenues of $26,741 from recyclable material sales are indicated. However, actual sales data were available only for January through June of fiscal year 1987. Total recyclable material sales were $13,370.52 for this six-month period. It was assumed that doubling this six-month total would provide a reasonable estimate of the annual average level over the two-year period for which cost information was available.

Total costs were grouped into six categories: purchase of recyclable materials, labor, equipment, facility, transportation, and miscellaneous costs. The purchase of recyclable materials was derived from purchases from participants. The average annual purchase of recyclable materials totalled $21,992 in column (3). The $21,992 recyclable material purchase cost was also listed under column (1), because all costs associated with the purchase of recyclable materials from collectors was covered by the Center. Total recyclable material purchase cost accounted for 41.3 percent of the total annual average in column (3).

Annual labor cost for the Watauga County Recycling Center amounted to $19,100 in column (1) and consisted of the manager's salary of $13,217, part-time labor wages of $3,350, and fringe benefits. Because all costs were covered by the Center, no amount was listed under column (2). Labor costs under column (3) accounted for 35.9 percent of total costs.

Equipment cost in column (1) includes equipment depreciation expense and repair and maintenance costs totalling $2,067 and $213, respectively. Total equipment cost covered by the Center was $2,280 under column (1). Equipment depreciation costs of $498 on equipment purchased with the Tennessee Valley Authority grant are indicated in column (2). Total equipment cost came to $2,778 and accounted for 5.2 percent of the total costs in column (3).

Facility costs in column (1) of Figure 16 included office supply cost of $222, insurance cost of $1,115, facility capital cost of $1,796, and an annual amortization cost for the building of $2,573. Total facility cost covered by the Center came to $5,706. The building amortization costs of $1,751 covered with Tennessee Valley Authority funds are indicated in column (2). Total facility costs in column (3) amounted to $7,457 and accounted for 14 percent of total costs.

Transportation cost in column (1) was derived from the cost of gas, oil, and maintenance to transport glass to a buyer. All transportation costs were covered by the facility. Total transportation cost averaged $336 annually. This cost accounted for .6 percent of the total costs in column (3).

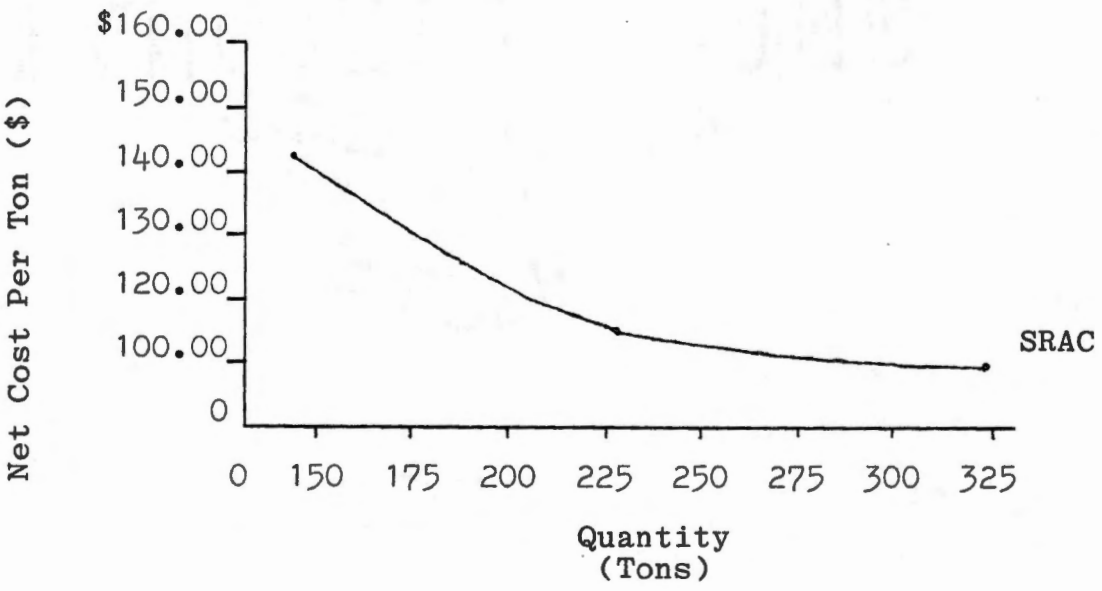
The miscellaneous cost category in column (1) was composed of other supplies cost totalling $540, postage cost of $1, miscellaneous repair cost of $1,052, and advertising costs covered by the Center amounted to $1,613 and accounted for 3 percent of annual average costs in column (3).

The $51,027 total in column (1) represents that portion of costs which were covered by the Watauga County Center. The $2,249 total in column (2) represents that portion of costs which were covered by outside sources. The total cost of $53,276 in column (3) represents what the recycling center would cost to operate on an annual average basis if all costs, including those funded by the Tennessee Valley Authority and Watauga County, were included.

Net returns for the Watauga County Recycling Center on an annual average basis indicate a net loss of $26,535. Estimated landfill cost savings are presented in Figure 16. Between July, 1985 and June, 1987, the Watauga County Recycling Center processed an estimated 455 tons of recyclable materials, based on the 94.9 tons processed over the five-month February through June, 1987 period. Total landfill cost savings between July, 1985 and June, 1987, with a disposal cost of $29 per ton, would thus have amounted to $13,195. This would be $6,598 on an annual average basis. Adding the $6,598 to the net loss of $26,535 in column (3) would reduce the net loss to $19,937.

Economies of Size

The annual tonnage of recyclable materials processed at the Watauga Recycling Center was estimated to be 228 tons. The net annual cost of recycling was estimated to be $26,535. The average annual net cost per ton of $116 in Figure 17 was calculated by dividing $26,535 by 228 tons.



SRAC = Short-run average cost curve

Figure 17. Estimated Economies of Size for the Watauga County Recycling Center.

No maximum recycling capacity for the Watauga County Center could be obtained from the manager. A reasonable maximum annual tonnage level was assumed by taking the largest monthly quantity of materials processed within the five months of data and multiplying that amount by twelve. The largest quantity processed in a single month was 27 tons. This resulted in a hypothetical maximum annual recycling capacity of 324 tons. Dividing 324 tons by 228 tons indicates that 1.421 as much volume could reasonably be processed by the Center. Assuming other expenses such as the purchase of recyclable materials, transportation, and other costs would increase proportionately, they were multiplied by the 1.421 figure. However, it was assumed that equipment and facility costs would remain constant. Total costs thus increased to $71,396. Revenues would also increase as more recyclable materials were sold. Multiplying the actual sales figure of $26,741 by 1.421 would result in an increase to $37,999. The net loss for this level of activity would thus be $33,397. Dividing this amount by the 324 tons assumed to be processed results in a net cost per ton of $103.

A similar procedure was followed to derive a net cost per ton for a minimal level of activity. The smallest monthly quantity of materials processed, 12 tons, was multiplied by twelve, resulting in a hypothetical minimum capacity of 144 tons annually. Dividing 144 tons by the 228

ton actual annual average indicates that only .632 as much volume would be processed at the Center. Again, the costs for purchase of recyclable materials, transportation, and other variable inputs were assumed to decrease proportionately, while equipment and facility expenses were assumed to remain constant. New cost figures were found by multiplying the costs in Figure 16 by .632, with total costs falling to $37,436. Revenues were also multiplied by .632, resulting in a decrease to $16,900. Subtracting total costs from revenues resulted in a net annual average cost of $20,536. Dividing this amount by 144 tons resulted in a net cost per ton of $143. Thus, there appears to be a great deal of potential for exploiting economies of size within the existing scale of the Watauga County Recycling Center.

Interview Findings

This section highlights important opinions expressed in the interview with the Watauga County Recycling Center manager. The Watauga County Center manager was asked to respond to questions regarding community education and political support, environmental ordinances, solid waste disposal facilities present in the county, seasonal factors for farm labor and climate, and general opinion questions.

Under the topic of community education and political support, the manager noted that the Center began an advertising campaign approximately three weeks prior to the

Center's opening. The methods of notifying the public involved newspapers, flyers, posted notices, radio, and word-of-mouth. According to the Watauga County manager, the recyclable material collection response was very poor initially. Residents continually asked about the recycling program due to the lack of an on-going promotional effort. However, the Center manager felt that there has been strong political support for the recycling facility from the start up to the present.

Under the category of environmental ordinances, the Watauga County Recycling Center manager noted that the county had ordinances prohibiting littering and dumping, and is working on a "no scavenging" ordinance. The Watauga County manager felt that a mandatory recycling ordinance for specified materials would have no effect on increasing county participation rates.

Considering the topic of solid waste disposal facilities present in the county, the Center manager noted that Watauga County has a "green box" collection system. The Watauga County manager was interested in developing a mobile recycling collection system in the next fiscal year.

Under the category of seasonal factors for farm labor and climate, the Center manager specified April, May, August, and September as the months requiring the most agricultural labor, due to planting and harvesting activities. This would decrease the time available for some county residents

to collect recyclable materials. The manager expressed the opinion that recyclable material collections for aluminum cans were best during the summer months.

Finally, under the general opinion category, six questions concerning which factors contributed the most in attracting resident collections at the center were then addressed. The facility manager was asked to rate these factors in importance on a scale from one to ten. The manager felt prices paid to collectors, the variety of materials accepted by the center, and education of residents on center activities had the most significance in increasing recyclable material collections. These factors rated an eight or higher. The other factors, center accessibility, hours of operation, and center appearance, were rated at six, three, and two, respectively. Responses to these questions for each recycling center have been summarized in Appendix B.

CHAPTER VI

CONCLUSIONS

Summary of Findings

The primary objectives in the case study analyses of three rural recycling centers were (1) to identify the expenditures necessary to begin each recycling operation, (2) to determine the economic feasibility of each recycling center, (3) to investigate whether economies of size were present for each center, and (4) to identify the significant factors associated with recyclable material volume collections at each center. A secondary objective was to document the perceptions held by those responsible for center operations concerning the centers' external environment and factors important to success.

Equipment and facility costs for each center were identified to provide an approximation of the start-up costs necessary to begin operations such as currently exist at each facility. Total equipment costs were $58,629, $27,000, and $41,193 for the Athens-Limestone, Grainger County, and Watauga County Recycling Centers, respectively. Because the facilities in Limestone and Grainger Counties had been recently built some years ago and used for other purposes, it was difficult to determine what current facility

construction costs would be in these two cases. However, facility construction costs were $42,000 for the Watauga County facility, and, given this point of reference, could be expected to be in the range of $30,000 to $40,000 for an operation the size of that in Grainger County and $45,000 to $55,000 for facilities such as those in Limestone County. Thus, total start-up costs for operations such as these would range from approximately $60,000 to $120,000 if a facility had to be constructed.

The economic feasibility of each center was evaluated with two or three years of data converted to an annual average basis to smooth out year-to-year variations in revenues and costs. Net returns for each center were negative when outside sources of funding were not considered. These average annual negative net returns or net costs ranged from about $10,000 for the Athens-Limestone Center to about $20,000 to $25,000 for the other two centers. However, estimated annual landfill cost savings ranged from about $2,000 for Grainger County to about $12,000 for Limestone County. In addition, outside sources of funding, converted to an annual basis ranged from about $3,000 for the Watauga Center to about $13,000 for the Grainger Center. If landfill cost savings and outside funding were taken into account, the Athens-Limestone Center would show a positive annual net return of about $10,000, while the annual net costs for the Grainger and Watauga Centers would fall to about $7,000 and $17,000, respectively.

When net costs (ignoring landfill cost savings and outside funding) were put on a per ton basis for comparison with costs of alternative solid waste disposal methods and consideration of economies of size, the significance of the much higher volume of material (primarily corrugated board) processed at the Athens-Limestone Center compared to the other two centers became clearly evident. While net cost per ton for the Athens-Limestone Center were about $9 per ton, net cost per ton for the other two centers was in the $125 to $150 per ton range. All three recycling operations showed significant potential for exploiting economies of size within their existing scales, that is, for reducing net cost per ton of material recycled by increasing their volume.

Multiple regression models were developed based on data from Athens-Limestone and Grainger County Recycling Centers to explore whether particular variables were strongly associated with variation in the amount of recyclable materials collected at each center. While the price paid to collectors for aluminum cans had a significant positive relationship to the volume of all materials collected at the Grainger County Center, the price paid for corrugated board at the Athens-Limestone Center proved insignificant, probably due to the limited variation in the price over the model period. A time trend variable included in the model to capture the likely effect of public awareness of the center and its activities proved to be highly significant in both models. The model

results indicated that at both centers material collections were significantly higher in the spring months as compared to the fall and winter months, other things being equal. However, while collections in the summer months were significantly higher than in the winter and fall months at the Grainger County Center, just the reverse was true at the Athens-Limestone Center. The monthly county unemployment rate was positively related to material collections at the Athens-Limestone Center, though with only a moderate level of significance.

Findings from the survey of those responsible for managing or overseeing operation of the centers indicated that political and community support was critical for the establishment and continued operation of each of the centers. Across the three centers, the most important factors in encouraging participation and attracting collections were considered to be education or publicity regarding the center and its operation, the prices paid to participants for material collected, the variety of materials accepted, and accessibility of the center (Appendix B). With regard to the characteristic of accessibility, each of those responding to the survey indicated that satellite drop-off sites would likely increase participation a great deal.

Conclusions and Implications

What can be said then, by way of conclusions from these case study analyses, about the economic feasibility of rural recycling? And what are the implications for local decision-makers in rural communities, state or federal government agencies, or further research? Generalizations must certainly be qualified by the obvious limitations of information from only three case study centers. However, a number of conclusions and implications can reasonably be drawn. Finding stable markets for resale of recyclable materials did not seem to be a major hurdle for the centers studied. However, economic feasibility, in the sense of a recycling center "breaking even" when considering only revenues from recyclable material sales and full costs of operation, would be extremely difficult to achieve for rural communities the size of those in this study, given market prices for the period studied. Only the Athens-Limestone Center could expect to come close to achieving economic feasibility in this sense, and then only with a substantial increase in volume processed to the maximum capacity for their current scale (based on facility equipment capacity).

However, there are other factors to be considered beyond this narrow concept of economic feasibility. One is the potential for reducing landfill costs by diverting material from the waste flow into recycling. These cost savings were

not insignificant relative to the net cost of the recycling operations in this study. In fact, for the Athens-Limestone Center, estimated landfill cost savings more than offset the net cost of the recycling operation. In addition, recycling may at least delay the need to site a new landfill and thus delay the political and protest costs generally associated with siting efforts.

Other possible local benefits include the income provided to participants, aesthetic improvements, and community pride. While for many people who participate in recycling, the personal financial incentive may be a minor factor, there is evidence to suggest that in each of the cases studied here, for a significant number of people, the opportunity to earn supplemental income was an important factor in their participation. While benefits in terms of aesthetic improvements and community pride are difficult to measure, they may be important. Grainger County's recycling effort started in part as an alternative to having prisoners pick up litter along highways, while the Athens-Limestone Center grew out of a volunteer community group effort.

From a local government accounting stance, outside funding can help to reduce net costs of a recycling operation, such as grants for equipment from agencies like the Tennessee Valley Authority to special programs providing subsidies for labor costs. In addition, use of a publicly-owned facility can eliminate start-up costs associated with constructing a

new facility or out-of-pocket expenses to lease a private facility. For example, Grainger County took advantage of outside funds for both equipment and labor. If one also assumes that the abandoned county-owned school building used for the recycling facility has a very low opportunity cost, Grainger County came close to "breaking even" from a local cash-flow accounting stance.

Rural recycling also generates benefits that go far beyond a local accounting stance. The benefits mentioned in Chapter I related to virgin resource conservation, energy conservation, and reductions in pollution all represent positive externalities. Thus, subsidies from state or federal governments can reasonably be justified and may in some cases make a difference in local decisions regarding recycling.

Returning to what can be done locally to move a recycling operation toward economic feasibility or at least an acceptable level of net cost, increasing volume within a given scale or so that more efficient larger-scale equipment can be justified seems to be the key (Appendix D). Further research on economies of size could help to clarify the importance of this factor.

While education or publicity to increase or maintain awareness is certainly important, prices offered and accessibility seem to be critical factors in influencing volume.

While the Athens-Limestone Center did process a significantly larger volume than the other two centers, its lower net cost was also a function of its larger margin between the prices paid to collectors and the prices received from resale to industry compared to the other two centers. An important tradeoff exists in pricing strategy. While lower prices to collectors (with a given resale price) would increase the margin per pound of material, if volume fell too much, then total margin might actually decrease. This emphasizes the importance of further research along the lines of the regression analyses for the Athens-Limestone and Grainger County Centers which can provide better information about the relationship between prices and volume collected.

Accessibility was emphasized as important in the survey responses and ideas for increasing accessibility through satellite drop-off sites or mobile units were suggested. This is consistent with the findings by Markley and Park that travel distance was negatively related to participation from analysis of data from the Grainger County Center. Further research is needed in this area with regard to the importance of travel distance and the expected costs and revenues from satellite drop-off sites or mobile units.

Two additional areas of possible research can be identified. First, the composition of the rural solid waste stream and how various components are typically disposed

could be better identified so as to guide development of rural recycling strategies. Second, cooperative strategies at a multi-county or regional basis could be developed and analyzed from the standpoint of increasing transportation efficiency or bargaining power in negotiating on resale prices with industry representatives.

Solid waste management is likely to become an increasingly challenging issue for rural communities in the future. As landfills approach full capacity and siting new landfills becomes more difficult due to environmental restrictions and public opposition, alternative methods of disposal will become more attractive. Recycling represents one solid waste disposal alternative that should receive consideration in addressing rural solid waste management needs.

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APPENDICES

Appendix A

Demographic and Economic Characteristics of Selected Counties[a]

County	Limestone	Grainger	Watauga
Population	47,300	17,309	34,084
Population Density[b]	82.3	63.7	108.5
Rural Population (%)	68.3	100.0	68.0
Land Area[c]	559	273	314
Unemployment Rate	10.8	13.4	5.3
Per Capita Income	$9,375	$6,909	$8,467
Type of Center Operation	Nonprofit	County	County

[a]Demographic and economic data were obtained from the Alabama Department of Economic Affairs, the Employment Security Commission of North Carolina, and the Tennessee Department of Employment Security. Data Year: 1984.

[b]Population per square mile.

[c]Square miles.

Appendix B

Responses to Survey Questions on Factors Considered to be the Most Significant in Attracting Recyclable Material Collections to Each Center[a]

Those responsible for recycling center operations were asked to rate the following six questions on a scale from one to ten, with one being least important to ten being most important.

	County			
	Lime-stone	Grainger	Watauga	Response Average
1. Center Accessibility	8	8	6	7.33
2. Prices Paid to Collectors	8	5	9	7.33
3. Hours of Operation	5	8	3	5.33
4. Variety of Materials Accepted by Center	8	8	8	8
5. Center Appearance	5	10	2	5.67
6. Education of Residents	9	7	9	8.33

[a]Surveys were given to the Athens-Limestone Recycling Center Manager and Athens-Limestone Recycling Center Board chairman, the Grainger County Executive, and the Watauga County Recycling Center manager.

Appendix C

Resource Recovery Equipment List

Athens-Limestone Recycling Center

Aluminum Can Crusher with Conveyor
Fork Lift
Flat-bed Truck with Trailer
Glass Crusher
Hand Trucks
Horizontal Bailing Press with Conveyor
Slab Scales
Vertical Bailing Press

Grainger County Recycling Center

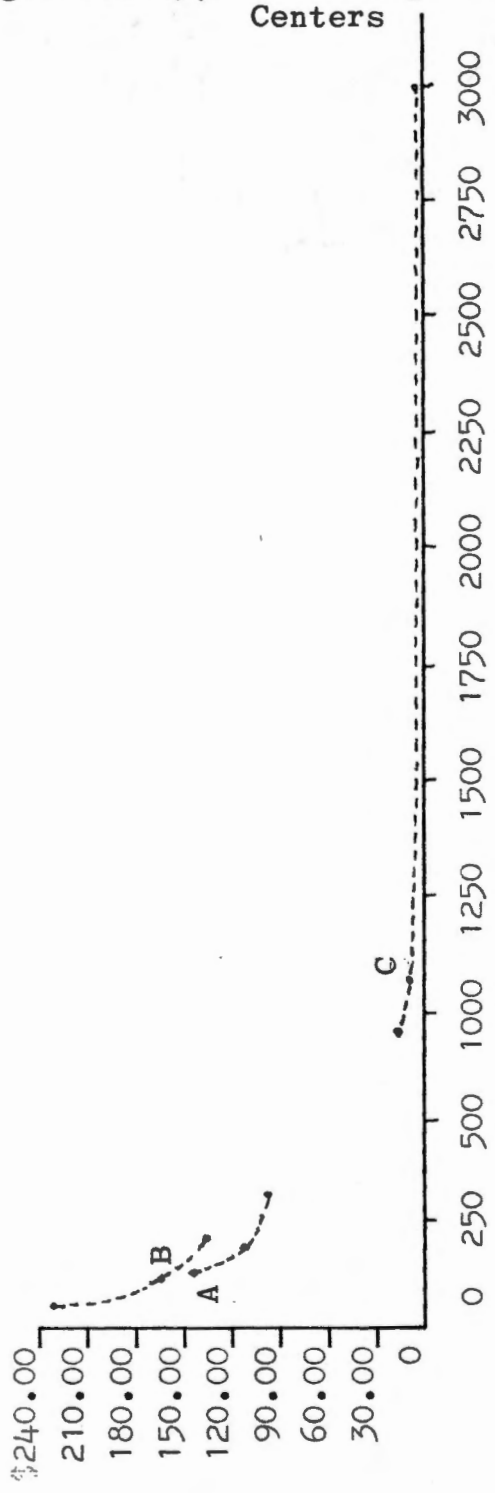
Aluminum Can Crusher
Bobcat Loader
Floor Scales
Glass Crusher
Pallet Jack
Pickup Truck
Trailer
Vertical Bailing Press

Watauga County Recycling Center

Glass Crusher
Horizontal Bailing Press
Two and One-Half Ton Dump Truck
Vertical Bailing Press

Appendix D

Short-Run Average Cost Curves Showing Potential Economies of Size for the Athens-Limestone, Grainger County, and Watauga County Recycling Centers



A = Average net cost per ton for the Grainger County Recycling Center.
B = Average net cost per ton for the Watauga County Recycling Center.
C = Average net cost per ton for the Athens-Limestone Recycling Center.

Appendix E

Sample Survey

I. Public Education of Recycling Center

1. When did you begin recycling center advertising?

   A. Three weeks prior to opening _____
      Two weeks prior to opening _____
      One week prior to opening _____
   B. Day center opened _____
   C. After center opened (specify) _____
   D. Other (specify) _____

2. How long did you advertise your recycling center once it opened?

   A. One week _____
   B. Two weeks _____
   C. Three weeks _____
   D. Still advertising _____
   E. Other (specify) _____

3. What type(s) of advertising did you use?

   A. Newspapers _____
   B. Flyers _____
   C. Posted Notices _____
   D. Radio _____
   E. Word-of-Mouth _____
   F. Television _____
   G. Other (specify) _____

4. How well did your advertising work to bring collectors to the center?

5. In your opinion, how important is education in reaching collectors?

   A. Very important _____
   B. Moderately important _____
   C. Slightly important _____
   D. Not important _____

II. Weather Conditions

1. How important are participation rates of collectors in different weather conditions?

   A. Very important _____
   B. Moderately important _____
   C. Slightly important _____
   D. Not important _____

2. Which season(s) are best for collections?

   A. Summer _____
   B. Fall _____
   C. Winter _____
   D. Spring _____
   E. All of the above _____

III. Amount of Material Available for Collectors to Retrieve

1. In your opinion where are the best sources of recyclable materials brought to your center?

   A. Roadside litter collection _____%
   B. Resident home collection _____%
   C. Scavenging of waste disposal sites ___%
   D. Other (specify) _____

2. Are local businesses or industries good sources of recyclable materials for your center?

   A. Department stores _____%
   B. Grocery stores _____%
   C. Industry (specify type) _____%
   D. Other (specify) _____

3. What percentage do individual residents contribute to collections?

4. What percentage do groups (e.g., civic, scouts, etc.) contribute to collections?

IV. Other Solid Waste Facilities in the Area

1. How many currently operating landfill(s) are there in your county?

2. Are there any other recycling centers in your county?

   A. How many? _____ What items do they accept? ____

   _____

3. Does your county have a convenience center collection system (materials received, but not processed)?

   A. How many convenience centers are there in your county? _____

4. Does your county have a "green box" collection system?

   _____

5. To what degree do neighboring county residents bring materials to your center?

   A. Large amounts _____%
   B. Moderate amounts _____%
   C. Slight amounts _____%
   D. Not at all _____

6. To what degree do neighboring county landfill(s), recycling centers, or convenience centers, etc. attract local resident collection out of your county - in your opinion?

7. Do you feel collections would increase at your center if:

   A. There were more recycling centers or satellite stations in your county? _____

   B. There were less recycling centers or other solid waste collection facilities in your county? _____

   C. There were fewer landfill(s) in your county? _____

   D. There were more convenience centers in your county? _____

   E. Other (specify) _____

V. Seasonal Factors for Agricultural Labor

1. Which month(s) in your opinion, require the most agricultural labor (for such activities as planting, harvesting, etc.)?

VI. Environmental/Aesthetic Concerns

1. In your opinion, on a scale from one to ten (with one being not concerned, to ten being very concerned with the environment), how do residents bringing materials to the center feel about the environment? (Circle)

A. 1 2 3 4 5 6 7 8 9 10
Not Concerned ... Very Concerned

2. In your opinion, how important do attractive roadsides, parks, and other public areas appear to residents bringing in collections - on a scale from one to ten? (Circle)

A. 1 2 3 4 5 6 7 8 9 10
Not Important ... Very Important

VII. Environmental Laws/Ordinances

1. Does your county or city have any ordinances involving?

A. No littering _____
B. No dumping _____
C. No scavenging _____
D. Other (specify) _____

2. In your opinion, how well are ordinances (such as littering, dumping, etc.) enforced in your county or city?

A. Greatly _____
B. Moderately _____
C. Slightly _____
D. Not at all _____

3. Do you feel a mandatory recycling ordinance for specified materials in the county or city (such as newsprint, aluminum cans, or glass, etc.) would increase participation rates by collectors at your center?

A. Greatly _____
B. Moderately _____
C. Slightly _____
D. Not at all _____

4. How much of a role did environmental laws or ordinances play in your desire to start a recycling center?

A. Greatly _____
B. Moderately _____
C. Slightly _____
D. Not at all _____

VIII. Landfill Capacity

1. How much capacity is left in the county's/city's landfill(s)?

IX. Community/Political Support

1. In your opinion, how much community/political support was there for your recycling project?

A. A great deal of support _____
B. Moderate support _____
C. Some support _____
D. No support _____

2. Do you feel you still have community/political support for your recycling center?

A. More support now than when first opened _____
B. The same now as when first opened _____
C. Less now than when first opened _____

3. Which group(s) gave you the most support?

A. Residents _____
B. Business people _____
C. Church groups _____
D. Schools _____
E. Civic organizations _____
F. Local political leaders _____
G. State political leaders _____
H. Federal political leaders _____
I. Other (specify) _____

4. How important is political or community support to your center?

   A. Very important _____
   B. Moderately important _____
   C. Slightly important _____
   D. Not important _____

X. General

1. Which factor(s) would you consider to be the most significant in attracting collections by residents, businesses, etc. - on a scale from one to ten? (Circle)

   A. Center accessibility

   1 2 3 4 5 6 7 8 9 10
   Not Important ... Very Important

   B. Prices paid to collectors (if not on a voluntary collection center)

   1 2 3 4 5 6 7 8 9 10
   Not Important ... Very Important

   C. Hours of operation

   1 2 3 4 5 6 7 8 9 10
   Not Important ... Very Important

   D. The variety of materials accepted by the center

   1 2 3 4 5 6 7 8 9 10
   Not ... Very

   E. Center appearance

   1 2 3 4 5 6 7 8 9 10
   Not Important ... Very Important

X. General (continued)

F. Education of residents

1	2	3	4	5	6	7	8	9	10
Not Important									Very Important

G. Other (specify) _____

2. In your opinion, what will business be like this time next year at your center?

A. It will increase ____
B. It will be the same ____
C. It will decrease ____

3. If you have any further comments regarding your center's operations or on the topic of recycling in general, please feel free to mention them below.

VITA

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