United States
Environmental Protection
Agency

Municipal Environmental Research
Laboratory
Cincinnati OH 45268

EPA-600/2-80-007b
July 1980

Research and Development

Processing Equipment for Resource Recovery Systems

Volume II. Magnetic Separators, Air Classifier and Ambient Air Emissions Tests

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into nine series. These nine broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The nine series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies
6. Scientific and Technical Assessment Reports (STAR)
7. Interagency Energy-Environment Research and Development
8. "Special" Reports
9. Miscellaneous Reports

This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY series. This series describes research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

EPA-600/2-80-007b
July 1980

PROCESSING EQUIPMENT FOR RESOURCE RECOVERY SYSTEMS

Volume II. Magnetic Separators, Air Classifier and Ambient Air Emissions Tests

by

B. W. Simister
David Bendersky
Midwest Research Institute
Kansas City, Missouri 64110

Contract No. 68-03-2387

Project Officer

Donald A. Oberacker
Solid and Hazardous Waste Research Division
Municipal Environmental Research Laboratory
Cincinnati, Ohio 45268

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

DISCLAIMER

This report has been reviewed by the Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendations for use.

FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is a necessary first step in problem solution, and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved systems technology to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research.

This report presents the results of a study of equipment and systems for processing municipal solid wastes into energy related products. The study was divided into three phases. The first phase, reported in Volume I, was devoted to a study of the state of the art and formulation of the research needs. This Volume II report discusses the second phase, which was devoted to field tests of magnetic separators, air classifier and air emissions, and describes the procedures and results of tests performed at the Outagamie County, Wisconsin, and Baltimore County, Maryland, municipal solid waste (MSW) processing facilities. The third phase was involved with field tests of shredders and is is presented in Volume III.

Francis T. Mayo, Director
Municipal Environmental Research
Laboratory

ABSTRACT

This report presents the results of tests conducted to determine the performance of the magnetic separators and the nature of the in-plant air emissions at the Outagamie County waste processing plant, located in Appleton, Wisconsin, and at the Baltimore County plant, located at Cockeysville, Maryland. The air classifier at the Baltimore County plant was also tested. Various parameters were changed in a systematic fashion to determine their effect on the equipment performance.

The data from the magnetic separator system tests indicate that the present ferrous metal recovery efficiency at Outagamie County is about 81% and at Baltimore County about 79%.

The emissions tests showed that all trace metals were well below their threshold limit values (TLVs) and the highest emission concentration was below the nuisance dust TLV. In all cases more than 30% of the particulates were below 2 μm. No trace of asbestos was found at Outagamie County, the only site tested for this material.

The air classifier at Baltimore County was tested by changing the input material feed rate with a constant air flow rate through the unit. It was found that there is a critical point for the air-to-solids ratio. At or above the critical point, the amount of fuel fraction recovered is maximized and is relatively stable. Below the critical point, the amount of fuel fraction recovered is significantly reduced. The critical point for the Baltimore County air classifier air-to-solids ratio (by weight) was found to be about 20.

This report is of interest to those involved in designing and operating resource recovery plants and also is of interest to decision makers involved in equipment selection.

This report was submitted as part of Contract No. 68-03-2387, by Midwest Research Institute under the sponsorship of the U.S. Environmental Protection Agency and covers work done during the period August 1977 through March 1978.

CONTENTS

FIGURES

TABLES

ACKNOWLEDGMENT

This report was prepared by Midwest Research Institute for the Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio, under EPA Contract No. 68-03-2387. The project officer for the Environmental Protection Agency was Donald A. Oberacker.

This report was prepared by Messrs. B. W. Simister and David Bendersky. However, many of Midwest Research Institute's personnel contributed to the activities which resulted in this publication. Foremost among the contributors are Emile Baladi, Calvin Bolze, Charles Brown, Carl Clark, Chris Cole, Douglas Fiscus, Carol Green, John LaShelle, and Ted Sutikno.

We gratefully acknowledge the cooperation of officials at Outagamie County, Baltimore County, Maryland Environmental Services, and Teledyne National in furnishing their facilities for tests. Valuable assistance was provided by Edward Maloney, Outagamie County MSW facility manager, Ken Cramer, Baltimore County MSW facility manager, and their staffs.

SECTION 1

INTRODUCTION

The combined need for new energy sources and better waste disposal techniques in the U.S. has stimulated considerable interest and activity in the recovery of energy and other resources from municipal solid waste (MSW). A variety of energy recovery systems have been designed which produce waste-derived fuels in solid, liquid, or gaseous forms. The raw waste is processed through various combinations of equipment which usually include one or more of the following unit operations: shredding, magnetic separation, air classification, screening, drying, and densification. In addition to these unit operations, these systems usually also include receiving facilities, conveyors, dust collectors, cyclone separators, electrical controls, storage and retrieval bins, and other ancillary equipment.

The processing of MSW into fuels and fuel feedstocks is a relatively new industry, the first full scale plant having been demonstrated in St. Louis in 1974. Thus far, operating experience, tests, and evaluations of waste-to-fuel systems have been insufficient to provide a firm basis for optimum design, selection, and operation of processing equipment for these systems.

In light of the situation, the U.S. Environmental Protection Agency contracted with Midwest Research Institute to conduct research, tests, and evaluations of alternative processing equipment and systems for converting municipal solid waste into a solid fuel or feedstock for liquid/gaseous fuel conversion systems. The project was intended to stimulate and advance the technology of waste-to-fuel systems by providing information useful to equipment manufacturers, system designers, and system operators.

Phase I of the study, reported in Volume I, was concerned with (1) a study of the present state of the art of equipment used to process MSW into energy related products,* and (2) the identification of areas which require additional research to improve the state of the art. Phases II and III were

* Only equipment which affects the energy-related product streams were included in this study; equipment used to process only the nonenergy streams, such as metals and glass recovery, was not included in this study.

devoted to in-plant tests and evaluations of processing equipment aimed at satisfying some of the research needs.

This report presents the results of tests performed under Phase II at the Outagamie County, Wisconsin, in August 1977, and Baltimore County, Maryland, in March 1978, waste processing plants. An air classifier and two magnetic separator systems were tested along with the air emissions within the facilities.*

The first section of this report describes the facilities tested. The subsequent sections deal with each piece of equipment tested, giving a description, the test procedure, and results. Each of these sections includes a discussion of the results and general observations noted about the equipment during the tests.

The scope of this study was limited by the small number of operating waste processing plants that were available for tests during this contract period. A considerable number of plants have recently been put into operation, so that consideration should be given to conducting additional tests on similar and other types of waste processing equipment.

---

* Field tests of shredders are being conducted under Phase III and will be reported under EPA Contract No. 68-03-2589.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The thrust of this contract was to test equipment as part of resource recovery systems under normal operating conditions. The normal adjustment ranges of the equipment and the normal mix of incoming material yielded valuable information about a specific piece of equipment at a specific site, but it did not provide for testing the equipment to their limits. Additional research and development work is needed to provide more complete information about the equipment, as independently as possible of the system.

MAGNETIC SEPARATOR TESTS

The magnetic separator tests conducted at the Outagamie County and Baltimore County plants show that both systems recovered approximately 80 percent of the available ferrous metal out of the input stream, but the recovered material at Outagamie County contained more impurities than at Baltimore County. The cleaner material at Baltimore County does not appear to be as much a result of the magnetic separator system as the condition of the input material. The particle size after shredding is smaller at Baltimore County and the material contains about twice as much ferrous.

There is no information available describing the distribution of the ferrous in the material on the conveyor. A study to determine the distribution of the ferrous in the shredded material, both along the conveyor and across the conveyor, would yield valuable information for establishing sample size for statistically sound results. Also, the information could be used to adjust the position of the magnetic separator.

At both plants, observations indicated that the impurities controls were not effective. At Outagamie County, light paper and plastic floated across the splitter blade on air currents, being completely detached from any ferrous material. At Baltimore County, very little material was freed at the air gap; the return belt ran virtually empty. A test program which provided for modifications to the equipment should allow a change in the air flow in the hopper to determine how much of the nonferrous is being carried over by the air.

At Baltimore County, the lowest position of the magnetic separator was controlled by the system design. It is suspected that at higher recovery rates more nonferrous material would have been pulled out of the incoming material, which may have been removed by the air gap feature. At the available height setting, the air gap settings did not effect the performance of the system.

At both sites, there was a linear correlation between the height of the separator and the percent ferrous recovered. The splitter blade tests at Outagamie County indicated the closer to the vertical the blade was positioned, the higher the rate of recovery. This is explained by observing the recovered ferrous bouncing off of the hopper back plate when it was released from the magnetic field. With the blade in the vertical position, the least amount of recovered ferrous could fly back into the light fraction chute.

AIR CLASSIFIER TESTS

The air classifier system at Baltimore County was tested at a fixed velocity with various input feed rates.

Because the air velocity was held constant, the larger air/solids ratios were obtained by reducing the input feed rates. An operating plant producing RDF will operate as close to the left on the curve of Figure 50 as possible without leaving the horizontal portion.

One important relationship cannot be found from the available Baltimore County data; i.e., changes in air velocity. Some unpublished test results indicate that an increase in velocity increases the air-to-solids ratio and the critical point.

The effect of the changes in $\dot{m}_s$ on the amount of material reporting to the light fraction in the air classifier operation was apparent at Baltimore County. This points up the need for either a flow control device or a belt weighing system with a minicomputer connected to the fan. If the air velocity in the classifier could be changed in response to the variations in $\dot{m}_s$, the split could be controlled closer to the critical point.

The handpick method of determining the percent combustibles is inadequate. The time required for this operation limits the sample size. A test plan designed to establish a standard burning method for a large quantity of sample is needed. This would result in both percent combustibles and percent ash in the sample.

EMISSIONS TESTS

Emissions tests were conducted at the Outagamie County and Baltimore County plants to determine the nature of the air emissions produced by processing and handling MSW. The emissions of specific interest were particle concentration, particle size, trace metal concentration, and asbestos concentration. Hi-Vol and Acu-Vol samplers were placed near specific pieces of equipment to determine the emissions from that unit.

No asbestos was found at Outagamie County, and based on the St. Louis and Houston tests which also showed no asbestos,1/ it was decided not to test for asbestos at Baltimore County.

The highest particulate concentration reading was at the tipping floor at Outagamie County with a reading of 6.617 mg/Nm^3 which is approximately 66 percent of the nuisance dust TLV of 10 mg/Nm^3.2/ This location is not an 8-hour worker station.

The data from the trace metal analysis, of the particulate collected, indicates that the amounts of toxic metals were well below their respective TLV's. The sample closest to TLV contained a lead content of 0.018 mg/Nm^3 compared to a TLV of 0.150 mg/Nm^3 or approximately a factor of 10 below the TLV.

The tests of the dust control system at each facility were inconclusive. Further research and possibly development is needed in this area.

Material spillage is a major housekeeping problem at resource recovery facilities. The source of the spillage is not obvious, but appears mainly at conveyor transfer points. More information is needed to pinpoint these sources. Once known, modifications could be made as part of a program to develop effective solutions.

ECONOMICS

Attempts to gather long-term economic data on individual pieces of equipment were generally unsuccessful because most plants do not maintain such records. For example, labor maintenance costs are generally spread over a variety of equipment. It is recommended that detailed cost records on individual equipment be instigated.

1/ St. Louis Demonstration Final Report, MRI Project No. 4033-L, page 64. Evaluation of Fabric Filter Performance at Browning Ferris Industries/ Raytheon Service Company Resource Recovery Plant, Houston, Texas, MRI Project No. 4290-L(13), page 44.

2/ TLV (threshold limit value) from American Conference of Governmental and Industrial Hygienists.

SECTION 3

DESCRIPTIONS OF TEST FACILITIES

OUTAGAMIE COUNTY (APPLETON), WISCONSIN, PROCESSING PLANT

The Outagamie County facility processes MSW to produce shredded material for landfill and for the recovery of ferrous metal. Shredding of MSW reduces the volume requirements and the rodent, bird, and odor problems at a landfill. Furthermore, MSW which has been shredded does not require daily cover, thus reducing operating costs. Figure 1 is a general view of the facility from the southeast. Figure 2 is the floor plan of the main building. The incoming truck dumping area occupies the entire north part of the building on the upper level with the shredders located in the building extension on the south side. The elevated building at the left of Figure 1 houses the magnetic separator system for ferrous recovery. The tall pipe in Figure 1 is part of an air-classifier prototype unit belonging to the Allis Chalmers Company and is not part of the normal processing line. The operating part of the facility covers 4700 m^2. Figure 3 is the pictorial flow diagram and Figure 4 is the schematic flow diagram of the facility.

The incoming packer trucks dump an average of 180 metric tons of MSW per day into the steel receiving pits (Figure 5) which have capacity of 36 metric tons each. The floor of each pit is equipped with a drag conveyor. The flow of material to the next drag conveyor, 3 or 4, is controlled by the operator who starts and stops the pit conveyor. Drag conveyors 3 and 4 feed directly into the shredders (Figure 6). At each of these conveyors, a plant employee picks out by hand the items which are difficult to shred and arranges material on the conveyor to smooth the shredder load.

The shredders are Allis Chalmers 18 metric tons/hr, Model No. KH 12-18 (Figures 7, 8). The power requirement is 24 kw-hr/0.9 metric tons using a 300-hp electric motor connected to the hammer shaft through a belt set.

Each shredder has four rows of free swinging hammers. The input opening of each shredder is covered with a rubber curtain to help control dust and retain projectiles. Each shredder is equipped with a water spray system which injects water into the MSW inside the shredder just above the hammers. This is to reduce the energy required for shredding, and the wet shredded MSW produces less dust. The unshreddables that get into the shredders are ejected through a spring loaded door mounted on the back of the shredder above the deflector grating (Figure 9). The shredded material falls out at the bottom of the shredders on to belt conveyor No. 1, which transfers the shredded MSW to belt conveyor No. 2 (Figures 8, 10).

Belt conveyor No. 2 carries the shredded MSW up to the magnetic separator system (Figure 11).

The recovered ferrous metal falls directly into an open trailer for shipment to a local scrap dealer (Figure 12).

The rejects fall onto belt conveyor No. 3, which is reversible and feeds one of two compactors (Figure 11) that compact the remaining MSW into trailer trucks for hauling to the landfill.

The conveyor specifications are listed in Table A-1 of Appendix A.

BALTIMORE COUNTY (COCKEYSVILLE) MARYLAND PROCESSING PLANT

The Baltimore County facility, located in Cockeysville, Maryland, processes household and selected industrial solid waste for the county. This processing plant is operated by Teledyne National for Baltimore County in conjunction with the Maryland Environmental Service. The facility is also used for research and development by Teledyne National. As part of this work, the facility has produced RDF by air classification, trommelling, and secondary shredding. The RDF has been test burned as produced and as pellets.

Figure 13 is a general view of the facility as seen from the west. The overhead doors are the access to the storage pits. The rectangular structure at the north end of the building, with the piping connected to it, is the baghouse for the dust collection system. The open structure on the east side of the building is the magnetic separator system. The first building south of the main building houses the extensive maintenance and parts area.

The plot plan for the proposed complete facility is shown in Figure 14. The existing site has two shredders, not three as shown, and the secondary separation and recovery portion does not exist. The operating part of the facility utilizes 7580 m^2. Figures 15 and 16 are pictorial flow diagrams and Figure 17 is a schematic flow diagram of the facility.

Citizens bringing in small quantities of waste deposit it in open-topped trailers at the facility entrance. When the trailers are full, they are weighed at the scales (Item 2)* before dumping into the holding pit (Item 5) or push pits (Item 4).

* Item numbers refer to the plot plan, Figures 14 and 15.

Commercial loads are also weighed before going to the pit area.

The average daily weight of incoming MSW for 37 days from February 22, 1978, through April 5, 1978, was 442.25 metric tons.

The pit area is made up of a holding pit with two movable bridges (Item 3) giving access to the four push pits. The material dumped into the holding pit is later transferred into the push pits using a grappling crane which can travel over the entire pit area.

Each line operator sits in an enclosure built into the wall that divides the storage area and the shredder room. From this vantage point the operator can control the flow of material into each shredder. Small grapples are used to mix the material in the push pits before feeding it into the shredder.

Lines 1 and 2 are identical through the magnetic separator system; therefore, the following description will use the conveyor numbers of Line 1 (Figure 15).

The material is transported from the push pits to the shredder input by drag conveyor 2. The shredders are Tracor Marksman Model 860, 50 metric ton/hr units driven by 1,000 horsepower, Toshiba reversible electric motors directly coupled to the rotor shaft. The three spherical objects in Figure 18 are part of the Fenwal explosion supression system.

The shredded MSW is carried to the elevated magnetic separation system (Figure 19) on belt conveyor 7. The nonmagnetic material drops onto belt conveyor 8 and eventually into the RDF processing building.

The recovered magnetic material is transported to the output chute by belt conveyor 9. This chute collects the material from both magnetic separators and empties into an open-topped trailer (Figure 20). Figure 21 is a view down belt conveyor 4 carrying a typical load of ferrous metal. Belt conveyor 10 carries the rejected material to belt conveyor 11, which combines the material from both streams for further processing. Belt conveyor 11 is reversible to allow bypassing the processing building by feeding into the open-topped trailer shown in Figure 22. Belt conveyor 11 normally feeds the short horizontal belt conveyor 12. The material is then transported via belt conveyors 13 and 14 into the processing building.

At the intersection of belt conveyors 14 and 15, there is a power-operated diverter blade which directs the flow onto belt 15 or into the compactor hopper. Figure 23 shows the beginning of belt conveyor 15 and the diverter blade housing.

The RDF processing is monitored and controlled at the panel in Figure 24. The T.V. screens used to monitor six critical locations provide the information to set the material infeed rate, through the diverter blade, for optimum recovery of combustible product.

Belt conveyor 15 empties into the air classifier which uses two fans to pull off the lighter (mostly combustible) part of the shredded MSW. The light material is then collected in two cyclone separators and fed through air locks (Figure 25) onto belt conveyor 19 (Figure 26). Belt conveyor 20 carries this material into the trommel where the fine material (mostly glass and dirt) is removed.

The heavier part of the infeed to the air classifier drops out of the bottom onto belt conveyor 16 then to 17 and 18 into a truck for hauling to the landfill.

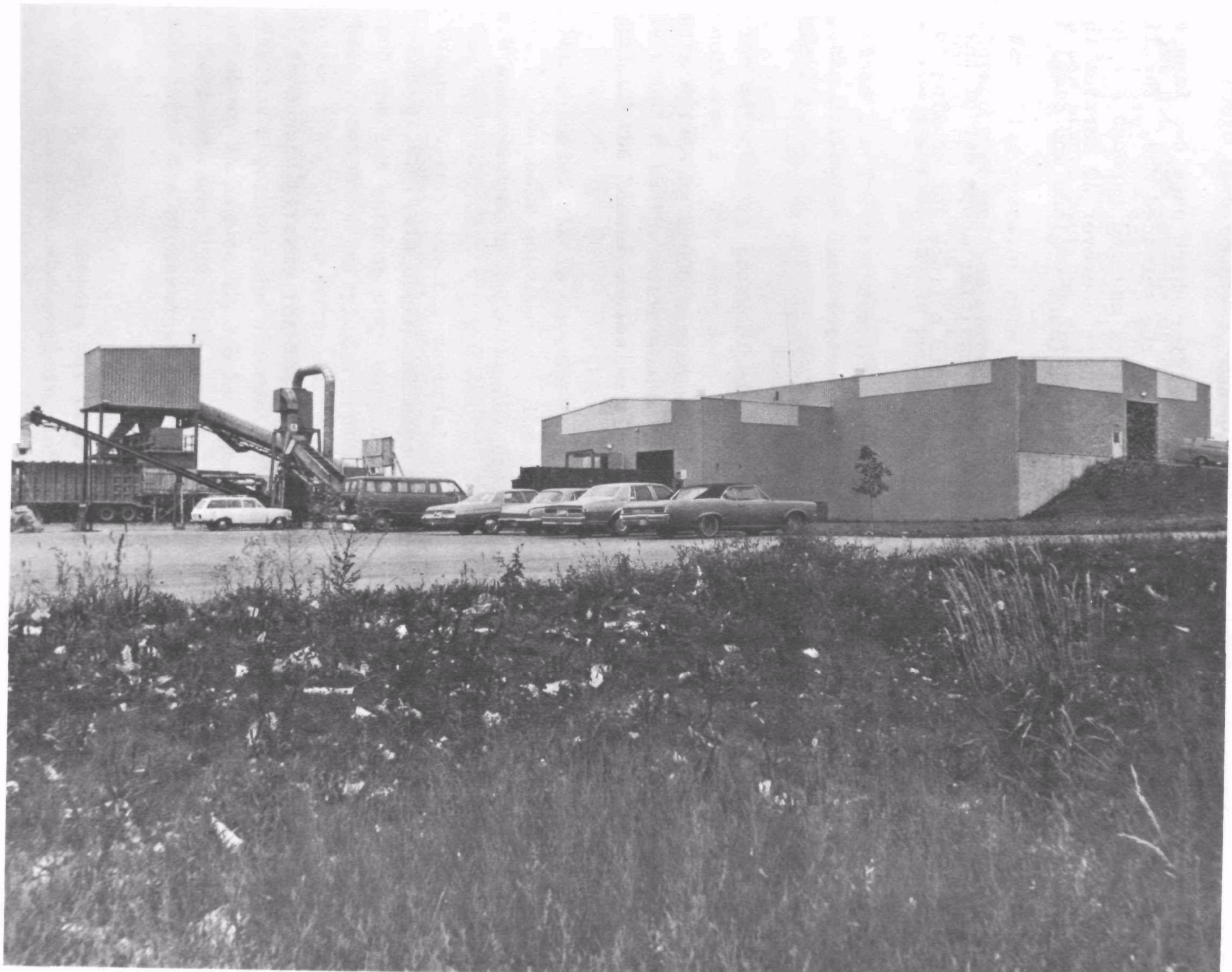


Figure 1. General View of Outagamie County, Wisconsin, Solid Waste Processing Plant

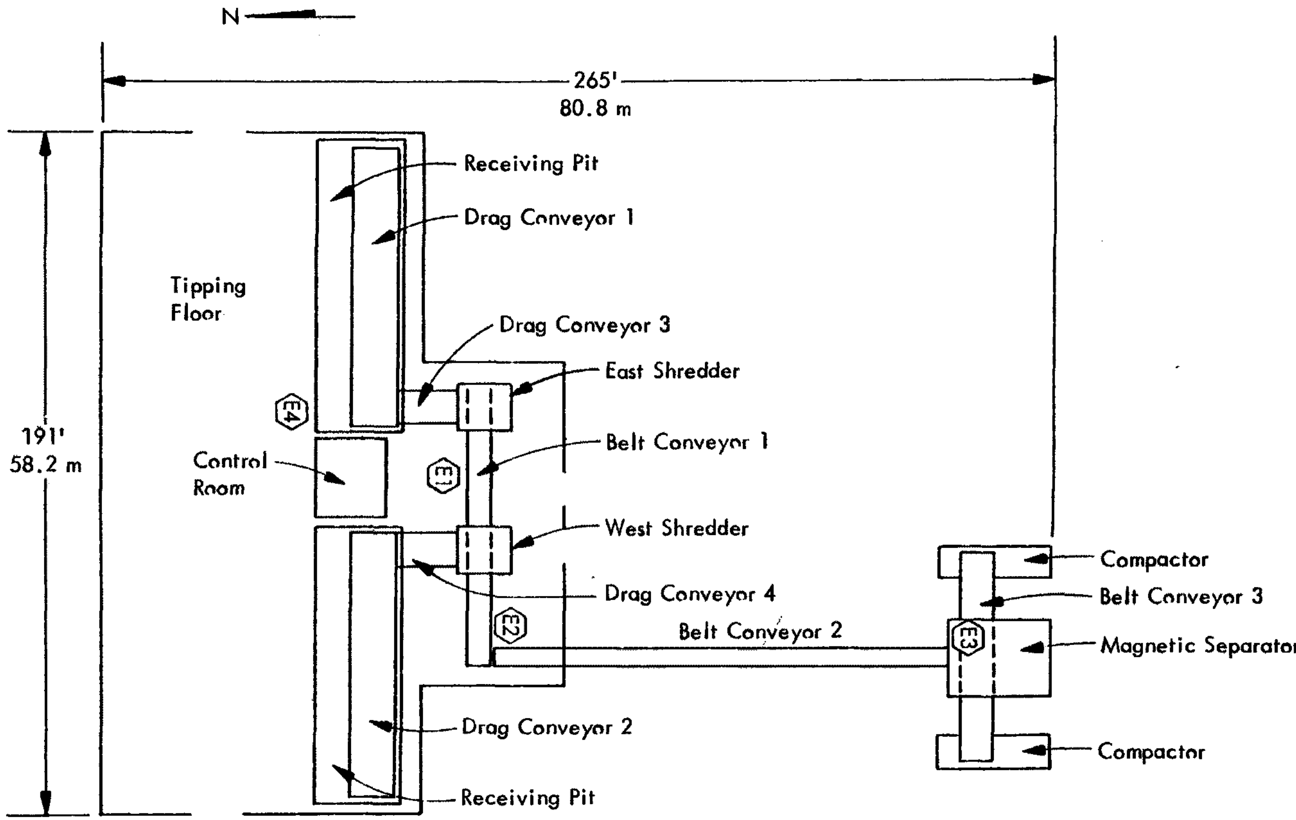


Figure 2. Plot Plan - Outagamie County, Wisconsin, Solid Waste Processing Plant

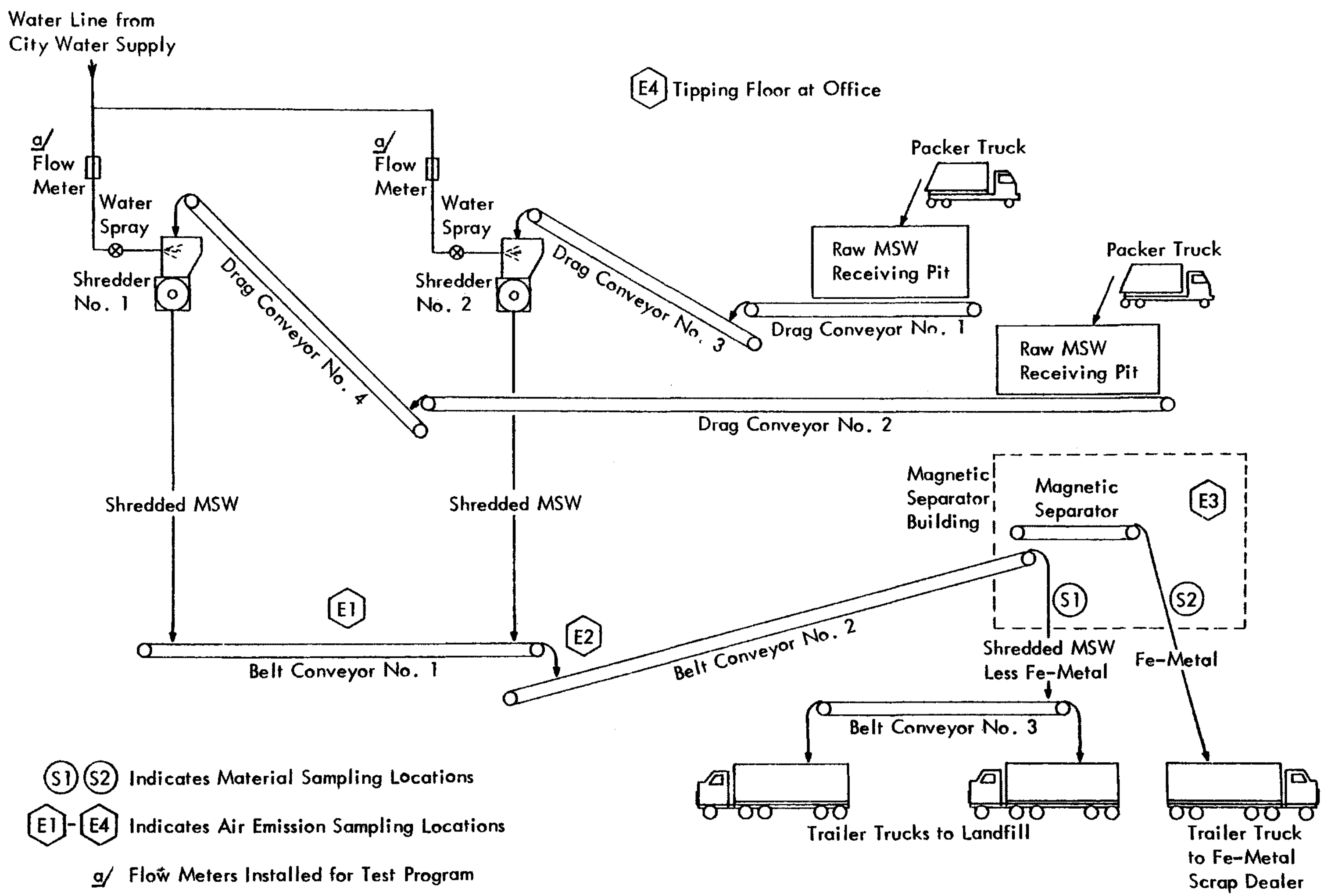


Figure 3. Pictorial Flow Diagram - Outagamie County, Wisconsin

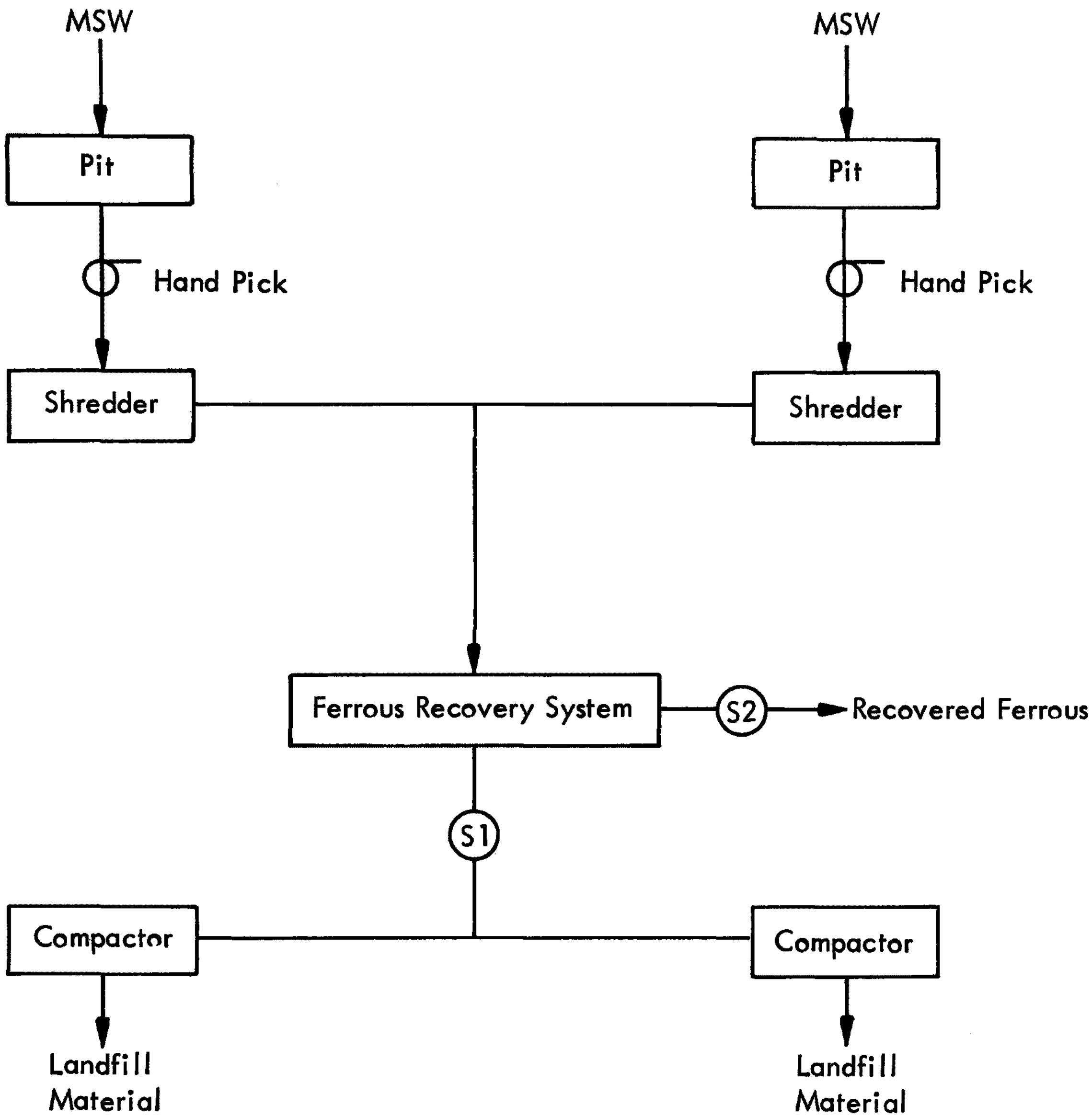


Figure 4. Schematic Flow Diagram of Outagamie County, Wisconsin, Solid Waste Processing Facility

Figure 5. Outagamie County, Wisconsin, Receiving Pit and Entrance to Tipping Floor

Figure 6. Inclined Drag Conveyor Into Shredder
Outagamie County, Wisconsin

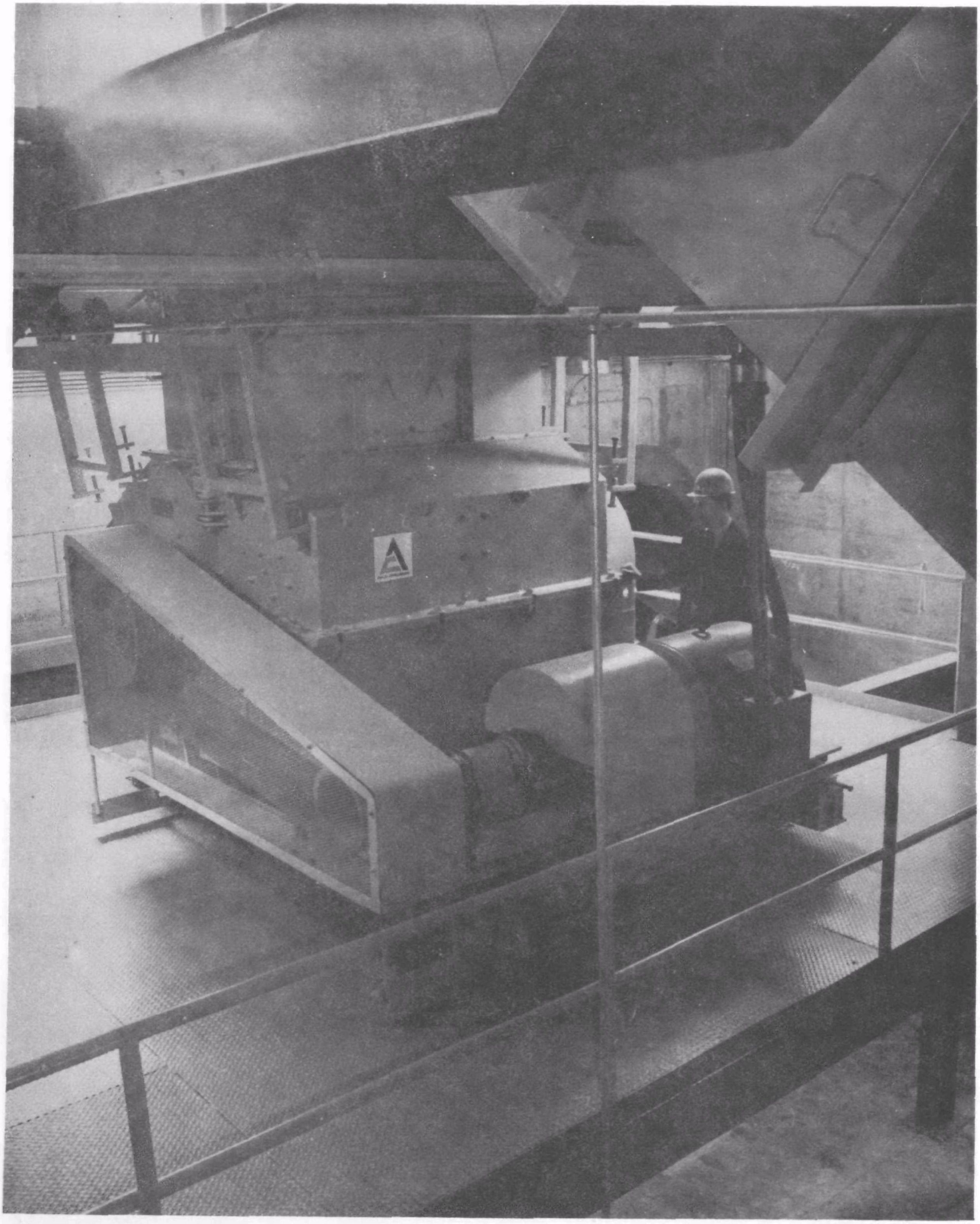


Figure 7. Shredder - Rotor Section, Outagamie County, Wisconsin
(Photo Courtesy of Allis Chalmers)

Figure 8. Overall View of Shredder (Photo Courtesy of Allis Chalmers) Outagamie County, Wisconsin

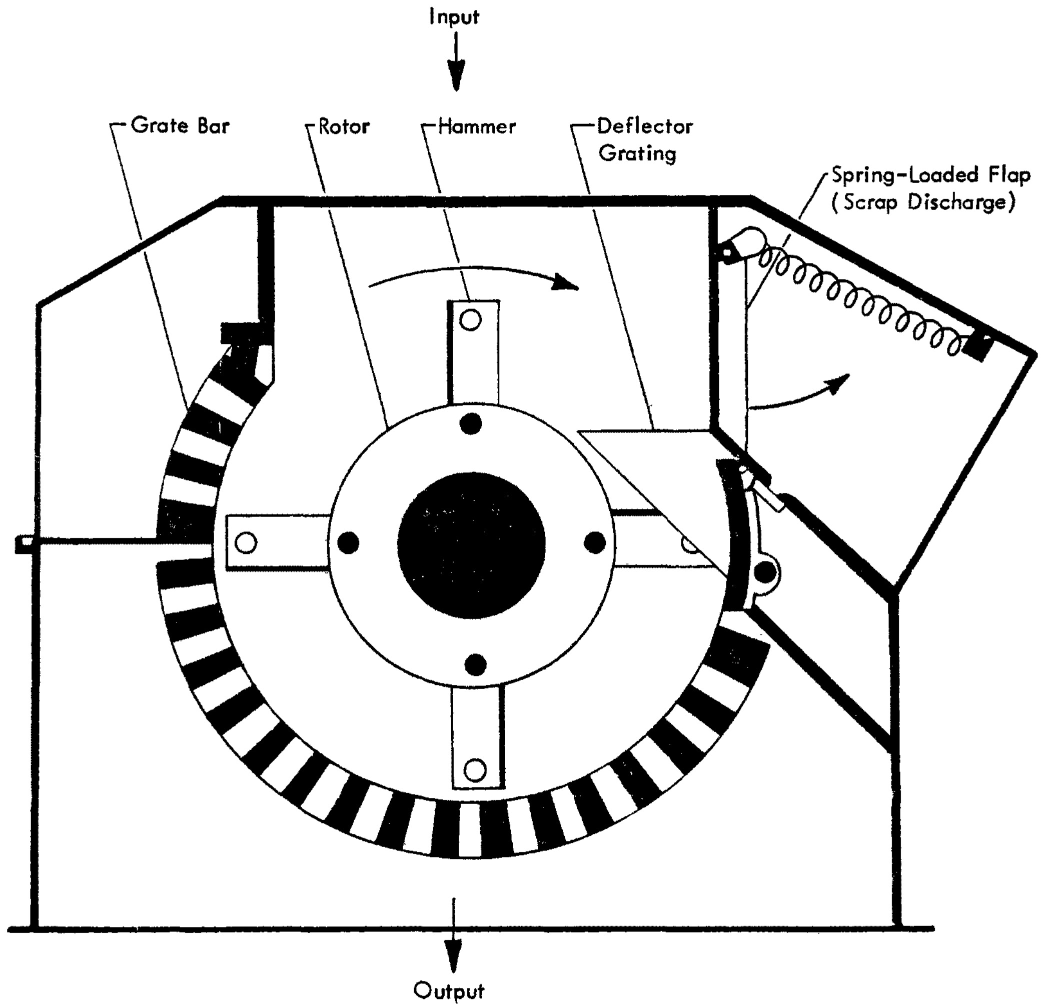


Figure 9. Section Through the Shredder
Outagamie County, Wisconsin

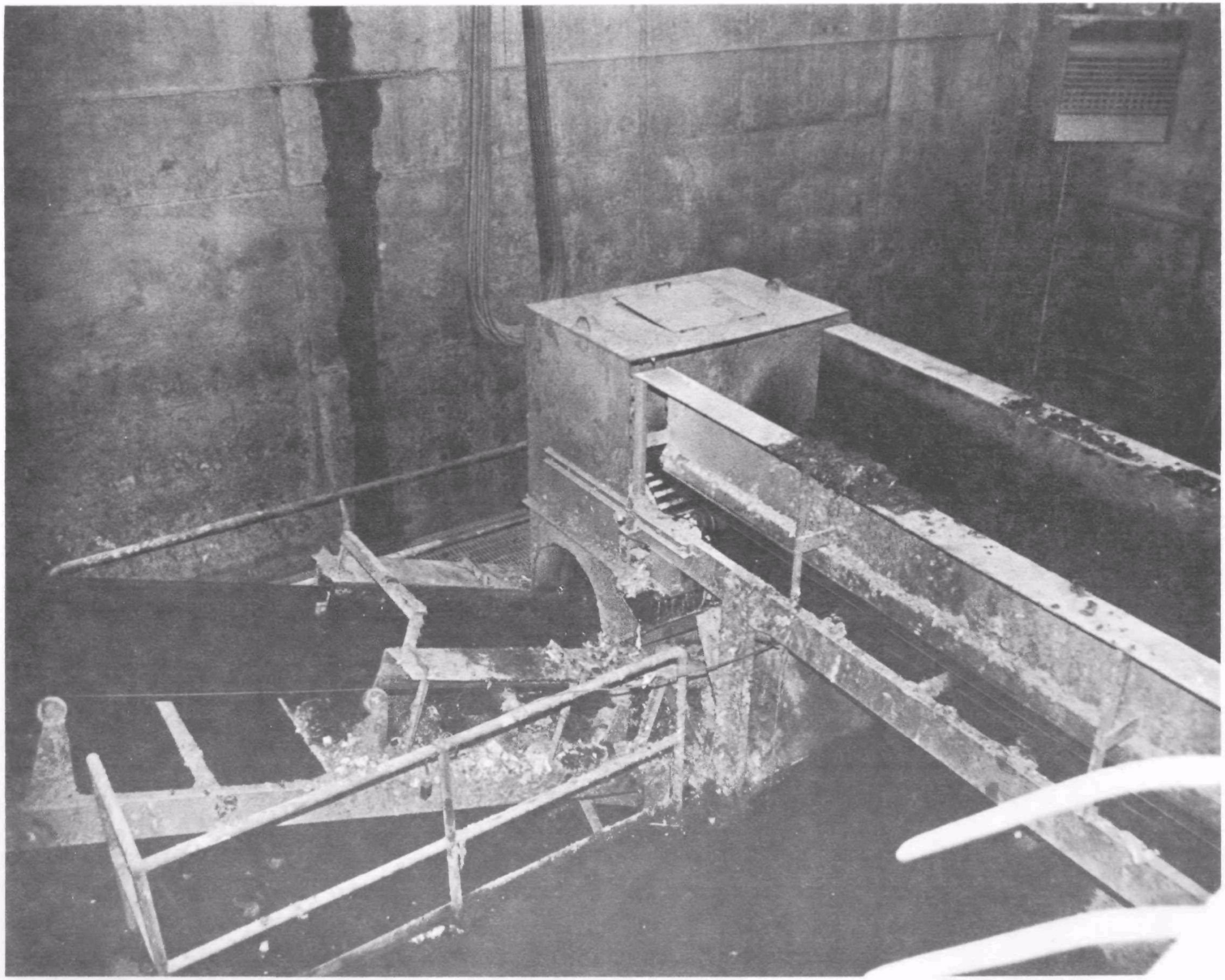


Figure 10. Transfer Point, Belt Conveyors 1 and 2
Outagamie County, Wisconsin

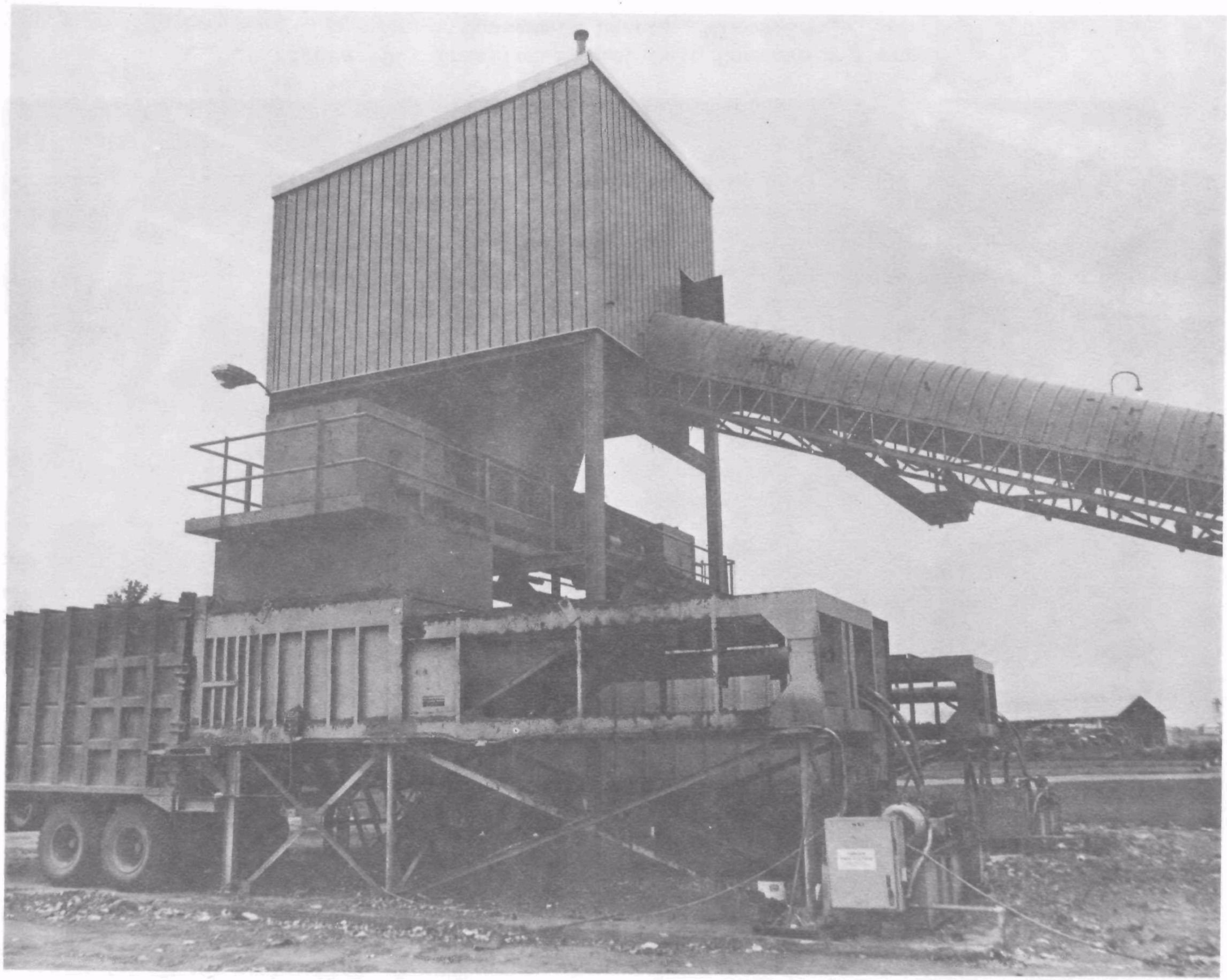


Figure 11. General View - Belt Conveyors 2 and 3, Magnetic Separator Building and Compactors, Outagamie County, Wisconsin

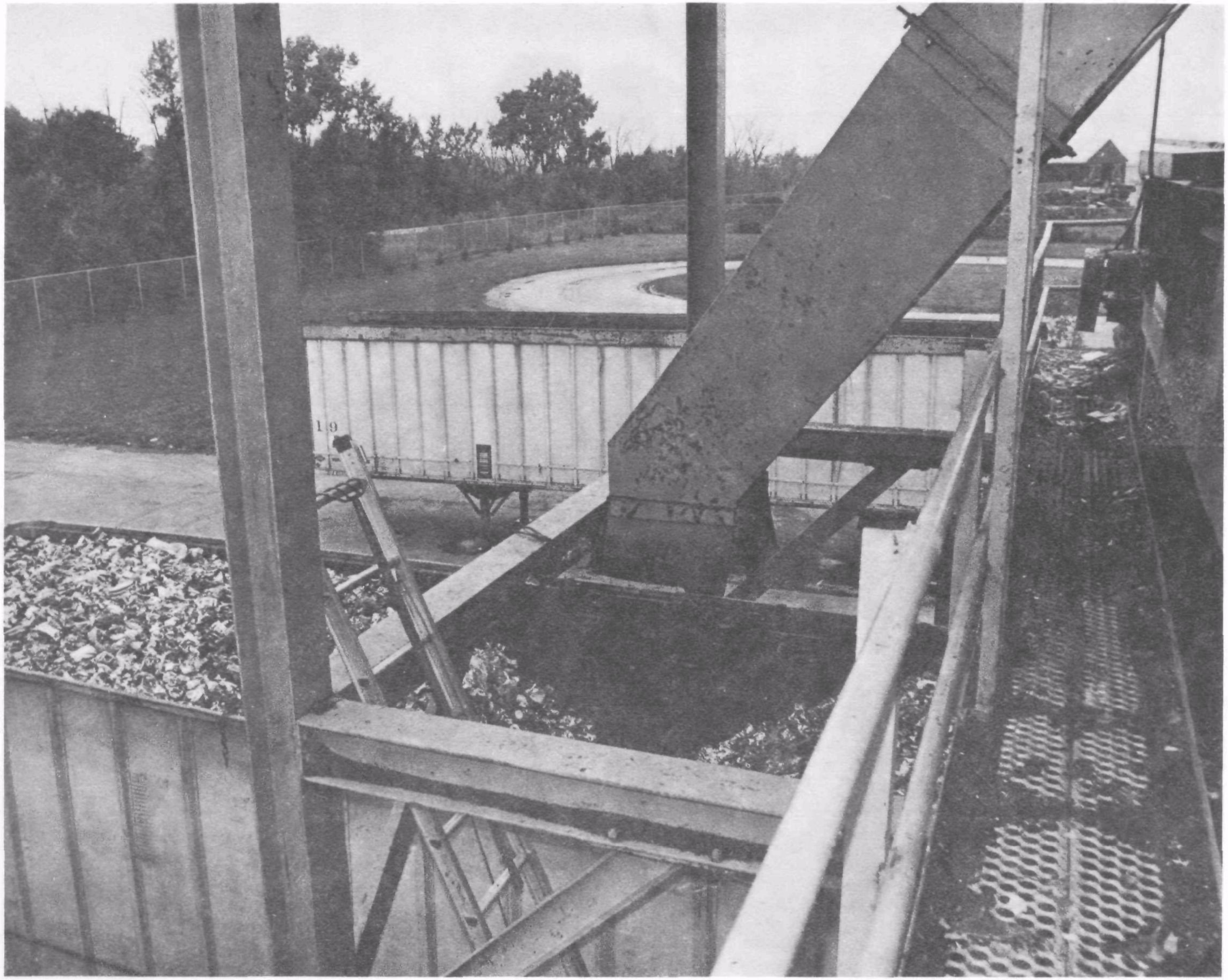


Figure 12. Ferrous Metal Chute and Trailer, Outagamie County, Wisconsin

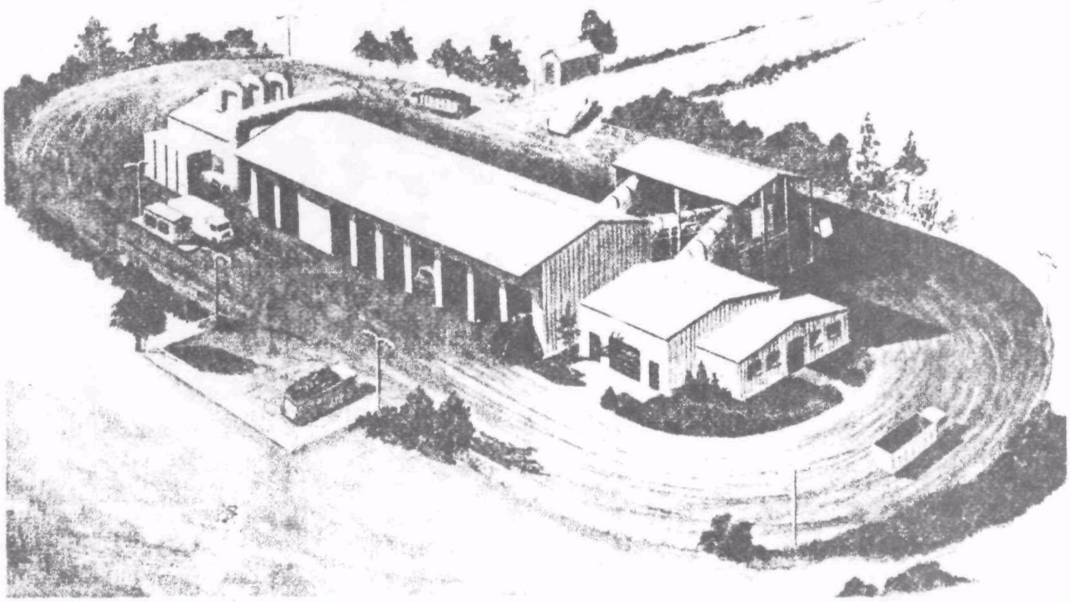


Figure 13. General View - Baltimore County, Cockeysville, Maryland, Solid Waste Processing Plant

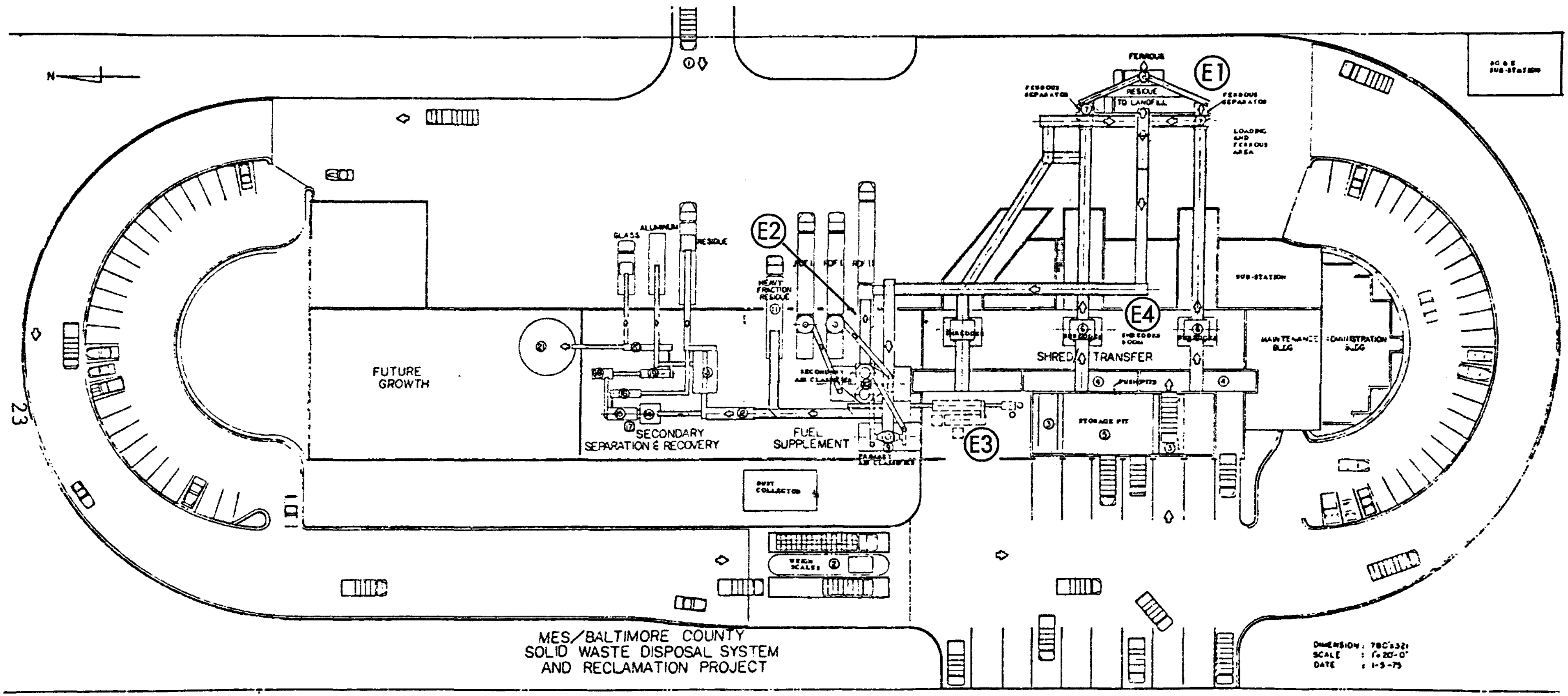


Figure 14. Plot Plan - Baltimore County Solid Waste Processing Plant

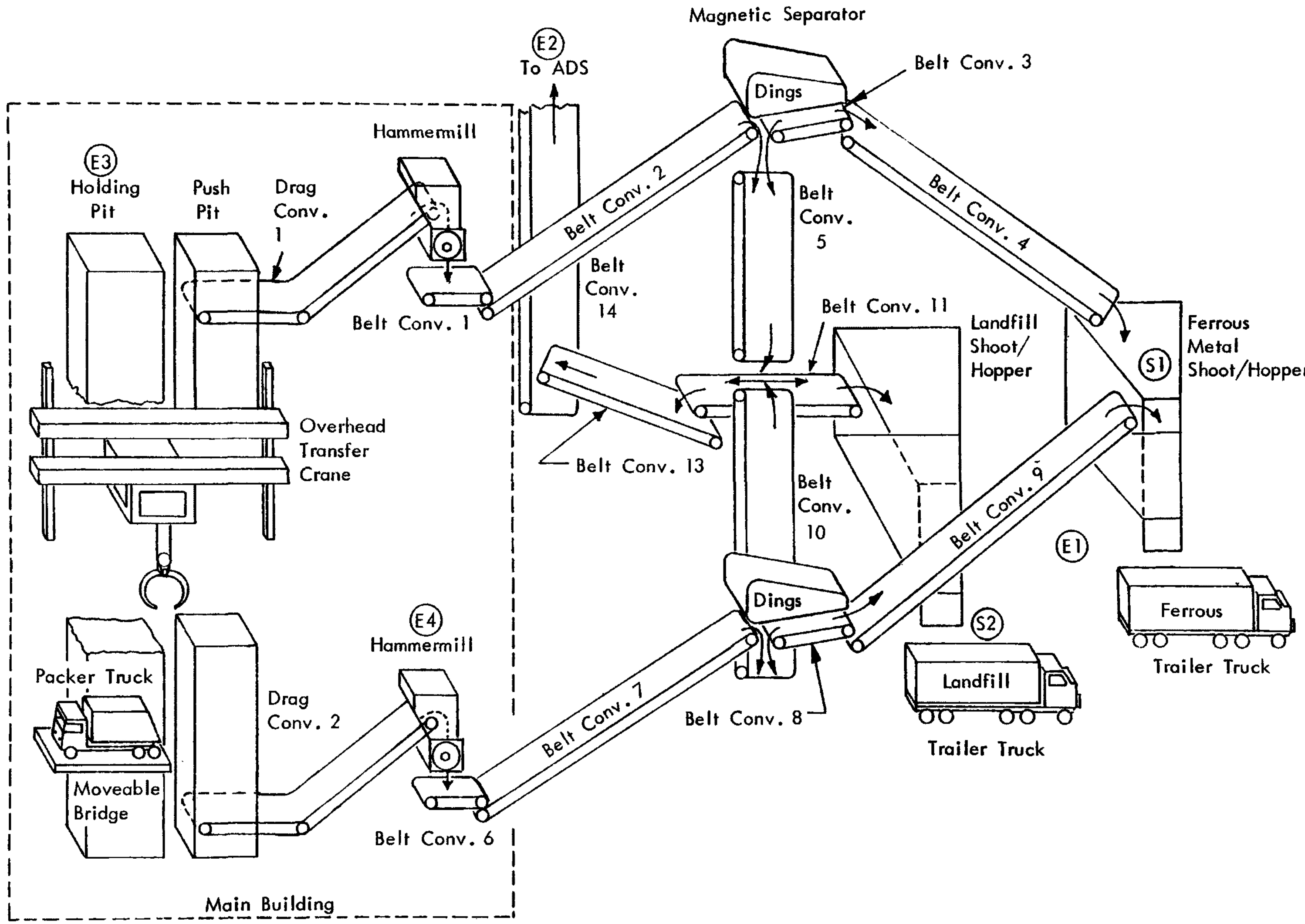
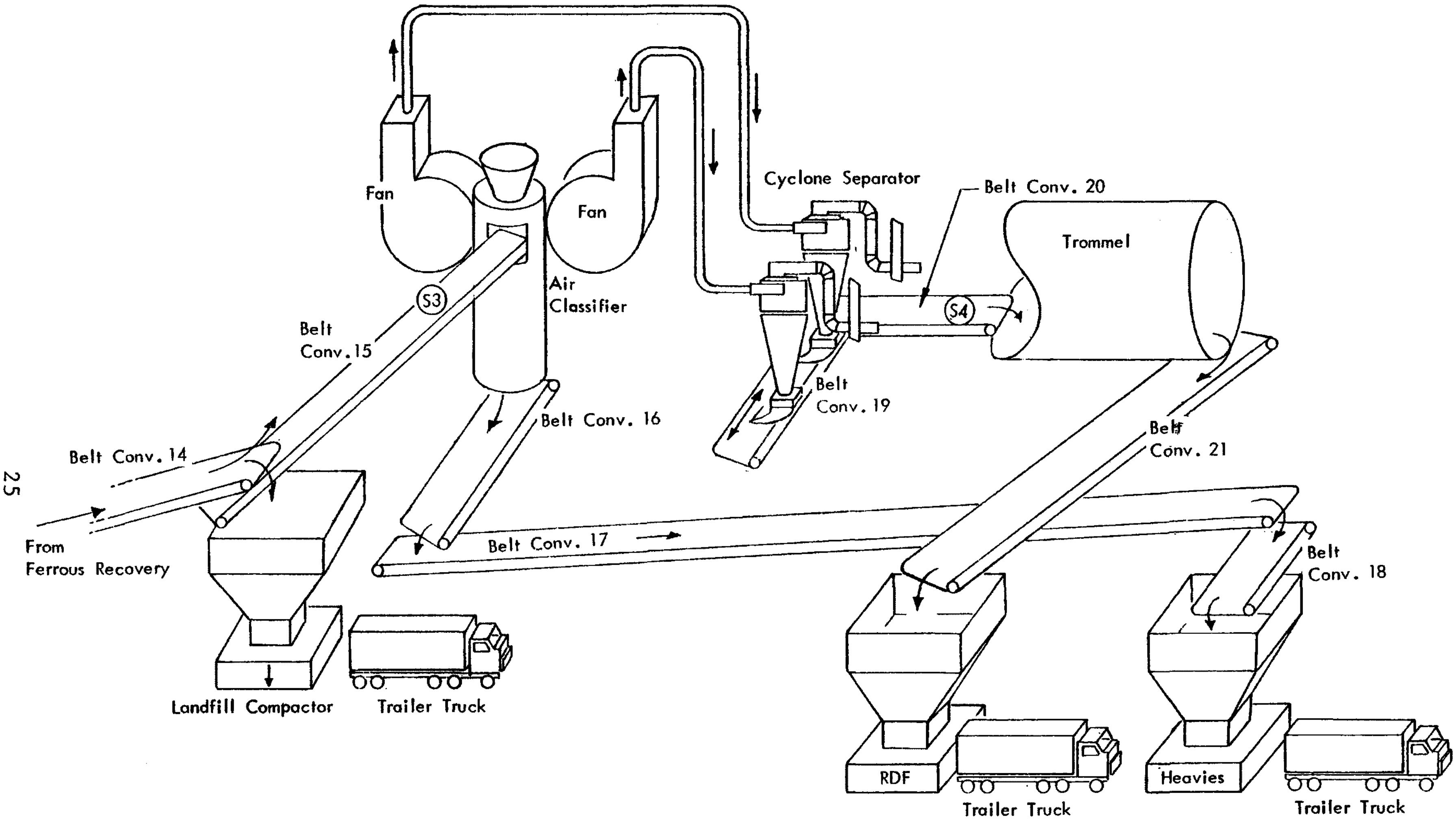


Figure 15. Flow Diagram From Receiving Through Ferrous Recovery - Baltimore County, Maryland


Fan
Fan
Air Classifier
Cyclone Separator
Belt Conv. 20
Trommel
S3
S4
Belt Conv. 15
Belt Conv. 16
Belt Conv. 19
Belt Conv. 14
Belt Conv. 21
From Ferrous Recovery
Belt Conv. 17
Belt Conv. 18
Landfill Compactor
Trailer Truck
RDF
Trailer Truck
Heavies
Trailer Truck

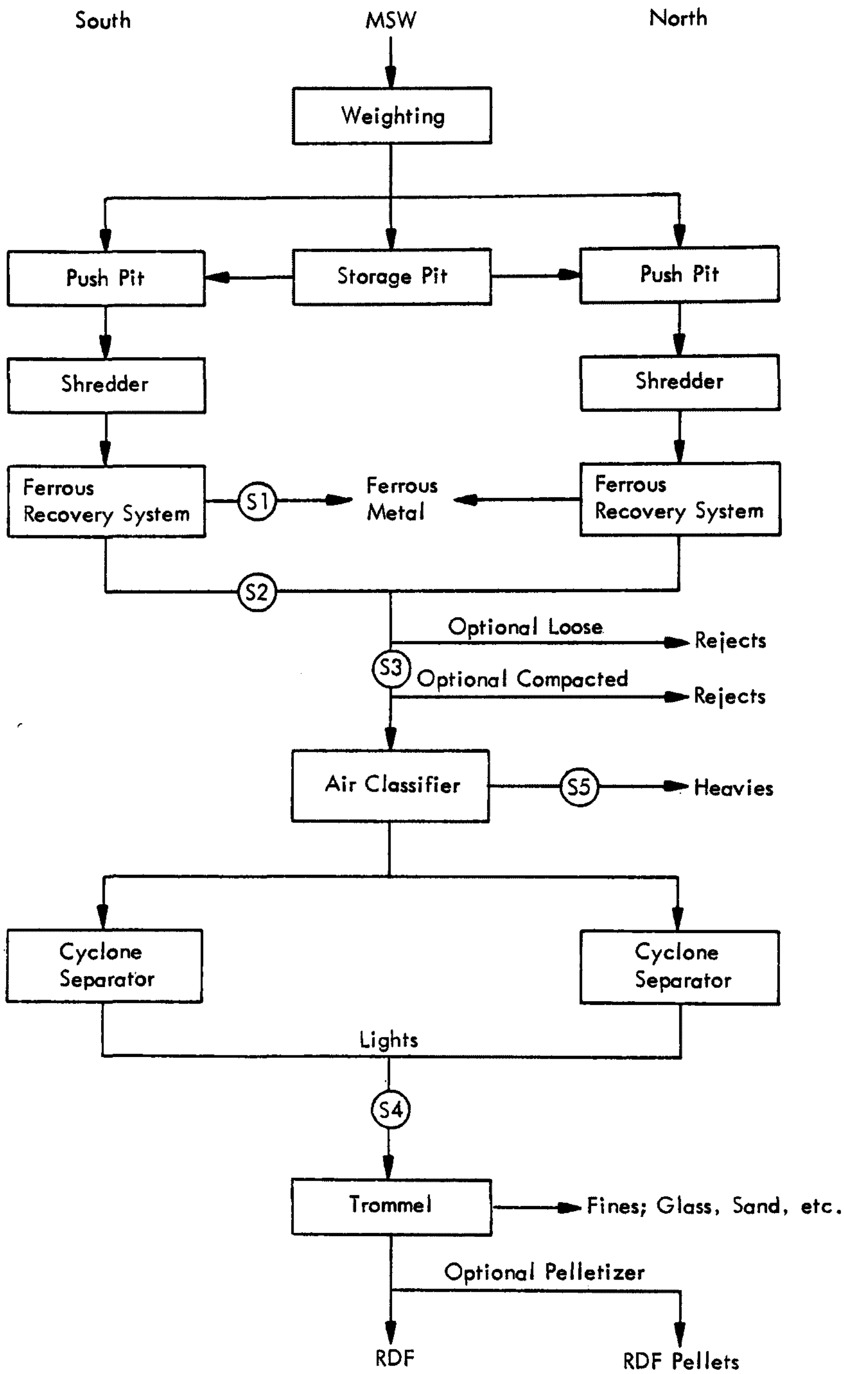


Figure 17. Schematic Flow Diagram - Baltimore County, Maryland

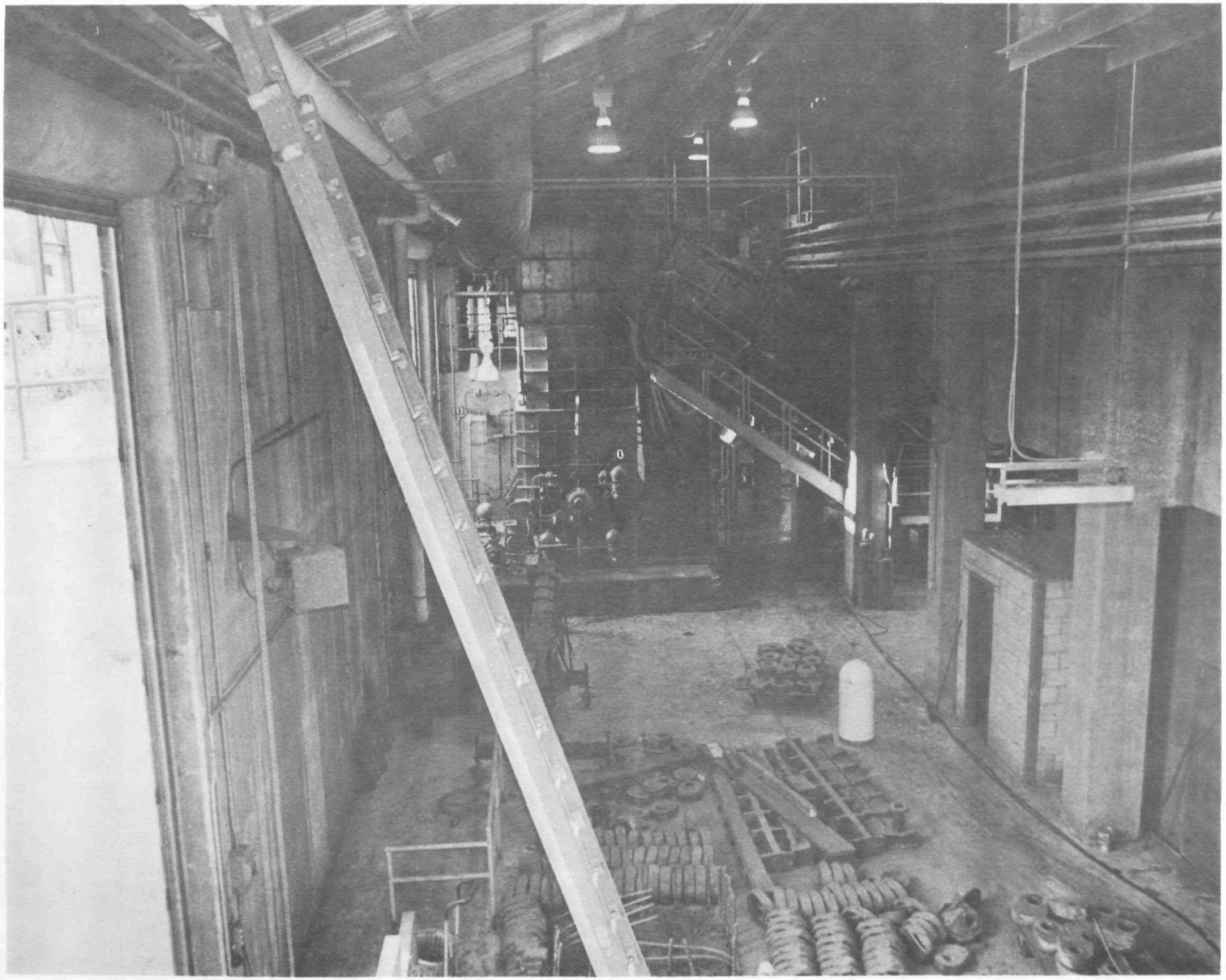


Figure 18. Background: Shredder and Inclined Drag Conveyor to Shredder,
Foreground: Grate Bars and Hammers, Baltimore County, Maryland

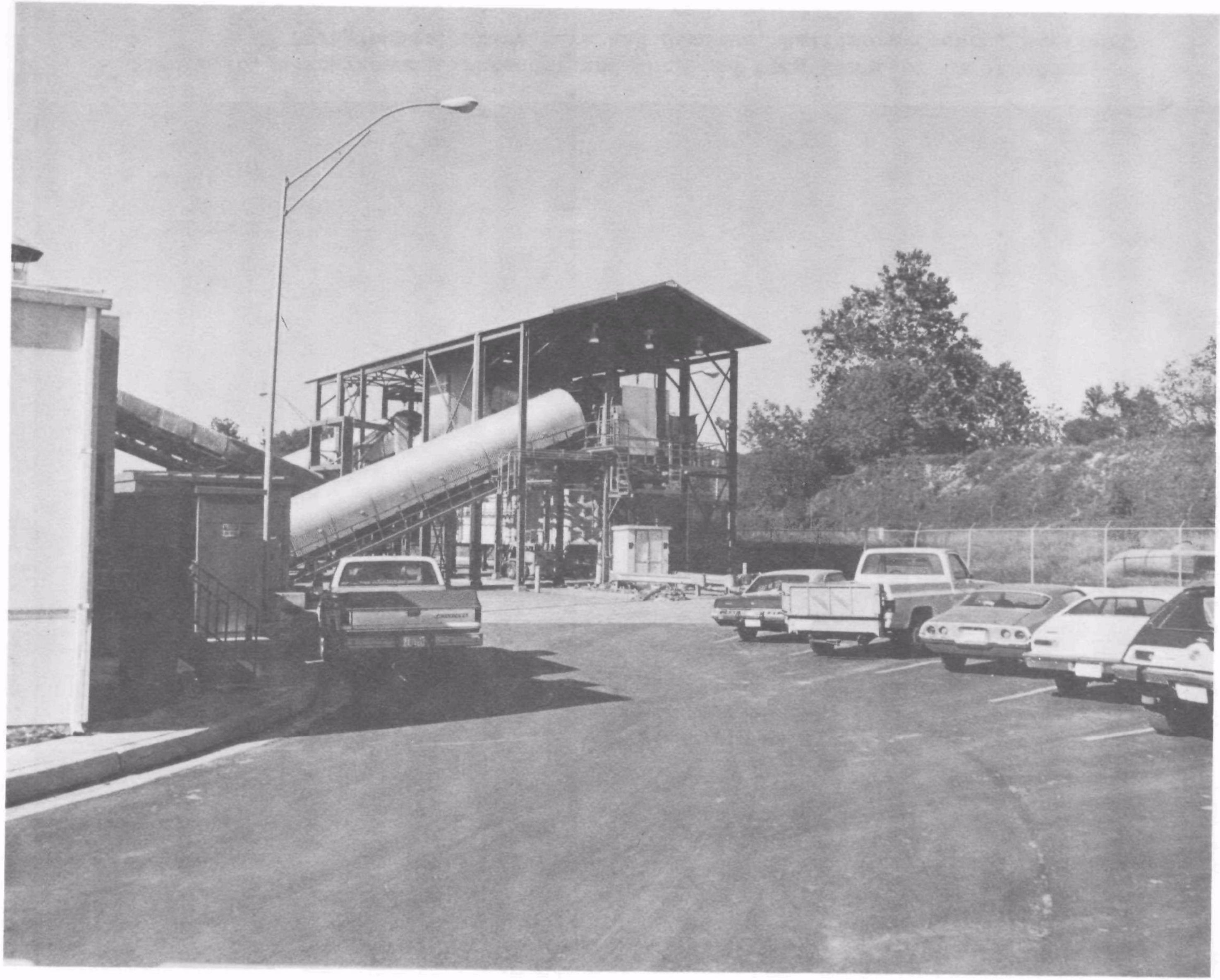


Figure 19. Magnetic Separator System, Baltimore County, Maryland

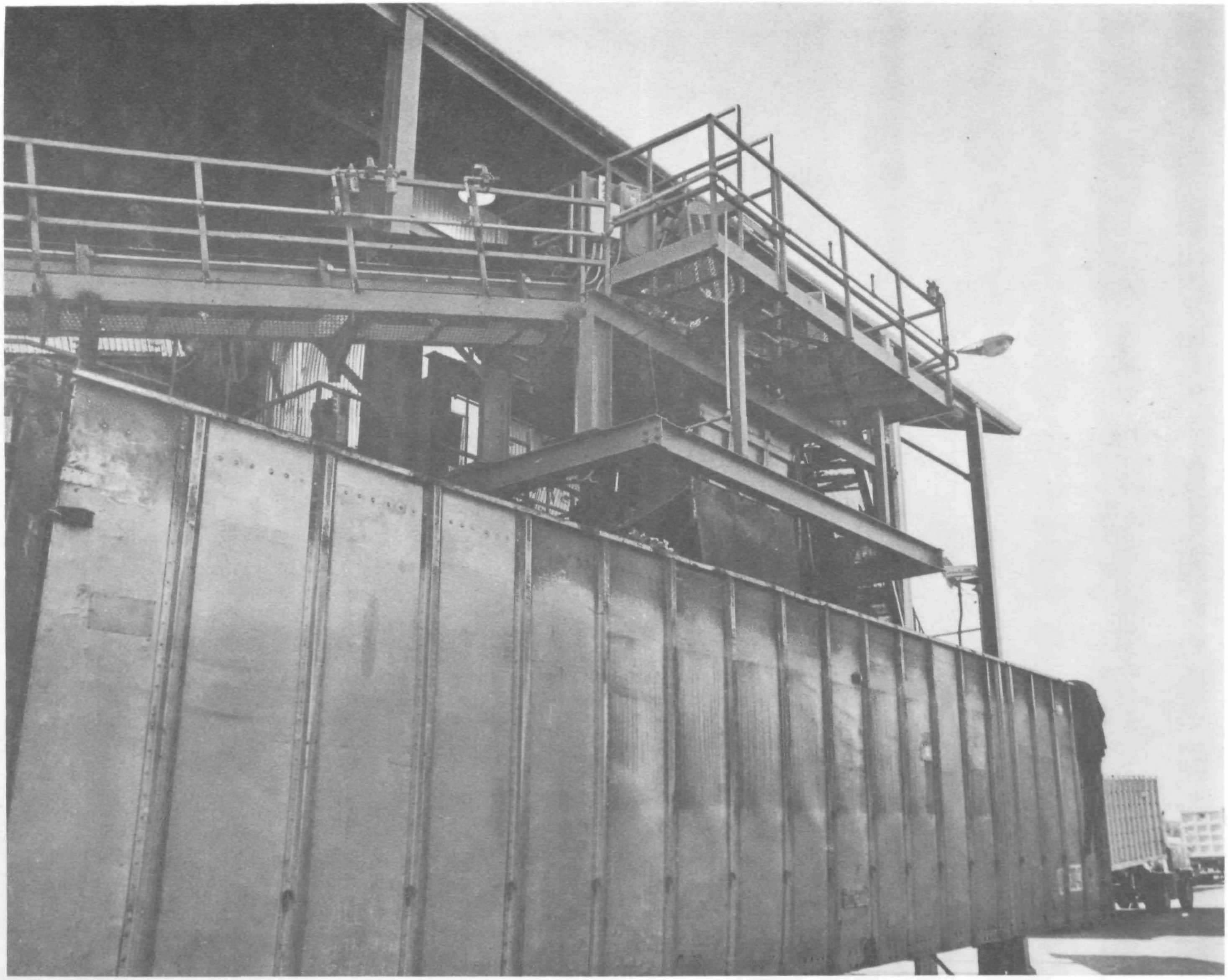


Figure 20. Magnetic Separator System Output, Baltimore County, Maryland

Figure 21. Output Belt, Magnetic Separator, Baltimore County, Maryland

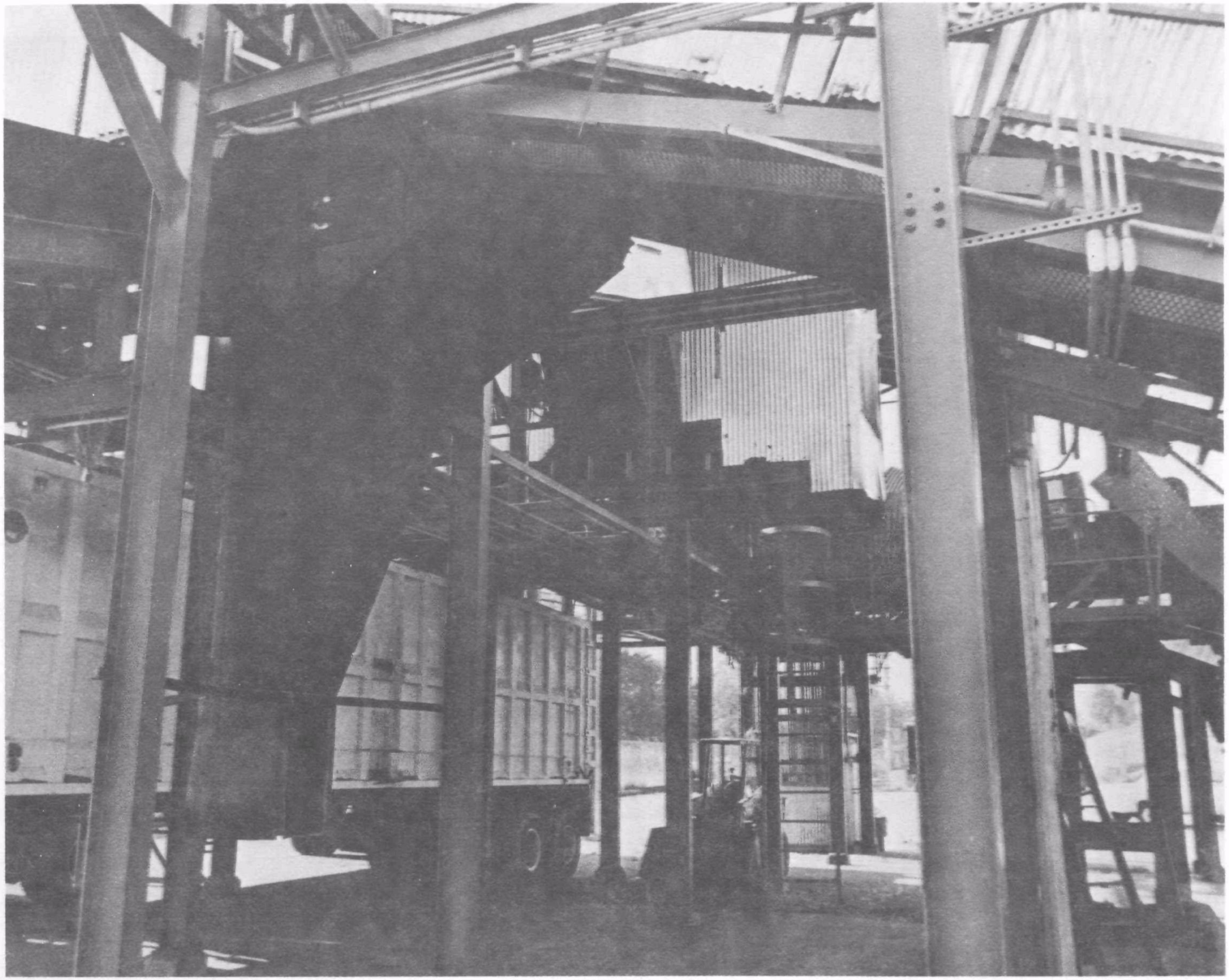


Figure 22. Output Chute for Rejects, Baltimore County, Maryland

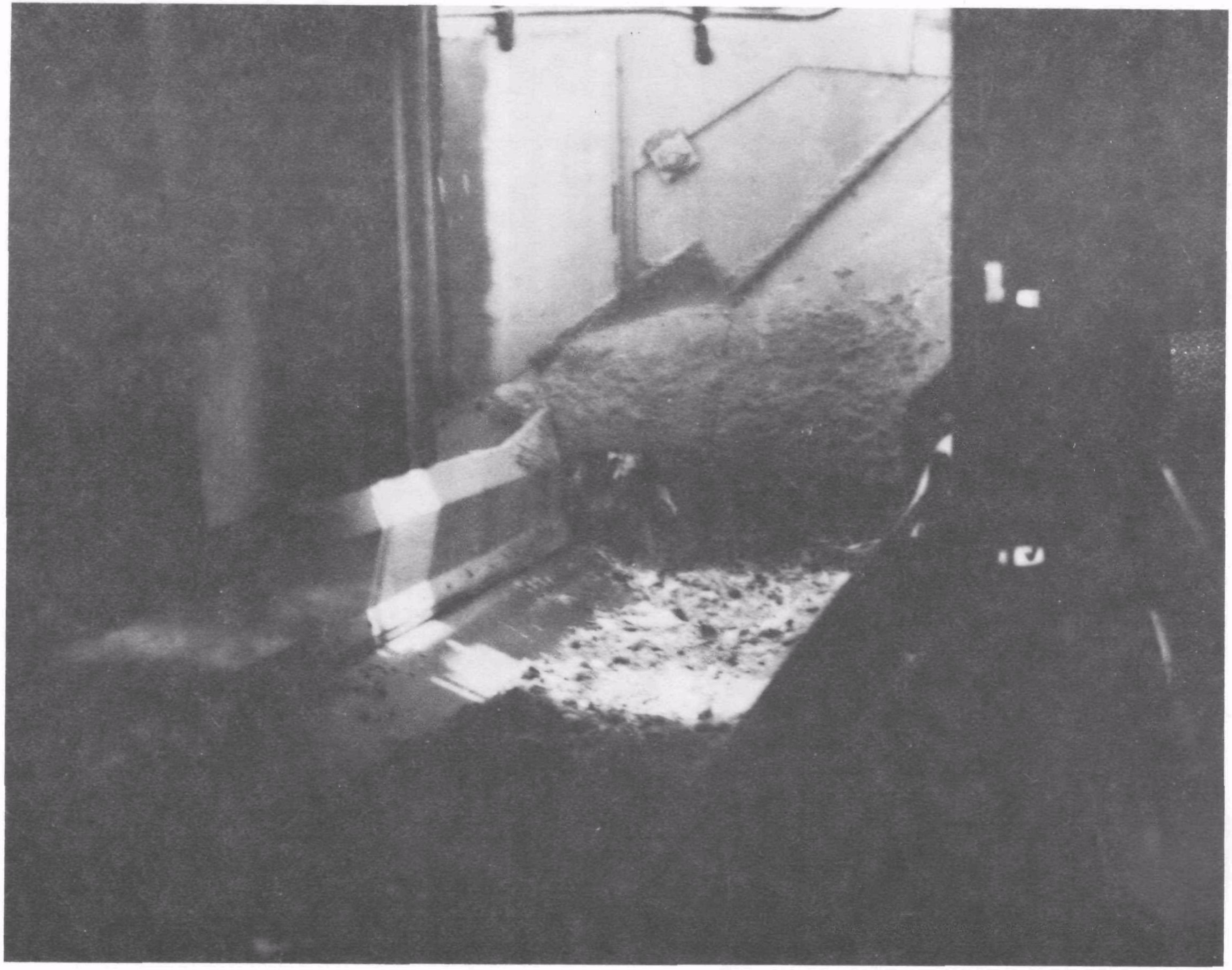


Figure 23. Belt Conveyor 15 and Diverter Housing, Baltimore County, Maryland

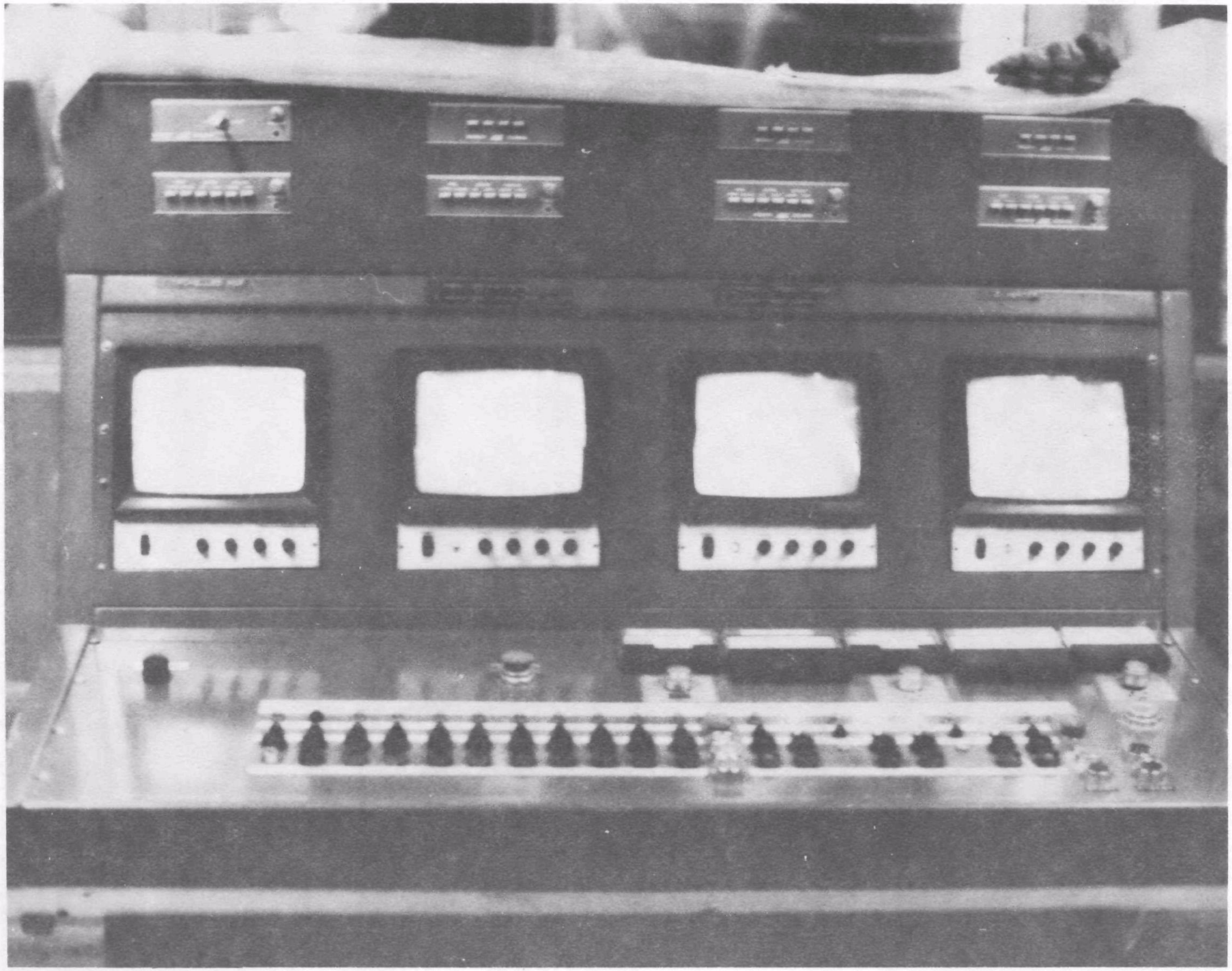


Figure 24. RDF Processing Line Control Panel, Baltimore County, Maryland

Figure 25. Cyclones and Airlock for Light Material, Baltimore County, Maryland

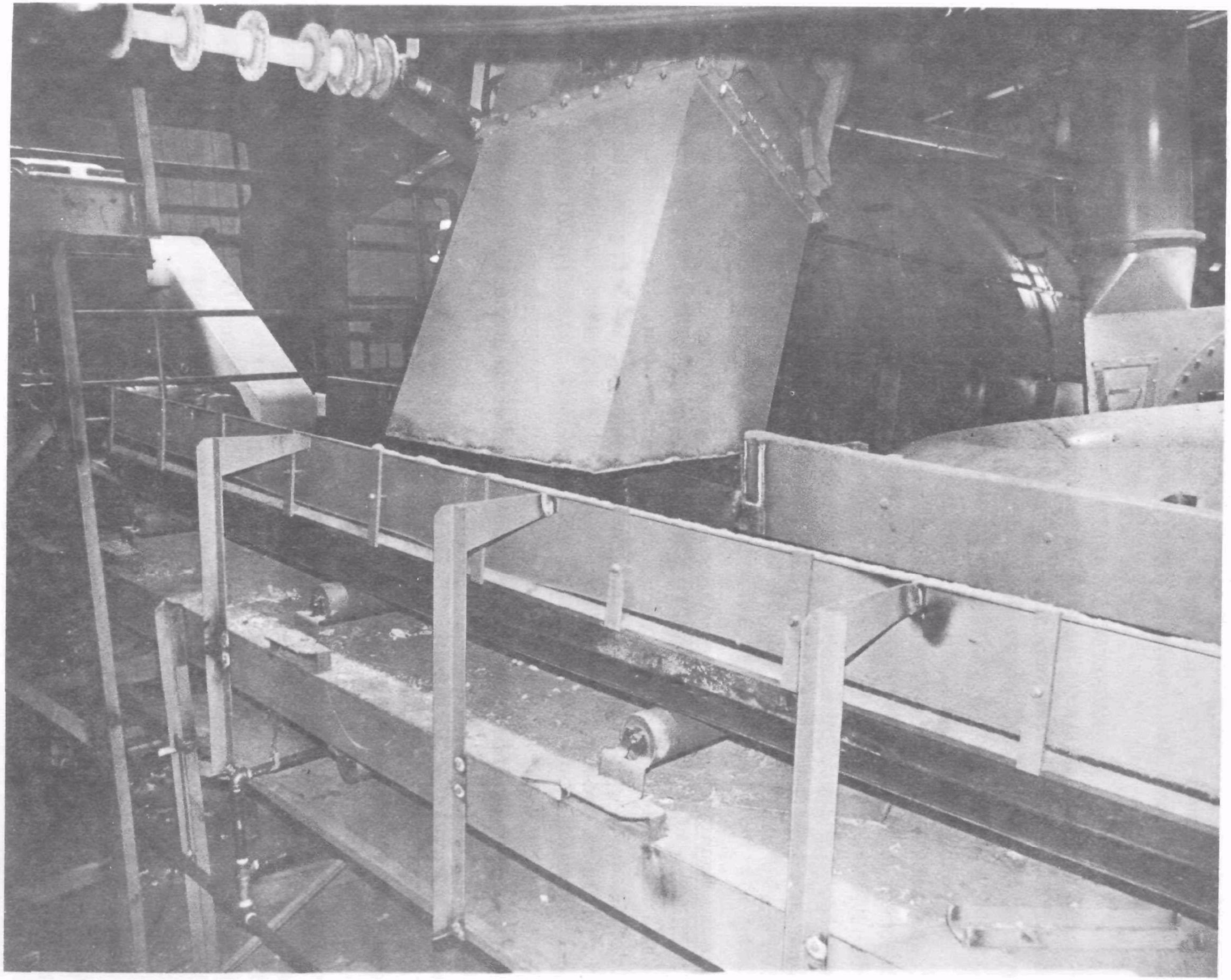


Figure 26. Belt Conveyor 19 - Trommel in Background, Baltimore County, Maryland

SECTION 4

MAGNETIC SEPARATOR SYSTEMS TESTS

SYSTEM DESCRIPTIONS

The Outagamie and Baltimore counties plants both use a belt-style magnetic separator for ferrous recovery which is suspended above the shredded MSW input belt conveyor. Both systems are fed approximately 27 metric tons/hr of shredded MSW with approximately the same input conveyor speed of 70 m/min; therefore, the depth of material on the conveyor is similar. The separator systems are located in elevated structures to allow top-filling of the open-topped scrap trailers.

Outagamie County

The magnetic separator system at Outagamie County (Figure 27) consists of an Eriez Model V separator (Figure 28 suspended at a 21-degree declination over the input conveyor and hopper, which is split into two chutes.

The Eriez Model V separator utilizes a box electromagnet for extraction and an electromagnetic head pulley for transferring the recovered ferrous material to the proper chute. The cleated belt, used to carry the recovered material, travels at 95 m/min. This belt is 91 cm wide with 8.9 cm tall cleats at 29.2 cm spacing. Urethane strips are used between the cleats (Figure 29) to help reduce belt wear.

The steel plate hopper of Allis Chalmers design has two output chutes and an adjustable splitter blade. The splitter blade allows fine tuning of the system. The output chute for the nonferrous material becomes part of the housing for the reversible conveyor to the compactors (Figure 11). The ferrous metal chute opens to the atmosphere and empties into an open-topped trailer.

The splitter blade pivots at the junction of the two chutes and is adjustable from 24.5 to 49.5 degrees from the vertical. The original 50.8 cm steel blade was not far enough into the magnet field to be magnetized, but the 22.9 cm bolt-on extension was and had to be made from nonmagnetic stainless steel. Figure 30 shows the extended splitter blade in the 49.5 degree position with typical nonferrous material collecting on it.

Baltimore County

The magnetic separator system at Baltimore County (Figures 31 and 32) is part of the Tracor Marksman front-end package which has been modified by Teledyne National. The magnetic separator is a Dings Model "Solid Waste Magnetic System" suspended horizontally above the input and return conveyors. The ferrous metal is carried past the return conveyor and dropped onto belt conveyor 9.

The Dings Model "Solid Waste Magnetic System" (called "Hockey Stick" in the trade) (Figure 33) contains three box electromagnets. Magnet 3 is movable to allow adjustment of the air gap between it and magnet 2. The principle of the air gap is to allow the ferrous metal picked up by magnet 1 and transferred to magnet 2 to momentarily fall away from the belt. When the ferrous metal falls away, any nonferrous material held between the ferrous metal and the belt should also fall away and only the ferrous metal will be picked up and carried along by magnet 3. Figure 34 shows the Dings belt moving toward the viewer and return belt conveyor 8 moving away. Teledyne National installed the return conveyor to carry the nonferrous material back to the rejects stream. The bottom of the front half of the separator is inclined to allow a more effective approach to the shredded MSW falling over the head pulley of input conveyor 7.

TEST PROCEDURES

The tests were conducted to gain data necessary to compare the two systems. A magnetic separator system is set up to extract the ferrous metal for a particular market. Since an optimum set-up at one site may not be optimum for the other, it was necessary to change the critical system variables in a step-like fashion to find their effect on the recovered ferrous metal stream.

This contract did not allow for equipment modifications; therefore, the changes in the variables had to be within the present adjustment range of the system. At Outagamie County, the minimum height of the separator above the input conveyor was limited by the depth of material on the conveyor, allowing for surges. At Baltimore County, the same variable was controlled by the adjustment available.

The two output streams were sampled where the material was in free fall. The samples were analyzed for the weight percent of ferrous metal versus nonattached (extractable, pickable) nonferrous material. Each sample was handsorted with a magnet to remove all magnetic material and anything attached to it. The magnetic and non-magnetic parts of each sample were weighed (Tables A-3 and A-4 in Appendix A). The heavy segments were weighed with a Chatillion Model 7200 hanging scale which has a range of 68 kg graduated in 0.11 kg increments. The lighter segments were weighed on an Ohaus Model 700 beam balance with a capacity of 2,610 g and a sensitivity of 0.1 g.

The energy used to operate the magnetic separator system was measured. An operating magnetic separator system is a steady state device; therefore, the energy could be calculated from instantaneous reading of current, voltage, and the power factor.

Outagamie County

The Outagamie County system has three variables which were thought to control the amount and cleanliness of the ferrous metal recovered. These three variables, shown in Figure 35, are: the height of the separator above the input conveyor (A), the splitter blade length (B), and splitter blade angle (θ).

The systematic changes made in these variables are shown in Table 1.

TABLE 1. SYSTEM CONFIGURATION FOR TEST DAY

	System configuration		
Test day	A (cm)	B (cm)	θ(degrees)
1	33	50.8	49.5
2	35.6	50.8	49.5
3	48.3	50.8	49.5
4	33	50.8	24.5
5	33	73.7	24.5
6	33	73.7	37.0
7	33	73.7	49.5

On each test day, four 11-liter samples were taken from a free-falling part of the two output streams. The ferrous stream was sampled at location S2 (Figure 3) where the material fell into the open trailer. The nonferrous (landfill) stream was sampled at location S1 (Figure 3) where the material fell from belt conveyor 3 into the landfill trucks. These samples could not be taken simultaneously; therefore, the four component weights did not add to the input. The sample analysis provided weight percents of ferrous and non-ferrous in both streams. The weights of both components of each stream for that test day were determined by multiplying these percentages by the total stream weight for that day. The total stream weight was the total of trucks weighted from that stream.

As part of the facility's normal operation, all incoming trucks and landfill trucks are weighed. During the test period, the truck used to collect the ferrous metal was weighed each morning. The oversized bulky material that was picked out by hand before shredding was put into two trailers, one for metal and the other for nonmetal items. These two trailers were weighed at the beginning and end of the test period. The basic truck weights are given in Table A-5 of Appendix A. The daily weights of the trailers for the bulky items were arrived at by dividing the total weight by the number of test days for an average, these averages were then weighed based on the total input for that day.

Baltimore County

The Baltimore County system allowed for simultaneous sampling of the ferrous and nonferrous streams; therefore, the results of the sampling method added to the input. At each test setting, four 5-sec simultaneous samples were taken.

The variables tested, shown in Figure 36, were the height of the magnetic separator above the input conveyor 7 (A) and the width of the air gap between the second and third magnets (B). The changes made in the variables are shown in Table 2.

TABLE 2. SYSTEM CONFIGURATION FOR TEST DAY

Test day	System configuration A (cm)	System configuration B (cm)
1	51	18
2	56	18
3	64	18
4	46	18
5	46	36 (max)
6	46	6 (min)

The magnetic stream was sampled at location S1 (Figure 15) where the output conveyors from the two lines meet at the chute to the ferrous scrap trailer. A special container was built to fit between the two conveyors. The nonmagnetic stream was sampled at S2 (Figure 15) at the output of the chute to the landfill trailer. A special container was built to fit over the bottom of this chute and catch all the material for 5 sec. Line 2 was shut down during the sampling.

Two indicators were used to ensure that the two samples were taken simultaneously. A 45 x 45 cm piece of cardboard and a metal can were painted red. The metal can was placed on the cardboard; then these were placed on the burden on the input conveyor midway between the shredder and the magnetic separator. When the red cardboard went over the head pulley of conveyor 10, conveyor 11 was reversed, which fed the nonmagnetic material down the chute into the special container. The red can was obvious in the ferrous stream, and when it went over the head pulley of conveyor 9, all the stream material was collected for 5 sec.

RESULTS

Summary

The Outagamie County and Baltimore County systems have many characteristics in common relative to magnetic separation, as shown in Table 3. The main differences in the two systems are the quantity of ferrous in the input stream (5.16 vs. 10.8%) and the impurities (amount of pickable tramp) in the recovered ferrous (1.8 vs. 0.2%).

TABLE 3. SYSTEM COMPARISON

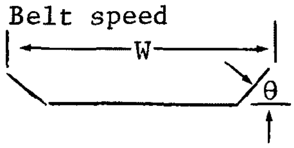
Item	Outagamie County	Baltimore County	Notes
Input rate	26 tons/hr	28 tons/hr	Results in ≈ the same burden depth
Belt speed	65.5 m/min	79 m/min	
	110 cm	117 cm	
	30°	30°	
Ferrous in input	5.16%	10.8%	
Ferrous recovered	81%	79%	Best setting for recovery for their market
Impurities (pickable)	1.8%	0.2%	
Ferrous in rejects	0.9%	2.6%	
Energy	8.3 kw	18.8 kw	
Cost	$30,000	$30,000	Approximate only
Belt speed	95 m/min	117 m/min	Magnetic separator
Belt width	91 cm	122 cm	

Table 4 gives an overview of the effects of the changes in the test variables on the percent ferrous recovered (recovery efficiency), percent nonferrous in the recovered ferrous (impurities), and the percent ferrous in the reject stream. This information is discussed fully in the following text.

The original evaluation parameters were recovery efficiency, purity, energy, capital cost, and maintenance cost. The data analysis indicated that the percent of incoming material which is magnetic and therefore available for recovery, is also an important parameter.

Quantity of Ferrous Metal in MSW

Two methods were used to determine the quantity of ferrous metal in the shredded MSW conveyed to the separator system at Outagamie County.

The first method was based on 30-liter samples taken from the material on the input conveyor to the magnetic separator system. These samples were hand-sorted with a magnet. The data are given in Table A-6 of Appendix A. For the five test days when multiple samples were taken, the average weight percent of magnetic material was 2.55% with an individual sample range from 0 to 6.50%.

The second method applied the percentages from the output stream samples to the total daily weights of the streams. Table A-7 in Appendix A lists the results. The average for the seven test days was 5.16% magnetic material in the shredded input stream to the magnetic separator system. The range of values was 3.52 to 7.45%.

The data based on the second method approximates the national average of 7.3% ferrous material in MSW. Also, this method includes the weight of the bulky metal items pulled out of the stream before shredding. These results will be used as more representative of the Outagamie County MSW. The discrepancy between these two methods can be explained, in part, by the fact that the second method involved more samples which produced improved results.

With the sampling method used at Baltimore County, the weight percent of magnetic material in the input stream can be derived from the sum of the output samples. Table A-8 in Appendix A contains this information. The average is 11.12% with a range from 3.7 to 22.7%.

Figure 37 is a graph of the percent magnetic material in the input to the magnetic separator versus the percent pickable (extractable) nonmagnetics in the recovered ferrous metal (impurities). This graph indicates that as the percent of available magnetic material increases the purity of the recovered ferrous improves. This can be explained in terms of the density of ferrous metal in the shredded MSW. If it is assumed that the distribution of ferrous metal in the two streams of shredded MSW are similar, then the stream with the

TABLE 4. EFFECTS OF VARIABLE CHANGES

OUTAGAMIE COUNTY

	Recovery efficiency	Impurities	Ferrous in rejects
Height (cm)	(%)	(%)	(%)
33	81	1.79	0.92
35.6	76	1.50	1.24
38.3	39	1.69	4.73
Short blade angle (degrees)			
24.5	71	1.80	1.50
49.5	81	1.79	0.92
Long blade angle (degrees)			
24.5	80	1.95	0.73
37.0	72	2.40	1.70
49.5	61	2.41	--
Blade length at 24.5° (cm)			
50.8	71	1.80	1.50
73.7	80	1.95	0.73
Blade length at 49.5° (cm)			
50.8	81	1.79	0.92
73.7	61	2.41	1.70

BALTIMORE COUNTY

Height (cm)			
46	78	0.36	2.15
51	73	0.28*	4.38
56	50	0.22	4.80
64	32	0.16	8.98
Air gap (cm)			
36	79	0.42	2.19
18	78	0.36	2.15
6	79	0.18	2.64

* See discussion of purity

higher density will have more recoverable material and less nonferrous per cubic meter in the load on the conveyor. With the higher density in the Baltimore County MSW, reflected by the 10.8% ferrous, the recovered ferrous disturbed less nonferrous while being extracted; therefore, the magnetic separator did not have to deal with as much nonferrous. The smaller quantity of nonferrous disturbed during ferrous extraction results in less nonferrous to be cleaned out of the ferrous during recovery.

Recovery Efficiency

For this study, recovery efficiency of ferrous metal is defined as the amount of ferrous metal extracted from the available ferrous metal in the input stream.

$$R_E = \frac{W_1}{W_1 + W_2} \times 100$$

Where: R_E = Recovery efficiency
W_1 = Weight of ferrous metal recovered
W_2 = Weights of ferrous metal in rejects

Table 5 lists data used to arrive at the recovery efficiency at the Outagamie County plant indicating the method of applying the sample percentages to the truck weights.

TABLE 5. RECOVERY EFFICIENCY, OUTAGAMIE COUNTY

	Ferrous			Non-Ferrous			
Test Day	Total Truck Weight (kg)	Sample Weight Percent Magnetic	W_1 (kg)	Total Truck Weight (kg)	Sample Weight Percent Magnetic	W_2 (kg)	Recovery Efficiency (%)
1	7,675	98.26	7,541	196,977	0.91	1,793	81
2	5,625	98.54	5,543	146,972	1.20	1,764	76
3	6,241	98.35	6,138	212,490	4.46	9,477	39
4	6,441	98.22	6,326	174,751	1.48	2,586	71
5	5,842	98.09	5,731	201,948	0.72	1,454	80
6	7,793	97.68	7,612	182,217	1.59	2,897	72
7	5,969	97.58	5,825	192,577	1.93	3,717	61

On test day 1, the total weight of material collected in the ferrous scrap trailer was 7,675 kg. From the samples analyzed it was determined that 98.26% of the material that went into the trailer was ferrous metal; therefore 7,541 kg of ferrous metal was recovered on test day 1. The same procedure resulted in 1,793 kg of ferrous metal being lost to the landfill. The total material going into the shredder on each test day came out of the system either in the ferrous scrap trailer or the landfill trailers; therefore, the total of the two ferrous weights calculated above add to the ferrous in the input stream.

Table 6 lists the recovery efficiency at Baltimore County, which is derived directly from the sample weights.

TABLE 6. RECOVERY EFFICIENCY, BALTIMORE COUNTY

Test day	Ferrous W_1 Sample Weight Magnetics (g)	Non-Ferrous W_2 Sample Weight Non-magnetics (g)	Recovery Efficiency (%)
1	2,147	813	73
2	1,764	1,746	50
3	1,318	2,795	32
4	2,164	694	78
5	2,437	638	79
6	3,157	816	79

At both Outagamie County and Baltimore County the main system variable influencing recovery efficiency is the height of the magnetic separator above the input conveyor. This is shown in Table 4 and graphically in Figure 38. There is a linear correlation between the height of the magnetic separator above the input conveyor and the recovery efficiency. Four heights were used at Baltimore County with the air gap between the magnets constant at the midpoint. Table 4 indicates there is no correlation between the air gap (Figure 31) setting and recovery efficiency. The data from Outagamie County indicate there is a correlation between the position of the long splitter blade and recovery efficiency. This is shown in Figure 39. The recovery efficiency as a function of the short splitter blade position is inconclusive with only two data points. Observing the system in operation turned up two points. First, with the magnetic separation belt moving at 95 m/min, the recovered ferrous metal has a large amount of kinetic energy when it leaves the magnetic field of the head pulley. The recovered material bounces off the back plate of the hopper and sometimes rebounds over the splitter blade. This rebound zone is shown in Figure 40. The rebound explains the high recovery efficiency values for the long blade.

Second, the output chute for the landfill is part of the reversible conveyor housing, and it is relatively airtight; but the output chute to the ferrous trailer is open to the atmosphere. This produces an air flow from the input conveyor 2 area out the ferrous chute, which is aggravated by the fan effect of the cleats on the fast-moving separation belt. The nonferrous material floats out of the landfill chute over the splitter blade into the ferrous chute. The amount being transferred was not measured, but it appears to be considerable.

Observation of the Baltimore County system showed that very little material travels back on return conveyor 8. This indicates the air gap feature is not functioning, which is supported by the recovery and impurity data shown in Table 4, under "Air Gap." One would expect some decrease in the recovery rate as the air gap is widened due to the dropping of low inertia ferrous. The impurity figures seem to be reversed. As the gap is increased one would expect an improved cleaning effect. It was observed that the material falling away from magnet 2 traveled down to the return conveyor, then back up to magnet 3 at all air gap settings. The small amount of nonferrous seen at the air gap at Baltimore County accounts for this reversed purity data. Figure 39 indicates there may be a critical low limit to the percent ferrous in the input stream. Baltimore County was operating above this limit; therefore, the test conditions were not right for evaluating the air gap function.

Both systems lose about 20% of the available ferrous metal; at Outagamie County this is approximately 1,700 kg/day, but at Baltimore County it is 4,400 kg/day. The difference is due to the amount of available ferrous at the two sites in terms of actual weight rather than percents.

Purity

The following discussion of purity is concerned with the amount of extractable nonmagnetic material in the recovered ferrous metal. In addition to the extractable nonmagnetic material, there is approximately 5%* nonmagnetics attached to the ferrous metal. This consists of glued-on labels, material crimped into the ferrous metal during shredding, organics in the cans, coating, etc. A magnetic separator system is designed to remove the pickable (loose) material only; therefore, the analysis of the samples for magnetic material content was done with a hand magnet that left any attached material attached.

The effect of the test variable changes on impurity is shown in Table 4. The 0.28% figure in brackets in the Baltimore County data was derived from Figure 41, which is a plot of height versus impurity. Three of the four data points fall along a straight line; therefore, it was assumed that the 0.63% figure was in error.

* Outagamie County, Wisconsin, facility study.

At Baltimore County there was a linear relationship between both height (Figure 41) and air gap setting and purity. It can be concluded that as the height of the magnetic separator above the conveyor is reduced, the recovery efficiency increases, and the amount of nonmagnetic material (impurities) in the ferrous stream also increases. As the air gap is increased, the purity decreases while the recovery efficiency stays constant. Background data are given in Table A-9 and A-10 of Appendix A.

As the data indicates, at Outagamie County there is no plottable relationship between the test variables and the purity.

Energy

The energy to operate a magnetic separator system is considered as part of the equipment evaluation. The rising cost of energy has a direct influence on the economics of the system. Table 7 lists the energy data from the two sites.

TABLE 7. ENERGY REQUIREMENTS

Consumer	E (Volts)	I (Amps)	Power Factor	Power (kw)
		OUTAGAMIE COUNTY		
Magnets / Belt Drive	480	10	1	8.3
		BALTIMORE COUNTY		
Conveyors	480	2.75	0.55	1.2
Magnets	480	17.50	0.99	14.3
Belt Drive	480	5.20	0.55	2.3
			TOTAL	18.8

The system at Outagamie County has a single circuit for both magnets and drive motor and draws 8.30 kw of power compared to Baltimore County which has three circuits and a system requirement of 18.8 kw. Both systems were fed the same amount of incoming shredded material with the same recovery rate (Table 3); therefore, the Baltimore County system uses about twice as much energy to do the same job at the Outagamie system.

Costs

The cost of either the Eriez magnetic separator at Outagamie County or the Dings unit at Baltimore County is approximately $30,000. The complete system cost could only be estimated because the actual cost is part of the total facility cost.

Both systems require minimum maintenance, amounting to lubrication and belt adjustment. Neither facility kept records on the maintenance labor or materials by specific unit operation.

DISCUSSION

The constraints of this contract did not allow testing the magnetic separators to their limits or independent of their system. A test program is needed which is designed to determine the effect of burden depth and system design characteristics such as the air flow problem at Outagamie County.

Another question to be answered by field testing is, is the magnetic field strong enough at the bottom of the burden to remove the ferrous which is located close to the belt, or is the material being recovered coming from the upper portion of the burden?

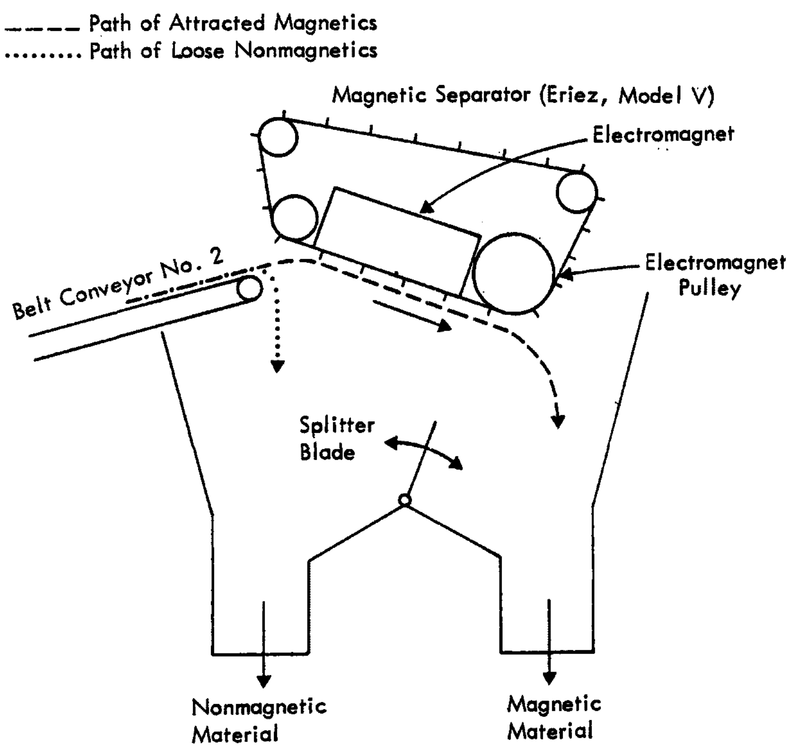


Figure 27. Magnetic Separator System, Outagamie County, Wisconsin

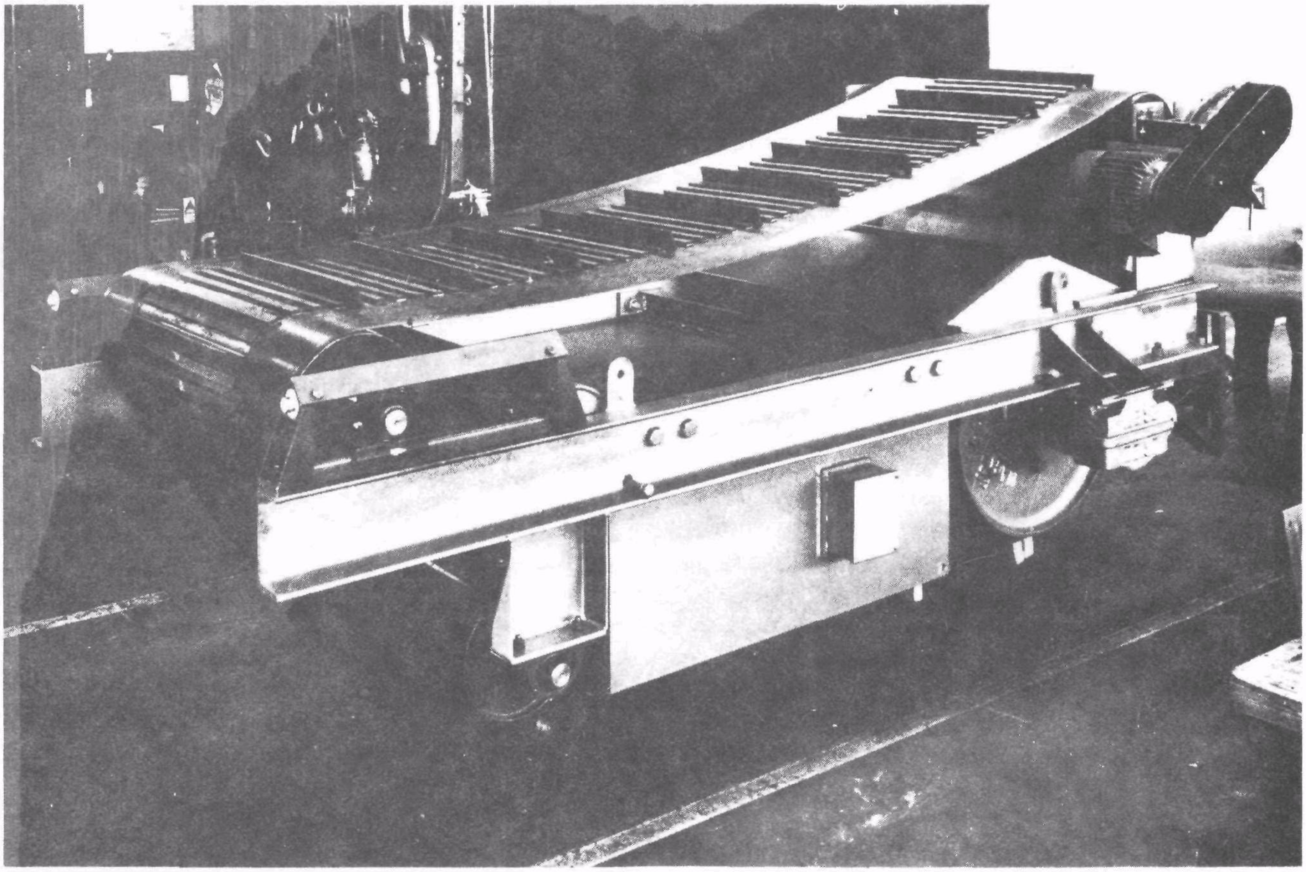


Figure 28. Eriez Magnetic Separator, Model V,
Outagamie County, Wisconsin

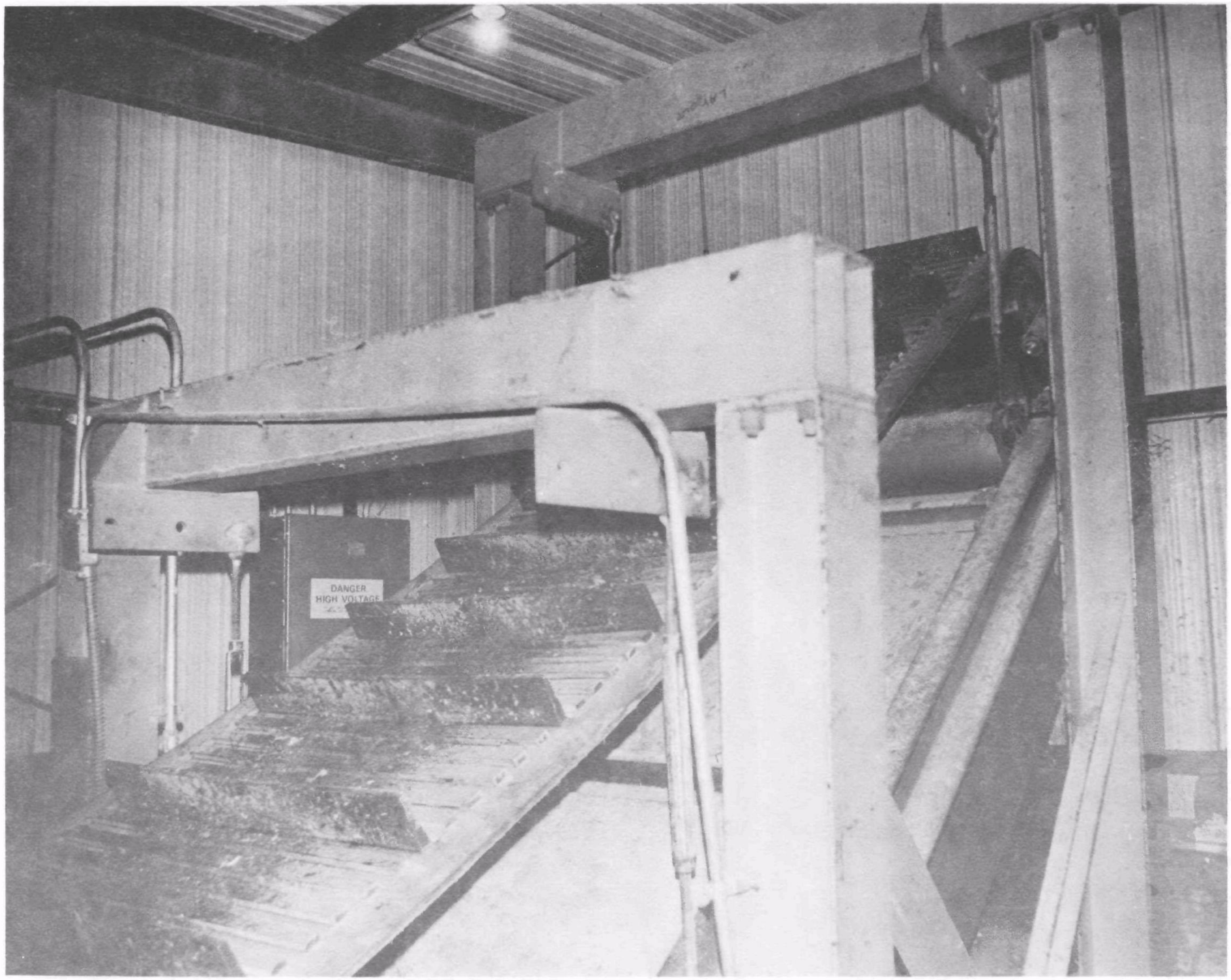


Figure 29. Cleated Belt - Magnetic Separator, Outagamie County, Wisconsin

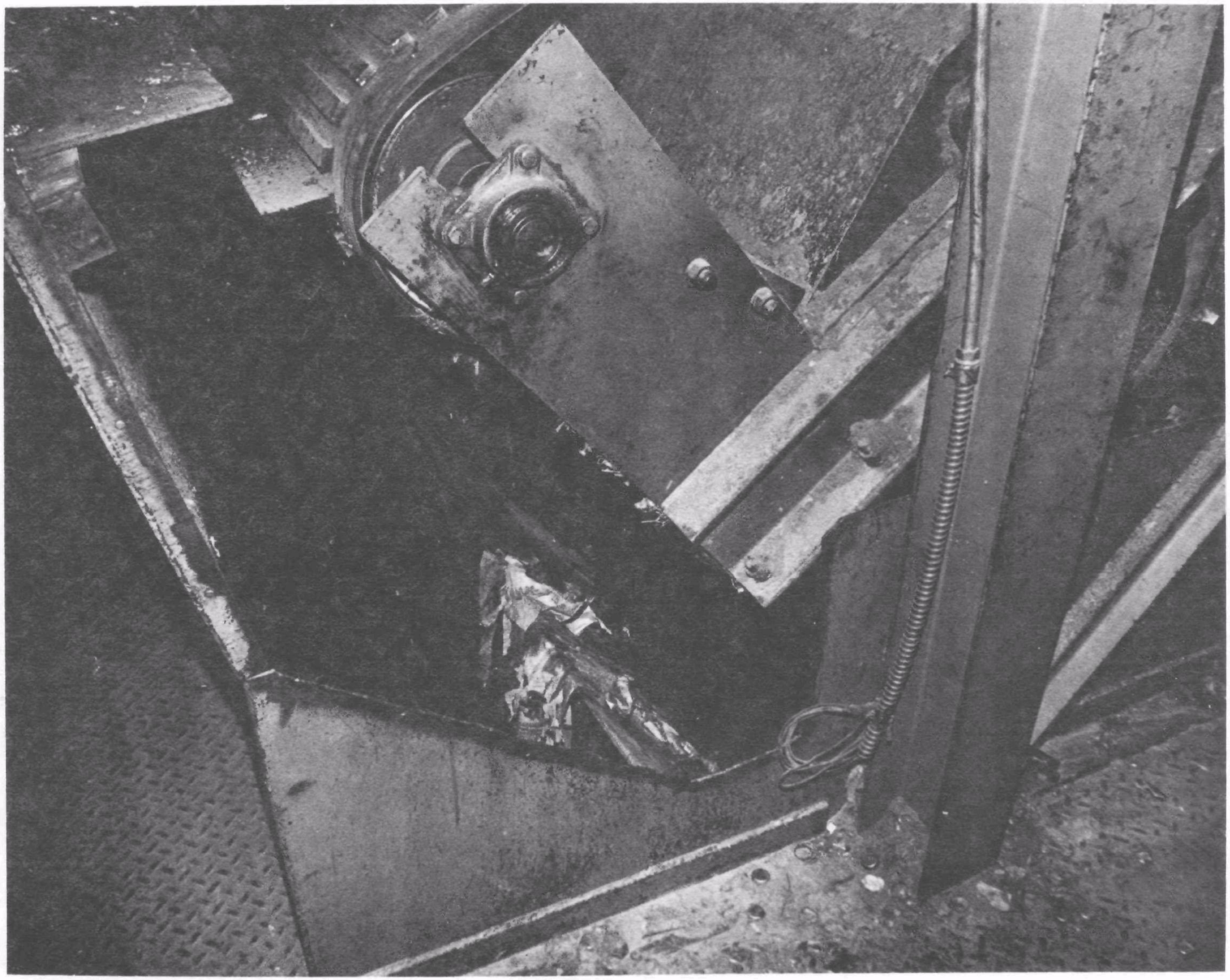


Figure 30. Hopper, Magnetic Separator System - Showing End Pulley and Splitter Blade, Outagamie County, Wisconsin

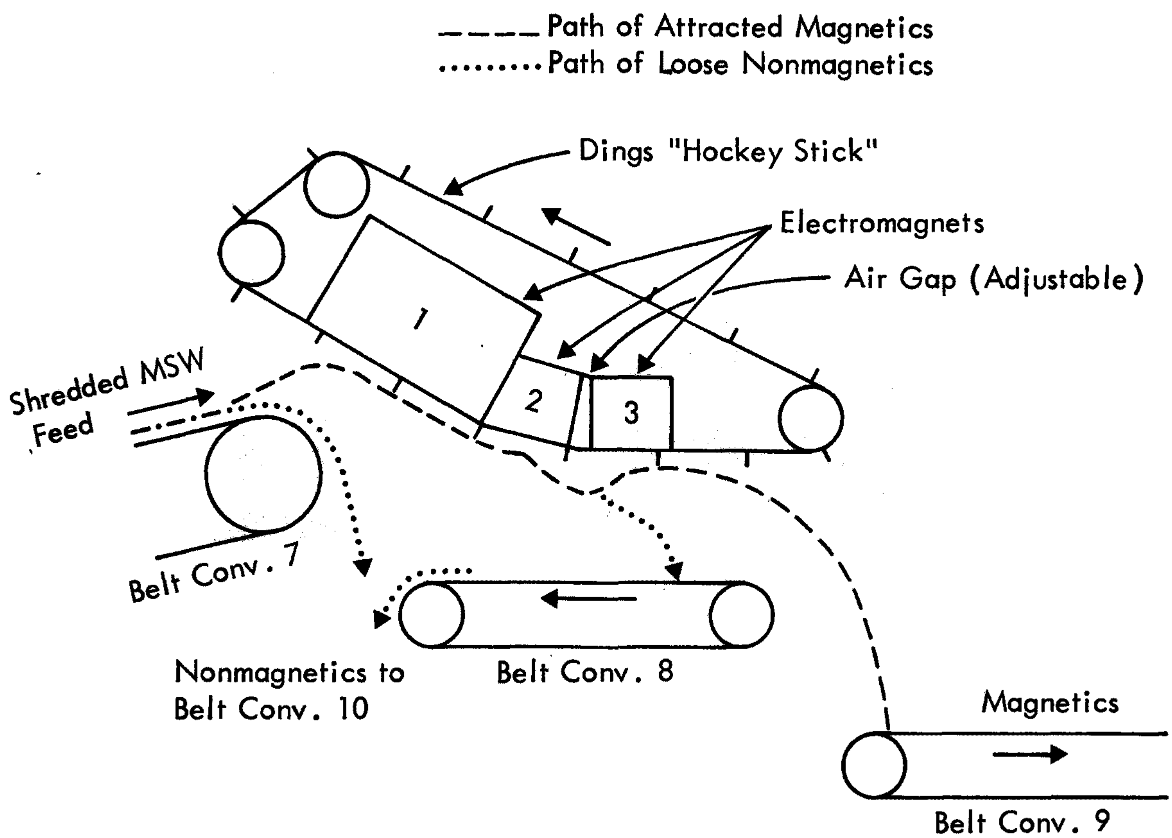


Figure 31. Magnetic Separator System,
Baltimore County, Maryland

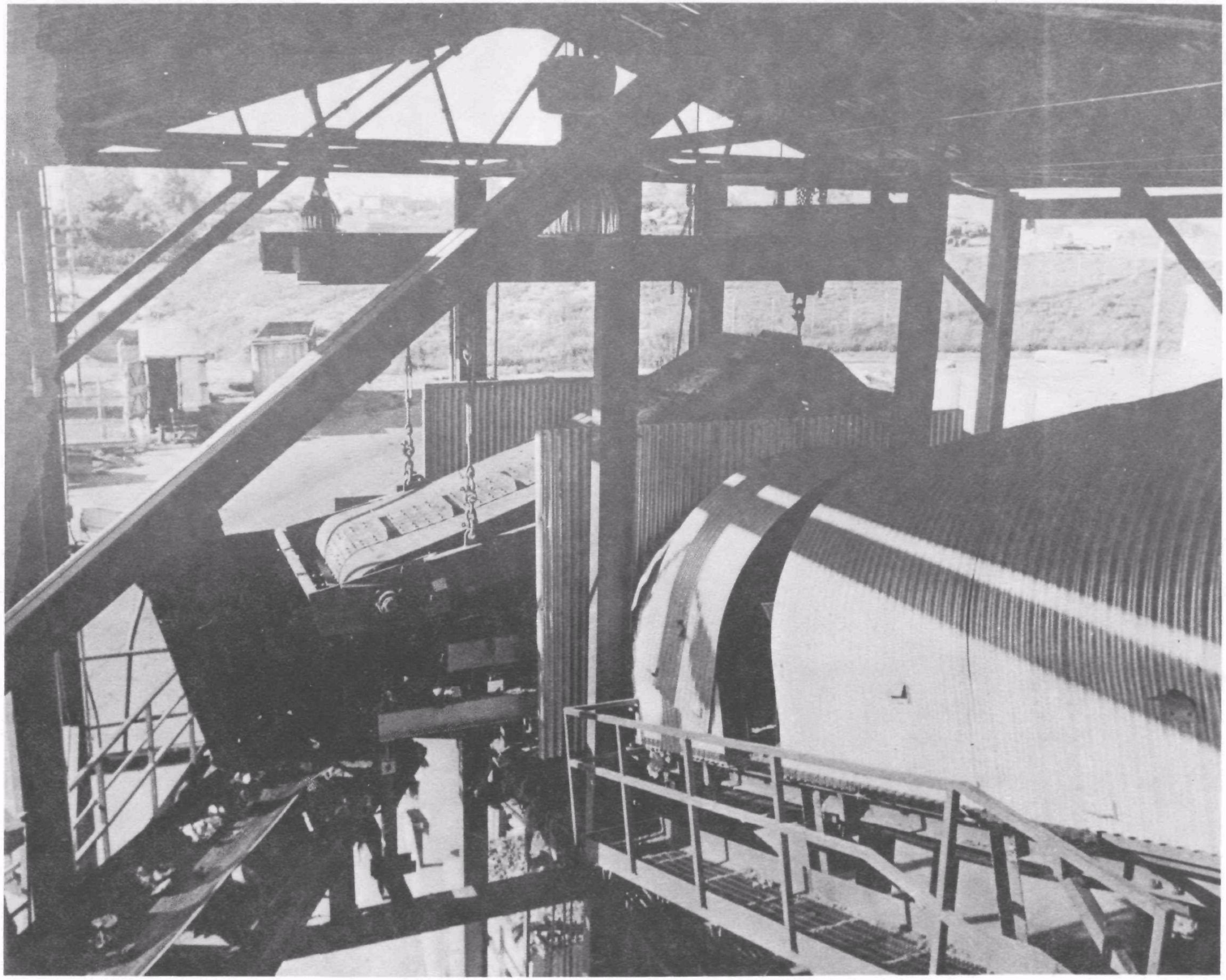


Figure 32. Magnetic Separator System, Baltimore County, Maryland

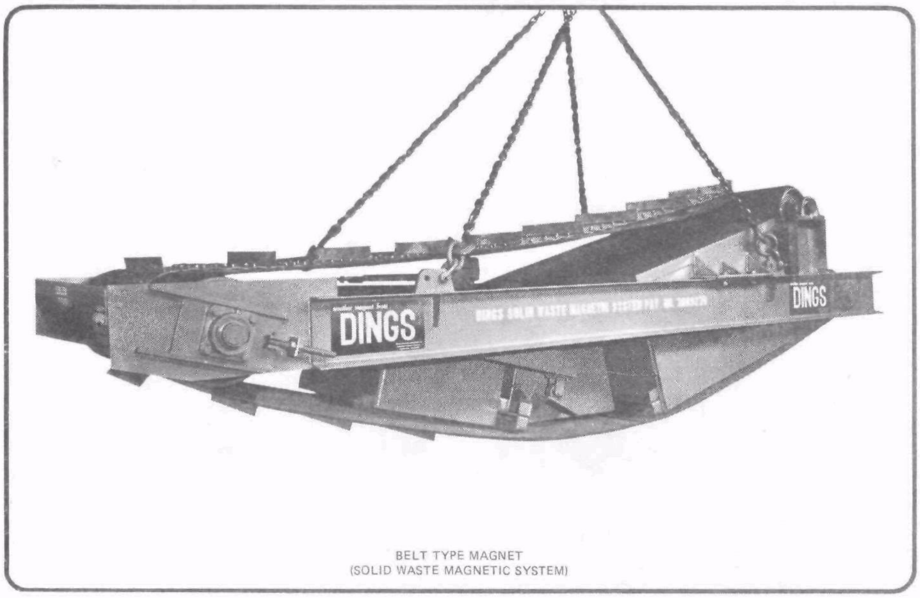


Figure 33. Dings "Hockey Stick" Solid Waste Magnetic System, Baltimore County, Maryland

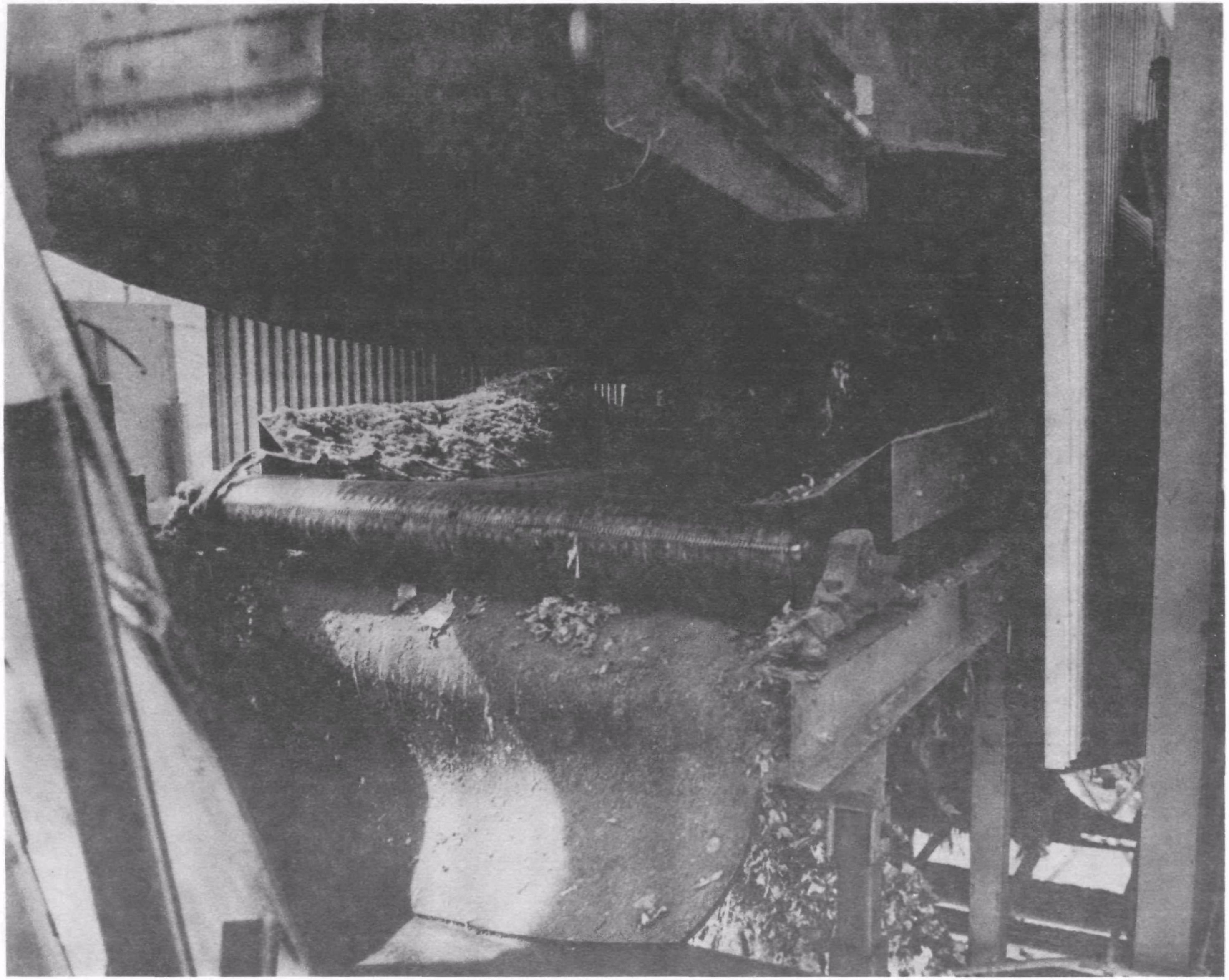


Figure 34. Magnetic Separator Output, Baltimore County, Maryland.

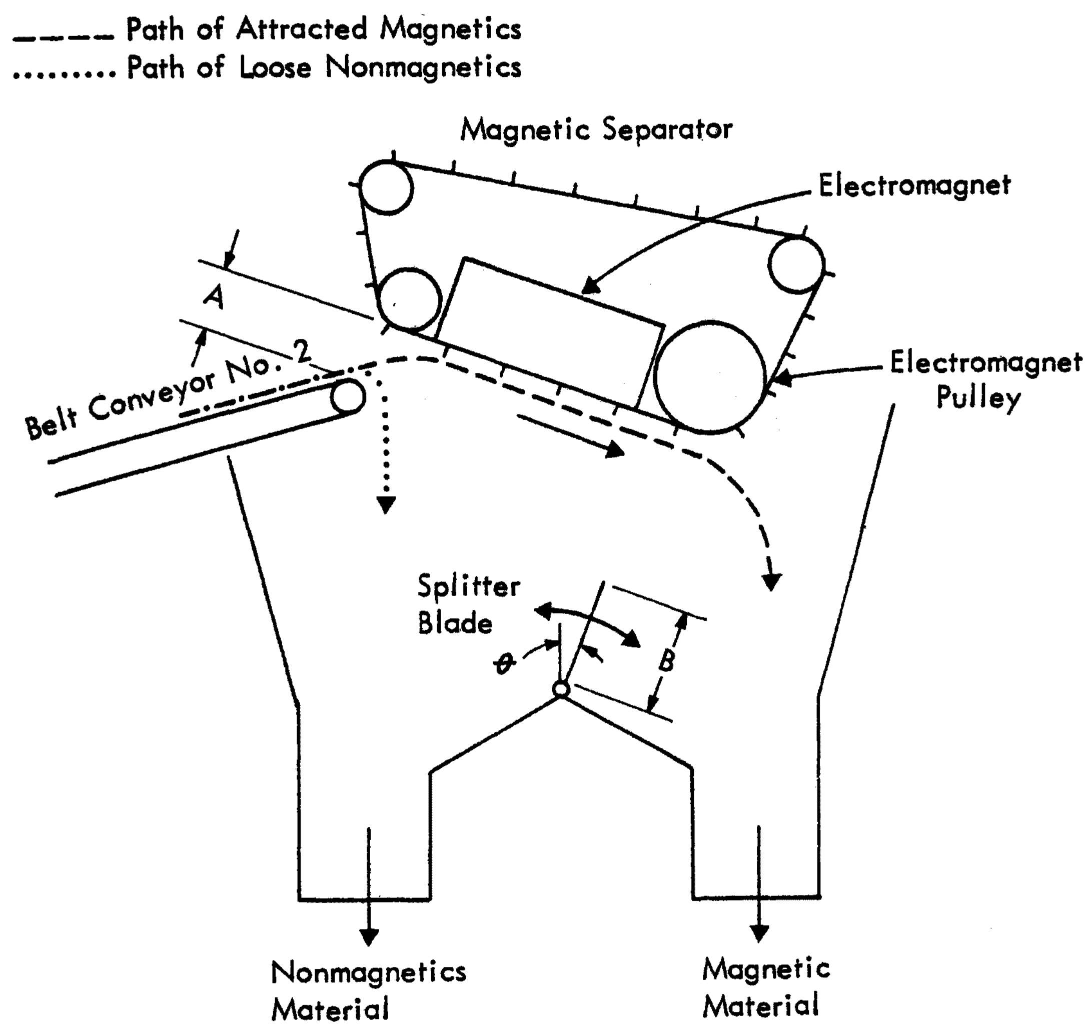


Figure 35. Test Variables, Outagamie County, Wisconsin Magnetic Separator System

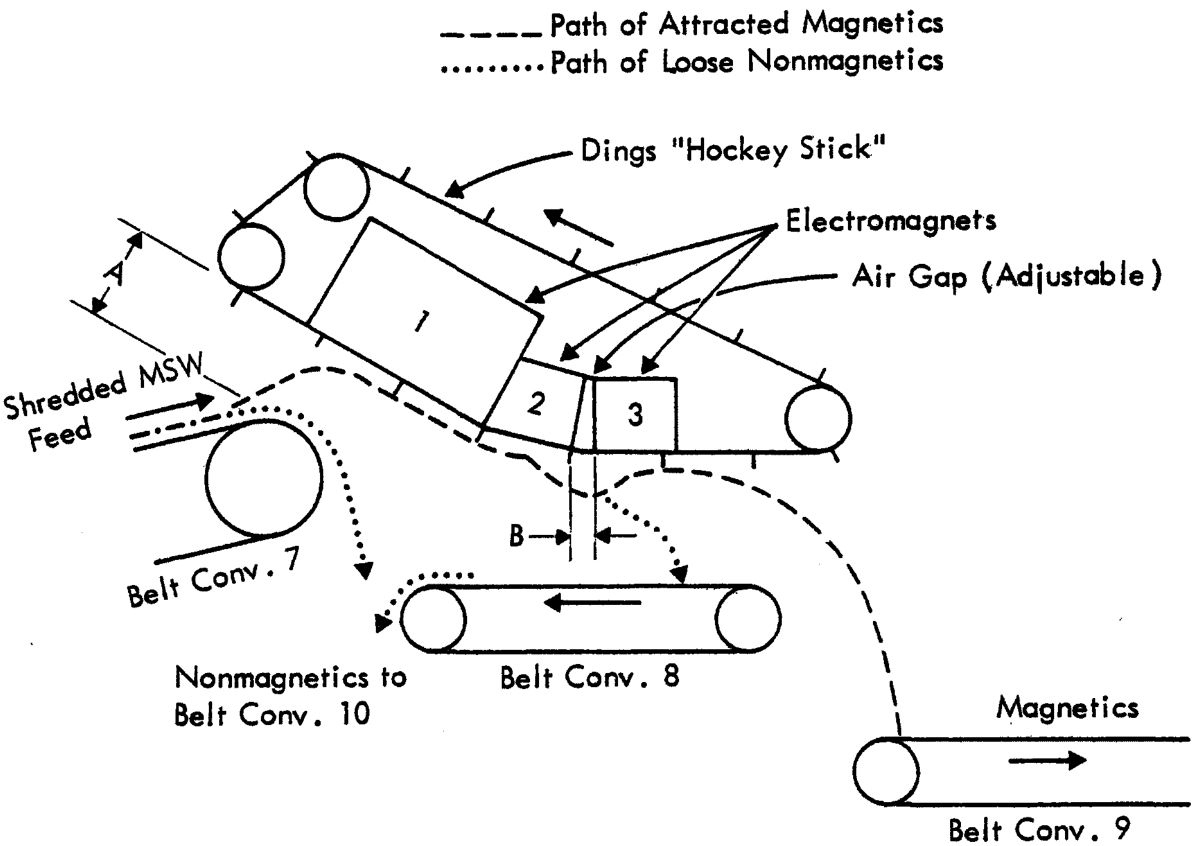


Figure 36. Test Variables, Baltimore County, Maryland, Magnetic Separator System

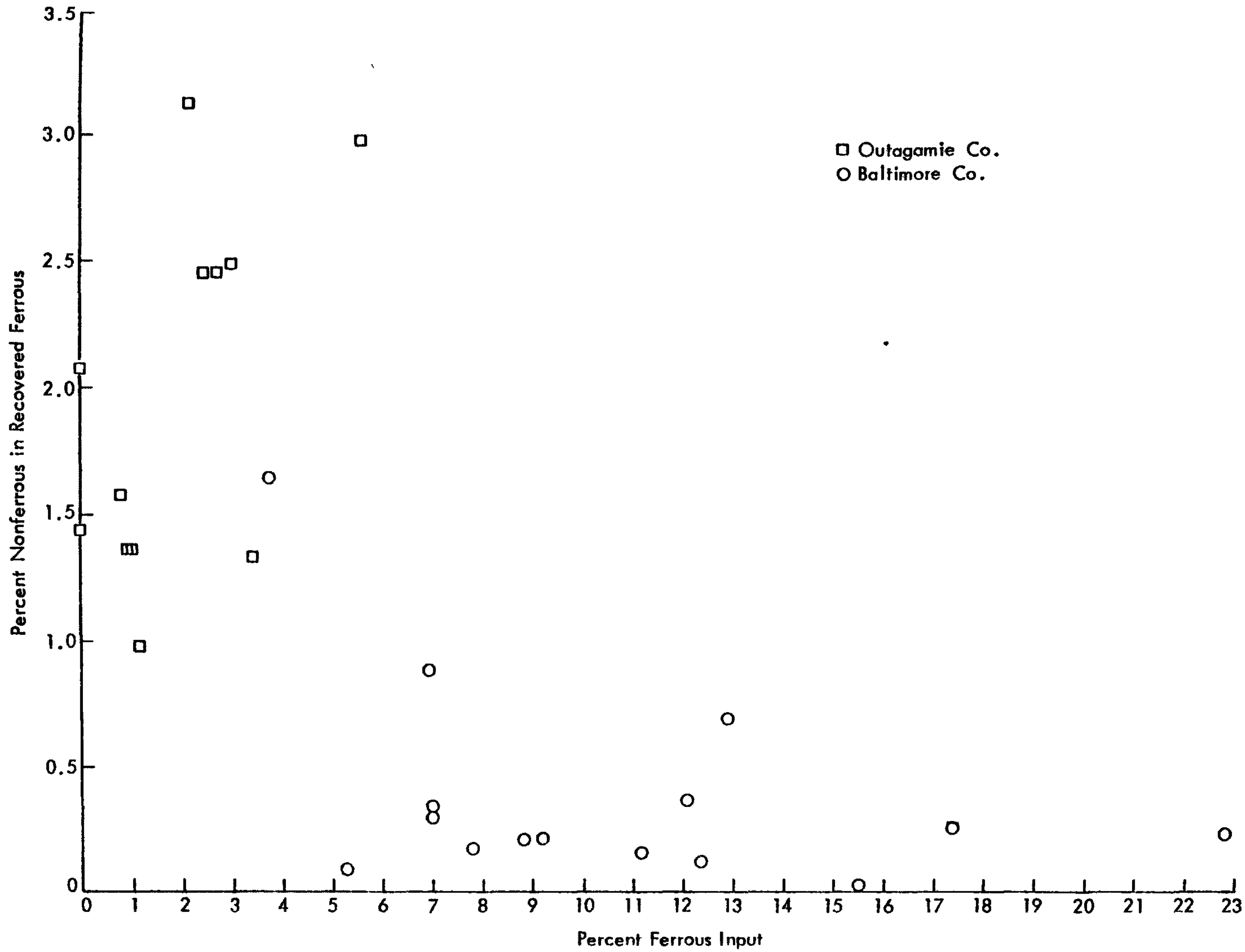


Figure 37. Percent Ferrous in Input Versus Percent Nonferrous in Recovered

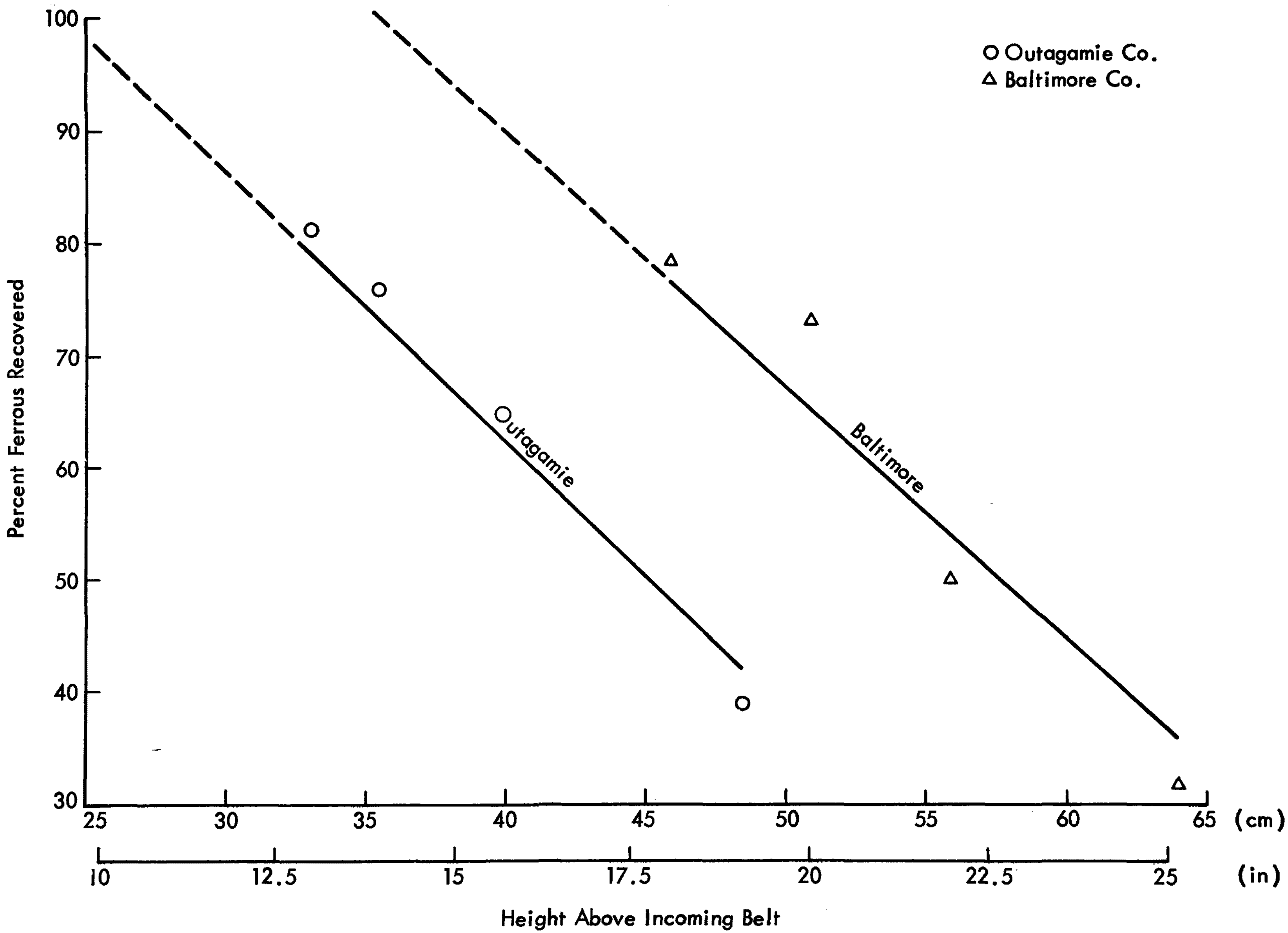


Figure 38. Magnetic Separator Height Above Incoming Belt Versus Percent Ferrous Recovered

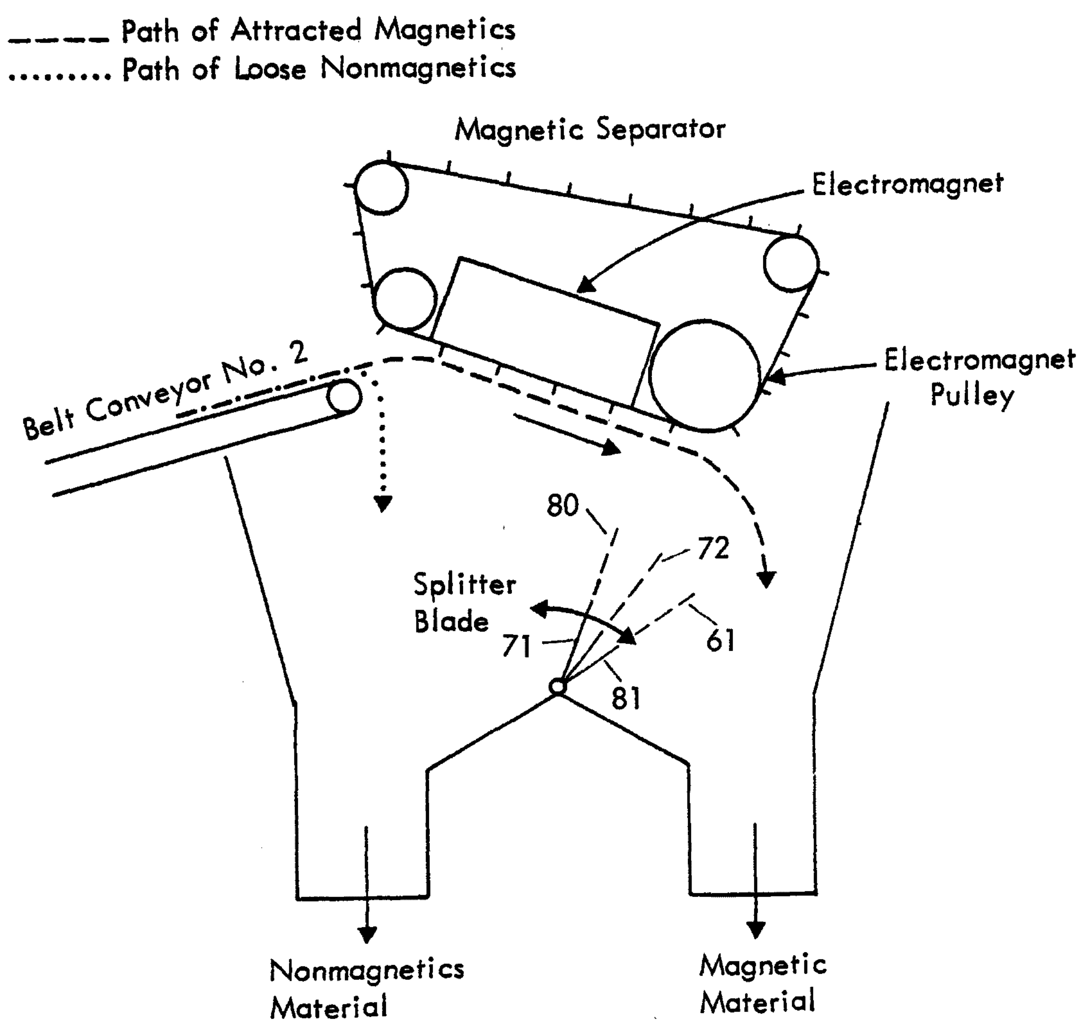


Figure 39. Splitter Blade Length and Position Versus Ferrous Recovery Efficiency, Outagamie County, Wisconsin

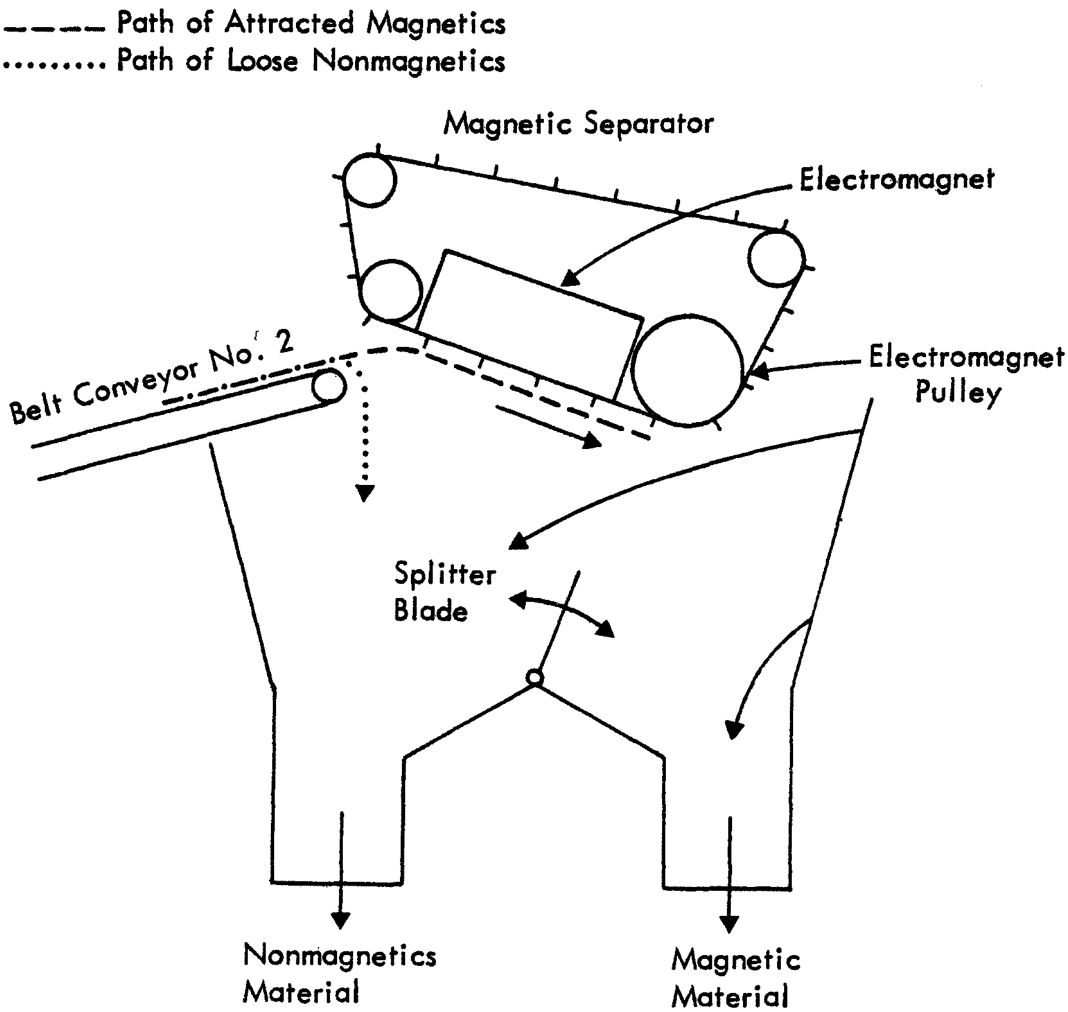


Figure 40. Approximate Rebound Zone of Ferrous Metal in Hopper, Outagamie County, Wisconsin

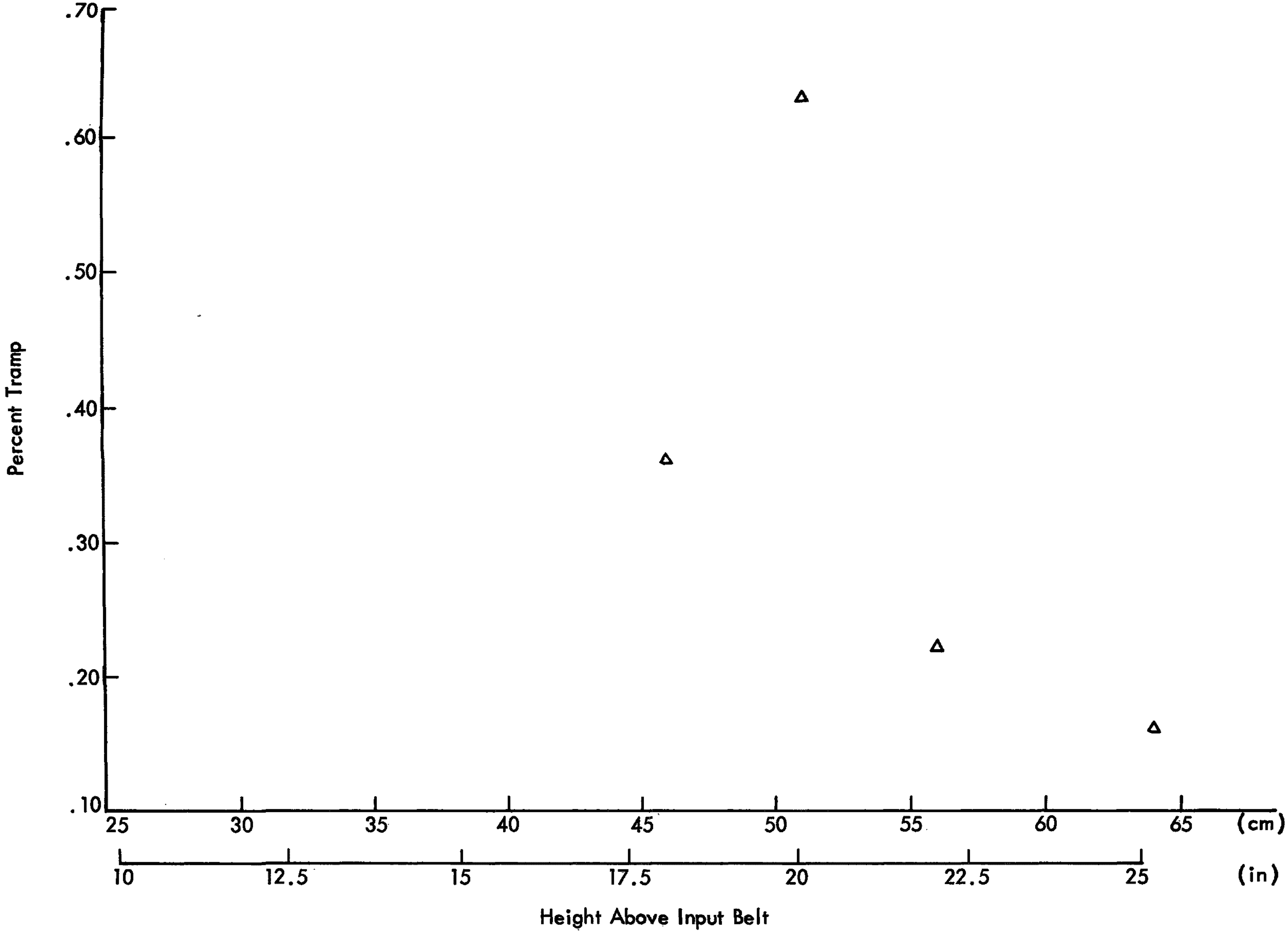


Figure 41. Magnetic Separator Height Versus Percent Tramp,
Baltimore County, Maryland

SECTION 5

AIR CLASSIFIER SYSTEM TEST

SYSTEM DESCRIPTION

The air classifier system at Baltimore County consists of an input material flow control device (diverter blade); vertical cylinder classifier, two fans, two cyclone separators, airlocks in series, control console, and associated conveyors.

The shredded MSW with most of the ferrous metal removed is carried on conveyor 14 to the hopper for the landfill compactor (Figure 16). Inside the hopper, there is a rectangular opening covered with a sliding plate called the "diverter blade" (Figure 42). If the diverter blade is covering the opening, the material falls into the compactor. The diverter blade, which is operated from the control console, is opened to allow the material to pass out of the hopper onto conveyor 15. Conveyor 15 transports the material to the air classifier inlet.

The air classifier is a vertical column 213 cm in diameter with the lower section tapered to 122 cm (Figure 43). Slightly above the beginning of the straight section, there is a double cone. The cone is suspended in the center of the column to help break up clumps of incoming material.

The material enters the column through an opening in the side just below the air outlet ducts. The opening has a flexible curtain which helps to seal the air classifier and get maximum air flow from the bottom.

The air flow is induced by two fans, one on each side of the classifier. The material entrained in the air stream, called "lights," also passes through the fans into two cyclone separators. The entrained material drops out of the air stream in the cyclones and passes through airlocks onto conveyor 19 (Figures 44, 45).

The material which falls through the air classifier onto conveyor 16 is called "heavies."

The amount of material which travels either path is determined by the air classifier design, the feed rate of input material, and the air flow rate.

At Baltimore County, the speed of each fan is fixed; therefore, the percent of material going in each direction, called "split," is controlled by the material input rate.

The air classification system is monitored and controlled at the console by one person. Closed-circuit T.V. (Figure 46) is used to monitor the diverter blade. The vantage points are from conveyor 15 looking toward the air classifier, and from the junction of conveyors 16 and 17 and conveyor 20.

TEST PROCEDURE

The input feed rate was adjusted with the diverter blade to a steady burden depth by viewing the T.V. monitor for input conveyor 15. When the system was stabilized the input and output conveyors were stopped. The MRI test crew then took a measured length of material from each of the three belts and put them in plastic bags. Each sample was weighed. Having the length of belt, belt speed and weight of sample, the material flow rate was calculated. The sample was then poured into a measured container and weighed to determine its bulk density.

The bulk density sample was used for the handpicking procedure (Figure 47), that was utilized to determine the weight percent of combustible (paper and plastic) and "other." The "other" part consisted of everything that could not be identified as paper or plastic. The ferrous metal was sorted out of the "other" part, with a hand magnet, and weighed separately.

The section of the sample not used for bulk density determination was collected and shipped to Raltech in St. Louis, Missouri, for analysis of percent ash, percent moisture, and heat value. A sample from each stream was shipped to Raltech each test day. Each sample was a composite of that day's stream samples.

Data were found for each of the following variables:

$\dot{m}_s$ = Input stream flow rate;
$\dot{m}_{lf}$ = Light fraction flow rate;
$\dot{m}_{hf}$ = Heavy fraction flow rate:
Weight percent combustible material;
Weight percent other (noncombustible);
Weight percent ferrous metal:
ρ = Bulk density.

Each of the four test days was used for a different input flow rate.

The air stream velocity, in the air classifier was determined with two traverses at 90 degrees, midway up the air classifier column. When the traverses were made, there was no material being fed into the unit. From the traverses, the average column velocity (V_o) was determined. Having the temperature and relative humidity, the air mass flow rate (m_o) was determined.

The pressure drop across the system was determined by taking pressure readings in the air classifier column and in the duct after each fan.

The fan energy consumption was calculated from readings of the voltage, current and power factor. The current draw for each fan was read from the panel meter on the control console.

TEST RESULTS

The objective of this test was to gather the data necessary to evaluate the performance of the air classifier and to determine the relationships between the variables. The first set of variables determined was the three mass flow rates: $\dot{m}_s$ - input; $\dot{m}_{lf}$ - light fraction (entrained in airstream); and $\dot{m}_{hf}$ - heavy fraction (dropped out of the bottom of the classifier). In a steady state system, the mass flow rates should balance.

$$\dot{m}_s = \dot{m}_{lf} + \dot{m}_{hf}$$

At an MSW processing plant, the material input to the shredder is not constant; therefore, $\dot{m}_s$ is not constant. The error in the average mass balance was 15% of $\dot{m}$ and 13% of $(\dot{m}_{lf} + \dot{m}_{hf})$. This report is based on the assumption that at any instant the sum of the outputs equaled the input when those two fractions entered the air classifier. The value of $\dot{m}$ used in this report is the sum of $\dot{m}_{lf} + \dot{m}_{hf}$, and not the $\dot{m}_s$ calculated from the samples taken from the input belt. Having $\dot{m}$ and mass flow rate of air ($\dot{m}_o$), the air-to-solids ratio (α) was calculated.

All the sample data are listed in Tables B-2, B-3, B-4, B-5 and B-6 in Appendix B.

In Figure 48, α is plotted against the weight percent of the input that reported to the lights. Figure 49 is the plot of the heavy fraction.

The weight percent of material recovered as potential fuel increases with an increase in α up to an α of about 20. At 20 the light fraction stabilizes at about 83 percent of the input. With a constant $\dot{m}_o$, a decrease in $\dot{m}_s$ will result in an increase in α . Any decrease in $\dot{m}$ above where the value of $\alpha = 20$, at Baltimore County, would unnecessarily reduce the throuthput of the air classifier. The $\dot{m}_s$ to the air classifier is not constant in an RDF plant; therefore, if the air flow is fixed, the actual set point for $\dot{m}_s$ must be small enough that α does not fall much below 20, which would result in a deterioration of the recovered light fraction.

The test data did not indicate a correlation between the density of the input material and the amount or quality of the material reporting to the light fraction.

The quality of the fuel is based on its heating value and weight percent of ash after combustion.

Figure 50 graphically indicates the changes in the quality of the lights as α increases. These data show a significant increase in the light quality up to $\alpha = 20$, but not beyond. Therefore, $\dot{m}_s$ should be set as close as possible to $\alpha = 20$. Increasing α above 20 increased only slightly the heat value of the recovered material and decreased the ash slightly. At the critical point of the air classifier ($\alpha = 20$), the heating value is about 14.9×10^6 J/kg.

The curve for moisture in Figure 50 indicates that, within the range shown, it does not affect the other parameters.

As should be expected, there is correlation between the weight percent combustibles in the light fraction and the heat value.

The heavy fraction data plotted in Figure 51 also show $\alpha = 20$ as the critical point. There is a more definite correlation between heat value and weight percent ash, and the loss of combustibles to the lights as α increases is indicated. The data point for heat value and ash at $\alpha = 59$ does not appear to be valid. Both were from the same 1-g sample used in the calorimeter. The high heat value may have been caused by an excessive amount of plastic in that small sample.

The pressure drop across the air classifier system was 7.6 in H_2O on the north fan and 7.8 in H_2O on the south fan.

The total energy used by the two fans was calculated as follows:

$$P = EI \times \text{Power Factor} \times 3 \times 2 \text{ fans;}$$
$$P = (480)(85)(.93)(3)(2);$$
$$P = 131.4 \text{ kw}$$

DISCUSSION

The recovered light fraction passes through the fans before going to the cyclone separator. The air classifier system fans at Baltimore County were worn out. They are in the process of rebuilding the fans and relocating them to the air output side of the cyclones to minimize the wear problem.

Table 8 lists performance characteristics of the air classifiers at St. Louis, Missouri; Ames, Iowa; and Baltimore County (as tested, and estimated values with the fans rebuilt).

TABLE 8. AIR CLASSIFIER PERFORMANCE CHARACTERISTICS

	St. Louis[a]	Ames[b]	Baltimore County As tested	Baltimore County Rebuilt(est)
Throat width (m)	0.51	0.51	2.13 dia.	2.13 dia.
Throat length (m)	2.49	2.49	---	---
Throat area (m^2)	1.27	1.27	3.56	3.56
Split to lights (%)	81.7	84.1	47.0	50.0
Velocity (m/s)	10.6	16.6	5.3	6.1
Input flow rate ($\frac{\text{metric tons}}{\text{hr}}$)	31.4	29.5	30.0	30.0
Air-to-solids ratio	1.9	2.6	2.7	3.13
Column loading ($\frac{\text{metric tons}}{\text{hr}} \div m^2$)	24.8	28.1	8.4	8.4

The data listed for Baltimore County, rebuilt, are based on the assumption that the new fans will each pull 23,000 SCFM of air.

a/ St. Louis demonstration final report: Refuse Processing Plant Equipment, Facilities and Environmental Evaluation, EPA 600/2-77-155a.

b/ Test and Evaluation of Ames, Iowa, Refuse Fuel Project, Grant No. R-803903-01.

The base item for this table is the input material flow rate of approximately 30 metric tons per hour. The value of 50% for the light fraction when the fans are rebuilt at Baltimore County was taken from Figure 50. The expected 20 percent velocity increase will decrease α to about 3.13, which corresponds to 50% in Figure 50.

Using the split as the common base for Table 8, at Baltimore County the input feed rate would have to be reduced to 4 mg/hr, which would yield a column loading of 1.23 mg/hr - m^2.

One important relationship cannot be found from the available Baltimore County data; i.e., changes in air velocity. Some unpublished test results indicate that an increase in velocity increases the air-to-solids ratio and the critical point.

The effect of the changes in $\dot{m}_s$ on the amount of material reporting to the light fraction in the air classifier operation was apparent at Baltimore County. This points up the need for either a flow control device or a belt weighing system with a minicomputer connected to the fan. If the air velocity in the classifier could be changed in response to the variations in m_s, the split could be controlled closer to the critical point.

The handpick method of determining the percent combustibles is inadequate. The time required for this operation limits the sample size. A test plan designed to establish a standard burning method for a large quantity of sample is in order. This method would result in both percent combustibles and percent ash in the sample.

The air classifier test data, when compared to similar data from Ames, Iowa, and St. Louis, Missouri, indicates that the throughput at Baltimore County, with 80 percent flying to the fuel fraction, is very low relative to the cross sectional area of the unit. The air velocity in the air classifier at Baltimore County is half that at St. Louis and a third that at Ames. System constraints did not allow changes in the air velocity. It is recommended that a series of air classifier tests be done on a unit with air velocity change capabilities.

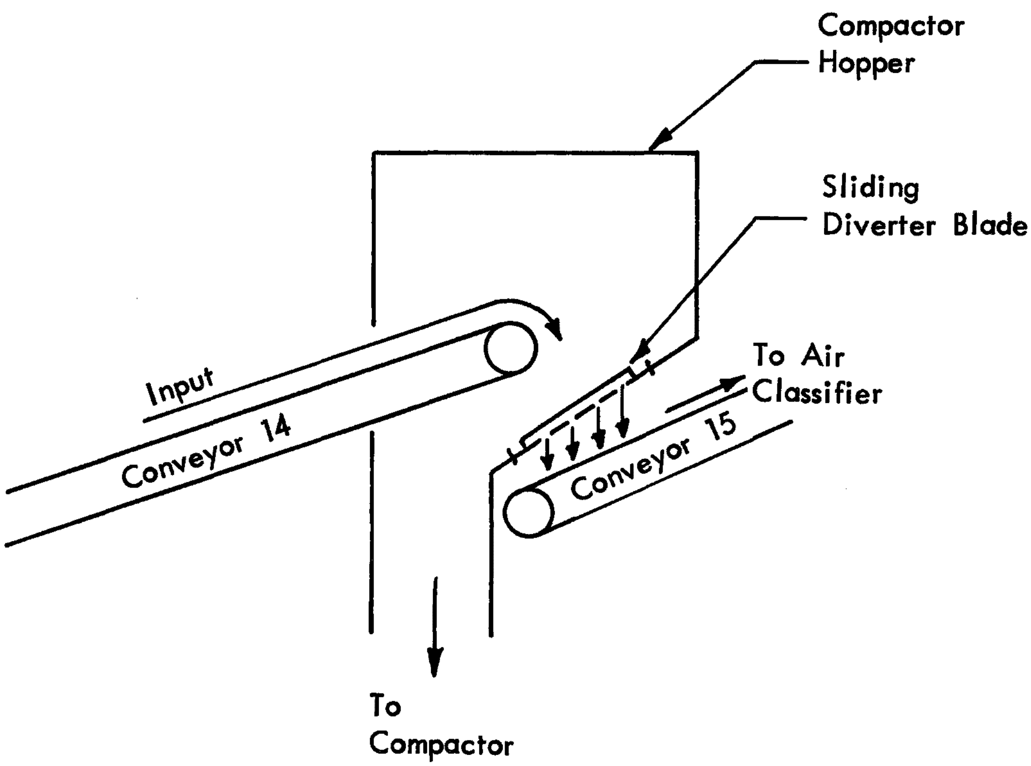


Figure 42. Diverter Blade System, Baltimore County, Maryland

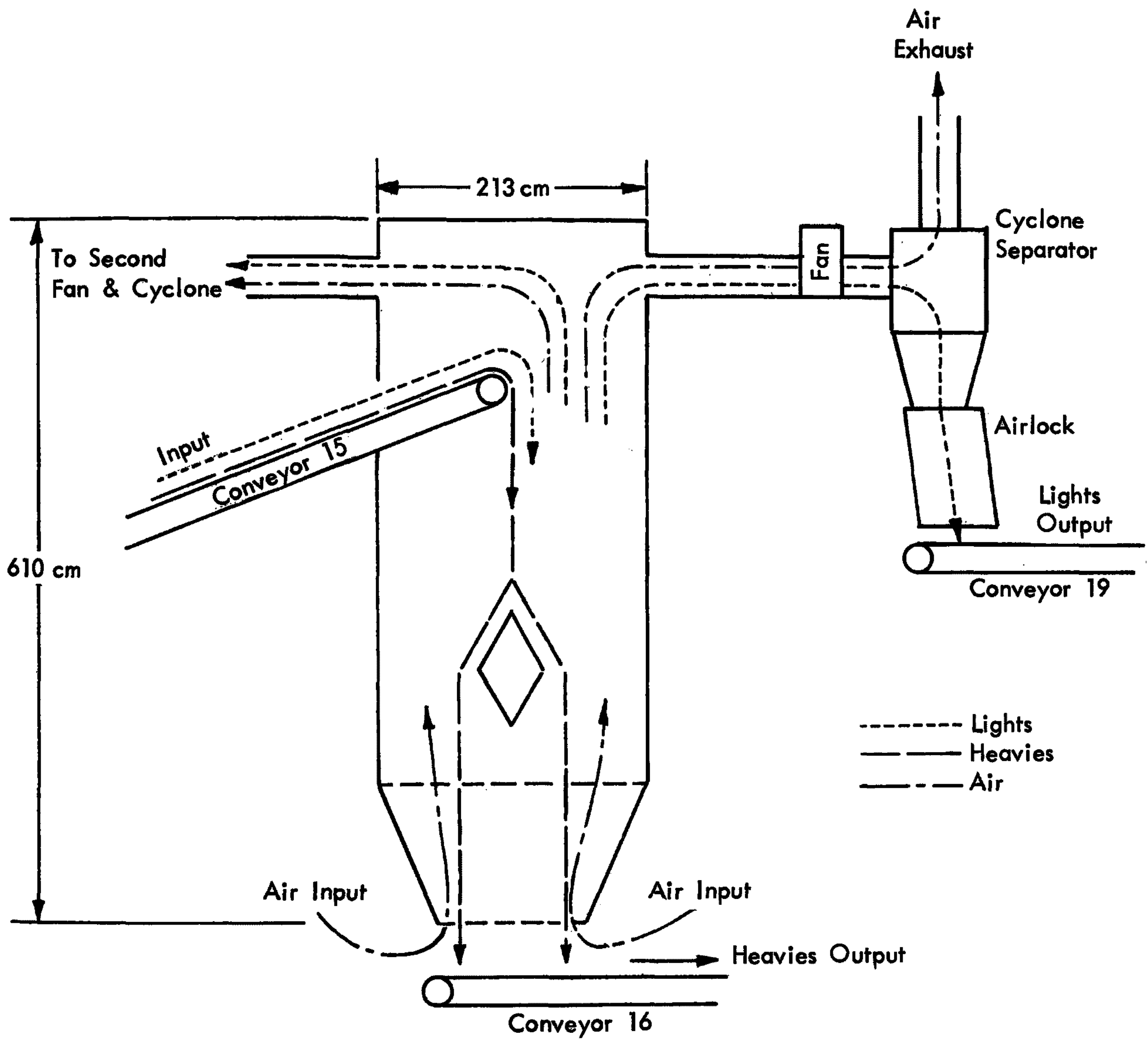


Figure 43. Air Classifier System, Baltimore County, Maryland

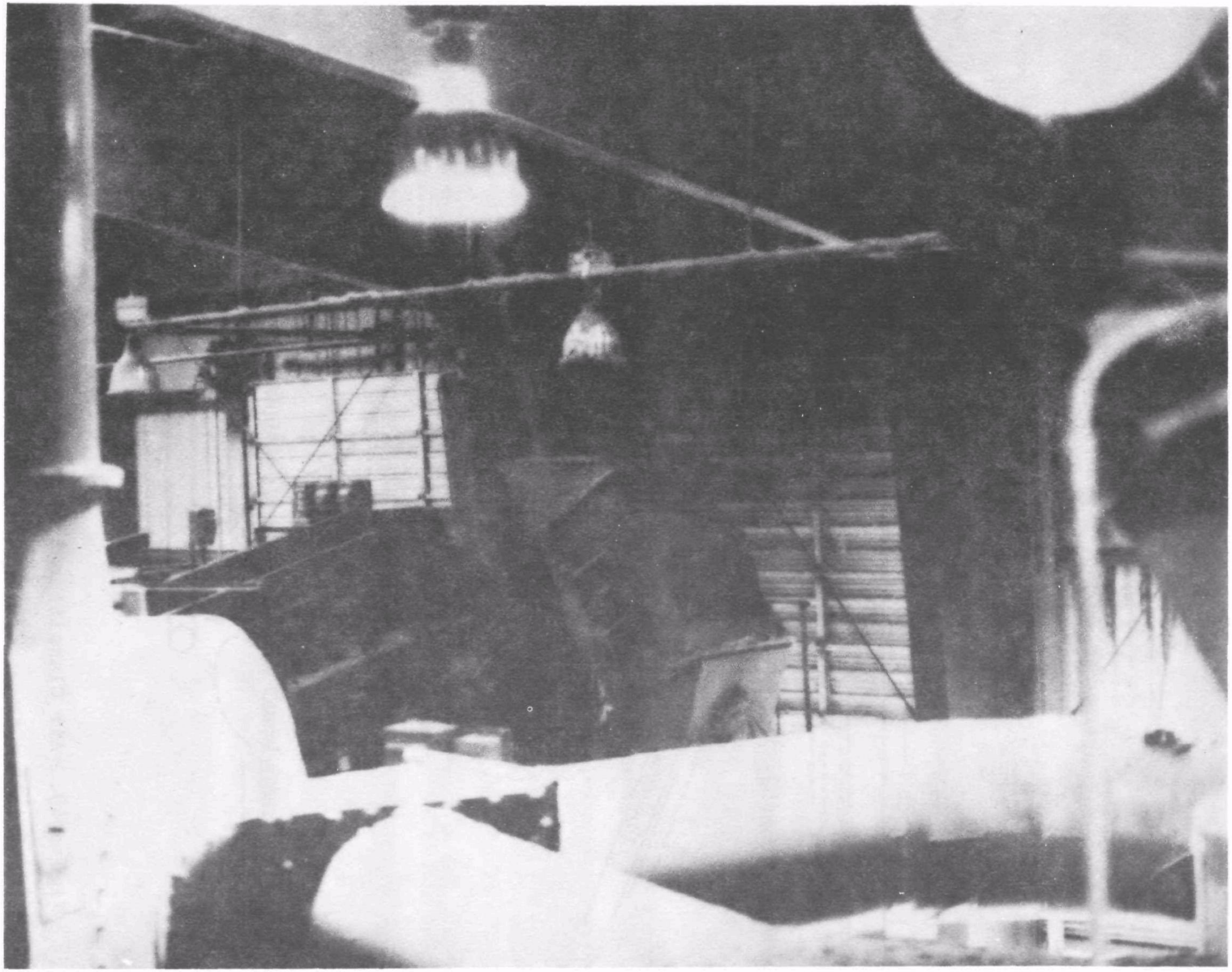


Figure 44. Air Lock Attached to Cyclone Output, Baltimore County

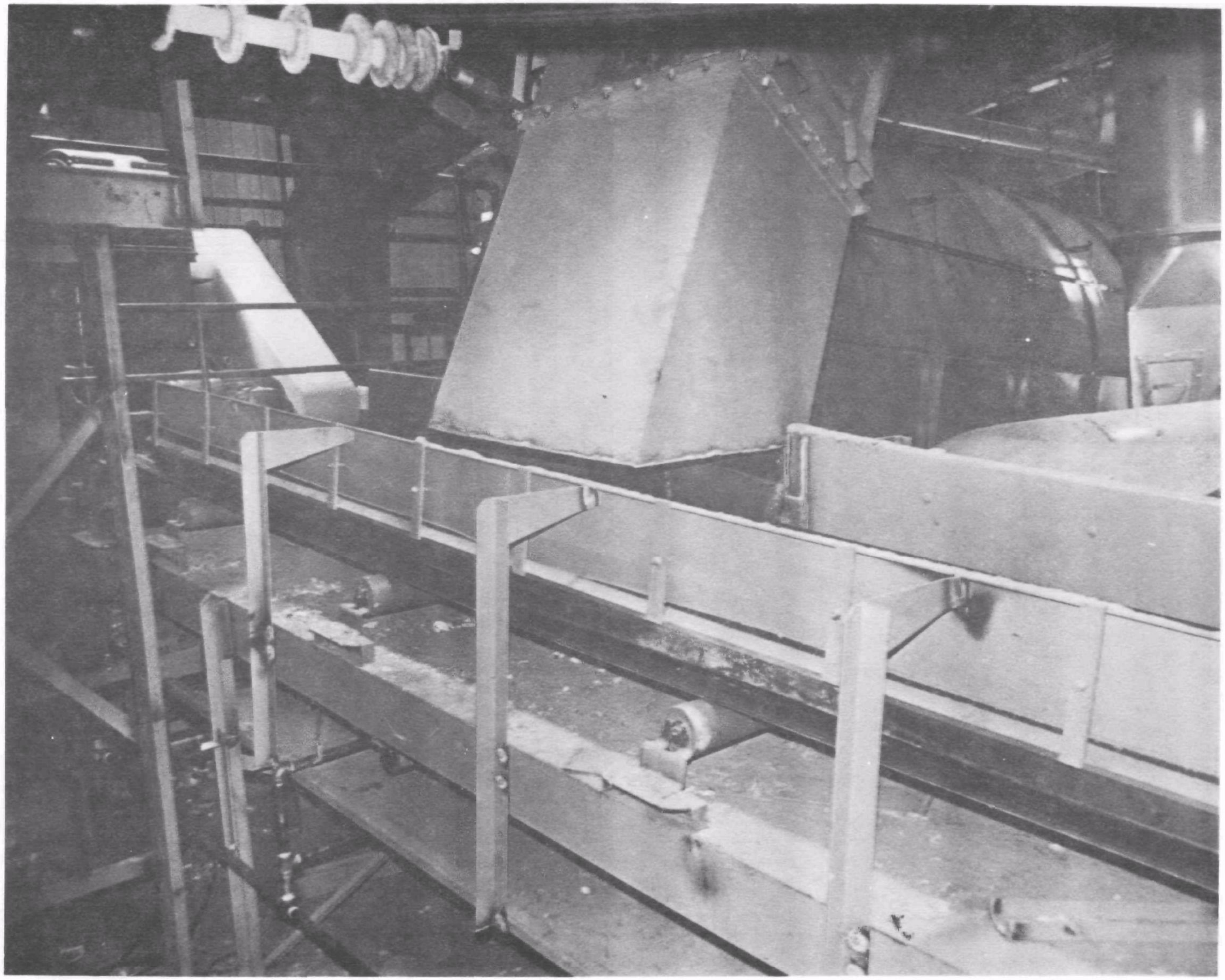


Figure 45. Cyclone Separator Outlet Chute from Air Lock, Baltimore County

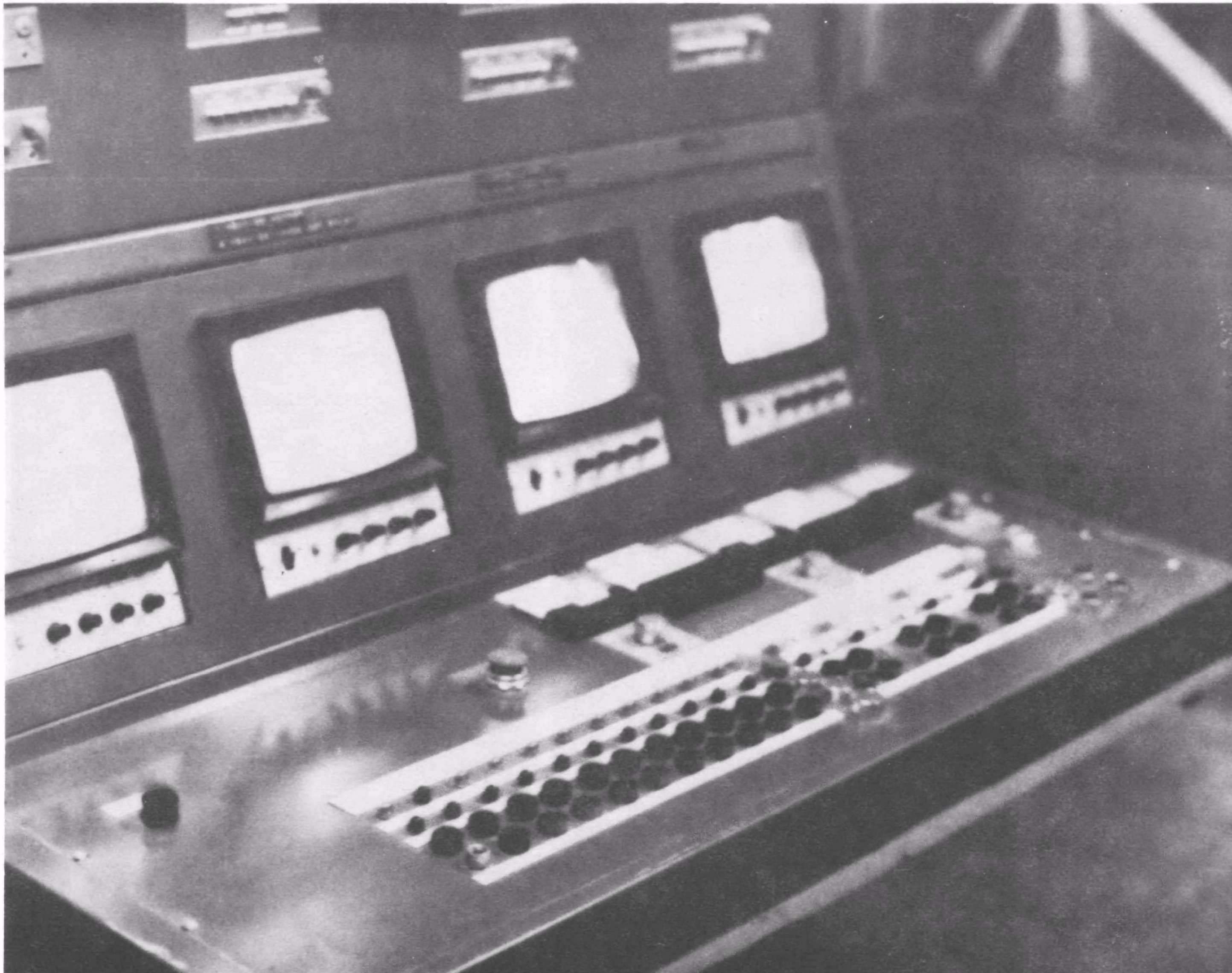


Figure 46. Air Classifier Control Console, Baltimore County

Figure 47. Sample Being Hand Sorted, Baltimore County

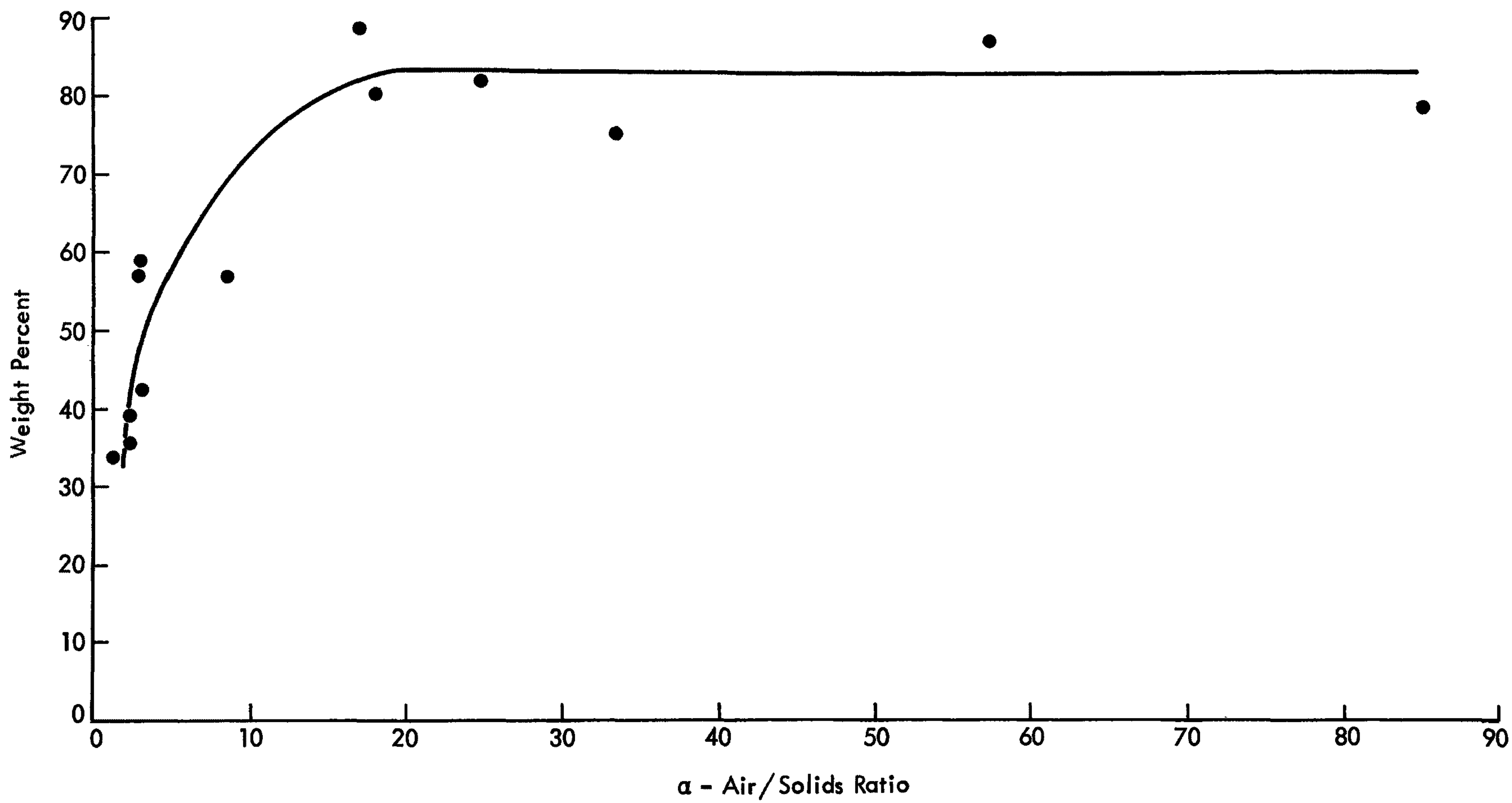


Figure 48. Split to Light Fraction, Baltimore County

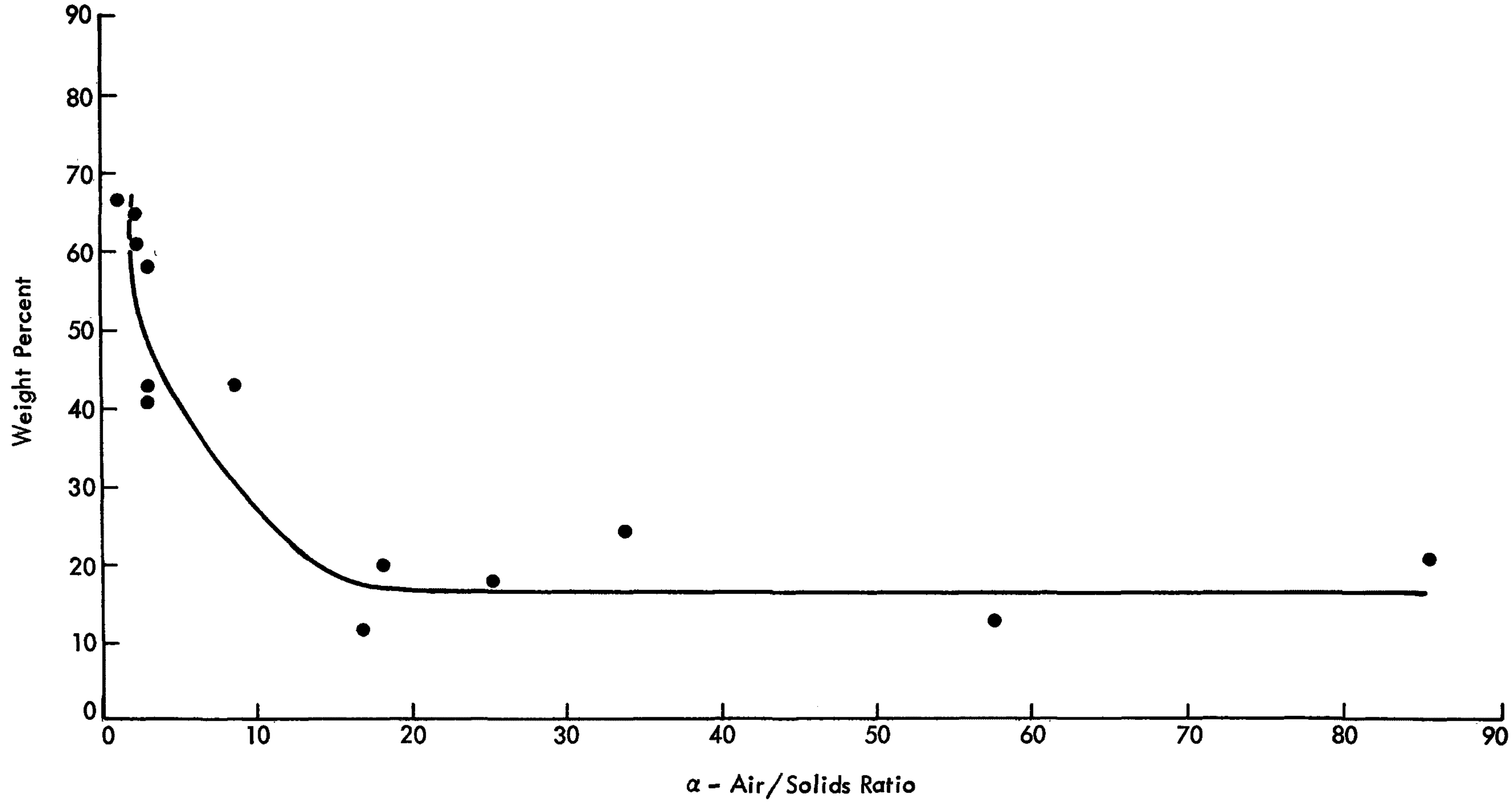


Figure 49. Split to Heavy Fraction, Baltimore County

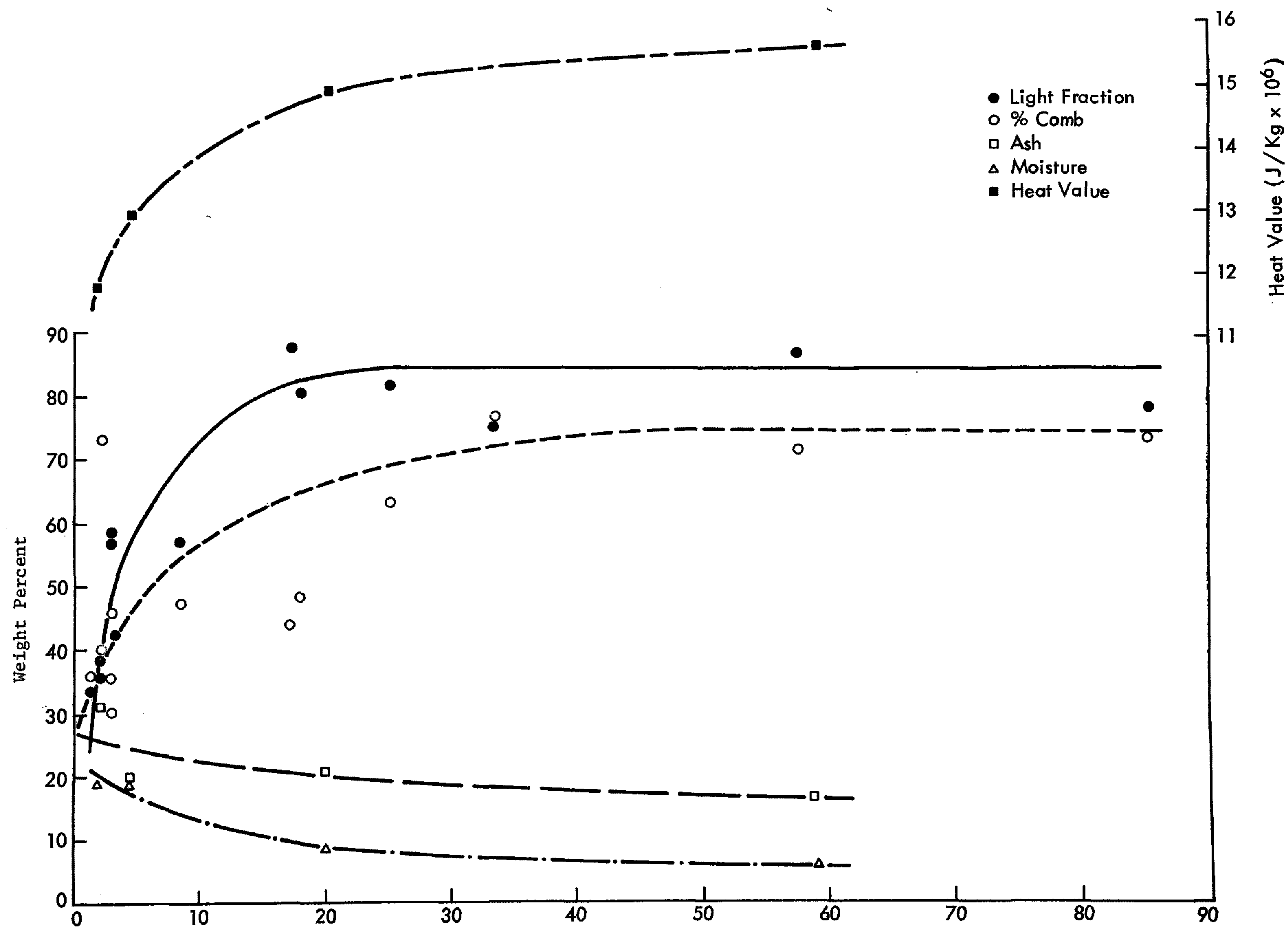


Figure 50. Light Fraction Analysis: Baltimore County

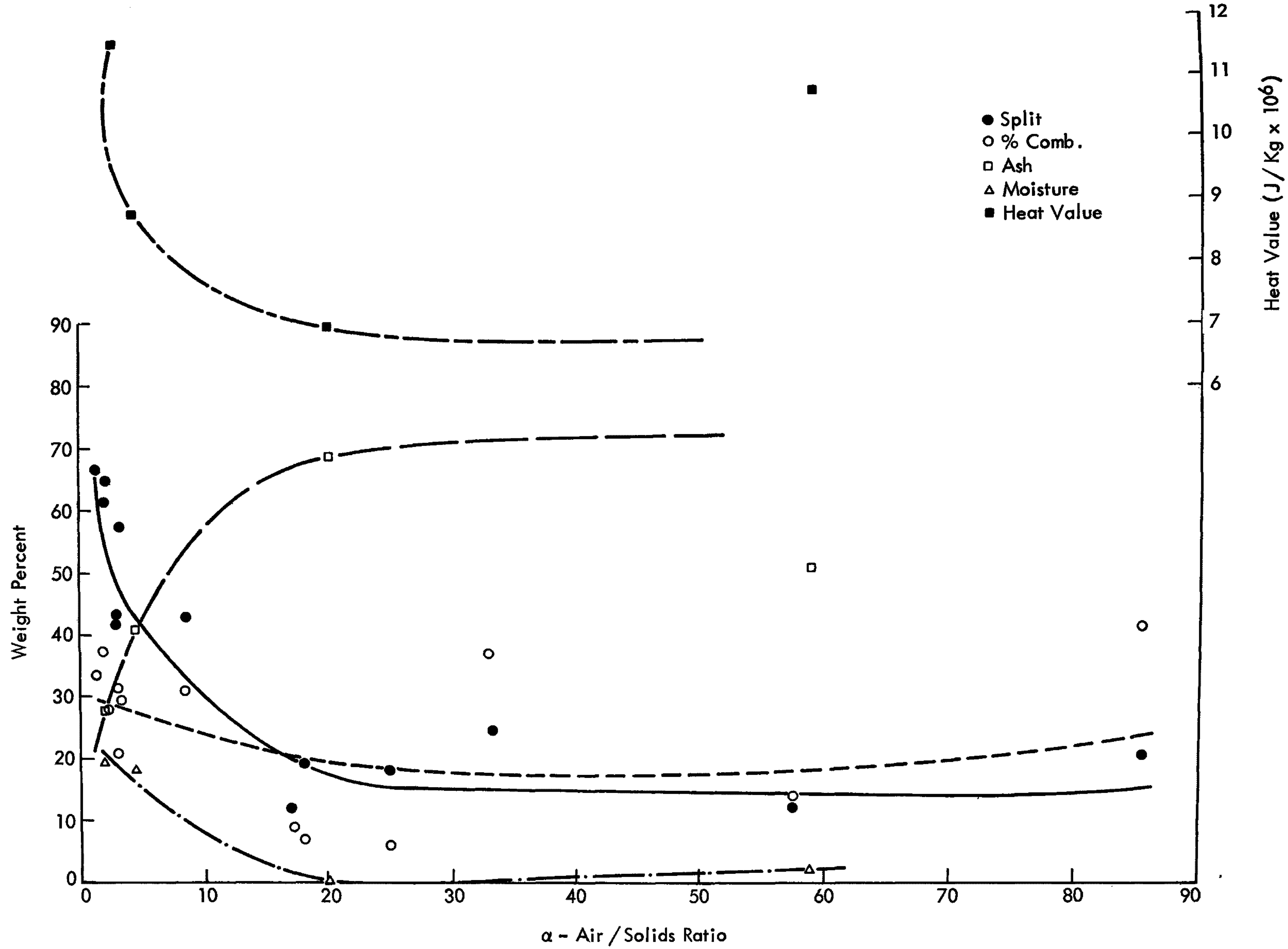


Figure 51. Heavy Fraction Analysis, Baltimore County

SECTION 6

AMBIENT AIR EMISSIONS TESTS

INTRODUCTION

The emissions tests at the Outagamie County and Baltimore County plants were conducted to determine the nature of the air emissions from MSW produced by the processing and handling equipment. The emissions of specific interest were particle concentration, particle size, trace metal concentration, and asbestos concentration.

Hi-Vol and Acu-Vol samplers were used for all sampling. The Sierra heads on the Acu-Vols sorted the particulate emissions by size. At each site, four locations were chosen for the Hi-Vol samplers and three locations for the Acu-Vols. These locations were not necessarily worker exposure areas.

SAMPLE AND ANALYSIS PROCEDURE

The four Hi-Vol samplers were calibrated to a flow rate of $\approx 4\ m^3/min$, then monitored hourly to ensure the filters were not over-loading which would decrease the flow rate. The Acu-Vol samplers have an internal control system which maintains the calibrated flow rate of $\approx 4\ m^3/min$ as the filters become loaded.

The Hi-Vols used 8 in. x 10 in. fiberglass matrix filters. Five slotted (4 in. x 5 in.) filters and a backup (8 in. x 10 in.) fiberglass matrix filter were used in the Acu-Vols for particle sizing.

Before going to the field, each filter was conditioned for 2 days in a 40% constant humidity room and weighed. After sampling, the filters were again conditioned and weighed by the same person and under the same conditions to maintain accuracy.

The filters used for trace metal anlaysis were then cut into 10 x 10 cm (4 in. x 4 in.) sections, and each section was weighed. The tare weight of each section was calculated from the original tare weight of the entire filter and subtracted from the weighted portion to yield a particulate weight. The weights used for calculating metal concentrations are listed in Tables C-1 through C-20 in Appendix C. Samples were digested in two different mixtures: (1) HNO_3-$HClO_4H_2SO_4$ (30:20:5, v/v) for the analyses of Cd, Cr, Cu, Zn, Ag, and Ti; and (2) HCl-HNO_3 (7:3, v/v) for the analyses of As, Sb, Be, Hg, Se, V, Ba, and Pb. All metals were analyzed using atomic absorption techniques.

Approximately 50% of the samples were analyzed in duplicate to determine the homogeneity of the samples and to give a measure of the precision of the methods.

To determine the accuracy of the methods, standard reference materials (Bureau of Mines 107A Refuse and NBS 1571 Orchard Leaves) were analyzed and compared to certified values; reagent blanks, filters, and approximately 50% of the samples were fortified with the metals prior to digestion and analyzed for recovery efficiency. Reagent blanks and filter blanks were analyzed for contamination levels; and determined levels were subtracted before final calculation of the metal concentrations.

The results from the quality assurance analyses are attached in Tables C-21 through C-23 of Appendix C. A discussion of the precision, accuracy, and possible sources of error in the results is given in the following paragraphs.

The difference between concentrations of duplicate analysis is a measure of the precision. The differences are listed in Tables C-1 through C-20 in Appendix C. Differences ranging from 0% (copper) to 57% (barium) were not dependent on sample weight, indicating great variations in homogeneity of the samples.

The accuracy of the methods was determined via analysis of standard reference materials, and fortified reagents, filters, and samples. Standard reference materials (Bureau of Mines 107A Refuse and NBS 1571 Orchard Leaves) were analyzed and compared to certified ranges or values. Metal concentrations for BOM Refuse fell within the ranges for all elements. Metal concentrations determined for NBS Orchard Leaves were close to the certified values except for high Cr and Cu, which indicates possible contamination; however, Cr and Cu concentrations observed in the samples were much higher than the Orchard Leaves samples. The possible low contamination level indicated does not greatly affect the sample concentration value.

Reagent recoveries were very good; the metals were not lost with the digestion methods used. Filter recoveries were somewhat lower than reagent recoveries for Cd, Cu, and Zn. This may indicate a problem with metal removal from a filter during digestion.

Recoveries of fortified reagents and filters were calculated by:

$$\% \text{ Recovery} = \frac{\mu g^* - \mu g^b}{\mu g^f} \times 100$$

Where μg^* = Total weight (μg) determined in a fortified sample.
μg^b = Weight (μg) determined in an unfortified sample.
μg^f = Weight (μg) added to the sample (fortification level).

Sample recoveries ranged from 31% (copper) to 137% (zinc). The recoveries were calculated based on the assumption that the samples were homogeneous. Since duplicate samples varied by as much as 57%, the recoveries must reflect this variation. The recovery was calculated by:

$$\% \text{ Recovery} = \frac{\mu g^* - \mu g^c}{\mu g^f} \times 100$$

Where μg^* = Total weight (μg) determined in a fortified sample.
μg^c = Weight (μg) calculated for an unspiked sample of equivalent weight.
μg^f = Weight (μg) added to the sample (fortification level).

Variations in precision and accuracy may be due in part to errors in initial and final conditioning and weighing of filters, imperfect filter sectioning, variations in the weight of a sectioned filter, sample inhomogeneity, difficulty in removing the dissolved metal from the filter, and the precision of the analytical methods.

Because tare and final weights are used to calculate metal concentrations, errors in weights, especially for low filter loadings, contribute to errors in metal concentrations.

To determine the combined error in sectioning and taring filters, filter blanks were sectioned and weighed; the section weights varies by <0.040 g. Any weight less than this weighing error cannot be used to calculate metal concentrations. No weights less than twice the weighting error were used to calculate concentrations.

Outagamie County

At Outagamie County the suspected sources of emissions were the shredders, conveyor transfer point, magnetic separator, and the transfer from drag conveyor 1 to 3. These locations are shown in Figures 2 and 3, as E1, E2, E3, and E4, respectively.

E1 was next to belt conveyor 1 midway between the discharge of the two shredders for the purpose of sampling the emissions produced when the shredded MSW fell onto the conveyor. The output chutes of the shredders are skirted all the way to the conveyor side plates.

E2 was chosen as close as possible to the intersection of belt conveyors 1 and 2 (Figure 52), since observation indicated the transfer of the shredded MSW from one conveyor to the next produced emissions.

E3, inside the magnetic separator system house, was as close as possible to the point where belt conveyor 2 dumped into the hopper.

E4 was located next to the control room on the tipping floor (Figure 53), on test day 2, after the dust produced by the transfer of material from drag conveyor 1 to conveyor 3 was observed.

The four locations were sampled using Hi-Vol samplers in order to determine particle concentration and to provide samples for trace metal analysis. The samples for the first four test days were collected on fiberglass matrix (8 in. x 10 in.) filter blanks. The last three test days' samples were collected on (8 in. x 10 in.) milipore membrane filters to facilitate analysis for asbestos.

Locations E1, E2 and E3 were sampled using an Acu-Vol sampler with a five-stage Sierra head for particle size distribution. The flow rate through the heads was controlled at $\approx 4\ m^3/min$ ($\approx 50\ ft^3/min$).

On alternate test days, the water spray in the shredders was off during sampling in order to determine its effects on the emissions.

The filters from the Hi-Vols were weighed to determine $\mu g/m^3$ of particle concentration. The amount of trace metals As, Sb, Ba, Be, Cd, Cr, Cu, Pb, Hg, Se, Ag, Ti, V and Zn were found by analysis. The millipore filters were also analyzed for asbestos by a physicochemical morphology electron microscope method by Illinois Institute of Technology (IITRI).*

The material on the Sierra filters was assumed to have a density of 1; therefore, based on the measured flow rate, the cutoff diameter of the collected particulate at locations E1 and E2 were 6.9, 2.7, 1.3, 0.85, 9.44μm, and at E3, 6.2, 2.6, 1.3, 0.81, 0.42μm.

---

* Illinois Institute of Technology, Research Institute, Chicago, Illinois.

Baltimore County

The sample locations used at Baltimore County are shown in Figures 14 and 15 as E1, E2, E3 and E4.

E1 was on the ground at the south edge of the magnetic separator system structure (Figure 54) to capture the fallout from the system.

E2 was inside the processing building next to the landfill compactor (Figure 55). This location was exposed to the material falling from the transfer point of belt conveyor 14 to 15, where the diverter blade is located. The equipment in the processing building was not operating; therefore, the sampler was not moved further inside.

E3 was on the tipping floor at the north end of the holding pit (Figure 56). These samplers sampled the emissions produced by the dumping of the packer trucks and the overhead grappling crane operations.

E4 was on top of the motor control room for shredder 1 (Figure 57). This location is between shredders 1 and 2 just below the input to the shredders.

The four locations were sampled using Hi-Vol samplers in order to determine the particle concentration and to provide samples for trace metal analysis. Fiberglass matrix (8 in. x 10 in.) filters were used for this sampling.

Locations E1, E3 and E4 were sampled using Acu-Vol samplers with five stage Sierra heads for particle size distribution data. The flow rate through the heads was ≈4 m^3/min (≈50 ft^3/min).

The third Hi-Vol sampler, shown in Figure 56, contained a (8 in. x 10 in.) fiberglass filter but was not operated. This filter was used to determine background emissions for correction of the sample weights. The same filter was used at all four locations and the resulting weight of collected material was averaged among them.

The Baltimore County facility has a dust collection system connected to the shredders. Figure 58 shows the duct work for this system. Figure 59 is a view of line 2 shredder, showing the duct connected to the input chute opposite the input opening. The baghouse for collecting the particles is located on the west side of the facility and is labeled "Dust Collection" in Figure 14.

To test for the effect of the dust collection system, the first 2 days were sampled with the system off; then the system was on for the last 2 days.

The filters from the Hi-Vols were weighed to determine $\mu g/m^3$ of particulate concentration. The analytical laboratory used these filters to determine the concentration of the trace metals Ba, Cd, Cr, Cu, Pb and Zn.

The material on the Sierra filters was assumed to have a density of 1; therefore, based on the measured flow rate, the cutoff diameters of the collected particles were 6.9, 2.7, 1.3, 0.85, and 0.44μm.

TEST RESULTS

The emissions data of interest from a health and safety standpoint are particle concentration, particle size distribution, trace metals, and asbestos present in the in-plant ambient air (worker exposure). This study is centered around equipment evaluation; therefore, the samplers were located to test for the emissions due to equipment.

Particle Concentration

The data indicate that particle concentration is not a danger at either the Outagamie County or Baltimore County plants, based on current TLV's.* Figures 60 and 61 show graphically the dust levels at the four test locations at Outagamie and Baltimore counties, respectively. The highest level of particle concentration was at location 4 at Outagamie County on day 2 with 6.617 mg/Nm^3. As explained below, the level of trace metal concentration was low enough that the only consideration is nuisance dust, which has a TLV* of 10 mg/m^3. The highest average for the 4 days is 5.546 mg/m^3, again at location 4, at Outagamie County. Detailed data are given in Tables C-24 and C-25 in Appendix C for Outagamie County and Baltimore County, respectively.

Particle Size Distribution

The particle size distribution for the three sites tested at Outagamie County, E1, E2 and E3, are plotted in Figures 62 to 68, and the background data are in Tables C-26 to C-32 in Appendix C. This same information for Baltimore County is plotted in Figures 69 to 72, with background data in Tables C-33 to C-36 in Appendix C.

The alveolar (lung's air sacks) deposition range or particle sizes are of interest from a health standpoint. The quantity of particles in mg/Nm^3 is calculated by multiplying the percent of particles in the alveolar deposition zone (Figures 62 to 72) by the corresponding particle concentration from Tables C-24 and C-25 in Appendix C. The results are plotted in Figure 73 for Outagamie County and Figure 74 for Baltimore County. The background data for these graphs are in Table C-37 of Appendix C. On these graphs, the cross-hatched bars indicate the days the dust control system was on.

---

* TLV (threshold limit value) from American Conference of Governmental and Industrial Hygienists.

With the exception of the dust collected at the magnetic separator system at Outagamie County, there is no clear indication that the particles in the alveolar deposition zone are controlled with the existing systems. As was pointed out in the section on particle concentration, these levels are not a health hazard.

Trace Metals

The data from the trace metal analysis (Tables C-1 to C-20) are tabulated by test day and location in Tables C-38, 39 and 40 in Appendix C. In all cases, the amount of toxic metals was well below their respective TLVs. Table 9 lists the metals that the samples were analyzed for, for each location, with the published TLV and the highest concentration found. The sample with concentration closest to its TLV was lead, at Outagamie County, with 0.018 mg/Nm^3 and a TLV of 0.150 mg/Nm^3.

DISCUSSION

The results of inplant air emissions tests indicate that nuisance dust, trace metals and asbestos are not health hazards. Two previous EPA sponsored test programs reached the same conclusions;* therefore, it is recommended that no further testing, of this type, be done until there is some indication of a problem area.

* St. Louis Demonstration Final Report: Refuse Processing Plant Equipment, Facilities, and Environmental Evaluations. EPA-600/2-77-155a.
Evaluation of Fabric Filter Performance at Browning Ferris Industries/ Raytheon Service Company Resource Recovery Plant, Houston, Texas. EPA Contract No. 68-02-2166.

TABLE 9. TLV OF METALS ANALYZED VERSUS CONCENTRATION

Metal	TLV mg/Nm^3	Highest Concentration mg/Nm^3	
		Baltimore County	Outagamie County
Antimony	0.5		0.002
Arsenic	0.5		0.00007
Asbestos*			
Barium	0.5	0.0018	0.003
Beryllium	0.002	0	0.000013
Cadmium	0.1	0.0001	0.00014
Chromium	0.5	0.0134	0.00648
Copper	1.0	0.0019	0.00158
Lead	0.15	0.0052	0.018
Mercury	0.05		0.000037
Selenium	0.2		0.000007
Silver	0.01		0.000036
Titanium			0.00134
Vanadium	0.01		0.000296
Zinc	5.0	0.0037	0.00788

* Asbestos: The 12 millipore filters from Outagamie County were sectioned in MRI's laboratory and shipped to an independent laboratory for physicochemical morphology electron microscope analysis for asbestos. The three filters with the most sample were analyzed and no asbestos was found. Based on two previous similar investigations for asbestos, which found only 0.46% and 0.0% by weight of sample,1,2/ the decision was made not to analyze the remaining nine filters or test for asbestos at Baltimore County.

1/ St. Louis Demonstration Final Report, MRI Project No. 4033-L, page 64.

2/ Evaluation of Fabric Filter Performance at Browning Ferris Industries/Raytheon Service Company Resource Recovery Plant, Houston, Texas, MRI Project No. 4290-L(13), page 44.

Figure 52. Emission Sampler at Conveyor Belt Intersection (Location E2)

Figure 53. Emission Sampler on Tipping Floor (Location E4)

Figure 54. Emission Sampler Location E1, Baltimore County

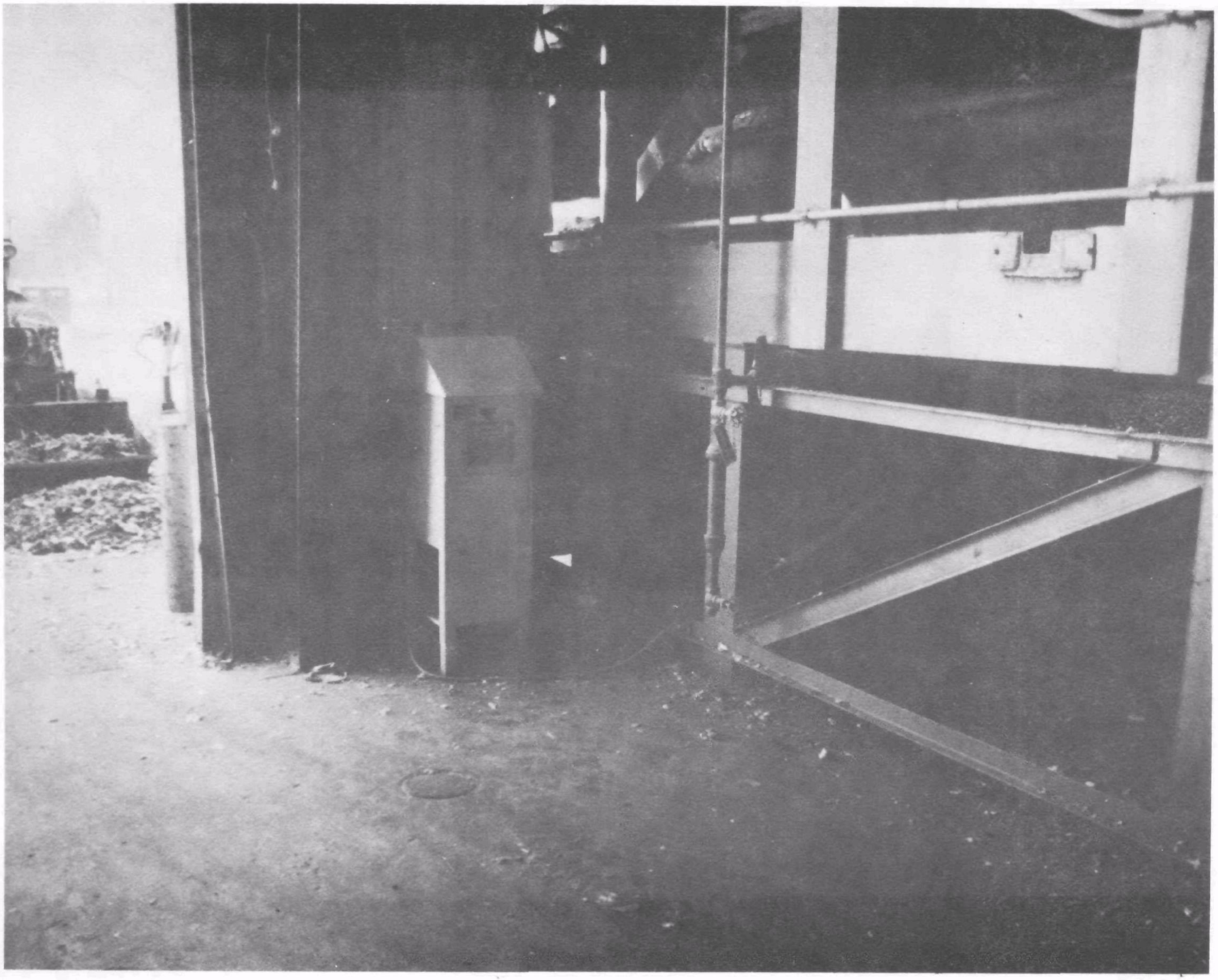


Figure 55. Emission Sampler Located E2, Baltimore County

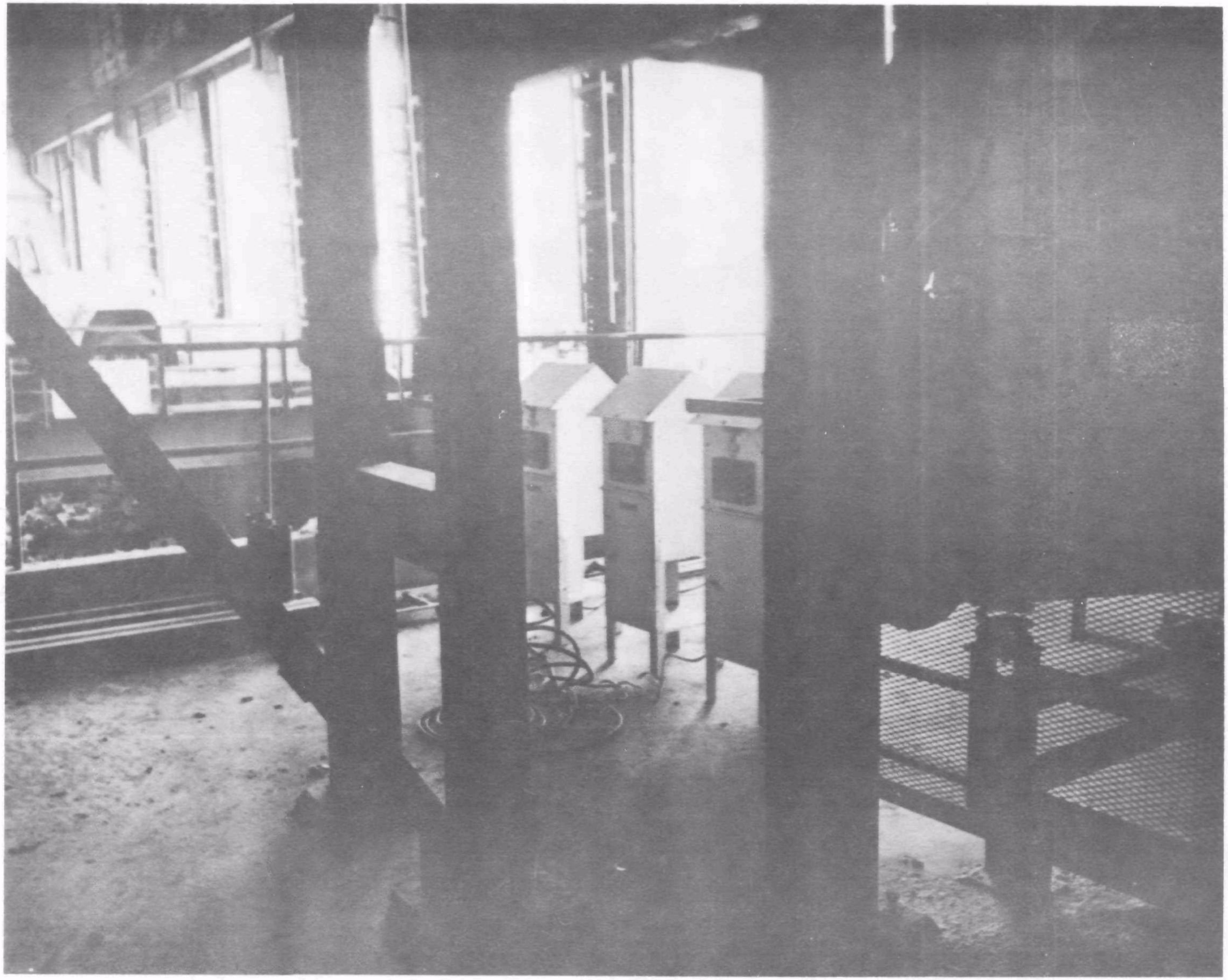


Figure 56. Emission Samplers Location E3, Baltimore County

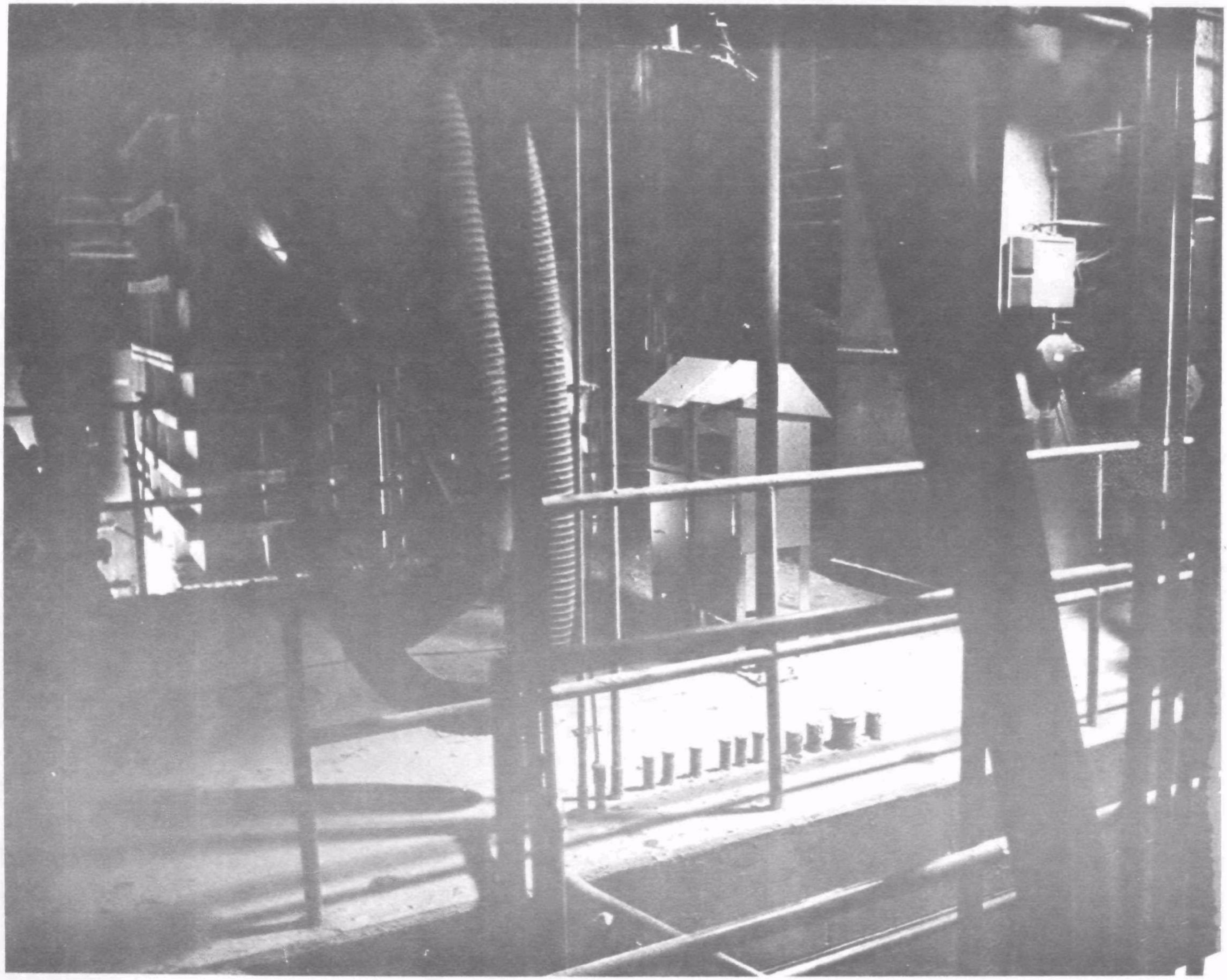


Figure 57. Emission Sampler Location E4, Baltimore County

Figure 58. Duct Work for Dust Collection System, Baltimore County

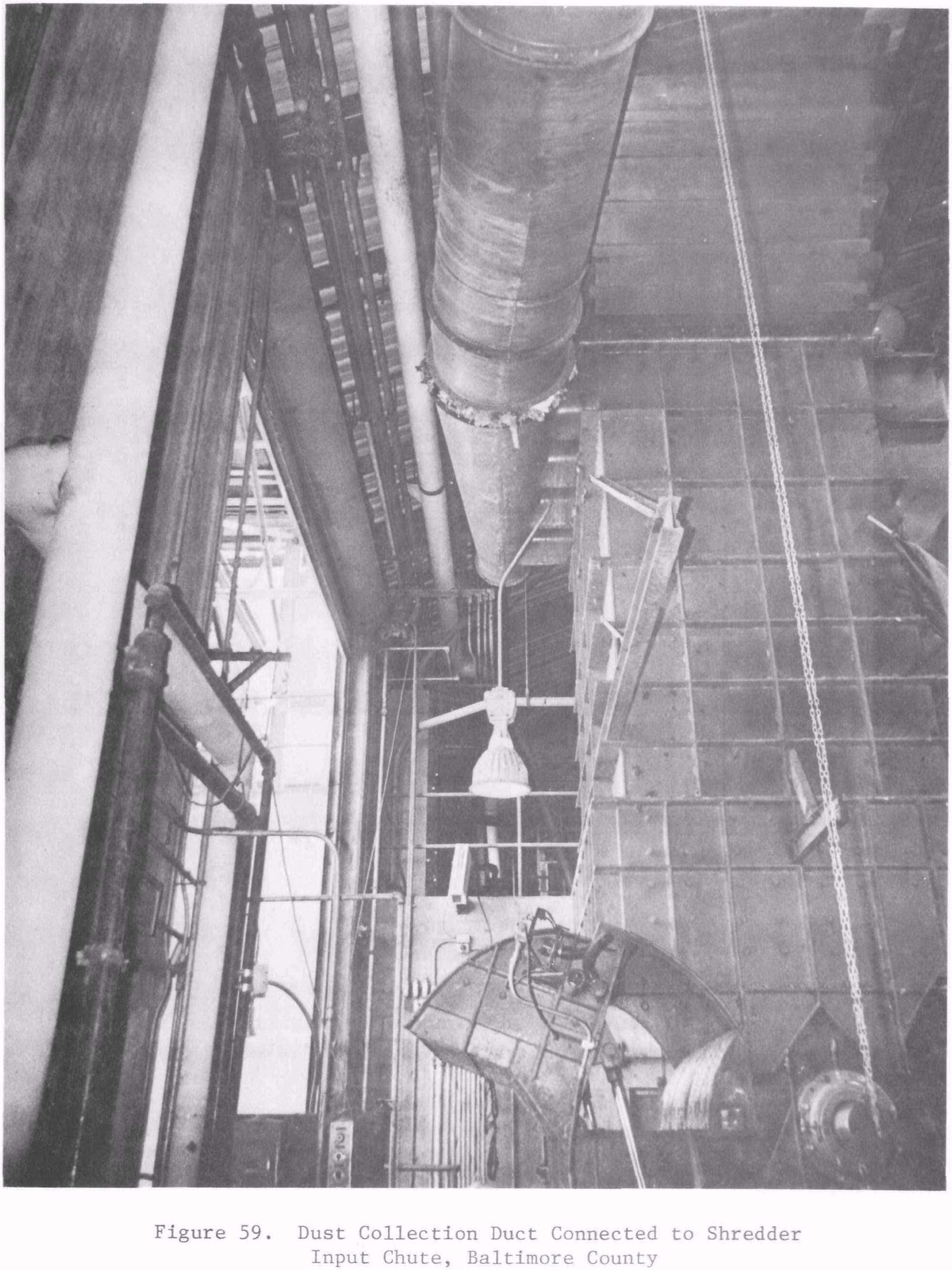


Figure 59. Dust Collection Duct Connected to Shredder Input Chute, Baltimore County

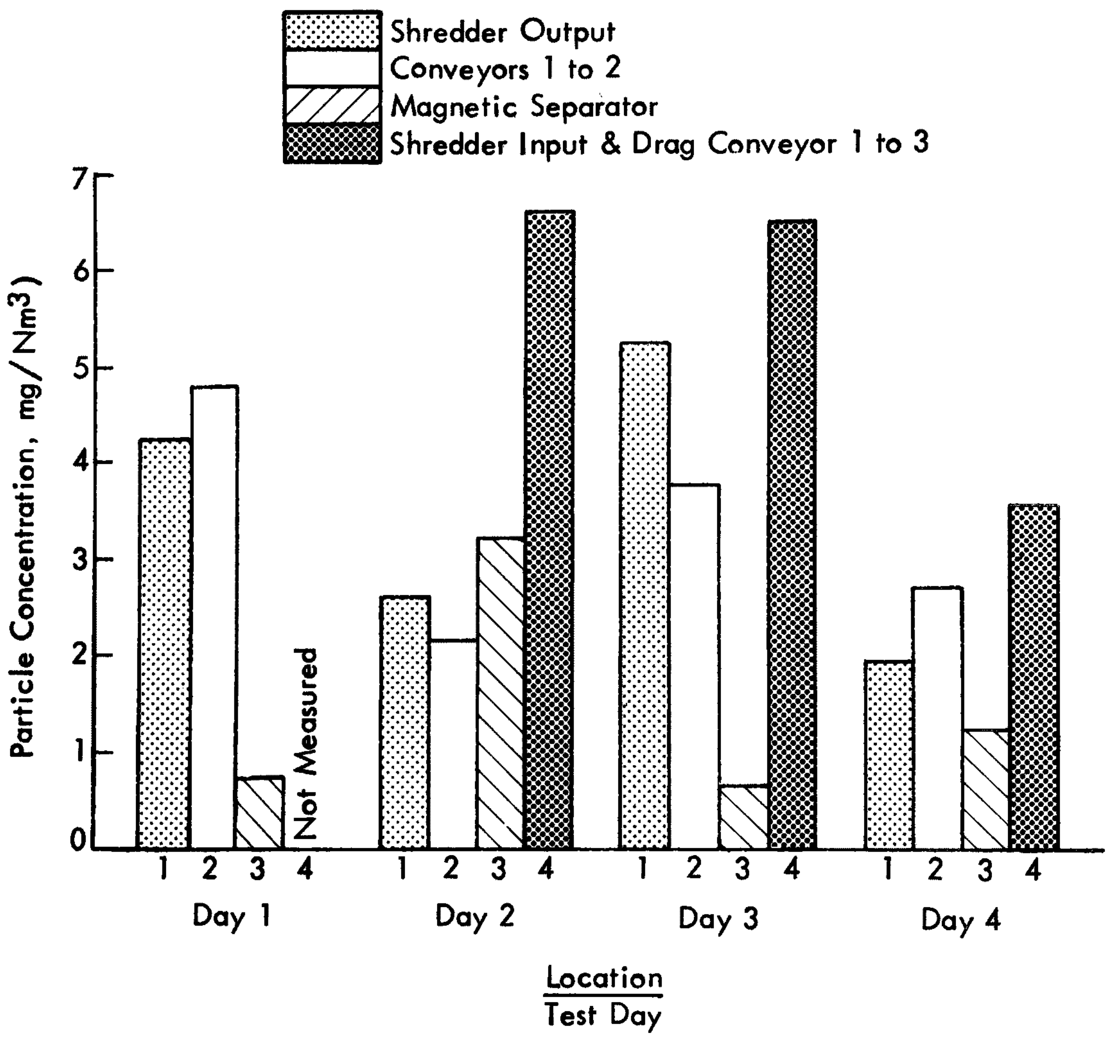


Figure 60 - Particle Concentration Versus Day by Location

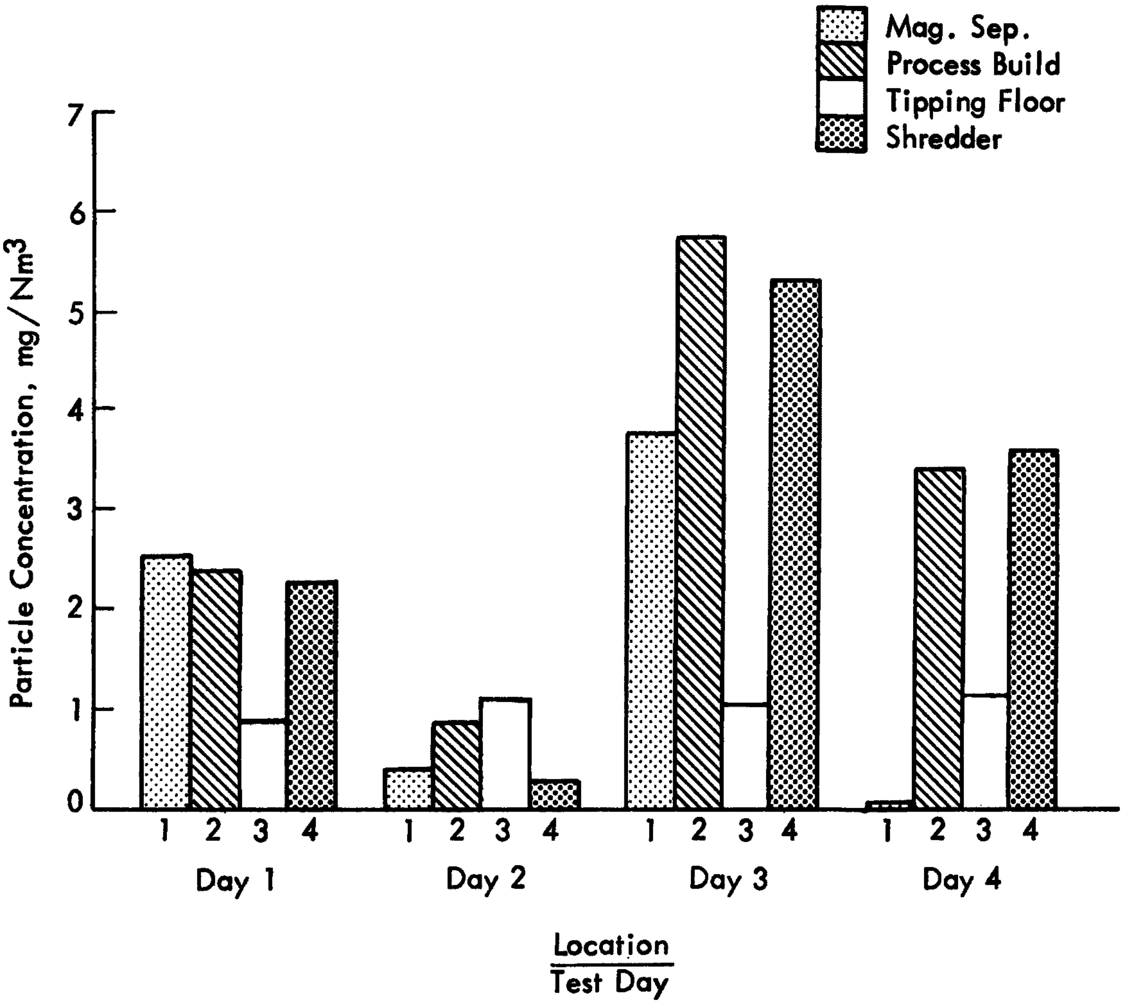


Figure 61 - Particulate Concentration Versus Day by Location, Baltimore County

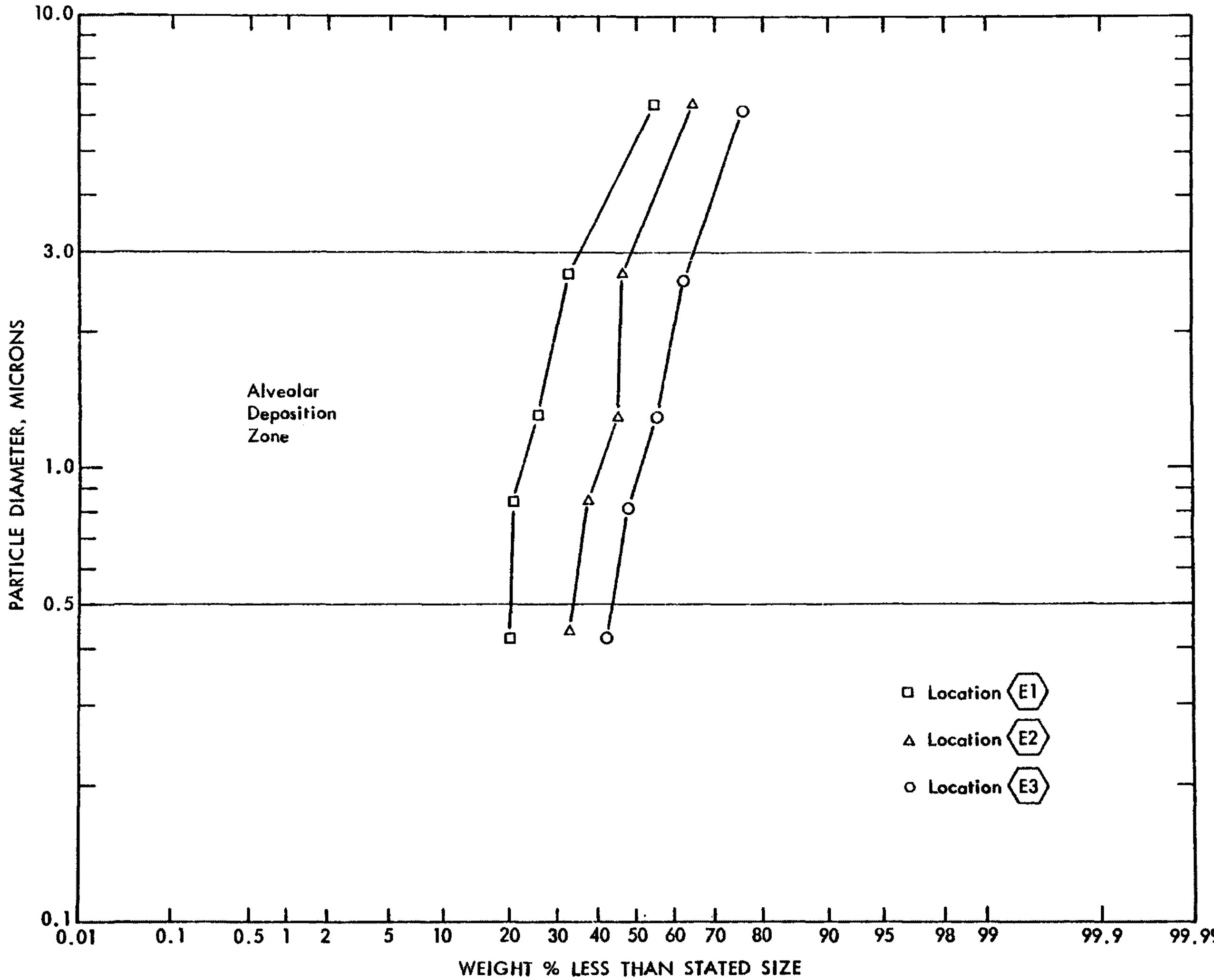


Figure 62. Particle Size Distribution, Day 1,
Outagamie County

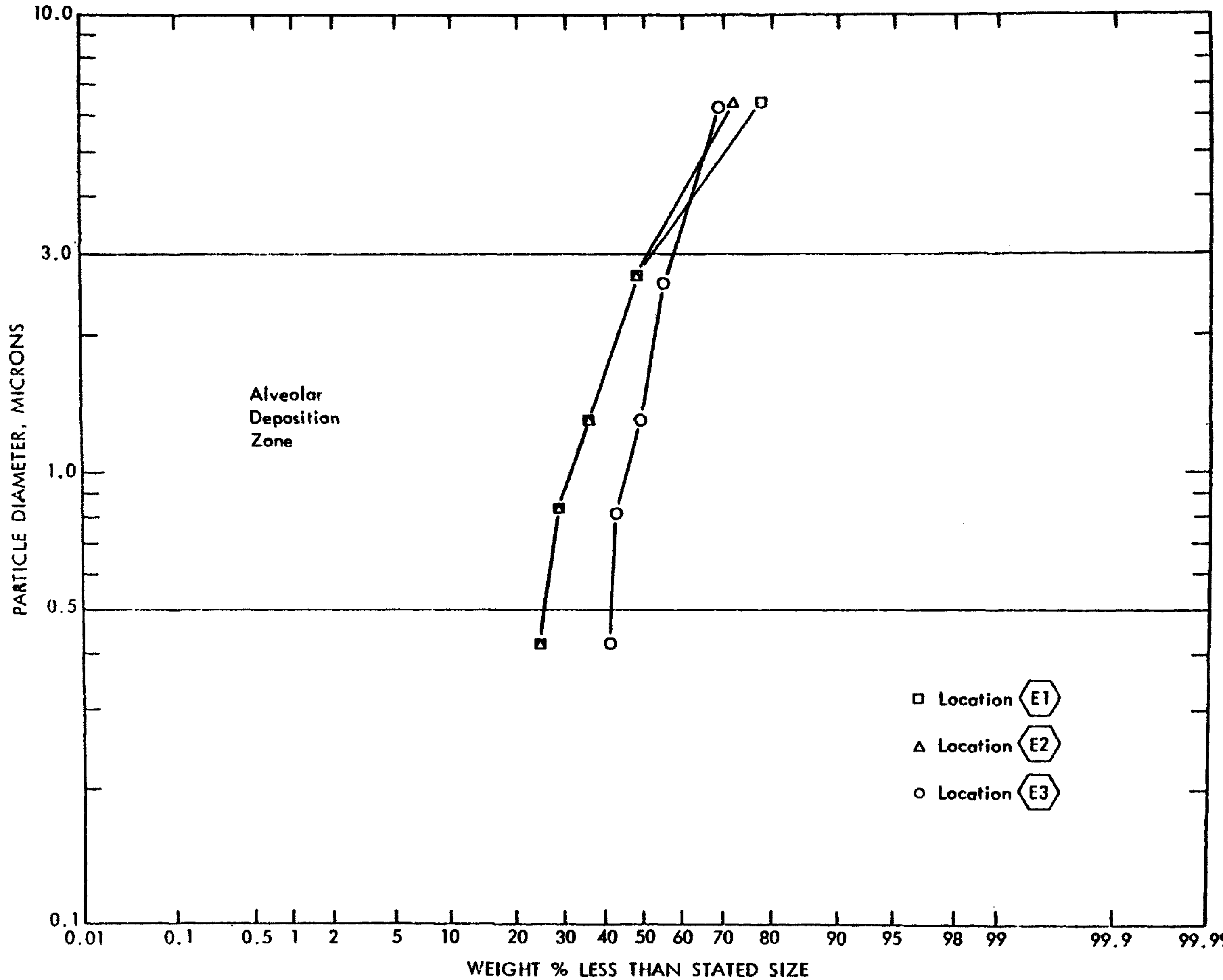


Figure 63 - Particle Size Distribution, Day 2, Outagamie County

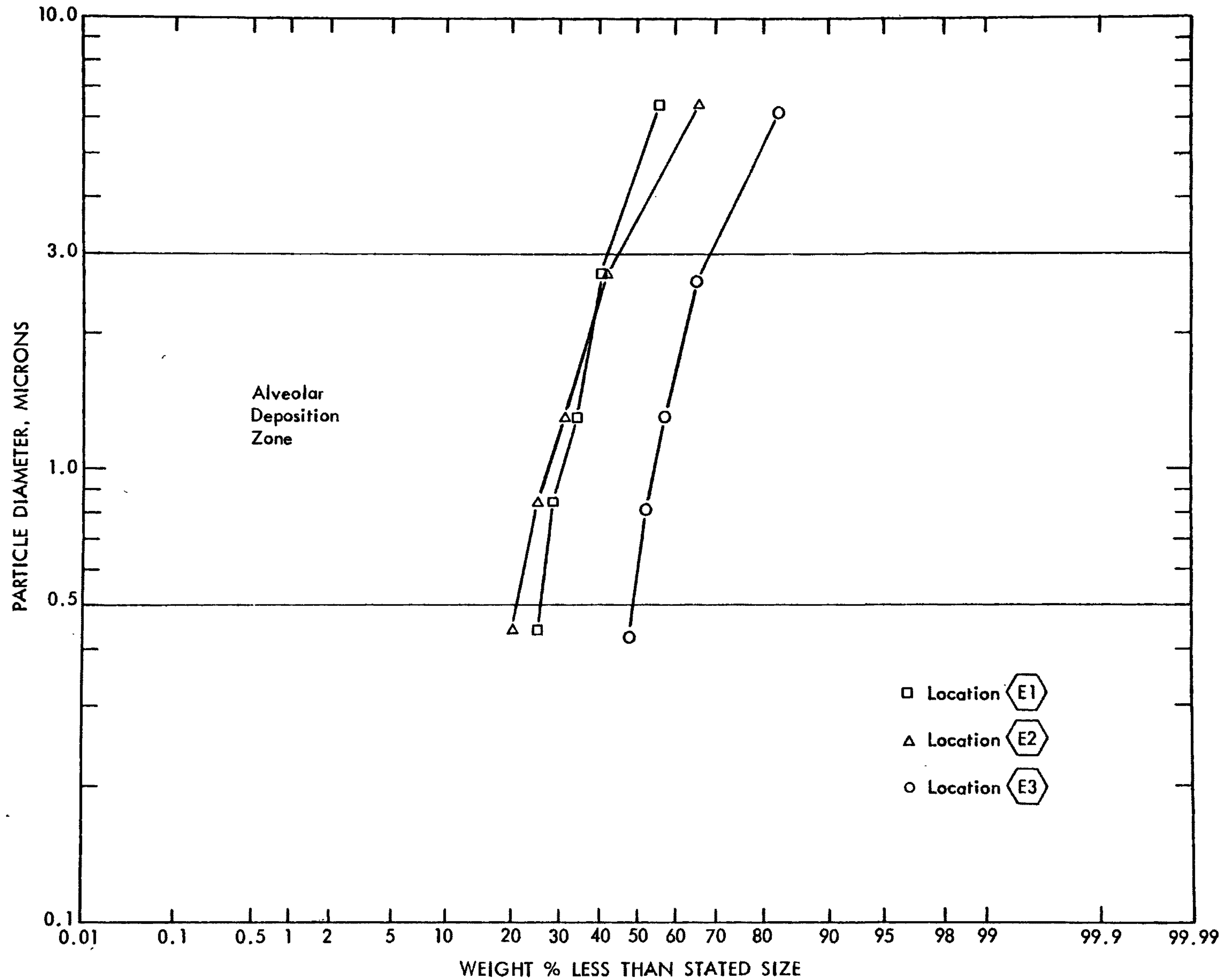


Figure 64. Particle Size Distribution, Day 3, Outagamie County

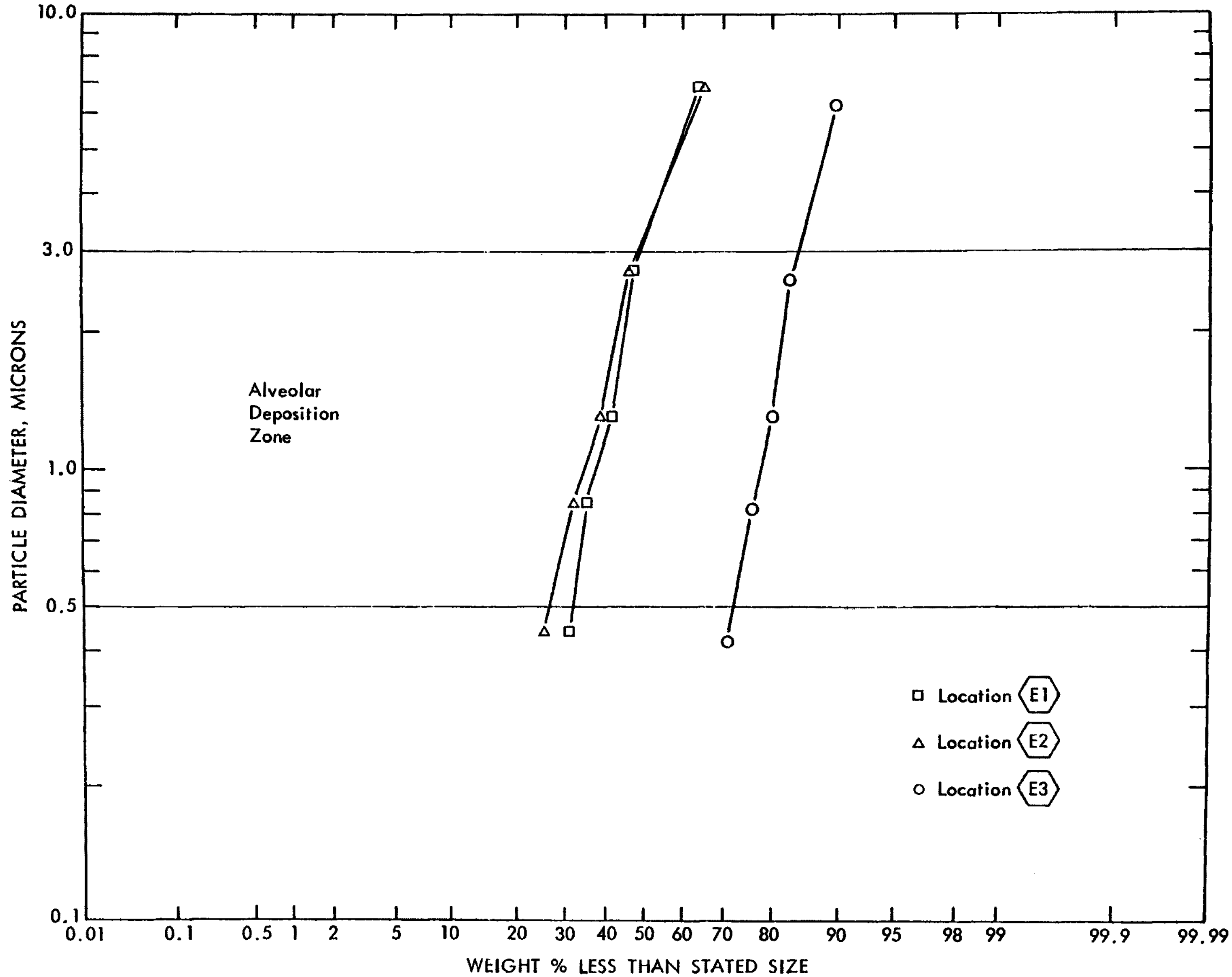


Figure 65. Particle Size Distribution, Day 4, Outagamie County

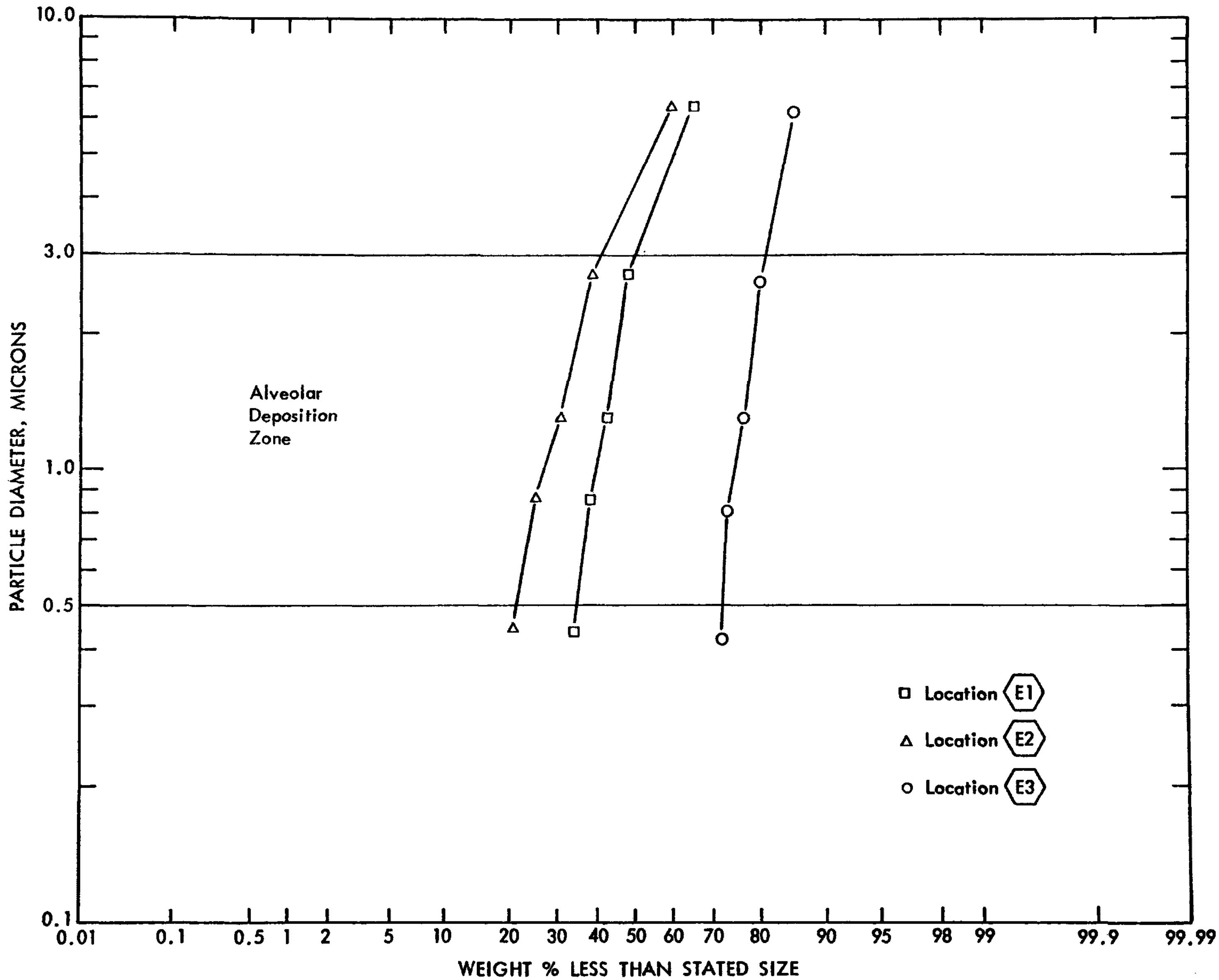


Figure 66. Particle Size Distribution, Day 5,
Outagamie County

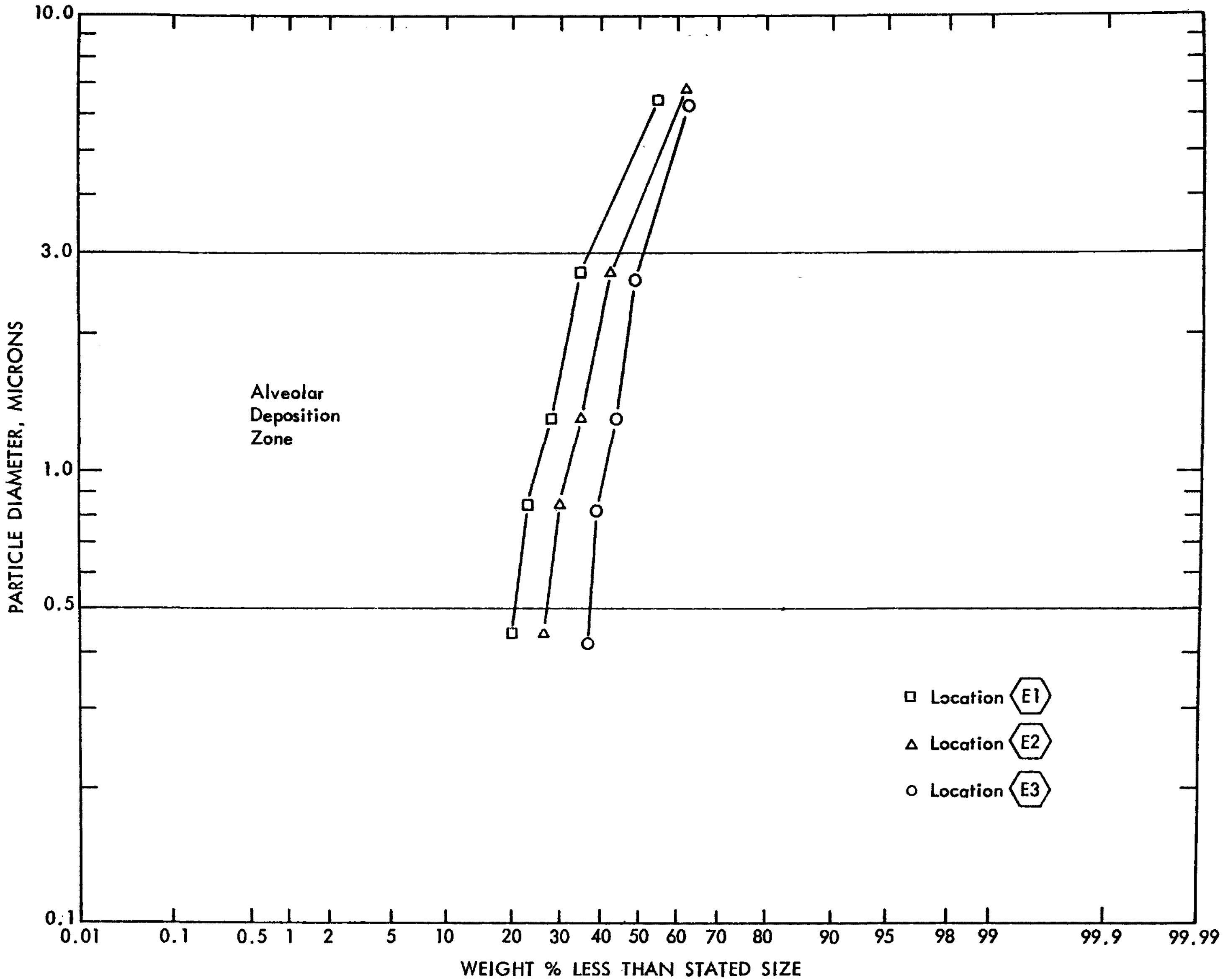


Figure 67. Particle Size Distribution, Day 6, Outagamie County

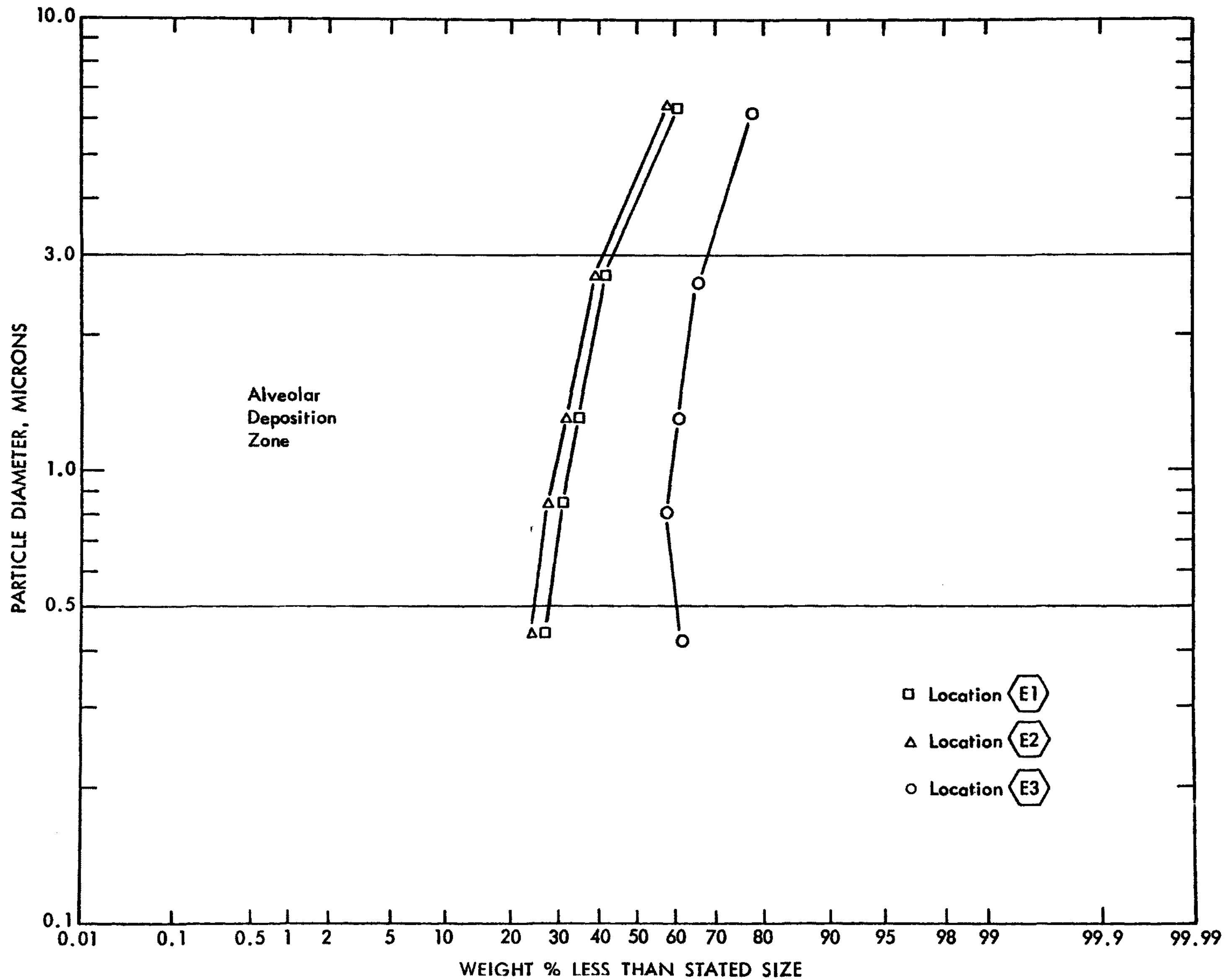


Figure 68. Particle Size Distribution, Day 7,
Outagamie County

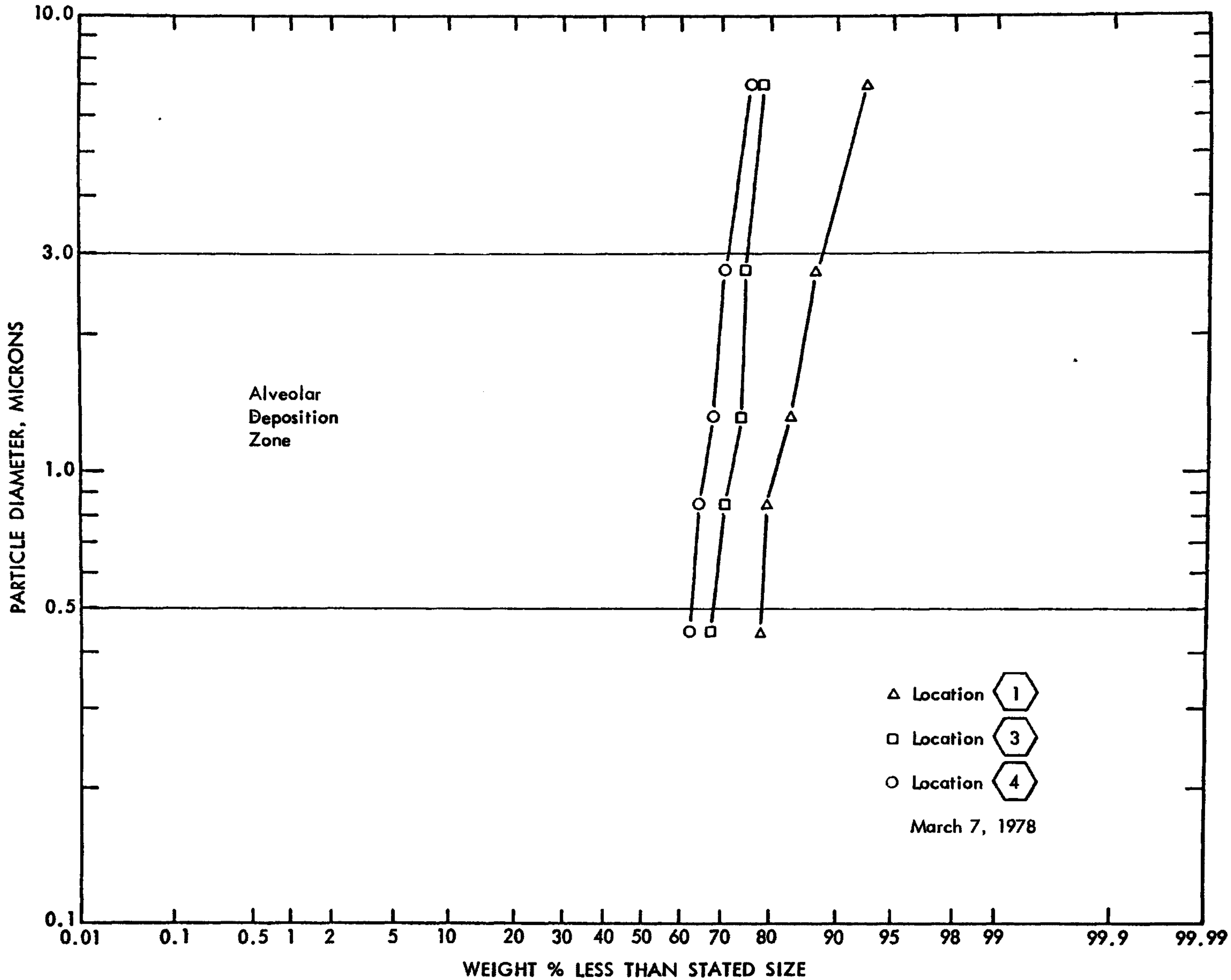


Figure 69. Particle Size Distribution, Day 1,
Baltimore County

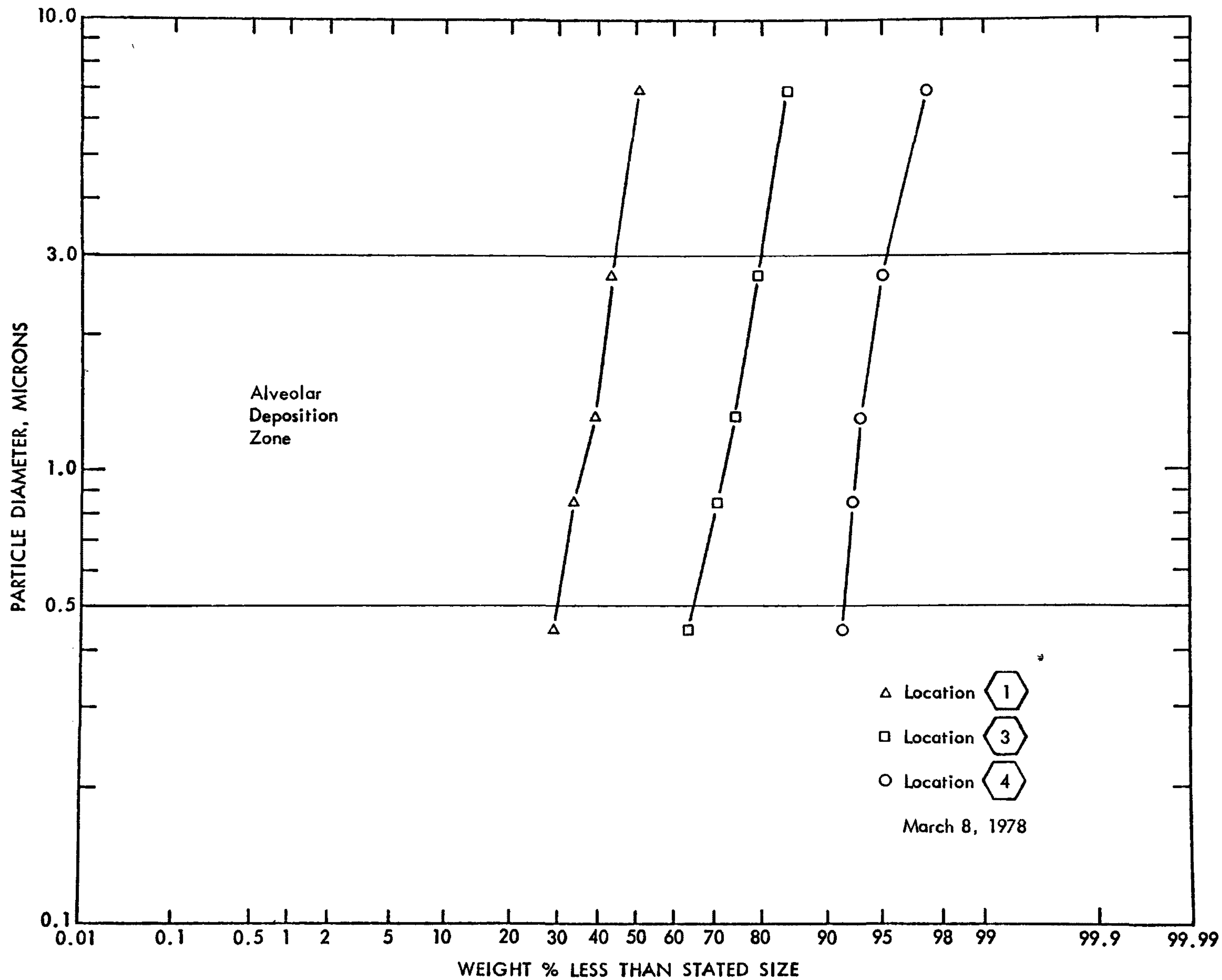


Figure 70. Particle Size Distribution, Day 2, Baltimore County

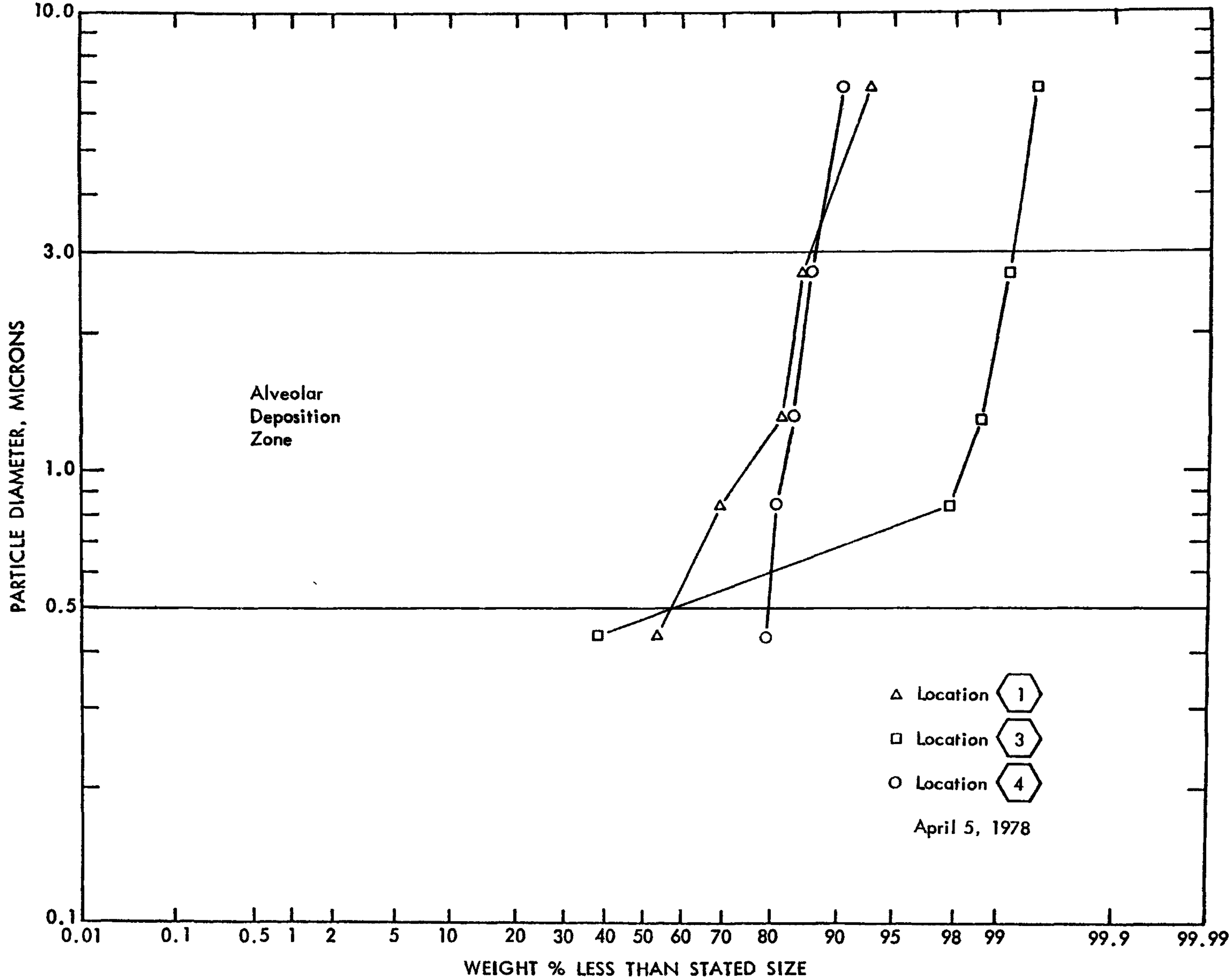


Figure 71. Particle Size Distribution, Day 3, Baltimore County

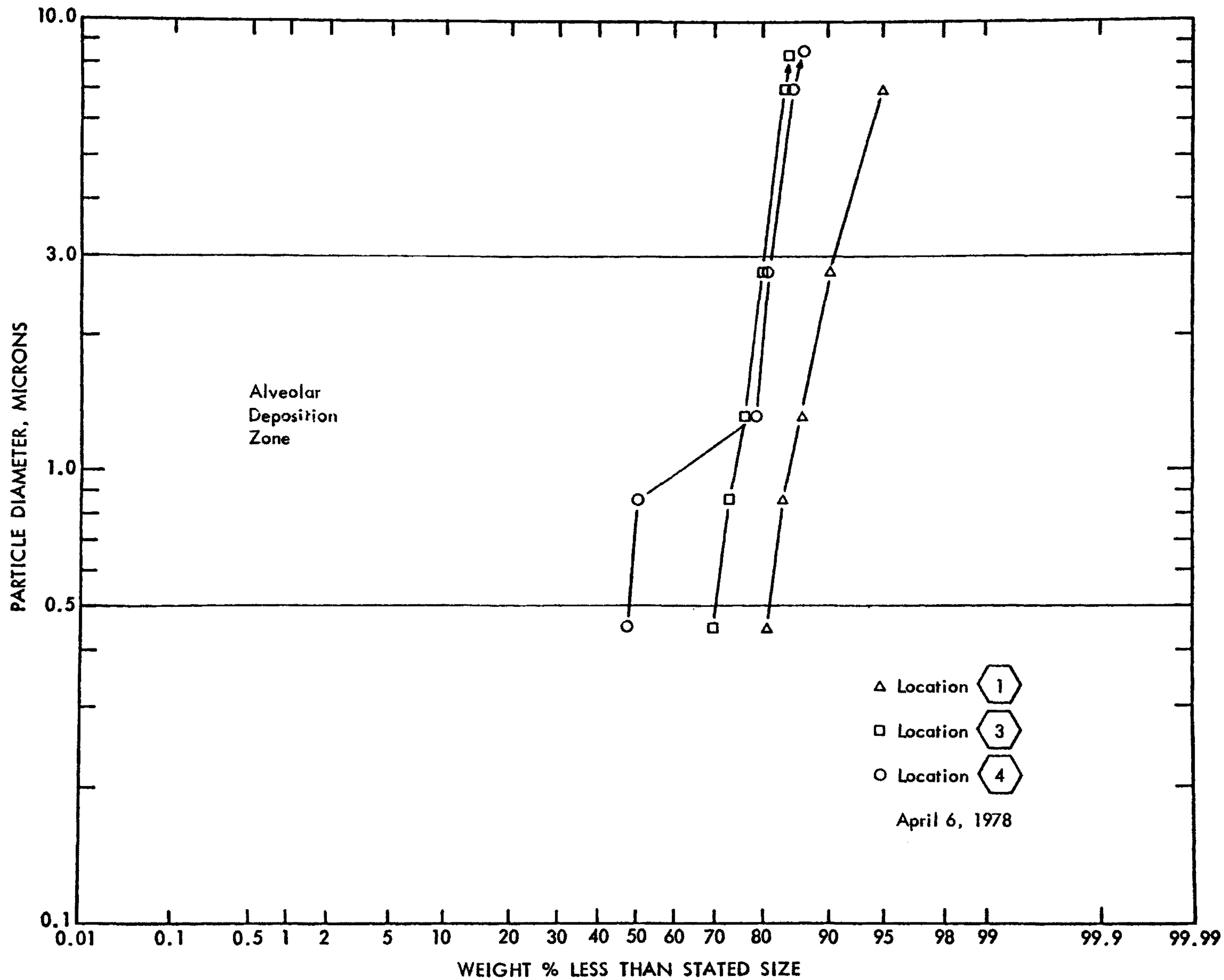


Figure 72. Particle Size Distribution, Day 4, Baltimore County

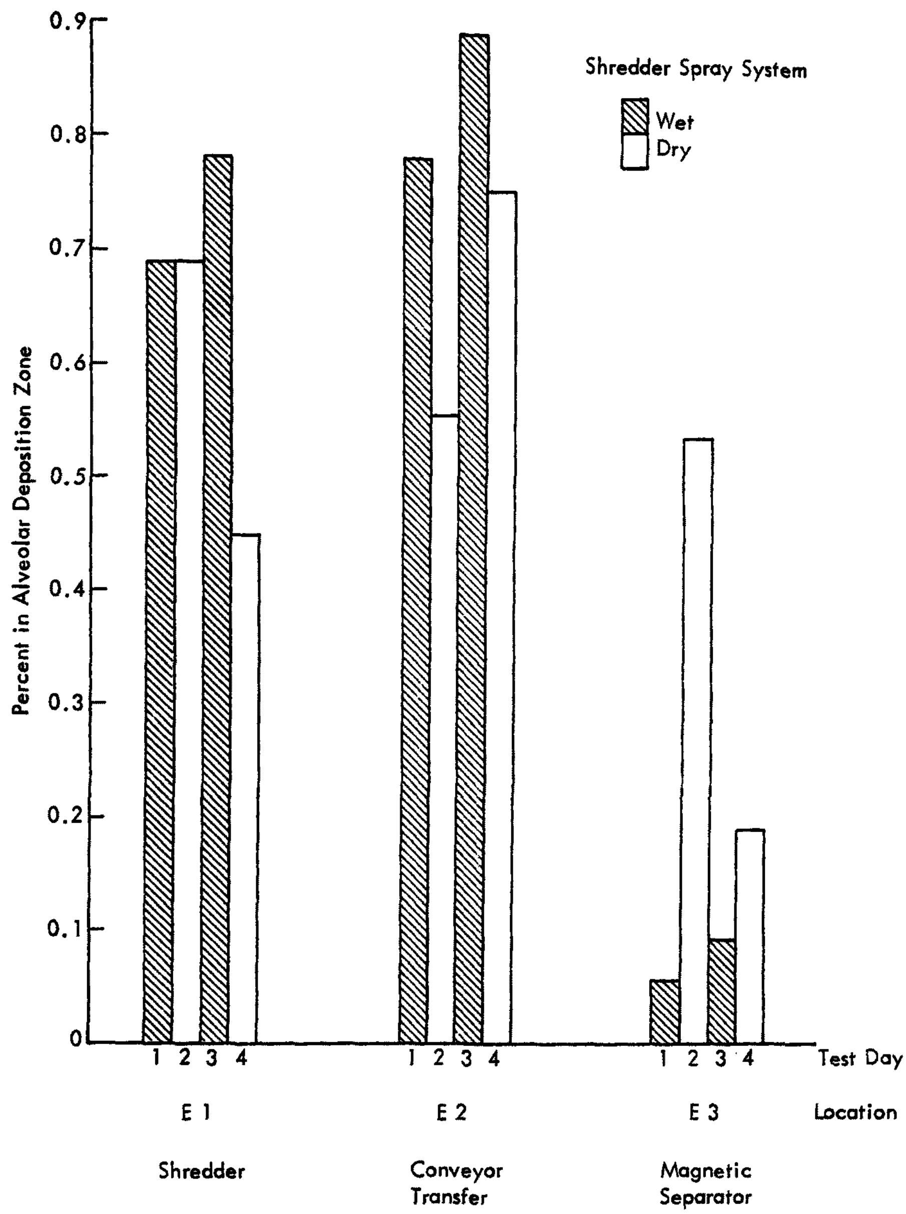


Figure 73. Percent Particulate in Alveolar Deposition Zone Versus Test Day and Location, Outagamie County

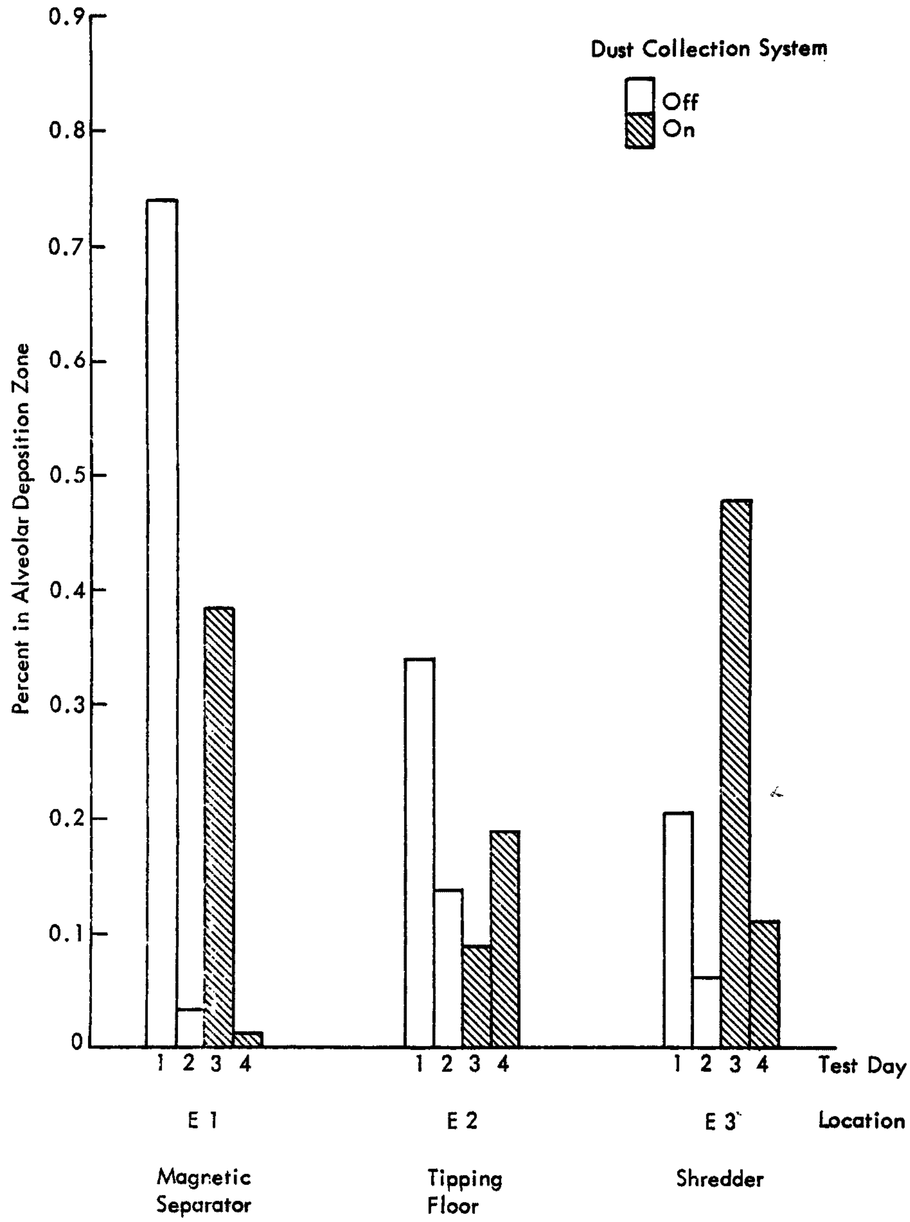


Figure 74. Percent Particulate in Alveolar Deposition Zone Versus Test Day and Location, Baltimore County

APPENDIX A - MAGNETIC SEPARATOR DATA

TABLE A-1. CONVEYOR SPECIFICATIONS - OUTAGAMIE COUNTY

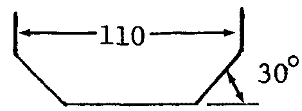
Conveyor	Type	Incline Degrees	Velocity m/min	Width cm
DRAG 1 + 2	Steel Piano Hinge	0	3.0	274
DRAG 3 + 4	Steel Piano Hinge	35	0 to 6.1	182
Belt 1	B. F. Goodrich Nyloc 250 Korseal	0	65.5	122
Belt 2	B. F. Goodrich Nyloc 250 Korseal	21	65.5	
Belt 3	B. F. Goodrich Nyloc 250 Korseal	0	Reversible 65.5	122
Magnetic Separator	Special	21	95	91

TABLE A-2. CONVEYOR SPECIFICATIONS - BALTIMORE COUNTY

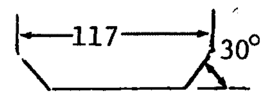
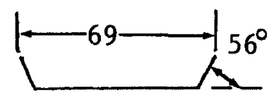
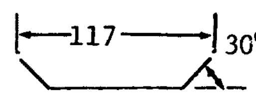
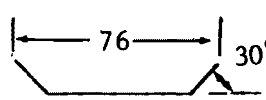
Conveyor	Type	Incline Degrees	Velocity m/min	Width cm
DRAG 1 + 2	Steel Piano Hinge	34	0 to 7.3	183
Belt 1 + 6	B.F. Goodrich Flexseal Nylon Polyester Polyester	0	93	213
Belt 2		22	128	
Belt 3 + 8		0	44	152
Belt 4 + 9		9.5	50	
Belt 5 + 10		17	87	
Belt 7		22	79	See Belt 2
Belt 11		0	Reversible 87	152
Belt 12		0	91	152
Belt 13		20	134	152
Belt 15		12	84	See Belt 2
Belt 16		15.5	46	See Belt 2
Belt 17		12.5	41	
Belt 18		24	41	122
Belt 19		8	84	152
Belt 20		0	82	152
Belt 21		12.5	83	See Belt 17
Magnetic Separator	Special	0	117	152

TABLE A-3. WEIGHTS OF SAMPLE COMPONENTS IN GRAMS

OUTAGAMIE COUNTY

Test		Ferrous Stream S2		Reject Stream S1	
Day	Sample	Ferrous	Nonferrous	Ferrous	Nonferrous
1	1	6,409	85.90	7.05	2,018
	2	7,611	75.30	37.80	2,858
	3	6,827	85.00	7.40	4,286
	4	9,244	326.70	41.50	2,268
2	1				
	2	8,210	122.50	8.95	4,060
	3	7,484	142.20	1.75	794
	4	5,615	60.30	6.25	2,835
3	1	9,412	78.80	68.00	1,973
	2	13,553	338.30	59.20	2,381
	3	8,868	207.70	154.60	2,404
	4	5,375	55.90	109.10	1,701
4	1				
	2	6,804	106.70	30.40	1,814
	3	5,216	69.20	15.60	680
	4	8,346	212.60	11.80	2,087
5	1	7,303	219.10	15.20	1,814
	2	6,532	91.60	21.40	2,948
	3	7,099	177.50	21.80	2,835
	4	8,278	75.60	15.30	2,767
6	1	3,152	73.90	0.90	635
	2	6,963	180.00	1.80	816
	3	10,251	329.50	64.40	1,996
	4	5,897	81.60	76.40	2,608
7	1	7,711	235.20	127.30	2,381
	2	6,917	45.50	18.00	1,905
	3	6,305	172.50	12.40	1,633
	4	4,695	165.00	18.90	1,928

TABLE A-4. WEIGHTS OF SAMPLE COMPONENTS IN GRAMS

BALTIMORE COUNTY

Test Day	Sample	Ferrous Stream S2 Ferrous	Ferrous Stream S2 Nonferrous	Reject Stream S1 Ferrous	Reject Stream S1 Nonferrous	Test Day	Sample	Ferrous Stream S2 Ferrous	Ferrous Stream S2 Nonferrous	Reject Stream S1 Ferrous	Reject Stream S1 Nonferrous
	1	454	7.6	326.7	20334		1	1260	4.3	671.7	25600
	2	4083	9.4	1271.7	18222		2	1590	1.4	393.3	36493
1	3	1905	0.4	840.9	14953	4	3	3630	25.3	1206.7	32753
	4						4	2174	6.5	503.3	34886
	1	544	3.0	1012.1	37415.9		1	3445	7.3	546.1	39810
	2	2540	0.3	3799.2	31204.8		2	3531	12.8	1107.2	33647
2	3	2225	2.2	996.4	41809.6	5	3	1864	3.8	458.4	24040
	4	1747	3.6	1175.6	33488.4		4	909	8.2	439	18349
	1	966	0.3	565.5	5678.5		1	2540	4.6	584.4	37209
	2	2051	4.2	3051.5	49002.5		2	2994	3.5	624.9	25647
3	3	1109	3.2	4745.6	34136.4	6	3	2043	3.1	452.2	20014
	4	1148	1.4	2818.9	29304.1		4	5027	12.5	1601.6	34672

TABLE A-5. MASS BALANCE DATA

OUTAGAMIE COUNTY

Test Day	Date	Weighted Incoming (kg)	Bulk[a] Ferrous (kg)	Bulk[a] Landfill (kg)	Shredder Water Spray (kg)	Total[b] Shredded (kg)	Shredders Run Time (hours)	Shredder thru-put (Mg/hr)	Ferrous Recovered (kg)	Landfill Material (kg)	Total[c] Outgoing (kg)	Balance + = more out (kg)	Percent of Input
1	Monday	179,446	557	902	25,145	203,132	13.30	15.27	7,675	196,977	206,111	- 1,459	- 0.70
2	Tuesday	147,254	457	740	12,629	158,686	10.80	14.69	5,625	146,972	153,794	- 6,089	- 3.80
3	Wednesday	194,491	603	977	22,399	215,310	15.00	14.35	6,241	212,490	220,311	+ 3,421	+ 1.58
4	Thursday	160,408	498	806	10,874	169,978	10.20	16.66	6,441	174,751	182,496	+ 11,214	+ 6.55
5	Friday	189,538	588	952	27,694	215,692	14.10	15.30	5,842	201,948	209,330	- 7,902	- 3.64
6	Monday	189,738	588	953	28	188,225	14.00	13.44	7,793	182,217	191,551	+ 1,785	+ 0.94
7	Tuesday	173,853	539	874	26,051	198,491	13.70	14.49	5,969	192,577	199,959	+ 55	+ 0.03

a/ Daily bulk weights calculated from weighted average based on incoming.
b/ Total shredded = incoming - bulk ferrous - bulk landfill + water
c/ Total outgoing = bulk ferrous + bulk landfill + ferrous recovered + landfill material.

TABLE A-6. MAGNETIC SEPARATOR INPUT PERCENT FERROUS METAL

OUTAGAMIE COUNTY				
Test Day	Sample Weight (kg)	Ferrous Weight (kg)	Ferrous Weight %	Ferrous Weight % Average
1	NO SAMPLES TAKEN			
2	1.41	0.00	0.00	
3 a	11.23	0.34	3.03	
b	9.15	0.14	1.53	
c	6.34	0.17	2.68	
d	6.77	0.44	6.50	
Average				3.44
4 a	2.63	0.02	0.76	
b	4.46	0.15	3.36	
c	7.51	0.20	2.66	
Average				2.26
5 a	10.70	0.59	5.52	
b	9.88	0.09	0.91	
c	4.42	0.11	2.49	
d	10.04	0.11	1.10	
Average				2.51
6 a	2.37	0.00	0.00	
b	7.60	0.23	3.03	
c	10.69	0.23	2.15	
d	2.93	0.03	1.02	
Average				1.55
7 a	8.50	0.04	0.47	
b	7.16	0.24	3.35	
c	5.38	0.21	3.90	
d	7.81	0.33	4.22	
Average				2.99
			Overall -	2.55

TABLE A-7. MAGNETIC SEPARATOR INPUT PERCENT FERROUS METAL

OUTAGAMIE COUNTY

Test Day	Recovered Magnetics (kg)	Landfill (kg)	Ferrous in Landfill (%)	Ferrous in Landfill (kg)	Material to System (kg)	Ferrous in Input (kg)	Ferrous in Input (%)
1	3481	89347	0.92	822	92828	4303	4.64
2	2551	66665	1.24	827	69216	3378	4.88
3	2831	96384	4.73	4559	99215	7390	7.45
4	2922	79266	1.50	1189	82188	4111	5.00
5	2650	91602	0.73	669	94252	3319	3.52
6	3535	82652	1.70	1405	86187	4940	5.73
7	2707	87351	1.93	1686	90058	4393	4.88
						AVERAGE =	5.16

TABLE A-8. PERCENT FERROUS METAL IN INPUT STREAM

BALTIMORE COUNTY

Test Day	Sample Weight (kg)	Recovered Ferrous Weight (kg)	Last Ferrous Weight (kg)	Total Ferrous Weight (kg)	Total Ferrous (%)	Average
1 a	21.12	0.45	0.33	0.78	3.7	
b	23.59	4.08	1.27	5.35	22.7	
c	17.70	1.91	0.84	2.75	15.5	
Average						14.00
2 a	38.98	0.54	1.01	1.55	4.0	
b	37.54	2.54	3.80	6.34	16.9	
c	45.03	2.22	1.00	3.22	7.2	
d	36.41	1.75	1.18	2.93	8.0	
Average						9.03
3 a	7.21	0.97	0.57	1.54	21.2	
b	54.11	2.05	3.05	5.10	9.4	
c	39.99	1.11	4.75	5.86	14.6	
d	33.27	1.15	2.82	3.97	11.9	
Average						14.28
4 a	27.54	1.26	0.67	1.93	7.0	
b	38.48	1.59	0.39	1.98	5.2	
c	37.62	3.63	1.21	4.84	12.9	
d	37.57	2.17	0.50	2.67	7.1	
Average						8.05
5 a	43.81	3.45	0.55	4.00	9.1	
b	38.30	3.53	1.11	4.64	12.1	
c	26.37	1.86	0.46	2.32	8.8	
d	19.71	0.91	0.44	1.35	6.8	
Average						9.20
6 a	40.34	2.54	0.58	3.12	7.7	
b	29.27	2.99	0.62	3.61	12.4	
c	22.51	2.04	0.45	2.49	11.1	
d	38.27	5.03	1.60	6.63	17.3	
Average						12.13
					Overall -	11.12

TABLE A-9. PERCENT NON-MAGNETIC MATERIAL IN MAGNETIC STREAM

OUTAGAMIE COUNTY

Test Day	Sample No.	Sample Weight (kg)	Non-Magnetics Weight (kg)	Non-Magnetics Weight %	Average %
1	1	6.49	0.09	1.39	
	2	7.69	0.08	1.04	
	3	6.91	0.09	1.30	
	4	9.57	0.33	3.44	
Average					1.79
2	1	NO SAMPLE			
	2	8.33	0.12	1.44	
	3	7.63	0.14	1.83	
	4	5.68	0.06	1.06	
Average					1.44
4	1	NO SAMPLE			
	2	6.91	0.11	1.59	
	3	5.29	0.07	1.32	
	4	8.56	0.21	2.45	
Average					1.79
5	1	7.52	0.22	2.93	
	2	6.62	0.09	1.36	
	3	7.28	0.18	2.47	
	4	8.35	0.08	0.96	
Average					1.93
6	1	3.23	0.07	2.17	
	2	7.14	0.18	2.52	
	3	10.58	0.33	3.12	
	4	5.98	0.08	1.33	
Average					2.29

TABLE A-10. PERCENT NON-MAGNETIC MATERIAL IN MAGNETIC STREAM

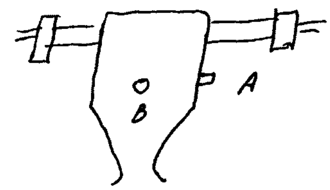
BALTIMORE COUNTY

Test Day	Sample No.	Sample Weight (g)	Non-Magnetics Weight (g)	Non-Magnetics Weight %	Non-Magnetics Average %
1	1	461.6	7.6	1.65	
	2	4092.4	9.4	0.23	
	3	1905.4	0.4	0.02	
	4	NO SAMPLE			
Average					0.63
4	1	1264.3	4.3	0.34	
	2	1591.4	1.4	0.09	
	3	3655.3	25.3	0.69	
	4	2180.5	6.5	0.30	
Average					0.36
5	1	3452.3	7.3	0.21	
	2	3543.8	12.8	0.36	
	3	1867.8	3.8	0.20	
	4	917.2	8.2	0.89	
Average					0.42
6	1	2544.6	4.6	0.18	
	2	2997.5	3.5	0.12	
	3	2046.1	3.1	0.15	
	4	5039.5	12.5	0.25	
Average					0.18

APPENDIX B - AIR CLASSIFIER DATA

TABLE B-1. PRELIMINARY VELOCITY TRAVERSES

PLANT TELEDYNE NATIONAL
DATE June 20 1978
LOCATION Cockeysville, md.
STACK I.D. Air Classifier
BAROMETRIC PRESSURE, in. Hg
STACK GAUGE PRESSURE, in. H_2O - 0.24
OPERATORS Tek Jutekno, Charles Brown
Humidity 40 %



SCHEMATIC OF TRAVERSE POINT LAYOUT

A

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0.10	84°
2	0.13	
3	0.14	
4	0.13	
5	0.12	
6	0.10	
7	0.08	
AVERAGE	0.11	

B

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	0.10	84°
2	0.14	
3	0.14	
4	0.10	
5	0.01	
6	0.025	
6 Horiz	0.03	
7	0.085	
7 Horiz	0.020	
7A	0.085	
7A Horiz	0.010	
AVERAGE	0.09	

EPA (Dur) 233
4/72

TABLE B-2. AIR CLASSIFIER MATERIALS STREAMS DATA, TEST DAY 1

BALTIMORE COUNTY

Sample No.	Fraction	Total Weight (g)	Paper and Plastic Weight (g)	Paper and Plastic Weight (%)	Other Weight (g)	Length of Sample (m)	Belt Speed (m/sec)	Flow Rate $\dot{m}_s$ (Mg/hr)	α $\dot{m}_o/\dot{m}_s$	Split Weight (%)	Ash Weight (%)	Moisture Weight (%)	Heating Value (J/kg) x 10^3	Bulk Density (kg/m^3)	Ferrous Weight (g)	Ferrous Weight (%)
01	Input	339.3	131.9	38.87	207.4	3.048	1.40	0.56						---	0.9	0.27
04		6,142	2,746	44.71	3,401	1.524		20.27						116.6	402.7	6.56
07		1,134	561.4	49.51	572.4	3.048		1.87						92.1	11.0	0.97
10		784.7	255.2	32.52	530.0	3.048		1.29						73.7	64.3	8.19
	Average	2,100	923.6	43.98	1,178			6.00			24.26	1.03	15,607	94.1	119.7	5.7
00	Lights	249.0	138.8	55.74	110.1	3.048	1.37	0.40		77.19				---	0	0
03		2,200	1,068	48.56	1,132	3.048		3.56		80.70				61.67	1.1	0.05
06		2,540	1,105	43.50	1,435	3.048		4.12		88.16				91.95	0	0
09		1.624	1,029	63.36	594	3.048		2.63		81.92				55.74	0	0
	Average	1,653	835.2	50.53	817.8			2.68		82.00	20.14	8.74	14,860	69.8	1.1	0.07
02	Heavies	141.1	0	0	140.9	3.048	0.69	0.11		22.81				---	67.5	47.84
05		1,052	73.3	6.97	979.5	3.048		0.85		19.30				---	93.6	8.90
08		684.9	61.0	8.91	623.8	3.048		0.55		11.84				---	91.3	13.33
11		716.7	36.4	5.08	681.3	3.048		0.58		18.02				---	5.4	0.75
	Average	648.7	42.68	6.58	606.4			0.52		18.00	69.21	0.81	6,966	---	64.45	9.94
	Output	390.1	212.1	54.37	251.0			0.51	155.0						67.5	17.30
	(Lights and Heavies)	3,252	1,141	35.09	2,112			4.41	18.1						94.7	2.91
		3,225	1,166	36.16	2,059			4.67	17.1						91.3	2.83
		2,341	1,065	45.49	1,275			3.21	24.9						5.4	0.23
	Average	2,302	896.0	38.92	1,424			3.20	20.0						64.7	5.81

TABLE B-3. AIR CLASSIFIER MATERIAL STREAMS DATA, TEST DAY 2

BALTIMORE COUNTY

Sample No.	Fraction	Total Weight (g)	Paper and Plastic Weight (g)	Paper and Plastic Weight (%)	Other Weight (g)	Length of Sample (m)	Belt Speed (m/sec)	Flow Rate $\dot{m}_s$ (Mg/hr)	α $\dot{m}_o/\dot{m}_s$	Split Weight (%)	Ash Weight (%)	Moisture Weight (%)	Heating Value (J/kg) x 10^3	Bulk Density (kg/m^3)	Ferrous Weight (g)	Ferrous Weight (%)
21	Input	6,577	1,946	29.59	4,627	0.92	1.40	35.95						132.8	934.4	14.21
24		4,990	1,569	31.44	3,583	0.61		41.14						140.2	27.22	0.55
27		8,051	4,050	50.30	4,001	0.92		44.01						79.0	49.90	0.62
	Average	6,539	2,522	38.56	4,070			40.37			26.57	20.50	10,260	117.4	337.2	5.16
20	Lights	3,969	1,447	36.46	2,522	0.92	1.37	21.30		33.42				90.8	0	0
23		2,381	948.0	39.82	1,433	0.92		12.78		35.30				52.2	0	0
26		2,722	1,982	72.82	734.8	0.92		14.61		38.55				55.1	0	0
	Average	3,024	1,459	48.25	1,563			16.23		35.76	30.42	18.90	11,670	66.0	0	0
22	Heavies	10,550	3,529	33.45	7,017	0.61	0.69	42.70		66.58				159.1	31.75	0.30
25		8,732	2,477	28.36	6,260	0.92		23.43		64.70				182.4	158.8	1.82
28		5,783	2,155	37.26	3,624	0.61		23.41		61.45				132.6	444.5	7.69
	Average	8,355	2,720	32.56	5,634			29.85		64.24	28.47	19.80	11,480	158.0	211.7	2.54
	Output	14,520	4,976	34.27	9,539			64.00	1.25						31.75	0.22
	(Lights and Heavies)	11,110	3,425	30.83	7,693			36.21	2.20						158.8	1.43
		8,505	4,137	48.64	4,359			38.02	2.10						444.5	5.23
	Average	11,380	4,179	37.91	7,197			46.08	1.85						211.7	2.29

TABLE B-4. AIR CLASSIFIER MATERIAL STREAMS DATA, TEST DAY 3

BALTIMORE COUNTY

Sample No.	Fraction	Total Weight (g)	Paper and Plastic Weight (g)	Paper and Plastic Weight (%)	Other Weight (g)	Length of Sample (m)	Belt Speed (m/sec)	Flow Rate $\dot{m}_s$ (Mg/hr)	α $\dot{m}_o/\dot{m}_s$	Split Weight (%)	Ash Weight (%)	Moisture Weight (%)	Heating Value (J/kg) x 10^3	Bulk Density (kg/m^3)	Ferrous Weight (g)	Ferrous Weight (%)
41	Input	428.2	280.8	65.57	147.4	3.048	1.40	0.71						62.3	0	0
44		580.6	290.3	50.00	294.8	3.048		0.96						---	58.97	10.16
47		639.6	381.0	59.57	254.0	2.438		1.32						78.5	0	0
	Average	549.5	317.4	57.76	232.1			1.00						70.4	19.66	3.58
40	Lights	452.7	336.1	74.25	116.6	3.048	1.37	0.73		78.60				40.4	0	0
43		553.4	430.9	77.87	122.5	1.524		1.79		75.57				49.6	0	0
46		598.7	435.4	72.73	163.3	2.438		1.21		87.60				48.7	0	0
	Average	534.9	400.8	74.93	134.1			1.24		80.60	16.71	6.40	15,642	46.2	0	0
	Heavies	244.9	99.8	40.75	145.1	3.048	0.69	0.20		21.40				---	0	0
42		712.1	263.1	36.94	449.1	3.048		0.58		24.43				---	58.97	8.28
45		213.2	27.2	12.77	186.0	3.048		0.17		12.40				---	9.07	4.26
48	Average	390.1	130.0	33.33	260.1			0.32		19.40	50.88	1.31	10,497	---	22.68	5.81
	Output	697.6	435.9	62.49	261.7			0.93	85.6						0	0
	(Light and Heavies)	1,266	694.0	54.82	571.6			2.37	33.7						58.97	4.66
		811.9	462.6	56.98	349.3			1.38	57.6						9.07	1.12
	Average	925.2	530.8	58.10	394.2			1.56	59.0						22.68	2.89

TABLE B-5. AIR CLASSIFIER MATERIAL STREAMS DATA, TEST DAY 4

BALTIMORE COUNTY

Sample No.	Fraction	Total Weight (g)	Paper and Plastic Weight (g)	Paper and Plastic Weight (%)	Other Weight (g)	Length of Sample (m)	Belt Speed (m/sec)	Flow Rate $\dot{m}_s$ (Mg/hr)	α $\dot{m}_o/\dot{m}_s$	Split Weight (%)	Ash Weight (%)	Moisture Weight (%)	Heating Value (J/kg) x 10^3	Bulk Density (kg/m^3)	Ferrous Weight (g)	Ferrous Weight (%)
61	Input	4,853	1,315	27.11	3,538	1.22	1.40	20.00						99.0	0	0
64		4,491	1,579	35.15	2,898	1.52		14.86						106.7	0	0
67		5,670	2,767	48.80	2,892	1.22		23.37						92.1	79.38	1.40
70		2,540	1,057	41.61	1,483	1.52		8.40						79.8	0	0
	Average	4,389	1,680	38.27	2,703						13.12	61.30	5,478	94.4	19.85	0.45
60	Lights	3,970	1,179	29.71	2,767	1.22	1.37	16.07		57.10				88.1	0	0
63		1,633	771.1	47.22	861.8	1.52		5.31		56.86				62.8	0	0
66		2,658	1,225	46.08	1,451	1.22		10.76		42.50				78.3	0	0
69		2,889	1,025	35.48	1,864	0.91		15.68		58.50				77.0	0	0
	Average	2,788	1,050	39.62	1,736			11.96		53.74	19.40	19.00	12,914	76.6	0	0
62	Heavies	5,965	1,270	21.29	4,686	1.22	0.69	12.07		42.90				155.4	285.8	4.79
65		2,449	757.5	30.93	1,696	1.52		3.98		43.14				54.3	158.8	6.48
68		9,004	2,676	29.72	6,350	1.52		14.63		57.50				217.8	181.4	2.02
71		6,827	2,114	30.96	4,695	1.52		11.09		41.50				161.8	113.4	1.66
	Average	6,061		28.23	4,357					46.26	41.29	18.10	8,748	147.3	184.9	3.05
	Output (Lights and Heavies)	9,935	2,449	24.65	7,453			28.14	2.84						285.8	2.88
		4,082	1,529	37.46	2,558			9.20	8.60						158.8	3.89
		11,660	3,901	33.46	7,801			25.39	3.15						181.4	1.56
		9,716	3,139	32.31	6,559			26.77	3.00						113.4	1.17
	Average	8,848	2,755	31.97	6,093			22.38	4.40						184.9	2.38

TABLE B-6. SAMPLE DATA FROM RALTECH

BALTIMORE COUNTY

Test Day	Sample No.	Fraction	As Received Ash (%)	As Received Moisture (%)	As Received Heat Value (J/kg) x 10^3	Moisture Free Basis Ash (%)	Moisture Free Basis Heat Value (J/kg) x 10^3	Sample Weight (g)
1	13	Light	20.14	8.74	14,860	22.07	16,280	1,086
	14	Light	19.76	3.24	16,000	20.43	16,540	833
	12	Heavy	69.21	0.81	6,966	69.78	7,025	2,227
2	31	Light	30.42	18.90	11,670	37.51	14,390	1,476
	32	Light	20.72	18.90	12,930	25.54	15,940	775
	33	Heavy	28.47	19.80	11,480	35.49	14,310	2,178
	34	Heavy	27.37	12.60	12,510	31.31	14,310	1,758
3	49	Light	16.71	6.40	15,640	17.85	16,710	703
	51	Heavy	50.88	1.31	10,500	51.55	10,640	987
4	72	Light	19.40	19.00	12,910	23.95	15,940	1,110
	73	Light	18.53	28.80	11,390	26.03	15,990	1,071
	76	Heavy	41.29	18.10	8,748	50.41	10,680	2,878
	77	Heavy	30.70	18.90	10,510	37.86	12,950	2,839

APPENDIX C - EMISSION DATA

TABLE C-1. ANTIMONY

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C , D or D[a/]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (g)	Rec (%)
1	365	0.455, 0.519	15.6	2.1		-
1	368	0.157, 0.146	21.6	-	10	43
1	0001	0.623, 0.738	423	10		-
1	15	0.216, 0.171	54.7	3.8		-
1	9001 ≈	0.025, 0.025	13.8[b/]	-	10	71
1	9007	0.109, -	6.7	-		-
1	9017	0.031, 0.016	3.6[b/]	-		-
2	371	0.461, 0.167	16.0	1.3		-
2	367	0.090, 0.098	38.8	-	10	140
2	0002	0.498, 0.500	219	15		-
2	16	0.148, 0.177	42	-	10	167
2	9002	0.066, 0.075	15	6		-
2	9008	0.091, 0.127	4.2	-	10	72
2	9018	0.034, 0.041	7.7[b/]	-	10	70
3	372	0.076, 0.074	25	-		-
3	366	0.221, 0.148	7.1	1.7		-
3	0003	0.093, 0.089	55	-	10	89
3	17	0.171, 0.134	26	6		-
3	9003 ≈	0.003, 0.002	b/	-	10	71
3	9009 ≈	0.014, 0.014	b/	-		-
3	9019 ≈	0.004, 0.004	b/	-		-
4	2136	0.576, 0.404	45	4		-
4	14	0.983, 0.786	340	35		-
4	21	0.408, 0.358	108	-	10	104
4	9005	0.205, 0.190	40	-	10	19
4	9010	0.082, 0.057	2.4	-	10	49
4	9020	0.056, 0.070	< 5	-		-
Pooled relative standard deviation of duplicate analyses				12.6%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-2. ARSENIC

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C, D or D[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (µg)	Recovery (%)
1	365	0.455, 0.519	12.8	0.7		-
1	368	0.157, 0.146	12.5	0.3		
1	0001	0.623, 0.738	10.1	-	40	47
1	15	0.216, 0.171	9.1	0.3		-
1	9001	≈ 0.025, ≈ 0.025	< 10[b]	-	40	69
1	9007	0.109, -	< 2	-		-
1	9017	0.031, 0.016	< 8[b]	-		-
2	371	0.461, 0.167	10.8	-		-
2	367	0.090, 0.098	17.0	0.7		-
2	0002	0.498, 0.500	11.5	0.6		-
2	16	0.148, 0.177	8.8	-	40	67
2	9002	0.066, 0.075	20.1	2.7		-
2	9008	0.091, 0.127	< 7	-	40	94
2	9018	0.034, 0.041	< 19[b]	-	40	80
3	372	0.076, 0.074	18.4	-	40	65
3	366	0.221, 0.148	3.2	-		-
3	0003	0.093, 0.089	11.8	-	40	63
3	17	0.171, 0.134	25.7	-		-
3	9003	≈ 0.003, ≈ 0.002	b/	-	40	85
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.576, 0.404	13.3	4.4		-
4	14	0.983, 0.786	11.0	-	40	57
4	21	0.408, 0.358	10.0	-	40	75
4	9005	0.205, 0.190	98.0	-	40	44
4	9010	0.082, 0.057	< 3	-	40	97
4	9020	0.056, 0.070	< 4	-		-
Pooled relative standard deviation of duplicate analyses				9.8%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-3. BARIUM

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C , D or D[a/]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	0.455, 0.519	502	98		-
1	368	0.157, 0.146	247	8		-
1	0001	0.623, 0.738	591	-	100	97
1	15	0.216, 0.171	364	42		-
1	9001	≈ 0.025, ≈ 0.025	907[b/]	-	100	50
1	9007	0.109, -	549	-		-
1	9017	0.031, 0.016	738[b/]	-		-
2	371	0.461, 0.167	292	22		-
2	367	0.090, 0.098	374	69		-
2	0002	0.498, 0.500	540	19		-
2	16	0.148, 0.177	388	-	1,000	64
2	9002	0.066, 0.075	879	147		-
2	9008	0.091, 0.127	549	-	100	50
2	9018	0.034, 0.041	670[b/]	-	100	72
3	372	0.076, 0.074	553	258		-
3	366	0.221, 0.148	328	57		-
3	0003	0.093, 0.089	242	-	100	39
3	17	0.171, 0.134	267	25		-
3	9003	≈ 0.003, ≈ 0.003	b/	-	100	83
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.576, 0.404	570	18		-
4	14	0.983, 0.786	481	-	1,000	32
4	21	0.408, 0.358	624	-	1,000	99
4	9005	0.205, 0.190	1,310	-		-
4	9010	0.082, 0.057	669	-	100	67
4	9020	0.056, 0.070	579	-		-
Pooled relative standard deviation of duplicate analyses				13.1%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-4. BERYLLIUM

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C , D or D[a/]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	0.455, 0.519	1.6	0.1		-
1	368	0.157, 0.146	0.2	-		-
1	0001	0.623, 0.738	2.4	-	2	95
1	15	0.216, 0.171	0.5	0.2		-
1	9001	≈ 0.025, ≈ 0.025	1.0[b/]	-	2	69
1	9007	0.109, -	0.9	-		-
1	9017	0.031, 0.016	1.3[b/]	0.3		-
2	371	0.461, 0.167	0.31	0.04		-
2	367	0.090, 0.098	0.5	-		-
2	0002	0.498, 0.500	1.2	0.2		-
2	16	0.148, 0.177	0.5	-	2	89
2	9002	0.066, 0.075	1.4	0.2		-
2	9008	0.091, 0.127	0.9	-	2	95
2	9018	0.034, 0.041	1.1[b/]	-	2	56
3	372	0.076, 0.074	< 0.1	-	2	59
3	366	0.221, 0.148	0.1	-		-
3	0003	0.093, 0.089	< 0.1	-	2	62
3	17	0.171, 0.134	0.14	0.04		-
3	9003	≈ 0.003, ≈ 0.002	b/	-	2	37
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.576, 0.404	2.5	1.3		-
4	14	0.983, 0.786	1.4	0		-
4	21	0.408, 0.358	0.9	-	2	86
4	9005	0.205, 0.190	2.2	-	2	101
4	9010	0.082, 0.057	0.9	-	2	92
4	9020	0.056, 0.070	0.45	0.01		-
Pooled relative standard deviation of duplicate analyses				17.7%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-5. CADMIUM

OUTGAMIE COUNTY

Site	Sample No.	Weight (g) A , B or B[a/]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	- , 0.527	8.9	-		-
1	368	0.204, 0.112	14.7	-	2.5	120
1	0001	0.587, 0.609	18.1	-	25	73
1	15	0.185, 0.157	34.7	2.2		-
1	9001	≈ 0.025, ≈ 0.025	114[b/]	-	2.5	80
1	9007	0.091, 0.068	22.8	5.2		-
1	9017	0.044, 0.010	32	-		-
2	371	1.096, 0.179	6.5	3		-
2	367	0.149, 0.176	19.1	0.4		-
2	0002	0.497, 0.402	27.6	1.4		-
2	16	0.246, 0.433	25.7	-	25	34
2	9002	0.079, 0.072	48.6	7		-
2	9008	0.080, 0.090	21.3	-	2.5	84
2	9018	0.052, 0.036	49.6	-	2.5	105
3	372	0.097, 0.068	19.6	-	2.5	67
3	366	0.243, 0.120	7.1	2.2		-
3	0003	0.040, 0.043	42.6	-	2.5	30
3	17	0.073, 0.064	37.3	1.3		-
3	9003	≈ 0.003, ≈ 0.003	b/	-	2.5	128
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.575, 0.379	16.9	0.5		-
4	14	1.233, 0.916	18.2	-	25	42
4	21	0.553, 0.323	38.7	-	25	68
4	9005	0.270, 0.245	39.9	-	25	76
4	9010	0.090, 0.047	21.1	-	2.5	136
4	9020	0.028, 0.014	49.3[b/]	-	2.5	148
Pooled relative deviation of duplicate analyses				14.8%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-6. CHROMIUM

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) A , B or B[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	- , 0.527	848	-		-
1	368	0.204, 0.112	113	-	30	123
1	0001	0.587, 0.609	1,190	53		-
1	15	0.185, 0.157	2,600	178		-
1	9001	≈ 0.025, ≈ 0.025	1,790[b]	-	30	50
1	9007	0.091, 0.068	1,250	491		-
1	9017	0.044, 0.010	1,580	-		-
2	371	1.096, 0.179	1,320	790		-
2	367	0.149, 0.176	174	-	30	87
2	0002	0.497, 0.402	1,640	73		-
2	16	0.246, 0.433	2,400	560		-
2	9002	0.079, 0.072	914	43		-
2	9008	0.080, 0.090	1,490	-	30	83
2	9018	0.052, 0.036	1,700	-		-
3	372	0.097, 0.068	2,860	-	300	71
3	366	0.243, 0.120	1,250	395		-
3	0003	0.040, 0.043	10,500	-	30	110
3	17	0.073, 0.064	4,200	150		-
3	9003	≈ 0.003, ≈ 0.003	[b]	-	30	127
3	9009	≈ 0.014, ≈ 0.014	[b]	-		-
3	9019	≈ 0.004, ≈ 0.004	[b]	-		-
4	2136	0.575, 0.379	116	18		-
4	14	1.233, 0.916	671	-	300	57
4	21	0.553, 0.323	773	-	300	106
4	9005	0.270, 0.245	366	-	300	63
4	9010	0.090, 0.047	988	-		-
4	9020	0.028, 0.014	2,430[b]	-		-
Pooled relative deviation of duplicate analyses				18.7%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-7. COPPER

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) A , B or Ba/	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (µg)	Recovery (%)
1	365	- , 0.527	185	-		-
1	368	0.204, 0.112	224	-	50	133
1	0001	0.587, 0.609	304	-	500	53
1	15	0.185, 0.157	359	20		-
1	9001	≈ 0.025, ≈ 0.025	13,300b/	-		-
1	9007	0.091, 0.068	16,000	2,800		-
1	9017	0.044, 0.010	24,600	-		-
2	371	1.096, 0.179	227	45		-
2	367	0.149, 0.176	366	-	50	68
2	0002	0.497, 0.402	365	5		-
2	16	0.246, 0.433	373	-	500	53
2	9002	0.079, 0.072	3,380	106		-
2	9008	0.080, 0.090	5,570	11		-
2	9018	0.052, 0.036	7,560	-	500	31
3	372	0.097, 0.068	955	-	50	127
3	366	0.243, 0.120	316	107		-
3	0003	0.040, 0.043	2,720	-	50	41
3	17	0.073, 0.064	1,020	11		-
3	9003	≈ 0.003, ≈ 0.003	b/	-	50	100
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.575, 0.379	163	8		-
4	14	1.233, 0.916	275	-	500	39
4	21	0.553, 0.323	377	-	500	69
4	9005	0.270, 0.245	1,390	-	500	65
4	9010	0.090, 0.047	3,290	-	500	30
4	9020	0.028, 0.014	4,800b/	-		-
Pooled relative deviation of duplicate analyses				10.3%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-8. LEAD

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C, D or D[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	0.455, 0.519	794	52		-
1	368	0.157, 0.146	430	48		-
1	0001	0.623, 0.738	1,500	-	2,000	54
1	15	0.216, 0.171	3,390	328		-
1	9001	≈ 0.025, ≈ 0.025	2,300[b]	-	200	73
1	9007	0.109, -	998	-		-
1	9017	0.031, 0.016	1,530[b]	-		-
2	371	0.461, 0.167	602	16		-
2	367	0.090, 0.098	613	52		-
2	0002	0.498 0.500	1,500	29		-
2	16	0.148, 0.177	6,650	-	2,000	52
2	9002	0.066, 0.075	1,740	292		-
2	9008	0.091, 0.127	2,000	84		-
2	9018	0.034, 0.041	2,050[b]	-	200	60
3	372	0.076, 0.074	3,080	-	200	54
3	366	0.221, 0.148	209	121		-
3	0003	0.093, 0.089	2,740	-	200	59
3	17	0.171, 0.134	1,230	87		-
3	9003	≈ 0.003, ≈ 0.003	b/	-	200	80
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.576, 0.404	709	3		-
4	14	0.983, 0.786	1,330	-	2,000	72
4	21	0.408, 0.358	3,020	-	2,000	65
4	9005	0.205, 0.190	1,900	-	2,000	74
4	9010	0.082, 0.057	1,420	-	200	92
4	9020	0.056, 0.070	805	68		-
	Pooled relative deviation of duplicate analyses			13.1%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-9. MERCURY

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C , D or D[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	0.455, 0.519	2.1	0.1		-
1	368	0.157, 0.146	2.4	0.3		-
1	0001	0.623, 0.738	2.9	-	10	69
1	15	0.216, 0.171	4.5	0.1		-
1	9001	≈ 0.025, ≈ 0.025	10.2[b]	-	10	85
1	9007	0.109	6.9	-		-
1	9017	0.031, 0.016	18[b]	3		-
2	371	0.461, 0.167	2.1	0.1		-
2	367	0.090, 0.098	3.6	0.2		-
2	0002	0.498, 0.500	4.5	0.5		-
2	16	0.148, 0.177	5.6	-		-
2	9002	0.066, 0.075	7.1	1.1		-
2	9008	0.091, 0.127	< 4	-	10	84
2	9018	0.034, 0.041	18.8[b]	-	10	71
3	372	0.076, 0.074	4.3	-	10	52
3	366	0.221, 0.148	2.2	0.7		-
3	0003	0.093, 0.089	2.7	-	10	60
3	17	0.171, 0.134	2.4	0.5		-
3	9003	≈ 0.003, ≈ 0.002	b/	-	10	70
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.576, 0.404	4.6	0.3		-
4	14	0.983, 0.786	2.9	-	10	58
4	21	0.408, 0.358	10.6	-	10	56
4	9005	0.205, 0.190	6.1	-	10	46
4	9010	0.082, 0.057	1.6	-	10	78
4	9020	0.056, 0.070	4.7	2.5		-
Pooled relative standard deviation of duplicate analyses				14.8%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-10. SELENIUM

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C , D or D[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (µg)	Recovery (%)
1	365	0.455, 0.519	1.1	0.2		-
1	368	0.157, 0.146	< 3	-		-
1	0001	0.623, 0.738	1.0	-	10	68
1	15	0.216, 0.171	2.6	0.6		-
1	9001	≈ 0.025, ≈ 0.025	16[b]	-	10	55
1	9007	0.109, -	< 8	-		-
1	9017	0.031, 0.016	3.9[b]	-		-
2	371	0.461, 0.167	1.0	-		-
2	367	0.090, 0.098	< 4	-		-
2	0002	0.498, 0.500	1.8	0.2		-
2	16	0.148, 0.177	< 2	-	10	65
2	9002	0.066, 0.075	5.1	-		-
2	9008	0.091, 0.127	< 8	-	10	83
2	9018	0.034, 0.041	< 25[b]	-	10	58
3	372	0.076, 0.074	< 5	-	10	58
3	366	0.221, 0.148	< 2	-		-
3	0003	0.093, 0.089	< 4	-	10	50
3	17	0.171, 0.134	< 2	-		-
3	9003	≈ 0.003, ≈ 0.002	< [b]	-	10	68
3	9009	≈ 0.014, ≈ 0.014	[b]	-		-
3	9019	≈ 0.004, ≈ 0.004	[b]	-		-
4	2136	0.576, 0.404	1.1	0.1		-
4	14	0.983, 0.786	0.7	-	10	75
4	21	0.408, 0.358	1.2	-	10	53
4	9005	0.205, 0.190	< 4	-	10	76
4	9010	0.082, 0.057	< 4	-	10	90
4	9020	0.056, 0.070	< 10	-		-
Pooled relative deviation of duplicate analyses				11.5%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-11. SILVER

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) A , B or B[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	- , 0.527	3.2	-		-
1	368	0.204, 0.112	4.1	1.2		-
1	0001	0.587, 0.609	3.0	0.4		-
1	15	0.185, 0.157	3.6	0.3		-
1	9001	≈ 0.025, ≈ 0.025	8.9[b]			
1	9007	0.091, 0.068	32	10		-
1	9017	0.044, 0.010	18	-		-
2	371	1.096, 0.179	1.9	0.4		-
2	367	0.149, 0.176	0.8			100
2	0002	0.497, 0.402	3.5	0.1	4	-
2	16	0.246, 0.433	4.7	1.0		-
2	9002	0.079, 0.072	3.3			
2	9008	0.080, 0.090	25	-		108
2	9018	0.052, 0.036	11.5	-	4	125
3	372	0.097, 0.068	1.0	-	4	88
3	366	0.243, 0.120	1.6	1.0	4	-
3	0003	0.040, 0.043	1.8	0		-
3	17	0.073, 0.064	4.1	-		-
3	9003	≈ 0.003, ≈ 0.003	b/	-		102
3	9009	≈ 0.014, ≈ 0.014	b/	-	4	-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.575, 0.379	7.1	0.1		-
4	14	1.233, 0.916	2.1	0.3		-
4	21	0.553, 0.323	2.4	-	4	75
4	9005	0.270, 0.245	2.8	0.6		-
4	9010	0.090, 0.047	50	14		-
4	9020	0.028, 0.014	14[b]	-		-

Pooled relative deviation of duplicate analyses 17.9%

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-12. TITANIUM

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) A , B or B[a/]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	- , 0.527	319	-		-
1	368	0.204, 0.112	108	-	500	68
1	0001	0.587, 0.609	196	-	500	126
1	15	0.185, 0.157	100	8		-
1	9001	≈ 0.025, ≈ 0.025	2,560[b/]	-	500	91
1	9007	0.091, 0.068	423	225		-
1	9017	0.044, 0.010	1,740	-		-
2	371	1.096, 0.179	160	103		-
2	367	0.149, 0.176	333	64		-
2	0002	0.497, 0.402	215	53		-
2	16	0.246, 0.433	305	-	500	90
2	9002	0.079, 0.072	1,670	290		-
2	9008	0.080, 0.090	1,440	702		-
2	9018	0.052, 0.036	1,990	59		-
3	372	0.097, 0.068	262	180		-
3	366	0.243, 0.120	168	57		-
3	0003	0.040, 0.043	952	-	500	75
3	17	0.073, 0.064	526	132		-
3	9003	≈ 0.003, ≈ 0.003	b/	-		-
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.575, 0.379	169	35		-
4	14	1.233, 0.916	30	8		-
4	21	0.553, 0.323	272	69		-
4	9005	0.270, 0.245	263	-	500	63
4	9010	0.090, 0.047	200	-	500	85
4	9020	0.028, 0.014	2,150[b/]	-	500	121
Pooled relative deviation of duplicate analyses				26.0%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-13. VANADIUM

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) C , D or D[a/]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	0.455, 0.519	40	5		-
1	368	0.157, 0.146	15	4		-
1	0001	0.623, 0.738	57	-	600	87
1	15	0.216, 0.171	35.6	0.3		-
1	9001	≈ 0.025, ≈ 0.025	57[b/]	-	600	105
1	9007	0.109, -	32	-		-
1	9017	0.031, 0.016	48[b/]	-		-
2	371	0.461, 0.167	20	2		-
2	367	0.090, 0.098	14.4	0.4		-
2	0002	0.498, 0.500	28	1		-
2	16	0.148, 0.177	12	-	600	75
2	9002	0.066, 0.075	32	-		-
2	9008	0.091, 0.127	30	-	600	106
2	9018	0.034, 0.041	56[b/]	-	600	101
3	372	0.076, 0.074	17	-	600	64
3	366	0.221, 0.148	7.3	-		-
3	0003	0.093, 0.089	25	-	600	68
3	17	0.171, 0.134	12	2		-
3	9003	≈ 0.003, ≈ 0.002	b/	-		-
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.576, 0.404	31	2		-
4	14	0.983, 0.786	38	-	600	75
4	21	0.408, 0.358	30	-	600	70
4	9005	0.205, 0.190	59	-	600	86
4	9010	0.082, 0.057	34	-	600	85
4	9020	0.056, 0.070	24	4	-	-
Pooled relative standard deviation of duplicate analyses.				9.3%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-14. ZINC

OUTAGAMIE COUNTY

Site	Sample No.	Weight (g) A , B or B[a]	Concentration (ppm)	Difference in Duplicate Analysis (ppm)	Fortification Level (μg)	Recovery (%)
1	365	- , 0.527	1,360	-		-
1	368	0.204, 0.112	873	-	400	80
1	0001	0.587, 0.609	1,390	-	4,000	61
1	15	0.185, 0.157	2,240	34		-
1	9001	≈ 0.025, ≈ 0.025	2,110[b]	-	400	100
1	9007	0.091, 0.068	1,950	571		-
1	9017	0.044, 0.010	3,470	-		-
2	371	1.096, 0.179	968	85		-
2	367	0.149, 0.176	1,460	-	400	70
2	0002	0.497, 0.402	1,480	34		-
2	16	0.246, 0.433	2,920	-	4,000	53
2	9002	0.079, 0.072	1,940	25		-
2	9008	0.080, 0.090	1,530	-	400	111
2	9018	0.052, 0.036	8,240	-	400	120
3	372	0.097, 0.068	2,450	-	400	68
3	366	0.243, 0.120	2,100	697		-
3	0003	0.040, 0.043	3,710	-	400	94
3	17	0.073, 0.064	2,820	172		-
3	9003	≈ 0.003, ≈ 0.003	b/	-	400	110
3	9009	≈ 0.014, ≈ 0.014	b/	-		-
3	9019	≈ 0.004, ≈ 0.004	b/	-		-
4	2136	0.575, 0.379	1,080	112		-
4	14	1.233, 0.916	1,180	-	4,000	43
4	21	0.553, 0.323	1,660	-	4,000	64
4	9005	0.270, 0.245	1,450	-	4,000	82
4	9010	0.090, 0.047	1,130	-	400	122
4	9020	0.028, 0.014	7,470[b]	-	400	142
Pooled relative deviation of duplicate analyses				11.7%		

a/ Fortified sample.
b/ Weights < 50 mg.

TABLE C-15. BARIUM

BALTIMORE COUNTY					
Site	Sample	Weight (g)	Concentration (ppm)	Fortification (ppm)	Recovery (%)
Process Building	4	0.3530, 0.2514	310	800	79
	18	0.1296, 0.2110	70 ± 40		
	11	0.6862, 0.6689	300 ± 10		
	8	0.3533, 0.1498	160	670	88
Shredder	5	0.3240, 0.2828	800 ± 200		
	17	a/			
	27	0.6438, 0.3448	200 ± 60		
	31	0.3762, 0.2646	240	760	86
Tipping Floor	6	0.1003, 0.1025	690	980	68
	15	0.2029, 0.1441	1,200 ± 600		
	13	0.1028, 0.1289	360 ± 40		
	29	0.1078, 0.0972	260	1,030	65
Magnetic Separator	7	0.4299, 0.2746	130	730	114
	19	a/			
	26	0.4408, 0.5170	190	580	65
	32	a/			
Field Blank	12	a/		690	56
Filter Blank			b/	1	112
Reagent Blank			b/	1, 12	56, 93

a/ Weight less than twice the variation of filter blank sections.
b/ All measurements of metal concentration were corrected where necessary for reagent blank.

TABLE C-16. CADMIUM

BALTIMORE COUNTY

Site	Sample	Weight (g)	Concentration (ppm)	Fortification (ppm)	Recovery (%)
Process Building	4	0.3993, 0.2652	13	19	68
	18	0.1341	< 10		
	11	0.8640, 0.4391	7.4 ± 0.3		
	8	0.3061, 0.2995	3	17	96
Shredder	5	0.3298, 0.2456	26	20	54
	17	a/			
	27	0.8479, 0.4668	4.2 ± 0.3		
	31	0.3411, 0.2787	8.2	18	54
Tipping Floor	6	0.1360	7.4		
	15	0.1395, 0.1544	10 ± 2		
	13	0.1315, 0.0893	24 ± 2		
	29	0.1156, 0.0842	81	59	90
Magnetic Separator	7	0.3723, 0.3715	3.5	13	78
	19	a/			
	26	0.2995, 0.5260	5.3	19	66
	32	a/			
Field Blank	12	a/			
Filter Blank			b/	1	66
Reagent Blank			b/	1	88

a/ Weight less than twice the variation of filter blank sections.
b/ All measurements of metal concentration were corrected where necessary for reagent blank.

TABLE C-17. CHROMIUM

BALTIMORE COUNTY					
Site	Sample	Weight (g)	Concentration (ppm)[a]	Fortification (ppm)	Recovery (%)
Process Building	4	0.3993, 0.2652	820	1,130	115
	18	0.1341	490		
	11	0.8640, 0.4391	2300 ± 1300		
	8	0.3061, 0.2995	59	1,000	82
Shredder	5	0.3298, 0.2456	600	1,220	86
	17	a/			
	27	0.8479, 0.4668	140 ± 20		
	31	0.3411, 0.2787	810	1,080	108
Tipping Floor	6	0.0828, 0.1360	290	740	79
	15	0.1395, 0.1544	320 ± 10		
	13	0.1315, 0.0893	230 ± 20		
	29	0.1156, 0.0842	920	1,190	79
Magnetic Separator	7	0.3723, 0.3715	190	1,350	68
	19	a/			
	26	0.2995, 0.5260	170	950	75
	32	a/			
Field Blank	12	a/		860	109
Filter Blank			c/	2, 50	110, 99
Reagent Blank			c/	2, 50	120, 104

a/ Weight less than twice the variation of filter blank sections.
b/ Filter blank and reagent blanks subtracted.
c/ All measurements of metal concentration were corrected where necessary for reagent blank.

TABLE C-18. COPPER

BALTIMORE COUNTY					
Site	Sample	Weight (g)	Concentration (ppm)	Fortification (ppm)	Recovery (%)
Process Building	4	0.3993, 0.2652	340	380	88
	18	0.1341	320		
	11	0.8640, 0.4391	220 ± 40		
	8	0.3061, 0.2995	59	330	102
Shredder	5	0.3298, 0.2456	840	410	124
	17	a/			
	27	0.8479, 0.4668	180 ± 0		
	31	0.3411, 0.2787	160	360	31
Tipping Floor	6	0.0828, 0.1360	620 ± 10		
	15	0.1395, 0.1544	390 ± 40		
	13	0.1315, 0.0893	510 ± 40		
	29	0.1156, 0.0842	1,280	c/	c/
Magnetic Separator	7	0.3723, 0.3715	150	270	107
	19	a/			
	26	0.2995, 0.5260	170	190	54
	32	a/			
Field Blank	12	a/			
Filter Blank			b/	1, 10	80, 69
Reagent Blank			b/	1, 10	120, 90

a/ Weight less than twice the variation of filter blank sections.
b/ All measurements of metal concentration were corrected where necessary for reagent blank.
c/ Fortification level too low for recovery calculation.

TABLE C-19. LEAD

BALTIMORE COUNTY

Site	Sample	Weight (g)	Concentration (ppm)	Fortification (ppm)	Recovery (%)
Process Building	4	0.3530, 0.2514	640	1,590	67
	18	0.1296, 0.2110	600 ± 200		
	11	0.6862, 0.6689	900 ± 100		
	8	0.3533, 0.1498	690	1,340	84
Shredder	5	0.3240, 0.2828	1,400 ± 100		
	17	a/			
	27	0.6438, 0.3448	740 ± 30		
	31	0.3762, 0.2646	740	1,510	91
Tipping Floor	6	0.1003, 0.1025	830	1,950	55
	15	0.2029, 0.1441	2,200 ± 1,100		
	13	0.1028, 0.1289	890 ± 40		
	29	0.1078, 0.0972	1,140	2,060	64
Magnetic Separator	7	0.4299, 0.2746	570	1,460	100
	19	a/			
	26	0.4408, 0.5170	890	1,550	55
	32	a/			
Field Blank	12	a/		2,360	74
Filter Blank			b/	4, 32	83, 81
Reagent Blank			b/	4, 32	88, 96

a/ Weight less than twice the variation of filter blank sections.
b/ All measurements of metal concentration were corrected where necessary for reagent blank.

TABLE C-20. ZINC

BALTIMORE COUNTY					
Site	Sample	Weight (g)	Concentration (ppm)	Fortification (ppm)	Recovery (%)
Process Building	4	0.3993, 0.2652	890	1,130	93
	18	0.1341	730		
	11	0.8640, 0.4391	590 ± 40		
	8	0.3061, 0.2995	350	1,000	137
Shredder	5	0.3298, 0.2456	1,330	1,220	74
	17	a/			
	27	0.8479, 0.4668	700 ± 200		
	31	0.3411, 0.2787	840	1,080	103
Tipping Floor	6	0.0828, 0.1360	1,300		
	15	0.1395, 0.1544	870 ± 30		
	13	0.1315, 0.0893	1,200 ± 200		
	29	0.1156, 0.0842	1,480	1,190	88
Magnetic Separator	7	0.3723, 0.3715	700	1,350	78
	19	a/			
	26	0.2995, 0.5260	890 ± 20		
	32	a/			
Field Blank	12	a/		860	110
Filter Blank			b/	2	80
Reagent Blank			b/	2	105

a/ Weight less than twice the variation of filter blank sections.
b/ All measurements of metal concentration were corrected where necessary for reagent blank.

TABLE C-21. QUALITY ASSURANCE STANDARD REFERENCE MATERIALS

OUTAGAMIE COUNTY

	Bureau of Mines Refuse		NBS Orchard Leaves	
	Concentration (ppm)	Certified Ranges[a] (ppm)	Concentration (ppm)	Certified Values (ppm)
Antimony	6.9 ± 0.6	-	3.4 ± 0.1	2.9 ± 0.3
Arsenic	1.1	-	7.5 ± 0.6	10 ± 2
Barium	188 ± 45	< 30[b]	112 ± 5	(44)[c]
Beryllium	0.03	< 0.5- < 10	< 0.04	0.027 ± 0.010
Cadmium	3 ± 1	1.0-1.6	< 2	0.11 ± 0.02
Chromium	120 ± 20	60-160	13 ± 5	2.6 ± 0.3
Copper	81 ± 1	59-65	15.2 ± 0.2	12 ± 1
Lead	183 ± 5	130-180	65.7 ± 1.6	45 ± 3
Mercury	0.9 ± 0.2	-	< 0.3	0.155 ± 0.015
Selenium	< 2	-	< 2	0.08 ± 0.01
Silver	2.9 ± 0.1	3-6	0.58	-
Titanium	630 ± 170	1,800-3,300	8.7	-
Vanadium	9.4 ± 3.9	-	< 0.6	-
Zinc	350 ± 30	220-270	51 ± 4	25 ± 3

a/ Law, S. L., Private Communication, Analytical results of three Bureau of Mines laboratories.

b/ Results of one Bureau of Mines laboratory.

c/ Value noncertified.

TABLE C-22. QUALITY ASSURANCE FORTIFIED BLANKS

OUTAGAMIE COUNTY

	Acid Blank		Fiberglas Blank		Fiberglas No. 10		Millipore Blank		Millipore No. 9006	
	µg	% Recovery	µg	% Recovery	µg	% Recovery	µg	% Recovery	µg	% Recovery
Antimony	< 0.3	-	< 0.3	84	3 ± 1	-	-	-	< 0.3	86
Arsenic	< 0.3	-	< 0.3	78	< 0.3	-	-	-	< 0.6	72
Barium	< 45	-	< 45	64	< 45	-	-	-	< 45	60
Beryllium	< 0.01	-	< 0.01	70	< 0.01	-	-	-	< 0.01	77
Cadmium	< 0.8	92, 116, 103, 105	< 0.8	114, 80	< 0.8	-	-	120	< 0.8	148
Chromium	12 ± 1	120, 103, 86, 86	13	97, 83	9 ± 5	-	-	107	21	113
Copper	0.15 ± 0.05	104, 110, 94, 104	1.4	78, 78	0.75 ± 0.25	-	-	113	3.7	117
Lead	< 10	110, 123	< 10	70	15 ± 5	-	-	-	11.3	76
Mercury	< 0.08	-	< 0.1	78	< 0.4	-	-	-	< 0.4	85
Selenium	< 0.5	-	< 0.5	40	< 0.4	-	-	-	< 0.4	68
Silver	< 0.01	110, 123	< 0.01	73	< 0.01	-	-	-	0.02	120
Titanium	< 3	120, 92	< 3	75	< 3	-	-	125	4 ± 1	-
Vanadium	< 0.1	67	< 35	81	< 0.1	-	-	125	< 13	100
Zinc	0.8	100, 95, 109, 96	12	65, 60	6.5 ± 0.5	-	-	98	8	91

TABLE C-23. QUALITY ASSURANCE STANDARD REFERENCE MATERIALS

BALTIMORE COUNTY

	Bureau of Mines Refuse		NBS Orchard Leaves	
	Concentration (ppm)	Certified Ranges[a] (ppm)	Concentration (ppm)	Certified Values (ppm)
Barium	35 ± 2	< 30	< 70	(44)[b]
Cadmium	< 7	1.0-1.6	< 7	0.11 ± 0.02
Chromium	260 ± 40	60-160	81	2.6 ± 0.3
Copper	73 ± 1	59-65	25 ± 5	12 ± 1
Lead	153 ± 8	130-180	50	45 ± 3
Zinc	224 ± 7	220-270	19.5 ± 0.7	25 ± 3

a/ Law, S. L., Private Communication, Analytical results of three Bureau of Mines laboratories.

b/ Value noncertified.

TABLE C-24. PARTICLE CONCENTRATIONS

OUTAGAMIE COUNTY

Test	Date	Time (min)	Location	Millipore Sampler	Filter No.	Final Wt (g)	Tare Wt (g)	Difference (g)	Blank Correction (g)	Net Wt (g)	Flow Rate (acfm)	Total Flow (ft³)	Temperature (°R)	Pressure H_2O	Standard Flow (Nm³)	Concentration (mg/Nm³)
1	8/2	340	1	8,504	365	6.13454	3.98677	2.14777	None	2.14777	52.0	17,900	534.2	29.98	498	4.32
		335	2	8,595	371	6.30790	3.96869	2.33921	None	2.33921	51.0	17,100	534.2	29.98	481	4.86
		330	3	8,503	372	4.31799	3.99284	0.32515	None	0.32515	49.8	16,400	534.2	29.98	463	0.703
2	8/3	167	1	8,504	368	4.55037	3.91641	0.63396	None	0.63396	52.0	8,700	527.7	29.99	248	2.56
		167	2	8,595	367	4.47525	3.94880	0.52645	None	0.52645	51.0	8,500	527.7	29.99	243	2.178
		167	3	8,503	366	4.67930	3.92244	0.75686	None	0.75686	49.8	8,300	527.7	29.99	237	3.19
		175	4	8,596	2136	5.89020	3.91630	1.97390	None	1.97390	59.8	10,500	527.7	29.99	298	6.62
3	8/4	353	1	8,504	0001	6.43755	3.78885	2.64870	+0.00226	2.65096	52.0	18,400	534.4	29.54	509	5.21
		356	2	8,595	0002	5.70932	3.77500	1.93432	+0.00226	1.93658	51.0	18,200	534.4	29.54	503	3.85
		364	3	8,503	0003	4.05024	3.76446	0.28578	+0.00226	0.28804	49.8	18,100	534.4	29.54	500	0.537
		375	4	8,594	0014	7.85099	3.80595	4.04504	+0.00226	4.04730	59.8	22,400	534.4	29.54	622	6.51
4	8/5	265	1	8,504	0015	4.56266	3.81584	0.74682	-0.00935	0.73747	52.0	13,800	534.7	29.79	385	1.92
		268	2	8,595	0016	4.88003	3.82454	1.05549	-0.00935	1.04614	51.0	13,700	534.7	29.79	382	2.74
		271	3	8,503	0017	4.28375	3.81367	0.47008	-0.00935	0.46073	49.8	13,500	534.7	29.79	377	1.22
		285	4	8,594	0021	5.50420	3.82241	1.68179	-0.00935	1.67244	59.8	17,000	534.7	29.79	476	3.51
5	8/8	383	1	8,504	9001	3.11200	2.92744	0.18456	+0.00200	0.18656	5.20	1,990	541.7	30.14	556	0.336
		380	2	8,595	9002	3.04565	2.70702	0.33863	+0.00200	0.34063	5.10	1,980	541.7	30.14	540	0.630
		380	3	8,503	9003	2.67001	2.65696	0.01305	+0.00200	0.01505	4.98	1,890	541.7	30.14	528	0.0285
		395	4	8,594	9005	4.11601	2.97576	1.14025	+0.00200	1.14225	5.98	2,360	541.7	30.14	659	1.73
6	8/9	330	1	8,504	9007	3.36915	2.85750	0.51165	None	0.51165	5.70	1,720	530.0	29.99	487	1.05
		333	2	8,595	9008	3.29440	2.87010	0.42430	None	0.42430	5.10	1,700	530.0	29.99	482	0.880
		335	3	8,503	9009	2.92440	2.85644	0.06796	None	0.06796	4.98	1,670	530.0	29.99	474	0.144
		355	4	8,594	9010	3.24240	2.91443	0.32797	None	0.32797	5.98	2,120	530.0	29.99	603	0.544
7	8/10	255	1	8,504	9017	3.02825	2.87411	0.15414	None	0.15414	5.20	1,330	531.5	29.92	374	0.412
		256	2	8,595	9018	2.93209	2.75699	0.17510	None	0.17510	5.10	1,310	531.5	29.92	369	0.475
		256	3	8,503	9019	2.84702	2.82671	0.02031	None	0.02031	4.98	1,270	531.5	29.92	360	0.0564
		255	4	8,594	9020	3.06755	2.81098	0.25657	None	0.25657	5.98	1,520	531.5	29.92	431	0.596
											5.20					
											5.10					

TABLE C-25. PARTICLE CONCENTRATION

BALTIMORE COUNTY

Test	Date	Time (min)	Location	Millipore Sampler	Filter Number	Final Weight (g)	Tare Weight (g)	Difference (g)	Blank Correction (g)	Net Weight (g)	Flow Rate (acfm)	Total Flow (ft^3)	Temperature (°R)	Pressure (In H_2O)	Standard Flow (Nm^3)	Concentration (mg/Nm^3)
1	3/7	420	1	8,597	H-7	5.85419	4.31260	1.54159	-0.00106	1.54053	48.5	20,400	497	30.41	625	2.47
		420	2	8,594	H-4	5.78323	4.34506	1.43817		1.43711	48.5	20,400			625	2.30
		420	3	8,504	H-6	4.85873	4.36798	0.49075		0.48969	48.5	20,400			625	0.78
		420	4	8,505	H-5	5.80048	4.36800	1.43248		1.43142	49.0	20,600			632	2.27
2	3/8	420	1	8,597	H-19	4.13560	3.93062	0.20498	-0.00106	0.20392	48.5	20,400	492	30.33	630	0.324
		420	2	8,594	H-16,18	8.48612	7.92125	0.56487		0.56381	48.5	20,400			630	0.895
		420	3	8,504	H-15	4.72752	3.98272	0.74480		0.74374	48.5	20,400			630	1.18
		420	4	8,505	H-17	4.02125	3.89234	0.12891		0.12785	49.0	20,600			636	0.201
3	4/5	360	1	8,503	H-26	5.95083	3.99387	1.95696	-0.00106	1.95590	48.8	17,600	525	30.07	505	3.88
		364	2	8,591	H-11	6.99636	4.02161	2.97475		2.97369	48.8	17,800			510	5.83
		362	3	8,504	H-13	4.56235	4.02031	0.54204		0.54093	48.5	17,600			504	1.07
		362	4	8,505	H-27	6.73349	4.01601	2.71748		2.71642	49.0	17,800			510	5.33
4	4/6	265	1	8,503	H-32	4.04023	4.02018	0.02005	-0.00106	0.01899	48.8	12,900	513	30.23	382	0.050
		266	2	8,594	H-8	5.64185	4.32954	1.31231		1.31125	48.5	12,900			381	3.44
		282	3	8,504	H-29	4.49023	4.01410	0.47613		0.47507	48.5	13,700			404	1.18
		286	4	8,505	H-31	5.53367	4.01642	1.51725		1.51619	49.0	14,000			414	3.66

TABLE C-26. PARTICLE SIZE DISTRIBUTION, DAY 1

OUTAGAMIE COUNTY

Date	Sierra No.	Location	Stage	Filter No.	Final wt (g)	Tare wt (g)	Difference (g)	Blank Correction (g)	Net wt (g)	Stages wt (%)	1-5 + Filter Cum wt (%)	Cut-off (µm)
8/2	8421	1	1	3092	2.36978	1.62895	0.74083	- 0.00336	0.73747	44.59	55.41	6.4
			2	3093	1.91842	1.59270	0.38572	- 0.00336	0.38236	23.12	32.30	2.7
			3	3094	1.80273	1.68635	0.11638	- 0.00336	0.11302	6.83	25.46	1.3
			4	3095	1.76341	1.67525	0.08816	- 0.00336	0.08480	5.13	20.34	.85
			5	3096	1.70929	1.70290	0.00639	- 0.00336	0.00303	0.18	20.15	.44
			Back-up	362	4.28708	3.95473	0.33235	+ 0.00100	0.33335	20.15	-	
									1.65403			
8/2	8473	2	1	0412	2.15347	1.65942	0.49405	- 0.00336	0.49069	37.03	62.97	6.9
			2	0413	1.83666	1.62194	0.21472	- 0.00336	0.20800	15.70	47.27	2.7
			3	0414	1.81235	1.71924	0.09311	- 0.00336	0.08975	6.77	40.50	1.3
			4	0415	1.75156	1.67071	0.05085	- 0.00336	0.04749	3.58	36.91	.85
			5	0416	1.67077	1.61033	0.06044	- 0.00336	0.05708	4.31	32.61	.44
			Back-up	363	4.39299	3.96193	0.43106	+ 0.00100	0.43206	32.61	-	
									1.32507			
8/2	8372	3	1	0417	1.69243	1.65727	0.03566	- 0.00336	0.03230	23.64	76.36	6.2
			2	0418	1.63150	1.60981	0.02169	- 0.00336	0.01833	13.42	62.94	2.6
			3	0419	1.70116	1.68758	0.01358	- 0.00336	0.01022	7.48	55.46	1.3
			4	0420	1.71918	1.70564	0.01354	- 0.00336	0.01018	7.45	48.01	.81
			5	0421	1.68918	1.67839	0.01079	- 0.00336	0.00743	5.44	42.57	.42
			Back-up	364	4.04399	3.98684	0.05715	+ 0.00100	0.05815	42.57	-	
									0.13661			

TABLE C-27. PARTICLE SIZE DISTRIBUTION, DAY 2

Date	Sierra No.	Location	Stage	Filter No.	Final Wt (g)	Tare Wt (g)	Difference (g)	Blank Correction (g)	Net Wt	Stages Wt %	1-5 + Filter Cum Wt %	µm
8/3	8372	1	1	0432	1.33459	1.23315	0.10144	0.00336	0.09808	21.95	78.05	6.4
			2	0433	1.29700	1.16219	0.13481	0.00336	0.13145	29.42	48.63	2.7
			3	0434	1.21923	1.15934	0.05983	0.00336	0.05647	12.64	35.99	1.3
			4	0435	1.19906	1.16364	0.03542	0.00336	0.03206	7.18	28.81	.85
			5	0436	1.18035	1.16064	0.01971	0.00336	0.01635	3.66	25.15	44
			Back-up	2133	4.06604	3.95465	0.11139	+.00100	0.11239	25.15	-	
									0.44680			
8/3	8421	2	1	0427	1.25810	1.15658	0.10152	0.00336	0.09816	27.86	72.14	6.4
			2	0428	1.23884	1.15006	0.08878	0.00336	0.08542	24.25	47.89	2.7
			3	0429	1.19145	1.14727	0.04418	0.00336	0.04082	11.59	36.30	1.3
			4	0430	1.27420	1.24428	0.02992	0.00336	0.02656	7.54	28.76	.85
			5	0431	1.24889	1.23280	0.01609	0.00336	0.01273	3.61	25.15	.44
			Back-up	2134	4.06604	3.97845	0.08759	+.00100	0.08859	25.15	-	
									0.35228			
8/3	8473	3	1	0422	1.70750	1.60900	0.09850	0.00336	0.09514	31.46	68.54	6.2
			2	0423	1.70432	1.65984	0.04448	0.00336	0.04412	13.60	54.95	2.6
			3	0424	1.71763	1.69596	0.02167	0.00336	0.01831	6.05	48.89	1.3
			4	0425	1.73082	1.71048	0.02034	0.00336	0.01698	5.61	43.28	.81
			5	0426	1.16344	1.15458	0.00886	0.00336	0.00550	1.82	41.46	.42
			Back-up	2135	4.04055	3.91615	0.12440	+.00100	0.12540	41.46	-	
									0.30245			

TABLE C-28. PARTICLE SIZE DISTRIBUTION, DAY 3

OUTAGAMIE COUNTY

Date	Sierra No.	Location	Stage	Filter No.	Final Wt (g)	Tare Wt (g)	Difference (g)	Correction (g)	Net Wt (g)	Stages Wt %	1-5 + Filter Cum Wt %	μm
8/4	8421	1	1	0447	2.04545	1.20126	0.84419	0.00336	0.84053	43.36	56.64	6.4
			2	0448	1.52400	1.19948	0.32452	0.00336	0.32086	16.55	40.09	2.7
			3	0449	1.31786	1.19840	0.11946	0.00336	0.11580	5.97	34.12	1.3
			4	0450	1.29386	1.20100	0.09286	0.00336	0.08970	4.60	29.52	.85
			5	0451	1.28610	1.20195	0.08415	0.00336	0.08049	4.15	25.37	.44
			Back-up	0007	4.25634	3.76530	0.49104	+.00100	0.49204	25.38	-	
									1.93862			
8/4	8473	2	1	0442	1.72440	1.25121	0.47319	0.00336	0.46983	34.24	65.76	6.4
			2	0443	1.59072	1.24294	0.34778	0.00336	0.34442	25.10	40.66	2.7
			3	0444	1.33855	1.20875	0.12980	0.00336	0.12644	9.21	31.45	1.3
			4	0445	1.29683	1.20252	0.09431	0.00336	0.09095	6.63	24.82	.85
			5	0446	1.28155	1.20618	0.07537	0.00336	0.07201	5.25	19.59	.44
			Back-up	0008	4.01879	3.75122	0.26757	+.00100	0.26875	19.59	-	
									1.37222			
8/4	8372	3	1	0437	1.22852	1.20640	0.02212	0.00336	0.01846	17.23	82.77	6.2
			2	0438	1.22780	1.20508	0.02272	0.00336	0.01906	17.79	64.98	2.6
			3	0439	1.22761	1.21580	0.01181	0.00336	0.00815	7.61	57.37	1.3
			4	0440	1.25195	1.24223	0.00972	0.00336	0.00606	5.66	51.71	.81
			5	0441	1.24644	1.23838	0.00806	0.00336	0.00440	4.11	47.61	.42
			Back-up	0009	3.78100	3.73070	0.05030	+.00100	0.05130	47.89	-	
									0.10743			

TABLE C-29. PARTICLE SIZE DISTRIBUTION, DAY 4

Date	Sierra No.	Location	Stage	Filter No.	Final wt (g)	Tare wt (g)	Difference (g)	Blank Correction (g)	Net wt (g)	Stages wt (%)	1-5 + Filter Cum wt (%)	Cut-off (μm)
8/8	8372	1	1	0462	1.45467	1.23290	0.22177	- .00336	.21841	35.54	64.46	6.4
			2	0463	1.34388	1.23602	0.10786	- .00336	.10450	17.00	47.46	2.7
			3	0464	1.27136	1.22865	0.04271	- .00336	.03935	6.40	41.05	1.3
			4	0465	1.26939	1.23096	0.03843	- .00336	.03507	5.71	35.35	.85
			5	0466	1.26754	1.23734	0.03020	- .00336	.02684	4.37	30.98	.44
			Back-up	0018	3.99385	3.80442	0.18943	+ .00100	.19043	30.99	-	
									.61457			
8/8	8473	2	1	0452	1.41550	1.20707	0.20843	- .00336	.20507	34.67	65.33	6.4
			2	0453	1.31850	1.19994	0.11856	- .00336	.11520	19.48	45.85	2.7
			3	0454	1.24720	1.20246	0.04474	- .00336	.04138	7.00	38.86	1.3
			4	0455	1.25222	1.20739	0.04483	- .00336	.04147	7.01	31.85	.85
			5	0456	1.25300	1.20839	0.04461	- .00336	.04125	6.97	24.87	.44
			Back-up	0019	3.97850	3.83234	0.14616	+ .00100	.14716	24.88	-	
									.59150			
8/8	8421	3	1	0457	1.23680	1.21672	0.02008	- .00336	.01672	11.02	88.98	6.2
			2	0458	1.22237	1.21015	0.01222	- .00336	.00886	5.84	83.14	2.6
			3	0459	1.21318	1.20539	0.00779	- .00336	.00443	2.92	80.22	1.3
			4	0460	1.23322	1.22285	0.01037	- .00336	.00701	4.62	75.59	.81
			5	0461	1.24367	1.23580	0.01057	- .00336	.00721	4.75	70.84	.42
			Back-up	0020	3.94103	3.83454	0.10649	+ .00100	.10749	70.85	-	
									.15169			

TABLE C-30. PARTICLE SIZE DISTRIBUTION, DAY 5

OUTAGAMIE COUNTY

Date	Sierra No.	Location	Stage	Filter No.	Final Wt (g)	Tare Wt (g)	Difference (g)	Blank Correction (g)	Net Wt	Stages Wt (%)	1-5 + Filter Cum Wt (%)	(μm)
8/5	8372	1	1	0467	1.77361	1.24100	0.53261	-0.00336	0.52925	34.28	65.72	6.4
			2	0468	1.48822	1.22338	0.26484	-0.00336	0.26148	16.94	48.78	2.7
			3	0469	1.31677	1.22065	0.09612	-0.00336	0.09276	6.01	42.77	1.3
			4	0470	1.27710	1.20565	0.07145	-0.00336	0.06809	4.41	38.36	.85
			5	0471	1.26860	1.20723	0.06137	-0.00336	0.05801	3.76	34.60	.44
			Back-up	0022	4.31825	3.78500	0.53325	+0.00100	0.53422	34.60	-	
									1.54381			
8/5	8421	2	1	0472	1.87209	1.24538	0.62671	-0.00336	0.62335	40.00	60.00	6.4
			2	0473	1.56393	1.23850	0.32543	-0.00336	0.32207	20.67	39.34	2.7
			3	0474	1.35940	1.22961	0.12979	-0.00336	0.12643	8.11	31.22	1.3
			4	0475	1.31715	1.22661	0.09054	-0.00336	0.08718	5.59	25.63	.85
			5	0476	1.29073	1.22904	0.06169	-0.00336	0.05833	3.74	21.88	.44
			Back-up	0023	4.10441	3.76428	0.34013	+0.00100	0.34113	21.89	-	
									1.55849			
8/5	8473	3	1	0477	1.27070	1.22981	0.04089	-0.00336	0.03753	13.57	86.43	6.2
			2	0478	1.25955	1.23966	0.01989	-0.00336	0.01653	5.98	80.46	2.6
			3	0479	1.24121	1.22900	0.01221	-0.00336	0.00885	3.20	77.26	1.3
			4	0480	1.23936	1.22642	0.01294	-0.00336	0.00958	3.46	73.79	.81
			5	0481	7.24559	1.23966	0.00593	-0.00336	0.00257	.93	72.86	.42
			Back-up	0024	3.96155	3.76100	0.20055	+0.00100	0.20155	72.86	-	
									0.27661			

TABLE C-31. PARTICLE SIZE DISTRIBUTION, DAY 6

Date	Sierra No.	Location	Stage	Filter No.	Final Wt (g)	Tare Wt (g)	Difference (g)	Correction (g)	Net Wt (g)	Stage Wt %	1-5 + Filter Cum Wt (g)	μm
8/9	8473	1	1	0492	2.36287	1.23934	1.12353	-.00336	1.12017	44.86	55.14	6.4
			2	0493	1.74093	1.23809	0.50284	-.00336	.49948	20.00	35.14	2.7
			3	0494	1.41980	1.23801	0.18179	-.00336	.17843	7.15	27.99	1.3
			4	0495	1.35046	1.23161	0.11885	-.00336	.11519	4.61	23.38	.85
			5	0496	1.33082	1.24850	0.08232	-.00336	.07896	3.16	20.21	.44
			Back-up	0011	4.28375	3.78000	0.50375	+.00100	.50475	20.21	-	
									2.49698			
8/9	8372	2	1	0487	2.01158	1.23906	0.77252	-.00336	.76916	38.05	61.95	6.4
			2	0488	1.63605	1.24026	0.39579	-.00336	.39243	19.41	42.54	2.7
			3	0489	1.38976	1.23626	0.15350	-.00336	.15014	7.43	35.11	1.3
			4	0490	1.33699	1.23656	0.10043	-.00336	.09707	4.80	30.31	.85
			5	0491	1.30699	1.23930	0.06769	-.00336	.06433	3.18	27.13	.44
			Back-up	0012	4.36141	3.81405	0.54736	+.00100	.54836	27.13	-	
									2.02149			
8/9	8421	3	1	0482	1.36600	1.23966	0.12634	-.00336	.12298	37.17	62.83	6.2
			2	0483	1.28307	1.23647	0.04660	-.00336	.04324	13.07	49.96	2.6
			3	0484	1.26085	1.24004	0.02081	-.00336	.01745	5.27	44.49	1.3
			4	0485	1.26252	1.24365	0.01887	-.00336	.01551	4.69	39.80	.81
			5	0486	1.25135	1.23875	0.01260	-.00336	.00924	2.79	37.01	.42
			Back-up	0013	3.91925	3.79781	0.12144	+.00100	.12244	37.01	-	
									.33086			

TABLE C-32. PARTICLE SIZE DISTRIBUTION, DAY 7

OUTAGAMIE COUNTY

Date	Sierra No.	Location	Stage	Filter No.	Final Wt (g)	Tare Wt (g)	Difference (g)	Blank Correction (g)	Net Wt (%)	Stages Wt (%)	1-5 + Filter Cum Wt (%)	Cut-off size (μm)
8/10	8473	1	1	0507	1.54739	1.23630	0.31109	- .00336	.30773	39.34	60.66	6.4
			2	0508	1.39642	1.24648	0.14994	- .00336	.14658	18.74	41.92	2.7
			3	0509	1.28810	1.23279	0.05531	- .00336	.05195	6.64	35.28	1.3
			4	0510	1.26870	1.22990	0.03880	- .00336	.03544	4.53	30.75	.85
			5	0511	1.26835	1.23570	0.03265	- .00336	.02929	3.74	27.00	.44
			Back-up	0026	3.88874	3.67850	0.21024	+ .00100	.21124	27.00	-	
									.78223			
8/10	8372	2	1	0502	1.52618	1.23264	0.29354	- .00336	.29018	41.56	58.44	6.4
			2	0503	1.37113	1.23414	0.13699	- .00336	.13363	19.14	39.30	2.7
			3	0504	1.29095	1.23829	0.05266	- .00336	.04930	7.06	32.23	1.3
			4	0505	1.26977	1.23470	0.03507	- .00336	.03171	4.54	27.69	.85
			5	0506	1.26689	1.23793	0.02896	- .00336	.02560	3.67	24.03	.44
			Back-up	0027	3.82422	3.65748	0.16674	+ .00100	.16774	24.03	-	
									.69816			
8/10	8421	3	1	0497	1.25305	1.23375	0.01930	- .00336	.01594	21.85	78.15	6.2
			2	0498	1.25719	1.24528	0.01191	- .00336	.00855	11.72	66.43	2.6
			3	0499	1.24917	1.24165	0.00752	- .00336	.00416	5.70	60.73	1.3
			4	0500	1.23960	1.23422	0.00538	- .00336	.00202	2.77	57.96	.81
			5	0501	1.22605	1.22303	0.00302	- .00336	- .00304	- 4.17	62.12	.42
			Back-up	0028	3.73563	3.69131	0.04432	+ .00100	.04532	62.12	-	
									.07295			

TABLE C-33. PARTICLE SIZE DISTRIBUTION, DAY 1

BALTIMORE COUNTY

Date	Hi-Vol No.	Location	Sierra No.	Stage	Filter No.	Final Weight (g)	Tare Weight (g)	Difference (g)	Blank Correction (g)	Net Weight (g)	Stages (wt %)	Cumulative (wt %)	Cut-off (μm)
3/4	8503	1	8421	1	S-1	1.29934	1.27273	0.02661	+0.00112	0.02773	7.09	92.91	6.9
				2	S-2	1.31105	1.28930	0.02175		0.02287	5.84	87.07	2.7
				3	S-3	1.31015	1.29792	0.01223		0.01335	3.41	83.66	1.3
				4	S-4	1.31207	1.29781	0.01426		0.01538	3.93	79.73	0.85
				5	S-5	1.30510	1.30125	0.00385		0.00497	1.27	78.46	0.44
				Back Up	H-1	4.60515	4.29711	0.30804	-0.00106	0.30698	78.46	---	
										Σ0.39128			
3/7	8595	3	8372	1	S-11	1.55118	1.30046	0.25072	+0.00112	0.25184	24.90	78.70	6.9
				2	S-12	1.34841	1.31197	0.03644		0.03756	3.58	75.12	2.7
				3	S-13	1.34615	1.32365	0.02250		0.02362	2.25	72.87	1.3
				4	S-14	1.35899	1.33211	0.02688		0.02800	2.67	70.20	0.85
				5	S-15	1.32652	1.29933	0.02719		0.02831	2.70	67.50	0.44
				Back Up	H-2	5.03591	4.32659	0.70932	-0.00106	0.70826	67.50	---	
										Σ1.04928			
3/7	0009	4	8473	1	S-6	1.76979	1.36206	0.40773	+0.00112	0.40885	23.36	76.64	6.9
				2	S-7	1.44114	1.33953	0.10161		0.10273	5.87	70.77	2.7
				3	S-8	1.37327	1.32743	0.04584		0.04696	2.68	68.09	1.3
				4	S-9	1.38526	1.33657	0.04869		0.04981	2.85	65.24	0.85
				5	S-10	1.36299	1.30766	0.05533		0.05645	3.23	62.01	0.44
				Back up	H-3	5.38743	4.30109	1.08634	-0.00106	1.08528	62.01		
										Σ1.75008			

TABLE C-34. PARTICLE SIZE DISTRIBUTION, DAY 2

Date	Hi-Vol No.	Location	Sierra No.	Stage	Filter No.	Final Weight (g)	Tare Weight (g)	Difference (g)	Blank Correction (g)	Net Weight (g)	Stages (wt %)	Cumulative (wt %)	Cut-off (μm)
3/8	8503	1	8473	1	S-26	1.49405	1.29736	0.19669	+0.00112	0.19781	49.41	50.59	6.9
				2	S-27	1.32797	1.30049	0.02748		0.02860	7.14	43.45	2.7
				3	S-28	1.32164	1.30312	0.01852		0.01964	4.91	38.54	1.3
				4	S-29	1.31619	1.29708	0.01911		0.02023	5.05	33.49	0.85
				5	S-30	1.36859	1.35095	0.01764		0.01876	4.69	28.80	0.44
				Back Up	H-23	4.09617	3.97979	0.11638	-0.00106	0.11532	28.80		
										Σ0.40036			
3/8	8595	3	8421	1	S-16	1.36941	1.29024	0.07917	+0.00112	0.08029	15.28	84.72	6.9
				2	S-17	1.32723	1.29883	0.02840		0.02952	5.62	79.10	2.7
				3	S-18	1.31632	1.29471	0.02161		0.02273	4.33	74.77	1.3
				4	S-19	1.31304	1.28852	0.02452		0.02564	4.88	69.89	0.85
				5	S-20	1.32783	1.29719	0.03064		0.03176	6.04	63.85	0.44
				Back Up	H-22	4.31975	3.98322	0.33652	-0.00106	0.33546	63.85		
										Σ0.52540			
3/8	0009	4	8372	1	S-21	1.30175	1.29732	0.00443	+0.00112	0.00555	2.56	97.43	6.9
				2	S-22	1.30197	1.29788	0.00409		0.00521	2.41	95.02	2.7
				3	S-23	1.30626	1.30408	0.00218		0.00330	1.52	93.50	1.3
				4	S-24	1.32158	1.32047	0.00111		0.00223	1.03	92.47	0.85
				5	S-25	1.32814	1.32711	0.00103		0.00215	0.99	91.48	0.44
				Back Up	H-21	4.17132	3.97226	0.19906	-0.00106	0.19800	91.48		
										Σ0.21644			

TABLE C-35. PARTICLE SIZE DISTRIBUTION, DAY 3

BALTIMORE COUNTY

Date	Hi-Vol No.	Location	Sierra No.	Stage	Filter No.	Final Weight (g)	Tare Weight (g)	Difference (g)	Blank Correction (g)	Net Weight (g)	Stages (wt %)	Cumulative (wt %)	Cut-off (µm)
4/5	8597	1	8473	1	S-41	1.34016	1.26216	0.07800	+0.00112	0.07912	7.03	92.97	6.9
				2	S-42	1.36100	1.27250	0.08850		0.08962	7.96	85.01	2.7
				3	S-43	1.38938	1.35095	0.03843		0.03955	3.51	81.50	1.3
				4	S-44	1.47442	1.33766	0.13676		0.13788	12.25	69.25	0.85
				5	S-45	1.54055	1.35173	0.18882		0.18994	16.87	52.38	0.44
				Back Up	H-24	4.58448	3.99377	0.59071	-0.00106	0.58965	52.38		
										Σ1.12576			
4/5	8595	3	8421	1	S-31	1.27751	1.27168	0.00583	+0.00112	0.00695	0.48	99.52	6.9
				2	S-32	1.27836	1.27401	0.00435		0.00547	0.38	99.14	2.7
				3	S-33	1.28377	1.27728	0.00649		0.00761	0.53	98.61	1.3
				4	S-34	1.34957	1.33920	0.01037		0.01149	0.80	97.81	0.85
				5	S-35	1.35126	1.34356	0.00770		0.88200	61.13	36.68	0.44
				Back Up	H-28	4.51137	3.98107	0.53030	-0.00106	0.52924	36.68		
										Σ1.44276			
4/5	0009	4	8372	1	S-36	1.52663	1.33600	0.19063	+0.00112	0.19175	9.65	90.34	6.9
				2	S-37	1.44319	1.34309	0.10010		0.10122	5.09	85.25	2.7
				3	S-38	1.31398	1.27378	0.04020		0.04132	2.08	83.17	1.3
				4	S-39	1.33121	1.28192	0.04929		0.05041	2.54	80.63	0.85
				5	S-40	1.32381	1.27440	0.04941		0.05053	2.54	78.09	0.44
				Back Up	H-25	5.55731	4.00461	1.55270	-0.00106	1.55164	78.09		
										Σ1.98687			

TABLE C-36. PARTICLE SIZE DISTRIBUTION, DAY 4

Date	Hi-Vol No.	Location	Sierra No.	Stage	Filter No.	Final Weight (g)	Tare Weight (g)	Difference (g)	Blank Correction (g)	Net Weight (g)	Stages (wt %)	Cumulative (wt %)	Cut-off (m)
4/6	8597	1	8473	1	S-51	1.27820	1.27404	0.00416	+0.00112	0.00528	4.58	95.42	6.9
				2	S-46	1.35358	1.34848	0.00510		0.00622	5.39	90.03	2.7
				3	S-47	1.41407	1.41147	0.00260		0.00372	3.22	86.81	1.3
				4	S-49	1.27720	1.27456	0.00264		0.00376	3.26	83.55	0.85
				5	S-50	1.40861	1.40646	0.00215		0.00327	2.83	80.72	0.44
				Back Up	H-10	4.12216	4.02795	0.09421	-0.00106	0.09315	80.72		
										0.11540			
4/6	8595	3	8421	1	S-62	1.38538	1.32132	0.06406	+0.00112	0.06518	16.35	83.94	6.9
				2	S-53	1.34969	1.33536	0.01433		0.01545	3.88	80.06	2.7
				3	S-54	1.36459	1.35287	0.01172		0.01284	3.22	76.84	1.3
				4	S-55	1.42555	1.41153	0.01402		0.01514	3.80	73.04	0.85
				5	S-56	1.28354	1.27129	0.01225		0.01337	3.35	69.39	0.44
				Back Up	H-20	4.23112	3.95357	0.27755	-0.00106	0.27649	69.39		
										0.39847			
4/6	0009	4	8372	1	S-57	1.50082	1.27107	0.22975	+0.00112	0.23087	14.71	85.29	6.9
				2	S-58	1.34168	1.27621	0.06547		0.06659	4.24	81.05	2.7
				3	S-59	1.33730	1.30266	0.03464		0.03576	2.28	78.77	1.3
				4*	S-60	1.37683	1.33302	0.04381		0.44930	28.63	50.14	0.85
				5	S-61	1.35651	1.31894	0.03757		0.03869	2.47	47.67	0.44
				Back Up	H-30	4.77258	4.02342	0.74914	-0.00106	0.74808	47.67		
										1.56929			

TABLE C-37. CONCENTRATION WITHIN ALVEOLAR DEPOSITION RANGE

		OUTAGAMIE COUNTY					BALTIMORE COUNTY						
Test Day	Location	High Level of %	Low Level of %	Total (%)	Concentration mg/Nm³	Concentration Within Range mg/Nm³	Location	High Level of %	Low Level of %	Total (%)	Concentration mg/Nm³	Concentration Within Range mg/Nm³	
1	E1 Wet	36	20	16	4.315	.6904	E1	86	56	30	2.465	.7395	System Off
	E2 Wet	48	32	16	4.863	.7781	E3	99	56	43	0.784	.3371	System Off
	E3 Wet	66	43	23	0.703	.1617	E4	88	79	9	2.267	.2040	System Off
2	E1 Dry	52	25	27	2.560	.6912	E1	91	81	10	0.324	.0324	System Off
	E2 Dry	51	25	26	2.168	.5637	E3	81	70	11	1.181	.1299	System Off
	E3 Dry	58	41	17	3.192	.5426	E4	82	48	34	0.201	.0683	System Off
3	E1 Wet	41	26	15	5.208	.7812	E1	88	78	10	3.876	.3876	System On
	E2 Wet	44	21	23	3.847	.8848	E3	76	68	8	1.073	.0858	System On
	E3 Wet	68	49	18	0.537	.0967	E4	71	62	9	5.332	.4799	System On
4	E1 Dry	55	31	24	1.916	.4598	E1	44	29	15	0.050	.0075	System On
	E2 Dry	55	27	28	2.739	.7669	E3	80	64	16	1.175	.1880	System On
	E3 Dry	87	72	15	1.221	.1832	E4	95	92	3	3.661	.1098	System On

TABLE C-38. EMISSION CONCENTRATION OF TRACE METALS ($\mu g/Nm^3$)

OUTAGAMIE COUNTY

Test	Date	Filter No.	Location	Antimony TLV[a] 500	Arsenic TLV 500	Barium TLV 500	Beryllium TLV 2.00	Cadmium 100 TLV 40	Chromium TLV 500	Copper TLV 1000	Lead TLV 150
1	8/2	365	E1	0.066	0.054	2.108	0.007	0.03738	3.5616	0.777	3.3348
		371	E2	0.077	0.053	1.431	0.0015	0.03185	6.468	1.1123	2.9498
		372	E3	0.016	0.013	0.387	< 0.00007	0.01372	2.002	0.6685	2.156
2	8/3	368	E1	0.053	0.033	0.642	0.0005	0.03822	0.2938	0.5824	1.118
		367	E2	0.080	0.037	0.823	0.0011	0.04202	0.3828	0.8052	1.3486
		366	E3	0.024	0.010	1.050	0.00032	0.02272	4.000	1.0112	0.6688
		2136	E4	0.302	0.068	2.907	0.01275	0.08619	0.5916	0.8313	3.6159
3	8/4	0001	E1	2.244	0.053	3.073	0.01248	0.09412	6.188	1.5808	7.8
		0002	E2	0.827	0.044	2.052	0.00456	0.10488	6.232	1.3870	5.7
		0003	E3	0.033	0.007	0.145	< 0.00006	0.02556	6.300	1.6320	1.644
		0014	E4	2.187	0.072	3.127	0.0091	0.1183	4.3615	1.7875	8.645
4	8/5	0015	E1	0.099	0.017	0.692	0.00095	0.06593	4.94	0.6821	6.441
		0016	E2	0.110	0.024	1.048	0.00135	0.06939	6.48	1.0071	17.995
		0017	E3	0.034	0.031	0.320	0.00017	0.04476	5.04	1.224	1.476
		0021	E4	0.385	0.035	2.184	0.00315	0.13545	2.7056	1.3195	10.570

[a] Note: TLV from American Conference of Governmental and Industrial Hygienists.

TABLE C-39. EMISSION CONCENTRATION OF TRACE METALS
($\mu g/Nm^3$)

OUTAGAMIE COUNTY

Test	Date	Filter No.	Sampling Site	Location	Mercury TLV[a] 50.0	Selenium TLV 200.0	Silver TLV 10.0	Titanium	Vanadium TLV 100	Zinc TLV 5000.0
1	8/2	365	Shredder	E1	0.009	0.005	0.013	1.340	0.168	5.712
		371	Conveyors	E2	0.010	0.005	0.009	0.784	0.098	4.743
		372	Magnetic Separator	E3	0.003	< 0.004	0.001	0.183	0.012	1.715
2	8/3	368	Shredder	E1	0.006	< 0.008	0.011	0.281	0.039	2.270
		367	Conveyors	E2	0.008	< 0.009	0.002	0.733	0.032	3.212
		366	Magnetic Separator	E3	0.007	< 0.006	0.005	0.538	0.023	6.720
		2136	Tipping Floor	E4	0.023	0.006	0.036	0.862	0.158	5.508
3	8/4	0001	Shredder	E1	0.015	0.005	0.016	1.019	0.296	7.228
		0002	Conveyors	E2	0.017	0.007	0.013	0.817	0.106	5.624
		0003	Magnetic Separator	E3	0.002	0.002	0.001	0.571	0.015	2.226
		0004	Tipping Floor	E4	0.019	0.005	0.014	0.196	0.247	7.670
4	8/5	0015	Shredder	E1	0.009	0.005	0.007	0.190	0.068	4.256
		0016	Conveyors	E2	0.015	< 0.005	0.013	0.824	0.032	7.884
		0017	Magnetic Separator	E3	0.003	< 0.002	0.005	0.631	0.014	3.384
		0021	Tipping Floor	E4	0.037	0.004	0.008	0.952	0.105	5.810

[a] Note: TLV from American Conference of Governmental and Industrial Hygienists.

TABLE C-40. EMISSION CONCENTRATION OF TRACE METALS ($\mu g/Nm^3$)

BALTIMORE COUNTY

Test	Date	Sampling Site	Location	Filter No.	Barium 500	Cadmium 100	Chromium 500	Copper 1,000	Lead 150	Zinc 5,000
1	3/7	Magnetic Separator	E1	H-7	0.320	0.009	0.468	0.370	1.405	1.726
		Process Building	E2	H-4	0.713	0.030	1.885	0.782	1.472	2.046
		Tipping Floor	E3	H-6	0.541	0.006	0.227	0.486	0.650	1.019
		Shredder	E4	H-5	1.813	0.059	1.360	1.903	3.173	3.015
2	3/8	Magnetic Separator	E1	H-19	*	*	*	*	*	*
		Process Building	E2	H-18	0.063	<0.009	0.439	0.287	0.537	0.654
		Tipping Floor	E3	H-15	1.417	0.012	0.378	0.461	2.598	1.027
		Shredder	E4	H-17	*	*	*	*	*	*
3	4/5	Magnetic Separator	E1	H-26	0.736	0.021	0.659	0.659	3.450	3.450
		Process Building	E2	H-11	1.749	0.043	13.404	1.282	5.245	3.439
		Tipping Floor	E3	H-13	0.386	0.026	0.246	0.546	0.952	1.284
		Shredder	E4	H-27	1.066	0.022	0.746	0.960	3.946	3.732
4	4/6	Magnetic Separator	E1	H-32	*	*	*	*	*	*
		Process Building	E2	H-8	0.550	0.010	0.203	0.203	2.373	1.204
		Tipping Floor	E3	H-29	0.306	0.095	1.081	1.504	1.340	1.739
		Shredder	E4	H-31	0.879	0.030	2.966	0.586	2.709	3.076

* Weight less than twice the variation of filter blank sections.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/2-80-007b		

4. TITLE AND SUBTITLE	5. REPORT DATE
PROCESSING EQUIPMENT FOR RESOURCE RECOVERY SYSTEMS Volume II. Magnetic Separators, Air Classifier and Ambient Air Emissions Tests	July 1980 (Issuing Date) 6. PERFORMING ORGANIZATION CODE 4213D
7. AUTHOR(S) B. W. Simister and David Bendersky	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Midwest Research Institute 423 Volker Boulevard Kansas City, Missouri 64110	10. PROGRAM ELEMENT NO. 1NE624E624DW COS Wastes as Fuels Task 5.1 11. CONTRACT/GRANT NO. 68-03-2387
12. SPONSORING AGENCY NAME AND ADDRESS Municipal Environmental Research Laboratory-Cin., OH. Office of Research & Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268	13. TYPE OF REPORT AND PERIOD COVERED Final - Vol. II of III 14. SPONSORING AGENCY CODE EPA/600/14

15. SUPPLEMENTARY NOTES

See also Volume I (EPA-600/2-80-007a) and Volume III (EPA-600/2-80-007c)
Project Officer: Donald A. Oberacker 513/684-7881

16. ABSTRACT

This report presents the results of a study of equipment and sytems for processing municipal solid wastes into energy related products. The study was divided into three phases. The first phase was devoted to a study of the state of the art and formulation of the research needs. The second phase was devoted to field tests of magnetic separators, air classifier and air emissions. The third phase is involved with field tests of shredders.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Materials recovery Refuse Refuse disposal Processing Shredders Solid Waste Magnetic separators Air classifiers	Particulates Air emissions Waste as energy	13B 68

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release to public	unclassified	170
	20. SECURITY CLASS *(This page)* unclassified	22. PRICE

EPA Form 2220-1 (9-73)

☆ U.S. GOVERNMENT PRINTING OFFICE:1980--657-165/0100